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WaterSMART-Applied Science Grants for Fiscal Year 2023
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Prioritizing Nature-Based Solutions for Water Management: Assessing Potential Evapotranspiration Reductions through Riparian Restoration in the Middle Rio Grande, New Mexico

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EXECUTIVE SUMMARY

Date: October 16th, 2023

Applicant: World Wildlife Fund, Inc.

Location: Washington, DC

Project Summary:

Climate change and a regional megadrought have reduced river flows in the Rio Grande that support farmer livelihoods and food production as well as critically important aquatic, riparian, and wetland ecosystems that provide habitat for endangered species. Reduced river flows within New Mexico have also made it very difficult for the State of New Mexico to meet its water delivery obligations as required by the Rio Grande Compact. This project will analyze the potential for replacing invasive, exotic riparian vegetation species (tamarisk and Russian olive) with native plant communities as a strategy for reducing water consumed by evapotranspiration; the reduced consumption of river water is expected to enhance river flows for ecosystem benefits, provide increased water supply reliability for farming, and help New Mexico meet its water delivery obligations. Five project partners – World Wildlife Fund (WWF), University of New Mexico (Natural Heritage New Mexico (NHNM)), New Mexico State University (NMSU), NM Interstate Stream Commission (NMISC), and the Middle Rio Grande Conservancy District (MRGCD) – will advance the foundational science needed to drive this Nature-Based Solution (NbS) by mapping extant stands of exotic vegetation, estimating potential water savings through replacement with native species, and prioritizing stands for restoration using decision support tools based on a suite of ecosystem and water-saving benefits. The proposed project is aligned with the requirements of Project Type 4 of the WaterSMART-Applied Science NOFO and will improve modeling capabilities to increase water supply reliability as well as improve decision making for the implementation of Nature-Based Solutions, thus we believe this project meet the requirements to be eligible for the 75% Federal cost-share contribution.

Period of Performance: June 1, 2024 to May 30, 2026

Located at a Federal Facility: No

TECHNICAL PROJECT DESCRIPTION

Applicant Category

World Wildlife Fund (WWF), University of New Mexico—Natural Heritage New Mexico (NHNM), and New Mexico State University (NMSU) are applying as Category B Partners. WWF is one of the world's leading conservation organizations, a 501[c][3] registered non-profit, headquartered in Washington, D.C. Each of these three organizations works closely with the Category A applicants in identifying applied research needed to guide water management decision-making in the state.

The Category A applicants in this project are the New Mexico Interstate Stream Commission (NMISC) and the Middle Rio Grande Conservancy District (MRGCD), both of which are state agencies formed through state legislation. MRGCD was formed and derives statutory authority through the signing of the Conservancy Act.

This collaboration builds upon years of productive interaction among the partner entities in efforts to integrate ecological values into water management decision-making. WWF signed a Memorandum of Agreement, along with other 35 partners, with the US Bureau of Reclamation to become an official member of the Basin Study and is contributing cost-share to the study. The NMISC is also

an official member of the Basin Study. The proposed project will provide important input to the information base and strategy analysis to be undertaken as part of the Basin Study.

Detailed Project Description

Climate change and a regional megadrought have reduced river flows in the Rio Grande in recent decades. Annual river flows at Del Norte, Colorado during 2000-2021 were 13% lower than the long-term average. These diminished river flows, along with changes in river morphology and riparian vegetation, and the inability of water users to reduce their water consumption to the same degree, has led to multiple adverse consequences. One serious concern is New Mexico's shortfall in water deliveries to Elephant Butte Reservoir as mandated by the Rio Grande Compact (the Compact dictates water sharing requirements among Colorado, New Mexico, and Texas). As of 2022, New Mexico had an accrued debit of 93,000 acre-feet (AF) – equivalent to more than 20% of average annual delivery volumes. Additionally, climate change scientists are forecasting temperatures that will be ~5.4°F warmer by 2050, which will increase crop and riparian evapotranspiration (ET) demands.[1] Temperature warming, and increased ET is expected to cause a reduction in river flows of one-fourth as compared to current averages by 2050.[2]

New Mexico's water debt has created highly stressful conditions for farmers in both New Mexico and Texas because it constrains the ability to store irrigation water in New Mexico and it results in reduced water availability below Elephant Butte Reservoir. For example, farm water deliveries within the Elephant Butte Irrigation District on the Rio Grande in southern New Mexico were reduced by 70% and then completely shut off in June 2021, months before the end of the growing season, when the district's water-supply reservoir (Elephant Butte Reservoir) went nearly dry.[3] Diminished river flows in New Mexico have also created stressful conditions for the persistence of the highly-endangered Rio Grande silvery minnow (*Hybognathus amarus)*; river flow depletion has been a major factor in the imperilment of at least 75 species in the overall Rio Grande basin.[4]

These water scarcity challenges have motivated water managers within New Mexico to explore a variety of strategies for reducing water consumption in order to bring consumption back into balance with available water supplies. For example, the US Bureau of Reclamation – collaborating with the National Fish & Wildlife Foundation and the Middle Rio Grande Conservancy District – created a pilot "Environmental Water Leasing Program" beginning in 2020 to provide more river flow for the Rio Grande silvery minnow by paying farmers to fallow their farm acreage.

This proposal is based on the documented premise that water consumption can also be reduced by replacing invasive, exotic riparian plant species with native species. A recent hydrologic model developed by the University of Massachusetts and WWF in 2022[5] estimates that riparian ET in the Middle Rio Grande (MRG) in NM accounts for 14% of the total water outflows of the system (see Figure 1). Recent analysis from the 2022 Rio Grande Report Basin Health Card using the New Mexico Riparian Habitat Map (NMRipMap) estimates that 56% of the riparian vegetation in the

[1] Brown C., Eluwa C., Maharjan M. and Francois B., 2022. *Upper Rio Grande (URG) Futures Model: a tool to model and forecast the report card grades for the Upper Rio Grande Basin*. Final report submitted to WWF.
[2] New Mexico Bureau of Geology and Mineral Resources, 2022, *Climate change in New Mexico over the next 50 years: Impacts on water resources*. New Mexico Bureau of Geology and Mineral Resources, Bulletin 164.
[3] Davis, T. "'We're sounding the alarm' on waterflow, Elephant Butte managers say." *Albuquerque Journal*, June 19, 2021. Accessed September 9, 2022.
[4] Richter, B.D. and 14 co-authors. "Opportunities for Restoring Environmental Flows in the Rio Grande-Rio Bravo." *Journal of Water Resource Planning and Management*, in press.
[5] Brown C., Eluwa C., Maharjan M. and Francois B., 2022. Upper Rio Grande (URG) Futures Model: a tool to model and forecast the report card grades for the Upper Rio Grande Basin. Final report submitted to WWF.

Middle Rio Grande in NM is composed of invasive species.[6] Another 2009 study conducted by researchers from New Mexico State University (NMSU), in a field site at Bosque Del Apache National Wildlife Refuge, showed that ET in native cottonwood-dominated areas was on average 13% lower compared to ET in exotic tamarisk-dominated areas.[7] This presents the opportunity for implementation of restoration efforts that could substantially improve water-supply reliability and provide multiple ecological, economic, and legal benefits for the Rio Grande in New Mexico.

Accordingly, we propose to determine the locations and extent of all exotic species-dominated areas within the MRG, evaluate potential water savings associated with conversion of each individual exotic community, and prioritize each exotic community for restoration with stakeholder input. We will use these inputs to build a geospatial map database that portrays the likely replacement community for each exotic community, the reduced ET (water savings) associated with each replacement community, and the relative priorities among the restoration opportunities mapped in the MRG and embed a tracking system within the geospatial map database to track progress of future restoration interventions in priority areas. We plan to conduct stakeholder engagement at key moments in the process to develop this decision-making tool to gain their support and advice, ensuring optimum readiness for the follow-on NbS implementation phase.

