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LEGACY PARKWAY

STRUCTURE P-21

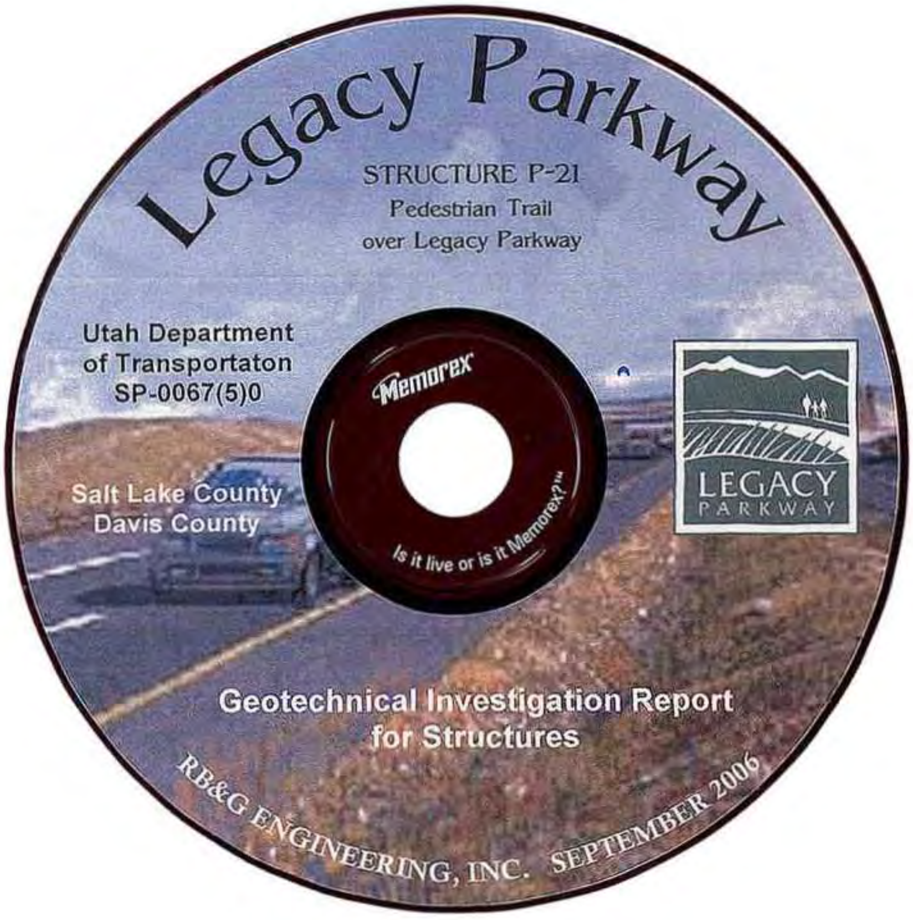
PEDESTRIAN TRAIL OVER LEGACY PARKWAY

Salt Lake & Davis Counties, Utah

Utah Department of Transportation
SP-0067(5)0

September 2006

Geotechnical Investigation Report for Structures



Legacy Parkway

STRUCTURE P-21
Pedestrian Trail
over Legacy Parkway

Utah Department
of Transportaton
SP-0067(5)0

Salt Lake County
Davis County

Geotechnical Investigation Report for Structures

RB&G ENGINEERING, INC. SEPTEMBER 2006

RB&G
ENGINEERING
INC.

September 5, 2006

Mr. Sohail Khan
Carter & Burgess
420 East South Temple Suite 342
Salt Lake City, Utah 84111-1321

Reference: Legacy Parkway Project No. SP-0067(5)0

Gentlemen:

A Geotechnical Investigation Report for Structures has been completed for Structure P-21, Pedestrian Trail over Legacy Parkway in Salt Lake and Davis Counties, Utah. The investigation has been conducted in accordance with a proposal submitted to your organization for the work, and the results of the study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

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Geotechnical Investigation Report for Structures

Legacy Parkway

Structure P-21

Pedestrian Trail over Legacy Parkway

Salt Lake & Davis Counties, Utah

Utah Department of Transportation
SP-0067(5)0

September 2006

RB&G ENGINEERING, INC.

Professional Engineers

LEGACY PARKWAY

UTAH DEPARTMENT OF TRANSPORTATION
SP-0067(5)0

GEOTECHNICAL INVESTIGATION REPORT FOR STRUCTURES

Structure P-21 – Pedestrian Trail over Legacy Parkway

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LEGACY PARKWAY

UTAH DEPARTMENT OF TRANSPORTATION
SP-0067(5)0

GEOTECHNICAL INVESTIGATION REPORT FOR STRUCTURES

Structure P-21 – Pedestrian Trail over Legacy Parkway

1.0 GENERAL

This report presents the results of geotechnical investigations and provides foundation recommendations for the following structure located within the Legacy Parkway project:

- P-21 – Pedestrian Trail over LP

The primary purpose of this investigation is to determine the characteristics of the subsurface material throughout the project area, and to make appropriate foundation design recommendations for the proposed structures. The report is intended to aid designers in evaluating the site and subsurface conditions for foundation design and potential construction problems.

1.1 PROJECT DESCRIPTION

The Legacy Parkway will be a four-lane, limited-access, divided highway extending approximately 14 miles from Interstate 215 at 2100 North in North Salt Lake, northward to the junction of Interstate 15 and U.S. Highway 89 near Farmington (see Figure 1) . A multiple-use pedestrian, bicycle, and horse trail will parallel the Parkway.

1.1.1 General

Bridge structures do not presently exist at the Pedestrian Trail Bridge site, located in Davis County. The proposed Legacy Parkway is located about 3,300 feet west of Redwood Road in this area. The site is located at the westerly edge of Woods Cross City, with Great Salt Lake wetlands encountered west of the Parkway alignment in this area.

1.1.2 Proposed Improvements

The proposed bridge structure will allow pedestrians to cross over the top of Legacy Parkway between multi-use trails on the east and west sides of the parkway. It is our understanding that the pedestrian bridge will be an eight-span structure. Preliminary drawings of the proposed structure are included for reference in Appendix A.

1.1.3 Climatic Conditions

The climate in the project area is characterized by relatively warm summers and cold winters. The frost depth ranges between 20 to 30 inches. Winter snow often requires plowing, and de-icing salt is regularly deposited on major roadways during the winter months.

2.0 PREVIOUS REPORTS AND INVESTIGATIONS

The following geotechnical reports and investigations have been completed previously by others for this project.

2.1 PB/FAK GEOTECHNICAL INVESTIGATION REPORT

UDOT provided copies of the Geotechnical Reports prepared by Parsons Brinckerhoff Quade & Douglas (PB) for Fluor Ames Kraemer (FAK), LLC as a part of the Design-Build Legacy Parkway Project. The report includes the results of subsurface investigations performed by Kleinfelder, Inc. and provides geotechnical recommendations for the structures contemplated in the original project. It should be noted that the project was divided into five segments for the Design-Build Project. Segment 2 of the Design Build project was to begin about 1000 feet north of Center Street (North Salt Lake) and continue in a northwesterly direction to the vicinity of the Bountiful City landfill. Included in the Design-Build report is the log for a roadway boring performed about 500 feet southwest of the proposed Pedestrian bridge site.

2.2 KLEINFELDER GEOTECHNICAL INVESTIGATION

It is our understanding the Kleinfelder, Inc. conducted an investigation of the preferred Legacy Parkway alignment for UDOT and the results were submitted in a report dated June 2, 2000. Some of its findings were reproduced in the PB/FAK Design Build reports referenced in Section 2.1 above.

2.3 DAMES & MOORE PRELIMINARY GEOTECHNICAL STUDY

It is our understanding that Dames & Moore completed a geotechnical study for the proposed preliminary Legacy Parkway corridor and presented the results in a 1998 report.

3.0 EXISTING FACILITIES

The proposed Parkway will travel at an approximate bearing of N 27° E in the vicinity of the Pedestrian trail bridge. No bridges are currently located at the site. Overhead power lines run parallel to the proposed parkway alignment about 300 feet to the west. The existing 2425 South Street approaches the Parkway from the east in this area and terminates at the Parkway project fence, about 500 feet south of the proposed pedestrian bridge. The nearest existing building is only about 200 feet away from the project site, on the South Bountiful Auto Parts property at 2166 W. 2425 S. Several other buildings are located further to the east on 2425 S. Various utility lines exist in the area, including the overhead power lines and buried utilities such as gas, oil, power, and communications lines. Davis County sewer lines also parallel the parkway alignment in this area, and may cross the alignment in the vicinity of the proposed pedestrian bridge.

4.0 FINDINGS

4.1 EXISTING SITE CONDITIONS

The topography is relatively flat throughout Segment 1 and generally slopes down to the west towards the Great Salt Lake. The proposed Legacy Parkway corridor begins just west of the existing I-215 / Redwood Road interchange on the south and continues northward. The southerly portion of the corridor travels along the westerly limits of North Salt Lake, Woods Cross, West Bountiful, and Centerville, about 0.5 to 2 miles west of I-15. North of Parrish Lane in Centerville, the Parkway corridor will be located less than about 0.25 miles west of I-15, with the two corridors essentially parallel continuing north to the I-15 / US-89 interchange in Farmington. The south and north interchanges are already partially constructed. A few industrial and commercial facilities are located along the alignment.

The Pedestrian Trail bridge area is generally flat, with some variations in topography due to previous construction, including placement of granular fill. Vegetation at the site consists primarily of native grass and sparse weeds. Portions of the site were very wet with some standing water observed at the time of the field investigations (March-April 2006).

4.2 SURFACE DRAINAGE

Surface drainage in the area generally follows the topography to the west and northwest towards the Great Salt Lake. In addition to the Jordan River and Oil Drain at the south interchange, some creeks, streams, and canals cross the alignment at various locations, creating the potential for flooding. Flooding and ponding on the soft surface soils can make access to bridge sites difficult.

4.3 GEOLOGY

The project is located within the Wasatch Front section of the Basin and Range physiographic region. The Wasatch Front consists of a series of down dropped valleys bounded primarily by the Wasatch Mountains on the east and the Great Salt Lake, Utah Lake and the Oquirrh Mountains on the west. The area extends from Juab County in the south up through Salt Lake, Davis, Weber and Box Elder counties to the north.

The general topography of the Wasatch Front is due, in large part, to Basin and Range extensional faulting. The Wasatch Fault is an extensional normal fault which trends northerly along the base of the Wasatch Mountains from Levan in the south, and up into Idaho to the north. Prior to extensional faulting, the region was subjected to compressional forces from the west resulting in extensive thrust faulting and mountain building. Extensional forces are still active today with various segments of the Wasatch Fault capable of generating large earthquakes with magnitudes near 7.4.

The Wasatch Mountains to the east consist predominately of Precambrian to Mesozoic, metamorphic and sedimentary bedrock. The valleys along the Wasatch Front are predominately covered with Pleistocene Lake Bonneville deposits, and younger alluvial fan and stream deposits. The Bonneville Lake Cycle began about 30,000 years ago when the climate was much cooler and wetter. The lake reached its highest elevation of about 5,100 feet, known as the Bonneville shoreline, between 16,000 to 14,500 years ago. From this shoreline, the lake eventually overtopped and breached through unconsolidated sediments near Red Rock Pass sending a catastrophic flood into the Snake River drainage system in southeastern Idaho, about 14,500 years before present. Within about a year, the lake had dropped to an elevation of about 4,740 feet, forming the Provo shoreline. Due to changing climatic conditions, the lake level gradually dropped to the historic levels of its modern day remnant, the Great Salt Lake. The last major high water shoreline of the lake was the Gilbert shoreline which reached an elevation of about 4,250 feet between 11,000 to 10,000 years ago. Historically, the Great Salt Lake has fluctuated between 4,211.9 and about 4,191 feet above sea level.

During Bonneville times thousands of feet of sediment were deposited in the valley. Deposits consist of deep-water silts and clays, shoreline sand and gravels and gravelly barrier beach and deltaic deposits. The unconsolidated to semi-consolidated valley fill deposits are thought to range from 2,000 to 5,000 feet thick (Black, and others, 2003; Currey, and others, 1984; Hintze, 1988; Stokes, 1986).

A geologic map of the Central Wasatch Front by Davis (1983) shows the surficial deposits in the proposed Parkway alignment to consist of floodplain and delta deposits (chiefly fine-grained and poorly drained sediments) in the vicinity of the south interchange, Provo Formation and younger lake bottom sediments (clays, silts, sands, and localized offshore bars) through the majority of the project, and landslide deposits near the north interchange. Newer maps of the area (Personius and Scott, 1992; Nelson and Personius, 1993), characterize the predominant surficial geologic deposits throughout the study area as Lake Bonneville lacustrine clay and silt, with Holocene to upper Pleistocene lateral spread deposits at some locations. Post-Bonneville lacustrine and marsh deposits are encountered along the easterly shores of the Great Salt Lake and encroach on the Parkway alignment from the west at some bridge sites. Localized upper Holocene stream alluvium associated with the Jordan River can be found along the shores of the river near the southerly terminus of the project. Bonneville lacustrine sand and gravel may be encountered near the northerly terminus, along with upper Holocene fan alluvium consisting of cobbles and gravel in a sandy matrix.

As shown on Figure 2a, the Pedestrian Bridge site lies within floodplain/delta deposits mapped by Davis (1983), with lake bottom sediments mapped a few thousand feet to the east of the site. Portions of newer maps by Nelson and Personius (1993) and Personius and Scott (1992) are overlaid on the Davis map on Figure 2b, and it will be noted from this figure that the areas was mapped as Holocene to upper Pleistocene lateral spread deposits. The deeper soils are likely lacustrine clays, silts, and sands.

Figure 2c shows landslide deposits mapped by Harty and Lowe (1992) in the North Salt Lake area. The authors of the map noted that they were unable to confirm that the North Salt Lake features are landslides; however, based on surface evidence and geologic evidence provided by others, the deposits are believed to be liquefaction-induced landslides. The deposits labeled Qmq$_3$ on Figure 2c are believed to predate the Gilbert shoreline (about 10,000 years ago). It will be noted that the Pedestrian Bridge site is located within Lake Bonneville Regressive Phase to early Great Salt Lake liquefaction-induced landslide deposits. Some small areas of younger stream alluvium deposits were identified within about 1,000 feet to both the north and the south of the site. The literature accompanying the map indicates that the possibility still exists for recurrent movement of the North Salt Lake landslides during earthquake ground shaking.

4.4 GEOLOGIC HAZARDS

Geologic hazards identified within the Legacy Parkway project area include ground shaking, liquefaction-induced lateral spreading and landslides, and subsidence during a moderate to large seismic event on the Salt Lake or Weber segments of the WFZ. Large seismic events on one of the other surrounding less studied faults such as the Great Salt Lake fault may also trigger these hazards.

Due to the close proximity of the Parkway to the Great Salt Lake, tilting of the lake during tectonic subsidence will shift the lake toward the east. This subsidence will cause a rise in already high ground-water tables and cause the lake to inundate toward the east. Subsidence and tilting will be greatest nearest the fault and will taper off away from the fault toward the west. Studies by Keaton (1987), and Chang and Smith (1998) have compared the 7.5 magnitude earthquake at Hebgen Lake, Montana in 1959 to a maximum credible earthquake along the Wasatch Front. Keaton's study shows the area near the most eastern extent of Farmington Bay to have the greatest potential for flooding. It should be noted that the magnitude of this hazard is directly related to the level of the lake and the location and magnitude of the earthquake. Ground shaking from surrounding faults or rupture of the Great Salt Lake fault beneath the lake also has the potential to generate wave hazards in the form of seiche (water oscillation waves) or a lake tsunami. The actual hazard potential to the Parkway from these waves is not known. Based on a study by Lin and Wang (1978) the hazard from seiche on the lake is likely low.

Other hazards include shallow ground water and potential flooding. A more detailed discussion of seismic hazards at the Pedestrian Trail bridge site is provided in Section 5.0.

4.5 SOIL MATERIALS

Much of the Segment 1 portion of the project has been covered with a layer of compacted granular fill, including the site of the proposed Pedestrian Trail bridge. Borings completed at the site generally encountered soft to stiff lean and fat clay in the upper 25 to 30 feet, followed interbedded layers of medium-dense to dense sand and stiff clay about 55 feet. The remainder of the profile to the maximum boring depth of 91.5 feet was primarily stiff lean and fat clay, with a medium-dense to very dense sand layer about 4 to 6 feet thick located between about 68 and 79 feet. Soil conditions are described in further detail in Section 7.1.2.

4.6 HYDROGEOLOGIC CONDITIONS

Groundwater in the Salt Lake Valley occurs in late Tertiary and Quaternary alluvial and lacustrine basin-fill deposits that range from coarse gravel to clay. Four hydraulically connected aquifers have been identified in the basin sediments: 1) a deep, unconfined aquifer in gravelly deposits along the fronts of the Wasatch Range and Oquirrh Mountains; 2) a deep, confined aquifer in the center of the valley in gravel deposits beneath clay confined beds; 3) a shallow, unconfined aquifer in the center of the valley overlying the confined aquifer; and 4) local perched aquifers located primarily adjacent to mountain fronts.

The hydraulic gradient in the Parkway area generally slopes down in a westerly direction toward the Great Salt Lake. The depth to groundwater was measured at each boring location as indicated on the boring logs and was within about 1 to 4 feet of the ground surface at the Pedestrian Trail bridge site at the time of drilling (March-April 2006). Fluctuations of a few feet can be expected due to typical seasonal variations. At some locations within Segment I, the existing ground is covered by water during at least part of the year, creating difficult access conditions. Artesian conditions were encountered in the lower confined aquifers at some locations.

4.7 POTENTIALLY HAZARDOUS MATERIALS

Potentially hazardous materials were not noted during the field investigation. All soil samples were re-examined in the laboratory and odors indicative of contamination were not noted. Potential sources of contamination include the oil drain at the southerly end of the project along with various past and present industrial sites located in the vicinity of the Parkway alignment. The apparent lack of contamination observed by field and lab personnel does not preclude the possible presence of potentially hazardous materials in the project area.

5.0 EARTHQUAKE CONSIDERATIONS

The study area is located within the seismically active Intermountain Seismic Belt which extends from Arizona to Canada. The nearest potentially active fault is the Salt Lake City Segment of the Wasatch Fault Zone (WFZ), located about 1.6 miles southeast of the Pedestrian Trail Bridge site. The Salt Lake City segment is capable of generating a magnitude 7.2 earthquake. The Weber Segment of the WFZ is located about 1.9 miles to the northeast with the capability of a magnitude 7.4 earthquake. The West Valley Fault Zone is located about 5.1 miles to the south. It is uncertain whether the West Valley Fault Zone has a true independent seismogenic source or if it functions as an antithetic fault to the WFZ.

5.1 DESIGN CRITERIA

The site is located at latitude 40.866° North and longitude 111.942° West. USGS-NEHRP probabilistic peak ground acceleration (PGA) values are tabulated below:

Probabilistic ground motion values in %g.

	10%PE in 50 yr	2%PE in 50 yr
PGA	28.57	68.20
0.2 sec SA	66.95	161.13
1.0 sec SA	23.16	68.20

It should be noted that the USGS-NEHRP mapped values are calculated for "firm rock" sites having a shear wave velocity of 1500 feet per second in the upper 100 feet (MCEER Site Class B/C boundary), and that bedrock ground motions may amplify or attenuate as they propagate through overburden soils.

Borings and testing completed at the site of the proposed structures indicate that the clayey soils in the upper 91 feet have average undrained shear strengths of about 1,100 to 1,300 psf, and that interbedded granular deposits are generally relatively dense. Based on this information, it is recommended that MCEER Site Class D be used for seismic design.

As part of the current Legacy Parkway project, Kleinfelder, Inc. developed site specific horizontal and vertical acceleration response spectra for the 1250 West bridge site and the State Street bridge site. It is our understanding that Kleinfelder will provide a report with conclusions and recommendations for applying the site-specific spectra at other sites on the project.

5.2 LIQUEFACTION AND LATERAL SPREAD

Liquefaction analyses were performed using the "Simplified Procedure" developed by Seed and Idriss (1971). This procedure involves determining the seismic shear stress ratio induced by an earthquake and comparing it with the seismic shear stress ratio required to cause liquefaction. Recommended refinements for the "Simplified Procedure" for SPT data presented at the 1996 NCEER workshop (Youd et al., 1997) were applied.

An evaluation of borings and testing indicates that several soil layers may liquefy during the seismic event having a 2 percent probability of exceedance in 50 years. Soil layers showing potential for liquefaction during the design event are noted on the boring logs in Appendix B. Layer thicknesses and potential liquefaction-induced settlement corresponding to volumetric strain are summarized below.

Boring No.	Thickness of Liquefiable Layers (ft)		Calculated Liquefaction Settlement (in)	
	Within Depth Investigated	Within Upper 50 Feet	Within Depth Investigated	Within Upper 50 Feet
RSB-X1-620	6.0	6.0	0.6	0.6
RSB-X1-621	17.6	9.9	2.8	1.6
RSB-X1-622	6.2	3.0	0.7	0.5
RSB-X1-623	0	0	0	0

It has been noted that surficial soils in the area are mapped as suspected lateral spread deposits. A review of the boring logs does not identify a continuous soil layer susceptible to lateral spread within the depth investigated. One silt layer encountered at a depth of 30 feet in Boring 621 exhibited possible lateral spread potential, and a few deeper silt and sand samples below 30 feet in the same borings had low enough blow counts to be susceptible to lateral spreading. SPT tests in the other three borings did not identifiy any vulnerable soil layers. Empirical evidence indicates that significant lateral spread displacements usually are limited to sites where the top of the susceptible soil layer is within 10 meters (about 33 feet) of the ground surface (Bartlett and Youd, 1992). Due to the depths and apparent discontinuity of potentially susceptible soil deposits laterally across the site, lateral spread mitigation is not considered necessary for the proposed structure.

6.0 FIELD AND LABORATORY TEST DATA

6.1 SUBSURFACE EXPLORATION

Subsurface investigations performed at the bridge sites include borings performed by Kleinfelder in conjunction with the Design-Build project, along with supplemental borings performed in 2006 for the current project.

Boring logs for bridge subsurface investigations performed in 2006 are included in Appendix B of this report. Test holes performed by RB&G Engineering in 2006 are labeled with the prefix "RSB" (or "RSC" for CPT holes, where applicable), followed by a number identifying the bridge site, then by a hole number in the 600 series. It will be noted that the Pedestrian Trail over LP bridge site is number X1, which was arbitrarily assigned because the bridge was not included (and therefore not assigned a number) in the Design-Build project. Roadway borings performed by Kleinfelder are labeled with the prefix "RB".

For all structure borings drilled in 2006, the subsurface investigation was performed using a CME 55 rotary drill rig with a tri-cone rock bit and NW casing to advance the boring and water as the drilling fluid. Sampling was generally performed at 5-foot intervals. At some locations, sampling was performed at closer intervals to evaluate liquefaction hazard for loose cohesionless soils in the upper 30 to 40 feet. Disturbed samples were obtained by driving a 2-inch split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. The drill rig used for each boring is noted on the boring log. The automatic trip hammer on the CME-55 No. 1 rig was evaluated by UDOT using Pile Driving Analyzer equipment in March 2006 and the energy ratio was determined to be about 72%. The CME-55 No. 2 rig uses a rope and cathead hammer which was determined by UDOT to have an average energy ratio of about 55%.

The number of hammer blows required to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value, corrected for overburden and hammer energy, provides a good indication of the in-place density of sandy material; however, it only provides an indication of the relative stiffness of cohesive material, since the penetration resistance of materials of this type is a function of the moisture content. Considerable care must be exercised in interpreting the standard penetration value in gravelly-type soils, particularly where the size of granular particles exceeds the inside diameter of the sampling spoon. If the spoon can be driven through the full 18 inches with a reasonable core recovery, the standard penetration value provides a good indication of the in-place density of gravelly-type material. For materials containing more than 35% gravel size particles, the density descriptions shown on the boring logs were developed based on correlations between relative density and standard penetration value for gravelly soils.

At some locations within the project it was not possible to drive the sampling spoon through the full 18 inches at some sampling depths. Where the sampling tube could not be driven through the full 18 inches, the number of blows to drive the spoon through a given depth of penetration is shown on the boring logs.

Undisturbed samples were obtained by pushing a 2.62-inch (inside diameter) thin-walled sampling tube into the subsurface material using the hydraulic pressure on the drill rig. The locations at which the undisturbed samples were obtained are shown on the boring logs.

Miniature vane shear (torvane) tests, which provide an indication of the undrained shearing strength of cohesive materials, were performed on samples of the cohesive soils during the field investigations. The results of these tests are shown on the boring logs as the torvane value in tsf.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbols designating soil types according to this system are presented on the boring logs. A description of the Unified Soil Classification System is included with the logs (see Appendix B), and the meaning of the various symbols shown on the logs can be obtained from this figure. Laboratory-tested samples were also classified according to the AASHTO Classification System, and the symbols designating the soil types according to this system are also presented on the boring logs.

6.2 LABORATORY TESTING

Laboratory tests performed during this investigation to define the characteristics of the subsurface material included:

1) Mechanical Analysis
2) Density
3) Natural Moisture Content
4) Atterberg Limits

5) Unconfined Compressive Strength
6) Triaxial Shear
7) Consolidation
8) Direct Shear
9) pH, Resistivity, Sulfates, and Chlorides

Laboratory testing was performed in accordance with applicable standards published by the American Society for Testing and Materials (ASTM) and/or the American Association of State Highway and Transportation Officials (AASHTO).

The results of laboratory tests performed during this investigation are presented on the boring logs and summarized on tables located in Appendix C of this report. Plots of applicable test data are also included in Appendix C.

7.0 STRUCTURES

7.1 DESCRIPTION

7.1.1 General

It is our understanding that Structure P-21 will be an eight-span concrete box-girder bridge structure. The bridge is expected to be about 15 feet wide with span lengths of 80 to 110 feet, for a total bridge length of about 800 feet. Controlling loads for the P-21 bridge bents have been provided by the structural engineer and are summarized below:

- Strength I Pile Load: 131 kips
- Service I Maximum Pile Load: 137 kips
- Service I Minimum Pile Load: -15 kips (tension)
- Service I Total Dead Load: 653 kips per bent
- Service I Live Load: 161 kips per bent

Loads have not been provided for abutment foundations. It is assumed that the individual pile loads at the abutments will be similar to the loads on the bent piles shown above.

7.1.2 Subsurface Conditions

Boring RB-399, completed about 500 feet southwest of the site by Kleinfelder encountered primarily medium-stiff to stiff lean clay and silt in the upper 27 feet, with a layer of dense silty sand between 27 feet and the bottom of the boring at 29 feet.

Borings RSB-X1-620 and RSB-X1-623 were drilled near the proposed locations of Bents 3 and 7, respectively of Structure P-21. These borings encountered 2 to 3.5 feet of gravelly fill at the surface, followed by lean clay with some layers of silty sand, sandy silt, and fat clay to the bottom of the borings at a depth of 41.5 feet. The lean clay samples tested had liquid limits between about 39 and 50 and plasticity indices between 19 and 25. The fat clay encountered between 11 and 15 feet in Boring 623 had a liquid limit of 52 and a plasticity index of 31. Consistency of cohesive soils was generally soft to firm in the upper 20 feet, and firm to stiff below 20 feet. The silty sand layers and non-plastic sandy silt layers were relatively thin (less than about 6 inches thick) above a depth of 26 feet.

Below 26 feet, the non-plastic silt and sand layers were about 2 to 6 feet thick, and SPT blow counts indicated that these layers were in a medium-dense to dense state.

Borings RSB-X1-621 and RSB-X1-622 were drilled near the anticipated locations of Bents 4 and 6, respectively and encountered conditions similar to those encountered by the shallower borings described above. Boring 621 extended to a depth of 86.5 feet, and Boring 622 extended to 91.5 feet. Below 40 feet, both borings encountered predominantly stiff lean clay and fat clay, with some medium-dense to dense sand and non-plastic silt layers ranging from about 2 to 6 feet thick. The liquid limit of the lean clay ranged from 33 to 38, while the plasticity index varied from 8 to 26 in these two deeper borings. For the tested samples of fat clay, the liquid limit was between 51 and 57, with the plasticity index between 28 and 34.

7.1.3 Groundwater Conditions

Groundwater was encountered at depths ranging from 1 to 4 feet below the ground surface (between approx. elev. 4220.5 and 4218.5 feet) at the time of drilling (March-April 2006). It is anticipated that up to two feet of fluctuation may occur due to typical seasonal variations in precipitation and climatic cycles.

7.2 RECOMMENDATIONS

7.2.1 Bridge Structures

Potential foundation types at this site include shallow foundations, such as spread footings, and deep foundations, such as drilled shafts or driven piles. Due to the magnitude of structural loads (including seismic design requirements) and generally low bearing resistance of shallow soils, deep foundations are expected to be the most efficient foundation type for major bridge structures on the project. The depth to competent bearing layers, along with foundation settlement considerations, favors the use of driven piles rather than drilled shafts. Given the anticipated subsurface soil and groundwater conditions, driven piles can be more readily installed to greater depths than drilled shaft foundations.

Each abutment foundation for Structure P-21 is expected to consist 10 piles in two rows, while each bent support will require 18 piles in a rectangular group. Recommendations for driven pile foundations are summarized below.

7.2.1.1 Driven Piles

Axial compression resistance values have been estimated for concrete-filled steel pipe piles of various diameters and embedment depths. The analyses were performed using the FHWA program SPILE. Geotechnical resistance factors were selected from the 2006 Interim AASHTO LRFD Bridge Design Specifications. Estimated resistance values for various combinations of pipe pile diameter and tip elevation are summarized below.

Pile Data Parameters	**Pile Size (inches OD)**							
	12.75	**14**	**16**	**16**	**18**	**18**	**24**	**24**
Estimated Pile Tip Elevation (ft)	4151	4151	4151	4147	4151	4147	4151	4147
Elev. of Min. Acceptable Pile Penetration (ft)	4154	4154	4154	4151	4154	4151	4154	4151
Strength I Axial Compression Resist. (kip)	119	135	161	176	189	207	265	291
Extreme Event I Compression Resist.. (kip)	158	175	204	227	234	262	324	364
Required Driving Resistance (kip)	184	208	248	272	291	319	409	448

The actual tip elevations may vary across the 9 foundation locations based on observed driving resistance and PDA test results during construction. The estimated tip elevations are located within or near zones of medium-dense to dense sand shown on the boring logs. While it is preferred that the observed pile driving resistance demonstrate a noticeable increase over the last 2 to 3 feet of driving (indicating that the pile tip has encountered the sand layer), such an increase is not expected to be necessary to meet pile capacity requirements. Because the sand layers near the estimated pile tip elevations are relatively thin (only about 4 to 6 feet thick), the pile tips were assumed to be located in clay for computations of end bearing resistance. The elevation of minimum acceptable pile penetration is a few feet above the estimated tip elevation to allow some flexibility in actual pile driving depths. All piles should be driven to at least the minimum penetration elevation unless the geotechnical engineer approves shorter piles based on a review of tested pile driving resistance and other foundation considerations, including foundation uplift resistance and settlement.

The estimates listed above assume that new embankments will be constructed with lightweight material and/or surcharged such that any significant embankment settlement will be completed or otherwise mitigated prior to placement of structural loads on the piles.

We recommend that piles be spaced at least 3 diameters apart (center-to-center) to reduce group effects. Potential for pile group failure under axial compression loads was checked for the following proposed pile group layouts.

- Abutments with 10 piles spaced over a rectangular area 17.3 feet long by 8.3 feet wide.
- Bent pile groups having 18 piles spaced over a rectangular area 17.8 feet long by 13.8 feet wide.

In each case, the potential for group (block) failure was found to be less critical than the axial compressive resistance of individual piles. Group resistance can therefore be determined by multiplying the single-pile resistance by the number of piles in the group, for both the Strength I and Extreme Event limit states.

A preliminary pile drivability analysis has been performed using the program GRLWEAP 2005. The analysis was performed for closed-end 16-inch OD steel pipe piles having wall thicknesses of 3/8 and 1/2 inch. The analyzed driving systems were a Delmag D 25-32 diesel hammer with the manufacturer's recommended hammer cushion, and an IHC S-90 Hydrohammer, without cushioning. The results of the analyses are summarized below.

16-inch OD closed-end pipe										
Hammer	3/8" Pipe Thickness					1/2" Pipe Thickness				
	Ultimate Capacity (kips)	Maximum Compress. Stress (ksi)	Blow Count (per foot)	Stroke (ft)	Energy (kip-ft)	Ultimate Capacity (kips)	Maximum Compress. Stress (ksi)	Blow Count (per foot)	Stroke (ft)	Energy (kip-ft)
D 25-32	275	25.9	25	7.3	29.3	275	24.9	24	7.5	28.0
	300	26.5	28	7.5	29.7	300	25.3	28	7.6	28.0
	400	28.3	53	8.1	31.3	400	26.5	46	8.1	29.2
	500	30.4	120	8.6	32.4	550	28.0	122	8.7	30.7
IHC S-70*	275	41.0	22	6.6	38.7	275	38.3	21	6.6	38.6
	300	41.0	25	6.6	38.5	300	38.3	24	6.6	38.4
	400	41.1	47	6.6	37.7	400	38.3	39	6.6	37.8
	510	41.2	122	6.6	37.5	570	38.4	118	6.6	37.5

* IHC S-70 assumed to operate at 80% efficiency.

It will be observed from the table that both hammers appear capable of driving the piles at this site to significantly greater resistance values than the required driving resistance of 272 kips, without significantly exceeding a hammer blow count of about 120 blows per foot. The calculated driving stresses are significantly greater for the IHC S-90 hammer than for the diesel hammer, due to the lack of cushioning and greater energy transfer to the pile.

Based upon the results of the WEAP analysis, pipe piles with 3/8" wall thickness can be successfully driven to the required driving resistance with either hammer system. A refined wave equation analysis should be performed for the proposed pile driving system prior to mobilizing the pile driving rig to the site.

Pile driving should be monitored to ensure that driving stresses do not exceed 90 percent of the yield strength of the steel piles. Based on the WEAP analysis, the yield strength of the steel pipe need not exceed 35 ksi to resist properly monitored driving stresses. The pile driving hammer should have an operating energy of at least 35 kip-ft. Special care should be taken to align the hammer properly with the pile head to limit the possibility of eccentric driving stresses, which can result in over-stressing of one side of the pile. Driving should be performed only with smooth, square ends of the piles (preferable the factory-cut ends) rather than rough field-cut pile ends.

It should be noted that piles are not expected to demonstrate the required driving resistance during initial driving. Significant set-up is likely to occur as pore pressures dissipate in the hours and days following driving, thus increasing the geotechnical resistance of the pile. It is anticipated that piles may be driven to the estimated tip elevation with less difficulty during initial driving conditions (prior to set-up). After set-up has occurred, it may be much more difficult to re-mobilize the pile.

7.2.1.2 Foundation Settlement

Pile resistance analyses were performed based on the neutral plane method. In this method, downdrag loads are not considered detrimental to the geotechnical pile resistance, and the resistance values above need not be reduced to account for downdrag. The effects of downdrag should, however, be accounted for in evaluations of the structural resistance of the pile section. For 16-inch OD steel pipe piles at each of the foundation locations listed above, the axial structural resistance of the concrete-filled pipe pile section should be checked to verify that the pile section can resist the Service I Load plus a factored downdrag load of 200 kips per pile. To account for potential corrosion, we recommend that the structural capacity evaluation be performed assuming 1/16 inch of corrosion will occur on the exterior of the steel pipe.

The Extreme Event I Resistance shown above assumes that liquefiable layers will not provide resistance during seismic loading. If this value is not exceeded, it is anticipated that the principle consequences of liquefaction will be pile group settlement resulting from downdrag loads transferred from settling soil above the liquefiable layers. The pile group could potentially settle as much as the surrounding ground surface during liquefaction before the temporary downdrag loads are neutralized and the piles regain the full Extreme Event I Resistance; however, actual pile group settlement during liquefaction is expected to be somewhat less than the settlement of the surrounding ground surface. The maximum estimated ground settlement due to liquefaction at this site is about 2.6 inches.

Consolidation settlement of an individuals bent foundations at Structure P-21 was estimated assuming 18 piles (16-inch OD) spaced over a rectangular area measuring 17.8 feet long by 13.8 feet wide. For a total service dead load of 1080 kips (60 kips per pile), the calculated pile group settlement is one inch. The pile group can therefore be designed to support an average service dead load of up to 60 kips per pile. Transient loads are not expected to contribute significantly to pile group settlement at this structure. As a result, the Service I Resistance shown on the plans may exceed 60 kips if necessary to support transient loads, provided the non-transient service loads do not exceed 60 kips per pile.

Consolidation settlement of abutment pile groups at Structure P-21 was estimated assuming 10 piles (16-inch OD) spaced over a rectangular area measuring 17.3 feet long by 8.3 feet wide. In the analysis it was assumed that settlements caused by placement of embankment and MSE fill will be mitigated/completed prior to placement of bridge loads on the piles. For a total service dead load of 800 kips (80 kips per pile), the calculated pile group settlement is one inch. Average non-transient loads greater than 80 kips per pile may cause a significant stress increase and settlement in the high-plasticity clay layer located about 40 feet below the ground surface. We therefore recommend that the average service dead load not exceed 80 kips per pile. As noted in the previous paragraph, transient loads are not expected to contribute significantly to pile group settlement at this site. The Service I Resistance shown on the plans may be greater than 80 kips per pile if necessary to support transient loads, under the condition that the non-transient loads do not exceed 80 kips per pile.

7.2.1.3 Uplift

Uplift capacities for individual piles computed using LRFD Procedures are summarized on the table below. A resistance factor of 0.35 was used for sandy soils, and a factor of 0.25 was used for clayey soils at the Strength I limit state.

Single-Pile Uplift Resistance								
Pile Diameter	12.75	14	16	16	18	18	24	24
Est. Pile Tip Elev. (ft)	4151	4151	4151	4147	4151	4147	4151	4147
Strength I (kips)	47	53	64	71	76	84	105	117
Extreme Event (kips)	150	166	191	215	218	246	296	336

Group uplift resistance for the case of block failure was evaluated by estimating the weight of each pile group plus the shear resisting force around the perimeter of the pile group for the abutment and bent pile group layouts described previously (see Section 7.2.1.1 above). For 16-inch OD piles driven to an estimated tip elevation of 4147 feet; the uplift resistance of the individual piles within the proposed pile groups was found to be more critical than the resistance to block failure. As a result, the group uplift resistance can be taken as the individual pile uplift resistance multiplied by the number of piles in the group.

7.2.1.4 Lateral Loading

Soil parameters and other recommendations for evaluation of lateral load response using the computer programs LPILE and GROUP are included on a summary sheet in Appendix D.

7.2.1.5 Load Tests

Table 10.5.5.2.3-3 of the 2006 AASHTO LRFD Interim Specifications shows the number of dynamic pile load tests with signal matching required at each site. The number of required PDA tests depends on site variability and the number of piles to be driven. With respect to the AASHTO table, the sites of the proposed Pedestrian Trail over Legacy Parkway structure can be considered to have low variability. For Structure P-21, the minimum number of tests is 4. Because the structure will be supported by 7 abutments and 2 bents, with spans of 80 to 110 feet between foundation locations, we recommend that at least one PDA test be performed at each abutment and bent, to verify pile driving resistance at each foundation. Additional PDA testing may be necessary if pile driving conditions indicate significant variability in the soil profile.

Pile resistance and driving criteria from PDA testing should be determined from "Beginning of Restrike" conditions. A minimum of 24 hours set-up time will likely be required after initial driving before piles demonstrate the required driving resistance, and additional time may be necessary in some instances.

7.2.1.6 Construction Considerations

Groundwater was encountered within 1 to 4 feet of the existing ground surface at the time of drilling, and dewatering will be required for construction of pile caps at the bents and other construction activities.

It is recommended that the groundwater be lowered to a depth of 2 feet below the bottom of the excavations. It is anticipated that dewatering can best be achieved using sumps and drain trenches where clay exists at the foundation level.

Soils at the bottom of excavations may be too soft to provide an adequate working surface. Stabilization methods will depend upon conditions encountered. Moderately soft areas can be stabilized by over excavating the foundation footprint to a depth of about 1 foot, placing a geotextile fabric such as Mirafi 500X or equal and backfilling with compacted sandy gravel. Very soft areas may be stabilized by tamping cobble rock (preferably angular to subangular) into the subgrade as needed. As a minimum, it is recommended that an 8 inch layer of granular borrow be placed below the pile cap to provide a working platform.

Depending upon construction sequence and methods employed, excavation and shoring of embankment preload fill may be necessary. Maximum excavation slopes in compacted granular fill material of 1H:1V can be used for temporary cuts less than 20 feet deep. For temporary cuts between 20 and 30 feet deep, 1.5H:1V cut slopes should be used. The stability of cuts in uncompacted fill and/or natural subgrade soils should be evaluated on a case-by-case basis.

We recommend that preconstruction surveys and vibration monitoring be performed for any critical structures or utilities located within 500 feet of the construction area.

7.2.2 Embankments

Analyses and recommendations for embankments are provided in a separate report by Kleinfelder.

7.2.3 Retaining Walls

Analyses and recommendations for retaining walls are provided in a separate report by Kleinfelder.

7.2.4 Lateral Earth Pressures

Lateral earth pressures can generally be calculated using the equation

$$P = \frac{1}{2} \gamma K H^2$$

Where P = total lateral force on the wall, plf
K = earth pressure coefficient
γ = unit weight of the soil (depends on fill material)
H =height of the wall

The earth pressure coefficient used in designing the walls will depend upon whether the wall is free to move during backfilling operations, or whether the wall is restrained during backfilling. If the wall is free to move away from the soil during backfilling operations, we recommend that an active earth pressure coefficient be used in the above equation to calculate the lateral earth pressures. If the walls are restrained or braced from movement during backfilling (as is generally the case with box culverts and similar structures), we recommend that an at-rest earth pressure coefficient be used to calculate the lateral earth pressures. A passive earth pressure coefficient should be used to calculate the lateral soil resistance where the wall is being pushed toward the soil. It should be recognized that the pressures, calculated by the above equation, are earth pressures only and do not include hydrostatic pressures. Where hydrostatic pressures may exist behind a retaining structure, we recommend either the wall be designed to resist hydrostatic pressure, or that a drainage system be placed behind the wall to prevent the development of hydrostatic pressures.

Lateral earth pressure coefficients and other recommendations for computing lateral earth pressures are included in Appendix D. A general earth pressure coefficient has been provided for calculation of earth pressures where mechanical compaction equipment is expected to be operated near non-yielding walls less than about 8 feet high. This scenario is anticipated during placement of fill around culverts. The residual pressure from compaction equipment can be reduced by limiting the proximity and weight of compacting equipment near culvert walls.

Recommendations for computing passive lateral earth pressures for the native clay subgrade on bent piles caps at the Pedestrian Trail bridge site are also included in Appendix D.

Recommendations based on the Mononobe-Okabe approach for active and passive seismic lateral earth forces are included in Appendix D. For non-yielding walls, recommended equations for calculating the dynamic thrust and dynamic overturning moment are also provided.

8.0 CORROSION INVESTIGATIONS

In order to obtain an indication of the corrosive nature of the subsurface material at these sites, resistivity, pH, sulfate, and chloride tests were performed on soil samples obtained in the Test Holes. The results of these tests are tabulated below:

Test Hole	Depth (ft)	Soil Type	Resistivity ohm-cm	pH	Sulfate (ppm)	Chloride (ppm)
RSB-X1-621	45-46.5	Sand w/ Silt	15,573	8.7	215	
RSB-12-623	3-4.5	Lean Clay	8,435	8.8	613	817
RSB-12-623	25-26.5	Lean Clay	19,467	8.6	116	241

The 2006 Interim LRFD specifications state that resistivity less than 2,000 ohm-cm, sulfate concentration greater than 1,000 ppm, and pH less than 5.5 (8.5 in highly organic soils) are all indicative of potential pile corrosion or deterioration. Due to the high resistivity and pH of tested samples, unusual potential for corrosion/deterioration of steel piles is not anticipated at this site. Type I or Type II cement may be used for concrete at this site; however Type II cement is preferred for its superior resistance to deterioration. For design of driven piles, it is recommended that 1/16 inch of corrosion be assumed for all surfaces in contact with soil or groundwater. This reduction has been accounted for in the pile analyses described in Section 7.2.1.1.

9.0 LIMITATIONS

The conclusions and recommendations presented in this report are based upon the results of the field and laboratory tests. It should be recognized that soil materials are inherently heterogeneous and that conditions may exist throughout this site which were not defined during this investigation. If during construction, conditions are encountered which appear to be different than those presented in this report, it is requested that we be advised in order that appropriate action may be taken.

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10.0 REFERENCES

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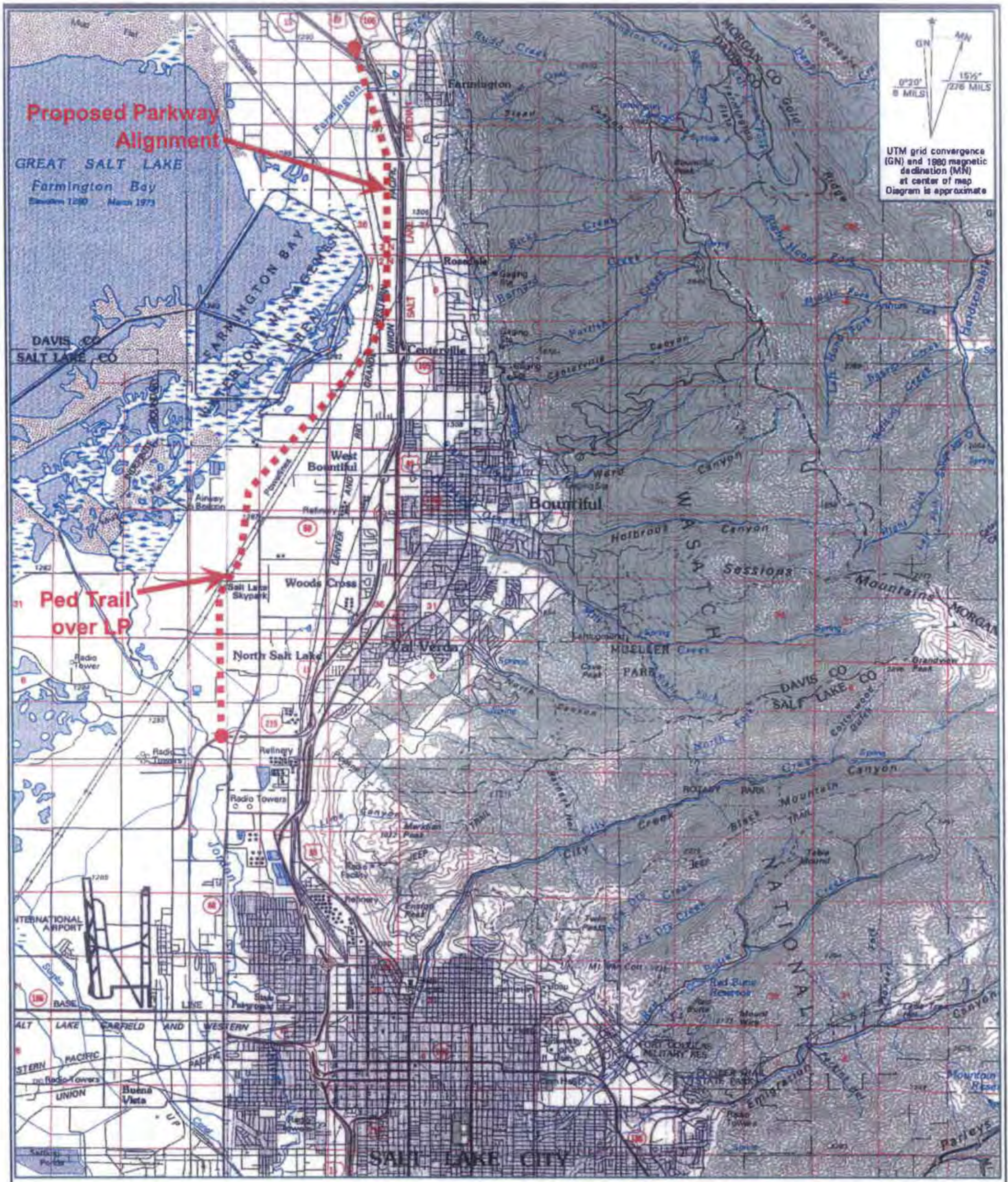
FIGURES



Portion of 1980 USGS 30 X 60 minute Salt Lake City (Utah-Wyoming) Quadrangle

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Figure 1 Vicinity Map
Proposed Legacy Parkway Alignment
Legacy Parkway
Salt Lake / Davis Counties, Utah

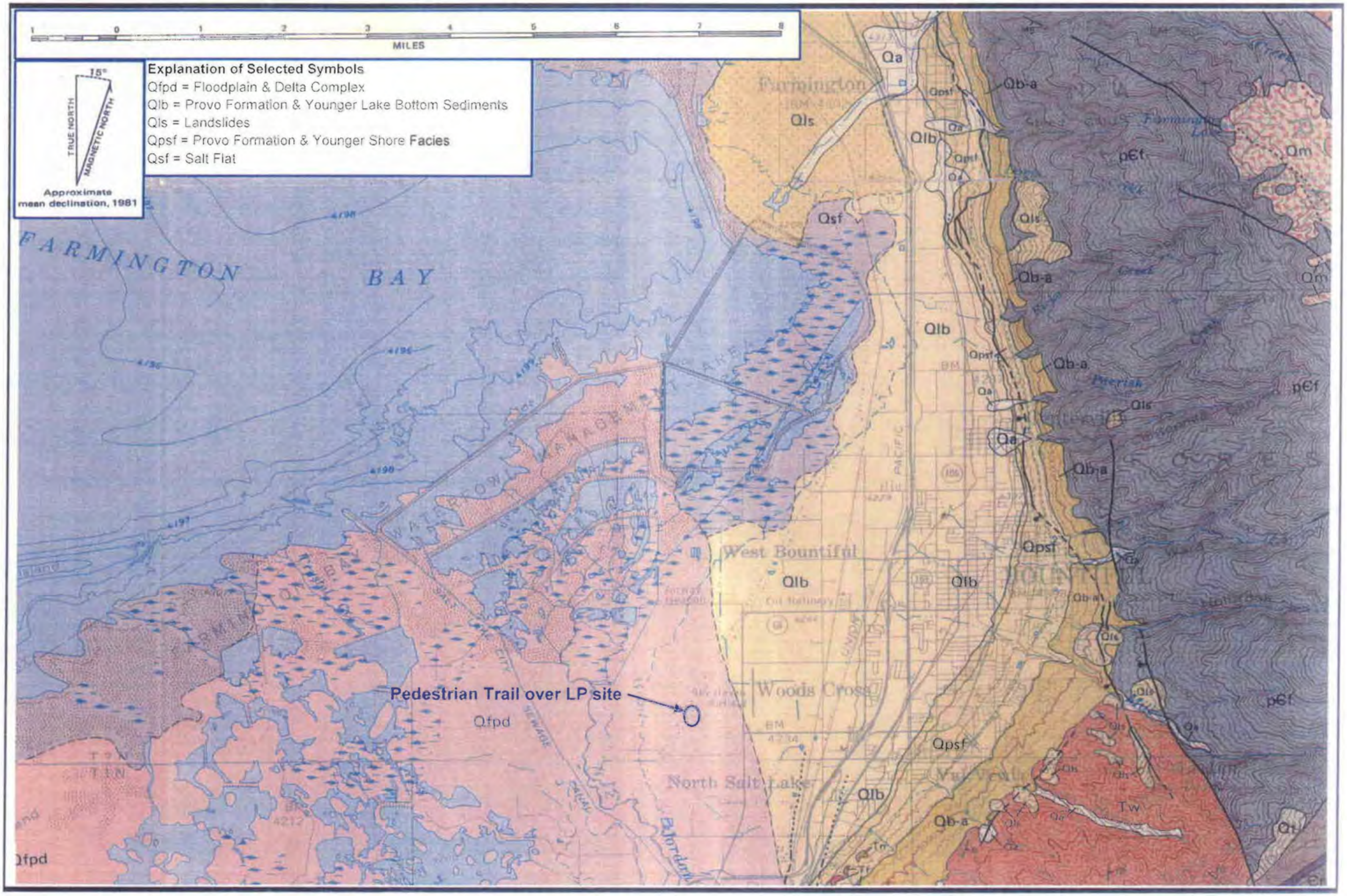

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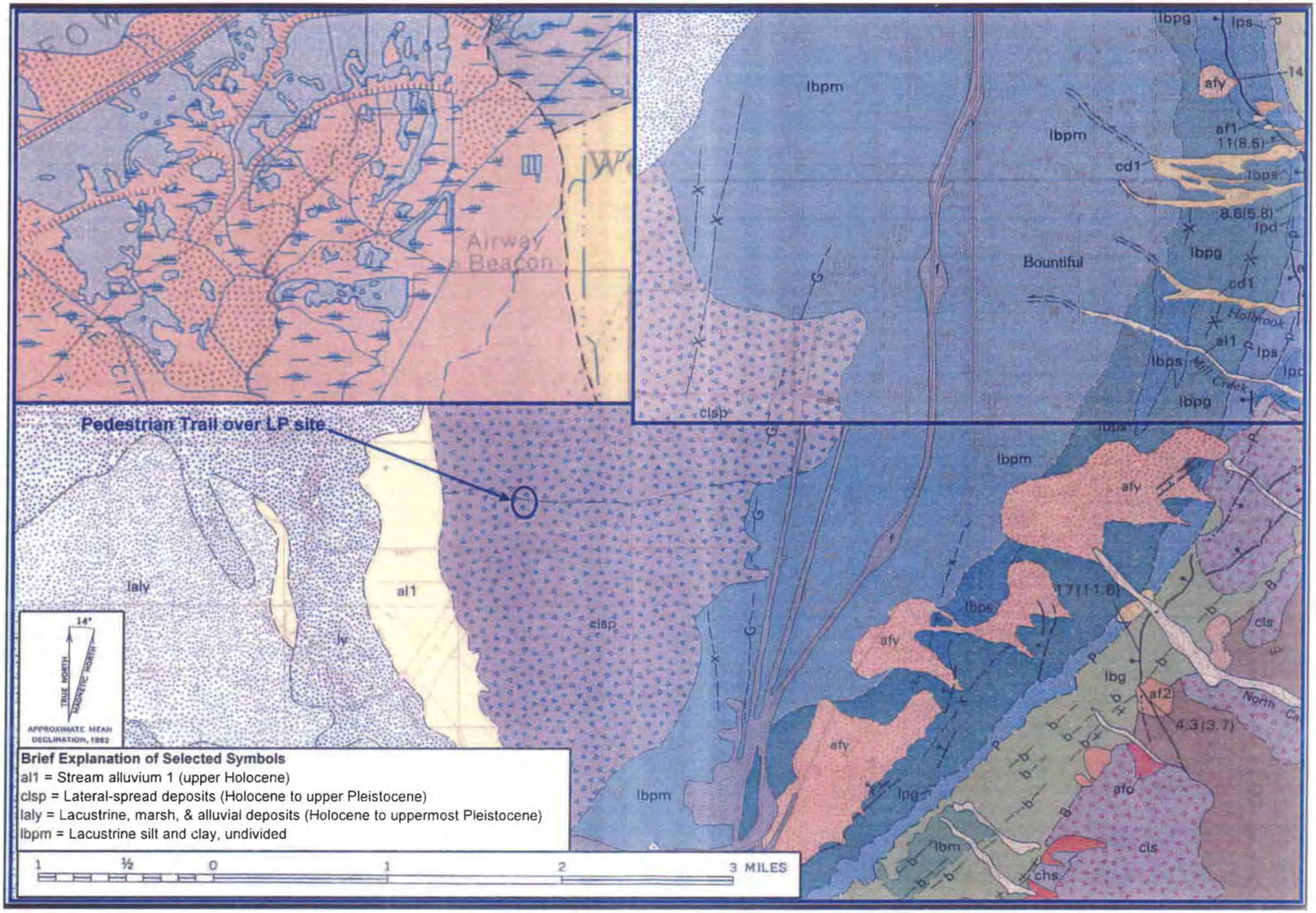
Figure 2a Geologic Map A
Pedestrian Trail over LP
Legacy Parkway
Salt Lake / Davis Counties, Utah

Map modified from:
Davis, 1983
Utah Geological and Mineral Survey



Brief Explanation of Selected Symbols

al1 = Stream alluvium 1 (upper Holocene)

clsp = Lateral-spread deposits (Holocene to upper Pleistocene)

laly = Lacustrine, marsh, & alluvial deposits (Holocene to uppermost Pleistocene)

lbpm = Lacustrine silt and clay, undivided

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Figure 2b Geologic Map B
Pedestrian Trail over LP
Legacy Parkway
Salt Lake / Davis Counties, Utah

Maps modified from:

Upper Left - Davis, 1983 (Utah Geological & Mineral Survey)

Uppper Right - Nelson & Personius, 1993 (US Geological Survey)

Bottom - Personius & Scott, 1992 (US Geological Survey)

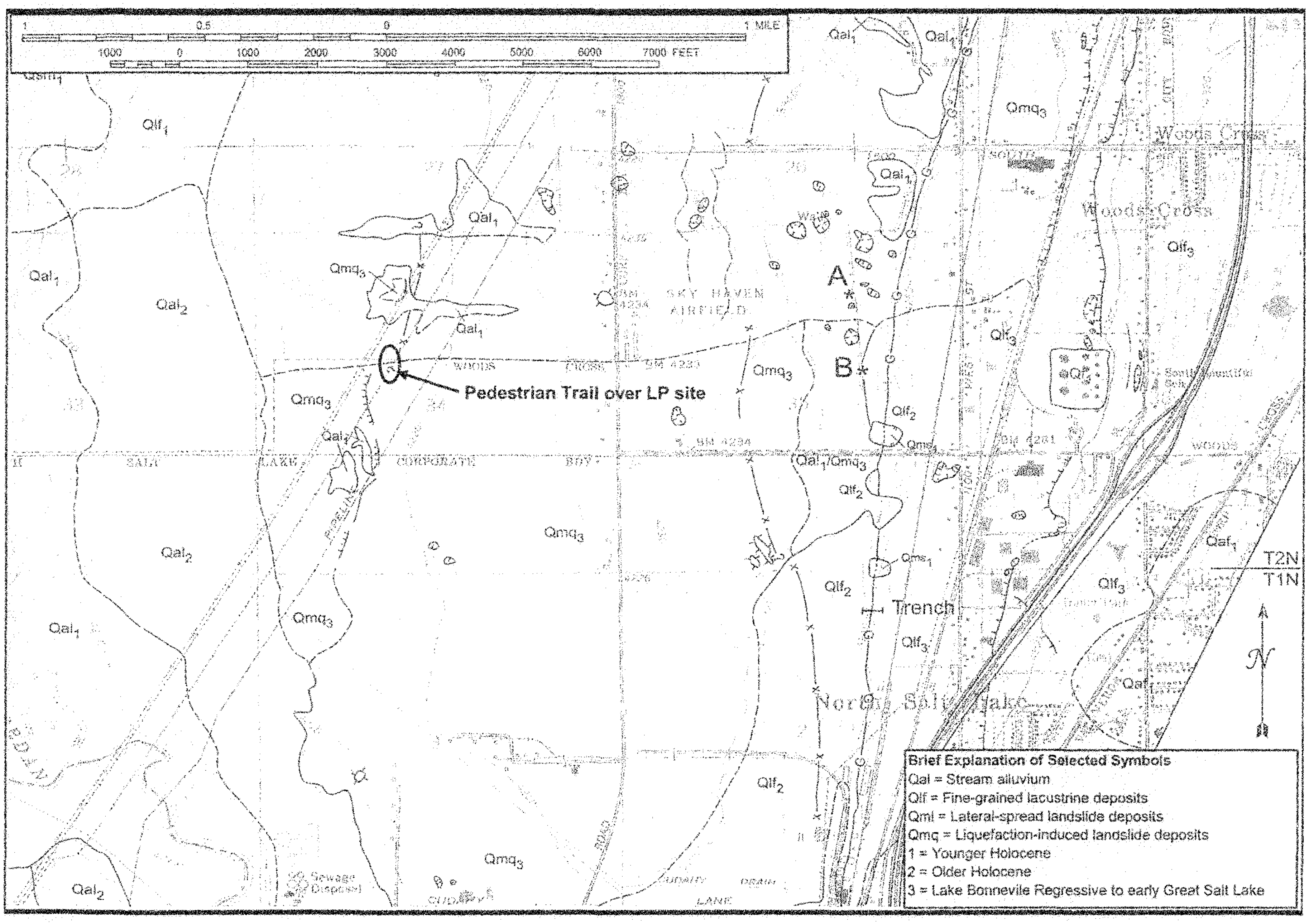

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Figure 2c Geologic Map C
North Salt Lake Landslides
Legacy Parkway
Salt Lake / Davis Counties, Utah

Map modified from:
Harty & Lowe, 1992

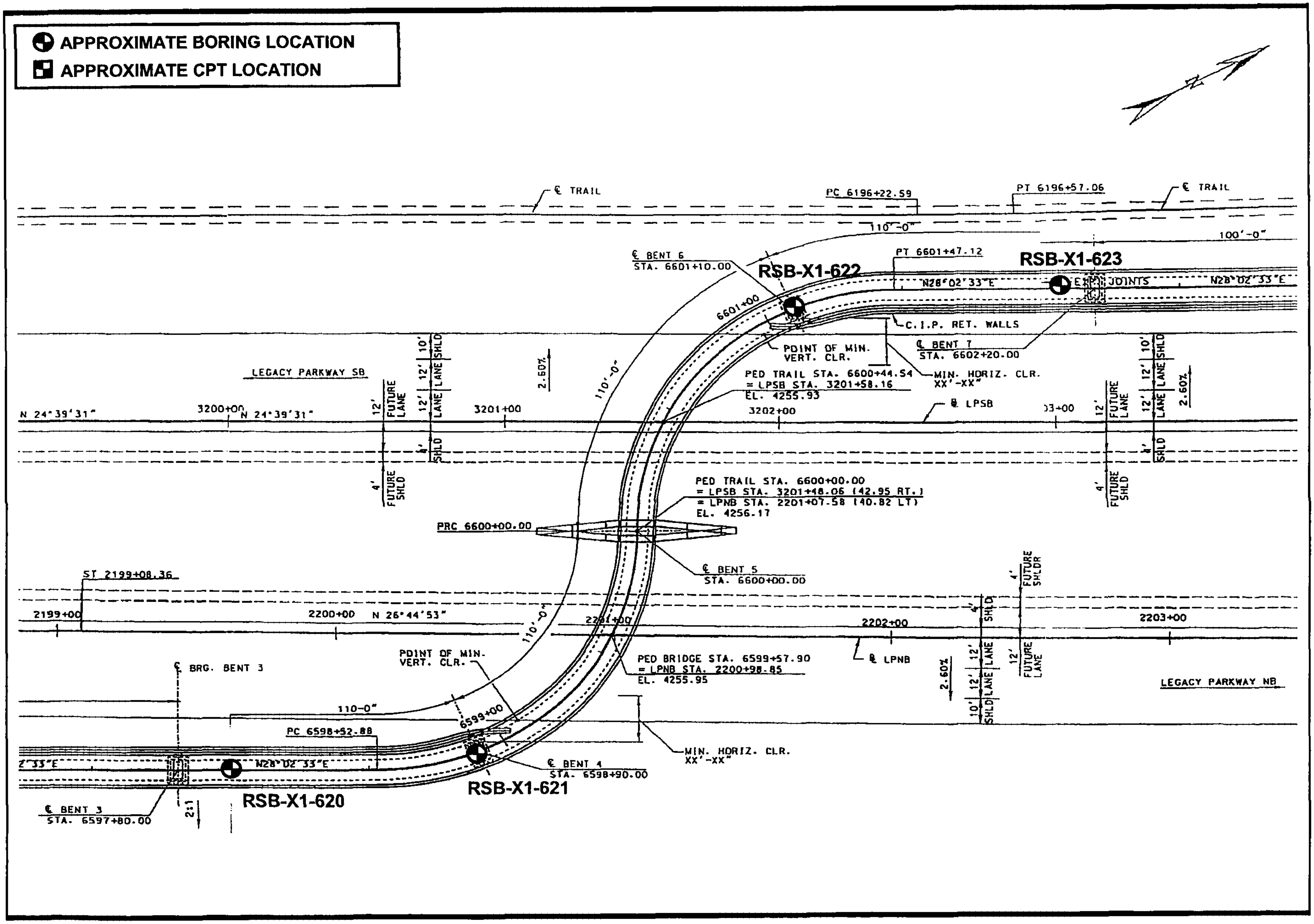

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Figure 3 Site Plan and Approximate Test Hole Locations
Pedestrian Trail over LP
Legacy Parkway
Salt Lake / Davis Counties, Utah

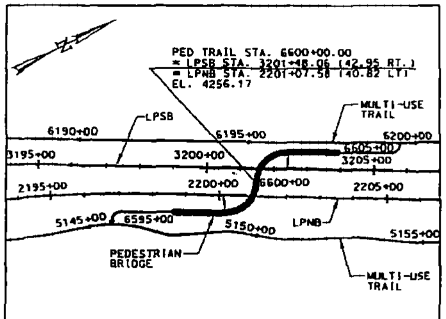
APPENDIX A
Structure Drawings

INDEX OF SHEETS

SHEET NO.	TITLE
1	SITUATION & LAYOUT 1
2	SITUATION & LAYOUT 2
3	SITUATION & LAYOUT 3
4	SITUATION & LAYOUT 4
5	SITUATION & LAYOUT 5
6	SITUATION & LAYOUT 6
7	FOUNDATION PLAN
8	ABUTMENT DIMENSIONS 1
9	ABUTMENT DIMENSIONS 2
10	ABUTMENT REINF DETAILS 1
11	TYPICAL BENT DIMENSIONS
12	BENT REINFORCEMENT 1
13	BENT REINFORCEMENT 2
14	BENT REINFORCEMENT 3
15	BENT REINFORCEMENT 4
16	DECK SECTIONS AND DETAILS 1
17	DECK SECTIONS AND DETAILS 2
18	GIRDER LAYOUT

GENERAL NOTES

1. USE COATED. DEFORMED BILLET-STEEL REINFORCING BARS IN ACCORDANCE WITH ASTM A615. GRADE 60. EPOXY COATED IN ACCORDANCE WITH AASHTO M 284.
2. PROVIDE STEEL FOR DRIVEN PIPE PILES CONFORMING TO ASTM A-252. GRADE 3. fy= 45.000 PSI.
3. PROVIDE 2 INCH COVER TO REINFORCING STEEL EXCEPT WHERE NOTED OTHERWISE.
4. CHAMFER EXPOSED CONCRETE CORNERS ¾ INCH EXCEPT WHERE NOTED OTHERWISE.
5. USE CLASS AA (AE) FOR SUPERSTRUCTURE CAST-IN-PLACE CONCRETE AND FOR SUBSTRUCTURE CAST-IN-PLACE.
6. ALL DIMENSIONS ARE IN FEET AND INCHES. ALL STATIONS AND ELEVATIONS ARE IN FEET.
7. DRAWINGS ARE NOT TO SCALE. HORIZONTAL DIMENSIONS ARE PLAN DIMENSIONS AND VERTICAL DIMENSIONS ARE PLUMB.
8. PROVIDE GRANULAR BACKFILL BORROW TO MEET UDOT'S CRITERIA FOR FREE DRAINING GRANULAR BACKFILL BORROW. SPECIFICATION 02061.
9. CONCRETE FOR CAST-IN-PLACE DECKS CONTAIN 5% SILICA FUME BY WEIGHT OF CEMENTIOUS MATERIAL.



