Appendix G2

Seismic Refraction Study

SEISMIC REFRACTION STUDY

NORTH IRIS LANE

Escondido, California

PREPARED FOR:

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March 10, 2021

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Atlas No. 121069SWG
Report No. 1

MR. TREVOR MYERS
GEOCON INC.
6960 FLANDERS DRIVE
SAN DIEGO, CA 92121

Subject: Seismic Refraction Study
North Iris Lane
Escondido, California

Dear Mr. Meyers:

In accordance with your authorization, Atlas Technical Consultants has performed a seismic refraction study pertaining to the North Iris Lane project located in Escondido, California. Specifically, our evaluation consisted of performing seven seismic P-wave refraction traverses at the project site. The purpose of our study was to develop subsurface velocity profiles of the areas studied, and to assess the depth to bedrock and apparent rippability of the subsurface materials. Our field services were conducted on February 23, 2021. This data report presents our methodology, equipment used, analysis, and results.

If you have any questions, please call us at (619) 280-4321.

Respectfully submitted,
Atlas Technical Consultants LLC

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1. INTRODUCTION

In accordance with your authorization, Atlas Technical Consultants has performed a seismic refraction study pertaining to the North Iris Lane project located in Escondido, California. Specifically, our evaluation consisted of performing seven seismic P-wave refraction traverses at the project site. The purpose of our study was to develop subsurface velocity profiles of the areas studied, and to assess the depth to bedrock and apparent rippability of the subsurface materials. Our field services were conducted on February 23, 2021. This data report presents our methodology, equipment used, analysis, and results.

2. SCOPE OF SERVICES

Our scope of services included:

- Performance of seven seismic P-wave refraction traverse at the project site.
- Compilation and analysis of the data collected.
- Preparation of this data report presenting our results and conclusions.

3. SITE AND PROJECT DESCRIPTION

The project site is located on adjoining residential properties to the southwest of the North Iris Lane and Robin Hills Lane intersection in Escondido, California (Figure 1). Specifically, seismic traverses were conducted around and between the residential buildings located at the site. The seismic traverses were performed at locations provided by you and your office. The area consisted of two residential buildings, as well as a number of ancillary buildings such as garages, sheds, and animal pens. Figures 2, 3a, and 3b depict the general site conditions in the area of the seismic traverses.

Based on our discussions with you, it is our understanding that your office requested this study in advance of construction activities for the subject project. We also understand that the results of our study may be used in the formulation of design and construction parameters for the project.

4. STUDY METHODOLOGY

A seismic P-wave (compression wave) refraction study was conducted at the project to develop subsurface velocity profiles of the areas studied, and to assess the depth to bedrock and apparent rippability of the subsurface materials. The seismic refraction method uses first-arrival times of refracted seismic waves to estimate the thicknesses and seismic velocities of subsurface layers. Seismic P-waves generated at the surface, using a hammer and plate, are refracted at boundaries separating materials of contrasting velocities. These refracted seismic waves are then detected by a series of surface vertical component 14-Hz geophones and recorded with a 24-channel Geometrics StrataView seismograph. The travel times of the seismic P-waves are used in conjunction with the shot-to-geophone distances to obtain thickness and velocity information on the subsurface materials.

Seven seismic traverses (SL-1 though SL-7) were conducted in the study area. The general location and length of the line was determined by surface conditions, site access, and depth of investigation, as determined by you. Shot points (signal generation locations) were conducted along the lines at the ends, midpoint, and intermediate points between the ends and the midpoint.

The seismic refraction theory requires that subsurface velocities increase with depth. A layer having a velocity lower than that of the layer above will not generally be detectable by the seismic refraction method and, therefore, could lead to errors in the depth calculations of subsequent layers. In addition, lateral variations in velocity, such as those caused by core stones, intrusions, or boulders can also result in the misinterpretation of the subsurface conditions. In general, the effective depth of evaluation for a seismic refraction traverse is approximately one-third to one-fifth of the length of the spread.

In general, the seismic P-wave velocity of a material can be correlated to rippability (see Table 1 below), or to some degree "hardness." Table 1 is based on published information from the Caterpillar Performance Handbook (Caterpillar, 2018), as well as our experience with similar materials, and assumes that a Caterpillar D-9 dozer ripping with a single shank is used. We emphasize that the cutoffs in this classification scheme are approximate and that rock characteristic, such as fracture spacing and orientation, play a significant role in determining rock quality or rippability. The rippability of a mass is also dependent on the excavation equipment used and the skill and experience of the equipment operator.

For trenching operations**,** the rippability values should be scaled downward. For example, velocities as low as 3,500 feet/second may indicate difficult ripping during trenching operations. In addition, the presence of boulders, which can be troublesome in narrow trenching operations, should be anticipated.

Table 1 – Rippability Classification

Seismic P-wave Velocity	Rippability
0 to 2,000 feet/second	Easy
2,000 to 4,000 feet/second	Moderate
4,000 to 5,500 feet/second	Difficult, Possible Blasting
5,500 to 7,000 feet/second	Very Difficult, Probable Blasting
Greater than 7,000 feet/second	Blasting Generally Required

It should be noted that the rippability cutoffs presented in Table 1 are slightly more conservative than those published in the Caterpillar Performance Handbook. Accordingly, the above classification scheme should be used with discretion, and contractors should not be relieved of making their own independent evaluation of the rippability of the on-site materials prior to submitting their bids.

