Rockfall Analysis

Pacific Gas and
Electric Company

Geosciences Department
245 Market Street, Room 418B
Mail Code N4C
P.O. Box 770000
San Francisco, CA 94177
Tel: (415) 973-2480
Fax: (415) 973-5778

Mr. Richard D. Hagler
PG&E Diablo Canyon Power Plant
ISFSI Project Engineer
800 Price Canyon Road
Pismo Beach, CA 93449

May 1, 2003

RE: Transmittal of Rockfall Hazard Evaluation and Mitigation Design Report

Dear Mr. Hagler,

Transmitted herewith please find the report entitled "Rockfall Hazard Evaluation and Mitigation Design, PG&E Diablo Canyon ISFSI Project" dated April 30, 2003, prepared by Mr. Jeff Bechhuber of William Lettis and Associates. Joseph Sun and William Page of PG&E Geosciences Department reviewed and commented on the draft report and the comments were incorporated into the final report dated April 30, 2003. This work was performed in response to A0574914 AE08.

If you have any questions, please feel free to call.

Joseph Sun
Geosciences Technical Coordinator, DCPP ISFSI Project

Enclosures:

1. Transmittal letter from Charles Brankman of William Lettis Associates to Joseph Sun, dated April 30, 2003
2. Technical Report Entitled "Rockfall Hazard Evaluation and Mitigation Design, PG&E Diablo Canyon ISFSI Project", includes 3 Tables, 7 Figures, and 6 Attachments.

WLA

William Lettis & Associates, Inc.

1777 Botelho Drive, Suite 262, Walnut Creek, California 94596
Voice: (925) 256-6070 FAX: (925) 256-6076

May 1, 2003

Dr. Joseph Sun
Pacific Gas & Electric Geosciences Department
245 Market Street, Room 421, N4C
San Francisco, CA 94177

Subject: Transmittal of Rockfall Hazard Evaluation and Mitigation Design, PG&E Diablo Canyon ISFSI Project, text and tables 2 and 3.

Dear Joseph:

This transmittal letter covers the transmittal of the following items:

Text of the report entitled "Rockfall Hazard Evaluation and Mitigation Design, PG&E Diablo Canyon ISFSI Project".

Table 2, "PG&E Diablo Canyon ISFSI Rockfall Modeling Input Data – ROCFALL"

Table 3, "PG&E Diablo Canyon ISFSI Rockfall Modeling Input Data – CRSP"

Appendices for this report were transmitted under separate cover.

Please do not hesitate to contact me or Jeff Bachhuber if you have any questions or require further information.

Yours truly,
WILLIAM LETTIS & ASSOCIATES, INC.

Charles M. Brankman, R.G.
Project Geologist

WLA

ROCKFALL HAZARD EVALUATION AND MITIGATION DESIGN
PG&E DIABLO CANYON ISFSI PROJECT

April 30, 2003

REGISTERED GEOLOGIST
JEFF BACHHUBER
EG 1534
ex. 5/31/04
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

Preparer: Jeff L. Bachhuber, William Lettis & Associates, Inc.
Certified Engineering Geologist No. 1534

REGISTERED GEOLOGIST
CHARLES M. BRANKMAN
exp 3/31/05
7426
STATE OF CALIFORNIA

Technical Reviewer/Checker: Charles M. Brankman
Registered Geologist No. 7426

Table of Contents

List of Tables

List of Figures

List of Attachments

1.0 PURPOSE

This report addresses the slope mitigation basis, analysis, and design criteria for possible earthquake-induced rockfall at the PG&E Diablo Canyon ISFSI. Figure 1 shows the location and layout of the ISFSI and hillslope that was evaluated for rockfall hazard and mitigation design. The rockfall evaluation was performed to provide additional information regarding the design basis for a rockfall catchment fence that will be constructed above the ISFSI to mitigate possible rockfall hazard.

The rockfall evaluation was performed by William Lettis & Associates, Inc. (WLA) under Pacific Gas & Electric Company (PG&E) Contract Work Authorizations Nos. 1223-92 and 1223-93. Specific tasks included:

- Review of the SAR and supporting documents;
- Development of rockfall models and input parameters;
- Rockfall analysis using the RocFall and CRSP computer programs;
- Compilation and review of rockfall mitigation approaches; and,
- Preparation of this memorandum.

The rockfall evaluation was performed by Jeff L. Bachhuber, C.E.G., and Charles M. Brankman, R.G. of WLA, with modeling assistance from Sean Sundermann of WLA. Internal WLA review was performed by Dr. William R. Lettis, C.E.G. Dr. Joseph Sun and Dr. William Page of PG&E Geosciences Department provided technical review and project oversight.

The following attachments provide the results from our rockfall analysis, backup design information, and case studies for the proposed rockfall catchment fence.

Attachment A – ISFSI Civil Design and Layout
Attachment B – Site Photographs
Attachment C – RocFall Program Model, Analyses Output, and Verification
Attachment D – CRSP Program Model and Analyses Output
Attachment E – GeoBrugg Rockfall Catchment Fence Manufacturer's Information
Attachment F – GeoBrugg Rockfall Catchment Fence Case Studies

2.0 POTENTIAL HILLSLOPE INSTABILITY DURING DESIGN BASIS EARTHQUAKE

Based on the ISFSI studies, strong ground shaking associated with the design basis earthquake could potentially trigger rockfall on the hillslope above the facility, but the likelihood and potential hazard of rockfall are believed to be low. However, because the ISFSI is a sensitive nuclear facility, specific rockfall mitigation is included in the ISFSI design to provide a high level of safety against these low probability events.

Potential rockfall could occur from two sources: (1) random small, loose rock blocks present on the face of the slope, and (2) rock blocks and slabs detached from the overthrust toes of possible rock slide masses that move over clay beds that locally dip out of the slope above the ISFSI. These are discussed below.

Random blocks on the face of the slope that are potentially susceptible to rockfall are typically between 1- to 2-feet in maximum dimension. These rocks include loose blocks on the face of the slope left by past construction (1971 borrow activities) or exploration on the hillslope, and dilated surficial blocks on the surface of bedrock outcrops. These blocks currently are stable under static conditions, and have not moved during past periods of heavy precipitation. No past rockfall has been noted at the site from these sources, suggesting that they would require strong ground shaking to initiate rolling. Because these rocks are inherently stable under present conditions, and because significant shaking would be required to initiate rolling, the random small blocks would likely roll slowly down the slope with little bouncing. Such rocks probably would be easily and quickly stopped by the tower access road bench, and by interaction and friction between the rock and the slope. The impact energy from the small random blocks on the slope would be much less than the energy from larger rocks released from the toes of bedrock sliding overthrusts, and therefore do not control mitigative design.

The other potential source of earthquake triggered rockfall is detached blocks from overthrust toes of large sliding masses over clay beds. The toe overthrusting could destabilize larger rock blocks (on the order of about 2- to 3-feet, and possibly up to 6-feet in maximum dimension) formed by intersecting joints that currently are keyed-into the rock mass in a stable configuration under present conditions. The overthrust portion of the rock, and the jointed rock immediately behind the overthrust, could be free to move out of the slope to form a rockfall hazard. Three potential slide masses were modeled during past ISFSI studies that conservatively bracket possible rock mass movements over clay beds in the bedrock: Models 1, 2, and 3 (Figures 2 through 4). These possible rock mass movements are low-likelihood events that represent worst-case slope movements during the design basis earthquake, and only could occur considering a number of conservative assumptions regarding clay bed thickness and lateral continuity, strength, and earthquake loading on the rock mass. As presented in the Safety Analysis Report (SAR; October, 2002), potential maximum rock mass displacements along clay beds in the hillslope during the design-basis earthquake range from 1 to 3 feet on the natural slope above the ISFSI cutslope, and from 1 to 2 feet on clay beds inferred to daylight at the cutslope mid-slope bench and toe. Potential hazards to the ISFSI from seismically-induced slope movements include rockfall from the overthrust toe region of the modeled rock slide mass models that daylight above, or in, the ISFSI pad cutslope (Figures 2 and 3), and localized heaving and deformation in the toe region of the deepest clay bed slide mass models that daylight at the base of the ISFSI cutslope (Figure 4) (SAR Sections 4.2.1.1.9.2). The geometry of the overthrust slide mass toes and rock mass jointing provide constraints on the potential size and shape of rockfall, as discussed below. The potential overthrust toes could generate larger rocks than the random loose rocks on the hillside discussed previously, and also would tend to have greater initial rotational velocities and horizontal trajectories. Therefore, the overthrust toe rockfall source is the controlling source for the ISFSI rockfall mitigation.

The modeling considered rockfall initiation at the four daylighting locations of the potential clay bed sliding overthrusts (Figures 1 through 5). These locations also conservatively bracket the possible locations of random rockfall from small blocks on the face of the slope, which are relatively insignificant in terms of inertial energy in comparison to the overthrust rockfall.

3.0 BASIS FOR EARTHQUAKE-INDUCED SLOPE MOVEMENTS

The basis for mitigation of seismically-induced slope movement includes the results from the ISFSI site geologic investigations summarized in Calculation Package GEO.DCPP.01.21, the results from the clay bed slope stability and deformation analysis summarized in Calculation Package GEO.DCPP.01.26, and the results from wedge sliding pseudostatic stability analysis of the ISFSI cutslope presented in Calculation Package GEO.DCPP.01.23. The analyses of rockfall hazard, and design criteria for rockfall mitigation, are described in the following sections.

Based on the geologic characterization of the ISFSI site presented in GEO.DCPP.01.21, seismically-induced slope movements would be localized along clay beds in the dolomite and sandstone bedrock. Results from the site investigation were used to determine the locations and geometries of clay beds in the ISFSI site area, and to define possible slide mass models for the slope stability and deformation analysis

(Figures 2 through 4). The modeled slide masses have basal failure planes along identified clay beds in the rock mass, and are bounded in the upslope direction by stair-stepping tensional detachment zones that break up from the clay beds through the jointed rock. Calculation Package GEO.DCPP.01.21 describes the procedures and basis for development of the rock mass slide models. The rock mass slide model failure planes were previously developed and analyzed for Section I-I' (Figures 2 to 4). For rockfall analysis of Section A-A', the locations of the rock mass models and basal clay zones were extrapolated from Section I-I' with consideration for the bedding dip direction and magnitude (Figure 5). We note that it is possible that the clay beds do not extend laterally between Sections I-I' and A-A'; therefore, the assumption of clay bed continuity is conservative. Because bedrock bedding dips westward, the clay bed locations were projected updip and occur at a higher elevation in Section A-A'.

The stability and deformation analyses performed in Calculation Package GEO.DCPP.01.26 provide calculated slope deformation magnitudes for the clay bed slide mass models for the design-basis earthquake loading conditions. The calculated earthquake-induced slope movements involve translation of the rock slope as a relatively coherent block over the clay beds with relatively little internal disruption and deformation within the sliding block itself. As a result, the rock mass movements are localized along the sliding block margins, and would result in the formation of a linear zone of cracking and settlement at the headscarp tension crack, and overthrusting of rock at the toe of the sliding mass above the clay bed. The locations of clay bed daylighting/overthrusting locations are shown on Figures 2 through 5. The overthrust toe region would be susceptible to calving and progressive raveling of detached rock blocks, and represents the primary source of earthquake-generated rockfall and potential hazard to the ISFSI. Calved/raveled blocks in the overthrust lip would detach from the rock mass along pre-existing, steeply-inclined joints that sole out and daylight in the overthrust zone, or that exist directly behind the overthrust lip. The size of the calved and raveled rocks from the overthrust toe region would be controlled by the size of the overthrust lip (between 1 and 3 feet; Figure 6), and the joint spacing in the rock mass which averages between 1 and 3 feet (Figure 7) as described in SAR Section 2.6.5.2.2. Based on these calculated ranges of displacements and rock mass joint spacing, likely maximum dimensions of rock blocks that could be dislodged from the clay bed overthrust regions are between 1 and 6 feet, with a most-likely range of between 1 and 3 feet. The geometry and size of possible blocks released at the slide overthrusts is discussed in Section 4.4.3.

Calculation Package GEO.DCPP.01.23 presents the basis for the ISFSI cutslope design and slope stabilization. Design parameters were developed for a rock anchor support system (30-foot long post-tensioned rock anchors on 5-foot centers, and wire-mesh-reinforced shotcrete) to maintain the static and dynamic stability of the 70 degree cutslope. The rock anchor support system is designed to provide direct support to the face of the ISFSI cutslope, and to reinforce the rock mass in the potential stress-relieved zone that will develop directly behind the cut in response to excavation. The rock anchor design will be locally modified, as needed, to address possible lower-strength friable rock zones that may be encountered in the cut excavation. The cutslope rock anchor system is not intended to resist the potential large-scale bedrock mass sliding. However, the toes of slide mass models 3a, 3b, and 3c daylight in, or at the base of, the rock anchor-reinforced cutslope (Figure 4). The basal plane for slide mass Models Nos. 3a and 3c toe-out below the cutslope anchors. The basal plane for slide mass model 3b toes-out at the back of the cutslope mid-slope bench, and projects through, or between, one or two rows of anchors. Because the rock slope failure mode involves planar translation over the clay beds with little internal deformation, the rock anchor reinforced cutslope and supported rock mass should be able to accommodate the possible clay bed translation without significant internal disruption or global cutslope failure. The tensioned rock anchors and anchored wire-reinforced shotcrete may experience localized heaving and cracking at the overthrust toe region of the clay bed slide masses, but should still be able to restrain any possible large rock blocks from falling out of the cutslope. The ISFSI pad is set back from the toe of the cutslope a distance of 41 feet. This setback provides a significant buffer zone to catch any possible minor small rockfall or small spalled chunks of shotcrete from the lower part of the cutslope, and provides a substantial separation between the pad and zone of possible deformation at the toe-of-slope daylight of slide mass model No. 3a and 3c. In addition, the cutslope includes a 25-foot-wide mid-slope horizontal bench. The significant width of the bench should effectively catch any possible small rocks released from the upper part of the cutslope (above the bench), and also provides a wide buffer zone to accommodate the calculated 1- to 2-foot of displacement for the slide mass model No. 3b that toes-out in the vicinity of the bench location.

4.0 ROCKFALL ANALYSES INPUT AND ASSUMPTIONS

4.1 General

The potential hazard to the ISFSI from rockfall was evaluated using state-of-practice evaluation methods (e.g., Federal Highway Administration (FHA); 1994) that include development of topographic cross sections along the rockfall paths, sensitivity analysis of key input parameters such as surface roughness and coefficient of restitution, evaluation of source rock characteristics, and iterative rockfall modeling using the RocFall computer program (Rocscience, Inc., 2002). Attachment F includes two case studies of rockfall analyses that incorporate these elements, and that are similar to the analysis proposed for the ISFSI project.

The RocFall program was selected as the preferred design basis program because of the following:

- RocFall was found to accurately model the observed and historic field performance of the ISFSI hillside and typical behavior predicted for slopes of the same inclination by Keefer (1984), Ritchie (1963), and the Federal Highway Administration (1991);
- Verification of the program is well-documented;
- RocFall permits probabilistic evaluation and complete sensitivity analyses of variation in the input parameters;
- The program was found to be stable with repeatable modeling runs;
- RocFall has received wide commercial use; and,
- The program has been reviewed by Dr. E. Hoek (Hoek, 2000).

In addition to RocFall, a second rockfall analysis program, the Colorado Rockfall Simulation Program (CRSP), was used to provide additional information and evaluation. However, the CRSP program was found to be less stable than the RocFall program, and the model output was contrary to observed field behavior. The CRSP results appear to be over-conservative with respect to rockfall runout distances, as discussed in Section 5.0.

The analysis approach for development of the input for the ISFSI rockfall modeling is outlined below:

- Evaluate past slope performance;
- Determine rockfall source locations and mechanics;
- Develop detailed topographic cross sections along rockfall paths;
- Evaluate source rock characteristics (dimensions, shape, hardness);
- Evaluate slope characteristics (roughness, coefficient of restitution, vegetative cover);
- Develop seismic loading initiation;
- Iterative rockfall computer modeling; and,
- Review of modeling results and development of mitigative design.

4.2 Slope Inclination and Past Slope Performance

The inclination of the hillslope above the ISFSI pad and cutslope is relatively gentle, on the order of about 15 to 21 degrees. Most rockfall occurs on slopes exceeding an inclination of about 40 degrees (Keefer, 1984; California Division of Mines and Geology, 1997), suggesting that the ISFSI hillslope is inherently stable against rockfall. Additionally, rockfall design charts and assessment methods developed by Ritchie (1963), and used by the Federal Highway Administration (e.g., FHA and U.S. Department of Transportation Manual "Rock Slopes"; 1991), predict that rockfalls on slopes with an inclination of less than 30 degrees should roll down slopes without significant bouncing. This suggests that possible rockfall on the hillslope above the ISFSI should roll over the surface with correspondingly low velocities.

No evidence of historic or prehistoric rockfalls were observed on the ISFSI slope area during our review of pre- and post-construction aerial photographs (refer to Calculation Package GEO.DCPP.001-21). Additionally, no significant rockfalls have occurred on the hillslope since the borrow cut excavation was made in 1971, further suggesting that the slope is not prone to rockfall under static conditions. Rainfall is one of the primary triggers for rockfall (e.g., Hoek, 2000), and the ISFSI hillslope has experienced periods of high rainfall numerous times (e.g., 1982/83, 1996) since the 1971 borrow excavation was completed without observed rockfall events.

During ISFSI site exploration activities, 22 test trenches and a switchbacking drill rig access road were excavated in the slope above the ISFSI cutslope area (Photos 1 and 2; Attachment B). These excavations were made through, and above, the bedrock slide model overthrust locations, and were made with tracked excavators and bulldozers that moved up and around on the hillslope. Thousands of rock blocks in the size range of 6 inches to about 2.5 feet in maximum dimension were excavated from the slope and placed in spoil piles on the slope adjacent to the test trenches and road excavations (Photos 3 through 5). Occasional blocks larger than 2.5 feet (and up to a maximum of about 4.5 feet) were also encountered during excavation, but these represented less than about 1% of the excavated blocks. Test trench excavation in some cases met refusal in massive, keyed-in rock below a surface veneer of talus and weathered rock. The spoil piles typically had sideslope inclinations on the order of 35 to 45 degrees, and were placed on slopes ranging in inclination from about 15 to 21 degrees. Excavated rock blocks were dumped out of the excavator bucket onto the spoil piles, or pushed into the spoil piles by the bulldozer blade. During the excavation and equipment movement activities, rock blocks only slightly shifted or stayed in place, and only two out of many thousands of rock blocks were observed to roll farther than a foot or two down the slope. One of these blocks, a 4.5 foot angular block, was dislodged from the slope when pushed downhill by the bulldozer blade, and slowly rolled several tens of feet downhill until it stopped on an inclined slope area. The other rock, a 1 to 1.5 foot subangular block, rolled down the slope several hundred feet before stopping on the inclined slope near the base of the hill in the ISFSI pad area. Both rocks rolled slowly over the slope surface without bounding. The smaller block rolled farther than the larger block, contrary to typical rockfall behavior where large blocks usually roll farther than small blocks. However, in this case, the small block was a single occurrence from a potential "pool" of thousands of blocks (and represents a small fraction of a percent of available blocks), and therefore does not represent typical behavior. The remaining blocks that were placed in the spoil pilesor that were shifted on the slope during equipment movement, remained in place, even on the steep or spoil pile slopes (Photos 1 and 2). This behavior indicates that loosened angular rocks on the 15 to 21 degree slope above the ISFSI do not tend to roll over the slope, even when pushed or dropped by excavation equipment.

4.3 Topographic Surveys and Analysis Profiles

Rockfall modeling was performed using two programs (RocFall and CRSP) on two surveyed cross sections: Sections A-A' and I-I' (Figures 1, 2 and 5). These sections extend upslope subnormal to the proposed ISFSI cutslope, and are oriented parallel to the most-likely direction of earthquake-induced slope movements. The topographic surveys, and basis for estimation of the earthquake-induced slope movement directions, are discussed in Calculation Package GEO.DCPP.001.21, rev. 1.

The topography along sections A-A' and I-I' were manually checked against the original topographic survey data, and was used to construct detailed slope profiles for input into the RocFall and CRSP computer models. The computer model profiles are included in Attachments C and D. Each of the profiles were constructed with control points at 10-foot horizontal spacings, and include topographic features such as slope breaks, and the tower access road benches.

4.4 Source Rock Characteristics

4.4.1 Rock Block Shape and Hardness

The source strata for earthquake-induced rockfall are dolomite (primary) and sandstone (secondary) beds. Based on site geologic investigations (GEO.DCPP.01.21, rev. 2), the dolomite and sandstone rock blocks are moderately hard to hard, and relatively angular. Rockfall blocks, therefore, would be relatively hard and tend to stay intact without significant breakage and desegregation, and the angular shape of the blocks would tend to resist rolling. The RocFall computer model uses only spherical rock shapes, while the CRSP computer program allows the user to select from three default shapes: spheroidal, cylindrical, and disk-shaped. The angular rock blocks at the ISFSI are better represented in a model by a square or rectangular shape. Therefore, the modeled shapes used in the rockfall modeling are conservative (round for RocFall, and cylindrical for CRSP).

4.4.2 Surface Roughness

Surface roughness along the rockfall trajectory path is an important input parameter for rockfall modeling. The slope surface between the rockfall source zones and the ISFSI cutslope location is relatively rough, with a surface irregularity on the order of about 6-inches to 2-feet formed by discrete rock boulders, outcrops, and slope indentations. The rock surface is covered by a thin veneer of rock rubble, and soil in places, that locally tends to smooth out the surface profile to the lower value of 6-inches. The tower access road surface also has a surface roughness of about 6-inches across the width of the road bed.

Values for our modeling of surface roughness were determined by consensus of three WLA geologists by review of detailed photographs of the slope obtained during site exploration (e.g., Photos 3 through 6). Although the range in surface roughness is from 6-inches to 2-feet, a value of 6-inches was used for the computer rockfall modeling programs. This value is believed to be conservative, and results in overprediction of rockfall rolling distances and impact energies for portions of the slope that are rougher than this value, especially for the CRSP program. Areas that are rougher than the 6-inch value typically are uphill from the tower access road. Surface roughness affects different rock block sizes to varying relative degrees. For example, a 6-inch surface roughness value is ½ the height of a 1-foot block, yet only 1/20th the height of a 10-foot block. Correspondingly, the 6-inch surface roughness would tend to inhibit or arrest the rolling of a 1-foot block much more than for the 10-foot block. This size-roughness ratio is automatically accommodated by the CRSP program, and only one value of surface roughness needs to be input. The RocFall program handles the roughness input differently. Roughness is input as an angle deviation from the slope profile. The influence of surface roughness relative to block size was accommodated in the RocFall program by determining the angular ratio between the block and surface roughness using the formula: $\theta = \tan^{-1}(S/R)$; where θ is the differential slope angle, S is the measured or estimated surface roughness, and R is the radius of the rock block.

4.4.3 Block Size/Mass

The size of a rockfall block is a significant factor that has a high influence on the rolling distance and impact energy. As discussed previously, the size of calved and raveled rocks from the overthrust toe regions of possible bedrock mass movements above the ISFSI would be controlled by the size of the overthrust lip (between 1 and 3 feet; Figure 6), and the joint spacing in the rock mass which averages between 1 and 3 feet (Figure 7). Photographs of typical rock mass discontinuity spacings from exploratory trenches in the rockfall source zone areas are included in Appendix B. A further basis for determining rockfall block sizes is evaluation of the size of blocks that break out of the rockmass during the excavation of the exploratory trenches and drill rig access road. The excavated blocks typically were between about 6 inches and 2.5 feet in maximum dimension, with the largest blocks up to about 4.5 feet. Very few blocks larger than about 2.5-feet in dimension were excavated from the slope.

The size of the potential blocks that could be released from bedrock slide overthrusting was evaluated by geometric construction and trigonometry using the slope inclination, inclination of clay beds forming the basal slide plane, and typical joint spacing, as shown in Figure 6. These potential blocks represent the greatest potential rockfall hazard, as described previously in Section 2.0. The overthrust blocks would likely have high height-to-length ratios that are controlled by the thickness of the overthrust lip, and would be triangular to rectangular in cross section (Figure 6). Maximum block heights would be on the order of 2 to 3 feet, and are controlled by the thickness of the overthrust lip (Figure 6). The maximum block width (measured along contour) is controlled by the dominant northwest- to northeast-trending, steep joint sets that are spaced about 1 to 3 feet apart, and impart a fabric in the rock mass. Based on the joint spacing, the maximum block width would be about 3 feet. The maximum block length (measured into-the-slope) ranges between 3 feet (the maximum length of the overthrust) and 6 feet, considering the possibility of widely-spaced slope-parallel joints (Figure 6), and an uphill release surface located at twice the typical joint spacing. Therefore, our calculated upper bound rock block that can be reasonably expected to fall from the overthrust lip based on geologic conditions and slope geometry is an angular (triangular to rectangular) block with the dimensions of 2x3x6 feet, or an equivalent mass of about 5,112 pounds using a typical dolomite and sandstone unit weight of 142 pounds per cubic foot. This geologically-based upper bound block is referred to as the "6 foot" block for the rest of this report, and for rockfall modeling. Because the ISFSI is a sensitive facility, and the approach for rockfall mitigation is a defense-in-depth approach, a larger hypothetical angular block with maximum dimensions of 2.5x5x10 feet was considered in the analysis to check the safety margins for calculated kinetic energy for the upper bound 6 foot block. The hypothetical 2.5x5x10 foot block is referred to as the "10 foot" block for the rest of the report and rockfall modeling. We note that the 10-foot block is not supported by the geologic and slope conditions, and predicted size of bedrock slide overthrust lips, and represents an extreme upper bound rock block that has a very low probability for occurrence. The equivalent mass of the 10 foot block is 17,750 pounds. It should be noted that the typical joint spacing of 1 to 3 feet in the rock mass make it relatively unlikely to form an intact rock block that has maximum lengths exceeding one or two-times the length of joint spacing without breaking up into smaller blocks.

The rockfall modeling programs do not allow input of irregular, angular block shapes, and simplify the rock geometry into equivalent spheres or rounded columns or disks. The equivalent maximum mass for the 6 foot upper bound block relates to a sphere with a diameter of about 4.5 feet diameter, or a rounded column with a diameter of 2.8 feet and length of 6 feet. The equivalent maximum mass for the 10 foot block relates to a sphere with a diameter of about 6.8 feet, or a rounded column with a diameter of 4.0 feet and length of 10 feet. Spherical rocks of diameters between 1 and 10 feet were modeled in the RocFall program to conservatively bracket the possible rockfall block sizes (Table 2). We note that the 10 foot diameter sphere has a mass significantly greater than the previously-described 10 foot angular block. Three rounded columnar rocks were modeled in the CRSP program to evaluate kinetic energy bracketing the maximum rockfall block masses: columns with a diameter-to-length aspects of 3x3 feet, 3x6 feet, and

5x10 feet (Table 3). The masses for the 3x6 and 5x10 foot columns significantly exceed those corresponding to the 6 foot upper bound block and 10 foot hypothetical block.

4.4.4 Coefficients of Restitution

The interface effects between the rolling or bounding rockfall block and the slope are factored into the rockfall computer models by inputting "coefficients of restitution". Two coefficients of restitution are input: the coefficient tangential to the slope/bounding block, and the coefficient normal to the slope surface. The coefficients of restitution are used to calculate energy loss by non-perfectly elastic collisions between the block and the slope which results in loss of kinetic energy, and corresponding reductions in velocity, bounce height, and impact energies. In general, the harder the slope, the higher the coefficients of restitution. The tangential coefficient determines how much the component of rock velocity parallel to the slope is reduced during impact. Vegetation, and to a lesser degree, rock or soil hardness and composition, influence the tangential coefficient. In a soft slope, the rock block can imbed into, or shear through, the surface materials, reducing the rotational energy of the falling rock, and slowing the rock to a greater degree with respect to a clean, hard surface with a high tangential coefficient of restitution. The normal coefficient of restitution is a measure of the change in the velocity normal to the slope after impact, compared to the normal velocity before impact. The normal coefficient is determined by the rigidity of the surface. A soft slope with low rigidity and normal coefficient of restitution causes a greater loss of energy during collision, and reduces the bounce height as compared with a hard rock surface.

We assigned different values of coefficient of restitution for two different materials encountered along the analyses cross sections: (1) general slope, and (2) tower access road surfaces. These coefficients were established on the basis of literature review of similar slope conditions and materials (e.g., Hungr and Evans, 1988; Robotham and others, 1995; FHA, 1994; Pfeiffer and Bowne, 1989; and Pfeiffer and Higgins, 1990), and our experience on previous projects. These values have been developed on the basis of rockfall field experiments and modeling case studies. The corresponding values of coefficient of restitution for these materials are presented in Table 1.

Table 1. Values of Coefficient of Restitution Used for Rockfall Modeling.

Material	Tangential Coefficient (Rt)	Normal Coefficient (Rn)
General Slope	0.83 (Stnd.Dev. of 0.04)	0.35 (Stnd.Dev. of 0.04)
Tower Access Roads	0.73 (Stnd.Dev. of 0.05)	0.40 (Stnd.Dev. of 0.05)

The values selected for the general slope are intermediate between values for hard bedrock outcrops and boulders, and talus. This is reasonable because the overall slope is approximately 25% interspersed rock outcrops separated by rock talus, and about 75% rock talus and soil.

As a comparison, the following values are reported for other slope conditions or materials ((Rocscience, 2002):

- hard, clean rock surface: Rt 0.9+, Rn 0.35
- wood plank: Rt 0.69, Rn 0.38
- soft soil slope: Rt 0.80, Rn 0.30

4.5 Initial Seismic Velocity

The RocFall and CRSP rockfall programs both permit an initial outward velocity for the rockfall blocks to mimic a triggering event such as earthquake shaking or disturbance by excavating equipment. It is common to use an initial starting velocity to initiate movement of the rolling block. Without this initial velocity, some of the models would not initiate rock rolling. For the ISFSI analysis, the initial velocity is used to model a triggering pulse of earthquake shaking. An initial horizontal velocity of 7.5 feet/second were input into the rockfall models. This value is comparable to the maximum calculated peak particle velocity for the 5 sets of rock input motions used for the slope stability analyses, resulting in maximum moving block velocities of 210 centimeters/second (7 feet/second) (J. Sun email correspondence, April 11, 2003). It is noted that the peak velocities usually occur concurrent with the strongest pulses of earthquake shaking, and that the rock overthrusting may lag somewhat in time behind the greatest velocity pulse. Therefore, the use of the 7.5 feet per second initial velocity is a conservative assumption.

The RocFall program also allows for an optional initial rotation velocity to that is superimposed on the horizontal initial velocity to represent a toppling-type initial movement of the rock block. We used an initial rotational velocity of 3 radians/second (approximately 180 degrees/second) to represent an initial topple movement caused by calving of the rockblocks away from the overthrust lip of the theoretical clay bed sliding masses. The 3 radians/second initial rotational velocity is believed to be a conservative upper bound velocity caused by rapid toppling of the overthrust blocks. The rotational velocity of smaller blocks less than 2 feet in height could reach the values used in the modeling, but would likely be considerably less for blocks over about 2 feet in height.

4.6 Rockfall Modeling Methodology

4.6.1 General and Computer Modeling Function

Rockfall computer models simulate rockfall events by calculating the rock trajectories along a defined slope. Rockfall events are simulated by rolling test rocks over a user-defined slope model. The programs use Monte Carlo simulations to randomly change the input slope parameters within the prescribed ranges each time the simulated rock contacts the slope. This results in variation of the falling rock trajectory path and energy, artificially simulating field variation in these parameters. The algorithms used to develop the rockfall paths and slope reactions were developed on the basis of rock mechanics theory and field experiments of test rockfalls, and have been verified by comparing the program output against additional field testing and case studies. Multiple rocks are simulated to develop an envelope of rock trajectories, and to calculate statistical variations in trajectory, velocity, bounce height, and energy.

The computer programs allow the user to estimate the rockfall trajectory path, bounce height, velocity, and impact force at selected analysis points along the slope profile. This information is used to develop design criteria for rockfall mitigation measures such as catchment benches or ditches, fences, or walls. Output from the programs includes a profile of the slope with an envelope of simulated rockfall trajectory paths, and graphs or data tables that present rock velocity, bounce height, and kinetic energy either at user-defined, discrete analysis points, or for the trajectory path.

4.6.2 Software, Hardware and Licensing

The ISFSI modeling was performed using the RocFall Version 4.037 (Rocscience, 2002) program licensed to William Lettis & Associates, Inc. A separate check of some of the RocFall runs was performed by repeating runs with the same input values and cross section using the Colorado Rockfall Simulation Program (CRSP) Version 4.0 marketed by the Colorado Department of Transportation (CDOT, 2000), also licensed to WLA. Both RocFall and CRSP are standard computer programs that include instructional manuals and technical support, and are widely used in industry and by government agencies.

Analysis was performed on a DELL Inspiron model 8000 laptop computer running the Microsoft Windows XP operating system. The software was purchased by, and is licensed to, William Lettis & Associates, Inc. (WLA), and all analyses were performed by WLA at their Walnut Creek, California, office. The programs have not been modified from the versions purchased from Rocscience, Inc. or CDOT.

4.6.3 Verification and Program Performance

Manufacturer verification of the RocFall program is well-documented in a series of verification reports that are available for downloading from the Rocscience website at www.rocscience.com. Verification of the RocFall program was made by performing parallel hand calculations, and independent checking of the program algorithms. Field testing by the CDOT and California Department of Transportation to calibrate and verify the CRSP program. The field testing results are described in the CRSP manual (CDOT, 2000).

We checked and verified the correct function of the RocFall and CRSP programs by accurately emulating the program output from example programs and tutorials in the program manuals and documentation. An example problem check output for the RocFall program is included in Appendix C. Models, input data, and results were compiled and/or checked by a team of three WLA geologists Jeff Bachhuber, Charles M. Brankman, and Sean Sundermann. Initial iterative test runs were made on program example and tutorial problems, and the ISFSI slope models, to further test the correct operation of the programs by adjusting the input values to assess the relative impacts of changing these parameters.

We attempted to independently verify the RocFall and CRSP programs by performing parallel model runs with the same input parameters. However, the two programs provided significantly different outputs. For example, the RocFall program calculated that all rock spheres from 3- to 10-feet in size stop within 20 feet of the initiation point. Conversely, using the same models, the CRSP program calculates that all of the 3-foot cylinders, most of the 6-foot cylinders, and some of the 10-foot cylinders roll to the bottom of the slope. Program documentation describes that the RocFall program is particularly sensitive to changes in coefficient of restitution, whereas the CRSP program is especially sensitive to changes in surface roughness. The different algorithms in the programs process the input data in different ways, resulting in the differences in the program outputs. The RocFall program was stable throughout the modeling, and we were able to accurately repeat model runs accounting for slight changes resulting from the randomness imparted by the Monte Carlo simulation and variations in input parameters within the specified ranges. However, the CRSP program was not always stable, and often would crash in the middle of a run. Sometimes a model run could be repeated, but other times a model that ran previously would crash during attempted repeats. The final runs were accepted only after at least one repeat could be performed.

5.0 RESULTS

5.1 Overview

Analysis cross sections A-A' and I-I' are shown on Figures 2 through 5. The RocFall and CRSP computer program analyses sections and output runs are included in Attachments C and D, respectively. Tables 2 and 3 show the input values and summarized program output for RocFall and CRSP, respectively. All program runs made with RocFall and CRSP included 1000 separate rocks per run. The trajectory of each simulated rock was varied by the program using the user-defined input values and value ranges that are shown on Tables 2 and 3.

RocFall was the primary program used for analysis, and discrete runs were made for rockfall originating point ("seed points") at the theorized overthrust toe locations for slope analysis models 1a, 1b, 2a, and 2b. All of these seed point locations are on the slope above the proposed ISFSI cutslope and rockfall catchment fence. As discussed previously, the daylighting toe locations for slope models 3a, 3b, and 3c daylight in the cutslope mid-bench, or at the toe of the cutslope, and therefore should not produce potential hazardous rockfall. Each RocFall seed point location was analyzed for spheres of 1, 3, 6, and 10-foot diameter (refer to Section 4.4.3 discussion). CRSP runs were performed for seed point location was analyzed for model 2a and 2b seed point locations that daylight nearest to the ISFSI cutslope and rockfall catchment fence location, both for sections A-A' and I-I'. The CRSP runs were performed for round columns with diameter and length values of 3x3, 3x6, and 5x10 feet (refer to Section 4.4.3 discussion).

The analysis results for RocFall and CRSP vary significantly, primarily due to differences in the simulation algorithms used to calculate the rockfall trajectory paths. The input slope profiles and material properties were the same for both programs (Tables 2 and 3). None of the modeled spheres from the RocFall program reached the top of the ISFSI cut, or the proposed rockfall fence locations. Conversely, all, or almost all, of the 3- and 6-foot columns modeled by the CRSP program rolled past the top of the ISFSI cut and rockfall catchment fence locations (Tables 2 and 3). Additionally, some of the 10-foot columns in the CRSP runs reach the top of the ISFSI cut location. A fundamental difference between the programs is that larger spheres (greater mass) in the RocFall program tend to roll farther downslope than smaller spheres, but the opposite is true for the ISFSI CRSP runs, in which smaller columns typically roll farther downhill. This is contrary to the CRSP program manual that states that larger rocks modeled by the program should roll farther than smaller blocks (CDOT, 2000).

The RocFall modeling matches the historic performance of the ISFSI slope and rockfall behavior for slopes of similar inclination reported in the literature by Keefer (1994), Ritchie,(1963), and the Federal Highway Administration (1991). However, the results from the CRSP modeling are contrary to the historic ISFSI slope behavior and reported literature. For example, as discussed in Section 5.2, only two rocks rolled a significant distance (over about 1 to 2 feet) during the extensive site exploration trenching and drilling access track construction on the site that generated thousands of blocks that were dumped onto oversteepened spoil piles on the slope. One of these blocks rolled several tens of feet down the hill before stopping, comparable to the predicted response by the RocFall model. The other continued in a slow-rolling mode without bouncing to near the lower part of the slope. If the CRSP modeling was correct, most of the blocks loosened from the slope should have rolled down to the base of the hill. This would be unprecedented behavior for slopes of the same inclination (between about 15 and 21 degrees) reported in the literature.

5.2 RocFall Computer Model

Rockfall modeling was performed using the computer program RocFall v.4.037 (Rocscience, 2002) that simulates the bounce paths of rock blocks down a slope, and calculates block velocities and kinetic energies at user specified points along the slope. The RocFall program was developed as a Masters thesis project performed at the University of Toronto, Canada (Stevens, 1998). The program includes algorithms that permit specification of ranges for input parameters (coefficient of restitution, slope angle/roughness, material friction), and performs iterative "probabilistic" calculations that randomly sample the values within the specified ranges. The RocFall program has been comprehensively verified by the manufacturer, and is widely used by the engineering and transportation industry (e.g., Hoek, 2000).

The program generates numerous rockfall runs using Monte Carlo simulation, and produces a probabilistic distribution of trajectories. The bounce height and energy distributions for the model runs are determined for set calculation points designated on the profile. The RocFall program allows probabilistic rockfall evaluation by processing a range of values for slope profile, surface roughness, and coefficient of restitution (Rn and Rt) that the user inputs for each slope segment of the model profile. These values are varied for each simulated rock and for each impact point, imparting a radomness that affects rock trajectory and velocity and emulating actual field conditions.

The results from the RocFall analysis are shown in Table 2. Prior to production runs, numerous test iterations were made with the program to evaluate the effects of changing the following input parameters: initial velocity, slope roughness, and coefficients of restitution. The iterative testing showed that the RocFall model was primarily sensitive to changes in initial velocity and coefficients of restitution (for large changes in values such as Rn from 0.3 to 0.45, or Rt from 0.80 to 0.95). However, the model results did not change significantly when the values were kept within reasonable ranges for the ISFSI slope and material conditions.

The simplified sphere dimensions are very conservative for modeling purposes, and still did not reach the ISFSI fence location from the overthrust toe locations, as described below. Because of these results, the size of the spheres were not adjusted (reduced) to reflect equivalent masses that more accurately reflect the masses of likely rockfall blocks. This is conservative, as the spheres with the greatest mass roll farthest down the slope and have the greatest impact energies.

Thirty two model runs were made with the RocFall program, sixteen each on sections A-A', and I-I'. The RocFall modeling shows that none of the 1000 rocks simulated per run would reach the top of the ISFSI cutslope and proposed rockfall catchment fence location (Table 2). After initiation of rolling by the initial 7.5 ft./sec. horizontal force combined with a 3 radians/second initial rotational force, the rocks roll between 1 and 17 feet downslope before stopping either on the tower access road, or the slope (Table 2). In general, the larger spheres tended to roll farther than the smaller spheres, but still stopped far short of the proposed catchment fence location. Test iterations made prior to production runs showed that changing the coefficients of restitution did not significantly change the program results.

The RocFall modeling matches the observed field performance as discussed in Section 5.2, and suggests that no rocks would reach the proposed rockfall catchment fence location at the top of the ISFSI cutslope. During their short trajectories, the simulated rocks had low bounce heights (less than about 1 to 3 feet), and quickly lost energy from the initial outward acceleration by friction and slope interaction.

5.3 CRSP Computer Model

In order to provide a second method to assess rockfall behavior on the ISFSI slope, we used the computer program CRSP (Colorado Rockfall Simulation Program), version 4.0 (CDOT, 2000). The CRSP program was originally developed as a Masters Thesis project at the Colorado School of Mines (Pfeiffer, 1988), and has been subsequently modified and adopted by the Colorado Department of Transportation based on calibrations by field testing. This program has had wide application for highway design and evaluation projects, however the results are often reported to be conservative (e.g., CDOT, 2000). Similar to RocFall, CRSP calculates the bounce trajectories and impact energies for rock blocks of set sizes down the modeled slope. The program generates numerous rockfall runs using Monte Carlo simulation, and produces a probabilistic distribution of trajectories. The bounce height and energy distributions for the model runs are determined for set calculation points designated on the profile. A key difference between the CRSP and RocFall programs is that the programs process the slope roughness input differently. The manner in which the CRSP program processes the slope roughness was found to be conservative.
As described in Section 4.1, the CRSP program was found to be less stable and reliable than the RocFall program, and the modeling results are contrary to observed and historic slope performance. Additionally, the CRSP model predictions also do not match typical slope performance for similar slopes (similar inclination, height, and materials) described in the literature (e.g., Keefer, 1994, Ritchie, 1963).

However, because all rocks modeled by the RocFall program did not reach the fence location, we needed to use the CRSP program to evaluate possible impact energies at the fence location associated with very low probability rockfall events that possibly could reach the fence. The CRSP program calculated numerous rocks to pass the fence location, as described below. We believe that our approach using the CRSP program to estimate rockfall catchment fence design capacities at the ISFSI site is conservative, and the CRSP-based impact energies therefore represent extreme, worst case events that require multiple conservative assumptions to occur.

The CRSP program was used to repeat the analysis runs for rockfall generated from the most critical slope failure models 2a and 2b on both cross sections A-A' and I-I'. The results from the CRSP modeling are shown in Table 3. Material properties and slope profiles used for CRSP were the same as input for the RocFall program. Rockfall blocks were modeled as cylindrical columns that bracket, and exceed, the equivalent masses for maximum predicted rock sizes described in Section 4.4.3: (1) a smallest cylinder with a diameter and length of 3 feet (2) a mid-size cylinder with a diameter of 3 feet and length of 6 feet; and, (3) a hypothesized maximum cylinder with a diameter of 5 feet and length of 10 feet. The 3x3 foot cylinder best reflects the most likely maximum block that could be shed of the hillslope, and the 3x6 foot cylinder is believed to conservatively capture the upper bound, geologically-reasonable block size. The 5x10 foot cylinders results need to be reviewed critically and with the understanding that the mass of these cylinders greatly exceeds any likely rock block mass that could be generated on the ISFSI hillside.

Six CRSP model runs were made for rockfall initiation points at the toe of each slope models 2a and 2b: three pairs of analyses for cross section A-A', and three pairs for cross section I-I' (Table 3). Similar to the RocFall program, 1000 rocks were simulated for each CRSP run.

The CRSP analysis shows that one hundred percent of the modeled 3x3 foot cylinders reaches the top of the ISFSI cutslope/rockfall catchment fence location for all initiation points. The 75th and 90th percentile impact kinetic energy for these cylinders ranges between about 11 and 25 foot-tons, and 12 to 28 foot-tons, respectively (Table 3). Ninety nine to one hundred percent of the 3x6 foot cylinders also rolled to the top of the ISFSI cutslope. The 75th and 90th percentile impact kinetic energy for the 3x6 foot cylinders ranged between 33 and 81 foot-tons, and 35 and 84 foot-tons, respectively. The 84 foot-ton energy value is believed to be a reasonable maximum value for the upper bound rock block that could be released from the hillslope above the ISFSI during a seismic event.

As discussed in Section 4.4.3, a very low probability hypothesized extreme rockfall block with a mass of 17,750 pounds was modeled by a cylinder measuring 5x10 feet. This "extreme event" cylinder is used as a basis of comparison against the calculated energies for the upper bound 6-foot block to ensure a high margin of safety for the rockfall catchment fence design. In contrast to the results from the 3x3 and 3x6 foot cylinders, in three of the four models (Section I-I' models 2a and 2b, Section A-A' model 2a) less than 5% of the 5x10 foot cylinders reach the top of the ISFSI cutslope. In the remaining model (Section A-A' model 2b), 37% of the 5x10 foot cylinders reach the top of the ISFSI cutslope. In the section A-A' model 26 analysis, 37% of the 1,000 randomly generated 10-foot long blocks reached the fence with 90th percentile of the impact energy of 294 ft-tons. This energy is close to 13 times the energy delivered by the more realistic block of 3x3 foot cylinder and about 4 times the kinetic energy delivered by the conservative block of 3x6 foot cylinder.

In the three remaining analytical cases for the oversized hypothetical cylinder, less than 5% of the 1,000 randomly generated rocks reached the fence. Section I-I model 2a resulted in 5% of the simulated rocks reaching the fence with the 90th percentile kinetic energy of 172 ft-ton. This impact kinetic energy is less then the 294 ft-ton discussed above. The next analytical case involved analysis of Section I-I model 2b. In this analytical case, only 0.6% of the 1,000 randomly generated rocks reached the fence with 90th percentile kinetic energy of 437 ft-tons. Due to the limited number of cylinders reaching the fence (6 out of 1000), the statistics analysis on 6 samples could potentially be strongly influenced by one or two sample results. In view of the very small percentage (0.6%) of hypothetical cylinder that reach the fence, we conclude that the results from this analytical case should not dictate the design. If we normalize the statistical runs to include all the oversize hypothetical cylinders that reach the fence from all four analysis cases, then the normalized 90th percentile energy would be reduced and the effects of the "stand out" model I-I' 26 runs would be reduced. The last case for the hypothetical 10-foot long cylindrical blocks analysis involves Section A-A with rocks initiating from El. 383. The results show none of the 10-foot cylindrical blocks would reach the fence in this analytical case.

Based on the CRSP analysis, the following conclusions are made:

1. For a realistic block size that can be reasonably expected at DCPP ISFSI site, it was modeled as 3-ft-dia and 3-ft-long cylindrical block in CRSP. The analysis showed that nearly 100% of the 1,000 randomly generated blocks would reach the fence with the 90th percentile kinetic deliver at the fence of 22 ft-tons.

2. For a more conservative block size modeled as 3-ft-dia and 6-ft-long cylindrical block in CRSP, the analysis showed that nearly 100% of the 1,000 randomly generated blocks would also reach the fence with the 90th percentile kinetic energy deliver at the fence of 84 ft-tons.

3. To adopt a defense-in-depth approach for the rock barrier design, a hypothetical oversize block was modeled in CRSP as 5-ft-dia and 10-ft long cylindrical blocks. The analysis showed that the percent of blocks reaching the fence is significantly reduced with this increase in block size. In three of the four analysis cases, the analysis shows less than 5% of the blocks would reach the fence. Although the trend of reducing percentage of blocks reaching the fence for this size block is consistent and important, however, performing statistical analysis on the kinetic energy for the individual analysis cases which has very few blocks reaching the fence could be mis-leading. The fourth analytical case using the large hypothetical block showed 37% of the 1,000 randomly generated blocks would reach the fence. Statistic analysis for the 370 or so blocks would be meaningful and the 90th percentile kinetic energy delivered at the fence is 294 ft-tons. According, the kinetic energy of 294 ft-ton was selected for the rock fence design using a hypothetic block size that has mass close to 10 times the mass of the realistic block size that can be reasonably expected at the site.

Maximum CRSP-predicted bounce heights were taken at the 75th percentile distribution, and are below 6.5 feet, with exception for the invalid 15.3 foot bounce height predicted for Model 2b.

6.0 DESIGN CRITERIA

The following ISFSI cutslope design features provide mitigation against possible rockfall. Together, these mitigative features provide a redundant, multiple line of defense against the already low rockfall hazard. The hillslope above the ISFSI cutslope is inclined between about 15 and 21 degrees, and rockfall rarely occurs during earthquakes on slopes less than about 40 degrees (Keefer, 1984; California Division of Mines and Geology, 1997). Additionally, our RocFall modeling and past slope performance show that even if rockfall is triggered, rockfall is unlikely to travel more than several tens of feet downhill before becoming arrested on the slope or the existing tower access road. Our detailed geologic and rock mass characterization of the site indicates that likely rockfall block sizes would be between 1 and 3 feet in maximum dimension, with a rare maximum size of 6 feet (GEO.DCPP.01.21). Such blocks would likely be angular with a rectangular or triangular cross sectional shape, and with maximum equivalent mass sphere diameters on the order of about 3 to 5 feet. Based on our rockfall modeling, a rockfall catchment fence with a design capacity of 295 foot-tons should provide a substantial safety margin for the ISFSI against even low-probability extreme rockfall events. Additionally, modeling, past slope performance, and literature review show that a fence with a height of about 8- to 10-feet should provide a substantial freeboard for rockfall blocks that likely would roll along the slope surface rather than bounding.

The following elements comprise the rockfall mitigation system for the ISFSI.

- The existing 10- to 12-foot wide tower access road provides an effective catchment bench for possible rockfall released above the roads. The road bench will be maintained and periodically cleared to maintain its effectiveness as a rockfall catchment bench.
- A 2- to 6-foot-wide, 1-foot-deep drainage ditch will be constructed at the top of the cutslope (see design drawings in Attachment A; Hagler, 2003). This ditch would help catch small rockfall blocks generated on the slope above the cutslope.
- An 8- to 10- oot high 295 foot-ton capacity rockfall barrier fence will be constructed at the top of the ISFSI cutslope that will be designed to absorb and dissipate energy from possible rockfall generated on the slope above. The design criteria and supporting basis for the rockfall barrier fence are described below.

The rockfall barrier fence to be constructed at the top of the ISFSI cutslope will be a commercially-available, rockfall fence system specifically designed for the possible site loading conditions. These types of rockfall barriers consist of a high-capacity, flexible cable net connected with frictional breaking systems and steel support posts. The cable is fixed to the slope with grouted rock anchors or concrete footings. As discussed in Section 5.3, the maximum bounce height of 6.5 feet, and maximum impact load of 294 foot-tons, are believed to provide a high margin of safety for the ISFSI against even unlikely extreme events. Commercial standard rockfall protection fences are available in heights of between about 9 and 15 feet, and capacities exceeding 294 foot-tons.

An example rockfall fence system under consideration is the GeoBrugg rockfall fence system that has been installed at numerous locations throughout the United States, and locally along Highway 1 by Caltrans. A brochure describing the GeoBrugg fence system, and several relevant case studies, are included in Attachments E and F, respectively. The final barrier design will be based on a rockfall calculation. On the basis of our computer rockfall analyses, a reasonable rockfall fence for ISFSI installation is the GeoBrugg Very High Impact fence (design load of 295 foot-tons), with a height of 8 to 10 feet. Such a system could easily withstand all foreseeable forces associated with realistic likely maximum rockfall blocks likely to be generated on the hillslope. The GeoBrugg fence is a complete system with components designed to act together to provide the 295 foot-ton capacity. These components are designed specifically to site conditions (e.g. post capacity spacing).

7.0 CONCLUSIONS

The rockfall evaluation for the ISFSI hillside shows that rockfall is unlikely to reach the top of the ISFSI cutslope. RocFall computer modeling shows that small random loose rocks on the slope, and possible blocks that could fall from the overthrust toes of rock mass movements over clay beds, would only roll several to about 20 feet downhill before becoming arrested on the slope or access road benches. This conclusion matches past performance of the slope and previous rockfall evaluations for slopes of similar inclination presented in the literature (e.g., Keefer, 1994).

On this basis, we conclude that rockfall mitigation is not necessary for the ISFSI. However, considering the importance of this facility, a rockfall mitigation system is included in the ISFSI design to provide a high level of safety against low probability extreme events. A multiple line of defense approach was used that includes a high-energy rockfall catchment fence at the top of the ISFSI cutslope. The capacity of the rockfall catchment fence was determined by forcing rockfalls to reach the fence location by simulation using the overly-conservative CRSP program. The resulting calculated impact forces recommended for design from the maximum rock block impacts is 295 foot-tons. This energy is within the range of the GeoBrugg High Capacity rockfall catchment fence. A fence height of 8- to 10-feet would provide a high margin of safety for likely extreme event bounce heights of rocks.

8.0 REFERENCES

California Division of Mines and Geology, 1997, Guidelines for evaluating and mitigating seismic hazards in California: Special Publication 117, Appendix E

Colorado Department of Transportation, 2000, Colorado Rockfall Simulation Program (CRSP), version 4.0 , collaborative program Colorado Department of Transportation (CDOT), Colorado School of Mines, Colorado Geological Survey, CDOT Publication CDOT-SYMB-CGS-99-1.

Federal Highway Administration (FHA), 1994, Rockfall hazard mitigation methods, NHI Course No. 13219 Participant Workbook, Publication FHA SA-93-085.

GEO.DCPP.01.21, rev. 2, Analysis of Bedrock Stratigraphy and Geologic Structure at the DCPP ISFSI Site.

GEO.DCPP.01.23, rev. 0, Pseudostatic Wedge Analysis of DCPP ISFSI Cutslope (SWEDGE Analysis).

GEO.DCPP.01.26, rev. 1, Determination of Earthquake-Induced Displacements of Potential Sliding Masses on DCPP ISFSI Slope.

Hagler, R.D., March 5, 2003, Transmittal Letter NPG PIMS A0574914 – Enercon Services, Inc. Drawing PGE-009-SK-340 "Site Plan ISFSI Drainage System" revision 0, October 15, 2001 and PGE-009-SK-341 "ISFSI & CTF Access Road Drainage Details and Ditches" revision 0, October 15, 2001.

Hoek, Evert. "Unpublished notes" (2002) NSERC Industrial Research Professor of Rock Engineering, Department of Civil Engineering, University of Toronto, St George Street, Toronto, Ontario, Canada M5S 1A4

Hungr, O. and Evans, S.G. 1988, Engineering evaluation of fragmental rockfall hazards. Proc. 5th International Symposium on Landslides, Lusanne. July 1988, Vol. 1, pp. 685-690.

Keefer, D.K., 1984, Landslides caused by earthquakes: Geological Society of America Bulletin V. 95, N. 4, p.406-421.

Pacific Gas & Electric Company, 2002, Safety Analysis Report Diablo Canyon ISFSI.

Pfeiffer, T.J., 1989, Rockfall Hazard Analysis Using Computer Simulation of Rockfalls, Thesis, Colorado School of Mines, 103p.

Pfeiffer, T.J., and Bowen, T.D., 1989, Computer Simulation of Rockfalls. Bulletin of Association of Engineering Geologists, Vol. 26, No. 1. pp135-146

Pfeiffer, T.J., and Higgens, J.D., 1990, Rockfall Hazard Analysis Using the Colorado Rockfall Simulation. Transportation Research Record 1288, TRB, National Research Council, Washington, D.C., pp117-126.

Robotham, M.E., and Wang, H., and Walton, G., "Assessment of risk from rockfall from active and abandoned quarry slopes." Institution of mining and Metallurgy, Section A. 1995.104(Jan-April), pp A25-A33

Rocscience, 2002, RocFall version 4.037 (downloaded update 4/10/03), Risk Analysis of Falling Rocks on Steep Slopes, Rocscience, Inc., (WLA license 3CBD9DHGCAACE36CA).

Stevens, W.D., 1998, RocFall: a tool for probabilistic analysis, design of remedial measures, and prediction of rockfalls, MS Thesis, University of Toronto.

Sun, Joseph I., April 11, 2003, email correspondence presenting earthquake-induced slope accelerations.

