

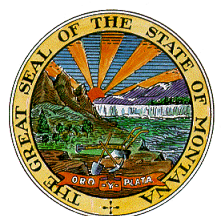


Kennedy Creek Watershed TMDL Implementation Evaluation



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Before and after photos of restoration efforts on Kennedy Creek.
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ACRONYMS

BMP	Best Management Practice
CWA	Clean Water Act
DEQ	Montana Department of Environmental Quality
MCA	Montana Code Annotated
NGO	Non-Government Organization
NOAA	National Oceanic and Atmospheric Administration
SAP	Sampling and Analysis Plan
TIE	TMDL Implementation Evaluation
TMDL	Total Maximum Daily Load
TU	Trout Unlimited
USDA	United States Department of Agriculture
USFS	United States Forest Service
WQPB	Water Quality Planning Bureau

DOCUMENT SUMMARY

The Kennedy Creek watershed encompasses approximately 3,513 acres in Missoula County in western Montana. Land use in the watershed consists mostly of traditional agricultural operations, remnants of historical mining activities and remediation of historical mining practices. The Kennedy Creek headwaters originate between McCormick Peak and Ch-paa-qn Peak in the Ninemile Divide Mountain range and flow westward (**Map A-1**) to its confluence with Ninemile Creek. Surface flow from Kennedy Creek does not reach Ninemile Creek.

As required by Montana state law and the federal Clean Water Act, the Montana Department of Environmental Quality (DEQ) develops total maximum daily load (TMDL) documents that provide water quality goals and criteria for impaired waterbodies to attain water quality standards (DEQ 2019). In 2005, DEQ published the “Water Quality Restoration Plan and Total Maximum Daily Loads for the Ninemile Planning Area”, which provides TMDLs for sediment and metals impairments in Kennedy Creek.

In watersheds with approved TMDL documents, DEQ periodically reviews the progress of restoration efforts, the progress toward meeting TMDL water quality goals, and documents the results in what is called a “TMDL implementation evaluation” (TIE) document. This Kennedy Creek Watershed TIE provides information as well as recommendations for potential next steps to address water quality impairments. As indicated in **Table 1** Kennedy Creek has a number of impairments, including sediment, metals, flow regime modifications, and alteration in stream-side or littoral vegetative covers. **Table 1** below identifies each of the waterbody and impairment causes in Kennedy Creek. The primary focus of this TIE is on metals and sediment impairments as they have established TMDLs. That being said, some additional evaluation of flow regime modifications or alterations in stream-side littoral vegetative covers are included.

Table 1. Waterbodies and Impairments Addressed by this TMDL Implementation Evaluation

Waterbody (Assessment Unit) and Location Description	Assessment Unit ID	Impairment(s)
Kennedy Creek, Headwaters to mouth (Ninemile Creek)	MT76M004_070	Mercury Zinc Lead Copper Flow regime modification Sedimentation/Siltation

Local, state, and federal entities have invested significant resources in reclamation and restoration efforts that have the potential to improve water quality within the Kennedy Creek and Ninemile watersheds. Trout Unlimited (TU), the U.S. Forest Service (Lolo National Forest), DEQ, and other private entities have all worked to restore beneficial uses to Kennedy Creek. These monitoring, planning, and restoration efforts have laid the foundation for additional work that will be needed to attain water quality standards. This includes continued planning and restoration efforts that will mitigate impacts from pollutant sources. While water quality monitoring can provide information about pollutant sources and pathways, the primary focus in the Kennedy Creek watershed should be on designing and implementing projects to reduce sediment and metals loading.

1.0 PURPOSE OF THIS TMDL IMPLEMENTATION EVALUATION

As required by Montana state law, DEQ develops TMDL documents that provide a framework for water quality restoration efforts. DEQ works with local, state, federal, and private partners to assist entities conducting voluntary nonpoint source water quality improvement activities. DEQ periodically reviews the progress of restoration efforts and documents the results in a “TMDL implementation evaluation” or (TIE) document.

In the 2000 and 2002 list of impaired waters (303(d) list), DEQ determined that Kennedy Creek did not support its aquatic life, cold-water fishery, or drinking water beneficial uses, and only partially supported its recreation beneficial use due to metals pollution, dewatering, flow alterations, and other habitat alterations. In 2005, DEQ published the “Water Quality Restoration Plan and Total Maximum Daily Loads for the Ninemile Planning Area” document (DEQ 2005), which provides TMDLs for sediment and metals for the Kennedy Creek watershed. Kennedy Creek is currently (2020 303(d) List) considered impaired for metals (copper, lead, zinc, and mercury), sediment, flow regime modifications and alteration in stream-side or littoral vegetative covers.

This TIE is an evaluation of progress toward meeting the water quality goals of the 2005 TMDLs, as well as an evaluation of the efforts to address water quality impairments and DEQ’s recommendations for potential next steps for addressing water quality impairments. The Kennedy Creek TIE also accomplishes the goal of providing a TMDL implementation evaluation consistent with the requirements of the Montana Water Quality Act (75-7-703(9), Montana Code Annotated).

2.0 KENNEDY CREEK WATERSHED TMDL IMPLEMENTATION EVALUATION CONCLUSIONS

The Kennedy Creek watershed continues to be impacted by pollution from a number of sources. DEQ has drawn the conclusion that reclamation work and reasonable land, soil and water conservation activities within the Kennedy Creek watershed have resulted in some improvements in water quality and habitat. Specifically, mercury is no longer considered to be causing impairment to Kennedy Creek, and Habitat conditions (alterations in stream side vegetation) are improving. However, conditions in Kennedy Creek have not improved to the point that standards for all parameters are being met (**Section 5.0**). At this time, Kennedy Creek will remain on DEQ’s list of impaired waters. Section 4 details the waterbody pollutant combinations that will remain on DEQs list of impaired waters and those that will come off the list. To achieve water quality standards and fully restore support for beneficial uses, additional reductions in metals and sediment loading are necessary. Additional focus is needed on funding and implementing projects and practices that reduce sediment and metals loading from historical mining, unpaved roads, and other disturbances caused by human activities.

Section 6.0 of this document outlines the planning efforts, reclamation and restoration actions, and water quality monitoring that has taken place in the watershed to support the above conclusions, and **Section 9.1** provides a list of individuals from DEQ and other agencies and organizations contacted to discuss those efforts. **Sections 6.0** and **7.0** of this document provide DEQ’s recommendations for next steps toward meeting the water quality goals of the 2005 TMDLs and attaining Montana’s water quality standards.

3.0 IMPAIRMENTS ADDRESSED IN THIS DOCUMENT

Land disturbances resulting from historical mining efforts, particularly those associated with the Kennedy Creek mining complex, comprise the main sources of metals and sediment in Kennedy Creek. These disturbances have caused widespread impacts to stream channel function. In general, mining in Kennedy Creek has resulted in elevated metals concentrations in sediment and surface water, exceedances of standards, over widening of the stream channel, a decrease in habitat diversity, and impaired riparian vegetation growth leading to continued stream channel degradation and decreased stream channel function.

Pollutants in the Kennedy Creek watershed are linked to particular sources. Metals are linked to historical mining, human caused land disturbances, and naturally occurring loading (local geology). In the case of sediment pollution, the primary sources include historical mining impacts, runoff from unpaved roads, and other human caused land disturbances. As each pollutant is linked to a source/sources, each source should be addressed before waterbodies can achieve water quality standards. TMDLs have been developed for the Kennedy Creek watershed for various pollutant-waterbody combinations. The main causes of impairment include sediment and metals (**Table 2**).

