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Waste Isolation Pilot Plant

Geotechnical Analysis Report for July 2021 – June 2022

U.S. Department of Energy
Carlsbad Field Office

October 31, 2023

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FOREWORD AND ACKNOWLEDGMENTS

This report contains the most recent assessment of the geotechnical status of the Waste Isolation Pilot Plant (WIPP). During the excavation of the WIPP principal underground access and experimental areas, the status was reported quarterly. Since 1987, when the initial construction phase was completed, reports have been published annually. This report presents and analyzes data collected from July 1, 2021 to June 30, 2022.

This Geotechnical Analysis Report (GAR) was prepared on the recommendation for periodic reporting of ongoing data collection in the Design Validation Final Report (DVR) (DOE, 1986) and to satisfy several regulatory requirements. It satisfies requirements contained in the WIPP Hazardous Waste Facility Permit[1] (HWFP) Part 4 Section 4.6.1.2, Reporting Requirements, and Attachment A2, Section A2-5b(2), Geomechanical Monitoring, and the Certification of Compliance[2] with Subparts B and C, Title 40 Code of Federal Regulations (CFR) Part 191, Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes. Part 191 defines the waste containment requirements. One of these requirements, stipulated in Part 191.14(b), is “Disposal systems shall be monitored after disposal to detect substantial and detrimental deviations from expected performance.” Part 194.42 describes the minimum post-disposal system parameters to be analyzed. This report focuses on the geotechnical performance of the various components of the WIPP underground facility, including shaft stations, access drifts, and waste disposal areas. The results of investigations of excavation effects and other geotechnical studies are also included.

This report compares the geotechnical performance of the repository to the design criteria, outlined in Table 9-1. It describes the techniques that were used to acquire the data. The depth and breadth of the evaluation of the different components of the underground facility vary according to the types and quantities of data available, and the complexity of the recorded geotechnical responses. Graphic documentation of data and tabular documentation of instrument history can be provided upon request.

This GAR was prepared by Salado Isolation Mining Contractors, LLC (SIMCO), for the U.S. Department of Energy (DOE), Carlsbad Field Office, in Carlsbad, New Mexico. Work was supported by the DOE under Contract No. 89303322-DEM-000077.

[1] New Mexico Environment Department (NMED), 2022, Waste Isolation Pilot Plant Hazardous Waste Facility Permit, NM4890139088-TSDF, Santa Fe, NM

[2] U.S. Environmental Protection Agency, 1998, "Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision," *Federal Register*, Vol. 63, No. 95, pp. 27354, May 18, 1998, Washington, DC

CHANGE HISTORY SUMMARY

Revision Number	Date Issued	Description of Changes
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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
bp	before present
bsc	below shaft collar
CFR	Code of Federal Regulations
CH	contact-handled
DOE	U.S. Department of Energy
DVR	Design Validation Report
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
GAR	Geotechnical Analysis Report
GIS	Geomechanical Instrumentation System
HWFP	Hazardous Waste Facility Permit
in	inch(es)
m	meter(s)
Ma	million years
MB	marker bed
NMED	New Mexico Environment Department
OMB	orange marker bed
Psi	pound(s) per square inch
RCRA	Resource Conservation and Recovery Act
RH	remote-handled
SDI	Salt Disposal Investigation
SDDI	Salt Defense Disposal Investigation
SIMCO	Salado Isolation Mining Contractors, LLC
SPDV	Site and Preliminary Design Validation
TRU	Transuranic
WIPP	Waste Isolation Pilot Plant

1.0 INTRODUCTION

This GAR presents and interprets geotechnical data from the underground excavations at the WIPP facility. The data, which are obtained as part of a regular monitoring program, are used to characterize conditions, to compare performance to the design criteria, and to evaluate and forecast the performance of the underground excavations.

During operation of the Site and Preliminary Design Validation (SPDV) Program, the architect/engineer for the project produced these reports quarterly to document the geomechanical performance during and immediately after early excavations of the underground facility. Since completion of the construction phase of the project in 1987, the management and operating contractor for the facility has prepared these reports annually. This report describes the performance and condition of selected areas of the WIPP underground facility for the period July 1, 2021 to June 30, 2022.

This report is divided into 10 sections. Section 1 provides background information on the WIPP Project, its mission, and the purpose and scope of the geomechanical monitoring program. Section 2 describes the local and regional geology of the WIPP site.
Sections 3 and 4 describe the geomechanical instrumentation in the shafts and shaft stations, present the data collected by that instrumentation, and provide interpretation of these data. Sections 5 and 6 present the results of geomechanical monitoring in the two main portions of the WIPP underground (the access drifts and the waste disposal area). Section 7 introduces the Salt Disposal Investigation (SDI) and Salt Defense Disposal Investigation (SDDI) areas. Section 8 discusses the results of the Geoscience Program, which include fracture mapping and observation borehole information. Section 9 summarizes the results of geomechanical monitoring and compares the current excavation performance to the design requirements. Section 10 lists references.

1.1 Location and Description

The WIPP facility is located in southeastern New Mexico, 26 miles east of Carlsbad (Figure 1-1). The surface facilities were built on flat to gently rolling terrain that is characteristic of the Los Medaños area. The underground facility is being excavated approximately 2,150 feet (ft) beneath the surface in the Salado Formation. Figure 1-2 shows a plan view of the underground configuration of the WIPP facility as of June 30, 2022.

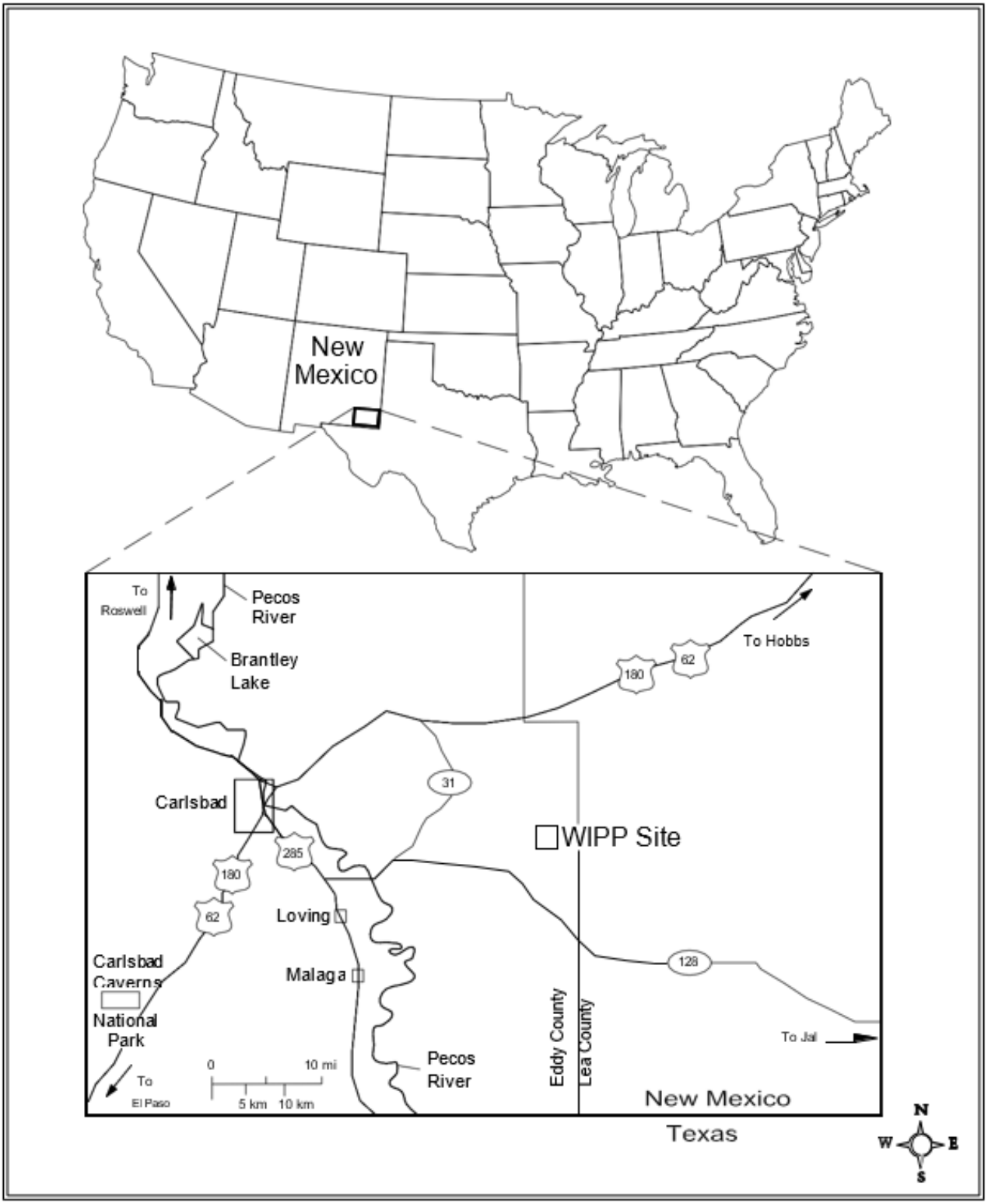

Figure 1-1 WIPP Site Location

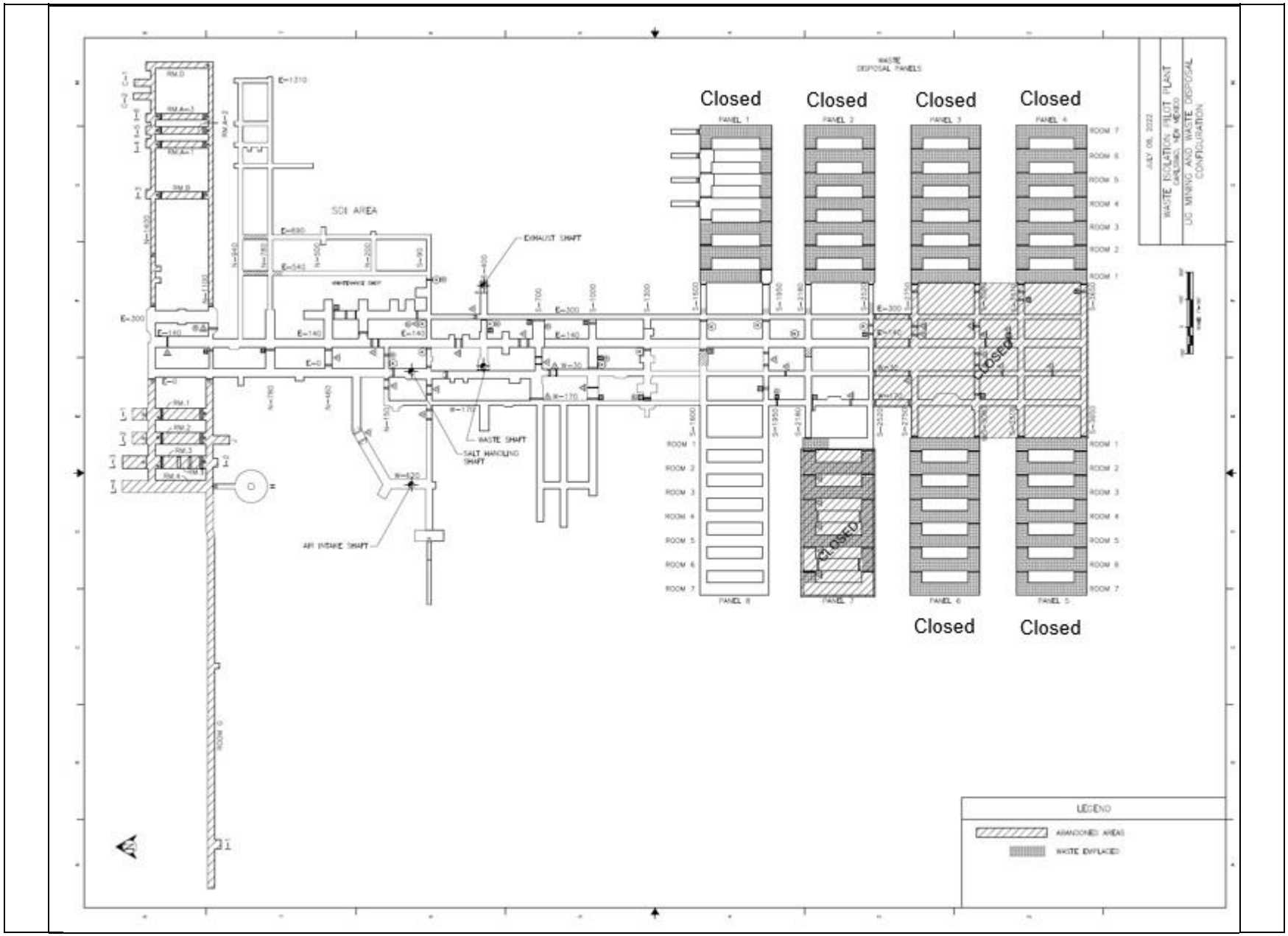

Figure 1-2 Underground Mining and Waste Disposal Configuration as of June 30, 2022

1.2 Project Background

In 1979 Congress authorized the WIPP Project (Public Law 96-164, Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980) to provide,"… a research and development facility to demonstrate the safe disposal of radioactive wastes resulting from the defense activities and programs of the United States exempted from regulation by the Nuclear Regulatory Commission." To fulfill this mission, the DOE constructed a full-scale facility to demonstrate both technical and operational principles of the permanent disposal of transuranic (TRU) and TRU mixed wastes. Technical aspects are those concerned with the design, construction, and performance of the subsurface excavations. Operational aspects refer to the receiving, handling, and emplacement of TRU wastes in the facility. The facility was first used for *in situ* studies and experiments without the use of radioactive waste. The DOE now receives, handles, and permanently disposes of TRU waste and TRU mixed waste at the WIPP facility.

1.3 Development Status

To fulfill its mission, the DOE developed the WIPP in a phased manner. The goal of the SPDV phase, begun in 1980, was to characterize the site and obtain in situ geotechnical data from underground excavations to determine whether site characteristics and *in situ* conditions were suitable for permanent waste disposal. During this phase, the Salt Shaft, a ventilation shaft, a drift to the southernmost extent of the proposed waste disposal area, a four-room experimental panel, and access drifts were excavated. Surface-based geological and hydrological investigations were also conducted. The data obtained from the SPDV investigations were reported in the Summary of the Results of the Evaluation of the WIPP Site and Preliminary Design Validation Program (DOE, 1983).

Based upon the favorable results of the SPDV investigations, additional activities were initiated in 1983. These included the construction of surface structures, conversion of the ventilation shaft for use as the Waste Shaft, excavation of the Exhaust Shaft, development of additional access drifts to the waste disposal area and excavation of additional experimental rooms to support research and development. Geotechnical data acquired during this phase were used to evaluate the performance of the excavations in the context of established design criteria (DOE, 1984). Results of these evaluations were reported in geotechnical field data reports (DOE, 1985; DOE, 1986a), and were summarized in the DVR (DOE, 1986b).

The DVR states DOE’s conclusion that the facility, including waste disposal areas, could be developed and operated to fulfill the long-term mission of the WIPP (DOE, 1986b). Available information validated the design of underground openings to safely accommodate the permanent disposal of waste under routine operating conditions.

The Air Intake Shaft was constructed between March 1988 and November 1989. Panel 1 mining began in 1986 and was completed in 1988. Panel 1 was intended to receive waste for an initial operations demonstration phase that was scheduled to start in October 1988; however, the demonstration phase was not put into effect because DOE decided to obtain needed permits for full scale operations before initiating waste emplacement were acquired.

In October 1996, the DOE submitted to the U.S. Environmental Protection Agency (EPA) a compliance certification application in accordance with Title 40 CFR Parts 191 and 194, which addressed the long-term (10,000-year) performance criteria for the disposal system. On May 18, 1998, the EPA published the final certification that allowed for the receipt of TRU waste at the WIPP facility. Immediately before this certification, the DOE Carlsbad Area Office completed an Operational Readiness Review, which is required by the DOE before the start-up or a process change of nuclear facility. As a result of the review, the DOE Carlsbad Area Office notified the Energy Secretary on April 1, 1998, that the WIPP facility was operationally ready to receive waste. On March 26, 1999, the first shipment of TRU waste was received from Los Alamos National Laboratory. By the end of June 2022, many additional waste generator sites had shipped waste to the WIPP facility. The cleanup of several small-quantity waste generator sites, as well as one large-quantity site (Rocky Flats Environmental Technology Site), is now complete.

New Mexico has primary responsibility for permitting, implementation, and enforcement of most aspects of the Resource Conservation and Recovery Act (RCRA). In 1999, the New Mexico Environment Department (NMED) granted the WIPP HWFP to the DOE. The WIPP HWFP was renewed for a ten-year period in 2010. In March 2020, the HWFP was submitted to the NMED for renewal and modification. The review was ongoing during this reporting period.

Waste disposal in Panels 1, 2, 3, 4, 5, and 6 is complete. Panels 1, 2, and 3 contain only contact-handled (CH) TRU waste. The first remote-handled (RH) TRU waste shipment arrived January 24, 2007. Panel 4 was the first to receive both CH and RH TRU waste. Waste emplacement had commenced in Panel 7, but was halted initially by a truck fire in the underground, which was followed by a radioactive release in Panel 7. Contact-handled TRU waste emplacement resumed in January 2017, and RH TRU waste emplacement was resumed in Panel 7 in February 2019 using shielded containers only. No additional borehole emplacement of RH TRU waste occurred during this reporting period. Panel 8 is scheduled to begin receiving waste in November of 2022, upon the completion of waste disposal in Panel 7.

1.4 Purpose and Scope of Geomechanical Monitoring Program

As specified in the WIPP HWFP Part 4 Section 4.6.1.2, Reporting Requirements, and Attachment A2, Section A2-5b(2), Geomechanical Monitoring (NMED, 2016), the purpose of the geomechanical monitoring program is to obtain *in situ* data to support the continuous assessment of the design for underground facilities.

Specifically, the program provides for:

- Early detection of conditions that could affect operational safety.
- Evaluation of disposal room closure that ensures adequate access.
- Guidance for design modifications and remedial actions.
- Data for interpreting the behavior of underground openings, in comparison with the established design criteria.

Data taken by, or input into the Geomechanical Instrumentation System (GIS), are evaluated and reported in this GAR. This annual report fulfills the requirements set forth in Part 4.6.1.2., Attachment A2, Section A2-5b (2) of the WIPP HWFP (NMED, 2022), and 40 CFR §191.14, Assurance Requirements, implemented through the certification criteria, 40 CFR Part 194.

The Geomechanical Monitoring Program generates the data for four of the compliance monitoring parameters:

- Creep closure and stresses
- Extent of deformation
- Initiation of brittle deformation
- Displacement of deformation features

The instrumentation system for geomechanical monitoring provides data for routine evaluations of safety, stability, and performance of underground openings. *In situ* data are also used to model long-term disposal system performance. Changes resulting from excavations are monitored by routine inspections of selected observation borehole arrays and fracture mapping to detect and quantify occurrences of discontinuities such as fractures and bed separations. Analysis of data indicating areas of potential instability allows timely corrective action before the areas become unsafe. Other geoscience activities include geologic mapping and sampling, and seismic monitoring.

The GIS provides data that are collected, processed, and stored for analysis. The following subsections briefly describe the major components of the GIS.

1.4.1 Instrumentation

Instrumentation installed for measuring the geomechanical response of the shafts, drifts, and other underground openings includes convergence points, convergence meters, extensometers, rock bolt load cells, pressure cells, strain gauges, piezometers, and joint meters. Table 1-1 lists a summary of the specifications for geomechanical instrumentation.

Instrument Type	Measures	Range[3]	Resolution[3]
Convergence point (tape extensometer)	Cumulative deformation	2 - 66 ft	0.001 in
Wire convergence meter	Cumulative deformation	0 – 40 in	0.005 in
Embedded strain gauge	Cumulative strain	0 – 3000 microstrain	1 microstrain
Spot-welded strain gauge	Cumulative strain	0 – 2500 microstrain	1 microstrain
Rock bolt load cell	Load	0 – 50 tons	40 pounds
Earth pressure cell	Pressure	0 – 1000 psi	1 psi
Piezometer	Fluid pressure	0 – 500 psi	0.5 psi
Joint meter	Cumulative deformation	0 – 4 in	0.001 in
Wire extensometer	Cumulative deformation	0 – 50 in	0.005 in

Table 1-1 Geomechanical Instrumentation Data Acquisition

Geomechanical instruments are read either manually, using portable devices, or remotely, by electronically polling the stations from the surface, in accordance with approved operating procedures. Remotely read instruments are connected to one of the underground data loggers, and readings are collected by initiating the appropriate polling routine. Upon completion of a verification process, data are transferred to a computer database. Manual readout devices are taken to instrument locations in the underground. Data are recorded on data sheets and later entered into an electronic database.

The underground data acquisition system consists of instruments, polling devices, and a communications network. Instruments are connected to polling devices that are installed in electrical enclosures near the instrument locations. Polling devices are connected by a data link to a surface computer.

[3] Manual readout boxes for the instruments were manufactured to render measurements in U.S. customary units. Range and resolution measurement units have not been converted to metric units. PSI denotes, pounds per square inch.

Whether acquired manually or remotely, geomechanical data are entered into the database files of the GIS data processing system. The data processing system consists of computer programs that are used to enter, reduce, and transfer the data to permanent storage files. Additional routines allow access to the permanent storage files for numerical analysis, tabular reporting, and graphical plotting. Copies of the report are available upon request[4].

1.4.2 Data Evaluation

Rounding and significant digits are used in the data tables of this document. The reference document is American Society for Testing and Materials (ASTM) document ASTM D 6026-06, Standard Practice for Using Significant Digits in Geotechnical Data.

Closure measurements are acquired manually from convergence point anchors and remotely from convergence meters. Data are presented in plots of closure versus time. Closure rate data are calculated and presented as part of the data analysis. Extensometers provide displacement data from instrumented rods or wires anchored at various depths. Plots show displacement versus time for individual anchors.

Displacement rate data from the hole (collar) to the deepest anchor are presented in the data analysis.

The annual closure rate is calculated as follows:

$$Rate\ (\frac{inches}{year}) = [\frac{reading2 - reading1}{date2 - date1}] * 365.25\ \frac{days}{year}$$

reading = the change from the initial reading (inches)

reading1 = reading closest to the beginning of the reporting period

reading2 = reading closest to the end of the reporting period

Comparisons between closure rates of the previous and current reporting periods are presented as percent changes in rate and are calculated as follows:

$$percent\ change\ in\ rate = (Rate_{Current\ Period} - Rate_{Previous\ Period}) / (Rate_{Previous\ Period}) \times 100\%$$

Rock bolt load cells are used to determine bolt support performance. Plots show load versus time for each instrumented bolt.

[4] Instrumentation data and data plots are presented in "Geotechnical Analysis Report for July 2021 - June 2022 Supporting Data" (DOE/WIPP-23-3610 Volume 2). The document is available upon request from the National Technical Information Service. See page ii for details and addresses.

Earth pressure cells and strain gauges are used to determine the stresses and deformation in and around the shaft liners. Data are depicted in time-based plots. Piezometers are used to measure the gauge pressure of groundwater and are installed in the shafts at varying elevations to monitor the hydraulic head acting on the shaft liners. Data are plotted as pressure versus time.

Joint meters, installed perpendicular to a fracture, monitor the dilation of the fracture with time. Data are presented as displacement versus time.

1.4.3 Data Errors

Geomechanical Instrumentation SystemIS data are processed through a comprehensive database management system. Whether acquired manually or remotely, GIS data are processed and permanently stored according to approved procedures. On occasion, erroneous readings can occur. There are several possible explanations for erroneous readings, including the following:

- The measuring device was misread.
- The reading was recorded incorrectly.
- The measuring device was not functioning within specifications.

When a reading is believed to be erroneous, the suspect reading is evaluated, and, if necessary, a second reading is collected. If the second reading falls in line with the instrument trend, the first reading is discarded and the second reading is entered in the database. If the second reading and subsequent readings remain out of the instrument trend, the ground conditions in the vicinity of the instrument are assessed to determine the reason for the discrepancy. In addition, the reading frequency may be increased.

2.0 GEOLOGY

This section provides a stratigraphic summary of the region and the WIPP site. Readers desiring further geologic information may consult the Geological Characterization Report, WIPP Site, Southeastern New Mexico (Powers et al., 1978). This report was developed as a source document on the geology of the WIPP site for individuals, groups, or agencies seeking basic information on geologic history, hydrology, geochemistry, or detailed information, such as physical and chemical properties of repository rocks. A more recent survey of WIPP stratigraphy is included in the Geologic Mapping of the Air Intake Shaft at the Waste Isolation Pilot Plant (Holt and Powers, 1990).

2.1 Regional Stratigraphy

The stratigraphy in the vicinity of the WIPP site includes rocks of Permian (295 to 250 million years [Ma] before present [bp]), Triassic, and Quaternary ages. The descriptions of formations provided in this section are given in order of deposition (oldest to youngest), beginning with the Castile Formation (Castile) (Figure 2-1).

2.1.1 Permian

The Permian system in southwestern North America is divided into four series. The last of these, the Ochoan Series, contains the host rock in which the WIPP repository is located.

The Ochoan Series is of mostly marine origin and consists of four formations: three evaporite formations (the Castile, the Salado Formation (Salado), and the Rustler Formation (Rustler) and one Redbeds Formation (Dewey Lake). The Ochoan evaporites overlie marine limestones and sandstones of the Guadalupian Series (Delaware Mountain Group). The younger redbeds represent a transition from the lower evaporite deposition to fluvial deposition on a broad, low-relief, fluvial plain. The Permian rocks are overlain by fluvial deposits of the Triassic and Quaternary periods.

2.1.1.1 Castile Formation

The Castile, lowermost of the four Ochoan formations, is approximately 1,250 ft thick in the WIPP site vicinity. Lithologically, the Castile is the least complex of the evaporite formations and is composed chiefly of interbedded anhydrite and halite, with limestone present in minor amounts.

2.1.1.2 Salado Formation

The Salado comprises nearly 2,000 ft of evaporites, primarily halite. The formation is subdivided into three informal members: the unnamed lower member, the McNutt potash zone, and the unnamed upper member. Each member contains similar amounts of halite, anhydrite, and polyhalite, and is differentiated on the basis of soluble potassium- and magnesium-bearing minerals. The WIPP disposal horizon is located within the unnamed lower member, 2,150 ft below the surface.

2.1.1.3 Rustler Formation

The Rustler is subdivided into five members, starting from its base: the Los Medaños Member (Los Medaños), the Culebra Dolomite Member (Culebra), the Tamarisk Member (Tamerisk), the Magenta Dolomite Member (Magenta), and the Forty-niner Member (Forty-niner).

In the vicinity of the WIPP site, the Rustler is approximately 310 ft thick and thickens to the east. The Los Medaños contains primarily fine sandstone to mudstone with lesser amounts of anhydrite, polyhalite, and halite. Bedded and burrowed siliciclastic sedimentary rocks with cross-bedding and fossil remains signify the transition from the strongly evaporitic environments of the Salado to the brackish lagoonal environments of the Rustler (Holt and Powers, 1990).

The upper portion of the Rustler contains interbeds of anhydrite, dolomite, and mudstone. The Culebra is generally brown, finely crystalline, and locally argillaceous. The Culebra contains rare to abundant vugs with variable gypsum and anhydrite filling, and is the most transmissive hydrologic unit within the Rustler.
The Tamarisk consists of lower and upper sulfate units separated by a unit that varies laterally from mudstone to mainly halite. The Magenta is a gypsiferous dolomite with abundant primary sedimentary structures and well-developed algal features. The Forty-niner consists of lower and upper sulfate units separated by a mudstone that displays sedimentary features and bedding. East of the Site area, halite correlates with the mudstone. The Culebra and Magenta are persistent and serve as important marker units.

2.1.1.4 Dewey Lake Redbeds

The Dewey Lake are the uppermost of the Ochoan Series formations. Within the series, the Dewey Lake represents a transition from the lower marine evaporite deposition to fluvial deposition on a broad, low-relief, fluvial plain. The redbeds, approximately 475 ft thick, consist of predominantly reddish-brown interbedded fine-grained sandstone, siltstone, and claystone. This formation is differentiated from others by its lithology and distinctive color (both of which are remarkably uniform), and by sedimentary structures, including horizontal- and cross-laminae and ripple marks. The redbeds also contain locally abundant greenish-gray reduction spots and gypsum filled fractures. The formation thickens from west to east due to eastward dips and erosion to the west.

2.1.2 Triassic

The only Triassic rocks present in the WIPP region belong to the Dockum Group.

2.1.2.1 Dockum Group

The Dockum Group consists of fine-grained floodplain sediments and coarse alluvial debris of Triassic age. From a pinch-out near the center of the WIPP site it thickens eastward, forming an erosional wedge. Local subdivisions of the Dockum Group are the Santa Rosa Sandstone (Santa Rosa) and the Chinle Formation; however, only the Santa Rosa occurs in the vicinity of the WIPP site. It consists primarily of poorly sorted sandstone with conglomerate lenses and thin mudstone partings, and contains impressions and remnants of fossils. These rocks have more variegated hues than the underlying uniformly colored Dewey Lake.

2.1.3 Quaternary

Quaternary Period deposits include the Gatuña Formation (Gatuña), Mescalero Caliche (Mescalero), and surficial sediments.

2.1.3.1 Gatuña Formation, Mescalero Caliche, and Surficial Sediments

The Gatuña (Powers and Holt, 1993) is a stream-laid deposit overlying the Dockum Group in the WIPP vicinity. At the WIPP site center, the formation consists of poorly consolidated sand, gravel, and silty clay at a thickness of approximately 13 ft. The Gatuña is light red and mottled with dark stains. The unit contains abundant calcium carbonate, but is poorly cemented. Sedimentary structures are abundant (Powers and Holt, 1993, 1995).

The Mescalero is approximately 4 ft thick in the WIPP vicinity. The Mescalero is a hard, resistant soil horizon that lies beneath a cover of wind-blown sand. The horizon is petrocalcic (i.e., very strongly cemented with calcium carbonate). Petrocalcic horizons form slowly beneath a stable landscape at the average depth of infiltration of soil moisture, and indicate stability and integrity of the land surface. Many of the surface buildings at the WIPP facility are founded on top of the Mescalero.

Surficial sediments include sandy soils developed from eolian material and active dune areas. The Berino Series (a soil type) covers about 50 percent of the WIPP site and consists of deep sandy soils that developed from wind-worked material of mixed origin.

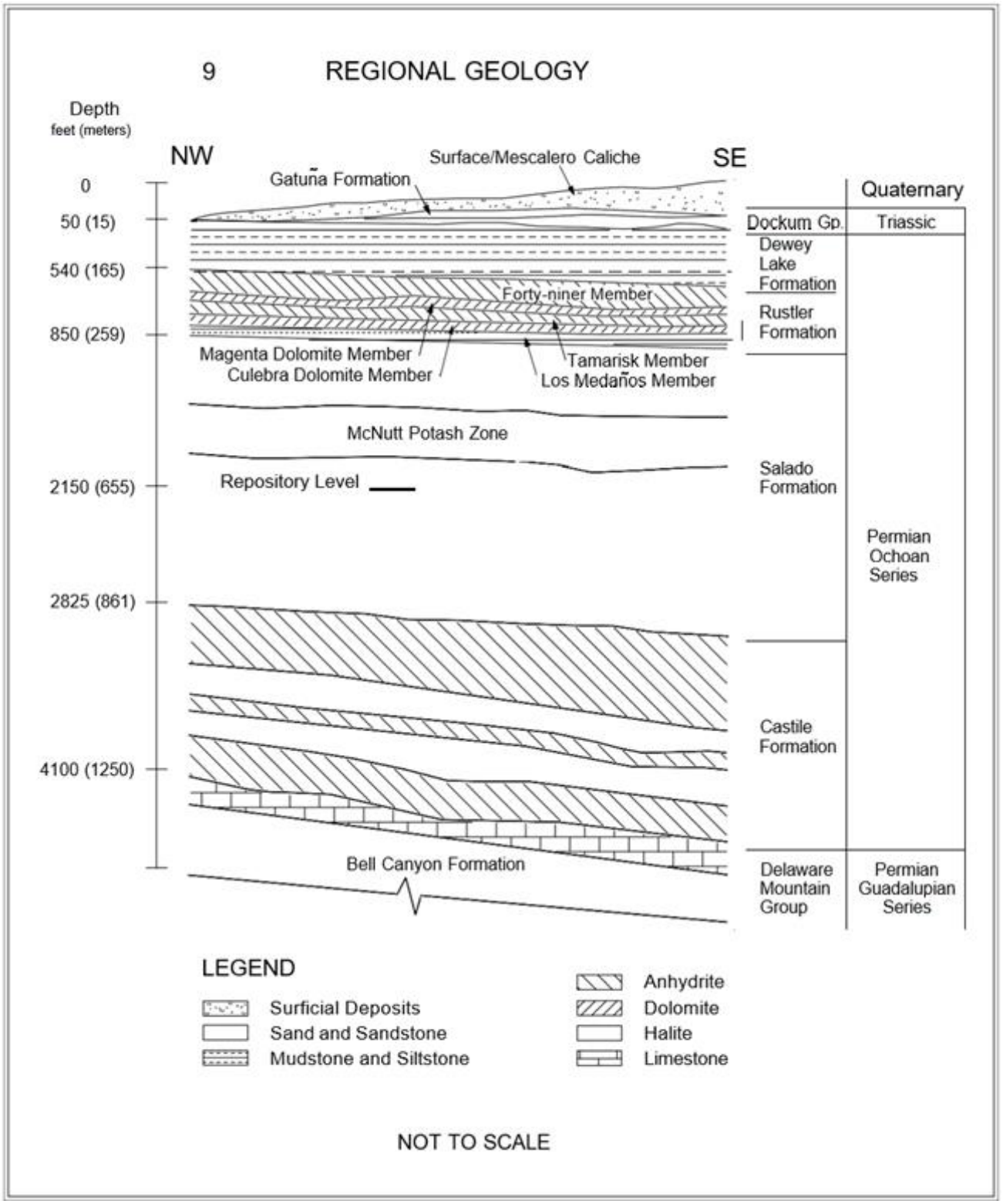

Figure 2-1 Regional Geology

2.2 Underground Facility Stratigraphy

The WIPP disposal horizon lies near the midpoint of the Salado. The Salado was deposited in a shallow saline lagoon environment, which progressed through numerous inundation and desiccation cycles that are reflected in the formation. An "ideal" cycle progresses upward as follows: a basal layer consisting predominantly of claystone, followed by a layer of sulfate, which is in turn followed by a layer of halite.
The entire sequence is capped by a bed of argillaceous (clay-rich) halite accumulated during a period of mainly subaerial exposure.

A regional system used for numbering the more significant sulfate beds within the Salado designates these beds as marker beds (MBs), counted from MB100 near the top of the formation to MB144 near the base. The repository is located between MB138 and MB139 within a sequence of laterally continuous depositional cycles as described above. Within this sequence, layers of clay and anhydrite that are locally designated (as shown) can have a significant impact on the geomechanical performance of the excavations. Clay layers provide surfaces along which slip and separation can occur, whereas anhydrites form brittle layers that do not deform plastically.

In the vicinity of the WIPP, the stratigraphy is fairly continuous and uniform. Beds generally dip toward the south-southeast at a slope of approximately 3 percent.

2.2.1 Disposal Horizon Stratigraphy of Panels 1, 2, and 7

This disposal horizon contains Panels 1, 2, and 7, the shaft areas, the shop areas, the SPDV areas (which are now closed), and the access drifts north of S-2520.
Farther south, the four main entries rise in a ramp that starts at S-2520 and ends at S2750. Panel 7 excavation was completed in January 2013. Most underground excavations are located within this disposal horizon (Figure 2-2). In it, the Orange Marker Bed (OMB) lies near the middle of the rib (i.e., the excavation wall). The OMB is a laterally consistent unit of moderate to light reddish-orange translucent halite, about 6 inches (in) thick that is used as a point of reference during excavation.

MB139 lies approximately 11.5 ft below the OMB. MB139 is a 20 to 32-in -thick layer of polyhalitic anhydrite. The top of the anhydrite undulates up to 15 in, while the bottom is sub-horizontal and is underlain by Clay E.

Above MB139, a unit of halite terminates at the base of the OMB. Within this unit, polyhalite is locally abundant and decreases upward, while argillaceous material increases upward.

Above the OMB, a thin band of argillaceous halite gives way to a thick sequence of clear halite that becomes increasingly argillaceous upward and is capped by Clay F. This constitutes a thin layer occasionally interrupted by partings and breaks and is readily visible in the upper ribs. Above Clay F, another sequence of halite begins that, as in lower sequences, becomes increasingly argillaceous upward. This sequence terminates at the Clay G/Anhydrite "b" interface, approximately 6.5 ft above the roof of most disposal horizon excavations, forming a roof beam that typically acts as a structural unit.

The roof of some disposal horizon excavations (e.g., the E-140 drift between S-1000 and S-1950) has been excavated to the upper contact of Anhydrite "b." In this case, a roof beam is formed by the next depositional sequence beginning with Anhydrite "b" and progressing upward to the Clay H/Anhydrite ’a’ interface, approximately 6.5 ft above the upper contact of Anhydrite "b."

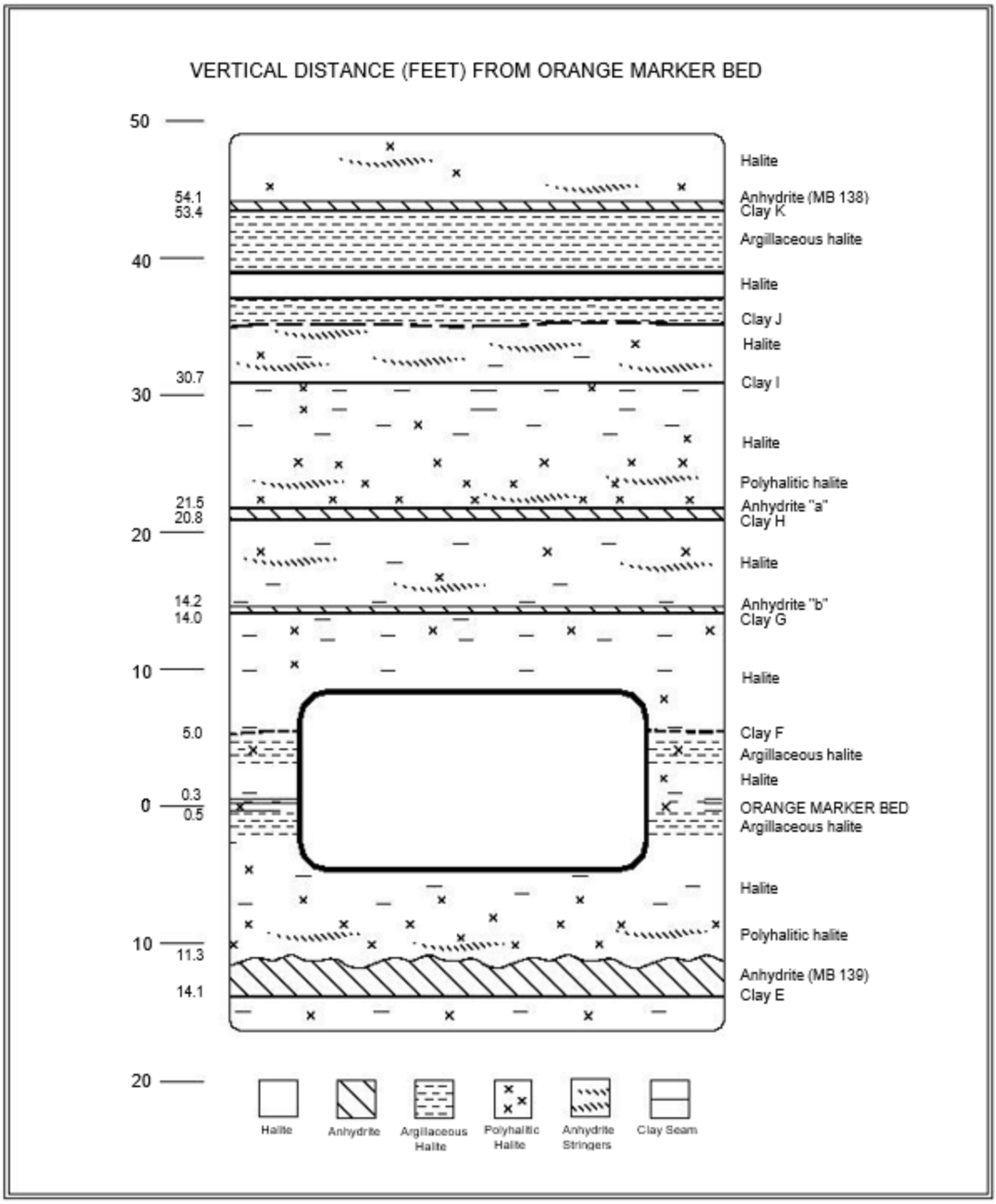

Figure 2-2 Repository Level Stratigraphy of Panels 1, 2, and 7

2.2.2 Disposal Horizon Stratigraphy of Panels 3, 4, 5, and 6

Field observations and computer modeling indicated that moving the disposal horizon stratigraphically upward (so that the roof was located at Clay G) would improve long-term ground conditions and provide a more stable roof configuration without significantly impacting repository performance. In 2000, the decision was made to implement this change by moving the mining horizon up approximately 6 ft. Subsequently, in 2000 and 2001, ramps were mined in the W-170, W-30, E-140, and E-300 drifts between S-2520 and S-2750 (Figure 1-2). As a result, the disposal horizon for Panels 3, 4, 5, and 6, and the associated connecting drifts, lie above the horizon for the other panels (Figure 2-3).

In this horizon, the OMB lies at or below the floor. MB139 lies about 12 ft below the floor. The roof lies at or slightly above Anhydrite "b." Clay G/Anhydrite "b" is used as the mining reference during excavation of this disposal horizon. Locally continuous anhydrite stringers are found within this horizon that extend to Clay H at Anhydrite “a,” generally concentrated in the lower portion toward Anhydrite "b." These effectively divide the roof beam itself into a series of thinner, independent beams, thereby weakening the overall beam strength.

2.2.3 Disposal Horizon Stratigraphy of Panel 8

Panel 8 was originally mined on the lower horizon, due to the interruption in mining. This interruption resulted in significant low angle shear and separation in the immediate back. In order to increase back stability, the back of Panel 8 has been mined to the upper horizon (Clay G / Anhydrite “b”). The floor of Panel 8 lies two feet below the OMB to reduce floor heave and movement.

2.2.4 Northeast Area Stratigraphy

The Northeast Area, formerly an experimental area, is now deactivated and closed for access. These excavations lie at a higher stratigraphic level than the disposal excavations. Floors are at Anhydrite "b." As in the lower units, the halite intervals between the clay seams/anhydrite beds contain relatively pure halite that becomes increasingly argillaceous upward. Above Clay I, two more halite intervals complete the underground facility stratigraphy. Clay J, at the top of the first of these intervals, may consist of a distinct seam or merely an argillaceous zone. Clay K tops the second interval and is overlain by MB138.4

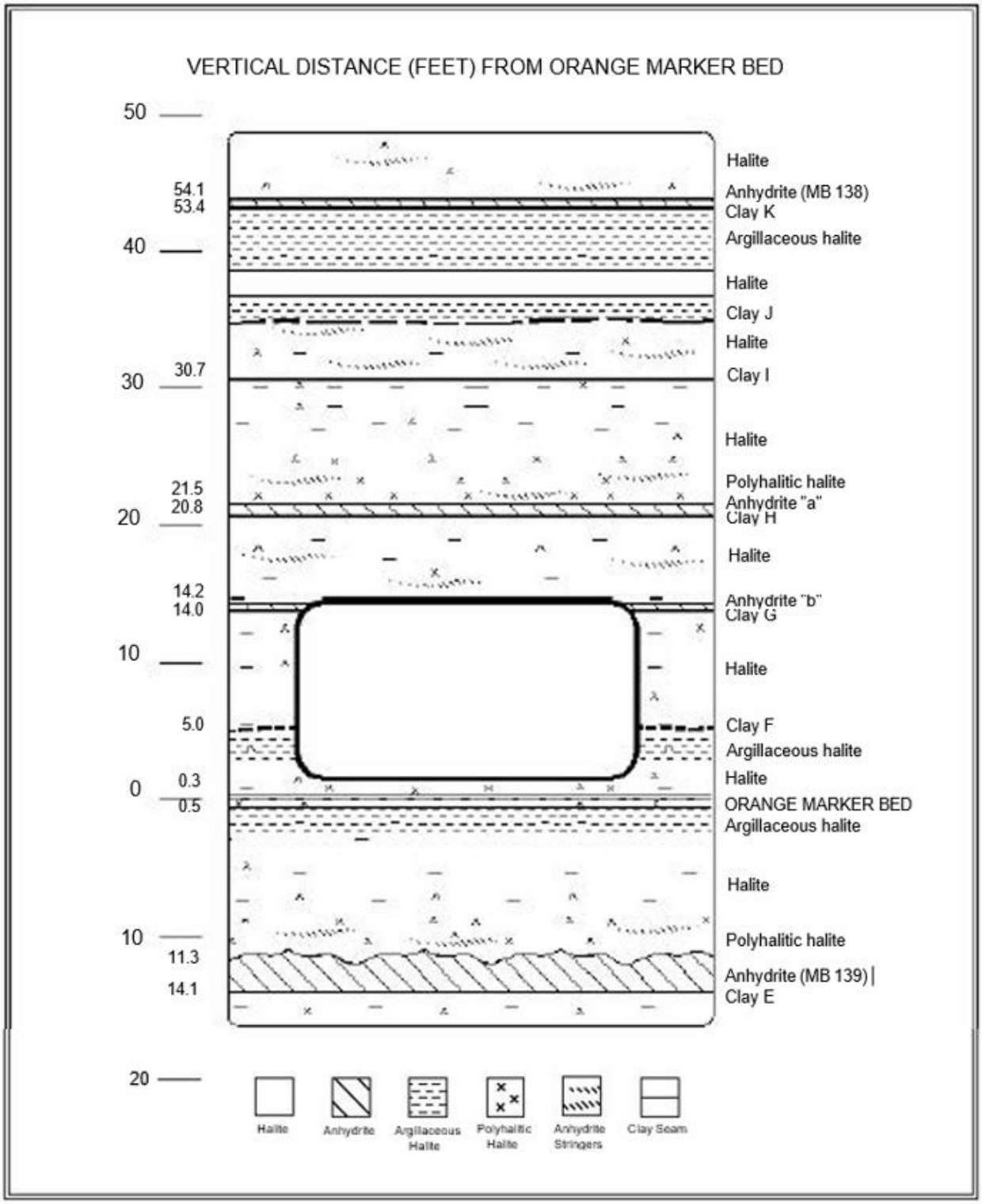

Figure 2-3 Repository Level Stratigraphy of Panels 3, 4, 5, and 6

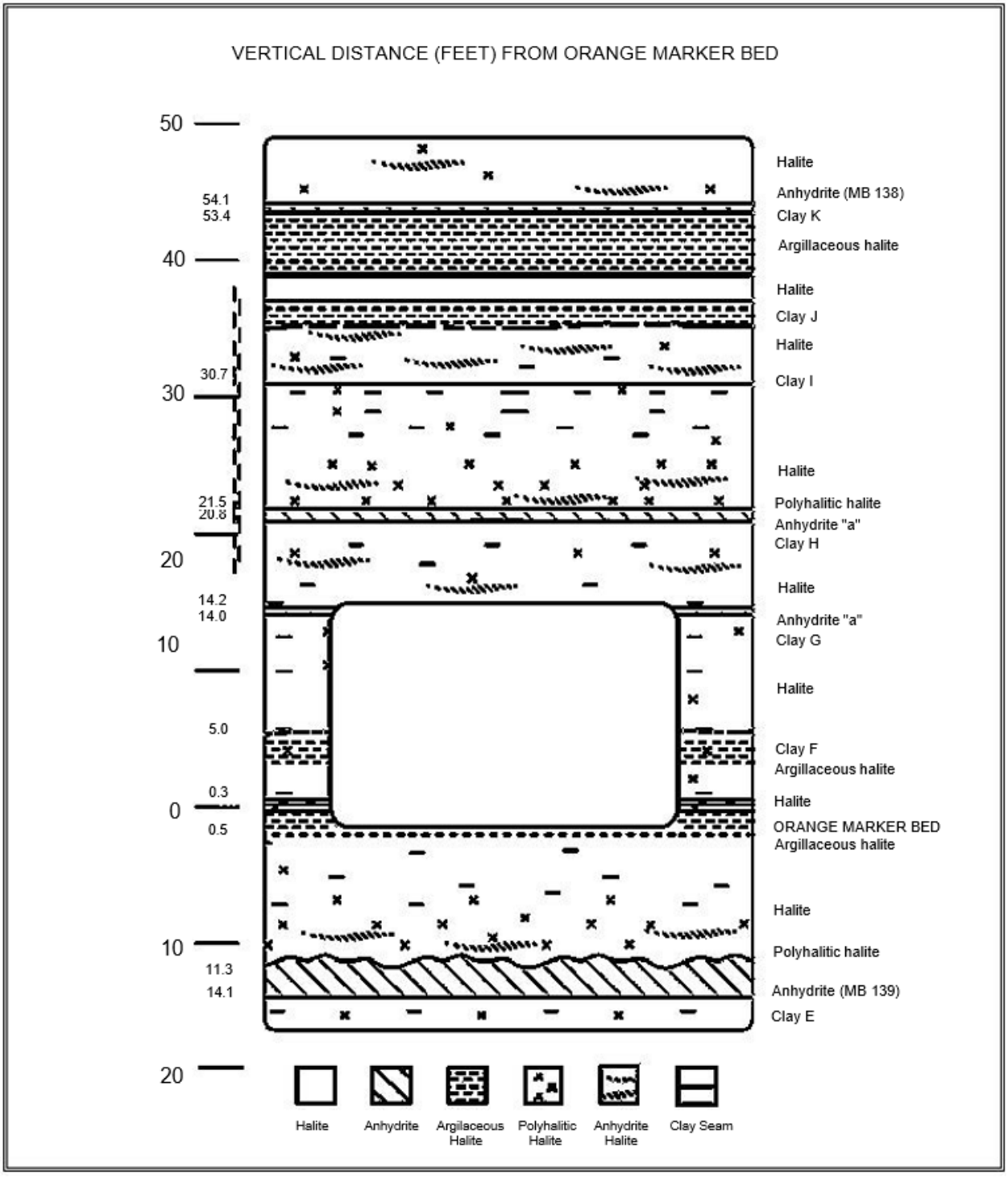

Figure 2-4 Repository Level Stratigraphy of Panel 8

3.0 PERFORMANCE OF SHAFTS AND KEYS

Four shafts connect the surface with the underground at the WIPP facility. They are the Salt Shaft, which is used primarily for removing excavated salt from the underground and for transporting personnel and materials; the Waste Shaft, which is used primarily for transporting TRU waste to the underground and for transporting personnel and materials; the Exhaust Shaft, which is used to exhaust the ventilation air from the underground; and the Air Intake Shaft, which is the primary source of fresh air ventilation to the underground. This section describes the geomechanical performance of these shafts.

Although much of the instrumentation installed in the shafts has failed through the years, there are no plans to replace it. Information on each failed instrument is still available to view in Section 3.1.2. The DOE has a good understanding of the expected movements in the shafts. Monitoring results up to the point of instrument failure did not indicate unusual shaft movements or displacements. Continued periodic visual inspections confirm the expected shaft performance and provide necessary observations to evaluate shaft performance. Replacement of failed instrumentation will not provide significant additional information.

3.1 Salt Shaft

The first construction activity undertaken during the SPDV Program was the excavation of the Exploratory Shaft. This shaft was subsequently referred to as the Construction and Salt Shaft, and is currently designated the Salt Shaft (see Figure 1-2). The shaft was drilled from July 4, to October 24, 1981, and geologically mapped in the spring of 1982 (DOE, 1983). Figure 3-1 presents the stratigraphy in the shaft.

The Salt Shaft is lined from the surface to 846 ft with steel casing having an inside diameter of 10 ft. The thickness of the steel liner (including external stiffener rings) increases from 0.62 in at the top to 1.5 in at the key (location of the transition between the Rustler and Salado). Cement grout was placed between the liner and the rock face. The 10-ft -diameter steel liner extends through the concrete shaft key to 880 ft. The shaft key is a 37.5-ft -long, reinforced concrete structure that begins 3.5 ft above the bottom of the steel liner. From the key to the bottom at 2,298 ft, the shaft has a nominal diameter of 12 ft.

Wire mesh anchored by rock bolts is installed in sections of the lower shaft as a safety screen to contain rock fragments that may become detached. The shaft extends approximately 140 ft below the repository horizon in order to accommodate the skip loading equipment and a sump. The Salt Shaft Pocket loading facility was evaluated and determined to need improvements. Bids were submitted at the end of the reporting period to develop a design to support the removal of the existing salt pocket steel structure and equipment, to relieve the salt pocket rib convergence, and re-establish it to its original design dimensions.

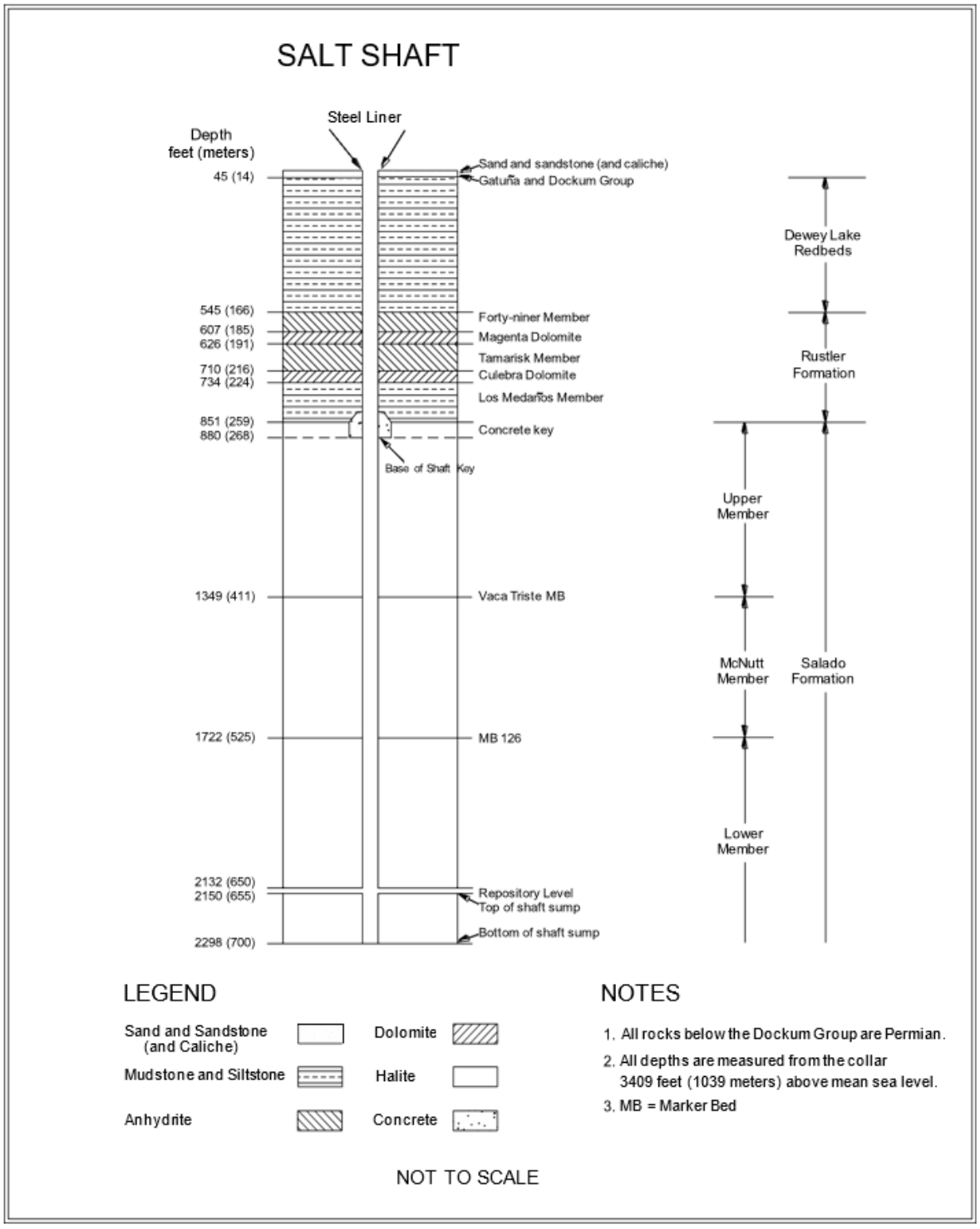

Figure 3-1 Salt Shaft Stratigraphy

3.1.1 Shaft Observations

Underground operations personnel conduct weekly visual inspections. These inspections are performed principally to assess the condition of the hoisting and mechanical systems, but they also include examining the shaft walls for water seepage, loose rock, or sloughing. Visual inspections during this reporting period found that the shaft remains in satisfactory condition. Only routine ground control activities were required.

3.1.2 Instrumentation

Geomechanical instruments (radial convergence points, extensometers, and piezometers) were installed at various levels in the shaft from April through July 1982 (Figures 3-2 and 3-3). Instruments in the shaft key included strain gauges, pressure cells, and piezometers. Radial convergence points were installed prior to outfitting. Upon completion of shaft outfitting, no more readings were taken.

Six piezometers continue to provide data. Due to age related instrumentation degradation and unreliability in provided data, the array of piezometers in the Salt Shaft is considered a legacy system.

Four Earth pressure cells were installed in the key section during concrete emplacement at the 860-ft level. These instruments measure the normal stress between the concrete key and the Salado as salt creep loads up the key structure.
After readings resumed in 03/2021, two Earth pressure cells continue to provide data. Both instruments indicate essentially no contact pressure since installation. This is most likely due to an installation problem.

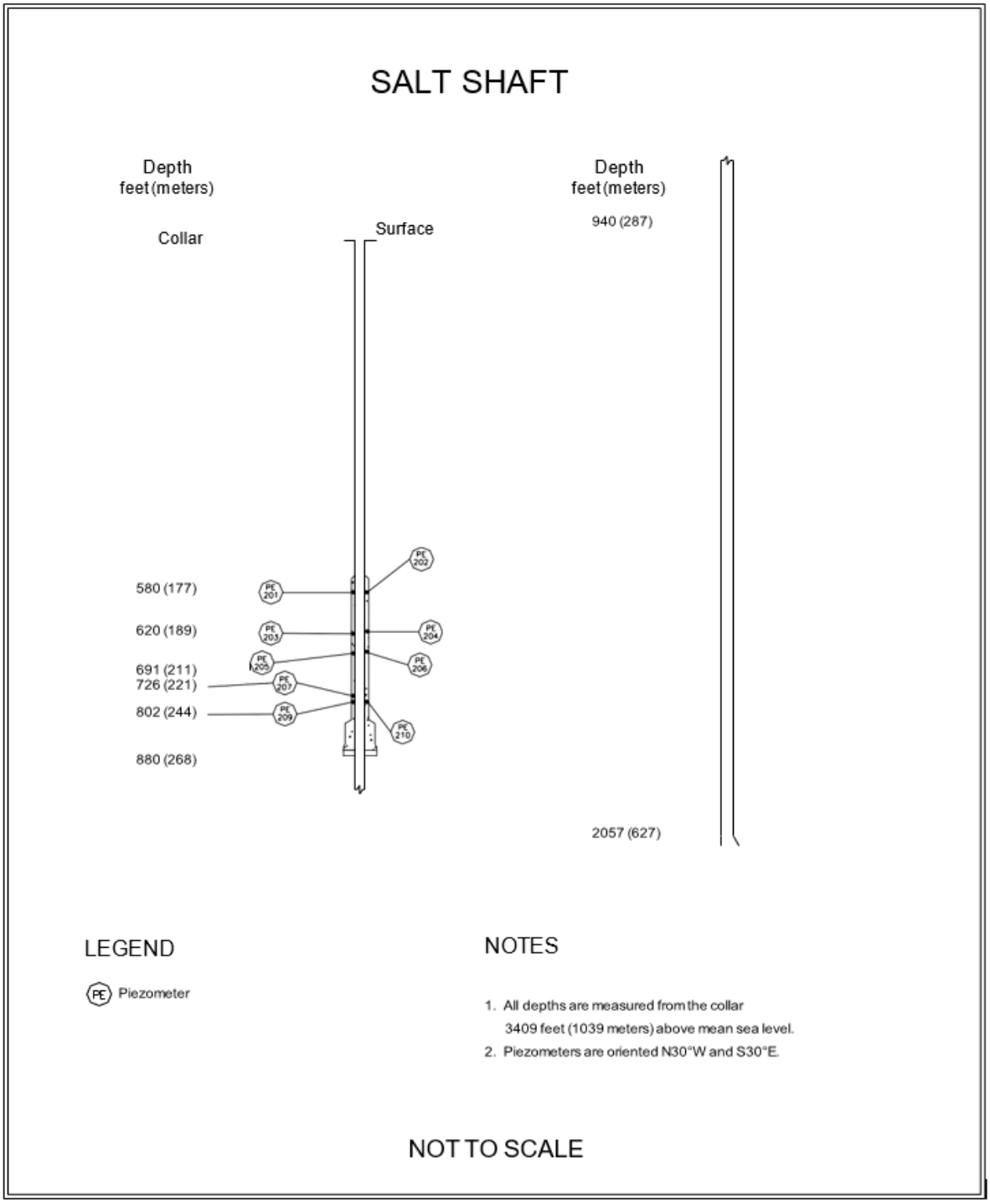

Figure 3-2 Salt Shaft Piezometer Locations

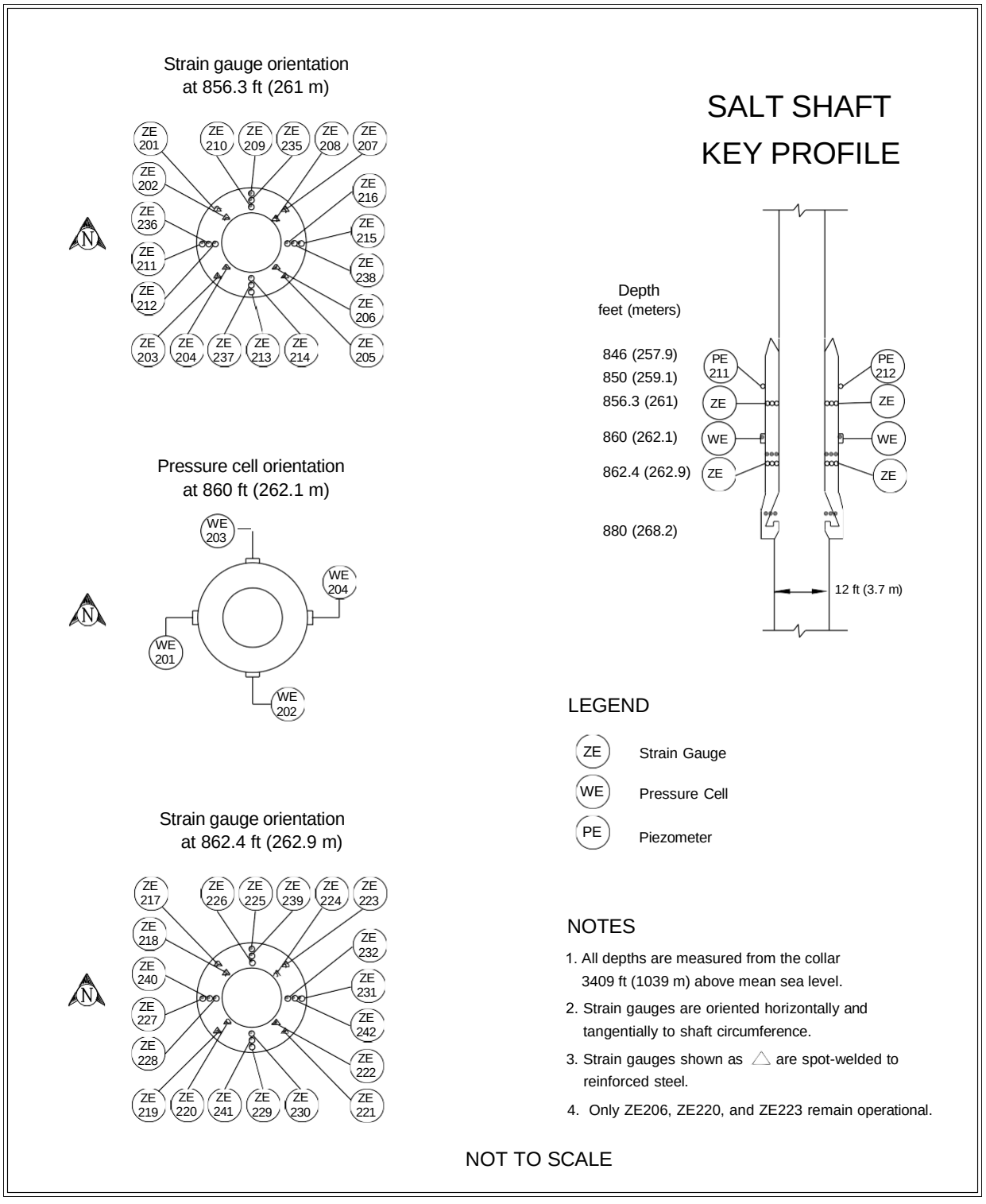

Figure 3-3 Salt Shaft Key Instrumentation Locations

Sixteen spot-welded and 24 embedment strain gauges were installed on and in the shaft key concrete at both the 856.3-ft (261-m) level and at the 862.4-ft (263-m) level. One spot-welded strain gauge is still functioning at the 856.3-ft (261-m) level.
The maximum strain this period is 683 microstrain and the maximum for the 2020-2021 reporting period was 663 microstrain.

Nineteen embedment strain gauges are still functioning. The strains of the nineteen embedment strain gauges located at the 856.3-ft (261-m) level ranged from -674 to 1005 microstrain. The strains from the six embedment strain gauges at the 862.4-ft (263-m) level were 45 to 3704 microstrain. The strain recorded by the spot-welded strain gauge and the embedment strain gauges during this reporting period are similar to the strains recorded by these instruments at the end of the previous reporting period.

3.2 Waste Shaft

As part of the SPDV Program, a 6-ft (2-m)-diameter ventilation shaft, now referred to as the Waste Shaft, was excavated from December 1981 through February 1982 (see Figure 1-2). This shaft and the Salt Shaft created a two-shaft underground air circulation system. From October 11, 1983, to June 11, 1984, the shaft was enlarged to a diameter of 20 to 23 ft and lined above the key. Stratigraphic mapping (Figure 3-4) was conducted during shaft enlargement from December 9, 1983, to June 5, 1984 (Holt and Powers, 1984).

The Waste Shaft is lined with non-reinforced concrete having a 19-ft inner diameter from the surface to the top of the key at 837 ft. Liner thickness increases from 10 in at the surface to 20 in at the key. The key is 63 ft long and 4.25 ft thick, and is constructed of reinforced concrete. The bottom of the key is 900 ft and increases to 23 ft just above the shaft station. The shaft below the key is lined with wire mesh anchored by rock bolts. The diameter of 23 ft extends to a depth of approximately 2,286 ft, with the shaft sump comprising the lower 119 ft of that interval.

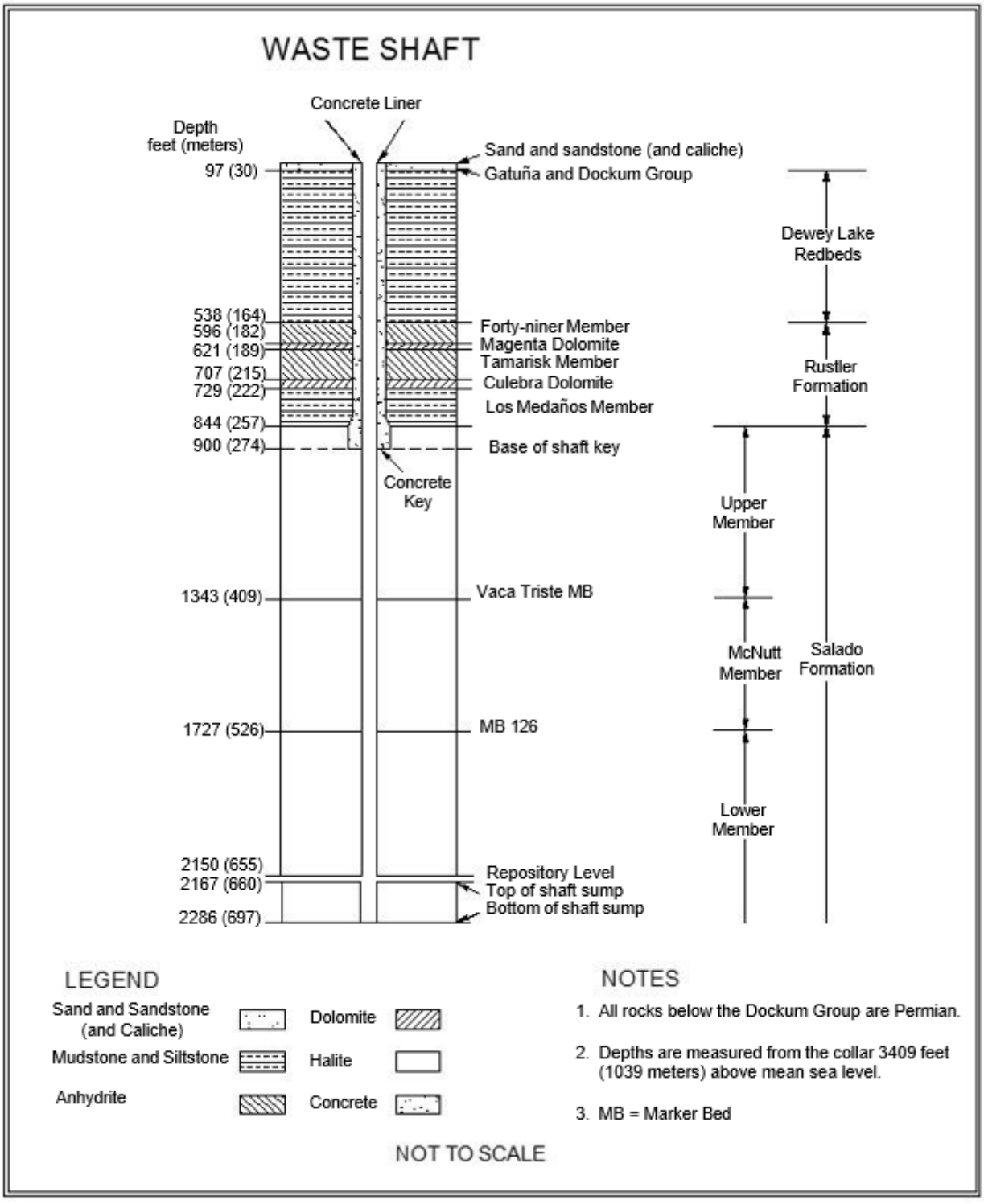

Figure 3-4 Waste Shaft Stratigraphy

3.2.1 Shaft Observations

Underground operations personnel conduct weekly visual inspections, principally to assess the condition of the hoisting and mechanical systems, but also to examine the shaft walls for water seepage, loose rock, or sloughing. The visual inspections found that the shaft was in satisfactory condition. No ground control activities other than routine maintenance were required.

3.2.2 Instrumentation

Radial convergence points, extensometers, piezometers, and earth pressure cells were installed in the Waste Shaft between August 27, and September 10, 1984. Radial convergence points were installed prior to the outfitting. Upon completion of shaft outfitting, no more radial convergence readings were taken. Figure 3-5 and Figure 3-6 show the instrument locations.

Nine multi-position extensometers were installed in arrays 1,071 ft, 1,566 ft, and 2,059 ft below the surface, as shown in Figure 3-5. Each array consists of three extensometers. No extensometer data have been collected in recent years due to the malfunction of the data acquisition equipment. Since the extensometer type installed in the shaft over 30 years ago is no longer manufactured, remote data acquisition equipment for these extensometers is also unavailable.

Twelve piezometers were installed in the lined section of the Waste Shaft on September 7 and 8, 1984, to monitor fluid pressure behind the shaft liner and the key section. As of this reporting period, data is no longer being received from any of the piezometers.

Four Earth pressure cells were installed in the key section of the Waste Shaft during concrete emplacement, which occurred between March 23 and April 3, 1984. Earth pressure cells measure the normal stress between the concrete key and the Salado Formation as salt creep loads the key structure. As of this reporting period, data is no longer being received from any of the Earth pressure cells.

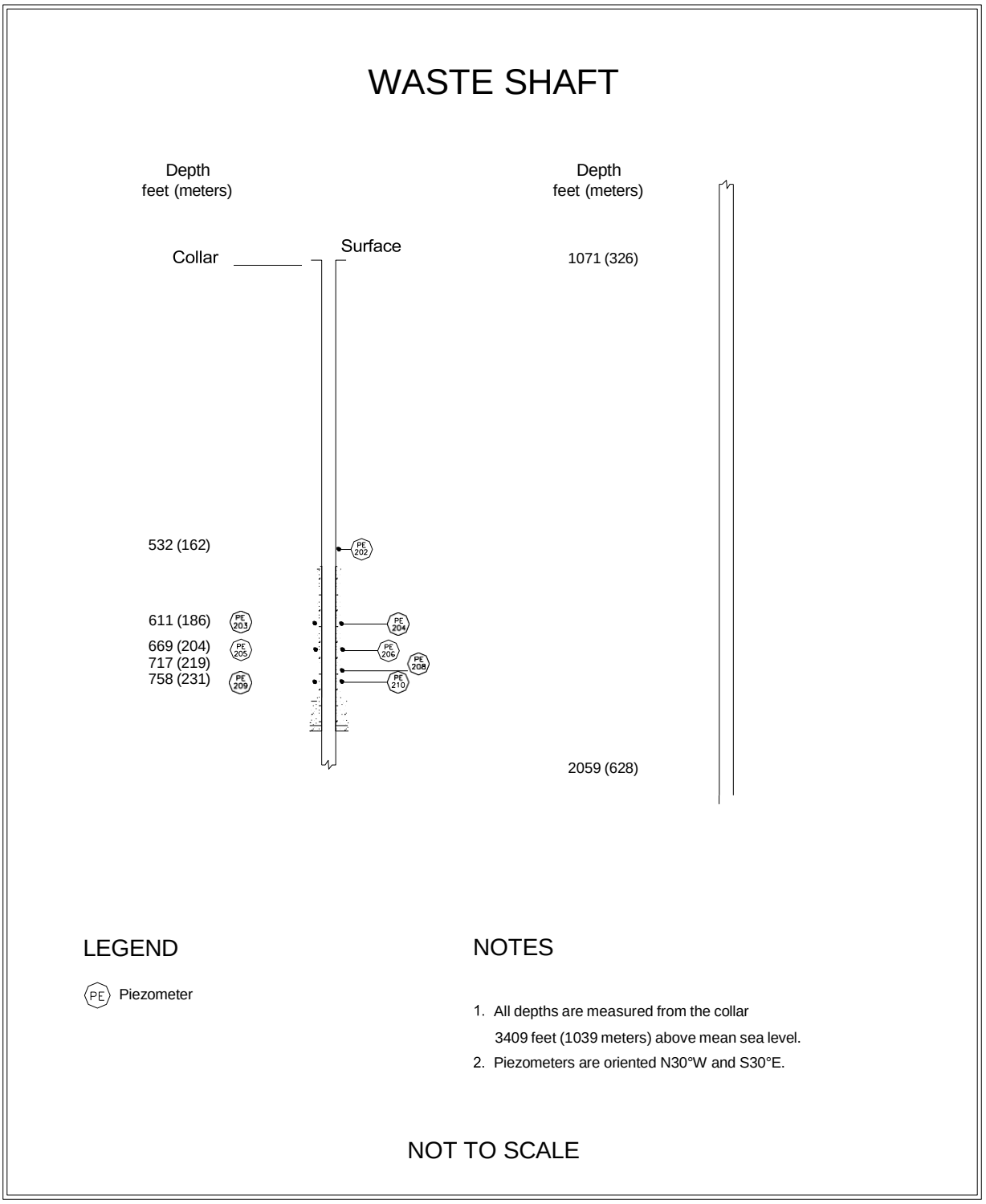

Figure 3-5 Waste Shaft Piezometer Locations

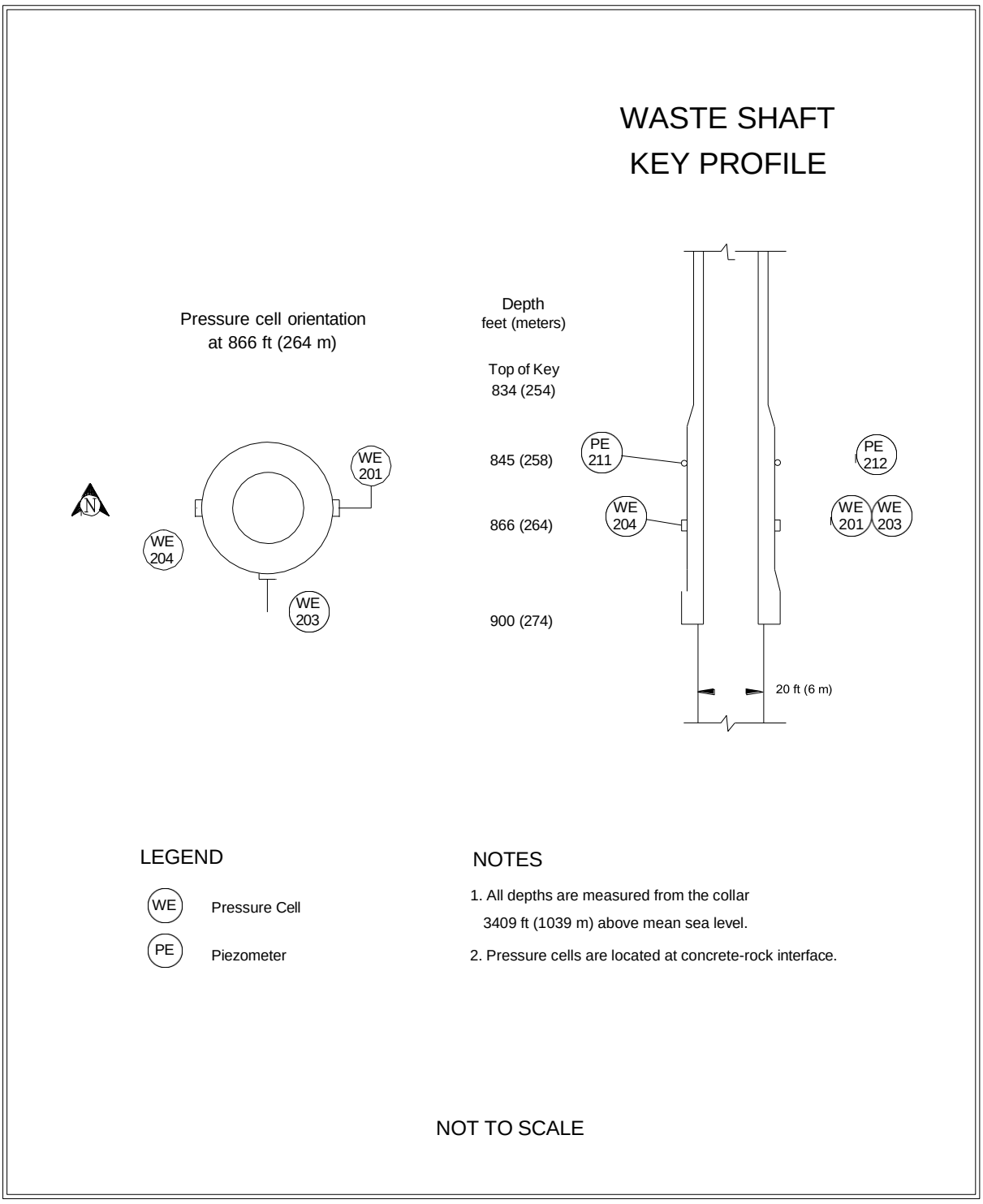

Figure 3-6 Waste Shaft Key Instrumentation Locations

3.3 Exhaust Shaft

The Exhaust Shaft was drilled from September 22, 1983, to November 29, 1984, to establish a route from the underground to the surface for exhaust air (Figure 1-2). Stratigraphic mapping was conducted from July 16, 1984, to January 18, 1985 (DOE, 1986). Figure 3-7 illustrates the shaft stratigraphy.

The Exhaust Shaft is lined with non-reinforced concrete from the surface to the top of the shaft key at 844 ft. The liner thickness increases from 10 to 16 in over that interval. The key is 63 ft long and 3.5 ft thick. The shaft diameter below the key is 15 ft, and the interval below the key is lined with wire mesh anchored by rock bolts. The shaft terminates at the facility horizon, approximately 2,150 ft deep. This shaft has no sump.

3.3.1 Quarterly Exhaust Shaft Inspection

Quarterly video inspections of the Exhaust Shaft are conducted according to approved WIPP procedures. Inspections are performed to evaluate the condition and to verify the integrity of the shaft. The shaft is examined for cracks, corrosion, salt buildup, seeps, and debris. In addition, inspections examine the condition of anchors, brackets, and down-hole equipment. Exhaust Shaft video inspections were performed this reporting period in August 2021, November 2021, March 2022, and June 2022.

3.3.1.1 Video Camera

Video inspections use a custom-designed, vertical-drop color camera in an aerodynamic housing, with pan, tilt, and zoom capability. The camera is suspended by a dual-armored cable. The cable contains five copper conductors and two multi-mode optical fibers. It is reeled out by a winch mounted in a control trailer. Inspections are recorded electronically. During the reporting period, video recording and streaming features were lost on the camera system. An alternative camera was engineered to attach onto the original camera housing and will be used until a new camera system arrives. The quality of the images from the alternative camera were of better quality than the original and more than adequate. The new camera system is anticipated to arrive in the summer of 2023.

3.3.1.2 Shaft Inspection Observations

Quarterly video inspection observations concentrate on four major areas: air-monitoring components, shaft liner, shaft walls, and equipment support and cabling. The air-monitoring components consist of one tube that provides a conduit for air-velocity measurements, and three tubes for monitoring possible radionuclides within the exhaust air stream, as shown in Figure 3-8. The video inspection includes examination of each device, including the transport assembly, guide tubes, the sample intake, and the support brackets that extend from Station "A" above the shaft to the shaft collar. Air-monitoring components extend from the collar 21 ft into the shaft. Video inspections indicate that the air-sampling components can accumulate salt buildup of up to several inches thick.

The Exhaust Shaft liner is examined for cracks, seepage, and general shaft stability. Currently, there are three principal zones of seepage in the shaft. The first is about 50 to 55 ft below the shaft collar (bsc), the second is about 60 to 65 ft bsc, and the third is about 80 to 85 ft bsc, as shown in Figure 3-9. Monitoring of seepage horizons started before 1995. Water entering the shaft through these cracks originated from a perched-shallow-water-bearing horizon at the base of the Santa Rosa. The fluid level in the Santa Rosa near the shaft is about 48 to 49 ft below the surface.
Based on examination of inspection videos, the flow rate into the shaft has been estimated to be about 1 to 1.5 gallons per minute. Seepage cracks are confined primarily to the eastern side of the shaft wall. It has been observed that flow of seepage varies seasonally.

When fluid was detected seeping into the shaft, a catch basin was designed and installed at the base of the Exhaust Shaft to intercept water and prevent it from draining into the Waste Shaft sump. Fluid was removed from the catch basin from March 1996 through October 2005, as needed. The catch basin was damaged in 2004 by fallen debris, either salt or instrumentation cables or both. A new catch basin was fabricated and installed in December 2004. This basin was damaged in August 2005, most likely the result of fallen debris. An interception well system was installed between November 2005 and March 2006 to replace the catch basin. Interception wells were drilled geologically down gradient in S-400 between E-140 and E-300 (Figure 3-10). The interception well system initially consisted of four 30-ft-deep 9-7/8-in-diameter fluid collection holes with a submersible pump and pressure transducer in each. Fluid was pumped from each hole to a series of storage containers in S-550. A data-acquisition system monitors the fluid level in each hole, turning the pump on and off between set limits, as needed.

Between February 2, and 6, 2008, two additional fluid collection wells, OH631 and OH632, were drilled in S-400 to improve the total volume of fluid recovered by the interception well system. They replaced OH613 and OH614, which generated little fluid. As with the previous four wells, the additional wells were drilled at 9-7/8-in diameter to a total depth of 30 ft. Pumps were pulled from OH613 and OH614 and installed in OH631 and OH632. Figure 3-10 shows the location of the interception well system.

The catch basin and the interception well system collected fluid from July 1997 through June 2006 and from July 2006 through June 2016, respectively. The largest reported volumes are typically associated with periods of reduced ventilation and increased humidity. For a discussion of the factors affecting the quantity of fluid produced in the Exhaust Shaft, refer to DOE/WIPP-00-2000, Brine Generation Study (DOE, 2000).

No fluid has been collected by the system since June 2016. The reason for this is the S550 location, which was the location of the three water interception 500-gallon storage tanks and associated equipment was deemed a safe-haven location, that is, two safe-havens were to be located in S550 alcove. Work commenced in August 2016 to dismantle the water interception equipment in S550 and install the equipment in the smaller S300 alcove. Due to space constraints, the three 500-gallon tanks were replaced with two 250-gallon tanks. This work continued until November 2016.

The Mining and Geotechnical Engineering (M&GE) section were the designers, installers and technical overseers of the water-interception system from the inception. In November 2016, with almost all of the reinstallation complete, all work on the reinstallation and startup of the relocated system was suspended due to serious, and somewhat prolonged ground control issues in Panel 7. Since August 2022 a restart of the system is ongoing. Work orders, procurements, and an Engineering Change Notice have been prepared and submitted; parts have been received. As of this writing, the Work Control document to accomplish the restoration of electrical power to 2 of the 4 interception well pumps is being prepared.

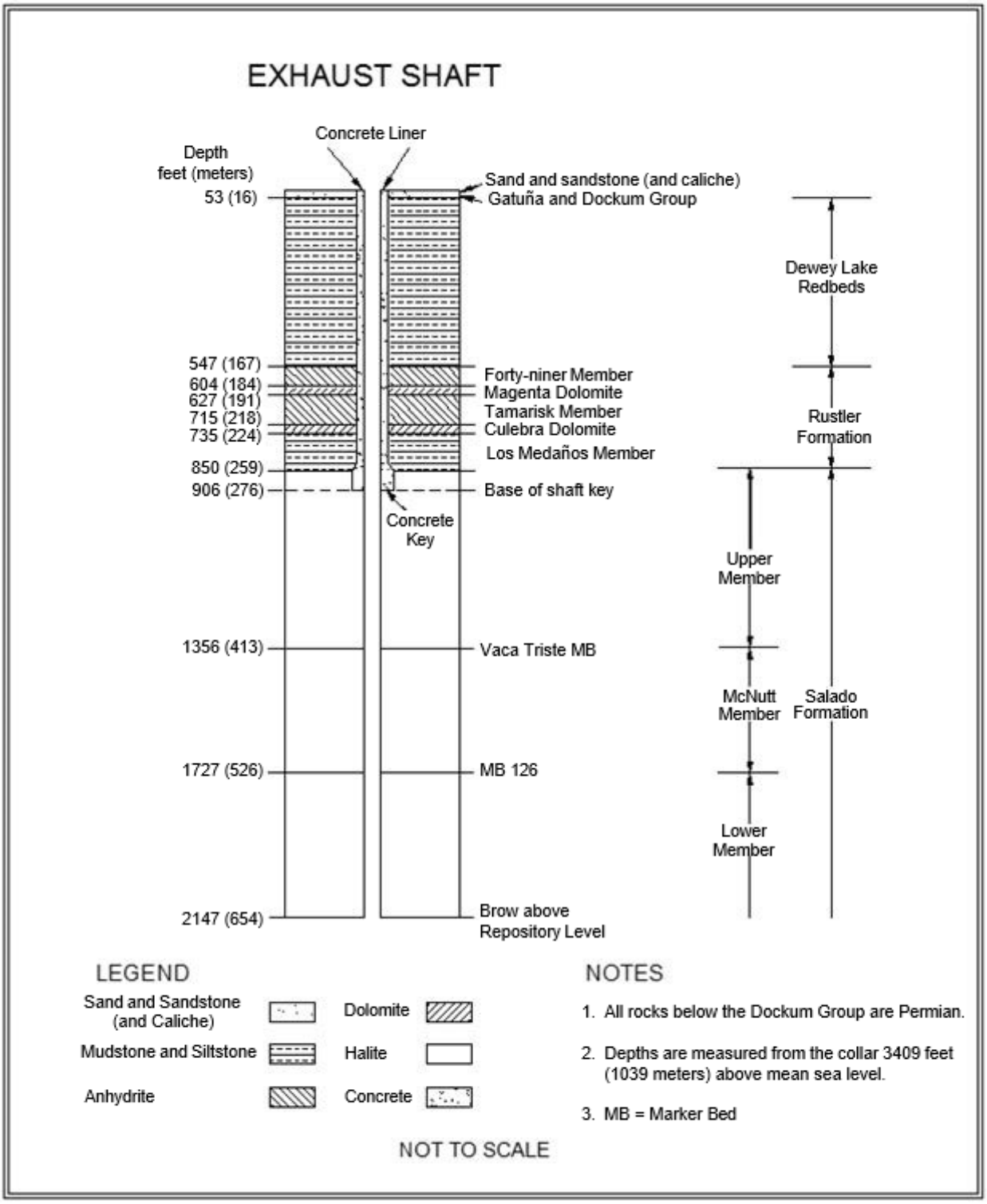

Figure 3-7 Exhaust Shaft Stratigraphy

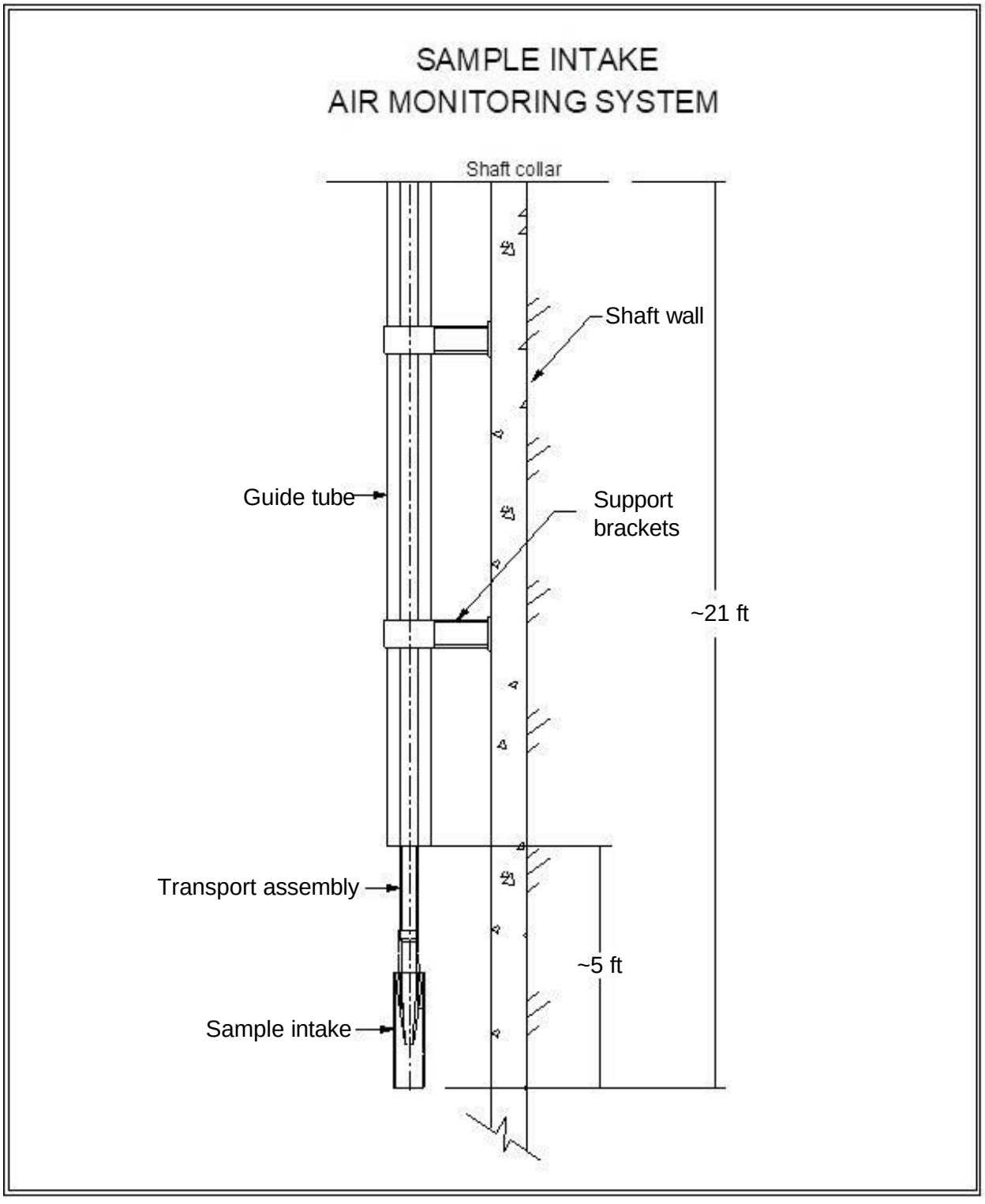

Figure 3-8 Sample Intake of Exhaust Shaft Air Monitoring System

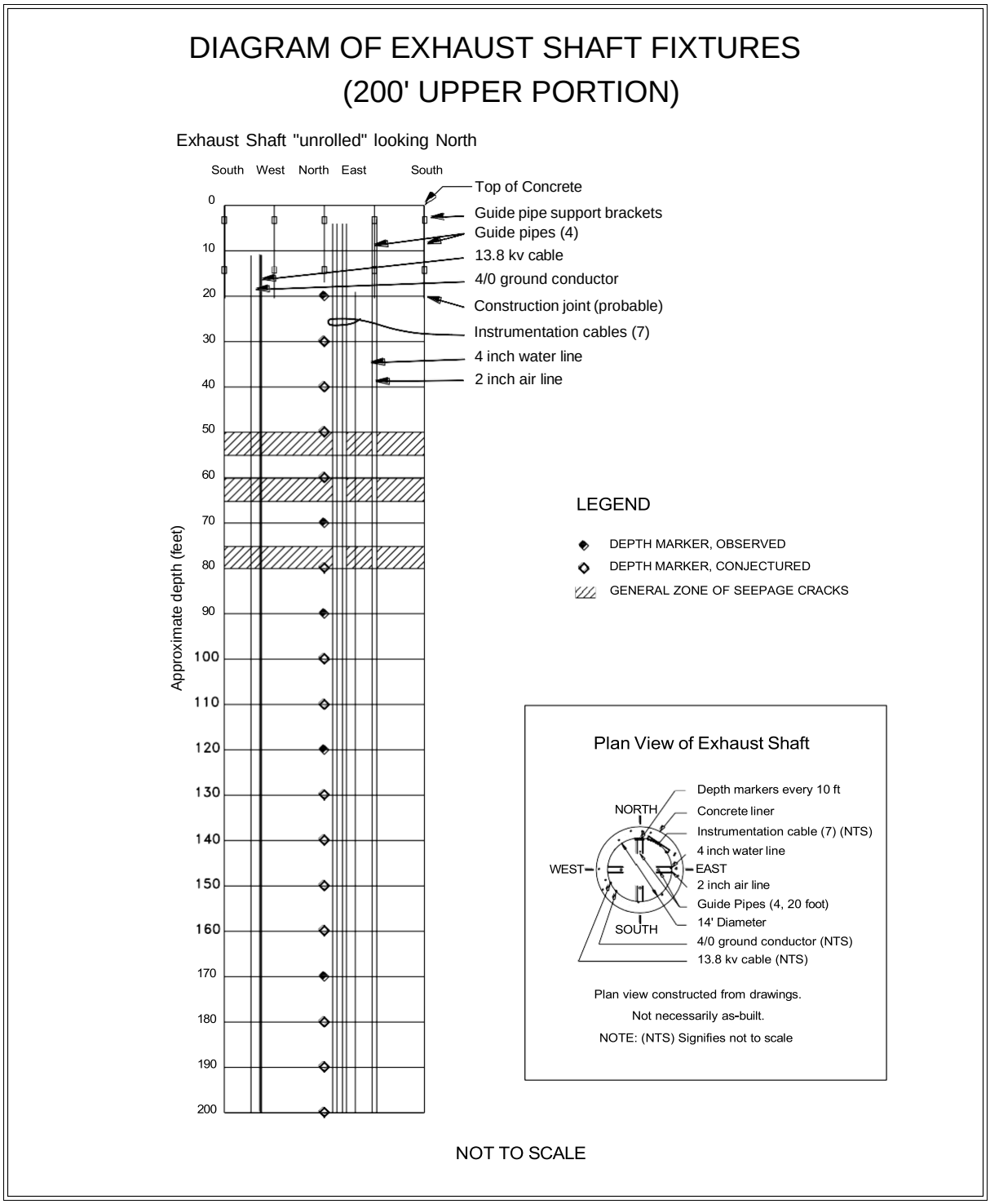

Figure 3-9 Diagram of Exhaust Shaft Fixtures and Seepage Zones (Upper 200 ft)

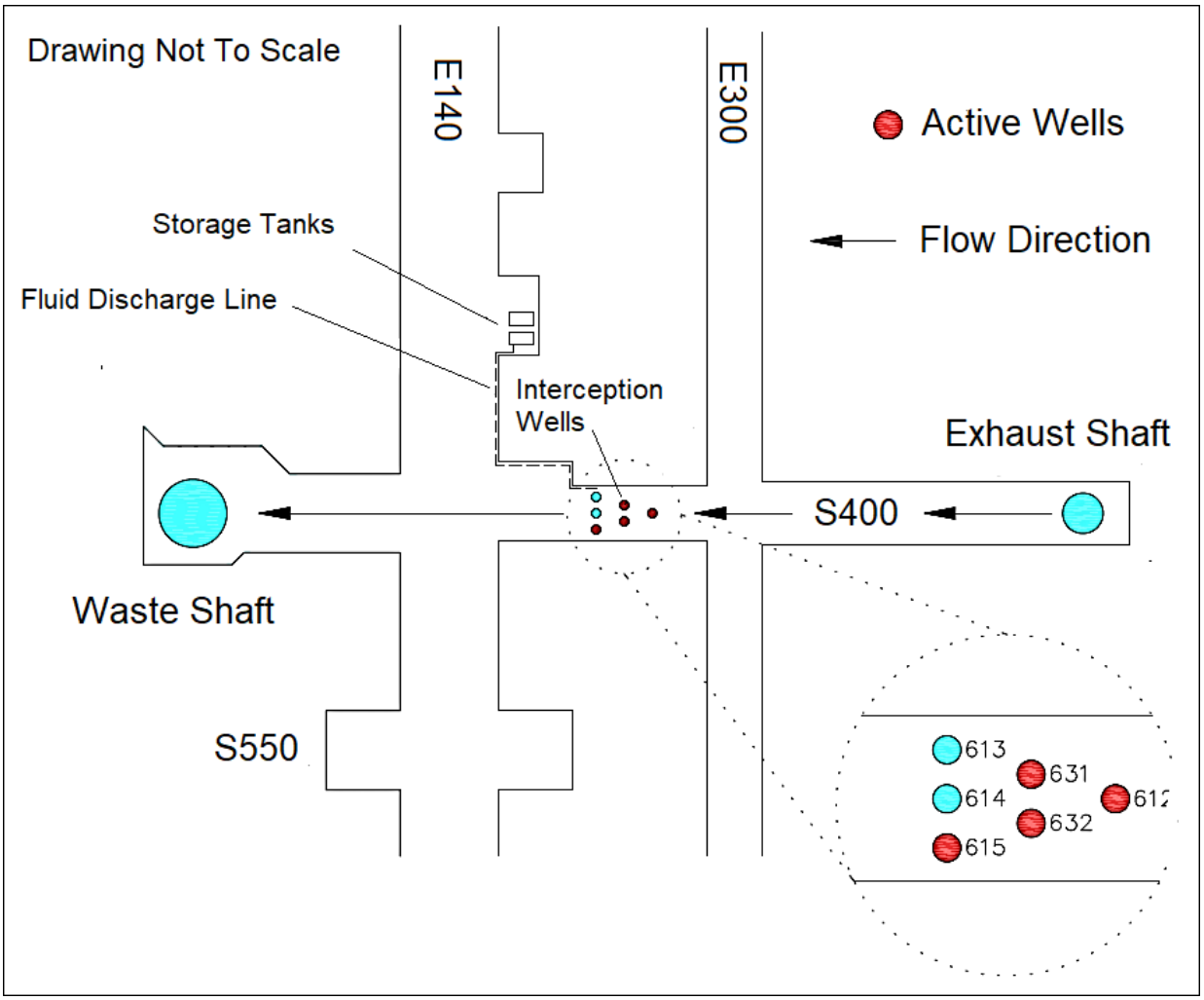

Figure 3-10 Location of Interception Wells and Storage Tanks

The shaft walls were examined for salt buildup, cracks, moisture, and encrustations, with particular attention paid to power cables, instrument cables, air and water lines, and the three water rings occurring at the base of the Magenta and Culebra and at the bottom of the shaft key. The condition of the shaft wall with respect to salt buildup varies depending on airflow, humidity, temperature, and underground mining activities. The shaft conditions for this reporting period largely mirror the conditions during the previous reporting period. There were no significant changes in the thickness of the salt in the shaft plenum, ranging from zero to several feet thick. The principle seepage in the shaft liner this period was located at about 60-65 ft and 80-85 ft bsc. At the same time, there continues to be an increase in the buildup of salt along the shaft walls in the form of stalactites in the lower portion of the shaft.

Similar to previous inspections, sporadic salt buildup continues on the remaining cables in the shaft. The long-term implication of salt buildup is increased loading on cables and cable hangers, accompanied by intermittent falling of debris. The 4-in compressed air line and the 2-in water line extend from the surface to the bottom of the shaft. At

present, neither line is being used. The integrity of the brackets holding the air and water lines continues to be essentially impossible to assess because of salt buildup. Many instrumentation cables and much of the abandoned 13.8 kilovolt ampere(s) (kVA) power cables have broken off and fallen to the base of the shaft. There are no visible signs of dissolution of the salt below the key.

3.3.2 Instrumentation

The Exhaust Shaft was equipped with geomechanical instrumentation in two stages. Earth pressure cells were installed behind the liner key in November 1984. Piezometers and nine multi-position extensometers were installed during November and December 1985. Figure 3-11 and Figure 3-12 show the instrument locations. None of these instruments currently provide data. Due to inaccessibility to the inside of the shaft, the failed instrumentation and associated cabling cannot be replaced.

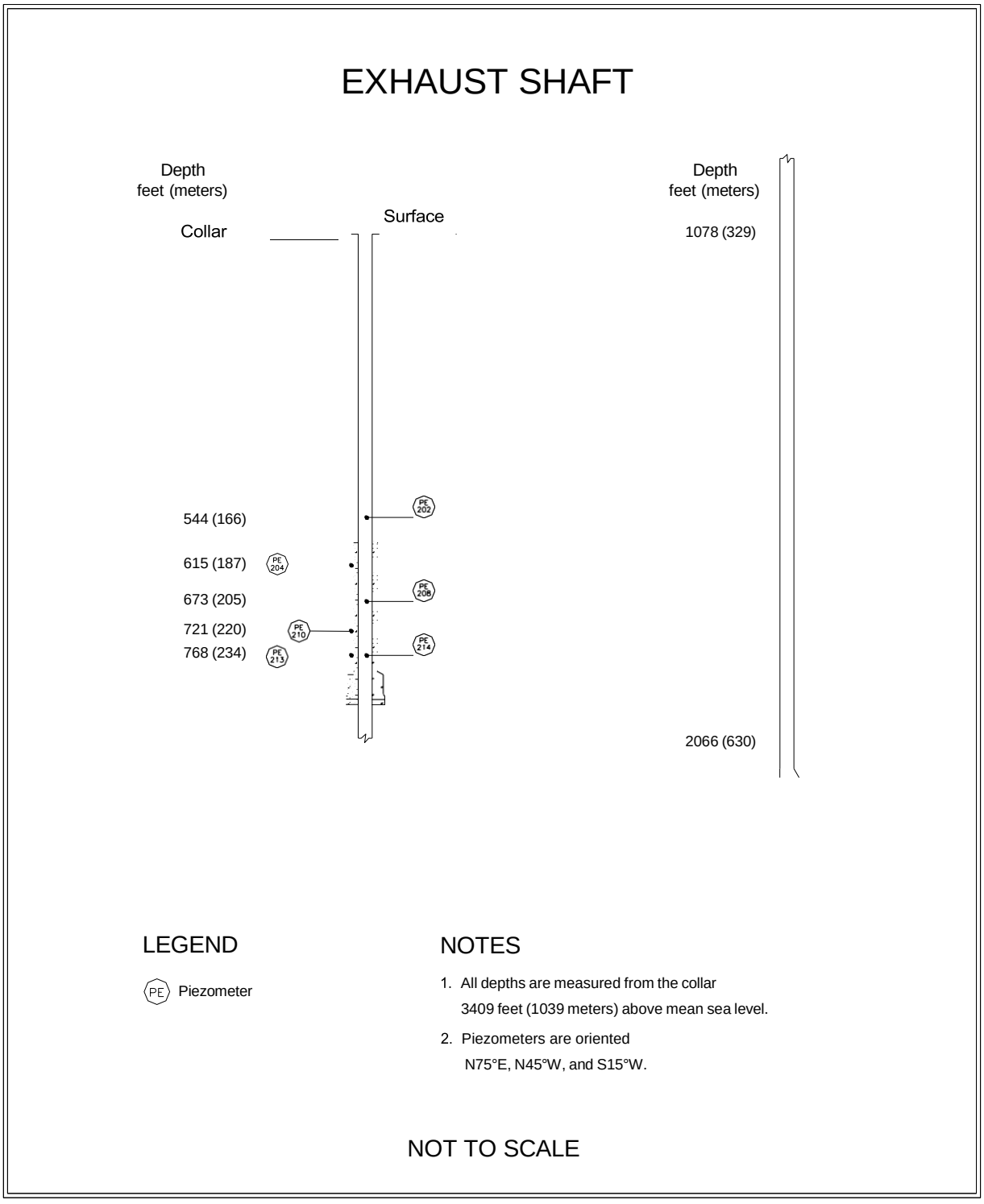

Figure 3-11 Exhaust Shaft Instrumentation

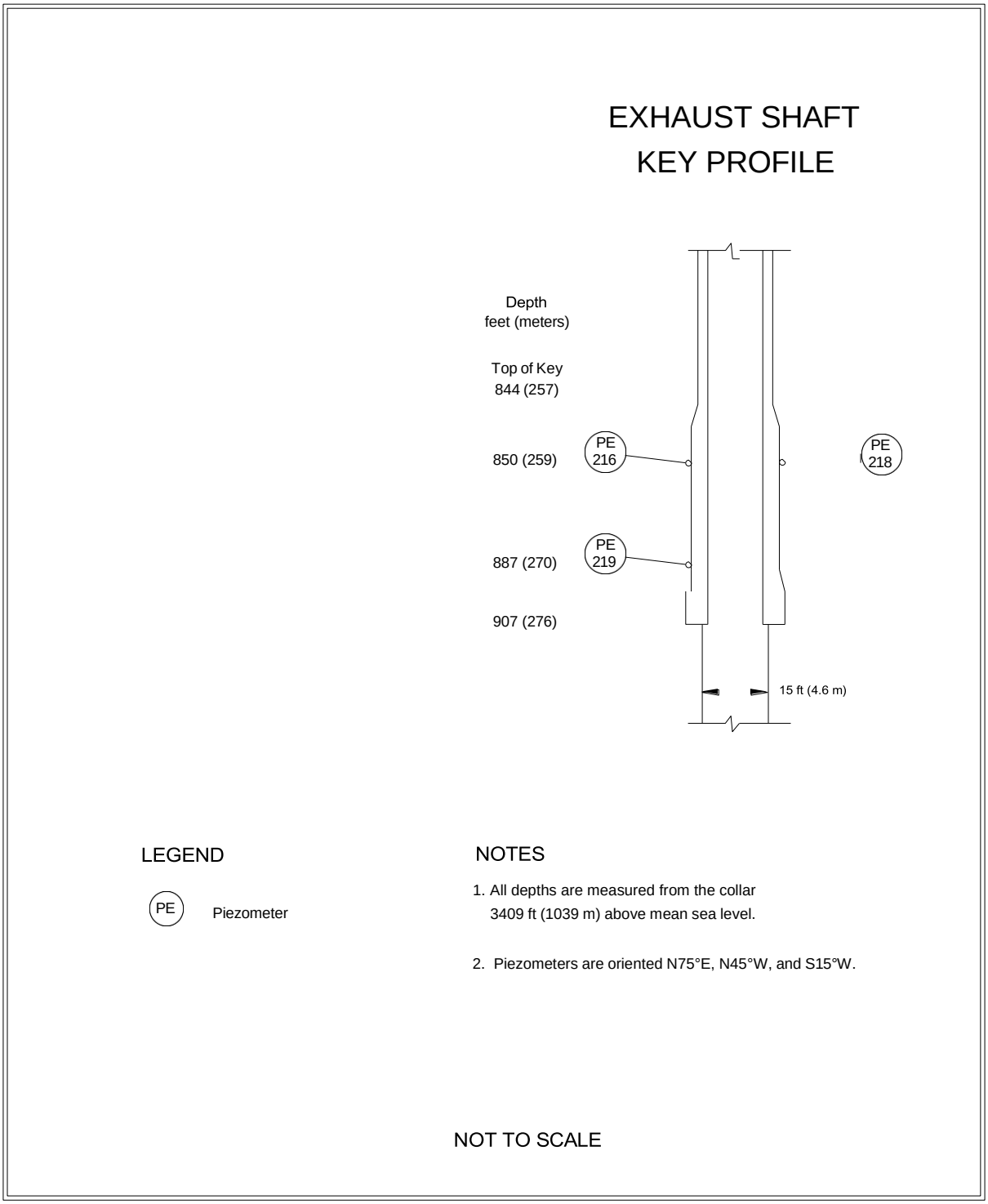

Figure 3-12 Exhaust Shaft Key Instrumentation

3.4 Air Intake Shaft

The Air Intake Shaft was drilled from December 4, 1987, to August 31, 1988, to establish a primary route for surface air to enter the repository (see Figure 1-2). The stratigraphy was mapped from September 14, 1988, to November 14, 1989 (Holt and Powers, 1990). Figure 3-14 summarizes the shaft stratigraphy.

The Air Intake Shaft is lined with non-reinforced concrete from the surface to the bottom of the shaft key at 903 ft. The key is 81 ft long with an inner diameter of 16 ft. The shaft diameter below the key is 20 ft, and the shaft below the key is unlined to the facility horizon at 2,150 ft. The shaft walls are bolted and meshed from just below the key all the way down to the shaft station. This shaft has no sump.

3.4.1 Shaft Performance

Weekly visual inspections were performed on the Air Intake Shaft during this reporting period, and the shaft was found to be in satisfactory condition. No ground control activities other than routine maintenance were required during this reporting period.

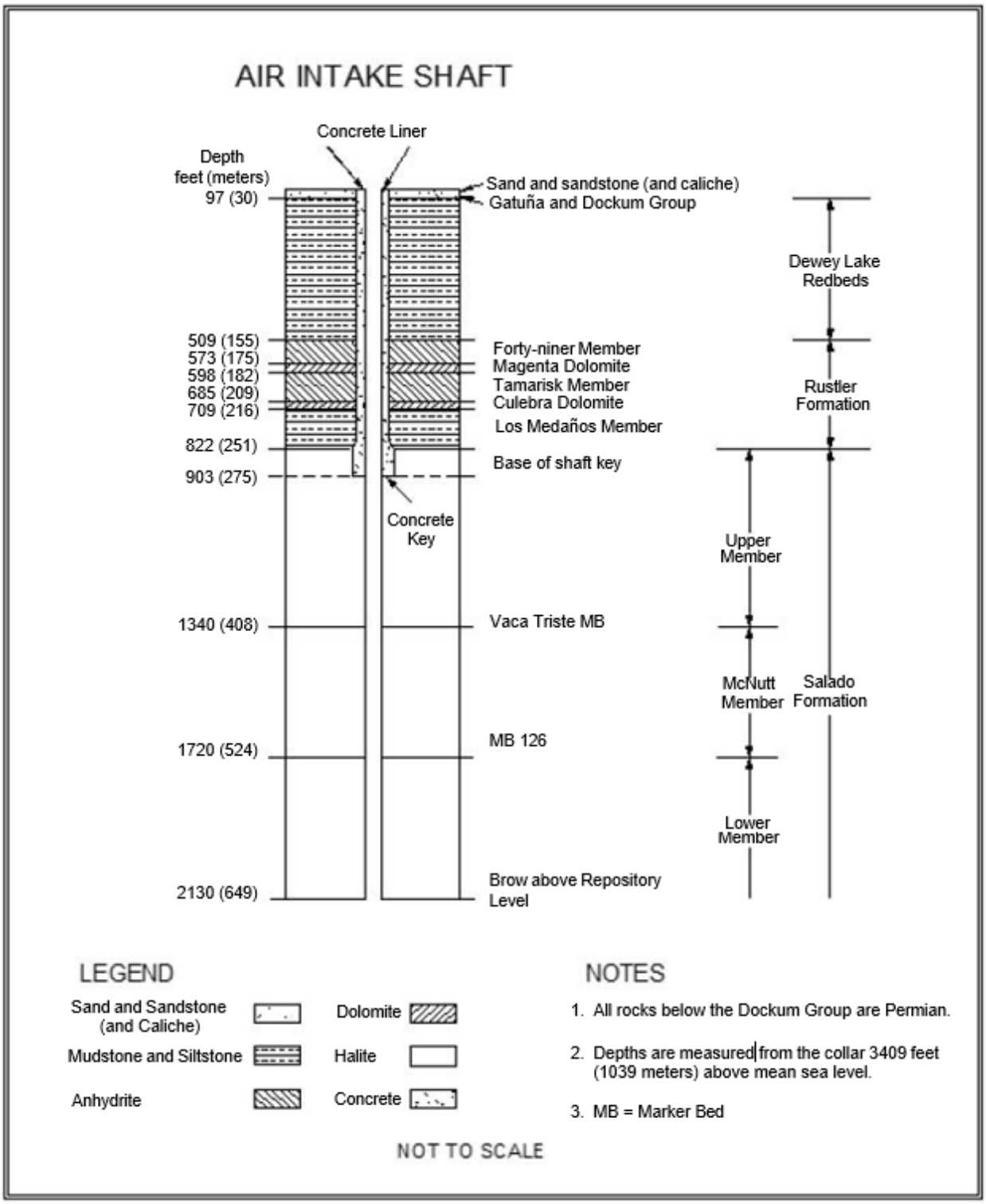

Figure 3-13 Air Intake Shaft Stratigraphy

4.0 PERFORMANCE OF SHAFT STATIONS

This section describes the instrumentation and geomechanical performance of the shaft stations at the base of the Salt Shaft, the Waste Shaft, and the Air Intake Shaft. The Exhaust Shaft does not have an enlarged shaft station; therefore, it is not included in this section.

4.1 Salt Shaft Station

The Salt Shaft Station was excavated by drilling and blasting between May 2, and June 3, 1982. In 1987, the station was enlarged by removing the roof beam up to Anhydrite "b" between S-90 and N-20 using a mechanical scaler. In 1995, the remaining roof beam at the north end of the station was also removed up to Anhydrite "b." The station area south of the shaft is 90 ft long and 32 to 38 ft wide. The height of the station south of the shaft is 18 ft. The station dimensions north of the shaft are approximately 30 ft long, 32 to 35 ft wide, and 18 ft high. The shaft extends approximately 140 ft below the facility horizon to accommodate the skip loading equipment and a sump. Figure 4-1 shows a cross section of the station.

4.1.1 Modifications to Excavation and Ground Control Activities

The Salt Shaft Station was not modified during this reporting period. Ground control activities were limited to routine maintenance. Rework of the Salt Pocket is anticipated for future reporting periods.

4.1.2 Instrumentation

Geomechanical instrumentation was installed in the Salt Shaft Station between June 1982 and February 1983, with subsequent re-installation of extensometers and convergence points, as necessary. Figure 4-2 shows the instrument locations after the roof beam was taken down.

Five vertical convergence points are currently monitored. Table 4-1 summarizes the vertical closure rates in the Salt Shaft Station from July 2021 through June 2022. The closure rates for this reporting period are slightly higher than the rates for the previous reporting period.

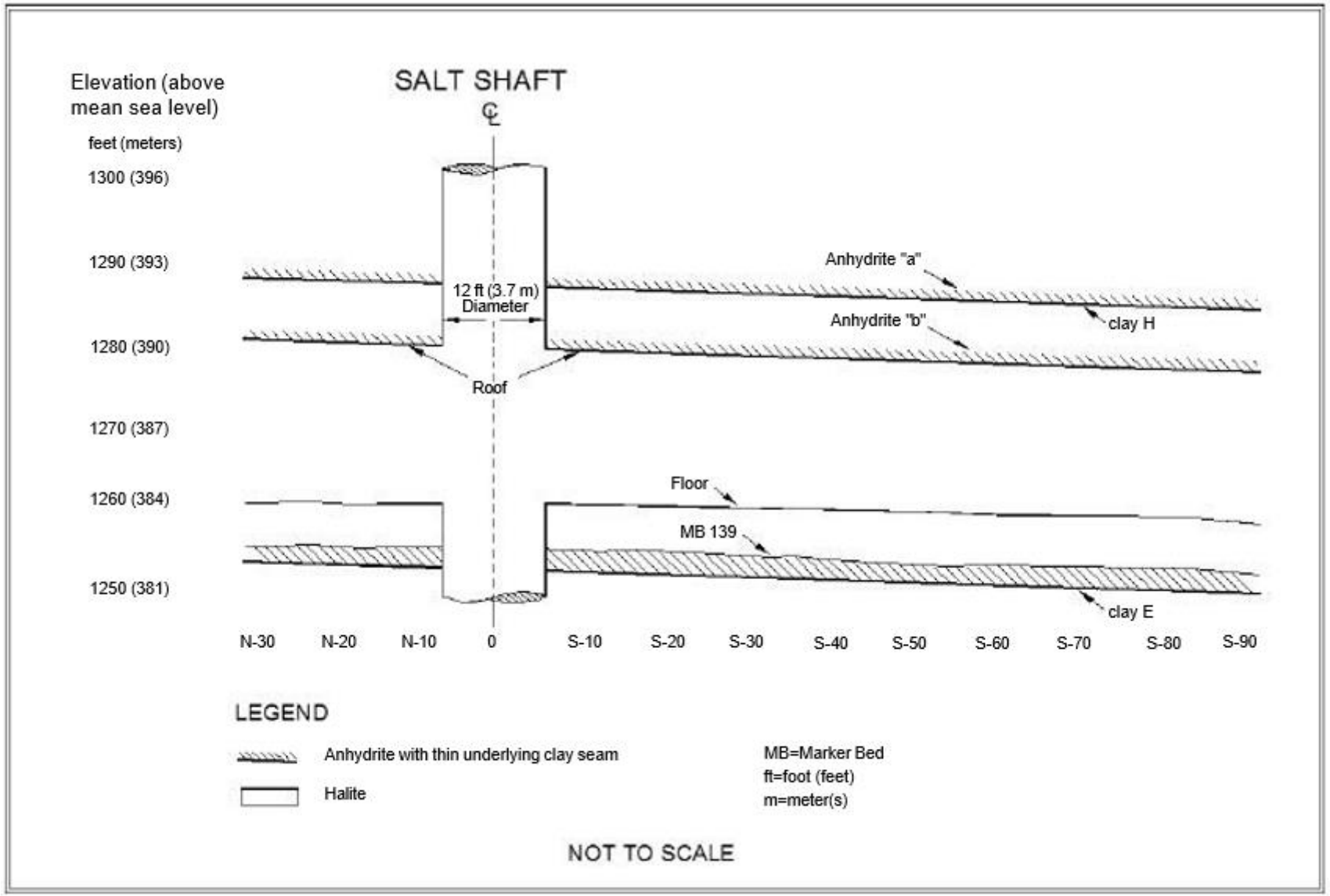

Figure 4-1 Salt Shaft Station Stratigraphy

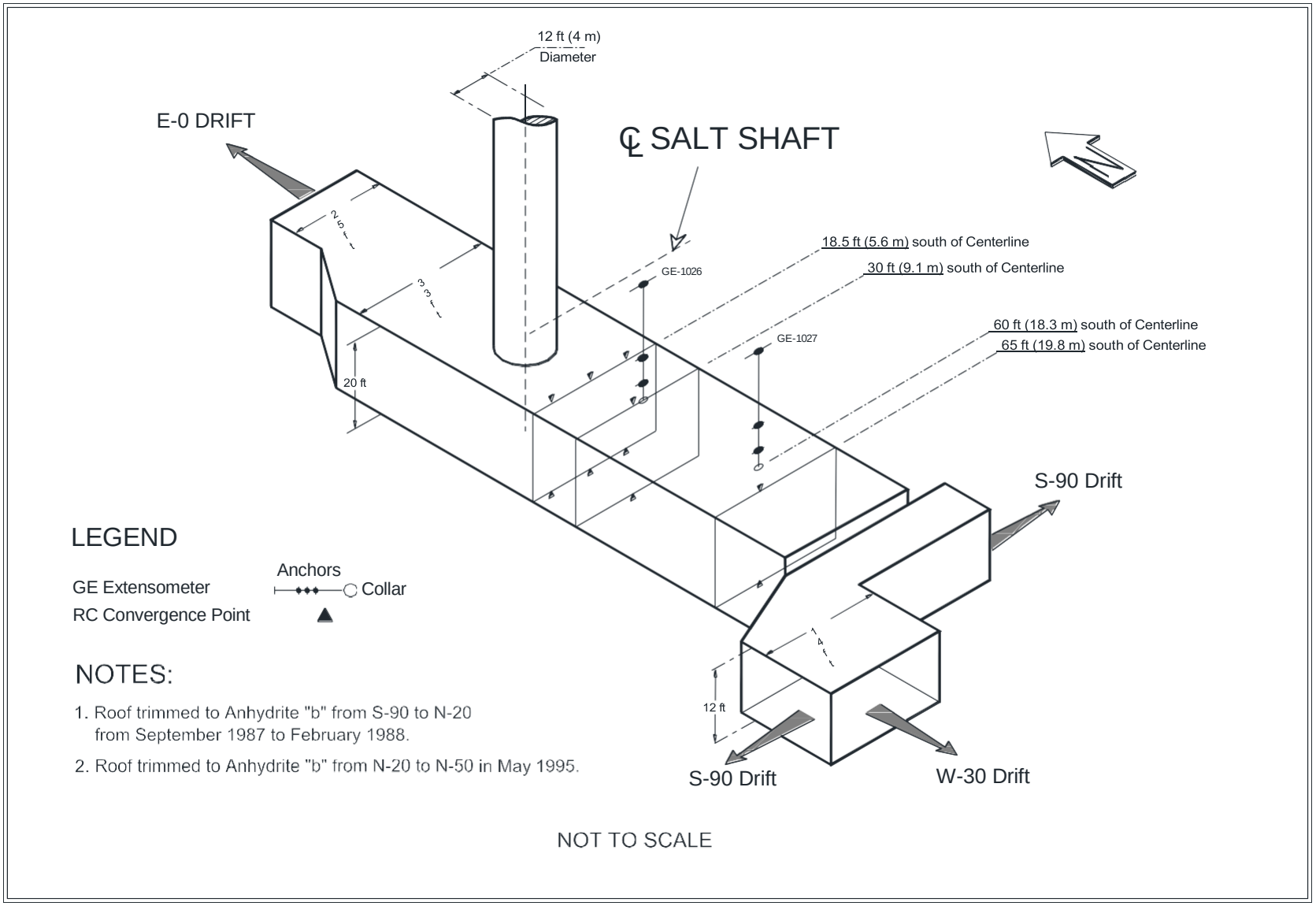

Figure 4-2 Salt Shaft Station Instrumentation after Roof Beam Excavation

Location	Chord[5]	Last Reading	Total Cumulative Displacement (in)	Closure Rate 2021-2022 (in/yr)	Closure Rate 2020-2021 (in/yr))	Rate Change (%)
E0-S18	A-E	06/16/22	39.492	2.11	2.15	-2
E0-S18	B-D	06/16/22	43.386	2.85	2.57	11
E0-S18	H-F	06/16/22	25.708	1.36	1.36	0
E0-S30	A-C	06/16/22	40.387	2.22	2.14	4
E0-S65	A-C	06/15/22	27.628	1.51	1.36	11

Table 4-1 Closure Rates in the Salt Shaft Station

4.2 Waste Shaft Station

The Waste Shaft Station was initially excavated with a continuous miner in November 1982 to serve as a ventilation connection to a 6-ft-diameter exhaust shaft. In 1984, the station was enlarged to a height of 15 to 20 ft and a width of 20 to 30 ft. The station is approximately 150 ft long. In 1988, the station walls were trimmed, and concrete was placed on the floor. Since 1988, the Waste Shaft Station has undergone five major floor renovations. A 53-ft long section of the reinforced concrete was removed in February 1991. In 1995, an additional 30-ft section of concrete was removed. In 2000, floor maintenance included trimming of the floor and reinstallation of the rails supported by segmented concrete panels on a crushed rock backfill. The roof of the Waste Shaft Station was mined up to Clay G in December 2008 to assure adequate operational clearance. Chain link fencing and 12-ft resin-anchored roof bolts were installed for ground support. Figure 4-3 shows a cross section of the Waste Shaft Station stratigraphy.