LOCATION PLAN

DESIGN DATA

H-10 LOADING IN ACCORDANCE WITH 3rd EDITION AASHTO LRFD SPECIFICATIONS. WITH INTERIMS THROUGH 2006.

PEDESTRIAN LOAD: 85 psf

CAST-IN-PLACE CONCRETE:
f'c = 6.500 psi: BOX GIRDER
f'c = 4.000 psi: ABUTMENTS. BENTS. PARAPET & PILES
Fy (REINF.) = 60 ksi: n = 8

PRESTRESSED CONCRETE:
F'c = 6.500 psi: Fy (NONPRESTRESSED) = 60 ksi: n = 6
Fy (PRESTRESSED) = 270.000 psi

STRUCTURAL STEEL: Fy = 50.000 psi

SEISMIC DESIGN DATA:
SEISMIC DESIGN PER MCEER/ATC 49
(2475 YR. RETURN PERIOD - 3% PE IN 75 YRS.)
Ss = MAX CONSIDERED EQ GROUND MOTION AT 0.2S = X.XXg
S1 = MAX CONSIDERED EQ GROUND MOTION AT 1.0S = X.XXg
SITE CLASS X

QUANTITIES

ITEM	ESTIMATED	UNIT	AS CONSTRUCTED
GRANULAR BACKFILL BORROW (PLAN QUANTITY)	XXX	CU.YDS.	
PILE DRIVING EQUIPMENT	1	LUMP	
DRIVEN PILES 16 INCH DIAM.	5.000	LIN.FT.	
STRUCTURAL CONCRETE (SUBSTRUCTURE EST. QTY 200.0 CU. YDS.)	1	LUMP	
STRUCTURAL CONCRETE (SUPERSTRUCTURE EST. QTY 500.0 CU. YDS.)	1	LUMP	
REINFORCING STEEL (EPOXY COATED)	260.000	LBS.	
PRESTRESSED CONCRETE MEMBERS. (TYPE V. XX'-XX")	XX	EACH	
STRUCTURAL STEEL (EST. QTY. XXX LBS.)	1	LUMP	
ELECTRICAL WORK - BRIDGES	1	LUMP	
PEDESTRIAN FENCE	XXX	FT.	
EXPANSION JOINT	30	FT.	
POST-TENSIONING TENDONS	26.000	LBS.	

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS

NO.	DATE	BY	REMARKS

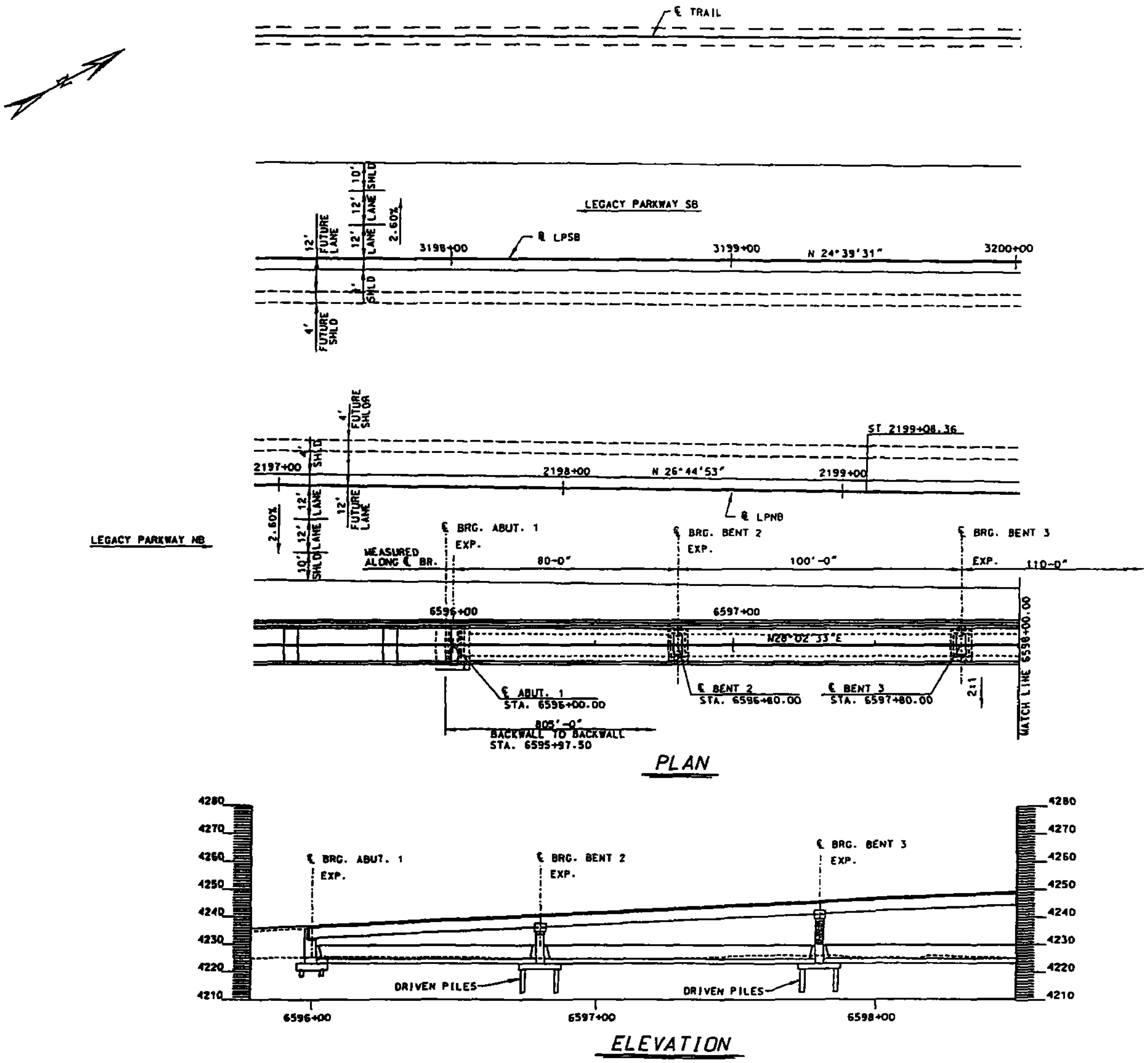
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN SKD 6/06 CHECK DVP 6/06
DRAWN BAH 6/06 CHECK SKD 6/06
QUANT. SKD 6/06 CHECK DVP 6/06

APPROVAL RECOMM. ____ DATE ____ SENIOR DESIGN ENGINEER
APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

LEGACY PARKWAY
PEDESTRIAN BRIDGE OVER LP
SITUATION & LAYOUT 1
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
P-21
BRIDGE NO.
SHT. 1 OF 6



PRELIMINARY
NOT FOR CONSTRUCTION

NO.	DATE	BY	REMARKS

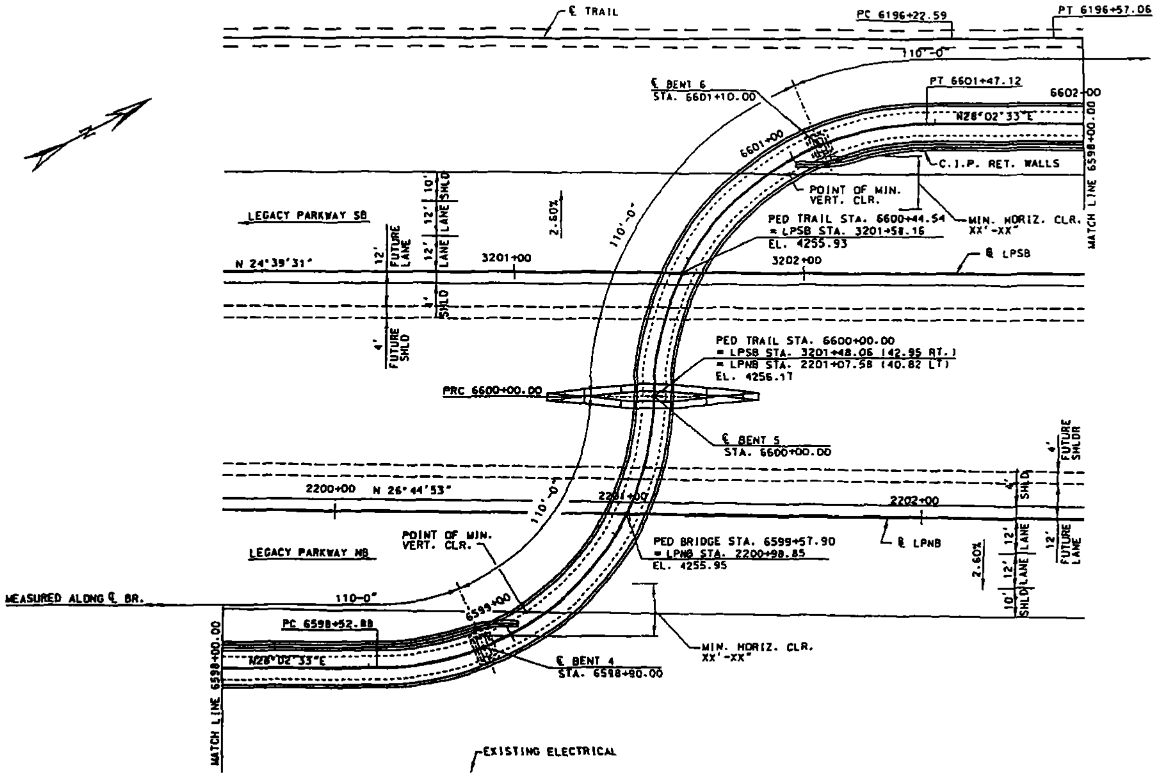
REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

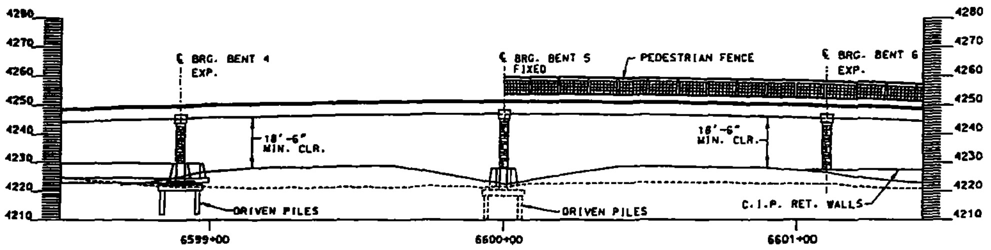
APPROVAL RECOMM. ____ DATE ____ SENIOR DESIGN ENGINEER	DESIGN XXX 6/06	CHECK XXX 6/06
	DRAWN XXX 6/06	CHECK XXX 6/06
APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER	QUANT. XXX 6/06	CHECK XXX 6/06

LEGACY PARKWAY
PEDESTRIAN TRAIL OVER LP
SITUATION & LAYOUT 2
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
X-PIN
BRIDGE NO.
SHT. 2 OF 6



PLAN



ELEVATION

PRELIMINARY
NOT FOR CONSTRUCTION

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN SKD 6/06	CHECK DYP 6/06		
DRAWN BAH 6/06	CHECK SKD 6/06		
QUANT. SKD 6/06	CHECK DYP 6/06		

APPROVAL RECOMM. ____ DATE ____ SENIOR DESIGN ENGINEER

APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

NO.	DATE	BY	REMARKS

REVISIONS

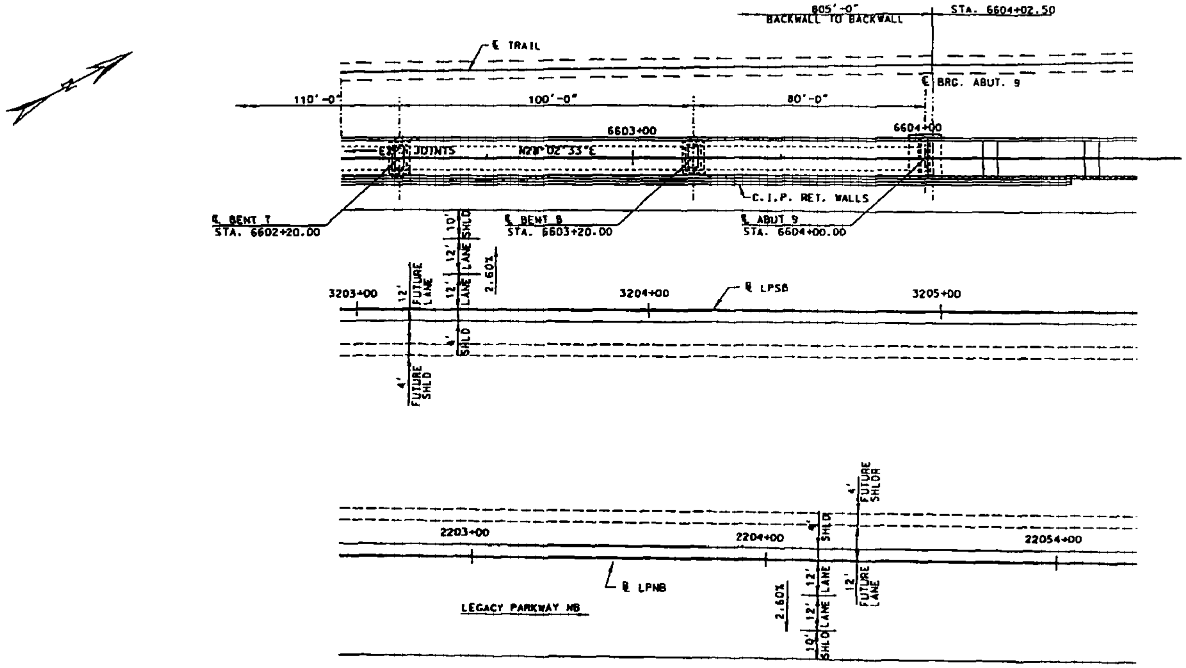
LEGACY PARKWAY
PEDESTRIAN TRAIL OVER LP
SITUATION & LAYOUT 3

PROJECT NUMBER SP-0067(5)0

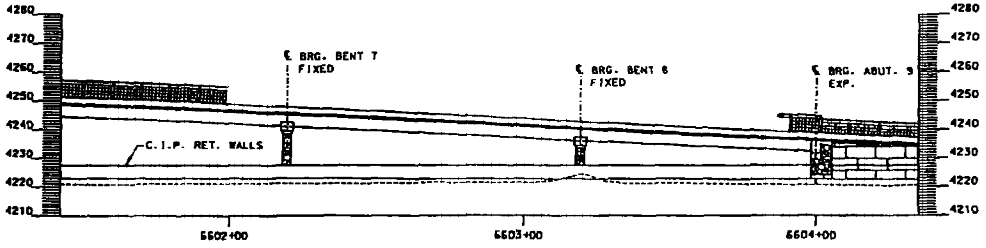
SL / DAVIS
COUNTY

P-21
BRIDGE NO.

SHT. 3 OF 6



PLAN



ELEVATION

PRELIMINARY
NOT FOR CONSTRUCTION

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

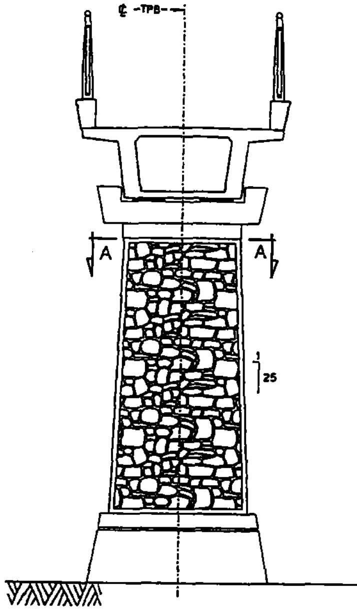
DESIGN XXX 6/05
DRAWN XXX 6/05
QUANT. XXX 6/05
CHECK XXX 6/05
CHECK XXX 6/05
CHECK XXX 6/05

APPROVAL RECOMM. ___ DATE ___ SENIOR DESIGN ENGINEER
APPROVED ___ DATE ___ CHIEF BRIDGE ENGINEER

NO. DATE BY REVISIONS REMARKS

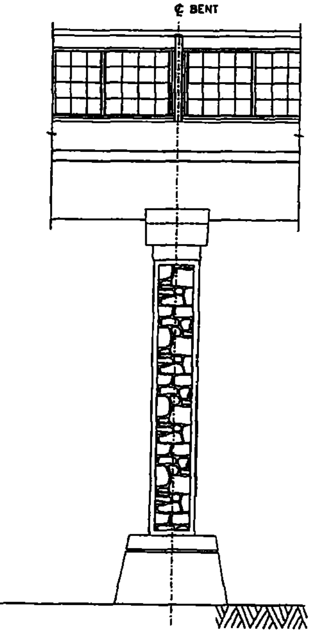
LEGACY PARKWAY
PEDESTRIAN TRAIL OVER LP
SITUATION & LAYOUT 4
PROJECT NUMBER SP-0067(5)0

SL / DAVIS
COUNTY
X-PIN
BRIDGE NO.
SHT. 4 OF 6

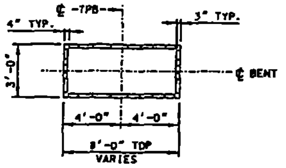


SECTION THRU STRUCTURE

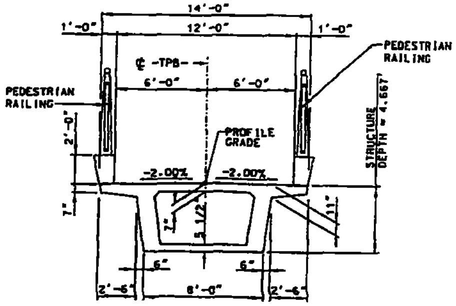
LOOKING UP STATION



END VIEW OF BENT

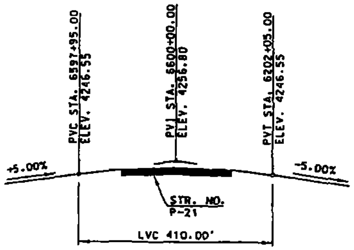


SECTION A-A



TYPICAL SECTION

LOOKING UP STATION

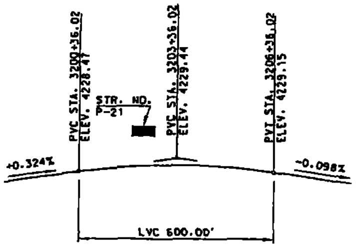


-TPB- PROFILE

CURVE DATA

TRAILS 2

Δ = 90°09'03" RT
R = 93.50'
L = 147.12'
T = 93.751'
PI STA. 6600+93.75
PC STA. 6600+00.00
PRC STA. 6601+47.12

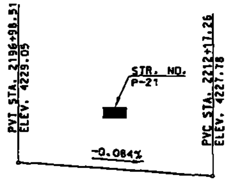


LPSB PROFILE

CURVE DATA

TRAILS 1

Δ = 90°09'03" LT
R = 93.50'
L = 147.12'
T = 93.75'
PI STA. 6599+46.63
PC STA. 6598+52.88
PRC STA. 6600+00.00



LPNB PROFILE

REVISIONS

NO. DATE BY REMARKS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN SKD 6/06 CHECK DVP 6/06
DRAWN BAH 6/06 CHECK SKD 6/06
QUANT. SKD 6/06 CHECK DVP 6/06

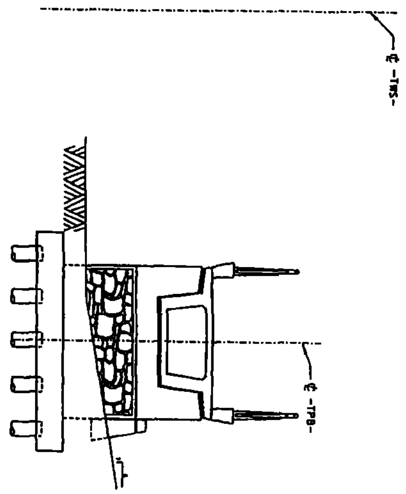
APPROVAL RECOM. ____ DATE ____ SENIOR DESIGN ENGINEER
APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

LEGACY PARKWAY
PEDESTRIAN BRIDGE OVER LP
SITUATION & LAYOUT 5
PROJECT NUMBER SP-0067(5)0

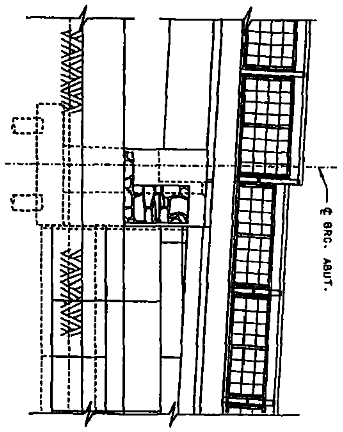
SL / DAVIS
COUNTY
P-21
BRIDGE NO.
SHT. 5 OF 6

FRONT ELEVATION

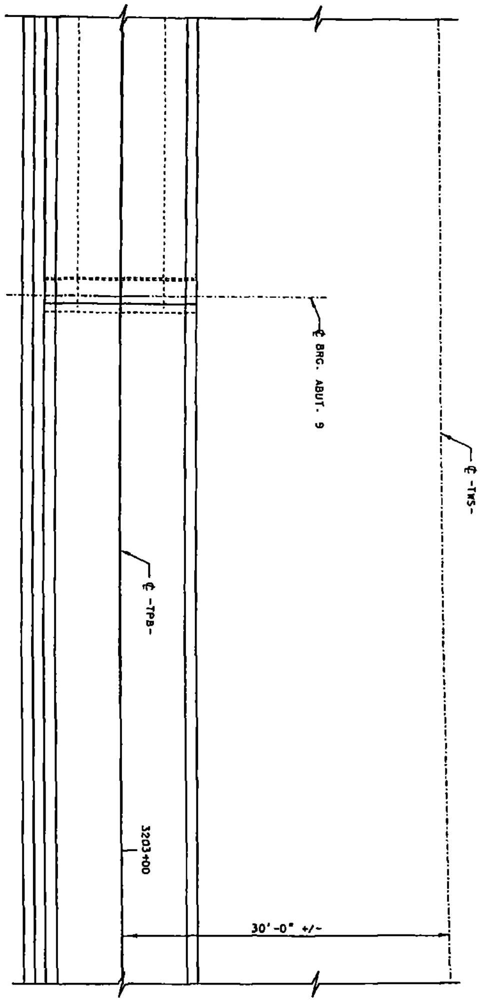
(ABUTMENT 1 SHOWN, ABUTMENT 5 SIMILAR)



ELEVATION



PLAN



PRELIMINARY
NOT FOR CONSTRUCTION

SL / DAVIS
COUNTY

P-21
BRIDGE NO.

SHT. 6 OF 6

LEGACY PARKWAY
PEDESTRIAN TRAIL OVER LP
SITUATION LAYOUT 6

PROJECT NUMBER SP-0067(5)0

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

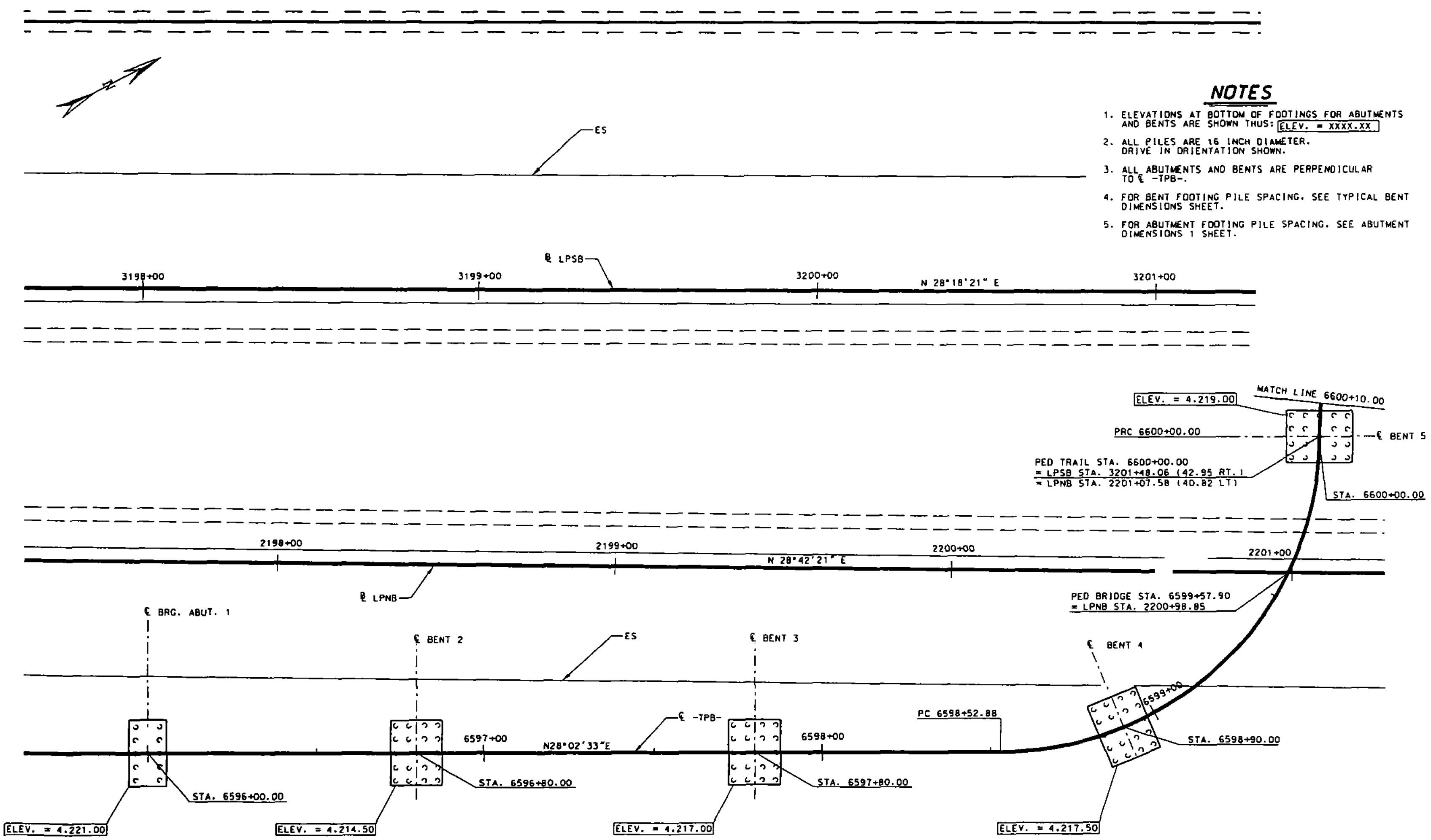
APPROVAL RECOM'D ______ DATE ______ SENIOR DESIGN ENGINEER

APPROVED ______ DATE ______ UDOT BRIDGE ENGINEER

DESIGN SKD	6/06	CHECK DVP	6/06
DRAWN JLH	6/06	CHECK SKD	6/06
QUANT. SKD	6/06	CHECK DVP	6/06

NO.	DATE	BY	REMARKS

REVISIONS



NOTES

1. ELEVATIONS AT BOTTOM OF FOOTINGS FOR ABUTMENTS AND BENTS ARE SHOWN THUS: ELEV. = XXXX.XX
2. ALL PILES ARE 16 INCH DIAMETER. DRIVE IN ORIENTATION SHOWN.
3. ALL ABUTMENTS AND BENTS ARE PERPENDICULAR TO € -TPB-.
4. FOR BENT FOOTING PILE SPACING, SEE TYPICAL BENT DIMENSIONS SHEET.
5. FOR ABUTMENT FOOTING PILE SPACING, SEE ABUTMENT DIMENSIONS 1 SHEET.

PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

NO.	DATE	BY	REMARKS

REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

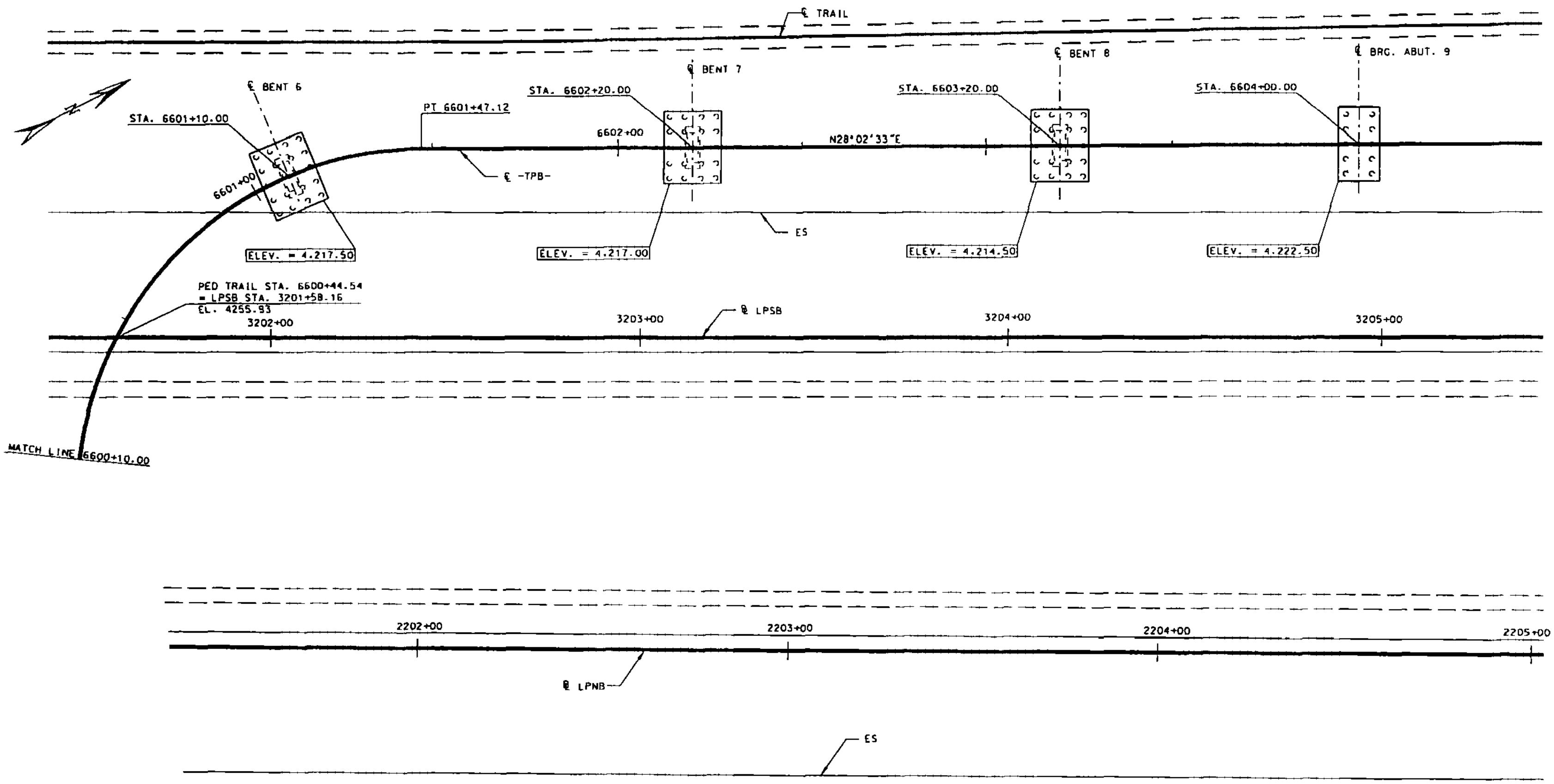
DESIGN MNP 7/06 CHECK JSO 7/06
DRAWN BRM 7/06 CHECK JSO 7/06
QUANT. NLM 7/06 CHECK MK 7/06

APPROVAL RECOMM. ______ DATE ______ SENIOR DESIGN ENGINEER
APPROVED ______ DATE ______ UDOT BRIDGE ENGINEER

LEGACY PARKWAY SEGMENT 1
PEDESTRIAN TRAIL OVER LP
FOUNDATION PLAN 1

PROJECT NUMBER SP-0067(1)0

SL / DAVIS
COUNTY
P-21
BRIDGE NO.
SHT. 8 OF 48



NOTES

1. ELEVATIONS AT BOTTOM OF FOOTINGS FOR ABUTMENTS AND BENTS ARE SHOWN THUS: ELEV. = XXXX.XX
2. ALL PILES ARE 16 INCH DIAMETER. DRIVE IN ORIENTATION SHOWN.
3. ALL ABUTMENTS AND BENTS ARE PERPENDICULAR TO ℄ -TPB-.
4. FOR BENT FOOTING PILE SPACING. SEE TYPICAL BENT DIMENSIONS SHEET.
5. FOR ABUTMENT FOOTING PILE SPACING. SEE ABUTMENT DIMENSIONS 1 SHEET.

PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS
NO. DATE BY REMARKS

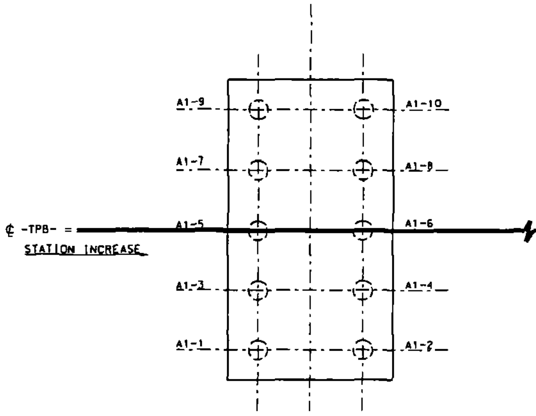
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN MNP 7/06 CHECK JSO 7/06
DRAWN BRM 7/06 CHECK JSO 7/06
QUANT. NLM 7/06 CHECK MK 7/06

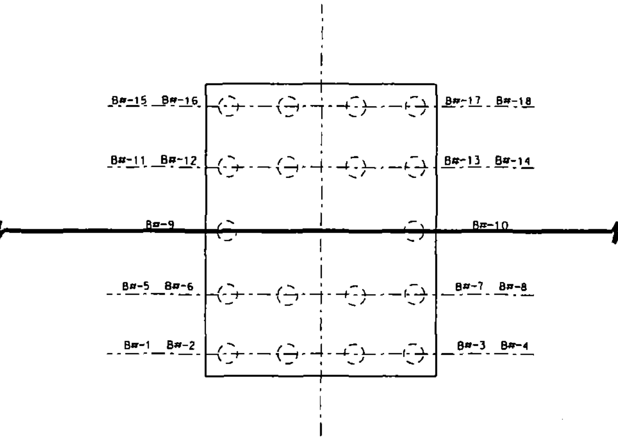
APPROVAL RECOMM. ______ DATE ______ SENIOR DESIGN ENGINEER
APPROVED ______ DATE ______ UDOT BRIDGE ENGINEER

LEGACY PARKWAY SEGMENT 1
PEDESTRIAN TRAIL OVER LP
FOUNDATION PLAN 2
PROJECT NUMBER SP-0067(11)0

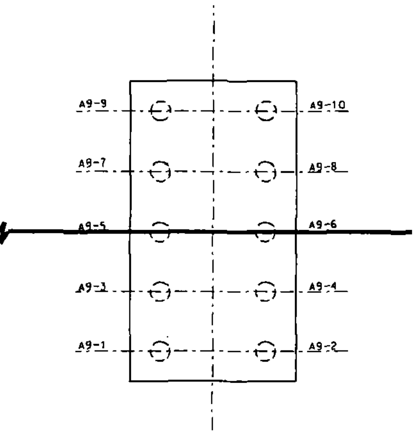
SL / DAVIS
COUNTY
P-21
BRIDGE NO.
SHT. 9 OF 48



PLAN ABUTMENT 1



TYPICAL BENT PLAN



PLAN ABUTMENT 9

ABUTMENT 1 AS-CONSTRUCTED PILE TIP ELEV.	
A1-1	
A1-2	
A1-3	
A1-4	
A1-5	
A1-6	
A1-7	
A1-8	
A1-9	
A1-10	

BENTS 2-8 AS-CONSTRUCTED PILE TIP ELEV.											
B2-1		B3-1		B4-1		B5-1		B6-1		B7-1		B8-1	
B2-2		B3-2		B4-2		B5-2		B6-2		B7-2		B8-2	
B2-3		B3-3		B4-3		B5-3		B6-3		B7-3		B8-3	
B2-4		B3-4		B4-4		B5-4		B6-4		B7-4		B8-4	
B2-5		B3-5		B4-5		B5-5		B6-5		B7-5		B8-5	
B2-6		B3-6		B4-6		B5-6		B6-6		B7-6		B8-6	
B2-7		B3-7		B4-7		B5-7		B6-7		B7-7		B8-7	
B2-8		B3-8		B4-8		B5-8		B6-8		B7-8		B8-8	
B2-9		B3-9		B4-9		B5-9		B6-9		B7-9		B8-9	
B2-10		B3-10		B4-10		B5-10		B6-10		B7-10		B8-10	
B2-11		B3-11		B4-11		B5-11		B6-11		B7-11		B8-11	
B2-12		B3-12		B4-12		B5-12		B6-12		B7-12		B8-12	
B2-13		B3-13		B4-13		B5-13		B6-13		B7-13		B8-13	
B2-14		B3-14		B4-14		B5-14		B6-14		B7-14		B8-14	
B2-15		B3-15		B4-15		B5-15		B6-15		B7-15		B8-15	
B2-16		B3-16		B4-16		B5-16		B6-16		B7-16		B8-16	
B2-17		B3-17		B4-17		B5-17		B6-17		B7-17		B8-17	
B2-18		B3-18		B4-18		B5-18		B6-18		B7-18		B8-18	

ABUTMENT 9 AS-CONSTRUCTED PILE TIP ELEV.	
A9-1	
A9-2	
A9-3	
A9-4	
A9-5	
A9-6	
A9-7	
A9-8	
A9-9	
A9-10	

PRELIMINARY
NOT FOR CONSTRUCTION

NO.	DATE	BY	REMARKS
REVISIONS			

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

APPROVAL RECOM. ____ DATE ____ SENIOR DESIGN ENGINEER
APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

DESIGN TAD 7/06 CHECK MLR 7/06
DRAWN BRM 7/06 CHECK MLR 7/06
QUANT. NLM 7/06 CHECK MK 7/06

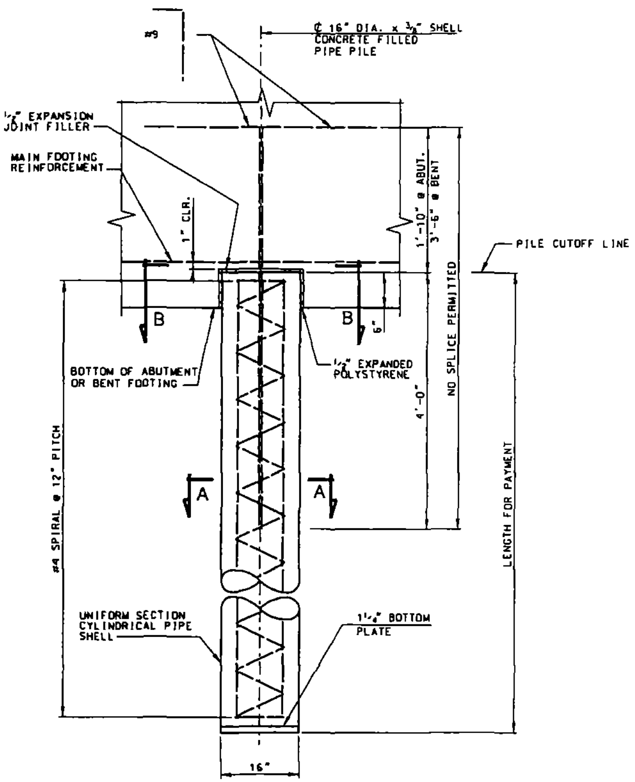
LEGACY PARKWAY SEGMENT 1
PEDESTRIAN TRAIL OVER LP
PILING PLAN

PROJECT NUMBER SP-0067(1)10

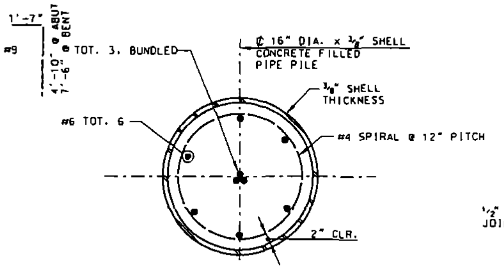
SL / DAVIS
COUNTY

P-21
BRIDGE NO.

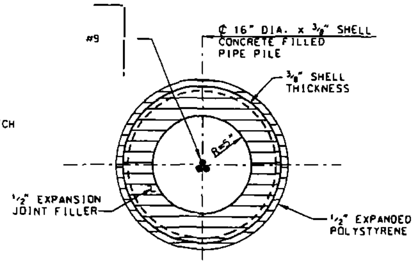
SHT. 10 OF 48



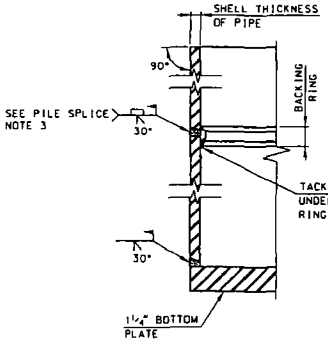
PIPE PILE DETAIL



SECTION A-A



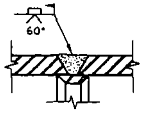
SECTION B-B



PILE SECTION

PILE SPLICE AND BOTTOM PLATE NOTES:

1. PROVIDE EACH BACKING RING WITH EQUALLY SPACED PINS.
2. CONFORM TO THE AASHTO/AWS BRIDGE WELDING CODE.
3. USE THE FOLLOWING WELD FOR FLAT WELD POSITION:



PILE SPLICE AND BOTTOM PLATE DETAILS

NOTES

1. PROVIDE PIPE MATERIAL CONFORMING TO ASTM A252 GRADE 3. Fy = 65 ksi.
2. FILL PILE SHELLS WITH CLASS "AA(AE)" CONCRETE. f'c = 4000 psi.
3. HOLD THE REINFORCING STEEL ADEQUATELY IN FINAL POSITION DURING PLACEMENT OF CONCRETE AROUND BARS.
4. PROVIDE UNCOATED REINFORCEMENT FOR PLACEMENT INTO PILES.

PILE DATA (TO BE COMPLETED ONCE GEOTECH REPORTS COMPLETED)

LOCATION	PILE DIAMETER (IN)	PILE SHELL THICKNESS (IN)	ESTIMATED PILE TIP ELEVATION (FT)	ELEVATION OF MIN. ACCEPTABLE PILE PENETRATION (FT)	STRENGTH I PILE LOAD (KIPS)	SERVICE I PILE RESISTANCE (KIPS)	STRENGTH I PILE RESISTANCE (KIPS)		ULTIMATE PILE RESISTANCE (KIPS)		MAXIMUM DRIVING LOAD (KIPS)	REQUIRED DRIVING RESISTANCE (KIPS)
							COMP.	TENSION	COMP.	TENSION		
ABUT. NO. 1	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248
BENT NO. 2	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248
BENT NO. 3	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248
BENT NO. 4	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248
BENT NO. 5	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248
BENT NO. 6	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248
BENT NO. 7	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248
BENT NO. 8	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248
ABUT. NO. 9	16	3/8	4.147	XXX	-	XXX	176	71	227	215	XXX	248

* DOWNDRAG NOT INCLUDED.
** A FACTORED DOWNDRAG OF XXX KIPS IS INCLUDED. THIS INCLUDES A FACTOR OF 1.3.

PRELIMINARY
NOT FOR CONSTRUCTION

NO.	DATE	BY	REMARKS

REVISIONS

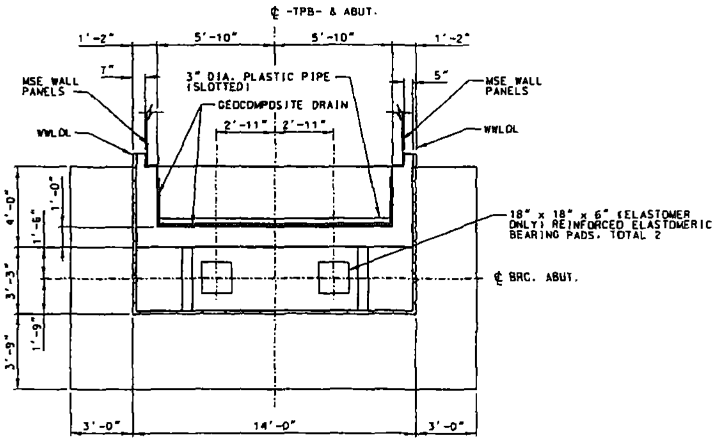
UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN GRY 7/06	CHECK JSO 7/06	APPROVAL RECOMM. ____ DATE	SENIOR DESIGN ENGINEER
DRAWN PSK 7/06	CHECK JSO 7/06		
QUANT. LNM 7/06	CHECK MK 7/06	APPROVED ____ DATE	UDOT BRIDGE ENGINEER

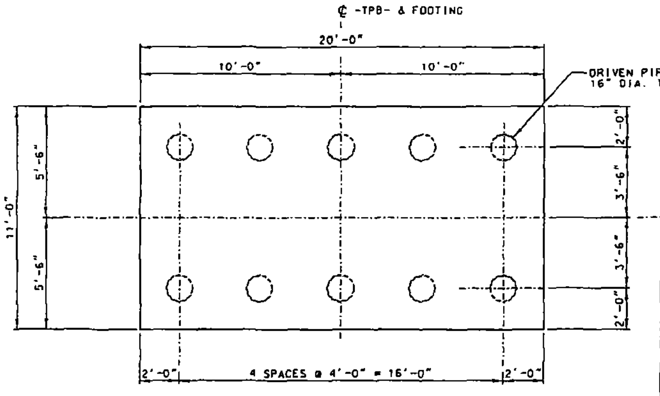
LEGACY PARKWAY SEGMENT 1
PEDESTRIAN TRAIL OVER LP
DRIVEN PILE DETAILS
PROJECT NUMBER SP-0067(11)0

SL / DAVIS
COUNTY
P-21
BRIDGE NO.
SHT. 11 OF 48

...\5417_P-21-11_DrvPDet.dgn 8/30/2006 9:32:37 AM

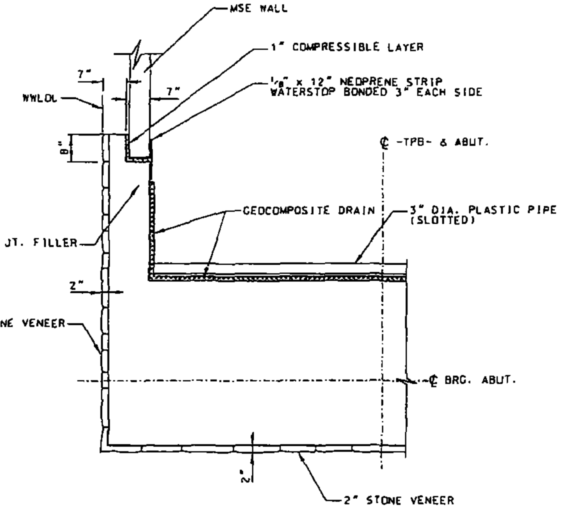


PLAN

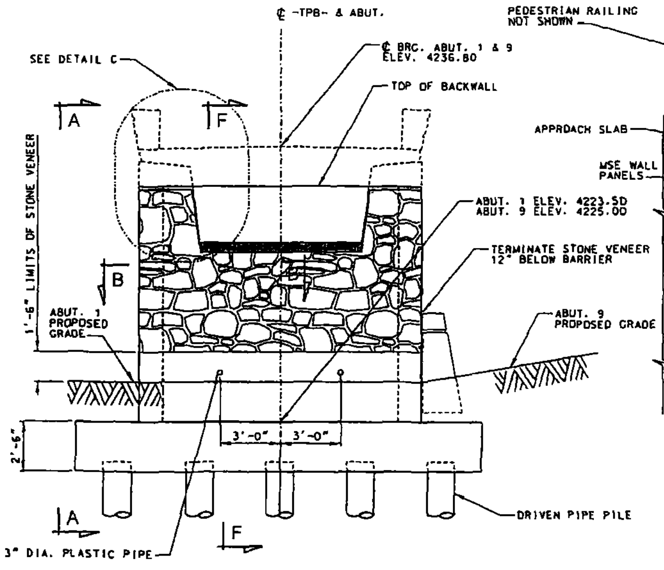


FOOTING PLAN

QUANTITIES STRUCTURAL CONCRETE	
ABUT. 1 FOOTING	21 CU YD
ABUT. 1	25 CU YD
ABUT. 9 FOOTING	21 CU YD
ABUT. 9	21 CU YD
TOTAL	88 CU YD

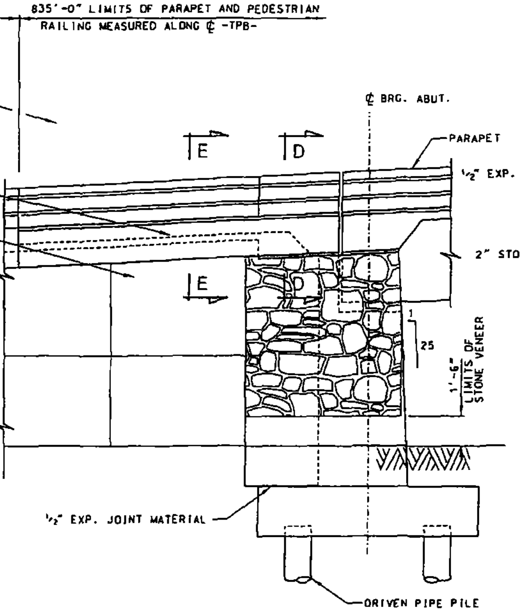


SECTION B-B



ELEVATION

(ABUTMENT 1 SHOWN, ABUTMENT 9 SIMILAR)



VIEW A-A

NOTES

1. FOR DRIVEN PIPE PILES, SEE DRIVEN PILE DETAILS SHEET.
2. FOR BEARING PADS, SEE ABUTMENT DIMENSIONS 2 SHEET.
3. FOR DETAIL C AND SECTION F-F, SEE ABUTMENT DIMENSIONS 2 SHEET.
4. FOR SECTIONS D-D AND E-E, SEE APPROACH SLAB DETAIL SHEET.

