Montana Fish, Wildlife & Parks

2300 Lake Elmo Drive
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October 30, 2007

TO: Environmental Quality Council
Director's Office, Dept. of Environmental Quality
Montana Fish, Wildlife & Parks*
- Director's Office
- Parks Division
- Fisheries Division
- Wildlife Division
- Lands Section
- Design & Construction
- Legal Unit
- Regional Supervisors

Mike Volesky, Governor's Office *
Sarah Elliott, Press Agent, Governor's Office*
Montana Historical Society, State Preservation Office
Janet Ellis, Montana Audubon Council
Montana Wildlife Federation
Montana State Library*
George Ochenski
Montana Environmental Information Center
Wayne Hirst, Montana State Parks Foundation
FWP Commissioner Shane Colton*
DNRC Area Manager, Southern Land Office
Other Local Interested People or Groups
* (Sent electronically)

Ladies and Gentlemen:

Attached for your review is a draft Environmental Assessment for treating approximately 2.5 miles of Crooked Creek on Custer National Forest and BLM administered land in the Pryor Mountains with rotenone. This will remove a limited brown trout population from above a permanent fish barrier, and protect and expand a genetically pure population of native Yellowstone cutthroat trout located in the upper end of the drainage.

Any questions should be addressed to Ken Frazer (247-2963). Written comments should be addressed to the undersigned at 2300 Lake Elmo Drive, Billings, MT 59105 or by email by November 13, 2007.

Sincerely,

Gary Hammond

Gary Hammond
Regional Supervisor
ghammond@mt.gov

Brown Trout Removal from Above Permanent Fish Barrier in Crooked Creek

Draft Environmental Assessment

Fall 2007
Montana Fish, Wildlife and Parks
Region 5, Billings

1.0 Purpose and Need for Action

1.1 Introduction

The Montana Department of Fish, Wildlife and Parks (FWP), in cooperation with the Custer National Forest (CNF), is proposing to use the EPA registered piscicide rotenone in the formulation of CFT Legumine to remove brown trout from a portion of Crooked Creek upstream of a recently constructed permanent fish barrier located at T.9S., R.27E., SW¼ Section 11 in the Pryor Mountains, Carbon County, Montana. The project could involve treating up to 5.5 miles of Crooked Creek from below the mouth of Gooseberry Hollow downstream to the permanent barrier. However, based on current known brown trout distribution data, the initial treatment would only involve approximately 2.5 miles of stream from an existing temporary barrier downstream to the permanent barrier (Figure 1).

1.2 Purpose and Need for Action

The purpose of the action is to provide long-term protection for a population of native, genetically pure Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) (YCT) from potential extinction through predation by and competition with non-native brown trout (*Salmo trutta*) (FWP et al. 2007).

Immediate action is needed due to the presence of brown trout in Crooked Creek upstream of a permanent fish barrier that was completed in October of 2007, and the loss of a natural barrier farther upstream following the Red Waffle fire in July 2002.

Prior to the Red Waffle fire, YCT exclusively inhabited approximately 4.1 miles of Crooked Creek (from Tibbs Hollow downstream to the confluence with Cave Creek, Figure 1) and were protected by a natural, boulder-formed barrier on land administered by the CNF. This barrier separated YCT in the headwaters and upper reaches from non-native fish species such as brown trout in the lower reaches. The historic barrier did not have bedrock control, and debris deposited after the Red Waffle fire re-routed the channel, creating potential opportunities for non-native trout to move into the reaches inhabited by YCT. The debris flows also eliminated almost half of the YCT population, and reduced the extent of stream occupied by YCT to about 2.6 miles in the unburned portion of upper Crooked Creek, i.e., from Tibbs Hollow downstream to Gooseberry Hollow.

Although the flows created some large woody debris jams that provided some degree of short-term protection from non-native species invasion, these barriers would only be effective temporarily due to the likelihood that they will be mobilized or breached by high flows. Without an effective, long-term barrier, it was likely that non-native fish would migrate into the headwaters of Crooked Creek, compete and hybridize with YCT, and eventually completely replace them throughout the entire drainage.

After field investigations in August of 2004 showed that the historic passage barrier (Figure 1) was no longer functional, fisheries biologists from FWP, CNF and BLM started working on a plan to replace this lost barrier with a permanent passage barrier that would protect the important

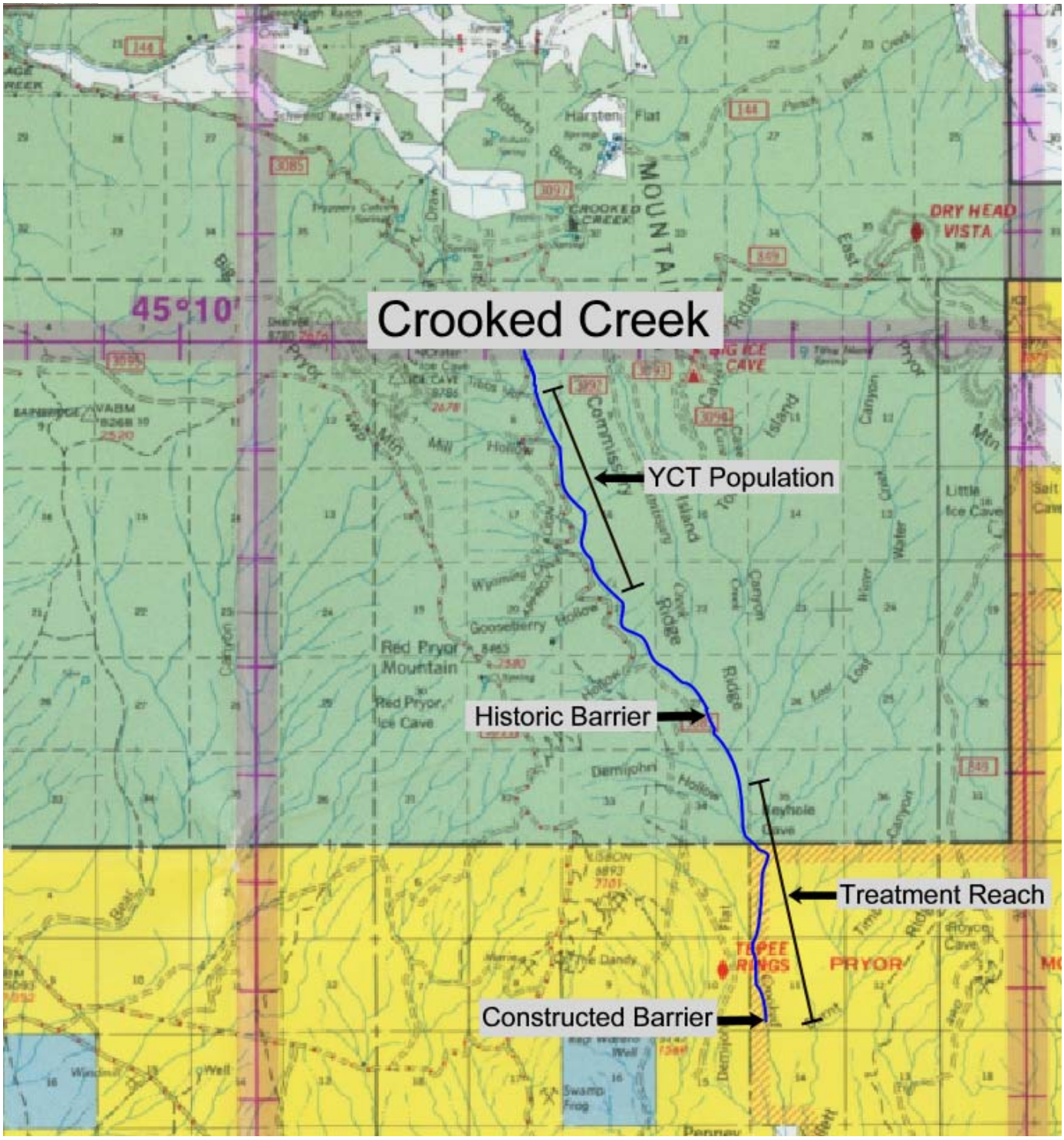

Figure 1. Site map of the proposed project area.

