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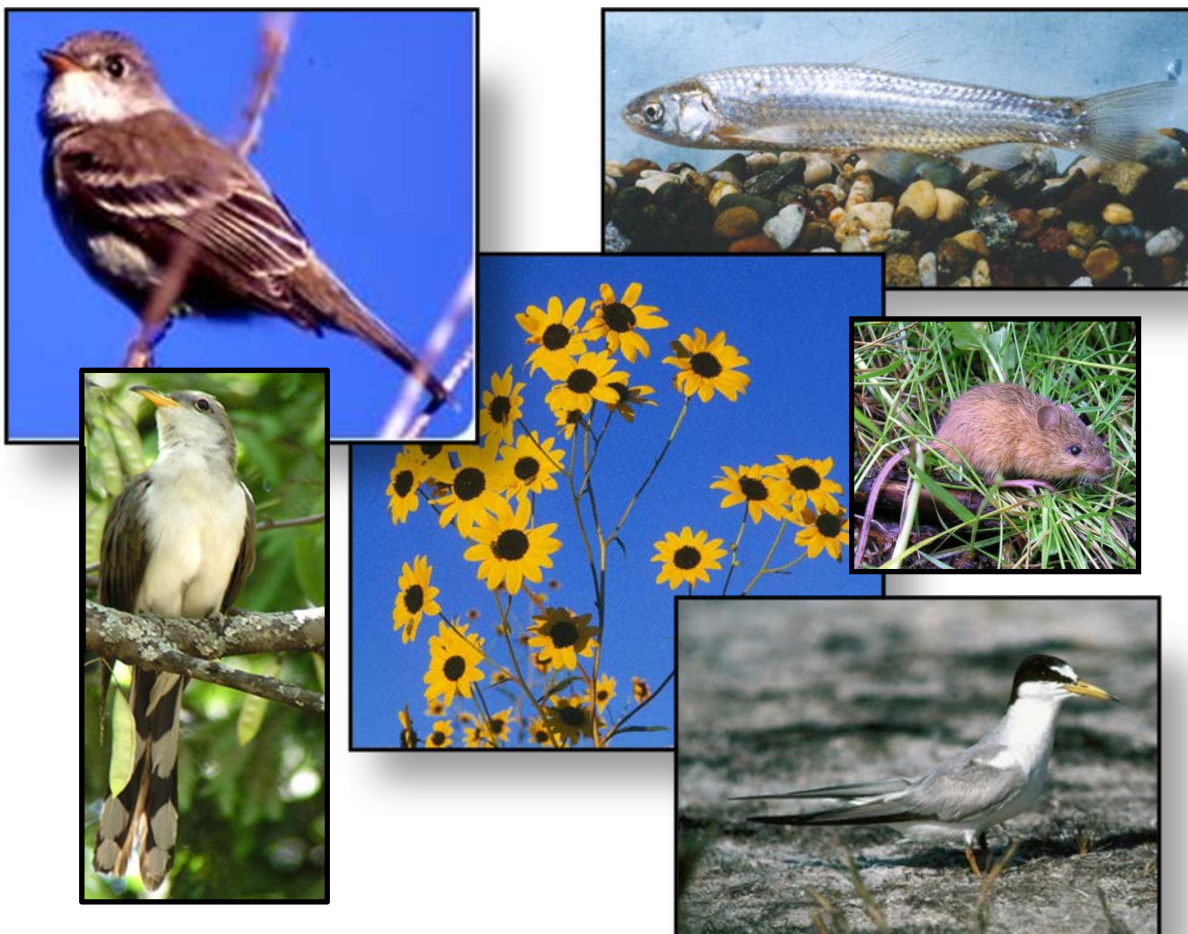
Joint Biological Assessment

Bureau of Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico

Middle Rio Grande Project, New Mexico
San Juan-Chama Project, New Mexico
Upper Colorado Region



U.S. Department of the Interior
Bureau of Reclamation

August 2015

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The Bureau of Indian Affairs' mission is to enhance the quality of life, to promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian tribes and Alaska Natives.

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Part III – Proposed Action and Effects: River and Infrastructure Maintenance and Restoration

Middle Rio Grande Project, New Mexico
San Juan-Chama Project, New Mexico
Upper Colorado Region

Submitted to the U.S. Fish and Wildlife Service

Rio Grande Silvery Minnow	**Southwestern Willow Flycatcher**
Yellow-billed Cuckoo	**New Mexico Meadow Jumping Mouse**
Pecos Sunflower	**Interior Least Tern**

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1. Description of Proposed Actions

1.1 Introduction and Background

1.1.1 Introduction

For the purposes of this BA, the term “river maintenance” refers to river and infrastructure maintenance and restoration actions that accomplish one or more of the following (the order listed does not imply importance):

- Provide for effective transport of water and sediment to Elephant Butte Reservoir
- Conserve surface water within the MRG Basin.
- Protect riverside structures and facilities
- Reduce and/or eliminate aggradation in the MRG
- Reduce the rate of channel degradation from Cochiti Dam south to Socorro
- Restore natural river processes
- Provide habitat improvement for the ESA-listed species within the MRG Project Area

This section describes the proposed actions for maintenance on the MRG above the Elephant Butte Full Pool Reservoir Level. In this document, four types of maintenance activities are described: river maintenance, other Reclamation MRG maintenance, MRGCD maintenance, and habitat restoration activities by the State of New Mexico. The State also has maintenance activities that fall within the described actions and effects of river maintenance and other Reclamation MRG maintenance; therefore, a separate section describing the State’s specific maintenance is not included.

Currently, the only recognized Pecos sunflower population within the defined maintenance action areas is located specifically on the Rhodes property south of Arroyo de las Cañas or on land managed by the NMDGF. Reclamation will work with the Service to avoid impact to the sunflower populations on any maintenance activities that would affect the Pecos sunflower population.

Specific details are provided for other Reclamation MRG Project maintenance activities (Section 1.7), including the anticipated operation and maintenance on the LFCC (Section 1.7.1), Project drains (Section 1.7.2), and the MRGCD MRG maintenance activities on irrigation and flood control facilities (Section 1.8). It is anticipated that sufficient detail is provided in this BA (and in Appendices B and C on habitat restoration techniques and river maintenance methods) and that these activities would require minimal subsequent coordination with the Service to provide ESA coverage for actions described herein.

For river maintenance, specific project details and areas are not described because exact projects are not defined at this time. Because Reclamation is seeking programmatic ESA coverage for its river maintenance program, a summary of the MRG Project's river maintenance authorization and current goals (Section 1.1.2) is presented. These goals, coupled with an understanding of the current geomorphic trends within each reach, are used to develop reach-based strategies (Section 1.2) to effectively accomplish river maintenance work within the context of a geomorphic/ecological process based approach. The proposed action for river maintenance describes the strategy approach formulated from coupling the river maintenance goals with the geomorphic trends. Because these strategies were developed to address the trends resulting from physical processes on a reach-basis, a more complete and encompassing view of the river is obtained, providing a broader river maintenance approach.

The proposed action for Reclamation's river maintenance consists of strategies, river maintenance methods, implementation techniques, support activities, and project details. Reclamation is proposing two types of river maintenance activities. The first type is proactive steps to minimize river maintenance activities based on the strategies that are presented in Section 1.2 and described in more detail in the *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a). This type of activity involves evaluating river maintenance strategies for an entire reach and prioritizing specific sites for implementation. To implement river maintenance strategies on a reach scale, river maintenance activities are determined by need and budget, and exact projects are not defined at this time. The second type is individual sites, described as priority or monitored sites (Part I, Section 4.2.2), which are designed to meet local river maintenance needs to address symptoms of an observed geomorphic trend.

River maintenance sites (Section 1.6.1), within the context of this BA, may be implemented as individual sites within a reach-based river maintenance strategy or as a priority site project. Both would be considered river maintenance sites as described in this proposed action. These two types of activities may use the same river maintenance methods (Section 1.3) and implementation techniques (Section 1.6.4.5). They also both rely on a variety of river maintenance support activities (Section 1.6.4).

Estimated river maintenance project area, footprint, duration, etc., are described conceptually for the implementation of project sites (Section 1.6) by whether the estimated impact area is expected to occur in the wetted portion of the river (wet) or occur totally above the water surface at the time of project implementation (dry). Specific project details and areas are not described because exact projects are not defined at this time. Four project descriptions, described below, are used in this document. These descriptions are used to provide further clarification of the two previously defined river maintenance project types.

- **New site work** (Section 1.6.1) – describes project locations where river maintenance activities have not previously been performed.
- **Adaptive Management work** – describes projects where an Adaptive Management process (Section 1.4) is being followed to address ongoing river responses that may undermine river maintenance activities previously performed at the site.
- **Interim work** (Section 1.6.1.2) – describes project locations where river maintenance activities may be needed due to threatening, but not immediate, risks to infrastructure, public health and safety, or potential for a significant loss of water.
- **Unanticipated work** (Section 1.6.1.1) – describes project locations where river maintenance activities may be needed due to immediate risks to infrastructure, public health and safety, or potential for a significant loss of water.

For river maintenance, it is expected that additional future information will be shared to define river maintenance projects, including specific site locations, project footprints, implementation techniques, and river maintenance methods. It also is anticipated that additional information may be needed to define new methods that have developed via technological advances and ongoing research, changes in reach trends, and continued monitoring or Adaptive Management. Reclamation expects that routine river maintenance support activities such as ongoing geomorphic data collection and maintained existing locations of stockpile sites, storage yards, and quarry/borrow areas are presented in sufficient detail and would not need to be described further. Part V provides procedural information on how Reclamation proposes future individual river maintenance projects will be covered under this programmatic, including tiered consultations.

1.1.2 River Maintenance Authorization and Goals

Traditional river engineering projects often created environmental problems as a result of imposing unnatural conditions on rivers by modifying channel cross sections and length, creating lateral confinements, and altering flow and sediment supply (Thorne et al. 1997, Gore and Petts 1989, Gore 1985, Brookes 1988, Brookes and Shields 1996). It should be recognized that, on the MRG, much of the original channelization, flow control, and sediment load reduction were planned to reduce and reverse aggradational trends in the channel. The channel was aggrading above the adjoining lands outside the levee even into the 1960s (Lagasse 1980, Makar and AuBuchon 2012), which endangered valley residents and local economies. These conditions formed the background for creating the MRG Project, which is authorized by the Federal Flood

Control Acts of 1948 and 1950 (Public Law 858 and 516). MRG Project components are assigned to Reclamation, the Corps, and the MRGCD in the House Documents (Reclamation 1947, 2003). Additional information about the House Documents and Project authorization can be found in the *Middle Rio Grande River Maintenance Plan, Part 1 Report* (Reclamation 2007).

Constructed channel and reservoir works to control aggradation have been effective at alleviating some of the original authorization concerns; however, the combination of anthropogenic and natural changes over time on the MRG has altered the water and sediment supply, resulting in different trends and impacts. The major current geomorphic trends observed on the MRG are listed below, although not every trend occurs on every reach. These trends and their applicability to the MRG are discussed in more detail in the report *Channel Conditions and Dynamics on the MRG* (Makar and AuBuchon 2012).

- Channel narrowing
- Vegetation encroachment
- Increased bank height
- Incision or channel bed degradation
- Bank erosion
- Coarsening of bed material
- Aggradation (river bed rising due to sediment accumulation)
- Channel plugging with sediment
- Perched channel conditions (river channel higher than adjoining riparian areas in the floodway or land outside the levee)
- Increased channel uniformity

River maintenance goals also have been updated to reflect the changing river conditions, the evolution of practices of river maintenance and management, and compliance with environmental statutes (Reclamation 2012a). The river maintenance goals are designed to reflect the river system as a whole, where possible, and to help implement the best methodology to achieve the original project authorization. The four river maintenance goals are as follows:

- Support channel sustainability
- Protect riverside infrastructure and resources
- Be ecosystem compatible
- Provide effective water delivery

These goals are described in more detail in the *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a). The current MRG trends identified above and their underlying processes create the need for channel maintenance to meet the river maintenance goals. For example, channel incision and narrowing can lead to lateral migration, which can lead to damage of riverside infrastructure and resources. River maintenance strategies and methods used to achieve the stated river maintenance goals remain consistent with the objectives specified in the MRG Project authorization and other federal responsibilities.

1.1.3 San Marcial Delta Water Conveyance Channel

The proposed action for Reclamation's river maintenance includes the proposed maintenance of the San Marcial Delta Water Conveyance Channel (Delta Channel, formerly known as Temporary Channel). The Delta Channel is located within the boundaries of the Elephant Butte Reservoir between 2002 RM 57.8 and the current active reservoir pool. Reclamation, in cooperation with the New Mexico Interstate Stream Commission, currently maintains the existing Delta Channel to facilitate delivery of water and sediment to the active reservoir pool. Maintenance activities primarily consist of maintaining existing berms, management of sediment accumulation, and management of vegetation growth within the channel. Reclamation evaluates the Delta Channel after the runoff period and monsoon season to determine what work will be needed. If any maintenance is required, work occurs between September 1 and March 30 of each year. A separate complete biological assessment for maintenance of the Delta Channel is included as Appendix A.

1.2 River Maintenance Strategies

Strategies define reach-based management approaches to meet the river maintenance goals on the MRG according to the physical and biological processes understood to be driving the current and predicted river trends. The proposed action for river maintenance describes the strategy approach formulated from coupling the river maintenance goals with the geomorphic trends. These strategies provide the ability to address the trends on a reach basis. In many cases, multiple strategies may be needed to work toward achieving a desired goal. The best outcome for the MRG as a whole requires a balance between desirable outcomes for individual goals and how they can best be applied given the varying reach characteristics. This is to be expected for multiple uses of a limited resource and provides a more complete and encompassing view of the river for river maintenance.

The following reach strategies were developed to address the major current trends resulting from physical processes on the MRG:

- Promote elevation stability
- Promote alignment stability

- Reconstruct/maintain channel capacity
- Increase available area to the river
- Rehabilitate channel and floodplain
- Manage sediment

Each strategy has an array of different methods used for implementation, different geomorphic responses that affect the MRG, and varying degrees of meeting the river maintenance goals. Each reach generally has multiple constraints such as public health and safety concerns, protection of riverside infrastructure, local variations in geology, and endangered species habitat. These reach strategies are intended to better help integrate the physical processes, reflected by the observed trends, occurring on the MRG with river maintenance programmatic actions. Reach strategies addressing currently observed trends are briefly described below. The reach strategies are described in more detail in the *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a).

1.2.1 Promote Elevation Stability

The objective of this strategy is to reduce the extent and rate of bed elevation changes. This strategy employs two distinct suites of methods to address the conditions of sediment transport capacity greater and less than sediment supply (i.e., raising the bed for degrading reaches and lowering the bed for aggrading reaches).

This strategy addresses all four river maintenance goals, but its applicability to the “Be ecosystem compatible” goal is method dependent. The strategy can help address the following trends: increased bank height, incision or channel bed degradation, coarsening of bed material, and aggradation.

An example of executing this strategy on a reach basis would be the implementation of cross channel features (Section 1.3.4) throughout a reach to minimize channel bed degradation. This could involve stabilizing the bed through maintaining a preferred river channel bed elevation with more permanent features or increasing the erosion resistance of the bed material to decrease the rate of channel incision. Cross channel methods would be low structures (~2 feet high or less), with a low gradient on the downstream apron to provide fish (silvery minnow) passage. Implementing these methods provides bed stability in the immediate area and for some distance upstream; cross channel features, however, do not prevent the continuation of downstream degradation (bed lowering). If the trend of downstream channel incision (bed degradation) continues, Adaptive Management may be needed to provide for continued fish passage.

Aggradation is also a trend that has been observed in several reaches of the Rio Grande due to an excess sediment supply. Because this trend affects and leads to bed elevation stability concerns, this strategy also could include minimization of aggradation where appropriate. It should be noted that, to minimize the overlap between strategy methods and effects, implementing this strategy is focused on method categories that directly address incision or channel bed degradation because there are other strategies that directly address aggradation. These other strategies are "Reconstruct/maintain channel capacity," "Increase available area," and "Manage sediment." The overlap in strategies means that projects likely will require the combination of multiple strategies (Section 1.2.7).

1.2.2 Promote Alignment Stability

The objective of this strategy is to provide alignment protection while allowing the river channel to adjust as much as possible horizontally within the lateral constraints. If the safety or integrity of riverside infrastructure and resources is likely to be compromised within the next few years, then bank protection or redirective flow measures are implemented to provide protection and reduce the risk of future migration in an undesirable direction. There are two basic types of lateral channel movement: migration, which generally occurs under degrading and tall bank conditions (sediment transport capacity greater than sediment supply), and avulsion, which generally occurs under aggrading and perched channel conditions (sediment transport capacity less than sediment supply).

This strategy can address all four river maintenance goals, but applicability to the "Be ecosystem compatible" goal is method dependent. The strategy also addresses the following trends: bank erosion, perched channel conditions, and channel plugging with sediment. This strategy addresses the trend of channel plugging with sediment and perched channel conditions by providing a suitable alignment so that protection is provided to infrastructure in the event of channel relocation via a sudden avulsion.

An example of implementing this strategy on a laterally migrating reach would be the implementation of bank protection/stabilization features (Section 1.3.3) throughout the reach. This could involve direct longitudinal bank stability methods such as bank slope regrading, stabilization with more erosion resistant material (vegetation, riprap, etc.), bank lowering, etc. It may also involve using features that redirect flow patterns, minimizing the hydraulic forces near the bank that affect bank stability.

This strategy also may be implemented under aggrading and perched channel conditions. Typically, under these conditions, this strategy is addressed with "Reconstruct/maintain channel capacity." Other strategies that also may be used to address perched river conditions include "Increase available area to the river" and "Manage sediment."

1.2.3 Reconstruct/Maintain Channel Capacity

The objective of this strategy is to help ensure safe channel capacity and to provide effective water delivery through a reach. Capacity can be lost through gradual aggradation over time, channel narrowing through island and bar deposits or vegetation encroachment, large sediment deposits at the mouths of ephemeral tributaries, and abrupt aggradation such as sediment plugs in the active river channel. This strategy also would address conditions where the channel bed is perched, or higher than the floodplain, due to past aggradation. This strategy can involve repositioning sediment so that the river can help transport it. Maintaining or excavating a wider and/or deeper channel helps ensure that safe channel capacity requirements are met consistent with Reclamation's authorization. This strategy most likely would be implemented in reaches where sediment deposition would create unsafe channel capacities.

This strategy addresses the "Protect riverside infrastructure and resources" and "Provide effective water delivery" goals. The strategy also addresses the following trends: channel narrowing, vegetation encroachment, aggradation, channel plugging with sediment, and perched channel conditions.

An example of implementing this strategy on a reach basis would be the implementation of channel modification features (Section 1.3.2) throughout a reach. This could involve changing the channel profile, plan shape, cross section, bed elevation, slope, and/or channel location to increase channel capacity.

1.2.4 Increase Available Area to the River

The objective of this strategy is to provide area for the river to evolve in response to changing conditions and to minimize the need for additional future river maintenance actions. The ideal condition would be that the river and floodplain area are large enough to accommodate more than the expected width of potential lateral migration; otherwise, the need for future channel maintenance work is more likely.

This strategy addresses the river maintenance goals of "Support channel sustainability," "Protect riverside infrastructure and resources," and "Be ecosystem compatible." Effects of this strategy on the "Provide effective water delivery" goal are uncertain and reach dependent. The strategy also addresses the following trends: channel narrowing, increased bank height, incision or channel bed degradation, bank erosion, coarsening of bed material, aggradation, channel plugging with sediment, perched channel conditions, and increased channel uniformity.

An example of implementing this strategy on a reach basis would be the implementation of infrastructure relocation and setback features (Section 1.3.1). This could involve moving irrigation/drainage features and accompanying spoil levees to a location further away from the river, increasing the available area for the river to adjust. Conservation easements also may be used to implement this strategy (Section 1.3.5).

1.2.5 Rehabilitate Channel and Floodplain

The objective of this strategy is to help stabilize the channel bed elevation and slope in reaches where sediment transport capacity is greater than sediment supply. Use of this strategy reconnects abandoned floodplains, which reduces the sediment transport capacity of higher flows and more closely matches the existing sediment supply.

This strategy addresses the river maintenance goals of “Support channel sustainability,” “Be ecosystem compatible,” and “Protect riverside infrastructure and resources,” although the degree to which it speaks to these goals is method dependent. Effects of this strategy on the “Provide effective water delivery” goal are uncertain and reach dependent. The strategy also addresses the following trends: channel narrowing, vegetation encroachment, increased bank height, incision or channel bed degradation, bank erosion, coarsening of bed material, and increased channel uniformity.

An example of implementing this strategy on a reach basis would be the implementation of channel modification features (Section 1.3.2) throughout a reach. This often involves changing the channel cross section by lowering the banks, so that flows go over bank at a lower discharge.

1.2.6 Manage Sediment

This strategy would aid in balancing sediment transport capacity with available sediment supply. There is currently an excess of sediment transport capacity in most of the reaches, so this strategy generally would involve the addition of sediment into the system. In some reaches, however, the sediment supply exceeds the sediment transport capacity; in those cases, implementation of the strategy would involve the reduction of sediment supply into the system.

This strategy addresses the “Support channel sustainability” and “Be ecosystem compatible” goals of river maintenance. The effects of this strategy on the “Provide effective water delivery” goal are uncertain and reach dependent. This strategy also may apply to the “Protect riverside infrastructure and resources” goal; however, it is difficult to ensure no impact to infrastructure. The strategy also addresses the following trends: increased bank height, incision or channel bed degradation, coarsening of bed material, aggradation, channel plugging with sediment, perched channel conditions, and increased channel uniformity.

An example of implementing this strategy on a reach basis would be to change the sediment supply (Section 1.3.6) throughout a reach. For a reach with an excess sediment transport capacity, features like arroyo reconnection, sediment bypass of water storage structures, and bank destabilization would augment the sediment supply and help the channel reach a dynamic equilibrium with its sediment transport capacity. This most likely is implemented, however, through combining with other strategies (Section 1.2.7). For a reach with excess sediment supply, features such as natural or constructed sediment basins would promote dynamic equilibrium by removing sediment to match the available sediment transport capacity. Once adding or removing sediment is implemented, this would need to continue indefinitely to realize long-term benefits. It is also likely that this strategy implementation would require more Adaptive Management than other strategies because of the uncertainty related to sediment augmentation or withdrawal and the complexity of the potential river response.

1.2.7 Strategy Combinations

While strategies have been developed and can be implemented individually, the combination of strategies is often the most effective approach to address observed reach trends.

For example, “Promote elevation stability” could include minimizing aggradation where appropriate. To achieve this result, “Reconstruct/maintain channel capacity” and “Increase available area to the river” could be combined through applicable features. For instance, changes to the channel configuration within “Reconstruct/maintain channel capacity” could be coupled with relocating river constraints under “Increase available area to the river.” This would increase the sediment transport capacity of the channel in the short term, while at the same time providing space for the river to realign in the long term. The combination of these two strategies allows a measure of elevation stability in the affected reach, thereby also addressing a third strategy, “Promote elevation stability.” The combination of strategies allows the creation of a longer-term implementation that gets incrementally closer to addressing the processes underlying the observed reach trends.

Another example can be taken from “Manage sediment.” For situations with an excess sediment transport capacity, features could be implemented from “Rehabilitate the channel and floodplain.” For instance, island and bar clearing and destabilization and floodplain creation by terrace lowering (longitudinal bank lowering) may help increase the available sediment supply, at least temporarily. If this was coupled with upstream features suitable to “Manage sediment,” similar to arroyo reconnection, or other sediment augmentation, both short- and long-term impacts are addressed. Combining these two strategies may increase the alignment stability, thereby benefiting “Promote alignment stability.” Methods within this strategy also could be used to provide direct protection to critical infrastructure in concert with “Manage sediment” and “Rehabilitate the channel and floodplain.”

1.2.8 Most Likely Strategies by Reach

Using reach geomorphic trends and reach characteristics (i.e., infrastructure, habitat and presence of ESA species, population and land use, and water delivery), the most likely strategies to be implemented for each reach are identified and listed in Table III-1. Strategies that address reach geomorphic trends are suitable for the reach and its geomorphic tendencies, and thus most likely to be implemented. Strategies that do not address reach trends and those for which trends do not indicate a need are described as not suitable. While current reach trends of importance to river maintenance have been identified, future trends of the river could change so that unsuitable strategies would become suitable, as well as the converse. Projects that work with reach geomorphic trends and processes are more likely to be sustainable and often address endangered species habitat needs. More information on the identification of most likely strategies by reach, and the rationale for why strategies are listed as unsuitable in a reach, can be found in the *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a).

Table III-1. Summary of most likely strategies by reach

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
Velarde to Rio Chama	Not Suitable	Suitable	Not Suitable	Suitable	Suitable	Not Suitable
Rio Chama to Otowi Bridge	Suitable	Suitable	Not Suitable	Suitable	Suitable	Not Suitable
Cochiti Dam to Angostura Diversion Dam	Suitable	Suitable	Not Suitable	Suitable	Suitable	Not Suitable
Angostura Diversion Dam to Isleta Diversion Dam	Suitable	Suitable	Not Suitable	Not Suitable	Suitable	Suitable
Isleta Diversion Dam to Rio Puerco	Suitable	Not Suitable	Suitable	Suitable	Suitable	Suitable
Rio Puerco to San Acacia Diversion Dam	Not Suitable	Suitable	Not Suitable	Suitable	Suitable	Not Suitable
San Acacia Diversion Dam to Arroyo de las Cañas	Suitable	Suitable	Not Suitable	Suitable	Suitable	Suitable
Arroyo de los Cañas to San Antonio Bridge	Suitable	Not Suitable	Suitable	Not Suitable	Not Suitable	Suitable
San Antonio Bridge to River Mile 78	Suitable	Not Suitable	Suitable	Suitable	Not Suitable	Suitable
River Mile 78 to Full Pool Elephant Butte Reservoir Level	Suitable	Not Suitable	Suitable	Suitable	Not Suitable	Suitable

1.3 River Maintenance Methods

River maintenance methods can be used as multiple installations as part of a reach-based strategy approach, at individual sites within the context of a reach-based approach, or at single sites to address a specific river maintenance issue that may be separate from a reach strategy. Methods are the river maintenance treatments used to implement reach strategies to meet river maintenance goals. The applicable methods for the MRG are organized into six major categories, each with similar features and objectives. Methods may be applicable, however, to more than one category because they can create different effects under various conditions. The major method categories are:

- Infrastructure relocation or setback
- Channel modification
- Bank protection/stabilization
- Cross channel (river spanning) features
- Conservation easements
- Change sediment supply

Method selection is dependent upon local river conditions, reach constraints, desired environmental effects or benefits, and the inherent properties of the method. The major method categories and their corresponding individual methods are described briefly in Sections 1.3.1 through 1.3.6 and in more detail in Appendix C (River Maintenance Methods) and Appendix B (Habitat Restoration Techniques Commonly Used in the Middle Rio Grande), as well as Appendix A of *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a). A caveat should be added that while these categories of methods are described in general, those descriptions are not applicable in all river situations, and will require more detailed, site-specific analysis and design for implementation. It is also important to note that no single method or combination of methods is applicable in all situations.

Table III-2 lists the most applicable major method categories for each strategy. For a given strategy, more than one method category can apply. The combination of method categories used depends upon local river conditions, reach trends, reach constraints, and the specific methods employed. The Most Likely Strategies and Methods by Reach (Appendix D) has additional information on the most likely strategies and methods that would be used in a specific reach.

Due to river channel condition variability, methods may be applicable locally in reaches where they are not considered most likely. River channel dynamics also include the probability that the designations of most likely strategies and methods by reach may change over time.

Table III-2. Method categories associated with strategies

Method	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Infrastructure Relocation or Setback				X		
Channel Modification			X		X	X
Bank Protection/ Stabilization		X				
Cross Channel (River Spanning) Features	X					
Conservation Easements				X	X	
Change Sediment Supply						X

1.3.1 Infrastructure Relocation and Setback

Riverside infrastructure and facilities constructed near the riverbanks may laterally constrain river migration. Relocating infrastructure provides an opportunity for geomorphic processes, especially lateral migration, to occur unencumbered by local lateral infrastructure constraints, encouraging the river towards long-term dynamic equilibrium (Newson et al. 1997, Brookes et al. 1996). Bank erosion can remove older growth riparian areas, while downstream bar deposition can create new floodplain and riparian areas. Potential facilities to be relocated include levees, dikes, access roads, canals, drains, culverts, siphons, utilities, etc. Infrastructure would need to be set back beyond the expected maximum extent of lateral migration; otherwise, bank erosion and stability problems may, in time, advance to the new infrastructure location. Thus, protection of relocated infrastructure may still be required as channel migration approaches the relocated facilities.

1.3.2 Channel Modification

Channel modifications are actions used to reconstruct, relocate, and reestablish the river channel in a more advantageous alignment or shape and slope consistent with river maintenance goals. Channel modification actions potentially may result in a larger channel capacity at various flow rates and cause changes in channel shape and slope. Excavating new channel alignments and plugging existing channel entrances are part of this method category. Channel modification techniques also have been used to address geomorphic disequilibrium, thereby reducing risks of bank erosion (Washington Department of Fish and Wildlife [WDFW] 2003). These methods include changes to channel profile, slope, plan shape, cross section, bed elevation, slope, and/or channel location.

1.3.3 Bank Protection/Stabilization

Bank protection works may be undertaken to protect the river bank against fluvial erosion and/or geotechnical failures (Hey 1994, Brookes 1988, Escarameia 1998, McCullah and Gray 2005). Bank protection methods described in the River Maintenance Methods (Appendix C) apply to cases where bank line and toe erosion is the primary mechanism for bank failure. In situations where the bank slope is unstable due to geotechnical processes, other methods would need to be applied in addition to bank stabilization (Escarameia 1998). This could include placing additional material at the toe of the slope or removing upslope material to minimize the potential for soil instabilities that may lead to bank failure (Terzaghi et al. 1996).

1.3.4 Cross Channel (River Spanning) Features

These features are placed across the channel using variable sized rock material without grout or concrete (Neilson et al. 1991, Watson et al. 2005). The objective of cross channel or river spanning features is to control the channel bed elevation and improve or maintain current floodplain connectivity and groundwater elevations. The primary focus of cross channel structures would be slowing or halting channel incision or raising the riverbed. Grade control features also have been used in cases where channel incision caused or was expected to cause excessive lateral migration and undermining of levees and riverside infrastructure (Bravard et al. 1999).

1.3.5 Conservation Easement

Conservation easements are land agreements that prevent development from occurring and allow the river to erode through an area as part of fluvial processes. Conservation easements also preserve the riparian zone and allow future evolution as determined by fluvial processes and floodplain connectivity.

This method preserves and promotes continuation of riparian forests, the ecosystem, and the river corridor (Karr et al. 2000). Conservation easements may involve infrastructure relocation or setback, which may increase the opportunity for the river to access historical floodplain areas.

1.3.6 Change Sediment Supply

Sediment transport and supply vary with discharge over time and from place to place within a river system. Where the supply of sediment is limited or has been reduced, the result is generally channel incision, bank erosion, and, on the MRG, possibly a channel pattern change from a low-flow, braided sand channel with a shifting sand substrate to a single-thread, mildly sinuous channel with a coarser bed. Where sediment supply is limiting, alluvial rivers generally respond through channel width decreases, channel depth increases, local longitudinal slope decreases, and sinuosity increases (Schumm 1977). The addition of sediment supply can stabilize or reduce these tendencies.

When a river system has more sediment supply than sediment transport capacity, channel aggradation will occur. In general, aggradation results in the channel width increasing, channel depth decreasing, local longitudinal channel slope increasing, sinuosity decreasing (Schumm 1977), and in decreased channel and flood capacity. Sediment berms also can form along the channel banks (Schumm 2005). The reduction of sediment supply can slow or reverse these trends.

1.4 Adaptive Management for River Maintenance

Much of the geomorphic change on the Rio Grande is driven by variations in flow and sediment supply, especially high-flow events. These high-flow events may change the needs of the river on an annual basis. Adaptive Management for river maintenance is a planned, systematic process to achieve the best set of decisions possible in the face of uncertainty and lack of knowledge as outcomes from strategy implementation and river dynamics become better understood. Adaptive Management work describes projects where an Adaptive Management process is being followed to address ongoing river responses that may undermine river maintenance activities previously performed at the site. The intent is to adjust the river maintenance implementation in a timely manner to address any concerns that may arise and provide lessons learned to projects in the future. Adaptive Management for river maintenance project sites, as described herein, has been used in the past (Part I, Section 4.2.2, Tables I-4 through I-15, provides information on historical utilization) and is proposed to continue into the future at discrete sites using the current implementation philosophy, as described in the MRG maintenance baseline (Part I, Section 4.2) and also as part of the implementation of river maintenance sites that are part of a reach strategy. The Adaptive Management, as practiced for river maintenance, requires a series of steps, as described below. The intent is to adjust the implementation in a timely manner to address any concerns that may arise and provide valuable lessons learned to projects in the future.

- Defining river maintenance and ecosystem function objectives (including stakeholder involvement)
- Identifying the approach to potential alternatives
- Predicting channel response (using state-of-the-art design and analysis methods) to each alternative

- Selecting the alternative approach that best meets objectives
- Developing monitoring plans (including baseline data collection)
- Implementing the selected alternative and monitoring plans
- Comparing monitoring results to predictions and objectives
- Adjusting the strategy/project approach as needed to achieve the desired objectives
- Documenting all steps

Adaptive Management within the framework of river maintenance will be performed using the U.S. Department of the Interior guidelines. Adaptive Management "recognizes the importance of natural variability" (Williams et al. 2009) in river response due to dynamic river conditions and the project implementation. "It is not a trial and error process, but rather emphasizes learning by doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits" (Williams et al. 2009). This is especially true for ecosystem function because it is influenced by river maintenance actions. Monitoring and evaluating will lead to improved scientific knowledge on the effects of river maintenance implementation upon the ecosystem and ways to improve the ecosystem function. Documenting the project objectives, process, and predicted results is necessary to understand which activities work (or do not) and why. The *why* is important because success or failure can result from factors such as incorrect assumptions, inadequate design/analysis methods, poorly implemented designs, changing conditions at the project site, flawed interpretation of monitoring data, or any combination of these factors. This information is essential to improve both the current and the next project or to repeat the success.

Using an Adaptive Management approach for river maintenance in dynamic river systems often extends the time period of river maintenance implementation, but goals are more likely to be met. Traditional maintenance methods are implemented within one implementation season. In contrast, some river maintenance work incorporates plans for reviews and works in subsequent implementation seasons after the occurrence or in the absence of significant channel forming flows. Additional information on Adaptive Management, as implemented by river maintenance, is provided in the *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a).

On the MRG, some strategies have a stronger Adaptive Management component than others. Adaptive Management is expected to be used for "Promote elevation stability" where cross channel features are implemented. The continuation of downstream channel incision (bed degradation) may require Adaptive Management to ensure continued fish (silvery minnow) passage. "Promote alignment stability" is intrinsically adaptive because monitoring of channel conditions is used to allow some lateral migration until infrastructure is threatened. It also is expected that “Rehabilitate channel and floodplain” may need continued evaluation and adjustments to ensure that flows go over bank at the desired discharge and frequency, the channel is stable, and infrastructure is not at risk. “Manage sediment” is likely to need adjustments as the channel responds to changes in the sediment supply. “Increase available area” has an adaptive component to ensure that water deliveries are not significantly impacted. Because it is unlikely that enough space can be acquired to permanently ensure that relocated levees will not be impacted by lateral migration, monitoring will be required for this strategy. For both these reasons, “Increase available area to the river” has an adaptive component. “Reconstruct/maintain channel capacity” requires ongoing monitoring and evaluation of available channel capacity to transport the incoming flows and sediment loads. This strategy requires ongoing maintenance; however, because it recreates the same channel, there is a minimal Adaptive Management component.

Certain reaches have more potential for Adaptive Management. For instance, Adaptive Management may be useful in reaches that have highly variable conditions such as RM 78 to the Full Pool Elephant Butte Reservoir Level, with its significant changes in base level control, or Angostura Diversion Dam to Isleta Diversion Dam, where sediment supply may be increasing due to Jemez Canyon Dam operations modifications, and reaches where the cumulative effects of numerous habitat restoration projects may be significant. Other reaches where Adaptive Management may be useful are those that are critical to endangered species. The implementation of river maintenance projects in reaches with critical habitat may require an Adaptive Management process to ensure a minimal impact to desirable habitat features and/or improve the functionality of a design element to further enhance the creation of desirable habitat features.

Finally, the continuing adjustments of channel conditions may create the need for Adaptive Management of previously completed river maintenance projects. Due to the uncertainty and lack of knowledge associated with designing in a dynamic river environment, it is expected that many completed river maintenance projects may at some time become candidates for more intensive Adaptive Management. An assessment of future river maintenance Adaptive Management needs is provided in Section 1.6.3.

1.5 River Maintenance Sites and the Interstate Stream Commission Cooperative Agreement

As previously discussed, one of the four river maintenance goals for the MRG Project is to “Provide effective water delivery” through the MRG reach. Providing effective water delivery includes conserving surface water in the Rio Grande Basin and providing for the effective transport of water to Elephant Butte Reservoir. The State has a common interest with Reclamation in ensuring the effective delivery of water to the Elephant Butte Reservoir.

Reclamation and the State have participated in a joint cooperative program for water salvage and river maintenance activities since 1956. The purpose of this program is to provide maintenance and improvements that mitigate stream flow losses and to reduce non-beneficial consumption of water by vegetation in the floodplain of the Rio Grande and its tributaries above Elephant Butte Reservoir. Projects pursued under this cooperative program fall into two general areas: projects that have a common river maintenance interest and projects that fall within the realm of other MRG activities.

In September 2012, a new Cooperative Agreement (R13CF40001) was executed between the NMISC and Reclamation to provide funding for water salvage work on the MRG Project. The purpose of this program is to provide maintenance and improvements that mitigate streamflow losses and to reduce non-beneficial consumption of water by vegetation in the floodplain of the Rio Grande and its tributaries above Elephant Butte Reservoir. Work includes river maintenance, as well as other MRG Project maintenance with water salvage potential. For most river maintenance projects done under the State Cooperative Agreement, Reclamation provides funding for engineering and environmental compliance support, while NMISC provides funding for implementation and equipment maintenance.

While proposed work under this agreement may include any of the described river maintenance strategies, there is a higher likelihood of pursuing a joint collaboration with the river maintenance strategies of "Promote elevation stability," "Promote alignment stability," and "Reconstruct/maintain channel capacity." The expected river maintenance methods that would be used in pursuit of work under this cooperative agreement include those within the method categories of channel modification, bank protection/stabilization, and cross channel (river spanning) features. Maintenance work pursued jointly between Reclamation and the NMISC is covered by the description and quantity of river maintenance project details provided in Section 1.6. It is expected that, for these joint maintenance projects, additional future information will be shared to define the maintenance projects, including specific site locations, project footprints, implementation techniques, and river maintenance methods.