PRELIMINARY
NOT FOR CONSTRUCTION

NO.	DATE	BY	REMARKS

REVISIONS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

DESIGN MNP 8/06 CHECK JSO 8/06
DRAWN BRM 8/06 CHECK JSO 8/06
QUANT. LNM 8/06 CHECK MK 8/06

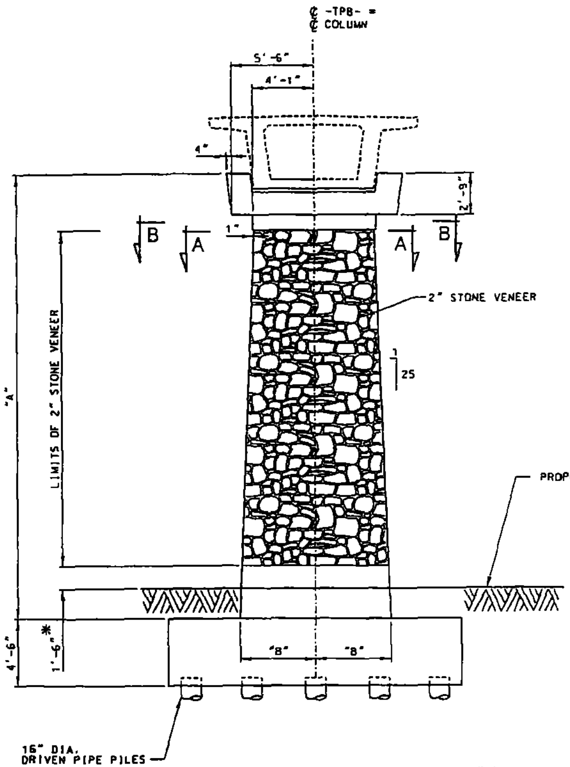
APPROVAL RECOMM. ____ DATE ____ SENIOR DESIGN ENGINEER
APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

LEGACY PARKWAY SEGMENT 1
PEDESTRIAN TRAIL OVER LP
ABUTMENT DIMENSIONS 1

PROJECT NUMBER SP-0067(11)0

SL / DAVIS
COUNTY

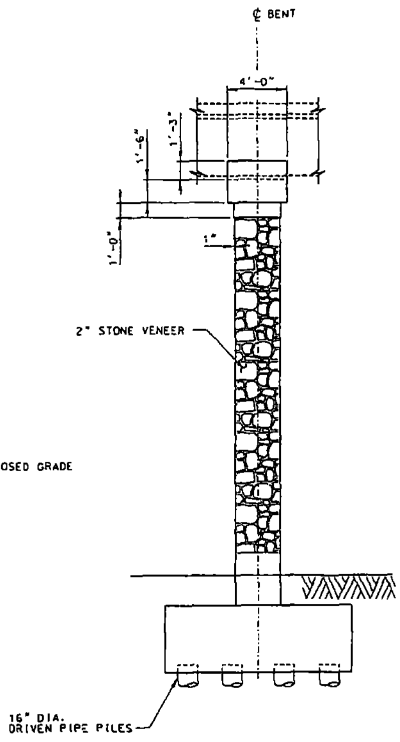
P-21
BRIDGE NO.



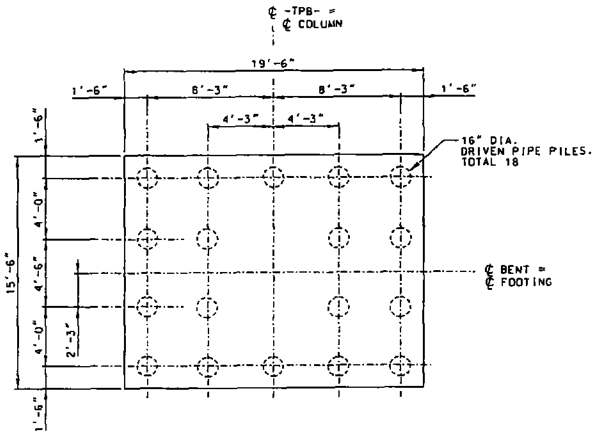
SECTION THRU STRUCTURE

LOOKING UP STATION

* TERMINATE STONE VENEER 12" BELOW WHERE BARRIER OCCURS



ELEVATION



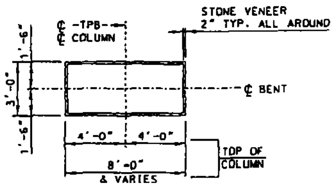
FOOTING PLAN

TABLE OF DIMENSIONS

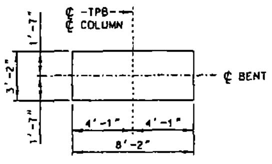
BENT	"A"	"B"
2	18.13'	4.58'
3	20.63'	4.68'
4	24.53'	4.83'
5	24.50'	4.83'
6	24.53'	4.83'
7	20.63'	4.68'
8	18.13'	4.58'

NOTE: DIMENSIONS BASED ON PAD THICKNESS OF 3"; ADJUST AS REQUIRED FOR ACTUAL PAD THICKNESS.

QUANTITIES STRUCTURAL CONCRETE	
BENT CAPS	23 CU YD
COLUMNS	129 CU YD
BENT FOOTING	353 CU YD
TOTAL	505 CU YD



SECTION A-A



SECTION B-B

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS

NO.	DATE	BY	REMARKS

UTAH DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
STRUCTURES DIVISION

APPROVAL RECOM. ____ DATE ____ SENIOR DESIGN ENGINEER
APPROVED ____ DATE ____ UDOT BRIDGE ENGINEER

DESIGN MNP 8/06 CHECK JSD 8/06
DRAWN BRM 8/06 CHECK JSD 8/06
QUANT. LNM 8/06 CHECK MK 8/06

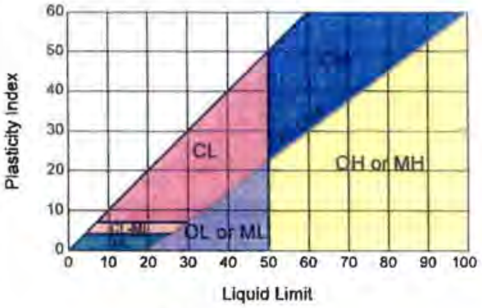
LEGACY PARKWAY SEGMENT 1
PEDESTRIAN TRAIL OVER LP
TYPICAL BENT DIMENSIONS
PROJECT NUMBER SP-0067(11)0

SL / DAVIS
COUNTY
P-21
BRIDGE NO.

APPENDIX B

Test Hole Logs

Unified Soil Classification System

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
COARSE-GRAINED SOILS *more than half of material is larger than No. 200 sieve*	**Gravels** *more than half of coarse fraction is larger than No. 4 sieve size*	**Clean Gravels** *little or no fines*	GW		Well graded gravels, gravel-sand mixtures, little or no fines	*For laboratory classification of coarse-grained soils*	$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 4 Between 1 and 3
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines	Determine percentage of gravel and sand from grain-size curve. Depending on percentage of fines (*fraction smaller than No. 200 sieve size*), coarse-grained soils are classified as follows: **Less than 5%** GW, GP, SW, SP **More than 12%** GM, GC, SM, SC **5% to 12%** Borderline cases requiring use of dual symbols**	Not meeting all gradation requirements for GW	
		Gravels With Fines *appreciable amount of fines*	GM*	d u	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
			GC		Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
	Sands *more than half of coarse fraction is smaller than No. 4 sieve size*	**Clean Sands** *little or no fines*	SW		Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 6 Between 1 and 3
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with Fines *appreciable amount of fines*	SM*	d u	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
			SC		Clayey sands, poorly graded sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
FINE-GRAINED SOILS *more than half of material is smaller than No. 200 sieve*	**Silts and Clays** *liquid limit is less than 50*		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	*For laboratory classification of fine-grained soils*  Plasticity Chart		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silt-clays of low plasticity			
	Silts and Clays *liquid limit is greater than 50*		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
HIGHLY ORGANIC SOILS			Pt		Peat and other highly organic soils			

*Division of GM and SM groups into subdivisions of d and U for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when liquid limit is 28 or less and the PI is 6 or less, the suffix U used when liquid limit is greater than 28.

***Borderline classification*: Soils possessing characteristics of two groups are designated by combinations of group symbols. (For example GW-GC, well graded gravel-sand mixture with clay binder.)

DRILL HOLE LOG

BORING NO. RSB-X1-620

SHEET 1 OF 1

PROJECT: LEGACY PARKWAY - STRUCTURE P-21 (PED. TRAIL OVER LEGACY PKWY)

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

PROJECT NUMBER: 200601.142

LOCATION: N 362,975, E 51,591

DATE STARTED: 4/5/06

DRILLING METHOD: CME-55 NO. 2 / N.W. CASING W/TRICONE BIT

DATE COMPLETED: 4/5/06

DRILLER: D. SAMPSON

GROUND ELEVATION: 4222.8'

DEPTH TO WATER - INITIAL: ⊻ 4.0'   **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
		■	3	17,15,12,(42)	GM	brown, moist, med. dense	SILTY GRAVEL W/SAND								
4220															
⊻		■	15	6,9,13,(34) *0.43*	CL	dk. brown to brown, moist, firm	SANDY LEAN CLAY W/GRAVEL (fill)								
					CL	dk. brown to gray, moist, firm	LEAN CLAY								
	5														
		☒	15	Pushed *0.40*	SP-SM	gray, wet, loose	SAND W/SILT								
					CL *(A-7-6(23))*	red-brown, moist, firm	LEAN CLAY W/SAND LENSES	92.2	29.7	42	23	0	4	96	CT UC
4215															
	10	■	17	1,1,2,(4) *0.13*	CL	red-brown, moist, soft									
4210		☒	17	Pushed *0.23*	CL	gray, moist, soft	LEAN CLAY W/SAND LENSES & LAYERS TO 4" THICK								
	15	■	20	0/8",1,2,(4) *0.06* *0.32*	CL	gray, moist, very soft to firm									
4205															
	20	☒	16	Pushed *0.36*	CL *(A-7-6(25))*	gray, moist, firm	LEAN CLAY	87.6	33.8	44	23	0	0	100	CT UC
4200															
	25	■	14	*0.29* 2,2,8,(10)	CL SM	gray, moist, firm gray, wet, med. dense	SILTY SAND								
4195															
	30	☒	16	Pushed *0.72*	CL *(A-7-6(23))*	gray, moist, stiff	LEAN CLAY W/SAND LENSES	94.9	30.2	41	24	0	8	92	UC
4190															
	35	■	11	8,8,11,(16)	ML *(A-4(0))*	brown, wet, med. dense	SANDY SILT		26.3		NP	0	47	53	
4185							FLOWING SANDS								
	40	■	20	4,4,4,(6) *0.40*	CL	gray, moist, firm	LEAN CLAY								
4180															
	45														
4175															

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE ■ 2,3,2,(6) ← Blow Count per 6" ; ← $(N_1)_{60}$ Value ; *0.45* ← Torvane (tsf)

UNDISTURBED SAMPLE ☒ PUSHED *0.45* ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
🟥 = Potential Liquefaction
🟦 = Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-X1-621

SHEET 1 OF 2

PROJECT: LEGACY PARKWAY - STRUCTURE P-21 (PED. TRAIL OVER LEGACY PKWY)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 363,057, E 51,626
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING W/TRICONE BIT
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ▽ 3.5'
AFTER 24 HOURS: ▼ 1.0'
PROJECT NUMBER: 200601.142
DATE STARTED: 4/3/06
DATE COMPLETED: 4/4/06
GROUND ELEVATION: 4221.5'
LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
4220	▼		■	9	2,3,2,(8) 0.16	CL	lt. brown, very moist, soft	LEAN CLAY W/GRAVEL								
	▽		☒	14	Pushed 0.40	CL (A-7-6(23))	red-brown, moist, firm	LEAN CLAY W/SAND LENSES & LAYERS TO 2" THICK & 1" TO 7" APART	90	30.1	42	23	0	4	96	CT UC
	5															
4215			■	15	1,1,2,(5) 0.17	CL	red-brown, moist, soft									
	10		☒	12	Pushed 0.27	CH (A-7-6(31))	gray, moist, firm	FAT CLAY W/SAND LENSES & LAYERS TO 2" THICK & 1" TO 7" APART	78.5	41.6	51	28	0	2	98	CT UC
4210			■	20	0/9",1,1,(3) 0.12	CL	gray, moist, soft									
			■	20	0/9",1,3,(6) 0.16 0.41	CL	gray, moist, soft to firm									
	15		☒	17	Pushed 0.28	CL	gray, moist, firm									
4205																
	20		■	16	3,4,6,(12) 0.72	CL	gray, moist, stiff	LEAN CLAY W/SAND LENSES & LAYERS TO 2" THICK & 1" TO 7" APART								
4200																
	25		☒	16	Pushed 0.34	CL (A-7-6(21))	gray, moist, firm		96.3	26.7	41	20	0	9	91	CT UC
4195																
	30	🟦	■	12	0.33	ML	gray-brown, moist, firm	SANDY SILT								
4190					5,9,22,(30)	SM	brown, wet, med. dense	SILTY SAND - FLOWING SANDS								
	35	🟥	☒	0	Pushed	-		SANDY SILT								
4185		🟥	■	17	6,8,4,(11) 0.55	ML (A-4(0))	brown, wet, med. dense			21.1		NP	1	47	52	
						CL	gray-brown, moist, stiff	LEAN CLAY								
	40		☒	20	Pushed 0.55	CL	gray-brown, moist, stiff									
4180																
	45	🟥	■	8	7,6,5,(9)	SP-SM (A-2-4(0))	gray, wet, med. dense	SAND W/SILT		26.5		NP	0	89	11	pH Resist. Sulfate
4175																
								CLAY driller's observation								

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PROVO, UTAH

LEGEND:

DISTURBED SAMPLE ■ 2,3,2,(6) 0.45
Blow Count per 6"
$(N_1)_{60}$ Value
Torvane (tsf)

UNDISTURBED SAMPLE ☒ PUSHED 0.45
Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
🟥 = Potential Liquefaction
🟦 = Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-X1-621

SHEET 2 OF 2

PROJECT: LEGACY PARKWAY - STRUCTURE P-21 (PED. TRAIL OVER LEGACY PKWY)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 363,057, E 51,626
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING W/TRICONE BIT
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ∇ 3.5' **AFTER 24 HOURS:** ▼ 1.0'
PROJECT NUMBER: 200601.142
DATE STARTED: 4/3/06
DATE COMPLETED: 4/4/06
GROUND ELEVATION: 4221.5'
LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
4170		🟥	☒	12	Pushed	SM	brown, wet	SILTY SAND								
		🟥	■	18	6,6,18,(18) *0.90*	SM *(A-4(0))*	brown, wet, med. dense			24.4		NP	0	62	38	
		▨				CL	brown, moist, stiff	LEAN CLAY								
	55	▨	■	14	*0.63*	CL	brown, moist, stiff									
					7,7,8,(11)	ML	brown, wet, med. dense	SANDY SILT								
4165		▨				CL	brown, moist, stiff									
4160	60	▨	☒	14	Pushed *0.87*	CL *(A-6(17))*	gray, moist, stiff	LEAN CLAY	100.9	23	34	18	0	5	95	CT UC
4155	65	▨	■	8	5,6,6,(8) *0.88*	CL	brown, moist, stiff									
	70	🟥	☒	18	Pushed	SP-SM	gray, wet	SAND W/SILT								
4150		🟥	■	11	2,5,15,(13)	SP-SM *(A-1-b(0))*	gray, wet, med. dense			21.9		NP	0	90	10	
4145	75	▨	■	17	7,18,22,(25) *0.52*	CL	lt. brown, moist, stiff	LEAN CLAY W/SILT LENSES 0.13" TO 1" APART								
4140	80	▨	☒	15	Pushed *1.14*	CL	gray-brown, moist, very stiff	LEAN CLAY	95.5	25.1	35	15	0	0	100	CT UC
4135	85	▨	■	14	5,15,23,(22) *1.09*	CL	gray-brown, moist, very stiff									
4130	90															
4125	95															

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PROVO, UTAH

LEGEND:

DISTURBED SAMPLE ■ 2,3,2,(6) ← Blow Count per 6" ← $(N_1)_{60}$ Value; *0.45* ← Torvane (tsf)

UNDISTURBED SAMPLE ☒ PUSHED *0.45* ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
🟥 = Potential Liquefaction
🟦 = Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-X1-622

PROJECT: LEGACY PARKWAY - STRUCTURE P-21 (PED. TRAIL OVER LEGACY PKWY)

SHEET 1 OF 2

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

PROJECT NUMBER: 200601.142

LOCATION: N 363,240, E 51,527

DATE STARTED: 3/30/06

DRILLING METHOD: CME-55 NO. 2 / N.W. CASING W/TRICONE BIT

DATE COMPLETED: 3/31/06

DRILLER: D. SAMPSON

GROUND ELEVATION: 4222.3'

DEPTH TO WATER - INITIAL: ▽ 3.3' **AFTER 24 HOURS:** ▼ 3.1'

LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
			■	2	8,6,11,(26)	GM	lt. brown, wet, very loose	SILTY GRAVEL W/SAND								
4220	▽▼	🟥														
		🟥	■	2	5,5,6,(17)	GM	red-brown, wet, very loose									
	5															
4215			☒	16	Pushed *0.49*	CL *(A-7-6(27))*	gray, moist, firm	LEAN CLAY W/SILT & SILTY SAND LENSES TO 0.13" THICK & 0.25" TO 2" APART	82.7	35.5	45	25	0	2	98	CT UC
			■	13	0,2,2,(6) *0.24*	CL	reddish-brown, moist, soft									
	10		■	13	2,1,2,(5) *0.16*	CL	reddish-brown, very moist, soft									
4210			■	19	0,0,0,(0) *0.32*	CL	gray, moist, firm									
	15		☒	14	Pushed *0.48*	CL *(A-6(14))*	gray, moist, firm		94.5	25.7	33	16	0	8	92	CT UC
4205																
	20		■	18	2,2,3,(6) *0.20* *0.54*	CL	brown to gray, moist, soft to firm	LEAN CLAY occasional silty sand lense								
4200																
	25		☒	16	Pushed *1.07*	CL *(A-7-6(28))*	gray, moist, very stiff			26.5	48	26	0	3	97	
4195																
	30		■	13	*0.56* 3,4,8,(12)	CL SM	gray, moist, stiff gray, wet, med. dense	LEAN CLAY								
4190																
	35		■	7	8,10,15,(23)	SM *(A-2-4(0))*	gray, wet, med. dense	SILTY SAND		23.7		NP	1	66	33	
4185																
	40		☒	17	Pushed *0.61*	CH *(A-7-6(38))*	gray, moist, stiff	FAT CLAY	68.5	53.5	57	33	0	1	99	CT UC
4180																
	45		■	12	13,16,23,(32)	SP-SM	gray, wet, dense	SAND W/SILT (FLOWING SANDS)								
4175																
								LEAN CLAY								

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE ■ 2,3,2,(6) *0.45*
- Blow Count per 6"
- $(N_1)_{60}$ Value
- Torvane (tsf)

UNDISTURBED SAMPLE ☒ PUSHED *0.45* — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
🟥 = Potential Liquefaction
🟦 = Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-X1-622

SHEET 2 OF 2

PROJECT: LEGACY PARKWAY - STRUCTURE P-21 (PED. TRAIL OVER LEGACY PKWY)
CLIENT: UTAH DEPARTMENT OF TRANSPORTATION
LOCATION: N 363,240, E 51,527
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING W/TRICONE BIT
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ∇ 3.3' **AFTER 24 HOURS:** ▼ 3.1'
PROJECT NUMBER: 200601.142
DATE STARTED: 3/30/06
DATE COMPLETED: 3/31/06
GROUND ELEVATION: 4222.3'
LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
			■	12	0.69	CL	brown, moist, stiff									
4170					4,7,12,(15)	(A-6(15)) ML	brown, very moist, med. dense	SANDY SILT		24.3	34	15	0	2	98	
4165	55		■	14	6,10,13,(17) 1.14 0.60	CL	red-brown to brown, moist, stiff to very stiff	LEAN CLAY								
4160	60		☒	15	Pushed 0.75	CH (A-7-6(57))	gray, moist, stiff	FAT CLAY	94.6	27.3	55	34	0	2	98	CT UC
4155	65		■	18	5,5,7,(8) 0.74	CH	brown, moist, stiff									
4150	70		■	12	6,10,10,(13) 0.41	CL (A-4(6))	gray-brown, moist, firm	SANDY LEAN CLAY W/SAND LAYERS TO 6" THICK		20.4	30	8	0	17	83	
4145	75		■	16	16,27,28,(35)	CL SM	gray, wet, very dense	SILTY SAND								
4140	80		☒	14	Pushed 0.51	CL (A-6(20))	gray, moist, stiff	LEAN CLAY	98.8	25.5	39	19	0	1	99	CT UC
								FLOWING SAND								
4135	85		■	15	8,10,27,(22) 0.90	CL	gray & black, moist, stiff	LEAN CLAY								
4130	90		☒	17	Pushed 0.75	CL (A-6(15))	gray, moist, stiff		93.1	26.1	34	15	0	1	99	CT UC
4125	95															

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE ■ 2,3,2,(6) ← Blow Count per 6" ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒ PUSHED 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
🟥 = Potential Liquefaction
🟦 = Potential Liquefaction & Lateral Spread

DRILL HOLE LOG

BORING NO. RSB-X1-623

PROJECT: LEGACY PARKWAY - STRUCTURE P-21 (PED. TRAIL OVER LEGACY PKWY)

SHEET 1 OF 1

CLIENT: UTAH DEPARTMENT OF TRANSPORTATION

PROJECT NUMBER: 200601.142

LOCATION: N 363,322, E 51,576

DATE STARTED: 4/3/06

DRILLING METHOD: CME-55 NO. 2 / N.W. CASING W/ROCK BIT

DATE COMPLETED: 4/3/06

DRILLER: D. SAMPSON

GROUND ELEVATION: 4222.0'

DEPTH TO WATER - INITIAL: ∇ 4.0' **AFTER 24 HOURS:** ▼ 2.0'

LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
4220 ▼			■	2	6,5,5,(16)	GM	lt. brown, moist, very loose	SILTY GRAVEL W/SAND								
∇	5		■	15	3,4,4,(12) *0.68*	CL *(A-6(15))*	brown to red-brown, moist, stiff			24.2	39	19	0	18	82	pH Resist. Sulfate
4215			☒	14	Pushed *0.30*	CL	red-brown, moist, firm	LEAN CLAY W/SAND LENSES & LAYERS TO 1.5" THICK & 1" TO 6" APART								
	10		■	14	1,2,2,(6) *0.17*	CL	brown to gray, very moist, soft									
4210			☒	18	Pushed *0.43*	CH *(A-7-6(32))*	dk. gray, moist, firm	FAT CLAY	68.8	48.5	52	31	0	7	93	CT UC
4205	15		■	16	2,3,3,(9) *0.27*	CL	gray & brown, moist, firm									
4200	20		☒	17	Pushed *0.72*	CL	gray, moist, stiff	LEAN CLAY occasional sand layer to 0.25" thick								
4195	25		■	17	3,5,5,(11) *0.77*	CL *(A-7-6(23))*	gray, moist, stiff			23.2	46	24	0	10	90	pH Resist. Sulfate
4190	30		■	16	2,4,5,(9) *0.73*	CL SM	gray, moist, stiff	LEAN CLAY								
4185	35		■	11	9,15,16,(29)	SM *(A-2-4(0))*	gray, wet, dense	SILTY SAND some flowing sand		21.9		NP	0	82	18	
4180	40		☒	19	Pushed *0.58*	CL/CH *(A-7-6(29))*	gray, most, stiff	LEAN TO FAT CLAY	73.7	47.7	50	25	0	1	99	CT UC
	45															
4175																

LOGV1 COLOR 142 LOGS COLOR.GPJ US EVAL.GDT 7/12/06

RB&G ENGINEERING INC.
PROVO, UTAH

LEGEND:

DISTURBED SAMPLE ■ 2,3,2,(6) ← Blow Count per 6"; (6) ← $(N_1)_{60}$ Value; *0.45* ← Torvane (tsf)

UNDISTURBED SAMPLE ☒ PUSHED *0.45* ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
TS = Triaxial Shear
CBR = California Bearing Ratio
🟥 = Potential Liquefaction
🟦 = Potential Liquefaction & Lateral Spread

Legacy Parkway - Preferred Alternative
I-215 to I-15/US 89 Interchange

KLEINFELDER

Project No. 35-8163-05

FIELD TEST BORING LOG

Boring: **RB-399**

Sheet 1 of 1

Boring: RB-399
Sheet 1 of 1

Elevation (m)	SAMPLE DESCRIPTION (ASTM D 2488/D 2487)	Sample Type	Recovery (mm)	Soil Classification USCS	Soil Classification AASHTO	N, Blows per 0.15 m (or interval shown)	● SPT $(N_1)_{60}$ ○ SPT $(N_1)_{60}$ (Greater than 50 Blows)	S_{Ub} kPa (torvane in italics)	Dry Density, kN/m³	Moisture, %	Liquid Limit	Plasticity Index	% Passing No. 200	Other Tests
	FILL: Silty GRAVEL - medium dense, moist, gray to tan	MC	508			6 8 7 7	28							
	Lean CLAY - stiff, wet, tan	SPT	356	CL	A-7-6	7 3 2	11							
1285	SILT - stiff, wet, gray to tan	SH	406	ML	A-4			*57*					95	
		SPT	254			2 2 2	10							
	Lean CLAY - stiff, wet, gray			CL	A-7-6									
	SILT - medium stiff, wet, gray to tan	MC	559	ML	A-4	4 2 2 6	6		14.4	31			96	
		SPT	457			2 1 2	6							
	Lean CLAY - medium stiff, wet, gray	SH	610	CL	A-7-6			16 67	14.2	38	46	26	100	C SG
	SILT - very stiff, wet, gray, low to medium plasticity	SPT	457	ML	A-4	2 6 8	26							
		MC	610			4 7 8 8	22							
1280	- occasional sandy silt lenses	SPT	457			4 5 7	20							
		SH	610										63	
	Silty SAND - dense, wet, gray	SPT	610	SM	A-2-4	5 9 12 18	33						39	
1275														
1270														

Depth: ft 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65; m 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

Graphic Log

SPT $(N_1)_{60}$ scale: 0, 25, 50

Test Results *

Logged by:	R. Khandokar
Date Start:	5/15/00
Date Finish:	5/15/00
Station:	6005+940.000 0.00 RT
Line:	D Mainline
Coordinates (m):	N 110,517.894 E 15,630.526
Elevation (m):	1286.467
Total Depth Drilled (m):	8.8
Drill Contractor:	RC Exploration
Driller:	N. Young
Rig Type:	Diedrich D-120 Truck
Drilling Method:	Hollow-Stem Auger
Hammer Type:	Automatic
Rod Type:	AW
Boring Diameter:	203 mm

LEGEND/NOTES

Elevations based upon North American Vertical Datum of 1988 (NAVD '88)

Coordinates are NAD '83

⊻	= Observed Groundwater depth at time of drilling
Blows	= Number of blows required to drive split spoon sampler 150 mm or interval shown
USCS	= Unified Soil Classification System
AASHTO	= American Association of State Highway and Transportation Officials
*	= See Key to Soil Logs for list of abbreviations and descriptions of tests

SAMPLE TYPE

SPT	= Standard Penetration Test, 34.9mm ID and 50.8mm OD split spoon sampler
MC	= Modified California Sampler, 50.8mm ID and 63.5mm OD split spoon sampler
P	= Piston Sampler, 76.2 mm OD
SH	= Shelby Tube, 76.2mm OD, pushed
BAG	= Bulk Sample

UTDOT Z8038UP.GPJ 8/31/00

APPENDIX C

Laboratory Testing

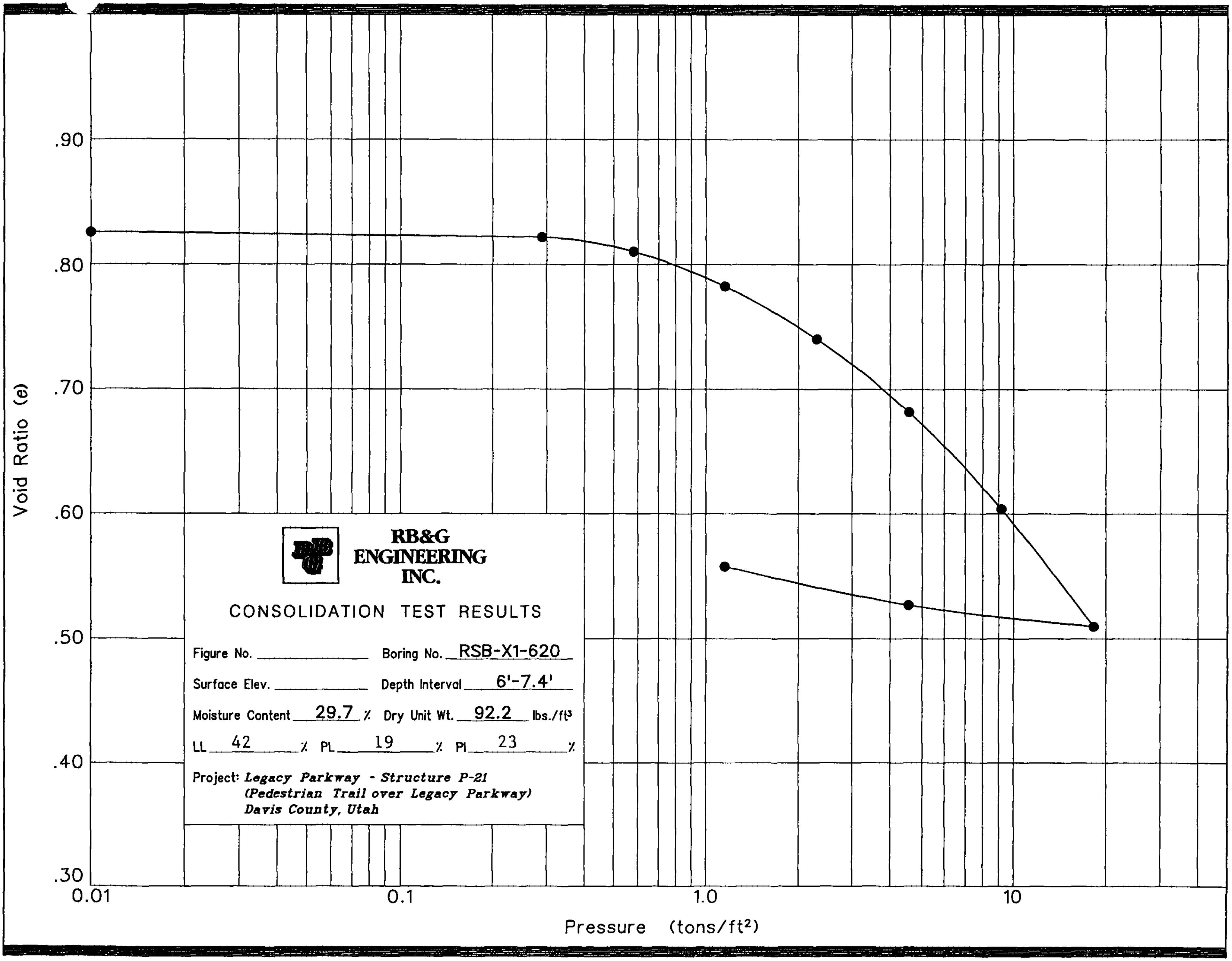
Table 1

SUMMARY OF TEST DATA

PROJECT	Legacy Parkway	PROJECT NO.	200601-142
LOCATION	Structure P-21 Pedestrian Trail over Legacy Parkway	FEATURE	Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM / (AASHTO Classification)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
RSB-X1-620	6-7.5	Shelby	92.2	29.7	1535	42	19	23	0	4	96	CL / A-7-6(23)
	20-21.5	Shelby	87.6	33.8	1092	44	21	23	0	0	100	CL / A-7-6(25)
	30-31.5	Shelby	94.9	30.2	1555	41	17	24	0	8	92	CL / A-7-6(23)
	35-36.5	19		26.3				NP	0	47	53	ML / A-4(0)
RSB-X1-621	3-4.5	Shelby	90.0	30.1	1863	42	19	23	0	4	96	CL / A-7-6(23)
	9-10.5	Shelby	78.5	41.6		51	23	28	0	2	98	CH / A-7-6(31)
	25-26.5	Shelby	96.3	26.7	1656	41	21	20	0	9	91	CL / A-7-6(21)
	36-37.5	12		21.1				NP	1	47	52	ML / A-4(0)
	45-46.5	11		26.5				NP	0	89	11	SP-SM / A-2-4(0)
	51.5-53	16		24.4				NP	0	62	38	SM / A-4(0)
	60-61.5	Shelby	100.9	23.0	2312	34	16	18	0	5	95	CL / A-6(17)
	71.5-73	20		21.9				NP	0	90	10	SP-SM / A-1-b(0)
	80-81.5	Shelby	95.5	25.1	4741	35	20	15	0	0	100	CL / A-6(16)
RSB-X1-622	6-7.5	Shelby	82.7	35.5	1461	45	20	25	0	2	98	CL / A-7-6(27)
	15-16.5	Shelby	94.5	25.7	2154	33	17	16	0	8	92	CL / A-6(14)
	25-26.5	Shelby		26.5		48	22	26	0	3	97	CL / A-7-6(28)
	35-36.5	25		23.7				NP	1	66	33	SM / A-2-4(0)
	40-41.5	Shelby	68.5	53.5	1664	57	24	33	0	1	99	CH / A-7-6(38)
	50-51.5	19		24.3		34	19	15	0	2	98	CL / A-6(15)
	60-61.5	Shelby	94.6	27.3	1525	55	21	34	0	2	98	CH / A-7-6(37)
	70-71.5	20		20.4		30	22	8	0	17	83	CL / A-4(6)
	80-81.5	Shelby	98.8	25.5	1807	39	20	19	0	1	99	CL / A-6(20)
	90-91.5	Shelby	93.1	26.1	2080	34	19	15	0	1	99	CL / A-6(15)
RSB-X1-623	3-4.5	8		24.2		39	20	19	0	18	82	CL / A-6(15)
	12-13.5	Shelby	68.8	48.5	845	52	21	31	0	7	93	CH / A-7-6(32)
	25-26.5	10		23.2		46	22	24	0	10	90	CL / A-7-6(23)
	35-36.5	31		21.9				NP	0	82	18	SM / A-2-4(0)
	40-41.5	Shelby	73.7	47.7	1654	50	25	25	0	1	99	CL/CH / A-7-6(29)

NP=Nonplastic



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

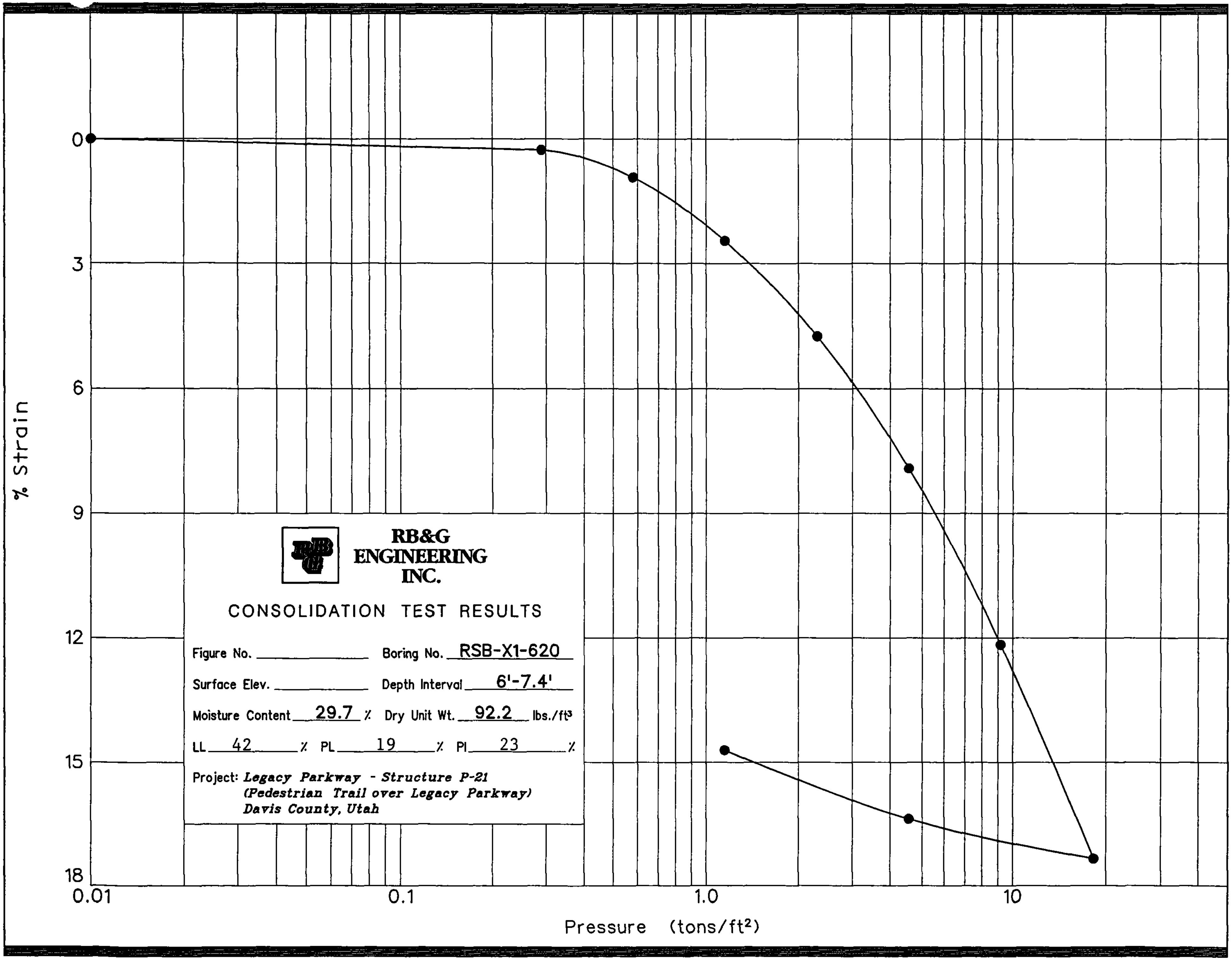
Figure No. ______ Boring No. RSB-X1-620

Surface Elev. ______ Depth Interval 6'-7.4'

Moisture Content 29.7 % Dry Unit Wt. 92.2 lbs./ft³

LL 42 % PL 19 % PI 23 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. ____________ Boring No. RSB-X1-620

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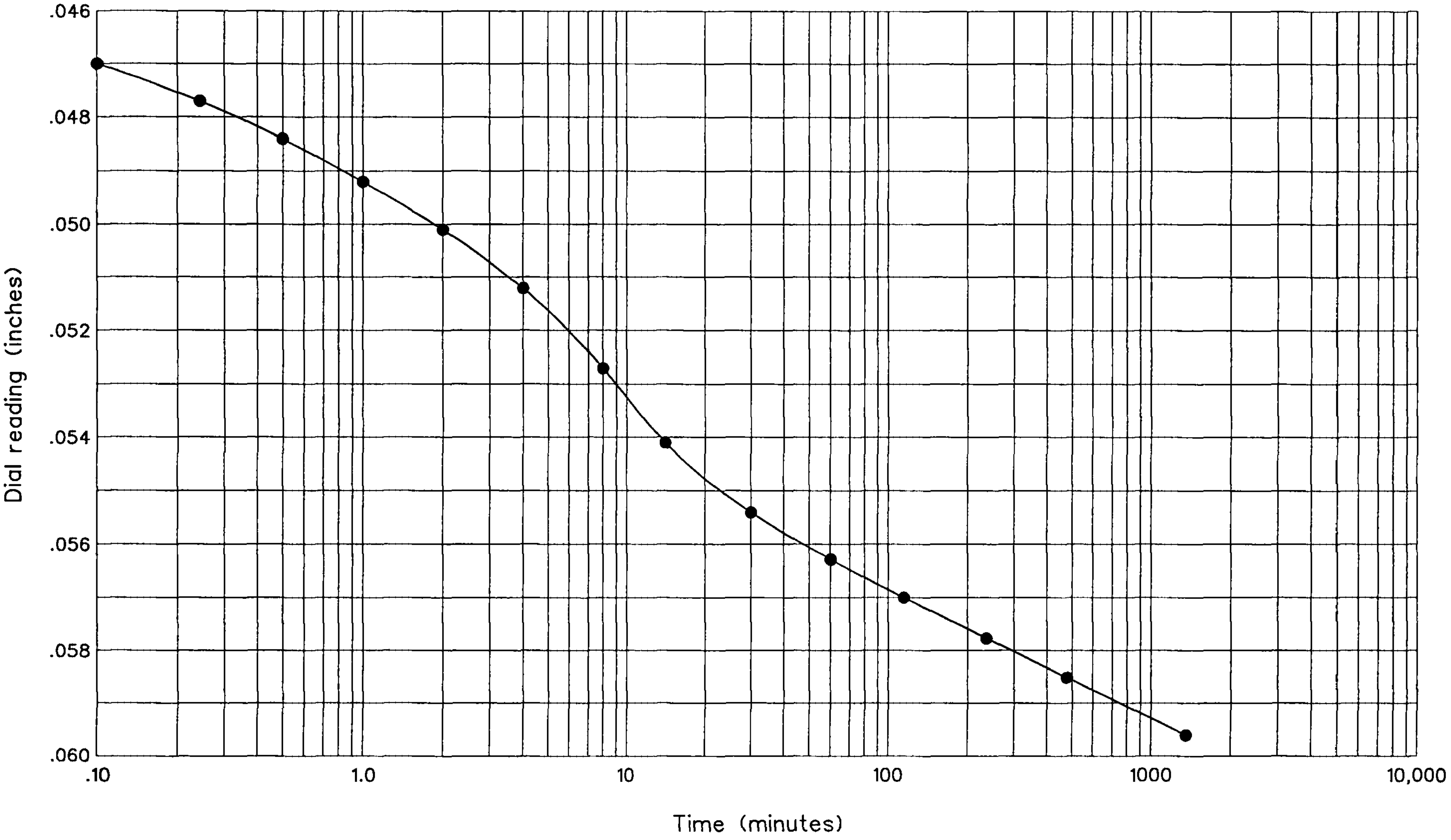


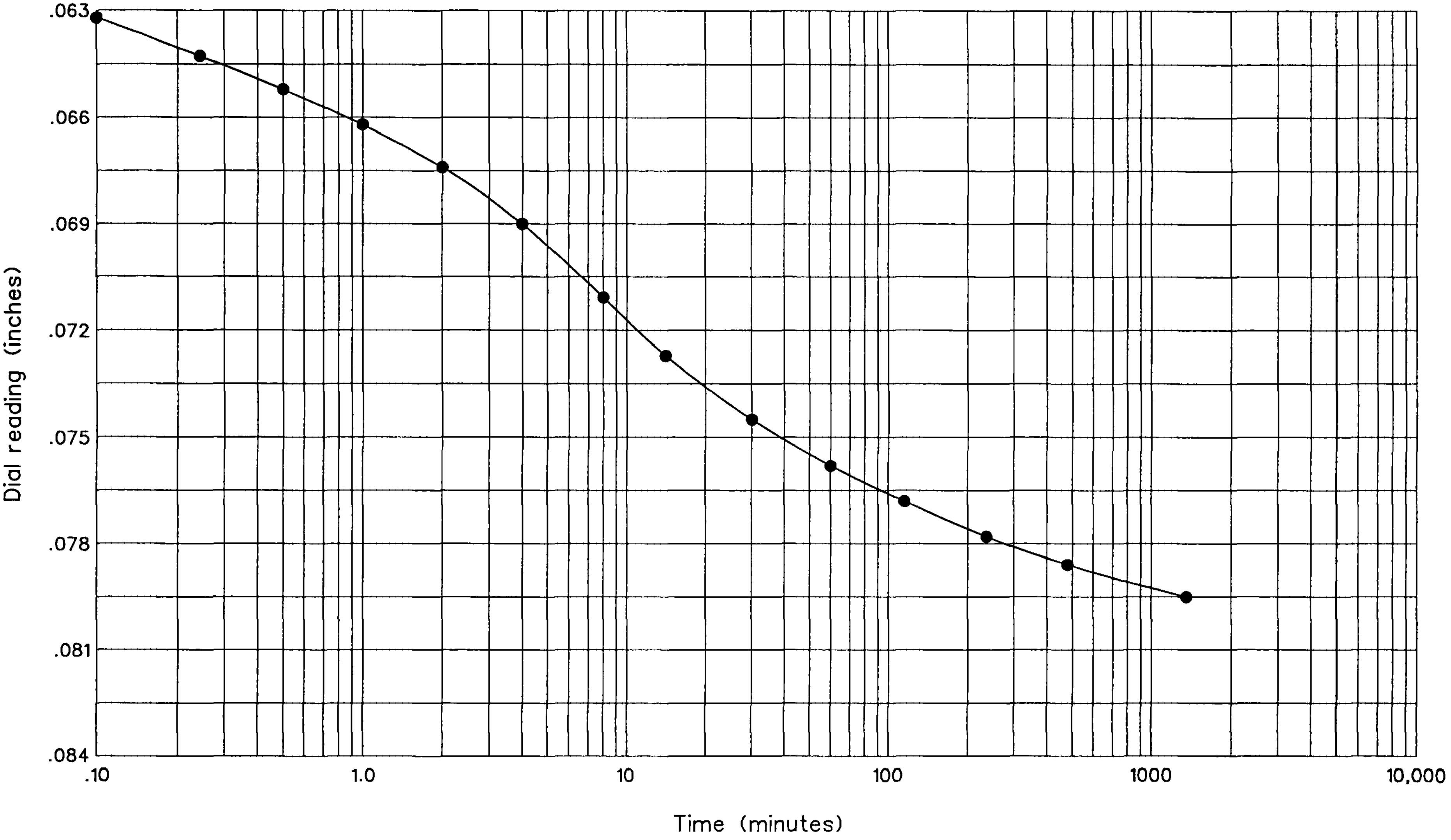
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-620
Depth: 6'-7.4'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



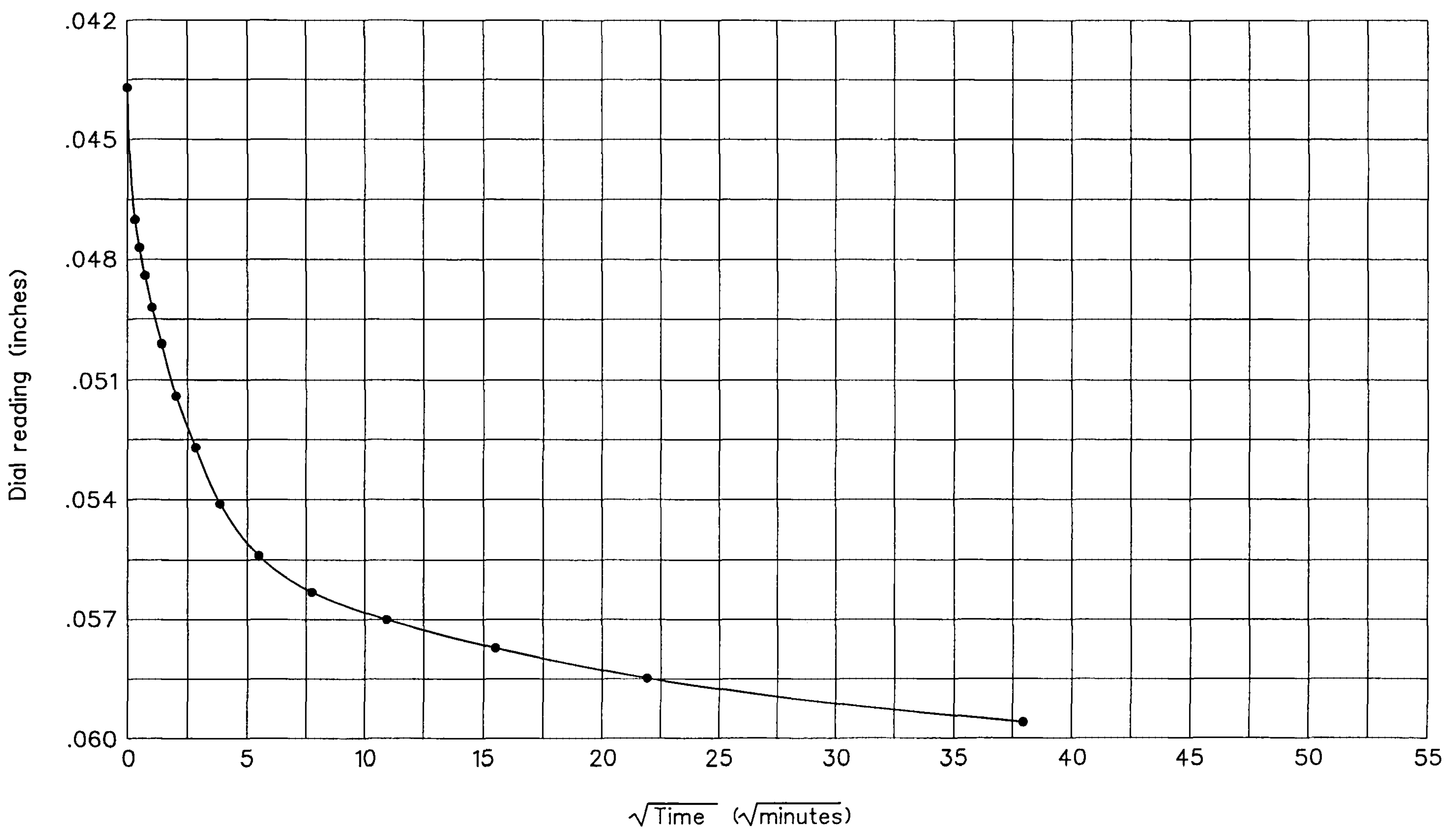
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-620
Depth: 6'-7.4'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



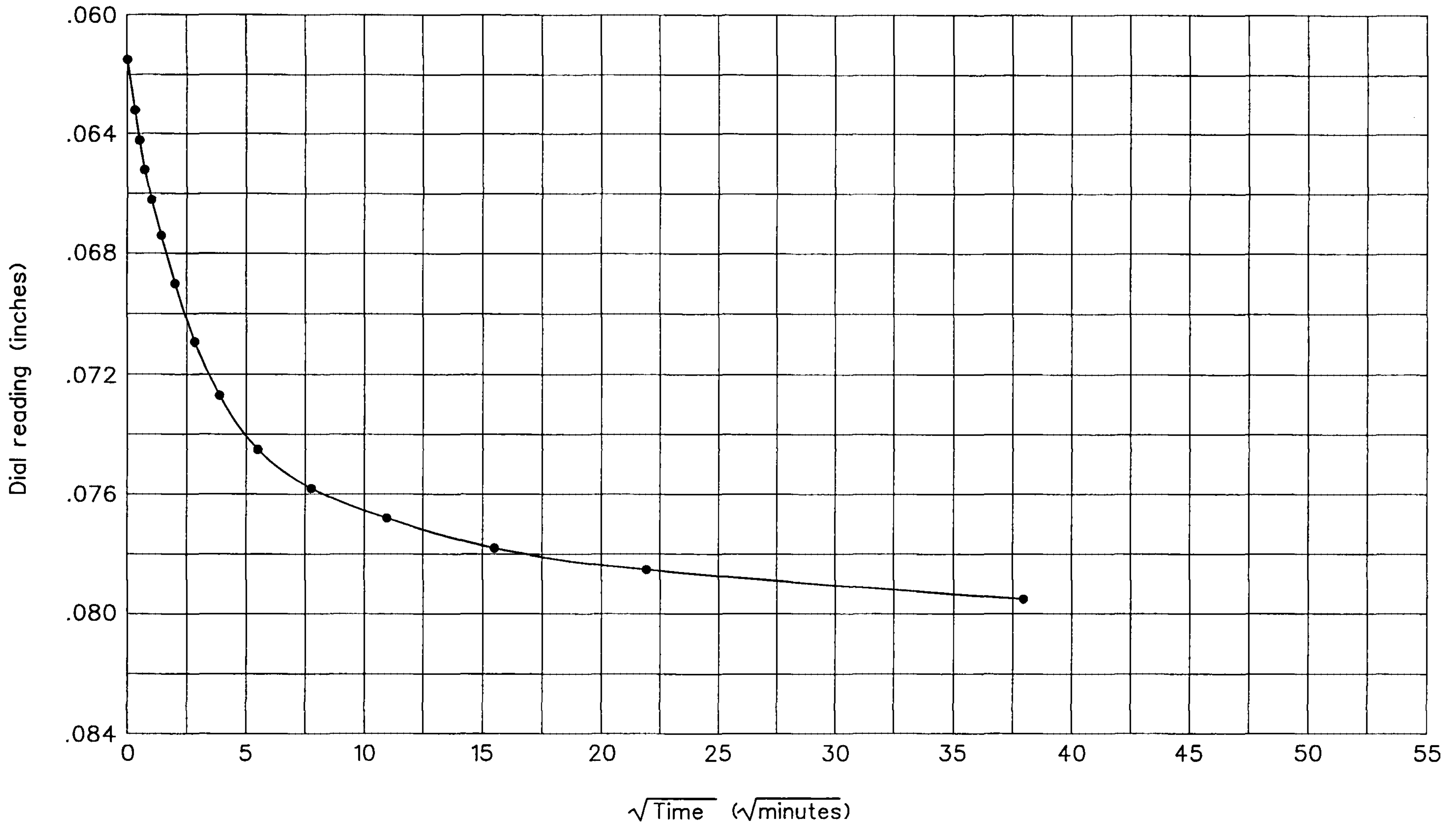
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-620
Depth: 6'-7.4'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-620
Depth: 6'-7.4'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

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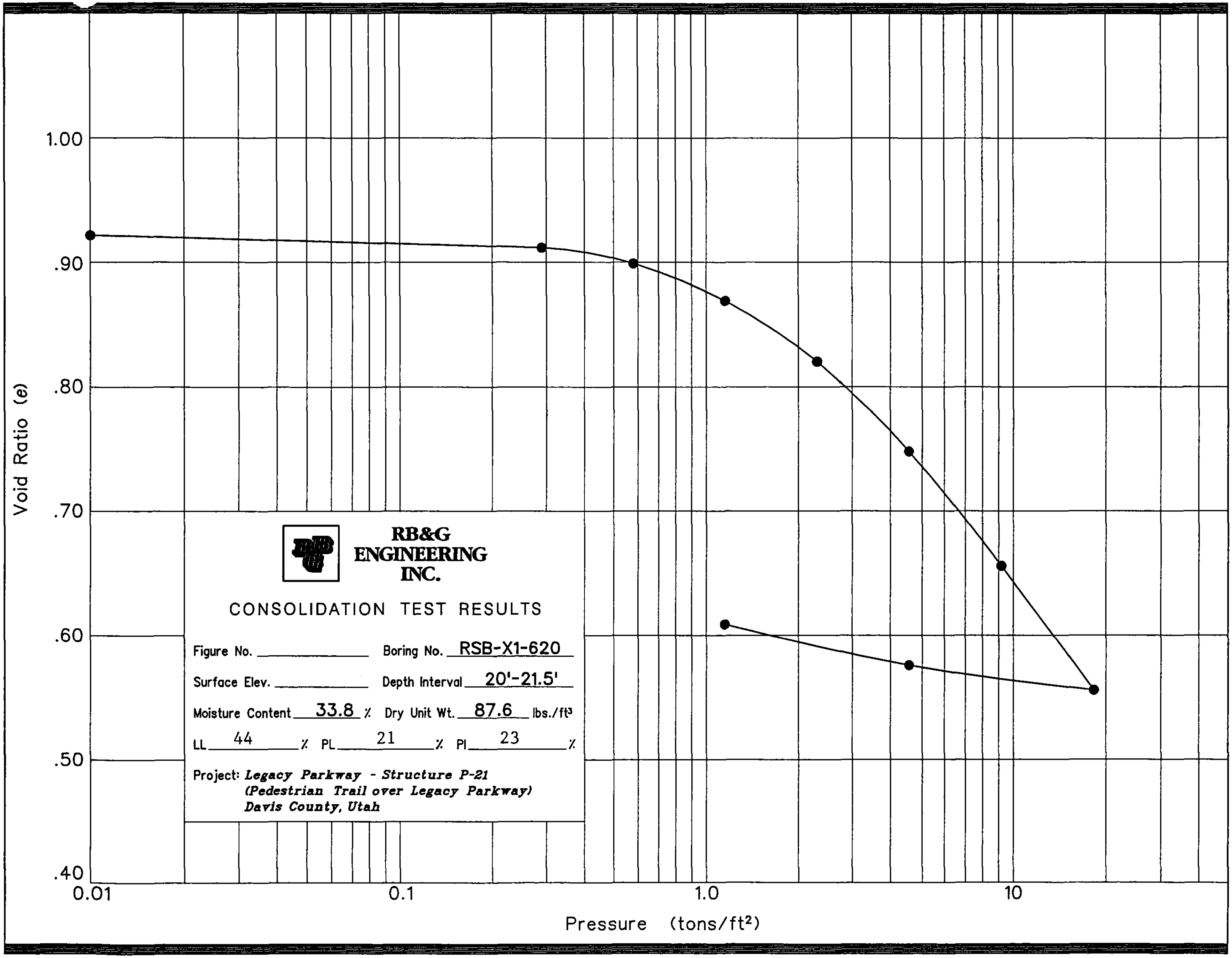

RB&G
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INC.