4.2.1 Modifications to Excavation and Ground Control Activities

No modifications to the Waste Shaft Station were made during this reporting period. Ground control activities were limited to routine maintenance.

[5] Chord is defined in Section 5.2 and illustrated in Figure 5-1.

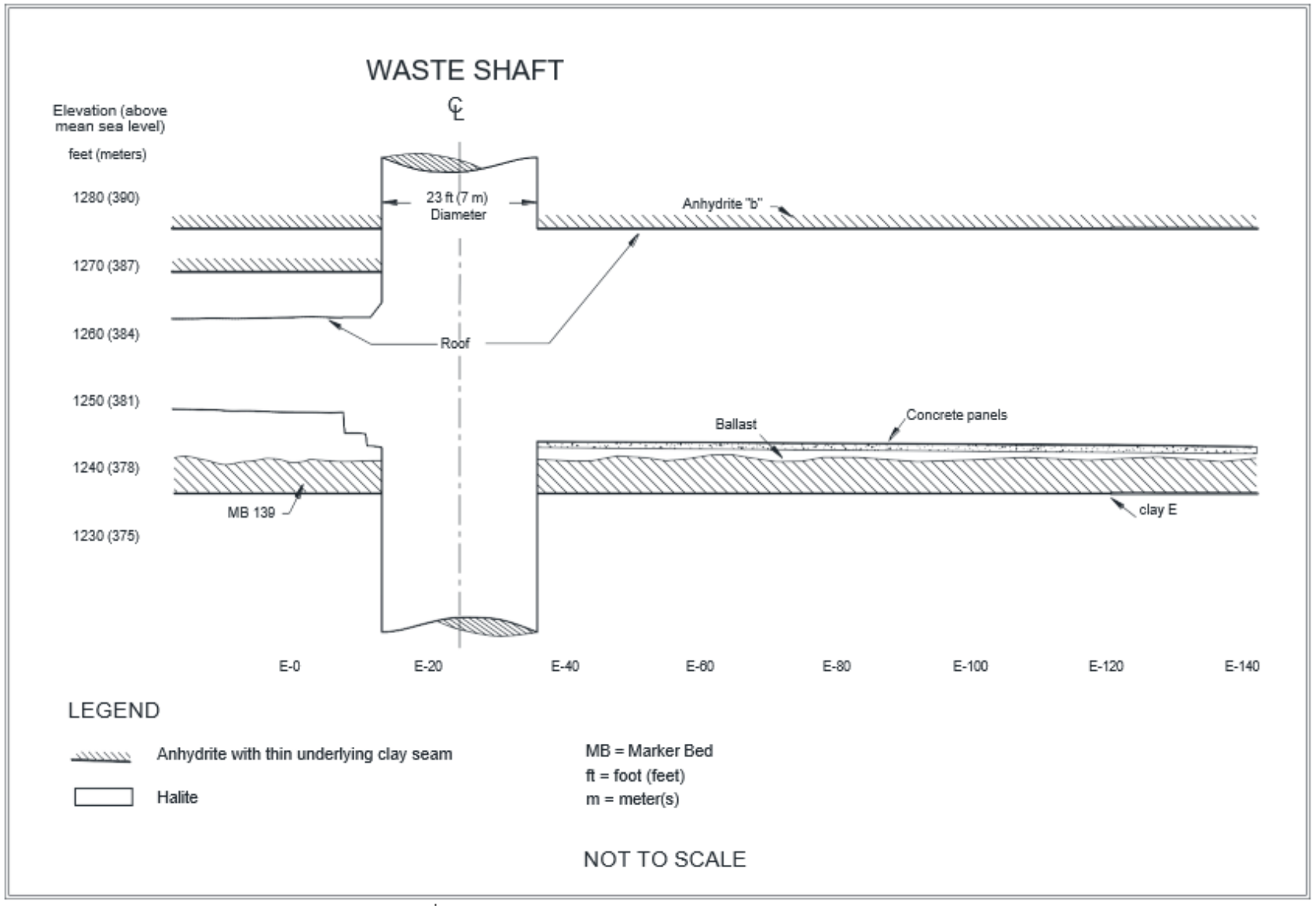

Figure 4-3 Waste Shaft Station Stratigraphy

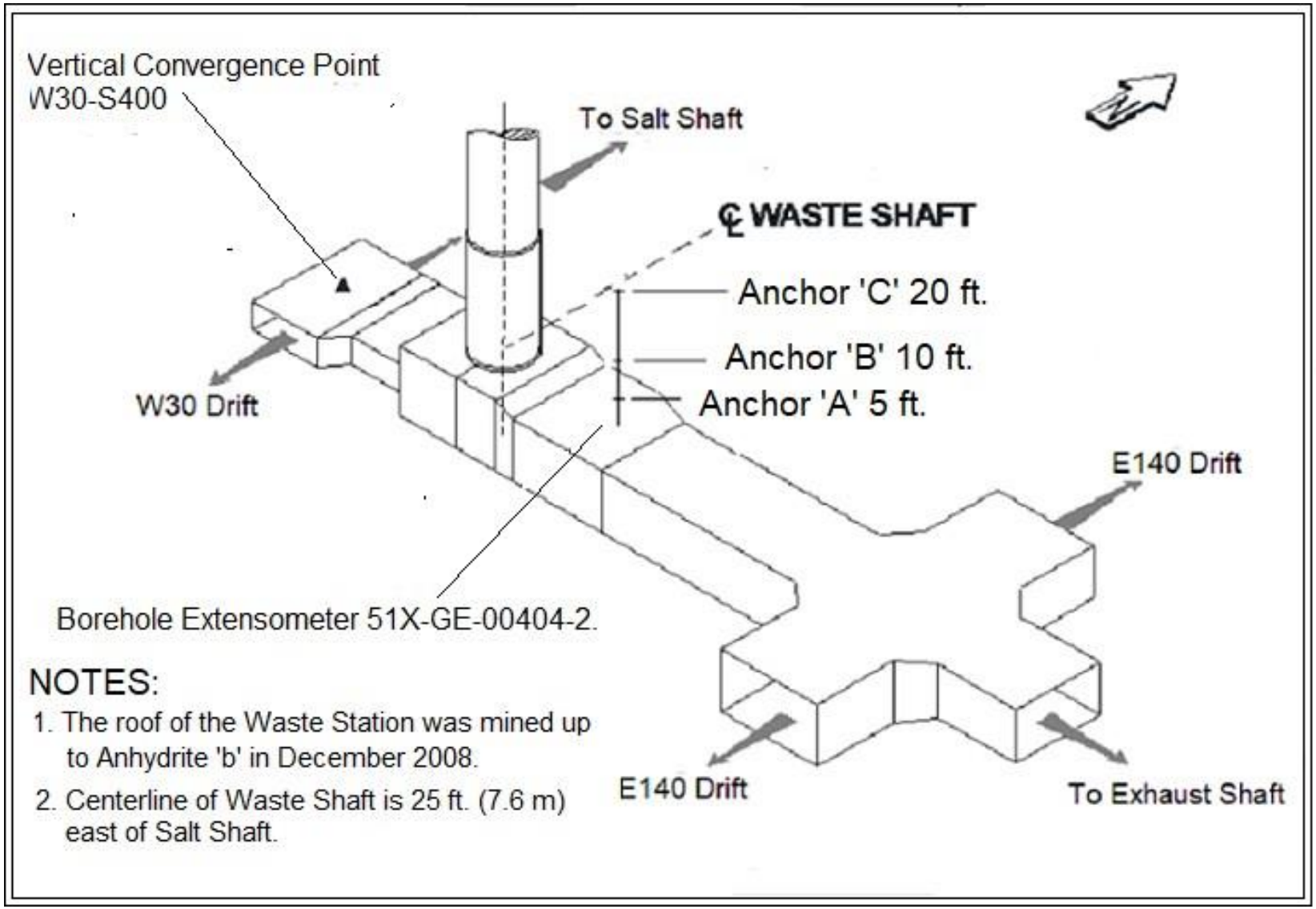

Figure 4-4 Waste Shaft Station Instrumentation

4.2.2 Instrumentation

The Waste Shaft Station geomechanical instrumentation, as depicted in Figure 4-4, consists of a vertical convergence point in W30-S400 and a borehole extensometer east of the Waste Shaft at S400-E35. The convergence rate this reporting period was 1.31 in/yr. The beam expansion rate as measured by the extensometer was 0.31 in/yr. The data are representative of a very stable back.

4.3 Air Intake Shaft Station

The Air Intake Shaft Station was excavated in late 1987 and early 1988, using a continuous miner. The Air Intake Shaft is furnished with a work platform and a small cage that can be raised and lowered to perform routine ground maintenance. The principal purpose of the cage is to provide emergency ingress and egress.

4.3.1 Modifications to Excavation and Ground Control Activities

The Air Intake Shaft Station was not modified during this reporting period. Ground control activities were limited to routine maintenance.

4.3.2 Instrumentation

Radial convergence point and extensometer instrumentation data near the Air Intake Shaft Station are presented in Section 5.0 as part of the discussion on the performance of the access drifts.

5.0 PERFORMANCE OF ACCESS DRIFTS

This section describes the geomechanical performance of the underground access drifts. The Waste Disposal Area is discussed in Section 6.0 and the Salt Disposal Investigation areas are discussed in Section 7.0. Four major north-south drifts in the WIPP underground are intersected by shorter east-west cross-drifts. Drift dimensions range from 13 ft to 21 ft high, and from 14 ft to 33 ft wide.

5.1 Modifications to Excavation and Ground Control Activities

Rock bolting, meshing, and drilling observational bore holes were performed during this reporting period. Table 5-1 summarizes these activities.

Location	Work Activity
Panel 8	Installed 4 ft. mechanical bolts in the back and ribs
Panel 8	Installed chain-link mesh over the back and ribs
Air Intake Shaft	Installed 4 ft. mechanical bolts in the back and ribs
E0 between N150 and N1400	Installed 4 ft. mechanical bolts in the back and ribs
Panel 7	Replaced failed 14 ft. resin anchored bolts in the back
Panel 7	Installed 4 ft. mechanical bolts in the back and ribs
W30 between S700 and S1950	Installed a new 14 ft. resin anchored bolt pattern in the back
E300 between N1400 and N1100 (EXO area)	Replaced failed 14 ft. resin anchored bolts in the back
W170 between N150 and S1950	Installed 4 ft. mechanical bolts in the back and ribs
E140 between S400 and S1950	Replaced failed 14 ft. resin anchored bolts in the back
SDI	Installed 4 ft. mechanical bolts in the back and ribs
E0 between N150 and N1400	Replaced failed 14 ft. resin anchored bolts in the back
E140 between S400 and S90	Replaced failed 14 ft. resin anchored bolts in the back
E140 between S90 and N1400	Replaced failed 14 ft. resin anchored bolts in the back
Mine Wide	Drilled observation boreholes in the back
E140 between S90 and N1400	Installed 4 ft. mechanical bolts in the back and ribs
E140 between S400 and S1950	Installed 4 ft. mechanical bolts in the back and ribs
S1600 between E300 and E140	Installed 4 ft. mechanical bolts in the back and ribs
W170 between S1600 and S2180	Installed a new 14 ft. resin anchored bolt pattern in the back
Panel 8	Installed a new 14 ft. resin anchored bolt pattern in the back
E300 from S1000 to S2180	Installed 4 ft. mechanical bolts in the back and ribs
W30 between S1950 and S2520	Installed a new 14 ft. resin anchored bolt pattern in the back
S1600 between E140 and W170	Installed 4 ft. mechanical bolts in the back and ribs
S1600 between E140 and W170	Installed chain-link mesh over the back and ribs
E140 S2180 overcast	Replaced failed 14 ft. resin anchored bolts in the back
W30 between S1600 and S1950	Installed 4 ft. mechanical bolts in the back and ribs
S700 between W170 and W620	Installed 4 ft. mechanical bolts in the back and ribs
S1600 between W30 and E140	Installed a new 14 ft. resin anchored bolt pattern in the back

Table 5-1 Summary of Modifications and Ground Control Activities in the Access Drifts: July 1, 2021, to June 30, 2022

5.2 Instrumentation

This section discusses instrumentation details in the access drifts.

5.2.1 Extensometers

Sixteen extensometers continue to be monitored at various locations in the access drifts. Where displacement data were available, annual displacement rates were calculated (see Section 1.4.3) for each active installation and compared to the annual displacement rates from the previous reporting period (see Table 4-1 in the 2021-2022 Supporting Data document (Vol 2). Extensometer data are obtained by measuring the displacement from the reference head anchor (collar) to each fixed anchor of the extensometer. These measurements are scheduled to be made at least monthly throughout the WIPP underground. Many of the E-140 extensometers indicate movement in the roof beam that may be attributed to shallow fracturing and the effects of anhydrite stringer separations in the roof. Lateral deformation in the roof beam may influence the extensometer readings, causing an increase in the measured displacement. Although the extensometer data indicate continued deformation and breakup of the lower beam, borehole logging indicates the roof bolt anchorage zone remains competent.

5.2.2 Convergence Points

Convergence point data are obtained by measuring the change in distance between fixed points anchored into the rock across an opening, either from rib to rib or from roof to floor. The measurement end-points constitute a "chord." Figure 5-1 shows typical convergence point array configurations along with typical chord designations.

Convergence points are routinely installed following new mining and in areas where ground maintenance has been performed and previously installed convergence points have been removed. A listing of convergence point installations performed in the access drifts during this reporting period are shown in Table 5-2, Convergence Point Installations in the Access Drifts: July 1, 2021, to June 30, 2022.

Where possible, annual closure rates were calculated from convergence point array data gathered in the access drifts. During this reporting period the active convergence points in the underground were distributed as follows: 208 convergence points in the access drifts, 6 accessible convergence points in Panel 7, and 49 convergence points in the Panel 8. A complete tabulation of the accessible convergence point data and calculated closure rates is presented in the supporting data document for this report (Vol 2).

Locations with increases in annual vertical closure rates of greater than 20 percent are shown in Table 5-3, Vertical Closure Rate Changes in Excess of Twenty Percent in the Access Drifts.

5.3 Analysis of Convergence Point and Extensometer Data

The 288 convergence points for this period had a roof-to-floor closure range of -1.3 to 6.5 in/yr, mean rate of 1.6 in/yr, and a standard deviation of 0.9. Statistically high standard deviation in access drift convergence rates is caused by wide ranging excavation variables such as drift dimension, age, horizon level, etc.

Vertical loading on mine pillars results in lateral stresses on the roof and floor beams. The composition of those beams, in part, determines how these structures will react to the horizontal stresses. In particular, horizontally continuous anhydrite stringers (see Section 2.2.2) divide the beam itself into a series of smaller independent beams.

Lateral strain on the beam imposed by vertical loading on the pillars is accommodated by vertical displacement over the mined opening. This requires that the horizontally oriented beam separate along the most favorable, or weakest, planes.

Where anhydrite stringers interpose the beam, they constitute a plane of weakness, and delamination occurs. The material is confined in the plane above, so that the roof accommodates the lateral strain by bending convex into the mined opening.

Two distinct results develop from this action. First, voids form within the beam as the portions closer to the opening move away from those deeper within the beam. Second, the convex portion of the bended plane is subjected to tensile loading perpendicular to the axis of the drift and superficial tears known as "tensile fractures" develop generally parallel to the axis of the drift.

Where anhydrite stringers are small and discontinuous or absent within the beam, horizontal loading is accommodated along shear planes. These develop at angles of approximately 35 degrees with respect to the horizontal. In some cases, a plane develops preferentially on one side of the drift, and the bulk of material is pushed into the mined opening on that side. This may be thought of as a cantilevered beam.

Whatever mechanism is used, vertical displacement into the mined opening is measured by convergence monitoring. Convergence points consider the displacement between two opposing surfaces: either the roof and floor or the two ribs. Extensometers consider the displacement between one surface (usually the back) and one or more points within the beam. Where a convergence point and an extensometer are adjacent to one another, it is possible to determine the individual displacements of both floor and roof beams.

These data are used to analyze the stability and mechanics of the beam, and to determine what actions may be taken to ensure the safety of personnel and equipment consistent with the safe operation of the facility.

5.4 Excavation Performance

Approximately 318 convergence points were read and assessed regularly throughout the WIPP underground this reporting period. Due to the effect rock temperature has on salt creep, convergence rates vary seasonally, typically increasing during the warmer summer months and decreasing during the cooler and drier winter months. These temperature effects are more pronounced nearer the fresh air intake.

The performance of the access drift excavations during this reporting period was within acceptable criteria. "Acceptable criteria" means that a drift remains accessible, and the ground can be controlled by routine maintenance. Standard remedial ground control in some areas was required to maintain the performance of the excavations. The accessible drifts remain stable and controlled. Of the 208 convergence locations measured in the access drifts, 40 locations had annual closure rates in excess of 20 percent from the previous year's value. See Table 5-3, Vertical Closure Rate Changes in Excess of Twenty Percent in the Access Drifts.

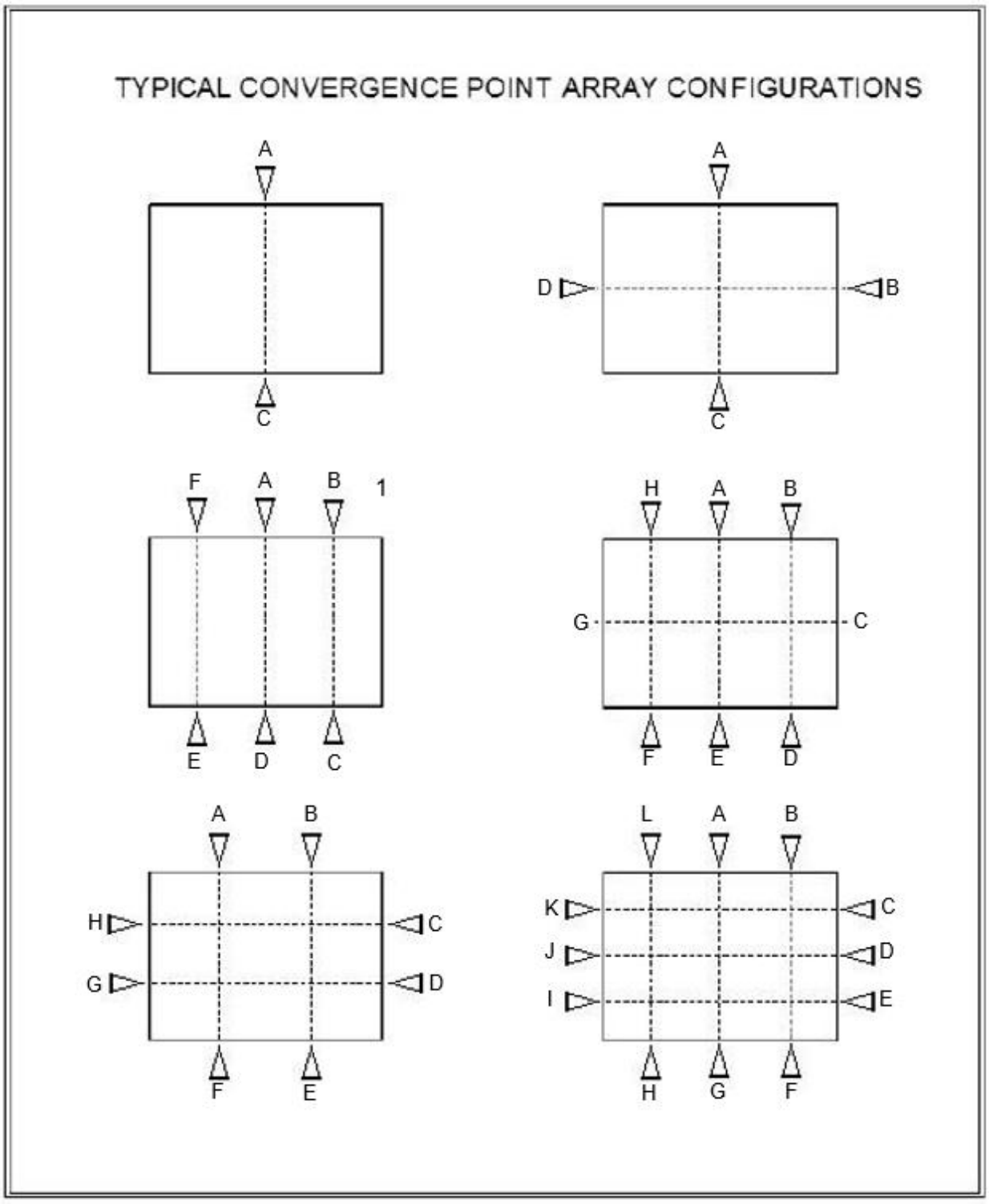

Figure 5-1 Typical Convergence Point Array Configurations Showing Anchor Designations

Location	Installation Date	Type of Installation[6]	Field Tag[7]
E0-N300	04/28/22	R	E0-N300-7 A-C
E140-S1496	02/25/22	R	E140-S1496-2 A-E
E300-S1687	07/07/21	R	E300-S1687-4 A-C
N250-E220	01/27/22	R	N250-E220-5 A-E
S700-W98	01/27/22	R	S700-W98-5 A-C
W170-S400	04/12/22	R	W170-S400-2 A-C
W170-S560	04/12/22	R	W170-S560-5 A-C
W170-S700	04/12/22	R	W170-S700-4 A-C
W170-S850	04/12/22	R	W170-S850-9 A-E
W170-S1150	01/27/22	R	W170-S1150-6 A-E
W30-S700	01/27/22	R	W30-S700-6 A-C
W30-S1300	07/16/21	R	W30-S1300-3 A-C
E140-N940	07/21/21	R	E140-N940-3 A-C
N460-E220	06/17/22	R	N460-E220-2 A-C
S1950-W1050	08/10/21	R	S1950-W1050-2 A-C
S1950-W455	09/30/21	R	S1950-W455-3 A-C
S1950-W520	09/30/21	R	S1950-W520-3 A-C
S1950-W585	08/10/21	R	S1950-W585-3 A-C
S1950-W660	08/10/21	R	S1950-W660-3 A-C
S1950-W725	08/10/21	R	S1950-W725-3 A-C
S1950-W790	08/10/21	R	S1950-W790-4 A-C
S1950-W855	08/10/21	R	S1950-W855-2 A-C
S1950-W920	08/10/21	R	S1950-W920-2 A-C
S1950-W985	08/10/21	R	S1950-W985-2 A-C
S2520-W390	01/05/22	R	S2520-W390-5 A-C
S2520-W455	09/29/21	R	S2520-W455-4 A-C
S700-W245	04/26/22	N	S700-W245-1 A-C
S700-W320	04/26/22	N	S700-W320-1 A-C
S700-W395	04/26/22	N	S700-W395-1 A-C
S700-W470	04/26/22	N	S700-W470-1 A-C
S700-W545	05/26/22	N	S700-W545-1 A-C
S700-W620	05/26/22	N	S700-W620-1 A-C
S850-W245	05/31/22	N	S850-W245-1 A-C
S850-W320	05/31/22	N	S850-W320-1 A-C
S90-E360	07/21/21	N	S90-E360-1 A-C
S90-E420	07/21/21	N	S90-E420-1 A-C
S90-E480	07/21/21	N	S90-E480-1 A-C

[6] R - denotes a replacement installation, e.g., roof or floor point(s) could have been mined out, damaged, etc. N – represents a new installation at that location.
[7] Field Tag (aka fieldtag) is a string consisting of 'location' + '- number of times a reinstall was conducted at that location' + ' chord'. Note that new installations do not have a reinstallation number.

Location	Installation Date	Type of Installation[6]	Field Tag[7]
W1050-S1687	07/08/21	R	W1050-S1687-2 A-C
W1050-S1775	07/08/21	R	W1050-S1775-2 A-C
W1050-S1862	07/08/21	R	W1050-S1862-2 A-C
W520-S1700	09/30/21	R	W520-S1700-2 A-C
W520-S1775	09/30/21	R	W520-S1775-2 A-C
W520-S1850	09/30/21	R	W520-S1850-2 A-C
W660-S1687	09/30/21	R	W660-S1687-2 A-C
W660-S1775	09/30/21	R	W660-S1775-2 A-C
W660-S1862	09/30/21	R	W660-S1862-2 A-C
W790-S1687	08/10/21	R	W790-S1687-2 A-C
W790-S1775	08/10/21	R	W790-S1775-2 A-C
W790-S1862	08/10/21	R	W790-S1862-2 A-C
W920-S1687	07/29/21	R	W920-S1687-2 A-C
W920-S1775	07/29/21	R	W920-S1775-2 A-C
W920-S1862	07/29/21	R	W920-S1862-2 A-C

Table 5-2 Radial Convergence Point Installations in the Access Drifts: July 1, 2021, to June 30, 2022

Location	Chord[8]	Last Reading Date	Closure Rate 2022 to 2021 (in/yr)	Closure Rate 2019 to 2020 (in/yr)	Rate Change (%)
E0-N300	A-C	06/16/22	2.9	1.7	71
E140-N626	A-C	06/02/22	3.9	3.0	30
E140-S1300	A-C	06/22/22	2.1	1.7	24
E140-S1534	B-D	09/23/21	6.5	3.5	86
E140-S1548	B-D	06/14/22	2.0	1.6	25
E140-S1667	B-D	05/16/22	3.9	3.0	30
E140-S1699	H-F	06/14/22	3.4	2.7	26
E300-N360	A-C	06/02/22	1.7	1.3	31
E300-N440	A-C	06/02/22	1.5	1.1	36
E300-N500	A-C	06/02/22	1.1	0.7	57
E300-S250	A-C	06/02/22	1.0	0.6	67
E300-S550	A-C	06/15/22	0.8	0.5	60
E300-S1000	A-C	06/15/22	1.3	1.0	30
E1300-N860	A-C	05/20/22	1.0	0.7	43
N140-E90	A-C	06/02/22	1.0	0.8	25
N215-W500	A-C	06/27/22	1.4	1.0	40
N215-W620	A-C	06/27/22	1.2	0.8	50
S90-W120	A-C	06/07/22	0.8	0.6	33
S90-W590	A-C	06/07/22	0.8	0.6	33
S400-E10	A-C	06/22/22	1.1	0.9	22
S400-E420	A-C	06/15/22	1.3	0.9	44
S400-W208	A-C	06/27/22	1.4	1.0	40
S400-W251	A-C	06/27/22	1.7	1.3	31
S1000-E120	A-C	06/22/22	1.4	1.1	27
S1000-W98	A-C	06/13/22	2.3	1.7	35
S1000-W120	A-C	06/13/22	2.0	1.5	33
S1600-E110	A-C	02/17/22	1.4	1.1	27
S1600-E170	A-C	06/22/22	1.6	1.2	33
S1950-E113	A-C	05/24/22	1.5	0.9	67
W30-S90	A-C	06/13/22	1.4	0.9	56
W30-S120	A-C	06/13/22	1.2	0.9	33
W30-S250	A-C	06/13/22	1.4	1.1	27
W30-S400	A-C	06/13/22	1.3	1.0	30
W30-S500	A-C	06/13/22	1.7	1.3	31
W30-S550	A-C	06/13/22	0.8	0.5	60
W170-N150	A-C	06/07/22	0.8	0.6	33
W170-S5	A-C	06/07/22	0.8	0.6	33

Location	Chord[8]	Last Reading Date	Closure Rate 2022 to 2021 (in/yr)	Closure Rate 2019 to 2020 (in/yr)	Rate Change (%)
W170-S232	A-C	06/07/22	0.9	0.7	29
W170-S1000	A-C	06/07/22	1.7	1.1	55
W660-N150	A-C	06/27/22	0.9	0.5	80

Table 5-3 Vertical Closure Rate Changes in Excess of Twenty Percent in the Access Drifts

[8] Chord is defined in Section 5.2.2 and illustrated in Figure 5-1.

6.0 PERFORMANCE OF THE WASTE DISPOSAL AREA

The Waste Disposal Area as of June 30, 2022, consisted of Panels 1, 2, 3, 4, 5, 6, 7, and a nearly completed Panel 8. Panels 1, 2, 3, 4, 5, and 6 were closed during previous reporting periods.

6.1 History

Excavation of Panel 1 began in May 1986 with the mining of the access entries. Initially, the disposal rooms and drifts were developed as pilot drifts, that were later excavated to nominal operational dimensions of 13 ft high, 33 ft wide, and 300 ft long. Room 1 was completed to these dimensions in August 1986, and pilot drifts for Rooms 2 and 3 were excavated in January and February 1987. Rooms 2 and 3 were completed in February and March 1988, and Rooms 4 through 7 were completed in May 1988. Four short access drifts designed to lead to smaller test alcoves were excavated north off the S-1600 drift and Rooms 4-7 in June 1989. Only the access drifts to the alcoves were completed; the alcoves themselves were not excavated. Panel 1 waste emplacement (in Rooms 1, 2, 3, 7, adjacent areas of S-1600, and all of S-1950) was completed in March 2003, and the panel is closed to all access.

Excavation of Panel 2 began in September 1999 with the mining of access entries. Initially, the disposal rooms and drifts were developed as pilot drifts, which were trimmed to finished dimensions. Room 1 was completed in January 2000, and pilot drifts for Rooms 2 and 3 were excavated in February 2000. Pilot drifts were completed for Rooms 4 through 6 in April 2000. The pilot drift for Room 7 was excavated in May 2000. All the rooms were excavated to final dimensions by August 2000. Waste emplacement in Panel 2 was completed during a prior reporting period, and the panel is closed to all access.

Excavation of Panel 3 began in May 2002 with the mining of access entries. As with Panel 2, the disposal rooms and drifts were initially developed as pilot drifts, which were trimmed to finished dimensions. All the rooms were excavated to final dimensions by the end of March 2004. Waste emplacement in Panel 3 was completed in February 2007. Substantial barriers and bulkheads were installed in the exhaust and intake drifts of Panel 3 to prevent access into the panel and to isolate it from the ventilation circuit.

Panel 4 access drift mining began in January 2005. The disposal rooms were initially developed as pilot drifts and were later trimmed to final dimensions. Mining was completed by June 2006. Waste emplacement in Panel 4 was completed in March 2009. Substantial barriers and bulkheads were installed in the exhaust and intake drifts of Panel 4 to prevent access into the panel and to isolate it from the ventilation circuit.

Panel 5 excavation activities began in June 2006. The panel was initially mined to less-than-final dimensions and later trimmed to specification. Mining was completed by February 2008. Waste emplacement was conducted from March 2009 through July 2011. Isolation walls were completed in November 2011.

Panel 6 mining began in April 2008. The panel was initially mined to less-than-final dimensions and later trimmed to specification. Mining was completed by April 2010. Waste emplacement began in March 2011 and was completed in January 2014.

Panel 7 mining began in April 2010 and was completed in August 2011. Initial mining placed the floor within 2 ft. of a polyhalitic bed (designated PH-4), which sits atop a thick anhydrite bed designated MB-139. Horizontal stresses caused significant uplift and the floor was then mined down through MB-139 and backfilled with run of mine salt. The remediation of the floor was completed in January 2013. Subsequent geomechanical monitoring indicates stable vertical convergence. RH waste emplacement began in Panel 7 in September 2013 and CH waste emplacement began in January 2014. Waste emplacement and ground control activities were suspended in February 2014 due to a truck fire in the underground followed by a radiation release in Panel 7. Ground control activities resumed in 2015. Waste emplacement resumed in January 2017 at the intersection of Room 6 and S2520.

Panel 8 rough-cut mining began on the lower horizon in September 2013. Mining was suspended in February 2014 due to an underground haul truck fire and a radioactive release in Panel 7. Panel 8 mining resumed in February 2018. The rough-cut mining with the back at Clay G (upper horizon) was completed in January 2020. Mining was moved to the upper horizon due to deformation in the immediate roof beam of the lower horizon caused by the lapse in mining and bolting after the events in 2014. The rib-cut mining was completed in October 2020. The installation and testing of the geomechanical instrumentation was completed in April 2022.

6.2 Modifications to Excavations and Ground Control Activities

No planned excavation modifications were performed this reporting period in Panel 7. An anticipated roof fall is thought to have occurred in Panel 7, S2180-W985 (a prohibited area closed to personnel access) around July 10, 2021. The potential for a fall to occur was predicted by increasing room closure rates as can be seen in Figure 6-1. The data obtained from the instrument after July 10, 2021, was not indicative of a fully operational instrument, inferring a roof fall had occurred damaging the instrument. Due to waste emplacement, a visual confirmation of the roof fall was not possible. However, data from previous roof falls would support a roof fall in this instance as indicated by the response of the displacement rate data in Figure 6-1 and the final instrument reading measuring a displacement rate of over 150 inches/yr.

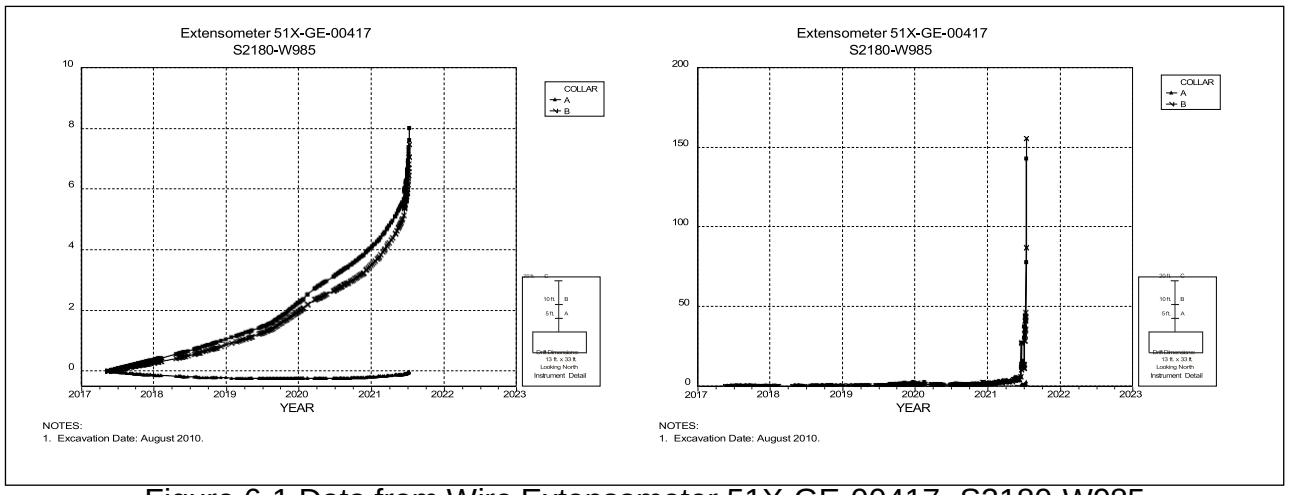

Figure 6-1 Data from Wire Extensometer 51X-GE-00417 -S2180-W985

Routine ground control activities were performed in Panel 7 to include scaling and meshing, as needed, and the replacement of broken roof bolts with 14-ft resin anchored bolts in areas that are still accessible.

A very significant modification to Panel 8 (see Section 6.1) is the mining of the back up to the upper horizon at Clay G. The back of Panel 8 is fully bolted with 6-foot resin anchor roof bolts. The bolts were installed as soon as possible after mining to slow the development of separations along anhydrite stringers within the roof beam and subsequent surface tension crack development. Currently, a final bolt pattern consisting of 14 ft resin-anchored bolts are being installed in Panel 8 to ensure its long-term stability as waste is emplaced. During the reporting period, this full pattern of 14 ft. resin-anchored bolts was completely installed in Room 7 of Panel 8 and a portion of the S1600 drift between Room 7 and Room 6. Bolting will continue until Panel 8 has been fully outfitted with the aforementioned 14 ft. bolt pattern.

6.3 Instrumentation

Panel 7 and Panel 8 instrumentation originally consisted of the following:

- Forty-nine vertical convergence points, distributed as 14 in each of the intake and exhaust drifts and three in each of the rooms; and
- Eleven wire extensometers, distributed as two in each of the intake and exhaust drifts and one in each of the rooms.

A schematic of the geomechanical instrumentation layout found in Panel 7 and Panel 8 is shown in Figure 6-1. This figure presents what has been a typical Waste Panel instrumentation layout since emplacement began in Panel 1.

6.4 Analysis of Extensometer and Convergence Point Data

Panel 7 is continuing to experience age-appropriate roof-beam, expansion and floor deformation in areas accessible to ground maintenance. Due to the aforementioned

S2180~W985 ground event in July 2021, future remote monitoring capabilities will be limited in Panel 7 to only Room 1.

Absent in this section are Rooms 4, 6, and 7. The rooms are inaccessible due to the following reasons:

- Room 4 experienced an anticipated roof fall over approximately 80% of the room in November 2016.
- Room 6 also experienced an anticipated roof fall over much of the room sometime between December 19, 2018, and January 2, 2019.
- Access to Room 7 was prohibited to general access immediately following the radioactive release in February 2014 and was subsequently closed following the video investigation of the waste stack.

The Room 3 extensometer measured a roof beam expansion rate this period of 2.5 in/yr, a 0 percent increase from the previous year's reading of 2.5 in/yr. Extensometer readings from Panel 7 Room 2 show a roof beam expansion rate of 1.57 in/yr, a 15 percent increase from the previous year's reading of 1.36 in/yr.

The Room 1 extensometer measured a roof beam expansion rate this period of 0.47 in/yr, a 48 percent decrease from the previous year's reading of 0.91 in/yr. The convergence points in Panel 7 measured rates of 1.2, 4.85, and 1.1 in/yr, all decreases from the previous reporting period. The indicated decrease in rates can be attributed to ground control efforts to sustain waste emplacement in Room 1.

Readings from Panel 8 show an average steady roof beam expansion rate of 1.83 in/yr through the 11 wire extensometers located throughout the panel. Convergence monitoring of the newly mined Panel 8 shows closure rates between 2.28 and 6.28 in/yr through 49 convergence stations. Convergence rates are typically higher in freshly mined areas before reaching a steady state, and decrease once sufficient ground support is installed.

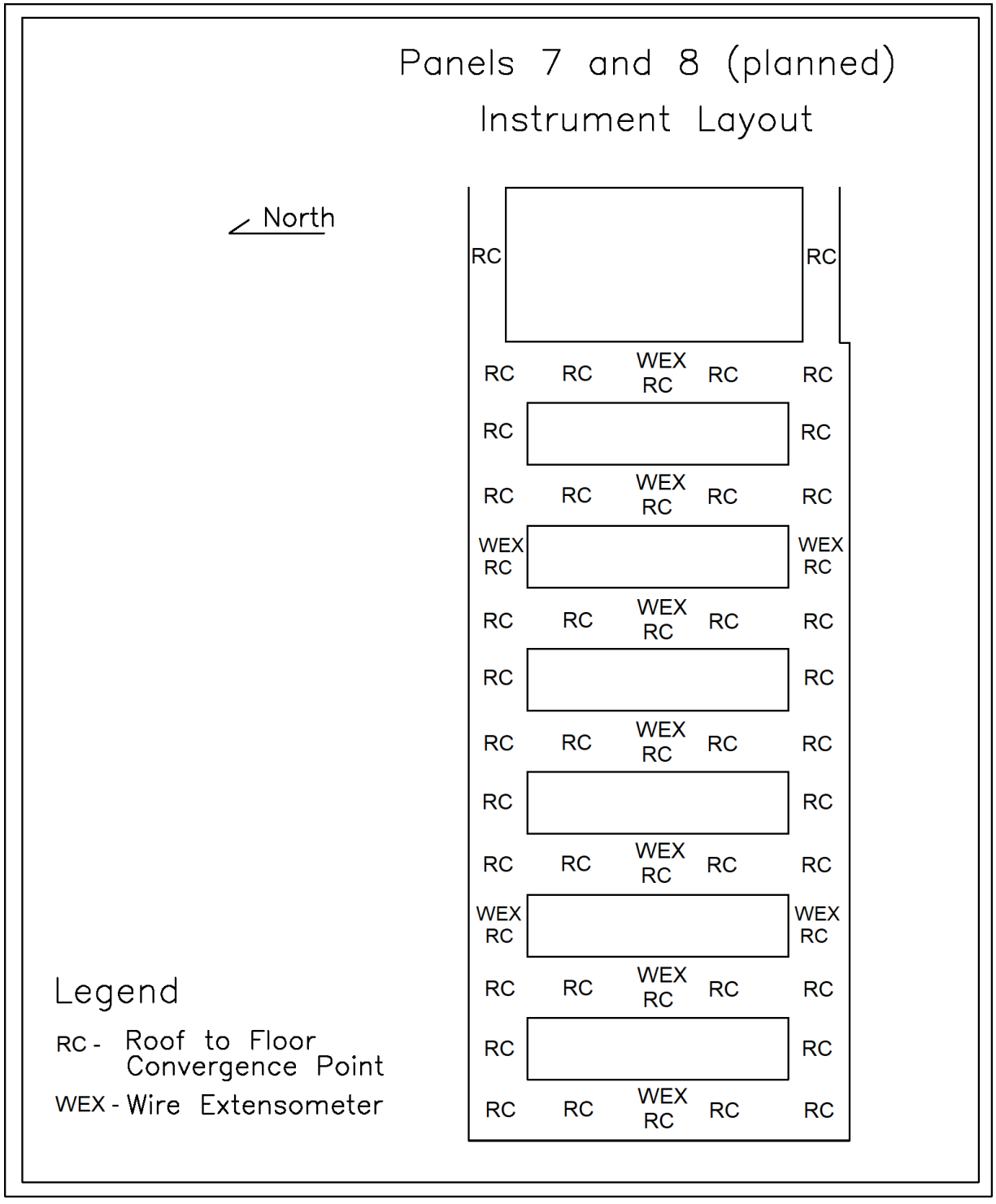

Figure 6-1 Typical Waste Panel Instrument Layout

6.5 Excavation Performance

Panel 7 is performing as expected considering its age and history. The panel should fulfill its intended purpose as long as ground control efforts can continue.

Panel 8 is performing as expected. The panel should fulfill its intended purpose as long as ground control efforts can continue.

7.0 PERFORMANCE OF THE SALT DISPOSAL INVESTIGATIONS AND SALT DEFENSE DISPOSAL INVESTIGATIONS

This chapter describes the geomechanical performance of the SDI and SDDI areas (hereafter referred to as SDI). Development of the area began in January 2012. When completed, most of the area will have nominal dimensions of 13 ft high and 16 ft wide.

7.1 Ground Control Program

Due to the relatively narrow drifts (nominally 16 ft across) and favorable mining horizon, ground control plans in the SDI area are confined to installing 4 ft mechanically anchored bolts and chain-link mesh over the roof and ribs of the entire area to control minor spalling and drummy roof. More substantial engineered ground control systems may be applied in the event the need is identified based on ongoing geomechanical monitoring and analysis of the area.

7.2 Instrumentation

Fifty-five convergence arrays have been installed in the SDI area. The arrays are read on a periodic basis, when accessible. During this reporting period 33 arrays were accessible.

7.3 Analysis of Convergence Point Data

The 33 convergence points for this period had a roof-to-floor closure range of 0.96 to 2.36 in/yr, mean rate of 1.56 in/yr, with a standard deviation of 0.34. Low rates of closure are expected for this area due to the factors described in the beginning of Section 7.1.

7.4 Excavation Performance

A combination of ground control, and to some extent ventilation challenges, led the Operations Department to restrict access to the SDI so the resources could be channeled to address more significant ground control remediation in other areas. The same operational challenges apply to this reporting period. The restricted areas primarily cover N-780 and N-940 drifts and their associated crosscuts. The prohibited areas are limited to areas in SDI south of the N-780 drift, which include 23 convergence stations.

8.0 GEOSCIENCE PROGRAM

Over this reporting period, borehole observations and stratigraphic mapping of Panel 8 were the only activities of the geoscience program completed. A description of the various aspects of the geoscience program is presented in the remainder of Section 8.0.

The geoscience program confirms the suitability of the WIPP site through the collection of various geologic data and excavation characteristics from the underground. These include the inspection of open observation holes for fractures (separations) and offsets (lateral displacements) in roof beams, and the mapping of fracture development on roof surfaces. Data collected through these activities support the design and evaluation of ground support systems.

Normally, the following activities are performed:

- Observation hole inspections
- Fracture mapping
- Stratigraphic mapping
- Drilling and Geologic Core Descriptions

Fracture development in the roof is primarily caused by the concentration of compressive stresses in the roof beam and is influenced by the size and shape of the excavation and the stratigraphy in the immediate vicinity of the opening. In a thick roof beam, pillar deformations induce lateral compressive stresses into the immediate roof and floor. With time, the buildup of stress causes differential movement along stratigraphic boundaries. This differential movement is identified as offsets in observation holes and by the bends in failed rock bolts. Large strains associated with lateral movements can induce fracturing in the roof, which is frequently seen near the ribs. However, this process may take years to develop.

At the upper repository horizon, clay or anhydrite stringers exert significant influence over the effective thickness of the roof beam. The presence of these stringers causes the roof beam to behave as a series of thin independent beams. Little or no tensile support is provided across the stringer interface. As horizontal end-loading continues, each beam can deflect downward causing a tensile fracture to develop along the bottom of the beam. These tensile fractures can develop in relatively new excavations soon after separation occurs along the stringer interface.

8.1 Observation Hole Inspections

Geotechnical observation holes are drilled at various locations throughout the underground facility. A location may contain one or more holes arranged in an array. These holes are drilled to depths that allow the monitoring of fracture development and offsetting and are inspected for the development of those features. Roof observation holes usually extend up past Clays G and H (Figure 8-1 and Figure 8-2).

The clay seams nearest the excavation surfaces define the immediate roof beam. The roof beam is bounded by Clay G in most of the access drifts and Panels 1, 2, and 7. Some areas, such as the Salt Shaft Station, portions of the E-0 and E-140 drifts, the south mains south of S-2620, and Panels 3, 4, 5, 6, and 8 are excavated to Clay G and have roof beams bounded by Clay H.

The offset in an observation hole is determined by visually estimating the degree of occlusion. The direction of offset along clay seams is observed as the movement of the strata nearer to the observer relative to the strata farther away. Typically, the nearer strata move toward the center of the excavation (Figure 8-3 and Figure 8-4). Based on previous observations in the underground, the magnitude of offset is usually greater in holes located near ribs than in those located along excavation centerlines. Offsetting along the clay layers is observable until total offset is reached or visibility is obstructed by intervening offsets at other clay seams or fractures.

Over this reporting period, only four observation holes (Vol. 2 Table 7-1) were inspected. Historically, an aluminum rod with a perpendicular flattened steel wire on the end was used to feel for separations and irregularities in the borehole wall. This equipment was updated to a ViewTech™ 6mm VJ-3 dual view camera, which allows a live feed view parallel and horizontal to the direction of the borehole during inspection. Along with the historically recorded features, the new system allows personnel to look for fluid production zones as well as clay and anhydrite stringers.

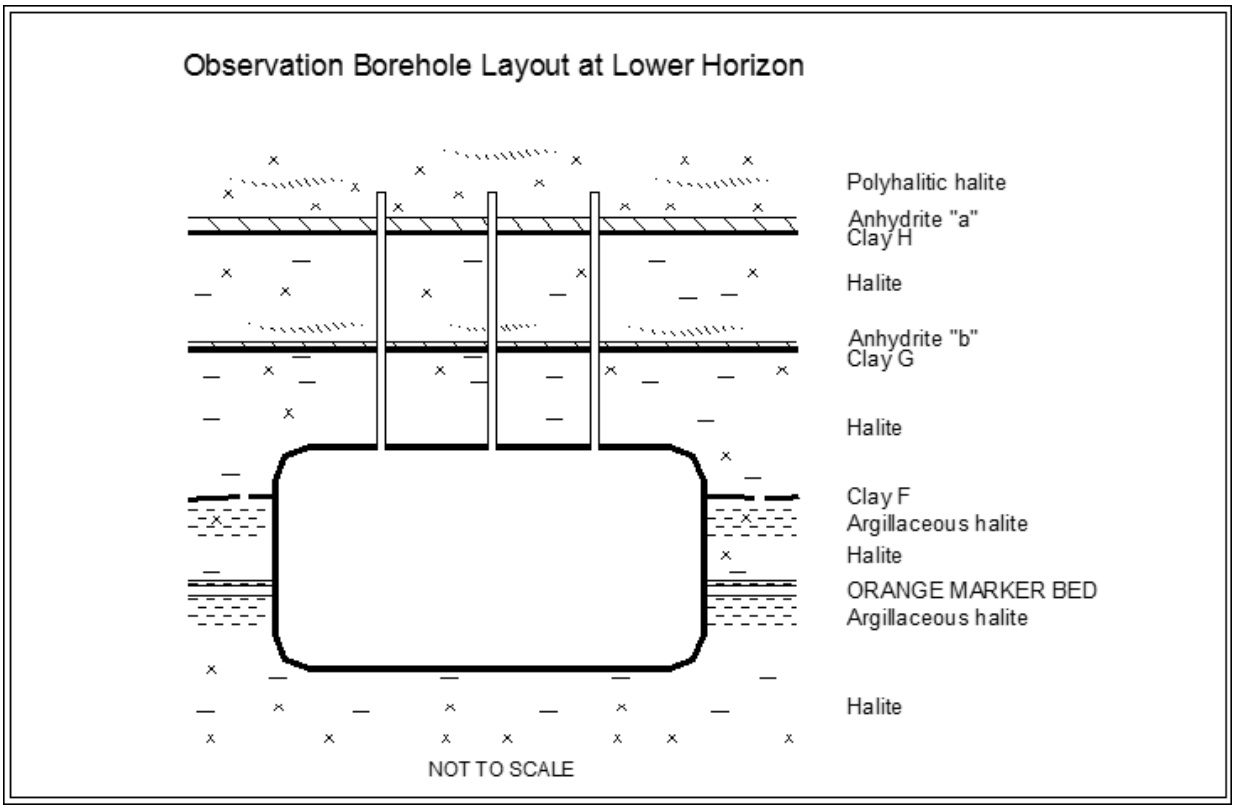

Figure 8-1 Example of Observation Hole Layout at Lower Horizon

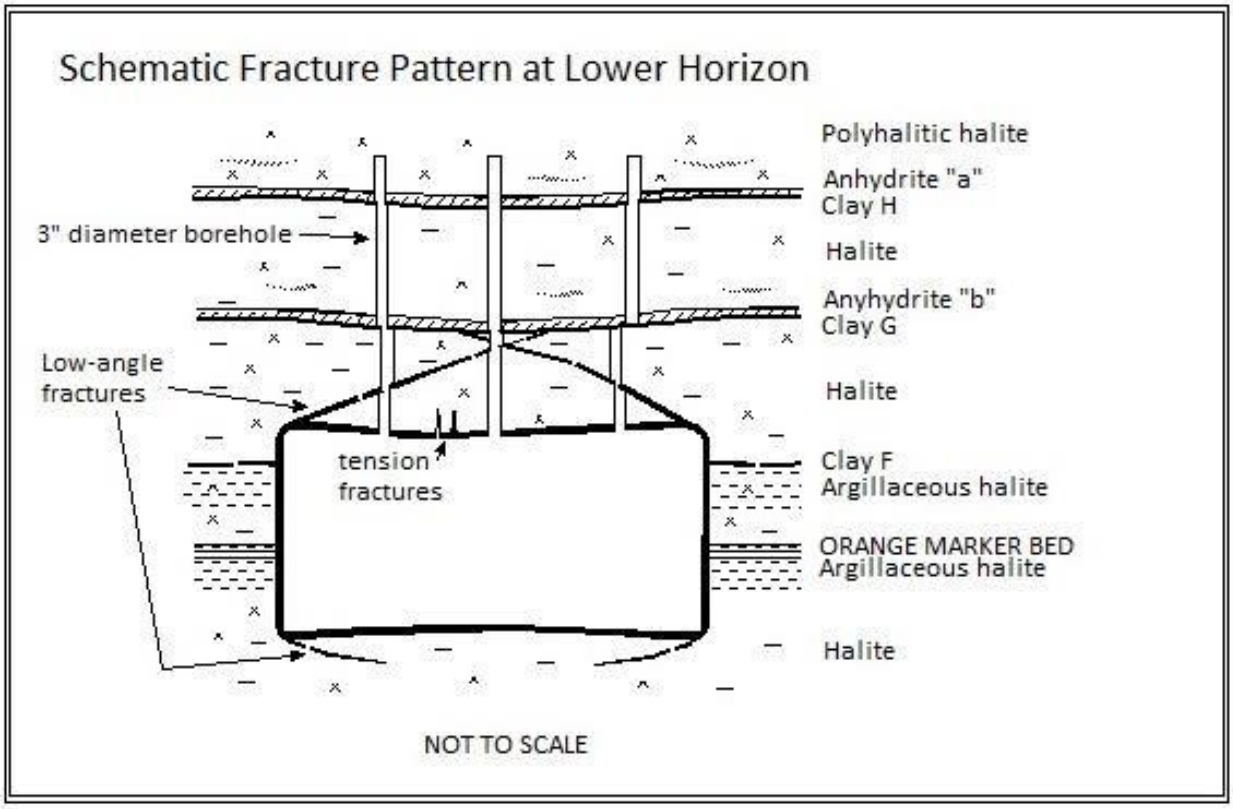

Figure 8-2 Typical Fracture Pattern at Lower Horizon

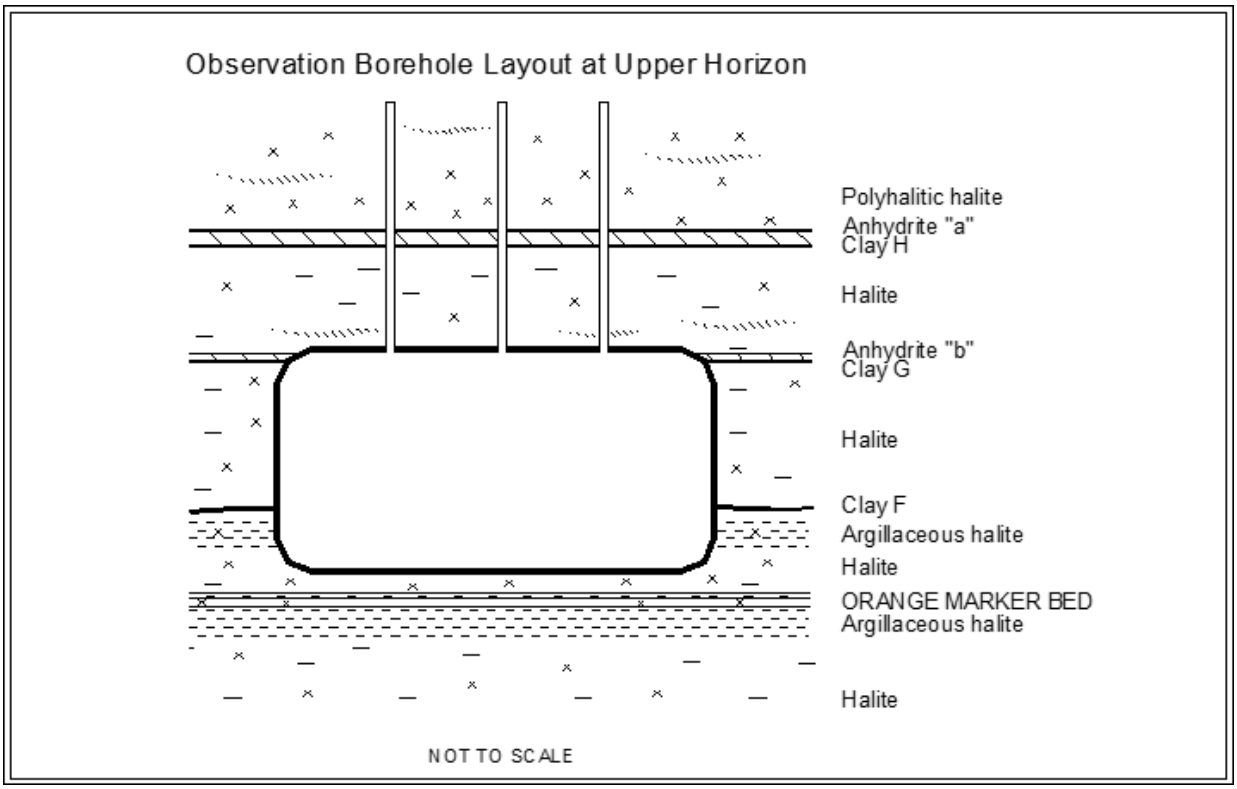

Figure 8-3 Example Observation Hole Layout at Upper Horizon

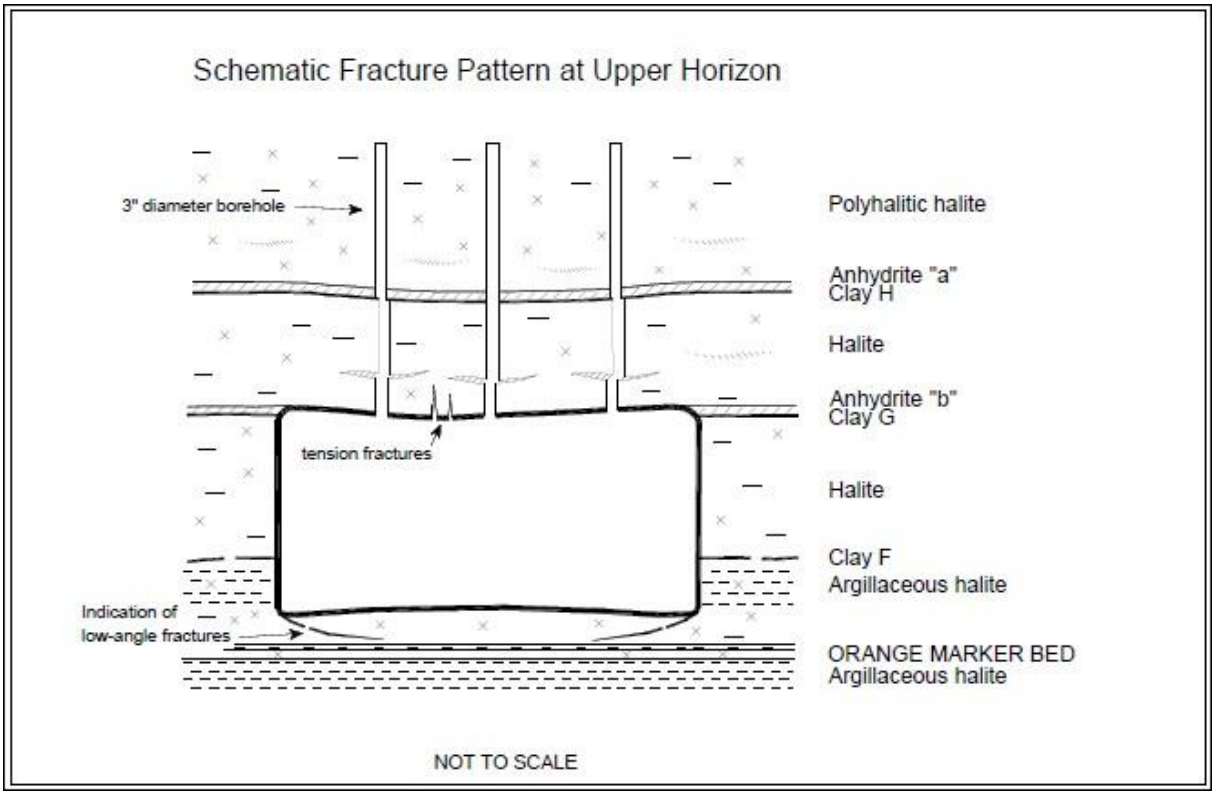

Figure 8-4 Typical Fracture Patterns at Upper Horizon

8.2 Fracture Mapping

Routine mapping documents the progression of fractures in the roof exposed on the excavation surfaces of the drifts and rooms in the underground repository. The fracture surveys are generally performed on an annual basis, and the fracture maps are updated. The fracture maps facilitate the analysis of strain in the immediate roof-beam because they document the development and propagation of fractures through time.

8.3 Stratigraphic Mapping

Stratigraphic mapping is the identification and partitioning of the sequence of rock strata based on their form, distribution, and lithological composition. It is used to verify that there are no nonconformities in the geology within the waste disposal horizon at the WIPP.

8.4 Drilling and Geologic Core Descriptions

As new panels and new experimental areas are excavated, holes are typically drilled and cored vertically into the back and into the floor to depths of 50 ft to identify and describe the stratigraphic units present.

9.0 SUMMARY

At the inception of the WIPP Project, criteria were developed that addressed the design requirements (DOE, 1984). They pertained to aspects of the mined facility and its operation for the demonstration of technical and operational methods for permanent disposal of CH and RH TRU waste. In 1994, as the DOE's focus moved toward the permanent disposal of TRU waste, these design requirements were reassessed and modified as system design descriptions. Table 9-1 shows the comparison of these design requirements with conditions actually observed in the underground from July 2021 through June 2022.

The performances of the accessible and bolted excavations continue to satisfy the appropriate design criteria. Although improvements to ground control maintenance activities in accessible areas in the underground have been made, additional efforts are still needed. Future changes to the planned life of some of the openings may require a change to the geometry of the access drifts by removing unstable roof beam or rib spalls, milling the floor for added clearance, and installing roof bolts with mesh or straps.

In addition to underground instrumentation, qualitative assessments of fracture development are documented through mapping the underground repository and inspecting the observation holes. As indicated in Section 8.0, 20 new observation boreholes were drilled and a total of 4 holes were inspected. Additionally, the accumulation of many years of collected information acquired from these programs contributes to the understanding of the dynamic geomechanical processes in the WIPP underground. This aids in the design of effective ground control and support systems.

Rough-cut mining of Panel 8 began on the lower horizon in September 2013. Mining was suspended due to the events in 2014. Mining resumed in February 2018 and was completed in January 2020 with the back at Clay G (upper horizon), due to deformation in the immediate roof beam of the lower horizon, caused by the lapse in mining and bolting after the events in 2014. The rib-cut mining was completed in October 2020. An anticipated roof fall is thought to have occurred in Panel 7, S2180-W985 (a prohibited area closed to personnel access) around July 10, 2021. Outfitting of Panel 8 is expected to be completed in July 2022.

Requirement	Comments
"The lining shall be designed for a hydrostatic pressure ....."	Water pressure observed on piezometers located behind the shaft liners remains below design levels.
"The key shall be designed to resist the lateral pressure generated by salt creep."	Visual inspections of all shaft keys do not indicate any deterioration due to creep loading.
"The key shall be designed to retain the rock formation and will be provided with chemical seal rings and a water collection ring with drains to prevent water from flowing down the unlined shaft from the lining above."	Shaft inspection observations show no indication of instability due to salt dissolution. No water has been observed flowing along the rock-liner interface.
"The underground waste disposal facilities shall be designed to provide space and adequate access for the underground equipment and temporary storage space to support underground operations."	Geomechanical instrument data and visual observations indicate that the current design provides adequate access and storage and disposal space. Ground control maintenance is performed as necessary to maintain access. If ground control activities cannot be performed in a timely manner and the geomechanical data suggest potential instability, access to the drift is to be restricted or even prohibited until ground remediation can occur.
"Entries and subentries to the underground disposal area and the experimental areas shall be provided and sized for personnel safety, adequate air flow, and space for equipment."	Deformation of excavation remains within the required limits. Normal periodic maintenance consisting of rock bolting, wire meshing, trimming, and scaling continue throughout accessible areas of the repository. Areas such as the waste transport route undergo periodic floor trims in order to maintain adequate operating height.
"Geomechanical instrumentation shall be provided to measure the cumulative deformation of the rock mass surrounding mined drifts ....."	Geomechanical instrumentation is operated and maintained to meet this requirement. This annual report provides a summary and analysis of the geomechanical data.

Table 9-1 Comparison of Excavation Performance to System Design Requirements[9]

[9] U.S Department of Energy (DOE), 1986, *Waste Isolation Pilot Plant Design Validation Final Report*, DOE-WIPP-86-010, Bechtel National, Inc., San Francisco, California.

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DOE/WIPP- 23-3610
Volume 2

Waste Isolation Pilot Plant

Geotechnical Analysis Report for July 2021 – June 2022

Supporting Data

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Waste Isolation Pilot Plant

Geotechnical Analysis Report For July 2021 – June 2022

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FOREWORD AND ACKNOWLEDGMENTS

This report contains an assessment of the geotechnical status of the Waste Isolation Pilot Plant (WIPP). During the excavation of the WIPP principal underground access and experimental areas, the status was reported quarterly. Since 1987, when the initial construction phase was completed, reports have been published annually. This report presents and analyzes data collected from July 1, 2021, to June 30, 2022.

The Geotechnical Analysis Report (GAR) prepared based on the recommendations for periodic reporting of ongoing data collection in the Design Validation Final Report (DVR) (DOE, 1986) and to satisfy several audiences. It satisfies requirements contained in the WIPP Hazardous Waste Facility Permit[1] and the Certification of Compliance[2] with Subparts B and C, Title 40 Code of Federal Regulations Part 191, Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes. The report focuses on the geotechnical performance of the various components of the WIPP underground facility, including the shafts, shaft stations, access drifts, and waste disposal areas. The results of investigations of excavation effects and other geotechnical studies are also included.

The report compares the geotechnical performance of the repository to the design criteria. It describes the techniques that were used to acquire the data. The depth and breadth of the evaluation of the different components of the underground facility according to the types, qualities, and quantities of data available and the complexity of the recorded geotechnical responses. Graphic documentation of data and tabular documentation of instrument history can be provided upon request.

This GAR was prepared by Salado Isolation Mining Contractors, LLC (SIMCO) for the U.S. Department of Energy (DOE), Carlsbad Field Office in Carlsbad, New Mexico. Work was supported by the DOE under Contract No. 89303322-DEM-000077.

[1] New Mexico Environment Department (NMED), 2023, Waste Isolation Pilot Plant Hazardous Waste Facility Permit, NM4890139088-TSDF, Santa Fe, NM

[2] U.S. Environmental Protection Agency (EPA), 1998, "Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision," Federal Register, Vol. 63, No. 95, pp. 27354, May 18, 1998, Washington, DC

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1.0 INTRODUCTION

This report is the compilation of geotechnical data for each active instrument installed in the underground at the WIPP facility from July 1, 2021 through June 30, 2022. A summary of the geotechnical analyses that were performed using the compiled data is provided in the Volume 1 of the GAR.

1.1 Instrumentation

Geomechanical instrument data included in this report reflect the measurements of the geotechnical response of the underground mine. The instruments consist of convergence points, borehole extensometers, rock bolt load cells, pressure cells, strain gauges, piezometers, and joint meters.

Closure measurements are taken at convergence points. Rock displacement is calculated by measuring the distance between two opposing points. Displacement is monitored over time and is plotted as closure versus time. Annual rates of closure are calculated for the convergence data and are compared with annual closure rates from previous reporting periods.

Borehole extensometers are used to determine the absolute movements of the ground around the openings within the mine. With these instruments, stainless steel cables are installed into a hole and anchored at various depths. The displacement at the extensometer head (located near the excavation face) is measured relative to each of the fixed anchors. These data are used in the extensometer displacement plots presented in this report. Annual rates of displacement are calculated for each extensometer and are compared with the annual displacement rate reported during the previous reporting period.

Rock bolt load cells are used to measure the load exerted by the overburden and the effectiveness of rock bolts. Plots for each instrumented rock bolt are presented as load versus time.

Earth pressure cells and strain gauges are used in and around the shaft liners to determine their loads. The data are depicted in time-based plots. Monitoring of these instruments indicates whether there are stresses building up in the shaft lining systems.

Piezometers are used to measure the gauge pressure of groundwater. They have been installed in the shafts at varying elevations to monitor the hydraulic head acting on the shaft liners. Plots from piezometers are presented as pressure versus time.

Joint meters are installed perpendicular to a crack and monitor changes in separation of the crack which may occur over time.

1.2 Data Plot Explanation

Data are presented in graphical form for ease of interpretation. Time-based plots are used in this report. Each plot generally displays a legend in the upper right-hand corner that gives the array name and specific location of the instrument or point evaluated. The legend ties the graphical cross-sectional representation of the drift or shaft typically presented in the lower right-hand corner to the symbols on the curve in the graph. For extensometers, each anchor is designated with an alpha character "A" closest to the collar and "B," "C," "D," or "E" for the furthest point from the collar (the deepest anchor). For convergence points, the horizontal and vertical sections of the drift are referred to as chords. Breaks in the graph for convergence data and a numeric designator added to the legend typically indicate that the convergence point was lost due to normal mine maintenance activities and later reinstalled.

1.3 Report Organization

Chapter 1.0 INTRODUCTION establishes a foundation for this Supporting Data volume of the GAR. Chapter 2.0 INSTRUMENTATION SUMMARY FOR THE SHAFTS provides instrument data analysis for the Salt Shaft, followed by data plots for the piezometers, Earth pressure cells, spot welded strain gauges, and embedment strain gauges installed in the Salt Shaft. Chapter 3.0 INSTRUMENTATION SUMMARY FOR THE SHAFTS STATIONS provides instrument data analysis for the Salt Shaft Station and data plots for convergence points located within the station. Chapter 4.0 INSTRUMENTATION SUMMARY FOR THE ACCESS DRIFTS provides instrument data analysis for the access drifts followed by data plots for the extensometers, convergence points, joint meters, and rock bolt load cells. Chapter 5.0 INSTRUMENTATION SUMMARY FOR THE WASTE DISPOSAL AREA provides instrument data analysis for the Waste Disposal Area followed by data plots for the extensometers and convergence points. Chapter 6.0 INSTRUMENTATION SUMMARY FOR THE SDI AREA provides convergence point instrument data analysis for the Salt Disposal Investigations (SDI) area. Chapter 7.0 GEOSCIENCE SUMMARY provides geologic data collected through the mapping of fractures, stratigraphic mapping, and the observed displacements in vertical boreholes.

2.0 INSTRUMENTATION SUMMARY FOR THE SHAFTS

Geomechanical instrumentation was originally installed in the Salt, Waste, and Exhaust Shafts. Following the construction of the Air Intake Shaft (AIS), the shaft was instrumented under the direction of Sandia National Laboratories (SNL). SNL also read and maintained the data from the AIS instrumentation for a period of time after installation.

Instrument readings from the Waste, AIS, and Exhaust Shafts are no longer available due to failed instruments, broken cabling, and/or inoperable/obsolete data acquisition equipment. Although much of the instrumentation installed in the shafts has failed through the years, there are no plans to replace it. The project has a good understanding of the expected movements in the shafts. Instrument readings up to the point of instrument failure did not indicate unusual shaft movements or displacements. Continued periodic visual inspections confirm the expected shaft performance and provide necessary observations to evaluate shaft performance. Replacement of failed instrumentation is not expected, at this time, to provide significant additional information, and will depend on what types are available to us due to funding.

Table 2-1 presents data and analysis of the Salt Shaft instrumentation. Plots of the instrument data are presented as Figures 2-1 through 2-11.

Table 2-1 Salt Handling Shaft Data Analysis

Piezometers								
Field Tag	Level feet	Figure Number	Date of 2021-2022 Max. Reading	2021-2022 Maximum Pressure Readings (psi)	Date of 2021-2022 Max. Reading	2020-2021 Maximum Pressure Readings (psi)	Change in Maximum Pressure From Previous Year (psi)	Comments [1]
37X-PE-00201	580	2-1	06/17/2022	74.5	04/16/2021	70.8	3.7	N/A
37X-PE-00202	580	2-1	06/17/2022	89.5	04/08/2021	109.3	-19.8	N/A
37X-PE-00205	691	2-2	05/11/2022	144.5	04/16/2021	142.2	2.3	N/A
37X-PE-00206	691	2-2	05/11/2022	140.1	04/16/2021	137.8	2.3	N/A
37X-PE-00210	802	2-3	04/01/2022	1.7	03/31/2021	-0.8	2.5	N/A
37X-PE-00212	850	2-4	05/11/2022	45.4	04/16/2021	52.6	-7.2	N/A
Earth Pressure Cells								
Field Tag	Level feet	Figure Number	Date of 2021-2022 Max. Reading	2021-2022 Maximum Pressure Readings (psi)	Date of 2020-2021 Max. Reading	2020-2021 Maximum Pressure Readings (psi)	Change in Maximum Pressure From Previous Year (psi)	Comments [1]
37X-WE-00201	860	2-5	02/25/2022	-13.6	03/31/2021	-13.8	0.2	N/A
37X-WE-00202	860	2-5	06/17/2022	-28.9	05/14/2021	1.2	-30.1	N/A
Spot-Welded Strain Gauges								
Field Tag	Level feet	Figure Number	Date of 2021-2022 Max. Reading	2021-2022 Maximum Strain Readings (με)	Date of 2020-2021 Max. Reading	2020-2021 Maximum Strain Readings (με)	Change in Maximum Strain From Previous Year (με)	Comments [1]
37X-ZE-00206	856.3	2-6	05/11/2022	683	04/16/2021	652	31	N/A

Table 2-1 Salt Handling Shaft Data Analysis (continued)

Embedment Strain Gauges								
Field Tag	Level feet	Figure Number	Date of 2021-2022 Max. Reading	2021-2022 Maximum Strain Readings (με)	Date of 2020-2021 Max. Reading	2020-2021 Maximum Strain Readings (με)	Change in Maximum Strain From Previous Year (με)	Comments[1]
37X-ZE-00209	856.3	2-7	06/17/2022	-495	03/31/2021	-498	3	N/A
37X-ZE-00210	856.3	2-7	02/08/2022	1005	04/16/2021	996	9	N/A
37X-ZE-00211	856.3	2-7	02/25/2022	344	04/08/2021	4252	-3908	N/A
37X-ZE-00212	856.3	2-7	06/17/2022	-674	05/14/2021	1176	-1850	N/A
37X-ZE-00213	856.3	2-7	06/17/2022	446	04/30/2021	1350	-904	N/A
37X-ZE-00214	856.3	2-7	05/11/2022	107	06/11/2021	1994	-1887	N/A
37X-ZE-00215	856.3	2-7	06/17/2022	169	05/14/2021	843	-674	N/A
37X-ZE-00216	856.3	2-7	05/11/2022	669	04/16/2021	662	7	N/A
37X-ZE-00225	862.4	2-8	02/25/2022	315	04/16/2021	312	3	N/A
37X-ZE-00226	862.4	2-8	05/11/2022	45	04/16/2021	41	4	N/A
37X-ZE-00229	862.4	2-8	05/11/2022	930	04/16/2021	908	22	N/A
37X-ZE-00230	862.4	2-8	05/11/2022	717	04/16/2021	2188	-1471	N/A
37X-ZE-00232	862.4	2-8	06/17/2022	3704	04/16/2021	625	3079	N/A
37X-ZE-00235	856.3	2-9	06/17/2022	-343	04/30/2021	1740	-2083	N/A
37X-ZE-00236	857	2-9	05/11/2022	152	05/14/2021	764	-612	N/A
37X-ZE-00237	856.3	2-9	06/17/2022	112	05/14/2021	-363	475	N/A
37X-ZE-00238	857	2-9	05/11/2022	577	04/16/2021	567	10	N/A
37X-ZE-00239	862.4	2-10	02/25/2022	420	04/16/2021	416	4	N/A
37X-ZE-00242	862.4	2-10	06/17/2022	2951	03/31/2021	96	2855	N/A

1. N/A : Not Applicable or No Comments or None

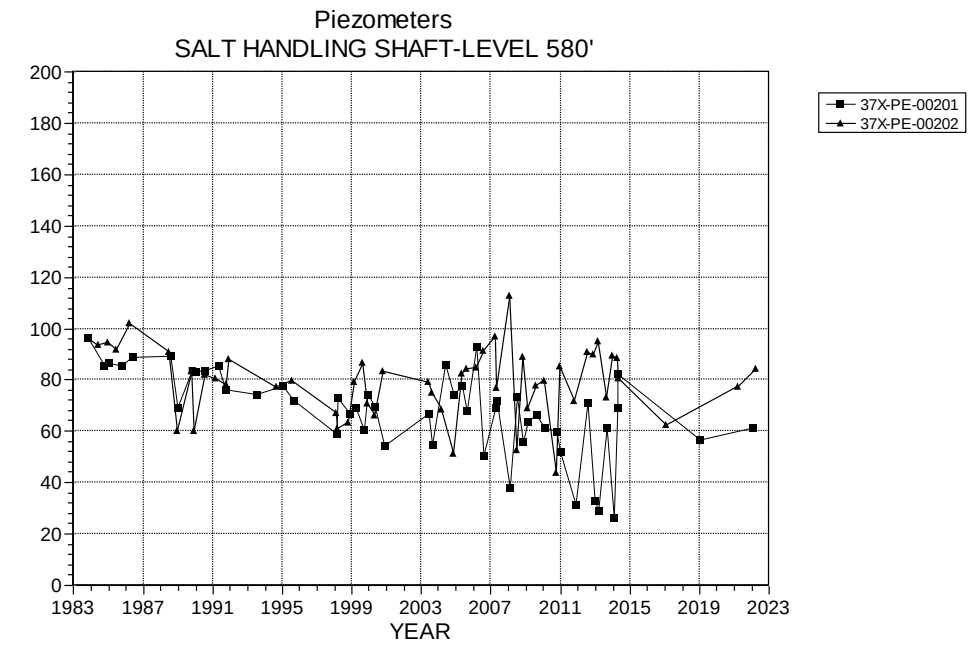

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Figure 2-1 Piezometers Salt Handling Shaft – Level 580 at the Forty-niner Member

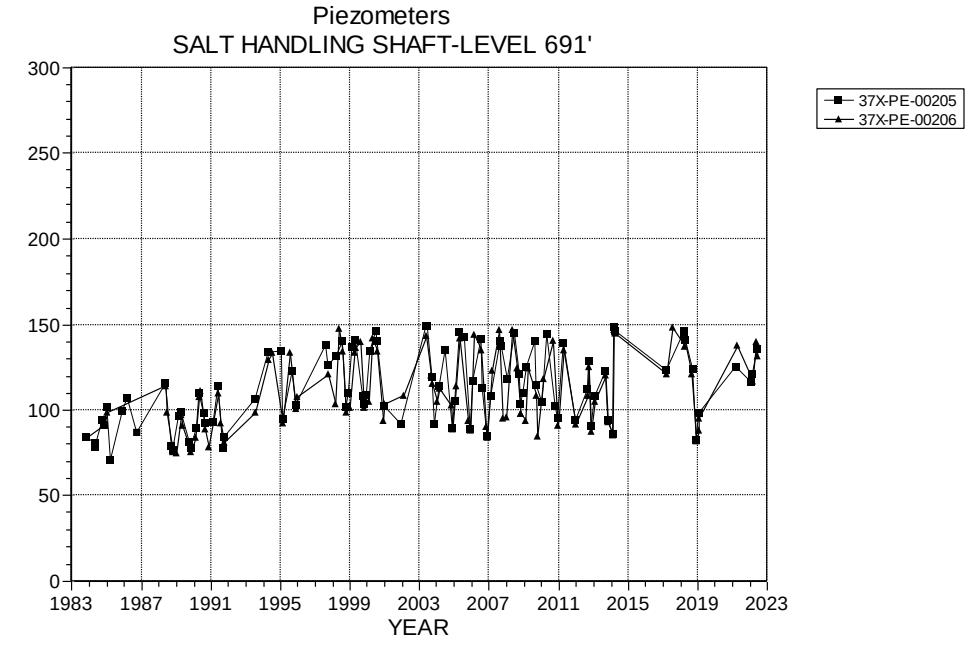


Figure 2-2 Piezometers Salt Handling Shaft – Level 691 at the Tamarisk Member

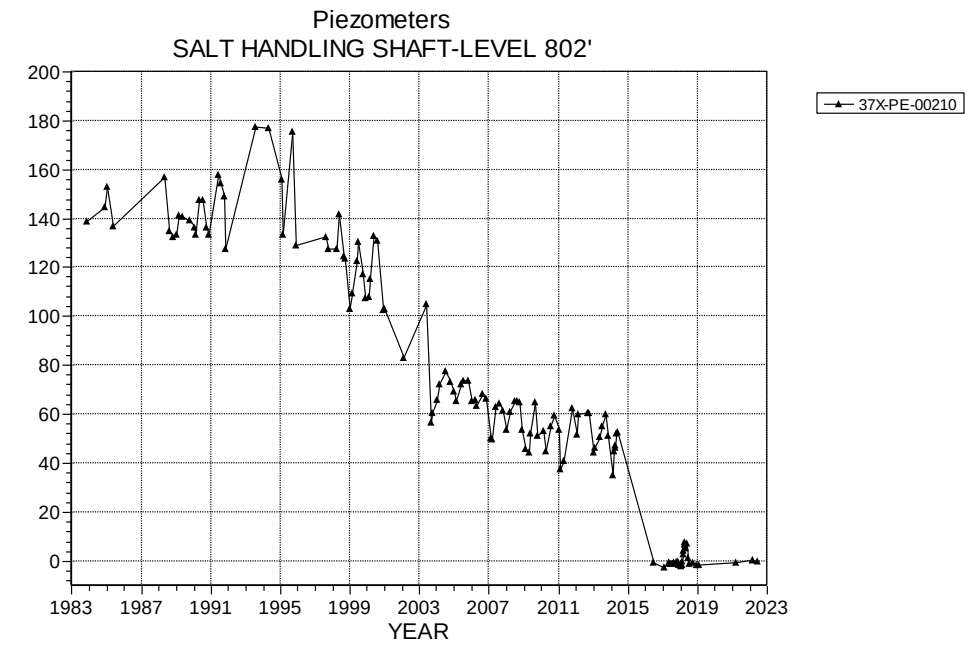


Figure 2-3 Piezometer Salt Handling Shaft – Level 802 at the Los Medaños Member

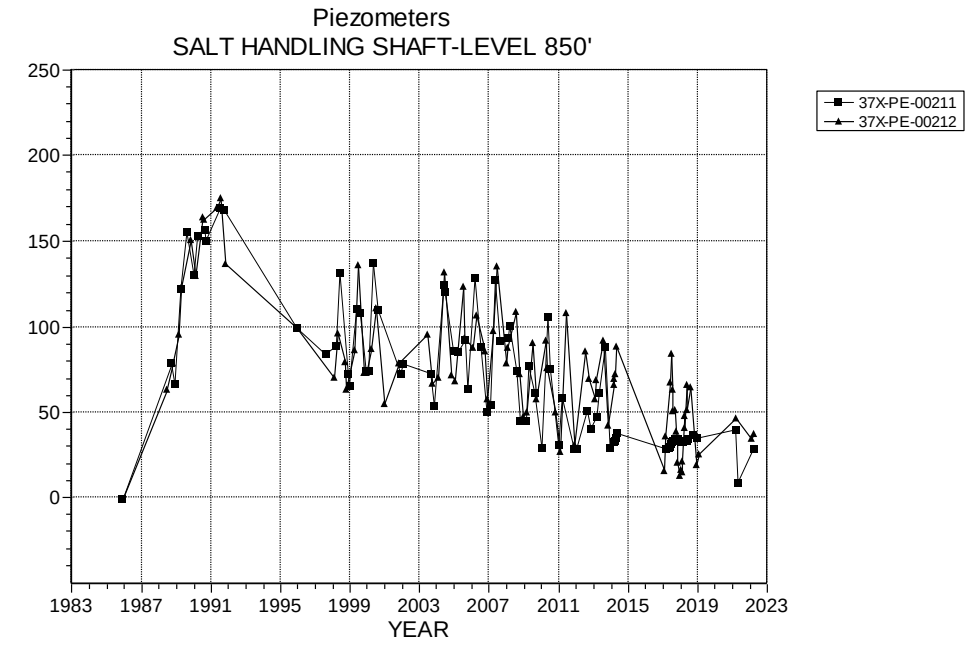


Figure 2-4 Piezometer Salt Handling Shaft – Level 850 at the Rustler-Salado Contact

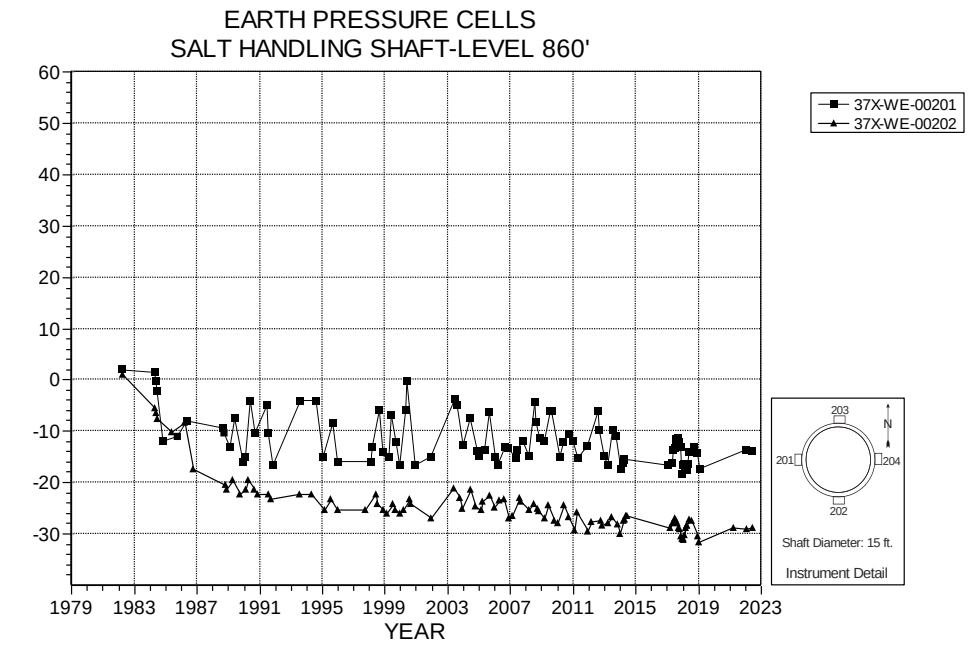


Figure 2-5 Earth Pressure Cells – Salt Handling Shaft Key – Level 860

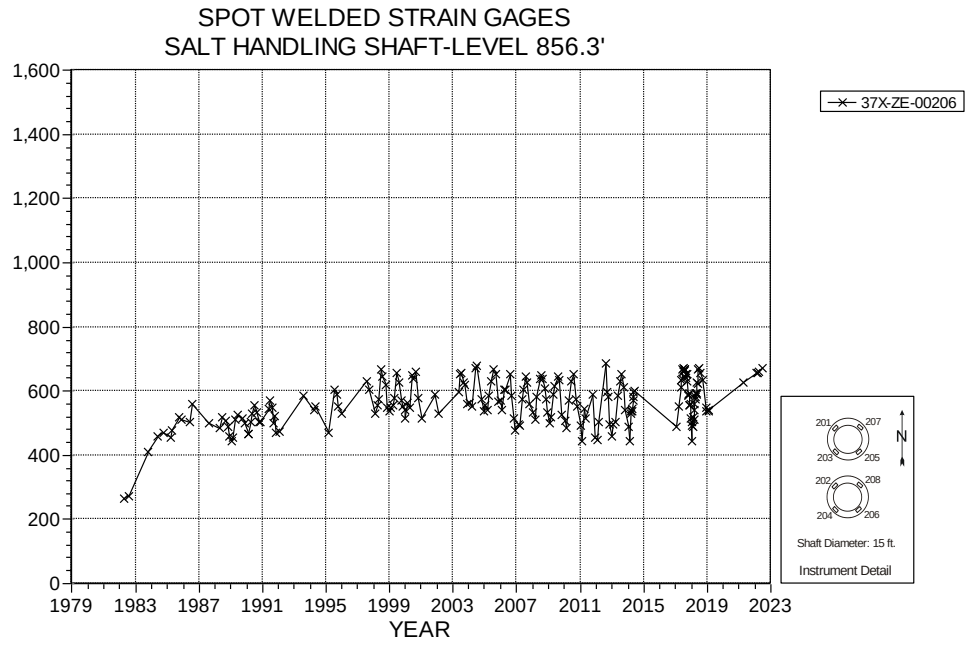
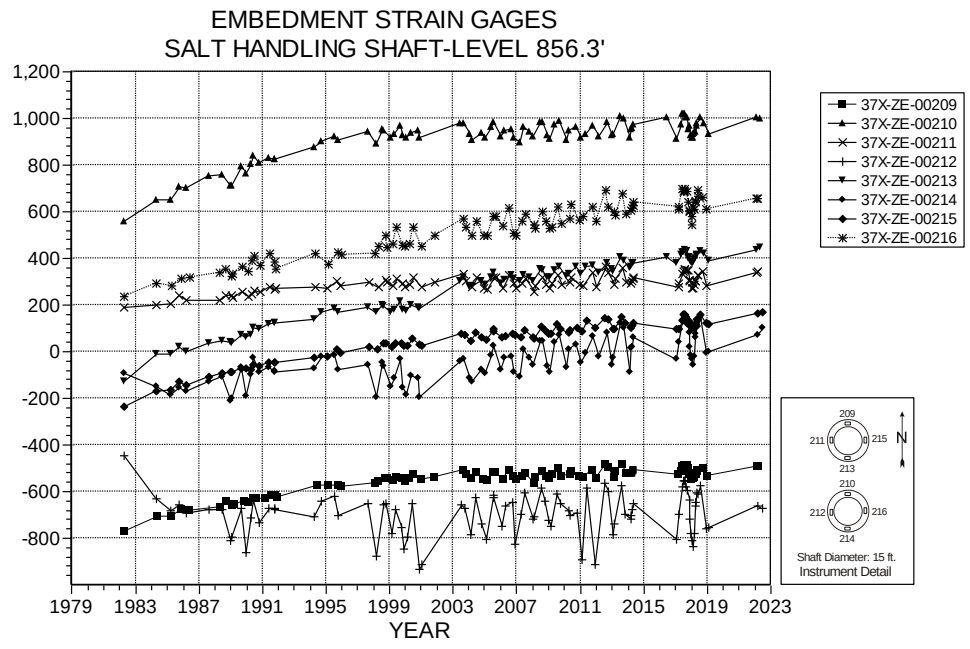
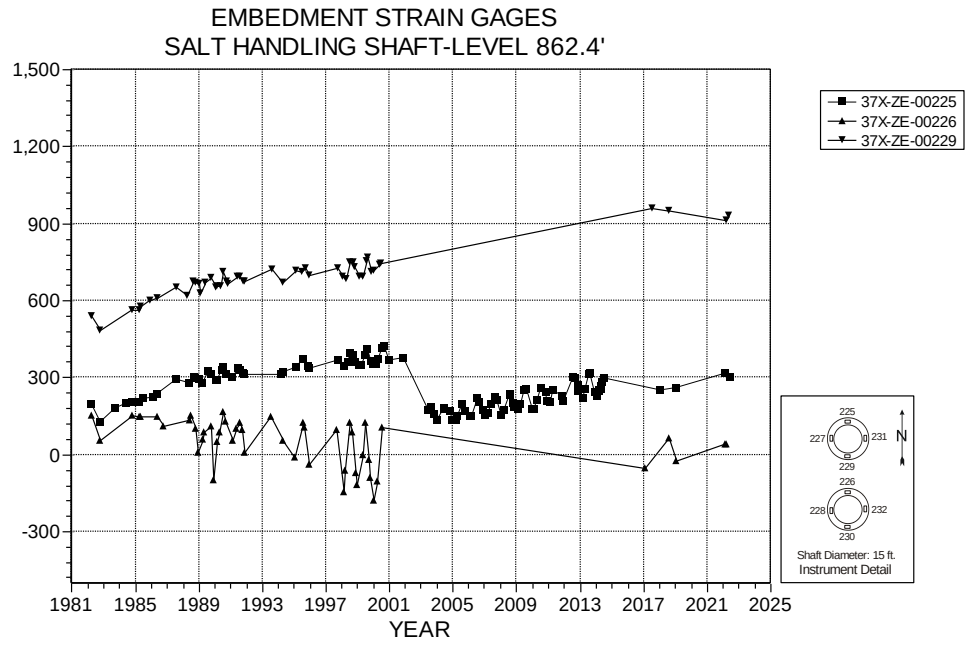


Figure 2-6 Spot Welded Strain Gauge – Salt Handling Shaft Key – Level 856.3



NOTES:

Figure 2-7 Embedment Strain Gauge – Salt Handling Shaft Key – Level 856.3



NOTES:

Figure 2-8 Embedment Strain Gauge – Salt Handling Shaft Key – Level 862.4

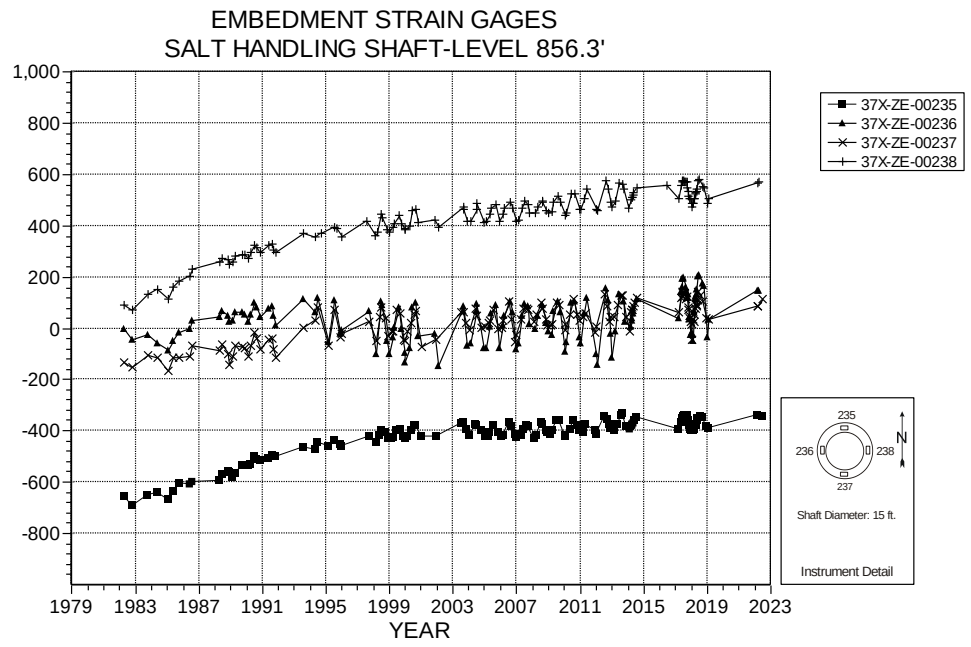


Figure 2-9 Embedment Strain Gauge – Salt Handling Shaft Key – Level 856.3

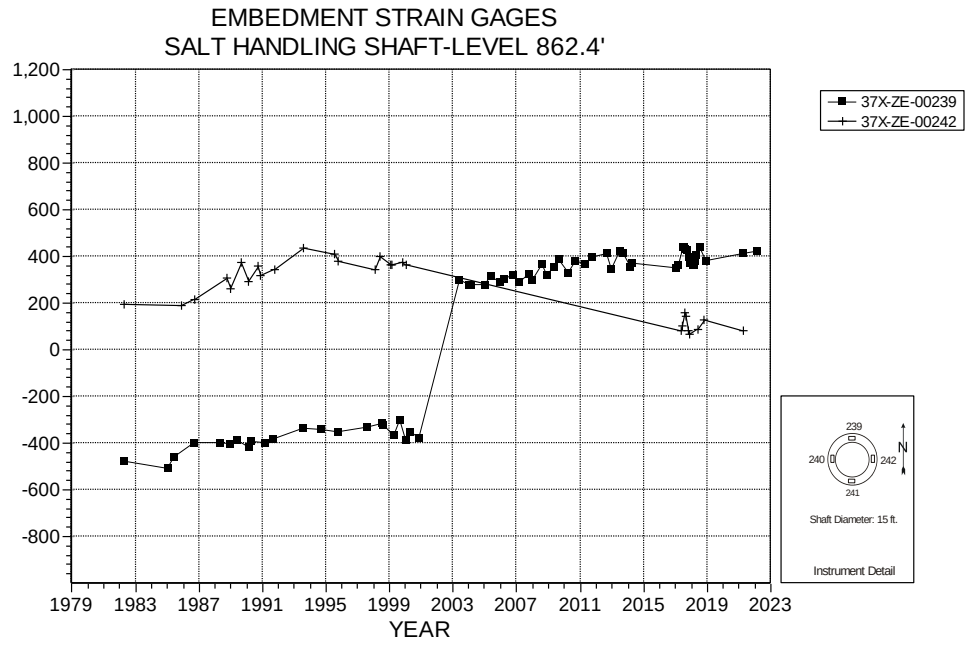


Figure 2-10 Embedment Strain Gauge – Salt Handling Shaft Key – Level 862.4

3.0 INSTRUMENTATION SUMMARY FOR THE SHAFTS STATIONS

The following instrumentation data analysis is for the Salt Handling Shaft Station. Table 3-1 presents data analyses for each of the Salt Handling Shaft Station instruments. Figures 3-1 through 3-4 present plots of the instrumentation data for the Salt Handling Shaft Station.

The Waste Shaft Station and the area around the bottom of the Air Intake Shaft are presented in Section 4.0, Table 4-1, and in the applicable graphs. Please note below the corresponding Instrument Field Tags, Locations, and Figure Number in the report.

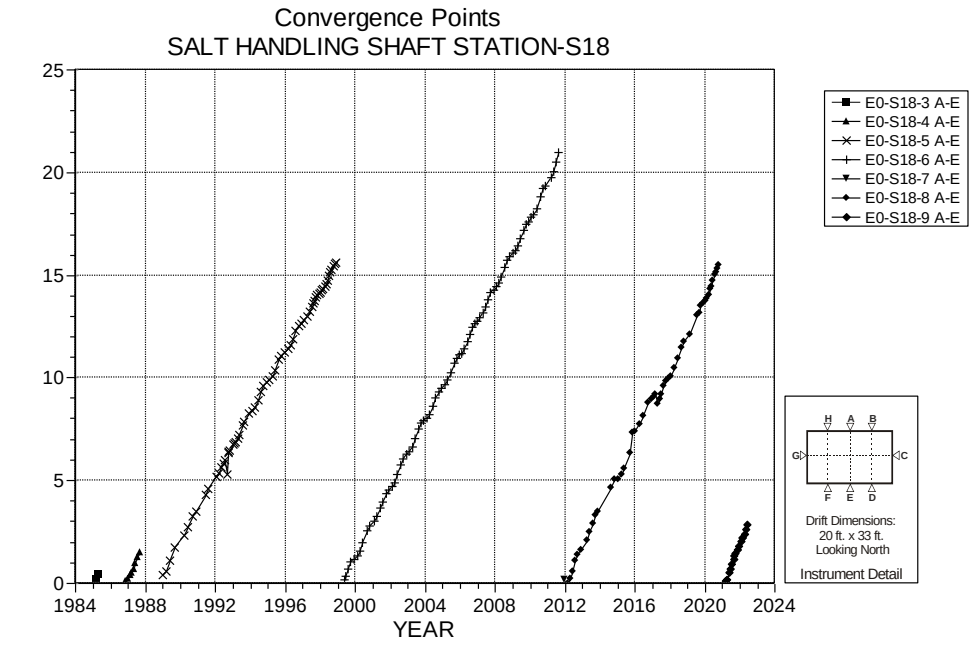
Waste Shaft Station			
Instrument Field Tag	Instrument Type	Location	Table 4-1 Figure Number
51X-GE-00404-2	Extensometer	S400-E35	4-12
W30-S400-2 A-C	Convergence Point	W30-S400	4-176

AIS Shaft Bottom			
Instrument Field Tag	Instrument Type	Location	Table 4-1 Figure Number
51X-GE-00401	Extensometer	W620- N20	4-11
51X-GE-00440	Extensometer	AIS North Brow	4-13
51X-GE-00441	Extensometer	AIS South Brow	4-14

Table 3-1 Salt Handling Shaft Station Data Analysis

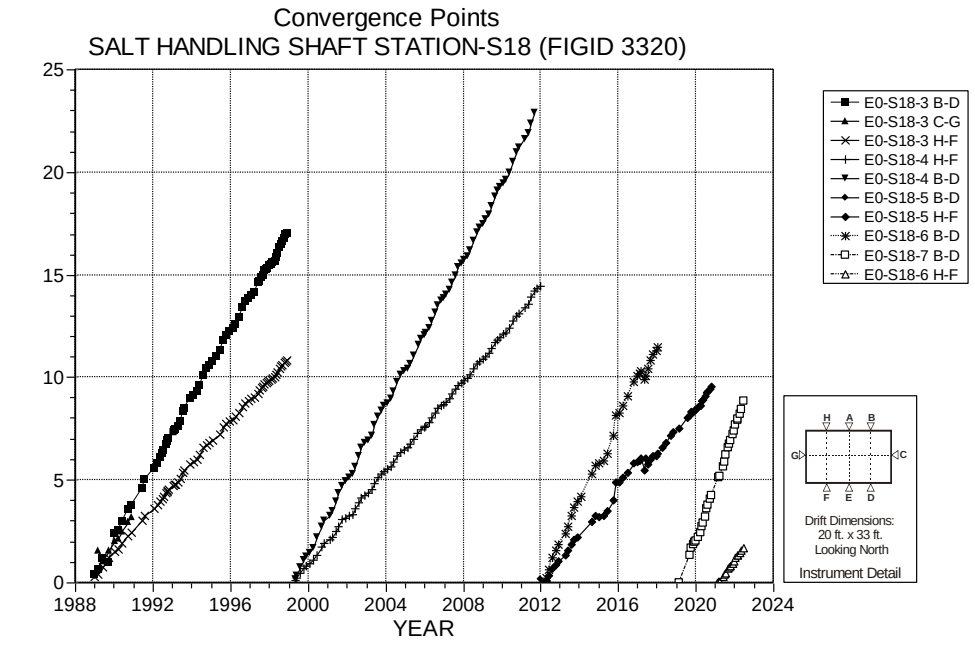
Convergence Points									
Field Tag	Location	Figure Number	Last Reading 2021-2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate 2020 to 2021 (in/year)	Rate Change Percent	Comments[1]
			Date	Inches					
E0-S18-9 A-E	E0-S18	3-1	06/16/2022	2.863	39.492	2.11	2.15	-2	N/A
E0-S18-7 B-D	E0-S18	3-2	06/16/2022	8.833	43.386	2.85	2.57	11	N/A
E0-S18-6 H-F	E0-S18	3-2	06/16/2022	1.706	25.708	1.36	1.36	0	N/A
E0-S30-7 A-C	E0-S30	3-3	06/16/2022	2.950	40.387	2.22	2.14	4	N/A
E0-S65-6 A-C	E0-S65	3-4	06/16/2022	1.998	27.628	1.51	1.36	11	N/A

1. N/A: Not Applicable or Not Available or No Comments



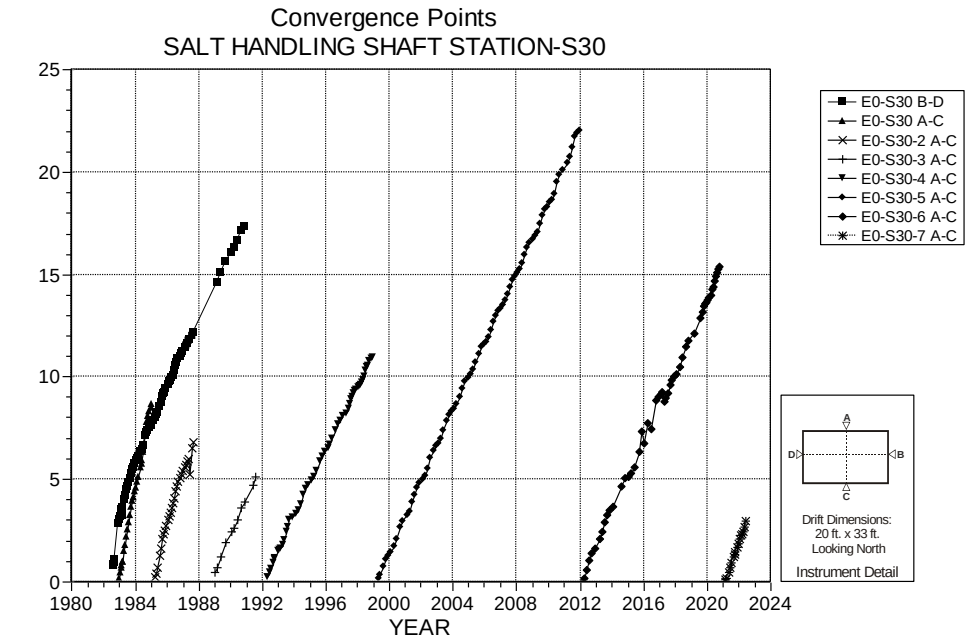
NOTES:
1. Excavation date: May 1982.

Figure 3-1 Convergence Point Array – Salt Handling Shaft Station at S18 – Roof to Floor



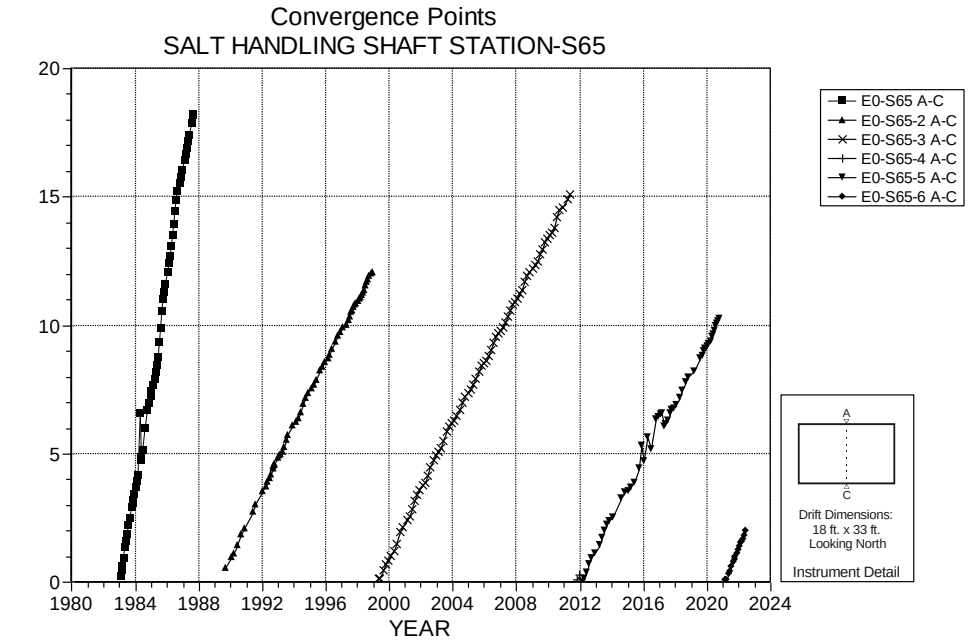
NOTES:
1. See FIGID 8455 for most recent history.
2. Rate drop on E0-S18-7 due to suspected floor fracturing at floor anchor point.

Figure 3-2 Convergence Point Array – Salt Handling Shaft Station at S18 – All Chords



NOTES:
1. Excavation date: May 1982.

Figure 3-3 Convergence Point Array – Salt Handling Shaft Station at S30 – All Chords



NOTES:
1. Excavation date: May 1982.

Figure 3-4 Convergence Point Array – Salt Handling Shaft Station at S65 – Roof to Floor

4.0 INSTRUMENTATION SUMMARY FOR THE ACCESS DRIFTS

This chapter presents the instrumentation data and data analyses for the access drifts throughout the WIPP underground:

- Table 4-1 provides the results of analyses performed on the instrument data including displacement, convergence rates, and rock bolt loading.
- Figures 4-1 through 4-5 present data from convergence meters in the access drifts.
- Figures 4-6 through 4-14 present data from borehole extensometers installed in the access drifts.
- Figures 4-15 through 4-215 present the convergence point data.
- Figures 4-200 through 4-203 present the AIS brow support rock bolt load cell data.