1.6 River Maintenance – Project Details

This section presents the specific details involved with implementing river maintenance projects on the MRG. The estimated number of river maintenance sites for a given year is provided in Section 1.6.1. In addition to river maintenance methods (Section 1.3 and the habitat restoration techniques and river maintenance methods in Appendices B and C), river maintenance projects during implementation also have specific site locations, implementation footprints, implementation techniques, and impacts from support activities. Implementation techniques describe how the work is implemented, while river maintenance methods describe the element that is being implemented. This section also provides a summary of estimated river maintenance impacts on the MRG.

Throughout this section, approximate numeric values are provided to help evaluate the programmatic effect of Reclamation's river maintenance. To provide the ability to achieve ESA programmatic coverage for river maintenance, the framework for these details is provided in this proposed action. While specific project locations are not described in this BA, the relative distribution of future river maintenance projects is described in Section 1.6.3 for both new sites and continued Adaptive Management of existing sites. Reclamation expects that, while these numbers are used to derive total river maintenance acreage, Reclamation would not be limited in the new BO by values like the number of sites in a given year and the future distribution of sites, but rather the resultant amount of programmatic take.

1.6.1 River Maintenance Sites

Based on Reclamation's historical performance (Part I, Section 4.2), it is expected that, on average, the river maintenance program would implement projects at approximately four river maintenance sites per year, with a range of one to eight sites in any given year (Table III-3). Of the four sites, it is expected that, on average, one would be ongoing Adaptive Management work at a previously completed site and one would be unanticipated/interim river maintenance work. The remaining three would be considered new project implementation at a river maintenance site location. Of the three new river maintenance sites, one would be unanticipated/interim river maintenance work. New river maintenance sites may develop at sites currently identified as river maintenance monitoring sites, may be totally new river maintenance sites where changing site conditions warrant declaring a new monitoring or priority site, or may be river maintenance sites that are used to implement a river maintenance strategy.

Table III-3. Estimated river maintenance projects per year (number)

	Average	Minimum	Maximum
New Sites	2	1	4
Adaptive Management	1	0	3
Interim/Unanticipated Work	1	0	1
Total	4	1	8

1.6.1.1 River Maintenance Unanticipated Work

River maintenance unanticipated work occurs due to variable channel response creating conditions where immediate action is needed to protect infrastructure, ensure public health and safety, or prevent excessive water loss. Because there is uncertainty in predicting the spatial and temporal timeframes of future channel changes, unanticipated work activities likely will be needed in the future. These typically are associated with bank erosion and safe channel capacity concerns. Unanticipated work would be pursued if the timeframe for finding solutions is pushed forward by an event on the river that accelerates the necessity of doing work, creating the need to address the risk immediately. Risk in the context of river maintenance refers to a threat to infrastructure or the loss of effective water delivery. These are projects where the compliance must be streamlined or would arise as an emergency and Reclamation would proceed using the ESA emergency response process. The implementation of river maintenance strategies on a reach scale (Section 1.2) may reduce the amount of unanticipated work when compared historically.

River maintenance methods typically used to address unanticipated work are described below. These methods fall in the method categories of channel modification and bank protection/stabilization. Additional information about river maintenance categories and methods can be found in Section 1.3, the River Maintenance Methods (Appendix C), and Appendix A of *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a). For areas of difficult terrain or access restrictions, it may be necessary to clear and/or create a road to the project site. Vegetation clearing is described in more detail in Section 1.6.4.1. Road creation may simply involve vegetation clearing, but also could include bringing in fill material—both dirt and rock—to ensure a suitable base for driving heavy equipment to the project site.

- **Riprap Revetments –** This is a method that may be used for river maintenance unanticipated work to address erosion and flooding threats. Riprap would be brought to the site and dumped at the bank that is actively eroding until the erosion is controlled, creating a riprap revetment that protects the bank slope. Riprap is typically hauled to the site from a Reclamation riprap stockpile site using highway dump trucks. Railway cars or articulated dump trucks also may be used in certain situations for sites that are difficult to access by highway trucks.

- **Levee Strengthening –** This is a method that may be used for river maintenance unanticipated work to address seepage and flooding threats. Levee strengthening involves bringing in fill material to increase the height and width of the levee. Levee strengthening also may involve rebuilding a levee section. Increasing the levee height provides additional freeboard to prevent floodwaters from overtopping a levee. Adding to the levee height, by default, also increases the levee width, which provides some level of protection from seepage concerns. Dirt is typically hauled to the site from Reclamation’s Valverde quarry using highway dump trucks. Articulated dump trucks also may be used in certain situations where the terrain is more difficult to maneuver around.

- **Riprap Windrow –** This is a method that may be used for river maintenance unanticipated work to address erosion threats. Riprap would be brought to the site and dumped on dry ground in a windrow along the length of the desired protection area. The windrow is designed to self-launch into the river as the bank erosion progresses, creating a riprap revetment. Riprap is typically hauled to the site from a Reclamation riprap stockpile site using highway dump trucks. Articulated dump trucks also may be used in certain situations where the terrain is more difficult to maneuver around.

1.6.1.2 River Maintenance Interim Work

River maintenance interim work is typically conducted at river maintenance sites where a primary solution is delayed and there are concerns caused by erosion, seepage, or flooding under certain flow scenarios. Interim work is a temporary stop gap measure, carried out in advance of immediate action to buy time until the primary solution can be constructed. Implementation of interim work can preclude the need for unanticipated work. Also, the planning timeframe for interim work is typically longer than for unanticipated work because the immediacy of the risk is less.

Levee strengthening and riprap windrow methods typically are used to address interim work. For areas of difficult terrain or access restrictions, it may be necessary to clear and/or create a road to the project site. Vegetation clearing is described in more detail in Section 1.6.4.1. Road creation may simply involve vegetation clearing, but also could include bringing in fill material—both dirt and rock—to ensure a suitable base for driving heavy equipment to the project site.

1.6.2 River Maintenance Project Footprint During Implementation

The anticipated river maintenance project footprint within the proposed action area is based on an analysis of Reclamation's historical performance (Part I, Section 4.2). The average predicted river maintenance project footprint is about 12 acres, with a historical footprint range of about 1–90 acres. Of this acreage, the anticipated acreage in the wet is 5 acres, and the remaining 7 acres would occur in upland or riparian areas in the dry. Impacts in the wet, as defined for river maintenance, would consist of disturbance areas in the water at base flow levels that are directly connected (i.e., not separated by a physical barrier such as an earthen berm) to flowing river water. All other acreage is defined as occurring in the dry, including areas that may be inundated at high flows, but are dry at base flows. The approximate range of future anticipated impact acres in the wet for a single river maintenance project is 0–65 acres, with an estimated average of 5 acres (Table III-4). The estimated river maintenance project impact acreage in the dry ranges from 1–70 acres, with an estimated average of 7 acres (Table III-4).

Table III-4. River maintenance project area (single site) during implementation (acres)

	Average	Minimum	Maximum
Wet	5	0	65
Dry	7	1	70
Total	**12**	**1**	**90** [1]

[1] The total maximum acreage disturbed is less than the sum of the maximum disturbance area listed in the wet and dry rows. Based on past projects, large acreage disturbances occurred predominantly in the wet or in the dry, depending on project scope. The historical maximum was around 90 acres.

The expected duration of river maintenance projects also is compiled from a summary of historical river maintenance work, with an average estimated duration of 6 months. The approximate river maintenance duration for a single project is expected to range from 1–16 months (Table III-5).

Table III-5. Approximate river maintenance project duration (single site in months)

	Average	Minimum	Maximum
Single Site	6	1	16

Implementation techniques (Section 1.6.4.5) used to implement a river maintenance project also may add additional impact acreage. Implementation techniques typically employed, along with other support activities for river maintenance sites, are described in Section 1.6.4. The river maintenance acreage impacts provided in Table III-8 in Section 1.6.5 include the impact acreage from the implementation techniques.

1.6.3 Distribution of Proposed River Maintenance Work

The uncertainty associated with predicting future channel changes makes it difficult to reliably estimate where future river maintenance actions would occur. This uncertainty, in alluvial rivers, is associated with the complex interactions among the flow, sediment supply, and channel characteristics (Einstein 1950). The interrelationship between the flow of water, the movement of sediment, and the variable character and composition of the channel boundaries over time and space contributes to the current channel morphology that we observe (Schumm 1977, Leopold et al. 1964). This channel morphology is constantly changing as rivers seek to balance the movement of sediment (sediment supply) with the energy available from the flow of water (sediment transport capacity) (Schumm et al. 1984, Biedenharn et al. 2008). Knowledge of current and expected MRG trends, coupled with an understanding of the relationships between sediment transport capacity and sediment supply and the history and effects of historical changes, both natural and anthropogenic, helps to reduce the uncertainty (Biedenharn et al. 2008). The continued process of predicting the future spatial distribution of sites and tracking where river maintenance work is done in the future may add additional reliability. However, uncertainty will always remain in any prediction of the spatial distribution of future river maintenance sites given the aforementioned factors. There is also additional uncertainty associated with specific reaches, like RM 78 to the Full Pool Elephant Butte Reservoir Level or Isleta Diversion Dam to Rio Puerco, because of the influence of controls or a higher uncertainty in the river's response to the drivers. Estimates provided in this section should be considered with these caveats in mind.

To estimate spatial distributions of river maintenance work, interim or unanticipated river maintenance work is considered to be encompassed by the spatial distribution of new river maintenance needs. The difference between interim/unanticipated work and new site work is the timing of the work, as interim and unanticipated work would be done at sites where time does not allow the development of a more comprehensive design. In many cases, interim and unanticipated work may be followed up with new site work; however, this would not increase the number of sites, but rather the number of times implementation is performed at a site. The spatial distribution of new sites would therefore account for both interim and unanticipated work. There then remains the need to forecast the relative spatial distribution of two types of river maintenance needs: new river maintenance sites and Adaptive Management at previously completed river maintenance sites. The majority of the existing river maintenance sites are locations previously completed with ongoing maintenance needs, sites that are currently being implemented, or sites that could be implemented (e.g., expect to have compliance initiated or in place) before March 2013. Because these represent essentially completed river maintenance sites, for the purpose of this BA, the current existing and completed river maintenance sites are folded into the spatial distribution of Adaptive Management sites. This section provides the background for estimating a percent spatial distribution by reach. Section 1.6.5 uses these percent distribution estimates to provide approximate impact areas by reach. The percent distribution of both new and Adaptive Management river maintenance work was considered in a predictive, qualitative assessment of where work may occur given two different hydrologic scenarios. Each assessment, while not restricted to a defined time period, would best be described as covering a 10-year period. Extending the results beyond that timeframe is difficult due to the level of uncertainties associated with the geomorphic drivers and controls on the system. These assessments also assume that the drivers and controls would fluctuate within the range of historical observations. The effect of habitat restoration projects, climate change, land use, natural resource changes, or even the effects of implementing a reach-based river maintenance strategy were not considered in this analysis.

The distribution of geomorphic change in the river is correlated with the frequency, magnitude, and duration of flows, especially the spring runoff flows. Because it is historically the spring runoff flows that have created the need for river maintenance activities, two spring runoff scenarios were qualitatively "modeled." The two hydrologic scenarios considered were both high-flow scenarios, as historically geomorphic change on the MRG for base or lower flows has been slower. Trends such as channel narrowing and vegetation encroachment that develop at base or lower flows can set up conditions at local sites, allowing infrastructure impacts to develop at high flows. Such channel evolution points to the continuing need for monitoring of trends. The two high-flow scenarios were based on two different decadal hydrographs that were considered to represent a reasonable range to estimate the spatial distribution of future river maintenance sites. The historical periods did not necessarily have high peak flow years (with their corresponding recurrence interval) for every year, but the sequence of events during these periods manifested itself in significant geomorphic changes when the peak flow years did occur. The first was a “normal” high spring runoff on the MRG. The distribution of peak flows and the magnitude of peak flows that occurred from 2000–2010 are an example of this decadal hydrograph. The qualitative peak flow for this scenario is in the 4,000–6,000 cfs flow range. The second was an “above normal” high spring runoff on the MRG. The distribution of peak flows and the magnitude of peak flows that occurred from 1980–1990 are an example of this decadal hydrograph, with multiple back to back peak flows. The qualitative peak flow for this scenario is in the 8,000–10,000 cfs flow range.

The relative or most likely distribution of new river maintenance sites potentially generated in each of the 10 river maintenance reaches was estimated in a collaborative effort with Reclamation staff from the Albuquerque and Denver offices. Existing or completed river maintenance priority sites were excluded from this analysis, except as how they might influence the location of new river maintenance sites. Engineering analysis and judgment were used to evaluate information from the 2010 aerial photography, historical channel alignments, geomorphic parameters (Makar and AuBuchon 2012), reach trends, field observations, and indicator results of future conditions from the *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a). The anticipated trajectory of change for a reach and resulting potential effects were assessed considering (1) the balance between sediment transport capacity and sediment supply, (2) the difference between the current channel slope and the stable slope for the current conditions, (3) planform changes such as narrowing, vegetation encroachment, and bend migration, (4) bank height, (5) bed and bank material size and stability, (6) tributary effects, (7) comparison of the calculated meander belt to river alignment and lateral constraints, (8) base level control effects of fluctuations in Elephant Butte Reservoir pool elevation, and (9) current channel proximity to infrastructure or other lateral constraints.

This information was integrated for each reach to estimate the relative number of new priority sites expected for both the “normal” and “above normal” flow scenarios. Table III-6 lists the estimated distribution of new river maintenance sites by reach over a 10-year period for each scenario.

Table III-6. Estimated spatial distributions of new river maintenance sites

Reach	Percent Distribution "Normal" Scenario	Percent Distribution "Above Normal" Scenario
Velarde to Rio Chama	4%	6%
Rio Chama to Otowi Bridge	4%	8%
Cochiti Dam to Angostura Diversion Dam	15%	8%
Angostura Diversion Dam to Isleta Diversion Dam	15%	15%
Isleta Diversion Dam to Rio Puerco	8%	13%
Rio Puerco to San Acacia Diversion Dam	4%	4%
San Acacia Diversion Dam to Arroyo de las Cañas	4%	8%
Arroyo de las Cañas to San Antonio Bridge	12%	8%
San Antonio Bridge to RM 78	15%	9%
RM 78 to Full Pool Elephant Butte Reservoir Level	19%	21%

The relative distribution of Adaptive Management sites was limited to where river maintenance work occurred in the recent past (after 2001), or where river maintenance currently has identified river maintenance priority sites. Maintenance risks to cross channel diversion structures and outfall locations, especially on the MRG between Velarde and Otowi, also were identified. The approach for the Adaptive Management analysis used engineering judgment to evaluate information from aerial photography, current reach trends, historical knowledge of natural and anthropogenic changes, river maintenance priority site details, and field observations.

The anticipated need for Adaptive Management at the site considered channel hydraulics, the balance between sediment transport capacity and sediment supply, bank stability from vegetation, and potential planform changes. Potential sites were identified as mentioned above and qualitatively rated, using professional judgment as a low, medium, or high risk for failure. A low rating represented a site where it was believed there would be negligible maintenance needed to provide protection at the site for either of the high flow scenarios. A medium rating was assigned to sites where some additional protection may be necessary to provide protection but would be minimal at the "normal" flow scenario but more likely on the "above normal" flow scenario. A high rating was assigned to sites where either of the flow scenarios likely would create the need for additional protection.

This information was integrated for each reach to estimate the relative distribution of Adaptive Management sites expected for both the "normal" and "above normal" flow scenarios. Because sites may be completed in the next 10 years that are not accounted for in looking at the current potential Adaptive Management need, some percent allocation of the new river maintenance site distribution also is needed. This would account for sites, currently unforeseen, that may be constructed in the next 10 years and for which an Adaptive Management need may then exist. In the last decade or so, the ratio of Adaptive Management projects to new river maintenance projects was 1 to 3.4. This ratio was used to obtain a percentage of new site distribution for which Adaptive Management would be needed. This percentage (30%) times the new river maintenance spatial distribution plus the remaining percentage (70%) times the Adaptive Management site distribution described above was used to derive an estimated future spatial Adaptive Management site distribution. This was assumed to be a reasonable representation of the spatial distribution of Adaptive Management sites for this BA. The spatial distribution range by reach over a 10-year period is listed in Table III-7.

Table III-7. Estimated spatial distributions of Adaptive Management river maintenance sites

Reach	Percent Distribution "Normal" Scenario	Percent Distribution "Above Normal" Scenario
Velarde to Rio Chama	10%	11%
Rio Chama to Otowi Bridge	6%	9%
Cochiti Dam to Angostura Diversion Dam	26%	28%
Angostura Diversion Dam to Isleta Diversion Dam	11%	14%
Isleta Diversion Dam to Rio Puerco	2%	4%
Rio Puerco to San Acacia Diversion Dam	3%	4%
San Acacia Diversion Dam to Arroyo de las Cañas	6%	9%
Arroyo de las Cañas to San Antonio Bridge	4%	2%
San Antonio Bride to RM 78	13%	9%
RM 78 to Full Pool Elephant Butte Reservoir Level	19%	10%

1.6.4 River Maintenance Support Activities

Several support activities are required to successfully and efficiently complete river maintenance actions. These activities, summarized in the following subsections, provide information on data collection (Section 1.6.4.4), access (Section 1.6.4.1), materials essential for the completion of river maintenance actions (Sections 1.6.4.2 and 1.6.4.3), and implementation techniques (Section 1.6.4.5). The sections on material essential for the completion of river maintenance actions and information on data collection refer to information described in Part I, Section 4.2, River Maintenance Historical Baseline.

1.6.4.1 Access Roads and Dust Abatement

Part of the support process for undertaking river maintenance is providing safe access to the site. Typically, existing access routes are used; however, on a few occasions, a new route must be created to provide adequate access. It is anticipated that the average river maintenance site will impact approximately 3 acres for the temporary development of site access roads, with an estimated impact range of 0–18 acres. This impact acreage is for new or minimally used access road, like two track dirt roads, and does not account for the acreage impact on existing maintained roads. An estimated typical impact range for these new or minimally used access roads is a total clearing width of 20–30 feet per linear foot of access road. Work activities associated with creating new or improving minimally used access roads include clearing of vegetation (clearing and trimming), placing fill, grading, shaping, installing culvert pipes, graveling, and dust abatement.

Existing maintained access routes that are typically used include drain and irrigation access roads, the LFCC O&M roads, levee top roads, paved roads, and graded dirt roads. Appropriate access permission and weight limitations are obtained prior to use of these routes. Because these routes have varying maintenance cycles and some are not maintained for heavy construction equipment, there are varying levels of work required to provide safe access to the action area. The level or work required depends on the type of activity (e.g., access for data collection or project implementation) and the initial state of the access route. Activities associated with maintained access roads include clearing of vegetation (mowing and trimming), placing fill, repairing washouts, restoring drainage ditches, grading, shaping, installing culvert pipes, graveling, and dust abatement. The total range of horizontal clearing (mowing) on either side of the existing road for a safe access road width would be approximately 5–10 feet on one side, for a total impact of around 10–20 feet wide per linear foot of access roads. The overhead height from the road surface to be cleared (trimming) varies with the type of equipment, with an estimated range of 10–20 feet per linear foot of access roads.

Vegetation clearing includes three distinct activities—clearing, mowing, and trimming—which may be used independently or in concert to ensure safe access. Clearing involves removing vegetation within the roadway with some amount of subsurface disturbance of the vegetation roots. This typically is undertaken with new or minimally used access routes. Mowing is the process of cutting vegetation in and to the sides of the access route to provide line-of-sight and safe conditions for access, including increasing the reaction time to respond to wildlife and livestock within the access road corridor. Horizontal clearance provides the ability for equipment to drive without hitting and damaging equipment. This action is performed by mowing the vegetation, with the expectation that vegetation will return in a year or two. Trimming involves the selective cutting of tree branches in the vertical direction that restricts vehicular access along the route. Vegetation clearing for new and minimally used access roads involves all three actions; vegetation clearing on maintained access roads involves mowing and trimming.

Dust abatement is a support activity undertaken on those projects for which dust control is necessary for safety or public health reasons. Dust abatement typically occurs on access routes and in project areas during implementation when there is not sufficient moisture in the soil to inhibit the formation of dust. Dust abatement involves placing water onto an earthen surface. Water sources may include the Rio Grande, irrigation and drainage facilities, the LFCC, city water system, or wells. The Rio Grande will be used only when water is unavailable from other sources or is cost prohibitive. Water from an open water source typically is derived through using a pump setup similar to that shown in Figure III-1. Pumping from the Rio Grande for river maintenance sites will use a 0.25-inch mesh screen at the opening to the intake hose to minimize entrainment of aquatic organisms. Typically, this would be done in areas that are clear of riparian vegetation and wetlands.

Figure III-1. Typical water pump setup for dust abatement

For areas where the depth to a level surface is too much for the pump setup, an intermediate area will be leveled to create a shelf to temporarily house the pump. Water typically is applied to the roadway using a truck-based water unit that allows for controlled and uniform spraying of the desired surface. Reclamation obtains the appropriate permits from the NMOSE. Reclamation's current permit (SP-04955) allows the use of 80 AFY. The quantity of water used under this permit is replenished through an associated leasing program. The expected water usage for the duration of a river maintenance project is about 4.5 AF of water, with an estimated range of 2–65 AF. Reclamation also ensures that applicable regulatory agencies, irrigation districts, landowners, and municipalities also are informed and that the appropriate permissions are obtained prior to procuring the water.

River maintenance activities between Velarde and Otowi would predominantly pull water for dust abatement from the Rio Grande. River maintenance projects within the vicinity of the LFCC (San Acacia Diversion Dam south) would predominantly pull water for dust abatement from the LFCC. It is anticipated that, for dust abatement purposes, river maintenance projects south of Cochiti Dam and north of the San Acacia Diversion Dam would use nearby irrigation and drainage facilities during irrigation season (March–October) and the Rio Grande from November–February. If it is not practicable (not enough flow volume, economically prohibitive, etc.) to use irrigation or drainage facilities during irrigation season, Reclamation would dig a sump in the proximate floodplain for pumping. Preparation of a sump involves digging a hole in the floodplain, away from the edge of the river. The sump would be located a minimum of 50 feet from the nearest open water in the river and excavated to about 30–35 feet square and approximately 3 feet below groundwater level. The excavated material would be temporarily placed as a berm between the sump and the river. The sump is less effective for pumping water but would exclude fish eggs and larvae during the spawning season. The sump would be filled back in with the excavated material when pumping is terminated.

If water is pumped from the river for dust abatement purposes, it would likely be pumped at a rate of 1.8–2.2 cfs for 4–8 minutes to fill a water truck. This would be a minimal impact to river flows, equating to a decrease in flows of approximately 0.2% for river flows of 1,000 cfs and approximately 0.1% for river flows of 1,500 cfs for 4–8 minutes. A typical project may use four to six truckloads per day and on rare occasions, may use 18 truckloads per day.

1.6.4.2 Stockpiles and Storage Yards

Reclamation currently has 10 established stockpile sites and 2 storage yards that support the MRG river maintenance needs within the defined action area. It is expected that these sites will continue to be used to support river maintenance into the foreseeable future in the same manner that they were historically described in Part I, Section 4.2.

1.6.4.3 Borrow and Quarry Areas

Reclamation currently has one active borrow area (Valverde Pit) and one active quarry area (Red Canyon Mine) to support river maintenance within the defined action area. The locations are outside the river corridor. It is expected that these sites will continue to be used to support river maintenance into the foreseeable future in the same manner that they were historically described in Part I, Section 4.2. The average river maintenance project disturbance for acquiring soil material from Valverde Pit is approximately 10 acres or less. It is expected that about 5–15% of river maintenance projects would require this material. The entire site acreage (18 acres) for Red Canyon Mine is expected to be used intermittently to support river maintenance, providing riprap material for river maintenance projects.

1.6.4.4 Data Collection

Data collection activities are required to support river maintenance actions and typically occur for two main purposes: specific projects and monitoring trends. It is expected that data collection will continue to be used to support river maintenance into the foreseeable future in the same manner as historically described in Part I, Section 4.2. Data collection methods may include hydrographic data collection (river cross sections, river profiles, sediment sampling [suspended sediment, bed load, and bed/bank material], gauge data, discharge and velocity measurements, etc.), surveying, subsurface investigations (borehole drilling, hand augers, test pits, geophysical tests, etc.), site visits (GPS points, site photographs, bank line measurements, site observations, etc.), oblique aerial photography, and controlled aerial photography and remote sensing. Data collection efforts are conducted through the use of boats, ATVs, and pedestrian travel (walking on land and wading in the river). The majority of the data collection methods are nondestructive in nature, requiring very little disturbance and intrusion into the natural system. The main exceptions are the monitoring of rangelines, subsurface monitoring, and water or sediment sampling.

Subsurface monitoring requires disturbing the earth to collect samples or provide a soil characterization. These are done infrequently and typically on a site-by-site basis, with an average of less than 2 acres of disturbance in any given year. This acreage also includes impacts to allow access into an area for sampling, especially borehole drilling. Water and sediment sampling require a physical sample to provide a scientific characterization. Water samples for water quality or suspended sediment analysis are typically 1-liter samples or less. The expected range of water sampling in any given year is 100–1,500 samples. Sediment samples range from approximately 1- to 100-pound samples, depending on the material being sampled. Coarser material, like gravels and cobbles, requires a larger sample size. Sediment samples may be collected from bars, island, bank side, or river beds. The expected range of sediment sampling in any given year is 50–500 samples.

Reclamation, on average, expects to clear and collect rangeline information for about 110 lines a year within the described action area, with an estimated range between 50–250 lines. Although the specific rangeline lengths vary throughout the MRG project area, a typical annual impact range for rangeline clearing is about 5–25 acres, with an average near 13 acres. With regard to rangeline clearing, the following best management practices (BMPs) would be followed.

- Impacts to any desirable vegetation present would be minimized to the extent possible.
- All vegetation clearing locations would be reviewed by Reclamation biologists for potential impacts prior to any brushing activity.

- Vegetation clearing activities located near flycatcher/cuckoo habitat would not occur during the breeding season (April 15– August 15, or September 1 for work in suitable cuckoo habitat).

- New transect endpoints would be moved upstream and downstream in the field to avoid impacts to riparian areas, including nesting sites or vegetation that is desirable to keep intact.

1.6.4.5 Typical River Maintenance Implementation Techniques

Reclamation has developed implementation techniques that are used during a river maintenance project to facilitate the field placement of river maintenance methods. Reclamation recognizes that these techniques may add additional impact acreage and has developed BMPs to minimize the impacts to the environment. Impacts of BMPs are described in the following sections by footprint area, duration used, and applicability (by percent) to river maintenance projects. Acreage impacts from these implementation techniques for river maintenance as a whole are described in Section 1.6.5. These BMPs fall into two general categories: (1) general BMPs that are applicable to all river maintenance methods and (2) specific BMPs to a method category. These techniques have been utilized historically, as listed by project in Part I, Section 4.2, Tables I-5 through I-15.

1.6.4.5.1 General BMPs

Timing of the Proposed Action

1. The BA Partners will seek to avoid impacts to birds protected by the Migratory Bird Treaty Act (MBTA) (16 United States Code [U.S.C.] 703), including the flycatcher and cuckoo, by conducting work activities outside of the normal breeding and nesting season (April 15 to August 15, or September 1 for work in suitable cuckoo habitat).

   1.1. If work is necessary between April 15 and August 15 (or September 1 for work in suitable cuckoo habitat), suitable/occupied migratory bird habitat will be avoided during the construction activities as much as possible, utilizing the most current annual survey results in conjunction with habitat suitability. The BA Partners will use current flycatcher and cuckoo monitoring data to avoid work within 0.25 miles of an active nest as much as possible. Coordination and consultation with the Service will occur prior to such work activities.

   1.2. Reseeding or revegetation may be accomplished by hand or by mechanized means, such as using a Truax imprinter followed by hand or tractor broadcast seeding (see section Vegetation Planting and Control below). Planting via mechanized means, includes using a hand-held or tractor-mounted auger. If mechanized means are used for either reseeding or replanting in the April 15 to August 15 timeframe (or September 1 for work in suitable cuckoo habitat), migratory bird surveys would be conducted immediately prior to the work to determine if any breeding birds are present. If birds are detected, Reclamation and/or the appropriate BA partner(s) would coordinate with the Service to determine appropriate next steps.

2. The BA Partners will seek to avoid impacts to the New Mexico meadow jumping mouse by not conducting work activities from August 15 to October 31 if suitable mouse habitat is found during mouse habitat surveys conducted prior to work. Mouse habitat surveys will occur in early summer (June or July) or when vegetation that characterizes mouse habitat is most likely to be at its peak growth. If suitable mouse habitat is found, Reclamation and/or the appropriate BA partner(s) will coordinate with the Service prior to work. Road maintenance such as grading and washout repair may be performed throughout the year to maintain safe access to and from the river, but vegetation control will not occur between April 15 and August 15 (or September 1 for work in suitable cuckoo habitat), as per MBTA measure 1 above.

Water Quality

3. The BA Partners will obtain all applicable permits prior to implementation of the project, including Clean Water Act permits (CWA). The BA Partners will comply with the requirements of the CWA and other permits associated with the project, including required reporting to the appropriate authorities as needed and will not begin work until all required permits are obtained.

4. Silt fences and/or appropriate erosional controls will be used around the project site to manage water runoff in the site in accordance with Clean Water Act requirements.

   4.1. If silt fencing is used, it will be installed approximately 2 feet (0.6 m) from the wetted perimeter of the bank in the water interface when construction activities occur in the wet and have the potential for adverse impacts (i.e., impacting the river bank). Water quality parameters will be monitored before silt fencing is installed, and the fencing will not be removed until water quality has returned to within 10% of its original measures.

5. The BA Partners will visually monitor for water quality in the areas below areas of river work before and during the work day. Water quality will be monitored during construction and after equipment operates in the river channel. Monitoring will include visual observations and may include direct sampling, as appropriate.

   5.1. If direct sampling is needed, water-quality parameters to be tested include pH, temperature, dissolved oxygen, and turbidity. Parameters will be measured both upstream and downstream of the work area.

5.2. Responses to changes in water-quality measures exceeding the applicable standards would include reporting the measurements to the NMED Surface Water Quality Bureau and moving construction activities away from the shore.

Equipment and Operations

6. Reclamation-led work activities that have the potential for adverse impacts will be monitored by properly trained Reclamation personnel in order to ensure compliance. Non-Reclamation partners will have an onsite environmental monitor during all work activities that have the potential for adverse impacts in order to ensure compliance. Also, an environmental monitor will regularly assess other activities to ensure compliance.

7. The BA Partners will excavate an area as few times as possible to minimize disturbance of sediments. When excavating within the wetted channel, the following practices will be used to minimize disturbance of sediments:

   7.1. Minimize movement of excavator tracks;

   7.2. Minimize excavator bucket contact with riverbed when not excavating.

8. Each individual operator will be briefed on and will sign off on local environmental considerations specific to the project tasks.

9. Minimize impact of hydrocarbons: To minimize potential for spills into or contamination of aquatic habitat:

   9.1. Hydraulic lines will be checked each morning for leaks and periodically throughout each work day. Any leaky or damaged hydraulic hoses will be replaced.

   9.2. All fueling will take place outside the active floodplain with a spill kit ready. Fuel, hydraulic fluids, and other hazardous materials may be stored on site overnight, but outside the normal floodplain, not near the river or any location where a spill could affect the river.

   9.3. All equipment will undergo high-pressure spray cleaning and inspection prior to initial operation in the project area.

   9.4. Equipment will be parked on pre-determined locations on high ground away from the river overnight, on weekends, and holidays.

   9.5. Spill protection kits will be onsite, and operators will be trained in the correct deployment of the kits.

9.6. External hydraulic lines are composed of braided steel covered with rubber. When there is increased risk of puncture such as during mastication while removing vegetation, external hydraulic lines will be covered with additional puncture-resistant material, such as steel-mesh guards, Kevlar, etc. to offer additional protection.

10. Equipment will be removed from the channel in the event of high storm surges.

11. To allow fish time to leave the area before in-water work begins, equipment will initially enter the water slowly. In-water work will be fairly continuous during work days, so that fish are less likely to return to the area once work has begun.

12. Riprap to be placed in the water will be reasonably clean to the extent possible. If there are large clumps of soil bigger than 1 foot within the riprap, those clumps will be set aside during the loading or placing operations.

13. Whenever possible, airboats will be operated through the center of the channel to minimize disturbance to aquatic species, including minnows.

Access and Staging

14. Impacts to terrestrial habitats will be minimized by using existing roads whenever possible. In general, equipment operation will take place in the most open area available, and all efforts will be made to minimize damage to native vegetation and wetlands (also see section titled Vegetation below).

15. All necessary permits for access points, staging areas, and study sites would be acquired prior to construction activity.

Vegetation Replanting and Control

16. A variety of revegetation strategies may be used: stem and pole cuttings (Los Lunas Plant Materials Center 2007b); long stem transplants (Los Lunas Plant Materials Center 2007a); and upland planting with and without a polymer, zeolite, or similar compound to maximize soil water retention (Dreesen 2008). Planting techniques may vary from site to site, and may consist of buckets, augers, stingers, and/or water jets mounted on construction equipment. In some areas, a trench may be constructed to facilitate the placement of a significant number of plants, specifically stem and pole cuttings. Seeding would be accomplished using a native seed drill, where feasible, and spread with a protective covering that would provide moisture to the seeds.

17. Vegetation control may consist of mechanical removal, burning, mowing, and/or herbicide treatment. Herbicides will be used when non-chemical methods are unsuccessful or are not economically feasible (see section Herbicide and Pesticide Use below).

    17.1. Vegetation control will be completed between August 15 (or September 1 for work in suitable cuckoo habitat) and April 15. Any need for deviations from this work window would be considered on a project-specific basis and coordinated with the Service. If work is planned within two weeks before April 15 or after August 15 (or September 1 for work in suitable cuckoo habitat), the BA Partners will conduct additional surveys, if warranted, to determine the presence of breeding flycatchers, cuckoos, or other breeding birds. Reclamation and the appropriate BA partner(s) will coordinate monitoring and work activities with the Service, as appropriate, if bird nests are found.

18. Native vegetation at work sites will be avoided to the extent possible. If large, native woody vegetation (primarily cottonwood), needs to be trimmed or removed, they will be replaced at a ratio of 10:1. When and where possible, small, native woody vegetation will be removed or harvested at the appropriate season to use for revegetation work at another location in the project area or at another project site. Native vegetation that cannot be replanted may be mulched (mulch will be removed or spread on site at a depth of three inches or less) or temporarily stockpiled and used to create dead tree snags or brush piles in the project area upon completion.

19. Nonnative vegetation that is removed at work sites will be mulched, burned, or removed offsite to an approved location. Mulched vegetation may also be spread on site at a depth of three inches or less.

Herbicide and Pesticide Use

20. The use of chemical herbicides or pesticides may be necessary to control undesirable plant species around stockpile sites and storage yards and also to prevent the spread of invasive species in areas cleared for maintenance activities. It also may be necessary to spray or control: arthropods (spiders, ants, cockroaches, and crickets) that pose a safety problem or are a nuisance in buildings and facilities, birds (pigeons and swallows) roosting in building structures that are considered a nuisance, and mice that get into structures and/or equipment. Becuase the application of herbicides and chemical spraying is tightly controlled by state and federal agencies, Reclamation will follow all state and federal laws and regulations applicable to the application of herbicides, including guidelines described by White (2007). Herbicides or pesticides will not be directly applied to or near water unless they are labeled for aquatic use and appropriate buffers will be observed. Communication with the Service would occur prior to any application to sites with threatened or endangered wildlife species.

Reclamation would follow the Albuquerque Area Office Integrated Pest Management Plan and Pesticide General Permit when applying herbicides or pesticides. The non-Reclamation BA partners will follow their agencies' herbicide/pesticide guidance, if applicable. Herbicides or pesticides may be applied using low pressure spray rigs mounted to OHVs, trucks and trailers with spray bars, or backpack sprayers (for spot applications). Treatments will be conducted by trained and approved personnel observing appropriate buffer distances and label directions. Treatment will not take place when winds exceed 10 miles per hour or when rain is forecasted for the local area within 48 hours of application. Care will be taken when mixing or applying any herbicide to avoid runoff onto the ground or into the water. Surfactants may also be added to certain herbicides to maximize herbicide/pesticide performance and minimize retreatments.

Dust Abatement

21. If water is needed for dust abatement or to facilitate grading of roads, water may be pumped from the Rio Grande, irrigation drains, sumps, or secondary channels adjacent to the river. During irrigation season (March 1 to October 31), water will not be pumped from the river but will be pumped from the irrigation drains if possible. Pumping from the river is not expected to be needed between April 15 and August 15 (or September 1 in suitable cuckoo habitat); however, if pumping is needed between May 1 and July 1 (emergencies only), Reclamation and/or the appropriate BA partner(s) will coordinate with the Service to avoid impacts to minnow eggs and larvae. Outside of the irrigation season, an amount not to exceed 5% of river flows at the time of pumping may be drawn from the Rio Grande. Pumping is short duration (minutes) for filling whatever water transport equipment is used. Sumps or secondary channels adjacent to the river will be used, whenever feasible. Pump intake pipes will use a 0.25 in (0.64 cm) mesh screen at the opening of the intake hose to minimize entrainment of aquatic organisms.

Other Measures

22. All treatment and control areas will be monitored for three years following construction to determine the effectiveness of the methods implemented and identify project-related hydrologic and geomorphic alterations. The monitoring will consist of biological, vegetation, geomorphic, and hydrologic monitoring, as appropriate to the project design and purpose.

23. The BA partners will monitor flows for two years following construction of side channels and, if flows at the nearest gage exceed the target inundation flows, will monitor the side channel for minnow entrapment in accordance with the appropriate protocol. After two years, it may be determined in coordination with the Service that further monitoring is unnecessary.

24. All project spoils and waste will be disposed of offsite at approved locations or may be used on site as appropriate to the project purpose consistent with applicable environmental requirements.

25. All work projects will have a contract in place for the rental of portable restroom facilities during the duration of the project.

1.6.4.5.2 Method Category BMPs

1. *River diversion* – This implementation technique places a berm across a portion or all of the river channel to redivert the river flow away from the river maintenance site. This technique allows construction equipment to work in relatively still water, minimizing downstream turbidity concerns during maintenance activities. Typically, the diversions are temporary, lasting the majority of the project duration. In a few cases, the diversions may be permanent where there is a need to relocate the river into a new channel location. The berm typically consists of fluvial sediment deposits available nearby; however, depending on the location and desired duration, the diversion also may include a more erosion resistant barrier, such as riprap and/or a geosynthetic/erosion control fabric. Material from the berm typically comes from the desired new channel location and is stockpiled in a suitable location to prepare for the diversion berm placement. The diversion berm is placed after the desired channel relocation had been completed and is placed from one side of the river to the other to minimize the formation of isolated pools. Typically, this is done with a dozer or other similar tracked construction equipment. A typical diversion berm would be sized to handle about a 2,000-cfs flow event, with an estimated 25-foot top width and a height that may vary from 6–12 feet. Using an assumed side slope of 2:1 (horizontal: vertical), this gives an estimated footprint range of 45–75 feet. The diversion berm length is dependent on the implementation area and whether existing features in the river channel, such as bars and islands, may be used to help isolate the project site from the main river flow. The expected diversion berm length range for river maintenance projects is approximately 100–500 feet. Temporary diversion berms are removed by breaching a section of the berm and then removing as much of the remaining material as possible. This requires some work in the wet and requires equipment to be in the river. It is expected that about 15–25% of river maintenance projects would require this technique. This technique may be used for methods within the channel modification, bank protection/stabilization, cross channel features, and change sediment supply method categories.

