



Project Report

Application of High Definition 2D and 3D Seismic Tests for Characterization of the Floridan Aquifer System in the Lake Okeechobee Area

Submitted to:

**Bob Verrastro, P.G.
Principal Hydrogeologist
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406**

Submitted by:

**Hughbert Collier, Ph.D., P.G.
Senior Vice President
Collier Consulting, Inc.
590 East South Loop
Stephenville, TX 76401**

Report by:

**Finn B. Michelsen, P.G.
Sr. Geophysicist

John Jansen, P.G.
Sr. Geophysicist/Hydrogeologist**



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1.0 Introduction

Under contract to South Florida Water Management District (Contract No. 4600003869), Collier Consulting Inc. (CCINC) was commissioned to perform a “Proof of Concept” application for acquisition and processing of high resolution seismic data at candidate site locations for construction of wells within the Floridan Aquifer System (FAS) around the Lake Okeechobee area. As part of the plan the District identified a need for improved geologic characterization of the FAS in terms of stratigraphic and hydro-geologic structure. High resolution 2D and 3D seismic acquisition, data processing, and seismic modeling methods, originally developed for oil and gas exploration, have been successfully adapted for high definition mapping and characterizing shallow geology. The “Proof of Concept” 2D and 3D seismic test program represents a qualitative performance evaluation of high resolution seismic data acquisition and processing methods to characterize formations within the Upper and Lower FAS. In addition, the program was designed to evaluate the potential to delineate karst systems and structures that can provide hydrogeologic information concerning the flow of groundwater between major permeable zones within the Floridan aquifer. The 2D and 3D results were compared to evaluate whether 3D significantly improves the geologic delineation.

The sites selected for seismic testing included Okeechobee Utility Authority (OUA), Kissimmee, Spoil Management Area (near Moore Haven), and the Palm Beach County Lake Region Area. Figure 1 shows the sites that were selected for the test seismic surveys.

The geophysical method used for this survey is seismic reflection. Seismic reflection records the travel time of seismic waves generated by a surface energy source to a geologic horizon along wave-field ray paths that are reflected off geologic interfaces and return to the surface. Seismic reflection provides very detailed images of the subsurface geology to depths ranging from a few hundred feet to thousands of feet bgs. It is different than seismic refraction, which uses longer wave paths of energy that travel along formation boundary interfaces and radiate seismic energy back to the surface as refracted head waves. Seismic refraction surveys are not capable of mapping geologic layers with seismic velocities that are lower than the overlying layer. Moreover, the depth of investigation for refraction surveys is one-fourth to one-fifth of the maximum active seismic line length, and is therefore limited with respect to application.

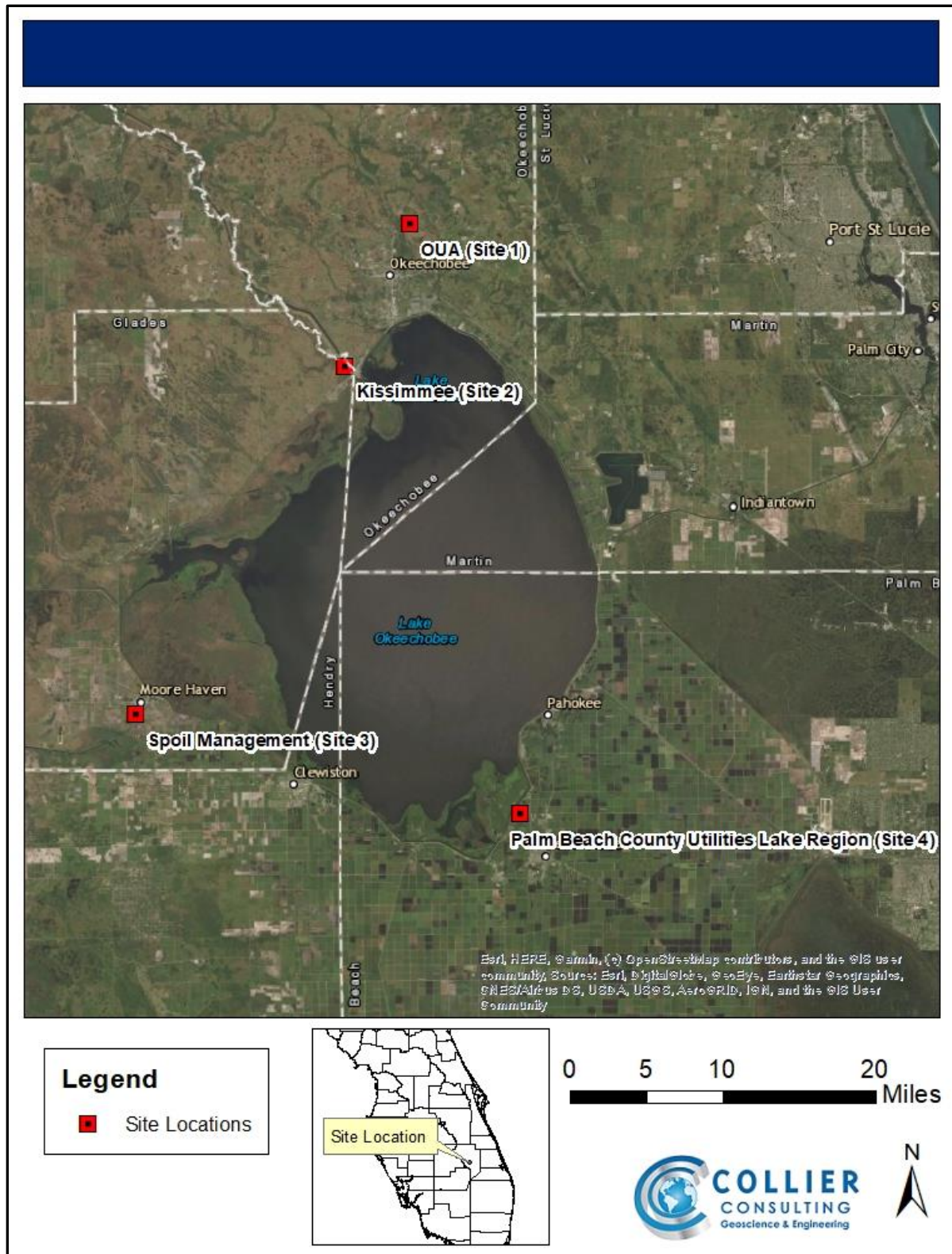


Figure 1: Location of Lake Okeechobee seismic test sites

CCINC initiated mobilization of equipment and personnel to Okeechobee, Florida in preparation for commencement of field work on December 3, 2018. Based on logistics requirements, the support for operations and equipment was setup and stationed in Okeechobee, and at the Okeechobee Utility Authority (OUA) Facility. Seismic data acquisition operations were performed December 3 – 19, 2018, and from January 3 – 7, 2019.

1.1 Seismic Survey Test Objectives

Area borehole data and other hydrogeologic information used for planning the installation and operation of FAS wells indicated the need for additional geophysical information to provide better geomorphological and geo-structure delineation for characterization of the FAS, the top of which is reported to be approximately 1,000 feet below ground surface (fbgs). The Boulder Zone, the lower member of the Oldsmar formation, is a karstic formation that exhibits various complex stratigraphic and structural attributes. In addition, SFWMD identified the need to delineate the formation boundaries and geo-stratigraphic and structural attributes associated with the overlying upper and lower Floridan Aquifer systems, especially with respect to the potential for stratigraphic viability, identifying faults, vertical channels, fracture zones, and other structural attributes that could potentially affect planning, installation, and long term operation of FAS wells at the selected test sites.

Based on the objectives for testing the application of 2D and 3D seismic methods, CCINC staff reviewed various historical sources of geologic and hydrogeologic information concerning the FAS. Design of the seismic survey programs were based on the following criteria:

1. Acquisition of P-wave seismic data that achieved depth objectives.
2. Expected complexity of the FAS in terms of the P-wave velocity structure; diffraction noise, peg-leg multiples, seismic energy dispersion.
3. Acquisition and processing of seismic data with sufficient signal and spatial resolution to delineate general geologic lithology; use available well log data to correlate approximate lithology with major seismic reflector horizons.
4. Maximum desired seismic signal and spatial resolution, with signal bandwidth between 10 and 100 Hertz; vertical and horizontal resolution of approximately 25 feet.
5. Use of seismic equipment that was cost effective, and portable enough for efficient field operations on 2D and 3D seismic surveys.

To achieve the desired seismic survey test objectives, the 2D and 3D surveys were designed using source and receiver geometries appropriate for processing and producing the required data spatial resolution.

thick and consists of silty to sandy clay with thin shell beds and basal limestone beds. In addition, limestone and coarse sand units can occur in the formation west of Lake Okeechobee. The Hawthorn Group forms a semi-confining unit between the SAS and the underlying FAS, referred to as an Intermediate Confining Unit. The Lower Hawthorn Production Zone lies beneath the Intermediate Confining Unit in the Basal Hawthorn Group. It is between 10 to 180 feet thick and forms the upper part of the Upper Floridan aquifer.

Beneath the Hawthorn Group lies the Early Oligocene Suwannee Limestone, and Eocene Ocala Limestone formations. The Suwannee is a thin, discontinuous 0 to 150 ft. thick phosphatic limestone that lies above the Ocala Limestone. The Ocala Limestone is 0 to 300 feet thick. These two units, along with the Lower Hawthorn Production Zone and the upper part of the Avon Park formation, comprise the Upper Floridan aquifer.

The Avon Park formation includes the Middle Confining and Middle Floridan Aquifer Units, which underlie the Ocala Limestone. The unit sequences were deposited during the Middle Eocene Age, and ranges in thickness from 500 to 1,200 feet. The upper part of this unit forms the base of the Upper Floridan aquifer. Within the upper 100 to 300 feet of the Avon Park formation, layers of dense limestone and dolomite form a semi-confining unit between the Upper and Lower Floridan aquifers called the Middle Confining Unit. The lower 400 to 900 feet of the Avon Park formation consists mainly of dolomite, dolomitic limestone, limestone, and some gypsum, forming an upper permeable zone within the Lower Floridan aquifer.

The Oldsmar formation underlies the Avon Park formation. It is 600 to 1,800 feet thick and forms the lower section of the Lower Floridan aquifer system. Lithologically, it consists of indurated crystalline dolostone that grades to alternating limestone and dolostone sequences. Depth to the Oldsmar Formation in the Lake Okeechobee region can range from 1,850 fbs to 2,700 fbs. Below 1,850 fbs anhydrite and gypsum are often present within the dolostone sequence. The lower 300 to 600 feet of the Oldsmar formation contains the Boulder Zone, a zone of discontinuous and highly permeable fractured or cavernous limestone-dolomite structures. Similar zones can also be present in the upper part of the Oldsmar Formation. Beneath the Oldsmar formation is the Paleocene Age Cedar Keys formation. The Cedar Keys formation consists of layers of dolomite and anhydrite, and is the lower confining unit at the base of the Lower Floridan aquifer; the sub-Floridan Confining Unit.

1.3 Seismic Survey Equipment

For recording of 2D and 3D seismic data, CCINC used the Geospace Technologies GSX cable-less seismic system. The GSX is designed for cable-free and radio-free seismic data recording. The self-contained GSX Land Based Recorder unit includes 1 to 4 channels of 24-bit A/D digitization, an integrated high sensitivity GPS receiver, built-in test signal generator, up to 32 GB per channel of non-volatile solid-state data storage, and a high-speed data port.

The unit is housed in a sealed case, with input connectors for battery and geophones.



Geospace GSX Seismic System

To propagate sufficient seismic energy for generation of signal reflections from the required target depths, and to produce data with a 10 to 100 Hertz bandwidth, CCINC elected to use the XLR8-2000 Accelerated Impact Source (AIS) system. In addition to performance, the XLR8-2000 is more economical and efficient than other seismic energy source systems. The XLR8 is designed to minimize impact on the environment and surface or subsurface infrastructure.



XLR8 Accelerated Impact Source (AIS)

The CCINC XLR8-2000 AIS was equipped with the Geospace Source Data Recorder (SDR) unit, GPS, Hammer “Hit” Sensor, and Source Signature Geophone. The SDR records the hammer hit time based on the GPS receiver clock to monitor and record in real-time the accurate control “time-break” (seismic zero-time). The SDR also records in real-time GPS X, Y, and Z coordinates for each of the source (SRC) stations. GSX and XLR8-2000 seismic equipment information and specifications are attached to this report in APPENDIX 1.

1.4 Seismic Line Geometry and Data Recording Parameters

The 2D and 3D seismic survey geometry and recording parameters were determined on the basis on SFWMD project objectives and plans for the Lake Okeechobee area, and on model analysis of geology and hydrogeology information.

For the OUA (Site #1) and Kissimmee (Site #2) 2D seismic survey geometry, CCINC used a 2D two-line swath survey; swath configuration can improve attenuation of seismic signal back-scatter associated with fracture zones.

2D Seismic Swath Geometry for OUA and Kissimmee Sites

Seismic Line Lengths	: 2 lines (1 mile each line)
Geophone Interval	: 50 ft. (Type: GS-One single 10 Hz)
Seismic Receiver Line Separation	: 50 ft.
Center Source Line Length	: 1 line (1 mile)
Source Line Offset from Receiver Lines	: 25 ft.
Source Point Interval	: 100 ft. (5 hits per SRC station @450-550 psi)
Recording Sample Rate	: 1 millisecond
Record Length	: 3 seconds (SEG Y Format)
Data Acquisition Filters	: 2 HZ Low-Cut, High-Cut Open

For the Kissimmee 2D swath line an additional seven (7) SRC roll-on/roll-off extension points were added to increase Common Depth Point (CDP) fold coverage near RCVR line end.

For the Lake Region 2D seismic survey, obstacles and environmental constraints prevented using the two-line swath configuration. In addition, the planned 2-mile seismic lines along State Road 80 and State Road 715 (NW 16th-17th Street) were divided into two 1-mile segments because of road intersections. The gap between line segments is equivalent to 10 receiver stations (~ 450 ft.).

2D Seismic Line Geometry for State Road 80 and State Road 715

Seismic Line Lengths	: 4 lines (1 mile each line)
Geophone Interval	: 50 ft. (Type: GS-One single 10 Hz)
Source Line Lengths	: 4 lines (1 mile each line)
Source Point Interval	: 100 ft. (5 hits per SRC station @ 350-400 psi)
Recording Sample Rate	: 1 millisecond
Record Length	: 3 seconds (SEG Y Format)
Data Acquisition Filters	: 2 HZ Low-Cut, High-Cut Open

Figures 3a, 3b, and 3c are plots of the locations for seismic receiver lines (RCVR) and AIS source (SRC) stations for OUA (Site #1), Kissimmee (Site #2), and the four seismic line segments for the Lake Region (Site #4 – State Road 80 and State Road 715) respectively.

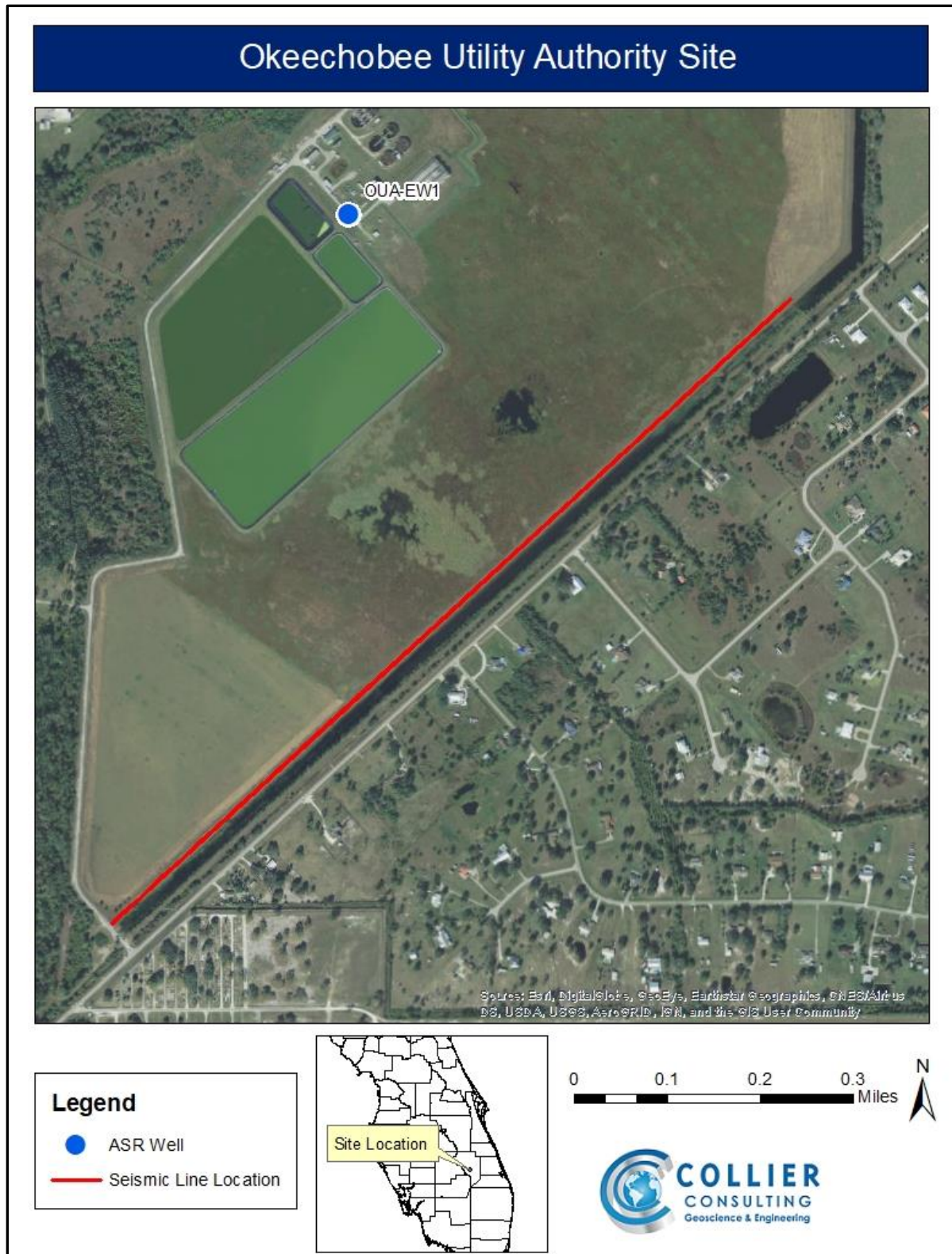


Figure 3a: OUA 2D seismic line location map.

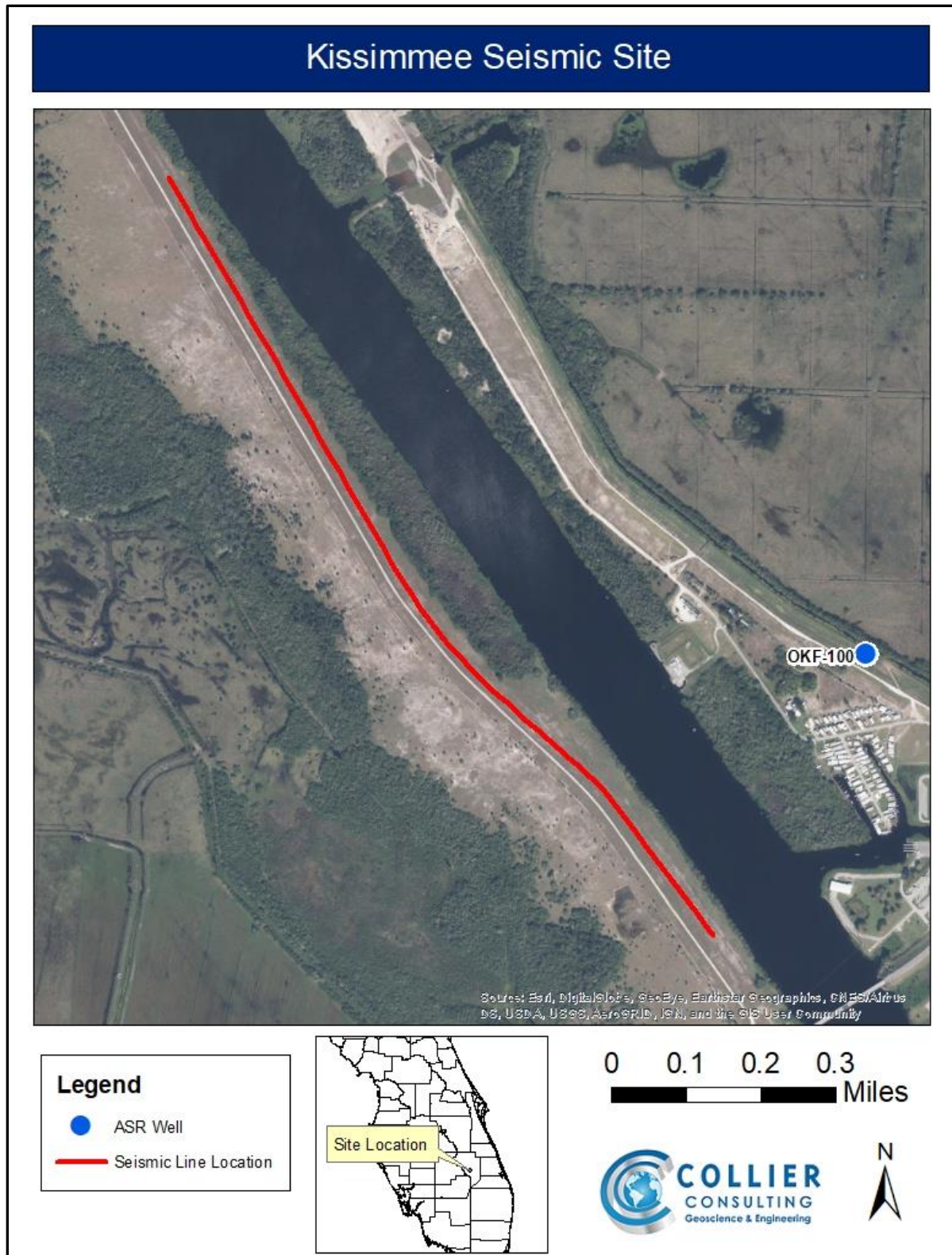


Figure 3b: Kissimmee 2D seismic line location map.

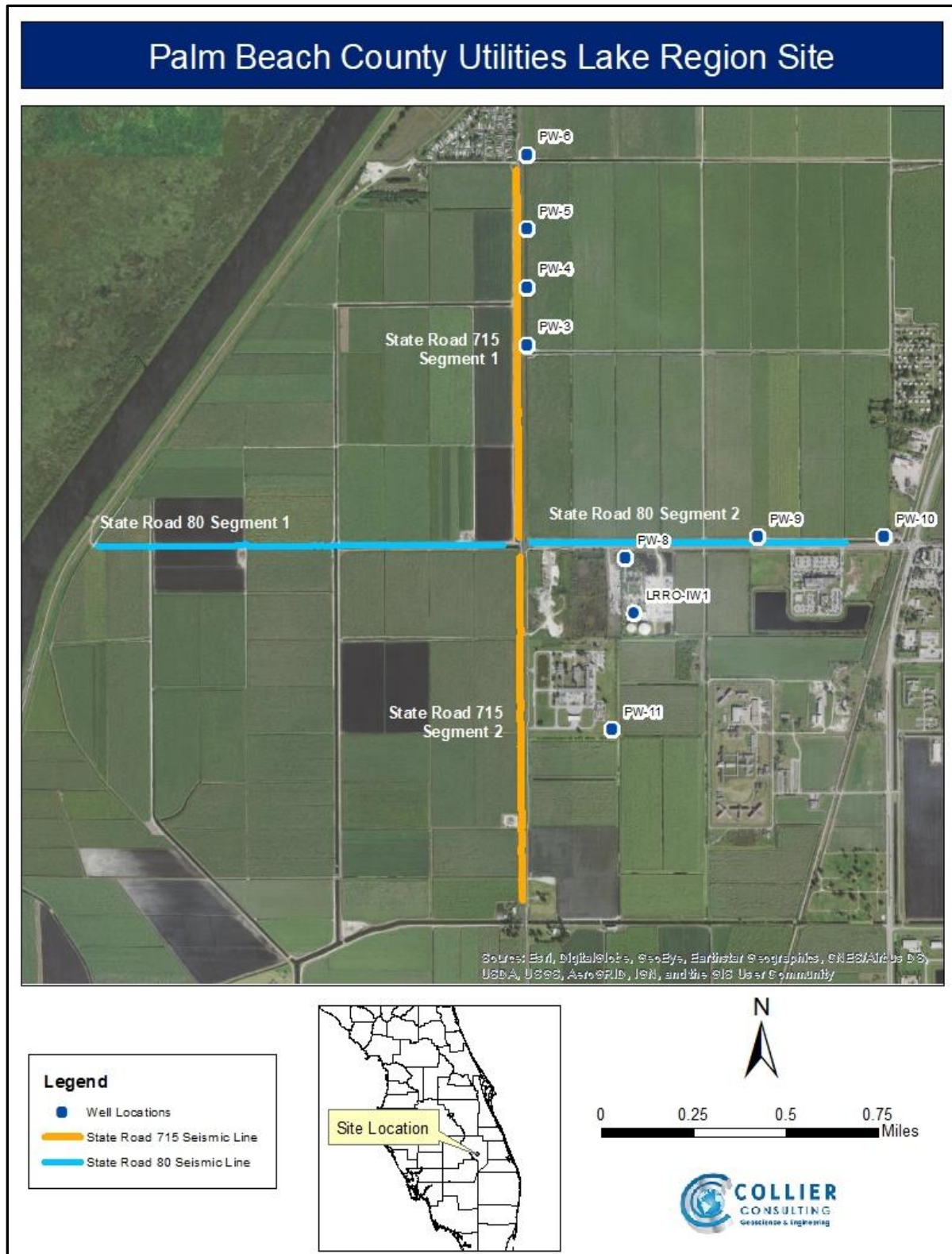


Figure 3c: Palm Beach County Lake Region seismic line location map.

3D Seismic Grid Geometry for Spoil Management Area (Site #3)

CCINC field crew acquired seismic data for 3D processing at the Spoil Management Site #3 using an orthogonal grid of RCVR and SRC lines. The original 2D seismic swath plan was aborted because the deployment of GSX RCVR units was limited to CDP coverage of no more than 0.5 miles. An alternative 3D grid design provided sufficient maximum SRC-to-RCVR offset and CDP bin azimuthal distribution, which was needed to generate seismic data with adequate CDP fold within the targets depth range. Figure 4 presents the 3D RCVR and SRC seismic survey grid.

Number of RCVR Lines	: 8 (east-west orientation, 5006 – 5012)
RCVR Line Spacing	: 200 ft.
Number of SRC Lines	: 11 (north-south orientation, 3003 - 3013)
SRC Line Spacing	: 200 ft.
Geophone Interval	: 50 ft. (Type: GS-One single 5 Hz)
Source Point Interval	: 100 ft. (5 hits per station @ 350-400 psi)

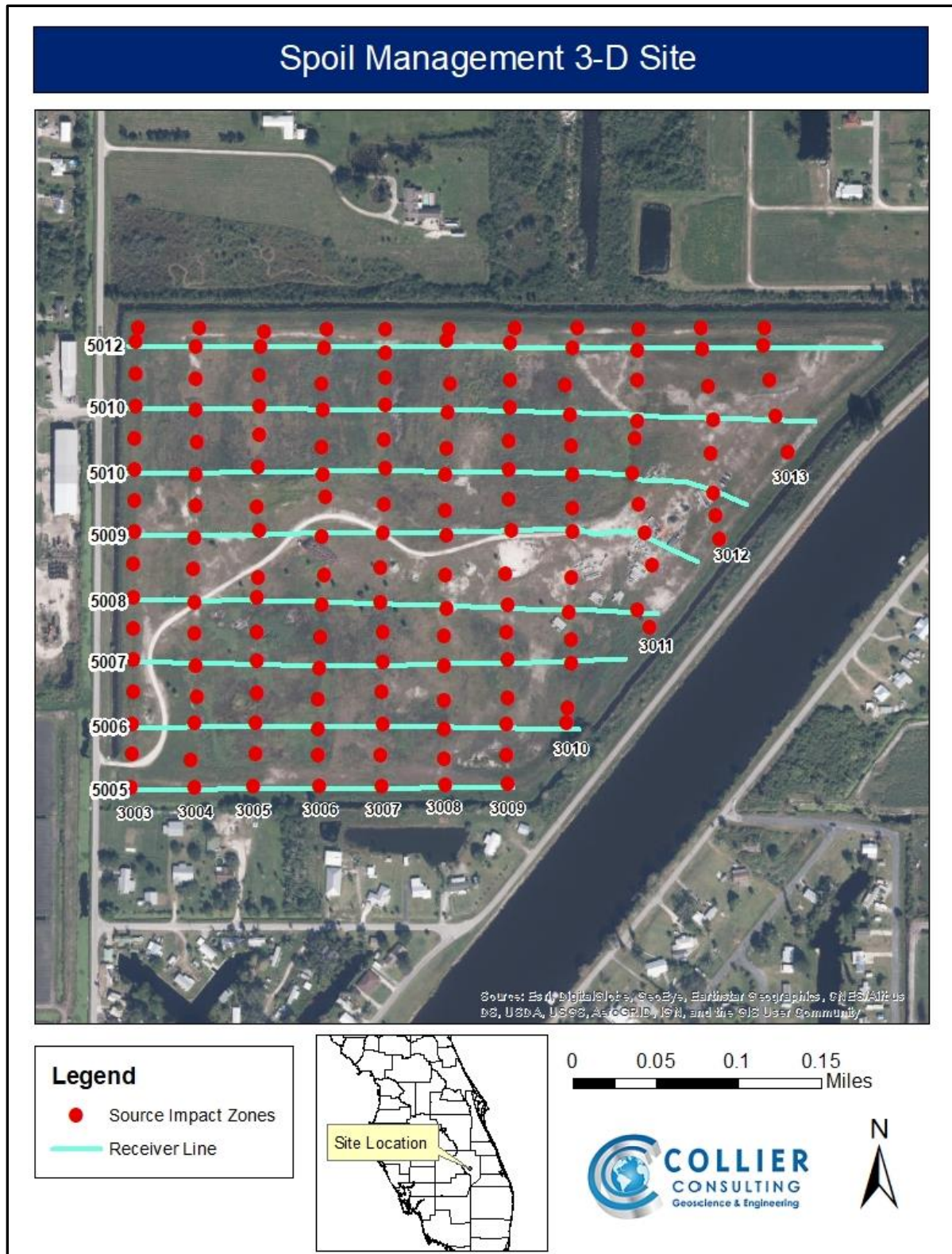


Figure 4: Spoil Management 3D survey grid design.

Geodetic coordinates for all Spoil Management 3D seismic survey RCVR and SRC coordinates are given in Appendix 2.

Seismic data recording parameters for the 3D survey were the same as used for the 2D swath seismic surveys; 1 millisecond sample rate, 3 second record length, 2 HZ low-cut and open high-cut filters.

1.5 Geodetic Survey Control

Geodetic survey control was established for all 2D and 3D RCVR and SRC lines using the Trimble R8 GPS system. The control survey points consisted of X, Y, Z coordinates for all RCVR and SRC line end points, and where possible, survey points at every 500 feet along each line. Final geodetic post processing and post-plots used all survey control points, and all recorded GSX and XLR8-2000 GPS coordinates. The Coordinate Projection System used for data processing and the generation of all RCVR and SRC stations is NAD 83 State Plane Florida East FIPS0901. Seismic RCVR and SRC station coordinates for all 2D and the 3D survey are presented in Appendix 2.



Trimble R8 GPS Receiver

2.0 Seismic Instruments and Data Acquisition QA/QC

The GSX data recording units require data survey parameter programming prior to deployment. During programming, all internal circuits are fully tested in accordance with manufacturer guidelines. In addition, batteries are charged and geophones performance tested prior to project mobilization. Once programmed, all required GSX data recording units are deployed using a GSX Line Viewer to record station ID, GSX GPS locations, and GSX unit operating status. Both the AIS and GSX seismic recording instruments were checked and inspected daily.

2.1 XLR8-2000 Accelerated Impact Source Performance

Critical to producing 2D and 3D high resolution seismic data is energy source performance. As part of the XLR8 AIS setup process, testing is performed to determine the optimum energy output and “shot stack” requirements. Given the desired seismic data frequency resolution needed for producing high-resolution seismic sections from processing, the required source signal frequency bandwidth must be between 12 – 96 Hertz. A shot stack count of five (5) ground impacts, operating at 450 psi, was more than sufficient to meet the specified recording of data with a frequency bandwidth 12 to 96 Hertz. Figure 5 is a power spectrum (dB value versus frequency) determined from pre-survey field testing.

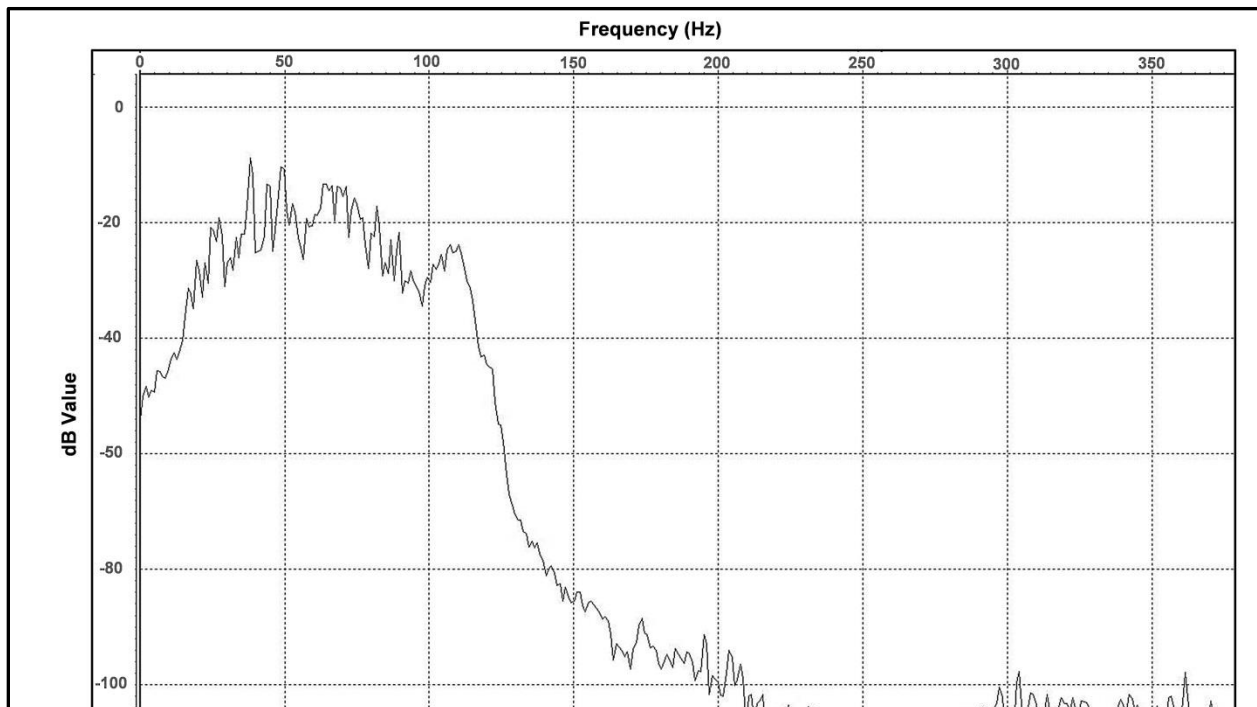


Figure 5: Raw unfiltered AIS amplitude versus frequency spectrum showing good seismic frequency content between 10 Hz and 125 Hz.

