APPENDIX D - REFERENCE CONDITIONS AND TARGET VALUE RATIONALE

D.1 Reference Conditions and Data Sources

DEQ uses the reference condition to evaluate compliance with many of the narrative WQS. The term “reference condition” is defined as the condition of a water body capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, reference condition reflects a water body’s greatest potential for water quality given historic land use activities.

DEQ applies the reference condition approach for making beneficial use-support determinations for certain pollutants (such as sediment) that have specific narrative standards. All classes of waters are subject to the provision that there can be no increase above naturally occurring concentrations of sediment and settleable solids, oils, or floating solids sufficient to create a nuisance or render the water harmful, detrimental, or injurious. These levels depend on site-specific factors, so the reference conditions approach is used.

Also, Montana WQS do not contain specific provisions addressing nutrients (nitrogen and phosphorous), or detrimental modifications of habitat or flow. However, these factors are known to adversely affect beneficial uses under certain conditions or combination of conditions. The reference conditions approach is used to determine if beneficial uses are supported when nutrients, flow, or habitat modifications are present.

Water bodies used to determine reference condition are not necessarily pristine or perfectly suited to giving the best possible support to all possible beneficial uses. Reference condition also does not reflect an effort to turn the clock back to conditions that may have existed before human settlement, but is intended to accommodate natural variations in biological communities, water chemistry, etc. due to climate, bedrock, soils, hydrology, and other natural physiochemical differences. The intention is to differentiate between natural conditions and widespread or significant alterations of biology, chemistry, or hydrogeomorphology due to human activity. Therefore, reference conditions should reflect minimum impacts from human activities. It attempts to identify the potential condition that could be attained (given historical land use) by the application of reasonable land, soil, and water conservation practices. DEQ realizes that presettlement water quality conditions usually are not attainable.

Comparison of conditions in a water body to reference water body conditions must be made during similar season and/or hydrologic conditions for both waters. For example, the Total Suspended Solids (TSS) of a stream at base flow during the summer should not be compared to the TSS of reference condition that would occur during a runoff event in the spring. In addition, a comparison should not be made to the lowest or highest TSS values of a reference site, which represent the outer boundaries of reference conditions.

The following methods may be used to determine reference conditions:

Primary Approach

- Comparing conditions in a water body to baseline data from minimally impaired water bodies that are in a nearby watershed or in the same region having similar geology, hydrology, morphology, and/or riparian habitat.
- Evaluating historical data relating to condition of the water body in the past.

- Comparing conditions in a water body to conditions in another portion of the same water body, such as an unimpaired segment of the same stream.

Secondary Approach

- Reviewing literature (e.g. a review of studies of fish populations, etc., that were conducted on similar water bodies that are least impaired.
- Seeking expert opinion (e.g. expert opinion from a regional fisheries biologist who has a good understanding of the water body's fisheries health or potential).
- Applying quantitative modeling (e.g. applying sediment transport models to determine how much sediment is entering a stream based on land use information, etc.).

DEQ uses the primary approach for determining reference condition if adequate regional reference data are available and uses the secondary approach to estimate reference condition when there is no regional data. DEQ often uses more than one approach to determine reference condition, especially when regional reference condition data are sparse or nonexistent.

Two main sources of data served as information for "reference conditions" in the LCF TPA. Target values for the parameters of interest were based on unpublished data from USFS PIBO data collected throughout the Kootenai and Lolo National Forests, and from data collected during the 2008 DEQ Lower Clark Fork sediment/habitat field study.

United States Forest Service Pacfish/Infish Biological Opinion (PIBO) data (2009) was reviewed for assistance in developing target values for width to depth ratios, percent fines less than 2mm and 6mm, pool frequency, and large woody debris frequency. PIBO data was specifically selected to include data from throughout the Cabinet and Plains-Thompson Falls Forest Districts, within the Kootenai and Lolo National Forests – both of which are partially within the Lower Clark Fork TPA.

2008 DEQ field data was used for the development of all parameter values. Data from the DEQ field effort was collected on listed and non-listed streams throughout the Lower Clark Fork TPA.

2008 DEQ data was categorized by the reach results based on the stream stratification procedure. No true "reference" reaches were identified through the stream stratification procedure; however, in the sampling analysis design for the 2008 field data study, sites were chosen to represent the variability among reach type categories and stratification parameters. Although few if any of the reaches represent full application of all reasonable land, soil, and water conservation practices, some reaches were sampled that reflected some of the healthiest reaches in the study area where negative impacts from land use activities were most limited.

