SEDIMENT BENEFICIAL USE SUPPORT ASSESSMENT FOR OTTER CREEK

Addresses Otter Creek Assessment Unit MT42C002_020

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1.0 Introduction

In the spring of 2013, the Water Quality Planning Bureau of the Planning, Prevention and Assistance Division of the Montana Department of Environmental Quality (DEQ) initiated TMDL development in the Otter Creek watershed in southeastern Montana. On the 2012 303(d) List, Otter Creek has a solids (suspended/bedload) impairment listing, (referred to as sediment from this point forward). Otter Creek was first listed in 1996 as only partially supporting the beneficial use of aquatic life due to sediment deposition from grazing in the riparian area, agriculture, and natural sources. The physical characteristics of most streams in eastern Montana, like Otter Creek, can be vastly different than streams in western Montana. Some of the major differences in physical characteristics can be seen in lithology, soil type, and climate. DEQ has a sediment assessment method for western Montana streams, but no standard approach to determine sediment impairments in eastern Montana streams, and therefore will use a weight of evidence approach to assess sediment in Otter Creek.

The substrate of Otter Creek is composed of fine sediment, therefore geomorphic indicators typical for coarse substrate streams were not used. Instead, DEQ examined suspended sediment concentrations (SSC) and discharge relationships in the watershed. To develop target values for SSC, DEQ referenced a study that was completed in 2009 by the United States Department of Agriculture (USDA) (Klimetz et al. 2009) which analyzed suspended sediment loading at USGS gage stations for Level III Ecoregions in the Environmental Protection Agency's (EPA) Region 8. This report developed sediment rating curves for stable or "reference" conditions for streams within Ecoregion 43 and the Tongue River watershed (Otter Creek is located within this ecoregion and watershed). Otter Creek existing suspended sediment yields are well below reference sediment yields developed for Ecoregion 43 and the Tongue River, indicating that sediment is not impairing beneficial uses in Otter Creek. Additionally, stream corridor and rapid geomorphic assessments from the Natural Resources Conservation Service (NRCS) determined that Otter Creek exhibited the characteristics of a deeply incised but stable prairie stream, and that 70% of the reach assessment sites were scored in the "Sustainable" category, indicating that Otter Creek is geomorphically stable (NRCS 2002). A 2012 Natural Heritage Program (NHP) report evaluated geomorphic conditions in the vicinity of the proposed Otter Creek Coal, LLC coal mine area and determined that eight of the eleven assessments found Otter Creek to be at a proper functioning condition (stable) (Stagliano 2012). DEQ considers the large amount of suspended sediment data available for the Otter Creek watershed and the resulting comparison between existing SSC conditions to the reference yields developed specifically for the Tongue River Basin by the USDA, sufficient evidence to delist Otter Creek for sediment. This is further evidenced and supported by the NRCS and NHP findings of geomorphic stability in Otter Creek.

Additionally, DEQ examined biological and source assessment data available for Otter Creek to ensure that possibly significant issues related to sediment are addressed in the watershed. The 2012 NHP study reported that for macroinvertebrates (using macroinvertebrate multi-metric index (MMI) scores), 100% of the sites sampled on Otter Creek were unimpaired; and for fish communities (using Montana's prairie fish integrated biotic indices (IBI's), 55% of the sites sampled were unimpaired (Stagliano 2012). The report indicated that fish may be experiencing stress from overcrowding caused by fish barriers, but also that the riparian areas in the sites that were sampled were experiencing impacts from cattle grazing. In 2007, the EPA developed the *Water Quality Assessment for the Tongue River Watershed* and identified cattle grazing as a source contributing sediment to Otter Creek. But, the assessment estimated that the contribution of sediment from upland and bank erosion is minimal (EPA 2007). Otter Creek is listed for a habitat impairment (alteration in stream-side vegetative cover) and this non-pollutant listing should remain on the impaired waters list. Although some of the riparian areas are impacted by cattle grazing in Otter Creek, DEQ believes that the weight of evidence from the previously referenced SSC and geomorphic assessments is sufficient to pursue a sediment delisting, as opposed to developing a TMDL for sediment. This paper examines and documents the details of this approach.

Watershed Description

The Otter Creek watershed is located within the Lower Tongue River Subbasin 10090102. The watershed encompasses approximately 711 square miles (455,228 acres/1841 km^2), with the majority of the project area being located in Powder River County and small portions of Big Horn and Rosebud Counties. Otter Creek is 108.1 miles in length and runs from its headwaters near the Montana-Wyoming border, northward to its mouth at the confluence with the Tongue River. The Otter Creek watershed falls within the Northwestern Great Plains (43) Level III Ecoregion and is further divided into three Level IV Ecoregions: the Central Grassland (43n), Ponderosa Pine Forest – Savanna Hills (43p), and Mesic Dissected Plains (43q).

Otter Creek is classified as a C-3 stream, which means that it must meet the following beneficial uses: bathing, swimming, and recreation, and growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl, and furbearers. The quality of C-3 waters is naturally marginal for drinking, culinary, and food processing purposes, agriculture, and industrial water supply. Otter Creek is currently listed as not supporting the agricultural and aquatic life beneficial uses with the following pollutants as probable cause: Iron, Salinity, and Solids (Suspended/Bedload). A non-pollutant cause of impairment is also present on Otter Creek, alteration in stream-side or littoral vegetative covers, and will not require a TMDL.

2.0 SEDIMENT ASSESSMENT

This section characterizes overall stream health, focusing on sediment related water quality conditions, and discusses sources of sediment loading within the watershed.