Table 2. PG&E Diablo Canyon ISFSI Rockfall Modeling Input Data - ROCFALL

For All Runs:

Initial Horizontal Velocity:	7.5 ft./s.
Initial Rotational Velocity:	3 rads./s.
Rock Block Density:	142 lbs./ft3

Coefficients of Restitution:	Rn	Rt
General Slope:	0.35 SD=0.04	0.83 SD=0.04
Tower Road:	0.40 SD=0.05	0.73 SD=0.05

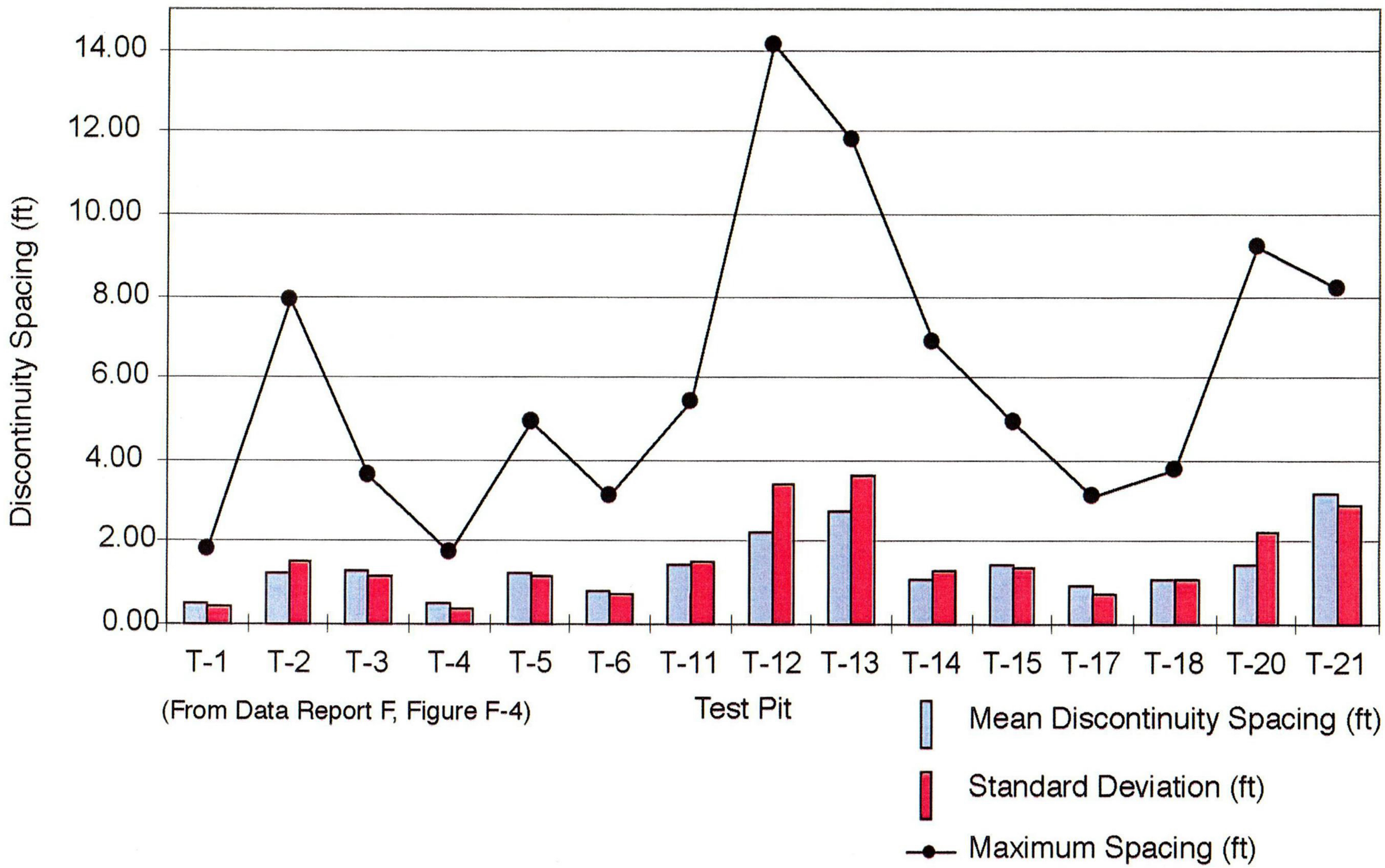
					Mean Slope Roughness (degrees)				Maximum Rolling Distance Y	Maximum Rolling Distance X	
Model Run No.	Initiation Point (seedpoint) Elevation (ft.)	Cross Section	Seed Location	Rock Block Size (ft.)	General Slope	Cutslope	Tower Road	Pad	Rockfall Endpoint Elevation (ft.)	Rockfall Endpoint Location (ft.)	Rockfall Ultimate Rolling Distance (ft.)
RI1a-1	450	I-I'	Model 1a Toe	1	37.0	26.0	26.0	0.0	450	653	1
RI1a-3	450	I-I'	Model 1a Toe	3	14.0	9.5	9.5	0.0	450	653	1
RI1a-6	450	I-I'	Model 1a Toe	6	7.1	4.8	4.8	0.0	450	654	2
RI1a-10	450	I-I'	Model 1a Toe	10	4.3	2.9	2.9	0.0	450	655	3
RI1b-1	487	I-I'	Model 1b Toe	1	37.0	26.0	26.0	0.0	484	569	9
RI1b-3	487	I-I'	Model 1b Toe	3	14.0	9.5	9.5	0.0	482	572	12
RI1b-6	487	I-I'	Model 1b Toe	6	7.1	4.8	4.8	0.0	482	572	12
RI1b-10	487	I-I'	Model 1b Toe	10	4.3	2.9	2.9	0.0	480	577	17
RI2a1-1	365	I-I'	Model 2a Toe	1	37.0	26.0	26.0	0.0	362	908	8
RI2a-3	365	I-I'	Model 2a Toe	3	14.0	9.5	9.5	0.0	361	910	10
RI2a-6	365	I-I'	Model 2a Toe	6	7.1	4.8	4.8	0.0	361	911	11
RI2a-10	365	I-I'	Model 2a Toe	10	4.3	2.9	2.9	0.0	360	913	13
RI2b-1	414	I-I'	Model 2b Toe	1	37.0	26.0	26.0	0.0	413	764	4
RI2b-3	414	I-I'	Model 2b Toe	3	14.0	9.5	9.5	0.0	413	765	5
RI2b-6	414	I-I'	Model 2b Toe	6	7.1	4.8	4.8	0.0	412	766	6
RI2b-10	414	I-I'	Model 2b Toe	10	4.3	2.9	2.9	0.0	410	772	12
RA1a-1	452	A-A'	Model 1a Toe	1	37.0	26.0	26.0	0.0	450	487	6
RA1a-3	452	A-A'	Model 1a Toe	3	14.0	9.5	9.5	0.0	450	487	6
RA1a-6	452	A-A'	Model 1a Toe	6	7.1	4.8	4.8	0.0	450	488	7
RA1a-10	452	A-A'	Model 1a Toe	10	4.3	2.9	2.9	0.0	450	489	8
RA1b-1	490	A-A'	Model 1b Toe	1	37.0	26.0	26.0	0.0	485	393	11
RA1b-3	490	A-A'	Model 1b Toe	3	14.0	9.5	9.5	0.0	485	393	11
RA1b-6	490	A-A'	Model 1b Toe	6	7.1	4.8	4.8	0.0	485	393	11
RA1b-10	490	A-A'	Model 1b Toe	10	4.3	2.9	2.9	0.0	484	396	14
RA2a1-1	383	A-A'	Model 2a Toe	1	37.0	26.0	26.0	0.0	381	684	6
RA2a-3	383	A-A'	Model 2a Toe	3	14.0	9.5	9.5	0.0	381	685	7
RA2a-6	383	A-A'	Model 2a Toe	6	7.1	4.8	4.8	0.0	380	687	9
RA2a-10	383	A-A'	Model 2a Toe	10	4.3	2.9	2.9	0.0	378	692	14
RA2b-1	412	A-A'	Model 2b Toe	1	37.0	26.0	26.0	0.0	410	603	6
RA2b-3	412	A-A'	Model 2b Toe	3	14.0	9.5	9.5	0.0	409	604	7
RA2b-6	412	A-A'	Model 2b Toe	6	7.1	4.8	4.8	0.0	408	607	10
RA2b-10	412	A-A'	Model 2b Toe	10	4.3	2.9	2.9	0.0	407	610	13
Verification "Simple" Tutorial	0	"simple"	slope apex		-	-	-	-	-24	21	

Table 3. PG&E Diablo Canyon ISFSI Rockfall Modeling Input Data - CRSP

Unit weight of rock:	142 lbs./ft3	
Initial Horizontal Velocity:	7.5 ft./sec.	
Initial Veritical Velocity:	0 ft./sec.	
Coefficient of Restitution:	Rn	Rt
General Slope:	0.35	0.83
Tower Road:	0.4	0.73

Model Run No.	Cross Section	Seed Location	Slope Roughness (ft.)	Rock Size(1) (ft.)	Initiation "seed" Point Elevation (ft.)	Equivalent Mass (pounds)	Percentage of rocks reaching top of ISFSI cut	Estimated Bounce Height Average (ft.)	Estimated Bounce Height 75th* percentile (ft.)	Total Kinetic Energy of Blocks Reaching top of ISFSI cut 75th* percentile (ft.-tons)	Total Kinetic Energy of Blocks Reaching top of ISFSI cut 90th* Percentile (ft.-tons)
CI2a-3	I-I'	Model 2a Toe	0.5	3X3	369	3,011	100	0.3	4.8	11.3	12.4
CI2a-6	I-I'	Model 2a Toe	0.5	3X6	369	6,022	100	0.2	5.8	33.2	34.8
CI2a-10	I-I'	Model 2a Toe	0.5	5X10	369	27,882	4.6	0.0	5.0	149.5	171.9
CI2b-3	I-I'	Model 2b Toe	0.5	3X3	417	3,011	100	0.7	4.4	24.8	27.6
CI2b-6	I-I'	Model 2b Toe	0.5	3X6	417	6,022	99	0.4	5.7	80.6	84.4
CI2b-10 (2)	I-I'	Model 2b Toe	0.5	5X10	417	27,882	0.6	0.3	15.3	405.9	437.5
CA2a-3	A-A'	Model 2a Toe	0.5	3X3	383	3,011	100	0.3	4.9	10.2	11.2
CA2a-6	A-A'	Model 2a Toe	0.5	3X6	383	6,022	100	0.1	6.1	30.1	32.2
CA2a-10	A-A'	Model 2a Toe	0.5	5X10	383	27,882	0	- -	- -	- -	- -
CA2b-3	A-A'	Model 2b Toe	0.5	3X3	411	3,011	100	0.5	4.7	18.1	20.3
CA2b-6	A-A'	Model 2b Toe	0.5	3X6	411	6,022	100	0.3	5.5	59.6	62.4
CA2b-10	A-A'	Model 2b Toe	0.5	5X10	411	27,882	37	0.1	6.2	265.3	294.2

(1) - Rock blocks were modeled as cylinders with diameters and heights of the given size. The actual blocks would be angular and exhibit lower velocities, bounce heights, energy, and probabilities for reaching the catchment fence location. The cylinder model therefore is very conservative.
(2) - Model CI2b-10 runs are believed unlikely and extremely low probability, and therefore are not recommended for design input.
* - 75th and 90th percentile values are calculated for the rocks that reach the fence location.

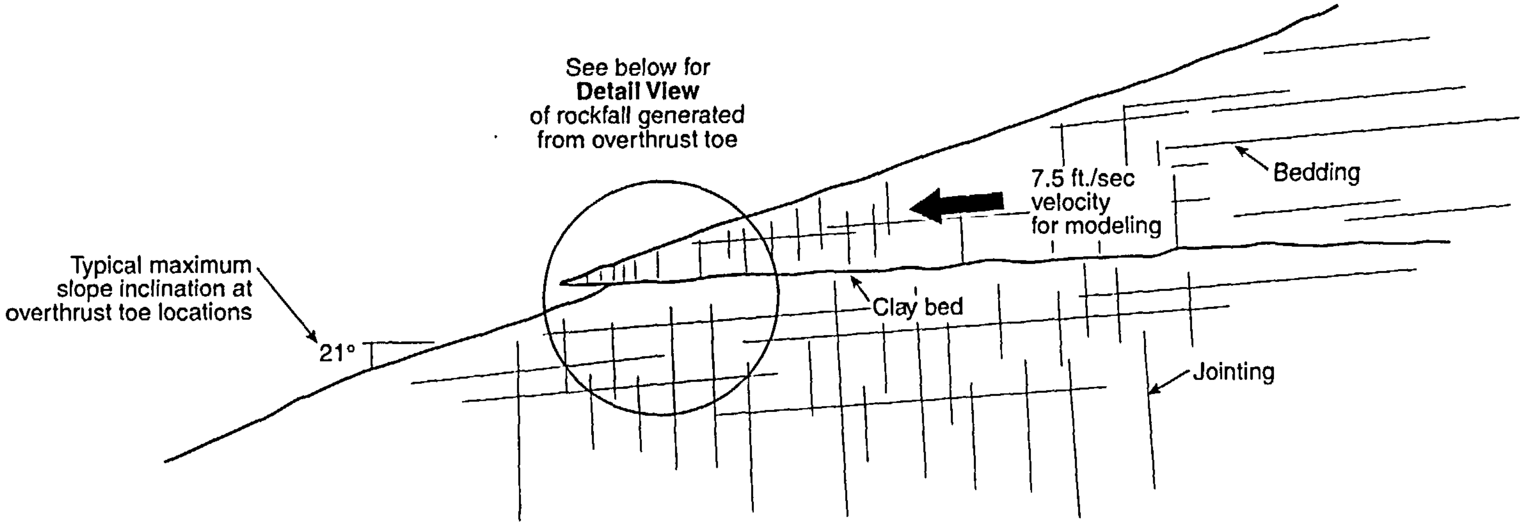


PG&E DIABLO CANYON

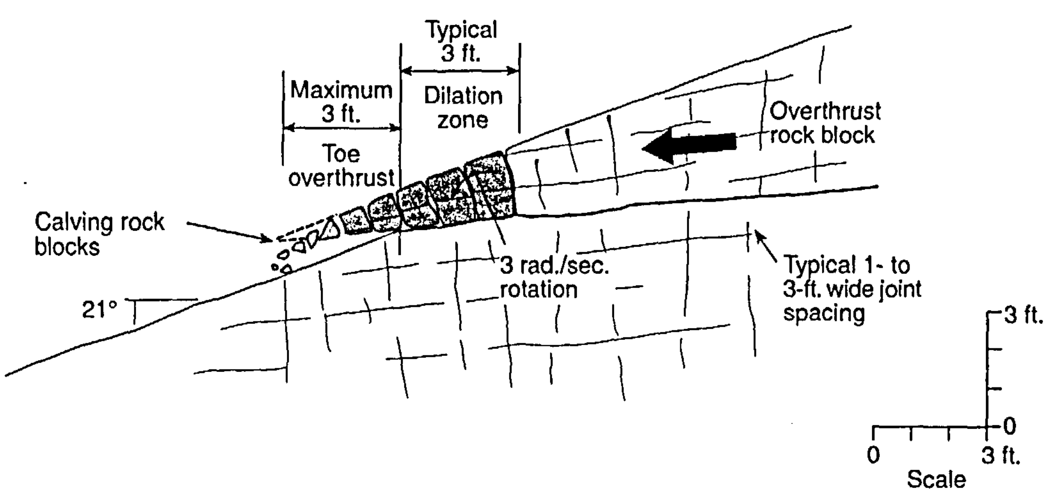
FIGURE 7
DISCONTINUITY SPACING FROM EXPLORATORY TEST TRENCHES

C01

Schematic Section based on Section I - I'



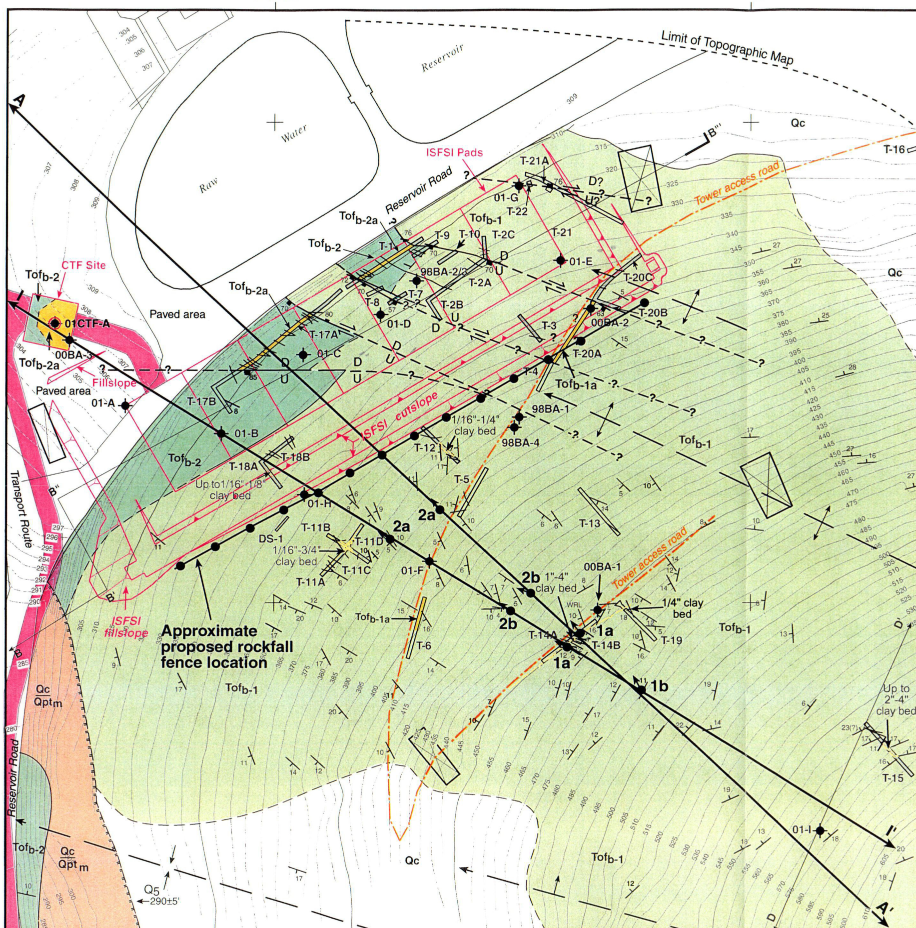
Detail View
of rockfall generated
from overthrust toe



Note: The dimensions of the overthrust toe do not permit formation of rock blocks greater that about 1 to 3 feet in height. Blocks with larger dimensions would be tabular with a greater height versus length aspect ratio.

PG&E DIABLO CANYON

FIGURE 6
OVERTHRUST TOE ROCKFALL INITIATION MODEL



Explanation

Qc Colluvium

Qptm Marine terrace deposit (overlain by Qc)

Obispo Formation (lower and middle Miocene)

DOLOMITE UNIT

Tofb-1 Dolomite, clayey dolomite, dolomitic siltstone to fine-grained dolomitic sandstone, and limestone. The unit contains occasional discontinuous to continuous (tens to hundreds of feet) clay beds that are generally 1/32- to 1/2-inch thick, but locally are thicker. Rocks in this unit are moderately to well cemented, moderately hard to hard, moderately to slightly weathered, brittle and typically medium strong.

Tofb-1a Friable dolomite and dolomitic siltstone of unit Tofb-1. These rocks typically have low hardness, are very weak to weak, and occur as discontinuous zones where weathering and/or alteration has been concentrated. Inferred lateral extent of friable zones is schematic.

SANDSTONE UNIT

Tofb-2 Fine to coarse-grained dolomitic sandstone and sandstone (arkosic to arenitic) with lesser dolomite beds. Detrital clasts are composed primarily of dolomitized feldspars, marine fossil fragments, and volcanic rock fragments. Discontinuous clay beds that are generally less than 1/2-inch thick occur locally within the unit. The rocks are of low to medium hardness, moderately to well cemented and typically medium strong.

Tofb-2a Friable sandstone of unit Tofb-2. These rocks typically are of low hardness, are very weak to weak, and occur as discontinuous zones where weathering and/or alteration has been concentrated. Inferred lateral extent of friable zones is schematic.

6 Strike and dip of bedding

U D 80 Minor fault, dip indicated, dashed where inferred, queried where uncertain, arrows show relative sense of displacement, U-upthrown, D-downthrown

Small, secondary faults exposed in trench

1/16" Clay bed, thickness indicated

Geologic contact, solid line where well-defined, dashed where approximate

01-C Boring for ISFSI, number indicated (initial number is year drilled, e.g. 01 was drilled in 2001)

T-4 Exploratory trench, number indicated

DS-1 Discontinuity survey line in bulldozer cut

Footprint of 500-kV tower

Cutslope above and fill prism west of ISFSI pads

Axis of anticline, larger arrow shows plunge, dashed where approximate

Axis of syncline, larger arrow shows plunge, dashed where approximate

Axis of monocline, larger arrow shows plunge, dashed where approximate

A A' Rockfall analyses cross section (bold)

1b Rockfall initiation (seed) point

Q5 290±5' Buried shoreline angle of marine terrace wave-cut platform, number and elevation indicated

Notes:

ISFSI geometry is based on PG&E Enercon Drwg. Base map from No. PGE-009-sk-001 dated 9/27/01.

Geology not shown in paved area and reservoir area.

N

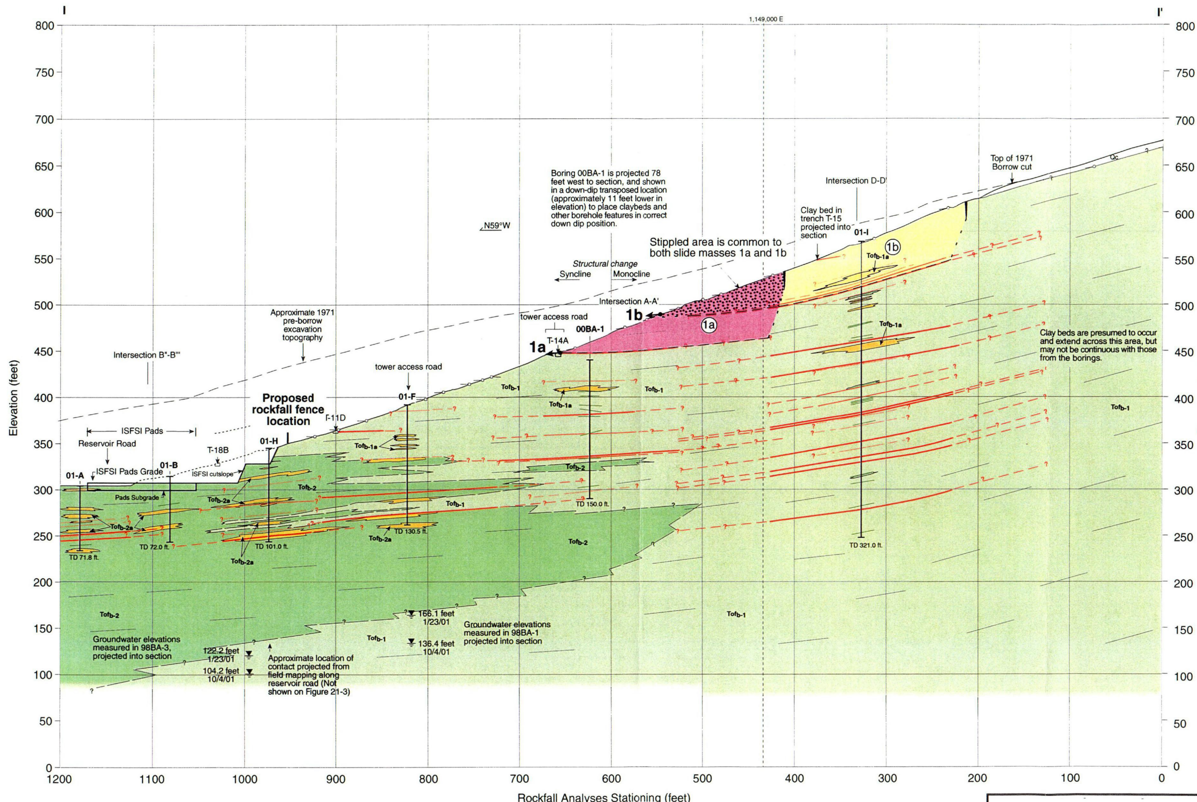
0 50 100 150 200

Contour interval = 5 feet

PG&E DIABLO CANYON

FIGURE 1
GEOLOGIC MAP OF ISFSI AND CTF SITES AND LOCATIONS OF ROCKFALL ANALYSES SECTIONS A - A' AND I - I'

C01A



Explanation

Failure plane through clay bed

Failure plane through jointed rock mass

Assumed 20-foot high tension crack at top of slide mass

Alternative Slide Mass Models

1a

1b

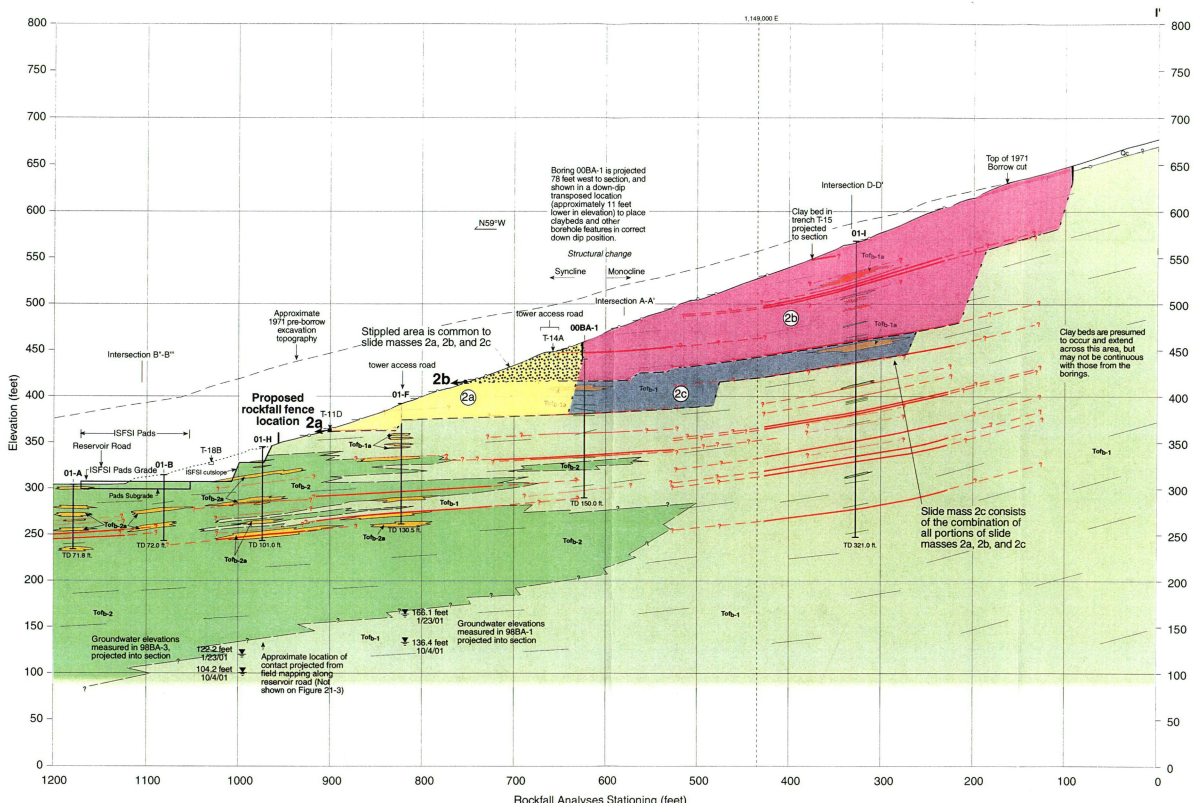
0 25 50 75 100 feet
Scale

PG&E DIABLO CANYON

FIGURE 2

SLIDE MASS MODEL 1

C02



Explanation

Failure plane through clay bed

Failure plane through jointed rock mass

Assumed 20-foot high tension crack at top of slide mass

Alternative Slide Mass Models

1a

1b

0 25 50 75 100 feet

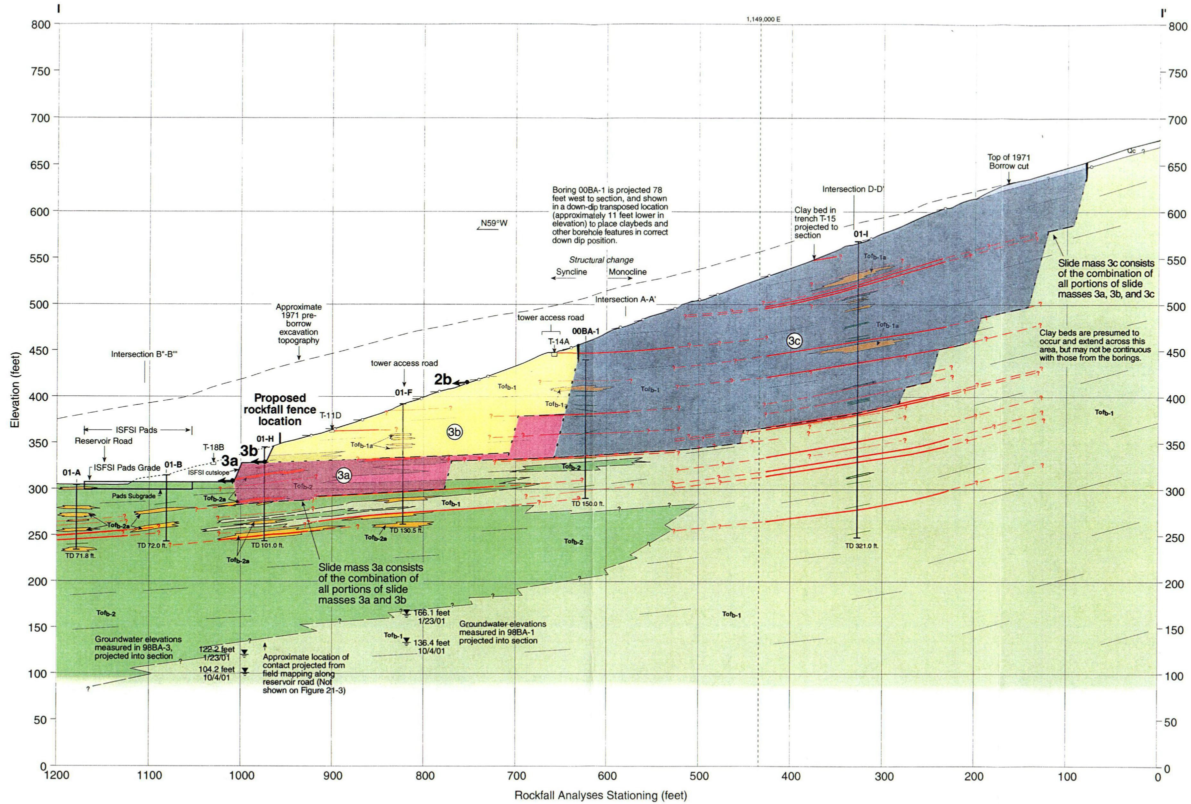
Scale

PG&E DIABLO CANYON

FIGURE 3

SLIDE MASS MODEL 2

C03



Explanation

- – – – Failure plane through clay bed
- · · · · Failure plane through jointed rock mass
- Assumed 20-foot high tension crack at top of slide mass

Alternative Slide Mass Models

1a

1b

0 25 50 75 100 feet

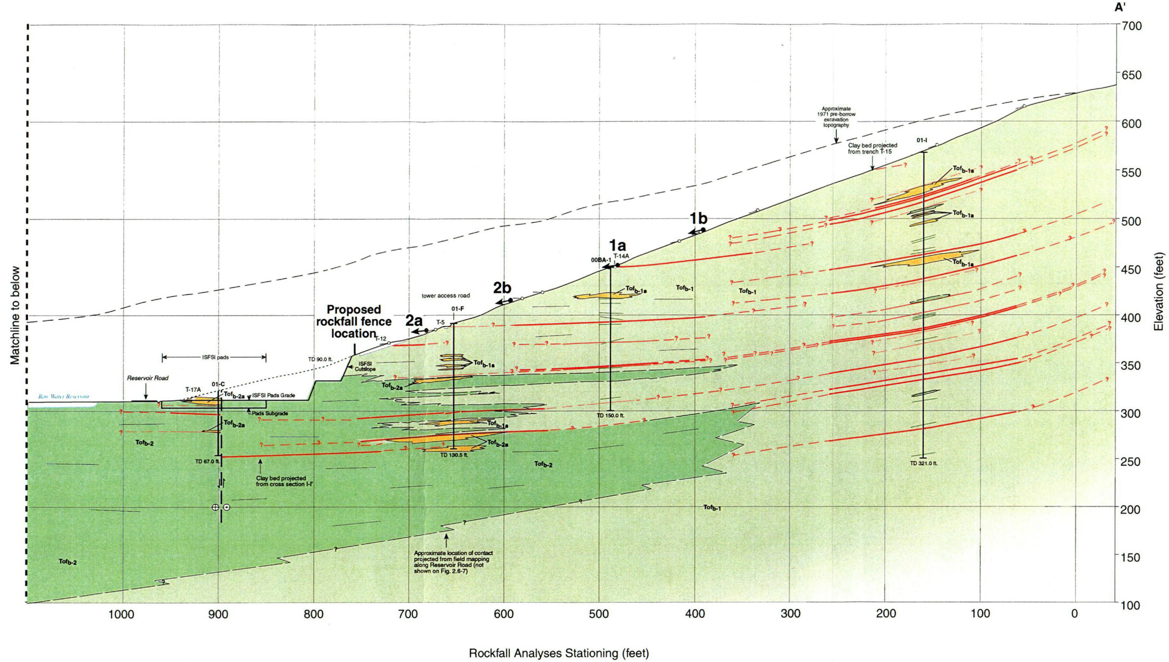
Scale

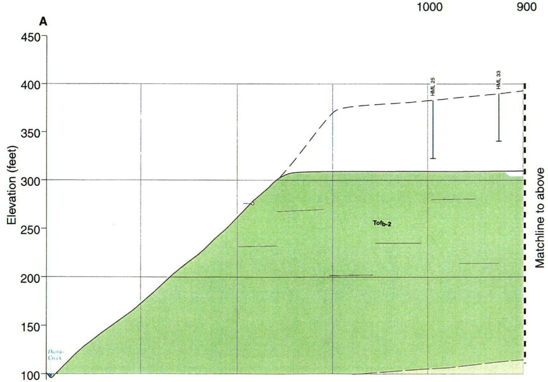
PG&E DIABLO CANYON

FIGURE 4

SLIDE MASS MODEL 3

C04





0 25 50 75 100 feet
Scale

PG&E DIABLO CANYON

FIGURE 5
CROSS SECTION A - A' ROCKFALL SOURCE LOCATIONS FROM PROJECTION OF ROCK MASS MODELS 1 AND 2

C05

Memorandum

Date: March 5, 2003 **File #:** **72.10.05**

To: NUCLEAR SERVICES GEOSCIENCES - PROJECT MANAGER

From: DCPP USED FUEL STORAGE PROJECT - PROJECT ENGINEER

Subject: NPG PIMS AR A0574914 Work Scope – Information Transmittal

Pacific Gas and Electric Company™

JOSEPH I. SUN

The purpose of this memorandum is to transmit the attached information to you for the subject work scope.

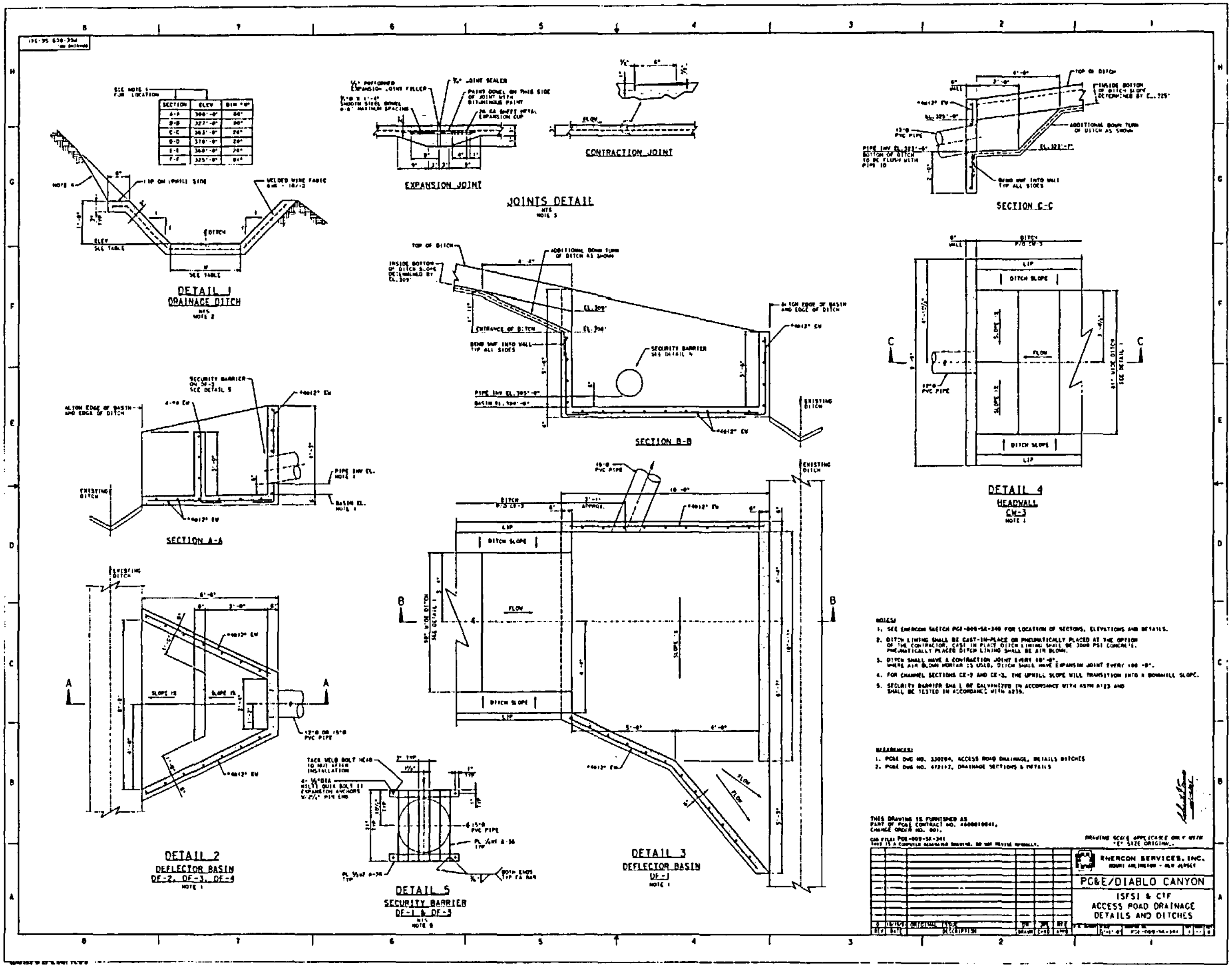
If you have any questions regarding this transmittal, please contact Rich Klimczak at company extension 8-691-6513.

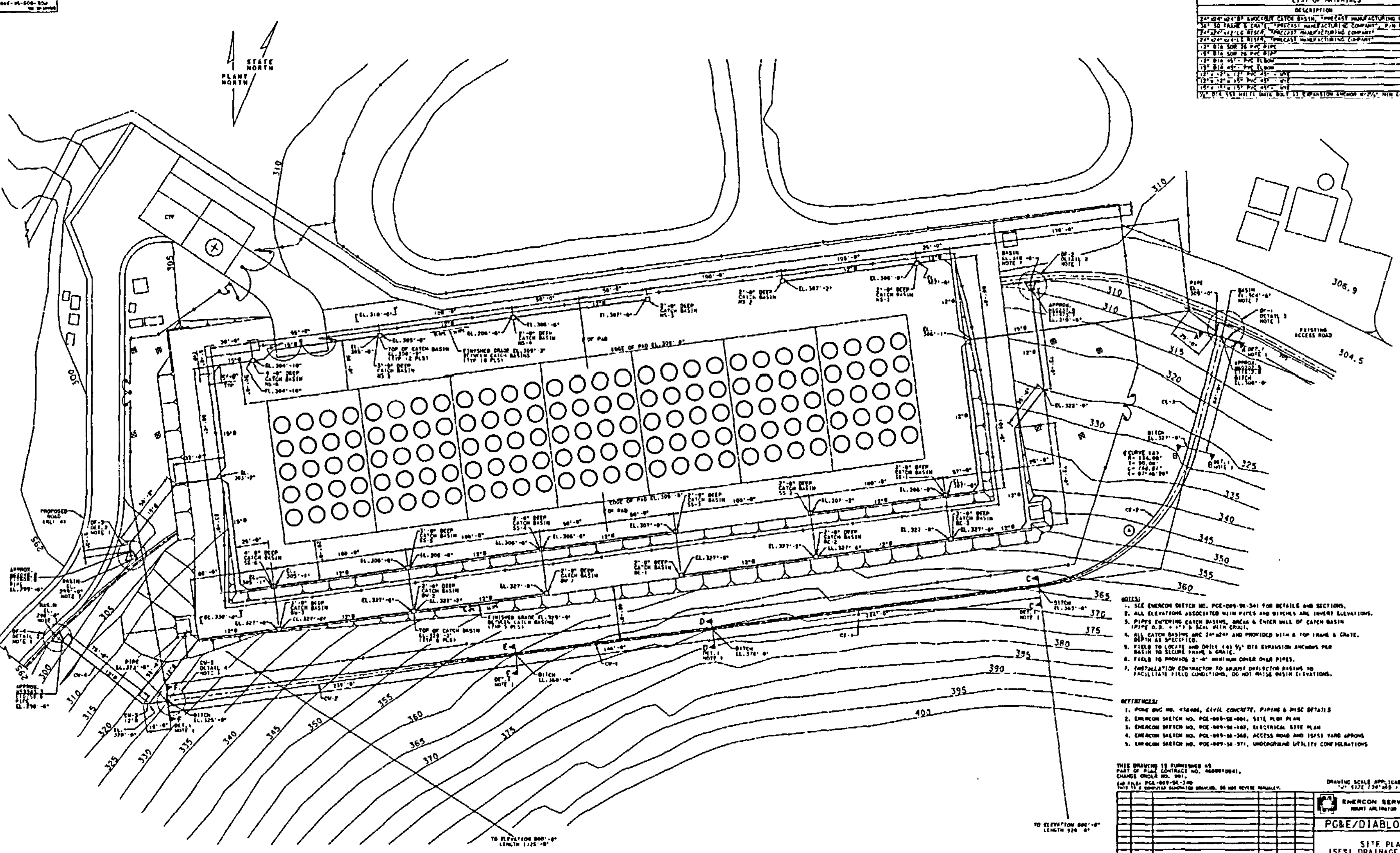
RICHARD D. HAGLER

Attachments

1. Enercon Services, Inc. Drawing PGE-009-SK-340, "Site Plan – ISFSI Drainage System," Revision 0, October 15, 2001.
2. Enercon Services, Inc. Drawing PGE-009-SK-341, "ISFSI & CTF Access Road Drainage Details and Ditches," Revision 0, October 15, 2001.

cc:		
	DBell	104/3/17B
	TLGrebel	165
	RLKlimczak	201
	BHPatton	165
	LJStrickland	165
	DCPP RMS	119/1


JOINTS DETAIL
NTS
NOTE 3
EXPANSION JOINT
CONTRACTION JOINT
DETAIL 1
DRAINAGE DITCH
NTS
NOTE 2
SECTION A-A
SECTION B-B
SECTION C-C
DETAIL 2
DEFLECTOR BASIN
DF-2, DF-3, DF-4
NOTE 1
DETAIL 3
DEFLECTOR BASIN
DF-1
NOTE 1
DETAIL 4
HEADWALL
CW-3
NOTE 1
DETAIL 5
SECURITY BARRIER
DF-1 & DF-5
NTS
NOTE 8
NOTES:
1. SEE ENERCON SKETCH PGE-009-SK-340 FOR LOCATION OF SECTIONS, ELEVATIONS AND DETAILS.
2. DITCH LINING SHALL BE CAST-IN-PLACE OR PNEUMATICALLY PLACED AT THE OPTION OF THE CONTRACTOR. CAST IN PLACE DITCH LINING SHALL BE 3000 PSI CONCRETE. PNEUMATICALLY PLACED DITCH LINING SHALL BE AIR BLOWN.
3. DITCH SHALL HAVE A CONTRACTION JOINT EVERY 10'-0". WHERE AIR BLOWN MORTAR IS USED, DITCH SHALL HAVE EXPANSION JOINT EVERY 100'-0".
4. FOR CHANNEL SECTIONS CE-2 AND CE-3, THE UPHILL SLOPE WILL TRANSITION INTO A DOWNHILL SLOPE.
5. SECURITY BARRIER SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A123 AND SHALL BE TESTED IN ACCORDANCE WITH A239.
REFERENCES:
1. PG&E DWG NO. 330284, ACCESS ROAD DRAINAGE, DETAILS DITCHES
2. PG&E DWG NO. 472117, DRAINAGE SECTIONS & DETAILS
THIS DRAWING IS FURNISHED AS PART OF PG&E CONTRACT NO. 4600010041, CHANGE ORDER NO. 001.
CAD FILE: PGE-009-SK-341
DRAWING SCALE APPLICABLE ONLY WITH "E" SIZE ORIGINAL.
ENERCON SERVICES, INC.
PG&E/DIABLO CANYON
ISFSI & CTF
ACCESS ROAD DRAINAGE
DETAILS AND DITCHES
0
ORIGINAL ISSUE
REV
DATE
DESCRIPTION
DRAWN
CHKD
APPD



LIST OF MATERIALS

DESCRIPTION	QTY
24"x24"x24"D" KNOCKOUT CATCH BASIN, "PRECAST MANUFACTURING COMPANY"	18
36" SQ FRAME & GRATE, "PRECAST MANUFACTURING COMPANY", P/N PCS-2018A	18
24"x24"x12"LG RISER, "PRECAST MANUFACTURING COMPANY"	4
24"x24"x6"LG RISER, "PRECAST MANUFACTURING COMPANY"	2
12" DIA SDR 26 PVC PIPE	[illegible]
15" DIA SDR 26 PVC PIPE	615'
12" DIA 45° - PVC ELBOW	13
15" DIA 45° - PVC ELBOW	17
12"x 12"x 12" PVC 45° - WYE	[illegible]
12"x 12"x 15" PVC 45° - WYE	1
15"x 15"x 15" PVC 45° - WYE	1
1/2" DIA SST HILTI KWIK BOLT II EXPANSION ANCHOR W/2 1/8" MIN EMBEDMENT	72

NOTES:

1. SEE ENERCON SKETCH NO. PGE-009-SK-341 FOR DETAILS AND SECTIONS.
2. ALL ELEVATIONS ASSOCIATED WITH PIPES AND DITCHES ARE INVERT ELEVATIONS.
3. PIPES ENTERING CATCH BASINS, BREAK & ENTER WALL OF CATCH BASIN (PIPE O.D. + 4") & SEAL WITH GROUT.
4. ALL CATCH BASINS ARE 24"x24" AND PROVIDED WITH A TOP FRAME & GRATE. DEPTH AS SPECIFIED.
5. FIELD TO LOCATE AND DRILL (4) 1/2" DIA EXPANSION ANCHORS PER BASIN TO SECURE FRAME & GRATE.
6. FIELD TO PROVIDE 2'-0" MINIMUM COVER OVER PIPES.
7. INSTALLATION CONTRACTOR TO ADJUST DEFLECTOR BASINS TO FACILITATE FIELD CONDITIONS, DO NOT RAISE BASIN ELEVATIONS.

REFERENCES:

1. PG&E DWG NO. 438606, CIVIL CONCRETE, PIPING & MISC DETAILS
2. ENERCON SKETCH NO. PGE-009-SK-001, SITE PLOT PLAN
3. ENERCON SKETCH NO. PGE-009-SK-107, ELECTRICAL SITE PLAN
4. ENERCON SKETCH NO. PGE-009-SK-340, ACCESS ROAD AND ISFSI YARD APRONS
5. ENERCON SKETCH NO. PGE-009-SK-371, UNDERGROUND UTILITY CONFIGURATIONS

THIS DRAWING IS FURNISHED AS PART OF PG&E CONTRACT NO. 4600010041, CHANGE ORDER NO. 001.

CAD FILE: PGE-009-SK-340
THIS IS A COMPUTER GENERATED DRAWING. DO NOT REVISE MANUALLY.

DRAWING SCALE APPLICABLE ONLY WITH "D" SIZE (34"x22") ORIGINAL.

ENERCON SERVICES, INC.
MOUNT ARLINGTON - NEW JERSEY

PG&E/DIABLO CANYON

SITE PLAN
ISFSI DRAINAGE SYSTEM

REV	DATE	DESCRIPTION	DRAWN	CHKD	APPD
0	[illegible]	ORIGINAL ISSUE	[illegible]	[illegible]	[illegible]

PGE-009-SK-340

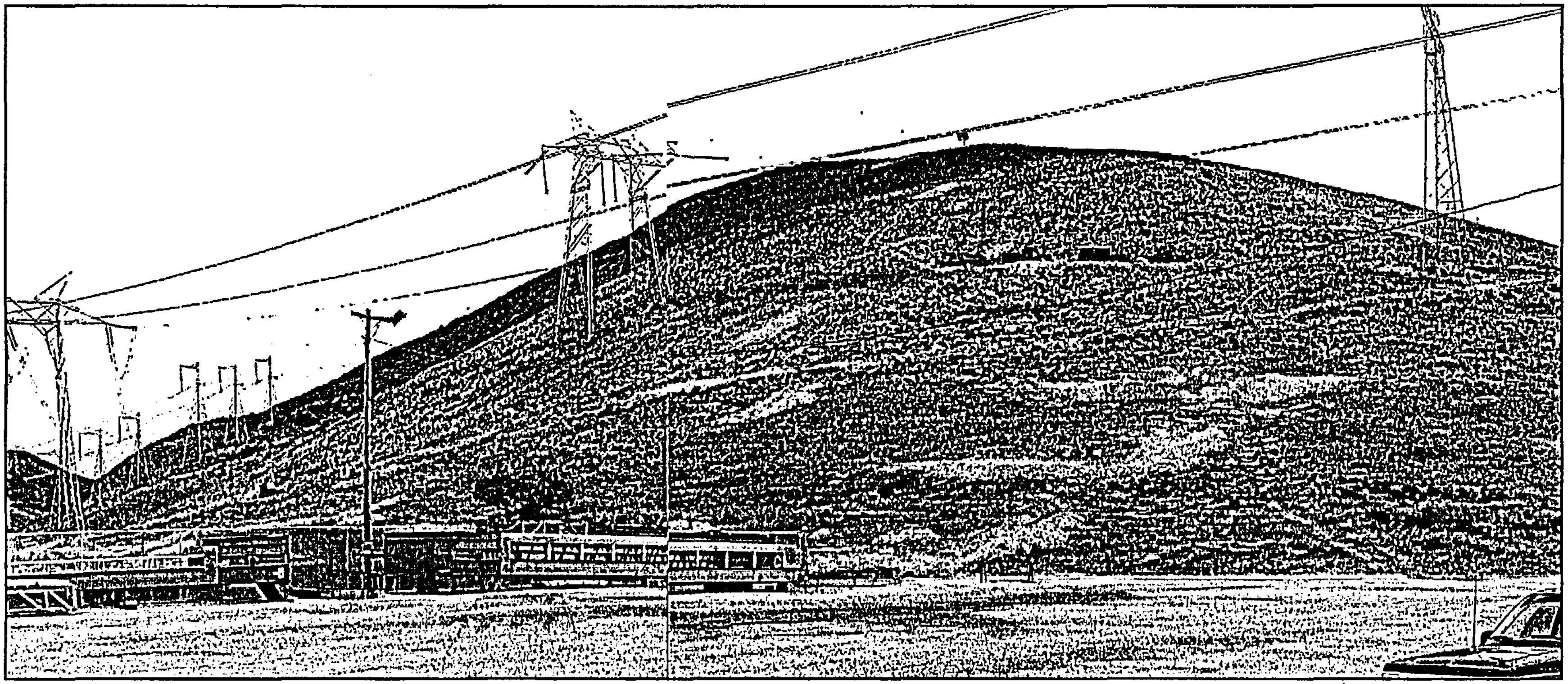
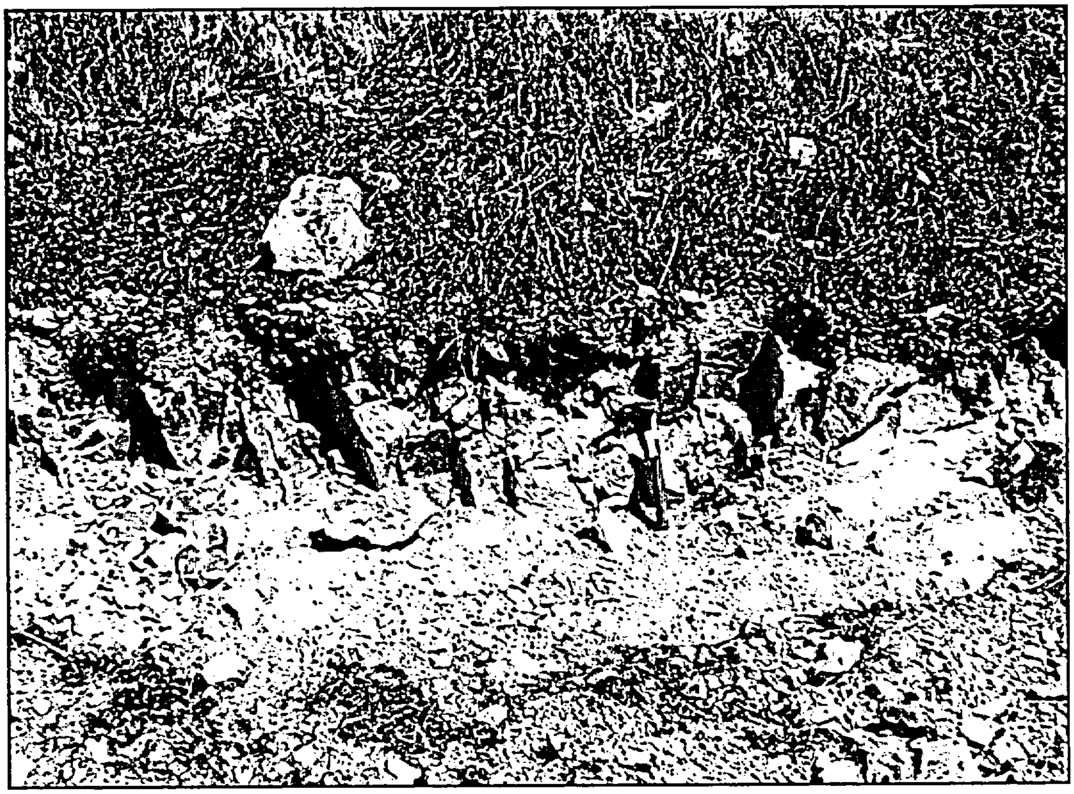


Photo 1. Overview of ISFSI slope site during exploration work. Note the steep spoil piles from exploration trenches and the lack of rockfall from the spoil piles.

Photo 2. Overview of ISFSI slope during a later stage of site exploration than shown in Photo 1. Note the switchbacking access track for drilling that extends high up the slope. Note also the lack of evidence for rolling rock from the track spoil windrows, or trench backfilling operations.



(Roll 00 00031.JPG)

Photo 3. Typical close to moderately-spaced jointing of in situ rock mass from exploration trench T-10 in ISFSI pad area.

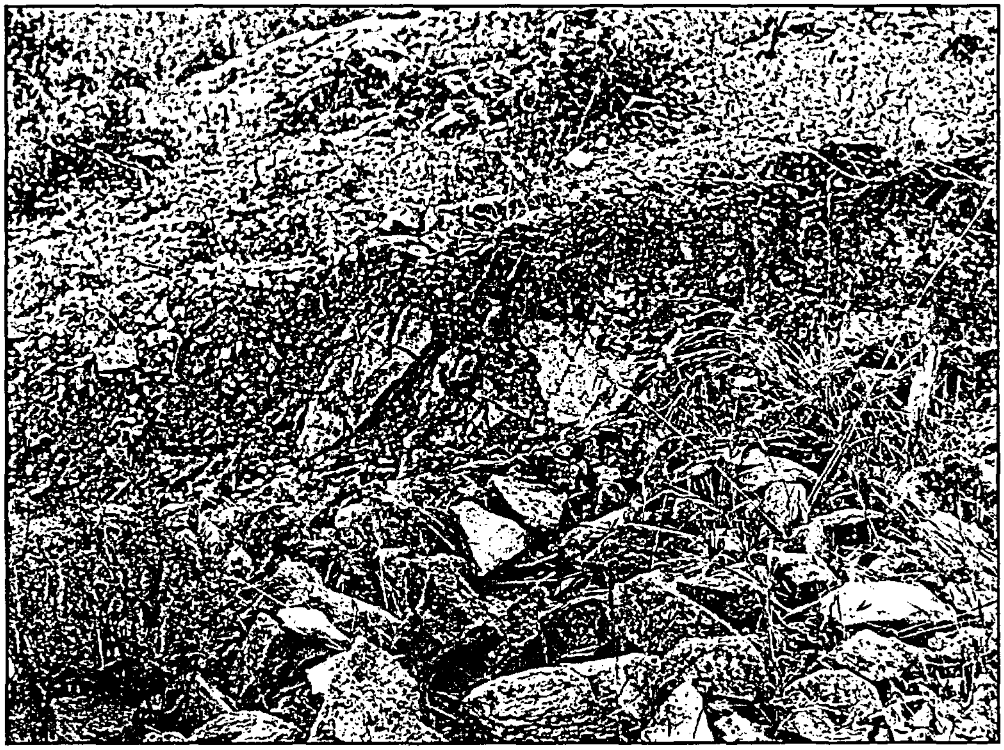


Photo 4. Typical close to moderately spaced jointing in rock mass in trench excavation, and slope surface roughness ranging from 6 inches to 1 foot. Note discontinuous outcrops and partial vegetation on slope.

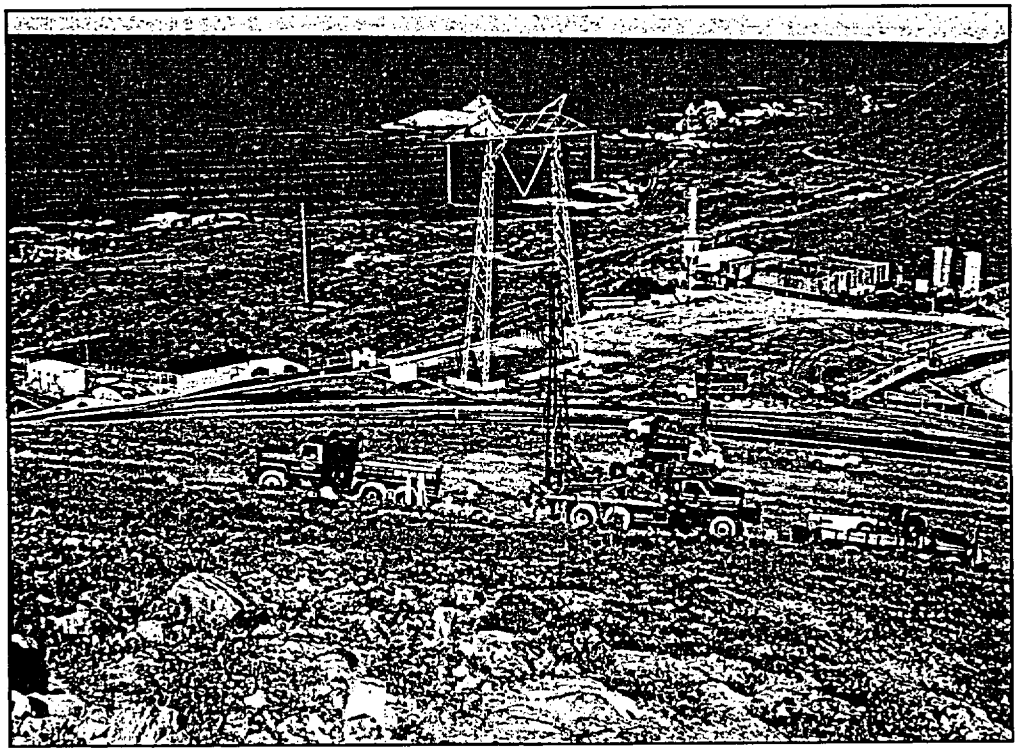
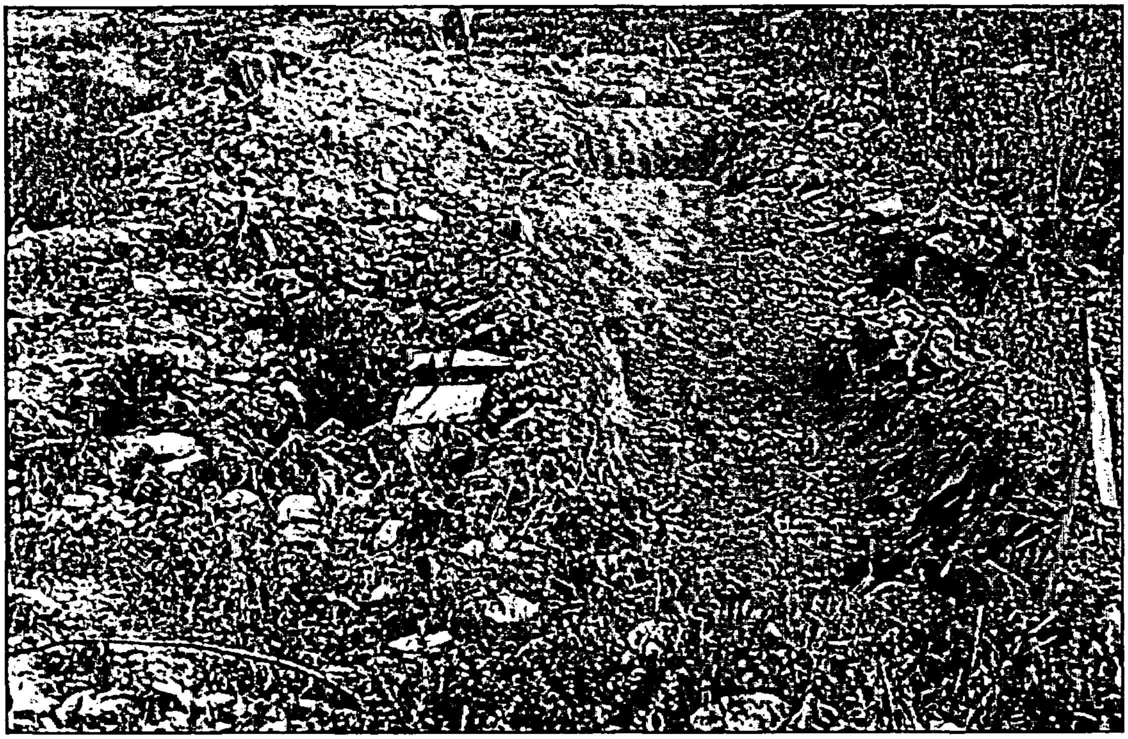


Photo 5. Typical upper-bound slope roughness of 1 to 2 feet formed by rock talus and small outcrops in the foreground. Note the rock talus and intermixed soil and vegetation between rock blocks and outcrops that would serve to "soften" the impact from potential rockfall.

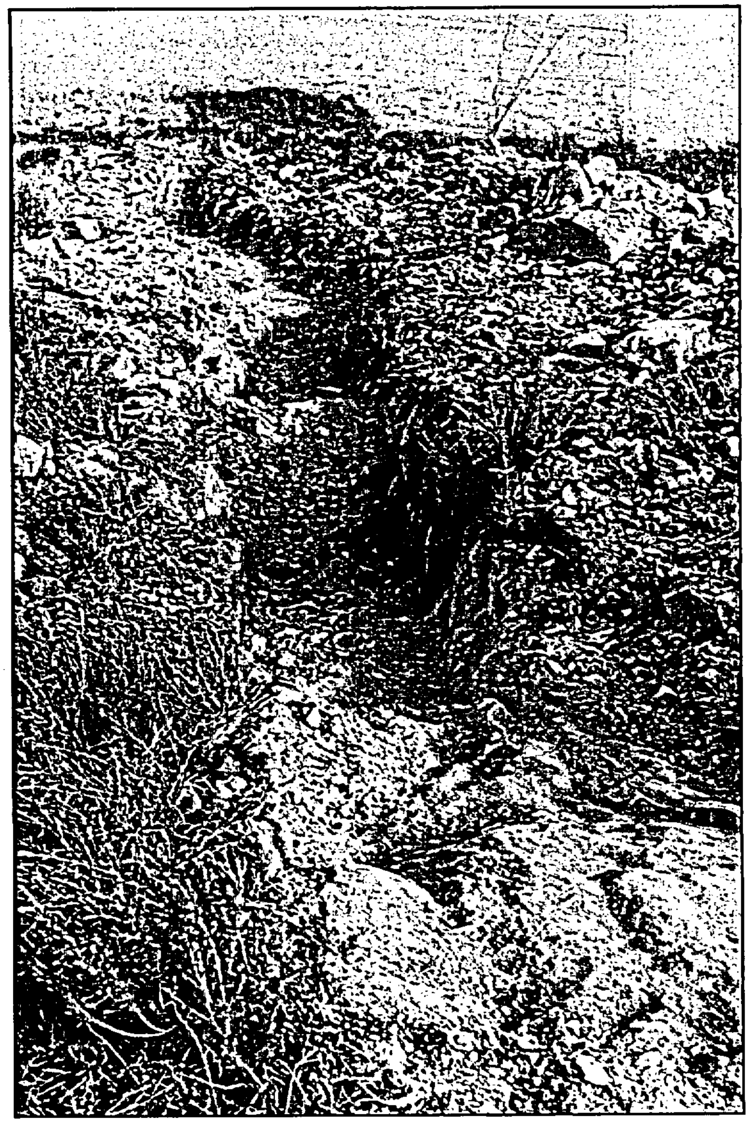
(Roll 00 00024.JPG)

Photo 6. Typical rock block size of 6 inches to 2 feet in maximum dimension in spoil pile from Trench T-3. Note the angular and flattended aspect of the rock blocks.