2. *River reconnection* – This implementation technique provides the excavation to reconnect sections of the river. This technique minimizes the amount of time construction equipment needs to work in the wet. Excavation typically proceeds from downstream to upstream, allowing the existing separation to act as a diversion berm for the project. The

last phase of this implementation technique is to remove this diversion berm. The majority of this technique is performed in the dry, with only the last removal phase requiring equipment to potentially be in the wet. Typically, this technique requires less than 1 week for work in the wet. It is expected that the range of river maintenance projects requiring this technique would be around 20–30%. This technique may be used for methods within the channel modification method category.

3. *Dewatering* –This implementation technique places dewatering wells in a hydraulically connected area of the project site to lower the water level. This technique is coupled with the river diversion technique to provide isolation of the project site from the main flow area. This technique minimizes the amount of time construction equipment needs to work in the wet. Water pumped from these wells is returned to the river downstream, with adequate protection at the return point to minimize surface erosion and the addition of sediment into the water column. Dewatering, where used, is needed for the majority of the project duration. It is expected that the range of river maintenance projects requiring this technique would be about 1–5%. This technique may be used for methods within the infrastructure relocation or setback, channel modification, bank protection/stabilization, and cross channel features method categories.

4. *River crossings* – This implementation technique facilitates moving construction materials and equipment from the side of the river opposite of the project site. If feasible, options to cross the river in the dry would be explored and acted upon first. This technique typically is employed where existing bridges have an inadequate load limitation for the construction equipment or where it is prohibitive (either from a cost or other compliance perspective) to transport material for a longer distance to the project site. This technique would be used only if no other feasible options exist. This technique minimizes disturbance acreage in the wet by defining a set path for the construction equipment to follow. Equipment moves slowly across the river and crossings are typically performed as part of an equipment caravan. River crossings also typically are grouped temporally to minimize the duration of river crossings. In areas with sufficient coarse bed material, the wetted river channel crossing will be placed, where possible, in a riffle. In areas with finer bed material, crossing platforms may be placed to facilitate the crossing of equipment, where possible, in a riffle. This is typically less of an issue with metal tracked equipment than with rubber tired equipment. Crossing platforms in areas of finer bed material may consist of areas hardened with larger sized bed material, like gravels or cobbles, or constructed mats that can be placed on the bed and driven over. Constructed mats likely would consist of cabled wooden beams but may also consist of cabled articulated, concrete blocks. Riffle crossings are preferable to the shortest distance across the river, which may have deeper water. Crossing locations also typically are located to minimize impacts of existing bank vegetation and to avoid areas of vertical

slopes. The estimated range of river crossings for river maintenance projects may vary from 100–1,000 feet in length. The typical crossing width is around 20 feet. The range of river crossings for a single river maintenance project, where needed, may vary from about 2–600 trips for the duration of a project. It is expected that about 20–30% of river maintenance projects would require this technique. This technique may be used for methods within the channel modification, bank protection/stabilization, cross channel features, and change sediment supply method categories.

5. *Working platforms* – This implementation technique creates a ramp from the floodplain, typically along an upstream or downstream key or tie-back feature, to allow trucks loaded with rock to back down the ramp and dump the rock in the river or at the end of the ramp. Rock dumped from the trucks then is pushed and/or placed into the river channel to form the lower portion of the rock layers required by the river maintenance method being implemented. As rock is placed into the river channel, larger rocks are placed and then positioned with the excavator bucket. Smaller rocks then are placed to fill voids between the larger rocks, forming a uniform layer of riprap. This lower portion of riprap forms a working platform approximately the same elevation as the flood plain and above the water surface elevation. Once working platforms are constructed, work would occur in the dry. This technique minimizes the amount of time construction equipment needs to work in the wet. This technique requires some level of work in the wet, but equipment does not work in the wet. This technique may be used for methods within the channel modification and bank protection/stabilization method categories.

6. *Partial excavation of bank* – This implementation technique lowers the bank in the project area to allow construction equipment to reach the desired placement area and elevation without having the equipment actively in the river. If the soil is geotechnically unstable, material such as gravel, clay, or more cohesive soil may be added to this platform to provide stability. This technique requires removing vegetation in an area wide enough to support a platform for the equipment (about 30 feet) and to allow the excavation to be adequately sloped (this distance varied with depth but is typically the same, if not more than the desired platform width) to ensure compliance with Reclamation’s safety standards (Reclamation 2009). Rock is placed from this excavated bank in a similar fashion as described for the working platform implementation technique. This technique minimizes the time construction equipment needs to work in the wet. This technique requires some level of work in the wet, but equipment does not work in the wet. This technique may be used for methods within the channel modification and bank protection/stabilization method categories.

7. *Top of bank work* – This implementation technique would be used in areas where construction equipment has adequate working space. This means equipment is able to

reach the desired placement area and elevation from the existing bank line without having the equipment actively in the river or needing to partially excavate the bank. This technique requires the removal of vegetation in an area wide enough to support a working area for the equipment (about 30 feet). Rock is placed from the bank line in a similar fashion as described for the working platform implementation technique. This technique minimizes the amount of time construction equipment needs to work in the wet. This technique requires some level of work in the wet, but equipment does not work in the wet. This technique may be used for methods within the channel modification and bank protection/stabilization method categories.

8. *Amphibious construction* – This implementation technique requires construction equipment to operate in the river flows. Typically, this method is employed when minimal disturbance of the dry portion of the project area is desirable, such as to minimize the loss of bank vegetation. This technique minimizes the disturbance to bank riparian areas. Material placement or removal follows the descriptions listed for those techniques. This technique typically is used only for a portion of the project duration. For projects requiring long durations of river work, this technique is done in conjunction with placement of a river diversion, as described above, upstream of the project area, to minimize the work being performed in flowing water. This technique may be used in conjunction with a project that places a river diversion on both the upstream and downstream end of the project site. Placement of the downstream diversion berm would be done after seining to exclude the entrapment of fish. It is expected that the range of river maintenance projects requiring this technique would be around 10–15% with no river diversion, about 10–15% with an upstream river diversion, and less than 5% with both an upstream and downstream diversion. This technique may be used for methods within the channel modification, bank protection/stabilization, cross channel features, and change sediment supply method categories.

9. *Material placement* – This technique involves the placement of construction material (typically rock or sediment) starting from the bank line at the upstream end of the project site and extending placement into the channel in the downstream direction. This technique helps prevent the formation of isolated pools or channels, which could trap fish or other species. If stranding occurs, Reclamation will coordinate with the Service to rescue stranded fish. This technique may be used for methods within the channel modification, bank protection/stabilization, cross channel features, and change sediment supply method categories.

10. *Material removal* – This technique prescribes that materials, such as sediment, jetty jacks, woody debris, riprap, or other material, will be removed in a consistent manner to help avoid the formation of isolated pools or channels, which could trap fish or other

species. If stranding occurs, Reclamation will coordinate with the Service to rescue stranded fish. This technique may be used for methods within the channel modification, bank protection/stabilization, cross channel features, and change sediment supply method categories.

11. *Infrastructure relocation* – This technique provides for the setback of features like irrigation canals or drains, including the LFCC. This technique avoids, for the time being, needing to perform river maintenance activities in the river. This technique includes the following sequence of steps, which may not always follow the exact sequence of steps listed. Equipment consists of both metal-tracked and rubber-tired equipment. Setback projects do not involve any work in the river. This technique may be used for methods within the Infrastructure Relocation or Setback and Conservation Easements method categories.

    a. Seining the facility to be relocated and installing a fish exclusion barrier downstream from the project site.

    b. Clearing vegetation in the project area.

    c. Excavating new wetted channel (starting downstream and working upstream).

    d. Placing new spoil berm (everywhere except across old channel).

    e. Lining new wetted channel with erosion protection (if designed).

    f. Connecting new wetted channel to old wetted channel.

    g. Filling old wetted channel in abandoned channel sections (fill placed from upstream to downstream).

    h. Connecting spoil berms.

    i. Final grading of and placing road material on O&M roads, excavating bar ditches, and placing rainfall runoff erosion controls.

1.6.5 Summary of Proposed River Maintenance Actions

Tables III-3 through III-5 (Sections 1.6.1 and 1.6.2) summarize the annual number of projects, project footprint acreage, and project duration for proposed river maintenance projects.

Tables III-3 through III-5 were used with the following assumptions to estimate river maintenance footprint acreage for the proposed action. The total footprint impact acreage, applying these assumptions, is listed in Table III-8.

1. 10-year analysis period.

2. Analysis period is used to estimate approximate numerical values to facilitate an ESA impact but is not expected to represent the desired ESA compliance period.

3. Approximately 2.5% of new sites for analysis period would be at the maximum acreage impact, both wet and total, as listed in Table III-4. This gives a wet impact area of 65 acres and dry impact area of 25 acres.

4. Approximately 2.5% of new sites for analysis period would be at the maximum acreage impact, both dry and total, as listed in Table III-4. This gives a wet impact area of 20 acres and dry impact area of 70 acres.

5. Approximately 50% of new sites for analysis period would be at the average acreage impacts stated in Table III-4.

6. Approximately 22.5% of new sites for analysis period will be one-half standard deviation above the average impact area. Based on the historical data, the standard deviation is 13 acres in the dry and 11 acres in the wet. This gives a wet area of 11 acres and a dry area of 14 acres.

7. Approximately 22.5% of new sites for analysis period will be one-half standard deviation below the average impact area. Based on the historical data, the standard deviation is 13 acres in the dry and 11 acres in the wet. This gives a wet area of 0 acres and a dry area of 1 acre.

8. New site acreage has the potential to span the acreage range indicated in Table III-4.

9. Adaptive Management and Interim/Unanticipated Work are expected to be at or less than the average acreage listed in Table III-4. For this analysis, the acreage will be taken as the average.

10. Estimated number of projects for analysis period (10 years): numbers reflect 10 times the project estimates listed in Table III-3.

    a. Average scenario: 40 (20 new, 10 Adaptive Management, 10 interim/unanticipated work)

    b. Minimum scenario: 10 (10 new)

    c. Maximum scenario: 80 (40 new, 30 Adaptive Management, 10 interim/unanticipated work)

11. Decadal footprint acreage for new sites is calculated by taking the number of new sites in a given scenario (average, minimum, maximum), multiplying by the percent of new sites

applicable and the acreage associated with one of those new sites (given in bullets above). This is repeated for each of the five scenarios listed above (bullet numbers 3–7) with all values summed together for the wet and dry cases, respectively. For example, the average scenario for wet, new sites would be the sum of the following calculations:

a. 20 (bullet 10a) * 0.025 * 65 (% and wet impact acreage from bullet 3) = 32.5 acres

b. 20 (bullet 10a) * 0.025 * 20 (% and wet impact acreage from bullet 4) = 10 acres

c. 20 (bullet 10a) * 0.50 * 5 (% from bullet 5, wet impact acreage from Table III-4) = 50 acres

d. 20 (bullet 10a) * 0.225 * 11 (% and wet impact acreage from bullet 6) = 49.5 acres

e. 20 (bullet 10a) * 0.225 * 0 (% and wet impact acreage from bullet 7) = 0

12. Decadal footprint for Adaptive Management and interim/unanticipated work is calculated by taking the number of sites in a given scenario (average, minimum, maximum) from Table III-3 and multiplying by 10 (to adjust to the decadal time scale) and the average acreage listed in Table III-8 for the wet and dry impact areas.

Table III-8. Approximate decadal river maintenance footprint acreage

	Average	Minimum	Maximum
Wet, New Sites	142	71	284
Dry, New Sites	185	93	370
Wet, Adaptive Management and Interim/ Unanticipated Work	100	0	200
Dry, Adaptive Management and Interim/ Unanticipated Work	140	0	280
Total	**567**	**164**	**1,134**

Additional impact acreage also is incurred by river maintenance for various support activities, including implementation techniques. Table III-9 lists additional annual or per project impacts from support activities, like data collection, water usage, and off river corridor areas, that are necessary for river maintenance but are indirectly related to specific project sites. Acreage for off river corridor areas and river maintenance data collection in Table III-10 is the sum of annual values listed in Table III-9. No multiplying factor is applied to extend this acreage over multiple years, as the area of disturbance is not changing from year to year.

Table III-9. River maintenance support activities indirectly related to project sites

	Average	Minimum	Maximum	Notes
Water Usage (acre-feet)				
Water Usage	4.5	2	65	Per project
Off River Corridor Areas (acres)				
Stockpile Sites/Storage Yards	67	67	75	Total area
Borrow Areas	10	1	114	5–15% projects utilize
Quarry Areas	18	0	18	
Data Collection				
Subsurface Monitoring (acres)	2	0	2	Area/year
Water Samples		100	1,500	Number of 1 liter samples
Sediment Samples		1	100	Sample weight in pounds
Sediment Samples		50	500	Number
Rangelines (lines)	110	50	250	Number lines per year
Rangelines (acres)	13	5	25	Acres per year – 3-foot width

Table III-10. Approximate decadal river maintenance acreage for indirect project support activities

	Average	Minimum	Maximum
Wet, river corridor	2	1	4
Dry, river corridor	170	50	290
Dry, off river corridor	95	68	207
Total, river corridor	172	51	294
Total, off river corridor	95	68	207

Acreage for river corridor values in Table III-10, both wet and dry, is based on the summation of annual values listed in Table III-9 and then multiplied by the analysis period (10 years). Dry river corridor acreage is a summation of subsurface monitoring and rangeline acreage. Wet river corridor acreage estimates a disturbance area for water and sediment sampling. Assuming that each sample disturbs an area about 9 square feet (likely an overestimate as these are point samples), an estimate of the acreage is obtained by multiplying the number of sites by the area (converting from square feet to acres) and the number of years (10) in the analysis period. The average impact is calculated as the average of the minimum and maximum impacts. Impacts from water usage were not evaluated on an acreage basis because pumping would occur within the described river maintenance footprint acreage.

The Rio Grande will be used only when water is unavailable from other sources or is cost prohibitive. If water is pumped from the river for dust abatement purposes, it likely would be pumped at a rate of 1.8–2.2 cfs for 4–8 minutes to fill a water truck. This would be a minimal impact to river flows, equating to a decrease in flows of approximately 0.2% for river flows of 1,000 cfs and approximately 0.1% for river flows of 1,500 cfs for 4–8 minutes. Additional impact acreage incurred by river maintenance for various support activities that are directly related to project site is listed in Table III-11. Estimated values in Table III-11 are per project. The total impact acreage for river maintenance for these activities is listed in Table III-12. For calculations in Table III-12, acreage in the dry is derived from access road impacts, while acreage in the wet is derived from impacts of implementation techniques, specifically river diversions and river crossings. Impacts from the implementation techniques of river reconnection are not included in Table III-12, as impacts are short in duration and would be covered under the delineated river maintenance footprint acreage from Table III-8. Impacts from the implementation technique of dewatering are also not included in Table III-12. On a spatial scale, these would fall within the river maintenance footprint acreage, and the volume of water removed would be returned to the river corridor within this footprint acreage.

Table III-11. River maintenance support activities directly related to project sites

	Average	Minimum	Maximum	Notes
Access Roads				
New/Minimally Used Access Roads	1	0	3	Only for new sites (acres)
Existing Roads – Width Cleared		10	20	Per foot of road (feet)
Existing Roads – Height Cleared		10	20	Per foot of road (feet)
Implementation Techniques				
River Diversions (width in feet)		45	75	
River Diversions (length in feet)		100	500	15–25% projects utilize
River Reconnection (duration in weeks)	1			20–30% projects utilize
Dewatering				1–5% projects utilize
River Crossings (width in feet)	20			
River Crossings (length in feet)	1000	100	600	
River Crossings (number of trips for project)	300	2	600	20–30% projects utilize
River Work, No Diversions				10–15% projects utilize
River Work, with Upstream Diversion				10–15% projects utilize
River Work, Two Diversions				< 5% projects utilize

Table III-12. Approximate decadal river maintenance acreage for direct project support activities

	Average	Minimum	Maximum
Wet, New Sites	691	1	1,992
Dry, New Sites	133	216	865
Wet, Adaptive Management Work	345	0	1,494
Dry, Adaptive Management and Interim/Unanticipated Work	73	0	145
Total	**1,242**	**217**	**4,496**

Acreage from existing access roads was calculated by assuming that each river maintenance project site would use approximately 2 miles of existing access roads. This length is then multiplied by the width ranges from Table III-11 for the minimum and maximum scenarios. The average of the minimum and maximum scenario was used to represent the average scenario. The height ranges from Table III-11 were not used because this would double count the estimated acreage impact. The access road impacts for a given project were estimated by summing the area for new access roads listed in Table III-11 and the calculated existing access road acreage as previously discussed. The per project access road acreage was then multiplied by the estimated number of projects for the three scenarios (average, minimum, and maximum). New access road acreage was assumed to apply only to new sites, while existing road acreage was applied to new, Adaptive Management, and interim/unanticipated sites.

Acreage from the river crossing and river diversion implementation techniques was calculated first on a project basis and then multiplied by a utilization percent and the estimated number of projects (Adaptive Management and new sites only) for the three scenarios (average, minimum, and maximum). These construction techniques are not applicable to the river maintenance methods described for interim/unanticipated projects. Utilization percent ranges are provided in Table III-11. The lower and upper values were assumed to represent the minimum and maximum scenarios, respectively, while the median of the range was used for the average scenario. Project acreage for river diversions is calculated from the length and width values provided in Table III-11. The average scenario acreage is the average of the minimum and maximum acreages. Project acreage for river crossings is calculated by multiplying the length, width, and the number of crossings for the average, minimum, and maximum scenarios.

To arrive at a total acreage impact for river maintenance (Table III-13), the acreage totals in Tables III-8, III-10, and III-12 were distributed to reaches using the predicted spatial distributions described and listed in Section 1.5.3. Only the river corridor acreage (wet and dry) is utilized from Table III-10 and assumed to apply equally to the new site and Adaptive Management spatial distributions. The average, minimum, and maximum acreages were used with both flow scenarios, applying Adaptive Management spatial distributions to Adaptive Management work and the new site spatial distribution to new and interim/unanticipated work. This results in two sets of average, minimum, and maximum acreages—one for the normal and one for the above-normal flow scenario. To arrive at a single, estimated value by reach, it was assumed that the probability of occurrence for either flow scenario is the same, thus providing the ability to average each of the average, minimum, and maximum scenarios, respectively. Wet, dry, and total acreage per reach are listed in Table III-13.

Tables III-10 and III-13 provide an estimate of the proposed river maintenance acreage impacts. While these acreage estimates are expected to be reasonable, the MRG is a dynamic river with complex adjustments that cannot be captured in an analysis such as this. It should be noted that approximate numerical values provided throughout Section 1.6 are provided to allow for an evaluation of the programmatic effect of river maintenance. To provide the ability to achieve ESA programmatic coverage, the framework for these details is provided in this proposed action. While specific project locations are not described in this BA, estimates are made as to the general type, amount, and distribution of future maintenance needs. Reclamation expects that, while these numbers are used to derive a total river maintenance acreage, river maintenance would not be limited in the new BiOp by values (i.e., the number of sites in a given year and the future distribution of sites), but rather the resultant amount of programmatic take.

Table III-13. Approximate decadal acreage distribution by reach of river maintenance sites

Reach	Average	Minimum	Maximum
Velarde to Rio Chama, wet	84	3	283
Velarde to Rio Chama, dry	45	19	114
Velarde to Rio Chama, Total	**129**	**22**	**397**
Rio Chama to Otowi Bridge, wet	79	4	251
Rio Chama to Otowi Bridge, dry	43	21	117
Rio Chama to Otowi Bridge, Total	**122**	**25**	**368**
Cochiti Dam to Angostura Diversion Dam, wet	210	8	707
Cochiti Dam to Angostura Diversion Dam, dry	111	45	281
Cochiti Dam to Angostura Diversion Dam, Total	**321**	**53**	**988**
Angostura Diversion Dam to Isleta Diversion Dam, wet	186	11	568
Angostura Diversion Dam to Isleta Diversion Dam, dry	103	55	290
Angostura Diversion Dam to Isleta Diversion Dam, Total	**289**	**66**	**858**
Isleta Diversion Dam to Rio Puerco, wet	106	8	302
Isleta Diversion to Rio Puerco, dry	60	36	180
Isleta Diversion to Rio Puerco, Total	**166**	**44**	**482**
Rio Puerco to San Acacia Diversion Dam, wet	49	3	153
Rio Puerco to San Acacia Diversion Dam, dry	27	14	75
Rio Puerco to San Acacia Diversion Dam, Total	**76**	**17**	**228**
San Acacia Diversion Dam to Arroyo de las Cañas, wet	79	4	251
San Acacia Diversion Dam to Arroyo de las Cañas, dry	43	21	117
San Acacia Diversion Dam to Arroyo de las Cañas, Total	**122**	**25**	**368**
Arroyo de las Cañas to San Antonio Bridge, wet	96	7	275
Arroyo de las Cañas to San Antonio Bridge, dry	54	33	164
Arroyo de las Cañas to San Antonio Bridge, Total	**150**	**40**	**439**
San Antonio Bridge to RM 78, wet	155	9	478
San Antonio Bridge to RM 78, dry	85	45	240
San Antonio Bridge to RM 78, Total	**240**	**54**	**718**
RM 78 to Full Pool Elephant Butte Reservoir Level , wet	235	14	707
RM 78 to Full Pool Elephant Butte Reservoir Level, dry	130	71	373
RM 78 to Full Pool Elephant Butte Reservoir Level, Total	**365**	**85**	**1,080**
Total, wet	**1,279**	**71**	**3,975**
Total, dry	**701**	**360**	**1,951**

1.7 Other Reclamation MRG Project Proposed Maintenance Actions

There are other activities, distinct from river maintenance actions and river maintenance support activities, that help achieve Reclamation's authorization under the Flood Control Acts of 1948 and 1950. These activities, as described in the authorization, include irrigation and drainage rehabilitation (maintenance) and operation and maintenance on the LFCC (Reclamation 1947, 2003b). Descriptions of these activities are provided in the following subsections.

Throughout Section 1.7, approximate numeric values are provided to evaluate the programmatic effect of other MRG Project maintenance. To provide the ability to achieve ESA programmatic coverage for Reclamation's maintenance on the LFCC and Project drains, the framework for these details is provided in this proposed action. While specific project locations are not described in this BA, the general type and annual amount of Reclamation's facility work is described. Reclamation expects that, while these numbers are used to derive a total other MRG Project maintenance acreage, Reclamation would not be limited in the new BO by values such as the number of sites in a given year and the future distribution of sites, but rather the resultant amount of programmatic take.

The use of sprays may be necessary to control undesirable plant species on the slopes of the LFCC and Project drains and along access roadway to control aquatic vegetation in the LFCC and Project drains, and to prevent the spread of invasive species in areas cleared for maintenance activities. Because the application of herbicides and chemical spraying is tightly controlled by state and federal agencies, Reclamation will follow all state and federal laws and regulations applicable to applying herbicides, including guidelines described by White (2007). Herbicides or chemicals will not be directly applied to or near water unless they are labeled for aquatic use. Communication with the Service would occur prior to any application to sites with threatened or endangered wildlife species. An example of the processes that would be followed by Reclamation is The Albuquerque Area Office Integrated Pest Management Plan and Pesticide General Permit.

1.7.1 LFCC O&M Proposed Actions

Reclamation has continued to maintain the LFCC as it serves important functions, including improving drainage, supplementing irrigation water supply to MRGCD, and supplying water to the BDA for irrigation and other uses. Reclamation does not propose any operational changes on the LFCC from what is described as historical maintenance in the MRG Maintenance Baseline (Part I, Section 4.2) with the exception of the distinction between safety mowing and vegetation control mowing and check structures built of rock throughout the channel. In many locations, the LFCC is the lowest point in the valley, and it provides drainage benefits for developed areas and protects infrastructure by collecting ephemeral storm runoff, irrigation return flows, and seepage water from the river. The LFCC, as part of the existing baseline in the perched reaches of the river, can increase seepage from the river and contribute to drying. The seepage rates from the river into the LFCC appear to be largest when the river stage is high and smallest when the stage is low.

Maintenance of the LFCC includes, but is not limited to, the following activities. For all of these activities, the general BMPs described in Section 1.6.4.5 are used.

- **Vegetation Control**: Vegetation control would occur within the area defined between the fence line west of the LFCC or from 20 feet west of the road (where applicable with no fence line) or the top of slope on the western edge of the LFCC channel (where no fence line or roads exist) and the eastern toe of slope on the levee between the river and the LFCC. Vegetation control, or mowing, can impact any vegetation along the 57-mile length of the LFCC. If mature cottonwoods are impacted, mitigation will take place at a ratio of 10 to 1. Vegetation control described herein is not intended for the Rio Grande channel. Mowing will typically be done with a radial blade mounted to a excavator or other heavy equipment and can impact a maximum of 4,390 acres (670 average lateral feet between the western edge of mowing specified above to the furthest toe of slope on the eastern levee over the course of 57 LFCC miles) every 3 calendar years. In a given calendar year, only one-third of the total LFCC length will be mowed, an average of 1,472 acres per year. This one-third rotational mowing was a commitment from an earlier ESA section 7 consultation (#2-22-96-1-069). The harvesting of vegetation is considered a subset of maintenance work done under the parameters and within the impact acreage of the described LFCC maintenance for vegetation control. Acres of impact of mowing within the LFCC corridor, related to supplemental pumping operations, also described in this BA, are not intended to be counted against the proposed mowing acreage totals outlined here. Mowing will not take place April 15–August 15, or September 1 in suitable cuckoo habitat, due to guidelines set forth in the Migratory Bird Treaty Act of 1918 and for ESA-specific considerations. The restrictions on mowing also benefit the flycatcher because the LFCC provides a potential migration corridor. On occasion, circumstances may warrant an exception to these dates, in which case, Reclamation biologists will be consulted to ensure endangered or threatened avian species will not be disturbed as a result of mowing or other vegetative clearing.

- **Safety Mowing**: In addition to the vegetation control mowing, Reclamation will annually safety mow the eastern slope of the LFCC (between the LFCC channel and the road) from Neil Cup (RM 90) to Ft Craig (RM 64). The vegetation will be mowed level with the road to provide a safe line of sight. This will still provide some habitat as much as 9 feet high at the deepest part of the channel. Also, understory vegetation within existing cleared areas of the four outfall channels/pipeline areas (Neil Cup, North Boundary BDA, South Boundary BDA, and Ft. Craig) will be cleared no greater than 150 feet away from the center of the drainage channel in the area between the river and the levee road. No mowing or clearing will take place between April 15 and August 15, or September 1 in suitable cuckoo habitat, due to guidelines set forth in the Migratory Bird Treaty Act of 1918 and for ESA-specific considerations.

- **Removal of Material**: This activity covers the removal of sediment, trash, and incidental vegetation such as gathered tumbleweeds and growing cattails from the LFCC channel to a degree that would allow adequate conveyance of water, which may be considered the original design geometry of the channel. This action would alleviate overbank flooding in areas of the LFCC where seasonal debris flows combine with large amounts of sediments in the LFCC. Proposed sediment removal can be either done with heavy excavating machinery or with vacuum-operated dredging. Reclamation proposes to remove sediment and any other material at any point along the LFCC between San Acacia Diversion Dam and Reclamation's established rangeline EB 34.5 (an approximate in-channel wetted area of 1,475 acres). Rangeline EB 34.5 is approximately 1.25 miles downstream from the Ft Craig Power lines and about 0.8 mile upstream of the Elephant Butte Full Pool Reservoir Level. Sediment removal described herein is intended only in the LFCC and not the Rio Grande. The area between Neil Cupp and rangeline EB 34.5 is the most frequent location where the highest amount of sedimentation in the channel and overbank flooding occurs (approximate wetted area of 920 acres). Sediment and other material removal will take place outside of the April 15–August 15 dates established in the Migratory Bird Treaty Act, or September 1 in suitable cuckoo habitat due to ESA-specific considerations. When emergency work is necessary that requires the removal of sediment and/or other material from the channel, work may have to be done at any point in the calendar year. In this case, the ESA emergency process will be followed and Reclamation biologists will be contacted to consult with the Service to ensure endangered or threatened avian species will not be disturbed as a result of this activity.

- **Road Maintenance:** Road maintenance on either side of the LFCC, including levee roads, will include routine grading, graveling, toe channel, and washout repairs. Maintenance of existing LFCC O&M roads and the spoil levee road is accomplished with typical heavy machinery including graders, excavators, bulldozers, and hauling equipment. The total road acreage between the San Acacia Diversion Dam and the Full Pool Elephant Butte Reservoir Level is estimated to be 788 acres. On average, Reclamation does not intend to maintain any more than 80 lateral miles of road in any given year, typically done in the winter season. Due to fluctuations of funding and availability of personnel and equipment, Reclamation could conceivably do maintenance activities on the entire stretch between the San Acacia Diversion Dam and the Full Pool

Elephant Butte Reservoir Level. While work typically is proposed to be done in the winter season, heavy precipitation during spring and summer may extensively damage any road and require immediate and extensive maintenance of the roads.

- **Structure Maintenance:** Maintenance of concrete bridges, siphons, and check structures in the LFCC corridor is only proposed as inspections dictate. Typical maintenance includes facility inspections, upkeep of metal work (painting, repairs, etc., to prevent rust), erosion protection along bridge abutments, vegetation clearing around structure, and adding material (soil and gravel) to maintain the slope of the roads approaching the structure. When foreseen maintenance is anticipated, work will be coordinated outside of the Migratory Bird Treaty Act dates of April 15–August 15, or September 1 in suitable cuckoo habitat due to ESA-specific considerations. Concrete bridges on the LFCC include those at San Acacia Diversion Dam, RM 111, Highway 1280, Brown Arroyo, Mid-Bosque del Apache, South Boundary, Ft. Craig, Nogal Canyon, and San Marcial. Routine maintenance also may include work on LFCC siphons at Brown Arroyo and the Socorro North Diversion Channel. As these structures are associated with the LFCC, which contains water nearly year-round at any given point along its length, work will likely be done while water is present and under supervision of Reclamation biologists using techniques that will limit disturbance of water and sediments in the LFCC. Work done on these structures typically will be carried out with common heavy equipment such as excavators, dump trucks, concrete trucks, and others.

1.7.2 Project Drain Proposed Actions

MRG project authorization provides for Reclamation (Reclamation 1947, 2003b) to perform irrigation and drain rehabilitation. The majority of these drains and irrigation facilities in the MRG are currently operated and maintained by MRGCD. There are a few drains, however, that MRGCD does not maintain and that benefit the State by increasing water salvage, thereby assisting the State in fulfilling the Rio Grande Compact requirements.

Irrigation drain improvements include routine maintenance of the following drains: Drain Unit 7, Drain Unit 7 Extension, San Francisco Drain, San Juan Drain, La Joya Drain, Escondida Drain, and Elmendorf Drain. Other drains or irrigation facilities may be added for routine maintenance as circumstances change. Maintenance activities include dredging, removing vegetation, mowing, placing riprap, maintaining earthwork on drain side slopes, repairing hydraulic structures, maintaining roads, repairing and installing culverts, repairing fences and gates, removing unauthorized crossings, and adjusting drain alignments. Drain maintenance work can occur at any time of year, although work in the vicinity of flycatcher/cuckoo nest sites is limited to portions of the year when the birds are not present. On occasion, circumstances may warrant an exception, in which case Reclamation biologists will be consulted to ensure that endangered or threatened avian species will not be disturbed as a result of this activity.

Additionally, areas near occupied Pecos sunflower habitats will be surveyed prior to any work. If Pecos sunflower are present within the needed maintenance area, Reclamation will work with the Service to avoid impact to the sunflower populations. The maintenance work typically involves the following construction equipment: mowers, excavators, scrapers, motor graders, loaders, water trucks, fuel trucks, bulldozers, and dump trucks.

Drain dimensions are shown in Table III-14. The actual dimensions vary throughout the length of the drain; the dimensions stated in the table are typical of the portions of the drain that are largest.

Table III-14. State drain dimensions

Drain	Length (feet)	Channel Width (feet)	Corridor Width (feet)
Drain Unit 7	30,000	50	150
Drain Unit 7 Extension	68,000	50	200
San Francisco	42,000	50	175
San Juan	87,000	50	150
La Joya	37,000	50	150
Escondida	18,000	40	120
Elmendorf	70,000	50	200

In a typical year, maintenance on these seven drains encompasses up to 50 acres of channel work in the wet and up to 200 acres of channel corridor (drain slope, O&M roads, spoil levees, and bar ditches) in the dry. The usual duration of maintenance is 2–4 months, but longer projects (up to 8 months) may occasionally be undertaken.

1.7.2.1 Typical Drain Maintenance Implementation Techniques

Typical implementation techniques used in drain maintenance are described below. The general BMPs described in Section 1.6.4.5 are used on drain maintenance projects. Methods specific to drain maintenance are described below.

1. *Material Placement* – This technique involves placement of construction material (typically rock or earth material) along the side slopes or invert of the drain, usually to fill in areas where erosion has occurred. The drain is thereby restored to its original geometry. Fill material is placed with an excavator or a loader.

2. *Dredging* – Sediment, aquatic vegetation, and other material is removed from the bottom of the drain and placed along the edge of the spoil levee or along the side of the maintenance road.

3. *Mowing* – Weeds and woody vegetation are removed from the side slopes of the drain, usually by a mower that drives along the edge of the drain. Larger woody vegetation may need to be removed with excavators with a thumb attachment. Additional mowing or mastication can occur within the entire width of the drain corridor.

4. *Hydraulic Structure Repairs* – Damaged hydraulic structure (such as culverts, inverted siphons, and hydraulic gates) in the drains are repaired as necessary. This may involve welding, as well as removing and replacing sheet pile, concrete, and other components of the structure. Earthwork to expose portions of the structures for maintenance and then cover them afterward may be necessary. New structures occasionally may be installed, and existing structures may be removed.

5. *Fence and Gate Work* – Fences and vehicle gates within the drain corridor periodically will be repaired, removed, and installed.

6. *Removing Unauthorized Crossings* – Culverts and bridges installed by landowners without authorization from Reclamation may be removed if they are negatively affecting the function of the drain or causing an undesirable increase in public access.

7. *Alignment Adjustments* – If the drain has changed its alignment through erosional processes, the original alignment may be restored through excavation and fill placement. Additionally, short sections of the drain may be relocated within the existing right-of-way as necessary to improve functionality. Drain realignment is accomplished with excavators, bulldozers, scrapers, loaders, dump trucks, and water trucks.

8. *Road Maintenance* – Service roads along the drains are maintained to ensure public safety and continued access. Road maintenance includes grading, placing fill material, removing vegetation, and gravel surfacing. Repairs and installation of drainage culverts also occur. Road maintenance work is performed primarily using motor graders, water trucks, and mowers, with occasional use of loaders, bulldozers, excavators, and dump trucks.

1.7.3 Summary of Other Reclamation MRG Project Proposed Maintenance Actions

Table III-15 summarizes the annual project footprint acreage for proposed other MRG Project maintenance activities as previously described above. Values in Table III-15 were calculated using the range of impact acreage described throughout Section 1.7. The calculation methodology and input data are described below.

- Annual analysis period.

- Analysis period is used to estimate approximate numerical values for the purpose of facilitating an ESA impact but is not expected to represent the desired ESA compliance period.

- Minimum acreage was assumed to be 0 acres, as it is plausible that no maintenance work may be performed.

- For Project drains, the typical annual maintenance was assumed to represent the average scenario.

- For Project drains, the maximum scenario was represented by two times the typical annual maintenance. A 40-foot width for the LFCC.

- For structural maintenance on the LFCC, the following scenarios were assumed:
  - Average scenario: 1 site per year.
  - Maximum scenario: 2 sites per year.
  - Site impact area for structural maintenance: 1 acre.
  - Structural maintenance may occur in the wet or dry.

Table III-15. Annual approximate other Reclamation MRG project maintenance acreage

	Average	Minimum	Maximum
Wet, LFCC	149	0	1,477
Dry, LFCC	1,736	0	5,180
Wet, Project Drains	50	0	100
Dry, Project Drains	200	0	400
Total	**2,135**	**0**	**7,157**

1.8 The MRGCD Proposed Maintenance Actions

The MRGCD constructs, maintains, modifies, repairs, and replaces irrigation and flood control structures and facilities throughout its boundaries to ensure the proper functioning of these facilities for their intended purpose. Maintenance typically involves vegetation control or removal, debris removal, earthwork, sediment removal, concrete work, cleaning, painting, etc. Repair, replacement, and modification typically involve earthwork and concrete work. These MRGCD activities may be divided into four broad categories as follows: (1) regular ongoing activities, (2) regular as-needed activities, (3) exceptional as-needed activities, and

(4) exceptional emergency activities. These facilities may be located within, or external to, designated critical habitat for the species.

The use of sprays may be necessary to control undesirable plant species on the slopes of irrigation facilities, access roadways, right-of-ways, boundary fences, and facility buildings to control aquatic vegetation in irrigation facilities and to prevent the spread of invasive species in areas cleared for maintenance activities. It also may be necessary to spray or control for arthropods (spiders, ants, cockroaches, and crickets) that pose a safety problem or are a nuisance in buildings and facilities, for example, birds (pigeons and swallows) roosting in building structures that are considered a nuisance, mice that get into structures and/or equipment, and mammals, like muskrat or beavers that create plugs within irrigation facilities. Because the application of herbicides and chemical spraying is tightly controlled by state and federal agencies, MRGCD will follow all state and federal laws and regulations applicable to the application of herbicides, including guidelines described by White (2007).

1.8.1 Regular Ongoing Activities

These are regular functions associated with keeping the irrigation system operating properly. These activities occur regularly, and often with great frequency. They will be performed during every irrigation season; in many cases, they may happen daily. They typically are associated with particular locations within the MRGCD. Examples of these would be regulation of gates at diversions structures, debris and sediment removal at diversion structures, cleaning and painting of diversion structures, bank and access road maintenance at diversion structures, mowing/ cleaning/debris removal from wasteway and drain outfalls, grading of access roads at wasteway and drain outfalls, grading and repair of levees, construction and maintenance of measurement stations on wasteway and drain outfalls, etc.

1.8.2 Regular As-Needed Activities

These are less regular functions associated with keeping the irrigation system operating properly. They are performed in response to observed changes over time, such as erosion happening along facilities. They may occur at anytime and anywhere throughout the MRGCD, but generally are not expected to occur frequently. Examples of these would include levee repair, realignment of wasteway and drain outfall channels, replacement of diversion measurement or control structures, replacement of pipe crossings for access roads, etc.

1.8.3 Exceptional As-Needed Activities

These are occasional functions performed in response to an observed need or changed condition. These may occur at anytime and anywhere throughout the MRGCD, but are not expected to occur frequently. Examples of these would include construction or modification of recreational facilities, construction of wildlife habitat features, construction of new outfall channels, abandonment of unused outfall channels, construction or modification of river control features, construction of access roads, etc.