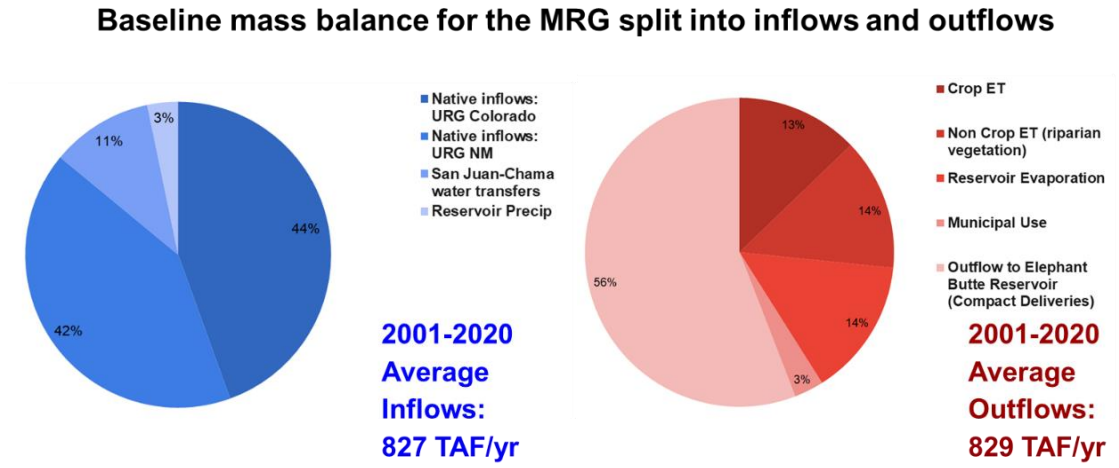

Figure 1. These pie charts help to explain the imbalance between inflows (left) and outflows (right) in the Middle Rio Grande of New Mexico (TAF=thousand acre-feet)[5]. As illustrated here, riparian evapotranspiration accounts for 14% of all water that is either consumed within New Mexico (upstream of Elephant Butte) or outflows to Elephant Butte (for Compact deliveries). When the outflows to Elephant Butte are excluded, riparian vegetation accounts for one-third (~32%) of all Rio Grande water consumed in New Mexico. Of that evapotranspiration volume, it has been estimated that more than half is consumed by exotic, invasive vegetation.

Activity 1. Mapping native and non-native (invasive) riparian vegetation throughout the Middle Rio Grande in NM (lead investigator: NMNH)

This project is geographically focused on the section of the Rio Grande between Cochiti Dam (north of Albuquerque) and Caballo Reservoir (in southern New Mexico), known as the "Middle Rio Grande" (MRG).

[6] WWF, UMCES, UMass-Amherst and Audubon, 2022. Upper Rio Grande Report Card Methodology: Methods report on data sources, calculation, and additional discussion.
[7] Bawazir, AS, Samani, Z., Bleiweiss, M., Skaggs, R. and Schmugge, T. 2009. Using ASTER satellite data to calculate riparian evapotranspiration in the Middle Rio Grande, New Mexico. *International Journal of Remote Sensing* 3(21): 5593-5603

Because both tamarisk (*Tamarix aphylla*, also known as saltcedar) and Russian olive (*Elaeagnus angustifolia*) are highly invasive species, they tend to form very dense stands that exclude native species; these exotic species have high ET rates as compared to native species and provide less-desirable habitat for bird species. These dense stands – located on public, private, and tribal lands – are the targets of our restoration efforts. Our primary objective in Activity 1 is to identify the likely native-dominated replacement plant communities for the exotic species communities that are removed (i.e., those dominated by tamarisk and/or Russian olive). This analysis will provide a foundation for comparison of evapotranspiration between the existing exotic-dominated plant community and the replacement native-dominated community. This identification of appropriate replacement species will be based upon the extensive vegetation field data collected by NHNM in the MRG and our knowledge base on vegetation community responses following the removal of exotic communities, which also includes understanding the lateral and vertical position of each exotic community within the floodplain and associated groundwater and surface water variables assisted by a surface water-groundwater integrated hydrologic model recently developed for the Middle Rio Grande basin by the NMISC and its consultants Geosystems Inc.

An accurate, high-resolution map of riparian vegetation communities in the MRG is needed to establish a foundation for the overall evaluation of potential water savings and other ecosystem services generated by restoration of native riparian vegetation. Accordingly, we propose to use the existing New Mexico Riparian Habitat Map (NMRipMap) version 2.0+ recently produced by Natural Heritage New Mexico (NHNM) in collaboration with the New Mexico Department of Game and Fish and the US Forest Service. It provides the most current mapping of composition, cover, and structure of riparian and wetland vegetation communities down to the quarter-acre patch size that will provide the spatial and thematic framework for Activity 2. Where possible, we will further refine the mapping of shrublands, meadows, and herbaceous wetlands with updated versions of the Hink and Ohmart (1984) vegetation map that has been commonly used to guide restoration in the MRG.[8]

The deliverable product from Activity 1 will be an online, searchable geospatial map of riparian communities (both native and exotic), with the capability of being able to click on any exotic community to reveal the likely replacement community and the estimated water savings (reduced evapotranspiration) as discussed under Activity 2. This geospatial map is expected to be hosted on the NHNM website with free access.

Activity 2. Estimating potential reductions in riparian evapotranspiration by replacing exotic species with native species (lead investigator: NMSU)

Riparian evapotranspiration (ET) constitutes a significant but poorly quantified component of the hydrologic budget for many rivers, particularly in the Southwest. Because riparian evapotranspiration is often poorly quantified, agencies involved in water management of the Rio Grande and in administering compliance with interstate compacts have great difficulty in assessing how different management strategies, restoration efforts, vegetation species changes, and weather variations may change river flows through the riparian corridor. Each of these factors has the potential to substantially affect the available water supply and New Mexico's ability to supply

[8] Milford, E., E. Muldavin, and A. Browder. 2007. Vegetation sampling for the Middle Rio Grande: Resampling the 1984 Hink and Ohmart transects, Year II. Natural Heritage New Mexico Publ. No. 07-GTR-312. Natural Heritage New Mexico, University of New Mexico

intrastate water needs while also meeting interstate obligations for water deliveries. The research proposed here would fill these critical information gaps.

The current technological advances in large data computation, web-based interactive mapping (ArcMap/GIS), satellite data-based (imagery) ET estimation algorithms, and ground-level instrumentation for measuring ET allow for substantially improved quantification of riparian ET. Recent improvements in satellite technology and meteorological algorithms have made it possible to accurately process satellite data and estimate evapotranspiration (ET) on scales ranging from small areas (30 m by 30 m scale) to entire watersheds. The SEBAL and METRIC models use satellite information and climate data to calculate ET values for various crops and vegetation canopies regardless of the type, density, soil moisture content, or other growth factors. Both models use surface energy balance methods to calculate ET. They use remotely sensed surface reflectance, near-infrared (NIR), and thermal bands (IR) to estimate ET as a residual of the energy balance equation (Allen et al., 2007).[9] The evapotranspiration flux or ET in the energy balance is calculated as ET= Rn-G-H, where Rn is the net radiation flux at the surface, G is the soil heat flux, and H is the sensible heat flux. METRIC differs from SEBAL in that each satellite image is auto-calibrated using hourly alfalfa reference (ET_r) calculated from ground-level measured weather data from local climate stations. The ETr in METRIC is used to extrapolate instantaneous ET derived from the satellite image to daily (24-hr) ET or longer rather than using the evaporative fraction as the SEBAL model. A similar methodology to SEBAL was used by Bawazir et al. (2009)[10] to determine the ET of tamarisk and cottonwood using the ASTER satellite data at Bosque del Apache National Wildlife Refuge in New Mexico.