D.2 Use of Statistics for Developing Reference Values or Ranges

Reference value development must consider natural variability as well as variability that can occur as part of field measurement techniques. Statistical approaches are commonly used to help incorporate variability. One statistical approach is to compare stream conditions to the mean (average) value of a reference data set to see if the stream condition compares favorably to this value or falls within the range of one standard deviation around the reference mean. The use of these statistical values assumes a normal distribution; whereas, water resources data tend to have a non-normal distribution (Helsel and Hirsch 1995). For this reason, another approach is to compare stream conditions to the median value of a reference data set to see if the stream condition compares favorably to this value or falls within the range defined by the 25th and 75th percentiles of the reference data. This is a more realistic approach than using one standard deviation since water quality data often include observations considerably higher or lower than most of the data. Very high and low observations can have a misleading impact on the statistical summaries if a normal distribution is incorrectly assumed, whereas statistics based on non-normal distributions are far less influenced by such observations.

Figure D-1 is an example boxplot type presentation of the median, 25th and 75th percentiles, and minimum and maximum values of a reference data set. In this example, the reference stream results are stratified by two different stream types. Typical stratifications for reference stream data may include Rosgen stream types, stream size ranges, or geology. If the parameter being measured is one where low values are undesirable and can cause harm to aquatic life, then measured values in the potentially impaired stream that fall below the 25th percentile of reference data are not desirable and can be used to indicate impairment. If the parameter being measured is one where high values are undesirable, then measured values above the 75th percentile can be used to indicate impairment.

The use of a non-parametric statistical distribution for interpreting narrative WQS or developing numeric criteria is consistent with EPA guidance for determining nutrient criteria (EPA 2000). Furthermore, the selection of the applicable 25th or 75th percentile values from a reference data set is consistent with ongoing DEQ guidance development for interpreting narrative WQS where it is determined that there is “good” confidence in the quality of the reference sites and resulting information (DEQ 2004). If it is determined that there is only a “fair” confidence in the quality of the reference sites, then the 50th percentile or median value should be used, and if it is determined that there is “very high” confidence, then the 90th percentile of the reference data set should be used. Most reference data sets available for water quality restoration planning and related TMDL development, particularly those dealing with sediment and habitat alterations, would tend to be “fair” to “good” quality. This is primarily due to a the limited number of available reference sites/data points available after applying all potentially applicable stratifications on the data, inherent variations in monitoring results among field crews, the potential for variations in field methodologies, and natural yearly variations in stream systems often not accounted for in the data set.

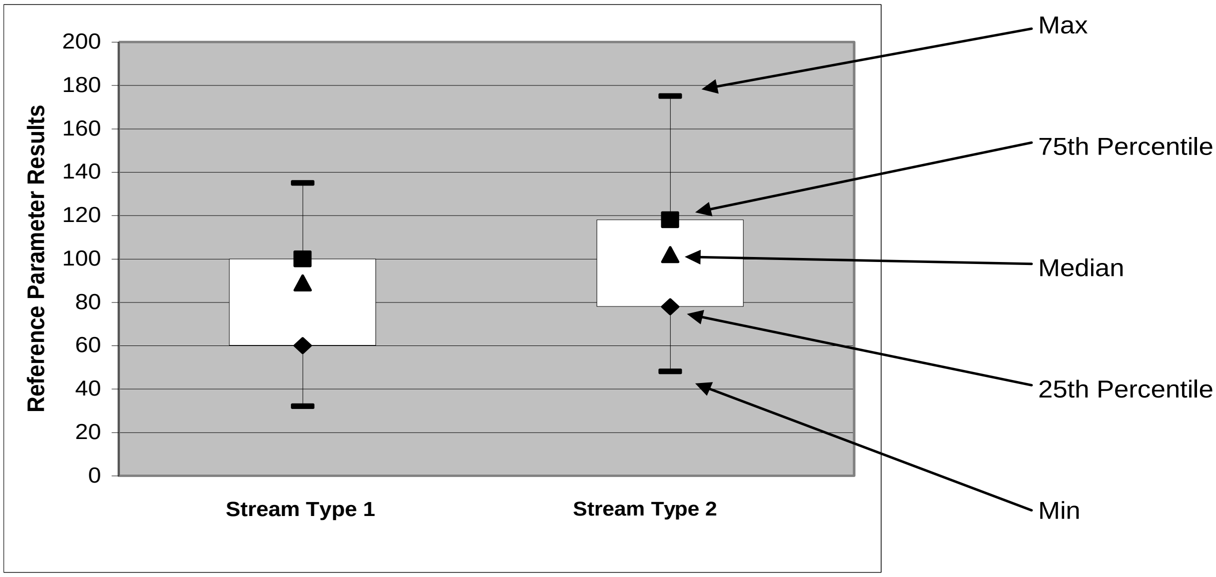

Figure D-1. Boxplot Example for Reference Data.