Table 4-1 Access Drifts Data Analysis

Wire Convergence Meters								
Field Tag	Location	Figure Number	Date of Last Reading	Displacement (inches)	Displacement Rate 2021 to 2022 (in/year)	Displacement Rate 2020 to 2021 (in/year)	Rate Change Percent[1]	Comments
51X-CW-01037	E140-S2750	4-1	6/08/2022	21.188	4.43	4.20	5	N/A
51X-CW-01038	W30-S2750	4-2	6/08/2022	33.482	5.06	6.61	-23	Max range reached 3/16/2022
51X-CW-01039	W170-S2735	4-3	6/08/2022	11.085	2.41	2.66	-9	N/A
51X-PG-00446	N460-E320	4-4	6/01/2022	4.157	1.14	1.14	0	N/A
51X-CW-01051-2	S2180-E80	4-5	6/29/2022	8.633	4.62	4.38	5	N/A
51X-CW-01052	S2180-E100	4-6	6/29/2022	3.781	2.05	1.93	6	N/A
Extensometers								
Field Tag	Location	Figure Number	Date of Last Reading	Collar Displacement Relative to Deepest Anchor (inches)	Displacement Rate 2021 to 2022 (in/year)	Displacement Rate[1] 2020 to 2021 (in/year)	Rate Change Percent[1]	Comments
51X-GE-00352-2	E0-N940	4-7	6/30/2022	3.883	1.16	1.22	-5	N/A
51X-GE-00353	E0-N626	4-8	6/30/2022	-0.877	-18.19	1.11	-1739	Max range reached 4/22/2022
51X-GE-00364	E140-N1266	4-9	6/30/2022	14.262	0.59	0.94	-37	N/A
51X-GE-00374	E300-N1186	4-10	6/30/2022	15.780	0.75	0.94	-20	N/A
51X-GE-00388	E300-N1266	4-11	6/30/2022	12.462	0.73	0.71	3	N/A
51X-GE-00401	W620- N20	4-12	6/30/2022	3.350	0.24	0.25	-4	N/A
51X-GE-00404-2	Waste Shaft Station	4-13	6/30/2022	3.516	0.31	0.29	7	N/A
51X-GE-00440	AIS North Brow	4-14	6/01/2022	1.491	0.30	0.29	3	N/A
51X-GE-00441	AIS South Brow	4-15	6/01/2022	1.788	0.34	0.28	21	N/A

Table 4-1 Access Drifts Data Analysis (continued)

Convergence Points									
Field Tag	Location	Figure Number	Last Reading 2021 - 2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent[1]	Comments
			Date	Inches					
E0-N75 A-C	E0-N75	4-16	6/16/2022	41.263	41.263	2.4	2.1	14	N/A
E0-N225-5 A-C	E0-N225	4-17	6/16/2022	5.662	53.477	1.8	1.6	13	N/A
E0-N300-6 A-C	E0-N300	4-18	3/3/2022	20.300	71.345	1.7	1.7	0	N/A
E0-N460-5 A-C	E0-N460	4-19	6/16/2022	5.664	66.741	2.3	2.0	15	N/A
E0-N562 A-C	E0-N562	4-20	6/16/2022	42.118	42.118	2.8	2.8	0	N/A
E0-N626-5 A-C	E0-N626	4-21	6/16/2022	16.993	88.389	2.7	2.6	4	N/A
E0-N686 A-C	E0-N686	4-22	6/16/2022	48.103	48.103	2.8	3.2	-13	N/A
E0-N780-2 A-C	E0-N780	4-23	6/16/2022	40.574	60.996	2.2	2.1	5	N/A
E0-N940-5 A-C	E0-N940	4-24	6/16/2022	48.062	96.114	2.8	2.6	8	N/A
E0-N1110-5 A-C	E0-N1110	4-25	6/16/2022	29.292	63.716	1.6	1.5	7	N/A
E0-N1266-4 A-C	E0-N1266	4-26	6/16/2022	45.331	82.238	2.2	2.3	-4	N/A
E0-N1420-2 A-C	E0-N1420	4-27	6/16/2022	22.185	36.649	1.2	1.0	20	N/A
E140-N5-8 A-C	E140-N5	4-28	6/2/2022	2.015	72.041	2.0	2.0	0	N/A
E140-N150-7 A-C	E140-N150	4-29	6/2/2022	2.104	47.708	2.0	2.6	-23	N/A
E140-N250-5 A-C	E140-N250	4-30	6/2/2022	1.893	24.477	1.8	1.9	-5	N/A
E140-N355-3 A-C	E140-N355	4-31	6/2/2022	2.829	45.595	2.7	3.1	-13	N/A
E140-N460-4 A-C	E140-N460	4-32	6/2/2022	2.230	64.952	2.1	2.6	-19	N/A
E140-N562-4 A-C	E140-N562	4-33	6/2/2022	3.246	60.458	3.0	3.1	-3	N/A
E140-N626-4 A-C	E140-N626	4-34	6/2/2022	7.134	96.541	3.9	3.0	30	N/A
E140-N686-3 A-C	E140-N686	4-35	6/2/2022	5.341	61.381	2.7	2.5	8	N/A
E140-N780-5 A-C	E140-N780	4-36	6/2/2022	2.287	80.564	2.1	1.8	17	N/A
E140-N940-3 A-C	E140-N940	4-37	6/2/2022	2.239	84.195	2.6	N/A	N/A	No Readings Taken for ’20-‘21.
E140-N1100-2 A-C	E140-N1100	4-38	6/2/2022	29.88	49.603	1.5	1.3	15	N/A
E140-N1266-3 A-C	E140-N1266	4-39	6/2/2022	48.333	86.088	2.5	2.5	0	N/A
E140-N1420-2 A-C	E140-N1420	4-40	6/16/2022	32.719	49.189	1.7	1.5	13	N/A
E140-S90-5 A-C	E140-S90	4-41	6/2/2022	2.127	49.163	2.1	2.7	-22	N/A
E140-S262-5 A-C	E140-S262	4-42	6/22/2022	20.764	57.785	2.3	2.0	15	N/A
E140-S460-8 A-C	E140-S460	4-43	6/22/2022	2.054	71.620	2.1	2.0	5	N/A

Table 4-1 Access Drifts Data Analysis (continued)

Convergence Points (continued)									
Field Tag	Location	Figure Number	Last Reading 2021-2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent[1]	Comments
			Date	Inches					
E140-S550-8 A-C	E140-S550	4-44	6/22/2022	4.552	64.429	2.4	2.1	14	N/A
E140-S700-9 A-D	E140-S700	4-45	6/22/2022	5.149	57.064	2.5	2.4	4	N/A
E140-S1000-5 A-C	E140-S1000	4-46	5/24/2022	16.424	56.771	2.1	1.8	17	N/A
E140-S1025-6 A-C	E140-S1025	4-47	6/22/2022	12.411	47.275	2.5	2.2	14	N/A
E140-S1075-5 A-E	E140-S1075	4-48	6/22/2022	29.696	58.498	3.6	3.5	3	N/A
E140-S1150-7 A-G	E140-S1150	4-49	6/22/2022	4.494	73.307	3.4	3.3	3	N/A
E140-S1225-7 A-E	E140-S1225	4-50	6/22/2022	4.690	67.988	3.4	3.1	10	N/A
E140-S1300-7 A-C	E140-S1300	4-51	6/22/2022	2.631	52.455	2.1	1.7	24	N/A
E140-S1378-4 A-E	E140-S1378	4-52	6/22/2022	30.808	73.349	3.2	3.0	7	N/A
E140-S1450-6 A-G	E140-S1450(1456)	4-53	6/22/2022	34.699	115.506	4.1	3.5	17	N/A
E140-S1496 A-E	E140-S1496 (Test Area)	4-54	6/14/2022	1.062	10.434	3.6	3.2	13	N/A
E140-S1496 B-D	E140-S1496 (Test Area)	4-55	6/14/2022	0.477	4.077	1.6	1.5	7	N/A
E140-S1496 H-F	E140-S1496 (Test Area)	4-56	6/14/2022	6.067	6.067	2.2	1.9	16	N/A
E140-S1534-5 A-E	E140-S1534 (Test Area)	4-57	6/14/2022	9.799	80.313	3.2	2.9	10	N/A
E140-S1534-6 B-D	E140-S1534 (Test Area)	4-58	9/23/2021	8.407	57.294	6.5	3.5	86	N/A
E140-S1534-5 H-F	E140-S1534 (Test Area)	4-59	8/13/2021	7.373	60.423	3.3	2.9	14	N/A
E140-S1548 A-E	E140-S1548 (Test Area)	4-60	6/14/2022	9.64	9.64	3.2	3.0	7	N/A
E140-S1548 B-D	E140-S1548 (Test Area)	4-61	6/14/2022	5.639	5.639	2.0	1.6	25	N/A
E140-S1548 H-F	E140-S1548 (Test Area)	4-62	6/14/2022	8.741	8.741	3.1	2.8	11	N/A
E140-S1600-8 A-C	E140-S1600	4-63	3/17/2022	3.849	71.941	3.7	3.5	6	N/A
E140-S1667 B-D	E140-S1667 (Test Area)	4-64	5/16/2022	10.202	10.202	3.9	3.0	30	N/A
E140-S1667 A-E	E140-S1667 (Test Area)	4-65	6/14/2022	10.283	10.283	3.3	3.4	-3	N/A
E140-S1667 H-F	E140-S1667 (Test Area)	4-66	6/14/2022	9.988	9.988	3.4	2.9	17	N/A
E140-S1687-5 A-E	E140-S1687	4-67	6/22/2022	16.014	79.468	3.9	3.4	15	N/A
E140-S1699 B-D	E140-S1699 (Test Area)	4-68	6/14/2022	9.764	9.764	3.5	3.2	9	N/A
E140-S1699 H-F	E140-S1699 (Test Area)	4-69	6/14/2022	8.817	8.817	3.4	2.7	26	N/A
E140-S1717 B-D	E140-S1717 (Test Area)	4-70	6/14/2022	7.507	7.507	2.7	2.4	13	N/A
E140-S1717 A-E	E140-S1717 (Test Area)	4-71	6/14/2022	10.558	10.558	3.7	3.3	12	N/A

Table 4-1 Access Drifts Data Analysis (continued)

Convergence Points (continued)									
Field Tag	Location	Figure Number	Last Reading 2021-2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent [1]	Comments
			Date	Inches					
E140-S1717 H-F	E140-S1717 (Test Area)	4-72	6/14/2022	13.664	13.664	5.0	4.5	11	N/A
E140-S1775-5 A-G	E140-S1775 (1784)	4-73	6/22/2022	5.121	104.098	3.9	3.6	8	N/A
E140-S1862-5 A-E	E140-S1862	4-74	6/22/2022	4.909	86.452	3.8	3.5	9	N/A
E140-S1950-8 A-C	E140-S1950	4-75	6/27/2022	5.672	93.801	4.1	3.7	11	N/A
E140-S2007-8 A-C	E140-S2007	4-76	6/27/2022	42.883	87.41	4.4	4.1	7	N/A
E140-S2065-8 A-C	E140-S2065	4-77	6/27/2022	18.975	82.707	3.6	3.4	6	N/A
E140-S2122-8 A-C	E140-S2122	4-78	6/27/2022	21.033	80.986	4.1	3.9	5	N/A
E140-S2170 A-C	E140-S2170	4-79	6/30/2022	5.145	5.145	4.1	4.5	-9	N/A
E140-S2190 A-C	E140-S2190	4-80	6/30/2022	4.559	4.559	3.6	4.0	-10	N/A
E140-S2275-7 A-C	E140-S2275	4-81	6/8/2022	52.733	131.67	5.8	5.7	2	N/A
E140-S2350-7 A-C	E140-S2350	4-82	6/8/2022	51.942	134.655	6.1	5.9	3	N/A
E140-S2425-6 A-C	E140-S2425	4-83	6/8/2022	43.592	99.098	4.8	4.7	2	N/A
E140-S2520-4 A-C	E140-S2520	4-84	6/8/2022	36.655	77.431	3.8	3.7	3	N/A
E220-S2180-2 A-C	E220-S2180	4-85	6/15/2022	5.265	30.024	1.9	1.8	6	N/A
E300-N45-2 A-E	E300-N45	4-86	6/2/2022	16.846	49.727	1.8	1.6	13	N/A
E300-N170-3 A-E	E300-N170	4-87	6/2/2022	20.421	53.895	2.2	2.0	10	N/A
E300-N250-5 A-C	E300-N250	4-88	6/2/2022	11.636	63.557	2.3	2.5	-8	N/A
E300-N280 A-C	E300-N280	4-89	6/2/2022	8.341	8.341	1.7	1.5	13	N/A
E300-N360 A-C	E300-N360	4-90	6/2/2022	7.697	7.697	1.7	1.3	31	N/A
E300-N440 A-C	E300-N440	4-91	6/2/2022	7.670	7.670	1.5	1.1	36	N/A
E300-N500 A-C	E300-N500	4-92	6/2/2022	5.356	5.356	1.1	0.7	57	N/A
N1100-E300-2 A-C	N1100-E300	4-93	6/16/2022	19.665	21.890	1.7	1.6	6	N/A
E300-N1262-5 A-C	E300-N1262	4-94	6/16/2022	5.171	53.304	2.9	2.6	12	N/A
E300-N1341-4 A-C	E300-N1341	4-95	6/16/2022	5.3	48.459	2.5	2.5	0	N/A
E300-S45-3 A-E	E300-S45	4-96	6/2/2022	13.73	40.934	1.5	1.4	7	N/A
E300-S90-3 A-C	E300-S90	4-97	6/2/2022	11.397	31.674	1.2	1.1	9	N/A
E300-S250-2 A-C	E300-S250	4-98	6/2/2022	17.578	21.963	1.0	0.6	67	N/A
E300-S400 A-C	E300-S400	4-99	6/15/2022	3.132	3.132	1.3	1.1	18	N/A
E300-S550 A-C	E300-S550	4-100	6/15/2022	1.708	1.708	0.8	0.5	60	N/A
E300-S700-2 A-C	E300-S700	4-101	6/15/2022	17.196	36.926	1.7	1.5	13	N/A
E300-S850-2 A-E	E300-S850	4-102	6/15/2022	8.933	24.015	1.0	0.8	25	N/A

Table 4-1 Access Drifts Data Analysis (continued)

Convergence Points (continued)									
Field Tag	Location	Figure Number	Last Reading 2021-2022 Date	Last Reading 2021-2022 Inches	Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent [1]	Comments
E300-S1000-2 A-C	E300-S1000	4-103	6/15/2022	12.025	31.57	1.3	1.0	30	N/A
E300-S1150-5 A-E	E300-S1150	4-104	6/15/2022	5.455	35.464	2.0	1.8	11	N/A
E300-S1300-3 A-C	E300-S1300	4-105	6/15/2022	4.185	28.616	1.5	1.4	7	N/A
E300-S1450-3 A-C	E300-S1450	4-106	6/15/2022	5.443	25.482	1.9	1.7	12	N/A
E300-S1687-3 A-C	E300-S1687	4-107	6/15/2022	1.853	23.724	2.0	1.9	5	N/A
E300-S1775-3 A-C	E300-S1775	4-108	6/15/2022	4.962	24.690	1.9	1.7	12	N/A
E300-S1862-3 A-C	E300-S1862	4-109	6/15/2022	4.739	26.193	1.8	1.6	13	N/A
E300-S2065-3 A-C	E300-S2065	4-110	6/15/2022	5.383	29.605	2.0	1.9	5	N/A
E300-S2275-3 A-C	E300-S2275	4-111	6/15/2022	9.751	45.154	3.4	3.4	0	N/A
E300-S2350-3 A-C	E300-S2350	4-112	6/15/2022	10.310	58.846	3.8	3.7	3	N/A
E300-S2425-3 A-C	E300-S2425	4-113	6/15/2022	8.938	48.935	3.4	3.2	6	N/A
N140-E90-3 A-C	N140-E90	4-114	6/2/2022	7.044	25.679	1.0	0.8	25	N/A
N215-W500-2 A-C	N215-W500	4-115	6/27/2022	24.653	42.982	1.4	1.0	40	N/A
N215-W620-2 A-C	N215-W620	4-116	6/27/2022	19.499	35.717	1.2	0.8	50	N/A
N250-E220-4 A-E	N250-E220	4-117	6/2/2022	0.877	63.929	2.5	2.6	-4	N/A
N300-W170-2 A-C	N300-W170	4-118	6/27/2022	31.095	53.355	1.8	1.6	13	N/A
N460-E70-3 A-C	N460-E70	4-119	6/16/2022	31.977	48.423	1.5	1.5	0	N/A
N460-E220 A-C	N460-E220	4-120	6/17/2022	0	0	N/A	N/A	N/A	Initial Reading for a Re-installation
N460-E310 A-C	N460-E310	4-121	6/2/2022	8.992	8.992	1.8	1.3	38	N/A
N780-E70 A-C	N780-E70	4-122	6/16/2022	27.699	27.699	1.6	1.4	14	N/A
N1420-E79 A-C	N1420-E79	4-123	6/16/2022	8.174	8.174	1.5	1.4	7	N/A
N1420-E212 A-C	N1420-E212	4-124	6/16/2022	7.427	7.427	1.4	1.3	8	N/A
N1420-E300 A-C	N1420-E300	4-125	6/16/2022	32.508	32.508	1.8	1.6	13	N/A
S90-E220 A-C	S90-E220	4-126	6/2/2022	8.888	8.888	1.0	0.9	11	N/A
S90-E360 A-C	S90-E360	4-127	6/2/2022	0.97	0.97	1.1	N/A	N/A	New Installation
S90-E420 A-C	S90-E420	4-128	6/2/2022	1.344	1.344	1.6	N/A	N/A	New Installation
S90-E480 A-C	S90-E480	4-129	6/2/2022	1.182	1.182	1.4	N/A	N/A	New Installation
S90-W120 A-C	S90-W120	4-130	6/7/2022	14.334	14.334	0.8	0.6	33	N/A

Table 4-1 Access Drifts Data Analysis (continued)

Convergence Points (continued)									
Field Tag	Location	Figure Number	Last Reading 2021-2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020to 2021 (in/year)	Rate Change Percent [1]	Comments
			Date	Inches					
S90-W400-3 A-C	S90-W400	4-131	6/7/2022	5.112	23.964	0.7	0.6	17	N/A
S90-W590-2 A-C	S90-W590	4-132	6/7/2022	10.294	19.623	0.8	0.6	33	N/A
S90-W620 A-C	S90-W620	4-133	6/7/2022	36.582	36.582	1.1	1.0	10	N/A
S400-E10 A-C	S400-E10	4-134	6/22/2022	1.513	1.513	1.1	0.9	22	N/A
S400-E360 A-C	S400-E360	4-135	6/15/2022	3.244	3.244	1.3	1.1	18	N/A
S400-E420 A-C	S400-E420	4-136	6/15/2022	3.244	3.244	1.3	0.9	44	N/A
S400-W20-2 A-C	S400-W20	4-137	6/13/2022	1.594	1.715	1.4	1.5	-7	N/A
S400-W198 A-C	S400-W198 CORE STORAGE	4-138	6/27/2022	32.362	32.362	1.4	N/A	N/A	No Readings Taken for ’20 – ‘21
S400-W208 A-C	S400-W208 CORE STORAGE	4-139	6/27/2022	34.113	34.113	1.4	1.0	40	N/A
S400-W240 A-C	S400-W240 CORE STORAGE	4-140	6/27/2022	41.276	41.276	1.6	N/A	N/A	No Readings Taken for ’20 – ‘21
S400-W251 A-C	S400-W251 CORE STORAGE	4-141	6/27/2022	41.619	41.619	1.7	1.3	31	N/A
S400-W279 A-C	S400-W279 CORE STORAGE	4-142	6/27/2022	39.865	39.865	1.4	N/A	N/A	No Readings Taken for ’20 – ‘21
S400-W295 A-C	S400-W295 CORE STORAGE	4-143	6/27/2022	35.759	35.759	1.2	N/A	N/A	No Readings Taken for ’20 – ‘21
S700-W98-5 A-C	S700-W98	4-144	6/7/2022	1.312	44.658	3.7	2.1	76	N/A
S700-W245 A-C	S700-W245	4-145	6/30/2022	0.848	0.848	4.8	N/A	N/A	New Installation
S700-W320 A-C	S700-W320	4-146	6/30/2022	1.019	1.019	5.7	N/A	N/A	New Installation
S700-W395 A-C	S700-W395	4-147	6/30/2022	1.378	1.378	7.7	N/A	N/A	New Installation
S700-W470 A-C	S700-W470	4-148	6/30/2022	1.9	1.9	10.7	N/A	N/A	New Installation
S700-W545 A-C	S700-W545	4-149	6/30/2022	1.071	1.071	11.2	N/A	N/A	New Installation
S700-W620 A-C	S700-W620	4-150	6/30/2022	3.215	3.215	33.6	N/A	N/A	New Installation
S850-W245 A-C	S850-W245	4-151	6/30/2022	0.327	0.327	4.0	N/A	N/A	New Installation
S850-W320 A-C	S850-W320	4-152	6/30/2022	0.422	0.422	5.1	N/A	N/A	New Installation
S1000-E58-4 A-C	S1000-E58	4-153	6/22/2022	23.169	38.635	1.5	1.3	15	N/A
S1000-E120-3 A-C	S1000-E120	4-154	6/22/2022	20.213	28.653	1.4	1.1	27	N/A
S1000-E160-3 A-C	S1000-E160	4-155	6/22/2022	13.214	21.424	1.1	1.0	10	N/A
S1000-W98-2 A-C	S1000-W98	4-156	6/13/2022	36.272	55.02	2.3	1.7	35	N/A

Table 4-1 Access Drifts Data Analysis (continued)

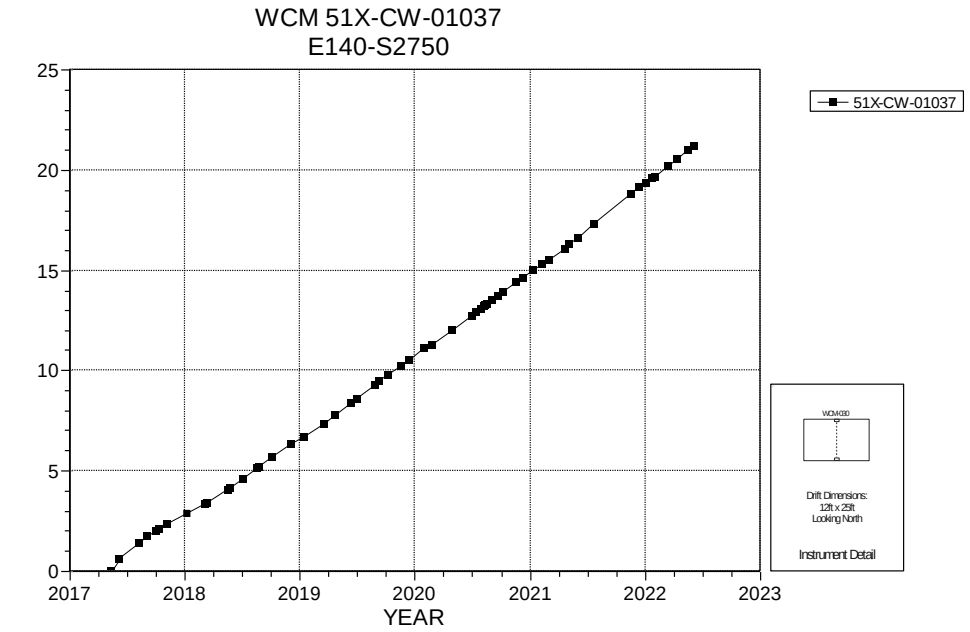
Convergence Points (continued)									
Field Tag	Location	Figure Number	Last Reading 2021-2022 Date	Last Reading 2021-2022 Inches	Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent [1]	Comments
S1000-W120 A-C	S1000-W120	4-157	6/13/2022	4.859	4.859	2.0	1.5	33	N/A
S1300-E24-2 A-C	S1300-E24	4-158	6/13/2022	8.419	34.402	1.8	1.5	20	N/A
S1300-E120 A-C	S1300-E120	4-159	6/22/2022	25.457	25.457	1.1	1.0	10	N/A
S1300-E160 A-C	S1300-E160	4-160	6/22/2022	48.018	48.018	3.0	2.6	15	N/A
S1300-W100-4 A-C	S1300-W100	4-161	6/13//2022	7.129	63.278	3.0	2.5	20	N/A
S1300-W155 A-C	S1300-W155	4-162	6/7/2022	2.089	2.089	1.7	1.9	-11	N/A
S1600-E110-2 A-C	S1600-E110	4-163	2/17/2022	10.246	26.968	1.4	1.1	27	N/A
S1600-E170-3 A-C	S1600-E170	4-164	6/22/2022	4.532	29.149	1.6	1.2	33	N/A
S1600-W100-2 A-C	S1600-W100	4-165	2/1/2022	18.238	19.255	3.9	3.5	11	N/A
S1950-E113-5 A-C	S1950-E113	4-166	5/24/2022	1.616	26.323	1.5	0.9	67	N/A
S1950-E160-2 A-C	S1950-E160	4-167	6/27/2022	2.798	9.432	2.1	2.0	5	N/A
S1950-E226 A-C	S1950-E226	4-168	6/27/2022	9.846	9.846	2.1	1.8	17	N/A
S1950-E281-3 A-C	S1950-E281	4-169	6/15/2022	28.767	35.309	1.4	1.3	8	N/A
S2180-W100-3 A-C	S2180-W100	4-170	2/2/2022	40.598	58.781	4.2	3.6	17	N/A
S2520-E55-3 A-C	S2520-E55	4-171	6/8/2022	3.565	42.373	3.1	3.1	0	N/A
S2520-E220 A-C	S2520-E220	4-172	6/15/2022	39.063	39.063	2.0	1.8	11	N/A
S2520-W100-3 A-C	S2520-W100	4-173	6/8/2022	3.801	54.008	3.8	3.7	3	N/A
W30-S90-2 A-C	W30-S90	4-174	6/13/2022	1.682	5.359	1.4	0.9	56	N/A
W30-S120-4 A-C	W30-S120	4-175	6/13/2022	1.493	35.635	1.2	0.9	33	N/A
W30-S250-5 A-C	W30-S250	4-176	6/13/2022	19.028	45.261	1.4	1.1	27	N/A
W30-S400-2 A-C	W30-S400	4-177	6/13/2022	15.588	33.416	1.3	1.0	30	N/A
W30-S500-3 A-C	W30-S500	4-178	6/13/2022	10.453	40.860	1.7	1.3	31	N/A
W30-S550 A-C	W30-S550	4-179	6/13/2022	2.051	2.051	0.8	0.5	60	N/A
W30-S700-6 A-C	W30-S700	4-180	6/13/2022	0.888	60.629	2.4	2.3	4	N/A
W30-S850-7 A-E	W30-S850	4-181	6/13/2022	0.704	43.664	2.0	1.8	11	N/A
W30-S1000-5 A-C	W30-S1000	4-182	6/13/2022	24.018	62.197	2.2	1.9	16	N/A
W30-S1150-3 A-C	W30-S1150	4-183	3/4/2022	10.109	44.748	3.2	3.0	7	N/A
W30-S1300-3 A-C	W30-S1300	4-184	6/13/2022	2.184	47.328	2.4	2.3	4	N/A

Table 4-1 Access Drifts Data Analysis (continued)

Convergence Points (continued)									
Field Tag	Location	Figure Number	Last Reading 2021-2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent [1]	Comments
			Date	Inches					
W30-S1453-3 A-C	W30-S1453	4-185	6/13/2022	17.1	46.328	3.2	3.1	3	N/A
W30-S1600-5 A-C	W30-S1600	4-186	4/1/2022	1.916	50.145	2.4	2.6	-8	N/A
W30-S1775-9 A-C	W30-S1775	4-187	6/13/2022	8.228	45.921	2.4	2.3	4	N/A
W30-S1950-3 A-C	W30-S1950	4-188	4/1/2022	26.305	55.979	3.1	2.8	11	N/A
W30-S2067-4 A-C	W30-S2067	4-189	6/13/2022	29.676	56.616	3.6	3.3	9	N/A
W30-S2425-5 A-C	W30-S2425	4-190	7/14/2021	6.617	45.593	N/A	3.7	N/A	One Reading Taken for '21 – '22
W30-S2520-5 A-C	W30-S2520	4-191	6/8/2022	3.729	57.888	3.7	3.4	9	N/A
W170-N150-3 A-C	W170-N150	4-192	6/7/2022	9.251	17.603	0.8	0.6	33	N/A
W170-S5-2 A-C	W170-S5	4-193	6/7/2022	5.432	21.628	0.8	0.6	33	N/A
W170-S90-3 A-C	W170-S90	4-194	6/7/2022	18.769	25.971	1.2	1.0	20	N/A
W170-S232-2 A-C	W170-S232	4-195	6/7/2022	13.478	19.067	0.9	0.7	29	N/A
W170-S400-2 A-C	W170-S400	4-196	6/7/2022	0.247	23.248	1.6	0.5	220	Near Newly Mined West Mains
W170-S560-5 A-C	W170-S560	4-197	6/7/2022	0.462	21.434	3.0	0.8	275	Near Newly Mined West Mains
W170-S700-4 A-C	W170-S700	4-198	6/7/2022	0.781	34.575	5.1	1.1	364	Near Newly Mined West Mains
W170-S850-9 A-E	W170-S850	4-199	6/7/2022	0.506	29.734	3.3	0.8	313	Near Newly Mined West Mains
W170-S1000-4 A-C	W170-S1000	4-200	6/7/2022	2.358	39.793	1.7	1.1	55	Near Newly Mined West Mains
W170-S1150-6 A-E	W170-S1150	4-201	6/7/2022	0.455	33.566	1.3	1.1	18	N/A
W170-S1300-4 A-C	W170-S1300	4-202	6/7/2022	31.514	52.472	2.7	2.4	13	N/A
W170-S1445-4 A-C	W170-S1445	4-203	06/7/2022	27.913	39.205	2.5	2.2	14	N/A
W170-S1600-6 A-C	W170-S1600	4-204	02/1/2022	2.008	50.362	3.7	3.2	16	N/A
W170-S1779-3 A-C	W170-S1779	4-205	06/7/2022	31.414	46.385	3.1	2.7	15	N/A
W170-S1950-3 A-C	W170-S1950	4-206	06/13/2022	25.68	38.861	2.3	2.2	5	N/A
W170-S2180-3 A-C	W170-S2180	4-207	06/8/2022	23.596	47.16	2.6	2.4	8	N/A
W170-S2275 A-C	W170-S2275	4-208	06/8/2022	35.05	35.05	2.4	2.1	14	N/A
W170-S2350 A-C	W170-S2350	4-209	06/8/2022	46.106	46.106	3.0	2.5	20	N/A
W170-S2425 A-C	W170-S2425	4-210	02/2/2022	35.923	35.923	2.2	1.9	16	N/A
W170-S2520-3 A-C	W170-S2520	4-211	06/8/2022	3.900	57.313	3.9	3.7	5	N/A
W660-N150-2 A-C	W660-N150	4-212	06/27/2022	2.134	5.357	0.9	0.5	80	N/A

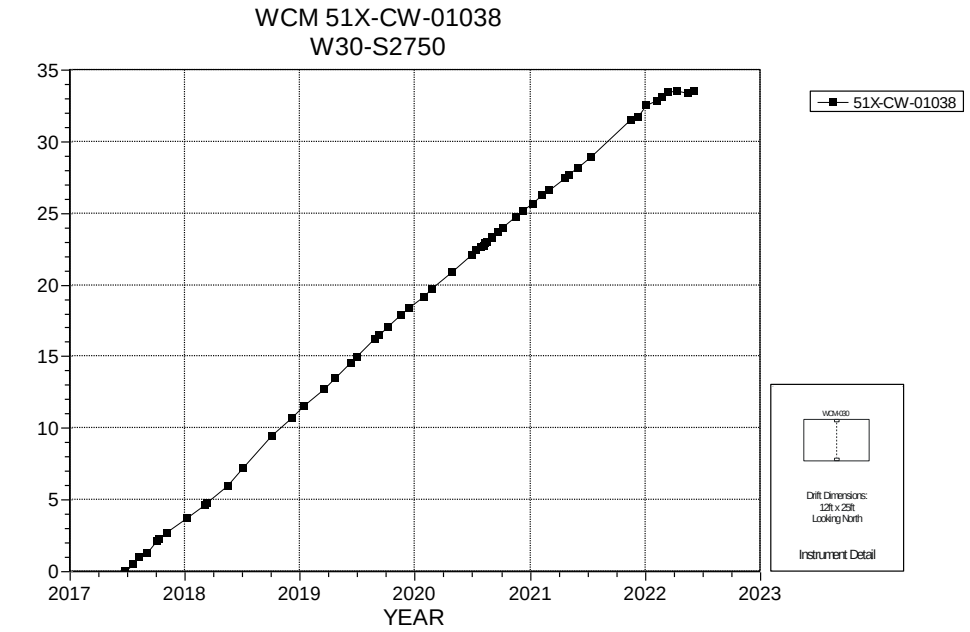
Table 4-1 Access Drifts Data Analysis (continued)

Rock Load Bolt Cells					
Field Tag	Location	Figure Number	Date of Last Reading	Load (kips)	Comments
51X-WG-00237	AIS South Brow	4-213	06/17/2022	1.92	N/A
51X-WG-00238	AIS South Brow	4-213	06/17/2022	3.34	N/A
51X-WG-00239	AIS South Brow	4-213	06/17/2022	37.26	N/A
51X-WG-00240	AIS South Brow	4-213	06/17/2022	1.79	N/A
51X-WG-00241	AIS South Brow	4-214	06/17/2022	1.14	N/A
51X-WG-00242	AIS South Brow	4-214	06/17/2022	0.00	N/A
51X-WG-00243	AIS South Brow	4-214	06/17/2022	34.47	N/A
51X-WG-00244	AIS South Brow	4-214	06/17/2022	29.77	N/A
51X-WG-00245	AIS South Brow	4-214	06/17/2022	0.62	N/A
51X-WG-00247	AIS North Brow	4-215	06/17/2022	1.27	N/A
51X-WG-00248	AIS North Brow	4-215	06/17/2022	39.31	N/A
51X-WG-00249	AIS North Brow	4-215	06/17/2022	0.22	N/A
51X-WG-00250	AIS North Brow	4-215	06/17/2022	10.49	N/A
51X-WG-00251	AIS North Brow	4-216	06/17/2022	18.52	N/A
51X-WG-00252	AIS North Brow	4-216	04/01/2022	175.92	N/A
51X-WG-00253	AIS North Brow	4-216	06/17/2022	0.00	N/A
51X-WG-00254	AIS North Brow	4-216	06/17/2022	6.14	N/A
51X-WG-00255	AIS North Brow	4-216	06/17/2022	9.16	N/A



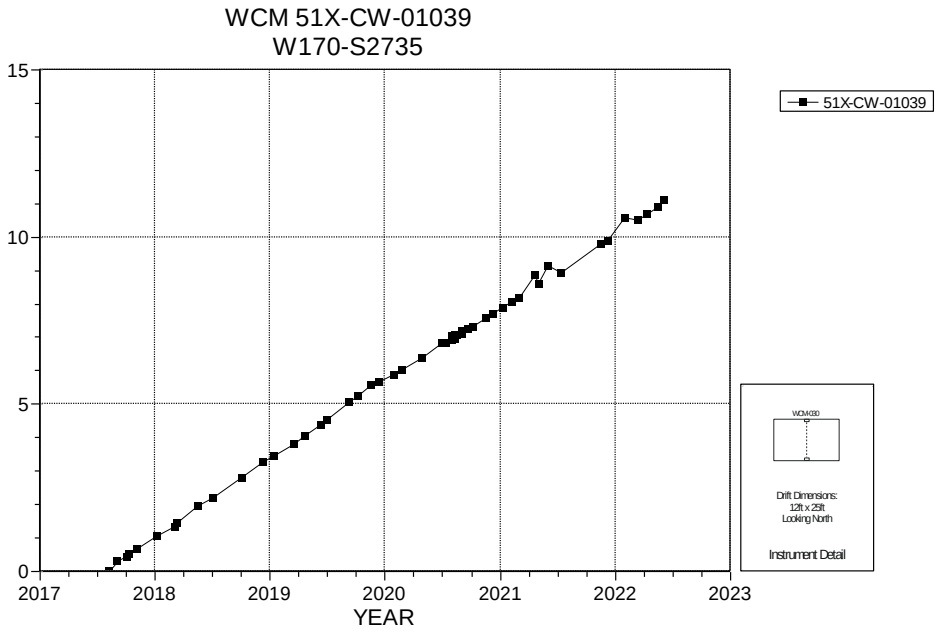
NOTES:
1. Excavation Date: January 1983.

Figure 4-1 Wire Convergence Meter 51X-CW-01037 – Roof to Floor



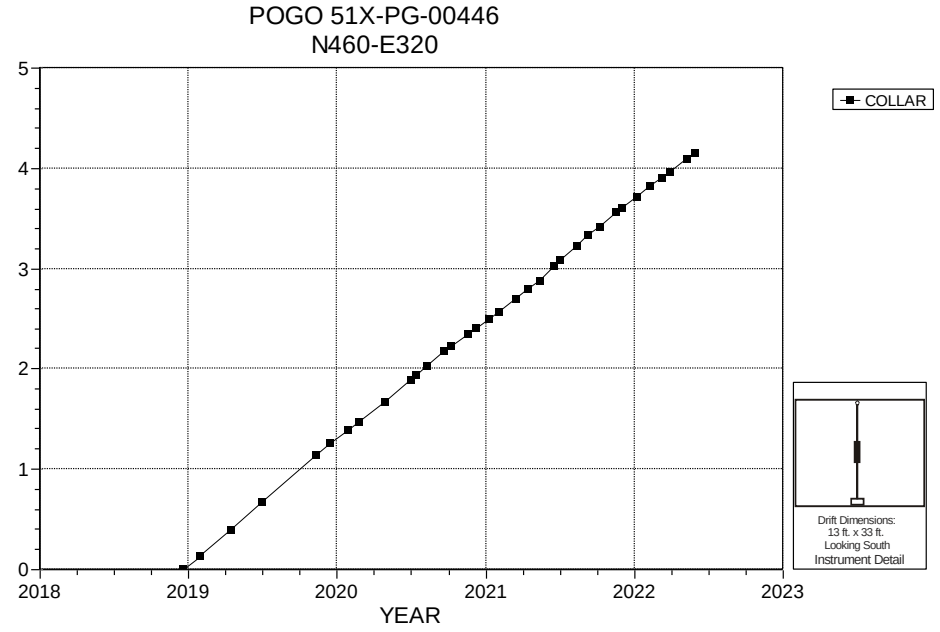
NOTES:
1. Excavation date: December 2000.
2. As of 12/14/2022, instrument has reached maximum reading capacity of potentiometer and will no longer be read.
3. Instrument is in an inaccessible prohibited area.

Figure 4-2 Wire Convergence Meter 51X-CW-01038 – Roof to Floor



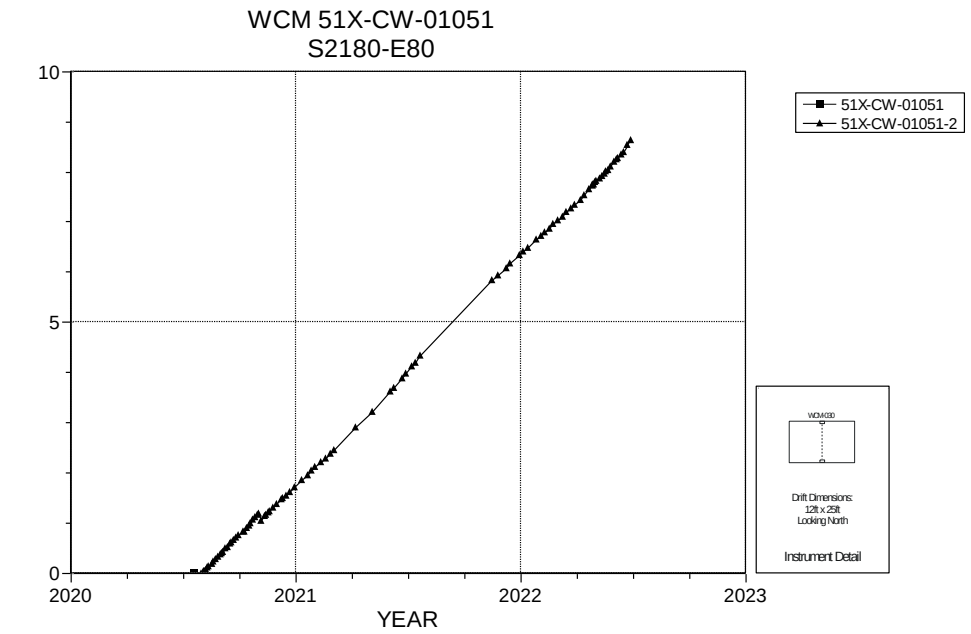
NOTES:
1. Excavation date: December 2000.

Figure 4-3 Wire Convergence Meters 51X-CW-01039 – Roof to Floor



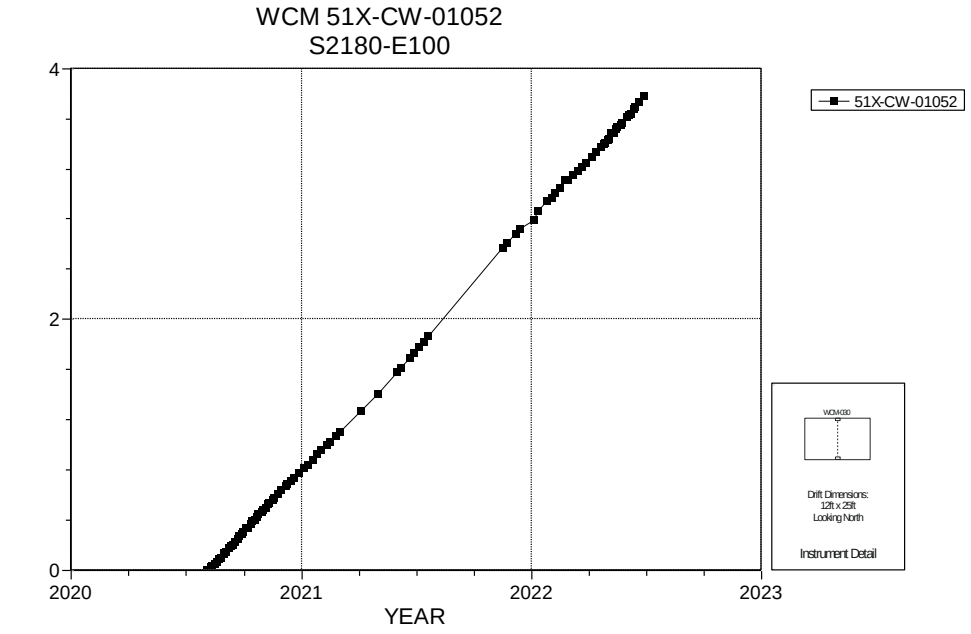
NOTES:
1. Excavation Date: January 1988.

Figure 4-4 POGO 51X-PG-00446 – Roof to Floor



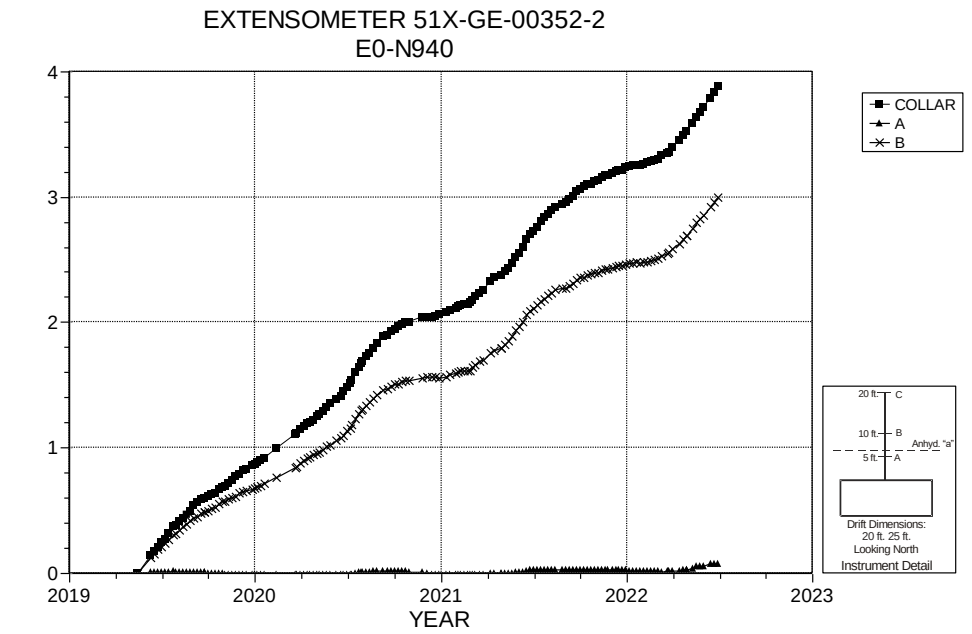
NOTES:

Figure 4-5 Wire Convergence Meter 51X-PG-01051-2 – Roof to Floor



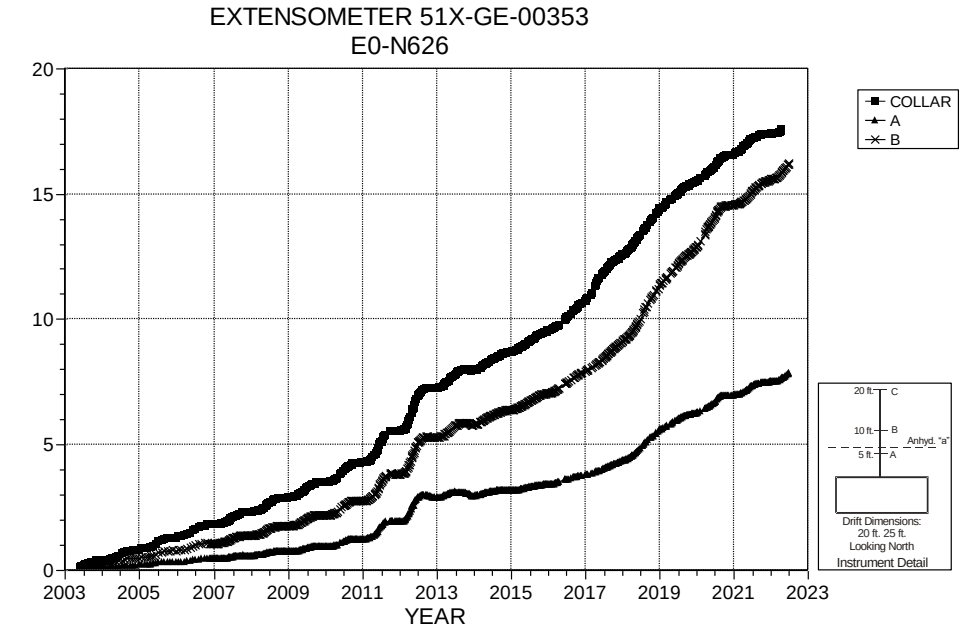
NOTES:

Figure 4-6 Wire Convergence Meter 51X-CW-01052 – Roof to Floor



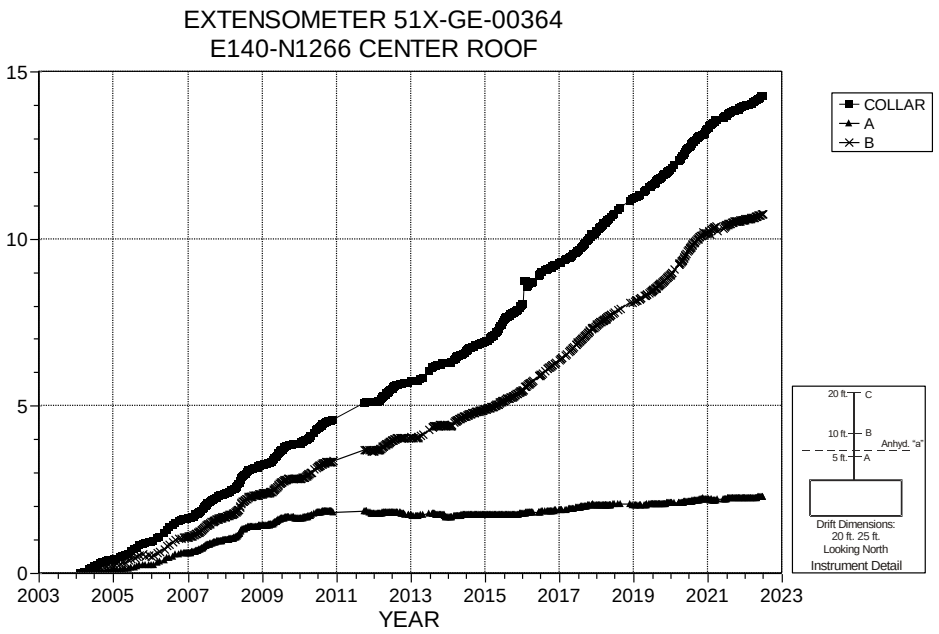
NOTES:
1. Excavation date: February 1983.
2. WEX Replacement. New WEX Field ID is 51X-GE-00352-2.

Figure 4-7 Extensometer 51X-GE-00352-2 – E0 N940 – Roof



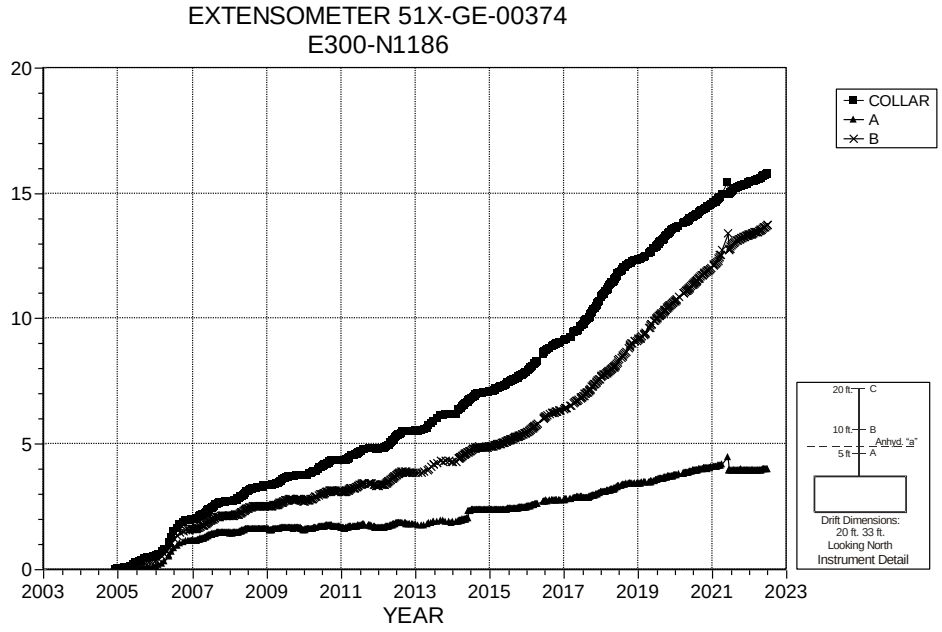
NOTES:
1. Excavation date: February 1983.
2. Anchor 'C' has reached its maximum range and the mechanical connection to the anchor has failed.

Figure 4-8 Extensometer 51X-GE-00353– E0 N626 – Roof



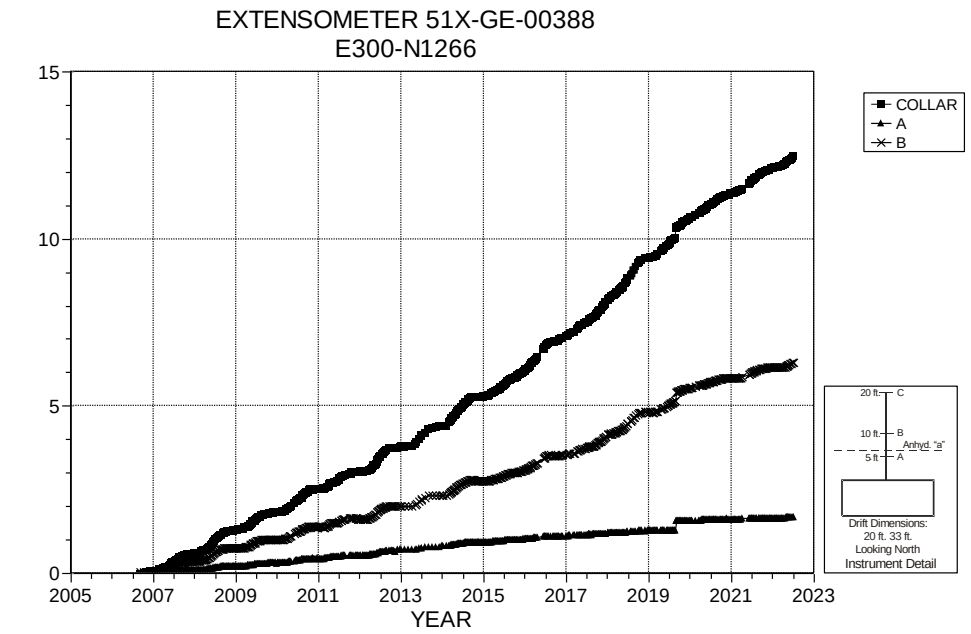
NOTES:
1. Excavation date: February 1983.

Figure 4-9 Extensometer 51X-GE-00364– E140 N1266 – Roof



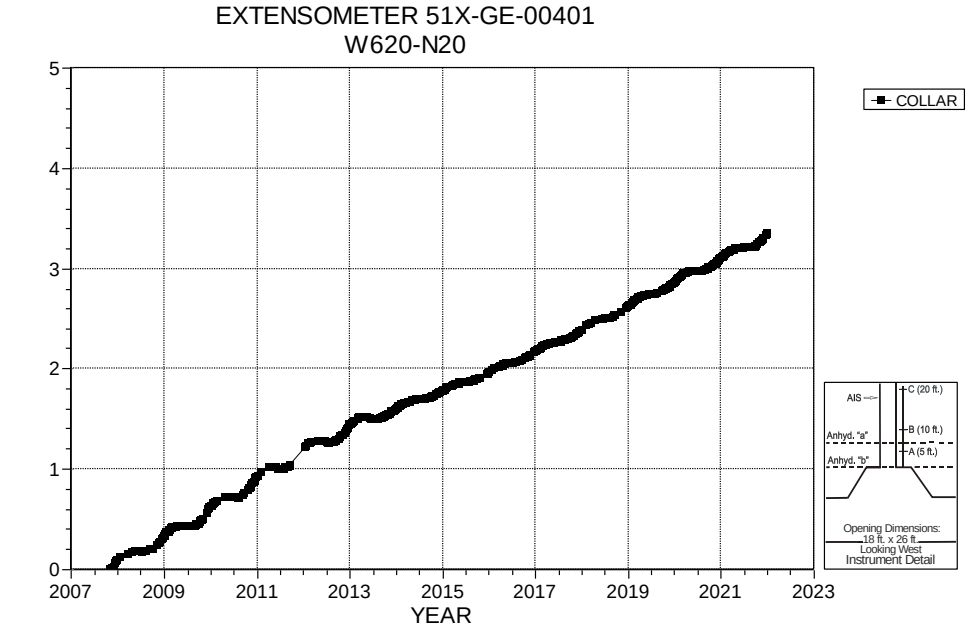
NOTES:
1. Excavation date: August 1989.

Figure 4-10 Extensometer 51X-GE-00374 – E300 N1186 – Roof



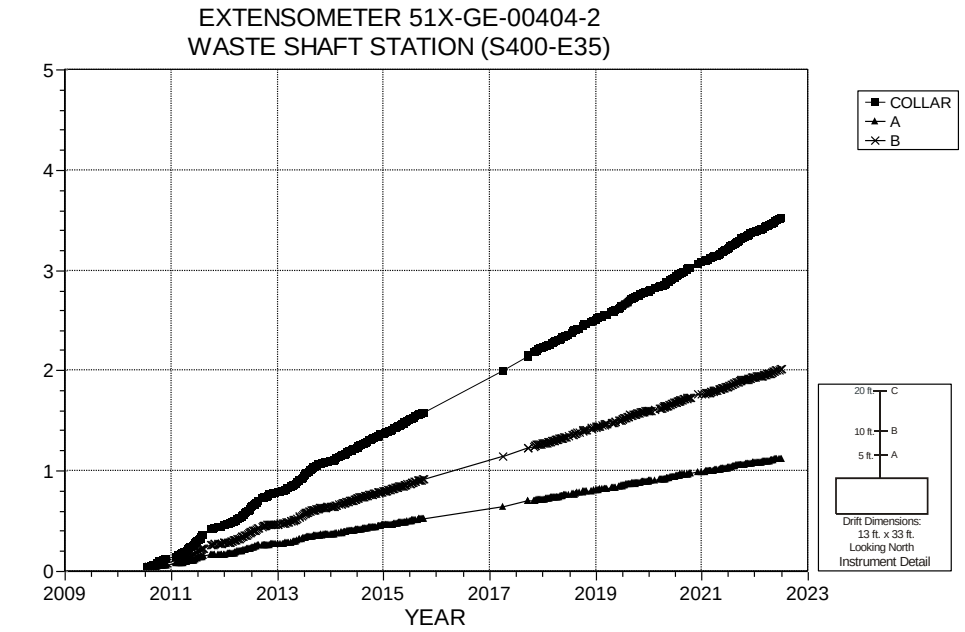
NOTES:
1. Excavation date: August 1989.
2. Instrument replaced in August 2006.

Figure 4-11 Extensometer 51X-GE-00388 – E300 N1266 – Roof



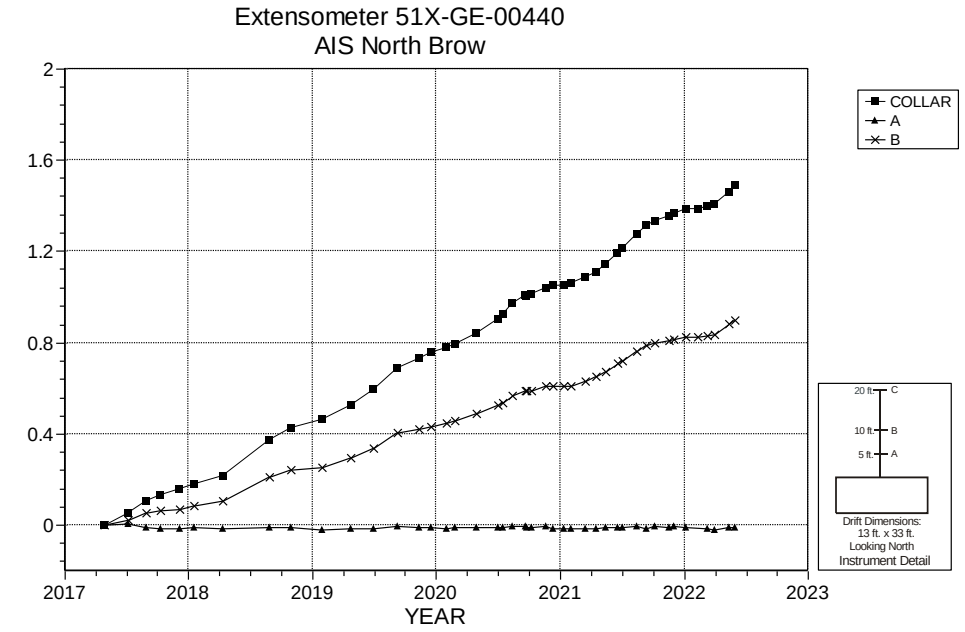
NOTES:
1. Excavation date: January 1988.
2. The mechanical connection to anchors "A" & "C" have failed, select CFI to view the plot.

Figure 4-12 Extensometer 51X-GE-00401 – W620 N20 – Roof



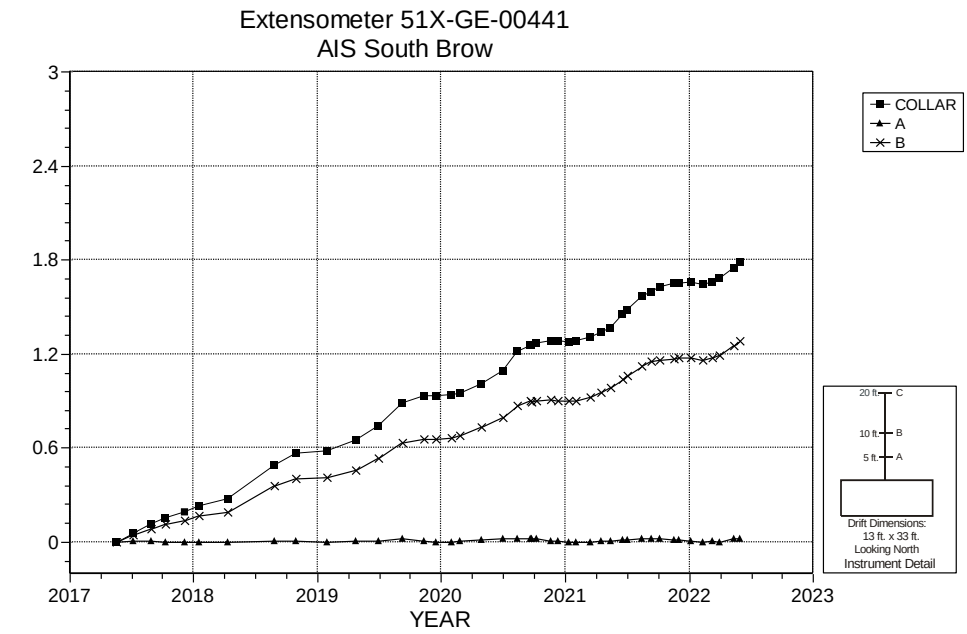
NOTES:
1. Excavation date: November 1982.
2. Extensometer 51X-GE-00404 was replaced by 51X-GE-00404-2 in July 2010.

Figure 4-13 Extensometer 51X-GE-00404-2 – Waste Shaft Station (S400 E35) – Roof



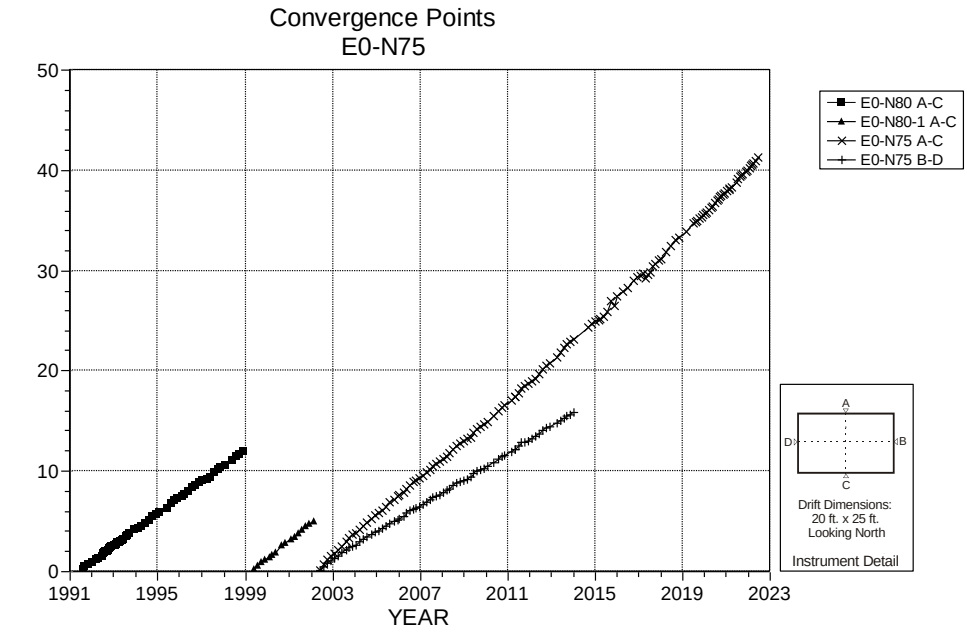
NOTES:
1. Excavation Date: January 1988.

Figure 4-14 Extensometer 41X-GE-00440 – AIS North Brow – Roof



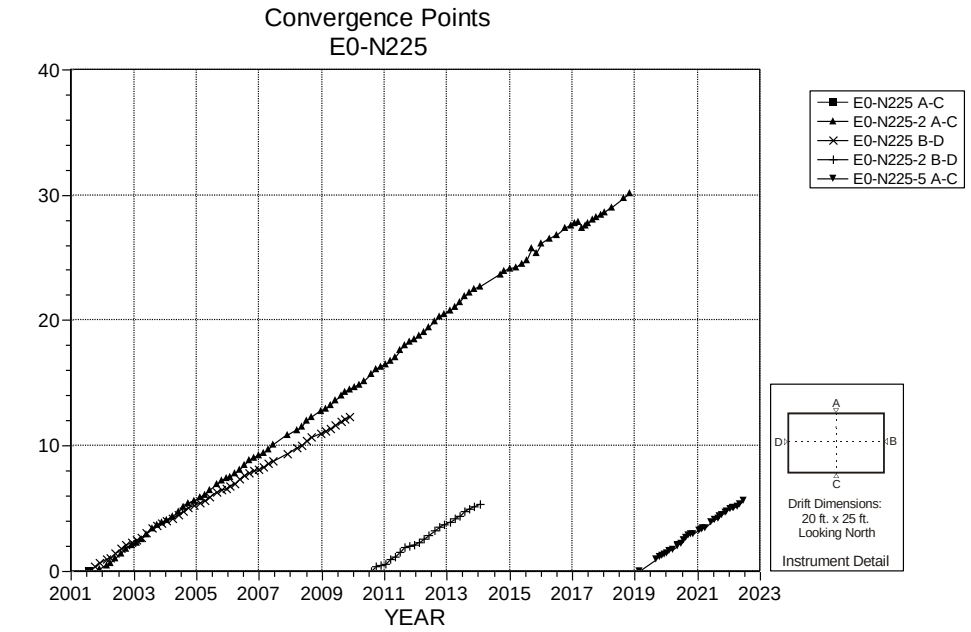
NOTES:
1. Excavation Date: January 1988.
2. Select CFI to view the plot.

Figure 4-15 Extensometer 51X-GE-00441– AIS South Brow – Roof



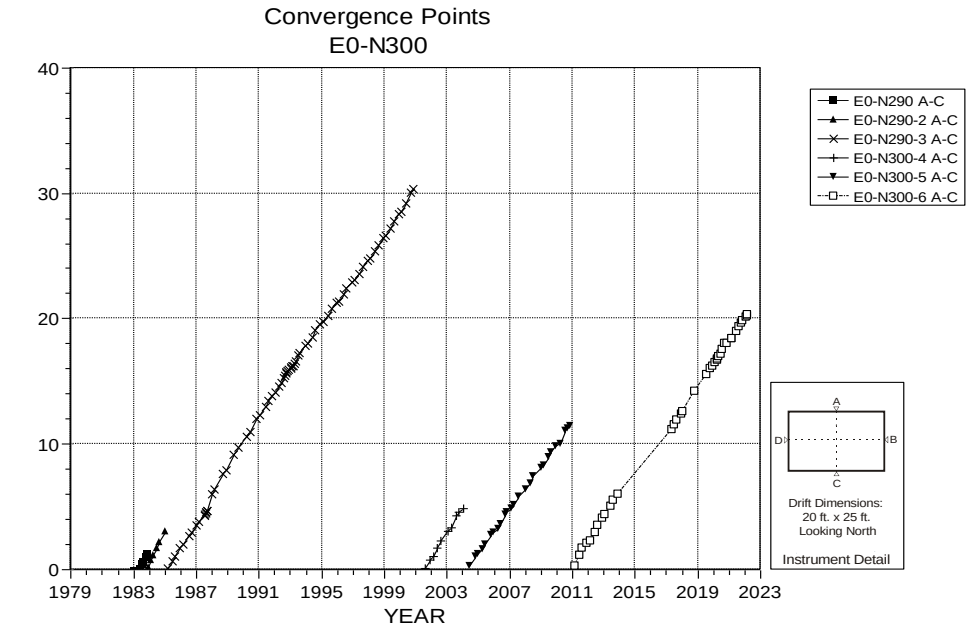
NOTES:
1. Excavation date: October 1982.
2. Roof excavated to Anhydrite "b".

Figure 4-16 Convergence Point Array – E0 N75 – All Chords



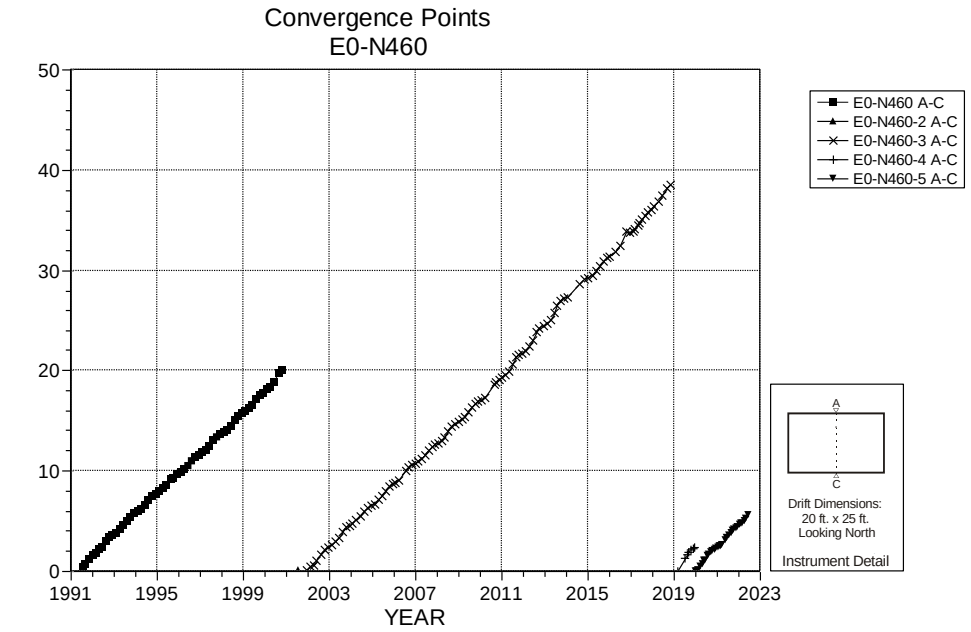
NOTES:
1. Excavation date: November 1982.
2. Roof excavated to Anhydrite "b".

Figure 4-17 Convergence Point Array – E0 N225 – All Chords



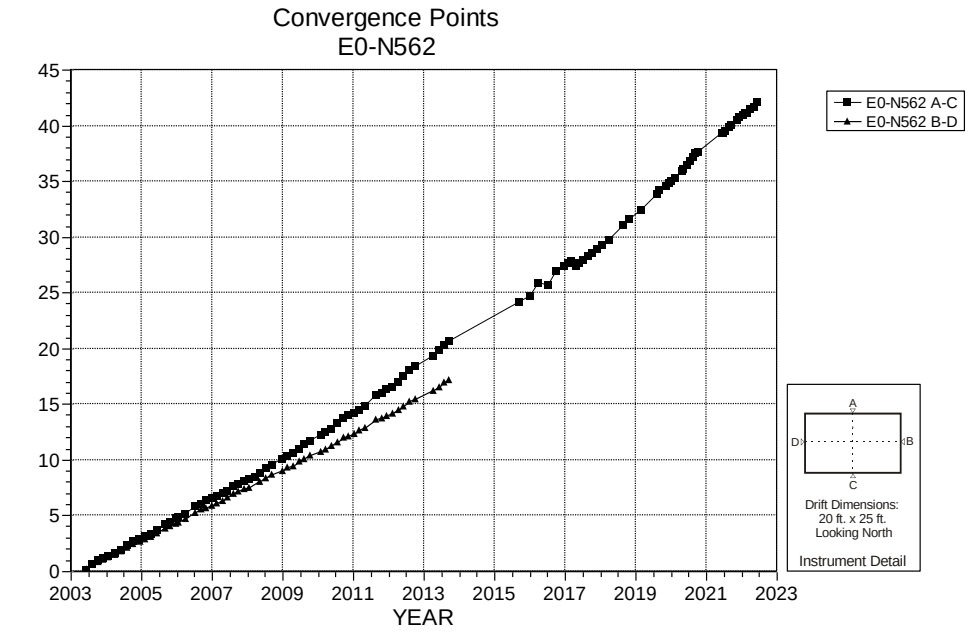
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b".
.

Figure 4-18 Convergence Point Array – E0 N300 – All Chords



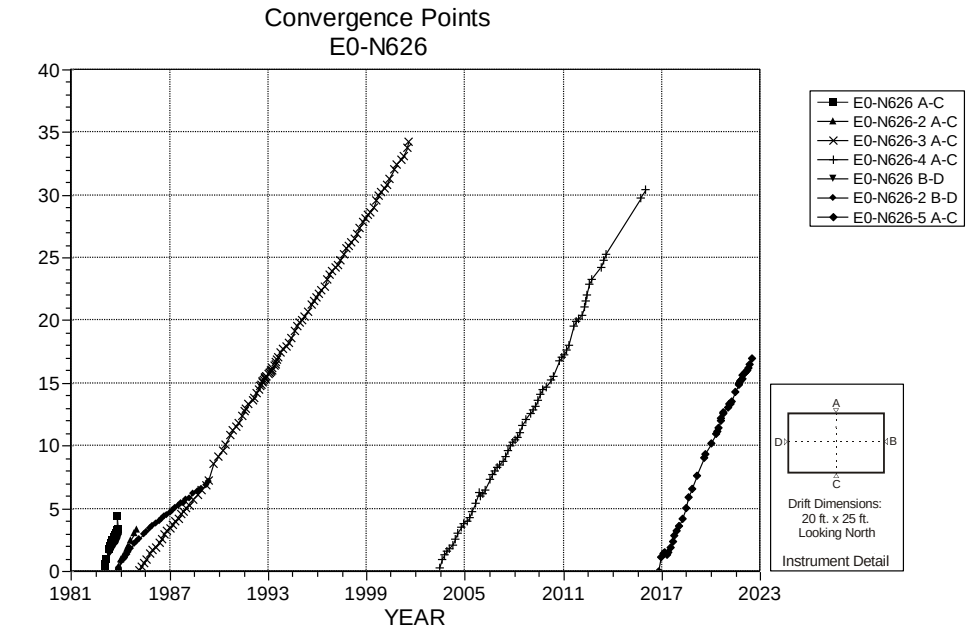
NOTES:
1. Excavation date: January 1983.
2. Roof excavated to Anhydrite "b".

Figure 4-19 Convergence Point Array – E0 N460 – Roof to Floor



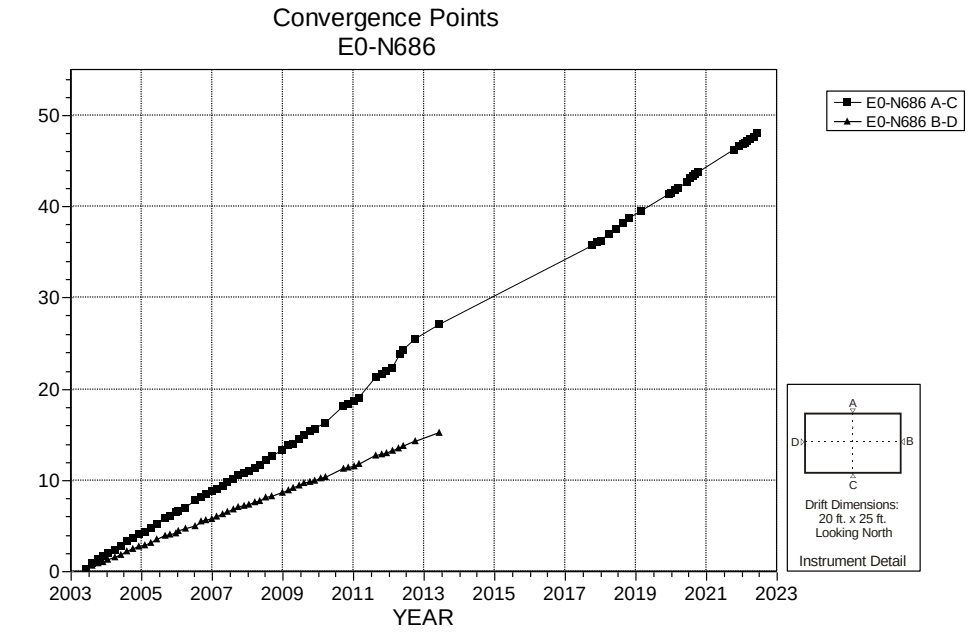
NOTES:
1. Excavation date: February 1983.
2. The RC floor point is covered by a muck pile.

Figure 4-20 Convergence Point Array – E0 N562 – All Chords



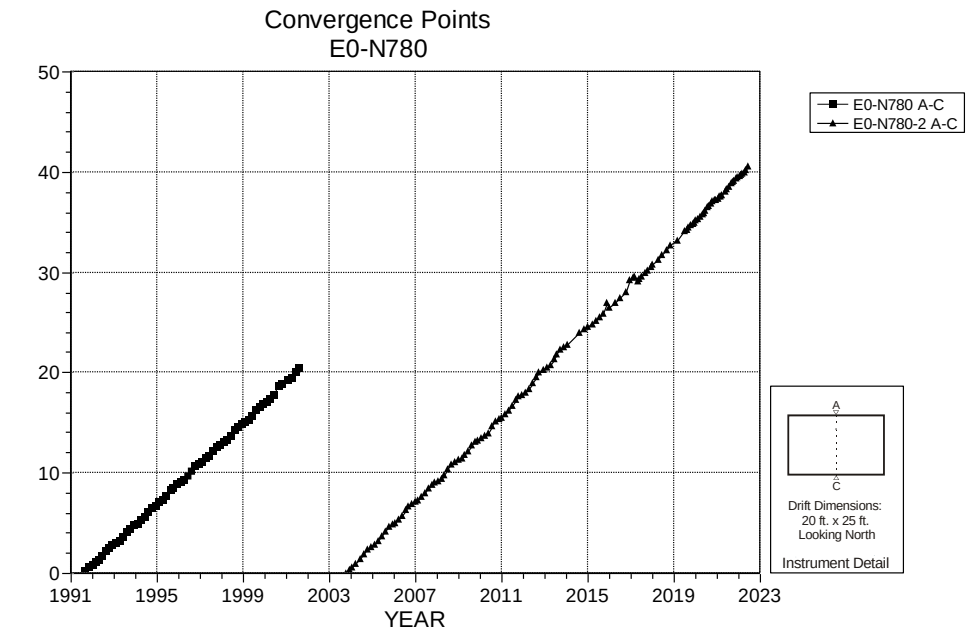
NOTES:
1. Excavation date: February 1983.
2. Roof excavated to Anhydrite "b".
3. The RC floor point is covered by a muck pile.

Figure 4-21 Convergence Point Array – E0 N626 – All Chords



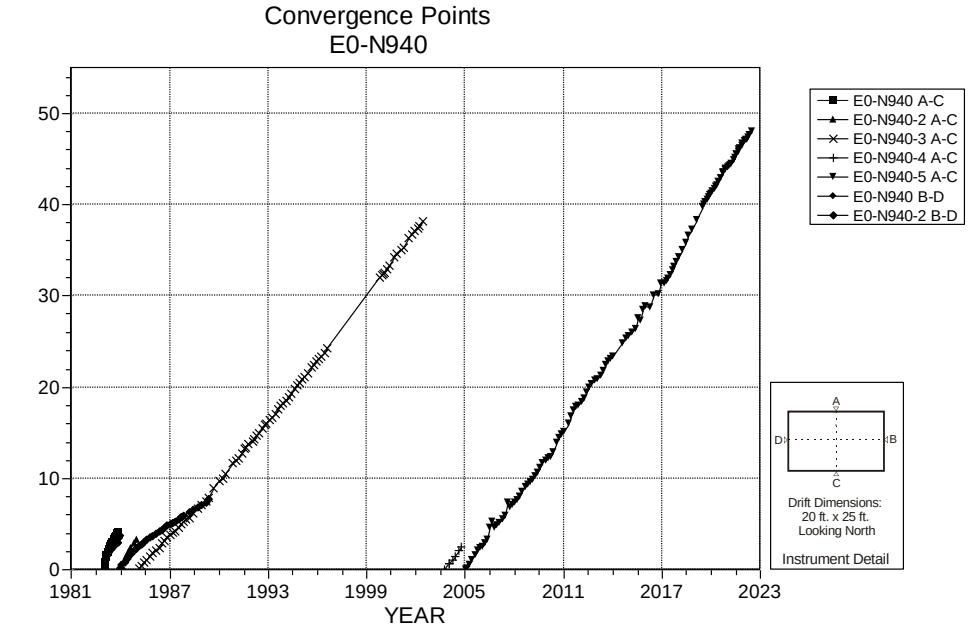
NOTES:
1. Excavation date: February 1983.
2. The RC floor point is covered by a muck pile.

Figure 4-22 Convergence Point Array – E0 N686 – All Chords



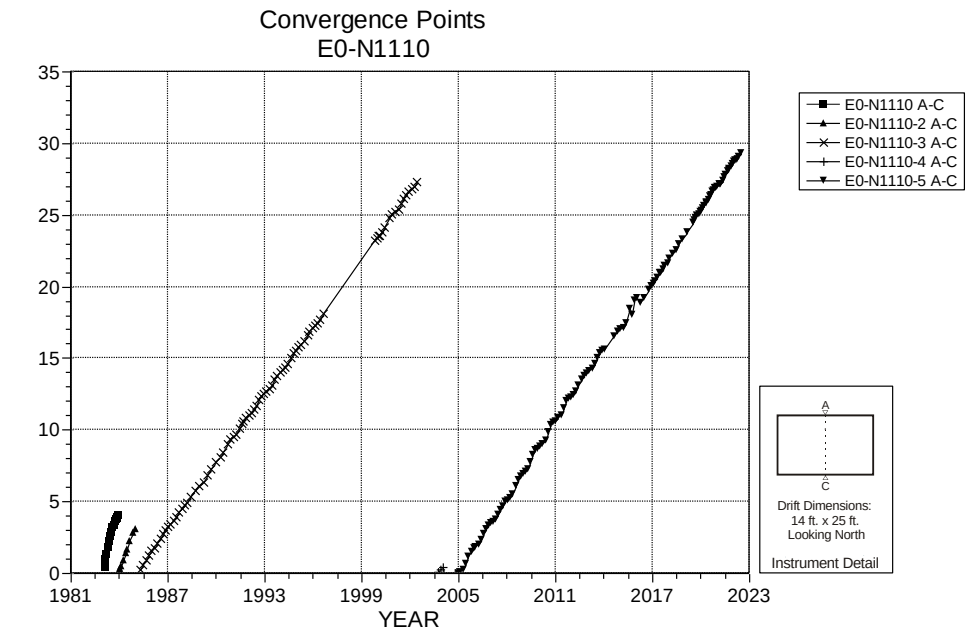
NOTES:
1. Excavation date: February 1983.

Figure 4-23 Convergence Point Array – E0 N780 – Roof to Floor



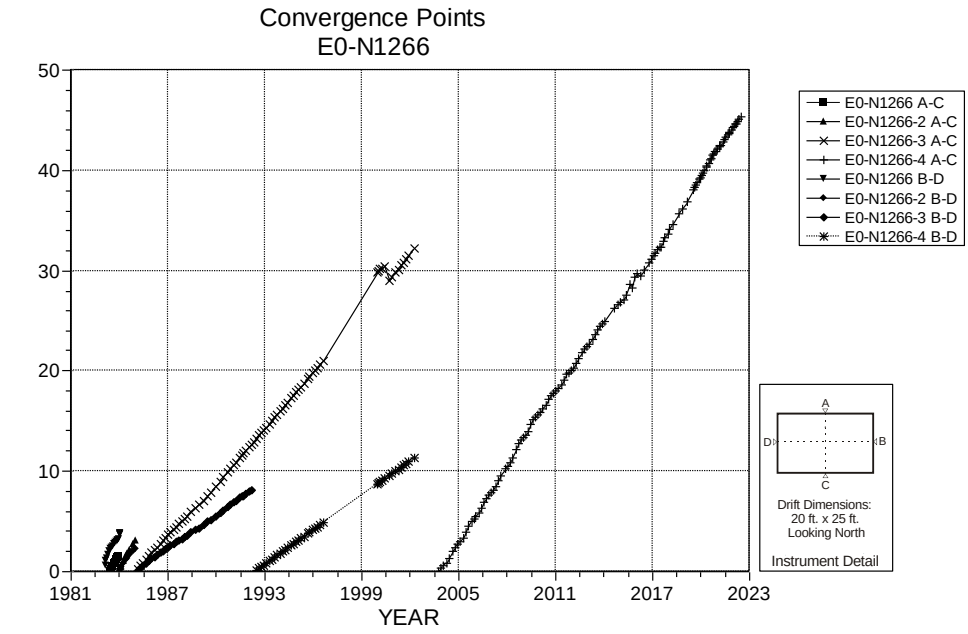
NOTES:
1. Excavation date: February 1983.

Figure 4-24 Convergence Point Array – E0 N940 – All Chords



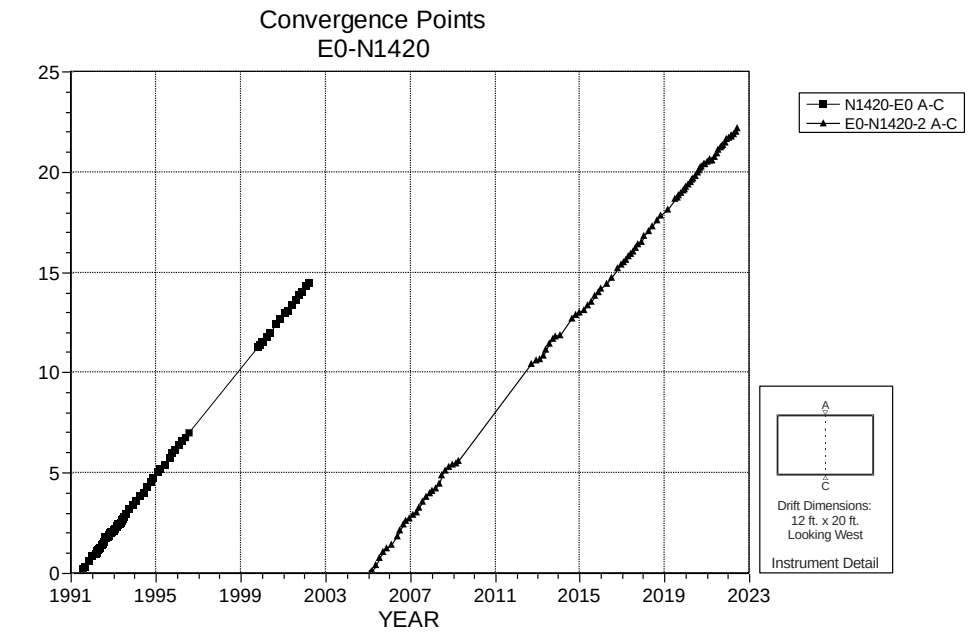
NOTES:
1. Excavation date: February 1983.
2. Inaccessible from 8/96 to 11/99.
3. Possible anchor slippage occurred between late January and early April 2004.

Figure 4-25 Convergence Point Array – E0 N1110 – Roof to Floor



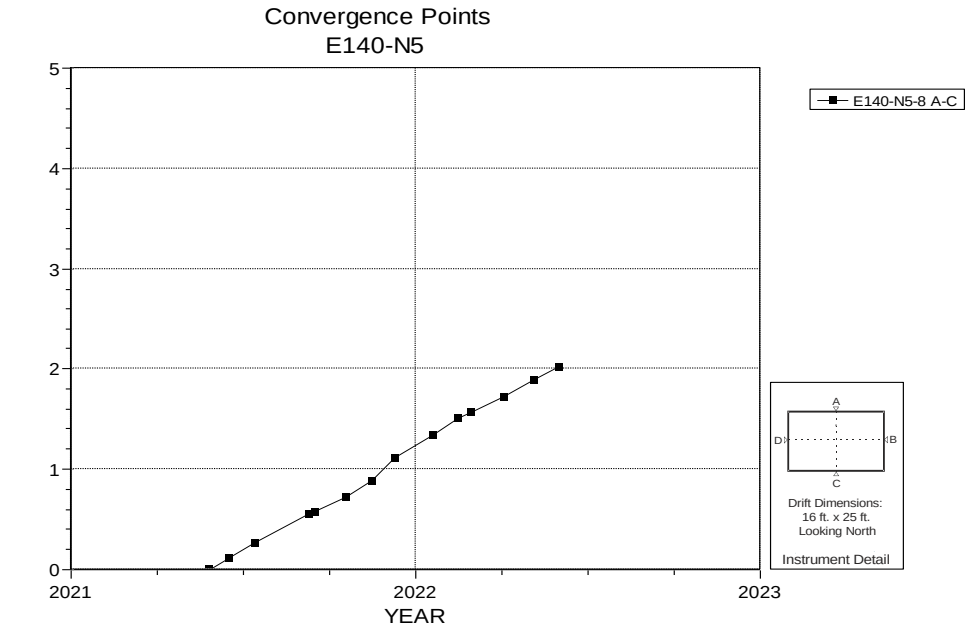
NOTES:
1. Excavation date: February 1983.

Figure 4-26 Convergence Point Array – E0 N1266 – All Chords



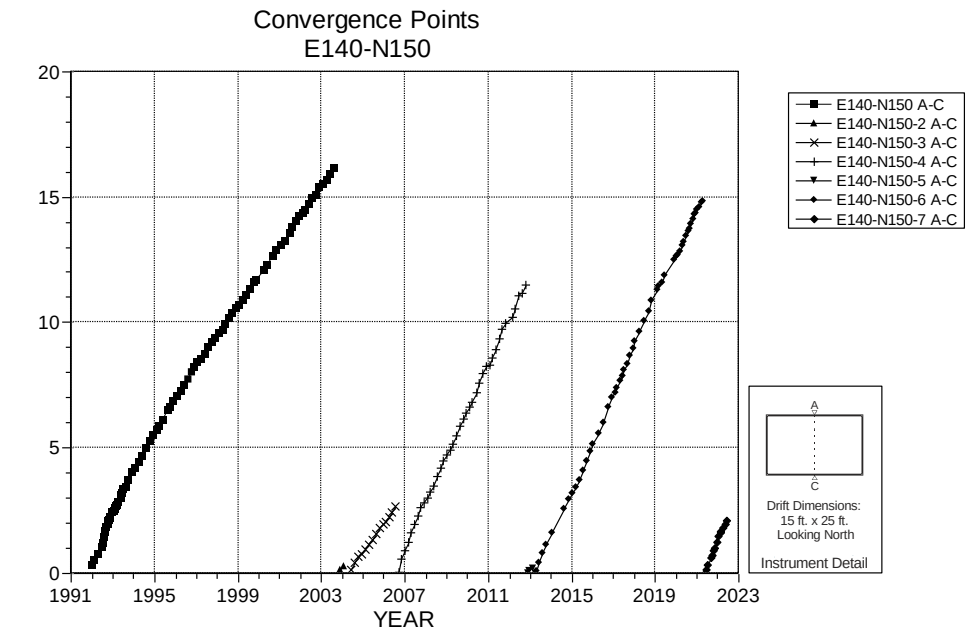
NOTES:
1. Excavation date: February 1983.
2. Inaccessible from 08/96 to 11/99.

Figure 4-27 Convergence Point Array – E0 N1420 – Roof to Floor



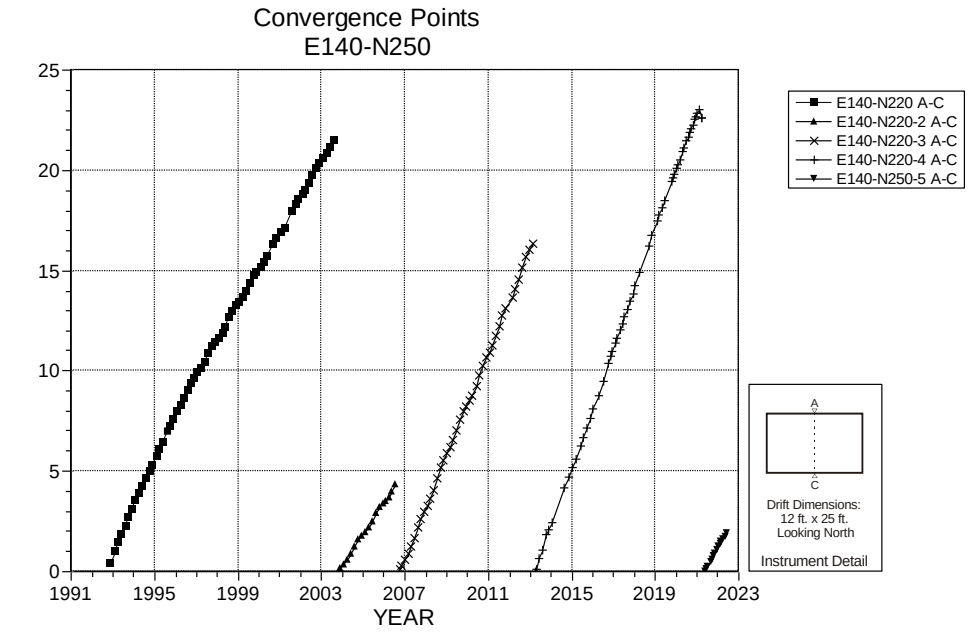
NOTES:
1. Excavation date: November 1982.

Figure 4-28 Convergence Point Array – E140 N5 – Roof to Floor



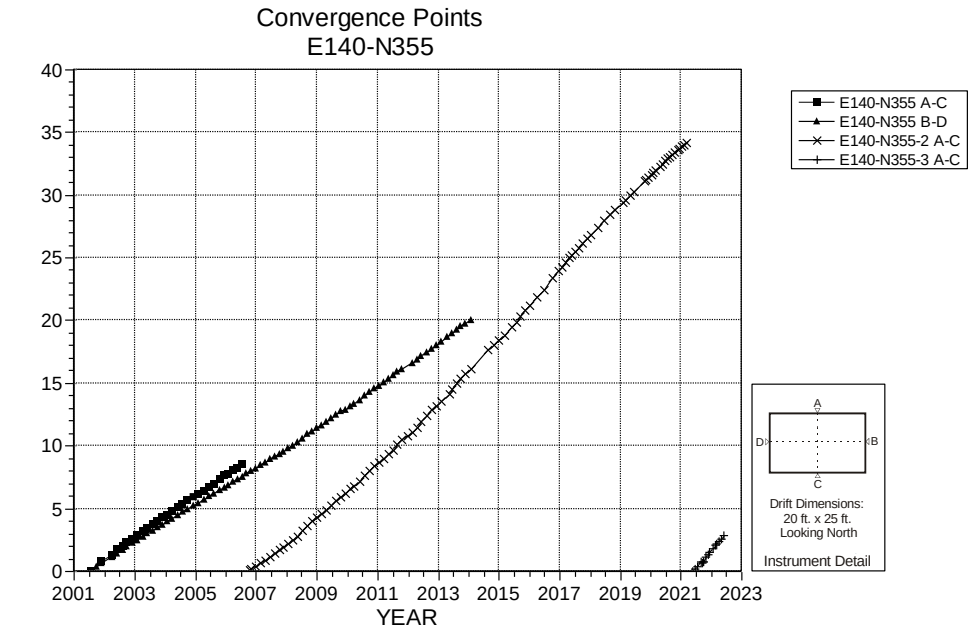
NOTES:
1. Excavation date: November 1982.
2. "C" Point mined out, reinstalled September 2006.

Figure 4-29 Convergence Point Array – E140 N150 – Roof to Floor



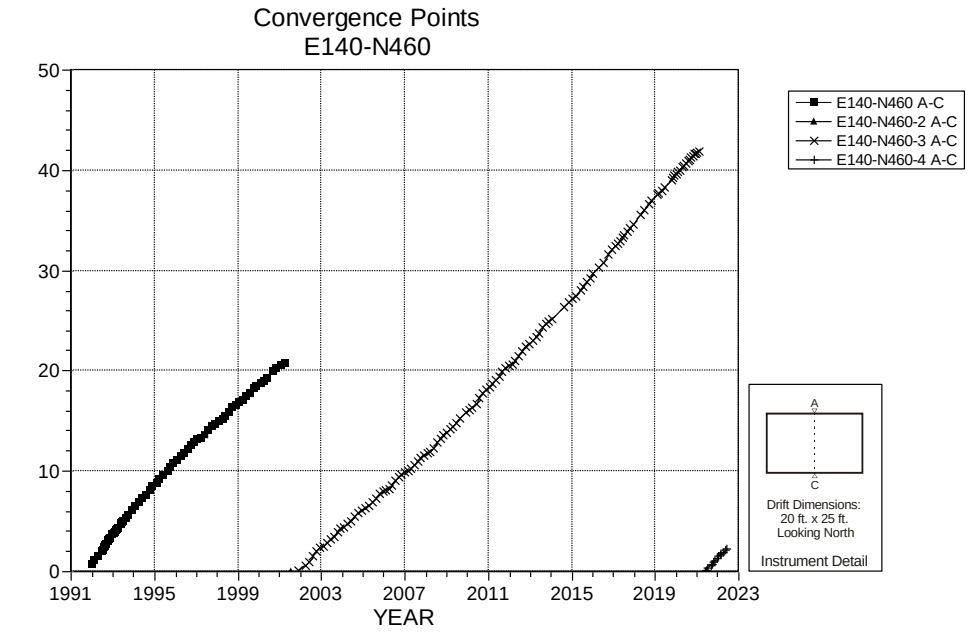
NOTES:
1. Excavation date: November 1982.
2. Reinstalled "C" point 9-27-2006.

Figure 4-30 Convergence Point Array – E140 N250 – Roof to Floor



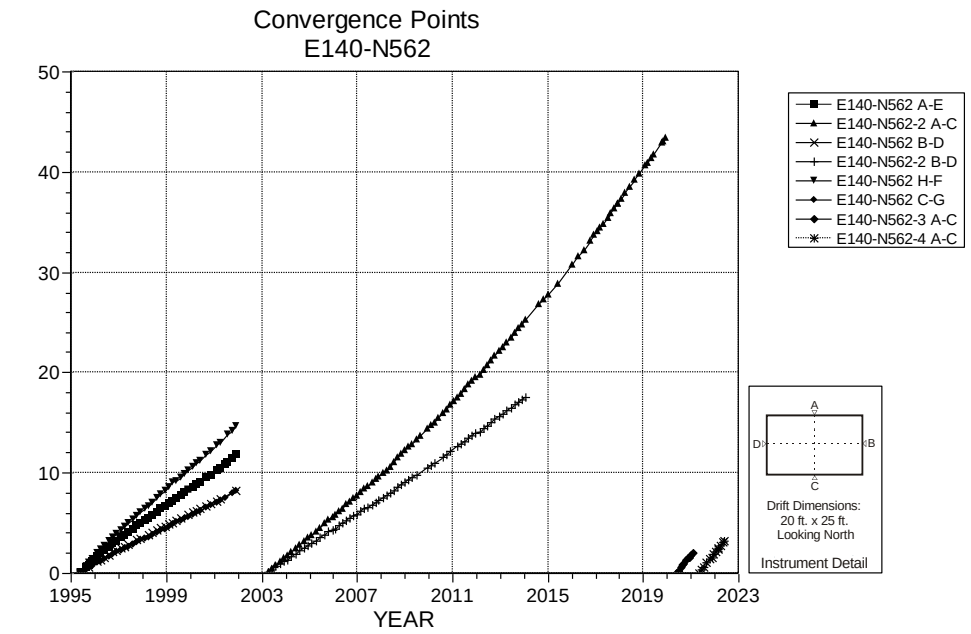
NOTES:
1. Excavation date: February 1983.
2. Roof excavated to Anhydrite 'b' in mid 2001.
3. Reinstalled "C" point 9-27-2006.

Figure 4-31 Convergence Point Array – E140 N355 – All Chords



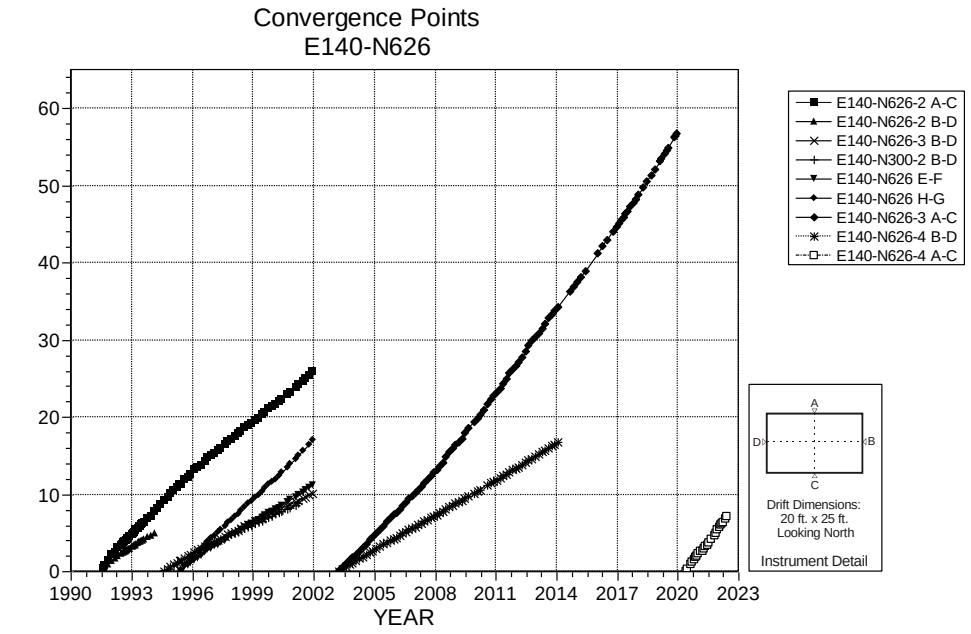
NOTES:
1. Excavation date: February 1983.
2. Roof excavated to Anhydrite 'b' in mid 2001.0

Figure 4-32 Convergence Point Array – E140 N460 – Roof to Floor



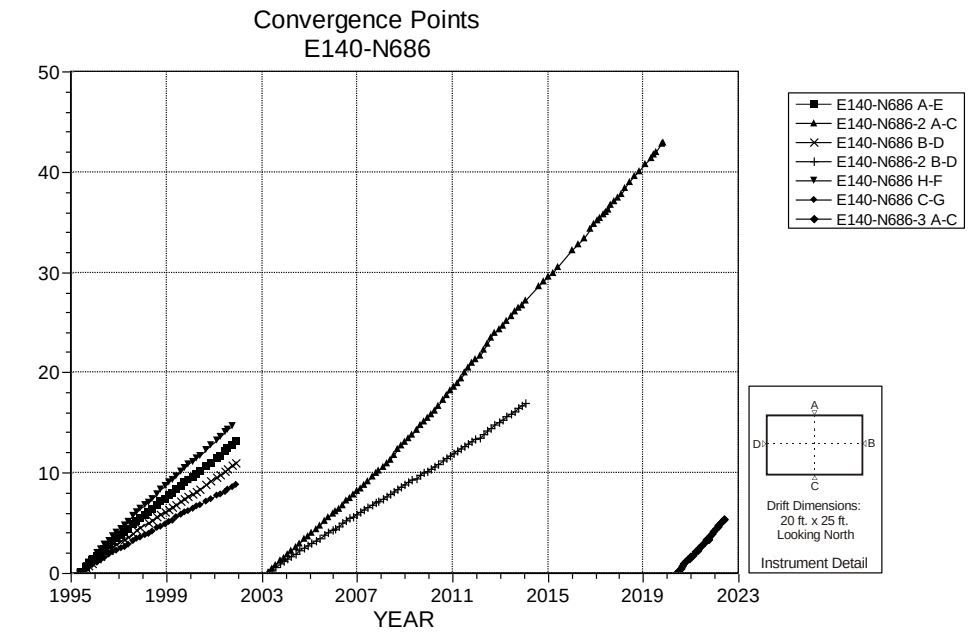
NOTES:
1. Excavation date: February 1983.
2. Roof excavated to Anhydrite "b" in early 2002.
3. Initially this location had three vertical chords: A-E, B-D, and H-F and a horizontal chord, G-G.

Figure 4-33 Convergence Point Array – E140 N562 – All Chords



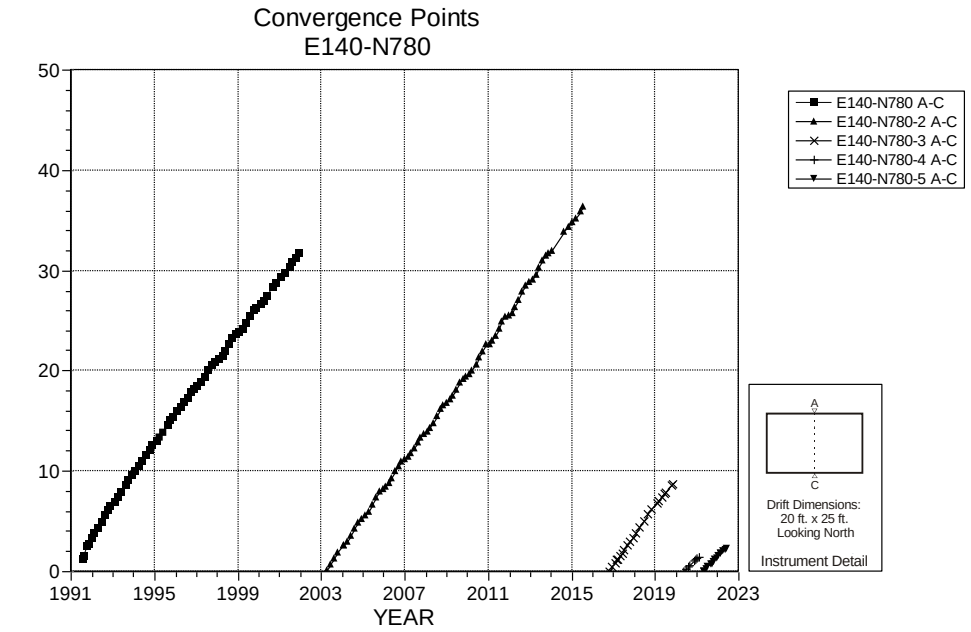
NOTES:
1. Excavation date: February 1983.
2. Roof excavated to Anhydrite "b" in early 2002.

Figure 4-34 Convergence Point Array – E140 N626 – All Chords



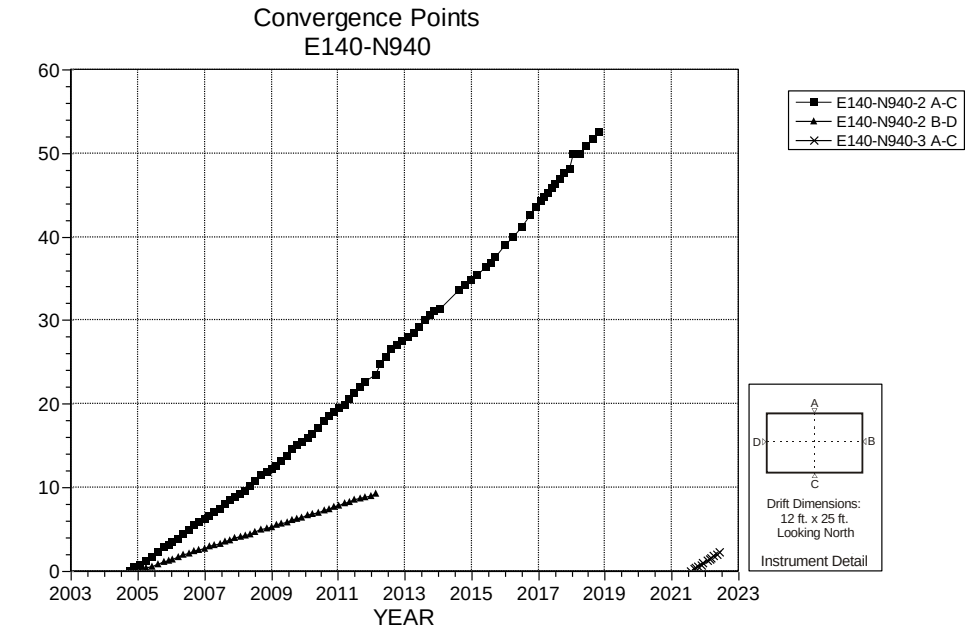
NOTES:
1. Excavation date: February 1983.
2. Roof excavated to Anhydrite "b" in early 2002.
3. Initially this location had three vertical chords: A-E, B-D, and H-F and a horizontal chord, G-G.

Figure 4-35 Convergence Point Array – E140 N686 – All Chords



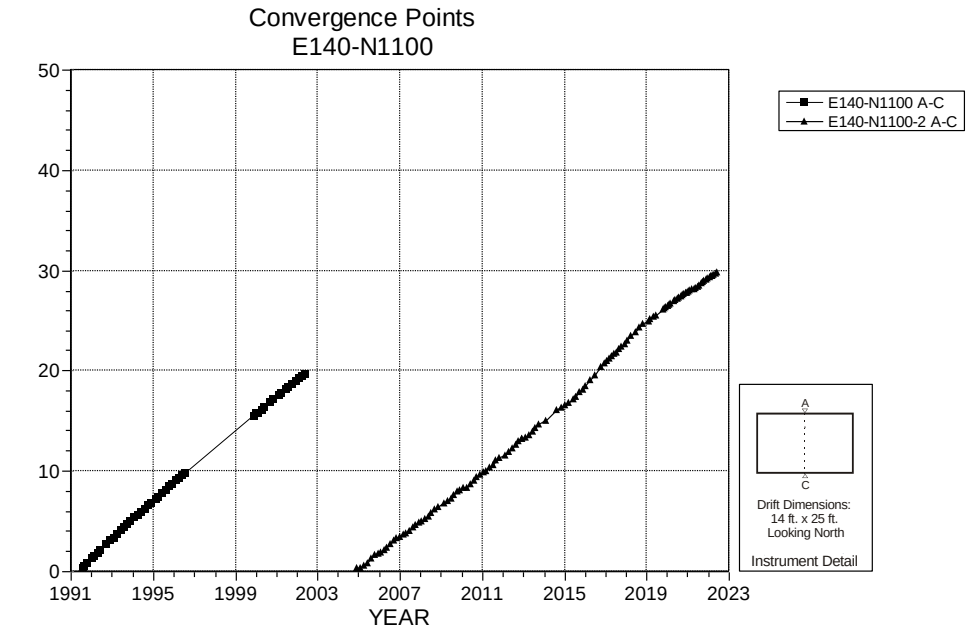
NOTES:
1. Excavation date: February 1983.
2. Roof excavated to Anhydrite 'b' in early 2002.
3. Anchor 'C' damaged by equipment, reinstalled October 2016.

Figure 4-36 Convergence Point Array – E140 N780 – Roof to Floor



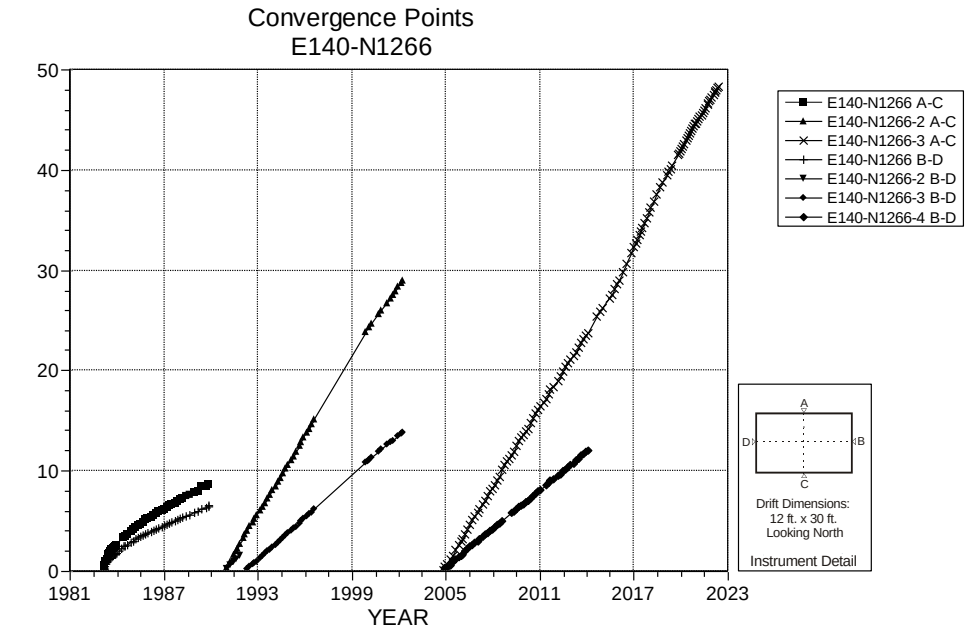
NOTES:
1. Excavation date: February 1983.
2. B-D chord location was mined out during SDI mining.

Figure 4-37 Convergence Point Array – E140 N940 – All Chords



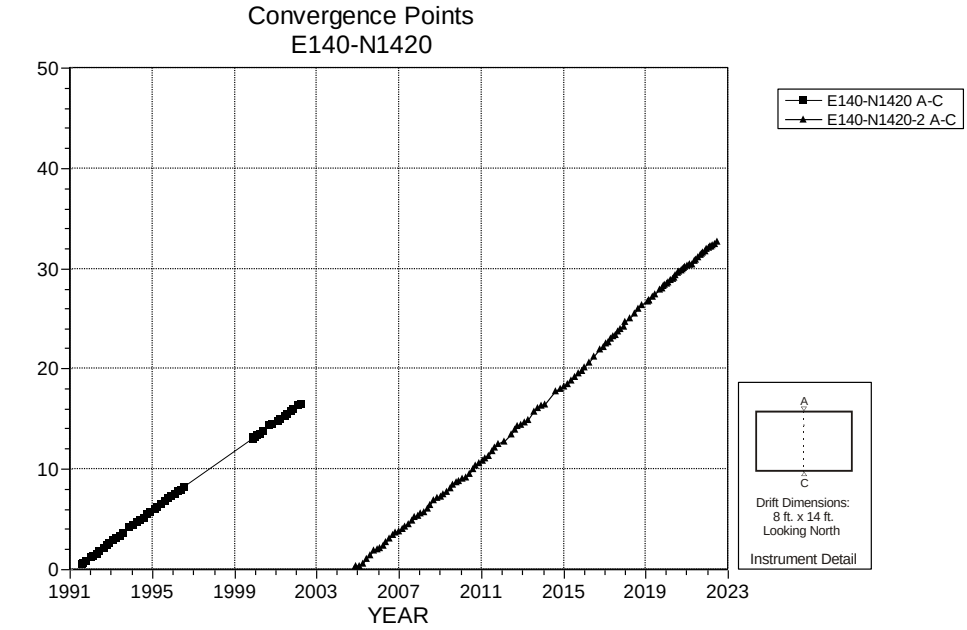
NOTES:
1. Excavation date: February 1983.
2. Inaccessible from 08/96 to 11/99.

Figure 4-38 Convergence Point Array – E140 N1100 – Roof to Floor



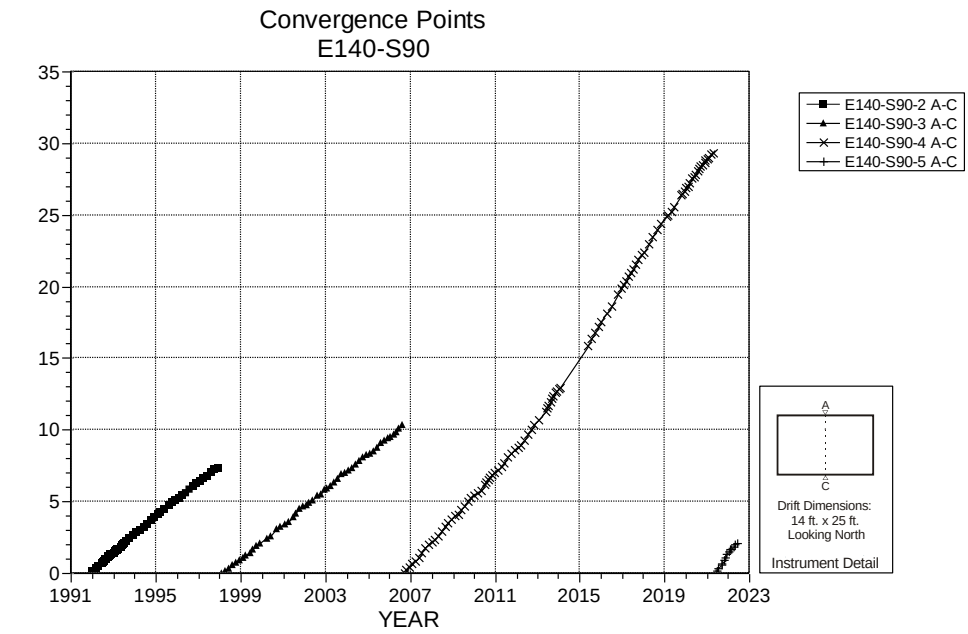
NOTES:
1. Excavation date: February 1983.
2. Enlarged from 8ft x 14ft in January 1990.
3. Inaccessible from 8/ 96 to 11/99.

Figure 4-39 Convergence Point Array – E140 N1266 – All Chords



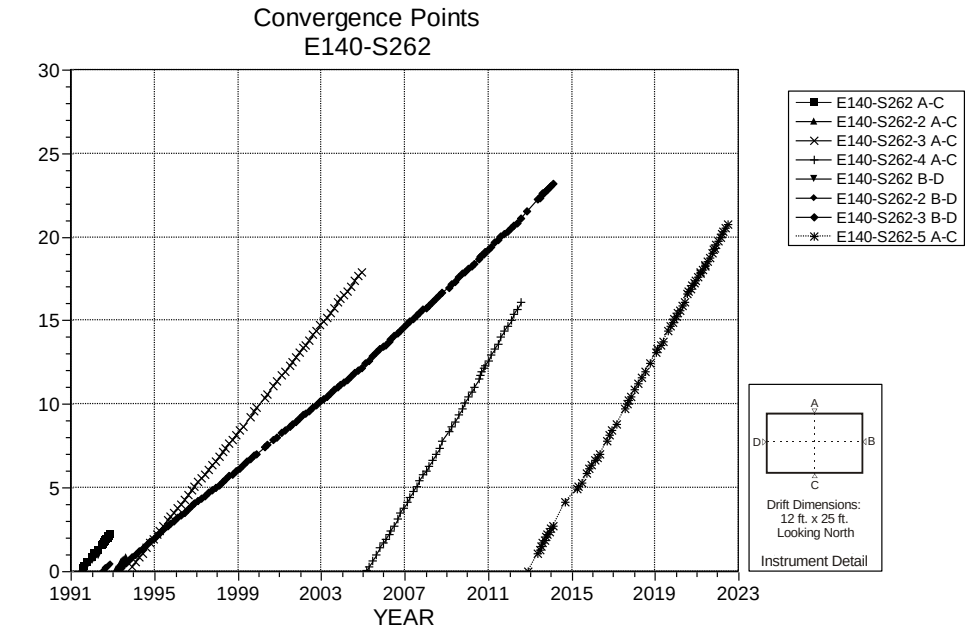
NOTES:
1. Excavation date: February 1983.
2. Inaccessible from August 1996 to November 1999.

Figure 4-40 Convergence Point Array – E140 N1420 – Roof to Floor



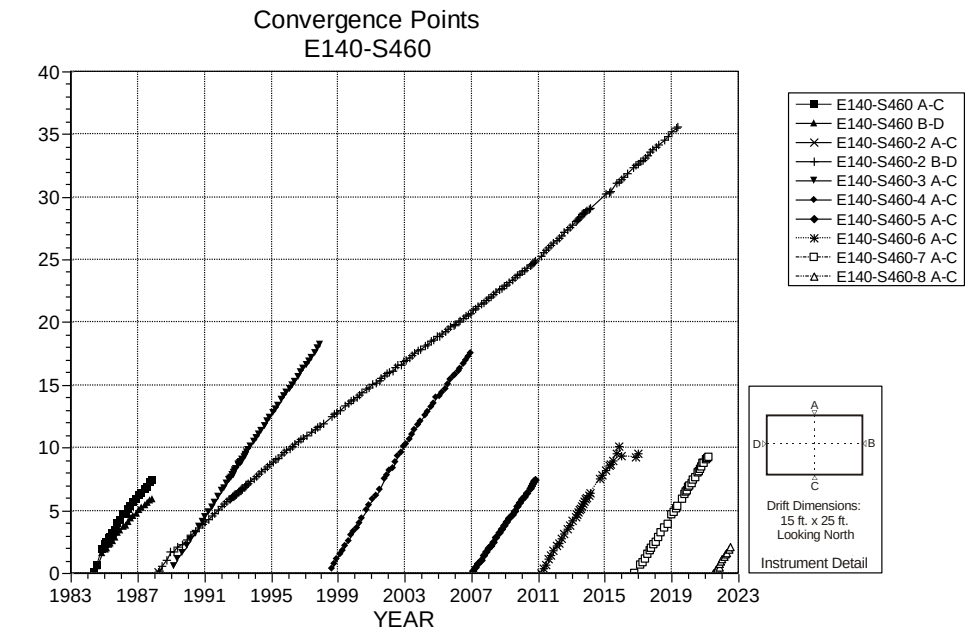
NOTES:
1. Excavation date: October 1982.
2. "C" Point mined out, reinstalled Sepetmber 2006

Figure 4-41 Convergence Point Array – E140 S90 – Roof to Floor



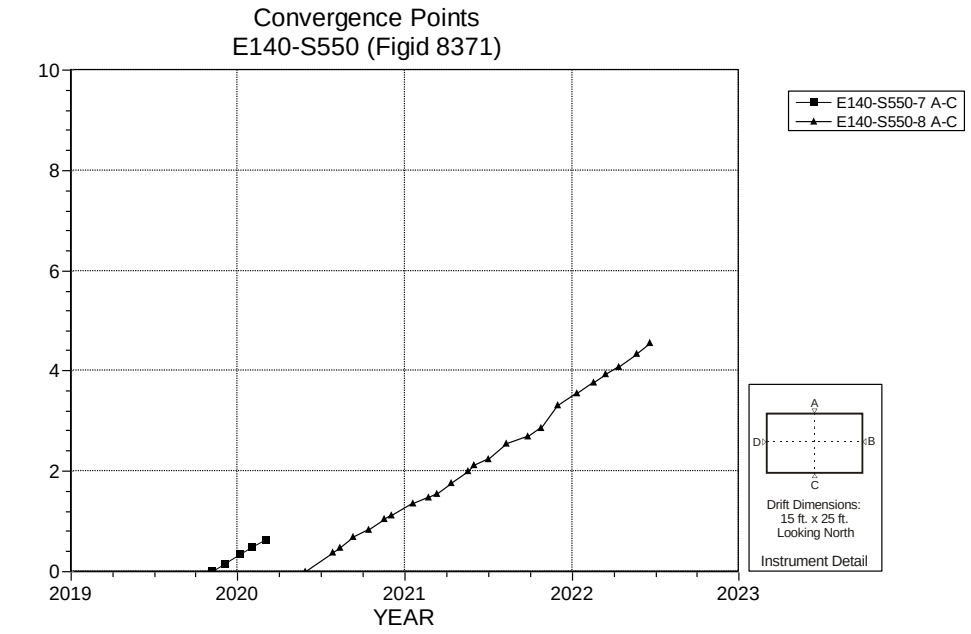
NOTES:
1. Excavation date: November 1982.

Figure 4-42 Convergence Point Array – E140 S262 – All Chords



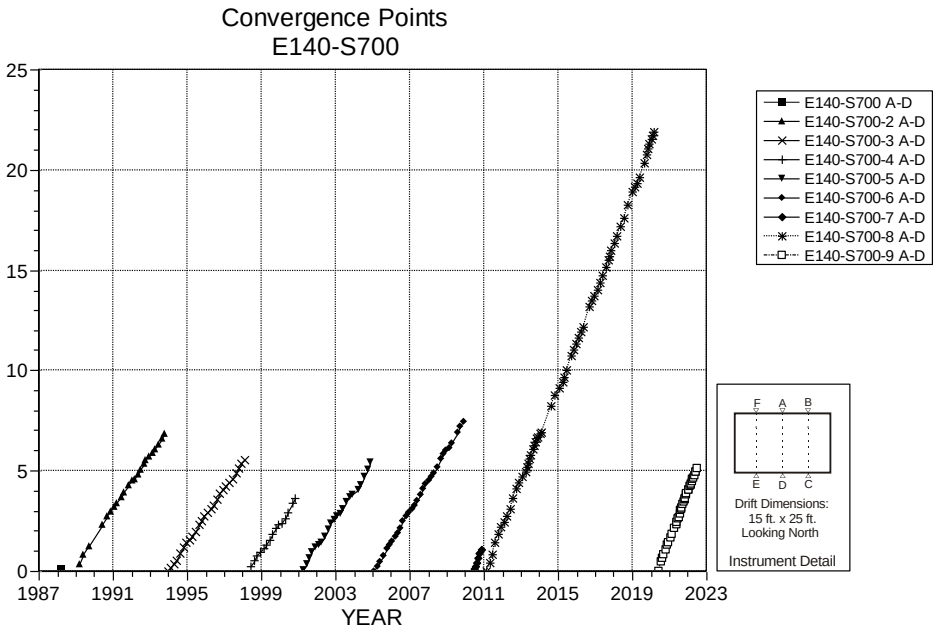
NOTES:
1. Excavation date: December 1982.
2. "C" point mined out, reinstall January 2007
3. Anchor 'C' mined out, reinstalled October 2016.

Figure 4-43 Convergence Point Array – E140 S460 – All Chords



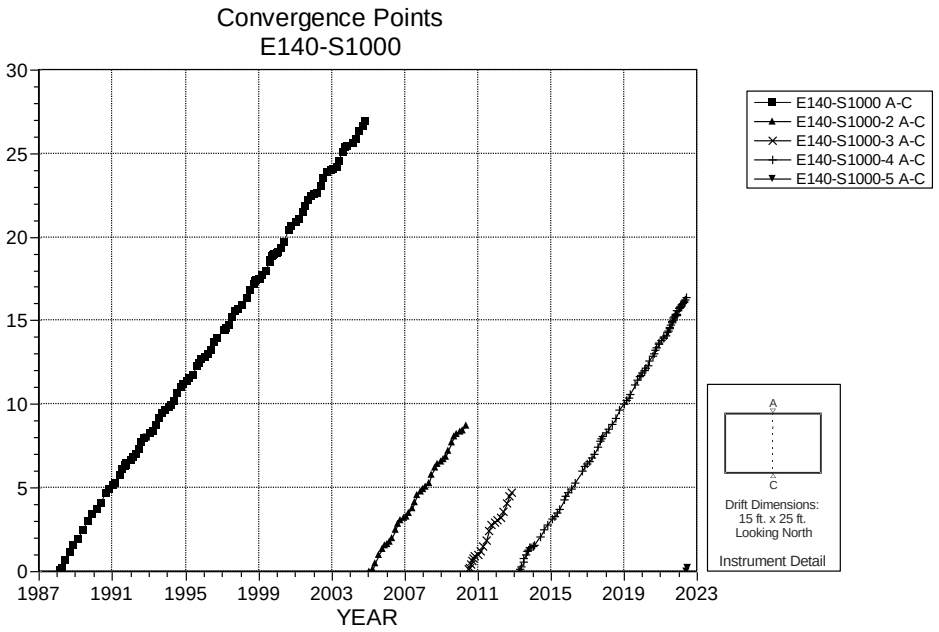
NOTES:
1. Excavation date: December 1982.
2. See FIGID 1745 for prior history.

Figure 4-44 Convergence Point Array – E140 S550 – Roof to Floor



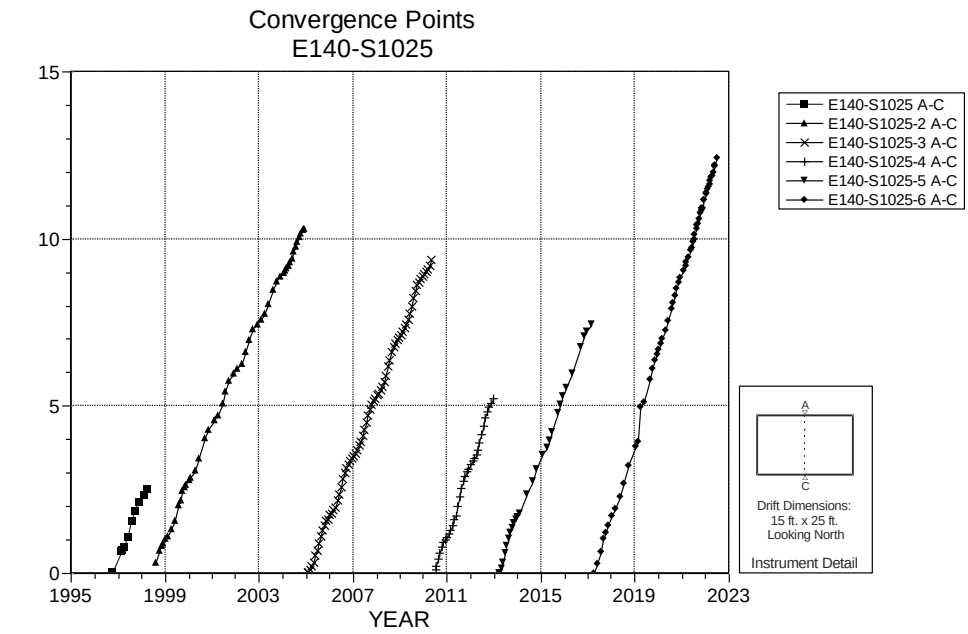
NOTES:
1. Excavation date: December 1982.

Figure 4-45 Convergence Point Array – E140 S700 – Roof to Floor



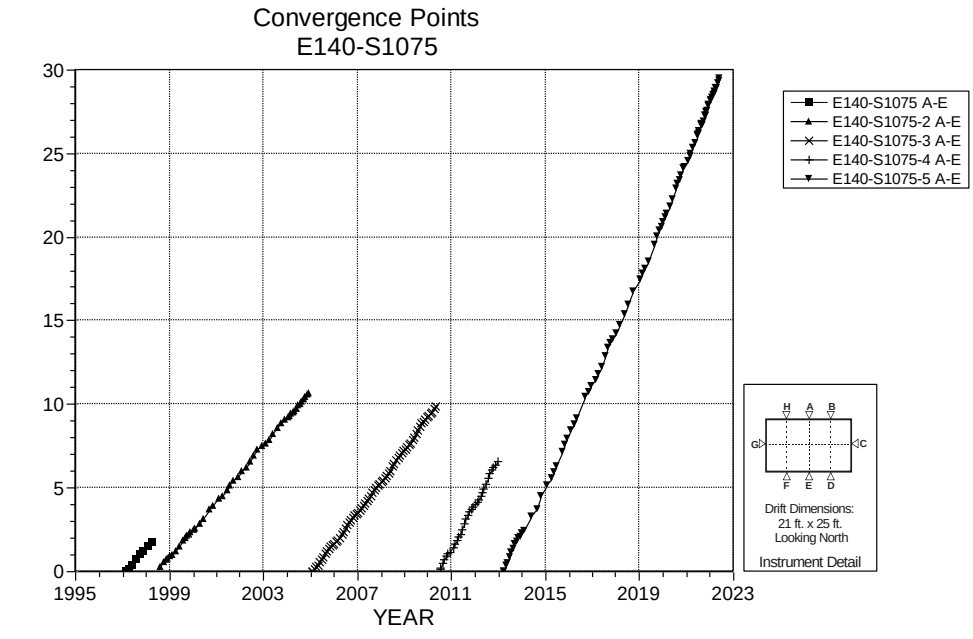
NOTES:
1. Excavation date: December 1982.

Figure 4-46 Convergence Point Array – E140 S1000 – Roof to Floor



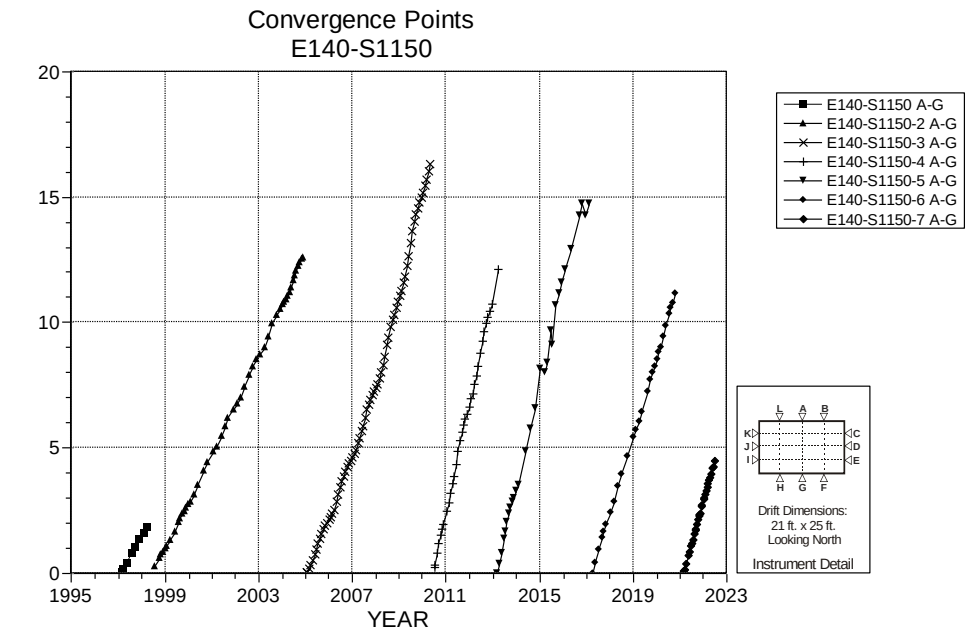
NOTES:
1. Excavation date: December 1982.

Figure 4-47 Convergence Point Array – E140 S1025 – Roof to Floor



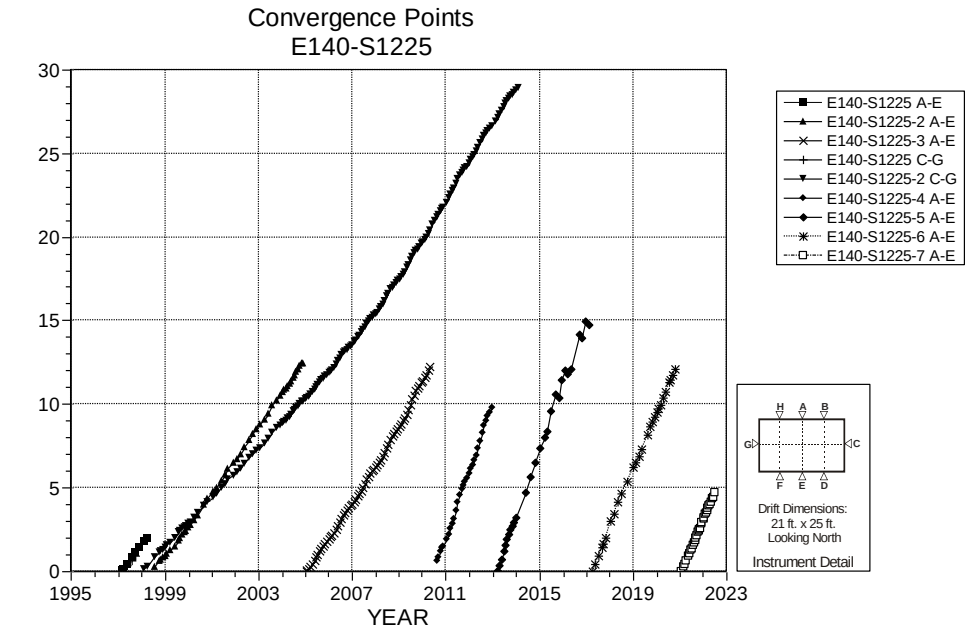
NOTES:
1. Excavation date: December 1982.

Figure 4-48 Convergence Point Array – E140 S1075 – All Chords



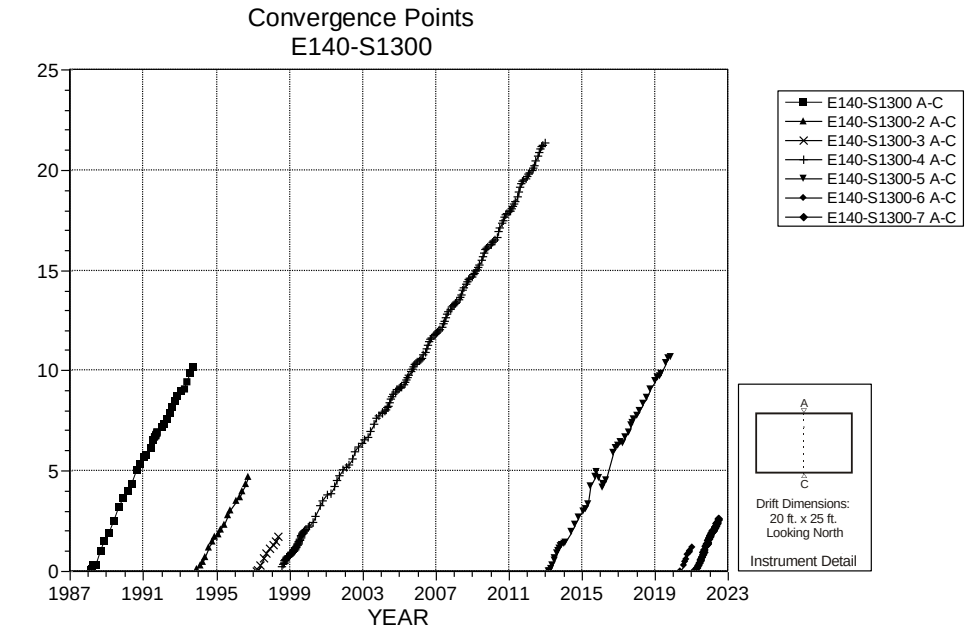
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b", November 1996.

Figure 4-49 Convergence Point Array – E140 S1150 – All Chords



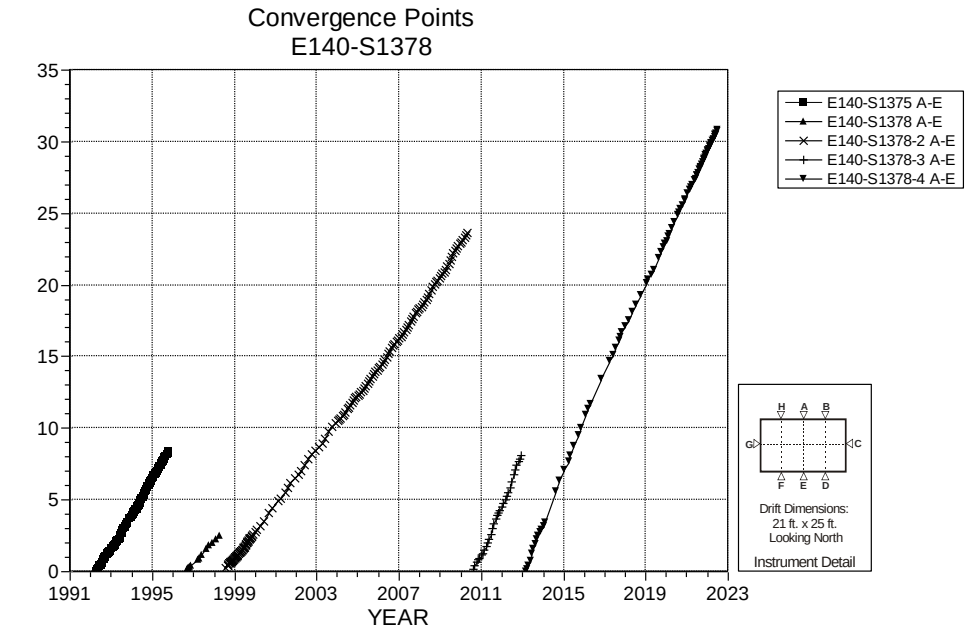
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b", November 1996.

Figure 4-50 Convergence Point Array – E140 S1225 – All Chords



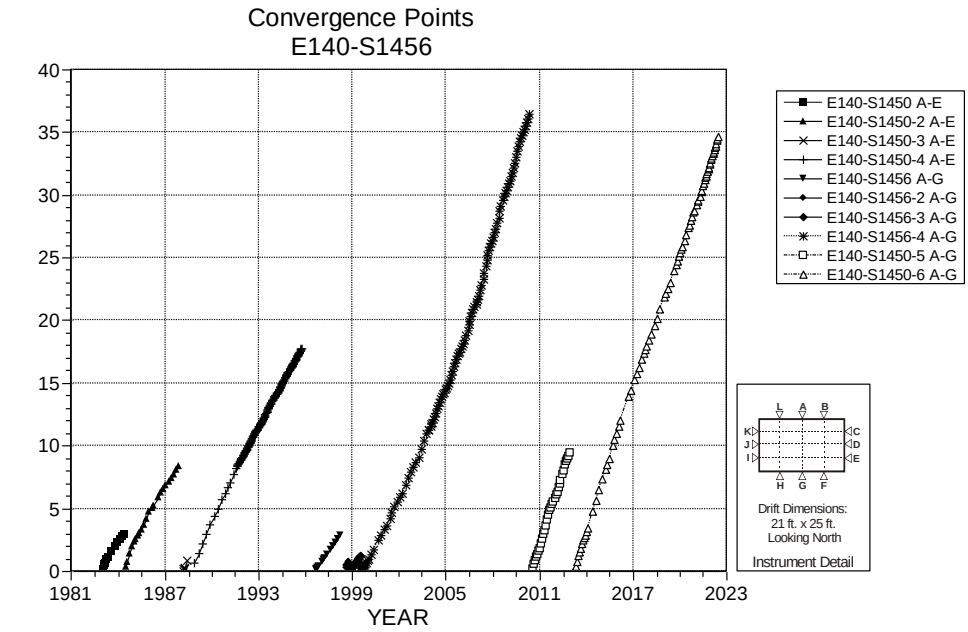
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in December 1996.

Figure 4-51 Convergence Point Array – E140 S1300 – Roof to Floor



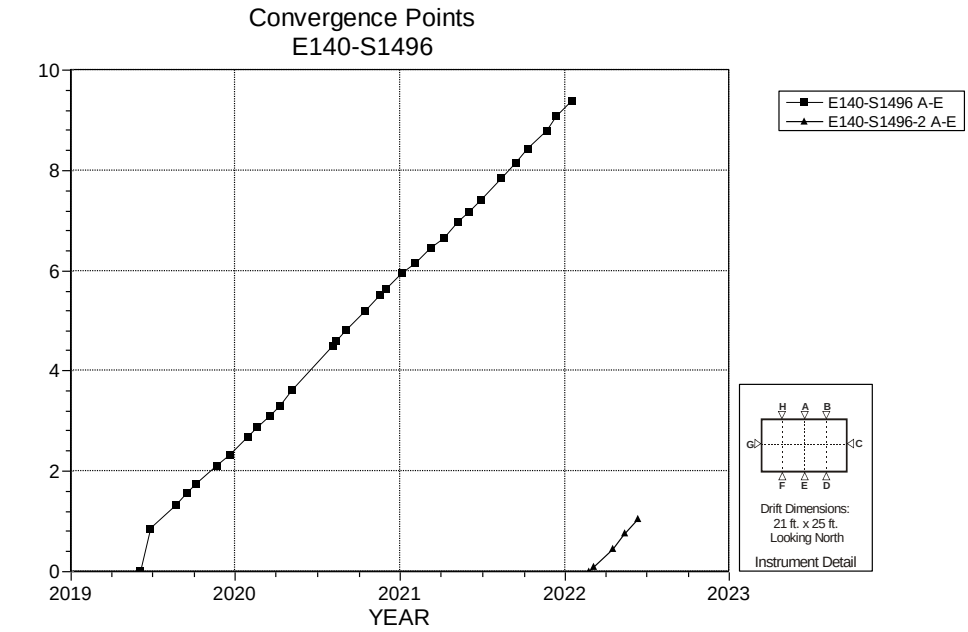
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in December 1995.