The seismic frequency bandwidth achieved for all 2D and 3D seismic data acquired exceeded minimum requirements. Using advanced Bandwidth Extension (BWE) source signal

processing, which improves source signature signal-to-noise, balances and flattens the frequency spectrum, the actual usable seismic data bandwidth used in processing was 12 Hz to 130 Hz. Figure 6 is the final AIS Power Spectrum with BWE.

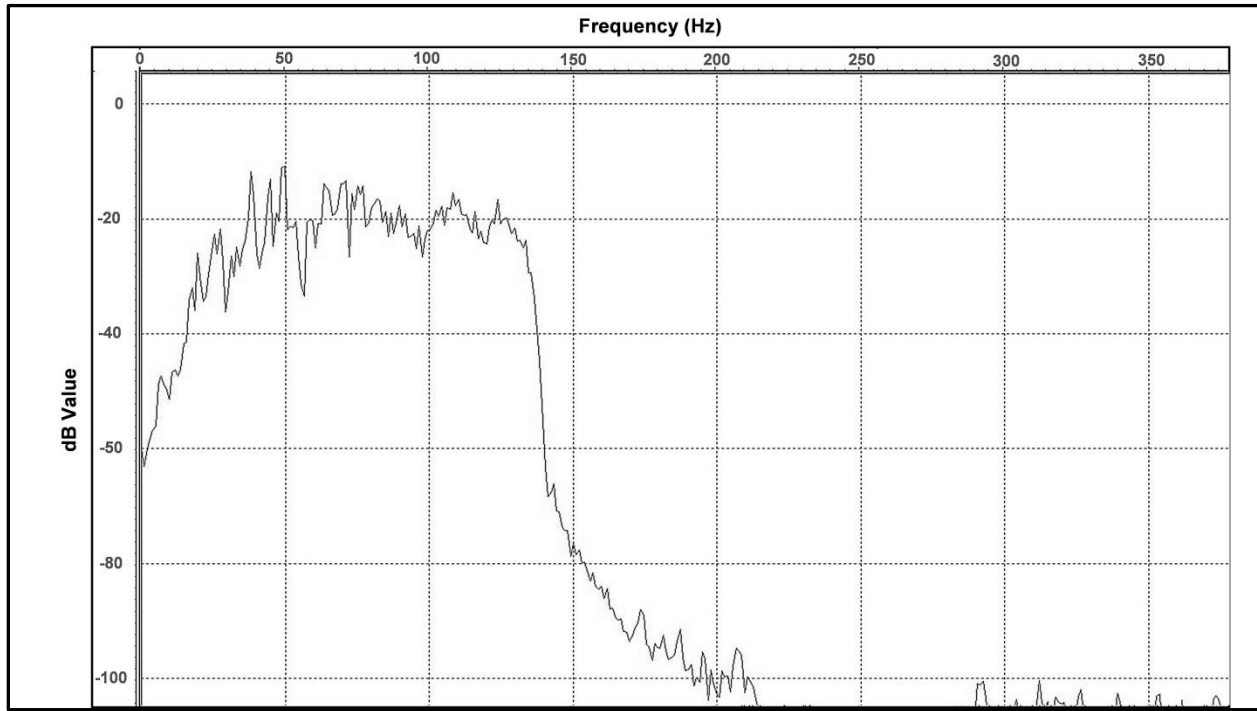


Figure 6: Final AIS frequency bandwidth used in processing all SFWMD 2D and 3D seismic data after application of Bandwidth Extension.

2.2 Seismic Data Quality

The Geospace GSX is a very reliable, efficient, and environmentally friendly seismic system. It has been in use by the oil and gas exploration industry for more than ten years, on 2D and 3D seismic projects requiring thousands of GSX seismic channels deployed. Like all cable-free seismic systems, it does not provide for real-time viewing of raw data during acquisition operations. Seismic data from each line is available for viewing only after the GSX units are retrieved from the field, data harvested, and output in SEG-D or SEG-Y standard formats. On seismic projects where only a small number of GSX seismic channels are deployed on short survey lines, the field geophysicist will perform data QA/QC after data from each seismic line is complete, data harvested and formatted. A complete review of all raw unprocessed seismic records is typically performed after the first seismic line is complete, mainly for inspection and evaluation of data quality.

Figure 7 is a raw unfiltered “stack” seismic record from OUA Line 5001, source station 1067 (center of RCVR line). Automatic Gain Control is applied for trace amplitude balancing, and the record length shown is a full 3 seconds. Figure 8 is a test CDP stack section to evaluate optimal data filter parameters and seismic reflection horizon continuity. Both Figures 7 and 8 are representative examples of industry standard geophysics QA/QC data analysis, performed

to confirm survey design acquisition parameters, data quality, and GSX data recording performance.

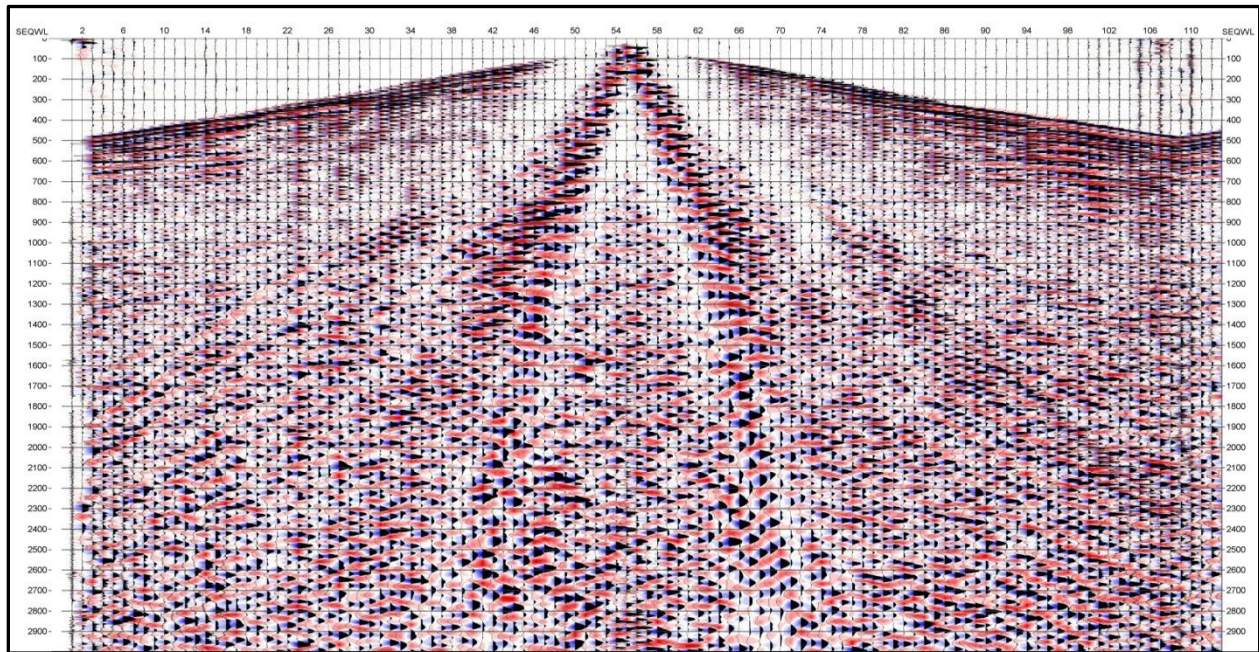


Figure 7: Unfiltered Automatic Gain Control (AGC) stack shot gather from OUA 2D seismic line 5001, source station 1067 (3 second record length, 1-mile RCVR line).

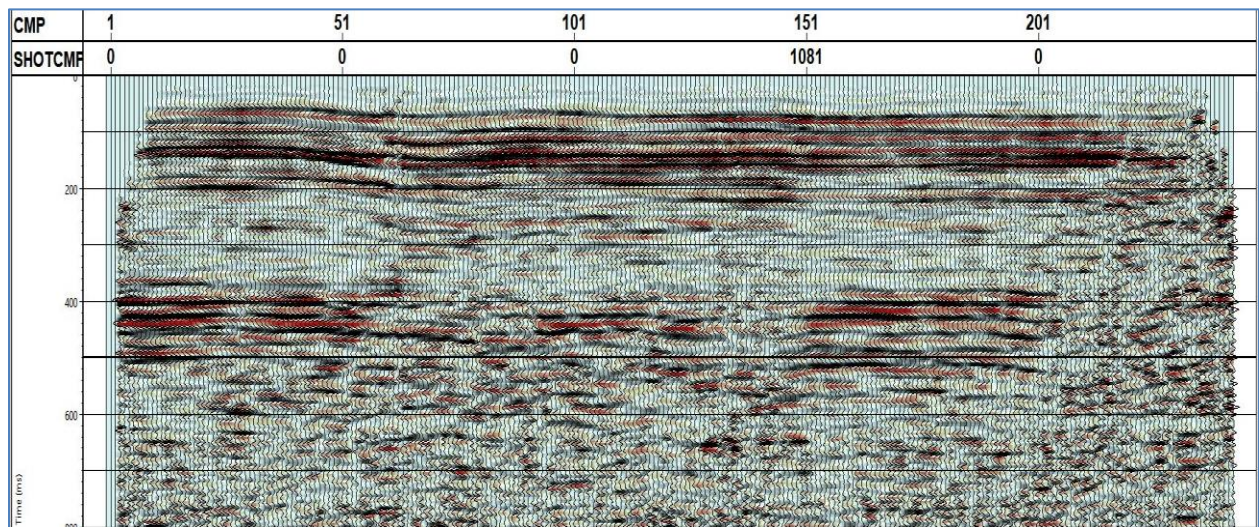


Figure 8: Preliminary 2D seismic CDP stack section (1-mile seismic line) for QA-QC of data filter parameters and overall seismic reflection quality.

3.0 2D and 3D Seismic Data Processing

Upon completion of data acquisition operations and pre-processing QA/QC, all 2D and 3D seismic and geodetic data were sorted and archived for delivery to the processing center. All geodetic survey data received post-processing analysis to compare and correlate Trimble R8

control survey data with the GSX and AIS GPS data. Maximum RCVR and SRC GPS station position error was $\sim \pm 2$ -3 feet.

All P-wave seismic data processing work was performed using the Vista™ 2D and 3D Seismic Data Processing program. Following comprehensive testing and analysis of data processing algorithms a final processing flow was designed.

General Seismic Data Processing Flow

1. Reformatting
2. Geometry / Trace Edit / Trace First Break Picks
3. Time Variant Logarithmic Scaling
4. Pre-filter 12 HZ - Out
5. Noise Reduction by Adaptive Subtraction
6. Surface Consistent & Source Signature Deconvolution, Shot and Receiver
Operator = 220 ms. Lag = 1 ms.
7. Spectral Balance
8. Datum Statics Datum = Sea Level
9. Refraction Statics
 - A. Vista 2-Layer Modeling
 - B. GeoTomo Tomographic Modeling
10. Automatic Surface Consistent Reflection Statics: 2 Passes
11. NMO/Mute
12. Noise Reduction by Radon Filter and Rank Reduction
13. DMO / Linear Noise Removal
14. White Noise Suppression by Principle Component Modeling
15. Final CDP Stack
16. Bandwidth Extension (BWE)
17. Migration
18. AGC
19. TVF

0-0.300 Sec.	20-120 HZ
0.45-0.65	20-96
0.80-1.5	20-84

Collier Consulting used the following additional advanced data processing techniques on the 2D and 3D high resolution seismic projects:

- Source Signature Deconvolution is applied using the recorded source signature wavelet for each source position, rather than through statistical derivation.
- Source Signature Bandwidth Extension is applied in order to flatten and balance the amplitude-frequency spectrum of the energy source seismic wave field. This maximizes the usable seismic bandwidth in processing and improves overall data resolution.

- Rather than use statistically derived velocity analysis to correct for near-surface statics, Collier Consulting used full waveform time and wave-field inversion processing to generate continuous vertical and horizontal tomography velocity data to accurately correct for both refraction and reflection statics. The application of more accurate near surface velocity data significantly improves signal and spatial resolution and eliminates the need for excessive spectral seismic data smoothing.
- Seismic tomography processing was also performed to aid with conversion from seismic time to depth domain, which can then provide better correlation between the non-linear seismic depth scale and synthetic seismographs. Since the geophysical well logs used to generate synthetic seismographs were from wells at great distances from the seismic test sites, predictive modeling was performed to derive a local regional average time-to-depth tomography velocity transfer function; used to reference off-site geophysical logs to seismic ties in depth and time. Figure 9 plots the two-way travel-time (TWT) versus depth to compare the modeled time-depth velocity curve and time-depth picks for the synthetic seismographs. The plot shows excellent correlation, and validates the use of time-depth seismic velocity modeling and correlation with the derived well log synthetic seismographs.
- Principal Component Analysis was applied as an additional advanced processing step to de-noise and improve overall signal-to-noise on the 2D seismic data sets. In addition to improvements on further noise attenuation, signal decomposition and constrained pattern recognition is performed to reduce seismic artifacts caused by diffractions and anomalous reflections generated by rock fracture systems.

The 2D and 3D data processing flow were developed on the basis of careful QA/QC tests with raw data files, as well as processing tests to determine best processing steps parameters. The final processing flow is fairly basic, but adds a few advanced steps that are unique to CCI for generating high-definition 2D and 3D panels that can be used for future specialized data attributes processing and analysis that focuses on a more comprehensive characterization and interpretation of the Floridan Aquifer System.

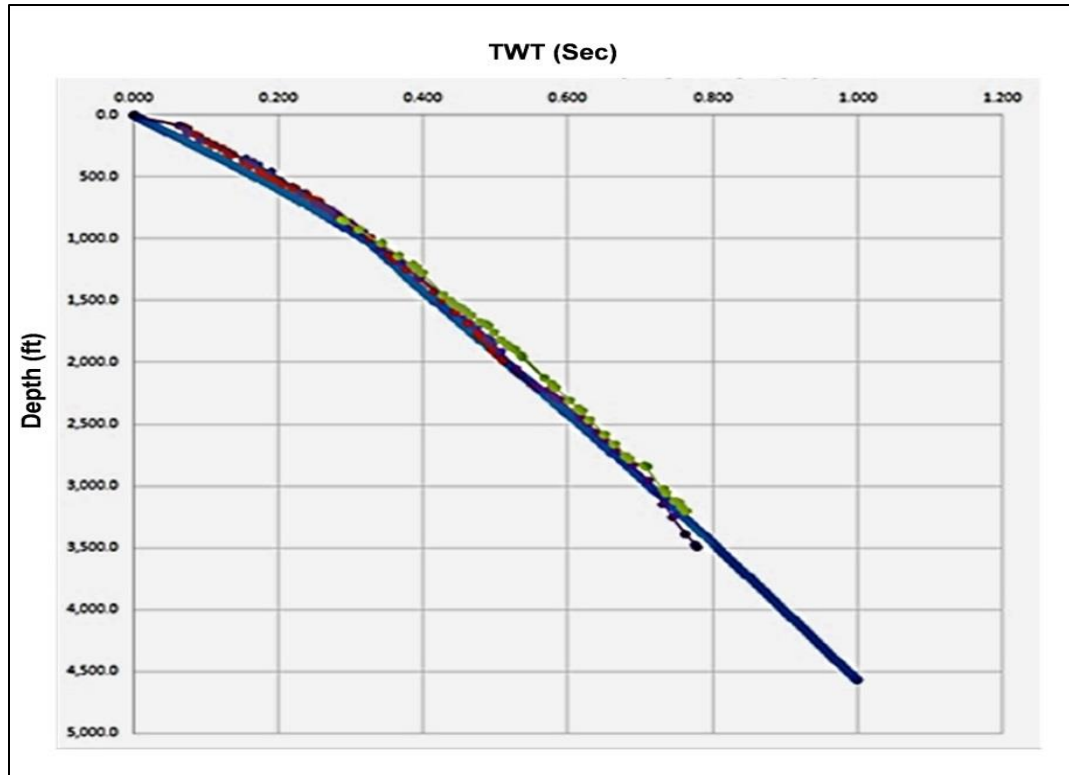


Figure 9: Plot of TWT versus depth comparing time-depth velocity modeling to time-depth synthetic seismograph.

3.1 Synthetic Seismographs

The Synthetic Seismographs that are used to tie site lithology to seismic reflectors in the depth domain were generated using geophysical well log data and lithology information from the Labelle, OUA, and Lake Region injection wells, all obtained from the SFWMD DBHYDRO database. Geophysical log data was selected for modeling of the local regional lithology and generation of synthetic seismographs, because of their nearest proximity to the seismic survey sites and quality-completeness of the log data. In addition to the logs from these well sites, the geophysical logs from a well located in Clewiston was also reviewed and compared with Labelle IW-1 well log data. Figures 10a, 10b, and 10c are the synthetic seismographs for OUA-EW1, Labelle IW-1, and LRRO-IW1, generated using the Ornsby Method (60 Hz center frequency). The synthetic curve picks and lithology correlation tie to seismic reflection data is based on the modeled time-depth-velocity analysis, and lithologic information for each well location.

Valid sonic log (DT) data for OUA-EW1 started at 804 feet BGS. For the Labelle IW-1 geophysical log runs, the sonic log started recording at a depth of 118.5 feet and stopped at 2,011.5 feet BGS. The time-depth average area velocity modeling, along with additional lithologic information, was used to infill the missing sonic log data, and to aid with tie-in to seismic data from each of the seismic test sites. The gamma and resistivity logs were also included in the generation of synthetic seismographs, but only for QC correlation purposes.

A correlation was made to the noted depth of the Underground Source of Drinking Water (UDSW) depth at each well. The USDW is based on water quality and not a stratigraphic unit. However, there was a distinct reflection event at the USDW depth on each log, suggesting that there may be a stratigraphic feature that controls the mixing of water quality in the formation. We referred to this event as the USDW marker and used it for time depth conversion because it was a consistent reflector with a known depth identified on each log.

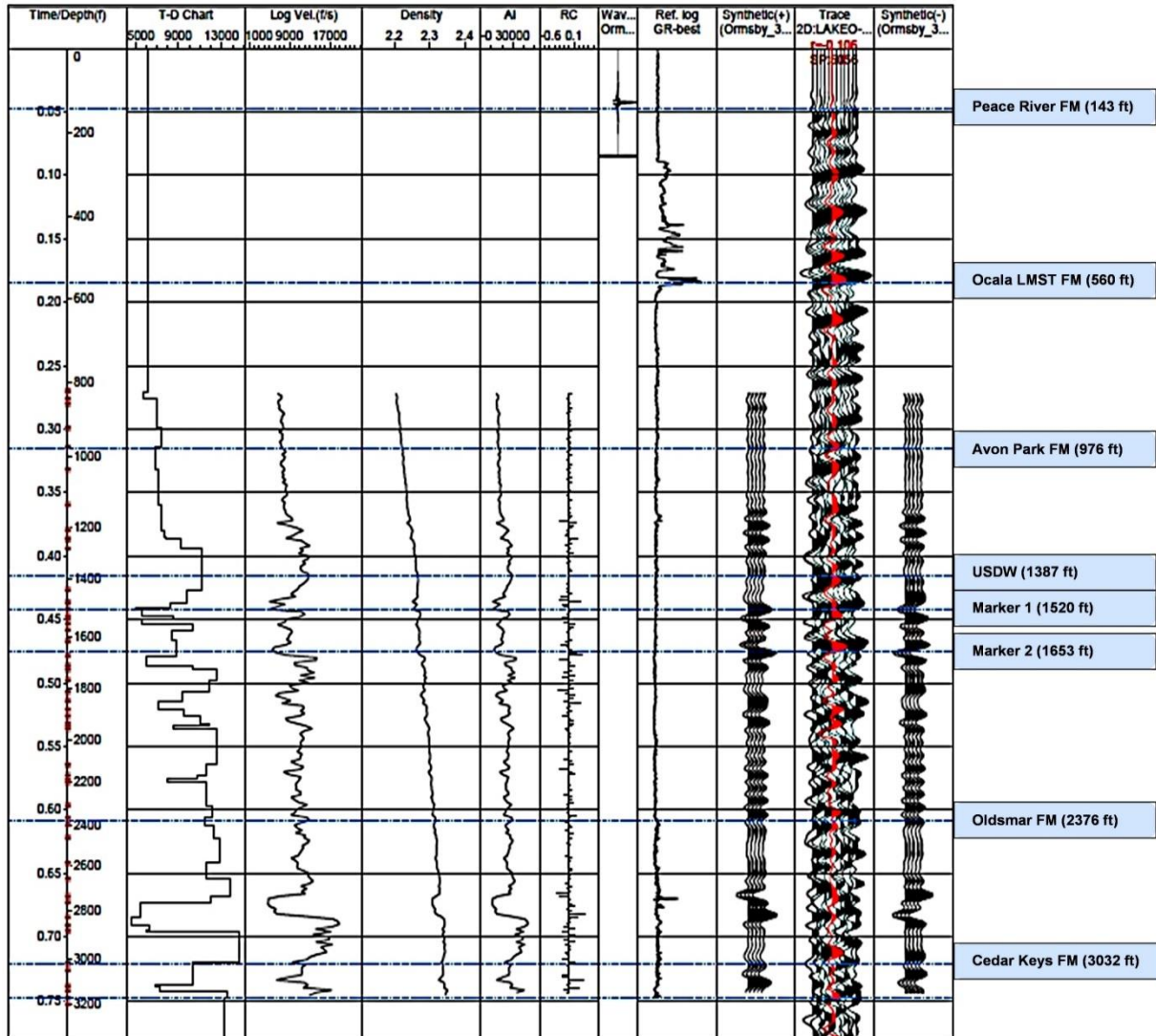


Figure 10a: OUA-EW1 synthetic seismograph tied to OUA 2D seismic data.

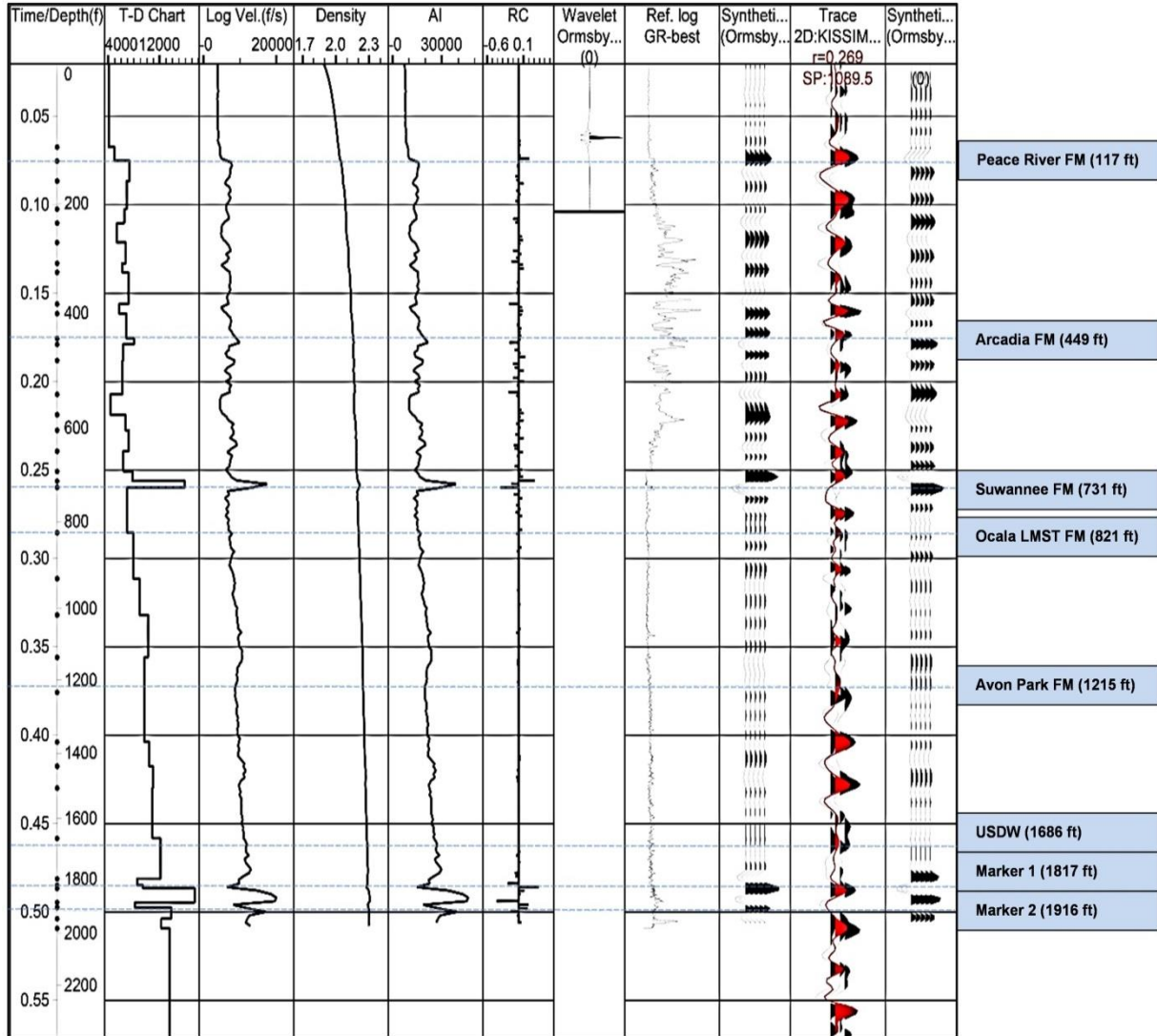


Figure 10b: Labelle IW-1 synthetic seismograph tied to Kissimmee 2D seismic data.

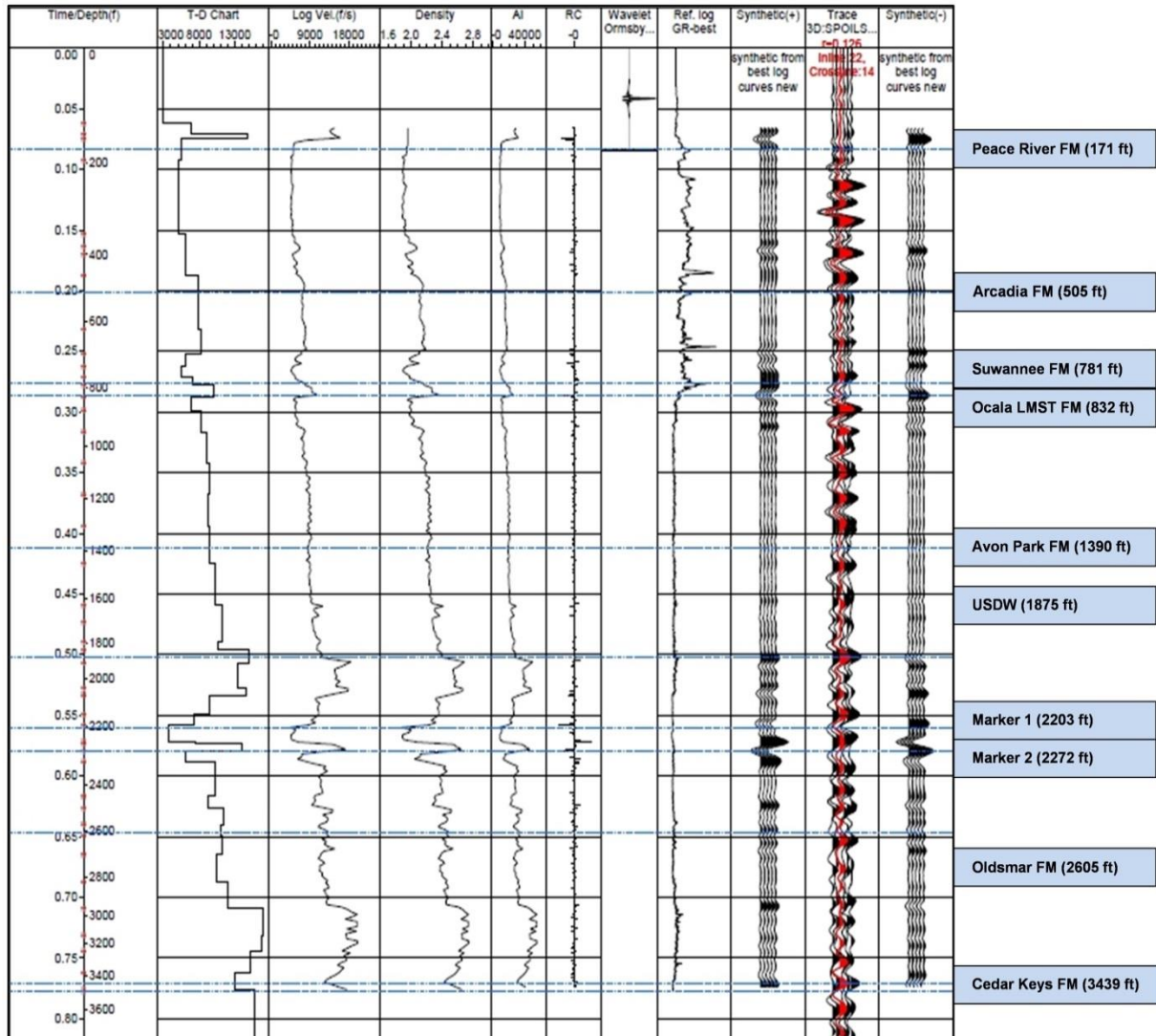


Figure 10c: Lake Region LRRO-IW1 synthetic seismograph tied to Spoil Management seismic data.

Using the final synthetic seismograph, seismic correlation ties, and area P-wave velocity models for each of the seismic test sites, a set of depth-time-velocity tables were generated, which includes both average and interval velocity. Tables 1a, 1b, and 1c are the final depth, time, and velocity versus depth information derived from the synthetic seismograph to seismic data ties for the OUA, Kissimmee, Palm Beach Lake Region, and Spoil Management sites.

Establishing an accurate time, depth, and P-wave velocity relationship using the synthetic seismograph to seismic trace correlation for each of the test sites is critical to interpretation of the 2D and 3D data. The TWT on seismic data does not have a linear relationship to depth because the P-wave velocity does not increase linearly. To generate a common time-depth scale for each of the seismic test sites, an area P-wave velocity model is derived from the synthetic seismograph analysis, from which the time and depth can be used to

pick formation reflection horizons that fit with well log lithology. The approximate depth error using this modeling and velocity transfer function method is +/- 15 feet.

Table 1a: Time to depth conversion for the OUA-EW1 Well log tied to Seismic Line 5001.

OUA-EW1 Lithology-Velocity				
Formation	Depth to Formation Top Elevation BGS (feet)	Average Velocity (feet/sec)	Interval Velocity (feet/sec)	Formation Top (milliseconds)
Peace River Formation	143	5967	6097	48
Suwannee Limestone	Absent			
Ocala Limestone	580	6064	6390	184
Avon Park Formation	976	6199	8184	314
USDW	1387	6679	10004	415
Oldsmar Formation	2376	7811	11546	608
Cedar Keys	3032	8399	10396	722

Table 1b: Time to depth conversion for the Labelle-IW-1 Well log tied to Seismic Line 5004.

Labelle IW-1 Lithology-Velocity				
Formation	Depth to Formation Top Elevation BGS (feet)	Average Velocity (feet/sec)	Interval Velocity (feet/sec)	Formation Top (milliseconds)
Peace River Formation	117	3082	6639	76
Arcadia Formation	449	5108	6718	178
Suwannee Limestone	731	5629	7020	260
Ocala Limestone	821	5754	9074	285
Avon Park Formation	1215	6529	10418	372
USDW	1686	7289	11490	463
Oldsmar Formation	2673	8740	13514	612
Cedar Keys	3210	9289	13514	691

Table 1c: Time to depth conversion for the LRRO-IW1 well log and tied to the Spoil Management Site.

LRRO-IW1 Lithology-Velocity				
Formation	Depth to Formation Top Elevation BGS (feet)	Average Velocity (feet/sec)	Interval Velocity (feet/sec)	Formation Top (milliseconds)
Peace River Formation	171	4413	5688	84
Arcadia Formation	505	5679	7375	200
Suwannee Limestone	781	5705	9245	270
Ocala Limestone	832	6096	8898	287
Avon Park Formation	1390	6278	10754	412
USDW	1875	7497	11280	502
Oldsmar Formation	2205	8078	9887	646
Cedar Keys	3439	8943	13460	770

3.2 Regional Geologic Correlation

Figure 11a shows the location of wells (OUA-EW1, Labelle-IW1, LRRO, IW1) in the study area that provided geophysical well log data required for developing regional cross-section ties between site seismic synthetic seismograms lithology, and sites stratigraphy. Figure 11b is the cross-section that was developed to show regional correlations of the major formations in the

study area using the geophysical well logs. Figure 11b illustrates that the Peace River through Suwannee formations are generally horizontal with uniform thickness along the line of section but the Ocala through Cedar Keys formations thicken significantly to the south, west, and east. Understanding of the well log correlations and seismic litho-stratigraphic relationship is important for interpretation of the seismic data for test sites 2D and 3D seismic data.

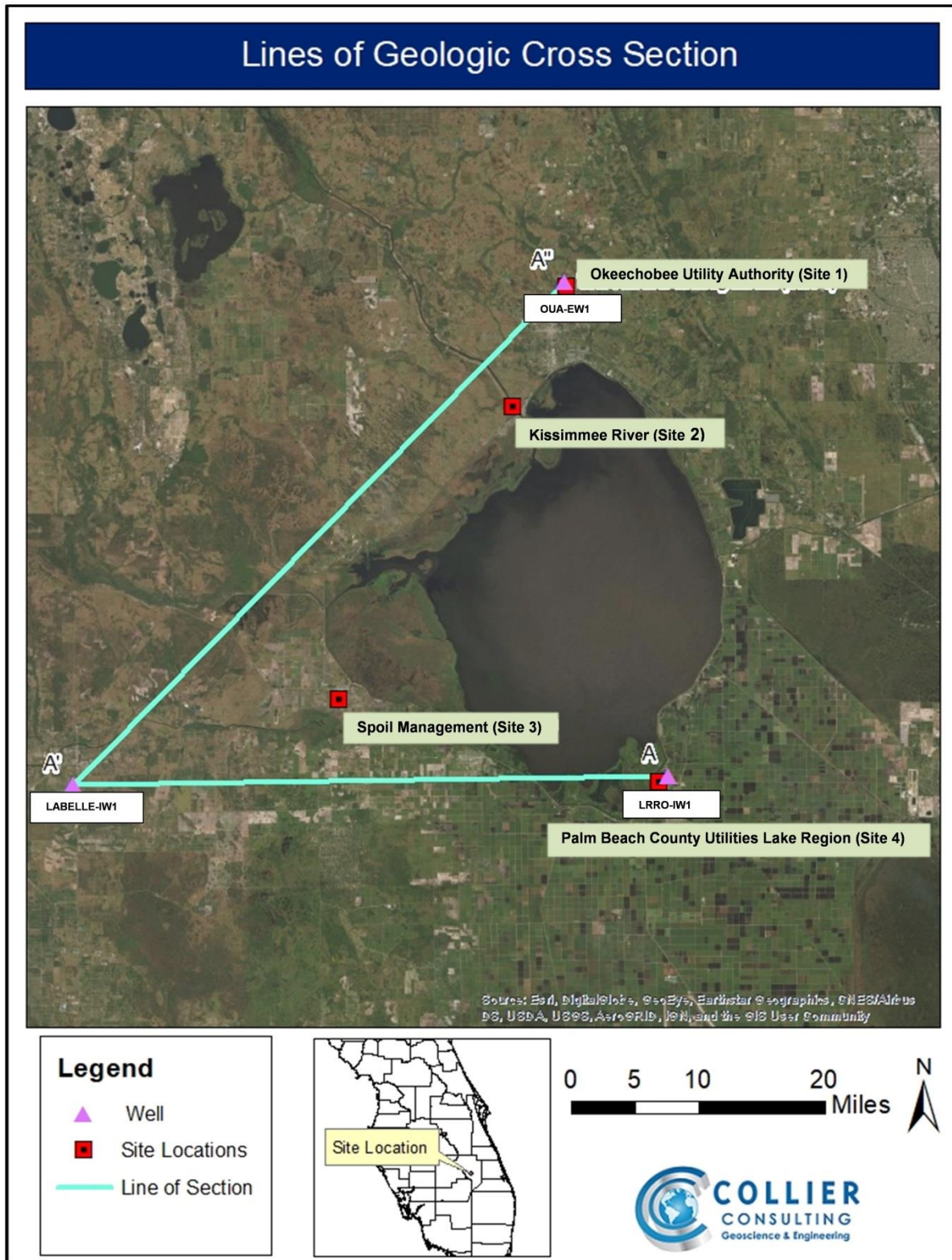


Figure 11a: Cross-Section lines from regional well logs.

