Summary of Central Clark Fork Tributaries TMDLs & Water Quality Improvement Plan

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Introduction

The Central Clark Fork Basin Tributaries TMDLs and Water Quality Improvement Plan (TMDL/WQIP) was written by the Montana Department of Environmental Quality in 2014 and is 697 pages long. The water quality restoration objective for the Central Clark Fork (CCF) Basin Tributaries Project Area is to reduce identified pollutant loads in order to meet the water quality standards and TMDL (total maximum daily load) targets for full recovery of beneficial uses for all impaired streams. Based on the assessment provided in the TMDL/WQIP plan, the TMDL targets can be achieved through proper implementation of appropriate Best Management Practices (BMPs).

This document summarizes the CCF Basin Tributaries TMDL/WQIP, which focuses on waterbodies impaired by pollutants (sediment, nutrients, temperature or turbidity) and on impairment causes, sources, and restoration approaches; guidance for monitoring and data collection; and current and past projects in the CCF Basin project area.

Key elements of this TMDL/WQIP & other relevant documents will be used to inform a Watershed Restoration Plan (WRP) for the CCF Basin Project Area. A WRP can provide a strategic framework for water quality restoration and monitoring in the CCF Basin Tributaries TMDL Project Area, focusing on how to meet the goals presented in the TMDL/Improvement Plan document. The WRP can also address additional water quality and watershed health issues of interest to local communities and stakeholders.

Project Area TMDLs

Within the CCF Basin Project Area, TMDLs were completed for 9 waterbody segments for sediment (Flat, WF Petty & Petty, Grant, Cramer, 10 Mile, Deep, Mulkey, Rattler), 8 segments for nutrients (Dry, Nemote, WF Petty, Stony, Grant, 10 Mile, Deep, Rattler), 3 segments for temperature (Nemote, Petty, Grant), and one for turbidity (Trout). Table 1 lists streams impaired by pollutants in the central Clark Fork basin and the causes and sources of impairment. CCF streams impaired by non-pollutants (so no TMDL) are Tamarack, Cedar, Fish, Rattlesnake, Mill, and Sixmile Creeks. Fully supporting streams are: Oregon Gulch, South Fork of Fish Creek, and Rock, Lost & Cache creeks. Streams that have not been assessed are: Reservoir, Madison Gulch, Eds, Johns, and Printers Creeks. The map below shows CCF streams impaired by sediment, nutrients, temperature and/or turbidity. Metals are handled in a different TMDL document.

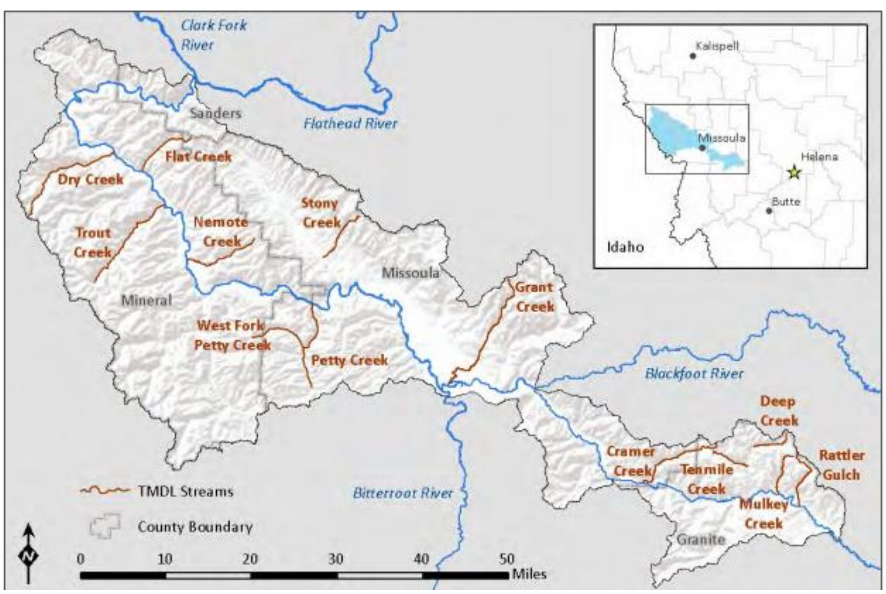

Figure 1. Location and streams of the Central Clark Fork Basin Tributaries TMDL Project Area

Table 1. Central Clark Fork Basin Tributaries TMDL impaired by pollutants.
Streams are listed from upstream to downstream; all streams are impaired from headwaters to mouth.

Waterbody Location	Impairment Causes and % Load Reduction called for in TMDL	Impairment Sources
Rattler Gulch (tributary of the Clark Fork River in Granite County)	Total Phosphorus (75%)	Agriculture, Silviculture, Mining, Subsurface Wastewater Disposal and Treatment (See Appendix A.1)
	Sedimentation/siltation (50%)	Roads, Streambank erosion, upland sediment (See Appendix AA.1)
	Alteration in streamside or littoral vegetative covers, low flow alterations	Contributing activities identified and described in Appendix AA.2
Mulkey Creek (tributary of the Clark Fork River in Granite County)	Sedimentation/siltation (51%)	Roads, Streambank erosion, upland sediment (See Appendix AA.1)
Deep Creek (tributary of Bear Creek, tributary of the Clark Fork River in Granite County)	Chlorophyll-a, nitrate/nitrite (N)	Agriculture, Silviculture, Mining, Subsurface Wastewater Disposal and Treatment (See Appendix A.2).
	Sedimentation/siltation (44%)	Roads, Streambank erosion, upland sediment (See Appendix AA.1)
	Low flow alterations	Contributing activities identified and described in Appendix AA.2
Tenmile Creek (tributary of Bear Creek; tributary of the Clark Fork River in Granite County)	Total phosphorus (83%)	Agriculture, Silviculture, Mining, Subsurface Wastewater Disposal and Treatment (See Appendix A.3)
	Sedimentation/siltation (48%)	Roads, Streambank erosion, upland sediment (See Appendix AA.1)
	Alteration in streamside or littoral vegetative covers	Contributing activities identified and described in Appendix AA.2
Cramer Creek (tributary of the Clark Fork River in Missoula County)	Sedimentation/siltation (57%)	Roads, Streambank erosion, upland sediment (See Appendix AA.1)
	Physical substrate habitat alterations	Contributing activities and described in Appendix AA.2
Grant Creek (tributary of the Clark Fork River in Missoula County)	Excess algal growth, nitrate/nitrite, Total Nitrogen (46%), water temperature (4%)	Agriculture, Silviculture, Mining, Subsurface Wastewater Disposal and Treatment (See Appendix A.4)
	Sedimentation/siltation (36%)	Roads, Streambank erosion, upland sediment, Construction Storm Water Permit, Industrial Storm Water Permit (See Appendix AA.1)
	Alteration in streamside or littoral vegetative covers, low flow alterations	Contributing activities identified and described in Appendix AA.2

Petty Creek (tributary of the Clark Fork River in Missoula County)	Sedimentation/siltation (32%), water temperature (6%)	Roads, Streambank erosion, upland sediment, Construction Storm Water Permit, Industrial Storm Water Permit (See Appendix AA.1)
	Alteration in streamside or littoral vegetative covers, low flow alterations	Contributing activities identified and described in Appendix AA.2
West Fork Petty Creek (tributary of Petty Creek, tributary of the Clark Fork River in Missoula County)	Total Phosphorus (36%) and Chlorophyll-a	Agriculture, Silviculture, Mining, Subsurface Wastewater Disposal and Treatment (See Appendix A.5)
	Sedimentation/siltation (25%)	Roads, Streambank erosion, upland sediment (See Appendix AA.1)
Stony Creek (tributary of Ninemile Creek, tributary of the Clark Fork River in Missoula County)	Total Phosphorus (11%)	Agriculture, Silviculture, Mining, Subsurface Wastewater Disposal and Treatment, Missoula MS4 stormwater discharge (See Appendix A.6)
Nemote Creek (tributary of Clark Fork River in Mineral County)	Total Nitrogen (49%), Total phosphorus (14%), chlorophyll-a, water temperature (19%)	Agriculture, Silviculture, Mining, Subsurface Wastewater Disposal and Treatment (See Appendix A.7)
	low flow alterations	Contributing activities identified and described in Appendix AA.2
Trout Creek (tributary of Clark Fork River in Mineral County)	Turbidity and sediment	Leachate from a waste pond; silviculture activities, mining activities (see Appendices AA.1 and B.3)
	Alteration of Physical substrate and/or streamside or littoral vegetative covers	Contributing activities identified and described in Appendix AA.2
Flat Creek (tributary of Clark Fork River in Mineral County)	Sedimentation/siltation (15%)	Roads, Streambank erosion, upland sediment (See Appendix AA.1)
	Physical substrate habitat alterations	Contributing activities identified and described in Appendix AA.2
Dry Creek (tributary of Clark Fork River in Mineral County)	Total Nitrogen (44%)	Agriculture, Silviculture, Mining, Subsurface Wastewater Disposal and Treatment (See Appendix A.8)
	Alteration in streamside or littoral vegetative covers, low flow alterations	Contributing activities identified and described in Appendix AA.2

Appendix A elaborates on impairment sources for Rattler, Deep, 10 Mile, Grant, W. Fork Petty, Stony, Nemote and Dry. Appendix AA elaborates on impairment associated with sediment, habitat & flow alterations which impact these creeks and also Mulkey, Cramer, Petty, Trout, Flat, Tamarack, Cedar, Fish, Rattlesnake, Mill, and Sixmile Creeks.

Approaches to Reducing Impairments – listed by Cause of Impairment

Reducing Sediment Loading:
Sediment TMDLs have been written for nine streams listed as impaired in the Central Clark Fork Basin Tributaries TMDL Project Area. An effective sediment restoration strategy for applying appropriate BMPs will help address sediment and other causes of impairment. The goal of the sediment restoration strategy is to limit the availability, transport, and delivery of excess sediment by a combination of minimizing sediment delivery, reducing the rate of runoff, and intercepting sediment transport. More information on sediment restoration activities and approaches can be found in Appendix B.1.

Reducing Nutrient Loading:
An effective nutrient restoration strategy is needed for these streams in order to implement BMPs to meet the established TMDLs. The goal of the nutrient restoration strategy is to reduce nutrient input to stream channels by increasing the filtering and uptake capacity of riparian vegetation, decreasing the amount of bare ground, and limiting the transport of nutrients from rangeland, cropland, and mined areas (including impoundments and other storage facilities). A detailed nutrient restoration approach can be found in Appendix B.2.

Reducing Turbidity:
A turbidity TMDL has been written for Trout Creek. An effective restoration strategy for turbidity is needed for Trout Creek in order implement BMPs to meet the established TMDLs. Turbidity is often associated with excess suspended sediment or solids and, therefore linked to a sediment impairment. The restoration strategy addresses excess turbidity associated with suspended sediment and solids by minimizing sediment delivery, reducing the rate of runoff, and intercepting sediment transport. More details on the approach can be found in Appendix B.3.

Addressing Non-pollutant Causes of Impairment:
Although TMDL development is not required for impairments caused by non-pollutants, they are frequently linked to pollutants, and addressing non-pollutant causes, such as, flow, habitat alterations, channelization, and degradation of riparian areas, wetlands and floodplains, is an important component of TMDL implementation. More on non-pollution approaches can be found in Appendix B.4.

Protecting and Restoring Riparian Areas, Wetlands, and Floodplains:
Healthy and functioning riparian areas, wetlands, and floodplains are critical for wildlife habitat, groundwater recharge, reducing the severity of floods and upland and streambank erosion, and filtering pollutants from runoff. The performance of the above named functions is dependent on the connectivity of riparian areas, wetlands, and floodplains to both the stream channel and upland areas. Human activities affecting the quality of these transitional habitats or their connectivity can alter their performance and greatly affect the transport of water, sediments, and contaminants (e.g., channelization, increased stream power, bank erosion, and habitat loss or degradation). Therefore, restoring, maintaining, and protecting riparian areas, wetlands, and floodplains within the watershed should be a priority of TMDL implementation in the Central Clark Fork Basin Tributaries TMDL Project Area. Reduction of riparian and wetland vegetative cover by various land management activities is a principal cause of water quality and habitat degradation in watersheds throughout Montana. Although implementation of passive BMPs that allow riparian and wetland vegetation to recover at natural rates is typically the most cost-effective approach, active restoration (i.e., plantings) may be necessary in some instances. More details on the riparian areas, wetlands, and floodplains approach can be found in Appendix B.5.