1.8.4 Exceptional Emergency Activities

These are MRGCD maintenance or repair activities associated with extreme or unexpected conditions that pose an immediate risk to human life or property. These are expected to be very infrequent, and hopefully never occur. Should they occur, however, immediate response is required. Examples of these types of activities include fire suppression efforts in riparian areas, levee repair during flood events, and sediment removal when required to prevent catastrophic flooding or major damage to irrigation structures. Under these circumstances, MRGCD would coordinate with Reclamation and proceed using the ESA emergency response process.

1.8.5 Best Management Practices

To minimize effects to species, MRGCD will designate certain geographic areas of the MRGCD where facility operation/maintenance/replacement/construction is expected to be frequent and ongoing and confine such activities to within those geographic boundaries.

Additionally, in geographic areas of the MRGCD where facility operation/maintenance/replacement/construction is expected to be less frequent, though still a part of regular operation, they will provide to the Service at the beginning of each year an inventory on the types of activities to be conducted in these areas. The MRGCD will conduct such activities in a manner designed to minimize impact to the species, will confine the footprint of activities within those geographic boundaries to the smallest practical extent, and will consider recommendations from the Service on how to best conduct these activities for the benefit of wildlife.

MRGCD will coordinate with Reclamation and the Service on exceptional activities occurring within the critical habitat to conduct these activities to produce the least possible impact to the species. When impacts are unavoidable, MRGCD will cooperate with Reclamation and the Service to provide appropriate mitigation measures.

When emergency actions are necessary to protect human life and property, MRGCD will follow the ESA emergency response process and coordinate with Reclamation and the Service as soon as is practical to minimize any potential impacts of these activities to the species.

1.9 The State of New Mexico Proposed Maintenance Actions

The State conducts habitat restoration activities in the MRG to benefit the listed species that are included in this BA. These habitat restoration activities occur at several sites along the MRG, as described in Table III-16. These activities are designed to benefit the listed species, and especially the silvery minnow through overbank habitat improvements, construction of spawning and rearing habitats, maintenance of habitats that are wetted during low-flow periods, bankline lowering and floodplain reconnection, and removal of nonnative vegetation to restore river processes.

The State employs seven fundamental techniques to restore habitats for the listed species, as described in Table III-17. Best management practices are used at each site to minimize adverse effects and maximize benefical effects to the listed species. Best management practices (BMPs, see also Section 1.6.4.5) include (1) working in after August 15 (or September 1 for work in suitable cuckoo habitat) to avoid affecting spawning, nesting, or rearing of young, (2) entering the water slowly, slowly ramping up activities, or removal of minnow to minimize the number of silvery minnow present in the construction zone, (3) having monitors present to observe and ensure minimal effects to listed species, and (4) returning sites to a condition that does not trap or otherwise harm or injure listed species, or for those sites where it is not possible to fully avoid risk of entrapment (e.g. side channels), monitor for entrapment.

Table III-16. State proposed habitat restoration sites

Conservation Measure	Description of Conservation Measure	Benefit to Listed Species and Critical Habitat
San Acacia Reach (Priority #1)	• Overbank habitat improvements from SADD to RM 100 will begin 2015-2016. Approximately 50 acres of backwater and ephemeral channels will be lowered to provide inundation at lower spring runoff flows (1,500 cfs) (**State with Reclamation, MRGCD**).	• This will create and maintain refugial habitat areas during periods of low and intermittent flows.
Isleta Reach (Priority #2)	• Sevilleta National Wildlife Refuge flycatcher and minnow habitat improvements being planned and implemented by a consortium of agencies including the 3 BA partners and the Service Sevilleta Refuge staff. Up to 80 acres of new habitat is planned 2015- 2017 (**State, Reclamation, MRGCD**). • Adaptive Management monitoring of Isleta habitat restoration includes maintenance and monitoring of new habitat restoration and existing habitat restoration near Los Lunas and Belen (**Reclamation, State**).	• The river near the Sevilleta is a perennial section of the Rio Grande due to the return flows from the Lower San Juan drain and other geomorphic factors. This section of the river is not highly developed and the presence of the La Jolla and Sevilleta wildlife refuges allow for protection and maintenance of habitat improvements. • Additional spawning and rearing habitats that are constructed in this section are expected to provide long term improvements for minnow. • In concert with some additional flycatcher habitat improvements in interior ponds of the Sevilleta, the removal of large monotypic tamarisk and planting of Gooddings and coyote willows with the preservation of cottonwood canopies by the refuge staff and the lowering and sculpting of overbank habitats will provide additional new habitat for flycatcher and cuckoo. • Refugial habitats are critical components for long term survival. It is anticipated that river drying will continue during summer and early fall in some sections of the Isleta Reach. Maintaining as many areas of wetted habitat and increasing the length and quality of the wetted habitat will provide the minnow with higher probability of survival. Minnow will have improved survival during ephemeral periods of channel drying if numerous sections of the Isleta Reach contain refugial habitats.
Angostura/Albuquerque Reach (Priority #3)	• Rio Rancho Habitat Restoration Phase II will be operational by spring 2016. Bankline lowering and floodplain reconnection is planned (**State**). • Atrisco Habitat improvements and O&M support a large and significant backwater and refugial habitat for minnow in the Albuquerque Reach. Continued testing and application to the Service for permitting of the site to be used as refugial habitat will occur in 2015–2016 (**State**).	• Addressing habitat needs above the South Diversion Channel to the Angostura Diversion Dam provides redistribution of sediment and can address some of the incision concerns in this section of the river. Rio Rancho restoration will be coupled with other existing efforts not described herein to provide minnow and flycatcher habitats. • The Atrisco large backwater was constructed near the Central Bridge on the west side that has been used by minnow during spring runoff. This habitat is being improved to allow for potential collection of fish after rearing.

Table III-16. State Proposed Habitat Restoration Sites

Conservation Measure	Description of Conservation Measure	Benefit to Listed Species and Critical Habitat
System-Wide Solutions for Habitat Improvements	• Habitat Monitoring Program established for habitat restoration and improvement of the GIS database to track habitat restoration (**Reclamation, State, MRGCD, and others through RIP**)	• The geomorphology of the river system is in disequilibrium or is controlled by physical barriers that reduce the natural evolution of habitats that support the listed species. • Better tracking and monitoring of habitat restoration projects should support improved decision-making for future restoration.

Table III-17. State techniques for habitat restoration

Restoration Technique	Description	Benefits of Technique
Passive restoration	No disturbance of river channel. Allows for higher-magnitude peak flows to accelerate natural channel-forming process and improve floodplain habitat.	Increases sinuosity and allows for development of complex and diverse habitat, including bars, islands, side channels, sloughs, and braided channels.
Evaluation and modification of islands and bars	Physical disturbance (discing, mowing, root-plowing, raking) of islands or bars to remove vegetation, allowing for the mobilization of island features during periods of high flow	Creates more complex habitat for silvery minnow by reducing average channel depth, widening the channel, and increasing backwaters, pools, eddies, and runs of various depths and velocities. Increased inundation would benefit native riverine vegetation, potentially increasing flycatcher habitat.
High-flow ephemeral channels	Construction of ephemeral channels on inlands and islands to carry flow from the main river channel during high-flow events	Creates shallow, ephemeral (normally dry), low-velocity aquatic habitats important for silvery minnow egg and larval development during high flow time periods. Increased inundation would benefit native vegetation, potentially increasing flycatcher habitat.
High-flow bank-line backwater channels and embayments	Cutting areas into banks where water enters, primarily during high-flow events, including spring runoff and floods	Intended to retain drifting silvery minnow eggs and to provide rearing habitat and enhance food supplies for developing silvery minnow larvae. Increased inundation would benefit native vegetation, potentially increasing flycatcher habitat.
Terrace and bank lowering	Removal of vegetation and excavation of soils adjacent to the main channel to create potential for overbank flooding	Could provide for increased retention of silvery minnow eggs and larvae. Increased inundation would benefit native vegetation, potentially increasing flycatcher habitat.
Removal of lateral confinements	Reduction or elimination of structural features and maintenance practices that decrease bank erosion potential.	Creates wider floodplain with more diverse channel and floodplain features, resulting in increased net-zero and low-velocity habitat for silvery minnow.
Woody debris	Placement of trees, root wads, stumps, or branches in the main river channel or along its banks.	Creates slow-water habitats for all life stages of silvery minnow, provides shelter from predators and winter habitat, and provides structure for periphyton growth to improve food availability for silvery minnow.

The following is a description and summary of each restoration technique:

- *Passive restoration*. When water is available, higher-magnitude peak flows are delivered through the MRG. This allows the energy in the river to accelerate natural channel-forming processes and improve floodplain habitat. These high flows redistribute sediment in the river channel, scour pool habitats, and remove nonnative vegetation that results in greater habitat diversity for listed species.

- *Evaluation and modification of islands and bars*. Many in-channel islands and bars are heavily overgrown with nonnative tamarisk and Russian olive. This technique employs physical disturbance (discing, mowing, root-plowing, raking) of islands or bars to remove vegetation, allowing for the mobilization of island features during periods of high flow. The mobilization of these features creates greater habitat diversity for listed species.

- *High-flow ephemeral channels*. Ephermeral channels flood during high flows and provide sheltered, productive habitats for silvery minnow. This technique involves construction of ephemeral channels on inlands and islands to carry flow from the main river channel during high-flow events and provide low-velocity habitats for shelter and feeding.

- *High-flow bank-line backwater channels and embayments*. Years of river confinement have disconnected the floodplain from the main river channel. Floodplains provide productive sheltered habitats at high flow that are important nursery areas for silvery minnow. This techniuque involves cutting areas into banks where water enters, primarily during high-flow events, including spring runoff and floods to reconnect parts of the floodplain and peripheral low-lying areas.

- *Terrace and bank lowering*. Another technique used to reconnect the floodplain is the removal of vegetation and excavation of soils adjacent to the main channel to create potential for overbank flooding. This creates important habitats for shelter, feeding, spawning and nursing by silvery minnow during high-flow events.

- *Removal of lateral confinements*. Reduction or elimination of structural features (e.g., jetty jacks) allows the river to restructure habitats during high flow. Where needed, this technique is employed with maintenance practices that decrease bank erosion potential.

- *Woody debris*. Woody debris is an important habitat features in the MRG as cover for silvery minnow and habitat for a greater diversity of aquatic insects than adjacent sandy areas. Woody debris, such as root wads also create scour zones that produce pool habitats for fish. This technique involves placement of trees, root wads, stumps, or branches in the main river channel or along the banks.

2. Analysis of Effects of Proposed Actions

The discussion of effects in this document is divided into several sections. The first two sections are general in nature and attempt to broadly define the impacts of river maintenance (Sections 2.1 and 2.2) on a large-scale, reach basis. The impacts of implementing river maintenance strategies on a reach level are discussed in Section 2.1. The implementation of river maintenance strategies (Section 1.2) within a reach is designed to address observed trends resulting from underlying physical processes. The general geomorphic impacts of implementing the six river maintenance strategies are described in Section 2.1.1 and in the Strategy Effects (Appendix E), with additional reach implementation geomorphic details provided in Section 2.1.2. The biological effects on the silvery minnow and the flycatcher/cuckoo are described in Section 2.1.3 based on the known channel dynamics (observed geomorphic channel trends) and the anticipated channel responses to strategy implementation. The anticipated channel responses and conditions may change if the observed geomorphic trends adjust in the future.

River maintenance sites, within the context of this BA, may be implemented as individual sites within the context of a reach-based river maintenance strategy or as a priority site project. These two types of activities may use the same river maintenance methods (Section 1.3) and implementation techniques (Section 1.6.4.5). They also both rely on a variety of river maintenance support activities (Section 1.6.4). The implementation of individual river maintenance site projects has localized effects on geomorphology, endangered species, and habitat conditions. The localized geomorphic effects of river maintenance methods are described in Section 2.2. Biological effects for both silvery minnow and flycatchers/cuckoos are estimated based on the amount and distribution of work that has been performed historically or as predicted by the river maintenance Proposed Action. These effects are analyzed throughout Section 2.2. Currently, the only recognized Pecos sunflower population within the defined river maintenance action area is on the Rhodes property south of Arroyo de las Cañas. Reclamation will work with the Service to avoid impact to the sunflower populations on any river maintenance activities that would affect the Pecos sunflower population.

Section 2.3 describes the biological and geomorphic effects from operation and maintenance of Project drains and the LFCC. Pecos sunflower effects are analyzed in conjunction with the Project drain near La Joya State Wildlife Area (Section 2.3.2.3), as there are currently no known Pecos sunflower populations within the floodplain of the Rio Grande.

MRGCD MRG maintenance proposed actions are analyzed within Section 2.4. A summary of all MRG biological effects is provided in Section 2.5.

2.1 River Maintenance Strategy Effects on Geomorphology

Strategies define reach-scale management approaches to meet the river maintenance goals (Section 1.2). Strategies were assessed by geomorphic suitability for a reach. More information on the identification of the most likely strategies by reach and the rationale for why strategies are listed as unsuitable in a reach can be found in the *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a). Only strategies that were determined to be suitable are described in this document. The following general (Section 2.1.1) and reach by reach (Section 2.1.2) sections describe the effects of suitable river maintenance strategies given the current geomorphic reach trends. Estimated effects on silvery minnow and flycatcher/cuckoo habitat due to implementation of these strategies are outlined later in this chapter. It should be noted that future geomorphic trends of the river could change, and the selection of suitable strategies could be different.

General strategy effects on the geomorphology are described based on the expected outcome of the change in the balance between sediment transport capacity and sediment supply within a reach after implementation. Where the probable magnitude of an effect is known, it is stated. The balance between sediment transport capacity and sediment supply affects channel processes and strongly influences geomorphic changes and conditions. An imbalance between sediment transport capacity and sediment supply is the key cause of most channel and floodplain adjustments. These are evinced in the river through changes in trends. Complementary strategies are those that create similar changes, relative to the balance between sediment transport capacity and sediment supply and could be used to address the same trends. Complementary strategies are also strategies that more likely are to be used in combination. Effects of multiple strategy combinations are not described explicitly, but the use of combinations from complementary strategies generally would produce the same described effects.

Reaches where sediment transport capacity is generally less than sediment supply are the reaches between Arroyo de las Cañas and the Full Pool Elephant Butte Reservoir Level. For these reaches, changes and corresponding strategies that bring sediment transport capacity closer to sediment supply include the following:[1]

- Increase sediment transport capacity – Reconstruct/maintain channel capacity
- Reduce sediment supply – Manage sediment

[1] "Promote elevation stability" is an applicable strategy for aggrading reaches; however, the actual implementation would be through the complementary strategies of "Reconstruct/maintain channel capacity," "Increase available area to the river," "Manage sediment," and/or "Promote alignment stability."

- Allow channel realignment to lower bed elevation – Increase available area to the river, Promote alignment stability
- Initiate channel realignment to lower elevation – Reconstruct/maintain channel capacity
- Levee strengthening/raising to allow realignment – Reconstruct/maintain channel capacity

Reaches where sediment transport capacity is generally greater than sediment supply are the reaches between Velarde and Otowi Bridge and between Cochiti Dam and Arroyo de las Cañas. For these reaches, changes and corresponding strategies that bring sediment transport capacity closer to sediment supply include the following:

- Increase length of channel – Promote alignment stability, Increase available area to the river
- Limit bank erosion – Promote alignment stability
- Add sediment supply – Manage sediment
- Reduce sediment transport capacity of high flows – Rehabilitate channel and floodplain
- Reduce or control future channel bed lowering – Promote elevation stability

2.1.1 General River Maintenance Geomorphic Effects

The geomorphic effects of implementing river maintenance strategies (Section 1.2 provides a description of the strategies) are estimated through an analysis of the expected physical changes in a reach as a result of strategy implementation. While the effects are described qualitatively, several tools were developed and used to aid in understanding the observed river trends and the strategy implementation effects on these trends on a reach by reach basis. These tools include mobile and fixed bed modeling (Varyu et al. 2011), meander belt analysis (Varyu et al. 2011), and the MRG planform evolution model (Massong et al. 2010). Results from these tools helped provide a qualitative understanding of the existing conditions and expected trajectory of reach adjustments without maintenance. The results also provided a means to assign and evaluate the effects of strategy implementation through a comparison of modeled physical results, such as:

- Bed elevation changes
- Floodplain inundation changes
- Bed material size changes
- Channel length changes
- Lateral mobility and its relationship with existing lateral constraints

- Sediment load changes
- Geomorphic planform changes

For the reaches between Cochiti Dam and the Full Pool Elephant Butte Reservoir Level; the modeling and analysis tool results (Varyu et al. 2011, Reclamation, 2012a) were coupled with professional judgment and individual reach geomorphology to provide a qualitative description of the reach implementation effects of river maintenance strategies. This description relies on the different methods that will be used to implement reach based strategies (see River Maintenance Methods (Appendix C) for a description of localized methods associated with a strategy and a description of those methods and their general effects). The general method effects are combined with strategy characteristics to create a general description of the effects. These general effects are then refined to reach specific effects (Section 2.1.2). Professional judgment and an understanding of reach trends were used to provide a qualitative description of the geomorphic effects of river maintenance strategies for the 10 reaches.

The Strategy Effects in Appendix E provides a list, by strategy, of the general reach trends addressed (not in order of importance), the effects of implementing each strategy in a reach, additional potential complementary strategies that address the same trends, and effects of strategy implementation in downstream and upstream reaches. Strategies address observed geomorphic trends through four primary actions: stopping, reducing, reversing, and making it a non-issue. The first three are straightforward actions related to the strategy effect on the trend, given the current understanding on the MRG. The last one allows the trend to continue, while reducing the need for river maintenance. The Strategy Effects in Appendix E provides a further separation of strategy implementation and ensuing effects by the relationship between sediment transport capacity and sediment supply, as the outcomes are different if the sediment transport capacity is greater than or less than the sediment supply. If a strategy only lists one condition, such as sediment transport capacity less than sediment supply for “Reconstruct and maintain channel capacity,” then it can be assumed that this strategy is not applicable to the other condition—in this case, sediment transport capacity greater than sediment supply. These are general reach effects, so there may be uncertainty in the magnitude of physical effect. Where the probable magnitude of physical effect is known, it is so stated.

2.1.2 Most Likely Geomorphic Strategy Effects by Reach

Strategies that address geomorphic trends, and thus are the most likely to be implemented, have been identified in the Proposed Action by reach (Section 1.2.8). Where potential future geomorphic trends influence the effect of strategy implementation, they are included in each reach effects description. These potential future trends are identified through analysis of patterns of historical changes, results from Varyu et al. (2011), the planform evolution model (Massong et al. 2010), and professional judgment. Where the probable magnitude of an effect is known, it is stated. Where the magnitude of effect is uncertain, more information is needed to estimate it; this would be developed, tiered off this programmatic river maintenance BA and coordinated with the Service.

Some general strategy effects are included in each reach strategy effects discussion where they are of much more significance than other general effects. It is possible that future geomorphic trends of the river could change so that additional strategies would become suitable for a reach or the converse. The 10 reaches are identified and shown graphically in Part I, Chapter 2. Estimated effects on silvery minnow and flycatcher/cuckoo habitat due to implementation of these strategies in each reach are outlined later in this document.

2.1.2.1 Velarde to Rio Chama – RM 285 to 272

2.1.2.1.1 Trends

This reach has been influenced by historical activity and past variability in the sediment and hydrology, resulting in a floodplain that is absent or disconnected from the main channel. Historical conditions and current hydrological inputs upstream and sediment inputs from tributaries located within this reach have contributed to the following trends currently observed in this reach.

- Channel narrowing
- Vegetation encroachment
- Bank erosion
- Coarsening of bed material
- Increased channel uniformity

2.1.2.1.2 Promote Elevation Stability

This strategy is not suitable because there is a low potential for new degradation.

2.1.2.1.3 Promote Alignment Stability

Reach Effects – In general, this strategy addresses the trend of bank erosion through stabilizing the banks and preventing additional bank erosion that would harm or endanger public infrastructure, such as roads, irrigation facilities, houses, etc. The narrowness of this reach and the proximity of infrastructure likely would result in using a more direct and permanent bank protection method. Field observations show bank erosion opposite some new tributary deposits in the main channel. The general effects of this method implemented on a reach scale, for the sediment transport capacity greater than sediment supply case, are described in Table 1 of the Strategy Effects (Appendix E). However, in this reach, the contribution of sediment from bank erosion is relatively low due to low rates of bend migration. Therefore, a decrease in sediment supply is not expected to have significant effects. This strategy likely would keep the current conditions for sinuosity and overbanking wetted area. Within this reach, there are numerous diversion dams that provide vertical stabilization through their effect on the river bed elevation. These diversion dams, to some extent, also help provide local alignment stability, as bank protection is typically provided in close vicinity to the dams, upstream and downstream, to prevent flanking.

Upstream and Downstream Effects – The general upstream and downstream effects are listed in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The sediment supply for the Rio Chama to Otowi Bridge Reach may decrease slightly, but effects are expected to be minimal. For the reach north of Velarde, it is not expected that there would be significant upstream effects.

2.1.2.1.4 Reconstruct and Maintain Channel Capacity

This strategy is not suitable because a reach-wide loss of channel capacity is not expected.

2.1.2.1.5 Increase Available Area to the River

Reach Effects – In general, this strategy addresses channel narrowing, increased bank height, and bank erosion. The effects of this strategy would be to increase the degrees of freedom on the channel, as described in Table 4 of the Strategy Effects (Appendix E), for the sediment transport capacity greater than sediment supply case. This allows for the possibility to increase the sinuosity and the overbanking wetted area by allowing the channel to migrate and create new depositional features. This channel evolution also may create the opportunity to decrease high-flow energy that may have the effect of decreasing the bed material size.

Upstream and Downstream Effects – Implementing this strategy will provide additional area for future river migration but will not immediately affect current downstream or upstream reach trends. The general upstream and downstream effects are listed in Table 4 of the Strategy Effects in Appendix E for the sediment transport capacity greater than sediment supply case. The Rio Chama to Otowi Bridge Reach has an existing sediment transport capacity greater than sediment supply, so the Rio Chama to Otowi Bridge Reach effects of adding sediment are expected to be minimal. If the bank material is fine enough, this strategy may deliver increased sediment load to the Cochiti Reservoir pool and have an impact on its serviceable life. Over time as the channel evolves nearer to dynamic equilibrium, downstream sediment supply from lateral migration will decrease. It is expected that the reduced sediment supply in the long term would have minimal effect on channel trends in the Rio Chama to Otowi Bridge Reach. The reach north of Velarde is outside the MRG Project area and is strongly influenced by geologic controls. Actions in the Velarde to Rio Chama Reach are expected to have minimal upstream effects for the reach north of Velarde. Near the upstream boundary on the Velarde to Rio Chama Reach is the Los Chico and La Canova Diversion Dam that effects bed elevation and river location and further limits effects upon the reach north of Velarde.

2.1.2.1.6 Rehabilitate Channel and Floodplain

Reach Effects – In general, this strategy addresses channel narrowing, vegetation encroachment, and bank erosion. This strategy would increase the overbanking wetted area and may increase the channel sinuosity. This strategy also would have the general effects as described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. This strategy also may increase the braiding within the reach; however, sediment loads are relatively small, so this effect is expected to be minimal. In the long term, this strategy may reduce the high-flow sediment transport capacity.

Upstream and Downstream Effects – Implementing this strategy has the general upstream and downstream effects as described in Table 5 of the Strategy Effects in Appendix E for the sediment transport capacity greater than sediment supply case. The Rio Chama to Otowi Bridge Reach has an existing transport capacity greater than supply, so the downstream reach effects of the addition of sediment are expected to be minimal. If the bank material is fine enough, this strategy may deliver increased sediment load to the Cochiti Reservoir pool, although the increase to the sediment supply is expected to be small and would be expected to have only a minimal impact on the reservoir pool’s serviceable life. Some methods also may induce sediment deposition, thereby decreasing downstream sediment supply. In comparison to downstream reaches, the sediment load in the Velarde to Rio Chama Reach is small, so this effect on the Rio Chama to Otowi Bridge Reach is expected to be minimal. It is expected that the reduced sediment supply in the long term would have minimal effect on channel trends in the Rio Chama to Otowi Bridge Reach. The upstream reach effects, for the reach north of Velarde, are expected to be minimal as described in Table 5 of the Strategy Effects in Appendix E for the sediment transport capacity greater than sediment supply case.

2.1.2.1.7 Manage Sediment

This strategy is not suitable because there is no reach-wide imbalance in sediment transport capacity and sediment supply.

2.1.2.2 Rio Chama to Otowi Bridge – RM 272 to 257.6

2.1.2.2.1 Trends

This reach has been influenced by historical activity and past variability in the sediment and hydrology, resulting in the abandonment of a once relatively large floodplain. Historical conditions and current hydrological inputs upstream and sediment inputs from tributaries located within this reach have contributed to the following trends currently observed in this reach:

- Channel narrowing
- Vegetation encroachment
- Bank erosion
- Coarsening of bed material
- Increased channel uniformity

2.1.2.2.2 Promote Elevation Stability

Reach Effects – In general, this strategy addresses the trends of increased bank height, incision or channel bed degradation, and coarsening of bed material. The general effects of this method implemented on a reach scale are described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. This strategy is expected to maintain the status quo for overbanking wetted area and sinuosity, although there is the possibility, depending on how the strategy is implemented, to increase the overbanking wetted area. The additional overbanking wetted area likely would be small because the expected maximum increase in bed elevation through implementing this strategy is 1–2 feet. In local areas where the bed elevation is below riparian vegetation root zone, additional bank erosion could occur. This strategy would help stabilize the bed in the reach and also may provide additional bank stability.

Upstream and Downstream Effects – The general upstream and downstream effects are as described in Table 1 of the Strategy Effects in Appendix E for the sediment transport capacity greater than sediment supply case. This strategy may decrease the amount of sediment available for the river to transport through the White Rock Canyon Reach. This reach has considerable geological controls, and effects from this strategy in the White Rock Canyon Reach are expected to be minimal. For the Velarde to Rio Chama Reach, this strategy may temporarily lower the sediment transport capacity. The bed through the Velarde to Rio Chama Reach may rise slightly, especially on the southern end of the downstream reach, with a minimal change expected in channel morphology and floodplain connectivity. The effects of implementing this strategy in the Rio Chama to Otowi Bridge Reach also may have the effect of a short-term bed material fining in the Velarde to Rio Chama Reach.

2.1.2.2.3 Promote Alignment Stability

Reach Effects – In general, this strategy addresses the trend of bank erosion through stabilizing the banks and preventing additional bank erosion that would harm or endanger public infrastructure, such as roads, irrigation facilities, recreational facilities, houses, etc. The general effects of this method implemented on a reach scale are described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. However in this reach, due to low rates of lateral migration, the contribution of sediment from bank erosion is relatively low. Therefore, a decrease in sediment supply from bank erosion is not expected to have significant reach geomorphic effects. This strategy likely would keep the status quo for sinuosity and overbanking wetted area.

Upstream and Downstream Effects – The general upstream and downstream effects are as described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The sediment supply to the White Rock Canyon Reach may decrease slightly, but effects are expected to be minimal due to the extent of geological controls in the downstream reach. The downstream reach also feeds into the Cochiti Reservoir pool, so implementing this strategy in the Rio Chama to Otowi Bridge Reach may help to lengthen the reservoir life. It is not expected that there would be significant effects in the Velarde to Rio Chama Reach.

2.1.2.2.4 Reconstruct and Maintain Channel Capacity

This strategy is not suitable because a significant loss of channel capacity is not expected.

2.1.2.2.5 Increase Available Area to the River

Reach Effects – In general, this strategy addresses channel narrowing, bank erosion, and increased channel uniformity. The effects of this strategy would be to increase the degrees of freedom on the channel, as described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. This allows for the possibility to increase the sinuosity and the overbanking wetted area by allowing the channel to migrate and create new depositional features. This channel evolution also may create the opportunity to decrease high-flow energy that may have the effect of decreasing the bed material size.

Upstream and Downstream Effects – Implementing this strategy will provide additional area for future river migration but will not immediately affect current downstream or upstream reach trends. The general upstream and downstream effects are as described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. This strategy may increase the sediment supply to the White Rock Canyon Reach as the channel lengthens. Over time and as the channel evolves nearer to dynamic equilibrium, the White Rock Canyon Reach sediment supply from lateral migration will decrease. The White Rock Canyon Reach has significant geological controls, so minimal changes are expected in the local channel morphology or floodplain connectivity. If the bank material is fine enough, this strategy may deliver a small increase in sediment load to the Cochiti Reservoir pool and would be expected to have only a minimal impact on the reservoir pool’s serviceable life. In the Velarde to Rio Chama Reach, there is the potential for this strategy to decrease the channel sediment transport capacity and/or reduce bed material size. However, this potential change is expected to have minimal effect on the channel morphology and floodplain connectivity.

2.1.2.2.6 Rehabilitate Channel and Floodplain

Reach Effects – In general, this strategy addresses channel narrowing, vegetation encroachment, bank erosion, and increased channel uniformity. This strategy would increase the overbanking wetted area and may increase the channel sinuosity. This strategy also would have the general effects as described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. This strategy may increase the braiding within the reach. In the long term, this strategy may reduce the high-flow sediment transport capacity, but the effect may diminish as sediment deposits in the overbank area and the high-flow channel becomes narrower.

Upstream and Downstream Effects – Implementing this strategy has the general upstream and downstream effects as described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The White Rock Canyon Reach has significant geological controls, so the downstream reach effects of the addition of sediment are expected to be minimal. The White Rock Canyon Reach geology has a controlling effect on the bed elevation and river location of this reach. If the bank material is fine enough, this strategy may deliver increased sediment load to the Cochiti Reservoir pool, although the increase to the sediment supply is expected to be small and would be expected to have only a minimal impact on the reservoir pool's serviceable life. Some methods also may induce sediment deposition, thereby decreasing the White Rock Canyon Reach sediment supply. In comparison to downstream reaches, the sediment load in the Rio Chama to Otowi Bridge Reach is small, so the effect in the White Rock Canyon Reach is expected to be minimal. In the Velarde to Rio Chama Reach, the potential exists for this strategy to decrease the channel sediment transport capacity and/or reduce the bed material size; however, the effect upon channel morphology and floodplain connectivity is expected to be minimal.

2.1.2.2.7 Manage Sediment

This strategy is not suitable because there is not a reach-wide imbalance in sediment transport capacity and sediment supply.

2.1.2.3 Cochiti Dam to Angostura Diversion Dam – RM 232.6 to 209.7

2.1.2.3.1 Trends

This reach is strongly influenced by the storage of the upstream sediment load in Cochiti Reservoir and coarse bed material sizes that have retarded incision. Bed material sediment load primarily is supplied from ephemeral tributaries and bank erosion. These sand and gravel sediments are mobilized at higher flows and deposit downstream on active mid-channel and bank-attached bars. The historical floodplain is hydrologically disconnected from the river because of reduced flow peaks and channel bed lowering. Cochiti Dam will continue to reduce sediment supply and high-flow peaks in this reach. Channel evolution due to the closure of

Cochiti Dam has largely already occurred, and the following trends likely are to continue but potentially at a slower rate than other reaches of the MRG:

- Channel narrowing
- Vegetation encroachment
- Bank erosion
- Coarsening of bed material
- Increased channel uniformity

2.1.2.3.2 Promote Elevation Stability

Reach Effects – The general effects of this method implemented on a reach scale are as described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. This strategy addresses the trends of incision or channel bed degradation, increased bank height, and coarsening of bed material. This strategy indirectly addresses bank erosion where a potential exists for the degradation to continue below the riparian root zone. Some additional channel incision and bed degradation is possible in this reach. This reach has well defined riffles that would become the boundary of sediment deposition above the structure. Sinuosity would remain the same as prior to implementation. Bed material size downstream from these structures is not expected to change. Sand and fine gravel sizes from ephemeral tributaries could initially deposit upstream, but this effect is expected to be temporary.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The upstream reach is White Rock Canyon, and Cochiti Dam prevents any upstream effects from occurring. Sediment delivery to downstream reaches would remain about the same as pre-implementation. Bed material size would not be affected downstream from this reach.

2.1.2.3.3 Promote Alignment Stability

Reach Effects – In general, Promote Alignment Stability addresses the trend of bank erosion through stabilizing the banks where riverside infrastructure is threatened. The general effects of this method implemented on a reach scale are as described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The width of the floodplain bounded by infrastructure in this reach is relatively narrow in some locations (Varyu et al. 2011), increasing the number of potential sites where this strategy could be implemented. The amount of sediment available from bank erosion would be reduced, with potential local bed coarsening. Where split channels exist, the effect of locally increasing the velocity and depth should affect the channel where implemented, while the other channel would not be influenced. Within the reach, upstream alignment stability can help downstream infrastructure by reducing the approach angle, influencing the channel alignment.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Strategies implemented in this reach do not impact upstream reaches because the reach is bounded on the north by Cochiti Dam. Angostura Diversion Dam confines the lateral location of this reach's downstream boundary. Reduced bank erosion could cause a relatively small decrease in sediment supply to the Angostura Diversion Dam to Isleta Diversion Dam Reach.

2.1.2.3.4 Reconstruct and Maintain Channel Capacity

This strategy is not suitable because a significant loss of channel capacity is not expected.

2.1.2.3.5 Increase Available Area to the River

Reach Effects – This strategy addresses the trends of channel narrowing, coarsening of bed material, bank erosion, and increased channel uniformity. The general effects of this method implemented on a reach scale area as described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Lateral confinement is significant in this reach (Varyu et al. 2011), and providing an opportunity for the river to migrate across a larger portion of its historical floodplain would allow current geomorphology processes to continue. The small amount of channel lengthening and sinuosity increase would reduce or eliminate the potential for additional bed degradation. The size of active mid-channel and bank-attached bars throughout this reach likely would increase creating more depositional surfaces that are hydrologically connected.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Strategies implemented in this reach do not impact upstream reaches because the reach is bounded on the north by Cochiti Dam. The downstream reach boundary is Angostura Diversion Dam that controls the bed elevation and river location. A small increase in channel length may result in a lower amount of sediment being supplied to the Angostura Diversion Dam to Isleta Diversion Dam Reach downstream when the slope decreases and the size of mid-channel and bank-attached bars increases.

2.1.2.3.6 Rehabilitate Channel and Floodplain

Reach Effects – This strategy addresses channel narrowing, vegetation encroachment, coarsening of bed material, and increased channel uniformity. The general effects of this method implemented on a reach scale are as described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Excavation of the channel banks to establish a lower elevation floodplain decreases the flow required to go over bank, and increases high-flow channel width. High-flow sediment transport rates would be reduced. Vegetation regrowth would occur in the excavated floodplain and on the channel margins. Due to the relatively low suspended sediment load from ephemeral tributaries and bank erosion, inundating flows will have a lower tendency to deposit sediment in the excavated floodplain than in reaches with greater load.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Strategies implemented in this reach do not impact upstream reaches because the reach is bounded on the north by Cochiti Dam. Angostura Diversion Dam exercises influence on the bed elevation and river location at the downstream reach boundary. The reduction in high-flow sediment transport capacity and overbank sediment deposition could result in a lower sediment supply to the Angostura Diversion Dam to Isleta Diversion Dam Reach. This could result in bed lowering downstream from existing grade control structures resulting in decreased floodplain connectivity and a narrower, deeper channel. These effects are expected to be small because the Jemez River supplies sediment to the Rio Grande about 1.5 miles downstream from the diversion dam, and the sediment supply in this reach is relatively smaller than downstream reaches.

2.1.2.3.7 Manage Sediment

This strategy is not suitable because modeling results show both aggradation and degradation within the reach.

2.1.2.4 Angostura Diversion Dam to Isleta Diversion Dam – RM 209.7 to 169.3

2.1.2.4.1 Trends

The storage of sediment and reduced high-flow peaks as a result of Cochiti Reservoir continue to affect this reach. Sediment is supplied to the reach by the Jemez River and other tributaries. Operational changes to increase sediment pass through at Jemez Canyon Dam will reduce the imbalance in sediment transport capacity and load, but the effects are not well known at this time. The reach is also affected by the formation of mid-channel and bank-attached bars that are becoming stabilized with vegetation. Three subreaches have been evolving as identified in the geomorphology baseline (Part I, Section 4.5). The upstream subreach largely has become a fairly narrow, single thread, gravel-dominated channel. The central subreach is a transition reach in which the percentage of gravel in the bed is increasing, and the downstream subreach is still sand dominated. In each of the three subreaches, the following reach-wide trends are present:

- Channel narrowing
- Vegetation encroachment

- Increased bank height
- Incision or channel bed degradation
- Bank erosion
- Coarsening of bed material
- Increased channel uniformity

The way in which each strategy affects these reach-wide trends can vary between subreaches.

2.1.2.4.2 Promote Elevation Stability

Reach Effects – This strategy addresses the trends of incision or channel bed degradation, increased bank height, and coarsening of bed material. This strategy also may indirectly influence bank erosion where there is potential for the degradation to continue below the riparian root zone. The general effects of this method implemented on a reach scale are described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. When the river bed is raised about 1–2 feet, the water surface elevation is increased upstream to the next riffle or higher bed elevation location, promoting greater floodplain connectivity. In the downstream subreach (Bridge Street Bridge to Isleta Diversion Dam), there likely will be greater potential for increased floodplain connectivity when compared to the gravel-dominated bed reach that has already experienced some channel incision and degradation. Upstream of the structures in the sand-dominated bed subreach, sediment deposition would potentially occur faster than in the gravel bed dominated subreach because sand sizes are mobilized at lower discharges than gravel bed sizes. Sediment deposition upstream of the structures could become vegetated on the channel margins without sufficient flows to periodically mobilize sediment deposits, requiring maintenance/Adaptive Management to maintain channel hydraulic capacity. Sinuosity would remain the same as prior to implementation. The ABCWUA low-head inflatable dam exerts a bed level controlling effect within this reach.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Ttable 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Sediment delivery to downstream reaches would remain about the same as pre-implementation. There may be a temporary short period of time where the sediment supply is slightly reduced as the upstream river bed establishes its post implementation elevation. However, this is likely a small amount of the total annual sediment load. The bed material size in the downstream reach is expected to remain the same. Bed elevations are controlled at the upstream and downstream reach boundaries by Angostura Diversion Dam and Isleta Diversion Dam, respectively.

2.1.2.4.3 Promote Alignment Stability

Reach Effects – In general, this strategy addresses the trend of bank erosion, through stabilizing the banks where the laterally constraining infrastructure is threatened. The general effects of this method implemented on a reach scale are described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. This strategy is most applicable currently in the gravel-dominated bed subreach that has already experienced more bed degradation and lateral migration than the transition and sand-dominated bed subreaches. Should the bed material coarsen and/or incision and lateral migration occur in the future in the transition and sand-dominated bed subreaches, this strategy is likely to become more applicable. This is especially true because a significant amount of the calculated potential future meandering channel length is outside the current lateral constraints (Varyu et al. 2011). After implementation, the amount of sediment available from bank erosion potentially would be reduced, leading to local bed coarsening. Due to sediment inflow from the Jemez River and the numerous ephemeral tributaries, the reduction of sediment supply from bank erosion may be relatively small. Sinuosity would increase as the channel lengthens until lateral migration threatens the integrity of riverside infrastructure.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The bed elevation and river location upstream of this reach are strongly influenced by Angostura Diversion Dam; thus, any effects upon the bed elevation as a result of potential channel lengthening from lateral migration will not affect the upstream reach. Isleta Diversion Dam exerts a controlling effect upon the bed elevation and river location at the downstream boundary of this reach. There could be a small reduction in the portion of the total sediment supply derived bank erosion. However, given the number of tributaries, including the Jemez River, providing sediment supply, this effect is expected to be small.