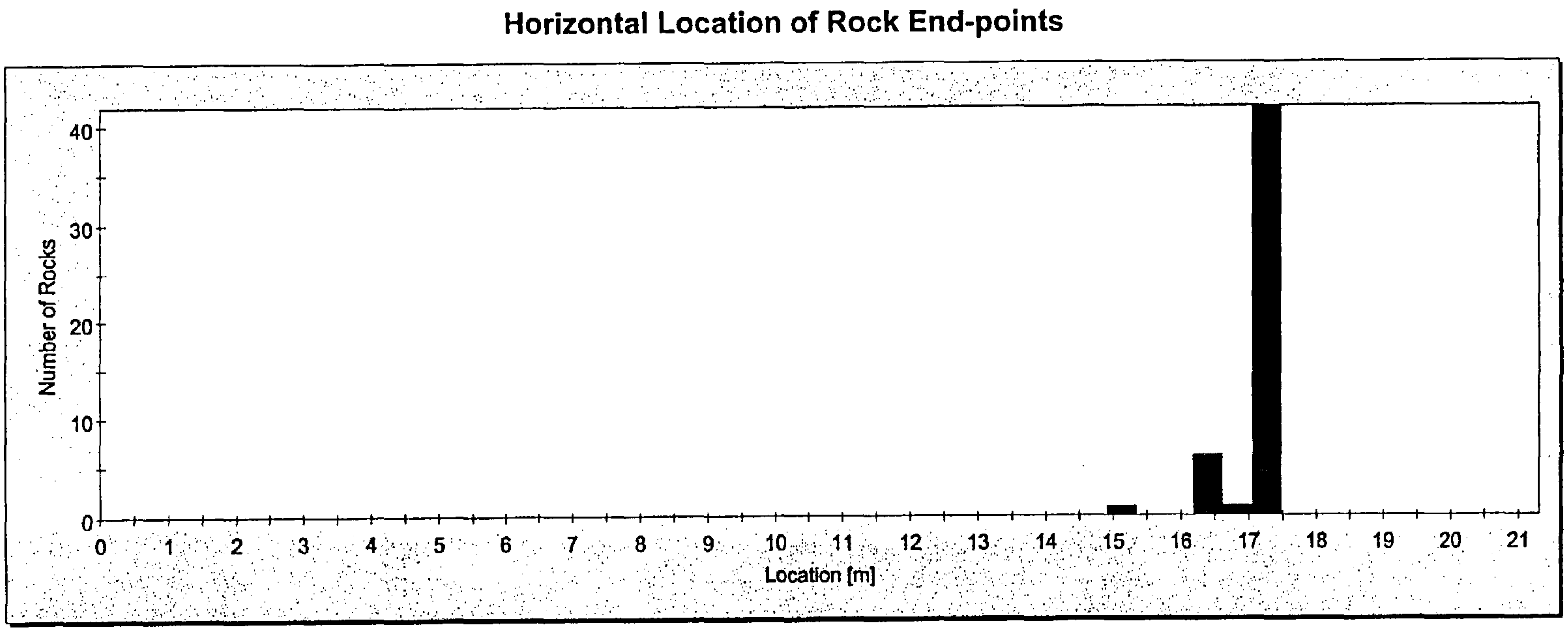
(Roll 00 JLB-4)

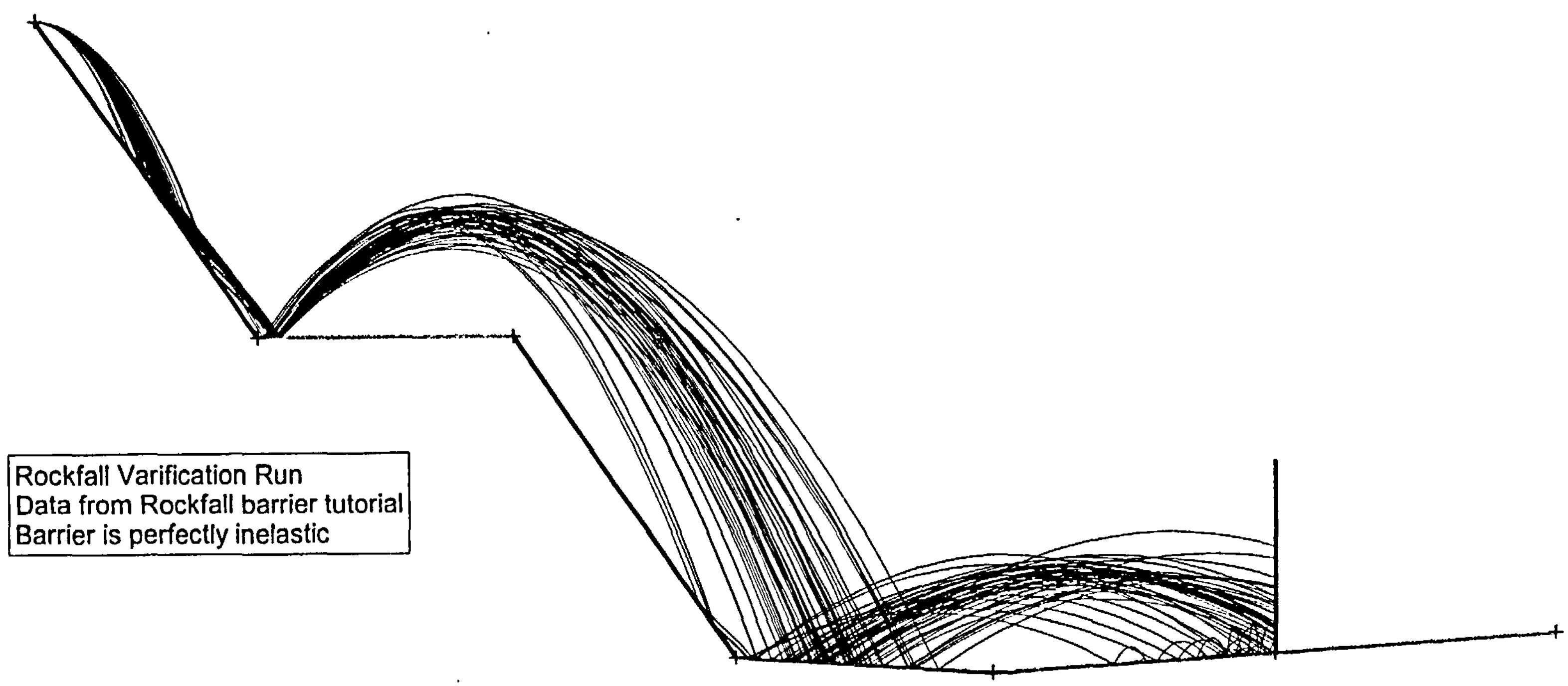
Photo 7. Rocks excavated from Trench T-13 showing typical block size of 6 inches to 2 feet in maximum dimension. The trench spoils were placed on one of the steepest slope areas above the ISFSI, and the rocks stayed on the slope without rolling, even after being dumped from the excavator bucket.



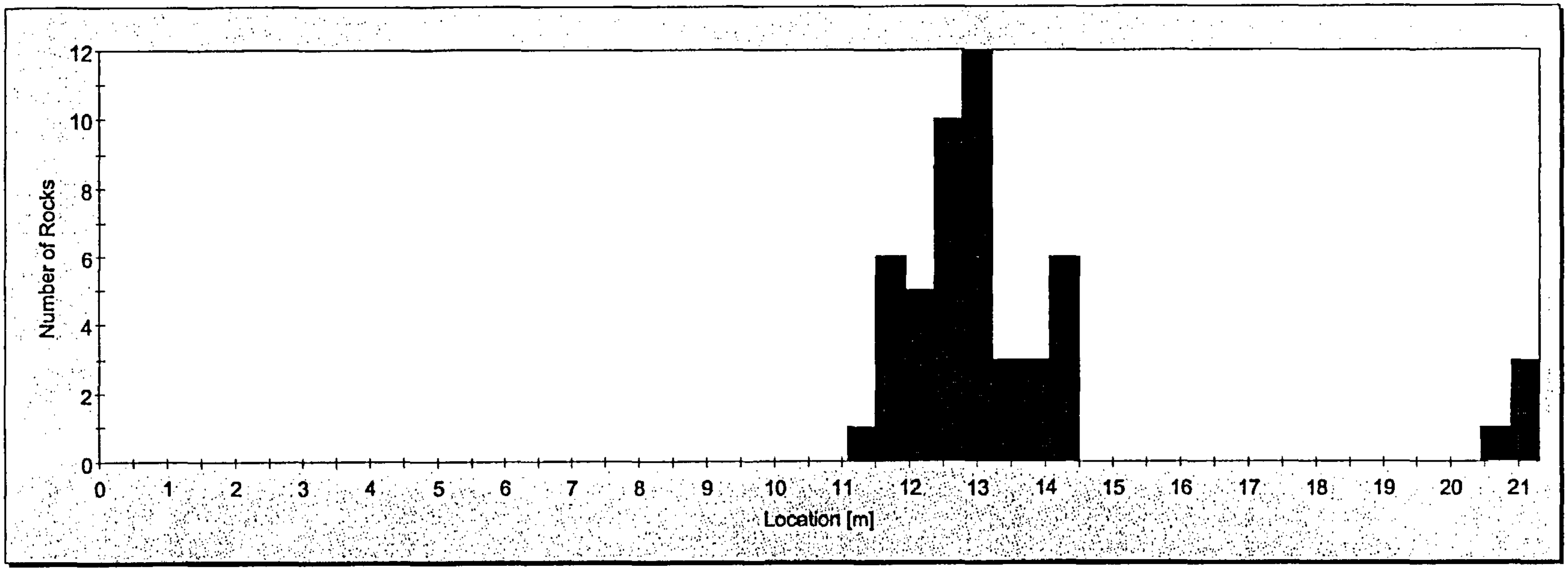
(Roll 00 JLB-3)

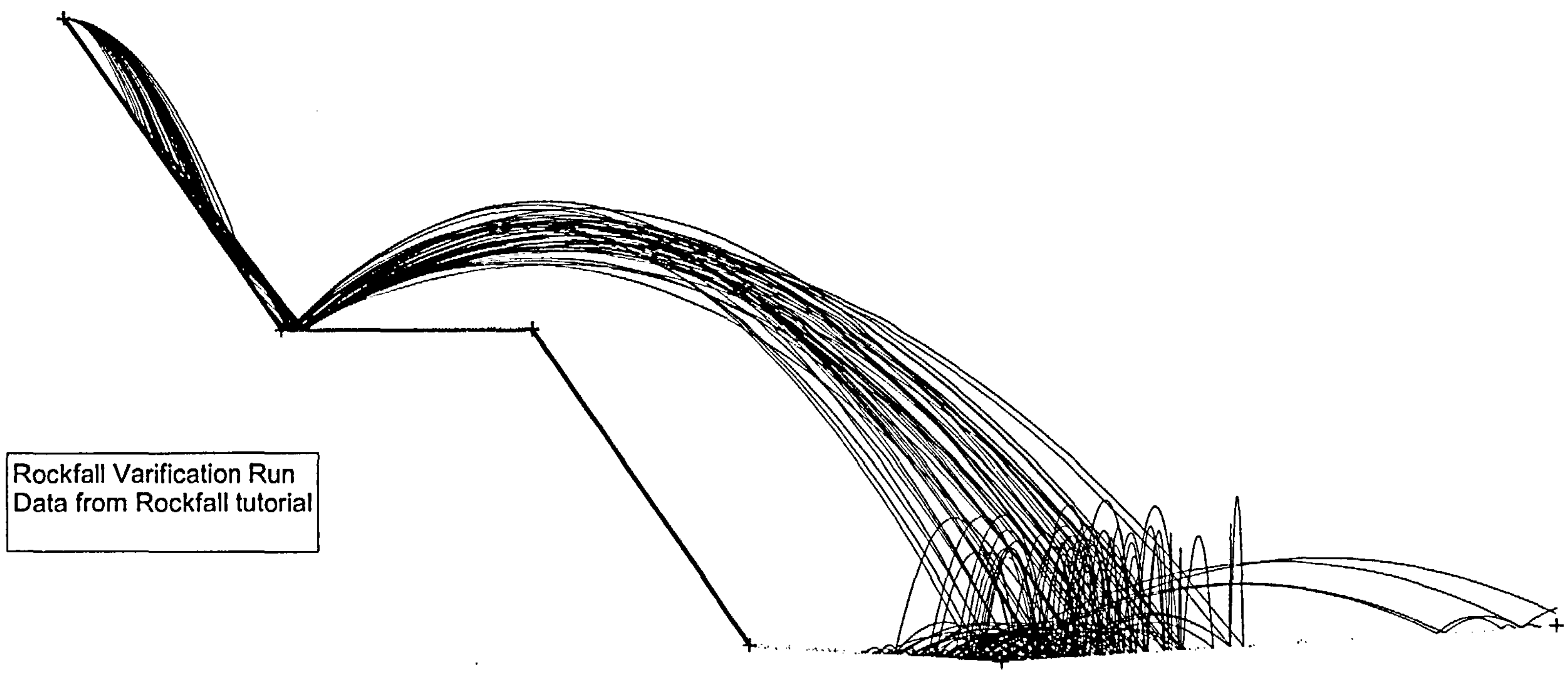
Photo 8. Rocks excavated from Trench T-19 in the vicinity of slope failure model toe 1a location. Typical block sizes are between 6 inches and 2 feet in maximum dimension. As discussed on Photo 7, the spoil pile for Trench T-19 was placed on a step slope area without shedding rolling rocks.


Horizontal Location of Rock End-points
Number of Rocks
0
10
20
30
40
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Location [m]


Rockfall Varification Run
Data from Rockfall barrier tutorial
Barrier is perfectly inelastic

Horizontal Location of Rock End-points





RocFall Analysis Information

Document Name

RA1a

Project Settings

Units: Imperial
Friction angle: Use friction angle specified in material editor
Minimum Velocity=0.1
Angular Velocity of the rocks CONSIDERED
Standard Deviations NOT USED when generating slope vertices
Random-number generation: Random

Slope

Segment 1, Material: ISFSIPad
Start Point: X mean=1000 std dev=0 Y mean=309 std dev=0
End Point: X mean=990 std dev=0 Y mean=311 std dev=0

Segment 2, Material: ISFSIPad
Start Point: X mean=990 std dev=0 Y mean=311 std dev=0
End Point: X mean=980 std dev=0 Y mean=311 std dev=0

Segment 3, Material: ISFSIPad
Start Point: X mean=980 std dev=0 Y mean=311 std dev=0
End Point: X mean=970 std dev=0 Y mean=311 std dev=0

Segment 4, Material: ISFSIPad
Start Point: X mean=970 std dev=0 Y mean=311 std dev=0
End Point: X mean=960 std dev=0 Y mean=311 std dev=0

Segment 5, Material: ISFSIPad
Start Point: X mean=960 std dev=0 Y mean=311 std dev=0
End Point: X mean=950 std dev=0 Y mean=311 std dev=0

Segment 6, Material: ISFSIPad
Start Point: X mean=950 std dev=0 Y mean=311 std dev=0
End Point: X mean=940 std dev=0 Y mean=311 std dev=0

Segment 7, Material: ISFSIPad
Start Point: X mean=940 std dev=0 Y mean=311 std dev=0
End Point: X mean=930 std dev=0 Y mean=311 std dev=0

Segment 8, Material: ISFSIPad
Start Point: X mean=930 std dev=0 Y mean=311 std dev=0
End Point: X mean=920 std dev=0 Y mean=311 std dev=0

Segment 9, Material: ISFSIPad
Start Point: X mean=920 std dev=0 Y mean=311 std dev=0
End Point: X mean=910 std dev=0 Y mean=311 std dev=0

Segment 10, Material: ISFSIPad
Start Point: X mean=910 std dev=0 Y mean=311 std dev=0
End Point: X mean=900 std dev=0 Y mean=311 std dev=0

Segment 11, Material: ISFSIPad
Start Point: X mean=900 std dev=0 Y mean=311 std dev=0
End Point: X mean=805 std dev=0 Y mean=311 std dev=0

Segment 12, Material: ISFSICutSlope
Start Point: X mean=805 std dev=0 Y mean=311 std dev=0
End Point: X mean=800 std dev=0 Y mean=327 std dev=0

Segment 13, Material: ISFSICutSlope
Start Point: X mean=800 std dev=0 Y mean=327 std dev=0
End Point: X mean=798 std dev=0 Y mean=331 std dev=0

Segment 14, Material: ISFSICutSlope
Start Point: X mean=798 std dev=0 Y mean=331 std dev=0
End Point: X mean=790 std dev=0 Y mean=331 std dev=0

Segment 15, Material: ISFSICutSlope
Start Point: X mean=790 std dev=0 Y mean=331 std dev=0
End Point: X mean=780 std dev=0 Y mean=331 std dev=0

Segment 16, Material: ISFSICutSlope
Start Point: X mean=780 std dev=0 Y mean=331 std dev=0
End Point: X mean=770 std dev=0 Y mean=331 std dev=0

Segment 17, Material: ISFSICutSlope
Start Point: X mean=770 std dev=0 Y mean=331 std dev=0
End Point: X mean=760 std dev=0 Y mean=358 std dev=0

Segment 18, Material: ISFSIGeneralSlope
Start Point: X mean=760 std dev=0 Y mean=358 std dev=0
End Point: X mean=750 std dev=0 Y mean=362 std dev=0

Segment 19, Material: ISFSIGeneralSlope
Start Point: X mean=750 std dev=0 Y mean=362 std dev=0
End Point: X mean=740 std dev=0 Y mean=365 std dev=0

Segment 20, Material: ISFSIGeneralSlope
Start Point: X mean=740 std dev=0 Y mean=365 std dev=0
End Point: X mean=730 std dev=0 Y mean=368 std dev=0

Segment 21, Material: ISFSIGeneralSlope
Start Point: X mean=730 std dev=0 Y mean=368 std dev=0
End Point: X mean=720 std dev=0 Y mean=372 std dev=0

Segment 22, Material: ISFSIGeneralSlope
Start Point: X mean=720 std dev=0 Y mean=372 std dev=0
End Point: X mean=710 std dev=0 Y mean=374 std dev=0

Segment 23, Material: ISFSIGeneralSlope
Start Point: X mean=710 std dev=0 Y mean=374 std dev=0
End Point: X mean=700 std dev=0 Y mean=376 std dev=0

Segment 24, Material: ISFSIGeneralSlope
Start Point: X mean=700 std dev=0 Y mean=376 std dev=0
End Point: X mean=690 std dev=0 Y mean=379 std dev=0

Segment 25, Material: ISFSIGeneralSlope
Start Point: X mean=690 std dev=0 Y mean=379 std dev=0
End Point: X mean=680 std dev=0 Y mean=382 std dev=0

Segment 26, Material: ISFSIGeneralSlope
Start Point: X mean=680 std dev=0 Y mean=382 std dev=0
End Point: X mean=678 std dev=0 Y mean=383 std dev=0

Segment 27, Material: ISFSIGeneralSlope
Start Point: X mean=678 std dev=0 Y mean=383 std dev=0
End Point: X mean=670 std dev=0 Y mean=385 std dev=0

Segment 28, Material: ISFSITowerRoad
Start Point: X mean=670 std dev=0 Y mean=385 std dev=0
End Point: X mean=666 std dev=0 Y mean=388 std dev=0

Segment 29, Material: ISFSITowerRoad
Start Point: X mean=666 std dev=0 Y mean=388 std dev=0
End Point: X mean=660 std dev=0 Y mean=388 std dev=0

Segment 30, Material: ISFSITowerRoad
Start Point: X mean=660 std dev=0 Y mean=388 std dev=0
End Point: X mean=656 std dev=0 Y mean=388 std dev=0

Segment 31, Material: ISFSIGeneralSlope
Start Point: X mean=656 std dev=0 Y mean=388 std dev=0
End Point: X mean=650 std dev=0 Y mean=392 std dev=0

Segment 32, Material: ISFSIGeneralSlope
Start Point: X mean=650 std dev=0 Y mean=392 std dev=0
End Point: X mean=640 std dev=0 Y mean=395 std dev=0

Segment 33, Material: ISFSIGeneralSlope
Start Point: X mean=640 std dev=0 Y mean=395 std dev=0
End Point: X mean=630 std dev=0 Y mean=398 std dev=0

Segment 34, Material: ISFSIGeneralSlope
Start Point: X mean=630 std dev=0 Y mean=398 std dev=0
End Point: X mean=620 std dev=0 Y mean=402 std dev=0

Segment 35, Material: ISFSIGeneralSlope
Start Point: X mean=620 std dev=0 Y mean=402 std dev=0
End Point: X mean=610 std dev=0 Y mean=407 std dev=0

Segment 36, Material: ISFSIGeneralSlope
Start Point: X mean=610 std dev=0 Y mean=407 std dev=0
End Point: X mean=600 std dev=0 Y mean=411 std dev=0

Segment 37, Material: ISFSIGeneralSlope
Start Point: X mean=600 std dev=0 Y mean=411 std dev=0
End Point: X mean=597 std dev=0 Y mean=412 std dev=0

Segment 38, Material: ISFSIGeneralSlope
Start Point: X mean=597 std dev=0 Y mean=412 std dev=0
End Point: X mean=590 std dev=0 Y mean=414 std dev=0

Segment 39, Material: ISFSIGeneralSlope
Start Point: X mean=590 std dev=0 Y mean=414 std dev=0
End Point: X mean=580 std dev=0 Y mean=418 std dev=0

Segment 40, Material: ISFSIGeneralSlope
Start Point: X mean=580 std dev=0 Y mean=418 std dev=0
End Point: X mean=570 std dev=0 Y mean=421 std dev=0

Segment 41, Material: ISFSIGeneralSlope
Start Point: X mean=570 std dev=0 Y mean=421 std dev=0
End Point: X mean=560 std dev=0 Y mean=424 std dev=0

Segment 42, Material: ISFSIGeneralSlope
Start Point: X mean=560 std dev=0 Y mean=424 std dev=0
End Point: X mean=550 std dev=0 Y mean=427 std dev=0

Segment 43, Material: ISFSIGeneralSlope
Start Point: X mean=550 std dev=0 Y mean=427 std dev=0
End Point: X mean=540 std dev=0 Y mean=430 std dev=0

Segment 44, Material: ISFSIGeneralSlope
Start Point: X mean=540 std dev=0 Y mean=430 std dev=0
End Point: X mean=530 std dev=0 Y mean=434 std dev=0

Segment 45, Material: ISFSIGeneralSlope
Start Point: X mean=530 std dev=0 Y mean=434 std dev=0
End Point: X mean=520 std dev=0 Y mean=438 std dev=0

Segment 46, Material: ISFSIGeneralSlope
Start Point: X mean=520 std dev=0 Y mean=438 std dev=0
End Point: X mean=510 std dev=0 Y mean=442 std dev=0

Segment 47, Material: ISFSIGeneralSlope
Start Point: X mean=510 std dev=0 Y mean=442 std dev=0
End Point: X mean=500 std dev=0 Y mean=446 std dev=0

Segment 48, Material: ISFSITowerRoad
Start Point: X mean=500 std dev=0 Y mean=446 std dev=0
End Point: X mean=494 std dev=0 Y mean=450 std dev=0

Segment 49, Material: ISFSITowerRoad
Start Point: X mean=494 std dev=0 Y mean=450 std dev=0
End Point: X mean=490 std dev=0 Y mean=450 std dev=0

Segment 50, Material: ISFSITowerRoad
Start Point: X mean=490 std dev=0 Y mean=450 std dev=0
End Point: X mean=484 std dev=0 Y mean=450 std dev=0

Segment 51, Material: ISFSIGeneralSlope
Start Point: X mean=484 std dev=0 Y mean=450 std dev=0
End Point: X mean=481 std dev=0 Y mean=452 std dev=0

Segment 52, Material: ISFSIGeneralSlope
Start Point: X mean=481 std dev=0 Y mean=452 std dev=0
End Point: X mean=480 std dev=0 Y mean=452 std dev=0

Segment 53, Material: ISFSIGeneralSlope
Start Point: X mean=480 std dev=0 Y mean=452 std dev=0
End Point: X mean=470 std dev=0 Y mean=456 std dev=0

Segment 54, Material: ISFSIGeneralSlope
Start Point: X mean=470 std dev=0 Y mean=456 std dev=0
End Point: X mean=460 std dev=0 Y mean=462 std dev=0

Segment 55, Material: ISFSIGeneralSlope
Start Point: X mean=460 std dev=0 Y mean=462 std dev=0
End Point: X mean=450 std dev=0 Y mean=465 std dev=0

Segment 56, Material: ISFSIGeneralSlope
Start Point: X mean=450 std dev=0 Y mean=465 std dev=0
End Point: X mean=440 std dev=0 Y mean=469 std dev=0

Segment 57, Material: ISFSIGeneralSlope
Start Point: X mean=440 std dev=0 Y mean=469 std dev=0
End Point: X mean=430 std dev=0 Y mean=472 std dev=0

Segment 58, Material: ISFSIGeneralSlope
Start Point: X mean=430 std dev=0 Y mean=472 std dev=0
End Point: X mean=420 std dev=0 Y mean=476 std dev=0

Segment 59, Material: ISFSIGeneralSlope
Start Point: X mean=420 std dev=0 Y mean=476 std dev=0
End Point: X mean=410 std dev=0 Y mean=480 std dev=0

Segment 60, Material: ISFSIGeneralSlope
Start Point: X mean=410 std dev=0 Y mean=480 std dev=0
End Point: X mean=400 std dev=0 Y mean=483 std dev=0

Segment 61, Material: ISFSIGeneralSlope
Start Point: X mean=400 std dev=0 Y mean=483 std dev=0
End Point: X mean=390 std dev=0 Y mean=486 std dev=0

Segment 62, Material: ISFSIGeneralSlope
Start Point: X mean=390 std dev=0 Y mean=486 std dev=0
End Point: X mean=382 std dev=0 Y mean=490 std dev=0

Segment 63, Material: ISFSIGeneralSlope
Start Point: X mean=382 std dev=0 Y mean=490 std dev=0
End Point: X mean=380 std dev=0 Y mean=491 std dev=0

Segment 64, Material: ISFSIGeneralSlope
Start Point: X mean=380 std dev=0 Y mean=491 std dev=0
End Point: X mean=370 std dev=0 Y mean=495 std dev=0

Segment 65, Material: ISFSIGeneralSlope
Start Point: X mean=370 std dev=0 Y mean=495 std dev=0
End Point: X mean=360 std dev=0 Y mean=499 std dev=0

Segment 66, Material: ISFSIGeneralSlope
Start Point: X mean=360 std dev=0 Y mean=499 std dev=0
End Point: X mean=350 std dev=0 Y mean=502 std dev=0

Segment 67, Material: ISFSIGeneralSlope
Start Point: X mean=350 std dev=0 Y mean=502 std dev=0
End Point: X mean=340 std dev=0 Y mean=506 std dev=0

Segment 68, Material: ISFSIGeneralSlope
Start Point: X mean=340 std dev=0 Y mean=506 std dev=0
End Point: X mean=330 std dev=0 Y mean=509 std dev=0

Segment 69, Material: ISFSIGeneralSlope
Start Point: X mean=330 std dev=0 Y mean=509 std dev=0
End Point: X mean=320 std dev=0 Y mean=514 std dev=0

Segment 70, Material: ISFSIGeneralSlope
Start Point: X mean=320 std dev=0 Y mean=514 std dev=0
End Point: X mean=310 std dev=0 Y mean=517 std dev=0

Segment 71, Material: ISFSIGeneralSlope
Start Point: X mean=310 std dev=0 Y mean=517 std dev=0
End Point: X mean=300 std dev=0 Y mean=520 std dev=0

Segment 72, Material: ISFSIGeneralSlope
Start Point: X mean=300 std dev=0 Y mean=520 std dev=0
End Point: X mean=290 std dev=0 Y mean=524 std dev=0

Segment 73, Material: ISFSIGeneralSlope
Start Point: X mean=290 std dev=0 Y mean=524 std dev=0
End Point: X mean=280 std dev=0 Y mean=527 std dev=0

Segment 74, Material: ISFSIGeneralSlope
Start Point: X mean=280 std dev=0 Y mean=527 std dev=0
End Point: X mean=270 std dev=0 Y mean=530 std dev=0

Segment 75, Material: ISFSIGeneralSlope
Start Point: X mean=270 std dev=0 Y mean=530 std dev=0
End Point: X mean=260 std dev=0 Y mean=534 std dev=0

Segment 76, Material: ISFSIGeneralSlope
Start Point: X mean=260 std dev=0 Y mean=534 std dev=0
End Point: X mean=250 std dev=0 Y mean=538 std dev=0

Segment 77, Material: ISFSIGeneralSlope
Start Point: X mean=250 std dev=0 Y mean=538 std dev=0
End Point: X mean=240 std dev=0 Y mean=541 std dev=0

Segment 78, Material: ISFSIGeneralSlope
Start Point: X mean=240 std dev=0 Y mean=541 std dev=0
End Point: X mean=230 std dev=0 Y mean=545 std dev=0

Segment 79, Material: ISFSIGeneralSlope
Start Point: X mean=230 std dev=0 Y mean=545 std dev=0
End Point: X mean=220 std dev=0 Y mean=548 std dev=0

Segment 80, Material: ISFSIGeneralSlope
Start Point: X mean=220 std dev=0 Y mean=548 std dev=0
End Point: X mean=210 std dev=0 Y mean=552 std dev=0

Segment 81, Material: ISFSIGeneralSlope
Start Point: X mean=210 std dev=0 Y mean=552 std dev=0
End Point: X mean=200 std dev=0 Y mean=556 std dev=0

Segment 82, Material: ISFSIGeneralSlope
Start Point: X mean=200 std dev=0 Y mean=556 std dev=0
End Point: X mean=190 std dev=0 Y mean=559 std dev=0

Segment 83, Material: ISFSIGeneralSlope
Start Point: X mean=190 std dev=0 Y mean=559 std dev=0
End Point: X mean=180 std dev=0 Y mean=562 std dev=0

Segment 84, Material: ISFSIGeneralSlope
Start Point: X mean=180 std dev=0 Y mean=562 std dev=0
End Point: X mean=170 std dev=0 Y mean=566 std dev=0

Segment 85, Material: ISFSIGeneralSlope
Start Point: X mean=170 std dev=0 Y mean=566 std dev=0
End Point: X mean=160 std dev=0 Y mean=570 std dev=0

Segment 86, Material: ISFSIGeneralSlope
Start Point: X mean=160 std dev=0 Y mean=570 std dev=0
End Point: X mean=150 std dev=0 Y mean=574 std dev=0

Segment 87, Material: ISFSIGeneralSlope
Start Point: X mean=150 std dev=0 Y mean=574 std dev=0
End Point: X mean=140 std dev=0 Y mean=577 std dev=0

Segment 88, Material: ISFSIGeneralSlope
Start Point: X mean=140 std dev=0 Y mean=577 std dev=0
End Point: X mean=130 std dev=0 Y mean=582 std dev=0

Segment 89, Material: ISFSIGeneralSlope
Start Point: X mean=130 std dev=0 Y mean=582 std dev=0
End Point: X mean=120 std dev=0 Y mean=586 std dev=0

Segment 90, Material: ISFSIGeneralSlope
Start Point: X mean=120 std dev=0 Y mean=586 std dev=0
End Point: X mean=110 std dev=0 Y mean=589 std dev=0

Segment 91, Material: ISFSIGeneralSlope
Start Point: X mean=110 std dev=0 Y mean=589 std dev=0
End Point: X mean=100 std dev=0 Y mean=594 std dev=0

Segment 92, Material: ISFSIGeneralSlope
Start Point: X mean=100 std dev=0 Y mean=594 std dev=0
End Point: X mean=90 std dev=0 Y mean=598 std dev=0

Segment 93, Material: ISFSIGeneralSlope
Start Point: X mean=90 std dev=0 Y mean=598 std dev=0
End Point: X mean=80 std dev=0 Y mean=603 std dev=0

Segment 94, Material: ISFSIGeneralSlope
Start Point: X mean=80 std dev=0 Y mean=603 std dev=0
End Point: X mean=70 std dev=0 Y mean=608 std dev=0

Segment 95, Material: ISFSIGeneralSlope
Start Point: X mean=70 std dev=0 Y mean=608 std dev=0
End Point: X mean=60 std dev=0 Y mean=614 std dev=0

Segment 96, Material: ISFSIGeneralSlope
Start Point: X mean=60 std dev=0 Y mean=614 std dev=0
End Point: X mean=50 std dev=0 Y mean=617 std dev=0

Segment 97, Material: ISFSIGeneralSlope
Start Point: X mean=50 std dev=0 Y mean=617 std dev=0
End Point: X mean=40 std dev=0 Y mean=620 std dev=0

Segment 98, Material: ISFSIGeneralSlope
Start Point: X mean=40 std dev=0 Y mean=620 std dev=0
End Point: X mean=30 std dev=0 Y mean=622 std dev=0

Segment 99, Material: ISFSIGeneralSlope
Start Point: X mean=30 std dev=0 Y mean=622 std dev=0
End Point: X mean=20 std dev=0 Y mean=624 std dev=0

Segment 100, Material: ISFSIGeneralSlope
Start Point: X mean=20 std dev=0 Y mean=624 std dev=0
End Point: X mean=10 std dev=0 Y mean=627 std dev=0

Segment 101, Material: Clean hard bedrock [default]
Start Point: X mean=10 std dev=0 Y mean=627 std dev=0
End Point: X mean=0 std dev=0 Y mean=629 std dev=0

Materials

Material name: ISFSICutSlope
Coefficient of Normal Restitution (RN): mean=0.45 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.74 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSITowerRoad
Coefficient of Normal Restitution (RN): mean=0.4 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.73 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSIGeneralSlope
Coefficient of Normal Restitution (RN): mean=0.35 std dev=0.04
Coefficient of Tangential Restitution (RT): mean=0.83 std dev=0.04
Friction Angle: mean=32 std dev=2

Roughness: 1' block std dev=37.0
3' block std dev=14.0
6' block std dev=7.1
10' block std dev=4.3

Material name: ISFSIPad
Coefficient of Normal Restitution (RN): mean=0.5 std dev=0
Coefficient of Tangential Restitution (RT): mean=0.9 std dev=0
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=0
3' block std dev=0
6' block std dev=0
10' block std dev=0

Seeders

Point Seeder
Horizontal Velocity: mean=7.5, std dev=0
Vertical Velocity: mean=0, std dev=0
Mass: 1' block mean=142, std dev=0
3' block mean=3834, std dev=0
6' block mean=30672, std dev=0
10' block mean=142000, std dev=0
Angular Velocity: mean=3, std dev=0
Location: 481, 452

Data Collectors

Data Collector name: Collector001
Start Point: 755.882, 360.392
End Point: 754.901, 370.196

RocFall Analysis Information

Document Name

RA1b

Project Settings

Units: Imperial
Friction angle: Use friction fngle specified in material editor
Minimum Velocity=0.1
Angular Velocity of the rocks CONSIDERED
Standard Deviations NOT USED when generating slope vertices
Random-number generation: Random

Slope

Segment 1, Material: ISFSIPad
Start Point: X mean=1000 std dev=0 Y mean=309 std dev=0
End Point: X mean=990 std dev=0 Y mean=311 std dev=0

Segment 2, Material: ISFSIPad
Start Point: X mean=990 std dev=0 Y mean=311 std dev=0
End Point: X mean=980 std dev=0 Y mean=311 std dev=0

Segment 3, Material: ISFSIPad
Start Point: X mean=980 std dev=0 Y mean=311 std dev=0
End Point: X mean=970 std dev=0 Y mean=311 std dev=0

Segment 4, Material: ISFSIPad
Start Point: X mean=970 std dev=0 Y mean=311 std dev=0
End Point: X mean=960 std dev=0 Y mean=311 std dev=0

Segment 5, Material: ISFSIPad
Start Point: X mean=960 std dev=0 Y mean=311 std dev=0
End Point: X mean=950 std dev=0 Y mean=311 std dev=0

Segment 6, Material: ISFSIPad
Start Point: X mean=950 std dev=0 Y mean=311 std dev=0
End Point: X mean=940 std dev=0 Y mean=311 std dev=0

Segment 7, Material: ISFSIPad
Start Point: X mean=940 std dev=0 Y mean=311 std dev=0
End Point: X mean=930 std dev=0 Y mean=311 std dev=0

Segment 8, Material: ISFSIPad
Start Point: X mean=930 std dev=0 Y mean=311 std dev=0
End Point: X mean=920 std dev=0 Y mean=311 std dev=0

Segment 9, Material: ISFSIPad
Start Point: X mean=920 std dev=0 Y mean=311 std dev=0
End Point: X mean=910 std dev=0 Y mean=311 std dev=0

Segment 10, Material: ISFSIPad

Start Point: X mean=910 std dev=0 Y mean=311 std dev=0
End Point: X mean=900 std dev=0 Y mean=311 std dev=0

Segment 11, Material: ISFSIPad
Start Point: X mean=900 std dev=0 Y mean=311 std dev=0
End Point: X mean=805 std dev=0 Y mean=311 std dev=0

Segment 12, Material: ISFSICutSlope
Start Point: X mean=805 std dev=0 Y mean=311 std dev=0
End Point: X mean=800 std dev=0 Y mean=327 std dev=0

Segment 13, Material: ISFSICutSlope
Start Point: X mean=800 std dev=0 Y mean=327 std dev=0
End Point: X mean=798 std dev=0 Y mean=331 std dev=0

Segment 14, Material: ISFSICutSlope
Start Point: X mean=798 std dev=0 Y mean=331 std dev=0
End Point: X mean=790 std dev=0 Y mean=331 std dev=0

Segment 15, Material: ISFSICutSlope
Start Point: X mean=790 std dev=0 Y mean=331 std dev=0
End Point: X mean=780 std dev=0 Y mean=331 std dev=0

Segment 16, Material: ISFSICutSlope
Start Point: X mean=780 std dev=0 Y mean=331 std dev=0
End Point: X mean=770 std dev=0 Y mean=331 std dev=0

Segment 17, Material: ISFSICutSlope
Start Point: X mean=770 std dev=0 Y mean=331 std dev=0
End Point: X mean=760 std dev=0 Y mean=358 std dev=0

Segment 18, Material: ISFSIGeneralSlope
Start Point: X mean=760 std dev=0 Y mean=358 std dev=0
End Point: X mean=750 std dev=0 Y mean=362 std dev=0

Segment 19, Material: ISFSIGeneralSlope
Start Point: X mean=750 std dev=0 Y mean=362 std dev=0
End Point: X mean=740 std dev=0 Y mean=365 std dev=0

Segment 20, Material: ISFSIGeneralSlope
Start Point: X mean=740 std dev=0 Y mean=365 std dev=0
End Point: X mean=730 std dev=0 Y mean=368 std dev=0

Segment 21, Material: ISFSIGeneralSlope
Start Point: X mean=730 std dev=0 Y mean=368 std dev=0
End Point: X mean=720 std dev=0 Y mean=372 std dev=0

Segment 22, Material: ISFSIGeneralSlope
Start Point: X mean=720 std dev=0 Y mean=372 std dev=0
End Point: X mean=710 std dev=0 Y mean=374 std dev=0

Segment 23, Material: ISFSIGeneralSlope
Start Point: X mean=710 std dev=0 Y mean=374 std dev=0
End Point: X mean=700 std dev=0 Y mean=376 std dev=0

Segment 24, Material: ISFSIGeneralSlope

Start Point: X mean=700 std dev=0 Y mean=376 std dev=0
End Point: X mean=690 std dev=0 Y mean=379 std dev=0

Segment 25, Material: ISFSIGeneralSlope
Start Point: X mean=690 std dev=0 Y mean=379 std dev=0
End Point: X mean=680 std dev=0 Y mean=382 std dev=0

Segment 26, Material: ISFSIGeneralSlope
Start Point: X mean=680 std dev=0 Y mean=382 std dev=0
End Point: X mean=678 std dev=0 Y mean=383 std dev=0

Segment 27, Material: ISFSIGeneralSlope
Start Point: X mean=678 std dev=0 Y mean=383 std dev=0
End Point: X mean=670 std dev=0 Y mean=385 std dev=0

Segment 28, Material: ISFSITowerRoad
Start Point: X mean=670 std dev=0 Y mean=385 std dev=0
End Point: X mean=666 std dev=0 Y mean=388 std dev=0

Segment 29, Material: ISFSITowerRoad
Start Point: X mean=666 std dev=0 Y mean=388 std dev=0
End Point: X mean=660 std dev=0 Y mean=388 std dev=0

Segment 30, Material: ISFSITowerRoad
Start Point: X mean=660 std dev=0 Y mean=388 std dev=0
End Point: X mean=656 std dev=0 Y mean=388 std dev=0

Segment 31, Material: ISFSIGeneralSlope
Start Point: X mean=656 std dev=0 Y mean=388 std dev=0
End Point: X mean=650 std dev=0 Y mean=392 std dev=0

Segment 32, Material: ISFSIGeneralSlope
Start Point: X mean=650 std dev=0 Y mean=392 std dev=0
End Point: X mean=640 std dev=0 Y mean=395 std dev=0

Segment 33, Material: ISFSIGeneralSlope
Start Point: X mean=640 std dev=0 Y mean=395 std dev=0
End Point: X mean=630 std dev=0 Y mean=398 std dev=0

Segment 34, Material: ISFSIGeneralSlope
Start Point: X mean=630 std dev=0 Y mean=398 std dev=0
End Point: X mean=620 std dev=0 Y mean=402 std dev=0

Segment 35, Material: ISFSIGeneralSlope
Start Point: X mean=620 std dev=0 Y mean=402 std dev=0
End Point: X mean=610 std dev=0 Y mean=407 std dev=0

Segment 36, Material: ISFSIGeneralSlope
Start Point: X mean=610 std dev=0 Y mean=407 std dev=0
End Point: X mean=600 std dev=0 Y mean=411 std dev=0

Segment 37, Material: ISFSIGeneralSlope
Start Point: X mean=600 std dev=0 Y mean=411 std dev=0
End Point: X mean=597 std dev=0 Y mean=412 std dev=0

Segment 38, Material: ISFSIGeneralSlope

Start Point: X mean=597 std dev=0 Y mean=412 std dev=0
End Point: X mean=590 std dev=0 Y mean=414 std dev=0

Segment 39, Material: ISFSIGeneralSlope
Start Point: X mean=590 std dev=0 Y mean=414 std dev=0
End Point: X mean=580 std dev=0 Y mean=418 std dev=0

Segment 40, Material: ISFSIGeneralSlope
Start Point: X mean=580 std dev=0 Y mean=418 std dev=0
End Point: X mean=570 std dev=0 Y mean=421 std dev=0

Segment 41, Material: ISFSIGeneralSlope
Start Point: X mean=570 std dev=0 Y mean=421 std dev=0
End Point: X mean=560 std dev=0 Y mean=424 std dev=0

Segment 42, Material: ISFSIGeneralSlope
Start Point: X mean=560 std dev=0 Y mean=424 std dev=0
End Point: X mean=550 std dev=0 Y mean=427 std dev=0

Segment 43, Material: ISFSIGeneralSlope
Start Point: X mean=550 std dev=0 Y mean=427 std dev=0
End Point: X mean=540 std dev=0 Y mean=430 std dev=0

Segment 44, Material: ISFSIGeneralSlope
Start Point: X mean=540 std dev=0 Y mean=430 std dev=0
End Point: X mean=530 std dev=0 Y mean=434 std dev=0

Segment 45, Material: ISFSIGeneralSlope
Start Point: X mean=530 std dev=0 Y mean=434 std dev=0
End Point: X mean=520 std dev=0 Y mean=438 std dev=0

Segment 46, Material: ISFSIGeneralSlope
Start Point: X mean=520 std dev=0 Y mean=438 std dev=0
End Point: X mean=510 std dev=0 Y mean=442 std dev=0

Segment 47, Material: ISFSIGeneralSlope
Start Point: X mean=510 std dev=0 Y mean=442 std dev=0
End Point: X mean=500 std dev=0 Y mean=446 std dev=0

Segment 48, Material: ISFSITowerRoad
Start Point: X mean=500 std dev=0 Y mean=446 std dev=0
End Point: X mean=494 std dev=0 Y mean=450 std dev=0

Segment 49, Material: ISFSITowerRoad
Start Point: X mean=494 std dev=0 Y mean=450 std dev=0
End Point: X mean=490 std dev=0 Y mean=450 std dev=0

Segment 50, Material: ISFSITowerRoad
Start Point: X mean=490 std dev=0 Y mean=450 std dev=0
End Point: X mean=484 std dev=0 Y mean=450 std dev=0

Segment 51, Material: ISFSIGeneralSlope
Start Point: X mean=484 std dev=0 Y mean=450 std dev=0
End Point: X mean=481 std dev=0 Y mean=452 std dev=0

Segment 52, Material: ISFSIGeneralSlope

Start Point: X mean=481 std dev=0 Y mean=452 std dev=0
End Point: X mean=480 std dev=0 Y mean=452 std dev=0

Segment 53, Material: ISFSIGeneralSlope
Start Point: X mean=480 std dev=0 Y mean=452 std dev=0
End Point: X mean=470 std dev=0 Y mean=456 std dev=0

Segment 54, Material: ISFSIGeneralSlope
Start Point: X mean=470 std dev=0 Y mean=456 std dev=0
End Point: X mean=460 std dev=0 Y mean=462 std dev=0

Segment 55, Material: ISFSIGeneralSlope
Start Point: X mean=460 std dev=0 Y mean=462 std dev=0
End Point: X mean=450 std dev=0 Y mean=465 std dev=0

Segment 56, Material: ISFSIGeneralSlope
Start Point: X mean=450 std dev=0 Y mean=465 std dev=0
End Point: X mean=440 std dev=0 Y mean=469 std dev=0

Segment 57, Material: ISFSIGeneralSlope
Start Point: X mean=440 std dev=0 Y mean=469 std dev=0
End Point: X mean=430 std dev=0 Y mean=472 std dev=0

Segment 58, Material: ISFSIGeneralSlope
Start Point: X mean=430 std dev=0 Y mean=472 std dev=0
End Point: X mean=420 std dev=0 Y mean=476 std dev=0

Segment 59, Material: ISFSIGeneralSlope
Start Point: X mean=420 std dev=0 Y mean=476 std dev=0
End Point: X mean=410 std dev=0 Y mean=480 std dev=0

Segment 60, Material: ISFSIGeneralSlope
Start Point: X mean=410 std dev=0 Y mean=480 std dev=0
End Point: X mean=400 std dev=0 Y mean=483 std dev=0

Segment 61, Material: ISFSIGeneralSlope
Start Point: X mean=400 std dev=0 Y mean=483 std dev=0
End Point: X mean=390 std dev=0 Y mean=486 std dev=0

Segment 62, Material: ISFSIGeneralSlope
Start Point: X mean=390 std dev=0 Y mean=486 std dev=0
End Point: X mean=382 std dev=0 Y mean=490 std dev=0

Segment 63, Material: ISFSIGeneralSlope
Start Point: X mean=382 std dev=0 Y mean=490 std dev=0
End Point: X mean=380 std dev=0 Y mean=491 std dev=0

Segment 64, Material: ISFSIGeneralSlope
Start Point: X mean=380 std dev=0 Y mean=491 std dev=0
End Point: X mean=370 std dev=0 Y mean=495 std dev=0

Segment 65, Material: ISFSIGeneralSlope
Start Point: X mean=370 std dev=0 Y mean=495 std dev=0
End Point: X mean=360 std dev=0 Y mean=499 std dev=0

Segment 66, Material: ISFSIGeneralSlope

Start Point: X mean=360 std dev=0 Y mean=499 std dev=0
End Point: X mean=350 std dev=0 Y mean=502 std dev=0

Segment 67, Material: ISFSIGeneralSlope
Start Point: X mean=350 std dev=0 Y mean=502 std dev=0
End Point: X mean=340 std dev=0 Y mean=506 std dev=0

Segment 68, Material: ISFSIGeneralSlope
Start Point: X mean=340 std dev=0 Y mean=506 std dev=0
End Point: X mean=330 std dev=0 Y mean=509 std dev=0

Segment 69, Material: ISFSIGeneralSlope
Start Point: X mean=330 std dev=0 Y mean=509 std dev=0
End Point: X mean=320 std dev=0 Y mean=514 std dev=0

Segment 70, Material: ISFSIGeneralSlope
Start Point: X mean=320 std dev=0 Y mean=514 std dev=0
End Point: X mean=310 std dev=0 Y mean=517 std dev=0

Segment 71, Material: ISFSIGeneralSlope
Start Point: X mean=310 std dev=0 Y mean=517 std dev=0
End Point: X mean=300 std dev=0 Y mean=520 std dev=0

Segment 72, Material: ISFSIGeneralSlope
Start Point: X mean=300 std dev=0 Y mean=520 std dev=0
End Point: X mean=290 std dev=0 Y mean=524 std dev=0

Segment 73, Material: ISFSIGeneralSlope
Start Point: X mean=290 std dev=0 Y mean=524 std dev=0
End Point: X mean=280 std dev=0 Y mean=527 std dev=0

Segment 74, Material: ISFSIGeneralSlope
Start Point: X mean=280 std dev=0 Y mean=527 std dev=0
End Point: X mean=270 std dev=0 Y mean=530 std dev=0

Segment 75, Material: ISFSIGeneralSlope
Start Point: X mean=270 std dev=0 Y mean=530 std dev=0
End Point: X mean=260 std dev=0 Y mean=534 std dev=0

Segment 76, Material: ISFSIGeneralSlope
Start Point: X mean=260 std dev=0 Y mean=534 std dev=0
End Point: X mean=250 std dev=0 Y mean=538 std dev=0

Segment 77, Material: ISFSIGeneralSlope
Start Point: X mean=250 std dev=0 Y mean=538 std dev=0
End Point: X mean=240 std dev=0 Y mean=541 std dev=0

Segment 78, Material: ISFSIGeneralSlope
Start Point: X mean=240 std dev=0 Y mean=541 std dev=0
End Point: X mean=230 std dev=0 Y mean=545 std dev=0

Segment 79, Material: ISFSIGeneralSlope
Start Point: X mean=230 std dev=0 Y mean=545 std dev=0
End Point: X mean=220 std dev=0 Y mean=548 std dev=0

Segment 80, Material: ISFSIGeneralSlope

Start Point: X mean=220 std dev=0 Y mean=548 std dev=0
End Point: X mean=210 std dev=0 Y mean=552 std dev=0

Segment 81, Material: ISFSIGeneralSlope
Start Point: X mean=210 std dev=0 Y mean=552 std dev=0
End Point: X mean=200 std dev=0 Y mean=556 std dev=0

Segment 82, Material: ISFSIGeneralSlope
Start Point: X mean=200 std dev=0 Y mean=556 std dev=0
End Point: X mean=190 std dev=0 Y mean=559 std dev=0

Segment 83, Material: ISFSIGeneralSlope
Start Point: X mean=190 std dev=0 Y mean=559 std dev=0
End Point: X mean=180 std dev=0 Y mean=562 std dev=0

Segment 84, Material: ISFSIGeneralSlope
Start Point: X mean=180 std dev=0 Y mean=562 std dev=0
End Point: X mean=170 std dev=0 Y mean=566 std dev=0

Segment 85, Material: ISFSIGeneralSlope
Start Point: X mean=170 std dev=0 Y mean=566 std dev=0
End Point: X mean=160 std dev=0 Y mean=570 std dev=0

Segment 86, Material: ISFSIGeneralSlope
Start Point: X mean=160 std dev=0 Y mean=570 std dev=0
End Point: X mean=150 std dev=0 Y mean=574 std dev=0

Segment 87, Material: ISFSIGeneralSlope
Start Point: X mean=150 std dev=0 Y mean=574 std dev=0
End Point: X mean=140 std dev=0 Y mean=577 std dev=0

Segment 88, Material: ISFSIGeneralSlope
Start Point: X mean=140 std dev=0 Y mean=577 std dev=0
End Point: X mean=130 std dev=0 Y mean=582 std dev=0

Segment 89, Material: ISFSIGeneralSlope
Start Point: X mean=130 std dev=0 Y mean=582 std dev=0
End Point: X mean=120 std dev=0 Y mean=586 std dev=0

Segment 90, Material: ISFSIGeneralSlope
Start Point: X mean=120 std dev=0 Y mean=586 std dev=0
End Point: X mean=110 std dev=0 Y mean=589 std dev=0

Segment 91, Material: ISFSIGeneralSlope
Start Point: X mean=110 std dev=0 Y mean=589 std dev=0
End Point: X mean=100 std dev=0 Y mean=594 std dev=0

Segment 92, Material: ISFSIGeneralSlope
Start Point: X mean=100 std dev=0 Y mean=594 std dev=0
End Point: X mean=90 std dev=0 Y mean=598 std dev=0

Segment 93, Material: ISFSIGeneralSlope
Start Point: X mean=90 std dev=0 Y mean=598 std dev=0
End Point: X mean=80 std dev=0 Y mean=603 std dev=0

Segment 94, Material: ISFSIGeneralSlope

Start Point: X mean=80 std dev=0 Y mean=603 std dev=0
End Point: X mean=70 std dev=0 Y mean=608 std dev=0

Segment 95, Material: ISFSIGeneralSlope
Start Point: X mean=70 std dev=0 Y mean=608 std dev=0
End Point: X mean=60 std dev=0 Y mean=614 std dev=0

Segment 96, Material: ISFSIGeneralSlope
Start Point: X mean=60 std dev=0 Y mean=614 std dev=0
End Point: X mean=50 std dev=0 Y mean=617 std dev=0

Segment 97, Material: ISFSIGeneralSlope
Start Point: X mean=50 std dev=0 Y mean=617 std dev=0
End Point: X mean=40 std dev=0 Y mean=620 std dev=0

Segment 98, Material: ISFSIGeneralSlope
Start Point: X mean=40 std dev=0 Y mean=620 std dev=0
End Point: X mean=30 std dev=0 Y mean=622 std dev=0

Segment 99, Material: ISFSIGeneralSlope
Start Point: X mean=30 std dev=0 Y mean=622 std dev=0
End Point: X mean=20 std dev=0 Y mean=624 std dev=0

Segment 100, Material: ISFSIGeneralSlope
Start Point: X mean=20 std dev=0 Y mean=624 std dev=0
End Point: X mean=10 std dev=0 Y mean=627 std dev=0

Segment 101, Material: Clean hard bedrock [default]
Start Point: X mean=10 std dev=0 Y mean=627 std dev=0
End Point: X mean=0 std dev=0 Y mean=629 std dev=0

Materials

Material name: ISFSICutSlope
Coefficient of Normal Restitution (RN): mean=0.45 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.74 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSITowerRoad
Coefficient of Normal Restitution (RN): mean=0.4 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.73 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSIGeneralSlope
Coefficient of Normal Restitution (RN): mean=0.35 std dev=0.04
Coefficient of Tangential Restitution (RT): mean=0.83 std dev=0.04
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=37.0

3' block std dev=14.0
6' block std dev=7.1
10' block std dev=4.3

Material name: ISFSIPad
Coefficient of Normal Restitution (RN): mean=0.5 std dev=0
Coefficient of Tangential Restitution (RT): mean=0.9 std dev=0
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=0
3' block std dev=0
6' block std dev=0
10' block std dev=0

Seeders

Point Seeder
Horizontal Velocity: mean=7.5, std dev=0
Vertical Velocity: mean=0, std dev=0
Mass: 1' block mean=142, std dev=0
3' block mean=3834, std dev=0
6' block mean=30672, std dev=0
10' block mean=142000, std dev=0
Angular Velocity: mean=3, std dev=0
Location: 382, 490

Data Collectors

Data Collector name: Collector001
Start Point: 755.882, 360.392
End Point: 754.901, 370.196

RocFall Analysis Information

Document Name

RA2a

Project Settings

Units: Imperial
Friction angle: Use friction fngle specified in material editor
Minimum Velocity=0.1
Angular Velocity of the rocks CONSIDERED
Standard Deviations NOT USED when generating slope vertices
Random-number generation: Random

Slope

Segment 1, Material: ISFSIPad
Start Point: X mean=1000 std dev=0 Y mean=309 std dev=0
End Point: X mean=990 std dev=0 Y mean=311 std dev=0

Segment 2, Material: ISFSIPad
Start Point: X mean=990 std dev=0 Y mean=311 std dev=0
End Point: X mean=980 std dev=0 Y mean=311 std dev=0

Segment 3, Material: ISFSIPad
Start Point: X mean=980 std dev=0 Y mean=311 std dev=0
End Point: X mean=970 std dev=0 Y mean=311 std dev=0

Segment 4, Material: ISFSIPad
Start Point: X mean=970 std dev=0 Y mean=311 std dev=0
End Point: X mean=960 std dev=0 Y mean=311 std dev=0

Segment 5, Material: ISFSIPad
Start Point: X mean=960 std dev=0 Y mean=311 std dev=0
End Point: X mean=950 std dev=0 Y mean=311 std dev=0

Segment 6, Material: ISFSIPad
Start Point: X mean=950 std dev=0 Y mean=311 std dev=0
End Point: X mean=940 std dev=0 Y mean=311 std dev=0

Segment 7, Material: ISFSIPad
Start Point: X mean=940 std dev=0 Y mean=311 std dev=0
End Point: X mean=930 std dev=0 Y mean=311 std dev=0

Segment 8, Material: ISFSIPad
Start Point: X mean=930 std dev=0 Y mean=311 std dev=0
End Point: X mean=920 std dev=0 Y mean=311 std dev=0

Segment 9, Material: ISFSIPad
Start Point: X mean=920 std dev=0 Y mean=311 std dev=0
End Point: X mean=910 std dev=0 Y mean=311 std dev=0

Segment 10, Material: ISFSIPad

Start Point: X mean=910 std dev=0 Y mean=311 std dev=0
End Point: X mean=900 std dev=0 Y mean=311 std dev=0

Segment 11, Material: ISFSIPad
Start Point: X mean=900 std dev=0 Y mean=311 std dev=0
End Point: X mean=805 std dev=0 Y mean=311 std dev=0

Segment 12, Material: ISFSICutSlope
Start Point: X mean=805 std dev=0 Y mean=311 std dev=0
End Point: X mean=800 std dev=0 Y mean=327 std dev=0

Segment 13, Material: ISFSICutSlope
Start Point: X mean=800 std dev=0 Y mean=327 std dev=0
End Point: X mean=798 std dev=0 Y mean=331 std dev=0

Segment 14, Material: ISFSICutSlope
Start Point: X mean=798 std dev=0 Y mean=331 std dev=0
End Point: X mean=790 std dev=0 Y mean=331 std dev=0

Segment 15, Material: ISFSICutSlope
Start Point: X mean=790 std dev=0 Y mean=331 std dev=0
End Point: X mean=780 std dev=0 Y mean=331 std dev=0

Segment 16, Material: ISFSICutSlope
Start Point: X mean=780 std dev=0 Y mean=331 std dev=0
End Point: X mean=770 std dev=0 Y mean=331 std dev=0

Segment 17, Material: ISFSICutSlope
Start Point: X mean=770 std dev=0 Y mean=331 std dev=0
End Point: X mean=760 std dev=0 Y mean=358 std dev=0

Segment 18, Material: ISFSIGeneralSlope
Start Point: X mean=760 std dev=0 Y mean=358 std dev=0
End Point: X mean=750 std dev=0 Y mean=362 std dev=0

Segment 19, Material: ISFSIGeneralSlope
Start Point: X mean=750 std dev=0 Y mean=362 std dev=0
End Point: X mean=740 std dev=0 Y mean=365 std dev=0

Segment 20, Material: ISFSIGeneralSlope
Start Point: X mean=740 std dev=0 Y mean=365 std dev=0
End Point: X mean=730 std dev=0 Y mean=368 std dev=0

Segment 21, Material: ISFSIGeneralSlope
Start Point: X mean=730 std dev=0 Y mean=368 std dev=0
End Point: X mean=720 std dev=0 Y mean=372 std dev=0