Approaches to Reducing Impairments -- listed by Source Category:

Agricultural Sources:
Reduction of pollutants from upland agricultural sources can be accomplished by limiting the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil and runoff before it enters a waterbody. Not all agricultural sources of pollutants discussed in this section were identified in the Central Clark Fork Basin Tributaries TMDL Project Area; however, the recommendations below provide a useful guideline for a variety of agricultural activities. The main BMP recommendations for the Central Clark Fork Basin Tributaries TMDL Project Area include nutrient management plans, irrigation water management plans, riparian buffers, wetland restoration, and vegetative filter strips, where appropriate. These methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept pollutants. Three key approaches addressed in the TMDL pertain to grazing, flow and irrigation, and cropland. Agriculture approaches are expanded on in Appendix C.1.

Forestry and Timber Harvest Sources:
The Central Clark Fork Basin Tributaries TMDL Project Area has been impacted by recent and historical timber harvest activities. The Montana Forestry BMPs cover timber harvesting and site preparation, harvest design, other harvesting activities, slash treatment and site preparation, winter logging, and hazardous substances. Increased use, construction, and maintenance of unpaved roads associated with forestry and timber harvest activities should be addressed with appropriate BMPs. Noxious weed control should be actively pursued in all harvest areas and along all forest roads. More information on the Forestry and Timber Harvest Approach can be found in Appendix C.2.

Residential/Urban Development Sources:
There are multiple sources and pathways of pollution to consider in residential and urban areas. Destruction of riparian areas, pollutants from both functioning and failing septic systems, and stormwater generated from impervious areas and construction sites are discussed further in Appendix C.3.

Mining Sources:
Like much of Montana, the Central Clark Fork Basin Tributaries TMDL Project Area has a legacy of mining that continues today. Mining activities may have impacts that extend beyond increased metal concentrations in the water. Channel alteration, riparian degradation, and runoff and erosion associated with mining (especially historic placer mining) can lead to sediment, habitat, nutrient, and temperature impacts as well. The need for further characterization of impairment conditions and loading sources is examined in Appendix C.4.

Data and Monitoring Needs

Strengthening Source Assessments

In the Central Clark Fork Basin Tributaries TMDL Project Area, the identification of pollutant sources was conducted largely through reviewing and analyzing available data, tours of the watershed, assessments of aerial photographs, the incorporation of GIS information, and the review of published scientific studies. In many cases, assumptions were made based on known watershed conditions and extrapolated throughout the project area. As a result, the level of detail often does not provide specific areas on which to focus restoration efforts, only broad source categories to reduce pollutant loads from each of the discussed streams and sub-watersheds. Strategies for strengthening source assessments for each of the pollutant categories are outlined in Appendix D.1 by sediment, temperature, nutrients, and turbidity.

Consistent Data Collection and Methodologies

Within the Central Clark Fork Basin Tributaries TMDL Project Area, suggestions are provided for strengthening data collection and methodologies, in order to promote consistency in project areas. Consistent data collection strategies are detailed in Appendix D. 2, sorted by sediment, temperature, nutrients.

Monitoring Guidelines

As restoration activities are implemented, monitoring is valuable to determine if restoration activities are improving water quality, instream flow, and aquatic habitat and communities. Monitoring can help attribute water quality improvements to restoration activities and ensure that restoration activities are functioning effectively. Restoration projects will often require additional maintenance after initial implementation to ensure functionality. It is important to remember that degradation of aquatic resources happens over many decades and that restoration is often also a long-term process. An efficiently executed long-term monitoring effort is an essential component to any restoration effort. Objectives for future monitoring for the Central Clark Fork Basin Tributaries TMDL Project Area are provided in Appendix D.3.

Completed and Ongoing Projects and Other WRPs in the basin

Increased shading from riparian vegetation reduces sunlight hitting the stream and, thus reduces the heat load to the stream. Shade targets were developed to provide temperature control on Petty, Nemote, and Grant Creek. Two different approaches were used to meet these targets. For Petty Creek, the approach is based on a riparian buffer target that will provide the effective shade consistent with a naturally occurring condition. For Nemote and Grant, DEQ used a new approach, identifying reaches where the riparian shade is likely at potential and setting corresponding average effective shade as the target for the shade-deficient reaches. These approaches and efforts are detailed in Appendix E.

The Ninemile Planning Area listed water quality in the watershed as impaired, with causes of impairments including flow alterations, habitat alterations, sedimentation/siltation, and metals (copper, lead, zinc, and mercury). The most significant probable sources for these impacts to water quality stem from erosion and sediment loading and can be linked to historic placer mining and other resource extraction, transportation infrastructure, and agricultural practices. The fires of 2000 and historical timber harvests contributed appreciable quantities of sediment to Ninemile Creek. Primary sources include: Mining and Resource Extraction, Transportation Infrastructure, and Agriculture. A 72-page Watershed Restoration Plan was written in 2013 for the Ninemile Creek TMDL Planning Area and includes restoration strategies.

St. Regis Watershed stakeholders are currently working on a Watershed Restoration Plan for that watershed.

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NOTE:
Appendix A elaborates on impairment sources for Rattler, Deep, 10 Mile, Grant, W. Fork Petty, Stony, Nemote and Dry. Appendix AA elaborates on impairment associated with sediment, habitat & flow alterations which impact the above creeks and also Mulkey, Cramer, Petty, Trout, Flat, Tamarack, Cedar, Fish, Rattlesnake, Mill, and Sixmile Creeks.

APPENDIX A – Creek by creek summary of pollutant source categories for: Rattler, Deep, 10 Mile, Grant, W. Fork Petty, Stony, Nemote and Dry Creeks

A.1 Rattler Gulch – p. 192

Assessment of Loading by Source Categories

The Rattler Gulch soils are volcanic in nature, highly erosive, and likely elevated in phosphorus compared with other soil types encountered in the Middle Rockies Level III Ecoregion. There were insufficient data in this area with significant human caused sources of TP to differentiate between background and human-caused load fractions. Once all reasonable soil, land, and water conservation practices have been implemented in the sub-watershed, further investigation is warranted to establish the background condition based on reference sites within the Rattler Gulch sub-watershed. There has been no recent fire activity in the Rattler Gulch sub-watershed. Rattler Gulch does not appear on the FWP dewatered streams list. This list identifies streams that support or contribute to important fisheries that are significantly dewatered, referring to a reduction in streamflow below the point where stream habitat is adequate for fish. However, Rattler Gulch does not have direct surface water connectivity with the Clark Fork River for much of the year as its lower reaches flow only intermittently. This loss of water in the channel to the subsurface appears to be, in part, due to the geology of the sub-drainage where the stream flows across limestone and an alluvial fan near the mouth.

Agriculture

Agriculture is a primary land use and potentially significant nutrient source in the Rattler Gulch sub-watershed, with livestock grazing far more prevalent and likely to be contributing to elevated nutrient concentrations than crop production. With the exception of a very small parcel in the southeastern extent, the entire Rattler Gulch sub-watershed is encompassed by two grazing allotments. The Mulkey East allotment number 07108 is 11,561 acres, of which approximately 8,028 acres (69%) are within the Rattler Gulch watershed. Of the total allotment area, 2,758 acres are within public (mostly BLM administered) land and there are 93 permitted AUMs. The Spring Gulch allotment number 07115 is 2,570 acres, of which approximately 1,683 (65%) are within the Rattler Gulch watershed. Of the total allotment area, 1,040 acres are within public (mostly BLM administered) land and there are 64 permitted AUMs. The Rattler Gulch sub-watershed is 9,841 acres and 3,567 acres (36%) of this is public land. These public lands are all within the two grazing allotment boundaries described which have a maximum of 157 permitted AUMs. While it may be unlikely that all 157 permitted AUMs for the entire allotment areas will be grazed exclusively on public lands within the Rattler Gulch sub-watershed, this represents the maximum AUMs possible at any given time. No attempts were made to verify actual grazing practices or current stocking densities. Recent field observations, photographs and comments in the Rattler Gulch assessment records indicate evidence of livestock grazing in the stream channel and along its riparian corridor, including livestock caused hummocks and hoof pugging, particularly in the upper reaches. Land used for pasture and hay production is found interspersed along the entire stream channel but is particularly prevalent in the lower one-third of the stream where there is intermittent flow. A very small portion of irrigated cropland is located near the mouth in the southeastern portion of the drainage although, particularly given lack of connectivity in these lower reaches, this is likely having no discernable impacts on nutrient concentrations in the creek.

Silviculture

Silviculture activities are the other primary land use in the Rattler Gulch sub-watershed. An analysis of aerial imagery and geospatial land cover data suggests silviculture activities are extensive in the Rattler Gulch sub-watershed, particularly in the upper half where much of the land is administered by BLM or owned by a private logging company. Timber harvest has occurred on parcels on both sides of the stream channel and aerial images show a multitude of logging roads in the drainage. Further, as noted in DEQ's Rattler Gulch assessment record and apparent in recent site photographs, the logging road that leads up the sub-drainage along the stream was installed essentially in the middle of the riparian corridor and stream bed itself. Considerable bank alteration and bank instability was noted in stream reaches along this road. Timber harvest and logging roads exist in close proximity to the stream channel from the headwaters of Rattler Gulch along the stream corridor between the upper and lower site where TP concentrations increase in the downstream direction. Runoff from timber harvest activities and potential sedimentation from logging roads in close proximity of the stream are quite likely introducing phosphorus to the AU. Given the volcanic parent material for soils in the drainage, soils are not only at a greater risk of erosion, but are also likely phosphorus rich compared with other sub-watersheds in the Central Clark Fork Basin Tributaries TMDL Project Area.

Mining

According to DEQ records, there are five abandoned mines in the Rattler Gulch sub-watershed, none of which appear on DEQ's Priority Mine Sites List. There is one active permitted mine, Drummond Quarry (limestone), which is situated in the southeastern extent of the Rattler Gulch up a tributary which joins with Rattler Gulch near the mouth. One of the five abandoned mines is near the Drummond Quarry, one is just below the uppermost monitoring site location, one is above the mouth, one is in the south central region of the sub-watershed quite far from the stream channel, and one, Hitchcock Quarry (calcium), is situated very near the stream channel approximately mid-segment. These sites are having no discernable impact on nutrient water quality.

Subsurface Wastewater Disposal and Treatment

According to DEQ records, there are no individual septic systems in the Rattler Gulch sub-watershed and septic effluent is not a contributor to the existing Rattler Gulch TP load.

A.2 Deep Creek – p. 186

Assessment of Loading by Source Categories

Deep Creek does not appear on the FWP dewatered streams list. This list identifies streams that support or contribute to important fisheries that are significantly dewatered, referring to a reduction in streamflow below the point where stream habitat is adequate for fish. However, Deep Creek does not have direct surface water connectivity with Bear Creek during some parts of the year and its lower reaches were dry during monitoring visits. It is not known at this time to what degree this dewatering is due to naturally losing reaches as opposed to water diversions in the upper reaches used to supply water for mining activities. While approximately 80 percent of the Deep Creek sub-drainage is publicly owned land, a majority of the land surrounding the stream channel itself is privately owned. There has been no recent fire activity in the Deep Creek sub-watershed. DEQ was unable to gain access permission to flowing sections of Deep Creek in order to conduct a stream assessment in 2012. Based on field notes and site photos taken as part of 2004 and 2012 field work, the channel has been significantly affected by past timber harvesting practices and by historical and current placer mining operations in the channel. There is a reservoir in the upper portion of the Deep Creek drainage out of which Deep Creek flows, with a portion diverted into a pipe for apparent use in a mining operation. Deep Gulch Road parallels Deep Creek along much of its length. Field visits noted that the channel quickly went dry and lost definition in an area of active mining. Flowing water was again observed downstream of the Gambler Creek confluence. In this reach, the channel resembled a small spring creek flowing through wetland vegetation. The stream then became channelized by the road and proceeded to go dry. Further downstream, the channel remained encroached upon by Deep Gulch Road and evidence of historic placer mining was observed, including a portion where a small rock wall had been constructed along both sides of the channel. As the valley opens up, there was no flowing water and no defined channel in an area upstream of the Deep Creek confluence with Bear Creek where extensive mine related disturbance has occurred.

