Submitted To:  
Mr. Paul Knutzen, PE  
Meier Architecture Engineering  
8697 Gage Boulevard  
Kennewick, Washington 99336

By:  
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January 14, 2014

Mr. Paul Knutzen, PE
Meier Architecture Engineering
8697 Gage Boulevard
Kennewick, Washington 99336

RE: ALTERNATIVE GEOTECHNICAL ENGINEERING RECOMMENDATIONS;
SAGECREST ELEMENTARY SCHOOL, KENNEWICK, WASHINGTON

Dear Mr. Knutzen:

Shannon & Wilson, Inc. prepared this Alternative Geotechnical Engineering Recommendations report for the proposed Sagecrest Elementary School in Kennewick, Washington. We conducted our work in general accordance with our proposal and your subsequent authorization, each dated December 22, 2014.

We appreciate the opportunity to assist you with this project. Please contact us should you have comments or questions regarding this report.

Sincerely,

SHANNON & WILSON, INC.

Clinton A. Wilson, P.E.
Principal Engineer

CAW:TMG/caw

Enc: Alternative Geotechnical Engineering Recommendations; Sagecrest Elementary School, Kennewick, Washington
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>PROJECT AND SITE DESCRIPTION</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>GEOLOGY AND SUBSURFACE CONDITIONS</td>
<td>2</td>
</tr>
<tr>
<td>3.1</td>
<td>Site Geology</td>
<td>2</td>
</tr>
<tr>
<td>3.2</td>
<td>Subsurface Conditions</td>
<td>2</td>
</tr>
<tr>
<td>3.3</td>
<td>Laboratory Test Results</td>
<td>3</td>
</tr>
<tr>
<td>4.0</td>
<td>ENGINEERING CONCLUSIONS</td>
<td>3</td>
</tr>
<tr>
<td>4.1</td>
<td>General</td>
<td>3</td>
</tr>
<tr>
<td>4.2</td>
<td>Foundations</td>
<td>3</td>
</tr>
<tr>
<td>4.3</td>
<td>Concrete Slabs-on-Grade</td>
<td>4</td>
</tr>
<tr>
<td>4.4</td>
<td>Seismic Design Criteria</td>
<td>5</td>
</tr>
<tr>
<td>5.0</td>
<td>CONSTRUCTION CONSIDERATIONS</td>
<td>6</td>
</tr>
<tr>
<td>5.1</td>
<td>Test Pit Backfill</td>
<td>6</td>
</tr>
<tr>
<td>5.2</td>
<td>Earthwork</td>
<td>6</td>
</tr>
<tr>
<td>5.3</td>
<td>Excavations/Slopes</td>
<td>7</td>
</tr>
<tr>
<td>5.4</td>
<td>Construction Practices</td>
<td>8</td>
</tr>
<tr>
<td>5.5</td>
<td>Construction Observation</td>
<td>8</td>
</tr>
<tr>
<td>6.0</td>
<td>LIMITATIONS</td>
<td>8</td>
</tr>
<tr>
<td>7.0</td>
<td>REFERENCES</td>
<td>10</td>
</tr>
</tbody>
</table>

## TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Seismic Design Parameters</td>
<td>5</td>
</tr>
</tbody>
</table>

## FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vicinity Map</td>
</tr>
<tr>
<td>2</td>
<td>Site and Exploration Plan</td>
</tr>
</tbody>
</table>

## APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Previous Geotechnical Studies</td>
</tr>
<tr>
<td>B</td>
<td>Laboratory Test Results</td>
</tr>
<tr>
<td>C</td>
<td>Important Information About Your Geotechnical/Environmental Report</td>
</tr>
</tbody>
</table>
ALTERNATIVE GEOTECHNICAL ENGINEERING RECOMMENDATIONS
SAGECREST ELEMENTARY SCHOOL
KENNEWICK, WASHINGTON

1.0 INTRODUCTION

Shannon & Wilson, Inc. (Shannon & Wilson) prepared this Alternative Geotechnical Engineering Recommendations report for the proposed Sagecrest Elementary School in Kennewick, Washington. The purpose of this report is to present the site geology, surface and subsurface conditions, and provide foundation and earthwork recommendations for the proposed improvements in accordance with current seismic design criteria.