Segment 22, Material: ISFSIGeneralSlope
Start Point: X mean=720 std dev=0 Y mean=372 std dev=0
End Point: X mean=710 std dev=0 Y mean=374 std dev=0

Segment 23, Material: ISFSIGeneralSlope
Start Point: X mean=710 std dev=0 Y mean=374 std dev=0
End Point: X mean=700 std dev=0 Y mean=376 std dev=0

Segment 24, Material: ISFSIGeneralSlope

Start Point: X mean=700 std dev=0 Y mean=376 std dev=0
End Point: X mean=690 std dev=0 Y mean=379 std dev=0

Segment 25, Material: ISFSIGeneralSlope
Start Point: X mean=690 std dev=0 Y mean=379 std dev=0
End Point: X mean=680 std dev=0 Y mean=382 std dev=0

Segment 26, Material: ISFSIGeneralSlope
Start Point: X mean=680 std dev=0 Y mean=382 std dev=0
End Point: X mean=678 std dev=0 Y mean=383 std dev=0

Segment 27, Material: ISFSIGeneralSlope
Start Point: X mean=678 std dev=0 Y mean=383 std dev=0
End Point: X mean=670 std dev=0 Y mean=385 std dev=0

Segment 28, Material: ISFSITowerRoad
Start Point: X mean=670 std dev=0 Y mean=385 std dev=0
End Point: X mean=666 std dev=0 Y mean=388 std dev=0

Segment 29, Material: ISFSITowerRoad
Start Point: X mean=666 std dev=0 Y mean=388 std dev=0
End Point: X mean=660 std dev=0 Y mean=388 std dev=0

Segment 30, Material: ISFSITowerRoad
Start Point: X mean=660 std dev=0 Y mean=388 std dev=0
End Point: X mean=656 std dev=0 Y mean=388 std dev=0

Segment 31, Material: ISFSIGeneralSlope
Start Point: X mean=656 std dev=0 Y mean=388 std dev=0
End Point: X mean=650 std dev=0 Y mean=392 std dev=0

Segment 32, Material: ISFSIGeneralSlope
Start Point: X mean=650 std dev=0 Y mean=392 std dev=0
End Point: X mean=640 std dev=0 Y mean=395 std dev=0

Segment 33, Material: ISFSIGeneralSlope
Start Point: X mean=640 std dev=0 Y mean=395 std dev=0
End Point: X mean=630 std dev=0 Y mean=398 std dev=0

Segment 34, Material: ISFSIGeneralSlope
Start Point: X mean=630 std dev=0 Y mean=398 std dev=0
End Point: X mean=620 std dev=0 Y mean=402 std dev=0

Segment 35, Material: ISFSIGeneralSlope
Start Point: X mean=620 std dev=0 Y mean=402 std dev=0
End Point: X mean=610 std dev=0 Y mean=407 std dev=0

Segment 36, Material: ISFSIGeneralSlope
Start Point: X mean=610 std dev=0 Y mean=407 std dev=0
End Point: X mean=600 std dev=0 Y mean=411 std dev=0

Segment 37, Material: ISFSIGeneralSlope
Start Point: X mean=600 std dev=0 Y mean=411 std dev=0
End Point: X mean=597 std dev=0 Y mean=412 std dev=0

Segment 38, Material: ISFSIGeneralSlope

Start Point: X mean=597 std dev=0 Y mean=412 std dev=0
End Point: X mean=590 std dev=0 Y mean=414 std dev=0

Segment 39, Material: ISFSIGeneralSlope
Start Point: X mean=590 std dev=0 Y mean=414 std dev=0
End Point: X mean=580 std dev=0 Y mean=418 std dev=0

Segment 40, Material: ISFSIGeneralSlope
Start Point: X mean=580 std dev=0 Y mean=418 std dev=0
End Point: X mean=570 std dev=0 Y mean=421 std dev=0

Segment 41, Material: ISFSIGeneralSlope
Start Point: X mean=570 std dev=0 Y mean=421 std dev=0
End Point: X mean=560 std dev=0 Y mean=424 std dev=0

Segment 42, Material: ISFSIGeneralSlope
Start Point: X mean=560 std dev=0 Y mean=424 std dev=0
End Point: X mean=550 std dev=0 Y mean=427 std dev=0

Segment 43, Material: ISFSIGeneralSlope
Start Point: X mean=550 std dev=0 Y mean=427 std dev=0
End Point: X mean=540 std dev=0 Y mean=430 std dev=0

Segment 44, Material: ISFSIGeneralSlope
Start Point: X mean=540 std dev=0 Y mean=430 std dev=0
End Point: X mean=530 std dev=0 Y mean=434 std dev=0

Segment 45, Material: ISFSIGeneralSlope
Start Point: X mean=530 std dev=0 Y mean=434 std dev=0
End Point: X mean=520 std dev=0 Y mean=438 std dev=0

Segment 46, Material: ISFSIGeneralSlope
Start Point: X mean=520 std dev=0 Y mean=438 std dev=0
End Point: X mean=510 std dev=0 Y mean=442 std dev=0

Segment 47, Material: ISFSIGeneralSlope
Start Point: X mean=510 std dev=0 Y mean=442 std dev=0
End Point: X mean=500 std dev=0 Y mean=446 std dev=0

Segment 48, Material: ISFSITowerRoad
Start Point: X mean=500 std dev=0 Y mean=446 std dev=0
End Point: X mean=494 std dev=0 Y mean=450 std dev=0

Segment 49, Material: ISFSITowerRoad
Start Point: X mean=494 std dev=0 Y mean=450 std dev=0
End Point: X mean=490 std dev=0 Y mean=450 std dev=0

Segment 50, Material: ISFSITowerRoad
Start Point: X mean=490 std dev=0 Y mean=450 std dev=0
End Point: X mean=484 std dev=0 Y mean=450 std dev=0

Segment 51, Material: ISFSIGeneralSlope
Start Point: X mean=484 std dev=0 Y mean=450 std dev=0
End Point: X mean=481 std dev=0 Y mean=452 std dev=0

Segment 52, Material: ISFSIGeneralSlope

Start Point: X mean=481 std dev=0 Y mean=452 std dev=0
End Point: X mean=480 std dev=0 Y mean=452 std dev=0

Segment 53, Material: ISFSIGeneralSlope
Start Point: X mean=480 std dev=0 Y mean=452 std dev=0
End Point: X mean=470 std dev=0 Y mean=456 std dev=0

Segment 54, Material: ISFSIGeneralSlope
Start Point: X mean=470 std dev=0 Y mean=456 std dev=0
End Point: X mean=460 std dev=0 Y mean=462 std dev=0

Segment 55, Material: ISFSIGeneralSlope
Start Point: X mean=460 std dev=0 Y mean=462 std dev=0
End Point: X mean=450 std dev=0 Y mean=465 std dev=0

Segment 56, Material: ISFSIGeneralSlope
Start Point: X mean=450 std dev=0 Y mean=465 std dev=0
End Point: X mean=440 std dev=0 Y mean=469 std dev=0

Segment 57, Material: ISFSIGeneralSlope
Start Point: X mean=440 std dev=0 Y mean=469 std dev=0
End Point: X mean=430 std dev=0 Y mean=472 std dev=0

Segment 58, Material: ISFSIGeneralSlope
Start Point: X mean=430 std dev=0 Y mean=472 std dev=0
End Point: X mean=420 std dev=0 Y mean=476 std dev=0

Segment 59, Material: ISFSIGeneralSlope
Start Point: X mean=420 std dev=0 Y mean=476 std dev=0
End Point: X mean=410 std dev=0 Y mean=480 std dev=0

Segment 60, Material: ISFSIGeneralSlope
Start Point: X mean=410 std dev=0 Y mean=480 std dev=0
End Point: X mean=400 std dev=0 Y mean=483 std dev=0

Segment 61, Material: ISFSIGeneralSlope
Start Point: X mean=400 std dev=0 Y mean=483 std dev=0
End Point: X mean=390 std dev=0 Y mean=486 std dev=0

Segment 62, Material: ISFSIGeneralSlope
Start Point: X mean=390 std dev=0 Y mean=486 std dev=0
End Point: X mean=382 std dev=0 Y mean=490 std dev=0

Segment 63, Material: ISFSIGeneralSlope
Start Point: X mean=382 std dev=0 Y mean=490 std dev=0
End Point: X mean=380 std dev=0 Y mean=491 std dev=0

Segment 64, Material: ISFSIGeneralSlope
Start Point: X mean=380 std dev=0 Y mean=491 std dev=0
End Point: X mean=370 std dev=0 Y mean=495 std dev=0

Segment 65, Material: ISFSIGeneralSlope
Start Point: X mean=370 std dev=0 Y mean=495 std dev=0
End Point: X mean=360 std dev=0 Y mean=499 std dev=0

Segment 66, Material: ISFSIGeneralSlope

Start Point: X mean=360 std dev=0 Y mean=499 std dev=0
End Point: X mean=350 std dev=0 Y mean=502 std dev=0

Segment 67, Material: ISFSIGeneralSlope
Start Point: X mean=350 std dev=0 Y mean=502 std dev=0
End Point: X mean=340 std dev=0 Y mean=506 std dev=0

Segment 68, Material: ISFSIGeneralSlope
Start Point: X mean=340 std dev=0 Y mean=506 std dev=0
End Point: X mean=330 std dev=0 Y mean=509 std dev=0

Segment 69, Material: ISFSIGeneralSlope
Start Point: X mean=330 std dev=0 Y mean=509 std dev=0
End Point: X mean=320 std dev=0 Y mean=514 std dev=0

Segment 70, Material: ISFSIGeneralSlope
Start Point: X mean=320 std dev=0 Y mean=514 std dev=0
End Point: X mean=310 std dev=0 Y mean=517 std dev=0

Segment 71, Material: ISFSIGeneralSlope
Start Point: X mean=310 std dev=0 Y mean=517 std dev=0
End Point: X mean=300 std dev=0 Y mean=520 std dev=0

Segment 72, Material: ISFSIGeneralSlope
Start Point: X mean=300 std dev=0 Y mean=520 std dev=0
End Point: X mean=290 std dev=0 Y mean=524 std dev=0

Segment 73, Material: ISFSIGeneralSlope
Start Point: X mean=290 std dev=0 Y mean=524 std dev=0
End Point: X mean=280 std dev=0 Y mean=527 std dev=0

Segment 74, Material: ISFSIGeneralSlope
Start Point: X mean=280 std dev=0 Y mean=527 std dev=0
End Point: X mean=270 std dev=0 Y mean=530 std dev=0

Segment 75, Material: ISFSIGeneralSlope
Start Point: X mean=270 std dev=0 Y mean=530 std dev=0
End Point: X mean=260 std dev=0 Y mean=534 std dev=0

Segment 76, Material: ISFSIGeneralSlope
Start Point: X mean=260 std dev=0 Y mean=534 std dev=0
End Point: X mean=250 std dev=0 Y mean=538 std dev=0

Segment 77, Material: ISFSIGeneralSlope
Start Point: X mean=250 std dev=0 Y mean=538 std dev=0
End Point: X mean=240 std dev=0 Y mean=541 std dev=0

Segment 78, Material: ISFSIGeneralSlope
Start Point: X mean=240 std dev=0 Y mean=541 std dev=0
End Point: X mean=230 std dev=0 Y mean=545 std dev=0

Segment 79, Material: ISFSIGeneralSlope
Start Point: X mean=230 std dev=0 Y mean=545 std dev=0
End Point: X mean=220 std dev=0 Y mean=548 std dev=0

Segment 80, Material: ISFSIGeneralSlope

Start Point: X mean=220 std dev=0 Y mean=548 std dev=0
End Point: X mean=210 std dev=0 Y mean=552 std dev=0

<u>Segment 81, Material: ISFSIGeneralSlope</u>
Start Point: X mean=210 std dev=0 Y mean=552 std dev=0
End Point: X mean=200 std dev=0 Y mean=556 std dev=0

<u>Segment 82, Material: ISFSIGeneralSlope</u>
Start Point: X mean=200 std dev=0 Y mean=556 std dev=0
End Point: X mean=190 std dev=0 Y mean=559 std dev=0

<u>Segment 83, Material: ISFSIGeneralSlope</u>
Start Point: X mean=190 std dev=0 Y mean=559 std dev=0
End Point: X mean=180 std dev=0 Y mean=562 std dev=0

<u>Segment 84, Material: ISFSIGeneralSlope</u>
Start Point: X mean=180 std dev=0 Y mean=562 std dev=0
End Point: X mean=170 std dev=0 Y mean=566 std dev=0

<u>Segment 85, Material: ISFSIGeneralSlope</u>
Start Point: X mean=170 std dev=0 Y mean=566 std dev=0
End Point: X mean=160 std dev=0 Y mean=570 std dev=0

<u>Segment 86, Material: ISFSIGeneralSlope</u>
Start Point: X mean=160 std dev=0 Y mean=570 std dev=0
End Point: X mean=150 std dev=0 Y mean=574 std dev=0

<u>Segment 87, Material: ISFSIGeneralSlope</u>
Start Point: X mean=150 std dev=0 Y mean=574 std dev=0
End Point: X mean=140 std dev=0 Y mean=577 std dev=0

<u>Segment 88, Material: ISFSIGeneralSlope</u>
Start Point: X mean=140 std dev=0 Y mean=577 std dev=0
End Point: X mean=130 std dev=0 Y mean=582 std dev=0

<u>Segment 89, Material: ISFSIGeneralSlope</u>
Start Point: X mean=130 std dev=0 Y mean=582 std dev=0
End Point: X mean=120 std dev=0 Y mean=586 std dev=0

<u>Segment 90, Material: ISFSIGeneralSlope</u>
Start Point: X mean=120 std dev=0 Y mean=586 std dev=0
End Point: X mean=110 std dev=0 Y mean=589 std dev=0

<u>Segment 91, Material: ISFSIGeneralSlope</u>
Start Point: X mean=110 std dev=0 Y mean=589 std dev=0
End Point: X mean=100 std dev=0 Y mean=594 std dev=0

<u>Segment 92, Material: ISFSIGeneralSlope</u>
Start Point: X mean=100 std dev=0 Y mean=594 std dev=0
End Point: X mean=90 std dev=0 Y mean=598 std dev=0

<u>Segment 93, Material: ISFSIGeneralSlope</u>
Start Point: X mean=90 std dev=0 Y mean=598 std dev=0
End Point: X mean=80 std dev=0 Y mean=603 std dev=0

<u>Segment 94, Material: ISFSIGeneralSlope</u>

Start Point: X mean=80 std dev=0 Y mean=603 std dev=0
End Point: X mean=70 std dev=0 Y mean=608 std dev=0

Segment 95, Material: ISFSIGeneralSlope
Start Point: X mean=70 std dev=0 Y mean=608 std dev=0
End Point: X mean=60 std dev=0 Y mean=614 std dev=0

Segment 96, Material: ISFSIGeneralSlope
Start Point: X mean=60 std dev=0 Y mean=614 std dev=0
End Point: X mean=50 std dev=0 Y mean=617 std dev=0

Segment 97, Material: ISFSIGeneralSlope
Start Point: X mean=50 std dev=0 Y mean=617 std dev=0
End Point: X mean=40 std dev=0 Y mean=620 std dev=0

Segment 98, Material: ISFSIGeneralSlope
Start Point: X mean=40 std dev=0 Y mean=620 std dev=0
End Point: X mean=30 std dev=0 Y mean=622 std dev=0

Segment 99, Material: ISFSIGeneralSlope
Start Point: X mean=30 std dev=0 Y mean=622 std dev=0
End Point: X mean=20 std dev=0 Y mean=624 std dev=0

Segment 100, Material: ISFSIGeneralSlope
Start Point: X mean=20 std dev=0 Y mean=624 std dev=0
End Point: X mean=10 std dev=0 Y mean=627 std dev=0

Segment 101, Material: Clean hard bedrock [default]
Start Point: X mean=10 std dev=0 Y mean=627 std dev=0
End Point: X mean=0 std dev=0 Y mean=629 std dev=0

Materials

Material name: ISFSICutSlope
Coefficient of Normal Restitution (RN): mean=0.45 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.74 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSITowerRoad
Coefficient of Normal Restitution (RN): mean=0.4 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.73 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSIGeneralSlope
Coefficient of Normal Restitution (RN): mean=0.35 std dev=0.04
Coefficient of Tangential Restitution (RT): mean=0.83 std dev=0.04
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=37.0

3' block std dev=14.0
6' block std dev=7.1
10' block std dev=4.3

Material name: ISFSIPad
Coefficient of Normal Restitution (RN): mean=0.5 std dev=0
Coefficient of Tangential Restitution (RT): mean=0.9 std dev=0
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=0
3' block std dev=0
6' block std dev=0
10' block std dev=0

Seeders

Point Seeder
Horizontal Velocity: mean=7.5, std dev=0
Vertical Velocity: mean=0, std dev=0
Mass: 1' block mean=142, std dev=0
3' block mean=3834, std dev=0
6' block mean=30672, std dev=0
10' block mean=142000, std dev=0
Angular Velocity: mean=3, std dev=0
Location: 678, 383

Data Collectors

Data Collector name: Collector001
Start Point: 755.882, 360.392
End Point: 754.901, 370.196

RocFall Analysis Information

Document Name

RA2b

Project Settings

Units: Imperial
Friction angle: Use friction fngle specified in material editor
Minimum Velocity=0.1
Angular Velocity of the rocks CONSIDERED
Standard Deviations NOT USED when generating slope vertices
Random-number generation: Random

Slope

Segment 1, Material: ISFSIPad
Start Point: X mean=1000 std dev=0 Y mean=309 std dev=0
End Point: X mean=990 std dev=0 Y mean=311 std dev=0

Segment 2, Material: ISFSIPad
Start Point: X mean=990 std dev=0 Y mean=311 std dev=0
End Point: X mean=980 std dev=0 Y mean=311 std dev=0

Segment 3, Material: ISFSIPad
Start Point: X mean=980 std dev=0 Y mean=311 std dev=0
End Point: X mean=970 std dev=0 Y mean=311 std dev=0

Segment 4, Material: ISFSIPad
Start Point: X mean=970 std dev=0 Y mean=311 std dev=0
End Point: X mean=960 std dev=0 Y mean=311 std dev=0

Segment 5, Material: ISFSIPad
Start Point: X mean=960 std dev=0 Y mean=311 std dev=0
End Point: X mean=950 std dev=0 Y mean=311 std dev=0

Segment 6, Material: ISFSIPad
Start Point: X mean=950 std dev=0 Y mean=311 std dev=0
End Point: X mean=940 std dev=0 Y mean=311 std dev=0

Segment 7, Material: ISFSIPad
Start Point: X mean=940 std dev=0 Y mean=311 std dev=0
End Point: X mean=930 std dev=0 Y mean=311 std dev=0

Segment 8, Material: ISFSIPad
Start Point: X mean=930 std dev=0 Y mean=311 std dev=0
End Point: X mean=920 std dev=0 Y mean=311 std dev=0

Segment 9, Material: ISFSIPad
Start Point: X mean=920 std dev=0 Y mean=311 std dev=0
End Point: X mean=910 std dev=0 Y mean=311 std dev=0

Segment 10, Material: ISFSIPad
Start Point: X mean=910 std dev=0 Y mean=311 std dev=0
End Point: X mean=900 std dev=0 Y mean=311 std dev=0

Segment 11, Material: ISFSIPad
Start Point: X mean=900 std dev=0 Y mean=311 std dev=0
End Point: X mean=805 std dev=0 Y mean=311 std dev=0

Segment 12, Material: ISFSICutSlope
Start Point: X mean=805 std dev=0 Y mean=311 std dev=0
End Point: X mean=800 std dev=0 Y mean=327 std dev=0

Segment 13, Material: ISFSICutSlope
Start Point: X mean=800 std dev=0 Y mean=327 std dev=0
End Point: X mean=798 std dev=0 Y mean=331 std dev=0

Segment 14, Material: ISFSICutSlope
Start Point: X mean=798 std dev=0 Y mean=331 std dev=0
End Point: X mean=790 std dev=0 Y mean=331 std dev=0

Segment 15, Material: ISFSICutSlope
Start Point: X mean=790 std dev=0 Y mean=331 std dev=0
End Point: X mean=780 std dev=0 Y mean=331 std dev=0

Segment 16, Material: ISFSICutSlope
Start Point: X mean=780 std dev=0 Y mean=331 std dev=0
End Point: X mean=770 std dev=0 Y mean=331 std dev=0

Segment 17, Material: ISFSICutSlope
Start Point: X mean=770 std dev=0 Y mean=331 std dev=0
End Point: X mean=760 std dev=0 Y mean=358 std dev=0

Segment 18, Material: ISFSIGeneralSlope
Start Point: X mean=760 std dev=0 Y mean=358 std dev=0
End Point: X mean=750 std dev=0 Y mean=362 std dev=0

Segment 19, Material: ISFSIGeneralSlope
Start Point: X mean=750 std dev=0 Y mean=362 std dev=0
End Point: X mean=740 std dev=0 Y mean=365 std dev=0

Segment 20, Material: ISFSIGeneralSlope
Start Point: X mean=740 std dev=0 Y mean=365 std dev=0
End Point: X mean=730 std dev=0 Y mean=368 std dev=0

Segment 21, Material: ISFSIGeneralSlope
Start Point: X mean=730 std dev=0 Y mean=368 std dev=0
End Point: X mean=720 std dev=0 Y mean=372 std dev=0

Segment 22, Material: ISFSIGeneralSlope
Start Point: X mean=720 std dev=0 Y mean=372 std dev=0
End Point: X mean=710 std dev=0 Y mean=374 std dev=0

Segment 23, Material: ISFSIGeneralSlope
Start Point: X mean=710 std dev=0 Y mean=374 std dev=0
End Point: X mean=700 std dev=0 Y mean=376 std dev=0

Segment 24, Material: ISFSIGeneralSlope
Start Point: X mean=700 std dev=0 Y mean=376 std dev=0
End Point: X mean=690 std dev=0 Y mean=379 std dev=0

Segment 25, Material: ISFSIGeneralSlope
Start Point: X mean=690 std dev=0 Y mean=379 std dev=0
End Point: X mean=680 std dev=0 Y mean=382 std dev=0

Segment 26, Material: ISFSIGeneralSlope
Start Point: X mean=680 std dev=0 Y mean=382 std dev=0
End Point: X mean=678 std dev=0 Y mean=383 std dev=0

Segment 27, Material: ISFSIGeneralSlope
Start Point: X mean=678 std dev=0 Y mean=383 std dev=0
End Point: X mean=670 std dev=0 Y mean=385 std dev=0

Segment 28, Material: ISFSITowerRoad
Start Point: X mean=670 std dev=0 Y mean=385 std dev=0
End Point: X mean=666 std dev=0 Y mean=388 std dev=0

Segment 29, Material: ISFSITowerRoad
Start Point: X mean=666 std dev=0 Y mean=388 std dev=0
End Point: X mean=660 std dev=0 Y mean=388 std dev=0

Segment 30, Material: ISFSITowerRoad
Start Point: X mean=660 std dev=0 Y mean=388 std dev=0
End Point: X mean=656 std dev=0 Y mean=388 std dev=0

Segment 31, Material: ISFSIGeneralSlope
Start Point: X mean=656 std dev=0 Y mean=388 std dev=0
End Point: X mean=650 std dev=0 Y mean=392 std dev=0

Segment 32, Material: ISFSIGeneralSlope
Start Point: X mean=650 std dev=0 Y mean=392 std dev=0
End Point: X mean=640 std dev=0 Y mean=395 std dev=0

Segment 33, Material: ISFSIGeneralSlope
Start Point: X mean=640 std dev=0 Y mean=395 std dev=0
End Point: X mean=630 std dev=0 Y mean=398 std dev=0

Segment 34, Material: ISFSIGeneralSlope
Start Point: X mean=630 std dev=0 Y mean=398 std dev=0
End Point: X mean=620 std dev=0 Y mean=402 std dev=0

Segment 35, Material: ISFSIGeneralSlope
Start Point: X mean=620 std dev=0 Y mean=402 std dev=0
End Point: X mean=610 std dev=0 Y mean=407 std dev=0

Segment 36, Material: ISFSIGeneralSlope
Start Point: X mean=610 std dev=0 Y mean=407 std dev=0
End Point: X mean=600 std dev=0 Y mean=411 std dev=0

Segment 37, Material: ISFSIGeneralSlope
Start Point: X mean=600 std dev=0 Y mean=411 std dev=0
End Point: X mean=597 std dev=0 Y mean=412 std dev=0

Segment 38, Material: ISFSIGeneralSlope
Start Point: X mean=597 std dev=0 Y mean=412 std dev=0
End Point: X mean=590 std dev=0 Y mean=414 std dev=0

Segment 39, Material: ISFSIGeneralSlope
Start Point: X mean=590 std dev=0 Y mean=414 std dev=0
End Point: X mean=580 std dev=0 Y mean=418 std dev=0

Segment 40, Material: ISFSIGeneralSlope
Start Point: X mean=580 std dev=0 Y mean=418 std dev=0
End Point: X mean=570 std dev=0 Y mean=421 std dev=0

Segment 41, Material: ISFSIGeneralSlope
Start Point: X mean=570 std dev=0 Y mean=421 std dev=0
End Point: X mean=560 std dev=0 Y mean=424 std dev=0

Segment 42, Material: ISFSIGeneralSlope
Start Point: X mean=560 std dev=0 Y mean=424 std dev=0
End Point: X mean=550 std dev=0 Y mean=427 std dev=0

Segment 43, Material: ISFSIGeneralSlope
Start Point: X mean=550 std dev=0 Y mean=427 std dev=0
End Point: X mean=540 std dev=0 Y mean=430 std dev=0

Segment 44, Material: ISFSIGeneralSlope
Start Point: X mean=540 std dev=0 Y mean=430 std dev=0
End Point: X mean=530 std dev=0 Y mean=434 std dev=0

Segment 45, Material: ISFSIGeneralSlope
Start Point: X mean=530 std dev=0 Y mean=434 std dev=0
End Point: X mean=520 std dev=0 Y mean=438 std dev=0

Segment 46, Material: ISFSIGeneralSlope
Start Point: X mean=520 std dev=0 Y mean=438 std dev=0
End Point: X mean=510 std dev=0 Y mean=442 std dev=0

Segment 47, Material: ISFSIGeneralSlope
Start Point: X mean=510 std dev=0 Y mean=442 std dev=0
End Point: X mean=500 std dev=0 Y mean=446 std dev=0

Segment 48, Material: ISFSITowerRoad
Start Point: X mean=500 std dev=0 Y mean=446 std dev=0
End Point: X mean=494 std dev=0 Y mean=450 std dev=0

Segment 49, Material: ISFSITowerRoad
Start Point: X mean=494 std dev=0 Y mean=450 std dev=0
End Point: X mean=490 std dev=0 Y mean=450 std dev=0

Segment 50, Material: ISFSITowerRoad
Start Point: X mean=490 std dev=0 Y mean=450 std dev=0
End Point: X mean=484 std dev=0 Y mean=450 std dev=0

Segment 51, Material: ISFSIGeneralSlope
Start Point: X mean=484 std dev=0 Y mean=450 std dev=0
End Point: X mean=481 std dev=0 Y mean=452 std dev=0

Segment 52, Material: ISFSIGeneralSlope
Start Point: X mean=481 std dev=0 Y mean=452 std dev=0
End Point: X mean=480 std dev=0 Y mean=452 std dev=0

Segment 53, Material: ISFSIGeneralSlope
Start Point: X mean=480 std dev=0 Y mean=452 std dev=0
End Point: X mean=470 std dev=0 Y mean=456 std dev=0

Segment 54, Material: ISFSIGeneralSlope
Start Point: X mean=470 std dev=0 Y mean=456 std dev=0
End Point: X mean=460 std dev=0 Y mean=462 std dev=0

Segment 55, Material: ISFSIGeneralSlope
Start Point: X mean=460 std dev=0 Y mean=462 std dev=0
End Point: X mean=450 std dev=0 Y mean=465 std dev=0

Segment 56, Material: ISFSIGeneralSlope
Start Point: X mean=450 std dev=0 Y mean=465 std dev=0
End Point: X mean=440 std dev=0 Y mean=469 std dev=0

Segment 57, Material: ISFSIGeneralSlope
Start Point: X mean=440 std dev=0 Y mean=469 std dev=0
End Point: X mean=430 std dev=0 Y mean=472 std dev=0

Segment 58, Material: ISFSIGeneralSlope
Start Point: X mean=430 std dev=0 Y mean=472 std dev=0
End Point: X mean=420 std dev=0 Y mean=476 std dev=0

Segment 59, Material: ISFSIGeneralSlope
Start Point: X mean=420 std dev=0 Y mean=476 std dev=0
End Point: X mean=410 std dev=0 Y mean=480 std dev=0

Segment 60, Material: ISFSIGeneralSlope
Start Point: X mean=410 std dev=0 Y mean=480 std dev=0
End Point: X mean=400 std dev=0 Y mean=483 std dev=0

Segment 61, Material: ISFSIGeneralSlope
Start Point: X mean=400 std dev=0 Y mean=483 std dev=0
End Point: X mean=390 std dev=0 Y mean=486 std dev=0

Segment 62, Material: ISFSIGeneralSlope
Start Point: X mean=390 std dev=0 Y mean=486 std dev=0
End Point: X mean=382 std dev=0 Y mean=490 std dev=0

Segment 63, Material: ISFSIGeneralSlope
Start Point: X mean=382 std dev=0 Y mean=490 std dev=0
End Point: X mean=380 std dev=0 Y mean=491 std dev=0

Segment 64, Material: ISFSIGeneralSlope
Start Point: X mean=380 std dev=0 Y mean=491 std dev=0
End Point: X mean=370 std dev=0 Y mean=495 std dev=0

Segment 65, Material: ISFSIGeneralSlope
Start Point: X mean=370 std dev=0 Y mean=495 std dev=0
End Point: X mean=360 std dev=0 Y mean=499 std dev=0

Segment 66, Material: ISFSIGeneralSlope
Start Point: X mean=360 std dev=0 Y mean=499 std dev=0
End Point: X mean=350 std dev=0 Y mean=502 std dev=0

Segment 67, Material: ISFSIGeneralSlope
Start Point: X mean=350 std dev=0 Y mean=502 std dev=0
End Point: X mean=340 std dev=0 Y mean=506 std dev=0

Segment 68, Material: ISFSIGeneralSlope
Start Point: X mean=340 std dev=0 Y mean=506 std dev=0
End Point: X mean=330 std dev=0 Y mean=509 std dev=0

Segment 69, Material: ISFSIGeneralSlope
Start Point: X mean=330 std dev=0 Y mean=509 std dev=0
End Point: X mean=320 std dev=0 Y mean=514 std dev=0

Segment 70, Material: ISFSIGeneralSlope
Start Point: X mean=320 std dev=0 Y mean=514 std dev=0
End Point: X mean=310 std dev=0 Y mean=517 std dev=0

Segment 71, Material: ISFSIGeneralSlope
Start Point: X mean=310 std dev=0 Y mean=517 std dev=0
End Point: X mean=300 std dev=0 Y mean=520 std dev=0

Segment 72, Material: ISFSIGeneralSlope
Start Point: X mean=300 std dev=0 Y mean=520 std dev=0
End Point: X mean=290 std dev=0 Y mean=524 std dev=0

Segment 73, Material: ISFSIGeneralSlope
Start Point: X mean=290 std dev=0 Y mean=524 std dev=0
End Point: X mean=280 std dev=0 Y mean=527 std dev=0

Segment 74, Material: ISFSIGeneralSlope
Start Point: X mean=280 std dev=0 Y mean=527 std dev=0
End Point: X mean=270 std dev=0 Y mean=530 std dev=0

Segment 75, Material: ISFSIGeneralSlope
Start Point: X mean=270 std dev=0 Y mean=530 std dev=0
End Point: X mean=260 std dev=0 Y mean=534 std dev=0

Segment 76, Material: ISFSIGeneralSlope
Start Point: X mean=260 std dev=0 Y mean=534 std dev=0
End Point: X mean=250 std dev=0 Y mean=538 std dev=0

Segment 77, Material: ISFSIGeneralSlope
Start Point: X mean=250 std dev=0 Y mean=538 std dev=0
End Point: X mean=240 std dev=0 Y mean=541 std dev=0

Segment 78, Material: ISFSIGeneralSlope
Start Point: X mean=240 std dev=0 Y mean=541 std dev=0
End Point: X mean=230 std dev=0 Y mean=545 std dev=0

Segment 79, Material: ISFSIGeneralSlope
Start Point: X mean=230 std dev=0 Y mean=545 std dev=0
End Point: X mean=220 std dev=0 Y mean=548 std dev=0

Segment 80, Material: ISFSIGeneralSlope
Start Point: X mean=220 std dev=0 Y mean=548 std dev=0
End Point: X mean=210 std dev=0 Y mean=552 std dev=0

Segment 81, Material: ISFSIGeneralSlope
Start Point: X mean=210 std dev=0 Y mean=552 std dev=0
End Point: X mean=200 std dev=0 Y mean=556 std dev=0

Segment 82, Material: ISFSIGeneralSlope
Start Point: X mean=200 std dev=0 Y mean=556 std dev=0
End Point: X mean=190 std dev=0 Y mean=559 std dev=0

Segment 83, Material: ISFSIGeneralSlope
Start Point: X mean=190 std dev=0 Y mean=559 std dev=0
End Point: X mean=180 std dev=0 Y mean=562 std dev=0

Segment 84, Material: ISFSIGeneralSlope
Start Point: X mean=180 std dev=0 Y mean=562 std dev=0
End Point: X mean=170 std dev=0 Y mean=566 std dev=0

Segment 85, Material: ISFSIGeneralSlope
Start Point: X mean=170 std dev=0 Y mean=566 std dev=0
End Point: X mean=160 std dev=0 Y mean=570 std dev=0

Segment 86, Material: ISFSIGeneralSlope
Start Point: X mean=160 std dev=0 Y mean=570 std dev=0
End Point: X mean=150 std dev=0 Y mean=574 std dev=0

Segment 87, Material: ISFSIGeneralSlope
Start Point: X mean=150 std dev=0 Y mean=574 std dev=0
End Point: X mean=140 std dev=0 Y mean=577 std dev=0

Segment 88, Material: ISFSIGeneralSlope
Start Point: X mean=140 std dev=0 Y mean=577 std dev=0
End Point: X mean=130 std dev=0 Y mean=582 std dev=0

Segment 89, Material: ISFSIGeneralSlope
Start Point: X mean=130 std dev=0 Y mean=582 std dev=0
End Point: X mean=120 std dev=0 Y mean=586 std dev=0

Segment 90, Material: ISFSIGeneralSlope
Start Point: X mean=120 std dev=0 Y mean=586 std dev=0
End Point: X mean=110 std dev=0 Y mean=589 std dev=0

Segment 91, Material: ISFSIGeneralSlope
Start Point: X mean=110 std dev=0 Y mean=589 std dev=0
End Point: X mean=100 std dev=0 Y mean=594 std dev=0

Segment 92, Material: ISFSIGeneralSlope
Start Point: X mean=100 std dev=0 Y mean=594 std dev=0
End Point: X mean=90 std dev=0 Y mean=598 std dev=0

Segment 93, Material: ISFSIGeneralSlope
Start Point: X mean=90 std dev=0 Y mean=598 std dev=0
End Point: X mean=80 std dev=0 Y mean=603 std dev=0

Segment 94, Material: ISFSIGeneralSlope
Start Point: X mean=80 std dev=0 Y mean=603 std dev=0
End Point: X mean=70 std dev=0 Y mean=608 std dev=0

Segment 95, Material: ISFSIGeneralSlope
Start Point: X mean=70 std dev=0 Y mean=608 std dev=0
End Point: X mean=60 std dev=0 Y mean=614 std dev=0

Segment 96, Material: ISFSIGeneralSlope
Start Point: X mean=60 std dev=0 Y mean=614 std dev=0
End Point: X mean=50 std dev=0 Y mean=617 std dev=0

Segment 97, Material: ISFSIGeneralSlope
Start Point: X mean=50 std dev=0 Y mean=617 std dev=0
End Point: X mean=40 std dev=0 Y mean=620 std dev=0

Segment 98, Material: ISFSIGeneralSlope
Start Point: X mean=40 std dev=0 Y mean=620 std dev=0
End Point: X mean=30 std dev=0 Y mean=622 std dev=0

Segment 99, Material: ISFSIGeneralSlope
Start Point: X mean=30 std dev=0 Y mean=622 std dev=0
End Point: X mean=20 std dev=0 Y mean=624 std dev=0

Segment 100, Material: ISFSIGeneralSlope
Start Point: X mean=20 std dev=0 Y mean=624 std dev=0
End Point: X mean=10 std dev=0 Y mean=627 std dev=0

Segment 101, Material: Clean hard bedrock [default]
Start Point: X mean=10 std dev=0 Y mean=627 std dev=0
End Point: X mean=0 std dev=0 Y mean=629 std dev=0

Materials

Material name: ISFSICutSlope
Coefficient of Normal Restitution (RN): mean=0.45 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.74 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSITowerRoad
Coefficient of Normal Restitution (RN): mean=0.4 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.73 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSIGeneralSlope
Coefficient of Normal Restitution (RN): mean=0.35 std dev=0.04
Coefficient of Tangential Restitution (RT): mean=0.83 std dev=0.04
Friction Angle: mean=32 std dev=2

Roughness: 1' block std dev=37.0
3' block std dev=14.0
6' block std dev=7.1
10' block std dev=4.3

<u>Material name: ISFSIPad</u>
Coefficient of Normal Restitution (RN): mean=0.5 std dev=0
Coefficient of Tangential Restitution (RT): mean=0.9 std dev=0
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=0
3' block std dev=0
6' block std dev=0
10' block std dev=0

Seeders

<u>Point Seeder</u>
Horizontal Velocity: mean=7.5, std dev=0
Vertical Velocity: mean=0, std dev=0
Mass: 1' block mean=142, std dev=0
3' block mean=3834, std dev=0
6' block mean=30672, std dev=0
10' block mean=142000, std dev=0
Angular Velocity: mean=3, std dev=0
Location: 597, 412

Data Collectors

<u>Data Collector name: Collector001</u>
Start Point: 755.882, 360.392
End Point: 754.901, 370.196

RocFall Analysis Information

Document Name

Rl1a

Project Settings

Units: Imperial
Friction angle: Use friction fngle specified in material editor
Minimum Velocity=0.1
Angular Velocity of the rocks CONSIDERED
Standard Deviations NOT USED when generating slope vertices
Random-number generation: Random

Slope

Segment 1, Material: ISFSIGeneralSlope
Start Point: X mean=0 std dev=0 Y mean=679 std dev=0
End Point: X mean=10 std dev=0 Y mean=677 std dev=0

Segment 2, Material: ISFSIGeneralSlope
Start Point: X mean=10 std dev=0 Y mean=677 std dev=0
End Point: X mean=20 std dev=0 Y mean=674 std dev=0

Segment 3, Material: ISFSIGeneralSlope
Start Point: X mean=20 std dev=0 Y mean=674 std dev=0
End Point: X mean=30 std dev=0 Y mean=671 std dev=0

Segment 4, Material: ISFSIGeneralSlope
Start Point: X mean=30 std dev=0 Y mean=671 std dev=0
End Point: X mean=40 std dev=0 Y mean=668 std dev=0

Segment 5, Material: ISFSIGeneralSlope
Start Point: X mean=40 std dev=0 Y mean=668 std dev=0
End Point: X mean=50 std dev=0 Y mean=665 std dev=0

Segment 6, Material: ISFSIGeneralSlope
Start Point: X mean=50 std dev=0 Y mean=665 std dev=0
End Point: X mean=60 std dev=0 Y mean=662 std dev=0

Segment 7, Material: ISFSIGeneralSlope
Start Point: X mean=60 std dev=0 Y mean=662 std dev=0
End Point: X mean=70 std dev=0 Y mean=659 std dev=0

Segment 8, Material: ISFSIGeneralSlope
Start Point: X mean=70 std dev=0 Y mean=659 std dev=0
End Point: X mean=80 std dev=0 Y mean=655 std dev=0

Segment 9, Material: ISFSIGeneralSlope
Start Point: X mean=80 std dev=0 Y mean=655 std dev=0
End Point: X mean=90 std dev=0 Y mean=652 std dev=0

Segment 10, Material: ISFSIGeneralSlope

Start Point: X mean=90 std dev=0 Y mean=652 std dev=0
End Point: X mean=100 std dev=0 Y mean=650 std dev=0

Segment 11, Material: ISFSIGeneralSlope
Start Point: X mean=100 std dev=0 Y mean=650 std dev=0
End Point: X mean=110 std dev=0 Y mean=646 std dev=0

Segment 12, Material: ISFSIGeneralSlope
Start Point: X mean=110 std dev=0 Y mean=646 std dev=0
End Point: X mean=120 std dev=0 Y mean=644 std dev=0

Segment 13, Material: ISFSIGeneralSlope
Start Point: X mean=120 std dev=0 Y mean=644 std dev=0
End Point: X mean=130 std dev=0 Y mean=641 std dev=0

Segment 14, Material: ISFSIGeneralSlope
Start Point: X mean=130 std dev=0 Y mean=641 std dev=0
End Point: X mean=140 std dev=0 Y mean=638 std dev=0

Segment 15, Material: ISFSIGeneralSlope
Start Point: X mean=140 std dev=0 Y mean=638 std dev=0
End Point: X mean=150 std dev=0 Y mean=636 std dev=0

Segment 16, Material: ISFSIGeneralSlope
Start Point: X mean=150 std dev=0 Y mean=636 std dev=0
End Point: X mean=160 std dev=0 Y mean=633 std dev=0

Segment 17, Material: ISFSIGeneralSlope
Start Point: X mean=160 std dev=0 Y mean=633 std dev=0
End Point: X mean=170 std dev=0 Y mean=630 std dev=0

Segment 18, Material: ISFSIGeneralSlope
Start Point: X mean=170 std dev=0 Y mean=630 std dev=0
End Point: X mean=180 std dev=0 Y mean=626 std dev=0

Segment 19, Material: ISFSIGeneralSlope
Start Point: X mean=180 std dev=0 Y mean=626 std dev=0
End Point: X mean=190 std dev=0 Y mean=621 std dev=0

Segment 20, Material: ISFSIGeneralSlope
Start Point: X mean=190 std dev=0 Y mean=621 std dev=0
End Point: X mean=200 std dev=0 Y mean=616 std dev=0

Segment 21, Material: ISFSIGeneralSlope
Start Point: X mean=200 std dev=0 Y mean=616 std dev=0
End Point: X mean=210 std dev=0 Y mean=614 std dev=0

Segment 22, Material: ISFSIGeneralSlope
Start Point: X mean=210 std dev=0 Y mean=614 std dev=0
End Point: X mean=220 std dev=0 Y mean=610 std dev=0

Segment 23, Material: ISFSIGeneralSlope
Start Point: X mean=220 std dev=0 Y mean=610 std dev=0
End Point: X mean=230 std dev=0 Y mean=606 std dev=0

Segment 24, Material: ISFSIGeneralSlope

Start Point: X mean=230 std dev=0 Y mean=606 std dev=0
End Point: X mean=240 std dev=0 Y mean=603 std dev=0

Segment 25, Material: ISFSIGeneralSlope
Start Point: X mean=240 std dev=0 Y mean=603 std dev=0
End Point: X mean=250 std dev=0 Y mean=599 std dev=0

Segment 26, Material: ISFSIGeneralSlope
Start Point: X mean=250 std dev=0 Y mean=599 std dev=0
End Point: X mean=260 std dev=0 Y mean=595 std dev=0

Segment 27, Material: ISFSIGeneralSlope
Start Point: X mean=260 std dev=0 Y mean=595 std dev=0
End Point: X mean=270 std dev=0 Y mean=591 std dev=0

Segment 28, Material: ISFSIGeneralSlope
Start Point: X mean=270 std dev=0 Y mean=591 std dev=0
End Point: X mean=280 std dev=0 Y mean=586 std dev=0

Segment 29, Material: ISFSIGeneralSlope
Start Point: X mean=280 std dev=0 Y mean=586 std dev=0
End Point: X mean=290 std dev=0 Y mean=583 std dev=0

Segment 30, Material: ISFSIGeneralSlope
Start Point: X mean=290 std dev=0 Y mean=583 std dev=0
End Point: X mean=300 std dev=0 Y mean=579 std dev=0

Segment 31, Material: ISFSIGeneralSlope
Start Point: X mean=300 std dev=0 Y mean=579 std dev=0
End Point: X mean=310 std dev=0 Y mean=574 std dev=0

Segment 32, Material: ISFSIGeneralSlope
Start Point: X mean=310 std dev=0 Y mean=574 std dev=0
End Point: X mean=320 std dev=0 Y mean=570 std dev=0

Segment 33, Material: ISFSIGeneralSlope
Start Point: X mean=320 std dev=0 Y mean=570 std dev=0
End Point: X mean=330 std dev=0 Y mean=567 std dev=0

Segment 34, Material: ISFSIGeneralSlope
Start Point: X mean=330 std dev=0 Y mean=567 std dev=0
End Point: X mean=340 std dev=0 Y mean=565 std dev=0

Segment 35, Material: ISFSIGeneralSlope
Start Point: X mean=340 std dev=0 Y mean=565 std dev=0
End Point: X mean=350 std dev=0 Y mean=561 std dev=0

Segment 36, Material: ISFSIGeneralSlope
Start Point: X mean=350 std dev=0 Y mean=561 std dev=0
End Point: X mean=360 std dev=0 Y mean=556 std dev=0

Segment 37, Material: ISFSIGeneralSlope
Start Point: X mean=360 std dev=0 Y mean=556 std dev=0
End Point: X mean=370 std dev=0 Y mean=552 std dev=0

Segment 38, Material: ISFSIGeneralSlope

Start Point: X mean=370 std dev=0 Y mean=552 std dev=0
End Point: X mean=380 std dev=0 Y mean=548 std dev=0

Segment 39, Material: ISFSIGeneralSlope
Start Point: X mean=380 std dev=0 Y mean=548 std dev=0
End Point: X mean=390 std dev=0 Y mean=545 std dev=0

Segment 40, Material: ISFSIGeneralSlope
Start Point: X mean=390 std dev=0 Y mean=545 std dev=0
End Point: X mean=400 std dev=0 Y mean=540 std dev=0

Segment 41, Material: ISFSIGeneralSlope
Start Point: X mean=400 std dev=0 Y mean=540 std dev=0
End Point: X mean=410 std dev=0 Y mean=538 std dev=0

Segment 42, Material: ISFSIGeneralSlope
Start Point: X mean=410 std dev=0 Y mean=538 std dev=0
End Point: X mean=420 std dev=0 Y mean=535 std dev=0

Segment 43, Material: ISFSIGeneralSlope
Start Point: X mean=420 std dev=0 Y mean=535 std dev=0
End Point: X mean=430 std dev=0 Y mean=531 std dev=0

Segment 44, Material: ISFSIGeneralSlope
Start Point: X mean=430 std dev=0 Y mean=531 std dev=0
End Point: X mean=440 std dev=0 Y mean=528 std dev=0

Segment 45, Material: ISFSIGeneralSlope
Start Point: X mean=440 std dev=0 Y mean=528 std dev=0
End Point: X mean=450 std dev=0 Y mean=523 std dev=0

Segment 46, Material: ISFSIGeneralSlope
Start Point: X mean=450 std dev=0 Y mean=523 std dev=0
End Point: X mean=460 std dev=0 Y mean=520 std dev=0

Segment 47, Material: ISFSIGeneralSlope
Start Point: X mean=460 std dev=0 Y mean=520 std dev=0
End Point: X mean=470 std dev=0 Y mean=516 std dev=0

Segment 48, Material: ISFSIGeneralSlope
Start Point: X mean=470 std dev=0 Y mean=516 std dev=0
End Point: X mean=480 std dev=0 Y mean=513 std dev=0

Segment 49, Material: ISFSIGeneralSlope
Start Point: X mean=480 std dev=0 Y mean=513 std dev=0
End Point: X mean=490 std dev=0 Y mean=509 std dev=0

Segment 50, Material: ISFSIGeneralSlope
Start Point: X mean=490 std dev=0 Y mean=509 std dev=0
End Point: X mean=500 std dev=0 Y mean=506 std dev=0

Segment 51, Material: ISFSIGeneralSlope
Start Point: X mean=500 std dev=0 Y mean=506 std dev=0
End Point: X mean=510 std dev=0 Y mean=504 std dev=0

Segment 52, Material: ISFSIGeneralSlope

Start Point: X mean=510 std dev=0 Y mean=504 std dev=0
End Point: X mean=520 std dev=0 Y mean=501 std dev=0

Segment 53, Material: ISFSIGeneralSlope
Start Point: X mean=520 std dev=0 Y mean=501 std dev=0
End Point: X mean=530 std dev=0 Y mean=497 std dev=0

Segment 54, Material: ISFSIGeneralSlope
Start Point: X mean=530 std dev=0 Y mean=497 std dev=0
End Point: X mean=540 std dev=0 Y mean=494 std dev=0

Segment 55, Material: ISFSIGeneralSlope
Start Point: X mean=540 std dev=0 Y mean=494 std dev=0
End Point: X mean=550 std dev=0 Y mean=490 std dev=0

Segment 56, Material: ISFSIGeneralSlope
Start Point: X mean=550 std dev=0 Y mean=490 std dev=0
End Point: X mean=560 std dev=0 Y mean=487 std dev=0

Segment 57, Material: ISFSIGeneralSlope
Start Point: X mean=560 std dev=0 Y mean=487 std dev=0
End Point: X mean=570 std dev=0 Y mean=483 std dev=0

Segment 58, Material: ISFSIGeneralSlope
Start Point: X mean=570 std dev=0 Y mean=483 std dev=0
End Point: X mean=580 std dev=0 Y mean=479 std dev=0

Segment 59, Material: ISFSIGeneralSlope
Start Point: X mean=580 std dev=0 Y mean=479 std dev=0
End Point: X mean=590 std dev=0 Y mean=476 std dev=0

Segment 60, Material: ISFSIGeneralSlope
Start Point: X mean=590 std dev=0 Y mean=476 std dev=0
End Point: X mean=600 std dev=0 Y mean=471 std dev=0

Segment 61, Material: ISFSIGeneralSlope
Start Point: X mean=600 std dev=0 Y mean=471 std dev=0
End Point: X mean=610 std dev=0 Y mean=466 std dev=0

Segment 62, Material: ISFSIGeneralSlope
Start Point: X mean=610 std dev=0 Y mean=466 std dev=0
End Point: X mean=620 std dev=0 Y mean=463 std dev=0

Segment 63, Material: ISFSIGeneralSlope
Start Point: X mean=620 std dev=0 Y mean=463 std dev=0
End Point: X mean=630 std dev=0 Y mean=459 std dev=0

Segment 64, Material: ISFSIGeneralSlope
Start Point: X mean=630 std dev=0 Y mean=459 std dev=0
End Point: X mean=640 std dev=0 Y mean=455 std dev=0

Segment 65, Material: ISFSIGeneralSlope
Start Point: X mean=640 std dev=0 Y mean=455 std dev=0
End Point: X mean=650 std dev=0 Y mean=452 std dev=0

Segment 66, Material: ISFSITowerRoad

Start Point: X mean=650 std dev=0 Y mean=452 std dev=0
End Point: X mean=652 std dev=0 Y mean=450 std dev=0

Segment 67, Material: ISFSITowerRoad
Start Point: X mean=652 std dev=0 Y mean=450 std dev=0
End Point: X mean=662 std dev=0 Y mean=450 std dev=0

Segment 68, Material: ISFSITowerRoad
Start Point: X mean=662 std dev=0 Y mean=450 std dev=0
End Point: X mean=670 std dev=0 Y mean=448 std dev=0

Segment 69, Material: ISFSIGeneralSlope
Start Point: X mean=670 std dev=0 Y mean=448 std dev=0
End Point: X mean=680 std dev=0 Y mean=444 std dev=0

Segment 70, Material: ISFSIGeneralSlope
Start Point: X mean=680 std dev=0 Y mean=444 std dev=0
End Point: X mean=690 std dev=0 Y mean=439 std dev=0

Segment 71, Material: ISFSIGeneralSlope
Start Point: X mean=690 std dev=0 Y mean=439 std dev=0
End Point: X mean=700 std dev=0 Y mean=435 std dev=0

Segment 72, Material: ISFSIGeneralSlope
Start Point: X mean=700 std dev=0 Y mean=435 std dev=0
End Point: X mean=710 std dev=0 Y mean=432 std dev=0

Segment 73, Material: ISFSIGeneralSlope
Start Point: X mean=710 std dev=0 Y mean=432 std dev=0
End Point: X mean=720 std dev=0 Y mean=429 std dev=0

Segment 74, Material: ISFSIGeneralSlope
Start Point: X mean=720 std dev=0 Y mean=429 std dev=0
End Point: X mean=730 std dev=0 Y mean=424 std dev=0

Segment 75, Material: ISFSIGeneralSlope
Start Point: X mean=730 std dev=0 Y mean=424 std dev=0
End Point: X mean=740 std dev=0 Y mean=420 std dev=0

Segment 76, Material: ISFSIGeneralSlope
Start Point: X mean=740 std dev=0 Y mean=420 std dev=0
End Point: X mean=750 std dev=0 Y mean=417 std dev=0

Segment 77, Material: ISFSIGeneralSlope
Start Point: X mean=750 std dev=0 Y mean=417 std dev=0
End Point: X mean=760 std dev=0 Y mean=414 std dev=0

Segment 78, Material: ISFSIGeneralSlope
Start Point: X mean=760 std dev=0 Y mean=414 std dev=0
End Point: X mean=770 std dev=0 Y mean=411 std dev=0

Segment 79, Material: ISFSIGeneralSlope
Start Point: X mean=770 std dev=0 Y mean=411 std dev=0
End Point: X mean=780 std dev=0 Y mean=407 std dev=0

Segment 80, Material: ISFSIGeneralSlope

Start Point: X mean=780 std dev=0 Y mean=407 std dev=0
End Point: X mean=790 std dev=0 Y mean=404 std dev=0

<u>Segment 81, Material: ISFSIGeneralSlope</u>
Start Point: X mean=790 std dev=0 Y mean=404 std dev=0
End Point: X mean=800 std dev=0 Y mean=400 std dev=0

<u>Segment 82, Material: ISFSIGeneralSlope</u>
Start Point: X mean=800 std dev=0 Y mean=400 std dev=0
End Point: X mean=810 std dev=0 Y mean=397 std dev=0

<u>Segment 83, Material: ISFSIGeneralSlope</u>
Start Point: X mean=810 std dev=0 Y mean=397 std dev=0
End Point: X mean=817 std dev=0 Y mean=394 std dev=0

<u>Segment 84, Material: ISFSITowerRoad</u>
Start Point: X mean=817 std dev=0 Y mean=394 std dev=0
End Point: X mean=827 std dev=0 Y mean=394 std dev=0

<u>Segment 85, Material: ISFSITowerRoad</u>
Start Point: X mean=827 std dev=0 Y mean=394 std dev=0
End Point: X mean=830 std dev=0 Y mean=389 std dev=0

<u>Segment 86, Material: ISFSIGeneralSlope</u>
Start Point: X mean=830 std dev=0 Y mean=389 std dev=0
End Point: X mean=840 std dev=0 Y mean=385 std dev=0

<u>Segment 87, Material: ISFSIGeneralSlope</u>
Start Point: X mean=840 std dev=0 Y mean=385 std dev=0
End Point: X mean=850 std dev=0 Y mean=381 std dev=0

<u>Segment 88, Material: ISFSIGeneralSlope</u>
Start Point: X mean=850 std dev=0 Y mean=381 std dev=0
End Point: X mean=860 std dev=0 Y mean=378 std dev=0

<u>Segment 89, Material: ISFSIGeneralSlope</u>
Start Point: X mean=860 std dev=0 Y mean=378 std dev=0
End Point: X mean=870 std dev=0 Y mean=376 std dev=0

<u>Segment 90, Material: ISFSIGeneralSlope</u>
Start Point: X mean=870 std dev=0 Y mean=376 std dev=0
End Point: X mean=880 std dev=0 Y mean=371 std dev=0

<u>Segment 91, Material: ISFSIGeneralSlope</u>
Start Point: X mean=880 std dev=0 Y mean=371 std dev=0
End Point: X mean=890 std dev=0 Y mean=369 std dev=0

<u>Segment 92, Material: ISFSIGeneralSlope</u>
Start Point: X mean=890 std dev=0 Y mean=369 std dev=0
End Point: X mean=900 std dev=0 Y mean=365 std dev=0

<u>Segment 93, Material: ISFSIGeneralSlope</u>
Start Point: X mean=900 std dev=0 Y mean=365 std dev=0
End Point: X mean=910 std dev=0 Y mean=361 std dev=0

<u>Segment 94, Material: ISFSIGeneralSlope</u>

Start Point: X mean=910 std dev=0 Y mean=361 std dev=0
End Point: X mean=920 std dev=0 Y mean=359 std dev=0

Segment 95, Material: ISFSIGeneralSlope
Start Point: X mean=920 std dev=0 Y mean=359 std dev=0
End Point: X mean=930 std dev=0 Y mean=357 std dev=0

Segment 96, Material: ISFSIGeneralSlope
Start Point: X mean=930 std dev=0 Y mean=357 std dev=0
End Point: X mean=940 std dev=0 Y mean=354 std dev=0

Segment 97, Material: ISFSIGeneralSlope
Start Point: X mean=940 std dev=0 Y mean=354 std dev=0
End Point: X mean=950 std dev=0 Y mean=351 std dev=0

Segment 98, Material: ISFSIGeneralSlope
Start Point: X mean=950 std dev=0 Y mean=351 std dev=0
End Point: X mean=960 std dev=0 Y mean=348 std dev=0

Segment 99, Material: ISFSI CutSlope
Start Point: X mean=960 std dev=0 Y mean=348 std dev=0
End Point: X mean=961 std dev=0 Y mean=347 std dev=0

Segment 100, Material: ISFSI CutSlope
Start Point: X mean=961 std dev=0 Y mean=347 std dev=0
End Point: X mean=970 std dev=0 Y mean=330 std dev=0

Segment 101, Material: ISFSI CutSlope
Start Point: X mean=970 std dev=0 Y mean=330 std dev=0
End Point: X mean=996 std dev=0 Y mean=330 std dev=0

Segment 102, Material: ISFSI CutSlope
Start Point: X mean=996 std dev=0 Y mean=330 std dev=0
End Point: X mean=1005 std dev=0 Y mean=310 std dev=0

Segment 103, Material: ISFSIPad
Start Point: X mean=1005 std dev=0 Y mean=310 std dev=0
End Point: X mean=1119 std dev=0 Y mean=310 std dev=0

Segment 104, Material: ISFSIPad
Start Point: X mean=1119 std dev=0 Y mean=310 std dev=0
End Point: X mean=1120 std dev=0 Y mean=306 std dev=0

Segment 105, Material: ISFSIPad
Start Point: X mean=1120 std dev=0 Y mean=306 std dev=0
End Point: X mean=1130 std dev=0 Y mean=305 std dev=0

Segment 106, Material: ISFSIPad
Start Point: X mean=1130 std dev=0 Y mean=305 std dev=0
End Point: X mean=1140 std dev=0 Y mean=304 std dev=0

Segment 107, Material: ISFSIPad
Start Point: X mean=1140 std dev=0 Y mean=304 std dev=0
End Point: X mean=1150 std dev=0 Y mean=304 std dev=0

Segment 108, Material: ISFSIPad

Start Point: X mean=1150 std dev=0 Y mean=304 std dev=0
End Point: X mean=1160 std dev=0 Y mean=304 std dev=0

Segment 109, Material: ISFSIPad
Start Point: X mean=1160 std dev=0 Y mean=304 std dev=0
End Point: X mean=1300 std dev=0 Y mean=304 std dev=0

Materials

Material name: ISFSICutSlope
Coefficient of Normal Restitution (RN): mean=0.45 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.74 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSITowerRoad
Coefficient of Normal Restitution (RN): mean=0.4 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.73 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSIGeneralSlope
Coefficient of Normal Restitution (RN): mean=0.35 std dev=0.04
Coefficient of Tangential Restitution (RT): mean=0.83 std dev=0.04
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=37.0
3' block std dev=14.0
6' block std dev=7.1
10' block std dev=4.3

Material name: ISFSIPad
Coefficient of Normal Restitution (RN): mean=0.5 std dev=0
Coefficient of Tangential Restitution (RT): mean=0.9 std dev=0
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=0
3' block std dev=0
6' block std dev=0
10' block std dev=0

Seeders

Point Seeder
Horizontal Velocity: mean=7.5, std dev=0
Vertical Velocity: mean=0, std dev=0
Mass: 1' block mean=142, std dev=0
3' block mean=3834, std dev=0
6' block mean=30672, std dev=0
10' block mean=142000, std dev=0
Angular Velocity: mean=3, std dev=0
Location: 652, 450

Data Collectors
Data Collector name: Collector001
Start Point: 956.943, 349.196
End Point: 956.943, 358.697