2.1 Summary of Information Sources

The following data sources represent the primary information used to characterize water quality for this assessment (**Figure 2-1**):

- DEQ assessment files
- USDA Agricultural Research Service (Klimetz et al. 2009) – Characterization of Suspended-Sediment Transport Conditions for stable, "Reference" Streams in Selected Ecoregions of EPA Region 8 (2009)
- USGS – gaging station 06307740 data (1974 – 2013)
- Montana Natural Heritage Program – Baseline Assessments and Analysis of Fish, Macroinvertebrates and Herpetofauna in the Otter Creek Coal Tracts Area of Powder River County (2011-2012)
- EPA – Water Quality Assessment for the Tongue River Watershed, Montana (2007)
- NRCS – Stream Corridor and Rapid Geomorphic Assessments (2002)

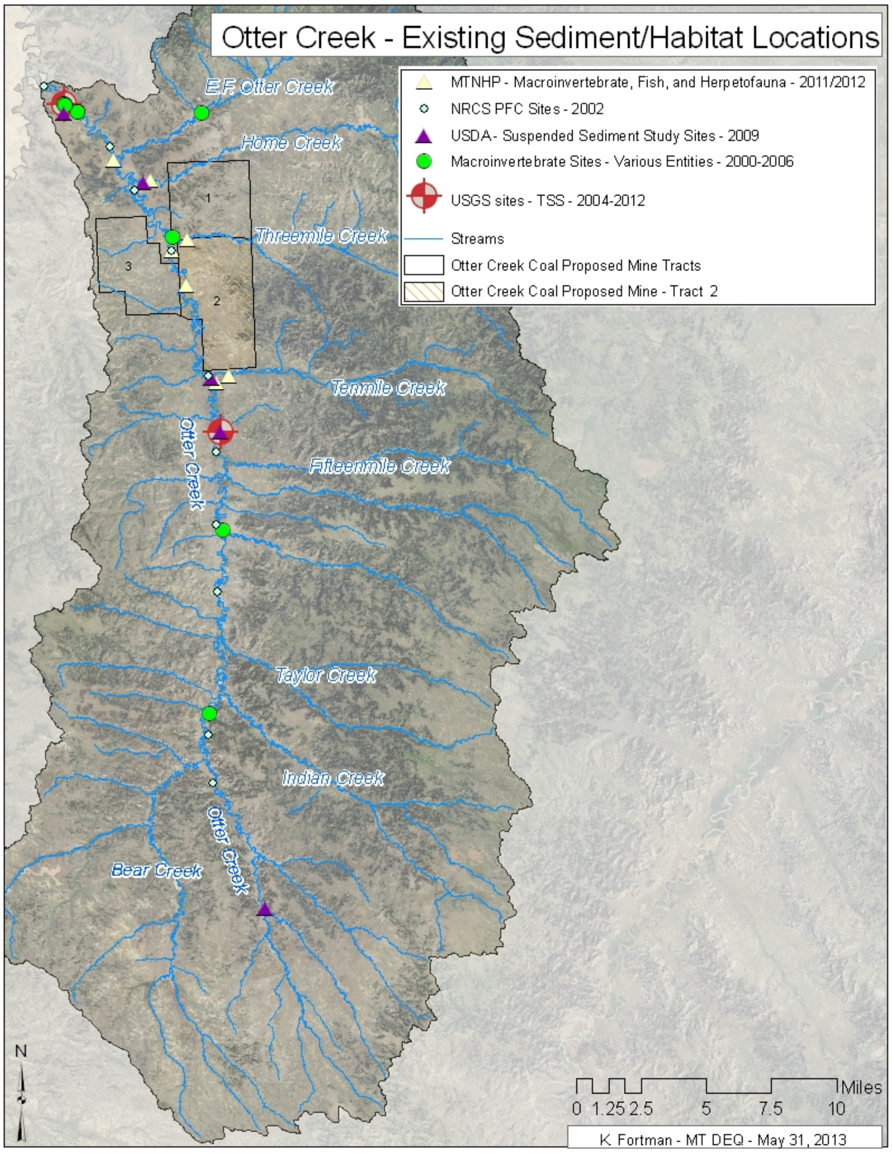

Figure 2-1. Otter Creek watershed data sources for sediment and habitat information

2.1.1 DEQ Assessment Files and Reference Sites

The DEQ assessment files contain information used to make the existing sediment impairment determinations. The file for Otter Creek includes a summary of physical, biological, and habitat data collected by DEQ, as well as other historical information collected or obtained by DEQ. The file for Otter Creek includes macroinvertebrate data from 2000-2006 collected by the DEQ and other entities. The file also includes information on sediment water quality characterization and potentially significant sources of sediment, as well as information on non-pollutant impairment determinations and associated rationale. Files are available electronically on DEQ's Clean Water Act Information Center website: http://cwaic.mt.gov/.

2.1.2 USDA - Characterization of Suspended-Sediment Transport Conditions for Stable, "Reference" Streams in Selected Ecoregions of EPA Region 8 (Klimetz et al., 2009)

This study was developed to analyze suspended sediment loading at USGS gage stations for Level III Ecoregions in EPA's Region 8. Sediment rating curves for stable or "reference" conditions were developed for streams within Ecoregion 43 and the Tongue River watershed.

2.1.3 USGS Data

There are 5 existing or historic USGS gage station locations within the Otter Creek watershed. These include:

- MT 06307665 (Otter Creek near Otter)
- MT 06307717 (Otter Creek below Fifteenmile Creek near Otter)
- MT 06307725 (Otter Creek above Tenmile Creek near Ashland)
- MT 06307735 (Home Creek near Ashland)
- MT 06307740 (Otter Creek at Ashland)

Most sites have been retired in recent years. However, there are two active gages collecting flow and water quality data: Otter Creek at Ashland (06307740) and Otter Creek below Fifteenmile Creek (06307717).