CONSOLIDATION TEST RESULTS

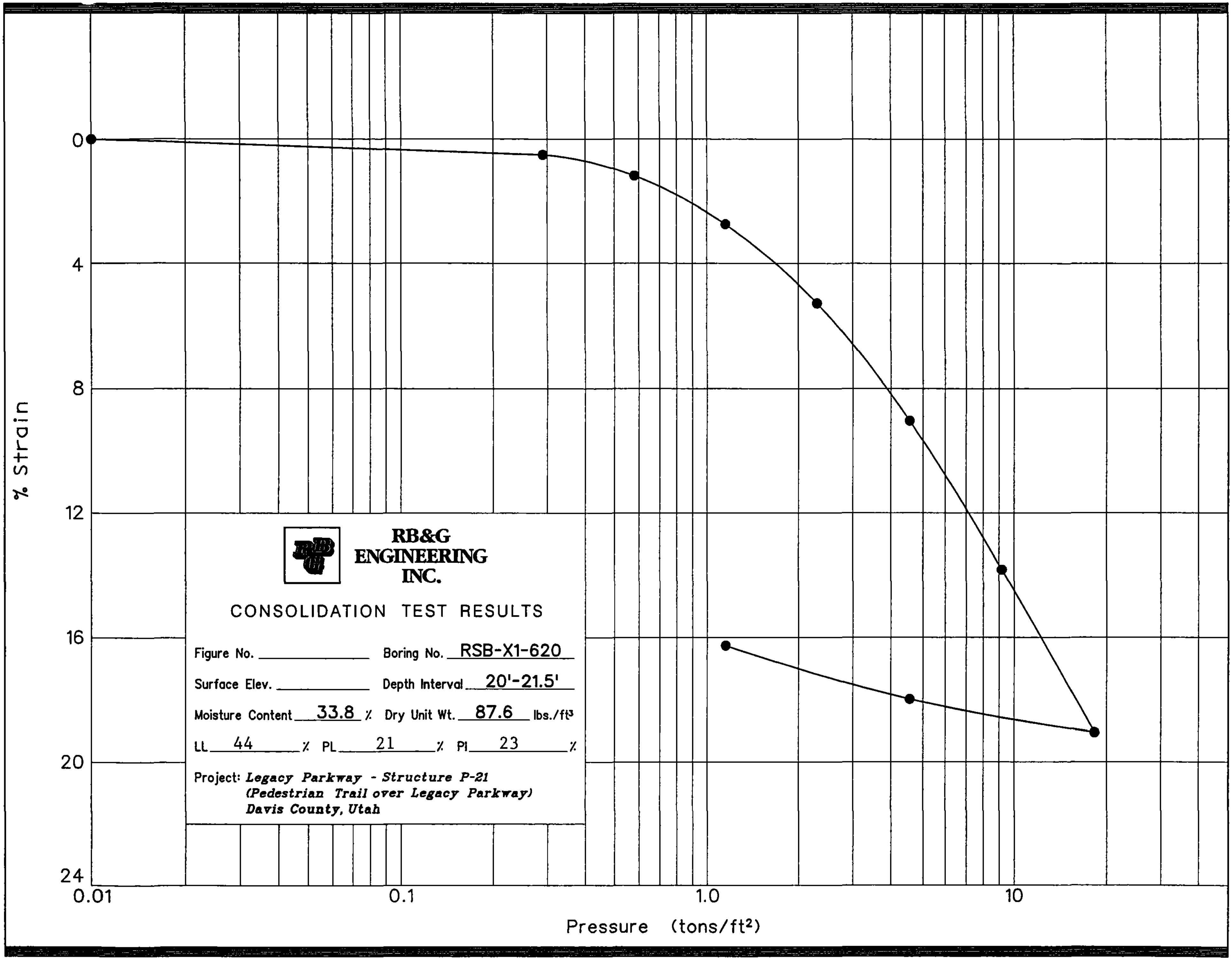
Figure No. ________ Boring No. RSB-X1-620

Surface Elev. ________ Depth Interval 20'-21.5'

Moisture Content 33.8 % Dry Unit Wt. 87.6 lbs./ft³

LL 44 % PL 21 % PI 23 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. RSB-X1-620

Surface Elev. ______ Depth Interval 20'-21.5'

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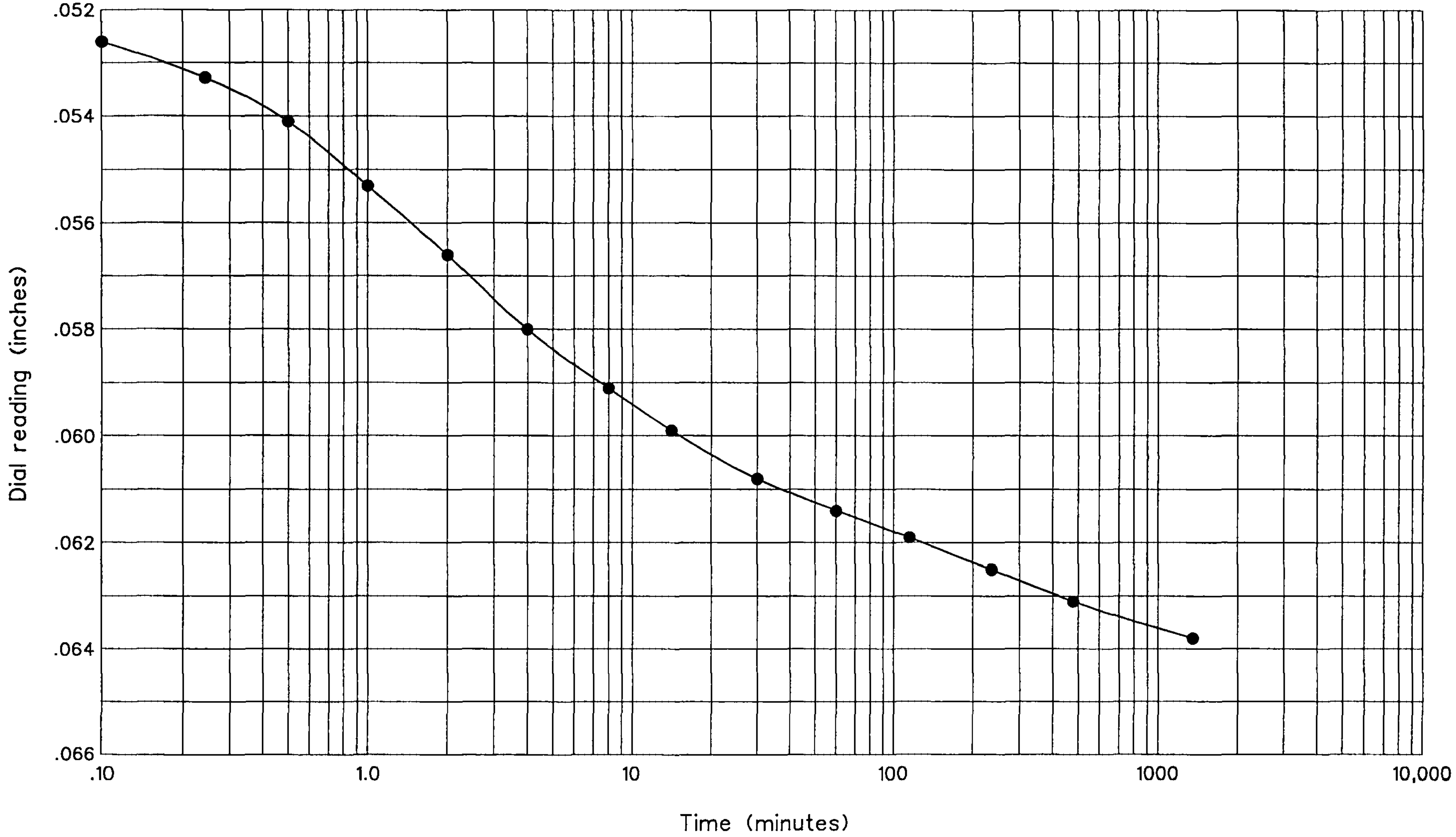
Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



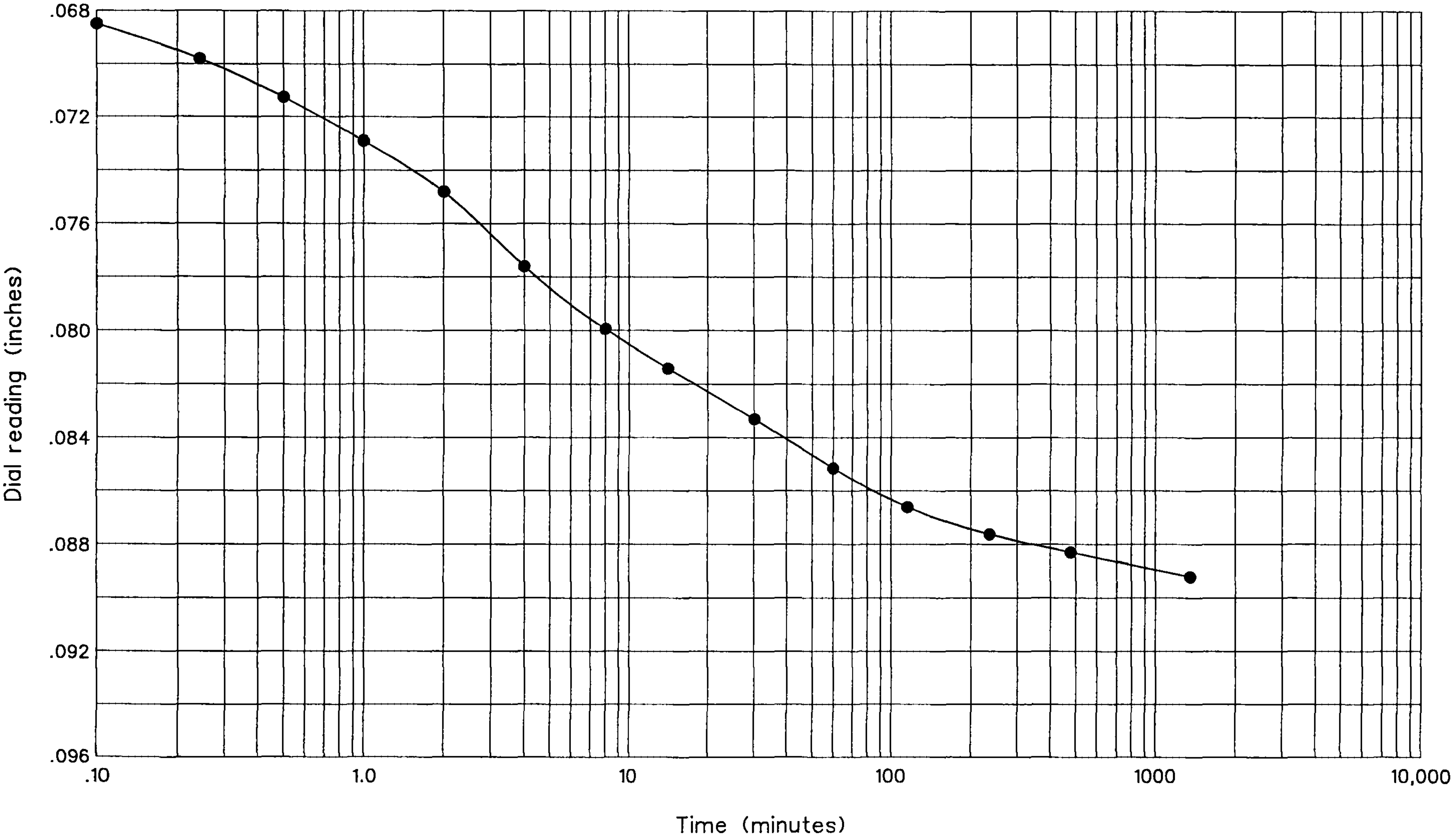
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-620
Depth: 20'-21.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



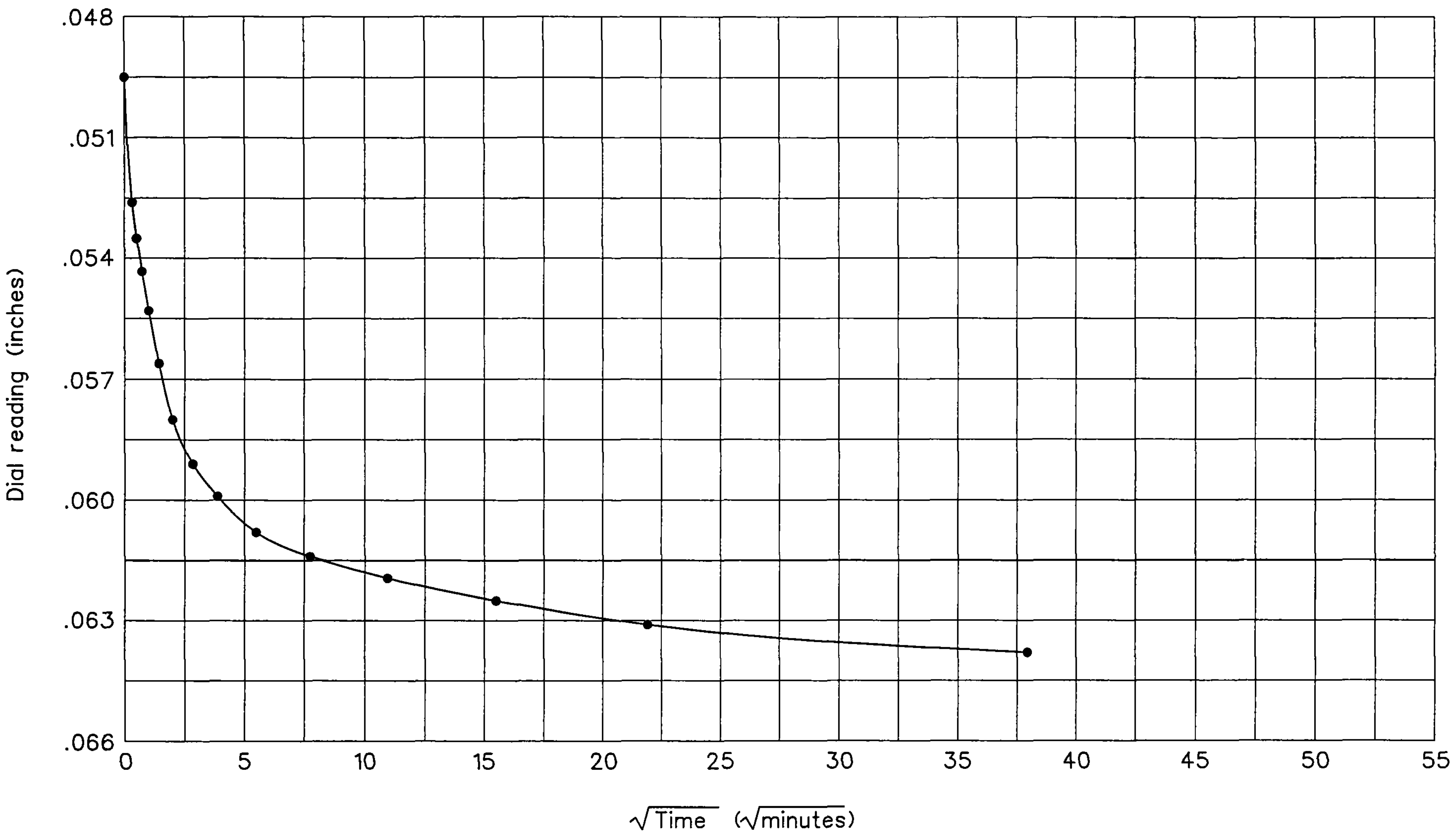
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-620
Depth: 20'-21.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



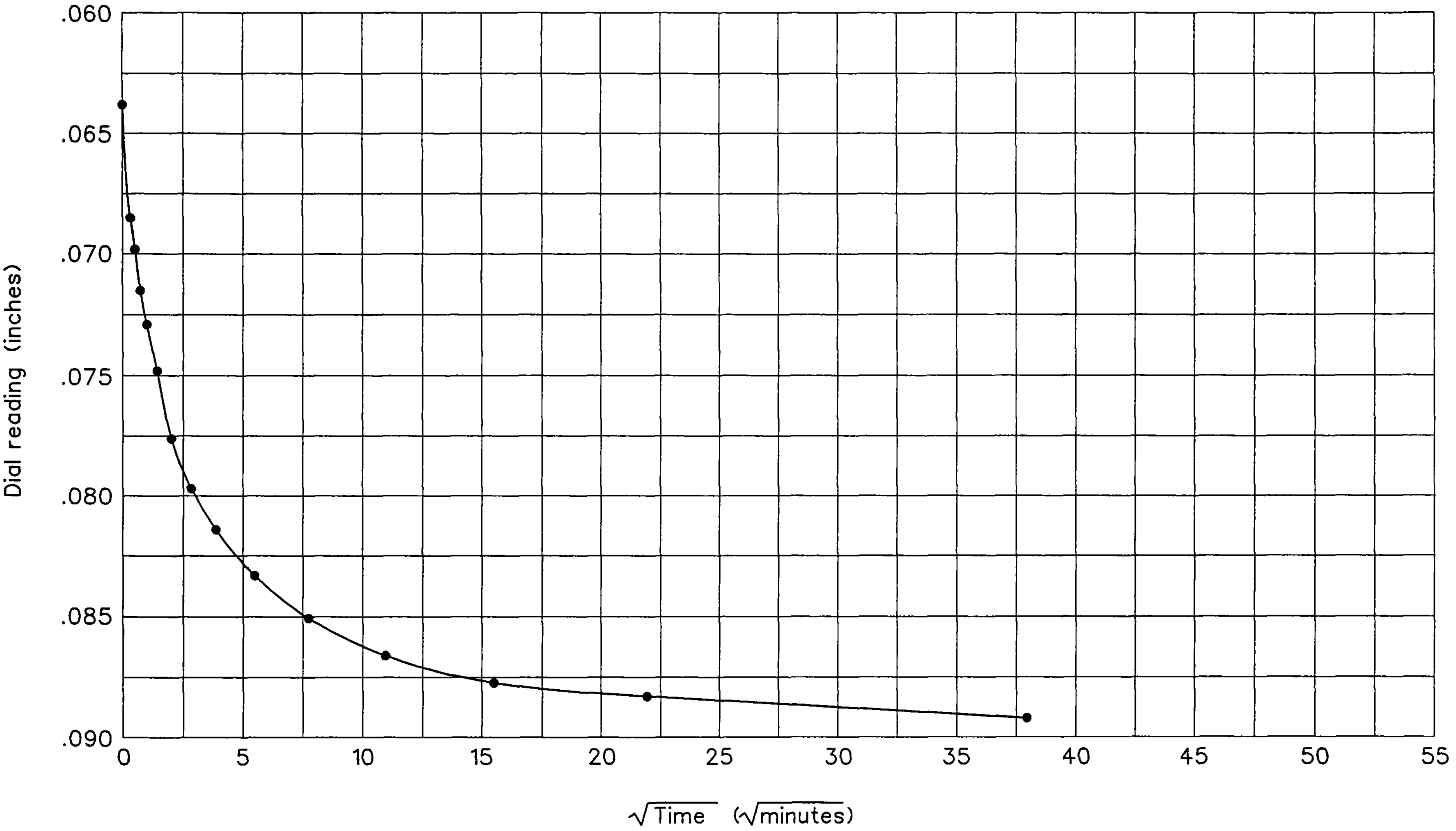
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-620
Depth: 20'-21.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



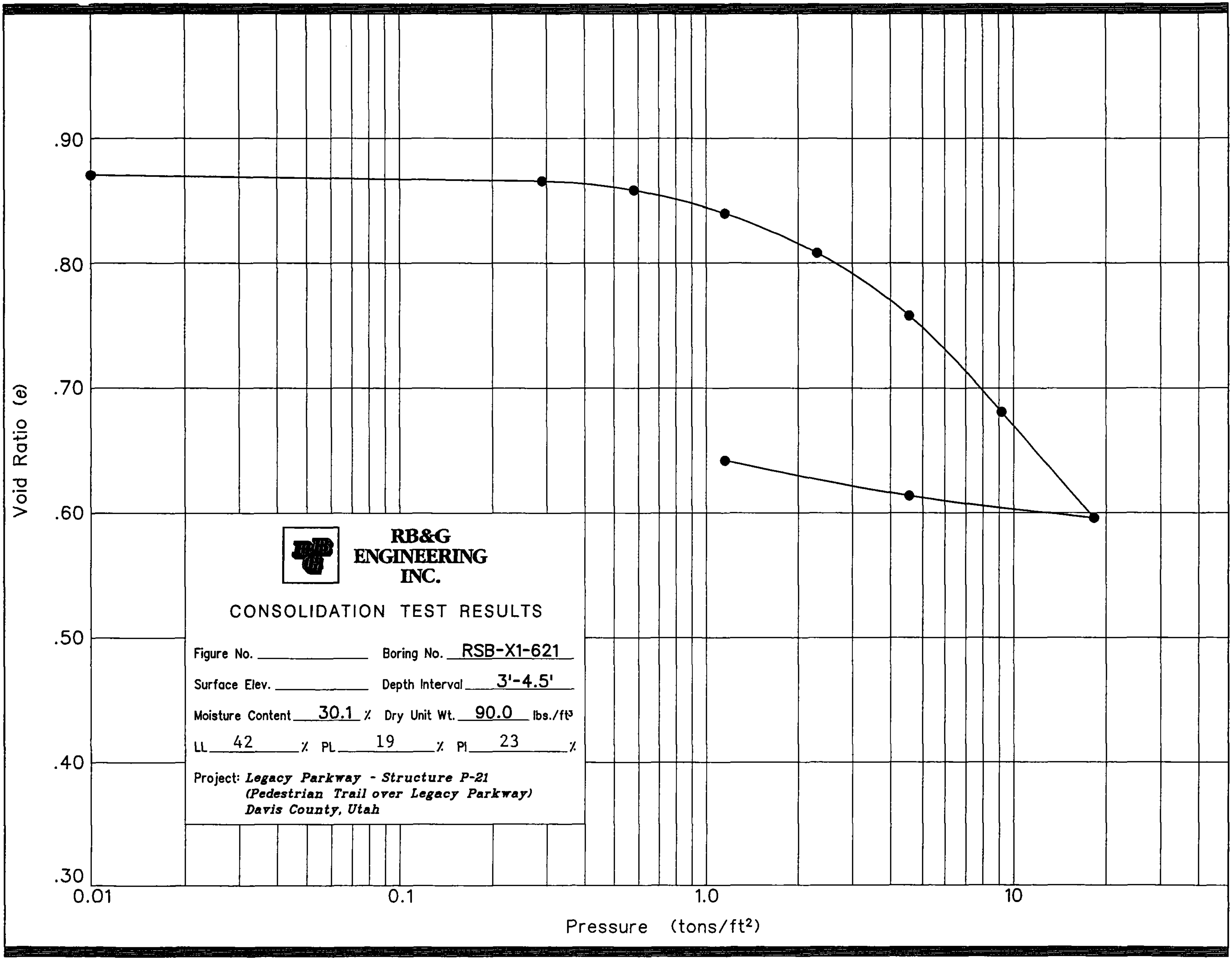
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-620
Depth: 20'-21.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G
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INC.

CONSOLIDATION TEST RESULTS

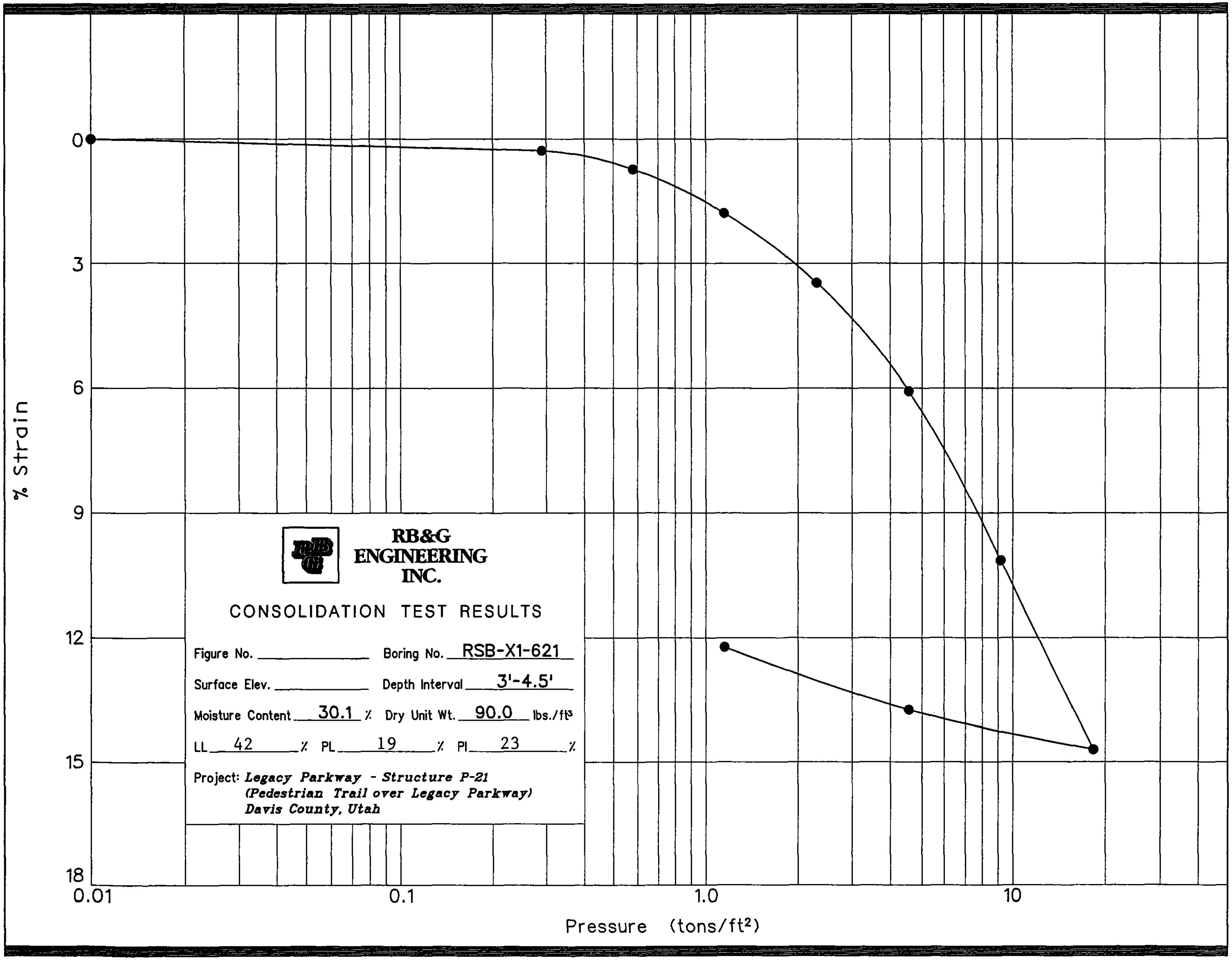
Figure No. ______ Boring No. RSB-X1-621

Surface Elev. ______ Depth Interval 3'-4.5'

Moisture Content 30.1 % Dry Unit Wt. 90.0 lbs./ft³

LL 42 % PL 19 % PI 23 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. ____________ Boring No. RSB-X1-621

Surface Elev. ____________ Depth Interval 3'-4.5'

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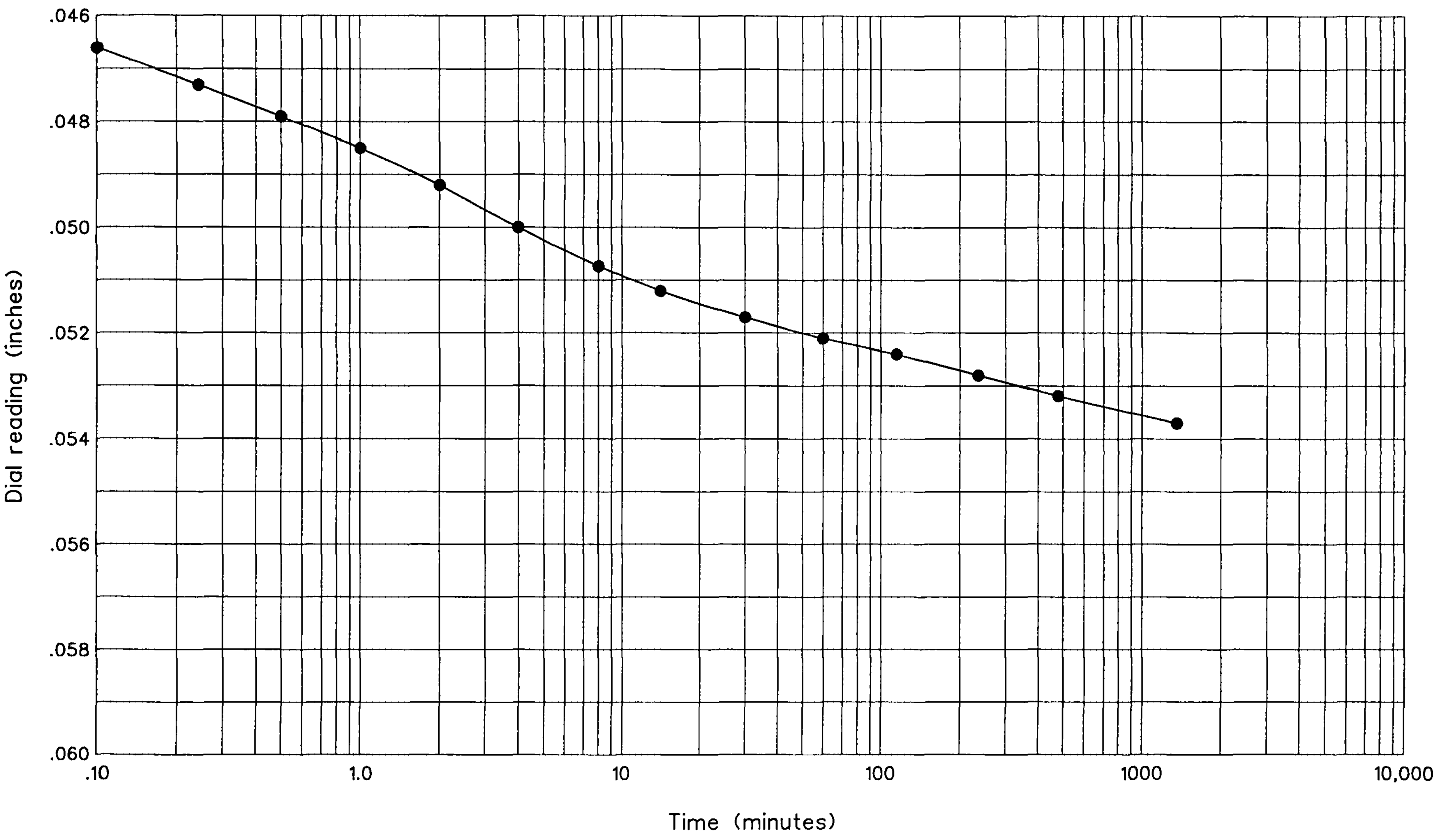
Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



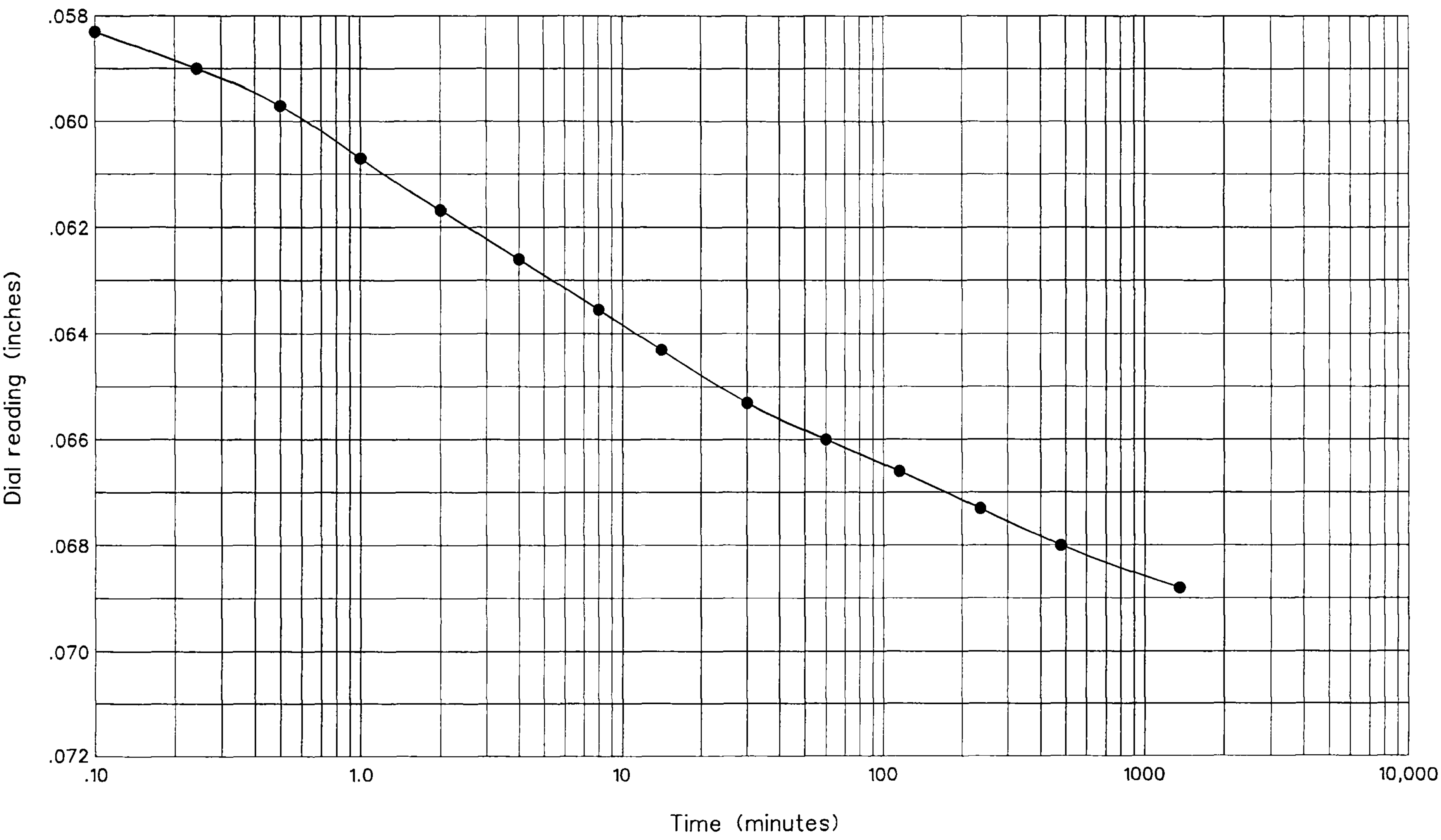
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 3'-4.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



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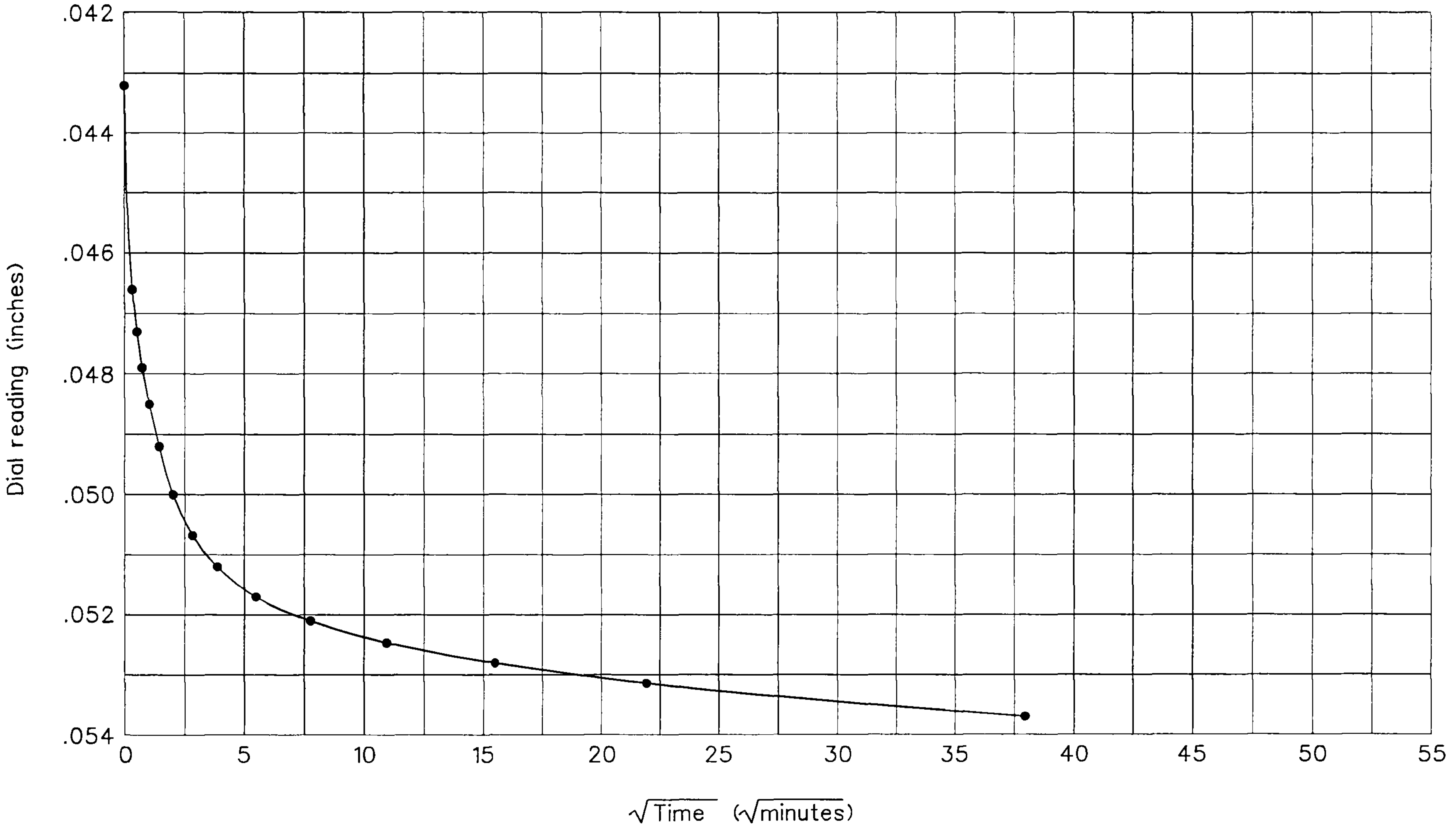
INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 3'-4.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



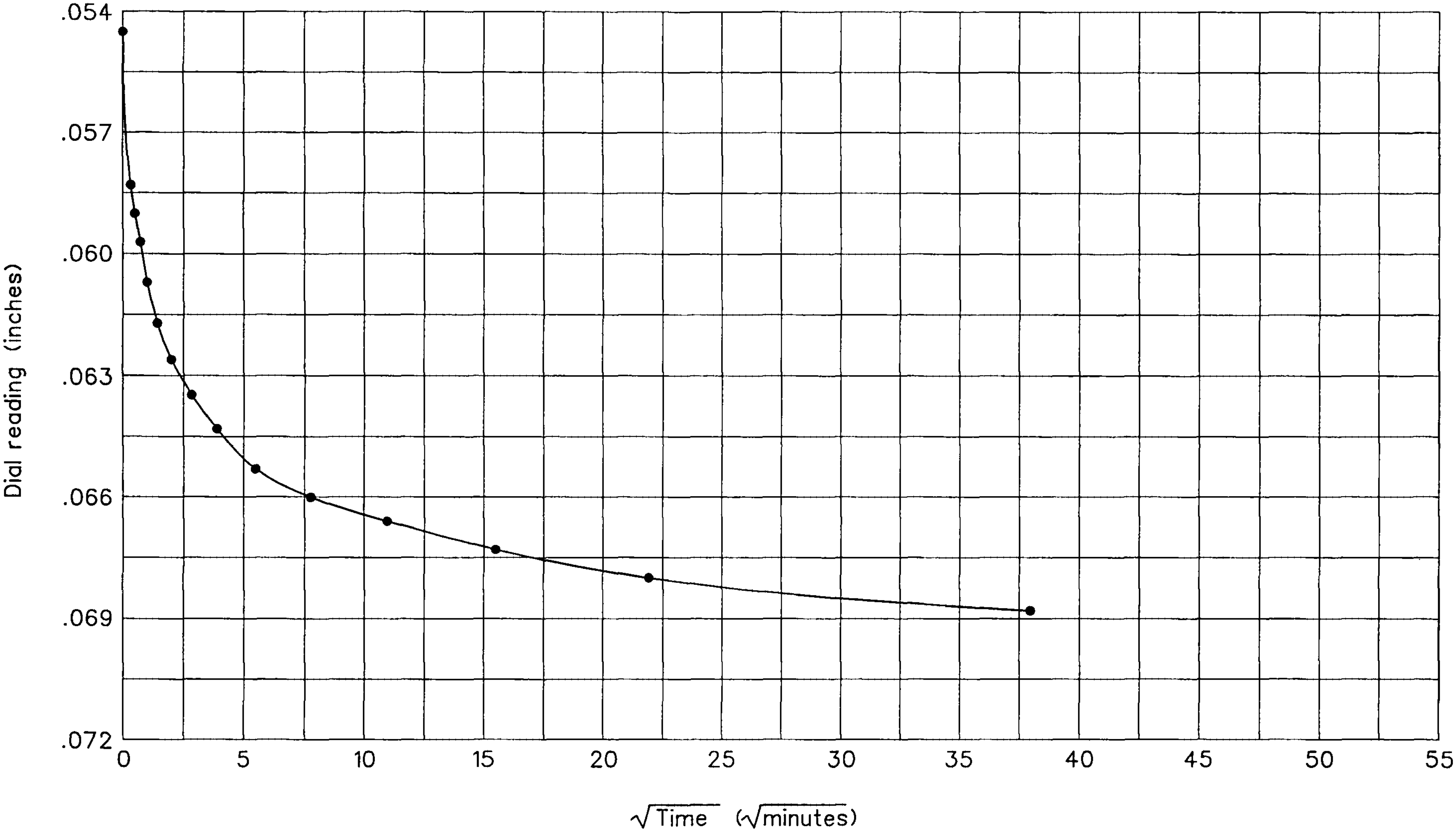
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 3'-4.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



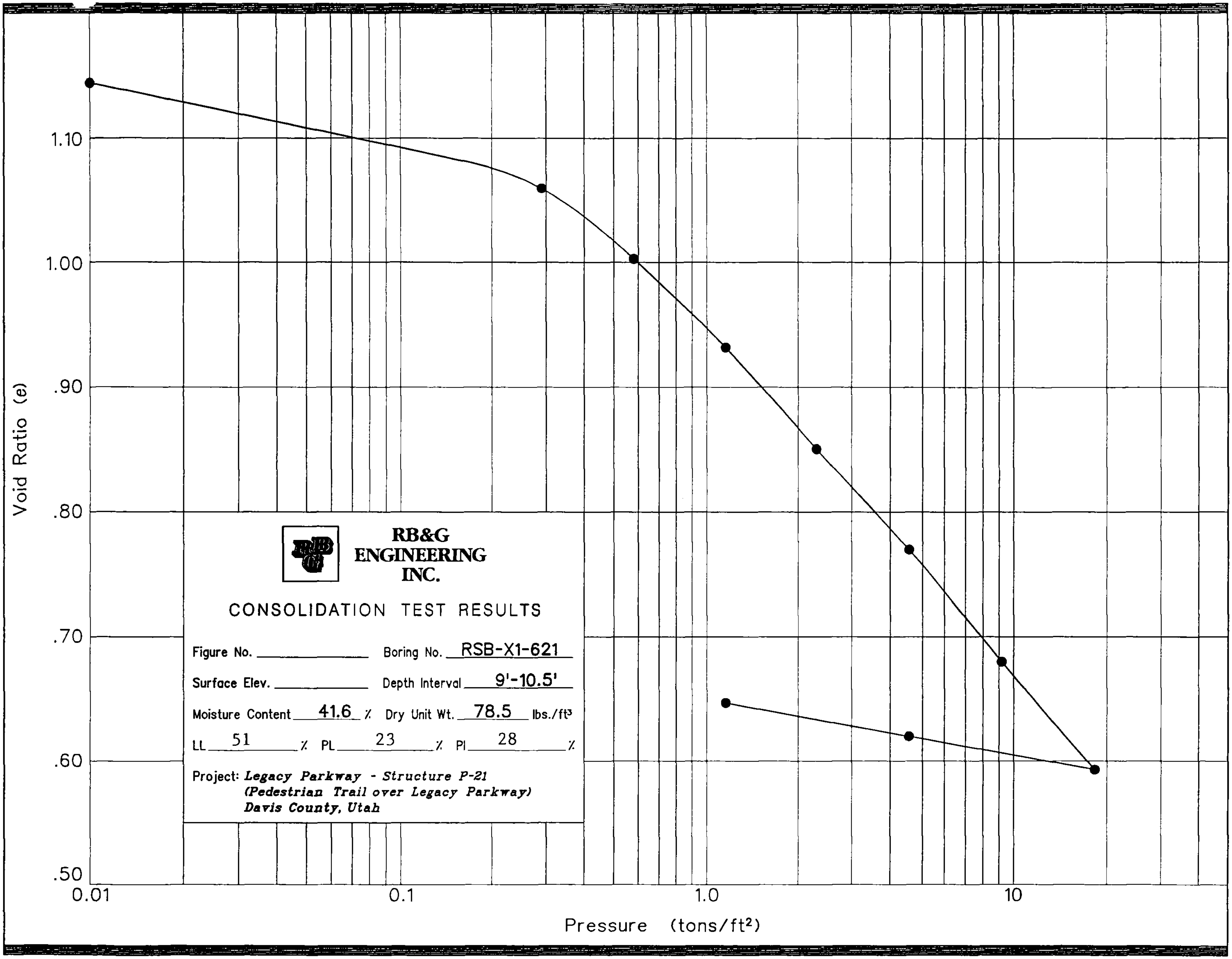
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 3'-4.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

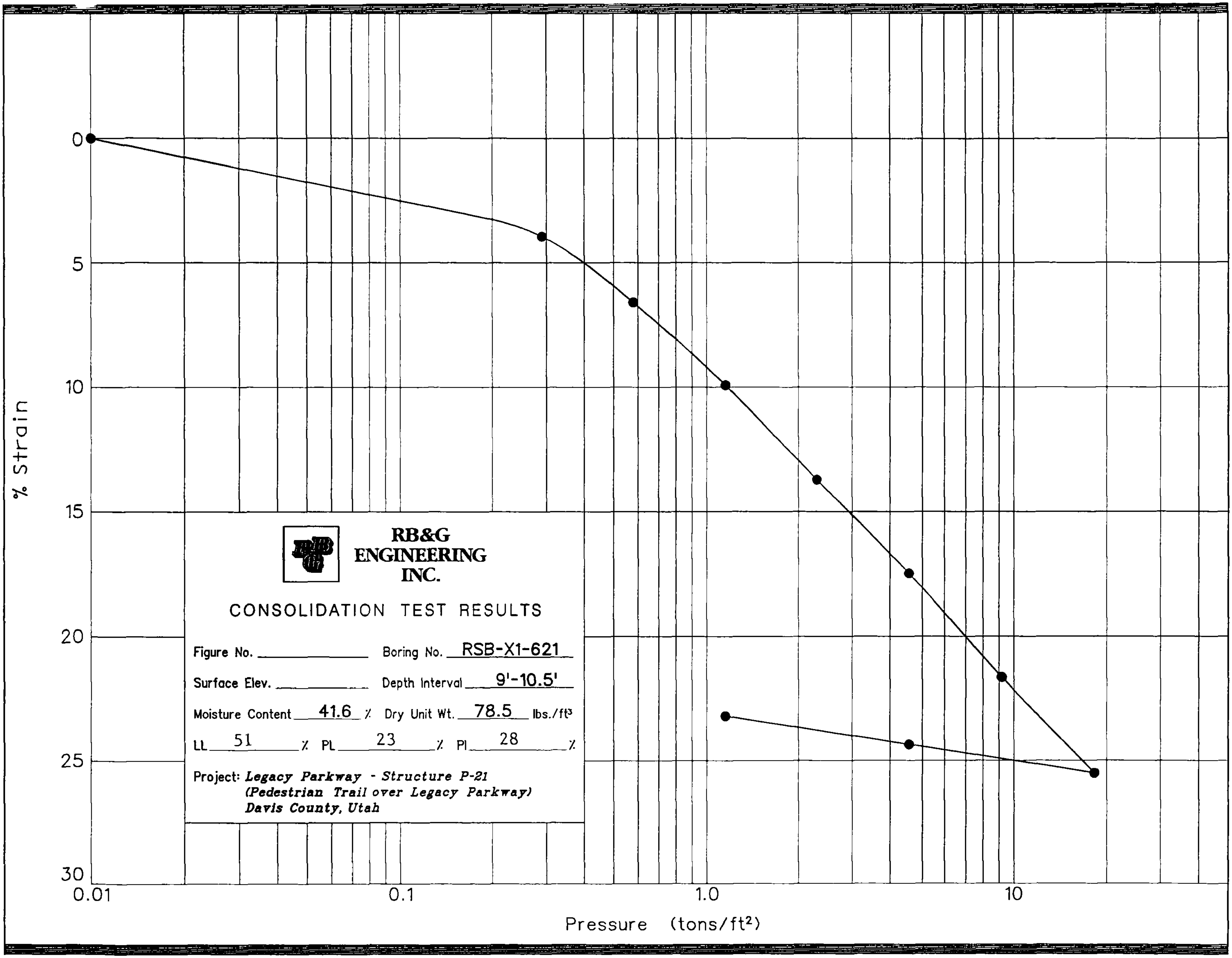
Figure No. ______________ Boring No. RSB-X1-621

Surface Elev. ______________ Depth Interval 9'-10.5'

Moisture Content 41.6 % Dry Unit Wt. 78.5 lbs./ft³

LL 51 % PL 23 % PI 28 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. RSB-X1-621

Surface Elev. ______ Depth Interval 9'-10.5'

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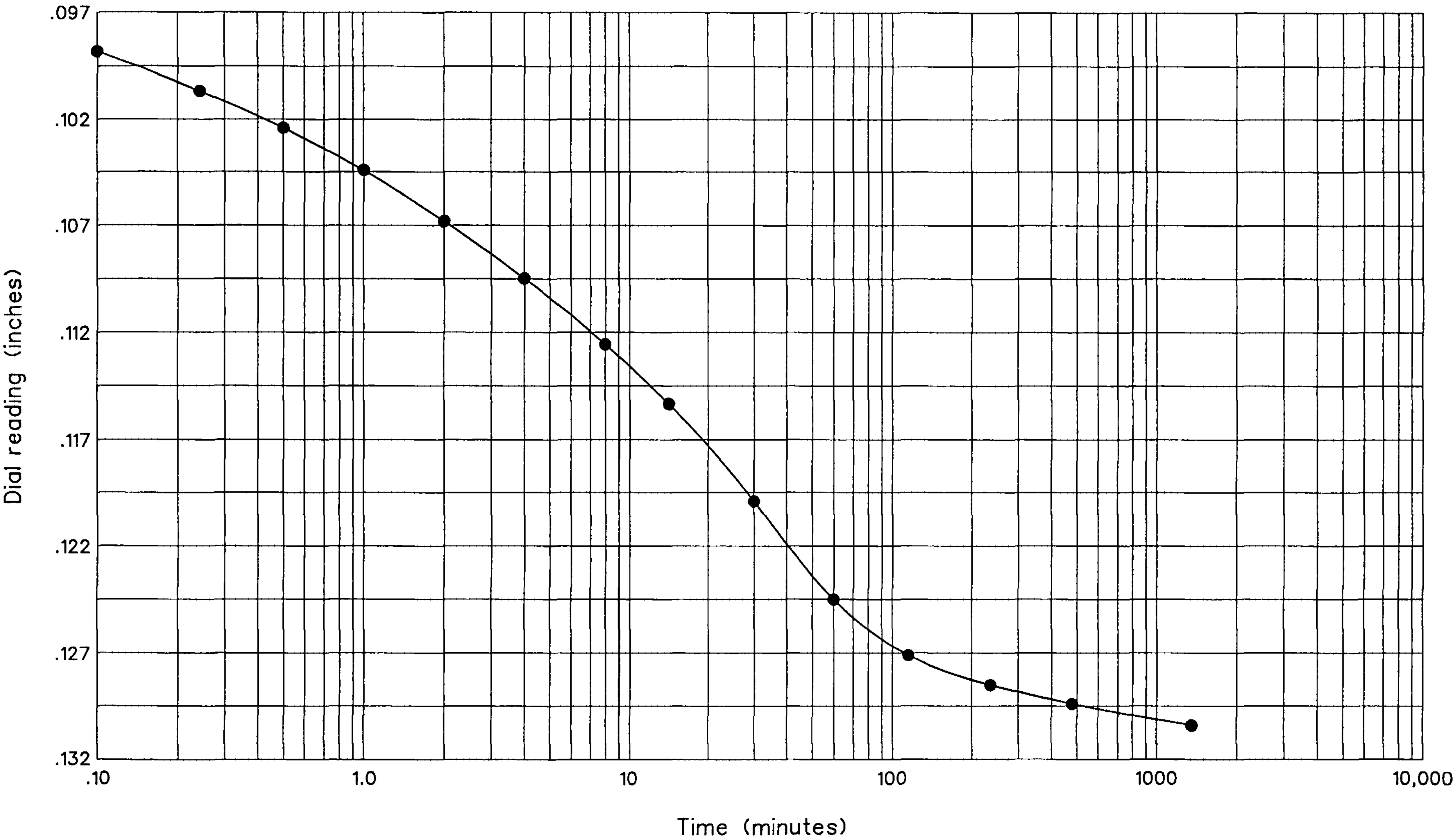
Project: ***Legacy Parkway - Structure P-21***
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



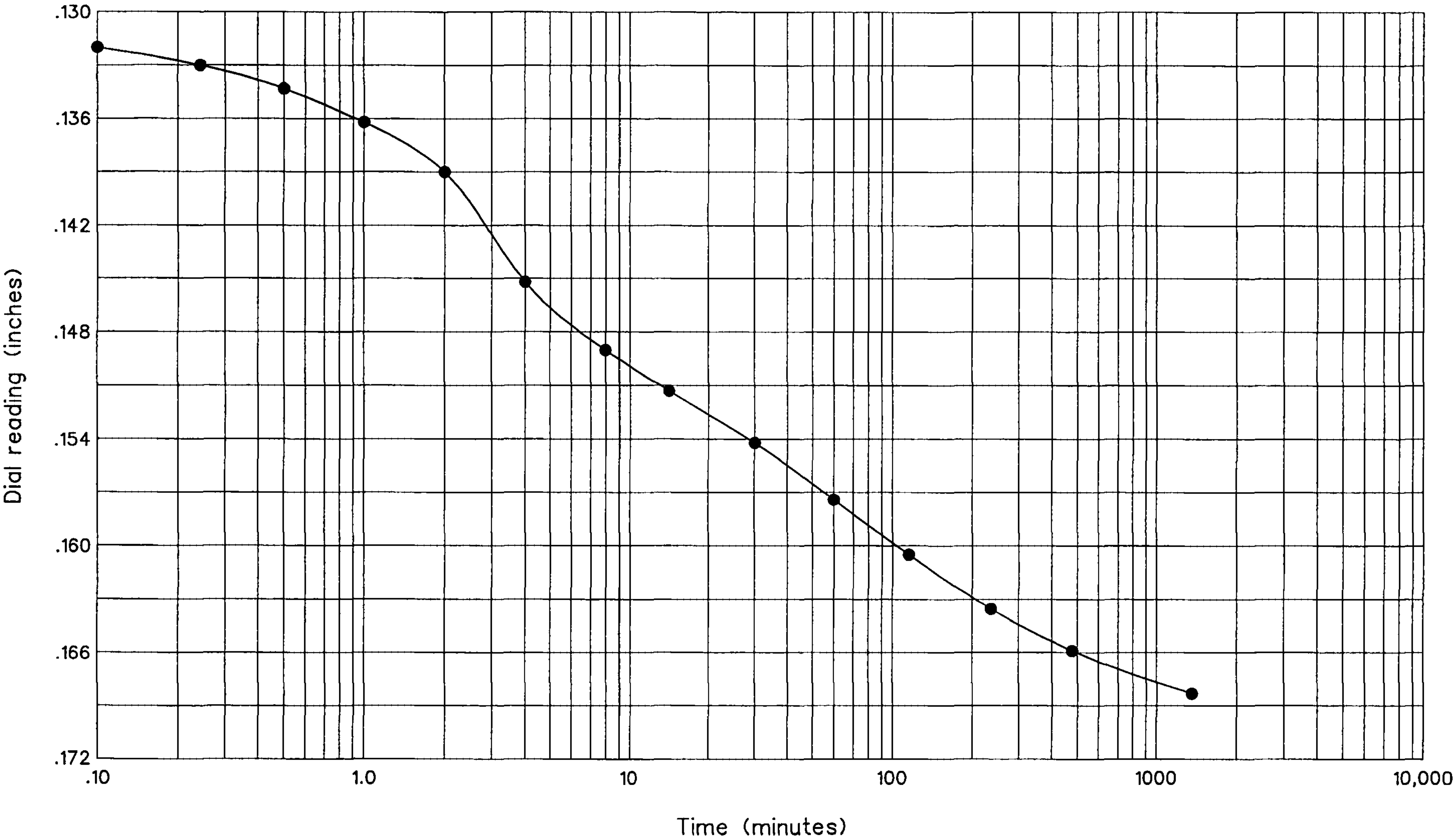
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 9'-10.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



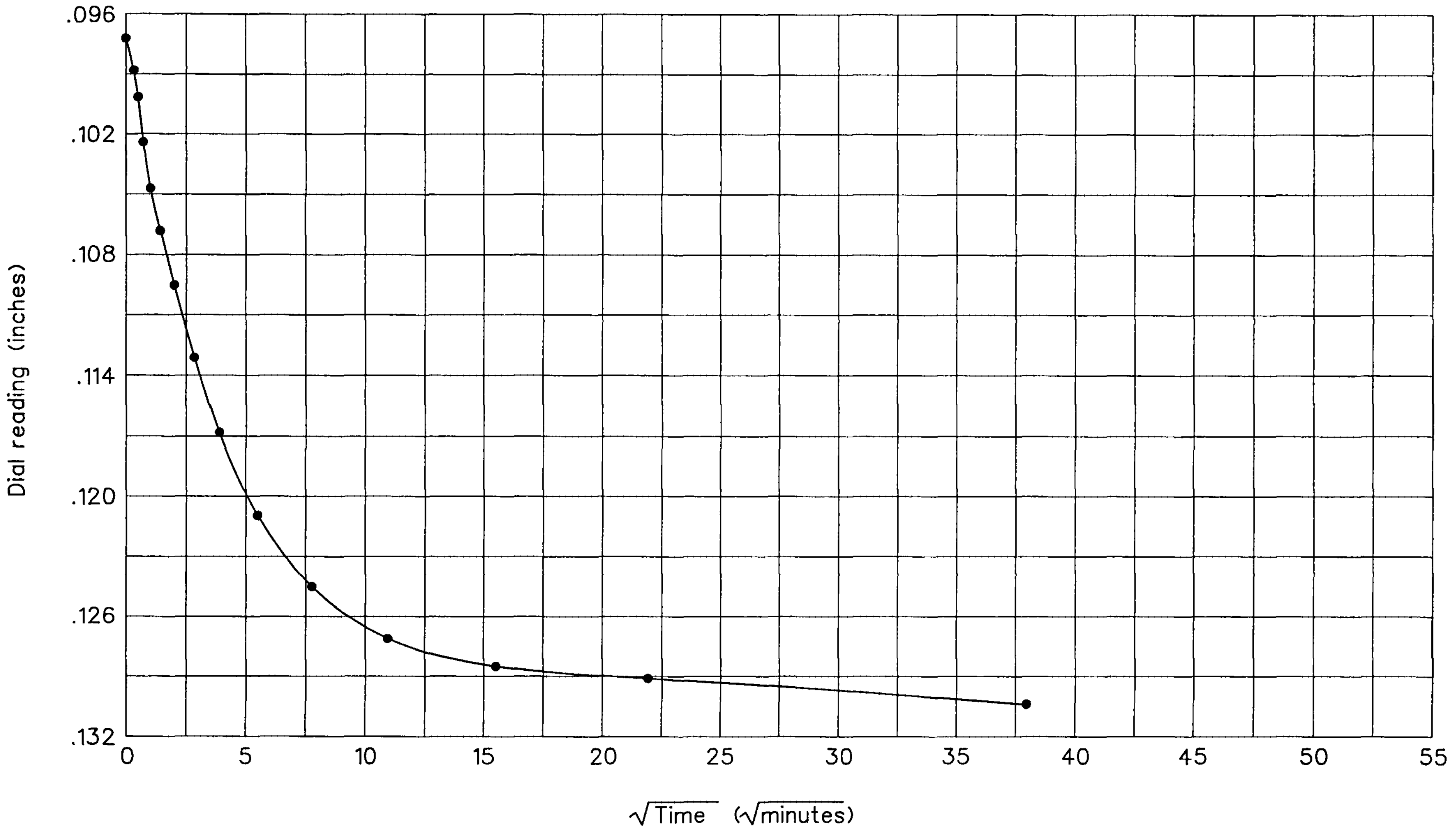
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 9'-10.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