RocFall Analysis Information

Document Name

RI1b

Project Settings

Units: Imperial
Friction angle: Use friction fngle specified in material editor
Minimum Velocity=0.1
Angular Velocity of the rocks CONSIDERED
Standard Deviations NOT USED when generating slope vertices
Random-number generation: Random

Slope

Segment 1, Material: ISFSIGeneralSlope
Start Point: X mean=0 std dev=0 Y mean=679 std dev=0
End Point: X mean=10 std dev=0 Y mean=677 std dev=0

Segment 2, Material: ISFSIGeneralSlope
Start Point: X mean=10 std dev=0 Y mean=677 std dev=0
End Point: X mean=20 std dev=0 Y mean=674 std dev=0

Segment 3, Material: ISFSIGeneralSlope
Start Point: X mean=20 std dev=0 Y mean=674 std dev=0
End Point: X mean=30 std dev=0 Y mean=671 std dev=0

Segment 4, Material: ISFSIGeneralSlope
Start Point: X mean=30 std dev=0 Y mean=671 std dev=0
End Point: X mean=40 std dev=0 Y mean=668 std dev=0

Segment 5, Material: ISFSIGeneralSlope
Start Point: X mean=40 std dev=0 Y mean=668 std dev=0
End Point: X mean=50 std dev=0 Y mean=665 std dev=0

Segment 6, Material: ISFSIGeneralSlope
Start Point: X mean=50 std dev=0 Y mean=665 std dev=0
End Point: X mean=60 std dev=0 Y mean=662 std dev=0

Segment 7, Material: ISFSIGeneralSlope
Start Point: X mean=60 std dev=0 Y mean=662 std dev=0
End Point: X mean=70 std dev=0 Y mean=659 std dev=0

Segment 8, Material: ISFSIGeneralSlope
Start Point: X mean=70 std dev=0 Y mean=659 std dev=0
End Point: X mean=80 std dev=0 Y mean=655 std dev=0

Segment 9, Material: ISFSIGeneralSlope
Start Point: X mean=80 std dev=0 Y mean=655 std dev=0
End Point: X mean=90 std dev=0 Y mean=652 std dev=0

Segment 10, Material: ISFSIGeneralSlope

Start Point: X mean=90 std dev=0 Y mean=652 std dev=0
End Point: X mean=100 std dev=0 Y mean=650 std dev=0

Segment 11, Material: ISFSIGeneralSlope
Start Point: X mean=100 std dev=0 Y mean=650 std dev=0
End Point: X mean=110 std dev=0 Y mean=646 std dev=0

Segment 12, Material: ISFSIGeneralSlope
Start Point: X mean=110 std dev=0 Y mean=646 std dev=0
End Point: X mean=120 std dev=0 Y mean=644 std dev=0

Segment 13, Material: ISFSIGeneralSlope
Start Point: X mean=120 std dev=0 Y mean=644 std dev=0
End Point: X mean=130 std dev=0 Y mean=641 std dev=0

Segment 14, Material: ISFSIGeneralSlope
Start Point: X mean=130 std dev=0 Y mean=641 std dev=0
End Point: X mean=140 std dev=0 Y mean=638 std dev=0

Segment 15, Material: ISFSIGeneralSlope
Start Point: X mean=140 std dev=0 Y mean=638 std dev=0
End Point: X mean=150 std dev=0 Y mean=636 std dev=0

Segment 16, Material: ISFSIGeneralSlope
Start Point: X mean=150 std dev=0 Y mean=636 std dev=0
End Point: X mean=160 std dev=0 Y mean=633 std dev=0

Segment 17, Material: ISFSIGeneralSlope
Start Point: X mean=160 std dev=0 Y mean=633 std dev=0
End Point: X mean=170 std dev=0 Y mean=630 std dev=0

Segment 18, Material: ISFSIGeneralSlope
Start Point: X mean=170 std dev=0 Y mean=630 std dev=0
End Point: X mean=180 std dev=0 Y mean=626 std dev=0

Segment 19, Material: ISFSIGeneralSlope
Start Point: X mean=180 std dev=0 Y mean=626 std dev=0
End Point: X mean=190 std dev=0 Y mean=621 std dev=0

Segment 20, Material: ISFSIGeneralSlope
Start Point: X mean=190 std dev=0 Y mean=621 std dev=0
End Point: X mean=200 std dev=0 Y mean=616 std dev=0

Segment 21, Material: ISFSIGeneralSlope
Start Point: X mean=200 std dev=0 Y mean=616 std dev=0
End Point: X mean=210 std dev=0 Y mean=614 std dev=0

Segment 22, Material: ISFSIGeneralSlope
Start Point: X mean=210 std dev=0 Y mean=614 std dev=0
End Point: X mean=220 std dev=0 Y mean=610 std dev=0

Segment 23, Material: ISFSIGeneralSlope
Start Point: X mean=220 std dev=0 Y mean=610 std dev=0
End Point: X mean=230 std dev=0 Y mean=606 std dev=0

Segment 24, Material: ISFSIGeneralSlope

Start Point: X mean=230 std dev=0 Y mean=606 std dev=0
End Point: X mean=240 std dev=0 Y mean=603 std dev=0

Segment 25, Material: ISFSIGeneralSlope
Start Point: X mean=240 std dev=0 Y mean=603 std dev=0
End Point: X mean=250 std dev=0 Y mean=599 std dev=0

Segment 26, Material: ISFSIGeneralSlope
Start Point: X mean=250 std dev=0 Y mean=599 std dev=0
End Point: X mean=260 std dev=0 Y mean=595 std dev=0

Segment 27, Material: ISFSIGeneralSlope
Start Point: X mean=260 std dev=0 Y mean=595 std dev=0
End Point: X mean=270 std dev=0 Y mean=591 std dev=0

Segment 28, Material: ISFSIGeneralSlope
Start Point: X mean=270 std dev=0 Y mean=591 std dev=0
End Point: X mean=280 std dev=0 Y mean=586 std dev=0

Segment 29, Material: ISFSIGeneralSlope
Start Point: X mean=280 std dev=0 Y mean=586 std dev=0
End Point: X mean=290 std dev=0 Y mean=583 std dev=0

Segment 30, Material: ISFSIGeneralSlope
Start Point: X mean=290 std dev=0 Y mean=583 std dev=0
End Point: X mean=300 std dev=0 Y mean=579 std dev=0

Segment 31, Material: ISFSIGeneralSlope
Start Point: X mean=300 std dev=0 Y mean=579 std dev=0
End Point: X mean=310 std dev=0 Y mean=574 std dev=0

Segment 32, Material: ISFSIGeneralSlope
Start Point: X mean=310 std dev=0 Y mean=574 std dev=0
End Point: X mean=320 std dev=0 Y mean=570 std dev=0

Segment 33, Material: ISFSIGeneralSlope
Start Point: X mean=320 std dev=0 Y mean=570 std dev=0
End Point: X mean=330 std dev=0 Y mean=567 std dev=0

Segment 34, Material: ISFSIGeneralSlope
Start Point: X mean=330 std dev=0 Y mean=567 std dev=0
End Point: X mean=340 std dev=0 Y mean=565 std dev=0

Segment 35, Material: ISFSIGeneralSlope
Start Point: X mean=340 std dev=0 Y mean=565 std dev=0
End Point: X mean=350 std dev=0 Y mean=561 std dev=0

Segment 36, Material: ISFSIGeneralSlope
Start Point: X mean=350 std dev=0 Y mean=561 std dev=0
End Point: X mean=360 std dev=0 Y mean=556 std dev=0

Segment 37, Material: ISFSIGeneralSlope
Start Point: X mean=360 std dev=0 Y mean=556 std dev=0
End Point: X mean=370 std dev=0 Y mean=552 std dev=0

Segment 38, Material: ISFSIGeneralSlope

Start Point: X mean=370 std dev=0 Y mean=552 std dev=0
End Point: X mean=380 std dev=0 Y mean=548 std dev=0

Segment 39, Material: ISFSIGeneralSlope
Start Point: X mean=380 std dev=0 Y mean=548 std dev=0
End Point: X mean=390 std dev=0 Y mean=545 std dev=0

Segment 40, Material: ISFSIGeneralSlope
Start Point: X mean=390 std dev=0 Y mean=545 std dev=0
End Point: X mean=400 std dev=0 Y mean=540 std dev=0

Segment 41, Material: ISFSIGeneralSlope
Start Point: X mean=400 std dev=0 Y mean=540 std dev=0
End Point: X mean=410 std dev=0 Y mean=538 std dev=0

Segment 42, Material: ISFSIGeneralSlope
Start Point: X mean=410 std dev=0 Y mean=538 std dev=0
End Point: X mean=420 std dev=0 Y mean=535 std dev=0

Segment 43, Material: ISFSIGeneralSlope
Start Point: X mean=420 std dev=0 Y mean=535 std dev=0
End Point: X mean=430 std dev=0 Y mean=531 std dev=0

Segment 44, Material: ISFSIGeneralSlope
Start Point: X mean=430 std dev=0 Y mean=531 std dev=0
End Point: X mean=440 std dev=0 Y mean=528 std dev=0

Segment 45, Material: ISFSIGeneralSlope
Start Point: X mean=440 std dev=0 Y mean=528 std dev=0
End Point: X mean=450 std dev=0 Y mean=523 std dev=0

Segment 46, Material: ISFSIGeneralSlope
Start Point: X mean=450 std dev=0 Y mean=523 std dev=0
End Point: X mean=460 std dev=0 Y mean=520 std dev=0

Segment 47, Material: ISFSIGeneralSlope
Start Point: X mean=460 std dev=0 Y mean=520 std dev=0
End Point: X mean=470 std dev=0 Y mean=516 std dev=0

Segment 48, Material: ISFSIGeneralSlope
Start Point: X mean=470 std dev=0 Y mean=516 std dev=0
End Point: X mean=480 std dev=0 Y mean=513 std dev=0

Segment 49, Material: ISFSIGeneralSlope
Start Point: X mean=480 std dev=0 Y mean=513 std dev=0
End Point: X mean=490 std dev=0 Y mean=509 std dev=0

Segment 50, Material: ISFSIGeneralSlope
Start Point: X mean=490 std dev=0 Y mean=509 std dev=0
End Point: X mean=500 std dev=0 Y mean=506 std dev=0

Segment 51, Material: ISFSIGeneralSlope
Start Point: X mean=500 std dev=0 Y mean=506 std dev=0
End Point: X mean=510 std dev=0 Y mean=504 std dev=0

Segment 52, Material: ISFSIGeneralSlope

Start Point: X mean=510 std dev=0 Y mean=504 std dev=0
End Point: X mean=520 std dev=0 Y mean=501 std dev=0

Segment 53, Material: ISFSIGeneralSlope
Start Point: X mean=520 std dev=0 Y mean=501 std dev=0
End Point: X mean=530 std dev=0 Y mean=497 std dev=0

Segment 54, Material: ISFSIGeneralSlope
Start Point: X mean=530 std dev=0 Y mean=497 std dev=0
End Point: X mean=540 std dev=0 Y mean=494 std dev=0

Segment 55, Material: ISFSIGeneralSlope
Start Point: X mean=540 std dev=0 Y mean=494 std dev=0
End Point: X mean=550 std dev=0 Y mean=490 std dev=0

Segment 56, Material: ISFSIGeneralSlope
Start Point: X mean=550 std dev=0 Y mean=490 std dev=0
End Point: X mean=560 std dev=0 Y mean=487 std dev=0

Segment 57, Material: ISFSIGeneralSlope
Start Point: X mean=560 std dev=0 Y mean=487 std dev=0
End Point: X mean=570 std dev=0 Y mean=483 std dev=0

Segment 58, Material: ISFSIGeneralSlope
Start Point: X mean=570 std dev=0 Y mean=483 std dev=0
End Point: X mean=580 std dev=0 Y mean=479 std dev=0

Segment 59, Material: ISFSIGeneralSlope
Start Point: X mean=580 std dev=0 Y mean=479 std dev=0
End Point: X mean=590 std dev=0 Y mean=476 std dev=0

Segment 60, Material: ISFSIGeneralSlope
Start Point: X mean=590 std dev=0 Y mean=476 std dev=0
End Point: X mean=600 std dev=0 Y mean=471 std dev=0

Segment 61, Material: ISFSIGeneralSlope
Start Point: X mean=600 std dev=0 Y mean=471 std dev=0
End Point: X mean=610 std dev=0 Y mean=466 std dev=0

Segment 62, Material: ISFSIGeneralSlope
Start Point: X mean=610 std dev=0 Y mean=466 std dev=0
End Point: X mean=620 std dev=0 Y mean=463 std dev=0

Segment 63, Material: ISFSIGeneralSlope
Start Point: X mean=620 std dev=0 Y mean=463 std dev=0
End Point: X mean=630 std dev=0 Y mean=459 std dev=0

Segment 64, Material: ISFSIGeneralSlope
Start Point: X mean=630 std dev=0 Y mean=459 std dev=0
End Point: X mean=640 std dev=0 Y mean=455 std dev=0

Segment 65, Material: ISFSIGeneralSlope
Start Point: X mean=640 std dev=0 Y mean=455 std dev=0
End Point: X mean=650 std dev=0 Y mean=452 std dev=0

Segment 66, Material: ISFSITowerRoad

Start Point: X mean=650 std dev=0 Y mean=452 std dev=0
End Point: X mean=652 std dev=0 Y mean=450 std dev=0

Segment 67, Material: ISFSITowerRoad
Start Point: X mean=652 std dev=0 Y mean=450 std dev=0
End Point: X mean=662 std dev=0 Y mean=450 std dev=0

Segment 68, Material: ISFSITowerRoad
Start Point: X mean=662 std dev=0 Y mean=450 std dev=0
End Point: X mean=670 std dev=0 Y mean=448 std dev=0

Segment 69, Material: ISFSIGeneralSlope
Start Point: X mean=670 std dev=0 Y mean=448 std dev=0
End Point: X mean=680 std dev=0 Y mean=444 std dev=0

Segment 70, Material: ISFSIGeneralSlope
Start Point: X mean=680 std dev=0 Y mean=444 std dev=0
End Point: X mean=690 std dev=0 Y mean=439 std dev=0

Segment 71, Material: ISFSIGeneralSlope
Start Point: X mean=690 std dev=0 Y mean=439 std dev=0
End Point: X mean=700 std dev=0 Y mean=435 std dev=0

Segment 72, Material: ISFSIGeneralSlope
Start Point: X mean=700 std dev=0 Y mean=435 std dev=0
End Point: X mean=710 std dev=0 Y mean=432 std dev=0

Segment 73, Material: ISFSIGeneralSlope
Start Point: X mean=710 std dev=0 Y mean=432 std dev=0
End Point: X mean=720 std dev=0 Y mean=429 std dev=0

Segment 74, Material: ISFSIGeneralSlope
Start Point: X mean=720 std dev=0 Y mean=429 std dev=0
End Point: X mean=730 std dev=0 Y mean=424 std dev=0

Segment 75, Material: ISFSIGeneralSlope
Start Point: X mean=730 std dev=0 Y mean=424 std dev=0
End Point: X mean=740 std dev=0 Y mean=420 std dev=0

Segment 76, Material: ISFSIGeneralSlope
Start Point: X mean=740 std dev=0 Y mean=420 std dev=0
End Point: X mean=750 std dev=0 Y mean=417 std dev=0

Segment 77, Material: ISFSIGeneralSlope
Start Point: X mean=750 std dev=0 Y mean=417 std dev=0
End Point: X mean=760 std dev=0 Y mean=414 std dev=0

Segment 78, Material: ISFSIGeneralSlope
Start Point: X mean=760 std dev=0 Y mean=414 std dev=0
End Point: X mean=770 std dev=0 Y mean=411 std dev=0

Segment 79, Material: ISFSIGeneralSlope
Start Point: X mean=770 std dev=0 Y mean=411 std dev=0
End Point: X mean=780 std dev=0 Y mean=407 std dev=0

Segment 80, Material: ISFSIGeneralSlope

Start Point: X mean=780 std dev=0 Y mean=407 std dev=0
End Point: X mean=790 std dev=0 Y mean=404 std dev=0

Segment 81, Material: ISFSIGeneralSlope
Start Point: X mean=790 std dev=0 Y mean=404 std dev=0
End Point: X mean=800 std dev=0 Y mean=400 std dev=0

Segment 82, Material: ISFSIGeneralSlope
Start Point: X mean=800 std dev=0 Y mean=400 std dev=0
End Point: X mean=810 std dev=0 Y mean=397 std dev=0

Segment 83, Material: ISFSIGeneralSlope
Start Point: X mean=810 std dev=0 Y mean=397 std dev=0
End Point: X mean=817 std dev=0 Y mean=394 std dev=0

Segment 84, Material: ISFSITowerRoad
Start Point: X mean=817 std dev=0 Y mean=394 std dev=0
End Point: X mean=827 std dev=0 Y mean=394 std dev=0

Segment 85, Material: ISFSITowerRoad
Start Point: X mean=827 std dev=0 Y mean=394 std dev=0
End Point: X mean=830 std dev=0 Y mean=389 std dev=0

Segment 86, Material: ISFSIGeneralSlope
Start Point: X mean=830 std dev=0 Y mean=389 std dev=0
End Point: X mean=840 std dev=0 Y mean=385 std dev=0

Segment 87, Material: ISFSIGeneralSlope
Start Point: X mean=840 std dev=0 Y mean=385 std dev=0
End Point: X mean=850 std dev=0 Y mean=381 std dev=0

Segment 88, Material: ISFSIGeneralSlope
Start Point: X mean=850 std dev=0 Y mean=381 std dev=0
End Point: X mean=860 std dev=0 Y mean=378 std dev=0

Segment 89, Material: ISFSIGeneralSlope
Start Point: X mean=860 std dev=0 Y mean=378 std dev=0
End Point: X mean=870 std dev=0 Y mean=376 std dev=0

Segment 90, Material: ISFSIGeneralSlope
Start Point: X mean=870 std dev=0 Y mean=376 std dev=0
End Point: X mean=880 std dev=0 Y mean=371 std dev=0

Segment 91, Material: ISFSIGeneralSlope
Start Point: X mean=880 std dev=0 Y mean=371 std dev=0
End Point: X mean=890 std dev=0 Y mean=369 std dev=0

Segment 92, Material: ISFSIGeneralSlope
Start Point: X mean=890 std dev=0 Y mean=369 std dev=0
End Point: X mean=900 std dev=0 Y mean=365 std dev=0

Segment 93, Material: ISFSIGeneralSlope
Start Point: X mean=900 std dev=0 Y mean=365 std dev=0
End Point: X mean=910 std dev=0 Y mean=361 std dev=0

Segment 94, Material: ISFSIGeneralSlope

Start Point: X mean=910 std dev=0 Y mean=361 std dev=0
End Point: X mean=920 std dev=0 Y mean=359 std dev=0

Segment 95, Material: ISFSIGeneralSlope
Start Point: X mean=920 std dev=0 Y mean=359 std dev=0
End Point: X mean=930 std dev=0 Y mean=357 std dev=0

Segment 96, Material: ISFSIGeneralSlope
Start Point: X mean=930 std dev=0 Y mean=357 std dev=0
End Point: X mean=940 std dev=0 Y mean=354 std dev=0

Segment 97, Material: ISFSIGeneralSlope
Start Point: X mean=940 std dev=0 Y mean=354 std dev=0
End Point: X mean=950 std dev=0 Y mean=351 std dev=0

Segment 98, Material: ISFSIGeneralSlope
Start Point: X mean=950 std dev=0 Y mean=351 std dev=0
End Point: X mean=960 std dev=0 Y mean=348 std dev=0

Segment 99, Material: ISFSI CutSlope
Start Point: X mean=960 std dev=0 Y mean=348 std dev=0
End Point: X mean=961 std dev=0 Y mean=347 std dev=0

Segment 100, Material: ISFSI CutSlope
Start Point: X mean=961 std dev=0 Y mean=347 std dev=0
End Point: X mean=970 std dev=0 Y mean=330 std dev=0

Segment 101, Material: ISFSI CutSlope
Start Point: X mean=970 std dev=0 Y mean=330 std dev=0
End Point: X mean=996 std dev=0 Y mean=330 std dev=0

Segment 102, Material: ISFSI CutSlope
Start Point: X mean=996 std dev=0 Y mean=330 std dev=0
End Point: X mean=1005 std dev=0 Y mean=310 std dev=0

Segment 103, Material: ISFSIPad
Start Point: X mean=1005 std dev=0 Y mean=310 std dev=0
End Point: X mean=1119 std dev=0 Y mean=310 std dev=0

Segment 104, Material: ISFSIPad
Start Point: X mean=1119 std dev=0 Y mean=310 std dev=0
End Point: X mean=1120 std dev=0 Y mean=306 std dev=0

Segment 105, Material: ISFSIPad
Start Point: X mean=1120 std dev=0 Y mean=306 std dev=0
End Point: X mean=1130 std dev=0 Y mean=305 std dev=0

Segment 106, Material: ISFSIPad
Start Point: X mean=1130 std dev=0 Y mean=305 std dev=0
End Point: X mean=1140 std dev=0 Y mean=304 std dev=0

Segment 107, Material: ISFSIPad
Start Point: X mean=1140 std dev=0 Y mean=304 std dev=0
End Point: X mean=1150 std dev=0 Y mean=304 std dev=0

Segment 108, Material: ISFSIPad

Start Point: X mean=1150 std dev=0 Y mean=304 std dev=0
End Point: X mean=1160 std dev=0 Y mean=304 std dev=0

Segment 109, Material: ISFSIPad
Start Point: X mean=1160 std dev=0 Y mean=304 std dev=0
End Point: X mean=1300 std dev=0 Y mean=304 std dev=0

Materials

Material name: ISFSICutSlope
Coefficient of Normal Restitution (RN): mean=0.45 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.74 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSITowerRoad
Coefficient of Normal Restitution (RN): mean=0.4 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.73 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSIGeneralSlope
Coefficient of Normal Restitution (RN): mean=0.35 std dev=0.04
Coefficient of Tangential Restitution (RT): mean=0.83 std dev=0.04
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=37.0
3' block std dev=14.0
6' block std dev=7.1
10' block std dev=4.3

Material name: ISFSIPad
Coefficient of Normal Restitution (RN): mean=0.5 std dev=0
Coefficient of Tangential Restitution (RT): mean=0.9 std dev=0
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=0
3' block std dev=0
6' block std dev=0
10' block std dev=0

Seeders

Point Seeder
Horizontal Velocity: mean=7.5, std dev=0
Vertical Velocity: mean=0, std dev=0
Mass: 1' block mean=142, std dev=0
3' block mean=3834, std dev=0
6' block mean=30672, std dev=0
10' block mean=142000, std dev=0
Angular Velocity: mean=3, std dev=0
Location: 560, 487

Data Collectors
Data Collector name: Collector001
Start Point: 956.943, 349.196
End Point: 956.943, 358.697

RocFall Analysis Information

Document Name

RI2a

Project Settings

Units: Imperial
Friction angle: Use friction fngle specified in material editor
Minimum Velocity=0.1
Angular Velocity of the rocks CONSIDERED
Standard Deviations NOT USED when generating slope vertices
Random-number generation: Random

Slope

Segment 1, Material: ISFSIGeneralSlope
Start Point: X mean=0 std dev=0 Y mean=679 std dev=0
End Point: X mean=10 std dev=0 Y mean=677 std dev=0

Segment 2, Material: ISFSIGeneralSlope
Start Point: X mean=10 std dev=0 Y mean=677 std dev=0
End Point: X mean=20 std dev=0 Y mean=674 std dev=0

Segment 3, Material: ISFSIGeneralSlope
Start Point: X mean=20 std dev=0 Y mean=674 std dev=0
End Point: X mean=30 std dev=0 Y mean=671 std dev=0

Segment 4, Material: ISFSIGeneralSlope
Start Point: X mean=30 std dev=0 Y mean=671 std dev=0
End Point: X mean=40 std dev=0 Y mean=668 std dev=0

Segment 5, Material: ISFSIGeneralSlope
Start Point: X mean=40 std dev=0 Y mean=668 std dev=0
End Point: X mean=50 std dev=0 Y mean=665 std dev=0

Segment 6, Material: ISFSIGeneralSlope
Start Point: X mean=50 std dev=0 Y mean=665 std dev=0
End Point: X mean=60 std dev=0 Y mean=662 std dev=0

Segment 7, Material: ISFSIGeneralSlope
Start Point: X mean=60 std dev=0 Y mean=662 std dev=0
End Point: X mean=70 std dev=0 Y mean=659 std dev=0

Segment 8, Material: ISFSIGeneralSlope
Start Point: X mean=70 std dev=0 Y mean=659 std dev=0
End Point: X mean=80 std dev=0 Y mean=655 std dev=0

Segment 9, Material: ISFSIGeneralSlope
Start Point: X mean=80 std dev=0 Y mean=655 std dev=0
End Point: X mean=90 std dev=0 Y mean=652 std dev=0

Segment 10, Material: ISFSIGeneralSlope
Start Point: X mean=90 std dev=0 Y mean=652 std dev=0
End Point: X mean=100 std dev=0 Y mean=650 std dev=0

Segment 11, Material: ISFSIGeneralSlope
Start Point: X mean=100 std dev=0 Y mean=650 std dev=0
End Point: X mean=110 std dev=0 Y mean=646 std dev=0

Segment 12, Material: ISFSIGeneralSlope
Start Point: X mean=110 std dev=0 Y mean=646 std dev=0
End Point: X mean=120 std dev=0 Y mean=644 std dev=0

Segment 13, Material: ISFSIGeneralSlope
Start Point: X mean=120 std dev=0 Y mean=644 std dev=0
End Point: X mean=130 std dev=0 Y mean=641 std dev=0

Segment 14, Material: ISFSIGeneralSlope
Start Point: X mean=130 std dev=0 Y mean=641 std dev=0
End Point: X mean=140 std dev=0 Y mean=638 std dev=0

Segment 15, Material: ISFSIGeneralSlope
Start Point: X mean=140 std dev=0 Y mean=638 std dev=0
End Point: X mean=150 std dev=0 Y mean=636 std dev=0

Segment 16, Material: ISFSIGeneralSlope
Start Point: X mean=150 std dev=0 Y mean=636 std dev=0
End Point: X mean=160 std dev=0 Y mean=633 std dev=0

Segment 17, Material: ISFSIGeneralSlope
Start Point: X mean=160 std dev=0 Y mean=633 std dev=0
End Point: X mean=170 std dev=0 Y mean=630 std dev=0

Segment 18, Material: ISFSIGeneralSlope
Start Point: X mean=170 std dev=0 Y mean=630 std dev=0
End Point: X mean=180 std dev=0 Y mean=626 std dev=0

Segment 19, Material: ISFSIGeneralSlope
Start Point: X mean=180 std dev=0 Y mean=626 std dev=0
End Point: X mean=190 std dev=0 Y mean=621 std dev=0

Segment 20, Material: ISFSIGeneralSlope
Start Point: X mean=190 std dev=0 Y mean=621 std dev=0
End Point: X mean=200 std dev=0 Y mean=616 std dev=0

Segment 21, Material: ISFSIGeneralSlope
Start Point: X mean=200 std dev=0 Y mean=616 std dev=0
End Point: X mean=210 std dev=0 Y mean=614 std dev=0

Segment 22, Material: ISFSIGeneralSlope
Start Point: X mean=210 std dev=0 Y mean=614 std dev=0
End Point: X mean=220 std dev=0 Y mean=610 std dev=0

Segment 23, Material: ISFSIGeneralSlope
Start Point: X mean=220 std dev=0 Y mean=610 std dev=0
End Point: X mean=230 std dev=0 Y mean=606 std dev=0

Segment 24, Material: ISFSIGeneralSlope
Start Point: X mean=230 std dev=0 Y mean=606 std dev=0
End Point: X mean=240 std dev=0 Y mean=603 std dev=0

Segment 25, Material: ISFSIGeneralSlope
Start Point: X mean=240 std dev=0 Y mean=603 std dev=0
End Point: X mean=250 std dev=0 Y mean=599 std dev=0

Segment 26, Material: ISFSIGeneralSlope
Start Point: X mean=250 std dev=0 Y mean=599 std dev=0
End Point: X mean=260 std dev=0 Y mean=595 std dev=0

Segment 27, Material: ISFSIGeneralSlope
Start Point: X mean=260 std dev=0 Y mean=595 std dev=0
End Point: X mean=270 std dev=0 Y mean=591 std dev=0

Segment 28, Material: ISFSIGeneralSlope
Start Point: X mean=270 std dev=0 Y mean=591 std dev=0
End Point: X mean=280 std dev=0 Y mean=586 std dev=0

Segment 29, Material: ISFSIGeneralSlope
Start Point: X mean=280 std dev=0 Y mean=586 std dev=0
End Point: X mean=290 std dev=0 Y mean=583 std dev=0

Segment 30, Material: ISFSIGeneralSlope
Start Point: X mean=290 std dev=0 Y mean=583 std dev=0
End Point: X mean=300 std dev=0 Y mean=579 std dev=0

Segment 31, Material: ISFSIGeneralSlope
Start Point: X mean=300 std dev=0 Y mean=579 std dev=0
End Point: X mean=310 std dev=0 Y mean=574 std dev=0

Segment 32, Material: ISFSIGeneralSlope
Start Point: X mean=310 std dev=0 Y mean=574 std dev=0
End Point: X mean=320 std dev=0 Y mean=570 std dev=0

Segment 33, Material: ISFSIGeneralSlope
Start Point: X mean=320 std dev=0 Y mean=570 std dev=0
End Point: X mean=330 std dev=0 Y mean=567 std dev=0

Segment 34, Material: ISFSIGeneralSlope
Start Point: X mean=330 std dev=0 Y mean=567 std dev=0
End Point: X mean=340 std dev=0 Y mean=565 std dev=0

Segment 35, Material: ISFSIGeneralSlope
Start Point: X mean=340 std dev=0 Y mean=565 std dev=0
End Point: X mean=350 std dev=0 Y mean=561 std dev=0

Segment 36, Material: ISFSIGeneralSlope
Start Point: X mean=350 std dev=0 Y mean=561 std dev=0
End Point: X mean=360 std dev=0 Y mean=556 std dev=0

Segment 37, Material: ISFSIGeneralSlope
Start Point: X mean=360 std dev=0 Y mean=556 std dev=0
End Point: X mean=370 std dev=0 Y mean=552 std dev=0

Segment 38, Material: ISFSIGeneralSlope
Start Point: X mean=370 std dev=0 Y mean=552 std dev=0
End Point: X mean=380 std dev=0 Y mean=548 std dev=0

Segment 39, Material: ISFSIGeneralSlope
Start Point: X mean=380 std dev=0 Y mean=548 std dev=0
End Point: X mean=390 std dev=0 Y mean=545 std dev=0

Segment 40, Material: ISFSIGeneralSlope
Start Point: X mean=390 std dev=0 Y mean=545 std dev=0
End Point: X mean=400 std dev=0 Y mean=540 std dev=0

Segment 41, Material: ISFSIGeneralSlope
Start Point: X mean=400 std dev=0 Y mean=540 std dev=0
End Point: X mean=410 std dev=0 Y mean=538 std dev=0

Segment 42, Material: ISFSIGeneralSlope
Start Point: X mean=410 std dev=0 Y mean=538 std dev=0
End Point: X mean=420 std dev=0 Y mean=535 std dev=0

Segment 43, Material: ISFSIGeneralSlope
Start Point: X mean=420 std dev=0 Y mean=535 std dev=0
End Point: X mean=430 std dev=0 Y mean=531 std dev=0

Segment 44, Material: ISFSIGeneralSlope
Start Point: X mean=430 std dev=0 Y mean=531 std dev=0
End Point: X mean=440 std dev=0 Y mean=528 std dev=0

Segment 45, Material: ISFSIGeneralSlope
Start Point: X mean=440 std dev=0 Y mean=528 std dev=0
End Point: X mean=450 std dev=0 Y mean=523 std dev=0

Segment 46, Material: ISFSIGeneralSlope
Start Point: X mean=450 std dev=0 Y mean=523 std dev=0
End Point: X mean=460 std dev=0 Y mean=520 std dev=0

Segment 47, Material: ISFSIGeneralSlope
Start Point: X mean=460 std dev=0 Y mean=520 std dev=0
End Point: X mean=470 std dev=0 Y mean=516 std dev=0

Segment 48, Material: ISFSIGeneralSlope
Start Point: X mean=470 std dev=0 Y mean=516 std dev=0
End Point: X mean=480 std dev=0 Y mean=513 std dev=0

Segment 49, Material: ISFSIGeneralSlope
Start Point: X mean=480 std dev=0 Y mean=513 std dev=0
End Point: X mean=490 std dev=0 Y mean=509 std dev=0

Segment 50, Material: ISFSIGeneralSlope
Start Point: X mean=490 std dev=0 Y mean=509 std dev=0
End Point: X mean=500 std dev=0 Y mean=506 std dev=0

Segment 51, Material: ISFSIGeneralSlope
Start Point: X mean=500 std dev=0 Y mean=506 std dev=0
End Point: X mean=510 std dev=0 Y mean=504 std dev=0

Segment 52, Material: ISFSIGeneralSlope
Start Point: X mean=510 std dev=0 Y mean=504 std dev=0
End Point: X mean=520 std dev=0 Y mean=501 std dev=0

Segment 53, Material: ISFSIGeneralSlope
Start Point: X mean=520 std dev=0 Y mean=501 std dev=0
End Point: X mean=530 std dev=0 Y mean=497 std dev=0

Segment 54, Material: ISFSIGeneralSlope
Start Point: X mean=530 std dev=0 Y mean=497 std dev=0
End Point: X mean=540 std dev=0 Y mean=494 std dev=0

Segment 55, Material: ISFSIGeneralSlope
Start Point: X mean=540 std dev=0 Y mean=494 std dev=0
End Point: X mean=550 std dev=0 Y mean=490 std dev=0

Segment 56, Material: ISFSIGeneralSlope
Start Point: X mean=550 std dev=0 Y mean=490 std dev=0
End Point: X mean=560 std dev=0 Y mean=487 std dev=0

Segment 57, Material: ISFSIGeneralSlope
Start Point: X mean=560 std dev=0 Y mean=487 std dev=0
End Point: X mean=570 std dev=0 Y mean=483 std dev=0

Segment 58, Material: ISFSIGeneralSlope
Start Point: X mean=570 std dev=0 Y mean=483 std dev=0
End Point: X mean=580 std dev=0 Y mean=479 std dev=0

Segment 59, Material: ISFSIGeneralSlope
Start Point: X mean=580 std dev=0 Y mean=479 std dev=0
End Point: X mean=590 std dev=0 Y mean=476 std dev=0

Segment 60, Material: ISFSIGeneralSlope
Start Point: X mean=590 std dev=0 Y mean=476 std dev=0
End Point: X mean=600 std dev=0 Y mean=471 std dev=0

Segment 61, Material: ISFSIGeneralSlope
Start Point: X mean=600 std dev=0 Y mean=471 std dev=0
End Point: X mean=610 std dev=0 Y mean=466 std dev=0

Segment 62, Material: ISFSIGeneralSlope
Start Point: X mean=610 std dev=0 Y mean=466 std dev=0
End Point: X mean=620 std dev=0 Y mean=463 std dev=0

Segment 63, Material: ISFSIGeneralSlope
Start Point: X mean=620 std dev=0 Y mean=463 std dev=0
End Point: X mean=630 std dev=0 Y mean=459 std dev=0

Segment 64, Material: ISFSIGeneralSlope
Start Point: X mean=630 std dev=0 Y mean=459 std dev=0
End Point: X mean=640 std dev=0 Y mean=455 std dev=0

Segment 65, Material: ISFSIGeneralSlope
Start Point: X mean=640 std dev=0 Y mean=455 std dev=0
End Point: X mean=650 std dev=0 Y mean=452 std dev=0

Segment 66, Material: ISFSITowerRoad
Start Point: X mean=650 std dev=0 Y mean=452 std dev=0
End Point: X mean=652 std dev=0 Y mean=450 std dev=0

Segment 67, Material: ISFSITowerRoad
Start Point: X mean=652 std dev=0 Y mean=450 std dev=0
End Point: X mean=662 std dev=0 Y mean=450 std dev=0

Segment 68, Material: ISFSITowerRoad
Start Point: X mean=662 std dev=0 Y mean=450 std dev=0
End Point: X mean=670 std dev=0 Y mean=448 std dev=0

Segment 69, Material: ISFSIGeneralSlope
Start Point: X mean=670 std dev=0 Y mean=448 std dev=0
End Point: X mean=680 std dev=0 Y mean=444 std dev=0

Segment 70, Material: ISFSIGeneralSlope
Start Point: X mean=680 std dev=0 Y mean=444 std dev=0
End Point: X mean=690 std dev=0 Y mean=439 std dev=0

Segment 71, Material: ISFSIGeneralSlope
Start Point: X mean=690 std dev=0 Y mean=439 std dev=0
End Point: X mean=700 std dev=0 Y mean=435 std dev=0

Segment 72, Material: ISFSIGeneralSlope
Start Point: X mean=700 std dev=0 Y mean=435 std dev=0
End Point: X mean=710 std dev=0 Y mean=432 std dev=0

Segment 73, Material: ISFSIGeneralSlope
Start Point: X mean=710 std dev=0 Y mean=432 std dev=0
End Point: X mean=720 std dev=0 Y mean=429 std dev=0

Segment 74, Material: ISFSIGeneralSlope
Start Point: X mean=720 std dev=0 Y mean=429 std dev=0
End Point: X mean=730 std dev=0 Y mean=424 std dev=0

Segment 75, Material: ISFSIGeneralSlope
Start Point: X mean=730 std dev=0 Y mean=424 std dev=0
End Point: X mean=740 std dev=0 Y mean=420 std dev=0

Segment 76, Material: ISFSIGeneralSlope
Start Point: X mean=740 std dev=0 Y mean=420 std dev=0
End Point: X mean=750 std dev=0 Y mean=417 std dev=0

Segment 77, Material: ISFSIGeneralSlope
Start Point: X mean=750 std dev=0 Y mean=417 std dev=0
End Point: X mean=760 std dev=0 Y mean=414 std dev=0

Segment 78, Material: ISFSIGeneralSlope
Start Point: X mean=760 std dev=0 Y mean=414 std dev=0
End Point: X mean=770 std dev=0 Y mean=411 std dev=0

Segment 79, Material: ISFSIGeneralSlope
Start Point: X mean=770 std dev=0 Y mean=411 std dev=0
End Point: X mean=780 std dev=0 Y mean=407 std dev=0

Segment 80, Material: ISFSIGeneralSlope
Start Point: X mean=780 std dev=0 Y mean=407 std dev=0
End Point: X mean=790 std dev=0 Y mean=404 std dev=0

Segment 81, Material: ISFSIGeneralSlope
Start Point: X mean=790 std dev=0 Y mean=404 std dev=0
End Point: X mean=800 std dev=0 Y mean=400 std dev=0

Segment 82, Material: ISFSIGeneralSlope
Start Point: X mean=800 std dev=0 Y mean=400 std dev=0
End Point: X mean=810 std dev=0 Y mean=397 std dev=0

Segment 83, Material: ISFSIGeneralSlope
Start Point: X mean=810 std dev=0 Y mean=397 std dev=0
End Point: X mean=817 std dev=0 Y mean=394 std dev=0

Segment 84, Material: ISFSITowerRoad
Start Point: X mean=817 std dev=0 Y mean=394 std dev=0
End Point: X mean=827 std dev=0 Y mean=394 std dev=0

Segment 85, Material: ISFSITowerRoad
Start Point: X mean=827 std dev=0 Y mean=394 std dev=0
End Point: X mean=830 std dev=0 Y mean=389 std dev=0

Segment 86, Material: ISFSIGeneralSlope
Start Point: X mean=830 std dev=0 Y mean=389 std dev=0
End Point: X mean=840 std dev=0 Y mean=385 std dev=0

Segment 87, Material: ISFSIGeneralSlope
Start Point: X mean=840 std dev=0 Y mean=385 std dev=0
End Point: X mean=850 std dev=0 Y mean=381 std dev=0

Segment 88, Material: ISFSIGeneralSlope
Start Point: X mean=850 std dev=0 Y mean=381 std dev=0
End Point: X mean=860 std dev=0 Y mean=378 std dev=0

Segment 89, Material: ISFSIGeneralSlope
Start Point: X mean=860 std dev=0 Y mean=378 std dev=0
End Point: X mean=870 std dev=0 Y mean=376 std dev=0

Segment 90, Material: ISFSIGeneralSlope
Start Point: X mean=870 std dev=0 Y mean=376 std dev=0
End Point: X mean=880 std dev=0 Y mean=371 std dev=0

Segment 91, Material: ISFSIGeneralSlope
Start Point: X mean=880 std dev=0 Y mean=371 std dev=0
End Point: X mean=890 std dev=0 Y mean=369 std dev=0

Segment 92, Material: ISFSIGeneralSlope
Start Point: X mean=890 std dev=0 Y mean=369 std dev=0
End Point: X mean=900 std dev=0 Y mean=365 std dev=0

Segment 93, Material: ISFSIGeneralSlope
Start Point: X mean=900 std dev=0 Y mean=365 std dev=0
End Point: X mean=910 std dev=0 Y mean=361 std dev=0

Segment 94, Material: ISFSIGeneralSlope
Start Point: X mean=910 std dev=0 Y mean=361 std dev=0
End Point: X mean=920 std dev=0 Y mean=359 std dev=0

Segment 95, Material: ISFSIGeneralSlope
Start Point: X mean=920 std dev=0 Y mean=359 std dev=0
End Point: X mean=930 std dev=0 Y mean=357 std dev=0

Segment 96, Material: ISFSIGeneralSlope
Start Point: X mean=930 std dev=0 Y mean=357 std dev=0
End Point: X mean=940 std dev=0 Y mean=354 std dev=0

Segment 97, Material: ISFSIGeneralSlope
Start Point: X mean=940 std dev=0 Y mean=354 std dev=0
End Point: X mean=950 std dev=0 Y mean=351 std dev=0

Segment 98, Material: ISFSIGeneralSlope
Start Point: X mean=950 std dev=0 Y mean=351 std dev=0
End Point: X mean=960 std dev=0 Y mean=348 std dev=0

Segment 99, Material: ISFSI CutSlope
Start Point: X mean=960 std dev=0 Y mean=348 std dev=0
End Point: X mean=961 std dev=0 Y mean=347 std dev=0

Segment 100, Material: ISFSI CutSlope
Start Point: X mean=961 std dev=0 Y mean=347 std dev=0
End Point: X mean=970 std dev=0 Y mean=330 std dev=0

Segment 101, Material: ISFSI CutSlope
Start Point: X mean=970 std dev=0 Y mean=330 std dev=0
End Point: X mean=996 std dev=0 Y mean=330 std dev=0

Segment 102, Material: ISFSI CutSlope
Start Point: X mean=996 std dev=0 Y mean=330 std dev=0
End Point: X mean=1005 std dev=0 Y mean=310 std dev=0

Segment 103, Material: ISFSIPad
Start Point: X mean=1005 std dev=0 Y mean=310 std dev=0
End Point: X mean=1119 std dev=0 Y mean=310 std dev=0

Segment 104, Material: ISFSIPad
Start Point: X mean=1119 std dev=0 Y mean=310 std dev=0
End Point: X mean=1120 std dev=0 Y mean=306 std dev=0

Segment 105, Material: ISFSIPad
Start Point: X mean=1120 std dev=0 Y mean=306 std dev=0
End Point: X mean=1130 std dev=0 Y mean=305 std dev=0

Segment 106, Material: ISFSIPad
Start Point: X mean=1130 std dev=0 Y mean=305 std dev=0
End Point: X mean=1140 std dev=0 Y mean=304 std dev=0

Segment 107, Material: ISFSIPad
Start Point: X mean=1140 std dev=0 Y mean=304 std dev=0
End Point: X mean=1150 std dev=0 Y mean=304 std dev=0

Segment 108, Material: ISFSIPad
Start Point: X mean=1150 std dev=0 Y mean=304 std dev=0
End Point: X mean=1160 std dev=0 Y mean=304 std dev=0

Segment 109, Material: ISFSIPad
Start Point: X mean=1160 std dev=0 Y mean=304 std dev=0
End Point: X mean=1300 std dev=0 Y mean=304 std dev=0

Materials

Material name: ISFSICutSlope
Coefficient of Normal Restitution (RN): mean=0.45 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.74 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSITowerRoad
Coefficient of Normal Restitution (RN): mean=0.4 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.73 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSIGeneralSlope
Coefficient of Normal Restitution (RN): mean=0.35 std dev=0.04
Coefficient of Tangential Restitution (RT): mean=0.83 std dev=0.04
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=37.0
3' block std dev=14.0
6' block std dev=7.1
10' block std dev=4.3

Material name: ISFSIPad
Coefficient of Normal Restitution (RN): mean=0.5 std dev=0
Coefficient of Tangential Restitution (RT): mean=0.9 std dev=0
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=0
3' block std dev=0
6' block std dev=0
10' block std dev=0

Seeders

Point Seeder
Horizontal Velocity: mean=7.5, std dev=0
Vertical Velocity: mean=0, std dev=0
Mass: 1' block mean=142, std dev=0
3' block mean=3834, std dev=0
6' block mean=30672, std dev=0
10' block mean=142000, std dev=0
Angular Velocity: mean=3, std dev=0
Location: 900, 365

Data Collectors

Data Collector name: Collector001
Start Point: 956.943, 349.196
End Point: 956.943, 358.697

RocFall Analysis Information

Document Name

Rl2b

Project Settings

Units: Imperial
Friction angle: Use friction fngle specified in material editor
Minimum Velocity=0.1
Angular Velocity of the rocks CONSIDERED
Standard Deviations NOT USED when generating slope vertices
Random-number generation: Random

Slope

Segment 1, Material: ISFSIGeneralSlope
Start Point: X mean=0 std dev=0 Y mean=679 std dev=0
End Point: X mean=10 std dev=0 Y mean=677 std dev=0

Segment 2, Material: ISFSIGeneralSlope
Start Point: X mean=10 std dev=0 Y mean=677 std dev=0
End Point: X mean=20 std dev=0 Y mean=674 std dev=0

Segment 3, Material: ISFSIGeneralSlope
Start Point: X mean=20 std dev=0 Y mean=674 std dev=0
End Point: X mean=30 std dev=0 Y mean=671 std dev=0

Segment 4, Material: ISFSIGeneralSlope
Start Point: X mean=30 std dev=0 Y mean=671 std dev=0
End Point: X mean=40 std dev=0 Y mean=668 std dev=0

Segment 5, Material: ISFSIGeneralSlope
Start Point: X mean=40 std dev=0 Y mean=668 std dev=0
End Point: X mean=50 std dev=0 Y mean=665 std dev=0

Segment 6, Material: ISFSIGeneralSlope
Start Point: X mean=50 std dev=0 Y mean=665 std dev=0
End Point: X mean=60 std dev=0 Y mean=662 std dev=0

Segment 7, Material: ISFSIGeneralSlope
Start Point: X mean=60 std dev=0 Y mean=662 std dev=0
End Point: X mean=70 std dev=0 Y mean=659 std dev=0

Segment 8, Material: ISFSIGeneralSlope
Start Point: X mean=70 std dev=0 Y mean=659 std dev=0
End Point: X mean=80 std dev=0 Y mean=655 std dev=0

Segment 9, Material: ISFSIGeneralSlope
Start Point: X mean=80 std dev=0 Y mean=655 std dev=0
End Point: X mean=90 std dev=0 Y mean=652 std dev=0

Segment 10, Material: ISFSIGeneralSlope

Start Point: X mean=90 std dev=0 Y mean=652 std dev=0
End Point: X mean=100 std dev=0 Y mean=650 std dev=0

Segment 11, Material: ISFSIGeneralSlope
Start Point: X mean=100 std dev=0 Y mean=650 std dev=0
End Point: X mean=110 std dev=0 Y mean=646 std dev=0

Segment 12, Material: ISFSIGeneralSlope
Start Point: X mean=110 std dev=0 Y mean=646 std dev=0
End Point: X mean=120 std dev=0 Y mean=644 std dev=0

Segment 13, Material: ISFSIGeneralSlope
Start Point: X mean=120 std dev=0 Y mean=644 std dev=0
End Point: X mean=130 std dev=0 Y mean=641 std dev=0

Segment 14, Material: ISFSIGeneralSlope
Start Point: X mean=130 std dev=0 Y mean=641 std dev=0
End Point: X mean=140 std dev=0 Y mean=638 std dev=0

Segment 15, Material: ISFSIGeneralSlope
Start Point: X mean=140 std dev=0 Y mean=638 std dev=0
End Point: X mean=150 std dev=0 Y mean=636 std dev=0

Segment 16, Material: ISFSIGeneralSlope
Start Point: X mean=150 std dev=0 Y mean=636 std dev=0
End Point: X mean=160 std dev=0 Y mean=633 std dev=0

Segment 17, Material: ISFSIGeneralSlope
Start Point: X mean=160 std dev=0 Y mean=633 std dev=0
End Point: X mean=170 std dev=0 Y mean=630 std dev=0

Segment 18, Material: ISFSIGeneralSlope
Start Point: X mean=170 std dev=0 Y mean=630 std dev=0
End Point: X mean=180 std dev=0 Y mean=626 std dev=0

Segment 19, Material: ISFSIGeneralSlope
Start Point: X mean=180 std dev=0 Y mean=626 std dev=0
End Point: X mean=190 std dev=0 Y mean=621 std dev=0

Segment 20, Material: ISFSIGeneralSlope
Start Point: X mean=190 std dev=0 Y mean=621 std dev=0
End Point: X mean=200 std dev=0 Y mean=616 std dev=0

Segment 21, Material: ISFSIGeneralSlope
Start Point: X mean=200 std dev=0 Y mean=616 std dev=0
End Point: X mean=210 std dev=0 Y mean=614 std dev=0

Segment 22, Material: ISFSIGeneralSlope
Start Point: X mean=210 std dev=0 Y mean=614 std dev=0
End Point: X mean=220 std dev=0 Y mean=610 std dev=0

Segment 23, Material: ISFSIGeneralSlope
Start Point: X mean=220 std dev=0 Y mean=610 std dev=0
End Point: X mean=230 std dev=0 Y mean=606 std dev=0

Segment 24, Material: ISFSIGeneralSlope

Start Point: X mean=230 std dev=0 Y mean=606 std dev=0
End Point: X mean=240 std dev=0 Y mean=603 std dev=0

Segment 25, Material: ISFSIGeneralSlope
Start Point: X mean=240 std dev=0 Y mean=603 std dev=0
End Point: X mean=250 std dev=0 Y mean=599 std dev=0

Segment 26, Material: ISFSIGeneralSlope
Start Point: X mean=250 std dev=0 Y mean=599 std dev=0
End Point: X mean=260 std dev=0 Y mean=595 std dev=0

Segment 27, Material: ISFSIGeneralSlope
Start Point: X mean=260 std dev=0 Y mean=595 std dev=0
End Point: X mean=270 std dev=0 Y mean=591 std dev=0

Segment 28, Material: ISFSIGeneralSlope
Start Point: X mean=270 std dev=0 Y mean=591 std dev=0
End Point: X mean=280 std dev=0 Y mean=586 std dev=0

Segment 29, Material: ISFSIGeneralSlope
Start Point: X mean=280 std dev=0 Y mean=586 std dev=0
End Point: X mean=290 std dev=0 Y mean=583 std dev=0

Segment 30, Material: ISFSIGeneralSlope
Start Point: X mean=290 std dev=0 Y mean=583 std dev=0
End Point: X mean=300 std dev=0 Y mean=579 std dev=0

Segment 31, Material: ISFSIGeneralSlope
Start Point: X mean=300 std dev=0 Y mean=579 std dev=0
End Point: X mean=310 std dev=0 Y mean=574 std dev=0

Segment 32, Material: ISFSIGeneralSlope
Start Point: X mean=310 std dev=0 Y mean=574 std dev=0
End Point: X mean=320 std dev=0 Y mean=570 std dev=0

Segment 33, Material: ISFSIGeneralSlope
Start Point: X mean=320 std dev=0 Y mean=570 std dev=0
End Point: X mean=330 std dev=0 Y mean=567 std dev=0

Segment 34, Material: ISFSIGeneralSlope
Start Point: X mean=330 std dev=0 Y mean=567 std dev=0
End Point: X mean=340 std dev=0 Y mean=565 std dev=0

Segment 35, Material: ISFSIGeneralSlope
Start Point: X mean=340 std dev=0 Y mean=565 std dev=0
End Point: X mean=350 std dev=0 Y mean=561 std dev=0

Segment 36, Material: ISFSIGeneralSlope
Start Point: X mean=350 std dev=0 Y mean=561 std dev=0
End Point: X mean=360 std dev=0 Y mean=556 std dev=0

Segment 37, Material: ISFSIGeneralSlope
Start Point: X mean=360 std dev=0 Y mean=556 std dev=0
End Point: X mean=370 std dev=0 Y mean=552 std dev=0

Segment 38, Material: ISFSIGeneralSlope

Start Point: X mean=370 std dev=0 Y mean=552 std dev=0
End Point: X mean=380 std dev=0 Y mean=548 std dev=0

Segment 39, Material: ISFSIGeneralSlope
Start Point: X mean=380 std dev=0 Y mean=548 std dev=0
End Point: X mean=390 std dev=0 Y mean=545 std dev=0

Segment 40, Material: ISFSIGeneralSlope
Start Point: X mean=390 std dev=0 Y mean=545 std dev=0
End Point: X mean=400 std dev=0 Y mean=540 std dev=0

Segment 41, Material: ISFSIGeneralSlope
Start Point: X mean=400 std dev=0 Y mean=540 std dev=0
End Point: X mean=410 std dev=0 Y mean=538 std dev=0

Segment 42, Material: ISFSIGeneralSlope
Start Point: X mean=410 std dev=0 Y mean=538 std dev=0
End Point: X mean=420 std dev=0 Y mean=535 std dev=0

Segment 43, Material: ISFSIGeneralSlope
Start Point: X mean=420 std dev=0 Y mean=535 std dev=0
End Point: X mean=430 std dev=0 Y mean=531 std dev=0

Segment 44, Material: ISFSIGeneralSlope
Start Point: X mean=430 std dev=0 Y mean=531 std dev=0
End Point: X mean=440 std dev=0 Y mean=528 std dev=0

Segment 45, Material: ISFSIGeneralSlope
Start Point: X mean=440 std dev=0 Y mean=528 std dev=0
End Point: X mean=450 std dev=0 Y mean=523 std dev=0

Segment 46, Material: ISFSIGeneralSlope
Start Point: X mean=450 std dev=0 Y mean=523 std dev=0
End Point: X mean=460 std dev=0 Y mean=520 std dev=0

Segment 47, Material: ISFSIGeneralSlope
Start Point: X mean=460 std dev=0 Y mean=520 std dev=0
End Point: X mean=470 std dev=0 Y mean=516 std dev=0

Segment 48, Material: ISFSIGeneralSlope
Start Point: X mean=470 std dev=0 Y mean=516 std dev=0
End Point: X mean=480 std dev=0 Y mean=513 std dev=0

Segment 49, Material: ISFSIGeneralSlope
Start Point: X mean=480 std dev=0 Y mean=513 std dev=0
End Point: X mean=490 std dev=0 Y mean=509 std dev=0

Segment 50, Material: ISFSIGeneralSlope
Start Point: X mean=490 std dev=0 Y mean=509 std dev=0
End Point: X mean=500 std dev=0 Y mean=506 std dev=0

Segment 51, Material: ISFSIGeneralSlope
Start Point: X mean=500 std dev=0 Y mean=506 std dev=0
End Point: X mean=510 std dev=0 Y mean=504 std dev=0

Segment 52, Material: ISFSIGeneralSlope

Start Point: X mean=510 std dev=0 Y mean=504 std dev=0
End Point: X mean=520 std dev=0 Y mean=501 std dev=0

Segment 53, Material: ISFSIGeneralSlope
Start Point: X mean=520 std dev=0 Y mean=501 std dev=0
End Point: X mean=530 std dev=0 Y mean=497 std dev=0

Segment 54, Material: ISFSIGeneralSlope
Start Point: X mean=530 std dev=0 Y mean=497 std dev=0
End Point: X mean=540 std dev=0 Y mean=494 std dev=0

Segment 55, Material: ISFSIGeneralSlope
Start Point: X mean=540 std dev=0 Y mean=494 std dev=0
End Point: X mean=550 std dev=0 Y mean=490 std dev=0

Segment 56, Material: ISFSIGeneralSlope
Start Point: X mean=550 std dev=0 Y mean=490 std dev=0
End Point: X mean=560 std dev=0 Y mean=487 std dev=0

Segment 57, Material: ISFSIGeneralSlope
Start Point: X mean=560 std dev=0 Y mean=487 std dev=0
End Point: X mean=570 std dev=0 Y mean=483 std dev=0

Segment 58, Material: ISFSIGeneralSlope
Start Point: X mean=570 std dev=0 Y mean=483 std dev=0
End Point: X mean=580 std dev=0 Y mean=479 std dev=0

Segment 59, Material: ISFSIGeneralSlope
Start Point: X mean=580 std dev=0 Y mean=479 std dev=0
End Point: X mean=590 std dev=0 Y mean=476 std dev=0

Segment 60, Material: ISFSIGeneralSlope
Start Point: X mean=590 std dev=0 Y mean=476 std dev=0
End Point: X mean=600 std dev=0 Y mean=471 std dev=0

Segment 61, Material: ISFSIGeneralSlope
Start Point: X mean=600 std dev=0 Y mean=471 std dev=0
End Point: X mean=610 std dev=0 Y mean=466 std dev=0

Segment 62, Material: ISFSIGeneralSlope
Start Point: X mean=610 std dev=0 Y mean=466 std dev=0
End Point: X mean=620 std dev=0 Y mean=463 std dev=0

Segment 63, Material: ISFSIGeneralSlope
Start Point: X mean=620 std dev=0 Y mean=463 std dev=0
End Point: X mean=630 std dev=0 Y mean=459 std dev=0

Segment 64, Material: ISFSIGeneralSlope
Start Point: X mean=630 std dev=0 Y mean=459 std dev=0
End Point: X mean=640 std dev=0 Y mean=455 std dev=0

Segment 65, Material: ISFSIGeneralSlope
Start Point: X mean=640 std dev=0 Y mean=455 std dev=0
End Point: X mean=650 std dev=0 Y mean=452 std dev=0

Segment 66, Material: ISFSITowerRoad

Start Point: X mean=650 std dev=0 Y mean=452 std dev=0
End Point: X mean=652 std dev=0 Y mean=450 std dev=0

Segment 67, Material: ISFSITowerRoad
Start Point: X mean=652 std dev=0 Y mean=450 std dev=0
End Point: X mean=662 std dev=0 Y mean=450 std dev=0

Segment 68, Material: ISFSITowerRoad
Start Point: X mean=662 std dev=0 Y mean=450 std dev=0
End Point: X mean=670 std dev=0 Y mean=448 std dev=0

Segment 69, Material: ISFSIGeneralSlope
Start Point: X mean=670 std dev=0 Y mean=448 std dev=0
End Point: X mean=680 std dev=0 Y mean=444 std dev=0

Segment 70, Material: ISFSIGeneralSlope
Start Point: X mean=680 std dev=0 Y mean=444 std dev=0
End Point: X mean=690 std dev=0 Y mean=439 std dev=0

Segment 71, Material: ISFSIGeneralSlope
Start Point: X mean=690 std dev=0 Y mean=439 std dev=0
End Point: X mean=700 std dev=0 Y mean=435 std dev=0

Segment 72, Material: ISFSIGeneralSlope
Start Point: X mean=700 std dev=0 Y mean=435 std dev=0
End Point: X mean=710 std dev=0 Y mean=432 std dev=0

Segment 73, Material: ISFSIGeneralSlope
Start Point: X mean=710 std dev=0 Y mean=432 std dev=0
End Point: X mean=720 std dev=0 Y mean=429 std dev=0

Segment 74, Material: ISFSIGeneralSlope
Start Point: X mean=720 std dev=0 Y mean=429 std dev=0
End Point: X mean=730 std dev=0 Y mean=424 std dev=0

Segment 75, Material: ISFSIGeneralSlope
Start Point: X mean=730 std dev=0 Y mean=424 std dev=0
End Point: X mean=740 std dev=0 Y mean=420 std dev=0

Segment 76, Material: ISFSIGeneralSlope
Start Point: X mean=740 std dev=0 Y mean=420 std dev=0
End Point: X mean=750 std dev=0 Y mean=417 std dev=0

Segment 77, Material: ISFSIGeneralSlope
Start Point: X mean=750 std dev=0 Y mean=417 std dev=0
End Point: X mean=760 std dev=0 Y mean=414 std dev=0

Segment 78, Material: ISFSIGeneralSlope
Start Point: X mean=760 std dev=0 Y mean=414 std dev=0
End Point: X mean=770 std dev=0 Y mean=411 std dev=0

Segment 79, Material: ISFSIGeneralSlope
Start Point: X mean=770 std dev=0 Y mean=411 std dev=0
End Point: X mean=780 std dev=0 Y mean=407 std dev=0