Table 2. Waterbody Impairments identified in the TMDL and Probable Sources in Kennedy Creek

Waterbody Name	Impairment(s)	Sources
Kennedy Creek, Headwaters to mouth (Ninemile Creek)	Copper	Historical Mining, Roads, other Human Sources, Naturally Occurring
	Lead	
	Zinc	
	Mercury	
	Sedimentation/Siltation	Roads, Mining, Silviculture, Background
	Alteration in Stream-Side of Littoral Vegetative Covers	Not addressed in the 2005 TMDL Document
	Flow regime modification	

Alterations to stream-side vegetative cover and flow regime modification are considered “pollution,” while metals and sediment/siltation are considered “pollutants.” TMDLs are only required for “pollutants” that are causing or contributing to waterbody impairments. Since TMDLs are only required for pollutants and alterations to stream-side vegetative cover and flow regime modification are not pollutants, no TMDLs were developed for this pollution, and they will not be given thorough evaluation in this TIE.

4.0 INDICATORS OF PROGRESS

Local, state, and federal entities have invested resources in restoration efforts that have the potential to improve water quality within the Kennedy Creek watershed. Trout Unlimited, the USDA Forest Service, The Montana Department of Natural Resources and Conservation, DEQ, Missoula County, and private entities have all worked to restore functionality of portions of Kennedy Creek.

The USFS and Trout Unlimited have been particularly active in the watershed, overseeing projects such as mine reclamation, stream channel stabilization and restoration, road reconstruction and maintenance, and culvert removals. State and local government have also worked to fund and implement reclamation work in the watershed. **Table 3** identifies projects that have been implemented in Kennedy Creek and are contributing to the restoration of Kennedy Creek and the surrounding watershed.

Table 3. Efforts toward Restoring the Kennedy Creek Watershed

Project Name	Project Sponsor	Funding Year	Work Completed By	Project Description
Hazardous Materials Survey*	DEQ	1993	Pioneer Technical Services	Collection of waste rock samples from mine complex as well as streambed sediment, and surface water samples from Kennedy Creek
Kennedy Creek Site Investigation	Trout Unlimited	2010	Trout Unlimited	Continued investigation into the scale of metals pollution associated with historic mining
Preliminary Assessment and Site Investigation	Trout Unlimited/Missoula County	2011	New Fields (AMEC Geomatrix)	Evaluate the nature and extent of impacts to land and surface water resulting from historic mining practices
Kennedy Creek Mines Removal Project	USDA Forest Service	2015	USDA Forest Service	Mine reclamation, waste rock removal, construction of infiltration gallery, lined diversion ditch around waste rock repository
Sediment & Metals Reevaluation	DEQ	2020	DEQ	Reassessment of metals and sediment impairment status of Kennedy Creek, post remediation and restoration actions on the Kennedy Creek Mining Complex

* In 1993, the Montana Department of State Lands' (now DNRC) Abandoned Mine Reclamation Bureau Montana completed this work. DEQ now has jurisdiction over this type of work.

4.1 METALS DATA EVALUATION

In 2020, DEQ collected water quality samples at six sites on three occasions. These samples were analyzed for Aluminum (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Mercury (Hg), Lead (Pb), Selenium (Se), Silver (Ag), and Zinc (Zn). A total of six of the samples were collected during high flow in June. The remaining samples were collected during baseflow conditions. The majority of all metals sample concentrations that were above standards were taken during high flow conditions. Water column data for each metal was evaluated against numeric water quality standards (acute chronic and human health) according to DEQ's assessment method for metals (DEQ 2012). DEQ's Monitoring and Assessment Section performed a reassessment Kennedy Creek using the aforementioned data. The results of this reassessment will be available in the 2022 Integrated Report scheduled for publication in the spring of 2023. **Tables B-1 and B-2 in Appendix B** show the water

chemistry data for Cu, Pb, Zn and Hg (the existing metals impairments in Kennedy Creek) pre and post restoration.

Table 4 provides water quality restoration targets for those metals that exceed B-1 classification water quality standards in Kennedy Creek, including Cu, Pb, Zn and Hg. The water quality restoration targets for Cu, Pb and Zn are based on the hardness-adjusted chronic aquatic life criteria, which are the most stringent of the state's water quality standard for these metals. Hg standards are based on the human health standard, which is more stringent than the aquatic life standard; but for Hg the standard is not hardness dependent, and thus neither is the target.

Table 4. Impaired Metals Water Quality Targets

Parameter	Target concentration (ug/L)
Copper	5.2 (low flows) 2.9 (high flows)
Lead	1.3 (low flows) 0.5 (high flows)
Zinc	67 (low flows) 37 (high flows)
Mercury	0.05 (all flows)

Of the metals sampled in Kennedy Creek in 2020 (Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Se, Ag, and Zn), four (Al, Cu, Pb, and Zn) were found to be above water quality standards. Cu, Pb, and Zn were previously listed as impairments to Kennedy Creek and should remain on the impaired metals list. In addition to this, metals concentration in Al were found to be above the standard and should be added to the list of metals causing impairment to Kennedy Creek. Previous impairment determinations for Kennedy Creek indicated it as being impaired for Hg. No samples taken during the 2020 effort showed concentrations above the standards, and therefore the Hg impairment listing will be removed for Kennedy Creek in the 2022 Integrated Report.

Metals water quality data has been collected in the Kennedy Creek watershed on and off from as early as 1993. Not all the data collected prior to restoration meets DEQ quality assurance standards. Typical water quality data analysis conducted pre 2000 employed analysis methods that are not currently in use and are considered to have provided marginal results. As a result, data from this time have been excluded from DEQ's consideration. Exclusion of this data eliminates any data from upstream of the mine sites that could be used as a reference to background water quality. Data base queries through DEQs SANDS and Montana EQUIS (<https://deq.mt.gov/water/Programs/sw>) have yield additional data was collected in 2010. This data does not include quality assurance qualifiers such as the agency responsible for the data collection, analytical methods, method detection limits, hardness values, etc. As result, this data was eliminated from consideration from pre-restoration water quality.

In 2003 and 2004 DEQ collected water quality samples (**Table 2**) the results of which meet most of the WQPB quality assurance criteria. These data are used to provide a snapshot of metals water quality pre-restoration. Post restoration water quality data (**Table B-1**) were collected in 2020 at multiple monitoring locations throughout the watershed during the summer field season and meet the current DEQ quality assurance criteria.

The average pre-restoration (2003 and 2004 data) copper water quality concentration decreased from 3.25 ug/L to 2.02 ug/L post restoration (2020 data). The average lead concentrations decreased from 4.33 ug/L pre-restoration to 0.55 ug/L post-restoration. While there was limited data for mercury, data

indicate a decrease of average concentration from 0.20 pre restoration to 0.003 ug/L post-restoration. Average zinc concentrations indicate an increase from 62.25 mg/L pre restoration to 80.8 ug/L post restoration. With the exception of zinc concentrations, these data indicate an average decrease in metals concentrations. This decrease in metals concentrations can be attributable to restoration actions completed in the watershed.

4.2 SEDIMENT DATA EVALUATION

In 2020, metals sediment data were collected in Kennedy Creek. Benthic sediment metals data were considered separately from water column metals data and were not explicitly included in the assessment decision-making process. Data were evaluated using NOAA's Screening Quick Reference Tables for Inorganics in Soil or Probable Effect Levels (PEL). Three arsenic, one copper, three lead, and two zinc sample concentrations were above the screening criteria used. When compared to metals sediment data collected in 2003 as part of the TMDL development efforts, this indicates an overall increasing trend in metals sediment concentrations. **Table B-3 in Appendix B** contains pre and post restoration metals sediment data and the NOAA PELs.