5. DATA ANALYSIS

The collected data was processed using SIPwin (Rimrock Geophysics, 2003), a seismic interpretation program, and analyzed using SeisOpt Pro (Optim, 2008). SeisOpt Pro uses first arrival picks and elevation data to produce subsurface velocity models through a nonlinear optimization technique called adaptive simulated annealing. The resulting velocity model provides a tomography image of the estimated geologic conditions. Both vertical and lateral velocity information is contained in the tomography model. Changes in layer velocity are revealed as gradients rather than discrete contacts, which typically are more representative of actual conditions.

6. RESULTS AND CONCLUSIONS

As previously indicated, seismic traverses were performed at seven preselected areas as part of our study. Figures 4a through 4g present the velocity models generated from our analysis. The results from our seismic study revealed distinct layers/zones in the near surface that likely represent soil overlying granitic bedrock with varying degrees of weathering. Distinct vertical and lateral velocity variations are evident in the models. These inhomogeneities are likely related to the present of remnant boulders, intrusions, and differential weathering of the bedrock materials. It is also evident in the tomography models that the depth to bedrock is varied across the site.

Based on the refraction results, variability in the excavatability (including depth of rippability) of the subsurface materials should be expected across the project area. Furthermore, blasting may be required depending on the excavation, depth, location, equipment used, and desired rate of production. In addition, oversized materials should be expected. A contractor with excavation experience in similarly difficult conditions should be consulted for expert advice on excavation methodology, equipment, and production rate.

7. LIMITATIONS

The field evaluation and geophysical analyses presented in this report have been conducted in general accordance with current practice and the standard of care exercised by consultants performing similar tasks in the project area. No warranty, express or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be present. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface surveying will be performed upon request.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Atlas should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document. This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

8. SELECTED REFERENCES

Caterpillar, Inc., 2018, Caterpillar Performance Handbook, Edition 48, Caterpillar, Inc., Peoria, Illinois.

Mooney, H.M., 1976, Handbook of Engineering Geophysics, dated February.

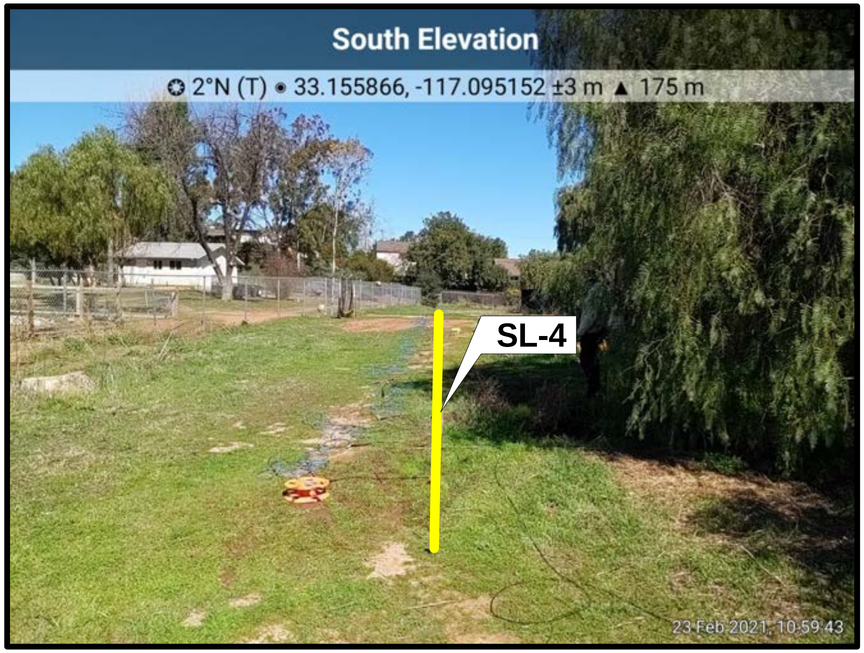
Optim, Inc., 2008, SeisOpt Pro, V-5.0.

Rimrock Geophysics, 2003, Seismic Refraction Interpretation Program (SIPwin), V-2.76.

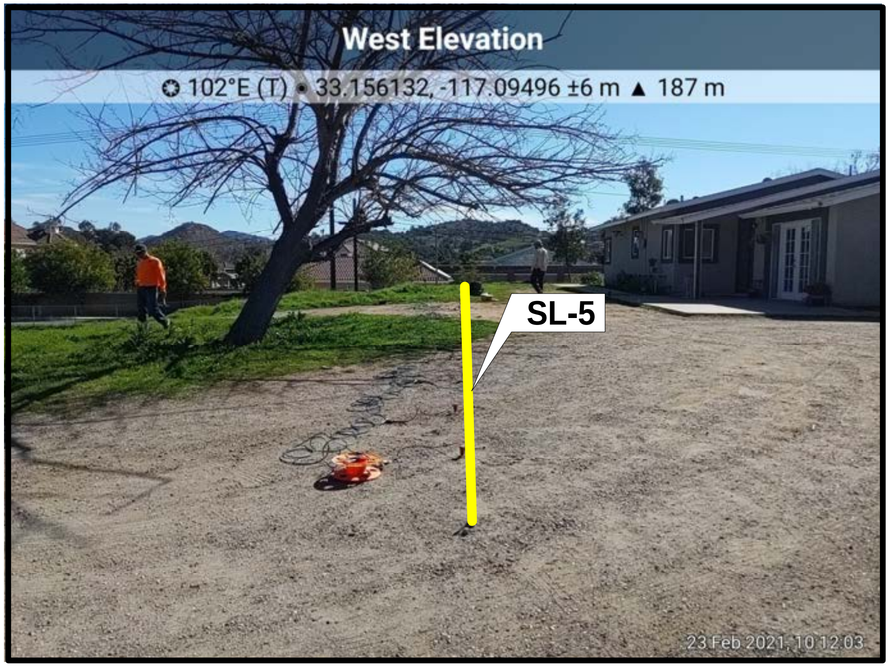
Telford, W.M., Geldart, L.P., Sheriff, R.E., and Keys, D.A., 1976, Applied Geophysics, Cambridge University Press.