Segment 80, Material: ISFSIGeneralSlope

Start Point: X mean=780 std dev=0 Y mean=407 std dev=0
End Point: X mean=790 std dev=0 Y mean=404 std dev=0

Segment 81, Material: ISFSIGeneralSlope
Start Point: X mean=790 std dev=0 Y mean=404 std dev=0
End Point: X mean=800 std dev=0 Y mean=400 std dev=0

Segment 82, Material: ISFSIGeneralSlope
Start Point: X mean=800 std dev=0 Y mean=400 std dev=0
End Point: X mean=810 std dev=0 Y mean=397 std dev=0

Segment 83, Material: ISFSIGeneralSlope
Start Point: X mean=810 std dev=0 Y mean=397 std dev=0
End Point: X mean=817 std dev=0 Y mean=394 std dev=0

Segment 84, Material: ISFSITowerRoad
Start Point: X mean=817 std dev=0 Y mean=394 std dev=0
End Point: X mean=827 std dev=0 Y mean=394 std dev=0

Segment 85, Material: ISFSITowerRoad
Start Point: X mean=827 std dev=0 Y mean=394 std dev=0
End Point: X mean=830 std dev=0 Y mean=389 std dev=0

Segment 86, Material: ISFSIGeneralSlope
Start Point: X mean=830 std dev=0 Y mean=389 std dev=0
End Point: X mean=840 std dev=0 Y mean=385 std dev=0

Segment 87, Material: ISFSIGeneralSlope
Start Point: X mean=840 std dev=0 Y mean=385 std dev=0
End Point: X mean=850 std dev=0 Y mean=381 std dev=0

Segment 88, Material: ISFSIGeneralSlope
Start Point: X mean=850 std dev=0 Y mean=381 std dev=0
End Point: X mean=860 std dev=0 Y mean=378 std dev=0

Segment 89, Material: ISFSIGeneralSlope
Start Point: X mean=860 std dev=0 Y mean=378 std dev=0
End Point: X mean=870 std dev=0 Y mean=376 std dev=0

Segment 90, Material: ISFSIGeneralSlope
Start Point: X mean=870 std dev=0 Y mean=376 std dev=0
End Point: X mean=880 std dev=0 Y mean=371 std dev=0

Segment 91, Material: ISFSIGeneralSlope
Start Point: X mean=880 std dev=0 Y mean=371 std dev=0
End Point: X mean=890 std dev=0 Y mean=369 std dev=0

Segment 92, Material: ISFSIGeneralSlope
Start Point: X mean=890 std dev=0 Y mean=369 std dev=0
End Point: X mean=900 std dev=0 Y mean=365 std dev=0

Segment 93, Material: ISFSIGeneralSlope
Start Point: X mean=900 std dev=0 Y mean=365 std dev=0
End Point: X mean=910 std dev=0 Y mean=361 std dev=0

Segment 94, Material: ISFSIGeneralSlope

Start Point: X mean=910 std dev=0 Y mean=361 std dev=0
End Point: X mean=920 std dev=0 Y mean=359 std dev=0

Segment 95, Material: ISFSIGeneralSlope
Start Point: X mean=920 std dev=0 Y mean=359 std dev=0
End Point: X mean=930 std dev=0 Y mean=357 std dev=0

Segment 96, Material: ISFSIGeneralSlope
Start Point: X mean=930 std dev=0 Y mean=357 std dev=0
End Point: X mean=940 std dev=0 Y mean=354 std dev=0

Segment 97, Material: ISFSIGeneralSlope
Start Point: X mean=940 std dev=0 Y mean=354 std dev=0
End Point: X mean=950 std dev=0 Y mean=351 std dev=0

Segment 98, Material: ISFSIGeneralSlope
Start Point: X mean=950 std dev=0 Y mean=351 std dev=0
End Point: X mean=960 std dev=0 Y mean=348 std dev=0

Segment 99, Material: ISFSI CutSlope
Start Point: X mean=960 std dev=0 Y mean=348 std dev=0
End Point: X mean=961 std dev=0 Y mean=347 std dev=0

Segment 100, Material: ISFSI CutSlope
Start Point: X mean=961 std dev=0 Y mean=347 std dev=0
End Point: X mean=970 std dev=0 Y mean=330 std dev=0

Segment 101, Material: ISFSI CutSlope
Start Point: X mean=970 std dev=0 Y mean=330 std dev=0
End Point: X mean=996 std dev=0 Y mean=330 std dev=0

Segment 102, Material: ISFSI CutSlope
Start Point: X mean=996 std dev=0 Y mean=330 std dev=0
End Point: X mean=1005 std dev=0 Y mean=310 std dev=0

Segment 103, Material: ISFSIPad
Start Point: X mean=1005 std dev=0 Y mean=310 std dev=0
End Point: X mean=1119 std dev=0 Y mean=310 std dev=0

Segment 104, Material: ISFSIPad
Start Point: X mean=1119 std dev=0 Y mean=310 std dev=0
End Point: X mean=1120 std dev=0 Y mean=306 std dev=0

Segment 105, Material: ISFSIPad
Start Point: X mean=1120 std dev=0 Y mean=306 std dev=0
End Point: X mean=1130 std dev=0 Y mean=305 std dev=0

Segment 106, Material: ISFSIPad
Start Point: X mean=1130 std dev=0 Y mean=305 std dev=0
End Point: X mean=1140 std dev=0 Y mean=304 std dev=0

Segment 107, Material: ISFSIPad
Start Point: X mean=1140 std dev=0 Y mean=304 std dev=0
End Point: X mean=1150 std dev=0 Y mean=304 std dev=0

Segment 108, Material: ISFSIPad

Start Point: X mean=1150 std dev=0 Y mean=304 std dev=0
End Point: X mean=1160 std dev=0 Y mean=304 std dev=0

Segment 109, Material: ISFSIPad
Start Point: X mean=1160 std dev=0 Y mean=304 std dev=0
End Point: X mean=1300 std dev=0 Y mean=304 std dev=0

Materials

Material name: ISFSICutSlope
Coefficient of Normal Restitution (RN): mean=0.45 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.74 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSITowerRoad
Coefficient of Normal Restitution (RN): mean=0.4 std dev=0.05
Coefficient of Tangential Restitution (RT): mean=0.73 std dev=0.05
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=26.0
3' block std dev=9.5
6' block std dev=4.8
10' block std dev=2.9

Material name: ISFSIGeneralSlope
Coefficient of Normal Restitution (RN): mean=0.35 std dev=0.04
Coefficient of Tangential Restitution (RT): mean=0.83 std dev=0.04
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=37.0
3' block std dev=14.0
6' block std dev=7.1
10' block std dev=4.3

Material name: ISFSIPad
Coefficient of Normal Restitution (RN): mean=0.5 std dev=0
Coefficient of Tangential Restitution (RT): mean=0.9 std dev=0
Friction Angle: mean=32 std dev=2
Roughness: 1' block std dev=0
3' block std dev=0
6' block std dev=0
10' block std dev=0

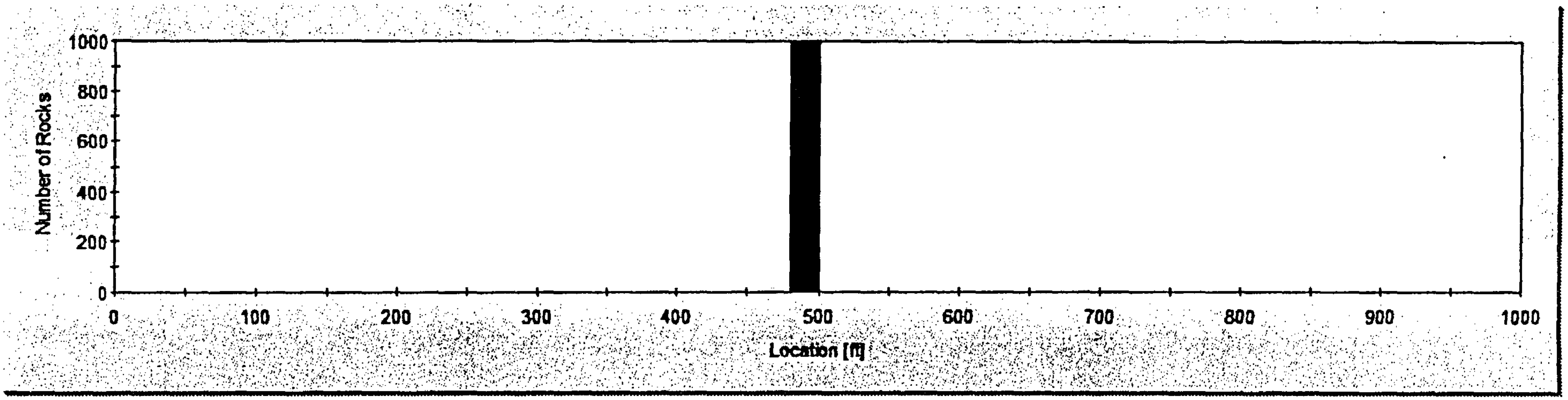
Seeders

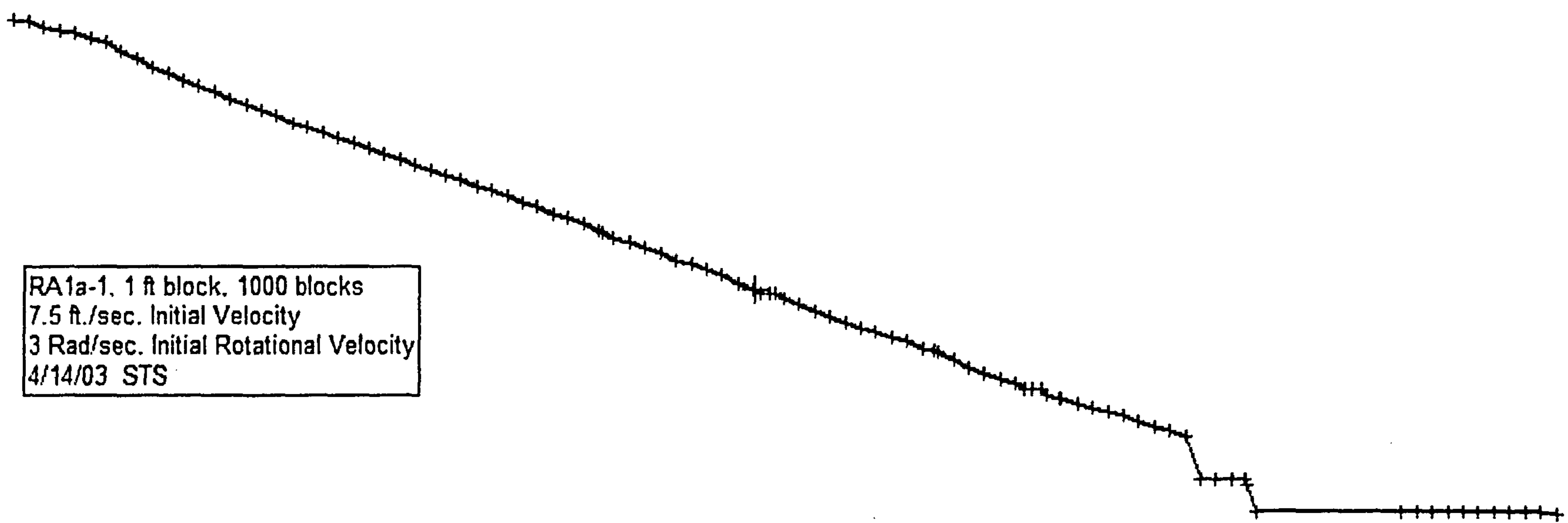
Point Seeder
Horizontal Velocity: mean=7.5, std dev=0
Vertical Velocity: mean=0, std dev=0
Mass: 1' block mean=142, std dev=0
3' block mean=3834, std dev=0
6' block mean=30672, std dev=0
10' block mean=142000, std dev=0
Angular Velocity: mean=3, std dev=0
Location: 760, 414

Data Collectors

Data Collector name: Collector001
Start Point: 956.943, 349.196
End Point: 956.943, 358.697

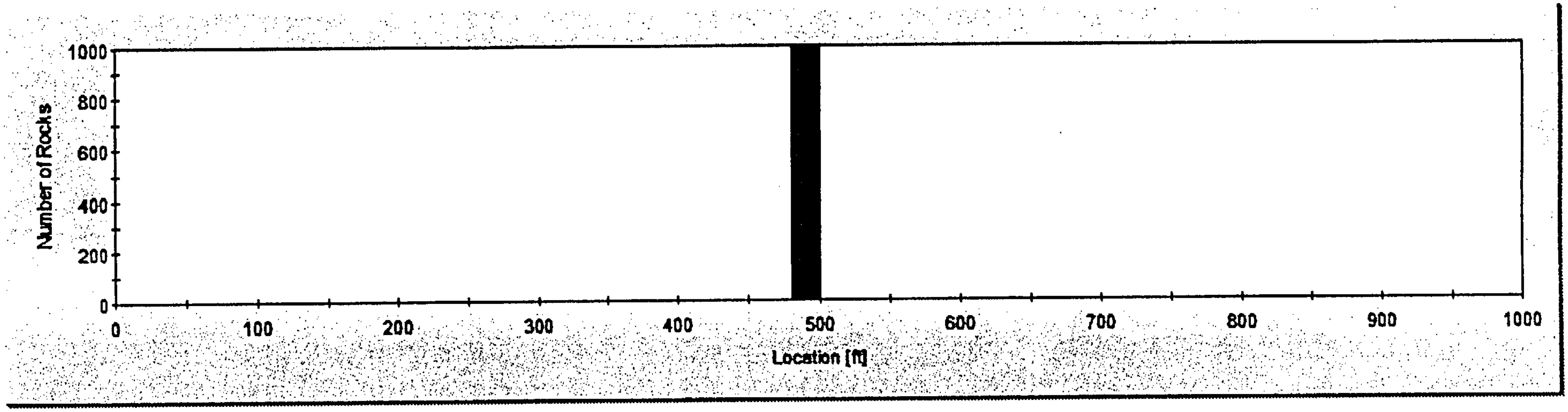
Horizontal Location of Rock End-points

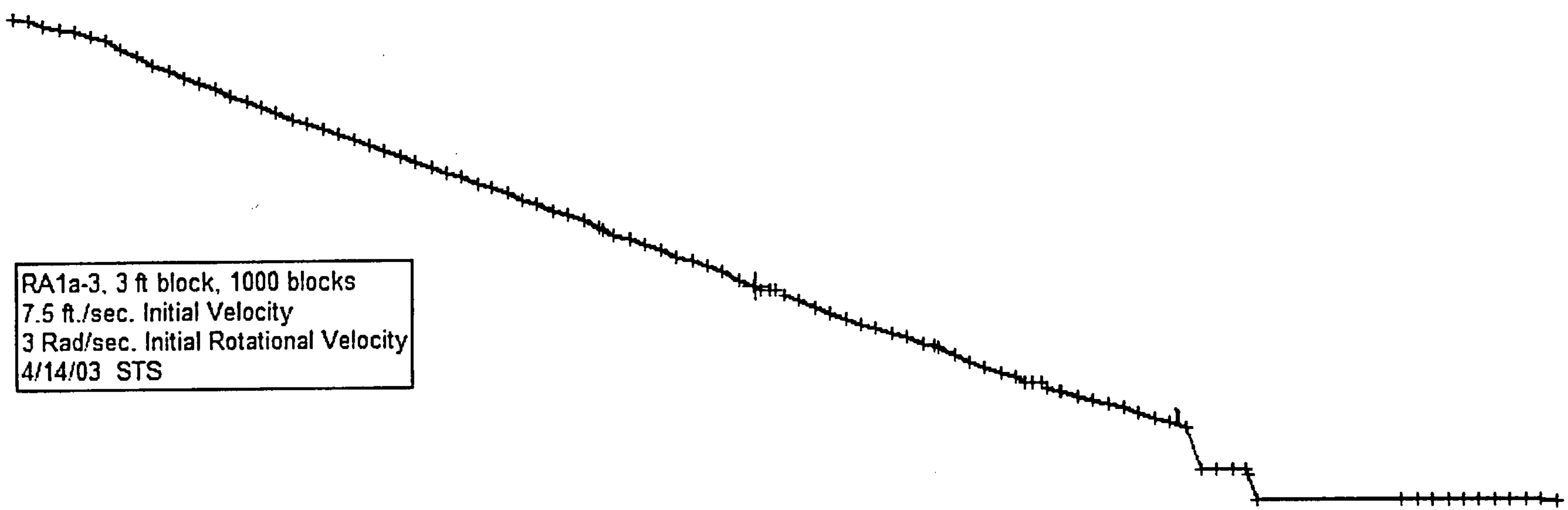




RA1a-1. 1 ft block. 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

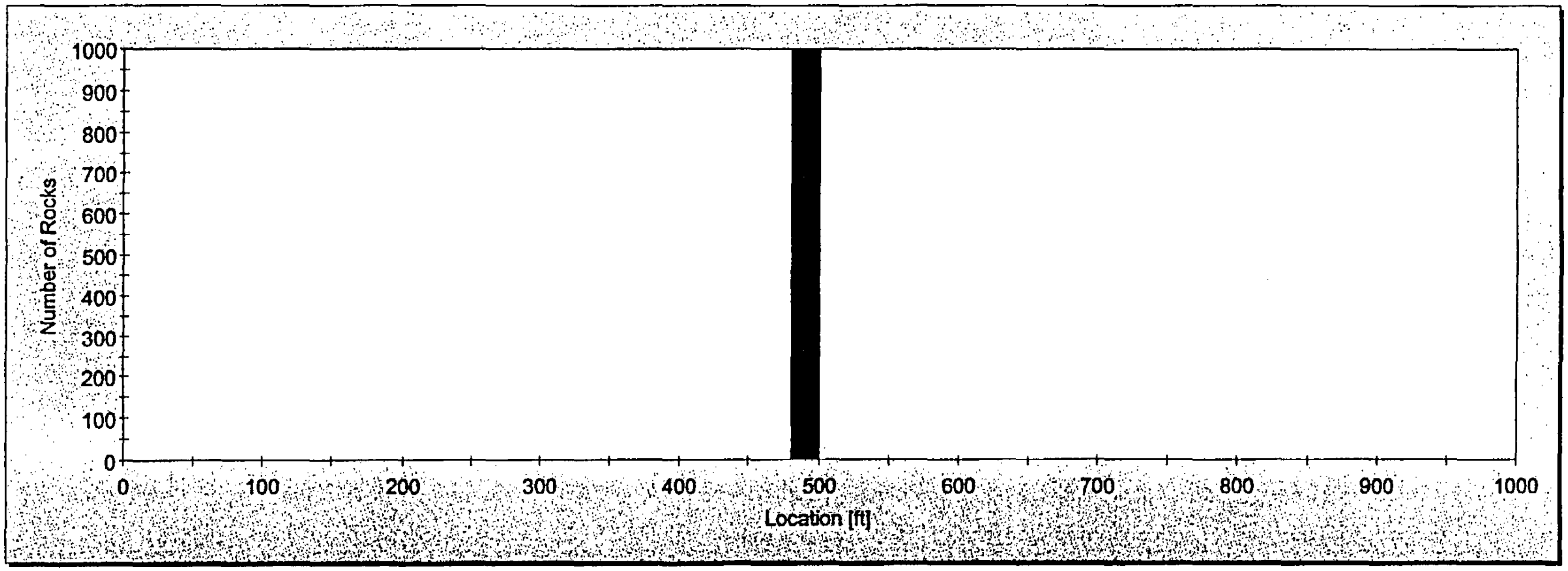
Horizontal Location of Rock End-points

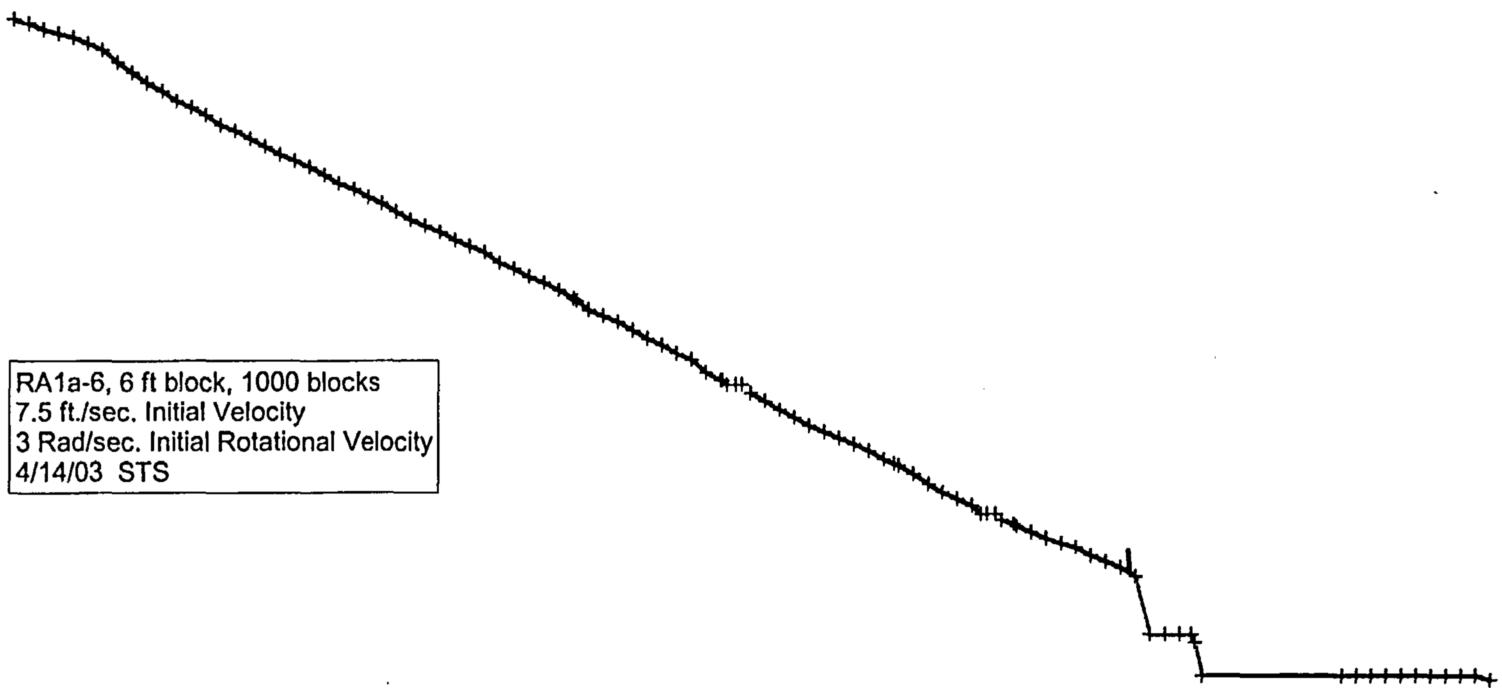




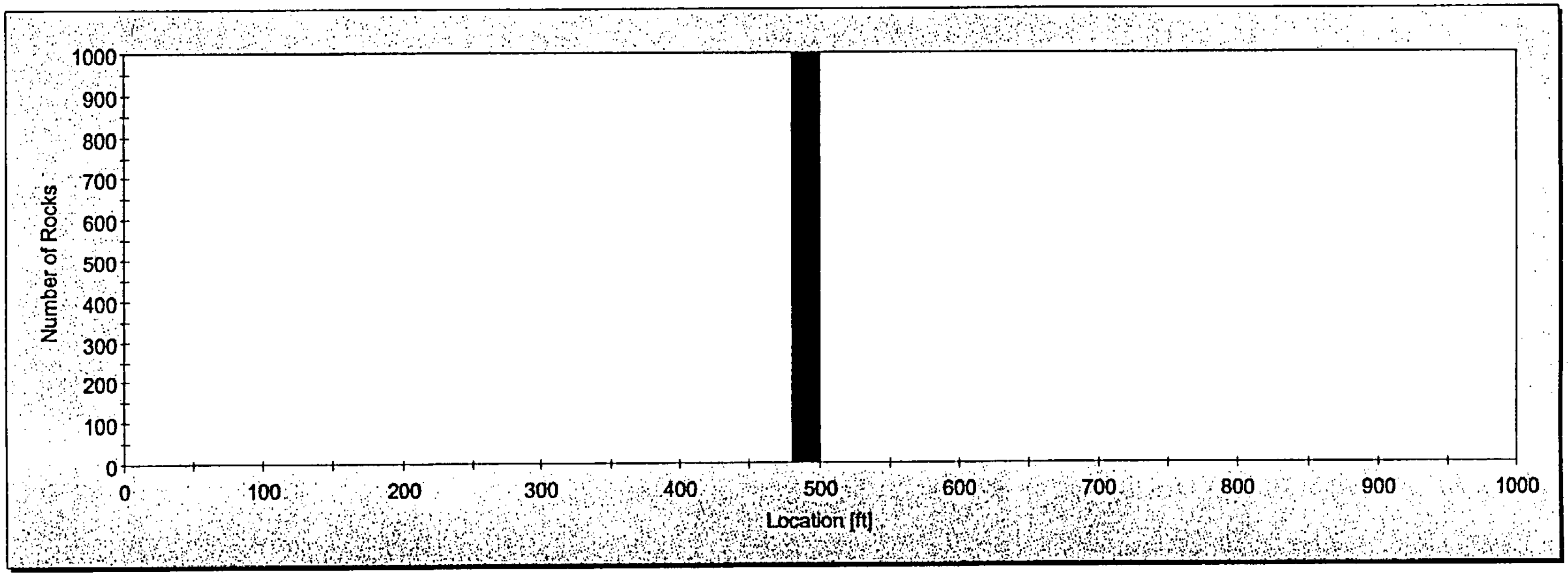
RA1a-3, 3 ft block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

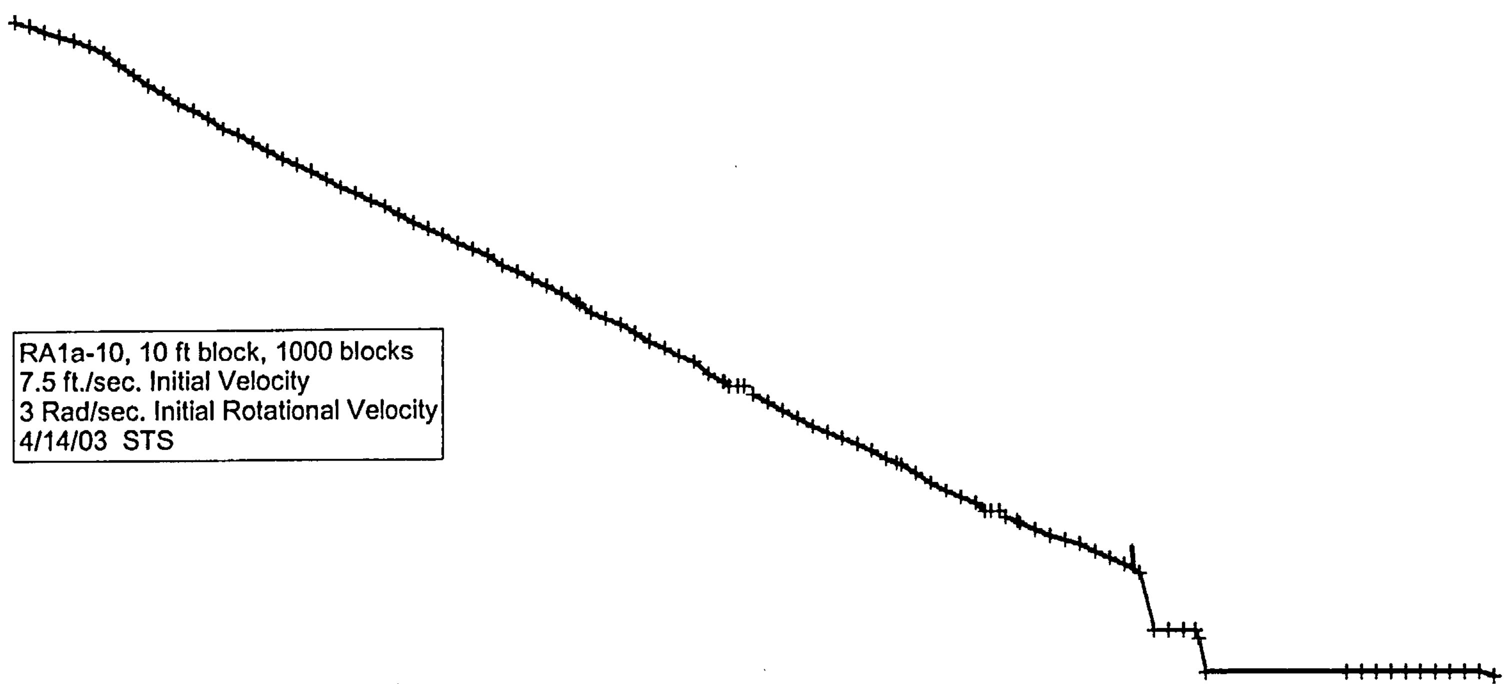
Horizontal Location of Rock End-points





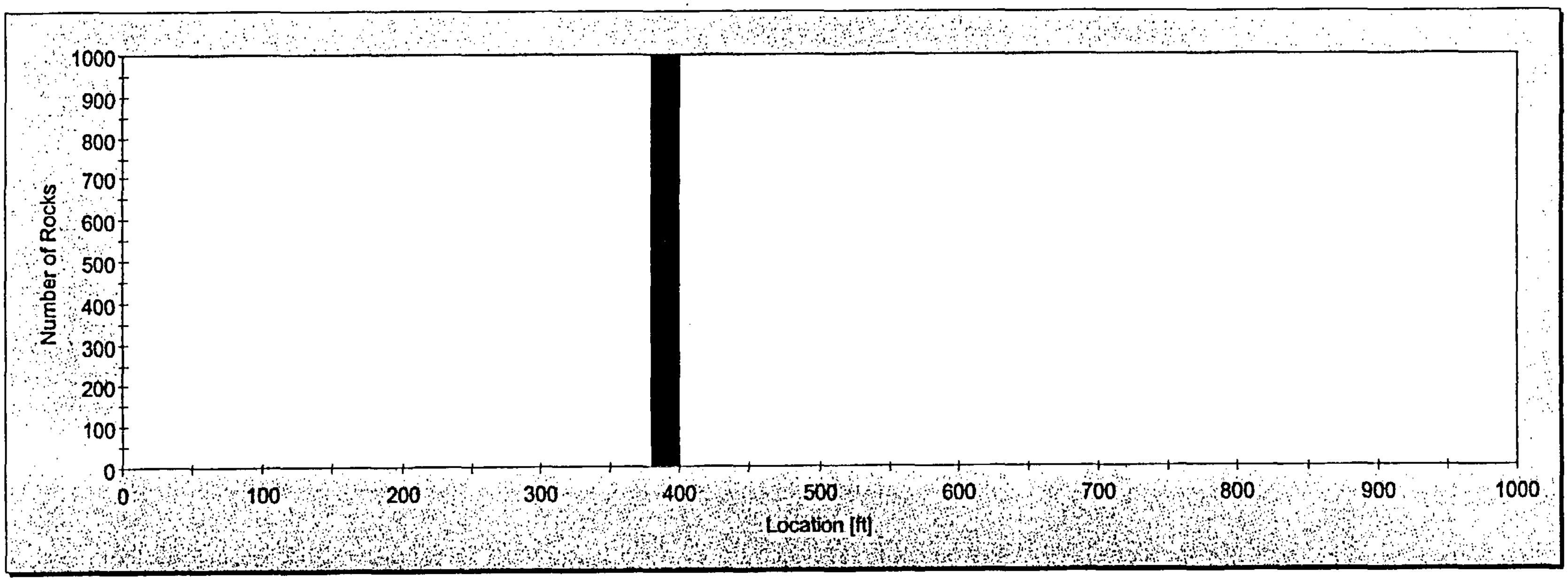
Horizontal Location of Rock End-points

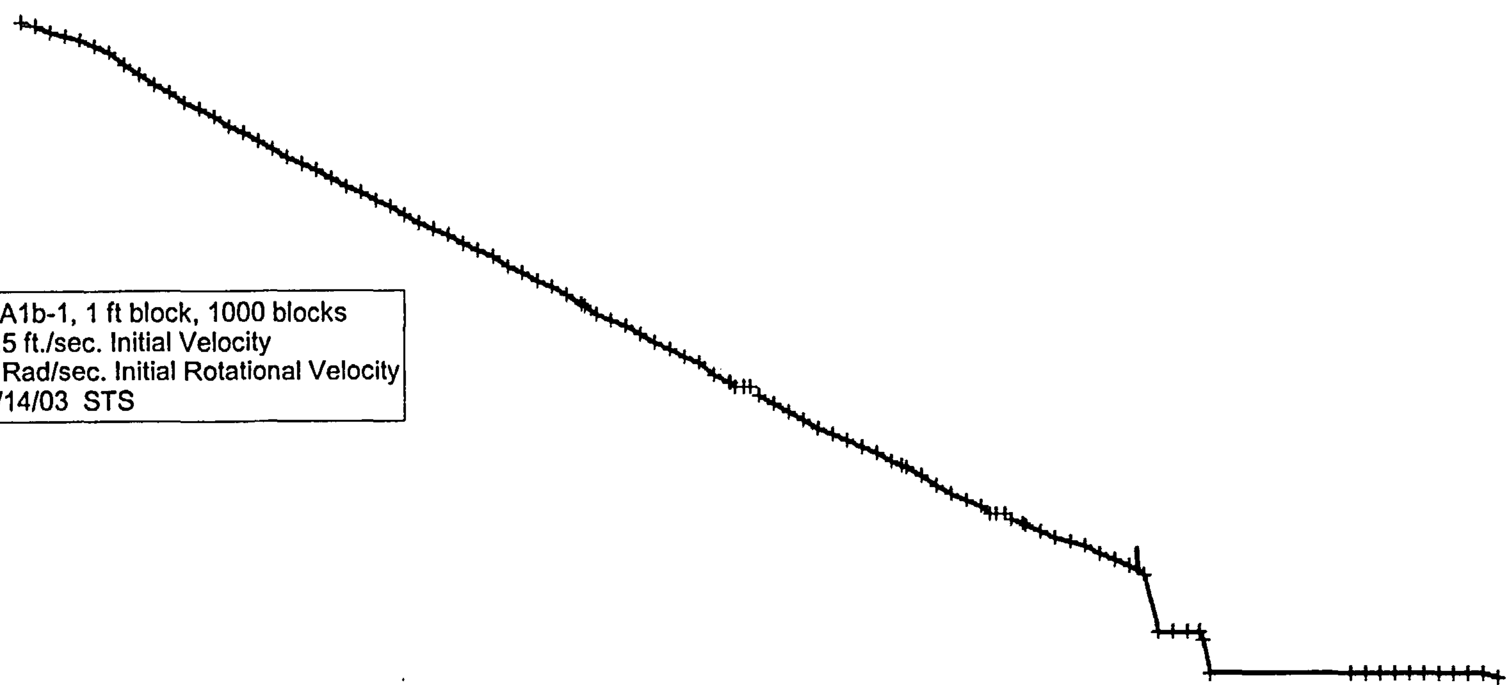




RA1a-10, 10 ft block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

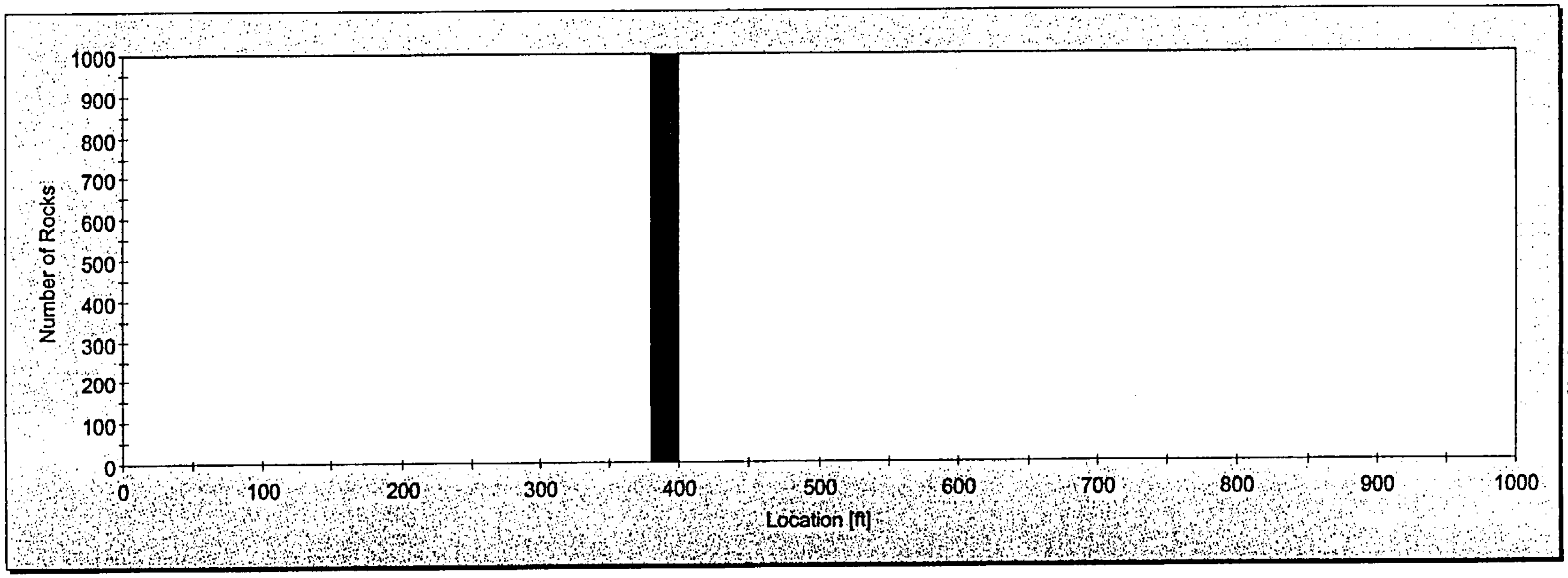
Horizontal Location of Rock End-points

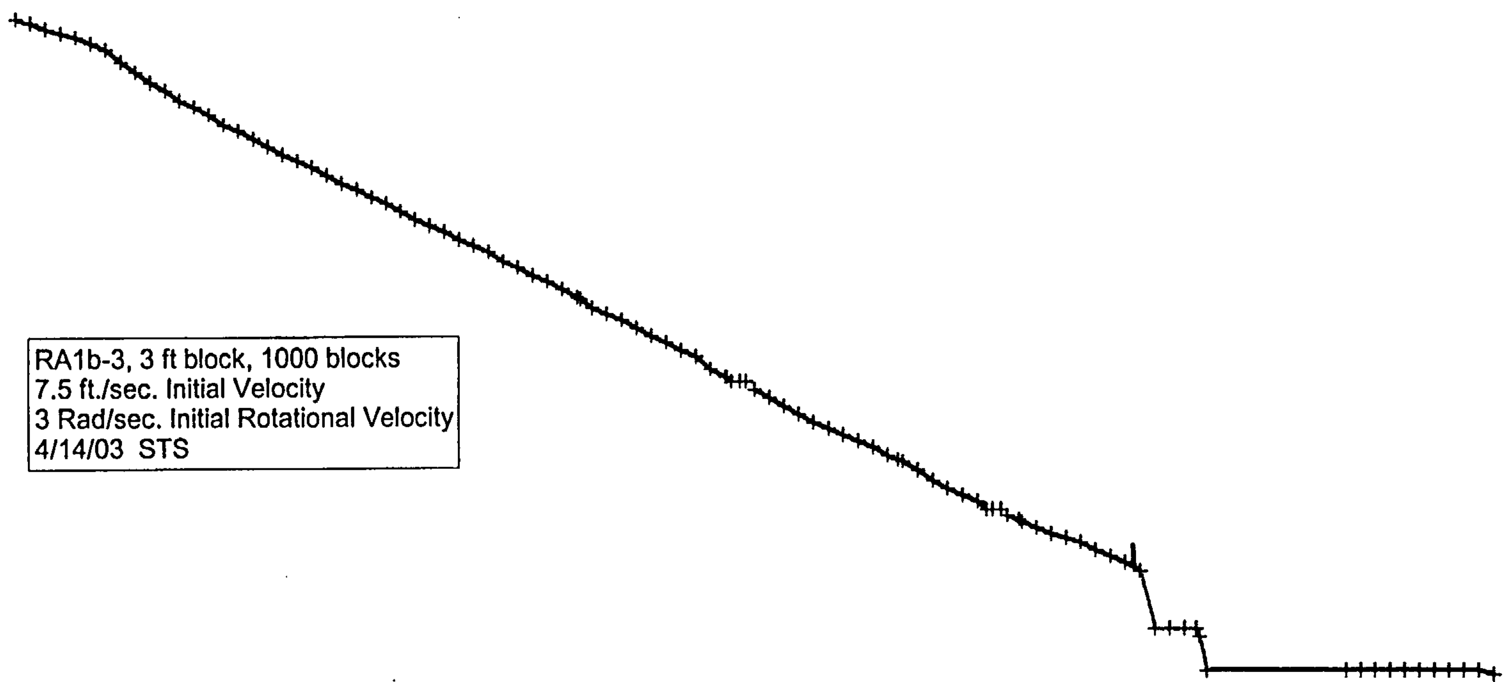




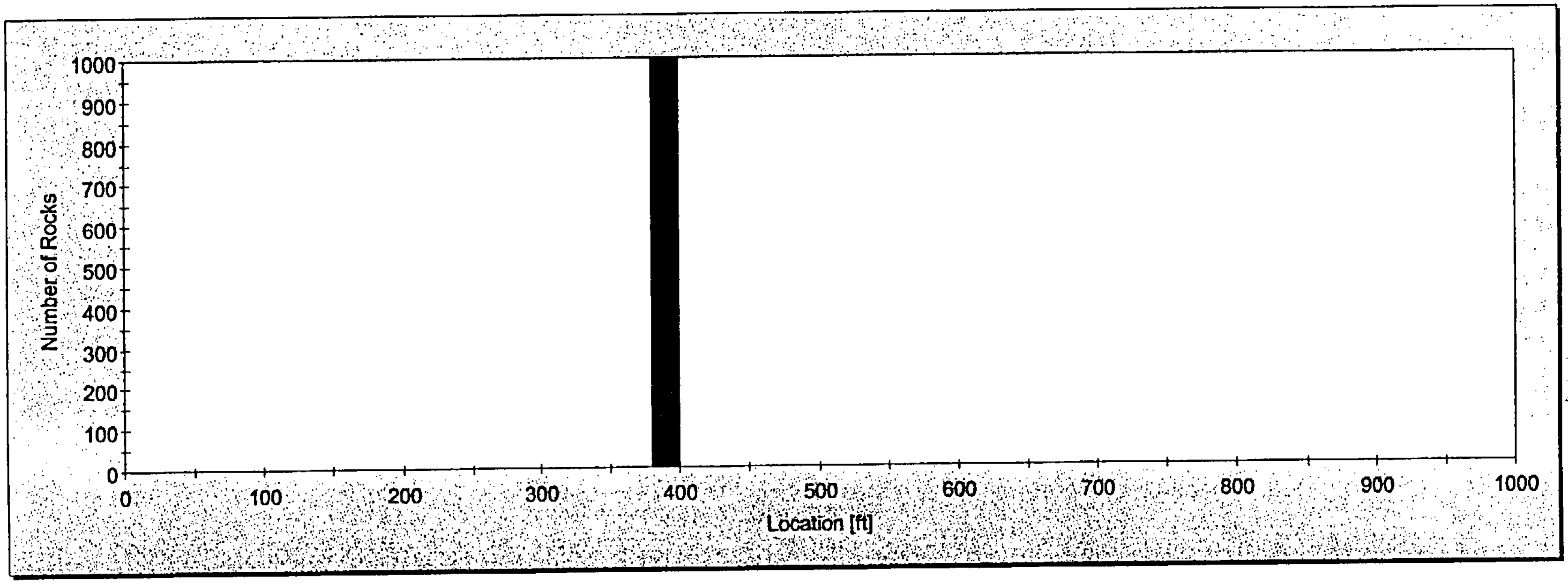
RA1b-1, 1 ft block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

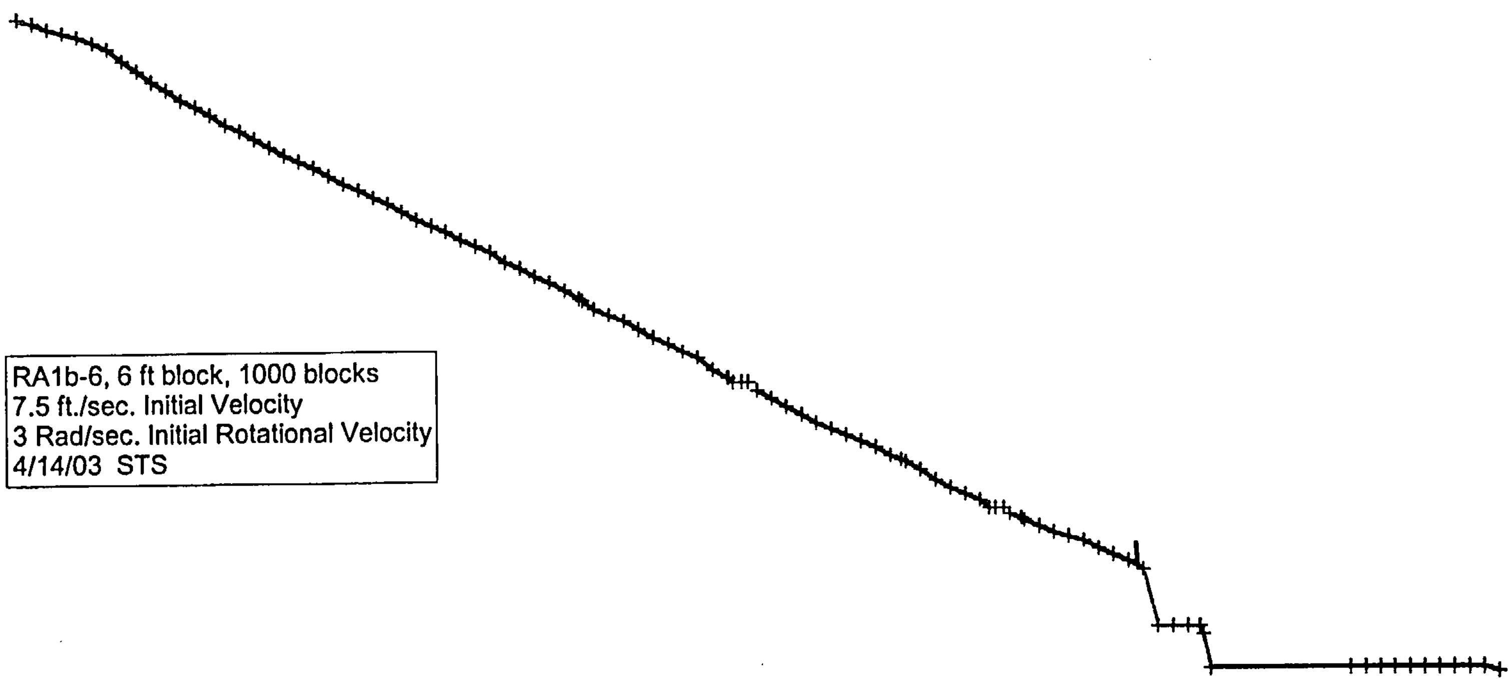
Horizontal Location of Rock End-points





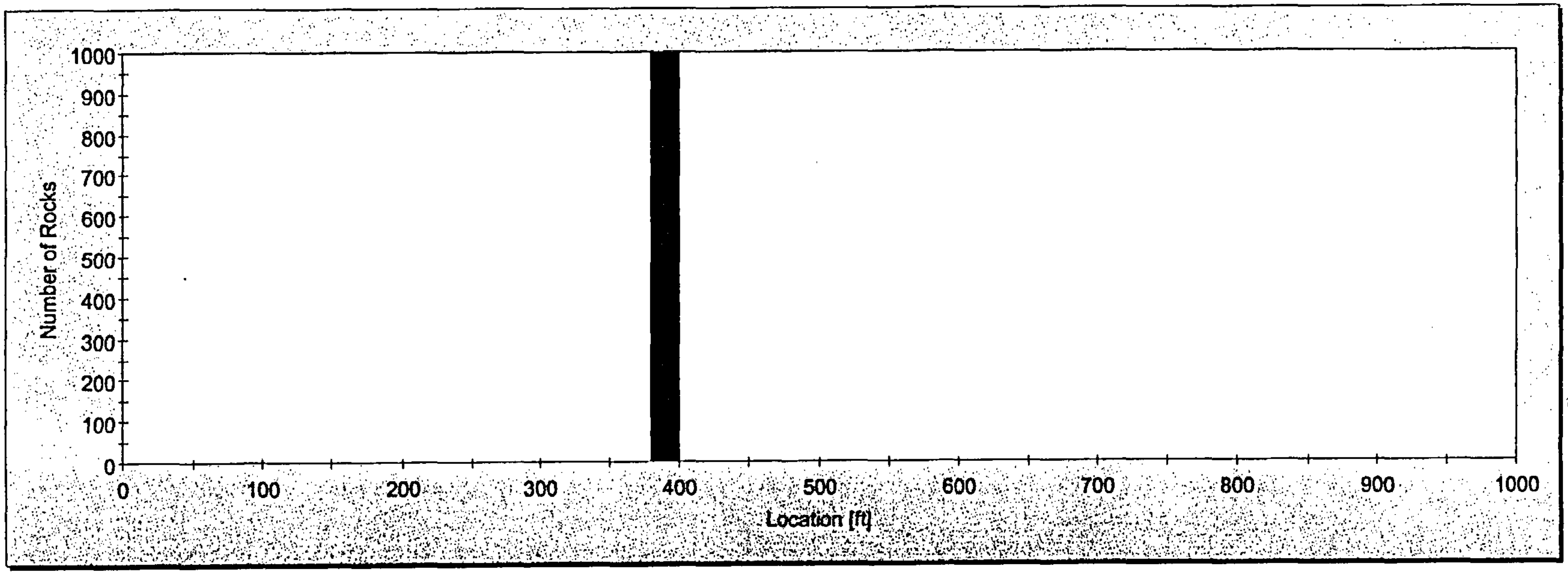
Horizontal Location of Rock End-points

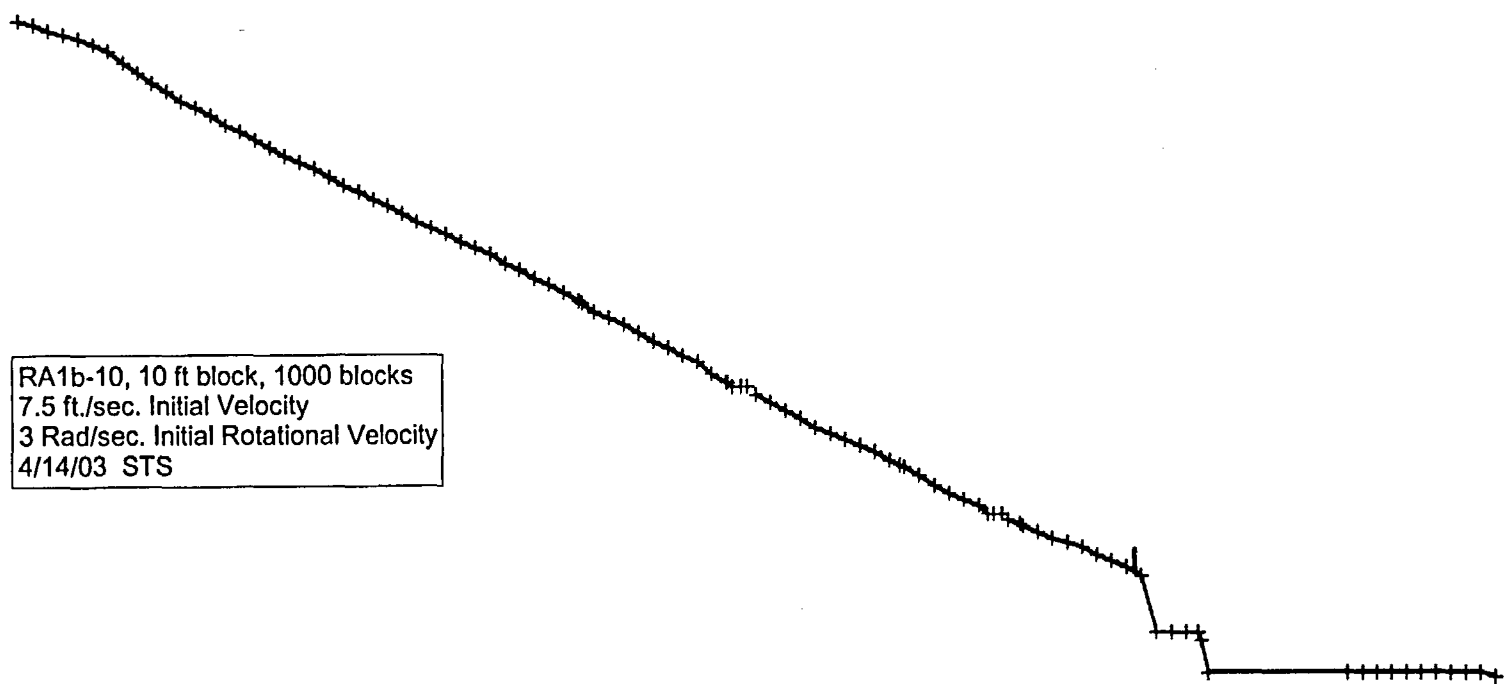




RA1b-6, 6 ft block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

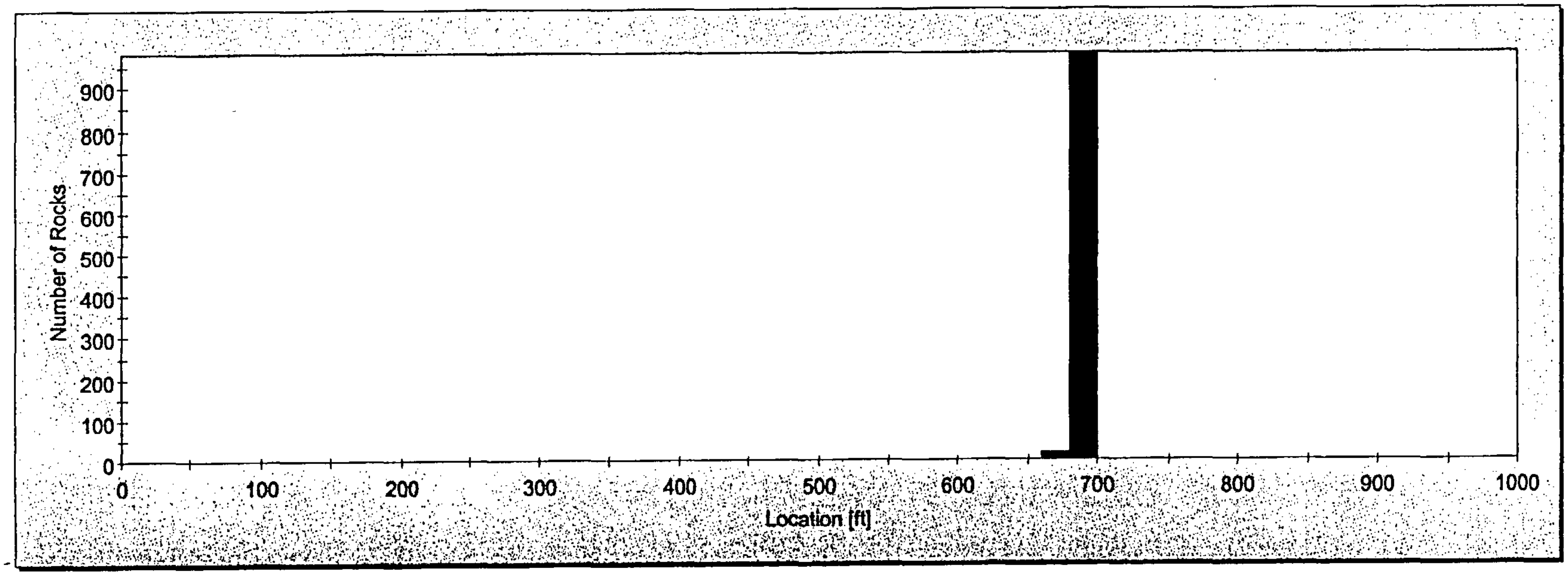
Horizontal Location of Rock End-points

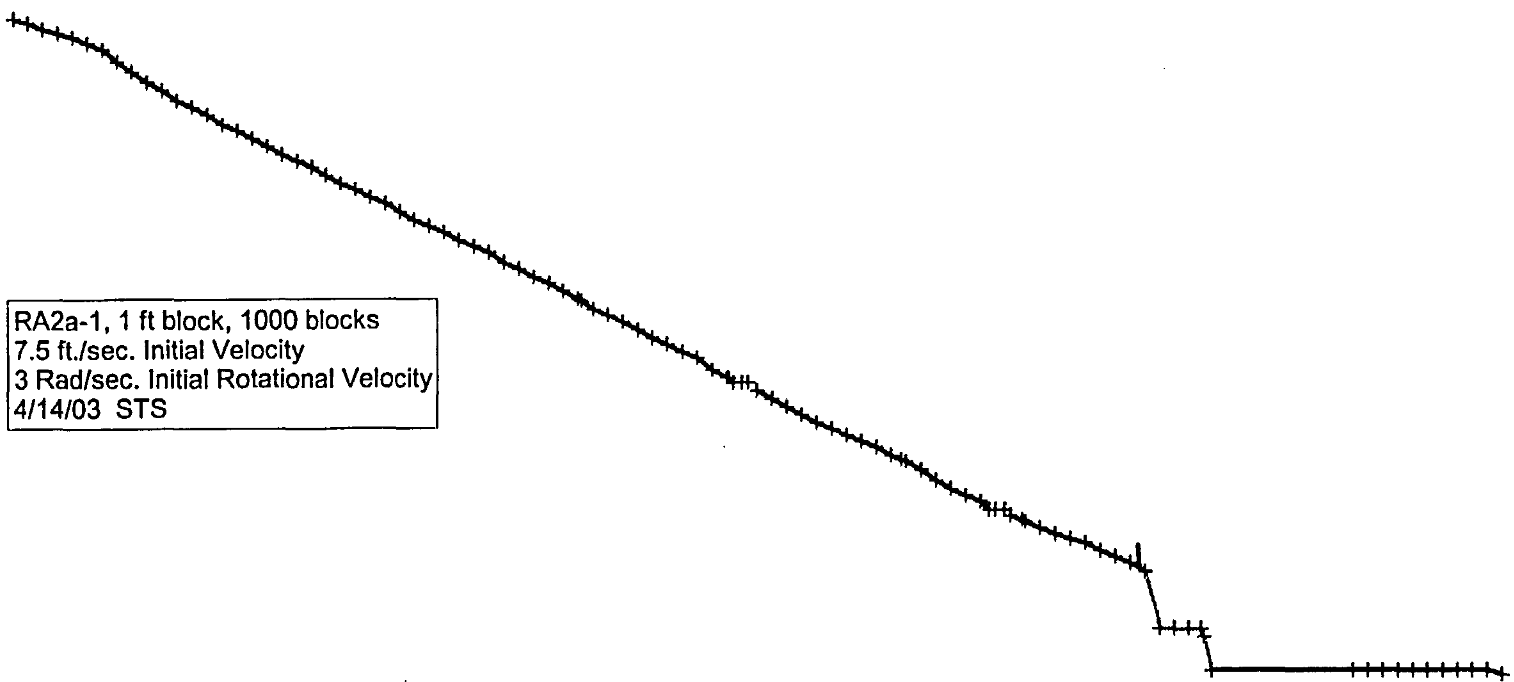




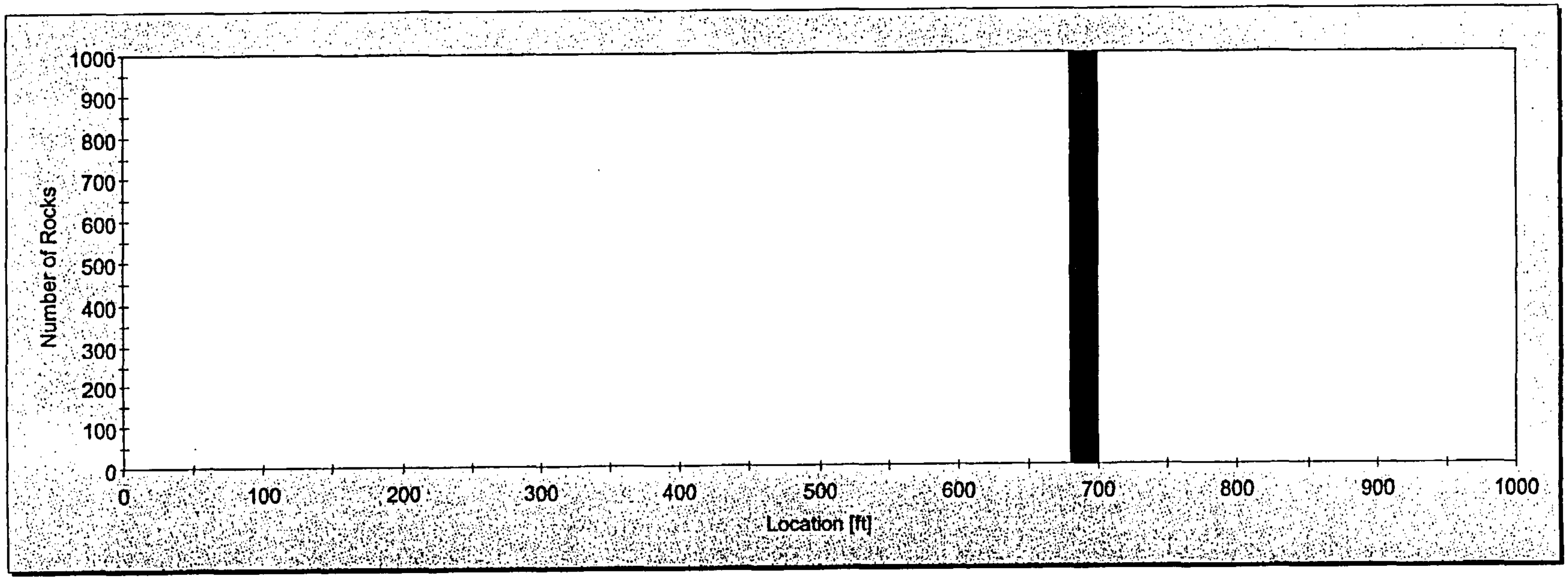
RA1b-10, 10 ft block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