2.1.2.4.4 Reconstruct and Maintain Channel Capacity

This strategy is not suitable because a significant loss of safe channel hydraulic capacity is not expected.

2.1.2.4.5 Increase Available Area to the River

This strategy is not suitable because urban development makes implementation so expensive as to be unfeasible.

2.1.2.4.6 Rehabilitate Channel and Floodplain

Reach Effects.—This strategy addresses channel narrowing, vegetation encroachment, increased bank height, incision or channel bed degradation, coarsening of bed material, and increased channel uniformity. The general effects of this method implemented on a reach scale are described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The reduced tendency for future bed coarsening would have the greatest effect on the sand-dominated bed subreach and should reduce or eliminate the tendency to develop a gravel dominated bed. Vegetation regrowth would occur in the excavated floodplain and on the channel margins. Inundating flows will likely deposit sediment in the vegetated overbank at a higher rate than in the Cochiti Dam to Angostura Diversion Dam subreach, due to the higher sediment load from tributaries.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The bed elevation and river location upstream of this reach are strongly influenced by Angostura Diversion Dam; thus, any effects upon the implementation reach will not affect the upstream reach. Reduction in high-flow sediment transport capacity and increased overbank sediment deposition could result in a lower amount of sediment being supplied to the Isleta Diversion Dam to Rio Puerco Reach. This effect is more pronounced during higher overbank flow peaks with longer durations and could result in downstream bed lowering, decreased floodplain connectivity, and a narrower, deeper channel.

2.1.2.4.7 Manage Sediment

Reach Effects – The increased bank height, incision or bed degradation, coarsening of bed material, and increased channel uniformity trends are addressed by this strategy. The general effects of managing sediment in this reach consist of those due to increasing sand size sediment supply, as described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The potential for future bank erosion caused by bed degradation below the root zone would be reduced. Depositional bars and islands may form downstream from augmentation sites. The potential change in bed material size would be greatest in the gravel dominated bed reach where the sand size portion of the bed material gradation would increase.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects of sediment augmentation are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The bed elevation and river location upstream of this reach are strongly influenced by Angostura Diversion Dam; thus, any effects upon the implementation reach will not affect the upstream reach. Deposition of bars and islands will likely occur in the Isleta Diversion Dam to Rio Puerco Reach unless the increased sediment supply can be transported through this reach. The bed elevation at Isleta Diversion Dam would be expected to remain the same. There is potential for additional sediment deposition upstream of the dam.

2.1.2.5 Isleta Diversion Dam to Rio Puerco – RM 169.3 to 127

2.1.2.5.1 Trends

Historically, the bed and alignment have been relatively stable except near the Rio Puerco. This reach is influenced by island and bar vegetation growth that has stabilized these once transient features, thereby narrowing the channel and encouraging new deposition along the bank. Current trends occurring in this reach are the following:

- Channel narrowing
- Vegetation encroachment
- Increased bank height
- Coarsening of bed material
- Increased channel uniformity

Continuation of these trends may cause additional trends to develop in the future:

- Incision or channel bed degradation
- Bank erosion

2.1.2.5.2 Promote Elevation Stability

Reach Effects – This strategy addresses the trends of increased bank height and coarsening of bed material. This strategy can address increased bank height but only in the case where it is due to degradation. Because it is very possible that bed degradation and incision will become a future trend, similar to other reaches of the MRG that have narrowed, this strategy has been identified as suitable. The general effects of this method implemented on a reach scale are described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Channel narrowing as a result of future channel incision would be reduced or slowed by bed elevation control. When the river bed is raised about 1–2 feet, the water surface elevation is increased upstream to the next riffle or high point in the bed, promoting greater floodplain connectivity and increased depth and velocity variability at high flows. Sediment deposition upstream of the structures could become vegetated on the channel margins without sufficient flows to periodically mobilize sediment deposits, requiring maintenance/Adaptive Management to maintain channel capacity. Sinuosity would remain the same as prior to implementation.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are as described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Sediment delivery to Rio Puerco to San Acacia Diversion Dam Reach would remain about the same as pre-implementation. Bed material size would not be affected downstream from the structures. The upstream bed elevation is controlled by Isleta Diversion Dam and would not change with this strategy.

2.1.2.5.3 Promote Alignment Stability

This strategy is not suitable because analysis results show the meander belt is expected to continue to fit between constraints.

2.1.2.5.4 Reconstruct and Maintain Channel Capacity

Reach Effects – This strategy addresses trends of channel narrowing and vegetation encroachment. The trend of increase bank height due to sediment deposition could potentially reduce high-flow floodway capacity. The general effects of this method implemented on a reach scale are described in Table 3 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. Where increased bank height has cut off side channels and backwaters, these may be reconnected. Vegetation encroachment could continue on the channel margins without sufficiently high flows to mobilize bed sediments after channel reconstruction. Potential bank erosion due to bed degradation and channel narrowing likely would decrease. No change in sinuosity is likely. The bed elevation may increase, and bed size may decrease due to reduced peak flow channel velocity and depth.

Effects on Upstream and Downstream Reaches.—The general upstream and downstream effects are as described in Table 3 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. The upstream bed elevation and river location are influenced by Isleta Diversion Dam. Reduction in high-flow sediment transport capacity could result in lower down-stream sediment supply. This could result in bed lowering, decreased floodplain connectivity, and a narrower, deeper channel in the Rio Puerco to San Acacia Diversion Dam Reach. The potential amount of these changes is not known.

2.1.2.5.5 Increase Available Area to the River

Reach Effects – This strategy addresses the trends of channel narrowing, coarsening of bed material and increased channel uniformity. The general effects of this method implemented on a reach scale are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Allowing the river more space for lateral erosion and bar deposition could result in the formation of a larger floodplain with increases in overall floodplain connectivity and increased channel width. Bed degradation tendencies would be reduced or eliminated as the channel lengthens. Potential for bank erosion increases with the development of migrating channel bends; however, there would be more space to accommodate that migration.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Relocating riverside infrastructure will provide additional area for future river migration but will not immediately effect current reach trends. If channel lengthening occurs, there would be a reduced tendency for upstream bed lowering. The upstream sediment supply/transport capacity relationship would remain about the same; thus, channel width and floodplain connectivity would be essentially unchanged. The sediment supply to the Rio Puerco to San Acacia Diversion Dam Reach could be reduced if channel lengthening reduces degradation potential. The potential amount of this reduction is an unknown at this time.

2.1.2.5.6 Rehabilitate Channel and Floodplain

Reach Effects – This strategy addresses channel narrowing, vegetation encroachment, increased bank height, coarsening of bed material, and increased channel uniformity. The general effects of this method implemented on a reach scale are described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Excavation of the channel banks to establish a lower elevation floodplain decreases the flow required to go over bank, and leads to increased high flow channel width. High flow sediment transport rates would be reduced, lowering the likelihood of future bed degradation and the tendency for the bed to coarsen. Vegetation regrowth would occur in the excavated floodplain, and on the channel margins. Inundating flows will likely deposit sediment in the vegetated overbank.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are as described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The potential for continued upstream bed degradation would be reduced. Reduction in high-flow sediment transport capacity and overbank sediment deposition could result in a lower downstream sediment supply. This could result in bed lowering, decreased floodplain connectivity, and a narrower, deeper channel in the Rio Puerco to San Acacia Diversion Dam Reach. The potential amount of these changes is not known.

2.1.2.5.7 Manage Sediment

Reach Effects – Increased bank height, coarsening of bed material, and increased channel uniformity are trends addressed by this strategy. The general effects of managing sediment in this reach consist of those due to increasing sediment supply are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The potential for future bank erosion caused by bed degradation below the root zone would be reduced. Downstream from augmentation sites, bars and islands may form due to sediment deposition.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects of sediment augmentation are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. No additional trends are expected in addition to these general upstream and downstream effects.

2.1.2.6 Rio Puerco to San Acacia Diversion Dam – RM 127 to 116.2

2.1.2.6.1 Trends

The uncontrolled, large, ephemeral tributaries of the Rio Puerco and Rio Salado strongly influence this reach through both peak flows and sediment load. The historically high load from the Rio Puerco has significantly decreased because that channel has evolved. Recent MRG evolution includes the development of small inset floodplains. Located between the tributary confluences is Sevilletta bend, which is a 2½-mile-long geologic constriction in the center of the reach. Above the bend, the channel is narrowing with vegetation encroachment. The Rio Salado enters immediately below Sevilletta bend. It contributes sediment that is coarser than the Rio Grande, and the Rio Salado delta tends to act as a grade control. From here downstream to San Acacia Diversion Dam, the channel is currently moving laterally and degrading. The delta deposits upstream of the diversion dam have become heavily vegetated and confine the channel north against the Drain Unit 7 Levee. The current reach trends are:

- Channel narrowing
- Vegetation encroachment
- Increased bank height
- Incision or channel bed degradation – local
- Coarsening of bed material
- Increased channel uniformity

2.1.2.6.2 Promote Elevation Stability

Reach Effects and Effects on Upstream and Downstream Reaches – As modeling results (Varyu et al. 2011) show, this reach is expected to mildly aggrade, so this strategy is suitable but would be implemented by methods falling primarily under the other strategies suitable for this reach—"Reconstruct and maintain channel capacity and manage sediment."

2.1.2.6.3 Promote Alignment Stability

Reach Effects – For much of the reach, there appears to be adequate space for lateral migration at the 2006 channel widths. Of note is that channel narrowing could set in motion a geomorphic shift toward channel migration and the Drain Unit 7 extension and other infrastructure may be threatened as the channel position changes. The trend of bank erosion that threatens infrastructure is addressed through armoring the bank line or deflecting the main flow path away from the area of concern. Effects are described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Modeling results (Varyu et al. 2011) do not show channel lengthening at the 2006 widths, but narrowing could change the stable slope to a condition where channel migration becomes an active process. Sinuosity could then increase because there is space available for lateral migration. Bed material could continue to coarsen as the supply of fines from bank erosion is reduced.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The downstream reach boundary is San Acacia Diversion Dam that controls bed elevation and puts boundaries on the lateral location of the river. There could be a relatively small decrease in sediment supplied to the San Acacia Diversion Dam to Arroyo de las Cañas Reach because of reduced bank erosion. Isleta Diversion Dam to Rio Puerco Reach effects are expected to be small.

2.1.2.6.4 Reconstruct and Maintain Channel Capacity

This strategy is not suitable because a significant loss of channel capacity is not expected.

2.1.2.6.5 Increase Available Area to the River

Reach Effects – The trends of channel narrowing increased bank height, incision or channel bed degradation, coarsening of bed material, and increased channel uniformity are addressed by setting aside space for the channel to evolve. The general effects of this strategy in this reach are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Land use outside the infrastructure constraints is agricultural or wildlife refuges and the AT&SF Railroad. Altering land use in agricultural or wildlife areas may be more implementable than changing the railroad alignment. Potential for bank erosion increases with the development of migrating channel bends; however, there would be more space to accommodate that migration. There is uncertainty on how significant the process of migration will become in this reach.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The downstream reach boundary is San Acacia Diversion Dam, which controls the bed elevation and puts bounds on river location. A longer channel could result in lower sediment supply to the San Acacia Diversion Dam to Arroyo de las Cañas Reach when the slope decreases and the size of mid-channel and bank-attached bars increases; but modeling results (Varyu et al. 2011) show that the channel is not expected to lengthen at the 2006 channel widths. Isleta Diversion Dam to Rio Puerco Reach effects are expected to be small.

2.1.2.6.6 Rehabilitate Channel and Floodplain

Reach Effects – The trends of channel narrowing, vegetation encroachment, increased bank height, incision or channel bed degradation, coarsening of bed material, and increased channel uniformity are addressed by decreasing high-flow energy through lowering the bank height that increases flow area at lower discharges. New riparian vegetation will grow, and then sediment deposition is expected in the lowered overbank areas. The effects listed in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case would apply, but specific effects will depend on the type of implementation.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. San Acacia Diversion Dam controls bed elevation and puts bounds on river location at the downstream reach boundary. Reduction in high-flow sediment transport capacity and overbank sediment deposition could result in a lower downstream sediment supply. This could then result in bed lowering, decreased floodplain connectivity, and a narrower, deeper channel in the San Acacia Diversion Dam to Arroyo de las Cañas Reach. The effect is not expected to be large.

2.1.2.6.7 Manage Sediment

This strategy is not suitable because modeling showed only a mild reach-wide imbalance in sediment transport capacity and sediment supply.

2.1.2.7 San Acacia Diversion Dam to Arroyo de las Cañas – RM 116.2 to 95

2.1.2.7.1 Trends

This reach is influenced by a large reduction in finer grain sizes from the Rio Puerco, but the Salado contributes coarser grain sizes. Additional influences include channel incision, formation of abandoned terraces, and width reduction. San Acacia Diversion Dam prevents upstream migration of channel bed degradation. Many of the ephemeral tributaries junctions now act effectively as grade controls as described in the geomorphology baseline (Part I, Section 4.5). Current trends in this reach are the following:

- Vegetation encroachment
- Increased bank height
- Incision or bed degradation
- Bank erosion
- Coarsening of bed material
- Increased channel uniformity

Near San Acacia Diversion Dam, the amount of bed material coarsening and channel degradation is the greatest, decreasing in the downstream direction. From Escondida to Arroyo de las Cañas, the bed is predominantly sand with intermittent gravel deposits. Several smaller tributaries have been reconnected, increasing sediment supply within the reach.

2.1.2.7.2 Promote Elevation Stability

Reach Effects – This strategy addresses the trends of increased bank height, incision or channel bed degradation, and coarsening of bed material. This strategy also may address bank erosion where there is potential for the degradation to continue below the riparian root zone. This strategy addresses increased bank height from the condition of channel bed degradation. The general effects of this method implemented on a reach scale are described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. This reach has natural grade controls from ephemeral tributary sediment deposits that could become the boundary of the relatively small amount of sediment deposition upstream of each structure. Channel narrowing as a result of future channel incision would be reduced or slowed by bed elevation control. Sediment deposition upstream of the structures likely would occur more quickly where the bed material load is largely sand sized. The upstream sediment deposits could become vegetated on the channel margins without sufficient flows to periodically mobilize sediment deposits, requiring maintenance/Adaptive Management to maintain channel capacity. Sinuosity would remain the same as prior to implementation. The lateral location of the river is fixed for most methods. Bed material size is not expected to change.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 1 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The upstream bed elevation is controlled by San Acacia Diversion Dam and would not change. Sediment delivery to the Arroyo de las Cañas to San Antonio Bridge Reach would remain about the same as pre-implementation. Bed material size would not be affected downstream from this reach. Bed elevation in the Arroyo de las Cañas to San Antonio Bridge is not likely to be affected by this strategy because sediment supply is not likely to change.

2.1.2.7.3 Promote Alignment Stability

Reach Effects – This strategy addresses the trend of bank erosion by stabilizing banks where infrastructure is threatened by river bank migration. The general effects of this method implemented on a reach scale are described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Sinuosity would increase as the channel lengthens until lateral migration threatens riverside infrastructure. Additional lateral migration would likely allow the river to increase the size of its inset floodplain. If the bed material size continues to coarsen in the downstream portion of this reach, and lateral migration were to occur in the future, this strategy will become more applicable.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 2 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The bed elevation and river location at the upstream boundary of this reach are controlled by San Acacia Diversion Dam; thus, any potential changes in bed elevation as a result of channel lengthening from lateral migration will not affect the upstream reach. The bed elevation in the Arroyo de las Cañas to San Antonio Bridge Reach is not likely to be influenced by a small reduction in sediment supplied by bank erosion because Arroyo de las Cañas appears to be acting as a grade control. The downstream lateral location could be influenced by the alignment of this strategy.

2.1.2.7.4 Reconstruct and Maintain Channel Capacity

This strategy is not suitable because a significant loss of channel capacity is not expected.

2.1.2.7.5 Increase Available Area to the River

Reach Effects – This strategy addresses the trends of channel narrowing, increased bank height, incision or bed degradation, coarsening of bed material, bank erosion, and increased channel uniformity. The general effects of this method implemented on a reach scale, are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Allowing the river more space for lateral erosion and bar deposition could result in the formation of a larger inset floodplain, increasing overall floodplain connectivity and channel width. Bed degradation tendencies would be reduced or eliminated as the channel lengthens, except where controlled by ephemeral tributary sediment deposits.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Relocating riverside infrastructure will provide additional area for future river migration. The presence of San Acacia Diversion Dam prevents any upstream reach channel changes. The downstream channel bed elevation most likely will not be affected due to Arroyo de las Cañas deposits in the river appearing to act as a grade control, even if the downstream sediment supply decreased. Sediment supply to the Arroyo de las Cañas to San Antonio Bridge Reach is likely to decrease because channel lengthening reduces degradation potential and sediment could be stored on forming point bars. Downstream sediment supply could be reduced if channel lengthening reduces degradation potential. The downstream reach has a sediment depositional trend, so this effect would potentially reduce the rate of aggradation.

2.1.2.7.6 Rehabilitate Channel and Floodplain

Reach Effects – This strategy addresses channel narrowing, vegetation encroachment, increased bank height, incision or channel bed degradation, bank erosion, coarsening of bed material, and increased channel uniformity. The general effects of this method implemented on a reach scale for the transport capacity greater than supply case are described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Excavation of the channel banks to establish a lower elevation floodplain, in the abandoned river terraces, decreases the flow required to go over bank and leads to increased high-flow channel width. High-flow sediment transport rates would be reduced, lowering the likelihood of future bed degradation and the tendency for the bed to coarsen. Vegetation regrowth would occur in the excavated floodplain and on the channel margins. Inundating flows likely will deposit sediment in the vegetated overbank because there can be significant amounts of sediment in suspension, particularly during Rio Puerco and Rio Salado flow events.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 5 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Upstream bed elevation is controlled by San Acacia Diversion Dam and would not be affected by this strategy. Reduction in high-flow sediment transport capacity and overbank sediment deposition could result in a lower sediment supply to the Arroyo de las Cañas to San Antonio Bridge Reach. This could result in slowing the aggradational trend in the downstream Arroyo de las Cañas Reach. It is not likely that this strategy would alter the downstream lateral channel location.

2.1.2.7.7 Manage Sediment

Reach Effects – The increased bank height incision or bed degradation, coarsening of bed material and increased channel uniformity trends are addressed by this strategy. The general effects of managing sediment in this reach consist of those due to increasing sediment supply, as described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. The potential for future bank erosion caused by bed degradation below the root zone would be reduced. Sediment deposition likely could occur on inset floodplain features, decreasing the frequency of inundation, downstream from augmentation sites.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects of sediment augmentation are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity greater than sediment supply case. Sediment augmentation would have no effect upon the upstream bed elevation or channel location controlled by San Acacia Diversion Dam. It is likely that this strategy would increase sediment supply to the Arroyo de las Cañas to San Antonio Bridge, potentially exacerbating the aggradational trend. The amount of potential sediment supply is an unknown.

2.1.2.8 Arroyo de las Cañas to San Antonio Bridge – RM 95 to 87.1

2.1.2.8.1 Trends

This reach has experienced less change in bed elevation and average channel width since channelization than most other reaches of the MRG. Recent trends, which appear to be declining in effect, include:

- Channel narrowing
- Vegetation encroachment

Aggradation is extending into this reach, but on a smaller in scale than historically documented in the San Antonio Bridge to RM 78 and RM 78 to RM 62 Reaches. Recent arroyo reconnections and aggradation in the San Antonio to RM 78 Reach contribute to these trends:

- Aggradation
- Increased channel uniformity

Sediment storage in the channel is key to the recent trends observed in this reach. Strategies that address the channel filling (related to both narrowing and aggradation) would be appropriate, but the recent narrowing could increase sediment transport, move more sediment through the reach, and therefore change the aggradation-related trends in this reach, potentially increasing bend migration.

2.1.2.8.2 Promote Elevation Stability

Reach Effects and Effects on Upstream and Downstream Reaches – As recent observations and modeling results (Varyu et al. 2011) show, this reach is expected to aggrade, so this strategy is suitable but would be implemented by methods falling primarily under the other strategies suitable for this reach—“Reconstruct and maintain channel capacity” and “Manage sediment.”

2.1.2.8.3 Promote Alignment Stability

This strategy is not suitable because modeling shows a low potential for lateral migration.

2.1.2.8.4 Reconstruct and Maintain Channel Capacity

Reach Effects – The current reach trends of channel narrowing, vegetation encroachment, and aggradation are addressed by directly removing sediment from the channel, increasing sediment transport capacity through confining high flows, or reducing impacts from channel realignment through levee strengthening/raising. Because the excess incoming sediment supply is not modified and sediment transport capacity is not likely to exceed previous levels, sediment excavation could require continued maintenance. The effects as described in Table 3 of the Strategy Effects (Appendix E) because the sediment transport capacity less than sediment supply case would apply in this reach. Bed material is expected to remain sand-dominated except in the upstream riffles. Sinuosity is not expected to change much, but the wetted area of the overbank at high flows is expected to decrease and discharge needed to go over bank increases, at least temporarily.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 3 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. Downstream effects include increased water and sediment delivery to the San Antonio Bridge to RM 78 Reach. Significant coarsening of bed material in the downstream reach is not expected. Arroyo de las Cañas deposits in the channel, at the upstream end of this reach, appear to be controlling degradation at current peak flows, but aggradation and bed material fining extending into the San Acacia Diversion Dam to Arroyo de las Cañas Reach is possible. The likelihood and magnitude of this effect is unknown at this time.

2.1.2.8.5 Increase Available Area to the River

This strategy is not suitable because modeling shows a low potential for lateral migration.

2.1.2.8.6 Rehabilitate Channel and Floodplain

This strategy is not suitable because of historically stable bed and modeling show aggradation.

2.1.2.8.7 Manage Sediment

Reach Effects – The reach trends of aggradation and increased channel uniformity can be addressed by this strategy. The general effects of this method implemented on a reach scale are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. Implementation would consist of reducing sediment supply. The reduction in sediment supply would reduce flooding and water losses.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. Reducing sediment supply in this reach should reduce the effects of sediment supply being greater than transport capacity in the upper portion of the San Antonio Bridge to RM 78 Reach. A reduction in aggradation in this reach might reduce aggradation in the San Acacia Diversion Dam to Arroyo de las Cañas Reach upstream.

2.1.2.9 San Antonio Bridge to RM 78 – RM 87.1 to 78

2.1.2.9.1 Trends

This reach is influenced by the pool elevation of Elephant Butte Reservoir. Under the current water and sediment loads, the pool is quite low and not expected to rise far in the near term. This base level lowering has led to the following current trends in the lower portion of the reach that are anticipated to be temporary (Makar and AuBuchon, 2012).

- Increased bank height
- Incision or channel bed degradation
- Bank erosion
- Coarsening of bed material – minor

Three trends currently are observed that may or may not reverse when water and sediment loads increase and the pool fills:

- Channel narrowing
- Vegetation encroachment
- Increased channel uniformity

Under historically more frequent conditions, there is an excess of sediment supply as compared to transport capacity and long-term trends of:

- Aggradation
- Channel plugging with sediment
- Perched channel conditions

The dependence on pool elevation makes conditions of this reach variable in the long term. Given the wide variation in trends and the need to preserve peak flow channel capacity, valley drainage, and capacity in Elephant Butte Reservoir, strategies that address the long-term aggradation trends are appropriate for this reach and have been addressed herein.

2.1.2.9.2 Promote Elevation Stability

Reach Effects and Effects on Upstream and Downstream Reaches – As this is a long-term aggrading reach, this strategy is suitable but would be implemented by methods falling under the other strategies suitable for this reach—“Reconstruct and maintain channel capacity,” “Increase available area to the river,” and “Manage sediment.”

2.1.2.9.3 Promote Alignment Stability

This strategy is not suitable because the reach over the long term is aggrading, and only localized lateral migration is expected.

2.1.2.9.4 Reconstruct and Maintain Channel Capacity

Reach Effects – This strategy addresses the trends of channel narrowing, vegetation encroachment, aggradation, channel plugging with sediment, and perched channel conditions by directly removing sediment from the channel, increasing transport capacity through confining high flows, or reducing levee impacts from channel realignment. Because the excess incoming sediment load is not modified and transport capacity likely will not exceed previous levels, sediment excavation likely will require continued maintenance. The effects are described in Table 3 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. Bed material is expected to remain sand. Sinuosity is not expected to change much, but wetted area of the overbank at high flows is expected to decrease and discharge needed to go over bank increase, at least temporarily.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 3 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. Downstream effects include increased water and sediment delivery to the RM 78 to Full Pool Elephant Butte Reservoir Level Reach and potentially to Elephant Butte Reservoir increasing the rate of storage capacity loss. Significant coarsening of the bed material in the RM 78 to Full Pool Elephant Butte Reservoir Level Reach is not expected. It is possible the Arroyo de las Cañas to San Antonio Bridge Reach aggradation could be reduced as channel filling in this reach is reduced.

2.1.2.9.5 Increase Available Area to the River

Reach Effects – This strategy addresses the trends of channel narrowing, increased bank height, incision or channel bed degradation, bank erosion, coarsening of bed material, increased channel uniformity, aggradation, channel plugging with sediment, and perched channel conditions through allowing natural channel processes to cause channel evolution. The trends of aggradation, channel plugging with sediment, and perched channel conditions are addressed through allowing space for channel relocation to lower bed elevations. The general effects of this method implemented on a reach scale are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. The majority of the surrounding land in this reach is federally owned. Sinuosity, wetted area, and discharge needed to go over bank are not expected to change significantly. However, it is possible that after natural channel realignment, the new channel bed elevation within the reach could be lowered far enough so that upstream effects could include channel degradation with higher flows required to go over bank and lowered water tables. This effect may be temporary unless the strategy is extended into the RM 78 to Full Pool Elephant Butte Reservoir Level Reach. Water delivery may be reduced until a continuous competent channel is formed. The magnitude of this effect is dependent on the increase in wetted area.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. It is possible that water delivery to the RM 78 to Full Pool Elephant Butte Reservoir Level Reach may be reduced, but the effect is expected to be small. Significant changes in the RM 78 to Full Pool Elephant Butte Reservoir Level Reach bed material size or sediment load are not expected. It is possible that effects due to lowered bed elevation, as discussed under reach effects, could extend into the Arroyo de las Cañas to San Antonio Bridge Reach. The extent and magnitude of the effect is dependent on the change in bed elevation.

2.1.2.9.6 Rehabilitate Channel and Floodplain

This strategy is not suitable because the reach over the long term is aggrading.

2.1.2.9.7 Manage Sediment

Reach Effects – The general effects of this method implemented on a reach scale are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. The trends of aggradation, channel plugging with sediment, perched channel conditions, and increased channel uniformity are addressed through storage of excess sediment supply in basins or by channel relocation to a lower elevation alignment. In either case, the sediment load transported and/or the perched condition where the elevation of the channel bed is higher than the floodplain should be reduced. Channel relocation would allow sediment storage in low lying areas, but maintenance may be required to sustain a continuous channel downstream in the new alignment. Sinuosity, local groundwater table, wetted area, and discharge needed to go over bank are dependent on locations selected for implementation.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. It is possible that water delivery downstream may be reduced, but the effect is expected to be small and may be temporary depending upon the method used. Sediment load to the RM 78 to Full Pool Elephant Butte Reservoir Level Reach would, of course, be reduced; and it is possible that the effect may extend to Elephant Butte Reservoir. Significant coarsening in the RM 78 to Full Pool Elephant Butte Reservoir Level Reach is not expected. Sediment deposition in low areas may temporarily reduce Arroyo de las Cañas to San Antonio Bridge Reach aggradation.

2.1.2.10 RM 78 to Full Pool Elephant Butte Reservoir Level

2.1.2.10.1 Trends

This reach is strongly influenced by the pool elevation of Elephant Butte Reservoir. Historically an aggrading and perched reach, the channel has degraded significantly. This is primarily due to the base level lowering effect of recent pool elevations. Under the current water and sediment loads, the pool is quite low and not expected to rise far in the near term. This base level lowering has led to the following current trends that are anticipated to be temporary:

- Increased bank height

- Incision or channel bed degradation
- Bank erosion
- Coarsening of bed material
- Increased channel uniformity

Two trends are currently observed that may or may not reverse when water and sediment loads increase and the pool fills:

- Channel narrowing
- Vegetation encroachment

Under historically more frequent conditions, there is an excess of sediment supply as compared to transport capacity and long-term trends of:

- Aggradation
- Channel plugging with sediment
- Perched channel conditions

The dependence on pool elevation makes conditions of this reach highly variable in the long term. Given the wide variation in trends and the need to preserve peak flow channel capacity, valley drainage and capacity in Elephant Butte Reservoir, strategies that address the long-term aggradation trends are appropriate for this reach. Loss of a continuous channel to the reservoir in this reach can impair water delivery.

2.1.2.10.2 Promote Elevation Stability

Reach Effects and Effects on Upstream and Downstream Reaches – As this is a long-term aggrading reach, this strategy is suitable but would be implemented by methods falling under the other strategies suitable for this reach—"Reconstruct and maintain channel capacity," "Increase available area to the river," and "Manage sediment."

2.1.2.10.3 Promote Alignment Stability

This strategy is not suitable because the reach over the long term is aggrading, and only localized lateral migration is expected.

2.1.2.10.4 Reconstruct and Maintain Channel Capacity

Reach Effects – This strategy addresses the trends of channel narrowing, vegetation encroachment, aggradation, channel plugging with sediment, and perched channel conditions by removing sediment from the channel. Sediment transport capacity is increased by confining high flows that can increase flow capacity within the levee system. Building on the discussion in the trends section above, the duration of the effects of increasing the sediment transport capacity through partial or complete channel reconstruction (see Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case) are likely to be shorter than in other reaches if the base level control of pool elevation rises and longer if it remains low. A continued need for maintenance is expected if this strategy is implemented. Partial reconstruction via a pilot channel through sediment plugs can restore channel capacity. Confining over bank flows can increase local transport capacity and may prevent plug formation. Levee raising and strengthening can reduce concerns of levee failure during plugs and high-flow events. Little change is expected in sinuosity or the discharge required to go over bank and the resulting wetted area.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 3 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. Downstream effects include increased water and sediment delivery to Elephant Butte Reservoir resulting in an increased rate of reservoir capacity loss. The downstream bed material size is likely to increase if the pool remains low but is expected to remain in sand sizes. The San Antonio Bridge to RM 78 Reach effects could be channel degradation and longer duration of increased channel capacity, again dependent on Elephant Butte pool elevation. Higher flows required to go over bank and lowered water tables may accompany the degradation.

2.1.2.10.5 Increase Available Area to the River

Reach Effects – This strategy addresses the trends of channel narrowing, increased bank height, incision or channel bed degradation, bank erosion, coarsening of bed material, and increased channel uniformity through allowing natural channel processes to cause channel evolution and increased length. The trends of aggradation, channel plugging with sediment, and perched channel conditions are addressed by allowing space for channel relocation. The San Marcial Railroad Bridge locally limits application of this strategy; however, as the majority of the surrounding land is federally owned, implementation could be easier than in other reaches. There appears to be enough land available to realize the effects listed in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. Wetted area of high flows would increase when channel filling resumes. Sinuosity could increase if the pool remains low and the channel migrates. The discharge needed to go over bank is not expected to change until the pool elevation comes up; then, the discharge needed to spill out of the channel will decrease.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 4 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. The increased area available for overbank deposition could reduce the sediment load reaching Elephant Butte Reservoir, extending its useful capacity life. The bed material size downstream is expected to remain about the same. The San Antonio Bridge to RM 78 Reach aggradation, which has historically occurred over the long term, is expected to be reduced (at least temporarily) because there would be more area for future sediment deposition.

2.1.2.10.6 Rehabilitate Channel and Floodplain

This strategy is not suitable because the reach over the long term is aggrading.

2.1.2.10.7 Manage Sediment

Reach Effects – The effects of managing sediment on a reach basis consist of those due to reducing sediment supply as described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. The trends of aggradation, channel plugging with sediment, perched channel conditions, and increased channel uniformity are addressed through storage of excess sediment supply. Federal land ownership of the majority of surrounding land means there is space available for constructed or natural basins. Wide variations in topography mean that using existing low spots is possible, minimizing implementation. If the deepest of the low spots are selected for implementation, higher discharges will be required for flows to go over bank, at least temporarily. Sinuosity will be a function of the locations selected for implementation.

Effects on Upstream and Downstream Reaches – The general upstream and downstream effects are described in Table 6 of the Strategy Effects (Appendix E) for the sediment transport capacity less than sediment supply case. The increased sediment deposition will reduce the sediment load reaching Elephant Butte Reservoir, extending its useful capacity life. Bed material size downstream from the deposition basins is expected to coarsen but remain in sand sizes. The downstream channel bed is likely to degrade because of basin sediment storage within this reach. The San Antonio Bridge to RM 78 Reach aggradation, which has historically occurred over the long term, is expected to be reduced (at least temporarily) because there would be more space for future sediment deposition in this reach. The channel bed upstream may aggrade in the future depending upon the rate basins fill with sediment and how often they are relocated. Channel lowering may occur in upstream reaches if the elevation difference between the current channel bed and the new alignment through the basins is great enough.

2.1.3 Most Likely Biological Effects of River Maintenance Strategies on Silvery Minnow, Flycatcher, Cuckoo, and Mouse by Reach

Tables III-18, III-19, III-20, and III-21 display the general reach by reach analysis of effects to silvery minnow, flycatcher, cuckoo, jumping mouse and their associated habitats from changes expected by implementing actions and strategies to achieve river maintenance goals identified in the Proposed Action for Reclamation (Section 1.2.8). The effects are general in nature and evaluate whether the river maintenance strategy would indicate a positive or negative outcome for the reach. Where the probable magnitude of an effect is known, it is analyzed. The effects of these strategies on critical habitat of silvery minnow and flycatchers and proposed critical habitat of cuckoo and jumping mouse would be variable depending on the design and location of the project. Most types of projects are expected to have a temporary adverse effect to critical habitat through disturbance to the water quality or riparian vegetation. Long-term indirect effects of most projects are expected to be beneficial.

2.2 River Maintenance Project Site Effects

The long-term geomorphic effects on the river and species habitat of a river maintenance site project are local in nature. There are short-term impacts for each of these method types that are related to the size of the impact area, the location or the project, implementation techniques and duration. The estimated effects are described by method in Section 2.2.1. Effects from river maintenance support activities and unanticipated and interim work are described in Sections 2.2.2 and 2.2.3. Effects predictions of specific acreages of impacts are analyzed in Section 2.2.4.

2.2.1 Effects of River Maintenance Methods

River maintenance methods, and their expected local geomorphic effects, are described in the River Maintenance Methods (Appendix C). A summary of predicted effects on species, river geomorphology, and habitat is provided in Table III-22. The geomorphic changes from a specific method in an isolated location are expected to be local in nature and have a negligible effect on the reach morphology.

Table III-18. Predicted effects to silvery minnow habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
Velarde to Rio Chama		No effects to silvery minnow or silvery minnow critical habitat.		No effects to silvery minnow or silvery minnow critical habitat.	No effects to silvery minnow or silvery minnow critical habitat.	
Rio Chama to Otowi Bridge	No effects to silvery minnow or silvery minnow critical habitat.	No effects to silvery minnow or silvery minnow critical habitat.		No effects to silvery minnow or silvery minnow critical habitat.	No effects to silvery minnow or silvery minnow critical habitat.	
Cochiti Dam to Angostura Diversion Dam	The current distribution of silvery minnow and habitat within the Cochiti Dam to Angostura Diversion Dam Reach is unknown. Though current conditions are not favorable to silvery minnow, any activity to promote elevation stability should maintain current conditions. The proposed action will not change current conditions. Channel spanning features to promote elevation stability would be constructed to facilitate movement of silvery minnow.	The current distribution of silvery minnow and habitat within the Cochiti Dam to Angostura Diversion Dam Reach is unknown. Methods to promote alignment stability may reduce the rivers potential to maintain habitat complexity.		Implementing projects to increase the channel area are likely to have a positive impact on habitat diversity for silvery minnow by increasing sinuosity and hydrologically connected surfaces. Downstream effects are minimized by Angostura Diversion Dam.	Implementation of methods intended to reconnect the flood plain at lower discharge levels are likely to have positive effects on silvery minnow habitat by creating high productivity larval fish habitats that are inundated more often than existing conditions. There is the possibility that silvery minnow may become entrained on the flood plain when inundation subsides, which may result in take.	

Table III-18. Predicted effects to silvery minnow habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
Angostura Diversion Dam to Isleta Diversion Dam	This reach is currently occupied by silvery minnow. Any activity to promote elevation stability should maintain or improve current conditions for silvery minnow. Channel spanning features to promote elevation stability would be constructed to facilitate movement of silvery minnow.	This reach is currently occupied by silvery minnow. Strategies to promote alignment stability may reduce habitat complexity.			Methods to rehabilitate the channel and flood plain are generally designed to help the river function more naturally and benefit silvery minnow. There is the possibility that silvery minnow may become entrained on the flood plain when inundation subsides, which may result in take.	Likely would maintain current conditions within the reach.
Isleta Diversion Dam to Rio Puerco	This reach is currently occupied by silvery minnow. Any activity to promote elevation stability should maintain or improve current conditions for silvery minnow. Channel spanning features to promote elevation stability would be constructed to facilitate movement of silvery minnow.		Depending on the method used, long term effects may be positive or negative. Methods that decrease complexity are negative, strategies that allow for reconnection of abandoned side channels and backwaters would be positive.	Implementing projects to increase the channel area are likely to have a positive impact on habitat diversity for silvery minnow by increasing sinuosity and hydrologically connected surfaces.	Methods to rehabilitate the channel and flood plain are generally designed to help the river function more naturally and benefit silvery minnow. There is the possibility that silvery minnow may become entrained on the flood plain when inundation subsides, which may result in take.	Likely would maintain current conditions within the reach. Depositional bars and islands may form downstream of augmentation sites. This may increase habitat complexity for silvery minnow.

Table III-18. Predicted effects to silvery minnow habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
Rio Puerco to San Acacia Diversion Dam	This reach is currently occupied by silvery minnow. Any activity to promote elevation stability should maintain or improve current conditions for silvery minnow. Channel spanning features to promote elevation stability would be constructed to facilitate movement of silvery minnow	This reach is currently occupied by silvery minnow. Strategies to promote alignment stability may reduce habitat complexity.		Implementing projects to increase the channel area are likely to have a positive impact on habitat diversity for silvery minnow by increasing sinuosity and hydrologically connected surfaces.	Methods to rehabilitate the channel and flood plain are generally designed to help the river function more naturally and benefit silvery minnow. There is the possibility that silvery minnow may become entrained on the flood plain when inundation subsides that may result in take.	
San Acacia Diversion Dam to Arroyo de las Cañas	This reach is currently occupied by silvery minnow. Any activity to promote elevation stability should maintain or improve current conditions for silvery minnow. Channel spanning features to promote elevation stability would be constructed to facilitate movement of silvery minnow	This reach is currently occupied by silvery minnow. Strategies to promote alignment stability may reduce habitat complexity.		Implementing projects to increase the channel area are likely to have a positive impact on habitat diversity for silvery minnow by increasing sinuosity and hydrologically connected surfaces.	Strategies to rehabilitate the channel and flood plain are generally designed to help the river function more naturally and benefit silvery minnow. There is the possibility that silvery minnow may become entrained on the flood plain when inundation subsides that may result in take.	Likely would maintain current conditions within the reach.
Arroyo de las Cañas to San Antonio Bridge	Suitable strategy, likely to be implemented by methods falling under the other strategies identified for this reach.		Overbank area is expected to decrease temporarily.			Likely would maintain current conditions within the reach.

