FINAL

Middle Rio Grande Bosque Restoration Project
Monitoring and Adaptive Management Plan

Approved March 25, 2011

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1.0 Authority and Purpose

Per Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007), feasibility studies for ecosystem restoration are required to include a plan for monitoring the success of the ecosystem restoration. "Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be need to attain project benefits." Therefore, Section 2039 also directs that a Contingency Plan (Adaptive Management Plan) be developed for all ecosystem restoration projects.

2.0 Goals of the Project to be measured through monitoring

The first step in designing an evaluation program for the Middle Rio Grande Bosque Restoration Project (MRG Project) is to define the goals and objectives of the project. As stated in the U.S. Army Corps of Engineers (Corps) Feasibility Report (December 2009), they are as follows:

1. Improve habitat quality and increase the amount of native bosque communities.
2. Reestablish fluvial processes in the bosque to a more natural condition.
3. Restore hydraulic processes between the bosque and the river to a more natural condition.
4. Reduce the risk of catastrophic fires in the bosque.
5. Protect, extend and enhance areas of potential habitat for listed species within the bosque.
6. Provide educational or interpretive features.
7. Integrate recreational features that are compatible with ecosystem integrity.

Goals for a Monitoring and Adaptive Management Plan for the project should measure whether these objectives have been met or not. Some general items to keep in mind when developing specific monitoring components to measure include:

- Provide a thorough understanding of the ecosystem with and without restoration.
- Show direct cause-effect relationships between restoration measures and ecological responses.
- Include quantifiable biological responses.
- Document changes that are of social and scientific importance. (USACE, 1992).

There are also some constraints to implementation of the restoration project that should be kept in mind when developing specific monitoring components to measure. Some of these are:

1. The Rio Grande is a multi-jurisdictional, multi-boundary natural resource that is extremely human managed and manipulated due to this multi-jurisdictional setting.
2. There are legal obligations in the form of water rights in the State of New Mexico and especially on the Rio Grande.
3. With the exception of some jetty jacks (not all), river channelization and manipulation structures will remain in place.

These are some of the constraints of not only the evaluation of restoration, but of the restoration components themselves. These are the constraints, challenges, and potential

benefits (when trying to approach this optimistically) that must be operated within in this large scale restoration effort.

3.0 Implementation

3.1 Implementation of the Monitoring Plan

Pre-construction, during construction and post construction monitoring shall be conducted by the Corps. After that time, monitoring would continue and be the responsibility of the local sponsor.

Monitoring will be aimed at evaluating project success and guiding adaptive management actions by determining if the project has met 'performance standards'. Validation monitoring will involve various degrees of quantitative monitoring aimed at verifying that restoration objectives have been achieved for both biological and physical resources. Effectiveness monitoring will be implemented to confirm that project construction elements perform as designed. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007, as noted in paragraph 3.c of the implementation guidance. Monitoring objectives have been tied to original baseline measurements that were performed during the Habitat Evaluation Assessment Tool (HEAT) modeling effort and are shown below.

Measurement	**Performance Standard**	**Adaptive Management**
Vegetation – tree density, tree canopy cover, shrub canopy cover, ground cover, species count/composition, % native/non-native; overall percent cover	Overall % cover – overall stand density mosaic per HEAT measurement goals: 50% native tree, 30% native shrub, 20% native herbaceous and/or wet habitat	Any planted material that has died shall be replaced (per one year warranty); After one year, adaptive management should focus on non-native vegetation treatment per below.
	Non-native vegetation % cover: </= 30%	On an annual basis, areas ¼ acre in size or larger that have > 30% areal cover by non-native vegetation shall be treated
	Noxious weeds: </= 30%	On an annual basis, areas ¼ acre in size or larger that have > 30% areal cover by weeds shall be treated
Hydrology – flood frequency, flood duration, depth, velocity, wetted area, groundwater depth	Increase flood frequency and duration into bosque by 10%; increase wetted area in bosque by 15%	As features potentially get filled with sediment, they will need to be cleaned out; Review designs for potential needed change
Avian monitoring -	Increase in species diversity by 10% in areas where wet	Ensure wet features are functioning (per hydrology

	habitat is constructed; Increase in species diversity by 10% of other areas within 3-5 years (noting that there will be an initial decrease); 10% increase in potential SWFL habitat	Performance Standard and Adaptive Management above); ensure native riparian vegetation is thriving (per vegetation Performance Standard and Adaptive Management above)