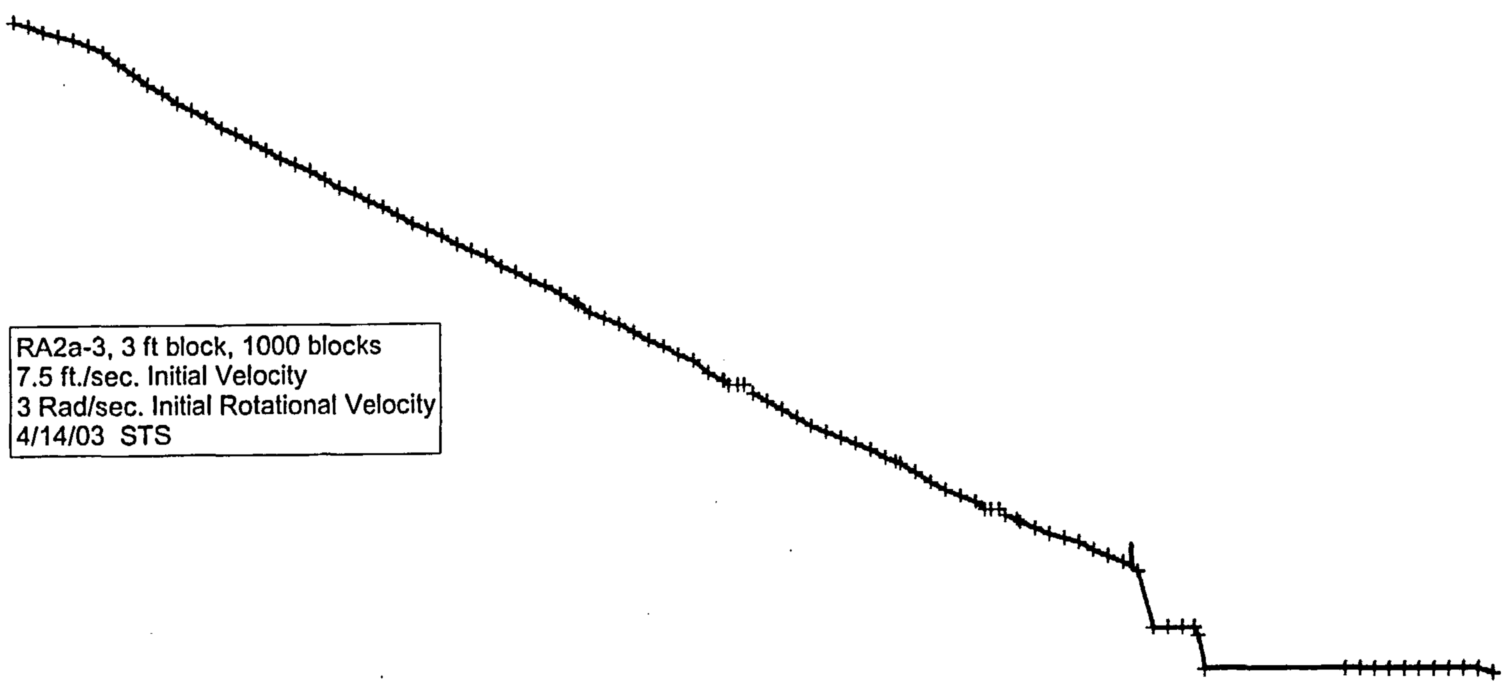
Horizontal Location of Rock End-points



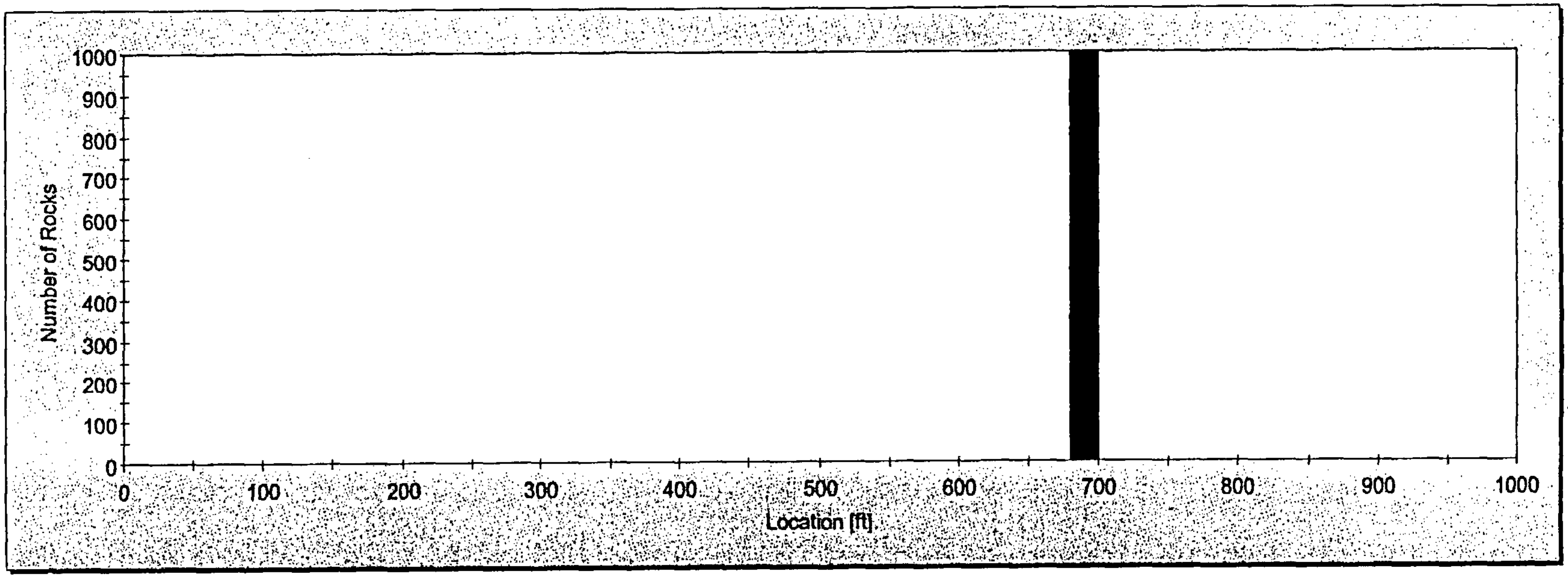


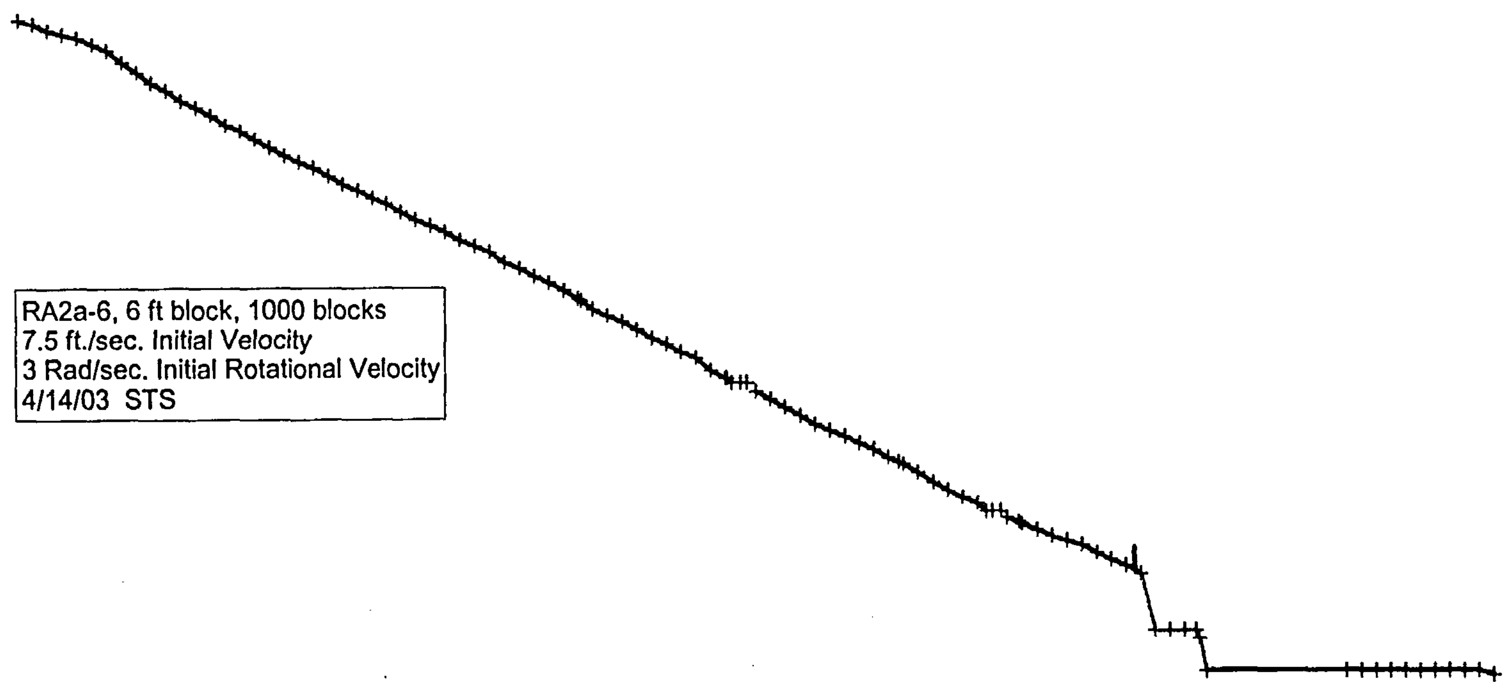
Horizontal Location of Rock End-points



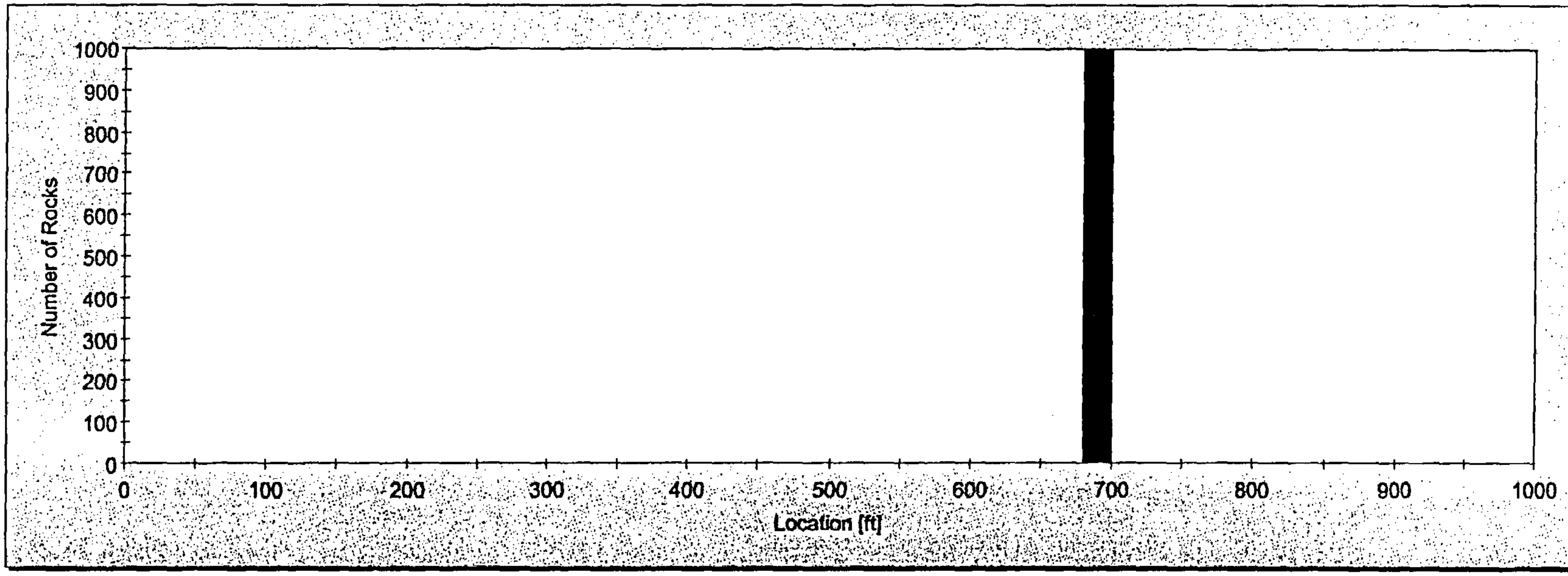


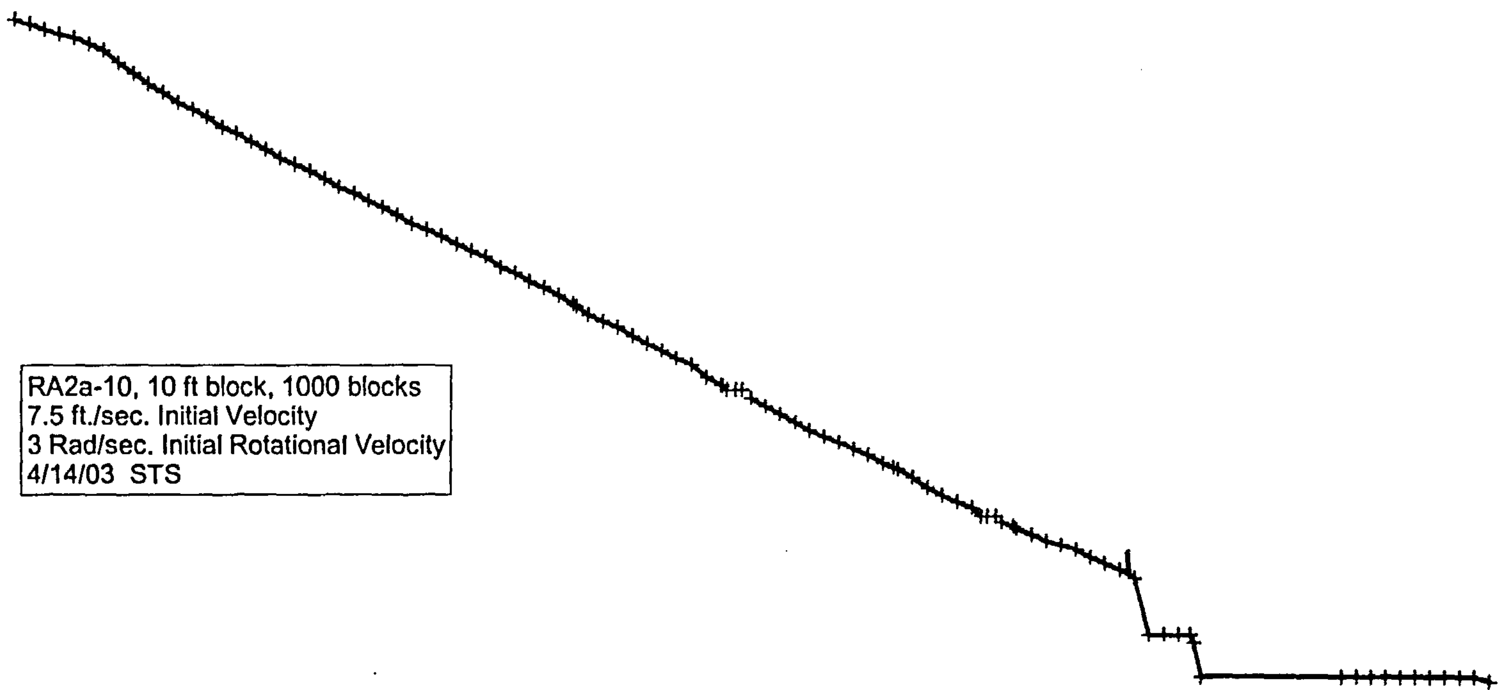
Horizontal Location of Rock End-points



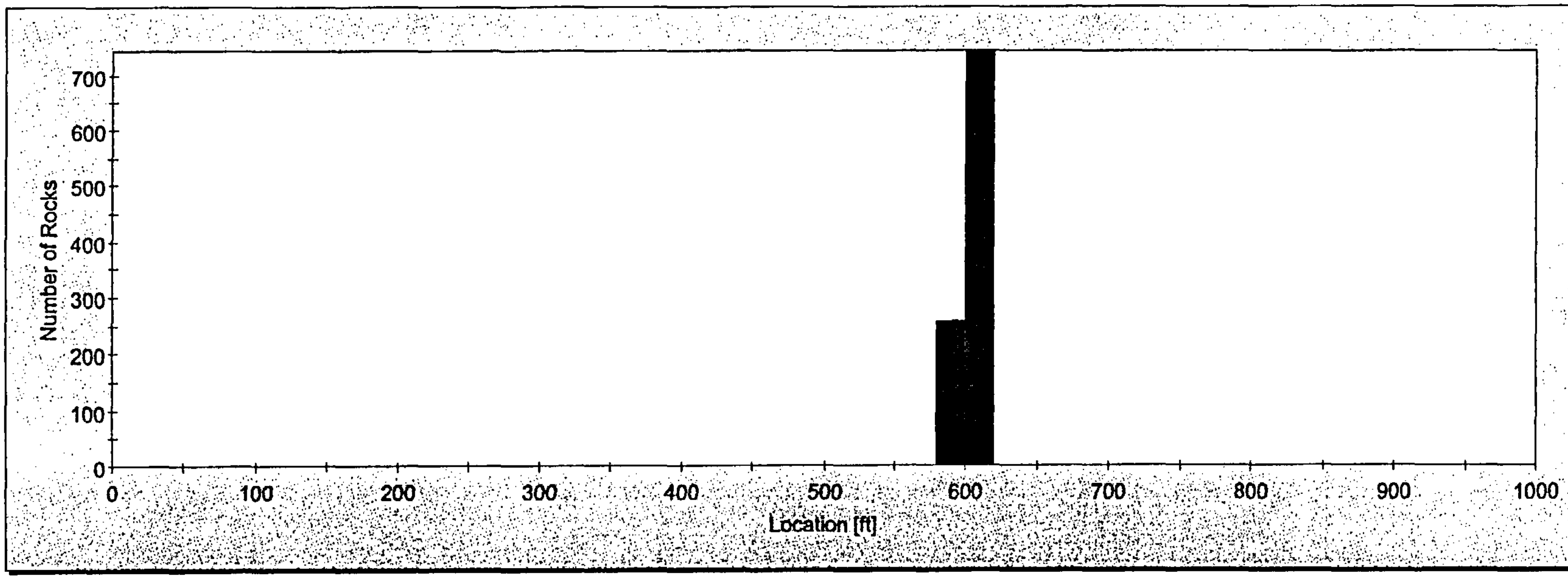


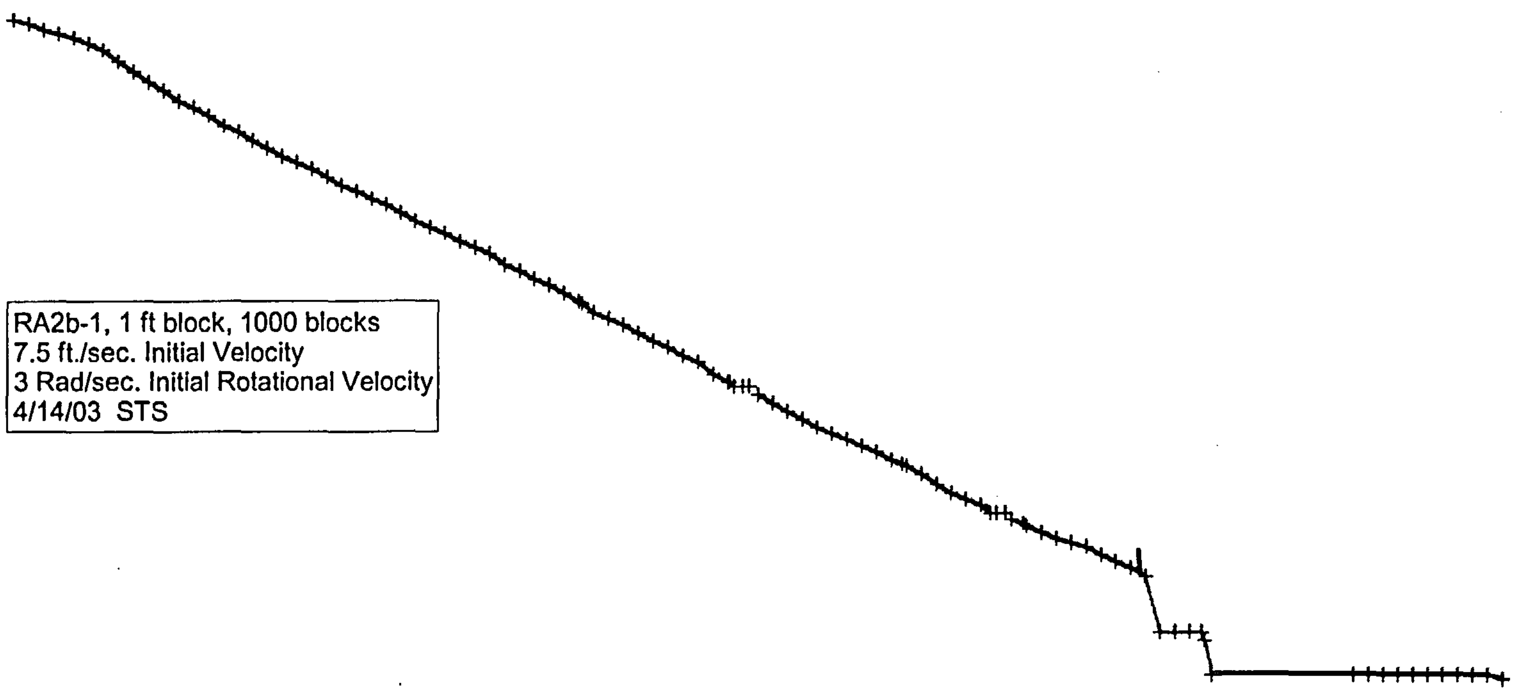
Horizontal Location of Rock End-points



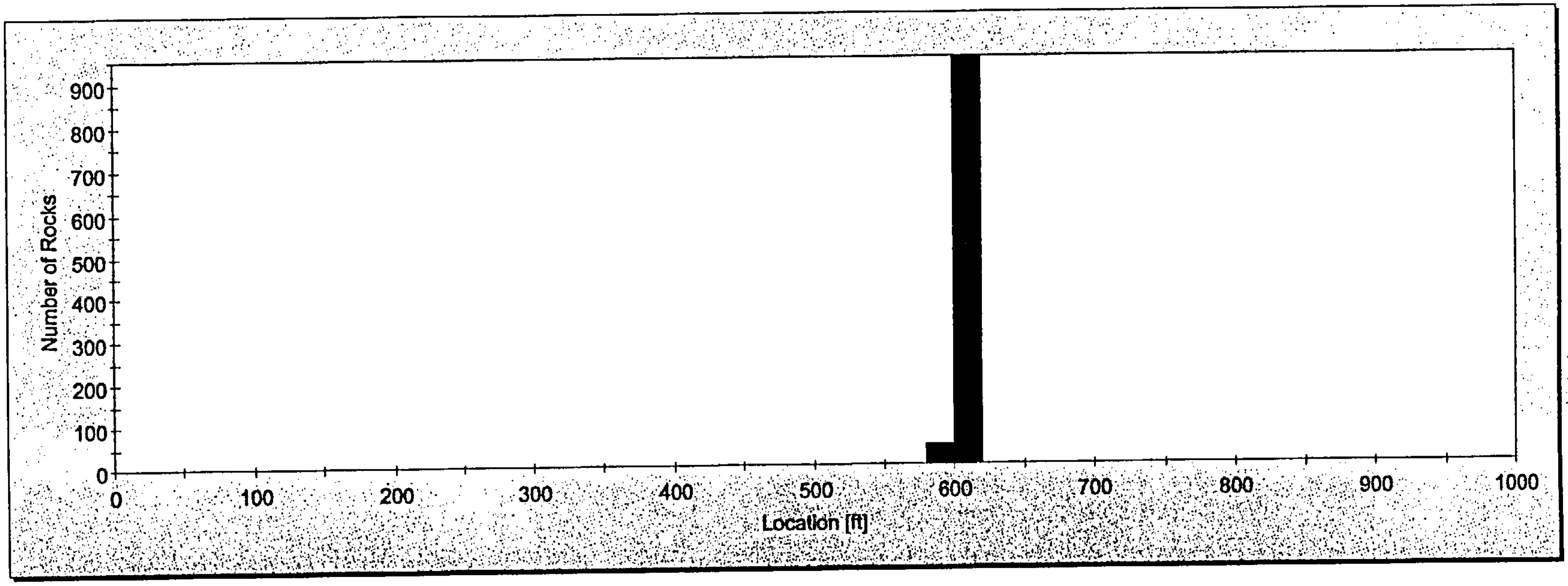


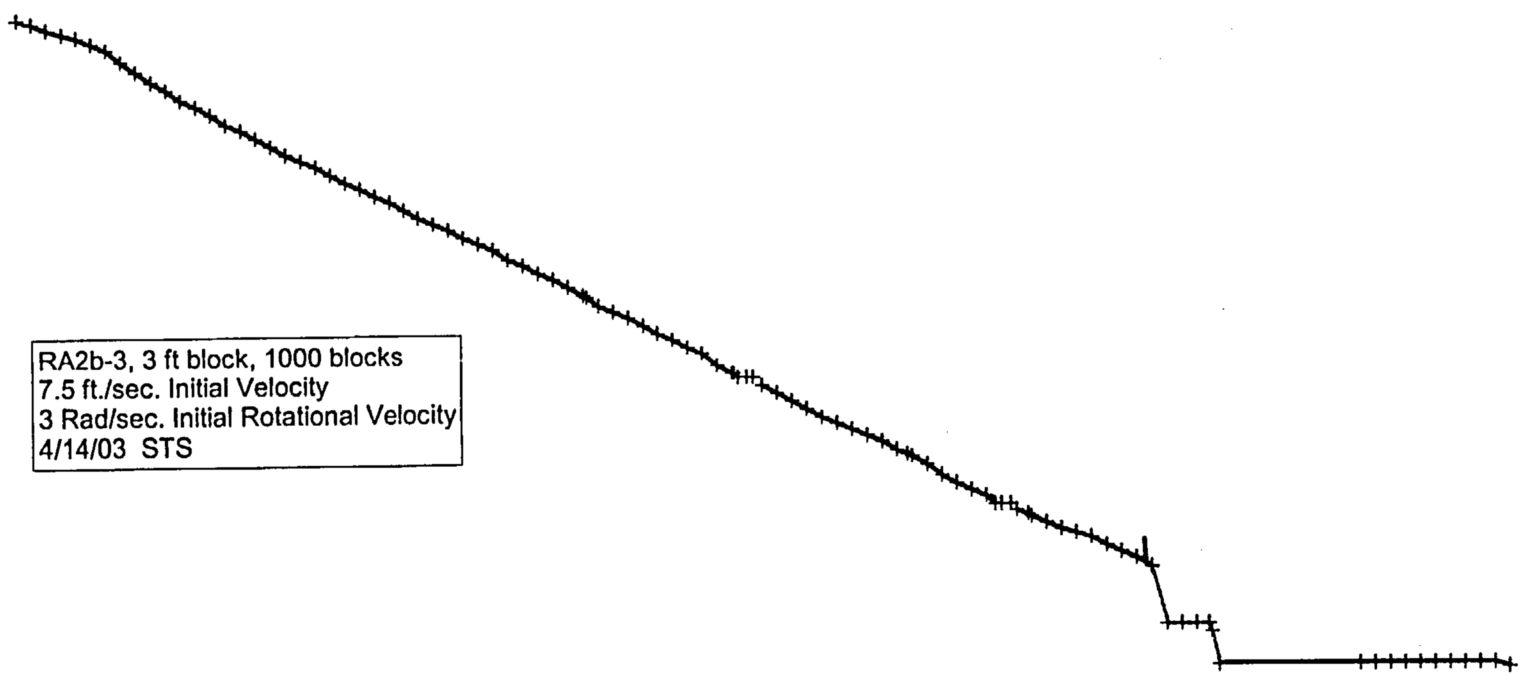
Horizontal Location of Rock End-points



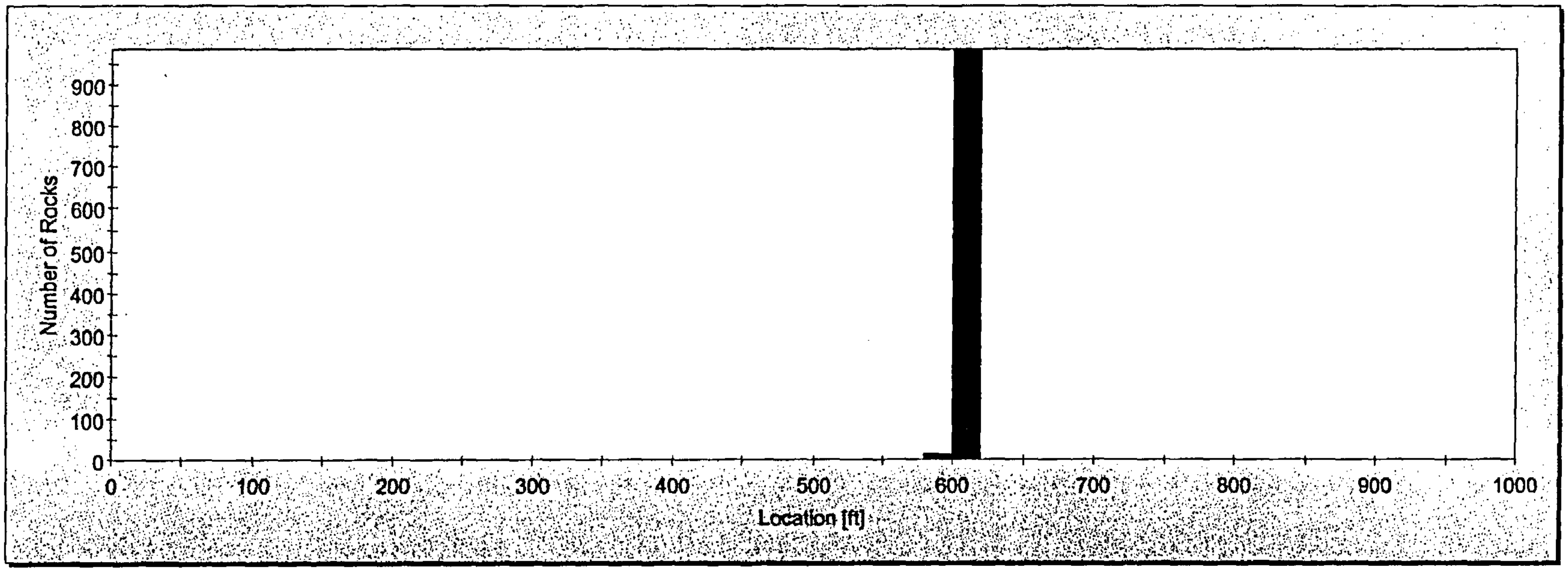


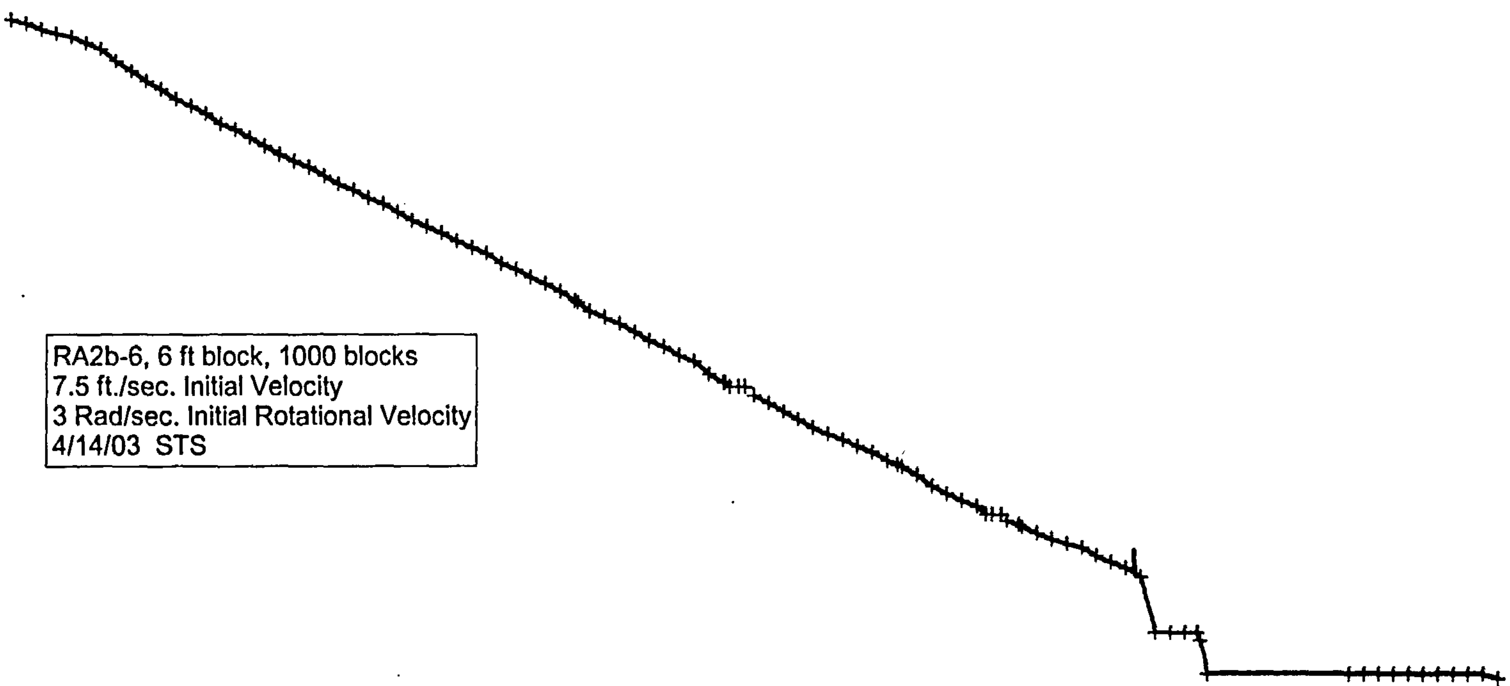
Horizontal Location of Rock End-points



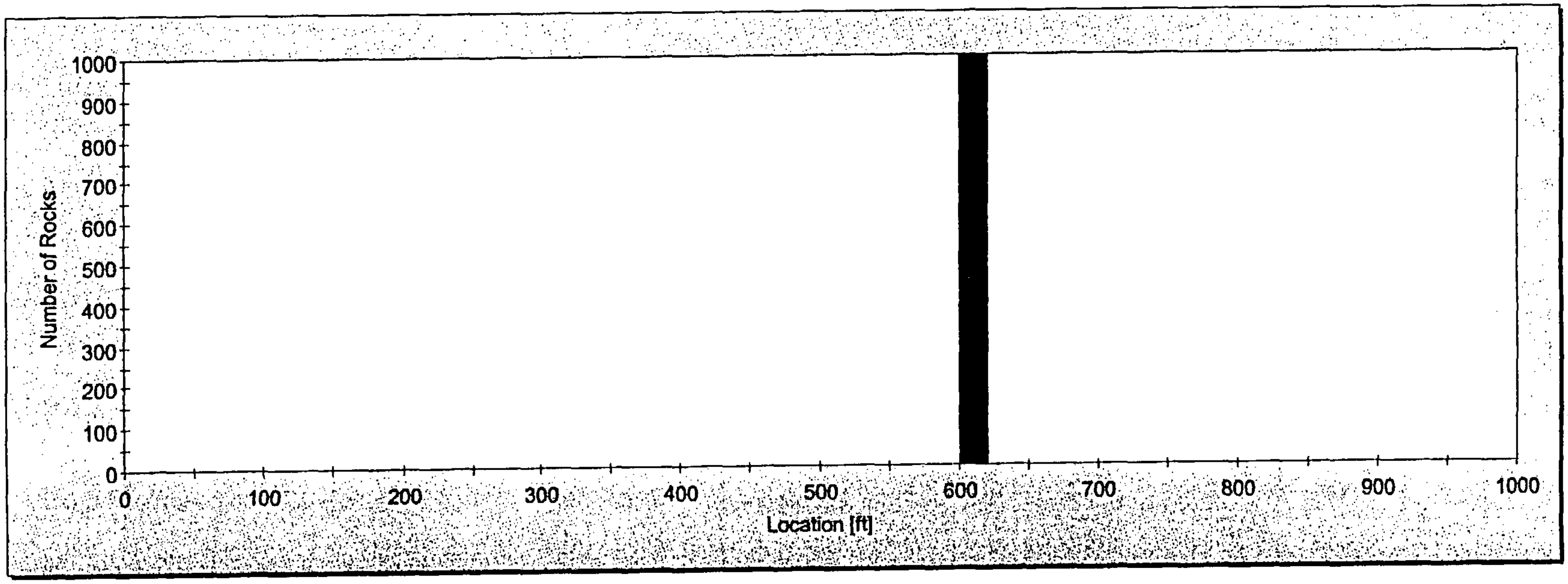


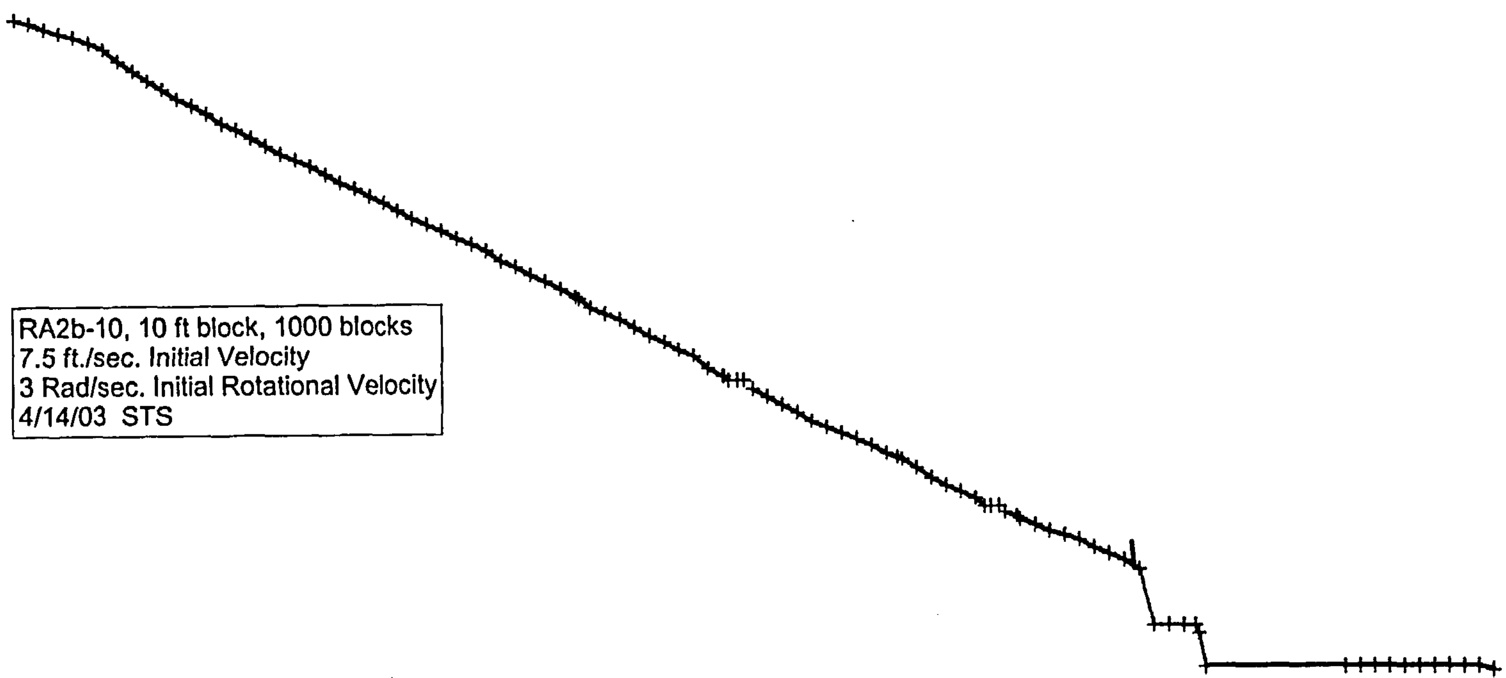
Horizontal Location of Rock End-points





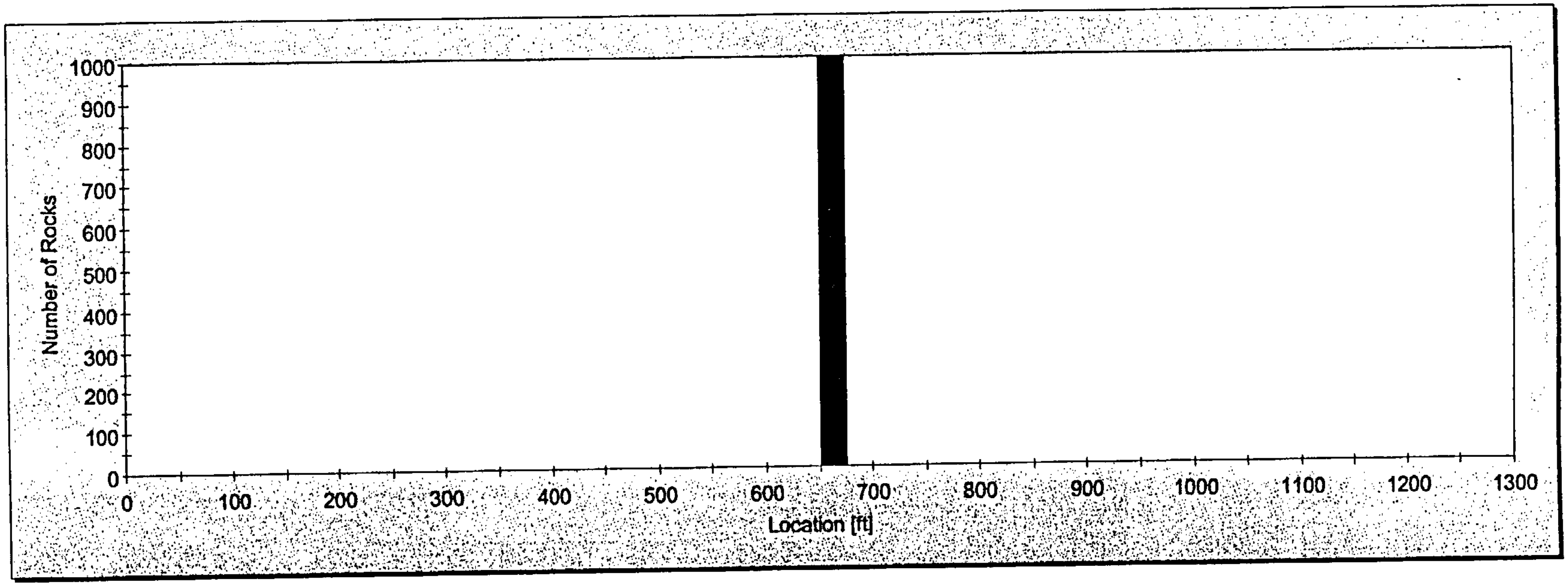
Horizontal Location of Rock End-points

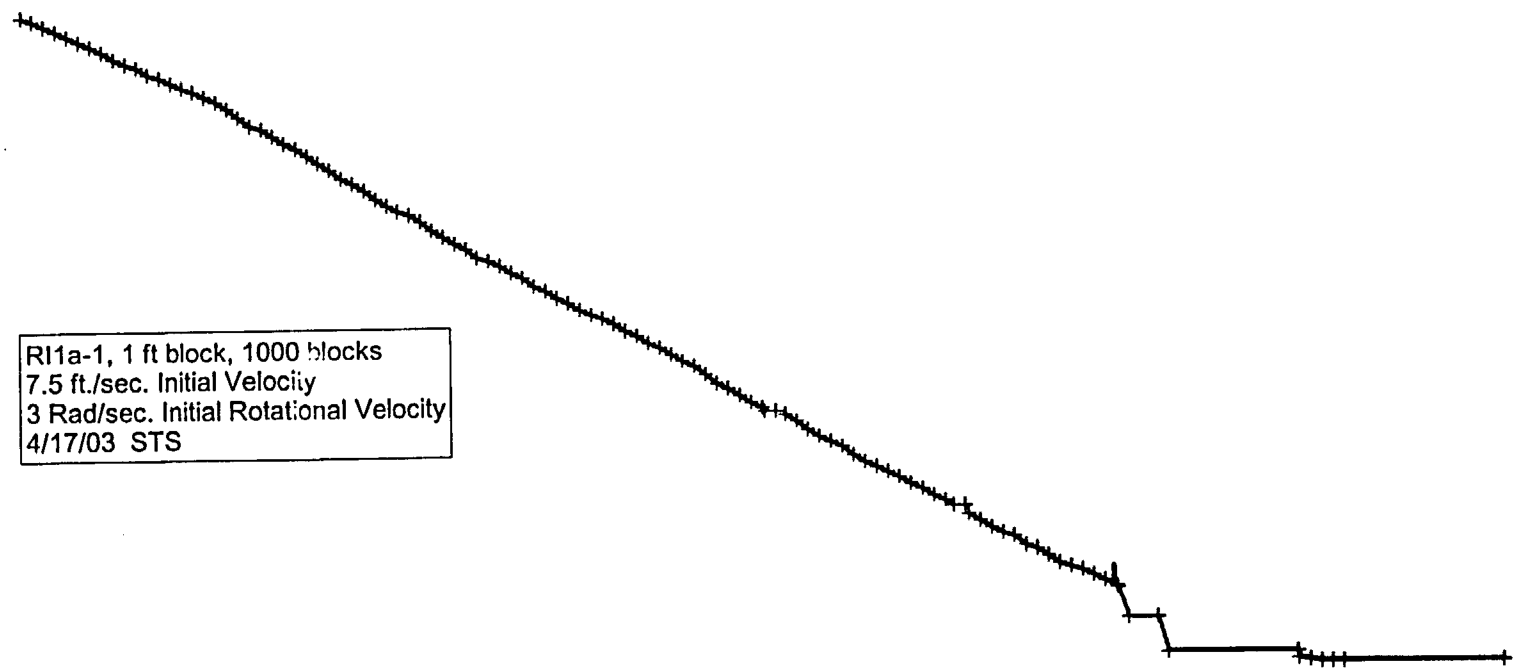




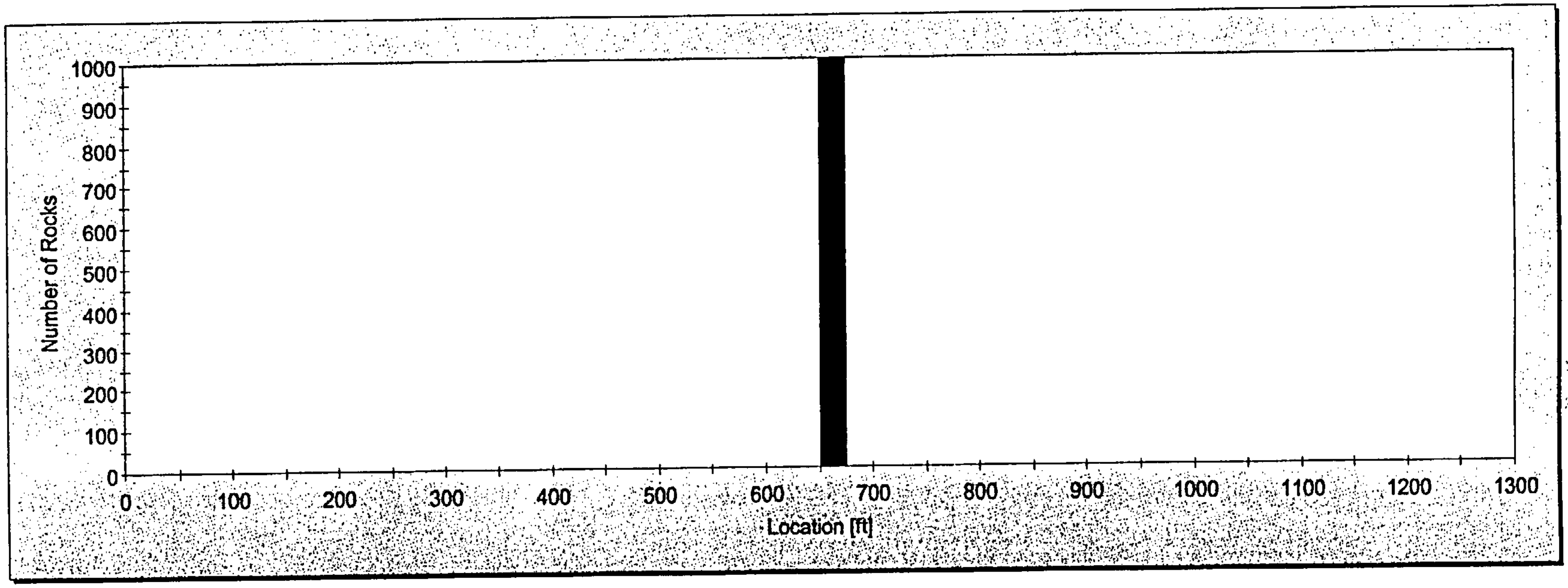
RA2b-10, 10 ft block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

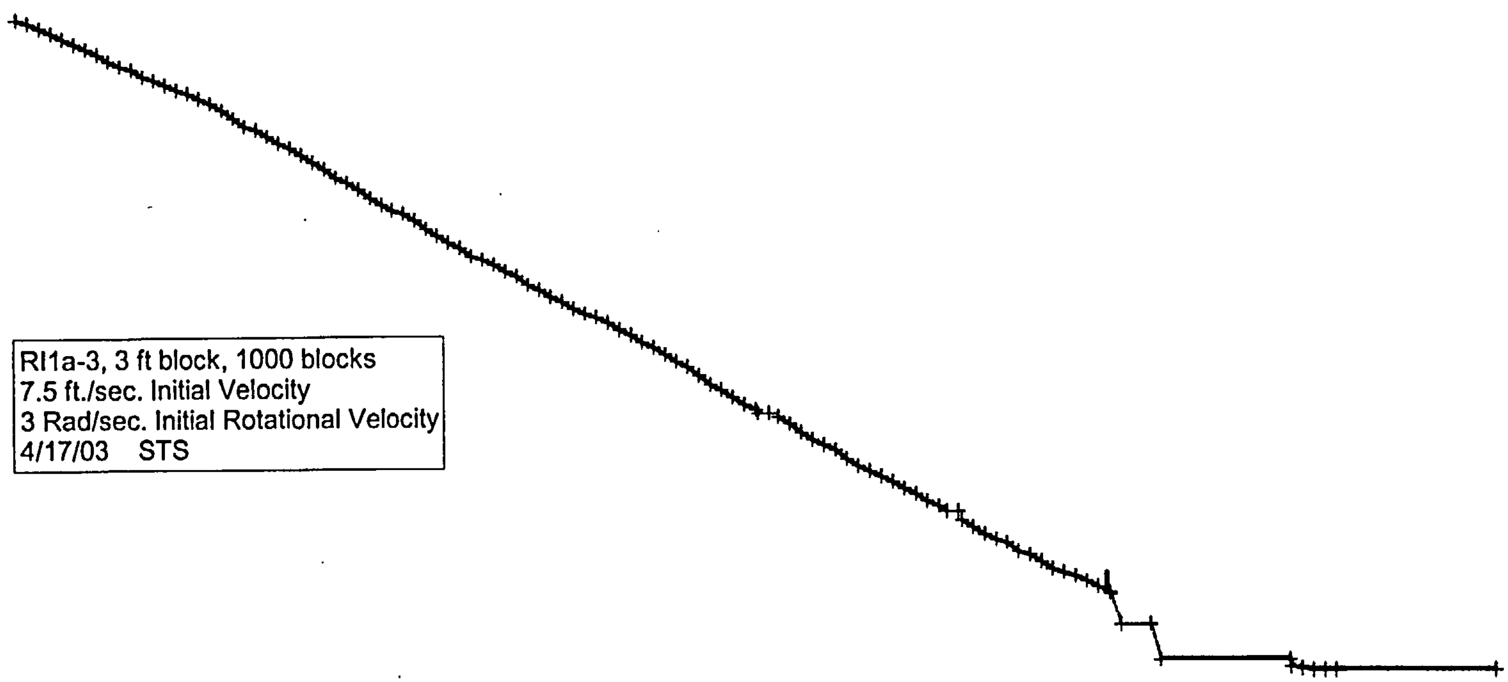
Horizontal Location of Rock End-points





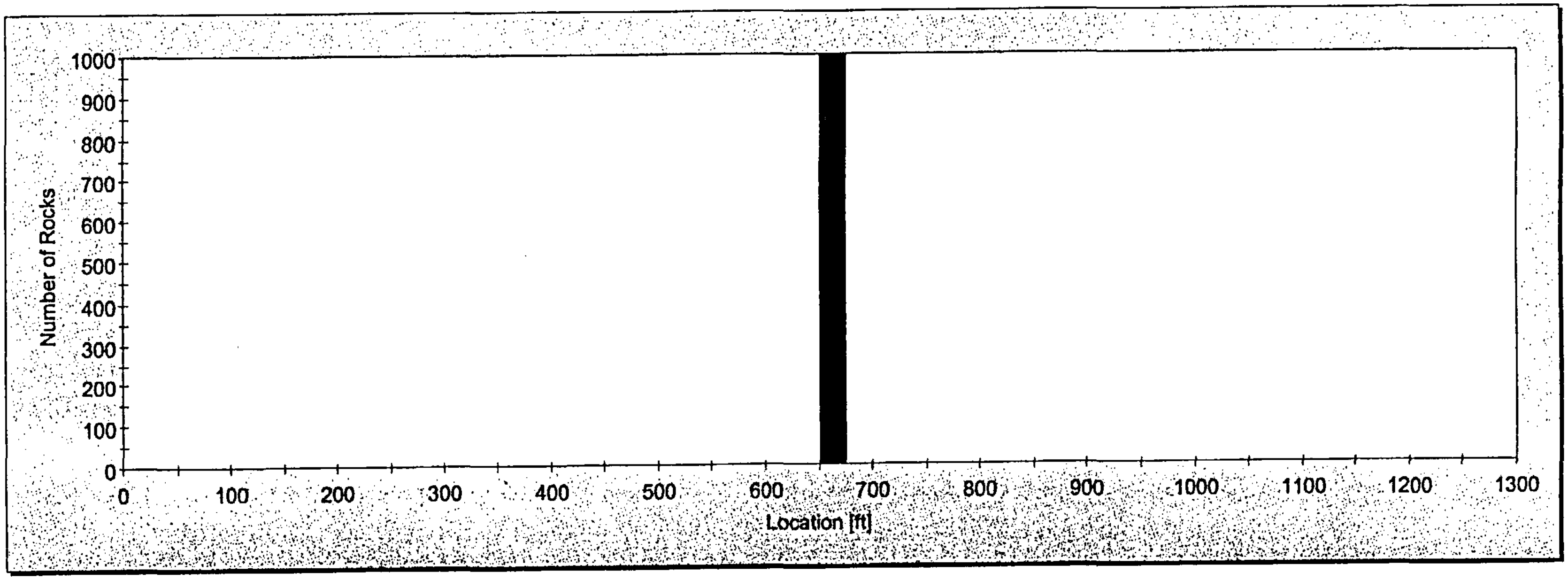
Horizontal Location of Rock End-points

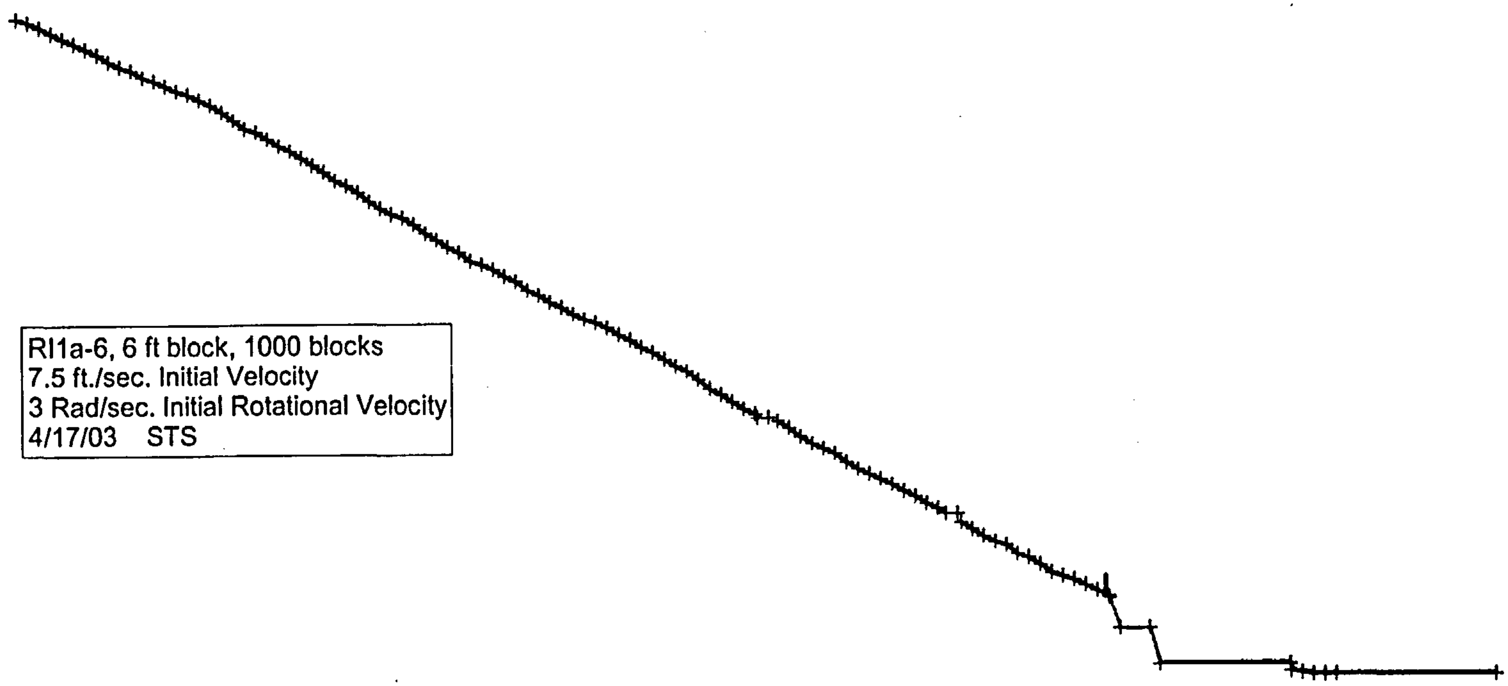




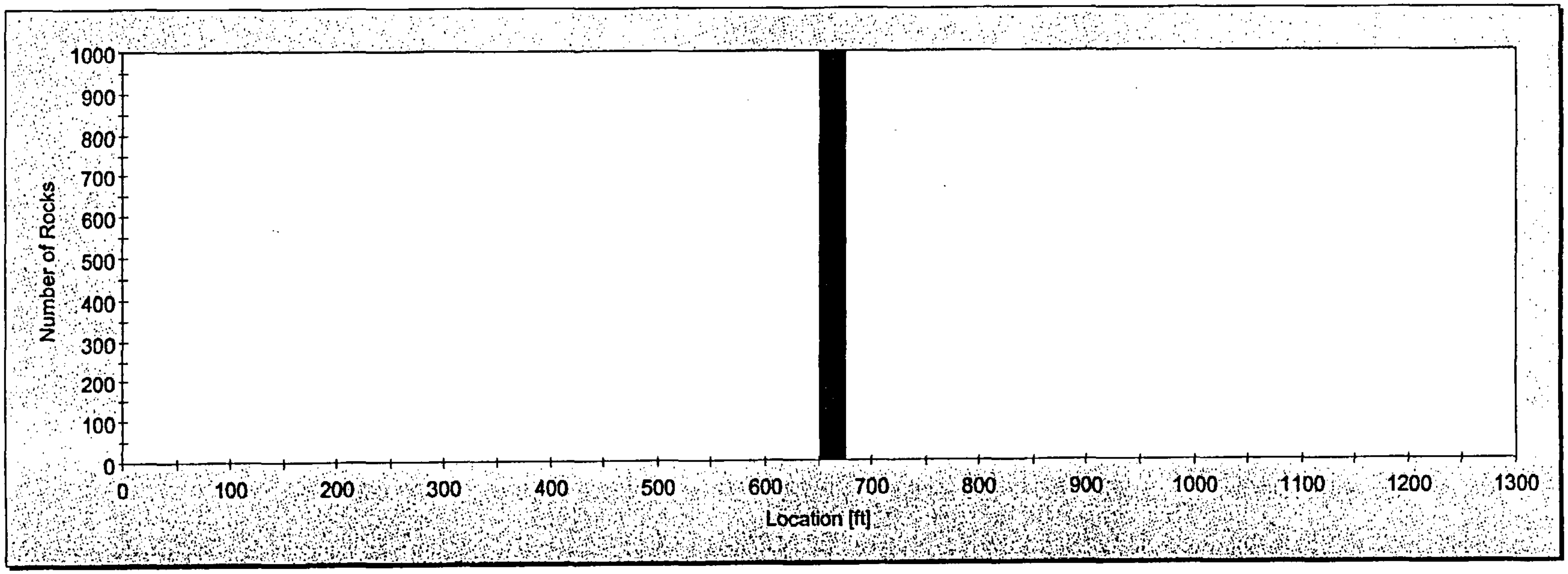
RI1a-3, 3 ft block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/17/03 STS