Figure 4-52 Convergence Point Array – E140 S1378 – Roof to Floor



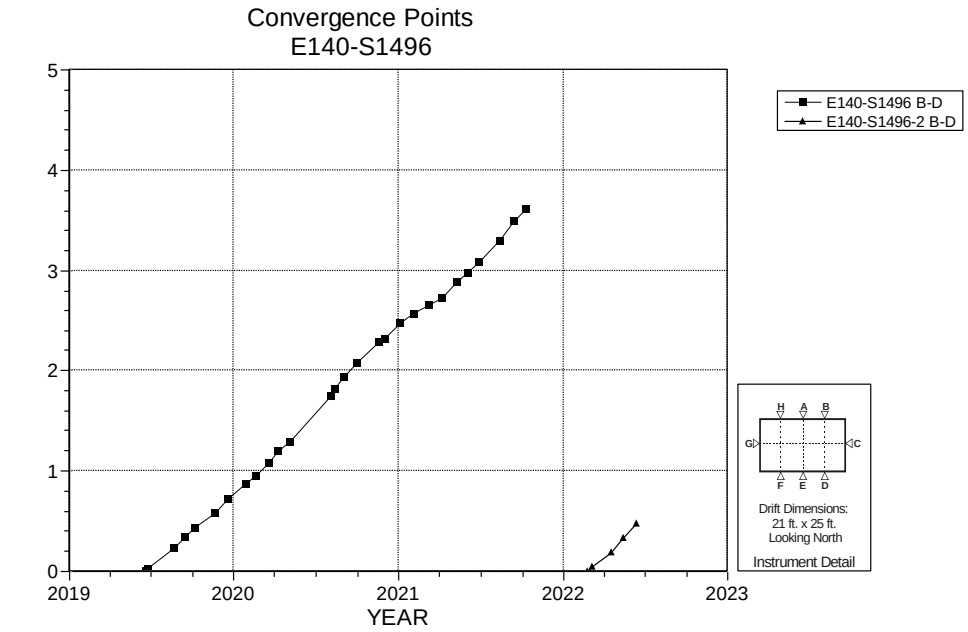
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in December 1995.

Figure 4-53 Convergence Point Array – E140 S1456 – Roof to Floor



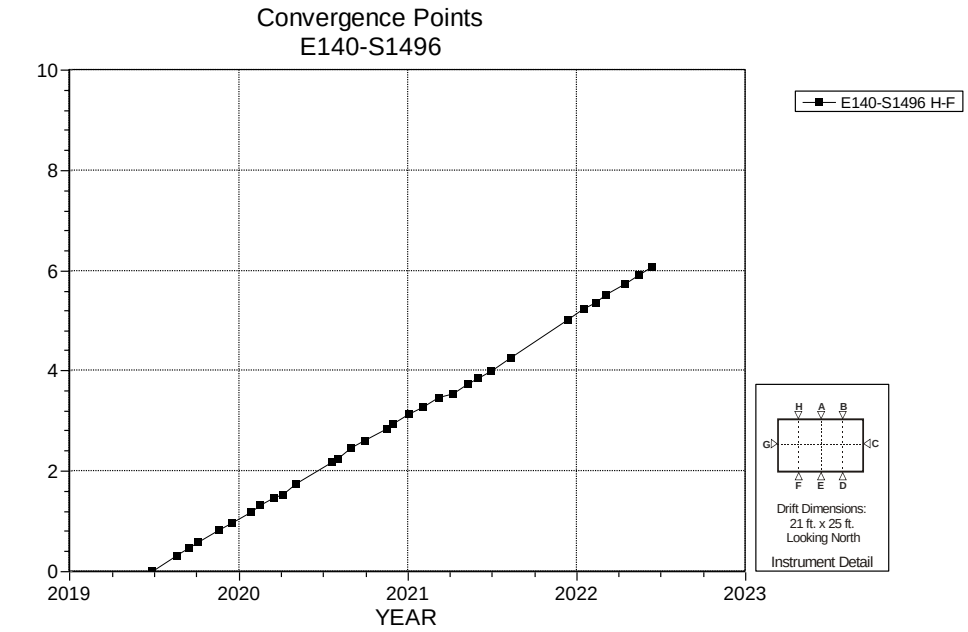
NOTES:
1. Excavation date: December 1982.

Figure 4-54 Convergence Point Array – E140 S1496 A-E – Roof to Floor – Test Area



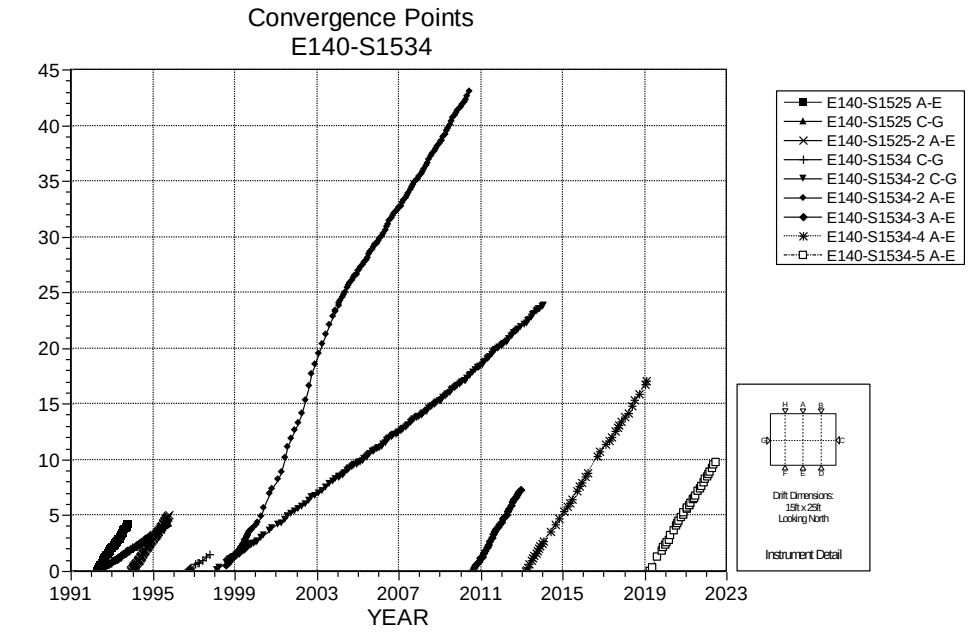
NOTES:
1. Excavation date: December 1982.

Figure 4-55 Convergence Point Array – E140 S1496 B-D – Roof to Floor – Test Area



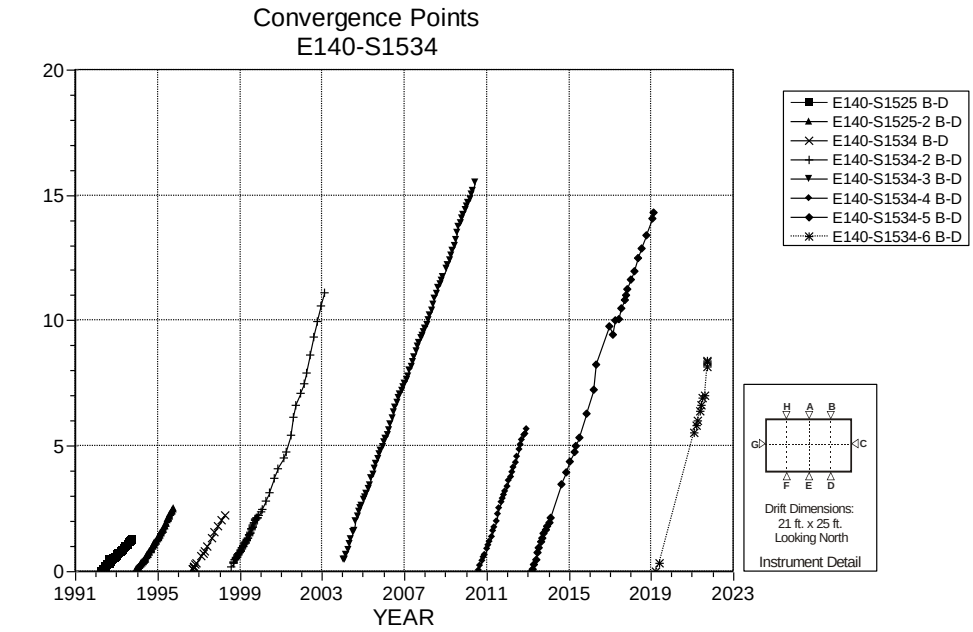
NOTES:
1. Excavation date: December 1982.

Figure 4-56 Convergence Point Array – E140 S1496 H-F – Roof to Floor – Test Area



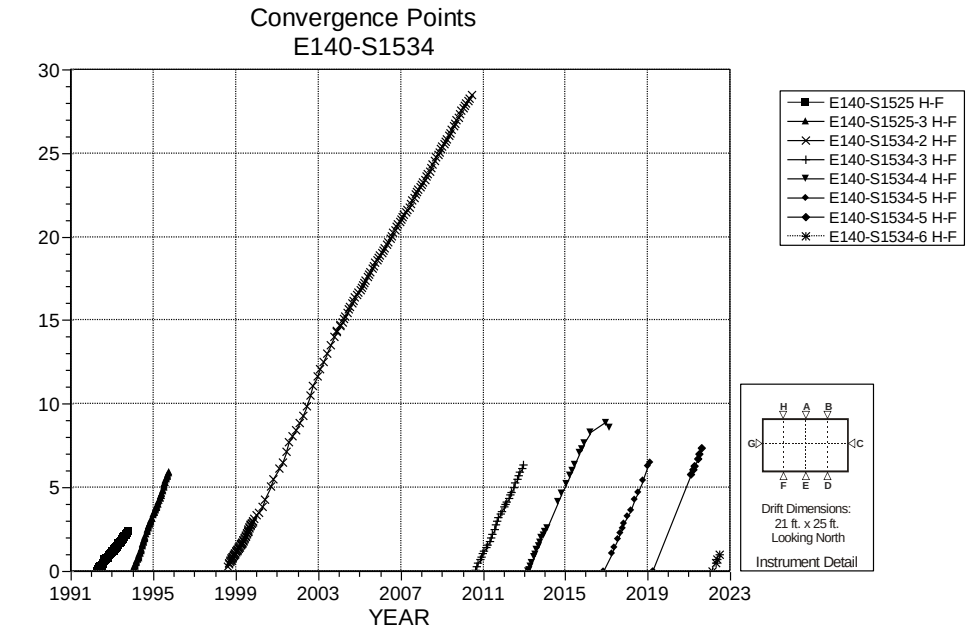
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in December 1995.
3. Replaced by E140-S1534.

Figure 4-57 Convergence Point Array – E140 S1534 A-E – Roof to Floor – Test Area



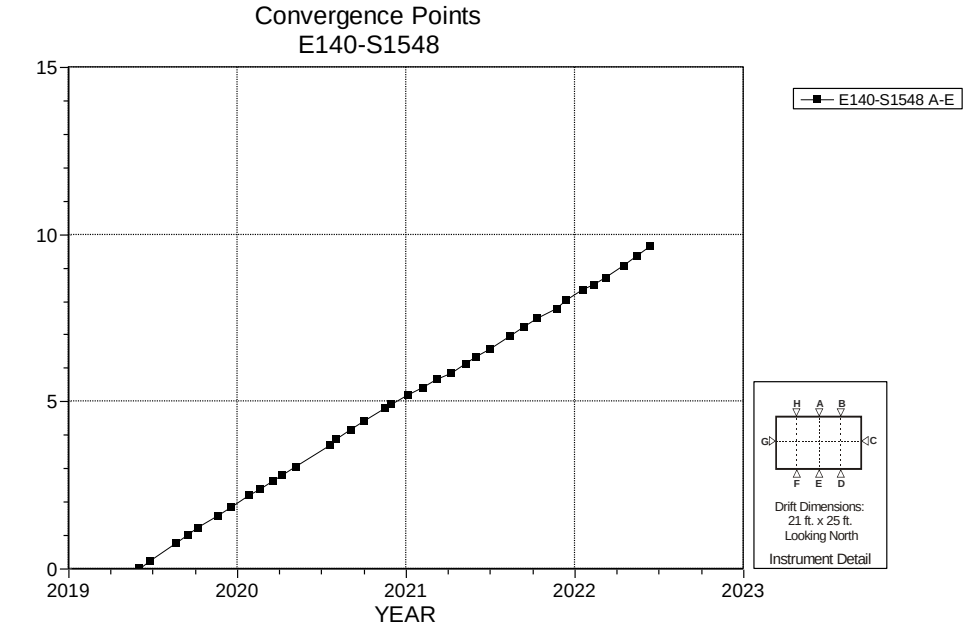
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in late 1995.

Figure 4-58 Convergence Point Array – E140 S1534 B-D – Roof to Floor – Test Area



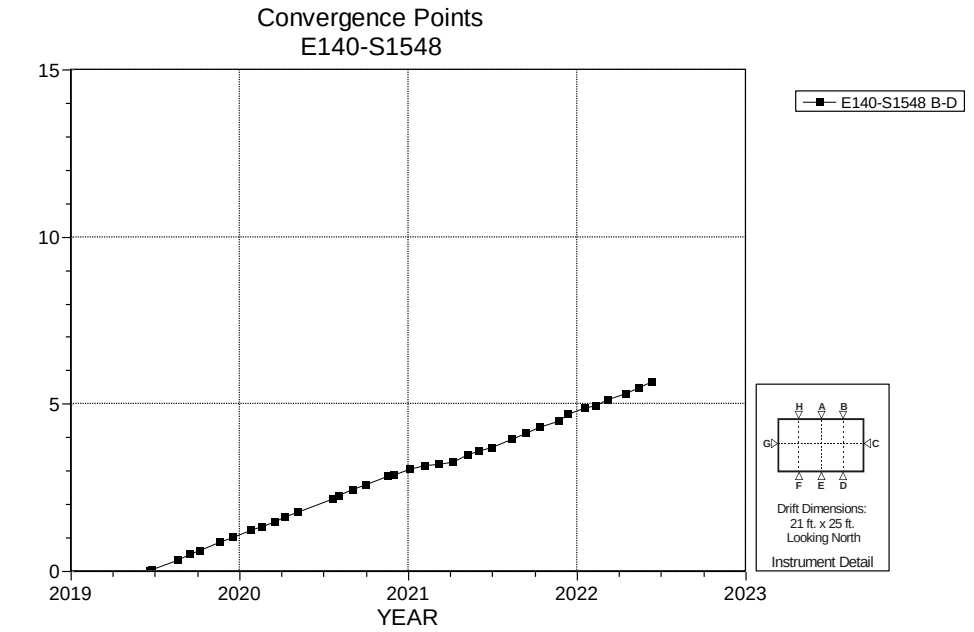
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in late 1995.

Figure 4-59 Convergence Point Array – E140 S1534 H-F – Roof to Floor – Test Area



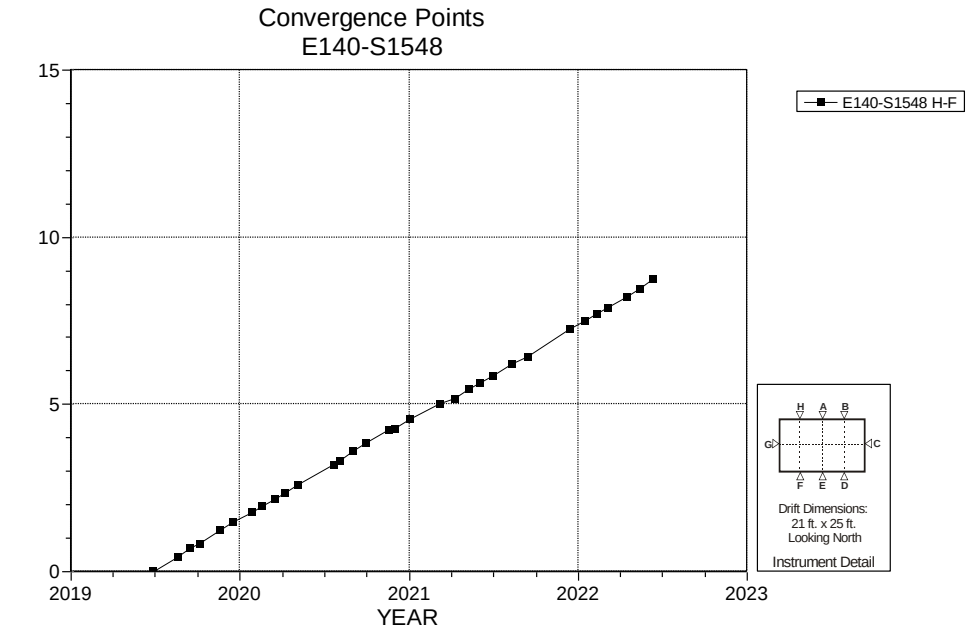
NOTES:
1. Excavation date: December 1982.

Figure 4-60 Convergence Point Array – E140 S1548 A-E – Roof to Floor – Test Area



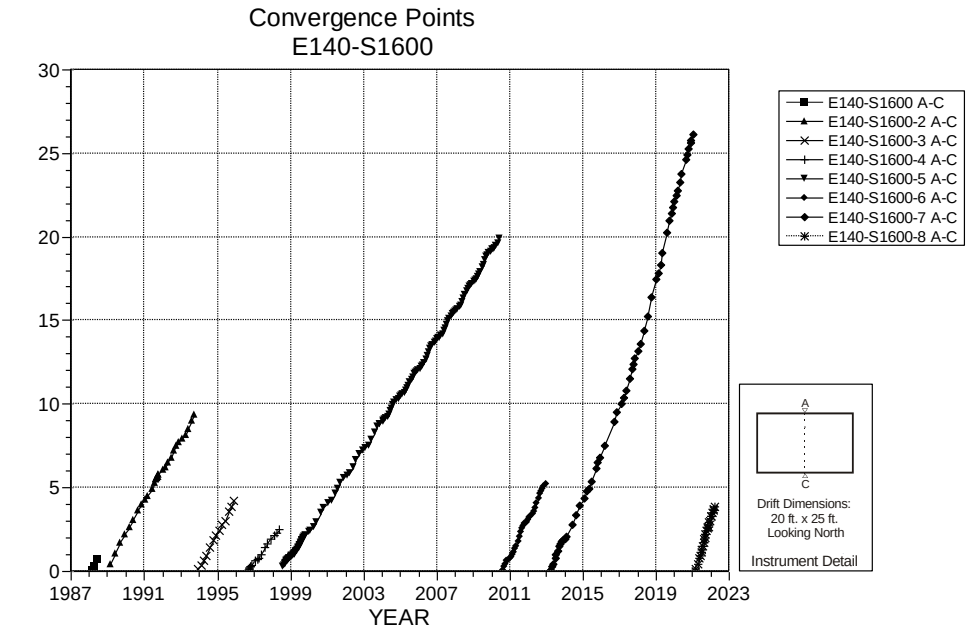
NOTES:
1. Excavation date: December 1982.

Figure 4-61 Convergence Point Array – E140 S1548 B-D – Roof to Floor – Test Area



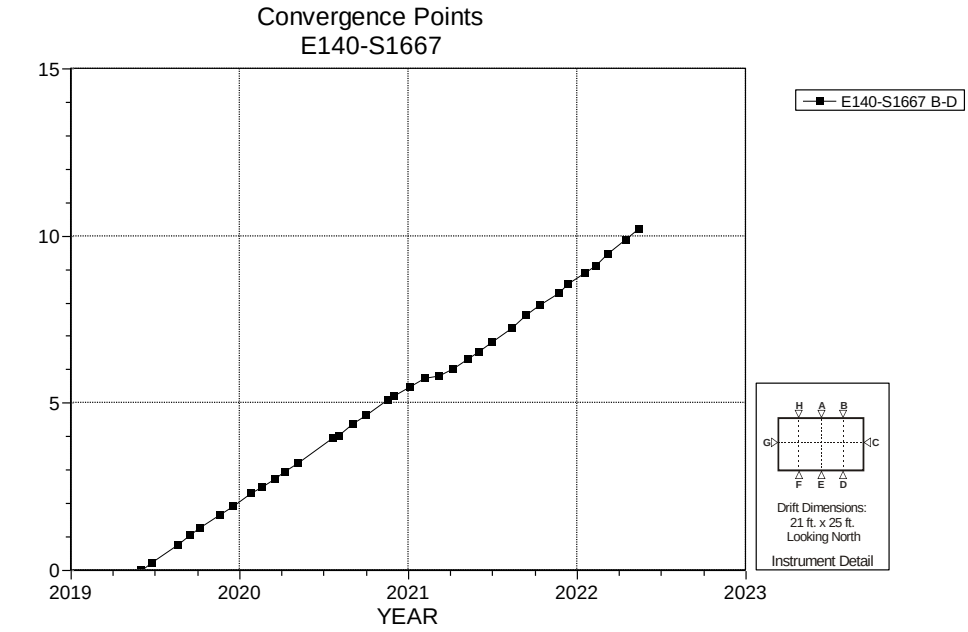
NOTES:
1. Excavation date: December 1982.

Figure 4-62 Convergence Point Array – E140 S1548 H-F – Roof to Floor – Test Area



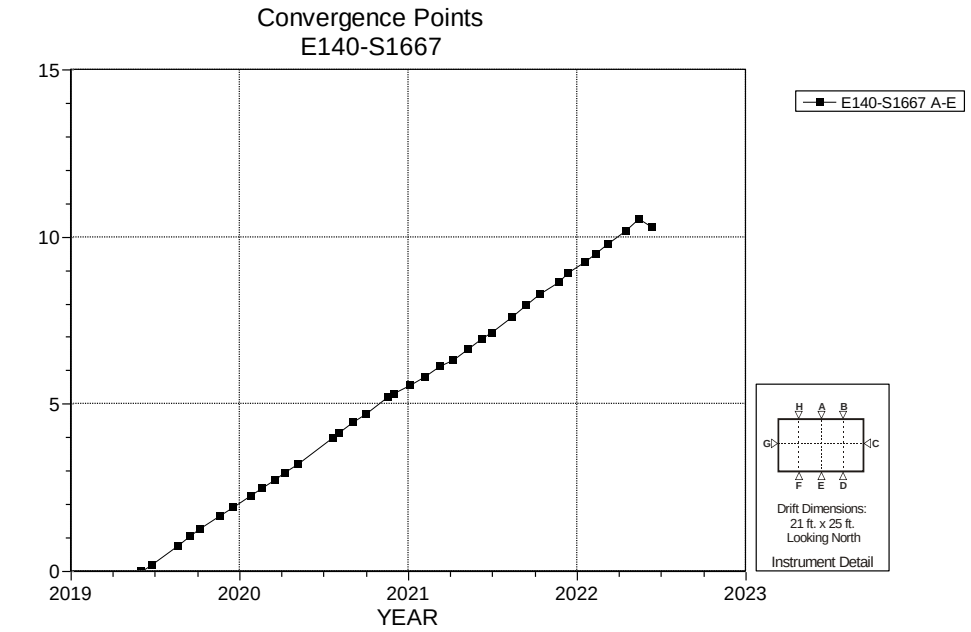
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in December 1996.

Figure 4-63 Convergence Point Array – E140 S1600 – Roof to Floor



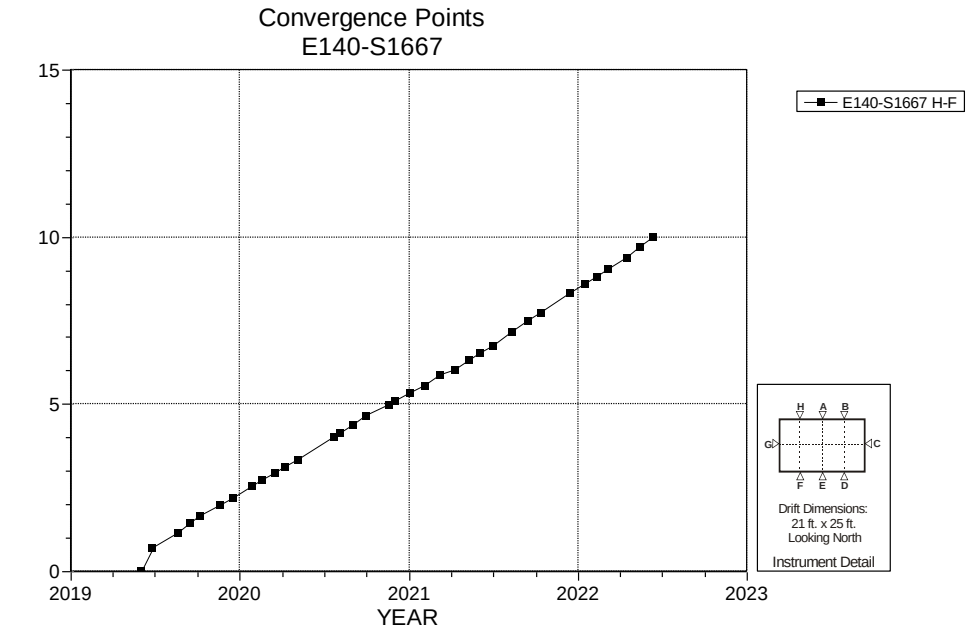
NOTES:
1. Excavation date: December 1982.

Figure 4-64 Convergence Point Array – E140 S1667 B-D – Roof to Floor



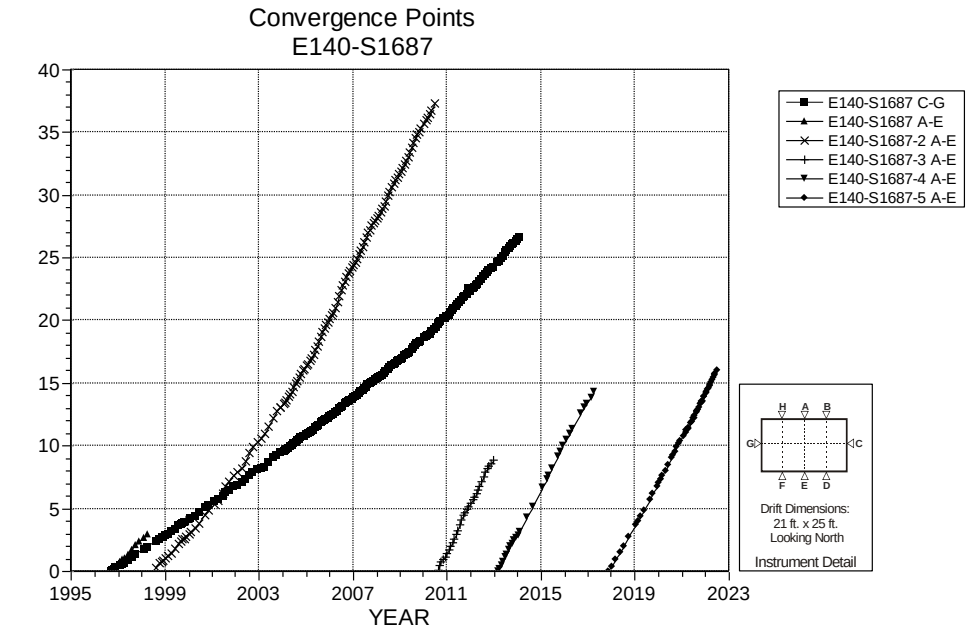
NOTES:
1. Excavation date: December 1982.

Figure 4-65 Convergence Point Array – E140 S1667 A-E – Roof to Floor



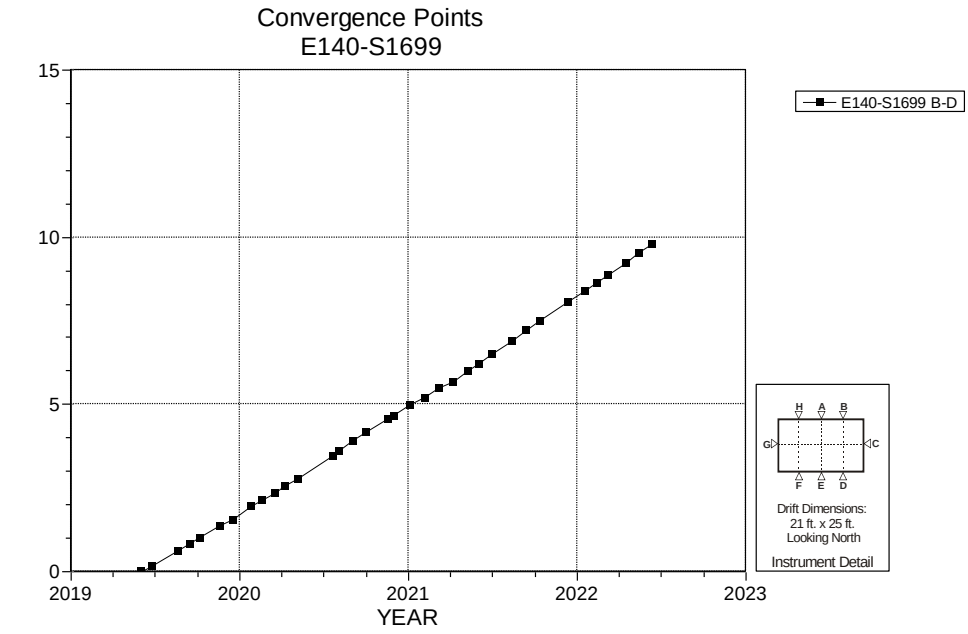
NOTES:
1. Excavation date: December 1982.

Figure 4-66 Convergence Point Array – E140 S1667 H-F – Roof to Floor



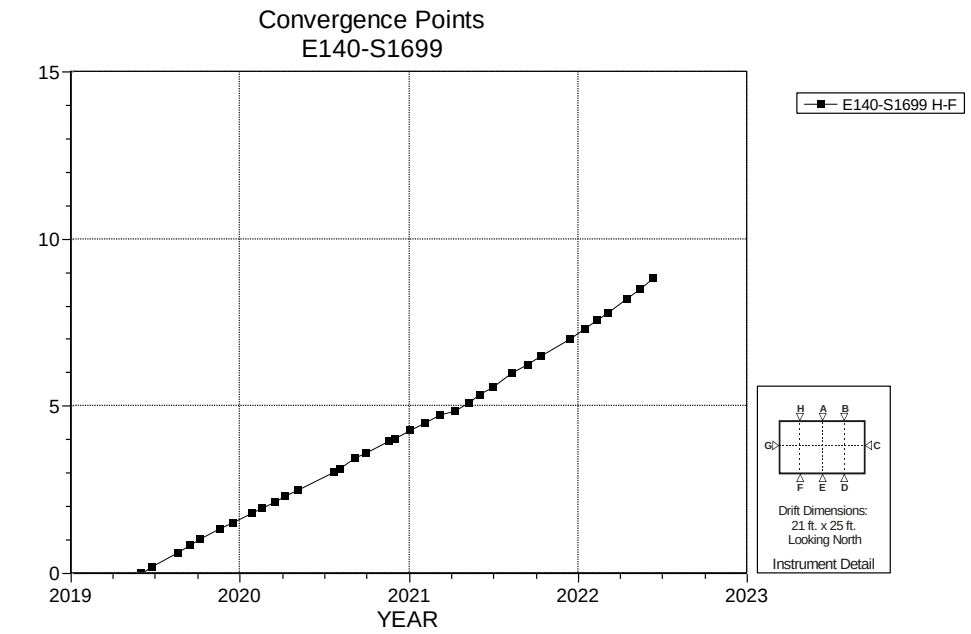
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in early 1996.

Figure 4-67 Convergence Point Array – E140 S1687 – Roof to Floor



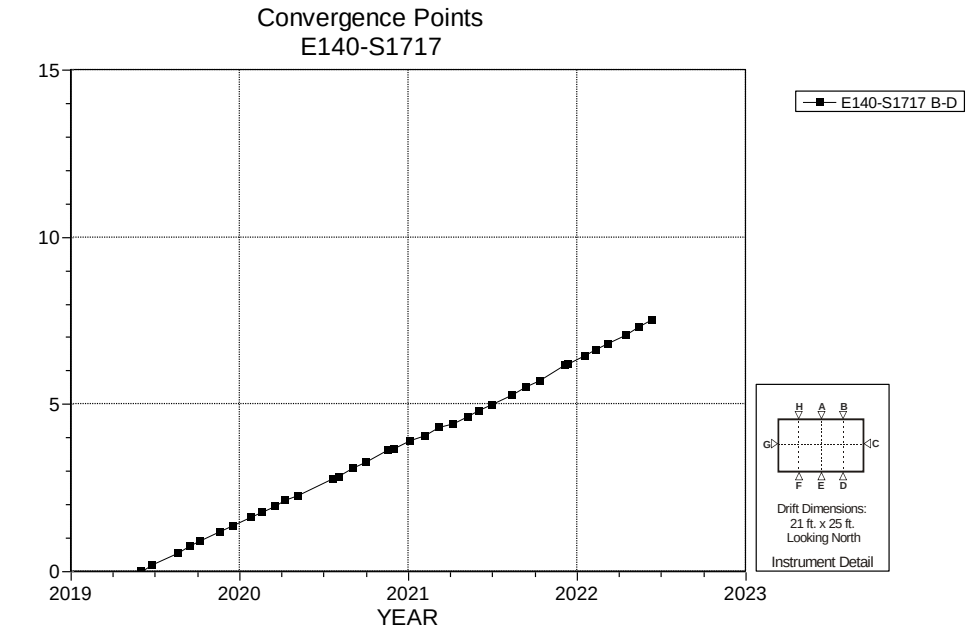
NOTES:
1. Excavation date: December 1982.

Figure 4-68 Convergence Point Array – E140 S1699 B-D – Roof to Floor



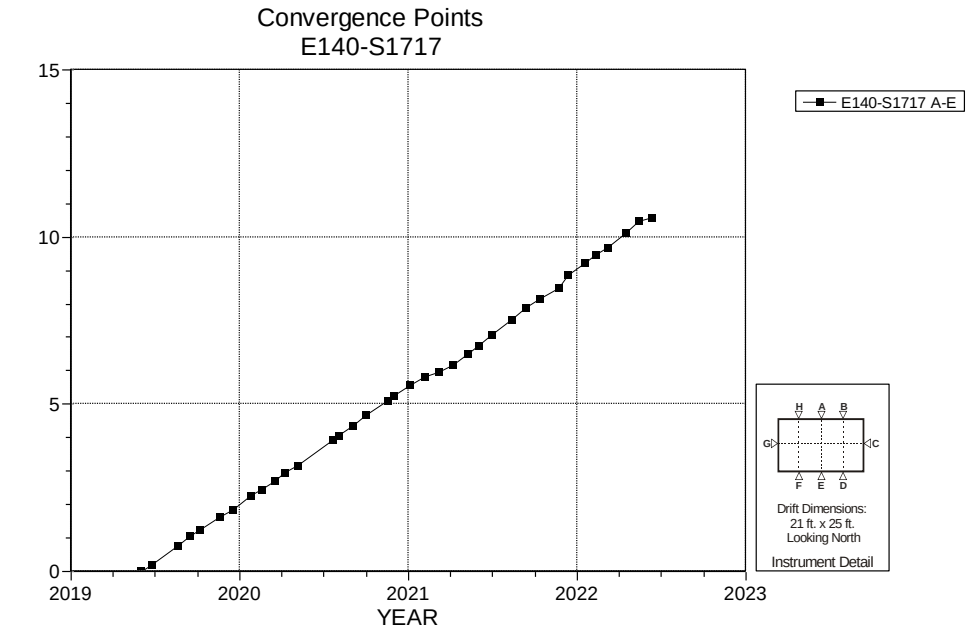
NOTES:
1. Excavation date: December 1982.

Figure 4-69 Convergence Point Array – E140 S1699 H-F – Roof to Floor



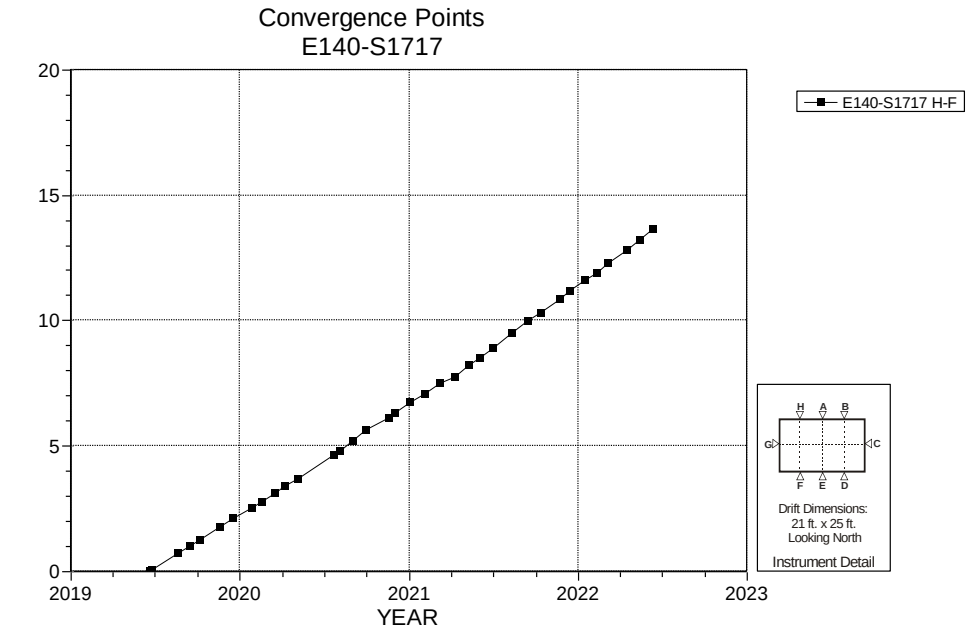
NOTES:
1. Excavation date: December 1982.

Figure 4-70 Convergence Point Array – E140 S1717 B-D – Roof to Floor



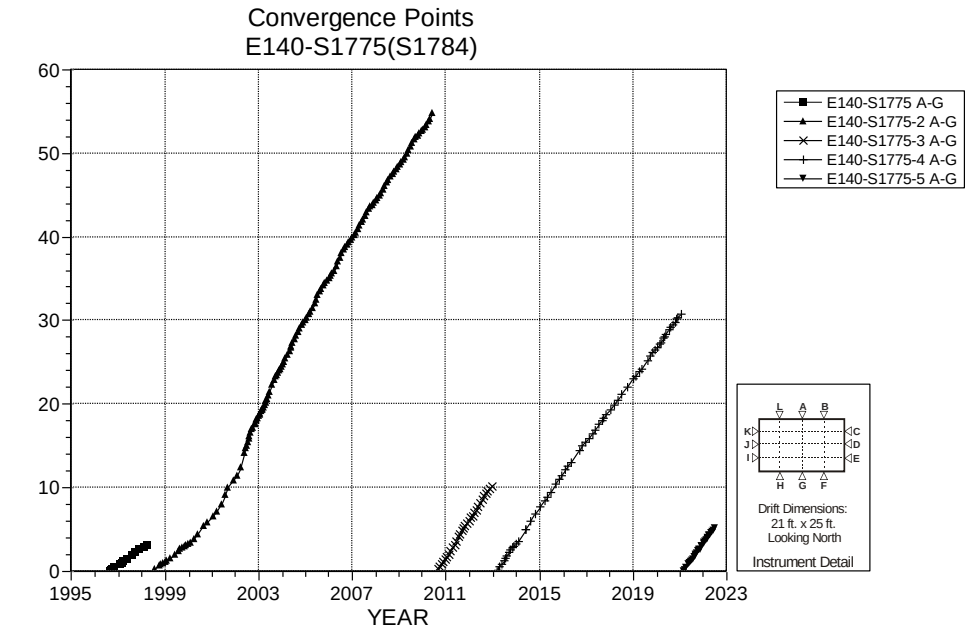
NOTES:
1. Excavation date: December 1982.

Figure 4-71 Convergence Point Array – E140 S1717 A-E – Roof to Floor



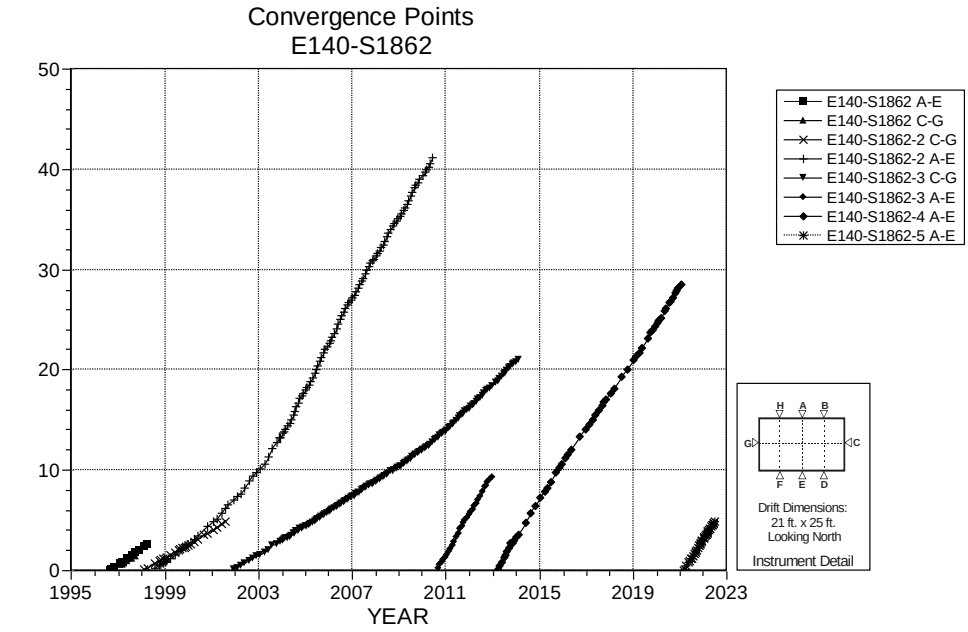
NOTES:
1. Excavation date: December 1982.

Figure 4-72 Convergence Point Array – E140 S1717 H-F – Roof to Floor



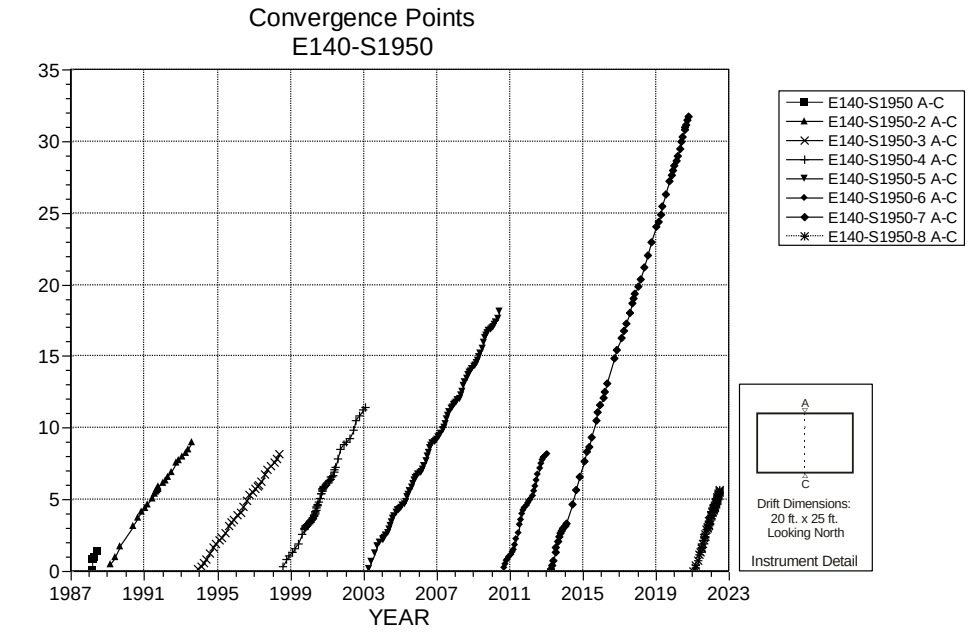
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in early 1996.

Figure 4-73 Convergence Point Array – E140 S1775 – Roof to Floor



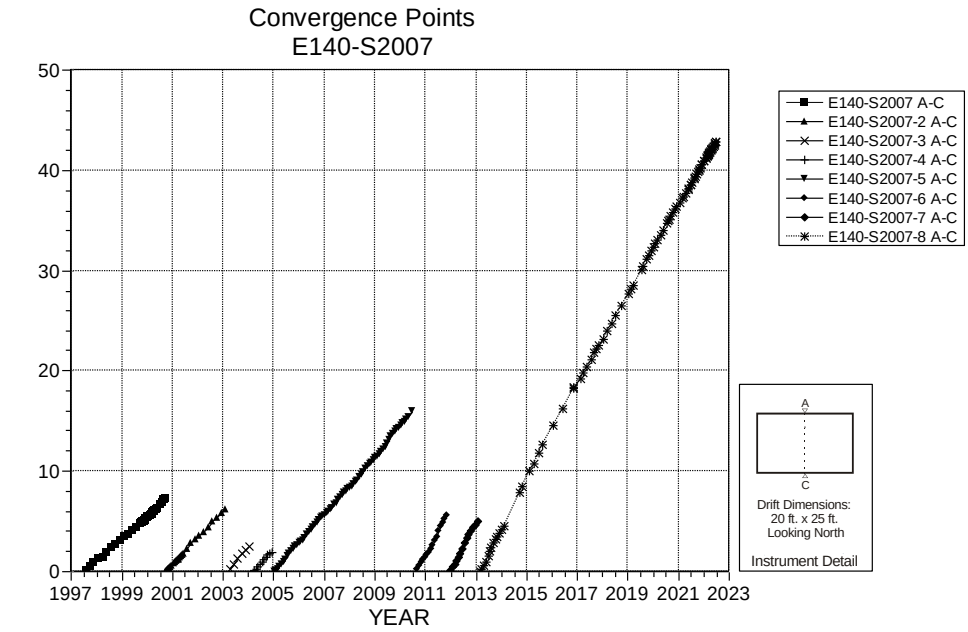
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b" in early 1996.

Figure 4-74 Convergence Point Array – E140 S1862 – All Chords



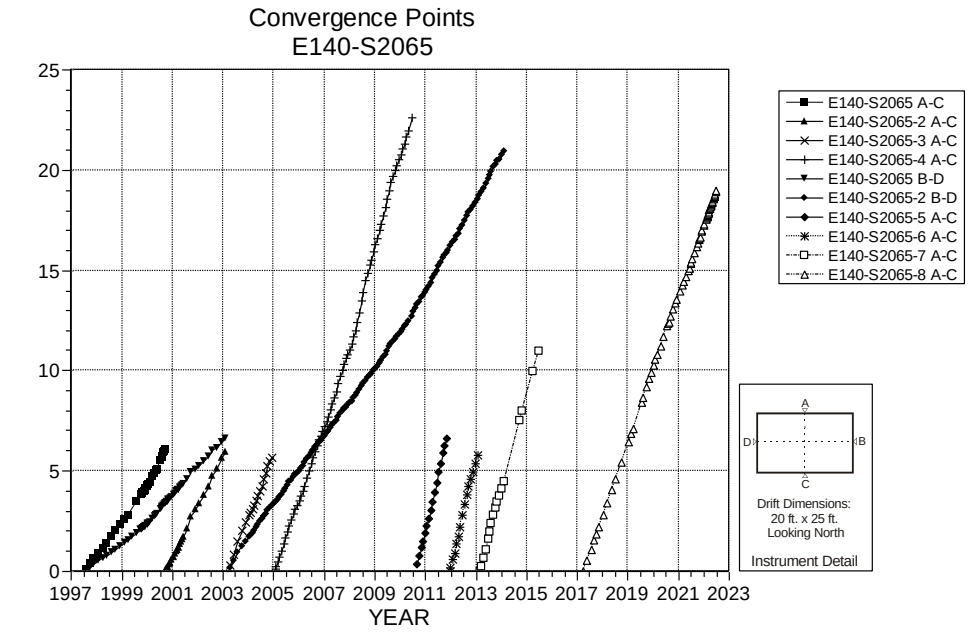
NOTES:
1. Excavation date: December 1982.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-75 Convergence Point Array – E140 S1950 – Roof to Floor



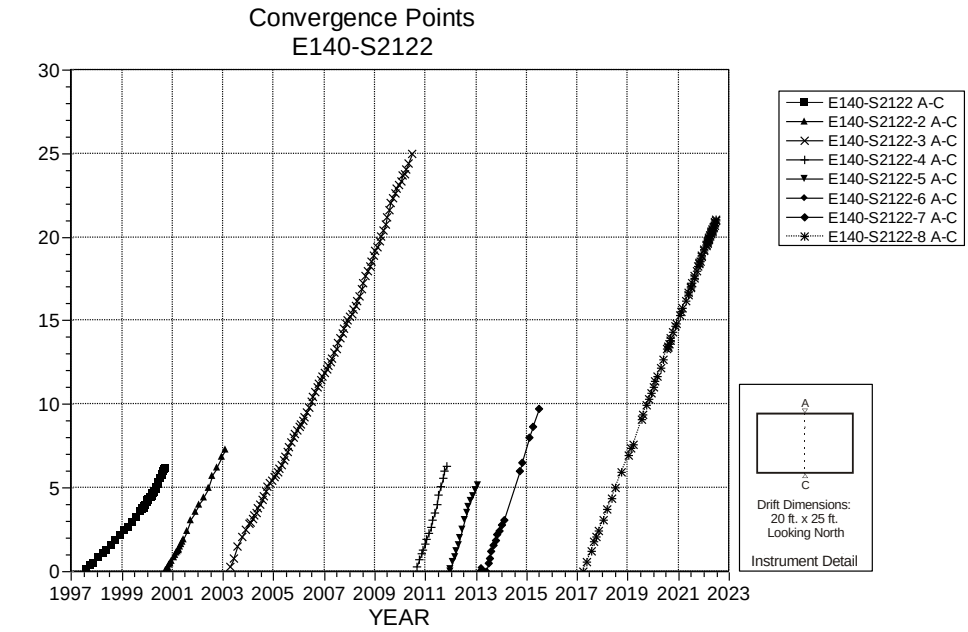
NOTES:
1. Excavation date: January 1993.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-76 Convergence Point Array – E140 S2007 - Roof to Floor



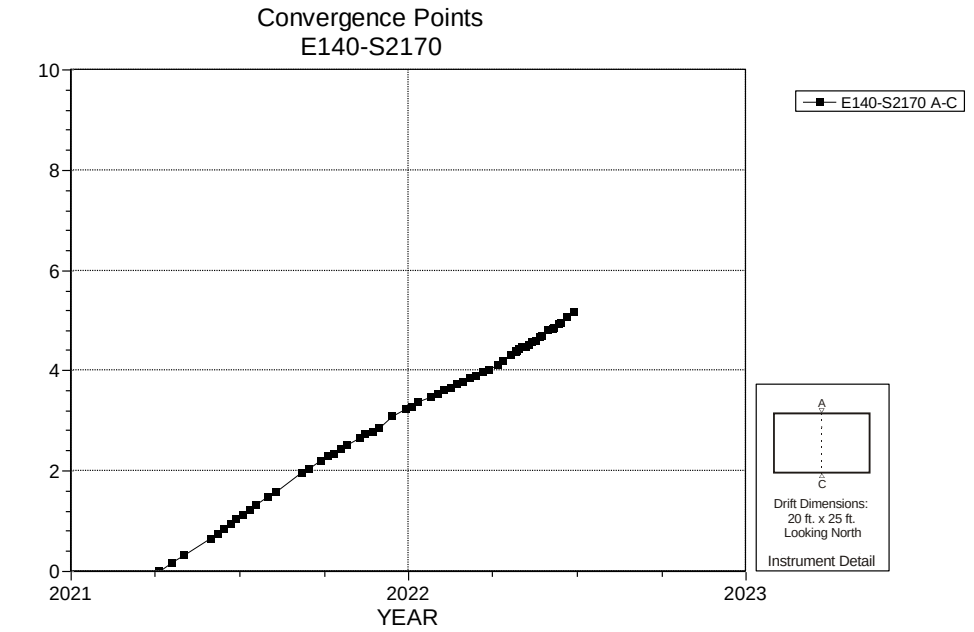
NOTES:
1. Excavation date: January 1993.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-77 Convergence Point Array – E140 S2065 – All Chords



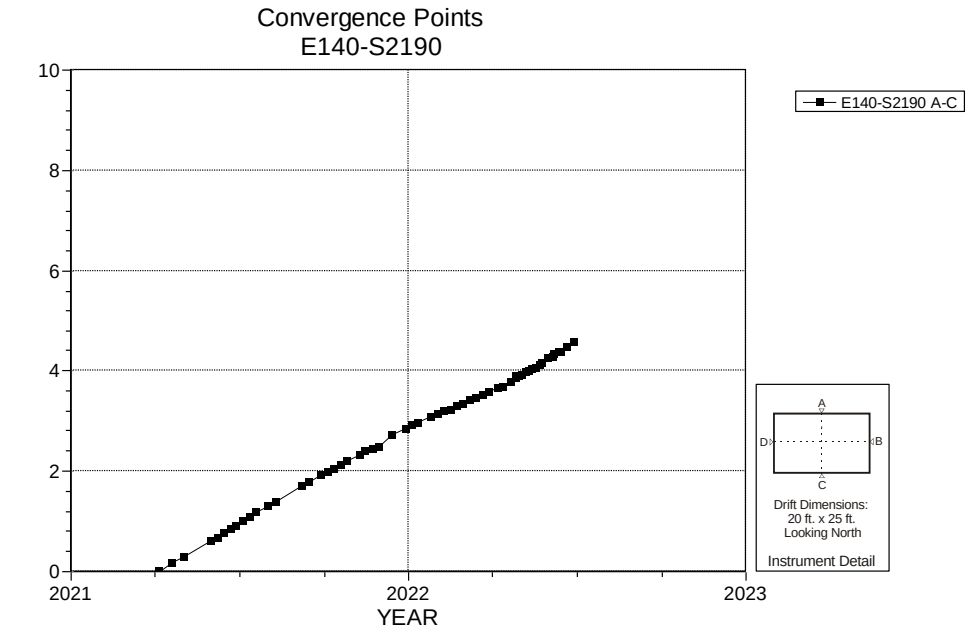
NOTES:
1. Excavation date: January 1993.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-78 Convergence Point Array – E140 S2122 – Roof to Floor



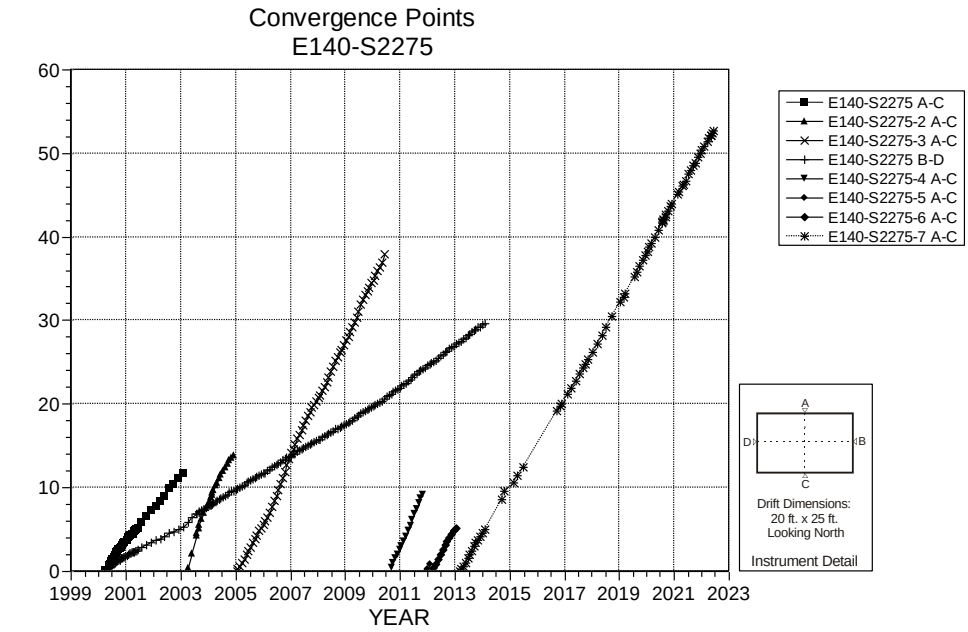
NOTES:
1. Excavation date: January 1993.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-79 Convergence Point Array – E140 S2170 – Roof to Floor



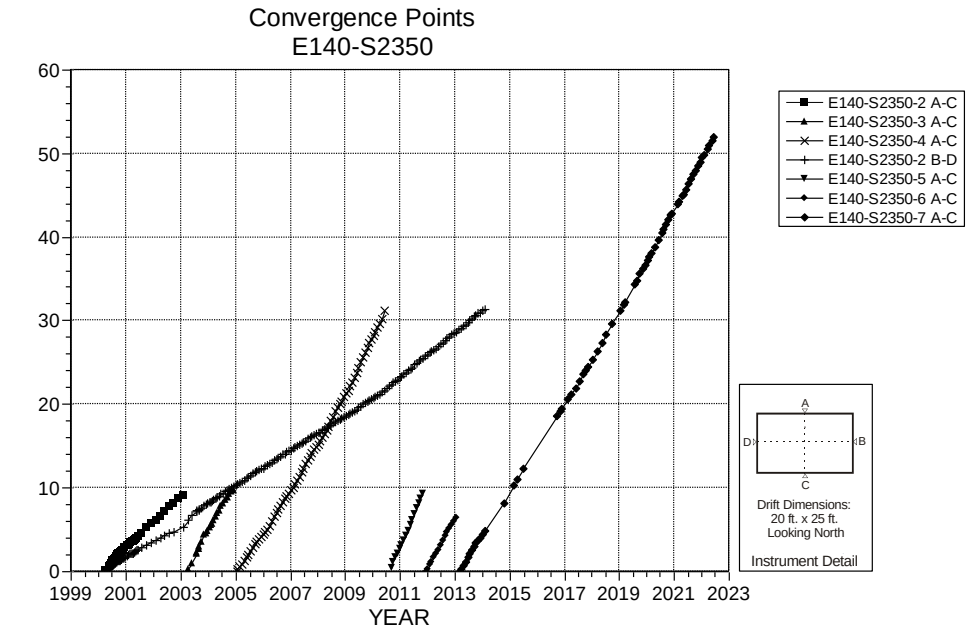
NOTES:
1. Excavation date: January 1983.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-80 Convergence Point Array – E140 S2190 – Roof to Floor



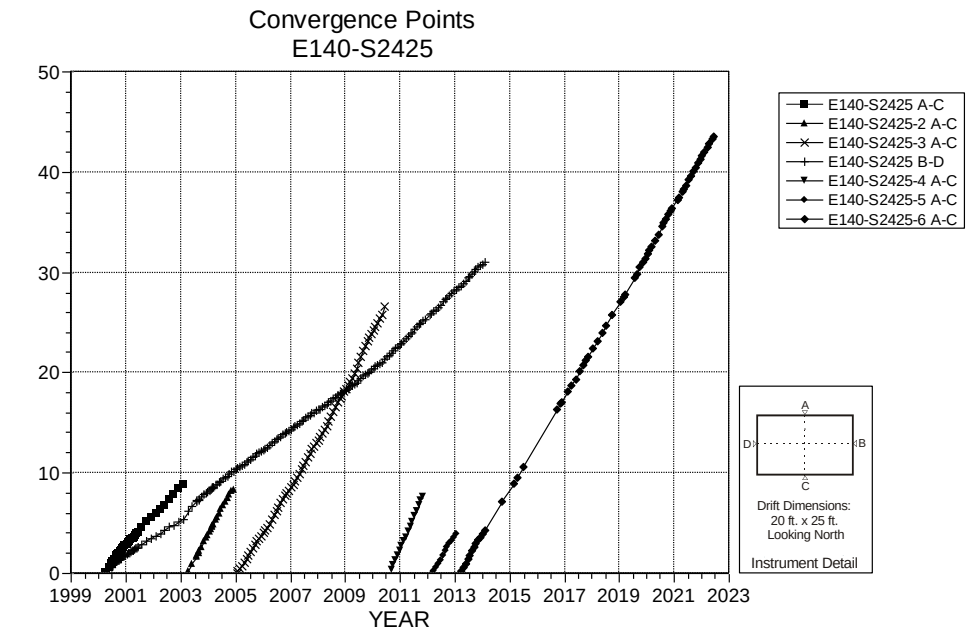
NOTES:
1. Excavation date: January 1983.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-81 Convergence Point Array – E140 S2275 – All Chords



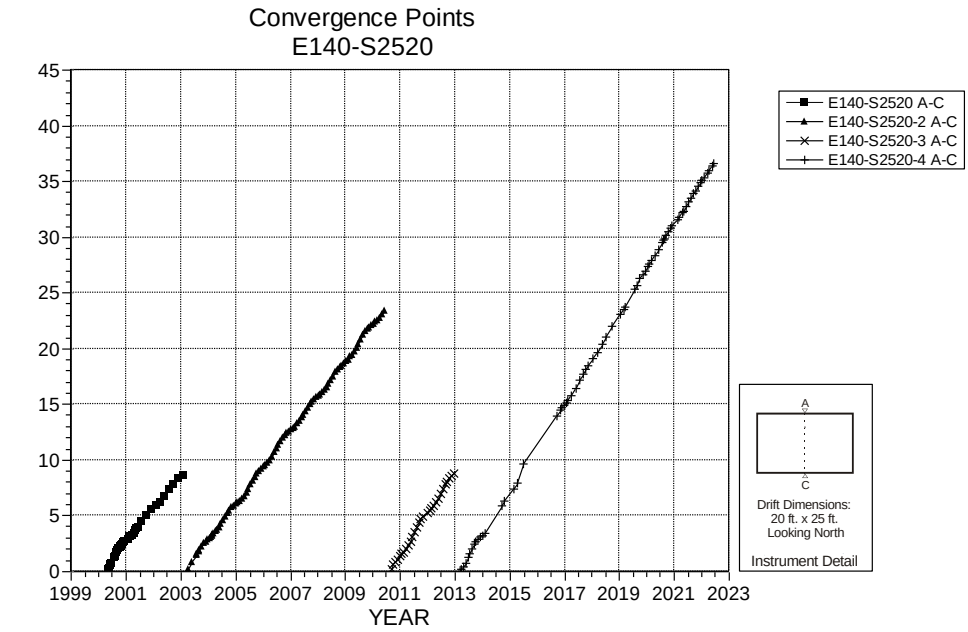
NOTES:
1. Excavation date: January 1983.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-82 Convergence Point Array – E140 S2350 – All Chords



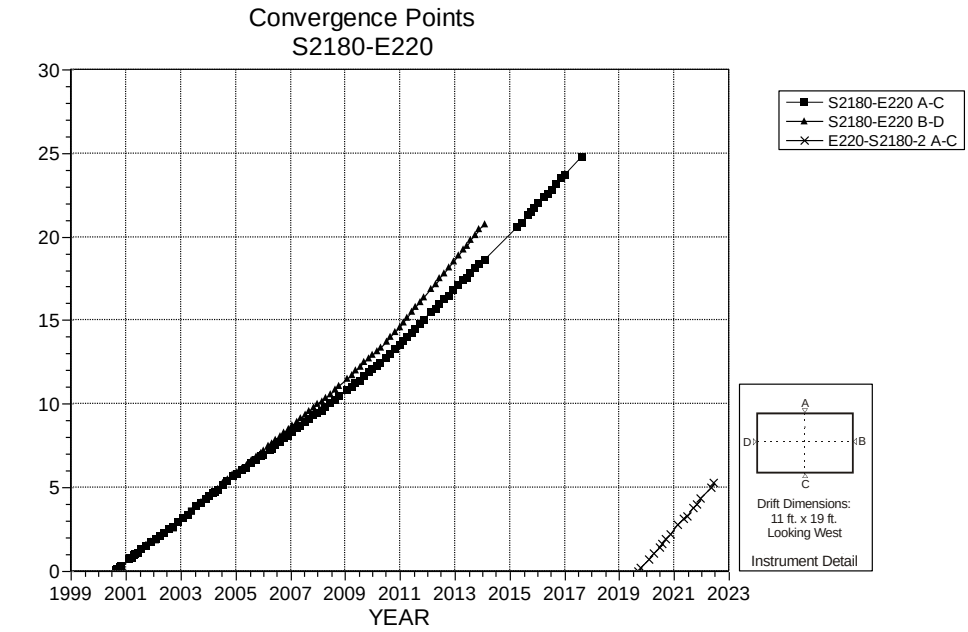
NOTES:
1. Excavation date: January 1983.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-83 Convergence Point Array – E140 S2425 – All Chords



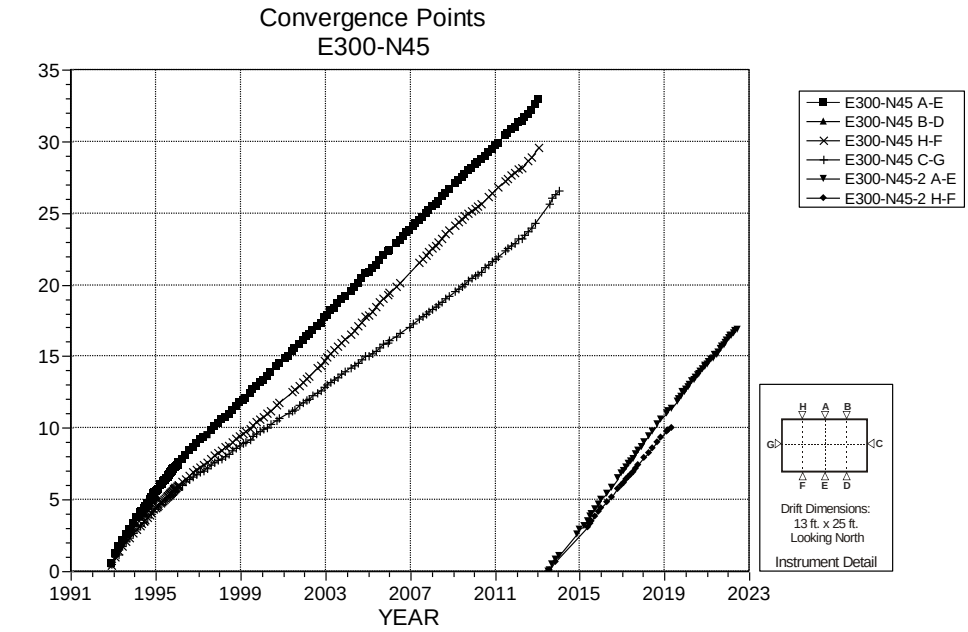
NOTES:
1. Excavation date: January 1983.
2. Roof excavated to Anhydrite "b", March 2003.

Figure 4-84 Convergence Point Array – E140 S2520 – Roof to Floor



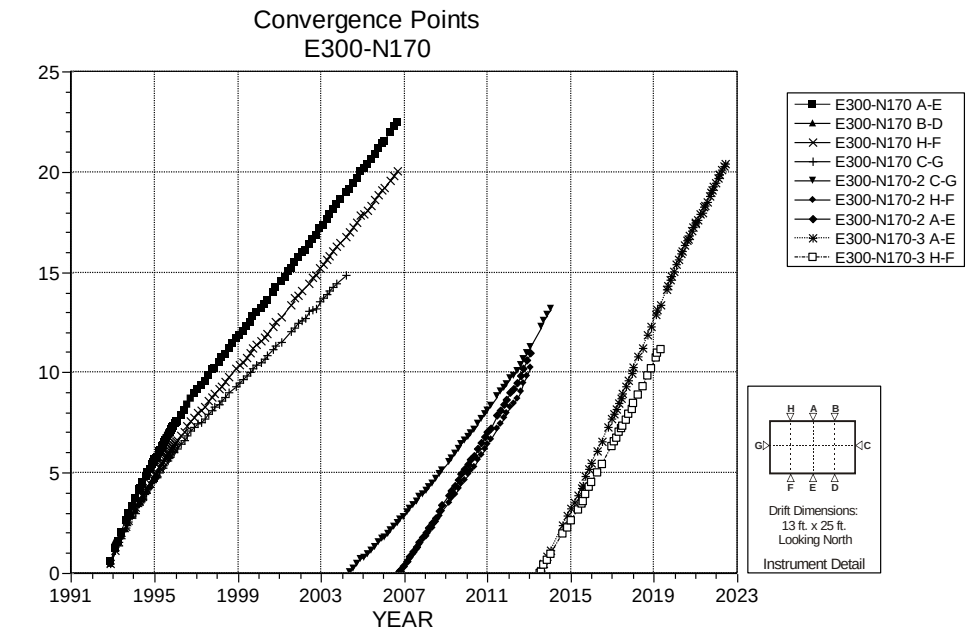
NOTES:
1. Excavation date: March 1986.

Figure 4-85 Convergence Point Array – E220 S2180 – All Chords



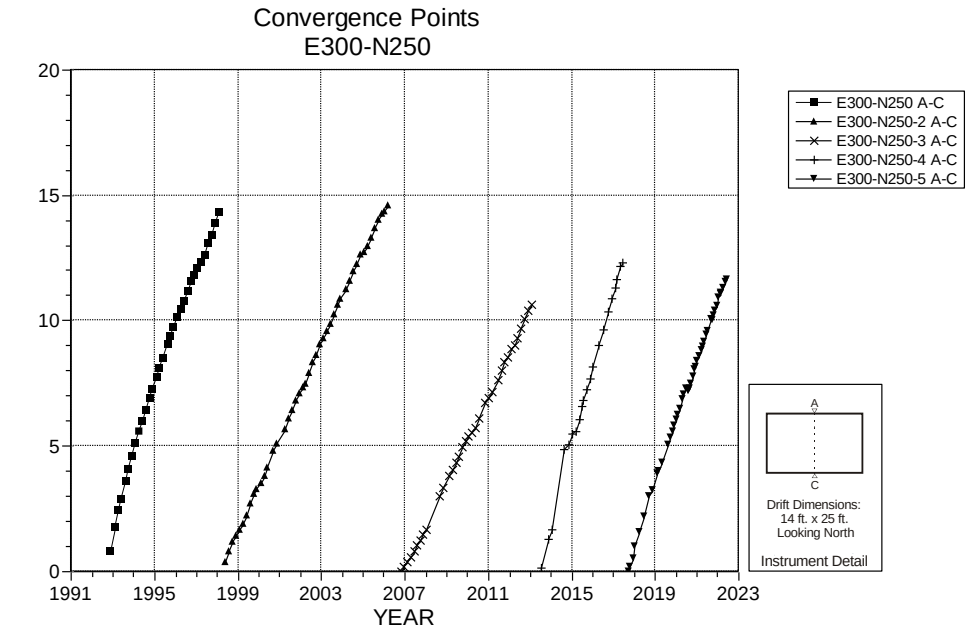
NOTES:
1. Excavation date: October 1992.

Figure 4-86 Convergence Point Array – E300 N45 – All Chords



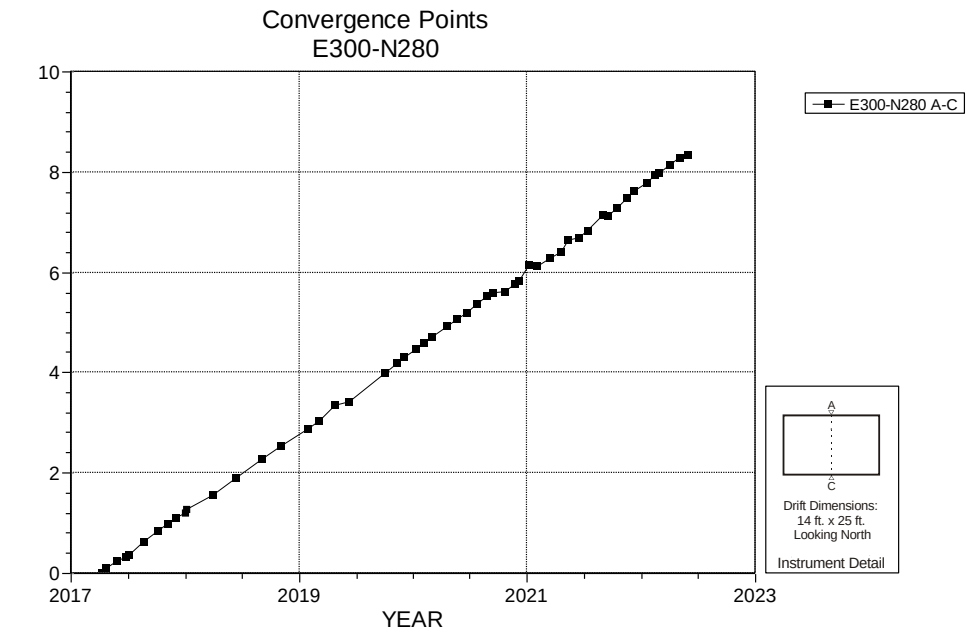
NOTES:
1. Excavation date: October 1992.
2. Reinstalled "E" and "F" points 9-27-2006.

Figure 4-87 Convergence Point Array – E300 N170 – All Chords



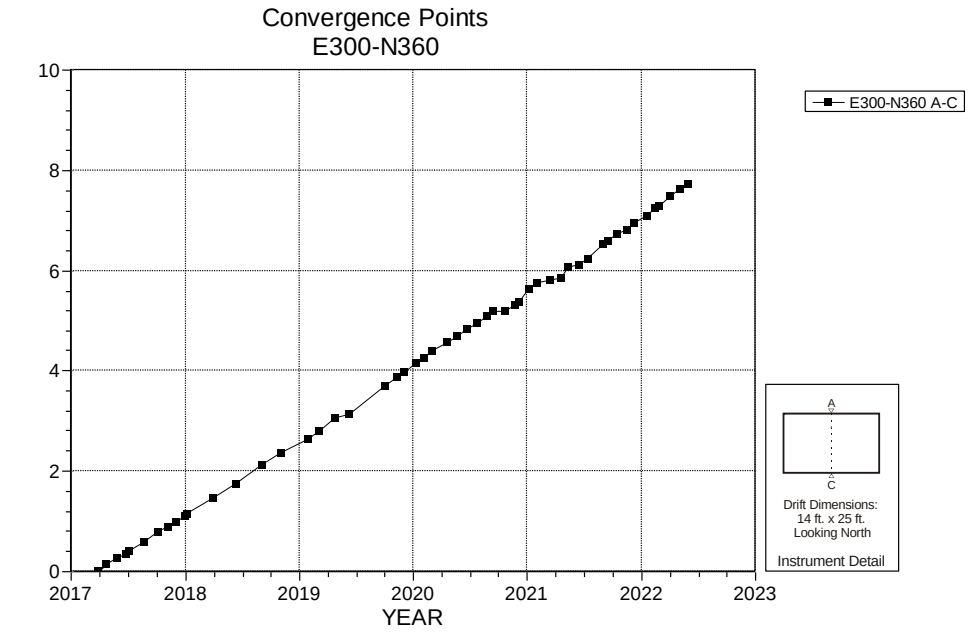
NOTES:
1. Excavation date: October 1992.
2. Reinstalled "c" point October 2006

Figure 4-88 Convergence Point Array – E300 N250 – Roof to Floor



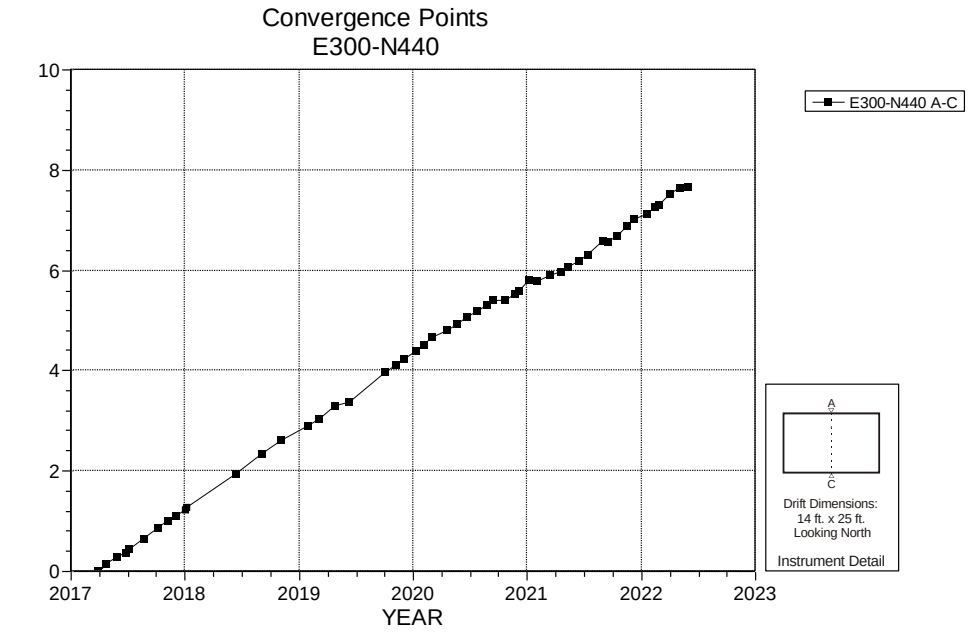
NOTES:
1. Excavation date: October 1992.

Figure 4-89 Convergence Point Array – E300 N280 – Roof to Floor



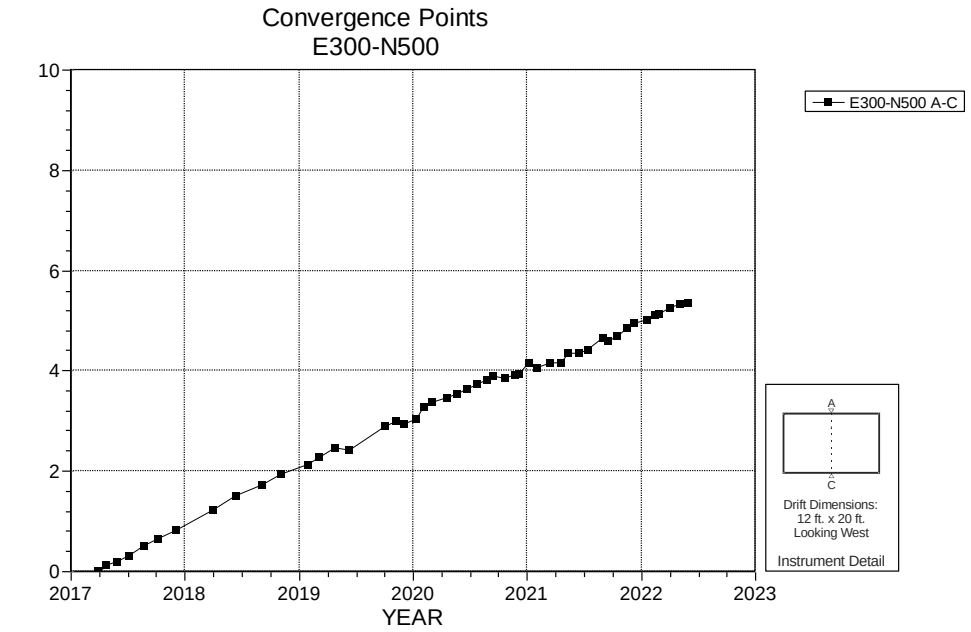
NOTES:
1. Excavation date: January 1991.

Figure 4-90 Convergence Point Array – E300 N360 – Roof to Floor



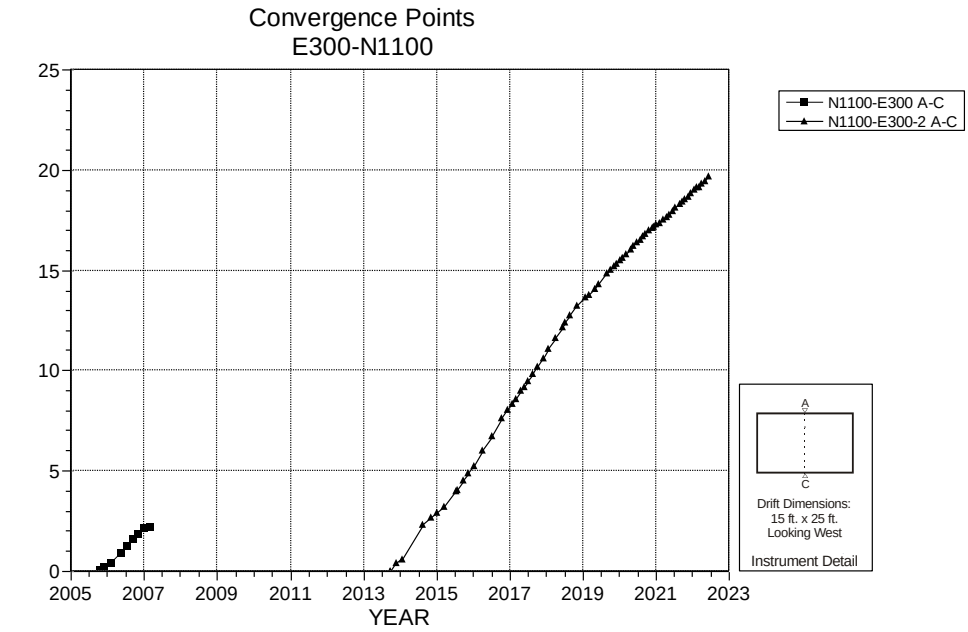
NOTES:
1. Excavation date: January 1991.

Figure 4-91 Convergence Point Array – E300 N440 – Roof to Floor



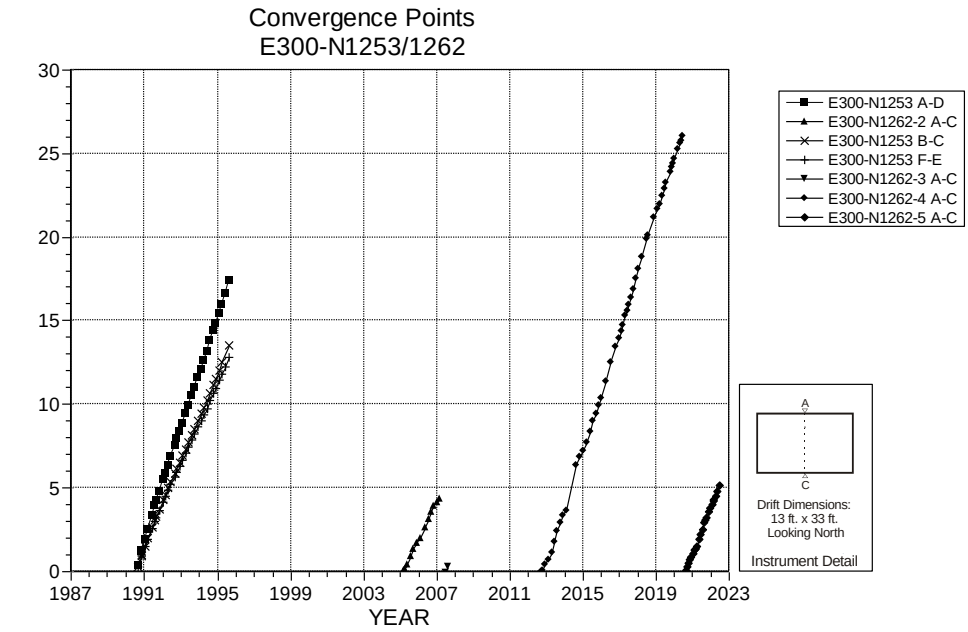
NOTES:
1. Excavation date: January 1991.

Figure 4-92 Convergence Point Array – E300 N500 – Roof to Floor



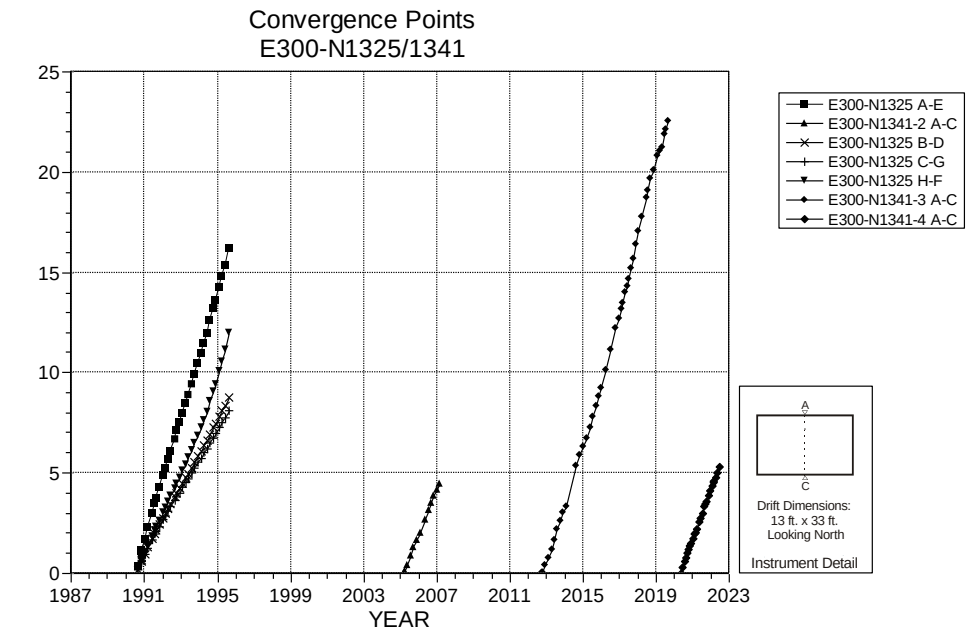
NOTES:
1. Excavation date: December 2004.
2. The gap in the readings was due to the area being inaccessible.

Figure 4-93 Convergence Point Array – E300 N1100 – Roof to Floor



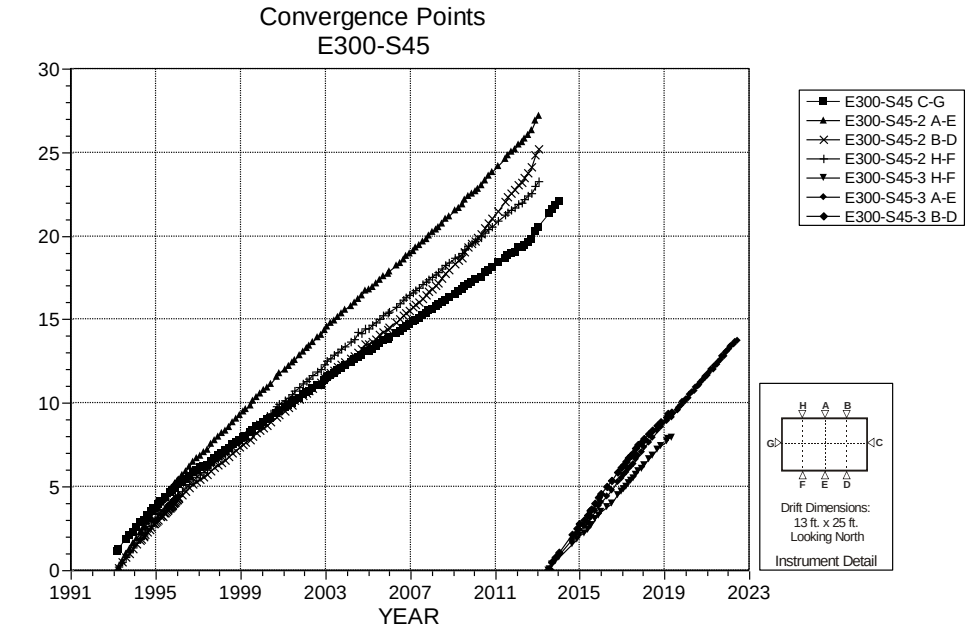
NOTES:
1. Excavation date: August 1989.
2. The gaps in the readings were due to the area being inaccessible.
3. The original installation had 3 vertical chords: A-D, B-C and F-E.

Figure 4-94 Convergence Point Array – E300 N1262 – Roof to Floor



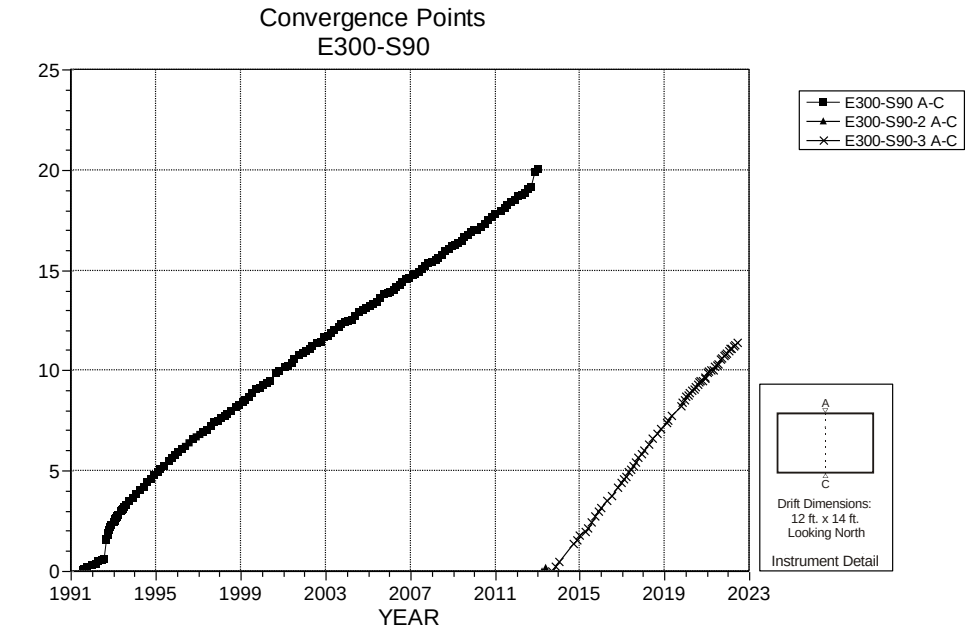
NOTES:
1. Excavation date: August 1989.
2. The gaps in the readings were due to the area being inaccessible.
3. The original installation had 3 vertical chords: A-D, B-C and F-E and horizontal chord C-G.

Figure 4-95 Convergence Point Array – E300 N1341 – Roof to Floor



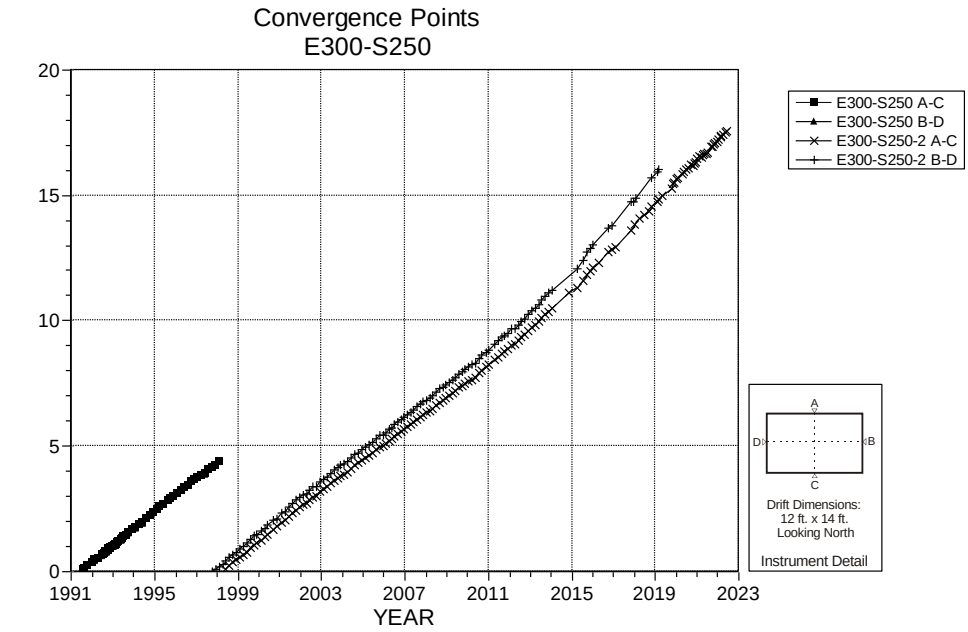
NOTES:
1. Excavation date: October 1992
2. The initial A-F, B-D and H-F chords were only read at installation.

Figure 4-96 Convergence Point Array – E300 S45 – All Chords



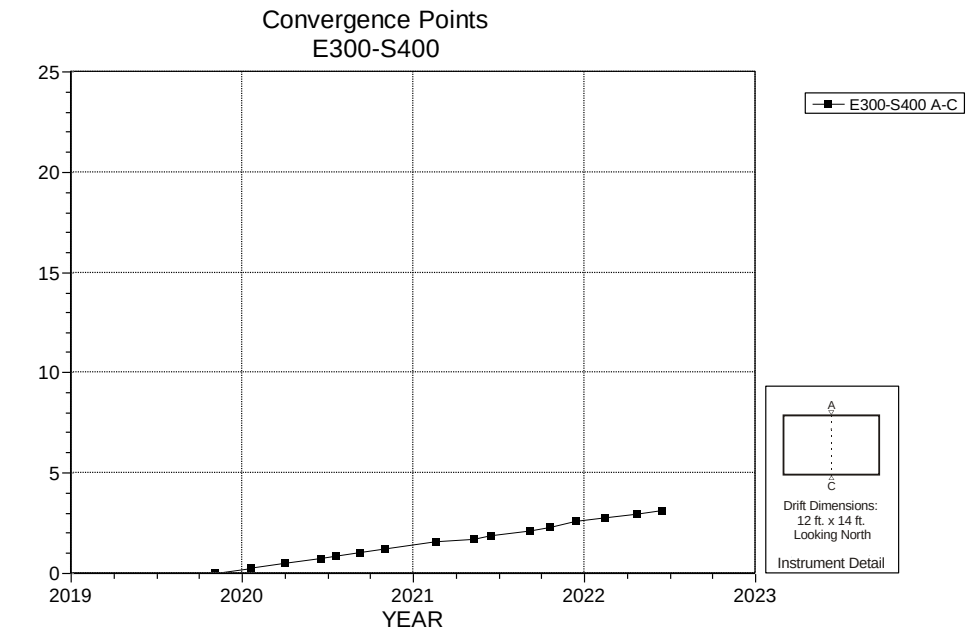
NOTES:
1. Excavation date: September 1985.

Figure 4-97 Convergence Point Array – E300 S90 – Roof to Floor



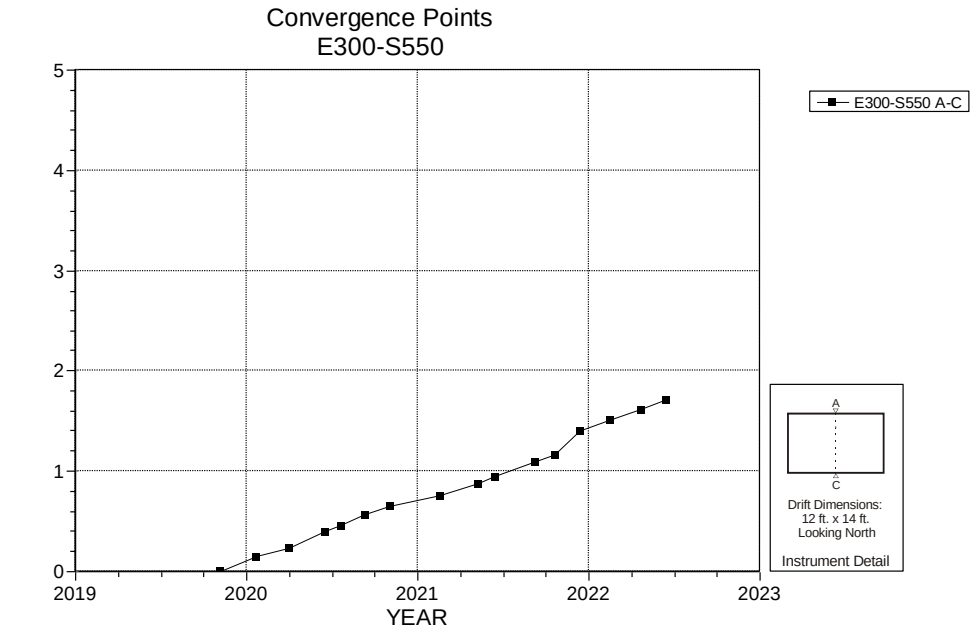
NOTES:
1. Excavation date: September 1985.

Figure 4-98 Convergence Point Array – E300 S250 – All Chords



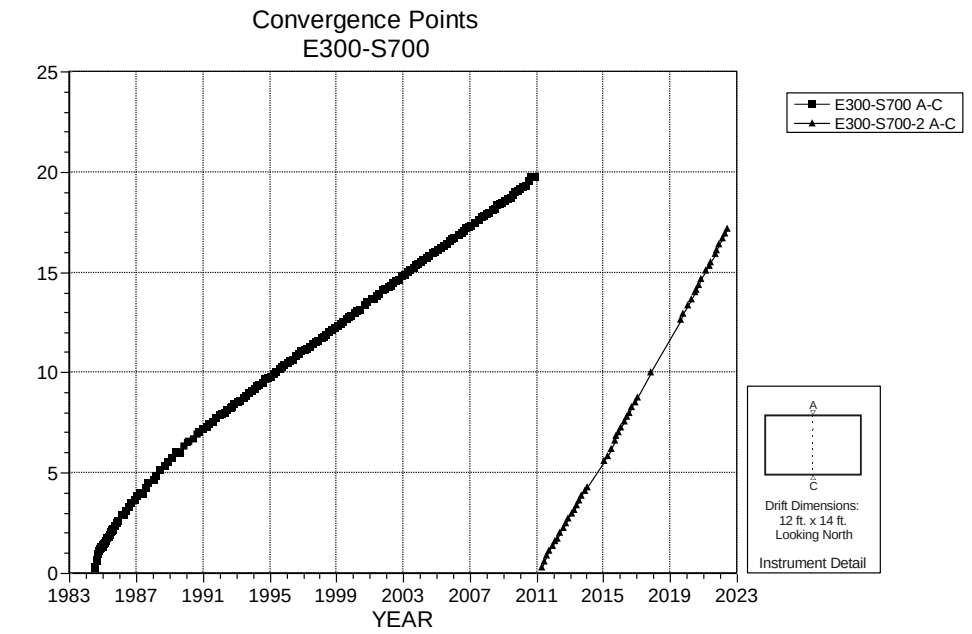
NOTES:
1. Excavation date: May 1984.

Figure 4-99 Convergence Point Array – E300 S400 – Roof to Floor



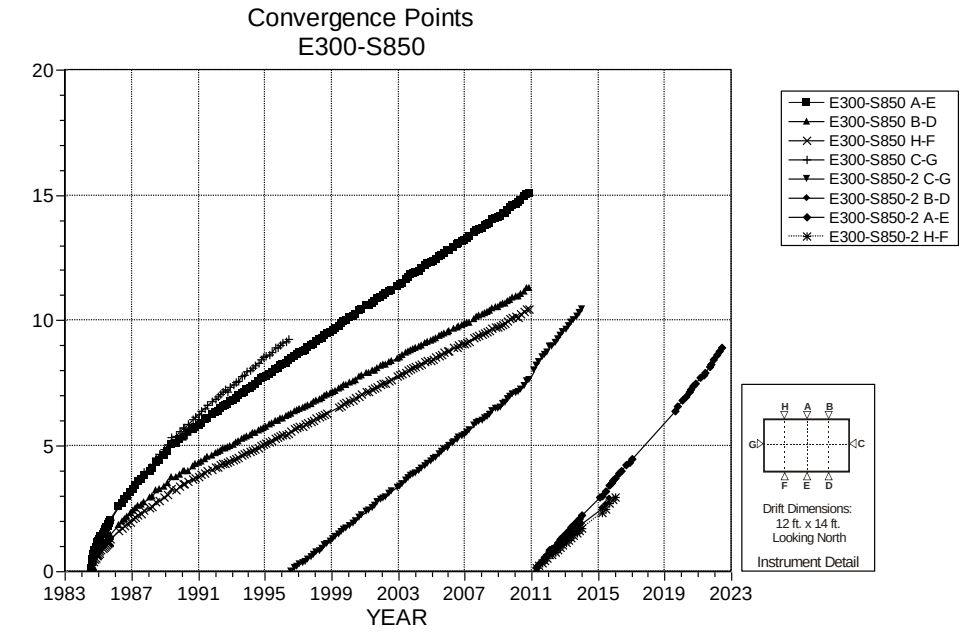
NOTES:
1. Excavation date: May 1984.

Figure 4-100 Convergence Point Array – E300 S550 – Roof to Floor



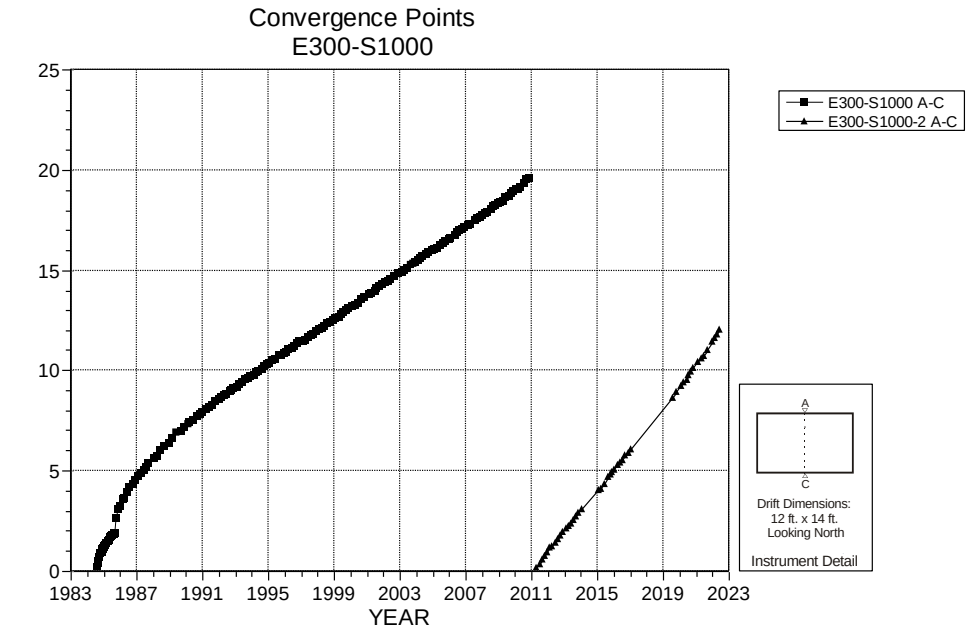
NOTES:
1. Excavation date: May 1984.
2. Reinstalled floor point mined out Dec. 2010.

Figure 4-101 Convergence Point Array – E300 S700 – Roof to Floor



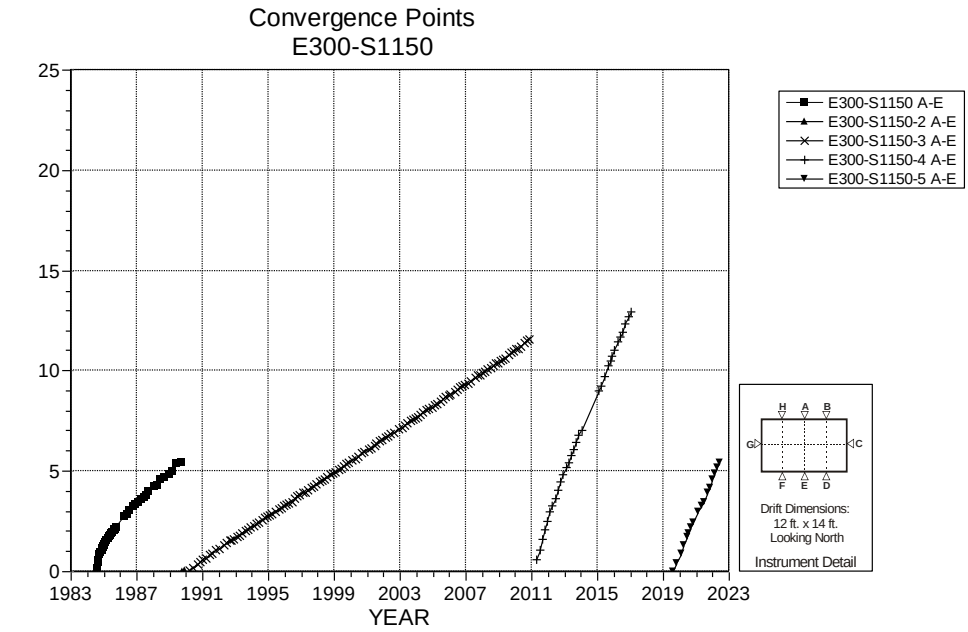
NOTES:
1. Excavation date: July 1984.
2. Reinstalled floor points mined out Dec. 2010.

Figure 4-102 Convergence Point Array – E300 S850 – All Chords



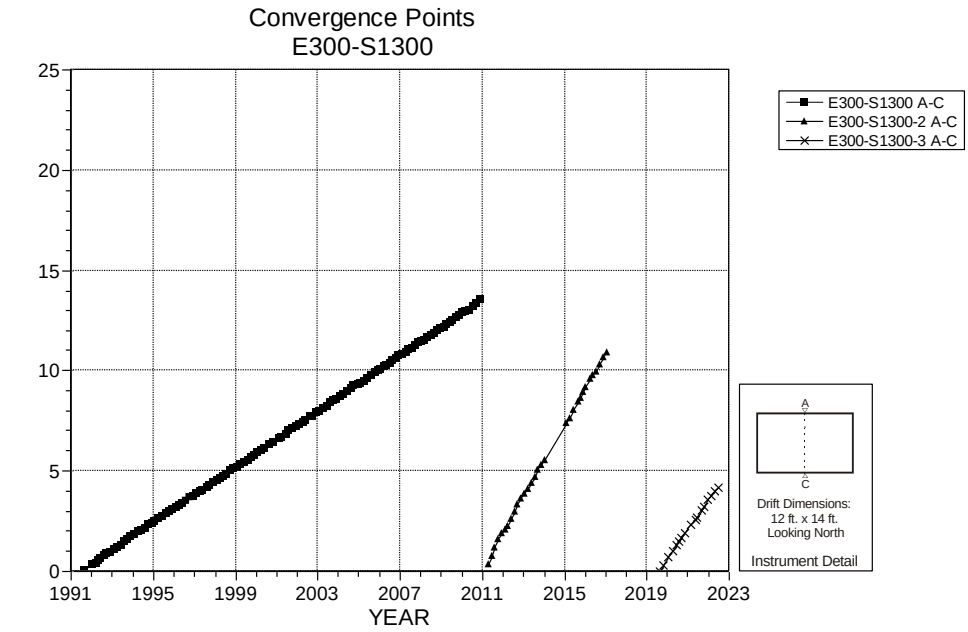
NOTES:
1. Excavation date: July 1984.
2. Reinstalled floor point mined out Dec. 2010.

Figure 4-103 Convergence Point Array – E300 S1000 – Roof to Floor



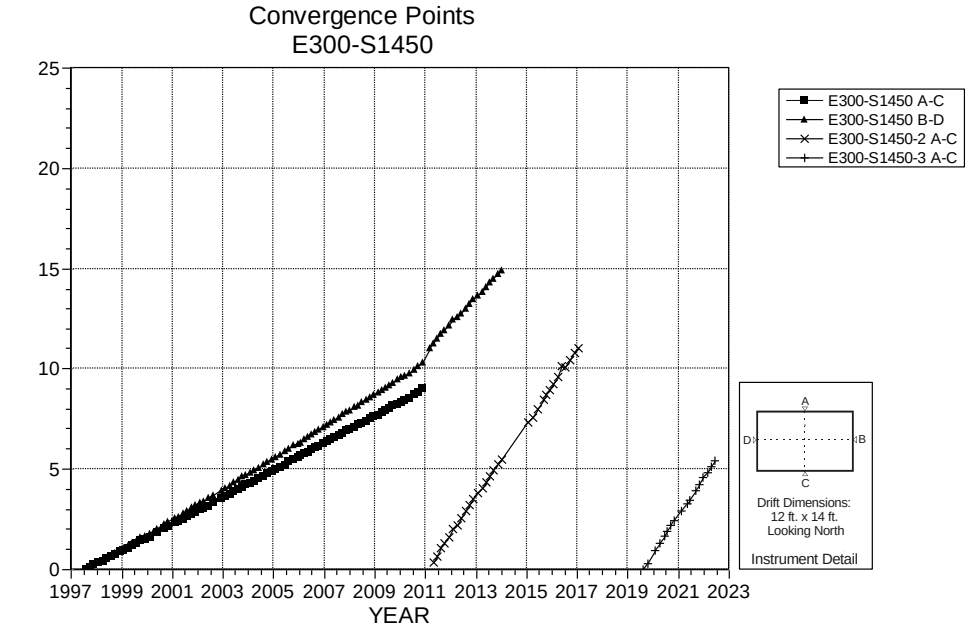
NOTES:
1. Excavation date: July 1984.
2. Reinstalled floor point mined out Dec. 2010.

Figure 4-104 Convergence Point Array – E300 S1150 – Roof to Floor



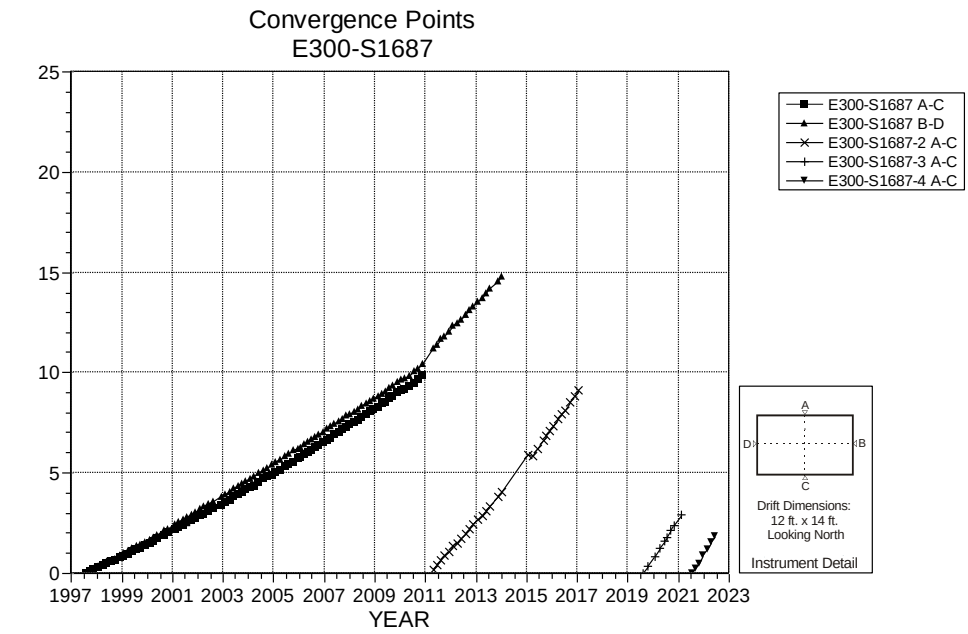
NOTES:
1. Excavation date: July 1984.
2. Reinstalled floor point mined out Dec. 2010.

Figure 4-105 Convergence Point Array – E300 S1300 – Roof to Floor



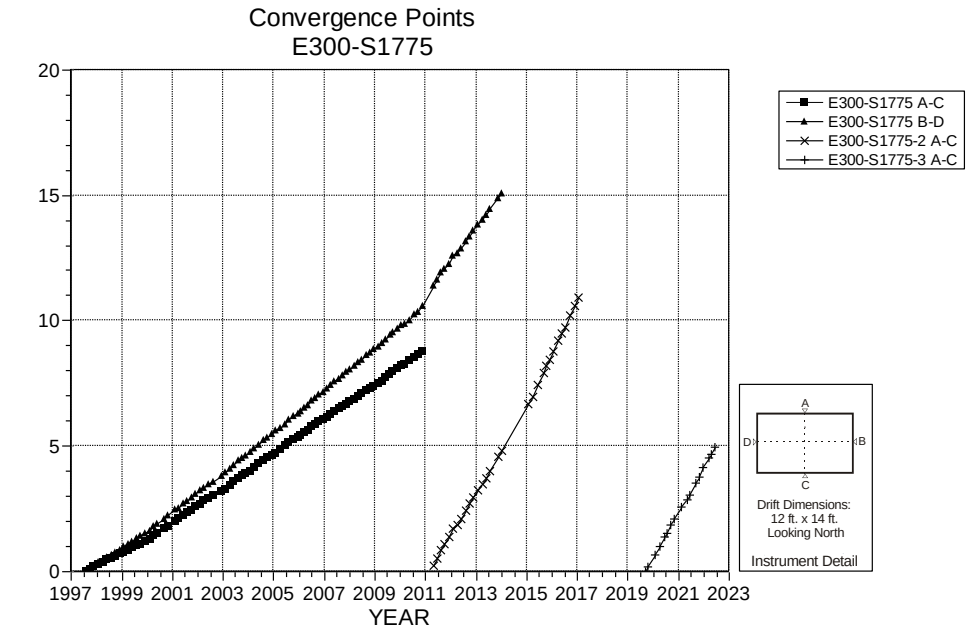
NOTES:
1. Excavation date: October 1985.
2. Reinstalled floor point mined out Dec. 2010.

Figure 4-106 Convergence Point Array – E300 S1450 – All Chords



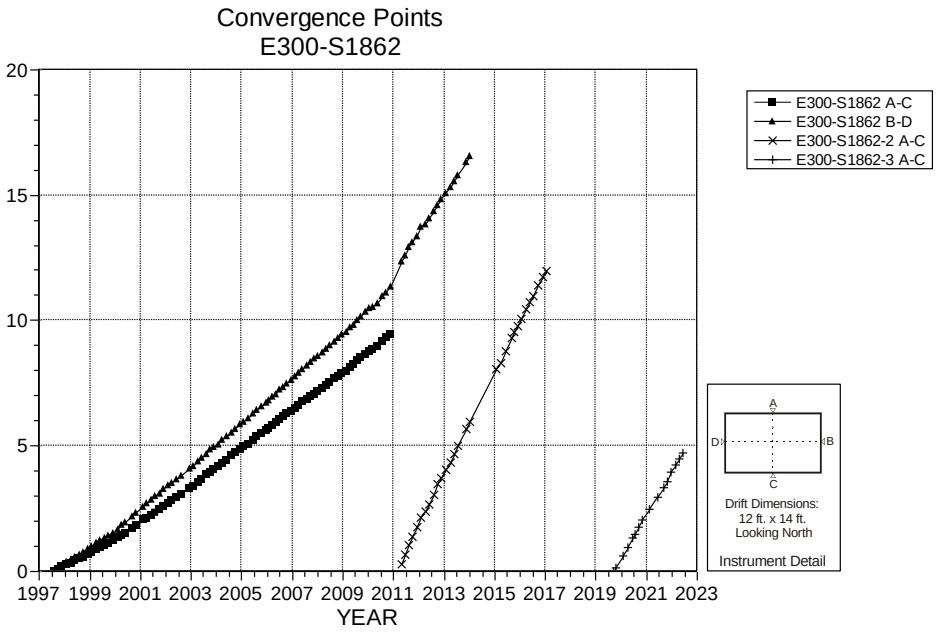
NOTES:
1. Excavation date: October 1985.

Figure 4-107 Convergence Point Array – E300 S1687 – All Chords



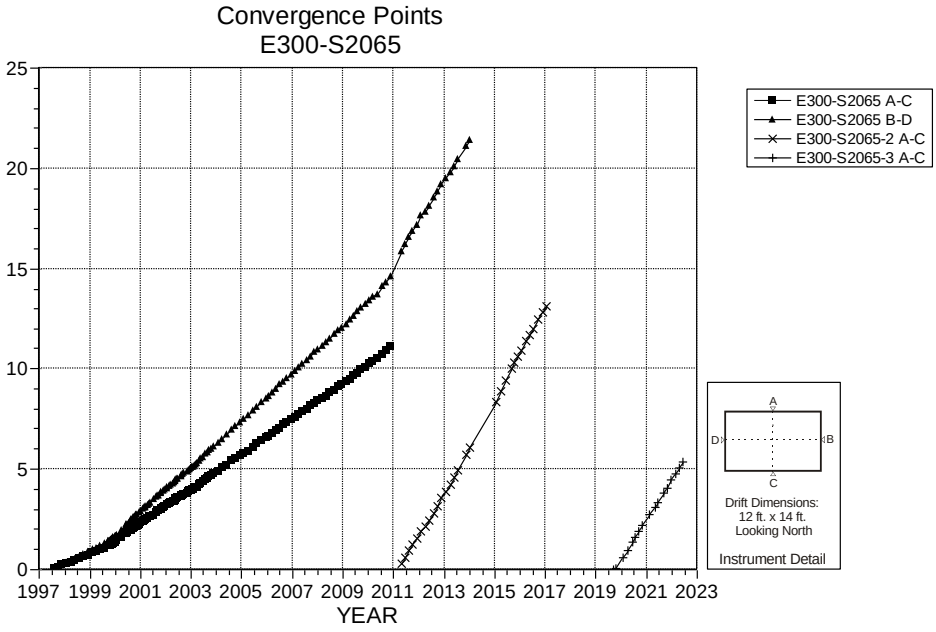
NOTES:
1. Excavation date: October 1985.

Figure 4-108 Convergence Point Array – E300 S1775 – All Chords



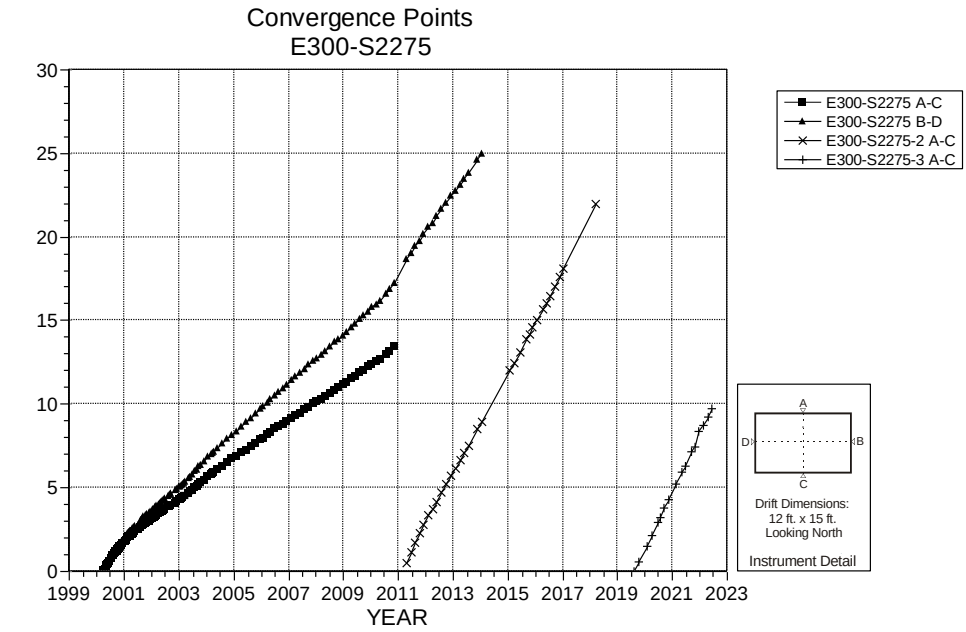
NOTES:
1. Excavation date: October 1985.

Figure 4-109 Convergence Point Array – E300 S1862 – All Chords



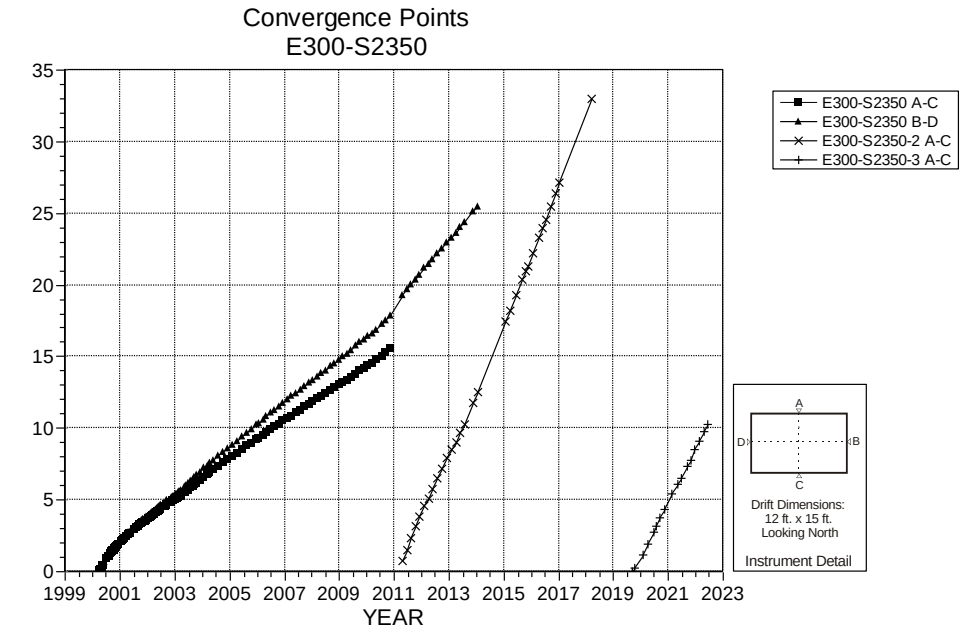
NOTES:
1. Excavation date: April 1986.

Figure 4-110 Convergence Point Array – E300 S2065 – Roof to Floor



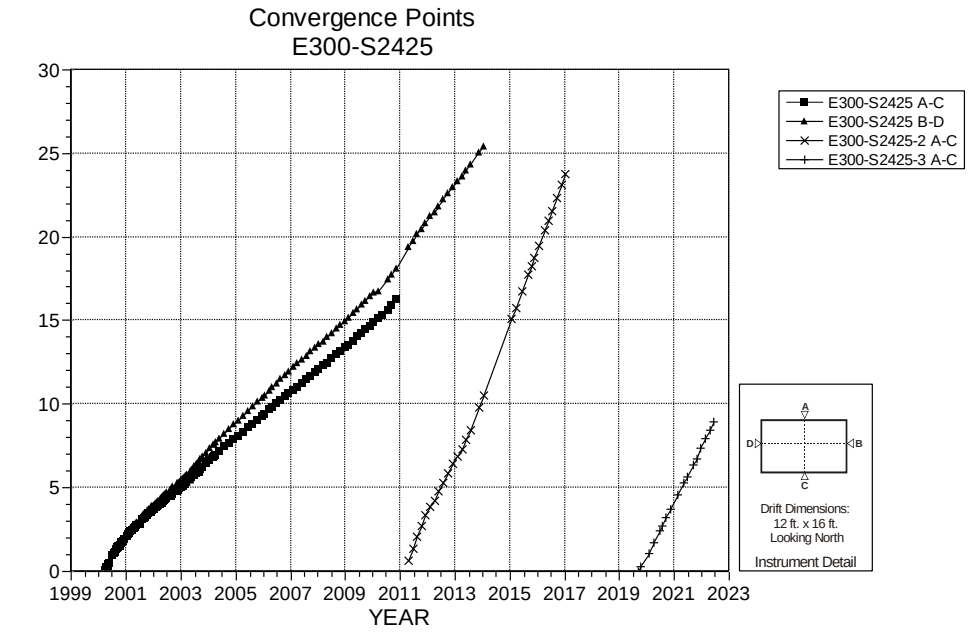
NOTES:
1. Excavation date: November 1999.

Figure 4-111 Convergence Point Array – E300 S2275 – All Chords



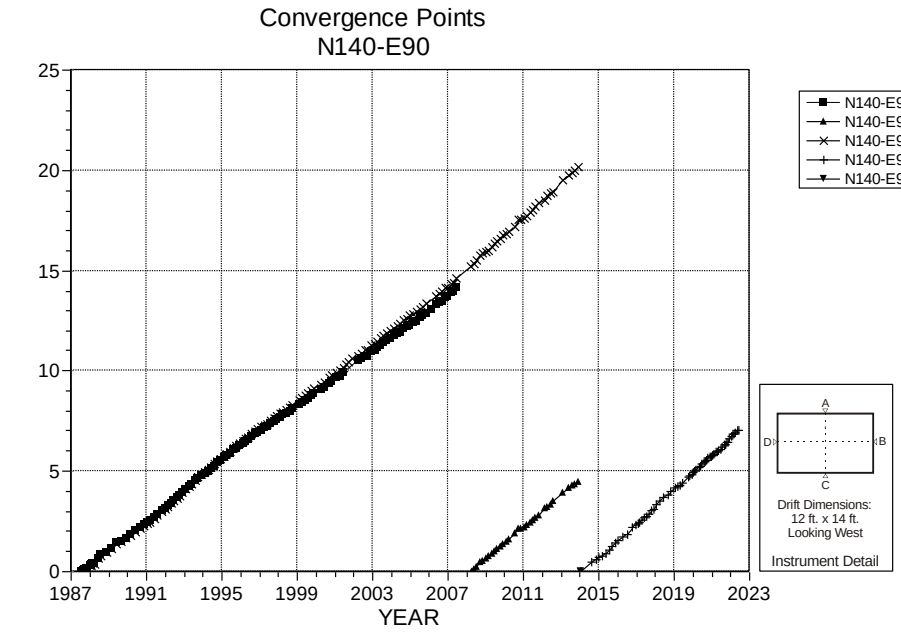
NOTES:
1. Excavation date: November 1999.

Figure 4-112 Convergence Point Array – E300 S2350 – All Chords



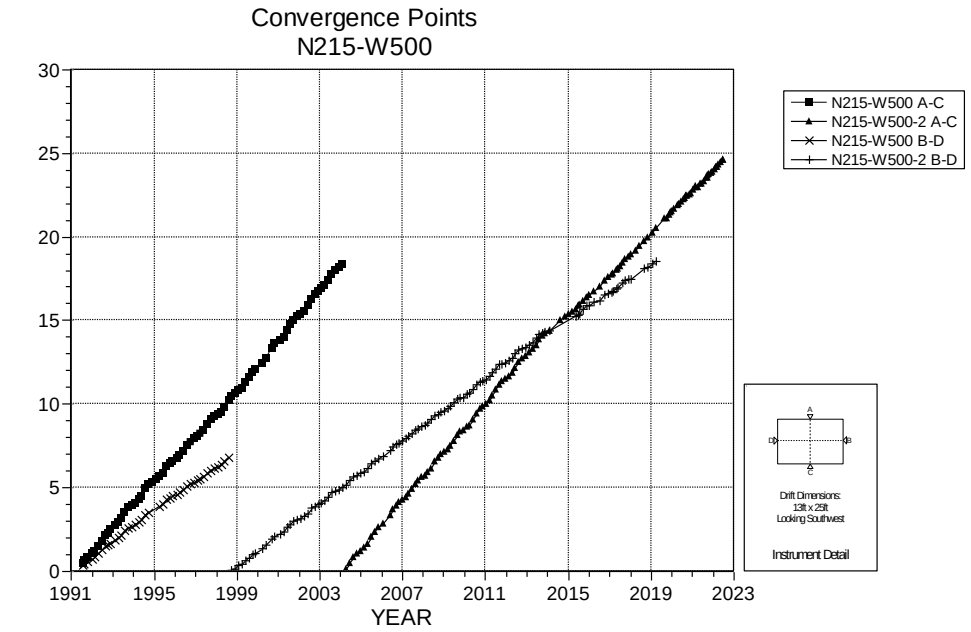
NOTES:
1. Excavation date: December 1999.