2.1.4 Montana Natural Heritage Program 2011 and 2012

The Montana Natural Heritage Program has produced two reports (2011 and 2012) that summarize baseline surveys for the aquatic assessment of fish, macroinvertebrates, and herpetofauna in the proposed Otter Creek Coal, LLC coal mine area. Additional baseline data collection occurred in 2013, and should be available in early 2014.

2.1.5 EPA - Water Quality Assessment for the Tongue River Watershed, Montana 2007

This water quality report was developed to assist with impairment cause determinations and TMDL development for the Tongue River Watershed within Montana. It includes a summary of water quality data as well as source inventories and limited pollutant loading source quantifications for Otter Creek.

2.1.6 NRCS 2002

Stream Corridor Assessments were performed in 2001-2002. This work included rapid aerial assessments and NRCS physical habitat assessments along 10 Otter Creek sites for which NRCS assigned scores to various channel characteristics to classify each site as "sustainable", "at risk", or "not sustainable." Rapid geomorphic assessments were also performed by the NRCS at the 4 USGS gage stations as part of the Klimetz et al. (2009) study identified above.

2.2 Water Quality Targets and Comparison to Existing Conditions

One of the major components of this assessment is the establishment of target conditions, which are used to evaluate the attainment of acceptable water quality. The targets allow for a comparison between observed conditions and conditions that are expected to restore designated uses.

For Otter Creek, the suspended sediment target was developed from a study conducted by the Watershed Physical Processes Research Unit (WPPRU) of the USDA, which used SSC data measured at stable streams in the same ecoregion. The target for Otter Creek comes from the reference yield in the Tongue River, which is 0.0165 tonnes per day per kilometer squared (t/d/km^2) at the effective discharge, which is the median yield value at discharge of the 1.5 recurrence interval flow ($Q_{1.5}$). The effective discharge is the discharge which moves the most sediment, or is the channel-forming flow. If the sediment target applicable for sediment in the water body is maintained during the effective discharge, then the health of the stream should improve.

2.2.1 Water Quality Target Development

The information and methodologies described in the following section (**2.2.1**) are based on a study, – Klimetz et al. 2009*,* conducted by the WPPRU of the National Sedimentation Laboratory – USDA in Oxford, Mississippi. This study evaluated channel conditions and analyzed suspended sediment loading at USGS gage stations throughout several Level III Ecoregions. Four sites, located in the vicinity of the USGS gage stations on Otter Creek were evaluated. Sediment rating curves for stable and unstable sites were developed for streams within each ecoregion. The study also examined fish inventory results, which were used to define fish functional traits and to evaluate potential impacts linked to excess sediment. The Northwestern Great Plains (Ecoregion 43), which includes the Tongue River and Otter Creek watersheds, was analyzed in greater detail than other ecoregions because of the large number of USGS sites with sediment and flow data. The primary sources of the information presented in **Section 2.2.1** are excerpts from this report.

> Impairment of designated stream uses by clean sediment (neglecting adsorbed constituents) may occur along the channel bed such as deposition of fines amidst a coarser-grained substrate, or by elevated concentrations of suspended-sediment in the water column. Fully mobile streambeds and deposition of fines amidst interstitial streambed gravels, can pose hazards to fish and benthic macro-invertebrate communities by disrupting habitats, degrading spawning habitat, and reducing the flow of oxygen through gravel beds. Although lethal or sub-lethal thresholds are currently unknown for many species, high concentrations of suspended-sediment over certain durations have been shown to adversely affect aquatic organisms (Newcombe and MacDonald, 1991 and Newcombe and Jensen, 1996). It is therefore important to determine the quantity and quality of sediment within a river system that does not adversely impact the specified designated uses.
>
> One way of accomplishing this is by differentiating between rates and conditions of sediment transport for stable and unstable streams within a given area or region. Unimpaired or stable, "reference" streams are defined in geomorphic terms of the purpose of this study. A stable stream is one in dynamic equilibrium, capable of transporting all sediment delivered to the system from upstream without altering its dimensions over a period of years. Conversely, an

unstable stream is one in which the supply of sediment from upstream is not in balance with the ability of the stream to transport that sediment through the reach without alterations to its geometry over a period of years. The definition of a "stable channel" used here is consistent with the definition used for the past 60 years since Mackin published his work on the Graded River in the 1940's (Mackin, 1948). Most alluvial rivers have active floodplains (if they are not deeply incised) where there is a transfer of sediment from upstream. The definition brings into consideration rates and scales of channel change. Stable alluvial rivers are not static, but may alter their geometry at very low rates, or may scour and fill over the course of a storm event. We have extended Mackin's (1948) definition which referred to only the slope of the channel to include lateral change. **(Klimetz et al. 2009)**

Using this general concept, "reference" suspended sediment transport rates have been developed for various Level III Ecoregions of the United States (Simon et al., 2004), including Ecoregion 43.

2.2.1.1 Selecting a Reference Condition

In order to identify those sediment transport conditions that represent impacted or impaired conditions, it is essential to first be able to define a non-disturbed, stable, or "reference" condition for the particular stream segment. For this study the channel evolution framework set out by Simon and Hupp (1986) is used to describe channel form and morphology (**Figure 2-2**). In most alluvial channels, disruption of the dynamic equilibrium generally results in a certain degree of upstream channel degradation and downstream aggradation.