Agriculture

Agricultural land use associated with both grazing and cropland appears minimal in the Deep Creek sub-watershed and is potentially a minor contributor to nutrient concentrations. The entire Deep Creek sub-watershed is encompassed by 3 grazing allotments. The Mulkey West allotment number 07104 is 15,525 acres, of which approximately 7,619 (49%) is within the Deep Creek sub-watershed. Of the total allotment area, 7,619 acres are within public (mostly BLM administered) land and there are 125 permitted AUMs. The Mulkey East allotment number 07108 is 11,561 acres, of which approximately 76 (1%) are within the Deep Creek sub-watershed. Of the total allotment area, 2,758 acres are within public (mostly BLM administered) land and there are 93 permitted AUMs. The Dry Mulkey allotment number 07105 is 2,061 acres, of which approximately 922 (45%) are within the Deep Creek sub-watershed. Of the total allotment area, 889 acres are within public (mostly BLM administered) land and there are 40 permitted AUMs. The Deep Creek sub-watershed is approximately 6,700 acres and 5,414 acres (81%) of this is public land. These public lands are all within the

3 grazing allotment boundaries described which have a maximum of 258 permitted AUMs. While it may be unlikely that all 258 permitted AUMs for the entire allotment areas will be grazed exclusively on public lands within the Deep Creek sub-watershed, this represents the maximum AUMs possible at any given time. Geospatial land cover data and lack of field observations of heavy grazing suggest this is likely an overestimate, although no attempts were made to verify actual grazing practices or current stocking densities. However, land cover data also suggests that the grazing that does occur in the drainage occurs along or near the stream channel, particularly in the lower reaches. There is no irrigated or dryland crop production in the Deep Creek sub-watershed. The sub-watershed is predominantly forested with intermittent shrubland.

Silviculture
Silviculture activities are a primary land use in the Deep Creek sub-watershed. An analysis of aerial imagery and geospatial land cover data suggests silviculture activities are extensive in the Deep Creek sub-watershed. Timber harvest is prevalent throughout the entire drainage area, although the logged parcels nearest to the stream channel are located in the upper reaches of the stream, above the uppermost monitoring site location from which water quality samples were collected. Timber harvest has occurred on parcels on both sides of the stream channel and aerial images show a multitude of logging roads in the drainage. Further, as noted in DEQ's Tenmile Creek assessment record and apparent in recent site photographs, the logging road that leads up the sub-drainage along the stream was installed in close proximity to the riparian corridor and stream channel itself. As noted in the assessment records for this stream, there exists a riparian buffer despite this road presence. However, there are portions in the upper reaches where the stream channel has been filled and displaced entirely by the road. This, coupled with water diversion from mining operations, complicates water quality analysis of Deep Creek. Timber harvest and roads exist in close proximity to the stream channel from the headwaters of Deep Creek along the stream corridor where nitrogen concentrations increase in the downstream direction. Runoff from timber harvest activities and potential sedimentation from logging roads in close proximity of the stream may be a minor contributor of nitrogen to the AU.

Mining
Deep Creek has the most extensive and active mining history of all nutrient impaired streams in the Central Clark Fork Basin Tributaries TMDL Project Area. This drainage is part of the Garnet Mining District in Granite County. DEQ records show approximately 27 abandoned mines; these were primarily placer and lode mines which produced gold, as well as copper, silver, mercury, and iron, none of which appear on DEQ's Priority Mine Sites List. Two of these are in the headwaters of a tributary that joins with the mainstem above the Springtown site; 15 are located around the headwaters of the Deep Creek mainstem, with all but two upstream of the headwaters site; seven are around the headwaters of Cayuse Gulch which joins just above the monitoring site C02DEEPC03; two abandoned placer gold mines are just above the site near the mouth of Deep Creek, and one stone quarry is located less than a mile upstream from the mouth near the channel. The Top o' Deep placer gold mine is listed as an active mine by MBMG in 2012, although these records suggest active mining at the Top O'Deep placer was delayed during the season while the owner and operator tested other properties. According to previous DEQ assessment records, the lower two miles of the stream were both placer and tunnel mined, which was quite detrimental to this section, and the current landowner is preparing to reopen the tunnel mines. Deep Creek is diverted into a pipe after approximately one mile of surface flow and is used to run the mining operation. Another pipe releases water just downstream from Cayuse Gulch. Given the extensive history and ongoing active status of mining in the Deep Creek drainage, mining is considered a potentially significant contributor to existing NO3+NO2 loads.

Subsurface Wastewater Disposal and Treatment
According to DEQ records, there are three individual septic systems in the Deep Creek sub-watershed. One is within 200 feet of the stream above the mouth, 1 is within 150 feet of the stream just below the headwaters and 1 is in the upper portion of the sub-watershed approximately 2,000 feet from the channel. While 2 of these systems are within a few hundred feet of the channel, the majority of these systems are located outside the main floodway. Septic effluent is considered a minor contributor to the existing Deep Creek NO3+NO2 daily load.

A.3 Ten Mile Creek – p. 180

Assessment of Loading by Source Categories

The Tenmile Creek soils are volcanic in nature, highly erosive, and likely elevated in phosphorus compared with other soil types encountered in the Middle Rockies Level III Ecoregion. There were insufficient data in this area with significant human-caused sources of TP to differentiate between background and human-caused load fractions. Once all reasonable soil, land, and water conservation practices have been implemented in the sub-watershed, further investigation is warranted to establish the background condition based on reference sites within the Tenmile Creek sub-watershed. Tenmile Creek does not appear on the FWP dewatered streams list. This list identifies streams that support or contribute to important fisheries that are significantly dewatered, referring to a reduction in streamflow below the point where stream habitat is adequate for fish. However, Tenmile Creek does not have direct surface water connectivity with Bear Creek at all times of the year as its lower reaches flow only intermittently. A forest fire was burning near the headwaters of Tenmile Creek during the monitoring event in August of 2012, preventing access to the upper monitoring site.

Agriculture

Agriculture is the primary land use and potentially significant nutrient source in the Tenmile Creek subwatershed, with livestock grazing far more prevalent and likely to be contributing to elevated nutrient concentrations than crop production. With the exception of a very small parcel in the southern corner, the entire Tenmile Creek sub-watershed is encompassed by 2 grazing allotments. The Ten Mile allotment number 07102 is 69,707 acres, of which approximately 6,072 acres (9%) are within the Tenmile Creek sub-watershed. Of the total allotment area, 1,320 acres are within public (mostly BLM administered) land and there are 69 permitted AUMs. The Bonita-Clinton allotment number 07101 is 10,955 acres, of which approximately 379 acres (3%) are within the Tenmile Creek sub-watershed. Of the total allotment area, 3,793 acres are within public (mostly BLM administered) land and there are 207 permitted AUMs. The Tenmile Creek sub-watershed is 6,715 acres and 768 acres (11%) of this is public land. These public lands are all within the 2 grazing allotment boundaries described above, which have a maximum of 276 permitted AUMs. While it may be unlikely that all 276 permitted AUMs for the entire allotment areas will be grazed exclusively on public lands within the Tenmile Creek sub-watershed, this represents the maximum AUMs possible at any given time. No attempts were made to verify actual grazing practices or current stocking densities. Recent field observations, photographs, and comments in the Tenmile Creek assessment records indicate evidence of livestock grazing in the stream channel and along its riparian corridor, including hoof pugging and altered riparian vegetation in most reaches. Bank erosion and failure and channel blow-outs noted in the assessment record were attributed, in part, to heavy grazing. Aerial imagery and geospatial land cover data suggest grazing is most prevalent near the headwaters and along the road that runs alongside the stream channel. There is no irrigated or non-irrigated cropland in the Tenmile Creek sub-watershed. The sub-watershed is predominantly forested with intermittent shrubland, especially around the headwaters.

Silviculture

Silviculture activities are the other primary land use in the Tenmile Creek sub-watershed. An analysis of aerial imagery and geospatial land cover data suggests silviculture activities are extensive in the Tenmile Creek sub-watershed, particularly in the upper half where much of the land is administered by BLM or owned by a private logging company. Timber harvest has occurred on parcels on both sides of the stream channel and aerial images show a multitude of logging roads in the drainage. Further, as noted in DEQ's Tenmile Creek assessment record and apparent in recent site photographs, the logging road that leads up the sub-drainage along the stream was installed in close proximity to the riparian corridor and stream channel itself. Timber harvest and logging roads exist in close proximity to the stream channel from the headwaters of Tenmile Creek along the stream corridor between the upper and lower site where TP concentrations decrease in the downstream direction. Runoff from timber harvest activities and potential sedimentation from logging roads in close proximity of the stream are likely introducing phosphorus to the AU. Given the volcanic parent material for soils in the drainage, soils are not only at a greater risk of erosion, but are also likely phosphorus rich compared with other sub-watersheds in the Central Clark Fork Basin Tributaries TMDL Project Area.

Mining

According to DEQ records, there is one abandoned mine, a lode mine for lead and silver, in the Tenmile Creek sub-watershed; this mine does not appear on DEQ's Priority Mine Sites List. The mine site is located approximately one mile north of the stream channel and is not having a discernable impact on nutrient water quality.

Subsurface Wastewater Disposal and Treatment
According to DEQ records, there is one individual septic system in the Tenmile Creek sub-watershed. This septic system is located approximately 800 feet from the stream channel and, as such, septic effluent is not considered a contributor to the existing Tenmile Creek TP load.

A.4 Grant Creek – p. 172

Assessment of Loading by Source Categories
The upper third of the Grant Creek sub-watershed is on USFS administered land, while the lower two-thirds are privately owned except for a few State-, City- and County-administered parcels. Grant Creek flows through four fairly distinct land uses. From the headwaters through the upper reaches, the stream flows through largely roadless forest (USFS) with some rural residences, which then transitions into rural and suburban residential areas north of the Interstate-90 crossing. From here, high intensity urban commercial-industrial area leads toward the lower reaches where the land use is primarily agriculture mixed with subdivisions. This sub-watershed has the highest percentage of developed land cover of all nutrient impaired streams in the Central Clark Fork Basin Tributaries TMDL Project Area and includes some areas with high intensity industrial/commercial development. Grant Creek appears on the FWP dewatered streams list as being chronically dewatered on the lowermost reaches from RM 0.0 to 5.0. This list identifies streams that support or contribute to important fisheries that are significantly dewatered, referring to a reduction in streamflow below the point where stream habitat is adequate for fish. Chronically dewatered streams describe where dewatering is a significant problem in virtually all years. Since settlement of the Missoula Valley, Grant Creek has been significantly altered in the lower portions of the watershed to mitigate flood risk and improve fish habitat and passage. The lower reaches of Grant Creek have been diverted since at least the 1950s and the riparian zone of the initial channel can be seen dissipating over time in aerial images. Grant Creek has been altered as an irrigation conduit downstream of International Drive since sometime before 1954 and likely only functions as a natural corridor downstream of Highway 263 (Mullan Road) where it enters the Clark Fork River floodplain (100-year recurrence interval). Through the later part of the 20th century and into the 21st century, the areal extent of irrigated acres in the Grant Creek watershed has steadily declined with increases in residential and commercial land development in many parts of the lower drainage and even over top of the original Grant Creek channel. There has been no recent fire activity in the Grant Creek sub-watershed that may be contributing nutrients. The most recent fires occurred in the late 1980s, with the 1988 Snowbowl Fire (approximately 88 acres) and the 1989 Grant Creek fire (approximately 13 acres), both of which are a substantial distance from the Grant Creek channel.

Agriculture
Agriculture is the primary land use in the lower reaches of Grant Creek below the Interstate-90 crossing and commercial-industrial development area. The Grant Creek sub-watershed is 18,738 acres, of which 10,600 acres (57%) is public land. However, the Grant Creek sub-watershed does not contain any grazing allotments. Cultivated cropland, including irrigated cropland, is a potentially significant nutrient source in the Grant Creek sub-watershed. There are readily apparent irrigation withdrawals and diversions in all but the top reach. Analysis of aerial imagery and geospatial land cover data reveals that some alfalfa, summer fallow, and a substantial amount of pasture/hay land exists along lower reaches of Grant Creek, interspersed among the residential subdivisions. Many of these residential lawns are likely irrigated and may be fertilized. Further, water is diverted from the Clark Fork River through a ditch for irrigation purposes in the lower reaches of Grant Creek; the irrigation return flow enters between the lower two sites which may be a substantial nutrient source and help explain the increase in nitrogen concentrations seen between the lower two monitoring sites. In addition, several small irrigated parcels are seen approximately mid-segment very near the creek, around the Snowbowl Road crossing, although based on field observations most or all of these are irrigated residential lawns. Much of the agricultural land in these lower reaches are within the Clark Fork River floodplain and the relatively high water table here likely increases the influence of surface water-groundwater interactions. This makes it more likely that, coupled with surface water irrigation return flows, nutrients from crop production and residential lawn care are contributing to the existing Grant Creek TN load. Also, irrigation water that has been diverted from the Clark Fork River enters Grant Creek in the lower reaches,

which may also be contributing to the existing nutrient load. These factors may, in part, explain the general increase in nitrogen concentrations in the downstream direction, with the highest TN concentrations seen in samples collected just above the mouth of Grant Creek.

