Attachment 2

Black Rock Consulting
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Attention: Kevin Crew, PE

July 24, 2009

Project Number 1091028

Project: Drift Creek Reservoir and Dam
Victor Point, Oregon

Subject: Geotechnical Reconnaissance

Dear Kevin,
As agreed, we have conducted a reconnaissance for the purpose of identifying geotechnical challenges related to the successful development of the project. Our work began with a paper study to review readily available documents including geologic publications, maps and site specific studies that were performed by others in recent years. This effort was followed by a foot traverse over much of the site mostly reviewing the terrain for indications of slope instability and a surficial review of shallow soil character. Most of our effort concentrated on the dam site which we explored using geophysical methods to gain an understanding of the deeper geology that will ultimately control the performance of the dam structure itself.

Through these efforts, we have discovered no overwhelming evidence to suggest that geotechnical hazards are present that result in recommendation to suspend or halt project feasibility evaluations. We have not identified any fatal flaws in the geology such as reason to suspect active faults in the area or dangerously unstable slopes. We have identified a few items that deserve more rigorous geotechnical evaluation which are listed later in this letter.

Project Understanding
It is our understanding that the proposed reservoir will impound roughly 12,000 acre feet through a portion of the Drift Creek drainage that currently is utilized as farm ground, low land grazing and other agricultural uses. The dam height is proposed at about 65 feet through a narrowing in the drainage near Fox Road and Victor Point Road in rural Marion County about six miles south of the town of Silverton. Cursory geologic investigation has been done by H. G. Schlicker & Associates of

Oregon City in 2005. This work included exploration of shallow soil conditions, review of readily available geologic data, and identification of ancient landslides within the reservoir area and a summary of the geologic setting including a cursory discussion of area faulting.

In general, our findings support the conclusions reached by H. G. Schlicker & Associates which in our opinion could have been presented with a stronger basis - original explorations extended less than 20 feet below grade; yet, it seems that the report is valid. Our work provides information to depths greater than 100 feet at the dam site as described later. Significantly more exploration and analysis including deep drilling, sampling and testing will be required in the future as the project progresses to the design level.

Conditions Encountered

H. G. Schlicker & Associates present a good description of area geology and we will not repeat this discussion here. In general, our findings agree with the expected geologic setting with the dam site dominated by fairly shallow basalt on each side of the canyon although our data indicates that the basalt is of limited thickness, underlain by a material of lesser, yet substantial strength.

The creek bottom supports moderately soft silty, saturated sediments of a thickness on the order of 20 feet. These sediments are compressible but of limited thickness such that the settlement of a heavy earth embankment dam is judged to be substantial but tolerable. Conditions along the creek bottom are depicted by seismic line S-2.

Looking downstream, the left wall of the drainage offers heavily jointed and fractured basalt at the surface along with a fairly thick accumulation of basaltic talus along with large boulders or “haystack” type floater blocks that have broken away from a larger mass and migrated to the current position. This is a common geologic phenomenon when a basalt layer is superimposed on a weaker layer composed of sediments or volcanics such as ash or tuff. The conditions along this slope are depicted by Seismic P-wave tomography S-1.

The right wall offers somewhat more mild slopes and on the surface displays the reddish, clayey silt soils common to the drainage. Below these soils at depths ranging from a few feet to up to about 15 feet we encountered a high P-wave velocity material that we judge to represent the area basalt. The basalt character varies somewhat in terms of P-wave velocity probably due to variation in fracturing, jointing and perhaps weathering. The conditions along this slope are depicted by Seismic P-wave tomography S-3.

We conducted no explorations throughout the reservoir area proper. Our judgment concerning the prevailing conditions is based on surface observations and information previously reported by H. G. Schlicker & Associates. These data suggest that the soils offer reasonably fine grained characteristics and are well suited for controlling seepage and as a source for low permeability construction materials. In fact, we have discovered only evidence of fine grained materials in the shallow subsurface and free-draining soils that would be used to construct internal drainage features of an earth dam may need to be imported – perhaps as processed materials from the basalt quarry just north of the dam site.