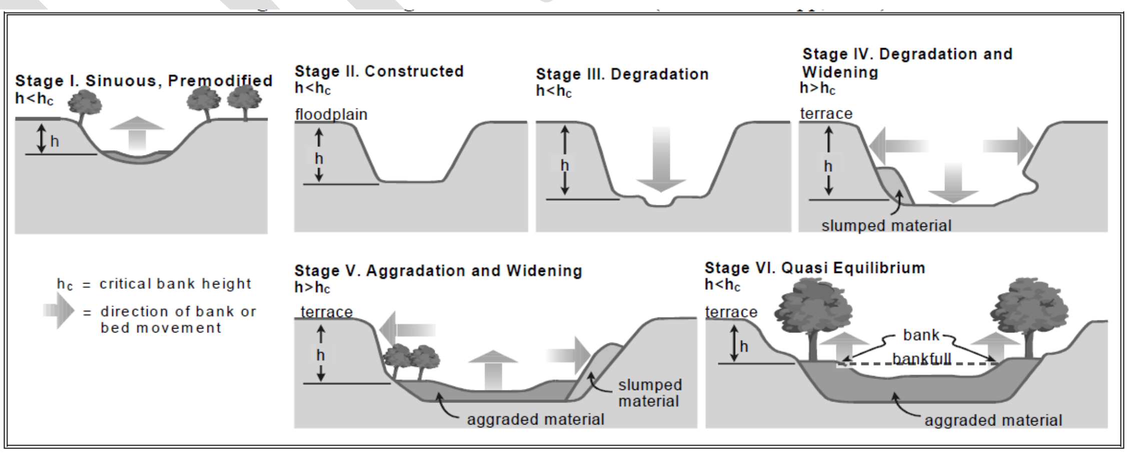

Figure 2-2. Channel evolution model stages (Simon and Hupp 1986)

With stages of channel evolution tied to discrete channel processes and not strictly to specific channel shapes, they have been successfully used to describe systematic channel-stability processes over time and space in diverse environments subject to various disturbances. Because the stages of channel evolution represent shifts in dominant channel processes, they are systematically related to suspended-sediment and bed-material discharge (Simon, 1989; Kuhnle and Simon, 2000), fish-community structure, rates of channel widening (Simon and Hupp, 1992), and the density and distribution of woody riparian vegetation (Hupp, 1992).

An advantage of a process-based channel-evolution scheme is that Stages I and VI represent two "reference" conditions. In some cases, channels are unlikely to recover to Stage I, pre-modified conditions. Stage VI, re-stabilized conditions are a more likely target under the present regional landuse and altered hydrologic regimes and can be used as a "reference" condition. However, in areas where disturbances have not occurred or where they are far less severe, Stage I conditions can be used as a "reference" condition.

Current channel-stability conditions were determined through field data collection at sites with existing flow and sediment data. Rapid Geomorphic Assessments (RGAs) were carried out to determine relative channel stability at USGS gaging-station locations with sufficient historical suspended-sediment and associated instantaneous-discharge data. Bed material was sampled at each location to determine relative embeddedness. For those sites where current stability conditions could not be related to historical sediment sampling, discharge-measurement data from the USFS were analyzed to determine trends of channel depth and width over time. (**Klimetz et al. 2009)**

2.2.1.2 Analysis of Available Suspended-Sediment Data for Target Development

Analysis of suspended-sediment transport data involves establishing a relation between flow and sediment concentration or load. Data of this type permit analysis of sediment-transport characteristics and the development of rating relations (Porterfield, 1972; Glysson, 1987). Ecoregion 43, the Northern Great Plains, had 194 sites with sufficient data to create a transport rating relation. At many of these sites, data on the particle-size distribution of suspended sediment were also available. USGS and ARS suspended-sediment sampling strategies are usually designed to obtain samples over a broad range of flows, particularly during storms when a large proportion of the annual load may be transported. In addition, peak-flow files maintained by the USGS were available for most of the sites.

Suspended-sediment concentration and associated flow discharge at time of sampling were downloaded from USGS websites and used to develop relations between sediment transport and discharge over the range of flows at each site. These relations serve as the fundamental analytic unit for calculations of sediment-transport rates as concentrations (in milligrams per liter, mg/L), loads (in tonnes, t) and yields in tonnes per day (or year) per square kilometer.

Initial considerations regarding the flow discharge to be used to calculate sediment loads or yields focused on a geomorphically effective flow. Because the “effective discharge” is that discharge or range of discharges that shape channels and perform the most geomorphic work (transport the most sediment) over the long term, it can serve as a useful indicator of regional suspended-sediment transport conditions for “reference” and impacted sites. The effective discharge is obtained by combining flow frequency data with sediment transport relationships. The conclusions of the USDA report were that the $Q_{1.5}$ proved to be a reasonably good measure of the effective discharge for suspended-sediment, and can therefore be used across a range of spatial scales in diverse environments to compare suspended-sediment transport rates.

Annual peak discharge for the period of record at each station were downloaded from USGS websites and used to develop the frequency distribution of peak flows for each site. A log-Pearson Type III distribution, using the annual-maximum peak-flow series for each of the sites with available data, were then used to calculate discharge of the 1.5 recurrence interval flow and subsequently, to obtain the suspended sediment load in t/d at the $Q_{1.5}$. Dividing by basin area produced a suspended-sediment yield for the $Q_{1.5}$ in t/d/km^2. (**Klimetz et al. 2009)**

2.2.1.3 Suspended-Sediment Yields at the 1.5-Year Recurrence Interval Discharge

Using the procedures for developing suspended-sediment transport relations and the $Q_{1.5}$ discharge, values of yield at the $Q_{1.5}$ were obtained for each site with fifteen or more suspended-sediment samples. Suspended-sediment transport data are reported in terms of yields (tonnes/day/km^2 for the $Q_{1.5}$), to enable comparison of streams of varying size within ecoregions. Because data for individual ecoregions were often non-normally distributed, quartile measures were used to describe data ranges and central tendencies (See Klimetz et al.