Table III-18. Predicted effects to silvery minnow habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
San Antonio Bridge to River Mile 78	Suitable strategy, likely to be implemented by methods falling under the other strategies identified for this reach.		Overbank area is expected to decrease. Increased water and sediment delivery to lower reaches may change likelihood of drying in those reaches.	Implementing projects to increase the channel area are likely to have a positive impact on habitat diversity for silvery minnow by allowing avulsions to occur, increasing hydrologically connected surfaces.		Likely would maintain current conditions within the reach.
River Mile 78 to Full Pool Elephant Butte Reservoir Level	Suitable strategy, likely to be implemented by methods falling under the other strategies identified for this reach.		Overbank area is expected to decrease temporarily.	Implementing projects to increase the channel area are likely to have a positive impact on habitat diversity for silvery minnow by increasing sinuosity and hydrologically connected surfaces.		Likely would maintain current conditions within the reach. May cause less aggradation in upstream reaches

Table III-19. Predicted effects to flycatcher habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
Velarde to Rio Chama		This reach has minimal flycatcher territories and suitable habitat. This strategy decreases the erosion and deposition ability of the river, from lateral erosion, in turn decreasing the opportunity for a variety of successional stages needed for flycatcher habitat. However, deposition and erosion processes may still continue on bars and islands.		This reach has minimal flycatcher territories and suitable habitat. Positive impacts to flycatcher habitat with this strategy and habitat availability in this reach likely would increase with the added area the river could potentially meander.	This reach has minimal flycatcher territories and suitable habitat. This strategy would increase overbank wetted area and may increase the channel sinuosity. Minimal effects are expected upstream of and downstream from this reach. Flycatcher habitat may improve.	
Rio Chama to Otowi Bridge	Minimal flycatcher territories and suitable habitat in this reach. No impact on flycatcher. If anything, positive, as it would not let further incision occur in this reach.	Minimal flycatcher territories and suitable habitat in this reach. Alignment stability decreases erosion and deposition for regenerating flycatcher habitat from lateral erosion. However, deposition and erosion processes may still continue on bars and islands.		Minimal flycatcher territories and suitable habitat in this reach. Allowing the river to meander over a greater flood plain could create new and younger age classes of vegetation for flycatcher through erosion and deposition of sediments. Flycatcher habitat could improve with a meandering river.	Minimal flycatcher territories and suitable habitat in this reach. This strategy could have a positive impact on flycatcher habitat from the increased likelihood of overbank flooding and greater sinuosity.	

Table III-19. Predicted effects to flycatcher habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
Cochiti Dam to Angostura Diversion Dam	This reach does not have flycatchers or flycatcher suitable habitat. Stabilizing the bed elevation would at least prevent further degradation of flycatcher habitat in this reach.	This reach does not have flycatchers or flycatcher suitable habitat. Reduced ability for erosion and deposition from lateral erosion needed for flycatcher habitat. However, deposition and erosion processes may still continue locally on bars and islands.		This reach does not have flycatchers or flycatcher suitable habitat. Allowing the river to meander over a greater flood plain could create new and younger age classes of vegetation for flycatcher through erosion and deposition of sediments.	This reach does not have flycatchers or flycatcher suitable habitat. Flycatcher habitat within this reach would not be affected as there really is none, or the potential for habitat creation would be slightly improved.	
Angostura Diversion Dam to Isleta Diversion Dam	Minimal flycatcher territories and suitable habitat. Current suitable habitat becoming over mature and declining in value for flycatchers. Preventing channel incision would help prevent further decrease in flycatcher habitat.	Minimal flycatcher territories and suitable habitat. Current suitable habitat becoming over mature and declining in value for flycatchers. No significant change to flycatcher habitat would occur.			Minimal flycatcher territories and suitable habitat. Current suitable habitat becoming over mature and declining in value for flycatchers. Flycatcher habitat within this reach would not be affected or would be slightly improved with an increased likelihood of flooding.	Minimal flycatcher territories and suitable habitat. Current suitable habitat becoming over mature and declining in value for flycatchers. Sediment management may build desirable point bar habitat for fly-catcher. However, the patch size may not be large enough for flycatcher. This reach has a low sediment supply and increasing the sediment supply could create islands and increased shoreline habitats.

Table III-19. Predicted effects to flycatcher habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
Isleta Diversion Dam to Rio Puerco	Promoting elevation stability in this reach likely would not have a great impact on flycatcher habitat as there is not much currently present. However, this strategy would prevent future channel incision in this reach.		Minimal flycatcher habitat or territories within this reach. Overall, this strategy would not change flycatcher habitat significantly from existing conditions. If management activities are taken that allows bed elevation increases and reconnection of side channels and backwaters, benefits to flycatcher habitat would occur.	Minimal flycatcher territories and suitable habitat in this reach. Current suitable habitat becoming over mature and declining in value for flycatchers. Impacts to flycatcher habitat from this strategy could be positive if the river were to migrate to occupy the newly available area.	Minimal flycatcher territories and suitable habitat in this reach. Flycatcher habitat may benefit from increasing overbank flooding.	Minimal flycatcher territories and suitable habitat in this reach. Impacts for flycatcher depend on the type of sediment management.
Rio Puerco to San Acacia Diversion Dam	No impact on flycatcher. If anything, positive as it would not let further incision occur in this reach and allow a continuation of overbank flooding.	This reach has historically had populations of flycatchers and suitable habitat. This strategy decreases the river's abilities for erosion and deposition from lateral migration and, thus, decreases regenerating flycatcher habitat.		Allowing the river to meander over a greater flood plain could create new and younger age classes of vegetation through erosion and deposition, potentially improving and regenerating flycatcher habitat.	This reach has had localized populations of flycatchers and areas of suitable habitat. Habitat for flycatcher in this reach likely would be improved by this strategy by providing increased overbank flooding.	

Table III-19. Predicted effects to flycatcher habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
San Acacia Diversion Dam to Arroyo de las Cañas	No impact on flycatcher as there are very few areas with suitable habitat or historic flycatcher territories. If anything, positive as it would not let further incision occur in this reach.	The river's ability for erosion and deposition would decrease, decreasing the potential for creating flycatcher habitat.		By increasing the space available for river movement, the potential for suitable conditions for seed establishment and creation of new flycatcher habitat would increase.	This strategy could have a positive impact on future potential flycatcher habitat from the increased likelihood of overbank flooding. Minimal areas of suitable or occupied habitat exist presently within this reach.	This reach likely would require the addition of sediment which would allow for some aggradation that would be beneficial for any potential flycatcher habitat creation in the future.
Arroyo de las Cañas to San Antonio Bridge	This strategy within this reach would involve stabilizing a rising bed, which would be achieved primarily through the Reconstruct/ Maintain Channel Capacity and Manage Sediment Strategies.		Overall, this strategy would not change the minimal flycatcher habitat existing currently within this reach. This reach currently has an aggrading channel and attached side channels; main-taining that trend would increase the possibility of flycatcher habitat creation. However, the maintenance of channel capacity in this reach may cause a reduction in potential overbank flooding and may reduce the possibility in habitat creation.			This strategy would not change flycatcher habitat significantly from existing conditions as there are minimal areas of suitable habitat or historic territories within this reach. However, the reduction in sediment in this reach may cause a reduction in potential overbank flooding and may reduce the possibility in habitat creation.

Table III-19. Predicted effects to flycatcher habitat from river maintenance strategies in various reaches

	Promote Elevation Stability	Promote Alignment Stability	Reconstruct/ Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Flood Plain	Manage Sediment
San Antonio Bridge to River Mile 78	This strategy within this reach would involve stabilizing a rising bed, which would be achieved primarily through the Reconstruct/ Maintain Channel Capacity, Increase Available Area to the River, and Manage Sediment Strategies.		There is a large population of flycatchers and an abundance of suitable habitat within this reach. Flycatcher impacts will depend on site locations and need site assessments.	This strategy would be beneficial to the abundance of currently existing flycatcher habitat by allowing the river to aggrade and potentially move into a larger flood plain, expanding habitat in the future.		Impacts would be site-specific for the large flycatcher population, but decreasing aggradation and the potential for occurrence of sediment plugs would negatively impact existing and developing flycatcher habitat.
River Mile 78 to Full Pool Elephant Butte Reservoir Level	No impact on the moderate amount of flycatcher habitat and territories mainly located in the northern extent of this reach. This strategy within this reach would involve stabilizing a rising bed, which would be achieved primarily through the Reconstruct/ Maintain Channel Capacity, Increase Available Area to the River, and Manage Sediment Strategies.		Removing sediment and preventing overbank flooding would be a detriment to flycatcher habitat. In instances where the channel would be relocated, if done so with a minimal bank height and an opportunity for overbank flooding, creation of flycatcher habitat may be possible.	Generally positive for flycatcher but needs to be accompanied by sediment management that promotes aggradation and the formation of potentially suitable flycatcher habitat, particularly in the severely degraded downstream portion of this reach. In areas where the bed degradation is currently below the root zone, the collapse of the bank may allow the formation of potentially suitable flycatcher habitat within the channel to occur.		Sediment augmentation may improve current flycatcher habitat in downstream portions of this reach, but settling basins would have the opposite effect. This strategy is very site-specific and depends on the Elephant Butte Reservoir level, and the incoming sediment supply in some areas the basin may create habitat, but require higher flows to allow for overbank flooding in other areas.

Table III-20. Predicted effects to cuckoo habitat from river maintenance strategies in various reaches

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Velarde to Rio Chama		This reach has an unknown number of breeding territories and has areas within this reach have been proposed for critical habitat designation. This strategy decreases the erosion and deposition ability of the river, from lateral erosion in turn decreasing the opportunity for a variety of successional stages needed for cuckoo habitat.		This reach has an unknown number of breeding territories and has areas within this reach have been proposed for critical habitat designation. Positive impacts to cuckoo habitat with this strategy and habitat availability in this reach would likely increase with the added area the river could potentially meander.	This reach has an unknown number of breeding territories and has areas within this reach have been proposed for critical habitat designation. This strategy would increase overbank wetted area and may increase the channel sinuosity. Minimal effects are expected upstream and downstream of this reach Cuckoo habitat may improve.	
Rio Chama to Otowi	This reach has no known cuckoo breeding territories and no proposed critical habitat. No impact on cuckoo. If anything, positive as it would not let further incision occur in this reach.	This reach has no known cuckoo breeding territories and no proposed critical habitat. Alignment stability decreases erosion and deposition for regenerating potential cuckoo habitat from lateral erosion.		This reach has no known cuckoo breeding territories and no proposed critical habitat. Allowing the river to meander over a greater floodplain could create new and younger age classes of vegetation creating that dynamic riverine process for cuckoo through erosion and deposition of sediments. Chances of potential cuckoo habitat could improve with a meandering river.	This reach has no known cuckoo breeding territories and no proposed critical habitat. This strategy could have a positive impact on potential cuckoo habitat from the increased likelihood of overbank flooding and greater sinuosity.	

Table III-20. Predicted effects to cuckoo habitat from river maintenance strategies in various reaches

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Cochiti Dam to Angostura Dam	This reach has an unknown number of breeding cuckoos and very little suitable habitat is present. Areas within this reach have been proposed for critical habitat designation. Stabilizing the bed elevation would at least prevent further degradation of possible cuckoo habitat in this reach.	This reach has an unknown number of breeding cuckoos and very little suitable habitat is present. Areas within this reach have been proposed for critical habitat designation. Reduced ability for erosion and deposition from lateral erosion needed for potential cuckoo habitat.		This reach has an unknown number of breeding cuckoos and very little suitable habitat is present. Areas within this reach have been proposed for critical habitat designation. Allowing the river to meander over a greater floodplain could create new and younger age classes of vegetation creating that dynamic riverine process for cuckoos through erosion and deposition of sediments.	This reach has an unknown number of breeding cuckoos and very little suitable habitat is present. Areas within this reach have been proposed for critical habitat designation. Cuckoo habitat within this reach would likely not be affected, or the potential for habitat creation would be slightly improved.	

Table III-20. Predicted effects to cuckoo habitat from river maintenance strategies in various reaches

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Angostura Dam to Isleta Dam	Cuckoo critical habitat has been proposed within this reach, though the habitat itself is considered marginal. There are an unknown number of breeding cuckoos within this reach. Current suitable habitat is likely becoming over-mature and declining in value for cuckoos. Preventing channel incision would help prevent further decrease in cuckoo habitat.	Cuckoo critical habitat has been proposed within this reach, though the habitat itself is considered marginal. There are an unknown number of breeding cuckoos within this reach. Current suitable habitat is likely becoming over-mature and declining in value for cuckoos. No significant change to possible cuckoo habitat would occur.		?	Cuckoo critical habitat has been proposed within this reach, though the habitat itself is considered marginal. There are an unknown number of breeding cuckoos within this reach. Current suitable habitat is likely becoming over-mature and declining in value for cuckoos. Any potential cuckoo habitat within this reach would not be affected or would be slightly improved with an increased likelihood of flooding.	Cuckoo critical habitat has been proposed within this reach, though the habitat itself is considered marginal. There are an unknown number of breeding cuckoos within this reach. Current suitable habitat is likely becoming over-mature and declining in value for cuckoos. Sediment management may build desirable point bar, but the patch size will not be large enough for cuckoos. This reach has a low sediment supply and increasing the sediment supply could create islands and increased shoreline habitats.

Table III-20. Predicted effects to cuckoo habitat from river maintenance strategies in various reaches

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Isleta to Rio Puerco	Promoting elevation stability in this reach would likely benefit the minimal cuckoo habitat present within this reach This strategy would prevent future channel incision in this reach.		Minimal cuckoo habitat or territories within this reach, but critical habitat is proposed throughout the reach in its entirety. Overall, this strategy would not change cuckoo habitat significantly from existing conditions. If management activities are taken that allows bed elevation increases and reconnection of side channels and backwaters, benefits to cuckoo habitat would occur.	Minimal cuckoo habitat or territories, but critical habitat is proposed throughout the reach in its entirety. Current suitable habitat becoming over-mature and declining in value for cuckoos. Impacts to cuckoo habitat from this strategy could be positive if the river were to migrate to occupy the newly available area.	Minimal cuckoo territories or suitable habitat in this reach, but critical habitat is proposed throughout the reach in its entirety. . Cuckoo habitat may benefit from increasing overbank flooding.	Minimal cuckoo territories or suitable habitat in this reach, but critical habitat is proposed throughout the reach in its entirety. . Impacts for cuckoos depend on the type of sediment management.
Rio Puerco to San Acacia	No impact on cuckoo. If anything, positive as it would not let further incision occur in this reach and allow a continuation of overbank flooding.	This reach has historically had breeding cuckoo territories and suitable habitat. This reach, in its entirety, is also proposed critical habitat. This strategy decreases the river's abilities for erosion and deposition from lateral migration, and thus decreases regenerating cuckoo habitat.		Allowing the river to meander over a greater floodplain could create new and younger age classes of vegetation through erosion and deposition, potentially improving and regenerating cuckoo dynamic riverine habitat.	This reach has had localized populations of cuckoos and areas of suitable habitat. This reach, in its entirety, is also proposed critical habitat. Habitat for cuckoos in this reach would likely be improved by this strategy by providing increased overbank flooding	

Table III-20. Predicted effects to cuckoo habitat from river maintenance strategies in various reaches

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
San Acacia to Arroyo de las Cañas	No impact on cuckoo habitat. If anything, positive as it would not let further incision occur in this reach.	The river's ability for erosion and deposition would decrease, decreasing the potential for creating cuckoo habitat.		By increasing the space available for river movement, the potential for suitable conditions for seed establishment and creation of new cuckoo habitat would increase.	This strategy could have a positive impact on future potential cuckoo habitat from the increased likelihood of overbank flooding. Minimal areas of suitable or occupied habitat exist presently within this reach, though the reach is proposed critical habitat.	This reach would likely require the addition of sediment ,which would allow for some aggradation and would be beneficial for any potential cuckoo habitat creation in the future.
Arroyo de las Cañas to San Antonio	This strategy within this reach would involve stabilizing a rising bed, which would be achieved primarily through the Reconstruct/Maintain Channel Capacity and Manage Sediment strategies.		Overall, this strategy would not change the minimal cuckoo habitat existing currently within this reach. This reach currently has an aggrading channel and attached side channels, maintaining that trend would increase the possibility of cuckoo habitat creation. However, the maintenance of channel capacity in this reach may cause a reduction in potential overbank flooding and may reduce the possibility in habitat creation.			This strategy would not change cuckoo habitat significantly from existing conditions as there are minimal areas of suitable habitat within this reach. However, the reduction in sediment in this reach may cause a reduction in potential overbank flooding and may reduce the possibility in habitat creation.

Table III-20. Predicted effects to cuckoo habitat from river maintenance strategies in various reaches

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
San Antonio to top of Delta Channe	This strategy within this reach would involve stabilizing a rising bed, which would be achieved primarily through the Reconstruct/Maintain Channel Capacity, Increase Available Area to the River, and Manage Sediment strategies.		There have historically been several cuckoo territories within this reach and is currently proposed critical habitat. Cuckoo impacts will depend on site locations and need site assessments.	This strategy would be beneficial to the abundance of currently existing cuckoo habitat by allowing the river to aggrade and potentially move into a larger floodplain, expanding habitat in the future.		Impacts would need to be evaluated based on project details for the cuckoo population, but decreasing aggradation and the potential for occurrence of sediment plugs would negatively impact existing and developing cuckoo habitat.
River Mile 78 to Elephant Butte Reservoir	No impact on the moderate amount of cuckoo habitat and territories mainly located in the northern extent of this reach. This strategy within this reach would involve stabilizing a rising bed, which would be achieved primarily through the Reconstruct/Maintain Channel Capacity, Increase Available Area to the River, and Manage Sediment strategies.		Removing sediment and preventing overbank flooding would be a detriment to cuckoo habitat. In instances where the channel would be relocated, if done so with a minimal bank height and an opportunity for overbank flooding, creation, restoration, or preservation of cuckoo habitat may be possible.	Generally positive for cuckoo but needs to be accompanied by sediment management that promotes aggradation and the formation of potentially suitable cuckoo habitat, particularly in the severely degraded downstream portion of this reach. In areas where the bed degradation is currently below the root zone, the collapse of the bank may allow the formation of potentially suitable cuckoo habitat within the channel to occur.		Sediment augmentation may improve current cuckoo habitat in downstream portions of this reach, but settling basins would have the opposite effect. This strategy is very site-specific and depends on the Elephant Butte Reservoir level and the incoming sediment supply. In some areas the basin may create habitat, but require higher flows to allow for overbank flooding in other areas.

Table III-21. Predicted effects to jumping mouse habitat from river maintenance strategies in various reaches.

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Velarde to Rio Chama		It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Ohkay Owingeh Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. This strategy decreases the erosion and deposition potential of the river, from lateral erosion in turn decreasing the opportunity for a variety of successional vegetation stages. This strategy protects existing infrastructure where mouse habitat occurs from lateral erosion		It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Ohkay Owingeh Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Habitat availability in this reach may increase with the added area the river could potentially meander.	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Ohkay Owingeh Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. This strategy may increase overbank wetted area and may increase the channel sinuosity, and therefore may increase habitat availability.	

Table III-21. Predicted effects to jumping mouse habitat from river maintenance strategies in various reaches.

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Rio Chama to Otowi Bridge	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Ohkay Owingeh Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. No impact on jumping mouse. If anything, the impact may be positive as it would not let further incision occur in this reach.	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Ohkay Owingeh Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. This strategy protects existing infrastructure where mouse habitat may occur.		It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Ohkay Owingeh Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. No impact on jumping mouse. Allowing the river to meander over a greater floodplain could create new and younger age classes of vegetation creating that dynamic riverine process for jumping mouse through erosion and deposition of sediments. Chances of jumping mouse habitat development could improve with a meandering river.	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Ohkay Owingeh Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. No impact on jumping mouse. This strategy could have a positive impact on jumping mouse habitat development from the increased likelihood of overbank flooding and greater sinuosity.	

Table III-21. Predicted effects to jumping mouse habitat from river maintenance strategies in various reaches.

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Cochiti Dam to Angostura Dam	This reach has no known jumping mouse populations and no proposed critical habitat. Stabilizing the bed elevation would at least prevent further degradation of any suitable jumping mouse habitat in this reach.	This reach has no known jumping mouse populations and no proposed critical habitat. This strategy protects existing infrastructure where mouse habitat may occur.		This reach has no known jumping mouse populations and no proposed critical habitat. Allowing the river to meander over a greater floodplain could create new and younger age classes of vegetation creating a dynamic riverine process for jumping mouse habitat development through erosion and deposition of sediments.	This reach has no known jumping mouse populations and no proposed critical habitat. Any suitable jumping mouse habitat within this reach would likely not be affected, or the potential for suitable habitat creation would be slightly improved.	
Angostura Dam to Isleta Dam	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Preventing channel incision would help prevent further a decrease in jumping mouse habitat.	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. This strategy protects existing infrastructure where mouse habitat occurs.			It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Any suitable jumping mouse habitat within this reach would not be affected or would be slightly improved with an increased likelihood of flooding.	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Sediment management may build desirable point bars that if vegetated could provide jumping mouse habitat.

Table III-21. Predicted effects to jumping mouse habitat from river maintenance strategies in various reaches.

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
Isleta to Rio Puerco	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Preventing channel incision would help prevent further a decrease in jumping mouse habitat.		It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Overall, this strategy would not change jumping mouse habitat significantly from existing conditions. If management activities are taken that allows bed elevation increases and reconnection of side channels and backwaters, benefits to jumping mouse habitat could occur.	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Impacts to jumping mouse habitat from this strategy could be positive if the river were to migrate and create new habitat.	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Jumping mouse habitat may benefit from increasing overbank flooding.	It is unknown if jumping mice presently inhabit this reach, though historically they occurred at Isleta Pueblo. Parts of the Pueblo are currently being proposed for critical habitat designation based on past presence of the species. Impacts for jumping mice depend on the type of sediment management.
Rio Puerco to San Acacia	This reach has no known jumping mouse populations and no proposed critical habitat. No impact on jumping mouse. If anything, positive as it would not let further incision occur in this reach and allow a continuation of overbank flooding.	This reach has no known jumping mouse populations and no proposed critical habitat. This strategy decreases the river's abilities for erosion and deposition from lateral migration, thus protecting existing habitat but decreasing the potential for new habitat creation.		This reach has no known jumping mouse populations and no proposed critical habitat. Allowing the river to meander over a greater floodplain could create new vegetation through erosion and deposition, potentially improving and regenerating jumping mouse riverine habitat.	This reach has no known jumping mouse populations and no proposed critical habitat. Habitat for jumping mouse in this reach would likely be improved by this strategy by providing increased overbank flooding	

Table III-21. Predicted effects to jumping mouse habitat from river maintenance strategies in various reaches.

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
San Acacia to Arroyo de las Cañas	This reach has no known jumping mouse populations and no proposed critical habitat. No impact on jumping mouse habitat. If anything, positive as it would not let further incision occur in this reach.	This reach has no known jumping mouse populations and no proposed critical habitat. This strategy decreases the river's abilities for erosion and deposition from lateral migration, thus protecting existing habitat but decreasing the potential for new habitat creation.		This reach has no known jumping mouse populations and no proposed critical habitat. By increasing the space available for river movement, the potential for suitable conditions for seed establishment and creation of new jumping mouse habitat would increase.	This reach has no known jumping mouse populations and no proposed critical habitat. This strategy could have a positive impact on future jumping mouse habitat from the increased likelihood of overbank flooding.	This reach has no known jumping mouse populations and no proposed critical habitat. This reach would likely require the addition of sediment, which would allow for some aggradation that would be beneficial for any potential jumping mouse habitat creation in the future.
Arroyo de las Cañas to San Antonio	This reach has no known jumping mouse populations and no proposed critical habitat. This strategy within this reach would involve stabilizing a rising bed, which would be achieved primarily through the Reconstruct/Maintain Channel Capacity and Manage Sediment strategies.		This reach has no known jumping mouse populations and no proposed critical habitat. Overall, this strategy would not change the jumping mouse habitat within this reach. This reach currently has an aggrading channel and attached side channels, maintaining that trend would increase the possibility of jumping mouse habitat creation. However, the maintenance of channel capacity in this reach may cause a reduction in potential overbank flooding and may reduce the possibility of habitat creation.			This reach has no known jumping mouse populations and no proposed critical habitat. This strategy would not change jumping mouse habitat significantly from existing conditions. However, the reduction in sediment in this reach may cause a reduction in potential overbank flooding and may reduce the possibility of habitat creation.

Table III-21. Predicted effects to jumping mouse habitat from river maintenance strategies in various reaches.

Reach	Promote Elevation Stability	Promote Alignment Stability	Reconstruct /Maintain Channel Capacity	Increase Available Area to the River	Rehabilitate Channel and Floodplain	Manage Sediment
San Antonio to top of Delta Channel	The only known extant population of jumping mice within the MRG occur in this reach at BDA. Areas within the BDA are currently being proposed for critical habitat designation. River maintenance occurs along existing floodway and not where jumping mouse currently exists on BDA canals and ditches. This strategy within this reach would involve stabilizing a rising bed, which would be achieved primarily through the Reconstruct/Maintain Channel Capacity, Increase Available Area to the River, and Manage Sediment strategies.		The only known extant population of jumping mice within the MRG occur in this reach at BDA. Areas within the BDA are currently being proposed for critical habitat designation. River maintenance occurs along existing floodway and not where jumping mouse currently exists on BDA canals and ditches. Jumping mouse impacts will depend on site locations and need site assessments.	The only known extant population of jumping mice within the MRG occur in this reach at BDA. Areas within the BDA are currently being proposed for critical habitat designation. River maintenance occurs along existing floodway and not where jumping mouse currently exists on BDA canals and ditches. This strategy would be beneficial to the jumping mouse habitat development by allowing the river to aggrade and potentially move into a larger floodplain, potentially expanding habitat in the future.		The only known extant population of jumping mice within the MRG occur in this reach at BDA. Areas within the BDA are currently being proposed for critical habitat designation. River maintenance occurs along existing floodway and not where jumping mouse currently exists on BDA canals and ditches. Impacts would need to be evaluated based on project details for the jumping mouse population, but decreasing aggradation and the potential for occurrence of sediment plugs could negatively impact developing jumping mouse habitat.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Infrastructure relocation or setback	Generally out of floodplain; can be positive for silvery minnow habitat by allowing sinuosity and habitat diversity. Generally positive for flycatcher and cuckoo habitat by allowing for a wider as opposed to deeper river system. A greater likelihood of overbank flooding. Generally positive for jumping mouse habitat as it creates a wider river with slower moving water and may create or expand existing wetland.	Can encourage current geomorphic processes to continue, such as bend migration, and the creation of new floodplain and riparian areas. Opportunity to connect to historical channels and oxbows. For incised channels, may provide an opportunity to establish new inset floodplain and riparian zone. Bank erosion should also result in deposition of sediment downstream and potentially establish bars and low surfaces. Bend migration can erode banks causing riparian vegetation to fall into the channel.	Inset floodplain increases overbank flooding and riparian zones, which creates variable depth and velocity habitat types including potential spring runoff silvery minnow nursery habitat. The lateral and down valley migration of the river provides more opportunity for successional age classes of potentially native vegetation for flycatcher and cuckoo habitat. Generally positive for jumping mouse habitat as it creates a wider river with slower moving water and may create or expand existing wetland. Bend migration creates broader floodplain and more favorable riparian zone habitat that could benefit jumping mouse. Longer meander bends may establish greater pool depth and eroding banks providing additional complexity.
Channel Modification			
Complete Channel Reconstruction and Maintenance	Depends on project design and scope. Generally negative for silvery minnow habitat due to decrease in low-velocity habitats. Projects may be designed to have less impact on silvery minnow habitat. Generally negative for flycatchers and cuckoos, if channel decreases potential for overbank flooding and/or acts as a drain, decreasing groundwater level that could cause stress for vegetation and eventually encourage exotic encroachment. Jumping mouse is only found on drains and canals on BDA.	Increased sediment transport through a delta or reconstructed channel. Decreases upstream channel aggradation. Can lead to channel bed lowering upstream of the project site, and low-flow alternate bars can form within the excavated channel. Relatively uniform width, depth, and velocity. Reduces braiding and split delta channels. Can lower the groundwater table, and reduce the size of river bars. If medial and alternate bars are not removed as part of ongoing maintenance, then the amount of shallower, lower velocity areas should increase.	Can have more uniform width, depth, and velocity. Limited amount of low or no velocity habitat; low amount of cover. Reduces braiding and distributary channels, and thus provides less opportunity for riparian growth. Lowers groundwater table and reduces the size of river bars. If medial and alternate bars are not removed as part of ongoing maintenance, then the amount of smaller depth and velocity habitat increases.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Channel Relocation Using Pilot Channels or Pilot Cuts	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat or may decrease habitat diversity by creating a monotypic channel for water conveyance. Projects may be designed to improve flycatcher and cuckoo habitat or may decrease habitat suitability if channel takes too long to widen and incision and lowering of the water table occurs. Projects may be designed to improve jumping mouse habitat, or may decrease suitability.	Lengthening can bring sediment transport capacity more in balance with sediment supply in supply-limited reaches. Reestablishes meanders, increases channel stability, and initiates new areas of bank erosion and deposition. Can provide overbank flooding and can create connected floodplain/ wetted areas.	Depending on project design and scope, can provide overbank flooding and establish new areas of riparian vegetation. Can increase the complexity of habitat by creating connected floodplain/wetted areas for silvery minnow egg entrainment and larval development. May enhance or create wetlands and riparian areas that could benefit jumping mouse.
Island and Bank Clearing and Destabilization	Generally positive for silvery minnow, reduces flow needed to inundate overbank habitat. Projects may be designed to improve flycatcher and cuckoo habitat or may decrease habitat suitability if channel takes too long to widen and incision and lowering of the water table occurs. Increased floodplain connectivity could improve jumping mouse habitat.	Promotes a wider channel with greater floodplain connectivity, and better transport capacity/supply balance. New sediment balance may be temporary unless increased supply is maintained. Reduces further degradation of the channel and lowering of the water table. learing and destabilization would result in the lowering and/or loss of islands and bars, but sediments from destabilized areas may deposit in new bars, which would be more connected to the main channel and suitable for vegetation growth. Cleared areas may become zones of sediment deposition and vegetation may regrow, making reclearing necessary for benefits to continue.	Islands/bars that are more connected to the main channel can provide silvery minnow with a greater variety of depth and velocity habitat types. Provides low-velocity habitat during high flows for adult fish. Increased overbank flooding creates variable depth and velocity habitat types including silvery minnow nursery habitat during spring runoff and aids in increasing egg and larval entrainment. Loss of flycatcher/cuckoo habitat may be temporarily negative depending on site specific details and proximity to territories; however, sediment accumulation forming new bars or islands could promote new seed establishment and potentially young native successional stands to develop into flycatcher/cuckoo habitat. By reducing further degradation of the channel and lowering of the water table, the floodplain has a better chance of connectivity, which is better overall for the flycatcher, cuckoo, and jumping mouse