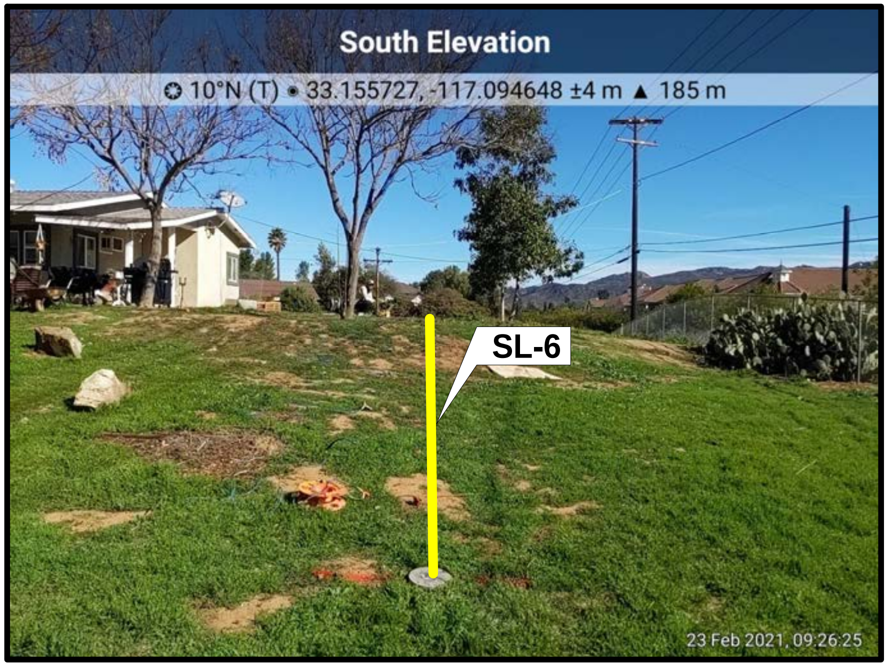
SITE LOCATION MAP	N	North Iris Lane Escondido, California	ATLAS Figure 1
		Project No.: 121069SWG / Date: 03/21	

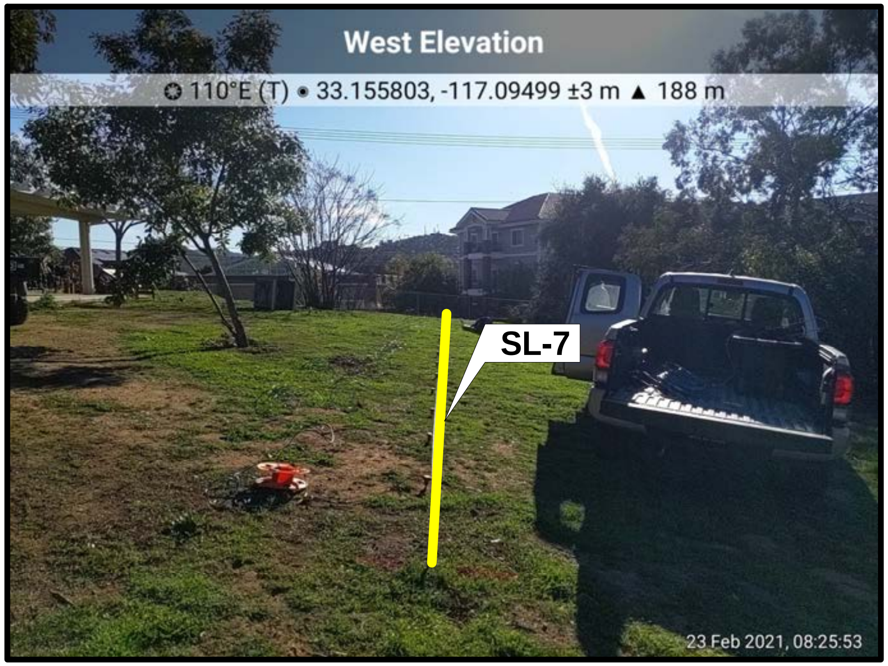
SEISMIC LINE LOCATION MAP	N	North Iris Lane Escondido, California Project No.: 121069SWG · Date: 03/21	ATLAS Figure 2	0 100 200 approximate scale in feet



SITE PHOTOGRAPHS (SL-1 through SL-4)	North Iris Lane Escondido, California Project No.: 121069SWG · Date: 03/21	ATLAS Figure 3a



