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September 26, 2012

John Svahn
Truckee Donner Land Trust
10069 West River Street
Truckee, California 96161
(530) 582-4711

RE: Initial Reconnaissance Site Visit and Implications of Division of Safety of Dams Jurisdiction at Lake Van Norden, Soda Springs, Placer and Nevada Counties, California

Dear Mr. Svahn:

We understand that the Truckee Donner Land Trust (TDLT) and your partners are in the process of acquiring the Royal Gorge Property near Soda Springs, California, including portions of Van Norden Meadow and Lake Van Norden. You have indicated that Lake Van Norden is under the jurisdiction of the State of California Division of Safety of Dams (DSOD), and that the dam is in need of repair. You have also indicated that TDLT is considering lowering the spillway elevation in order to lower the reservoir storage capacity below threshold sizes for DSOD jurisdiction.

At your invitation, you and I visited the site together on August 16, 2012, in order to develop a preliminary and initial reconnaissance-level assessment of the meadow condition and potential implications to the meadow associated with modifying the dam. Our site visit was relatively brief, (approximately 1.5-hour) and included observations of the meadow condition, including soils and hydrologic conditions, and evaluate potential impacts to the meadow associated with dam lowering. The remainder of this letter outlines: a) our initial understanding of the watershed processes affecting the meadow, b) reconnaissance-level observations of meadow conditions, c) potential impacts to the meadow associated with dam modification, and d) potential strategies to minimize those impacts.

Background

Van Norden Meadow occupies Summit Valley, just west of Donner Pass along Old U.S. Highway 40, and straddles the boundary between Placer and Nevada Counties, near Donner Summit and one of the earliest trans-Sierra wagon routes. Based on regional history and local anecdotes, land use in the watershed likely consisted initially of early transportation infrastructure, such as wagon roads and the first transcontinental railroad, followed by a number of deforestation, road building, and cattle and sheep ranching episodes. A number of roads and inferred historical road alignments are apparent in the meadow, and are visible on early maps of the region, including the 1889 Truckee Quadrangle. In the early 1900s, an earthen dam was constructed at the downstream end of the meadow to create Lake Van Norden. The dam was later improved and raised, flooding much of the valley to create a large recreational lake, suitable for motorized watercraft and waterskiing (N. Sayler, pers. comm.). The dam spillway was later modified and lowered to its current elevation, apparently in order to remove it from DSOD jurisdiction (C. Kull, pers. comm.).

For the past several hundred thousand years, Van Norden Meadow has experienced a number of glaciations, with extensive ice sheets covering the valley and lowering nearby peaks. A number of glacial features are present in the area (James, 2005). Published geologic and soils mapping (Saucedo and Wagner, 1981; Harwood, 1980; Hanes, 2002; Fischer and Sowers, 2006) and our site observations indicate the meadow to be composed of alluvium, with glacial deposits deposited along the margin of the valley against the valley walls. It is likely that proglacial (during glaciation) and transient post-glacial lakes occupied the valley bottom prior to sedimentation and meadow development during the Holocene.

Bedrock of the upper watershed and presumably underlying the meadow is Tertiary in age and composed of erodible pyroclastic volcanic deposits like tuff, welded tuff, ash layers, and more cohesive andesite and basalt. The meadow surface is mapped as aquolls/borolls (Hanes, 2002); poorly drained soils that have developed as a result of shallow groundwater and regularly or continuously saturated conditions. Valley margin soils have developed on glacial deposits. Mapped as Tallac-Cryumbrepts, wet complex, they tend to consist of fairly well-drained sandy and gravelly loam (Hanes, 2002). Soil types found on the meadow surface as well as the adjacent hillslopes are listed as erodible or highly erodible.