Silviculture
Silviculture activities are not a primary land use in the Grant Creek sub-watershed. An analysis of aerial imagery and geospatial land cover data reveals several small parcels in the central western portion of the sub-drainage, although these operations do not appear to be recent and are not within close proximity of the stream channel. Contributions of nutrients to Grant Creek from timber harvest or forest roads are unlikely. Grant Creek Road runs along much of the stream channel and is in relatively close proximity in some places, particularly north of Interstate-90 where the stream has been channelized in some reaches. However, there exists a substantial riparian buffer between the road and the channel in most places and this road is not thought to be a substantial contributor of nutrients.

Mining
According to DEQ records, there are 3 abandoned mines in the Grant Creek drainage, none of which appear on DEQ's Priority Mine Sites List (Pioneer Technical Services, Inc., 1995). There are two stone and pumice lode mines in the lower reaches and a copper and gold prospect mine above the uppermost monitoring site. These sites are having no discernible impacts on nutrient water quality.

Subsurface Wastewater Disposal and Treatment
According to DEQ records, there are 95 individual septic systems in the Grant Creek sub-watershed. This includes only septic systems that are not connected to the city of Missoula sewer system. Most of these septic systems are found approximately mid-segment in the residential neighborhoods surrounding the Snow Bowl road crossing, with others scattered throughout the lower reaches of the Grant Creek sub-watershed. Given the close proximity and high density of individual septic systems in the Grant Creek sub-watershed, septic effluent is considered a moderate contributor to the existing Grant Creek TN daily load. Several septic systems are located near the channel within the Clark Fork River floodplain and the relatively high water table here increases the influence of surface water-groundwater interactions, thereby increasing the likelihood of septic influence. Coupled with the other agricultural and residential land uses in this region, this may, in part, explain the general increase in nutrient concentrations in the downstream direction, with the highest TN concentrations seen in samples collected just above the mouth of Grant Creek.

Missoula MS4 stormwater discharge
The annual summer discharge from the city of Missoula stormwater catchment was estimated using the stormwater discharge area of 2.29 square miles, average annual (30 year) summer growing season precipitation of 3.1 inches, and an estimated 8% of total annual precipitation draining to surface water. This estimated annual summer growing season discharge is 1,322,411 cubic feet per summer or 37,446,506 liters. Approximately 60% of this discharge is from suburban/residential areas and the remaining 40% is from commercial areas. Nutrient concentration data collected at one site representing a residential area and one site representing a commercial area, as required by the MS4 permit, was used to estimate the existing TN load from the Missoula MS4 to Grant Creek. Based on the sample reporting for the MS4 permit, the 80th percentile concentration of TN in stormwater runoff from commercial areas is 5.58 mg/L and from residential area is 4.61 mg/L. Using these concentrations, DEQ estimated that the portion of the MS4 that discharges to Grant Creek contributes an annual summer growing season TN load of 412.7 lbs/summer (184.3 lbs/summer commercial and 228.4 lbs/summer residential). DEQ chose 0.25 inches of precipitation as a representative value of storm events that result in stormwater discharge. Between 1984 and 2013, there is an average 4.1 summer precipitation events that qualify as producing stormwater discharge. Therefore, by dividing the estimated annual summer TN loads by 4, DEQ estimates that the per-event loads (considered equivalent to daily loads given the short duration of rainfall and runoff events) are 103.2 lbs per summer storm event. Although nutrient loading only occurs a few times during the summer algal growing season, loading reductions are desirable and are possible via full implementation of stormwater BMPs consistent with the MS4 general permit requirements. Using the median TN concentrations of influent and effluent in this database, three BMPs significantly reduced TN concentrations in stormwater and had the highest reduction efficiencies: bioretention (28%), composite (28%) and retention ponds (30%).

A.5 West Fork Petty Creek – P. 162

Assessment of Loading by Source Categories

The upper reaches of West Fork Petty Creek flow through relatively undisturbed forest. The lower reaches appear similar to the upper, although moving in the downstream direction toward the mouth there are an increasing number of private residences. West Fork Petty Creek does not appear on the FWP dewatered streams list. This list identifies streams that support or contribute to important fisheries that are significantly dewatered, referring to a reduction in streamflow below the point where stream habitat is adequate for fish. In 2003, approximately one-quarter of the total Thompson Creek fire (33,653 acres) area burned in the West Fork Petty Creek sub-watershed. The western third of the West Fork Petty drainage was within the burn area, with the headwaters and several tributaries affected.

Agriculture

The West Fork Petty Creek sub-watershed is 9,373 acres, of which 8,137 acres (87%) is public land. However, there are no grazing allotments contained within the drainage. Based on field observations and land cover data, livestock grazing is limited to small scattered parcels of pasture in the lower reaches on private land. Minimal, if any, cropland exists. Agriculture is thought to be a minor contributor to existing nutrient loads to West Fork Petty Creek.

Silviculture

Silviculture activities are a primary land use in the West Fork Petty creek sub-watershed. An analysis of aerial imagery and geospatial land cover data reveals that timber harvest is extensive in the drainage, particularly to the north and south of the middle third of the stream segment. The West Fork Petty Creek drainage was part of the Montana Legacy Project where private timberlands were purchased by TNC and transferred to the USFS. In the West Fork Petty Creek sub-watershed, TNC lands were transferred to the Lolo National Forest in March 2010. The land transfer included approximately 9,400 acres or 36% of the West Fork Petty Creek sub-watershed. Included in this transfer was approximately 1 mile of stream frontage in the upper drainage. The DEQ assessment record indicates that aerial photographs show fairly extensive clear-cuts around the stream. Aerial images also show a multitude of logging roads in the drainage. These images also indicate that a substantial riparian buffer (greater than 100 feet) was retained. Runoff from timber harvest activities and sedimentation from logging roads in close proximity to the stream channel are likely contributing phosphorus to the segment and may help explain the increase in phosphorus concentrations moving in the downstream direction.

Mining

According to DEQ records, there are no abandoned or active mines in the West Fork Petty Creek drainage and mining is not considered a source of nutrients in the drainage.

Subsurface Wastewater Disposal and Treatment

According to DEQ records, there are 48 individual septic systems in the West Fork Petty Creek sub-watershed. These septic systems are all within approximately 1,500 feet of the stream channel and are scattered along the entire lower half of the stream channel on both sides (i.e., north and south). Several of these appear to be within several hundred feet of the stream channel. Given the number, proximity and relatively high density of individual septic systems in the lower West Fork Petty Creek sub-watershed, septic effluent may be contributing to the increasing nutrient concentrations in the downstream direction and is considered a moderate to significant contributor to the existing West Fork Petty Creek TP daily loads.

A. 6 Stony Creek – p. 168

Assessment of Loading by Source Categories

The upper reaches of Stony Creek flow through heavily forested land and, there is a gradual increase in the amount of agricultural and residential land use moving downstream to the lower reaches of the stream. Stony Creek does not appear on the FWP dewatered streams list. This list identifies streams that support or contribute to important fisheries that are significantly dewatered, referring to a reduction in streamflow below the point where stream habitat is adequate for fish.

There have not been any forest fires in the Stony Creek sub-watershed since 1994 when two small fires (each 18-19 acres) burned in the northwestern region of the drainage.

Agriculture
A primary land use and potentially significant nutrient source in the Stony Creek sub-watershed is agriculture, with livestock grazing and cropland likely to be contributing to elevated TP concentrations. A majority of the western half of the drainage is encompassed by two grazing allotments on USFS administered land. The Ninemile Adm. Pasture allotment number 00136 is 5,439 acres, of which approximately 4,287 acre (79%) is within the Stony Creek sub-watershed. This entire grazing allotment is on public land and there are 38 permitted AUMs. The Josephine-Butler allotment number 00063 is 34,073, of which 2,104 acres (6%) is within the Stony Creek drainage. Of the total allotment area, 34,058 acres are within public land and there are 12 permitted AUMs. The Stony Creek sub-watershed is approximately 11,700 acres and 9,439 acres (81%) is public land. These public lands are all within the two grazing allotment boundaries described above, which have 50 permitted AUMs at most. While it may be unlikely that all 50 permitted AUMs for the entire allotment areas will be grazed exclusively on public lands within the Stony Creek sub-watershed, this represents the maximum AUMs possible at any given time. No attempts were made to verify actual grazing practices or current stocking densities. Land used for cultivated crops in the vicinity of the stream or tributaries is found in the lower 1.5 miles of the stream. The DEQ assessment record notes that there are two substantial irrigation diversions and geospatial land cover data reveals that a network of irrigation ditches exists near and in these croplands.

Silviculture
Silviculture activities are present in the Stony Creek sub-watershed, although timber harvest is not widespread according to an analysis of aerial imagery and geospatial land cover data. There are several parcels of public land that have been harvested in the upper, northernmost extent of the sub-watershed area. Aerial images and assessment record comments suggest these areas have been clear-cut. Aerial images also show a multitude of logging roads in the drainage. Runoff from timber harvest activities and sedimentation from logging roads in close proximity to the stream channel are likely contributing phosphorus to the segment and may help explain the increase in phosphorus concentrations moving in the downstream direction.

Mining
According to DEQ records, there are no abandoned or active mines in the Stony Creek drainage and mining is not considered a source of nutrients in the drainage.

Subsurface Wastewater Disposal and Treatment
According to DEQ records, there are approximately 10 individual septic systems in the Stony Creek sub-watershed. About five of the septic systems are within 1,000 feet of the channel, which are all located around and just above the lowermost monitoring site; this coincides with the areas where phosphorus concentrations were becoming elevated. Septic effluent is considered a minor contributor to existing Stony Creek TP daily loads.

A.7 Nemote Creek p. 156

Assessment of Loading by Source Categories
The upper half of the Nemote Creek sub-watershed is forested with shrubland interspersed, and the valley is fairly narrow and steep. The lower half of the watershed, from near the South Fork Nemote Creek confluence to the mouth, includes ranches and hayfields, and the valley widens. The last quarter mile of the stream channel is in a steep and narrow canyon prior to entering the Clark Fork River. Nemote Creek appears on the FWP dewatered streams list as being chronically dewatered between Sheridan Creek and Miller Creek, and as being periodically dewatered between Miller Creek and the mouth. This list identifies streams that support or contribute to important fisheries that are significantly dewatered, referring to a reduction in streamflow below the point where stream habitat is adequate for fish. Chronically dewatered streams describe where dewatering is a significant problem in virtually all years whereas periodically dewatered streams describe where dewatering is a significant problem only in drought or water-short years. Two forest fires have burned in the Nemote Creek sub-watershed since 2001. The 2001 Mullan Gulch fire was quite small (approximately 15 acres) and was located in the Miller Creek drainage. The 2005 Tarkio fire was a large fire (approximately 9,477 acres), of which

approximately half or one-third of the total burn area was within the Nemote Creek drainage. This fire burned throughout most of the South Fork Nemote Creek drainage.

Agriculture

Agriculture is a primary land use in the Nemote Creek sub-watershed, particularly in the lower half of the stream, with crop production far more prevalent than livestock production. The Nemote Creek sub-watershed contains 3,175 acres (51%) of the Miller-Micayune grazing allotment number 00094. Nearly the entire area of this grazing allotment is public (USFS administered) land. However, according to USFS records, this grazing allotment is vacant with zero permitted AUMs, and the DEQ assessment record for Nemote Creek states that the allotment has been inactive since the 1970s. Several dryland parcels are used for pasture/hay production, particularly downstream along the lower reaches of the stream channel. DEQ's assessment record notes several crossings and trampled banks, which suggest grazing by livestock or game occurs throughout some of the private land in the lower reaches. Recent input from local landowners suggests that livestock grazing has not occurred along Nemote Creek for several years and that these areas are frequented by elk herds and other wildlife. Cultivated cropland is also common throughout the lower reaches on private land in the sub-watershed. A majority of the irrigated cropland is situated around the South Fork Nemote Creek confluence. The DEQ assessment record for Nemote Creek describes the stream as having frequent dry sections with subterranean flow, with adequate flow in the upper section but frequently dry throughout the lower reaches. The assessment record also includes local landowners' comments about recent and historic dredging that have altered the hydrologic properties of the stream, allowing water to go subsurface, and several points of diversion on the stream, some of which are substantial (e.g., > 4 cfs). Unirrigated crop production is also common in the vicinity of the Miller Creek confluence. For both TN and TP, several of the highest concentrations of nutrients were experienced around Miller Creek, suggesting agriculture (both crop and past livestock production) may be a relatively significant source contributing to the existing Nemote Creek TN and TP loads.