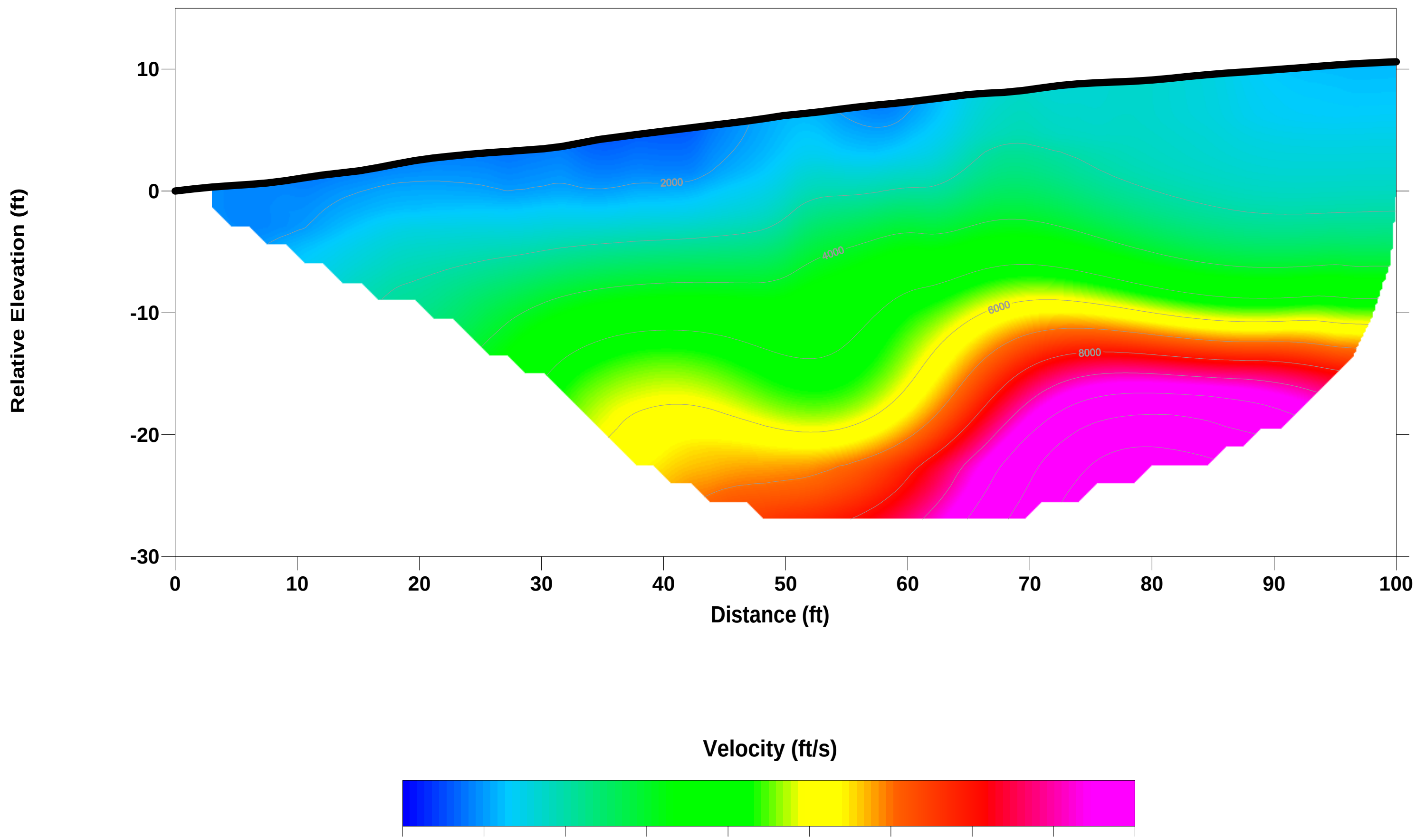




SITE PHOTOGRAPHS (SL-5 through SL-7)	North Iris Lane Escondido, California Project No.: 121069SWG — Date: 03/21	ATLAS Figure 3b