YCT population remaining in the upper end of Crooked Creek. A potential barrier site was identified on BLM administered lands approximately 6 miles downstream from the existing YCT population, and all three agencies (along with other private partners) began soliciting funding from numerous sources for design and construction of a permanent barrier. Single-pass

presence/absence backpack electrofishing surveys conducted in the section of Crooked Creek between the existing YCT population and the proposed barrier site captured one YCT in 2005 and 2006 approximately 1 mile upstream of the BLM/USFS boundary and no non-native fish. In the fall of 2006, a gabion fish barrier was constructed to prevent migration of non-native salmonids above the location of the proposed barrier. The gabion barrier was placed approximately 75 feet upstream of the proposed concrete barrier site. This gabion was not designed to function as a long-term barrier. Additional electrofishing surveys were conducted downstream and upstream of the gabion barrier after it was completed. A total of 9 adult brown trout were found upstream of the gabion barrier and removed in the fall of 2006. These fish had migrated upstream of the barrier site prior to the gabion construction. Extensive backpack electrofishing between Gooseberry Hollow and the gabion barrier in 2007 captured an additional 221 brown trout, which were removed from the stream. Eighty-seven of these were young-of-year (YOY) brown trout, indicating that some brown trout spawned successfully upstream of the gabion barrier in 2006. All of these brown trout were collected downstream of a temporary rock and log barrier located approximately 2.5 miles upstream of the permanent barrier site. At present, this structure appears to be acting as an upstream migration barrier for brown trout, but the efficacy of this structure is questionable. One high flow event could remove this barrier allowing brown trout to migrate all the way up to the existing YCT population.

During the spring and summer of 2007, a final design was completed for a permanent passage barrier at the proposed site on Crooked Creek. The BLM completed an in-depth Environmental Analysis for constructing a barrier in Crooked Creek (USDI 2007), obtained the final funding necessary for the project, and successfully let a bid for construction of the Crooked Creek fish barrier. Construction began in early September, and the permanent barrier was completed in early October.

Intense electrofishing efforts have seriously reduced the number of brown trout above the permanent barrier, but it is highly unlikely that all brown trout could be successfully removed from above the barrier by electrofishing alone. A great deal of time, effort and money has gone into completion of the permanent passage barrier on Crooked Creek; it is essential that the remaining brown trout be removed from above the barrier before they have the opportunity to become established in this reach of stream.

1.3 Sensitivity and Value of the Crooked Creek YCT Population

In addition to the threats posed by competition with brown trout, the Crooked Creek YCT are at high risk for extinction due to small population size, which was further limited by the Red Waffle fire. Reductions in population size are a concern because of increased potential of local extinction. According to Soule (1987), a population of fewer than about 50 fish is vulnerable to the immediate effects of inbreeding depression. Maintenance of adaptive genetic variation over longer periods of time probably requires a population size averaging more than 500 (Rieman and Allendorf 2001, Rieman et al. 1993). McIntyre and Rieman (1995) suggest that populations of cutthroat trout with fewer than 2,000 individuals are subject to a much higher risk of extinction than larger populations. In the absence of human intervention, the Crooked Creek population of YCT is the sole source capable of repopulating the stream reach that was impacted by the Red Waffle fire. Allowing the existing YCT to expand into 6 miles of additional habitat upstream of

the permanent fish barrier, without the threat of competition from non-native brown trout, would help secure this population from natural threats such as wild fires, flooding, and drought.

YCT are designated as a Sensitive Species by the BLM and Forest Service, and as a Species of Concern by the State of Montana. The genetic purity of the Crooked Creek YCT was also considered to have a "very high intrinsic value" and was considered a supplemental wilderness value in the inventory and EIS prepared to propose designated BLM lands in the area as a Wilderness Study Area (WSA) in 1986.

1.4 Relationship of Proposed Project to Existing Plans and Agreements

The action presented in this proposal is essentially an emergency follow-up to an ongoing effort by the cooperators on this proposal (FWP, CNF), and BLM to protect and expand the YCT population in Crooked Creek. The goal of the recently completed fish passage barrier project on Crooked Creek was to permanently isolate the upper reaches of Crooked Creek from potentially invasive non-native salmonid populations in the lower drainage before any could get above the proposed barrier site. These joint efforts included constructing a temporary gabion barrier just above the proposed permanent barrier site in the fall of 2006, when sampling indicated the upper reaches of Crooked Creek were still free of non-native trout. A limited number of adult brown trout did manage, however, to migrate above the barrier site before the gabion was in place, and they successfully spawned in 2006. The permanent fish passage barrier has now been completed on Crooked Creek, and extensive electrofishing efforts involving all three partners have reduced, but not eliminated brown trout above the barrier.

If the remaining brown trout are not removed from above the permanent barrier before they have a chance to become established, future efforts to remove brown trout would require considerable time, money, and effort and the common goal of protecting and expanding the YCT population in Crooked Creek may never be achieved.

A number of existing cooperative plans, agreements, and authorities, as noted below, supported recent efforts to protect and enhance the YCT population in Crooked Creek, and they also support this current proposal.

Cooperative Conservation Agreement for Yellowstone cutthroat trout within Montana.

The primary instrument guiding mutual cooperation in cutthroat conservation projects is the Cooperative Conservation Agreement for Yellowstone Cutthroat Trout (*Oncorhynchus clarki bouvieri*) in Montana (2000) (currently under revision). In 1998, FWP, CNF, and BLM joined numerous other agencies and the Crow Tribe in signing a Cooperative Conservation Agreement for YCT within the State of Montana. Agencies affiliated with this effort included FWP; Montana Department of Environmental Quality; USDA Forest Service (Northern Region), Gallatin-Custer National Forests; BLM; U.S. Fish and Wildlife Service; Bureau of Reclamation; Bureau of Indian Affairs; and the Crow Tribe. This agreement established a framework of cooperation among the participating parties to work together for the conservation of YCT. The primary goal of the Agreement and accompanying Yellowstone Cutthroat Trout Conservation

Program is to ensure the persistence of the YCT subspecies within its historic range in Montana, at levels and under conditions that provide protection and maintenance of both the intrinsic and recreational values associated with the subspecies.

As a pure population of YCT, the Crooked Creek population is considered both a core and conservation population under the Cooperative Conservation Agreement for Yellowstone cutthroat trout within Montana. FWP, CNF and BLM are all signatories to the agreement and, as such, have agreed to work toward joint objectives to "Maintain, secure and enhance all cutthroat trout populations in Montana designated as "core" or "conservation populations", "Seek collaborative opportunities to restore and/or expand each cutthroat trout subspecies into selected suitable habitats within their respective historical ranges", and "provide public outreach, technical information, inter-agency coordination, administrative assistance, and financial resources to meet the listed objectives and encourage the conservation of cutthroat trout." These cooperative efforts have resulted in the completion of a permanent fish barrier on Crooked Creek, but the obligations under this agreement will not be fully met until all brown trout are removed above the barrier.

1.5 Permits, licenses and Other Authorizations Required

1.5.1 A 308 Authorization from the Montana Department of Environmental Quality is required to apply a piscicide to waters of the State of Montana. This authorization is a temporary exemption to the state water quality standards.

1.5.2 A certified applicator licensed through the Montana Department of Agriculture is required for the application of piscicides in waters of the State of Montana.

1.6 Issues Studied in Detail

1.6.1 Impacts of piscicides on water quality

The application of rotenone to Crooked Creek will result in a temporary reduction in water quality. The reduction in water quality is expected to last less than 1 day in Crooked Creek as the piscicide naturally breaks down. During this time, water quality will be reduced such that the coldwater aquatic community, including the target organism (brown trout) and other non-target animals that respire using gills, will be impacted.

