Vandevert Ranch Association
P.O. Box 1617
Bend, Oregon 97709
Attention: Ted Haynes

December 15, 2006

Project Number: 1061053

Project: Vandevert Pond Expansion
Vandevert Ranch, Oregon

Subject: Geotechnical Reconnaissance

Ladies and Gentlemen:
As agreed, we have visited the pond site on several occasions for the purpose of assisting you through the planning and design of the proposed pond expansion.

Project Understanding
The pond, located in the northeast area of Vandevert Ranch is currently about 2.7 acres and was originally built in the early 1990's. The expansion is proposed to increase the pond footprint to about 4 acres, provide greater depth and improve the stability of banks.

We understand that historically the pond surface has been maintained a few feet above the prevailing shallow water table by pumping from a nearby well. We have reviewed the energy costs associated with operating this well which indicates annual expense on the order of $3000. Our objective is to help determine how the proposed pond expansion will influence the annual maintenance cost and develop/evaluate various options that are available to mitigate this expense through capital expenditure during the construction.

Observations:
As a basis for our current conclusions we have reviewed the following:

- Previous subsurface data that we have generated in the area
- recent exploration pits dug to the west of the pond
- an electrical imaging survey performed by us and
- observation during the drawdown (pumping) of the pond.

With this information it is our opinion that the water table tends to be reasonably stable at an elevation about 5 feet below the meadow elevation adjacent the west side of the pond. This water table is likely to vary seasonally and in a wet year could approach the surface. In an extended dry period the water level could fall a bit but we suspect that 5 feet below meadow elevation is nearly as low at the water table gets. Area groundwater moves most efficiently through a sandy lens that tends to be 5 to 6 feet below grade although saturated soils prevail to substantial depths (probably many hundreds of feet). Given these conclusions if one were to simply leave the pond to the forces of nature the excavation would be perpetually full to the same elevation as the prevailing water table – about 5 feet below grade and higher.

Seepage

When the pond surface is elevated by pumping, seepage is initiated through the underlying and surrounding soils. It appears that most of the seepage is likely a lateral migration into the more permeable sandy layer that is fairly shallow – about 6 feet or so below grade. Additional seepage takes place through other soils including the bottom.

Since the original construction some natural siltation and subsequent sealing has occurred to help slow seepage. Such a seal would be lost if disturbed in a reconstruction effort.

Deepening the pond would increase the pressure driving seepage through deeper layers. The attached electrical image R-1 indicates that at depths approaching the newly proposed depth 12 to 15 feet it is possible that more permeable strata could exist. Extending the pond into an underlying permeable zone could lead to more rapid seepage currently not experienced.

For this and other reasons including improved seepage estimates it is our opinion that a few simple tests should be performed to better understand the seepage characteristics of the proposed expansion area. These include large scale seepage tests using the existing exploration pits.

We propose that the two remaining open pits be filled to the surface with water and that the water level be maintained at the surface for a sufficiently long time to establish a steady state of seepage into surrounding soils. A day or so should be sufficient. Pumping should then be metered to adjust the flow rate such that it equals seepage from the pit. That is, determine an input flow that will maintain a constant water level in the pit. In our view, determining this rate for a water level that is a foot or so below ground level would be preferred to trying to keep the water at ground level. This flow rate should then be measured either by redirecting the pumped water to a known volume (such as a barrel or stock tank) and recording the time to fill the known volume or pass the water through a meter of established quality.

Prior to conducting seepage experiments the dimensions of the pits should be carefully recorded (depth, width and length) along with the original depth to the water table. In addition a measurement system should be established to monitor the pool level within the pit. With this information and the steady state flow rate to maintain a constant elevated water level we can calculate estimates of seepage likely to be experienced on a larger scale given similar geology.

