Questions and Answers Regarding the Proposed
FY 2001 Aerial Photography and LIDAR Overflights

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1. **Why is there an urgency to do the LIDAR flight this year?**

As GCMRC has conducted its PEP review of current monitoring activities, it has become clear that a statistically sound long-term monitoring program for the Colorado River ecosystem will require the ability to accurately (both horizontally and vertically) know the location of a specific monitoring plot, sampling site, or beach or sandbar location within the canyon. In order to do this, a survey control network and precise topographical information is required that allows you to accurately locate where you are in the canyon. GCES and GCMRC have been developing a control network through annually surveying in additional control points. In addition, GCMRC has been exploring the use of GPS, in conjunction with survey control as a means of establishing recoverable sampling points within the canyon.

As part of the remote sensing initiative, GCMRC has been exploring opportunities to establish control throughout the canyon and develop high-resolution topography and orthophotography of the entire Colorado River ecosystem using remote sensing. In March of 2000 GCMRC awarded a contract intended to obtain these products. However, the contractor failed to meet the contract specifications with respect to the horizontal and vertical accuracy of the digital elevation model and the orthophotography. At the same time, a contract was awarded to a different contractor to deliver a similar product for only 14 miles of the CRE. Those products are just now being received and are being evaluated for conformance to contract specifications. The evaluation will be completed before this years LIDAR flight contract is awarded.

It is critical that we fly the LIDAR again so we can establish some level of control for the entire CRE, and develop the high-resolution topographic map and orthophotography. Having these products will ensure that long-term monitoring sites that are being established are consistently recoverable and it will provide the basis for a sound statistical design where a random stratified approach is being utilized. In addition, these products will allow a more accurate and efficient system wide analysis of all historical aerial photography, and will allow the development of channel cross sections throughout the canyon. Until we have these products, change detection using the historical aerial photography is restricted to a limited number of sites where a set of fixed-point ground control points exists.

2. **Why don=t we follow the established protocols (8,0000 or 15,000 cfs) for aerial photography?**

GCMRC would prefer to follow the established protocols of 8,000 or 15,000 cfs established in our

July 31, 1998 memorandum. However, given current power costs and the most probable hydrology, the Bureau of Reclamation and the Western Area Power Administration will not commit to steady flows for the required 6.5 days at either 8,000 or 15,000 cfs from late May to the end of June. See the answer to question 4 for additional information regarding power costs.

In an effort to minimize the economic impacts, the Bureau of Reclamation and the Western Area Power Administration will commit to a steady flow of 12,800 cfs (the expected peak release for that time period) notwithstanding emergency power demands resulting from power shortages in the West. As the date of the over flight approaches, the Bureau of Reclamation has agreed to modify the allowable steady flow based on actual nominal flows. This means we could get closer to 8,000 cfs or 15,000 cfs depending on the actual releases at the time we implement steady flows.

3. **What is the impact to other projects of delaying the steady flow and the associated over flights?**

Not conducting the LIDAR over flights will further delay our efforts to implement a sound long-term monitoring program, as well as studies that require high resolution topographic data and orthophotography such as canyon-wide vegetation mapping, river centerline mapping, and stage discharge mapping.

4. **What is the economic impact of releasing 15,000 cfs?**

Each year as part of the monitoring program, aerial photography is flown downstream of Glen Canyon Dam to document changes in the ecosystem. This long term effort is a consistent and valuable part of the GCMRC data set, and typically calls for 3 - 4 days of steady flows at either 8,000 or 15,000 cfs, although other flow levels have been flows in previous years. We propose to increase the steady flow period to 6 + days this year to re-fly the LIDAR effort (7 half-days on-peak and 6 half-days off-peak).

Typical releases for this spring will likely be daily fluctuations ranging between 6,800 and 12,800 cfs (an average daily release of about 10,000 cfs). This daily operation theoretically produces the greatest economic benefit to power customers under the ROD constraints. Any deviation from this flow regime would produce a negative economic impact.

Releasing steady flows of 15,000 cfs requires additional water be taken from a future month in the water year and released during both the on-peak and off-peak period of the photography time period. The cost is then the differential between current and future expected power costs. June on-peak costs are expected to be about $320 / Mw-hr and off-peak $152 / Mw-hr, and September average costs of $308 / Mw-hr (average of on-peak and off-peak rates). We use September average costs since moving water from that month would come from both on-peak and off-peak periods. Using the conversion of 1 acre-foot = 0.48 Mw-hr, for the transfer from September average costs to an off-peak period for a total of 49,200 acre-feet (15,000 cfs - 6,800 cfs for + day = 8,200 acre-feet per day for a

total of 6 days), the cost differential of $156 / Mw-hr (September average to June off-peak) would produce a cost of about $3.7 million. For the transfer to an on-peak period for a total of 17,500 acre-feet (15,000 cfs - 12,800 cfs for + day = 2,500 acre-feet per day for a total of 7 days), the cost differential of -$12 / Mw-hr (September
average to June on peak) would produce a cost of about -$0.1 million. The total cost is therefore about $3.6 million.

