PAONIA RESERVOIR SEDIMENTATION MANAGEMENT STUDY
SCOPE OF WORK AND STATUS UPDATE
NOVEMBER, 2010

This update is intended to provide information on several items:

1. Describe the project team and task divisions.

2. Identify changes which have been made to the original scope of work as the project has progressed.

3. Provide information on the current status of the work.

4. Itemize previous and expected future expenditures.

5. Present an updated schedule for completion.

The team selected to conduct this investigation included a joint effort by Engineering and Hydrosystems, Inc. (now Golder Associates) led by Dr. George Annandale along with Western Engineers, Inc. led by Bruce Marvin, P.E. Dr. Annandale is a globally recognized expert on reservoir sedimentation. Western Engineers is located geographically close to the project and has conducted preliminary studies on various aspects of the Paonia Reservoir sedimentation problem. Dr. Annandale was a research partner in developing the RESCON method and software for the World Bank. The RESCON model is intended to provide a preliminary evaluation of sediment management options and compare those options based on an economic optimization mathematical function which ranks the viability of each option considered. The RESCON model is based on the assumption that current water storage supplies must be maintained (life cycle analysis as opposed to design life analysis). The work provided by Golder Associates primarily involves conducting the feasibility analyses of options. They also are providing consultation regarding drainage basin sediment yield reduction feasibility. Functions provided by Western Engineers includes providing hydrologic data, conducting geotechnical investigations, sediment sampling, conceptual designs, cost estimating and investigating permitting/environmental requirements.

The original proposal included performing the work in two phases. The first phase is to consist of identifying and evaluating possible mitigation options at a feasibility level in order to narrow the focus to the two or three most feasible alternatives. The objective of the first phase of the study is to assess the potential technical feasibility of alternative sediment management techniques, identify the most economical alternative, and identify potential fatal flaws. This phase also included researching regulatory requirements associated with optional sediment management techniques. Phase One scope of work includes the following:

1. Review Existing Information – Existing information includes original construction documents, established operation and maintenance procedures, sediment surveys performed by

the U.S. Bureau of Reclamation, as well as sampling and studies performed by the U.S. Geologic Survey, the Colorado Department of Health and Environment and the U.S. Forest Service. The initial step of the study includes research and familiarization with these and any other documents discovered. This work has been completed.

2. Peer Review of Previous Studies – This item consisted of a review by Golder of previous work conducted by Western Engineers. This item has been fully completed.

3. Collection of Additional Data - This task entailed collecting hydrologic data, drilling and sampling test holes, conducting laboratory tests on recovered samples, and sampling and testing stream flow for sediment concentration. This work has been completed except for laboratory testing related to final disposition of the sediment including organic carbon, agronomic characteristics and hazardous constituents. Since, based on analyses to date, dredging does not appear to be one of the more feasible options, performance of these tests has been deferred for Phase Two work as needed.
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4. Feasibility Evaluation of Optional Sediment Management Techniques – The original proposal indicated that the following range of possible mitigation options would be considered and evaluated:

a. Pressure Flushing – Pressure flushing is executed with a high water surface elevation in the reservoir and entails opening a low-level gate at the dam. This option is not being considered because it does not differ substantially in effect from the drawdown flushing option.

b. Drawdown Flushing – Drawdown flushing is used to remove deposited sediment from the reservoir bed by erosion with the reservoir drawn down. Preliminary analyses have been made of this option based on the installation of one or two low-level outlets. However it is desired to refine these preliminary evaluations prior to completion of the Phase One report in accordance with the following considerations:

i. Investigate an option in which the volume of flushing water matches the normal demand releases from reservoir storage (run of the river). Previous flushing models have been based on storage releases being made specifically for flushing.
ii. Estimate flushing benefits using the existing outlet configuration.
iii. Evaluate the potential benefits and costs associated with mechanically-assisted flushing during which flushing channels would be re-routed or expanded.

c. Reservoir Routing – This option entails creating flow conditions in the reservoir during high flows that will, ideally, transport incoming sediment through the reservoir without deposition. This technique has yet to be evaluated and will be done so for both the existing outlet configuration and the addition of a low level outlet.