A series of Landsat satellite data (Landsat5, Landsat7, Landsat8, and Landsat9) will be used for this project depending on the year that ground ET measurements of tamarisk, cottonwood, and managed locations were measured. The ET estimates from satellite-based model(s) will be compared to ground measurements for verification. The satellite data are available periodically but have sufficient resolution to predict ground ET accurately. Even though daily ET data are not calculated by the SEBAL or METRIC models, except when the satellite data is available for clear-sky days, a crop coefficient curve can be developed. Once the crop coefficient is developed, the daily ET can be calculated using climate data. The tasks to be performed by NMSU include:

1. Characterize ET depletions of riparian vegetation in the MRG using crop coefficients and the satellite-based ET models, the Surface Energy Balance Algorithm for Land (SEBAL) by Bastiaanssen et al.[11,12] (1998a, 1998b) and Mapping Evapotranspiration at high Resolution with Internalized Calibration (METRIC) by Allen et al.[13] Both models have been validated with ground measurements and used to estimate the ET of various ecological settings worldwide. Both models have been implemented in the OPENET platform (https://openetdata.org) for easier access to the public. The OPENET platform is currently

[9] Allen, R.G.; Tasumi, M., Morse, A., Trezza, R., Wright, JL, Bastiaanssen, WGM, Robison, CW. 2007. Satellite-based energy balance for mapping evapotranspiration with internalized calibration (METRIC)—Applications. *J Irrig. Drain Eng. 133*, 395-406
[10] Bawazir, AS, Samani, Z., Bleiweiss, M., Skaggs, R. and Schmugge, T. 2009. Using ASTER satellite data to calculate riparian evapotranspiration in the Middle Rio Grande, New Mexico. *International Journal of Remote Sensing* 3(21): 5593-5603
[11] Bastiaanssen, WGM., Meneni, M., Feddes, RA, and Holtslag, AAM, 1998a. The surface energy balance algorithm for land (SEBAL): 1. Formulation. Journal of Hydrology,212–213, pp. 198–212.
[12] Bastiaanssen, WGM, Pelgrum, H., Wang, Y., Ma, Y., Moreno, J.F., Roerink, G.J. and Van der Wal, T., 1998b. A remote sensing surface energy balance algorithm for land (SEBAL): 2. Validation. Journal of Hydrology, 212–213, pp. 213–229.
[13] Allen, R.G.; Tasumi, M., Morse, A., Trezza, R., Wright, JL, Bastiaanssen, WGM, Robison, CW. 2007. Satellite-based energy balance for mapping evapotranspiration with internalized calibration (METRIC)—Applications. *J Irrig. Drain Eng. 133*, 395-406.

being verified by Salim Bawazir and his team at NMSU for estimating the ET of pecan orchards with ground measurements using the eddy covariance method.[14]

2. Describe interannual variability in ET depletions from various locations relating to climatic conditions and management of exotic tamarisk and Russian olive. The recently developed New Mexico Riparian Habitat Map (https://nhnm.unm.edu/riparian/NMRipMap) will be used to identify riparian vegetation species and their habitats.
3. Assess ET reduction of riparian areas that have been managed to control tamarisk and Russian olive.
4. Evaluate spatial and temporal variation of ET on a regional basis. While the clearing of tamarisk and Russian olive may result in reducing localized ET, it may affect the regional ET of other vegetation due to changes in groundwater level or due to ecological and hydrologic alteration of the region.

The deliverable product from Activity 2 will be a set of geospatial datasets with interannual ET values for different riparian communities (both native and exotic) and regional ET estimations, that displays areas with different potentials for ET reductions (water savings) and ready to be overlaid onto the online, searchable geospatial map developed in Activity 1.

Activity 3. Initial prioritization of riparian restoration sites (lead investigators: NHNM and NMSU)

This project will build upon previous efforts by NHNM and the National Wildlife Federation to prioritize restoration efforts in the Upper Rio Grande. This previous analysis identified large blocks of native vegetation that were adjacent to potential restoration areas such as tamarisk or Russian olive stands. These areas were labelled "Riparian Conservation Opportunity Areas" (RCOAs). RCOAs are rated based on their natural area size and diversity plus potential restoration values based broadly on cost. With the support of New Mexico Department of Game and Fish, RCOAs are being developed for all river systems in New Mexico by NHNM. The MRG RCOAs have the highest priority and will be available for use by this project by June 30, 2024.

The primary goal in Activity 3 will be to prioritize those RCOAs where water saving through restoration can be maximized based on estimated ET reductions compiled from analyses completed in Activity 2 while optimizing restoration implementation on the ground. The deliverable product will be an initial water smart RCOA portfolio and map prioritized for water savings along with other ecological restoration goals.

Activity 4. Convene stakeholder workshops to refine restoration priorities and ensure users appropriation of the tool (lead manager: WWF).

We will initiate this project with a stakeholder orientation virtual meeting once the grant period begins. It is important that all interested parties are made aware of this project and the opportunities and benefits it presents, and any concerns are duly considered. Stakeholders will include water management agencies such as the US Bureau of Reclamation and the State Engineers' Office as well as our project partners (NMISC and MRGCD). There are numerous conservation organizations and Native American tribes focused on ecological protection and restoration in this region that will be included as stakeholders in this project. Other local organizations are involved in habitat restoration, such as Save Our Bosque Task Force and Rio Grande Return, that will be essential stakeholders as

[14] Bawazir, AS, Samani, Z., Bleiweiss, M., Skaggs, R. and Schmugge, T. 2009. Using ASTER satellite data to calculate riparian evapotranspiration in the Middle Rio Grande, New Mexico. *International Journal of Remote Sensing* 3(21): 5593-5603

they would likely be involved in implementing on-the-ground vegetation restoration efforts in any follow-on phase of this project (a subsequent WaterSMART grant will be pursued for this purpose).

After completion of Activities 1, 2, and 3, we will reconvene the stakeholders described above through a 1-day in-person workshop in Albuquerque, NM to share our initial findings and gather feedback and consensus from multiple experts and interested citizens to refine the prioritization of restoration areas. This session will be an important opportunity for identifying willing private or tribal landowners that would be receptive to native riparian restoration on their lands, and for identifying any barriers or constraints that might modify the relative priority of individual restoration sites. Overarching guidance will be provided by Middle Rio Grande Conservation Action with its emphasis on ecosystem restoration to meet multiple goals for a sustainable MRG.

The deliverable product from Activity 4 will be a short report with the summaries of each workshop, participants and their affiliations, main findings to inform which sites have highest potential for riparian restoration, and recommendations for designing a tracking tool (Activity 5) in a manner that is practical and informative for the potential users (e.g., conservation and restoration groups, water managers, government agencies).

Activity 5. Designing a restoration tracking system (lead investigators: NHNM and WWF)

We intend to follow this project with another application for a WaterSMART grant in a future funding year to enable implementation of the riparian restoration priorities identified under this project. The project partners strongly believe that it will be important to implement a restoration tracking system that can account for water saving progress as well as keeping stakeholders apprised of which projects have been successfully completed during coming years.

To develop the tracking system, we will build upon the online, searchable geospatial map database that will be developed under Activities 1 & 2. The tracking system will include updates on restoration efforts at each of the exotic vegetation communities identified in Activity 1 and progress towards restoring target RCOAs (whenever possible we will use existing databases for relevant restoration activities past and present, along with input from stakeholders). The design of this database will be discussed with stakeholders in Activity 4 to ensure that it is optimally useful to all interested parties. The product from Activity 5 will be the addition of information on restoration status in the geospatial map database on NHNM website.

Activity 6. Dissemination of results (lead manager: WWF)

In additional to dissemination through Activity 4, we intend to disseminate the results of this project with different stakeholders, water managers, and decision makers through the following activities:

- Publication of a final report describing project accomplishments, final results of identified tasks, and any lessons learned.
- A webinar to launch the results of the project and the geospatial map tool; this could be a Reclamation-sponsored webinar or one hosted by the implementing organizations.
- Potential presentations with the following groups after project completion:
    - Key staff from MRGCD and ISC
    - USBR-MRGCD Rio Grande Basin Study partners, particularly with the NGO Sectoral Committee
    - NHNM and NMSU forums

- Conservation Collaborative Groups in the Rio Grande in NM and the international stretch of the river.
- Other water managers in working on similar rivers in the West.