1.6.2 Impacts of piscicides on non-target organisms

The application of rotenone to Crooked Creek will result in temporary impacts to non-target aquatic organisms, namely aquatic invertebrates. Rotenone can also have negative effects on larval amphibians that respire through gills. There are no anticipated negative impacts to adult amphibians, terrestrial wildlife, and livestock that may consume treated water or fish killed by rotenone.

1.6.3 Impacts to recreation and public use of area

Although the reach of Crooked Creek upstream of the permanent barrier is on public land (CNF and BLM), access and public use is extremely limited. The section proposed to be treated does not support a substantial fishery because of the effects of the fire and subsequent flooding, and access issues and lack of huntable game essentially eliminates hunter use, so no recreational opportunities will be lost. Successful completion of this project will allow the limited YCT population to expand into over 6 miles of additional habitat on public land as habitat conditions continue to heal. Once established this YCT population would provide a unique opportunity for anglers willing to put in the effort to fish for unhybridized YCT in a very rugged, isolated setting.

2.0 Alternatives

This chapter describes the alternatives considered to provide long-term protection for a population of native, genetically pure YCT from potential extinction due to predation by and competition with non-native brown trout. It describes the activities and expected outcomes of the "Preferred" alternative and "No Action" alternative. It also discusses an alternative considered but not analyzed in detail.

2.1 Alternative A: No removal of brown trout (No Action)

Under the “No Action” alternative, no further attempts would be made to remove brown trout from above the permanent barrier in Crooked Creek. Although the current brown trout population upstream of the barrier is very low, these fish are residing in excellent habitat with no competition. Electrofishing efforts have already shown that they can successfully reproduce in this section of Crooked Creek, and those found in this section were very healthy. If the existing brown trout are allowed to remain and reproduce above the barrier, it is expected they would soon expand throughout the upper end of Crooked Creek. A combination of boulders and a large woody debris jam approximately 2.5 mile upstream from the permanent barrier appears to be acting as a temporary barrier, preventing them from reaching the existing YCT population. It is likely the effectiveness of this barrier will be lost with future high-flow events. If brown trout become established in the upper end of Crooked Creek, they will compete directly with and prey on the remaining YCT population in the upper drainage. The eventual outcome of this alternative would be the total loss of the eastern-most core population of indigenous YCT left in their historic range, and a waste of the time, effort and funds committed by numerous partners in designing and constructing the permanent fish passage barrier.

2.2 Alternative B: Chemical removal of brown trout above the permanent barrier (preferred alternative)

The intent of this project is to remove all brown trout that currently reside above the recently completed fish barrier in Crooked Creek. Successful removal of brown trout would allow the core population of pure YCT that occupy the upper 2.6 miles to expand into more than 6 miles of additional habitat without the threat of predation and competition from non-native brown trout. This alternative would also realize the full benefits of the permanent fish barrier.

To remove the brown trout, the use of the piscicide rotenone (in the formulation CFT Legumine) is being proposed. CFT Legumine has several advantages over other formulations, including a new emulsifier and solvent that reduce the presence of petroleum hydrocarbon solvents. The treatment is proposed for November of 2007, with a backup plan for early summer-fall 2008 if it is not possible to complete the treatment this fall.

A concentration of 1 ppm rotenone would be applied in Crooked Creek using a gravity-fed, constant-head application station. The application station consists of a 5 gallon reservoir connected to a constant volume drip head that dispenses a known constant volume of piscicide for a specific time period i.e. 4hr do 8 hr. Application stations are allowed to run for at least 8 hours. Backpack sprayers would be used to apply the piscicide to small spring seeps and backwater areas that are not well connected to Crooked Creek along the treatment area. Application stations would likely be spaced ¼ to 1 mile apart; the exact distance would be determined through a bioassay. A bioassay is an experiment where the chemical rotenone is applied to the target water or one of its tributaries to determine the exact distance the chemical would travel and effectively produce a 100% fish kill. Because factors such as water chemistry (pH, alkalinity), temperature, and turbulence can affect the breakdown rate of the rotenone, and these factors vary from stream to stream, a bioassay is commonly performed to determine the distance the piscicide can be expected to travel. A bioassay would be performed in Crooked Creek prior to treatment to determine the rotenone's travel time, which would also determine the spacing between application sites. A total of approximately 5 gallons of CFT Legumine would be used in Crooked Creek and associated spring seeps starting just above the temporary debris barrier located approximately 2.5 miles upstream of the constructed permanent barrier. The exact amount would be determined based upon the flow rate of the stream at the time of treatment.

Rotenone is detoxified in three different ways: 1) it breaks down naturally in the environment over time. Factors such as turbulence, exposure to sunlight and contact with organic materials all aid in its rapid breakdown. 2) dilution by fresh water , which occurs naturally in a flowing stream 3) addition of an oxidizing agent such as activated charcoal or $KMnO_4$.

The permanent fish barrier where the lowest application station would be located on Crooked Creek is over one mile upstream from the lower boundary of BLM administered property (Figure 1). If on-site assays show this is enough stream length to dilute the rotenone and allow it to to naturally break down before it reaches the private land downstream no detoxification station will be needed. The section of Crooked Creek on BLM administered property downstream of the barrier contains a limited brown trout population, but has essentially no recreational value due to the difficulty in accessing this section of stream.

As a contingency, and to ensure the treatment is contained with in the BLM administered land, an emergency detoxification station would be located approximately 40 minutes of stream travel time upstream of the BLM/private land boundary. Potassium permanganate is used to rapidly detoxify rotenone. $KMnO_4$ is a purple crystalline solid that readily dissolves in water. It is a strong oxidizer that is commonly used in drinking water treatment and other treatment facilities to oxidize metals, kill bacteria and viruses, and remove unpleasant tastes. Because fish are some of the most sensitive species to rotenone, the presence of the fish killing concentration of

rotenone in the water can be determined by observing the behavior and survival of caged fish. These sentinel fish would be placed in cages in the creek upstream of the detoxification location to monitor for the presence of rotenone in the water. Signs of rotenone poisoning include loss of equilibrium, surface gulping, erradic swimming behavior, and death. The sentinel fish would be YCT from the Big Timber Hatchery. If signs of rotenone poisoning occur, $KMnO_4$ would be administered to the water at a concentration of approximately 4 ppm. $KMnO_4$ is administered to the stream in the same manner as rotenone (i.e., using a constant-head drip station), except that a larger storage tank is used. The efficacy of the detoxification station would be monitored by sentinel fish located upstream of the BLM boundary. If rotenone is found to travel as far downstream as the detoxification station, and the sentinel fish located upstream of the detoxification station die, they would be periodically replaced to determine when rotenone is no longer present in the water. Additional sentinel fish would be kept in Crooked Creek downstream of the detox station at a distance of approximately 20 and 40 minutes travel time to determine the effectiveness of the detoxification station. If fish survive downstream of the detoxification station then the rotenone has been fully detoxified. Additional fish would be maintained out of the treatment area so that if sentinel fish die they can be replaced.

Success of the treatment would be monitored by backpack electrofishing upstream of the permanent barrier following treatment, and again in the spring of 2008. Spring electrofishing would cover the entire reach of stream from Gooseberry Hollow downstream to ensure that no brown trout had migrated upstream of the temporary debris barrier. If any brown trout were found, the treatment would be repeated in the summer of 2008 with monitoring in the fall of 2008 and spring of 2009.

2.3 Alternative C: Mechanical removal of brown trout above the permanent barrier

This alternative is no longer considered viable for Crooked Creek, so it has been eliminated from further consideration. Accessibility makes backpack electrofishing the only possible alternative for mechanically removing brown trout from above the barrier site. Crooked Creek is extremely overgrown with overhanging vegetation along much of the stream section where the brown trout need to be removed. This section of stream also contains some deep pools under debris jams that are difficult to effectively shock with a backpack unit. The treatment section has been extensively shocked on numerous occasions since brown trout were first discovered above the temporary gabion barrier in the fall of 2006. Much of this effort has included two backpack shocking units working side-by-side downstream, with two or three dip netters below the shockers. After the initial removal efforts, most of the brown trout caught in recent efforts have been blind captures with the dip netters holding their nets in the current while the shocking units are worked through the overhanging brush upstream. Approximately 80 to 90 % of recently captured brown trout were not seen until they were found in the nets, indicating there are probably many other brown trout present that are drifting past the stationary nets or avoiding the electricity altogether. With all the effort that has already been committed to mechanical removal it has become evident that this is not a viable method to remove brown trout from Crooked Creek.

