SSCL-SR-1082

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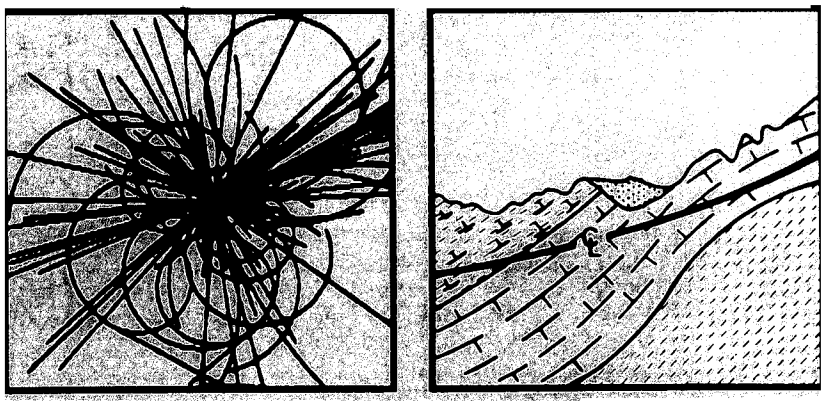
Superconducting Super Collider Site Reference Stratigraphic Column



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FOREWORD

The goal of the geotechnical studies at the Texas Superconducting Super Collider (SSC) site is to allow the geologist and engineer to build their level of knowledge and confidence about the geologic structures and geotechnical properties of the site materials to the point at which there remains only a realistically small risk of encountering geotechnical conditions during construction that would significantly increase construction costs or delay construction schedules. To do this, a characterization program has been designed to meet the following objectives:

- To confirm the site's suitability and optimize the ring location (the "footprint") and hall positions on the ring
- To provide data for a preliminary structural design
- To provide a rational framework within which construction contracts and schedules can be formulated
- To maximize the use of the site-specific data already gathered by the proposer.

The geotechnical program to meet these objectives has been divided into the following three phases of study:

- Footprint location data
- Global data (present phase)
- Structure-specific data (planned).

The primary purpose of the global data phase is compilation of broadly based, broadly distributed geotechnical database for the SSC site and its immediate environs. This global or systematic data set will consist of three attributes:

- Uniform geographic distribution over the site footprint
- Complete coverage of all of the strata through which the SSC tunnels and shafts will pass
- Consistency of the data from sampling site to sampling site.

This is one in a series of data reports prepared for the global data phase of geotechnical characterization at the SSC site.

The future planned program phase – structure-specific data collection – will concentrate on (1) evaluating ring areas where few geotechnical data are currently available and (2) conducting more detailed studies at the sites of the injector and experimental halls.

ACKNOWLEDGEMENTS

We wish to thank Allan Standen, James Donnelly, Byra Harpole, Jack Bailey, and Danny Sanchez of the Core Research Center, Texas Bureau of Economic Geology, for their efforts in preparing the SSC reference core type set. We are also grateful to Priscilla Nelson of the University of Texas at Austin, and Ed Garner of the Texas Bureau of Economic Geology, for their technical guidance.

SSC REFERENCE STRATIGRAPHIC COLUMN

The reference stratigraphic column (drawing in the pocket of this report) is a complete description of lithologic units at the site. It is based on many borings that overlap one another stratigraphically (see Figure 1); hence, it describes the lithology of the site—from top to bottom—in terms of characteristics that will occur throughout the site. Overall, the site stratigraphy will be as described in the reference column, although some minor variations may be expected locally.

The complete reference stratigraphic column includes the following:

- Lithologic descriptions of recognizable subdivisions of the site rocks, including the lower part of the Taylor Marl, all of the Austin Chalk, and the top part of the Eagle Ford Shale
- Nominal thicknesses of lithologic subdivisions referenced to key contacts
- Reference wireline logs (single point resistance and natural gamma) for use in correlations
- A reference library of core samples covering the full length of the site stratigraphic column.