As mentioned above, the recent (2020) water quality data collected in Kennedy Creek indicated exceedance of the water quality standards for Al, Cu, Pb and Zn. Sediment metals data indicated that select metals are present in concentrations above NOAA PELs, and in concentrations that appear higher than those from 2003. DEQ has conducted impairment determinations and concluded that Cu, Pb, and Zn should remain on the impaired metals list, Al should be added and Hg should be removed.

Sediment assessment parameters were monitored by DEQ at two sites in 2020, with all sites representing the same reach type (Middle Rockies ecoregion, reach slope between 2 and 4 percent, Strahler 1st stream order, and unconfined valley). These data are presented in **Table B-4 in Appendix B**. Fine sediment parameters (riffle and pool tail fines) and coarse sediment and habitat parameters (width to depth ratio, residual pool depth, and pool frequency) were evaluated to determine whether Kennedy Creek continues to be impaired by sediment.

To assess sediment parameters, the average of all sites (KNDY01-01 and KNDY02-01) were compared against a reference dataset to determine attainment of water quality standards for sediment. Two of three parameters (percent riffle fines < 6 mm and percent pool tail fines < 6 mm) for fine sediment did not meet reference conditions. No parameters for coarse sediment successfully passed reference targets for width to depth ratio, residual pool depth, or pool frequency. In addition, several locations on Kennedy Creek demonstrated increased aggradation of fine sediment moving downstream from the headwaters to the mouth. For these reasons, Kennedy Creek is considered impaired for sediment.

4.3 HABITAT DATA EVALUATION

While not impaired for fish passage or habitat alterations (alterations in stream side vegetation) significant work has been conducted on Kennedy Creek to improve habitat and remove fish passage barriers. Between August and November 2015, the U.S. Forest Service conducted reclamation activities on the Lost Cabin Mine and the Nugget Mine sites (**Map A-2**). During this effort mine waste rock from both mine sites was removed from locations adjacent to Kennedy Creek and relocated to an unlined repository, Kennedy Creek was relocated back to the center of the valley bottom, large woody debris was added to the stream channel and riparian vegetation was replanted. During this effort a partial fish passage barrier and a irrigation diversion were removed improving stream function.

4.4 PROGRESS SUMMARY

The monitoring and restoration efforts described above have laid the foundation for additional work that will be needed to attain water quality standards. This includes continued watershed-scale planning and restoration efforts that will mitigate impacts from mining and other human-caused sources. While water quality monitoring can provide additional information about pollutant sources and pathways, the primary focus in the Kennedy Creek watershed should be on designing and implementing projects to reduce sediment and metals loading.

5.0 STRATEGIC PLANNING

Addressing water quality impairments requires project planning, implementation, and monitoring of water quality improvements. In preparing the Kennedy Creek TIE, DEQ staff reached out to local, state, and federal entities involved in water quality improvement efforts (**See Section 9.0**). From these contacts, DEQ compiled a list of planning, restoration, and monitoring activities that provide an indication of progress addressing sediment, and metals pollution sources in the watershed. These indicators do not account for those efforts by private citizens that may be taking place to reduce nonpoint source water pollution.

State and federal agencies, local conservation organizations, and Non-Government Organizations (NGOs) have already contributed significant resources towards reducing pollution in the Kennedy Creek watershed. All the cooperating parties should take stock in the fact that these efforts will continue to show improvements in water and sediment quality, and the relationships built through these initial efforts serve as a building block for continued efforts in the watershed. These relationships are instrumental to getting projects completed. It is essential to encourage partnerships in the watershed and expand efforts to develop new working relationships between stakeholders.

Indicators of progress towards achieving Kennedy Creek watershed targets generally fall into one of three major categories: 1) Planning, 2) Restoration, and 3) Monitoring. Below is a summary of actions taken in the Kennedy Creek watershed under these broad categories.

5.1 PLANNING

- Trout Unlimited has discussed the potential for additional water quality monitoring of Kennedy Creek, additional monitoring and assessment of the upstream mine site (Hautilla), and restoration of instream flows that will allow for connectivity with Ninemile Creek
- The USFS has discussed the potential for reevaluation of the Kennedy Creek watershed. This may include water sampling that could be compared to data collected in the preliminary engineering report that was completed prior to reclamation (AMEC 2011a)
- The USFS is planning approximately 62 acres of Ecosystem Maintenance Burning, 187 acres of stand thinning and prescribed fire and 1,152 acres of thinning. Timing of these efforts is dependent on air quality/climate conditions and accessibility to treatment areas (USFS 2020)
- The USFS is planning to implement a tree thinning and slashing, prescribed fire, weed treatment and road treatments through the Soldier Butler fuels mitigation project. The project area includes Kennedy Creek and will:
 - Decrease fire potential and enhance firefighter efficiency

- Maintain and enhance the resilience of forested communities to stressors (Fire Draught etc.)
 - Manage variability across the landscape
 - Include an additional 3 miles of new road construction
- The USFS and a private landowner agreed to a settlement clarifying that the lower Flescher ditch was to be abandoned and the upper ditch with its associated conduit was to remain authorized

5.2 ON-THE-GROUND RESTORATION ACTIONS

- 2015 Mine Reclamation, Stream Channel Reconstruction, and Road Removal
 - Haul roads and waste rock repository construction erosion control measures included in construction efforts
 - Discharge from Nugget Mine diverted to the existing discharge pond. Kennedy Creek diverted. Erosion control measures implemented to ensure limited impacts from construction
 - Excavation of waste rock from Lost Cabin and Nugget mines; waste rock deposited in unlined repository
 - Kennedy Creek reconstructed to the center of the valley; riparian area stabilized and replanted.
 - Repository backfilled, covered with fill and topsoil, seeded, and dispersed wood debris across the site. A lined stormwater diversion ditch was constructed around the repository and catchment structures were installed
 - Infiltration gallery at nugget mine constructed
 - Mine adit unearthed at Nugget Mine site; adit drained and bulkhead installed; remaining adit drainage routed to infiltration gallery
 - As part of the mine reclamation, a partial fish passage barrier and non-compliant irrigation diversion, were removed, improving fish passage
- The USFS has implemented its weed treatment program on the reclamation site and repository for two years
- Private landowner to abandon use of lower Flescher ditch

5.3 MONITORING

- In 1993, Pioneer Technical Services completed hazardous materials inventories of the three mine sites in the Kennedy Creek mining complex
- In 2003 and 2004, DEQ conducted water quality monitoring and beneficial use assessment
- 2010 sampling was conducted by AMEC Geomatrix to inform site cleanup actions
- In 2011, New Fields Companies completed preliminary site assessments and site investigations at the 3 mine sites on behalf of Trout Unlimited and Missoula County
- In 2011, AMEC Geomatrix collected additional surface water data and adit water quality and discharge measurements to characterize the adit discharge at the Nugget Mine
- Engineering Evaluation and Cost Analysis for the Kennedy Creek mining complex completed by AMEC Geomatrix Inc. for Trout Unlimited and USFS
- In 2015, Trout Unlimited conducted photo point monitoring of the reclamation work that was being conducted at the Nugget and Lost Cabin mine sites
- In 2015, the USFS conducted soils monitoring of the mine waste piles to determine potential contributions of metals to Kennedy Creek

- In 2015, the USFS conducted water quality sampling of the existing discharge pond at the Nugget Mine site as well as water quality data from Kennedy Creek
- In 2020, DEQ collected water quality samples, sediment monitoring, and metals sediment samples for use in the reassessment of the impairment status of Kennedy Creek
- The USFS has been conducting ongoing monitoring of vegetation conditions in the Kennedy drainage with a focus on the reclaimed areas
- The USFS is conducting periodic site visits and observational monitoring to track improvement in the reclaimed areas. Reclamation and rehabilitation actions are currently meeting project goals and success criteria