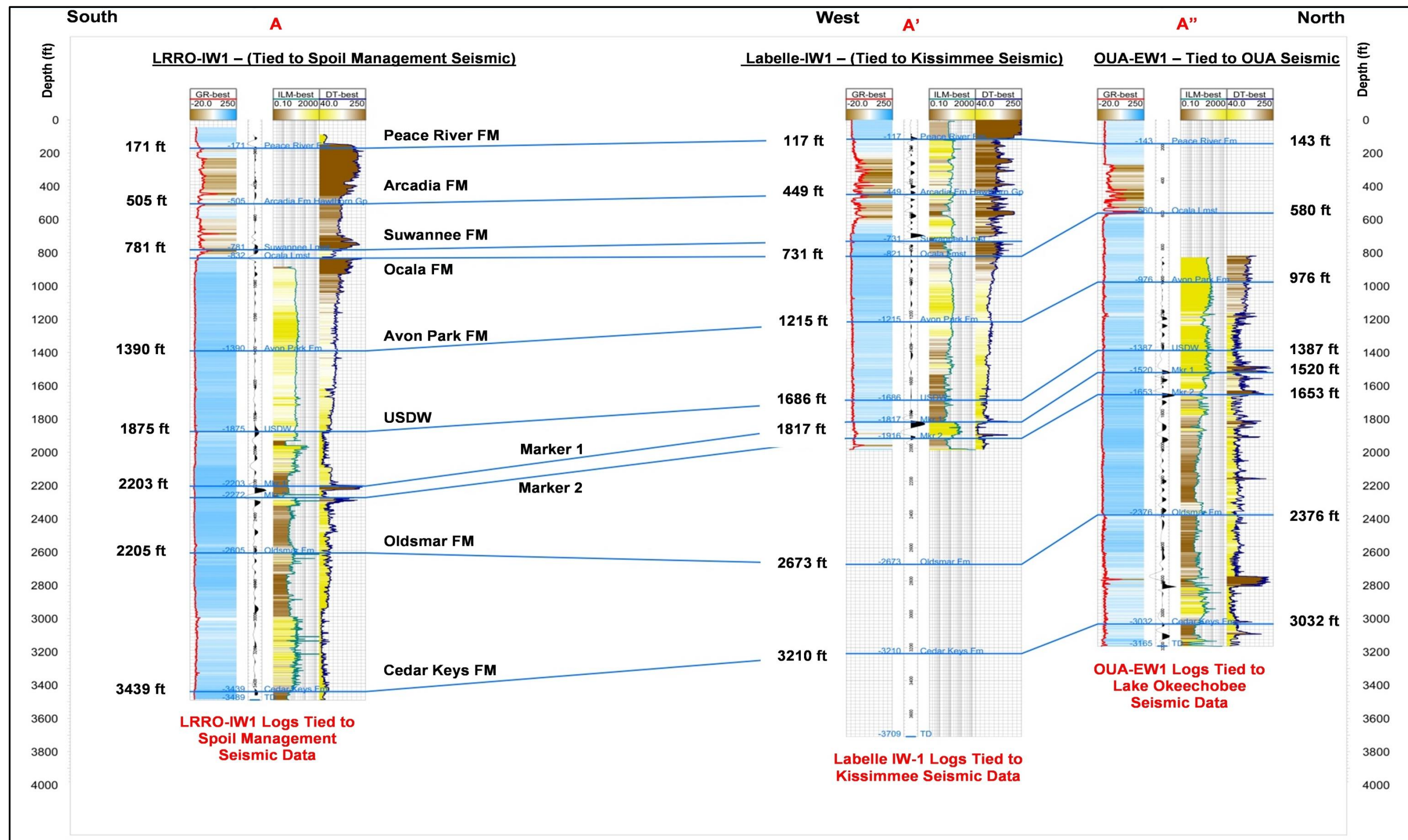


Figure 11b: Correlation of regional well logs LRRO-IW1, Labelle-IW1, OUA-EW1 across study area.

4.0 RESULTS/INTERPRETATION

This project was intended to be a demonstration of the ability of CCI proposed reflection seismic method to image the stratigraphy and structure of the Floridan Aquifer System (FAS), and also to evaluate seismic characterization of the Boulder Zone. While the seismic sections are in themselves proof that the survey was able to image the stratigraphy and structure of the geology to depth below the Boulder Zone, a more comprehensive level of seismic attributes processing and interpretation is necessary to fully appreciate the full spectrum of geologic and hydrogeologic information provided by the data. We have provided a brief interpretation of selected stratigraphic and structural elements of the data. However, the level of detail in the data is quite high and suitable for interpretation for multiple purposes. We have limited our interpretation to focus on features we believe to be most relevant to the current needs of SFWMD, namely the major formations and features that may affect the permeability of aquifer confining units and their effects on the hydraulic attributes of the FAS wells. Other entities may be more interested in other aspects of the geology, such as stratigraphic changes or depositional environments.

In addition, more advanced forms of data analysis, such as attribute processing, are available that can extract subtle but significant patterns from the data that can greatly facilitate the identification of structural and stratigraphic details. While this type of analysis was not part of our scope of work, we included some limited examples of simple attribute processing to demonstrate the power of the methods. A more detailed interpretation including more sophisticated attribute processing would improve the level of detail that can be extracted from the data and make the data useful for more purposes. A brief discussion of our limited interpretation is provided below.

NOTE: While the Ocala Limestone is recognized as a separate geologic unit, distinguishable from the overlying Suwannee and top of underlying Avon Park, the interpretations for this report we include the Ocala as part of the FAS hydrogeologic system.

4.1 Site 1, Okeechobee Utility Authority Plant 2D Seismic

Figure 12 presents an un-interpreted and interpreted seismic section for the line near the Okeechobee Waste Water Treatment Plant (OUA Line 5001 acquired in swath configuration as lines 5001 and 5002). The OUA injection well was installed in 2009 and is completed in a highly transmissive interval of the Boulder Zone, between the depths of 2,765 to 3,200 feet bls. The section shows generally parallel, horizontal reflectors in the Hawthorn Group, suggesting largely intact bedding in these units. A few truncations and seismic amplitude variations are apparent on the reflectors, indicating some lateral changes in stratigraphy and possible minor faulting. A broad sag feature is evident in the Hawthorn Group near the center of the OUA 2D seismic line. The sag feature overlies an apparent collapse structures deeper in the OUA seismic section (~ 1,000 to 2400 feet), which suggests this two or more periods of active subsidence before, and after deposition of the Hawthorn formation.

The Upper Avon Park formation has weaker reflectors, suggesting this unit is somewhat denser and stratigraphically homogeneous relative to the Hawthorn formation. Some minor changes in amplitude and offsets of reflectors are apparent, suggesting the presence of some stratigraphic changes, possible small karst features, and minor faulting.

The reflectors are stronger in the Middle and Lower Avon Park Formation suggesting more stratigraphic layering in this unit. The general pattern of this interval suggests normal faults stepping down into collapse structures near the base of the unit. A large sag feature is present in the center of the line as shown by the red ellipses. This feature contains numerous disrupted reflectors that step down into apparent collapse features deeper in the section. Most of the fractures do not propagate upward beyond the Middle Avon Park Formation, suggesting it is likely to be an effective confining unit in this area.

The Boulder Zone is characterized by sub-parallel and parallel reflectors with numerous zones of discontinuous vertical offsets. Significant amplitude variations along reflector horizons are identified, suggesting a mix of intact stratigraphy and broken chaotic zones of voids and probable faults and related fractures. The chaotic and disturbed seismic characterization is consistent with the known geophysical well log and core log information of the Boulder Zone.

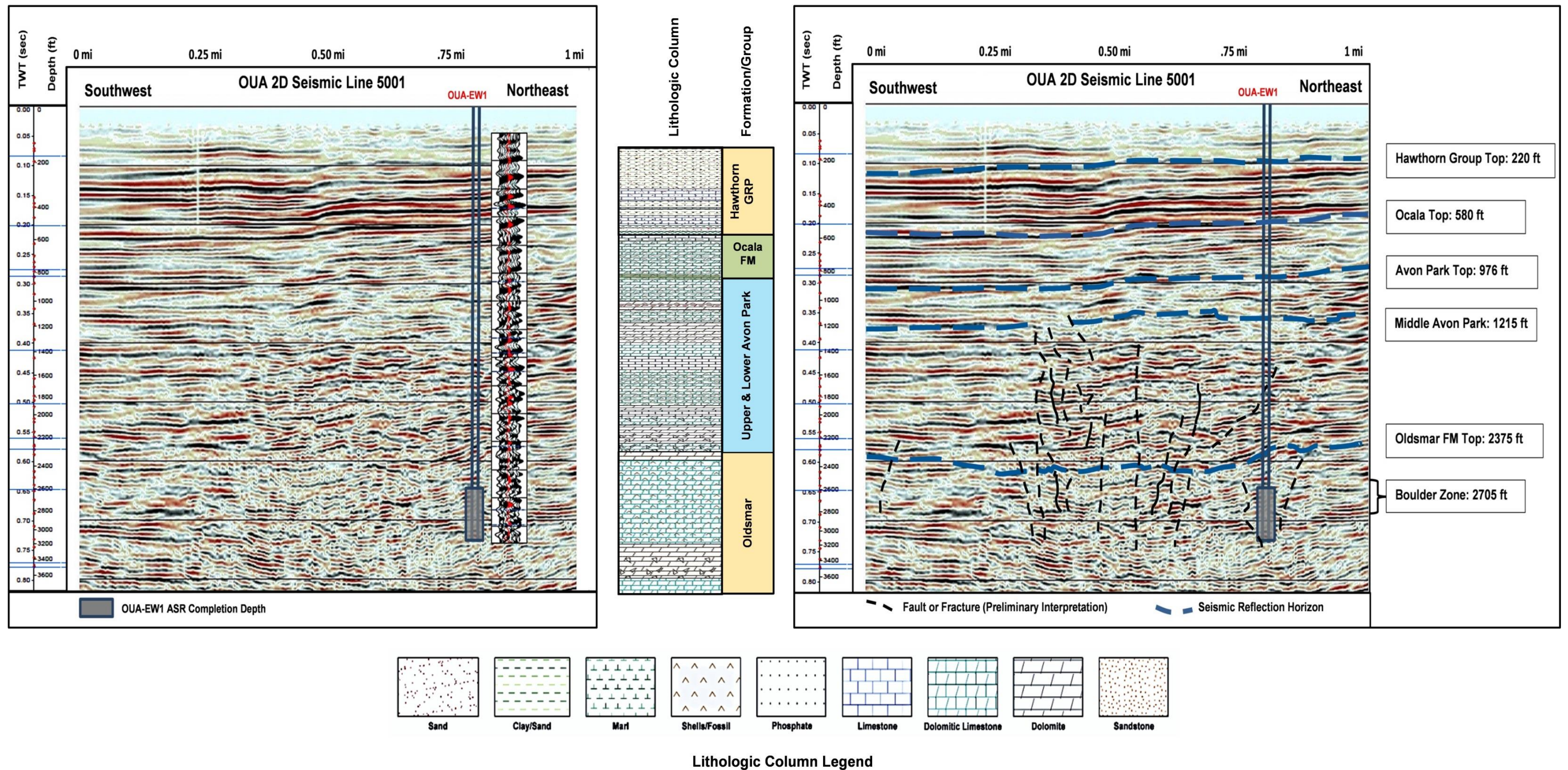


Figure 12: Un-interpreted and preliminary interpretation of the 2D seismic section for OUA Line 5001.

4.2 Site 2, Kissimmee River, 2D Seismic

Figure 13 presents an un-interpreted and interpreted seismic section for the Kissimmee seismic line 5004. The Kissimmee 2D seismic data was acquired in swath configuration, consisting of two separate receiver lines (5003 and 5004) deployed parallel at 50 ft separation. In processing, data from each of the two receiver lines was compared for repeatability with respect to data quality and seismic reflection character. Further processing to compensate for “out of the plane” artifacts was also evaluated, and Principal Component corrections applied to de-emphasize non-reflector noise.

Data for these seismic lines was acquired in close proximity to the ASR pilot project constructed as part of the Comprehensive Everglades Restoration Program. Seismic section 5004 shows generally parallel, horizontal reflectors in the FAS and Hawthorn Group, suggesting largely intact bedding in these units. A few truncations and amplitude variations are apparent on the reflectors suggesting some lateral changes in stratigraphy and possible minor faulting. A broad sag feature is evident in the reflectors in the Hawthorn Group in the southeast half of the line. The sag feature overlies an apparent collapse feature deeper in the section, which suggests this area experienced active subsidence following deposition of the Hawthorn formation.

The Upper Avon Park formation has much weaker reflectors, suggesting a denser homogeneous unit. Some changes in amplitude and offsets of reflectors are apparent suggesting the presence of some stratigraphic changes, possible karst features and faulting. Two large sag features are present as shown by the red ellipses. These features contain numerous faults and dipping and disrupted reflectors that step down into apparent collapse features deeper in the section.

The reflectors are stronger in the Middle and Lower Avon Park Formation suggesting more stratigraphic layering in this unit. The reflectors are broken with a general pattern of stepping downward to the west of the section. Some horizontal reflectors lap onto dipping reflectors, suggesting deposition onto a subsiding structure. The general pattern of this interval suggests normal faults stepping down into collapse structures near the base of the unit, with a general trend of greater subsidence to the southeast half of the line. The Boulder Zone is characterized by discontinuous reflectors with dips and offsets and with significant amplitude variations along reflectors, suggesting a more chaotic mix of intact stratigraphic sections broken up by large fracture zones or voids.

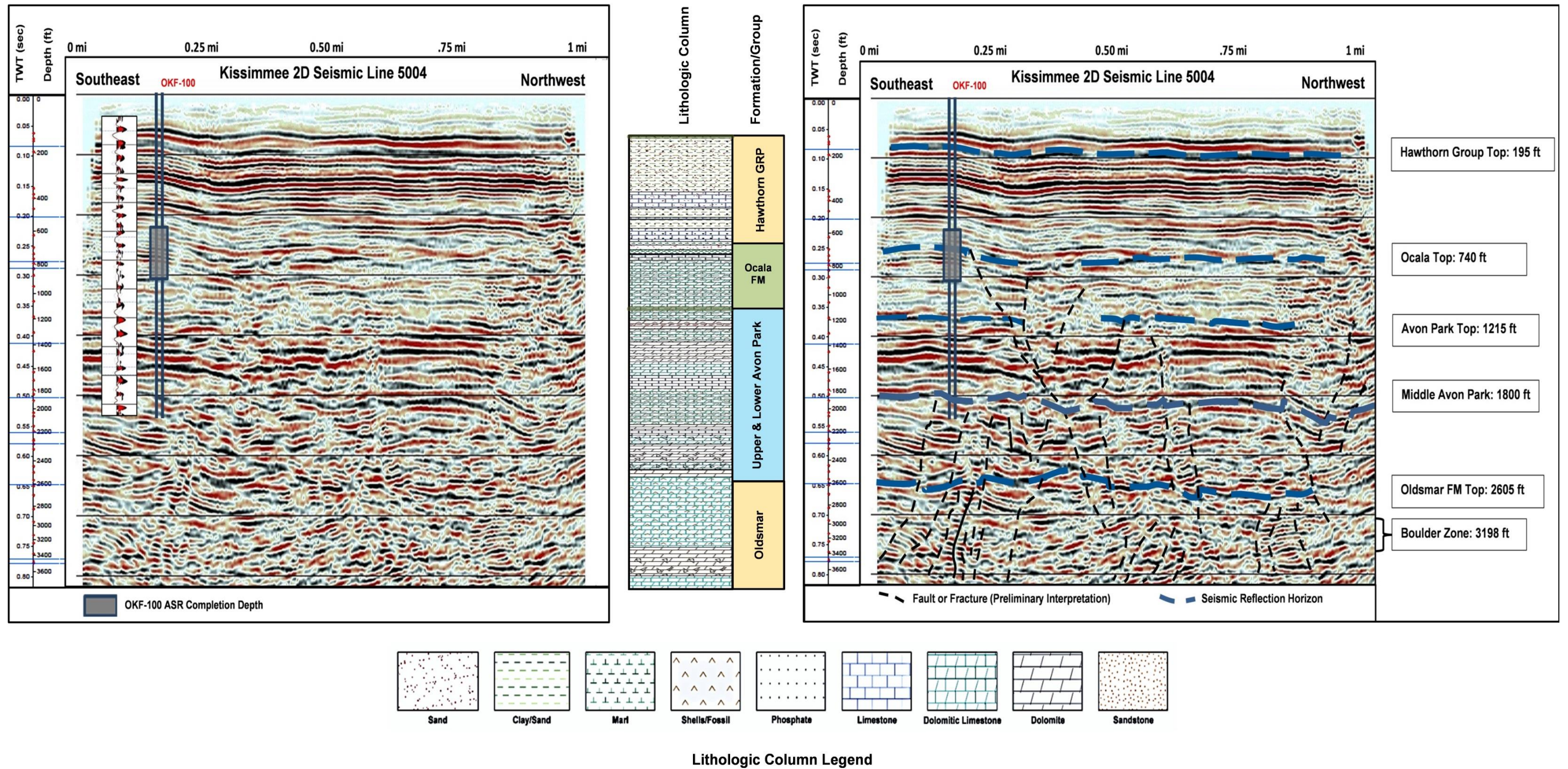


Figure 13: Un-interpreted and preliminary interpretation of the 2D seismic section for Kissimmee Line 5004.

quality provided by 3D acquisition. The major formation tops are marked to make it easier to see where specific reflection packages lie within the stratigraphic sequence. In comparison to the 2D lines acquired at the other three sites, the seismic data from the Spoil Management Site shows good seismic reflection continuity, and subtler changes in amplitude and character along each reflector. Subtle stratigraphic relationships, such as on-lapping and off-lapping reflectors, and bisecting or truncating reflectors are evident. These features can be interpreted to understand the detailed stratigraphic and structural relationships between the units, and infer the depositional environment of the sequences. The 3D reflection data is generally cleaner with better overall signal-to-noise, and can show more detail than the 2D lines.

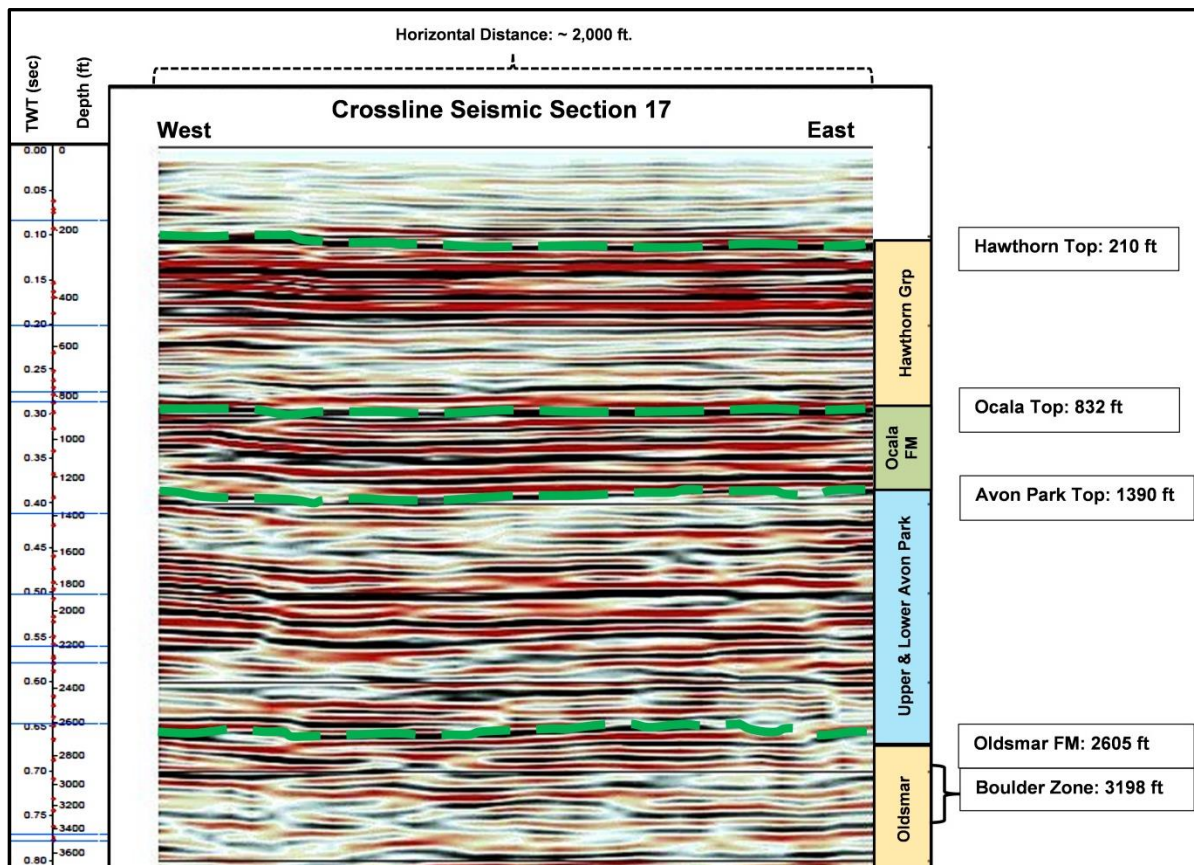


Figure 15: Interpreted crossline 17, from Site 3, Spoil Management Site, 3D seismic.

Figure 16 shows two interpreted crossline seismic sections for two lines located approximately 200 feet apart within the 3D data cube. A low cut filter has been applied and the color scale of the plots has been modified to fit frequency vs impedance to improve the visual contrast. The section shows generally parallel, horizontal reflectors in the upper Hawthorn Group, suggesting largely intact bedding in these units. The lower part of the Hawthorn Group has weaker reflectors suggesting this interval is denser and more homogeneous.

The Upper Avon Park formation has stronger reflectors, suggesting more distinct layering on this interval. Some changes in amplitude and offsets of reflectors are apparent suggesting the presence of some stratigraphic changes, possible karst features.

The reflectors are more discontinuous in the Middle and Lower Avon Park Formation suggesting more stratigraphic or structural changes in this unit. Two large subsidence features are present as shown by the red arrows. These features contain numerous small subsidence fringe faults, characterized by indications of dipping and vertically disrupted reflectors that step downward into apparent collapse features deeper in the section.

The Lower Avon Park and Oldsmar Formations are more intensely disrupted. The general pattern of this interval suggests normal faults stepping down into collapse structures near the base of the unit, with a general trend of greater subsidence to the southeast half of the line. The Boulder Zone is characterized by strong but discontinuous reflectors with dips and offsets and with significant amplitude variations along reflectors, suggesting a mix of intact stratigraphic sections broken up by fractures or voids.

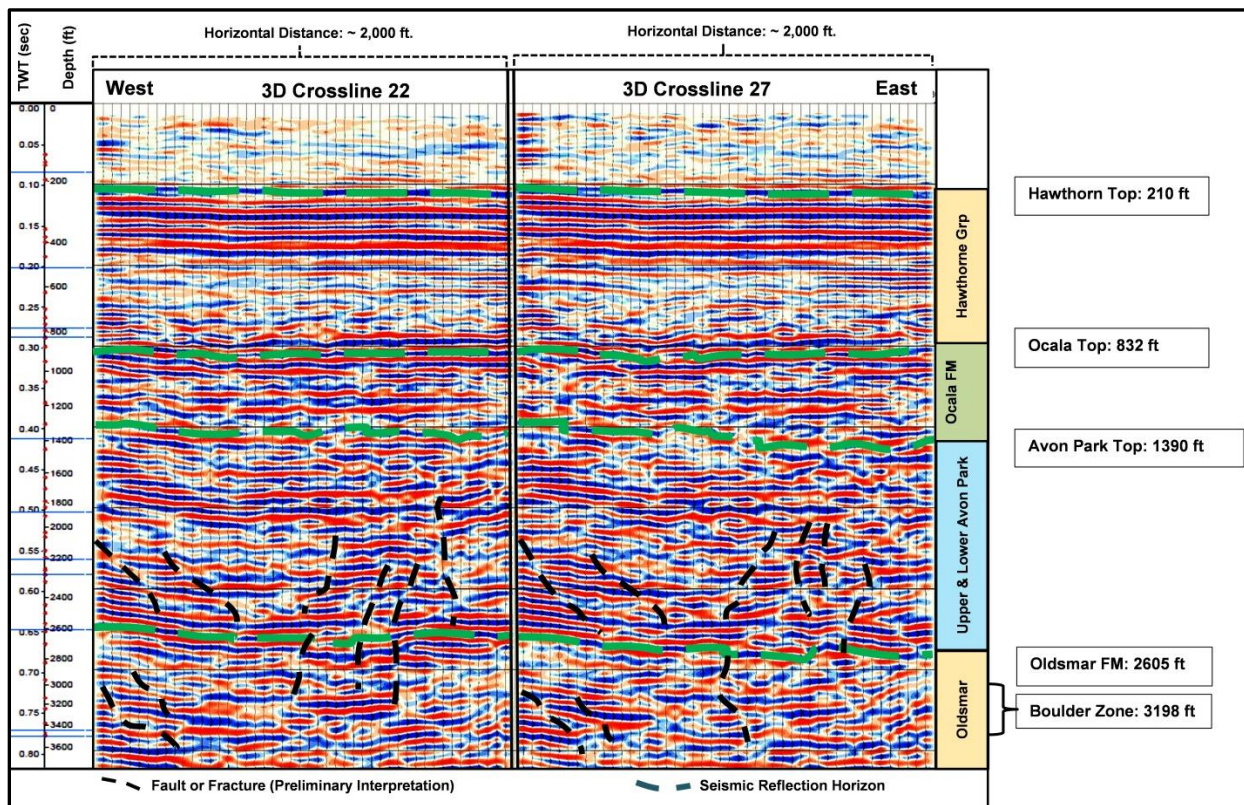


Figure 16: Interpreted crosslines 22 and 23 with color scale enhancement and band pass filtering, Site 3, Spoil Management Site, 3D seismic.

Figures 17 through 20 are depth slice elevation maps for the tops of the Arcadia, Ocala, Middle Avon Park and Oldsmar Formations, derived from two-way travel time (TWT) to depth conversion processing using TD-Velocity Inversion. The depth-slice surfaces show a prominent subsidence feature at each formation top. The subsidence structure appears more prominent at greater depth, and shifts south - southwest with increasing depth. Figure 21 is a stacked plot

of the time surfaces for the Arcadia, Ocala, Suwanee, Avon Park, and Oldsmar formation tops extracted from the 3D data cube. The increase in depth and translation to the southwest of the sag feature is apparent in the stacked surfaces. The shape of the formation surfaces suggests a collapse structure into a deeper feature that has been active through the period of deposition of the units.

A limited attribute processing analysis was applied to the 3D data cube to illustrate how variations in the wavelets along reflectors can be used to highlight structural and stratigraphic features that are not apparent to the human eye. Figure 22 shows the results of a composite attribute compiled from amplitude, frequency and velocity variations of the wavelets selected to emphasize voids and karst features. The plot shows the position of larger voids beneath the site as blue to yellow and red small bodies in the space between formation horizons. The voids and karst feature attributes are largely absent from the Hawthorn Group and more prevalent in the Lower Avon Park and Oldsmar Formations. These features would be promising drilling targets for high volume injection wells. Similarly, they would be features to avoid for applications where turbulent flow or mixing was undesirable, such as for an ASR storage zone, or where the integrity of a confining unit was critical, such as an injection zone below a water production zone. With more attributes processing these zones could be better defined and ranked in terms of size and probable permeability using other attributes of the wavelets. Other features such as faults, fractures, or lateral stratigraphic changes could also be mapped in three dimensions using attribute processing.

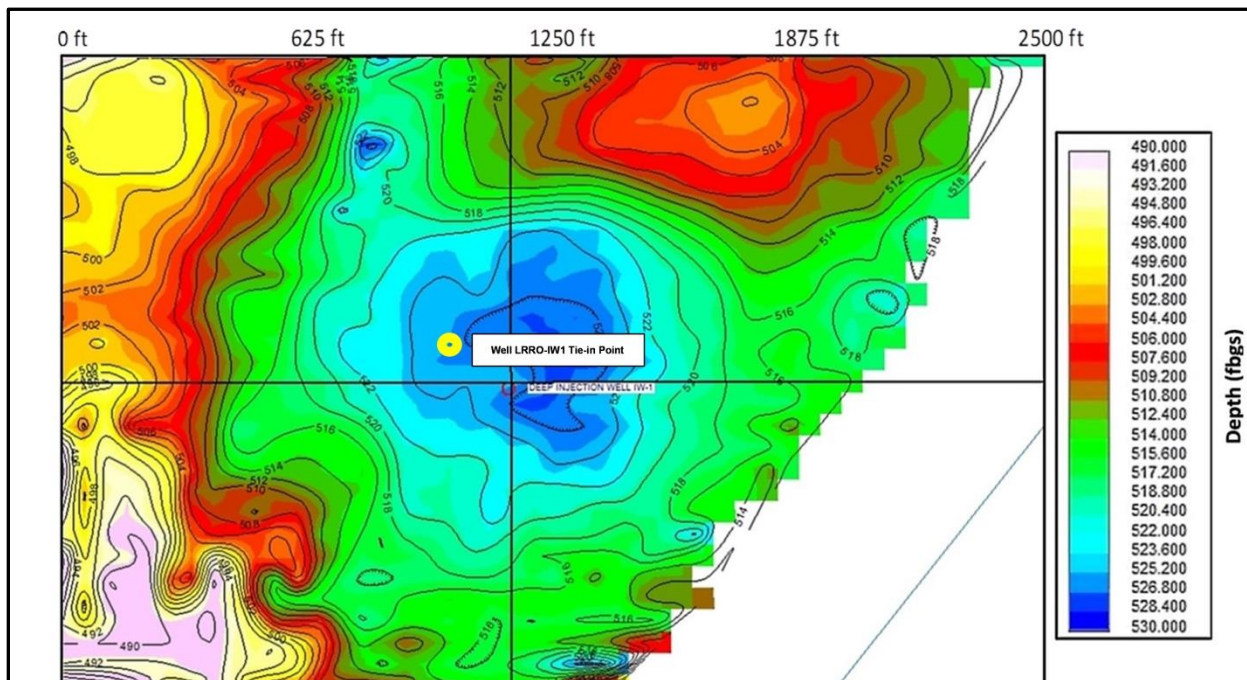


Figure 17: Top of Arcadia Formation from inverted time horizon, Site 3, Spoil Management Site, 3D seismic.

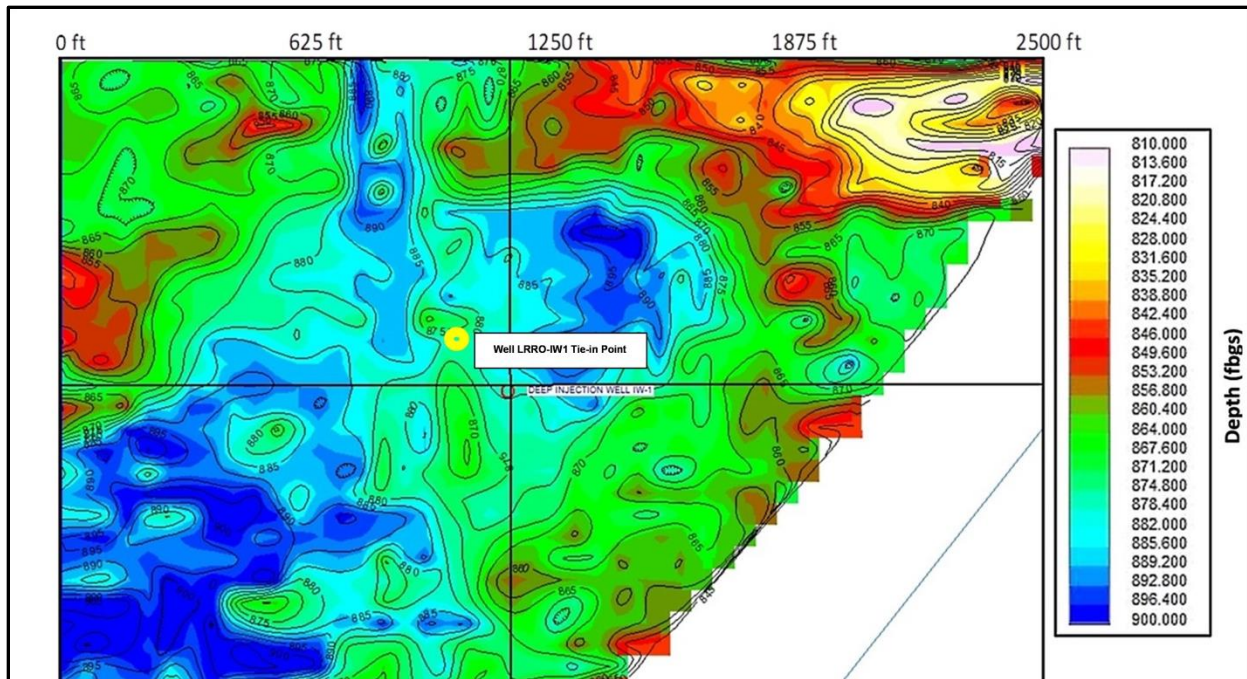


Figure 18: Seismic geomorphology contour map for top of Ocala formation (elevation range: 810 to 990 feet bls), Spoil Management Site 3D seismic.