3.0 Affected Environment and Environmental Impacts

3.1 Introduction

This chapter presents the existing conditions in the project area and the environmental consequences that could be expected from implementing the proposed action or taking no action.

3.2 General setting and post-fire environment

The Crooked Creek watershed from the headwaters to the barrier site encompasses 34.8 square miles, 95 percent of which is within the CNF (Figure 1). Elevations within the project area range from 4,660 feet at the potential barrier site on Crooked Creek to 8,786 feet on Big Pryor Mountain. Based on a 30-year period of record (1961-1990), the average annual precipitation associated with these elevations ranges from 12 to 26 inches, with the majority falling as spring and early summer rain (MT-NRIS, 2006).

The underlying geologic formation within the project area is limestone. This material has weathered to form relatively flat mountain plateaus with extremely steep, incised drainages. The limestone provides minimal capacity to store precipitation in near-surface, alluvial aquifers, although solution channels deep within the limestone appear to store water that surfaces at springs in tributary channels. Hence, ephemeral flow regimes dominate the majority of the tributary channels, although short segments of perennial flow occur below spring sources. The mainstem of Crooked Creek is perennial along the entire course beginning at spring sources along the uppermost reach.

Stream sediment loads are cyclic and highly dependant on natural disturbance events, e.g., wildfire followed by flood. Major exposure of limestone bedrock and lack of tributary surface flow result in relatively low surface erosion and annual sediment transport to stream systems. Over time, fine material accumulates in ephemeral draws until a major disturbance occurs in the headwaters.

Within the project area, the largest and most recent natural disturbance was the Red Waffle Fire, which occurred in July 2002. This fire burned nearly eight square miles (22 percent) within the Crooked Creek watershed, mainly along the western slopes. Day-time temperatures exceeding 100 degrees F produced high fire intensity throughout the timber stands and high fire severity throughout the soils, especially along the west side, where steep 50-70 percent slopes exist. Timber crowns and soil organic matter were totally consumed. Severe hydrophobic soil conditions were also common where high fire severity occurred.

A fire-ending rain event occurred nine days after the fire began. Estimated total precipitation from this event was 2.5-3 inches over six hours, corresponding to a 50 - 100 year return interval. This relatively high rain intensity on top of the hydrophobic soils produced overland flow throughout the burn area. Overland flow removed the remaining organic matter and ash from the

hillslopes and converged in headwater ephemeral channels resulting in significant scour and downcutting through decades of soil deposition. This scour resulted in a massive delivery of debris, including fine sediment, wood, and rock particles ranging in size from boulders to small gravels. The energy behind this flow resulted in the mobilization of the majority of bed material and woody debris in Crooked Creek, effectively modifying the entire stream channel downstream to approximately Lost Water Canyon (T 8S, R 27E, S 34). High-intensity rain events also occurred throughout the summer and fall of 2004, 2005 and 2006.

The Burn Area Emergency Response (BAER) assessment report identified risks to public safety and natural resources as a result of the Red Waffle Fire. These risks included potential failure of the road prism at stream crossings and cross-drain locations, sediment delivery from headwater channel scour and road failures to Crooked Creek, effects of sediment on water quality and pure-strain fisheries, and public safety hazards along open roads.

BAER treatments implemented to help mitigate these risks included land, channel and road treatments. Land treatments included critical-area seeding and noxious weed control. Channel treatments involved tree felling and woody debris placement in ephemeral and perennial channels. Road treatments included reconstruction of ephemeral stream crossings and maintenance of existing cross-drains.

3.3 Fisheries/Aquatics

3.3.1 Fisheries/Aquatics Affected Environment

Crooked Creek is a 19-mile long tributary to the Bighorn River, entering Bighorn Reservoir two miles south of the Montana/Wyoming border. It is classified as an impaired watershed on the 303d list, due primarily to habitat degradation on lands downstream of Crooked Creek Canyon.

Crooked Creek supports a genetically pure population of YCT, which is currently listed as a Species of Special concern by FWP and a sensitive species by the BLM and U.S. Forest Service. The Crooked Creek population is one of three small, genetically pure populations of YCT known to exist in the Pryor Mountains, and one of approximately 38 populations in the Montana.

Other aquatic organisms that may occur in the project area include aquatic macro-invertebrates (e.g. mayflies, stoneflies, etc.) and the following amphibians: tiger salamander (*Ambystoma tigrinum*), Plains spadefoot (*Spea bombifrons*), Great Plains toad (*bufo cognatus*), woodhouse's toad (*Bufo woodhousii*), boreal chorus frog (*Pseudacris maculate*), and Northern leopard frog (*Rana pipiens*). Of these species, the Plains spadefoot, Great Plains toad and Northern leopard frog are BLM sensitive species.

Pre-fire aquatic environment and trout populations

Prior to the Red Waffle Fire and subsequent rainstorm event (7/23/02), the stream-channel type classification (Rosgen 1994) for Crooked Creek upstream of Cave Creek was classified as an A1/A3/A4 with short inclusions (< 300 ft sections) of B1 and B4 channel. Overall, based on documented pre-fire habitat condition, it could be characterized as providing high quality YCT

habitat for approximately 4.1 miles upstream of Cave Creek. Frazer (1999) described Crooked Creek as "in good shape" noting a high frequency of woody debris, high quality pools, and a healthy riparian area with dense stands of woody riparian vegetation.

Historically, YCT were much more widely distributed throughout the upper Yellowstone basin and its tributary systems, and populations were much more interconnected. The current Crooked Creek population is small and isolated, confined to a high-elevation tributary steam, which is characteristic of the most surviving populations in the Yellowstone drainage. Because it is not connected with other populations of YCT, its habitat cannot be re-populated naturally if the YCT are lost due to another catastrophic event. Thus, habitat fragmentation, isolation, and extinction risk are critical concerns.

Two YCT population estimates have been conducted in the vicinity of Gooseberry Hollow, one in 1986 and the other in 1992. Fredenberg (1986) estimated densities of cutthroat upstream of Cave Creek at approximately 20/1,000 feet. Frazer (1992) reported similar numbers, indicating a fairly stable population in the upper drainage. Given this estimated density, and the 4.1 miles of stream determined to be capable of supporting fish upstream of the Cave Creek fish passage barrier, the entire pre-fire (prior to 2002) population of YCT was estimated at between 350 and 400 fish.

Genetic purity was electrophoretically verified in 1985 through analysis of tissue samples from 45 YCT collected in the vicinity of the mouth of Gooseberry Hollow (T 8S, R 27E, S21). There is one documented record of fish stocking in Crooked Creek. In 1941, approximately 4,000 YCT fry were planted in the creek in an undesignated location. It is unknown if the fish presently found in the stream are progeny of that plant or from an indigenous population. Fredenberg (1986) documented a conversation with R. Tillett (a local landowner), in which Tillett describes catching native cutthroat in 1922, prior to the documented stocking date. Additionally, Tillett reported the stocking of brook trout *(Salvelinus fontinalis)* in lower Crooked Creek in the 1930s by his father.

Non-native species were also known to be present in the lower drainage. In addition to brook trout, landowners (H. Tillett) in lower Crooked Creek reported catching brown and rainbow trout in the lower drainage before the 2002 fire. However, a natural barrier and high-gradient stream reach upstream of the Cave Creek confluence (T8S, R 27E, S27) (Figure 1) apparently prevented upstream migration. The barrier, described by Frazer (1999), consisted of two large boulders with a 5-foot vertical hydraulic drop.