To prepare this report, Shannon & Wilson:

- Discussed the proposed improvements and our scope of services with Mr. Paul Knutzen, PE of Meier, Inc.;
- Prepared our December 22, 2014, proposal including project description based on our understanding; and
- Performed engineering analyses and developed recommendations for foundation design and construction.

Shannon & Wilson prepared this report for use by Meier, Inc. (Meier) and the Kennewick School District design team. Do not use or rely upon this report for other locations.

2.0 PROJECT AND SITE DESCRIPTION

The Kennewick School District (KSD) proposes to construct Sagecrest Elementary School in south Kennewick, Washington. The school site lies along the Kennewick Irrigation District (KID) canal north side and south of the future W 38th Avenue. The Highway (Hwy) 395/Interstate 82 (I-82) interchange is approximately ¾-mile southeast of the project site. The site lies at approximate central coordinates 46.1749 degrees north latitude, 119.2078 degrees west longitude. We show the project location in Figure 1 (Vicinity Map).

Site plans by MMEC Architecture indicate the proposed elementary school site as an irregular shape, longer in the east-west direction, narrowest in the western portions, widest to the east, with the proposed W 38th Avenue forming a non-uniform northern boundary. The site currently consists primarily of an agricultural field with the eastern portion covered with weeds/grasses and/or sagebrush. We show the proposed site layout in Figure 2 (Site and Exploration Plan).
Previous geotechnical studies by Intermountain Materials Testing (IMT) and Shannon & Wilson indicate relatively shallow bedrock across much of the site. Meier indicates the KSD chooses to raise the site grades with import fill material placement to achieve a uniform building pad, as opposed to bedrock ripping and/or excavation.

Meier indicates EMAC Corporation, an earthwork contractor, will move a coarse pit-run gravel import material from a nearby development to the project site for the proposed school pad.

3.0 GEOLOGY AND SUBSURFACE CONDITIONS

3.1 Site Geology

Based on the Geologic Map of the Richland 1:100,000 Quadrangle, Washington (Reidel 1994), the site lies at or near the contact between Pleistocene age (between approximately 2.5 million years old to 11,000 years old) outburst flood deposits of fine-grained silt and sand (Qfs₃) and gravel with beds of fine sediment (Qfg₃).

3.2 Subsurface Conditions

Previous geotechnical studies have been completed by Intermountain Materials Testing (IMT) and Shannon & Wilson (see Appendix A). We show the exploration locations on Figure 2.

The IMT study included seven backhoe excavated test pits. The test pit excavations generally encountered bedrock at approximately 1½ to 2½ feet below the existing ground surface (bgs); refusal was generally at 2½ to 3 feet bgs. One test pit (TP-2) located in the site southeast portions, near the proposed school building east side, encountered bedrock approximately 5½ feet bgs, and refusal at 5¾ feet bgs.

Shannon & Wilson subsequently completed a bedrock characterization study using seismic refraction. The purpose of the refraction study was to evaluate bedrock depth across more of the site and estimate bedrock rippability characteristics. Recorded seismic velocities indicate bedrock is approximately 2 to 5 feet bgs. We estimate a large dozer, e.g., D10R or larger, is capable of ripping bedrock to various depths ranging from approximately 5 to greater than 20 feet bgs.

IMT did not encounter groundwater in any of their test pit explorations. The potential for locally perched groundwater exists lying on the bedrock. Local well logs indicate the static groundwater table exists at greater depths within bedrock.
3.3 Laboratory Test Results

IMT completed limited particle size distribution laboratory testing of one sample from each test pit TP-2 and TP-5. The IMT laboratory test results indicate the shallow soils consist of greater than 50 percent fines with varying amounts of fine to coarse sand, or sandy silt (ML). See the IMT report in Appendix A for their laboratory test results.