6.0 TMDL IMPLEMENTATION RECOMMENDATIONS

As described in the Ninemile Watershed TMDL document (DEQ 2005), excess sediment and metals loading to Kennedy Creek continue to prevent water quality standards from being achieved. Excess pollutant loading can lead to conditions that negatively impact a number of beneficial uses in each waterbody, as described in the 2005 TMDL document (DEQ 2005). Sediment and metals pollution in the Kennedy Creek watershed come from a wide variety of sources, including:

- Historical mining sites
- Improperly constructed and maintained road networks (over-steepened cut and fill slopes, etc.) and associated road features (culverts, stream crossings, etc.)
- Stream channel alterations resulting from human activity
- Other sources resulting from human caused land disturbances
- Naturally occurring

The 2005 TMDL document outlines general and site-specific recommendations to reduce sediment and metals pollution to acceptable levels. The sediment TMDL for Kennedy Creek was set at 49.9 tons /year. The TMDL can be achieved by reducing sediment loading from mining sources by 100 % (719 tons per year), and from forest roads by 81 % (31.8 tons per year). By achieving these reductions from existing sources, the TMDL of 49.9 tons/year can be achieved.

The Ninemile Watershed TMDL document also includes the recommendations described for Kennedy Creek below:

- Restore mining impacted areas
 - Passive and active restoration to achieve all reasonable land, soil, and water conservation practices
 - Increased water quality and sediment monitoring to better identify the impacts of historical mining
 - Pursue funding for restoration of historic mining impacts.
 - Utilization of the following state and federal mine reclamation program
 - The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
 - The Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA)
 - The Controlled Allocation of Liability Act (CALA)
 - The Voluntary Cleanup and Redevelopment Act (VCRA)

- The Abandoned Mine Lands Reclamation Program (AML)
- Reduce sediment contributions from roads
 - Upgrade forest roads to meet Montana Forestry BMPs
 - Reclaim forest roads that are surplus to the needs of forest managers
 - Upgrade undersized culverts over time to better accommodate large floods and reduce the risk of culvert failure
 - Reduce cut/fill slope length and proximity to waterbodies
 - Improving road crossings and culverts that contribute large quantities of sediment
 - Improve road maintenance and construction methods
- Improve stream channel floodplain restoration efforts
 - Reduce and repair straightened stream channel
 - Improve riparian vegetation health and abundance
 - Limit bank armoring
 - Develop a floodplain management plan
- General watershed scale restoration efforts
 - Implement Montana’s Forestry BMPs on all timber harvest operations
 - Conduct post fire restoration and sediment mitigation efforts as needed
 - Encourage riparian restoration
 - Manage noxious weeds.
 - Promote non-structural erosion control.
 - Identify and remove fish passage barriers that are significantly affecting the connectivity of native fish habitats.
 - Continue riparian management and monitoring in areas impacted by livestock use.
 - Encourage flood plain development setback.
 - Coordinate with the local watershed group to implement TMDL recommendations on private land and to bring residents and landowners into the TMDL and watershed restoration process.

7.0 RECOMMENDATIONS FOR ADDITIONAL RESTORATION EFFORTS

Below are specific recommendations to address sediment, nutrient, and metals pollutant reductions from the more prevalent sources in the Kennedy Creek watershed.

7.1 MINING

While the Nugget and lost Cabin Mines have been reclaimed, there is still reclamation/restoration work that can take place in the Kennedy Creek watershed.

Recommendations:

- Reclamation/restoration is needed at the Hautilla Mine site and in any areas that have not seen restoration.
 - At the Hautilla site, the stream channel on the uppermost portion of the site is constrained by historic mine tailings on either bank; the lowermost portion of the site is impacted from a culvert and road crossing.

- Hard rock mine reclamation efforts should focus on:
 - Removal of mine waste rock
 - Closure of adits
 - Decommissioning of associated infrastructure
 - Revegetation of disturbed land
- Assessment of the reclamation/restoration potential needed at several smaller mine sites scattered across the watershed. These sites include:
 - Kennedy Creek Gold Mine CI1821 Mine
 - Kennedy Creek Gold Mine CI1822 Mine
 - Kennedy Creek Placer I Mine
 - Kennedy Creek Placer II Mine
- Throughout the watershed, stakeholders should continue efforts to reclaim abandoned mining sites and seek assistance from state and federal agencies that can aid in these efforts
 - MT DEQ Abandoned Mine Lands program can support mine reclamation activities through CERCLA and CECRA if mine sites are considered Priority Mines
 - DNRC Reclamation and Development Program (RDP) can support planning and project grants that mitigate the effects of mineral development of public resources
 - USFS Abandoned Mines Land Program restoration policy is to minimize the environmental impacts resulting from mining and ensure that disturbed lands are returned to a use that is consistent with long-term forest land resource management plans
- In mined areas close or adjacent to the floodplain, it may be beneficial to:
 - Conduct stream channel restoration efforts that focus on streambank and floodplain disturbances downstream of mining sources and address:
 - Channel straightening
 - Mine waste in stream channel
 - Culverts or flow control structures that may be impeding flow or fish passage
 - Impairments of riparian vegetation
 - Protect riparian vegetation and allow natural floodplain building and recovery to continue.
 - Alternatively, consider the introduction of beaver or use of beaver mimicry structures and induced meandering techniques where feasible to restore natural stream form and function.
- All new mining activities must obtain the appropriate state and federal permits and apply all reasonable land, soil, and water conservation practices to protect water quality and channel condition.
- Conduct water quality, sediment, temperature, habitat, and photo point monitoring to refine source area locations, and determine if water quality and stream channel condition are improving and determine what extent of metals loading is a result of naturally occurring metals concentrations.
 - Monitoring should take place at established monitoring locations during period of high flow, base flow and low flows.
 - Monitoring should also take place upstream and downstream of the Hautilla Mine site to ascertain if this mine site is contributing metals or sediment to Kennedy Creek.
 - Monitoring should take place downstream of the infiltration gallery at the Nugget mine site that is receiving adit discharge water. Monitoring efforts should aim to determine if these features are contributing sources of metals and sediment to Kennedy Creek.

7.2 ROADS

Sediment loading to streams from roads has been significantly reduced in the watershed, but the road network should continue to be evaluated for maintenance or closure.

Recommendations:

- Use construction, restoration, and maintenance techniques that minimize sediment delivery to nearby surface waters.
- In those instances where water and associated sediments leave the road corridor, provide adequate sediment filtration between the road and stream. If possible and practicable, increase the distance between the road and stream. Encourage plant growth in riparian buffer areas and install slash filters and spreader structures.
- Prevent the disturbance of vulnerable slopes or other areas that will be difficult to maintain.
- Evaluate potential fish passage barriers in the form of culverts and use BMPs or mitigation practices to elevate these barriers.

7.3 IRRIGATION AND AGRICULTURAL WITHDRAWALS

Current irrigation and agricultural withdrawals from Kennedy Creek limit its ability to reach its confluence with Ninemile Creek. Some improvements to irrigation and livestock watering practices may help the system to regain connectivity. **Table 5** shows a description of active water rights in Kennedy Creek.