The above 25th – 75th percentile statistical approach has several considerations:

1. It is a simple approach that is easy to apply and understand.
2. About 25 percent of all streams would naturally fall into the impairment range. Thus, it should not be applied unless there is some linkage to human activities that could lead to the observed conditions. Where applied, it must be noted that the stream's potential may prevent it from achieving the reference range as part of an adaptive management plan.
3. About 25 percent of all streams would naturally have a greater water quality potential than the minimum water quality bar represented by the 25th to 75th percentile range. This may represent a condition where the stream's potential has been significantly underestimated. Adaptive management can also account for these considerations.
4. Obtaining reference data that represents a naturally occurring condition can be difficult, particularly for larger water bodies with multiple land uses within the drainage. This is because all reasonable land, soil, and water conservation practices may not be in place in many larger water bodies across the region. Even if these practices are in place, the proposed reference stream may not have fully recovered from past activities, such as riparian harvest, where reasonable land, soil, and water conservation practices were not applied.
5. A stream should not be considered impaired unless there is a relationship between the parameter of concern and the beneficial use such that not meeting the reference range is likely to cause harm or other negative impacts to the beneficial use as described by the WQS in **Table D-2**. In other words, if not meeting the reference range is not expected to negatively impact aquatic life, cold water fish, or other beneficial uses, then an impairment determination should not be made based on the particular parameter being evaluated. Relationships that show an impact to the beneficial use can be used to justify impairment based on the above statistical approach.

As identified in (2) and (3) above, there are two types of errors that can occur due to this or similar statistical approaches where a reference range or reference value is developed: (1) A stream could be considered impaired even though the naturally occurring condition for that stream parameter does not meet the desired reference range or (2) a stream could be considered not impaired for the parameter(s) of concern because the results for a given parameter fall just within the reference range, whereas the naturally occurring condition for that stream parameter represents much higher water quality and beneficial uses could still be negatively impacted. The implications of making either of these errors can be used to modify the above approach, although the approach used will need to be protective of water quality to be consistent with DEQ guidance and WQS (DEQ 2004). Either way, adaptive management is applied to this water quality plan and associated TMDL development to help address the above considerations.

Where the data does suggest a normal distribution, or reference data is presented in a way that precludes use of non-normal statistics, the above approach can be modified to include the mean plus or minus one standard deviation to provide a similar reference range with all of the same considerations defined above.

Options When Regional Reference Data is Limited or Does Not Exist

In some cases, there is very limited reference data and applying a statistical approach like above is not possible. Under these conditions, the limited information can be used to develop a reference value or range, with the need to note the greater level of uncertainty and perhaps a greater level of future monitoring as part of the adaptive management approach. These conditions can also lead to more reliance on secondary type approaches for reference development.

Another approach would be to develop statistics for a given parameter from all streams within a watershed or region of interest (EPA 2000). The boxplot distribution of all the data for a given parameter can still be used to help determine potential target values knowing that most or all of the streams being evaluated are either impaired or otherwise have a reasonable probability of having significant water quality impacts. Under these conditions you would still use the median and the 25th or 75th percentiles as potential target values, but you would use the 25th and 75th percentiles in a way that is opposite from how you use the results from a regional reference distribution. This is because you are assuming that, for the parameter being evaluated, as many as 50 percent to 75 percent of the results from the whole data distribution represent questionable water quality. **Figure D-2** is an example statistical distribution where higher values represent better water quality. In **Figure D-2**, the median and 25th percentiles represent potential target values versus the median and 75th percentiles discussed above for regional reference distribution. Whether you use the median, the 25th percentile, or both should be based on an assessment of how impacted all the measured streams are in the watershed. Additional consideration of target achievability is important when using this approach. Also, there may be a need to also rely on secondary reference development methods to modify how you apply the target and/or to modify the final target value(s). Your certainty regarding indications of impairment or non-impairment may be lower using this approach, and you may need to rely more on adaptive management as part of TMDL implementation.