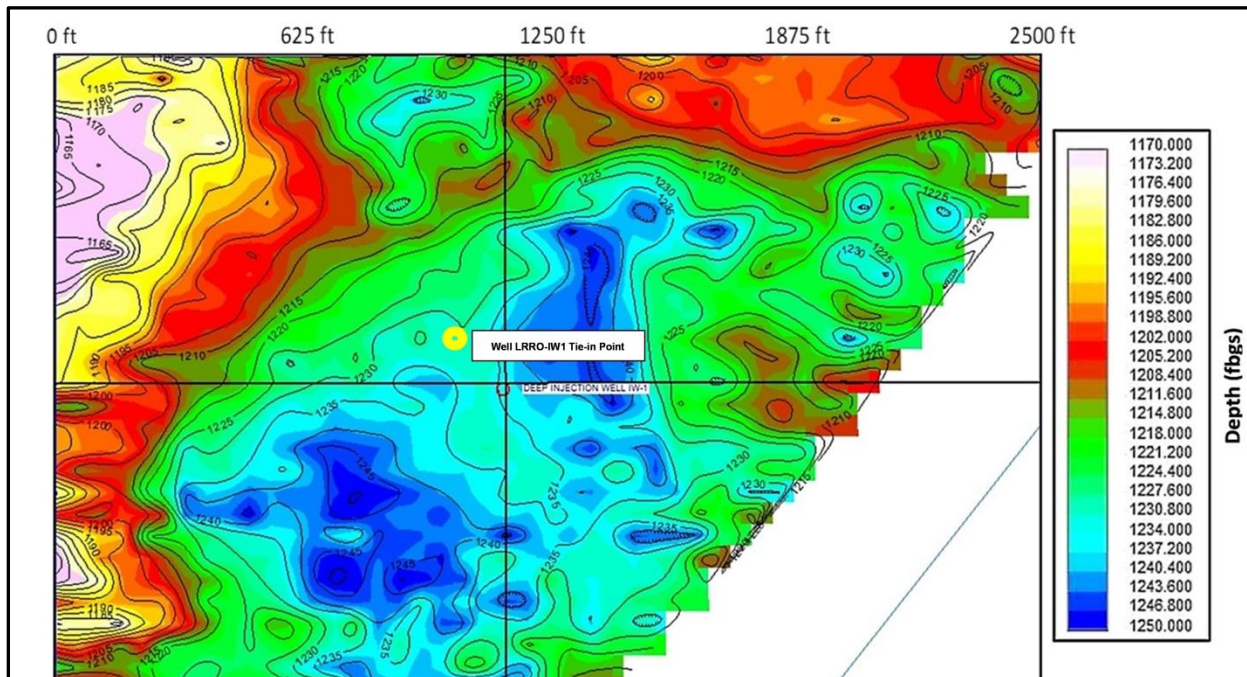


Figure 19: Seismic geomorphology contour map for top of Middle Avon Park (elevation range: 1170 to 1250 feet bls), Spoil Management Site 3D seismic.

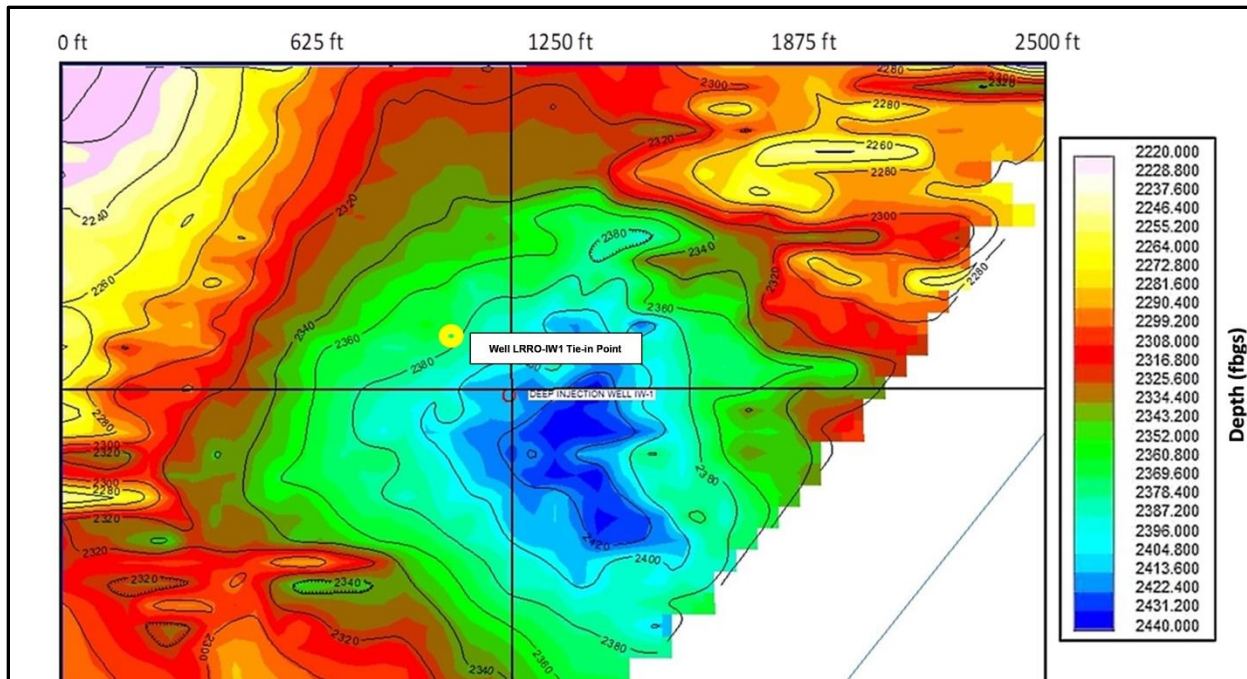


Figure 20: Seismic geomorphology contour map for top of Oldsmar formation (elevation range: 2220 to 2440 feet bls), Spoil Management Site 3D seismic.

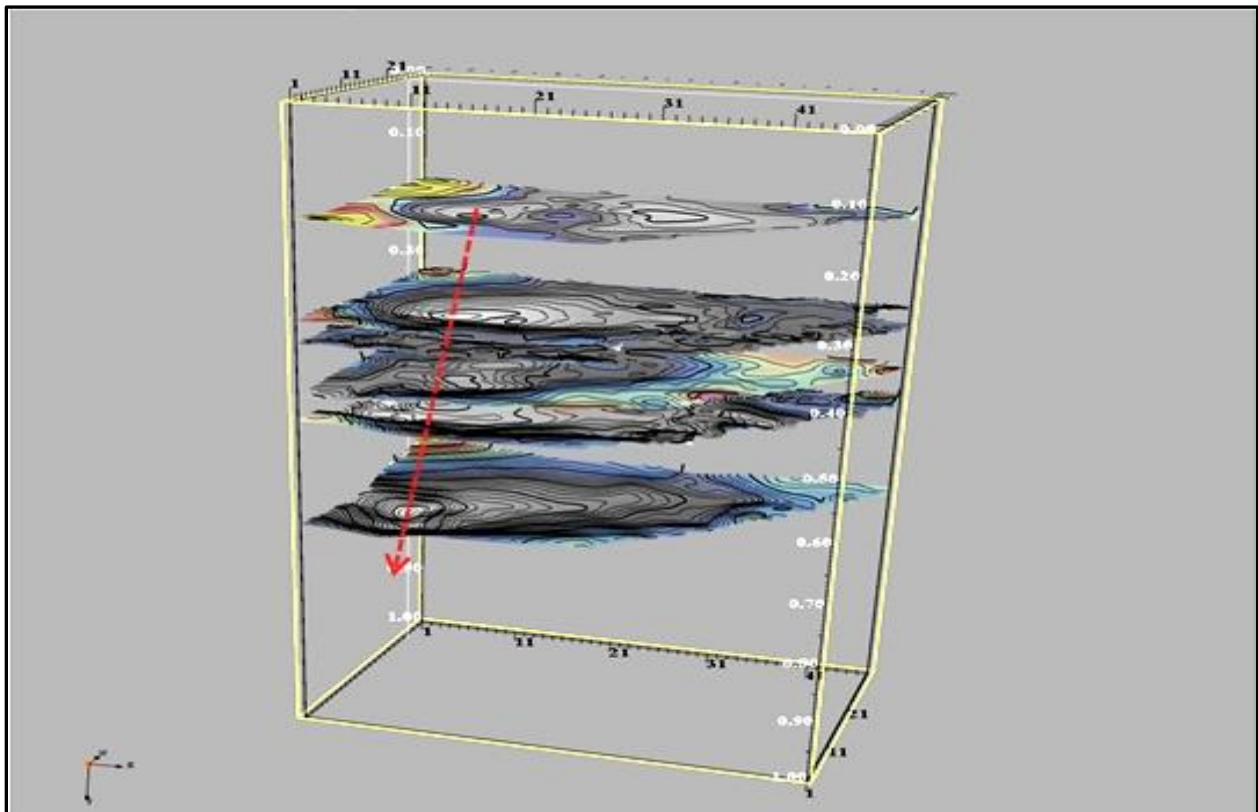


Figure 21: 3D rendering of formation tops from inverted time horizons showing progression of possible remnant collapse structure with depth, Spoil Management Site 3, 3D seismic.

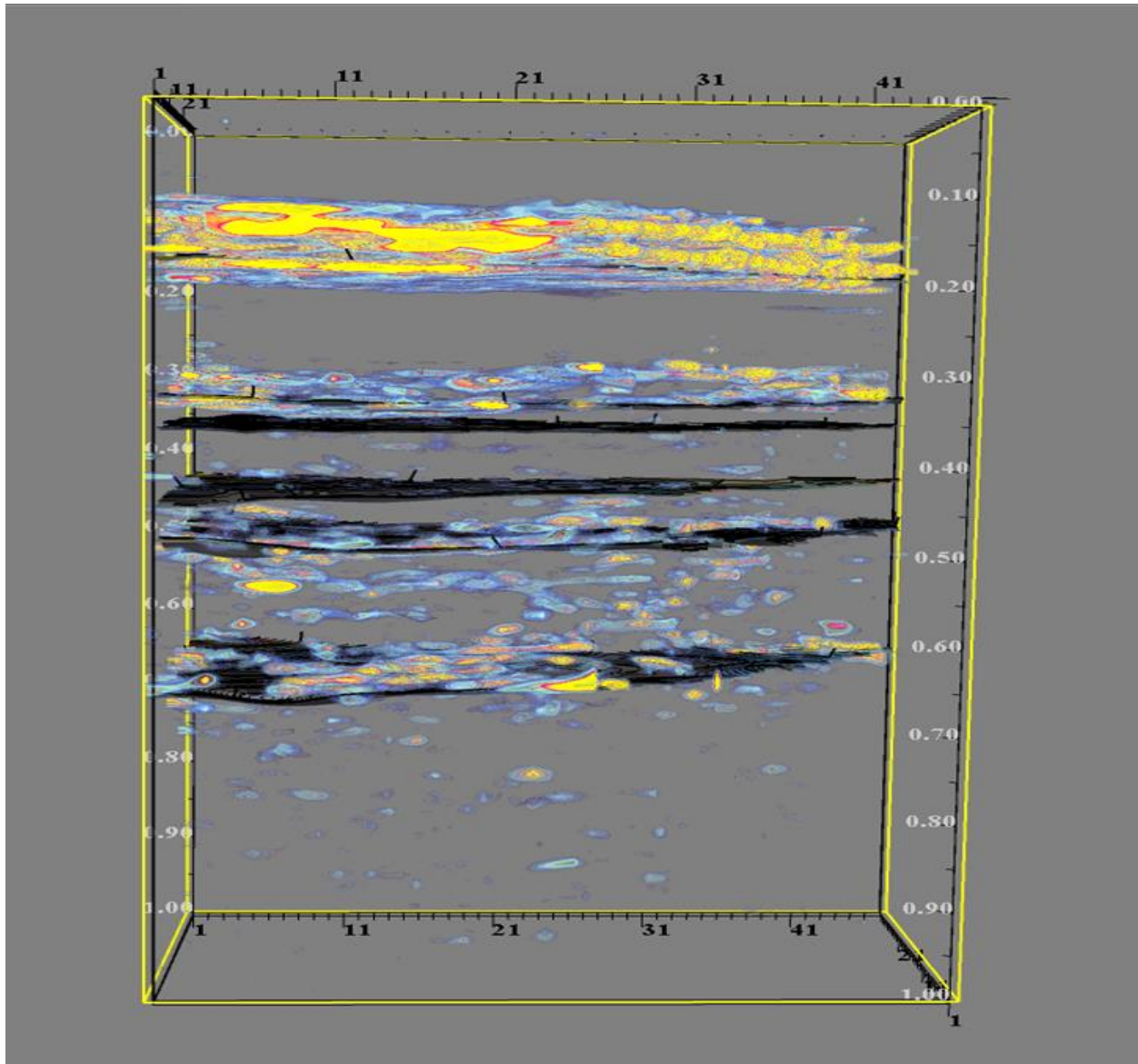


Figure 22: South view of Spoil Management Site 3 3D attributes processing showing voids and karst features within lower Avon Park and Oldsmar formations.

4.4 Site 4, Palm Beach County Lake Region, 2D Seismic

For the Palm Beach County Lake Region (Site 4) 2D seismic program, data was acquired as two lines of 1-mile segments along State Road 80 and State Road 715. The State Road 80 and State Road 715 intersection presented noise and other infrastructure obstacles that prevent layout of geophones across the roads. Undershooting to obtain subsurface seismic coverage below the intersection was not performed; line segments gaps were too wide. In addition, there is insufficient roadside shoulder access for deployment of more than one line. The 2D swath configuration (2-receiver line deployment) was not used over Site 4. Each seismic section segment represents data from a single receiver line. Figure 23 shows the individual State Road 80 and State Road 715 seismic segment locations, and area well sites.

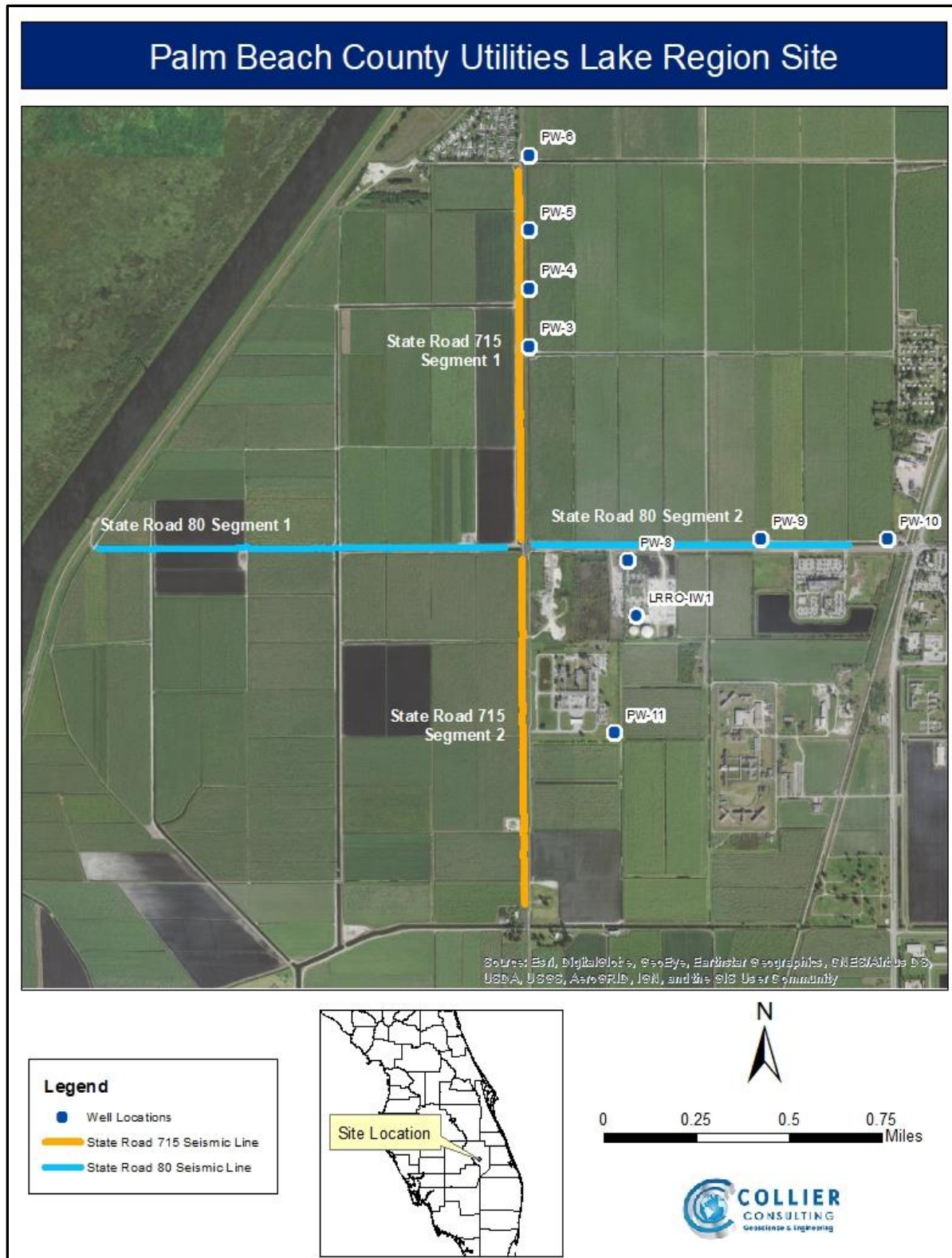


Figure 23: Palm Beach County 2D seismic line map for State Road 80 and State Road 715, west-east and north-south Segments 1 and 2. (Note: Line segment placements are not drawn to map scale)

4.4.1 State Road 80 Segments 1 and 2

Figures 24 and 25 are interpreted seismic sections of the State Road 80, line Segments 1 and 2. In Figure 24 the 1-mile Segment 1 section shows generally parallel, horizontal reflectors in the Hawthorn Group, suggesting largely intact bedding in these units. A few truncations and amplitude variations are apparent on the reflectors suggesting some lateral changes in stratigraphy and possible minor faulting.

The Upper Avon Park and Ocala formations have much weaker low amplitude reflectors, suggesting a denser homogeneous unit. Some changes in amplitude and apparent sag features are present suggesting the presence of some stratigraphic changes, possible karst features and faulting. The reflectors are stronger in the Middle and Lower Avon Park Formation suggesting more stratigraphic layering in this unit. The reflectors appear fractured with a general pattern of downward vertical offset to the west of the section. Some horizontal reflectors appear to overlap onto dipping reflectors, suggesting deposition over a subsidence structure. The general pattern of this interval suggests short-normal faults stepping down into collapse structures near the base of the unit, with a general trend of greater subsidence to the western end of the line. The Boulder Zone is characterized by discontinuous reflectors with dips, vertical offsets, and significant seismic amplitude variations along reflectors, suggesting a more chaotic mix of intact stratigraphic sections broken up by large fracture and/or voids. Based on review of geophysical well logs and sample cores (where available), this structure and stratigraphic character is consistent with of the Boulder Zone.

Figure 25 presents the seismic section for the eastern half of the State Road 80 line Segment 2. The general pattern of the reflectors is similar to Segment 1, but the reflectors in the Middle Avon Park appear to be less faulted and greater horizontal continuity. The Boulder Zone seismic reflectors appear to be more coherent and continuous, although some strongly dipping reflectors are still observed. The general pattern suggests that the faulting and karstification is less prominent on Segment 2 compared to Segment 1.

In Segment 1, there are 13 interpreted fractures identified in the Middle Avon Park, with 5 extending into the Ocala and “zero” extending into the Hawthorn. In Segment 2, there are 10 interpreted fractures identified in the Middle Avon Park, with 5 of these extending into the Ocala, 4 into the Hawthorn, and 3 extending into the Oldsmar formation. Typically, it is the fracturing that extends across confining and aquifer units, versus that limited to within an aquifer unit that has the greatest influence on groundwater groundwater quality. It is interesting to note that the greatest documentation of fracturing and disruption of the geologic units change in water quality when pumped is observed at PW-10.

Wells 8 and 9 are located next to the seismic survey line and the well bores have been projected onto the seismic section. Both wells have experienced increases of about 70 to 75% in Electrical Conductivity (EC), though Well 9 was drilled after Well 8 and had a higher initial EC reading. By 2018, the EC reading of Well 9 was about 40% higher than Well 8. Both wells are

completed in the Upper Avon Park. Well 9 appears to be completed in an area with more vertical faults extending into the Lower Avon Park and Oldsmar Formation. It is possible that these faults are a preferential flow path for higher TDS water causing Well 9 to experience a greater degree of migration from deeper sources of more conductive water which resulted in higher levels of EC and conductive TDS. Some portions of the Upper Avon Park, such as west of Well 8 on segment 2 and the west half of Segment 1 appear to have more continuous reflectors in the Upper Avon Park with fewer faults and vertical fissures that extend into the Upper Avon Park from deeper units. These areas may be more favorable for supporting wells with more stable water quality.

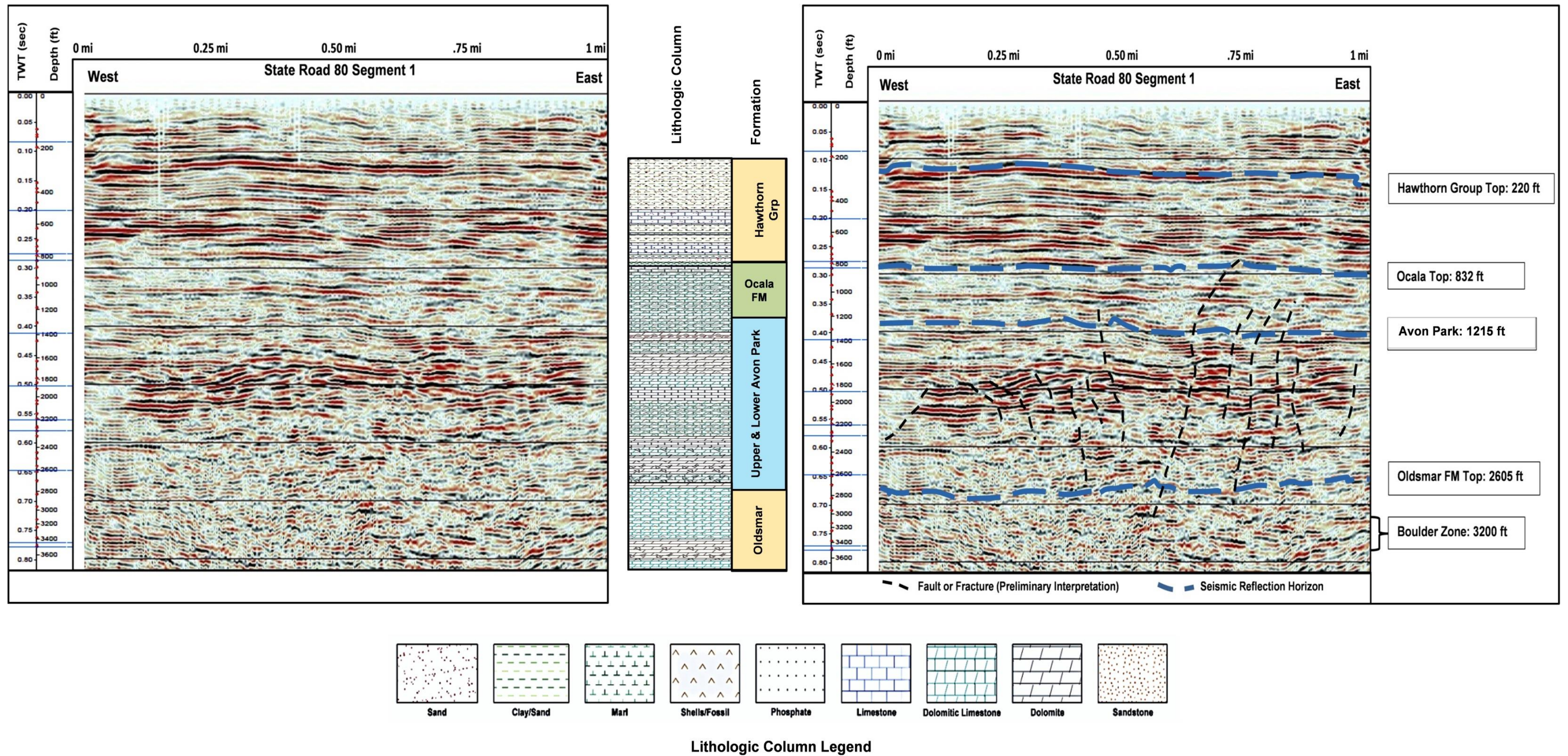


Figure 24: Un-interpreted and preliminary interpretation of the 2D seismic section for State Road 80 (Line 5015), Segment 1, Site 4.

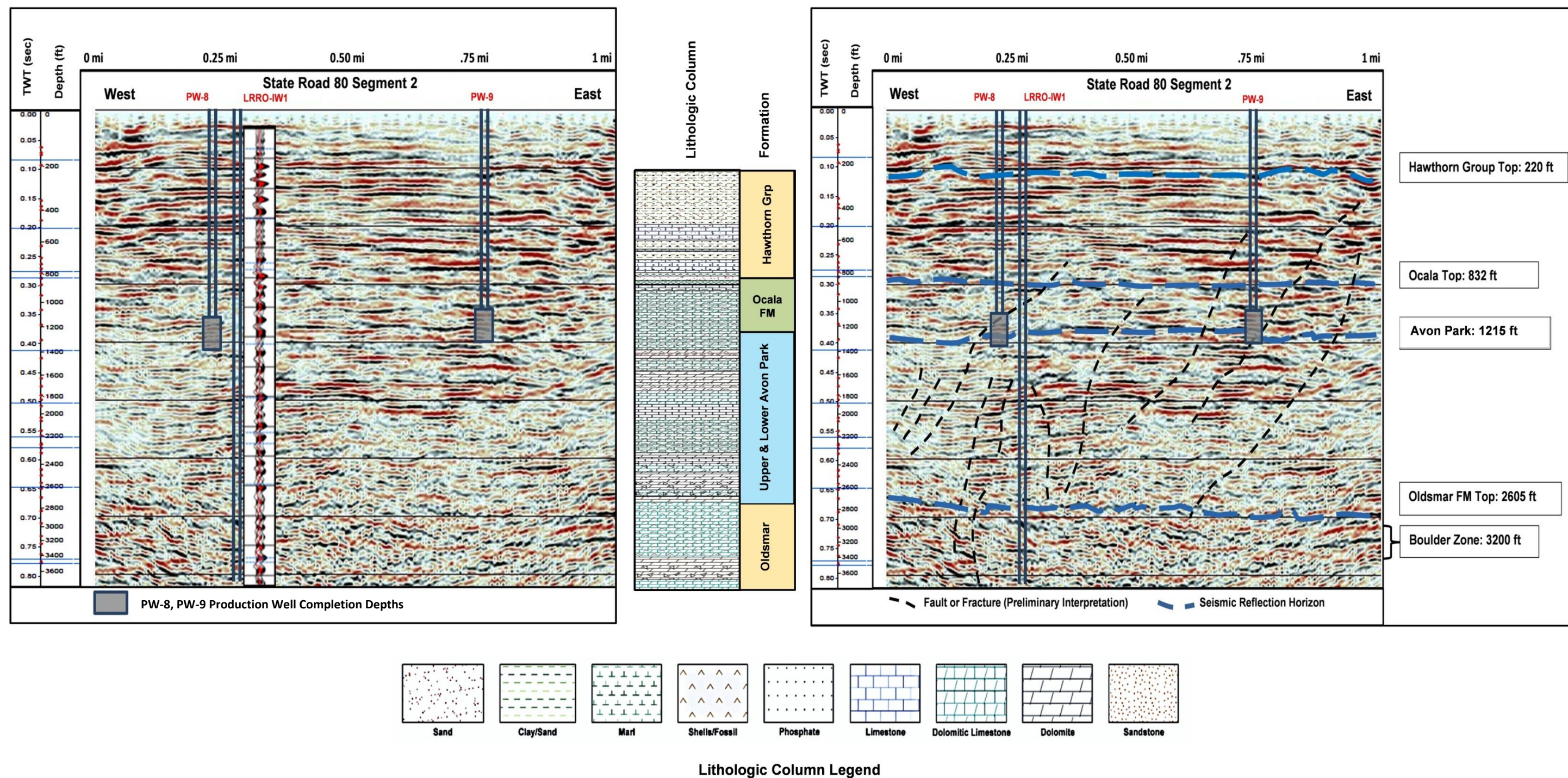


Figure 25: Un-interpreted and preliminary interpretation of the 2D seismic section for State Road 80 (Line 5015), Segment 2, Site 4.

4.4.2 State Road 715, Segments 1 and 2

Figures 26a and 27 are un-interpreted and interpreted (preliminary) seismic sections for State Road 715 seismic line Segments 1 and 2, where Segment 1 is the northern 1-mile segment and Segment 2 is the southern 1-mile segment. Along Segment 1 the general reflection pattern is similar to the State Road 80 seismic line. However, there appears to be greater lateral reflector discontinuity and amplitude changes within the Hawthorn Group, suggesting that there may be more stratigraphic structure changes and faulting. There are also deeper sag features and dipping reflectors in the Lower Avon Park Formation, especially in the northern one-third of the line. The Boulder zone has a similar reflector patterns as the State Road 80 line.

Wells 3, 4, and 5 are located along this segment and nearby well bore locations are projected onto the seismic section. Well 5 has experienced a more rapid increase in EC and TDS than Wells 3 and 4. Well 5 is located above a zone of dipping and disrupted reflectors in the Middle and Lower Avon Park formation, and adjacent to dipping reflectors in the Avon Park or Ocala Formations just north of the well. The reflector pattern suggests that Well 5 may be located in a more disturbed portion of the Avon Park Formation, and may have received more rapid upward migration of higher TDS water through faults and fractures within the confining units. Well 4 is located on the south side of an apparent subsidence feature, but is still in a zone of discontinuous and dipping reflectors in the Avon Park Formation. Well 3 is located in a stratigraphic zone that exhibits greater seismic reflection continuity in the Upper and Middle Avon Park Formation. Well 4 appears to have been less impacted by rising EC levels than Well 5, and more so than Well 3. Seismic Segment 1 for State Road 715 appears to indicate that the reflection continuity in the Upper and Middle Avon Park Formation may correlate with more stable water quality in the wells. Based on this assumption, the far southern portion of this segment may be a favorable location for production of better water quality; however, additional seismic attributes analysis and signal processing is needed to guide correlation between the hydrogeologic structures and water quality. Figure 26b is an enlargement of State Road 715 Segment 1 seismic section between 200 and 550 milliseconds (450ft to 1,800ft depth bsl). Image re-processing was performed to show stratigraphic inter-bedding, and the variability of seismic signal attributes associated with amplitude, frequency, and phase.

Figure 27 presents the seismic section for segment 2, the southern half of State Road 715. The general reflection pattern is similar to the Segment 1. There are stronger indications of apparent faults and subsidence features within the Middle to Lower Avon Park. There is a prominent subsidence feature in the far northern part of the Segment in the Lower Avon Park, but most of the faults and dipping beds do not extend into the Middle and Upper Avon Park and/or Ocala formations. The reflectors in the Middle Avon Park are largely continuous and horizontal on this segment. The Boulder Zone has similar reflector patterns as the State Road 80 seismic data. In Segment 1, there are 11 interpreted fractures identified in the Middle Avon Park with 6 extending into the Ocala, 4 into the Hawthorn, and 6 extending into the Oldsmar. In Segment 2, there are 14 interpreted fractures identified in the Middle Avon Park, with 3 extending into the Ocala, 1 into the Hawthorn, and 3 that appear to extend into the Oldsmar.

