3. Description of Proposed Actions

3.1 Introduction and Background

3.1.1 Introduction

This section contains a description of the proposed actions for maintenance on the MRG above the Elephant Butte Full Pool Reservoir Level. In this document, three types of maintenance activities are described: river maintenance, other Reclamation MRG maintenance, and Middle Rio Grande Conservancy District (MRGCD) maintenance. The State of New Mexico also has maintenance activities that are covered by this document; but since these maintenance activities fall within the described actions and effects of river maintenance and other Reclamation MRG maintenance, a separate section describing their 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 New Mexico Department of Game and Fish. 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 (see section 3.7), including the anticipated operation and maintenance on the LFCC (section 3.7.1), Project drains (see section 3.7.2), and the MRGCD MRG maintenance activities on irrigation and flood control facilities (section 3.8). It is anticipated that sufficient detail is provided in this BA 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. Since 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 3.1.2) is presented. These goals, coupled with an understanding of the current geomorphic trends within each reach, are used to develop reach-based strategies (section 3.2) 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. Since 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 3.2 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 (section 5.2.1), which are designed to meet local river maintenance needs to address symptoms of an observed geomorphic trend.

River maintenance sites (section 3.6.1), 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 3.3) and implementation techniques (section 3.6.4.5). They also both rely on a variety of river maintenance support activities (section 3.6.4).

Estimated river maintenance project area, footprint, duration, etc., are described conceptually for the implementation of project sites (section 3.6) 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 3.6.1) – describes project locations where river maintenance activities have not previously been performed.

- **Adaptive management work –** describes projects where an adaptive management process (section 3.4) is being followed to address ongoing river responses that may undermine river maintenance activities previously performed at the site.

- **Interim work** (section 3.6) – 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 3.5)– 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. Most of these individual project activities may be described in subsequent correspondence tiered off this programmatic maintenance BA. 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. Lastly, any new routine maintenance, tiered off this programmatic maintenance BA, would be developed with sufficient detail through coordination with the Service.

3.1.2 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 U.S. Army Corps of Engineers (USACE), and the MRGCD in the House Documents (Reclamation 1947; Reclamation 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, although not every trend occurs on every reach, are listed below. These trends and their applicability to the MRG are discussed in more detail in the report titled 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:

- 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.

3.2 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 towards 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 Flood Plain
- 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).

3.2.1 Promote Elevation Stability

The objective of this strategy is to reduce the extent and rate of bed elevation changes. Promote Elevation Stability has 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 (see section 3.3.4 for more details on this method category) 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 (Rio Grande silvery minnow [RGSM]) 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 because of an excess sediment supply. Since 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 projects likely will require the combination of multiple strategies (see section 3.2.7).

3.2.2 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 re-directive 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 (see section 3.3.3 for more details on this method category) throughout the reach. This could involve direct longitudinal bank stability methods such as bank slope re-grading, 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.

Promote Alignment Stability 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 the Manage Sediment.

3.2.3 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 flood plain, 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 (see section 3.3.2 for more details on this method category) 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.

3.2.4 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 flood plain 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 (see section 3.3.1 for more details on this method category). 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 (see section 3.3.5 for more details on this method category).

3.2.5 Rehabilitate Channel and Flood Plain

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. Rehabilitate Channel and Flood Plain reconnects abandoned flood plains, which reduces the sediment transport capacity of higher flows and more closely matches the existing sediment supply.

This strategy addresses the Support Channel Sustainability, Be Ecosystem Compatible, and Protect Riverside Infrastructure and Resources Goals of river maintenance, 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 (see section 3.3.2 for more details on this method category) 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.

3.2.6 Manage Sediment

This strategy would aid in balancing sediment transport capacity with available sediment supply. Currently, there is an excess of sediment transport capacity in most of the reaches, so this generally would involve the addition of sediment into the system. In some reaches, however, the sediment supply exceeds the sediment transport capacity and 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 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 (see section 3.3.6 for more details on this method category) 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 (see section 3.2.7). 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.

3.2.7 Strategy Combinations

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

As an 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 Flood Plain. For instance, island and bar clearing and destabilization and flood plain 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 Flood Plain.