Silviculture

Analysis of aerial imagery and geospatial land cover data indicates silviculture activities are relatively common in parts of the Nemote Creek sub-watershed, and these activities typically occur on public land in the upper half of the watershed. There are several small scattered parcels where timber harvest occurred in the upper 2.5 miles of the stream. Here, there is also a network of logging roads in relatively close proximity to the stream. Runoff from the timber harvest activities and/or sedimentation from road influence may help to explain the elevated phosphorus concentrations exhibited in the dataset for the uppermost monitoring site. The most substantial area of timber harvest is found north of the segment and approximately mid-segment before the creek reaches the wider valley, between the Alice Creek and Central Clark Fork Basin Tributaries South Fork Nemote Creek confluences. Water quality data collected in these reaches of the stream do not indicate a discernible impact on nutrient water quality from these activities. Silviculture activities may be a minor contributor to nutrient loads in Nemote Creek.

Mining

According to DEQ records, there is one abandoned mine in the Nemote Creek sub-watershed, the Highbar Placer gold mine. This mine is located above the mouth northeast of the frontage road near the Interstate-90 crossing, and it does not appear on DEQ's Priority Mine Sites List. The site is having no discernible impacts on nutrient water quality based on water quality at the two downstream water quality monitoring sites.

Subsurface Wastewater Disposal and Treatment

According to DEQ records, there are nine individual septic systems in the Nemote Creek sub-watershed. All potential septic influence is located below the Alice Creek confluence. There is one septic system below the Alice Creek confluence and another below the Sheridan Creek confluence, although both are outside the main floodway. The other septic systems along the mainstem are all below the Round Mountain Road crossing. One of these, below the South Fork confluence, appears to be within 100 feet of the channel, and all others are more than 500 feet from the channel. Two individual septic systems are found in the lower reaches of Miller Creek and appear to be in close proximity (approximately 50 feet) of the stream channel. Septic effluent is considered a minor contributor to the existing Nemote Creek TN and TP daily loads based on instream water quality results.

A.8 Dry Creek: p. 148

Assessment of Loading by Source Categories

Dry Creek appears on the FWP dewatered streams list as being chronically dewatered on the lowermost reaches from the Dry Fork to the mouth, RM 0.0 to 3.2. This list identifies streams that support or contribute to important fisheries that are significantly dewatered, referring to a reduction in streamflow below the point where stream habitat is adequate for fish. Chronically dewatered streams describe where dewatering is a significant problem in virtually all years. According to previous DEQ assessment records for Dry Creek, a large irrigation diversion was observed taking a significant amount of water from the channel. It is unclear if the removal of this water causes the channel to become intermittent or if the channel would lose water naturally. Observations of a very large pipe on the hillside above the stream channel between the Dry Fork confluence and the mouth were also noted in previous assessments, although it is unclear if this pipe is used to divert or return water. The majority of the Dry Creek sub-watershed is forested with shrubland interspersed throughout. Two forest fires have burned in the Dry Creek drainage since 2000: in 2000, the Torino Peak fire (approximately 10 acres), and in 2009, the Ann Arbor fire (approximately 42 acres). Both fires occurred in the upper, northwestern portion of the drainage several thousands of feet from the Dry Creek channel. Since these are relatively small fires that were not in close proximity of the Dry Creek channel, they are not thought to have contributed substantial nutrients.

Agriculture

Agricultural land use in the Dry Creek sub-watershed is minimal, with only small amounts of both grazing and crop production. The Dry Creek sub-watershed is 28,697 acres, and 27,422 acres (96%) of this is public land. The sub-watershed contains a very small amount of allotment area relative to the total area of public lands. There is one grazing allotment that overlaps with the Dry Creek sub-watershed. The public lands within the grazing allotment boundary have, at most, 20 permitted AUMs. While it may be unlikely that all 20 permitted AUMs for the entire allotment area will be grazed exclusively on public lands within the Dry Creek sub-watershed, this represents the maximum AUMs possible at any given time. No attempts were made to verify actual grazing practices or current stocking densities. Presence of pasture land and moderate livestock use was noted in previous DEQ assessment records based on field observations, verifying that livestock grazing may be a minor contributor to the existing TN load in Dry Creek.
Analysis of aerial imagery and geospatial land cover data reveals the majority of drainage is forested with relatively small parcels of pasture land scattered throughout the drainage, much of which is located in the lower one-third to one-fifth of the channel extent and watershed area. Several relatively small parcels of cultivated cropland and pasture/hay are located just upstream from the mouth of Dry Creek. One small parcel of irrigated cropland is in this area near the mouth, which corresponds to a small area of barley and alfalfa production. Like grazing, irrigated cropland may be another minor contributor to the existing TN load in Dry Creek.

Silviculture

Silviculture activities are not a primary land use in the Dry Creek sub-watershed. An analysis of aerial imagery and geospatial land cover data reveals several small parcels of timber harvest in the northwestern portion of the sub-drainage, although these operations are not within close proximity to the stream channel. Contributions of nutrients to Dry Creek from timber harvest are unlikely. Forest Road 342 runs along much of the stream channel and is in relatively close proximity in some places. However, there exists a substantial riparian buffer between the road and the channel in most places and this road is not thought to be a substantial contributor of nutrients.

Mining

According to DEQ records, there are nine abandoned mines in the Dry Creek drainage, none of which appear on DEQ's Priority Mine Sites List. One underground past producer gold lode mine is in the Fourth of July Creek drainage; no mines are present above Fourth of July Creek confluence. Three past producer fluorine lode mines (including the Spar Mine) are scattered around mouth of the Bear Creek confluence just below the C04DRYC05 monitoring site. One past producer fluorine lode mine (Lucky Jack/Wilson Gulch) is in the lower reaches of Wilson Gulch that joins with Dry Creek below the Bear Gulch confluence, and the other cluster of abandoned mines is situated near mouth of Dry Fork. The proximity of these mines to the stream channel suggests that mining may be a minor contributor to nutrient loads in Dry Creek.

Subsurface Wastewater Disposal and Treatment
According to DEQ records, there are 12 individual septic systems in the Dry Creek sub-watershed. These are located in two clusters. One cluster has five individual septic systems and is situated just above the Dry Fork confluence. The other cluster has seven septics and is located below the monitoring site 0.5 miles below the Dry Fork confluence and above the mouth. The upper cluster has two septics that are approximately 50 to 150 feet from the channel, and the lower cluster has one septic system approximately 175 feet from the channel; all others are 500 to 1000 feet from the channel and thought to be outside the main floodplain. There is a discernible increase in TN concentrations at the site below the upper cluster of septic systems, although the Dry Fork also joins between these points. It is possible that septic effluent is a minor contributor to the existing Dry Creek TN daily load.

APPENDIX AA:
Sediment sources & activities contributing to non-pollutant impairments in all creeks

AA.1 Sediment Sources
Sediment was identified as impairing aquatic life in nine of the waterbodies identified in this document, which include: Flat Creek, West Fork Petty Creek, Petty Creek, Grant Creek, Cramer Creek, Tenmile Creek, Deep Creek, Mulkey Creek, and Rattler Gulch. Four different contributors were identified by the Central Clark Fork TMDL document as causes for sediment impairment.

<u>Streambank Erosion</u>
Streambank stability and erosion rates are closely linked to the health of the riparian zone. Changes at the watershed level might be caused by logging, mining, road building, Changes at the reach level might be riparian area modifications due to vegetation change or loss, animal use, stream channel straightening, or channel excavation and/or removal of material (stream bed mining), avulsion (abrupt change in stream course, such as meander neck cut-off) or climate change. Reductions in sediment loading from bank erosion are expected to be achieved by applying BMPs within the riparian zone. Sediment loads associated with bank erosion are identified by separate source categories (e.g., transportation, grazing, natural), however, because of the inherent uncertainty in extrapolating this level of detail to the watershed scale, and also because of uncertainty regarding the effects of past land management activity, all sources of bank erosion were combined to express the TMDL and allocations.

<u>Upland Erosion</u>
Upland erosion occurs when water runs over land forming channels or gullies. Sediment is able to travel easier through the channels and into the lake. Upland erosion becomes even more of a problem when upland trees, shrubs, and undergrowth are removed or soil is compacted. Under natural circumstances, vegetation absorbs and stores water, slows the flow, and allows water to infiltrate the soil. Causes of upland erosion can be from removal of buffering vegetation, concentrated runoff, compacted soil, and improper placement of impervious surfaces and other constructions that change and increase runoff patterns across the land. For all upland sources, the largest percent reduction will be achieved via riparian improvements. The anticipated loading reductions achievable by implementing upland and riparian BMPs for each land cover category. For the TMDL, the allocation to upland erosion sources is presented as a single load and percent reduction.

<u>Roads</u>
Erosion on roads is an important source of fine-grained sediment in streams. Routine maintenance of the BMPs is also necessary to ensure that sediment loading remains consistent with the intent of the allocations. At some locations, road closure or abandonment alone may be appropriate. Further, because of the low erosion potential linked to native vegetation growth on the road surface, additional BMPs may not be necessary.

<u>Storm Water Permits</u>
Because construction activities at any given site are temporary and relatively short term, the number of construction sites covered by the general permit at any given time varies. Collectively, these areas of severe ground disturbance have the potential to be significant sediment sources if proper BMPs are not implemented and maintained. Each construction

stormwater permittee is required to develop a Storm Water Pollution Prevention Plan (SWPPP) that identifies the stormwater BMPs that will be in place during construction.

AA.2 Activities Contributing to Non-pollutant Impairments

Non-pollutants are often used as a probable cause of impairment when available data at the time of a water quality assessment does not provide a direct, quantifiable linkage to a specific pollutant. In some cases, the pollutant and non-pollutant categories are linked and appear together in the list of impairment causes for a waterbody; however a non-pollutant impairment cause may appear independently of a pollutant cause. The contributors below were identified by the Central Clark Fork TMDL document as causes for non-pollutant impairment.

<u>Alteration in Streamside or Littoral Vegetation Covers</u>

Alteration in streamside or littoral vegetation covers refers to circumstances where practices along the stream channel have altered or removed riparian vegetation and subsequently affected channel geomorphology and/or stream temperature. Such instances may be riparian vegetation removal for a road or utility corridor, or overgrazing by livestock along the stream. As a result of altering the streamside vegetation, destabilized banks from loss of vegetative root mass could lead to over-widened stream channel conditions, elevated sediment and/or nutrient loads, and the resultant lack of canopy cover can lead to increased water temperatures.

<u>Physical Substrate Habitat Alterations</u>

Physical substrate habitat alterations generally describe cases where the stream channel has been physically altered or manipulated, such as through the straightening of the channel or from human influenced channel downcutting, resulting in a reduction of morphological complexity and loss of habitat (riffles and pools) for fish and aquatic life. For example, this may occur when a stream channel has been straightened to accommodate roads, agricultural fields, or through placer mine operations.

<u>"Cause Unknown"</u>

A 'cause unknown' impairment occurs when biological indicators suggest that a beneficial use is impaired, but no specific cause of impairment has been determined at that time. In Cramer Creek, the 'cause unknown' impairment was later determined to be sediment from past logging practices. Lack of appropriate timber harvest BMPs caused aggradation of sediment in the stream channel, causing Cramer Creek to become an intermittent stream channel in areas.

<u>Chlorophyll-a and Excess Algal Growth</u>

A chlorophyll-a or excess algal growth impairment occurs when excess levels of chlorophyll-a or algae in the stream impairs aquatic life and/or primary contact recreation. These high levels of chlorophyll-a or algae are caused by excess concentrations of nutrients in the stream which increases algal biomass. Chlorophyll-a and excess algal growth impairments are typically addressed by nutrient TMDLs.

<u>Low Flow Alterations</u>

Flow alteration refers to a change in the flow characteristics of a waterbody relative to natural conditions. Streams are typically listed as impaired for low flow alterations when irrigation withdrawal management leads to base flows that are too low to support the beneficial uses designated for that system. This could result in dry channels or extreme low flow conditions unsupportive of fish and aquatic life. Lower flow conditions can also result in increased stream temperatures, which in turn lowers dissolved oxygen conditions which may stress aquatic life.

It should be noted that while Montana law states that TMDLs cannot impact Montana water rights and thereby affect the allowable flows at various times of the year, the identification of low flow alterations as a probable source of impairment does not violate any state or federal regulations or guidance related to stream assessment and beneficial-use determination. Subsequent to the identification of this as a probable cause of impairment, it is up to local users, agencies, and entities to improve flows through water and land management.