Shannon & Wilson completed Particle Size Analysis (ASTM D 422) for material characterization and engineering strength property correlations of the import material provided by Meier. The laboratory test results indicate the import material sample generally consists of 3-inch-minus gravel with some (around 10 percent) medium to coarse sand and trace to some (around 5 percent) fines (i.e., likely silt). We present the import material laboratory test results in Appendix B.

4.0 ENGINEERING CONCLUSIONS

4.1 General

Project exploration studies indicate a thin layer of outburst fine-grained deposits (sandy silt) overlie relatively shallow bedrock. We understand the KSD elects to import fill material as opposed to bedrock ripping/excavation to construct the proposed school building pad. The provided import material sample generally consists of 3-inch-minus gravel with minor sand and fines content. Extend the import material pad a minimum 8 feet horizontal beyond the building footprint, then slope at 2 horizontal to 1 vertical (2H:1V).

Shannon & Wilson assumes the entire school building pad will consist of same or very similar import materials from the same source. Additional potential sources which may also provide building pad fill material should be reviewed prior to import. Additionally, import source materials from the original source should be reviewed again if gradations appear to vary from the provided sample.

The following sections present earthwork, foundations, and International Building Code (IBC) seismic design recommendations. Shannon & Wilson’s scope to date does not include recommendations beyond the proposed school pad.

4.2 Foundations

The proposed school building structure may be constructed on conventional (i.e., spread and continuous footings) foundations founded on the prepared subgrade consisting of 3-inch-minus
import materials, or a granular structural fill placed over the coarser import materials, depending on foundation contractor preference. Prepare the foundation subgrade and place granular structural fill according to general earthwork recommendations below.

If a granular structural fill leveling course will be used, place a minimum 6-inch-thick layer of ⅝-inch minus crushed rock (or similar) over the prepared subgrade to create a working surface. Granular structural fill placed beneath footings should extend a minimum 8 inches beyond the footings on both sides, and then slope at 1 horizontal to 1 vertical (1H:1V).

Embed continuous strip and isolated footings a minimum 24 inches below adjacent grades for frost protection and bearing considerations. Use minimum 18-inch-wide continuous and 24-inch-wide square or rectangular footings. Footings constructed in accordance with the above recommendations may be designed using an allowable bearing pressure of 5,000 pounds per square foot (psf). The allowable bearing pressure may be increased by one-third for short-term, transient loading conditions (i.e., seismic and/or wind loads).

Clean debris and loose or disturbed soil from footing excavations prior to placing structural fill and/or concrete. Slope the ground surface away from the exterior footings to direct water away and prevent ponding next to the footings.

Provided footing subgrades are prepared in accordance with the recommendations presented in this report, we estimate total foundation settlements of less than 1-inch. This estimate assumes a maximum 15-kip per lineal foot (klf) wall loads and 150-kip column load. We anticipate differential settlement will be about half of total settlements between adjacent columns and along approximately 20 feet of continuous footings. We assume there is no stress overlap from adjacent footings. Footings located less than two times the footing width (2B) from each other will increase stresses beneath the adjacent footing, resulting in increased settlement.

Lateral loads acting on the footings may be resisted by passive earth pressures acting against the footing sides and friction forces on the footing bottoms. For lateral displacement design of compacted, level backfill, use an ultimate passive resistance of 300 psf per foot of embedment depth at depths greater than 2 feet below adjacent grades. Use a maximum 0.50 friction coefficient for footings placed on crushed rock.