Vegetation: Vegetation measurements listed above were performed during baseline analysis for this project in 2005. All of these measurements (tree density, tree canopy cover, shrub canopy cover, ground cover, species count, % native/non-native) are performed along a transect at the same time and can be completed fairly quickly.

Permanent rebar were placed at the original baseline sampling locations (which are within the recommended plan proposed construction sites) and serve both as the permanent plot marker and as the center point for two, perpendicularly aligned sampling transects (Figure 1). While the sampling distance along each transect will be 50-m, each transect will actually be extended 60-m because the 5-m circumference around the center rebar is not sampled to avoid measurement overlap, and because this area gets trampled during plot set-up. Thus the rebar was located at the 30-m mark for each perpendicular sampling transect, and no data is collected between distance marks 25-m to 35-m on either tape.

The orientation of the first 50-m tape was determined randomly by standing over the rebar and making an unobserved spin of a compass dial. The second transect will be oriented at a 90º angle to the first (Figure 1).

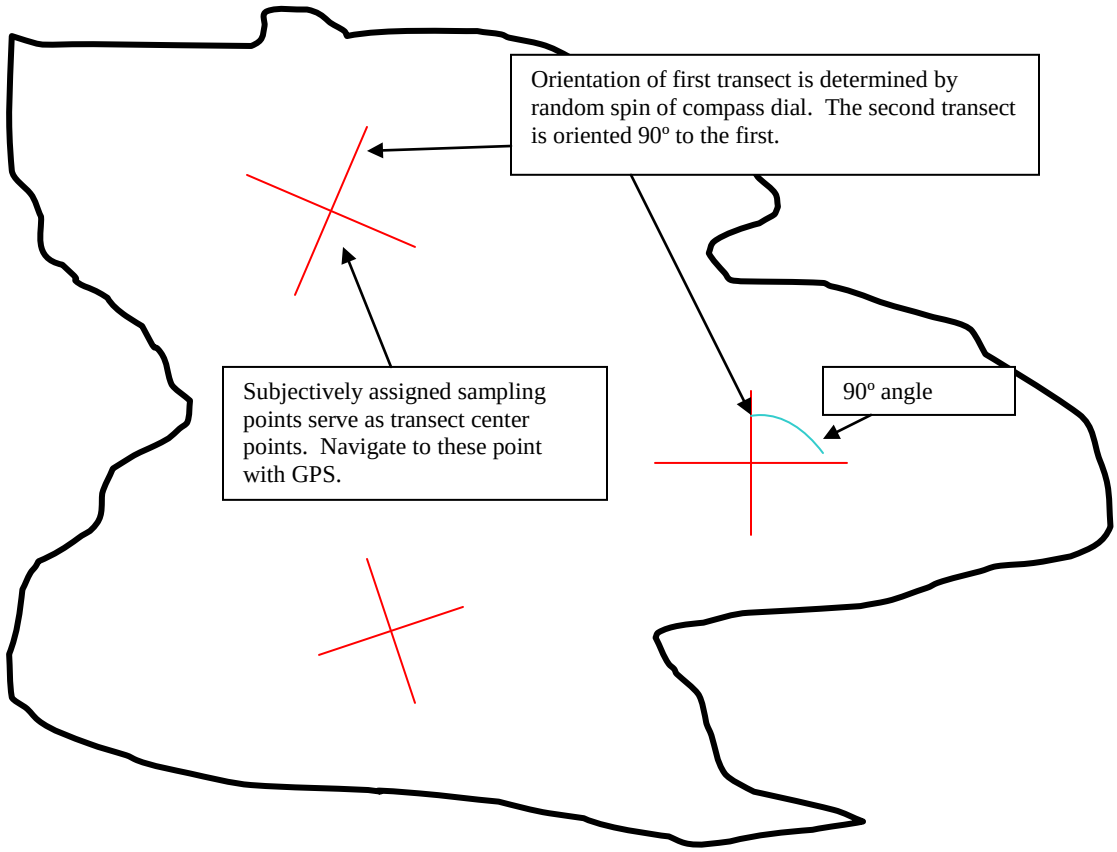

Figure 1. Sampling design. Each transect is 60-m long, although a 5-m circumference around the rebar (meter marks 25m – 35m) is not sampled, so only 50-m along each transect is sampled. Up to three 100-m plots may be established in a single vegetation polygon.

All of these measurements can then be translated into an overall percent cover. Overall percent cover should meet the performance standard for an overall mosaic per HEAT measurement goals: 50% native tree, 30% native shrub, 20% native herbaceous and/or wet habitat. Any planted material that has died shall be replaced (per one year warranty). After one year, adaptive management should focus on non-native vegetation treatment per below.

The measurements would also be used to determine the % of non-native vegetation present. Non-native vegetation % cover should be less than or equal to 30%. On an annual basis, areas ¼ acre in size or larger that have > 30% areal cover by non-native vegetation shall be treated per the Environmental Assessment and Operations and Maintenance Manual for this project. This typically includes treatment using herbicides via cut-stump or foliar application. Noxious weeds shall also be monitored with a performance standard of less than or equal to 30%. On an annual basis, areas ¼ acre in size or larger that have > 30% areal cover by non-native vegetation shall be treated per the Environmental Assessment for this project and Operations and Maintenance Manual for this project. This typically includes treatment using herbicides.