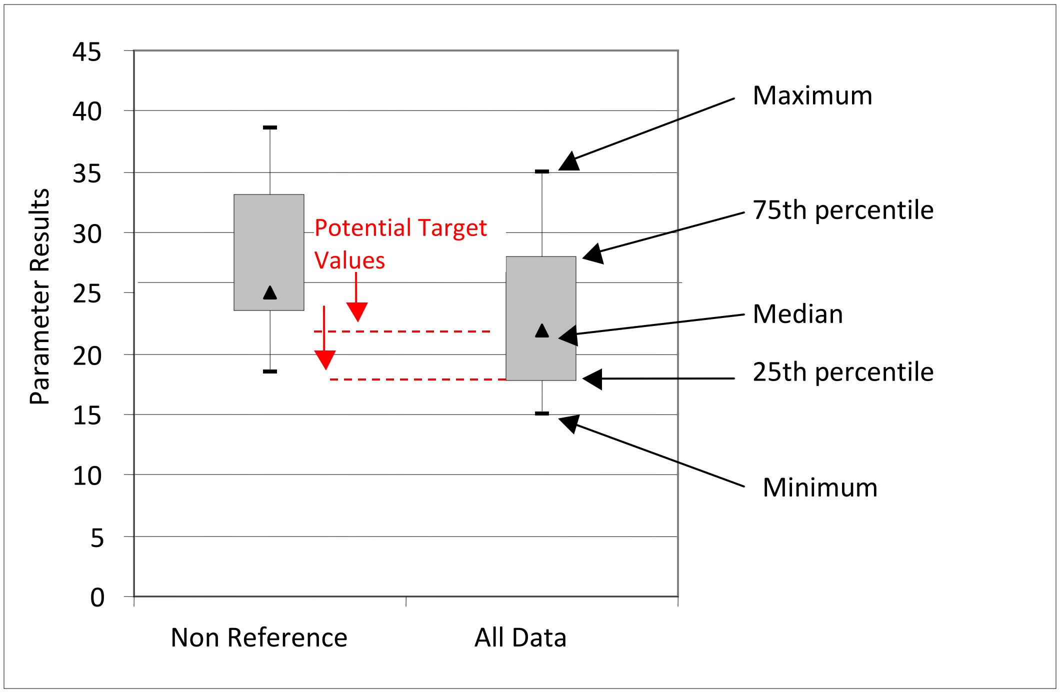

Figure D-2. Boxplot example for the use of all data to set targets.

D.3 Statistical Application and Target Development in the Lower Clark Fork

Target values are often presented for a range of values based on stream size, parent geology, or other significant factors that influence stream function and response. For instance, depending on the setting, sediment and habitat conditions in a 5th order stream may vary considerably from those in a 2nd order stream and therefore assessing the respective condition of each against the same target values would be inappropriate for some target values. In the Lower Clark Fork TPA, (with the exception of the Bull River) given the similar stream sizes, geographic setting, and response to influencing factors in all the streams assessed, as well as similarity in geographic setting to streams used within the PIBO comparison, data was sorted and analyzed based on stream gradient and level IV ecoregion. Bull River data was not included in the target setting data analysis due to the significant difference in stream size and character from the rest of the reaches investigated during the 2008 field session, and therefore would skew statistics. Applicable target values specific to the Bull River are discussed below in **Section D.4**.

In general, targets were developed for two categories for the purposes of this TMDL; those targets that are applicable to high gradient stream segments, also referred to as "transport reaches" (streams with a slope greater than 2%), and targets that are applicable to low gradient stream segments, or depositional reaches (slope less than 2%). Although USFS and DEQ employed two somewhat different methodologies for classifying the reaches and grouping the corresponding data, the methods used to collect data, the criteria for the reach classifications and the relationship to slope allow for some comparison. For additional applicability across methods and stream understanding, the two stream categories identified for this target setting can be described further: Rosgen A, B, and G reaches are classified with slopes >2% and thus qualify as high gradient reaches; Rosgen C and F reaches have slopes <2%, and apply to low gradient reaches. Rosgen E reaches, which are also characterized by slopes <2%, may not be comparable however due to the inherently higher fines and sediment storage that is typically associated with these reach types. The exception to this approach was used in the development of the Residual Pool Depth targets which were based on bankfull width rather than gradient, and in the development of Bull River targets which, due to a smaller local data set and different character from the other Lower Clark Fork tributaries investigated warranted exclusion from the water quality targets presented here.

