



## OIL & GAS ADMINISTRATION

JICARILLA APACHE NATION

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### **Jicarilla Apache Nation Request for Funding Watershed Study, Including Mapping, Engineering and Construction of the Roads to access the Oil Fields**

**Introduction:** The Nation is on the front-end of developing its Oil and Gas Resources and this next generation of O&G wells, based on horizontal drilling and hydraulic fracking to the Mancos Shale, will lead to increased revenues for the Nation and the State of New Mexico. This funding request to the State of New Mexico through the State Legislature is necessary to develop the Nation's Oil and Gas Resources by addressing acute problems we have with erosion and damage to the Nation's Roads.

1. The Watershed study as proposed would initially be a surficial mapping effort to identify deposits in arroyos and basins as well as bedrock units that may be prone to mobilization during intense storm events within the Largo Canyon watershed. Both arroyo erosion and excess sedimentation are problems that occur in the aftermath of a single storm, but the former presents a more immediate threat to infrastructure on the Reservation, the latter affecting downstream communities. Thus, surficial mapping will identify drainages and floodplain areas susceptible to flooding that can entrain loose sediment, undermine stream bends, erode new channels, and destroy existing control structures such as impoundments. Two of the important products of this study will be a surficial geologic map and a hazards map identifying areas at risk of low to extreme erosion.

Erosion along stream courses on Tribal lands may occur in a number of different ways such as channel incision, incision at knickpoints (abrupt changes in channel slope), avulsion (abrupt relocation of a channel), particle entrainment, headcut migration, and gully formation. The respective areas where these processes are most common will be readily identified through surficial mapping, supplemented by GIS analyses of elevation and channel and hillslope gradient. Field studies and GIS analyses will also allow researchers to construct longitudinal profiles of stream courses that show oversteepened reaches, where further incision is likely to occur, versus relatively shallow segments.

Two processes closely related to flooding and erosion, runoff and infiltration, will be characterized by field and laboratory analyses of soil, loose sediment, and bedrock texture (grain size and cementation). The geologic map will include descriptions that clearly define texture for each unit. Grain size distribution diagrams will be made for the most erosion-prone surficial map units, including bedrock where applicable.

In addition to flooding, two other hazards are known to contribute to erosion because of their effects on runoff, stream grade, and sediment supply: debris flows and landslides. These hazards will be mapped and assessed on hillslopes adjoining valleys and in other upland areas, particularly near the heads of drainages along the Continental Divide. Gully formation will also be mapped and assessed in these locations.

In order to model the amount of sediment generated during storm events, researchers will undertake repeat GPS surveys of erosion-prone areas impacted by intense precipitation. This data will be supplemented by field studies employing low-cost methods for determining erosion rate and sediment yield, such as sediment traps and straw dams. Survey and erosion/sedimentation rate data combined with surficial mapping will permit preliminary calculations of sediment generated and transported during storms, potentially impacting downstream communities and the San Juan River fishery.

Much of the work entails geologic mapping of surficial deposits at a scale of approximately 1:50,000 using remote sensing, particularly using high-resolution aerial imagery. Field studies of arroyo erosion and basin fill compositions and erosion/sedimentation rates will allow researchers to better assess the history of these hazards and their relative impact to local infrastructure. Additional context will be given to the current conditions through the collection and interpretation of radiocarbon age samples, which will aid in understanding previous cycles of erosion and sedimentation. Ultimately, these efforts are essential for constructing a hazards map that identifies the areas most at risk from continued erosion and is useful for infrastructure planning.

2. The Watershed study would be conducted by the New Mexico Bureau of Geology and Mineral Resources' Geologic/Hazards Mapping Program. The land to be studied is approximately 500,000 acres and includes the mountains east of the Reservation (approximately 10% of the study area) extending to the Continental Divide north and east of Lindrith. The remainder of the study area consists of wide valleys interspersed with low-lying mesas and buttes. See accompanying map.

As described above, a holistic approach will be taken in delineating the areas most prone to erosion by mapping and analyzing watersheds from their heads to their outlets.