The following are particularly desirable attributes of the reference column:

- It is site specific—based on borings at the site. This is preferable to extrapolating stratigraphic data from elsewhere in the region to the site.
- It describes lithologic divisions and subdivisions that are laterally traceable—i.e., can be recognized in borings—throughout the site.
- It describes site stratigraphy in more detail than was previously available.
- It is a good nominal description of rocks at the site.

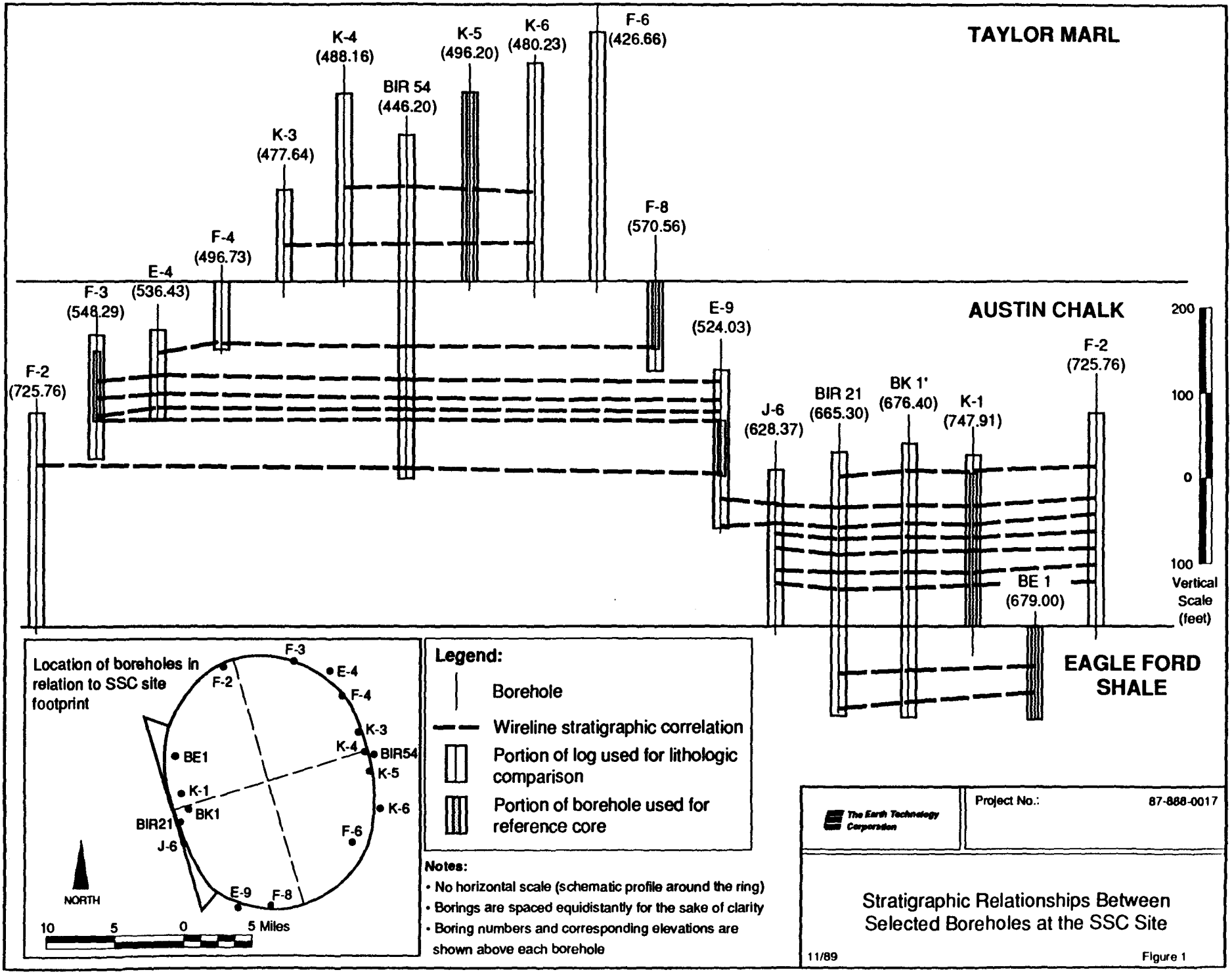
For the geologist, the reference stratigraphic column will be a baseline against which future borings may be compared. It can be an important tool for stratigraphic correlations around the ring. For the geotechnical engineer, it will serve as a nominal stratigraphic characterization of all the strata through which the ring tunnel will pass.