Hydrology: Flood frequency, flood duration, depth, velocity, wetted area and groundwater depth will be evaluated for constructed high-flow channels, bank terracing, willow swales and other wetland features. Results will inform need for adaptive management actions and will inform future restoration designs.

Flood frequency relates the magnitude of discharge to the probability of occurrence or exceedance. Discharge or flow rate is typically given in cubic feet per second (cfs). Flood duration defines the amount of time that a specific flood frequency will meet or exceed a given discharge or flow rate. Flood duration is typically defined in either hours or days.

Flood duration, frequency, depth and velocity would be measured using a FlowTrakker Acoustic Doppler Velocimeter (ADV). This meter samples velocity measurement over a given length of time (seconds) and averages velocity at a given point in the water column. The meter computes discharge, after transects are made, according to USGS standards.

Wetted area can be measured by measuring surface water area. This is done by using the top width of the feature (high flow channel, terrace and/or willow swale) and the duration of flow from the hydrograph. Some areas may be mapped by hand using a GPS to get the overall surface area of wetted area.

Seasonal depth to groundwater will be monitored utilizing existing instrumented shallow groundwater piezometers. Data will be used to evaluate floodplain-channel connectivity and to allow comparisons to vegetation growth parameters.

The overall Performance Standard is to increase flood frequency and duration into bosque by 10% and increase wetted area in bosque by 15%. As features potentially get filled with sediment, they will need to be cleaned out. In order to help reduce the maintenance need, an increase in interconnection between features is proposed. This will also potentially enhance wetted area habitat diversity and function in order to meet the Performance Standard. If this is occurring, adaptive management in form of the maintenance above and/or reviewing the original design would be implemented.

Avian Monitoring – Through other bosque projects, the Corps (via a contractor) has been monitoring transects and project specific locations within the recommended plan project area. This information has been used as baseline information specific to this project and monitoring of these locations prior to, during and after construction is proposed to continue.