TOMOGRAPHY MODEL

SL-1

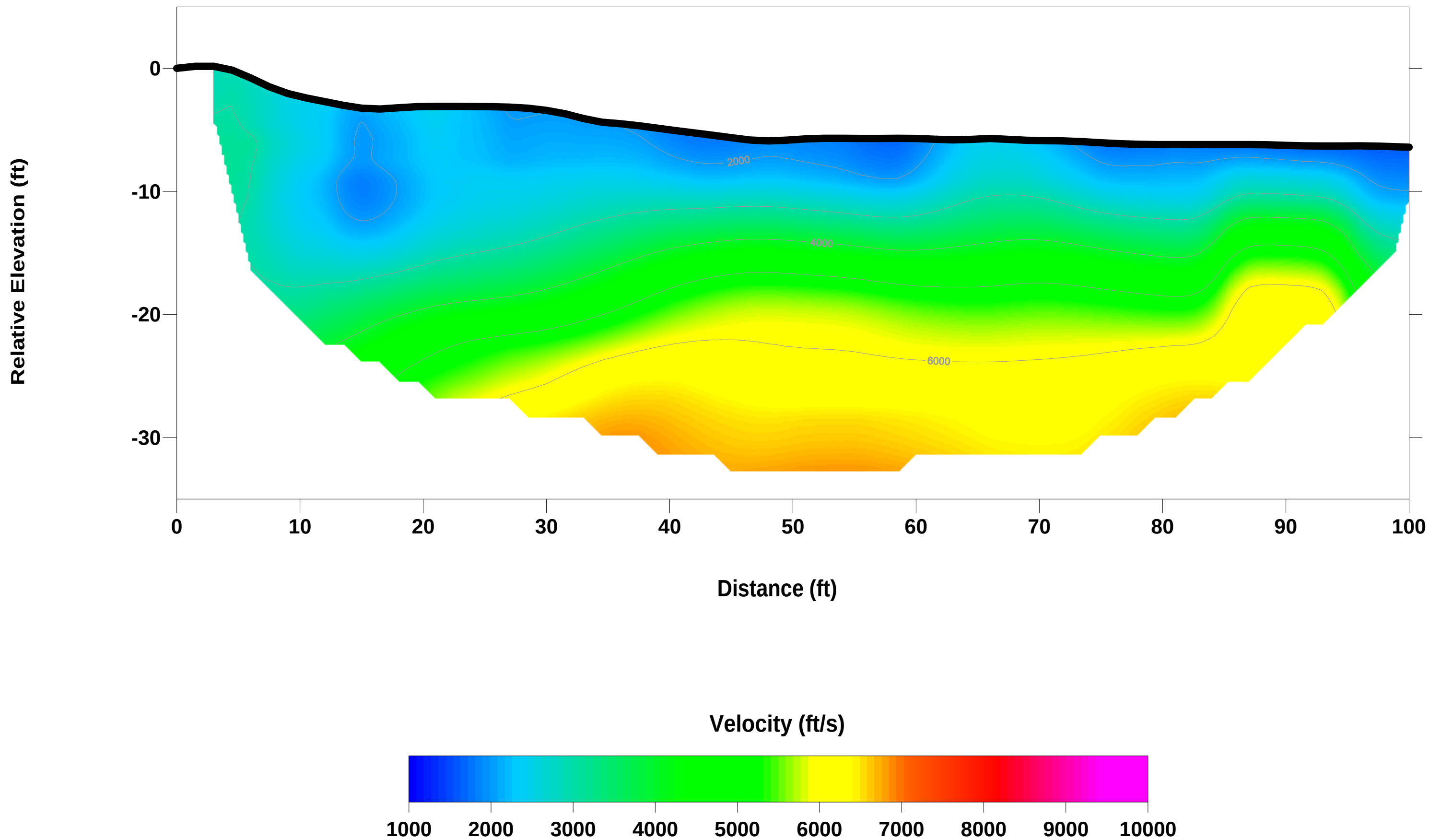


SEISMIC PROFILE (SL-1)	North Iris Lane Escondido, California Project No.: 121069SWG / Date: 03/21	ATLAS Figure 4a