d. Mechanical Dredging – Mechanical dredging involves using a mechanical dredge to loosen sediment material, pump it into a discharge line and transport the dredged slurry to a sedimentation basin where it can be settled and decanted. Preliminary analyses have been made of this option. However the following elements are yet to be completed prior to release of the Phase One report:

i. Identification of potential disposal sites and the implications associated with each site.

ii. Potential for marketable aggregate production and identification of possible markets.

iii. Refinement of the cost estimates.

e. Hydro-Suction – This option is similar in concept to mechanical dredging except that the removal of the sediment from the reservoir basin is done with out a pump based on the siphon effect due to the difference in elevation between the reservoir level and the downstream discharge point. This option has been investigated on a preliminary basis. However it is desired to refine these preliminary evaluations prior to completion of the Phase One report in accordance with the following considerations:

i. Investigate an option in which the volume of hydrosuction water matches the normal demand releases from reservoir storage (run of the river). Previous hydrosuction models have been based on storage releases being made specifically to maintain a constant hydrosuction release.

ii. Investigate the potential for making low-cost modifications to the existing outlet configuration (rather than installing a low-level outlet) that would accommodate hydrosuction discharges.

iii. Evaluate the potential for making hydrosuction discharges over the spillway.

f. Reduction of Basin Sediment Yield – This work has consisted of examining the drainage basin from fly-overs, geologic maps and aerial photos. This portion of the work has been completed.

g. An option which has been recommended for consideration prior to completion of the Phase One report but which was not included in the original proposal is the effect of combining drawdown flushing with hydrosuction without making modifications to the outlet works. This analysis has yet to be completed.

h. Another option which was not included in the original proposal but which should be considered in the Phase One report is the no-action option. The evaluation of this option has yet to be completed.

5. The original proposal did not include any Phase One work related to monitoring the rate of sediment accumulation. However, as will be discussed in subsequent paragraphs, it has become apparent that some consideration of monitoring options should be performed as part of the Phase One work.

6. Conceptual designs and associated cost estimates have been provided for work items completed but are yet to be done for items listed above which are not yet finished.

7. Investigate Regulatory Constraints – Some preliminary contacts have been made with regulating agencies but the bulk of that work is yet to be completed.

8. A preliminary Phase One report has been prepared, presented and discussed. The final Phase One report will include the work items yet to be completed as previously discussed. The objective will be to agree on two or three selected sediment management techniques that should be investigated in more detail in Phase Two.

Phase Two work will consist of refining the selected options by obtaining more comprehensive supporting data, performing more detailed engineering analyses, refining cost estimates and further pursuing needed permits. Because the actual scope of the Phase Two work will be somewhat dependent on the results of the Phase One analyses, there is some uncertainty regarding the details of the Phase Two work and associated costs. However, since much of the Phase One work has been completed, the degree of uncertainty has been reduced and the originally anticipated Phase Two scope of work has been adjusted as indicated below:

1. Preparation of Numeric Sediment Transport Model and Evaluation – Because the effectiveness of flushing and dredging options is highly dependent on sediment transport characteristics, this will still be an important work item.

2. The Phase One work included estimating the value of the water. However, the resulting value was found to be quite low relative to estimates from other projects throughout the United States. The water value is a critical parameter in the RESCON process. Therefore, the Phase Two work has been expanded to include a more robust evaluation of water value.

3. Dredging Disposal Sites – Based on evaluations performed to date, the dredging option appears to be significantly less cost effective than other options. However, it is possible that some of the investigations yet to be completed (such as marketable by-products) may improve the viability of this option. More detailed evaluation of the dredging option will be performed in Phase Two only if it is selected as one of the more optimal alternatives.

4. Drainage Basin Yield Reduction – At this point, it does not appear that further Phase Two investigation into drainage basin yield reduction will be justified. However, it was a minor part of the original Phase Two proposed scope of work.

5. Preliminary designs will be performed for installation of a low-level outlet gate. This work will include collaboration with the U.S. Bureau of Reclamation which retains safety and technical oversight of the facility.

6. Monitoring and Sampling – This work item included in the original proposal was specifically oriented toward installation, calibration and maintenance of automated turbidity monitoring stations. During the course of the Phase One work performed to date, it has become apparent that other options should be considered. Therefore, as previously mentioned some additional work has been included in Phase One for such preliminary investigations. More detailed analysis (and installation, if appropriate) will be conducted as part of the Phase Two work.