Post-fire conditions and current YCT population

The debris flow, which occurred after the Red Waffle Fire, resulted in the complete alteration of the physical nature of the stream channel and the quality and quantity of fish habitat downstream of Gooseberry Hollow. Thereafter, Crooked Creek downstream of Gooseberry Hollow was characterized as an A4 channel type dominated by a continuous low gradient riffle with a very low pool frequency and very little woody debris. The stream channel had essentially been filled with gravels and had started the long-term process of channel aggradation and degradation of its bed. Several channel adjustment features, such as active head cuts, scour at hydraulic slip faces, and depositional bar formation occurred throughout the affected reach.

Due to the highly confined valley bottom in the upper drainage and lack of off channel refugia from the debris flow, a complete fish kill was suspected from Gooseberry Hollow downstream to private lands, eliminating all biota in the lower 1.5 miles of previously occupied cutthroat habitat. On July 28, 2002, BLM wildlife biologist Jay Parks observed fish mortality (species could not be identified due to decomposition) in Crooked Creek upstream of the BLM/private land boundary. A complete loss of all surface-dwelling macroinvertebrates was also observed.

The establishment of healthy macroinvertebrate populations was identified as an essential precursor to the redistribution of YCT in the burned reach. Although the 2002 debris flows effectively eliminated surface-dwelling macroinvertebrates from the burned reach, populations were expected to quickly rebound and recolonize the area. Observations from 2005 and 2006 supported this expectation; abundant mayfly (*Ephemeroptera*) and caddis fly (*Trichoptera*) nymphs and adults were dispersed throughout the burned reach. Dip nets held in the current for any period of time during electrofishing efforts in 2007 captured numerous large stoneflys (*Plecoptera).*

Initial restoration efforts following the fire focused on overwintering pool habitat. Approximately 100 dead standing trees were felled along the mainstem of Crooked Creek to introduce large woody debris (LWD) to dissipate stream energy, trap bedload, and promote fish habitat diversity (Nienow 2005). By the time an aquatic habitat assessment and passage barrier survey was conducted in July 2005, several intense precipitation events had occurred, and much of the felled and naturally recruited LWD had been transported downstream to form several large log jams. Two of these log debris jams may serve as temporary barriers, although in 2006, one brown trout was found upstream of the jam located on the CNF/BLM boundary (Figure 1). The second debris jam is located about 2 miles upstream from the BLM/private land boundary. Both sites have a vertical plunge of approximately 6 feet. However, because flows are seeping through the interstices of the LWD configurations, the jams could deteriorate rapidly at either site.

At first, movement and redistribution of bed-load material “overloaded” the mainstem channel of Crooked Creek. The subsequent delivery of gravel substrata and the flushing of entrained fines, however, created good-quality spawning areas of unconsolidated sediments (Swanston 1991).

The existing Crooked Creek YCT population, upstream of Gooseberry Hollow to Tibbs Hollow, has remained undisturbed since the Red Waffle Fire and subsequent debris flows. A 2-pass removal estimate was attempted on a 300-foot section of Crooked Creek just upstream of Gooseberry Hollow in October 2002, shortly after the fire and flood event. Twelve YCT were handled,10 during the first pass and 2 during the second. These fish ranged from 4.3-8.0 in long. Several of these cutthroat were collected from one large pool formed at the lower end of the undisturbed section when debris from Gooseberry Hollow washed into Crooked Creek. This pool did not represent habitat conditions in the remainder of the unburned section above Gooseberry so the calculated estimate of 220 YCT per mile over represented population levels remaining upstream of Gooseberry. Additional population estimates have not been conducted in the unburned headwaters and “refuge” area to reduce potential mortality to the remaining YCT population in Crooked Creek. However, 3 to 4 age classes of YCT (ranging in size from 3

to 12 inches) were observed in the first 0.5 miles of Crooked Creek upstream from Gooseberry Hollow in August and September 2004 and July 2005. Numbers of YCT observed in the unburned area have remained fairly consistent with pre-fire observations so an estimate of approximately 200 individuals remains a reasonable estimate for the current YCT population in undisturbed section of Crooked Creek.

In 2006, 20 YCT were collected for genetic analysis. During this collection, observers noticed many adult fish compared to juveniles. In addition, the number of fish present in the stream indicated the population of YCT in the headwater section of Crooked Creek could be increasing. The genetic analysis confirmed the genetic purity of the YCT remaining in the upper end of Crooked Creek (University of MT 2007).

A single-pass presence/absence survey conducted from Gooseberry Hollow downstream to the permanent barrier site in the summer of 2007 captured 24 adult YCT between 0.5 and 1 mile downstream of Gooseberry. YCTs were pioneering into the disturbed section of Crooked Creek as it recovered. Good spawning gravel was limited in the undisturbed section of Crooked Creek upstream of Gooseberry Hollow, which may have been a limiting factor on this population in the past. Spawning gravel is abundant in the section downstream from the main debris influx at Gooseberry Hollow. The pioneering YCT should be able to spawn successfully in the spring of 2008, which could lead to a rapid expansion of the YCT population further downstream into the unpopulated section.

An electrofishing survey was conducted on private land (J. Tillett residence) upstream to the lower end of BLM section 14 in April 2005, to determine if the intense debris flows of July 2002 and June and July 2004 resulted in a complete fish kill in lower Crooked Creek. Two brook trout (5 and 5.5 inches in length) were captured, and one brook trout of similar size was observed. All three brook trout were within the private-land portion of the survey.

In 2006, a gabion fish barrier was constructed to prevent upstream migration of non-native salmonids. The gabion barrier, placed approximately 75 feet upstream of the proposed concrete barrier site, was not designed to function long-term. Additional electrofishing surveys were conducted downstream and upstream of the gabion barrier in the fall of 2006. Nine brown trout were found and eradicated upstream of the gabion barrier and a number of brown trout were captured or observed downstream of the barrier. The 9 fish found upstream of the barrier migrated upstream prior to barrier construction. Numerous electrofishing surveys conducted upstream of the gabion barrier in 2007, some starting as high upstream as Gooseberry Hollow, captured 221 additional brown trout, 87 of which were YOY fish. All of these brown trout were removed from the system, and no brown trout were captured upstream of a boulder and woody debris barrier located about 2.5 miles upstream of the gabion. A permanent concrete fish passage barrier was completed approximately 75 feet downstream of the gabion barrier in October of 2007, and the gabion was removed.

Field investigations conducted in August 2004 revealed that the natural fish passage barrier near Cave Creek was altered by debris flows following the Red Waffle fire, and that this structure was rendered passable to migrating salmonids. So the only obstacle preventing the brown trout that still exist above the permanent fish barrier from reaching the YCT population in the upper

end of Crooked Creek is the boulder and woody debris barrier located 2.5 miles upstream, which could be lost with the next high-flow event.

3.4.1 Fisheries/Aquatics Environmental Impacts

No Action Alternative
Under the no action alternative (no treatment of the brown trout upstream of the permanent barrier), the brown trout population in Crooked Creek would expand rapidly between the permanent barrier and the temporary debris barrier 2.5 miles upstream. There would be a high potential for this temporary barrier to fail over time, and for non-native brown trout to migrate upstream into YCT habitat. If brown trout mix directly with the remaining YCT population, they would prey upon and compete directly with them. The likely outcome of this alternative would be the eventual loss of this Core YCT population from Crooked Creek.

Proposed Action Alternative
The piscicide rotenone in the formulation CFT Legumine is proposed for use to remove brown trout from Crooked Creek upstream of the permanent fish passage barrier completed on the creek in October 2007. A concentration of 1 ppm formulation would be applied in Crooked Creek using a gravity-fed, constant-head application sites. Application sites would be allowed to run for at least 8 hours. Backpack sprayers would be used to apply the piscicide to small spring seeps and backwater areas that enter Crooked Creek along the treatment area. Application sites would likely be spaced ¼ to 1 mile apart; the exact distance would be determined through a bioassay. Approximately 5 gallons of CFT Legumine would be applied to Crooked Creek and associated spring seeps starting just above the temporary debris barrier located approximately 2.5 miles upstream of the constructed permanent barrier. The exact amount would be determined based upon the flow rate of the stream at the time of treatment.