Table 5: Active Water Rights in Kennedy Creek

Water Right Type	Status	Source	Means of Diversion	Purpose of Right	OWNER	Flow Rate (CFS)	Annual Volume (acre Ft)
PROVISIONAL PERMIT	ACTIVE	KENNEDY CREEK	HEADGATE	IRRIGATION	OUZEL REACH RANCH LLC		211.86
PROVISIONAL PERMIT	ACTIVE	KENNEDY CREEK	HEADGATE	STOCK	OUZEL REACH RANCH LLC		211.86
EXEMPT NOTICE	ACTIVE	KENNEDY CREEK	LIVESTOCK DIRECT FROM SOURCE	STOCK	WILD ROSE RANCH MT LLP		0.26
STATEMENT OF CLAIM	ACTIVE	KENNEDY CREEK	HEADGATE	MINING	USA (DEPT OF AGRICULTURE FOREST SERVICE)	2	725.78
PROVISIONAL PERMIT	ACTIVE	KENNEDY CREEK	UNKNOWN	DOMESTIC	HORNSETH, GARY & JEANNE	0.02	1
PROVISIONAL PERMIT	ACTIVE	KENNEDY CREEK	PUMP	MINING	SNELL ROY L	0.22	24
PROVISIONAL PERMIT	ACTIVE	KENNEDY CREEK	PIPELINE	MINING	MOUNTAIN CHIEF INC	0.27	73
STATEMENT OF CLAIM	ACTIVE	KENNEDY CREEK	HEADGATE	IRRIGATION	ZHN LP	1.78	441.8
STATEMENT OF CLAIM	ACTIVE	KENNEDY CREEK	HEADGATE	MINING	ZHN LP	4.5	990
STATEMENT OF CLAIM	ACTIVE	KENNEDY CREEK	DITCH/GRAVITY FLOW	DOMESTIC	EMERY, RICHARD K & TERESA T	0.03	6
STATEMENT OF CLAIM	ACTIVE	KENNEDY CREEK	DIKE	IRRIGATION	EMERY, RICHARD K & TERESA T	0.15	

STATEMENT OF CLAIM	ACTIVE	KENNEDY CREEK	HEADGATE	IRRIGATION	ESLINGER, DEBORAH A & Larry K	0.23	
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Recommendations:

- Work with the appropriate regulatory agency (MT DNRC) to determine if the correct water rights are being allocated
- Ensure that diversions and irrigation structures are being utilized in accordance with state and federal law
- Work with irrigators in the watershed to determine if irrigation efficiencies can be improved

8.0 MONITORING RECOMMENDATIONS

A number of monitoring efforts have taken place throughout the watershed. DEQ, Trout Unlimited, and USFS have collected flow, water quality, and sediment data in Kennedy Creek. Trout Unlimited has been particularly active in the Kennedy Creek watershed promoting the large-scale restoration projects. While these monitoring efforts have provided significant data, continued water quality monitoring is necessary.

Water quality, biological, stream morphology, and photo point monitoring are necessary to gather information about pollutant sources, pathways and impacts to the watershed. Monitoring should be conducted in a manner that will aid in determining restoration project effectiveness and provide information on future restoration activities. The primary focus in the Kennedy Creek watershed should be on designing and implementing projects to reduce sediment and metals loading.

Future sediment and metals related monitoring could focus on the list of below items. These efforts would ideally be in collaboration with DEQ's Monitoring and Assessment Section or other state and federal agencies and NGOs active in data collection in the watershed (DEQ, USFS, TU, etc.). Future monitoring needs to meet all of DEQ's quality assurance requirements including the use of appropriate analytical methods, as well as meeting sample preservation and holding times.

- Establish a long-term monitoring program that captures spatial and temporal variability in water quality, sediment and riparian health data in Kennedy Creek.
- Select monitoring locations that can serve as long-term monitoring stations. Consideration should be given to established sampling locations that have comprehensive data.
- Conduct sampling that targets pollutants of concern. This includes flow, sediment, metals and riparian vegetation health.
- Monitoring in the mainstem of Kennedy Creek should focus on areas that have seen restoration and are showing improvement in water quality or have the potential to improve in water quality.
- Conduct more detailed monitoring to establish current conditions, more precisely characterize contributing sources, and establish trends in water quality data for assessment and future restoration planning throughout the watershed.
 - This includes water quality sampling in Kennedy Creek above and below the Hautilla Mine, and sampling of seeps, springs, or adits within the footprint of the mine.
 - Additional monitoring should be conducted at the Nugget Mine bulkhead prior to discharge to the infiltration gallery to characterize the quality of water being discharged.

- Conduct sampling in accordance with approved sampling protocols, methodologies, and appropriate quality assurance and quality control to ensure data will be of a known quality.

Montana's water quality standards (DEQ 2019) serve as the water quality targets to be attained for a waterbody to be considered impaired. For each pollutant, water quality standards are applied to the parameters that link directly to the impaired beneficial use(s) and applicable water quality standard(s) (see **Tables B-1** and **B-2**). Comparing existing stream conditions to target values or narrative standards allows for a better understanding of the extent and severity of the problem. Numeric water quality standards are those that have been developed for parameters that are determined to be toxic, carcinogenic, or harmful and have a chronic or acute value that is not to be exceeded. Narrative standards are developed for substances or conditions that do not have numeric standards. Kennedy Creek has metals and sediment impairments - both numeric and narrative targets, respectively. How narrative standards were applied to individual waterbody and source combinations is complex. To determine how targets were applied to Kennedy Creek, it is best to reference DEQ's Ninemile TMDL document (DEQ 2005).

9.0 INFORMATION SOURCES AND REFERENCES

9.1 COMMUNICATION SOURCES

A number of individuals provided information in support of TIE development. A significant amount of information to support this document was gathered through personal conversations with individuals from other agencies and NGOs working in the watershed. Their names and associations are described in **Table 6**.

Table 6. Kennedy Creek Watershed Contacts

Name	Title	Organization
Paul Parson	Engineer	Trout Unlimited
Robert Wintergerst	Engineer	USFS, Lolo National Forest
Traci Stylte	Engineer, Hydrologist	USFS, Lolo National Forest
Jim Nave	Resource Conservation Manager	Montana Department of natural Resources and Conservation
Bob Flesher	Senior Environmental Project Officer	DEQ, Waste Management and Remediation Division
Eric Trum	Section Supervisor	DEQ, Nonpoint Source and Wetlands Section

9.2 DOCUMENT REFERENCES

AMEC Geomatrix, Inc. (AMEC), 2011a. Draft Engineering Evaluation & Cost Analysis, Project No. MT10160140. Missoula, Montana

AMEC Geomatrix, Inc. (AMEC), 2011b. Preliminary Assessment / Site Investigation (PA/SI) Report. February 2011

Montana Department of Environmental Quality. 2005. Water Quality Restoration Plan and Total Maximum Daily Loads for the Ninemile Planning Area. Helena, MT: Montana Department of Environmental Quality

<https://deq.mt.gov/files/water/wqpb/CWAIC/TMDL/C04-TMDL-01a.pdf>

Montana Department of Environmental Quality. 2012. Montana Department of Environmental Quality Metal Assessment Method. Helena, MT: Montana Department of Environmental Quality.

https://deq.mt.gov/files/Water/SurfaceWater/UseAssessment/Documents/Metals_Assessment_Method.pdf

Montana Department of Environmental Quality. 2019. Circular DEQ-7: Montana Numeric Water Quality Standards. Helena, MT: Montana Department of Environmental Quality.