Figure 4-113 Convergence Point Array – E300 S2425 – All Chords



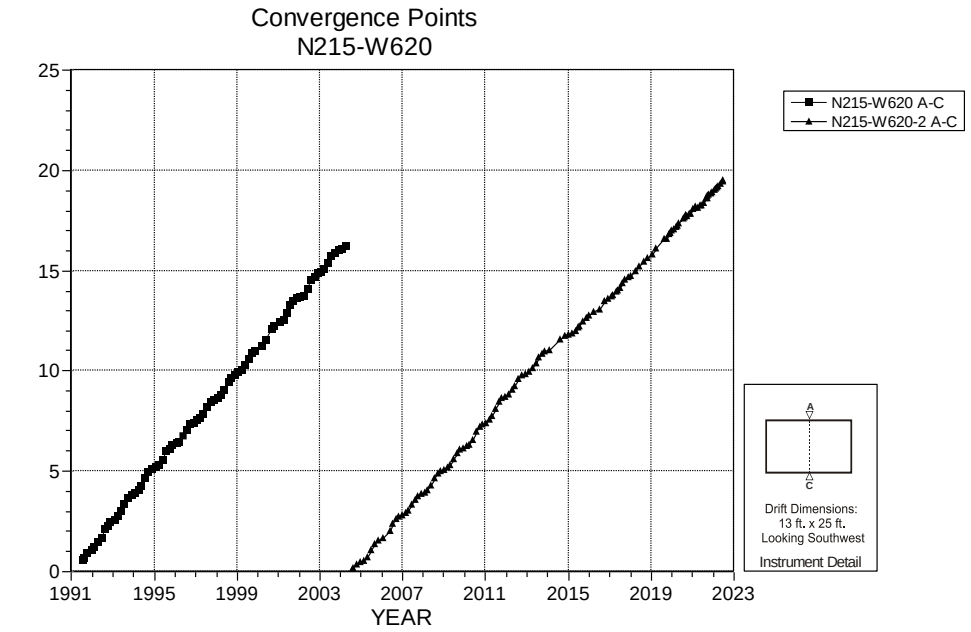
NOTES:
1. Excavation date: November 1982.

Figure 4-114 Convergence Point Array – N140 E90 – All Chords



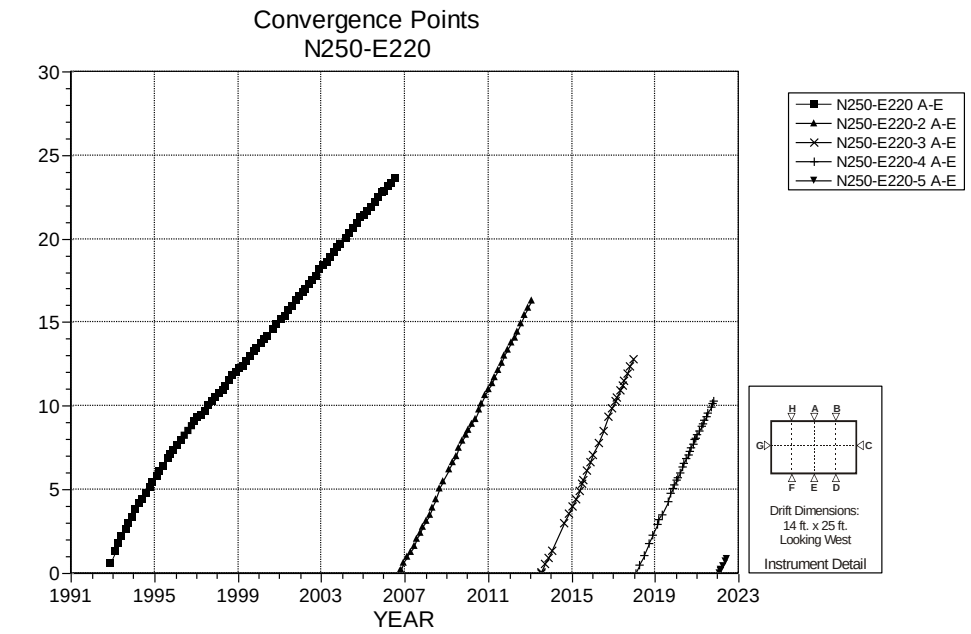
NOTES:
1. Excavation date: December 1987.

Figure 4-115 Convergence Point Array – N215 W500 – All Chords



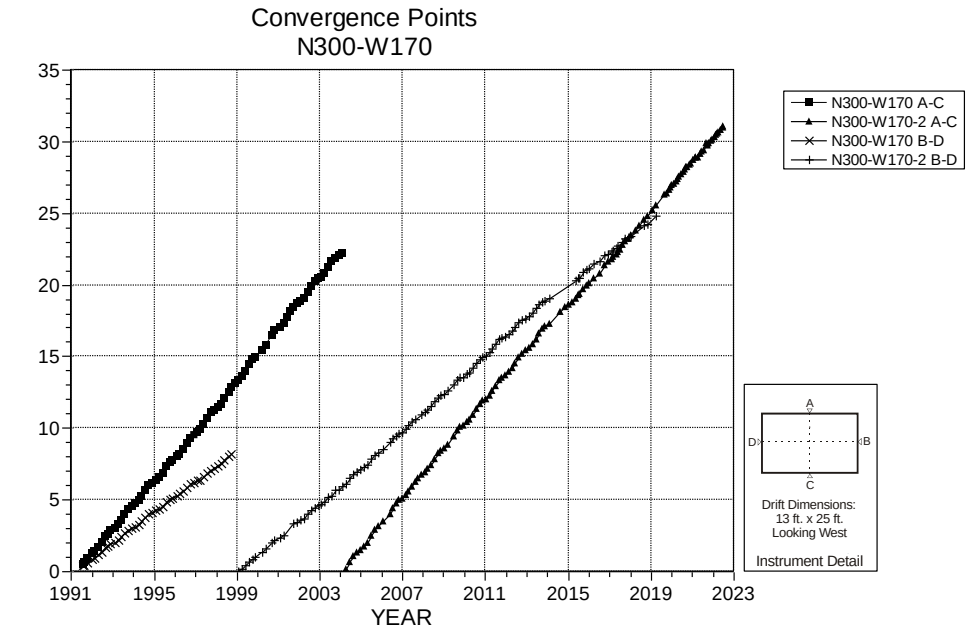
NOTES:
1. Excavation date: January 1988.

Figure 4-116 Convergence Point Array – N215 W620 – Roof to Floor



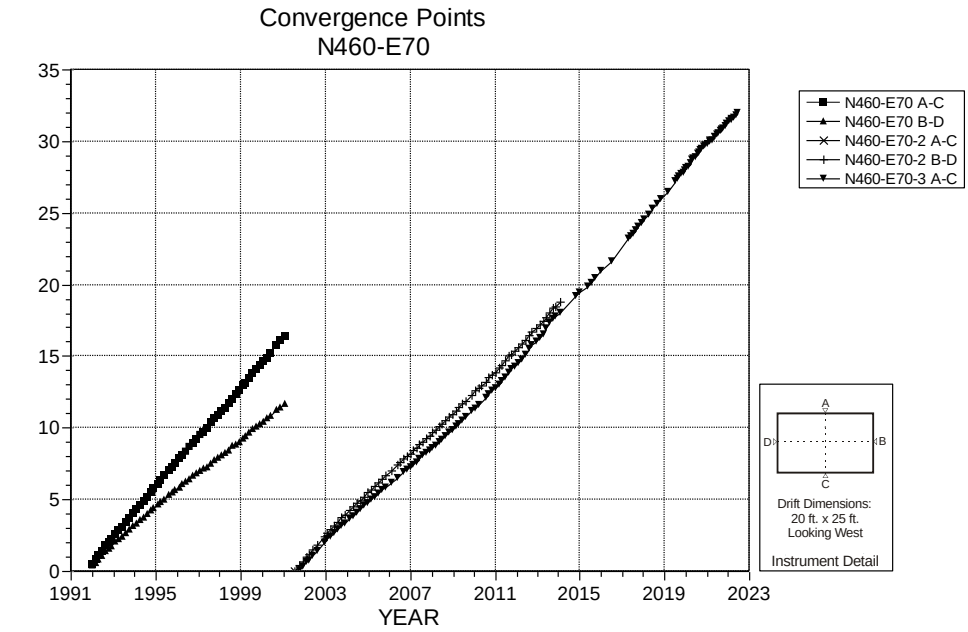
NOTES:
1. Excavation date: October 1992.

Figure 4-117 Convergence Point Array – N250 E220 – Roof to Floor



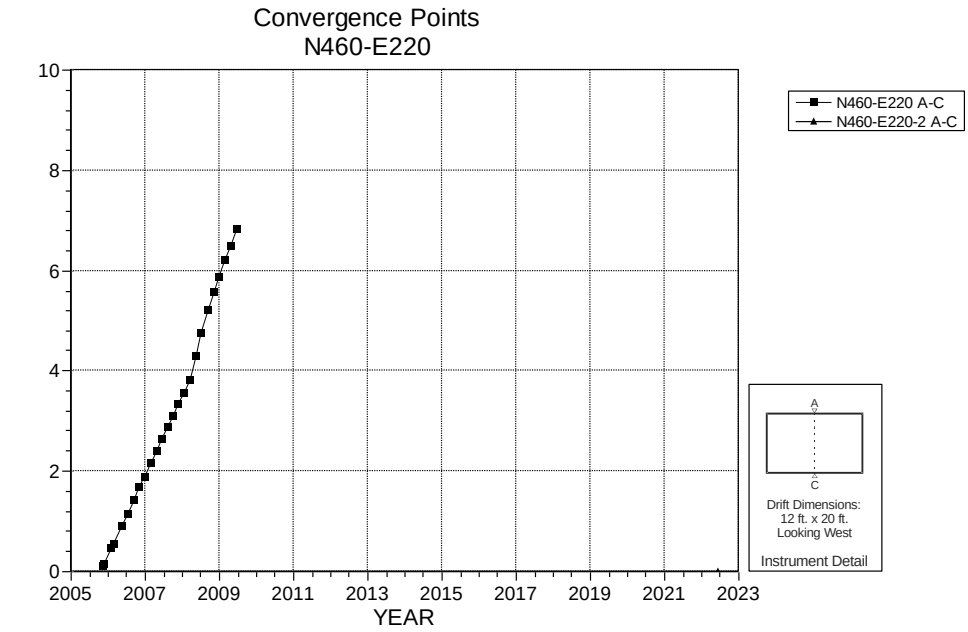
NOTES:
1. Excavation date: October 1987.

Figure 4-118 Convergence Point Array – N300 W170 – All Chords



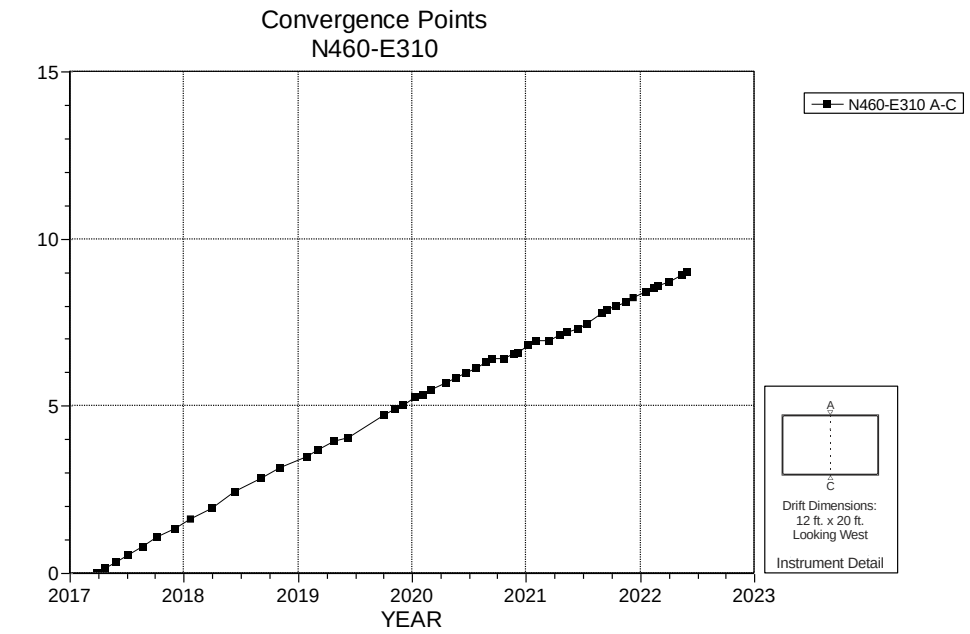
NOTES:
1. Excavation date: February 1983.
2. Roof excavated to Anhydrite "b".

Figure 4-119 Convergence Point Array – N460 E70 – All Chords



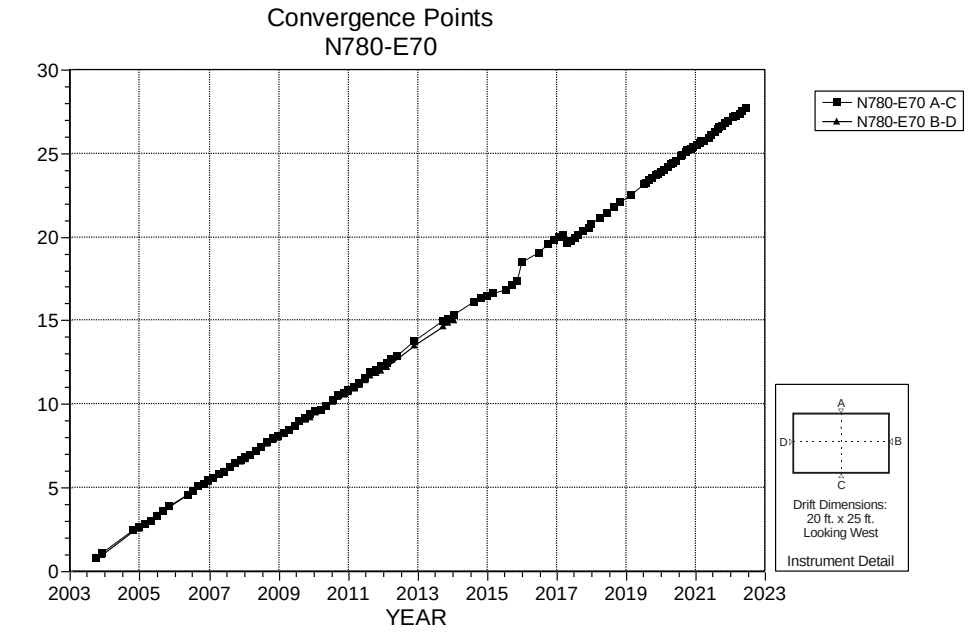
NOTES:
1. Excavation date: January 1991.

Figure 4-120 Convergence Point Array – N460 E220 – Roof to Floor



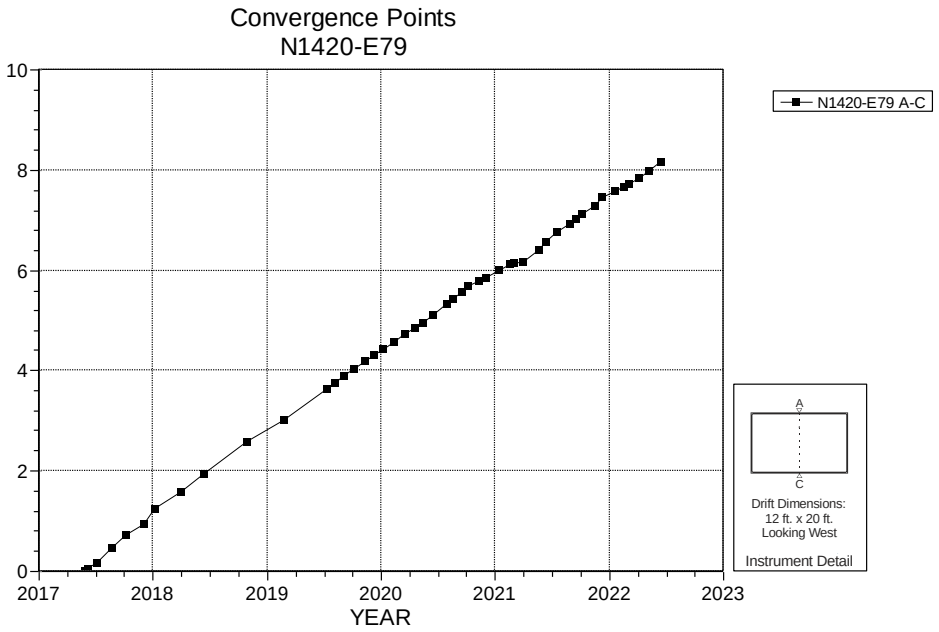
NOTES:
1. Excavation date: January 1991.

Figure 4-121 Convergence Point Array – N460 E310 – Roof to Floor



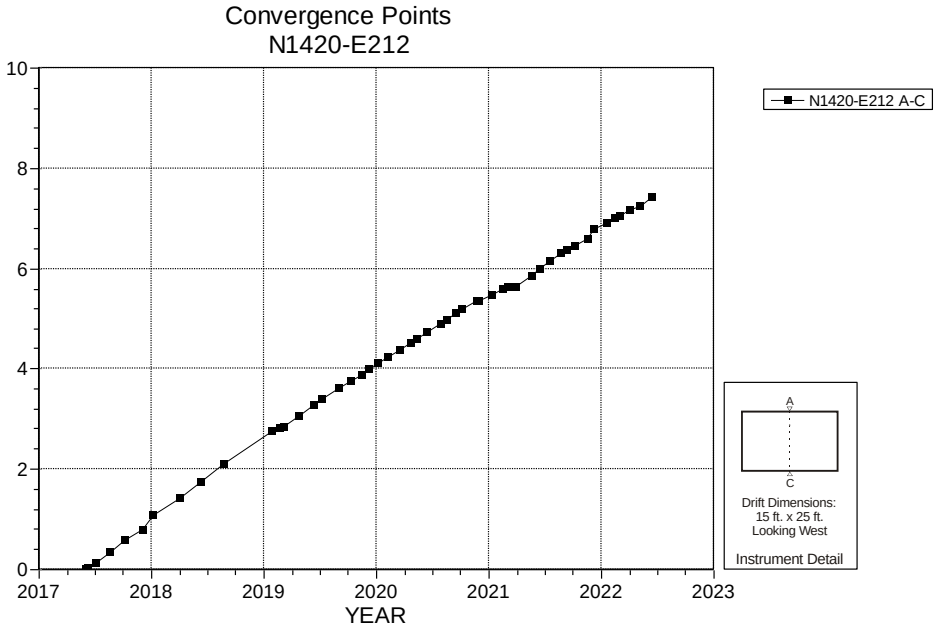
NOTES:
1. Excavation date: February 1983.

Figure 4-122 Convergence Point Array – N780 E70 – Roof to Floor



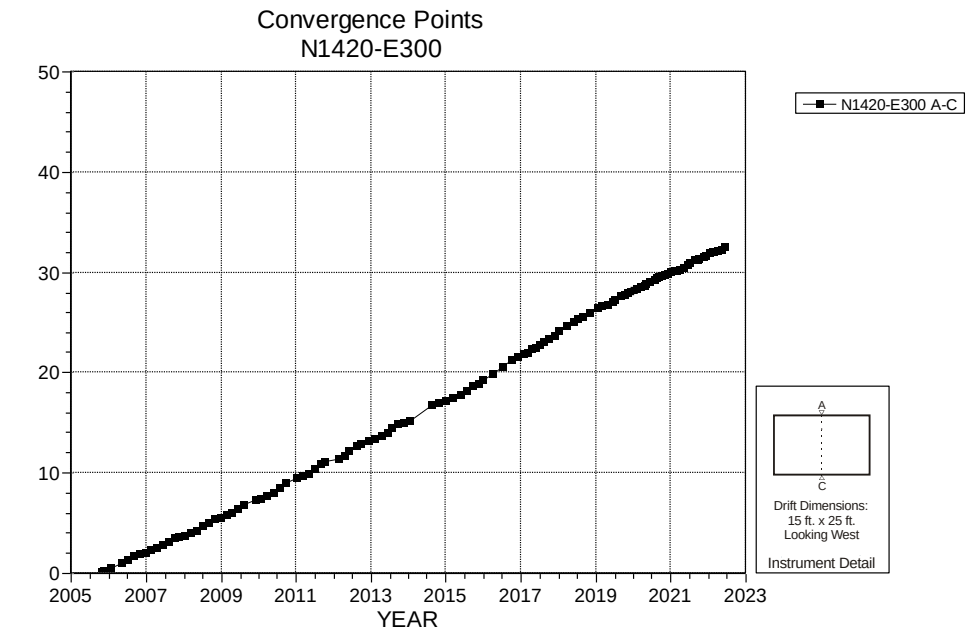
NOTES:
1. Excavation date: February 1983.

Figure 4-123 Convergence Point Array – N1420 E79 – Roof to Floor



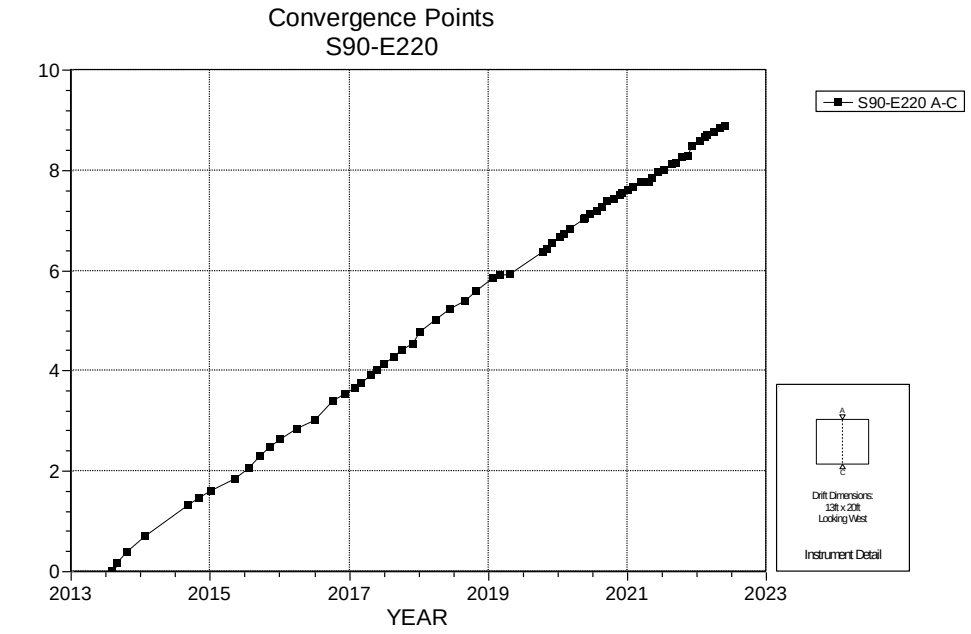
NOTES:
1. Excavation date: December 2004.

Figure 4-124 Convergence Point Array – N1420 E212 – Roof to Floor



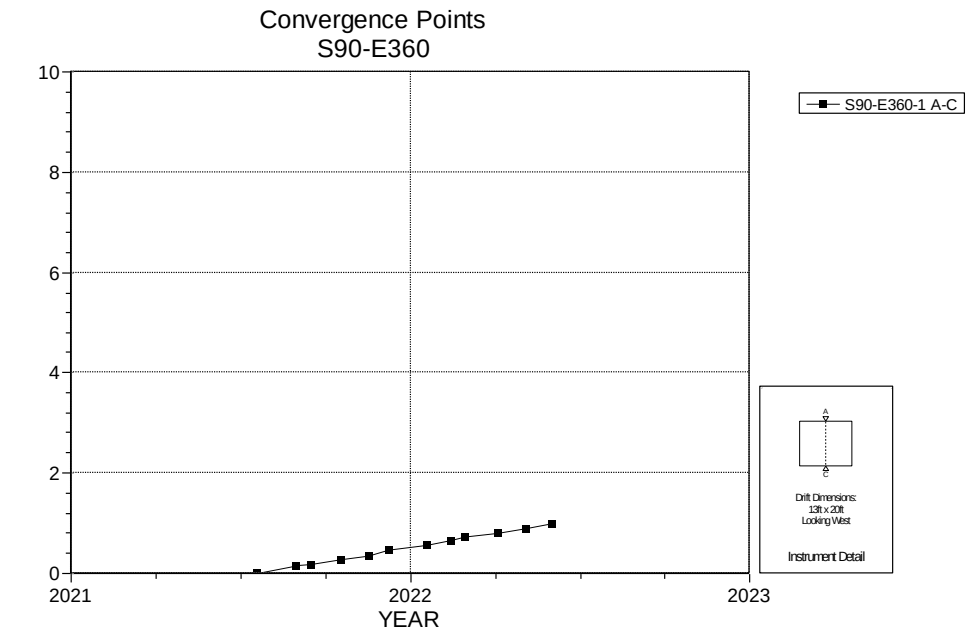
NOTES:
1. Excavation date: December 2004.

Figure 4-125 Convergence Point Array – N1420 E300 – Roof to Floor



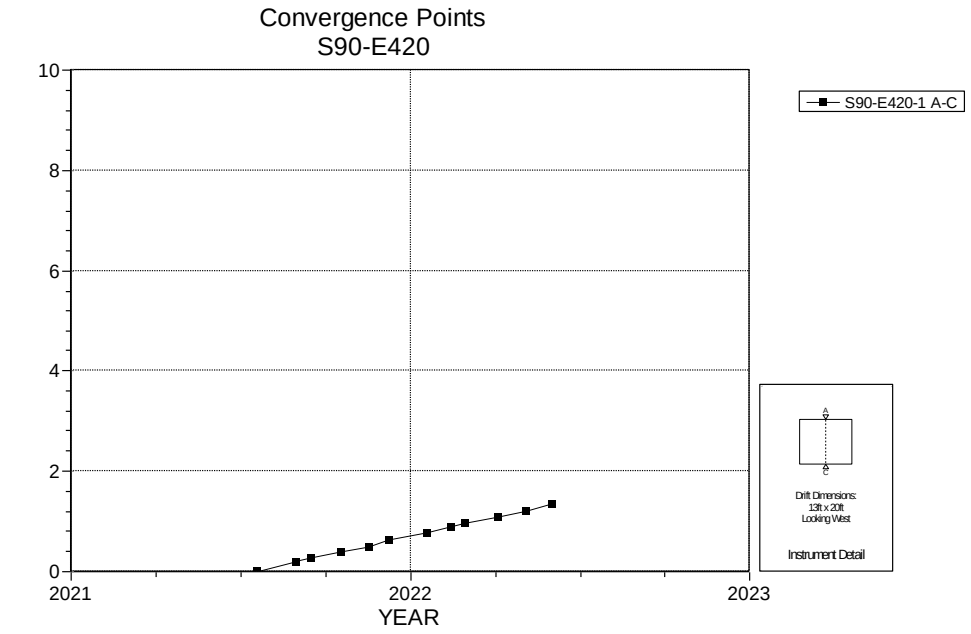
NOTES:
1. Excavation date: September 1985.

Figure 4-126 Convergence Point Array – S90 E220 – Roof to Floor



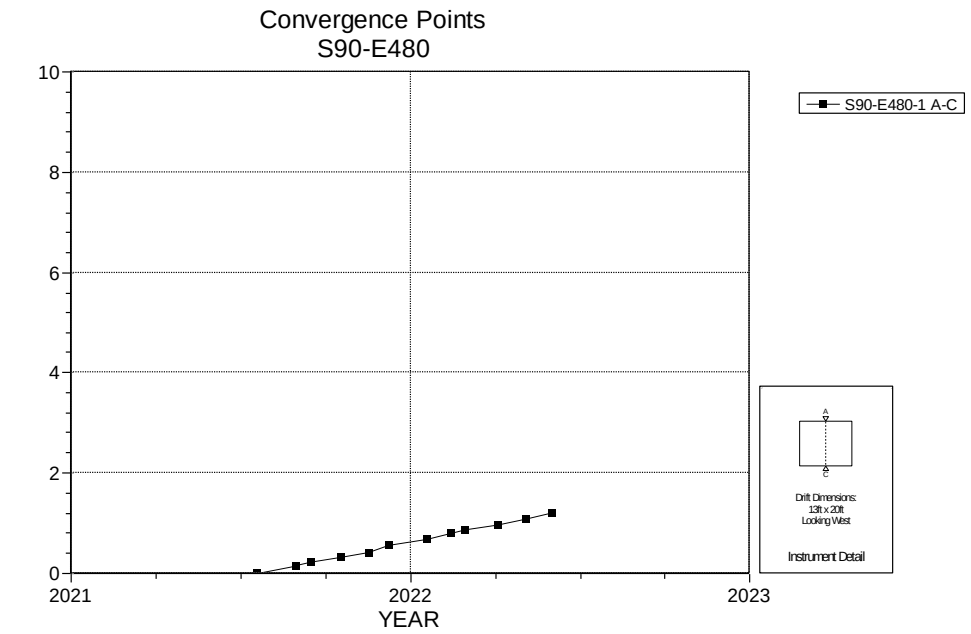
NOTES:
1. Excavation date: September 1985.

Figure 4-127 Convergence Point Array – S90 E360 – Roof to Floor



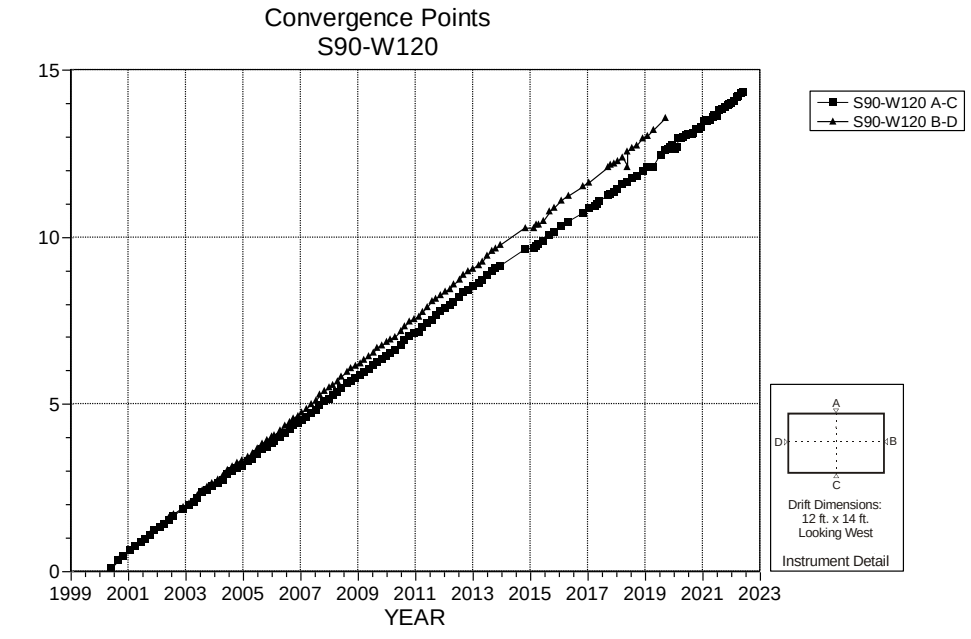
NOTES:
1. Excavation date: September 1985.

Figure 4-128 Convergence Point Array – S90 E420 – Roof to Floor



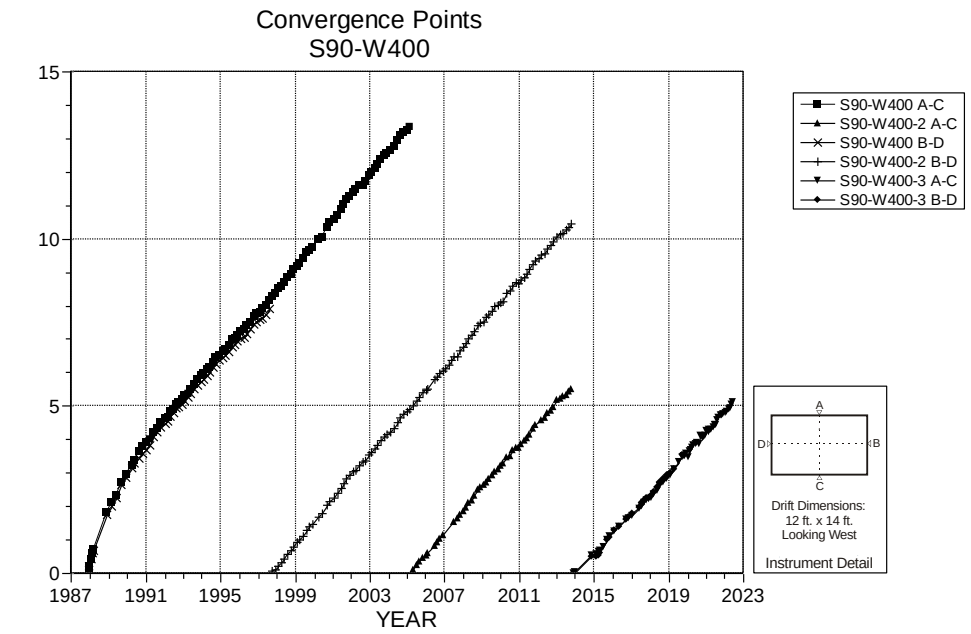
NOTES:
1. Excavation date: September 1985.

Figure 4-129 Convergence Point Array – S90 E480 – Roof to Floor



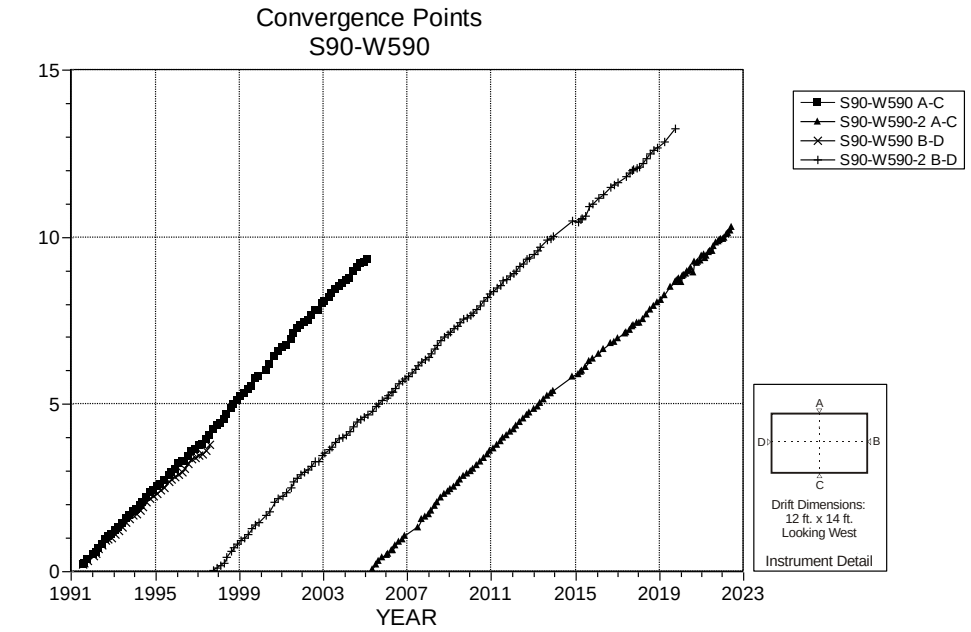
NOTES:
1. Excavation date: July 1985.

Figure 4-130 Convergence Point Array – S90 W120 – All Chords



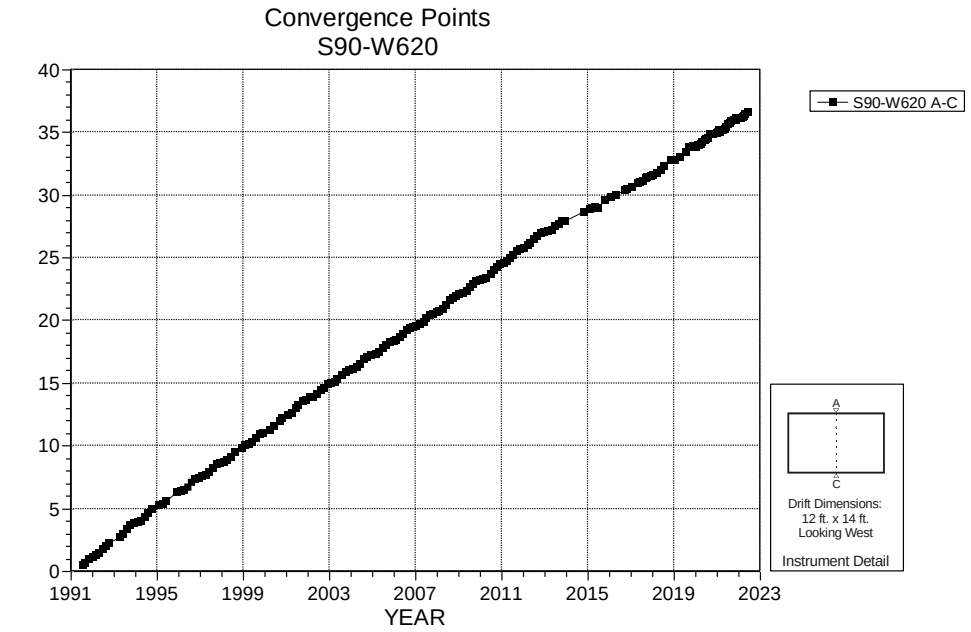
NOTES:
1. Excavation date: October 1987.

Figure 4-131 Convergence Point Array – S90 W400 – All Chords



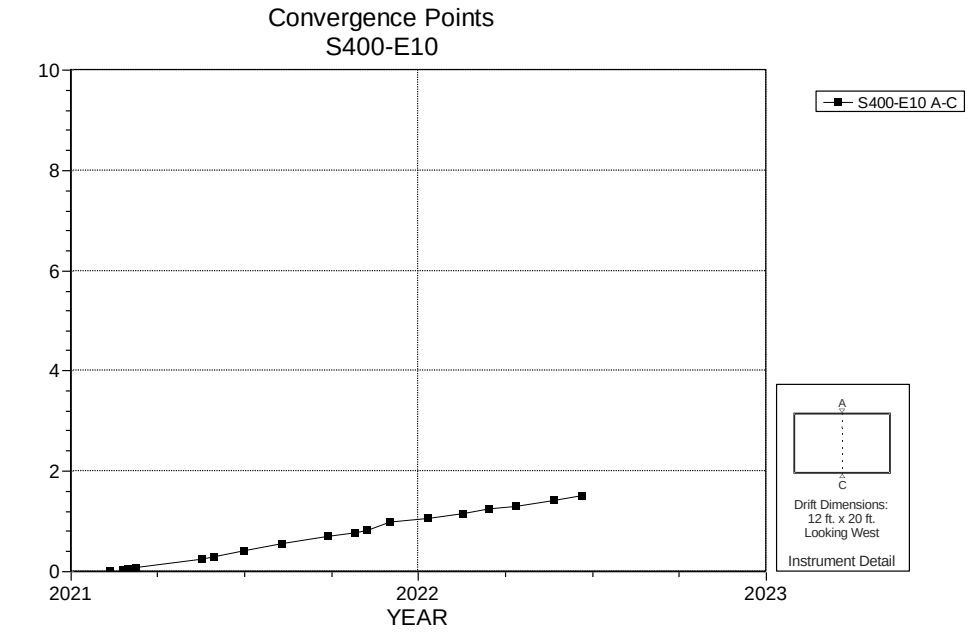
NOTES:
1. Excavation date: November 1987.

Figure 4-132 Convergence Point Array – S90 W590 – All Chords



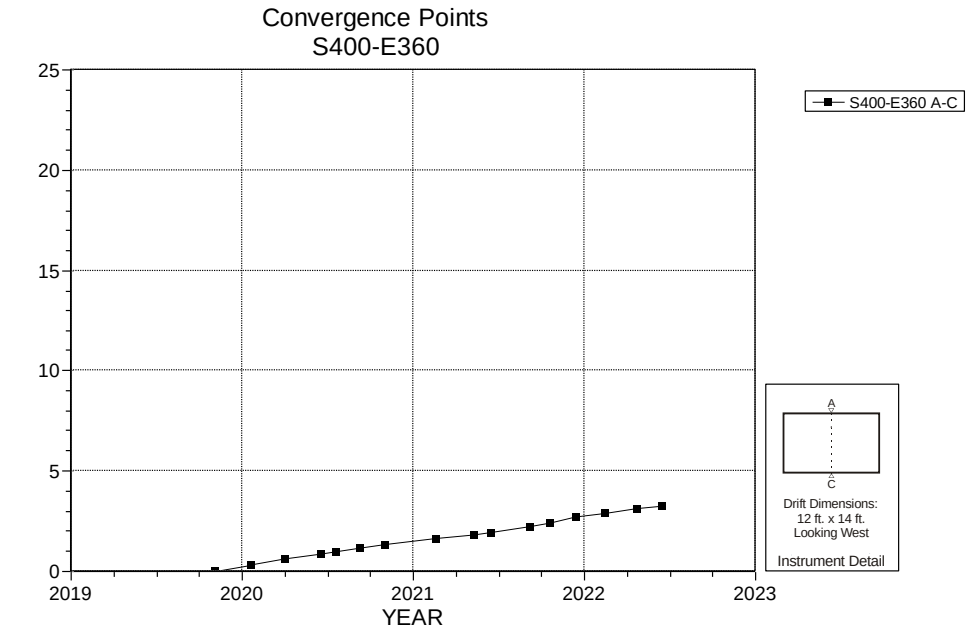
NOTES:
1. Excavation date: January 1988.

Figure 4-133 Convergence Point Array – S90 W620 – Roof to Floor



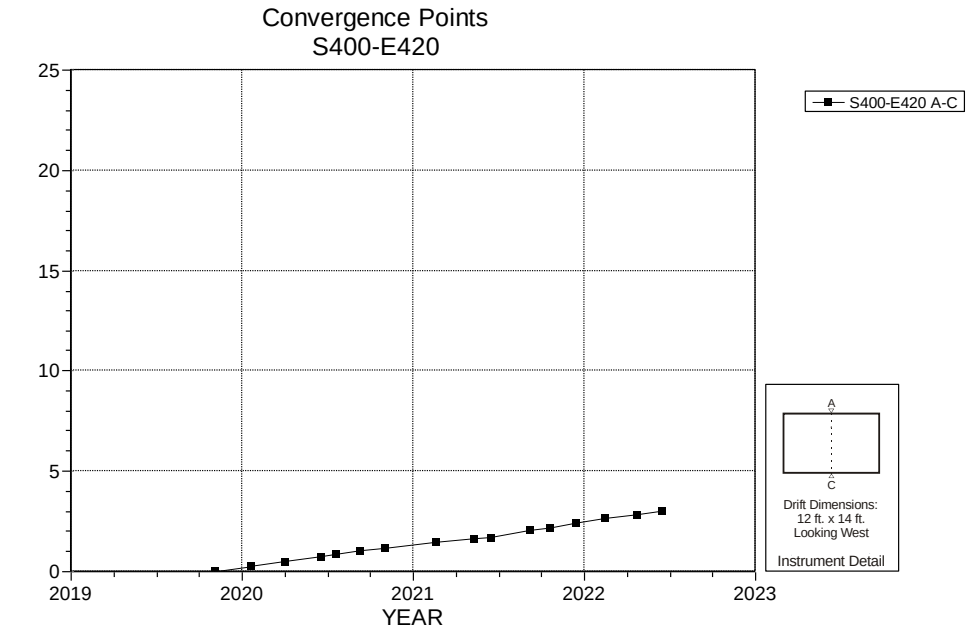
NOTES:
1. Excavation date: March 1983.

Figure 4-134 Convergence Point Array – S400 E10 – Roof to Floor



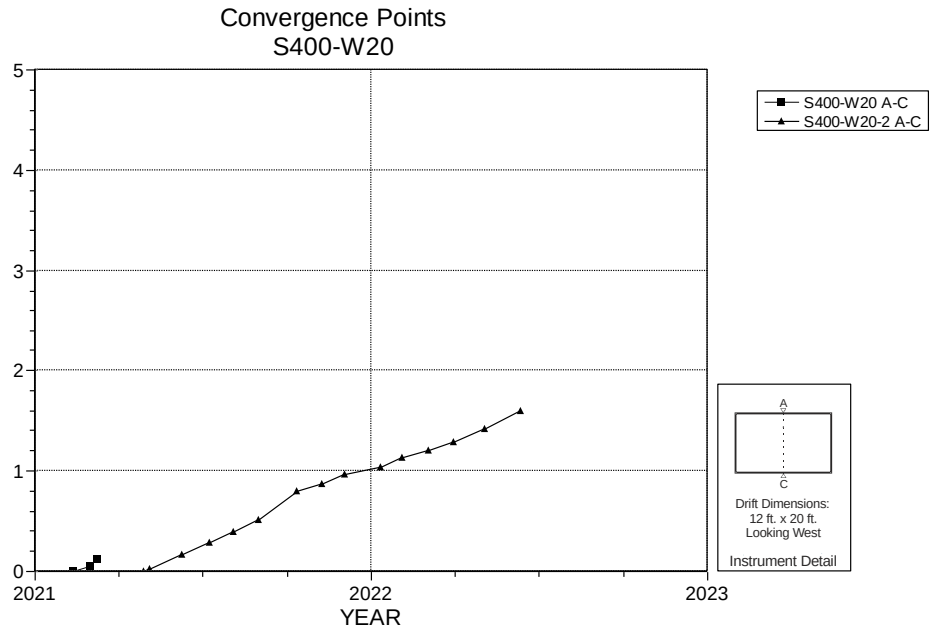
NOTES:
1. Excavation date: May 1984.

Figure 4-135 Convergence Point Array – S400 E360 – Roof to Floor



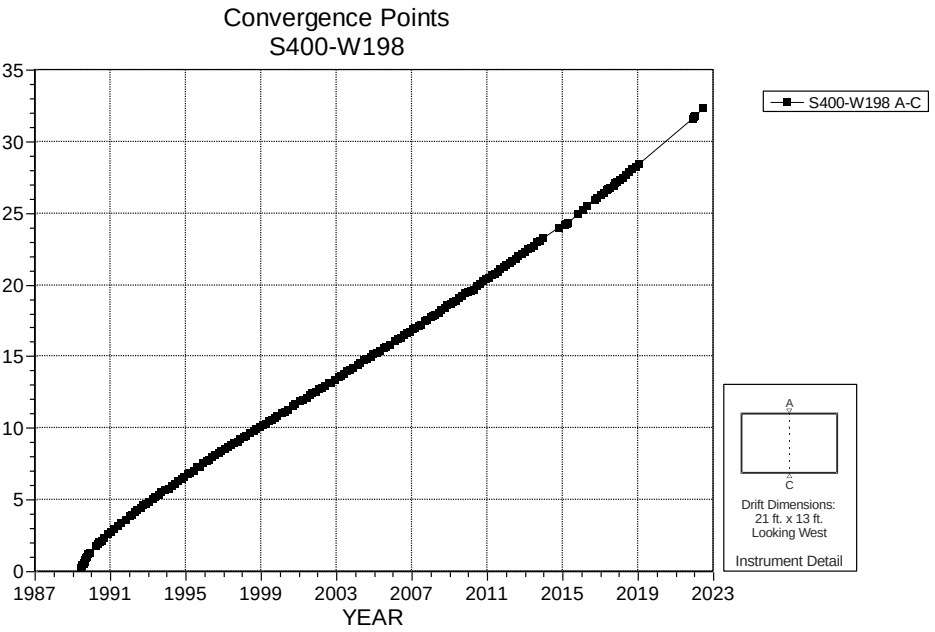
NOTES:
1. Excavation date: May 1984.

Figure 4-136 Convergence Point Array – S400 E420 – Roof to Floor



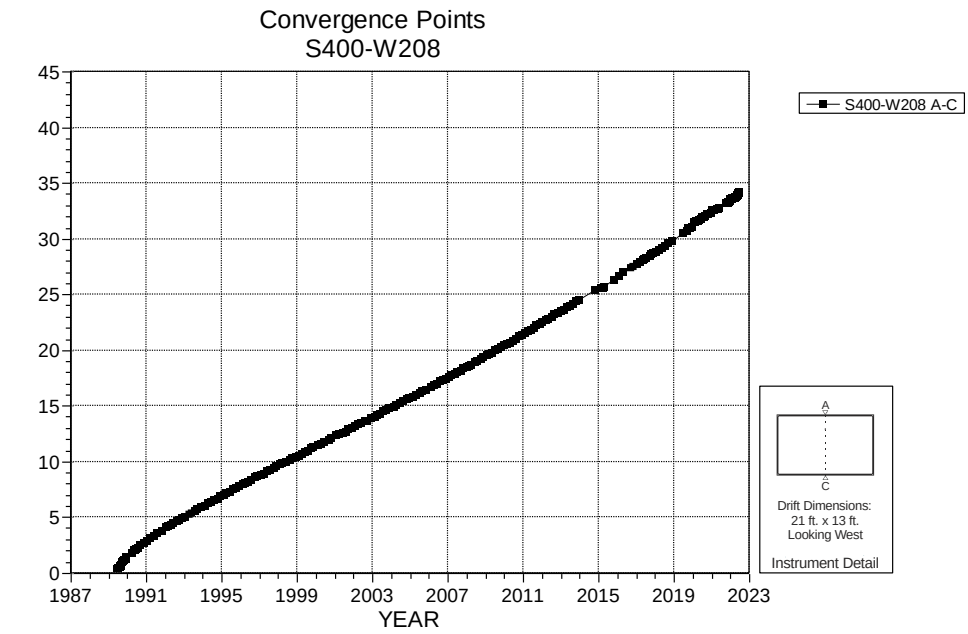
NOTES:
1. Excavation date: March 1983.

Figure 4-137 Convergence Point Array – S400 W20 – Roof to Floor



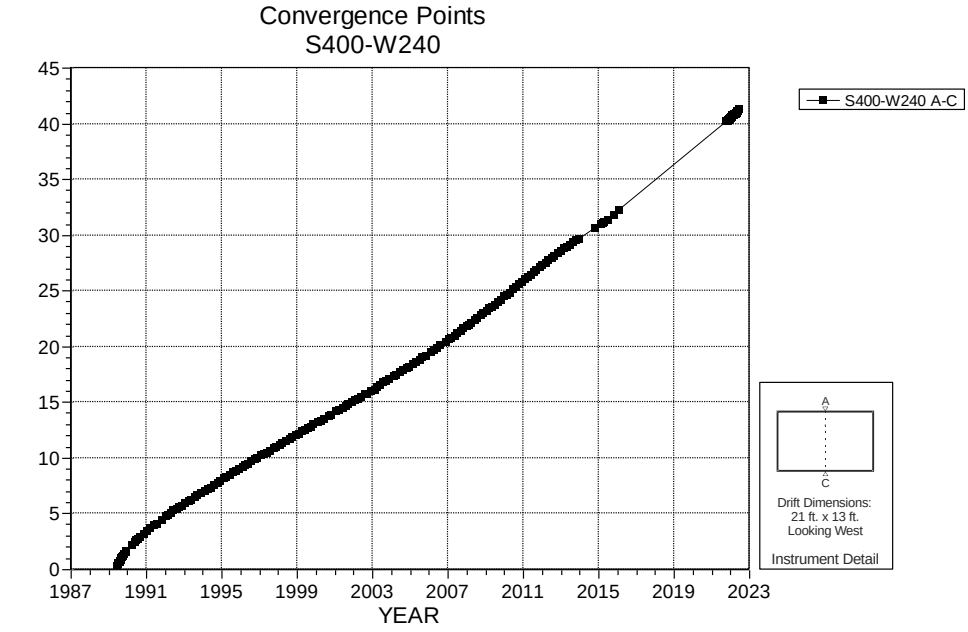
NOTES:
1. Excavation date: May 1989.

Figure 4-138 Convergence Point Array – S400 W198 – Roof to Floor



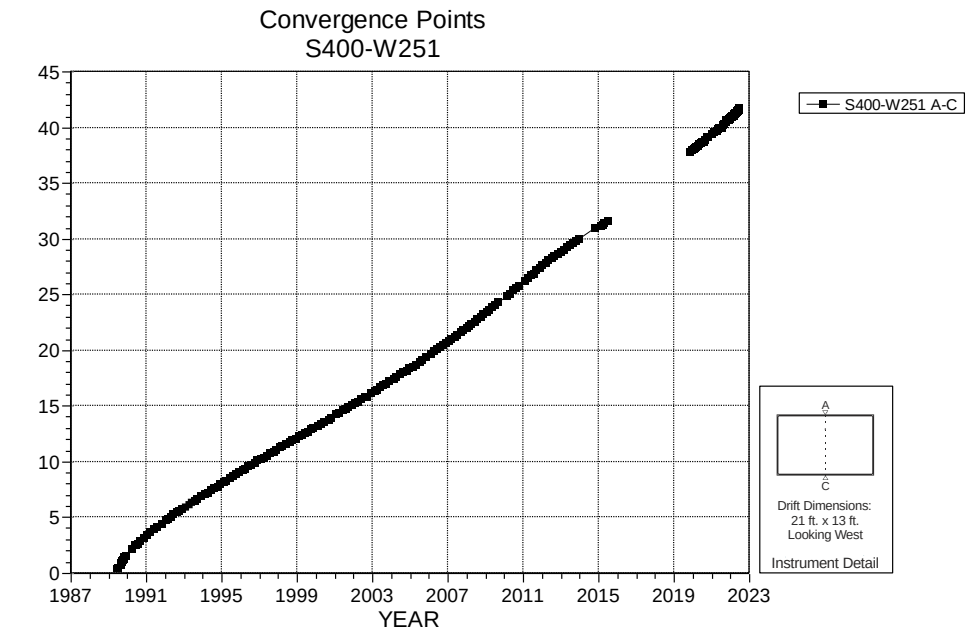
NOTES:
1. Excavation date: May 1989.

Figure 4-139 Convergence Point Array – S400 W208 – Roof to Floor



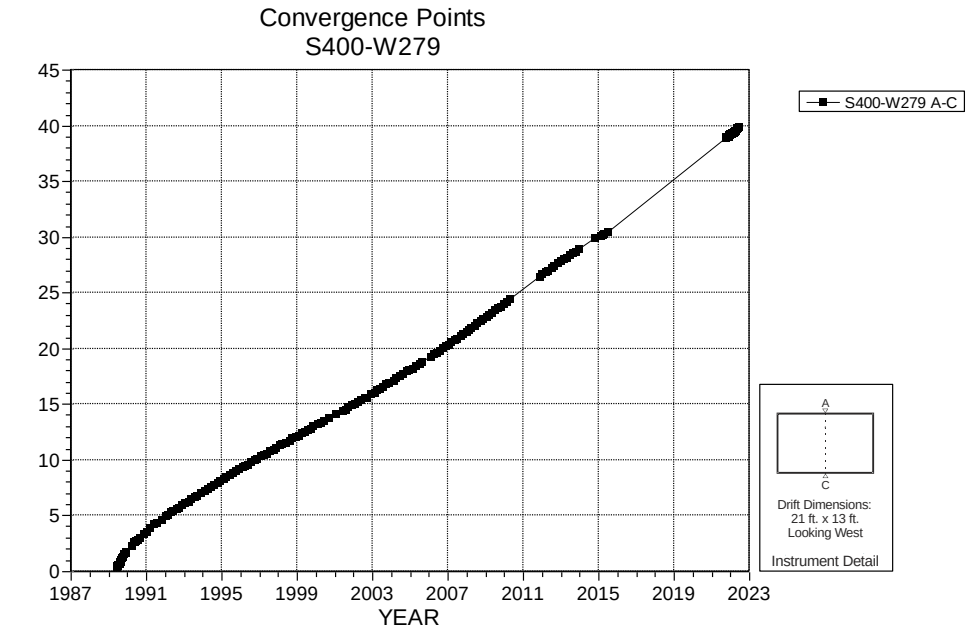
NOTES:
1. Excavation date: May 1989.

Figure 4-140 Convergence Point Array – S400 W240 – Roof to Floor



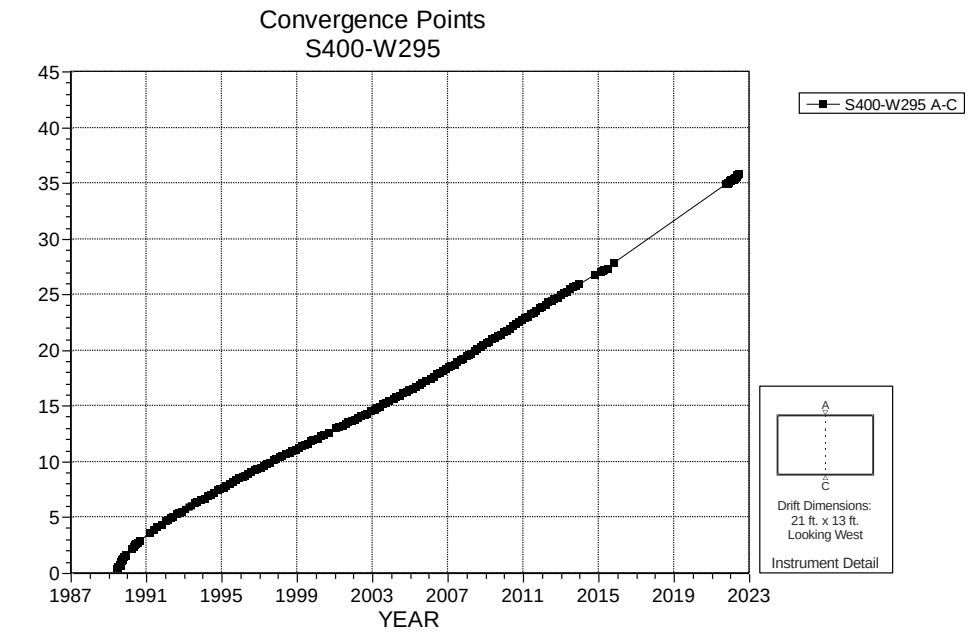
NOTES:
1. Excavation date: May 1989.

Figure 4-141 Convergence Point Array – S400 W251 – Roof to Floor



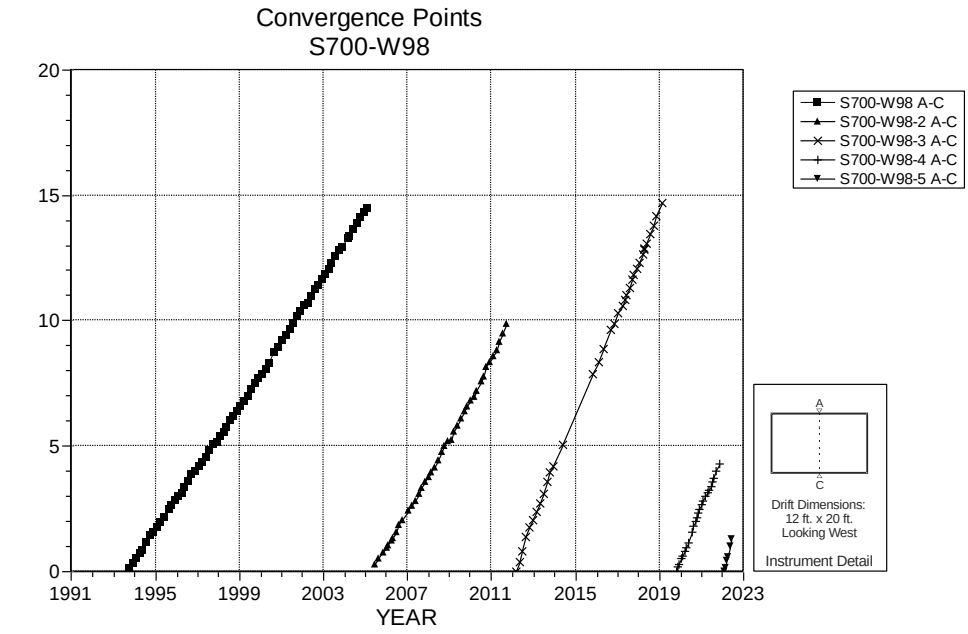
NOTES:
1. Excavation date: May 1989.

Figure 4-142 Convergence Point Array – S400 W279 – Roof to Floor



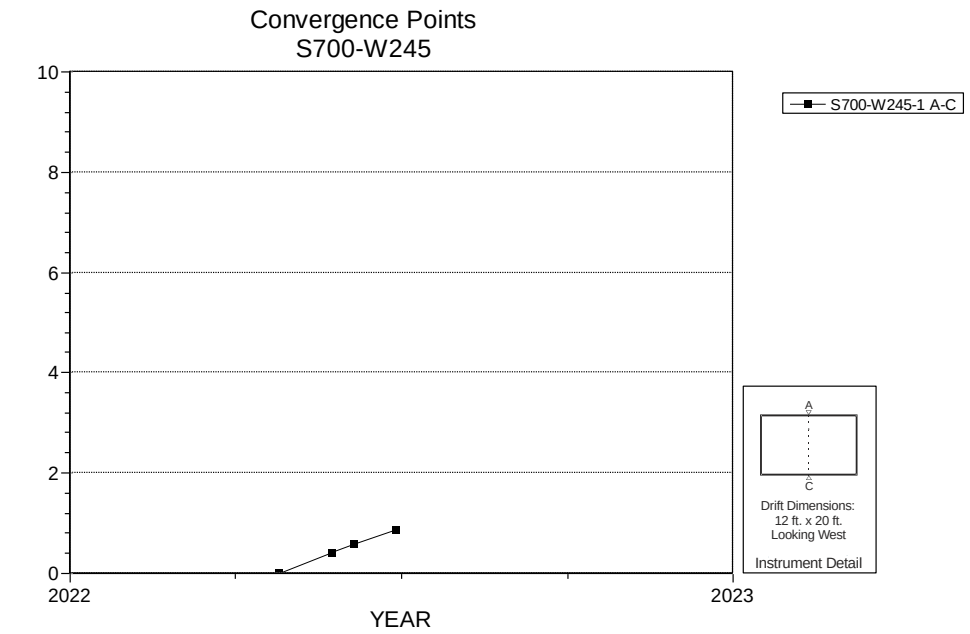
NOTES:
1. Excavation date: May 1989.

Figure 4-143 Convergence Point Array – S400 W295 – Roof to Floor



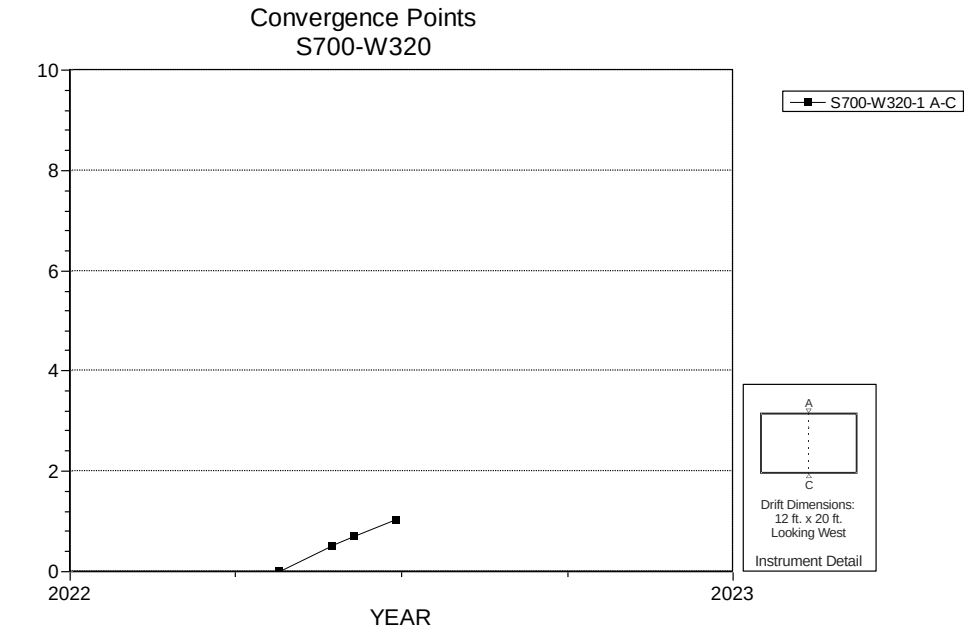
NOTES:
1. Excavation date: July 1985.

Figure 4-144 Convergence Point Array – S700 W98 – Roof to Floor



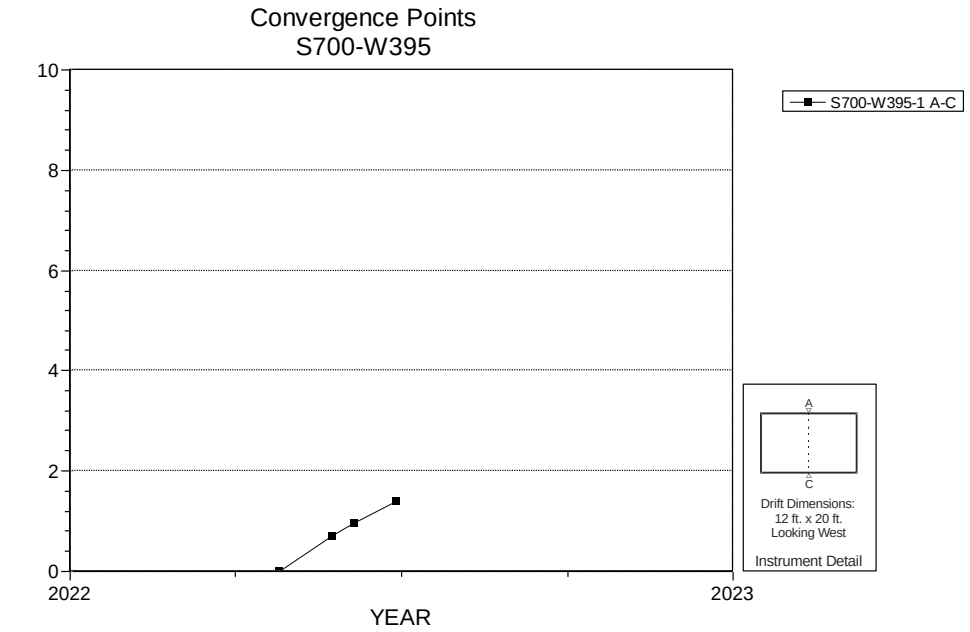
NOTES:
1. Excavation date: March 2022.

Figure 4-145 Convergence Point Array – S700 W245 – Roof to Floor



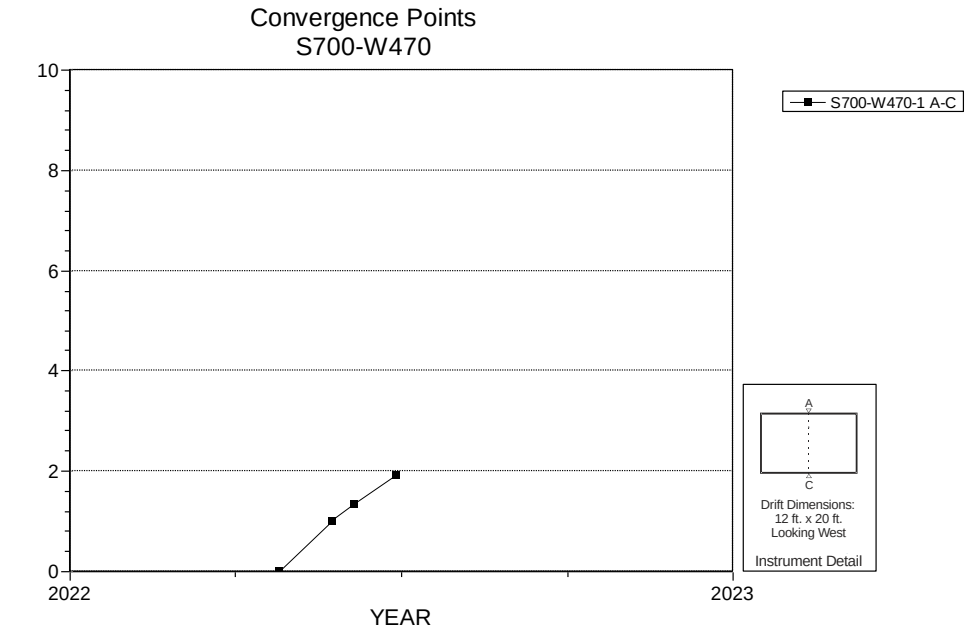
NOTES:
1. Excavation date: March 2022.

Figure 4-146 Convergence Point Array – S700 W320 – Roof to Floor



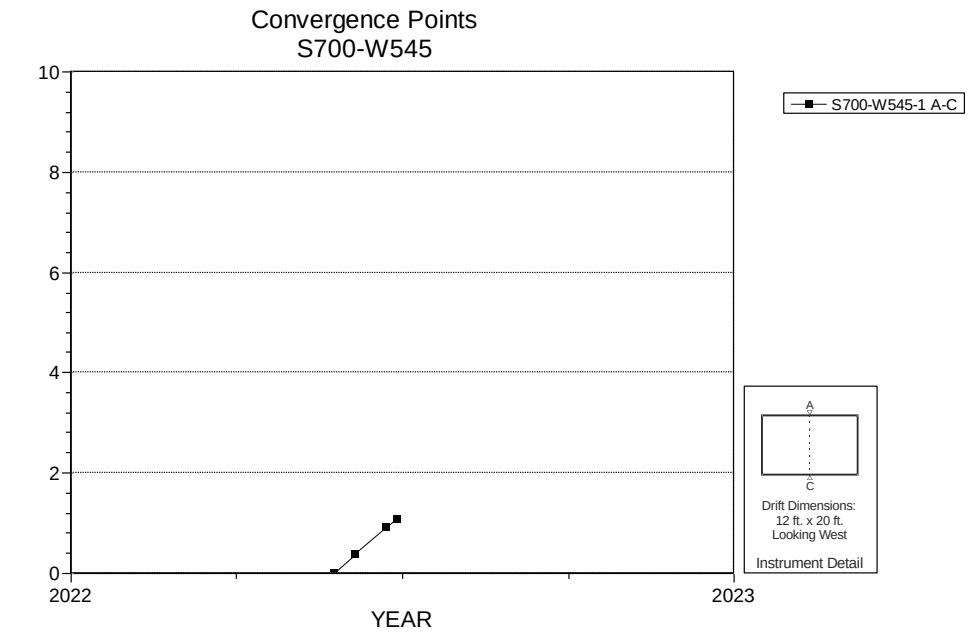
NOTES:
1. Excavation date: April 2022.

Figure 4-147 Convergence Point Array – S700 W395 – Roof to Floor



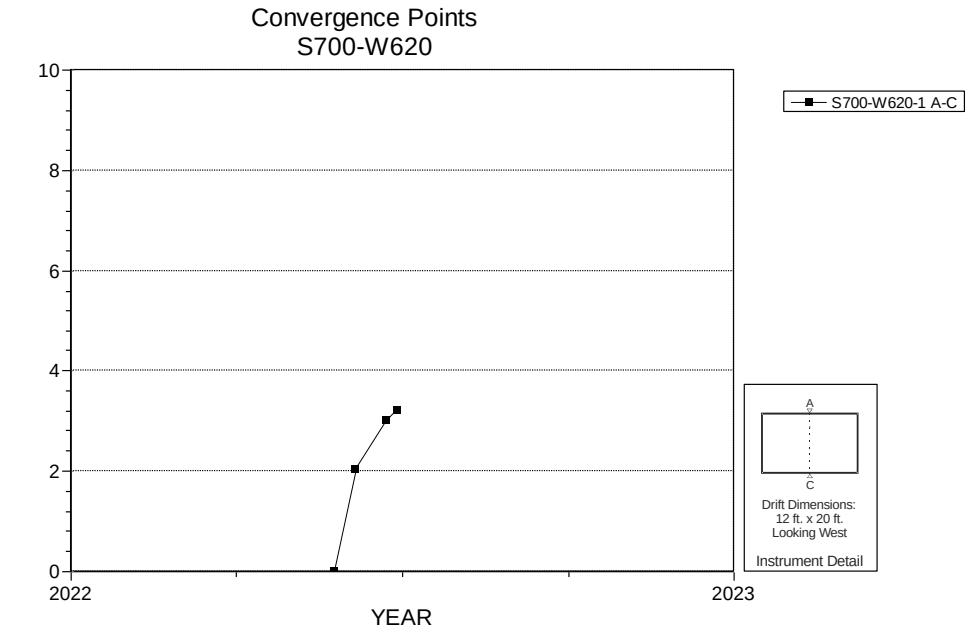
NOTES:
1. Excavation date: April 2022.

Figure 4-148 Convergence Point Array –S700 W470 – Roof to Floor



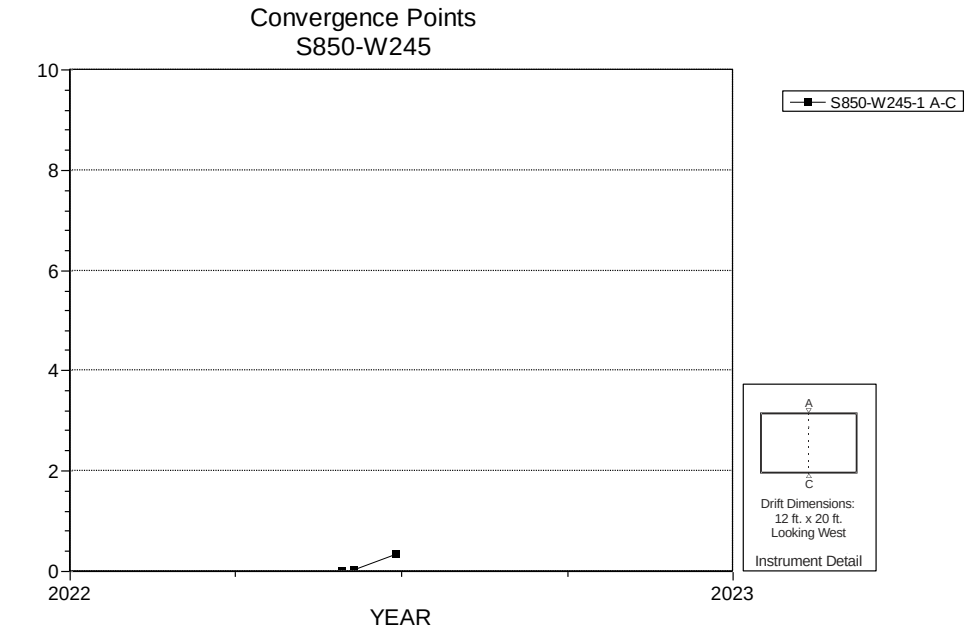
NOTES:
1. Excavation date: April 2022.

Figure 4-149 Convergence Point Array – S700 W545 – Roof to Floor



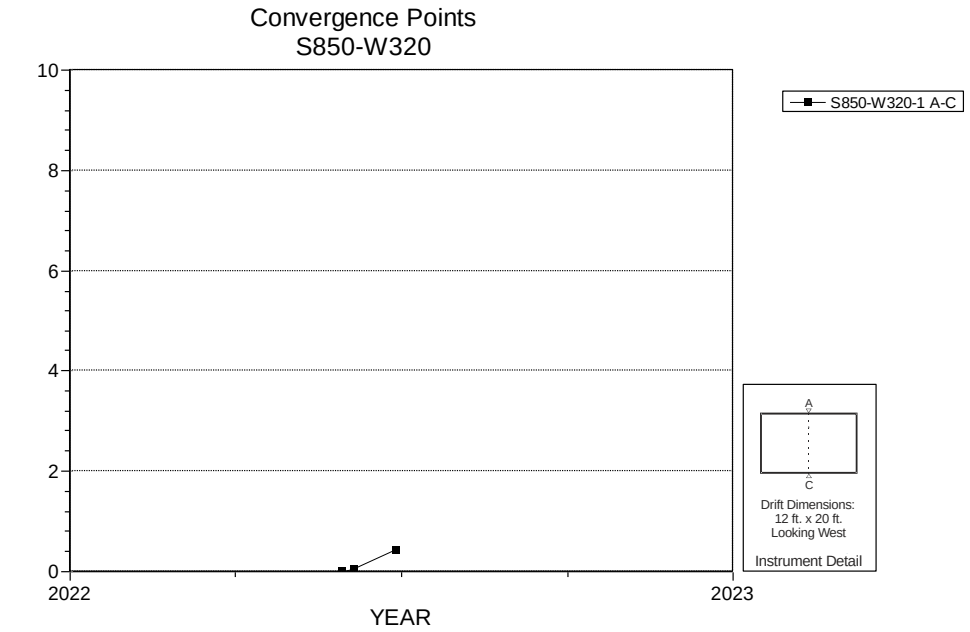
NOTES:
1. Excavation date: May 2022.

Figure 4-150 Convergence Point Array – S700 W620 – Roof to Floor



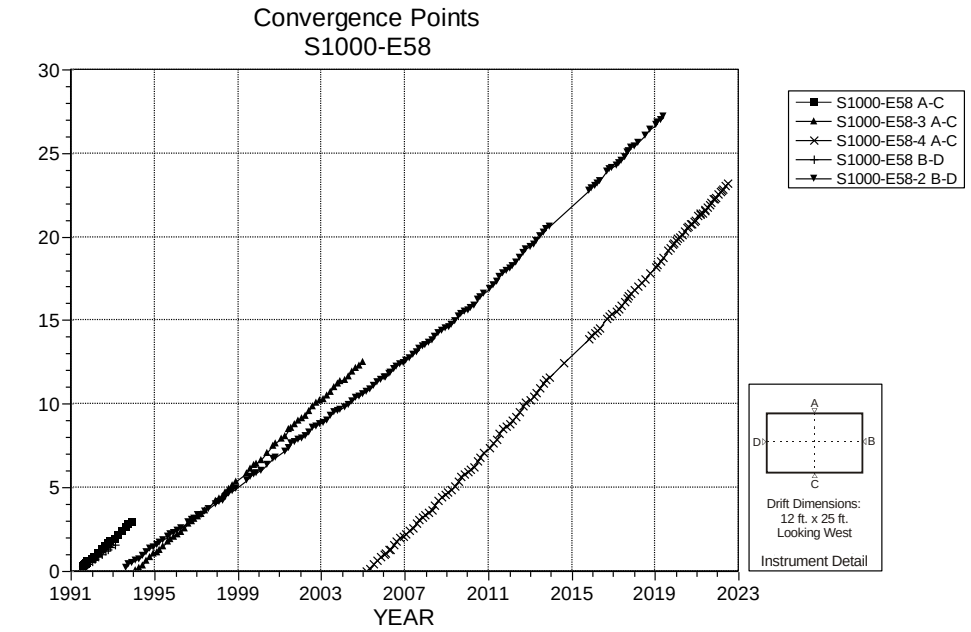
NOTES:
1. Excavation date: January 2022.

Figure 4-151 Convergence Point Array – S850 W245 – Roof to Floor



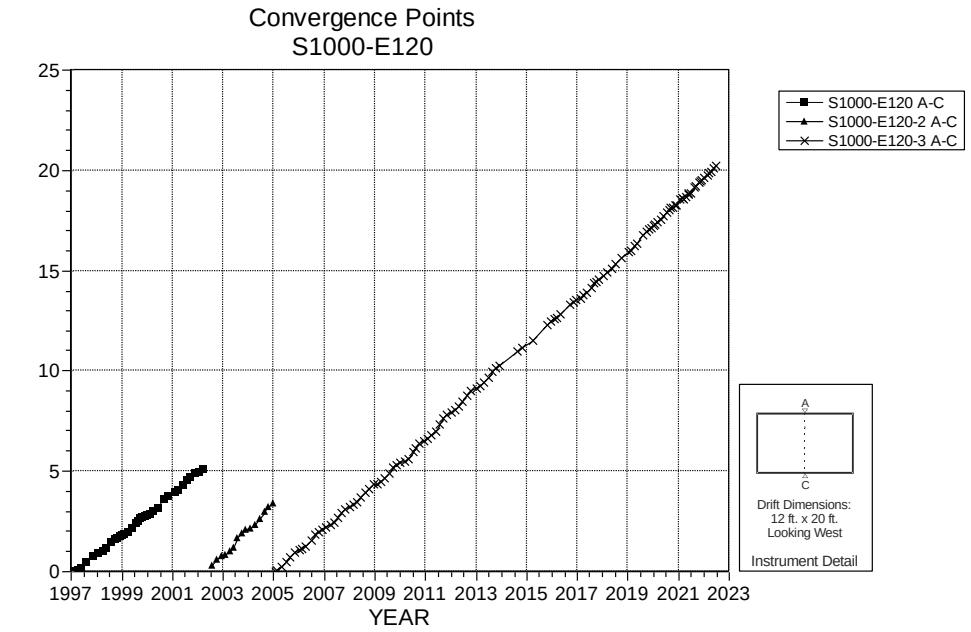
NOTES:
1. Excavation date: January 2022.

Figure 4-152 Convergence Point Array – S850 W320 – Roof to Floor



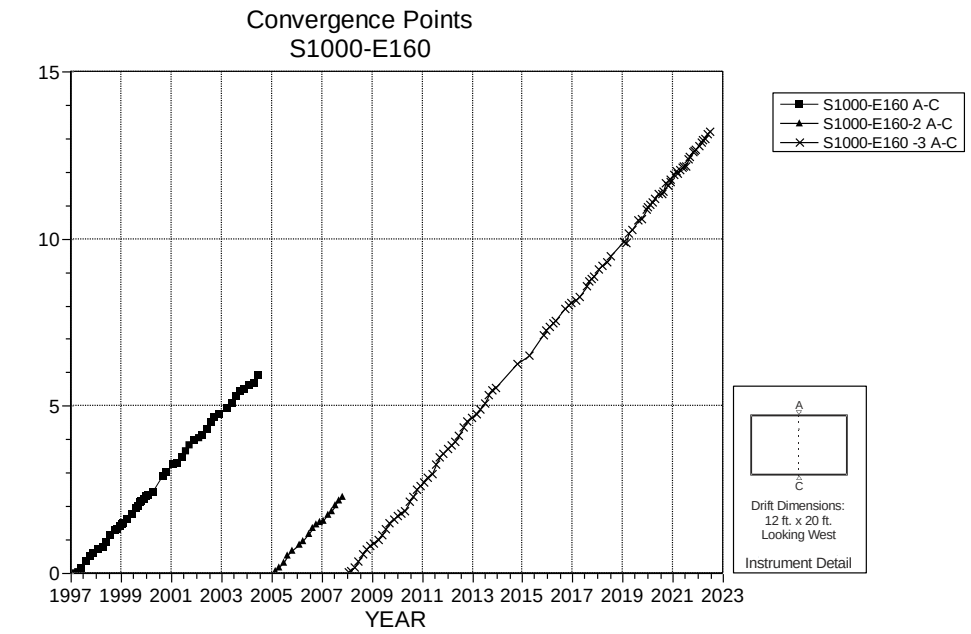
NOTES:
1. Excavation date: July 1984.

Figure 4-153 Convergence Point Array – S1000 E58 – All Chords



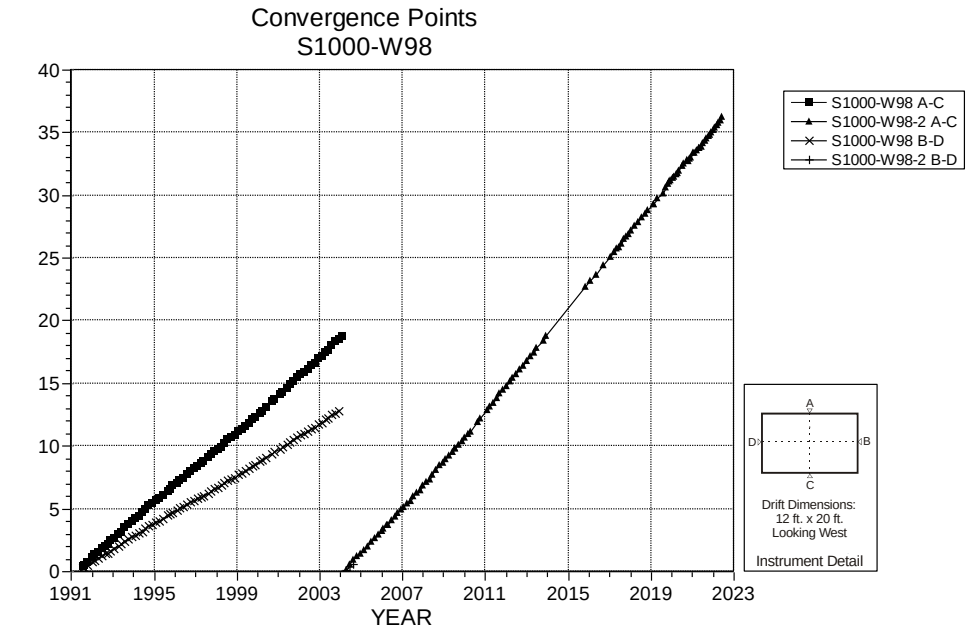
NOTES:
1. Excavation date: July 1984.

Figure 4-154 Convergence Point Array – S1000 E120 – Roof to Floor



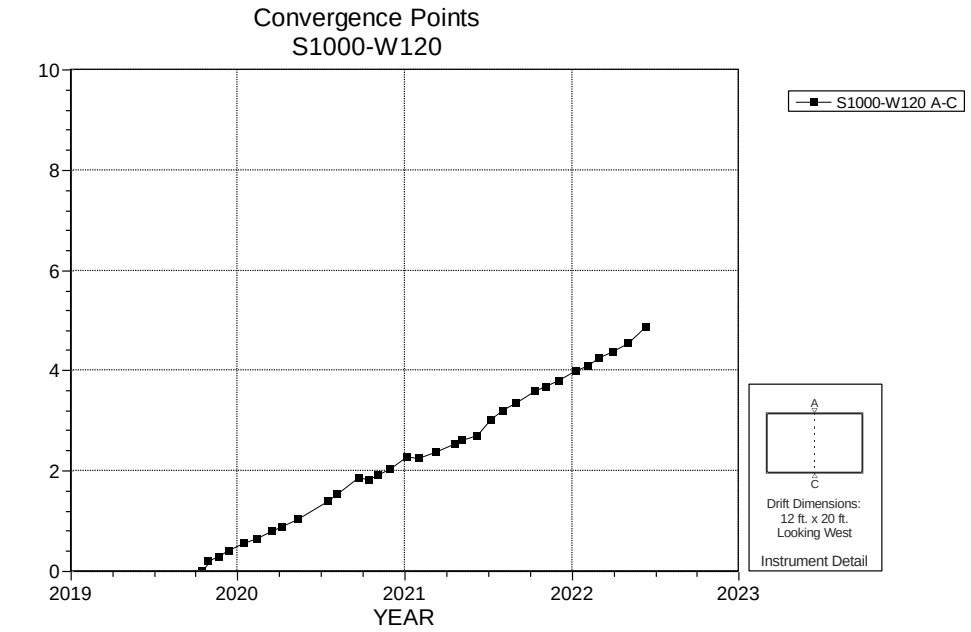
NOTES:
1. Excavation date: September 1985.
2. Reinstalled 'C' point, January 2008.

Figure 4-155 Convergence Point Array – S1000 E160 – Roof to Floor



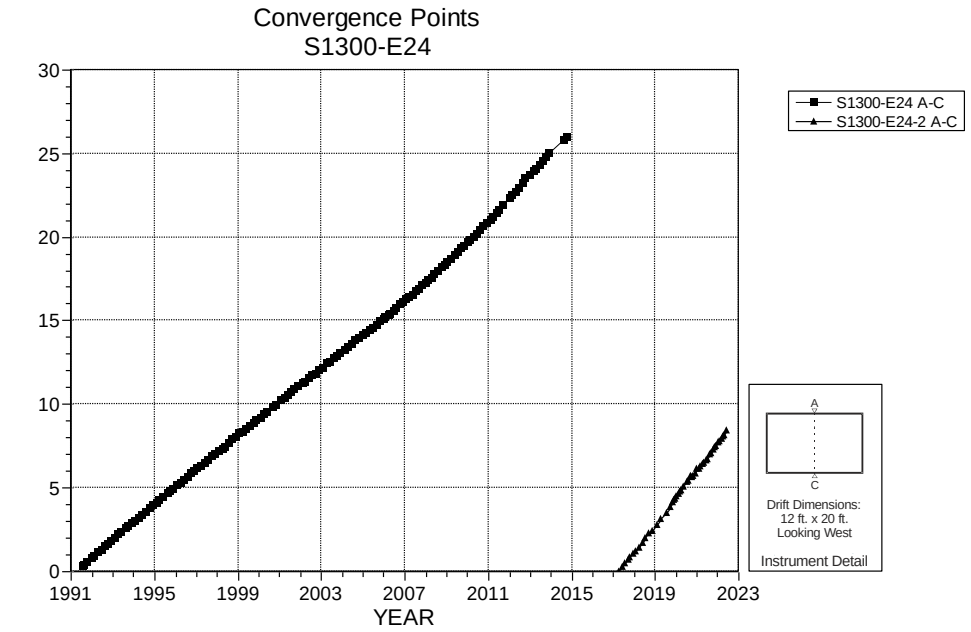
NOTES:
1. Excavation date: August 1985.

Figure 4-156 Convergence Point Array – S1000 W98 – All Chords



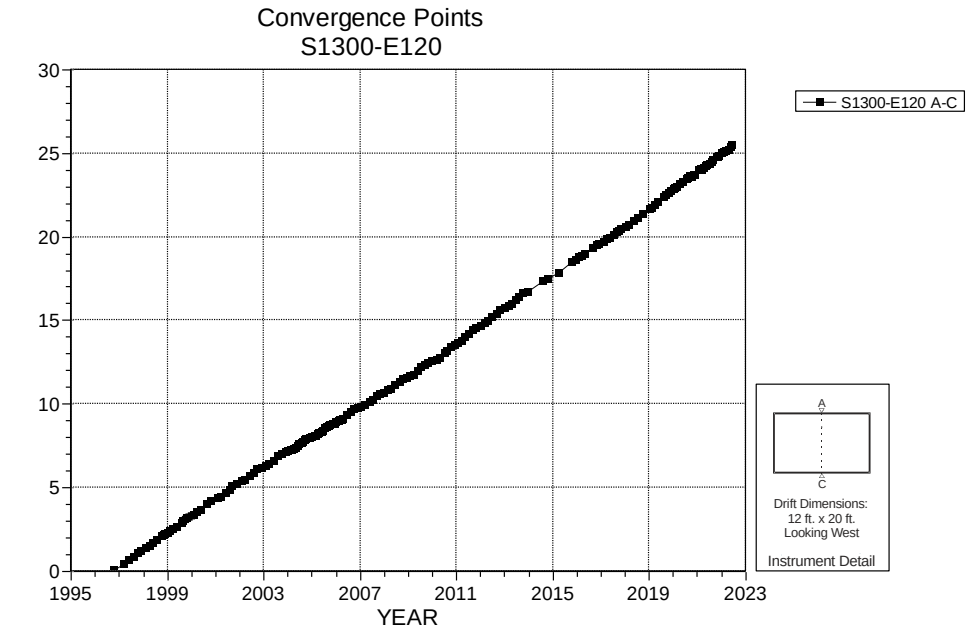
NOTES:
1. Excavation date: August 1985.

Figure 4-157 Convergence Point Array – S1000 W120 – Roof to Floor



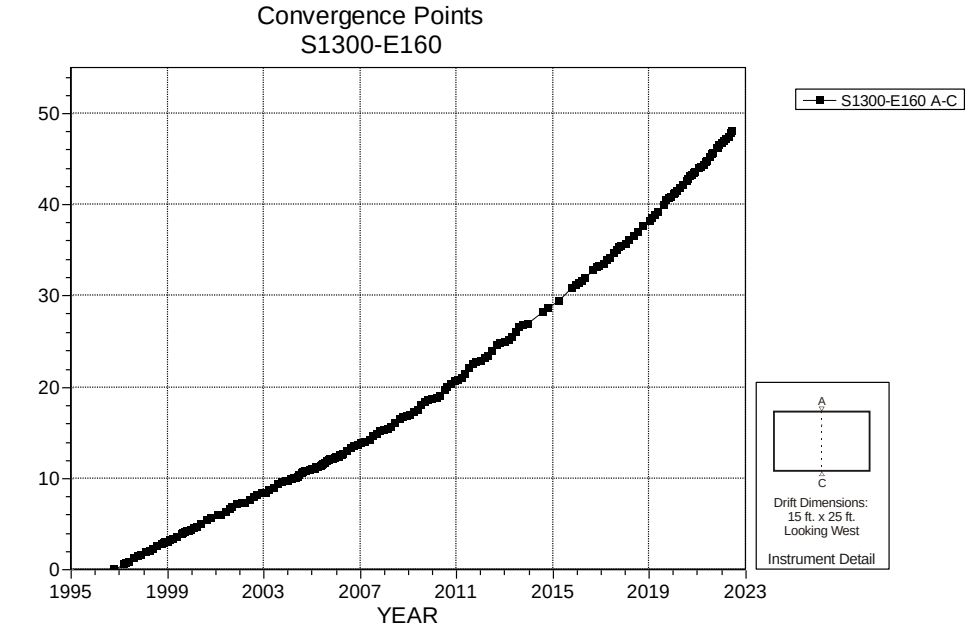
NOTES:
1. Excavation date: August 1985.

Figure 4-158 Convergence Point Array – S1300 E24 – Roof to Floor



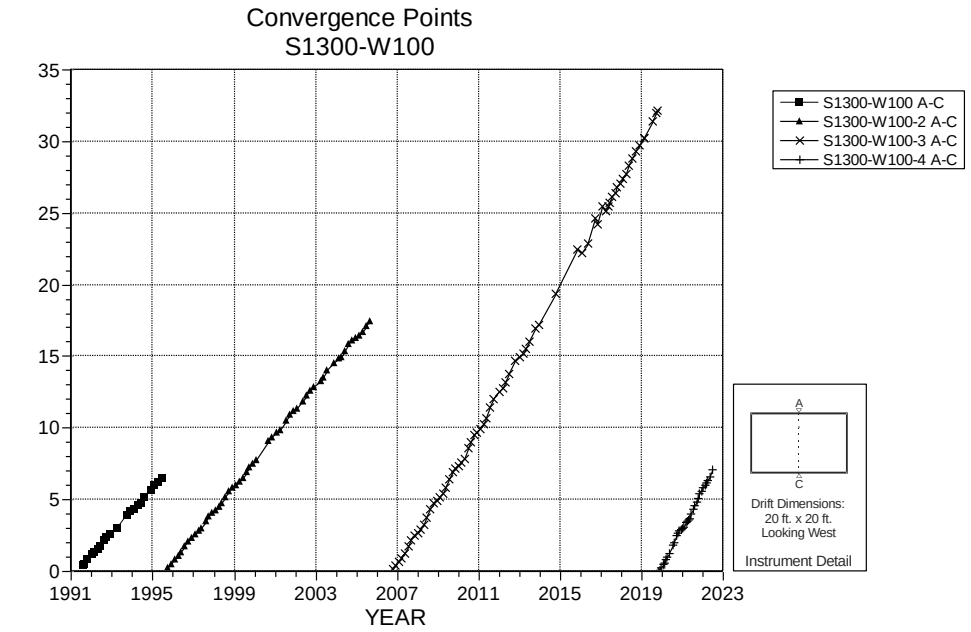
NOTES:
1. Excavation date: August 1984.

Figure 4-159 Convergence Point Array – S1300 E120 – Roof to Floor



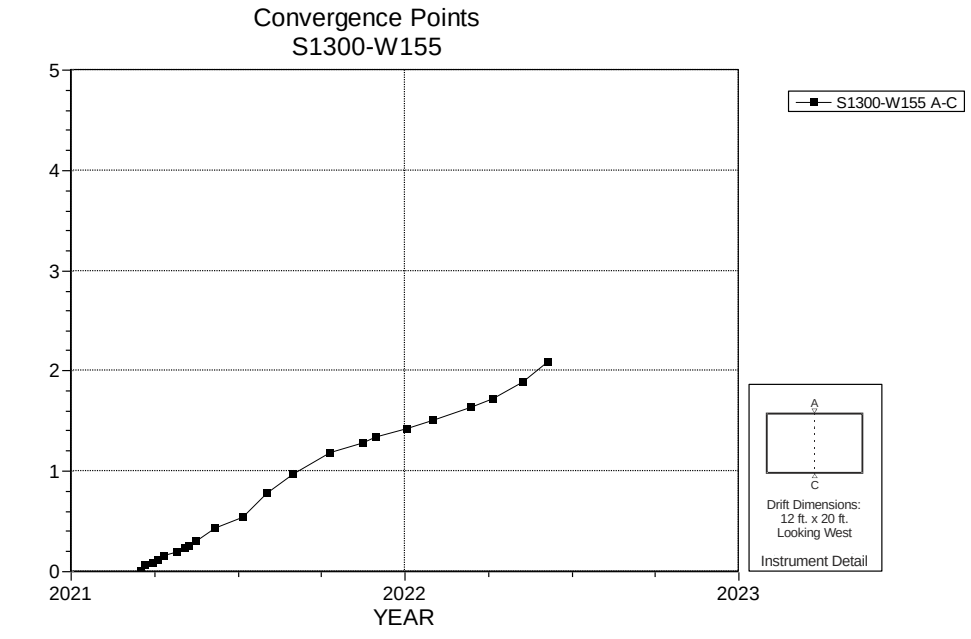
NOTES:
1. Excavation date: June 1984.

Figure 4-160 Convergence Point Array – S1300 E160 – Roof to Floor



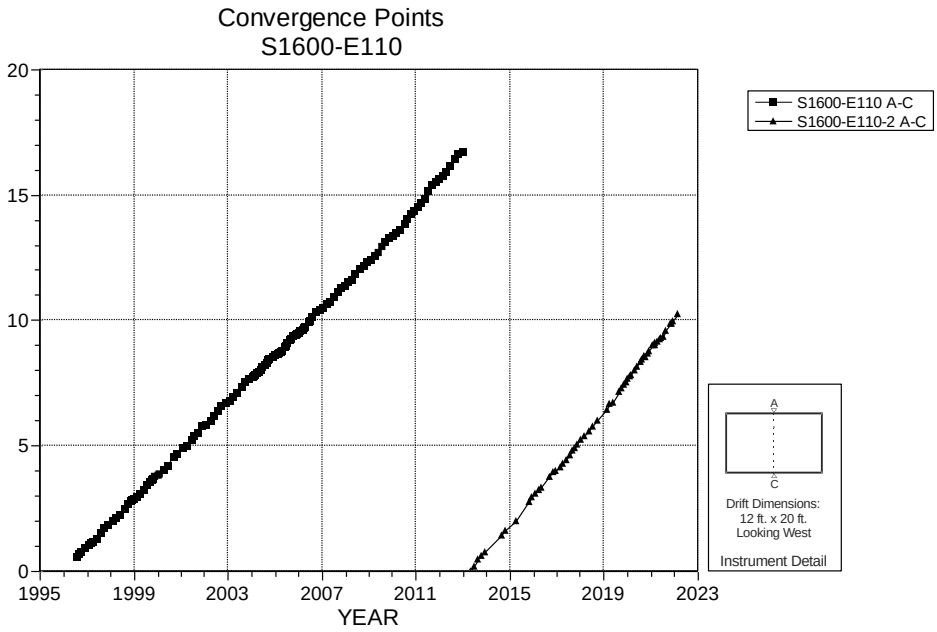
NOTES:
1. Excavation date: August 1984.
2. Instrument mined out, chord reinstalled September, 2006.

Figure 4-161 Convergence Point Array – S1300 W100 – Roof to Floor



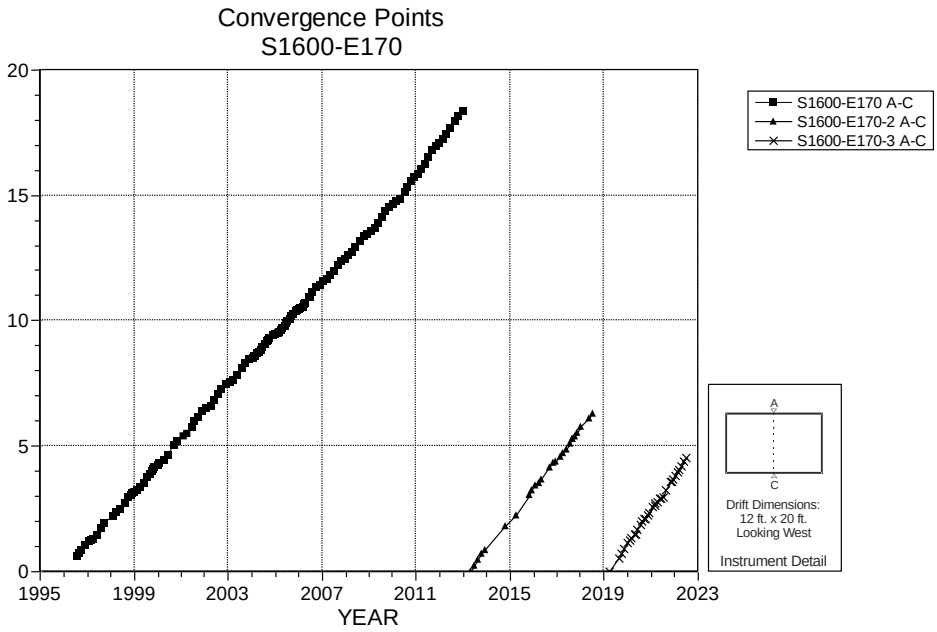
NOTES:
1. Excavation date: August 1984.

Figure 4-162 Convergence Point Array – S1300 W155 – Roof to Floor



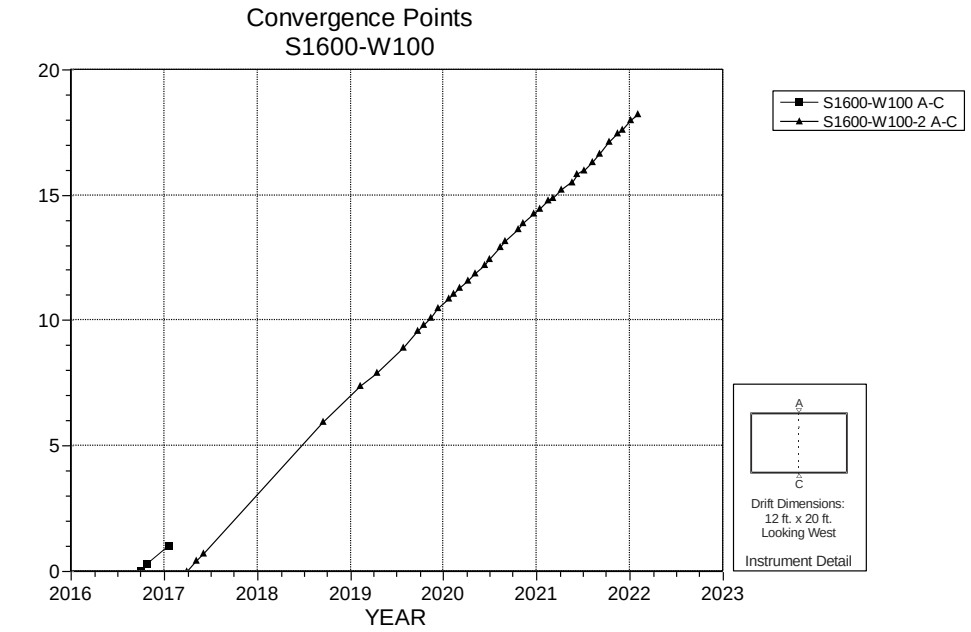
NOTES:
1. Excavation date: June 1984.

Figure 4-163 Convergence Point Array – S1600 E110 – Roof to Floor



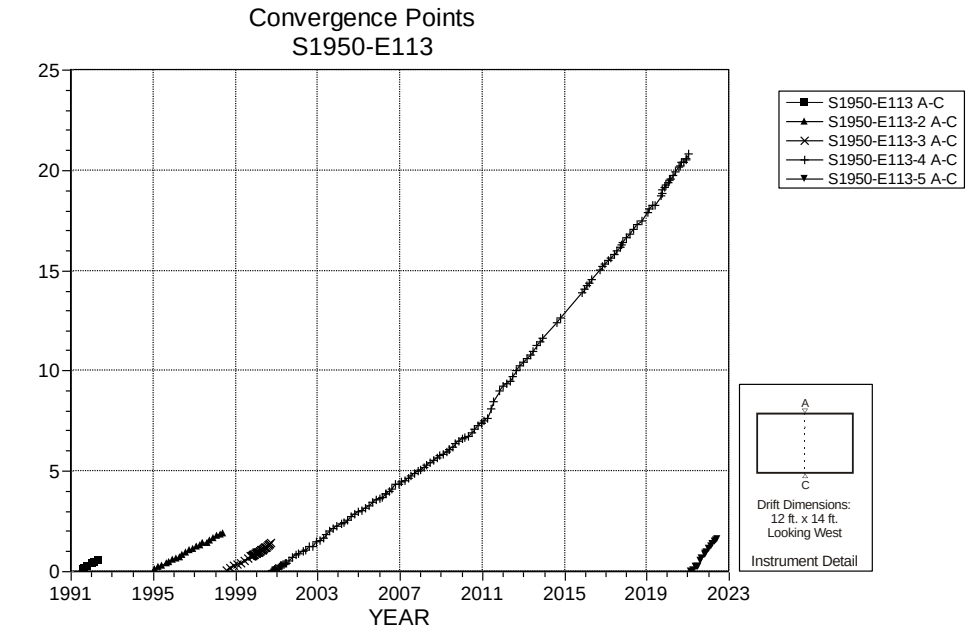
NOTES:
1. Excavation date: September 1985.

Figure 4-164 Convergence Point Array – S1600 E170 – Roof to Floor



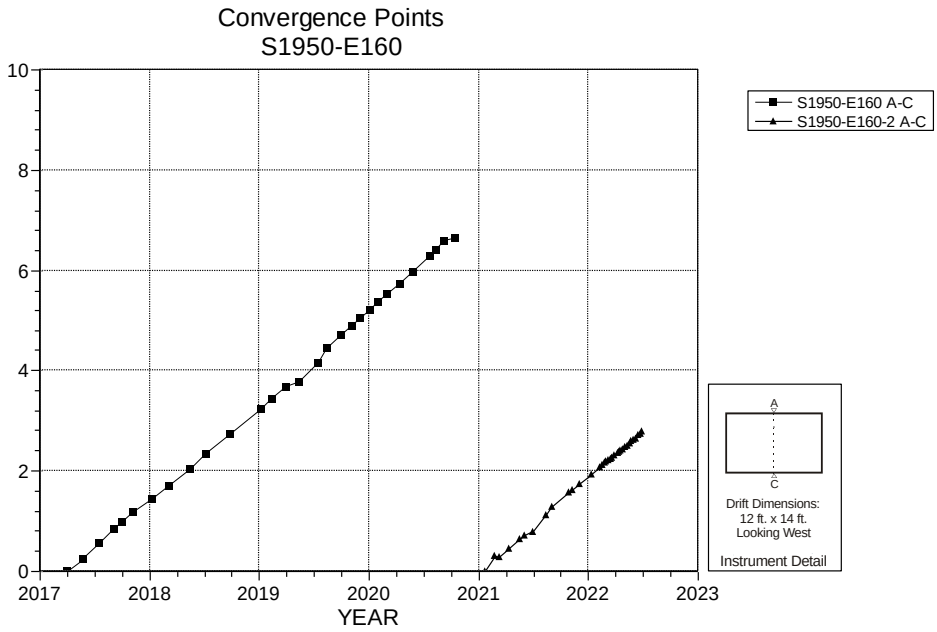
NOTES:
1. Excavation Date: August 1985.

Figure 4-165 Convergence Point Array – S1600 W100 – Roof to Floor



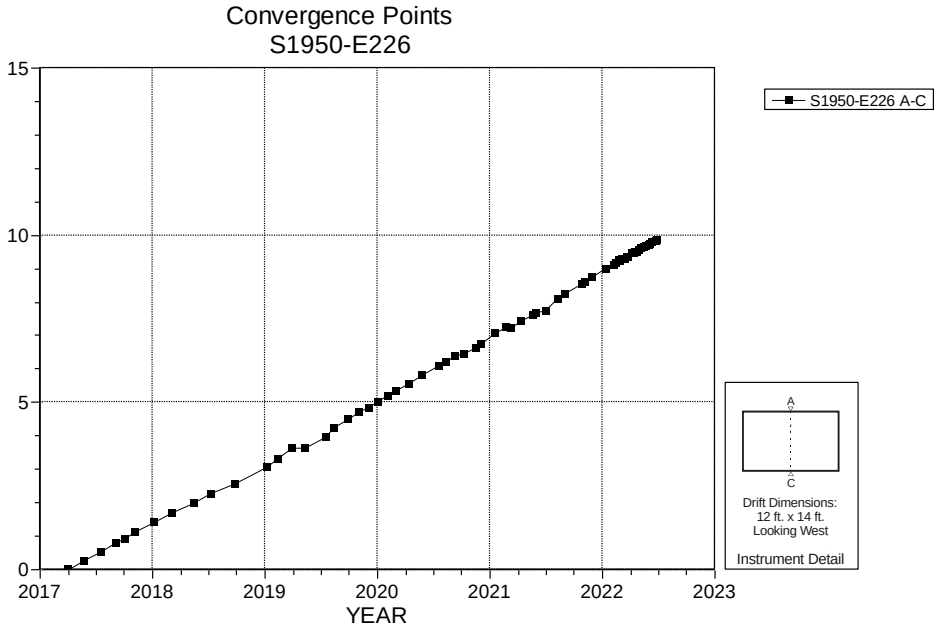
NOTES:
1. Excavation date: January 1986.

Figure 4-166 Convergence Point Array – S1950 E113 – Roof to Floor



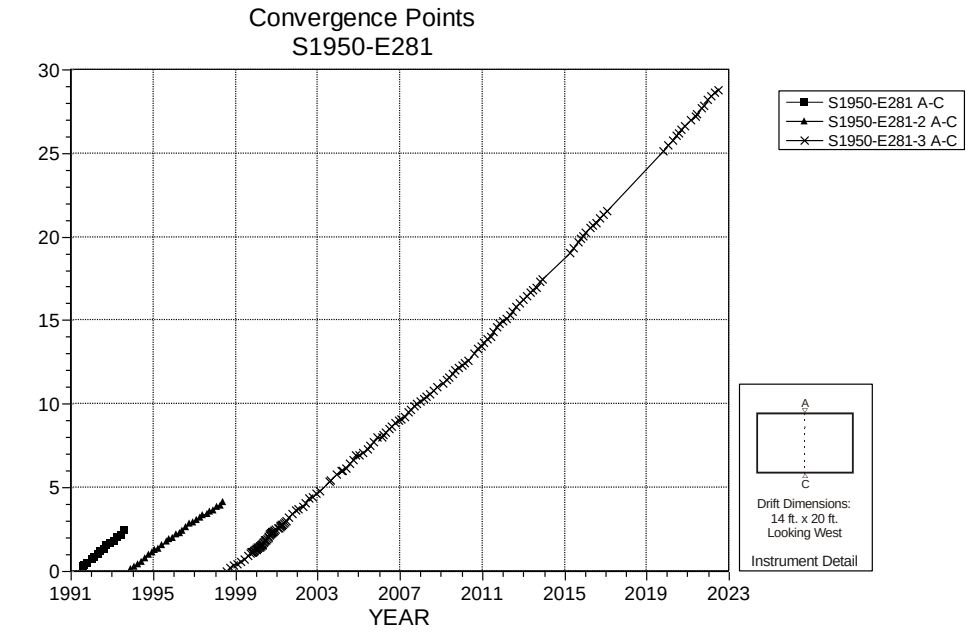
NOTES:
1. Excavation date: January 1986.

Figure 4-167 Convergence Point Array – S1950 E160 – Roof to Floor



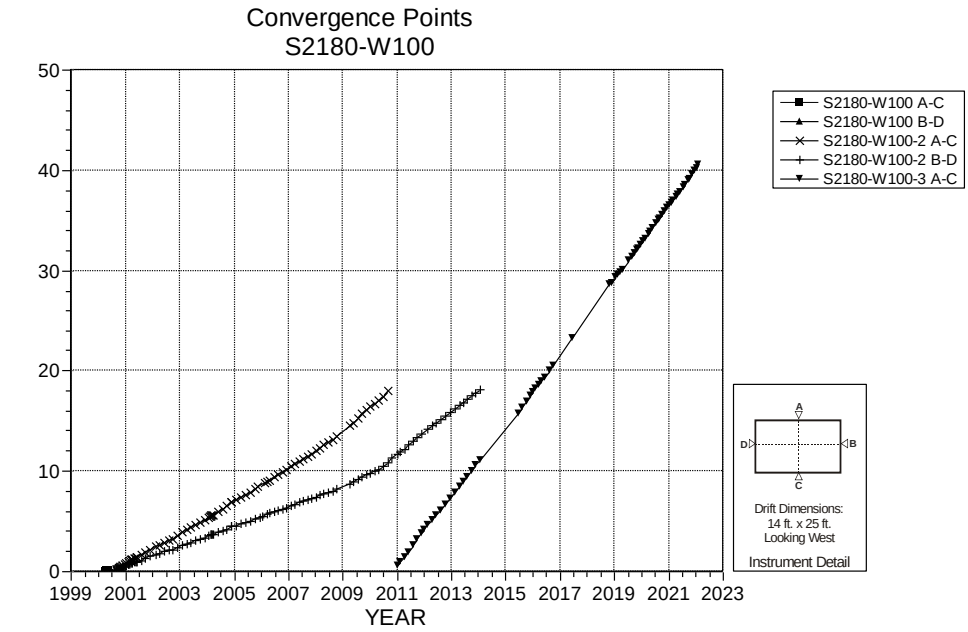
NOTES:
1. Excavation date: January 1986.

Figure 4-168 Convergence Point Array – S1950 E226 – Roof to Floor



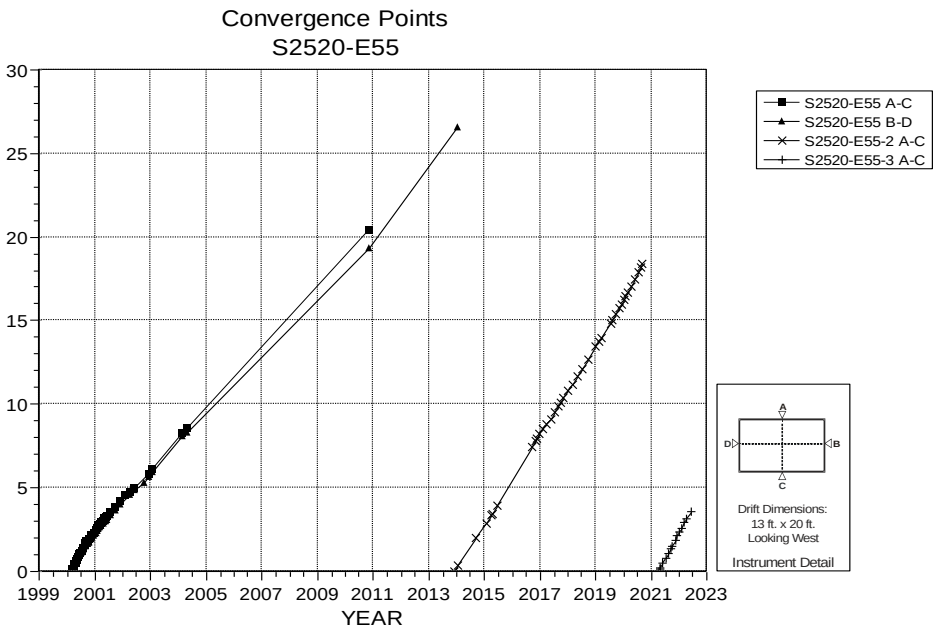
NOTES:
1. Excavation date: November 1985.

Figure 4-169 Convergence Point Array – S1950 E281 – Roof to Floor



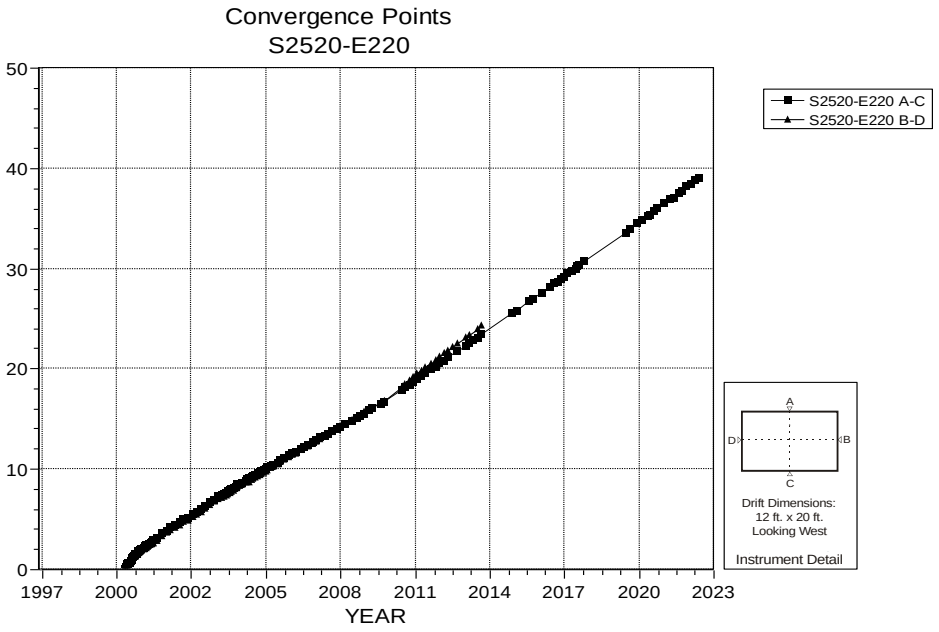
NOTES:
1. Excavation date: July 1986.

Figure 4-170 Convergence Point Array – S2180 W100 – All Chords



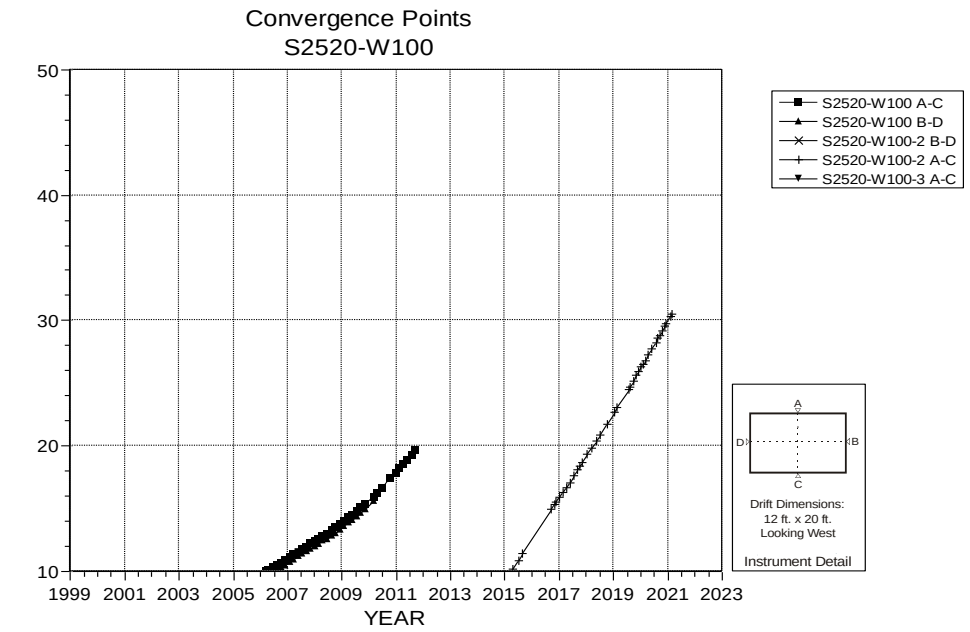
NOTES:
1. Excavation date: February 2000.
2. Blocked by electrical substation.

Figure 4-171 Convergence Point Array – S2520 E55 – All Chords



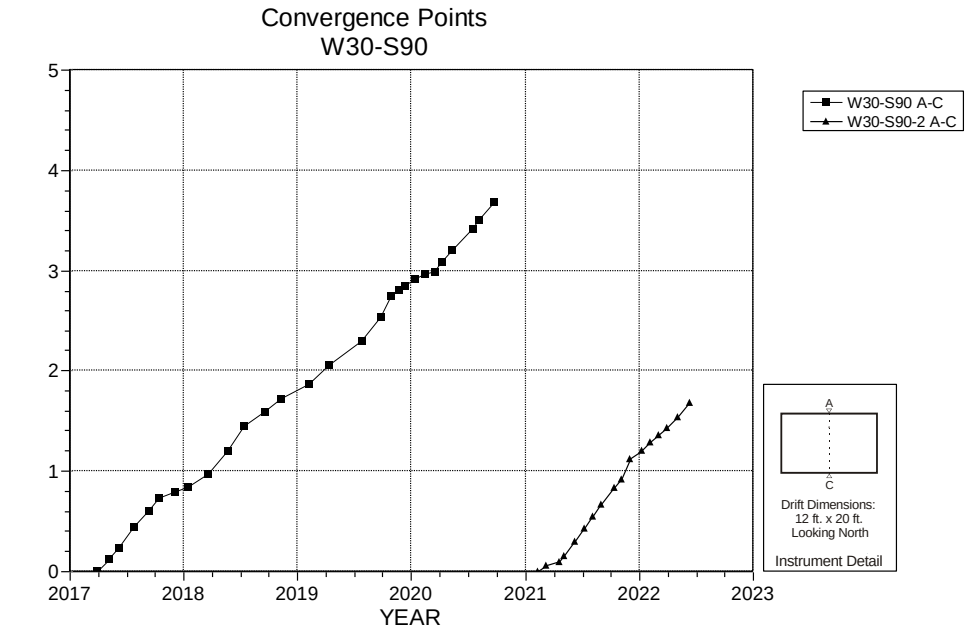
NOTES:
1. Excavation date: December 1999.

Figure 4-172 Convergence Point Array – S2520 E220 – All Chords



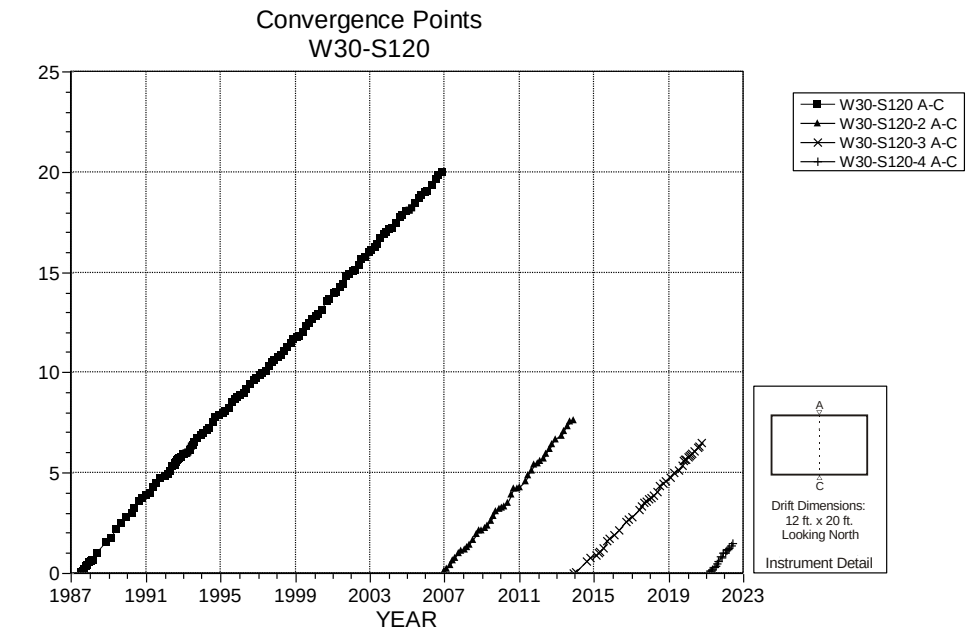
NOTES:
1. Excavation date: December 1999.

Figure 4-173 Convergence Point Array – S2520 W100 – All Chords



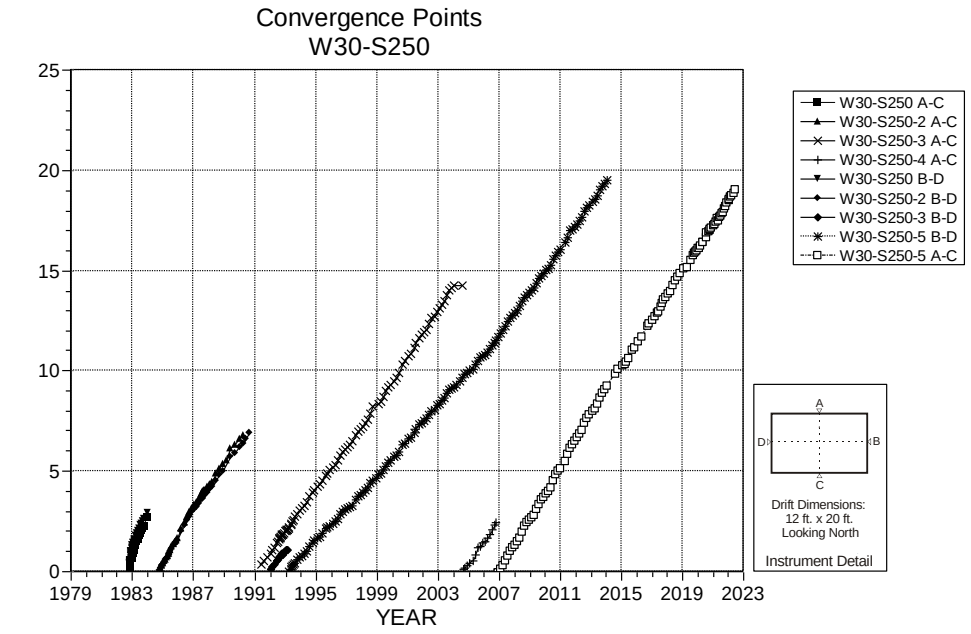
NOTES:
1. Excavation date: January 1982.