No detoxification is proposed for this treatment if a bioassay test shows that the rotenone would break down naturally in the stream between the lowest drip station (located at the permanent barrier) and the downstream boundary of the BLM administered property. As a contingency, and to ensure the rotenone does not affect fish populations on private land downstream of the BLM administered land, an emergency potassium permanganate detoxification station would be located on Crooked Creek approximately 40 minutes travel time upstream of the BLM/private land boundary. Potassium permanganate could be used to rapidly detoxify rotenone, if sentinel fish tests indicate the rotenone was still present in the water at the site of the detoxification station.

Successful completion of this alternative would result in complete removal of brown trout from above the permanent barrier on Crooked Creek, and would allow the current YCT population inhabiting the upper 2.6 miles of Crooked Creek to expand into over 6 miles of additional habitat on public land without the threat of competition from brown trout.

Treatment could be completed in the fall of 2007 or the summer of 2008 with follow-up electrofishing used to test the success of the treatment. A second treatment could be administered if a complete brown trout kill were not achieved with the first treatment.

Table 1. Summary of Predicted Environmental Effects

Issue	Predicted Effects of Alternative A (No Action)	Predicted Effects of Alternative B (Proposed Action)	Can Impact Be Mitigated
1. Water quality including cumulative effects on water quality	No change in surface or ground-water conditions in Crooked Creek	Surface water quality would be temporarily altered by the introduction of rotenone to kill brown trout. There would be no impacts to groundwater, as rotenone breaks down quickly in the environment and binds readily to organic material. Cumulative impacts to water quality would be temporary and minor.	Yes
2. Impact of piscicides on and non-target organisms	No effect on non-target species, such as aquatic invertebrates, in Crooked Creek.	Invertebrate populations would be reduced for 3 miles upstream of the permanent fish barrier and for a short distance downstream as a result of applying rotenone. These impacts are generally short term, with invertebrate species richness and abundance recovering to or above pre-treatment conditions within 1-4 years.	Aquatic invertebrates: No, Vertebrates: Yes
3. Impacts on coldwater fisheries	There could be a rapid expansion of the brown trout population in Crooked Creek upstream of the permanent barrier, which could have a significant impact on the pure YCT population in the upper end of the drainage including the possible elimination of YCT from Crooked Creek	Coldwater fisheries would be significantly impacted as a result of the proposed action. Impacts on brown trout would be minor because a very limited population currently exists in the treatment area, and it does not support any recreational fishing. Significant YCT enhancement would result from successful removal of brown trout from the treatment area. The existing YCT population in the upper end of Crooked Creek would be allowed to expand into almost 6 miles of additional, good-quality stream habitat upstream of the permanent fish barrier completed in September 2007. This population expansion could occur without the threat of competition from non-native salmonids.	Yes

Issue	Predicted Effects of Alternative A (No Action)	Predicted Effects of Alternative B (Proposed Action)	Can Impact Be Mitigated
4. Potential for chemical spill or accident	No potential for an accidental chemical spill.	There is a risk of chemical spill under the proposed action. This risk would be minimized by having a crew experienced in piscicide application and following the safe-handling procedures on the product label. Spill containment measures would also be utilized to mitigate risk. In the event of a spill of fuel or chemicals, Montana DEQ's spill reporting and clean-up requirements would be applied.	Yes
5. Potential risk of human exposure to hazardous chemicals	No risk of human exposure to rotenone or potassium permanganate.	Rotenone is a restricted-use pesticide. It can be fatal if inhaled or swallowed in powdered or highly concentrated form, and is an eye irritant. Once diluted in a stream at 1 ppm, however, rotenone becomes a negligible hazard to humans and other animals. Safety guidelines on the product labels will be followed for both rotenone and $KMnO_4$ to reduce hazard risks.	Yes
6. Cumulative watershed impacts	No predicted increase in cumulative impacts to the Crooked Creek watershed.	Cumulatively, the proposed action would have minor short-term impacts to water quality and non-target invertebrates in Crooked Creek, but affected populations would quickly recover.	Yes

Issue	Predicted Effects of Alternative A (No Action)	Predicted Effects of Alternative B (Proposed Action)	Can Impact Be Mitigated
7. Impacts to recreation and public use of area	No impacts to recreation in the area are anticipated.	Impacts would be minor during the project, but if successful, could provide a unique opportunity to fish for pure native YCT in a very isolated setting in the future. The treatment area is entirely on public land, but access to the area is very limited and difficult. There is currently no recreational fishery in the area to attract anglers, and hunters normally do not venture into the bottom of Crooked Creek canyon, so public use is almost nonexistent.	Yes
8. Impacts on the Proposed Burnt Timber Canyon Wilderness Study Area (WSA)	Significant impacts could occur if the brown trout are not removed, and they eventually replace the YCT population. The presence of a pure YCT population in Crooked Creek was one of the wilderness values identified in this designation.	Minimal short-term impacts to the stream segment in and adjacent to the WSA would occur under the proposed action. These impacts are limited primarily to temporary reductions in stream-dwelling aquatic invertebrates. Protection of the YCT population in Crooked Creek upstream of the permanent fish barrier would help maintain this important wilderness value for the area.	Aquatic invertebrates: No, Loss of this unique YCT population from no action: No
9. Impacts on additional services or funds provided by the government	No additional funding would be required under the "No Action" alternative. If brown trout become established and invade further upstream in Crooked Creek, however, the cost of eradication would be much greater than the proposed project.	Labor associated with this project would be approximately 12 person-days. Equipment, chemical and other costs would be minimal because the equipment and chemicals used would be left over from another project.	No

Issue	Predicted Effects of Alternative A (No Action)	Predicted Effects of Alternative B (Proposed Action)	Can Impact Be Mitigated
10. Impacts to the local economy	No change in the local economy.	Minimal change is expected in the local economy. The short duration of the project should have little impact on recreational use of the area, and improving the quality of the fishery in the area may have a positive effect on the local economy.	Yes
11. Impacts to endangered, threatened or sensitive species, including cumulative impacts	No impacts to endangered or threatened species but a potential significant impact to YCT, a sensitive species, if brown trout colonize the upper end of Crooked Creek and displace the YCT population.	Minimal and temporary potential impacts to sensitive species are expected. Although the proposed project area is within the known range of some of these species, expected impacts are only temporary displacements during the implementation of the project. Positive impacts to YCT are expected as a result of the proposed action, including protection of the current core YCT in Crooked Creek from invasion by brown trout, and the expansion of this population into approximately 6 miles of new habitat upstream of the permanent fish barrier completed in October 2007. The proposed action contributes to the current YCT conservation strategy, thereby reducing the likelihood of listing under the Endangered Species Act.	Yes

3.4.2 – Detailed description of affected resources and mitigation measures under Alternative B

Issue #1. Water quality, including cumulative effects on water quality

Chemical treatment of Crooked Creek would introduce the piscicide rotenone into the water resulting in a fish-kill. Rotenone is an EPA registered pesticide approved for fish removal projects and is highly effective at killing fish at low concentrations. It is derived from the derris root, a plant native to tropical areas of Central and South America. Native peoples dried the root and crushed it into a powder, which they applied to water to catch and kill fish for food. In the formulation CFT Legumine, the rotenone is extracted from the derris root and added to the formulation at a concentration of 5%. Rotenone has been extensively used to manage fish populations and has been routinely used in stream and lake rehabilitation. Rotenone kills fish by blocking a specific metabolic pathway at the cellular level. It enters the blood stream of fish through their gills. Rotenone is not readily absorbed into the blood through the digestive system or through the skin, lessening the risk of exposure to non-target organisms that may consume treated waters or fish killed by rotenone (Finlayson et al. 2000).

