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INDEPENDENT BOARD OF CONSULTANTS
REPORT NO. 1
SITES RESERVOIR

November 8, 2001

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Subject: **Sites Reservoir**
Board of Consultants Meeting No. 1

Gentlemen:

As scheduled by DOE Acting Program Manager, Ms. Jeanne Schallberger, by telephone on September 14, 2001 the first meeting of the Independent Board of Consultants for Sites Reservoir was held on November 6 – 8, 2001. The meeting was held according to the Agenda (Attachment A). The purpose of the meeting was to acquaint the Board with the issues and progress of feasibility level planning and design for the Sites Reservoir. As indicated on the Agenda, the Board received a briefing on the status of planning and design on November 6, 2001 in DOE offices in Sacramento. November 7 was spent in the field visiting the locations for the structures and viewing the potential borrow areas sites being considered for construction materials. This report was prepared and presented to the Department November 8, 2001. A list of attendees is included at Attachment B.

Prior to the meeting, Board members were provided copies of the following documents for review:

- Independent Consulting Board for Sites Reservoir—First Meeting—Information Package
- Engineering Progress Report on Feasibility Studies for Sites Reservoir—August 2000--Draft
- Sites Reservoir Feasibility Study—Materials Investigation, Testing, and Evaluation Program
- Sites Dam Site Foundation Geology Information Packet
- Golden Gate Dam Site and Appurtenant Structures Foundation Geology Information Packet
- Sites Saddle Dam Sites Foundation Geology Information Packet
- Sites Construction Materials Information Packet
- Phase II Fault and Seismic Hazards Investigation—North of Delta Offstream Storage Investigations—October 2001

During the formal presentations and field inspection informal discussions were held regarding project design and feasibility. The major issues were included in the following questions presented to the Board. The Board's responses to these questions along with additional comments follow:

Question 1

Based on preliminary inspections and presentations, is the completed and planned geologic investigation program adequate to complete the feasibility study of the Sites Reservoir Project?

Response

The Board has reviewed the geologic data developed for the feasibility study and discussed details of some of the investigations with the geologists during the field inspection. The review indicates that there is a good understanding of the regional and site geology and that exploration, including core borings, trenches, and seismic traverses have added vital information to further the understanding of the physical characteristics of foundations at the various structure locations. While it is recognized that there is much more detailed investigation needed for final design, it is the Board's judgment that the completed geologic investigations are adequate for the feasibility level studies of the Sites Reservoir Project. Should additional funding and time allow for additional field work, several items or issues are evident which could improve the accuracy of cost estimates for some of the structures. Those issues as well as other comments generated as a result of the review of the geologic data and field inspection follow:

- A large landslide has been mapped at the Sites dam site, a portion of which is located beneath the upstream shell section on the right side. Cost estimates could be refined if the presence of a landslide is verified, and if the depth of excavation, as well as the quantities to be removed to reach a suitable foundation could be determined.