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Bank Line Embayment	Depends on project design and scope. May be positive for silvery minnow by providing more low-velocity habitat for silvery minnow. May provide more surface water for vegetation, which would benefit cuckoos and possibly attract flycatchers establishing territories. Jumping mouse could also benefit from more wetted areas and wetland establishment.	Historical areas of channel slow water velocity and shallow bank line are restored/ rehabilitated. Bank line embayments are zones of sediment deposition and have a finite lifespan without periodic re-excavation.	Provides slow water velocity and shallow depth bank line habitat, which may increase egg retention and availability of nursery larval habitat during high flow. Increases probability of native vegetation growth and potential for flycatcher and cuckoo habitat. Results in an increase in herbaceous wetland vegetation, which could create additional jumping mouse habitat.
Pilot Cuts Through Sediment Plugs	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat or may decrease habitat diversity by creating a monotypic channel for water conveyance. Projects may be designed to improve flycatcher and cuckoo habitat via berm placement techniques that encourage sediment transport and deposition downstream for example, or may decrease habitat diversity by creating a monotypic channel for water conveyance that would decrease the chance of overbank flooding potential. Jumping mouse habitat improvement may occur if new areas of riparian vegetation are established or may decrease in the case of establishment of a monotypic channel.	Connecting small channels through sediment plugs results in plug material being transported downstream to re-establish preplug riverine conditions. Restores flow velocity and depth conditions found in the main river channel. Allows sediment transport to continue, which may possibly provide new bars and islands downstream.	Pilot cuts reduce the potential for silvery minnow stranding during receding flow conditions caused by sediment plugs. Allows sediment transport to continue, which may possibly provide new areas for riparian vegetation establishment, and possibly create additional jumping mouse habitat.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Side Channels (High Flow, Perennial, and Oxbow Re-establishment)	Generally positive for silvery minnow, provides greater habitat diversity. Generally positive for flycatcher and cuckoo, provides greater vegetation potential and increases water surface elevation. During construction, vegetation may need to be cleared, but long-term benefits could outweigh the disadvantages. An increase in vegetation adjacent to the side channels and reconnection of the floodplain to the channel could create habitat for the jumping mouse.	Important to natural systems for passage of peak flows. Sediment tends to fill in high-flow side channels over time. Can decrease peak-flow water surface elevation and may decrease sediment transport capacity until sediment blocks the side channel. Periodic inlets and outlet sediment removal may be needed to maintain project benefits. Side channels result in raising the groundwater table and can supply surface flows to overbank and floodplain areas. Can reconnect the floodplain to the channel, creating areas with variable depth and velocity.	Can result in higher groundwater table, increasing the health of the riparian zone. Can reconnect the floodplain to the channel, creating nursery habitat for silvery minnow with variable depth and velocity habitats. Provides low-velocity habitat during high flows for adult fish and developing larvae. Increase in retention of eggs and larvae during high flows. Raising the groundwater table to provide water to developing riparian areas increases vegetation health, which could benefit flycatchers, cuckoos, and jumping mice. Periods of increased surface flows, particularly during mid-May to mid-June, increases probability of flycatcher territory establishment in areas with suitable habitat.
Longitudinal Bank Lowering or Compound Channels	Generally positive for silvery minnow, reduces flow needed to inundate overbank habitat. Generally positive for flycatchers, cuckoos, and jumping mouse, and their associated habitat, reduces flow needed to inundate overbank habitat.	Lowered bank line can promote increases in channel width and decreases in main channel velocity, depth, shear stress, and sediment transport capacity. Reduces potential for channel degradation, thereby maintaining a higher water table and more connectivity with backwaters, side channels and floodplain. Increases overbank flooding, creating areas of variable depth and velocity.	Promotes overbank flooding favorable for establishment of riparian vegetation as well as creating variable depth and velocity habitat. Reduces potential for channel degradation, thereby maintaining a higher water table and more connectivity with backwaters and side channels. Increased overbank flooding creates variable depth and velocity habitat types including silvery minnow nursery habitat during spring runoff. Increased overbank flooding maintains moist soil conditions during flycatcher territory establishment. Growth of native riparian vegetation can enhance habitat conditions for the flycatcher and cuckoo. A higher water table and increased overbanking may improve jumping mouse habitat.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Longitudinal Dikes	Generally negative for silvery minnow habitat, reduces habitat complexity and sinuosity. Generally negative for flycatcher, cuckoo, and jumping mouse habitat; reduces habitat complexity and sinuosity. Construction activity is very intensive and requires a high amount of maintenance.	Can create a zone of higher main channel velocity resulting in increased sediment transport capacity. This can potentially cause the channel to deepen and create a sediment depositional zone downstream. Can decrease overbank flow area and can result in more uniform channel velocity and depth.	Can decrease overbank flows, reducing the health of riparian zone. This can be partially mitigated by providing culverts for wetting the riparian zone. Can result in more uniform channel velocity and depth.
Levee Strengthening	No change for silvery minnow, maintains current conditions. Depends on project design, scope and location. Projects would typically be in areas away from flycatchers and jumping mouse as they are typically located away from pre-existing levees and closer to the river or other water sources, and projects would also allow increased infrastructure capability to handle overbank flooding between the river and the levee, which would benefit flycatchers and cuckoos. Maintenance activity would be invasive to nearby vegetation.	The geomorphic response associated with levee installation has already occurred for the levee strengthening method. Initial levee construction generally resulted in floodplain narrowing. Raising or enlarging the levee causes very minor or no geomorphic effects. Small amounts of clearing may be required to enlarge the levee and reduce the side slope. May allow channel relocation nearer to levee.	Initial levee construction and the accompanying floodplain narrowing affect the habitat. Raising or enlarging the levee causes very minor or no habitat effects. Small amounts of clearing may be required to enlarge the levee and reduce the side slope.
Jetty/Snag Removal	Generally positive for silvery minnow; allows for bank migration and floodplain connectivity. Depends on project design and scope for flycatchers, cuckoos, and jumping mouse. By destabilizing the bank, could increase the possibility of lateral migration of the river or channel widening.	Jetty removal may result in channel widening and increased floodplain connectivity. Channel widening is less likely to occur where the riparian vegetation root zone provides more bank stability than the jetties. Channel widening (unless hampered by existing vegetation) could reduce channel flow depth and velocity.	The habitat may not change if the existing vegetation has more effect on bank stability than the jetties themselves. Otherwise, channel widening could reduce channel flow depth and velocity and create more bank line habitat.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Bank Protection/Stabilization			
Longitudinal Features			
Riprap Revetment	Generally negative for silvery minnow habitat, reduces habitat complexity and sinuosity. Riprap structures may provide habitat for predatory fishes. Depends on project design, scope, and location for flycatchers, cuckoos, and jumping mouse. Bank protection would protect suitable flycatcher and cuckoo habitat if present, but vegetation may already be declining in value in reaches where incision is to the point where lateral migration is occurring to such an extent that riprap revetment is necessary. Riprap could inhibit jumping mouse habitat from establishing adjacent to the river/drain.	Eliminates bank erosion; causes local scour and channel deepening. Studies about longer reach response are contradictory. Can be susceptible to flanking if upstream channel migration occurs. Prevents bend migration and the establishment of new depositional zones. Eliminates sediment supplied from local bank erosion. The point bar can remain connected to the main channel. The flow velocity, depth, and bank angle would be greater than typically found in natural channels along the outside bank of a river bend. Interstices within the riprap could host low-energy "pockets" along the bank.	Prevents bend migration and the establishment of new depositional zones where vegetation could become established. Eliminates sediment supplied from local bank erosion. The steep bank angle on the outside of the bend limits fish cover, except for the riprap interstitial spaces. The point bar remains connected to the main channel and remains static. The flow velocity and depth are greater than typically found in natural channels along the outside bank of a river bend.
Other Type of Revetments	Effects are essentially the same as riprap revetments.	Effects are essentially the same as riprap revetments.	Effects are essentially the same as riprap revetments
Longitudinal Stone Toe with Bioengineering	Effects are essentially the same as riprap revetments.	Similar to riprap revetment.	Same as riprap revetment. Bioengineering provides very minimal benefits to riparian community.
Trench Filled Riprap	Effects are essentially the same as riprap revetments.	Bank erosion processes continue until erosion reaches the location of the trench. After launching, response is the same as for riprap revetment.	Same as riprap revetment.
Riprap Windrow	Effects are essentially the same as riprap revetments.	Same as trench filled riprap.	Same as riprap revetment.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Deformable Stone Toe/Bioengineering and Bank Lowering	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat or may decrease habitat diversity by creating a high-velocity area with little habitat diversity. Projects may be designed to improve flycatcher, cuckoo, and jumping mouse habitat and lowering the banks on terraced locations could promote overbank flooding potential	The design is intended to allow bend migration at a slower rate than without protection. River maintenance may still be required in the future. Water surface elevations could be lower with bank lowering. After installation, and before the toe of the riprap becomes mobile, the channel bed may scour along the deformable bank line. Bank erosion occurs during peak-flow events, which mobilizes the small-sized riprap along the bank toe. Future bank migration would allow new depositional surfaces to be established.	If floodplain is created behind the stone toe and vegetation becomes established before the toe is lost, an expanded riparian area could develop. Future bank migration would allow new depositional surfaces to establish, which would become new riparian areas.
Bioengineering	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat or may decrease habitat diversity by creating a high velocity area with little habitat diversity. Bioengineering would not be a standalone method, and further analysis would need to be completed on a project specific description. May have long-term benefits to flycatchers, cuckoos, and jumping mouse.	Vegetation has the lowest erosion resistance of all available methods. Plantings require time to become established before any bank protection is realized. Lateral and down-valley bank line movement can continue because bioengineering does not permanently fix the bank location. Allows more natural movement of river channel.	If the technique is successful, it could promote the establishment and development of riparian vegetation without significant armament to the bank line. Allows more natural movement of river channel.
Riparian Vegetation Establishment	Effects of this type of project may be mixed. Initially vegetation may provide low-velocity refuge areas during overbank periods. Long-term establishment of vegetation may add to channel narrowing, which is negative for silvery minnow. Generally positive for flycatchers and cuckoos and their associated habitat. Encouraging new native growth could provide suitable habitat once mature. Generally positive for jumping mouse habitat.	Can cause sediment deposition in overbank areas due to increased flow resistance. Sediment deposition in the overbank can increase main channel sediment transport capacity by raising the bank height.	Directly adds to the amount of riparian vegetation. Increased growth of riparian vegetation in overbank areas can enhance habitat conditions for the silvery minnow, flycatcher, and cuckoo. Because this method is an intentional component of maintenance projects, it would be designed in a way to benefit the river system and not to contribute to overall vegetation encroachment trends.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Transverse Features or Flow Deflection Techniques	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat because they tend to create variable depth and velocity habitat, which increases complexity. In general, transverse features decrease bank erosion and deepen the main channel locally. Establishment of wetlands/riparian vegetation as a result of sediment deposition between structures could create mouse habitat.	These methods may cause local sediment deposition between structures and/or local scalloping along the bank line. Flow is deflected away from the bank line, thereby altering secondary currents and flow fields in the bend. Eddies, increased turbulence, and velocity shear zones are created. Methods induce local channel deepening at the tip. Shear stress increases in the center of the channel, which maintains sediment transport and flow capacity. Sediment deposition between structures may allow establishment of islands, bars, and backwater areas. Channel deepening and tip scour could occur locally.	Sediment deposition between structures may allow establishment of riparian vegetation and backwater areas. Channel deepening and tip scour could occur locally. Depending on site specific details, bendway weirs would allow for overbank flooding conditions for flycatchers. Local scour could provide habitat diversity and deep habitat during low-flow conditions.
Bendway Weirs	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat because they tend to create variable depth and velocity habitat, which increases complexity. Could trap sediment and encourage new vegetation growth. No significant effect on flycatcher or cuckoo habitat. Generally beneficial for jumping mouse if sediment is trapped and new vegetation growth occurs.	The location of the thalweg is shifted away from the outer bank line. Local scour at the tip occurs because of the three-dimensional flow patterns. Secondary currents are interrupted, and flows are redirected away from the bank. The outer bank can become a zone of lower velocity. The combined effect of the tip scour and lower velocity along the bank line creates a flow condition of variable depth and velocity. Scalloping also can occur along the bank line or sediment deposition between structures depending upon local conditions and bendway weir geometry. Can reduce local sediment supplied from bank erosion because the current river alignment is maintained.	Same as transverse features or flow deflection techniques above.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Spur Dikes	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat because they tend to create variable depth and velocity habitat, which increases complexity. Could trap sediment and encourage new vegetation growth. No significant effect on flycatcher or cuckoo habitat. Generally beneficial for jumping mouse if sediment is trapped and new vegetation growth occurs.	Spur dikes block the flow up to bank height, thus shifting the thalweg alignment to the dike tips. Peak flow capacity can be reduced initially until the channel adjusts. The channel adjusts to the presence of spur dikes by forming a deeper, narrower cross section with additional scour downstream of each spur dike. Sediment deposition can occur between spur dikes. There is a greater tendency for sediment deposition between spur dikes than the other transverse features.	Same as transverse features or flow deflection techniques above. There is a greater tendency for sediment deposition between spur dikes than the other transverse features.
Vanes or Barbs	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat because they tend to create variable depth and velocity habitat, which increases complexity. Could trap sediment and encourage new vegetation growth. No significant effect on flycatcher or cuckoo habitat. Generally beneficial for jumping mouse if sediment is trapped and new vegetation growth occurs.	These structures redirect flow from the bank toward the channel center and reduce local bank erosion while providing a downstream scour hole. Sediment deposition or bank scalloping can occur along the outer bank, depending upon spacing.	Same as transverse features or flow deflection techniques above.
J-Hook	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat because they tend to create variable depth and velocity habitat, which increases complexity. Could trap sediment and encourage new vegetation growth. No significant effect on flycatcher or cuckoo habitat. Generally beneficial for jumping mouse if sediment is trapped and new vegetation growth occurs.	Redirects flow away from eroding banks, the same as vanes or barbs, with an added downstream-pointing “J” configuration. The J-hook creates an additional scour hole pool and can produce a local downstream riffle. Remainder of the geomorphic response is the same as for vanes.	Same as transverse features or flow deflection techniques described above. Additional pool habitat is created by the J-hook.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Trench Filled Bendway Weirs	Depends on project design and scope. Projects may be designed to improve silvery minnow habitat because they tend to create variable depth and velocity habitat, which increases complexity. Could trap sediment and encourage new vegetation growth. No significant effect on flycatcher or cuckoo habitat. Generally beneficial for jumping mouse if sediment is trapped and new vegetation growth occurs.	Once the bank erosion reaches the bendway weir tips, the flow is redirected away from the eroding bank. The location of the thalweg is shifted away from the outer bank line. Local scour at the tip occurs because of the three-dimensional flow patterns. Secondary currents are interrupted. The outer bank can become a zone of lower velocity.	Provided the bendway weirs constructed in a trench remain intact, the habitat characteristics will be about the same as bendway weirs constructed in the channel.
Boulder Groupings	Generally projects are designed to provide refuge areas for silvery minnow during low-flow conditions. Projects may be designed to also provide some level of bank protection. Could trap sediment and encourage new vegetation growth. No significant effect on flycatcher or cuckoo habitat. Generally beneficial for jumping mouse if sediment is trapped and new vegetation growth occurs	Creates a zone of local scour immediately downstream of the boulders. Creates areas of variable depth and velocity. Creates velocity shear zones. Effects are localized to the immediate vicinity of the boulders. Increases channel roughness at high flows. Adds complexity to the system.	Can provide structure and habitat for fish.
Rootwads	Generally, projects are designed to create refuge areas for silvery minnow during low-flow conditions. Projects may be designed also to provide some level of bank protection. Silvery minnow response to past projects has been mixed. Could trap sediment and encourage new vegetation growth. No significant effect on flycatcher or cuckoo habitat. Generally beneficial for jumping mouse if sediment is trapped and new vegetation growth occurs.	Creates local scour pools and areas of variable velocity. Increases flow resistance along the bank line, which dissipates energy, traps and retains sediments, and creates turbulence that can move the main current away from the bank line. Adds complexity to the system. Variable depth and velocity conditions can be created. Some potential for creating areas of sediment deposition (depending on specific placement). Cottonwood tree rootwads have a design span of about 5 years; therefore, this method has been used with many other methods to create habitat.	Adds complexity to the system. Variable depth and velocity conditions can be created. Some potential for creating areas of sediment deposition (depending on specific placement), which is generally beneficial for establishing and developing riparian vegetation. Can provide structure and habitat for silvery minnow. Isolated pools are often maintained in scour pools caused by debris, including rootwads. This can serve as refugia habitat for silvery minnow during low-low periods. Similar to large woody debris (LWD). Could trap sediment and encourage new native vegetative growth.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Large Woody Debris	Generally, projects create refuge areas for silvery minnow during low-flow conditions. Projects may be designed also to provide some level of bank protection. Silvery minnow response to past projects has been mixed. Could trap sediment and encourage new vegetation growth. No significant effect on flycatcher or cuckoo habitat. Generally beneficial for jumping mouse if sediment is trapped and new vegetation growth occurs.	LWD can provide local stream cover and scour pool formations, deflect flows, and increases depth and velocity complexity. Can promote side channel formation and maintenance. LWD in the MRG can lead to sediment deposition, including formation of islands, in reaches with large sand material loads. Could establish new sediment deposition areas. LWD constructed from cottonwood trees last about 3–5 years.	Adds complexity to the system. Sediment deposition can create areas where new riparian vegetation becomes established. Can create variable depth and velocity habitat. Can provide structure and habitat for fish. May provide for habitat diversity in areas with monotypic flow patterns and refugia habitat during low flows. These habitats also may provide refuge for predatory fishes. Increased areas of moist or flooded soil conditions could assist in flycatcher territory establishment and native vegetation recruitment, which would also benefit cuckoos and jumping mice.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Cross Channel (River Spanning) Features			
Grade Control	Depends on project design and scope. Sediment deposition upstream of the structure may provide backwater habitat for silvery minnow, flycatcher, cuckoo, and jumping mouse. In general, river spanning grade control methods would not prevent the trend of continued downstream incision in degrading reaches, which may cause issues with upstream fish passage requiring Adaptive Management. Channel spanning features would be designed to provide for upstream fish passage.	Grade control can reduce the gradient upstream by controlling the bed elevation and dissipating energy in discrete steps. At least during low flows, the upstream water surface is raised, depending on structure height above the bed. Upstream velocity is reduced. There can be a local effect on sediment transport, scour, and deposition, depending on the structure characteristics. For low-head structures (1–2 feet), the amount of upstream sediment storage is low and usually does not cause downstream bed level lowering as a result of upstream sediment storage. In supply-limited reaches, channel degradation downstream of the structure will continue as a result of excessive sediment transport capacity. The slope of the downstream apron would be designed to provide fish passage and prevent local scour downstream from the structure. Due to the potential for the continuation of the downstream channel incision trend, Adaptive Management may be necessary to provide for continued fish passage. Reduces channel degradation upstream of this feature and can promote overbank flooding and raise the water table. Backwater areas could develop upstream, which also would raise the water table. If downstream degradation continued, the water table would be lowered.	Increased upstream connectivity with side channels at low flows, creating variable depth and velocity habitat. By preventing future upstream local degradation, the current level of floodplain connectivity can continue. Increased upstream water levels (except for peak flows) likely would increase vegetative health benefiting cuckoos and jumping mice, and could attract flycatchers, particularly if overbank flooding conditions occurred during territory establishment. Low downstream apron slopes would be designed for fish passage.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Deformable Riffles	Same as grade control above.	During low-flow conditions, where these structures are fixed, the effects upon channel morphology are described in the "grade control" response above. When the riprap material forming the riffle launches or deforms downstream, the bed can lower a relatively small amount.	Same as grade control above.
Rock Sills	Same as grade control above.	Riverbed elevation is held constant, while rock launches into the downstream scour hole. Because the bed is fixed, the effects on geomorphology are the same as for grade control.	Same as grade control above.
Riprap Grade Control (With or Without Seepage)	Same as grade control above.	Riprap is flexible and deforms into a scour hole. Can be at bed level or above. Can have short or long low-slope apron. Because the bed is fixed, the effects upon geomorphology are the same as for grade control.	Same as grade control above.
Gradient Restoration Facility (GRF)	Same as grade control above.	Bed is fixed. The effects upon geomorphology are the same as for grade control.	Same as grade control above.
Low-Head Stone Weirs (Loose Rock)	Same as grade control above. Provides pool habitat that could become low-flow silvery minnow refugia.	These structures typically are constructed above the bed elevation without grout. During low flows, there is an abrupt change in the water surface elevation through the structures, creating an upstream backwater effect. Generally, these structures do not raise the water surface during high flows. Sediment continuity can be reestablished after the scour pool and tailout deposit are formed. A series of structures can dissipate energy and reduce channel degradation. Can interrupt secondary currents and move main current to the center of the channel if constructed in bendways.	Same as grade control above. Can provide pool habitat. Fish usually can pass through the interstitial spaces between weir stones.

Table III-22. Summary description of effects of proposed river maintenance methods on endangered species, river geomorphology and habitat in MRG

Method	Endangered Species Effects	Geomorphic Effects	Habitat Effects
Conservation Easements	Similar to effects of infrastructure relocation or setback.	Allows space for existing fluvial processes to continue, which can preserve floodplain connectivity. Allows more natural river movement with variable depth and velocity and promotes greater area of undisturbed streamside terrain.	Allows more natural river movement and promotes greater area of undisturbed habitat.
Change Sediment Supply			
Increase Sediment Supply	Generally positive for silvery minnow habitat in downstream reaches, to find sediment equilibrium and control degradation. Within project area, reach effects would depend on project design and scope. Perched river channels have greater connectivity with floodplain but may be more prone to channel drying at low-flow conditions. Generally positive for flycatchers, cuckoos, and jumping mouse as it would provide a greater likelihood of overbank flooding.	Where the river is lacking in sediment, adding sediment can stabilize or even reverse channel incision. Adding sand-sized sediment can reduce bed material size, especially where coarser material is available in an incising channel. May result in sand deposits in pools, reduction of gravel riffle height, decreased depth, and increased width-to-depth ratio. Additional sediment could result in the establishment of river bars and terraces. Could increase the potential for overbank flooding and raise the water table elevation.	Additional sediment could result in establishing river bars and terraces, which would be conducive to establishing and developing riparian areas. Could increase the potential for overbank flooding and raise the water table elevation, which could also benefit the jumping mouse habitat.
Decrease Sediment Supply	Effects would depend on current status of sediment supply. Within project area, reach effects would depend on project design and scope. Perched river channels have greater connectivity with floodplain but may be more prone to drying. Projects that decrease sediment supply are generally negative for flycatchers, cuckoos, and jumping mouse as it may change the aggradational trend that promotes overbank flooding	Where the river has excess sediment supply, reducing or removing the sediment supply can stabilize or reverse aggradational trends. Reduction of sediment supply could cause the bed material to coarsen. In general, a more uniform channel depth and velocity would result. In addition, the tendency for the channel to braid and form split delta channels would be reduced. Water table may fall.	In general, more uniform depth and velocity habitat would result, which decreases habitat complexity for the silvery minnow. The opportunity for the channel to braid and form distributary channels would be reduced, providing less opportunity for riparian growth.

It is anticipated that river maintenance projects at multiple sites, implemented as part of a river maintenance strategy for a reach, may have a cumulative effect and a noticeable impact on the dynamics of the reach. It is expected that the reach effects of multiple river maintenance projects could be similar to the geomorphic effects of the river maintenance strategy that best describes the projects (Section 2.1.1). Reach monitoring would be implemented to determine the actual geomorphic and biological effects. Monitoring also will help determine the threshold for the number of projects, for both a reach and a given river maintenance strategy, needed to be implemented for the geomorphic effects across multiple projects to affect changes in the morphology on a reach basis.

2.2.2 Effects of River Maintenance Support Activities

2.2.2.1 Roads and Dust Abatement

This activity primary involves vegetation removal for access to sites and watering of the roads and construction area. Access roads are generally out of the wetted area. If dust becomes a safety concern during a project, roads will be wetted with water pumped from one of the nearby drains or the Rio Grande. Nearby drains will be used for dust abatement during irrigation season (March to October) and the Rio Grande from November to February. If it is not practicable (not enough flow volume) to utilize a drain during irrigation season, Reclamation may pump water from another nearby irrigation facility or the Rio Grande. Pumping of water directly from the portions of the Rio Grande occupied by silvery minnow will be avoided in times when it is likely that larval fish or eggs would be entrained into the pump.

When pumping from the Rio Grande, the pump setup will utilize a 0.25-inch mesh screen at the opening to the intake hose to minimize entrainment of aquatic organisms. For areas where the water surface is too far from the pump setup, an intermediate area will be leveled to create a temporary pad for the pump. If water is pumped from the river for dust abatement purposes, it would likely be pumped at a rate of 1.8–2.2 cfs for 4–8 minutes to fill a water truck. This would be a minimal impact to river flows, equating to a decrease in flows of approximately 0.2% for river flows of 1,000 cfs and approximately 0.1% for river flows of 1,500 cfs for 4–8 minutes. This activity has an insignificant effect on the silvery minnow and habitat for flycatchers/ cuckoos.

Creation and maintenance of access roads have a bigger impact on flycatchers and cuckoos due to the destruction of established habitat. Reclamation biologists will work with the project lead to minimize the acreage of roads that would be within suitable habitats. Any work that involves vegetation clearing would be scheduled outside of times when flycatchers, cuckoos, and nesting avian species may be in the area.

2.2.2.2 Stockpiles and Storage Yards

Reclamation is proposing to continue using existing stockpile and storage locations. These are all located outside of the floodplain. Periodically, these sites require vegetation clearing (mowing and trimming), grading, graveling, drainage, and/or fencing. There are no impacts to silvery minnow due to stockpiles and storage yards. Because there is no suitable habitat within existing storage yards, and those yards are located outside the floodplain, there are no impacts to the flycatcher, cuckoo and jumping mouse.

2.2.2.3 Borrow and Quarry Areas

Reclamation is proposing to continue using existing borrow and quarry locations. These are all located outside of the floodplain and outside of critical habitat for listed species. There are no impacts to the silvery minnow, flycatcher, cuckoo, and jumping mouse; there is no suitable habitat within existing quarries.

2.2.2.4 Data Collection Activities

Data collection efforts are conducted with the use of boats, all-terrain vehicles, and pedestrian travel (walking on land and wading in the river). Most of the data collection methods are nondestructive in nature and require only short-term impacts from human presence within the area. The main exceptions are monitoring rangelines, subsurface monitoring, and water or sediment sampling. Subsurface monitoring requires disturbing the earth to collect samples or provide a soil characterization. Reclamation is proposing to continue using existing rangelines. Periodically these sites require vegetation clearing (mowing and trimming). There are no impacts to silvery minnow due to rangeline clearing or soil collections in the dry. There would be negative impacts to silvery minnow due to sampling in the wet, though impacts would be minimal due to the small area generally affected (less than 1 acre annually). Impacts to flycatchers and cuckoos will be minimal near rangelines or soil collection sites, and coordination between the Reclamation biologist and project lead would ensure ground crews keep their distance from territories during the summer. Any work that involves vegetation clearing would be scheduled outside of times when flycatchers, cuckoos, or nesting avian species may be in the area. If necessary to complete vegetation clearing during the summer, surveys would be conducted and vegetation clearing would only be cleared if no nesting activity is observed to ensure no disturbance to avian species. Work areas would be evaluated by Reclamation for suitable jumping mouse habitat on a location and project specific basis. Annually, the average total area affected for all data collection activities (wet and dry) is less than 16 acres, and although some of that acreage may be within designated critical habitat for flycatcher, or proposed critical habitat for cuckoo, the minimal acreage affected compared to the overall critical habitat designation indicates there is not likely to be an adverse effect on the conservation value of this critical habitat. In addition, the PCEs of critical habitat for the flycatcher and cuckoo may not be present in the impacted area. Impacts may include disturbance due to activity within the river and disturbance of sediment, which may affect turbidity and dissolved oxygen.

2.2.2.5 River Maintenance Implementation Techniques

There are various techniques that have been developed by river maintenance as the standard way to implement the methods that are designed for river maintenance project sites. All construction has the potential to negatively impact endangered species. However, the benefits of using the described implementation techniques may help minimize the impact of the projects overall, while providing a net benefit for listed species across all projects. The benefits and construction impacts of the techniques are described in Table III-23. Project-specific documents will describe which of these techniques may be implemented to reduce impacts to species.

Table III-23. Standard implementation techniques used in MRG river maintenance projects and effects on listed species

	Implementation Technique	Benefits of Implementation Techniques	Effects on Silvery Minnow	Effects on Flycatcher, Cuckoo, and Jumping Mouse
1	River diversion	Minimizes downstream turbidity impact during construction.	During berm construction silvery minnow may be affected directly by construction equipment and the placement of material.	Generally no vegetation impacts.
2	River reconnection	Minimizes the amount of time construction equipment needed to work in the wet.	During construction, silvery minnow may be affected directly by construction equipment.	Minimal vegetation impacts; work is done outside the active channel area.
3	Dewatering	Coupled with the river diversion technique to provide isolation of the project site from the main flow area. This technique minimizes the amount of time construction equipment needs to work in the wet.	During construction, silvery minnow may be affected directly by construction equipment and drying of the river bed that may desiccate silvery minnow. This technique would be done in conjunction with river diversions, which may minimize the impacts to silvery minnow.	Depends on project design and scope. Short-term dewatering should have few impacts to established vegetation.
4	River crossings	Minimizes disturbance acreage in the wet by defining a set path for the construction equipment to follow. Equipment moves slowly across the river and are part of an equipment caravan. River crossings also are typically grouped temporally to minimize the time of disturbance for river crossings.	Silvery minnow may be impacted by equipment crossing the river.	Generally no vegetation impacts.

Table III-23. Standard implementation techniques used in MRG river maintenance projects and effects on listed species

	Implementation Technique	Benefits of Implementation Techniques	Effects on Silvery Minnow	Effects on Flycatcher, Cuckoo, and Jumping Mouse
5	Working platforms	Once working platforms are constructed, work occurs in the dry. This technique minimizes the amount of time construction equipment needs to work in the wet.	During working platform construction, silvery minnow may be affected directly by construction equipment and being crushed by material placement. Water work warning should minimize this risk.	Generally no vegetation impacts.
6	Partial excavation of banks	This technique minimizes the amount of time construction equipment needed to work in the wet.	During construction in wet, silvery minnow may be affected directly by construction equipment and being crushed by material placement in construction area. Water work warning should minimize this risk.	This may require removing vegetation that may impact flycatcher habitat.
7	Top of bank work	This means equipment was able to reach the desired placement area and elevation from the existing bank line without having the equipment actively in the river or needing to partially excavate the bank.	During construction in wet, silvery minnow may be affected directly by construction equipment and being crushed by material placement construction area. Water work warning should minimize this risk.	This may require removing vegetation that may impact flycatcher habitat.
8	Amphibious construction	Typically, this method is employed when minimal disturbance of the dry portion of the project area is desirable, such as to minimize the loss of bank vegetation. This technique minimizes the disturbance to bank riparian areas.	During construction, silvery minnow may be affected directly by construction equipment.	Generally no vegetation impacts.
9	Material placement	This technique helps prevent the formation of isolated pools or channels, which could trap fish or other species.	During construction, silvery minnow may be affected directly by construction equipment and being crushed by material placement construction area. Water work warning should minimize this risk. Preventing the formation of isolated pools decreases the likelihood of stranding.	This may require removing vegetation that may impact flycatcher habitat.

Table III-23. Standard implementation techniques used in MRG river maintenance projects and effects on listed species

Implementation Technique	Benefits of Implementation Techniques	Effects on Silvery Minnow	Effects on Flycatcher, Cuckoo, and Jumping Mouse
10 Material removal	This technique helps prevent the formation of isolated pools or channels, which could trap fish or other species.	During construction, silvery minnow may be affected directly by construction equipment and being stranded within the construction area. Preventing the formation of isolated pools decreases the likelihood of stranding.	This may require removing vegetation that may impact flycatcher habitat.
11 Infrastructure relocation	This technique may avoid the need to perform river maintenance activities in the river.	Work is generally out of the river channel and would have minimal impacts to silvery minnow.	This may require removing vegetation that may impact flycatcher habitat.

2.2.3 Unanticipated and Interim Work

The methods that are used for unanticipated and interim work for river maintenance are described within the river maintenance methods used (Table III-22). These include riprap revetments, levee strengthening, and riprap windrows. The effects of these methods would be similar to that described in Table III-22 for each method except that there may not be flexibility in the timing of the work that is needed and so may have greater effects on endangered species.

2.2.4 River Maintenance Site Size and Distribution Effects

Direct and indirect effects were evaluated for endangered species and their habitat from MRG river maintenance activities. Direct effects from implementation of river maintenance projects have been described in previous sections, and are dependent on project design and scope. Indirect and long-term effects on listed species are geared more towards the long-term changes that may occur within a reach or upstream and downstream. Indirect effects are expected to be local for the implementation of individual river maintenance projects and related to the river maintenance methods used (Section 2.2.1). The indirect effects from the implementation of multiple river maintenance projects within a river maintenance strategy are described in Section 2.1. Effects to the silvery minnow, flycatcher, cuckoo, jumping mouse, and sunflower are described in Sections 2.2.4.1, 2.2.4.2, and 2.2.4.3, 2.2.4.4, and 2.2.4.5, respectively.

2.2.4.1 Silvery Minnow

An estimated direct impact on silvery minnow from river maintenance activities occurring in the wet area of the river was developed by using information presented in Section 1.6, which predicts future acreage impacts for river maintenance projects within each occupied reach. Density of silvery minnow (Tables III-24 and III-25) is provided from Rio Grande population monitoring survey data (Dudley and Platania 2012). To capture the range of density values noted for each month of the year from 1993 to 2011, the mean density estimates for the silvery minnow from population monitoring data are presented for each month. Highest densities of silvery minnow generally occur in late spring and summer months (May and June), when maintenance work in the river historically has been restricted due to the occurrence of higher water depths associated with the snowmelt runoff. Within the Velarde to Rio Chama and Rio Chama to Otowi Bridge Reaches, silvery minnow are presumed to be absent, and there is no designated critical habitat. No systematic surveys are available for Cochiti Dam to Angostura Diversion Dam, so that reach is not analyzed for density impact effects.

Table III-24. Mean monthly catch rate (silvery minnow per 100 square meters [m^2]) from Rio Grande Population Monitoring Survey Data 1993–2011 (Not all reaches or months had equal numbers of surveys.)

	Angostura Diversion Dam to Isleta Diversion Dam		Isleta Diversion Dam to Rio Puerco		Rio Puerco to San Acacia Diversion Dam		San Acacia Diversion Dam to Arroyo de las Cañas		Arroyo de las Cañas to San Antonio Bridge		San Antonio Bridge to RM 78		RM 78 to Full Pool Elephant Butte Reservoir Level	
Month	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
1	**2.2**	1.5	**17.4**	14.9	**2.0**	1.4	**8.0**	5.7	**5.3**	2.7	**14.2**	13.6	**2.9**	2.2
2	**2.0**	0.5	**2.9**	1.0	**2.1**	0.5	**14.9**	4.9	**21.1**	11.2	**20.4**	11.5	**6.1**	1.8
3	**3.2**	1.3	**1.4**	0.7	**2.1**	1.1	**2.6**	1.0	**6.8**	4.9	**4.0**	3.4	**6.4**	4.8
4	**2.0**	0.7	**21.9**	16.8	**5.2**	3.3	**10.3**	4.3	**4.6**	2.2	**0.8**	0.3	**1.0**	0.3
5	**8.6**	6.3	**1.9**	0.6	**44.9**	43.4	**8.3**	3.9	**5.2**	2.5	**4.2**	3.2	**4.9**	2.9
6	**12.4**	4.0	**27.8**	9.0	**11.5**	4.6	**13.8**	5.7	**5.1**	1.8	**8.1**	4.1	**7.2**	2.2
7	**22.1**	9.0	**29.1**	10.5	**97.5**	45.3	**49.4**	17.3	**22.8**	9.2	**44.1**	30.2	**31.0**	18.2
8	**10.9**	2.9	**9.4**	2.7	**14.3**	9.2	**20.8**	8.4	**27.2**	11.2	**14.7**	12.3	**12.3**	4.7
9	**5.7**	1.7	**8.5**	2.9	**5.6**	3.0	**14.6**	5.8	**11.0**	4.8	**2.5**	1.9	**5.3**	1.7
10	**4.5**	1.1	**10.6**	4.0	**5.1**	1.7	**15.5**	4.7	**21.1**	9.1	**14.8**	8.1	**9.6**	4.2
11	**7.4**	3.7	**13.5**	5.6	**3.2**	1.6	**13.9**	9.8	**28.8**	22.3	**8.7**	8.6	**1.3**	0.9
12	**3.9**	1.4	**26.5**	15.1	**2.6**	0.7	**10.5**	2.4	**7.0**	2.0	**7.9**	6.0	**12.8**	5.6

Table III-25. Estimated 10-year total impact to Rio Grande silvery minnow and their habitat from average acreage river maintenance work occurring within the wet for each reach

10-year Average Estimated Impacts	Number Wetted Acres	Number m^2	Mean Silvery Minnow/100 m^2	Standard Error	Anticipated Decadal Impact (Number Silvery Minnow)
Angostura Diversion Dam to Isleta Diversion Dam	186	752,723	8.2	1.8	61,347
Isleta Diversion Dam to Rio Puerco	106	428,971	13.1	4.2	56,024
Rio Puerco to San Acacia Diversion Dam	49	198,298	27.8	12.9	55,206
San Acacia Diversion Dam to Arroyo de las Cañas	79	319,705	20.4	3.9	65,220
Arroyo de las Cañas to San Antonio Bridge	96	388,502	19.3	6.3	74,826
San Antonio Bridge to RM 78	155	627,270	12.7	3.6	79,600
RM 78 to Full Pool Elephant Butte Reservoir Level	235	951,022	9.7	1.9	91,774
10-year impact (number silvery minnow) based on mean density and average project size					**483,997**

All work in the wet below Angostura Diversion Dam is anticipated to have a direct effect and is likely to adversely affect silvery minnow and silvery minnow critical habitat. Table III-26 provides decadal wetted acreage amounts by reach for these projects.

Table III-26. Decadal wetted acreage by reach for river maintenance projects

10-year Average Estimated Impacts	BOR Average Wetted Area (Acres)	BOR Average Wetted Area (m^2)	State/MRGCD Wetted Area (Acres)	State/MRGCD Wetted Area (m^2)
Angostura Diversion Dam to Isleta Diversion Dam	186	752,723	140	564,543
Isleta Diversion Dam to Rio Puerco	106	428,971	80	321,729
Rio Puerco to San Acacia Diversion Dam	49	198,298	37	148,724
San Acacia Diversion Dam to Arroyo de las Cañas	79	319,705	60	239,779
Arroyo de las Cañas to San Antonio Bridge	96	388,502	72	291,377
San Antonio Bridge to RM 78	155	627,270	117	470,453
RM 78 to Full Pool Elephant Butte Reservoir Level	235	951,022	177	713,267
TOTAL	906	3,666,491	680	2,749,869
TOTAL COMBINED: 1,586 acres				

Average decadal wetted acreage for Reclamation projects in Table III-26 is derived from the information on decadal acreage distribution by reach provided in Table III-13. Average decadal wetted acreage for State and MRGCD projects in Table III-26 was derived assuming a combined effort that is 75% of the Reclamation effort for these types of projects. The decadal acreages above assume variation in the annual acreage impacted during the overall 10-year timeframe.

Impacts from projects in the wet that are conducted outside of the summer months would have less impact on early life stages of the silvery minnow. During times of high silvery minnow densities, the amount of take that would be estimated during a specific project would be higher. The proportional impact to the population at large is the same and related to the acreage, whether densities of silvery minnow are high or low when the project is taking place.

Using the average acreage of work within the wet and population numbers extrapolated for 10 years, approximately half a million silvery minnow may be impacted due to river maintenance activities in a 10-year timeframe (Table III-25). If the maximum estimated acreage is used, this number increases to around 1.5 million silvery minnow that would be impacted by river maintenance projects. It is unlikely that this full amount would be lethally impacted due to their ability to sense and avoid construction activity. Additionally, BMPs (Section 1.6.4.5) would minimize the amount of take during construction.

2.2.4.2 Flycatcher

Estimates on flycatcher habitat directly impacted by river maintenance proposed activities over the 10-year analysis period were completed by comparing the average acreage of 'dry' potential area to be impacted within the reach by river maintenance activities (Table III-13 in Section 1.7) to the approximate acreage of suitable flycatcher habitat using data from vegetation mapping and reconnaissance work completed in 2008 and 2012.

The river maintenance area between Velarde and Cochiti Reservoir has minimal areas of suitable flycatcher habitat patches. According to *Southwestern Willow Flycatcher Habitat Reconnaissance – Upper Rio Grande from the Colorado State Line to Cochiti Reservoir, New Mexico* (Ahlers 2009), the most suitable habitat within this entire stretch is located just north of Cochiti Reservoir. In total, from the New Mexico State line to Cochiti Reservoir (excluding areas that were not accessible), 89 river miles and approximately 5,334 total acres were evaluated, and 11.9% of the area was considered either suitable or marginally suitable for flycatchers. Some areas were not quantified, either because they were on tribal property or because they were inaccessible.

Using the 11.9% average of suitable/marginally suitable habitat and the average of 60 acres of floodplain area per river mile, the following was assumed. Floodplains are defined in this context as being areas typically confined within the levees or natural geographic constraints.

The one exception is in the San Marcial area, where floodplain also includes riparian vegetation to the west of the levees.

- Velarde to Rio Chama Reach (dry) (13 river miles) had an estimated 780 acres of floodplain area or potentially 92 acres of suitable habitat in 2008.

- Rio Chama to Otowi Bridge Reach (dry) (14 river miles) had an estimated 840 acres of floodplain area or potentially 100 acres of suitable habitat in 2008.

Because suitable habitat within the Cochiti Dam to Angostura Diversion Dam and Angostura Diversion Dam to Isleta Diversion Dam Reaches has not been quantified, the assumptions used to describe the Velarde to Rio Chama and Rio Chama to Otowi Bridge Reaches were also used for these reaches and resulted in the following:

- Cochiti Dam to Angostura Diversion Dam (dry) (23 river miles) has 1,380 acres of floodplain area or potentially 164 acres of suitable habitat.

- Angostura Diversion Dam to Isleta Diversion Dam (dry) (41 river miles) has 2,460 acres of floodplain area or potentially 292 acres of suitable habitat.

Using the 2012 vegetation classification system from *Southwestern Willow Flycatcher Habitat Suitability 2012 – Middle Rio Grande, New Mexico* (Siegle et al. 2013), the potential suitable or marginally suitable habitat values were determined for the remaining river maintenance reaches. These values indicate that:

- Isleta Diversion Dam to Rio Puerco (dry) area consists of 42 miles and 5,539 acres of vegetated floodplain area and potentially 1326 acres of suitable or marginally suitable habitat. This area had a higher potential for flycatcher establishment considering roughly 24% of the area had either suitable or marginally suitable areas and a wider floodplain when compared to those reaches farther north.

- Rio Puerco to San Acacia Diversion Dam (dry) (11 miles) has 2,060 acres of vegetated floodplain area or potentially 636 acres of suitable or marginally suitable habitat. Approximately 31% of the area was considered either suitable or marginally suitable for flycatchers.

- San Acacia Diversion Dam to Arroyo de las Cañas (dry) (21 miles) has 3,376 acres of vegetated floodplain area and 359 acres of suitable or marginally suitable habitat. Approximately 8% of the area was considered either suitable or marginally suitable for flycatchers.

- Arroyo de las Cañas to San Antonio Bridge (dry) (8 miles) has 1,525 acres of vegetated floodplain area and 143 acres of marginally suitable habitat (no polygons within this reach were considered suitable). Approximately 9% of the area was considered either suitable or marginally suitable for flycatchers.

- San Antonio Bridge to RM 78 (dry) (9 miles) has 3,839 acres of vegetated floodplain area and 1128 acres of suitable or marginally suitable habitat. Approximately 29% of the area was considered either suitable or marginally suitable for flycatchers.

- RM 78 to RM 62 (dry) (16 miles) has 8,436 acres of vegetated floodplain area and 989 acres of suitable or marginally suitable habitat. Approximately 12% of the area was considered either suitable or marginally suitable for flycatchers.

Given the two independent variables of construction area (using the average in the dry) and flycatcher suitable or marginally suitable habitat, the percent probability of the river maintenance project site implementation impacting flycatcher habitat was derived assuming the variables are random in nature and independent of each other within the total possible floodplain area. This exercise essentially provided an approximate acreage with the probability that the implementation effort would overlap the suitable or marginally suitable habitat for flycatchers. The percent probability and total acreage of flycatcher habitat that may be impacted is listed in Table III-27. It is also important to note that due to best management practices (Section 1.6.4.5), areas of suitable habitat would be intentionally avoided if possible; so this exercise is likely an overestimate of habitat that would be impacted by river maintenance activities. Obviously, consistency in data varies due to the timeframe differences as well as the methodology in determining the suitability. However, this analysis attempts to provide a rough estimate of potential flycatcher habitat that may be impacted by river maintenance (including rangeline maintenance) over the next 10 years.

Table III-27. Average estimated impacts to flycatcher suitable habitat from river maintenance projects occurring in the riparian area of the Rio Grande

Reach	Average River Maintenance Impact Acreage Over 10-Year Period	Acreage Suitable or Marginally Suitable Derived from 2008 or 2012 Reconnaissance or Vegetation Mapping	Total Possible Vegetated Floodplain Acreage Derived from 2008 or 2012 Reconnaissance or Vegetation Mapping	Percent Probability that Construction Efforts Would Occur Within Suitable Habitat	Total Acreage of Suitable Habitat Directly Impacted by Construction Activities Over 10-Year Period
Velarde to Rio Chama, dry	45	92	780	0.68%	5.31
Rio Chama to Otowi Bridge, dry	43	100	840	0.61%	5.12
Cochiti Dam to Angostura Diversion Dam, dry	111	164	1,380	0.96%	13.19
Angostura Diversion Dam to Isleta Diversion Dam, dry	103	292	2,460	0.50%	12.23
Isleta Diversion Dam to Rio Puerco, dry	60	1326	5,539	0.26%	14.36
Rio Puerco to San Acacia Diversion Dam, dry	27	636	2,060	0.40%	8.34
San Acacia Diversion Dam to Arroyo de las Cañas, dry	43	259	3,376	0.10%	3.30
Arroyo de las Cañas to San Antonio Bridge, dry	54	143	1,525	0.33%	5.06
San Antonio Bridge to River Mile 78, dry	85	1128	3,839	0.65%	24.98
River Mile 78 to Full Pool Elephant Butte Reservoir Level, dry	130	989	8,436	0.18%	15.24

2.2.4.3 Cuckoo

There is currently no habitat suitability model developed specifically for the cuckoo; however, because cuckoo and flycatcher habitat is relatively similar, it is assumed that impacts of river maintenance activities would also be similar. As opposed to calculating acreage of potential disturbance from river maintenance activities over the next 10 years as was done for the flycatcher, estimated impacts to cuckoo are derived from a combination of the assessment completed for the flycatcher and the river maintenance best management practices where areas of suitable habitat would be intentionally avoided if possible. Also, as common practice, should river maintenance activities be required to occur during summer months, Reclamation would follow the standard cuckoo protocol and conduct surveys to ensure activities would not cause direct take of cuckoo nests.