Rotenone has a half-life of 14 hours at 24°C, and 84 hours at 0°C, meaning that half of the rotenone is broken down and is no longer toxic within that time. As temperature and sunlight increase, the rate at which rotenone is broken down also increases. Higher alkalinity (>170 ppm) and pH (>9.0) also increase the rate of breakdown. Rotenone tend binds to and reacts with organic molecules rendering it ineffective, so higher concentrations are required in streams with large amounts of organic debris. Testing of wells at Soda Butte Campground adjacent to the rotenone treatment of Soda Butte Creek in 2003 indicated the chemical had not contaminated the groundwater supply. Monitoring of domestic wells adjacent to other rotenone projects in northwestern Montana has detected no rotenone or petroleum constituents in the water.

Without detoxification, rotenone in the streams would be reduced to non-toxic levels in 24-72 hours due to its natural breakdown and dilution in the aquatic environment. Rotenone is being constantly diluted in a stream environment, and factors such as turbulence, exposure to sunlight, and contact with organic material all aid in its rapid breakdown. Given the low concentration of chemical to be used (1 ppm), the short duration of the project, and the rapid natural breakdown of the piscicides, water quality impacts should be temporary and minimal.
To reduce the potential impact to water quality and non-target organisms (Issue #2), the following mitigation measures and monitoring efforts would be employed:

1. Only the minimum amount of piscicide to produce a 100% fish kill will be used during the project. A bioassay will be performed to determine the travel time of rotenone in Crooked Creek.
2. A detoxification station will be set up approximately 40 minutes of travel upstream of the BLM/private land boundary on Crooked Creek. If rotenone is present as indicated by adverse effects on sentinel fish, $KMnO_4$ will be used at a concentration of 4 ppm to neutralize the fish toxicant. This concentration should be more than adequate to travel a minimum of 20 minutes and reduce any remaining rotenone in the water. Experience from other projects indicates

that detoxifying at a rate of 4 ppm effectively neutralizes piscicides and has little impact on aquatic life. Two people will be stationed at the detoxification station to monitor its effectiveness.

3. Sentinel fish (YCT from Big Timber Hatchery) will be used to monitor for the presence of rotenone in the water above and below the detoxification station. Trout are more sensitive to rotenone than most other aquatic species, and they are used to monitor the presence of rotenone by placing them in cages in the stream. The effectiveness of the detoxification station will be monitored approximately 0.5 mile below the detoxification region. Sentinel fish placed in the stream upstream of the detoxification station will indicate when it should be started (i.e., when the fish begin to show symptoms of rotenone toxicity), and when it can be stopped (when fish can survive 24 hours upstream of the station).
4. Project personnel will be trained in the use of these chemicals, including the actions necessary to deal with spills. Personnel will wear proper safety equipment.
5. A communication and safety plan will be developed in the case of an accident. Personnel will be equipped with radios, so that communication can be maintained during the project implementation. A satellite phone will be available at the project area.
6. Only the amount of chemical necessary for one day of treatment will be stored near the stream.

The expected concentration of potassium permanganate needed to neutralize rotenone will be 4 mg/L (ppm). The EPA lists the chronic toxicity of $KMnO_4$ breakdown products to be of no health concern based on the fact that they are naturally occurring and common in surface waters. The safety of $KMnO_4$ is further demonstrated its routine use in drinking water treatment to achieve: oxidation of iron and manganese, oxidation of taste and odor compounds, and the control of nuisance organisms such as bacteria and viruses (USEPA 1999). At 4 ppm, the expected travel time of the permanganate is less than 1 mile before it is completely reduced. The reduction of permanganate can be visually determined by its changing from a purple to a rust color. Since $KMnO_4$ can have similar effects on aquatic life as rotenone, the potential impacts to water quality can be mitigated by only using the $KMnO_4$ if rotenone is present at the detoxification station downstream of the barrier on Crooked Creek. If the rotenone breaks down naturally before this point, no $KMnO_4$ will be used.

The Montana Department of Environmental Quality and FWP Piscicide Committee will also review this project before implementation to ensure that impacts to water quality are considered and minimized to the extent possible.

Issue #2. Impact of piscicides on non-target organisms

For terrestrial wildlife, the risk of negative effects of drinking treated waters or consuming fish killed by rotenone is minimal. The absorption of rotenone through the digestive system is

inefficient, and all animals, including fish, insects, birds, and mammals that have natural enzymes in the digestive tract and liver that neutralize it. Because of the low application rate (1 ppm), the low absorption rate if consumed, and the natural ability of enzymes to break down the chemical, there are no anticipated impacts on terrestrial non-target organisms. Further, because there is no effect on terrestrial animals, the product label does not restrict the use of treated water for livestock use. The rotenone will be stored in animal resistant containers, so the risk of animals coming in contact with non-diluted rotenone is minimal.

Unlike terrestrial wildlife, some forms of aquatic invertebrates are more susceptible to rotenone because the chemical is readily absorbed directly into their blood through skin or gills (non-oral route). Marked decreases in aquatic invertebrate populations are realized following treatment with rotenone. Both species richness and abundance are significantly impacted (Bramblett 1998; Olsen 2004). Aquatic invertebrates, however, are extremely resilient and populations quickly recover. In the treatment of Soda Butte Creek in 2003, species richness and abundance was dramatically impacted immediately following treatment with rotenone. Within one year, however, numbers of aquatic invertebrates exceeded pre-treatment levels. The total number of species was also equal to the total number observed before treatment; however, there were some differences in species composition (Olsen 2004). Other studies have reported similar results where, within 1-3 years following piscicide treatment, aquatic invertebrate communities have nearly recovered to pre-treatment levels (Walker 2003). To mitigate the impacts on aquatic invertebrates in Crooked Creek, at least 3 miles of the creek upstream of the treatment area will be left undisturbed. This area will serve as a source of invertebrates to recolonize the habitat in the treatment reach.

Rotenone has little harmful effect on adult amphibians, which respire primarily through lungs. Larval amphibians with gills are susceptible because the rotenone enters the blood rapidly through the gills, and because larvae are dependent on aquatic environments for survival whereas adults can escape the treated water. The potential impacts to amphibians can be mitigated through the timing of the chemical treatment. The treatment is proposed for late fall when the majority of amphibian juveniles will have metamorphosed into adults, which will not be affected at the concentrations proposed for this project.

Because $KMnO_4$ is a strong oxidizer, it can also have negative effects on non-target organisms. The effects observed for aquatic invertebrates are similar to those of piscicides (Walker 2003). $KMnO_4$ is non-specific, however, in the target compounds it reduces. Organisms affected by $KMnO_4$ have been found to recover quickly (i.e., within 1 year) following treatment. Therefore, the effects of $KMnO_4$ on non-target organisms are expected to be temporary.

Issue # 3. Impacts on coldwater fisheries

The proposed project will remove brown trout from 2.5 to 3 miles of Crooked Creek. The limited brown trout population in this section of stream has already been reduced through extensive backpack shocking. Due to the difficult and limited access and reduced numbers of brown trout due to the debris flow following the Red Waffle fire, this section of stream does not currently support a coldwater sport fishery to be impacted. If not removed from above the barrier, the brown trout population could expand to the level that would provide a coldwater

fishery; but again, due to access, it is doubtful a fishery would ever develop. If the treatment proposed in this project is successful and the YCT population is allowed to expand from their current distribution in about 2.6 miles into over 8 miles of stream, it is more likely someone looking for a unique opportunity to fish for pure YCT would make the effort to fish. It is very unlikely Crooked Creek will ever develop into an important coldwater fishery.

Issue #4. Potential for chemical spill or accident

With any project that requires the use of chemicals, there is always the risk of an accidental spill. Following the safe-handling information on the product label can mitigate the risk of a spill. Transporting and storing the chemical away from surface water will minimize the risk of contaminating surface waters. The properties of rotenone and $KMnO_4$ reduce the risk of a potential spill affecting groundwater. The ability of rotenone to move through soil is low to slight. Rotenone moves less than 1 inch in most types of soils. An exception would be in sandy soils where the movement can be slightly more than 3 inches. Rotenone is strongly bound to organic matter in soil, so it is unlikely that it would enter groundwater (Dawson et al. 1991). CFT Legumine is flammable because of the emulsifiers in the formulation. The safe handling of it according the product label, which includes keeping it from open flames or sparks, will minimize the risks of fire and explosion. A fire extinguisher will be kept at the project site. Before rotenone is administered to the stream, it will be diluted with water by a factor of approximately 50:1 at the application station, rendering the solution non-flammable.