Figure 4-174 Convergence Point Array – W30 S90 – Roof to Floor



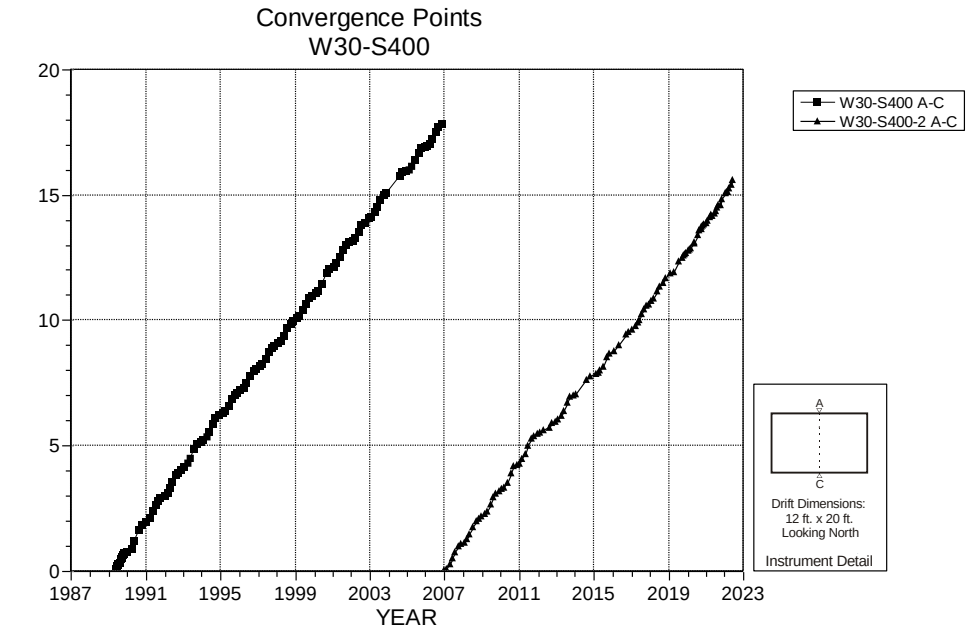
NOTES:
1. Excavation date: October 1982.
2. "C" Point mined out, reinstalled December 2006

Figure 4-175 Convergence Point Array – W30 S120 – Roof to Floor



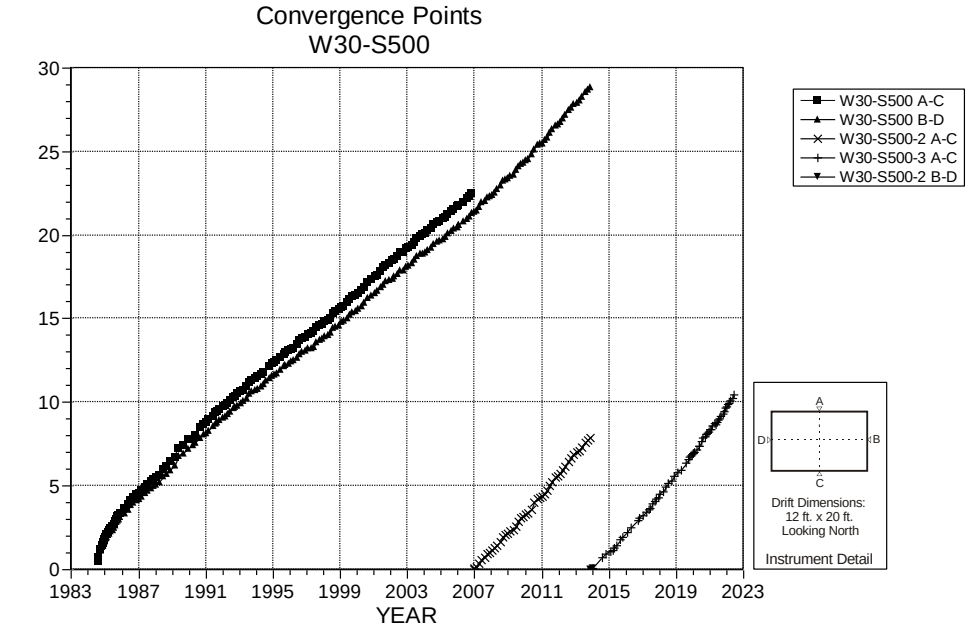
NOTES:
1. Excavation date: October 1982.
2. "C" Point mined out, reinstalled December 2006

Figure 4-176 Convergence Point Array – W30 S250 – All Chords



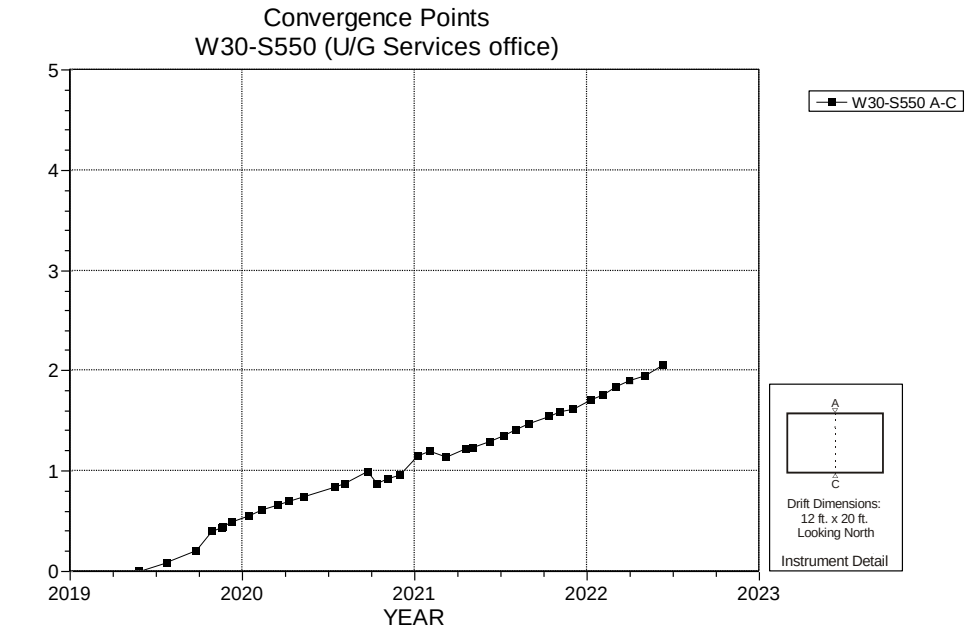
NOTES:
1. Excavation date: October 1982.
2. "C" Point mined out, reinstalled December 2006.

Figure 4-177 Convergence Point Array – W30 S400 – Roof to Floor



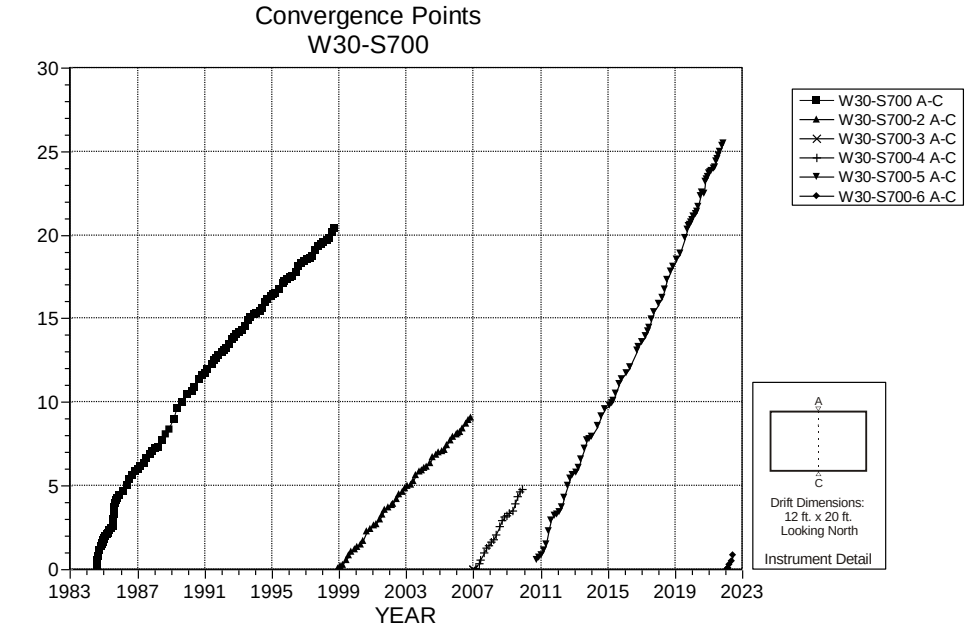
NOTES:
1. Excavation date: August 1984.
2. "C" Point mined out, reinstalled December 2006

Figure 4-178 Convergence Point Array – W30 S500 – All Chords



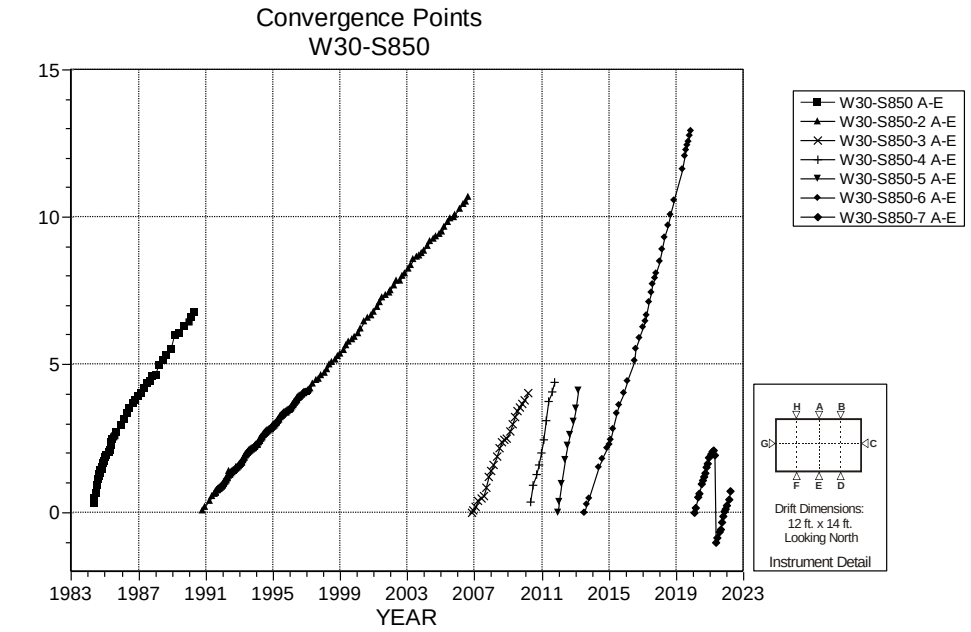
NOTES:
1. Excavation date: August 1984.
2. New installation on 5/29/2019.

Figure 4-179 Convergence Point Array – W30 S550 – Roof to Floor



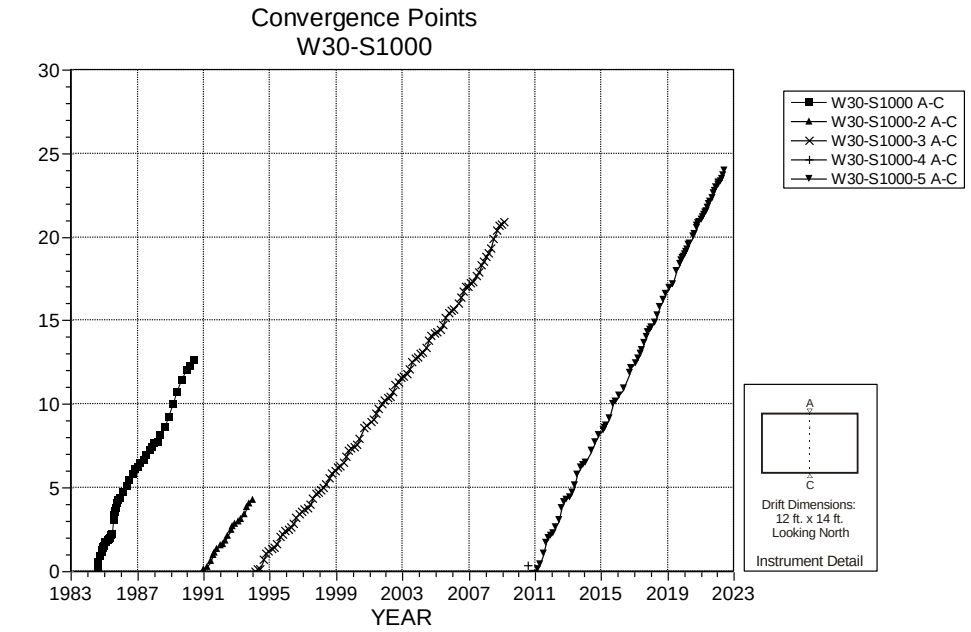
NOTES:
1. Excavation date: August 1984.
2. "C" Point mined out, reinstalled December 2006
3. "C" Point mined out, reinstalled January 2007

Figure 4-180 Convergence Point Array – W30 S700 – Roof to Floor



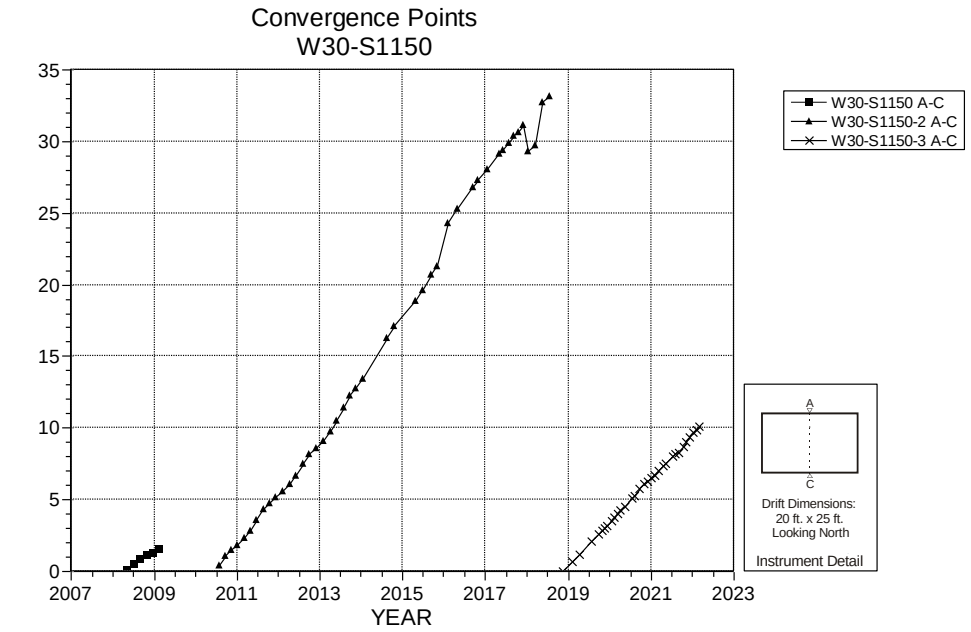
NOTES:
1. Excavation date: August 1984.
2. Rate drop on W30-S850-7 due to suspected floor heave fracturing.

Figure 4-181 Convergence Point Array – W30 S850 – Roof to Floor



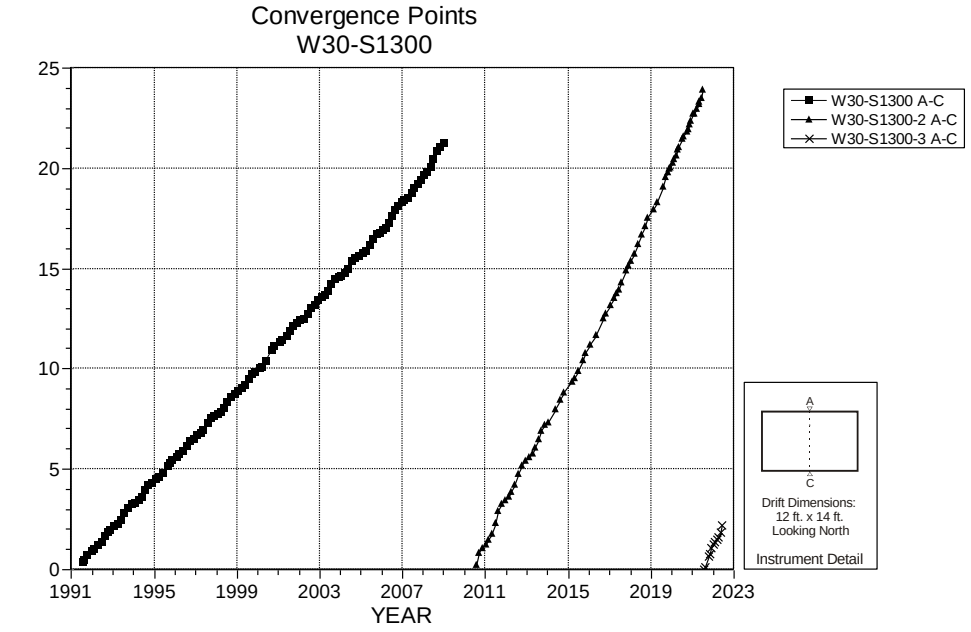
NOTES:
1. Excavation date: August 1984.

Figure 4-182 Convergence Point Array – W30 S1000 – Roof to Floor



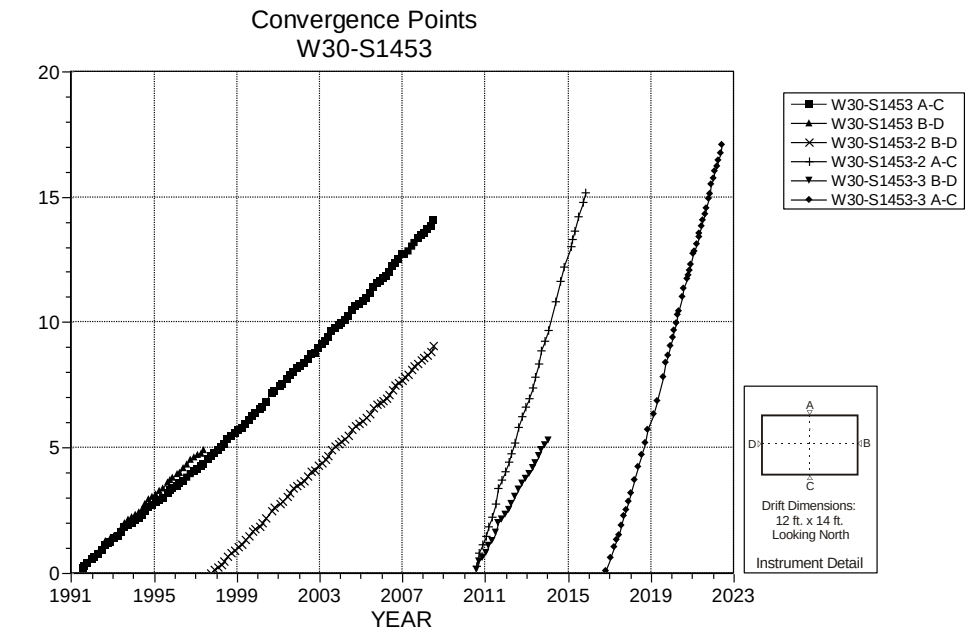
NOTES:
1. Excavation date: August 1984 .

Figure 4-183 Convergence Point Array – W30 S1150 – Roof to Floor



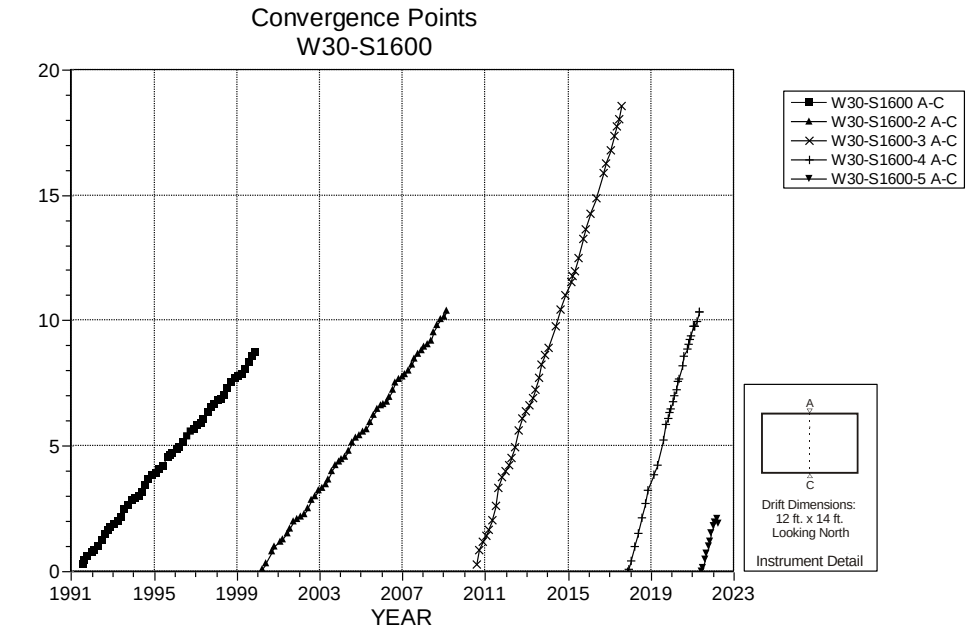
NOTES:
1. Excavation date: August 1984.

Figure 4-184 Convergence Point Array – W30 S1300 – Roof to Floor



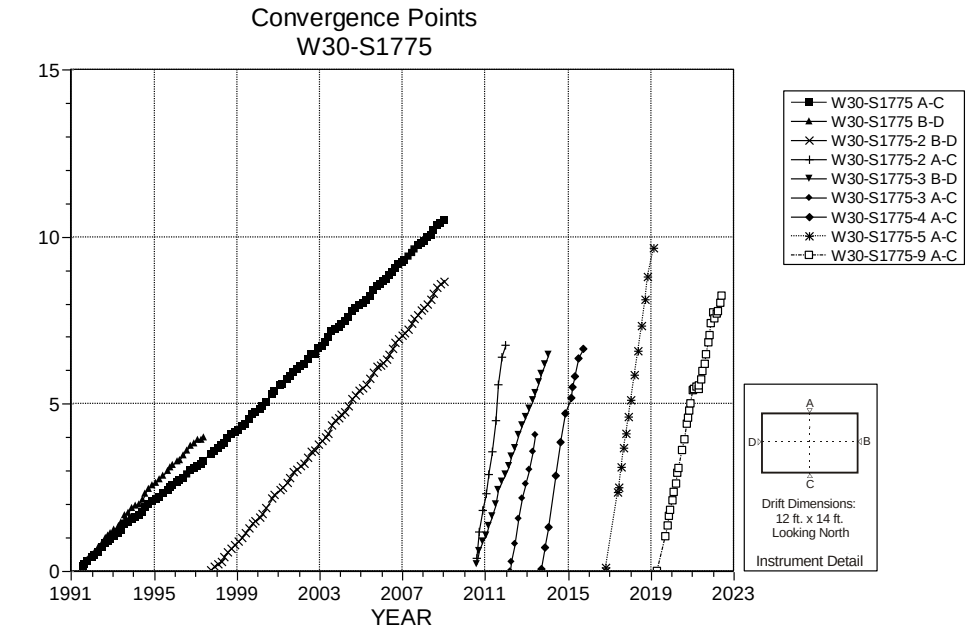
NOTES:
1. Excavation date: August 1984.
2. 'C' anchor mined out, reinstalled October 2016.

Figure 4-185 Convergence Point Array – W30 S1453 – All Chords



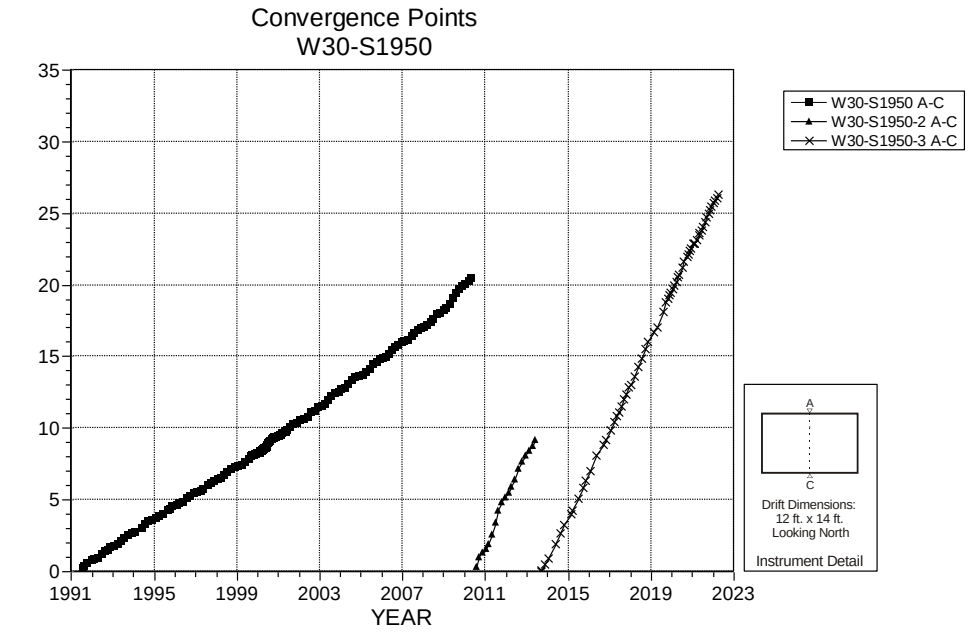
NOTES:
1. Excavation date: September 1984.

Figure 4-186 Convergence Point Array – W30 S1600 – Roof to Floor



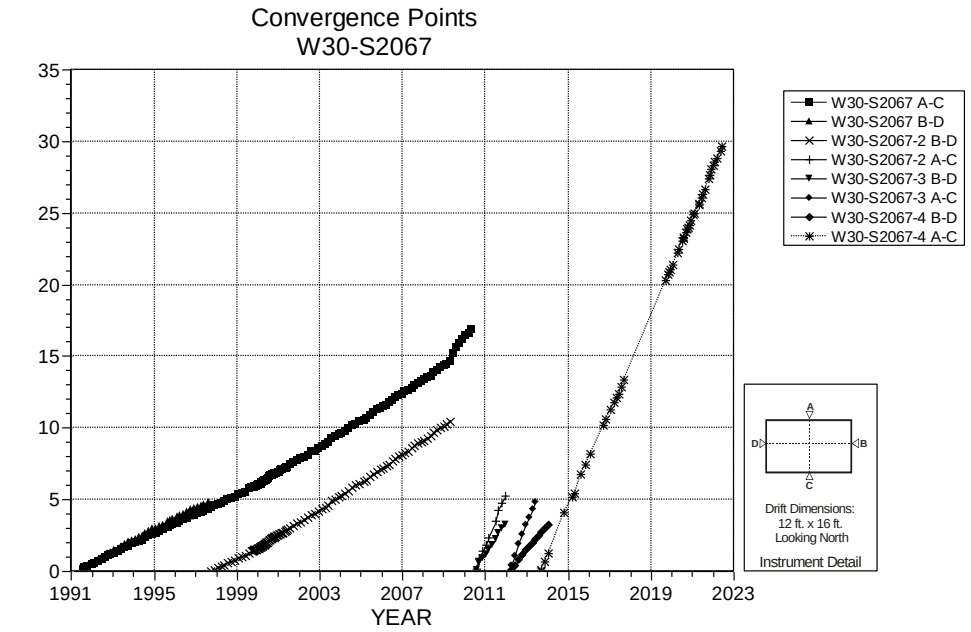
NOTES:
1. Excavation date: February 1986.
2. 'C' anchor mined out, reinstalled October 2016.

Figure 4-187 Convergence Point Array – W30 S1775 – All Chords



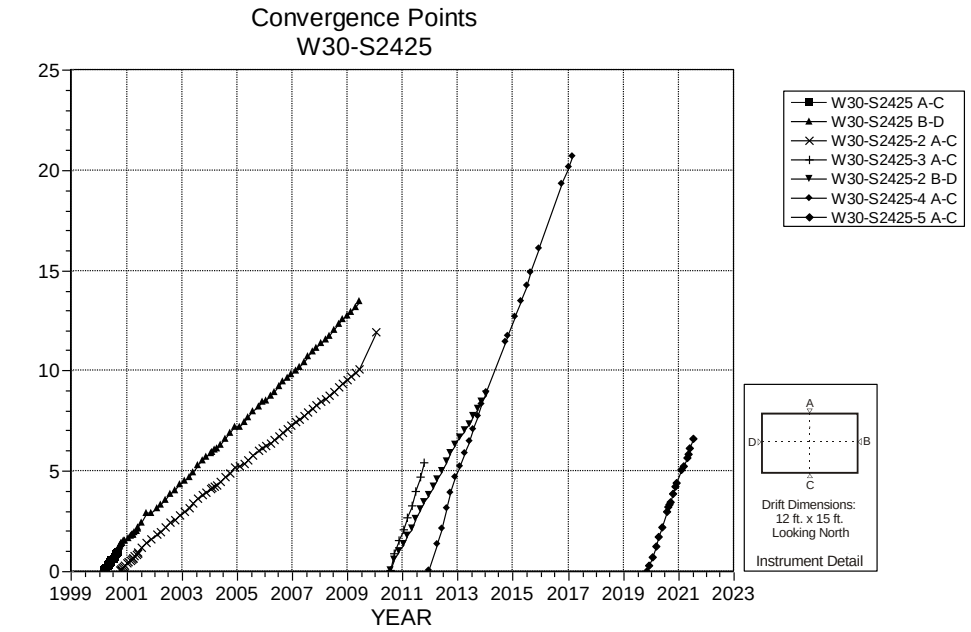
NOTES:
1. Excavation date: February 1986.

Figure 4-188 Convergence Point Array – W30 S1950 – Roof to Floor



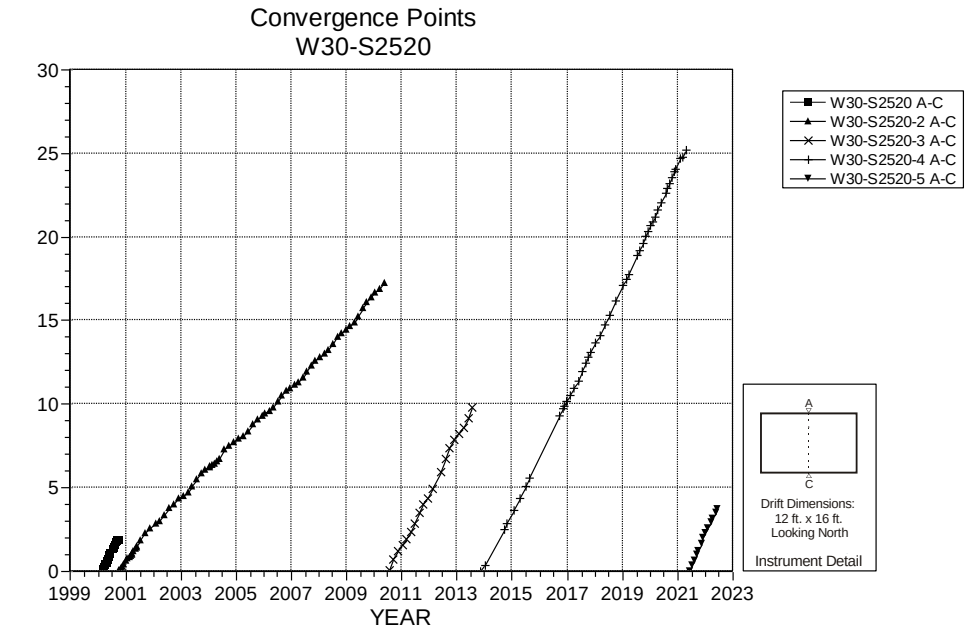
NOTES:
1. Excavation date: July 1988.

Figure 4-189 Convergence Point Array – W30 S2067 – All Chords



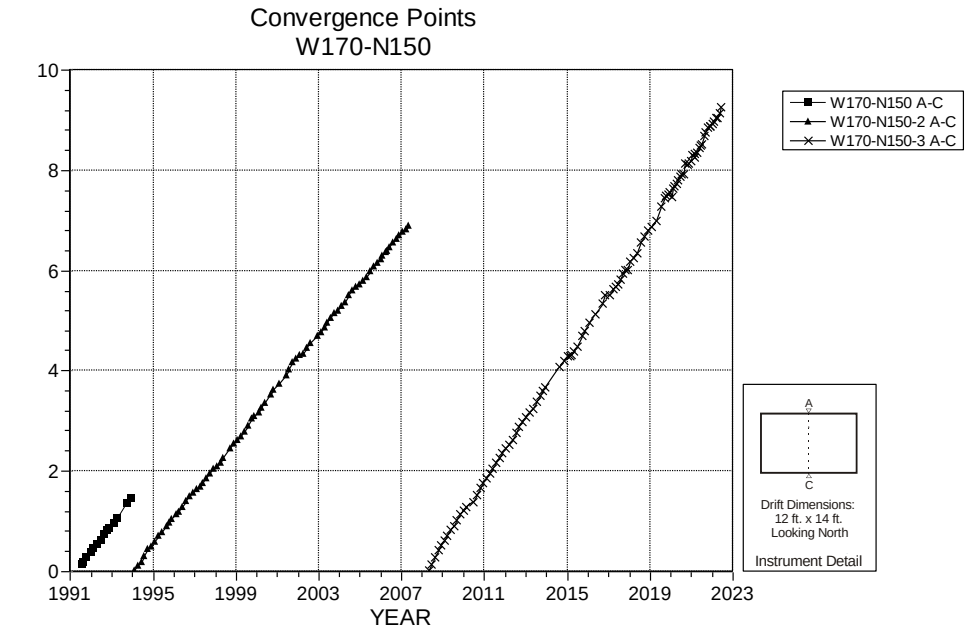
NOTES:
1. Excavation date: November 1999.

Figure 4-190 Convergence Point Array – W30 S2425 – All Chords



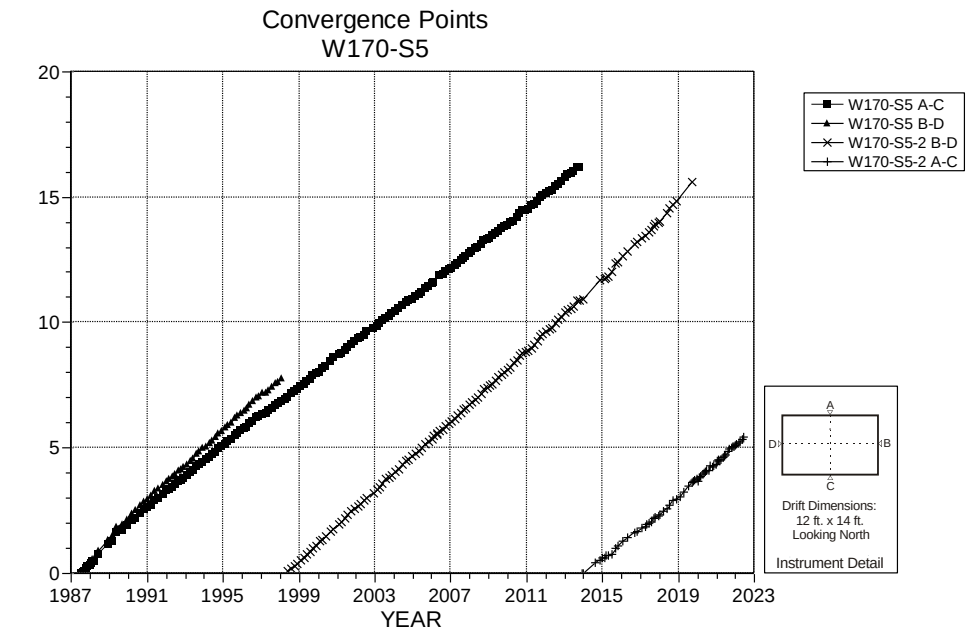
NOTES:
1. Excavation date: November 1999.

Figure 4-191 Convergence Point Array – W30 S2520 – Roof to Floor



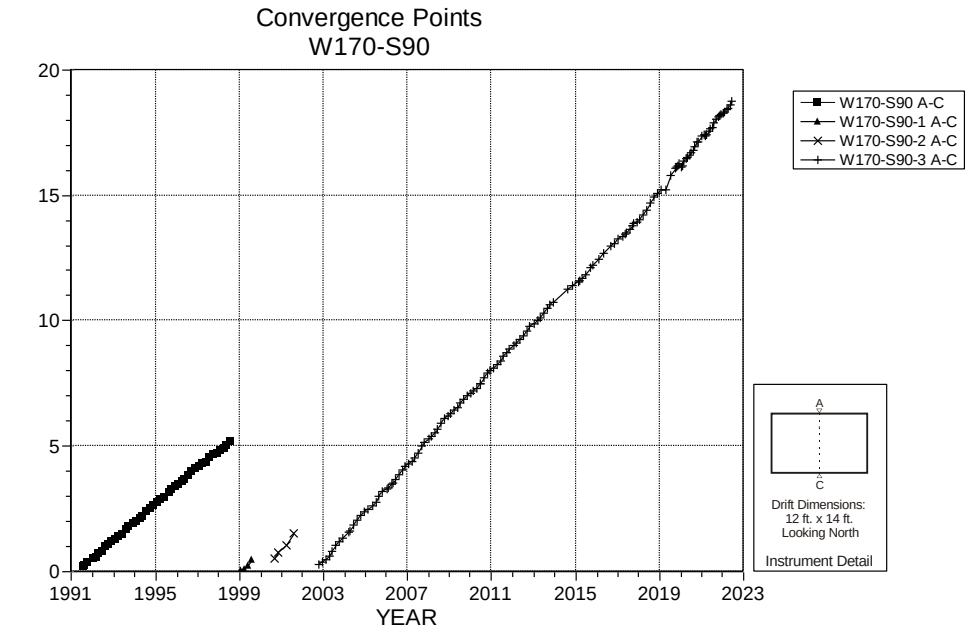
NOTES:
1. Excavation date: July 1984.

Figure 4-192 Convergence Point Array – W170 N150 – All Chords



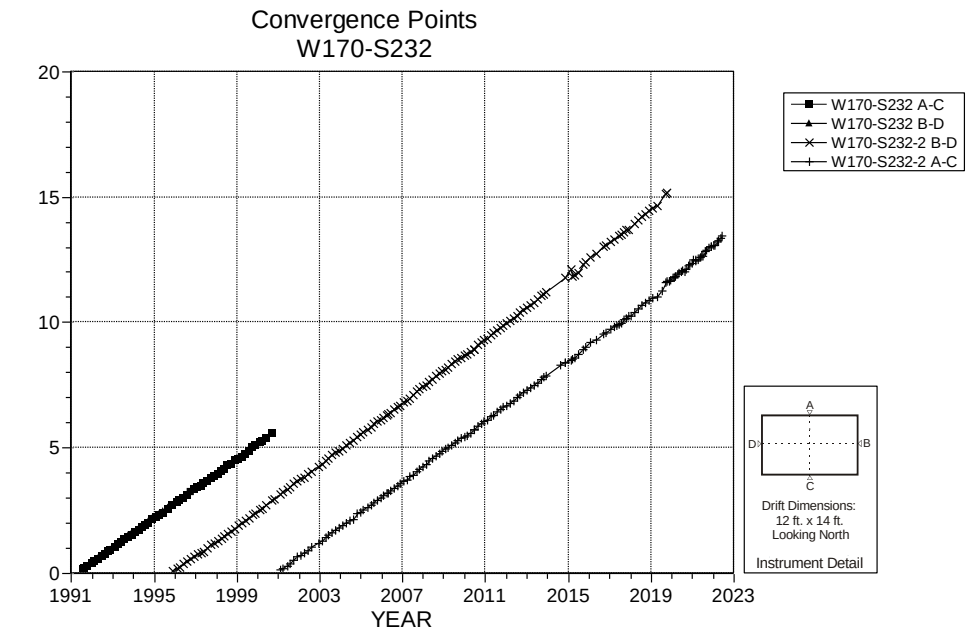
NOTES:
1. Excavation date: August 1984.

Figure 4-193 Convergence Point Array – W170 S5 – All Chords



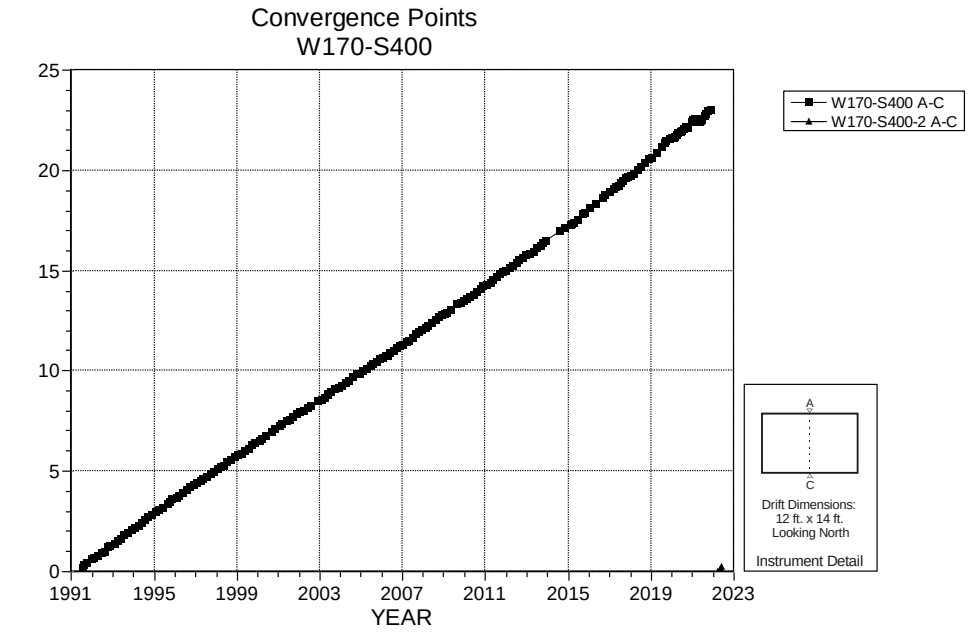
NOTES:
1. Excavation date: August 1984.

Figure 4-194 Convergence Point Array – W170 S90 – Roof to Floor



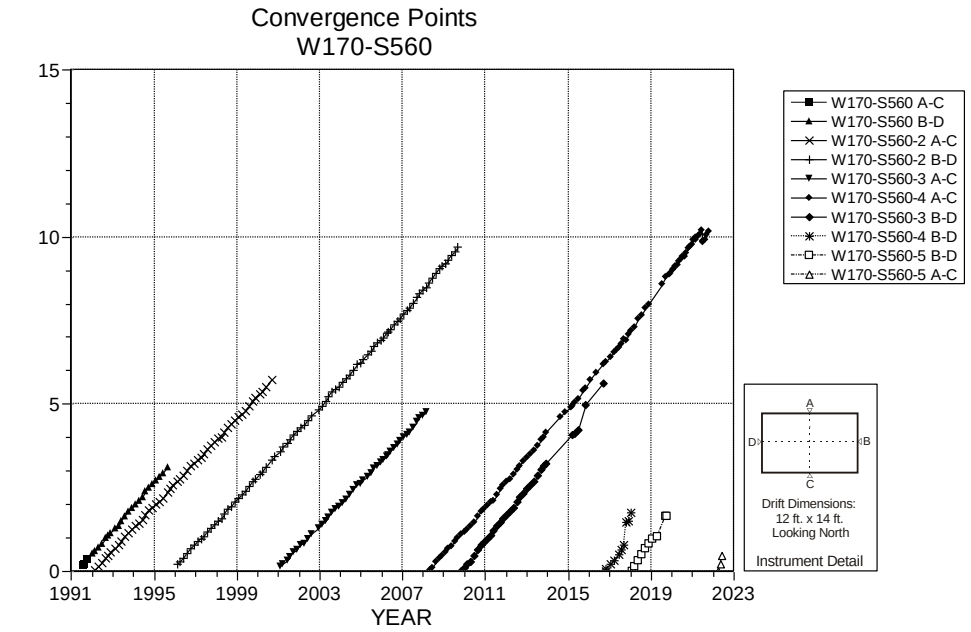
NOTES:
1. Excavation date: August 1984.

Figure 4-195 Convergence Point Array – W170 S232 – All Chords



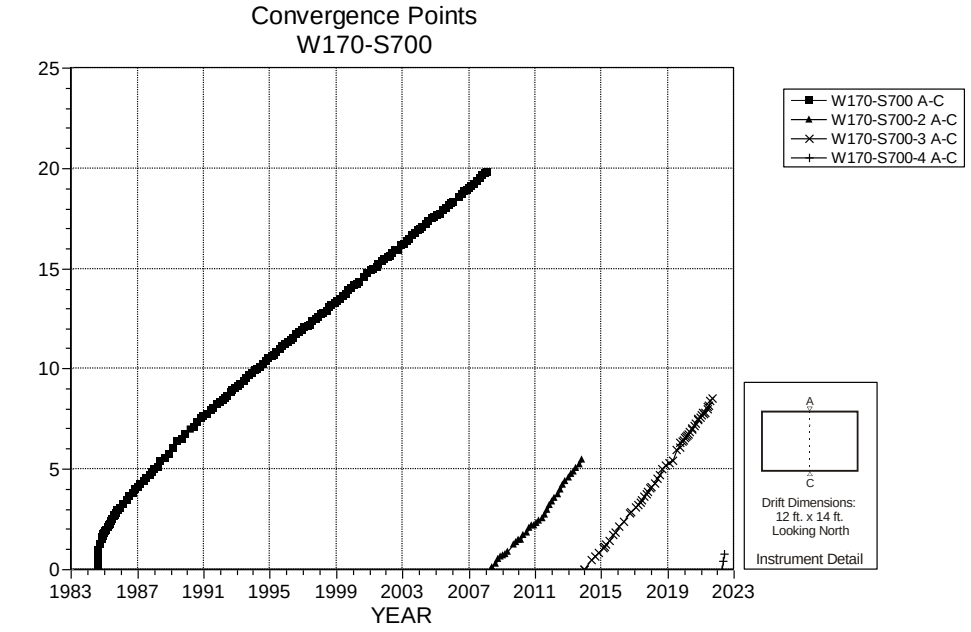
NOTES:
1. Excavation date: August 1984.

Figure 4-196 Convergence Point Array – W170 S400 – Roof to Floor



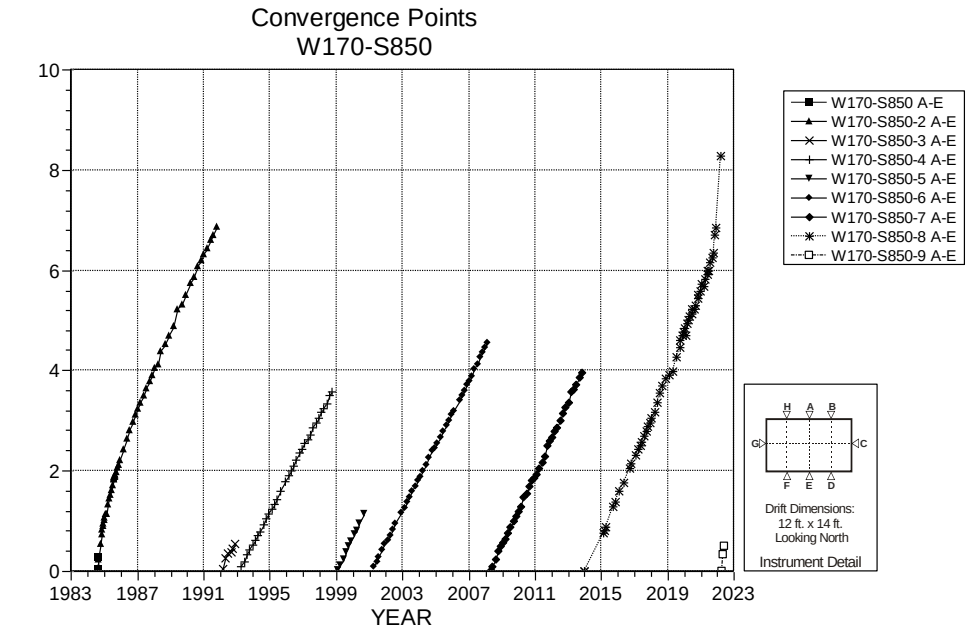
NOTES:
1. Excavation date: August 1984.
2. Reinstalled anchor 'D' due to fracturing of core hole.

Figure 4-197 Convergence Point Array – W170 S560 – All Chords



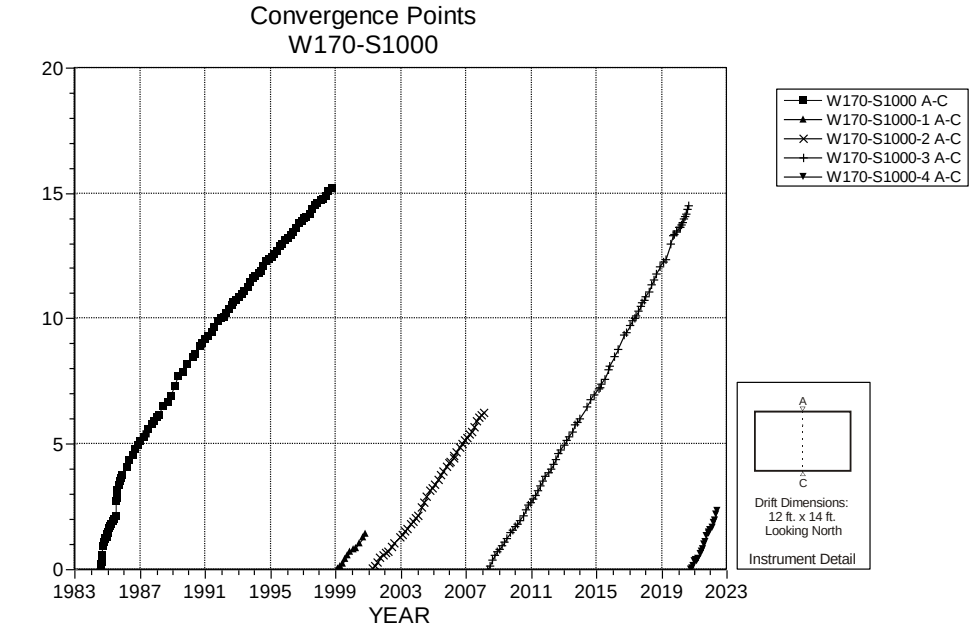
NOTES:
1. Excavation date: August 1984.

Figure 4-198 Convergence Point Array – W170 S700 – Roof to Floor



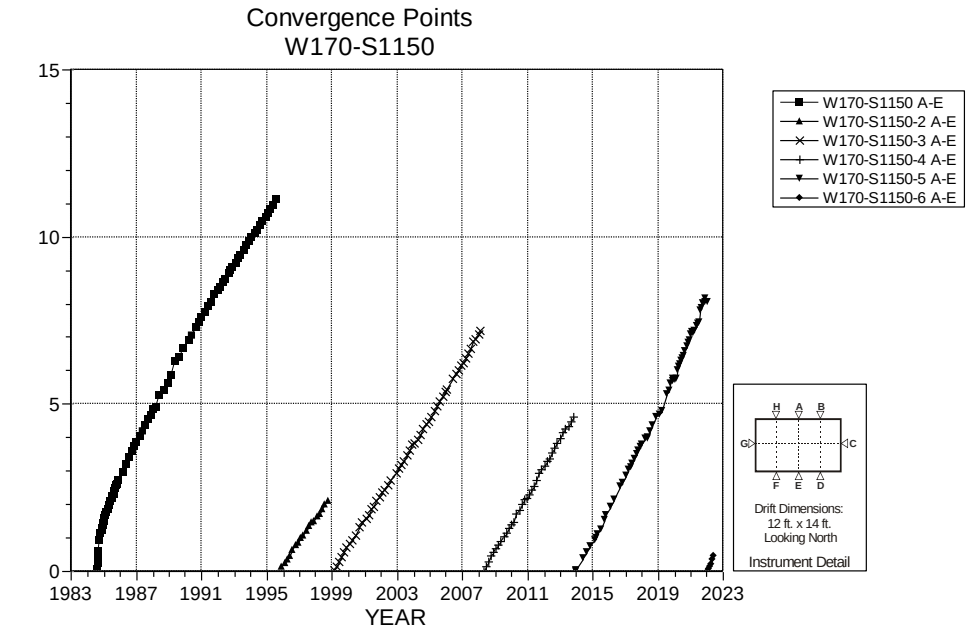
NOTES:
1. Excavation date: August 1984.
2. Chords for this location are on separate plots.

Figure 4-199 Convergence Point Array – W170 S850 – Roof to Floor



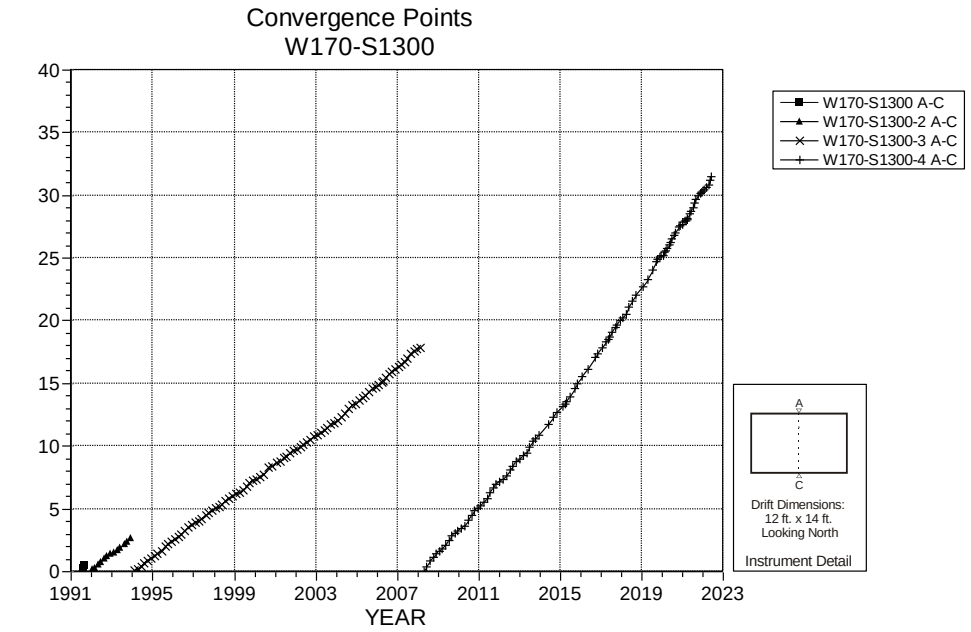
NOTES:
1. Excavation date: August 1984.

Figure 4-200 Convergence Point Array – W170 S1000 – Roof to Floor



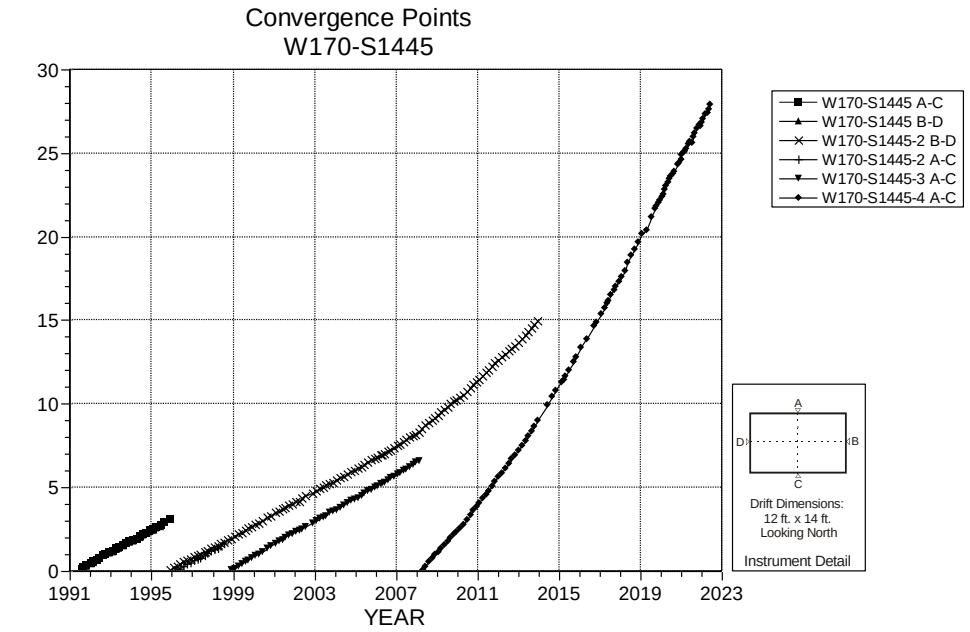
NOTES:
1. Excavation Date: August 1984.

Figure 4-201 Convergence Point Array – W170 S1150 – Roof to Floor



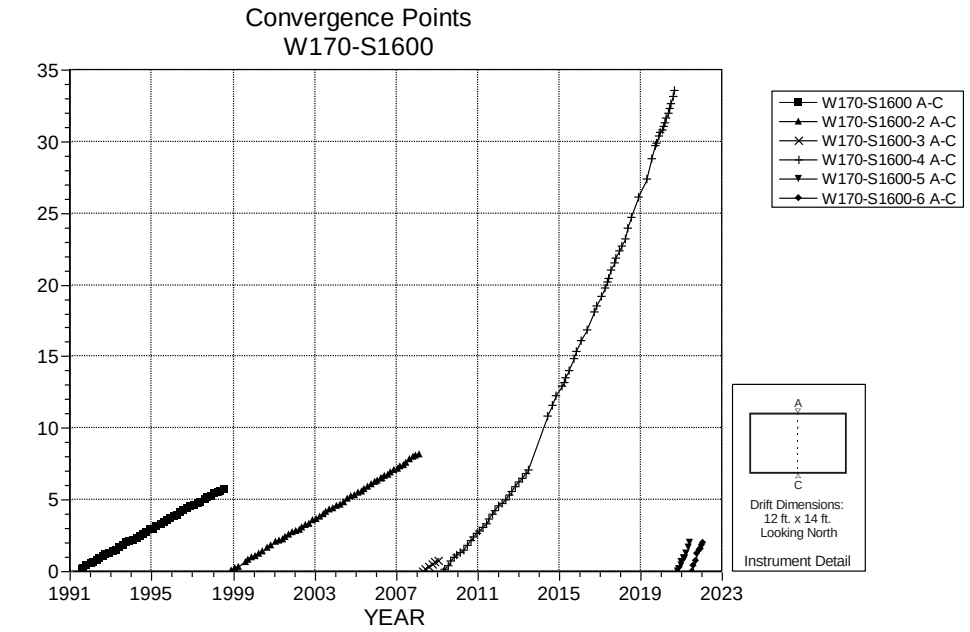
NOTES:
1. Excavation date: August 1984.

Figure 4-202 Convergence Point Array – W170 S1300 – Roof to Floor



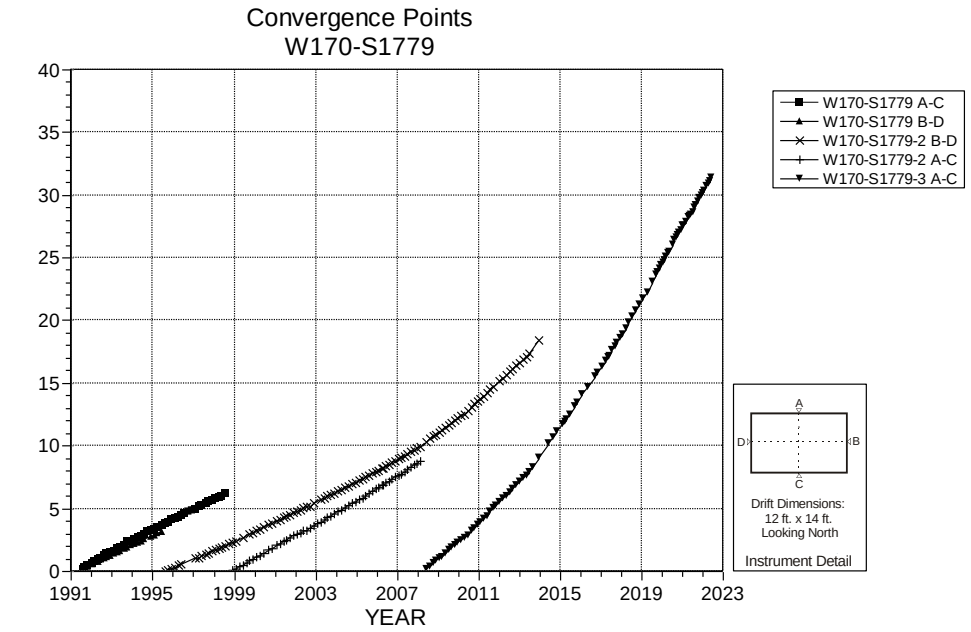
NOTES:
1. Excavation date: August 1984.

Figure 4-203 Convergence Point Array – W170 S1445 – All Chords



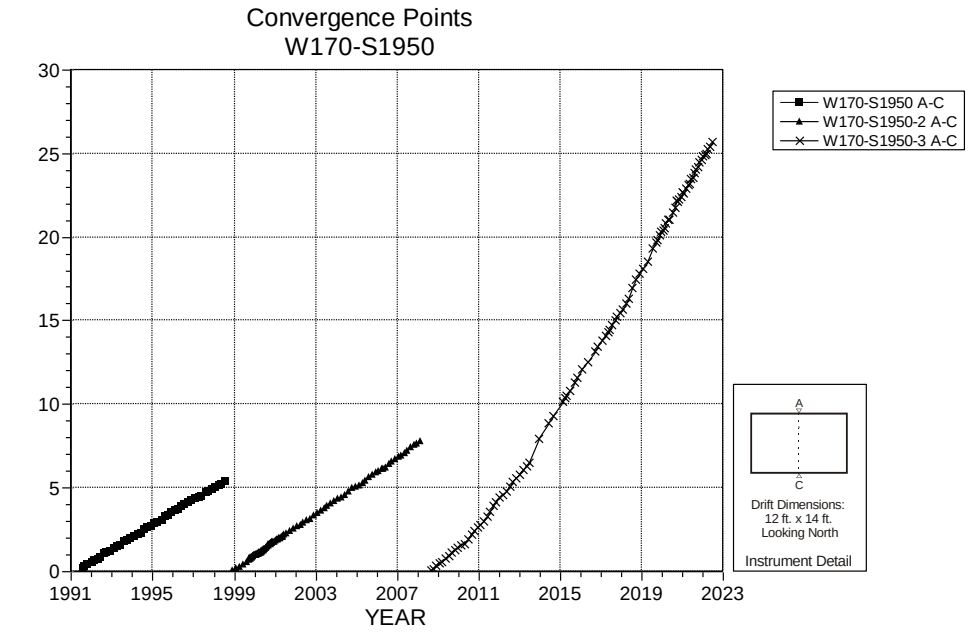
NOTES:
1. Excavation date: September 1984.

Figure 4-204 Convergence Point Array – W170 S1600 – Roof to Floor



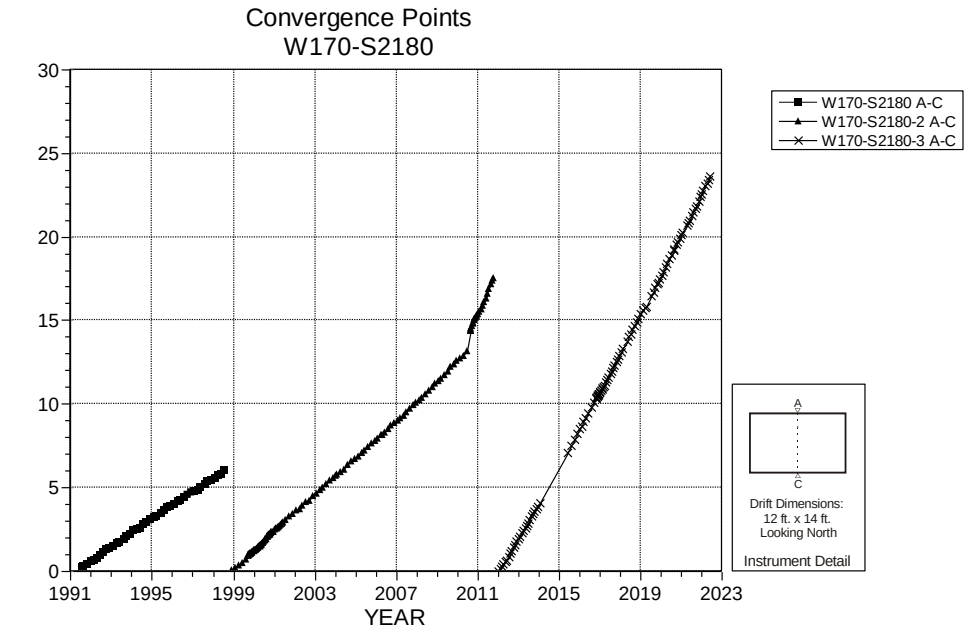
NOTES:
1. Excavation date: December 1985.

Figure 4-205 Convergence Point Array – W170 S1779 – All Chords



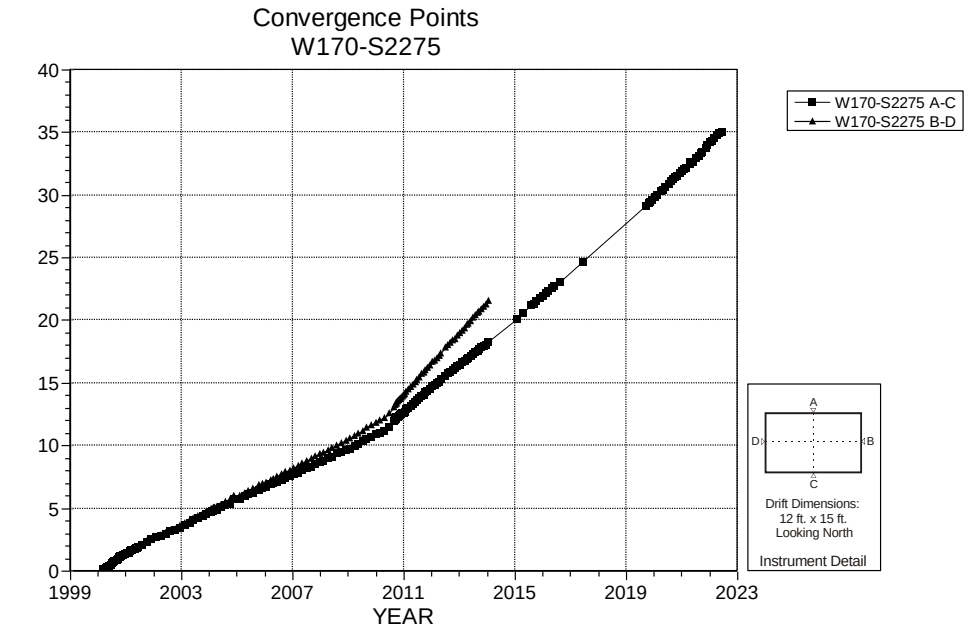
NOTES:
1. Excavation date: December 1985.

Figure 4-206 Convergence Point Array – W170 S1950 – Roof to Floor



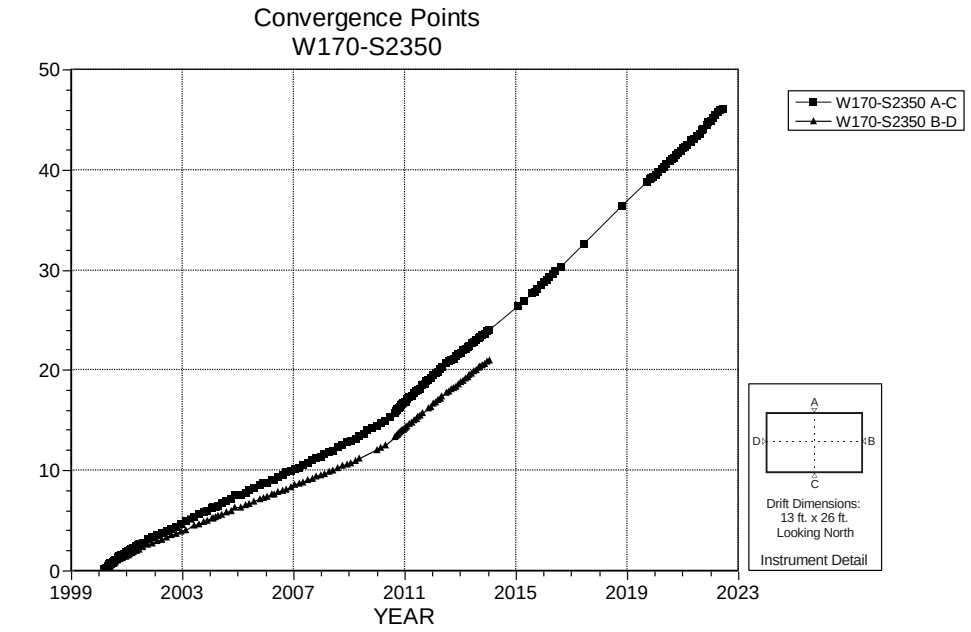
NOTES:
1. Excavation date: August 1988.

Figure 4-207 Convergence Point Array – W170 S2180 – Roof to Floor



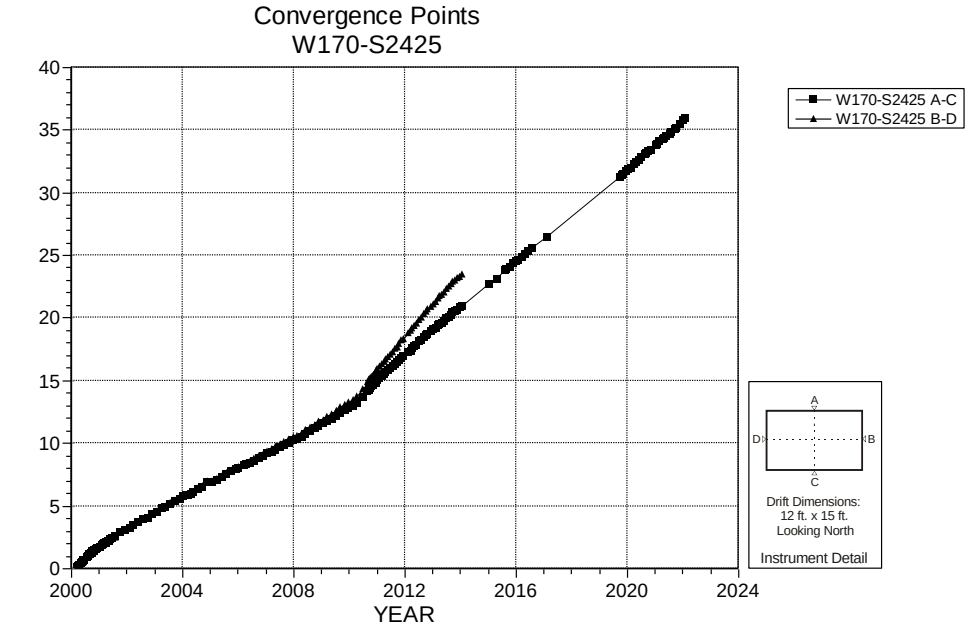
NOTES:
1. Excavation date: December 1999.

Figure 4-208 Convergence Point Array – W170 S2275 – All Chords



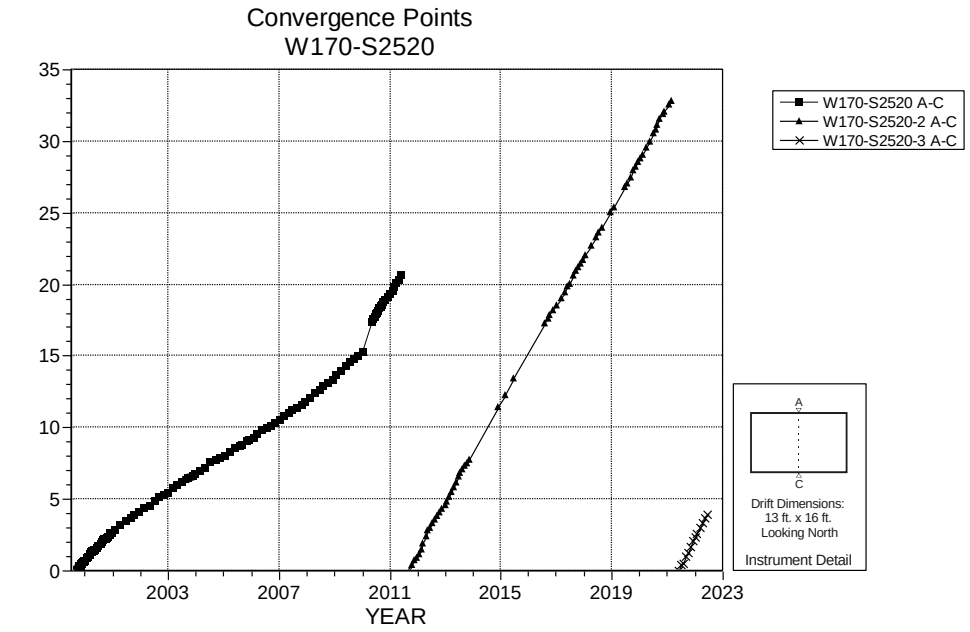
NOTES:
1. Excavation date: December 1999.

Figure 4-209 Convergence Point Array – W170 S2350 – All Chords



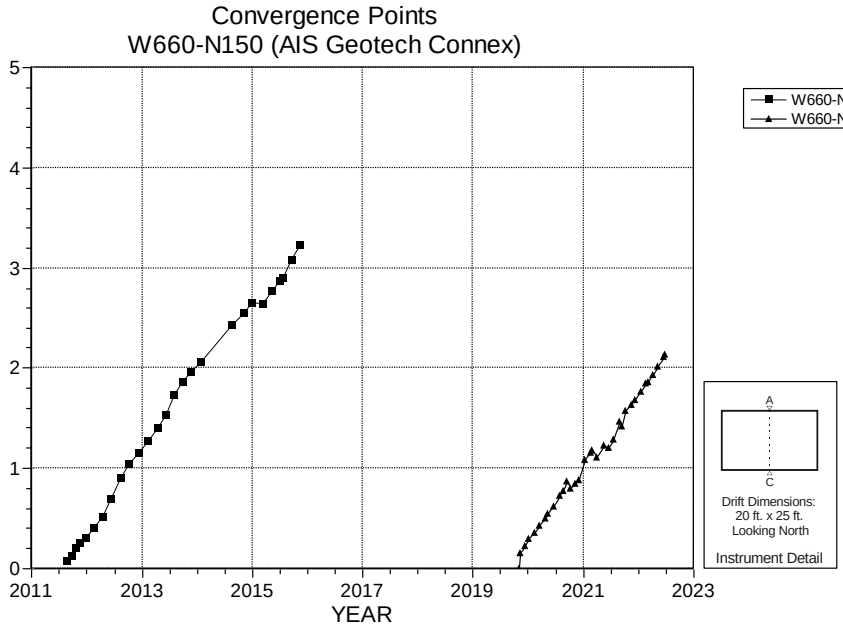
NOTES:
1. Excavation date: December 1999.

Figure 4-210 Convergence Point Array – W170 S2425 – All Chords



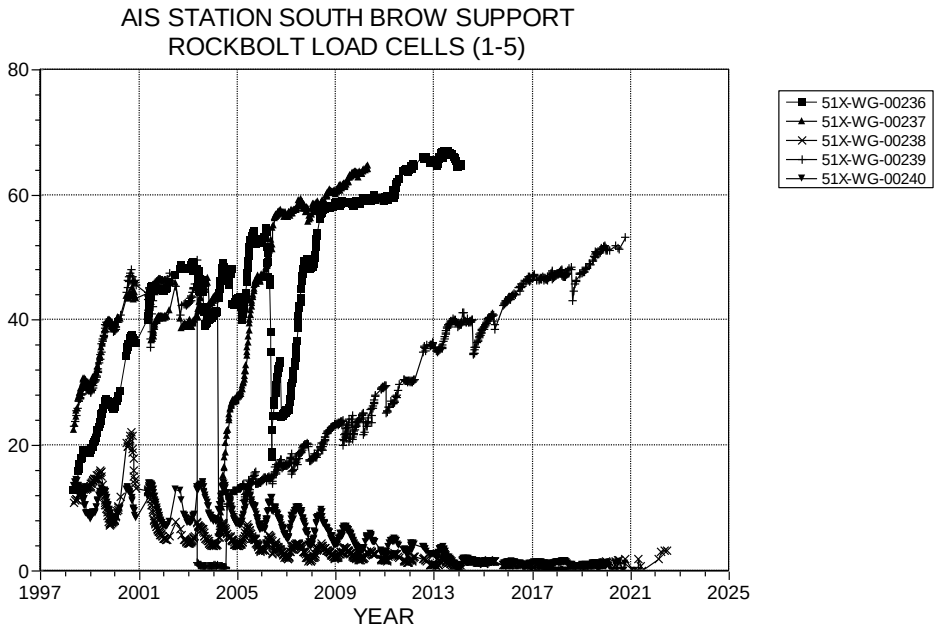
NOTES:
1. Excavation date: December 1999.

Figure 4-211 Convergence Point Array – W170 S2520 – Roof to Floor



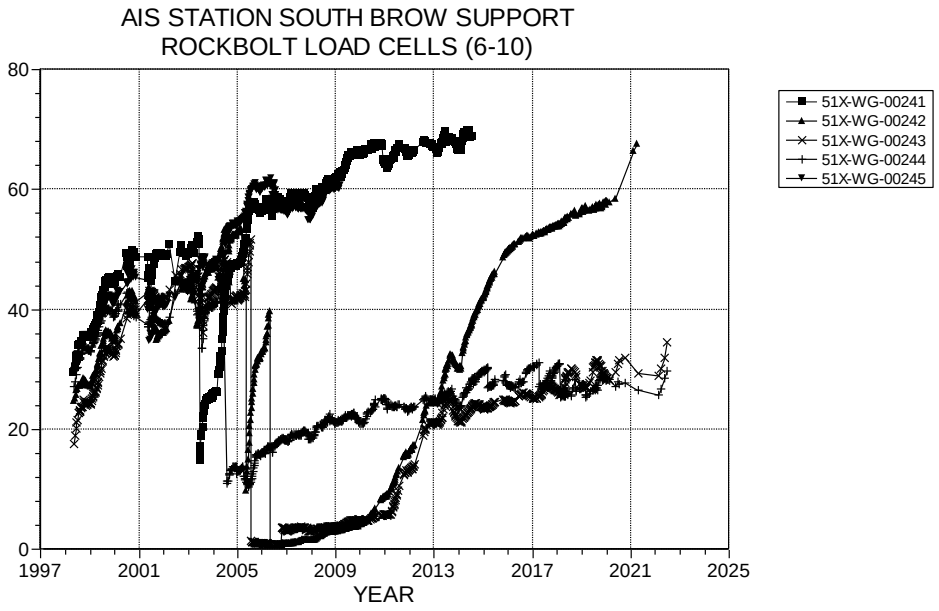
NOTES:
1. Excavation date: January 1988.

Figure 4-212 Convergence Point Array – W660 N150 – Roof to Floor



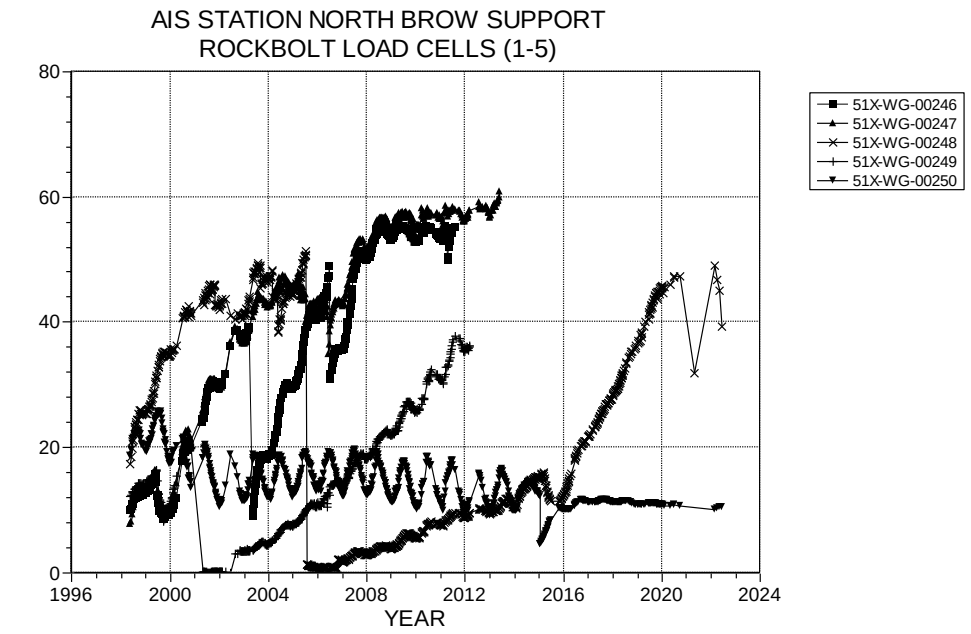
NOTES:
1. Excavation date: January 1988.
2. Load cell 51X-WG-00236 is on the only bolt, of the five instrumented bolts, still intact.

Figure 4-213 Rock Bolt Load Cell 51X-WG-00236 – 51X-WG-00240 – AIS South Brow



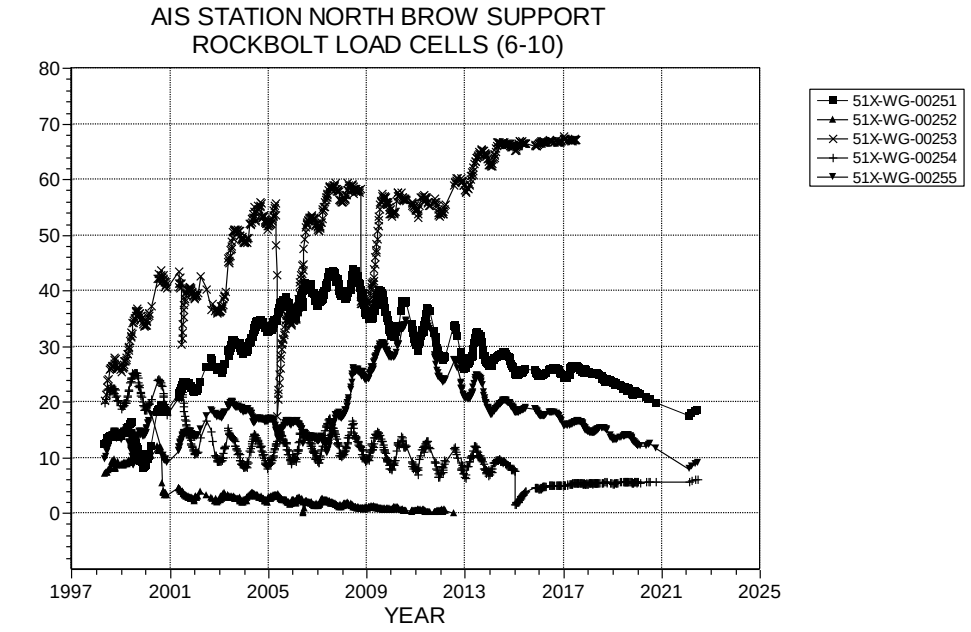
NOTES:
1. The rock bolt that load cell 51X-WG-00242 was on broke in May 2005; the load cell was reinstalled on the replacement bolt.
2. The bolt that load cell 51X-WG-00245 has failed.

Figure 4-214 Rock Bolt Load Cell 51X-WG-00241– 51X-WG-00245 – AIS South Brow



NOTES:
1. The bolts that load cells 51X-WG-00247 and 51X-WG-00249 are on have failed.

Figure 4-215 Rock Bolt Load Cell 51X-WG-00246 – 51X-WG-00250 – AIS North Brow



NOTES:
1. Load cell 51X-WG-00252 has failed and is no longer read.

Figure 4-216 Rock Bolt Load Cell 51X-WG-00251 – 51X-WG-00255 – AIS North Brow

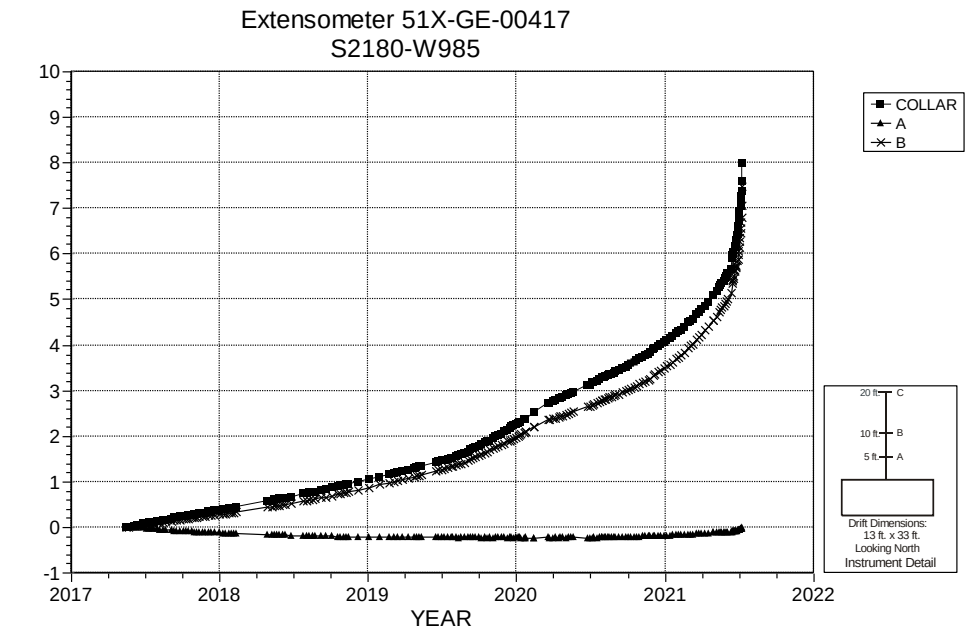
5.0 INSTRUMENTATION SUMMARY FOR THE WASTE DISPOSAL AREA

This chapter presents a summary of the data collected from instruments located in the Waste Disposal Area at the WIPP facility. Table 5-1 presents data and analysis of the instrumentation associated with Panel 7. Plots of the instrument data are presented as Figures 5-1 through 5-22. Table 5-2 presents instrument data from Panel 8. Plots of the instrument data are presented as Figures 5-23 through 5-71.

Table 5-1 Panel 7 Data Analysis

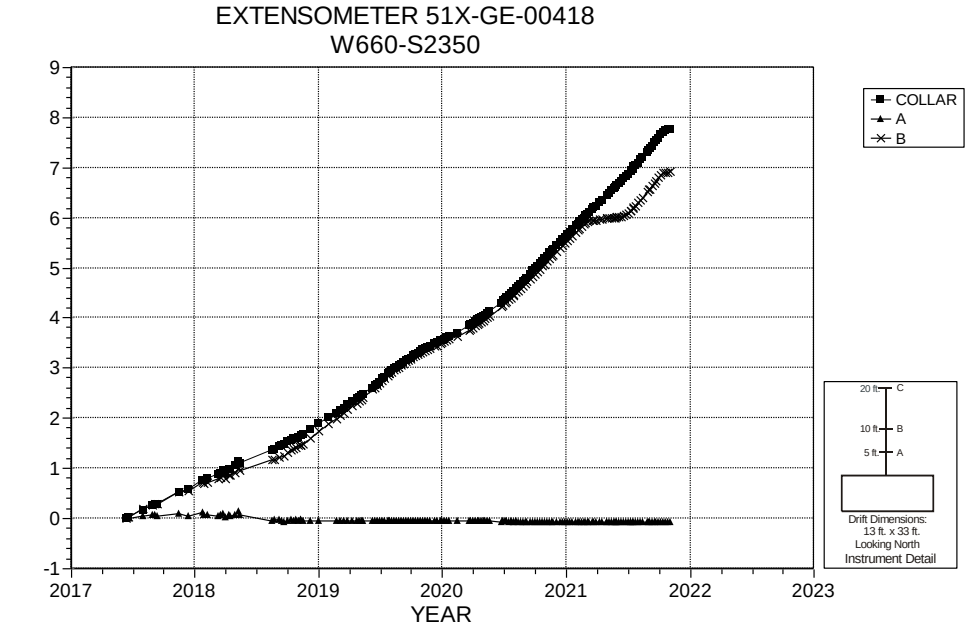
Extensometers								
Field Tag	Location	Figure Number	Date of Last Reading	Collar Displacement Relative to Deepest Anchor (inches)	Displacement Rate 2021 to 2022 (in/year)	Displacement Rate 2020 to 2021 (in/year)	Rate Change Percent	Comments
51X-GE-00417	S2180-W985	5-1	7/10/2021	7.983	55.32	3.43	94	Destroyed during a roof fall
51X-GE-00418	W660-S2350	5-2	11/05/2021	7.755	2.54	2.53	0	N/A
51X-GE-00420-1	W920-S2350	5-3	11/08/2021	15.732	8.66	5.84	33	N/A
51X-GE-00423-3	S2520-W585	5-4	11/05/2021	4.167	2.96	2.17	27	N/A
51X-GE-00425-3	W390-S2350	5-5	6/30/2022	2.293	0.47	0.91	-94	N/A
51X-GE-00426-2	W520-S2350	5-6	11/05/2021	3.571	1.57	1.36	13	N/A

Convergence Points									
Field Tag	Location	Figure Number	Last Reading 2021 to 2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate 2020 to 2021 (in/year)	Rate Change Percent	Comments
			Date	Inches					
W390-S2275-4 A-C	W390-S2275	5-7	4/13/2022	1.813	51.129	3.4	4.2	-25	N/A
W390-S2350-4 A-C	W390-S2350	5-8	6/8/2022	2.418	42.735	3.4	3.4	-1	N/A
W390-S2425-5 A-C	W390-S2425	5-9	6/8/2022	2.233	39.881	3.2	3.4	-6	N/A
S2180-W285-2 A-C	S2180-W285	5-10	6/8/2022	18.031	18.477	1.2	1.7	-42	N/A
S2520-W285-5 A-C	S2520-W285	5-11	6/8/2022	26.316	49.305	4.9	5.0	-2	N/A
S2520-W390-5 A-C	S2520-W390	5-12	6/8/2022	1.533	41.903	3.6	3.8	-7	N/A
S2520-W455-3 A-C	S2520-W455	5-13	6/8/2022	0.052	41.733	2.7	3.4	-25	N/A
S2520-W520-3 A-C	S2520-W520	5-14	7/14/2021	36.321	49.099	N/A	3.23	N/A	One Reading Taken for ’21 – ‘22



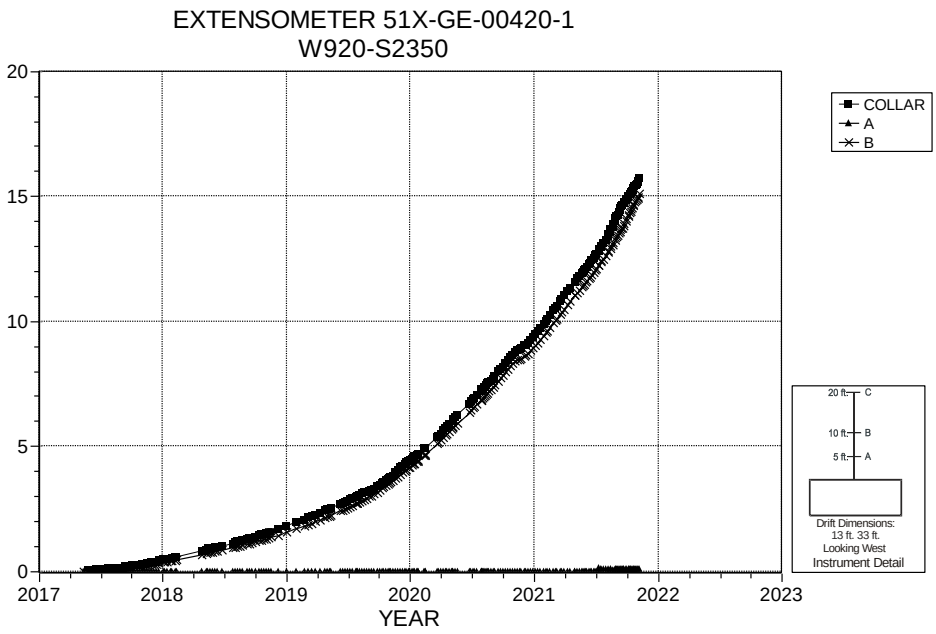
NOTES:
1. Excavation Date: August 2010.
2. The previously installed extensometer at this location went out-of-range.
3. Device taken out of service 8/2021 due to inability to remote poll.
4. Device is in an inaccessible area.

Figure 5-1 Extensometer 51X-GE-00417 – S2180 W985 – Roof



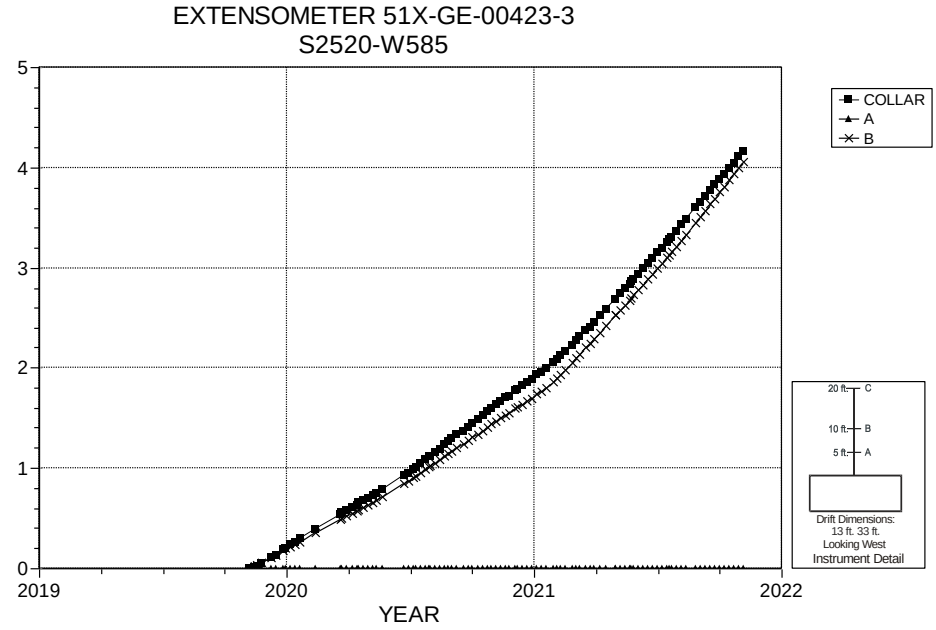
NOTES:
1. Excavation date: October 2010.
2. Device taken out of service on 12/2021 due to inability to remote poll.
3. Device is in an inaccessible area.

Figure 5-2 Extensometer 51X-GE-00418 – W660 S2350 – Roof



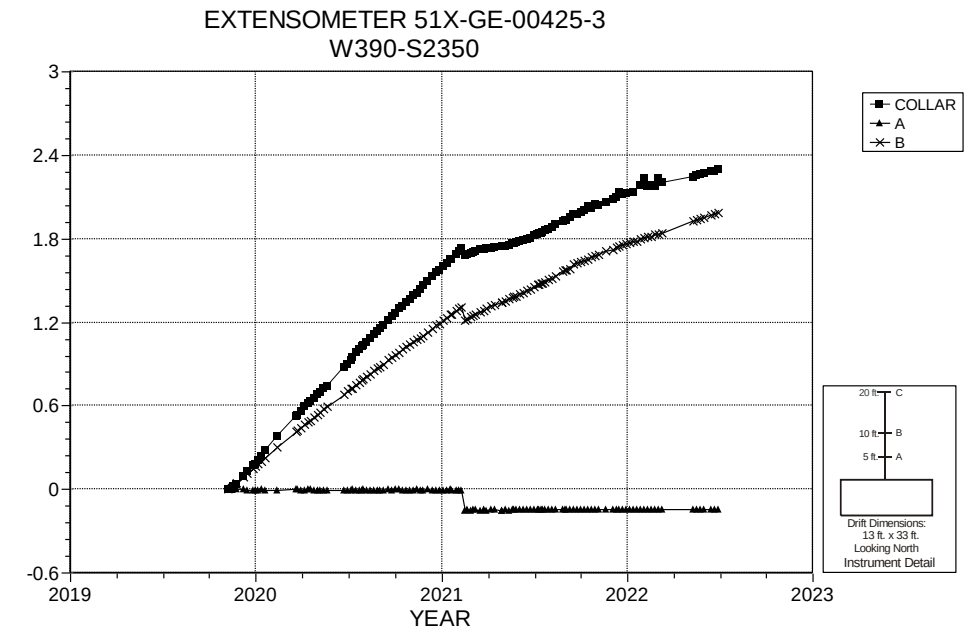
NOTES:
1. Excavation date: November 2010.
2. Device taken out of service 12/2021 due to inability to remote poll.
3. Device is in an inaccessible area.

Figure 5-3 Extensometer 51X-GE-00420-1 – W920 S2350 – Roof



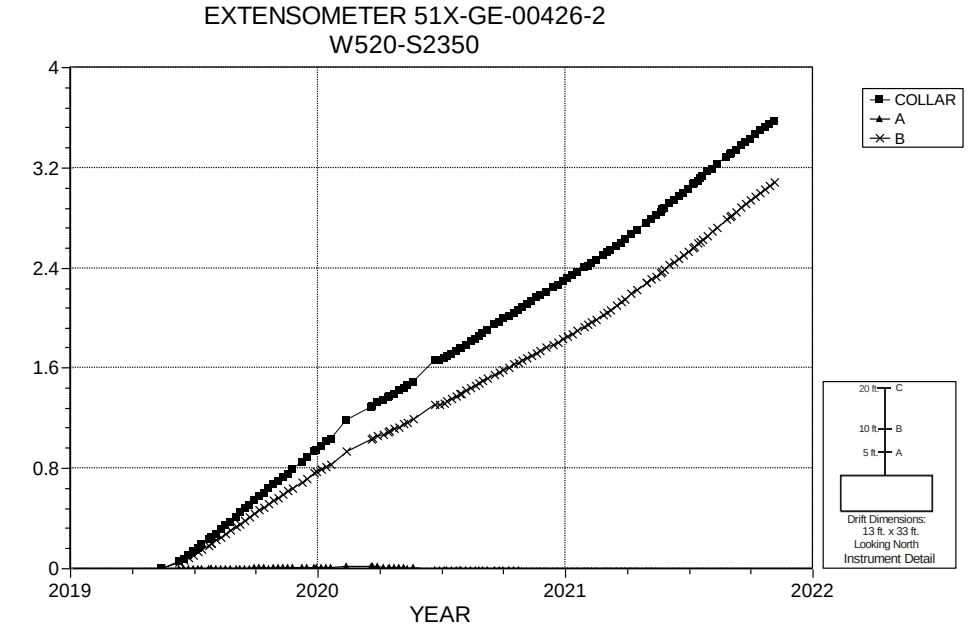
NOTES:
1. Excavation date: September 2010.
2. Device taken out of service 12/2021 due to inability to remote poll.
3. Device is in an inaccessible area.

Figure 5-4 Extensometer 51X-GE-00423-3 – S2520 W585 – Roof



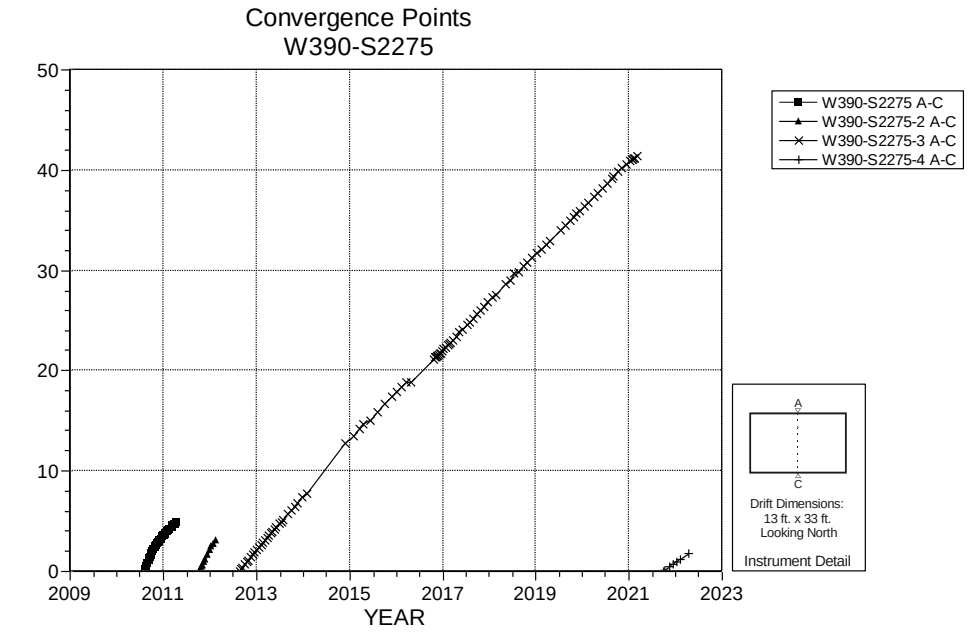
NOTES:
1. Excavation date: June 2010.
2. WEX Replacement.

Figure 5-5 Extensometer 51X-GE-00425-3 – W390 S2350 – Roof



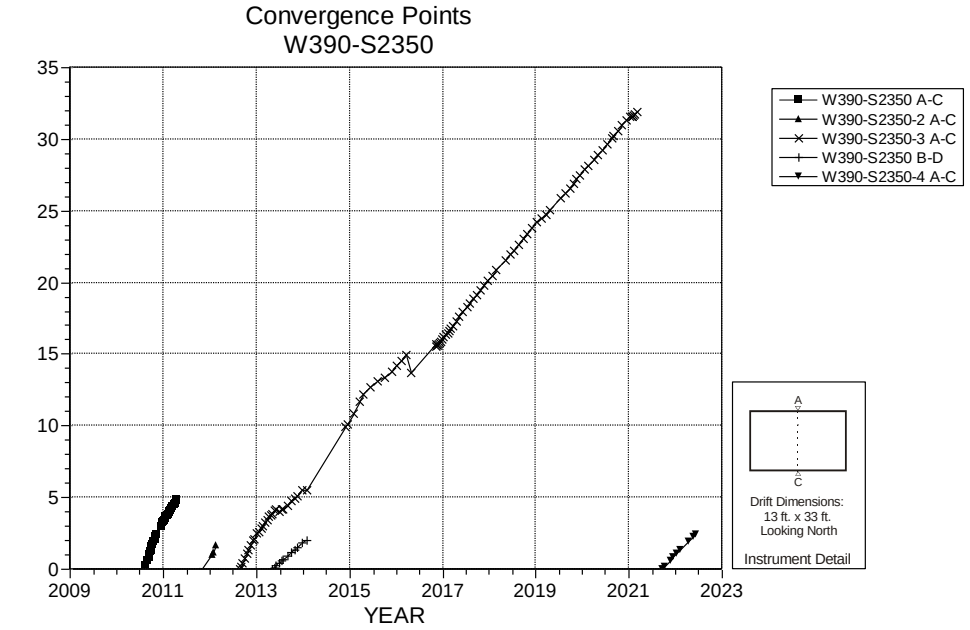
NOTES:
1. Excavation date: October 2010.
2. WEX Replacement.
3. Device taken out of service 12/2021 due to inability to remote poll.
4. Device is in an inaccessible area.

Figure 5-6 Extensometer 51X-GE-00426-2 – W520-S2350 – Roof



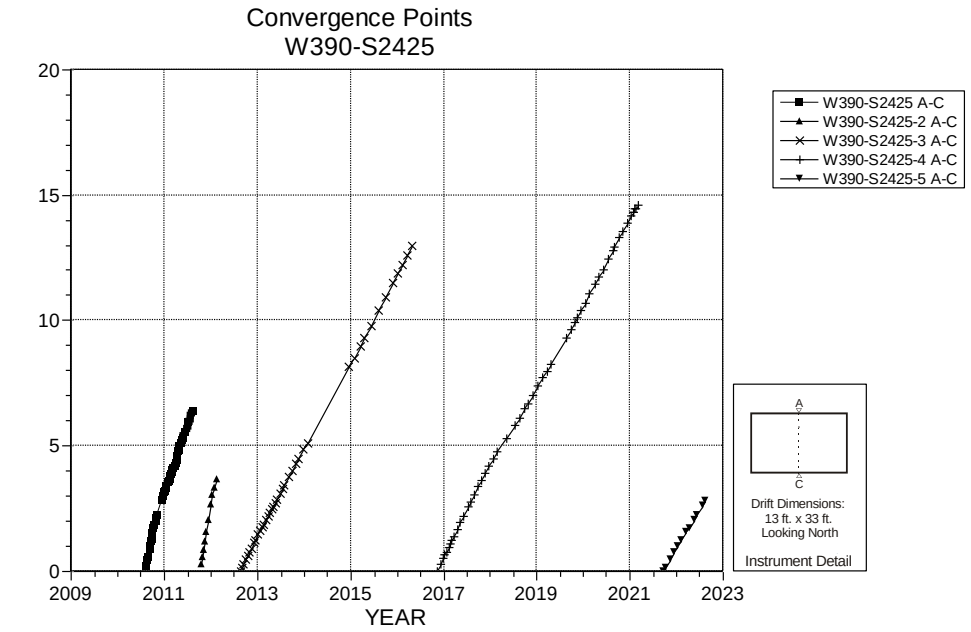
NOTES:
1. Excavation date: June 2010.

Figure 5-7 Convergence Point Array – W390 S2275 – Roof to Floor



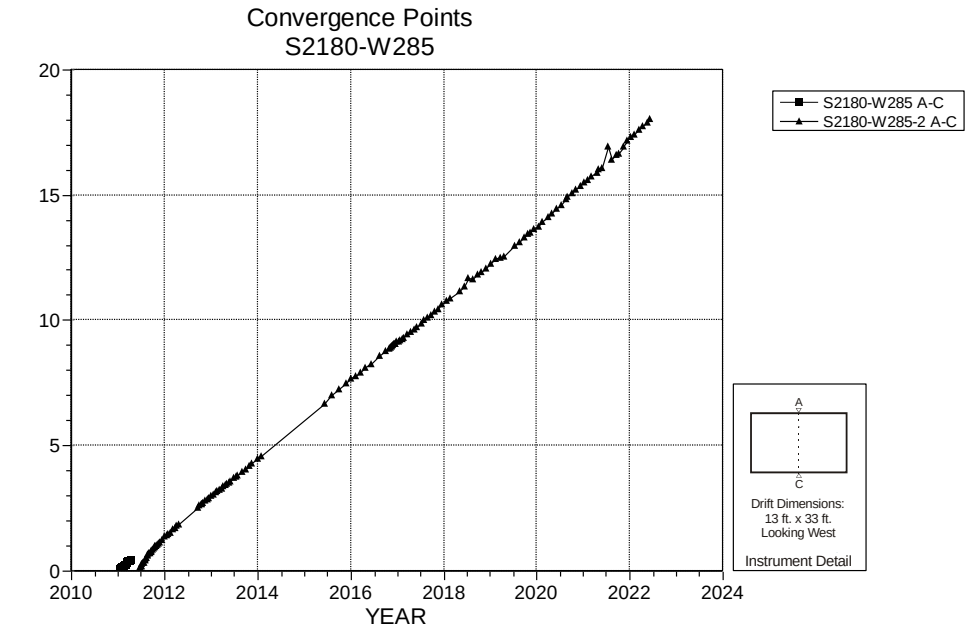
NOTES:
1. Excavation date: June 2010.

Figure 5-8 Convergence Point Array – W390 S2350 – Roof to Floor



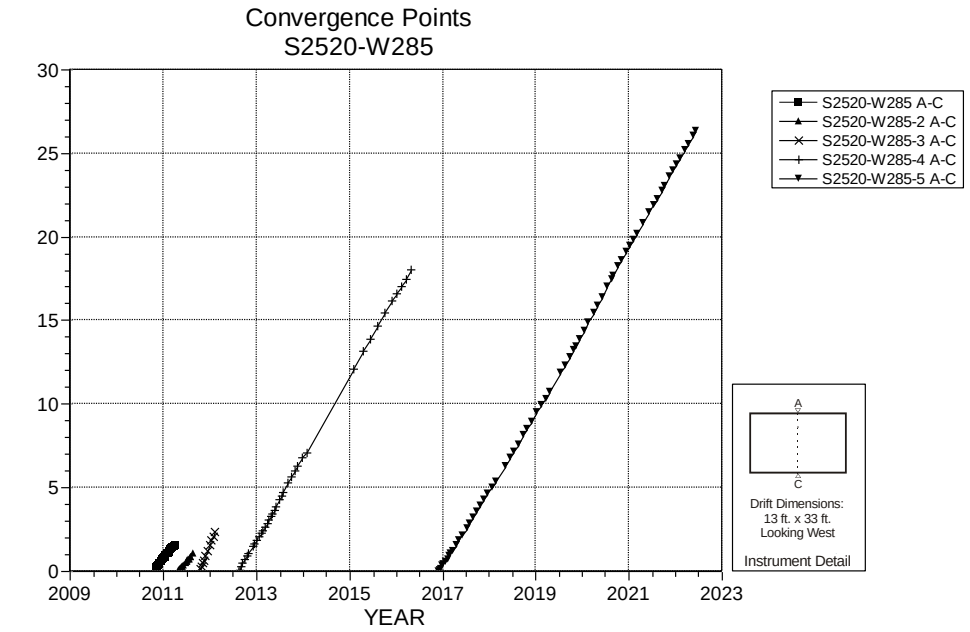
NOTES:
1. Excavation date: June 2010.

Figure 5-9 Convergence Point Array – W390 S2425 – Roof to Floor



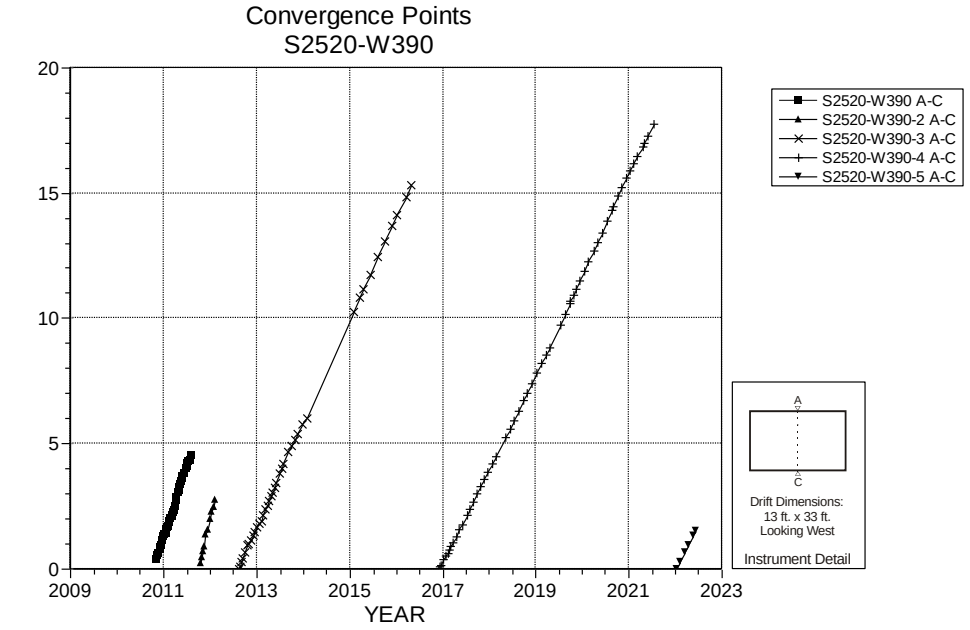
NOTES:
1. Excavation date: July 2010.

Figure 5-10 Convergence Point Array – S2180 W285 – Roof to Floor



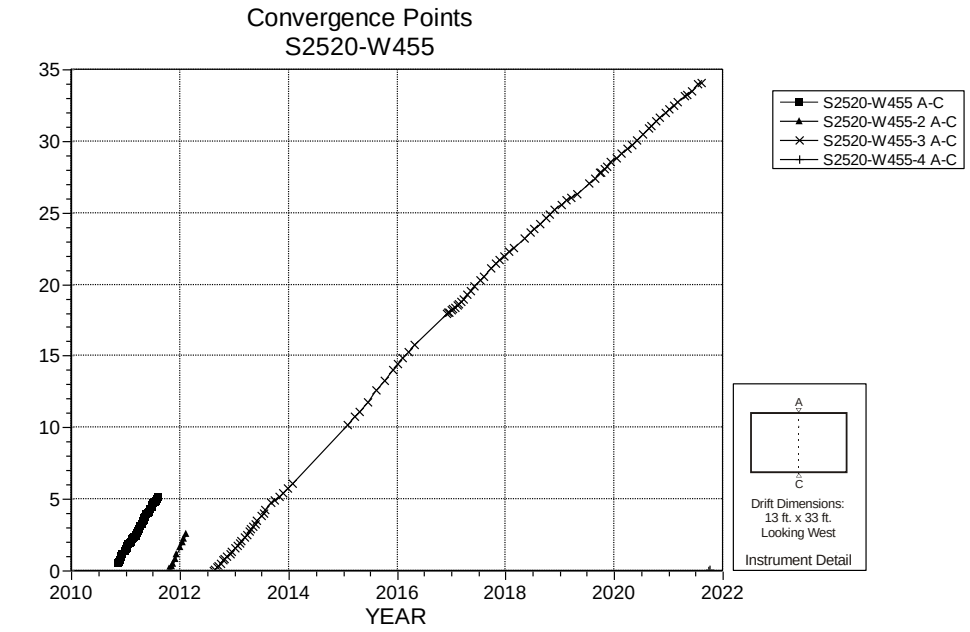
NOTES:
1. Excavation date: May 2010.

Figure 5-11 Convergence Point Array – S2520 W285 – Roof to Floor



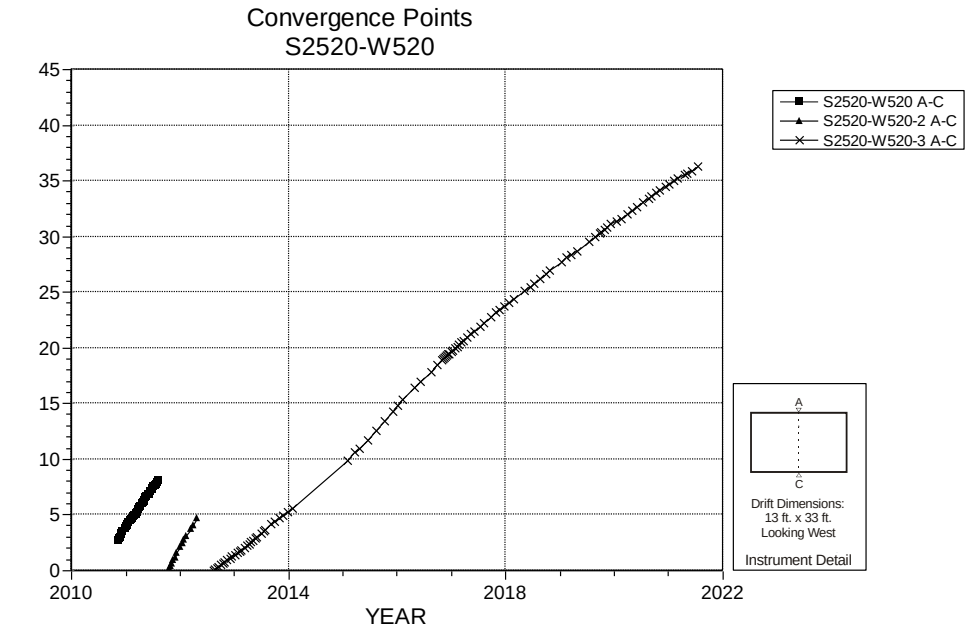
NOTES:
1. Excavation date: May 2010.

Figure 5-12 Convergence Point Array – S2520 W390 – Roof to Floor



NOTES:
1. Excavation date: May 2010.

Figure 5-13 Convergence Point Array – S2520 W455 – Roof to Floor



NOTES:
1. Excavation date: May 2010.

Figure 5-14 Convergence Point Array – S2520 W520 – Roof to Floor

Table 5-2 Panel 8 Data Analysis

Extensometers								
Field Tag	Location	Figure Number	Date of Last Reading	Collar Displacement Relative to Deepest Anchor (inches)	Displacement Rate 2021 to 2022 (in/year)	Displacement Rate[1] 2020 to 2021 (in/year)	Rate Change Percent	Comments
51X-GE-00451	W390-S1775	5-15	6/30/2022	1.254	1.52	1.20	27	N/A
51X-GE-00452	W520-S1775	5-16	6/30/2022	0.403	1.84	N/A	N/A	New Installation
51X-GE-00453	S1600-W585	5-17	6/30/2022	0.612	0.84	N/A	N/A	New Installation
51X-GE-00454	W660-S1775	5-18	6/30/2022	0.325	1.48	N/A	N/A	New Installation
51X-GE-00455	W790-S1775	5-19	6/30/2022	0.259	1.18	N/A	N/A	New Installation
51X-GE-00456	W920-S1775	5-20	6/30/2022	0.422	1.92	N/A	N/A	New Installation
51X-GE-00457	S1600-W985	5-21	2/10/2022	0.328	0.95	N/A	N/A	New Installation
51X-GE-00458	W1050-S1775	5-22	6/30/2022	0.444	0.79	N/A	N/A	New Installation
51X-GE-00459	W1190-S1775	5-23	5/17/2022	0.563	0.92	N/A	N/A	New Installation
51X-GE-00460	S1950-W985	5-24	6/30/2022	0.279	1.27	N/A	N/A	New Installation
51X-GE-00461	S1950-W585	5-25	6/30/2022	1.627	7.43	N/A	N/A	New Installation

Convergence Points									
Field Tag	Location	Figure Number	Last Reading 2021 to 2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent[1]	Comments
			Date	Inches					
W390-S1700-2 A-C	W390-S1700	5-26	6/08/2022	4.273	11.462	3.57	2.37	51	N/A
W390-S1775-2 A-C	W390-S1775	5-27	6/08/2022	5.534	13.606	4.65	1.95	138	N/A
W390-S1850-3 A-C	W390-S1850	5-28	6/08/2022	4.816	10.162	4.01	1.52	164	N/A
W520-S1700 A-C	W520-S1700	5-29	6/08/2022	2.342	10.680	3.41	3.28	4	N/A
W520-S1775 A-C	W520-S1775	5-30	6/08/2022	3.040	13.476	4.42	4.37	1	N/A
W520-S1850 A-C	W520-S1850	5-31	6/08/2022	2.935	13.072	4.27	4.15	3	N/A
W660-S1687-2 A-C	W660-S1687	5-32	6/08/2022	2.818	4.470	4.10	2.47	66	N/A
W660-S1775 A-C	W660-S1775	5-33	6/08/2022	2.762	8.018	4.02	3.72	8	N/A

[1] N/A – Insufficient data available to perform the calculation. This is usually due to the inability to read the instruments because of activities such as the removal of an instrument due to floor, rib, or back trimming; locations blocked by equipment or waste disposal; installation timing, access issues, etc.

Table 5-2 Panel 8 Data Analysis (continued)

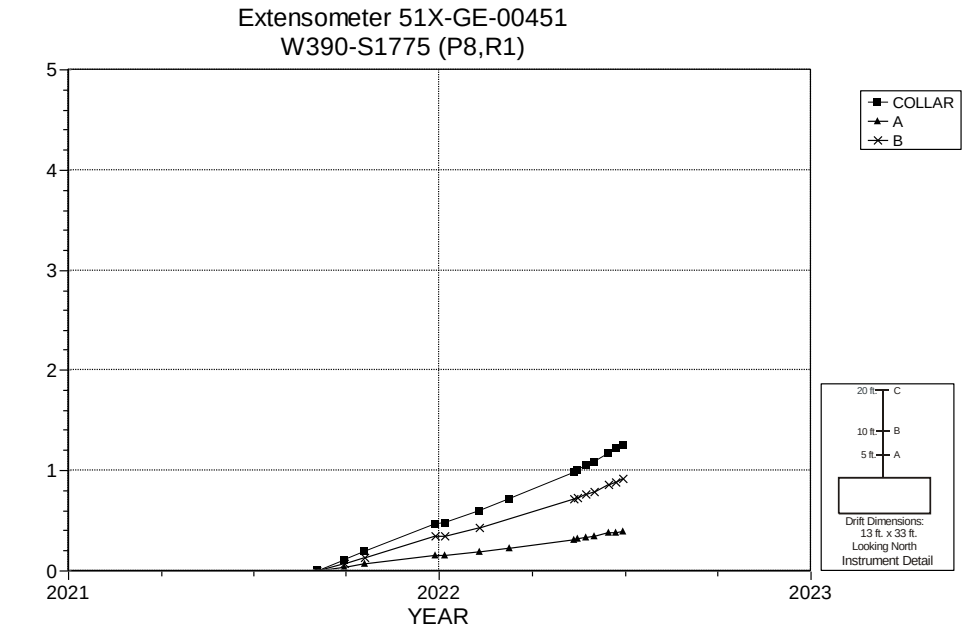
Convergence Points (continued)									
Field Tag	Location	Figure Number	Last Reading 2020 to 2021		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent[1]	Comments
			Date	Inches					
W660-S1862 A-C	W660-S1862	5-34	6/08/2022	2.269	6.801	3.30	3.23	2	N/A
W790-S1687 A-C	W790-S1687	5-35	6/08/2022	3.148	7.389	3.81	3.35	14	N/A
W790-S1775 A-C	W790-S1775	5-36	6/08/2022	3.601	8.312	4.36	3.72	17	N/A
W790-S1862-2 A-C	W790-S1862	5-37	6/08/2022	3.693	6.980	4.47	3.60	24	N/A
W920-S1687-2 A-C	W920-S1687	5-38	6/08/2022	3.717	7.488	4.32	3.74	16	N/A
W920-S1775-2 A-C	W920-S1775	5-39	6/08/2022	4.562	9.502	5.31	3.86	38	N/A
W920-S1862 A-C	W920-S1862	5-40	6/08/2022	4.484	9.498	5.22	3.96	32	N/A
W1050-S1687-2 A-C	W1050-S1687	5-41	6/08/2022	3.706	7.670	4.04	3.58	13	N/A
W1050-S1775-2 A-C	W1050-S1775	5-42	6/08/2022	4.056	8.034	4.42	3.61	22	N/A
W1050-S1862-2 A-C	W1050-S1862	5-43	6/08/2022	4.023	8.072	4.39	3.70	19	N/A
W1190-S1687-2 A-C	W1190-S1687	5-44	6/08/2022	4.303	8.640	3.95	3.46	14	N/A
W1190-S1775-2 A-C	W1190-S1775	5-45	6/08/2022	4.658	9.119	4.24	3.58	22	N/A
W1190-S1862-2 A-C	W1190-S1862	5-46	6/08/2022	4.634	8.739	4.15	3.39	19	N/A
S1600-W285-3 A-C	S1600-W285	5-47	2/08/2022	1.622	11.552	2.79	0.81	244	N/A
S1600-W390-4 A-C	S1600-W390	5-48	6/08/2022	3.514	22.859	2.90	1.76	65	N/A
S1600-W455-3 A-C	S1600-W455	5-49	6/08/2022	4.453	29.075	3.86	2.15	80	N/A
S1600-W520-4 A-C	S1600-W520	5-50	6/08/2022	4.302	32.045	4.15	2.47	68	N/A
S1600-W585-2 A-C	S1600-W585	5-51	6/08/2022	4.162	11.128	3.97	2.93	35	N/A
S1600-W660-2 A-C	S1600-W660	5-52	6/08/2022	4.610	4.610	4.54	2.98	52	N/A
S1600-W725-2 A-C	S1600-W725	5-53	6/08/2022	4.657	8.415	4.39	3.08	43	N/A
S1600-W790-2 A-C	S1600-W790	5-54	6/08/2022	4.736	8.247	4.65	2.67	74	N/A
S1600-W855-2 A-C	S1600-W855	5-55	6/08/2022	4.713	8.464	4.50	3.00	50	N/A
S1600-W920-2 A-C	S1600-W920	5-56	6/08/2022	5.645	9.967	5.19	3.66	42	N/A

[1] N/A – Insufficient data available to perform the calculation. This is usually due to the inability to read the instruments because of activities such as the removal of an instrument due to floor, rib, or back trimming; locations blocked by equipment or waste disposal; installation timing, access issues, etc.