APPENDIX B

Restoration strategies by pollutant causes (sediment, nutrients, turbidity, non-pollutants)

B.1 Sediment restoration strategies p. 278

An effective sediment restoration strategy for applying appropriate BMPs will help address sediment and other causes of impairment. The goal of the sediment restoration strategy is to limit the availability, transport, and delivery of excess sediment by a combination of minimizing sediment delivery, reducing the rate of runoff, and intercepting sediment transport. Sediment restoration activities on impaired stream segments will help reduce the amount of fine sediment, reduce width/depth ratio, increase residual pool depth, increase pool frequency, increase the amount of LWD (large woody debris), increase riparian understory shrub cover, reduce impacts of human-caused sediment sources, and restore appropriate macroinvertebrate assemblages. These are indicators of successful restoration activities targeted toward sediment reduction and need to be considered together and within the context of stream potential in comparison to appropriate reference sites. For example, LWD and pool frequency tend to decline as stream size increases; therefore, indicators for these parameters will vary.

Streamside riparian and wetland vegetation restoration and long-term management are crucial to achieving the sediment TMDLs. Native streamside riparian and wetland vegetation provides root mass that holds streambanks together. Suitable root mass density ultimately slows bank erosion. Riparian and wetland vegetation filters pollutants from upland runoff. Therefore, improving riparian and wetland vegetation will decrease bank erosion by improving streambank stability and will also reduce pollutant delivery from upland sources. Suspended sediment is also deposited more effectively in healthy riparian zones and wetland areas during flooding because water velocities slow in these areas enough for excess sediment to settle out. Restoration recommendations involve the promotion of riparian and wetland recovery through improved grazing and land management (including the timing and duration of grazing, the development of multi-pasture systems that include riparian pastures, and the development of offsite watering areas), application of timber harvest BMPs, restoration of streams affected by mining activity, floodplain and streambank stabilization, revegetation efforts, and instream channel and habitat restoration where necessary.

Appropriate BMPs will differ by location and are recommended to be included and prioritized as part of a comprehensive watershed scale plan (e.g., WRP). Unpaved roads are a small source of sediment at the watershed scale; however, sediment derived from roads may cause significant localized impact in some stream reaches. Restoration approaches for unpaved roads near streams primarily include measures that divert water to ditches before it enters the stream. The diverted water should be routed through natural healthy vegetation, which will act as filter zones for the sediment laden runoff before it enters streams. In addition, routine maintenance of unpaved roads (particularly near stream crossings) and proper sizing and maintenance of culverts, are crucial components to limiting sediment production from roads. Mining was not discussed in detail in the source assessment, but waste materials can be a component of upland and in-channel sediment loading.

The goal of the sediment restoration strategy is to limit the input of sediment to stream channels from abandoned mine sites and other mining-related sources. Goals and objectives for future restoration work include the following:

- Prevent waste rock and tailings materials/sediments from migrating to adjacent surface waters, where practicable.
- Reduce/eliminate concentrated runoff and discharges that transport sediment to surface waters, where practicable.
- Identify, prioritize, and select response and restoration actions of areas affected by historical mining, based on a comprehensive source assessment and risk analysis.

B.2 Nutrient Restoration strategies: P. 280

An effective nutrient restoration strategy is needed for nutrient impaired streams in order implement BMPs to meet the established TMDLs. The goal of the nutrient restoration strategy is to reduce nutrient input to stream channels by increasing the filtering and uptake capacity of riparian vegetation areas, decreasing the amount of bare ground, and limiting the transport of nutrients from rangeland, cropland, and mined areas (including impoundments and other storage facilities). The source assessment conducted to support TMDL development (Section 6.5 in full report) can help provide a starting point for where most loading is occurring but additional analysis and source identification will likely be required to identify site-specific delivery pathways and to develop restoration plans.

Development of an effective nutrient and irrigation management plans along with cropland filter strip extension, vegetative restoration, and long-term filter area maintenance are vital BMPs for agricultural areas. Grazing systems with the explicit goal of increased post-grazing vegetative ground cover are needed to address the same nutrient loading from rangelands. Grazing prescriptions that enhance the filtering capacity of riparian filter areas offer a second tier of controls on the sediment content of upland runoff.

Grazing and pasture management adjustments should consider:

- The timing, frequency, and duration of near-stream grazing
- The spacing and exposure duration of on-stream watering locations
- Providing off-stream watering areas to minimize near-stream damage and allow impoundment operations that minimize salt accumulations
- Active reseeding and rest rotation of locally damaged vegetation stands
- Improved management of irrigation systems
- Incorporation of streamside vegetation buffer to irrigated croplands and animal feeding areas

In general, these are sustainable grazing and cropping practices that can reduce nutrient inputs while meeting production goals. The appropriate combination of BMPs will differ according to landowner preferences and equipment but are recommended as components of a comprehensive plan for farm and ranch operators. Sound planning combined with effective conservation BMPs should be sought whenever possible. Assistance from resource professionals from various local, state, and federal agencies or non-profit groups is widely available in Montana.

In addition to the agricultural-related BMPs, a reduction of sediment delivery from roads and eroding streambanks is another component of the nutrient reduction restoration plan, particularly where excess phosphorus is a problem. All of the nutrient impaired streams in the Central Clark Fork Basin Tributaries TMDL Project Area are also impaired by sediment.

B.3 Turbidity Restoration strategies: p. 281

An effective restoration strategy for turbidity is needed for Trout Creek in order implement BMPs to meet the established TMDLs. Turbidity is often associated with excess suspended sediment or solids and, therefore linked to a sediment impairment. Trout Creek is also listed for sediment; therefore, the restoration strategy outlined in Appendix B.1 will address excess turbidity associated with suspended sediment and solids by minimizing sediment delivery, reducing the rate of runoff, and intercepting sediment transport. However, source assessment for Trout Creek points to wood leachate runoff from a holding pond on the site of a former sawmill operation as the primary source of turbidity. The holding pond has been filled and site has been converted to a facility producing posts and poles, wood pellets, and bark mulch since the original TMDL assessment was conducted. However, current operations still have the potential for wood leachate runoff and increases in turbidity above the standard. As with sediment, streamside riparian and wetland vegetation restoration and long-term management are crucial to achieving the turbidity TMDL. In addition, stormwater control measures should be implemented in order to reduce runoff from sawmill or wood product production operations. These can include: detention ponds to allow particles and associated pollutants to settle; turbidity curtains (minimize turbidity transport from a disturbed area to a body of water); and other practices designed to prevent water from entering or exiting the site.

B.4 Strategies for addressing impairments from Non-pollutants: p. 273 & 281

Although TMDL development is not required for non-pollutant listings, they are frequently linked to pollutants, and addressing non-pollutant causes, such as flow and habitat alterations, is an important part of TMDL implementation. Non-pollutant causes of impairment are often associated with sediment, nutrient, or temperature issues, but may have a deleterious effect on beneficial uses without a clearly defined quantitative link to a pollutant. Examples of non-pollutant causes found in this basin are: alteration in streamside or littoral vegetative covers (Mill, Sixmile), alteration of flow regimes (Cedar, Rattlesnake creeks), human constructed barriers that prevent fish passage (Tamarack Cr) and habitat alterations (Fish Cr). Typically, habitat impairments are addressed during implementation of associated pollutant TMDLs. Therefore, if restoration actions within the Central Clark Fork Basin Tributaries TMDL Project Area are not also addressing non-pollutant impairments, additional non-pollutant related BMP's should be considered. Many of these are described in the next section.

B.5 Riparian Areas, Wetlands, and Floodplains—values and restoration strategies: P. 285

Healthy and functioning riparian areas, wetlands, and floodplains are critical for wildlife habitat, groundwater recharge, reducing the severity of floods and upland and streambank erosion, and filtering pollutants from runoff. The performance of the above named functions is dependent on the connectivity of riparian areas, wetlands, and floodplains to both the stream channel and upland areas. Human activities affecting the quality of these transitional habitats or their connectivity can alter their performance and greatly affect the transport of water, sediments, and contaminants (e.g., channelization, increased stream power, bank erosion, and habitat loss or degradation). Therefore, restoring, maintaining, and protecting riparian areas, wetlands, and floodplains within the watershed should be a priority of TMDL implementation in the Central Clark Fork Basin Tributaries TMDL Project Area. Reduction of riparian and wetland vegetative cover by various land management activities is a principal cause of water quality and habitat degradation in watersheds throughout Montana. Although implementation of passive BMPs that allow riparian and wetland vegetation to recover at natural rates is typically the most cost-effective approach, active restoration (i.e., plantings) may be necessary in some instances. The primary advantage of riparian and wetland plantings is that installation can be accomplished with minimum impact to the stream channel, existing vegetation, and private property. Factors influencing the appropriate riparian and wetland restoration would include severity of degradation, site-potential for various species, and availability of local sources for native transplant materials. In general, riparian and wetland plantings would promote establishment of functioning stands of native species.

The following recommended restoration measures would help to stabilize soil, decrease sediment delivery to the stream, and increase absorption of nutrients from overland runoff:

- Harvesting and transplanting locally available sod mats with an existing dense root mass provides immediate promotion of bank stability and filtering nutrients and sediments
- Seeding with native graminoids (grasses and sedges) and forbs is a low cost activity at locations where lower bank shear stresses would be unlikely to cause erosion
- Willow sprigging expedites vegetative recovery, but involves harvest of dormant willow stakes from local sources
- Transplanting mature native shrubs, particularly willows (Salix sp.), provides rapid restoration of instream habitat and water quality through overhead cover and stream shading, as well as uptake of nutrients

Note: Before transplanting Salix from one location to another it is important to determine the exact species so that we do not propagate the spread of non-native species. There are several non-native willow species that are similar to our native species and commonly present in Montana watersheds. In addition to the benefits described above, it should be noted that in some cases, wetlands act as areas of shallow subsurface groundwater recharge and/or storage areas. The captured water via wetlands is then generally discharged to the stream later in the season and contributes to the maintenance of base flows and stream temperatures. Restoring ditched or drained wetlands can have a substantial effect on the quantity, temperature, and timing of water returning to a stream, as well as the pollutant filtering capacity that improved riparian and wetlands provide.

APPENDIX C
Restoration Approaches by Pollutant Source (agriculture, forestry, urban development)
P. 281-290

C1. Agriculture Sources:
Reduction of pollutants from upland agricultural sources can be accomplished by limiting the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil and runoff before it enters a waterbody. Not all agricultural sources of pollutants discussed in this section were identified in the Central Clark Fork Basin Tributaries TMDL Project Area; however, the recommendations below provide a useful guideline for a variety of agricultural activities. The main BMP recommendations for the Central Clark Fork Basin Tributaries TMDL Project Area include nutrient management plans, irrigation water management plans, riparian buffers, wetland restoration, and vegetative filter strips, where appropriate. These methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept pollutants. Filter strips and buffers are even more effective for reducing upland agricultural related sediment when used in conjunction with BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, and strip-cropping. Additional BMP information, design standards and effectiveness, and details on the suggested BMPs can be obtained from your local USDA Service Center and in Montana's Nonpoint Source Management Plan. An additional benefit of reducing sediment input to the stream is a decrease in sediment-bound nutrients. Reductions in sediment loads may help address some nutrient related problems. Nutrient management considers the amount, source, placement, form, and timing of plant nutrients and soil amendments. Conservation plans should include the following information:

- Field maps and soil maps
- Planned crop rotation or sequence
- Results of soil, water, plant, and organic materials sample analysis
- Realistic expected yields
- Sources of all nutrients to be applied
- A detailed nutrient budget
- Nutrient rates, form, timing, and application method to meet crop demands and soil quality concerns
- Location of environmentally sensitive areas, including streams, wetlands, springs, or other locations that deliver surface runoff to groundwater or surface water
- Guidelines for operation and maintenance

<u>C1.1. Grazing</u>
Grazing has the potential to increase sediment and nutrient loads, as well as stream temperatures (by altering channel width and riparian vegetation), but these effects can be mitigated with appropriate management. Development of riparian grazing management plans should be a goal for any landowner who operates livestock and does not currently have such plans. Private land owners may be assisted by state, county, federal, and local conservation groups to establish and implement appropriate grazing management plans. Riparian grazing management does not necessarily eliminate all grazing in riparian corridors. In some areas however, a more limited management strategy may be necessary for a period of time in order to accelerate reestablishment of a riparian community with the most desirable species composition and structure.