2009, pg. 53 for table). The “reference” or “target” value for suspended-sediment yield at the $Q_{1.5}$ (based on the median value at stable sites) was 0.17 T/d/km^2 in Ecoregion 43 (**Table 2-1**).

It is important to keep in mind that the “reference” approach as defined in geomorphic terms and adopted in this and previous studies (Simon et al., 2004a; Simon and Klimetz 2008a; 2008b) implicitly accounts for “natural” variability in sediment-transport rates between and within ecoregions. Data analysis proceeds initially at the broad, Level III scale to determine “reference” sediment-transport rates. Acknowledging the natural variability within ecoregions, “reference” sediment-transport rates were also determined by Level IV ecoregion or drainage basin where there were a sufficient number of sites.

Due to the large number of sites with historical flow and sediment transport data in Ecoregion 43, estimates of “reference” suspended-sediment yields were refined to the smaller, Level IV Ecoregion scale. (**Klimetz et al. 2009)**

At this reduced scale, there are 24 different Level IV Ecoregions in the Northwestern Great Plains, three of which make up the Otter Creek watershed (Montana Central Grasslands – 43n, Pine Scoria Hills – 43p, and Mesic Dissected Plains – 43q). The “reference” or “target" value for suspended sediment yield at the $Q_{1.5}$ (based on the median value at stable sites) was 0.042 t/d/km^2 in Ecoregion 43n, 0.014 t/d/km^2 in Ecoregion 43p, and unavailable in Ecoregion 43q due to a lack of stable sites (**Table 2-1**).

There were two basins within Ecoregion 43 (Cannonball-Heart-Knife and the Tongue) where difference between stable and unstable sites were tested statistically to determine if a “reference” yield for either basin would be valid. Significant differences were found for the “reference” yields in the Tongue River Basin ($Q_{1.5}$ = O.0165 t/d/ km^2;p = 0.017). (**Klimetz et al. 2009)**

The USDA 2009 report concludes that this reference yield for the Tongue River basin could be used as a target by TMDL practitioners. DEQ is using the Tongue River reference yields to set the target value for Otter Creek, as the data from the Tongue River basin is more regionally relevant compared to Ecoregion 43, which encompasses an area 10 times that of the Tongue River basin (**Figure 2-3**) and covers over a quarter of the state of Montana. Additionally, sub-ecoregions within Ecoregion 43 also span large areas of Montana that are outside of the Tongue River watershed (**Figure 2-3**).

It is recognized that the Tongue River data includes SSC and flow collected from sites within the Otter Creek watershed. However, including the data from Otter Creek actually skews the target value to a lower number (**Figure 2-4**). If the Otter Creek data were removed from the Tongue River dataset, the median value would be higher. Ecoregion 43 Level III and Level IV reference yields provide potential targets, however, because the Tongue River basin reference yields are more regionally relevant, the target for Otter Creek suspended sediment is the median yield at the $Q_{1.5}$: 0.0165 t/d/ km^2 (**Table 2-1 and Figure 2-4**).