7. Cost/Benefit Analysis – A cost/benefit analysis will be performed for each of the selected mitigation methods evaluated. Costs will include construction costs, life-cycle costs and any other indirect costs. Benefits will include both direct benefits from storage recovery as well as any identifiable indirect benefits.

8. Investigate Funding Options – Research will be done to assure that all feasible sources of funding have been identified. These may include but not be limited to water users, the Colorado River Water Conservation District, State agencies and Federal Agencies.

9. Investigate Partnering Possibilities – There may be other entities which have an interest in pursuing sediment mitigation but are not in a position to contribute funding to the project. These entities might be able to contribute technical expertise, political support or administrative assistance. These groups might include, but not be limited to, the U.S. Natural Resource Conservation Service, the U.S. Bureau of Reclamation, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the local Soil Conservation District, local water users groups, the Colorado Department of Health and Environment, the Colorado Division of Wildlife, the North Fork River Improvement Association and the Colorado Water Conservation Board. The potential interested parties will be identified and contacted to determine interest and ability to assist.

10. Meetings and Preparation of Report – Status and steering meetings will be held with the North Fork Water Conservancy District and other interest parties at selected intervals. A final report will be prepared which summarizes the investigations performed and their results, provides updated costs estimates for the alternatives, presents advantages and disadvantages of each alternative and presents conclusions and recommendations for future action.

Table 1 includes a summary of the Phase One costs. It should be noted that the costs for all of the additional Phase One work previously described are shown on Table 1 under items "Feasibility of Management Options" or "Phase One Report and Meeting" and coming from the contingency amount. It is seen that, after completion of the Phase One work, it is estimated that $28,898 of the contingency amount will have been expended. That represents about 70 percent of the total original contingency amount ($41,177) compared with a total original Phase One proposed cost at about 32 percent of the combined Phase One and Phase Two amounts. In other words, the Phase One work will have consumed a disproportionate amount of the total contingency.

The modified schedule is included on Figure 1. The bulk of the Phase Two work will be completed in 2011 or early 2012. However, the schedule extends beyond that to include periodic stream sampling, sediment surveys, instrument calibration and monitoring.

TABLE 1
SUMMARY OF PHASE ONE COSTS

WORK ITEM	PROPOSED AMOUNT	ACTUAL TO-DATE BILLED AMOUNT	ESTIMATED REMAINING AMOUNT	AMOUNT TAKEN FROM CONTINGENCY
Review Existing Information	$ 4,305	$ 4,296	$ 9	$ 0
Peer review of Existing Studies	$ 2,960	$ 2,343	$ 617	$ 0
Collection of Additional Data	$ 26,865	$ 26,219	$ 646	$ 0
Feasibility of Management Options	$ 23,190	$ 18,427	$ 22,223	$ 17,280
Conceptual Designs and Cost Estimates	$ 9,090	$ 6,436	$ 2,654	$ 0
Regulatory Constraints	$ 10,480	$ 5,487	$ 4,993	$ 0
Phase One Report and Meeting	$ 11,680	$ 9,239	$ 3,631	$ 1,190
Transportation, Copying, Misc	$ n/a	$ 695	$ n/a	$ 0
Contingency	$ n/a	$ 10,428	$ n/a	$ 10,428
TOTALS	$ 88,570	$ 83,570	$ 34,773	$ 28,898

	2010		2011												2012												2013	
TASK ITEM:	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
PHASE ONE EVALUATION:																												
Review Existing Information																												
Peer Review of Existing Studies																												
Collection of Additional Data																												
Feasibility of Management Options																												
Conceptual Designs and Cost Estimates																												
Regulatory Constraints																												
Report and Meeting																												
PHASE TWO EVALUATION:																												
Evaluation of Selected Options																												
Monitoring And Sampling																												
Cost Benefit Analysis																												
Runoff Prediction Tools																												
Investigate Funding Options																												
Investigate Partnering Possibilities																												
Meetings And Preparation of Report																												

NORTH FORK WATER CONSERVANCY DISTRICT

SEDIMENTATION MANAGEMENT STUDY FOR PAONIA RESERVOIR

SCHEDULE OF WORK ITEMS

FIGURE 1
4/17/2007
REVISED 12/10/2007
REVISED 7/16/2008
REVISED 8/14/2008
REVISED 11/11/2010

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ENGINEERS, INC.