As described above, the use of median and percentiles in statistical analysis is often employed when data, such as water quality data, tend to have a non-normal distribution. Also, limited amounts of data can sometimes lead to skewed results if using normal distribution statistics. For these reasons, it is more appropriate to use non-normal or non-parametric statistics for setting reference conditions and determining target values for most parameters.

If parameters are used where lower numbers represent better water quality conditions, then typically the 75th percentile of the reference data set is often the reference value used as a potential target value because values greater than the 75th percentile are beyond the range of expected variability. If the opposite were true, then the 25th percentile would apply. Where there is less confidence in the data to represent “reference” conditions, the 50th percentile or median value can be used, such as when a total data set incorporates both reference and non-reference conditions.

Since no true “reference sites” were identified when developing target values, generally the median (50th percentile) of the total population of the DEQ and USFS data sets were reviewed and a target value was determined based on a comparison between the data sets, best professional judgment, and relation to commonly accepted literature values. For comparison, the 25th or 75th percentile of the total population was also included (dependent on which percentile represented “best” conditions). Including this number provides some insight into what may be the most desirable of the values that may be achievable. Twenty two sites were assessed during the 2008 DEQ field study, 16 sites qualified as “Low Gradient” or “depositional” reaches, and 6 sites qualified as “High Gradient” or “transitional” reaches. The PIBO data set provided an additional 31 low gradient sites, and 15 high gradient sites.

The use of a non-parametric statistical distribution for interpreting narrative water quality standards or developing numeric criteria is consistent with EPA guidance for determining ‘water quality’ criteria (EPA, 2000). Therefore, the selection of the applicable statistics from a data set is consistent with ongoing MDEQ and EPA guidance development for interpreting narrative water quality standards.

Information and rationale used to derive target values follows below. Target parameter description and rationale for inclusion is presented in **Section 5.4**.

D.3.1 WIDTH DEPTH RATIO

Table D-1. Width Depth Ratio

	High Gradient (>2%) ***Rosgen A, B, G***	**Low Gradient (<2%)** ***Rosgen C, F***
Median – DEQ all reaches	19.0	24.2
Median – USFS PIBO all reaches	18.9	24.9
25th percentile – DEQ all reaches	13.5	19.1
25th percentile – USFS PIBO all reaches	16.7	20.3
Target Value	**≤20**	**≤25**

Delineative criteria based on Rosgen stream type classification for width to depth ratios gives guidance of <12 for A and G stream types, and >12 for B and C stream types. The high gradient category incorporates A, B and G Rosgen stream types, however the data set does not include any reaches greater than 4% as reaches with such a steep gradient are generally located in headwater areas where human impacts are limited, and field sampling is impractical. Therefore, the targets for high gradient reaches are more focused on B reaches, but incorporate A reaches. Based on analysis of the data, width/depth ratios of <20 under most circumstances should represent stable channel conditions for high gradient streams.

Similarly, the low gradient reach target is based on the results of C channel investigations. However, the Bull River and other streams occasionally exhibit E channel characteristics, which despite having low gradients, have a width/depth criteria of <12. For those instances where E channels occur, the width/depth value should be consistent with the Rosgen reach type criteria of <12.

D.3.2 ENTRENCHMENT

Table D-2. Entrenchment

	High Gradient (>2%) ***Rosgen B***	**Low Gradient (<2%)** ***Rosgen C,E***
Median – DEQ all reaches	3.0	5.7
75th percentile – DEQ all reaches	4.3	7.2
Target Value	**>1.4-<2.2**	**>2.2**

Delineative criteria based on Rosgen stream type classification for entrenchment gives guidance of <1.4 for A, F and G streams, 1.4-2.2 for B streams, and >2.2 for C, E streams. These literature values will serve as the target ranges for entrenchment in the Lower Clark Fork as well. The most commonly encountered high gradient reaches assessed through the DEQ field effort were Rosgen B reaches and therefore the B reach entrenchment target is presented above. In general, A stream types (gradients 4-10%) often do not occur in places where anthropogenic influence has much immediate impact on entrenchment values and therefore target comparison is most relevant to B reach types in high gradient systems. Entrenchment values >2.2 are described by Rosgen as slightly entrenched to non-entrenchment as the values increase. A target value based on Rosgen delineative criteria of >2.2 is thereby assigned for low gradient reaches, however the upper range of values should be consistent with the upper range from the data set.