DSOD Jurisdiction

Figure 1 outlines the dam and reservoir parameters that dictate whether a dam is under the jurisdiction of the California DSOD. You have provided a bathymetric map and point depth data for the lake under current conditions, as developed by Chuck Kull (unpublished). The elevation of the spillway, as measured from the toe of slope on the downstream side, is greater than 6 feet and less than 25 feet (C. Kull, pers. comm.). While significant habitat and water quality benefits, and perhaps structural benefits to the dam, could be achieved by modifying the existing plunge pool and dirt parking lot at the downstream toe of the spillway slope, we also understand that these modifications would not warrant removing the dam from DSOD jurisdiction (C. Kull pers. comm.), even if the modifications resulted in a dam height of less than 6 feet. Therefore, the only other method of removing the dam from jurisdiction would be to lower the water level to achieve a storage capacity of less than 50 acre-feet.

Rough calculations based on these data indicate the volume of the lake to be on the order of 200 to 250 acre-feet, with a surface area of roughly 70 acres. Much of this area is between 2 to 3 feet deep, so lowering the zone of lake level fluctuation by 3 feet is thought to result in a storage capacity of less than 50 acre-feet (C. Kull, pers. comm.).

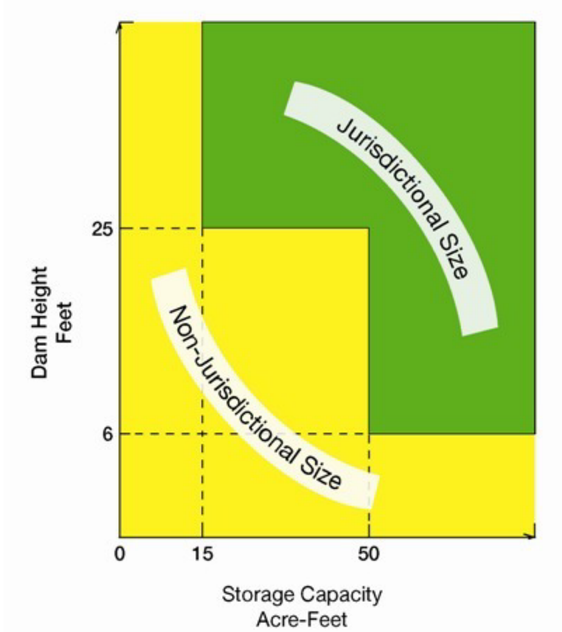

Figure 1. Provisions of Division 3 of the California Water Code affecting jurisdiction over dams and reservoirs. (Source: California Department of Water Resources, Division of Safety of Dams, downloaded from http://www.water.ca.gov/damsafety/jurischart/index.cfm)

Channel and Meadow Condition

Van Norden Meadow appears to be largely intact, with some disturbance and impacts associated with historical land use and creation of Lake Van Norden. The main ('primary') channel is present on the south side of the meadow and is shown as the 'South Yuba' on recent USGS topographic maps. This channel has a distinct geomorphic character in comparison to secondary relict channels toward the center and north side of the meadow. Bed material along the primary channel is much coarser, the bed and banks have very limited vegetative cover. Width-to-depth ratios are much lower than the secondary channels. The primary channel appears to have undergone periods of incision in historical and recent times, with only limited evidence of equilibration and stabilization. Incision is evidenced by inset terrace features, which we interpret to be remnants of former channel beds or inset floodplain deposits, exposed tree roots, and other signs of incision or base-level adjustment. Limited equilibration is evidenced by limited channel widening. The primary channel appears to be in a state of disequilibrium, perhaps due to effects of land-use changes in the watershed or more direct impacts associated with historical grazing operations.

The lower portion of the meadow, near the margin of the lake, has a low gradient with somewhat hummocky terrain and a number of relict and secondary channels. These secondary and relict channels have higher width-to-depth ratios than the primary channel, with more extensive herbaceous vegetation and sod cover on the beds and banks. Some widening and aggradation appears to be taking place near the mouths of these channels, as would be expected in delta environments where channels enter standing water of the lake. Based on field observations, bathymetric surveys by Chuck Kull, and recent aerial photography, these channels and their low-gradient floodplains appear to be submerged at the eastern margin of the lake, where they used to flow toward the primary channel under pre-reservoir conditions.