The deliverables for Activity 6 will be a final technical report, a functioning online geospatial map with final priority restoration areas, and virtual presentations targeted to audiences with water or power delivery authority or who are implementing or funding riparian restoration work in the Rio Grande basin or other similar river basins.

Project Goals

1. Determine the locations and areal extent of all exotic species-dominated areas within the MRG.
2. Evaluate potential water savings associated with conversion of each individual exotic community.
3. Prioritize each exotic community for restoration with stakeholder input.
4. Build a geospatial map database that portrays the likely replacement community for each exotic community, the reduced ET (water savings) associated with each replacement community, and the relative priorities among the restoration opportunities mapped in the MRG.
5. Embed a tracking system within the geospatial map database to track progress of future restoration interventions in priority areas.
6. Engage stakeholders to gain their support and advice, ensuring optimum readiness for the follow-on Nature-Based Solutions implementation phase.

PROJECT LOCATION

This project will span the length of the Rio Grande from Cochiti Dam downstream to Caballo Reservoir.

Figure 2. Middle Rio Grande Study Area.

DATA MANAGEMENT PRACTICES

All spatially explicit tools for this project will be developed in ArcGIS Pro and viewable through ArcGIS Online web map viewers. NMRipMap and the MRG RCOA portfolio, including potential water savings from Activity 2, will be housed and maintained at NHNM. All the Landsat data will be downloaded and processed using the GeoTIFF format with the WGS 1984 UTM Zone 13N projected coordinate system (ESPG: 32613). Imagery using this format is easily loaded into any modern GIS package, including ArcGIS Pro, QGIS, and GRASS GIS, for further examination. All data assembled or analyzed in this project will be available upon request by the project manager.

EVALUATION CRITERIA

Evaluation Criterion A—*Water Management Challenge(s)*

1. Describe the water management challenge(s).

As detailed in the Project Description, diminished river flows resulting from climate warming and a megadrought, and insufficient reductions in consumptive agricultural and urban water uses, have led to a damaging imbalance between water supplies and demands. This has created a situation in which New Mexico is falling behind in its water delivery obligations to Elephant Butte Reservoir under the Rio Grande Compact, compromised water reliability for farmers in both New Mexico and Texas, threatened the persistence of endangered species and aquatic, riparian, and wetland habitats, and impacted recreational and cultural values including those held by Native American tribes.

This project directly addresses this critical water scarcity as well as future water uncertainty with a NbS: assessing the potential reduction of water consumption through riparian restoration, in which water-intensive exotic plant species (tamarisk and Russian olive) will be replaced with native vegetation, to help bring the water budget back into balance with water supplies.

2. Describe the concerns or outcomes if this water management challenge is not addressed?

One major concern is the accrued debit of New Mexico to under the Rio Grande Compact. This situation creates great challenges for water managers because the Rio Grande Compact Article VII mandates that whenever there is less than 400,000 AF of storage in the Rio Grande Project (mainly Elephant Butte Reservoir which is currently at 336,200 AF of capacity[15]), New Mexico cannot capture additional native water for storage in upstream reservoirs constructed after 1929. This severely limits the long-term water management options that can be implemented to improve water supply for agriculture, cities, Compact deliveries, environmental flow management to sustain highly imperiled species and ecosystems, and recreational and cultural values including those held by Native American tribes.

Another concern expressed by different water management agencies, such as ISC and MRGCD, is that part of the water saved through different water conservation efforts (e.g., the Environmental Water Leasing Program) is being consumed by the extensive areas of exotic and invasive riparian vegetation along the Rio Grande that have higher ET demands than native vegetation. This partially negates the positive impact that water conservation programs could otherwise have for improving Compact water deliveries and water-supply reliability.

Finally, the challenge of bringing water consumption back into balance with available water supplies in the Rio Grande is expected to become even greater in coming years with diminishing river flows due to climate change (increasing temperatures). Thus, it is of critical importance to explore every

[15] Water Data for Texas, October 10, 2023. Elephant Butte Lake Water Levels. https://waterdatafortexas.org/reservoirs/individual/elephant-butte

available option to reduce water demands in the system. Our NbS approach offers the substantial added benefit of also supporting stressed ecosystems and endangered species and helping communities to adapt and build resilience to drought and water shortages in coming years.

3. Explain how your project will address the water management issues identified.

This proposal is based on the premise that water consumption can be substantially reduced by replacing invasive, exotic riparian plant species with native species, or in other words use a nature-based feature to reduce water supply and demand imbalances. A recent hydrologic model developed by the University of Massachusetts and WWF in 2022[16] estimate that riparian evapotranspiration (ET) in the Middle Rio Grande (MRG) in NM accounts for 14% of the total water outflows of the system (see Figure 1), and a third of all water consumed in New Mexico. Recent analysis from the 2022 Rio Grande Report Basin Health Card using the New Mexico Riparian Habitat Map (NMRipMap) estimates that 56% of the riparian vegetation in the Middle Rio Grande in NM is composed of invasive species.[17] And another 2009 study conducted by researchers from New Mexico State University (NMSU), in a field site at Bosque Del Apache National Wildlife Refuge, showed that ET in native cottonwood-dominated areas was on average 13% lower compared to ET in exotic tamarisk-dominated areas.[18] This presents the potential opportunity for implementation of restoration efforts that could substantially improve water-supply reliability for multiple uses, management of deliveries to comply with the Rio Grande Compact, improve water supply for reliability of ecological and cultural values, including critical habitats to meet endangered species requirements and provide economic, and legal benefits for the Rio Grande in New Mexico. Ultimately, this project will help improve overall basin health, which according to the recently launched Rio Grande Basin Health Report Card is in "moderate condition," and directly improve many of the indicators such as river low flows or agricultural water supply that are currently in a poor or very poor condition. (note: the Rio Grande Basin Health Report Card was developed in collaboration with more than 100 stakeholders from 60+ organizations across Colorado, New Mexico, and Texas who provided essential input to identify and develop 29 basin health indicators through comprehensive data analysis).

Evaluation Criterion B—*Project Benefits*

1. Describe how the need for the project was identified.

The presence and expansion of exotic and invasive riparian vegetation and the associated higher ET demands compared to native vegetation is well documented to be an environmental problem along the Rio Grande in Colorado, New Mexico, Texas and Mexico. And investment in riparian restoration efforts in the Rio Grande has long been part of the conservation work for many research groups,[19] conservation groups,[20] and government agencies.[21]

Thus, this project and the collaboration it offers builds upon years of productive interaction among the partner entities in efforts to integrate ecological values into water management decision-making,

[16] Brown C., Eluwa C., Maharjan M. and Francois B., 2022. Upper Rio Grande (URG) Futures Model: a tool to model and forecast the report card grades for the Upper Rio Grande Basin. Final report submitted to WWF.
[17] WWF, UMCES, UMass-Amherst and Audubon, 2022. Upper Rio Grande Report Card Methodology: Methods report on data sources, calculation, and additional discussion.
[18] Bawazir, AS, Samani, Z., Bleiweiss, M., Skaggs, R. and Schmugge, T. 2009. Using ASTER satellite data to calculate riparian evapotranspiration in the Middle Rio Grande, New Mexico. *International Journal of Remote Sensing* 3(21): 5593-5603
[19] Bosque Ecosystem Monitoring Program. https://bemp.org/
[20] WWF, 2017. Using fire to beat back invasive giant cane on the banks of the Rio Grande.
[21] IBWC, 2022. Habitat restoration activities in the Rio Grande canalization project: summary June 2009 – September 2022.

including efforts from the USBR to advance a Rio Grande Basin Study, MRGCD's Conservation Program, and the Middle Rio Grande Endangered Species Collaborative Program. Other recent planning efforts include a San Acacia Science Forum hosted in June 2023 by a group of NGOs and NM State agencies, seeking to develop long-term solutions for the health of the Rio Grande; this process identified "holistic vegetation management" (especially exotic vegetation replacement) as a high-priority strategy.