3.2.8 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 2. 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 more likely are 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 2. 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

3.3 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 3.3.1–3.3.6 and in more detail in the River Maintenance Methods Attachment, as well as the report titled Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide, Appendix A (Reclamation 2012b). 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 3, below, contains 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 Attachment 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 3. 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 Flood Plain	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

3.3.1 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 flood plain 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 re-located infrastructure may still be required as channel migration approaches the relocated facilities.

3.3.2 Channel Modification

Channel modifications are actions used to re-construct, relocate, and re-establish 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.

3.3.3 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 Attachment 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).

3.3.4 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 flood plain connectivity and ground water 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).

3.3.5 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 flood plain 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 flood plain areas.

3.3.6 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.

3.4 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 (section 5.2.2, table 18 and tables 19–28, 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 (see section 5.2.1) 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 report, 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 (RGSM) 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 Flood Plain may need continued evaluation and adjustments to ensure flows go over bank at the desired discharge and frequency, the channel is stable, and to ensure 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; but since 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 River Mile 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. Because of 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 3.6.3.

3.5 River Maintenance Sites and the Interstate Stream Commission Cooperative Agreement

As previously discussed in section 3.1.2, 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 of New Mexico has a common interest with Reclamation in ensuring the effective delivery of water to the Elephant Butte

Reservoir. Reclamation and the State of New Mexico 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 flood plain of the Rio Grande and its tributaries above Elephant Butte Reservoir. Projects pursued under this cooperative program fall into two general areas, one being projects that have a common river maintenance interest, and the other being projects that fall within the realm of other MRG activities.

In February 2007, a new Cooperative Agreement (07-CF-40-2627) was executed between the New Mexico Interstate Stream Commission (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 stream flow losses and to reduce nonbeneficial consumption of water by vegetation in the flood plain 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 (section 3.2). The expected river maintenance methods (section 3.3) 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 3.6. 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.

3.6 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 3.6.1. In addition to river maintenance methods (section 3.3 and the River Maintenance Methods Attachment), river maintenance projects during implementation also have specific site locations (section 3.6.3), implementation footprints (section 3.6.2), implementation techniques (see section 3.6.4.5), and impacts from support activities (section 3.6.4). 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 section 3.6 of this document, 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 3.6.3 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 BiOp 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.

3.6.1 River Maintenance Sites

Based on Reclamation's historical performance (section 5.2, table 18), 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 5, shown later in this document). 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 (section 3.6.1.1 and 3.6.1.2). 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 (sections 3.6.1.1 and 3.6.1.2). New river maintenance sites may develop at sites currently identified as river maintenance monitoring sites, be totally new river maintenance sites where changing site conditions warrant declaring a new monitoring or priority site, or be river maintenance sites that are used to implement a river maintenance strategy.

3.6.1.1 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 Reclamation would need to label the project as an emergency and proceed using the ESA emergency protocols. The implementation of river maintenance strategies on a reach scale (see section 3.2) 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 3.3, the River Maintenance Methods Attachment, and the report, titled Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide, Appendix A (Reclamation 2012b). 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 3.6.4.1. 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. Typically riprap is 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. Typically, dirt is 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. Typically, riprap is 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.

3.6.1.2 River Maintenance Interim Work

River maintenance interim work typically is 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 (as discussed in section 3.6.1.1) 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 3.6.4.1. 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.

3.6.2 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 (see section 5.2, table 17). 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 between 0–65 acres, with an estimated average of 5 acres (table 6, shown later in this document). The estimated river maintenance project impact acreage in the dry ranges between 1–70 acres, with an estimated average of 7 acres (table 6).

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 range of river maintenance duration for a single project is expected to range between 1–16 months (table 7, shown later in this document).

Implementation techniques (section 3.6.4.5) 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 3.6.4. The river maintenance acreage impacts provided in table 14 include the impact acreage from the implementation techniques.