Much of the meadow, especially the zone immediately east of the lake contains extensive willow communities. In contrast, the vegetation communities shown on an early photo of Summit Valley from the 1860s[1] appear to be primarily grassland, with willow communities limited to the edge of channels. This photo also shows several channels flowing across the meadow, converging toward the downstream end of the meadow to form a single channel with apparent willow or riparian woodlands limited to the channel corridor. We interpret these to be the secondary, now relict, channels, with a currently inundated confluence with the main channel. It is not clear to what extent grazing in the 1860s limited willow extent at the time of that photo. Today's ungrazed willow communities are likely supported by elevated groundwater conditions around the fringe of the lake.

Potential Implications of Dam Lowering

Based on the available information and our brief site reconnaissance visit, we have identified the following risks associated with lowering the dam and lake level by 3 feet.

- Lowering of groundwater levels near the lake margin. Groundwater conditions at the lacustrine fringe are dictated by lake level fluctuations, groundwater inflow from upgradient areas, and soil texture and hydraulic properties. When lake levels drop, the groundwater gradient will increase, increasing the rate of groundwater flow from the lacustrine fringe. This may potentially cause a shift in vegetation communities. If the meadow surface is of a sufficiently low gradient, soils are of a low enough transmissivity[2], and groundwater flow from upstream is high enough, these impacts may be limited. However, if these conditions are not met, then soils could become drier in places, causing shifts or losses in riparian and wetland vegetation communities.

- Reconnection of secondary channels to the incised primary channel. As described above, a number of channels are present on the meadow and in flooded portions of the meadow. The incised primary channel is no longer connected to aggrading secondary channels. As result, base level on the secondary channels has been maintained by the lake, offering protection from headward incision. Lowering of the lake level, combined with a reconnection to the lowered primary channel may induce headward incision in a number of tributary channels, potentially lowering groundwater levels (discussion above), and delivering sediment to downstream areas.

- Further incision along the primary channel. The bathymetry of Lake Van Norden is not well surveyed. If submerged channels and the meadow surface are a consistent gradient between the current and future lake edge, minimal incision may be expected. However, if deeper areas are

[1] As viewed at www.svnm.org, courtesy of the Society of California Pioneers.
[2] Transmissivity is a measure of permeability, and influences the sensitivity and area over which water table declines at a given point (e.g. a well) are detectable. Low transmissivity soils will not transmit water table declines across large distances, while highly transmissive soils will.

approached, or if borrow areas become exposed, the channel may become much steeper and susceptible to a new generation of incision.

- Sluicing of delta deposits. Where streams enter lakes it appears that sediment deposition has taken place and limited deltas have formed. With lowered lake levels, these features should be expected to be exposed and potentially eroded, resulting in active sediment entrainment and delivery to downstream areas.

- Downstream effects. Modification of the dam's storage functions may cause changes to flow in the South Yuba, including both surface and groundwater storage behind the dam. These changes might in turn, affect bank conditions and sediment transport in the South Yuba River to a limited, but possibly discernible, extent. Similarly, seepage to wetlands near the dam face may be altered.

Management Approaches

A number of physical changes associated with dam lowering are possible, though it is not clear to what degree these changes will affect habitat and vegetation communities. We presume that prior to inundation, the lower meadow was in a state of dynamic equilibrium, or quasi-stable. Simply removing open water from the meadow could therefore have very little negative impact, with associated shifts in the spatial extent of vegetation and ecologic communities. Similarly, it is not clear to what degree groundwater will be affected by a lower lake level. Some portions of the meadow, especially those areas where soils are mapped as aquolls/borolls, may continue to experience very shallow groundwater conditions, as they did prior to being inundated.