Through this monitoring and research, much has been learned about species loss due to increase in non-native vegetation, effects of fuel reduction/exotic removal on bird species, and effects of mid-canopy removal on bird species. These studies have been conducted specifically within the project area (Hawks Aloft, 2003-2008). Therefore, information has been utilized form these studies in order to guide alternative development, project design and construction implementation. One of the main goals of this project is to improve habitat quality and increase the amount of native vegetation.

Monitoring of avian species can aid in understanding whether or not this goal has been met by evaluating the current (and recent past) use of these areas compared to their use during construction (which is hypothesized to decrease initially) and after construction (which is hypothesized to increase over time). Previous work has shown an increase in the diversity of bird species in areas where water features have been added. In areas where thinning of non-native vegetation occurs, there is an initial decrease in species diversity though population sizes remain roughly the same. Over time, species diversity increases again. Therefore, these findings have been used to develop the Performance Standards which include an increase in species diversity by 10% in areas where wet habitat is constructed; and an increase in species diversity by 10% of other areas within 3-5 years (noting that there will be an initial decrease). Through monitoring for Southwestern Willow Flycatcher (SWFL), an increase in potential habitat will be captured. Therefore, the Performance Standard is to also increase potential SWFL habitat by 10%. SWFL surveys would only be performed in areas that are expanding potential habitat (ie: willow swales). Performance Standard and Adaptive Management above); ensure native riparian vegetation is thriving (per vegetation Performance Standard and Adaptive Management above).

Methodologies used by Hawks Aloft would continue and include breeding bird point counts and monitoring of existing transects.

3.2 Additional monitoring – It should also be noted that additional endangered species monitoring for Rio Grande silvery minnow (RGSM) would be performed per the Biological Opinion for this project. While it is not listed as a specific Performance Standard above, it would still provide information regarding the use of water features by RGSM.

3.3 General periodic site assessment: In terms of assessing overall effectiveness of the restoration construction, a general annual assessment of each site would be conducted. A site assessment form is included in Appendix A.

3.4 Reporting

The Corps and/or their agents will prepare annual reports that include specific information pertaining to each of the monitoring elements. These reports will include information about all equipment and techniques used for monitoring purposes.

Annual reports will be submitted to the Middle Rio Grande Conservancy District (MRGCD), City of Albuquerque Open Space Division (OSD), U.S. Bureau of Reclamation (Reclamation, U.S. Fish and Wildlife Service (USFWS), New Mexico Department of Game and Fish (NMDGF) and other interested parties by December 31 of each monitoring year.

3.5 Photographic Documentation

Permanent locations for photographic documentation (i.e., photo points) will be established at strategic locations within each project site so that a visual record of habitat development can be provided. A sufficient number of photo points will be established in

order to provide representative photographs of the site as it changes over time. The locations will be identified in the pre-construction monitoring report. Photographs taken from each of these locations will be included in subsequent monitoring reports.

4.0 Integration of project monitoring and adaptive management with other, ongoing restoration and research efforts in the bosque

One of the biggest challenges and potentially another component to this evaluation program is the coordination of monitoring and adaptive management restoration efforts. Current restoration and research efforts are underway and on the ground in the Albuquerque Reach of the Middle Rio Grande by the City of Albuquerque Open Space Division, the Middle Rio Grande Conservancy District (project sponsor), U.S. Bureau of Reclamation, Natural Heritage New Mexico, BEMP, etc. Many of the research efforts are currently being funded by the Corps in relation to other bosque projects and providing information toward pre-construction monitoring information for this project. As mentioned above, the Corps is a member of the Collaborative Program which is monitoring components of the system specifically for SWFL and RGSM. These monitoring methods have been included above (where appropriate) and close coordination of efforts on the ground would occur. The key to a successful restoration program in the Middle Rio Grande will be to collaborate with these efforts in creating a fully integrated and ecosystem-based evaluation program.