Table 5-2 Panel 8 Data Analysis (continued)

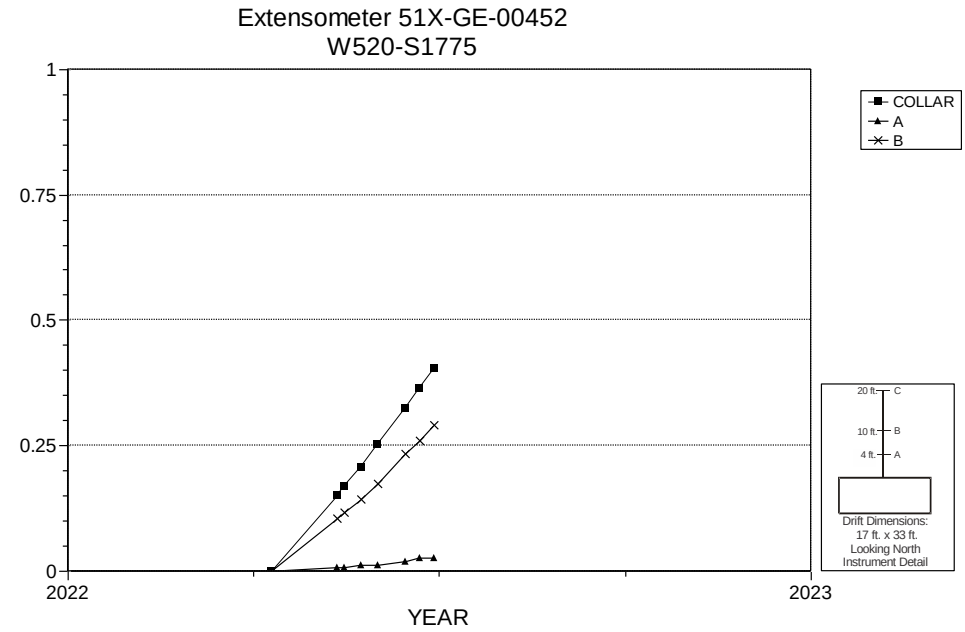
Convergence Points (continued)									
Field Tag	Location	Figure Number	Last Reading 2021 to 2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate[1] 2020 to 2021 (in/year)	Rate Change Percent[1]	Comments
			Date	Inches					
S1600-W985-2 A-C	S1600-W985	5-57	6/08/2022	4.754	8.789	4.46	3.29	36	N/A
S1600-W1050-2 A-C	S1600-W1050	5-58	6/08/2022	4.821	8.740	4.30	3.35	28	N/A
S1600-W1120-2 A-C	S1600-W1120	5-59	6/08/2022	3.819	7.507	3.67	2.75	33	N/A
S1600-W1190-2 A-C	S1600-W1190	5-60	6/08/2022	3.172	6.216	2.93	2.35	25	N/A
S1950-W285-3 A-C	S1950-W285	5-61	6/08/2022	3.018	7.111	2.28	2.66	-14	N/A
S1950-W390-4 A-C	S1950-W390	5-62	6/08/2022	3.514	8.205	2.90	3.08	-6	N/A
S1950-W455-3 A-C	S1950-W455	5-63	6/08/2022	2.677	11.865	3.90	4.61	-15	N/A
S1950-W520-4 A-C	S1950-W520	5-64	6/08/2022	4.315	11.068	6.28	5.82	8	N/A
S1950-W585-2 A-C	S1950-W585	5-65	6/08/2022	3.647	14.972	4.41	3.87	14	N/A
S1950-W660-2 A-C	S1950-W660	5-66	6/08/2022	4.624	17.218	5.59	4.67	20	N/A
S1950-W725-3 A-C	S1950-W725	5-67	6/08/2022	3.898	14.331	4.71	3.65	29	N/A
S1950-W790-4 A-C	S1950-W790	5-68	6/15/2022	4.798	15.111	5.67	4.61	23	N/A
S1950-W855 A-C	S1950-W855	5-69	6/08/2022	3.738	8.933	4.52	4.07	11	N/A
S1950-W920-2 A-C	S1950-W920	5-70	6/08/2022	3.862	8.860	4.67	4.01	16	N/A
S1950-W985-2 A-C	S1950-W985	5-71	6/08/2022	3.706	8.940	4.48	3.94	14	N/A
S1950-W1050-2 A-C	S1950-W1050	5-72	6/08/2022	3.949	8.952	4.78	4.31	11	N/A
S1950-W1120-2 A-C	S1950-W1120	5-73	6/08/2022	4.590	8.752	4.15	3.53	18	N/A
S1950-W1190-2 A-C	S1950-W1190	5-74	6/08/2022	3.670	7.184	3.35	2.82	19	N/A

[1] N/A – Insufficient data available to perform the calculation. This is usually due to the inability to read the instruments because of activities such as the removal of an instrument due to floor, rib, or back trimming; locations blocked by equipment or waste disposal; installation timing, access issues, etc.



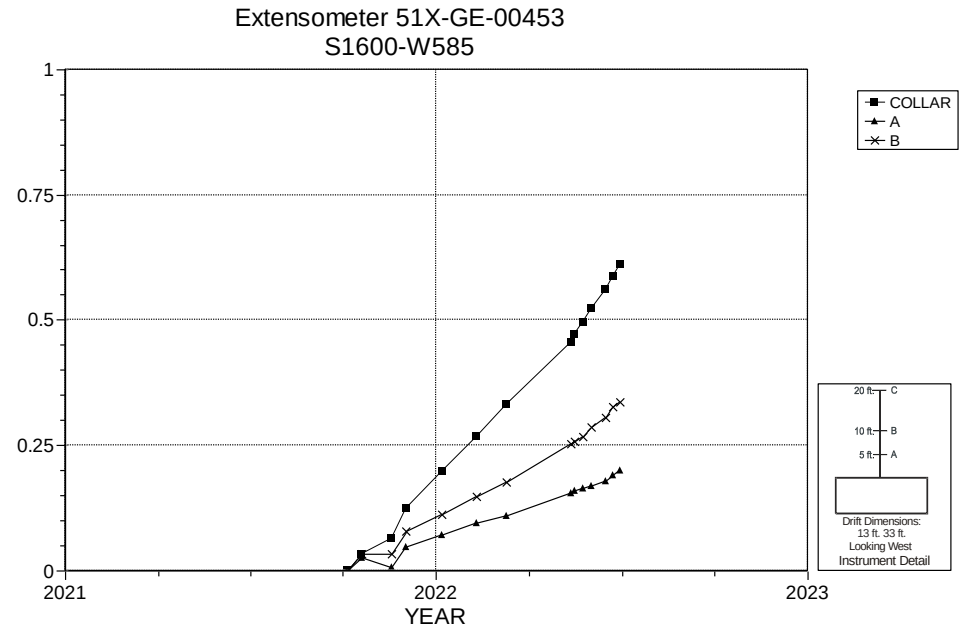
NOTES:
1. Excavation date: October 2013.

Figure 5-15 Extensometer 51X-GE-00451 – W390 S1775



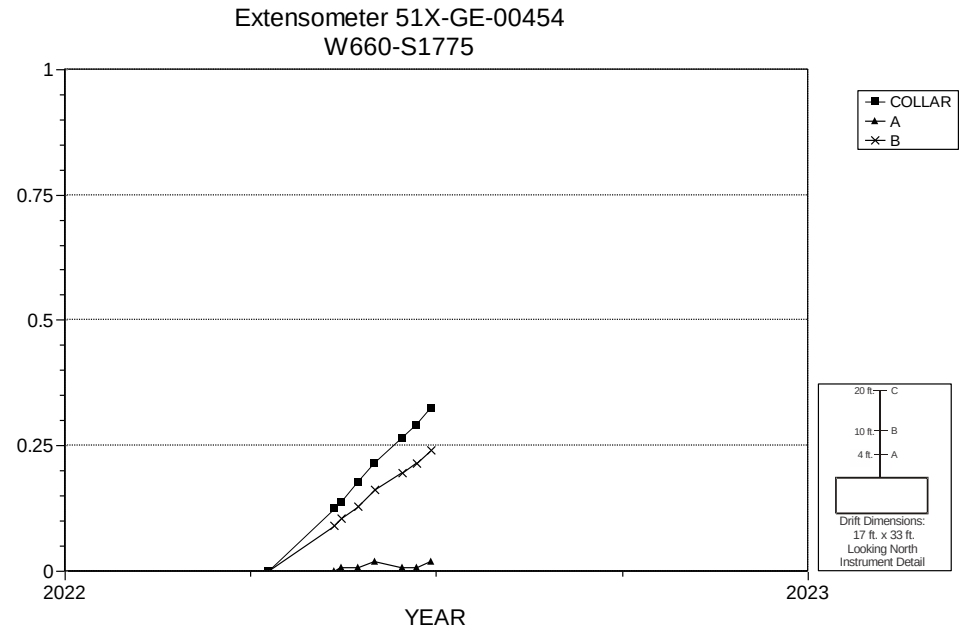
NOTES:
1. Excavation date: January 2020.

Figure 5-16 Extensometer 51X-GE-00452 – W520 S1775



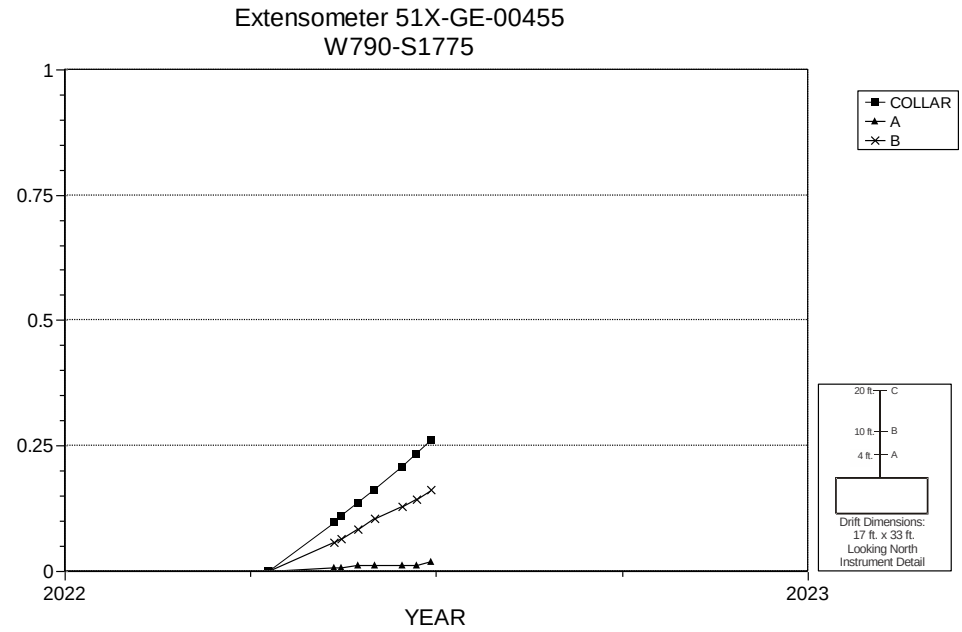
NOTES:
1. Excavation date: January 2014.

Figure 5-17 Extensometer 51X-GE-00453 – S1600 W585



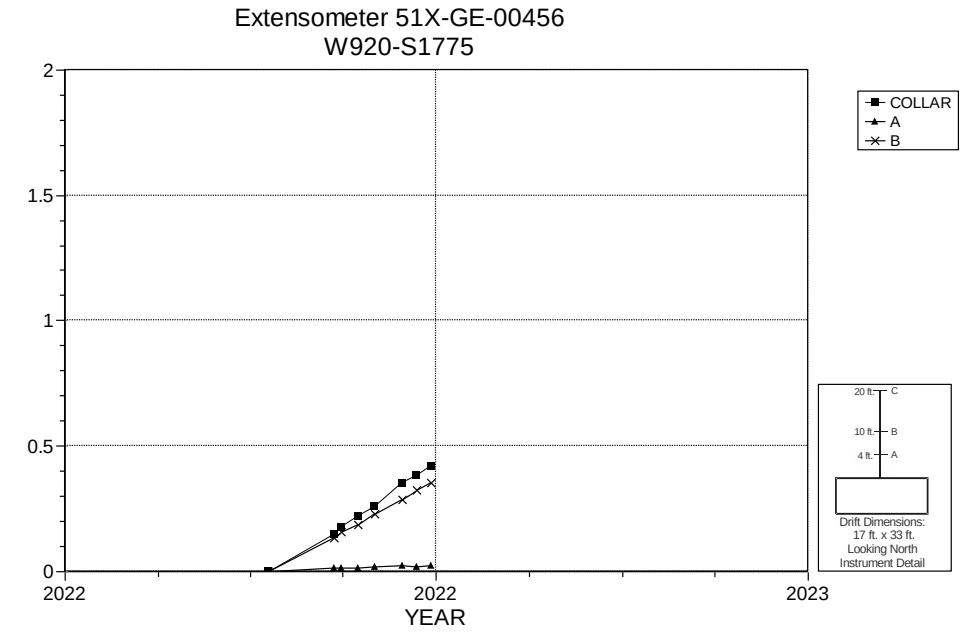
NOTES:
1. Excavation date: January 2020.

Figure 5-18 Extensometer 51X-GE-00454 – W660 S1775



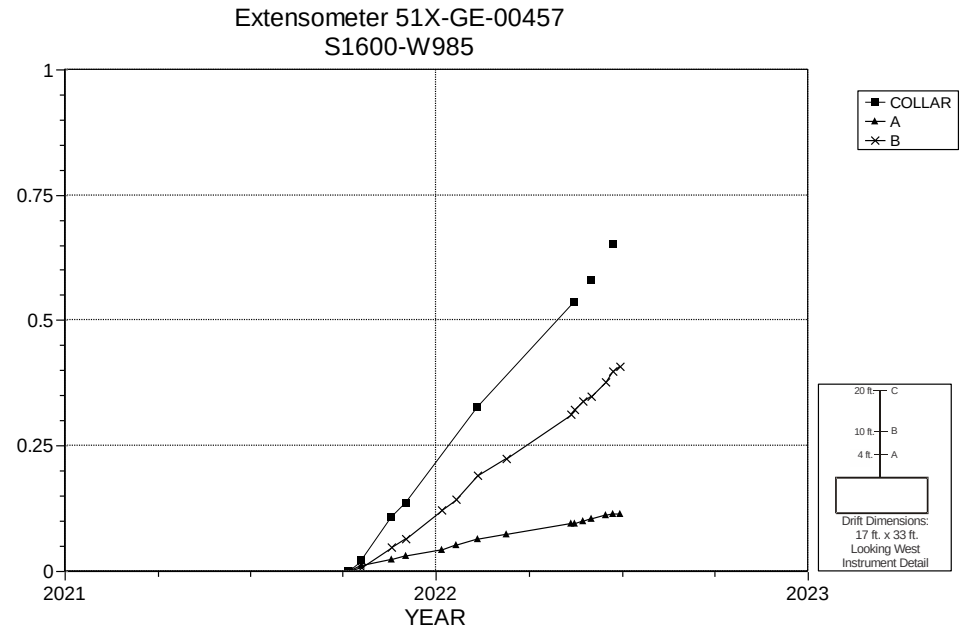
NOTES:
1. Excavation date: January 2020.

Figure 5-19 Extensometer 51X-GE-00455 – W790 S1775



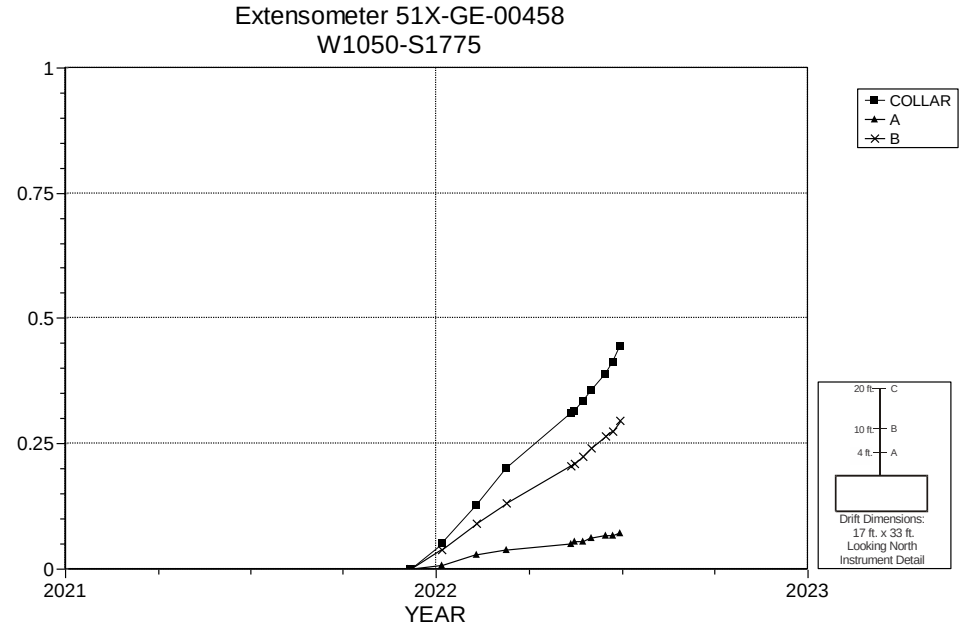
NOTES:
1. Excavation date: January 2020.

Figure 5-20 Extensometer 51X-GE-00456 – W920 S1775



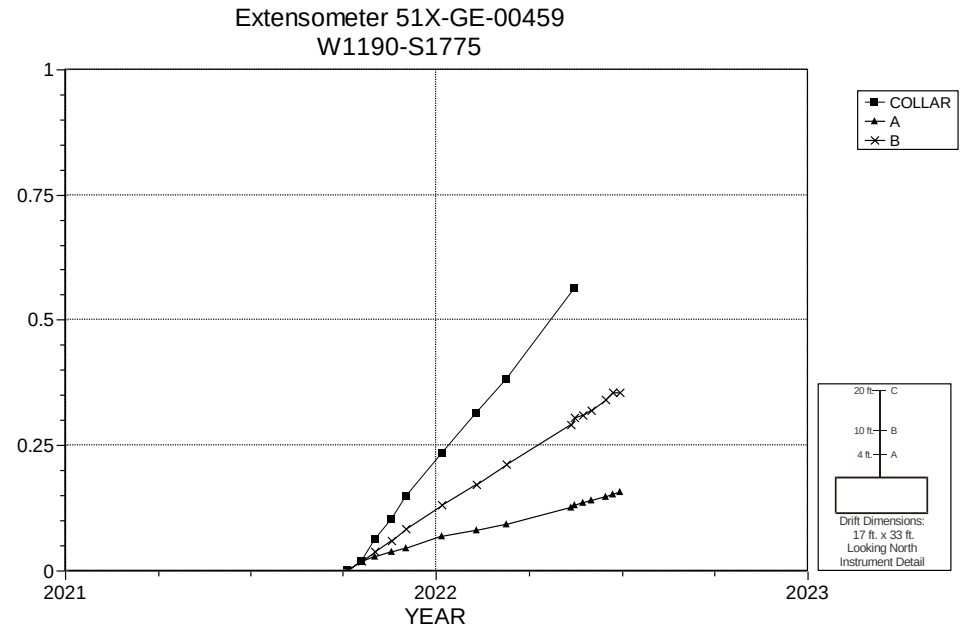
NOTES:
1. Excavation date: July 2019.

Figure 5-21 Extensometer 51X-GE-00457 – S1600 W985



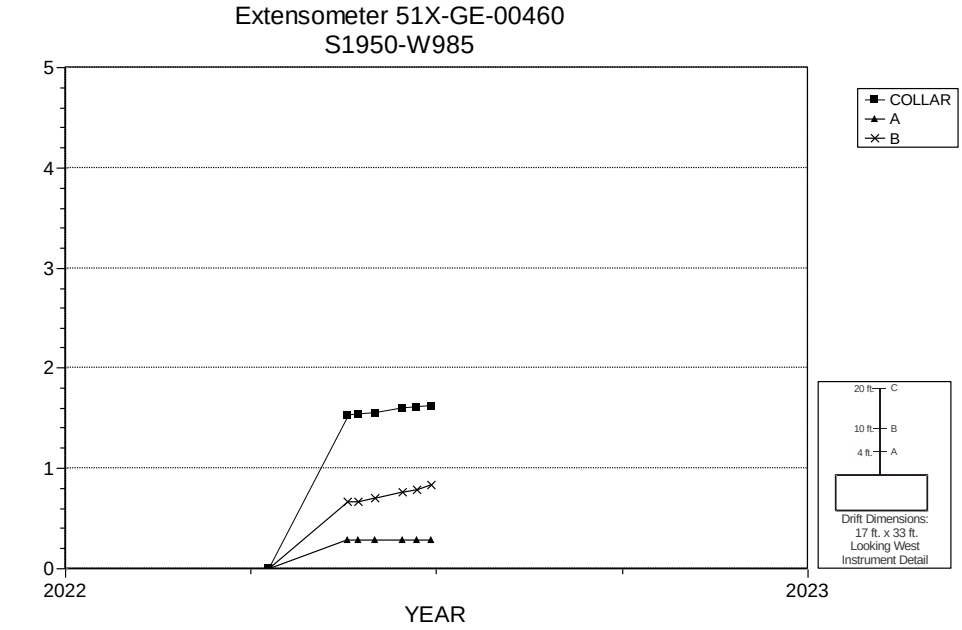
NOTES:
1. Excavation date: January 2020.

Figure 5-22 Extensometer 51X-GE-00458 – W1050 S1775



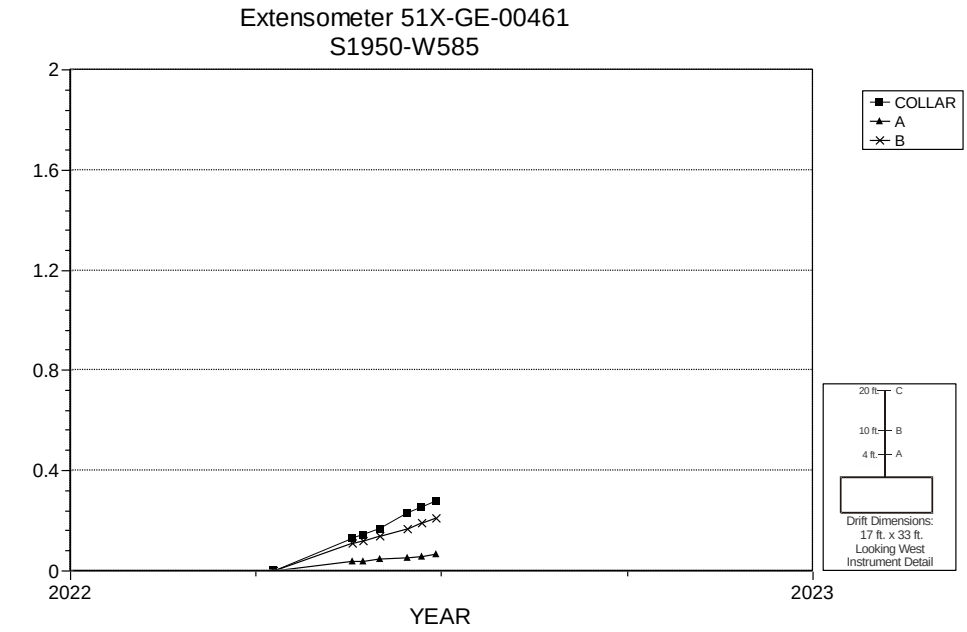
NOTES:
1. Excavation date: January 2020.
2. Anchor 'C' Potentiometer BO. Bad data readings deleted from 5/25/22 - 7/28/22.

Figure 5-23 Extensometer 51X-GE-00459 – W1190 S1775



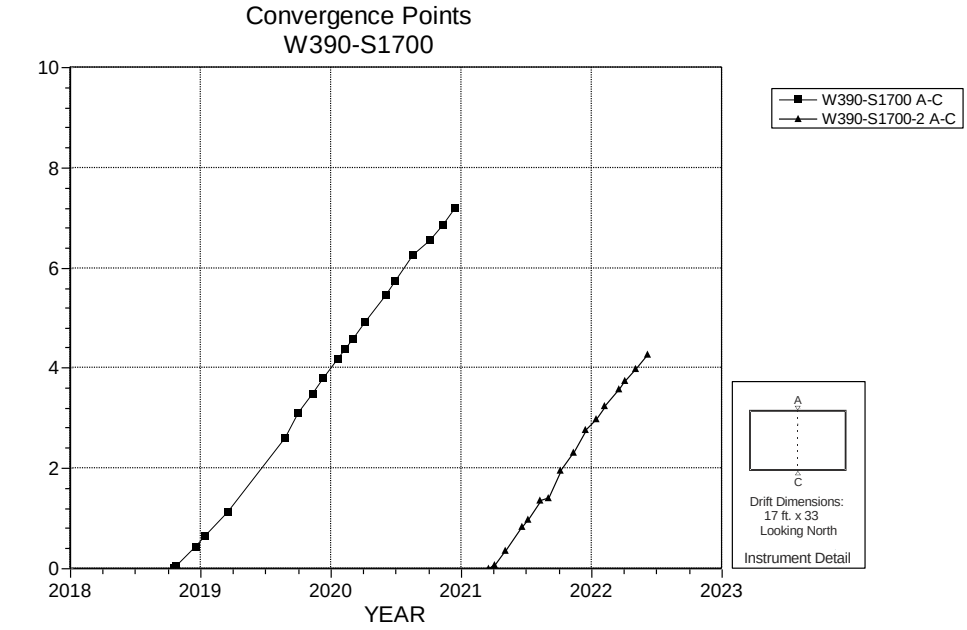
NOTES:
1. Excavation date: January 2020.

Figure 5-24 Extensometer 51X-GE-00460 – S1950 W985



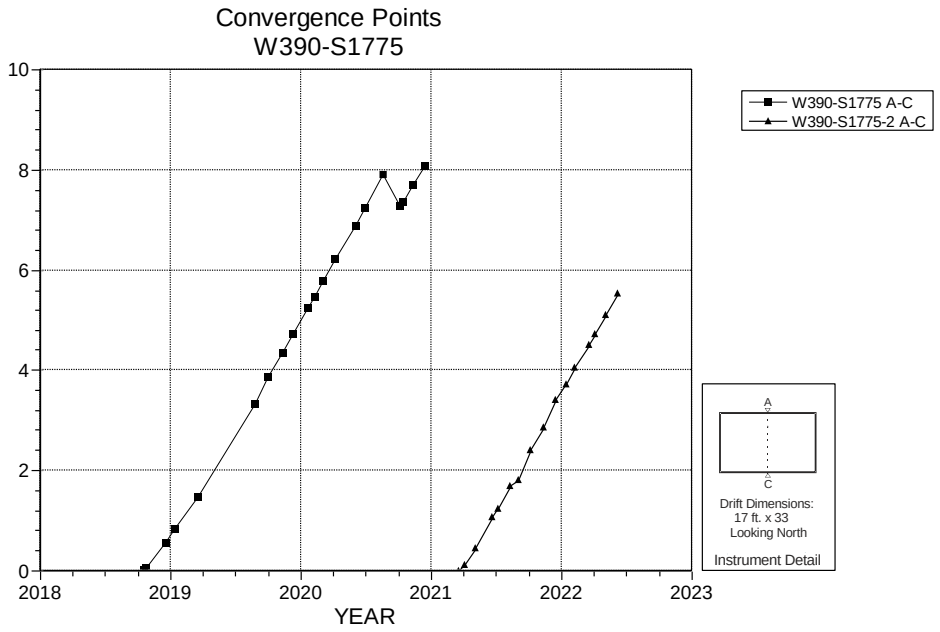
NOTES:
1. Excavation date: January 2020.

Figure 5-25 Extensometer 51X-GE-00461 – S1950 W585



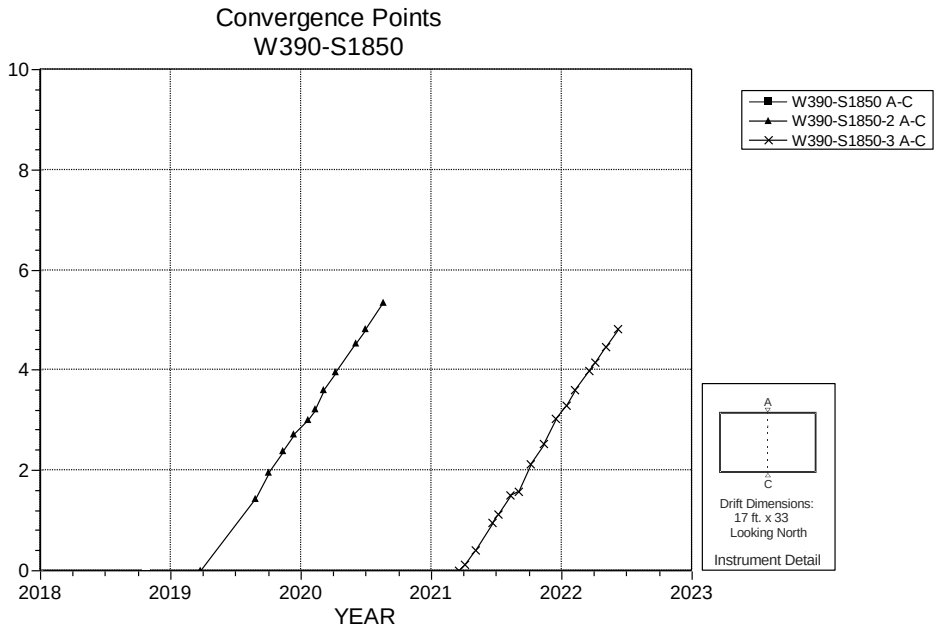
NOTES:
1. Excavation date: October 2013.

Figure 5-26 Convergence Point Array – W390 S1700 – Roof to Floor



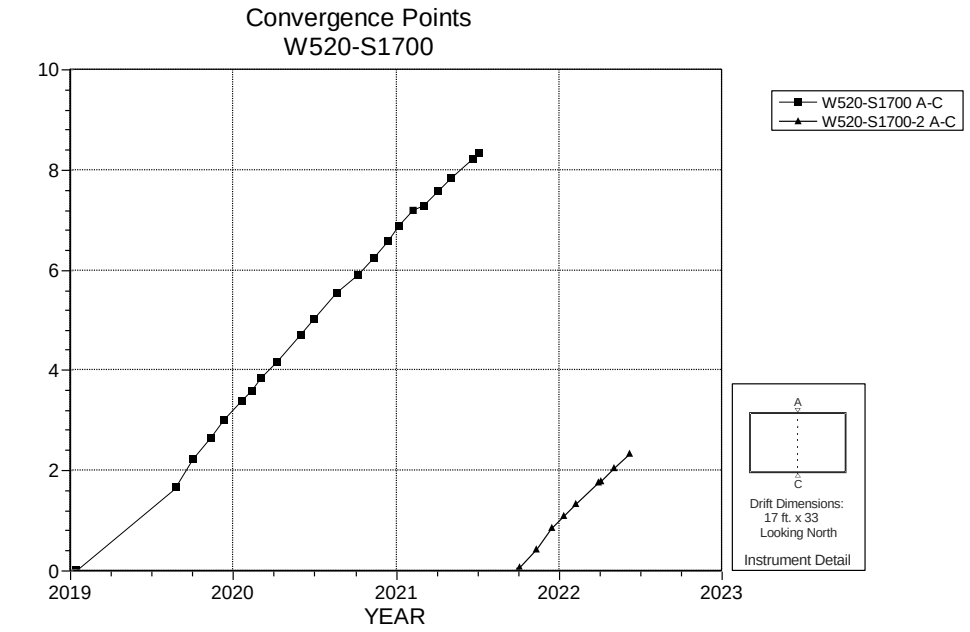
NOTES:
1. Excavation date: October 2013.

Figure 5-27 Convergence Point Array – W390 S1775 – Roof to Floor



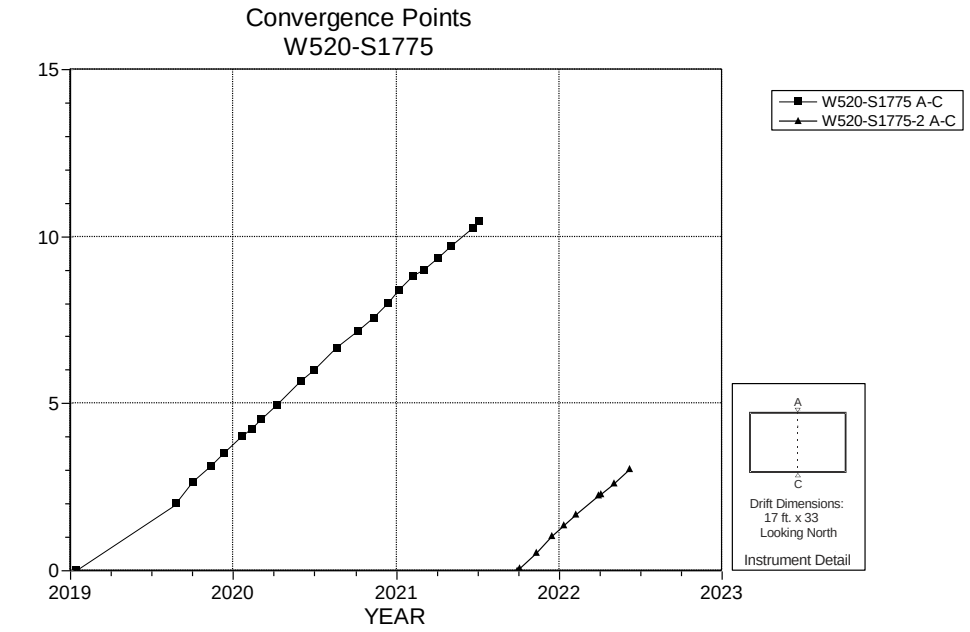
NOTES:
1. Excavation date: October 2013.

Figure 5-28 Convergence Point Array – W390 S1850 – Roof to Floor



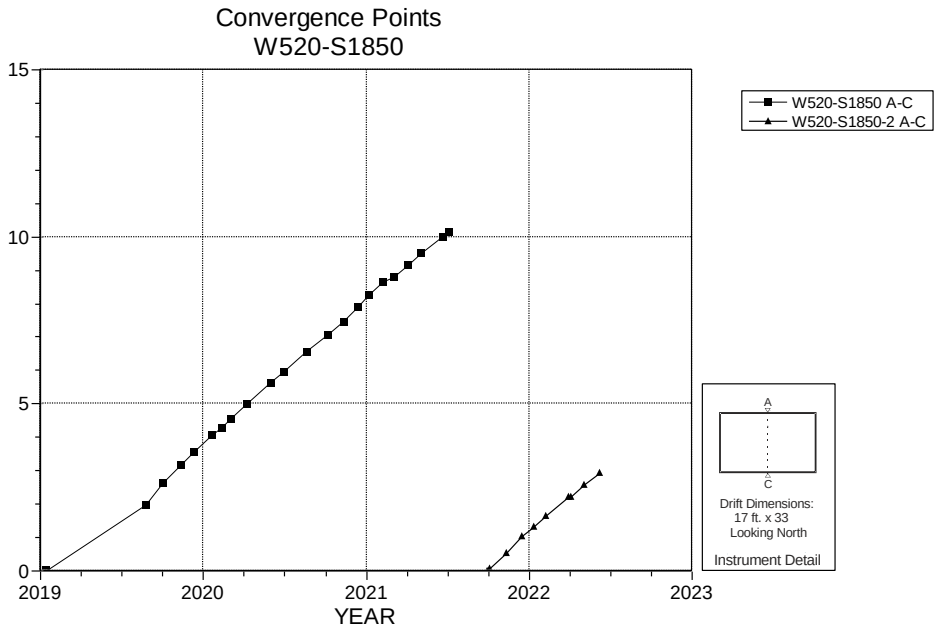
NOTES:
1. Excavation date: October 2013

Figure 5-29 Convergence Point Array – W520 S1700 – Roof to Floor



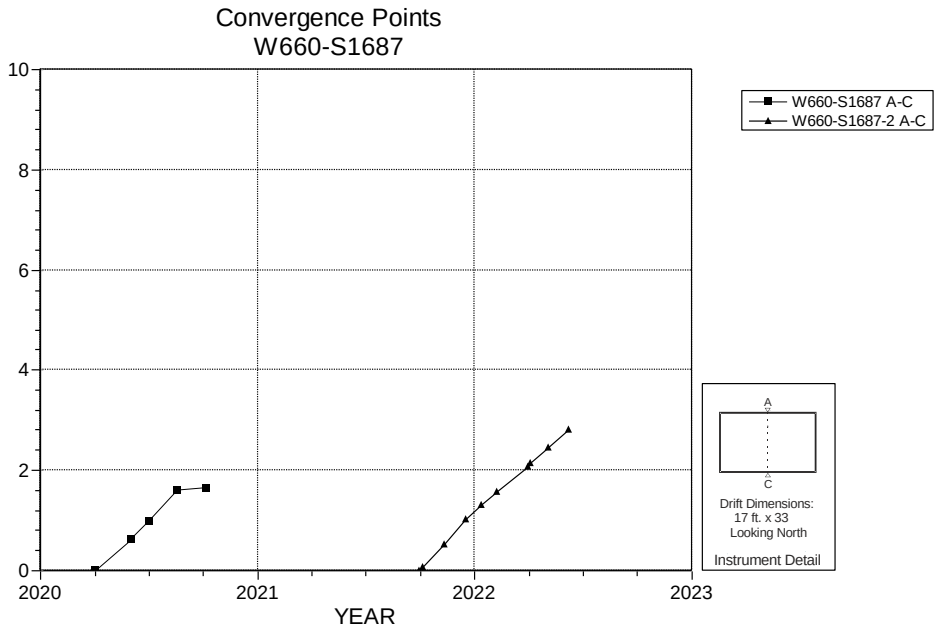
NOTES:
1. Excavation date: October 2013

Figure 5-30 Convergence Point Array – W520 S1775 – Roof to Floor



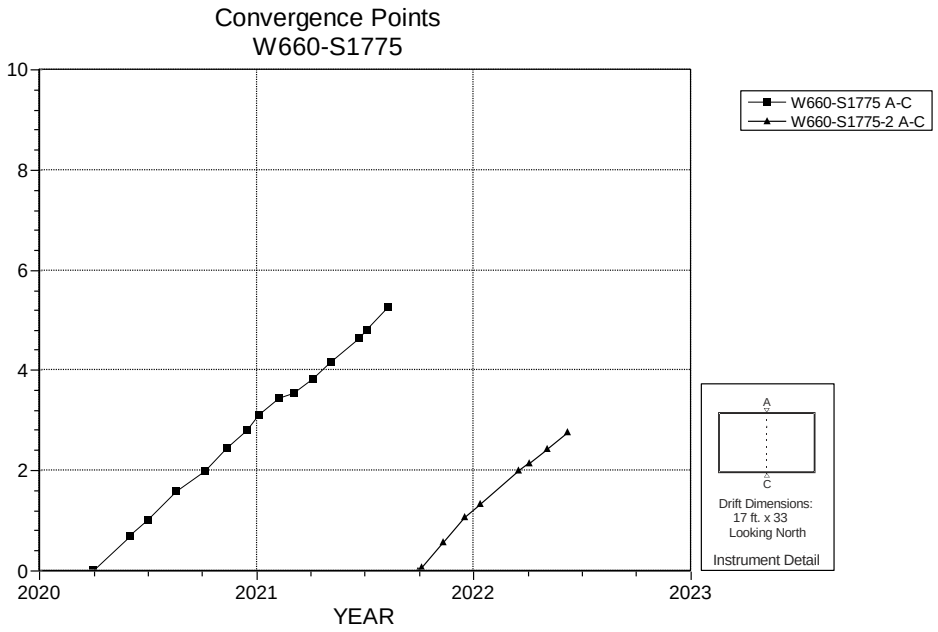
NOTES:
1. Excavation date: October 2013

Figure 5-31 Convergence Point Array – W520 S1850 – Roof to Floor



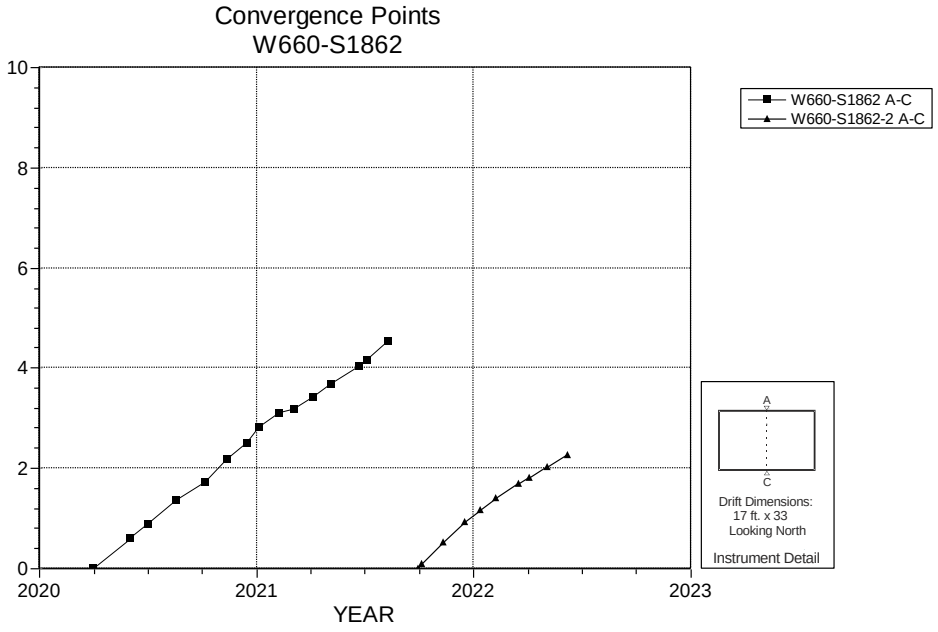
NOTES:
1. Excavation Date: January 2020.

Figure 5-32 Convergence Point Array – W660 S1687 – Roof to Floor



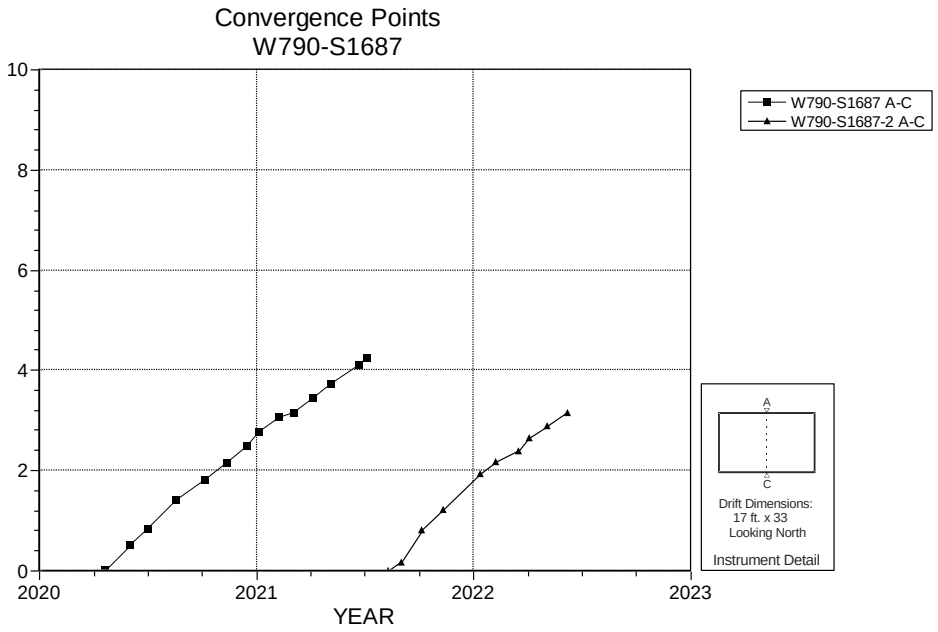
NOTES:
1. Excavation date: January 2020.

Figure 5-33 Convergence Point Array – W660 S1775 – Roof to Floor



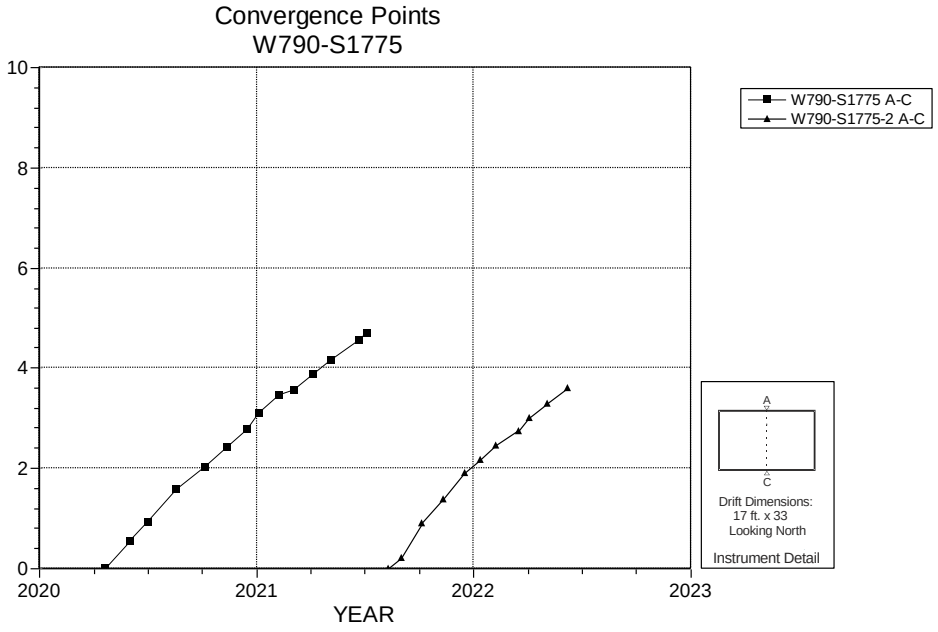
NOTES:
1. Excavation date: January 2020.

Figure 5-34 Convergence Point Array – W660 S1862 – Roof to Floor



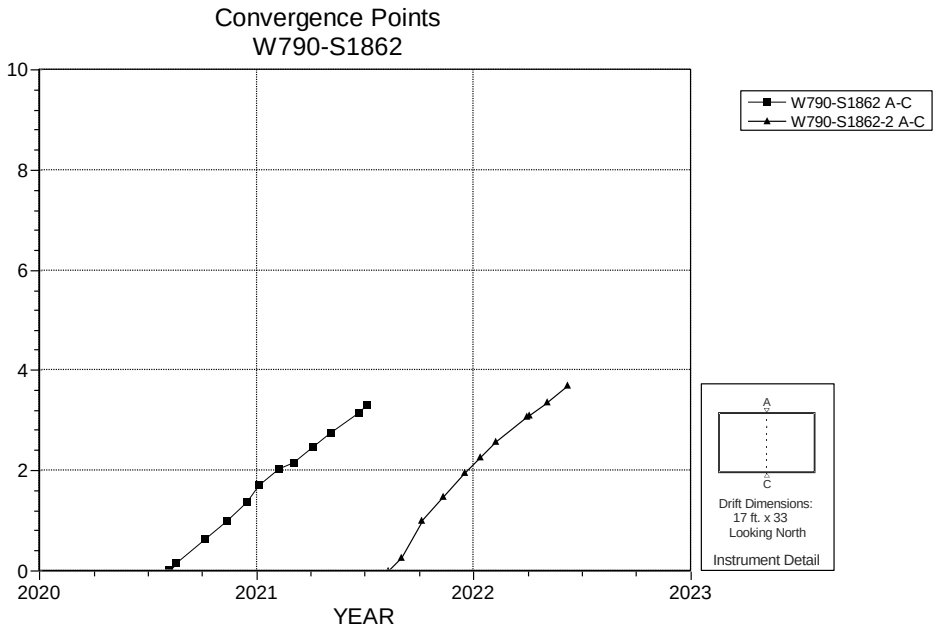
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-35 Convergence Point Array – W790 S1687 – Roof to Floor



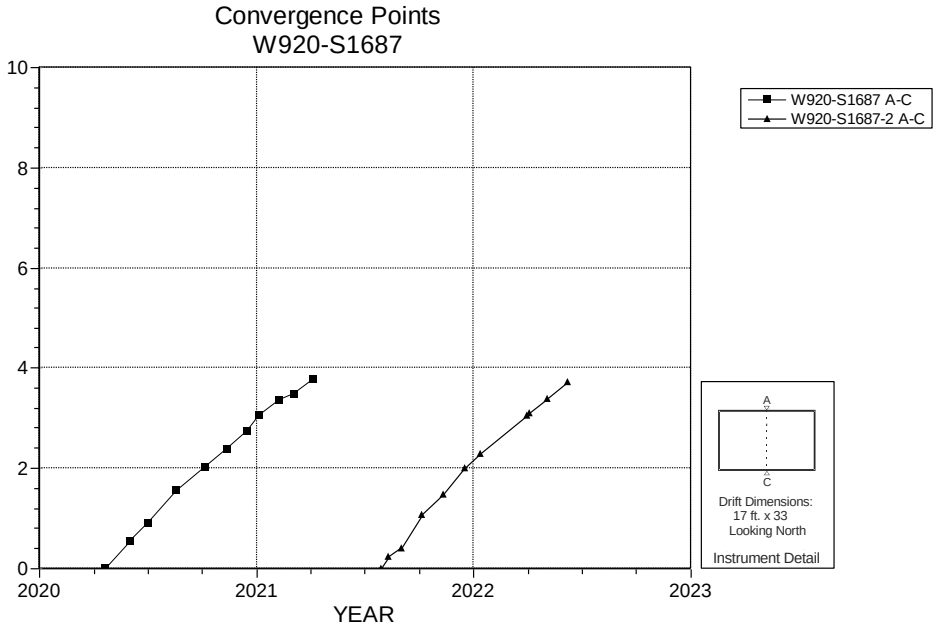
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-36 Convergence Point Array – W790 S1775 – Roof to Floor



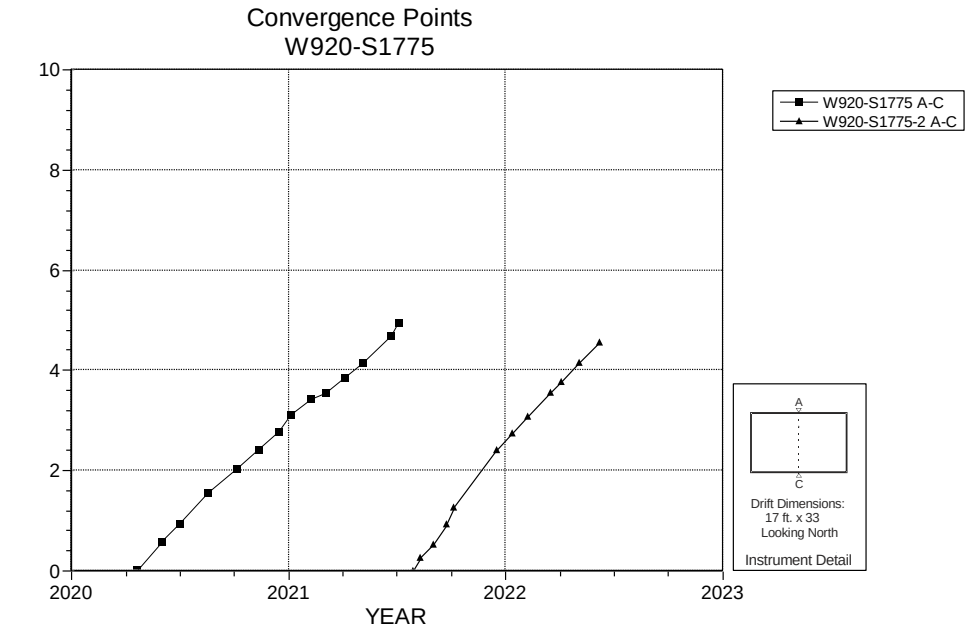
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-37 Convergence Point Array – W790 S1862 – Roof to Floor



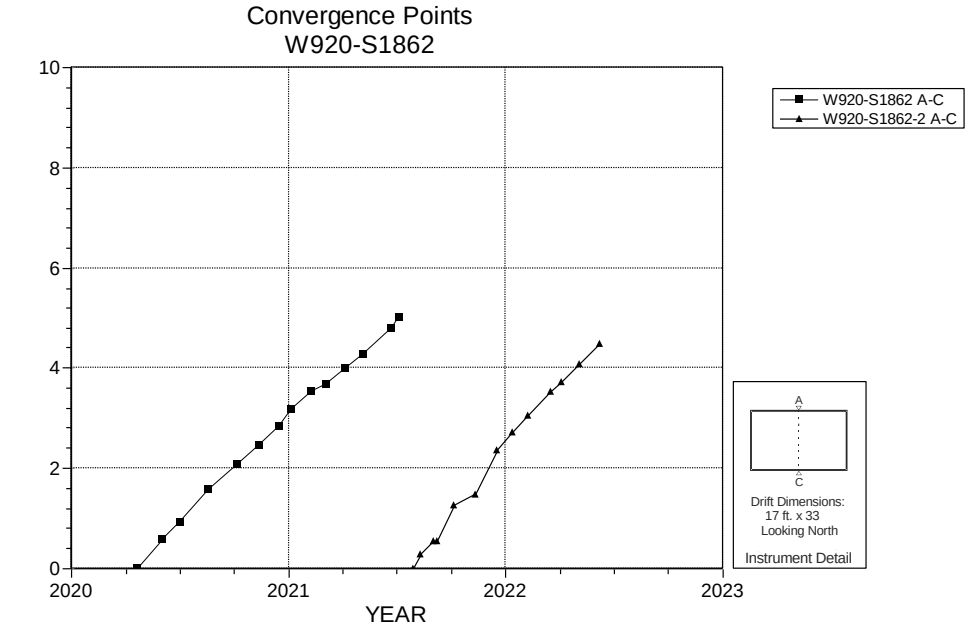
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-38 Convergence Point Array – W920 S1687 – Roof to Floor



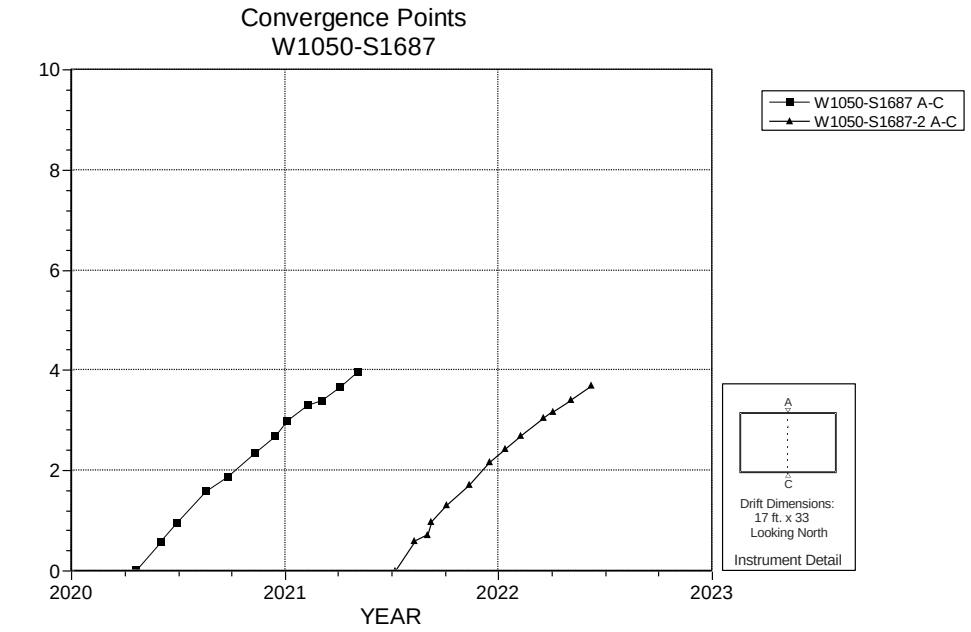
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-39 Convergence Point Array – W920 S1775 – Roof to Floor



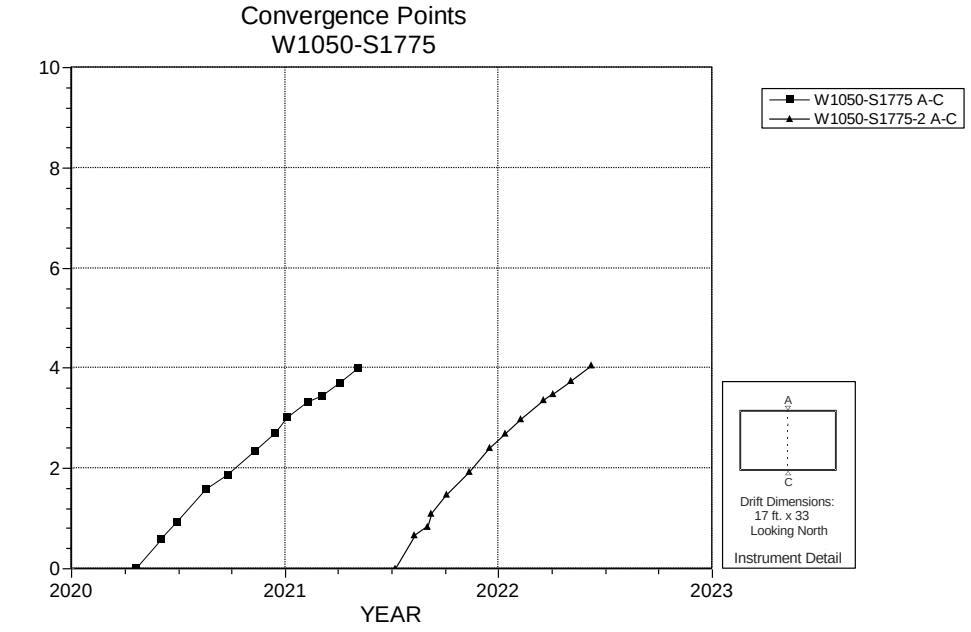
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-40 Convergence Point Array – W920 S1862 – Roof to Floor



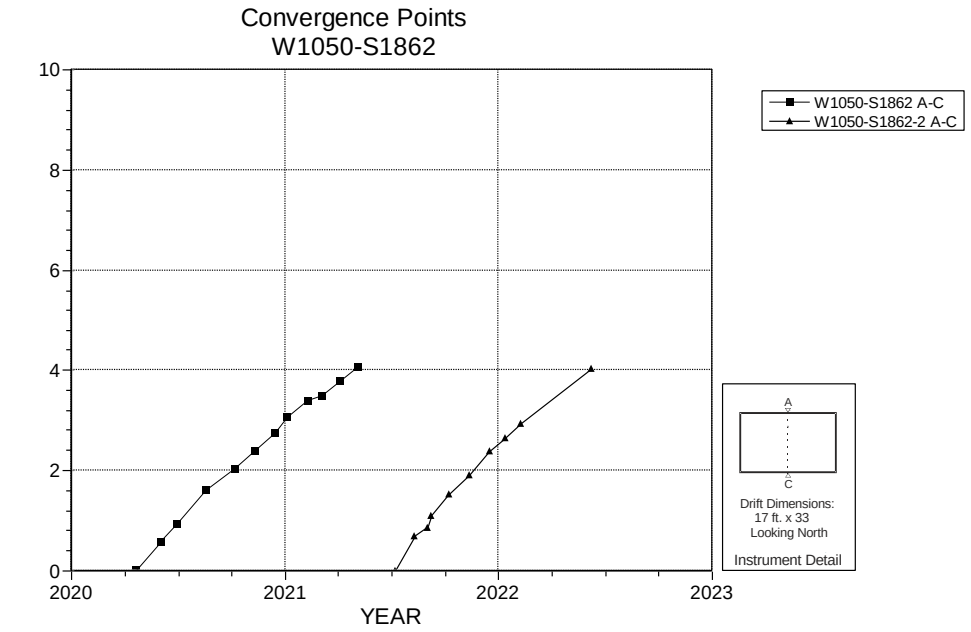
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-41 Convergence Point Array – W1050 S1687 – Roof to Floor



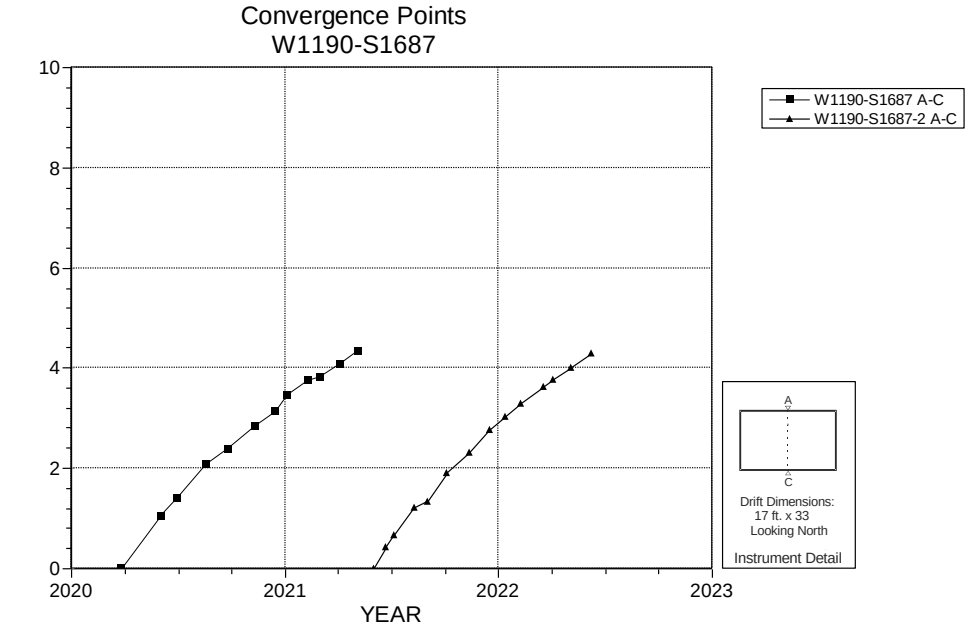
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-42 Convergence Point Array – W1050 S1775 – Roof to Floor



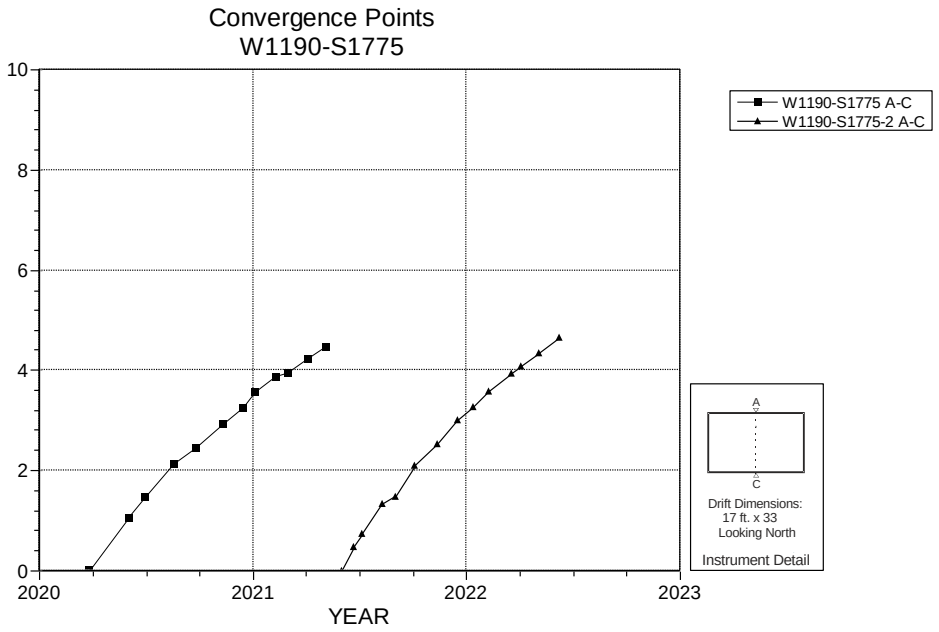
NOTES:
1. Excavation date: Janaury 2020.

Figure 5-43 Convergence Point Array – W1050 S1862 – Roof to Floor



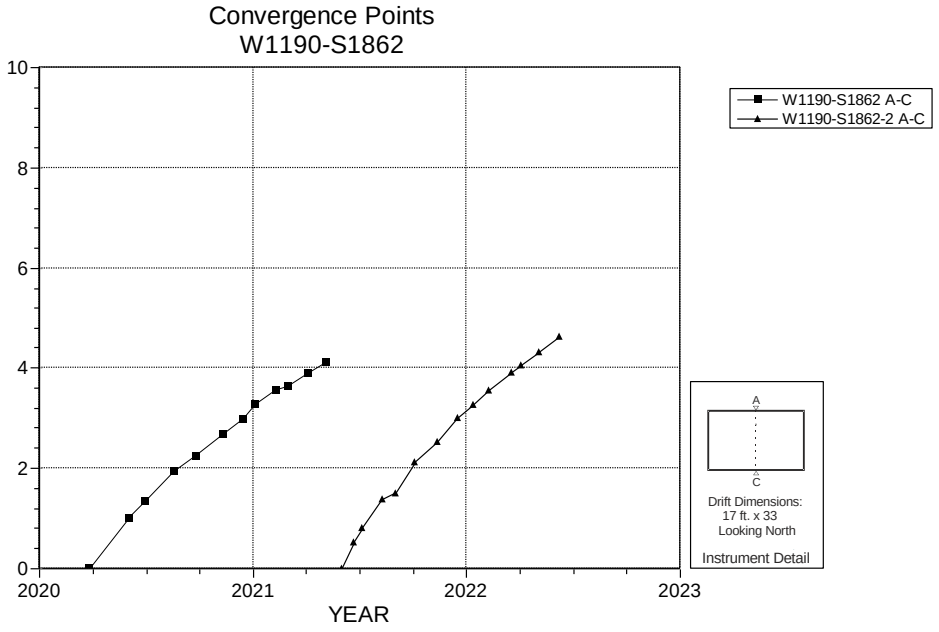
NOTES:
1. Excavation date: January 2020.

Figure 5-44 Convergence Point Array – W1190 S1687 – Roof to Floor



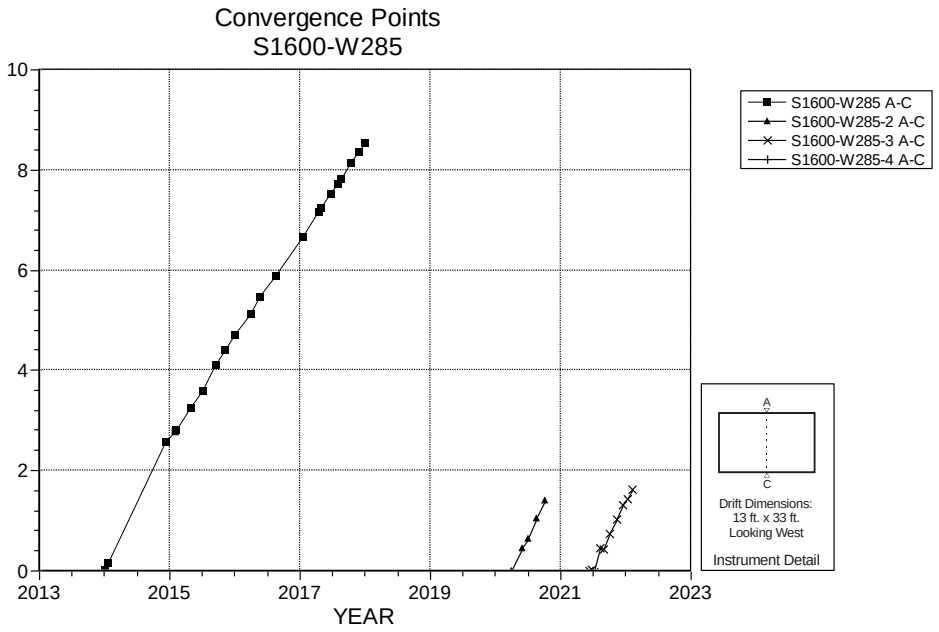
NOTES:
1. Excavation date: January 2020.

Figure 5-45 Convergence Point Array – W1190 S1775 – Roof to Floor



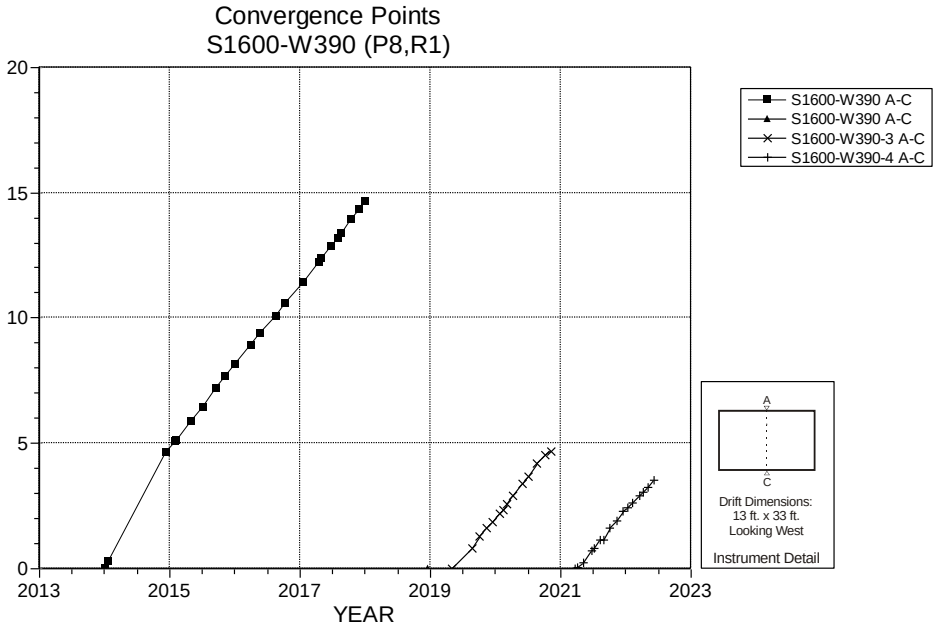
NOTES:
1. Excavation date: January 2020.

Figure 5-46 Convergence Point Array – W1190 S1862 – Roof to Floor



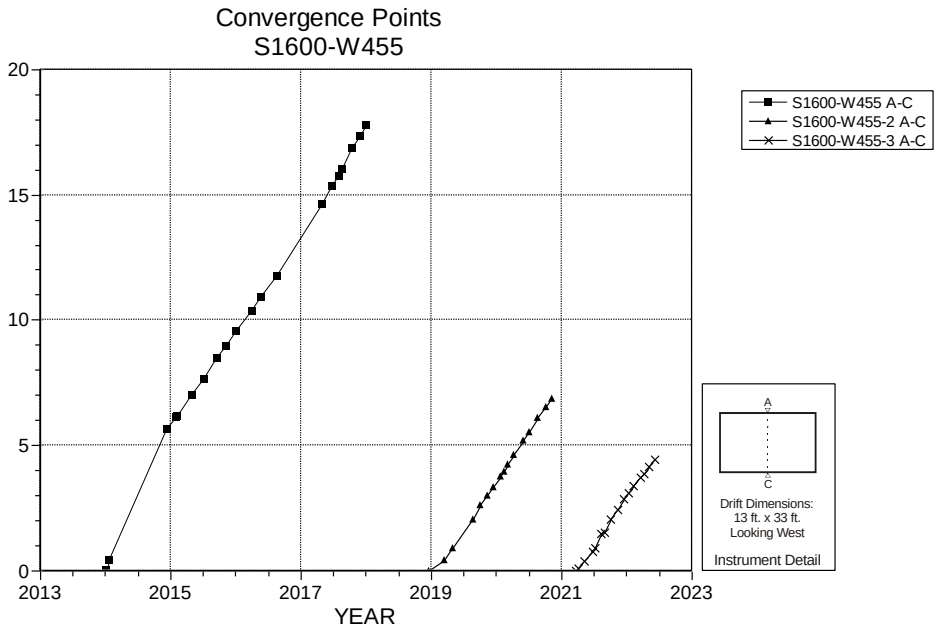
NOTES:
1. Exacavtion Date: October 2013.

Figure 5-47 Convergence Point Array – S1600 W285 – Roof to Floor



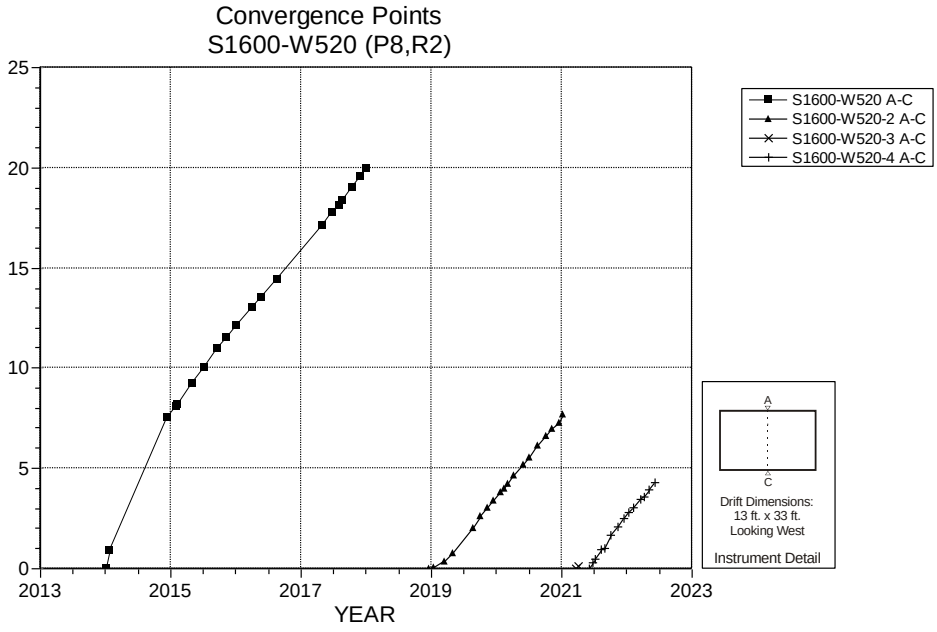
NOTES:
1. Excavation Date: October 2013.

Figure 5-48 Convergence Point Array – S1600 W390 – Roof to Floor



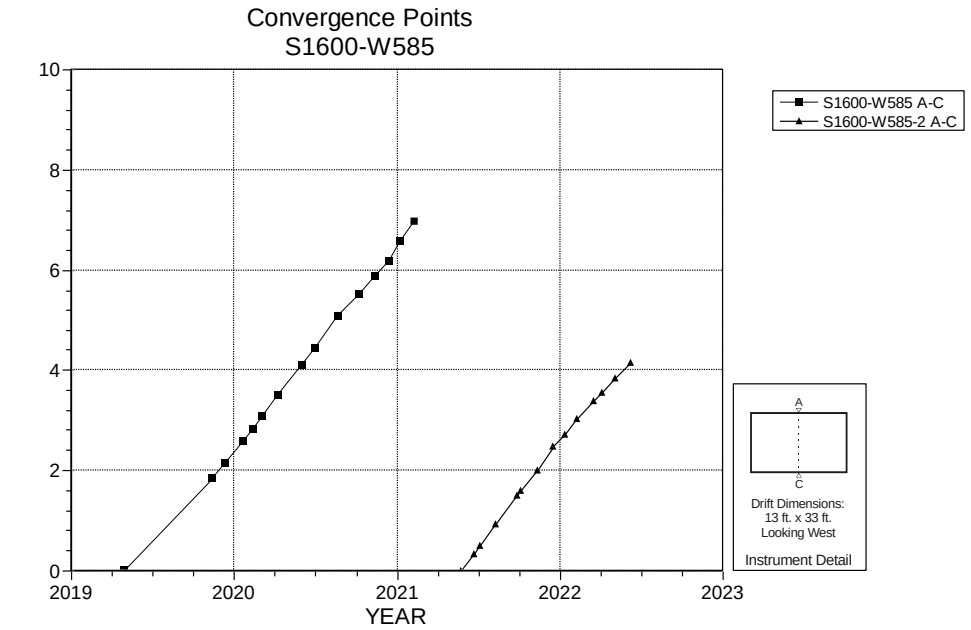
NOTES:
1. Excavation Date: October 2013.

Figure 5-49 Convergence Point Array – S1600 W455 – Roof to Floor



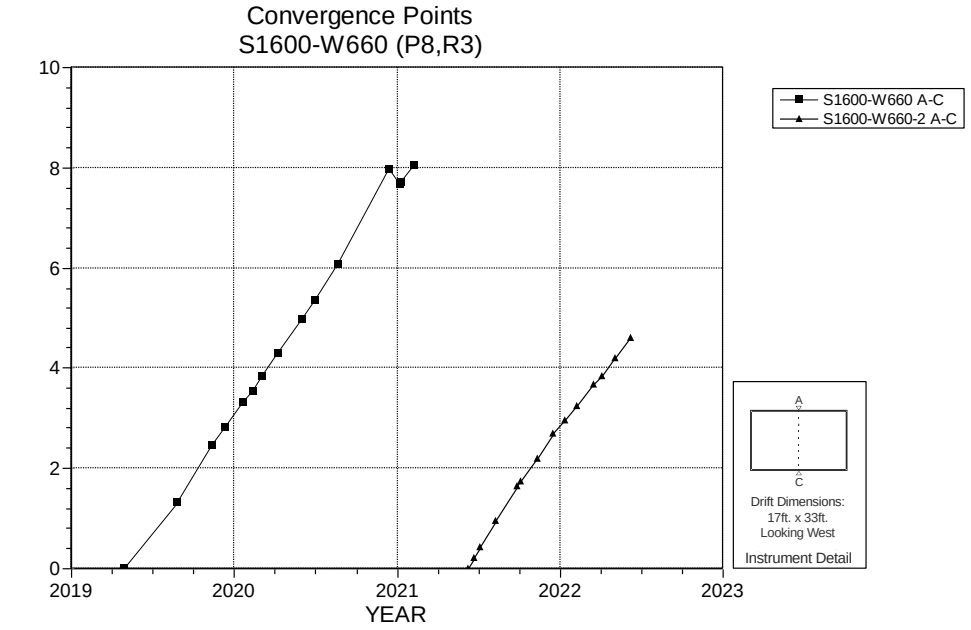
NOTES:
1. Excavation Date: December 2013.

Figure 5-50 Convergence Point Array – S1600 W520 – Roof to Floor



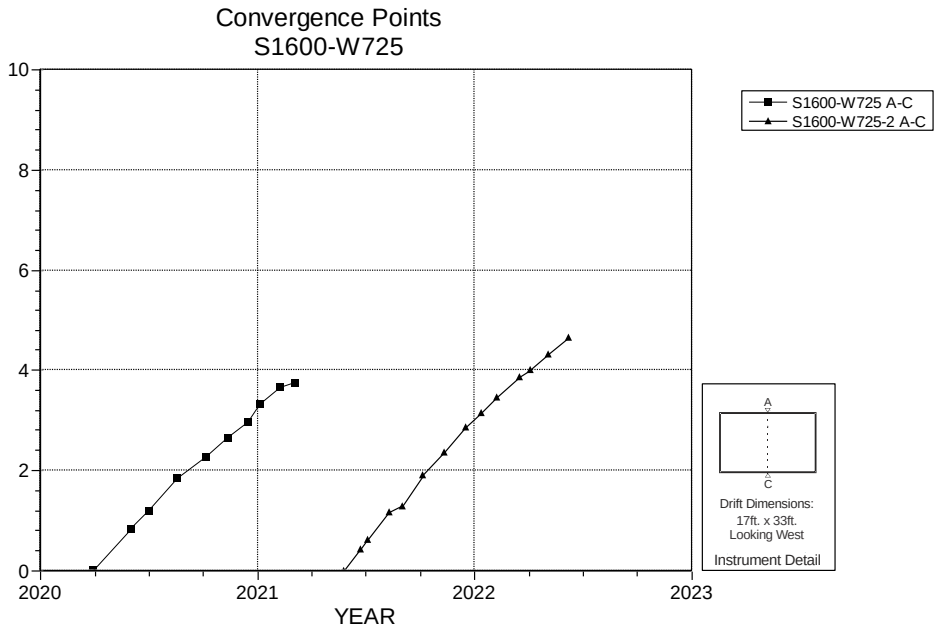
NOTES:
Excavation date: October 2013

Figure 5-51 Convergence Point Array – S1600 W585 – Roof to Floor



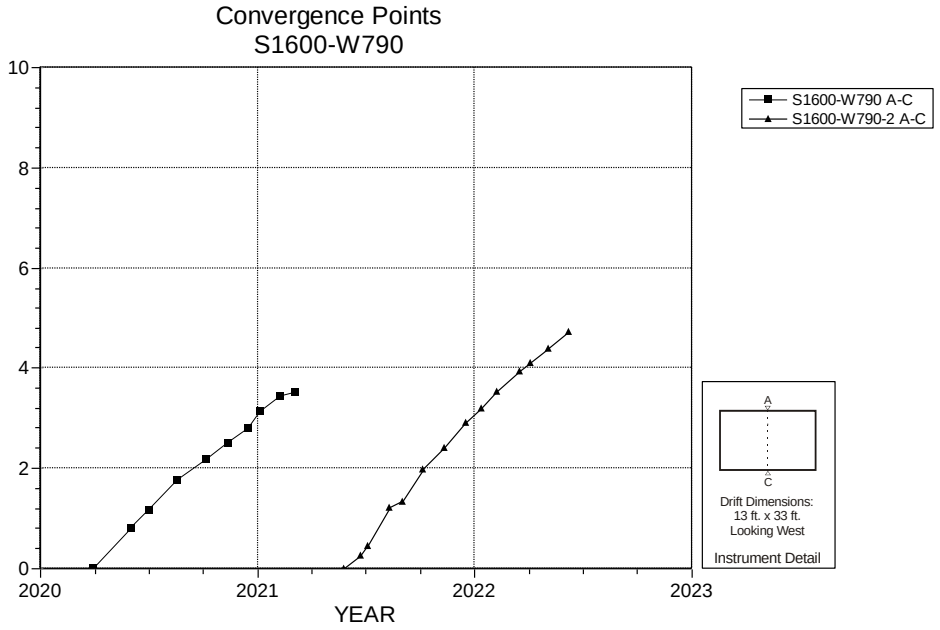
NOTES:
Excavation date: October 2013

Figure 5-52 Convergence Point Array – S1600 W660 – Roof to Floor



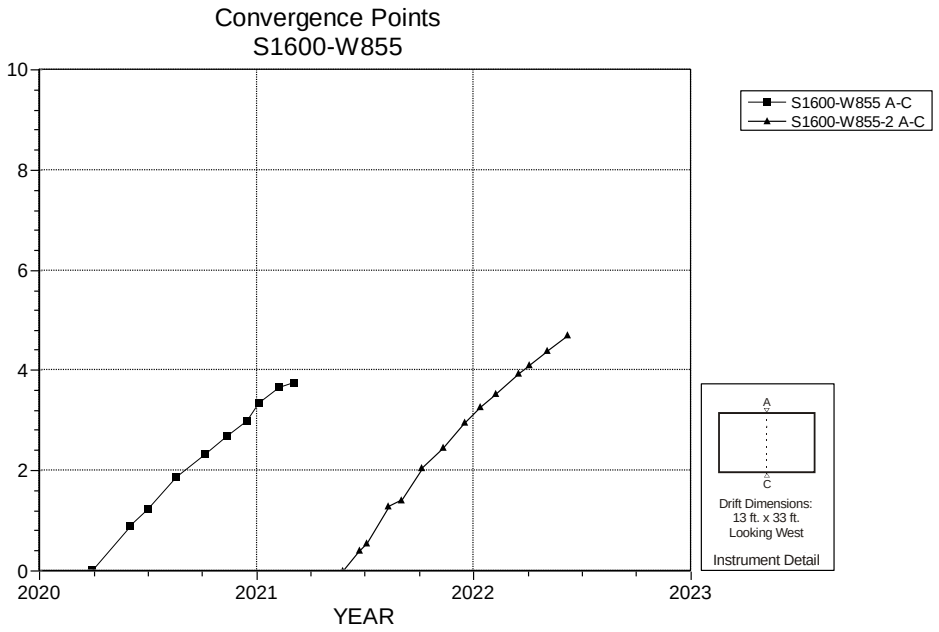
NOTES:
1. Excavation Date: January 2020

Figure 5-53 Convergence Point Array – S1600 W725 – Roof to Floor



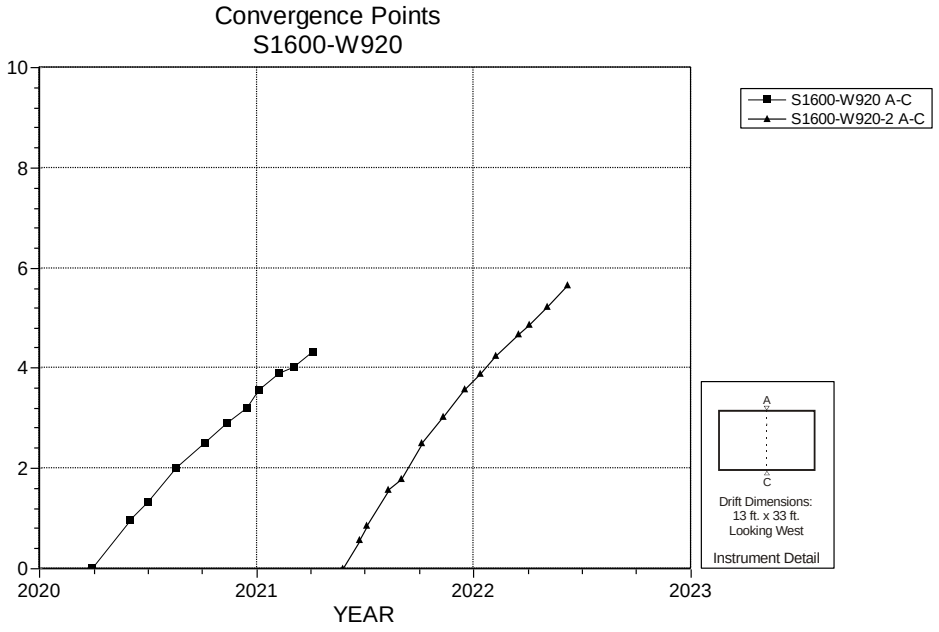
NOTES:
1. Excavation date: January 2020.

Figure 5-54 Convergence Point Array – S1600 W790 – Roof to Floor



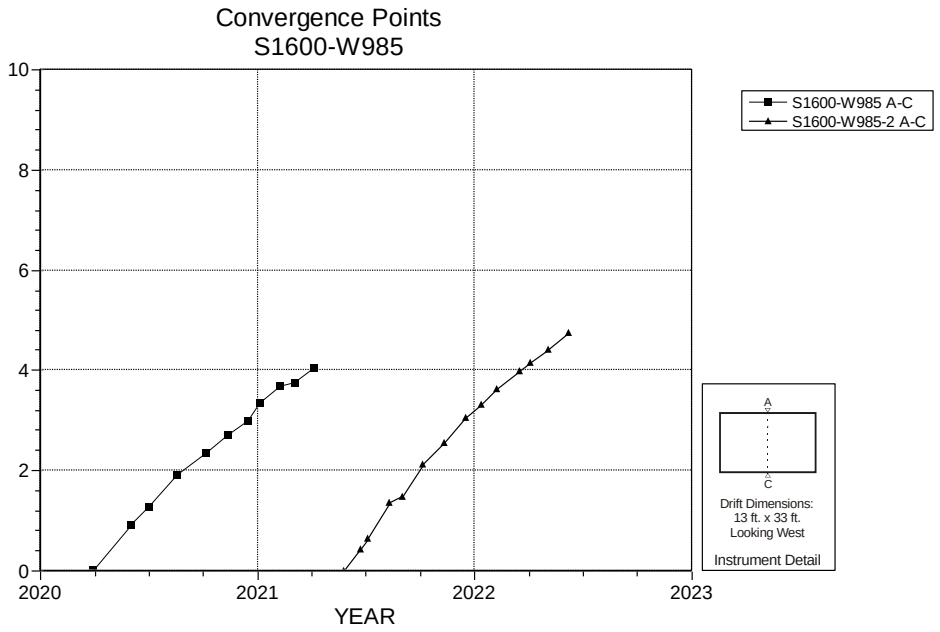
NOTES:
1. Excavation date: January 2020.

Figure 5-55 Convergence Point Array – S1600 W855 – Roof to Floor



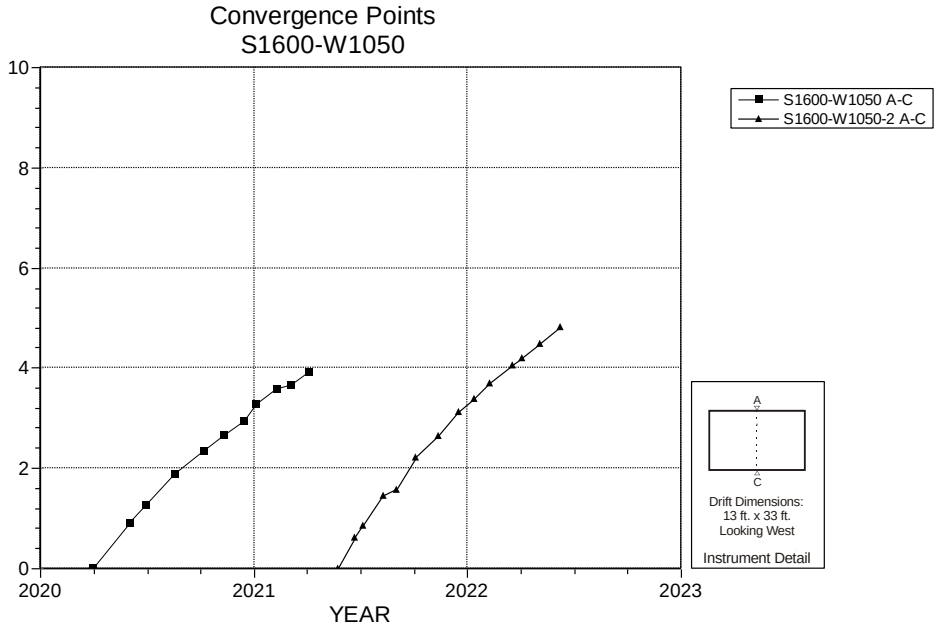
NOTES:
1. Excavation date: January 2020.

Figure 5-56 Convergence Point Array – S1600 W920 – Roof to Floor



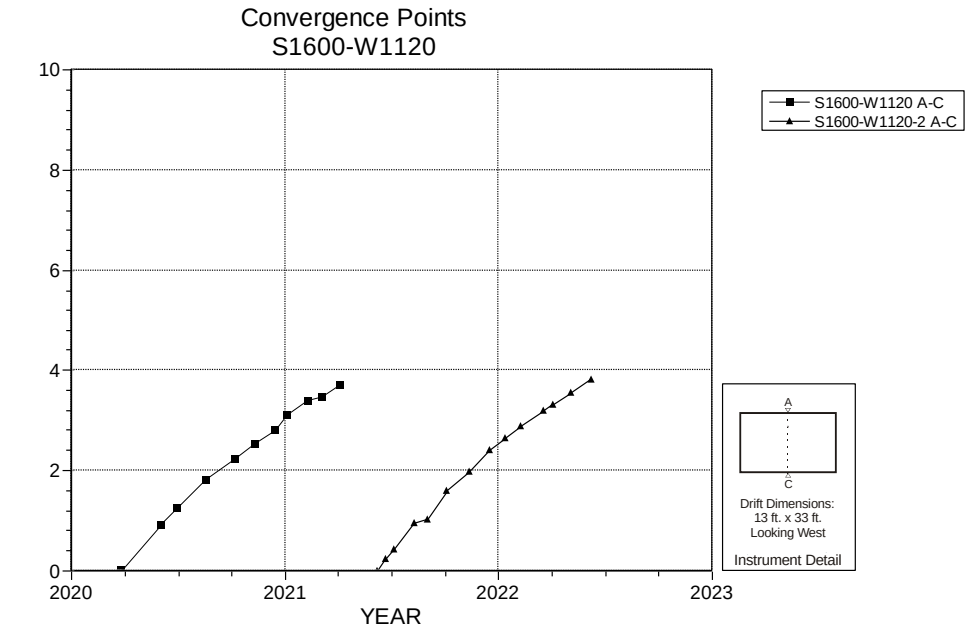
NOTES:
1. Excavation date: January 2020.

Figure 5-57 Convergence Point Array – S1600 W985 – Roof to Floor



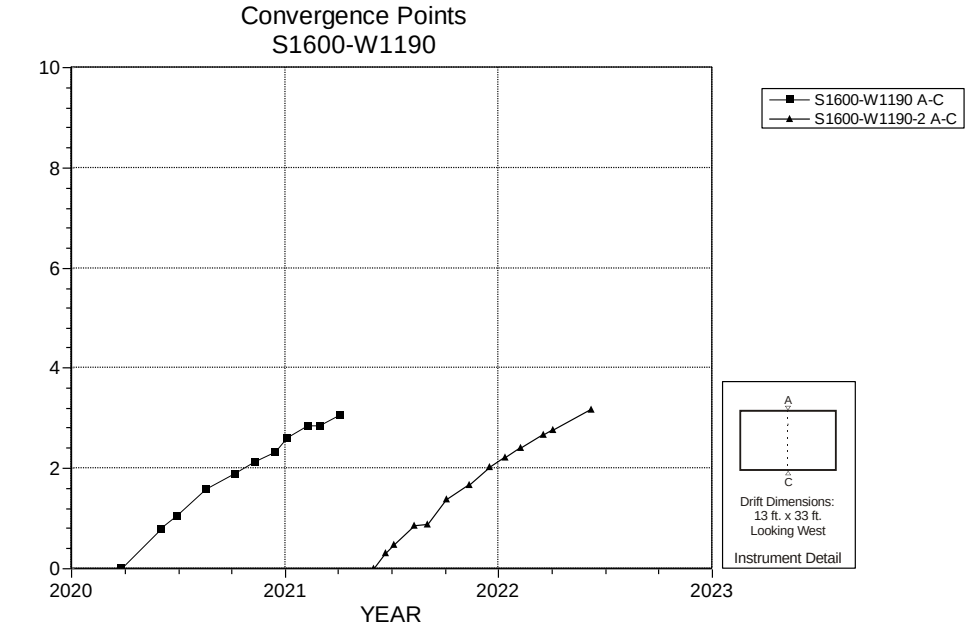
NOTES:
1. Excavation date: January 2020.

Figure 5-58 Convergence Point Array – S1600 W1050– Roof to Floor



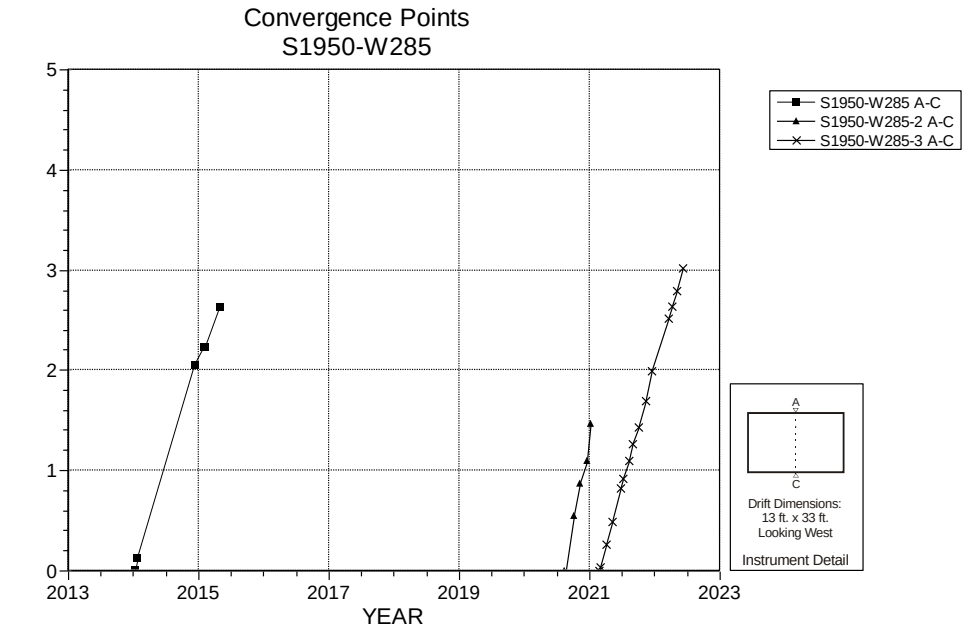
NOTES:
1. Excavation date: January 2020.

Figure 5-59 Convergence Point Array – S1600 W1120 – Roof to Floor



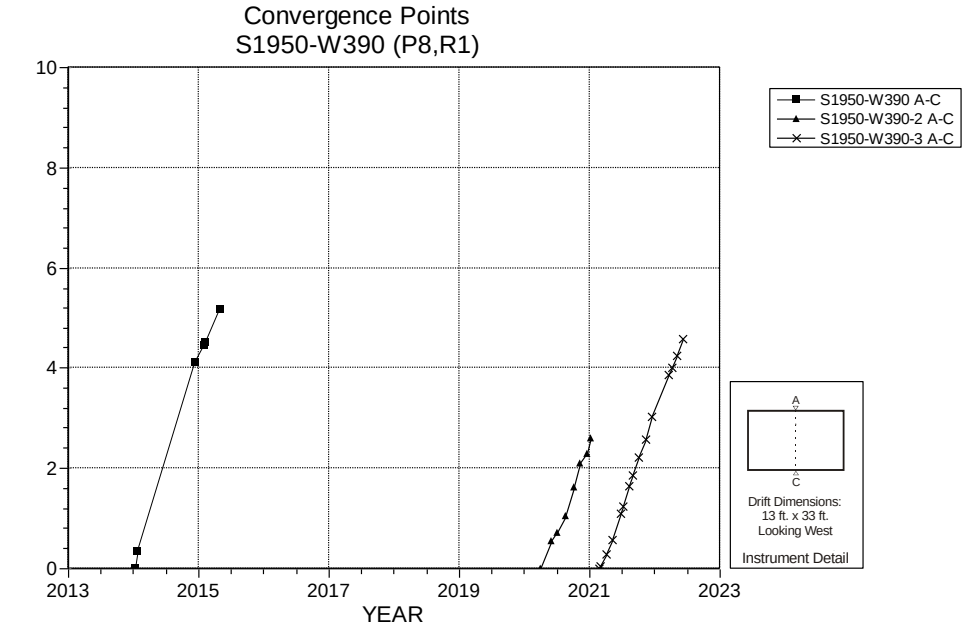
NOTES:
1. Excavation date: January 2020.

Figure 5-60 Convergence Point Array – S1600 W1190 – Roof to Floor



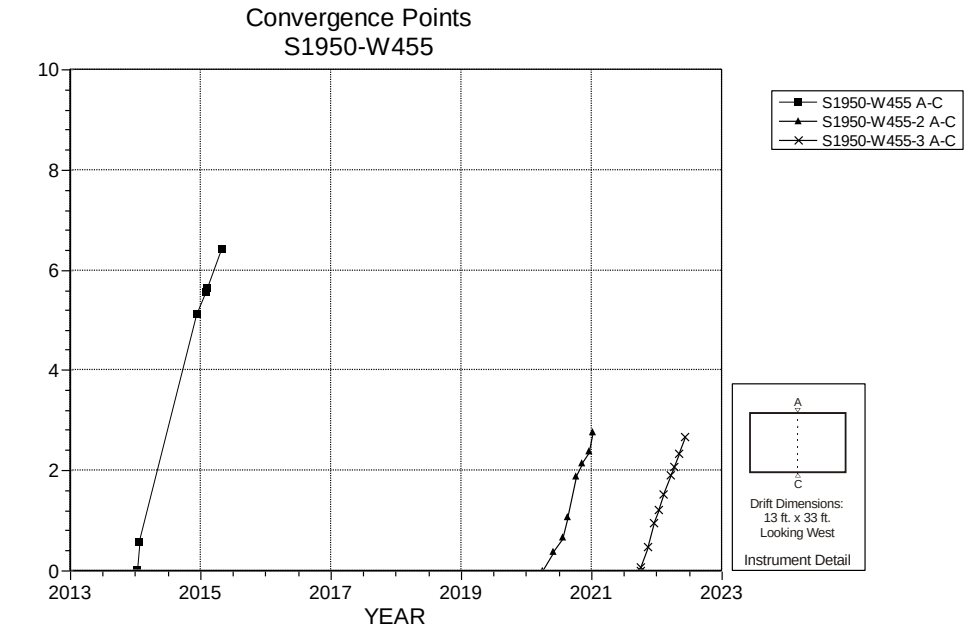
NOTES:
1. Excavation Date: September 2013.

Figure 5-61 Convergence Point Array – S1950 W285 – Roof to Floor



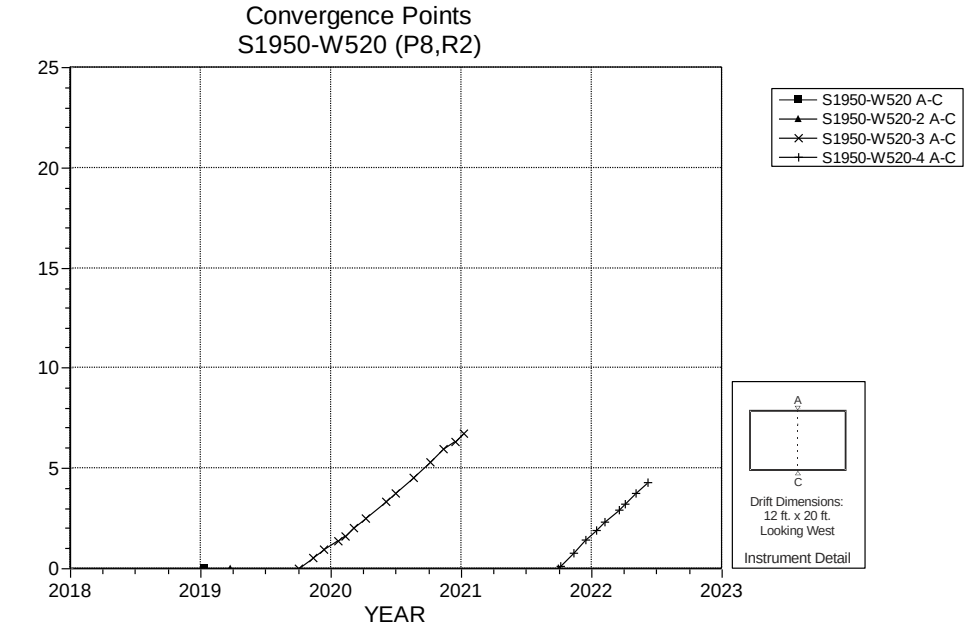
NOTES:
1. Excavation Date: November 2013.

Figure 5-62 Convergence Point Array – S1950 W390 – Roof to Floor



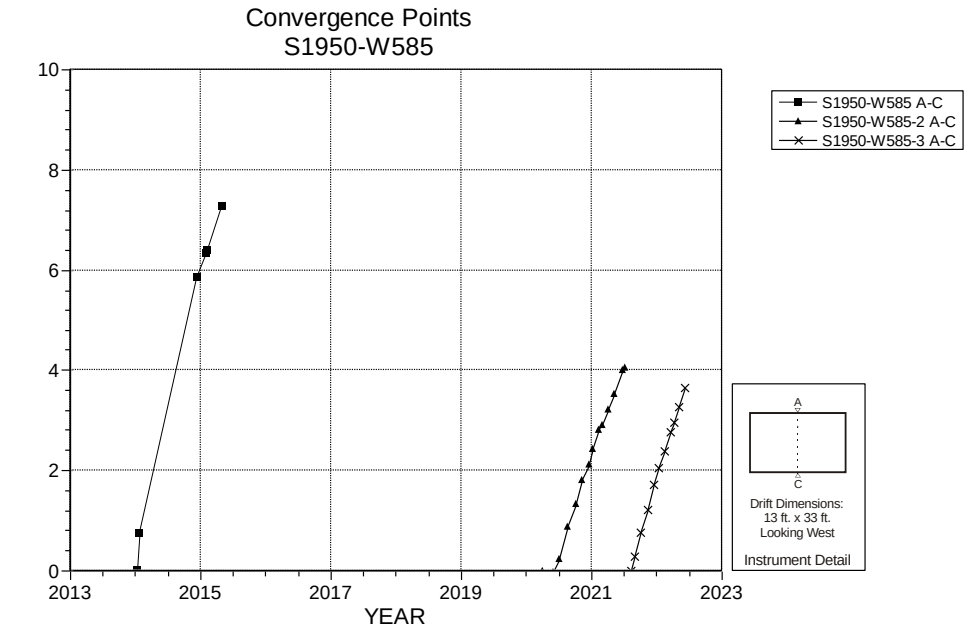
NOTES:
1. Excavation Date: November 2013.

Figure 5-63 Convergence Point Array – S1950 W455 – Roof to Floor



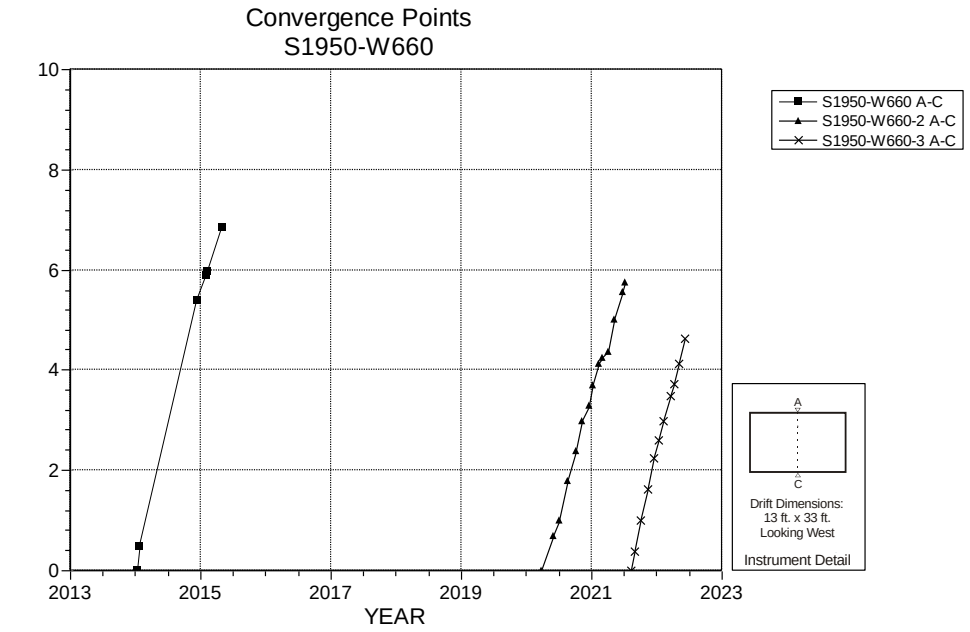
NOTES:
1. Excavation date: October 2013

Figure 5-64 Convergence Point Array – S1950 W520 – Roof to Floor



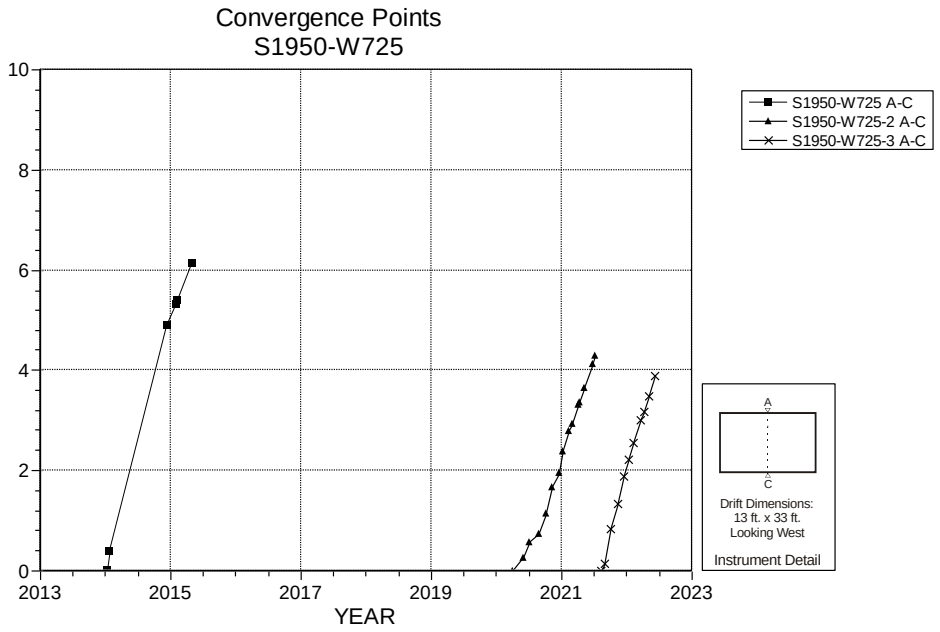
NOTES:
1. Excavation Date: November 2013.

Figure 5-65 Convergence Point Array – S1950 W585 – Roof to Floor



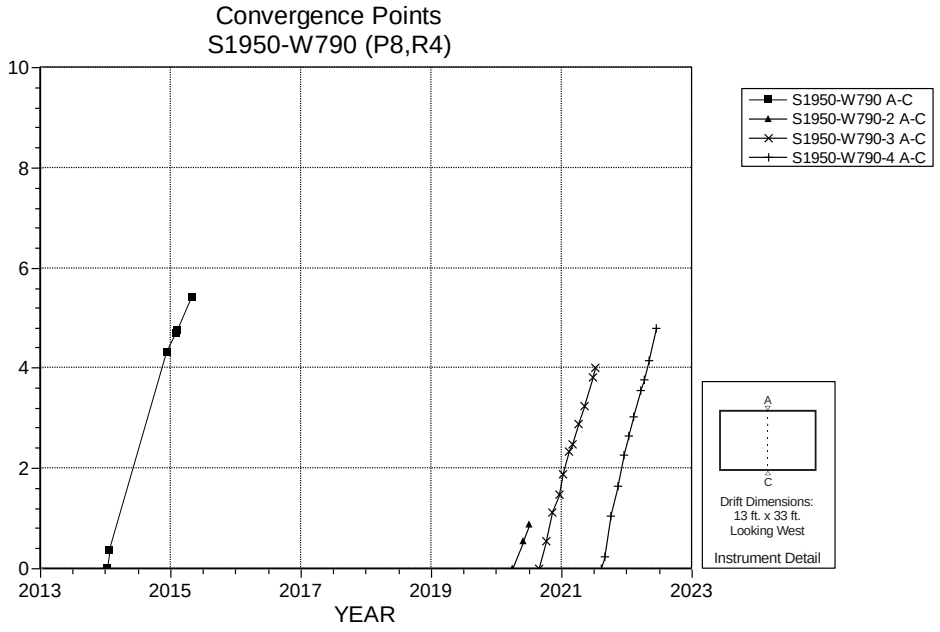
NOTES:
1. Excavation Date: November 2013.

Figure 5-66 Convergence Point Array – S1950 W660 – Roof to Floor



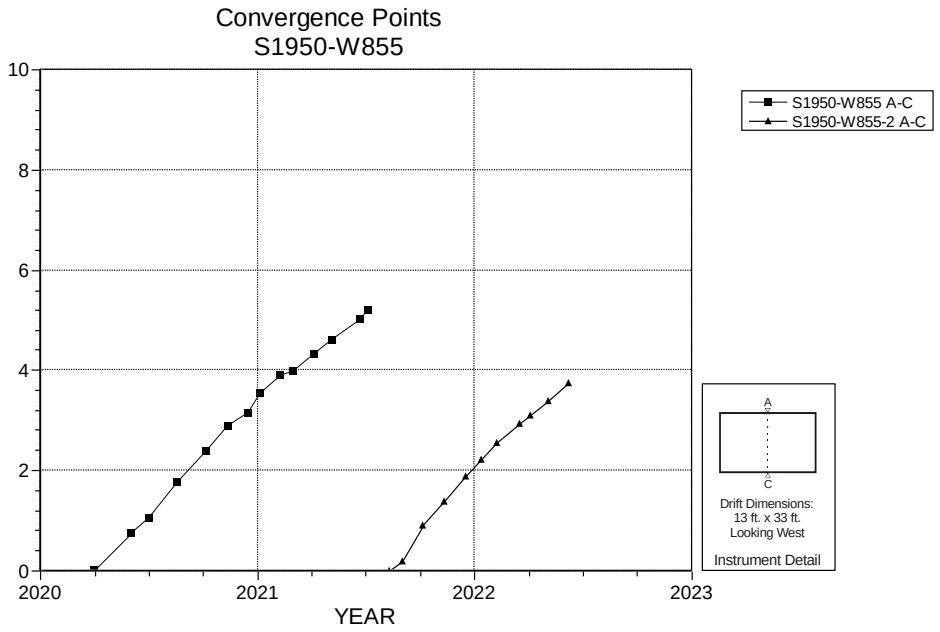
NOTES:
1. Excavation Date: December 2013.

Figure 5-67 Convergence Point Array – S1950 W725 – Roof to Floor



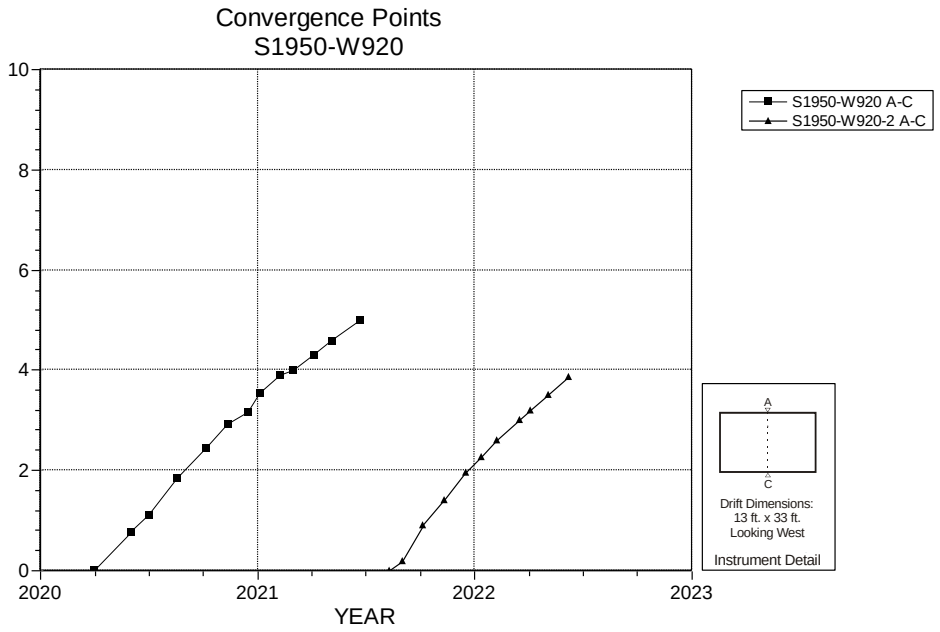
NOTES:
1. Excavation Date: December 2013.

Figure 5-68 Convergence Point Array – S1950 W790 – Roof to Floor



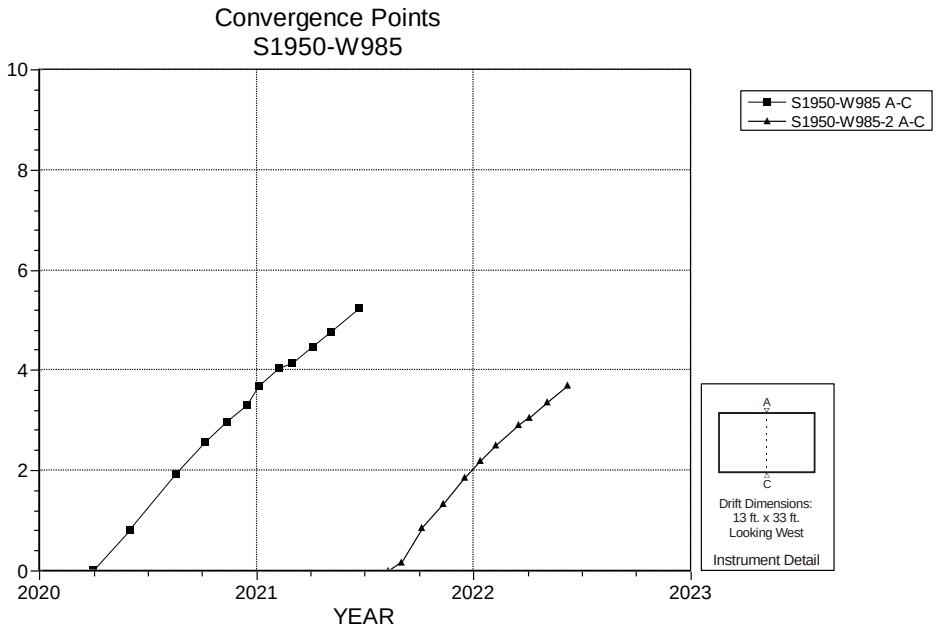
NOTES:
1. Excavation date: January 2020.

Figure 5-69 Convergence Point Array – S1950 W855 – Roof to Floor



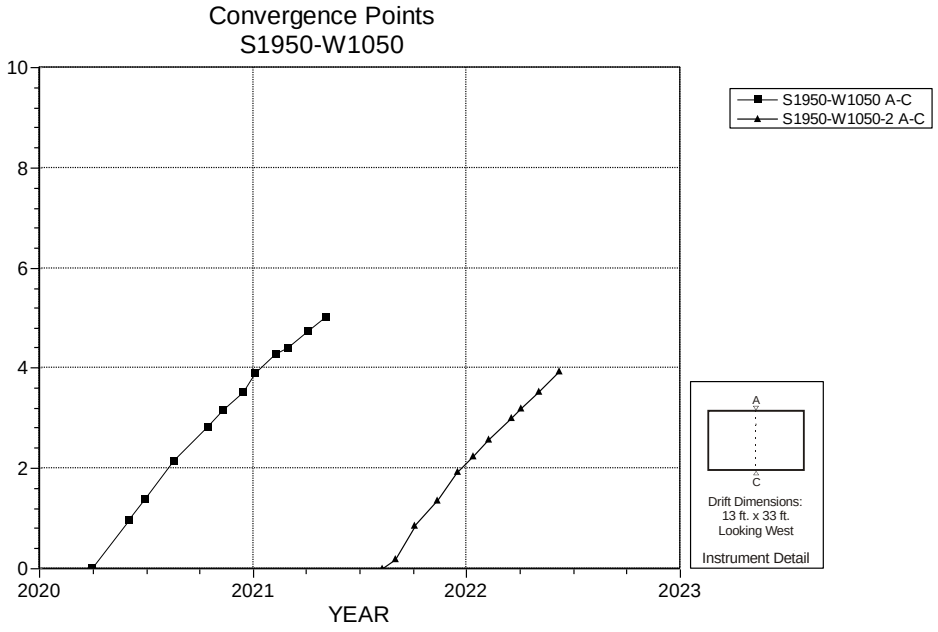
NOTES:
1. Excavation date: January 2020.

Figure 5-70 Convergence Point Array – S1950 W920 – Roof to Floor



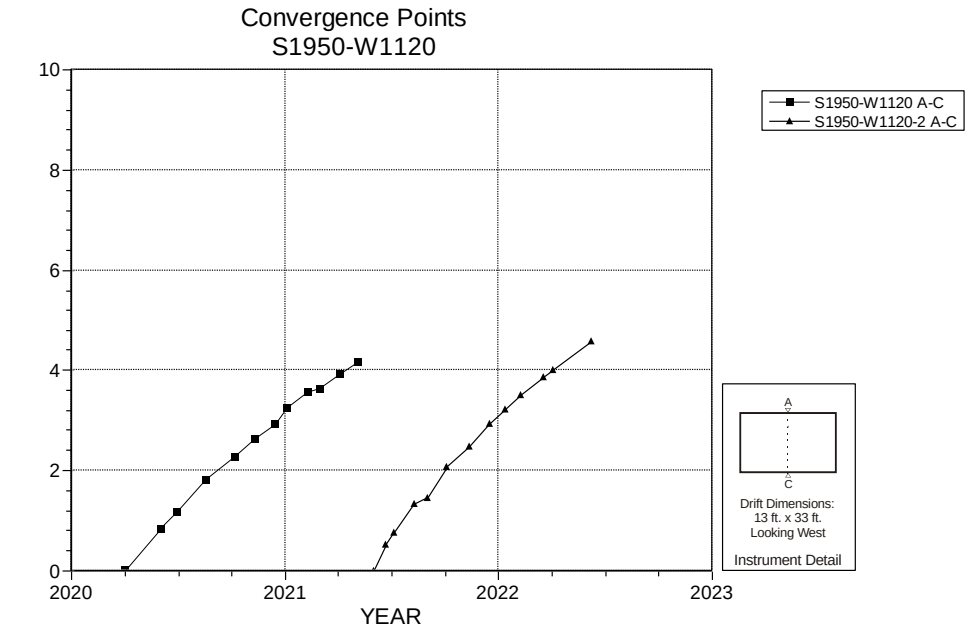
NOTES:
1. Excavation date: January 2020.

Figure 5-71 Convergence Point Array – S1950 W985 – Roof to Floor



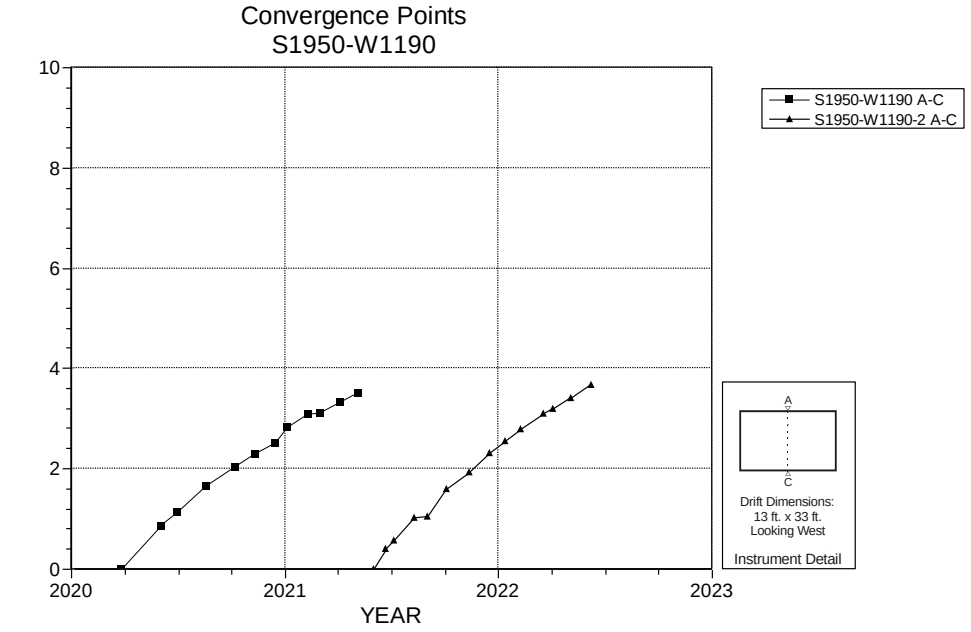
NOTES:
1. Excavation date: January 2020.

Figure 5-72 Convergence Point Array – S1950 W1050 – Roof to Floor



NOTES:
1. Excavation Date: January 2020.

Figure 5-73 Convergence Point Array – S1950 W1120 – Roof to Floor



NOTES:
1. Excavation Date: January 2020.

Figure 5-74 Convergence Point Array – S1950 W1190 – Roof to Floor

6.0 INSTRUMENTATION SUMMARY FOR THE SDI AREA

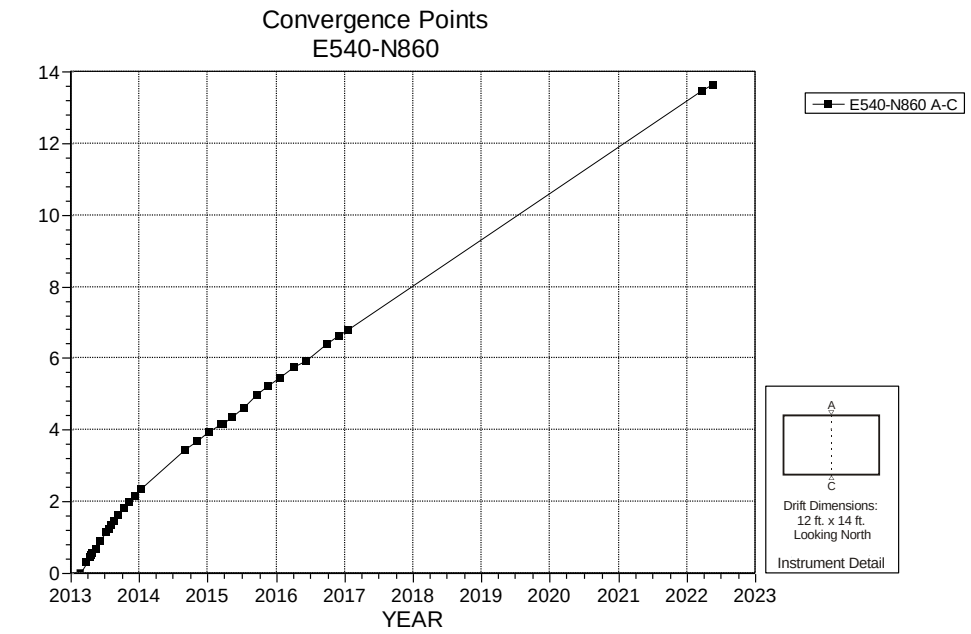
This chapter presents a summary of the data collected from the radial convergence stations located in the SDI area at the WIPP facility. A combination of ground control, and to some extent ventilation challenges, led the Operations Department to continue prohibiting access to a portion of the SDI area during the reporting period in order to allocate resources to other priority areas. As a result, only 35 convergence points out of 55 installed in the SDI were accessible and read during the reporting period. They are captured in the following pages.