2.2.4.4 Jumping Mouse

Although no habitat suitability model for the jumping mouse has been developed to date, Frey and Kopp (2014) evaluated vegetation data through a GIS process with limited field work, including identifying habitat polygons inferred as “suitable” for jumping mouse habitat. Because the vegetation GIS layers were not at the level required to reliably identify suitable jumping mouse habitat and tended to overassign “suitable habitat,” Reclamation will use the Frey and Kopp (2014) report as a guide for areas to investigate for suitable jumping mouse habitat through field checks. The only known population of jumping mice in the MRG is located in BDA on the Riverside Drain. No river maintenance activities are proposed by Reclamation or its BA partners for the Riverside Drain where jumping mice occur. Although no jumping mice are known to occur outside the BDA, to minimize the potential for any effects to jumping mice elsewhere, Reclamation would evaluate MRG river maintenance activities on a project and location basis for the presence of suitable habitat. If necessary, surveys would be conducted to ensure activities would not cause direct take of jumping mice.

2.2.4.5 Pecos Sunflower

Currently the only recognized Pecos sunflower population within the river maintenance action area is located specifically on the Rhodes property south of Arroyo de las Cañas. Reclamation will evaluate areas to determine if Pecos sunflower is present in the area prior to work and will design projects to avoid impacts that may affect the Pecos sunflower population.

2.3 Effects from Other Reclamation MRG Project Proposed Maintenance Activities

The geomorphic effects to the MRG of the other described MRG Project maintenance actions are expected to be insignificant. There is a small hydrologic effect of work associated with other MRG Project maintenance actions, when compared to existing condition, by improving the conveyance of water to the MRG. The drainage benefits are to developed areas, meaning that they benefit human activities and infrastructure. They do not necessarily benefit listed species. Two general types of effects (direct and indirect) were evaluated for endangered species and their habitat from other MRG Project maintenance activities. The specific impacts for each species are described below. Direct effects from implementation of other MRG Project maintenance activities are dependent on types of activities performed. Long-term effects for endangered species (indirect effects) also may occur due to the long-term changes that may occur within a reach or upstream and downstream. Effects from the LFCC O&M and Project drain maintenance are described in Section 2.3.1 and 2.3.2, respectively.

2.3.1 LFCC O&M

2.3.1.1 Silvery Minnow

There are sporadic captures of silvery minnow within the LFCC. Reclamation opportunistically sampled the LFCC in 2010 and 2012. Silvery minnow were detected at 5 of the 26 sites sampled (Figure III-2). A total of 12 silvery minnow were collected in over 1,700 m^2 sampled. This equates to 0.7 silvery minnow per 100 m^2, or roughly 42,700 silvery minnow within the LFCC from San Acacia Diversion Dam to RM 60. Sediment removal within this section is likely to adversely affect silvery minnow with direct effects due to dredging operations and indirect effects due to less suitable habitat within the LFCC with the removal of shallow, low-velocity areas that silvery minnow use. Vegetation control and road maintenance would have little impact on silvery minnow due to it being conducted in the dry along the banks of the LFCC. Maintenance of the structure itself may or may not have adverse impacts because some of the projects may be able to be conducted in the dry. Those that require work within the channel may have adverse impacts to silvery minnow.

The LFCC is not considered part of critical habitat. Dredging of the LFCC near to the river may have a small hydrologic effect on the water in the river if the level of the LFCC is lower than the riverbed. This effect is likely very small but may adversely affect silvery minnow critical habitat. The existence of the LFCC may slightly increase seepage from the river in the reaches where there are perched channel conditions and contribute to drying, but the magnitude of this effect is likely small. Furthermore, the seepage rates from the river into the LFCC would be largest when the river stage was high and smallest when the stage was low. The proposed maintenance will not significantly change the elevation of the LFCC. Water levels within the LFCC are also a driver of this seepage; these water levels are controlled by pumping of water by BDA and Reclamation and operations of the check dams within the LFCC.

2.3.1.2 Flycatcher

Flycatchers have been known to migrate through less desirable habitat, including the narrow growth around the LFCC, or to nest in areas in close proximity to roads. For this reason and to be in compliance with MBTA, areas would not be mowed within the April 15–August 15 period. Because mowing activities would ensure a 3-year rotation or mowing of about one-third of the area along the banks, habitat would remain for migration activity. Maintenance of the LFCC would have minimal impacts to flycatchers north of RM 62. The maintenance could be beneficial to flycatchers to ensure efficient delivery of water reaching flycatchers occupying habitat in areas south of the action area described in this BA. Dredging of the LFCC has a small hydrologic effect on the nearby vegetation. This effect is likely very small but may adversely affect flycatcher critical habitat.

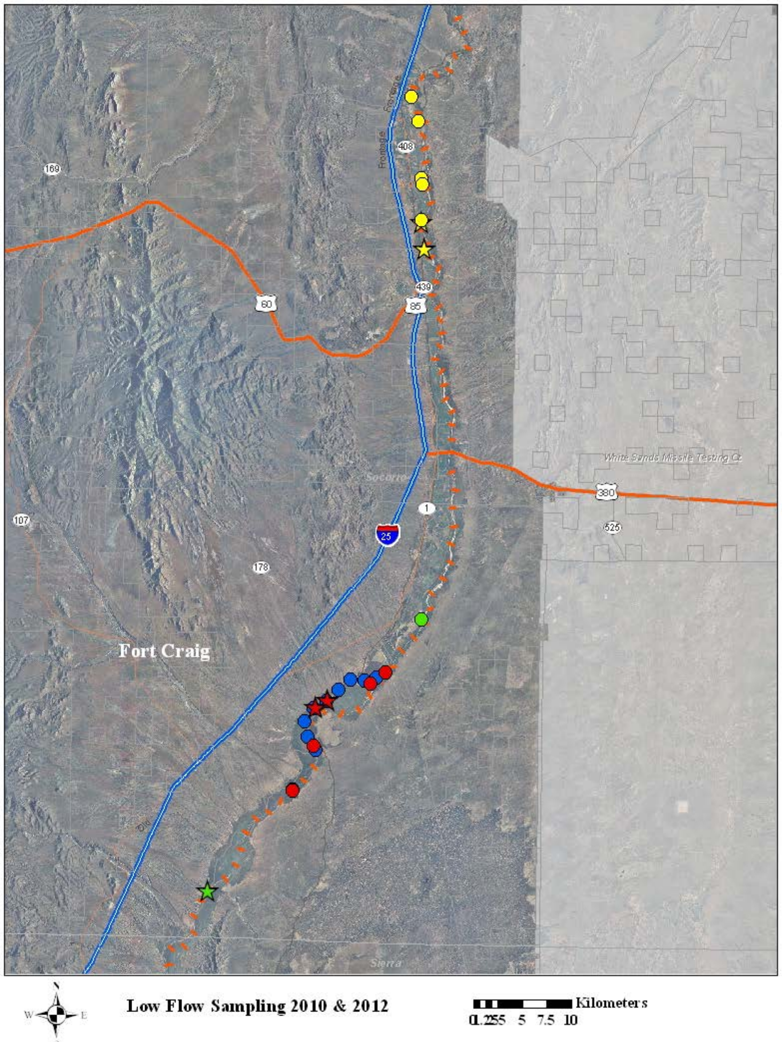

Figure III-2. Presence/absence of silvery minnow at LFCC sites in 2010 and 2012. Stars indicate silvery minnow present at site. Green: February 2010, Yellow: March 2010, Red: September 2010, Blue: February 2012.

2.3.1.3 Cuckoo

Cuckoos have been known to migrate through less desirable habitat, including the narrow growth around the LFCC, or to nest in areas in close proximity to roads. For this reason and to be in compliance with the MBTA, areas would not be mowed within the April 15–August 15 period, or September 1 in suitable cuckoo habitat. Also, as common practice, should river maintenance activities be required to occur during summer months, Reclamation would follow standard MBTA protocol and conduct surveys to ensure activities would not cause direct take of cuckoo nests. Because mowing activities would ensure a 3-year rotation or mowing of about one-third of the area along the banks, habitat would remain for migration and general foraging activity. The maintenance could be beneficial to cuckoos to ensure efficient delivery of water reaching cuckoos occupying habitat in areas south of the action area described in this BA. Dredging of the LFCC has a small hydrologic effect on the nearby vegetation. This effect is likely very small but may adversely affect cuckoo proposed critical habitat.

2.3.1.4 Jumping Mouse

Jumping mice are not known to occur on the LFCC. Currently the only known population of jumping mice occurs in BDA. Nonetheless, Reclamation would evaluate the work areas for suitable jumping mouse habitat to ensure that no effects to the species occur. Because mowing activities would ensure a 3-year rotation, or mowing of about one-third of the area along the banks, jumping mouse habitat is not expected to occur in the density and height required to be suitable jumping mouse habitat. Dredging of the LFCC has a small hydrologic impact on the nearby vegetation. There is no effect to the jumping mouse.

2.3.2 Project Drain Maintenance

2.3.2.1 Silvery Minnow

There have been no recent surveys for silvery minnow within the Project drains. Cowley et al. (2007) surveyed within the Peralta Canals that are on the east side of the river. They found that silvery minnow were present within the drainage system, especially during irrigation season and dry periods in the river. It is expected that many of the drains in the MRG would contain low levels of silvery minnow. Work within the wet portions of the drains is likely to adversely affect silvery minnow with direct effects due to dredging operations and indirect effects due to less suitable habitat within the Project drains with the removal of shallow, low-velocity areas that silvery minnow use.

Using the estimated density of silvery minnow developed for the LFCC, we would estimate that, on average, 1,500 silvery minnow would be impacted annually by work within the Project drains. It appears that, during non-irrigation season, densities of silvery minnow are lower. Work conducted during this season would have a smaller impact on the species. These drains are not considered part of the critical habitat. Dredging of the drains near the river may have a small hydrologic effect on the water in the river if the level of the drain is lower than the riverbed. This effect is likely very small but may adversely affect silvery minnow critical habitat.

2.3.2.2 Flycatcher

Flycatchers have been known to migrate through less desirable habitat, including the narrow growth around the State drains or nest in areas in close proximity to roads. For this reason and to be in compliance with the MBTA, areas would not be mowed within the April 15–August 15 period. Most drains are located outside of suitable flycatcher habitat, but maintenance on the San Juan Drain, for example, would have more of an impact to flycatcher habitat because there are flycatcher territories in close proximity to the drain. Coordination between the Reclamation biologist and the project lead for drain maintenance would need to take place to ensure maintenance actions would not have any effect to flycatchers. Dredging of the drains has a small hydrologic effect on the nearby vegetation. This effect is likely very small but may adversely affect flycatcher critical habitat.

2.3.2.3 Cuckoo

Cuckoos have been known to migrate through and forage in less desirable habitat, including the narrow growth around the State drains or nest in areas in close proximity to roads. For this reason and to be in compliance with the MBTA, areas would not be mowed within the April 15–August 15 period, or September 1 in suitable cuckoo habitat. Also, as common practice, should river maintenance activities be required to occur during summer months, Reclamation would follow standard MBTA protocol and conduct surveys to ensure activities would not cause direct take of cuckoo nests. Coordination between the Reclamation biologist and the project lead for drain maintenance would need to take place to ensure maintenance actions would not have any effect to cuckoos. Dredging of the drains has a small hydrologic effect on the nearby vegetation. This effect is likely very small but may adversely affect proposed cuckoo critical habitat.

2.3.2.4 Jumping Mouse

Jumping mice utilize specific microhabitats, including such areas of dense vegetation growth as occurs around the canals and drains. Currently the only known population of jumping mice occurs in BDA, and drain maintenance in BDA is not part of this proposed action, except for the LFCC. Coordination between Reclamation and the lead agency for drain maintenance projects would take place to ensure that a site evaluation is conducted for suitable mouse habitat so that maintenance actions would not have any effect to jumping mice. Dredging of the drains has a small hydrologic effect on the nearby vegetation. There is no effect to the jumping mouse.

2.3.2.5 Pecos Sunflower

The population of Pecos sunflower (Figure III-3) located on La Joya WMA exists along the La Joya Drain. Water from the drain augments the wetlands on the wildlife area from direct irrigation and possibly from seepage. Any maintenance that would affect flow or seepage of water from this drain may have an adverse affect on the Pecos sunflower population. Reclamation will evaluate areas to determine if Pecos sunflower is present in the area prior to work and will design projects to avoid impacts that may affect the Pecos sunflower population. If Pecos sunflower are present within the needed maintenance area or work is planned for the La Joya Drain that would impact affect water delivery to the sunflower population or otherwise impact occupied habitat, Reclamation will work with the Service to develop a plan to avoid impact to the sunflower populations. The Rhodes population is not affected by work along the LFCC or the Project drains.

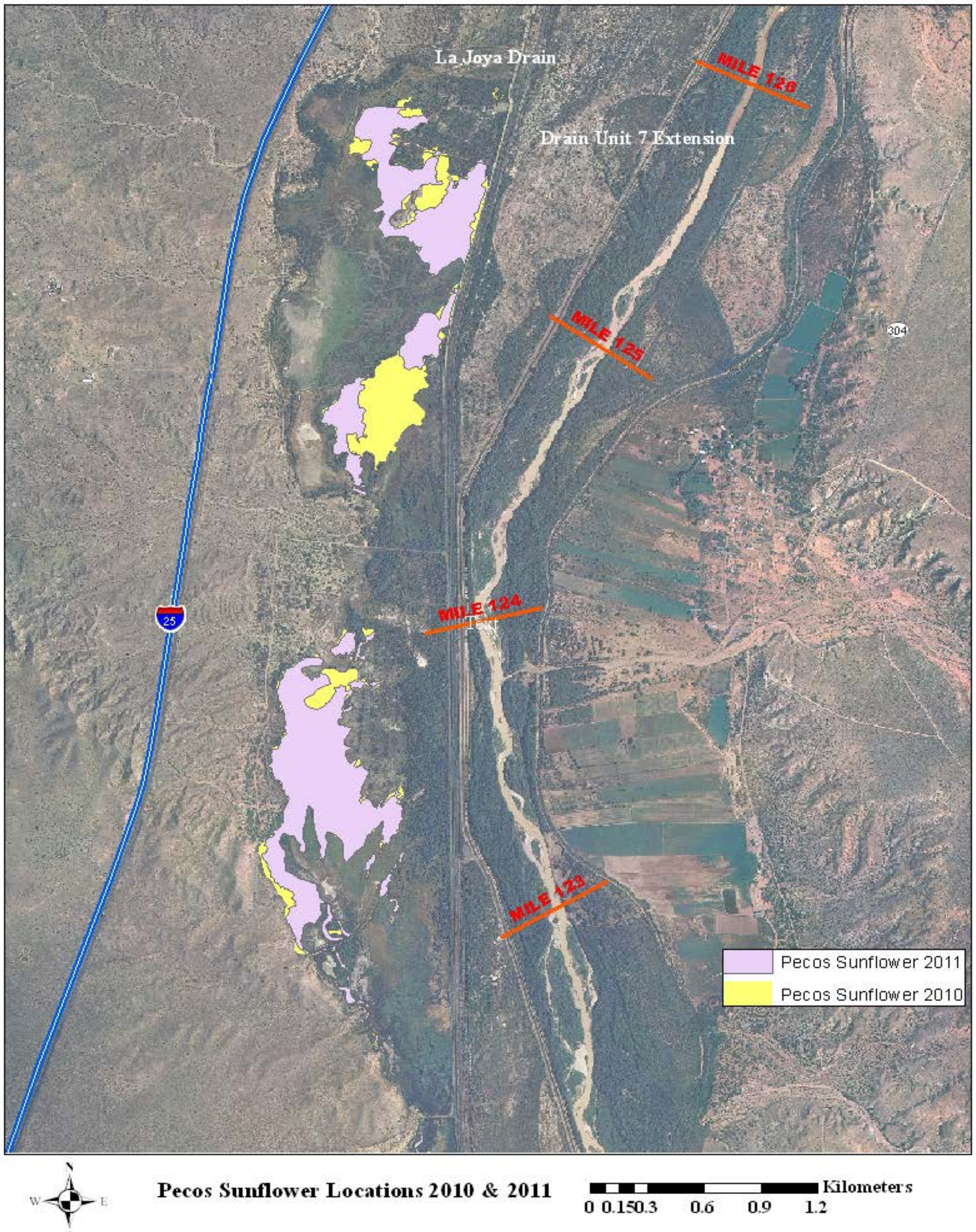

Figure III-3. Extent of area occupied by Pecos sunflower on La Joya WMA

2.4 Effects from the MRGCD Proposed Maintenance Activities

The MRGCD constructs, maintains, modifies, repairs, and replaces irrigation and flood control structures and facilities throughout its boundaries to ensure the proper functioning of these works for their intended purposes. These activities may have effects to the listed species.

Regular ongoing activities occur in specific geographic areas and may occur quite frequently (often daily), for example, the presence of men and equipment in these areas. However, these are previously disturbed and regularly accessed areas, so it is unlikely that listed species will be present; therefore, effects to the listed species will be minimal.

Regular, as-needed activities occur throughout the MRGCD with similar effects as above but occur with lesser frequency. Although these areas also are previously disturbed or modified, reduced frequency of access increases the possibility that listed species may be present.

Some activities are performed with much less frequency, dictated by changing needs or conditions. These may occur at anytime and anywhere throughout the MRGCD but are not expected to occur frequently. Due to the infrequent nature, there often is considerable planning in advance of these activities. Certain activities may occur under extreme or unexpected conditions that pose an immediate risk to human life or property. Should this situation occur, an immediate response is required.

The effects of all the types of activities are similar and are mainly due to the physical presence of men/machinery and the associated noise as well as modification of habitat due to vegetation control/removal and confinement of the channel to existing infrastructure.

2.4.1 Silvery Minnow

Cowley et al. (2007) performed a fish survey within the Peralta Canals that are on the east side of the river. They found that silvery minnow were present within the drainage system, especially during irrigation season and dry periods in the river. Work within the wet portions of the drains and canals is likely to adversely affect silvery minnow with direct effects due to dredging operations and indirect effects due to less suitable habitat within the MRGCD drains and canals with removing shallow, low-velocity areas that silvery minnow use. It appears that, during non-irrigation season, densities of silvery minnow are lower. Work conducted during this season would have less impact on the species. The MRGCD's drains and canals are not considered part of critical habitat. Dredging of the MRGCD's drains and canals near to the river may have a small hydrologic effect on the water in the river if the level of these facilities is lower than the riverbed. This effect is likely very small but may adversely affect silvery minnow critical habitat.

2.4.2 Flycatcher

Flycatchers have been known to migrate through less desirable habitat, including the narrow growth around the drains and other canals as well as nest in areas in close proximity to roads. Coordination between MRGCD and the Service for maintenance actions involving removal of established vegetation would need to take place to ensure maintenance actions would not have any effect to flycatchers. Dredging of the MRGCD's drains and canals has a small hydrologic effect on the nearby vegetation. This effect is likely very small but may adversely affect flycatcher critical habitat.

2.4.3 Cuckoo

Cuckoos have been known to migrate through and forage in less desirable habitat, including the narrow growth around the drains and other canals as well as nest in areas in close proximity to roads. Coordination between MRGCD and the Service for maintenance actions involving removal of established vegetation would need to take place to ensure maintenance actions would not have any effect to cuckoos. Dredging of the MRGCD's drains and canals has a small hydrologic effect on the nearby vegetation. This effect is likely very small but may adversely affect proposed cuckoo critical habitat.

2.4.4 Jumping Mouse

Jumping mice utilize specific microhabitats, including areas of dense vegetation around the drains and other canals, or nesting areas in adjacent upland. Currently the only known population of jumping mice occurs in BDA, which is not part of MRGCD's proposed maintenance action. Dredging of the MRGCD's drains and canals has a small hydrologic effect on the nearby vegetation. There is no effect to the jumping mouse.

2.4.5 Pecos Sunflower

The population of Pecos sunflower located on La Joya WMA exists along the La Joya Drain. Water from the drain augments the wetlands on the wildlife area from direct irrigation and possibly from seepage. Any maintenance that would affect flow or seepage of water from this drain may have an adverse effect on the Pecos sunflower population. Maintenance near occupied Pecos sunflower habitats will be surveyed prior to any work. If Pecos sunflower are present within the needed maintenance area or work is planned for the La Joya Drain that would impact affect water delivery to the sunflower population or otherwise impact occupied habitat, MRGCD and Reclamation will work with the Service to develop a plan to avoid impact to the sunflower populations. Work on specific project sites near the La Joya Drain System would need to be analyzed on a case-by-case basis. The Rhodes population is not affected by work on MRGCD facilities.

2.5 Summary of Effects Analysis

In summary, two general types of effects (direct and indirect) were evaluated for endangered species and their habitat from MRG maintenance activities. Direct effects from implementation of river maintenance projects were described in Section 2.2 and are dependent on project design and scope. Direct effects from maintenance on the LFCC and Project drains were described in Section 2.3 and depend on types of activities performed.

Indirect effects for endangered species are geared more toward the long-term changes that may occur within a reach or upstream and downstream. Indirect effects are expected to be local for the implementation of individual river maintenance projects and dependent on the river maintenance methods used. These are described in Section 2.2.1. The indirect effects from the implementation of multiple river maintenance projects within a river maintenance strategy are described in Section 2.1. The indirect effects from other MRG Project maintenance actions are expected to be negligible. The determinations for all maintenance activities and proposed actions to the silvery minnow, flycatcher, cuckoo, jumping mouse, and sunflower are describedin Sections 2.5.1, 2.5.2, 2.5.3, 2.5.4, and 2.5.5, respectively.

2.5.1 Silvery Minnow

2.5.1.1 Direct Effects

Direct effects are caused by activities that occur within occupied portions of the river, LFCC or State drains, and MRGCD facilities. BMPs have been and will continue to be used to minimize negative effects to silvery minnow. Analysis from Sections 2.2 and 2.3 indicates that the potential acreage of impacted silvery minnow habitat would *likely adversely affect 1,586 acres of their critical habitat over a 10-year timeframe.*

2.5.1.2 Indirect Effects

These are effects that occur after maintenance activities are complete and are due to geomorphic changes in the river as a result of the maintenance activities. Indirect effects are expected to be localized from implementation of individual river maintenance projects and dependent on the river maintenance methods used and location of the project. These are described in Section 2.2.1. The indirect effects from the implementation of projects as part of a river maintenance strategy within a reach are described in Section 2.1. The long-term effect of implementing river maintenance strategies on the habitat within the river are expected as a whole to be positive to the silvery minnow because they were designed to minimize future river maintenance needs and direct impacts to the river. Local indirect effects at river maintenance project sites may have positive and negative impacts to silvery minnow depending on the river maintenance methods used. For example, river maintenance methods that strive to create more complexity in the river or reconnect the floodplain may have long-term benefits to silvery minnow. However, river maintenance methods that create a deep, fast channel that may be more efficient for water delivery would have negative consequences for silvery minnow habitat. Reclamation is not proposing specific river maintenance projects at this time aside from the Delta Channel (Appendix A), but indirect effects caused by river maintenance activities have the potential to be beneficial. Part V provides procedural information on how Reclamation proposes future individual river maintenance projects will be covered under this programmatic, including tiered consultations.

The indirect effects from other MRG Project maintenance actions are expected to be negligible but *may adversely affect silvery minnow and their critical habitat*.

2.5.2 Flycatcher

2.5.2.1 Direct Effects

Direct effects are caused by activities that occur within existing or developing suitable habitat or in close proximity to historic flycatcher territories. BMPs (as described in Sections 1.6.4.5, 1.7.1, and 1.7.2) have been and will continue to be used to minimize negative effects to flycatchers. BMPs to note include, but may not be limited to, avoiding construction from April 15–August 15, conducting annual surveys to ensure flycatcher territories are identified, and ensuring at least a ¼-mile 'buffer' between construction activities and known flycatcher territories. Analysis from Section 2.2.4.2 indicates that the likely potential acreage of impacted flycatcher habitat would be minimal in the next 10 years. However, direct effects caused by construction activities do have the potential to *adversely affect flycatchers or flycatcher critical habitat.*

2.5.2.2 Indirect Effects

These are effects due to maintenance activities that occur away from historical flycatcher territories or existing or developing suitable habitat and/or while flycatchers have not arrived to their breeding grounds. They also include effects that occur due to geomorphic changes in the river as a result of the maintenance activities. Indirect effects are expected to be local for the implementation of individual river maintenance projects and dependent on the river maintenance methods used. These are described in Section 2.2.1. The indirect effects from the implementation of multiple river maintenance projects within a river maintenance strategy are described in Section 2.1. The long-term effect of implementing river maintenance strategies on the habitat within the river corridor are expected, as a whole, to be positive to flycatchers because they were designed to minimize future river maintenance needs and direct impacts to the river. Local indirect effects at river maintenance project sites may have positive and negative impacts to flycatchers depending on the river maintenance methods used. For example, river maintenance methods that modify the river channel tend to change overbank flooding occurrences, frequency or locations, and also vegetation composition over time. These effects can occur upstream of or downstream from the site as well. Implementing these methods can be positive or negative depending on characteristics at the specific location. In some instances (e.g., channel relocation), over the long term, it may actually be beneficial for the flycatchers because this activity mimics the historically ever-changing and meandering river system and the dynamic system of vegetation being created in a new area, as the old vegetation matures. In general, river maintenance methods that reduce channel incision, promote floodplain connectivity, and provide a greater potential for overbank flooding are more beneficial for flycatchers than river maintenance methods that would increase the flood-flow capacity within the channel and lower the water table. Similar to direct effects, indirect effects from maintenance activities do have the potential to be beneficial but also may *adversely affect flycatchers or flycatcher critical habitat.*

2.5.3 Cuckoo

2.5.3.1 Direct Effects

Direct effects are caused by activities that occur within existing or developing suitable habitat or near historical cuckoo territories. BMPs (as described in Sections 1.6.4.5, 1.7.1, and 1.7.2) have been and will continue to be used to minimize negative effects to cuckoos. BMPs to note include, but may not be limited to, avoiding construction from April 15–August 15 or September 1 in suitable cuckoo habitat, conducting annual surveys to ensure cuckoo territories are identified, and analyzing projects individually to determine impacts to known cuckoo territories. Because cuckoo territories are quite large and overlap, a standard and defined 'buffer' as used for the flycatcher does not also apply to the cuckoo. Analysis from Section 2.2.4.3 indicates that the likely potential acreage of impacted flycatcher habitat would be minimal in the next 10 years, and it is assumed this potential acreage would also apply to cuckoo habitat. However, direct effects caused by construction activities have the potential to *adversely affect cuckoos or proposed cuckoo critical habitat.*

2.5.3.2 Indirect Effects

These are effects due to maintenance activities that occur away from historical cuckoo territories or existing or developing suitable habitat and/or while cuckoos have not arrived to their breeding grounds. They also include effects that occur due to geomorphic changes in the river as a result of the maintenance activities. Indirect effects are expected to be local for the implementation of individual river maintenance projects and dependent on the river maintenance methods used. These are described in Section 2.2.1. The indirect effects from the implementation of multiple river maintenance projects within a river maintenance strategy are described in Section 2.1. The long-term effect of implementing river maintenance strategies on the habitat within the river corridor are expected, as a whole, to be positive to the cuckoo because they were designed to minimize future river maintenance needs and direct impacts to the river. Local indirect effects at river maintenance project sites may have positive and negative impacts to cuckoo depending on the river maintenance methods used. For example, river maintenance methods that modify the river channel tend to change overbank flooding occurrences, frequency or locations, and also vegetation composition over time. These effects can occur upstream of or downstream from the site as well. Implementing these methods can be positive or negative depending on characteristics at the specific location. In some instances (e.g., channel relocation), over the long term, it may actually be beneficial for the cuckoos because this activity mimics the historically ever changing and meandering river system and the dynamic system of vegetation being created in a new area, as the old vegetation matures. In general, river maintenance methods that reduce channel incision, promote floodplain connectivity, and provide a greater potential for overbank flooding are more beneficial for cuckoos than river maintenance methods that would increase the flood-flow capacity within the channel and lower the water table. Similar to direct effects, indirect effects from maintenance activities do have the potential to be beneficial but also *may adversely affect cuckoos or proposed cuckoo critical habitat.*

2.5.4 Jumping Mouse

Table III-28 summarizes the biological effects of the proposed river maintenance actions on the jumping mouse and the proposed critical habitat PCEs; Sections 2.5.4.1 and 2.5.4.2 discuss direct and indirect effects, respectively.

Table III-28. Effects of proposed river maintenance actions on jumping mouse within the MRG.

Action Category	Active Season (May – October)	Dormant Season (November – April)
River Maintenance – Up to 8 projects per year (average of 4 per year); includes State cooperative agreement for MRG Project Area	The only known extant population of jumping mice within the MRG occurs in BDA in association with irrigation drains, but river maintenance actions are not proposed to occur within this area. All individual river maintenance project areas would be evaluated for suitable jumping mouse habitat by Reclamation on a project and location specific basis. ***Direct and Indirect Effects - no effect to the jumping mouse***	The only known extant population of jumping mice within the MRG occurs in BDA in association with irrigation drains, but river maintenance actions are not proposed to occur within this area. All individual river maintenance project areas would be evaluated for suitable jumping mouse habitat by Reclamation on a project and location specific basis ***Direct and Indirect Effects - no effect to the jumping mouse***
River Maintenance – Support activities; includes maintenance of access roads, storage sites, stockpile sites, borrow areas, and quarries. Also covers pumping water for dust abatement and data collection	Support activities for river maintenance projects would likely be located outside of the proposed critical habitat areas. All individual project areas for support activities would be evaluated for suitable jumping mouse habitat by Reclamation on a project and location specific basis. ***Direct and Indirect Effects - no effect to the jumping mouse***	The only known extant population of jumping mice within the MRG occurs in BDA in association with irrigation drains, and river maintenance support activities are not proposed to occur within this area. Support activities for river maintenance projects would likely be located outside of the proposed critical habitat areas. All individual project areas for support activities would be evaluated for suitable jumping mouse habitat by Reclamation on a project and location specific basis. ***Direct and Indirect Effects - no effect to the jumping mouse***

Table III-28. Effects of proposed river maintenance actions on jumping mouse within the MRG.

Action Category	Active Season (May – October)	Dormant Season (November – April)
Drain Maintenance – Drain and LFCC maintenance; includes State cooperative agreement for MRG Project Area	The only known extant population of jumping mice within the MRG occurs in BDA in association with the Riverside Drain, but the proposed maintenance activities would not occur in this location except for LFCC maintenance. Jumping mouse is not currently found along the LFCC. Drain maintenance would likely be located outside of the proposed critical habitat areas. All individual project areas would be evaluated for suitable jumping mouse habitat by the lead agency for the project (Reclamation, State, or MRGCD) on a project and location specific basis. ***Direct and Indirect Effects - no effect to the jumping mouse***	The only known extant population of jumping mice within the MRG occurs in BDA in association with the Riverside Drain, but the proposed maintenance activities would not occur in this location except for LFCC maintenance. Jumping mouse is not currently found along the LFCC. Drain maintenance would likely be located outside of the proposed critical habitat areas. All individual project areas would be evaluated for suitable jumping mouse habitat by the lead agency for the project (Reclamation, State, or MRGCD)) on a project and location specific basis. ***Direct and Indirect Effects - no effect to the jumping mouse***
Maintenance of River Facilities – River facilities, dams, and levee maintenance	The only known extant population of jumping mice within the MRG occurs in BDA in association with irrigation drains, and facility maintenance activities are not proposed to occur within this area. Maintenance of river facilities would likely be located outside of the proposed critical habitat areas. All individual project areas would be evaluated for suitable jumping mouse habitat by MRGCD on a project and location specific basis. ***Direct and Indirect Effects - no effect to the jumping mouse***	The only known extant population of jumping mice within the MRG occurs in BDA in association with irrigation drains, and facility maintenance activities are not proposed to occur within this area. Maintenance of river facilities would likely be located outside of the proposed critical habitat areas. All individual project areas would be evaluated for suitable jumping mouse habitat by MRGCD on a project and location specific basis. ***Direct and Indirect Effects - no effect to the jumping mouse***
Proposed Critical Habitat PCEs		
1. Riparian Community	"Riparian communities along rivers and streams, springs and wetlands, or canals and ditches characterized by one of two wetland community types: persistent emergent herbaceous wetlands dominated by beaked sedge (*Carex rostrate*) or reed canarygrass (*Phalaris arundinacea*) alliances; or scrub-shrub riparian areas that are dominated by willows (*Salix* spp.) or alders (*Alnus* spp.)." The Proposed Action ***may affect, but is not likely to adversely affect*** the riparian community utilized by jumping mice. River maintenance activities would likely be located outside of the proposed critical habitat areas. However, if projects located in or near the proposed critical habitat units on Isleta and Okhay Owingeh Pueblos, and BDA become necessary, further evaluation and modified project development may become necessary to protect the riparian community PCE. River maintenance often includes habitat creation or restoration components that have the potential to benefit the jumping mouse habitat.	

Table III-28. Effects of proposed river maintenance actions on jumping mouse within the MRG.

Action Category	Active Season (May – October)	Dormant Season (November – April)
Proposed Critical Habitat PCEs (cont.)		
2. Vegetation Structure and Composition	"Flowing water that provides saturated soils throughout the jumping mouse's active season that supports tall (average stubble height of herbaceous vegetation of at least 69 cm (27 inches), and dense herbaceous riparian vegetation (cover averaging at least 61 vertical cm (24 inches) composed primarily of sedges (*Carex* spp. or *Schoenoplectus pungens*) and forbs, including, but not limited to one or more of the following associated species: spikerush (*Eleocharis macrostachya*), beaked sedge (*Carex rostrate*), reed canarygrass (*Phalaris arundinacea*), rushes (*Juncus* spp. and *Scirpus* spp.), and numerous species of grasses such as bluegrass (*Poa* spp.), slender wheatgrass (*Elymus trachycaulus*), brome (*Bromus* spp.), foxtail barley (*Hordeum jubatum*), or Japanese brome (*Bromus japonicas*), and forbs such as water hemlock (*Circuta douglasii*), field mint (*Mentha arvense*), asters (*Aster* spp.), or cutleaf coneflower (*Rudbeckia laciniata*)." The Proposed Action ***may affect, but is not likely to adversely affect*** the vegetation structure and composition PCE. River maintenance activities are unlikely to impact the proposed critical habitat areas, as in the MRG the proposed critical habitat is found on canals and ditches. All individual project areas would be evaluated for suitable jumping mouse habitat by the lead agency for the project (Reclamation, State, or MRGCD) on a project- and location-specific basis.	
3. Habitat Area (active season)	"Sufficient areas of 9 to 24 km (5.6 to 15 mi) along a stream, ditch, or canal that contain suitable or restorable habitat to support movements of individual New Mexico meadow jumping mice…" The Proposed Action ***may affect, but is not likely to adversely affect*** the area of proposed critical jumping mouse habitat in the MRG utilized during the active season. This habitat is located on irrigation canals and ditches that typically maintain reliable and consistent water elevations that support existing habitat areas. All individual project areas would be evaluated for suitable jumping mouse habitat by the lead agency for the project (Reclamation, State, or MRGCD) on a project- and location-specific basis.	
4. Habitat Area (hibernation)	"Include adjacent floodplain and upland areas extending approximately 100 m (330 ft) outward from the water's edge (as defined by the bankfull stage of streams)." The Proposed Action ***may affect, but is not likely to adversely affect*** the adjacent floodplain and upland areas of jumping mouse habitat utilized during hibernation. These areas are at drier, higher elevations, but may be impacted if the project involves ground clearing or mowing in these areas. All individual project areas would be evaluated for suitable jumping mouse habitat by the lead agency for the project (Reclamation, State, or MRGCD) on a project- and location-specific basis.	

2.5.4.1 Direct Effects

Direct effects are caused by activities that occur within existing occupied jumping mouse habitat. Currently the only known population of the jumping mouse occurs in BDA along the Riverside Drain; however, the proposed action will not occur in this location. BMPs would be used to minimize the risk of any adverse effects to the jumping mouse elsewhere. BMPs may include, but are not limited to, conducting project specific site evaluations to ensure that jumping mouse suitable habitat is identified and appropriately assessed prior to construction. Maintenance actions are not likely to occur in proposed critical habitat at Ohkay Owingeh or Isleta Pueblos.

Therefore, construction activities will have *no direct effect to the jumping mouse, and may affect, but not likely to adversely affect proposed jumping mouse critical habitat.*

2.5.4.2 Indirect Effects

Indirect effects are those due to maintenance activities that occur away from existing occupied jumping mouse habitat. They may include effects that occur due to geomorphic changes in the river as a result of the maintenance activities. Indirect effects are expected to be local for the implementation of individual river maintenance projects and dependent on the river maintenance methods used as described in Section 2.2. The indirect effects from the implementation of multiple river maintenance projects within a river maintenance strategy are described in Section 2.1. Local indirect effects at river maintenance project sites may have positive and negative impacts to jumping mouse depending on the river maintenance methods used. For example, river maintenance methods that modify the river channel tend to change overbank flooding occurrences, frequency or locations, and also vegetation composition over time. In general, river maintenance methods that reduce channel incision, promote floodplain connectivity, and provide a greater potential for overbank flooding are more beneficial for jumping mouse than river maintenance methods that would increase the flood-flow capacity within the channel and lower the water table. The only known population of jumping mice in the MRG is at BDA and it occurs along the Riverside Drain rather than the Rio Grande itself. Maintenance actions are not likely to occur in proposed critical habitat at Ohkay Owingeh or Isleta Pueblos. Similar to direct effects, maintenance activities will have *no indirect effect to the jumping mouse, and may affect, but not likely to adversely affect proposed jumping mouse critical habitat.*

2.5.5 Pecos Sunflower

Impacts to Pecos sunflower are possible due to maintenance actions, specifically Project drain maintenance on the La Joya Drain that occurs within occupied habitat or in close proximity to Pecos sunflower populations or changes in water delivery to those areas. Project areas near occupied Pecos sunflower habitats will be surveyed prior to any work. If Pecos sunflower are present within the needed maintenance area or work is planned for the La Joya Drain that would impact affect water delivery to the sunflower population or otherwise impact occupied habitat, Reclamation will work with the Service to develop a plan to avoid impact to the sunflower populations.

With these measures in place, maintenance activities are *not likely to adversely affect Pecos sunflower*.