Note: Contour Interval = 1,000 feet per second

TOMOGRAPHY MODEL

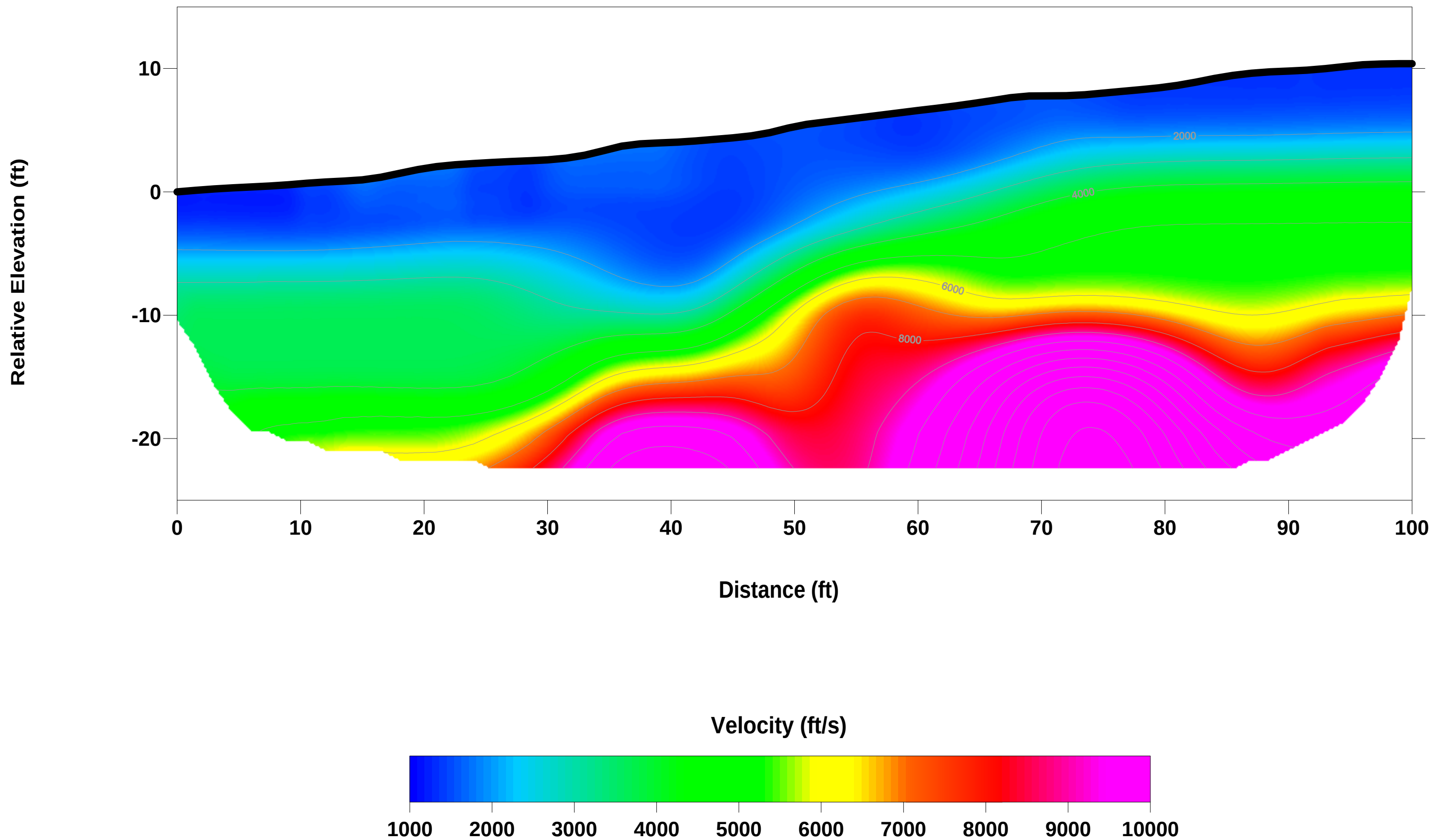
SL-2



SEISMIC PROFILE (SL-2)	North Iris Lane Escondido, California Project No.: 121069SWG — Date: 03/21	ATLAS Figure 4b	**Note: Contour Interval = 1,000 feet per second**

TOMOGRAPHY MODEL

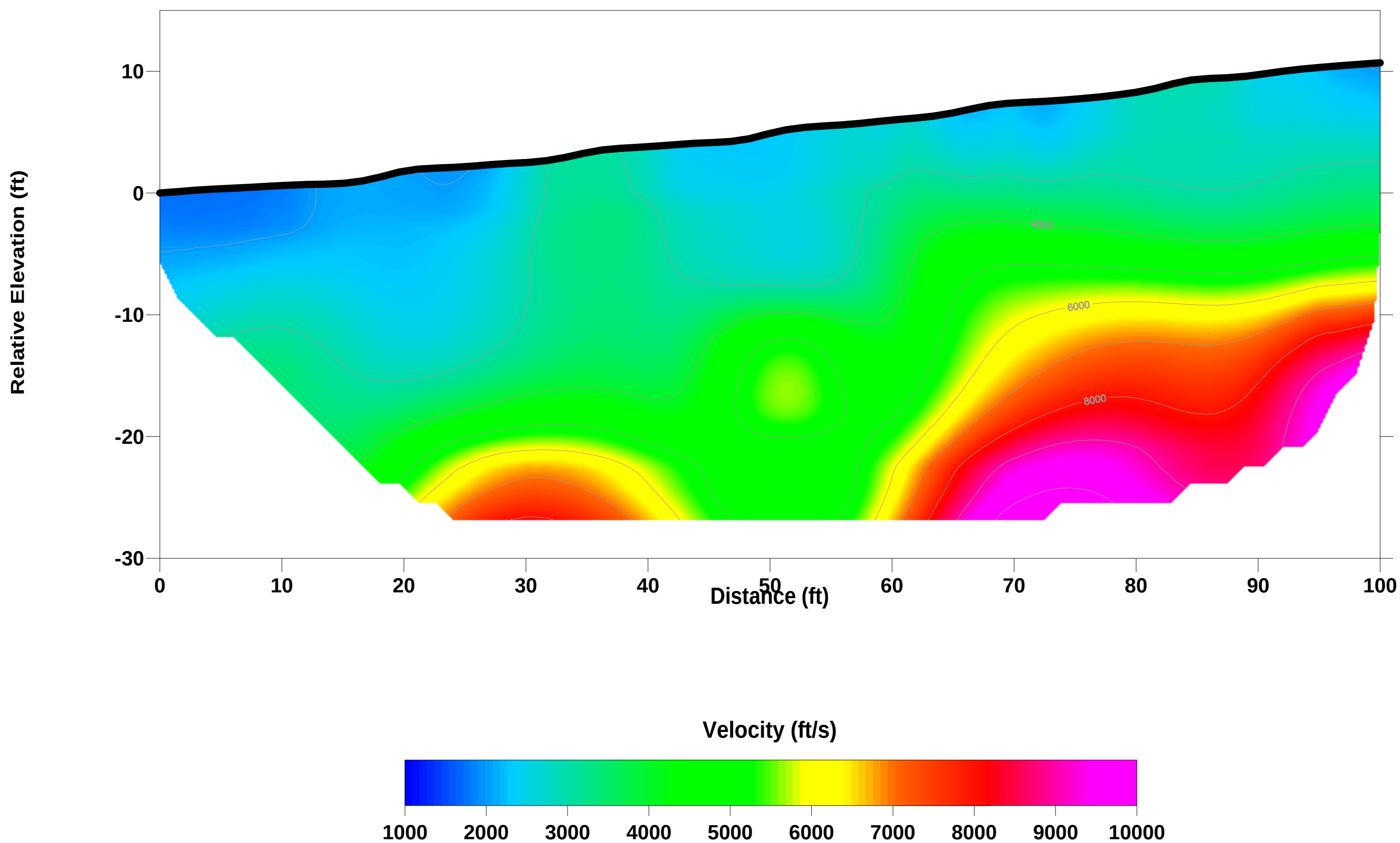
SL-3



SEISMIC PROFILE (SL-3)	North Iris Lane Escondido, California Project No.: 121069SWG — Date: 03/21	ATLAS Figure 4c	**Note: Contour Interval = 1,000 feet per second**