3.6.3 Distribution of Proposed River Maintenance Work

The uncertainty associated with predicting future channel changes makes it difficult to estimate reliably 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 River Mile 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, since 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, but 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, therefore, would 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. Since 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 3.6.5 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. Since historically it is 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, since 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 between 2000–2010 are an example of this decadal hydrograph. The qualitative peak flow for this scenario is in the 4,000- to 6,000-cubic-feet-per-second (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 between 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- to 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 (listed in section 3.1), 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 the balance between sediment transport capacity and sediment supply; the difference between the current channel slope and the stable slope for the current conditions; planform changes such as narrowing, vegetation encroachment, and bend migration; bank height; bed and bank material size and stability; tributary effects; comparison of the calculated meander belt to river alignment and lateral constraints; base level control effects of fluctuations in Elephant Butte Reservoir pool elevation; and 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 4 lists the estimated distribution of new river maintenance sites by reach over a 10-year period for each scenario.

Table 4. 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 Bride to River Mile 78	15%	9%
River Mile 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 5.

Table 5. 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 River Mile 78	13%	9%
River Mile 78 to Full Pool Elephant Butte Reservoir Level	19%	10%

3.6.4 River Maintenance Support Activities

Several support activities are required to successfully and efficiently complete river maintenance actions. These activities, summarized in the following sections, provide information on data collection (section 3.6.4.4), access (section 3.6.4.1), materials essential for the completion of river maintenance actions (sections 3.6.4.2 and 3.6.4.3), and implementation techniques (section 3.6.4.5). The sections on material essential for the completion of river maintenance actions and information on data collection refer to information described in Section 5.2.4, River Maintenance Historical Baseline.

3.6.4.1 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-site 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 what is shown in figure 2. 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 2. 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 Office of the New Mexico State Engineer. Reclamation's current permit (SP-04955) allows the use of 80 acre-feet per year. 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 acre-feet of water, with an estimated range of 2–65 acre-feet. 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 flood plain for pumping. Preparation of a sump involves digging a hole in the flood plain, 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 ground water 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 between 1.8 and 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 truck loads per day and on rare occasions, may use 18 truck loads per day.

3.6.4.2 Stockpiles and Storage Yards
Reclamation currently has ten established stockpile sites and two 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 section 5.2.4.2.

3.6.4.3 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 section 5.2.4.3. 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.

3.6.4.4 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 section 5.2.4.4. 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 photos, 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.

1. Impacts to any desirable vegetation present would be minimized to the extent possible.

2. All vegetation clearing locations would be reviewed by Reclamation biologists for potential impacts prior to any brushing activity.

3. Vegetation clearing activities located near willow flycatcher habitat would not occur during the breeding season (April 15–August 15).

4. 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.

3.6.4.5 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 3.6.5. These BMPs fall into two general categories. The first refers to general BMPs that are applicable to all river maintenance methods. The second are specific BMPs to a method category. These techniques have been utilized historically, as listed by project in tables 19–29 located in section 5.2.

General BMPs

1. *Management of local site water runoff* – Dirt berms, straw bales, silt fences, silt curtains or other appropriate material will be placed at strategic locations to manage water runoff in the river maintenance site in accordance with the NPDES storm water permit and plan.

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

    a. Hydraulic lines will be checked each morning for leaks and periodically throughout each work day.

    b. All fueling will take place outside the active flood plain. Fuel will be stored onsite overnight but not near the river or any location where a spill could affect the river.

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

    d. Equipment will be parked on predetermined locations on high ground, away from the project area overnight, on weekends, and holidays.

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

3. *Visual monitoring of water quality* – Reclamation visually monitors for water quality at and below areas of river work before and during the work day.

4. *Bird surveys* – Reclamation will avoid impacts to birds protected by the Migratory Bird Treaty Act (16 United States Code [U.S.C.] 703) by periodically conducting breeding bird surveys during the normal breeding and nesting season (approximately April 15–August 15) for most avian species.

5. *Vegetation clearing* – Vegetation clearing, required for each project site, will be completed after August 15 and before April 15. Any need for deviations from this work window would be considered on a project-specific basis in the tiered consultations for each river maintenance project at a later date. Work after April 1 would be accompanied by appropriate surveys. Reclamation coordinates monitoring and work activities with the Service, as appropriate, if bird nests are found. Nonnative vegetation at the project site will be mulched, burned, or removed offsite to an approved location. If a project requires removing native vegetation, where possible, this material will be removed or harvested at the appropriate season to use in revegetation at another location in the project area or at another project site. If it is not possible for native vegetation to be replanted, material will be mulched or temporarily stockpiled and used to create dead tree snags or brush piles in the project area upon completion.