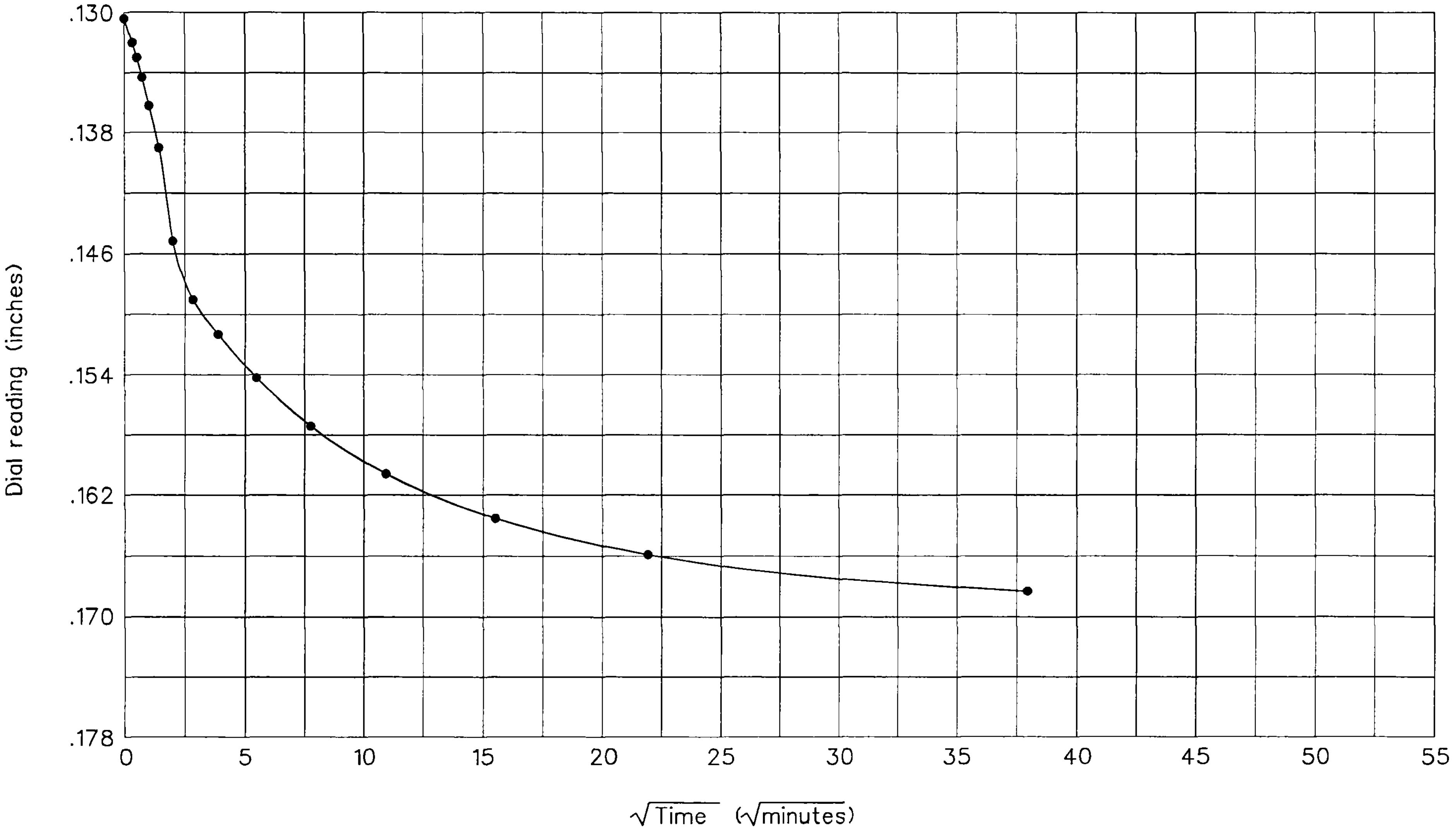
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 9'-10.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



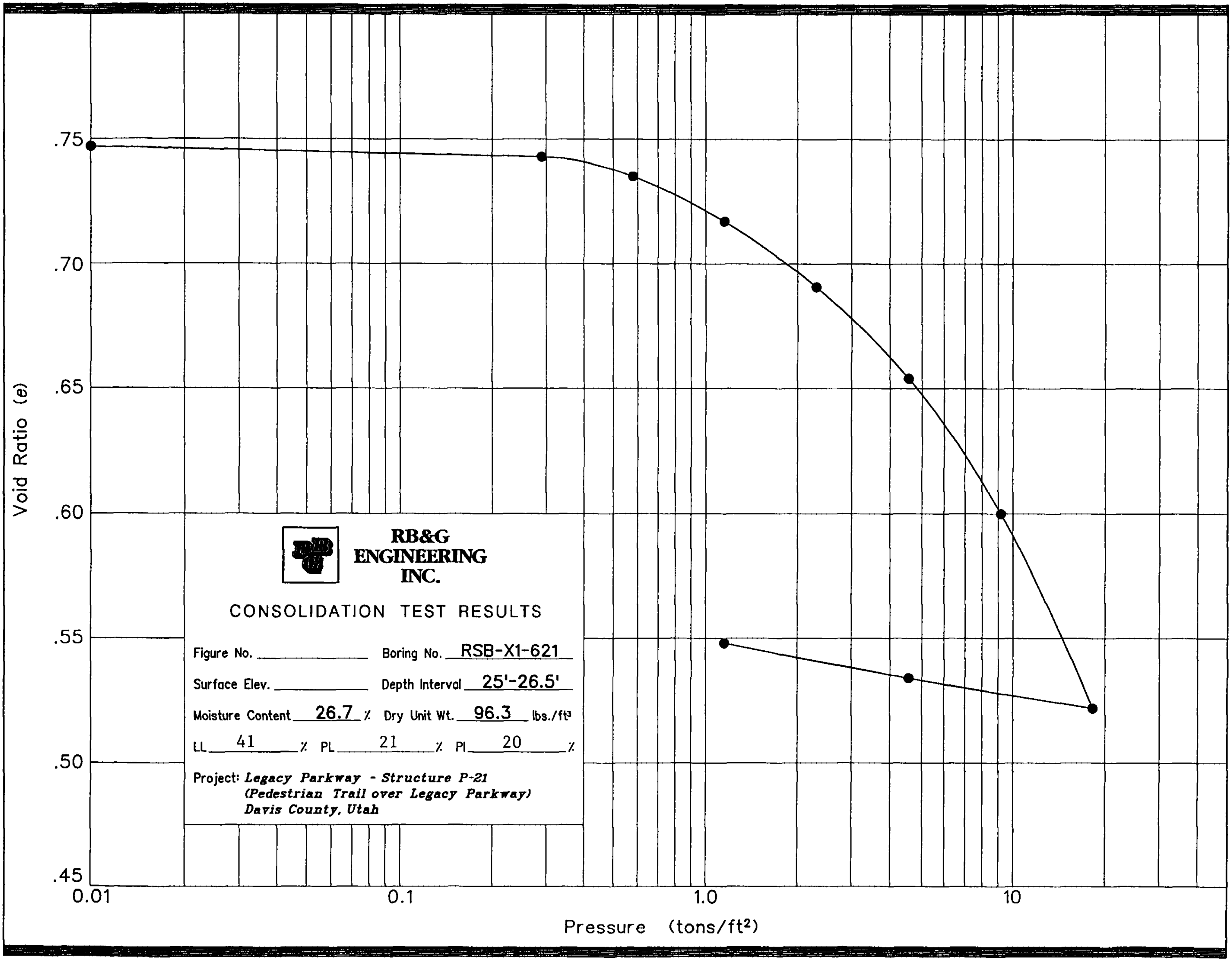
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 9'-10.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

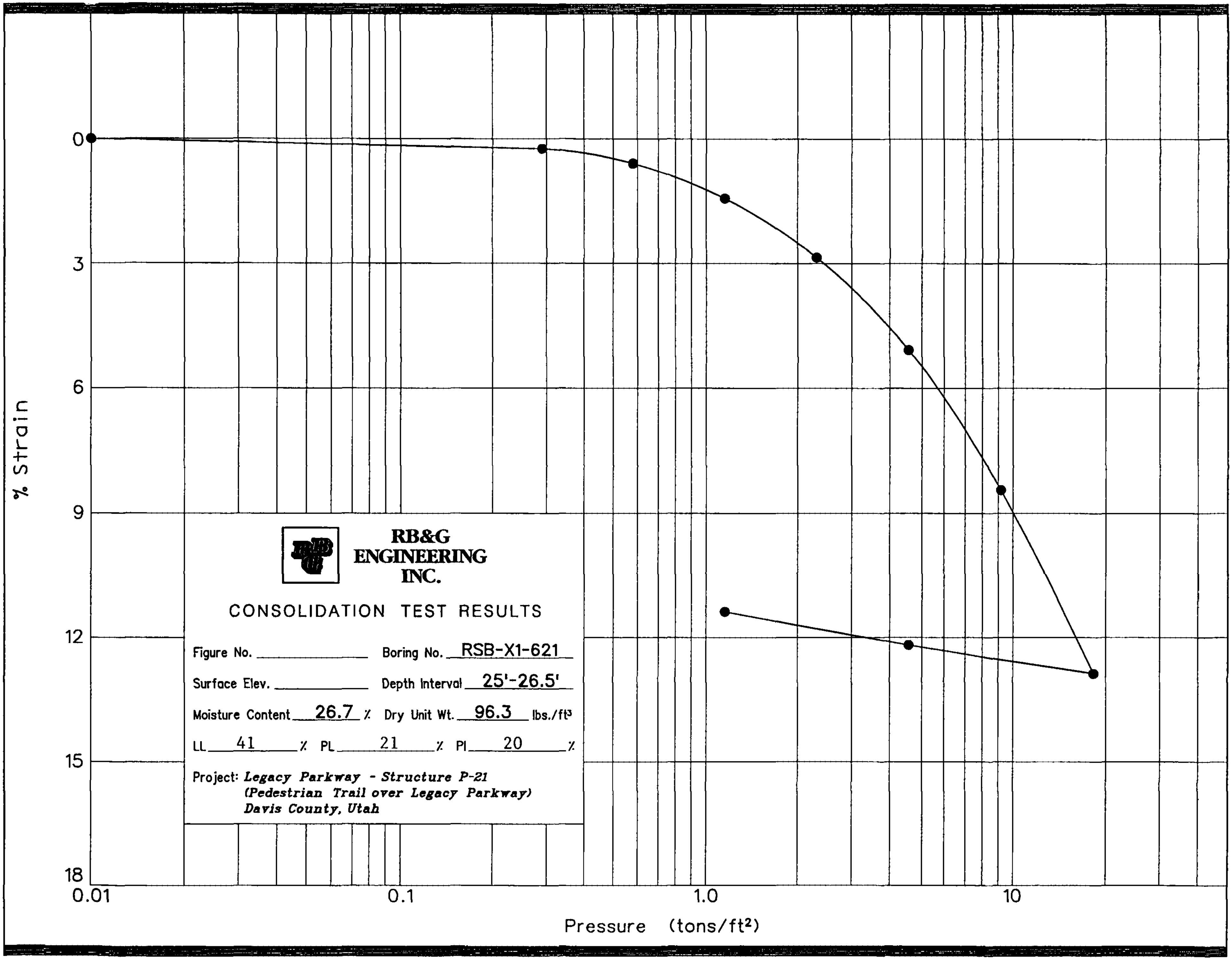
Figure No. ____________ Boring No. RSB-X1-621

Surface Elev. ____________ Depth Interval 25'-26.5'

Moisture Content 26.7 % Dry Unit Wt. 96.3 lbs./ft³

LL 41 % PL 21 % PI 20 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. RSB-X1-621

Surface Elev. ______ Depth Interval 25'-26.5'

Moisture Content 26.7 % Dry Unit Wt. 96.3 lbs./ft³

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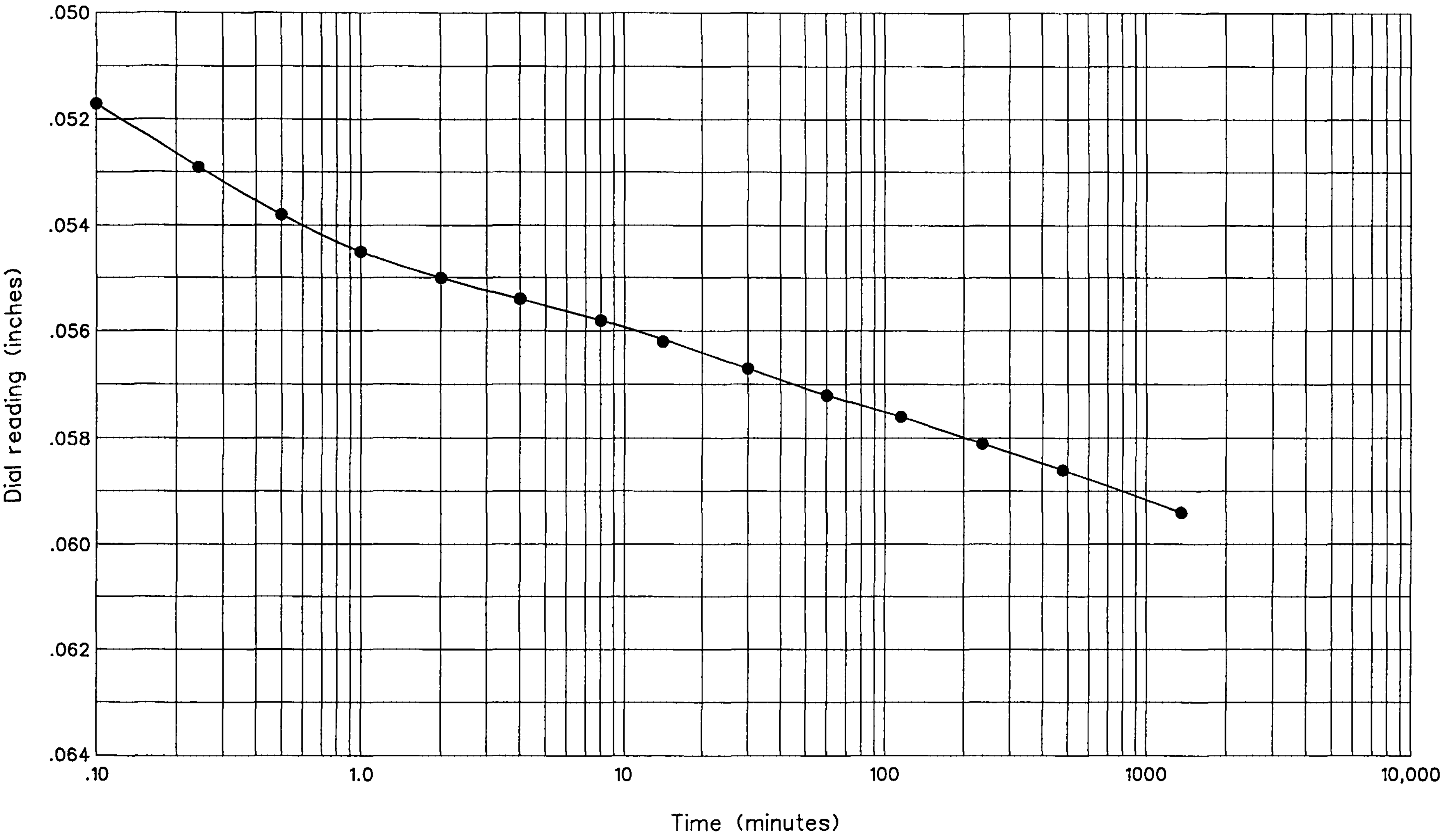
Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



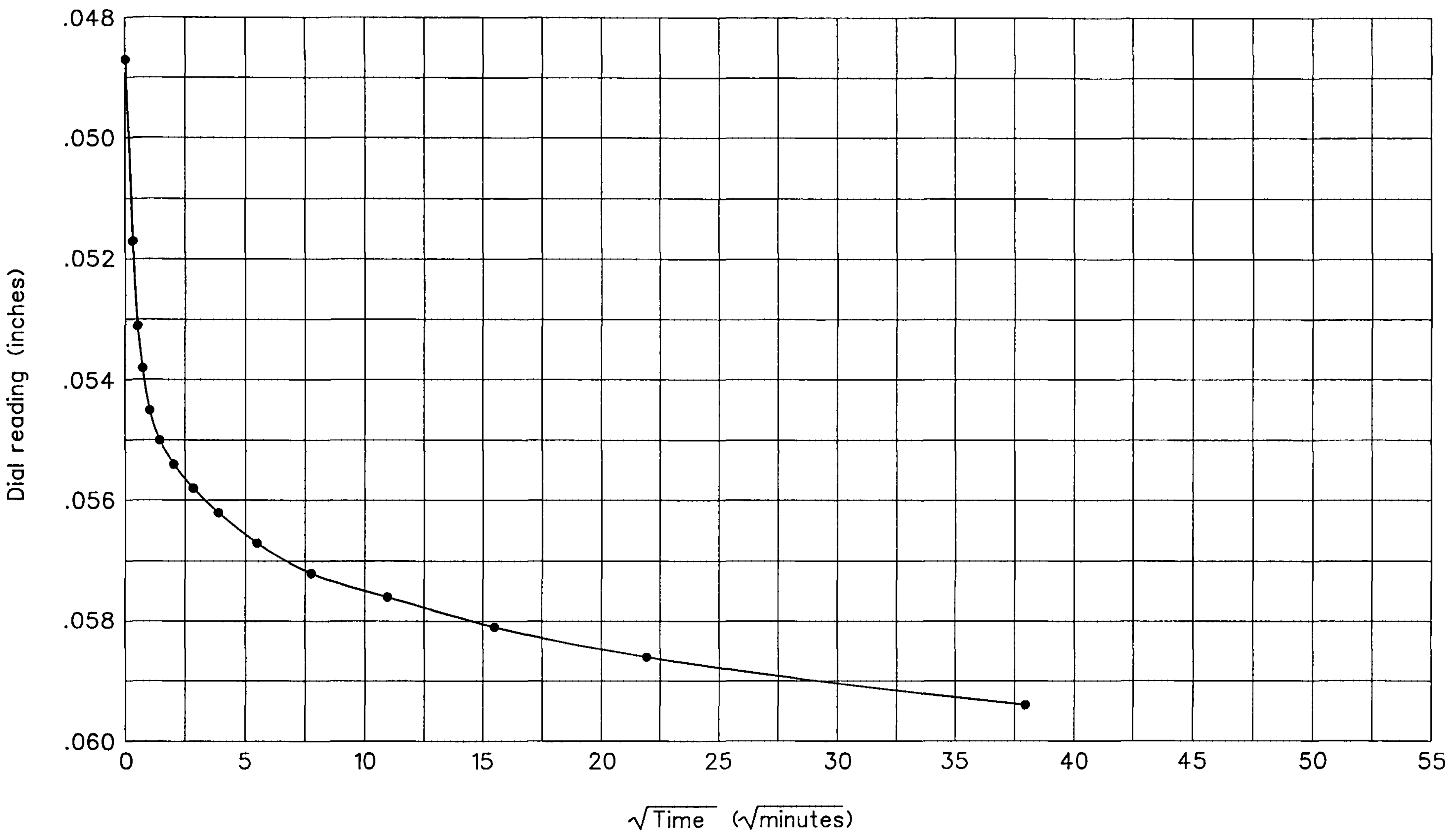
RB&G ENGINEERING INC.
Provo. Utah

Hole no.: RSB-X1-621
Depth: 25'-26.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



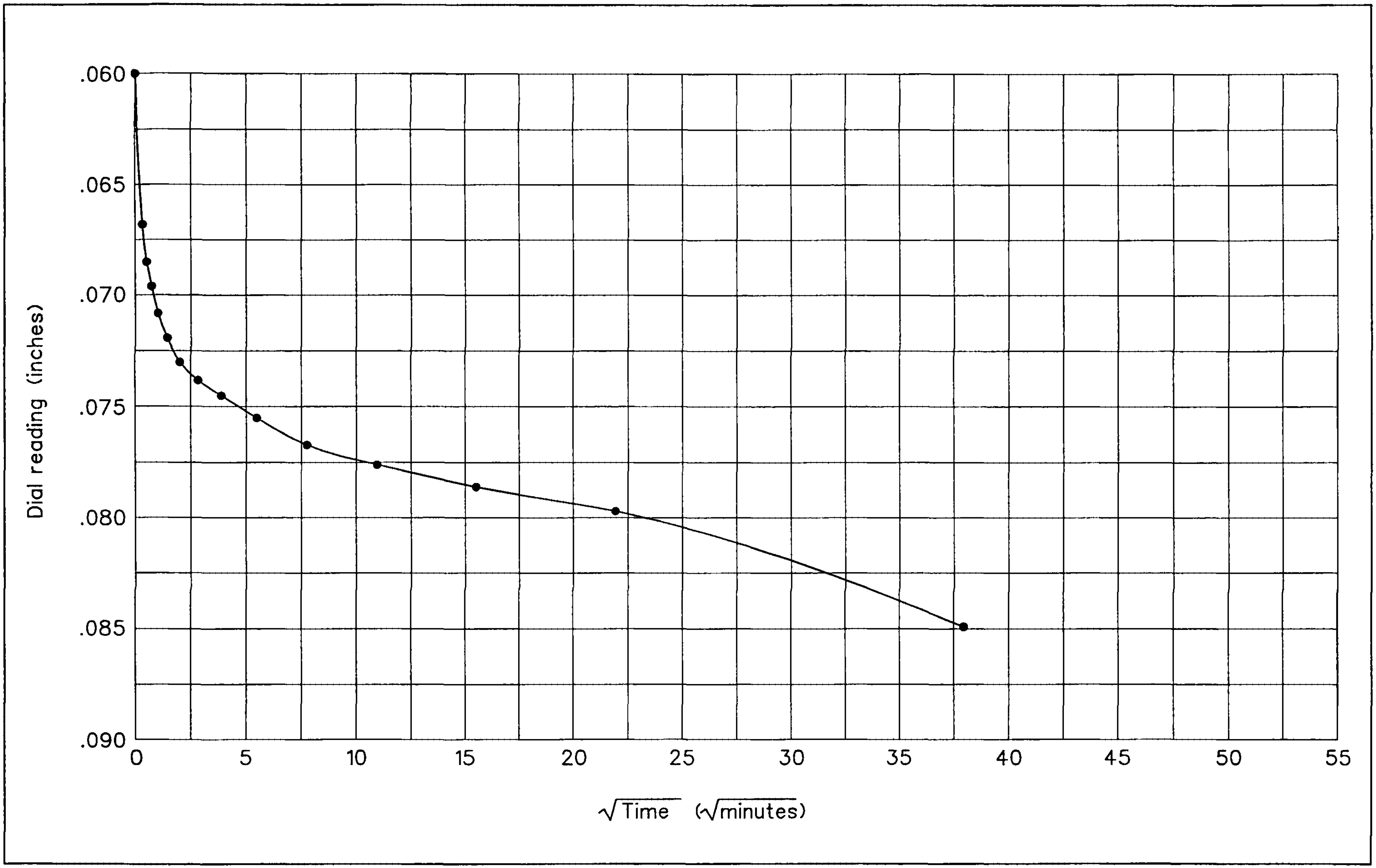
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 25'-26.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



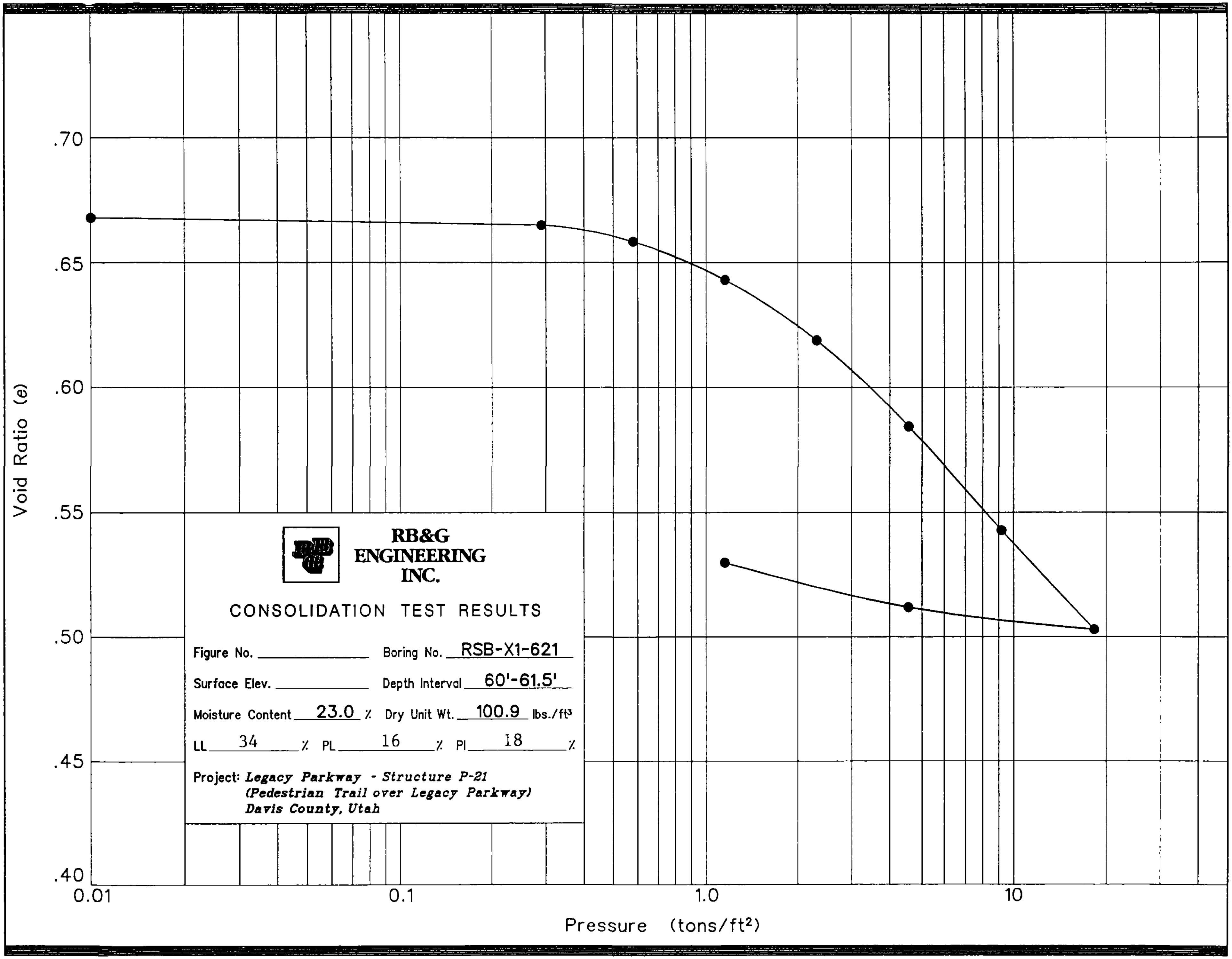
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 25'-26.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

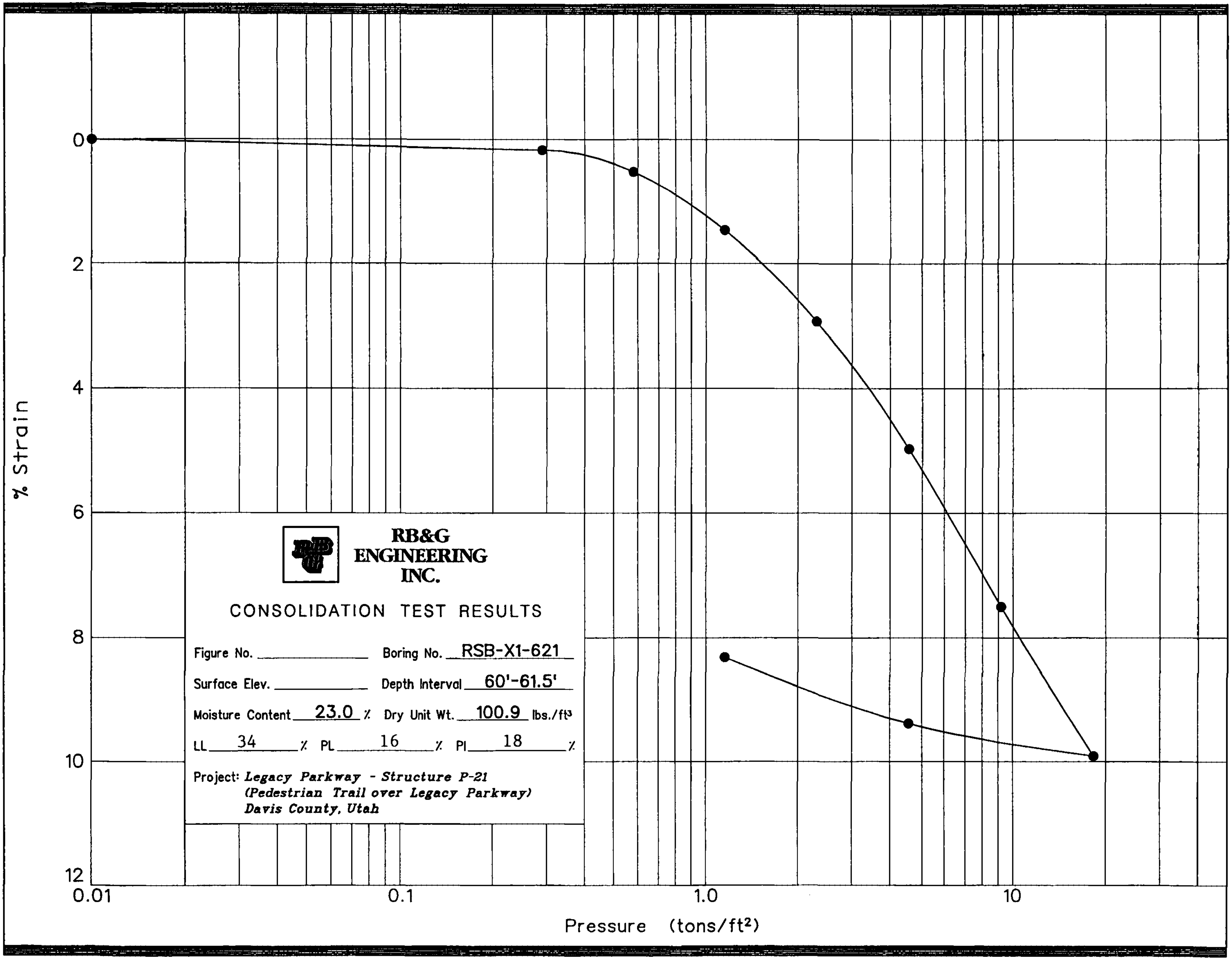
Figure No. ______ Boring No. RSB-X1-621

Surface Elev. ______ Depth Interval 60'-61.5'

Moisture Content 23.0 % Dry Unit Wt. 100.9 lbs./ft³

LL 34 % PL 16 % PI 18 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

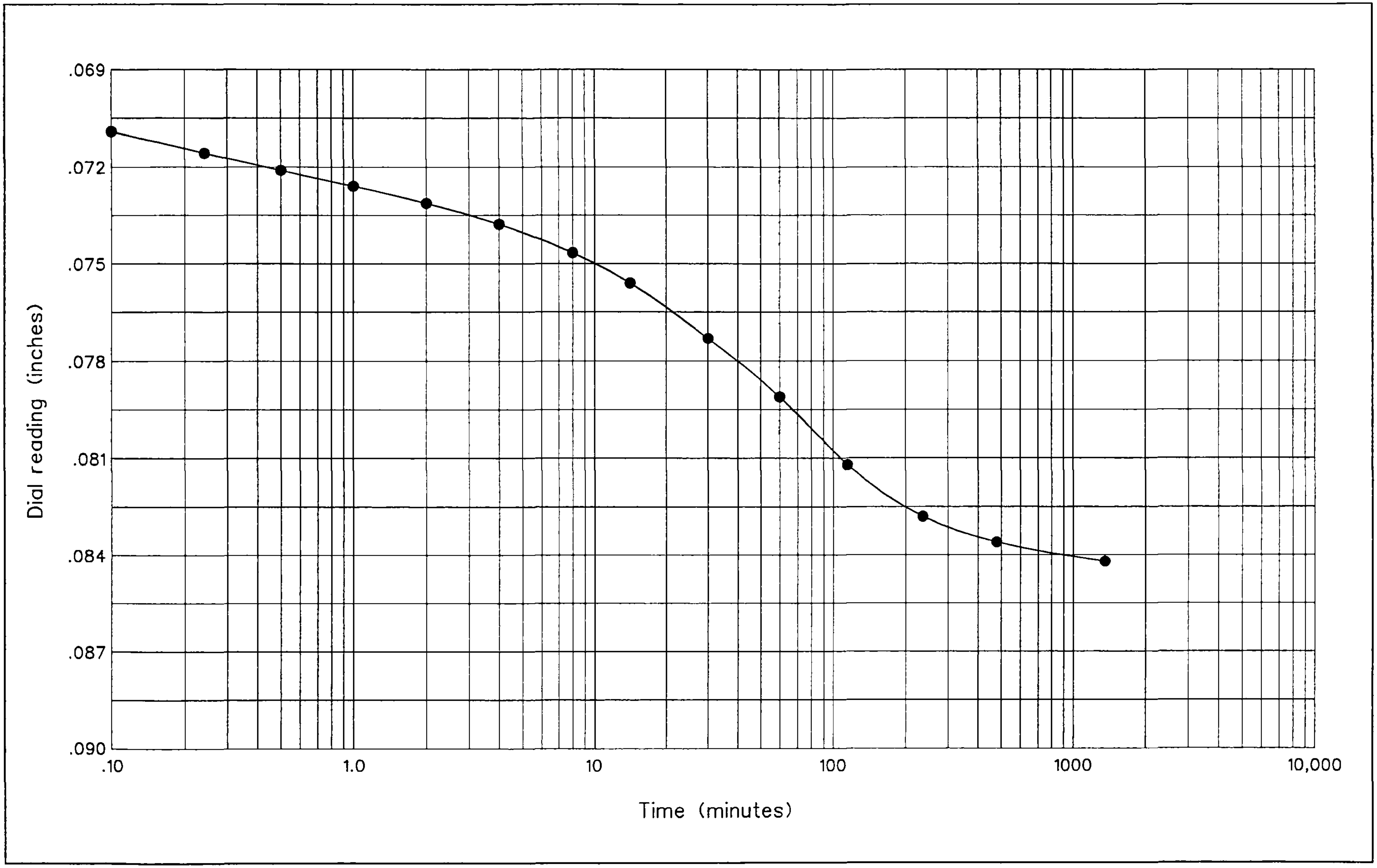
Figure No. ______ Boring No. RSB-X1-621

Surface Elev. ______ Depth Interval 60'-61.5'

Moisture Content 23.0 % Dry Unit Wt. 100.9 lbs./ft³

LL 34 % PL 16 % PI 18 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



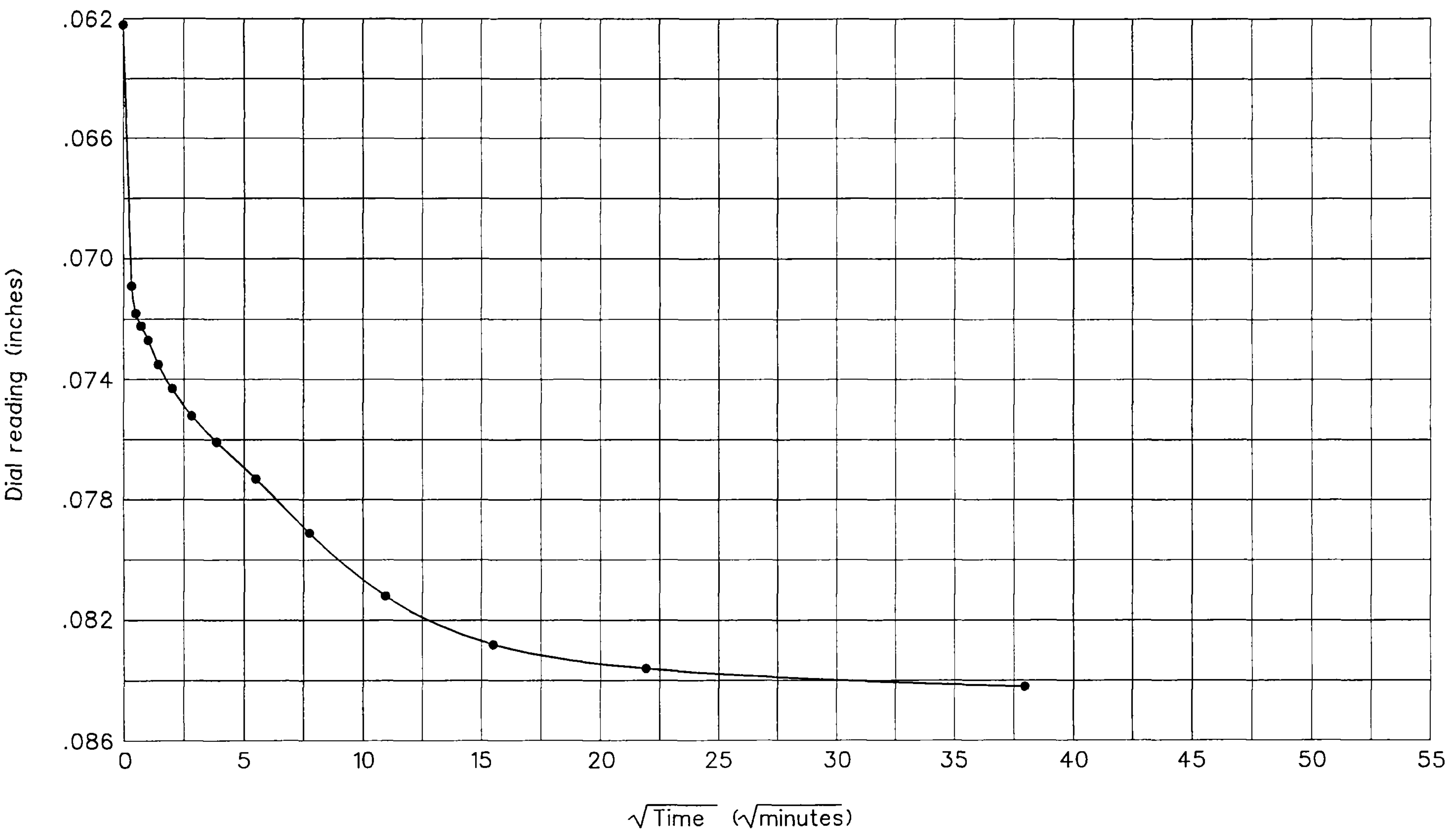
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 60'-61.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



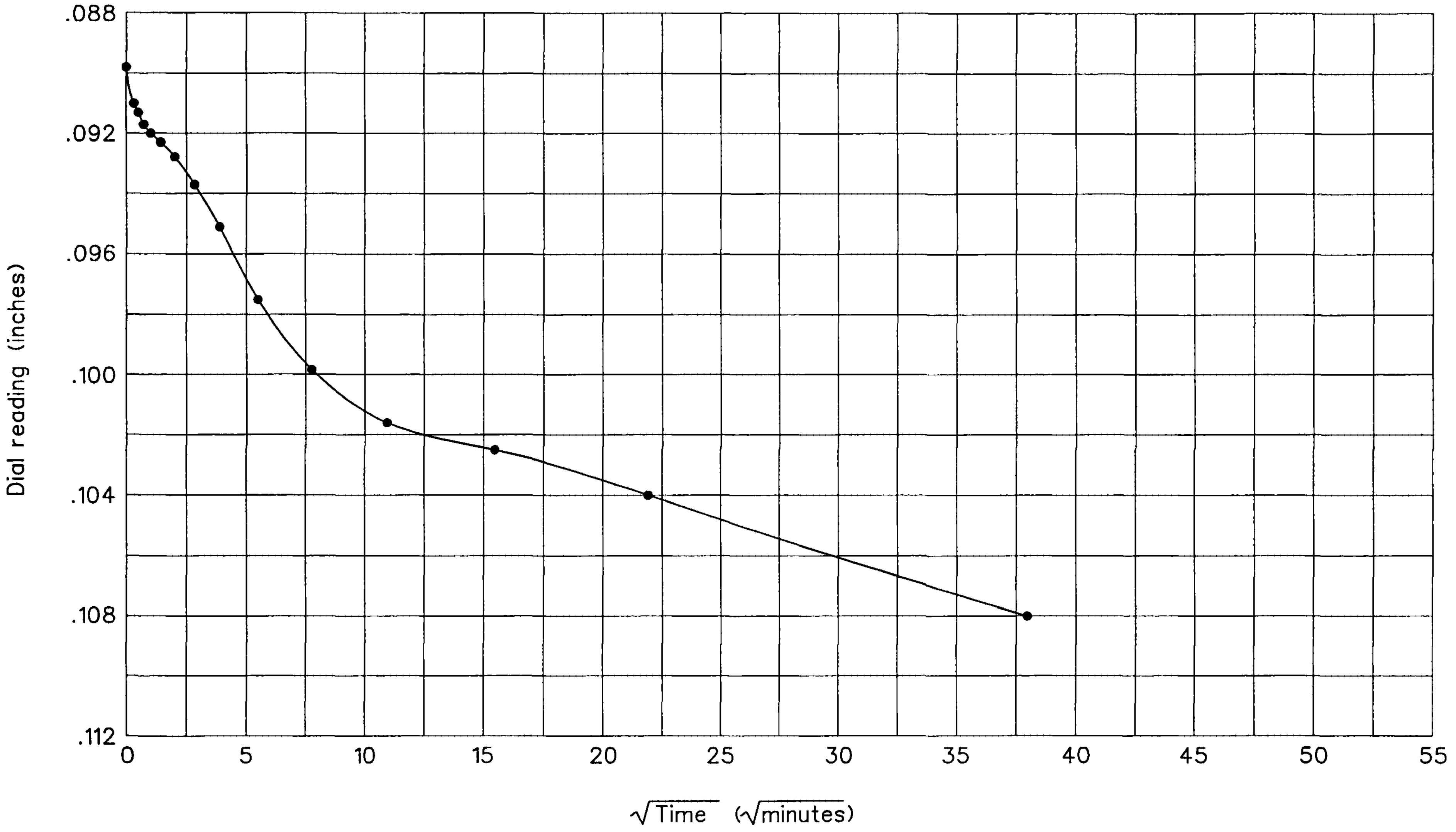
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 60'-61.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



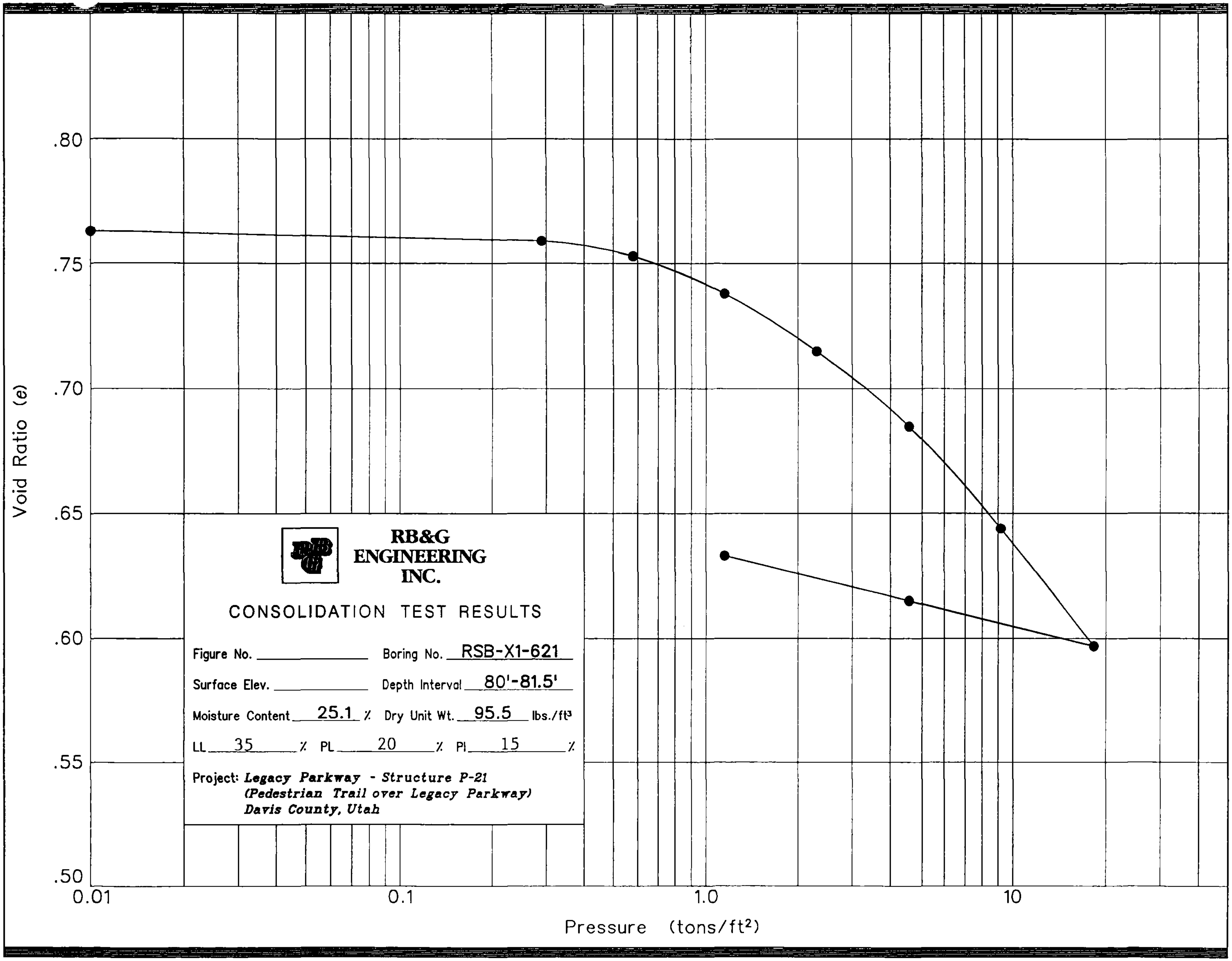
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 60'-61.5'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

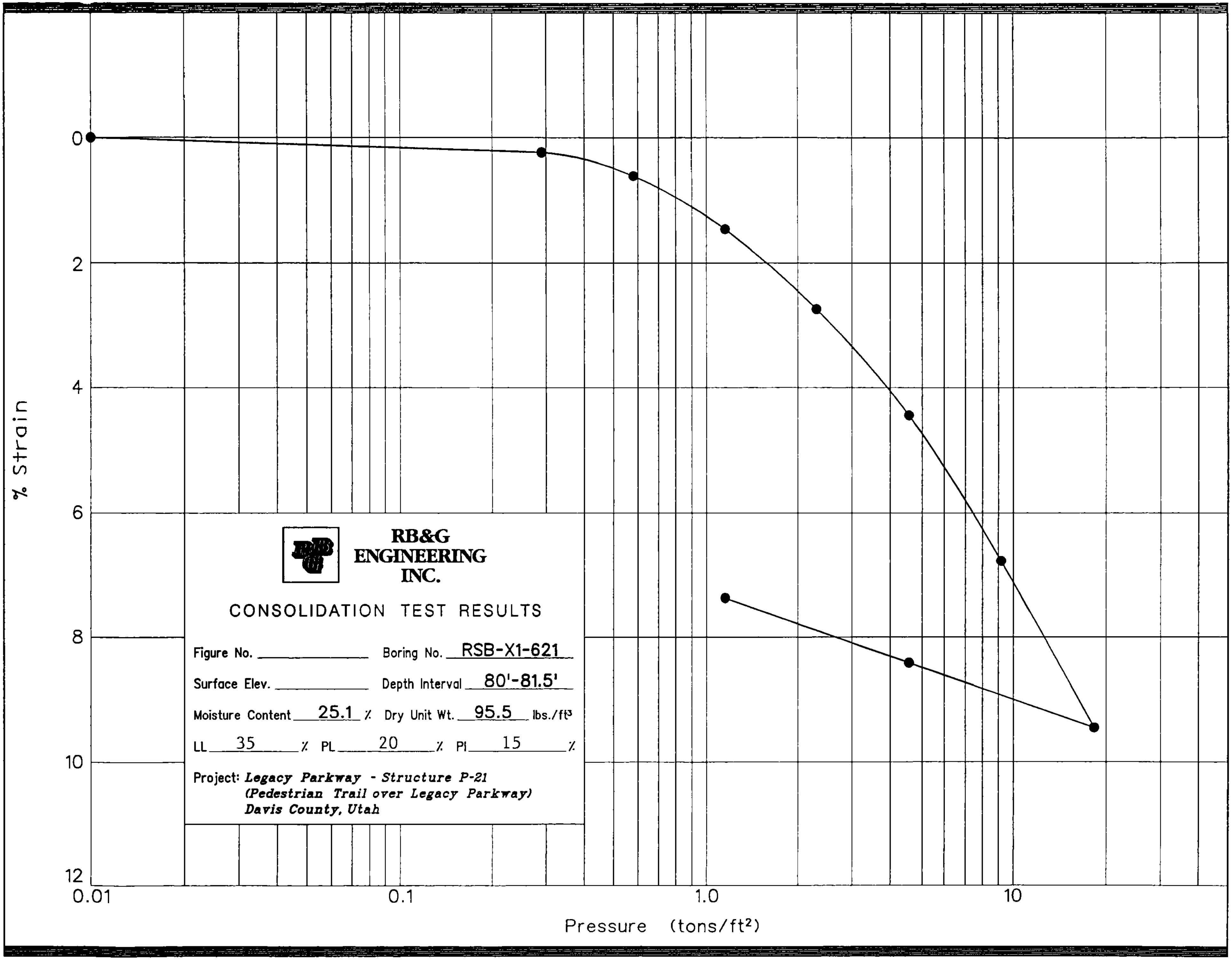
Figure No. ______ Boring No. RSB-X1-621

Surface Elev. ______ Depth Interval 80'-81.5'

Moisture Content 25.1 % Dry Unit Wt. 95.5 lbs./ft³

LL 35 % PL 20 % PI 15 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

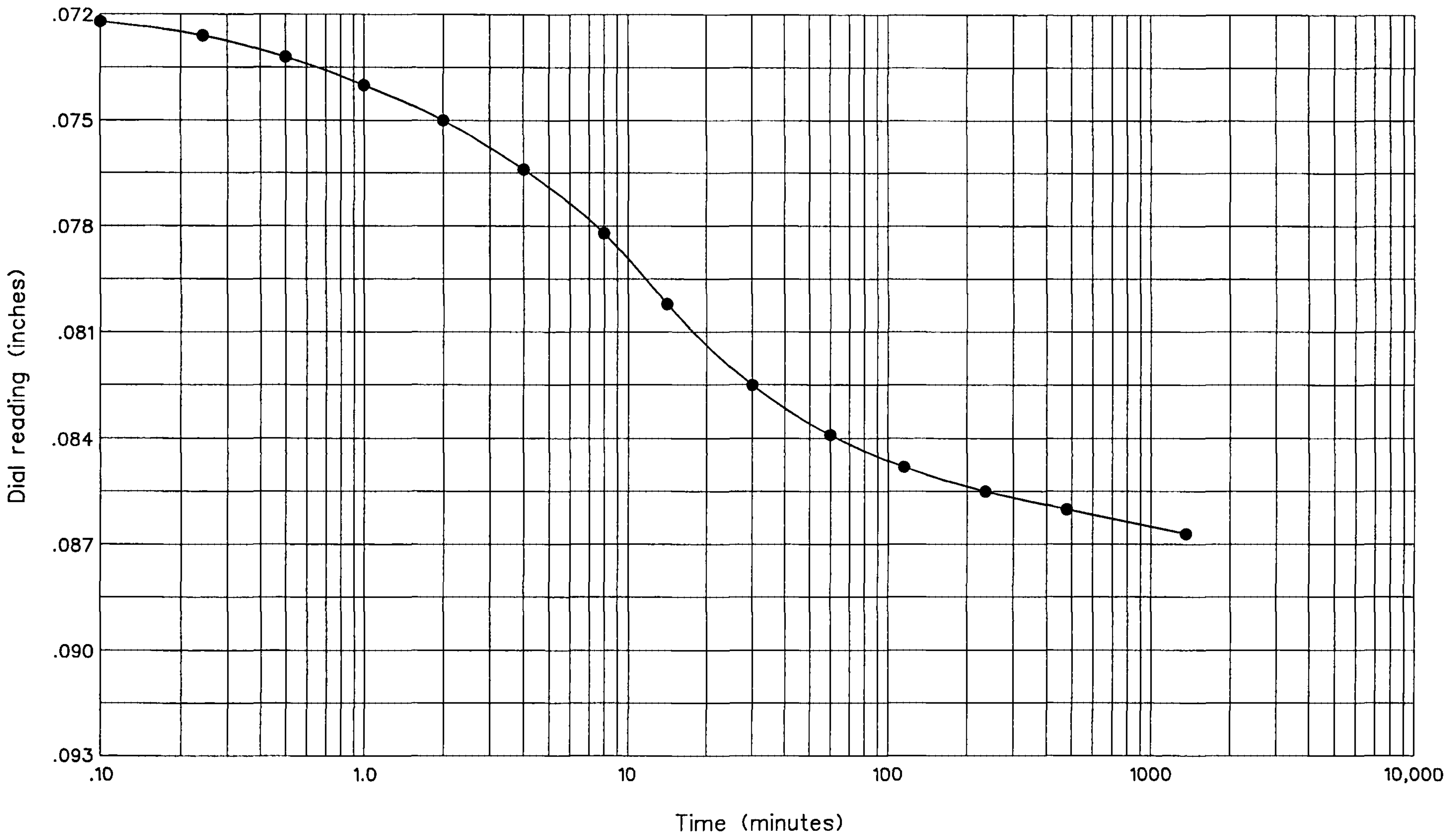
Figure No. ____________ Boring No. RSB-X1-621

Surface Elev. ____________ Depth Interval 80'-81.5'

Moisture Content 25.1 % Dry Unit Wt. 95.5 lbs./ft³

LL 35 % PL 20 % PI 15 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



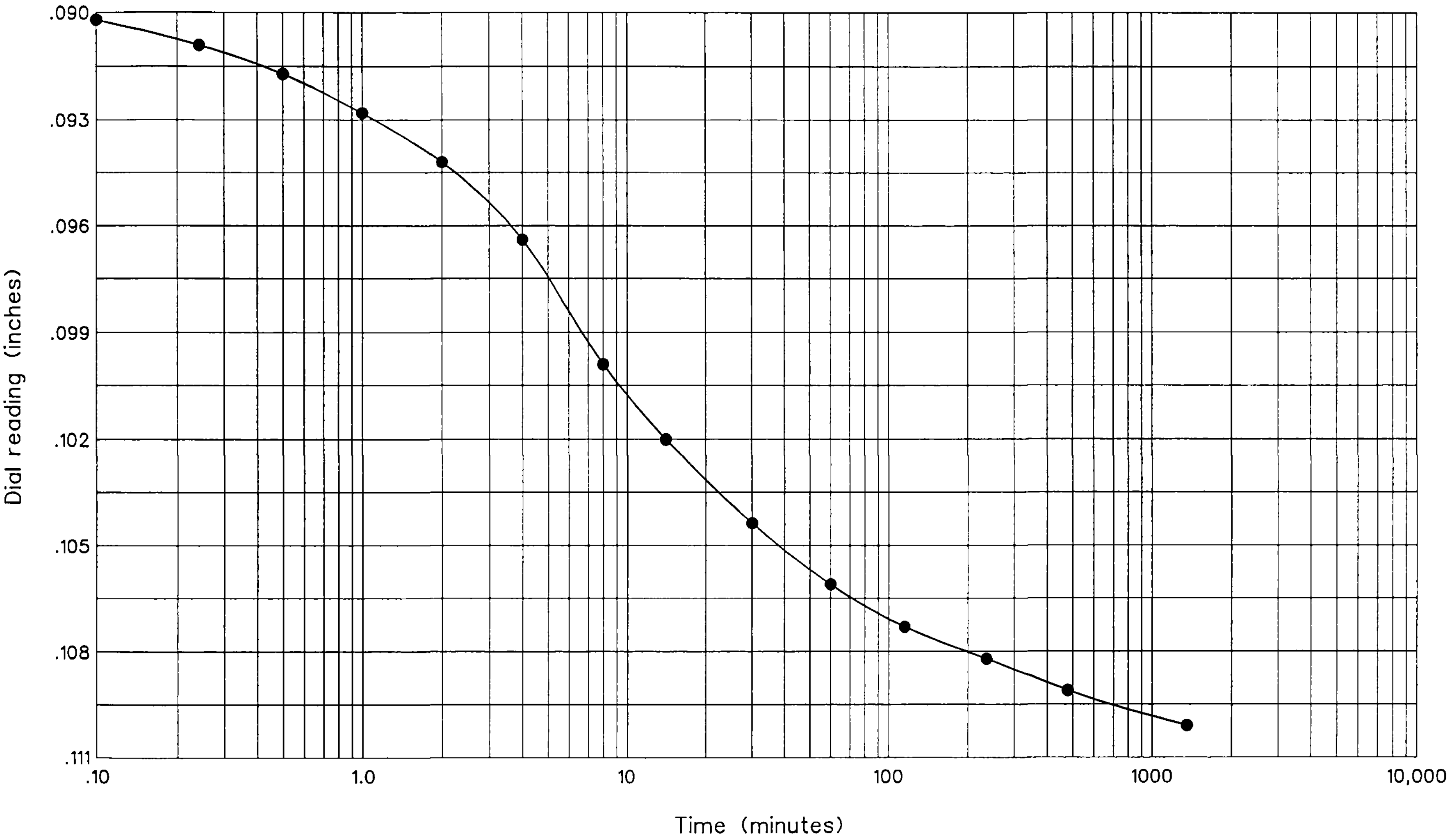
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 80'-81.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



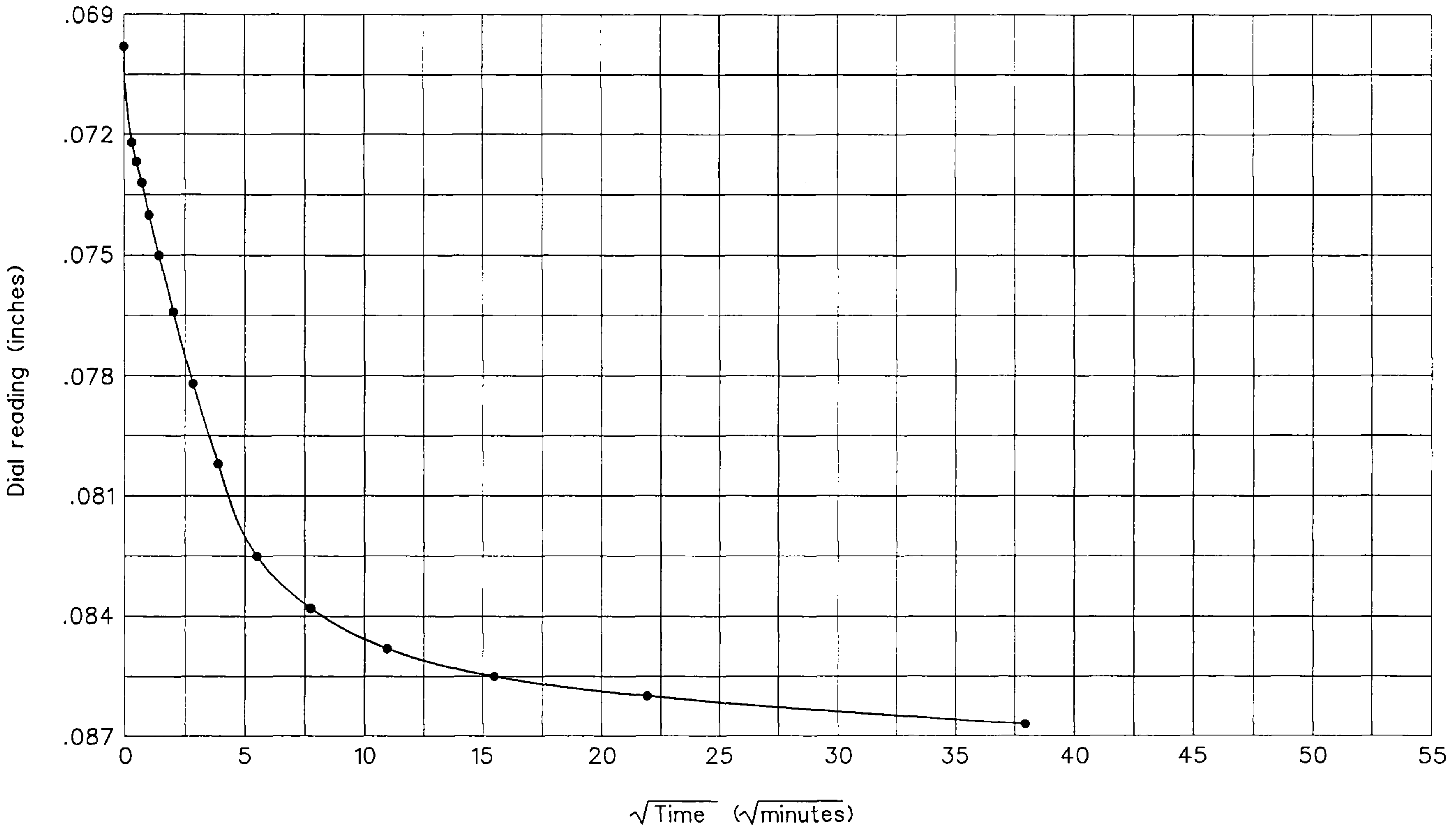
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 80'-81.5'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