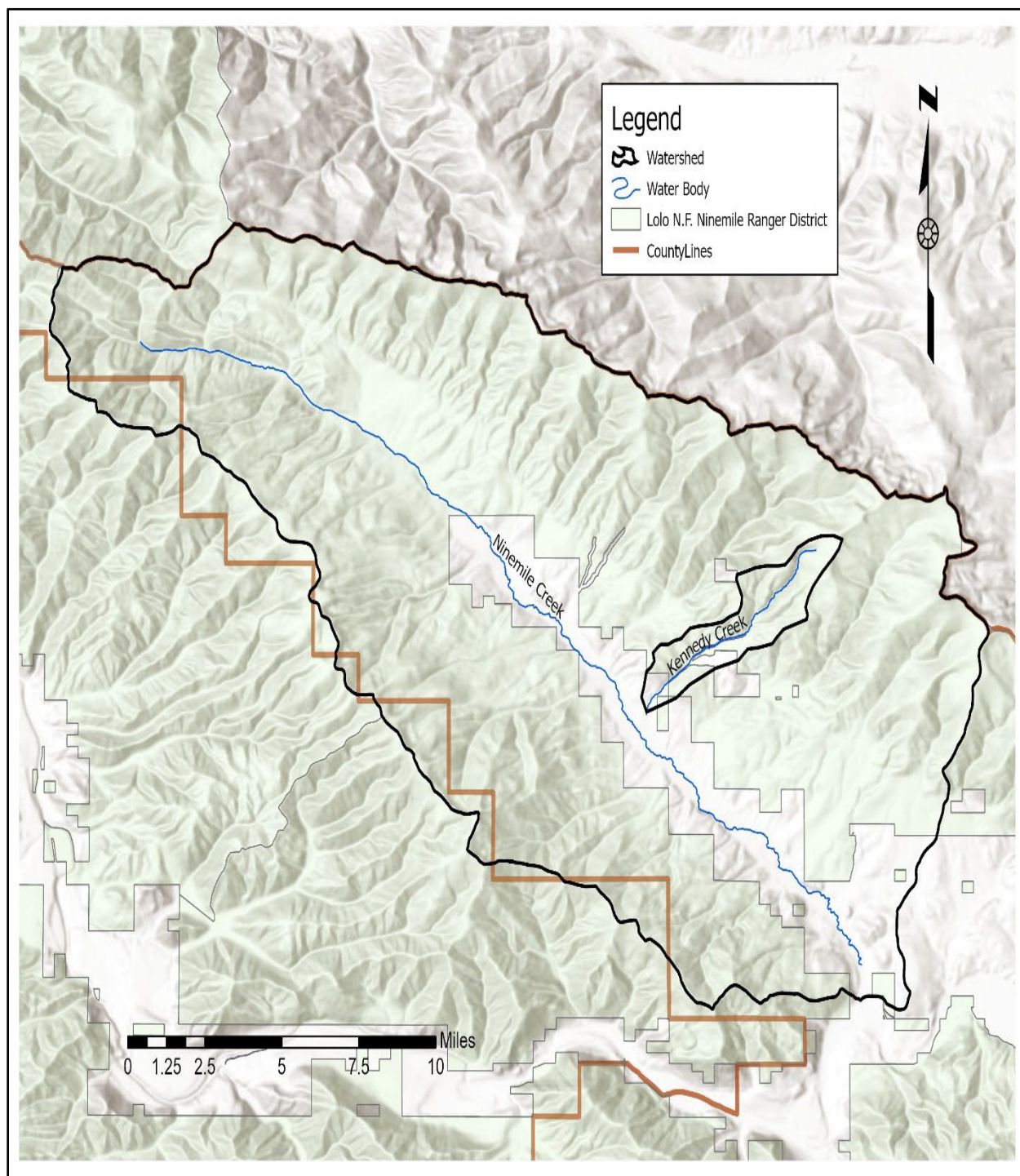
<https://deq.mt.gov/files/Water/WQPB/Standards/PDF/DEQ7/DEQ-7.pdf>.

Pioneer Technical Services, 1993. Excerpt from: Hazardous Materials Inventory. Prepared for Montana Department of State Lands, Bureau of Abandoned Mines. July 1993.

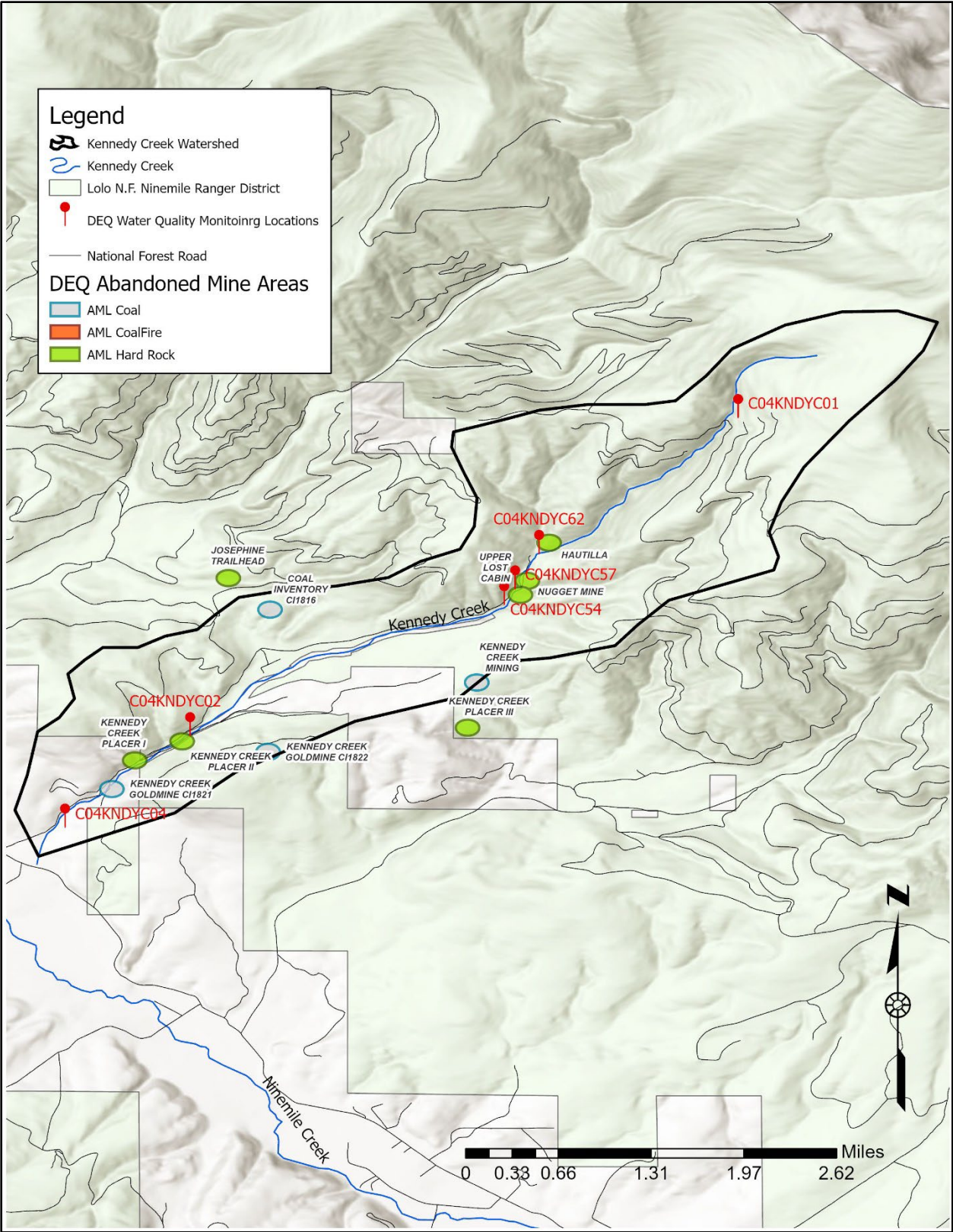
Trout Unlimited (TU), 2010. Kennedy Creek Site Investigation. Prepared by Trout Unlimited and attached to Trout Unlimited Request for Proposal for Kennedy Creek Preliminary Assessment and Site Investigation. April 12, 2010.