D.3.3 PEBBLE COUNT - <6MM

Table D-3. Pebble Count - <6mm

	High Gradient (>2%) ***Rosgen A, B, G***	**Low Gradient (<2%)** ***Rosgen C, F***
Median – DEQ all reaches	5	10
Median – USFS PIBO all reaches	8	9
25th percentile – DEQ all reaches	4	8
25th percentile – USFS PIBO all reaches	3	3
Target Value	**<5**	**<10**

High gradient reaches are also defined within this document as "transport" reaches, or those reaches where slope and velocity are conducive to the movement of sediment through a system, rather than low gradient reaches, which tend to deposit sediment on the stream bottom. As a result, it is expected that transport reaches will have less percent surface fines than low gradient reaches. Consequently, based on the values found in the DEQ and USFS PIBO data, the values determined to be both representative of 'good' conditions under most circumstances in the Lower Clark Fork and that are protective of aquatic life and cold water fisheries are <5% for high gradient reaches, and <10% for low gradient reaches have been chosen.

It should be noted that a distinctive difference in the pebble count data between the DEQ dataset and the USFS data set exists and that the values from the two agencies presented here are only for broad comparisons, and to help with the decision making process when developing the target values. In the case of the DEQ dataset, pebble counts were conducted at riffles, using the Wolman pebble count method which randomly and systematically measures approximately 100 substrate particles across the channel. In the case of the USFS PIBO data, the available percent surface fines data were measured at pool tails, using a grid method in which particles less than 2mm and 6mm are observed and recorded if they occur beneath an intersection in the grid. The number of occurrences are then divided by the number of intersections observed (50) to derive a percent. (Percent fines in pool tails, using the grid method, was also conducted by DEQ during the 2008 field assessment, however, pool fines data was sporadic and deemed insufficient for inclusion in the analysis and comparison for these targets.) Despite the differences between the DEQ and PIBO percent fines datasets, both measures are essentially looking at the accumulation of fine sediment particles in areas of the stream most likely to be used by cold water fish for spawning. The higher the surface fines values, the greater the impact on spawning success. In the case of the Lower Clark Fork, the target values were derived mainly from the results of the DEQ riffle pebble count data, and therefore should be applied to the results from pebble counts in riffles, however the PIBO pool grid toss data is provided to allow a cursory comparison with the overall sediment conditions witnessed in Lower Clark Fork streams.

It should also be noted that this target does not apply to E channels, which typically exhibit much higher natural values of percent surface fines. Not enough data was collected specific to E channels through this study to develop a TPA specific target, therefore, percent fines in E channel reaches should be evaluated on a case by case basis.

D.3.4 Pebble Count - <2mm

Table D-4. Pebble Count - <2mm

	High Gradient (>2%) ***Rosgen A, B, G***	**Low Gradient (<2%)** ***Rosgen C, F***
Median – DEQ all reaches	2	7
Median – USFS PIBO all reaches	4	4
25th percentile – DEQ all reaches	1	5
25th percentile – USFS PIBO all reaches	0	1
Target Value	**<5**	**<5**

In this case, a value of <5% was determined to be an appropriate target value for all tributary streams based on the results from the DEQ and PIBO data sets, and the understanding that <5% is protective for fishery and aquatic life beneficial uses.

As with the pebble count target for percent fines less than 6mm, it should also be noted that this target does not apply to E channels, which typically exhibit much higher natural values of percent surface fines. Not enough data was collected specific to E channels through this study to develop a TPA specific target, therefore, percent fines in E channel reaches should be evaluated on a case by case basis.

D.3.5 Residual Pool Depth

Table D-5. Residual Pool Depth

	Bankfull Width 20-29 feet	Bankfull Width 30-39 feet	Bankfull Widths 40-49
Median – DEQ all reaches	1.1	1.5	1.7
Median – PIBO	1.0	1.6	-
75th percentile – DEQ all reaches	1.3	1.7	1.8
75th percentile - PIBO	1.2	1.7	-
Target Value	**≥1.2**	**≥1.6**	**≥1.7**

A slightly different approach was taken when developing target values for residual pool depth. In this case, because pool depths are often more a function of stream size and volume as opposed to simply using stream gradient, it was deemed appropriate to segregate sampled reaches by bankfull width, which provides an indication of general stream dimensions and power that affects pool size and quality. Three categories were broken out based on the sampled reaches; bankfull widths between 20-30', bankfull widths between 31-39', and bankfull widths 40-49'. Bankfull widths greater than 50', generally speaking, are larger than most of the tributary streams represented in the Lower Clark Fork TPA, the exception being the Bull River, and therefore would require targets for larger size streams, such as the Bull River targets as discussed in **Section 5.4.3.1**. The Bull River data was not included in this analysis – each of the three Bull River reaches had bankfull widths greater than 60 feet. In addition, of the USFS PIBO data sets, very limited data was available specific to residual pool depths and therefore was not included in the analysis here.