- The trace of the GG-2 fault passes through the upper right abutment of the Golden Gate Dam. Although the risk of movement along the GG-2 fault is considered very low, estimates of the magnitude of movement range from a low of a few inches to a maximum of about 2 feet. The exact location and width of the fault could be refined, however that information is not vital at this time. The width of the fault, based on trenches at other locations, is known to be narrow, on the order of a foot or so, although the disturbed zone of rock on each side of the fault can extend for tens of feet. Regardless of the exact fault characteristics, the dam will need to be designed with defensive measures in the vicinity of the fault.
- The trace of the S-2 fault passes across the uppermost part of the right abutment of the Sites Dam. Similar to comments about the GG-2 fault at the Golden Gate dam site, the location and physical characteristics need to be verified and the dam will necessarily have to have similar defensive features designed into the section as at the Golden Gate Dam.
- The Salt Lake fault passes through the foundation of Saddle Dam 2 at an angle of about 90 degrees to the axis of the dam. This fault has been identified as active, based on trenches across the fault to the north. There has been no exploration done to precisely locate the fault or to determine its physical characteristics at the dam site. Although not vital for feasibility, it would be useful to have a better understanding of the significance and effects this fault will have on the design of the dam at this location.
- Several of the "Saddle Dams" are major dams, the highest being about 130 feet high. These dams all have foundations in the Boxer formation that consists chiefly of bedded mudstones with some interbedded sandstone horizons. A number of the sites have faults or lineaments trending upstream – downstream through the sites. In some respects, design of dams for these sites will be more challenging than for the larger dams at the Golden Gate and Sites locations. Clearly, considerably more exploration will be needed during final design at the Saddle Dam sites to define the foundation conditions and significance of shears or faults. As the locations for Saddle Dams 8 and 9 are approached, the Boxer formation beds become near horizontal. Determination of the shear strength along bedding planes will be important in design of a structure for these sites. Feasibility design of the Saddle Dams should be conservative to account for the conditions noted above and provide adequate cost estimates for building safe structures at these sites.
- Several borings have been completed for the inlet/outlet tunnel alignment and pumping station and geologic mapping has been accomplished. This amount of work is adequate for the feasibility studies. It is noted that the S-3 fault possibly passes across the penstock alignment between the pumping station and the tunnel portal. This feature will need to be further defined during final design and the penstock will need to be appropriately designed to accommodate the small amount of displacement which could occur.

Question 2

Does the Board consider the Department's investigation, testing, and evaluation of the planned construction materials adequate for preparation of feasibility level designs and cost estimates?

Response

Results of construction materials investigations, testing and evaluations for Sites and Golden Gate Dams and concrete aggregates are well documented in the reports furnished to the Board and were explained in the briefing and during the field inspection. The test results are being checked against material properties of materials from other projects and appears be reasonable.

There are adequate materials available to construct the two dams. An abundant supply of clay core material has been identified. Use of Venado sandstone for rockfill appears feasible, but presents challenges. Environmental/aesthetic considerations may preclude use of the best quarry sites. Oversized materials will be produced. Interbedded mudstone could produce excess fines. These factors support the assumption that the rockfill would need to be processed. Sufficient sources of random material have been identified. The durability testing indicates that sandstone will produce marginal filter/drain material and concrete aggregate, thereby validating the assumption for feasibility studies, that materials would be purchased from commercial sources. The durability testing and the performance of local sandstone riprap at Funks Dam indicate that the sandstone will produce adequate riprap, recognizing that some periodic rock replacement may be required.

Although no exploration and testing has been done on the approximately 10 million cubic yards of material needed to construct the nine saddle dams, it appears that the bulk of the material could be developed on site and filter/drain material supplied by commercial aggregate sources. If flatter slopes are used for the Saddle Dams than for the Sites and Golden Gate Dams, Boxer formation mudstone material may be sufficient for most of the embankments.

Question 3

Based on the presentations and completed reports, is the work on the seismic fault study adequate to conclude that the faulting would not be a fatal flaw of the project?

Response

The Board is impressed with the thoroughness and quality of the Phase II Fault and Seismic Hazards Investigation and commends the Department for supporting this extensive effort. The seismicity and faulting concepts are complex considering the major seismogenic source is a blind thrust fault named the "Great Valley fault" or more specifically in the area of the Sites Reservoir, the Funks segment of the Great Valley fault

system. The study has included the determination of location and characteristics of two primary sets of surface faults in vicinity of the dam sites that are:

- Northeast –striking faults that cut the bedrock units and which display right lateral strike slip displacements. Examples of these faults include GG-1, GG-2, GG-3, and S-2 faults which pass through or are near to the Golden Gate and Sites dam sites
- North striking faults approximately parallel to the strike of bedding. The Salt Lake and S-3 faults are examples of this set.