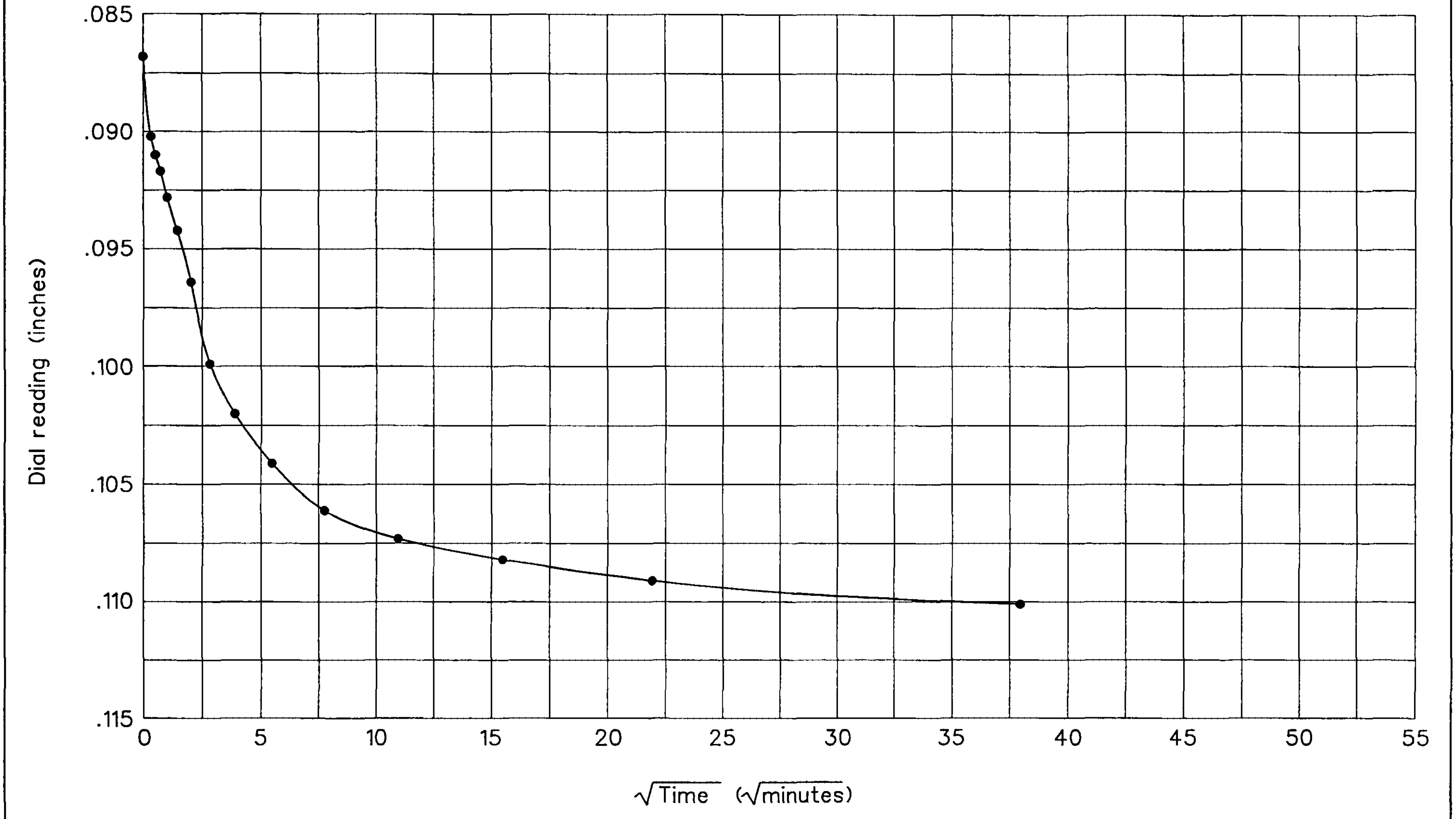
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-621
Depth: 80'-81.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



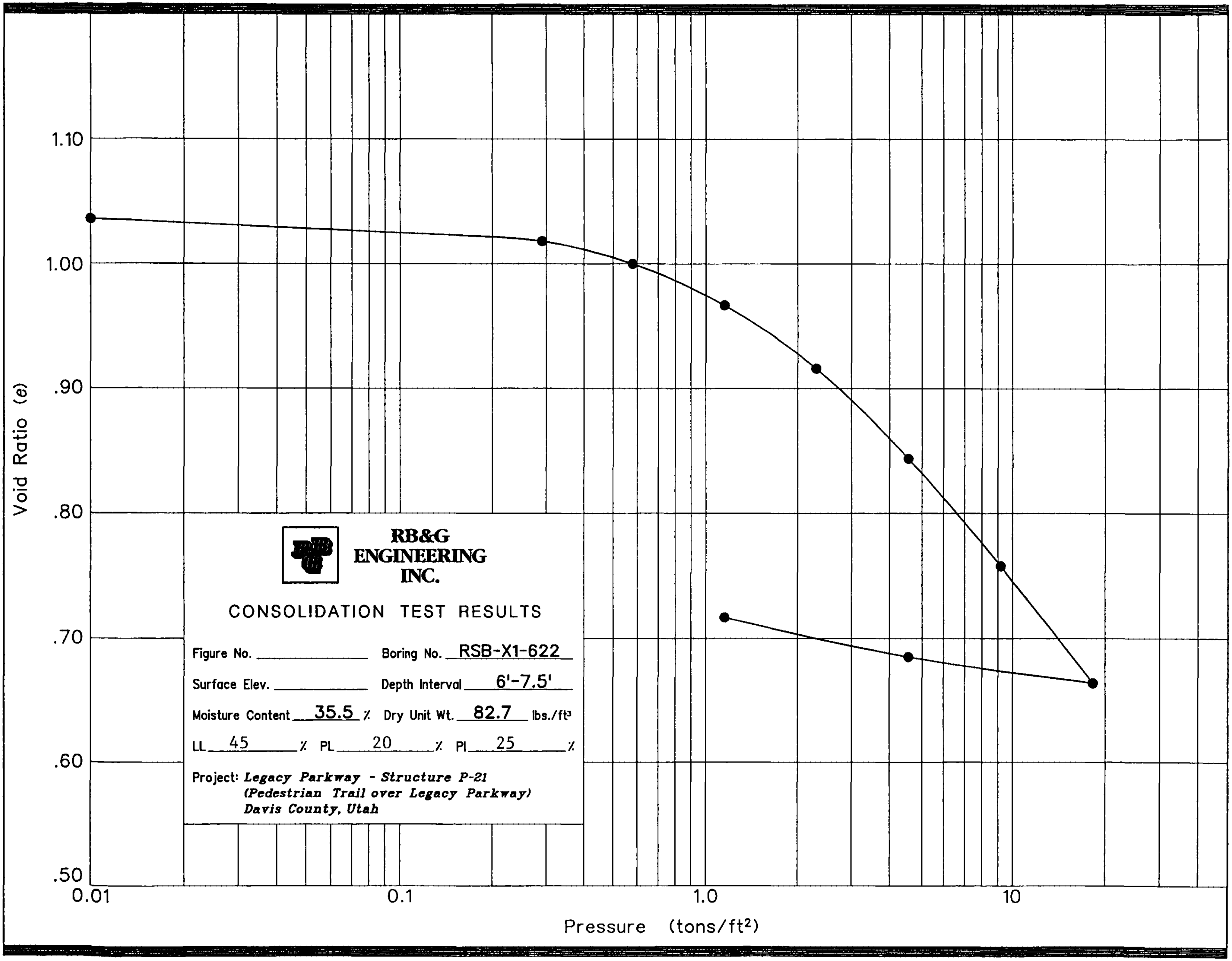
RB&G ENGINEERING INC.
Provo, Utah

Hole no.:	RSB-X1-621
Depth:	80'-81.5'
Load:	9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

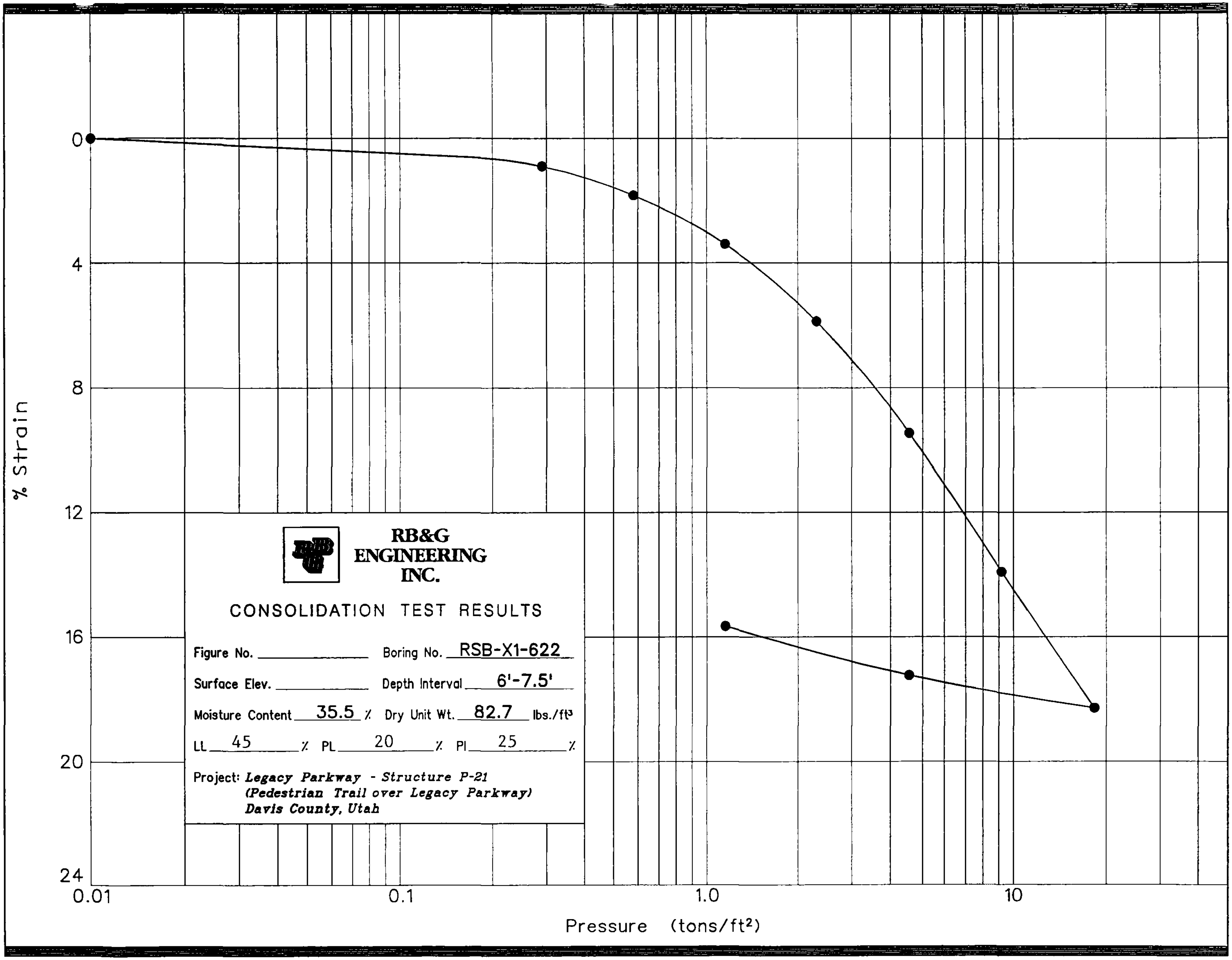
Figure No. ______ Boring No. RSB-X1-622

Surface Elev. ______ Depth Interval 6'-7.5'

Moisture Content 35.5 % Dry Unit Wt. 82.7 lbs./ft^3

LL 45 % PL 20 % PI 25 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

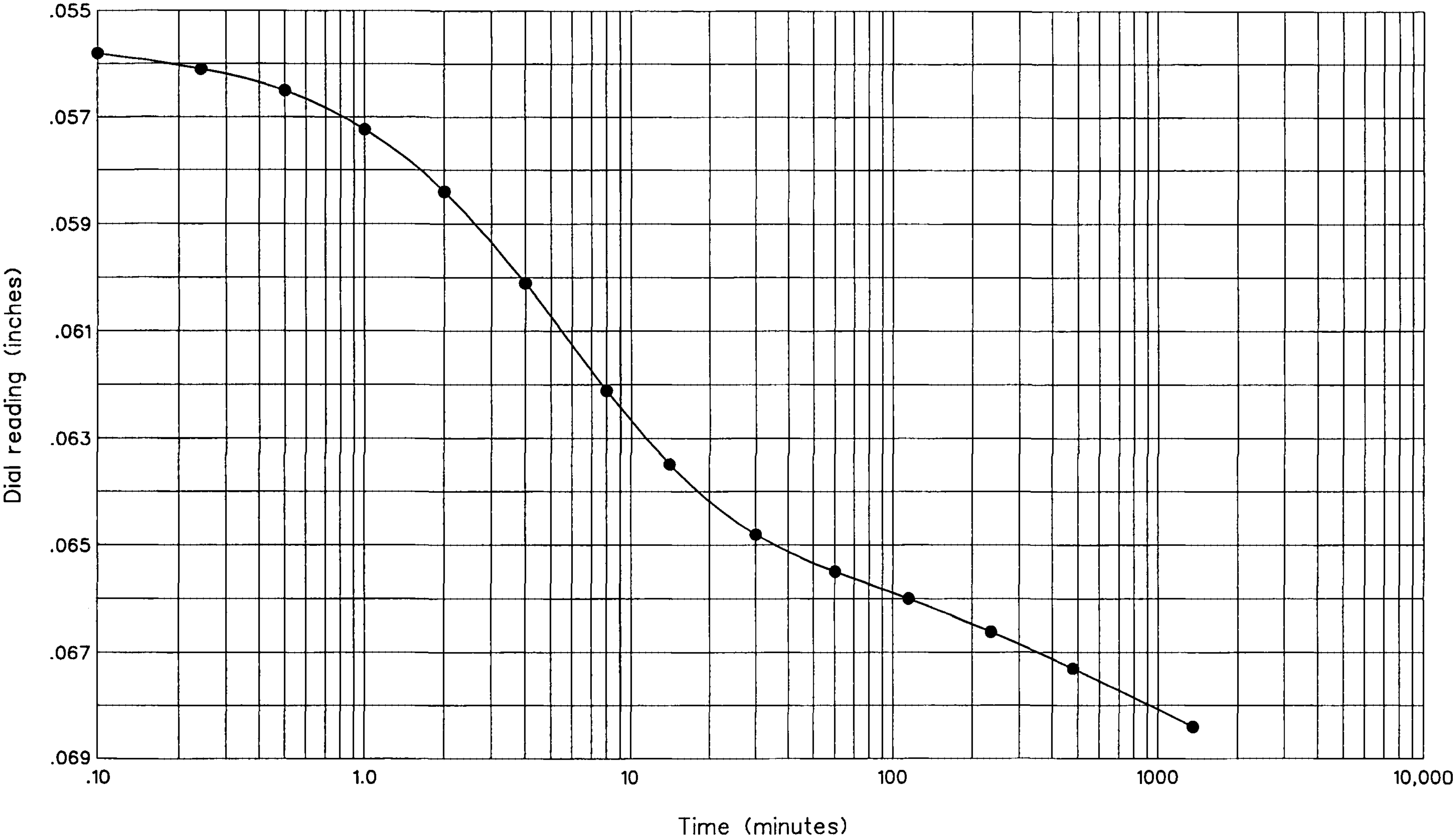
Figure No. ______________ Boring No. RSB-X1-622

Surface Elev. ______________ Depth Interval 6'-7.5'

Moisture Content 35.5 % Dry Unit Wt. 82.7 lbs./ft³

LL 45 % PL 20 % PI 25 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



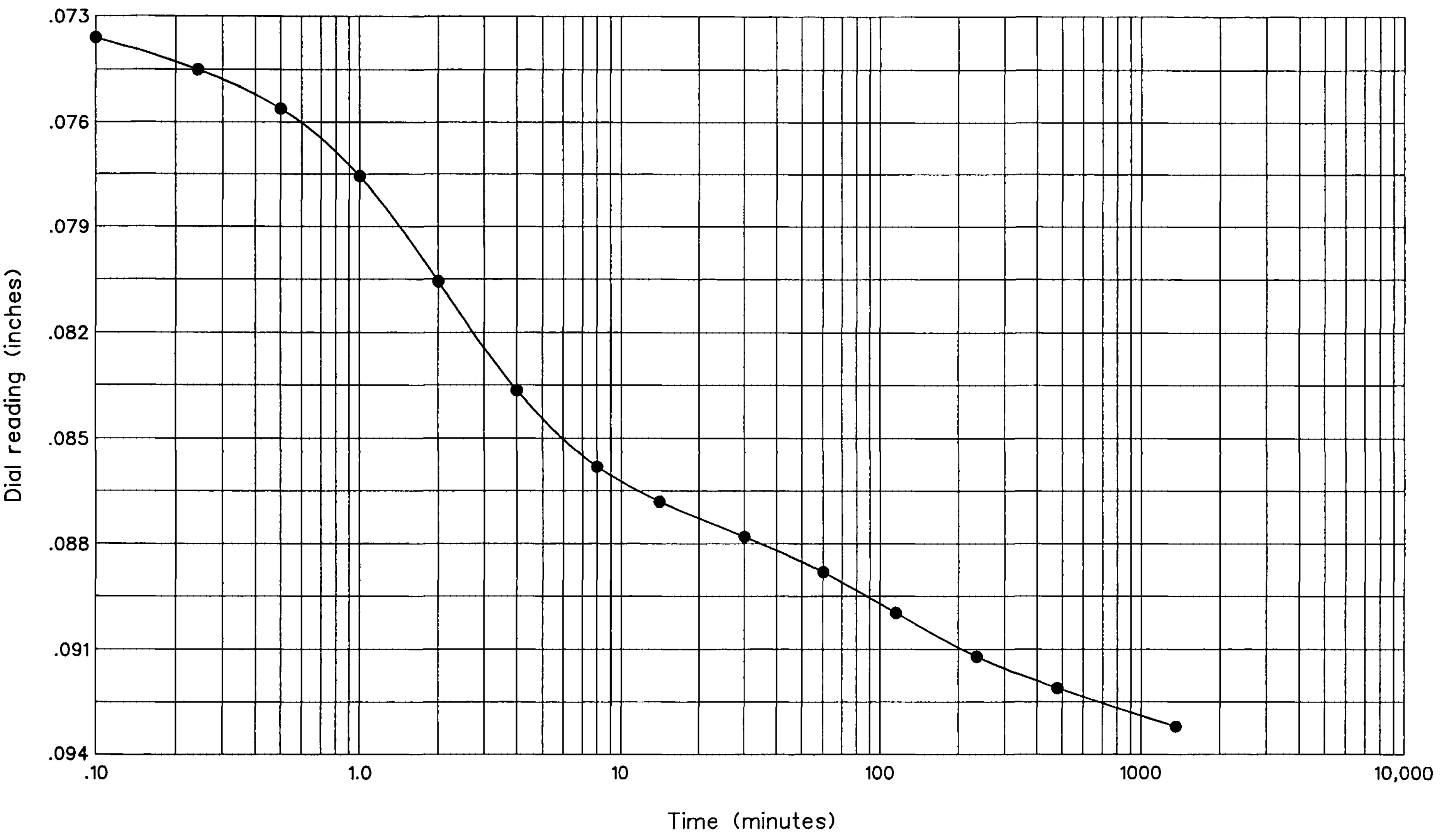
RB&G ENGINEERING INC.
Provo. Utah

Hole no.: RSB-X1-622
Depth: 6'-7.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



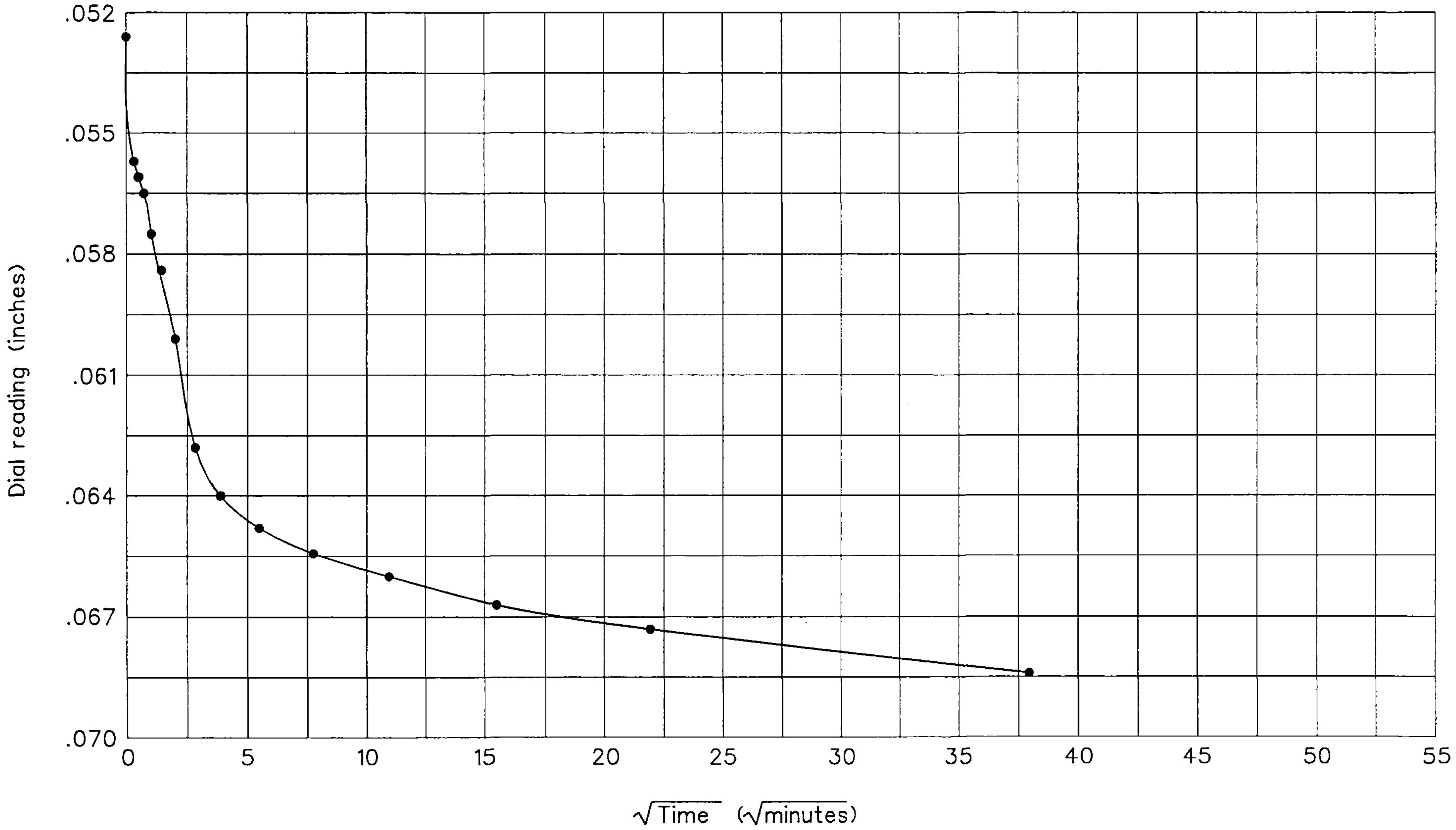
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 6'-7.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



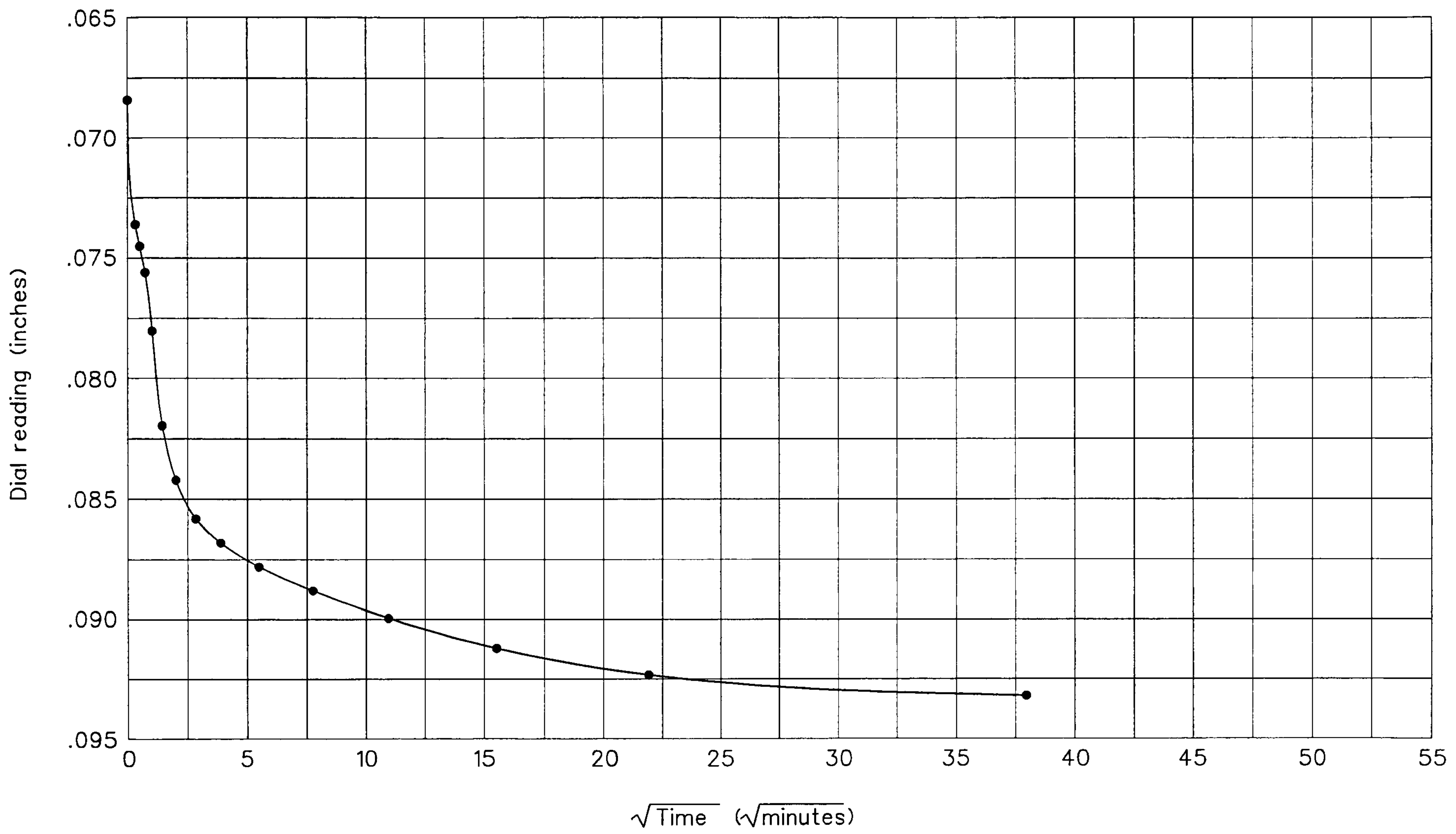
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 6'-7.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



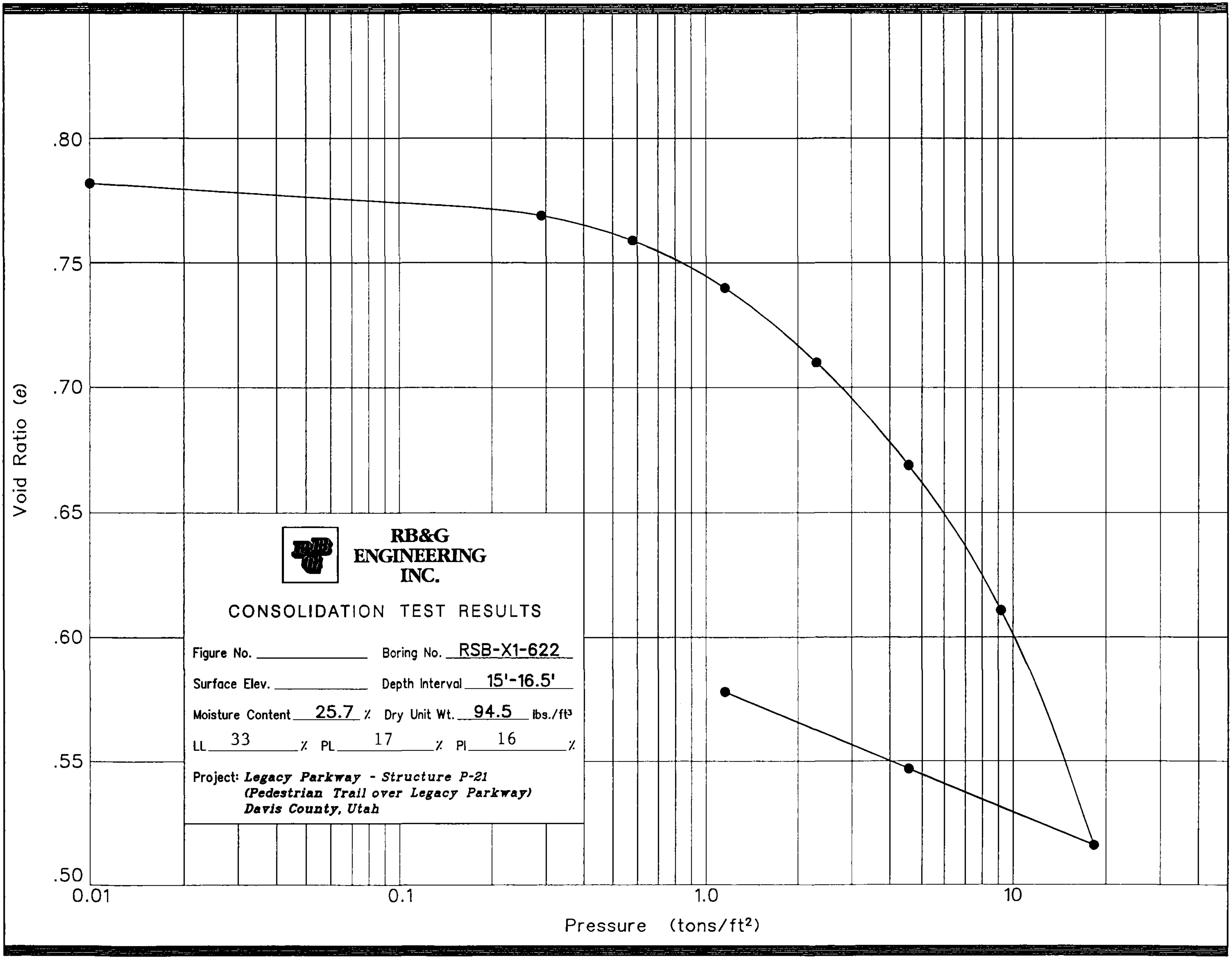
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 6'-7.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

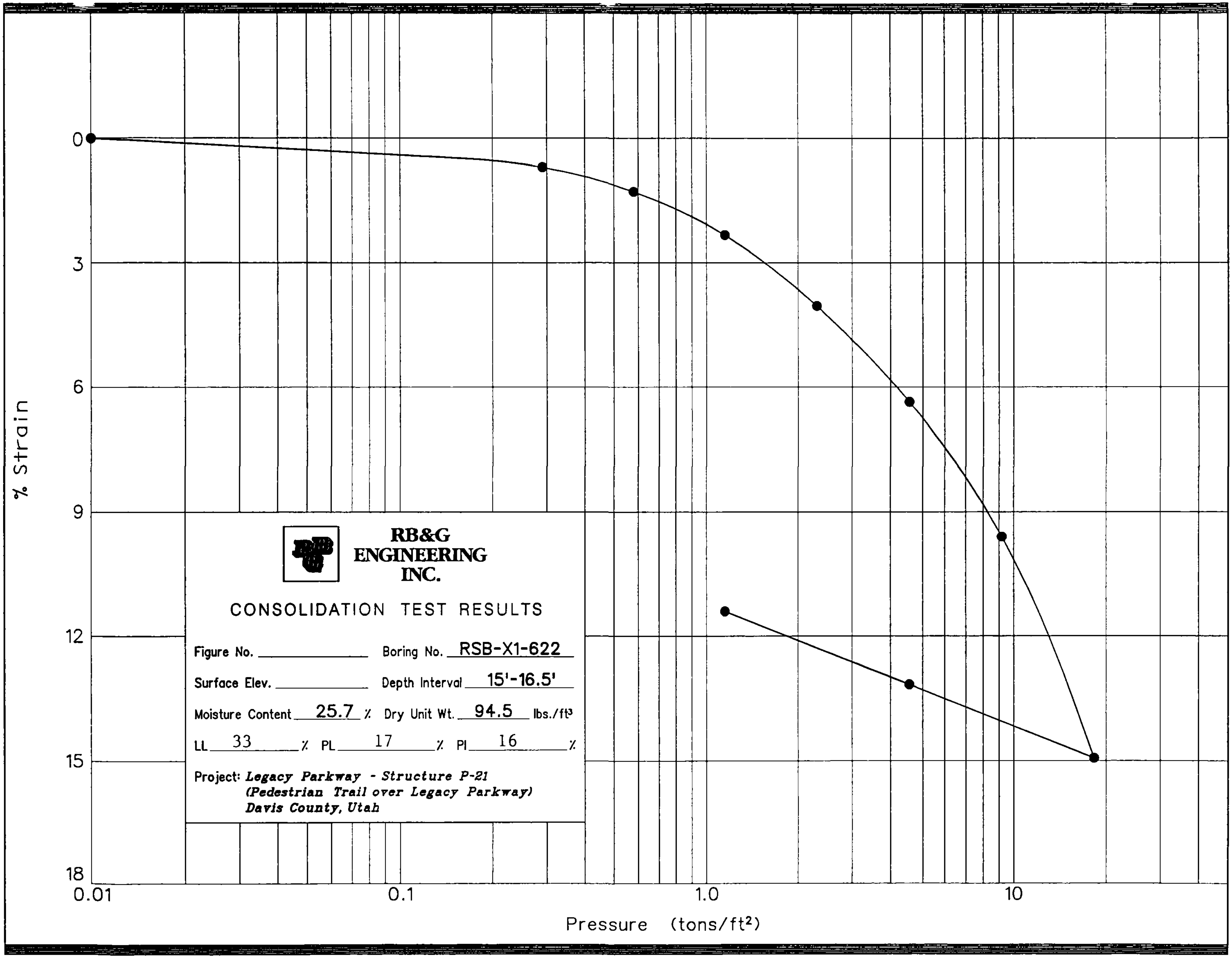
Figure No. ____________ Boring No. RSB-X1-622

Surface Elev. ____________ Depth Interval 15'-16.5'

Moisture Content 25.7 % Dry Unit Wt. 94.5 lbs./ft³

LL 33 % PL 17 % PI 16 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

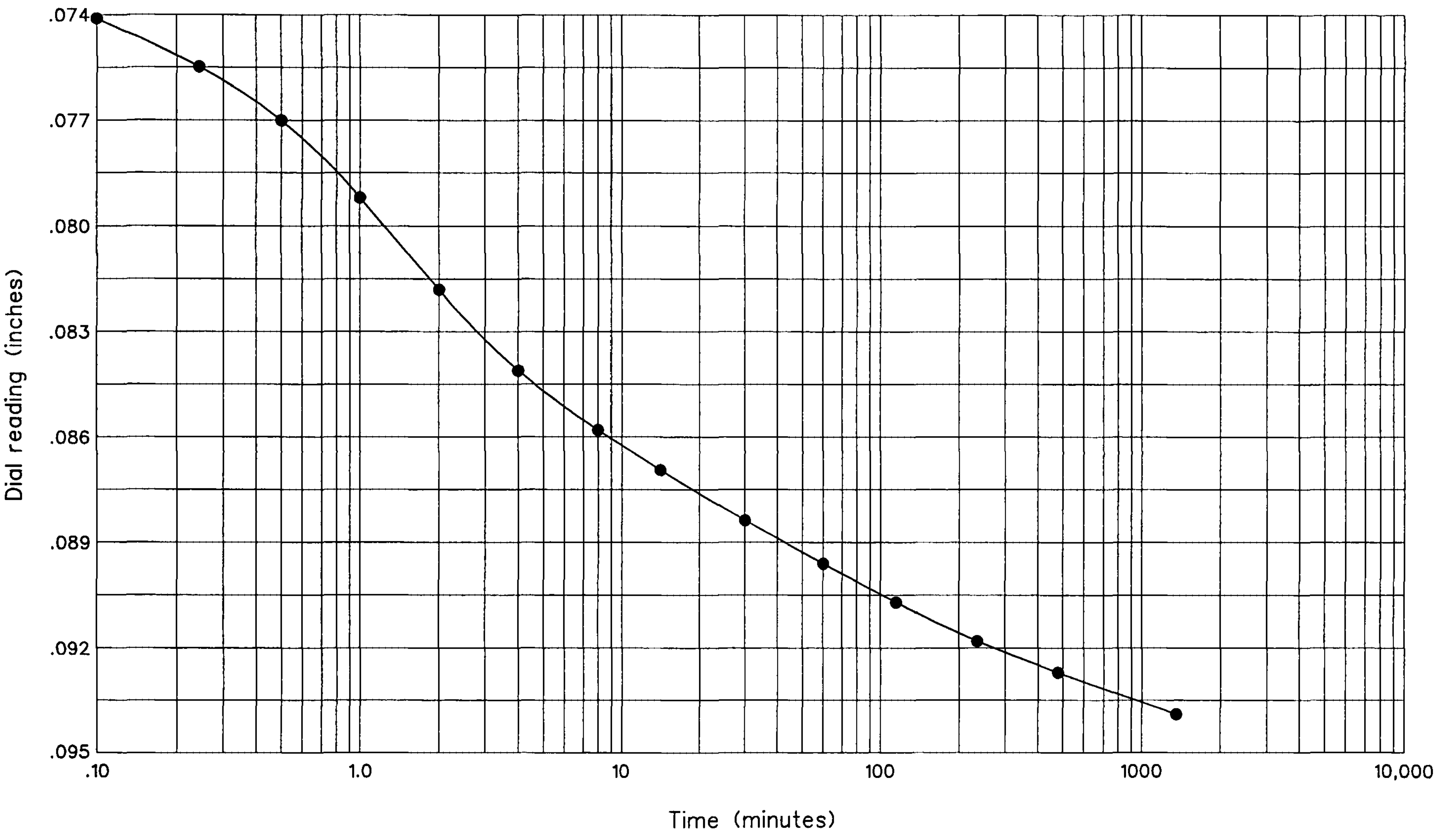
Figure No. ______ Boring No. RSB-X1-622

Surface Elev. ______ Depth Interval 15'-16.5'

Moisture Content 25.7 % Dry Unit Wt. 94.5 lbs./ft³

LL 33 % PL 17 % PI 16 %

Project: ***Legacy Parkway - Structure P-21***
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



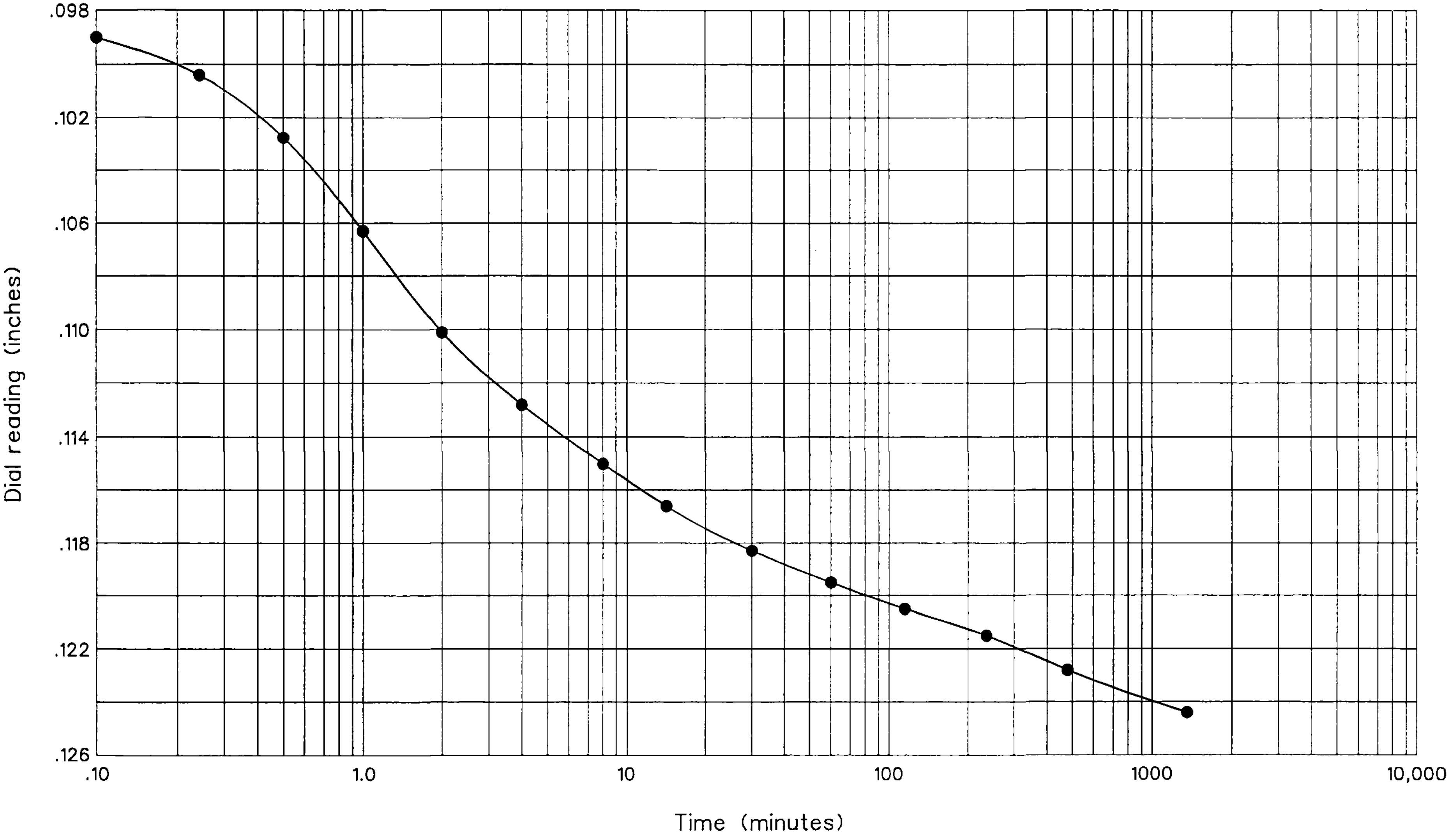
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 15'-16.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



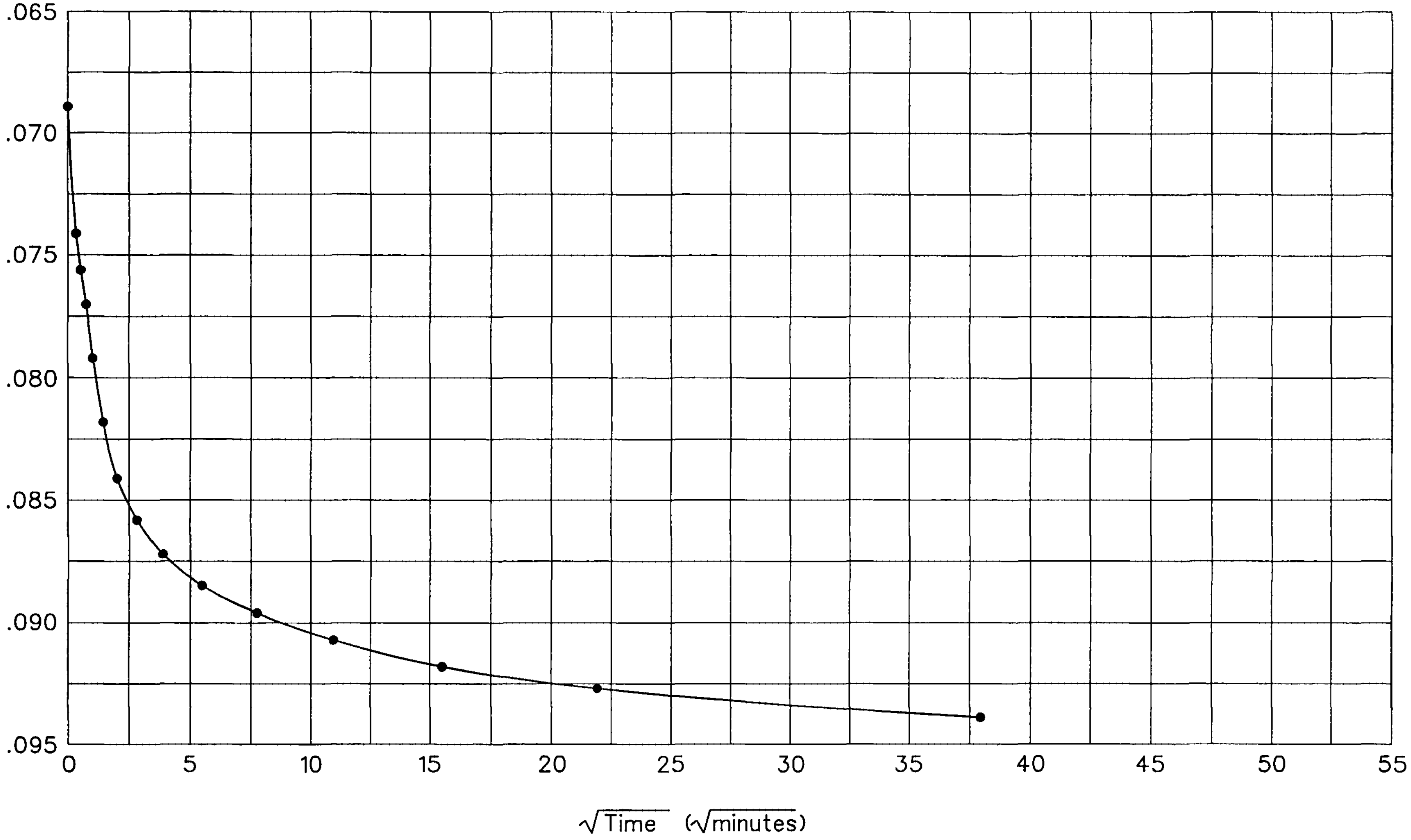
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 15'-16.5'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



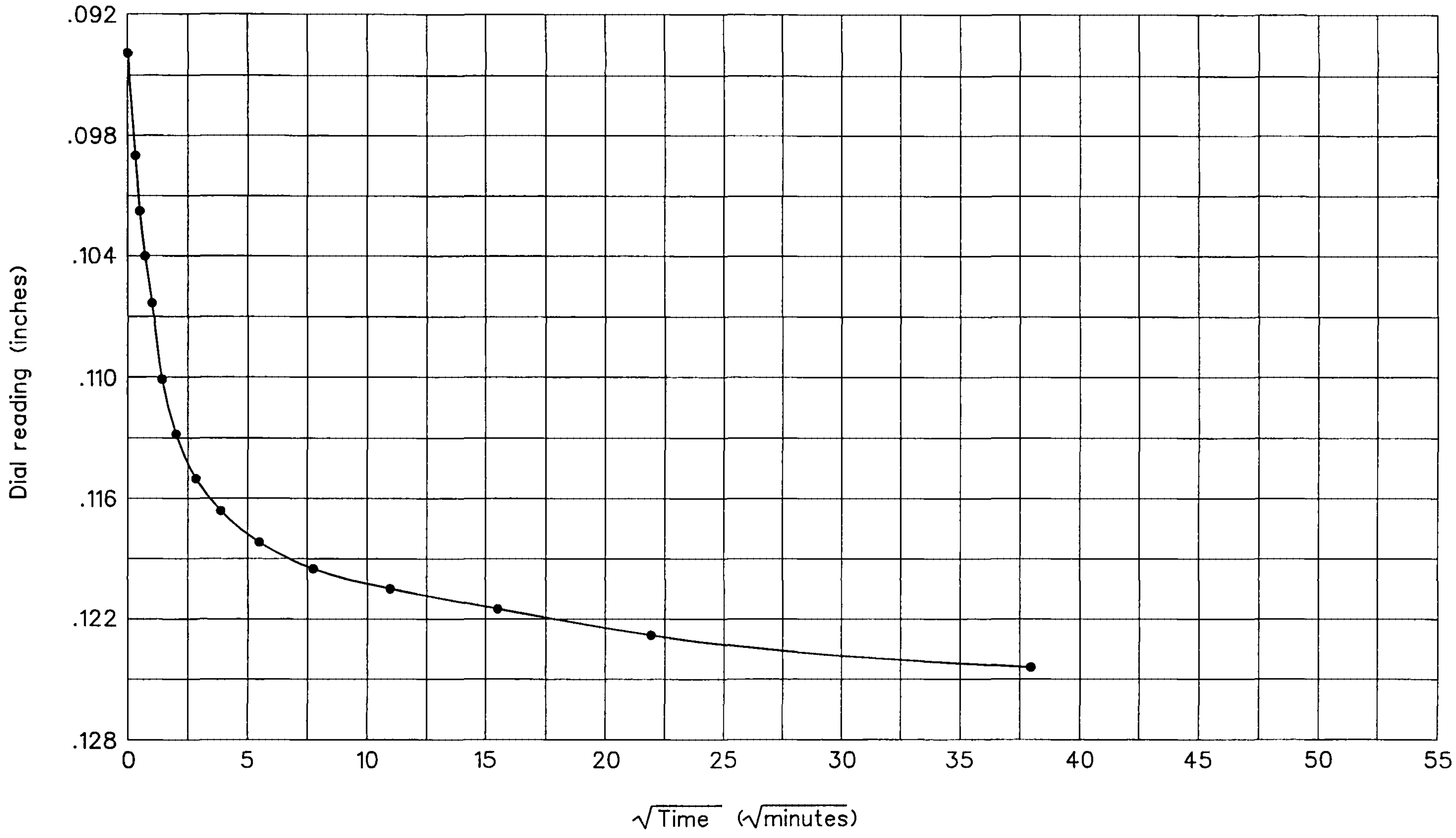
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 15'-16.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



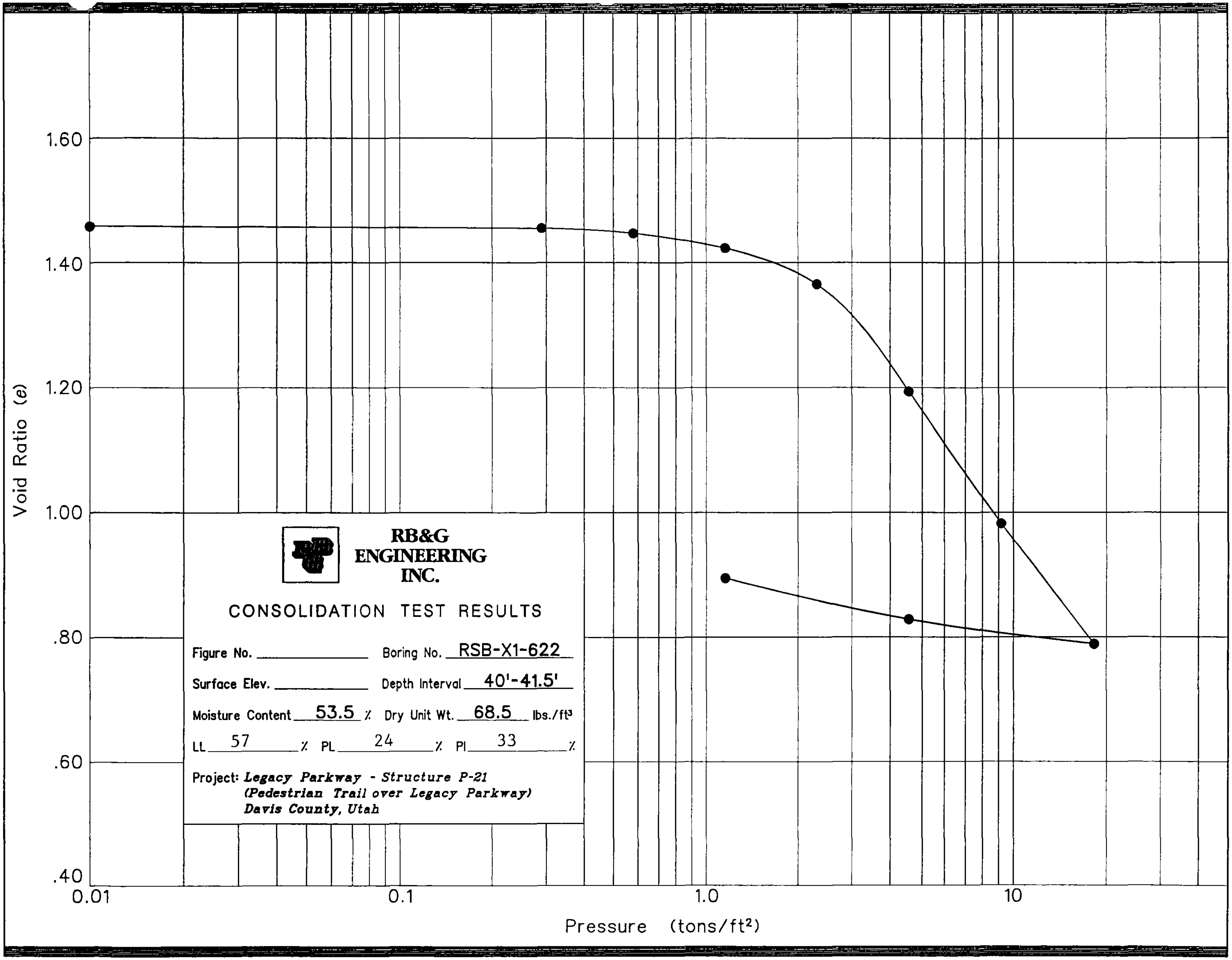
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 15'-16.5'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

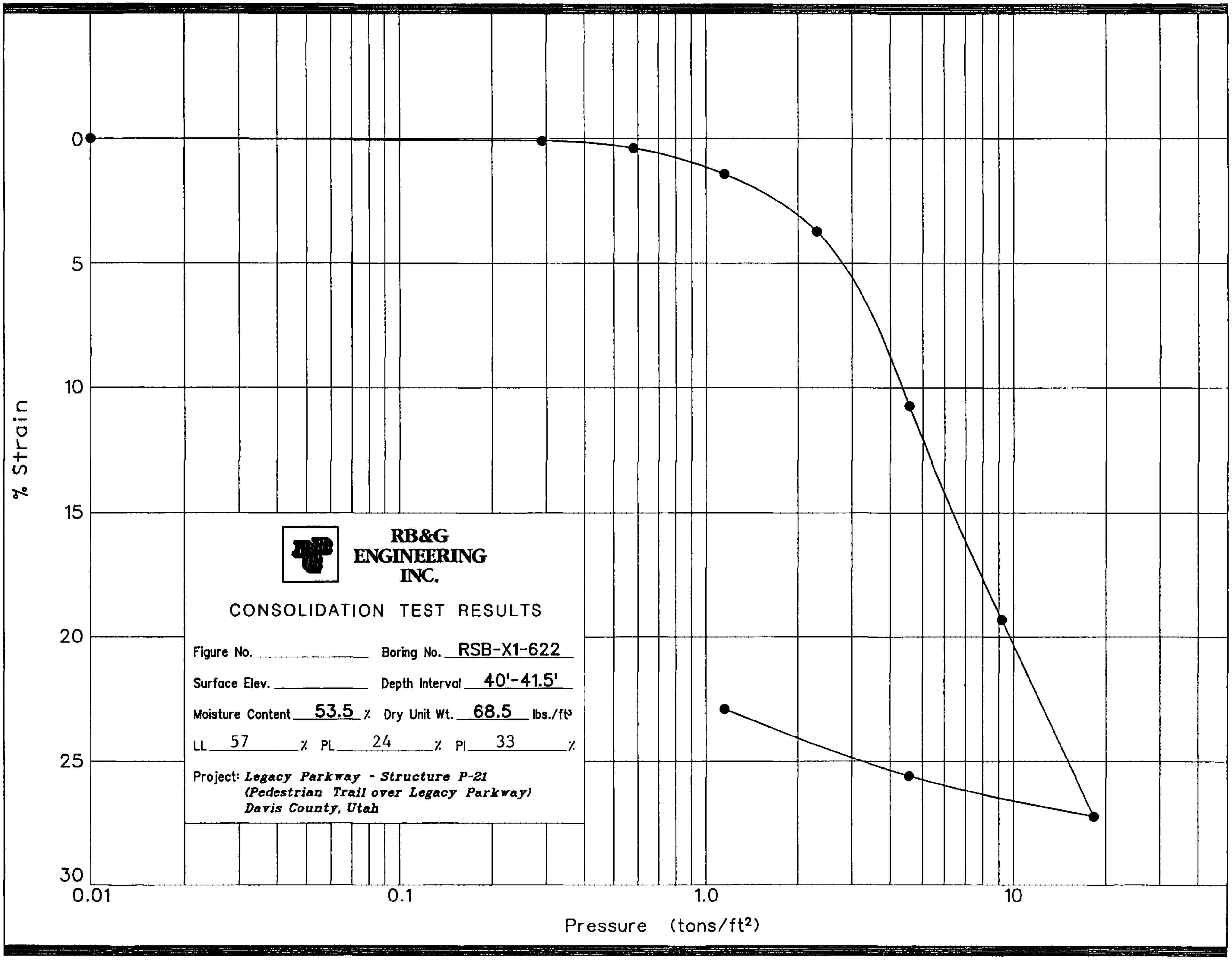
Figure No. ____________ Boring No. RSB-X1-622

Surface Elev. ____________ Depth Interval 40'-41.5'

Moisture Content 53.5 % Dry Unit Wt. 68.5 lbs./ft³

LL 57 % PL 24 % PI 33 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. RSB-X1-622

Surface Elev. ______ Depth Interval 40'-41.5'