4.3 **Concrete Slabs-on-Grade**

Concrete slabs-on-grade may be supported on a minimum 4-inch aggregate leveling course overlain by a minimum 4-inch-thick capillary break layer. The aggregate leveling course should
consist of compacted, ⅝-inch-minus crushed gravel with less than 12 percent fines (GP, GW, or GP-GM) to provide uniform support. The capillary break layer should consist of washed, uniformly graded (i.e., predominantly of one size), rounded or angular gravel with a maximum ⅝-inch particle size and less than 3 percent fines. Thoroughly wet the crushed gravel leveling course and/or capillary break layer prior to placing concrete.

Within structure footprints, the designer should consider a moisture retarder (i.e., visqueen sheeting or similar approved material typically placed immediately below the concrete) to prevent moisture migration through the slab, especially in heated spaces.

Concrete floor slabs within building footprints with a crushed rock underlayment may be designed using a Modulus of Subgrade Reaction, $k_s$, of 250 pounds per cubic inch (pci). Design exterior flatwork using a $k_s$ of 200 pci.

### 4.4 Seismic Design Criteria

Based on the project subsurface explorations, and in accordance with the 2012 IBC, the soil profile is generally consistent with Site Class B (rock). We present seismic design parameters in accordance with the current IBC in Table 1 below.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>$S_s$</td>
<td>Spectral Response Acceleration for Short Periods</td>
<td>0.420g</td>
</tr>
<tr>
<td>$S_1$</td>
<td>Spectral Response Acceleration at 1-second Period</td>
<td>0.162g</td>
</tr>
<tr>
<td>$F_a$</td>
<td>Site Coefficient</td>
<td>1.000</td>
</tr>
<tr>
<td>$F_v$</td>
<td>Site Coefficient</td>
<td>1.000</td>
</tr>
<tr>
<td>$S_{MS}$</td>
<td>Adjusted MCE Spectral Response Acceleration for Short Periods</td>
<td>0.420g</td>
</tr>
<tr>
<td>$S_{M1}$</td>
<td>Adjusted MCE Spectral Response Acceleration at 1-second Period</td>
<td>0.162g</td>
</tr>
<tr>
<td>$S_{DS}$</td>
<td>Design Spectral Response Acceleration for Short Periods</td>
<td>0.280g</td>
</tr>
<tr>
<td>$S_{D1}$</td>
<td>Design Spectral Response Acceleration at 1-second Period</td>
<td>0.108g</td>
</tr>
</tbody>
</table>

Notes:
- $g$ = gravity
- MCE = Maximum Considered Earthquake
5.0 CONSTRUCTION CONSIDERATIONS

5.1 Test Pit Backfill

We anticipate project explorations by IMT were loosely backfilled with the excavated material(s) at completion. Test pits located within building and/or pavement footprints should be over-excavated and backfilled with compacted, granular structural fill in accordance with the earthwork recommendations below.

5.2 Earthwork

Surface vegetation (weeds, grasses, and sagebrush), topsoil, and any other deleterious materials must be stripped within all areas to receive structural fill. Based on project explorations to date, we estimate a minimum 6- to 8-inch stripping depth; deeper and/or shallower stripping depths may be necessary (for sagebrush root balls, agricultural crop, etc.) as identified by Shannon & Wilson during construction. The stripped (root-zone and topsoil) materials are not suitable for use in engineered fill. Strippings may be used in landscaped areas or disposed.

Prior to fill placement on cut ground surfaces, remove loose soil and debris. We anticipate the stripped bedrock surface will be relatively non-uniform.

Fill should be free of debris, organic material, and any other deleterious material. If import material (other than the general building pad 3-inch-minus pit-run material) is required, we recommend using a well-graded, 2-inch minus, pit-run sand and gravel with less than 5 percent fines, or crushed rock for structural fill, except where noted. Shannon & Wilson should review and approve material for import prior to transporting to the site. The native sandy silt is not suitable for building pad construction due to potential structure behavior differences across the building footprint given the considerable bedrock elevation differences. Foundations founded within greater fine-grained fill depths will behave differently than those founded on or near bedrock.