The study concludes that the controlling seismic source in the area of the dam sites is the Funks segment of the Great Valley fault system. The model of interpretation relates slip on the northeast and north-south sets of surface faults to result from slip on the Funks segment of the Great Valley fault. The interpretation is that those faults move in sympathy with moderate to large magnitude earthquakes on the Funks segment and, although not an independent seismic source, could be a source of aftershocks following a large earthquake on the Funks segment. The Board has reviewed the hypotheses and assumptions and believes that the interpretations presented are credible and believable considering the seismic environment in the vicinity of the Project.

For development of the maximum magnitude earthquake of the Funks segment potential rupture areas were computed and used along with data from trenches and published data to arrive at a recommended maximum magnitude of M_w 6.9. The Board believes that the interpretation of displacement on the thrust fault extending up the ramp and extending on the lesser dip portion of the thrust fault to a point directly beneath the dam sites to be extremely severe. Thusly, the M_w 6.9 event for movement on the Funks segment of the Great Valley fault is considered very conservative.

Analysis of data from surface trenches across the Salt Lake fault indicates that about 16 inches of surface rupture is possible during large earthquakes on the Funks segment of the Great Valley fault. Likewise, similar analysis of data for the northeast set of faults suggest that displacements could be as much as about 16 inches but are more likely in the range of 1 to 8 inches.

The Board believes the results of the Fault and Seismic Hazards Investigation are reasonable and conservative. The Sites Reservoir structures can confidently be designed to accommodate the estimated ground motions and/or possible displacements. Therefore the Board concludes that faulting at the Sites Reservoir is not a fatal flaw of the Project.

Question 4

Does the Board have any recommendations for changes or additions to the preliminary layouts or proposed design concepts of the Sites Reservoir Project?

Response

General:

In general the approach underway for most of the layouts and the design concepts for the proposed project features are suitable for feasibility level design and cost estimates. For the Sites and Golden Gate dams, it is understood that the Department has made a preliminary comparison of embankment type dams versus Roller Compacted Concrete type dams, and that the decision has been made to proceed with the feasibility studies assuming that all the dams are embankment type dams. We recommend that the Department prepare a memorandum documenting the basis of this decision.

Sites Dam:

The Board does not recommend any changes to the location of the axis of the dam or changes to the conceptual design of the dam section for Sites Dam. The preliminary layout of the embankment dam and the design concept proposed for the zoned embankment section are adequate for feasibility level design purposes.

A conceptual design should be prepared to address the existing slide area, which is located upstream of the right abutment. A proposed scheme needs to be provided for the feasibility level design (preliminary excavation plan, etc.) so that allowances can be provided for the cost estimates for the feasibility report. The detailed design of the slide area can be accomplished during the final design phase after additional investigations are carried out.

Golden Gate Dam:

It is understood that several alignments have been considered for the proposed Golden Gate Dam. These include a downstream straight axis, a downstream curved axis and an upstream axis. Additionally, the USBR had previously studied an upstream alignment, which is at a different location than the upstream location studied by the Department.

The downstream curved axis appears to be the preferred alignment, based on the current understanding of foundation conditions and the faults that have been identified. The curved downstream alignment, which allows for better abutment contacts than the straight axis, is appropriate for feasibility level design purposes. The downstream alignment also allows for a shorter escape channel for the high level outlet, as currently proposed. Because of the complexity of site topography, however, the following factors should be considered in developing the feasibility level design:

- Minimizing the contact with GG-2 Fault
- Favorable core contacts with the foundation;
- Grout curtain location; and
- Dam section design to provide an adequate embankment section through out the stream cross-section.

The design concept for the embankment section is adequate for feasibility level design. We would recommend that a preliminary plan of excavation be prepared to assist in meeting the objectives listed above.

Outlet Facilities and Pumping/Generation Plant:

It is understood that additional planning studies need to be completed, before the size of the Pumping/Generation Plant and the conveyances can be finalized, and that the feasibility level design of these facilities is still evolving. Our comments are based on our current understanding of the conceptual design of these facilities as presented in the Engineering Progress Report (August 2000 draft).