This project was also greatly advanced by recent developments in high resolution mapping of riparian vegetation communities and priority restoration areas (RipMap and RCOAs), along with the ability to generate accurate estimates of the potential reductions in ET demands through restoring native vegetation. This has inspired water managers and conservation interests to think and plan at the scale and severity of the problem for the Rio Grande in New Mexico, motivating the partnering organizations in this proposal to align around the proposed project.

2. Describe how the tool, method, or information will be applied and when it will be applied.

The main goal of the proposed project is to target and prioritize riparian restoration areas that will be acted upon immediately following this effort, subject to funding availability. Local conservation groups are already implementing small-scale restoration projects, and their efforts will benefit from the advanced targeting available from this project. The project proponents envision scaling up existing efforts by an order of magnitude.

3. Describe, in detail, the extent of benefits that can be expected to occur upon implementation of the project and provide support for your responses.

We believe the results and tools developed in this project will immediately inform MRGCD, ISC, and USBR – the three leading water management agencies in the Rio Grande – by helping direct their future funding of restoration projects. As mentioned in Activity 5, we intend to follow this project with a subsequent WaterSMART grant that would fund implementation of the riparian restoration priorities identified under this project; we have identified multiple other sources of funding for this effort as well. As mentioned previously, local conservation groups are already conducting restoration work in the basin with philanthropic funding from private foundations and individuals. These efforts will benefit immediately from improved prioritization, and from knowledge of potential water savings that will help strengthen their funding proposals.

- How will the project improve water management decisions?

As discussed previously, the water consumed by riparian evapotranspiration is a poorly understood aspect of water management and planning, yet it can be a significant component of a river system's water budget. This project will therefore fill a large gap in water knowledge by quantifying the volume of ET consumption, as well as estimating the degree to which the river's water budget can be improved by reducing ET through riparian restoration. Having a portfolio of priority restoration areas that could yield the greatest water savings and environmental benefits in the water stressed Middle Rio Grande will aid various groups and agencies in making better decisions regarding the scale of restoration needed, plans to direct restoration investments to high impact areas, and to further highlight the importance to invest in Nature-Based Solutions as a key strategy to build resilience in the face of increasing temperatures and droughts.

- Describe if the results of your project will be applicable elsewhere.

We are confident that the approach proposed here for the Middle Rio Grande will be transferable to other regions of the Rio Grande basin – both in the US and Mexico – and to other rivers in the Western US. We expect that the volume of potential ET reduction quantified here will be notable

and significant, thereby motivating other organizations and agencies to pursue similar approaches for reducing water scarcity. Our project deliverables will detail what is needed to implement this approach elsewhere, such as the mapping of riparian communities and estimation of ET consumption by native vs. exotic plant communities and will explain how to engage and mobilize local stakeholders in similar efforts, and how to access key information such as remote sensing data. We note, however, that due to differences in local hydrological and biological conditions among river basins, other practitioners will need to perform their own evaluations to accurately evaluate potential water savings and other restoration considerations.

- To what extent will the project address the water management challenges described in Evaluation Criterion A?

Figure 1 in the "Overall Project Purpose" section helps to explain the imbalance between inflows (left) and outflows (right) in the Middle Rio Grande of New Mexico. Riparian evapotranspiration accounts for 14% of all water that is either consumed within New Mexico (upstream of Elephant Butte reservoir) or outflows to Elephant Butte, and a third of all water consumed in Middle Rio Grande of New Mexico. Of that evapotranspiration volume, it has been estimated that more than half is consumed by exotic, invasive vegetation. Even though riparian ET is only a portion of the overall water balance of the basin and efforts are needed to advance water management in other water use categories, the fact that irrigated crops and riparian vegetation consume roughly the same volume of water is an important consideration, suggesting that equal consideration needs to be given to both sectors of water consumption. The great added benefit of riparian restoration is that it can also improve critically important habitat along with recreational and cultural values.

4. Explain how your project complements other similar efforts in the area where the project is located.

As stated in our response to Evaluation Criterion B above, this project and its associated collaboration builds upon years of productive interaction among the partner entities in efforts to integrate ecological values into water management decision-making, including the efforts from the USBR to advance a Rio Grande Basin Study, MRGCD Conservation Program, the Middle Rio Grande Endangered Species Collaborative Program and other planning efforts led by conservation groups, such as the recent San Acacia Science Forum in June 2023. There are also ongoing work in riparian restoration being undertaken by the Save Our Bosque Task Force and Rio Grande Return.

Rather than duplicate or complicate those efforts, the partnering organizations in this proposal understand that this project will fill a critical information gap identified by each of these previous or ongoing efforts by estimating the potential ET reduction associated with replacing invasive, exotic riparian plant species with native species. It will also benefit ongoing riparian restoration efforts by prioritizing future restoration areas according to their water savings and habitat values. Ultimately, this project will help all parties to better understand where the Rio Grande's water goes, and the extent to which the river system's water budget can be modified through riparian restoration at a scale exponentially greater than has been accomplished to date, helping to make the case for the importance of Nature-Based Solutions as a strategy to address water and environmental challenges of the Rio Grande in the long-term.

Evaluation Criterion C—*Project Implementation*

1. Briefly describe and provide support for the approach and methodology that will be used to meet the objectives of the project

1. Activity 1. Mapping native and non-native (invasive) riparian vegetation throughout the Middle Rio Grande in NM. This will include identification of likely native species to replace exotic species, providing a basis for estimating potential water savings in Activity 2. The creation of an online searchable map database will aid communications with stakeholders about prioritization of restoration efforts and helping to track progress.
2. Activity 2. Estimating potential reductions in riparian evapotranspiration by replacing exotic species with native species. This quantification will help us to understand the potency of riparian restoration in rebalancing the Rio Grande's water budget. Our results will help to fill an information gap needed to refine restoration priorities in the context of water conservation. NMSU has published extensively on the use of high-resolution remote sensing to estimate riparian ET in the Rio Grande and has conducted extensive in-situ riparian ET in the Middle Rio Grande that will be used to validate remote sensing estimates.
3. Activity 3. Initial prioritization of riparian restoration sites. This will be of great benefit in directing and funding restoration efforts based on of their water-saving potential. We will advance this activity by incorporating the results of Activity 2 to the recent approach from NHNM and NWF to identify Riparian Conservation Opportunity Areas (RCOAs) for the Upper Rio Grande that is currently being developed for all river systems in New Mexico by NHN, with the support of New Mexico Department of Game and Fish. The addition of water-saving potential in this prioritization scheme will support identifying sites with the highest potential to return water to the system.
4. Activity 4. Convene stakeholder workshops to refine restoration priorities and ensure users appropriation of the tool. Convening stakeholders and experts to gather their input for the development of this decision-making tool is at the core of the process to sure the final products of this project are useful, practical, and of easy access, since they will be the main users of these tools. This workshop will be key in understanding which stakeholders would be interested in implementing on-the-ground vegetation restoration efforts in any follow-on phase of this project. This will be done by an initial virtual meeting, and an in-person workshop to discuss initial findings from Activities 1-3, and by creating an online searchable map database.
5. Activity 5. Designing a restoration tracking system. This effort is a complement and product of Activities 1-4, enabling all stakeholders to understand the progress being made to reduce ET consumption at each restoration site.
6. Activity 6. Dissemination of results. We will promote the dissemination of results through the process described in Activity 4, preparation of a final report, a webinar to launch the results of the project and the geospatial map tool and a few presentations to targeted audiences of the partnering organizations, USBR Rio Grande Basin Study partners, particularly with the NGO Sectoral Committee, other conservation collaborative groups working in the Rio Grande and potentially other water managers in working on similar rivers in the West.