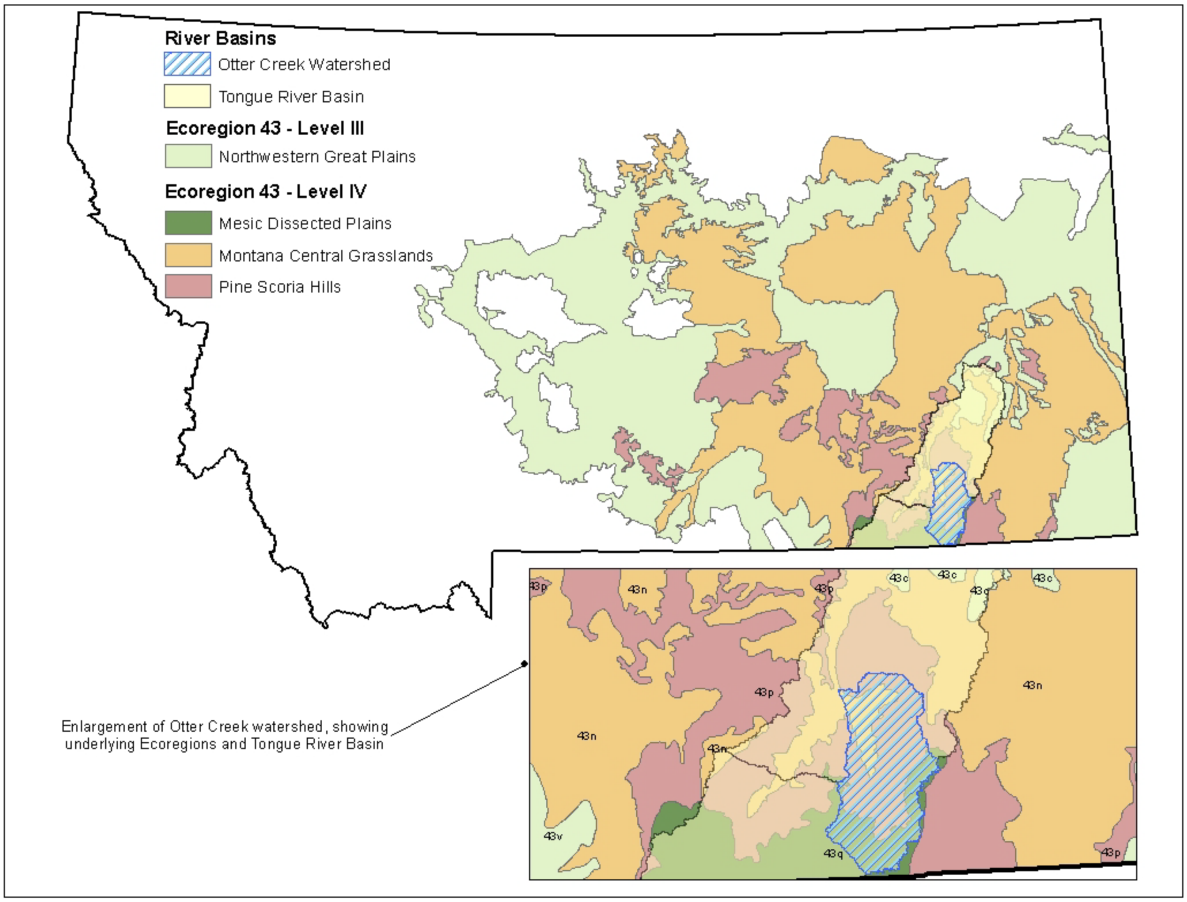

Figure 2-3. Map shows the large extent of Ecoregion 43 (Level III and IV), and the location of the Tongue River and Otter Creek Basins

Table 2-1. Potential target yields - Level III and IV Ecoregions and for the Tongue River Basin

Yield at the $Q_{1.5}$ in t/d/km2			
	Location	**n**	**50th percentile**
Potential Target Conditions for Otter Creek	Level III Ecoregion 43 – stable streams	50	0.1700
	Level IV Ecoregion 43n – stable streams	10	0.0419
	Ecoregion 43p – stable streams	3	0.0136
	Ecoregion 43q – stable streams	1	NA
	Tongue – stable streams	6	0.0165

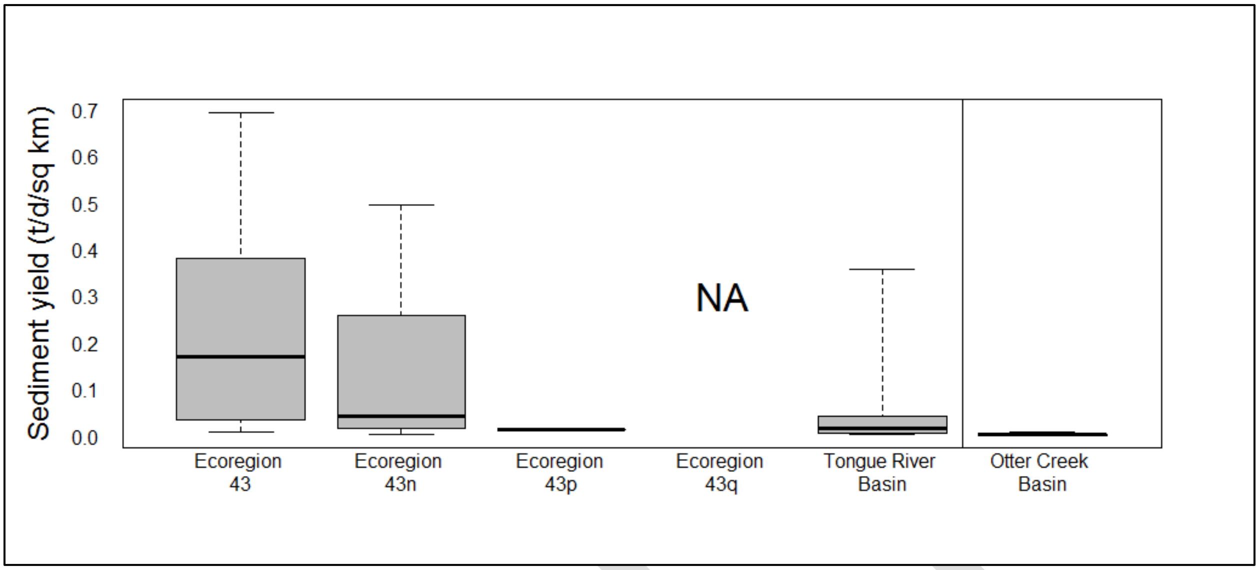

Figure 2-4. Potential target yields for Level III and IV Ecoregions and for the Tongue River Basin. Boxes represent quartiles and whiskers represent the 10th and 90th percentiles. Otter Creek existing conditions are also displayed for comparison.

2.2.2 Existing Condition and Comparison to Water Quality Target

Otter Creek was listed for Solids (Suspended/Bedload) on the 2012 303(d) List. Otter Creek flows 108.1 miles from its headwaters to the mouth (Tongue River).

Physical Condition and Sediment Sources

The Otter Creek watershed, like many eastern Montana watersheds, has high natural background sediment loading. Human related sources of sediment loading to the stream include grazing and irrigated agriculture. A review of aerial photography shows agricultural fields near many of the lower reaches of Otter Creek as well as along portions of some of the Otter Creek tributaries. There is a history of cattle grazing within the watershed which appears to have influenced sediment loading via riparian degradation and associated stream geomorphic impacts. Grazing in upland areas also has the potential for increased erosion, although this has not been previously documented as a concern. Historical tillage and other agricultural related soil disturbances, along with historical grazing impacts, may have influenced Otter Creek geomorphology and associated sediment production. The unpaved road network within the Otter Creek watershed represents another potential sediment loading source. Although no formal road erosion analysis was conducted by the DEQ, during a field visit by DEQ staff in July, 2012, coarse gravels from roads were found in the streambed up to several hundred feet downstream of road crossings. Coal mining and coal bed methane (CBM) production represent potential future sediment loading sources.