Moisture Content 53.5 % Dry Unit Wt. 68.5 lbs./ft³

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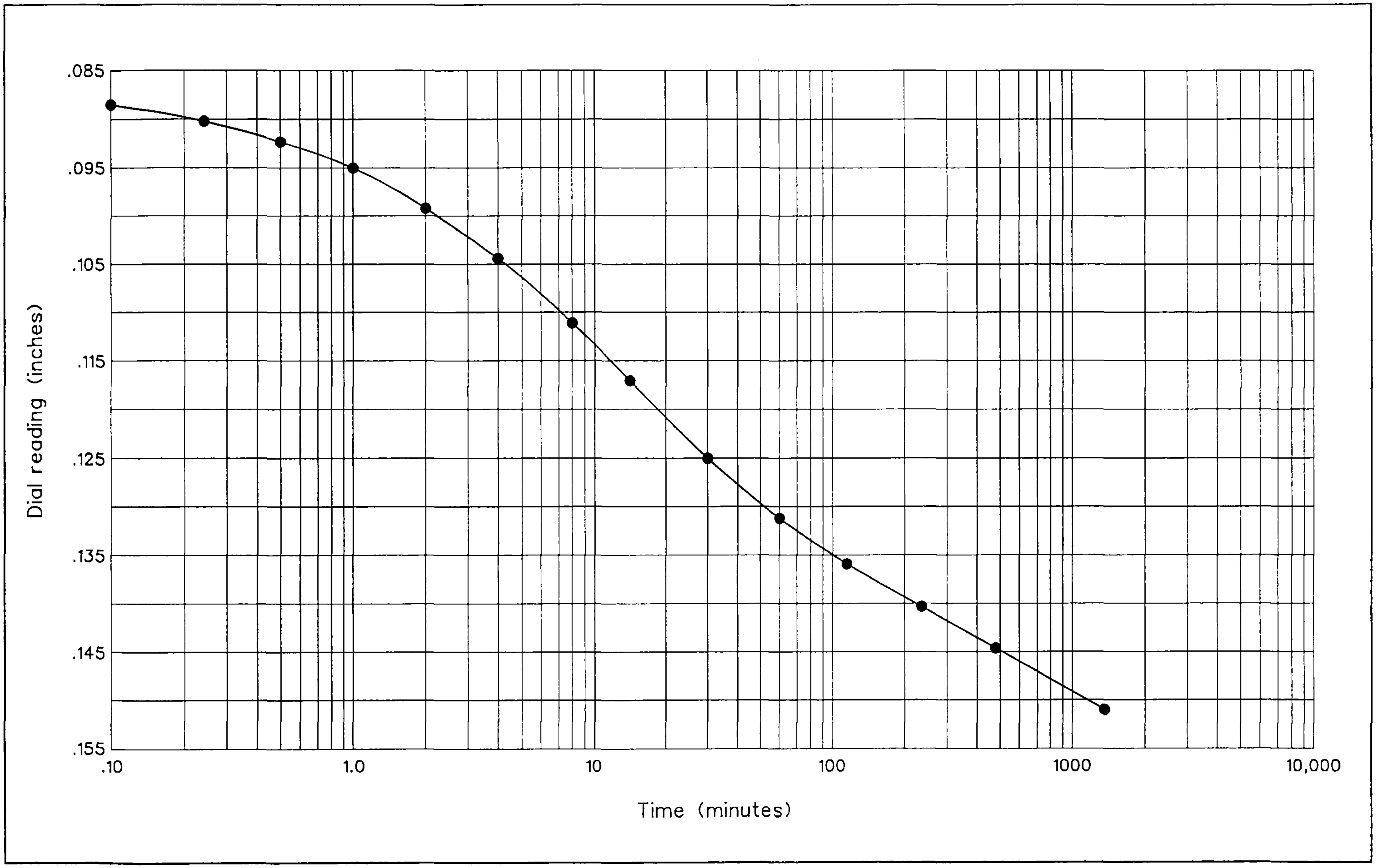
Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



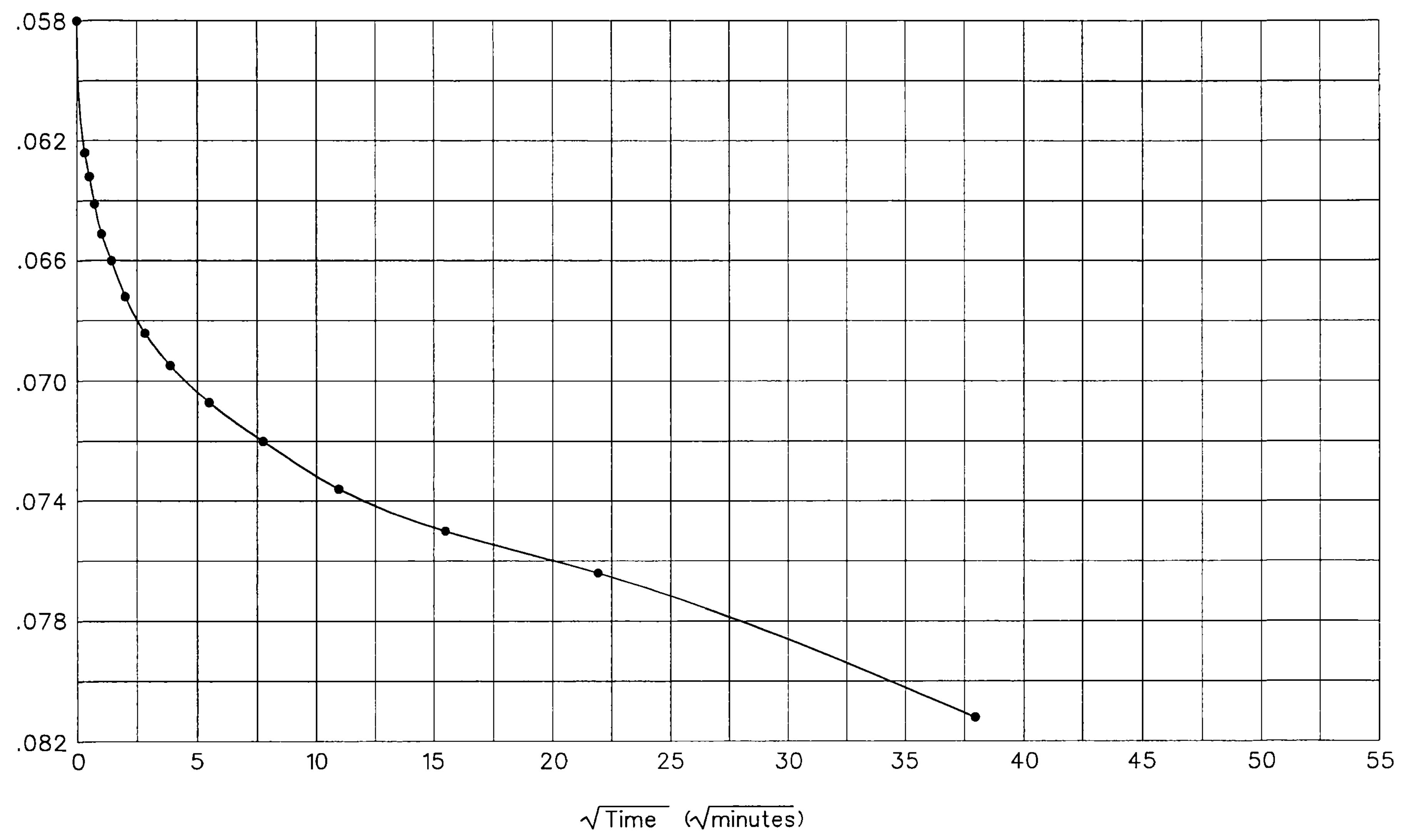
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 40'-41.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



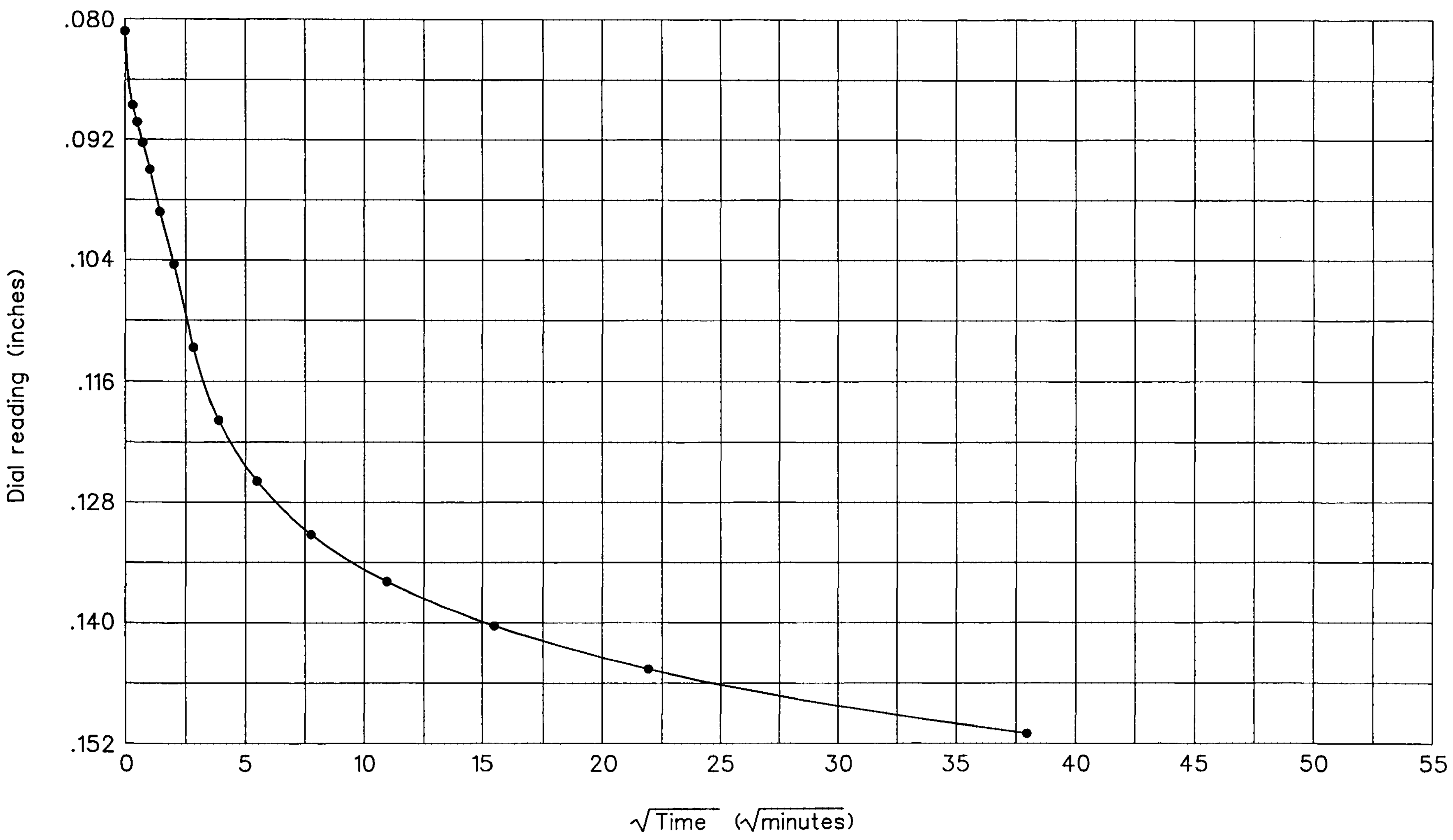
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 40'-41.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



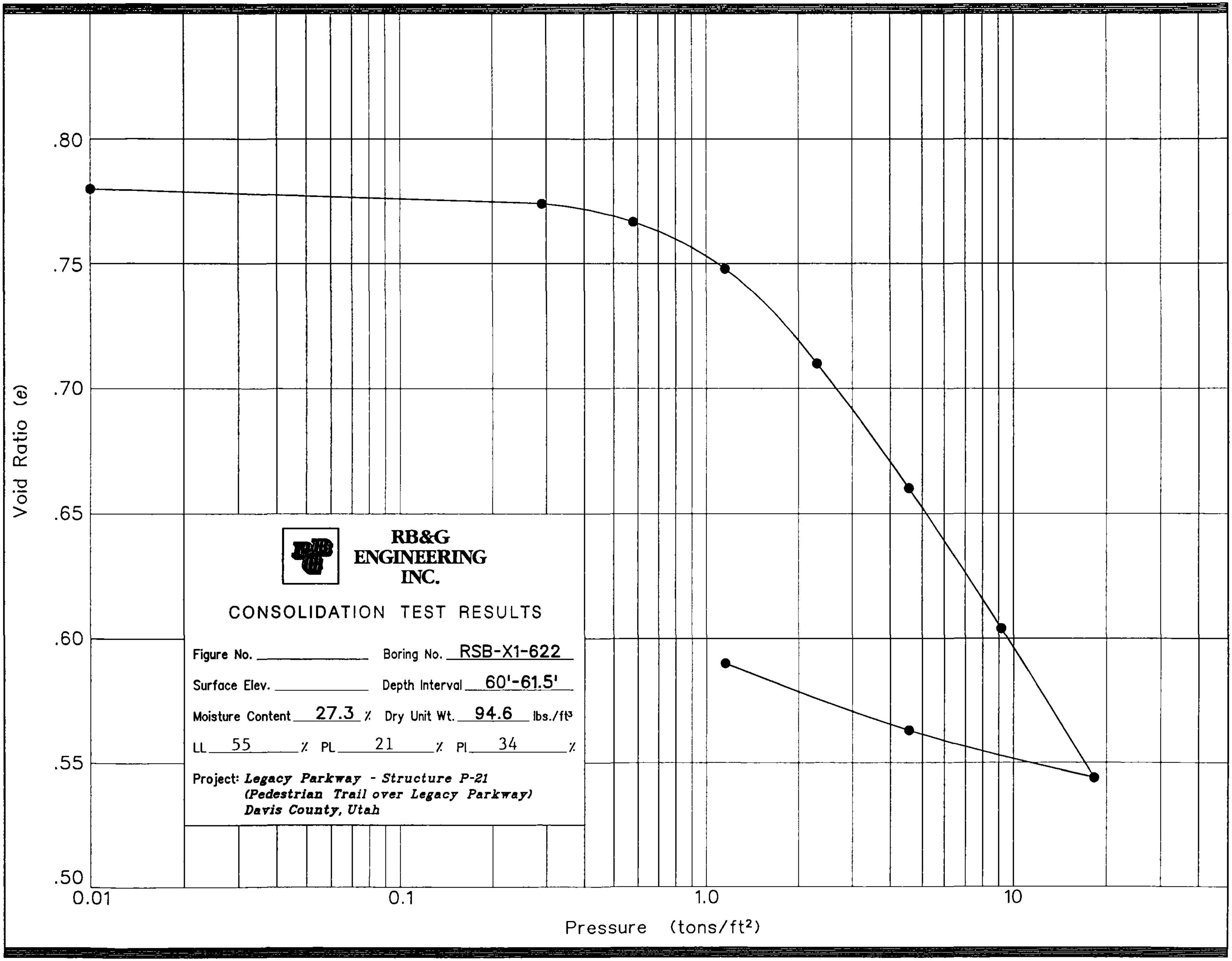
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 40'-41.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

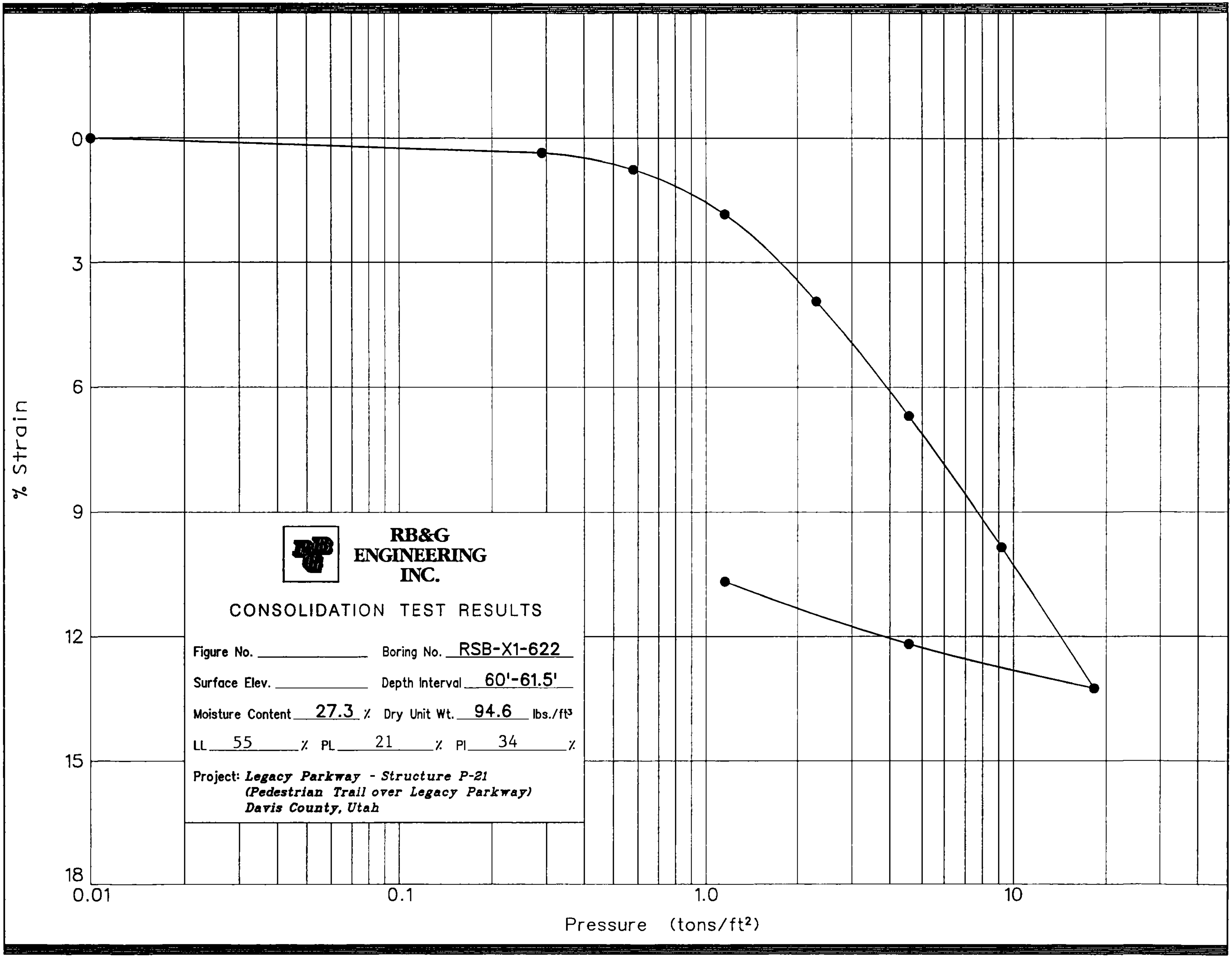
Figure No. ____________ Boring No. RSB-X1-622

Surface Elev. ____________ Depth Interval 60'-61.5'

Moisture Content 27.3 % Dry Unit Wt. 94.6 lbs./ft³

LL 55 % PL 21 % PI 34 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

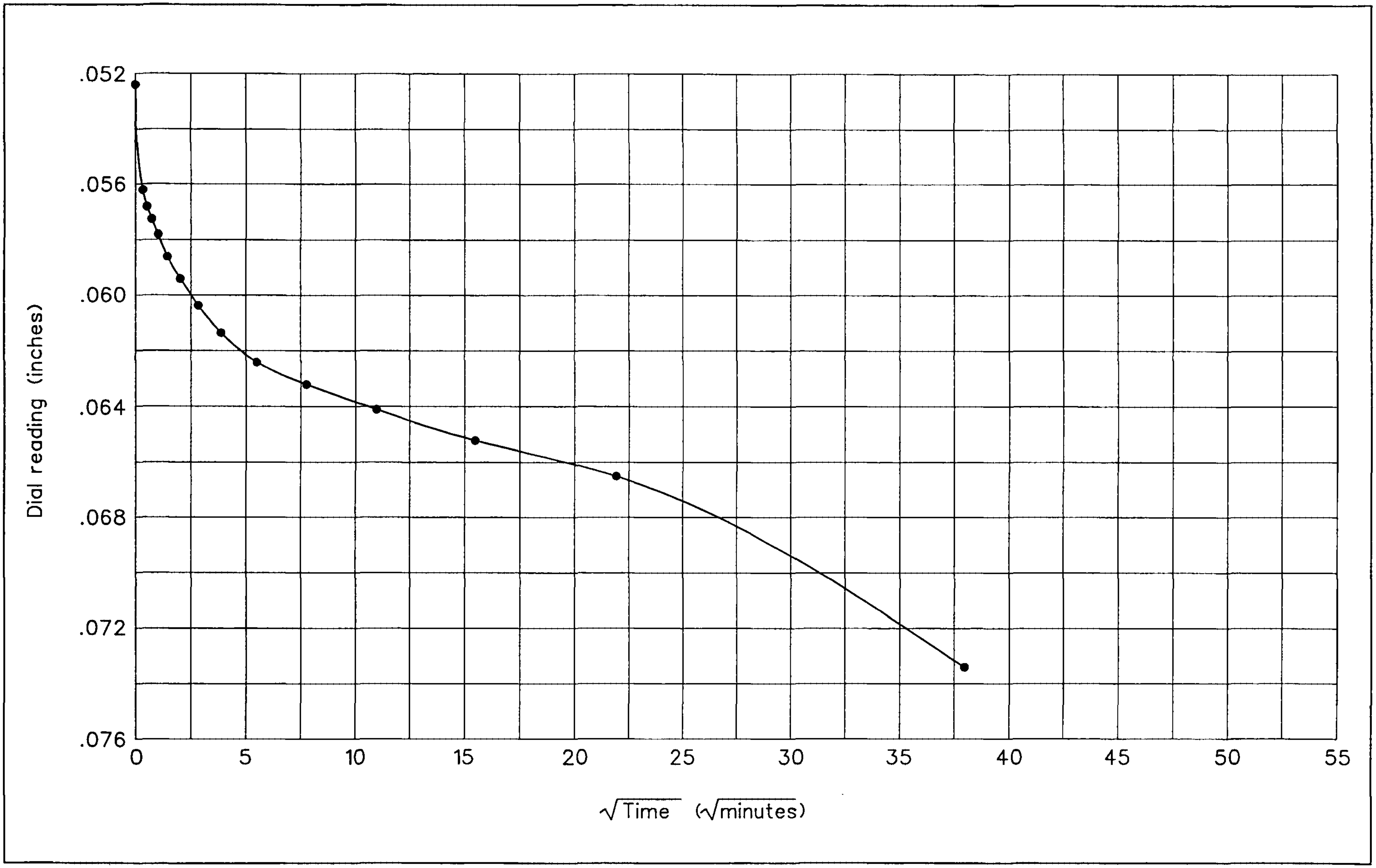
Figure No. ______ Boring No. RSB-X1-622

Surface Elev. ______ Depth Interval 60'-61.5'

Moisture Content 27.3 % Dry Unit Wt. 94.6 lbs./ft³

LL 55 % PL 21 % PI 34 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



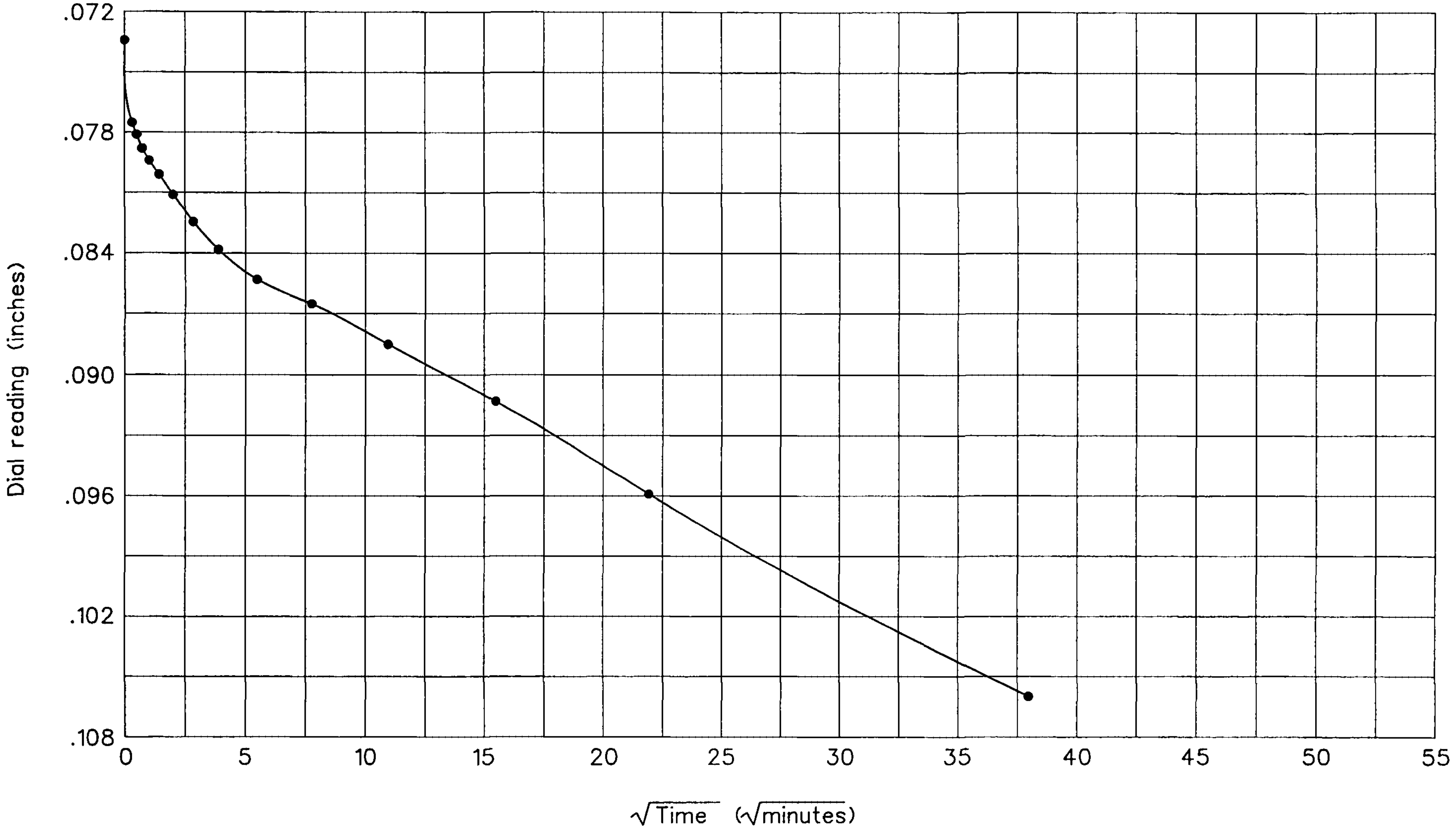
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 60'-61.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



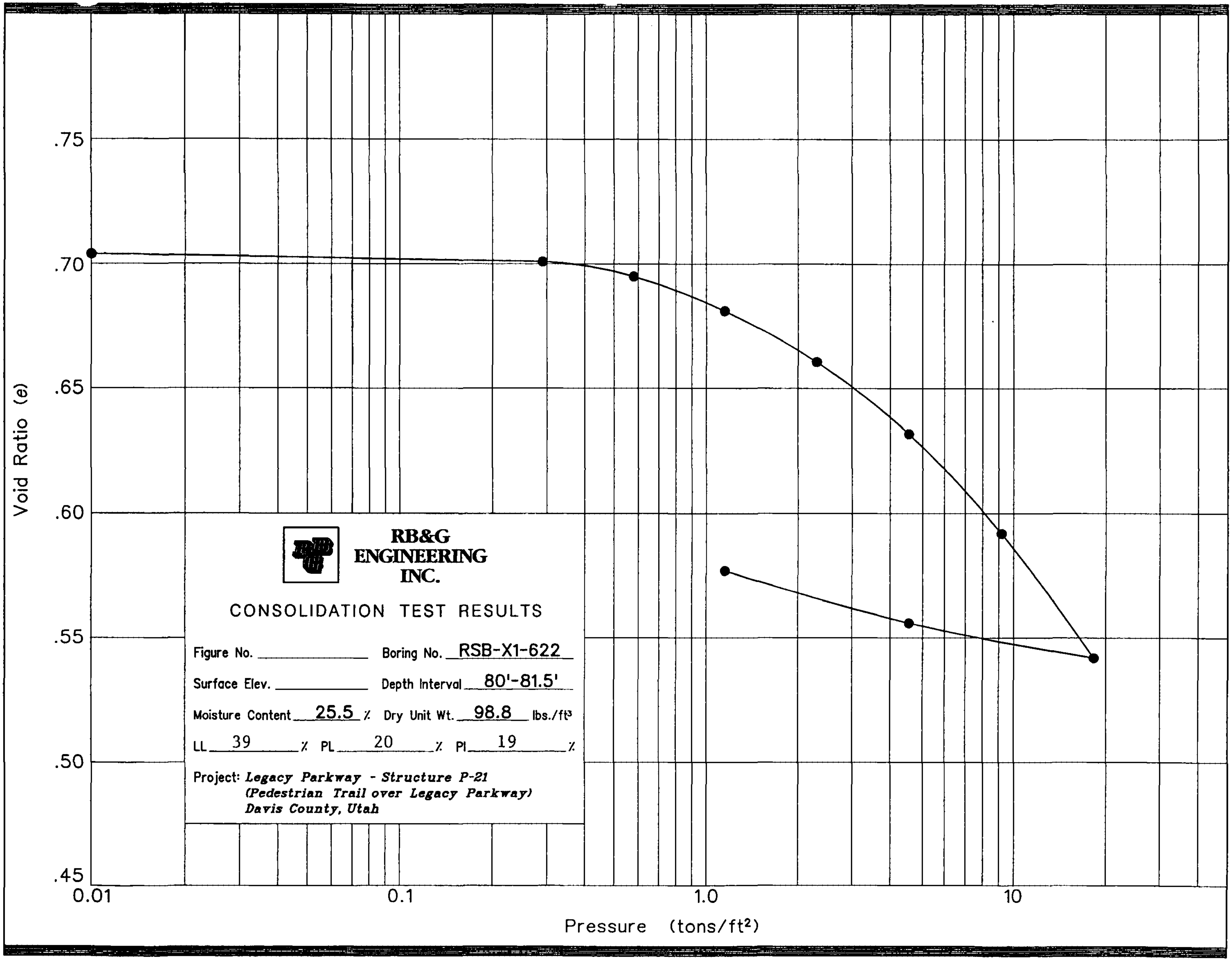
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 60'-61.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

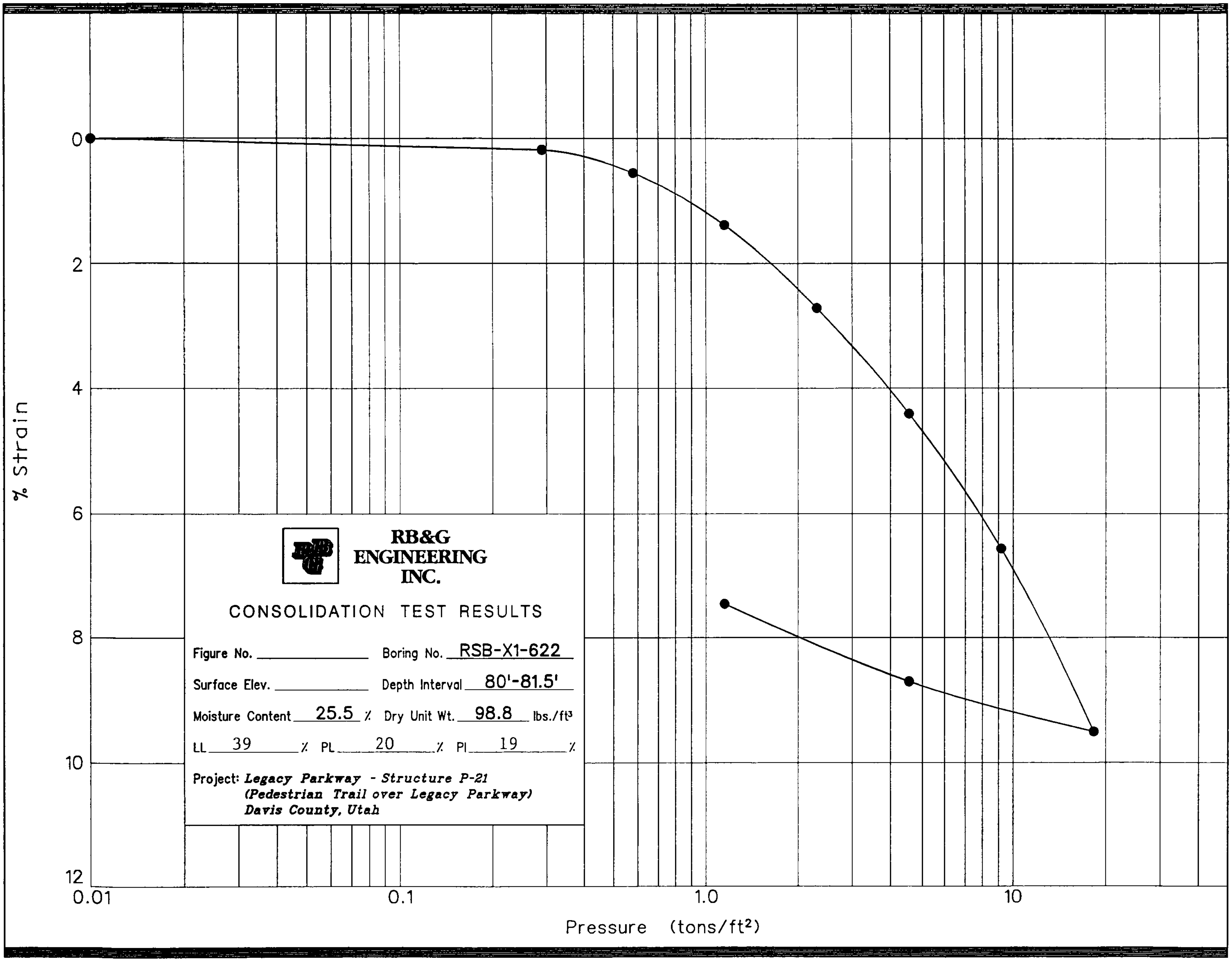
Figure No. ______________ Boring No. RSB-X1-622

Surface Elev. ______________ Depth Interval 80'-81.5'

Moisture Content 25.5 % Dry Unit Wt. 98.8 lbs./ft³

LL 39 % PL 20 % PI 19 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

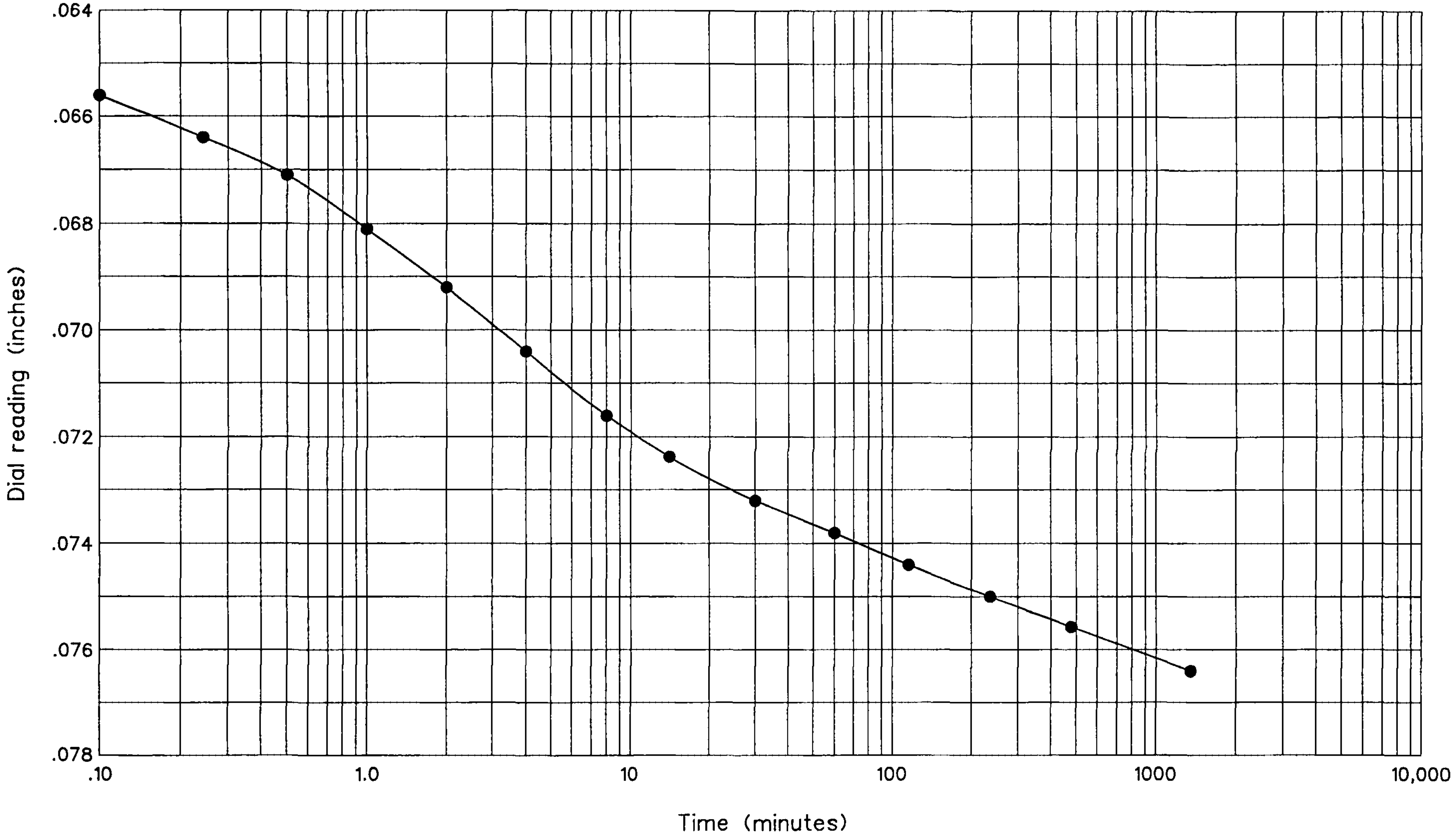
Figure No. ______ Boring No. RSB-X1-622

Surface Elev. ______ Depth Interval 80'-81.5'

Moisture Content 25.5 % Dry Unit Wt. 98.8 lbs./ft³

LL 39 % PL 20 % PI 19 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



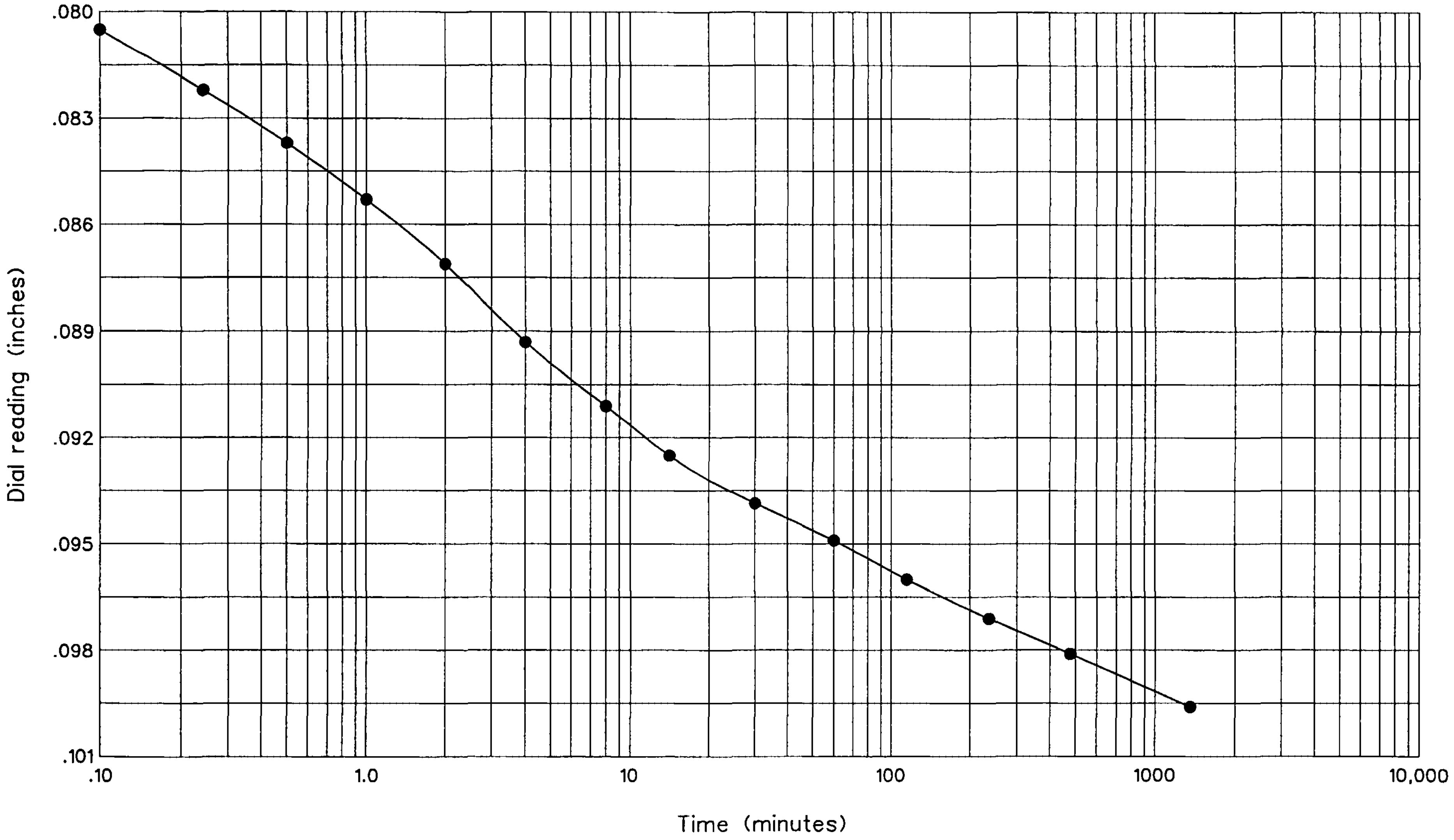
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 80'-81.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



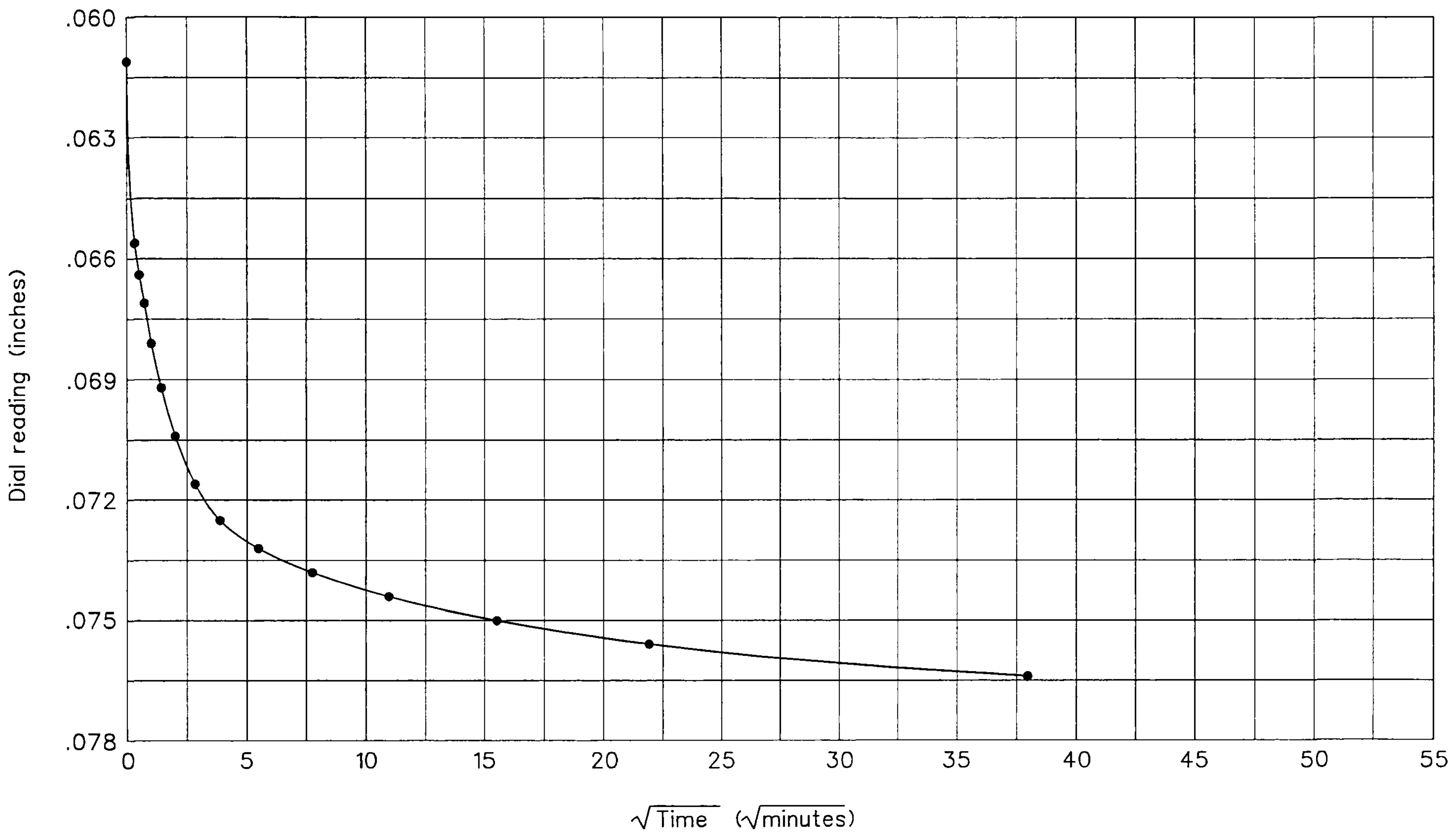
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 80'-81.5'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



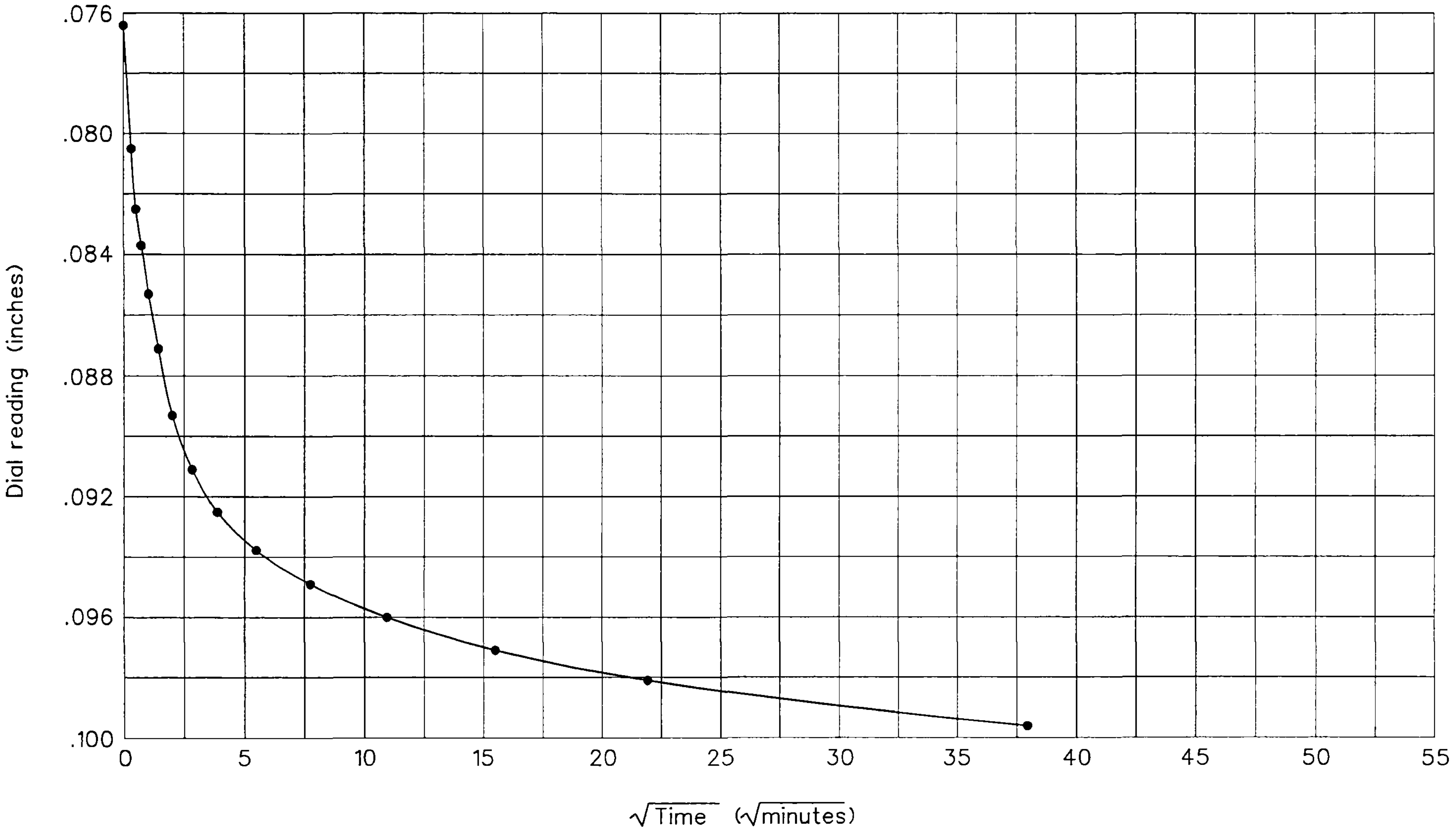
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 80'-81.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



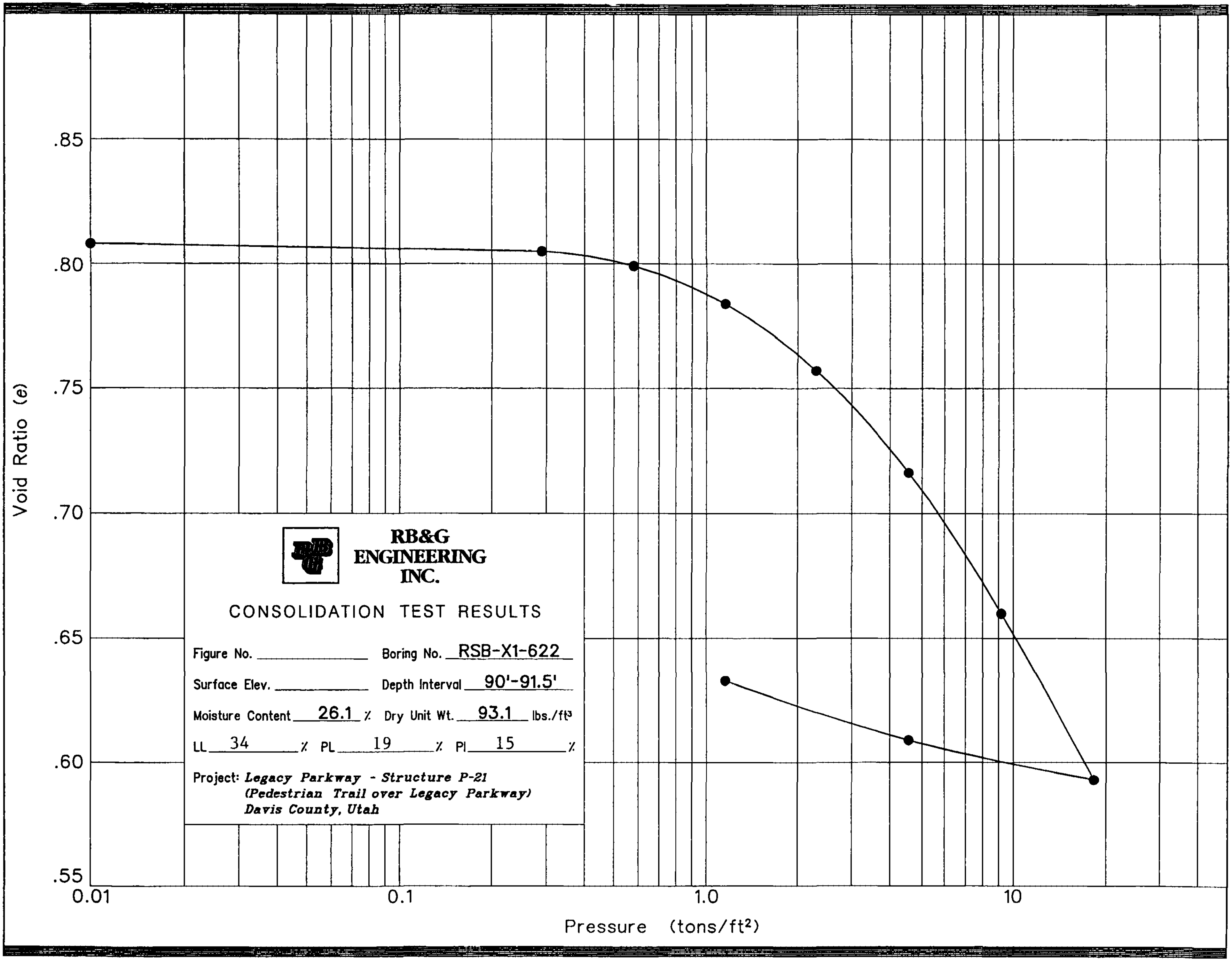
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 80'-81.5'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

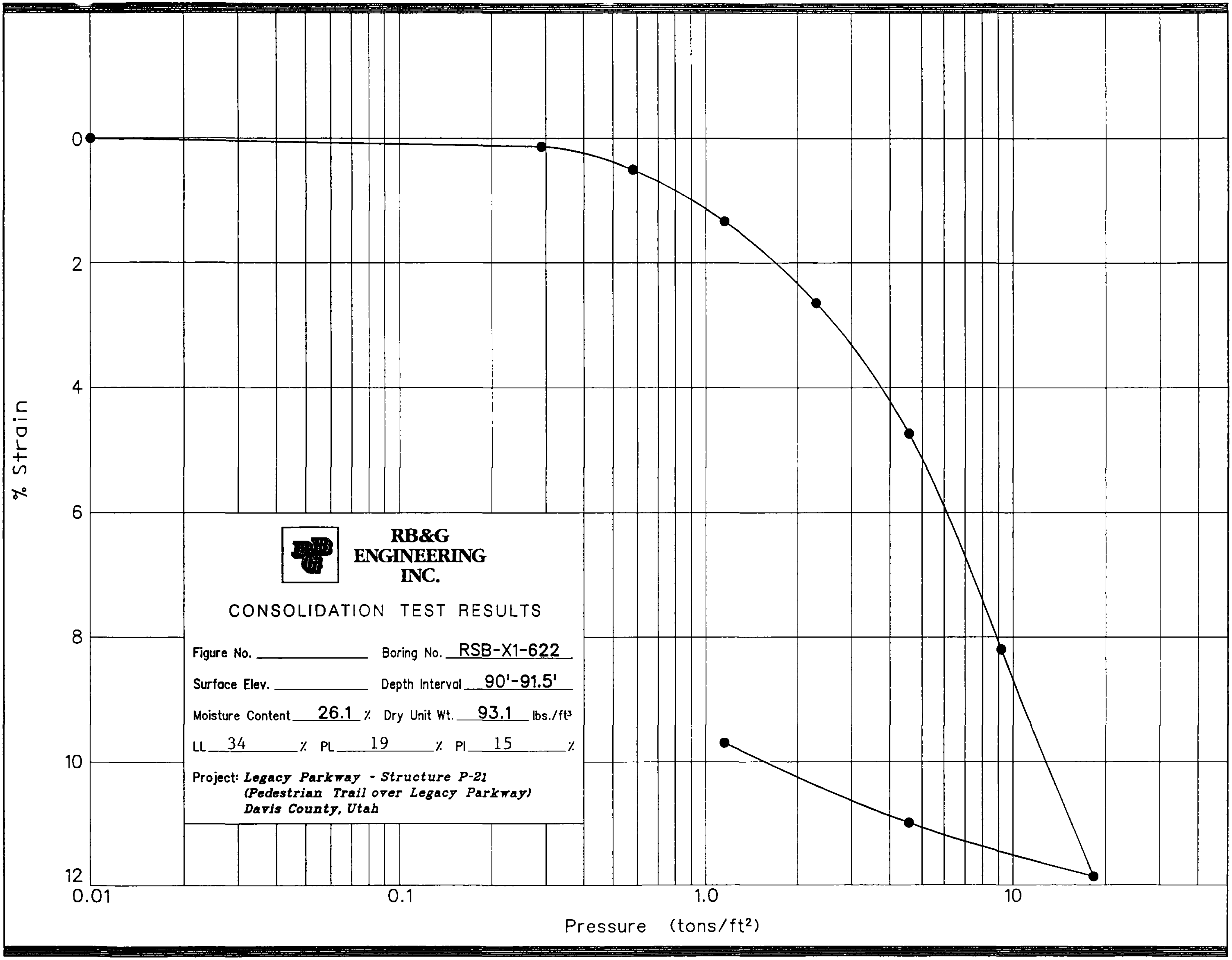
Figure No. ______________ Boring No. RSB-X1-622

Surface Elev. ______________ Depth Interval 90'-91.5'

Moisture Content 26.1 % Dry Unit Wt. 93.1 lbs./ft³

LL 34 % PL 19 % PI 15 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. RSB-X1-622

Surface Elev. ______ Depth Interval 90'-91.5'

Moisture Content 26.1 % Dry Unit Wt. 93.1 lbs./ft³

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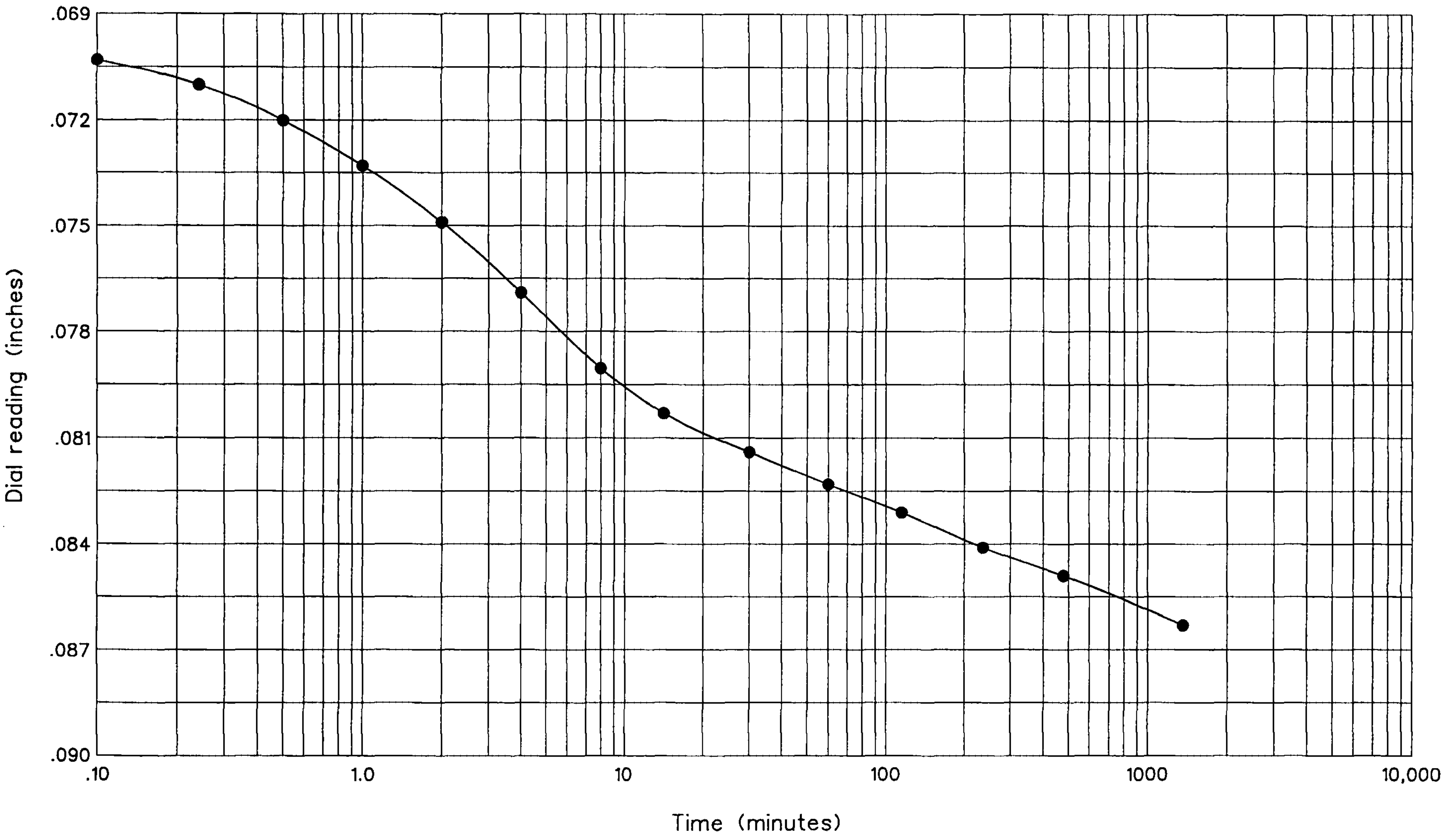
Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