There are a large number of monitoring efforts currently being conducted in the Project Area. Many are efforts currently contracted by the Corps Albuquerque District that would continue to be contracted as part of implementing this monitoring and adaptive management plan. Other efforts are conducted by other agencies or Programs that are being coordinated with in order to reduce a duplication of effort.

The Corps has spearheaded a demonstration or 'test' of this effort during implementation of the BioPark Restoration Project and the Ecosystem Restoration @ RT66 Project. The BioPark Restoration project was completed in October 2006 and the RT66 Project is currently under construction to be completed in April 2010. The BioPark Restoration Project is currently being monitored and providing valuable input toward design of this project as well as input toward monitoring efforts. These projects are also crucial components to the analysis for adaptive management. Adaptive management will be the key to the long-term success of the MRG Project as well as the monitoring program.

5.0 Estimated Cost

Per discussion above, annual costs can fluctuate depending upon specific monitoring needs as well as available funding. Potential annual costs based on the potential combination of monitoring elements are below:

Pre-construction monitoring:

Monitoring Element	**Estimated Cost**
Vegetation	$ 25,000
Hydrology	$ 25,000
Avian Monitoring	$ 50,000
TOTAL ESTIMATED COST	$100,000

Post-construction Year 1:

Monitoring Element	**Estimated Cost**
Vegetation	$ 25,000
Hydrology	$ 25,000
Avian Monitoring	$ 55,000
TOTAL ESTIMATED COST	$105,000

Post-construction Year 2:

Monitoring Element	**Estimated Cost**
Vegetation	$ 25,000
Hydrology	$ 25,000
Avian Monitoring	$ 60,000
TOTAL ESTIMATED COST	$110,000

Post-construction Year 3:

Monitoring Element	**Estimated Cost**
Vegetation	$ 30,000
Hydrology	$ 30,000
Avian Monitoring	$ 65,000
TOTAL ESTIMATED COST	$125,000

Post-construction Year 4:

Monitoring Element	**Estimated Cost**
Vegetation	$ 32,000
Hydrology	$ 32,000
Avian Monitoring	$ 70,000
TOTAL ESTIMATED COST	$134,000

Post-construction Year 5:

Monitoring Element	**Estimated Cost**
Vegetation	$ 34,000
Hydrology	$ 34,000
Avian Monitoring	$ 75,000
TOTAL ESTIMATED COST	$143,000

References

Hawks Aloft, Inc. 2009. Bird and vegetation community relationships in the Middle Rio Grande Bosque: 2008 Interim Report. Submitted to: U.S. Army Corps of Engineers. 105 pp.

U.S. Army Corps of Engineers. 1992. Kissimmee River Restoration Study Report. Communication from the Assistant Secretary of the Army.

APPENDIX A
PERIODIC SITE ASSESSMENT FORM
Sample Format for Periodic Site Assessment Form

Middle Rio Grande Bosque Restoration Project Assessment Report

Site:
Location of site (include map:
Personnel:
Date:

Item No.	Description	Response	
		Yes	No
1	Erosion observed in revegetation areas? If yes, describe location(s) and provide a map of affected area(s).		
2	Erosion control blankets, geotextile mats, and underlying soil on low berm in good condition?		
3	Fire damage to vegetation or other site features?		
4	Flood damage to vegetation or other site features?		
5	Wind damage to vegetation or other site features?		
6	Herbicide damage to desired vegetation?		
7	Wildlife damage to desired vegetation?		
8	Vandalism to desired vegetation?		
9	Vandalism to other site features (e.g., signs)?		
10	Debris or refuse present?		
11	Access roads maintained as specified?		
12	Access gates, barriers and locks in good working order?		
13	Volunteer establishment of desired species observed?		
14	Portions of revegetation areas currently flooded? If yes, describe extent of flooding and provide a map of affected area(s).		
15	Other items?		
Comments:			