Every livestock grazing operation should have a grazing management plan. The NRCS Prescribed Grazing Conservation Practice Standard (Code 528) recommends the plan include the following:

- A map of the operation showing fields, riparian and wetland areas, winter feeding areas, water sources, animal shelters, etc.
- The number and type of livestock
- Realistic estimates of forage needs and forage availability
- The size and productivity of each grazing unit (pasture/field/allotment)
- The duration and time of grazing
- Practices that will prevent overgrazing and allow for appropriate regrowth

- Practices that will protect riparian and wetland areas and associated water quality
- Procedures for monitoring forage use on an ongoing basis
- Development plan for off-site watering areas reducing grazing pressure in riparian and wetland areas and improving forage stand health are the two keys to preventing NPS pollution from grazing. Grazing operations should use some or all of the following practices:
- Minimizing or preventing livestock grazing in riparian and wetland areas
- Providing off-stream watering facilities or using low-impact water gaps to prevent 'loafing' in wet areas • Managing riparian pastures separately from upland pastures
- Installing salt licks, feeding stations, and shelter fences in areas that prevent 'loafing' in riparian areas and help distribute animals
- Replanting trodden down banks and riparian and wetland areas with native vegetation (this should always be coupled with a reduction in grazing pressure)
- Rotational grazing or intensive pasture management that takes season, frequency, and duration into consideration

The key strategy of the recommended grazing BMPs is to develop and maintain healthy riparian and wetland vegetation and minimize disturbance of the streambank and channel. The primary recommended BMPs for the Central Clark Fork Basin Tributaries TMDL Project Area are limiting livestock access to streams and stabilizing the stream at access points, providing off-site watering sources when and where appropriate, planting native stabilizing vegetation along streambanks, and establishing and

C1.2. Flow and Irrigation

Flow alteration and dewatering are commonly considered water quantity rather than water quality issues. However, changes to streamflow can have a profound effect on the ability of a stream to flush sediment and attenuate other pollutants, especially nutrients, metals, and heat. Flow reduction may increase water temperature, allow sediment to accumulate in stream channels, reduce available habitat for fish and other aquatic life, and may cause the channel to respond by changing in size, morphology, meander pattern, rate of migration, bed elevation, bed material composition, floodplain morphology, and streamside vegetation if flood flows are reduced. Restoration targets and implementation strategies recognize the need for specific flow regimes, and may suggest flow-related improvements as a means to achieve full support of water quality beneficial uses. However, local coordination and planning are especially important for flow management because state law indicates that legally obtained water rights cannot be divested, impaired, or diminished by Montana's water quality law (MCA 75-5-705). Irrigation management is a critical component of attaining both coldwater fishery conservation and TMDL goals. Understanding irrigation water, groundwater, and surface water interactions is an important part of understanding how irrigation practices will affect streamflow during specific seasons. Some irrigation practices in western Montana are based on flood irrigation methods. Occasionally head gates and ditches leak, which can decrease the amount of water in diversion flows. The following recommended activities could potentially result in notable water savings:

- Install upgraded head gates for more exact control of diversion flow and to minimize leakage when not in operation
- Develop more efficient means to supply water to livestock
- Determine necessary diversion flows and timeframes that would reduce over watering and improve forage quality and production
- Where appropriate, redesign or reconfigure irrigation systems
- Upgrade ditches (including possible lining, if appropriate) to increase ditch conveyance efficiency

Some water from spring and early summer flood irrigation likely returns as cool groundwater to the streams during the heat of the summer. These critical areas could be identified so that they can be preserved as flood irrigation areas. Other irrigated areas which do not contribute to summer groundwater returns to the river should be identified as areas where year-round irrigation efficiencies could be more beneficial than seasonal management practices. Winter baseflow should also be considered during these investigations.

C1. 3. Cropland

The primary strategy of the recommended cropland BMPs is to reduce sediment inputs. The major factors involved in decreasing sediment loads are reducing the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil before it enters waterbodies. The main BMP recommendations for the Central Clark Fork Basin Tributaries TMDL Project Area are vegetated filter strips and riparian buffers. Both of these methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept sediment. Effectiveness is typically about 70 percent for the filter strips and 50 percent for the buffers. Filter strips and buffers are most effective when used in conjunction with agricultural BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, strip cropping, and precision farming. Filter strips along streams should be composed of natural vegetative communities. BMPs that reduce sediment delivery are also effective for decreasing nutrient loads to streams. However, developing a nutrient management plan is also recommended for cropland agricultural activities.

C2.   Forestry and Timber Harvest – P. 285

The Central Clark Fork Basin Tributaries TMDL Project Area has been impacted by recent and historical timber harvest activities. Future harvest activities should be conducted by all landowners according to Forestry BMPs for Montana and the Montana SMZ Law (77-5-301 through 307 MCA). The Montana Forestry BMPs cover timber harvesting and site preparation, harvest design, other harvesting activities, slash treatment and site preparation, winter logging, and hazardous substances. While the SMZ Law is intended to guide commercial timber harvesting activities in streamside areas (i.e., within 50 feet of a waterbody), the riparian protection principles behind the law can be applied to numerous land management activities (i.e., timber harvest for personal use, agriculture, development). Prior to harvesting on private land, landowners or operators are required to notify the Montana DNRC. The DNRC is responsible for assisting landowners with BMPs and monitoring their effectiveness. The Montana Logging Association and DNRC offer regular Forestry BMP training sessions for private landowners. The SMZ Law protects against excessive erosion and therefore is appropriate for helping meet sediment LAs. USFS INFISH Riparian Habitat Conservation Area guidelines provide significant sediment protection as well as protection from elevated thermal loading (i.e., elevated temperature) by providing adequate shade. This guidance improves upon Montana's SMZ law and includes an undisturbed 300 foot buffer on each side of fish bearing streams and 150 foot buffer on each side of non-fish bearing streams with limited exclusions and BMP guidance for timber harvest, roads, grazing, recreation and other human sources. The Lolo National Forest adheres to these guidelines. The NFHCP developed by Plum Creek Timber includes a riparian management section that supplements the SMZ riparian buffer rules to help Plum Creek minimize impacts from timber harvest in riparian areas. It includes specific commitments to leave more trees in locations that provide the maximum benefit, such as channel migration zones and provide for an additional caution area outside of the SMZ. Many of the requirements of the NFHCP are still attached to lands purchased as part of the Montana Legacy Project. In addition to the BMPs identified above, effects that timber harvest may have on yearly streamflow levels, such as peak flow, should be considered. Water yield and peak flow increases should be modeled in areas of continued timber harvest and potential effects should be evaluated. Furthermore, increased use, construction, and maintenance of unpaved roads associated with forestry and timber harvest activities should be addressed with appropriate BMPs. Finally, noxious weed control should be actively pursued in all harvest areas and along all forest roads.

C.3   Residential/Urban Development – P. 286-286

There are multiple sources and pathways of pollution to consider in residential and urban areas. Destruction of riparian areas, pollutants from both functioning and failing septic systems, and stormwater generated from impervious areas and construction sites are discussed below.

C.3.1. Riparian Degradation

Residential development adjacent to streams can affect the amount and health of riparian vegetation, the amount of LWD available in the stream, and might result in placement of riprap on streambanks. As discussed in the above section on riparian areas, wetlands, and floodplains, substantially degraded riparian areas do not effectively filter pollutants from upland runoff. Riparian areas that have been converted to lawns or small acreage pastures for domestic livestock may suffer from increased contributions of nutrients, sediment, and bacteria, as well as increased summer stream temperatures, increased channel erosion, and greater damage to property from flooding. For landowners, conservation easements can be a viable alternative to subdividing land and can be facilitated through several organizations such as TNC, the Trust for

Public Land, and FWP. DEQ encourages the consideration of adopting local zoning or regulations that protect the functions of floodplains and riparian and wetland areas where future growth may occur. Requirements for protecting native vegetation riparian buffers can be an effective mechanism for maintaining or improving stream health. Local outreach activities to inform new residential property owners of the effects of riparian degradation may also prevent such activities from occurring, including providing information on: appropriate fertilizer application rates to lawns and gardens, regular septic system maintenance, preserving existing riparian vegetation, native vegetation for landscaping, maintaining a buffer to protect riparian and wetland areas, and practices to reduce the amount of stormwater originating from developed property. Montana's Nonpoint Source Management Plan contains suggested BMPs to address the effects of residential and urban development, and also contains an appendix of setback regulations that have been adopted by various cities and counties in Montana.

C.3.2. Septic Systems

There are 95 identified septic systems within the Central Clark Fork Basin Tributaries TMDL Project Area, the majority of which are within the Grant, West Fork Petty, and Stony Creek watersheds. This number is likely to increase with future residential development within the Central Clark Fork Basin Tributaries TMDL Project Area. Nutrient loading values for septic systems vary depending on soil type and distance to the nearest stream, but typical values for nitrate and total phosphorous loads from individual septic systems are 30.5 lbs/yr and 6.44 lbs/yr, respectively. However, septic systems should already have minimum design/installation requirements, which should serve as a basic BMP. Older systems should be upgraded and all new systems should meet these minimum requirements.

C.3.3. Stormwater

Where precipitation from rain or snowmelt events does not infiltrate soils in urban areas and at construction sites, it drains off the landscape as stormwater, which can carry pollutants into waterways. As the percentage of impervious surfaces (e.g., streets, parking lots, roofs) increases, so does the volume of stormwater and pollutant loads delivered to waterbodies. Although rain and snowmelt events contribute to pollutant loads, stormwater is not currently identified as a major source of pollutant contributions for the streams discussed in this document. Sediment, nutrient and temperature loads can also be affected by stormwater runoff from these point sources. However, DEQ assumes that the WLAs will be met by adhering to the permit requirements, and the WLAs are not intended to add load limits to these permits. Although no LAs are provided for nonpoint contributions, stormwater management should be a consideration when identifying water quality improvement objectives within the WRP. The primary method to control stormwater discharges is the use of BMPs.

C.3.4. Bank Hardening/Riprap/Revetment/Floodplain Development

The use of riprap or other "hard" approaches is not recommended and is not consistent with water quality protection or implementation of this plan. Although it is necessary in some instances, it generally redirects channel energy and exacerbates erosion in other places. Bank armoring should be limited to areas with a demonstrated threat to infrastructure. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of the upper bank, reduce stream scouring energy, and provide shading and cover habitat. Limit threats to infrastructure by reducing floodplain development through local land-use planning initiatives. Bank stabilization using natural channel design techniques can provide both bank stability and aquatic habitat potential. The primary recommended structures include natural or "natural-like" structures, such as LWD jams. These natural arrays can be constructed to emulate historical debris assemblages that were introduced to the channel by the adjacent cottonwood-dominated riparian community types. When used together, woody debris jams and straight log vanes can benefit the stream and fishery by improving bank stability, reducing bank erosion rates, adding protection to fillslopes and/or embankments, reducing near-bank shear stress, and enhancing aquatic habitat and lateral channel margin complexity.

C.3.5. Unpaved Roads and Culverts

Unpaved roads contribute sediment (as well as nutrients and other pollutants) to streams in the Central Clark Fork Basin Tributaries TMDL Project Area. The road sediment reductions provided in this document, and detailed in Appendix D, represent an estimate of the sediment load that would remain once additional road BMPs are applied. The main focus of the BMPs used to estimate reduction in loading was to reduce the contributing length to the maximum extent practicable at each crossing. Achieving this reduction in sediment loading from roads may occur through a variety of methods at the discretion of local land managers and restoration specialists. Examples of road BMPs can include:

- Providing adequate ditch relief upgrade of stream crossings
- Constructing waterbars, where appropriate, and up-grade of stream crossings
- Using rolling dips on downhill grades with an embankment on one side to direct flow to the ditch
- Insloping roads along steep banks with the use of cross slopes and cross culverts
- Outsloping low traffic roads on gently sloping terrain with the use of a cross slope
- Using ditch turnouts and vegetative filter strips to decrease water velocity and sediment carrying capacity in ditches
- For maintenance, grading materials to the center of the road and avoid removing the toe of the cutslope
- Preventing disturbance to vulnerable slopes
- Using topography to filter sediments; flat, vegetated areas are more effective sediment filters
- Where possible, limiting road access during wet periods when drainage features could be damaged

Undersized and improperly installed and maintained culverts can be a substantial source of sediment to streams, and a barrier to fish and other aquatic organisms. As culverts fail, they should be replaced by culverts that pass a 100-year flood event on fish bearing streams and at least 25-year events on non-fish bearing streams. If funding is available, culverts should be prioritized and replaced prior to failure. Another consideration for culvert upgrades should be fish and aquatic organism passage.

C. 4 Mining - P. 289

The Central Clark Fork Basin Tributaries TMDL Project Area and Montana more broadly, have a legacy of mining that continues today. Mining activities may have impacts that extend beyond increased metal concentrations in the water. Channel alteration, riparian degradation, and runoff and erosion associated with mining can lead to sediment, habitat, nutrient, and temperature impacts as well. There is also a need for further characterization of impairment conditions and loading sources.