6. *Clean material* – Riprap and other material 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 material, those clumps will be set aside during the loading or placing operations.

7. *Implementation waste* – All project spoils and waste are disposed of offsite at approved locations. All river maintenance projects have a contract in place for the rental of porta potty facilities during the duration of the project.

8. *Water work warning* – To allow fish time to leave the area before implementation activities begins, the first piece of equipment (in the case of articulated trucks, dozers, front end loaders, scrapers, etc.) initially will enter the water slowly at the start of each work sequence in the river. If work involves placing rock or other material in the river channel from a platform, an object will be lowered and raised slowly into the water before placing the material. The object typically will be the bucket of an excavator, or similar piece of construction equipment. This will be done at the start of each work sequence in the river.

9. *Water work duration* – 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. River maintenance work in the river during spring runoff or monsoonal events greater than 1,000 cfs

will not be conducted unless a river diversion, described in the Method Category BMPs below, is constructed.

10. *Revegetation* – A variety of revegetation techniques, such as stem and pole cuttings (Los Lunas Plant Materials Center 2007b), long stem transplants (Los Lunas Plant Materials Center 2007a), upland planting with and without a polymer, zeolite, or similar compound to maximize soil water retention (Dreesen 2008), etc., may be used on river maintenance projects. Actual planting techniques may vary from site to site, using buckets, augers, stingers, water jets, etc., mounted on construction equipment to provide a hole for stem and pole plantings and long stem transplants. In some areas, a trench may be constructed to facilitate the placement of a significant number of plants, specifically stem and pole cuttings. Upland plantings like shrubs will use similar techniques. Seeding would be done using a native seed drill, where feasible, and spread with a protective covering to facilitate the gathering of moisture to the seeds.

11. *Herbicide/Chemical spraying* – The use of sprays 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 for 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. Since 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 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* Socorro Field Division Integrated Pest Management Plan (Reclamation 2008).

Method Category BMPs

1. *River diversion* – This implementation technique places a berm across a portion or all of the river channel to re-divert 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. The diversions, in a few cases, 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; but 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 flood plain, 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.

3.6.5 Summary of River Maintenance Proposed Actions

Tables 6–8 summarize the annual number of projects, project footprint acreage, and project duration for proposed river maintenance projects as previously described in Section 3.6, River Maintenance Project Details.

Table 6. 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**

Table 7. River Maintenance Project Area (Single Site) During Implementation (Acres)

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

[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.

Table 8. Approximate River Maintenance Project Duration (Single Site in Months)

	Average	Minimum	Maximum
Single Site	**6**	**1**	**16**

Tables 6 and 7 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 8.

1. Ten-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 7. 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 7. 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 7.

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 7.

9. Adaptive Management and Interim/Unanticipated Work are expected to be at or less than the average acreage listed in table 7. 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 6.

    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)*.025*65 (percent and wet impact acreage from bullet 3) = 32.5 acres

    b. 20 (bullet 10a)*.025*20 (percent and wet impact acreage from bullet 4) = 10 acres

    c. 20 (bullet 10a)*.50*5 (percent from bullet 5, wet impact acreage from table 7) = 50 acres

    d. 20 (bullet 10a)*.225*11 (percent and wet impact acreage from bullet 6) = 49.5 acres

    e. 20 (bullet 10a)*.225*0 (percent 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 6 and multiplying by 10 (to adjust to the decadal time scale) and the average acreage listed in table 9 for the wet and dry impact areas..

Table 9. 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 10 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 11 is the sum of annual values listed in table 10. No multiplying factor is applied to extend this acreage over multiple years, since the area of disturbance is not changing from year to year.