We anticipate that the watershed study will be completed within two years, and provide the foundation for engineering studies to mitigate the identified hazards. Engineering and construction activities are to be started in the second year and continue into subsequent years as funding allows.

3. The Bureau anticipates that this level of effort would require a team of 2-3 researchers. This funding will support the Bureau's soft-money staff members. The Bureau is also willing to provide some in-kind match in salary from one of their hard-money staff members working on the project.

The researchers will undertake the following activities: i) conduct mapping through field visits and remote sensing; ii) develop field descriptions of each map unit, including properties related to erodibility, infiltration, and runoff; iii) perform GPS surveys of areas with extreme erosion; iv) determine erosion and sedimentation rates using low-cost field techniques; v) collect and submit radiocarbon age samples to better understand the history of erosion and sedimentation; and vi) conduct laboratory analyses of texture and other pertinent sediment/bedrock properties. The Bureau team will also include a GIS Analyst who will provide support to the researchers in the form of data acquisition and interpretation.

4. The Watershed study would benefit the Nation and the State of New Mexico by providing state-of-the-art geologic interpretations, GIS data identifying the distribution of surficial and bedrock units, drainage catchments spatially related to Tribal infrastructure, and interpretations of areas prone to geologic hazards like flooding, gully formation, debris flows, and landslides. In addition to satisfying the direct infrastructure needs of the Nation, this work will also facilitate mitigation in regions where similar patterns of arroyo erosion and sedimentation exist.

5. The Watershed study will provide the Nation with GIS information for planning O&G lease roads, silt trapping ponds/impoundments, other water diversions, and a map of the hazards described above classified by severity across the southern part of the Reservation. At a minimum, GIS products will include: i) watershed map; ii) slope map; iii) longitudinal profile of Cañon Largo-Cañada Larga, the study area's largest drainage; iv) surficial geologic map; and v) hazard map with areas delineated by low, moderate, and high hazard for flooding, gully formation, debris flows, and landslides.
6. The Watershed study will also benefit communities west (downstream) of the Reservation by allowing the Nation to better understand hazards related to high intensity runoff, identify areas particularly prone to runoff, and designing catchment systems to control erosion. The downstream communities on the western side of the Reservation are impacted by sedimentation, caused by high intensity storms, that also threatens rivers and fisheries along the San Juan River Basin, impacting endangered species. Surveys of erosion-prone areas conducted by Bureau researchers will allow preliminary quantification of sediment entrained during intense storm events, helping to guide design and placement of erosion control systems. Our effort to understand and mitigate these hazards benefits a broad constituency living on and downstream of the Reservation.
7. This funding request is also intended to engineer and design a solution(s) to problems identified through geologic mapping and hazard characterization in the Watershed study. We need to study the source of the problem and then develop an engineering plan for the solution by contracting with the Mineral Engineering Department of New Mexico Tech to better understand technologies to stabilize soils in large precipitation events and to engineer impoundments to minimize sediment mobilization. At this stage, the primary focus would be on initial site investigation, a literature review related to the geology, hydrology, and geomechanics of the area, short-term monitoring of the site, preliminary laboratory tests, and a historical review of infrastructure failure and contributing factors associated in the region.
8. The actual construction of erosion and sedimentation solutions will be performed by Tribal Departments, Contract and Tribal Roads department, utilizing the monies from this funding request.
9. This work will cost over a million dollars; however, we expect significant in-kind work to supplement the cost for this program. The funding request for the Watershed study, mapping, engineering, and construction is one million dollars roughly allocated as follows: i) 20% for the Watershed study and mapping; ii) 30% for engineering; iii) 35% for construction; and iv) 15% for contingencies and overhead. We anticipate completion of the project within three years, just as the oil and gas development will become most active.

**Contact Persons are as follows:**

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If there are any questions regarding this request, please feel free to contact Guillermo or Mike directly.

On behalf of the Jicarilla Apache Nation,  
Sincerely, /s/ *Guillermo DeHerrera*  
Guillermo DeHerrera, Director Jicarilla Oil and Gas Administration  
Cc: JAN President, Mr. Levi Pesata