Moisture condition fill materials to within 2 percent of optimum and place in maximum 6- to 8-inch-thick, horizontal, loose lifts. Compact fill materials to a minimum in-place dry density of 95 percent of the Modified Proctor maximum dry density, as determined by ASTM Designation: D 1557, Laboratory Compaction Characteristics of Soil Using Modified Effort.

Lift thicknesses may be altered during construction by Shannon & Wilson subject to the contractor’s construction equipment, means and methods, quality control testing, and compaction
performance. Mitigate insufficient subgrade areas, as identified by Shannon & Wilson. Only hand-operated compaction equipment should be allowed within 3 feet of below-grade structures.

Import materials will likely contain significant coarse aggregate (greater than approximately 2 to 3 inches) quantity and relatively minor sand and fines content. Our experience indicates the coarse aggregate is acceptable for building pad import fill with the proper compaction and testing procedures. Typical nuclear density testing procedures may not apply to coarse aggregate fill, depending on coarse aggregate quantity and size, gradation, and fines content. In such cases, a performance specification shall be determined in the field by the geotechnical engineer. Generally, we recommend placing gravelly materials in 6- to 8-inch-thick maximum, horizontal, loose lifts, depending on the actual particle sizes. Using heavy kneading and/or vibratory-type equipment, compact each lift with steady, uniform passes until a non-yielding state is achieved. Typically, five or more passes will be required.

Utility trenching and backfilling should be accomplished in accordance with Washington State Department of Transportation (WSDOT)/American Public Works Association (APWA) Standard Specifications. Based on our explorations, we anticipate that conventional excavation equipment can accomplish the proposed excavations across the site. Utility trenches should be backfilled using structural fill compacted as specified herein. Sufficient backfill should be placed over the utility before compacting with heavy compactors to prevent damage.

Gravelly soils with aggregates less than 3 inches may be used for general utility backfill (i.e., above the initial backfill) a minimum 12 inches above the utility. Aggregates up to 6 inches may be used for general backfill greater than 24 inches above the utility at the designer’s discretion. Note, gravelly general backfill may require performance testing as described above.

5.3 Excavations/Slopes

Based on our subsurface explorations, we characterize the generally cohesionless, granular site soils as Occupational Safety and Health Administration (OSHA) Type C with maximum temporary slopes of 1½H:1V. We characterize the site bedrock materials as OSHA Type A with maximum temporary slopes of ¾H:1V; competent bedrock (i.e., stable bedrock) may stand vertical. The OSHA slope inclinations do not consider surcharge loads placed along excavation benches or perimeter, such as equipment or material stockpiling. Surcharged slopes should be evaluated by the geotechnical engineer based on the Contractor’s proposed construction site layout. The Contractor is responsible for the temporary excavation slope and the safety of all temporary excavations based on exposed ground conditions.
Permanent cut and fill slopes should be constructed with inclination no steeper than 2H:1V and must be protect from both wind and water erosion. Erosion protection may consist of a vegetative cover or a minimum 3-inch layer of coarse concrete aggregate conforming to the requirements of WSDOT Specification 9-03.1(4)c, “Concrete Aggregate AASHTO Grading No. 57.”

5.4 Construction Practices

The applicability of our recommendations is contingent upon good construction practices. Poor construction techniques may alter conditions from those on which our recommendations are based and, therefore, result in reduced foundation capacity or additional settlement and movement. The following sections present construction considerations for this project.

5.5 Construction Observation

Variations in soil conditions are possible at the site and may be encountered during construction. Geotechnical design recommendations are developed from a limited number of explorations and tests. Therefore, recommendations may need to be adjusted in the field. Shannon & Wilson should be retained to provide construction observation services during the project earthwork, excavation, and foundation preparation. Construction observation allows the geotechnical engineer to observe the actual soil conditions exposed during construction, determine if the proposed design is compatible with the design recommendations, and if the conditions encountered at the site are consistent with those observed during the geotechnical study. Construction observation is conducted to reduce the potential for problems arising during and after construction. However, in all cases, the Contractor is responsible for the quality and completeness of their work and for adhering to the plans, specifications, and recommendations on which their work is based.