Table 10. 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 11. 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 11, both wet and dry, is based on the summation of annual values listed in table 10 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 since 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 since 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 between 1.8 and 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 12. Estimated values in table 12 are per project. The total impact acreage for river maintenance for these activities is listed in table 13. For calculations in table 13, 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 13, since impacts are short in duration and would be covered under the delineated river maintenance footprint acreage from table 9. Impacts from the implementation technique of dewatering are also not included in table 13. 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 12. 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 13. 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 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 12 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 12 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 12 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 12. 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 12. 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 14), the acreage totals in tables 9, 11, and 13 were distributed to reaches using the predicted spatial distributions described and listed in section 3.5.3. Only the river corridor acreage (wet and dry) is utilized from table 11 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 averages, 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 14.

Table 14. 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 River Mile 78, wet	155	9	478
San Antonio Bridge to River Mile 78, dry	85	45	240
San Antonio Bridge to River Mile 78, Total	**240**	**54**	**718**
River Mile 78 to Full Pool Elephant Butte Reservoir Level , wet	235	14	707
River Mile 78 to Full Pool Elephant Butte Reservoir Level, dry	130	71	373
River Mile 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**

Tables 11 and 14 provide an estimate of the proposed river maintenance acreage impacts. While these acreages 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 3.6 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.

3.7 Other Reclamation MRG Project Proposed Maintenance Actions

There are other activities, distinct from river maintenance actions and river maintenance support activities, which 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 Low Flow Conveyance Channel (Reclamation 1947; Reclamation 2003). Descriptions of these activities are provided in the following sections.

Throughout section 3.7 of this document, 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 BiOp 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. Since 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 Socorro Field Division Integrated Pest Management Plan.

3.7.1 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 BDANWR 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 (section 5.3.1). 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, subsurface drainage water, irrigation return flows, and seepage water from the river in some areas. The LFCC, as part of the existing baseline in the perched reaches of the river, can slightly increase seepage from the river and contribute to drying. The magnitude of this effect is likely small, especially as compared to the general infiltration of water into the river banks and bed. Furthermore, 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 3.6.4.5 are used.

- **Vegetation Control**: Vegetation control would occur within the area defined between the top of slope on the western edge of the LFCC channel 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 54-mile length of the LFCC. Vegetation control described herein is not intended for the Rio Grande channel. Mowing will typically be done with a radial blade mounted to a backhoe or other heavy equipment and can impact a maximum of 4,390 acres (670 average lateral feet between the western slope of LFCC channel to the furthest toe of slope on the eastern levee over the course of 54 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 due to guidelines set forth in the Migratory Bird Treaty Act of 1918. The restrictions on mowing also benefit the willow 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.

- **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 San Marcial 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. 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, 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, backhoes, dump trucks, 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 20 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. Concrete bridges on the LFCC include those at San Acacia Diversion Dam, River Mile 111, Highway 1280, Brown Arroyo, Mid-Bosque del Apache, South Boundary, Ft. Craig, 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 that 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 backhoes, dump trucks, semitrucks, concrete trucks, and others.

3.7.2 Project Drain Proposed Actions

MRG project authorization provides for Reclamation (Reclamation 1947; Reclamation 2003) to perform irrigation and drain rehabilitation. The majority of these drains and irrigation facilities in the Middle Rio Grande are currently operated and maintained by MRGCD. There are a few drains, however, that MRGCD does not maintain and that benefit the State of New Mexico 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 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 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 below in table 15. 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 15. 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.

3.7.2.1 Typical Drain Maintenance Implementation Techniques

Typical implementation techniques used in drain maintenance are described below. The general BMPs described in section 3.6.4.5 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 sideslopes 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 sideslopes of the drain, usually by a mower that drives along the edge of the drain. Larger woody vegetation may need to be removed with chainsaws. Additional mowing 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.

3.7.3 Summary of Other Reclamation MRG Project Proposed Maintenance Actions

Table 16 summarizes the annual project footprint acreage for proposed other MRG Project maintenance activities as previously described above. Values in table 16 were calculated using the range of impact acreage described throughout section 3.7. 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, since 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 16. 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**

3.8 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. 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—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. Since 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).

3.8.1 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; and; 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.

8.3.2 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, re-alignment of wasteway and drain outfall channels, replacement of diversion measurement or control structures, replacement of pipe crossings for access roads; etc.

8.3.3 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.

8.3.4 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. However, should they occur, 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.

8.3.5 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 coordinate with Reclamation and the Service as soon as is practical to minimize any potential impacts of these activities to the species.