On the other hand, the degree of disturbance associated with building the dam, as well as other historical disturbances may require more proactive management approaches to address the potential impacts outlined above; in particular:

- The potential for channel headcutting could be reduced with strategic grade control structures, through either bioengineering with living structures, or more traditional approaches like concrete and rock;

- Remobilization of post-dam delta deposits and transport of sediment to downstream areas is a concern, but if a lake remains, the downstream transport of sediment will likely be limited. Targeted delta revegetation approaches may help regulate sediment generation from these features; and

- Upper portions of the meadow may have already become dewatered with the onset of channel incision on the South Yuba. To offset potential groundwater storage losses associated with lowering the lake, channel bed aggradation could be induced in the upper meadow through integrated watershed management (presumably reversing the conditions which have promoted incision) or, more narrowly, the construction of in-channel debris dams or similar structures. With an ample supply of sediment from the erosive upper watershed, these features would have a high potential to aggrade, slow flows and distribute water across the meadow, thereby increasing upstream groundwater storage for release to areas of the meadow affected by dam modifications.

Conclusion and Next Steps

The potential impacts associated with Lake Van Norden outlet and lake level changes include potential headward incision in tributary channels, potential loss of groundwater storage and release through groundwater lowering, and potential increased sediment supply through erosion of sediment deposits at the fringe of the lake. These impacts can be minimized through the implementation of a number of watershed and meadow management and/or restoration strategies. In order to further elucidate the meadow condition, predict response to dam and lake modifications, and develop management strategies, the following additional investigations should take place, including but not limited to:

- Interpretation of historical and false-color infrared aerial photography to discern historical disturbance, the current range in inundation extent, water levels, and vegetation communities, and areas where groundwater discharge or naturally shallow groundwater conditions may exist;
- Detailed bathymetric surveys of the lake and establishment of depth-storage relationships;
- Topographic analysis, channel and riparian conditions assessment, geomorphic mapping, and late spring site reconnaissance visits to document channel networks, meadow drainage, and relative stability of various channel reaches;
- Soils investigations and sampling to evaluate the hydraulic properties of soils so that estimates of transmissivity and associated extent of groundwater level response may be inferred; and
- Developing a quantitative, or even semi-quantitative, understanding of how water-level management in the lake affects (a) groundwater discharge into the South Yuba downstream, and (b) runoff routing through the lake. This may entail some limited groundwater monitoring and modeling.

Conclusions and Limitations

This is a reconnaissance-level assessment, carried out during the late summer, after a year with less than average precipitation and early snowmelt. As such, observed conditions are not necessarily representative of the full range of hydrologic conditions. Similarly, we did not survey the entire meadow. Rather, we attempted to observe representative conditions in select locations.

Balance Hydrologics has prepared this letter report for the client's exclusive use on this project. The analysis is based in part on work performed by experts in related fields, information provided by the client or its consultants, and/or upon reference values commonly used in the area or developed by sources generally held to be reliable. We have not independently verified their validity, accuracy or appropriateness to this or other sites. The recommendations provided in this report are based on the assumption that an appropriate and adequate follow-up program will be conducted. Finally, we ask that readers who have additional pertinent information, who have observed changes in conditions, or who may note any potential errors or misinterpretations contact us with their findings at the earliest possible date, so that appropriate changes can be made in a timely fashion.

Closing

Once again, we thank you for including us on this important project. We look forward to discussing these preliminary conclusions after you have reviewed this letter.

Sincerely,

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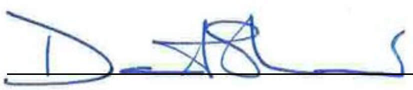

David Shaw, P.G.
Principal Hydrologist/Geologist

References:

Saucedo G.J., and Wagner, D.L., 1992, Geologic Map of the Chico Quadrangle: California Division of Mines and Geology Regional Geologic Map Series, Map No. 7A.

Harwood, David S., 1980, Geologic Map of the North Fork American River Wilderness Study Area and Adjacent Parts of the Sierra Nevada, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1177-A.

Hanes, R.O., 2002, Soil Survey of the Tahoe National Forest Area, PDF version 2.0 compiled by Tiffany Norman, U.S.D.A. U.S. Forest Service Tahoe National Forest.

Fischer P., and Sowers, R., 2006, Geotechnical Conditions Report: Royal Gorge Site, Placer and Nevada Counties, California: Blackburn Consulting letter report prepared for Todd B. Foster, Royal Gorge LLC, 12 p. + figures.