Target values for the bankfull width categories are presented in the above table and were determined based on review of the median and 75th percentiles of the two data sets for each bankfull width category. No PIBO data was available for Bankfull Widths greater than 39 feet. The target values are assumed to be representative of quality residual pool depths that would be found under desired conditions for most Lower Clark Fork tributaries.

D.3.6 Pool Frequency (per 1000')

Table D-6. Pool Frequency (per 1000')

	High Gradient (>2%) *Rosgen A, B, G*	Low Gradient (<2%) *Rosgen C, F*
Median – DEQ all reaches	8	9
Median – USFS PIBO all reaches	5	12
75th percentile – DEQ all reaches	14	11
75th percentile – USFS PIBO all reaches	13	17
Target Value	**>9**	**>9**

In some environments, pool frequency may vary based on gradient, geology, and other environmental factors affecting the stream (riparian health and large woody debris). Often, high gradient reaches are characterized by more numerous albeit smaller and shallower pools, than low gradient reaches. Based on the data for the Lower Clark Fork tributaries reviewed here, not much discernable difference in pool frequency between high and low gradient reaches is apparent. The median value of 9 for low gradient reaches also matches the pool frequency target for the nearby Prospect Creek TPA, and therefore a minimum of 9 pools per 1000' (47 pools per mile) is targeted for the Lower Clark Fork TPA.

D.3.7 Greenline – Percent Shrub

Table D-7. Greenline – Percent Shrub

	High Gradient (>2%) ***Rosgen A, B, G***	**Low Gradient (<2%)** ***Rosgen C, F***
Median – DEQ all reaches	91	58
75th percentile – DEQ all reaches	93	72
Target Value	**>90**	**>60**

Riparian green line is not used as a true "target" for analysis in the Lower Clark Fork; however it is reviewed as supplemental information because of its relation to bank stability and therefore potential sediment production and an overall gage of stream health. Shrub cover in particular provides stronger, more stable stream side woody vegetation, and it often provides an indicator of potential bank stability and temperature variability. Although riparian health is not dependent on the slope of the terrain in many cases, data from the 2008 field study do suggest some differentiation between riparian conditions in high and low gradient reaches.

The statistics for riparian greenline are presented here to demonstrate the range of values that occur in the sites sampled as part of the 2008 field study. In this case, half of the high gradient reaches sampled had over 90% of their banks established with shrub-class vegetation. Therefore, a suggested target of >90% is presented for high gradient reaches. As for low gradient reaches, half of the reaches sampled had 58% or greater shrub presence, and one quarter of the low gradient reaches investigated had 72% or better. As a result, >60% shrub cover is conservatively suggested for low gradient reaches.

D.3.8 Greenline – Percent Bare Ground

Table D-8. Percent Bare Ground

	High Gradient (>2%) ***Rosgen A, B, G***	**Low Gradient (<2%)** ***Rosgen C, F***
Median – DEQ all reaches	0	0
25th percentile – DEQ all reaches	0	0
Target Value	**0%**	**0%**

Riparian green line is not used as a true "target" for analysis in the Lower Clark Fork; however it is reviewed as supplemental information because of its relation to potential sediment production and overall gage of stream health. Bare ground along the riparian is the most unstable and most indicative display of sediment sources. Similar to the percent shrub analysis, the statistics for percent bare ground are only used as a relative gage by which to select an appropriate value to achieve. In this case, lower percentages of percent bare ground are the expected and desired condition. Based on a review of the available information, the Lower Clark Fork TPA would not expect to see any bare ground under most normal natural conditions. As such, the target for bare ground in conjunction with anthropogenic activities is 0%, however, it is acknowledged that some natural conditions (although not witnessed in this data) may result in a small percentage of bare ground near the bank and therefore, this target is not absolute and will allow for some variance under specific natural conditions.