6.0 LIMITATIONS

This report was prepared for the exclusive use of Meier, Inc. and their design team for specific application to the design and construction of the project at this site as it relates to the geotechnical aspects discussed herein. Its purpose is to provide information on factual data only; it should not be construed as a warranty of subsurface conditions, such as those interpreted from the exploration logs and subsurface conditions discussions in this report.

The analyses, conclusions, and recommendations contained in this report are based upon site conditions as they presently exist. We further assume that the site explorations are representative
of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the field explorations and observations.

Within the limitations of scope, schedule, and budget, the conclusions and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical and geological principles and practice in this area at the time this report was prepared. We make no other warranty, either expressed or implied.

Our scope of services did not include an evaluation regarding the presence or absence of wetlands, or an evaluation regarding the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air on or below or around this site. If such contamination exists, it would not be possible to determine it within this limited scope of work.

Shannon & Wilson, Inc. prepared Appendix C, “Important Information About Your Geotechnical/Environmental Report,” to assist the design team, and others who might read this report, in understanding the use and limitations of our work.

SHANNON & WILSON, INC.

Clinton A. Wilson, P.E.
Principal Engineer

CAW:LJR:TMG/caw
7.0 REFERENCES


Sagecrest Elementary School
Kennewick, Washington

VICINITY MAP

January 2015 22-1-03087-002

NOTE
Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth™ Mapping Service.
LEGEND

TP-1 ☐ Test Pit Designation and Approximate Location by others

Seismic Refraction Line Designation and Approximate Location

NOTE

Figure adapted from file 748400XC01.dwg received October 27, 2014.
APPENDIX A

PREVIOUS GEOTECHNICAL STUDIES
November 7, 2014

Mr. Paul Knutzen, PE
Meier Architecture Engineering
8697 Gage Boulevard
Kennewick, Washington 99336

RE: GEOTECHNICAL ENGINEERING STUDY; BEDROCK CHARACTERIZATION USING SEISMIC REFRACTION, SAGECREST ELEMENTARY SCHOOL, KENNEWICK, WASHINGTON

Dear Mr. Knutzen:

Shannon & Wilson, Inc. presents this letter report summarizing our bedrock characterization/rippability study at the proposed Sagecrest Elementary School site in Kennewick, Washington.

BACKGROUND

The Kennewick School District proposes to construct Sagecrest Elementary School in south Kennewick, Washington. Site plans by MMEC Architecture indicate the school site is north of the Kennewick Irrigation District (KID) canal and south of the future W 38th Avenue. The site currently consists primarily of an agricultural field with the eastern site portion covered with weeds/grasses and/or sagebrush.

The project geotechnical study (by others) included seven backhoe excavated test pits. The test pit excavations generally encountered bedrock at approximately 1½ to 2½ feet below the existing ground surface (bgs); refusal was generally at 2½ to 3 feet bgs. One test pit encountered bedrock approximately 5½ feet bgs, and refusal at 5¾ feet bgs.

Meier indicates the bedrock depth is well within the planned grading elevations. Meier requests this seismic refraction study to evaluate importing material to raise site grades versus potential rock excavation/grading.
SEISMIC REFRACTION SURVEY

Shannon & Wilson completed five (5) seismic refraction (SR) lines (L1 through L5) spread around the proposed elementary school site. We describe the SR study below and provide results of our rock characterization and excavation methods assessment in following sections. We show the approximate SR line locations in Figure 2, Site and Exploration Plan.