2. Describe the work plan for implementing the proposed scope of work.

Activity and estimated cost by activity (*detailed budget breakdown is attached in the budget narrative separately*)	**Implementation Schedule**							
	2024		**2025**				**2026**	
	Q3	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**
Activity 1. Mapping native and non-native (invasive) riparian vegetation throughout the Middle Rio Grande in NM (lead investigator: NMNH) - $80,000 (20%)								
Milestone. Develop the online, searchable geospatial map of								

Activity and estimated cost by activity (*detailed budget breakdown is attached in the budget narrative separately*)	**Implementation Schedule**							
	2024		**2025**				**2026**	
	Q3	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**
riparian communities (both native and exotic), with the capability of being able to click on any exotic community to reveal the likely replacement community. Hosted on NHNM website.								
Activity 2. Estimating potential reductions in riparian evapotranspiration by replacing exotic species with native species (lead investigator: NMSU) - $120,000 (30%)								
Milestone. Characterize ET depletions of riparian vegetation in the MRG								
Milestone. Describe interannual variability in ET depletions from various locations								
Milestone. Assess ET reduction of riparian areas that have been managed to control tamarisk and Russian olive								
Milestone. Incorporate the estimated water savings (reduced evapotranspiration) to the geospatial map								
Activity 3. Initial prioritization of riparian restoration sites (lead investigators: NHNM and NMSU)- $80,000 (20%)								
Milestone. Complete MRG ROCAs (*NHNM separate project not included in this proposal but key input for this project*)								
Milestone. Incorporate the water-saving results from Activity 2 to the RCOAs framework and refine priority areas for MRG								
Activity 4. Convene stakeholder workshops to refine restoration priorities and ensure users appropriation of the tool (lead manager: WWF)- $80,000 (20%)								
Milestone. Stakeholder orientation virtual meeting								
Milestone. In-person stakeholder workshop in Albuquerque, NM								
Milestone. Update restoration priority areas based on stakeholder input and update priority data layer on the geospatial map								
Activity 5. Designing a restoration tracking system (lead investigators: NHNM and WWF) - $20,000 (5%)								
Milestone. Incorporate functionalities to track restoration efforts in the final geospatial map database.								
Activity 6. Dissemination of Results (lead manager: WWF) - $20,000 (5%)								
Milestone. Publication of the Final Technical Report								
Milestone. Webinar to launch and socialize the final Geospatial Map (Decision making tool)								
Milestone. At least 2 presentations to key staff of partner organizations, other government agencies and NGO collaborative conservation groups in NM								

3. Provide a summary description of the products that are anticipated to result from the project.

Project Activity	Product/Deliverable
Activity 1. Mapping native and non-native (invasive) riparian vegetation throughout the Middle Rio Grande in NM	Online, searchable geospatial map of riparian communities (both native and exotic), with the capability of being able to click on any exotic community to reveal the likely replacement community and the estimated water savings (reduced evapotranspiration) as discussed under Activity 2.
Activity 2. Estimating potential reductions in riparian evapotranspiration by replacing exotic species with native species	Geospatial datasets with interannual ET values for different riparian communities (both native and exotic) and regional ET estimations, that displays areas with different potentials for ET reductions (water savings) and ready to be overlaid onto the online, searchable geospatial map developed in Activity 1.
Activity 3. Initial prioritization of riparian restoration sites	Initial water smart Riparian Conservation Opportunity Areas portfolio and map prioritized for areas where water saving through restoration can be maximized based on the ET reductions analyzed in Activity 2 along with other ecological restoration goals.
Activity 4. Convene stakeholder workshops to refine restoration priorities and ensure users appropriation of the tool	Summary report with the synthesis of each workshop, participants and their affiliations, main findings to be considered for the final prioritization of riparian restoration sites, and input to design the tracking tool in a manner that is practical and informative for the potential users.
Activity 5. Designing a restoration tracking system	Set of functionalities or attributes to track restoration efforts embedded into the final geospatial map database.
Activity 6. Dissemination of Results	Final technical report, functioning online geospatial map with final priority restoration areas, and virtual presentations targeted to key audiences (potential decision-tool users).

4. Who will be involved in the project as project partners?

Category A partners. Middle Rio Grande Conservancy District and New Mexico Interstate Stream Commission. These partners will provide support by offering input and feedback to conduct the research and design the tracking tool for project implementation, along with participation in the stakeholder orientation meeting and workshop to identify priority restoration areas. The NMISC will collaborate on this research effort with hydrologic model data input, upon request, and include this study's results in the agency's Vegetation Management Plan for the MRG. The MRGCD and NMISC have agreed to assist in meeting organization and involve key staff in each organization to disseminate the results of the project and foster its use and application in their conservation and water management programs.

Category B partners. World Wildlife Fund US is the main applicant of the proposal and will serve as the project management and grant administration organization. Will also provide technical support to UNM's NHNM and NMSU throughout the proposed work in Activities 1, 2, 3 and 5. WWF will lead the stakeholder engagement under Activity 4 and coordinate the activities to disseminate the results. NHNM will lead Activities 1, 3 and 5 and support Activities 4 and 6. New Mexico State University will lead Activity 2 and provide support on Activities 1, 3, 4, 5 and 6.

Stakeholder Engagement. Stakeholder engagement will be conducted as part of Activity 4 through an initial project orientation meeting, an in-person stakeholder workshop in Albuquerque, NM and additional ad-hoc small group meetings. Later, in the final phases of the project in Activity 6, stakeholders will be engaged through different efforts to disseminate the results of the project, such as webinars, presentations, and meetings.

5. Identify staff with appropriate credentials and experience and describe their qualifications.

All partners staff participating in this project as project managers and lead investigators have completed several similar projects to the one proposed here. The team, listed below, will be ready to start the project upon entering into a financial agreement.

World Wildlife Fund

- **Enrique Prunes M.S.** Rio Grande/Bravo Manager and Freshwater Lead Specialist at WWF US. Has been a water resources specialist and river conservationist in WWF for 14 years. In his current role, he works across the Freshwater and Food team to incorporate the connections of surface water, groundwater, agricultural water consumption, and related science and policy areas into all team initiatives. He leads the programmatic work in the Rio Grande/Rio Bravo including continued partnership development, donor cultivation, and strategic decision-making around program direction, and implementation. He also supports the development of the Science-Based Targets methodology for freshwater, water balance, and resource accounting models.
- **Brian Richter M.S.** Currently serving as a Senior Freshwater Fellow for WWF. Has been a global leader in water science and conservation for more than 30 years. He is the president of Sustainable Waters, a global organization focused on water scarcity challenges, where he promotes sustainable water use and management with governments, corporations, universities, and local communities. He previously served as Director of the Global Water Program of The Nature Conservancy, an international conservation organization. Brian has consulted on more than 170 water projects worldwide. He has developed scientific tools and methods to support river protection and restoration efforts, including the Indicators of Hydrologic Alteration software used by water managers and scientists worldwide. He has published many scientific papers on the importance of ecologically sustainable water management in international journals. He co-authored a book with Sandra Postel entitled Rivers for Life: Managing Water for People and Nature. His latest book, Chasing Water: A Guide for Moving from Scarcity to Sustainability, has been published in five languages.

Natural Heritage New Mexico

- **Esteban Muldavin Ph..D.** Joined Natural Heritage New Mexico as the Senior Ecologist in 1991 and became its Director in 2008. Dr. Muldavin received his B.S. and M.S. in Natural Resources from Humboldt State University in 1982 and a Ph.D. in Biology from New Mexico State University, Las Cruces NM in 1988 with a focus on forest ecology. Dr. Muldavin has spent his career as an ecologist in the Southwest applying multidisciplinary approaches to broad range of issues in ecology and conservation biology. As Director, he leads a staff committed to inventory, monitoring, and assessment of New Mexico's ecosystems, and building a comprehensive database and modeling program on sensitive species and ecosystems for the state. He is also Chairman of the Ecological Society of America Panel on Vegetation Classification and is a contributing scientist on the Sevilleta LTER.