TOMOGRAPHY MODEL

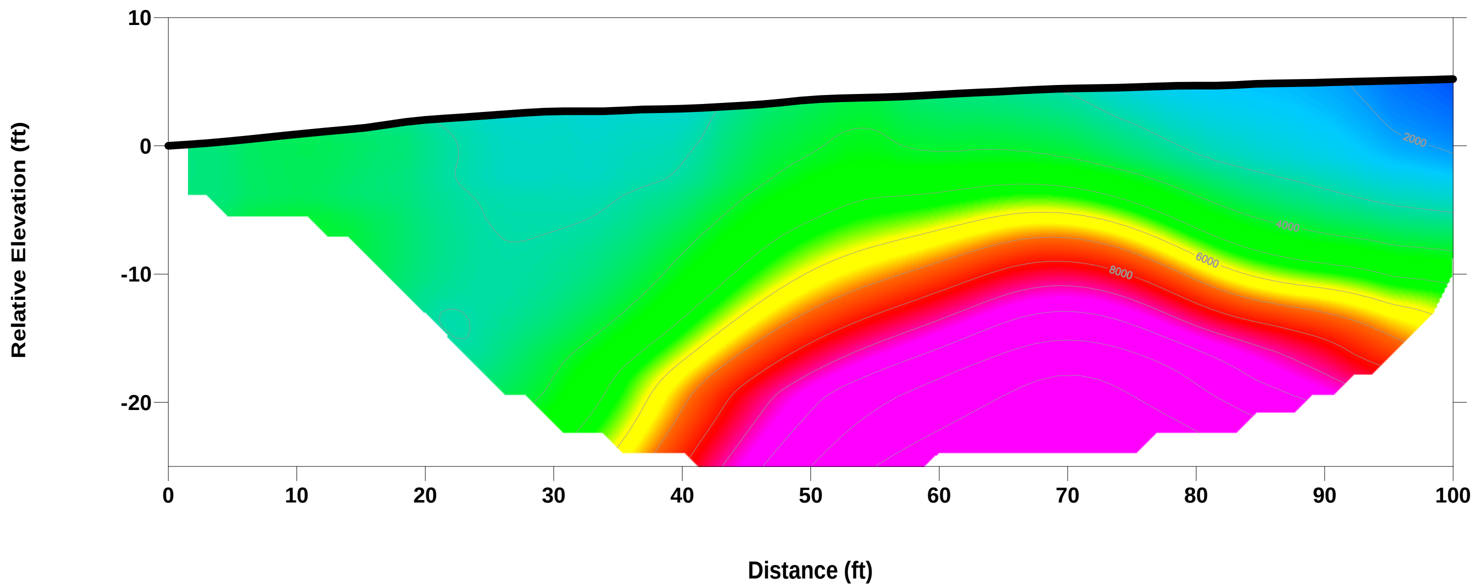
SL-4

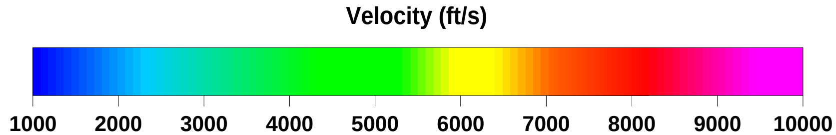


SEISMIC PROFILE (SL-4)	North Iris Lane Escondido, California Project No.: 121069SWG — Date: 03/21	ATLAS Figure 4d	**Note: Contour Interval = 1,000 feet per second**