Conclusions

Based on the information currently available – which is a bit sparse, we conclude that the project is very likely to be feasible and reasonably economical in terms of dam size compared to reservoir capacity. Several unresolved concerns follow:

We have identified several areas occupied by timbered and heavy vegetation that offer indication of tenuous slope stability. These steep slopes exist along the eastern reservoir boundary and are marked on the USGS site plan that accompanies this letter. Instability appears to be manifest in soils that are in a process of creeping down slope as indicated by the trunks of trees that have bowed out and up to maintain vertical growth as the founding soils move. The stability of these slopes will be compromised when inundated and the severity of a slope failure is related to the thickness of the soil present on these hillsides. If stable rock is located at shallow depth, the failures would be nothing more than a nuisance, if deep, thick soils are present, a more substantial landslide could promote tsunami type waves that could cause overtopping of the dam. In our view, this potential should be evaluated.

While not presented, we conducted a series of DC electrical resistivity surveys through the dam site. These data provide some indication of more permeable seams through the shallow soils that require more characterization and could lead to the implementation of some sort of deep cut-off wall at the dam site to control seepage. Similar seams could exist within the reservoir floor and such possibilities should be explored to begin a process of evaluation to mitigate this potential and prevent disturbance if located in borrow areas.

Limitations

This letter presents our professional opinion based upon limited research, surface observations and

geophysical exploration. The resulting interpretations are intended to represent an endeavor to conform to the standard of practice currently employed by geoprofessionals conducting similar geophysical reconnaissance in the Victor Point, Oregon area – we make no other warranty express or implied.

We appreciate the opportunity to provide this exploration and sincerely hope that it meets your needs. If you have questions concerning the items discussed or the results that we present, just ask.

Respectfully submitted,
Siemens & Associates

J. Andrew Siemens, P.E., G.E.

Encl: References
Description of Geophysical Methods
USGS Site Plan
Dam Site after Stuntzner
Geophysical Profiles S-1, S-2 and S-3

References

1. State of Oregon, Department of Geology and Mineral Industries. Geological Map Series, GMS-100, Earthquake Hazard Maps for Oregon, 1996. By Ian P. Madin and Matthew A. Mabey. Donald A Hull, State Geologist.
2. State of Oregon, Department of Geology and Mineral Industries. Geological Map of the Scotts Mills Quadrangle, Oregon Series, GMS-33, 1984. By Paul R. Miller and William N. Orr. Donald A. Hull, State Geologist.
3. State of Oregon, Department of Geology and Mineral Industries. Geological Map of the Drake Crossing Quadrangle, Marion County, Oregon, Series GMS-50, 1986. By William N. Orr and Paul R. Miller. Donald A. Hull, State Geologist.
4. State of Oregon, Department of Geology and Mineral Industries. Geological Map of the Stayton NE Quadrangle, Oregon, Series GMS-34, 1984. By William N. Orr and Paul R. Miller. Donald A Hull, State Geologist
5. State of Oregon, Department of Geology and Mineral Industries. Statewide Landslide Information Database for Oregon, Release1, SLIDO-1, 2008. By William J. Burns, Ian P. Madin, and Lina Ma. Vicki S. McConnell, State Geologist.
6. State of Oregon, Department of Geological and Mineral Industries. Relative Earthquake Hazard Maps of the Salem East and Salem West Quadrangles, Marion and Polk Counties, Oregon, GMS-105, 1996. By Humei Wang and William J. Leonard. D.A. Hull, State Geologist.
7. State of Oregon, Department of Geology and Mineral Industries. Interpretive Map Series – Disk 1, 2 and 3 of 3, IMS-24, 2008. BY William J. Burns, R. Jon Hofmeister, and Yumei Wang. Vicki S. McConnell, State Geologist.
8. State of Oregon, Department of Geology and Mineral Industries. Maps showing faults, bedrock geology, & sediment, thickness of W. half of Oregon City, 1:100,000 quad, Washington, Multnomah, Clackamas and Marion Counties, Oregon, 1998. By S. Burns, L. Growney, B. Brodersen, R. Yeats, and T. Popowski. John D. Beaulieu, State Geologist.
9. Oregon Department of Geology and Mineral Industries. Oregon Geologic Data Compilation (OGDC), Release 5 (Statewide), 2009. Compiled by Linda Ma, Ian P. Madin, Keith V. Olson, Rudie J. Watzig. Vicki S. McConnell, State Geologist.
10. Stuntzner (untitled) July 2, 2005 report to Dave Bielenberg of East Valley Water District.
11. H. G. Schlicker & Associates, June 24, 2005: Engineering Geologic Information For Feasibility of Proposed Drift Creek Dam, Silverton, Oregon.