New Mexico State University

- **Salim Bawazir Ph.D.** Has been with NMSU for over 25 years and is currently an Associate Professor and Associated Department Head of the Civil Engineering Department. During his tenure at NMSU has conducted research and published extensively on topics related to hydrometeorology research related to evaporation from reservoirs and evapotranspiration from agricultural crops and riparian vegetation, measurements and forecasting of processes related to water and energy fluxes and storage terms, modeling and application of remote sensing

technology in riparian and agricultural water management and ecological rehabilitation of riparian regions using engineered natural systems approach.

Middle Rio Grande Conservancy District

- **Casey Ish LL.M.** Has been with the District since Fall of 2019. He is a Water Resources Specialist and serves as Coordinator and primary point of contact for the District's Conservation Program. A graduate from the University of New Mexico, he received a BLA in Fresh Water Conservation and Management, as well as a minor in Sustainability Studies. Casey most recently completed his master's degree at the University of New Mexico's School of Law where he received his MSL in Natural Resource and Water Law.

New Mexico Interstate Stream Commission

- **Page Pegram M.S.** Has been with the ISC as a Hydrologist for over 22 years and is currently the Rio Grande Bureau Chief, the department in charge of managing all issues related to the Rio Grande Interstate Compact of 1938. She is New Mexico's Engineer Adviser to the Rio Grande Compact. She has a B.S. in Geology from Brown University and an M.S. in Hydrology from New Mexico Tech.
- **Grace Haggerty M.S**. Sr. Hydrologist with the NMISC for over 20 years and is the Program Manager of projects related to the Endangered Species Act in the Middle Rio Grande and associated Biological Opinions. She is the agency's representative on the MRGESCP Executive Committee, supervises staff in the development of an integrated surface water-groundwater hydrologic model, supervises staff at its Rio Grande Silvery Minnow conservation facility, and manages large-scale habitat restoration and water conveyance projects.

Evaluation Criterion D—*Dissemination of Results*

Explain how project results will be disseminated.
We intend to disseminate the results of this project with interested internal and externals stakeholders, water managers, and decision makers as described in Activity 4, as well as the following activities:

- Publication of a final report describing project accomplishments, final results of identified tasks, and any lessons learned.
- A webinar to launch the results of the project and the geospatial map tool, could be Reclamation-sponsored webinar or a webinar hosted by the partnering organizations.
- Potential presentations with the following groups after project completion:
    - Key staff from MRGCD and ISC
    - USBR-MRGCD Rio Grande Basin Study partners, particularly with the NGO Sectoral Committee
    - NHNM and NMSU forums
    - Conservation Collaborative Groups in the Rio Grande in NM and the international stretch of the river.
    - Coalition of Six Middle Rio Grande Pueblos
    - Other water managers in working on similar rivers in the West.

Evaluation Criterion E—*Presidential and Department of the Interior Priorities*

Climate Change: This project advances a Nature-Based Solution to climate change adaptation. Climate warming and a regional megadrought have substantially reduced river flows, yet water users

have been unable to reduce their water consumption to the degree necessary to sustain a supply-demand balance. This project focuses on management of riparian vegetation communities in a manner that will reduce consumptive water use by reducing ET associated with invasive, exotic plant communities along the river. Riparian ET presently accounts for one-third of all water consumed from the Rio Grande in New Mexico as estimated by Brown et al. 2022.[22] By approaching the climate-driven imbalance in the water budget through vegetation restoration, we are helping to adapt to climate change in a long-term sustainable manner that improves water supply reliability while also enhancing habitats for endangered species and improving recreational and cultural values.

Disadvantaged or Underserved Communities: According to the Climate and Economic Justice Screening Tool almost all of the Middle Rio Grande region, and almost all New Mexico State, is considered disadvantaged because it meets at least 1 burden threshold and the associated socioeconomic threshold, but in many tracts more than 1 burden thresholds. Additionally, from data retrieved from the EPA 2019. Environmental Justice Screening and Mapping Tool (EJSCREEN) and U.S. Census Bureau, 2019 these are some of the demographics of New Mexico:

- 68% Minority in New Mexico state. 49.3 % Hispanic, 2.6% Black/African American, 2% Asian/Pacific Islander, 11% American Indian/Alaska Native and 2.6% two or more races.
- 45% Low income. Population in households where the household income is less than or equal to twice the federal "poverty level."
- 13% Less than high school education. People age 25 or older whose education is short of a high school diploma.
- 4% Linguistic isolation. A household in which all members age 14 years and over speak a non-English language and also speak English less than "very well" (have difficulty with English) is linguistically isolated.
- 7% are under age 5. And 14% are over age 64.

Tribal Benefits: The Coalition of Six Middle Rio Grande Pueblos is comprised of the six Pueblo tribes whose lands are within the Middle Rio Grande Valley – the Pueblos of Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta. The territory of these Pueblos partially covers the study region of the proposed project. Many members of these tribes are farmers and the tribes themselves are key water rightsholders on the Rio Grande. Therefore, the results of this project would be useful for the restoration efforts that each Pueblo may implement, as well as river flow enhancement would benefit cultural values held by the tribes. We have explicitly included Native American tribal members among our stakeholder community. Additionally, the development of the decision- making tools proposed for this project could greatly benefit from the input of these rightsholders and will also help to foster their inclusion in the water management and decision-making process.[23] Each Pueblo has its own Environmental Department and invitations will be extended to representatives of these Departments to participate in the stakeholder workshop.

- Does the proposed project support Reclamation's Tribal trust responsibilities or a Reclamation activity with a Tribe? No.

[22] Brown C., Eluwa C., Maharjan M. and Francois B., 2022. *Upper Rio Grande (URG) Futures Model: a tool to model and forecast the report card grades for the Upper Rio Grande Basin*. Final report submitted to WWF.
[23] Source NM, 2022. Pueblos again seek inclusion in Rio Grande decision-making. https://sourcenm.com/2022/05/16/pueblos-again-seek-inclusion-in-rio-grande-decision-making/

NEW MEXICO INTERSTATE STREAM COMMISSION

BATAAN MEMORIAL BUILDING, ROOM 101
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October 13, 2023

Dear WaterSmart-Applied Science Review Panel,

On behalf of the New Mexico Interstate Stream Commission (NMISC), I am pleased to offer this letter for World Wildlife Fund US (WWF) in partnership, as a Category A partner, and strong support on their proposal for the WaterSmart- Applied Science Grant 2023 titled: "Prioritizing Nature-Based Solutions for Water Management: Assessing Potential Evapotranspiration Reductions through Riparian Restoration in the Middle Rio Grande, NM." The NMISC is headquartered in Santa Fe, New Mexico, and has broad powers to investigate, protect, conserve, and develop New Mexico's waters including both interstate and intrastate stream systems. The Commission's authority under state law includes negotiating with other states to settle interstate stream controversies. New Mexico is a party to eight interstate stream basins compacts, including the Rio Grande Compact. To ensure basin compliance, NMISC staff analyze, review, and implement projects in New Mexico and analyze streamflow, reservoir, and other data on the stream systems.

New Mexico's use of water in the middle Rio Grande is limited by the Rio Grande Compact, and the state has had difficulty in the past 5-10 years in meeting its annual Compact delivery obligation. As described in New Mexico's Leap Ahead Analysis (NMBGMR Bulletin 164, 2022), which is the scientific foundation for New Mexico's 50-year Water Plan, New Mexico's average temperature is expected to rise 5 to 7 degrees in the next 50 years. Along with the rise in temperature comes an increase in depletions by riparian evapotranspiration (ET). New Mexico is very interested in research, analysis, and methods to reduce current and future water consumption by riparian vegetation.

The NMISC agrees that the content of the proposed project to be conducted by WWF, University of New Mexico (UNM)-NHNM and NMSU-Civil Engineering Department can be of great value in quantifying potential savings in ET from restoring areas of invasive vegetation to native vegetation. Such savings could benefit the river ecosystem and help meet Rio Grande Compact deliveries. The study can also provide decision making tools for water managers and conservation groups to guide the implementation of priority restoration projects in areas that can yield the greatest ecosystem benefits and water savings.