The Otter Creek channel, as well as several Otter Creek tributaries, exhibit significant sinuosity. Historical channel migration patterns are evident in the aerial photos, although it appears that floodplain access is limited relative to historic levels. Recent rapid geomorphic assessment (RGA) results indicate that the Otter Creek channel is relatively stable, consistent with undisturbed conditions in some upstream locations while consistent with an incised channel that has recovered to a more "stable" form in other locations (Klimetz et al., 2009). NRCS evaluations also support the apparent historical stream incision, noting subsequent, but not full, recovery (NRCS 2002). This is consistent with recent DEQ field reconnaissance, where it appears the stream has not reached its full habitat recovery potential in flowing (non-dammed) reaches. Check dams are common along Otter Creek to facilitate sub-irrigation via increased water table elevations or to allow irrigation water diversion, which has altered the geomorphology of the stream.

In 2011 and 2012, Dave Stagliano from the Montana Natural Heritage Program conducted surveys and collected baseline information on the aquatic and riparian communities occurring in Otter Creek and three tributaries in the vicinity of the proposed mine area. The surveys included habitat, macroinvertebrate, and fish community evaluations. A summary table (**Table 2-2**) of those evaluations and evaluations from previous years are provided below (from Stagliano 2012):

Table 2-2. Summary table of habitat scores, fish IBIs and MMIs from Stagliano 2012

Otter Creek Temporal Habitat Scores, Fish IBIs and MMIs. Metric Score Ranks (+): unimpaired, (-): impaired, (=): marginal, (na)= not applicable, taxa group not collected. Spatial relationship in river miles (rm) to them adjacent Coal Tract Study Site

Site Code	Site Name	Spatial Relation	Date	BLM PFC	BLM Hab Score	Fish IBI	MT MMI	Metric Score Ranks
ATG_203	Otter Creek at Camp Creek Road	~16 rm ups	7/11/2010	PFC	20	50	58.4	+ , + , +
ATG_235	South Fork Taylor Creek	~13 rm ups	7/11/2010	PFC	22	71	73.5	+ , + , +
ATG_202	Otter Creek at Taylor Creek Road	~12 rm ups	7/11/2010	PFC	19	60	36.3	+ , + , -
ATG_CCC	Otter Creek at CCC Camp USFS	~3 rm ups	7/11/2010	PFC	19	58	37.9	+ , + , =
ATG_201	Otter Creek at Tenmile Cr Road	100m ups	7/11/2010	PFC	19	52	44.6	+ , = , +
OTTER_23	Tenmile Creek @ Denson Ranch	0 rm	5/10/2011	FAR	16	**75**	36.8	- , + , -
OTTER_23	Tenmile Creek @ Denson Ranch	0 rm	7/18/2011	FAR	17	**na**	35.2	- , na , -
OTTER_23	Tenmile Creek @ Denson Ranch	0 rm	10/10/2011	FAR	17	**na**	35.6	- , na , -
OTTER_22	Otter Creek at Tenmile Cr Road	0 rm	5/10/2011	PFC	22	66.1	46.3	+ , +, +
OTTER_22	Otter Creek at Tenmile Cr Road	0 rm	7/18/2011	PFC	22	67.3	54.3	+ , +, +
OTTER_22	Otter Creek at Tenmile Cr Road	0 rm	10/10/2011	PFC	22	69.2	65.9	+ , +, +
OTTER_16	Otter Creek at Ranch Road x	0 rm	5/19/2011	PFC	19	62.3	44.4	+ , +, +
OTTER_16	Otter Creek at Ranch Road x	0 rm	7/16/2011	PFC	19	50.7	51.2	+ , - , +
OTTER_16	Otter Creek at Ranch Road x	0 rm	10/15/2011	FAR	18	44.4	46.2	= , - , +
OTTER_2	Otter Creek at Ranch Road x	0 rm	7/16/2011	FAR	17	62.7	na	= , + , na
OTTER_2	Otter Creek at Ranch Road x	0 rm	10/15/2011	FAR	17	63.1	na	= , + , na
YL_S70REM	Otter Creek at 3mile creek	400m dns	7/18/2000	na	na	na	59.7	na , na , +
OTTER_JT	Otter Creek J Trusler site	0 rm	5/17/2011	PFC	19	44.9	64.6	+ , - , +
OTTER_JTs	Otter Creek J Trusler site	0 rm	7/18/2011	PFC	19	43.8	65.8	+ , - , +
OTTER_JTf	Otter Creek J Trusler site	0 rm	10/15/2011	PFC	19	48.9	43.4	+ , - , +
YL_S0070dn	Otter Creek below Trusler site	300m dns	6/2/2003	na	na	na	56.2	na , na , +
OTTER_1A	Home Creek	0 rm	5/16/2011	FAR	11	70.8	57.4	- , + , +
OTTER_1A	Home Creek	0 rm	7/17/2011	FAR	12	70.8	43.2	- , + , +
OTTER_1A	Home Creek	0 rm	10/15/2011	FAR	13	46.5	37.9	- , - , =

The 2007 EPA report, *Water Quality Assessment for the Tongue River Watershed, Montana* examined upland sediment and bank erosion loads in Otter Creek. According to the 2007 report:

Upland sediment loads were estimated using soil survey data, GIS, and the Universal Soil Loss Equation (USLE). In the Otter Creek watershed, there was very little difference between the existing and "natural" upland sediment delivery. Natural conditions are defined as "no human alterations, resulting in no active agricultural land and increased total vegetative ground cover." USLE calculations showed that there is only a 0.31 percent increase in sediment load over naturally occurring conditions (19,496 versus 19,558 tons of sediment per year). This suggests that human management has not had a major effect on upland sources in the Otter Creek watershed. It should be noted that this analysis does not take into account streambank erosion or riparian degradation.