Description of Geophysical Methods

Two geophysical methods are presented to gain an understanding of the subsurface conditions through the dam site. The different methods provide a means of improving the interpretations and therefore greater confidence in the data as a whole. The geophysical results provide data regarding much greater volumes of earth than do test pits or drilling and do not disturb the integrity of the foundation soils like test pits do. The disadvantage of these indirect methods is the absence of sample for visual description and laboratory analysis. Geophysical interpretations are presented by annotated color renderings - locations of each survey are defined on the Site Plan of the dam site originally prepared by Stuntzner Engineering & Forestry, LLC. These interpretations are presented as attachments to this appendix.

Location of the proposed dam centerline was determined through review of the Stuntzner site plan using physically mapped features as identified on that plan, a 300 foot fiberglass tape and compass. These methods are fairly crude and the locations of our work should only be considered approximate (accurate to perhaps the nearest 20 feet). Further, elevation data were determined through a process of interpretation of contour data and slope inclination measurement by us. As such, elevation data is also approximate.

Refraction Seismic

Refraction seismic surveying was done to gather P-wave data allowing interpretation of the prevailing geology through generation and review of a two dimensional velocity model. Seismic refraction methods measure the transmission of compression waves (P-waves) through the subsurface. We generated seismic P-waves (signal) using a Betsy Seisgun detonating 400 grain black powder charges and with an 18 pound hammer striking an aluminum plate where we encountered difficult drilling conditions. Seismic refraction methods are suitable to obtain the depth to bedrock surfaces and the water table; to characterize rock/soil type and degree of weathering; and to locate fractures, faults, and buried channels. A straight line arrays composed of 21 to 24 receivers set on 10 foot spacing were used to collect the data. Shot points were induced between every other receiver gathering first arrival times utilized in the interpretation. The data were processed using the latest version (v6.0) of SeisOpt@2D developed by Optim Software, Reno, Nevada.

The 2D velocity models are annotated to describe our interpretation of the conditions encountered. Refraction seismic velocity models are indicative of soil and rock strength particularly when combined with shear-wave data as described in the next section. Since refraction methods rely on a general assumption that the velocity of geologic layers increase with depth (as is typically the case) when this constrain is not satisfied the depth of the velocity model is prematurely terminated.

When investigating for strength characteristics, geophysical methods offer significant advantages over drilling and test pit excavation including depth of investigation, two dimensional coverage (as opposed to

one dimensional boring), limited opportunity to disturb underground utilities and improved opportunity to discover large scale geologic features.