The NMISC is excited to partner with the research on this proposal, and we are willing to provide our support by offering input and feedback to conduct the research and design the tracking tool for projects implementation, participate in the stakeholder workshop to identify priority restoration areas, and share NMISC information and data that could be helpful during the research.

If you require further information from the NMISC, please contact me at 505-695-5622, or by email at page.pegram@ose.nm.gov.

Sincerely,

Page Pegram
Rio Grande Basin Manager
New Mexico Interstate Stream Commission

October 9, 2023

MIDDLE RIO GRANDE CONSERVANCY DISTRICT

U.S. Bureau of Reclamation
Water Resources and Planning Division
P.O. Box 25007, MS 84-51000
Denver, CO 80225

RE: Letter of Support for World Wildlife Fund's US WaterSMART 2023 Applied Science Grant

To Whom It May Concern:

On behalf of the Middle Rio Grande Conservancy District (MRGCD), I am pleased to offer this letter of support for World Wildlife Fund's US (WWF) WaterSMART 2023 Applied Science Grant Titled: "Prioritizing Nature-Based Solutions for Water Management: Assessing Potential Evapotranspiration Reductions through Riparian Restoration in the Middle Rio Grande, NM". The MRGCD is headquartered in Albuquerque, NM and operates, maintains, and manages irrigation, drainage, and river flood control, promotes efficient and responsible water management, protects the environment and endangered species in cooperation with other agencies in the Middle Rio Grande Valley. MRGCD is a Category A Partner in this project.

As of 2022, New Mexico had accumulated 93,000 acre-feet (AF) of debt under the terms of the Rio Grande Compact, resulting from drought and system inefficiencies. This water debt has created highly stressful conditions for farmers in both New Mexico and Texas and placed endangered species in peril. A recent model developed by the University of Massachusetts and WWF estimate that the riparian evapotranspiration (ET) in the Middle Rio Grande in NM accounts for 14% of the total water outflows of the system. Recent analysis from the Natural Heritage New Mexico research program mapped that 56% of the riparian vegetation in the Middle Rio Grande in NM is composed of invasive species. And another 2009 study conducted by researchers from New Mexico State University (NMSU) in a field site at Bosque Del Apache National Wildlife Refuge showed that ET in Cottonwood (native) areas was on average 13% lower compared to ET in Salt cedar (invasive) areas. This presents the potential opportunity for implementation of restoration efforts that could provide multiple benefits for the Rio Grande.

Thus, MRGCD agrees with the content of the proposed project to be conducted by WWF, University of New Mexico (UNM)-NHNM, and NMSU-Civil Engineering Department that will be of great value in quantifying potential reductions in ET of restoring areas of invasive vegetation to native vegetation to increase water savings that can be used for the river ecosystem and meet Rio Grande Compact deliveries, and providing decision making tools for water managers and conservation groups to guide the implementation of Nature Based Solutions in priority restoration areas that can yield the greatest ecosystem benefits and water savings. This project will complement ongoing efforts by the MRGCD to manage the bosque and transition it into a more climate adapted mosaic.

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MRGCD is excited to partner with the research on this proposal and willing to provide support by offering input and feedback on research and design of the tracking tool for project implementation, along with participation in the stakeholder workshop to identify priority restoration areas. To the extent possible, MRGCD will also provide information and data that could be helpful during the research. If you have any questions, please contact Casey Ish at casey@mrgcd.us.

Sincerely,

Jason M. Casuga, P.E.
CEO/Chief Engineer

OFFICE OF SPONSORED PROJECTS

October 11, 2023

Carter Roberts
President and CEO, World Wildlife Fund
1250 24th St NW
Washington, DC 20037
Re: WaterSMART-Applied Science Grants for FY 2023 (NOFO #R23AS00446)

Dear Mr. Roberts,

The Regents of the University of New Mexico, an Hispanic Serving Institution of Higher Education, has intent to participate as a proposed subrecipient in your application to USBR WaterSmart Applied Science Grant on the implementation of the "*Prioritizing Nature-Based Solutions for Water Management: Assessing Potential Evapotranspiration Reductions through Riparian Restoration in the Middle Rio Grande, New Mexico*" project. The University of New Mexico, under the direction of Dr. Esteban Muldavin, will be responsible for the portion of the project described in the subaward application materials.

Enclosed is the UNM cost proposal totaling $120,000, which represents Direct Costs of $106,667 and Facility & Administrative Recovery Costs of $13,333 for the period of April 1, 2024 through June 30, 2026. UNM commits to providing $40,000 in additional support representing imputed Facility & Administrative Recovery Costs.

UNM, through Natural Heritage New Mexico (NHNM), has extensive experience in characterizing and analyzing the distribution of riparian ecosystems in New Mexico and particularly in the Middle Rio Grande . This includes the recently completed state-wide riparian map (NMRipMap), the development of a Riparian Conservation Area toolkit, and building tools for delivery of our products and data for users through the New Mexico Conservation Information System (NM-CIS). MHNM maintains a fulltime staff of ecologists, GIS specialists, and data managers that will address the analysis activities listed below for the project.

UNM looks forward to working with World Wildlife Fund to implement the "*Prioritizing Nature-Based Solutions for Water Management: Assessing Potential Evapotranspiration Reductions through Riparian Restoration in the Middle Rio Grande, New Mexico" project. UNM will serve as the lead investigator for Activity 1*". Mapping native and non-native (invasive) riparian vegetation throughout the Middle Rio Grande in NM" and Activity 3 "*Prioritization of riparian restoration sites*", and co-lead Activity 5 "*Designing a restoration tracking system*". Additionally, will provide support to WWF and the other partners in this proposal on the rest of the proposed activities in this project.

Should an award be made to World Wildlife Fund, The Regents of the University of New Mexico is prepared to address suitable terms and conditions to enter into a negotiated agreement. Questions regarding technical material should be directed to Dr. Muldavin, at muldavin@unm.edu. Should you have any administrative questions or concerns, I will be your point of contact and can be reached at the contact information below. Please send any award documents to awards@unm.edu. Thank you for your consideration of this proposal.

Respectfully Submitted,

Miriam E Sargent-Shearin
Digitally signed by Miriam E Sargent-Shearin
Date: 2023.10.11 17:20:03 -06'00'

Miriam Sargent-Shearin, Sponsored Projects Officer
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UNM PD1097

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October 16, 2023

Carter Roberts
President and CEO, World Wildlife Fund
1250 24th St NW
Washington, DC 20037

Re: WaterSMART-Applied Science Grants for FY 2023 (NOFO #R23AS00446)

Dear Mr. Roberts,

This letter is to confirm New Mexico State University's (NMSU) intention to collaborate with World Wildlife Fund on the implementation of the "Prioritizing Nature-Based Solutions for Water Management: Assessing Potential Evapotranspiration Reductions through Riparian Restoration in the Middle Rio Grande, New Mexico" project.

NMSU looks forward to working with World Wildlife Fund to implement the "Prioritizing Nature-Based Solutions for Water Management: Assessing Potential Evapotranspiration Reductions through Riparian Restoration in the Middle Rio Grande, New Mexico" project. NMSU will serve as the lead investigator for Activity 2 of the proposed project "Estimating potential reductions in riparian evapotranspiration by replacing exotic species with native species" and co-lead in Activity 3 "prioritization of riparian restoration sites". Additionally, will provide support to WWF and the other partners in this proposal on the rest of the proposed activities in this project.

If you have any technical questions, please direct them to Dr. Salim Bawazir at abawazir@nmsu.edu. For administrative or contractual inquiries, please contact Vanessa Gonzalez at nessaglz@nmsu.edu or at 575-646-1590.

Sincerely,

Barbara Gonzales,
Assoc. Director, Pre-Award Admin

Digitally signed by Barbara Gonzales, Assoc. Director, Pre-Award Admin
Date: 2023.10.16 15:50:12 -06'00'

for

Alisha A. Giron
Assoc. VP, Research Admin.
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