GENERAL SSC STRATIGRAPHY

The three major lithologic units at the site are the Taylor Marl, Austin Chalk, and Eagle Ford Shale. The primary characteristics of these units are described below.

Taylor Marl

- Medium-gray to bluish-black shale bound with calcite cement
- Soft to medium hard, fissile
- Occasional fossil fragments and calcite seams
- Maximum thickness at the site is 282.0 feet.


TAYLOR MARL
AUSTIN CHALK
EAGLE FORD SHALE
F-2 (725.76)
F-3 (548.29)
E-4 (536.43)
F-4 (496.73)
K-3 (477.64)
K-4 (488.16)
BIR 54 (446.20)
K-5 (496.20)
K-6 (480.23)
F-6 (426.66)
F-8 (570.56)
E-9 (524.03)
J-6 (628.37)
BIR 21 (665.30)
BK 1' (676.40)
K-1 (747.91)
BE 1 (679.00)
F-2 (725.76)
200
100
0
100
Vertical Scale (feet)
Location of boreholes in relation to SSC site footprint
F-3
E-4
F-2
F-4
K-3
K-4
BIR54
K-5
BE1
K-1
BK1
K-6
BIR21
F-6
J-6
E-9
F-8
NORTH
10 5 0 5 Miles
Legend:
Borehole
Wireline stratigraphic correlation
Portion of log used for lithologic comparison
Portion of borehole used for reference core
Notes:
• No horizontal scale (schematic profile around the ring)
• Borings are spaced equidistantly for the sake of clarity
• Boring numbers and corresponding elevations are shown above each borehole
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Stratigraphic Relationships Between Selected Boreholes at the SSC Site
11/89
Figure 1

Austin Chalk

Top 150 feet*

- Massive chalk beds, generally greater than 1 foot in thickness but ranging from 0.1 to 7.7 feet thick, alternating with calcareous shale and argillaceous beds that are usually less than 1 foot thick but range from 0.1 to 5.3 feet thick
- Infrequent bentonitic shale beds
- Contact with underlying argillaceous chalk has no convenient identifiable stratum for separation; however, the upper 150 feet generally have fewer argillaceous chalk interbeds than the underlying beds.

Middle 195 feet*

- Chalk with frequent interbeds of calcareous shale and argillaceous chalk
- Frequent bentonitic layers, generally 1 to 2 inches in thickness
- Pyrite nodules, generally 1 to 3 inches in diameter, occur in greater abundance than found either above or below
- Contact with underlying cleaner chalk is denoted by a marker bed of bentonite (0.75 to 1.00 feet thick) approximately 65 to 85 feet above the Austin Chalk/Eagle Ford Shale contact.

Bottom 65 feet*

- Massive chalk beds alternating with thin calcareous shale beds, becoming more argillaceous near the base
- Lithologically similar to the upper 150 feet
- Small (less than 0.25 inch in diameter) pyrite nodules
- Base is denoted by a fossiliferous argillaceous and arenaceous zone.

Eagle Ford Shale

- Dark, gray-black, soft to medium hard shale
- Contains very thin calcite seams as well as calcite and pyrite nodules
- Calcareous zone, approximately 0.4 feet thick, located approximately 40 feet below the Austin Chalk/Eagle Ford Shale contact
- Over 106 feet thick at the site.