Methodology

A seismic refraction survey consists of a series of tasks to produce, record, and analyze seismic waves to determine the seismic velocity of subsurface materials. In general terms, we derive the seismic velocity of the subsurface from the travel time of compressional wave (P-wave) energy over the distance from the source to recording devices. An impulsive source generates P-wave energy at the surface. The P-wave energy propagates into the subsurface and is refracted along subsurface interfaces (likely layers) representing an increase in velocity. The P-wave energy returns to the surface where an array of geophones detects the waves, and a seismograph records them. We analyze these data to produce theoretical depth, thickness, and seismic velocity of the subsurface layers. We correlate the seismic velocity of the subsurface materials to soil and rock types and rock weathering and competency.

Data Acquisition

Shannon & Wilson completed three SR lines at various locations across the proposed project site. Each seismic line consists of seven (7) shot points distributed along a collinear array of 24 geophones, with a multi-channel receiver (seismograph) located at one end of the array to collect the data. We placed geophones at 10-foot intervals along the array. We generated compressional wave (P-wave) energy at each shot point using multiple impacts with an 18-pound sledge hammer striking an aluminum or steel plate placed on the ground surface.

Our field representative led the field exercises and monitored the data acquisition. We located the seismic lines by taping and referencing from known site features, and obtained global positioning system (GPS) points to correlate to the provided survey for plotting. We obtained a relative elevation profile along each SR line for analysis input using a construction laser level.

Data Analysis

Shannon & Wilson analyzed the data using Geometric, Inc.’s SeisImager computer program. We prepared the enclosed Figures 3 through 7, Seismic Refraction Profile, based on our acquired data and analyses. We discuss the SR survey results below.
EXCAVATION CHARACTERISTICS

Excavation characteristics based on seismic velocities of subsurface materials have been developed by construction equipment manufacturers. CAT publishes the “Caterpillar Performance Handbook¹,” which relates the performance of the D8, D9, D10, and D11 dozers to the p-wave velocity of various rock types, including Igneous rock formations such as Granite, Basalt, and Trap Rock. Seismic velocity ranges considered “Rippable” and “Non-Rippable” are tabulated for a D8 through D11R dozer (with single shank ripper) in the following table; velocities between “Rippable” and “Non-Rippable” are typically considered “Marginal.”

<table>
<thead>
<tr>
<th>Dozer Class</th>
<th>Compressional Wave Velocity Range (fps)</th>
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<tbody>
<tr>
<td></td>
<td>Rippable</td>
</tr>
<tr>
<td>D8R/D8R Series II</td>
<td>&lt; 6,300</td>
</tr>
<tr>
<td>D9R</td>
<td>&lt; 7,550</td>
</tr>
<tr>
<td>D10R</td>
<td>&lt; 8,000</td>
</tr>
<tr>
<td>D11R</td>
<td>&lt; 8,850</td>
</tr>
</tbody>
</table>

fps = feet per second

The above information should be used only as a general guideline; rock rippability also depends on many other factors beyond the seismic velocity. These factors include the rock jointing and fracture patterns, the equipment operator experience, and the equipment and excavation methods selected. “Marginal” and/or “Non-Rippable” seismic velocities will be lower than those indicated above for an excavator.

RESULTS

Recorded seismic velocities range from approximately 500 to 6,500 feet per second (fps) over SR lines L1 and L2, and greater than approximately 7,500 fps in SR lines L3, L4, and L5. We estimate an approximately 2- to 4½-foot-thick overburden (i.e., less than approximately 1,000 fps) layer is present across all SR lines. We estimate bedrock velocities grade to above 8,000 fps as indicated in the following table.

ESTIMATED DEPTH TO SEISMIC
REFRACTION VELOCITIES ABOVE 8,000 fps

<table>
<thead>
<tr>
<th>SR Line</th>
<th>Depth* (feet)</th>
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<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>L1</td>
<td>&gt;30</td>
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<td>L2</td>
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<td>L4</td>
<td>17 ½</td>
<td>20</td>
</tr>
<tr>
<td>L5</td>
<td>9</td>
<td>&gt;30</td>
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*Note: Listed depths assume the use of a D10R dozer.

fps = feet per second

We enclose the interpreted SR line profiles in Figures 3 through 7. The figures illustrate the seismic velocity variations in the upper subsurface horizon. Color shading represents seismic velocities according to the velocity scale on the figure right side. The seismic velocity profile shows a general increase in velocity with depth.