As evidenced by the NRCS riparian assessment, cattle have impacted riparian areas and stream banks in several areas (NRCS, 2002). The extent of this effect is unknown, although NRCS attributed lack of deep binding root mass and woody vegetation at two segments to grazing impacts (NRCS, 2002).

To estimate bank erosion in Otter Creek, a simple analysis was performed using literature values and conservative assumptions. It was assumed that stream banks are eroding an average of 0.10 feet per year, and have a height of one foot (adapted from Rosgen, 1996). The 2001 NRCS riparian assessment found 59.9 of 76.6 assessed miles to be "sustainable." It is conservatively assumed that bank erosion occurs along the entire length of both banks of the total length rated "at risk" (33.4 miles), and that all of that erosion is human caused (note: this assumption is an over estimate presented as a "worst case" analysis). Assuming an average bulk density of 60 pounds per cubic feet, this equates to an average sediment load of 529 tons of sediment per year from bank erosion. **(EPA 2007)**

According to the EPA report, the 529 tons of sediment per year from bank erosion appears to be contributing a relatively small portion of the total sediment load in the watershed and DEQ field reconnaissance supports this observation. Streamside grazing is impacting bank erosion in localized areas, but the majority of bank erosion noted during field reconnaissance was associated with check dams and slowly eroding banks.

As of October, 2013 the only existing Montana pollutant discharge elimination system (MPDES) permitted point sources for surface water discharge within the Otter Creek watershed were two construction stormwater permits linked to ongoing highway construction work near the lower reach. MPDES discharge permits are anticipated for proposed coal mining activity (Arch Coal) in the watershed.

These permits would cover stormwater and anticipated surface discharge outfalls from storage ponds. Discharges would be to Otter Creek and/or Otter Creek tributaries. Future CBM production also has the potential to result in additional MPDES surface water discharge permits. No existing MPDES ground water permits have been identified in the Otter Creek watershed.

Analysis of Suspended Sediment Data

Suspended sediment concentration and associated flow discharge at time of sampling from 1974-2013 were downloaded from the USGS website for Otter Creek at Ashland, MT (USGS 06307740) and used to develop relations between sediment transport and discharge. A log-Pearson Type III distribution, using the annual-maximum peak-flow series for Otter Creek was used to calculate discharge of the 1.5 recurrence interval flow and subsequently, to obtain the suspended sediment load in t/d at the $Q_{1.5}$. Dividing by 1831km^2 (Otter Creek drainage area at the Ashland gage station) produced a suspended-sediment yield for the $Q_{1.5}$ in t/d/km^2.

Comparison to Water Quality Targets

The existing data in comparison to the targets for Otter Creek are summarized in **Table 2-3** and **Figure 2.5**.

Table 2-3. Existing Otter Creek conditions compared to target condition

Yield at the $Q_{1.5}$ in t/d/km2		
	Location	**50th percentile**
Target Condition	Tongue – stable streams	0.0165
Existing Condition	Otter Creek	0.0023

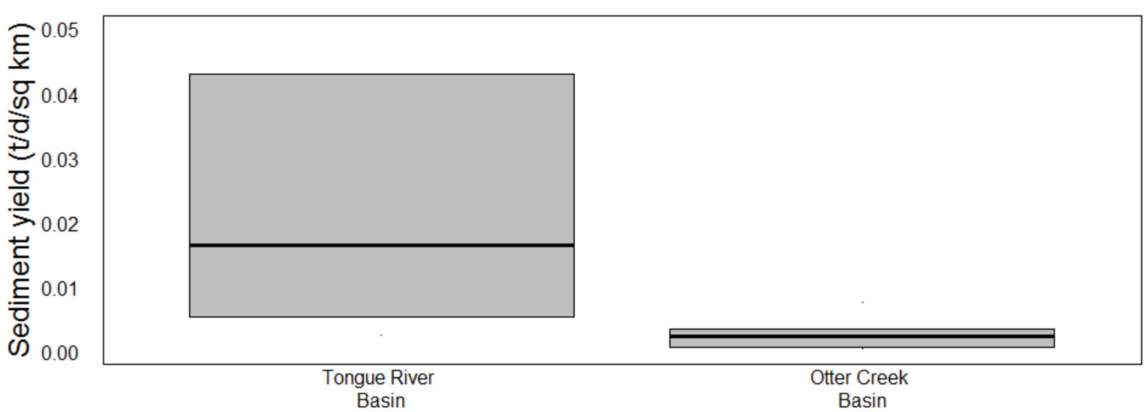

Figure 2-5. Existing Otter Creek conditions compared to Tongue River target conditions (shown in quartiles)

2.3 SEDIMENT ASSESSMENT SUMMARY

The existing sediment yield in Otter Creek at the $Q_{1.5}$ in t/d/km^2 is almost an order of magnitude below the Tongue River stable stream target condition (**Table 2-2 and Figure 2-5**). Additionally, the existing sediment yield is well below Ecoregion 43 target yield values. The physical habitat assessments by NRCS found that Otter Creek is a "deeply incised but stable prairie stream," and that "limitations observed were primarily related to riparian vegetation disturbance" (NRCS 2002). DEQ personal examined several reaches throughout Otter Creek in July of 2012 and found that Otter Creek has limited bank erosion with stable and vegetated banks, and high sinuosity. The existing suspended sediment yields and geomorphic assessments provide sufficient evidence to delist Otter Creek for sediment. Although there are existing sediment sources throughout the watershed linked to grazing, check dams, and road crossings; they are not contributing a degraded condition on Otter Creek to the extent where sediment is impairing beneficial uses for a C3 stream.

3.0 REFERENCES

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