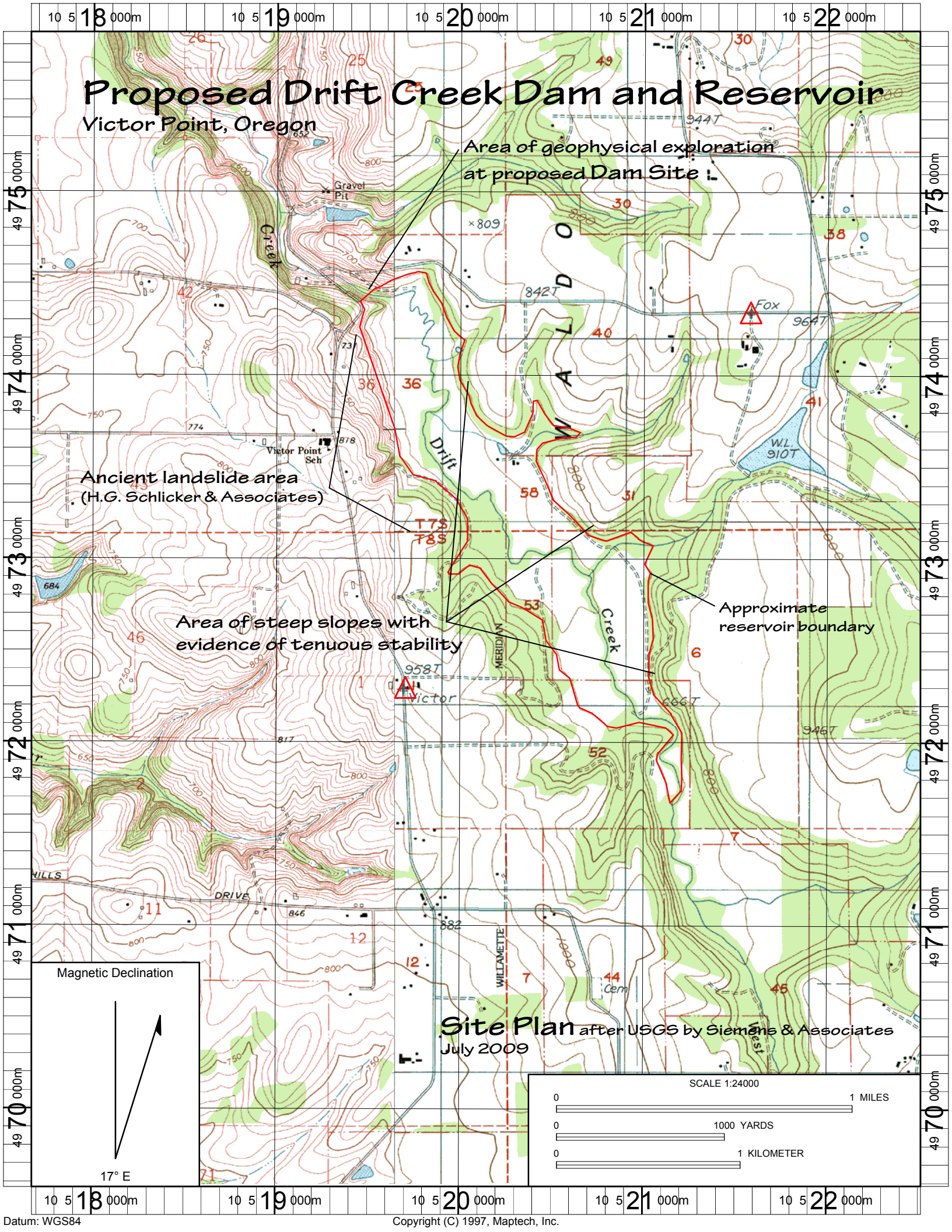
Refraction Microtremor Analysis (ReMi)

The ReMi analysis develops the shear-wave velocity/depth profile using a reasonably conventional engineering seismograph, low frequency receivers (geophones) and array aperture. Ambient surface wave energy is recorded using relatively long (15 to 30 seconds) records which we enhanced at this quiet site by driving a 1 ton truck near the seismic array. The microtremor records are transformed as a simple, two-dimensional slowness-frequency (p-f) plot where the ray parameter "p" is the horizontal component of slowness (inverse velocity) along the array and "f" is the corresponding frequency (inverse of period). The p-f analysis produces a record of the total spectral power in all records from the site, which plots within the p-f axes. If one identifies trends within these axes where a coherent phase has significant power, then the slowness-frequency picks can be plotted on a typical period-velocity diagram for dispersion analysis. Picking the points to be entered into the dispersion curve is done manually along the lowest velocity envelope bounding the energy appearing in the p-f image.

It is important to recognize that the one dimensional interpretation (plot) of shear-wave velocity versus depth from a ReMi survey is representative of the "average" conditions in the area of the survey and may or may not correlate well with data gathered from more traditional methods such as cross-hole techniques that measure conditions at a select location. The ReMi analysis would, however agree well with the average of many down-hole measurements if such extensive work were done in the area of the ReMi survey and agreement would be achieved with a single down-hole test if subsurface conditions were reasonably uniform across the survey site.

At this site, the ReMi interpretation correlates well with the P-wave tomography describing a steady increase in shear wave velocity with depth then a velocity reversal below the base of the refraction models.

Data were recorded with our DAQLINK II digital seismograph and processed using the latest versions of SeisOpt ReMi software.