United States Forest Service. December 2015. Completer Report Kennedy Creek Mining Complex. Prepared by: Bob Wintergerst, Contracting Officer's Representative USDA-Forest Service

United States Forest Service. December 2020. Solider-Butte Project Final Decision Notice, Ninemile Ranger District, Lolo National Forest, Huson, Montana

APPENDIX A – MAPS

Map A-1. Kennedy Creek and Surrounding Area



APPENDIX B – DATA

Table B-1 Kennedy Creek Water Quality Data

Site Name	Sample date	Discharge (cfs)	Aluminum		Copper			Lead			Zinc		Mercury (µg/L)	Hardness (mg/L)	Corrected Hardness (mg/L)	pH
			Result (µg/L)	Chronic Standard (µg/L)	Result (µg/L)	Acute Standard (µg/l)	Chronic Standard (µg/l)	Result (µg/L)	Acute Standard (µg/l)	Chronic Standard (µg/l)	Result (µg/L)	Acute & Chronic Standard (µg/l)				
C04KNDYC01	6/4/2020	3.35	80	87	0.6	3.792	2.853	ND	13.980	0.545	ND	37.016	0.007	C5	25	7.36
	8/7/2020	0.06	18		0.4	3.792	2.853	ND	13.980	0.545	ND	37.016	0.0015	C8	25	7.23
	9/23/2020	0.5	6		0.8	3.792	2.853	0.19	13.980	0.545	ND	37.016	0.0015	14	25	7.8
C04KNDYC62	6/4/2020	4.43	52		0.7	3.792	2.853	0.09	13.980	0.545	ND	37.016	0.008	8	25	7.98
	8/6/2020	0.16	8		1	4.219	3.144	0.2	16.150	0.629	2	40.747	0.0022	28	28	7.47
	9/23/2020	0.09	ND		0.8	5.346	3.897	0.1	22.238	0.867	ND	50.416	0.0008	36	36	8.24
C04KNDYC57	6/4/2020	5.1	92		3	3.792	2.853	0.4	13.980	0.545	5	37.016	0.008	11	25	7.59
	8/6/2020	0.26	5		2	4.644	3.429	0.3	18.384	0.716	15	44.417	0.001	31	31	7.49
	9/23/2020	0.18	4		3	5.626	4.081	0.4	23.823	0.928	22	52.780	0.0008	38	38	7.89
C04KNDYC54	6/4/2020	4.47	96		3	3.792	2.853	2.8	13.980	0.545	19	37.016	0.007	11	25	7.59
	8/6/2020	0.16	5		3	4.785	3.524	1	19.142	0.746	218	45.628	0.0011	32	32	7.53
	9/23/2020	0.11	3		2	5.765	4.172	0.7	24.624	0.960	444	53.954	0.0008	39	39	7.98
C04KNDYC02	6/4/2020	5.29	159		4	3.792	2.853	1.1	13.980	0.545	39	37.016	0.006	14	25	7.52
	8/6/2020	0.19	12		2	5.066	3.711	0.19	20.678	0.806	30	48.033	0.0009	34	34	7.64
	9/23/2020	0.11	4		2	6.459	4.626	0.14	28.711	1.119	22	59.760	0.0007	44	44	8.06
C04KNDYC04	6/4/2020	5.8	144		4	3.792	2.853	1	13.980	0.545	38	37.016	0.006	15	25	7.95
	8/6/2020	0.22	16		2	5.346	3.897	0.15	22.238	0.867	24	50.416	0.0008	36	36	7.33
	9/23/2020	0.05	8		2	6.043	4.355	0.11	26.242	1.023	18	56.290	0.0009	41	41	8.1

Bold = Values above the Water Quality Standard

TABLE B-2 Pre Restoration Water Quality Data for Impaired Metals on Kennedy Creek

Site	Date	Flow (cfs)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Mercury (ug/L)
Above Mining Complex	Aug-04	NS				<0.2
C04KNDYC01	Sep-03	NS	ND	ND	ND	NS
Below Mining Complex (Corresponds closely with C04KNDYC54)	Jun-04		3.0	NS	40.0	0.2
C04KNDYC02	Sep-03	NS	3.0	1.0	20.0	NS
Near Mouth (Corresponds closely with C04KNDYC04)	Sep-03	NS	NS	2.0	NS	
	Jun-04	NS	3.0	NS	140.0	
	Aug-04	NS				0.2
C04KNDYC04	Sep-03	NS	4.0	2.0	49.0	NS
NS=Not Sampled						

Table B-3 Pre and Post Restoration Sediment Metals Data and NOAA Probable Effects Levels

Post Remediation Sediment Quality Data					NOAA PEL (mg/kg)	Pre Remediation Sediment Quality Data				
Station ID	Station name	Date	Parameter	Result (mg/kg)		Station ID	Station name	Date	Parameter	Result (mg/kg)
C04KNDYC01	Kennedy Creek upstream of FR Road 5507	8/7/2020	Arsenic	18	17	Kennedy 1	Upstream of Mining Complex (Corresponds with C04KNDYC01)	2003	Arsenic	30.3
C04KNDYC01	Kennedy Creek upstream of FR Road 5507	8/7/2020	Cadmium	0.8	3.53	Kennedy 1	Upstream of Mining Complex (Corresponds with C04KNDYC01)	2003	Cadmium	<0.5
C04KNDYC01	Kennedy Creek upstream of FR Road 5507	8/7/2020	Chromium	9.98	90	Kennedy 1	Upstream of Mining Complex (Corresponds with C04KNDYC01)	2003	Chromium	11.7
C04KNDYC01	Kennedy Creek upstream of FR Road 5507	8/7/2020	Copper	102	197	Kennedy 1	Upstream of Mining Complex (Corresponds with C04KNDYC01)	2003	Copper	37.3
C04KNDYC01	Kennedy Creek upstream of FR Road 5507	8/7/2020	Iron	12300	NA	Kennedy 1	Upstream of Mining Complex (Corresponds with C04KNDYC01)	2003	Iron	20600
C04KNDYC01	Kennedy Creek upstream of FR Road 5507	8/7/2020	Lead	120	91.3	Kennedy 1	Upstream of Mining Complex (Corresponds with C04KNDYC01)	2003	Lead	39.4
C04KNDYC01	Kennedy Creek upstream of FR Road 5507	8/7/2020	Mercury	0.13	0.486	Kennedy 1	Upstream of Mining Complex (Corresponds with C04KNDYC01)	2003	Mercury	NA
C04KNDYC01	Kennedy Creek upstream of FR Road 5507	8/7/2020	Zinc	279	315	Kennedy 1	Upstream of Mining Complex (Corresponds with C04KNDYC01)	2003	Zinc	49.1
C04KNDYC62	Kennedy Creek downstream of Hautilla Mine	8/6/2020	Arsenic	26.2	17					
C04KNDYC62	Kennedy Creek downstream of Hautilla Mine	8/6/2020	Cadmium	0.208	3.53					
C04KNDYC62	Kennedy Creek downstream of Hautilla Mine	8/6/2020	Chromium	9.28	90					
C04KNDYC62	Kennedy Creek downstream of Hautilla Mine	8/6/2020	Copper	68	197					
C04KNDYC62	Kennedy Creek downstream of Hautilla Mine	8/6/2020	Iron	16700	NA					
C04KNDYC62	Kennedy Creek downstream of Hautilla Mine	8/6/2020	Lead	28.9	91.3					
C04KNDYC62	Kennedy Creek downstream of Hautilla Mine	8/6/2020	Mercury	0.1	0.486					