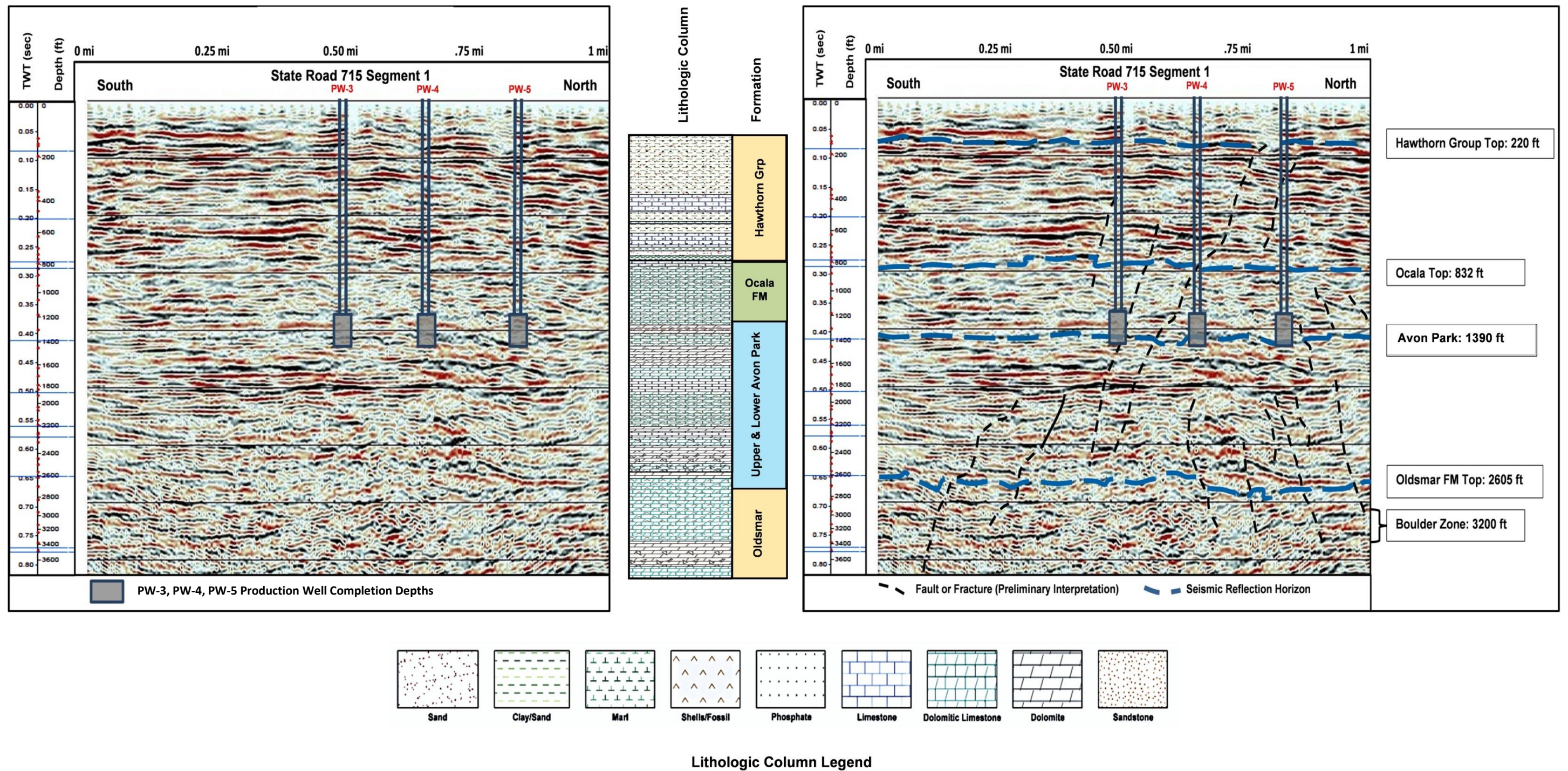


Figure 26a: Un-interpreted and preliminary interpretation of seismic section for State Road 715 Segment 1 (Line 5017),

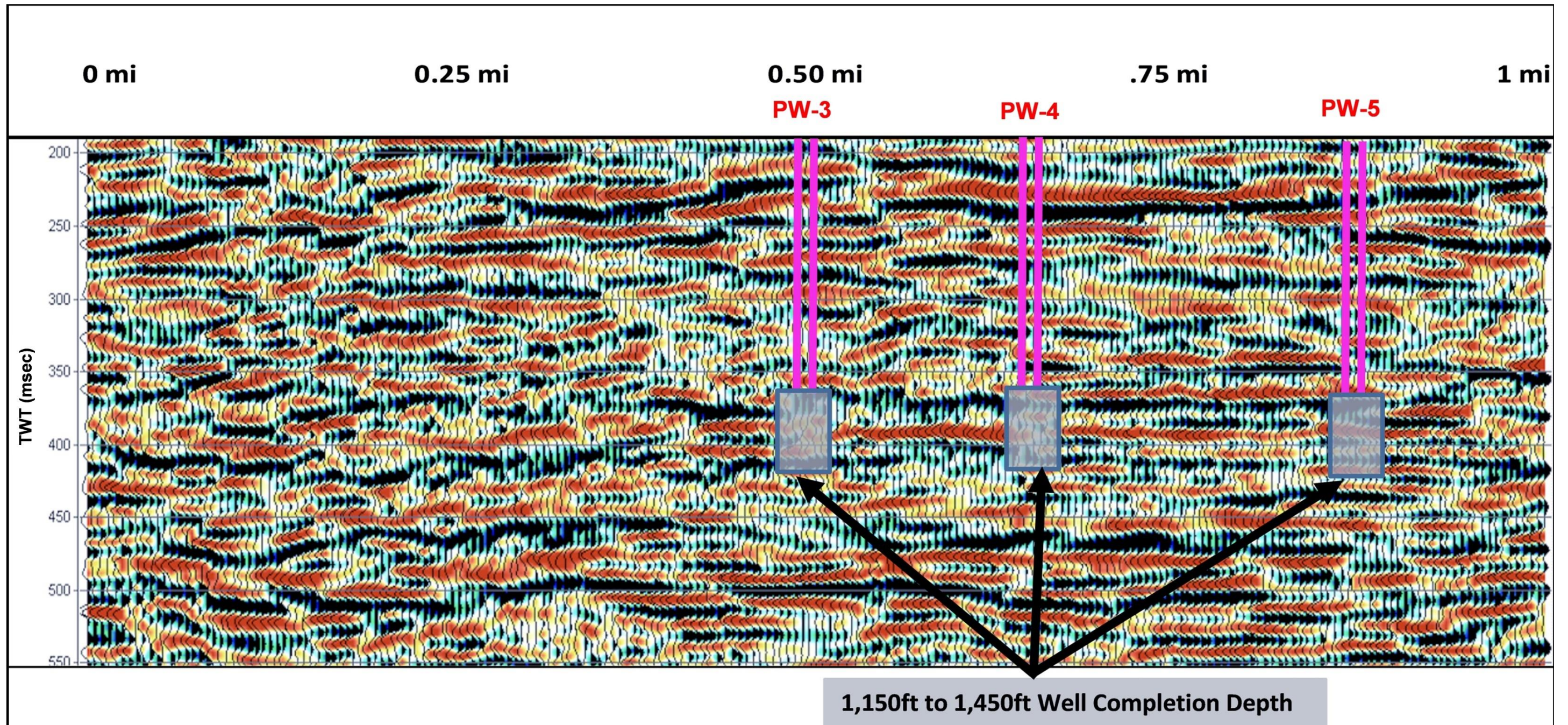


Figure 26b: Re-processing of State Road 80 Segment 1 to generate enlargement of 2D seismic section between 200ms (450ft depth) and 550ms (1,800ft depth). Re-processing includes overlay of seismic traces to enhance seismic reflection attribute changes.

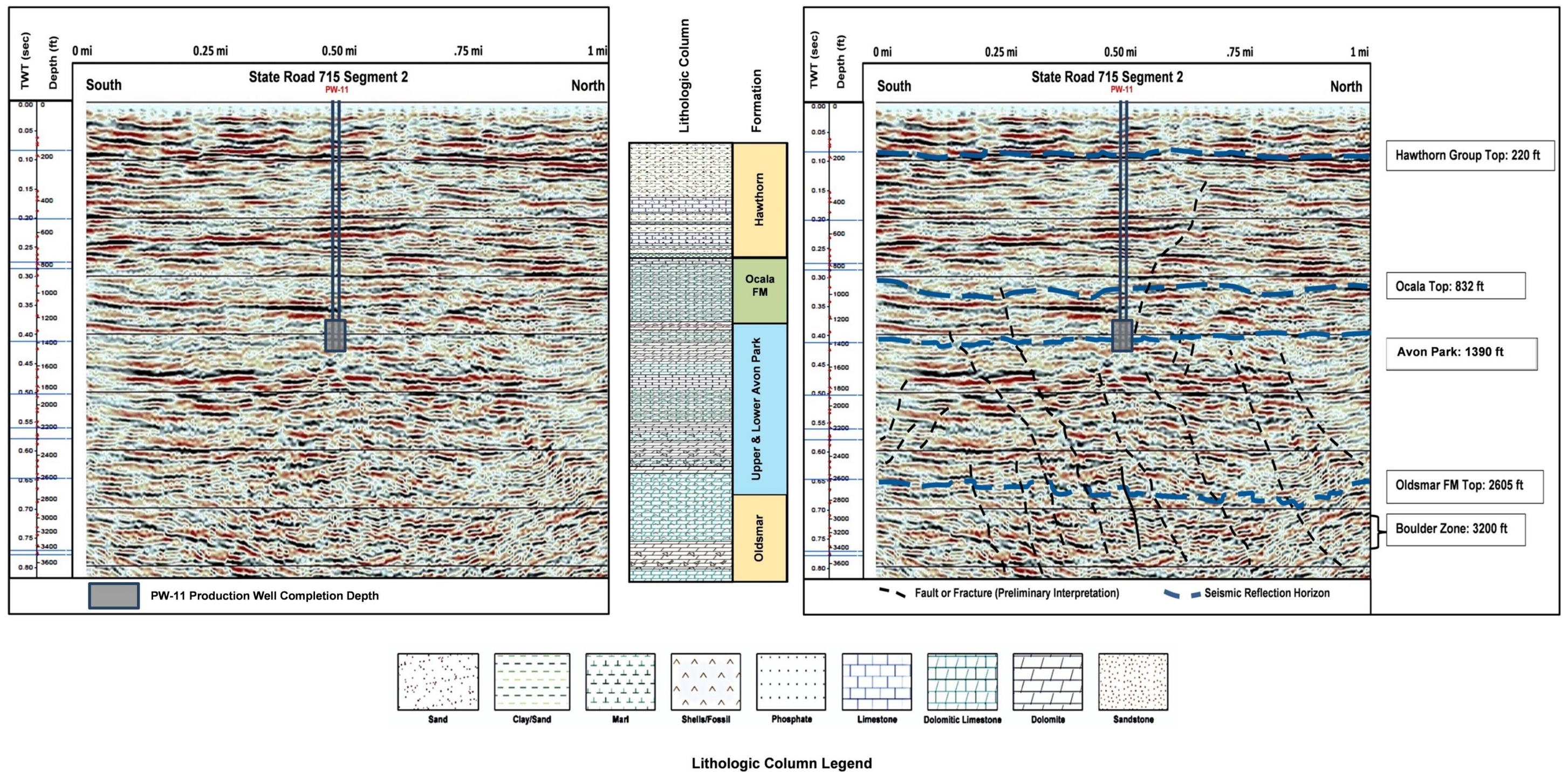


Figure 27: Un-interpreted and preliminary interpretation of seismic section for State Road 715 seismic line (Line 5017), segment 2, Site 4.

4.4.3 PBC WUD Well Field Water Quality Trends

Palm Beach County operates 10 FAS supply wells at the Lake Region Water Treatment Plant (WTP) well field along State Road 715 and State Road 80. The locations for 8 of the 11 wells constructed are shown on Figures 3c and 23. The wells were drilled to depths of approximately 1,350 to 1,450 feet bls and are completed at depths of between 1,113 to 1,450 feet bls in the Upper Avon Park Formation. Some of the wells have experienced increases in chloride and total dissolved solid (TDS) concentrations over the period of operation of about 10 years.

Figure 28 is a plot of groundwater data for the wells that illustrate the change in Electrical Conductivity (EC) over time. EC is a good proxy for salinity, with TDS concentrations in ppm being approximately 57% of the EC value in uS/cm for this well field. Wells 1, 4, 5, 6 and 7 have experienced increasing EC levels in the produced water more than triple in less than 10 years. Other wells, such as Wells 3 and 8 have experienced lower rates of increase over the same period. Well 10 experienced a decline from initially high EC levels to lower levels when operated on a standby basis. TDS and chloride concentrations in these wells followed similar trends.

Wells in close proximity to each other have experienced significant differences in changes in water quality. For example, Wells 3 and 4 are only about 800 feet apart, but Well 3 has experienced only about a 50% increase in EC over the last 10 years while Well 4 has experienced more than a doubling of EC levels. Well 5, located about another 800 feet north of Well 4 experienced a rapid rise in EC, nearly tripling in about 3 years, at which time it was taken offline. Well 8 exhibited the smallest increases in EC and TDS in the well field. No data was reviewed for Well 11. The continuity of the reflectors in the Upper and Middle Avon Park and/or Ocala Formations suggests that the far southern part of this segment may be a favorable location for more stable water quality.

The Upper Floridan Aquifer typically is characterized by an increase in groundwater TDS concentration with increasing depth. Where present, the hydro-stratigraphic units that comprise the Upper Floridan Aquifer, the basal Hawthorn Unit, Suwannee Limestone, Ocala Group and Avon Park Formation, can exhibit differences in groundwater quality as a result of discrete aquifer zones (flow zones) that can be hydraulically isolated from one another by lower hydraulic conductivity intra and inter aquifer aquicludes and semi-confining units. Often, where an increasing TDS concentration in groundwater with depth in the Upper Floridan Aquifer is present, it may be attributed to the occurrence of multiple layered aquifer and semi-confining zones.

The natural occurrence or absence, due to depositional or diagenetic variations of these aquicludes or semi-confining units, determines the magnitude of groundwater quality variation and hydraulic connection between the discrete aquifer zones under both static and dynamic (groundwater pumping withdrawals) conditions. Occurrences and features that can breach and compromise the semi-confining units, post deposition or formation, include karst, collapse, fracturing or faulting. Vertical upward movement of groundwater from deeper aquifer zones exhibiting higher TDS concentrations occurs across absent or breached semi-confining units into shallower aquifer zones, in response to vertical upward gradients, causing an increase in TDS concentration in the shallower aquifer zones.

Vertical upward gradients can cause groundwater to flow across absent or compromised semi-confining unit(s). Increases in TDS concentrations in the Upper Floridan Aquifer in response to groundwater withdrawal may be attributed to this phenomenon. However, where the semi-confining units are present and have not been breached, migration of groundwater from the deeper aquifer zones into the shallower aquifer zones is slower and more limited. Upper Floridan Aquifer groundwater quality, its variation with depth, the presence or absence of discrete aquifer zones, semi-confining units and their characteristics can be determined at a particular location only by construction of a well. However, installation and testing of a well characterizes the subsurface at the site only in very close proximity to the well. Reflection seismic surveys provide information laterally, on the continuity of some of the subsurface characteristics between point locations where the subsurface has been characterized by construction of a well.

The presence and continuity or absence and/or disruption of aquifer and semi-confining zones over an existing or proposed wellfield area is a key factor for evaluating the potential for long term, sustainable groundwater withdrawals from the Upper Floridan Aquifer. For this reason, reflection seismic survey investigations provide valuable information on subsurface conditions influencing performance of both existing and proposed water supply wells.

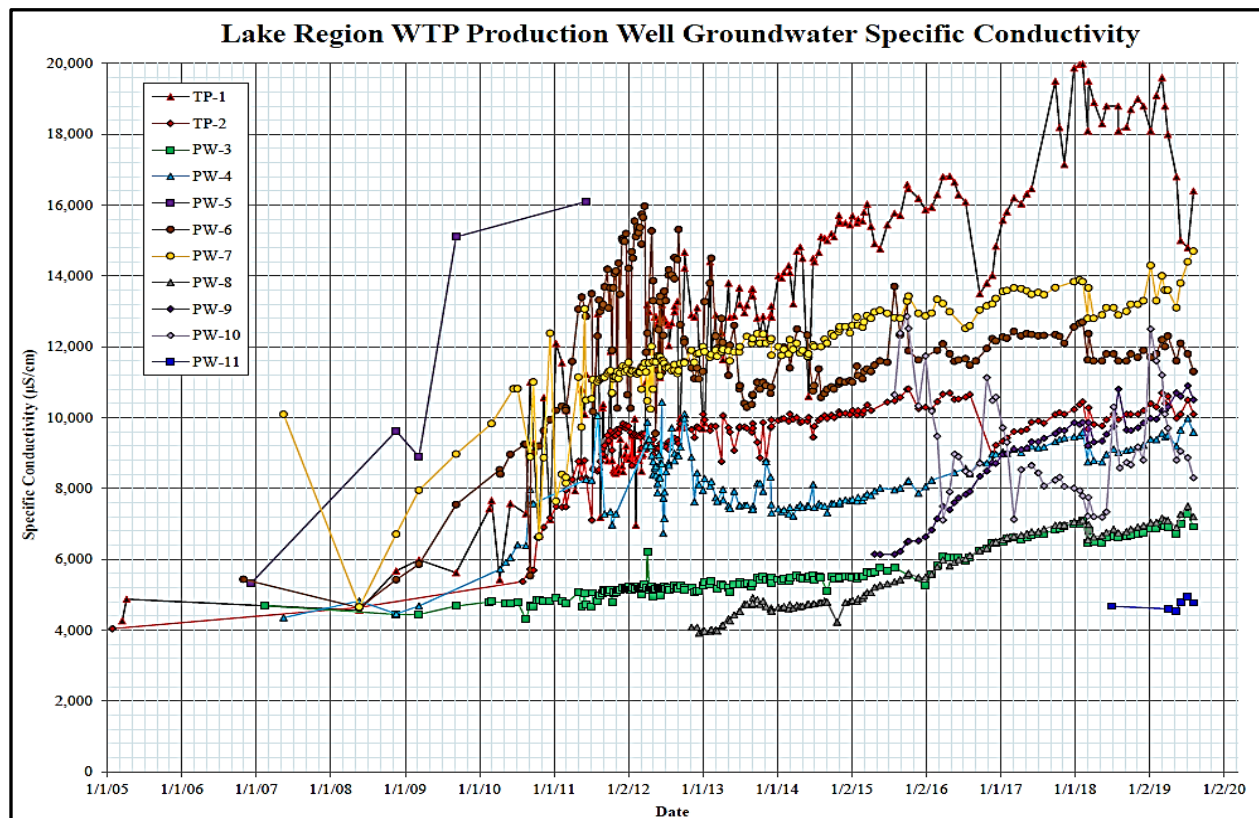


Figure 28: Lake Region Wellfield Historical Specific Conductivity Data.

5.0 SUMMARY

Seismic reflection data was collected at four sites to demonstrate the ability of the seismic reflection method to map the stratigraphy and structure of the Floridan aquifer system. Data was collected using 2D swath geometry at three sites. Data was collected using 3D acquisition geometry at one site. The data from all four sites produced high resolution images of the stratigraphy, faulting, fracture zones and karst features to depths below the FAS on all sites. The surveys produced rich, high resolution data suitable for hydrogeology and stratigraphic analysis. The 3D survey produced data with higher spatial resolution. However, all four surveys produced data suitable for several types of geologic analysis.

Attribute processing was applied to the 3D data set to map large discontinuities in the formation that indicate voids or large karst features. These features may be favorable targets for injection wells, particularly in the Boulder Zone. Conversely, zones where these features are absent may be more favorable locations for supply or ASR wells where minimal mixing and the integrity of confining units is critical. Additional attribute analysis could be applied to both the 3D and 2D data sets to enhance features of interest for a variety of hydrogeologic and geologic studies.

It is important to note that features interpreted on the 2D seismic lines are three-dimensional features transected by 2D seismic lines. It is impossible to be certain how these features trend between lines and how continuous they may be. For these reasons, additional comparison of the 2D swath geometry lines is important to get a sense of the projected trend of the features. It may also be prudent to collect 3D surveys over critical areas before drilling new wells to better define the trend and extent of features of interest, either; faults, fractures or collapse structures that may hasten migration of saline water, or zones of continuous parallel reflectors that may inhibit migration and reduce the increase in TDS over time. With careful review, including attribute processing, high resolution seismic reflection data can be used to screen sites as to having a higher density of voids and karst features in the Boulder Zone and being more favorable for injection wells, or as having lower densities of fractures and faults in the Upper Avon Park and Suwanee intervals and being more suitable for production wells or ASR storage zones. The high resolution reflection data provides the only practical method to screen potential well sites prior to drilling in the FAS. Given the cost of drilling, this method promises to provide significant savings in terms of maximizing the performance of wells depending upon their intended use.



Appendix 1 – Geodetic Survey Data

- OUA Receiver & Source Line Coordinates
- Kissimmee Receiver & Source Line Coordinates
- State Road 80 Segments 1 and 2 Receiver & Source Line Coordinates
- State Road 715 Segments 1 and 2 Receiver and Source Line Coordinates

OUA RCVR Line 5001 X-Y Station Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5001	1001	218094.480	327437.910	35.1010
5001	1002	218106.020	327448.080	35.1010
5001	1003	218117.280	327458.260	35.0882
5001	1004	218128.540	327468.430	35.0639
5001	1005	218139.790	327478.600	35.0292
5001	1006	218151.050	327489.090	34.9852
5001	1007	218162.310	327499.260	34.9329
5001	1008	218173.850	327509.430	34.8729
5001	1009	218185.110	327519.610	34.8062
5001	1010	218196.370	327529.780	34.7333
5001	1011	218207.630	327539.950	34.6550
5001	1012	218218.880	327550.430	34.5717
5001	1013	218230.140	327560.610	34.4839
5001	1014	218241.400	327570.780	34.3921
5001	1015	218252.940	327580.960	34.2967
5001	1016	218264.200	327591.130	34.1980
5001	1017	218275.460	327601.300	34.0965
5001	1018	218286.710	327611.480	33.9923
5001	1019	218297.970	327621.960	33.8857
5001	1020	218309.230	327632.130	33.7770
5001	1021	218320.770	327642.300	33.6663
5001	1022	218332.030	327652.480	33.5540
5001	1023	218343.290	327662.650	33.4400
5001	1024	218354.540	327672.830	33.3247
5001	1025	218365.800	327683.310	33.2081
5001	1026	218377.060	327693.480	33.0904
5001	1027	218388.600	327703.650	32.9835
5001	1028	218399.850	327713.830	32.8864
5001	1029	218411.110	327724.000	32.7980
5001	1030	218422.370	327734.180	32.7175
5001	1031	218433.630	327744.660	32.6442
5001	1032	218444.890	327754.830	32.5772
5001	1033	218456.420	327765.000	32.5160
5001	1034	218467.680	327775.180	32.4599
5001	1035	218478.940	327785.350	32.4085
5001	1037	218501.460	327805.700	32.3613
5001	1038	218512.720	327816.180	32.3179
5001	1039	218523.980	327826.350	32.2779
5001	1040	218535.510	327836.530	32.2409
5001	1041	218546.770	327846.700	32.2067
5001	1042	218558.030	327856.880	32.1750
5001	1043	218569.290	327867.050	32.1455

5001	1044	218580.550	327877.530	32.1180
5001	1045	218591.800	327887.710	32.0923
5001	1046	218603.340	327897.880	32.0682
5001	1047	218614.600	327908.050	32.0456
5001	1048	218625.850	327918.230	32.0243
5001	1049	218637.110	327928.400	32.0042
5001	1050	218648.370	327938.880	31.9852
5001	1051	218659.630	327949.060	31.9671
5001	1052	218671.160	327959.230	31.9499
5001	1053	218682.420	327969.400	31.9316
5001	1054	218693.680	327979.580	31.9123
5001	1055	218704.940	327989.750	31.8921
5001	1056	218716.200	327999.930	31.8710
5001	1057	218727.460	328010.410	31.8493
5001	1058	218738.990	328020.580	31.8269
5001	1059	218750.250	328030.760	31.8039
5001	1060	218761.510	328040.930	31.7803
5001	1061	218772.760	328051.100	31.7563
5001	1062	218784.020	328061.280	31.7319
5001	1063	218795.280	328071.760	31.7070
5001	1064	218806.810	328081.930	31.6819
5001	1065	218818.070	328092.110	31.6564
5001	1066	218829.330	328102.280	31.6306
5001	1067	218840.590	328112.460	31.6046
5001	1068	218851.850	328122.630	31.5783
5001	1069	218863.100	328133.110	31.5519
5001	1070	218874.640	328143.290	31.5252
5001	1071	218885.900	328153.460	31.4984
5001	1072	218897.150	328163.630	31.4715
5001	1073	218908.410	328173.810	31.4444
5001	1074	218919.670	328183.980	31.4172
5001	1075	218930.930	328194.160	31.3898
5001	1076	218942.460	328204.640	31.3624
5001	1077	218953.720	328214.810	31.3349
5001	1078	218964.980	328224.990	31.3073
5001	1079	218976.240	328235.160	31.2889
5001	1080	218987.490	328245.340	31.2788
5001	1081	218998.750	328255.510	31.2760
5001	1082	219010.280	328265.990	31.2800
5001	1083	219021.540	328276.170	31.2900
5001	1084	219032.800	328286.340	31.3055
5001	1085	219044.060	328296.510	31.3258
5001	1086	219055.320	328306.690	31.3505

5001	1087	219066.570	328316.860	31.3791
5001	1088	219078.110	328327.350	31.4113
5001	1089	219089.360	328337.520	31.4467
5001	1090	219100.620	328347.690	31.4850
5001	1091	219111.880	328357.870	31.5259
5001	1092	219123.140	328368.040	31.5691
5001	1093	219134.400	328378.220	31.6144
5001	1094	219145.650	328388.390	31.6616
5001	1095	219157.190	328398.870	31.7105
5001	1097	219179.700	328419.220	31.7609
5001	1098	219190.960	328429.400	31.8128
5001	1099	219202.220	328439.570	31.8658
5001	1100	219213.750	328449.750	31.9200
5001	1101	219225.010	328460.230	31.9752
5001	1102	219236.260	328470.400	32.0312
5001	1103	219247.520	328480.580	32.0881
5001	1104	219258.780	328490.750	32.1457
5001	1105	219270.040	328500.930	32.2040
5001	1106	219281.290	328511.100	32.2629

Geodetic Coordinate System: NAD 83 State Plane Florida East FIPS0901

OUA RCVR Line 5002 X-Y Station Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5002	1001	218084.290	327449.280	35.1010
5002	1002	218095.550	327459.460	35.1010
5002	1003	218107.080	327469.630	35.0991
5002	1004	218118.340	327479.800	35.0956
5002	1005	218129.600	327489.980	35.0906
5002	1006	218140.860	327500.150	35.0842
5002	1007	218152.120	327510.630	35.0766
5002	1008	218163.380	327520.810	35.0679
5002	1009	218174.920	327530.980	35.0583
5002	1010	218186.180	327541.150	35.0477
5002	1011	218197.430	327551.330	35.0364
5002	1012	218208.690	327561.500	35.0243
5002	1013	218219.950	327571.670	35.0116
5002	1014	218231.210	327582.150	34.9983
5002	1015	218242.750	327592.330	34.9844
5002	1016	218254.010	327602.500	34.9701
5002	1017	218265.260	327612.680	34.9554
5002	1018	218276.520	327622.850	34.9403
5002	1019	218287.780	327633.020	34.9249
5002	1020	218299.040	327643.500	34.9091
5002	1021	218310.300	327653.680	34.8931
5002	1022	218321.830	327663.850	34.8768
5002	1023	218333.090	327674.020	34.8603
5002	1024	218344.350	327684.200	34.8436
5002	1025	218355.610	327694.370	34.8267
5002	1026	218366.870	327704.850	34.8096
5002	1027	218378.130	327715.030	34.7924
5002	1028	218389.660	327725.200	34.7751
5002	1029	218400.920	327735.370	34.7550
5002	1030	218412.180	327745.550	34.7326
5002	1031	218423.440	327755.720	34.7079
5002	1032	218434.700	327765.900	34.6813
5002	1033	218445.960	327776.380	34.6530
5002	1034	218457.490	327786.550	34.6230
5002	1035	218468.750	327796.720	34.5916
5002	1036	218480.010	327806.900	34.5589
5002	1037	218491.270	327817.070	34.5251
5002	1039	218513.790	327837.730	34.4902
5002	1040	218525.320	327847.900	34.4544
5002	1041	218536.580	327858.070	34.4177
5002	1042	218547.840	327868.250	34.3803
5002	1043	218559.100	327878.420	34.3422

5002	1044	218570.350	327888.600	34.3035
5002	1045	218581.610	327899.080	34.2642
5002	1046	218593.150	327909.250	34.2244
5002	1047	218604.400	327919.430	34.1842
5002	1048	218615.660	327929.600	34.1436
5002	1049	218626.920	327939.770	34.1026
5002	1050	218638.180	327949.950	34.0613
5002	1051	218649.440	327960.120	34.0196
5002	1052	218660.700	327970.600	33.9778
5002	1053	218672.230	327980.780	33.9356
5002	1054	218683.490	327990.950	33.8933
5002	1055	218694.750	328001.120	33.8508
5002	1056	218706.010	328011.300	33.8161
5002	1057	218717.260	328021.470	33.7886
5002	1058	218728.520	328031.950	33.7674
5002	1059	218740.060	328042.130	33.7520
5002	1060	218751.310	328052.300	33.7417
5002	1061	218762.570	328062.480	33.7361
5002	1062	218773.830	328072.650	33.7347
5002	1063	218785.090	328082.820	33.7370
5002	1064	218796.350	328093.310	33.7428
5002	1065	218807.880	328103.480	33.7515
5002	1066	218819.140	328113.650	33.7631
5002	1067	218830.400	328123.830	33.7771
5002	1068	218841.660	328134.000	33.7933
5002	1069	218852.910	328144.180	33.8116
5002	1070	218864.170	328154.350	33.8316
5002	1071	218875.710	328164.830	33.8533
5002	1072	218886.960	328175.010	33.8764
5002	1073	218898.220	328185.180	33.9009
5002	1074	218909.480	328195.360	33.9265
5002	1075	218920.740	328205.530	33.9532
5002	1076	218932.000	328215.700	33.9808
5002	1077	218943.530	328226.190	34.0093
5002	1078	218954.790	328236.360	34.0386
5002	1079	218966.040	328246.530	34.0686
5002	1080	218977.300	328256.710	34.0992
5002	1081	218988.560	328266.880	34.1304
5002	1082	218999.820	328277.060	34.1598
5002	1083	219011.350	328287.540	34.1876
5002	1084	219022.610	328297.710	34.2140
5002	1085	219033.870	328307.890	34.2391
5002	1086	219045.120	328318.060	34.2630

5002	1087	219056.380	328328.240	34.2859
5002	1088	219067.640	328338.410	34.3079
5002	1089	219079.170	328348.580	34.3290
5002	1090	219090.430	328359.070	34.3493
5002	1091	219101.690	328369.240	34.3689
5002	1092	219112.950	328379.410	34.3880
5002	1093	219124.200	328389.590	34.4065
5002	1094	219135.460	328399.760	34.4244
5002	1095	219146.990	328409.940	34.4420
5002	1096	219158.250	328420.420	34.4591
5002	1097	219169.510	328430.590	34.4758
5002	1098	219180.770	328440.770	34.4923
5002	1100	219203.280	328461.120	34.5084
5002	1101	219214.820	328471.290	34.5243
5002	1102	219226.070	328481.470	34.5399
5002	1103	219237.330	328491.950	34.5553
5002	1104	219248.590	328502.120	34.5706
5002	1105	219259.850	328512.300	34.5856
5002	1106	219271.100	328522.470	34.6005

OUA SRC Line 1001 X-Y Station Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
1001	5001	218089.5000	327443.4000	36.0436
1001	5003	218112.0000	327463.8000	36.0440
1001	5005	218134.6000	327484.4000	36.0446
1001	5007	218157.4000	327504.8000	36.0456
1001	5009	218179.9000	327525.1000	36.0471
1001	5011	218202.4000	327545.8000	36.0491
1001	5013	218225.2000	327566.1000	36.0513
1001	5015	218247.7000	327586.5000	36.0540
1001	5017	218270.2000	327607.1000	36.0569
1001	5019	218293.0000	327627.5000	36.0600
1001	5021	218315.5000	327647.8000	36.0635
1001	5023	218338.1000	327668.5000	36.0671
1001	5025	218360.8000	327688.8000	36.0709
1001	5027	218383.4000	327709.2000	36.0749
1001	5029	218405.9000	327729.8000	36.0739
1001	5031	218428.7000	327750.2000	36.0684
1001	5033	218451.2000	327770.5000	36.0589
1001	5035	218473.7000	327791.2000	36.0456
1001	5037	218496.5000	327811.5000	36.0291
1001	5039	218519.0000	327831.9000	36.0097
1001	5041	218541.5000	327852.5000	35.9876
1001	5043	218564.3000	327872.9000	35.9630
1001	5045	218586.8000	327893.2000	35.9364
1001	5047	218609.4000	327913.6000	35.9078
1001	5049	218632.2000	327934.2000	35.8774
1001	5051	218654.7000	327954.6000	35.8455
1001	5053	218677.2000	327974.9000	35.8121
1001	5055	218700.0000	327995.6000	35.7828
1001	5059	218745.0000	328036.3000	35.7570
1001	5061	218767.8000	328056.9000	35.7345
1001	5063	218790.3000	328077.3000	35.7149
1001	5065	218812.8000	328097.6000	35.6979
1001	5067	218835.4000	328118.3000	35.6833
1001	5069	218858.2000	328138.6000	35.6708
1001	5071	218880.7000	328159.0000	35.6602
1001	5073	218903.2000	328179.6000	35.6513
1001	5075	218926.0000	328200.0000	35.6440
1001	5077	218948.5000	328220.3000	35.6381
1001	5079	218971.0000	328240.7000	35.6334
1001	5081	218993.8000	328261.3000	35.6299
1001	5083	219016.3000	328281.7000	35.6309
1001	5085	219038.8000	328302.0000	35.6360

1001	5087	219061.6000	328322.7000	35.6448
1001	5089	219084.1000	328343.0000	35.6570
1001	5091	219106.7000	328363.4000	35.6721
1001	5093	219129.4000	328384.1000	35.6900
1001	5095	219152.0000	328404.4000	35.7102
1001	5097	219174.5000	328424.8000	35.7327
1001	5099	219197.3000	328445.4000	35.7571
1001	5101	219219.8000	328465.8000	35.7832
1001	5103	219242.3000	328486.1000	35.8110
1001	5105	219265.1000	328506.8000	35.8402

Geodetic Coordinate System: NAD 83 State Plane Florida East FIPS0901

Kissimmee RCVR Line 5003 X-Y Station Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5003	1001	212312.2034	312140.0111	20.0780
5003	1002	212303.8742	312151.0668	20.1788
5003	1003	212294.3417	312163.3660	20.2795
5003	1004	212285.2852	312175.4687	20.3803
5003	1005	212276.8979	312187.4242	20.4810
5003	1006	212267.3863	312199.7443	20.5818
5003	1007	212258.6927	312211.8659	20.6825
5003	1008	212248.9559	312224.2679	20.7833
5003	1009	212239.3310	312236.5666	20.8840
5003	1010	212229.6568	312249.0011	20.9848
5003	1011	212221.2484	312260.4316	21.0855
5003	1012	212210.8453	312272.8568	21.1863
5003	1013	212199.9936	312284.9992	21.2870
5003	1014	212189.6106	312296.0770	21.3878
5003	1015	212178.3830	312306.0980	21.4885
5003	1016	212167.0232	312315.7945	21.5893
5003	1017	212155.5145	312325.8479	21.6900
5003	1018	212144.7696	312335.5785	21.7908
5003	1019	212132.7682	312346.0025	21.8915
5003	1020	212120.5317	312356.1385	21.9923
5003	1021	212109.5908	312366.1854	22.0930
5003	1022	212097.7426	312376.3340	22.1938
5003	1023	212086.1991	312386.0478	22.2945
5003	1024	212075.2157	312396.3021	22.3953
5003	1025	212063.3831	312406.1549	22.4960
5003	1026	212052.1128	312416.1804	22.5968
5003	1027	212041.7974	312425.4687	22.6975
5003	1028	212029.2570	312436.0254	22.7983
5003	1029	212018.5303	312446.3655	22.8990
5003	1030	212007.0215	312455.8552	22.9998
5003	1031	211995.4559	312466.1371	23.1005
5003	1032	211984.1019	312476.1289	23.2013
5003	1033	211972.2808	312486.1394	23.3020
5003	1034	211961.1773	312495.7045	23.4028
5003	1035	211949.7483	312506.8014	23.5035
5003	1036	211938.4643	312517.2362	23.6043
5003	1037	211927.4501	312527.5720	23.7050
5003	1038	211916.8357	312538.7955	23.8058
5003	1039	211905.6568	312549.9622	23.9065
5003	1040	211895.6404	312560.6853	24.0073
5003	1041	211886.2701	312571.1975	24.2062

5003	1042	211875.8506	312583.4611	24.1704
5003	1043	211866.0387	312594.0504	24.1346
5003	1044	211856.2425	312605.3272	24.0988
5003	1045	211846.4024	312617.3410	24.0630
5003	1046	211837.0931	312628.8563	24.0272
5003	1047	211827.4921	312640.3599	23.9914
5003	1048	211818.6085	312653.0579	23.9556
5003	1049	211809.9918	312665.0400	23.9199
5003	1050	211800.9574	312677.6737	23.8841
5003	1051	211792.4683	312690.1416	23.8483
5003	1052	211784.1930	312702.9334	23.8125
5003	1053	211776.4247	312716.7000	23.7767
5003	1054	211768.9674	312728.8270	23.7409
5003	1055	211760.5601	312741.8155	23.7051
5003	1056	211753.2753	312754.6673	23.6693
5003	1057	211745.4497	312768.2358	23.6335
5003	1058	211737.6428	312780.7248	23.5977
5003	1059	211729.9250	312793.9534	23.5620
5003	1060	211722.3452	312806.9656	23.5262
5003	1061	211714.7972	312819.7101	23.4904
5003	1062	211707.2916	312833.5680	23.4546
5003	1063	211698.9499	312846.4890	23.4188
5003	1064	211691.5124	312860.0936	23.3830
5003	1065	211683.6201	312872.7357	23.3472
5003	1066	211675.2339	312885.4213	23.3114
5003	1067	211668.1258	312898.4294	23.2756
5003	1068	211660.3274	312912.1527	23.2399
5003	1069	211652.4128	312924.7947	23.2041
5003	1070	211644.2543	312938.0824	23.1683
5003	1071	211637.2185	312952.1778	23.1325
5003	1072	211630.1281	312963.6812	23.0967
5003	1073	211621.2938	312976.9394	23.0609
5003	1074	211614.5864	312989.9651	23.0251
5003	1075	211606.8654	313003.4979	22.9893
5003	1076	211598.9194	313016.7369	22.9535
5003	1077	211591.5379	313030.0377	22.9178
5003	1078	211584.0190	313043.0034	22.8820
5003	1079	211575.8731	313055.5616	22.8462
5003	1080	211568.4627	313069.3229	22.8104
5003	1081	211560.9342	313082.3943	22.7746
5003	1082	211552.6598	313094.9079	22.7388
5003	1083	211544.6842	313108.6483	22.7030
5003	1084	211537.2669	313121.8492	22.6672