If the photography release were limited to 12,800 cfs, the only cost involved would be the transfer of September average deliveries to June off-peak deliveries. This would be a total of 36,000 acre-feet (12,800 cfs - 6,800 cfs for + day = 6,000 acre-feet per day for a total of 6
days), the cost differential of $156 / Mw-hr (September average to June off-peak) would produce a cost of about $2.7 million.

Of the 6 + days of steady flows, 4 days (or about 2/3 of the time period) would have been required even without the LIDAR work for annual aerial photographs monitoring. Therefore, of the $2.7 million, about 1/3, or $900,000 is the additional cost of replacement purchase power
due to the LIDAR work.

5. **Can the data collected at 12,800 cfs be "clipped" back to 15,000 cfs level?**

Shorelines can be generated for different stage/discharge relationships with high-resolution topographic data. The accuracy of the derived shoreline will depend upon the topographic spatial coverage, accuracy, and the slope of the area. Based on limited work done with estimating shorelines in the past from LIDAR data, relative position to the "true" shoreline shown in the orthophoto was more accurate where the slope was steep (below one meter) and less accurate in areas of gentle slopes (15 meters). These are rough estimates that can be verified with additional work. A 15,000 cfs shoreline can be generated based upon channel geometry that could be used to clip the 12,800 cfs data.

6. **What is the purpose of the LIDAR data collection? Will it make a difference at what flow level the data is collected?**

The LIDAR data will be used to generate a high-resolution digital elevation model (DEM), a high-resolution topographic map, ortho-rectify aerial photography, and extend the GCMRC control network throughout the Colorado River ecosystem. More of the channel can be mapped at a flow of 8,000 cfs. Although we would prefer to obtain this data at 8,000 cfs, given the trade-off of collecting this data at 12,800 cfs in FY 2001 versus waiting for an uncertain time in the future when we might collect this data, GCMRC recommends collecting the data at a flow of 12,800 cfs.

7. **What is the status of data collected in FY 2000?**

The final contract modifications for the FY 2000 canyon-wide LIDAR mapping were signed on January 29, 2001. The first 100 miles of the river will be delivered by March 31, 2001 the second 100 miles by

May 31, 2001 and the third 100 miles by July 31, 2001. The following products will be delivered: Orthorectified CIR digital imagery, panchromatic digital imagery, contour map at one meter contour interval, and four meter digital elevation model The products will have the following horizontal and vertical accuracy: one to two meters horizontal for orthorectified imagery and 30 centimeters horizontal and 15 centimeters vertical for LIDAR (Note: LIDAR accuracy has not yet been verified). While these will be the most accurate canyon-wide products delivered to date, they will fail to meet the accuracy needs of specific long-term monitoring activities.

In addition, the site-specific LIDAR data, covering approximately 14 miles of the canyon and being provided by a different contractor will be provided in February and March of 2001. A preliminary review of the data provided to date indicates that LIDAR, when collected and post-processed properly can provide accurate products that meet our long-term monitoring requirements.

8. How is LIDAR data "verified"?

The LIDAR is verified by comparing it to existing survey data and known control points. A second approach involves comparing LIDAR generated points with a limited number of "panels" that were placed in the field during the time of the data acquisition and whose location is accurately known. Finally, it is possible to verify the LIDAR data by going into the field and surveying in new control points.

9. What are the products from proposed FY 2001 LIDAR over flight?

A DEM for the entire Colorado river ecosystem that will allow the generation of an accurate center-line for the river as well as accurate river miles, high resolution topographic maps with less than 1 m contours, black & white and color-infrared aerial photography that is ortho-rectified to within 50 centimeters for the entire Colorado River ecosystem, and extension of the control network to provide system-wide control.

10. How much will it cost?

The total project is estimated to cost $300,000, but included in that amount is our standard annual aerial photography effort (about $100,000).

11. Timeline for developing over flight data into integrated GIS?

Six months for data delivery and an additional three months for quality assurance and integration into our GIS.

12. Update on Survey Control Network?

The Survey group is currently on the river working on the control network. At the end of this trip, the

control network will be completed from the GCD to river mile 139 (about Kanab Creek).