Datum: WGS84

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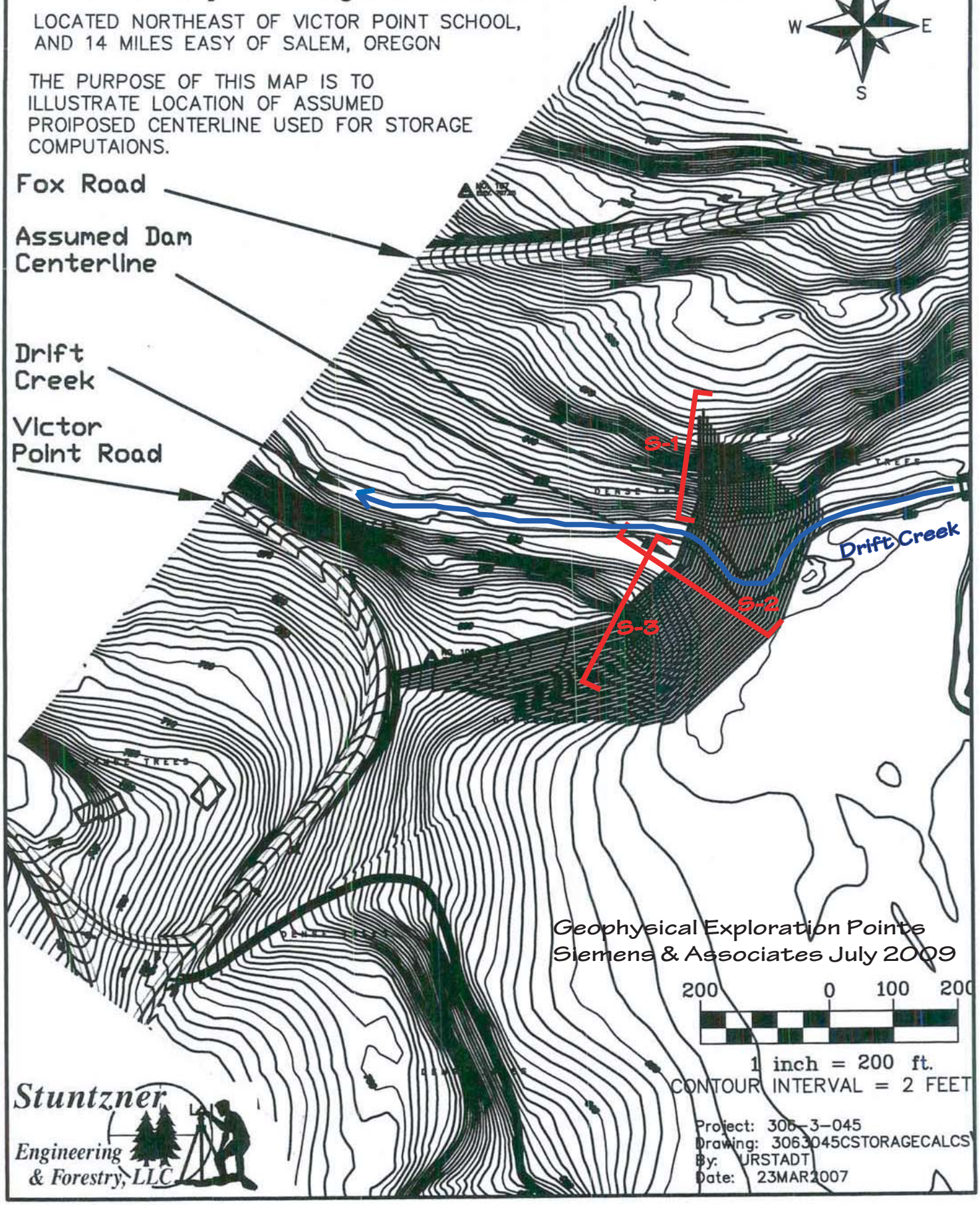
Proposed Drfit Creek Dam Centerline used for Preliminary Storage Estimation Purposes

LOCATED NORTHEAST OF VICTOR POINT SCHOOL, AND 14 MILES EASY OF SALEM, OREGON

THE PURPOSE OF THIS MAP IS TO ILLUSTRATE LOCATION OF ASSUMED PROIPOSED CENTERLINE USED FOR STORAGE COMPUTAIONS.