High Level Outlet:

The purpose of the High Level Outlet is to provide emergency drawdown capability of up to 10 percent of maximum reservoir head. As proposed, the High Level Outlet will consist of a Headworks structure with top seal radial gates, concrete lined chute more than 2,000 feet long, and a stilling basin about 400 feet long. The design capacity proposed is more that 40,000 cfs. Deep excavations will be required (more than 120 feet) to construct the chute and stilling basin. Additional excavations will probably need to be made upstream of the headworks structure to provide for efficient flow conditions in the entrance channel to the headworks.

The large flow capacity is required, because of the falling head conditions on the overflow crest during the reservoir drawdown period. The flow will reduce dramatically as the reservoir head drops, and the final few feet of the drawdown will take several days. The High Level Outlet as proposed will not be able to provide for emergency drawdown below reservoir water surface elevation 480 feet.

Because of the cost of this structure, and its efficiency in accomplishing the required drawdown of the reservoir head, we recommend that the Department consider incorporating the emergency drawdown capability into the conveyance required for the Pumping/Generation Plant and the outlet works. (This recommendation concurs with the studies that included in the tasks to be completed by the Department.) A bypass could be provided in the steel penstock just downstream of the tunnel portal, and the outlet works for the emergency releases could be included in one end of plant adjacent to the pump/generation units. Additionally, if required, an emergency outlet works facility could be provided in the design of either Sites Dam or Golden Gate Dam or both to supplement the outlet capability of the bypass facility incorporated into the plant.

In addition, we recommend that the Department consider an intake structure/tower that has multiple intake ports with the capability of drawing water at different levels in the reservoir. (This recommendation concurs with the studies that included in the tasks to be completed by the Department.) This type of intake may be required to provide the

flexibility needed to control the temperature and dissolved oxygen content of the reservoir releases.

Spillway:

The spillway as currently proposed, which is a relatively small facility, consists of an uncontrolled side channel crest structure that is incorporated into the headworks structure of the High Level Outlet. If the High Level Outlet is eliminated, we recommend that the Department consider relocating the spillway to a location adjacent to one of the Saddle Dams on the Northerly ridge of the reservoir.

Saddle Dams:

There are nine saddle dams along the northerly ridge of the reservoir that are required to attain the reservoir storage required. The Saddle Dams impound more than two thirds of the total reservoir storage. The Saddle Dams are major embankments both in terms of height and embankment volume.

The feasibility level designs should treat these embankments as major features, especially because of the foundation conditions (Boxer Formation) and the fault crossings. In addition, consideration should be given to the different dam sections required based on the specific characteristics of the construction materials available.

Question 5

Based on the presented material and observations of the site, does the Board have any other comments on the work completed to date and planned for the future or specific comments on the Project Management Plan?

Response

We recommend that a Project Management Plan (PMP) be developed for the Offstream Storage Investigation for the Sites Reservoir. The purpose of the PMP would be to ensure the successful and efficient completion of the tasks required to complete the feasibility report by June 2002, and to meet the schedule for the EIR/EIS. The PMP would primarily be for internal distribution within the DWR.

As a minimum the PMP should include the following elements:

- Project overview (project features, key technical issues, etc.);
- Key factors for success;
- Work Breakdown Structure (WBS);
- Milestone Schedule (using the same tasks as in WBS);
- Project organization;

- Responsibility matrix for the tasks in the WBS (with names of individuals); and
- List of project deliverables (reports, memorandums, drawings, etc.)

It's also important that a rough draft of the PMP be prepared as quickly as possible to initially coordinate the work and get all participants informed.

Concluding Remarks:

Thank you for your assistance in making the arrangements for the meetings and site visit.

Respectfully Yours,

Donald H. Babbitt Alan O'Neill John Williams