5003	1085	211529.7898	313134.5791	22.6314
5003	1086	211522.1177	313147.6379	22.5956
5003	1087	211514.3425	313160.7818	22.5599
5003	1088	211506.9441	313173.6547	22.5241
5003	1089	211498.9431	313187.2655	22.4883
5003	1090	211491.1949	313199.5893	22.4525
5003	1091	211483.1334	313213.2330	22.4167
5003	1092	211475.9521	313226.3327	22.3809
5003	1093	211468.2817	313239.4205	22.3451
5003	1094	211460.4916	313252.5841	22.3093
5003	1095	211452.8369	313265.6774	22.2735
5003	1096	211445.2044	313278.3412	22.2378
5003	1097	211437.3946	313292.7541	22.2020
5003	1098	211429.8740	313305.1854	22.1662
5003	1099	211421.9887	313318.1739	22.1304
5003	1100	211414.4988	313331.5130	22.0946
5003	1101	211406.4082	313344.3094	22.0588
5003	1102	211399.0459	313357.1550	22.0230
5003	1103	211391.2187	313370.0425	21.9872
5003	1104	211383.6303	313383.7640	21.9514
5003	1105	211375.7457	313396.7008	21.9156
5003	1106	211367.4710	313410.3047	21.8799

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Kissimmee RCVR Line 5004 X-Y Station Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5004	1001	212300.9763	312130.1952	24.5367
5004	1002	212291.5144	312143.3838	24.5367
5004	1003	212282.0751	312154.6243	24.5380
5004	1004	212273.0636	312167.2907	24.5404
5004	1005	212264.3444	312179.6164	24.5436
5004	1006	212255.1635	312191.1012	24.5476
5004	1007	212245.9295	312203.5278	24.5520
5004	1008	212237.1343	312215.5679	24.5569
5004	1009	212227.6249	312227.2725	24.5622
5004	1010	212218.5831	312239.3857	24.5677
5004	1011	212209.2603	312251.1005	24.5735
5004	1012	212199.4951	312263.2229	24.5794
5004	1013	212189.5205	312274.1400	24.5855
5004	1014	212179.4932	312284.7942	24.5917
5004	1015	212168.3210	312295.0943	24.5980
5004	1016	212156.8769	312304.7896	24.6043
5004	1017	212146.0013	312314.8337	24.6675
5004	1018	212134.4064	312325.0671	24.7761
5004	1019	212122.6014	312335.1195	24.9211
5004	1020	212111.0689	312345.1304	25.0952
5004	1021	212099.0863	312355.3672	25.2926
5004	1022	212088.5166	312364.7853	25.5085
5004	1023	212076.3638	312374.9848	25.7394
5004	1024	212064.8331	312384.8976	25.9822
5004	1025	212053.4214	312395.0959	26.2345
5004	1026	212042.1773	312405.1165	26.4944
5004	1027	212030.2363	312415.3878	26.7605
5004	1028	212019.5004	312425.2560	27.0314
5004	1029	212007.3113	312435.7113	27.3062
5004	1030	211995.6296	312445.9645	27.6012
5004	1031	211984.1349	312456.5899	27.8347
5004	1032	211972.9319	312465.7893	28.0193
5004	1033	211961.3947	312475.5489	28.1645
5004	1034	211949.8869	312486.7820	28.2784
5004	1035	211939.7720	312496.2826	28.3671
5004	1036	211927.6807	312506.4250	28.4358
5004	1037	211917.2840	312517.3277	28.4883
5004	1038	211906.1330	312528.3720	28.5280
5004	1039	211895.2587	312538.1041	28.5574
5004	1040	211885.1939	312549.9752	28.5786
5004	1041	211875.0454	312562.0334	28.5932

5004	1042	211864.6722	312572.8409	28.6025
5004	1043	211854.8238	312584.7279	28.6076
5004	1044	211844.5802	312595.9577	28.6094
5004	1045	211834.4843	312607.4861	28.6084
5004	1046	211824.9055	312620.1660	28.6053
5004	1047	211815.6114	312632.4717	28.6005
5004	1048	211806.8470	312643.8044	28.5942
5004	1049	211797.7553	312656.9656	28.5869
5004	1050	211788.7884	312669.6758	28.5787
5004	1051	211780.5546	312681.9095	28.5630
5004	1052	211772.0024	312694.7465	28.5413
5004	1053	211764.0754	312708.1667	28.5149
5004	1054	211755.7244	312721.0235	28.4846
5004	1055	211748.0888	312733.1909	28.4513
5004	1056	211740.3907	312746.6310	28.4155
5004	1057	211732.7604	312760.1046	28.3778
5004	1058	211725.0307	312772.4942	28.3385
5004	1059	211717.1669	312786.0671	28.2979
5004	1060	211709.3924	312798.4269	28.2563
5004	1061	211702.2512	312811.9897	28.2140
5004	1062	211693.6528	312825.2245	28.1710
5004	1063	211685.6615	312838.4335	28.1274
5004	1064	211678.4353	312851.1895	28.0835
5004	1065	211670.1539	312864.9375	28.0392
5004	1066	211662.5496	312877.9089	27.9947
5004	1067	211655.6016	312891.0054	27.9500
5004	1068	211647.5077	312904.2311	27.9051
5004	1069	211638.3471	312916.5687	27.8600
5004	1070	211632.6501	312930.0180	27.8149
5004	1071	211625.0078	312943.5179	27.7697
5004	1072	211617.5414	312956.4802	27.7244
5004	1073	211609.6087	312969.5733	27.6790
5004	1074	211601.7409	312982.9493	27.6336
5004	1075	211594.3165	312995.6504	27.5882
5004	1076	211586.2143	313009.2029	27.5427
5004	1077	211578.7189	313022.0116	27.4972
5004	1078	211571.0978	313035.9098	27.4517
5004	1079	211563.2353	313047.8997	27.4062
5004	1080	211555.2094	313061.9575	27.3607
5004	1081	211548.1064	313074.4089	27.3151
5004	1082	211540.2128	313087.5356	27.2696
5004	1083	211532.8827	313101.3914	27.2240
5004	1084	211524.1888	313114.2225	27.1785

5004	1085	211516.3761	313126.7468	27.1329
5004	1086	211508.5715	313140.3759	27.0874
5004	1087	211501.4843	313153.6763	27.0418
5004	1088	211493.7355	313167.0494	26.9962
5004	1089	211485.8513	313179.7525	26.9506
5004	1090	211477.6789	313193.0947	26.9051
5004	1091	211469.8060	313205.9397	26.8595
5004	1092	211462.1764	313219.1415	26.8139
5004	1093	211454.9396	313232.2681	26.7684
5004	1094	211447.1039	313244.3935	26.7228
5004	1095	211439.5538	313258.0859	26.6772
5004	1096	211431.4636	313270.7512	26.6316
5004	1097	211424.1745	313283.6866	26.5861
5004	1098	211415.9924	313297.1900	26.5405
5004	1099	211408.5179	313309.8298	26.4949
5004	1100	211401.1051	313322.7813	26.4493
5004	1101	211393.0422	313336.0022	26.4038
5004	1102	211385.3633	313349.1220	26.3582
5004	1103	211377.9115	313362.7640	26.3126
5004	1104	211370.2743	313376.2086	26.2670
5004	1105	211362.1814	313389.2016	26.2215
5004	1106	211354.3141	313401.3465	26.1759

Geodetic Coordinate System: NAD 83 State Plane Florida East FIPS0901

Kissimmee SRC Line 3000 X-Y Station Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3000.00	1001.00	212437.0000	311968.1000	22.0170
3000.00	1003.00	212417.4000	311991.8000	22.0170
3000.00	1005.00	212398.3000	312016.8000	22.0190
3000.00	1007.00	212380.2000	312041.3000	22.0227
3000.00	1009.00	212362.2000	312065.2000	22.0277
3000.00	1011.00	212343.7000	312089.4000	22.0337
3000.00	1013.00	212325.4000	312113.3000	22.0406
3000.00	1015.00	212306.4000	312136.3000	22.0481
3000.00	1017.00	212288.0000	312160.7000	22.0562
3000.00	1019.00	212269.4000	312185.7000	22.0646
3000.00	1021.00	212251.6000	312209.6000	22.0735
3000.00	1023.00	212233.0000	312233.9000	21.9409
3000.00	1025.00	212214.0000	312258.3000	21.8713
3000.00	1027.00	212194.0000	312281.5000	21.8523
3000.00	1029.00	212171.9000	312303.3000	21.8737
3000.00	1031.00	212149.1000	312323.1000	21.9273
3000.00	1033.00	212126.5000	312343.1000	22.0068
3000.00	1035.00	212102.8000	312363.1000	22.1070
3000.00	1037.00	212080.0000	312383.6000	22.2237
3000.00	1039.00	212057.6000	312403.7000	22.3536
3000.00	1041.00	212034.2000	312423.2000	22.4942
3000.00	1043.00	212011.1000	312443.1000	22.6432
3000.00	1045.00	211988.4000	312463.7000	22.7989
3000.00	1047.00	211965.8000	312483.7000	22.9601
3000.00	1049.00	211943.4000	312503.7000	23.1257
3000.00	1051.00	211921.4000	312525.2000	23.2947
3000.00	1053.00	211899.8000	312546.0000	23.4664
3000.00	1055.00	211879.2000	312569.3000	23.6404
3000.00	1057.00	211859.1000	312591.7000	23.8162
3000.00	1059.00	211839.4000	312615.2000	23.9934
3000.00	1061.00	211821.0000	312639.3000	24.1717
3000.00	1063.00	211803.2000	312663.6000	24.3510
3000.00	1065.00	211786.3000	312689.0000	24.5309
3000.00	1067.00	211769.6000	312714.5000	24.7115
3000.00	1069.00	211753.7000	312740.3000	24.8590
3000.00	1071.00	211738.1000	312765.9000	24.9802
3000.00	1073.00	211722.7000	312793.0000	25.0803
3000.00	1075.00	211707.3000	312818.2000	25.1634
3000.00	1077.00	211691.8000	312845.3000	25.2331
3000.00	1079.00	211676.7000	312871.3000	25.2920
3000.00	1081.00	211661.1000	312897.9000	25.3422

3000.00	1083.00	211645.4000	312924.7000	25.3854
3000.00	1085.00	211630.8000	312950.5000	25.4232
3000.00	1087.00	211615.6000	312976.4000	25.4565
3000.00	1089.00	211600.1000	313002.5000	25.4863
3000.00	1091.00	211584.7000	313028.7000	25.5132
3000.00	1093.00	211569.5000	313054.8000	25.5144
3000.00	1095.00	211554.3000	313081.0000	25.4950
3000.00	1097.00	211538.2000	313106.5000	25.4592
3000.00	1099.00	211523.5000	313132.8000	25.4101
3000.00	1101.00	211507.7000	313159.8000	25.3505
3000.00	1103.00	211492.9000	313186.5000	25.2825
3000.00	1105.00	211477.1000	313212.4000	25.2077
3000.00	1107.00	211461.7000	313237.6000	25.1275
3000.00	1109.00	211446.4000	313264.0000	25.0430
3000.00	1111.00	211430.8000	313290.1000	24.9551
3000.00	1113.00	211415.5000	313316.5000	24.8644
3000.00	1115.00	211399.8000	313343.6000	24.7714
3000.00	1117.00	211385.4000	313368.6000	24.6767
3000.00	1119.00	211369.5000	313396.1000	24.5806
3000.00	1121.00	211353.5000	313421.9000	24.4834
3000.00	1123.00	211338.3000	313448.4000	24.3852
3000.00	1125.00	211322.2000	313473.7000	24.2864
3000.00	1127.00	211307.0000	313499.6000	24.1869
3000.00	1129.00	211291.4000	313525.9000	24.0870
3000.00	1131.00	211276.6000	313551.5000	23.9867
3000.00	1133.00	211260.4000	313578.8000	23.8861

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State Road 80 RCVR Segment 1 Line 5015 X-Y Station Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5015	1001	229578.5600	265056.4500	12.9880
5015	1002	229593.3600	265055.3300	12.9661
5015	1003	229608.0900	265056.3000	12.9442
5015	1004	229624.1500	265055.0800	12.9223
5015	1005	229638.8100	265056.6400	12.9004
5015	1006	229654.7400	265056.1700	12.8784
5015	1007	229669.2100	265057.1600	12.8565
5015	1008	229685.3500	265056.2800	12.8346
5015	1009	229699.4400	265057.2700	12.8127
5015	1010	229715.9000	265056.2600	12.7908
5015	1011	229730.2500	265057.5600	12.7689
5015	1012	229746.5000	265056.1400	12.7470
5015	1013	229760.6300	265057.0800	12.7251
5015	1014	229776.8700	265056.2200	12.7031
5015	1015	229791.9000	265056.8000	12.6812
5015	1016	229810.5900	265053.3700	12.6593
5015	1017	229820.1200	265057.4300	12.6374
5015	1018	229851.9000	265058.9800	12.6155
5015	1019	229868.8800	265057.7300	12.5936
5015	1020	229882.8700	265058.6200	12.5717
5015	1021	229898.8500	265057.9800	12.5498
5015	1022	229913.1800	265059.0900	12.5279
5015	1023	229929.4800	265057.2200	12.5059
5015	1024	229943.8400	265058.4000	12.4840
5015	1025	229959.8500	265058.5800	12.4621
5015	1026	229974.3000	265058.5000	12.4402
5015	1027	229990.5400	265058.0800	12.4183
5015	1028	230005.0700	265058.3500	12.3964
5015	1029	230020.3900	265058.0000	12.3745
5015	1030	230036.3400	265057.9500	12.3526
5015	1031	230051.7300	265058.0600	12.3306
5015	1032	230066.0800	265058.6700	12.3087
5015	1033	230081.6400	265058.1900	12.2868
5015	1034	230096.3400	265058.7000	12.2649
5015	1035	230111.9800	265058.3200	12.2430
5015	1036	230127.1300	265059.2000	12.2211
5015	1037	230143.1000	265058.6400	12.1992
5015	1038	230157.7700	265058.6800	12.1773
5015	1039	230173.5600	265058.0100	12.1554
5015	1040	230187.7800	265064.7700	12.1334
5015	1041	230205.3700	265064.5400	12.1115
5015	1042	230223.7000	265068.4100	12.0896

5015	1043	230234.4100	265057.5400	12.0677
5015	1044	230249.6000	265058.8000	12.0458
5015	1045	230265.2800	265058.3100	12.0239
5015	1046	230279.5300	265059.4500	12.0020
5015	1047	230295.5800	265058.1300	11.9801
5015	1048	230309.8500	265059.7900	11.9581
5015	1049	230326.6000	265059.0500	11.9362
5015	1050	230341.0100	265059.3100	11.9143
5015	1051	230356.4500	265058.4600	11.8924
5015	1052	230372.0100	265059.7100	11.8705
5015	1053	230387.0600	265059.2800	11.8486
5015	1054	230402.4700	265059.1500	11.8267
5015	1055	230417.3700	265058.8600	11.8048
5015	1056	230432.4600	265060.0200	11.7829
5015	1057	230448.6400	265059.6400	11.7609
5015	1058	230463.7300	265059.4700	11.7390
5015	1059	230479.1500	265059.2500	11.7171
5015	1060	230493.8200	265059.8700	11.6952
5015	1061	230509.5100	265059.7500	11.6733
5015	1062	230524.2400	265060.1100	11.6514
5015	1063	230539.7500	265059.6800	11.6295
5015	1064	230554.7200	265060.0900	11.6076
5015	1065	230571.2500	265059.0100	11.5856
5015	1066	230584.8200	265059.8100	11.5637
5015	1067	230600.9100	265058.2000	11.5418
5015	1068	230617.6000	265060.8800	11.5199
5015	1069	230634.1500	265059.2000	11.4980
5015	1070	230646.8300	265061.1900	11.4854
5015	1071	230662.7900	265060.6200	11.4727
5015	1072	230677.0200	265061.4600	11.4601
5015	1073	230692.9800	265060.3500	11.4474
5015	1074	230708.2400	265061.6600	11.4348
5015	1075	230723.6000	265060.4500	11.4222
5015	1076	230738.4800	265061.1800	11.4095
5015	1077	230753.7700	265060.2200	11.3969
5015	1078	230768.5600	265061.0400	11.3843
5015	1079	230784.6600	265060.4500	11.3716
5015	1080	230799.4800	265061.7500	11.3590
5015	1081	230816.0200	265060.5600	11.3463
5015	1082	230830.1600	265061.5600	11.3337
5015	1083	230845.8200	265060.0300	11.3211
5015	1084	230860.4800	265060.8500	11.3084
5015	1085	230876.4500	265060.4100	11.2958

5015	1086	230891.4100	265061.3600	11.2831
5015	1087	230907.2400	265060.6100	11.2705
5015	1088	230921.4500	265061.9500	11.2579
5015	1089	230936.6000	265061.6500	11.2452
5015	1090	230952.3100	265061.8900	11.2326
5015	1091	230968.0600	265061.1700	11.2200
5015	1092	230982.7200	265061.5500	11.2073
5015	1093	230998.4300	265061.9500	11.1947
5015	1094	231013.2600	265062.5000	11.1820
5015	1095	231029.1400	265061.4300	11.1694
5015	1096	231043.9100	265061.8200	11.1568
5015	1097	231059.2400	265061.7400	11.1441
5015	1098	231074.1200	265062.6000	11.1315
5015	1099	231089.5400	265061.5500	11.1189
5015	1100	231104.8800	265063.1300	11.1062
5015	1101	231120.2500	265062.2000	11.0936
5015	1102	231135.4700	265062.9300	11.0809
5015	1103	231150.4200	265062.8800	11.0683
5015	1104	231165.9500	265063.4900	11.0557
5015	1105	231181.6100	265062.2500	11.0430
5015	1106	231196.0100	265064.0300	11.0304
5015	1107	231211.9500	265062.5200	11.0177
5015	1108	231227.1000	265062.9100	11.0051
5015	1109	231242.3900	265062.9600	10.9925
5015	1110	231256.6900	265063.4700	10.9798
5015	1111	231272.7100	265062.9700	10.9672
5015	1112	231287.9100	265063.5500	10.9546
5015	1113	231303.5200	265063.6500	10.9419
5015	1114	231318.1500	265063.8000	10.9293
5015	1115	231333.9900	265064.2100	10.9166
5015	1116	231347.3400	265064.5400	10.9040

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State Road 80 SRC Segment 1 Line 1015 X-Y Station Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
1015	5001	229570.9000	265063.8000	12.9880
1015	5002	229601.0000	265062.9000	12.9442
1015	5003	229632.5000	265063.3000	12.9004
1015	5004	229662.3000	265064.0000	12.8565
1015	5005	229692.7000	265063.1000	12.8127
1015	5006	229723.7000	265064.1000	12.7689
1015	5007	229753.8000	265062.4000	12.7251
1015	5008	229783.6000	265063.4000	12.6812
1015	5009	229814.6000	265064.7000	12.6374
1015	5010	229845.0000	265064.1000	12.5936
1015	5011	229876.2000	265063.0000	12.5498
1015	5012	229906.1000	265063.3000	12.5059
1015	5013	229935.6000	265063.4000	12.4621
1015	5014	229967.2000	265063.8000	12.4183
1015	5015	229997.6000	265063.6000	12.3745
1015	5016	230028.0000	265063.6000	12.3306
1015	5017	230058.1000	265063.4000	12.2868
1015	5018	230088.5000	265063.5000	12.2430
1015	5019	230118.9000	265064.8000	12.1992
1015	5020	230149.6000	265064.2000	12.1554
1015	5021	230180.2000	265064.3000	12.1115
1015	5022	230210.4000	265064.7000	12.0677
1015	5023	230240.5000	265066.6000	12.0239
1015	5024	230271.7000	265066.7000	11.9801
1015	5025	230302.1000	265065.8000	11.9362
1015	5026	230331.7000	265065.0000	11.8924
1015	5027	230362.9000	265065.3000	11.8486
1015	5028	230392.5000	265065.1000	11.8048
1015	5029	230423.4000	265065.2000	11.7609
1015	5030	230453.3000	265065.9000	11.7171
1015	5031	230484.5000	265065.3000	11.6733
1015	5032	230514.6000	265065.1000	11.6295
1015	5033	230544.7000	265065.8000	11.5856
1015	5034	230574.3000	265065.9000	11.5418
1015	5035	230605.5000	265066.2000	11.4980
1015	5036	230635.7000	265070.6000	11.4727
1015	5037	230665.8000	265070.4000	11.4474
1015	5038	230695.9000	265070.1000	11.4222
1015	5039	230726.9000	265069.9000	11.3969
1015	5040	230757.3000	265069.7000	11.3716
1015	5041	230787.1000	265069.8000	11.3463
1015	5042	230817.5000	265070.1000	11.3211

1015	5043	230851.2000	265070.2000	11.2958
1015	5044	230882.7000	265070.0000	11.2705
1015	5045	230912.6000	265070.7000	11.2452
1015	5046	230944.3000	265071.4000	11.2200
1015	5047	230975.3000	265071.1000	11.1947
1015	5048	231005.4000	265070.6000	11.1694
1015	5049	231036.9000	265071.3000	11.1441
1015	5050	231066.2000	265071.7000	11.1189
1015	5051	231097.2000	265072.7000	11.0936
1015	5052	231128.7000	265073.1000	11.0683
1015	5053	231158.0000	265073.4000	11.0430
1015	5054	231188.6000	265073.5000	11.0177
1015	5055	231219.0000	265073.0000	10.9925
1015	5056	231248.9000	265073.3000	10.9672
1015	5057	231279.8000	265073.4000	10.9419
1015	5058	231309.1000	265073.2000	10.9166
1015	5059	231339.0000	265074.8000	10.9166

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State Road 80 RCVR Segment 2 Line 5015 X-Y Station Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5015	1127	231467.5000	265072.0400	8.1590
5015	1128	231482.9700	265072.3900	8.1354
5015	1129	231497.8900	265072.7300	8.1118
5015	1130	231513.3700	265072.4600	8.0882
5015	1131	231528.5700	265072.8100	8.0647
5015	1132	231544.0500	265073.1600	8.0411
5015	1133	231560.3500	265072.8900	8.0175
5015	1134	231575.0000	265073.2300	7.9939
5015	1135	231589.3700	265072.6500	7.9703
5015	1136	231605.4000	265072.6900	7.9467
5015	1137	231620.3200	265072.7300	7.9231
5015	1138	231636.6300	265073.0800	7.8996
5015	1139	231647.4100	265072.4900	7.8760
5015	1140	231663.7100	265073.1500	7.8524
5015	1141	231678.0800	265072.8800	7.8288
5015	1142	231693.5600	265073.5300	7.8052
5015	1143	231708.2000	265072.9500	7.7816
5015	1144	231723.6800	265073.6000	7.7580
5015	1145	231739.7100	265073.3400	7.7344
5015	1146	231754.0800	265073.0700	7.7109
5015	1147	231768.4500	265073.1000	7.6873
5015	1148	231784.2000	265073.4500	7.6637
5015	1149	231799.1300	265073.1800	7.6401
5015	1150	231813.7800	265072.2900	7.6165
5015	1151	231829.8000	265073.2600	7.5929
5015	1152	231845.0000	265073.2900	7.5693
5015	1153	231860.4800	265073.0200	7.5458
5015	1154	231875.6800	265072.1400	7.5222
5015	1155	231890.3300	265073.1000	7.4986
5015	1156	231905.8000	265074.3700	7.4750
5015	1157	231921.0000	265073.7900	7.4986
5015	1158	231935.6500	265074.1400	7.5223
5015	1159	231951.4000	265073.5600	7.5459
5015	1160	231966.6000	265074.2200	7.5695
5015	1161	231982.9100	265073.0300	7.5932
5015	1162	231997.0000	265073.9800	7.6168
5015	1163	232012.2000	265073.4100	7.6404
5015	1164	232027.9500	265074.0600	7.6641
5015	1165	232042.6000	265073.4800	7.6877
5015	1166	232058.6300	265073.8300	7.7113
5015	1167	232073.5500	265072.9500	7.7349
5015	1168	232088.7500	265073.2900	7.7586

5015	1169	232104.2300	265074.2600	7.7822
5015	1170	232119.1500	265073.6800	7.8058
5015	1171	232134.9100	265073.1000	7.8295
5015	1172	232150.1000	265074.6800	7.8531
5015	1173	232165.3000	265073.4900	7.8767
5015	1174	232181.0600	265074.1400	7.9004
5015	1175	232195.9800	265072.9500	7.9240
5015	1176	232211.4600	265073.3000	8.0098
5015	1177	232227.2200	265071.1800	8.0956
5015	1178	232242.6900	265073.0700	8.1814
5015	1179	232256.7800	265073.1000	8.2673
5015	1180	232273.3600	265073.7600	8.3531
5015	1181	232287.1800	265073.4900	8.4389
5015	1182	232303.4800	265073.8400	8.5247
5015	1183	232318.1300	265073.2600	8.6105
5015	1184	232334.4400	265074.2200	8.6963
5015	1185	232349.6400	265073.3400	8.7821
5015	1186	232364.8400	265073.0700	8.8679
5015	1187	232380.3200	265072.5000	8.9538
5015	1188	232395.7900	265073.4600	9.0396
5015	1189	232410.7200	265072.5700	9.1254
5015	1190	232426.7500	265072.6100	9.2112
5015	1191	232440.8500	265069.8800	9.2970
5015	1192	232455.4900	265070.8400	9.3073
5015	1193	232471.5200	265071.8100	9.3176
5015	1194	232486.9900	265073.0800	9.3279
5015	1195	232501.9100	265073.1100	9.3382
5015	1196	232517.6700	265072.2300	9.3485
5015	1197	232533.1400	265072.8900	9.3588
5015	1198	232548.6200	265073.2300	9.3692
5015	1199	232563.2600	265073.8900	9.3795
5015	1200	232579.5700	265074.2400	9.3898
5015	1201	232593.6700	265073.3500	9.4001
5015	1202	232610.2500	265073.7000	9.4104
5015	1203	232624.6200	265073.7400	9.4207
5015	1204	232640.0900	265073.4700	9.4310
5015	1205	232655.2900	265074.7400	9.4413
5015	1206	232671.3200	265073.2400	9.4516
5015	1207	232685.6900	265073.2800	9.4619
5015	1208	232701.7200	265073.3200	9.4722
5015	1209	232716.3700	265073.6700	9.4825
5015	1210	232729.9100	265073.3900	9.4928
5015	1211	232745.3900	265073.1300	9.5032



5015	1212	232762.8000	265073.1700	9.5135
5015	1213	232776.6100	265074.4400	9.5238
5015	1214	232791.5400	265072.9400	9.5341
5015	1215	232806.1900	265072.9700	9.5444
5015	1216	232822.4900	265073.0200	9.5547
5015	1217	232837.1400	265073.0600	9.5650

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State Road 80 SRC Segment 2 Line 1015 X-Y Station Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
1015	5069	231465.4500	265069.3500	8.1590
1015	5070	231493.0300	265066.9100	8.1118
1015	5071	231521.9100	265070.0700	8.0647
1015	5072	231555.9200	265068.2100	8.0175
1015	5073	231585.4800	265068.4100	7.9703
1015	5074	231616.0900	265068.6800	7.9231
1015	5075	231638.8900	265068.3400	7.8760
1015	5076	231674.0500	265067.7100	7.8288
1015	5077	231704.3000	265066.7000	7.7816
1015	5078	231734.6900	265067.1800	7.7344
1015	5079	231765.1900	265067.7400	7.6873
1015	5080	231793.7500	265067.3500	7.6401
1015	5081	231825.4100	265067.2000	7.5929
1015	5082	231856.5200	265066.7700	7.5458
1015	5083	231887.7100	265066.4900	7.4986
1015	5084	231916.6400	265068.3800	7.4986
1015	5085	231945.2000	265070.6200	7.5459
1015	5086	231976.7800	265066.9600	7.5932
1015	5087	232006.6600	265067.3500	7.6404
1015	5088	232040.6300	265067.8800	7.6877
1015	5089	232068.3300	265067.3900	7.7349
1015	5090	232100.7400	265068.4200	7.7822
1015	5091	232130.9200	265068.0300	7.8295
1015	5092	232159.9000	265066.6700	7.8767
1015	5093	232190.1400	265067.5200	7.9240
1015	5094	232226.6100	265065.4700	8.0956
1015	5095	232254.5500	265066.0200	8.2673
1015	5096	232285.0400	265067.7800	8.4389
1015	5097	232315.7900	265069.1300	8.6105
1015	5098	232344.4300	265068.4100	8.7821
1015	5099	232375.2000	265069.1700	8.9538
1015	5100	232406.6100	265066.8500	9.1254
1015	5101	232436.6900	265066.8500	9.2970
1015	5102	232469.0000	265067.7500	9.3176
1015	5103	232497.2000	265067.0600	9.3382
1015	5104	232529.6900	265070.2300	9.3588
1015	5105	232559.0600	265070.6600	9.3795
1015	5106	232588.9800	265070.9400	9.4001
1015	5107	232620.3600	265069.3000	9.4207
1015	5108	232646.9700	265071.6900	9.4413



1015	5109	232680.2000	265071.1700	9.4619
1015	5110	232713.4400	265068.8000	9.4825
1015	5111	232741.9400	265068.1400	9.5032
1015	5112	232772.8500	265067.9400	9.5238
1015	5113	232804.5100	265067.2600	9.5444
1015	5114	232832.6800	265067.9800	9.5650

Geodetic Coordinate System: NAD 83 State Plane Florida East FIPS0901



State Road 715 RCVR Segment 1 Line 5017 X-Y Station Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5017	1001	231403.8900	266648.5500	9.8500
5017	1002	231405.0400	266632.2400	9.8500
5017	1003	231404.5200	266617.1600	9.8487
5017	1004	231404.8400	266602.0800	9.8463
5017	1005	231405.1500	266587.0000	9.8429
5017	1006	231404.9100	266572.2300	9.8385
5017	1007	231405.5000	266557.1500	9.8334
5017	1008	231405.8100	266543.3000	9.8274
5017	1009	231406.6800	266526.3800	9.8208
5017	1010	231407.0000	266511.6100	9.8136
5017	1011	231406.4800	266496.5200	9.8058
5017	1012	231406.7900	266482.0600	9.7976
5017	1013	231406.8300	266466.6700	9.7889
5017	1014	231406.5900	266451.5900	9.7798
5017	1015	231407.4600	266436.2000	9.7704
5017	1016	231408.8800	266420.2000	9.7606
5017	1017	231407.5300	266406.3500	9.7505
5017	1018	231407.8500	266390.9600	9.7402
5017	1019	231407.3300	266375.8800	9.7297
5017	1020	231407.9200	266360.5000	9.7189
5017	1021	231407.6900	266344.1800	9.7079
5017	1022	231408.2800	266330.3400	9.6968
5017	1023	231407.4800	266314.9500	9.6855
5017	1024	231408.3500	266300.4800	9.6741
5017	1025	231407.8300	266285.4000	9.6626
5017	1026	231408.1500	266270.9400	9.6509
5017	1027	231408.1900	266255.2400	9.6464
5017	1028	231408.5000	266239.8500	9.6484
5017	1029	231408.2600	266224.7700	9.6562
5017	1030	231408.0200	266210.6200	9.6692
5017	1031	231408.6100	266194.3100	9.6869
5017	1032	231407.2600	266181.0700	9.7088
5017	1033	231408.4100	266164.7600	9.7345
5017	1034	231408.7200	266149.6800	9.7637
5017	1035	231408.7600	266134.9100	9.7960
5017	1036	231408.5200	266119.8300	9.8310
5017	1037	231408.8400	266103.5200	9.8686
5017	1038	231408.8700	266089.9800	9.9084
5017	1039	231408.6300	266074.5900	9.9502
5017	1040	231408.6700	266059.8100	9.9938

5017	1041	231408.7100	266044.4300	10.0391
5017	1042	231409.0200	266029.3500	10.0858
5017	1043	231409.0600	266013.9600	10.1339
5017	1044	231408.5400	265999.1800	10.1832
5017	1045	231409.1300	265983.8000	10.2335
5017	1046	231409.1700	265968.7200	10.2849
5017	1047	231409.7600	265953.3300	10.3371
5017	1048	231409.5200	265938.2500	10.3900
5017	1049	231409.8400	265923.1700	10.4437
5017	1050	231409.8700	265908.0900	10.4980
5017	1051	231408.2500	265893.6200	10.5529
5017	1052	231410.5400	265864.7000	10.6083
5017	1053	231410.3000	265849.6200	10.6139
5017	1054	231411.4400	265835.4600	10.6159
5017	1055	231410.9200	265819.4600	10.6148
5017	1056	231411.2400	265804.9900	10.6108
5017	1057	231409.8900	265790.5200	10.6042
5017	1058	231411.0300	265775.1400	10.5953
5017	1059	231410.5200	265759.4400	10.5843
5017	1060	231410.5600	265744.9800	10.5715
5017	1061	231410.3200	265729.2800	10.5569
5017	1062	231411.1800	265714.5100	10.5409
5017	1063	231410.6700	265698.8100	10.5234
5017	1064	231411.2600	265683.7300	10.5048
5017	1065	231410.4700	265669.2700	10.4850
5017	1066	231411.3300	265653.8800	10.4642
5017	1067	231411.1000	265638.4900	10.4425
5017	1068	231411.9600	265623.7200	10.4201
5017	1069	231411.4500	265608.3300	10.3969
5017	1070	231411.7600	265593.5600	10.3730
5017	1071	231411.8000	265576.9400	10.3485
5017	1072	231411.5600	265563.0900	10.3236
5017	1073	231412.1500	265547.0900	10.2981
5017	1074	231412.1900	265533.2400	10.2722
5017	1075	231412.2300	265516.9300	10.2460
5017	1076	231412.5400	265503.0800	10.2193
5017	1077	231412.3000	265487.0800	10.1924
5017	1078	231413.4400	265471.6900	10.1659
5017	1079	231411.2700	265456.3000	10.1399
5017	1080	231412.9700	265441.8400	10.1143
5017	1081	231413.5600	265425.5300	10.0890
5017	1082	231413.3200	265411.3700	10.0640
5017	1083	231412.8000	265395.9800	10.0393