TOMOGRAPHY MODEL

SL-5

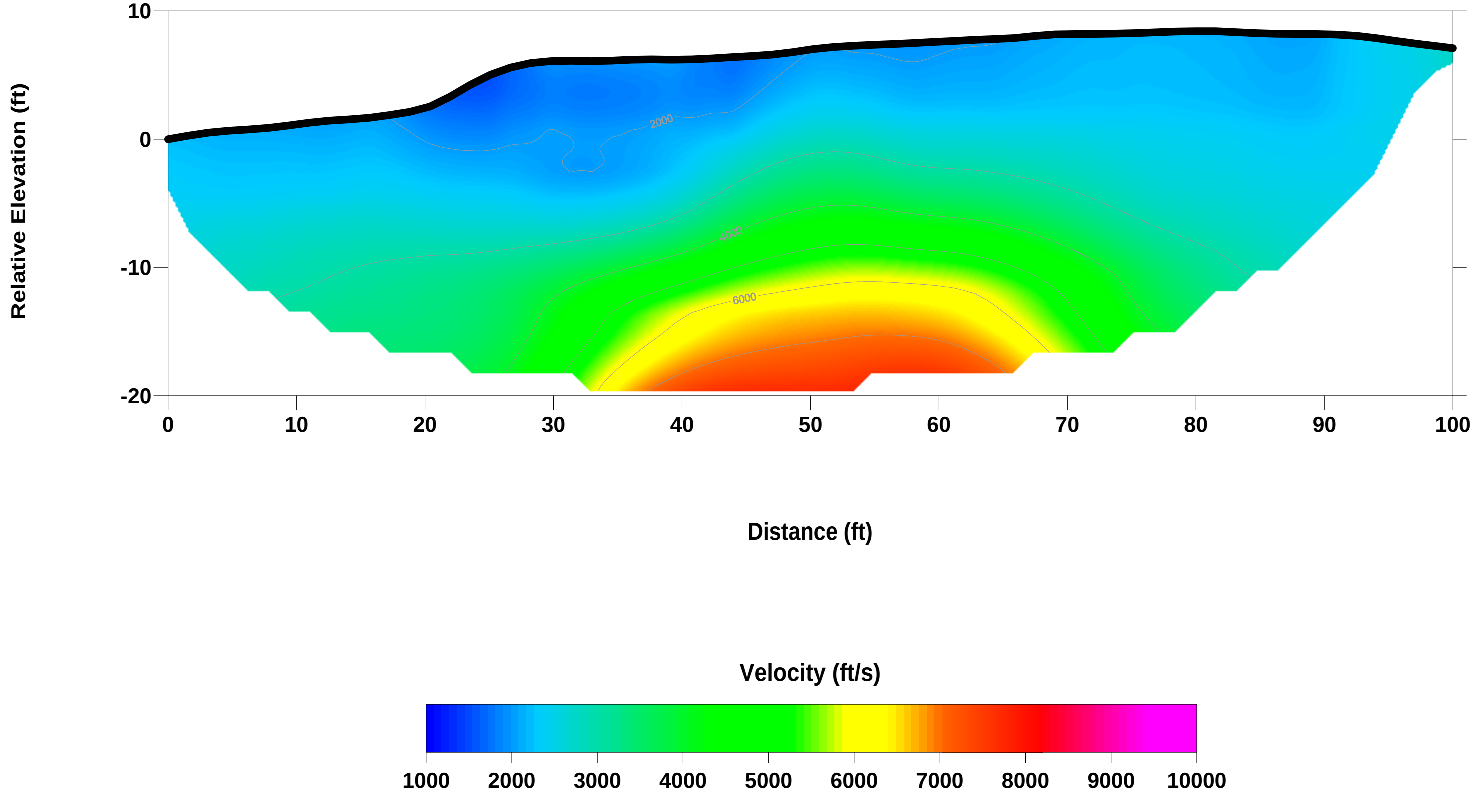




SEISMIC PROFILE (SL-5)	North Iris Lane Escondido, California Project No.: 121069SWG Date: 03/21	ATLAS Figure 4e	**Note: Contour Interval = 1,000 feet per second**

TOMOGRAPHY MODEL

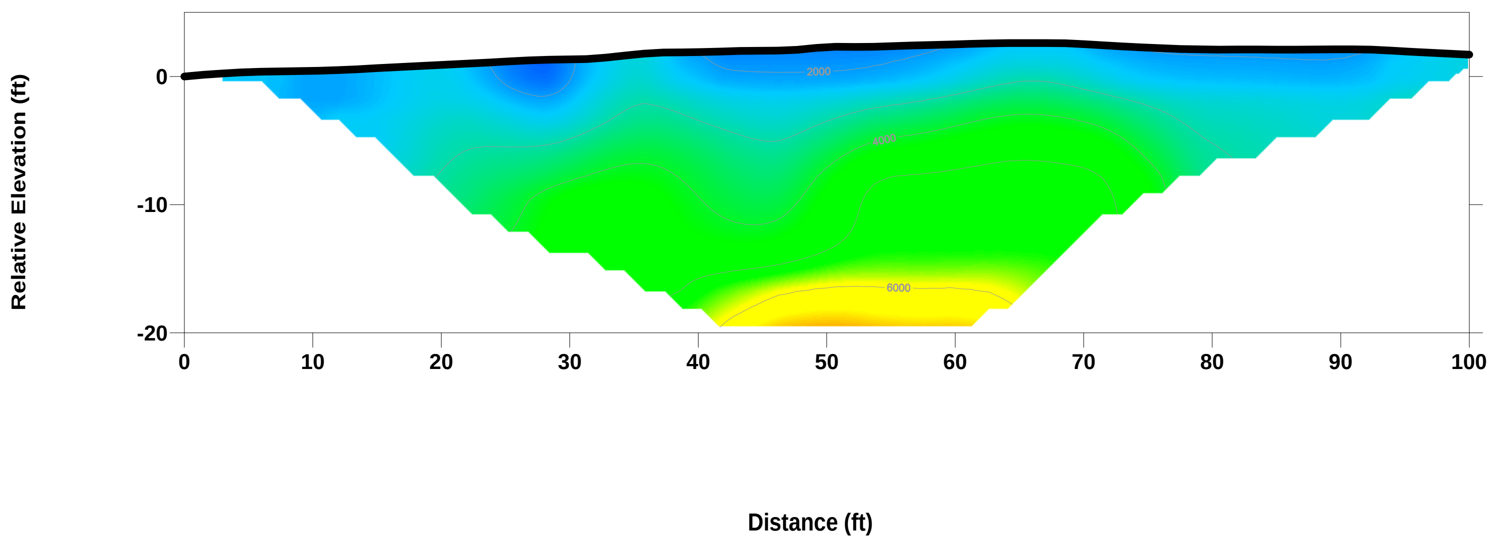
SL-6

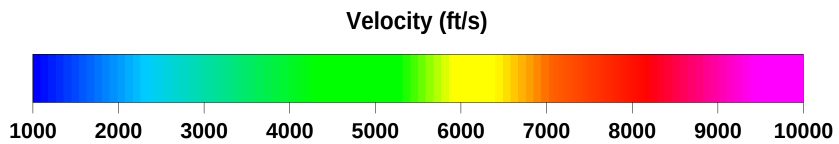


SEISMIC PROFILE (SL-6)	North Iris Lane Escondido, California	ATLAS Figure 4f	**Note: Contour Interval = 1,000 feet per second**
	Project No.: 121069SWG / Date: 03/21		

TOMOGRAPHY MODEL

SL-7





SEISMIC PROFILE (SL-7)	North Iris Lane Escondido, California		ATLAS Figure 4g
	Project No.: 121069SWG	Date: 03/21	

Note: Contour Interval = 1,000 feet per second