The seismic refraction method assumes increasing velocities with depth and may not be able to identify low-velocity layers below higher-velocity materials. The seismic profile lines designating the interface of seismic velocity layers are approximate; the transition between soil/rock types may be abrupt or gradual. We make no recommendations, expressed or implied, based on the findings of our seismic refraction surveys.

LIMITATIONS

This letter report was prepared for the exclusive use of Meier, Inc. as it relates to the geotechnical aspects discussed herein. Its purpose is to provide information on factual data only; it should not be construed as a warranty of subsurface conditions, such as those interpreted from the exploration logs and subsurface conditions discussions in this report and project reports to date.

Shannon & Wilson, Inc. based this report on the acquired data. The accuracy of our findings is subject to the inherent limitations of the seismic refraction investigation technique and specific site conditions. The lines designating the interface of seismic velocity layers on our seismic profiles are approximate. The transition between soil/rock types may be abrupt or gradual. Seismic refraction
surveys usually reflect average conditions. We make no recommendations, expressed or implied, based on the findings of our seismic refraction surveys.

Within the limitations of scope, schedule, and budget, the conclusions and recommendations presented in this letter report were prepared in accordance with generally accepted professional geotechnical and geological principles and practice in this area at the time this letter report was prepared. We make no other warranty, either expressed or implied.

Our scope of services did not include an evaluation regarding the presence or absence of wetlands, or an evaluation regarding the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air on or below or around this site. If such contamination exists, it would not be possible to determine it within this limited scope of work.

Shannon & Wilson prepared the enclosed “Important Information about Your Geotechnical/Environmental Report” to assist you and others in understanding the use and limitations of our reports.

Please call if you have any questions or require additional information.

Sincerely,

SHANNON & WILSON, INC.

Clinton A. Wilson, P.E.
Principal Engineer

Enc: Figure 1: Vicinity Map
      Figure 2: Site and Exploration Plan
      Figure 3: Seismic Refraction Profile - Line L1
      Figure 4: Seismic Refraction Profile - Line L2
      Figure 5: Seismic Refraction Profile - Line L3
      Figure 6: Seismic Refraction Profile - Line L4
      Figure 7: Seismic Refraction Profile - Line L5
      Important Information about Your Geotechnical/Environmental Report
NOTE
Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth ™ Mapping Service.
NOTE
Figure adapted from file 748400XC01.dwg received October 27, 2014.
FIG. 3

SAGECREST ELEMENTARY SCHOOL
KENNEWICK, WASHINGTON

SEISMIC REFRACTION PROFILE
LINE 1

November 2014
22-1-03087-001

SHANNON & WILSON, INC.
Environmental Consultants
SEISMIC REFRACTION PROFILE
LINE 3
November 2014

Sagecrest Elementary School
Kennewick, Washington

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants
FIG. 5
Approximate Scale in Feet

Sagecrest Elementary School
Kennewick, Washington

SEISMIC REFRACTION PROFILE
LINE 5
November 2014 22-1-03087-001
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants FIG. 7
IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.
A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform additional or alternative work believed necessary to obtain the data specifically appropriate for construction estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland
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SOIL MOISTURE DETERMINATION - ASTM D2216

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Grain Size Distribution

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DATE SAMPLED: 12/22/2014
DATE TESTED: 12/23/2014
TESTED BY: AJD/SRB

REVIEWED BY: X Shriver
APPENDIX C

IMPORTANT INFORMATION ABOUT YOUR
GEOTECHNICAL / ENVIRONMENTAL REPORT
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