Table B-3 Pre and Post Restoration Sediment Metals Data and NOAA Probable Effects Levels

Post Remediation Sediment Quality Data					NOAA PEL (mg/kg)	Pre Remediation Sediment Quality Data				
Station ID	Station name	Date	Parameter	Result (mg/kg)		Station ID	Station name	Date	Parameter	Result (mg/kg)
C04KNDYC62	Kennedy Creek downstream of Hautilla Mine	8/6/2020	Zinc	101	315					
C04KNDYC57	Kennedy Creek just downstream of Lost Cabin Mine	8/6/2020	Arsenic	15.7	17					
C04KNDYC57	Kennedy Creek just downstream of Lost Cabin Mine	8/6/2020	Cadmium	0.662	3.53					
C04KNDYC57	Kennedy Creek just downstream of Lost Cabin Mine	8/6/2020	Chromium	9.25	90					
C04KNDYC57	Kennedy Creek just downstream of Lost Cabin Mine	8/6/2020	Copper	82.2	197					
C04KNDYC57	Kennedy Creek just downstream of Lost Cabin Mine	8/6/2020	Iron	11300	NA					
C04KNDYC57	Kennedy Creek just downstream of Lost Cabin Mine	8/6/2020	Lead	98.4	91.3					
C04KNDYC57	Kennedy Creek just downstream of Lost Cabin Mine	8/6/2020	Mercury	0.14	0.486					
C04KNDYC57	Kennedy Creek just downstream of Lost Cabin Mine	8/6/2020	Zinc	229	315					
C04KNDYC54	Kennedy Creek downstream of Nugget Mine	8/6/2020	Arsenic	32.3	17	Kennedy 2	Downstream of mining complex (Corresponds with C04KNDYC54)	2003	Arsenic	20.1
C04KNDYC54	Kennedy Creek downstream of Nugget Mine	8/6/2020	Cadmium	1.52	3.53	Kennedy 2	Downstream of mining complex (Corresponds with C04KNDYC54)	2003	Cadmium	0.8

Table B-3 Pre and Post Restoration Sediment Metals Data and NOAA Probable Effects Levels

Post Remediation Sediment Quality Data					NOAA PEL (mg/kg)	Pre Remediation Sediment Quality Data				
Station ID	Station name	Date	Parameter	Result (mg/kg)		Station ID	Station name	Date	Parameter	Result (mg/kg)
C04KNDYC54	Kennedy Creek downstream of Nugget Mine	8/6/2020	Copper	247	197	Kennedy 2	Downstream of mining complex (Corresponds with C04KNDYC54)	2003	Copper	63.8
C04KNDYC54	Kennedy Creek downstream of Nugget Mine	8/6/2020	Iron	15300	NA	Kennedy 2	Downstream of mining complex (Corresponds with C04KNDYC54)	2003	Iron	16000
C04KNDYC54	Kennedy Creek downstream of Nugget Mine	8/6/2020	Lead	486	91.3	Kennedy 2	Downstream of mining complex (Corresponds with C04KNDYC54)	2003	Lead	64.1
C04KNDYC54	Kennedy Creek downstream of Nugget Mine	8/6/2020	Mercury	0.11	0.486	Kennedy 2	Downstream of mining complex (Corresponds with C04KNDYC54)	2003	Mercury	NA
C04KNDYC54	Kennedy Creek downstream of Nugget Mine	8/6/2020	Zinc	1720	315	Kennedy 2	Downstream of mining complex (Corresponds with C04KNDYC54)	2003	Zinc	464
C04KNDYC02	Kennedy Creek 2 miles above mouth below mining complex	8/6/2020	Arsenic	12.3	17					
C04KNDYC02	Kennedy Creek 2 miles above mouth below mining complex	8/6/2020	Cadmium	0.455	3.53					
C04KNDYC02	Kennedy Creek 2 miles above mouth below mining complex	8/6/2020	Chromium	5.61	90					
C04KNDYC02	Kennedy Creek 2 miles above mouth below mining complex	8/6/2020	Copper	43.9	197					
C04KNDYC02	Kennedy Creek 2 miles above mouth below mining complex	8/6/2020	Iron	11900	NA					
C04KNDYC02	Kennedy Creek 2 miles above mouth below mining complex	8/6/2020	Lead	47.3	91.3					
C04KNDYC02	Kennedy Creek 2 miles above mouth below mining complex	8/6/2020	Mercury	0.04	0.486					
C04KNDYC02	Kennedy Creek 2 miles above mouth below mining complex	8/6/2020	Zinc	305	315					
C04KNDYC04	Kennedy Creek above mouth, upstream of Ninemile Creek Road	8/6/2020	Arsenic	11.5	17	Kennedy 3	Close to mouth (corresponds with C04KNDYC04)	2003	Arsenic	11.8

Table B-3 Pre and Post Restoration Sediment Metals Data and NOAA Probable Effects Levels

Post Remediation Sediment Quality Data					NOAA PEL (mg/kg)	Pre Remediation Sediment Quality Data				
Station ID	Station name	Date	Parameter	Result (mg/kg)		Station ID	Station name	Date	Parameter	Result (mg/kg)
C04KNDYC04	Kennedy Creek above mouth, upstream of Ninemile Creek Road	8/6/2020	Cadmium	0.546	3.53	Kennedy 3	Close to mouth (corresponds with C04KNDYC04)	2003	Cadmium	<0.5
C04KNDYC04	Kennedy Creek above mouth, upstream of Ninemile Creek Road	8/6/2020	Chromium	6.2	90	Kennedy 3	Close to mouth (corresponds with C04KNDYC04)	2003	Chromium	6.3
C04KNDYC04	Kennedy Creek above mouth, upstream of Ninemile Creek Road	8/6/2020	Copper	46.9	197	Kennedy 3	Close to mouth (corresponds with C04KNDYC04)	2003	Copper	41.5
C04KNDYC04	Kennedy Creek above mouth, upstream of Ninemile Creek Road	8/6/2020	Iron	12400	NA	Kennedy 3	Close to mouth (corresponds with C04KNDYC04)	2003	Iron	12800
C04KNDYC04	Kennedy Creek above mouth, upstream of Ninemile Creek Road	8/6/2020	Lead	47.5	91.3	Kennedy 3	Close to mouth (corresponds with C04KNDYC04)	2003	Lead	38
C04KNDYC04	Kennedy Creek above mouth, upstream of Ninemile Creek Road	8/6/2020	Mercury	0.05	0.486	Kennedy 3	Close to mouth (corresponds with C04KNDYC04)	2003	Mercury	NA
C04KNDYC04	Kennedy Creek above mouth, upstream of Ninemile Creek Road	8/6/2020	Zinc	362	315	Kennedy 3	Close to mouth (corresponds with C04KNDYC04)	2003	Zinc	318

Bold = Exceedances of the NOAA Probable Effects Level

Table B-4 Kennedy Creek Sediment Assessment Data

SITE_ID	Date	Downstream		Upstream		Channel Status	Mean Bankfull Width	Mean Gradient (%)	Mean Riffle % <6mm	Mean Riffle % <2mm	Mean Pool % <6mm	Median Width/Depth Ratio	Median Entrenchment Ratio	Mean Residual Pool Depth	Pools/100 ft.	Pools/1000 ft.
		Latitude	Longitude	Latitude	Longitude											
KNDY01-01	9/24/22	47.12285	-114.4921	47.12164	-114.4931	wet	7.4	2.9	31	19	28	7.9	2.06	0.38	2.18	21.8
KNDY02-01	9/25/22	47.14003	-114.4671	47.14068	-114.4653	wet	7.6	2	15	14	5	8	4.28	0.53	2.08	20.8