5017	1084	231413.3900	265381.2100	10.0148
5017	1085	231412.6000	265366.1300	9.9906
5017	1086	231413.4700	265351.0500	9.9666
5017	1087	231413.5000	265335.9700	9.9427
5017	1088	231413.5400	265320.5800	9.9190
5017	1089	231412.7500	265305.5000	9.8955
5017	1090	231413.6200	265290.7300	9.8721
5017	1091	231412.8200	265275.9500	9.8488
5017	1092	231414.2400	265260.5700	9.8257
5017	1093	231413.4500	265244.8700	9.8026
5017	1094	231413.2100	265230.7100	9.7796
5017	1095	231414.0800	265214.7100	9.7567
5017	1096	231413.8400	265199.9400	9.7339
5017	1097	231413.8800	265183.9400	9.7112
5017	1098	231414.4700	265169.1600	9.6885
5017	1099	231414.7900	265153.1600	9.6658
5017	1100	231414.5400	265139.0000	9.6432
5017	1101	231415.9700	265123.0000	9.6206
5017	1102	231416.0000	265107.9200	9.5981
5017	1103	231414.3800	265093.7600	9.5756

Geodetic Coordinate System: NAD 83 State Plane Florida East FIPS0901

State Road 715 SRC Segment 1 Line 1017 X-Y Station Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
1017	5001	231411.8100	266652.6600	9.8500
1017	5002	231410.5600	266622.4600	9.8487
1017	5003	231410.3800	266593.5700	9.8429
1017	5004	231410.6600	266562.2300	9.8334
1017	5005	231411.4600	266531.6500	9.8208
1017	5006	231412.0100	266502.1800	9.8058
1017	5007	231411.5800	266470.3700	9.7889
1017	5008	231412.7300	266442.7800	9.7704
1017	5009	231412.5000	266412.0200	9.7505
1017	5010	231412.6500	266381.8300	9.7297
1017	5011	231413.3700	266349.9500	9.7079
1017	5012	231413.1800	266320.2600	9.6855
1017	5013	231412.5900	266289.7700	9.6626
1017	5014	231412.4200	266259.9700	9.6464
1017	5015	231412.5000	266228.7600	9.6562
1017	5016	231413.2500	266199.0700	9.6869
1017	5017	231413.5500	266169.5500	9.7345
1017	5018	231413.7600	266138.1700	9.7960
1017	5019	231413.4100	266108.9900	9.8686
1017	5020	231413.4300	266079.1900	9.9502
1017	5021	231413.0200	266048.5800	10.0391
1017	5022	231413.5000	266019.4900	10.1339
1017	5023	231413.6900	265988.2400	10.2335
1017	5024	231414.5100	265957.0100	10.3371
1017	5025	231414.6000	265927.1800	10.4437
1017	5026	231412.0700	265905.3200	10.5529
1017	5027	231412.7400	265860.7200	10.6139
1017	5028	231415.3200	265824.4800	10.6148
1017	5029	231415.1300	265794.0800	10.6042
1017	5030	231415.0600	265763.3000	10.5843
1017	5031	231415.8100	265733.5600	10.5569
1017	5032	231415.6200	265702.6500	10.5234
1017	5033	231415.8700	265672.9700	10.4850
1017	5034	231415.5200	265643.2600	10.4425
1017	5035	231415.9000	265612.8500	10.3969
1017	5036	231415.8700	265582.7100	10.3485
1017	5037	231416.5800	265552.7400	10.2981
1017	5038	231416.5700	265521.8100	10.2460
1017	5039	231416.2600	265493.0400	10.1924
1017	5040	231416.5700	265461.5600	10.1399

1017	5041	231416.8300	265431.4800	10.0890
1017	5042	231417.5900	265400.3400	10.0393
1017	5043	231416.9900	265371.0700	9.9906
1017	5044	231417.3200	265340.8600	9.9427
1017	5045	231417.6300	265309.8100	9.8955
1017	5046	231417.8200	265279.4000	9.8488
1017	5047	231418.7700	265250.0900	9.8026
1017	5048	231418.0700	265217.3700	9.7567
1017	5049	231418.4600	265188.7700	9.7112
1017	5050	231418.6500	265159.1300	9.6658
1017	5051	231420.5900	265128.6100	9.6206
1017	5052	231415.3300	265097.3000	9.5756

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State Road 715 RCVR Segment 2 Line 5017 X-Y Station Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5017	1113	231421.7600	265014.9900	9.8760
5017	1114	231421.5200	264999.3000	9.8760
5017	1115	231421.5600	264984.8300	9.8744
5017	1116	231421.3200	264969.4400	9.8714
5017	1118	231421.9500	264938.9800	9.8671
5017	1119	231421.1600	264924.8200	9.8617
5017	1117	231421.6300	264955.2900	9.8552
5017	1120	231421.4700	264909.1200	9.8478
5017	1121	231420.6800	264893.7300	9.8395
5017	1122	231421.0000	264878.0400	9.8305
5017	1123	231421.3100	264863.5700	9.8208
5017	1124	231421.0700	264848.1800	9.8105
5017	1125	231420.8300	264833.4100	9.7997
5017	1126	231420.8700	264818.0200	9.7883
5017	1127	231420.3500	264802.6300	9.7765
5017	1128	231420.9400	264787.2500	9.7643
5017	1129	231421.2600	264772.1700	9.7518
5017	1130	231421.3000	264756.7800	9.7389
5017	1131	231421.3300	264742.0100	9.7257
5017	1132	231421.6500	264726.9300	9.7123
5017	1133	231421.6800	264712.1600	9.6986
5017	1134	231422.5500	264695.5400	9.6847
5017	1135	231422.0300	264682.0000	9.6706
5017	1136	231422.0700	264665.6800	9.6563
5017	1137	231421.5600	264650.6000	9.6430
5017	1138	231421.8700	264636.1400	9.6303
5017	1139	231421.6300	264620.4400	9.6184
5017	1140	231421.9500	264605.3600	9.6072
5017	1141	231421.4300	264591.2000	9.5965
5017	1142	231420.9200	264574.8900	9.5863
5017	1143	231421.7800	264559.5100	9.5766
5017	1144	231421.5400	264545.0400	9.5673
5017	1145	231420.7500	264529.9600	9.5584
5017	1146	231420.7900	264514.8800	9.5498
5017	1147	231421.3800	264499.8000	9.5415
5017	1148	231421.1400	264484.1000	9.5335
5017	1149	231421.4600	264469.0200	9.5257
5017	1150	231421.2200	264454.2500	9.5181
5017	1151	231420.9800	264438.8600	9.5108
5017	1152	231421.5700	264423.7800	9.5036

5017	1154	231421.6400	264393.9300	9.4966
5017	1153	231421.8800	264409.0100	9.4898
5017	1155	231422.7900	264378.8500	9.4830
5017	1156	231421.7200	264364.0800	9.4764
5017	1157	231422.3100	264348.3800	9.4699
5017	1158	231421.7900	264333.9200	9.4635
5017	1159	231421.8300	264318.2200	9.4572
5017	1160	231422.4200	264303.4500	9.4509
5017	1161	231422.7300	264287.7500	9.4447
5017	1162	231422.7700	264273.2900	9.4386
5017	1163	231422.8100	264258.2100	9.4326
5017	1164	231423.1200	264242.8200	9.4265
5017	1165	231423.1600	264227.4300	9.4206
5017	1166	231422.3700	264212.3500	9.4147
5017	1167	231423.7900	264196.9700	9.4088
5017	1168	231423.5500	264181.8900	9.4029
5017	1169	231423.8600	264166.8100	9.3971
5017	1171	231424.7700	264135.7200	9.3913
5017	1170	231424.4600	264151.1100	9.3855
5017	1172	231425.0800	264121.2600	9.3798
5017	1173	231425.1200	264106.1800	9.3874
5017	1174	231425.7100	264090.7900	9.4072
5017	1175	231426.0200	264075.4100	9.4379
5017	1176	231425.7900	264060.6300	9.4783
5017	1177	231425.5500	264044.9400	9.5276
5017	1178	231426.1400	264030.1700	9.5847
5017	1179	231426.1800	264014.7800	9.6491
5017	1180	231426.4900	264000.6200	9.7198
5017	1181	231426.5200	263985.2300	9.7964
5017	1182	231427.1100	263970.1500	9.8781
5017	1183	231426.8800	263955.3800	9.9645
5017	1184	231427.4700	263940.0000	10.0551
5017	1185	231427.7800	263925.5300	10.1496
5017	1186	231426.9900	263910.1400	10.2474
5017	1187	231427.8500	263895.0600	10.3483
5017	1189	231427.0900	263869.2100	10.4520
5017	1188	231427.3400	263879.6700	10.5582
5017	1190	231426.8600	263849.2000	10.6666
5017	1191	231427.7300	263834.1300	10.7770
5017	1192	231427.7700	263819.0500	10.8893
5017	1193	231427.8000	263803.6600	11.0031
5017	1194	231427.2900	263788.8800	11.1185
5017	1195	231427.6000	263773.1900	11.2351

5017	1196	231427.6400	263757.8000	11.3530
5017	1197	231428.2300	263742.7200	11.4719
5017	1198	231427.9900	263727.0300	11.5918
5017	1200	231427.7900	263696.5600	11.7126
5017	1199	231428.0300	263712.2500	11.8141
5017	1201	231428.1100	263681.7800	11.9072
5017	1202	231428.1400	263666.4000	11.9925
5017	1203	231427.0800	263651.0100	12.0710
5017	1204	231428.5000	263635.9300	12.1432
5017	1205	231427.9800	263620.8500	12.2099
5017	1206	231427.7400	263606.0700	12.2716
5017	1207	231428.0600	263589.7600	12.3287
5017	1208	231428.0900	263575.3000	12.3817
5017	1209	231427.8600	263558.0600	12.4311

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State Road 715 SRC Segment 2 Line 1017 X-Y Station Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
1017	5062	231414.2500	265017.2100	9.8760
1017	5063	231415.8900	264989.0300	9.8744
1017	5064	231415.3600	264958.4200	9.8671
1017	5065	231415.2700	264927.6900	9.8552
1017	5066	231414.9200	264898.1400	9.8395
1017	5067	231415.1200	264869.2800	9.8208
1017	5068	231415.5200	264838.6700	9.7997
1017	5069	231416.1500	264806.5400	9.7765
1017	5070	231415.6700	264779.2100	9.7518
1017	5071	231415.4700	264747.3700	9.7257
1017	5072	231417.1200	264716.7000	9.6986
1017	5073	231416.4300	264686.8400	9.6706
1017	5074	231416.2300	264655.8200	9.6430
1017	5075	231417.5600	264625.9500	9.6184
1017	5076	231417.3400	264594.9100	9.5965
1017	5077	231417.2000	264564.6400	9.5766
1017	5078	231416.4800	264533.5800	9.5584
1017	5079	231417.1800	264504.9800	9.5415
1017	5080	231417.7200	264474.1200	9.5257
1017	5081	231417.3200	264443.4500	9.5108
1017	5082	231416.9100	264414.5500	9.4966
1017	5083	231417.3300	264383.7900	9.4830
1017	5084	231417.8700	264354.1100	9.4699
1017	5085	231418.4300	264322.5800	9.4572
1017	5086	231418.1400	264292.7900	9.4447
1017	5087	231419.0300	264260.9400	9.4326
1017	5088	231418.8100	264231.6700	9.4206
1017	5089	231419.4200	264201.7800	9.4088
1017	5090	231419.9700	264171.8300	9.3971
1017	5091	231419.5900	264140.7500	9.3855
1017	5092	231419.5200	264110.2200	9.3874
1017	5093	231419.5400	264081.9300	9.4379
1017	5094	231420.4300	264049.1400	9.5276
1017	5095	231420.9100	264020.1100	9.6491
1017	5096	231420.3700	263989.5500	9.7964
1017	5097	231420.9500	263959.3600	9.9645
1017	5098	231420.9100	263930.3000	10.1496
1017	5099	231421.3200	263899.9600	10.3483
1017	5100	231421.3900	263871.1900	10.5582
1017	5101	231417.4900	263839.4700	10.7770



1017	5102	231417.7500	263809.5800	11.0031
1017	5103	231418.1500	263777.8900	11.2351
1017	5104	231418.5700	263748.6800	11.4719
1017	5105	231418.8000	263717.3800	11.7126
1017	5106	231418.8000	263686.6900	11.9072
1017	5107	231419.1200	263656.4700	12.0710
1017	5108	231419.3400	263627.0900	12.2099
1017	5109	231419.0400	263596.7500	12.3287
1017	5110	231418.6800	263565.1500	12.4311

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Spoil Management 3D Receiver Line 5005 Coordinates

RCVR Line	RCVR Station	X (feet)	Y (ft)	Elevation (ft)
5005	1001	189411.49	275400.92	11.3490
5005	1002	189426.12	275400.90	11.9630
5005	1003	189442.69	275401.50	12.5770
5005	1004	189457.60	275401.18	12.8218
5005	1005	189472.51	275401.17	13.0666
5005	1006	189487.97	275400.85	13.3114
5005	1007	189503.16	275401.76	13.5562
5005	1008	189518.63	275402.06	13.8010
5005	1009	189533.81	275401.74	14.0458
5005	1010	189548.17	275402.34	14.2906
5005	1011	189563.91	275402.02	14.5354
5005	1012	189579.38	275402.62	14.7802
5005	1013	189594.01	275402.61	15.0250
5005	1014	189609.47	275403.21	15.2698
5005	1015	189624.94	275403.20	15.5146
5005	1016	189639.85	275403.19	15.7594
5005	1017	189655.31	275402.87	16.0042
5005	1018	189670.50	275403.16	16.2490
5005	1019	189685.41	275403.77	16.2005
5005	1020	189701.15	275403.75	16.1520
5005	1021	189715.79	275404.05	16.1035
5005	1022	189731.80	275404.34	16.0550
5005	1023	189746.99	275403.72	16.0065
5005	1024	189762.18	275404.32	15.9580
5005	1025	189777.09	275403.69	15.9095
5005	1026	189791.44	275403.68	15.8610

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Spoil Management 3D Receiver Line 5006 Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5006	1001	189413.75	275462.16	15.0120
5006	1002	189428.93	275461.53	15.0120
5006	1003	189444.40	275461.21	15.0120
5006	1004	189459.03	275462.12	14.8642
5006	1005	189473.67	275461.80	14.8098
5006	1006	189489.68	275462.09	14.8300
5006	1007	189504.32	275461.77	14.9100
5006	1008	189520.06	275461.45	14.0730
5006	1009	189535.24	275462.06	13.4209
5006	1010	189550.43	275461.43	12.9167
5006	1011	189565.89	275462.03	12.5308
5006	1012	189581.63	275461.71	12.2396
5006	1013	189597.65	275461.39	12.0241
5006	1014	189611.46	275461.99	11.8692
5006	1015	189626.64	275461.67	11.7628
5006	1016	189641.83	275461.66	12.8182
5006	1017	189656.74	275462.26	13.1858
5006	1018	189672.20	275462.56	13.4491
5006	1019	189687.11	275461.93	13.6289
5006	1020	189702.58	275461.92	13.7421
5006	1021	189718.87	275461.91	13.8019
5006	1022	189733.78	275461.59	13.8189
5006	1023	189748.42	275462.19	13.8018
5006	1024	189764.43	275461.25	13.7574
5006	1025	189779.89	275461.55	13.6911
5006	1026	189794.53	275460.92	13.6073
5006	1027	189809.99	275460.60	13.5095
5006	1028	189826.28	275459.97	13.4005
5006	1029	189841.19	275459.96	13.2825
5006	1030	189856.38	275459.33	13.1574

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Spoil Management 3D Receiver Line 5007 Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5007	1001	189413.52	275523.71	14.5424
5007	1002	189428.43	275522.47	14.5090
5007	1003	189444.17	275522.45	14.8466
5007	1004	189459.36	275523.36	14.8720
5007	1005	189474.82	275523.35	14.9384
5007	1006	189489.73	275523.03	14.8816
5007	1007	189505.20	275522.71	14.4639
5007	1008	189520.66	275522.39	14.1529
5007	1009	189535.85	275521.76	13.9273
5007	1010	189550.76	275522.06	13.7699
5007	1011	189565.94	275521.43	13.6673
5007	1012	189581.41	275520.80	13.6083
5007	1013	189596.32	275520.79	13.5843
5007	1014	189611.50	275521.08	13.5883
5007	1015	189627.24	275520.46	13.6147
5007	1016	189642.43	275520.44	13.6589
5007	1017	189657.62	275520.74	13.7175
5007	1018	189672.53	275520.73	13.7876
5007	1019	189687.99	275521.33	13.8668
5007	1020	189703.45	275521.32	13.9533
5007	1021	189718.09	275522.23	14.0458
5007	1022	189733.55	275522.22	14.1429
5007	1023	189749.29	275522.51	14.2437
5007	1024	189763.93	275522.50	14.3476
5007	1025	189779.39	275522.79	14.4539
5007	1026	189794.30	275523.09	14.5621
5007	1027	189809.77	275523.69	14.6718
5007	1028	189825.23	275524.30	14.7828
5007	1029	189840.14	275525.21	14.8947
5007	1030	189855.05	275526.12	15.0075
5007	1031	189870.79	275526.72	15.1209
5007	1032	189885.43	275526.71	15.2347
5007	1033	189901.17	275527.31	15.3490

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Spoil Management 3D Receiver Line 5008 Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5008	1001	189414.40	275582.80	13.2292
5008	1002	189429.86	275583.71	13.2620
5008	1003	189445.05	275583.70	14.0202
5008	1004	189461.62	275584.61	14.5440
5008	1005	189476.81	275583.36	15.0565
5008	1006	189491.99	275582.12	15.5601
5008	1007	189507.18	275583.95	16.0565
5008	1008	189521.81	275583.02	15.8610
5008	1009	189537.00	275583.01	15.3336
5008	1010	189552.74	275582.07	14.9404
5008	1011	189568.20	275582.06	14.6545
5008	1012	189582.84	275581.43	14.4545
5008	1013	189598.30	275581.72	14.3232
5008	1014	189614.04	275581.10	14.2469
5008	1015	189628.40	275580.78	14.2146
5008	1016	189643.31	275579.84	14.2174
5008	1017	189658.49	275579.83	14.2483
5008	1018	189674.23	275579.82	14.3018
5008	1019	189688.87	275579.19	14.3733
5008	1020	189704.05	275578.56	14.4592
5008	1021	189719.79	275578.55	14.5566
5008	1022	189735.26	275577.92	14.6633
5008	1023	189750.44	275577.29	14.7773
5008	1024	189765.08	275577.28	14.8972
5008	1025	189781.09	275576.04	15.0218
5008	1026	189796.00	275575.41	15.1502
5008	1027	189812.02	275574.47	15.2817
5008	1028	189826.93	275574.15	15.4155
5008	1029	189841.84	275574.45	15.5513
5008	1030	189857.30	275573.82	15.6887
5008	1031	189872.49	275573.50	15.2619
5008	1032	189887.67	275572.56	15.0358
5008	1033	189902.58	275572.24	14.9702
5008	1034	189917.49	275571.31	15.0329
5008	1035	189932.68	275570.68	15.1983

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Spoil Management 3D Receiver Line 5009 Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5009	1001	189415.83	275645.27	16.9471
5009	1002	189430.47	275645.26	17.0127
5009	1003	189445.93	275645.25	17.1280
5009	1004	189460.84	275645.55	17.2102
5009	1005	189476.86	275645.22	17.3015
5009	1006	189491.49	275645.83	17.4002
5009	1007	189506.96	275646.12	17.5047
5009	1008	189521.87	275645.49	17.6138
5009	1009	189537.05	275646.40	17.7268
5009	1010	189552.79	275646.39	17.8427
5009	1011	189567.70	275646.38	17.9610
5009	1012	189583.17	275647.29	18.0812
5009	1013	189598.63	275647.28	18.2030
5009	1014	189614.37	275647.88	18.2833
5009	1015	189629.00	275647.56	18.3304
5009	1016	189643.92	275648.16	18.3510
5009	1017	189659.65	275647.53	18.3504
5009	1018	189674.57	275648.14	18.3328
5009	1019	189689.20	275648.13	18.3016
5009	1020	189704.66	275648.73	18.2595
5009	1021	189719.85	275648.72	18.2087
5009	1022	189734.76	275649.32	18.1510
5009	1023	189750.22	275649.31	18.0877
5009	1024	189765.14	275649.30	18.0200
5009	1025	189780.32	275649.90	17.9487
5009	1026	189796.89	275650.19	17.8746
5009	1027	189811.25	275651.10	17.7975
5009	1028	189827.54	275651.09	17.7181
5009	1029	189841.62	275650.77	17.6369
5009	1030	189856.81	275651.38	17.5542
5009	1031	189873.10	275647.05	17.4702
5009	1032	189888.01	275648.27	17.3854
5009	1033	189902.92	275649.80	17.2997
5009	1034	189917.28	275646.10	17.2135
5009	1035	189930.80	275638.39	17.1267
5009	1036	189945.16	275631.92	17.0396
5009	1037	189958.40	275625.75	16.9522
5009	1038	189971.93	275619.89	16.8645

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Spoil Management 3D Receiver Line 5010 Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5010	1001	189415.61	275705.29	14.0896
5010	1002	189430.79	275706.20	14.0660
5010	1003	189445.98	275706.19	14.0660
5010	1004	189461.72	275706.17	13.9788
5010	1005	189476.08	275706.16	13.9588
5010	1006	189491.27	275705.84	13.9301
5010	1007	189506.45	275706.14	13.8944
5010	1008	189521.64	275705.82	13.8531
5010	1009	189537.38	275706.42	13.8074
5010	1010	189552.29	275706.10	13.7580
5010	1011	189567.48	275706.70	13.7058
5010	1012	189582.39	275707.30	13.6513
5010	1013	189597.57	275706.98	13.5949
5010	1014	189613.31	275706.66	13.5371
5010	1015	189628.22	275707.27	13.4782
5010	1016	189644.24	275706.95	13.4182
5010	1017	189658.87	275706.32	13.3576
5010	1018	189674.34	275706.92	13.2963
5010	1019	189689.52	275707.52	13.2345
5010	1020	189704.43	275707.20	13.1724
5010	1021	189719.35	275706.58	13.1099
5010	1022	189734.53	275705.95	13.0472
5010	1023	189749.99	275705.94	12.9843
5010	1024	189765.46	275705.92	12.9213
5010	1025	189780.09	275706.22	12.8581
5010	1026	189796.38	275705.28	12.7949
5010	1027	189810.74	275706.19	12.7315
5010	1028	189826.48	275704.64	12.6681
5010	1029	189841.94	275705.55	12.6046
5010	1030	189856.58	275704.93	12.5411
5010	1031	189871.49	275705.84	12.4775
5010	1032	189887.23	275704.90	12.4140
5010	1033	189902.97	275703.97	12.3504
5010	1034	189917.32	275699.34	12.7912
5010	1035	189932.78	275697.48	13.6356
5010	1036	189947.69	275697.47	13.9598
5010	1037	189962.33	275696.22	14.2429
5010	1038	189977.23	275691.60	14.4931



5010	1039	189991.31	275686.66	14.7168
5010	1040	190005.11	275680.80	14.9195
5010	1041	190019.74	275675.25	15.1053

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Spoil Management 3D Receiver Line 5011 Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5011	1001	189417.32	275767.76	14.0955
5011	1002	189432.23	275766.83	14.0693
5011	1003	189446.31	275765.28	14.0660
5011	1004	189462.60	275766.19	13.9788
5011	1005	189477.23	275766.48	13.9588
5011	1006	189492.70	275766.47	13.9301
5011	1007	189508.16	275767.07	13.8944
5011	1008	189523.35	275765.83	13.8531
5011	1009	189538.26	275766.43	13.8074
5011	1010	189553.72	275766.42	13.7443
5011	1011	189568.91	275766.71	13.6674
5011	1012	189584.09	275766.39	13.5794
5011	1013	189599.00	275767.00	13.4825
5011	1014	189614.74	275767.60	13.3786
5011	1015	189629.66	275767.89	13.2689
5011	1016	189645.39	275767.88	13.1548
5011	1017	189660.03	275768.18	13.0370
5011	1018	189675.77	275767.86	12.9163
5011	1019	189690.40	275767.84	12.7933
5011	1020	189705.31	275765.99	12.6684
5011	1021	189720.50	275766.59	12.5421
5011	1022	189736.51	275765.65	12.4145
5011	1023	189750.32	275765.33	12.2860
5011	1024	189767.16	275765.32	12.8056
5011	1025	189782.07	275764.69	12.9435
5011	1026	189796.43	275764.99	13.0171
5011	1027	189812.45	275764.05	13.0394
5011	1028	189827.36	275764.04	13.0206
5011	1029	189841.99	275764.03	12.9689
5011	1030	189858.00	275762.78	12.8908
5011	1031	189873.74	275763.08	12.7918
5011	1032	189888.10	275762.76	12.6759
5011	1033	189903.29	275762.44	12.5465
5011	1034	189917.92	275760.58	13.5238
5011	1035	189933.94	275759.95	14.0880
5011	1036	189948.85	275759.63	14.3218



5011	1037	189964.31	275759.31	14.5325
5011	1038	189979.22	275759.30	14.7247
5011	1039	189993.30	275759.29	14.9022
5011	1040	190010.15	275758.35	15.0678
5011	1041	190024.50	275757.73	15.2239
5011	1042	190040.24	275756.79	15.3725
5011	1043	190055.43	275755.86	15.5150
5011	1044	190071.17	275755.23	15.6527
5011	1045	190086.35	275754.91	15.7865

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Spoil Management 3D Receiver Line 5011 Coordinates

RCVR Line	RCVR Station	X (feet)	Y (feet)	Elevation (ft)
5012	1001	189416.81	275827.47	14.1298
5012	1002	189432.00	275828.07	14.1626
5012	1003	189446.91	275828.06	14.1908
5012	1004	189462.37	275828.35	14.2340
5012	1005	189477.84	275827.42	14.2697
5012	1006	189492.47	275828.64	14.3815
5012	1007	189507.93	275828.01	14.4473
5012	1008	189523.40	275828.00	14.4762
5012	1009	189538.86	275827.37	14.4756
5012	1010	189554.05	275827.97	14.4514
5012	1011	189569.79	275827.65	14.4083
5012	1012	189584.42	275828.25	14.3502
5012	1013	189599.88	275827.93	14.2800
5012	1014	189615.62	275828.23	14.2000
5012	1015	189630.81	275827.91	14.1124
5012	1016	189646.00	275827.89	14.0186
5012	1017	189661.46	275827.57	13.9198
5012	1018	189676.37	275828.18	13.8171
5012	1019	189691.00	275827.24	13.7112
5012	1020	189707.29	275827.54	13.6028
5012	1021	189722.48	275827.83	13.4924
5012	1022	189737.39	275827.51	13.3803
5012	1023	189753.13	275827.50	13.3920
5012	1024	189768.04	275827.18	13.5027
5012	1025	189783.23	275827.78	13.6926
5012	1026	189799.24	275827.77	13.9458
5012	1027	189814.43	275827.14	14.2498

5012	1028	189829.34	275827.13	14.5943
5012	1029	189843.97	275827.12	14.9712
5012	1030	189859.44	275827.11	14.7270
5012	1031	189874.90	275826.79	14.5118
5012	1032	189890.09	275826.16	14.3199
5012	1033	189905.27	275826.76	14.1467
5012	1034	189920.74	275827.06	13.9883
5012	1035	189936.20	275826.74	13.8418
5012	1036	189951.66	275826.42	13.7049
5012	1037	189965.74	275827.02	13.5756
5012	1038	189981.76	275826.09	13.4524
5012	1039	189997.77	275826.07	13.3341
5012	1040	190012.41	275825.75	13.2197
5012	1041	190027.59	275825.74	13.1084
5012	1042	190043.33	275825.11	12.9996
5012	1043	190058.24	275825.10	12.8928
5012	1044	190073.98	275825.09	12.7876
5012	1045	190089.17	275825.08	12.6837
5012	1046	190104.91	275825.06	12.9049
5012	1048	190135.00	275824.73	13.3862
5012	1047	190119.54	275823.51	14.0755
5012	1049	190150.47	275824.72	14.3227

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Spoil Management 3D Source Line 3003 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3003	1001	189420.17	275403.61	11.5653
3003	1002	189421.79	275435.10	11.3490
3003	1003	189421.33	275464.32	11.7153
3003	1004	189422.33	275495.66	12.3746
3003	1005	189422.24	275526.35	12.8551
3003	1006	189422.30	275556.12	13.1926
3003	1007	189422.86	275585.61	13.3312
3003	1008	189423.03	275617.66	13.3108
3003	1009	189423.77	275649.20	13.6663
3003	1010	189424.31	275678.82	14.3224
3003	1011	189423.95	275708.83	14.5616
3003	1012	189424.23	275738.39	14.4672
3003	1013	189424.59	275769.25	14.3923
3003	1014	189425.06	275800.62	14.3329
3003	1015	189424.70	275831.32	14.2889
3003	1016	189427.55	275844.38	14.2571

Spoil Management 3D Source Line 3004 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3004	1001	189482.35	275404.02	13.0666
3004	1002	189478.59	275429.97	13.2435
3004	1003	189481.62	275465.40	13.2409
3004	1004	189483.98	275490.61	13.5547
3004	1005	189483.29	275520.50	13.8186
3004	1006	189481.98	275551.08	14.0425
3004	1007	189481.77	275581.42	14.2335
3004	1008	189481.40	275613.18	14.3981
3004	1009	189481.87	275643.14	14.7543
3004	1010	189483.83	275673.66	15.2637
3004	1011	189482.83	275704.03	15.3370
3004	1012	189484.17	275734.67	15.0614
3004	1013	189482.85	275765.30	14.8409
3004	1014	189483.89	275795.55	14.6645
3004	1015	189483.73	275825.89	14.5544
3004	1016	189487.42	275843.85	14.4975

Spoil Management 3D Source Line 3005 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3005	1001	189539.38	275405.17	14.2344
3005	1002	189541.29	275435.58	14.0458
3005	1003	189541.81	275465.05	13.9833
3005	1004	189542.61	275493.93	13.8708
3005	1005	189543.10	275525.00	13.8315
3005	1006	189542.99	275552.16	13.8506
3005	1007	189543.27	275586.02	14.0066
3005	1008	189543.87	275604.41	14.2720
3005	1009	189544.67	275650.13	14.7236
3005	1010	189542.80	275673.04	15.3243
3005	1011	189543.52	275711.26	15.4128
3005	1012	189544.71	275742.30	15.0917
3005	1013	189545.49	275769.29	14.8349
3005	1014	189544.77	275799.39	14.6294
3005	1015	189546.50	275826.17	14.5318
3005	1016	189550.44	275840.88	14.5205

Spoil Management 3D Source Line 3006 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3006	1001	189603.71	275405.25	15.2345
3006	1002	189602.54	275434.57	15.0250
3006	1003	189601.85	275459.58	14.7249
3006	1004	189602.35	275488.29	14.1847
3006	1005	189603.80	275517.41	13.9086
3006	1006	189604.36	275547.73	13.8438
3006	1007	189605.99	275578.51	13.8658
3006	1008	189608.66	275607.17	13.9573
3006	1009	189606.46	275644.64	14.4184
3006	1010	189609.29	275681.70	15.1753
3006	1011	189607.58	275703.23	15.3201
3006	1012	189606.53	275729.87	14.9750
3006	1013	189606.74	275765.70	14.6878
3006	1014	189605.50	275791.00	14.4467
3006	1015	189608.66	275825.30	14.3336
3006	1016	189611.06	275842.40	14.3229

Spoil Management 3D Source Line 3007 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3007	1001	189664.68	275404.96	16.2340
3007	1002	189663.61	275434.23	16.0042
3007	1003	189665.61	275463.70	15.7224
3007	1004	189664.87	275495.28	15.2150
3007	1005	189665.27	275523.23	14.8624
3007	1006	189665.35	275552.76	14.6334
3007	1007	189663.40	275581.03	14.5033
3007	1008	189662.73	275613.96	14.4523
3007	1009	189665.42	275647.52	14.8217
3007	1010	189666.57	275674.98	15.5274
3007	1011	189667.50	275709.29	15.5927
3007	1012	189666.94	275736.54	15.1457
3007	1013	189668.37	275770.74	14.7560
3007	1014	189668.00	275796.02	14.4122
3007	1015	189667.99	275820.44	14.2255
3007	1016	189668.04	275843.27	14.1643

Spoil Management 3D Source Line 3008 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3008	1001	189726.33	275405.39	16.2343
3008	1002	189724.56	275430.32	16.1035
3008	1003	189725.33	275459.25	15.8733
3008	1004	189725.29	275487.39	15.4590
3008	1005	189724.93	275520.65	15.1520
3008	1006	189724.76	275549.38	14.9307
3008	1007	189727.92	275574.92	14.8048
3008	1008	189725.81	275607.24	14.7552
3008	1009	189727.05	275645.65	15.0807
3008	1010	189725.83	275669.58	15.7063
3008	1011	189726.36	275704.04	15.6685
3008	1012	189728.07	275728.98	15.1568
3008	1013	189728.18	275762.90	14.6906
3008	1014	189730.60	275790.62	14.2609
3008	1015	189727.52	275832.59	14.0122
3008	1016	189729.67	275842.77	13.9082

Spoil Management 3D Source Line 3009 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3009	1001	189787.09	275407.50	16.2432
3009	1002	189785.78	275434.75	15.9095
3009	1003	189786.38	275463.69	15.6877
3009	1004	189787.23	275489.34	15.2883
3009	1005	189787.05	275525.62	15.0452
3009	1006	189785.91	275552.47	14.9269
3009	1007	189787.09	275578.03	14.8891
3009	1008	189785.01	275607.78	14.9156
3009	1009	189790.66	275650.00	15.2296
3009	1010	189787.82	275679.32	15.7734
3009	1011	189787.84	275708.86	15.6994
3009	1012	189788.33	275736.10	15.1311
3009	1013	189788.95	275767.54	14.6851
3009	1014	189788.99	275794.50	14.3368
3009	1015	189788.90	275830.03	14.1330
3009	1016	189793.92	275843.91	14.0449

Spoil Management 3D Source Line 3010 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3010	1001	189844.49	275464.88	13.5756
3010	1002	189845.79	275479.15	13.2825
3010	1003	189848.48	275523.16	13.4438
3010	1004	189848.94	275545.53	13.7340
3010	1005	189847.16	275571.08	14.0318
3010	1006	189848.53	275604.31	14.3357
3010	1007	189849.74	275649.24	14.7874
3010	1008	189850.40	275670.93	15.3573
3010	1009	189850.05	275703.55	15.3100
3010	1010	189849.24	275731.01	14.7689
3010	1011	189848.01	275760.98	14.3725
3010	1012	189843.23	275789.25	14.0917
3010	1013	189849.62	275824.59	14.0674
3010	1014	189854.45	275843.86	14.2482

Spoil Management 3D Source Line 3011 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3011	1001	189924.64	275557.59	15.2346
3011	1002	189913.13	275573.37	15.0329
3011	1003	189927.65	275616.82	15.2510
3011	1004	189920.63	275647.46	15.6435
3011	1005	189914.95	275675.65	15.5152
3011	1006	189908.86	275705.03	14.9704
3011	1007	189910.88	275737.62	14.6078
3011	1008	189913.48	275754.74	14.3910
3011	1009	189913.46	275793.66	14.2640
3011	1010	189913.38	275823.32	14.2089
3011	1011	189914.72	275842.86	14.2536

Spoil Management 3D Source Line 3012 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3012	1001	189992.88	275641.74	17.2343
3012	1002	189989.72	275664.86	16.8645
3012	1003	189986.52	275685.58	16.6273
3012	1004	189985.24	275723.49	16.2005
3012	1005	189986.77	275756.36	15.8822
3012	1006	189982.26	275788.49	15.6507
3012	1007	189976.31	275824.34	15.3383
3012	1008	189974.70	275844.69	14.9611

Spoil Management 3D Source Line 3013 Coordinates

SRC Line	SRC Station	X (feet)	Y (feet)	Elevation (ft)
3013	1001	190059.83	275725.39	16.1234
3013	1002	190047.91	275759.32	15.6527
3013	1003	190042.04	275794.34	15.3662
3013	1004	190036.40	275827.95	14.8505
3013	1005	190036.76	275844.64	14.6073

Appendix 2 – Instruments & Equipment

- Geospace GSX Nodal Seismic System
- Trimble R8 GPS Survey Instruments
- Accelerated Impact Source (AIS) Energy Source System

GSX

Land Based Recorder



Cable-free, Radio-free, Autonomous Data Recorder

- Scalability greater than 50,000 channels
- Delivers high-resolution with a 24-bit delta-sigma ADC
- Built-in GPS receiver and disciplined clock
- Greater than 30 days of continuous recording
- Compatible with explosive, vibratory, and impulsive energy sources
- Accepts standard analog sensor inputs
- Has a built-in full-resolution test generator
- Available as 1, 2, 3, or 4 channel versions
- Has an LED Status/Deployment state indicator

Cable-free, Radio-free Autonomous Data Recording

The GSX is designed for cable-free/radio-free seismic data recording. The self-contained unit includes 1 to 4 channels of 24-bit digitization, an integrated high sensitivity GPS receiver, built-in test signal generator, up to 32 GB per channel of non-volatile solid-state data storage, and a high-speed data port. The unit is housed in a sealed case, with an input connector and an extended life battery/data port connector.