APPENDIX D

Detailed Recommendations for Data Collection and Monitoring

D. 1. Strategies for Strengthening Source Assessment for specific Pollutants - P. 295-297

Strategies for Strengthening Sediment Assessments:
• Field surveys of all roads and road crossings to identify specific contributing segments and crossings, their associated loads, and prioritize those road segments/crossings of most concern.
• Reviews of land-use practices within the specific sub-watersheds of concern to determine where the greatest potential for improvement and likelihood of sediment reduction can occur for the identified major land-use categories.
• More thorough examinations of streambank erosion conditions and investigation of related contributing factors for each sub-watershed of concern through site visits and sub-watershedscale BEHI assessments.

Additionally, the development of bank erosion retreat rates specific to the Central Clark Fork Basin Tributaries TMDL Project Area would provide a more accurate quantification of sediment loading from bank erosion. Bank retreat rates can be determined by installing bank pins at different positions on the streambank at several transects across a range of landscape settings and stability ratings. Bank erosion is documented after high flows and throughout the year for several years to capture retreat rates under a range of flow conditions.

Strategies for Strengthening Temperature Assessments:
• Field surveys to better identify and characterize riparian area conditions and potential for improvement
• Identification of possible areas for improvement in shading along major tributaries
• Evaluating potential temperature improvements (via shade) within major tributaries and then incorporating those improvements into future modeling to further refine naturally occurring conditions
• Collection of flow measurements at all temperature monitoring locations during the time of data collection • Identify areas where wildlife may be impacting riparian vegetation
• Investigation of groundwater influence on instream temperatures, and relationships between groundwater availability and water use in the Nemote, Petty, and Grant Creek watersheds and the entire Central Clark Fork Basin Tributaries TMDL Project Area
• Assessment of irrigation practices and other water use in Nemote, Petty, and Grant Creek watershed and Central Clark Fork Basin Tributaries TMDL Project Area and potential for improvements in water use that would result in increased instream flows
• Use of additional collected data to evaluate and refine the temperature targets

Strategies for Strengthening Nutrient Assessments:
• A better understanding of nutrient concentrations in groundwater (as well as the sources) and the spatial variability of groundwater with high nutrient concentrations
• A better understanding of cattle grazing practices and the number of animals grazed in the Central Clark Fork Basin Tributaries TMDL Project Area
• A better understanding of the impacts of wildlife grazing in riparian areas
• A more detailed understanding of nutrient contributions from historical and current mining within the watershed
• A better understanding of septic system contributions to nutrient loads, specifically in the Grant, Stony, and West Fork Petty Creek watersheds
• A review of land management practices specific to sub-watersheds of concern to determine where the greatest potential for improvement can occur for the major land-use categories
• Additional sampling in streams that have limited data

Strategies for Strengthening Turbidity Assessments:
• A better understanding of background turbidity levels on Trout Creek and other streams within the Central Clark Fork Basin Tributaries TMDL Project Area

• A more detailed and updated assessment of sources of turbidity on Trout Creek
• Regularly scheduled sampling at consistent locations, under a variety of seasonal conditions to assess overall stream health and monitor change.

D.2 Consistent Data Collection and Methodologies P. 294-298

Sediment:
For sediment investigation in the Central Clark Fork Basin Tributaries TMDL Project Area, each of the streams of interest was stratified into unique reaches based on physical characteristics and human caused influences. A total of 17 sites were sampled throughout the watershed, which is only a small percentage of the total number of stratified reaches, and even less on a stream by stream basis. Sampling additional monitoring locations to represent some of the various reach categories that occur would provide additional data to assess existing conditions. It would also provide more specific information on a per-stream basis and for the Central Clark Fork Basin Tributaries TMDL Project Area as a whole and can be used for reach by reach comparisons and assessing potential influencing factors and resultant outcomes that exist throughout the project area.

When possible, when collecting sediment and habitat data in the Central Clark Fork Basin Tributaries TMDL Project Area it is recommended that at a minimum the following parameters be collected to allow for comparison to TMDL targets:
• Riffle Cross Section: using Rosgen methodology
• Riffle Pebble Count: using Wolman Pebble Count Methodology
• Pool Assessment: count and residual pool depth measurements

Additional information will undoubtedly be useful and assist DEQ with TMDL effectiveness monitoring in the future. Macroinvertebrate studies, McNeil core sediment samples, and fish population surveys and redd counts are examples of additional useful information used in impairment status monitoring and TMDL effectiveness monitoring that were not developed as targets but were reviewed where available during the development of these TMDLs.

Temperature:
Temperature investigation for Nemote, Petty, and Grant Creek watersheds included a total of 28 data loggers, deployed throughout these streams and selected tributaries in summer months of either 2011 or 2012. Increasing the number of data logger locations and the number of years of data, including collection of associated flow data, would improve our understanding of instream temperature changes and better identify influencing factors on those changes. Collecting additional stream temperature data in sections with the most significant temperature changes and/or largest spatial gaps between loggers will also help refine the characterization of temperature conditions in Nemote, Petty, and Grant Creeks. In addition, riparian shade data were collected using a combination of field data and aerial imagery analysis. A Solar PathfinderTM was used to measure effective shade on dates during the late summer at 22 sites. Since shade is the major focus of the allocations, a more detailed assessment of existing riparian conditions and identification of areas for passive and active restoration of riparian vegetation on Nemote, Petty, and Grant Creeks and their major tributaries is recommended. Since Nemote Creek did not have a sediment TMDL developed for it, width-depth ratio and channel dimension data were not collected. Collecting this data in the future can help further understand the temperature issues on Nemote Creek. Finally, coordinating with other organizations to incorporate suitable temperature data will improve future assessments of Central Clark Fork Basin Tributaries TMDL Project Area streams.

It is important that temperature data are collected in consistent locations and using consistent methods. Data loggers should be deployed at the same locations through the years to accurately represent the site-specific conditions over time, and recorded temperatures should at a minimum represent the hottest part of the summer when aquatic life is most sensitive to warmer temperatures. Data loggers should be deployed in the same manner at each location and during each sampling event, and follow a consistent process for calibration and installation. Any modeling that is used should refer to previous modeling efforts for consistency in model development to ensure comparability. In addition, flow measurements should also be conducted using consistent locations and methodology.

Nutrients:
Water quality sampling locations for nutrients were distributed spatially along each stream in order to best delineate nutrient sources and provide a comprehensive upstream to downstream view of nutrient concentrations. Sampling occurred over several seasons from 2003 through 2012, with most data collected after 2011. Additional water column and biological sampling is recommended to help refine the impairment cause(s) and sources. To better evaluate nutrient loading, source refinement will continue to be necessary on all streams with nutrient TMDLs and those that have not yet been assessed in the project area. With changing land uses and/or new permitted discharges to surface waters, it will be important to continually assess nutrient sources in a watershed.
For those watershed groups and/or government agencies that monitor water quality, it is recommended that the same analytical procedures and reporting limits are used so that water quality data may be compared to TMDL targets. In addition, stream discharge should be measured at time of sampling.

D.3 Monitoring Guidelines – P. 294

As restoration activities are implemented, monitoring is valuable to determine if restoration activities are improving water quality, instream flow, and aquatic habitat and communities. Monitoring can help attribute water quality improvements to restoration activities and ensure that restoration activities are functioning effectively. Restoration projects will often require additional maintenance after initial implementation to ensure functionality. It is important to remember that degradation of aquatic resources happens over many decades and that restoration is often also a long-term process. An efficiently executed long-term monitoring effort is an essential component to any restoration effort.

The objectives for future monitoring in the Central Clark Fork Basin Tributaries TMDL Project Area include:

- Strengthen the spatial understanding of sources for future restoration work, which will also improve source assessment analysis for future TMDL review
- Gather additional data to supplement target analysis, better characterize existing conditions, and improve or refine assumptions made in TMDL development
- Coordinate among agencies and watershed groups to ensure that information is comparable to the established water quality targets and allows for common threads in discussion and analysis
- Expand the understanding of streams and NPS pollutant loading throughout the Central Clark Fork Basin Tributaries TMDL Project Area beyond those where TMDLs have been developed and address issues
- Track restoration projects as they are implemented and assess their effectiveness
- Monitor the impacts of wildlife grazing in riparian areas

APPENDIX E

Completed and Ongoing Projects Focused on Temperature – P. 274-279

Shade targets were developed to provide temperature control on Petty, Nemote, and Grant Creek. The goal of the temperature restoration approach is to reduce water temperatures where possible to be consistent with naturally occurring conditions. Two different approaches were used to meet temperature goal targets in the Project Area. For Petty Creek, the approach is based on a riparian buffer target that will provide the effective shade consistent with a naturally occurring condition. For Nemote and Grant, the target is based on an effective shade value that would result from a naturally occurring riparian buffer.

Petty Creek

Based on several literature sources finding that most shade is obtained within a buffer width of 50 feet, and that 50 feet is the minimum buffer width for the Montana SMZ, the riparian shade target is a buffer width of 50 feet. This buffer should consist of medium density trees, dense shrubs such as willow or alder, or any vegetation providing equivalent effective shade. DEQ realizes most healthy riparian buffers are composed of more than a single category of vegetation, but a buffer of medium density trees or dense shrubs, such as willow or alder, is used as the Petty Creek shade target for two reasons: 1) the actual composition of the riparian zone under target shade conditions will vary over time and is too complex to model with QUAL2K, and 2) based on existing vegetation in the watershed and what is known of historical conditions, the effective shade provided by medium density trees or dense shrubs was determined to be a reasonable target. Considering the variability in potential vegetation and shade, these vegetation categories were used as surrogates to represent the average achievable shade condition; effective shade is the result of topography and vegetative height and density, so the target shade condition could be achieved by a large combination of vegetation types and densities. Additionally, the effective shade potential at any given location may be lower or higher than the target depending on natural factors such as fire history, soil, topography, and aspect but also because of human alterations to the near-stream landscape including roads and riprap that may not feasibly be modified or relocated.

Nemote and Grant Creeks

For Nemote Creek and Grant Creek, DEQ used a new approach, identifying reaches where the riparian shade is likely at potential and setting corresponding average effective shade as the target for the shade-deficient reaches. The shade target is provided as a quantitative guide for field assessment of standard attainment. Since it is intended to represent a naturally occurring condition after implementation of all reasonable land, soil, and water conservation practices, then application of these practices will eventually result in these streams will be meeting the riparian shade target. Nevertheless, there could be a time lag between application of the reasonable land, soil, and water conservation practices necessary to obtain a healthy stream buffer and meeting the shade targets since it can take years or even decades for trees to grow in areas where they have been removed or negatively impacted.

Other Temperature Control Approaches:

Other factors that will help are: using water conservation measures to maximize water left in the stream, improving over-widened portions of the stream, improving urban stormwater management, and maintaining conditions where theses creeks are currently meeting the targets. Increases in shade can be accomplished through passive restoration and protection of shade-providing vegetation within the riparian corridor. This type of vegetation can also have the added benefit of improving streambank stabilization to reduce bank erosion, slowing lateral river migration, and providing a buffer to prevent pollutants from upland sources from entering the stream. There are numerous BMPs that provide guidelines for reducing impacts in these areas to help restore riparian vegetation, such as fencing, zoning and setback regulations, and off-road vehicle management. Other areas may require planting, active bank restoration, and protection from browse to establish vegetation.

Portions of Petty and Nemote Creeks ran dry by the end of the summer during data collection. It is unknown to what extent instream flow could be increased. If increases in instream summer flows are possible, they can be achieved through a thorough investigation of water use practices and water conveyance infrastructure, and a willingness and ability of local water users to keep more water in the stream. These scenarios showed that improvements in stream temperatures can primarily be made by improvements to riparian shade. It is strongly encouraged that resource managers and land owners continue to work to identify all potential areas of improvement and develop projects and practices to reduce stream temperatures in Grant, Nemote, and Petty Creeks, as well as other streams in the Central Clark Fork Basin Tributaries TMDL Project Area that show the potential for elevated water temperatures. Local water users should work collectively and with local, state, and federal resource management professionals to review water use options and available assistance programs. Recovery of stream channel morphology in most cases will occur slowly over time following the improvement of riparian condition, stabilization of streambanks, and reduction in overall sediment load.

The full 697 page Central Clark and Tribs TMDL/Water Quality Improvement Plan can be seen at :

http://deq.mt.gov/Portals/112/water/wqpb/CWAIC/TMDL/COL-TMDL-01a.pdf