D.3.9 LARGE WOODY DEBRIS

Table D-9. Large Woody Debris (per 1000')

	High Gradient (>2%) ***Rosgen A, B, G***	**Low Gradient (<2%)** ***Rosgen C, F***
Median – DEQ all reaches	34	37
Median – USFS PIBO all reaches	47	46
75th percentile – DEQ all reaches	96	56
75th percentile – USFS PIBO all reaches	86	67
Target Value	**>40**	**>40**

Large woody debris is not used as a true "target" for analysis in the Lower Clark Fork; however it is reviewed as supplemental information because of its relation to riparian condition and sediment production, its affect on pool formation and habitat creation for both fish and macroinvertebrates, and its overall gage of stream health.

The Lower Clark Fork TPA is dominated by forest throughout its landscape and prior to agricultural development in some of the valleys, and timber harvest along the banks, the Lower Clark Fork tributaries likely were bordered by lush and dense riparian areas for nearly their entire lengths. The high counts of large woody debris evident in the data suggest this as well. Based on the median values, a minimum of 40 large woody debris pieces per 1000' is recommended as a guideline minimum value for this area.

D.4 BULL RIVER TARGETS

The size and character of the mainstem Bull River varies considerably from the majority of the tributaries reviewed during the 2008 field effort. As a result, although three Bull River sites were investigated, the data from these sites was not deemed sufficient enough to develop targets to represent the entire Bull River watershed. Additionally, the data from these three sites was not included in the pool of data used to develop targets for the Lower Clark Fork tributaries, for concern that it did not represent the commonly occurring streams in the watershed, and would skew the results. Because of this, data from other TMDLs, developed for watersheds in geographic close proximity (and therefore sharing similar geology and climate characteristics) and for streams of a more similar size to the Bull River were relied upon for target setting. Sediment targets from the St. Regis River, Prospect Creek, and Yaak TPAs were reviewed, and targets were determined using these values and best professional judgment.

Yaak River Sediment Related Targets

- Width/Depth Ratio = within the expected range for the appropriate Rosgen stream type
- Entrenchment Ratio = within the expected range for the appropriate Rosgen stream type
- Percent Surface Fines <6mm (riffle) = <20%
- Percent Surface Fines <2mm (riffle) = <20%

St. Regis River Sediment Related Targets
- Width/Depth Ratio = ≤30
- Percent Surface Fines <2mm (riffle) = <20%
- Percent Surface Fines <6mm (pool tail outs); using grid toss method = ≤8%
- Pools/Mile (C stream types >20’ and <45’ wide) = ≥16
- Large Woody Debris (B/C Stream types >35’ wide) = ≥104

Prospect Creek Sediment Related Targets
- Width/Depth Ratio = <30
- Percent Surface Fines <6mm (riffle); pebble count = <15%
- Percent Surface Fines <6mm (pool tail/riffles); using grid toss or equivalent = <10%
- Pools/Mile = >26

As a result of the review of the above targets, sediment targets for the Bull River were selected and are presented in **Table D-10** below. In addition, most of the stream types described in the Yaak, St. Regis, and Prospect TPAs deal with B and C stream types, however there are significant sections of the Bull River that are classified as an E stream type. E stream types are typically more sinuous, deeper, and often demonstrate higher fines accumulations. In the Bull River, some of these E stream type reaches are also characterized by monocultures of reed canary grass, and extensive bank erosion. Although, the E reaches in the Bull River may very well show naturally higher fines, to remain protective of bull trout and westslope cutthroat trout the values for percent fines presented here will be set as the target until further assessment and evaluation of the Bull River system can be conducted to refine these targets, and management in the Bull River watershed is improved to reduce bank erosion input.

Table D-10. Lower Clark Fork TPA Sediment and Habitat Targets; Bull River

Sediment and Habitat Water Quality Target			
Morphology			
Width/Depth Ratio	Within expected values for appropriate Rosgen stream type; (Width/Depth guidelines: C types <30, B types <25, E < 12)		
Entrenchment			
Substrate Composition			
Pebble Count, % <2mm	≤20		
Pebble Count, % <6mm	≤20		
Pool Habitat			
Pool Frequency (per 1000’)	>4		
Residual Pool Depth	**Bankfull Width 30-39 feet**	**Bankfull Width 40-49 feet**	**Bankfull Width >50 feet**
	≥1.6	≥1.7	≥1.9