GSX System Tests

The seismic channel performance and sensor tests can be performed by the GSX System. The user can choose a partial or complete set of tests that can be run in sequence. The user can also choose to display all of the results or only the failures. In the tests described below, the system software automatically controls the Channel Input Switch Positions and Test Oscillator Settings during the tests. All tests can be run at all sample intervals and preamp gains of the GSX.

- | | |
|---|---|
| ☐ Harmonic Distortion | ☐ Gain Accuracy |
| ☐ Impulse Response | ☐ Common Mode Rejection |
| ☐ Equivalent Input Noise | ☐ Geophone Impedance and THD |
| ☐ Instantaneous System Dynamic Range | ☐ Crossfeed (multi-channel) |

FEATURES and SPECIFICATIONS

- 24-bit digital recorder
- Built-in GPS and disciplined clock
- Built-in full resolution test signal generator
- Solid-state flash memory
- Scalability greater than 50,000 channels
- Greater than 30 days of continuous recording
- Compatible with vibratory, explosive, and impulsive energy sources
- LED Status/Deployment State Indicator
- Accepts standard analog sensor input
- Available as 1, 2, 3, or 4 channel versions
- 24-bit delta-sigma ADC
- 1 Hz to 1600 Hz freq. response
- <20 μ sec of UTC (GPS clock)
- Up to 32 GBytes per channel flash memory storage
- External extended life battery
- Operating Temperature: -40° C to $+85^{\circ}$ C
- Humidity: 0 to 100%
- Selectable Gains:
 - X1, X2, X4, X8, X16, X32, X64
 - 0, 6, 12, 18, 24, 30, 36 dB
- Sample Intervals:
 - .25, .5, 1, 2, 4 milliseconds

Max Input Signal:	1.80 Vrms @ 0 Gain
Total Dynamic Range:	140 dB
System Dynamic Range @ 0dB Gain:	
	126 dB @ 4 msec SI
	124 dB @ 2 msec SI
	120 dB @ 1 msec SI
	117 dB @ .5 msec SI
	106 dB @ .25 msec SI
Equivalent Input Noise @ 2 msec SI:	
	1.13 μ V @ Gain 0 dB
	0.58 μ V @ Gain 6 dB
	0.33 μ V @ Gain 12 dB
	0.22 μ V @ Gain 18 dB
	0.19 μ V @ Gain 24 dB
	0.18 μ V @ Gain 30 dB
	0.17 μ V @ Gain 36 dB
Input Impedance:	
	20 k Ω /0.06 μ f Difference Mode
	205 k Ω Common Mode

System Dynamic Range @ 2 msec SI:	
	124 dB @ Gain 0 dB
	123 dB @ Gain 6 dB
	122 dB @ Gain 12 dB
	120 dB @ Gain 18 dB
	115 dB @ Gain 24 dB
	110 dB @ Gain 30 dB
	105 dB @ Gain 36 dB
Total Harmonic Distortion:	0.0005%
Common Mode Rejection:	0.001%
Gain Accuracy:	1%
Anti-Alias Filter:	
	Rejection @ Nyquist: 130 dB
	Frequency @ -3 dB: 0.83 Nyquist
	Linear or Minimum Phase
GPS Time Standard:	<1 ppm
Weight:	2 lbs.
Max Dimensions:	3.5"W x 3.0"H x 6.67"L

Big Advances in Small Packages



GSX1 with a BN6 battery and a GS-ONE geophone in a Land Case.

Trimble R8s

GNSS SYSTEM

One Receiver Configured for Today Scalable for Tomorrow

Rather than a pre-configured system, the Trimble® R8s GNSS system gives you just the features and benefits you need, in one flexible, scalable system. It's never been easier to build a system tailored to your job.

The Trimble R8s easily integrates with Trimble S-Series total stations and the innovative Trimble V10 imaging rover. Create a complete solution by combining the Trimble R8s receiver with a Trimble controller running Trimble Access™ field software, and Trimble Business Center office software.

Configure and Scale With Ease

With the Trimble R8s, it's easy and simple to build a receiver that is right for the job. Choose the configuration level that suits your needs best, whether it's post-processing, base, rover, or a combination of base and rover functionality. After you've selected a configuration level, additional individual options can be added to further extend the receiver functionality.

The Trimble R8s offers the ultimate in scalability. As your requirements change, the Trimble R8s can adapt. Simply add functionality whenever you need it.

Trimble 360 Technology

Each Trimble R8s comes integrated with powerful Trimble 360 tracking technology that supports signals from all existing and planned constellations, and augmentation systems. Trimble 360 technology can expand the reach of your GNSS rover to sites that were previously inaccessible due to moderate vegetation or other obstructions by taking advantage of the availability of additional satellite signals.

The Trimble R8s includes two integrated Maxwell™ 6 chips and 440 GNSS channels. Capable of tracking a full range of satellite systems, including GPS, GLONASS, Galileo, BeiDou and QZSS.

Communication Options and Remote Access Via Web UI

The Trimble R8s GNSS receiver provides data communication options including an integrated wide-band UHF radio or 3G cellular modem.

Trimble's exclusive Web UI eliminates the need to travel for routine monitoring of base station receivers.

The Complete Solution

Create an industry-leading field solution by pairing the Trimble R8s GNSS receiver with a powerful Trimble controller loaded with our easy-to-use Trimble Access field software.

Trimble Access field software offers the features and capabilities to simplify everyday work. Our streamlined workflow modules such as Roads, Monitoring, Mines, and Tunnels guide crews through common project types, enabling them to get the job done faster. Survey companies can also implement their unique workflows by taking advantage of the customization capabilities available in the Trimble Access Software Development Kit (SDK).

Once you're back in the office, Trimble Business Center enables you to check, process and adjust your data with confidence. No matter what Trimble solution you use in the field, you can trust that Trimble Business Center office software will help you generate industry leading deliverables.

Trimble Mobile App—A New Way to Quickly Collect GNSS Raw Data

The Trimble DL Android app provides a simple and easy to use mobile interface for collecting static GNSS raw data for post-processing purposes without the need of using a Trimble controller or Trimble Access field software. This free of charge app is available through the Google Play Store and operates on Android smart phones and tablets.

Key Features

- ▶ One configurable receiver that is scalable for future needs
- ▶ Available in post-processing, base only, rover only, or base & rover configurations
- ▶ Advanced satellite tracking with Trimble 360 receiver technology
- ▶ Includes Trimble Maxwell 6 chips with 440 channels
- ▶ Simple integration with Trimble S-Series Total Stations and the V10 Imaging Rover
- ▶ Intuitive Trimble Access Field Software and Trimble Business Center Office Software



DATASHEET

Trimble R8s GNSS SYSTEM

PERFORMANCE SPECIFICATIONS¹

Measurements

- Advanced Trimble Maxwell 6 Custom Survey GNSS chips with 440 channels
- Future-proof your investment with Trimble 360 tracking
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, un-smoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low elevation tracking technology
- Satellite signals tracked simultaneously:
 - GPS: L1C/A, L1C, L2C, L2E, L5
 - GLONASS: L1C/A, L1P, L2C/A, L2P, L3
 - SBAS: L1C/A, L5 (for SBAS satellites that support L5)
 - Galileo: E1, E5A, E5B
 - BeiDou (COMPASS): B1, B2
 - SBAS: QZSS, WAAS, EGNOS, GAGAN
- Positioning rates: 1 Hz, 2 Hz, 5 Hz, 10 Hz, and 20 Hz

POSITIONING PERFORMANCE²

Code differential GNSS positioning	
Horizontal	0.25 m + 1 ppm RMS
Vertical	0.50 m + 1 ppm RMS
SBAS differential positioning accuracy ³	typically <5 m 3DRMS
Static GNSS surveying	
High-Precision Static	
Horizontal	3 mm + 0.1 ppm RMS
Vertical	3.5 mm + 0.4 ppm RMS
Static and Fast Static	
Horizontal	3 mm + 0.5 ppm RMS
Vertical	5 mm + 0.5 ppm RMS
Postprocessed Kinematic (PPK) GNSS surveying	
Horizontal	8 mm + 1 ppm RMS
Vertical	15 mm + 1 ppm RMS
Real Time Kinematic surveying	
Single Baseline <30 km	
Horizontal	8 mm + 1 ppm RMS
Vertical	15 mm + 1 ppm RMS
Network RTK⁴	
Horizontal	8 mm + 0.5 ppm RMS
Vertical	15 mm + 0.5 ppm RMS
Initialization time ⁵	typically <8 seconds
Initialization reliability ⁶	typically >99.9%

HARDWARE

Physical

Dimensions	19 cm x 10.4 cm (7.5 in x 4.1 in), including connectors
Weight	1.52 kg (3.35 lb) with internal battery, internal radio and antenna 2.81 kg (6.20 lb) items above plus range pole, controller & internal radio
Operating Temperature ⁷	-40 °C to +65 °C (-40 °F to +149 °F)
Storage Temperature	-40 °C to +75 °C (-40 °F to +167 °F)
Humidity	100%, condensing
Ingress Protection	IP67 dustproof, protected from temporary immersion to depth of 1 m (3.28 ft)
Shock and vibration	
Tested and meets the following environmental standards:	
Shock	Non-operating: Designed to survive a 2 m (6.6 ft) pole drop onto concrete. Operating: to 40 G, 10 msec, sawtooth
Vibration	MIL-STD-883C, F14.5.5.2.1

ELECTRICAL

- Power 10.5 V DC to 28 V DC external power input with over-voltage protection on Port 1 (7-pin Lemo)
- Rechargeable, removable 7.4 V, 2.8 Ah Lithium-ion smart battery
- Power consumption is <3.2 W in RTK rover mode with internal radio and Bluetooth[®] in use⁹
- Operating times on internal battery⁸:
 - 450 MHz receive only option: 5.0 hours
 - 450 MHz receive/transmit option (0.5 W): 2.5 hours
 - Cellular receive option: 4.0 hours

COMMUNICATIONS AND DATA STORAGE

- Serial: 3-wire serial (7-pin Lemo) on Port 1; full RS-232 serial (Dsub 9 pin) on Port 2
- Radio Modem¹⁰: fully integrated, sealed 450 MHz wide band receiver/transmitter with frequency range of 403 MHz to 473 MHz, support of Trimble, Pacific Crest, and SATEL radio protocols:
 - Transmit power: 0.5 W
 - Range: 3–5 km typical / 10 km optimal¹⁰
- Cellular¹⁰: fully integrated, sealed internal GSM/GPRS/EDGE/UMTS/HSPA+ modem option. CSD (Circuit-Switched Data) and PSD (Packet-Switched Data) supported. Global Operation:
 - Penta-Band UMTS/HSPA+ (850/900/900/1900, and 2100 MHz)
 - Quad-Band GSM/CSD & GPRS/EDGE (850/900/1800, and 1900 MHz)
- Bluetooth: fully integrated, fully sealed 2.4 GHz communications port (Bluetooth)[®]
- External communication devices for corrections supported on Serial and Bluetooth ports
- Data storage: 56 MB internal memory, 960 hours of raw observables (approx. 14 MB/day), based on recording every 15 sec from an average of 14 satellites

Data Formats

- CMR, CMR+, CMRx, RTCM 2.1, RTCM 2.3, RTCM 3.0, RTCM 3.1, RTCM 3.2 inputs and outputs
- 23 NMEA outputs, GSOE, RT17 and RT27 outputs, supports BINEX and smoothed carrier

WebUI

- Offers simple configuration, operation, status, and data transfer
- Accessible via Serial and Bluetooth

Supported Trimble Controllers¹

- Trimble TSC3, Trimble Slate, Trimble CU, Trimble Tablet Rugged PC

CERTIFICATIONS

IEC 60950-1 (Electrical Safety); FCC OET Bulletin 65 (RF Exposure Safety); FCC Part 15.105 (Class B), Part 15.247, Part 90; PTCRB (AT&T); Bluetooth SIG; IC ES-003 (Class B); Radio Equipment Directive 2014/53/EU, RoHS, WEEE; Australia & New Zealand RCM; Japan Radio and Telecom MIC

- Based on Trimble R8s GNSS receiver configuration. Radio frequency settings are country specific.
- Precision and reliability may be subject to anomalies due to multipath, obstructions, satellite geometry, and atmospheric conditions. The specifications stated recommend the use of stable mounts in an open sky view, DMI and multipath clean environment, optimal GNSS constellation configurations, along with the use of survey practices that are generally accepted for performing the highest order surveys for the applicable application including occupation time appropriate for baseline length. Baselines longer than 30 km require precise ephemeris and occupations up to 24 hours may be required to achieve the high precision static specification.
- Depends on SBAS system performance.
- Network RTK PPM values are referenced to the closest physical reference station.
- May be affected by atmospheric conditions, signal multipath, obstructions and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
- Receiver will operate normally to -40 °C. Internal batteries are rated to -20 °C, optional internal cellular modem operates to -40 °C.
- Tracking GPS, GLONASS and SBAS satellites.
- Varies with temperature and wireless data rate. When using a receiver and internal radio in the transmit mode, it is recommended that an external 6 Ah or higher battery is used. The specified operating time on an internal battery for the cellular receive option are in GSM CSD (Circuit-Switched Data) or GPRS PSD (Packet-Switched Data) mode.
- Varies with terrain and operating conditions.
- Bluetooth type approvals are country specific.

Specifications subject to change without notice.



Application of the Accelerated Impact Source (AIS) to High Resolution 2D/3D Seismic Imaging

I. Introduction and Review

Two of most common seismic energy sources used by the seismic industry for 2D and 3D seismic exploration surveys have been Vibroseis and explosives. A less common, but much improved alternative seismic energy source is the Accelerated Impact Source (AIS). All three seismic source types have been in use for more than fifty years worldwide, and GSS utilizes all three energy source types. However, in the past 10 years, significant improvements with the Accelerated Impact Source performance and durability make this source an excellent lower cost, more efficient, and practical alternative to Vibroseis and explosives. With the exception of special seismic surveys where the application of Vibroseis and dynamite are necessary, performance evaluations of AIS has shown it can produce data that is equivalent or superior to Vibroseis and dynamite.

Land seismic surveys that are located over challenging terrain and environmentally sensitive areas can make it difficult or impossible to consider using Vibroseis or explosives. In recent years we have experienced an increase with regard to environmental obstacles and property regulations that often prohibit the use of Vibroseis and explosives. Moreover, the cost associated with using these seismic energy sources is often becoming too expensive and/or risk burdened in many regions. For these reasons, there has been a resurgent interest during the last 5-10 years in the development of more powerful and durable alternative AIS systems that are comparatively equivalent or better than the performance of Vibroseis and explosive seismic energy sources.

Where applicable and economical, Collier Consulting uses both Vibroseis and explosive seismic sources. However, wherever environmental conditions, terrain constraints, infrastructure, and other hazardous risk factors limit the practical and economical use of Vibroseis and explosives CCI will often recommend using the AIS systems, especially where geologic target objectives are 10,000 feet or less. Since 2008, the AIS have been used successfully on numerous high resolution seismic surveys worldwide.

II. Accelerated Impact Source Development

Some of the more fundamental criteria for acquisition of good quality 2D or 3D data on any land seismic project depend largely on energy source performance. Vertical and horizontal seismic resolution, maximum depth of exploration, and to some extent seismic signal-to-noise; all have some dependency on performance of the seismic energy source. Regardless of whether we use Vibroseis, explosives, or the Accelerated Impact Source, there must be sufficient source signal frequency bandwidth and total energy output. Apart from the earth frequency filtering properties, which can vary significantly, source signal bandwidth governs the effective vertical resolution of the data. Horizontal resolution is also governed by source seismic bandwidth, but also the CDP spatial sampling. For many 2D and 3D seismic surveys the typical effective source bandwidth ranges from 10 Hz to 80 Hz. The higher frequency bandwidth

component can reach or exceed 100 Hz on some shallow target seismic surveys ($\leq 10,000$ feet). With the exception of differences caused by near surface signal attenuation and ground decoupling effects, the Vibroseis source, explosives, and Accelerated Impact Source systems can all produce nearly the same source signal bandwidth attributes.

III. The Geophone Coupling Factor



Experiments have been conducted to examine the effects of geophone ground coupling on amplitude frequency bandwidth detection. These tests confirm that poor geophone ground coupling sensitivity and amplitude-frequency response can be severely degraded. With poor geophone coupling the detected seismic signal bandwidth is often significantly reduced, and is dominated by the lower frequency components. This is especially evident where geophones are deployed in poorly consolidated soils, sandy soils, and other loose organic soil materials. For 2D and 3D seismic surveys where geophones are even partially de-coupled, the attenuation of nearly all amplitude-frequency signals above 55 - 62 Hz can be severe. With good geophone coupling, seismic frequency bandwidth and amplitude response is significantly improved.

For several years, significant improvements have been achieved using high performance marsh type geophones (single element) on seismic surveys where soil consolidation conditions are poor. To avoid geophone de-coupling marsh geophones are planted in shallow auger pilot holes, in soil material that is at least semi consolidated and geophone coupling is assured. Often, the depth of the geophone pilot hole is only 4 to 6 inches below ground. The result of using this technique is detection and recording of the best possible broadband seismic data, which is especially critical for shallow exploration targets requiring high resolution seismic data.

IV. Accelerated Impact Source (AIS) Seismic Projects

The AIS systems, in various configurations, have been used with success on several non-test commercial production seismic surveys, and on some of these projects, demonstrated that the AIS seismic data was actually superior to previously surveys acquired using Vibroseis and explosives.

AIS Mexico Seismic Project

In 2008 and 2010, 2D reconnaissance seismic data was acquired to delineate a Jurassic Sand reservoir target in the Tampico, Mexico area. The Jurassic Sand overlies a

fractured and faulted basement marine carbonate structure. Because the survey area was located in urban and commercial zones, Vibroseis and explosives were strictly prohibited. Moreover, environmental sensitivities also made it impossible to use Vibroseis and explosives. For the 2008 seismic program, a truck mounted AIS equipped with a 2700 lb source hammer was used. On the 2010 2D seismic program, the newer AF750 AIS mounted on a track vehicle was used. Figure 1 presents an end-to-end composite section for some of the interpreted 2008 2D seismic data. The top of section starts at 1.2 seconds TWT.

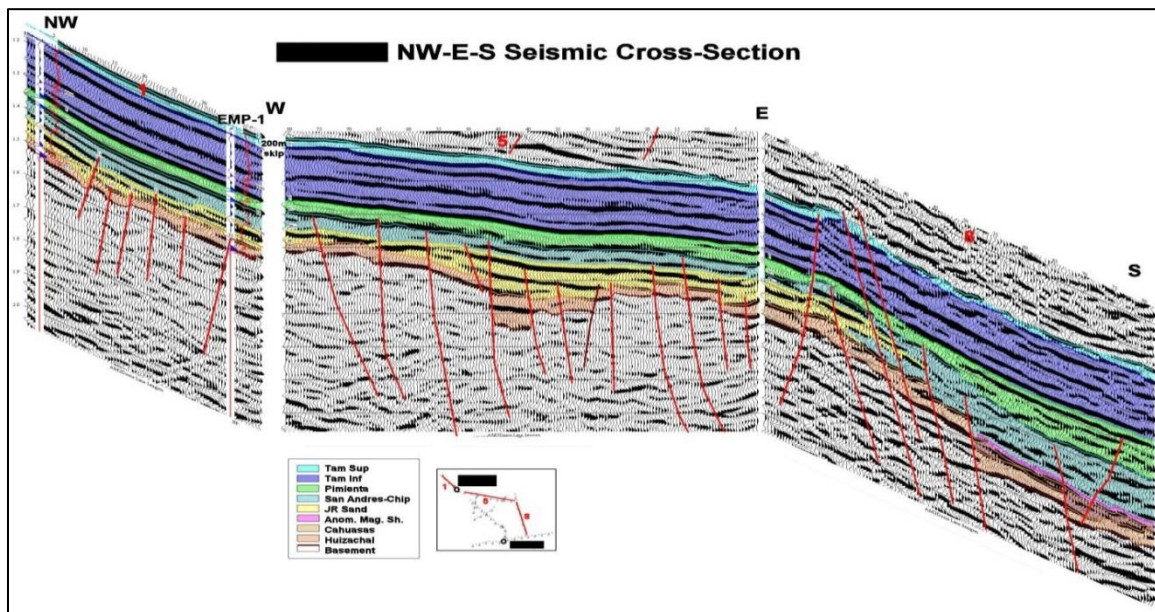


Figure 1. 2D seismic section from 2008 Mexico project. Data was acquired to depth of 3,000 meters using AIS system and cable-free GSX seismic system.



AF750 AIS for Mexico Projects

Advancements in source and cable-free seismic instruments technology were used on the Mexico project to improve the efficiency of the acquisition program and transmit field data to processors for quick turnaround processing. The newer AF750 AIS track mounted “impulsive source” was used to enable efficient, non-intrusive movement around areas congested with urban and commercial infrastructure, and over rough and wet terrain.

In some oil & gas exploration areas, we often discover that little or no seismic information is available for assessment and evaluation of target prospects. In addition, while it may be considered desirable to conduct a 3D seismic program over such areas, 3D surveys are

not necessarily the most practical or cost effective approach since the exploration target zone characteristics and attributes may also be unknown. It is often possible that a high quality and less costly 2D / 2.5D seismic program will produce sufficient information for prospect evaluation and initial exploration drilling. For a 2.5D seismic imaging program, a 3D grid for the area of seismic coverage is created in processing, and all X, Y, Z CDP points from each of the 2D lines is binned accordingly. With 2.5D binning of all 2D seismic grid data, it is possible to generate volume based horizontal and vertical composite depth sections and horizon contour maps to interpret potential exploration target attributes. As a reconnaissance tool, the 2.5D data volume can also be used to identify geo-target zones within the survey area that may require full 3D seismic imaging. Once a 3D zone is identified, in-fill data can be acquired according to a 3D patch source-receiver and azimuthal distribution parameters. For any full 3D zone of coverage, both the original 2.5D binned data and the in-fill data can be merged and re-cubed to generate zone specific 3D grids.

In 2015 a 2D / 2.5D seismic reconnaissance survey was conducted to help identify and isolate target prospects within a 70 square kilometer area. Figure 2a – Peru 2D Seismic Survey Grid & AIS). Because the survey area is located in the northern Peru, Sechura desert region, the Accelerated Impact Source (AIS) as the energy source, along with the Geospace GSX cable-free seismic system. Dynamite and Vibroseis could not be used because of regulatory concerns, and because Vibroseis suffers from severe base plate de-coupling over desert sands. Single element marsh geophones were planted in pilot holes and buried to improve ground coupling, and to eliminate “wind” noise.

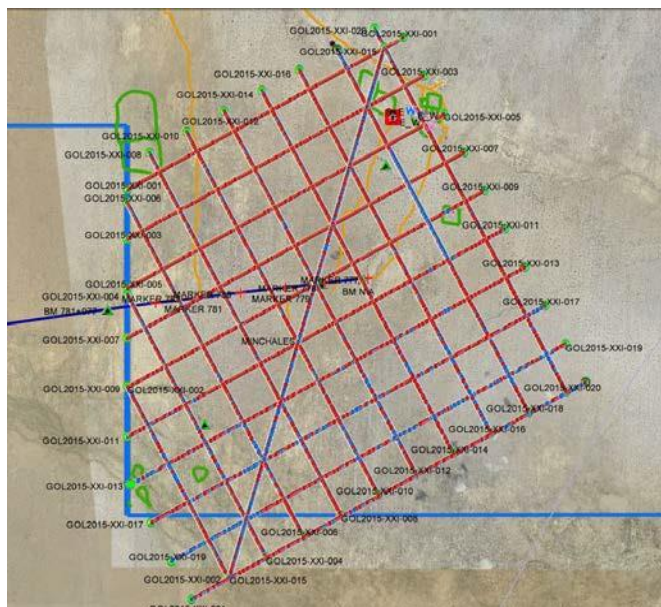


Figure 2a. Sechura Basin Peru 2D / 2.5D 210 km Seismic Program Grid



Geospace GSX Cable-Free Seismic System



CCI XLR8 2000 AIS System

The combined use of cable-free seismic system and Accelerated Impact Source technologies significantly increased field operations efficiency, and reduced project costs by

40% when compared to alternative seismic source and data acquisition instruments. In addition, the 2D / 2.5D method of seismic acquisition and processing produced exceptionally good results in terms of building a pseudo-3D seismic data volume that could be used to identify and characterize significant target prospect attributes to a depth of 2,000 meters (Figure 2b – Peru High Resolution 2D Seismic Section).

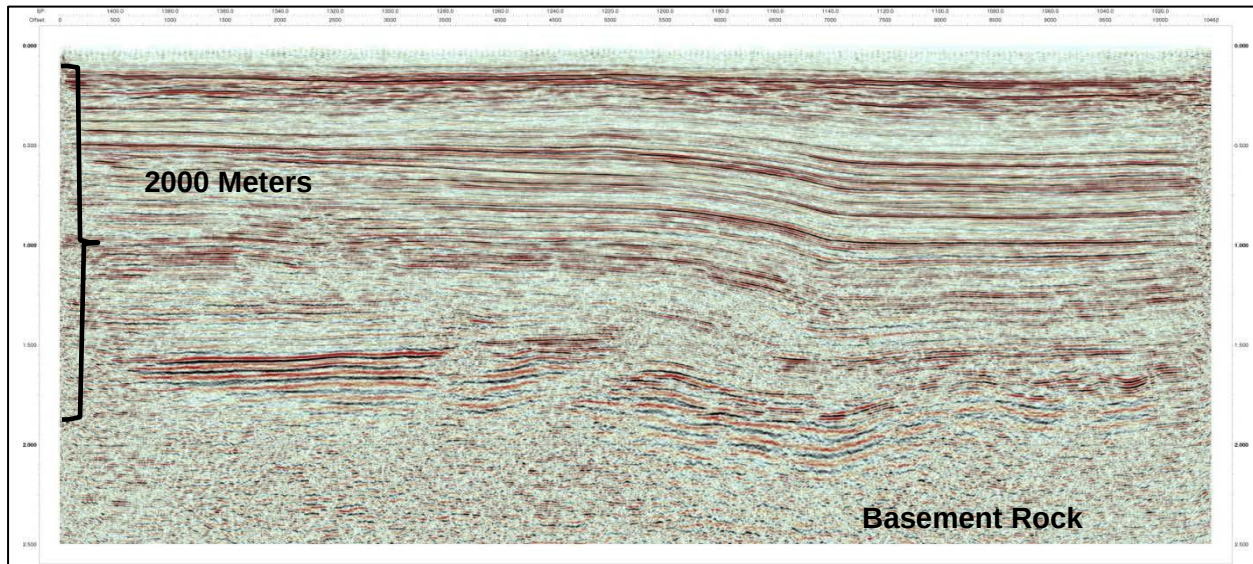


Figure 2b. Sechura Basin 6 km high-resolution 2D seismic section from data acquired using the XLR8 2000 and GSX seismic system. Bandwidth is 12 Hz to 104 Hz

V. Conclusions and Comments

Given any exploration project, the selection of any of the three seismic energy sources should be based on a thorough understanding of the geologic target objectives, the desired resolution, environmental and near surface soil conditions, terrain and climate conditions, and other factors that will affect source operation and data quality. In the last five years we have experienced a renewed interest with the use of Accelerated Impact Source technology as an alternative to Vibroseis and explosives. The latest AIS designs have been successfully field proven in terms of reliability, durability, and overall performance when compared to Vibroseis and explosives.

In some of the more difficult and environmentally sensitive areas, and where exploration target objectives are fairly shallow ($\leq 10,000$ ft), the AIS can often be the best selection of energy sources. It is becoming increasingly costly, impractical, and too difficult in many parts of the world to use Vibroseis or explosives. Sometimes we can combine energy source types, such as dynamite and AIS on seismic projects that are located in survey areas that have limited access zones for using explosives. At CCI we do employ the use of AIS, Vibroseis, and explosives. However, we will recommend an energy source type based on a number of criteria, all of which must benefit field seismic operations costs, environmental friendliness, local regulations, and overall data quality expected. The combination of cable-free seismic recording instruments and the AIS can provide added flexibility with survey designs and increased density of CDP coverage for 2D and 3D surveys. For even greater flexibility and

economy, the 2D / 2.5D reconnaissance data acquisition and processing technique can be a more suitable seismic exploration alternative, especially over areas where we may only need to improve the continuity of seismic horizon and attributes definition, geo-structures characterization, obtain a better focus on prospect zones that may eventually require full 3D seismic imaging. For exploration projects where guidance for delineation of target drill locations is required, the 2D / 2.5D may be all that is needed.

Appendix 3 – Comment & Questions – Author Response Section

I. General Comments

From: Jon Arthur, Ph.D., P.G.
Director and State Geologist
Florida Geologic Survey
Florida Department of Environmental Protection

Comments

1. “I have completed reading the report and it looks solid. Two of my staff have reviewed it as well. The report is a good first pass at a “proof of concept” for using seismic to delineate subsurface structures and the boulder zone (BZ). The preliminary results (e.g., karst and other deformation) indeed raise concerns regarding potential fluid movement”.
2. “With the BZ being a target, we expected the interpreted seismic sections to extend deeper, rather than being truncated just below the BZ. Being able to see another thousand feet deeper would allow better comparison of deeper contrasting(?) seismic facies. Similarly, regarding processing, to what extent might artifacts due to the migration step influence the interpretation? Is it possible that deeper parts of the section may reflect downward propagation of distortion”?
3. “I note that the interpreted fractures/faults are all symbolized the same. I suspect they are not all identified at the same level of confidence. Perhaps symbology reflecting “highly likely” faults/fractures relative to those less likely is possible? Solid lines imply a certain level of confidence that may or may not be intended by report authors”.
4. “In cases, wells used for correlation are several miles off the seismic line. I realize this is a challenge in a data-poor region. A discussion of vertical resolution/uncertainty stemming from the distant control would be a good addition. I did see the impressive depth-error value. I am uncertain how this ties into my old-fashioned way of thinking about “observed versus expected” in context of ground-truthing to borehole lithology”.

Author Response

Comment #1. The “Proof of Concept” was to confirm that using the Accelerated Impact Source, the GSX nodal seismic system, and the data acquisition techniques, broadband high resolution 2D and 3D seismic data could achieve the test objectives. The seismic data bandwidth was 12 Hz to 128 Hz and produced sufficient resolution to delineate numerous horizons and signal attributes from top of the Hawthorn Group to the “Boulder Zone”. The preliminary interpretations of karst and other related deformation structures do indeed give rise for concern regarding fluid movement, but also can serve as a general guide to identifying future drilling locations. Although currently beyond the scope of work for this seismic test, additional seismic attributes processing should be performed to extract more information

(Velocity versus Porosity, Curvature Attributes, Instantaneous Phase, Fracture Analysis & Mapping).

Comment #2.

Although all seismic data was recorded with a 3 second record length, the seismic test was limited to the top of Oldsmar formation and the “Boulder Zone” (2700 ft to 3500 ft objective). In the time domain 800 ms is the maximum depth of investigation for the SFWMD test project. However, it may be possible to use the test data for imaging deeper into the Cedar Keys formation using Micro-Focusing and Diffraction Imaging processing techniques. Based on preliminary interpretations of faults/fracture zones and vertical deformation, there is reason to believe that the deeper seismic information may provide some additional insight and understanding about the origins of shallow (upper 3000 feet) fracture systems and apparent subsidence/vertical deformations. We believe that there is need in some areas to obtain seismic data to at least 5000 feet.....or more. The 3D and 2D seismic survey design is limited with respect to maximum source-receiver offsets. To achieve seismic imaging to greater depth may require deployment of active seismic spreads with lengths up to 2.0 miles.

The migration step used seismic tomography analysis to derive velocity fields in the depth domain for migration. Comparison between migrated and un-migrated sections showed little or no distortion or artifacts. Principal Component Analysis was also performed to suppress some of the noise artifacts. However, diffractions do still give rise to artifacts that can affect the migration. Additional processing could include Diffraction Mapping and/or Multi-Focus processing.

Comment #3

With the exception of Spoil Management Site 3D survey and the Lake Regions 2D seismic program, acquisition of all other 2D seismic data used the swath approach; layout of two parallel receiver lines with centered parallel source line. This method generates two CDP seismic lines. Interpretation looks for similarities and dis-similarities to guide interpretation of faults and fracture zones. The level of confidence with respect to delineation of fractures and faults is fairly good. 3D surveys, however, do improve accuracy with respect to identifying stratigraphic and structural features.

Comment #4

The OUA well was about 0.5 miles from seismic lines 5001 and 5002. The LRRO-IW1 was only a few hundred yards from State Road 80 Segment 1. The Labbelle-IW1 well was located closest to Spoil Management 3D seismic survey site, but exceeded 10 miles. On review of all geophysical well log data we discovered that log runs were conducted in separate runs, and at different sample rates for the sonic logs. Extensive work was performed to merge the segments, and to normalize the sonic log sampling rates. To the extent possible, sonic, resistivity and gamma ray data were used to develop synthetic seismic traces, some of which were correlated with video logs and coring logs.

For correlation of synthetic seismograms with the seismic data, final velocity analysis results from all of the test sites seismic data was compared and found to be fairly uniform and consistent with respect to formation. Synthetic seismograph horizon picks we also compared to the velocity derived horizon depths. When plotting synthetic picks with seismic horizons in the time and depth domain, the fit was fairly good regionally and we were able to establish reasonable ties between the seismic data depth scale and the synthetic seismogram time and depth scale. There are small site to site differences and the ties could be further refined in the future. In addition, it might be prudent to incorporate other well data to develop a more accurate geologic formation and seismic reflection-velocity model.