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* These site-specific divisions do not correlate with the formally defined Upper, Middle, and Lower Austin Chalk members. It is likely that the top 150 feet of the Austin Formation at the SSC site is a much-thinned equivalent of the Upper and Middle Austin Chalk observed elsewhere in the region.

Further subdivisions of these three principal units are shown on the attached reference stratigraphic column (in pocket). The approach for recognizing these divisions is described below.

HOW THE REFERENCE COLUMN WAS PREPARED

The reference stratigraphic column is based on core, lithologic logs, and resistance and natural gamma logs from borings drilled during June and July 1987 for the initial Dallas/Fort Worth SSC site proposal, and also borings made in May and June 1989. Mason-Johnston Associates and Southwestern Laboratories drilled all the borings and ran the 1987 geophysical logs; the 1989 geophysical logging was done by Beeline Services.

The start of the reference column was a reference core type set compiled by the Core Research Center of the Texas Bureau of Economic Geology. The type set consisted of core intervals from nine boreholes of the 1987 site investigation. Relative stratigraphic correlations between borings represented in the core type set were double-checked by comparing their respective geophysical logs. Other core intervals were chosen for those instances where the geophysical wireline data were incomplete or wireline stratigraphic correlations between different logs were poor.

When good wireline correlations were found between borings from drilling site to drilling site, their corresponding lithologic logs were compared to discern contacts, marker beds, and important descriptive aspects (such as weathered zones and fossiliferous zones). The geophysical logs were also further divided into a number of vertical intervals that could be interpolated between different borings. These intervals, called wireline stratigraphic units, were examined for their particular lithologic characteristics and an average lithologic description was made for each wireline stratigraphic unit, or, in some instances, similar pairs of wireline stratigraphic units. Several borings not represented in the reference type set were also used to make up the representative lithologic log. Finally, a column of lithologic symbols was compiled from a combination of lithologic information and wireline interpretations of more and less argillaceous intervals.

REFERENCE CORE LIBRARY

A reference core library, corresponding to the reference stratigraphic column, is available for future studies and comparisons. The reference core library consists of core intervals from five 1987 borings (pre-proposal phase) and one boring from the 1989 footprint phase. All borings are NX. The 1987 borings provide coverage of the Taylor Marl and Austin Chalk. One 1989 boring was included to provide greater coverage of the Eagle Ford Shale than was available from the earlier borings.

The reference core library consists of the following borings and core intervals:

TABLE 1. COMPOSITION OF REFERENCE STRATIGRAPHIC COLUMN

Boring Number	Formation Encountered	Depth Below Surface (feet)	Length of Core Interval (feet)	Thickness Above/Below Reference Contact (feet)
K-5	Taylor Marl	34.0 - 259.0	225.0	0.0 - 225.0 Above Austin Chalk
F-8	Austin Chalk	67.5 - 145.5	78.0	0.0 - 78.0 Below Taylor Marl
F-3	Austin Chalk	47.5 - 127.7	80.2	78.0 - 158.2 Below Taylor Marl
E-9	Austin Chalk	110.2 - 172.0	61.8	158.2 - 220.0 Below Taylor Marl
K-1	Austin Chalk	33.0 - 216.2	183.2	220.0 - 403.2 Below Taylor Marl
BE1	Eagle Ford Shale	106.1 - 212.0	105.9	0.0 - 105.9 Below Austin Chalk
		Total	734.1	

WIRELINE STRATIGRAPHIC UNITS

The reference stratigraphic column has been further subdivided into "wireline stratigraphic units." Just as stratigraphic units are correlatable, laterally traceable lithologic groupings, "wireline stratigraphic units" are correlatable, laterally traceable signatures from the wireline logs—in this case single point resistance and natural gamma. A wireline stratigraphic unit is thus a geophysical signature for a particular stratigraphic unit that can be correlated between different borings. For some of the site formations, particularly the Austin Chalk, the wireline units are more distinctive and traceable than the visible lithology.