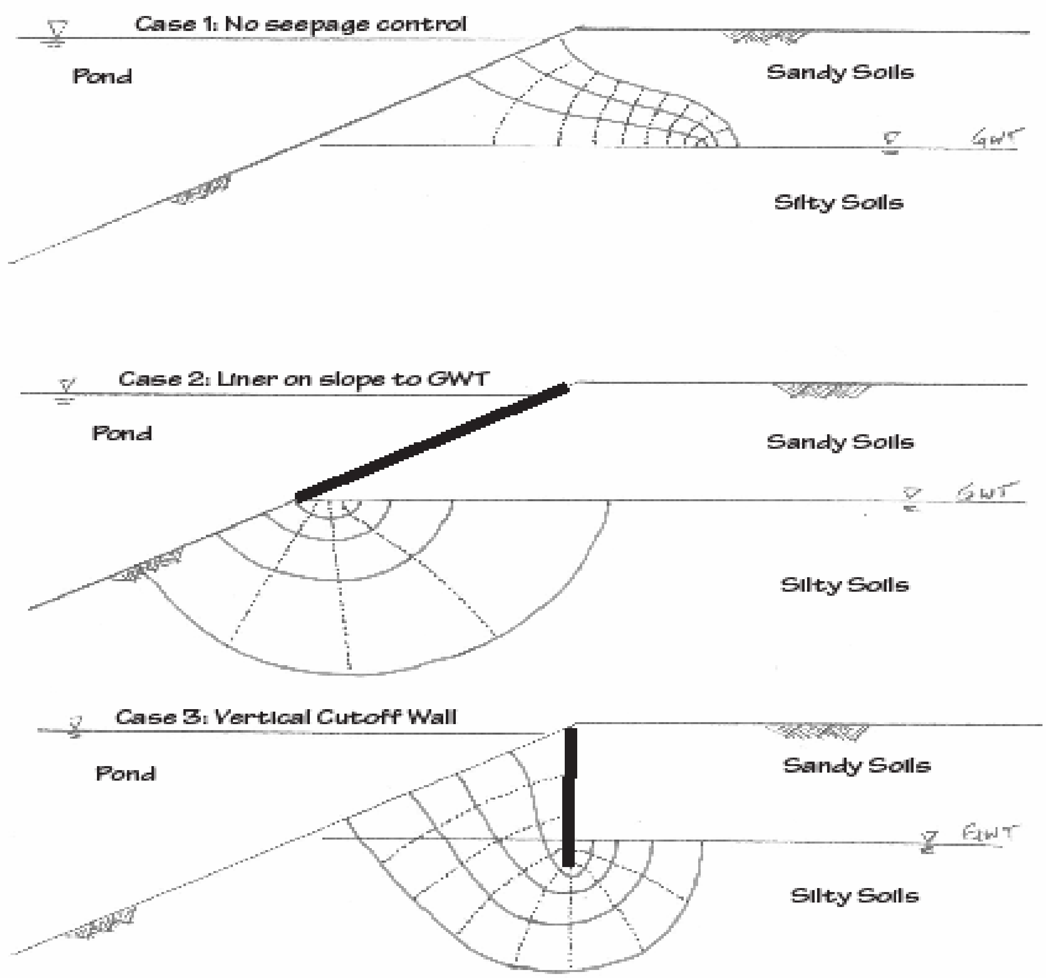
To judge the similarity of the test sites to the conditions in the expansion area we recommend additional electrical imaging. We propose a survey through the test pit area and probably two more through the expansion zone.

Seepage Control

Following the seepage tests we will calculate estimates of seepage from the expanded pond that can in turn be related to pumping cost. With this information decisions can be made concerning the economic advantage of efforts to control seepage loss. In our view, feasible options to control seepage include constructing a liner (probably clay amended soil) and installation of a vertical cutoff wall near the pond perimeter. The following sketches illustrate several possibilities to implement seepage control:

From these sketches we can estimate seepage loss with the addition of information including perimeter distance and coefficient of permeability (k). Without the proposed seepage tests at the test pits the parameter k is unknown.

Case 1 illustrates seepage through the



upper, presumably more permeable sandy soil. Case 2 is our model of flow around a clay liner placed along the interior slope down to the GWT (ground water table) and Case 3 shows flow around a vertical cutoff wall extending through the upper, most permeable soils. Given the assumption that the soil's coefficient of permeability is markedly slower at depth Case 1 produces the greatest seepage followed by Case 2 and then Case 3. Unfortunately, seepage estimate are not available without a quantity estimate of the permeability that would be developed through onsite testing.

The test as described in an open pit will provide "k" for the upper soil horizon although a simulated vertical cutoff wall would need to be installed around the pit to evaluate "k" for the lower horizon.

Slope Stability
Significant variability in slope inclination exists. It is not clear if the flatter slopes indicate slumping or if they were originally constructed so. The steeper slopes appear to coincide with established vegetation – the root system of which is likely contributing to long-term stability. In general, area soils are relatively weak and not capable of long-term stability if inclined steeper than about 3 or 4 to 1 (horizontal to vertical) in the submerged condition.