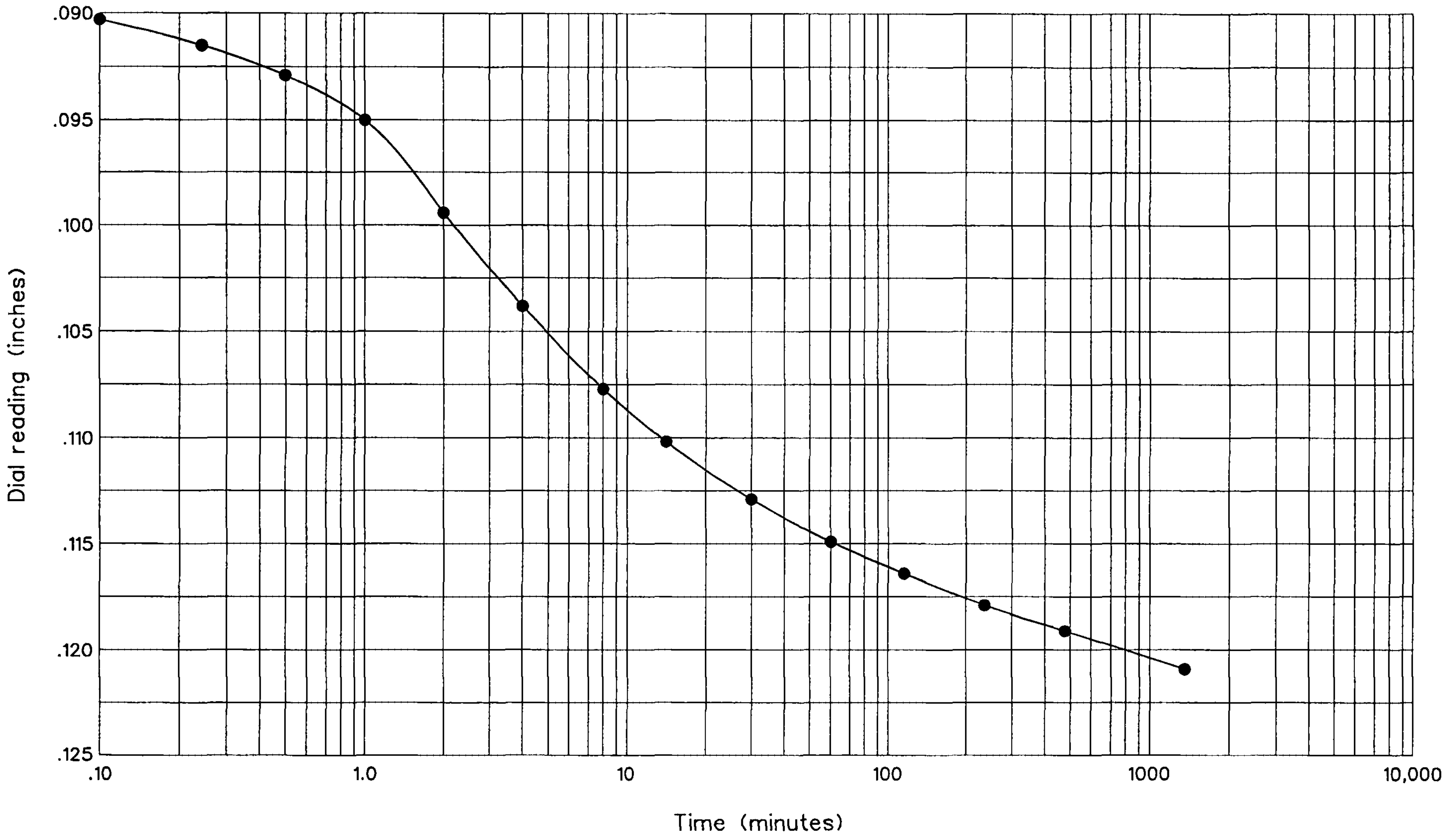
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 90'-91.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



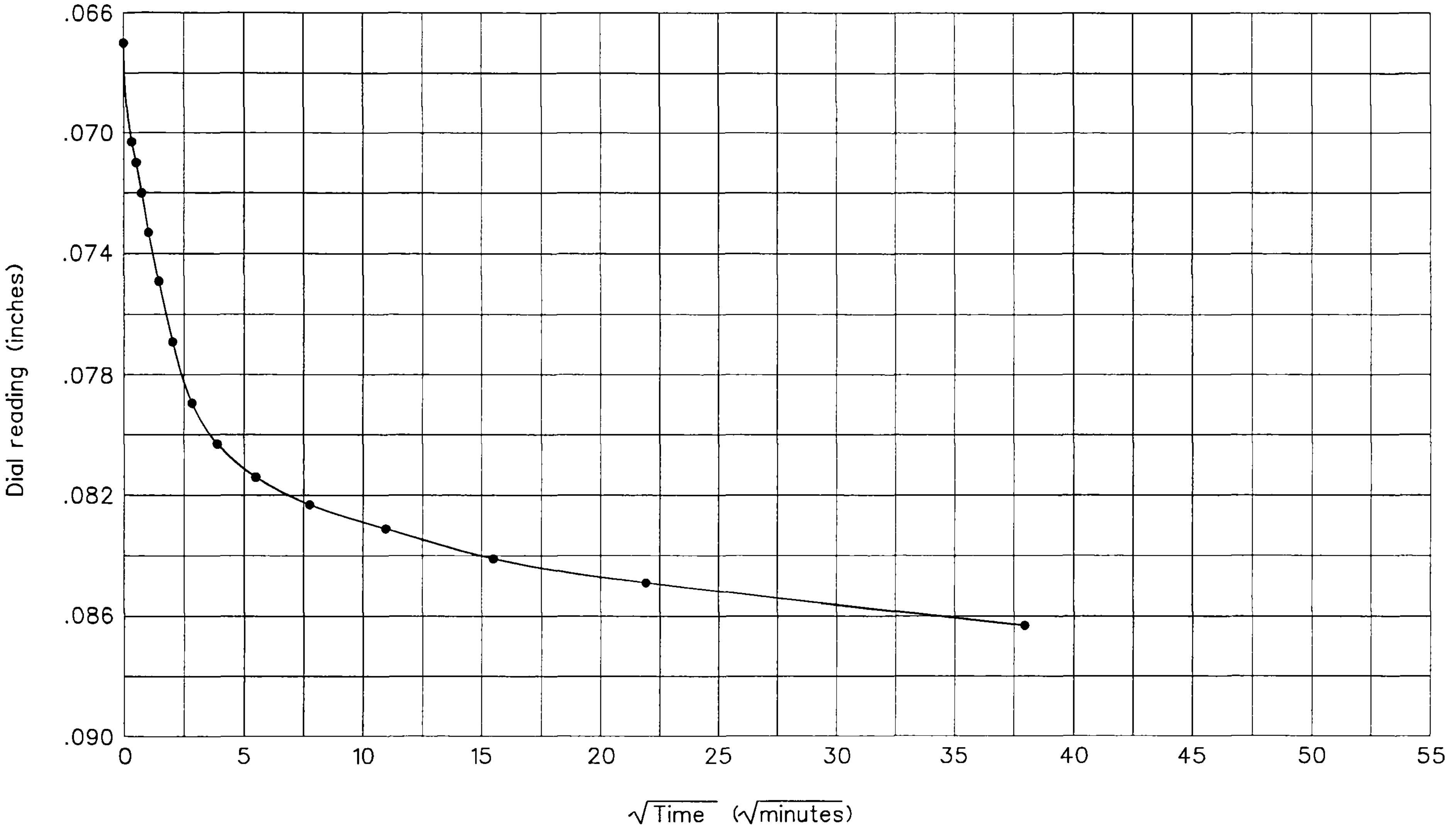
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 90'-91.5'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



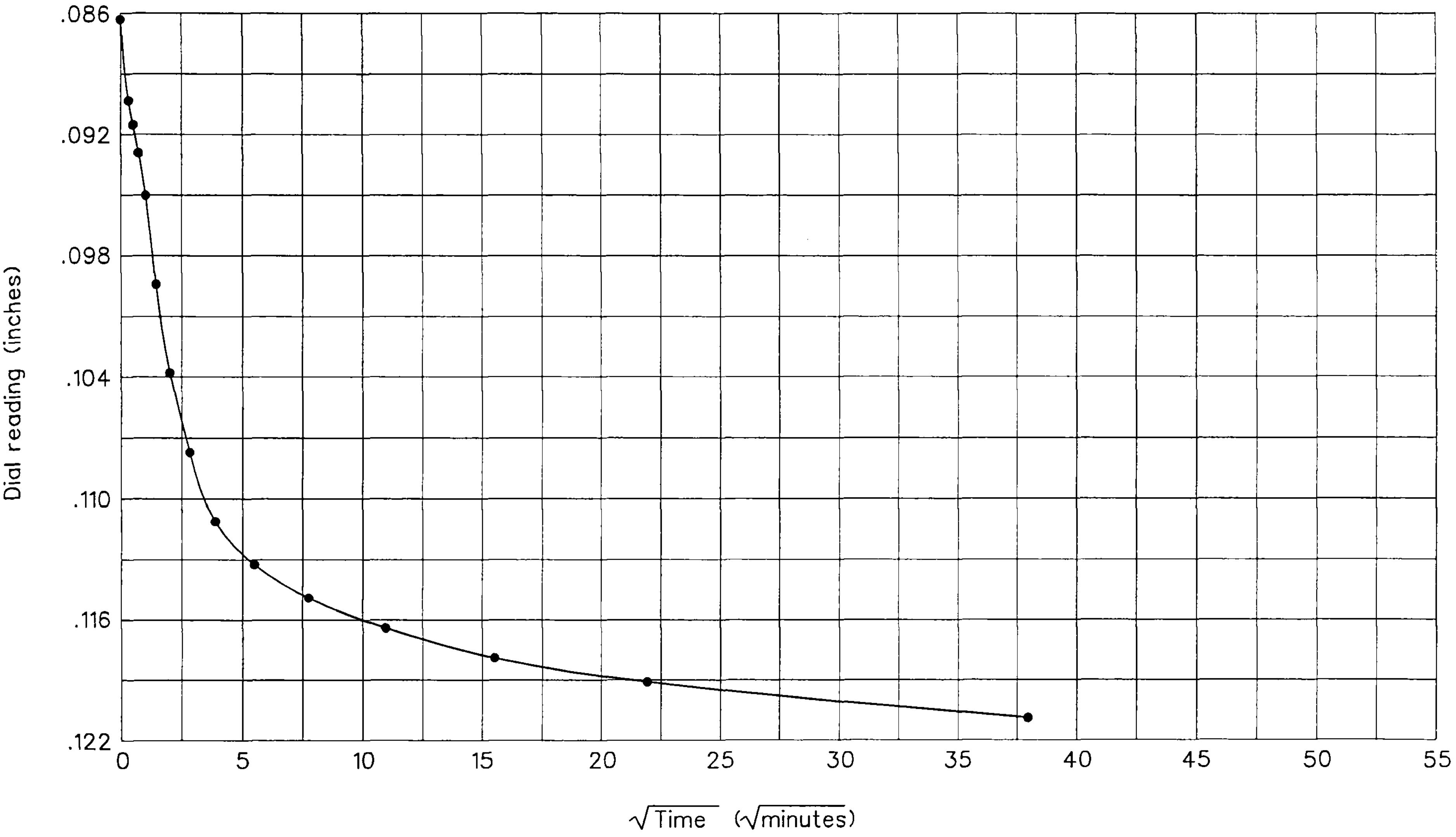
RB&G ENGINEERING INC.
Provo, Utah

Hole no.:	RSB-X1-622
Depth:	90'-91.5'
Load:	4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



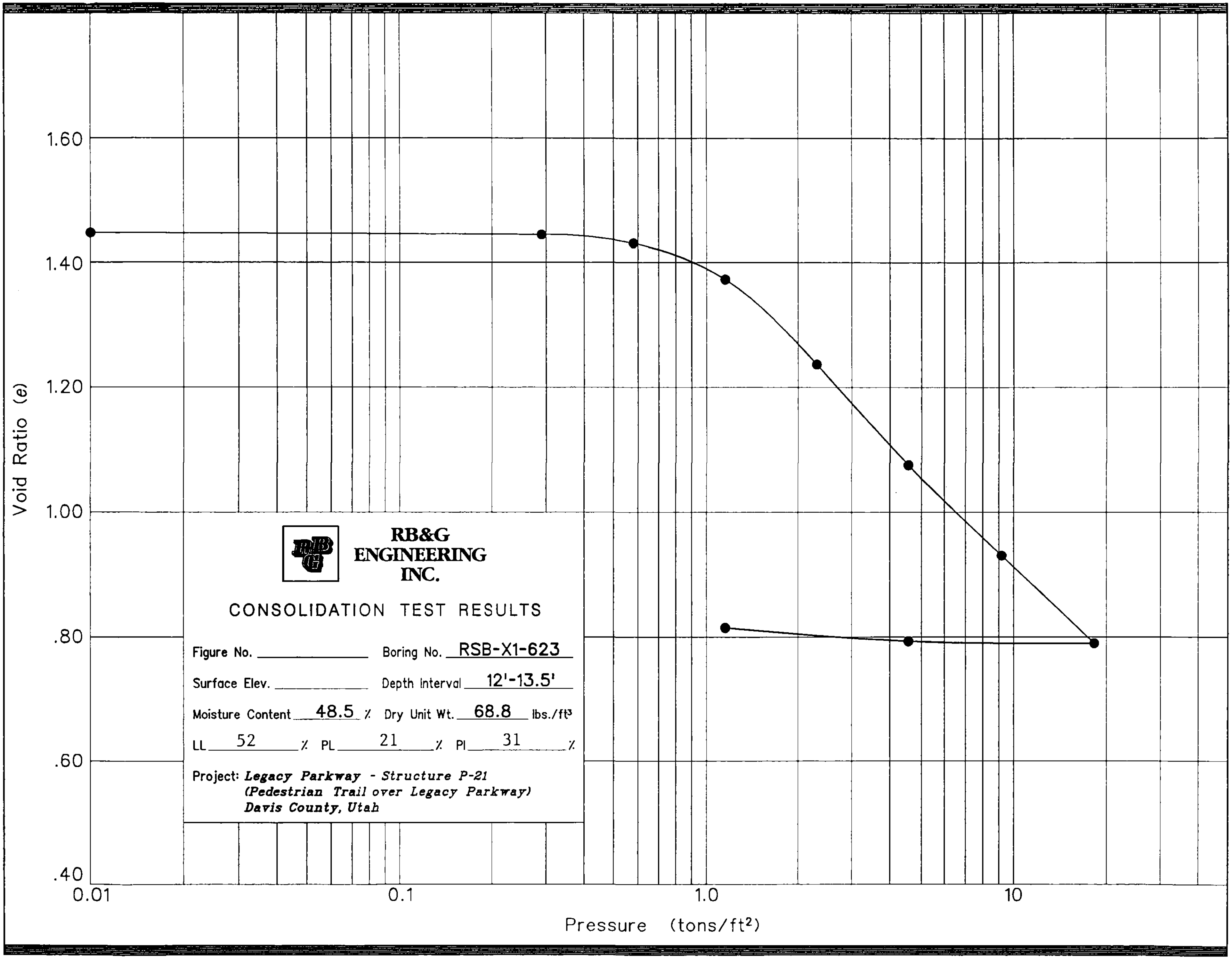
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-622
Depth: 90'-91.5'
Load: 9.20 to 18.40 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

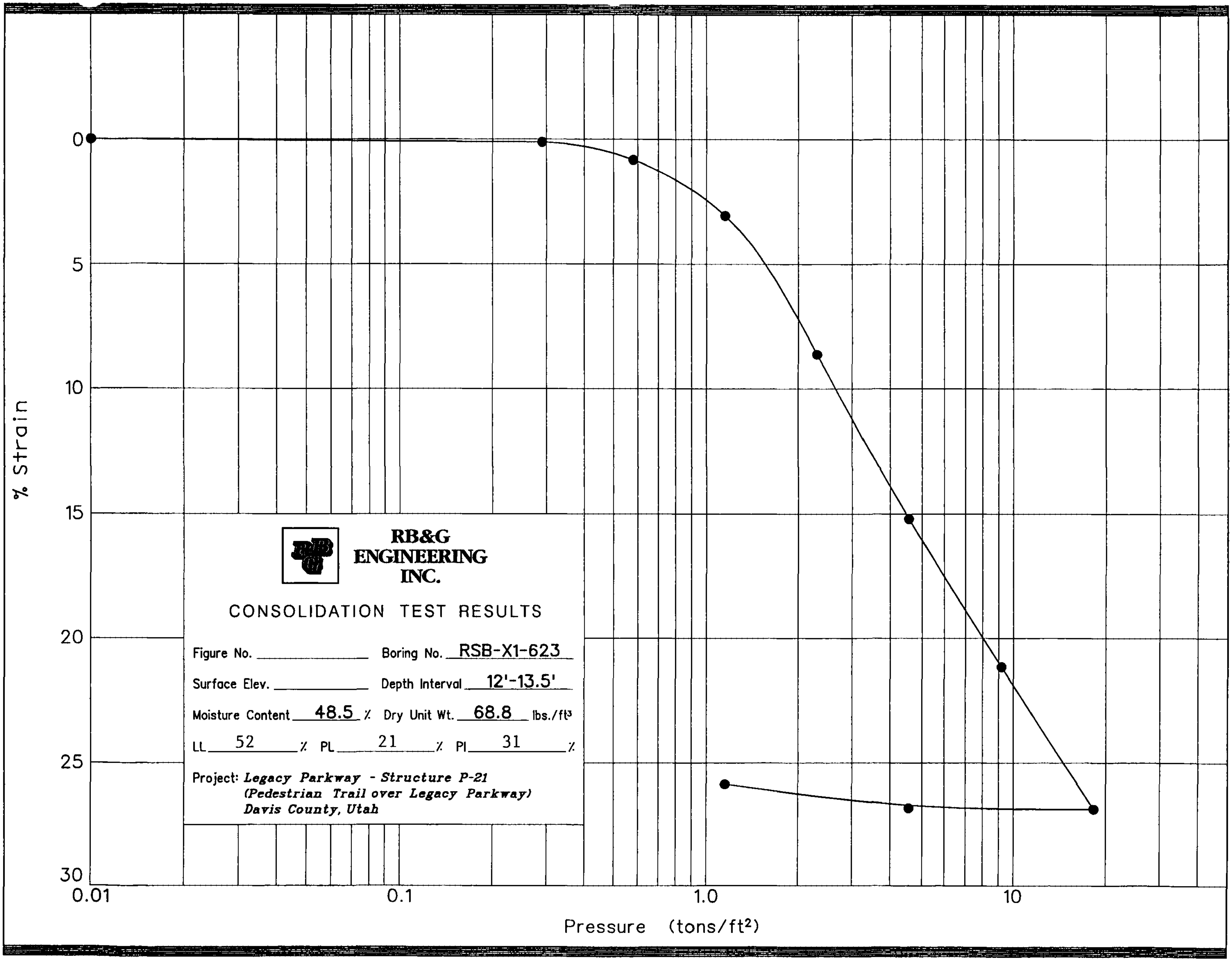
Figure No. ______ Boring No. RSB-X1-623

Surface Elev. ______ Depth Interval 12'-13.5'

Moisture Content 48.5 % Dry Unit Wt. 68.8 lbs./ft³

LL 52 % PL 21 % PI 31 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

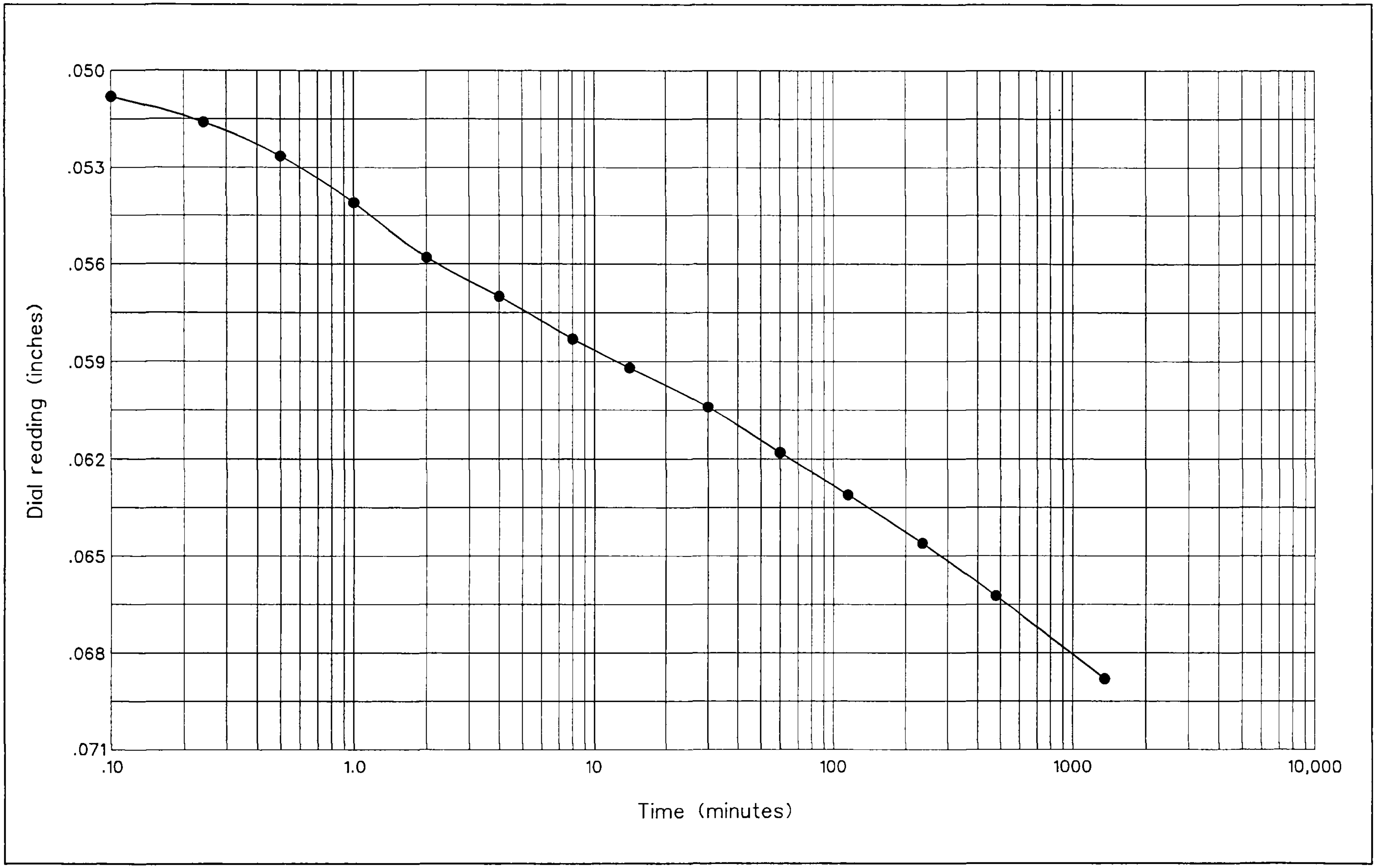
Figure No. ______ Boring No. RSB-X1-623

Surface Elev. ______ Depth Interval 12'-13.5'

Moisture Content 48.5 % Dry Unit Wt. 68.8 lbs./ft³

LL 52 % PL 21 % PI 31 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



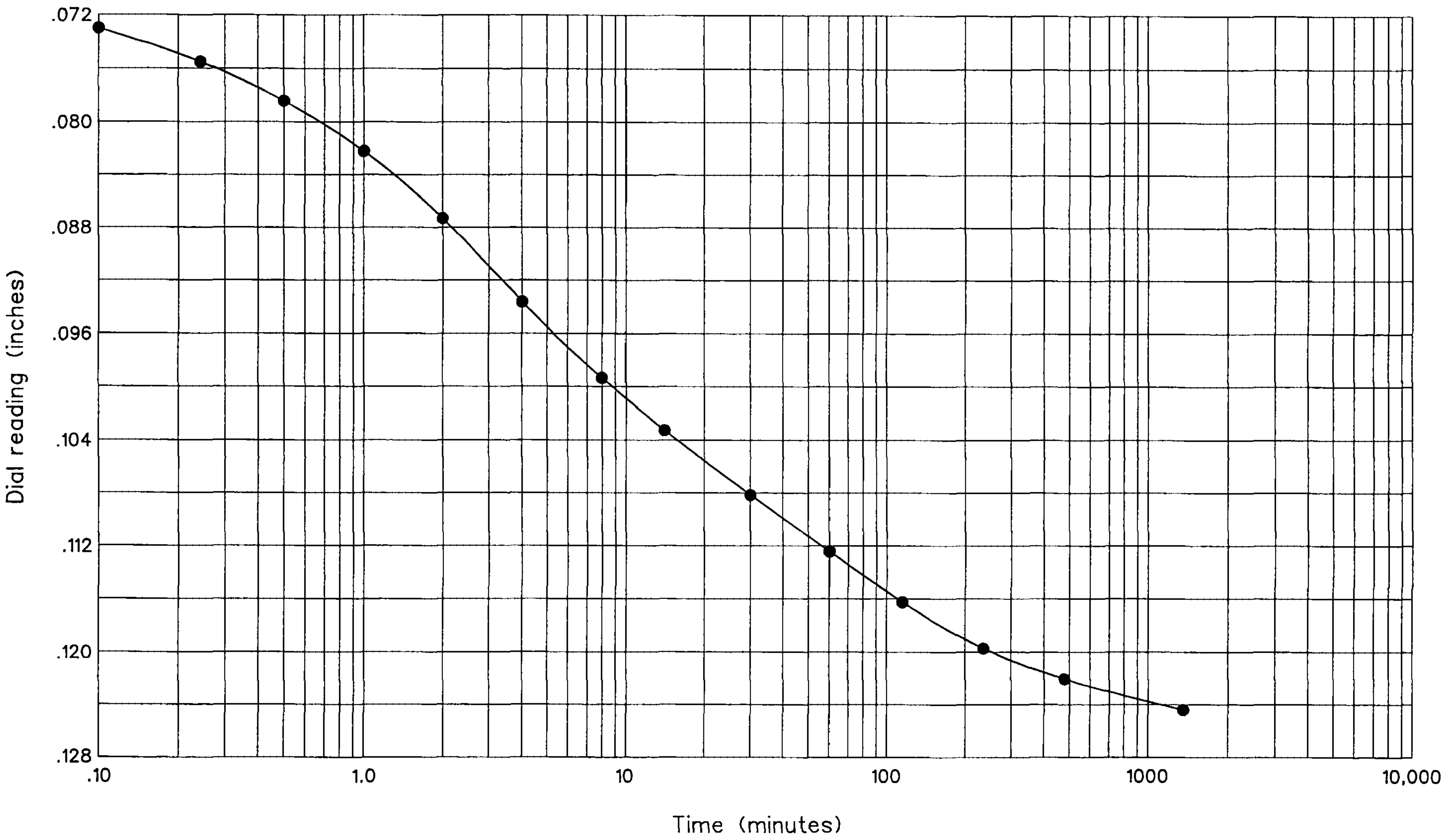
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-623
Depth: 12'-13.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



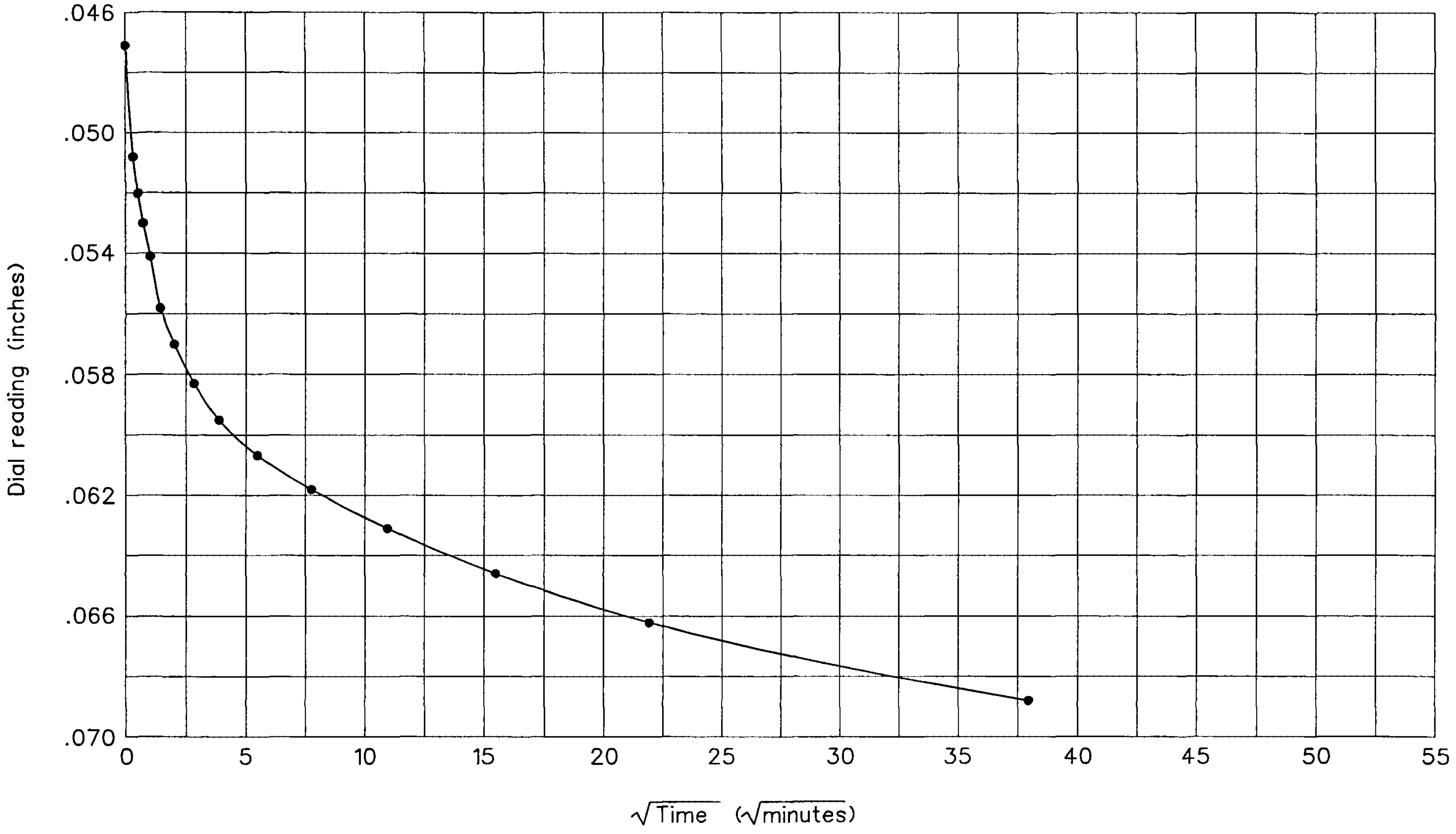
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-623
Depth: 12'-13.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



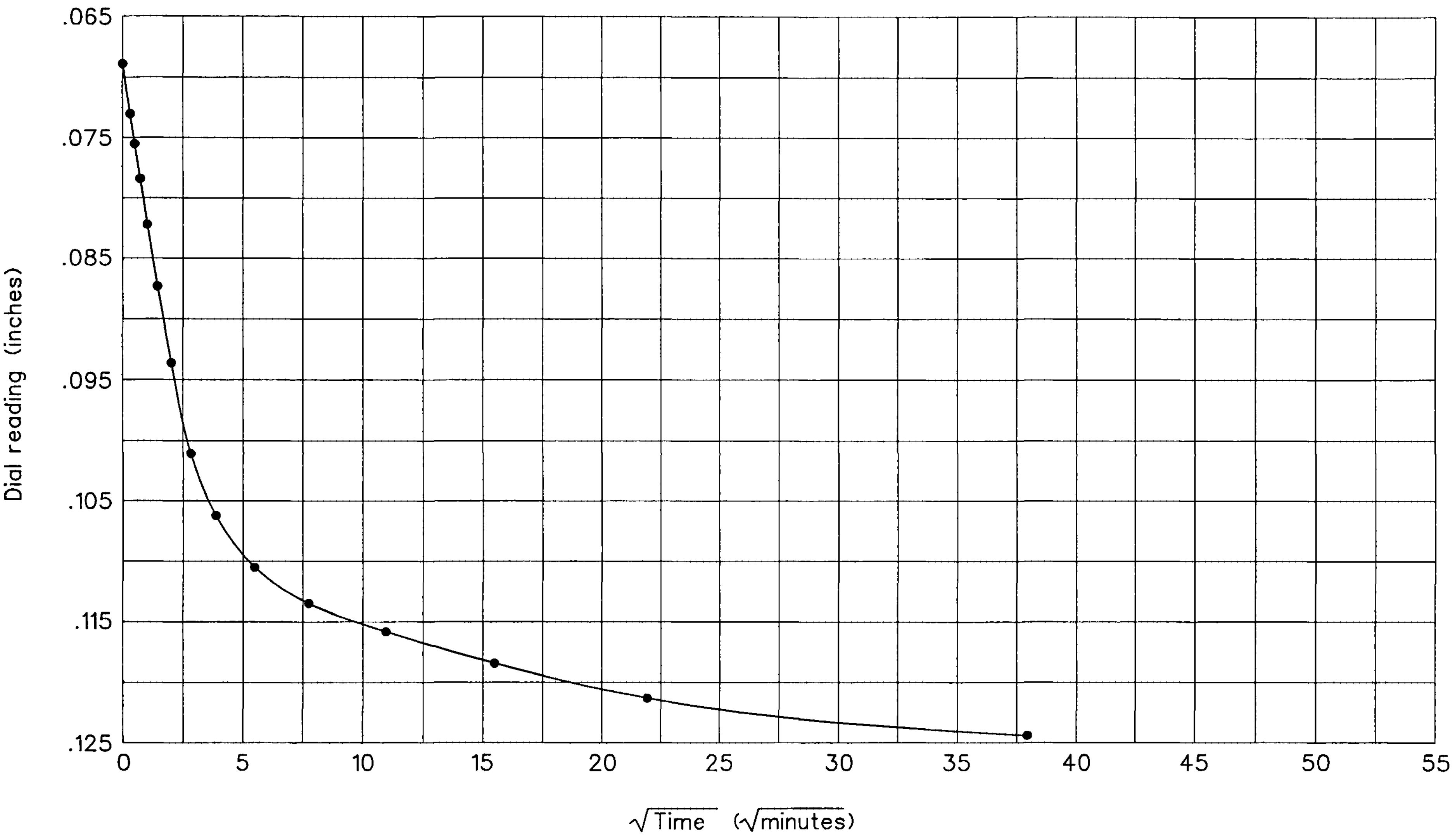
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-623
Depth: 12'-13.5'
Load: 1.15 to 2.30 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



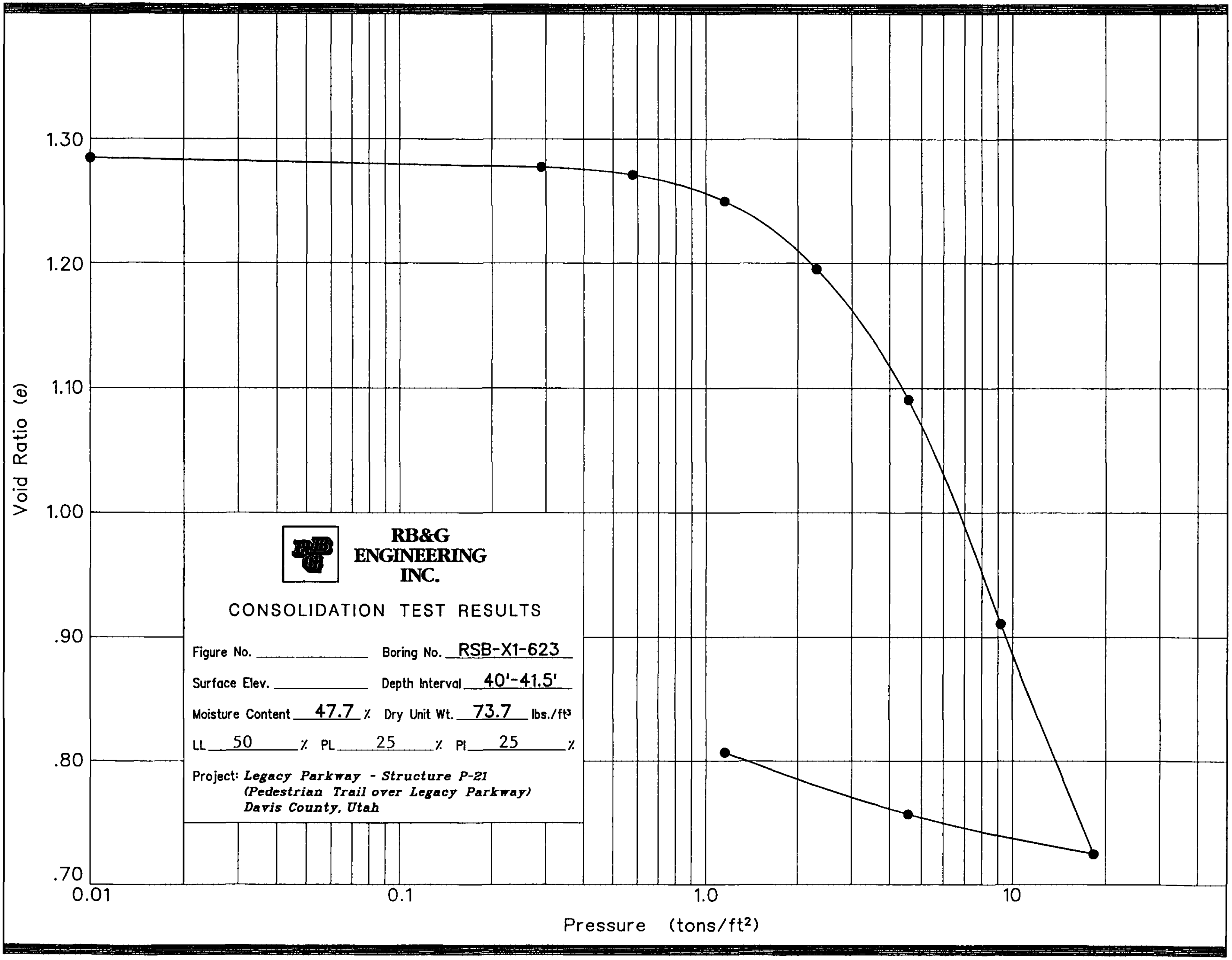
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-623
Depth: 12'-13.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

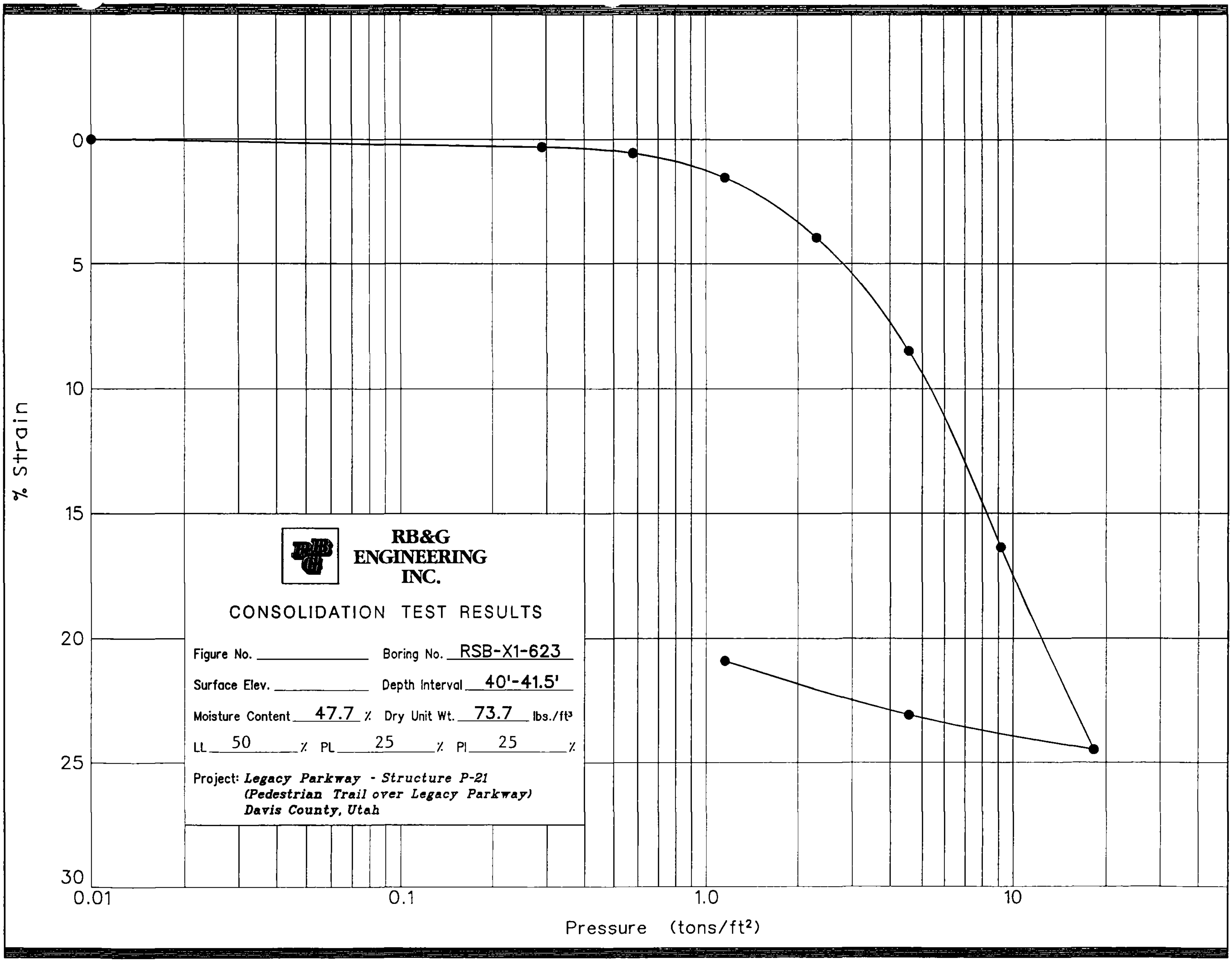
Figure No. ____ Boring No. RSB-X1-623

Surface Elev. ____ Depth Interval 40'-41.5'

Moisture Content 47.7 % Dry Unit Wt. 73.7 lbs./ft³

LL 50 % PL 25 % PI 25 %

Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. RSB-X1-623

Surface Elev. ______ Depth Interval 40'-41.5'

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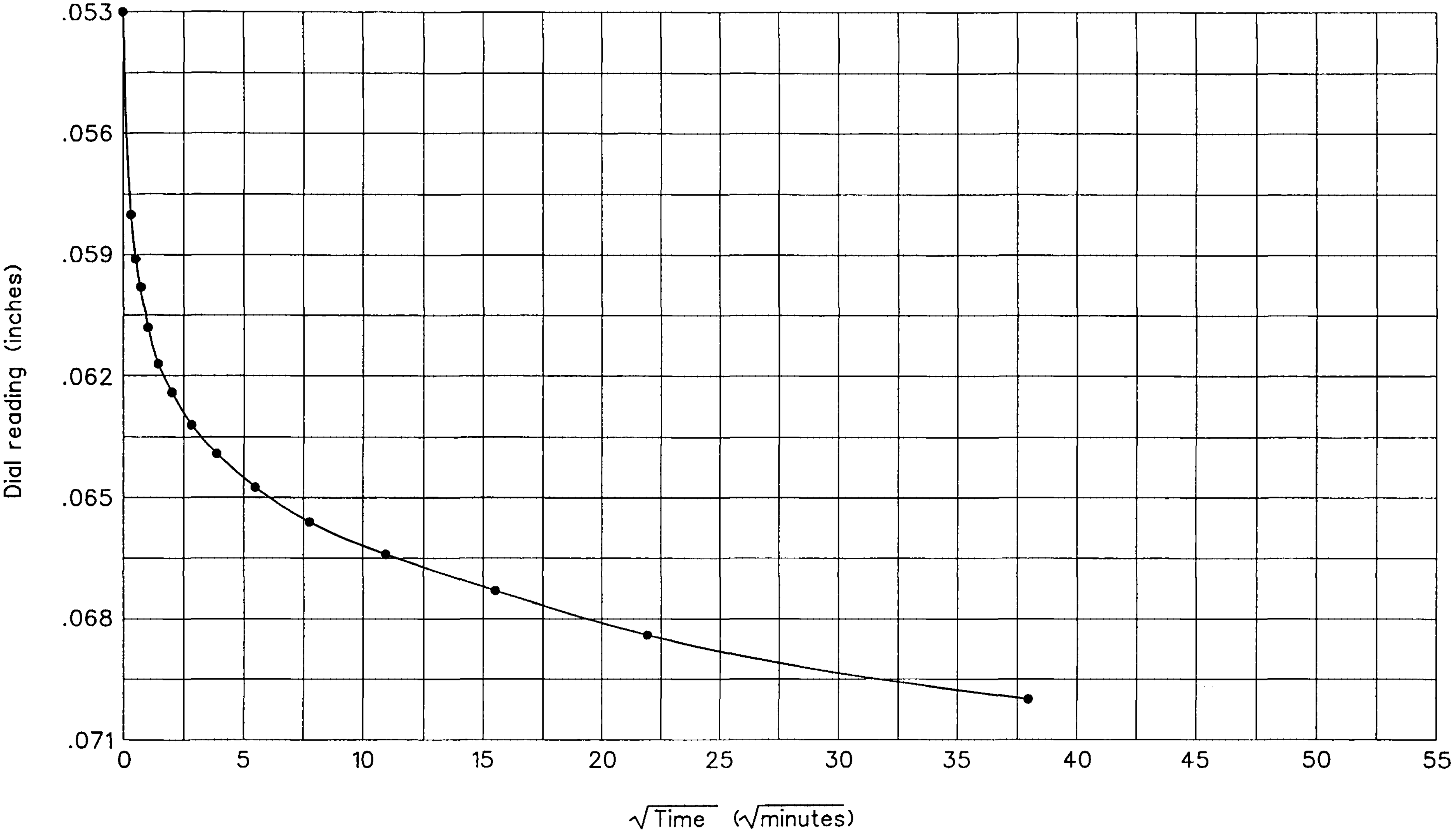
Project: *Legacy Parkway - Structure P-21*
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah



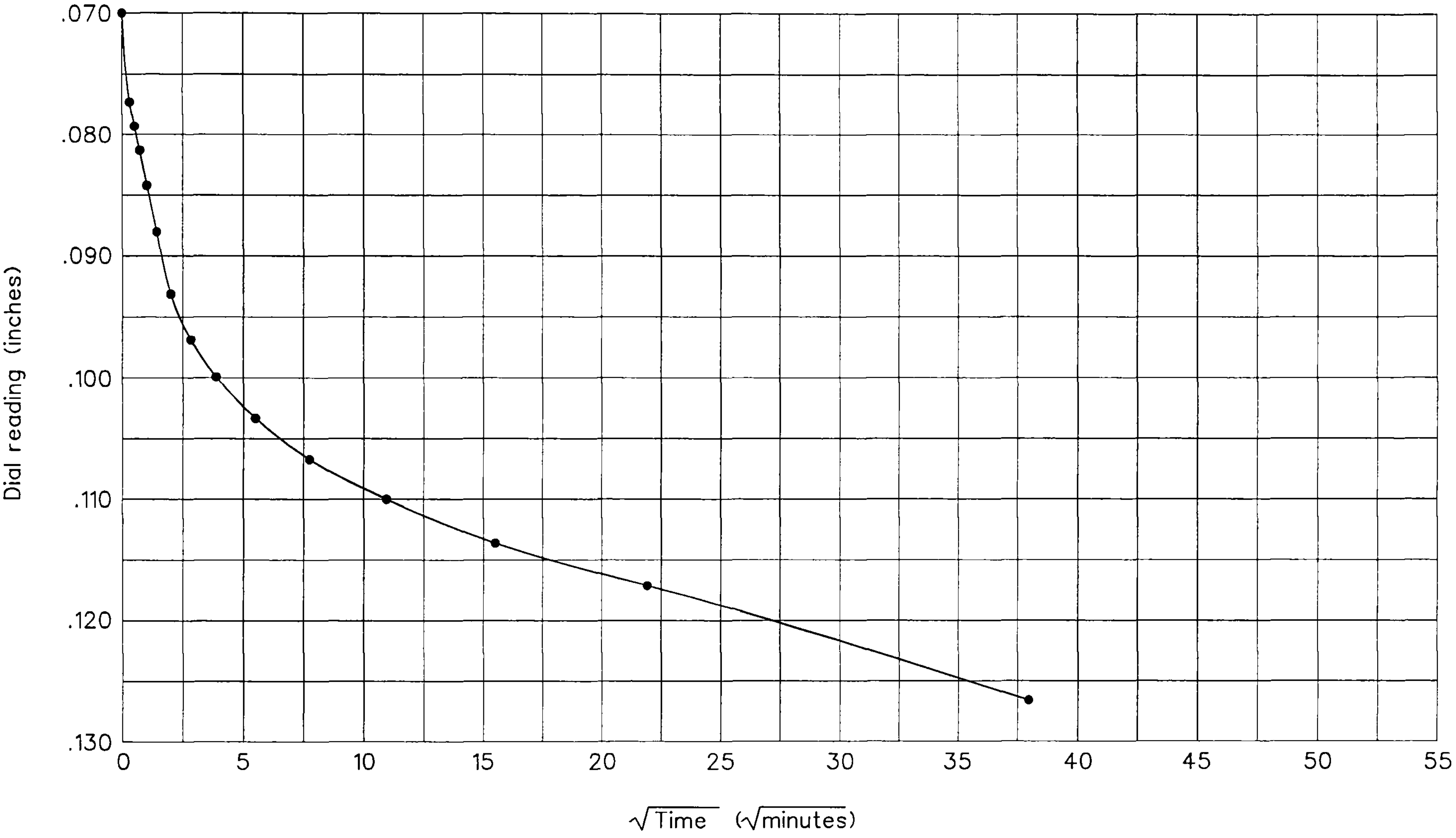
RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-623
Depth: 40'-41.5'
Load: 2.30 to 4.60 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure



RB&G ENGINEERING INC.
Provo, Utah

Hole no.: RSB-X1-623
Depth: 40'-41.5'
Load: 4.60 to 9.20 tons

TIME CONSOLIDATION

Legacy Parkway - Structure P-21
(Pedestrian Trail over Legacy Parkway)
Davis County, Utah

Figure

APPENDIX D
Supplemental Data

Recommendations for LPILE and GROUP analyses.

Project: Legacy Parkway
Structure No: P-21 FAK No: n/a
Description: Pedestrain Trail over Legacy Parkway

by: srj
date: 4/14/2006

Exist. Ground Surface Elev: 4222 ft
Est. Pile Tip Elev: 4151 ft
Pile Length Below Ground: 71 ft

Pile Type: Closed-End Pipe Pile
Size: 16 inch O.D.
Water Table: Upper 3 feet

Soil Layers

									Max Unit Resistance	
Thickness (ft)	Top Elev (ft)	Bottom Elev (ft)	Soil Type (p-y model)	Eff. Unit Wt. (pci)	Cohesion (psi)	Strain Factor ε_{50}	Friction Angle (degrees)	p-y Modulus, k (pci)	Side (psi)	End (psi)
5	4222	4217	Soft Clay (Matlock)	0.033	5	0.015	0	45	0.0	0
26	4217	4191	Soft Clay (Matlock)	0.033	4.5	0.015	0	50	4.3	0
6	4191	4185	Liquefiable Sand	0.030	0	0	0	10	2.0	0
6	4185	4179	Soft Clay (Matlock)	0.033	5.5	0.015	0	45	5.5	0
4	4179	4175	Liquefiable Sand	0.030	0	0	0	10	2.0	0
23	4175	4152	Soft Clay (Matlock)	0.033	6.9	0.010	0	100	6.9	0
1	4152	4151	Sand (Reese)	0.033		0	34	120	16.4	62.4

Other Considerations

Corrosion of Pipe Pile

Reduce Pipe pile wall thickness by 1/16 inch to account for corrosion.

Group Effects

Use P-Multipliers for pile groups as outlined in AASHTO LRFD 2006 Interim Section 10.7.2.4

Abutment Fill

For the length of the pile extending through the abutment fill:
For Effective Unit Weights use 0.069 pci (regular weight) or 0.046 pci (pumice)
Assume Friction Angle of 38 degrees. Consider reduced parameters for loading towards MSE wall face.

MSE Walls

For piles located less than 6B from MSE wall, use P-Multiplier of 0.3 or less for the MSE fill layer when loading is perpendicular to MSE wall face. MSE wall designer should be notified if MSE fill will be relied upon for lateral pile resistance.

Legacy Parkway Project

Summary of Lateral Earth Pressure Recommendations

Recommended Soil Parameters

Fill Description	Total Unit Weight (pcf)	Internal Friction Angle (degrees)	Cohesion (psf)	Comments
Sandy Gravel	150	38	0	Recommend 150 pcf and 38 degrees for loads, and 125 pcf and 34 degrees for resistance.*
Silty Sand	125	34	0	
Pumice	85	38	0	Recommend 85 pcf for loads and 80 pcf for resistance.*

*Recommendations per Memo dated April 18, 2006

In the equations listed herein:

γ = effective unit weight of soil

H = height of wall

(1) Active Lateral Earth Force (yielding walls)

$P_A = 0.5K_A\gamma H^2$ (triangular distribution)

$K_A = 0.24$ for Sandy Gravel and Pumice

0.28 for Silty Sand

(2) Passive Lateral Earth Force (yielding walls)

$P_P = 0.5K_P\gamma H^2$ (triangular distribution)

$K_P = 4.2$ for Sandy Gravel and Pumice

3.5 for Silty Sand

(3) At-Rest Lateral Earth Force (non-yielding walls)

$P_O = 0.5K_O\gamma H^2$ (triangular distribution)

$K_O = 0.38$ for Sandy Gravel and Pumice

0.44 for Silty Sand

(4) At-Rest Lateral Earth Force Modified for Compaction (non-yielding walls)

Use if activity of mechanical compaction equipment is anticipated within a distance equal to half the wall height.

General Equations for walls less than about 8 feet high

$P_O{}^* = 0.5K_O\gamma H^2$ (triangular distribution)

$K_O{}^* = 2.8$ for Sandy Gravel and Pumice

Walls greater than 8 feet high should be considered on a case-by-case basis. Pressures listed above may be reduced by limiting size of compaction equipment permitted within a distance equal to half the wall height.

(5) Seismic Lateral Earth Forces (yielding walls)

Probabilistic Peak Ground Accelerations

General Bridge Site Location	10% PE in 50 Years	2% PE in 50 Years
From Mill Creek North	0.22g - 0.26g	0.60g - 0.63g
South of Mill Creek	0.26g - 0.30g	0.65g - 0.73g

Equations by Okabe (1926) and Mononobe and Matsuo (1929), referenced in Kramer (1996)

Total Active Thrust

$P_{AE} = 0.5K_{AE}\gamma H^2$

K_{AE} = (see table below)

Dynamic Component

$\Delta P_{AE} = P_{AE} - P_A$

P_A has triangular distribution (resultant at H/3 above base of wall)

ΔP_{AE} acts at about 0.6H above base of wall (same direction as P_A)

(5) Seismic Lateral Earth Forces (continued from previous page)

Total Passive Thrust

$P_{PE} = 0.5K_{PE}\gamma H^2$

K_{PE} = (see table below)

Dynamic Component

$\Delta P_{PE} = P_P - P_{PE}$

P_P has triangular distribution (resultant at H/3 above base of wall)

ΔP_{PE} acts at about 0.6H above base of wall (opposite P_P)

Dynamic Earth Pressure Coefficients (for minimal wall displacement)*

Case	Friction Angle	Peak Ground Acceleration			
		0.25	**0.30**	**0.63**	**0.73**
Active (K_{AE})	**38**	0.35	0.38	0.65	0.77
	34	0.41	0.44	0.75	0.92
Passive (K_{PE})	**38**	3.77	3.68	3.01	2.76
	34	3.14	3.05	2.39	2.11

* Assumes k_h = 0.8PGHA. See memo dated April 18, 2006

*Dynamic Earth Pressure Coefficients (for wall displacement up to 10A inches**)*

Case	Friction Angle	Peak Ground Acceleration			
		0.25	**0.30**	**0.63**	**0.73**
Active (K_{AE})	**38**	0.31	0.32	0.44	0.49
	34	0.36	0.37	0.51	0.56
Passive (K_{PE})	**38**	3.94	3.89	3.51	3.38
	34	3.29	3.24	2.89	2.77

** Assumes k_h = 0.5PGHA. See memo dated April 18, 2006

(6) Seismic Lateral Earth Pressures (non-yielding walls)

Equations by Wood (1973), referenced in Kramer (1996)

Dynamic Thrust

$\Delta P_{eq} = a_h\gamma H^2$

a_h= Peak Ground Acceleration Coefficient (PGA/g)

Dynamic Overturning Moment

$\Delta M_{eq} = 0.53a_h\gamma H^3$

Point of Application of Dynamic Thrust

$h_{eq} = \Delta M_{eq}/\Delta P_{eq}$

$\approx 0.53H$

References

Kramer, S. (1996). "Geotechnical earthquake engineering," Prentice Hall, Upper Saddle River, NJ.

Mononobe, N. and Matsuo, H. (1929). "On the determination of earth pressures during earthquakes," *Proceedings, World Engineering Congress,* 9 p.

Okabe, S. (1926). "General theory of earth pressures," *Journal of the Japan Society of Civil Engineering*, Vol. 12, No. 1.

Project: Pedestrian Trail over Legacy Parkway (P-21)
Date: 6/9/2006

PASSIVE LATERAL EARTH PRESSURE ON BENT PILE CAPS IN NATIVE SOIL

use $\sigma_p = K_p\sigma_v' + 2c_u(K_p)^{1/2}$

where: K_p = 1.0 for cohesionless soil

c_u = undrained cohesion = 550 psf

σ_v' = vertical effective stress = $\gamma'z$

assume: γ = 115 pcf

γ' = 115 - 62.4 = 52.6 pcf

z = depth (ft)

$$\sigma_p = 1.0(52.6\ \text{pcf})z + 2(550\ \text{psf})(1.0)^{1/2}$$
$$= 52.6z + 1100\ \text{psf}$$

Example