The Taylor Marl has been divided into 3 wireline stratigraphic units, the Austin Chalk has been divided into 13 wireline stratigraphic units, and the Eagle Ford Shale has been divided into 3 stratigraphic units. The wireline units for the Taylor, Austin, and Eagle Ford have been given an alphabetic prefix of T, A, and E, respectively, followed by a numeric suffix that increases with increasing geologic age. The depths, thicknesses, and position relative to reference contacts for each wireline stratigraphic unit are shown in Table 2.

TABLE 2. WIRELINE STRATIGRAPHIC UNITS

Wireline Stratigraphic Unit	Reference Boring	Depth Below Surface for Boring (feet)	Thickness of Unit (feet)	Thickness Above/Below Reference Contact (feet)	
T-21	K-5	34.0 - 150.0	116.0	109.0 - 225.0	Above Austin Chalk
T-22	K-5	150.0 - 212.0	62.0	47.0 - 109.0	Above Austin Chalk
T-23	K-5	212.0 - 259.0	47.0	0.0 - 47.0	Above Austin Chalk
A-15	F-8	67.5 - 144.0	76.5	0.0 - 76.5	Below Taylor Marl
A-16	F-8	144.0 - 145.5	31.4	76.5 - 107.9	BelowTaylor Marl
	F-3	47.5 - 77.4			
A-17	F-3	77.4 - 98.3	20.9	107.9 - 128.8	Below Taylor Marl
A-18	F-3	98.3 - 116.9	18.6	128.8 - 147.4	Below Taylor Marl
A-19	F-3	116.9 - 127.7	14.1	147.4 - 161.5	Below Taylor Marl
	E-9	110.2 - 113.5			
A-20	E-9	113.5 - 170.0	56.5	161.5 - 218.0	Below Taylor Marl
A-21	E-9	170.0 - 172.0	40.0	218.0 - 258.0	Below Taylor Marl
	K-1	33.0 - 71.0			
A-22	K-1	71.0 - 90.5	19.5	258.0 - 277.5	Below Taylor Marl
A-23	K-1	90.5 - 106.0	15.5	277.5 - 293.0	Below Taylor Marl
A-24	K-1	106.0 - 123.5	17.5	293.0 - 310.5	Below Taylor Marl
A-25	K-1	123.5 - 147.4	23.9	310.5 - 334.4	BelowTaylor Marl
A-26	K-1	147.4 - 164.4	17.0	334.4 - 351.4	Below Taylor Marl
A-27	K-1	164.4 - 216.2	51.8	351.4 - 403.2	Below Taylor Marl
E-20	BE1	106.1 - 147.8	41.7	0.0 - 41.7	Below Austin Chalk
E-21	BE1	147.8 - 182.0	34.2	41.7 - 75.9	Below Austin Chalk
E-22	BE1	182.0 - 212.0	30.0	75.9 - 105.9	Below Austin Chalk

GLOSSARY

arenaceous containing sand-sized particles.

argillaceous containing clay or clay minerals.

bentonite sedimentary rock formed from the alteration of volcanic ash; usually represents episodes of single volcanic ash falls; largely composed of the clay mineral montmorillonite.

calcareous consisting of, or containing, calcium carbonate.

chalk soft, white to light gray limestone composed of the tests (hard coverings) of floating microorganisms, such as foraminifera, in a finely crystalline calcite matrix.

claystone indurated (rendered hard by heat, pressure, or cementation) clay having the composition of shale but lacking the fissility or fine lamination.

cyclical describes a depositional cycle, or sequence of related processes that are repeated and recorded in the sedimentary record.

limestone bedded sedimentary deposit chiefly consisting of calcium carbonate, generally formed from the lithification of limy mud, calcareous sand, or shell fragments.

marl a general term for any calcareous sedimentary rock. The Taylor Marl at the site is more specifically a calcareous shale, or intimate mixture of clay and particles of calcite (or dolomite).

shale rock consisting of consolidated clay or mud, exhibiting fissility and a finely laminated structure.