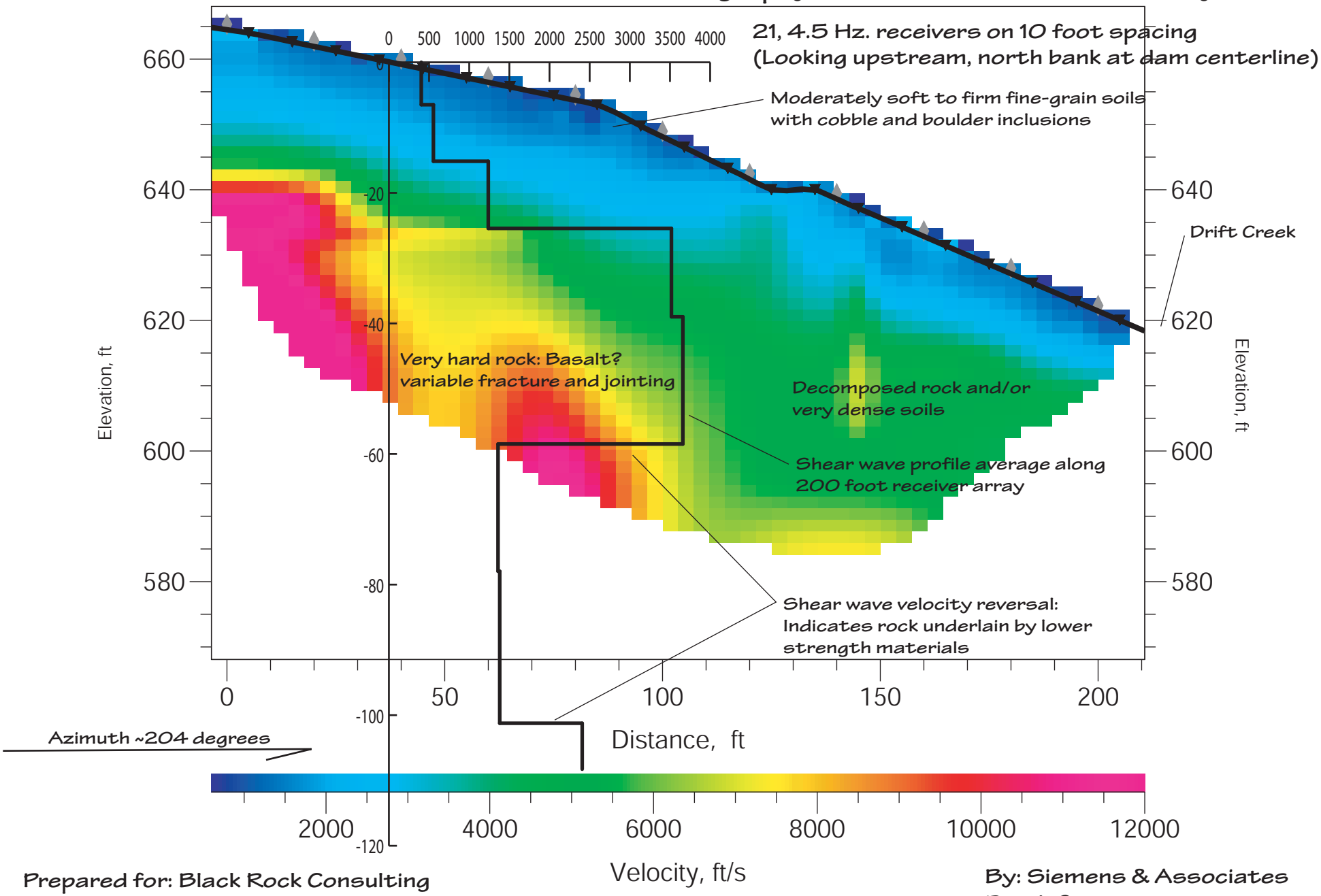


Drift Creek Dam Site
Victor Point, Oregon

S-1

July 2009

Seismic P-wave Tomography with ReMi Shear-wave overlay