Issue #5. Potential risk of human exposure to hazardous chemicals

Rotenone does not affect humans or other animals that consume treated waters or fish killed by rotenone for two reasons. First, the main pathway for rotenone to enter the bloodstream is through the respiratory system. Rotenone is not readily absorbed into the blood through the digestive system or skin of humans. Second, the concentration needed to kill fish is extremely low (1 ppm) compared to that necessary to affect humans or other terrestrial animals. Limited data from the effects on animals indicates the safe concentration for short-term human consumption is about 350 mg/l (350 ppm), nearly 100 times the application concentration (California Department of Fish and Game 1994). Rotenone does not bioaccumulate in the tissues of animals. The livers of fish and terrestrial animals can readily metabolize non-lethal doses of rotenone, converting the chemical into inert compounds that can be excreted through urine. The product label indicates that fish killed by rotenone are not to be consumed by humans. Sufficient human clinical trials have not been conducted to certify that fish killed with rotenone are safe for human consumption. The mitigation measures mentioned in Issue #1 should reduce the risk of human and animal exposure to treated waters. The safety guidelines on the product label, which include the use of chemically resistant gloves, eye protection, and organic vapor cartridge-type respirator will be followed by all personnel who handle or apply rotenone. Personnel who handle $KMnO_4$ will follow similar safety precautions, including protective gloves, safety glasses, and a respirator.

Issue #6. Cumulative watershed impacts

Treatment of Crooked Creek with rotenone could have short-term impacts to water quality and non-target invertebrates. Because the length of stream being treated is short and the fact that there will be at least 3 miles of untreated habitat upstream of the treatment to serve as a source of invertebrates to recolonize the habitat in the treatment reach, affected populations should recover quickly.

Issue # 7. Impacts to recreation and public use of area

As discussed under Issue #3, recreational use in the proposed treatment area is extremely limited due to access and lack of recreational opportunities. Successful completion of this project would allow the YCT population to expand into 6 miles of additional habitat in Crooked Creek, which could result in a slight increase in recreational use in the area as anglers looked for a unique opportunity to fish for this native species.

Issue # 8. Impacts on the Proposed Burnt Timber Canyon Wilderness Study Area (WSA)

Impacts of the "No Action" alternative on the WSA would be much greater than impacts of the proposed treatment. The presence of a pure-strain population of YCT in Crooked Creek was considered to have a "very high intrinsic value" and was considered a supplemental wilderness value in the inventory and EIS prepared to designate BLM lands in the area as a proposed WSA in 1986. If the existing brown trout population upstream of the permanent barrier were allowed to remain and become established in this section of Crooked Creek, there is a strong possibility that this important YCT population would eventually be lost from the area.

Issue #9. Impacts on additional services funds provided by the government

The proposed project would be accomplished cooperatively using personnel time contributed by the CNF, BLM and FWP. The necessary chemicals and equipment are available through the FWP office in Billings. The equipment was purchased for another, recently completed treatment project, and there was enough rotenone and potassium permanganate left from this large project to complete the small project on Crooked Creek. This project will not result in any significant additional government costs.

Issue #10. Impacts to the local economy

As indicated above, recreational use associated with Crooked Creek is very limited due to difficulty of access and lack of recreational opportunities. If the YCT population is allowed to expand and become well established there may be more interest in Crooked Creek as a fishery, but any increase in use would probably be too small to impact the local economy.

Issue #11. Impacts to endangered, threatened or sensitive species, including cumulative impacts

As previously mentioned, the proposed project area is within the known range of several amphibian species listed as sensitive species by the BLM. Rotenone has little harmful effect on adult amphibians, which respire primarily through lungs. Juvenile amphibians (tadpoles), however, are affected by the piscicide because respiration occurs primarily through their skin. The potential impacts to amphibians can be mitigated through the timing of the chemical treatment. The treatment in this project is proposed for late fall when the majority of amphibian juveniles will have metamorphosed into adults. Positive impacts to YCT are expected as a result of the proposed action, including protection of the current core YCT in Crooked Creek from invasion by brown trout, and the expansion of this population into approximately 6 miles of new habitat upstream of the permanent fish barrier.

4.0 List of Individuals Associated with the Project

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5.0 Literature Cited

Bramblett, R.G. 1998. Environmental Assessment. Madison River drainage westslope cutthroat trout conservation and restoration program: Cherry Creek native fish introduction. Montana Fish Wildlife & Parks, Region 3, Bozeman, MT 59718-5496

Dawson, V. K., W. H. Gingerich, R. A. Davis, and P. A. Gilderhus. 1991. Rotenone persistence in freshwater ponds: effects of temperature and sediment adsorption. North American Journal of Fisheries Management 11:226-231.

Finlayson, B. J., R. S. Schnick, R. L. Cailteux, L. DeMong, W. D. Horton, W. McClay, C.W. Thompson, G. J. Tichacek. 2000. Rotenone use in fisheries management. American Fisheries Society, Bethesda, MD.

Frazer, K. 1992. Memorandum: 1992 Work on Crooked Creek in the Pryor Mountains. Montana Fish, Wildlife and Parks. Billings, Montana.

Frazer, K. 1999. Memorandum: Crooked Creek Canyon. Montana Fish, Wildlife and Parks. Billings, Montana.

Fredenberg, W. 1986. Memorandum: Summary of Crooked Creek exploratory survey. Montana Fish, Wildlife and Parks. Billings, Montana.

FWP and 12 others. 2007. Memorandum of understanding and conservation agreement for westslope and Yellowstone cutthroat trout in Montana. Montana Department of Fish, Wildlife and Parks, Helena, Montana.

McIntyre, J.D. and B.E. Rieman. 1995. Westslope cutthroat trout in Conservation Assessment for Inland Cutthroat Trout. General Technical Report RM-256. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. M.K. Young, tech. Ed. Pages 1-15.

MT-NRIS, 2006. Montana State Library - Natural Resource Information System. Average Annual Precipitation Map – Carbon County [Online]. Available: http://nris.state.mt.us/gis/gisdatalib/downloads/precip_Carbon.pdf.

Nienow, M. 2005. Monitoring Report: BAER Treatment Effectiveness, Red Waffle Fire. Custer National Forest Supervisors Office, Billings, Montana.

Olsen, J. R. 2004. Mid-Yellowstone Drainage investigations, survey and inventory of coldwater streams. Montana Fish, Wildlife and Parks Job Progress Report F-13-R-1-2, Job I-i.

Rieman, B., D. Lee, J. McIntyre, K. Overton, and R. Thurow. 1993. Consideration of extinction risks for salmonids. FHR Currents, Fish Habitat Relationships, Technical Bulletin 14 December. USDA Forest Service, Boise, Idaho.

Rieman, B.E. and F.W. Allendorf. 2001. Effective Population Size and Genetic Conservation Criteria for Bull Trout.

Rosgen, D.L. 1994. A classification of natural rivers. Catena 22:169-199.

Soule, M.E. 1987. Where do we go from here? Pages 175-183 *in* M.E. Soule, editor. Viable Populations for Conservation. Cambridge University Press, Cambridge, England.

Swanston, D. N. 1991. Natural processes. Pages 139-179 in W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitat. Special Publication 19. American Fisheries Society, Bethesda, Maryland.

University of Montana. 2007. Montana Conservation Genetics Lab Report. Division of Biological Sciences. Missoula, MT

United Sates Department of Interior. 2007. Environmental Analysis for the Crooked Creek Barrier Construction Project. Bureau of Land Management: Billings Field Office.

Walker, C. A. 2003. Effects of antimycin treatment on benthic macroinvertebrates in Sams Creek and Starkey Creek, Great Smoky Mountains National Park, Blount/Sevier counties, Tennessee. Masters Thesis, The University of Tennessee, Knoxville.