We reviewed an onsite stockpile of shot-rock basalt stored near the Vandevert Ranch stables. This rock is suitable for use to mechanically enhance slope stability although the available volume suggests that only part of the perimeter could be treated in this manner without importing more rock. The design of such a mechanical stabilization would be the result of a more careful review of the available shallow soils combined with consultation with the design team to meet project objective.

Soil Type
The dominate soil type to be expected from the excavation is judged to be a dark colored silty sand. Seams of fine gravel and more coarse sand along with the occasional seam of finer grained soil will also be included in the mix. These soils are predominately volcanic in origin and offer moderate to low unit weight and will likely require nutrient amendment to support plant growth.

Limitations:
This letter presents our professional opinion based upon a brief site visit and surface observations. The conclusions are intended to endeavor to conform to the standard of practice currently employed by area geoprofessionals conducting similar geotechnical assessment – we make no other warranty express or implied.

If you have any questions, please call.

Respectfully submitted,
Siemens & Associates

J. Andrew Siemens, P.E., G.E.
Renews 6/30/2008

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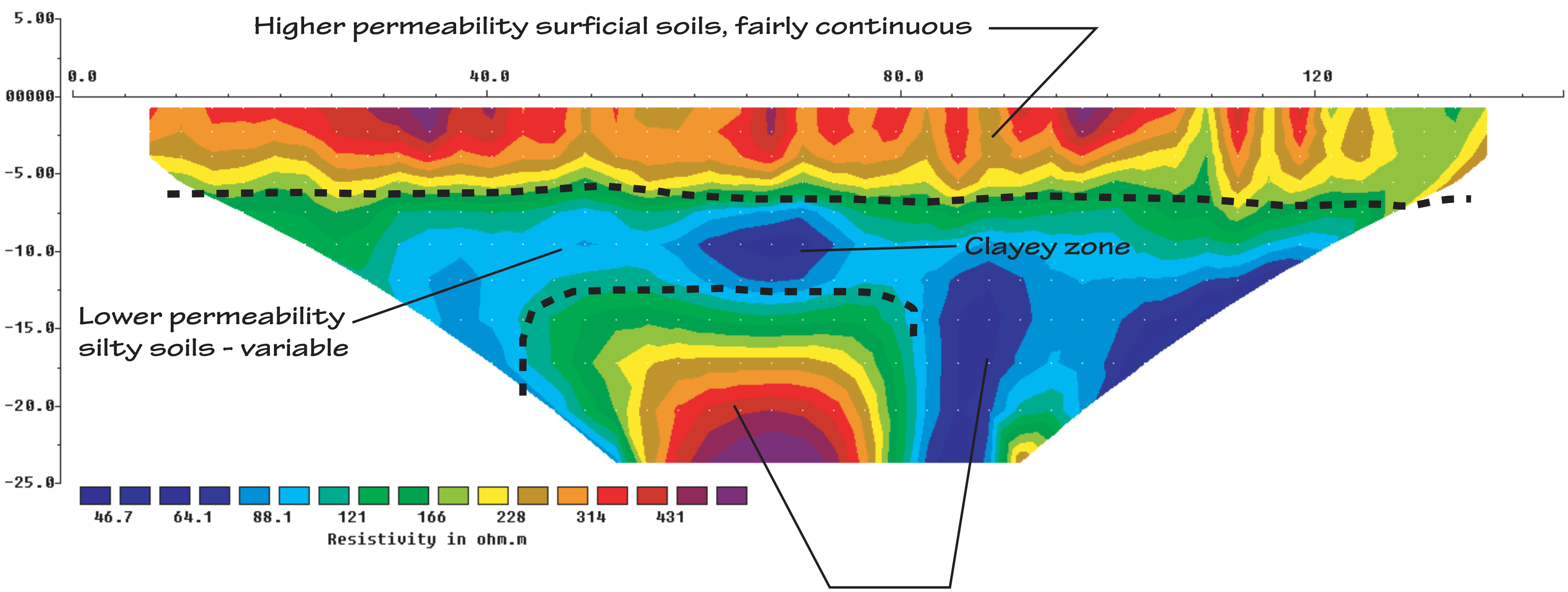
Earth Resistivity Image: R-1

~ Parallel west edge of pond, offset 40 feet



High and low resistivity anomaly:
High resistivity zone at depth could indicate permeable soils (old river channel??) that could lead to increased seepage if exposed as bottom of an unlined pond. The verticaly oriented low resistivity area is an inigma but unlikely to be detrimental to pond performance or excavatability.

Prepared for Vandevert Ranch Association

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