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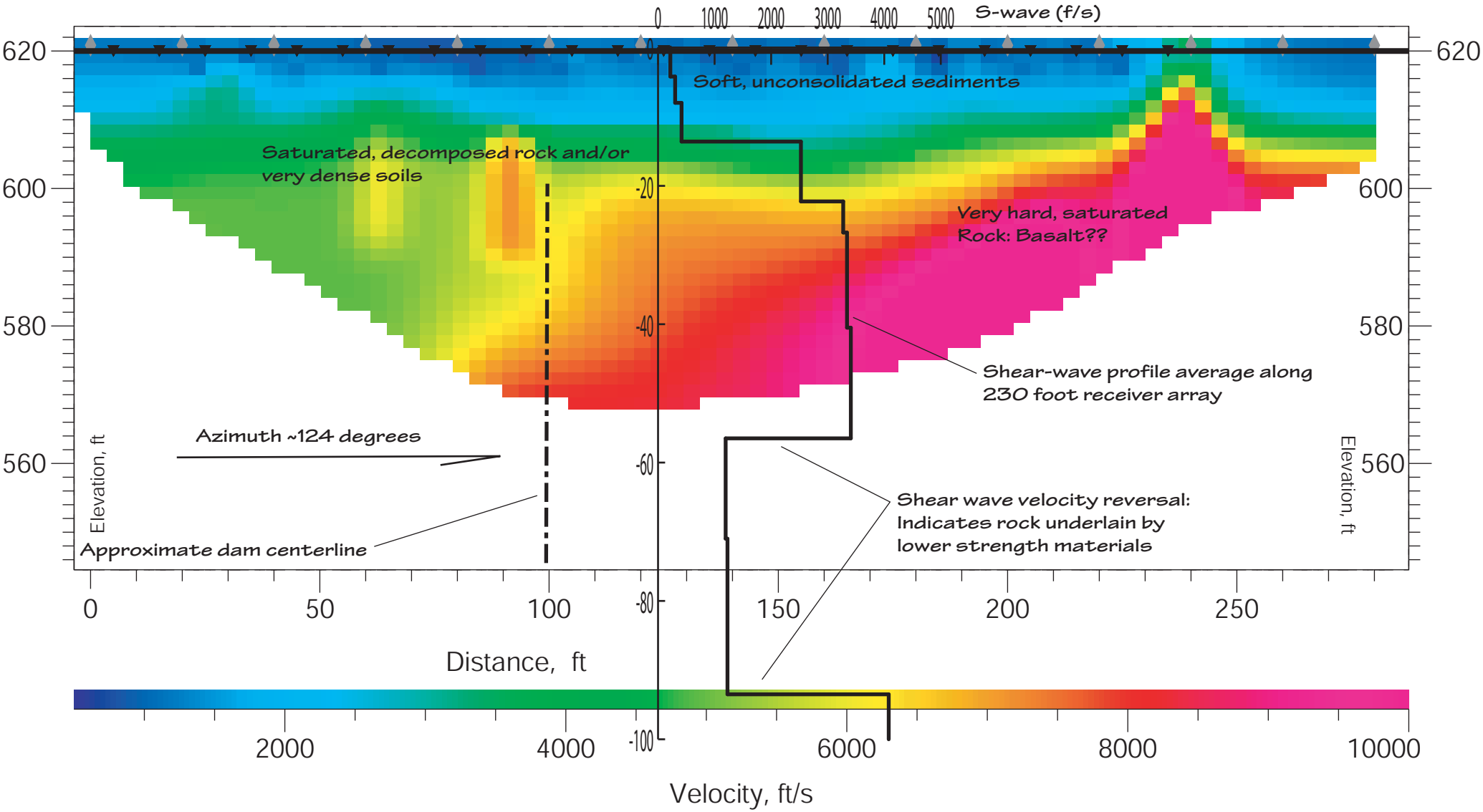
Drift Creek Dam Site
Victor Point, Oregon