Table 6-1 SDI Data Analysis

Convergence Points									
Field Tag	Location	Figure Number	Last Reading 2021 to 2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate 2020 to 2021 (in/year)	Rate Change Percent	Comments
			Date	Inches					
E540-N860 A-C	E540-N860	6-1	5/20/2022	13.643	13.643	1.11	N/A	N/A	No Readings Taken for ’20 – ‘21
E690-N860-2 A-C	E690-N860	6-2	5/20/2022	8.932	9.154	1.80	N/A	N/A	No Readings Taken for ’20 – ‘21
E1110-N860 A-C	E1110-N860	6-3	5/20/2022	0.723	0.723	1.30	N/A	N/A	New Installation
E1300-N860 A-C	E1300-N860	6-4	5/20/2022	9.677	9.677	1.04	0.72	44	N/A
N780-E220-5 A-C	N780-E220	6-5	5/20/2022	2.427	37.145	2.36	2.28	4	N/A
N780-E300-3 A-C	N780-E300	6-6	5/20/2022	18.472	21.101	1.99	1.69	18	N/A
N780-E420-2 A-C	N780-E420	6-7	5/20/2022	15.333	19.159	1.76	1.33	32	N/A
N780-E540-2 A-C	N780-E540	6-8	5/20/2022	19.775	24.195	1.90	1.59	19	N/A
N780-E615-2 A-C	N780-E615	6-9	5/20/2022	15.432	18.650	1.57	1.27	24	N/A
N780-E690-2 A-C	N780-E690	6-10	5/20/2022	20.396	25.746	2.02	1.69	20	N/A
N780-E768 A-C	N780-E768	6-11	5/20/2022	16.973	16.973	1.64	1.35	21	N/A
N780-E845 A-C	N780-E845	6-12	5/20/2022	18.581	18.581	1.73	1.38	25	N/A
N780-E922 A-C	N780-E922	6-13	5/20/2022	18.836	18.836	1.76	1.39	27	N/A
N780-E1050 A-C	N780-E1050	6-14	5/20/2022	17.531	17.531	1.46	1.13	29	N/A
N780-E1100 A-C	N780-E1100	6-15	5/20/2022	17.527	17.527	1.39	1.05	32	N/A
N780-E1150 A-C	N780-E1150	6-16	5/20/2022	16.444	16.444	1.42	1.07	33	N/A
N780-E1200 A-C	N780-E1200	6-17	5/20/2022	16.052	16.052	1.36	1.01	35	N/A
N780-E1250 A-C	N780-E1250	6-18	5/20/2022	13.471	13.471	1.21	0.89	36	N/A
N780-E1300 A-C	N780-E1300	6-19	5/20/2022	8.781	8.781	0.96	0.6	60	N/A
N940-E220-2 A-C	N940-E220	6-20	5/20/2022	9.585	11.020	0.96	0.77	25	N/A
N940-E300-2 A-C	N940-E300	6-21	5/20/2022	11.769	13.535	1.30	1.07	21	N/A
N940-E420-2 A-C	N940-E420	6-22	9/9/2021	15.374	17.820	2.63	1.68	57	N/A
N940-E540-2 A-C	N940-E540	6-23	5/20/2022	16.665	19.616	1.75	1.68	4	N/A
N940-E615-2 A-C	N940-E615	6-24	5/20/2022	16.283	19.108	1.49	1.45	3	N/A
N940-E690-3 A-C	N940-E690	6-25	5/20/2022	23.425	25.793	2.21	1.91	16	N/A
N940-E768-2 A-C	N940-E768	6-26	5/20/2022	16.656	17.491	1.84	1.59	16	N/A
N940-E845-2 A-C	N940-E845	6-27	5/20/2022	14.740	15.663	1.59	1.38	15	N/A
N940-E922-2 A-C	N940-E922	6-28	5/20/2022	14.990	16.213	1.53	1.28	20	N/A
N940-E1000 A-C	N940-E1000	6-29	5/20/2022	16.901	16.901	1.67	1.38	21	N/A
N940-E1050-2 A-C	N940-E1050	6-30	5/20/2022	13.849	15.366	1.44	1.10	31	N/A
N940-E1100 A-C	N940-E1100	6-31	5/20/2022	17.509	17.509	1.77	1.41	26	N/A
N940-E1150 A-C	N940-E1150	6-32	5/20/2022	13.943	13.943	1.45	1.14	27	N/A
N940-E1200 A-C	N940-E1200	6-33	5/20/2022	14.554	14.554	1.47	1.13	30	N/A
N940-E1250 A-C	N940-E1250	6-34	5/20/2022	11.217	11.217	1.19	0.87	37	N/A

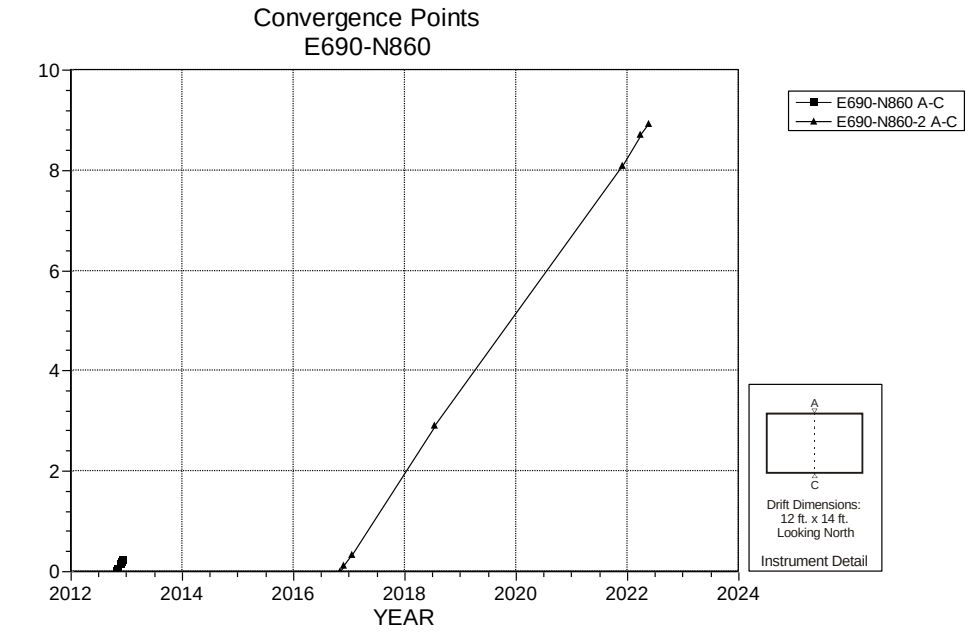
Table 6-1 SDI Data Analysis (Continued)

Convergence Points (Continued)									
Field Tag	Location	Figure Number	Last Reading 2021 to 2022		Cumulative Displacement (inches)	Closure Rate 2021 to 2022 (in/year)	Closure Rate 2020 to 2021 (in/year)	Rate Change Percent	Comments
			Date	Inches					
N940-E1300 A-C	N940-E1300	6-35	5/20/2022	12.598	12.598	1.31	0.95	38	N/A



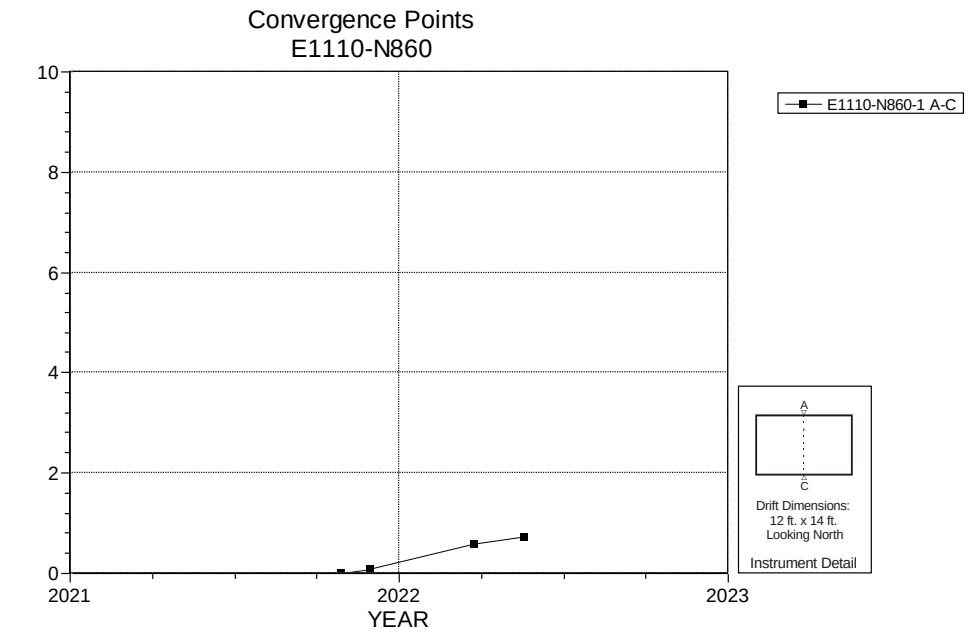
NOTES:
1. Excavation date: June 2012.

Figure 6-1 Convergence Point Array – E540 N860 – Roof to Floor



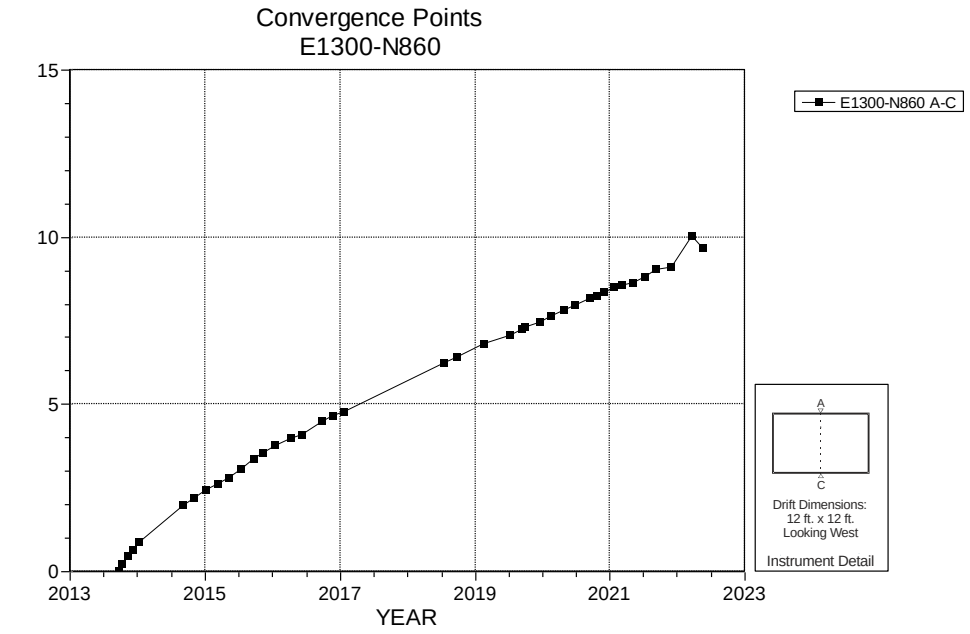
NOTES:
1. Excavation date: August 2012.

Figure 6-2 Convergence Point Array – E690 N860 – Roof to Floor



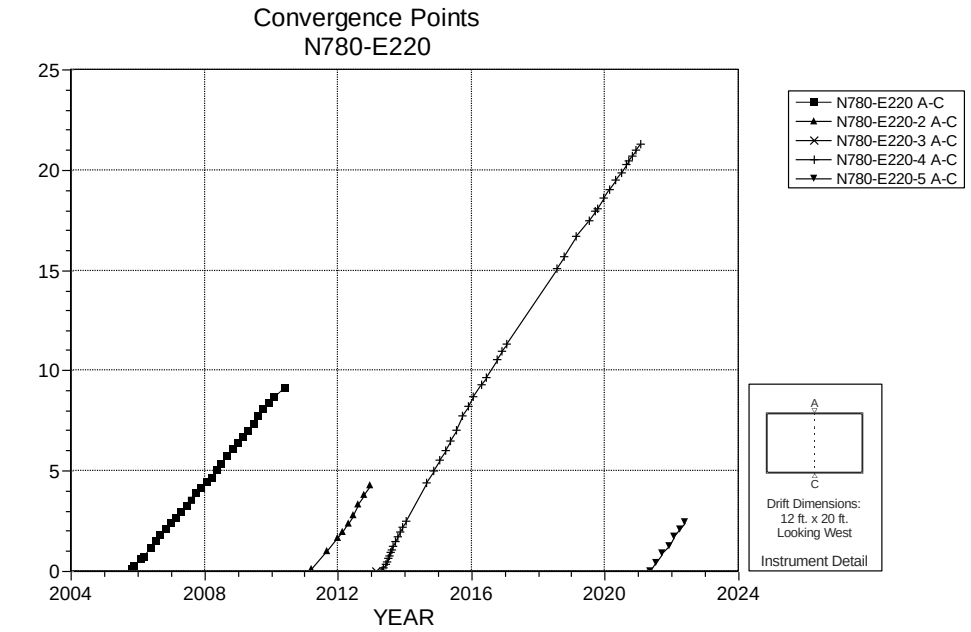
NOTES:
1. Excavation date: June 2012.

Figure 6-3 Convergence Point Array – E1110 N860 – Roof to Floor



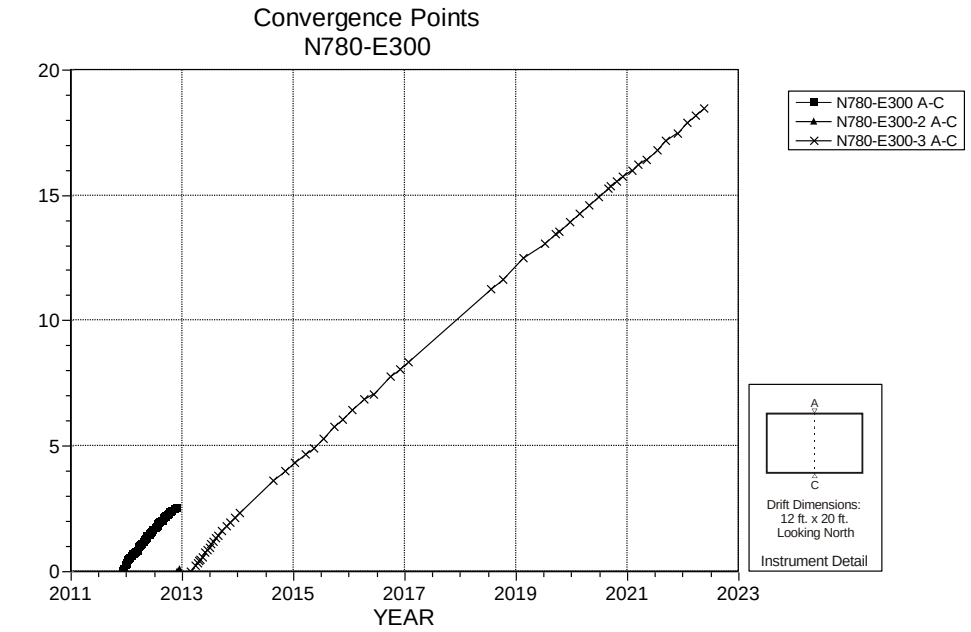
NOTES:
1. Excavation date: July 2013.

Figure 6-4 Convergence Point Array – E1300 N860 – Roof to Floor



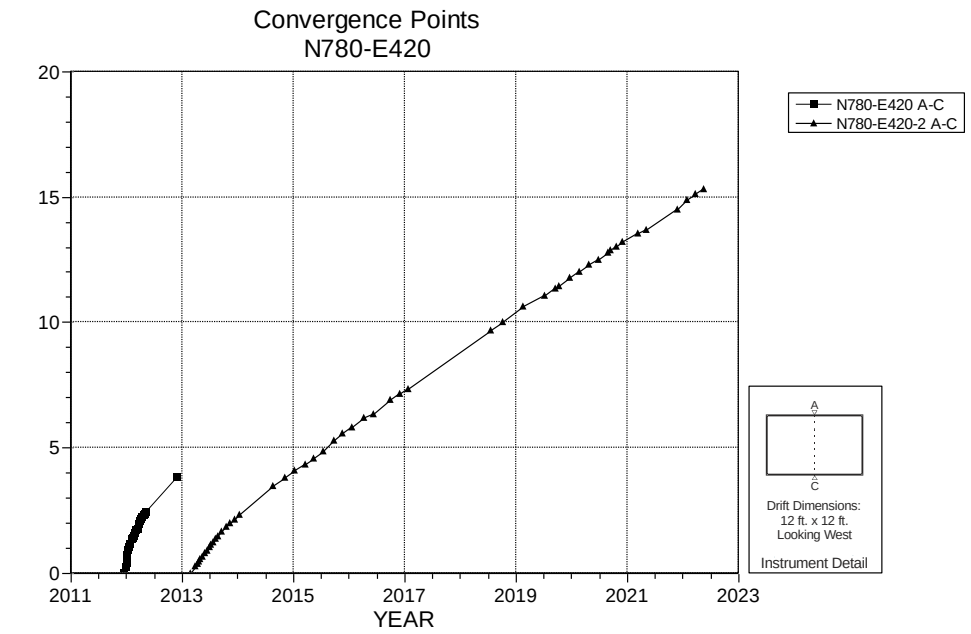
NOTES:
1. Excavation date: February 1983.

Figure 6-5 Convergence Point Array – N780 E220 – Roof to Floor



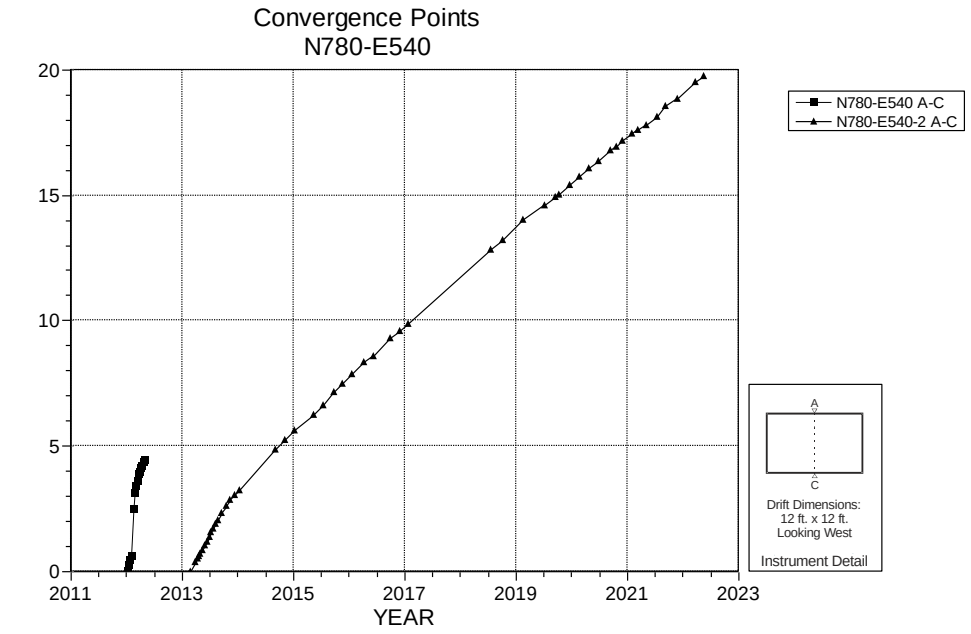
NOTES:
1. Excavation date: December 2011.

Figure 6-6 Convergence Point Array – N780 E300 – Roof to Floor



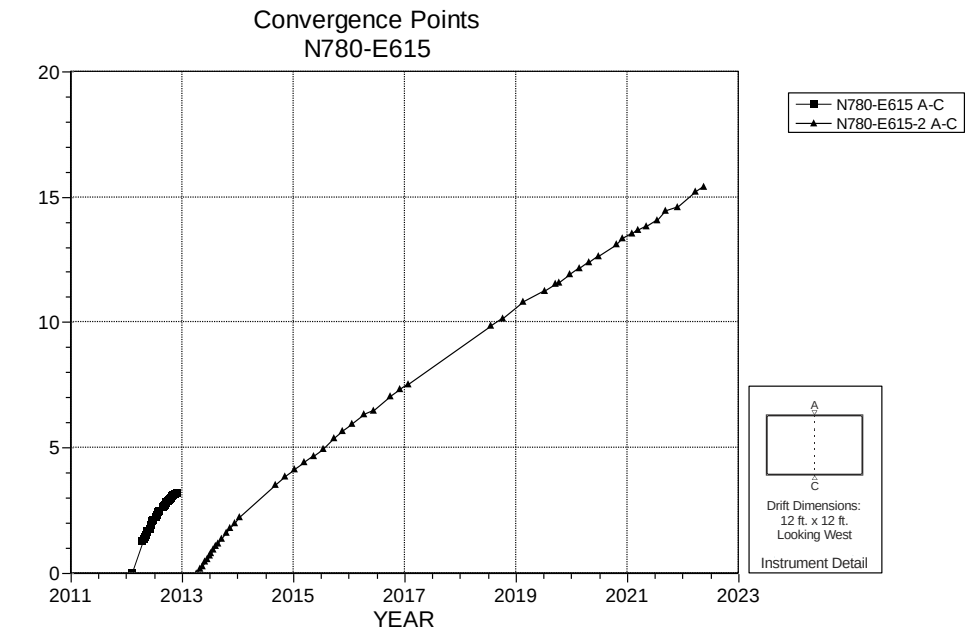
NOTES:
1. Excavation date: December, 2011.

Figure 6-7 Convergence Point Array – N780 E420 – Roof to Floor



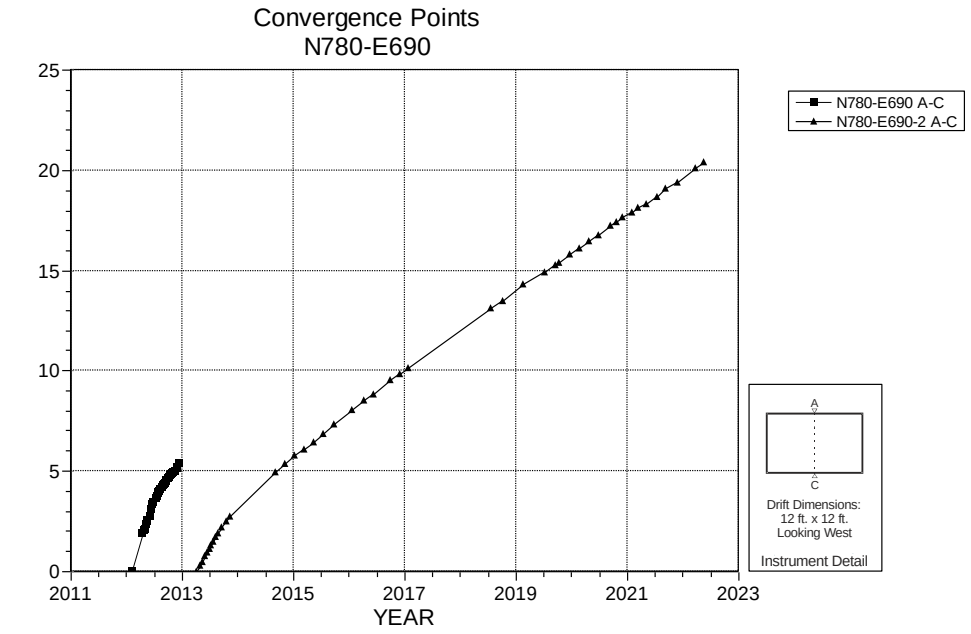
NOTES:
1. Excavation date: January 2012.

Figure 6-8 Convergence Point Array – N780 E540 – Roof to Floor



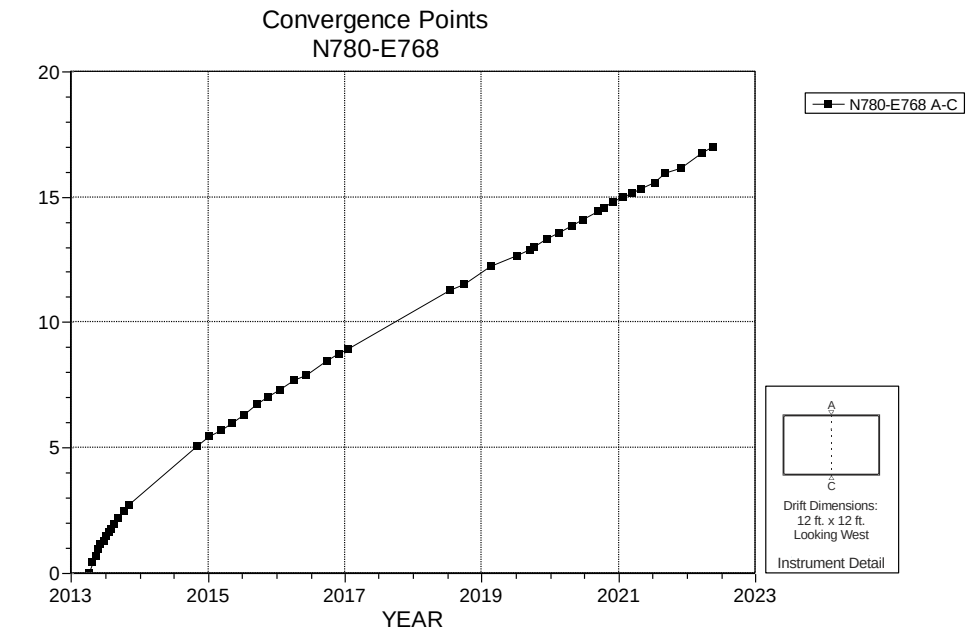
NOTES:
1. Excavation date: January 2012.

Figure 6-9 Convergence Point Array – N780 E615 – Roof to Floor



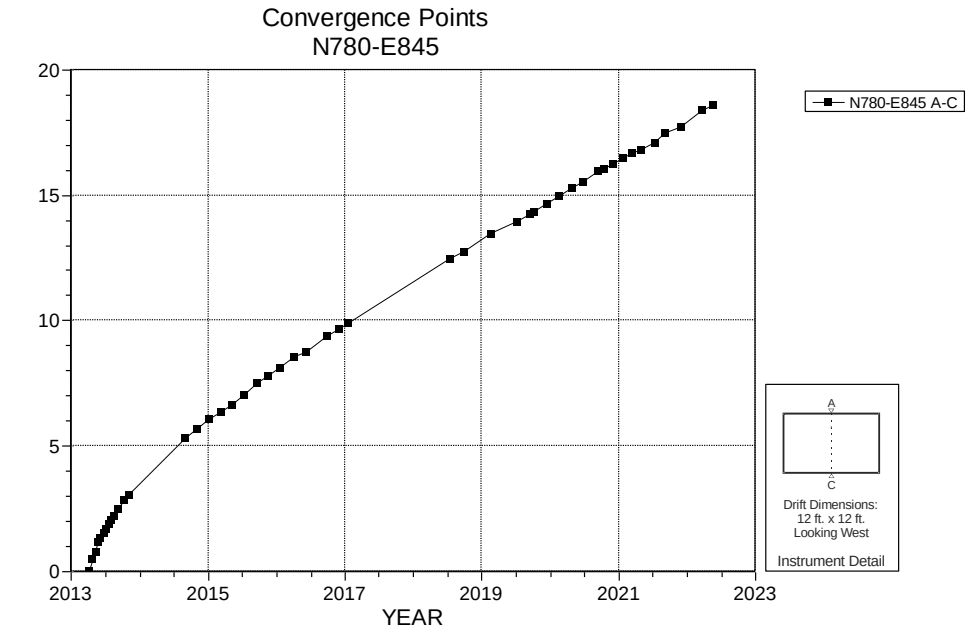
NOTES:
1. Excavation date: January 2012.

Figure 6-10 Convergence Point Array – N780 E690 – Roof to Floor



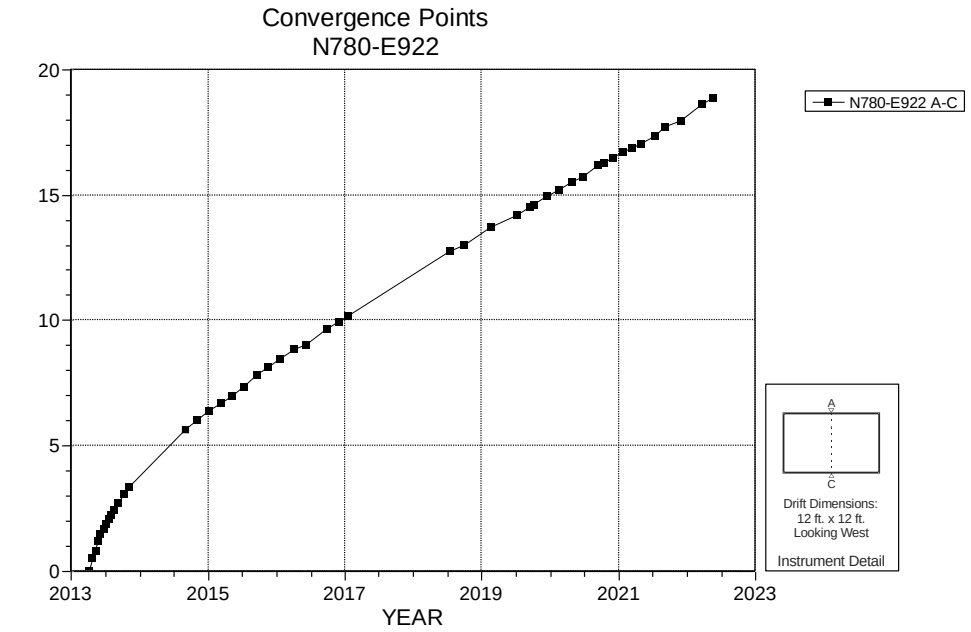
NOTES:
1. Excavation date: February 2013.

Figure 6-11 Convergence Point Array – N780 E768 – Roof to Floor



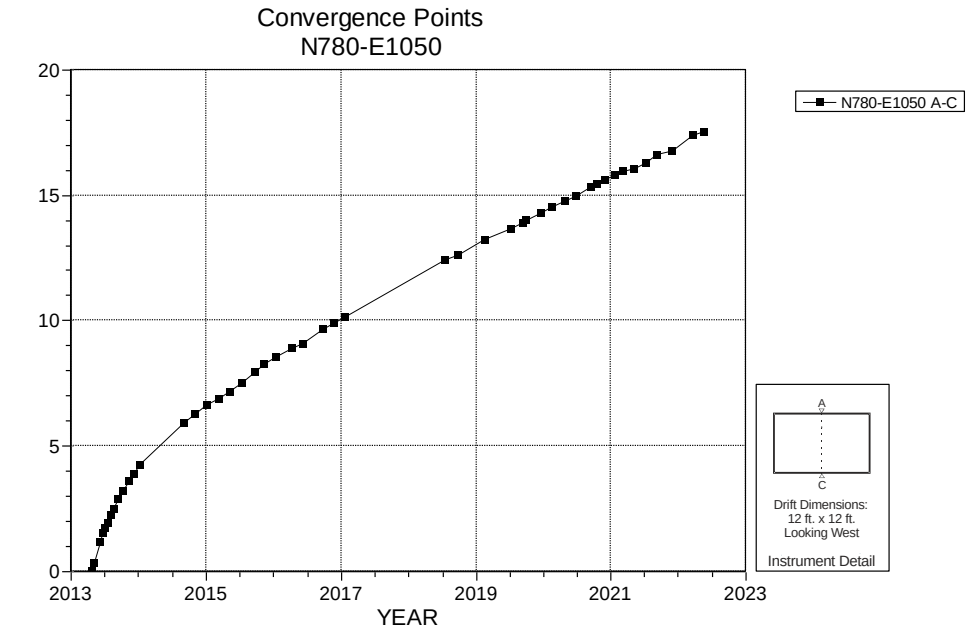
NOTES:
1. Excavation date: February 2013.

Figure 6-12 Convergence Point Array – N780 E845 – Roof to Floor



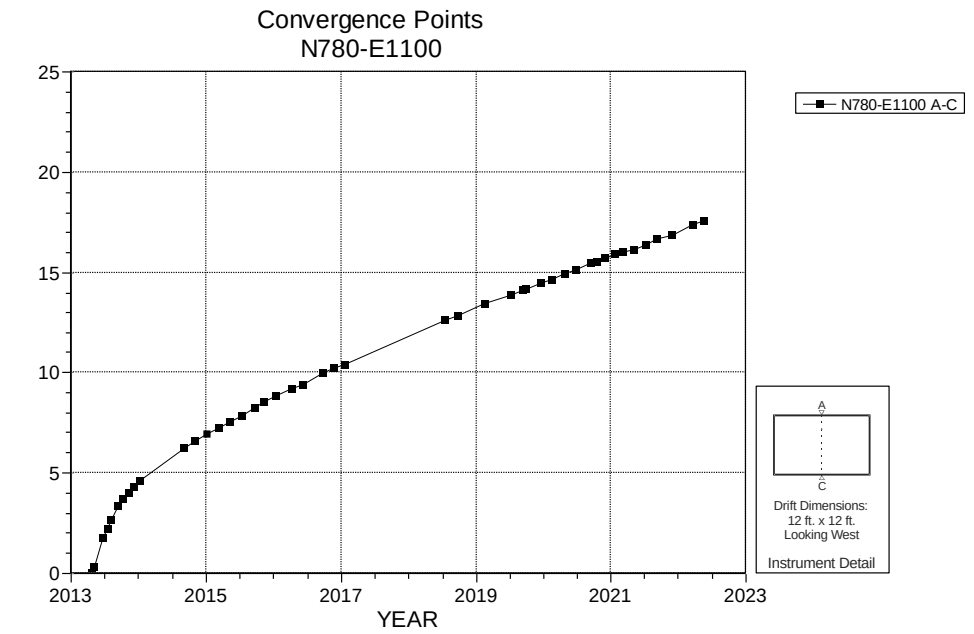
NOTES:
1. Excavation date: February 2013.

Figure 6-13 Convergence Point Array – N780 E922 – Roof to Floor



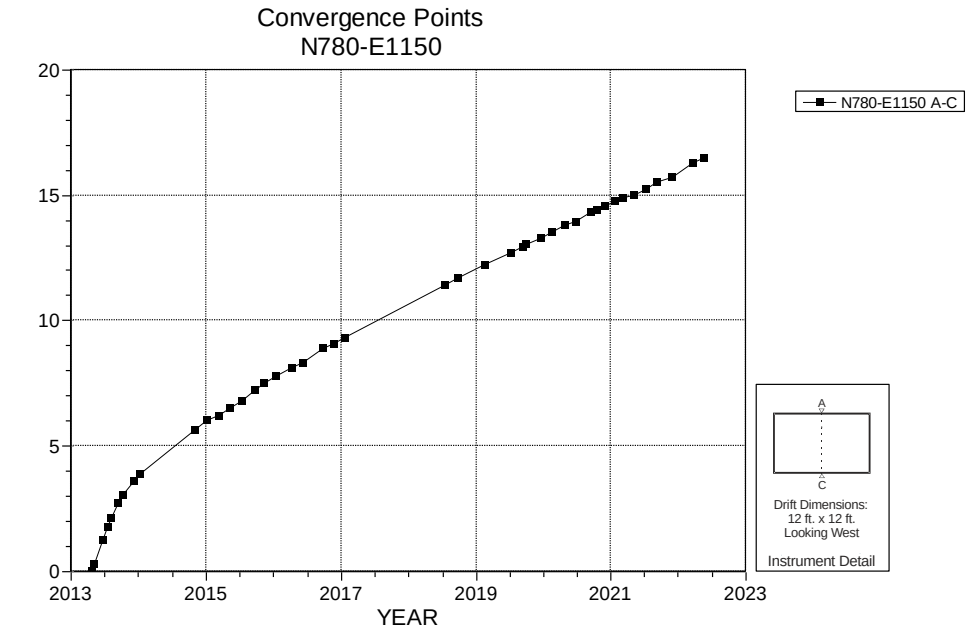
NOTES:
1. Excavation date: March 2013.

Figure 6-14 Convergence Point Array – N780 E1050 – Roof to Floor



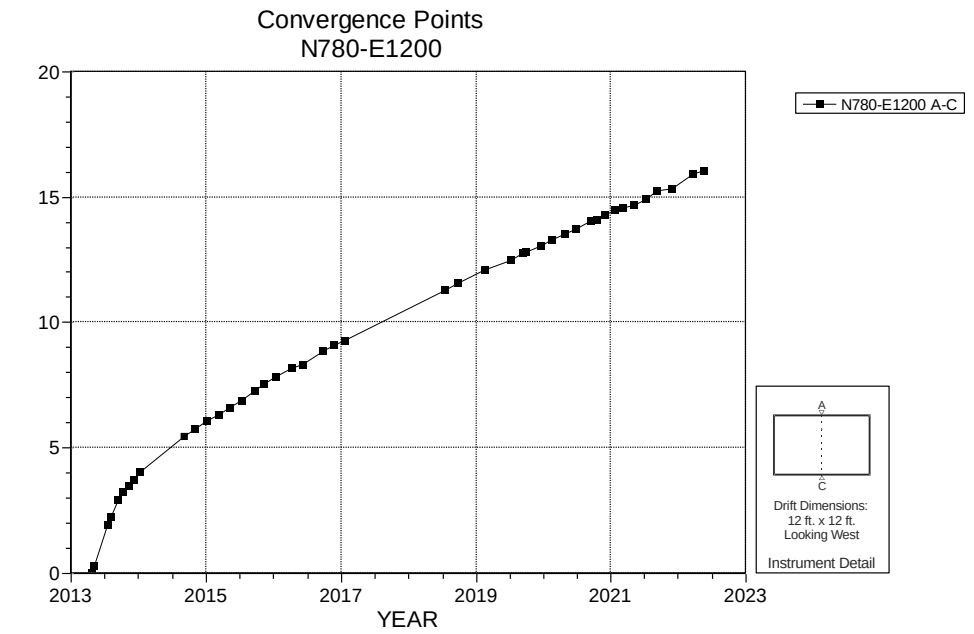
NOTES:
1. Excavation date: March 2013.

Figure 6-15 Convergence Point Array – N780 E1100 – Roof to Floor



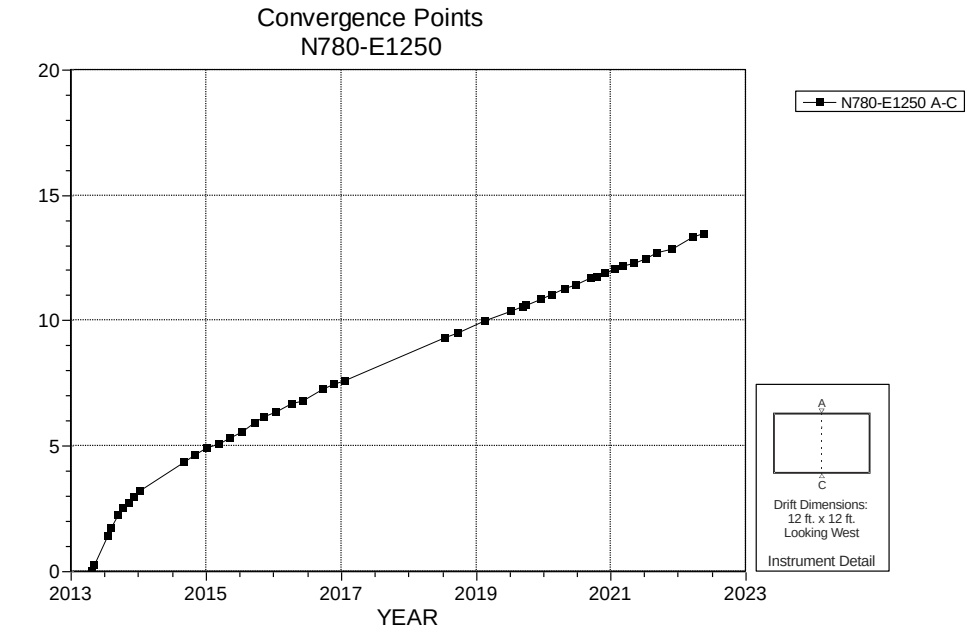
NOTES:
1. Excavation date: March 2013.

Figure 6-16 Convergence Point Array – N780 E1150 – Roof to Floor



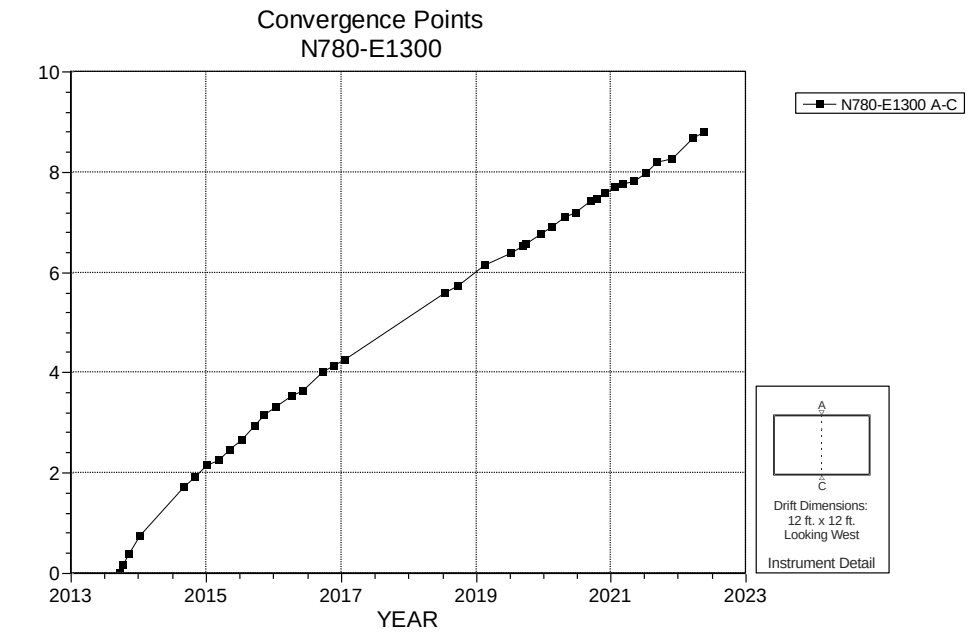
NOTES:
1. Excavation date: March 2013.

Figure 6-17 Convergence Point Array – N780 E1200 – Roof to Floor



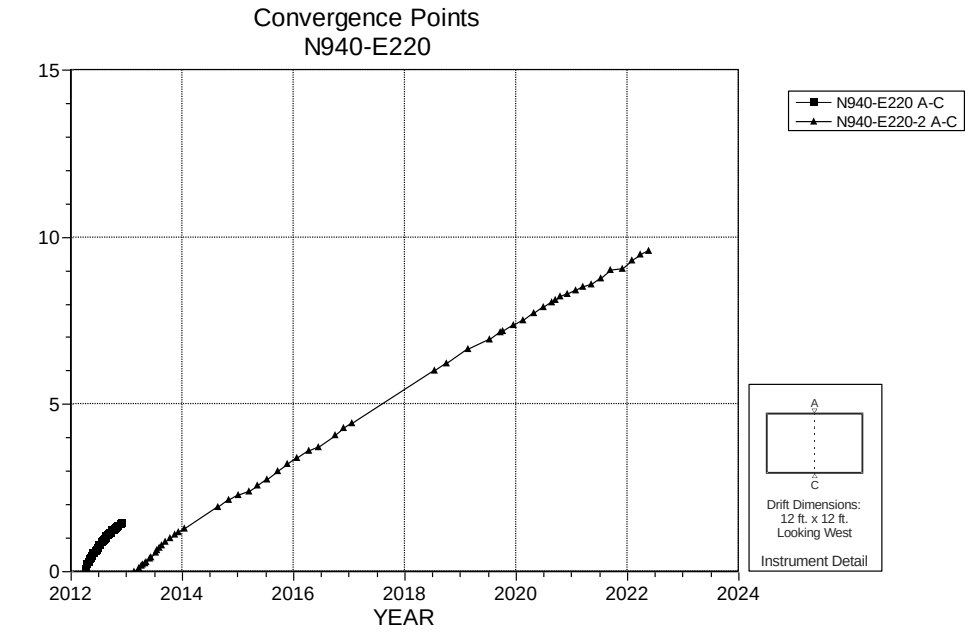
NOTES:
1. Excavation date: April 2013.

Figure 6-18 Convergence Point Array – N780 E1250 – Roof to Floor



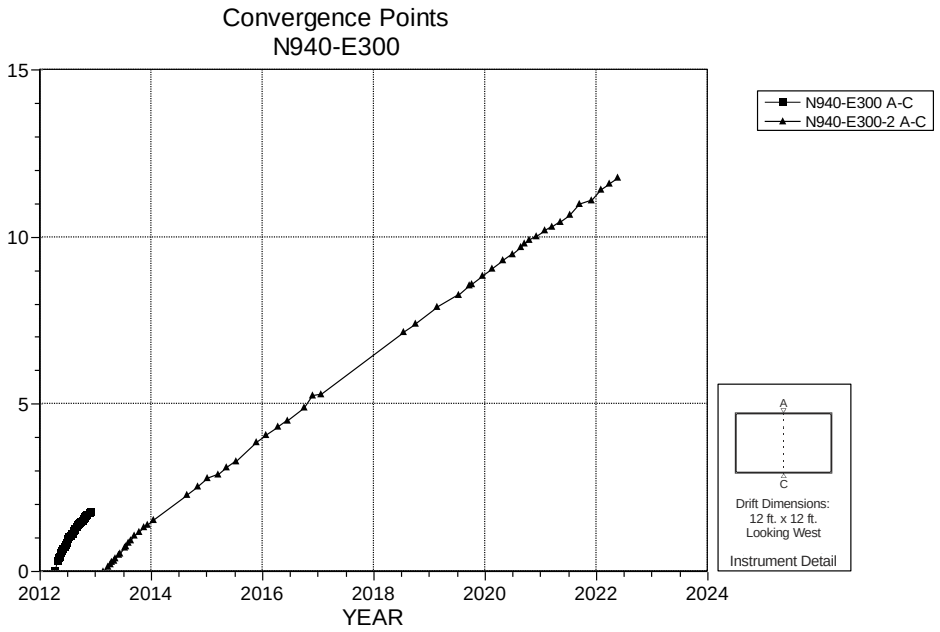
NOTES:
1. Excavation date: April 2013.

Figure 6-19 Convergence Point Array – N780 E1300 – Roof to Floor



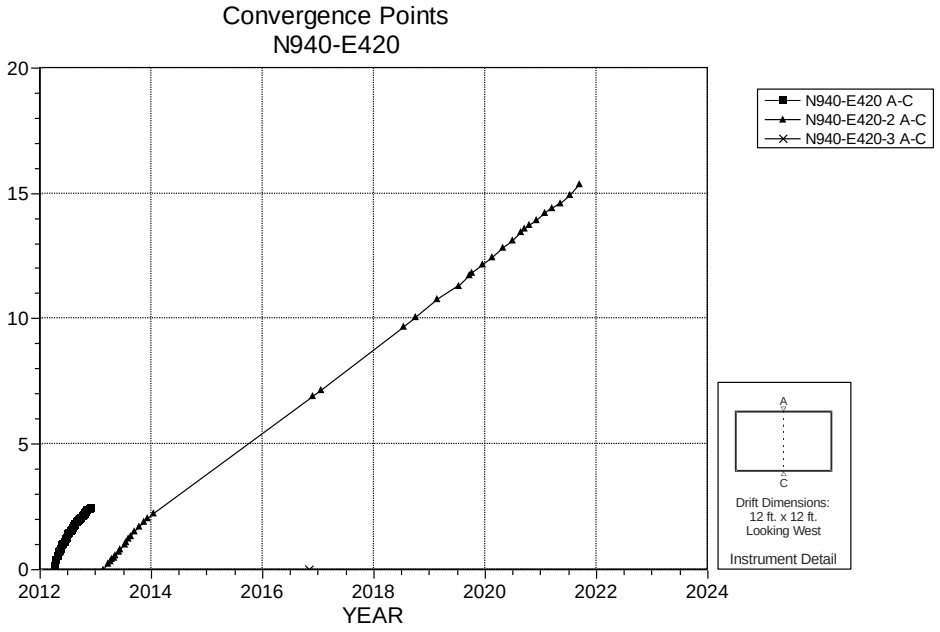
NOTES:
1. Excavation date: March 2012.

Figure 6-20 Convergence Point Array – N940 E220 – Roof to Floor



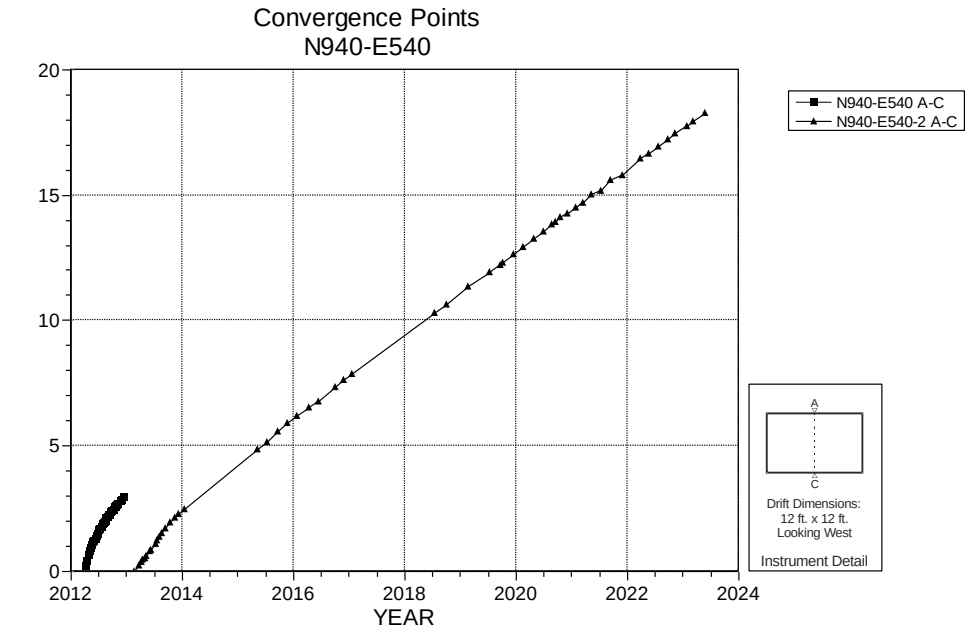
NOTES:
1. Excavation date: March 2012.

Figure 6-21 Convergence Point Array – N940 E300 – Roof to Floor



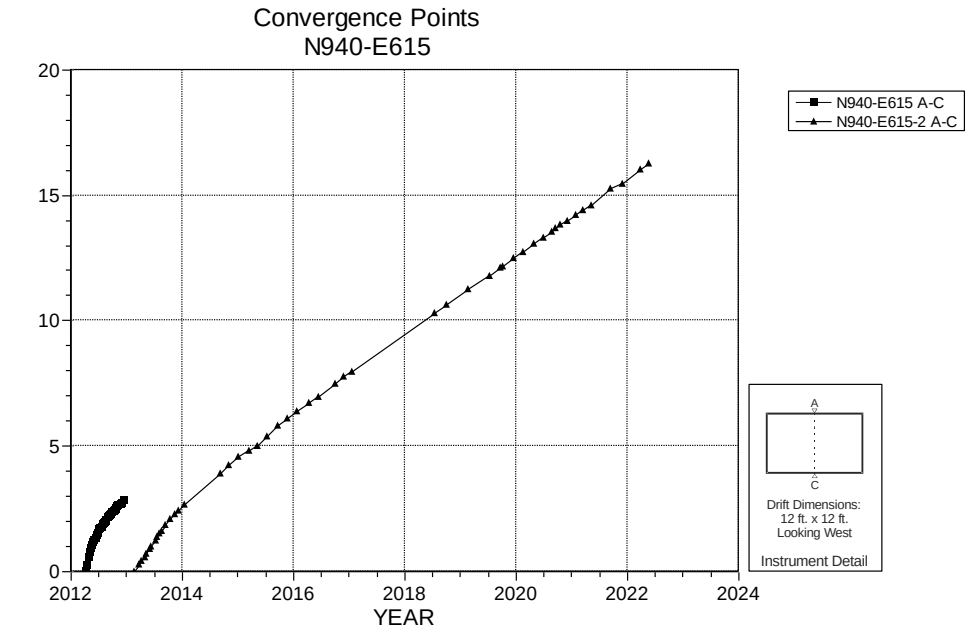
NOTES:
1. Excavation Date: March 2012.

Figure 6-22 Convergence Point Array – N940 E420 – Roof to Floor



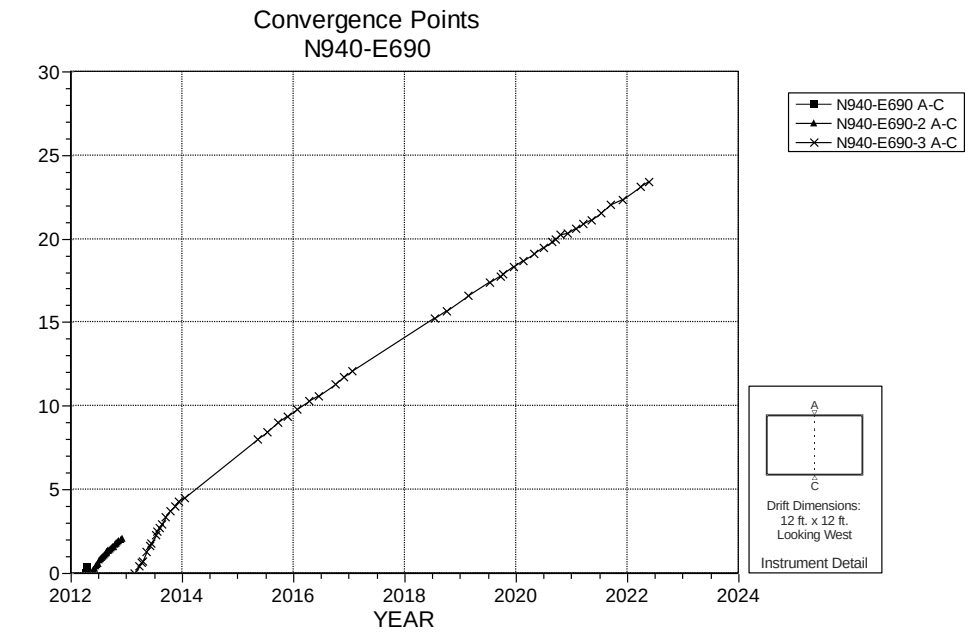
NOTES:
1. Excavation date: March 2012.

Figure 6-23 Convergence Point Array – N940 E540 – Roof to Floor



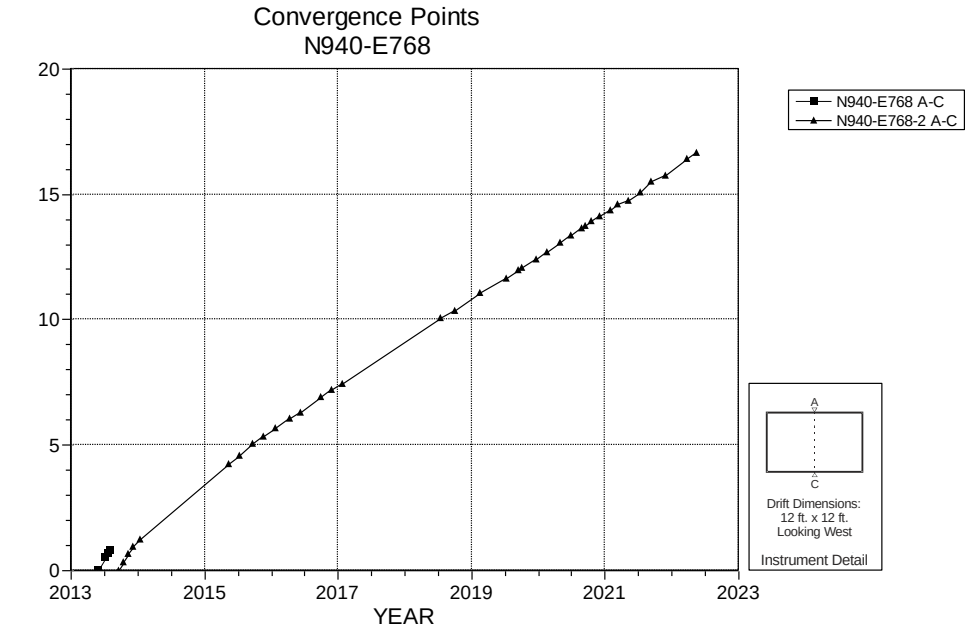
NOTES:
1. Excavation date: March 2012.

Figure 6-24 Convergence Point Array – N940 E615 – Roof to Floor



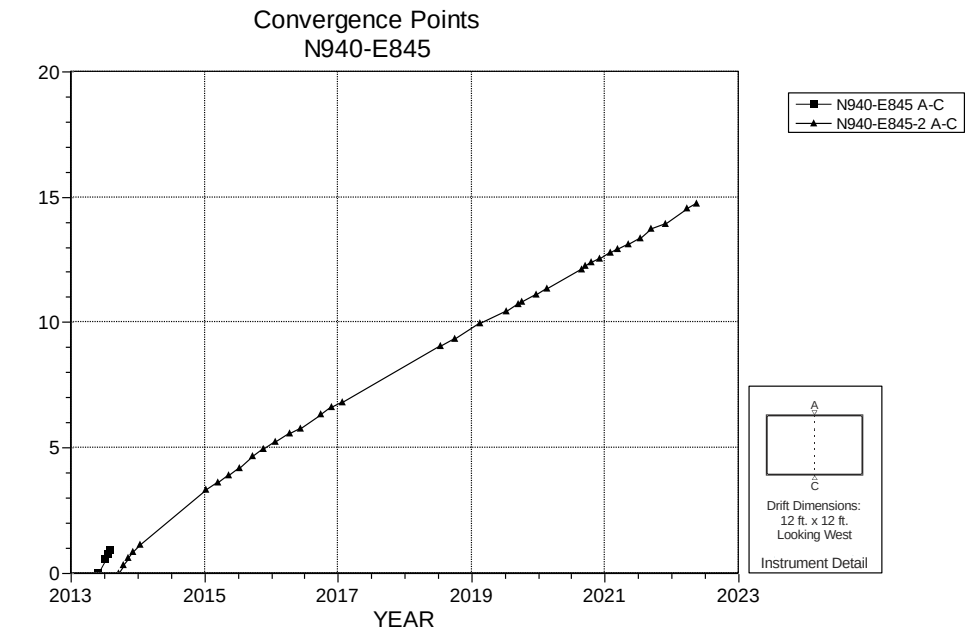
NOTES:
1. Excavation date: March 2012.

Figure 6-25 Convergence Point Array – N940 E690 – Roof to Floor



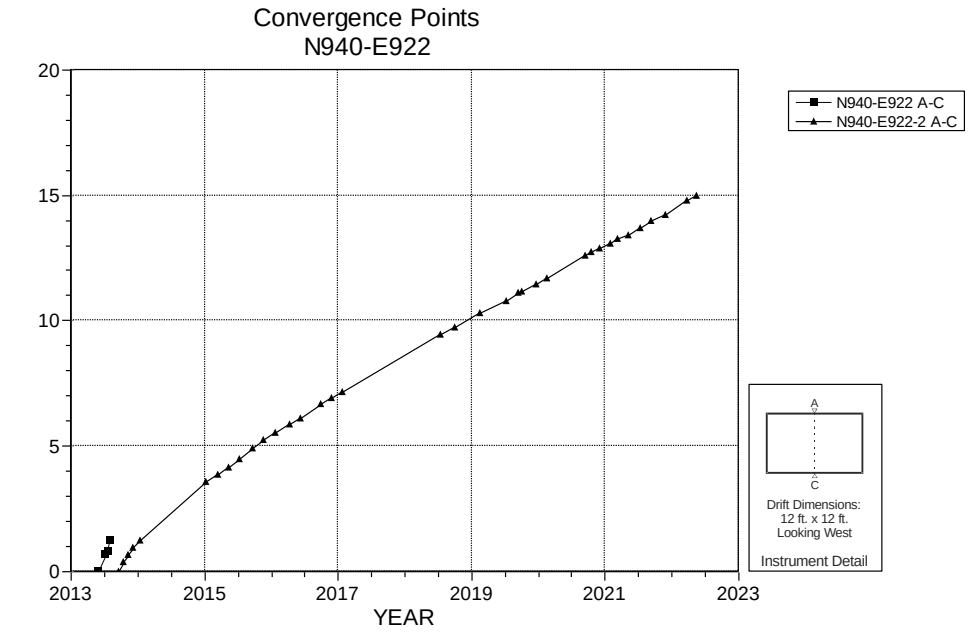
NOTES:
1. Excavation date: April 2013.

Figure 6-26 Convergence Point Array – N940 E768 – Roof to Floor



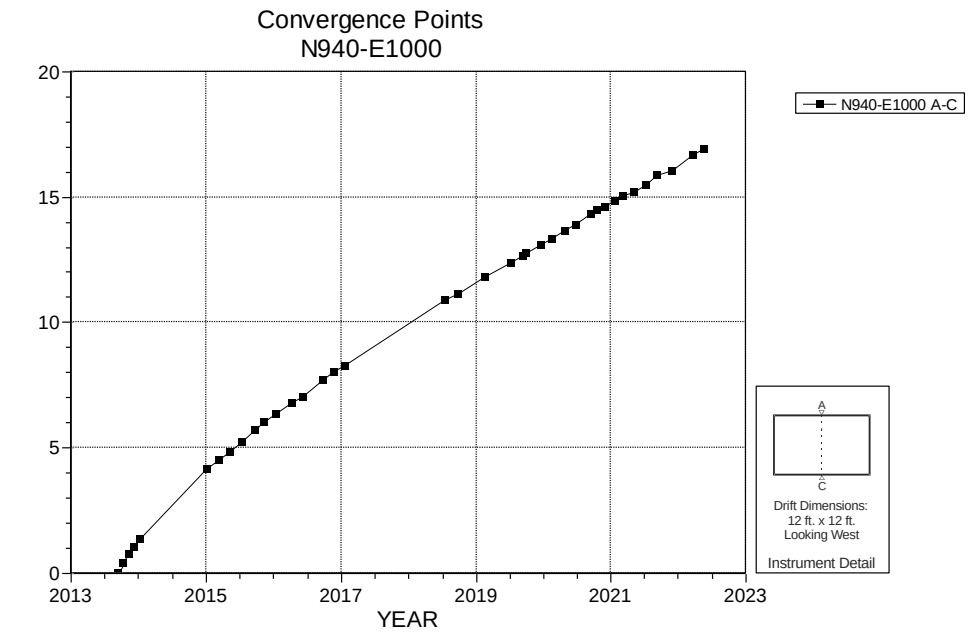
NOTES:
1. Excavation date: May 2013.

Figure 6-27 Convergence Point Array – N940 E845 – Roof to Floor



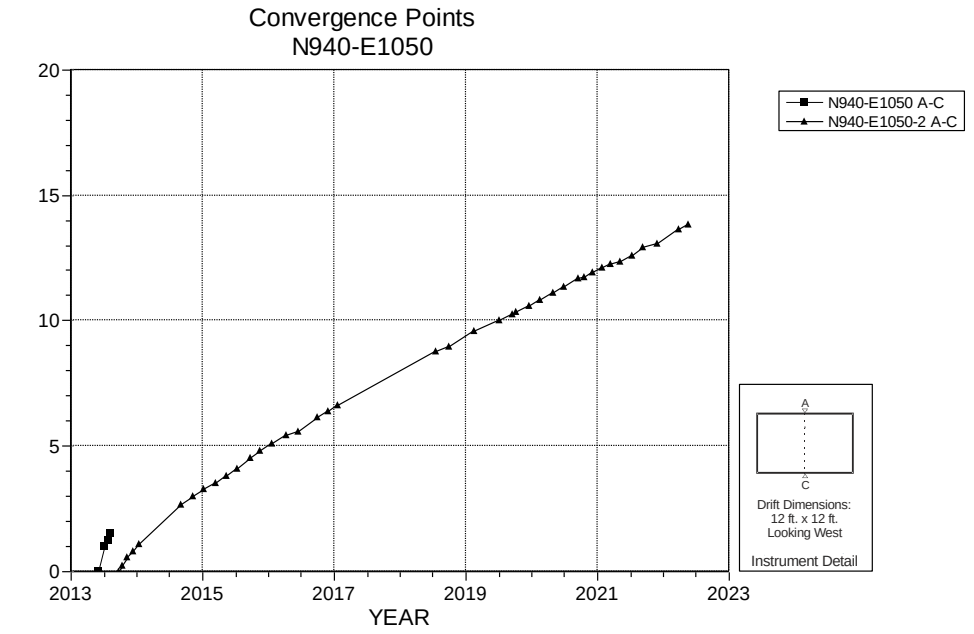
NOTES:
1. Excavation date: May 2013.

Figure 6-28 Convergence Point Array – N940 E922 – Roof to Floor



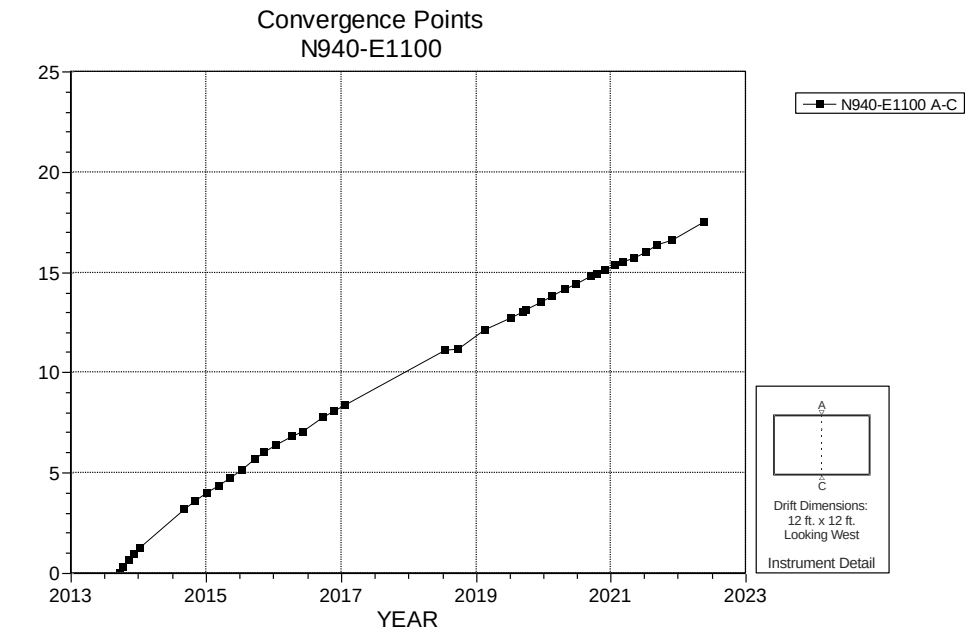
NOTES:
1. Excavation date: May 2013.

Figure 6-29 Convergence Point Array – N940 E1000 – Roof to Floor



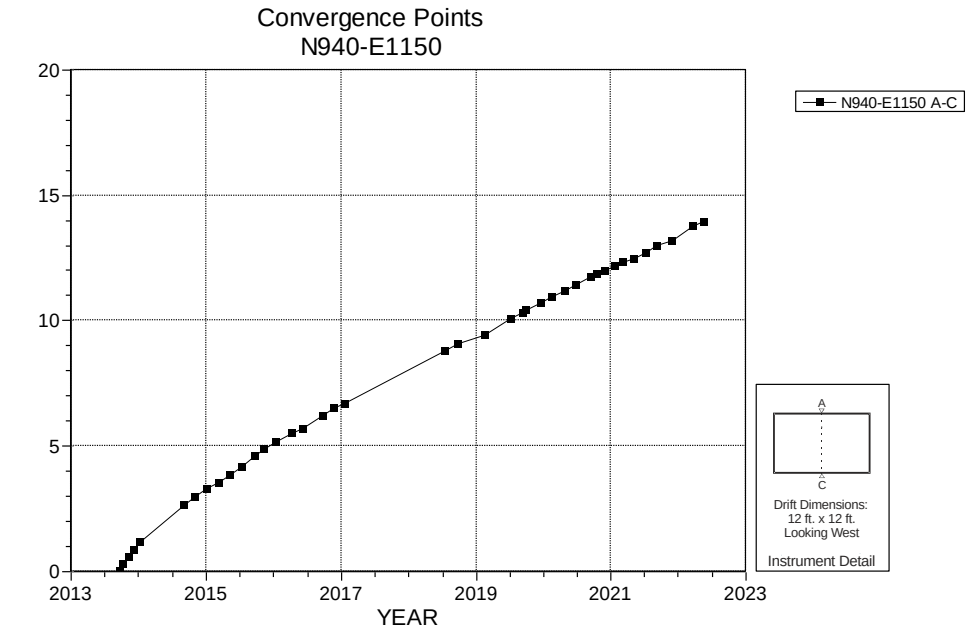
NOTES:
1. Excavation date: May 2013.

Figure 6-30 Convergence Point Array – N940 E1050 – Roof to Floor



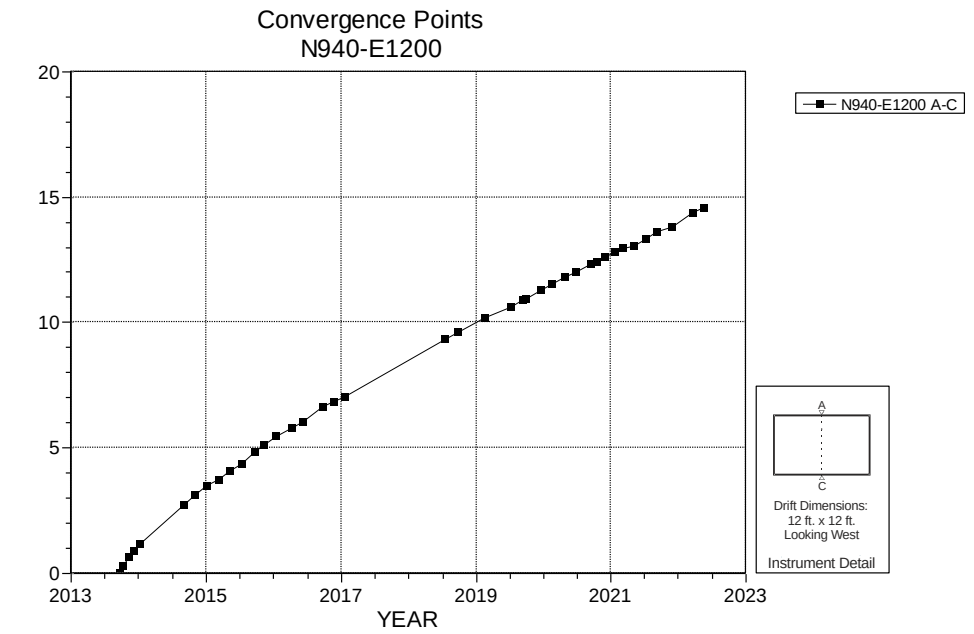
NOTES:
1. Excavation date: June 2013.

Figure 6-31 Convergence Point Array – N940 E1100 – Roof to Floor



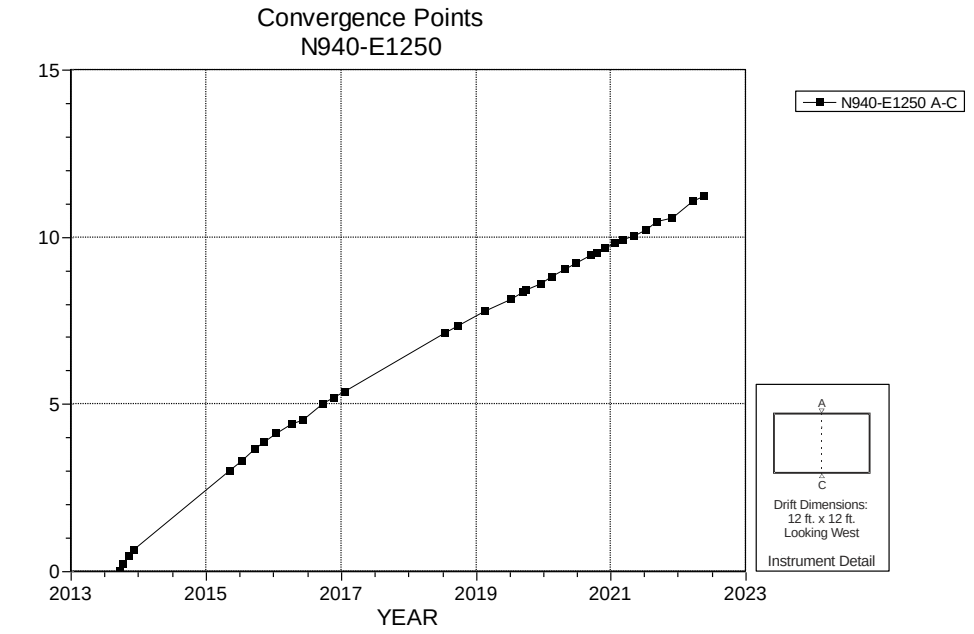
NOTES:
1. Excavation date: June 2013.

Figure 6-32 Convergence Point Array – N940 E1150 – Roof to Floor



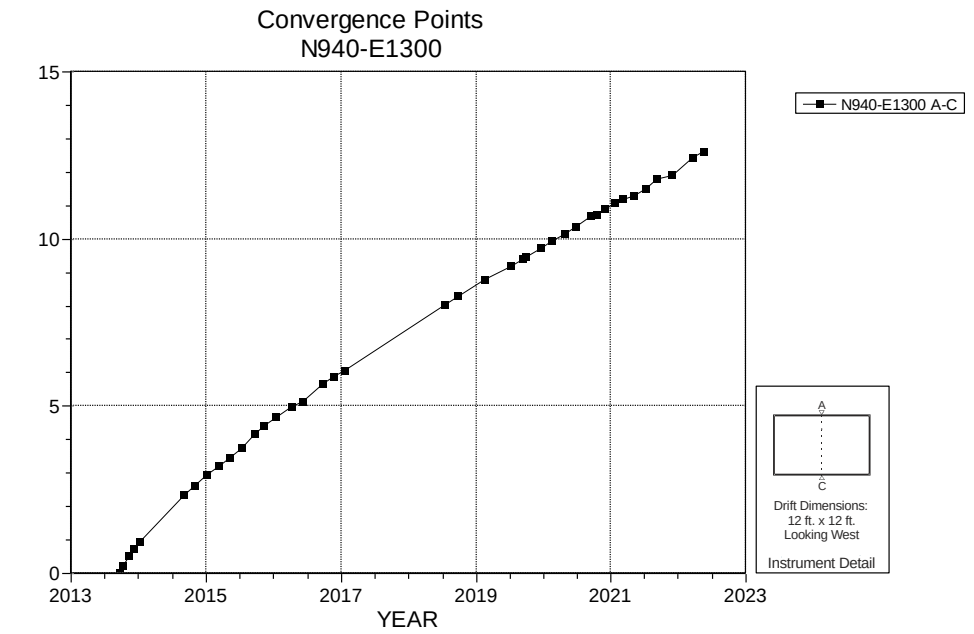
NOTES:
1. Excavation date: June 2013.

Figure 6-33 Convergence Point Array – N940 E1200 – Roof to Floor



NOTES:
1. Excavation date: July 2013.

Figure 6-34 Convergence Point Array – N940 E1250 – Roof to Floor



NOTES:
1. Excavation date: July 2013.

Figure 6-35 Convergence Point Array – N940 E1300 – Roof to Floor

7.0 GEOSCIENCE SUMMARY

Chapter 7 historically presented data acquired to support the WIPP Geoscience Program. This included fracture maps of excavation surfaces, stratigraphic mapping, and drilling vertical observation holes to monitor clay seam displacements and other significant geological features.

The last reporting period where a full complement of routine geoscience activities (fracture mapping, stratigraphic mapping, and borehole examinations) were performed was during the July 2013 – June 2014 period. The final activities, that period, were performed in early February 2014 just days before the fire, followed days later by an unrelated radioactive release.

Unlike broken bolt counts and instrumentation readings accompanied by routine visual inspections, the geoscience program does not necessarily provide an early warning as to near term and imminent ground control problems. Geoscientific borehole inspections are routinely performed either quarterly or biannually, depending on their location.

Occasions do occur when geotechnical engineers want non-routine observation borehole or fracture data. Such as when an accessible area may experience an increase in rates of roof beam expansion or in roof to floor closure. Or possibly when designing a new bolting pattern. These types of “on demand” inspections are still occurring during the current absence of routine inspections under the geoscience program.

The elements of the geoscience program have collectively produced a body of information over almost 38 years that has described both typical and atypical characteristics of deformation at the repository horizon currently excavated. For example, low-angle fracturing, a key component to most of the roof falls that have occurred at the WIPP facility, was first identified and mapped in Site Preliminary and Design Validation Room 1 in the early 1990s as part of the geoscience program.

Observation borehole inspection data for this reporting period are detailed in Table 7-1. Panel 8 stratigraphic models can be found in Figure 7-1 through 7-10, while corehole logs can be found in Figure 7-11 through 7-12

Table 7-1 Observation Borehole Fractures and Offset Summary

Observation Borehole Fractures and Offset Summary								
OH Number	Location	Date of Inspection	Feature	Feature Depth (ft)	Separation (in)	Offset (in)	Compass	Hole Closure (%)
OH577-2	E140-S1070	6/30/2022	Separation	1.5	1	NA	NA	NA
			Separation	3.2	0.125	NA	NA	NA
			Separation	4.3	23	NA	NA	NA
			Separation	8.5	0.5	NA	NA	NA
OH872-3	E140-S1390	6/30/2022	Separation	3	0.5	NA	NA	NA
			Separation	4.2	0.125	NA	NA	NA
			Separation	5.5	5	NA	NA	NA
			Separation	6.1	0.25	NA	NA	NA
			Separation	6.9	1.5	NA	NA	NA
			Rough Spot	7.4	NA	NA	NA	NA
			Bottom of Hole	19.6	NA	NA	NA	NA
OH1166	E140-S1300	6/30/2022	Separation	5.4	0.0625	NA	NA	NA
			Separation	5.8	0.125	NA	NA	NA
			Separation	7.4	0.125	NA	NA	NA
			Bottom of Hole	20.2	NA	NA	NA	NA
OH1170	E140-S1000	6/30/2022	Separation	4.5	12	NA	NA	NA
			Separation	13	0.125	NA	NA	NA
			Bottom of Hole	20	NA	NA	NA	NA

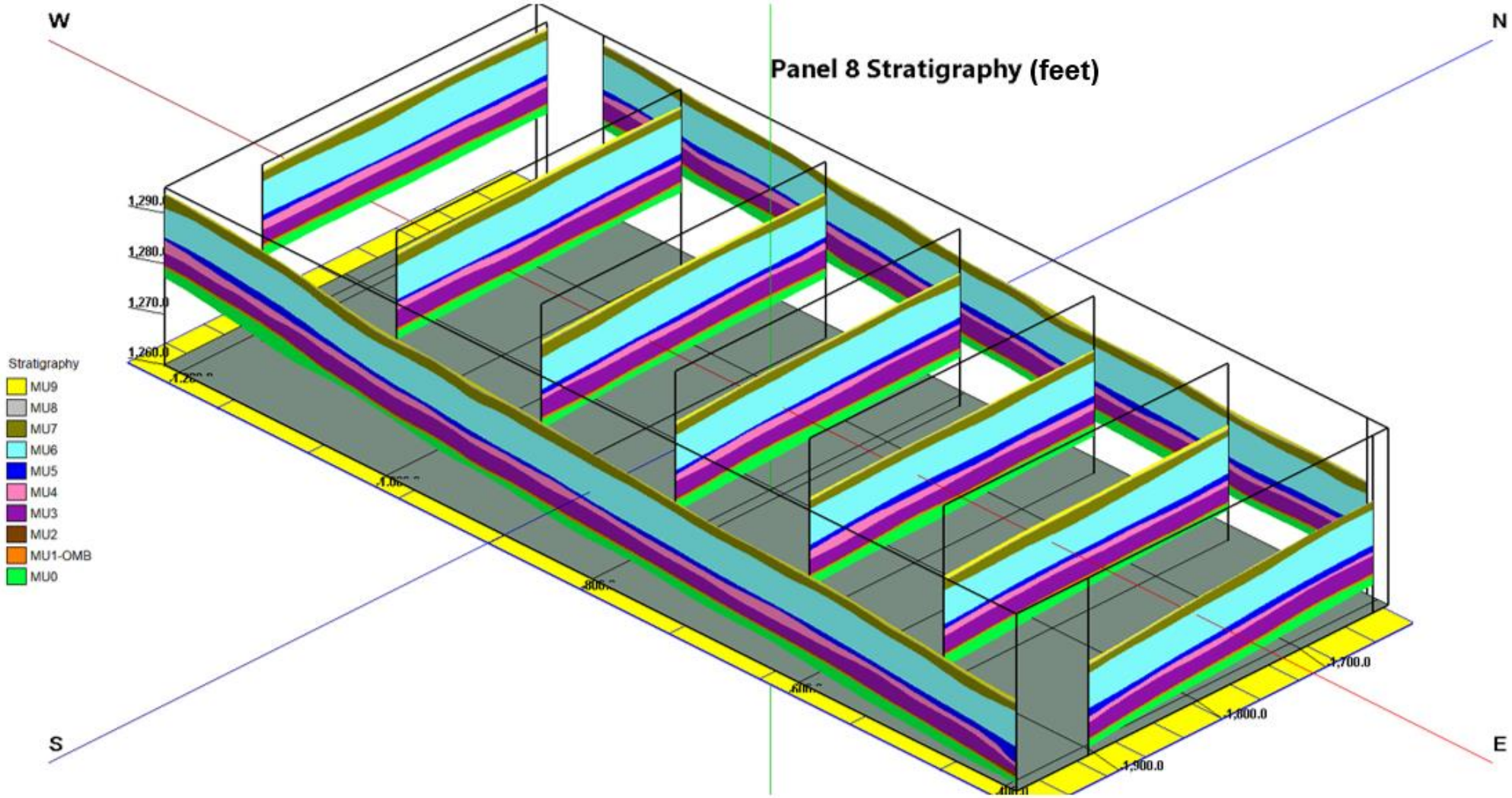


Figure 7-1 Stratigraphic Overview of Panel 8

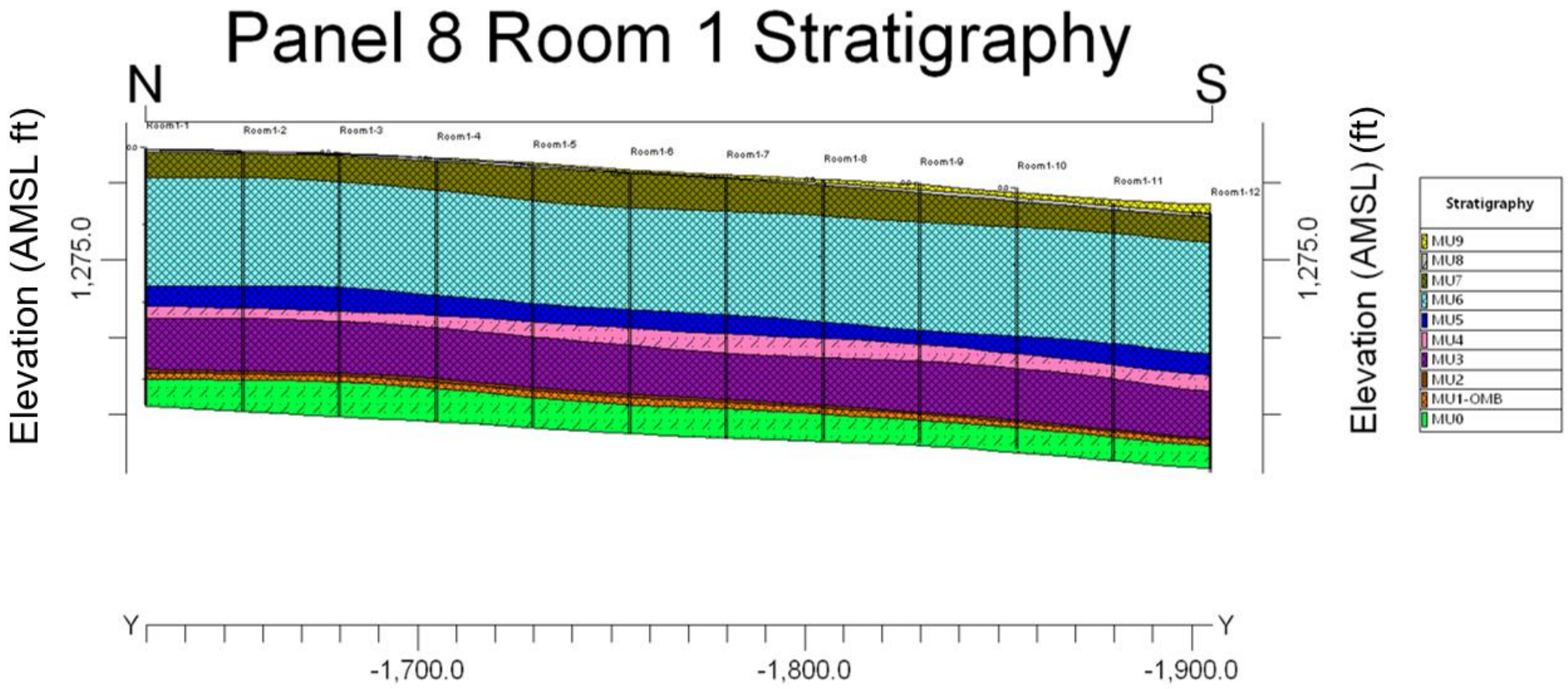


Figure 7-2 Panel 8 Room 1 Stratigraphy

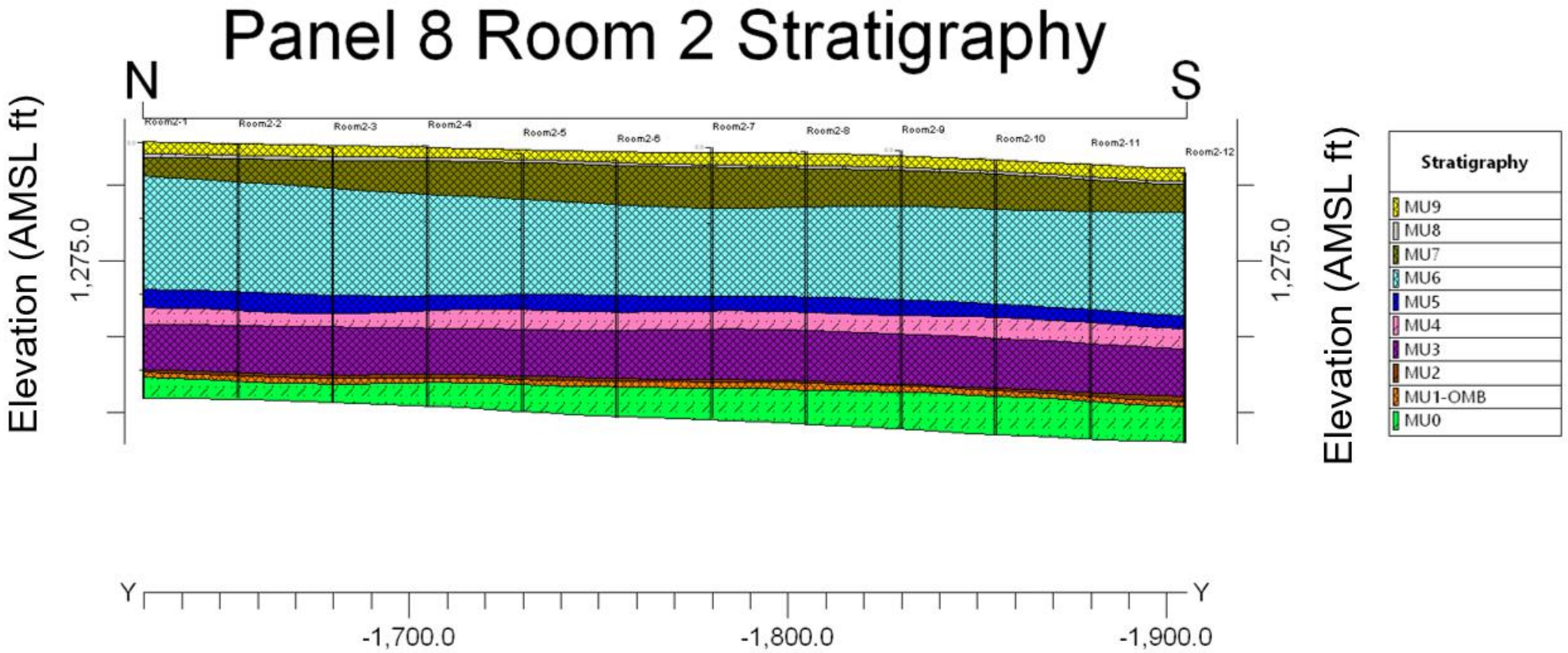


Figure 7-3 Panel 8 Room 2 Stratigraphy

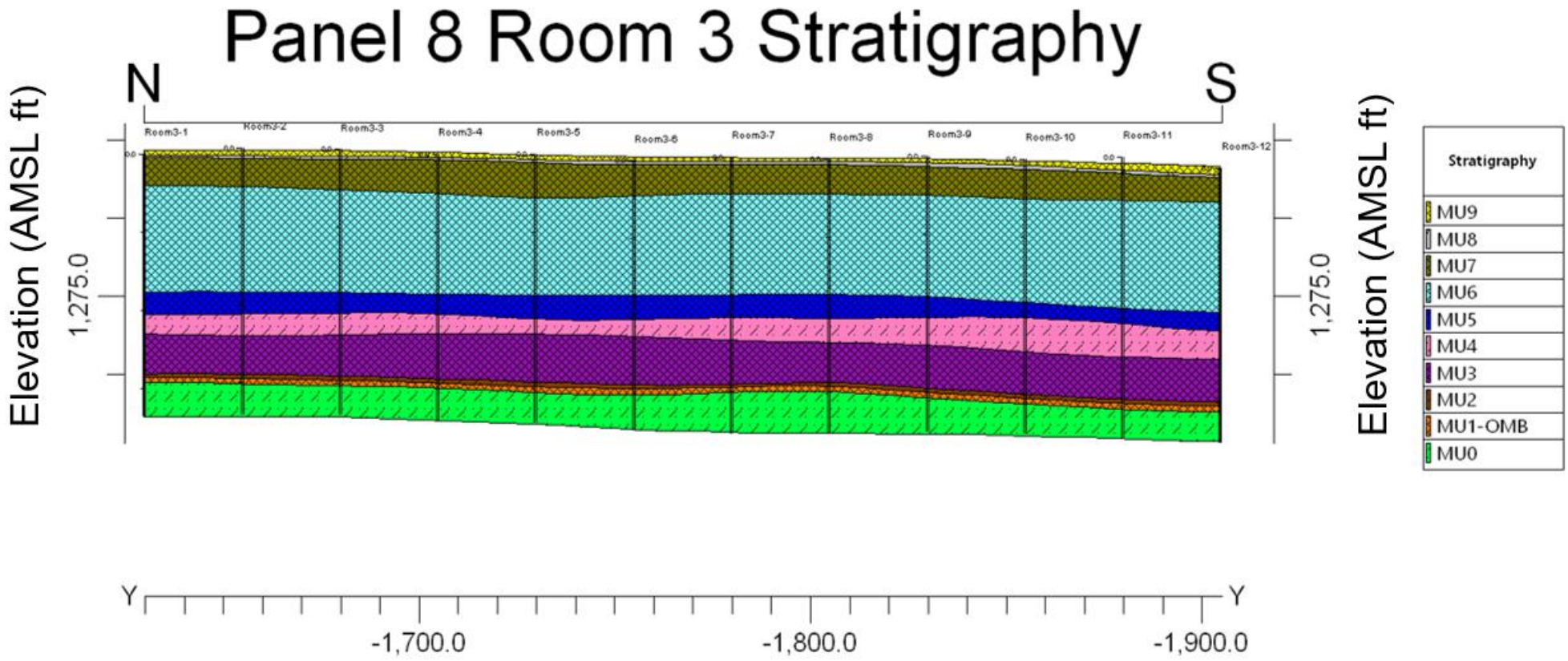


Figure 7-4 Panel 8 Room 3 Stratigraphy

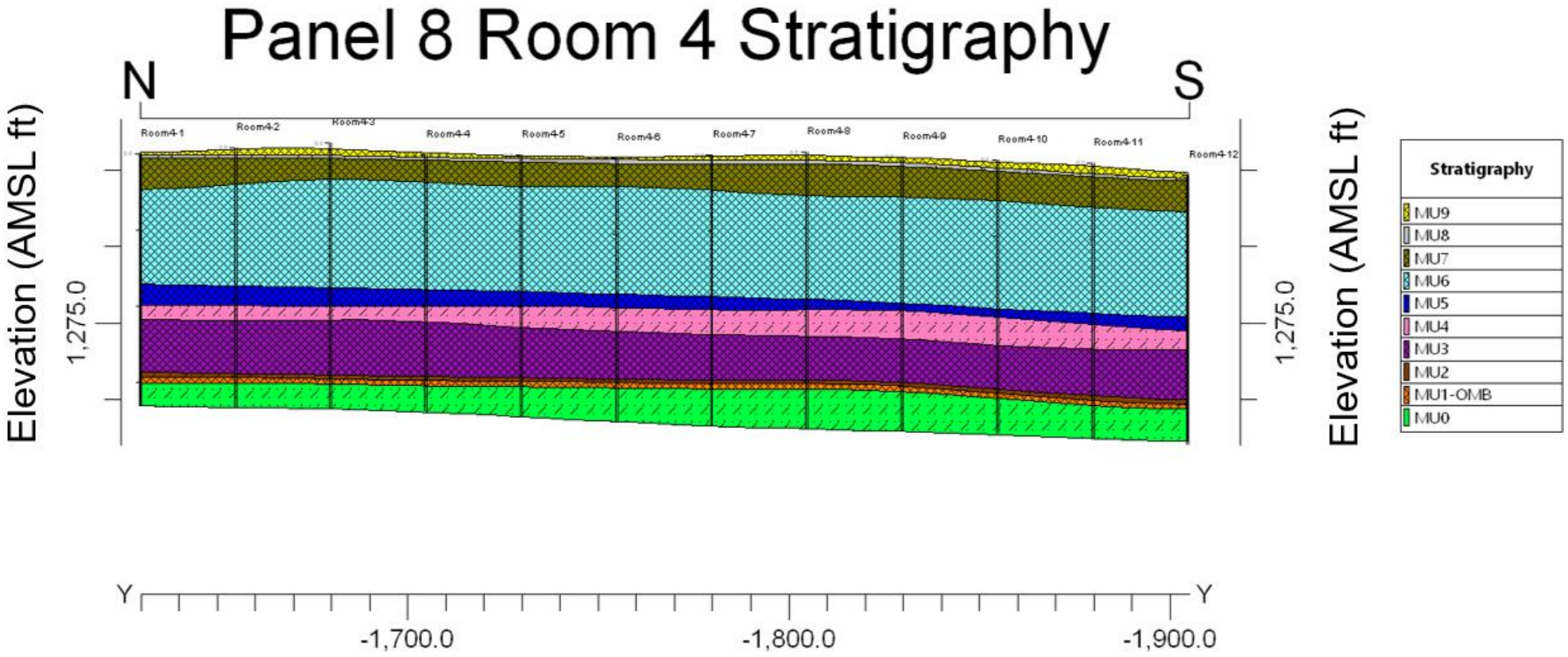


Figure 7-5 Panel 8 Room 4 Stratigraphy

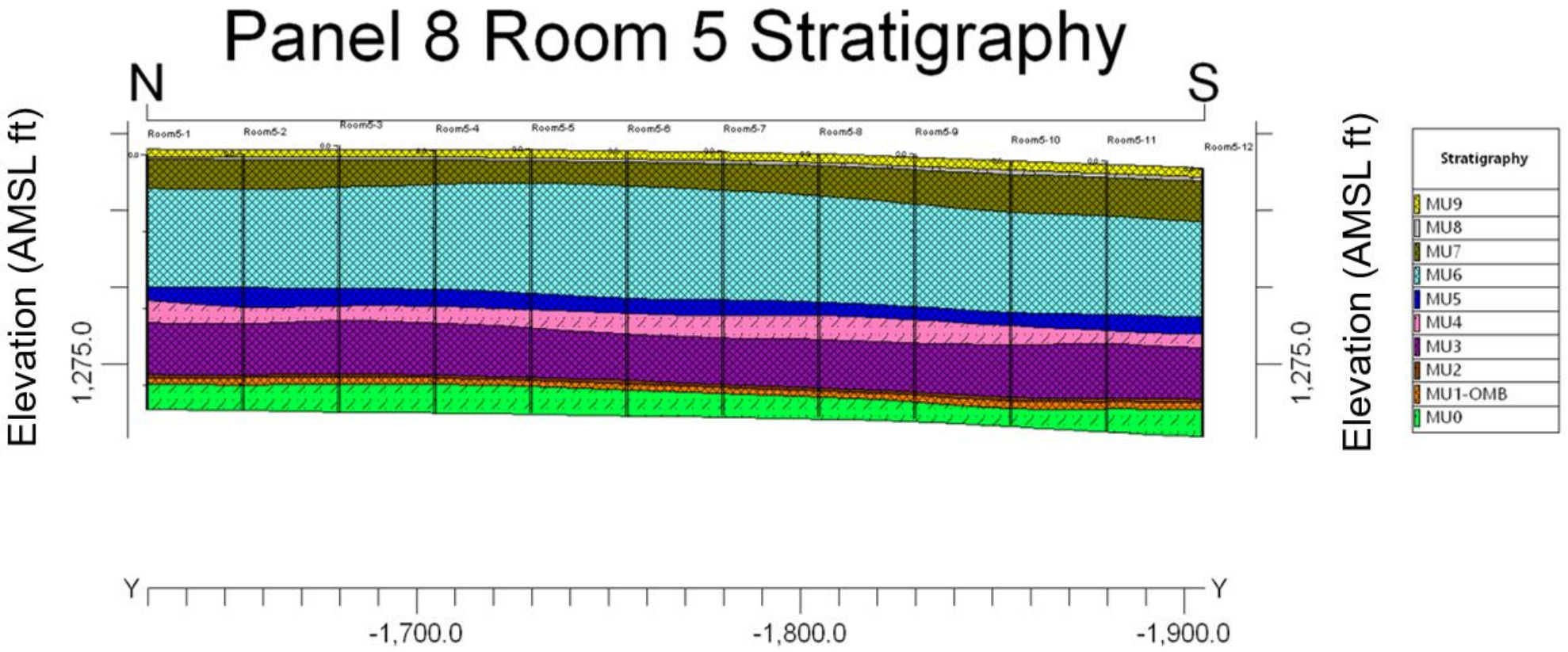


Figure 7-6 Panel 8 Room 5 Stratigraphy

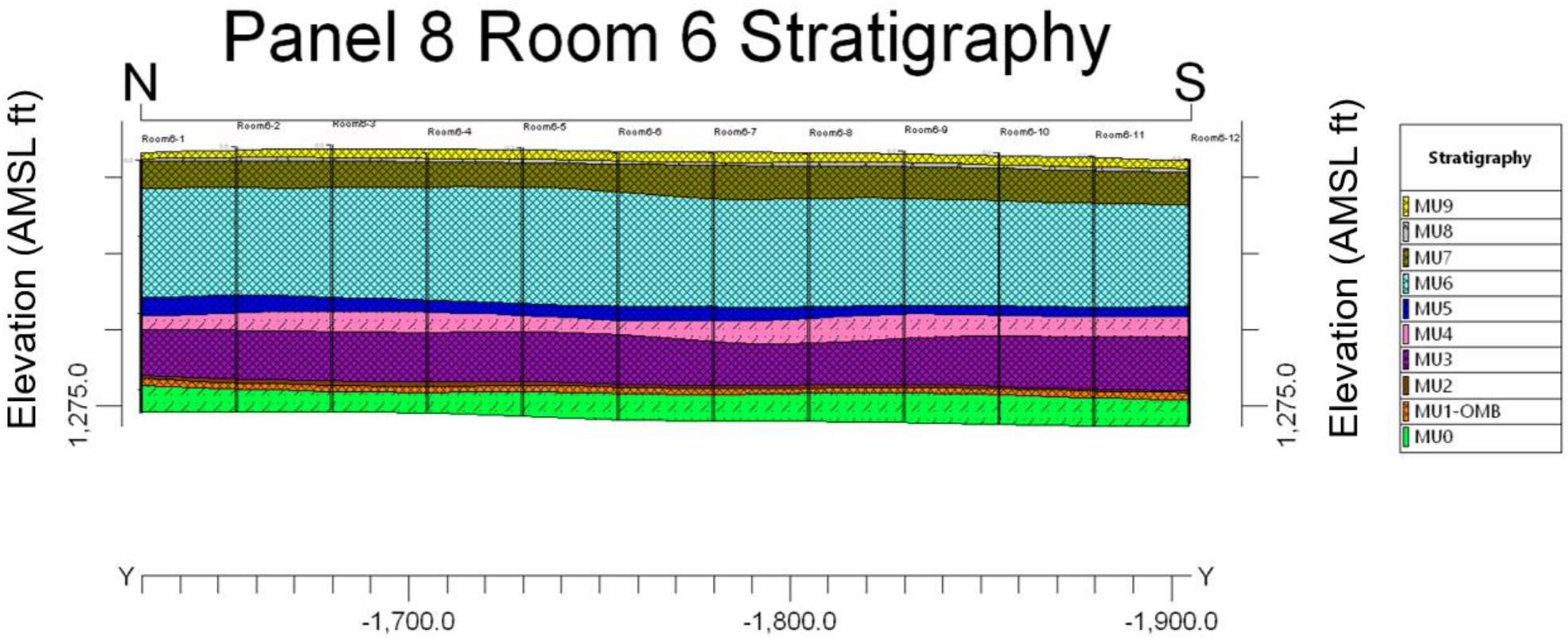


Figure 7-7 Panel 8 Room 6 Stratigraphy

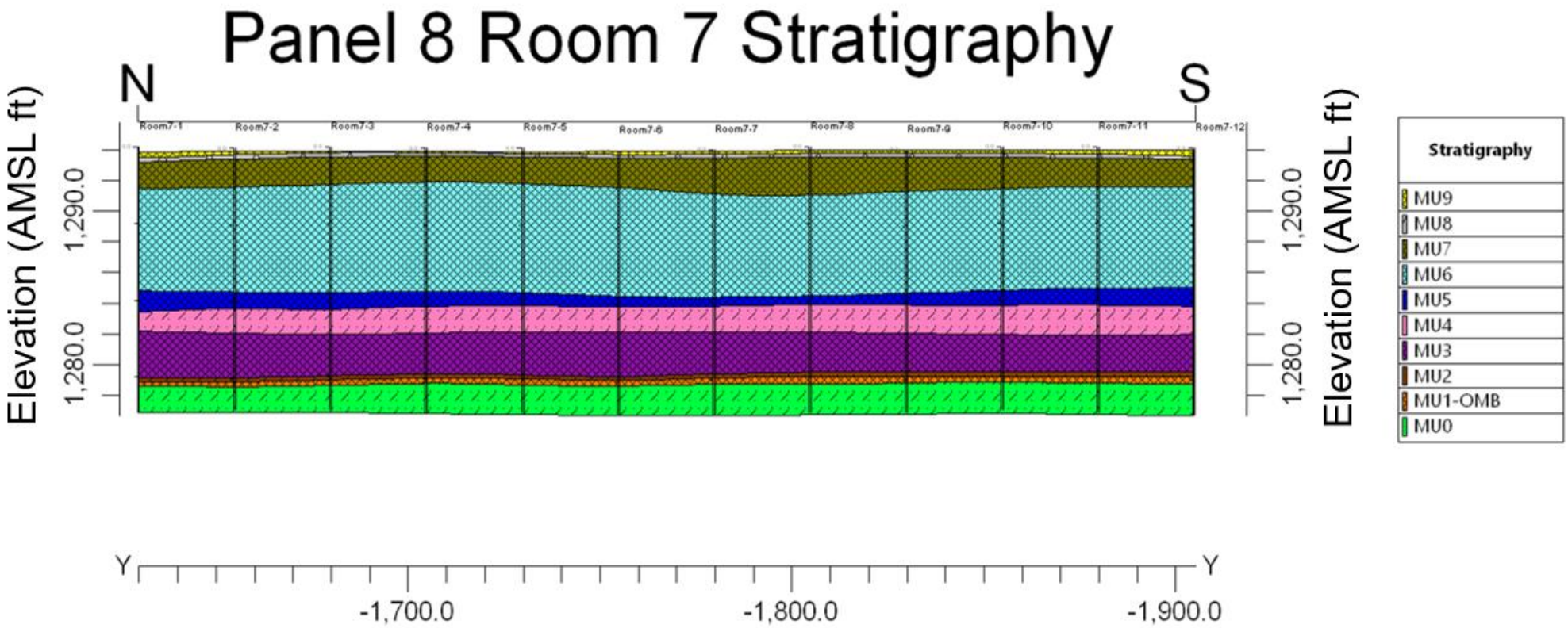


Figure 7-8 Panel 8 Room 7 Stratigraphy

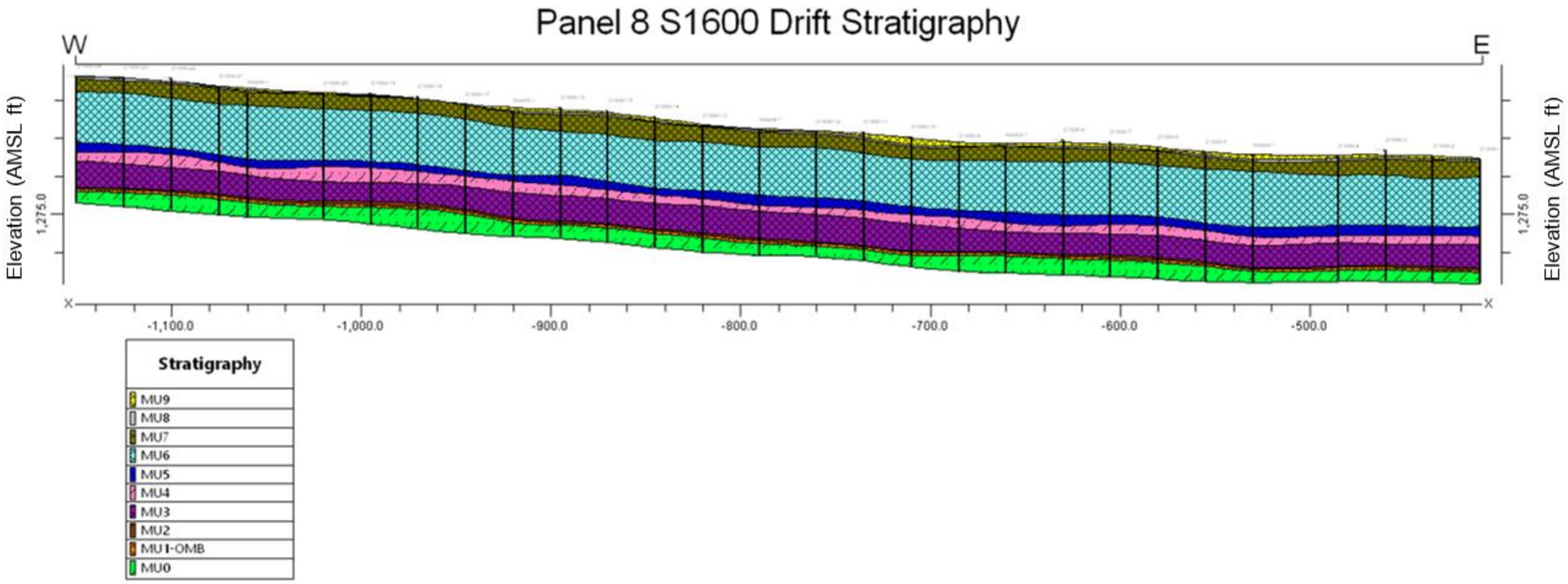


Figure 7-9 Panel 8 S1600 Drift Stratigraphy

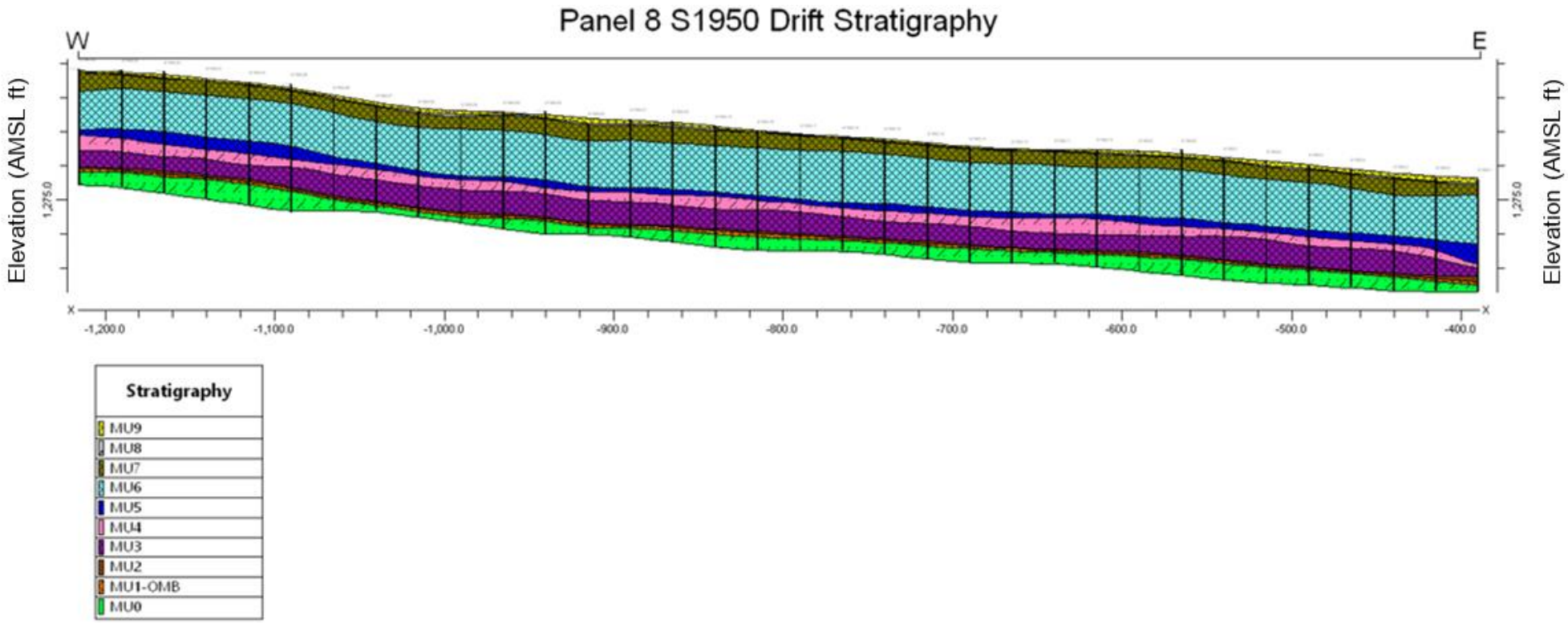


Figure 7-10 Panel 8 S1950 Drift Stratigraphy

Attachment 1 - Core Log

Page 1 of 2

CORE LOG Sheet 1 of 7

Hole ID: CHPBR7D Location Panel 8 Room 7 - S1600

Drill Date: 5/4/22 - 5/17/22
Drill Crew: Jeremy Rascon, David, Barry, Collin

Drill Method: Reverse Rotary
Hole Diameter: 0.4 ft
Hole Depth: 50.25 ft
Hole Orient: Vertical Down

Drill Make/Model: Diamec 264
Barrel Specs: NM
Drill Fluid: Air
Core Preserv: None

Logged by: Brett Seal Date: 5/4/22 - 5/17/22 Scale: NA

	Northing	Easting	Elevation
Survey Coordinates: (Ft)	8,066.661	5,706.102	1276.856

Comments: Panel 8 Certification Corehole,

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 1	1	100%	70.6%		Argillaceous Halite (0-2.7 ft) medium grained, light gray halite with dark reddish brown stringers and blebs	
1.42						
Run 2	2	97%	63.2%			
2.83				x x	Halite (2.7-3.73 ft) coarse grained light gray to light pink with orange polyhalite blebs	
Run 3	3 4	96.8%	65.6%			
4.2				x x x x x x x x	Argillaceous Halite (3.73-5.1 ft) medium grained light gray to dark gray halite with dark reddish brown clay layering. Some pink polyhalite banding	
Run 4	4 5	100%	100%			
5.5				x x x x x x	Polyhalitic Halite (5.1-8 ft) fine grained light gray to light pink halite with dark reddish orange polyhalite banding	
Run 5	6	100%	40%			

REFERENCE USE

Figure 7-11 Panel 8 Down Corehole

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Attachment 1 - Core Log

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Hole ID: CHP8R7D — CORE LOG (cont. sheet) — Sheet 2 of 7

Logged by: Brett Seal — Date: 5/4/22 - 5/17/22

Run Number	Depth ( )	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 5 cont.	6.75				Increase in polyhalite content with depth, red to dark reddish orange	
Run 6	7, 8	100%	44%			
Run 7	8, 9	100%	0%		Anhydrite stringers (8-10.5 ft) increasing in anhydrite content with depth. Light gray microcrystalline anhydrite stringers in a light pink polyhalitic halite matrix	MB139 MB content changes from polyhalite dominantto anhydrite dominant with depth
Run 8	9.25, 10	100%	0%		Anhydrite, light gray microcrystalline with blebs of polyhalite and halite pseudomorphs	
Run 9	10.5, 11	100%	100%		Claystone (<.1 ft) fine grained well sorted dark gray clay Agrillaceous Halite (10.5-14.4 ft) fine to medium grained light to dark gray halite with light gray stringers	Clay E
Run 10	11.83, 12, 13	100%	100%			
Run 11	13.16, 14	92%	62%		Contact at 14.4	

REFERENCE USE

Figure 7-11 Panel 8 Down Corehole continued

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Attachment 1 - Core Log

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Hole ID: CHP8R7D CORE LOG (cont. sheet) Sheet 3 of 7

Logged by: Brett Seal Date: 5/4/22 - 5/17/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
14.5						
Run 12	15	100%	60%	x x x x x	Halite (14.4-15.7 ft) white to light gray coarse grained halite with blebs of polyhalite that increase in quantity with depth	
15.83						
Run 13	16	100%	35%	x x x x x	Halite (15.7-18.6 ft) white to light pinkish gray fine to medium grained halite with blebs of polyhalite	
17.16	17					
Run 14	18	100%	0%	x x x	Thick (~.2 ft) polyhalite stringer, reddish orange	Argillaceous halite (18.6-18.7 ft) medium grained light gray with brown clay layer at contact
18.5						
Run 15	19	100%	0%	x x x	Argillaceous Halite (18.7-20.5 ft) medium grained light gray to gray halite with light gray stringers and blebs Some poly blebs at 19.5-19.9 ft	
20	20					
Run 16	21	100%	0%	x x x	Halite (20.5-25 ft) medium to coarse grained light gray to light pink halite with polyhalite blebs and stringers	
21.42						
Run 17	22	97%	41%	x x x		

REFERENCE USE

Figure 7-11 Panel 8 Down Corehole continued

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Attachment 1 - Core Log

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Hole ID: CHPER7D CORE LOG (cont. sheet) Sheet 4 of 7

Logged by: Brett Seal Date: 5/4/22 - 5/17/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
22.5 Run 17 / Run 18		80%	0%			
22.75 Run 19	23 – 24	100%	43%			
24.16 Run 20	25	100%	100%		Anhydrite (24.6-25 ft) light gray microcrystalline with stringers of clay in the top .1 ft, with clay blebs towards the bottom	
25.6 Run 21	26	100%	100%	x x x x	Halite (25-27 ft) fine to medium grained, gray to dark gray halite with polyhalite blebs and red clay stringers	
26.85 Run 22	27 – 28	100%	100%	x x	Very clear coarse grained light gray Halite ~.1 ft Agrillaceous Halite (27-29.1 ft) fine grained light to medium gray halite with dark reddish brown clay stringers, sparse polyhalite blebs present	
28.3 Run 23	29	100%	100%		Light gray clean halite banding can be seen throughout this section	
29.7 Run 24	30			x x x	Halite (29.1-30 ft) fine grained light gray to light pink halite with polyhalite blebs	

REFERENCE USE

Figure 7-11 Panel 8 Down Corehole continued

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Attachment 1 - Core Log

Page 2 of 2

Hole ID: CHPBR7D CORE LOG (cont. sheet) Sheet 5 of 7

Logged by: Brett Seal Date: 5/4/22 - 5/17/22

Run Number	Depth ( )	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 24 Cont	31	100%	40%	x x xxxxxxxx	Polyhalitic Halite (30-35 ft) medium grained light gray to light orange halite with orange to reddish orange polyhalite blebs and stringers	
31.2						
Run 25	32	100%	69%	x x x x x		
32.5						
Run 26	33	88%	0%	x xxxxxxxx		
33.3						
Run 27	34	98%	62%	x x x xxxxxxxx x		
34.75						
Run 28	35	100%	31%		Anhydrite (35-35.5) light gray to gray microcrystalline	
36.05	36			x x x x x x	Halite (35.5-37.1 ft) light gray to gray medium grainedhalite with light orange polyhalite blebs	
Run 29	37	100%	37%			
37.4						
Run 30	38	100%	87%	- - - - - - - -	Argillaceous halite (37.1-38.9 ft) light gray fine grained halite with reddish brown clay stringers	

REFERENCE USE

Figure 7-11 Panel 8 Down Corehole continued

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Attachment 1 - Core Log

Page 2 of 2

Hole ID: CHPBR7O CORE LOG (cont. sheet) Sheet 6 of 7

Logged by: Brett Seal Date: 5/4/22 - 5/17/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 30 Cont.						
38.9						
Run 31	39–40	100%	62%	x, x	Halite (38.9-42 ft) light gray medium grained halite with sparse polyhalite blebs	
40.2						
Run 32	41	93%	53%	x, x		
41.7						
Run 33	42–43	100%	61%	x, x, x, x, x, x, x, x	Halite (42-43.6 ft) medium grained gray to dark gray halite with more polyhalite than the above layer. Increase in polyhalite and shift towards light orange with depth	
43.1						Argillaceous Halite (43.6-44 ft) light gray to gray fine grained halite with dark reddish brown clay stringers
Run 34	44	97%	62%	x, x	Halite (44-45.8 ft) fine grained light gray to gray halite with sparse orange polyhalite blebs	
44.55						
Run 35	45	100%	71%	x, x		
45.95						
Run 36	46			x	Argillaceous halite (45.8-46.5 ft) fine to medium grained gray to dark gray halite with fine grained gray clay stringers and sparse polyhalite	

REFERENCE USE

Figure 7-11 Panel 8 Down Corehole continued

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Attachment 1 - Core Log

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Hole ID: CHPBR7D CORE LOG (cont. sheet) Sheet 7 of 7

Logged by: Brett Seal Date: 5/4/22 - 5/17/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 36	47	100%	82%		Halite (46.5-50.25 ft) fine to medium grained light gray halite	
47.4						
Run 37	48	97%	83%			
48.85						
Run 38	49	100%	100%			
50.25	50				Total Depth 50.25 ft below floor	
	51					

REFERENCE USE

Figure 7-11 Panel 8 Down Corehole continued

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Attachment 1 - Core Log

Page 1 of 2

CORE LOG Sheet 1 of 7

Hole ID: CHPB#7U
Location: Panel 8 Room 7 - S1600
Drill Date: 5/18/22 - 5/20/22
Drill Crew: Tommy Rascon, David, Bary, Collin
Drill Method: Reverse Rotary
Hole Diameter: 0.4 ft
Hole Depth: 50.16
Hole Orient: Vertical up
Drill Make/Model: Diamec 264
Barrel Specs: NA
Drill Fluid: Air
Core Preserv: NA
Logged by: Brett Seal
Date: 5/18/22 - 5/20/22
Scale: NA

Survey Coordinates: (Ft)	Northing	Easting	Elevation
	8,066.661	5,706.102	1,293.452

Comments: Panel 8 Certification Up core hole

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
	51					
					End of Core hole	
50.16						
Run 38	50	100%	0%	X X	Halite (44.8-50.16 ft) medium grained light gray halite with thick orange to reddish orange blebs of polyhalite with one band of dark brown clay stringers	
48.9	49					
Run 37	48	100%	0%	X X X

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Attachment 1 - Core Log

Page 2 of 2

CORE LOG (cont. sheet)

Hole ID: CHPBR7U Sheet 2 of 7

Logged by: Brett Seal Date: 5/18/22 - 5/2-/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 34	44	86%	86%		Top of unit consist of a halite matrix with light orange polyhalite nodules with dark brown clay drapes between nodules	Core barrel came came out damp
43.4 Run 33	43	100%	71%		Agrillaceous Halite (41.2-44.8 ft) medium grained light gray to light orange halite with dark brown clay	
42.7 Run 32	42	100%	43%			
41.5 Run 31	41	100%	36%		Halite (38.1-41.2 ft) medium grained light gray with sparse reddish orange blebs of polyhalite with one zone of dark reddish brown clay Upper contact is dipping at approx 45 degrees, possible dissolution pipe	
40.1 Run 30	40	100%	0%			
38.8 Run 29	39	100%	57%			
37.4 Run 28	38	100%	50%			
	37					

REFERENCE USE

Figure 7-12 Panel 8 Up Corehole continued

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Attachment 1 - Core Log

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Hole ID: CHPBR7U — **CORE LOG (cont. sheet)** — Sheet 3 of 7

Logged by: Brett Seal — Date: 5/18/22 - 5/20/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 28	36.0					
Run 27	35	100%	0%		Argillaceous Halite (34.1-38.1 ft) medium grained light gray halite with dark reddish brown clay blebs and stringers. Numerous stringers dipping at 30 degrees including the upper contact of unit	
Run 26	34.5 34	98%	22%			
Run 25	33.4 33	100%	0%	x x x x x x x	Halite (30.5-34.1 ft) medium to coarse grained light gray halite with orange polyhalite blebs	
Run 24	32.0 32 31	100%	0%		Anhydrite stringers microcrystalline light gray, thicknesses approx 0.03 and 0.1 ft	
Run 23	30.5 30	100%	42%		Anhydrite (30-30.5 ft) microcrystalline gray to dark gray	MB138
Run 22	29.3 29	100%	0%		Clay K (29.8-30 ft) dark brown	Air pocket contacted at 30 ft coincides with Clay K

REFERENCE USE

Figure 7-12 Panel 8 Up Corehole continued

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Attachment 1 - Core Log

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Hole ID: CHPBR7U — **CORE LOG (cont. sheet)** — Sheet 4 of 7

Logged by: Brett Seal — Date: 5/18/22 - 5/20/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 22	28.0 – 27				Argillaceous Halite (24-29.8 ft) medium grained light gray to gray halite with brown to dark brown clay blebs. Higher occurance of clays at the top and bottom of the unit. Some orange polyhalite blebs are present	
Run 21	27 – 26.8	100%	46%			
Run 20	26 – 25.5	100%	0%			
Run 19	25 – 24.1	100%	0%			
Run 18	24 – 22.9	100%	0%	x x x	Halite (21.9-24 ft) coarse grained light gray halite with sparse light orange polyhalite blebs	
Run 17	23 – 21.6	100%	31%			
Run 16	22 – 21	100%	31%		Argillaceous Halite (20.4-21.9 ft) medium grained gray to dark gray halite with dark reddish brown clay blebs and stringers. Contact with above unit is a thin clay layer (approx. 0.05 ft)	

REFERENCE USE

Figure 7-12 Panel 8 Up Corehole continued

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Attachment 1 - Core Log

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Hole ID: CHPBR7 U — **CORE LOG (cont. sheet)** — Sheet 5 of 7

Logged by: Brett Seal — Date: 5/18/22 - 5/20/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 16	20.33					Clay J was absent from core samples
Run 15	20 – 19	100%	0%	x x	Halite (16.3-20.4 ft) medium grained light gray halite with sparse dark reddish orange polyhalite blebs	
Run 14	19.0 – 18	100%	0%	x		
Run 13	17.6 – 17	97%	0%	x x	Light gray anhydrite stringers can be found towards the bottom within the halite matrix	
	16.16					Clay I (16.2-16.3 ft) dark reddish brown clay with light gray anhydrite stringers
Run 12	16 – 15	100%	0%	x x	Halite (10.7-16.2 ft) fine to medium grained light gray halite with dark reddish brown clay blebs and stringers. Some light orange polyhalite blebs are present. Concentration of clay decreases upwards	
Run 11	14.8 – 14	102%	0%	x x		
Run 10	13.42 – 13	108%	0%			

REFERENCE USE

Figure 7-12 Panel 8 Up Corehole continued

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Attachment 1 - Core Log

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Hole ID: CHPBR7 U — **CORE LOG (cont. sheet)** — Sheet 6 of 7

Logged by: Brett Seal — Date: 5/18/22 - 5/20/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 10	12					
Run 9	11	100%	100%		High concentration of clay at 11.5 ft	
Run 8	10	100%	77%		Halite (7.3-10.7 ft) medium to coarse grained light gray to light pink halite with blebs of orange to dark reddish orange polyhalite	
Run 7	9	100%	68%			
Run 6	8	100%	83%			
Run 5	7	92%	0%		Anhydrite (7.0-7.3 ft) microcrystalline light gray anhydrite stringers in a light gray halite matrix Halite (6.5-7.0 ft) medium grained light gray bottom to dark red with increasing polyhalite towards the top Anhydrite (6-6.5 ft) microcrystalline light gray	Anhydrite A Clay H (5.8-6 ft) solid light gray clay band at bottom of section approx .05 ft with light gray stringers in halite matrix above
Run 4	6	90%	26%		**Argillaceous Halite (4.9-5.8 ft) fine grained** light gray to gray halite with dark reddish brown clay towards the bottom grading to light gray clay towards the top	
	5					

12.08 — 10.7 — 9.33 — 8.0 — 6.8 — 5.5

REFERENCE USE

Figure 7-12 Panel 8 Up Corehole continued

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Attachment 1 - Core Log

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CORE LOG (cont. sheet)

Hole ID: CHPBR7U Sheet 7 of 7

Logged by: Brett Seal Date: 5/18/22 - 5/20/22

Run Number	Depth (ft)	% Recovered	RQD	Profile (Rock Type)	Description	Remarks
Run 4	4			x	Halite (0-4.9 ft) med to coarse grained white to light gray halite, fairly clean halite without clay and sparse polyhalite blebs	
4.0						
Run 3	3	100%	0%	x		
2.66						
Run 2	2	100%	32%	x		
1.25						
Run 1	1	100%	52%	x		
	0				Start of hole, Back of Mine	

REFERENCE USE

Figure 7-12 Panel 8 Up Corehole continued