July 2009

S-2

Seismic P-wave Tomography with ReMi Shear-wave overlay

24, 4.5 Hz. receivers on 10 foot spacing



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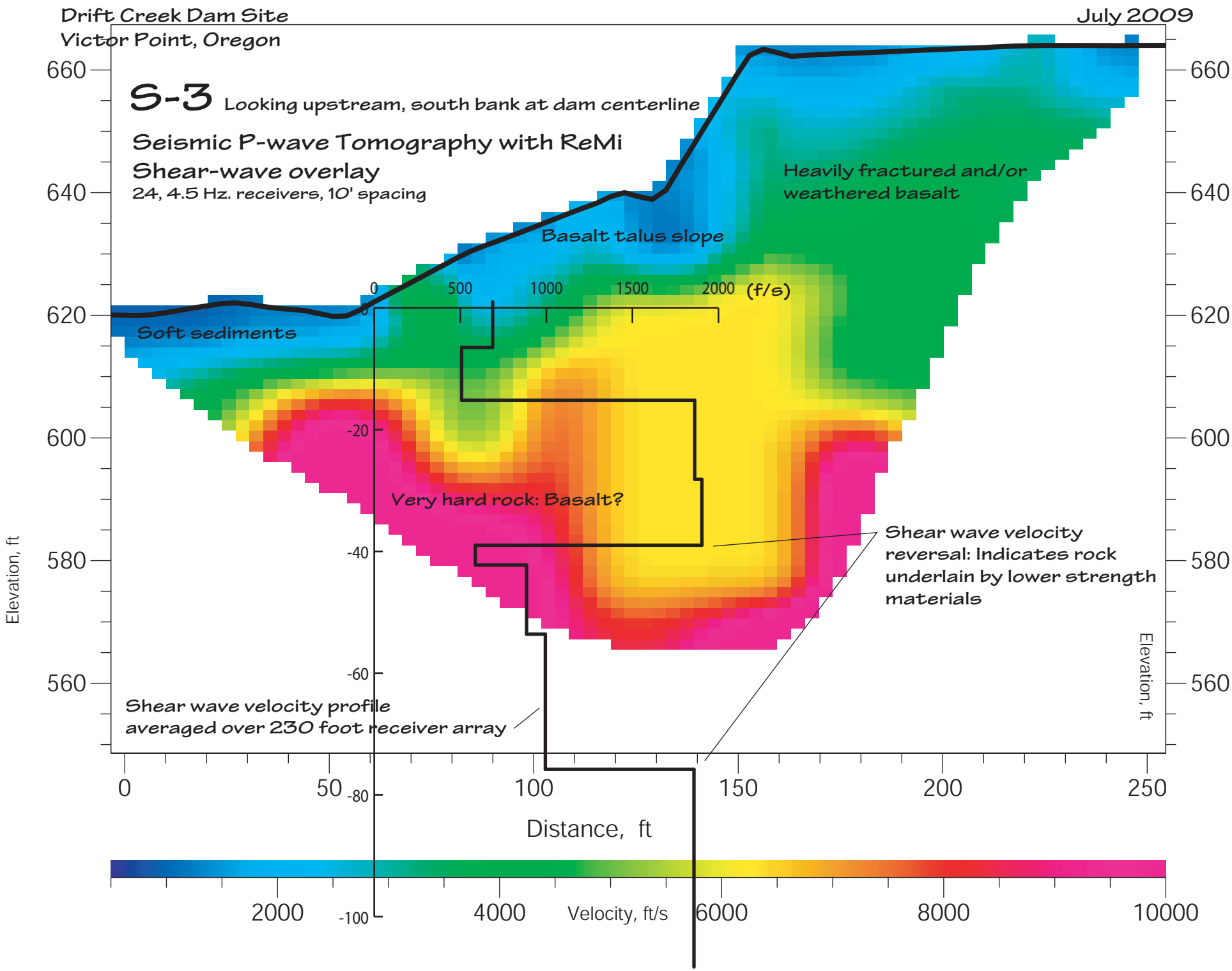
Drift Creek Dam Site
Victor Point, Oregon
July 2009
S-3 Looking upstream, south bank at dam centerline
Seismic P-wave Tomography with ReMi
Shear-wave overlay
24, 4.5 Hz. receivers, 10' spacing
Heavily fractured and/or weathered basalt
Basalt talus slope
Soft sediments
0
500
1000
1500
2000
(f/s)
Very hard rock: Basalt?
Shear wave velocity reversal: Indicates rock underlain by lower strength materials
Shear wave velocity profile averaged over 230 foot receiver array
Elevation, ft
660
640
620
600
580
560
-20
-40
-60
-80
-100
0
50
100
150
200
250
Distance, ft
2000
4000
Velocity, ft/s
6000
8000
10000