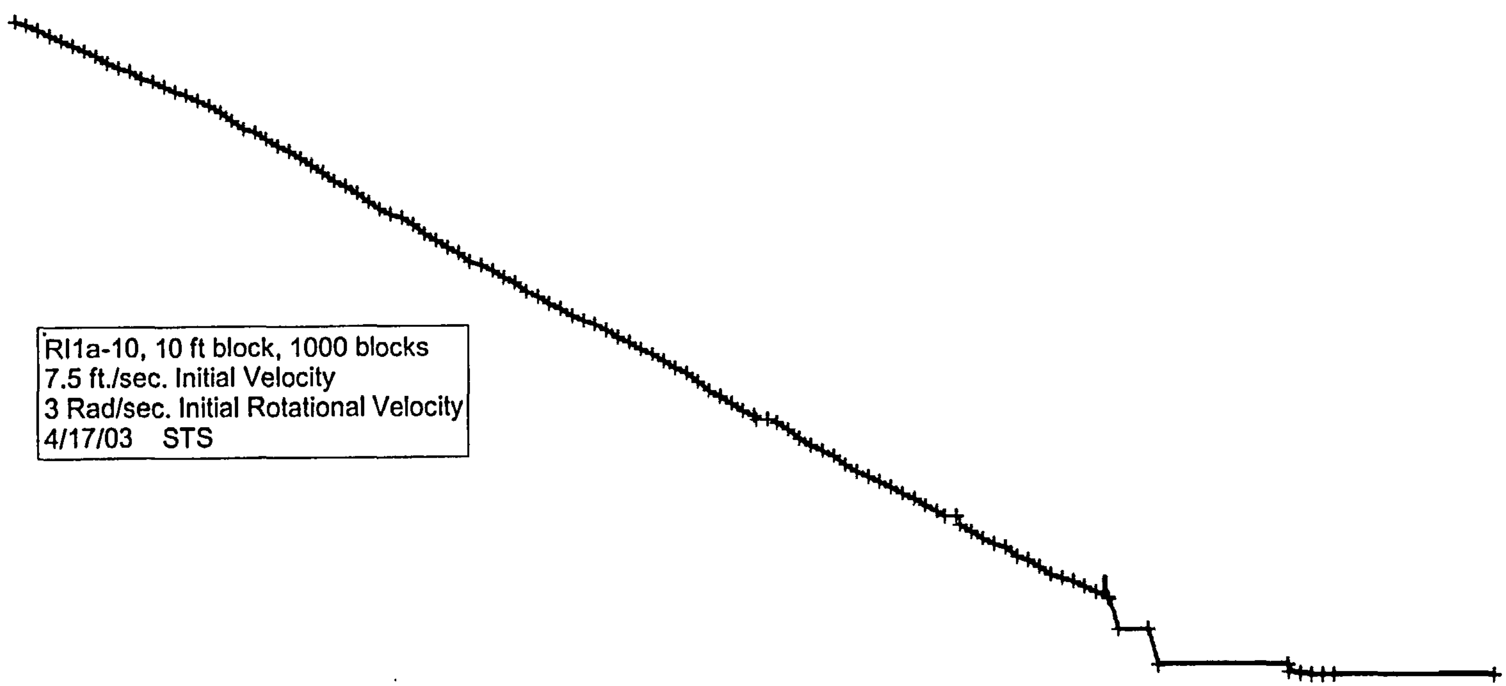
Horizontal Location of Rock End-points



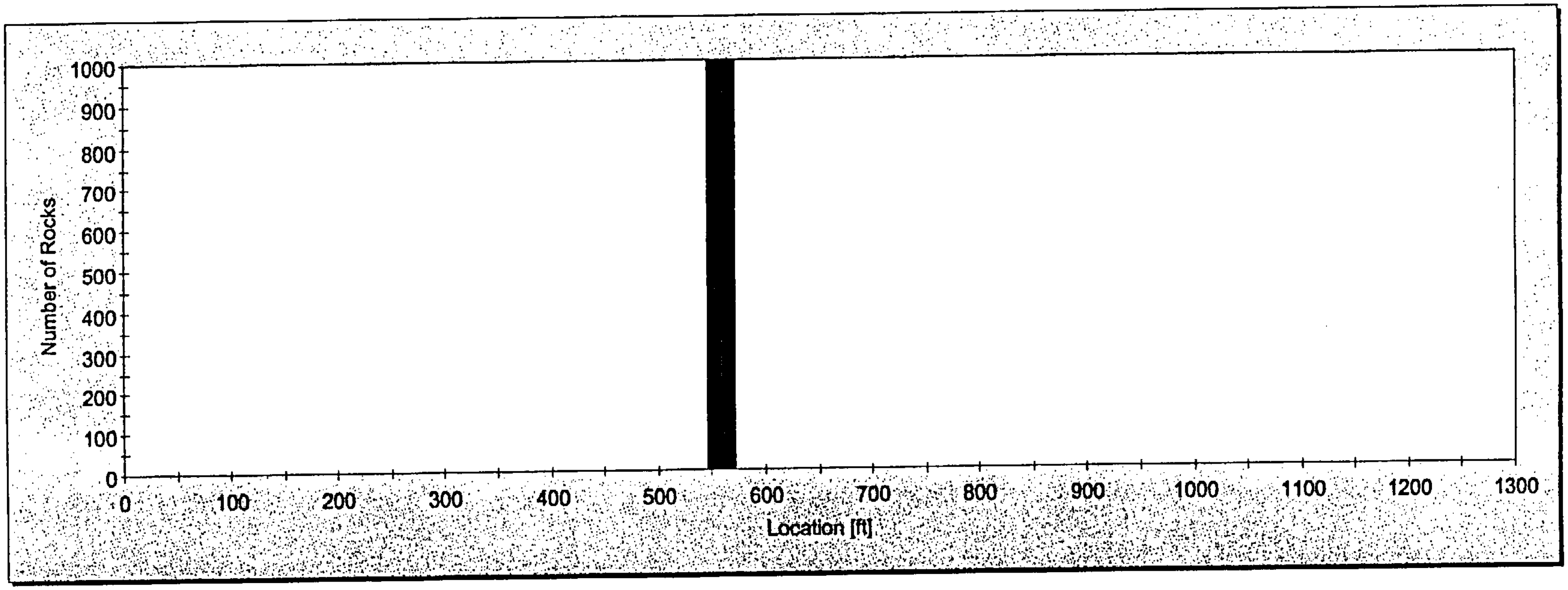


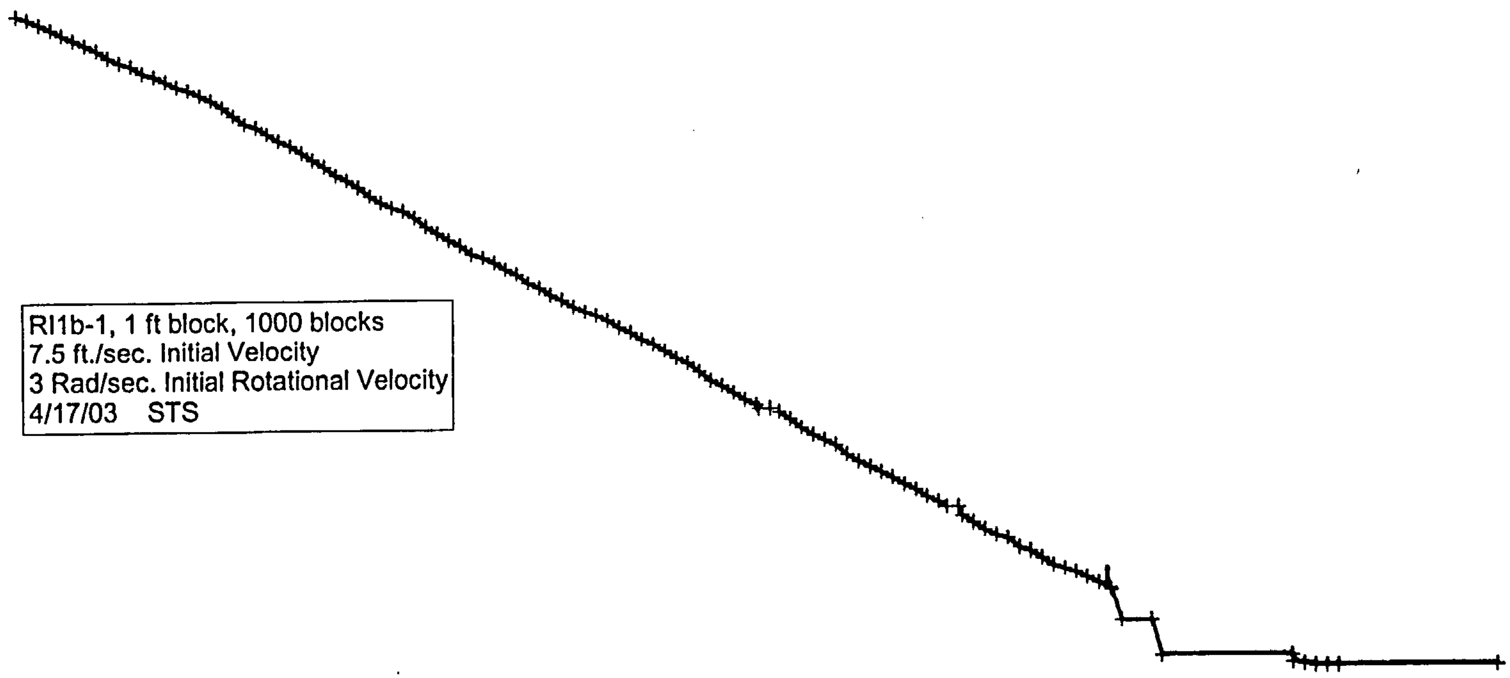
Horizontal Location of Rock End-points



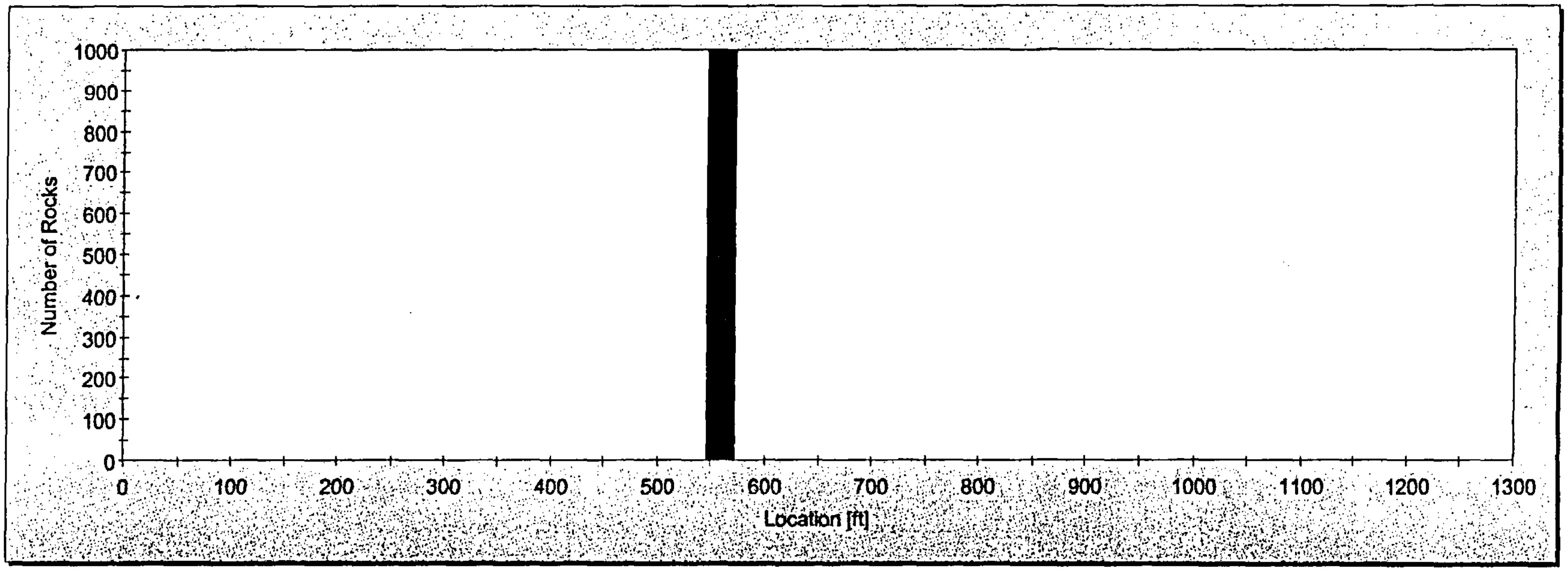


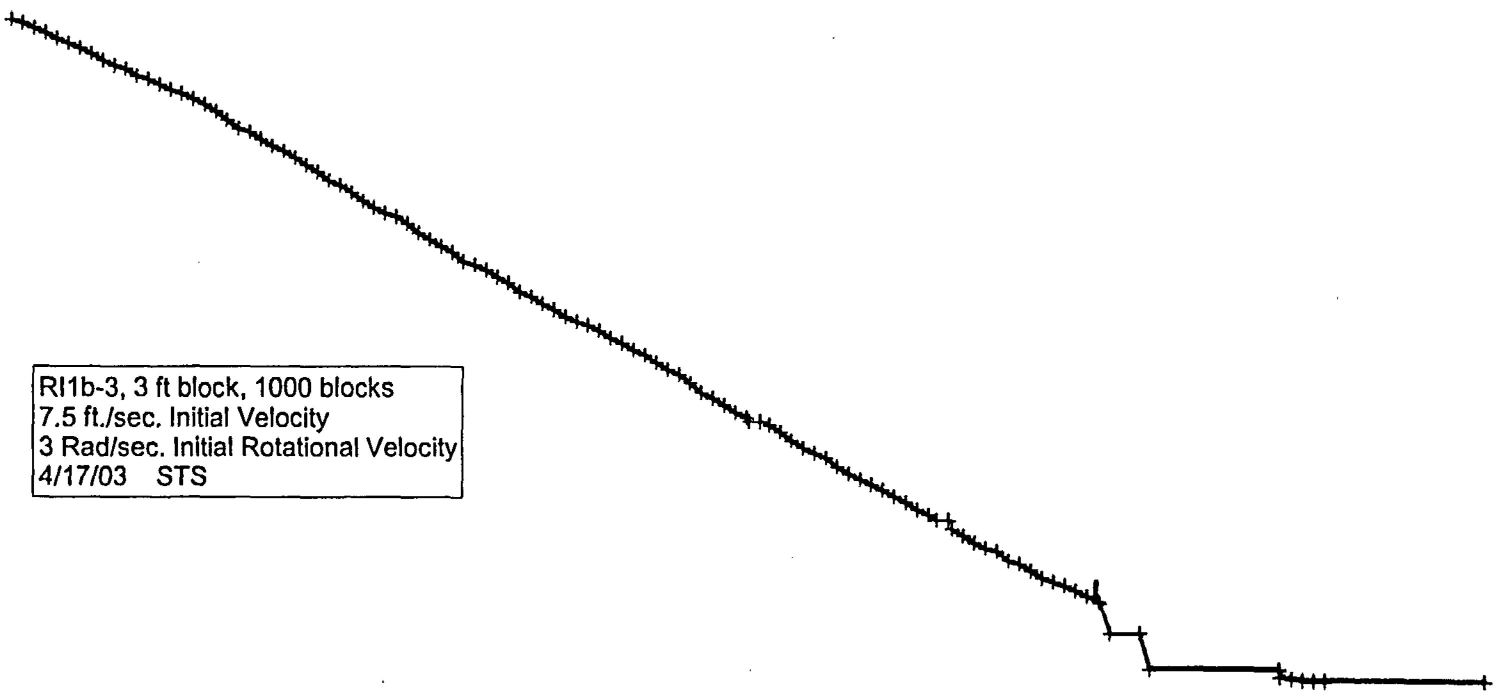
Horizontal Location of Rock End-points



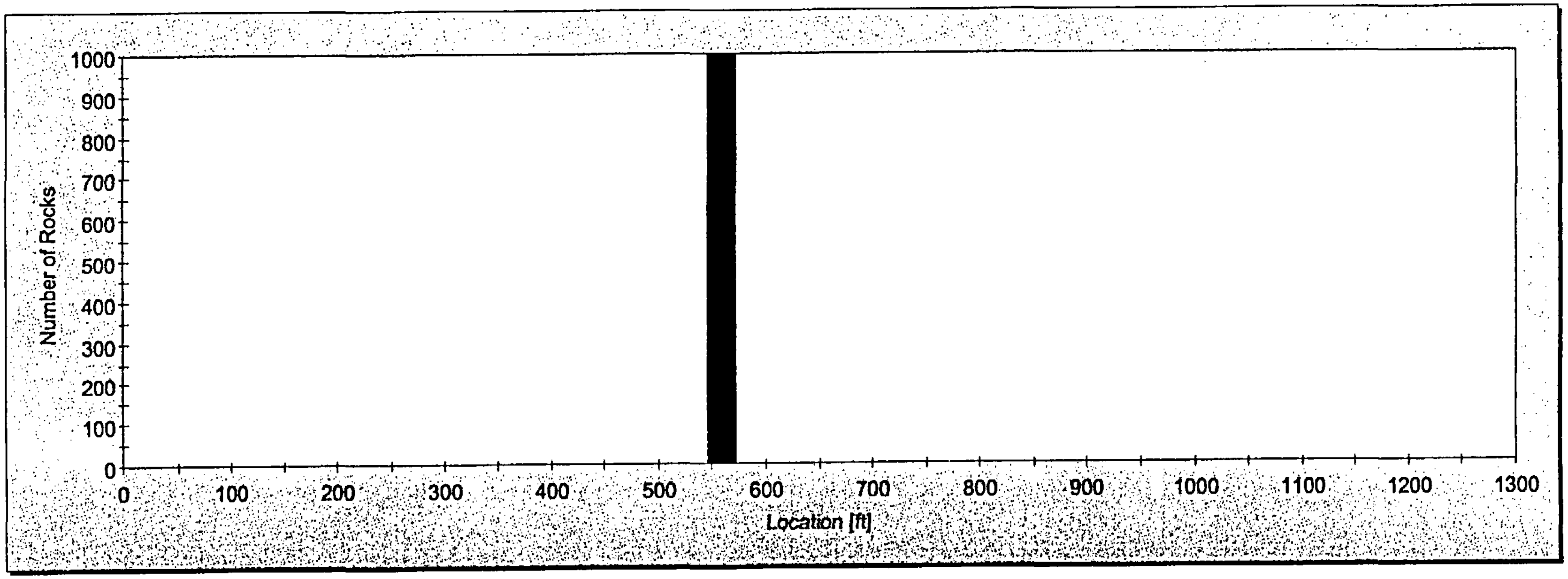


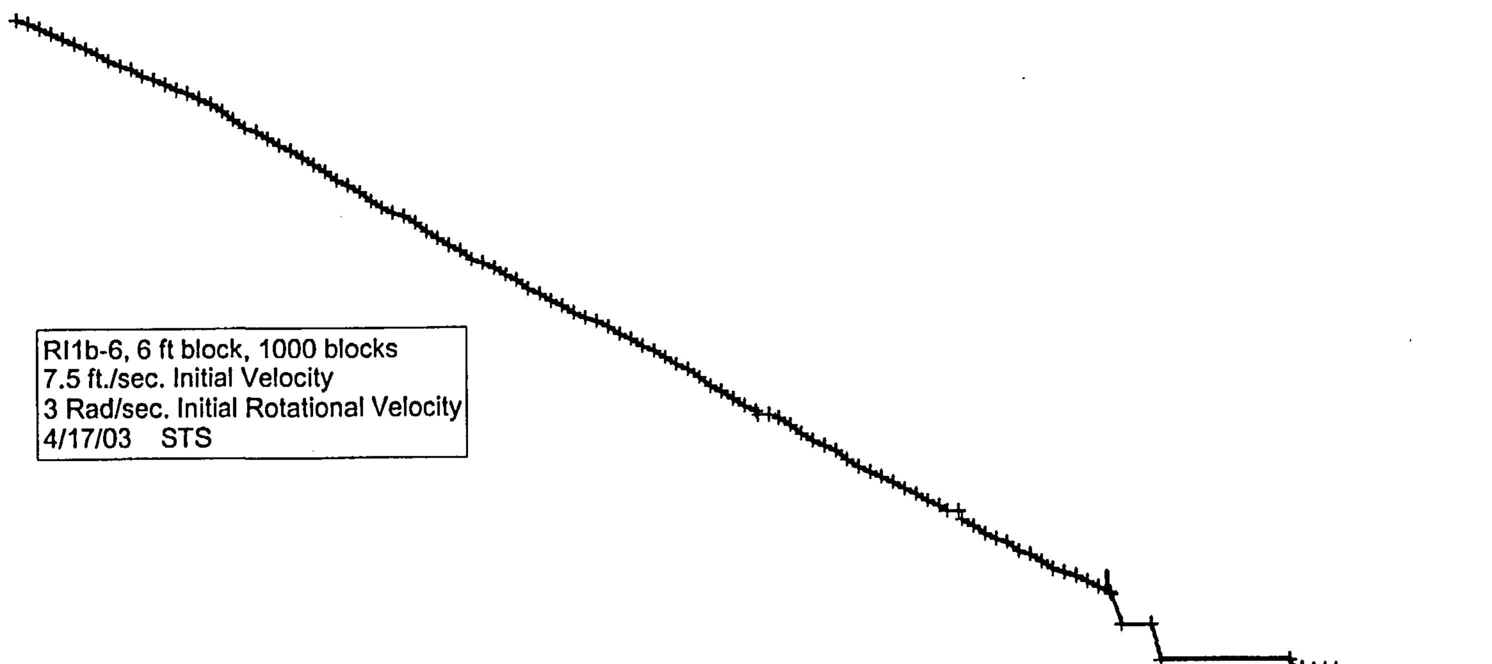
Horizontal Location of Rock End-points



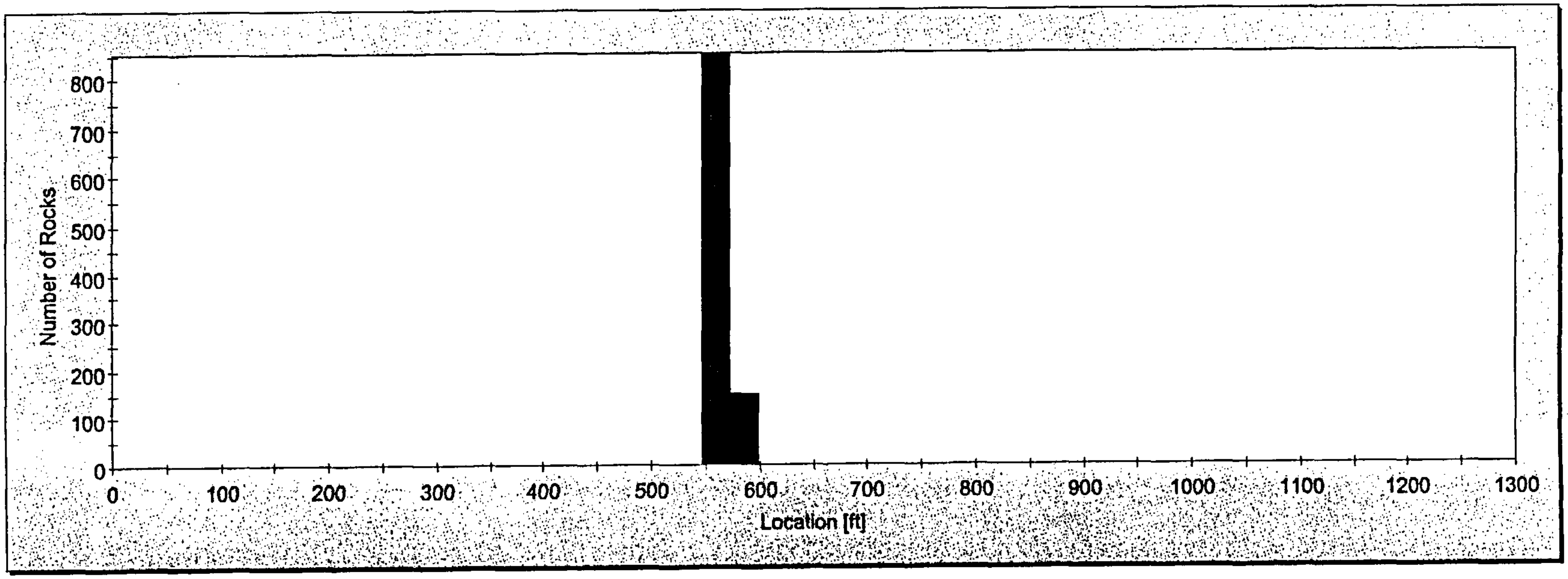


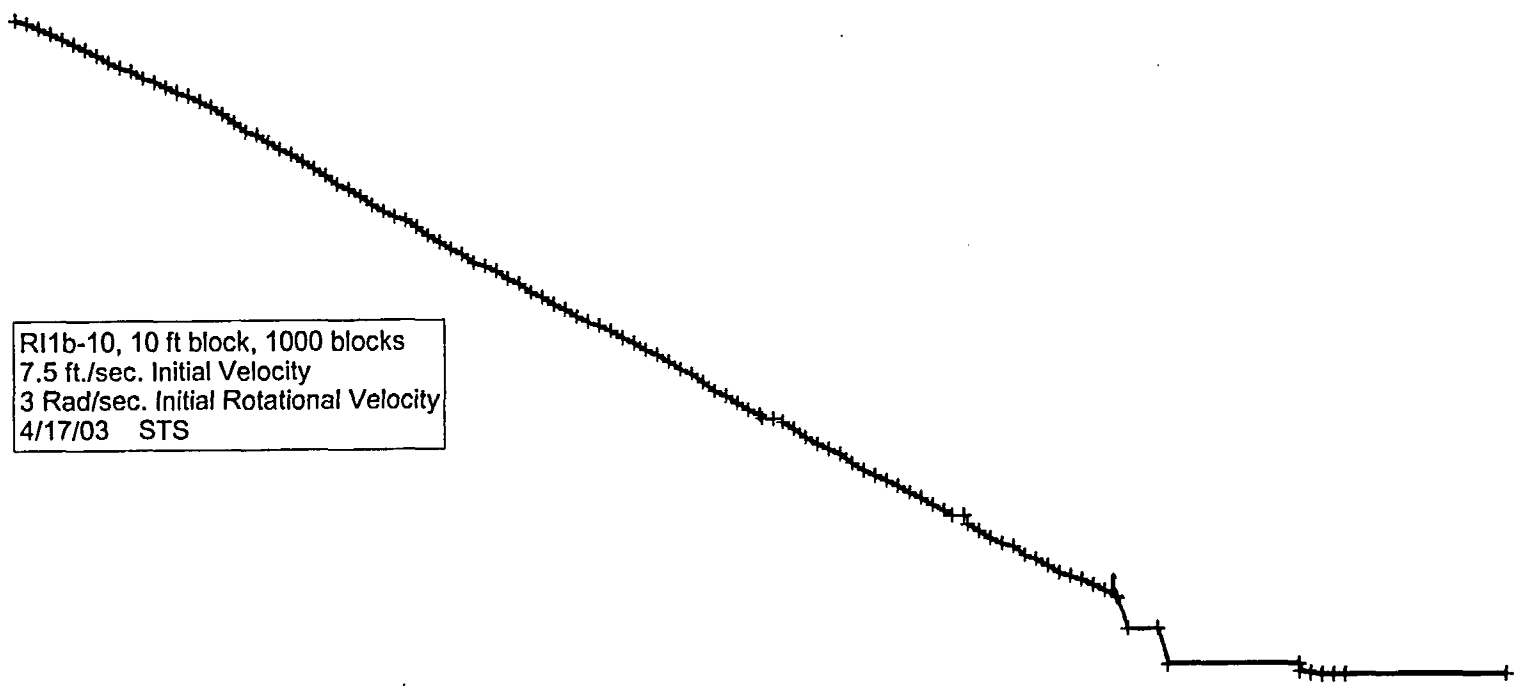
Horizontal Location of Rock End-points





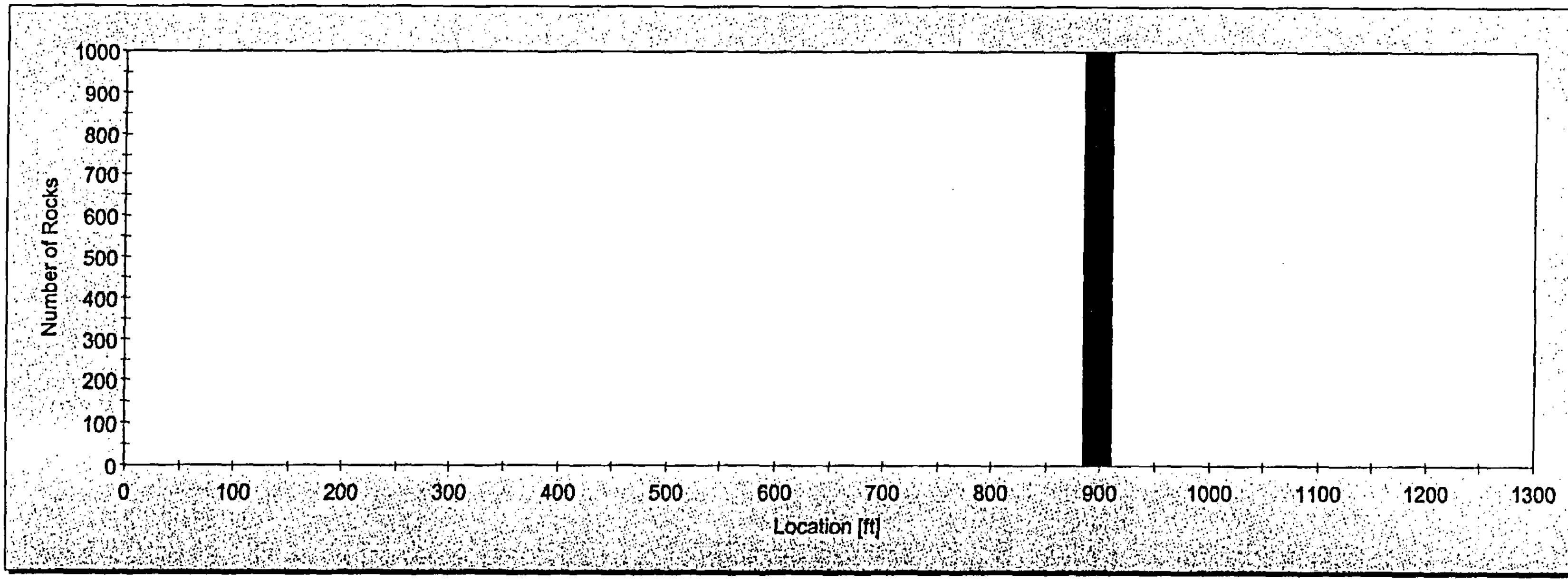
Horizontal Location of Rock End-points

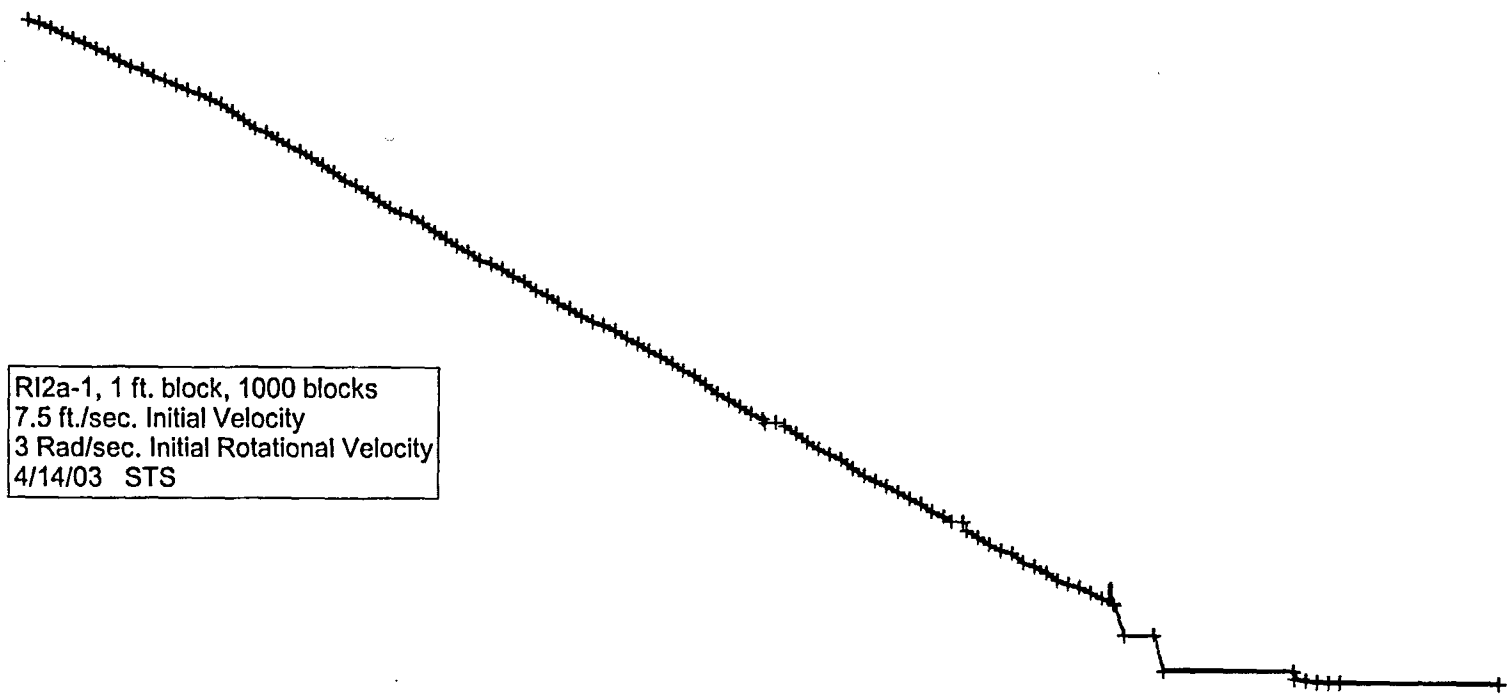




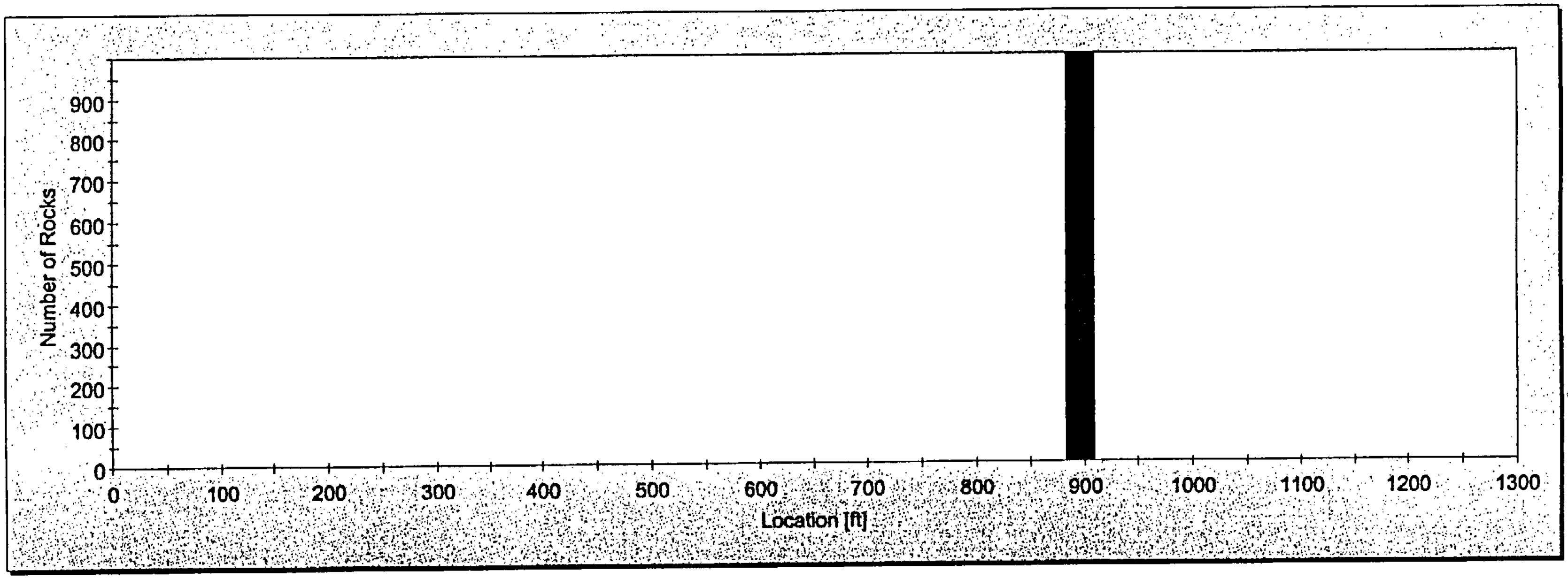
RI1b-10, 10 ft block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/17/03 STS

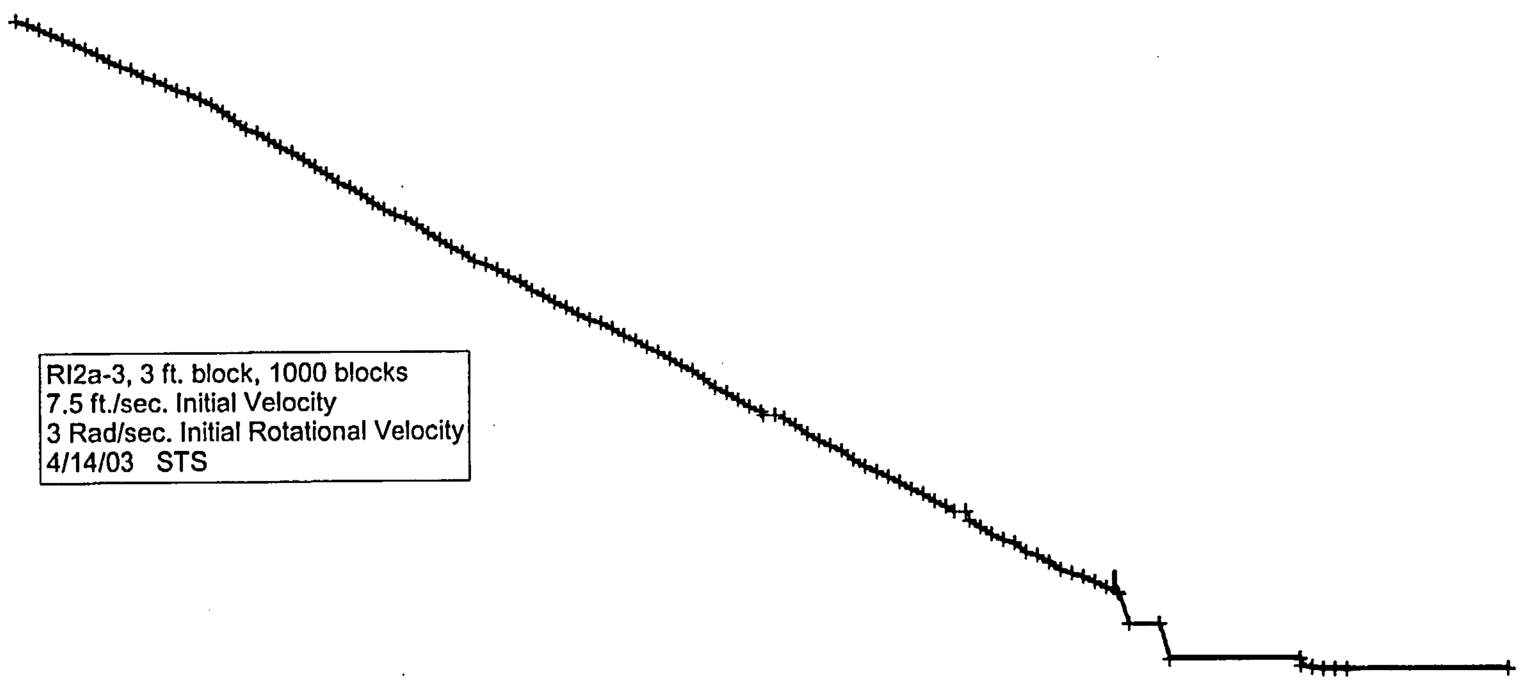
Horizontal Location of Rock End-points





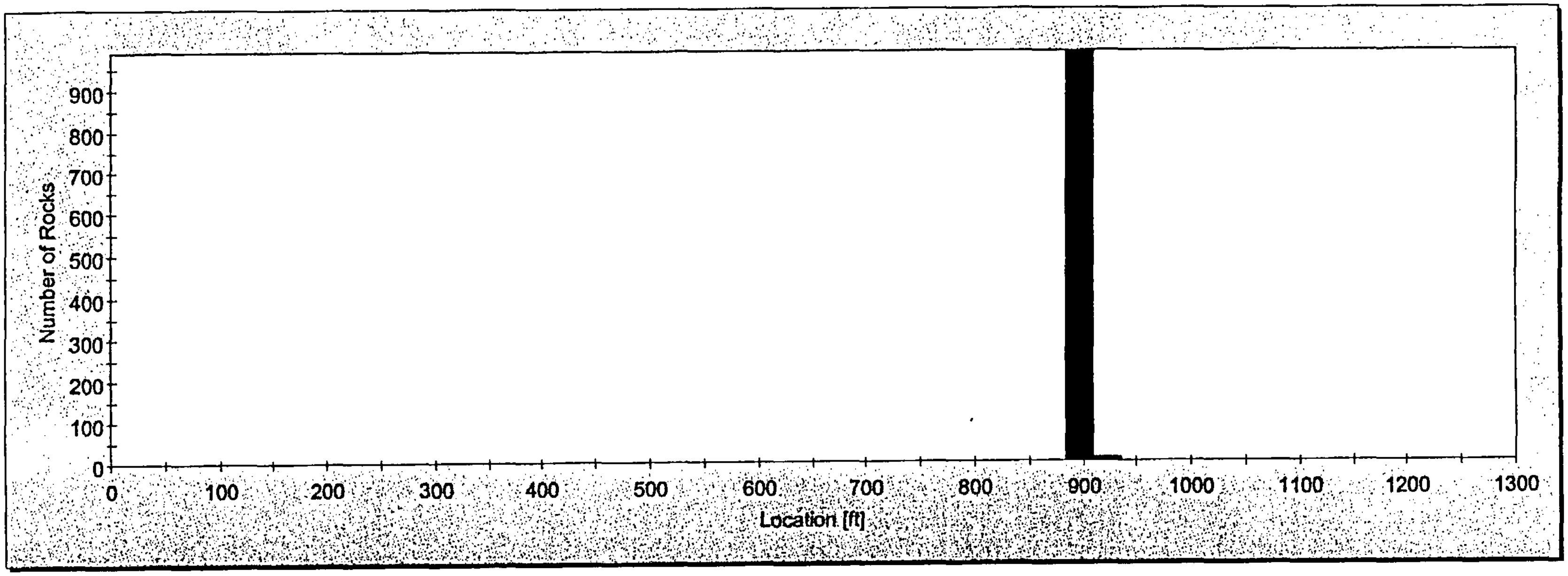
Horizontal Location of Rock End-points

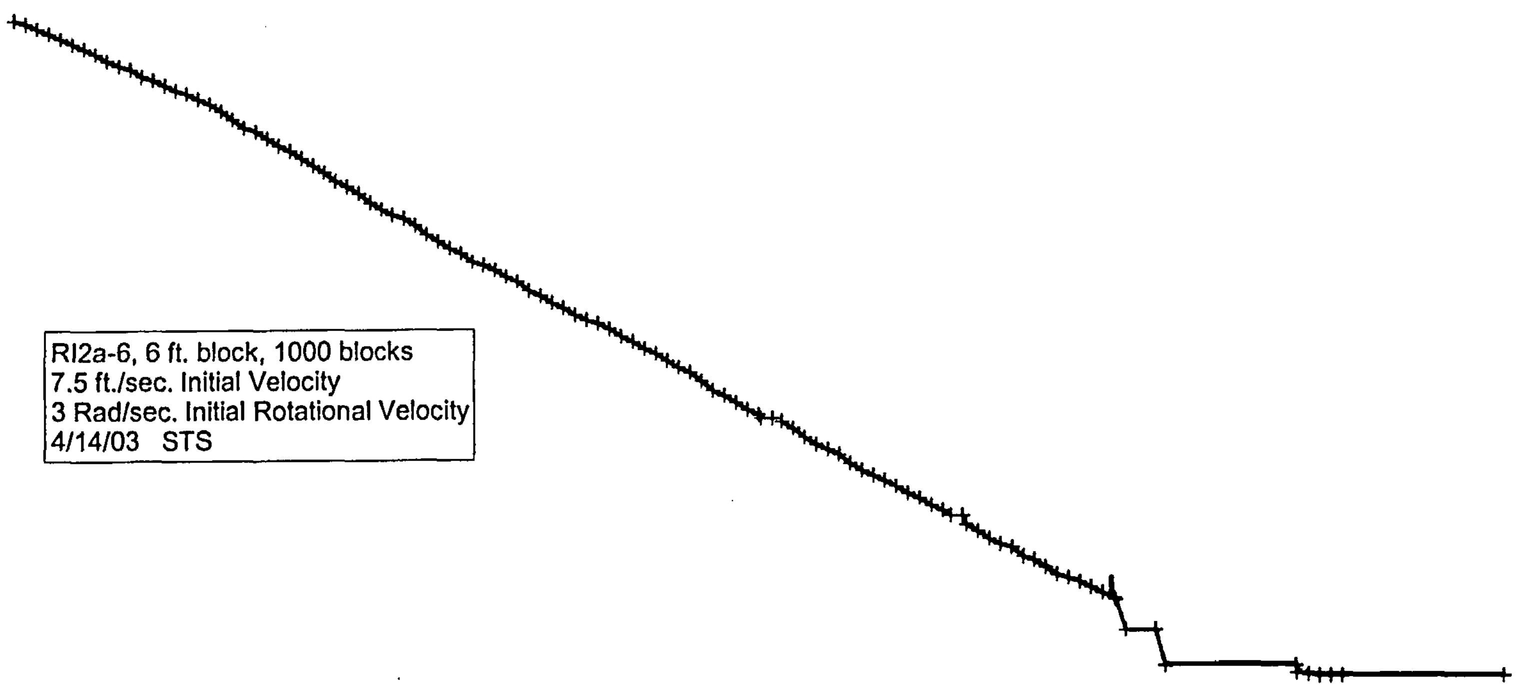




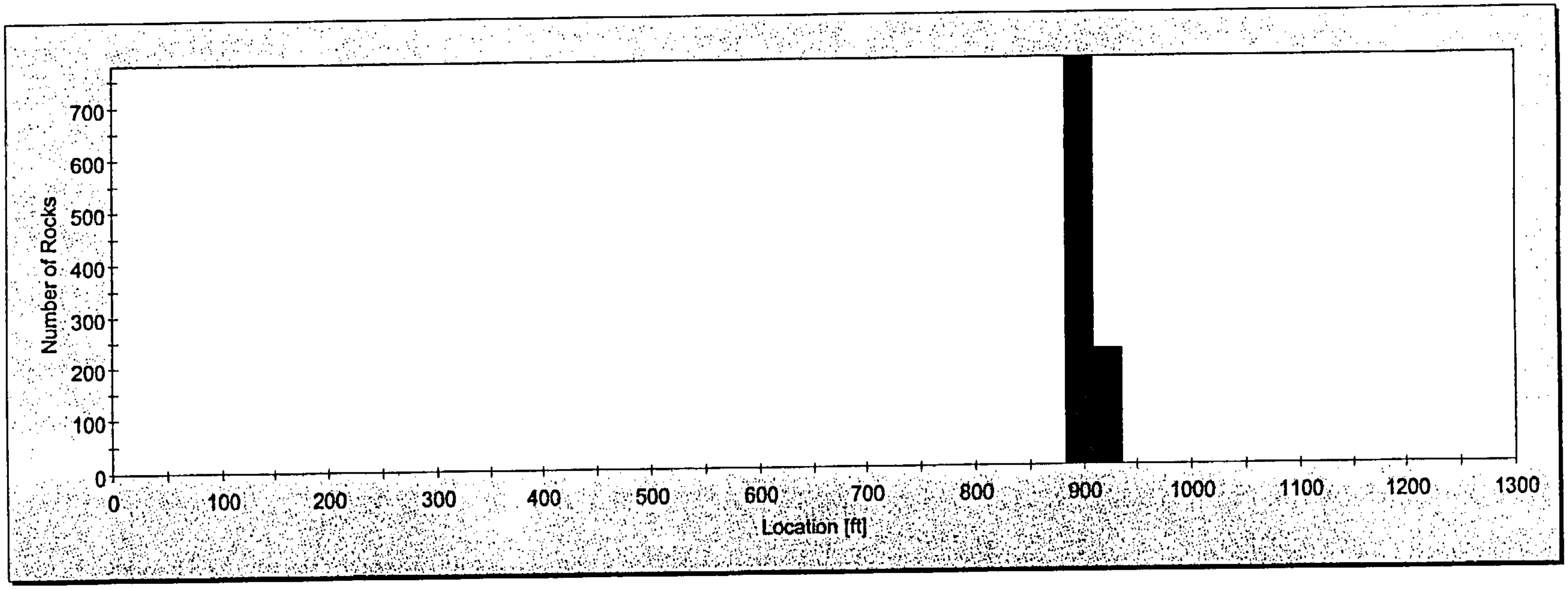
RI2a-3, 3 ft. block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

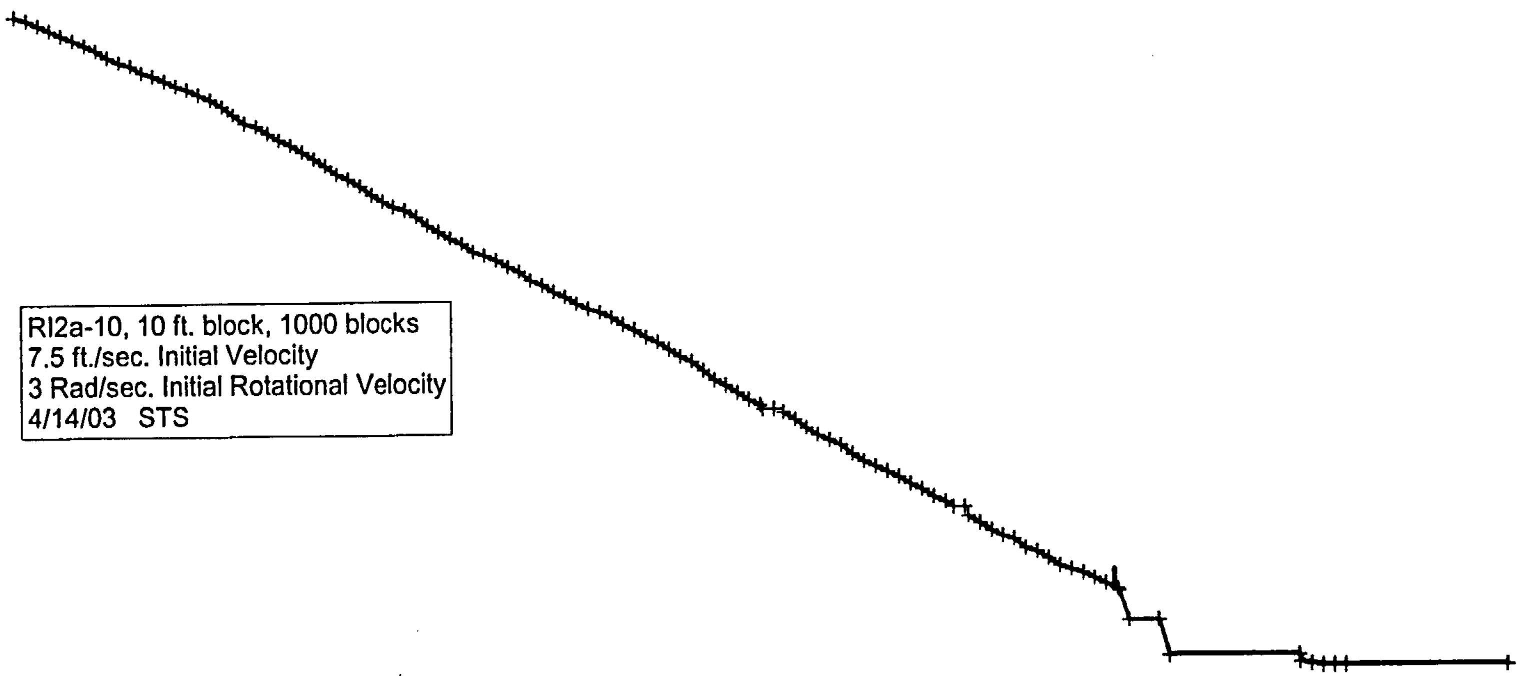
Horizontal Location of Rock End-points





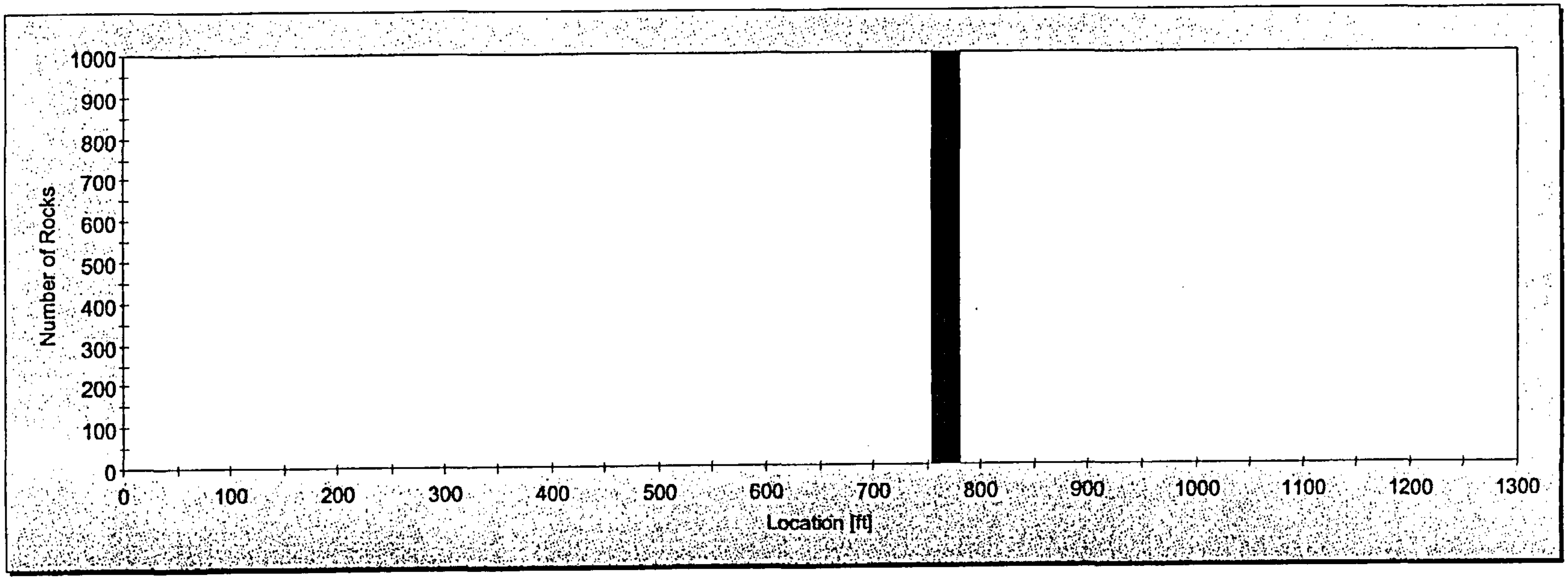
Horizontal Location of Rock End-points

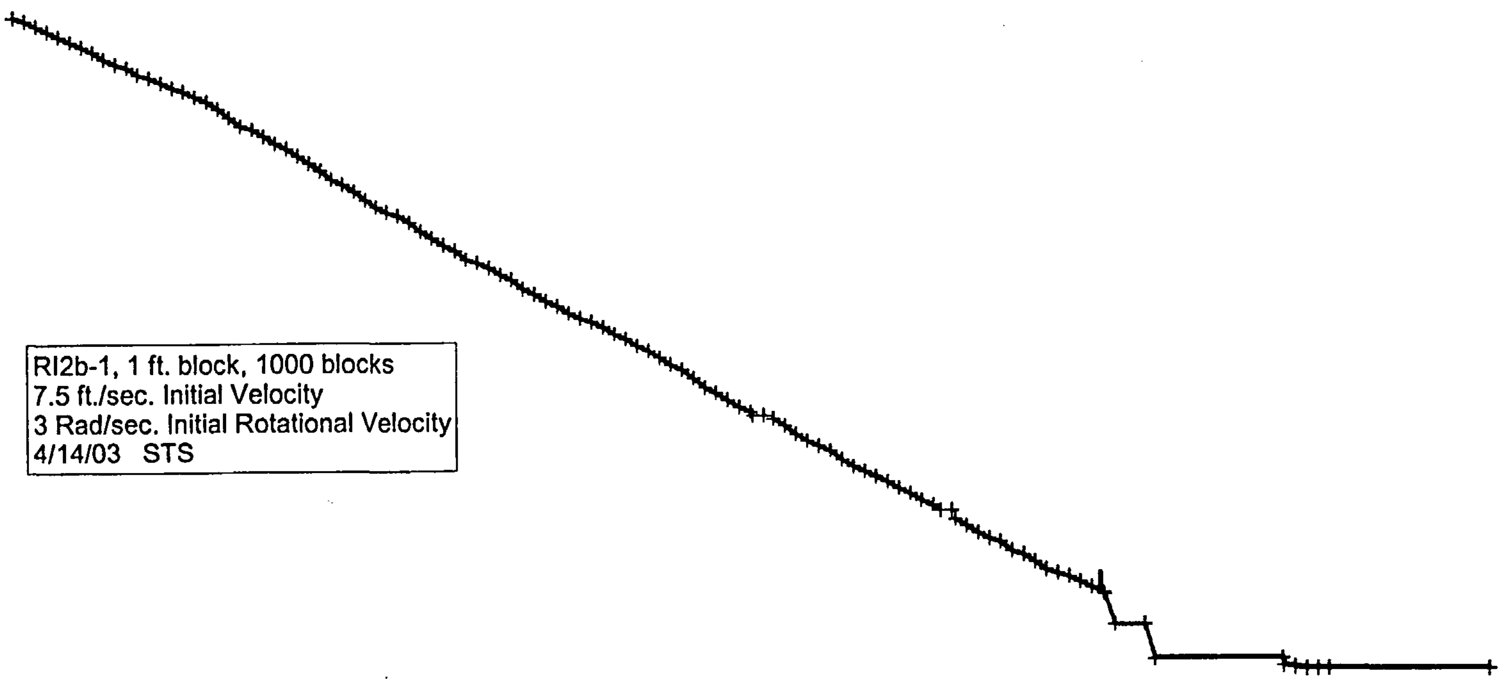




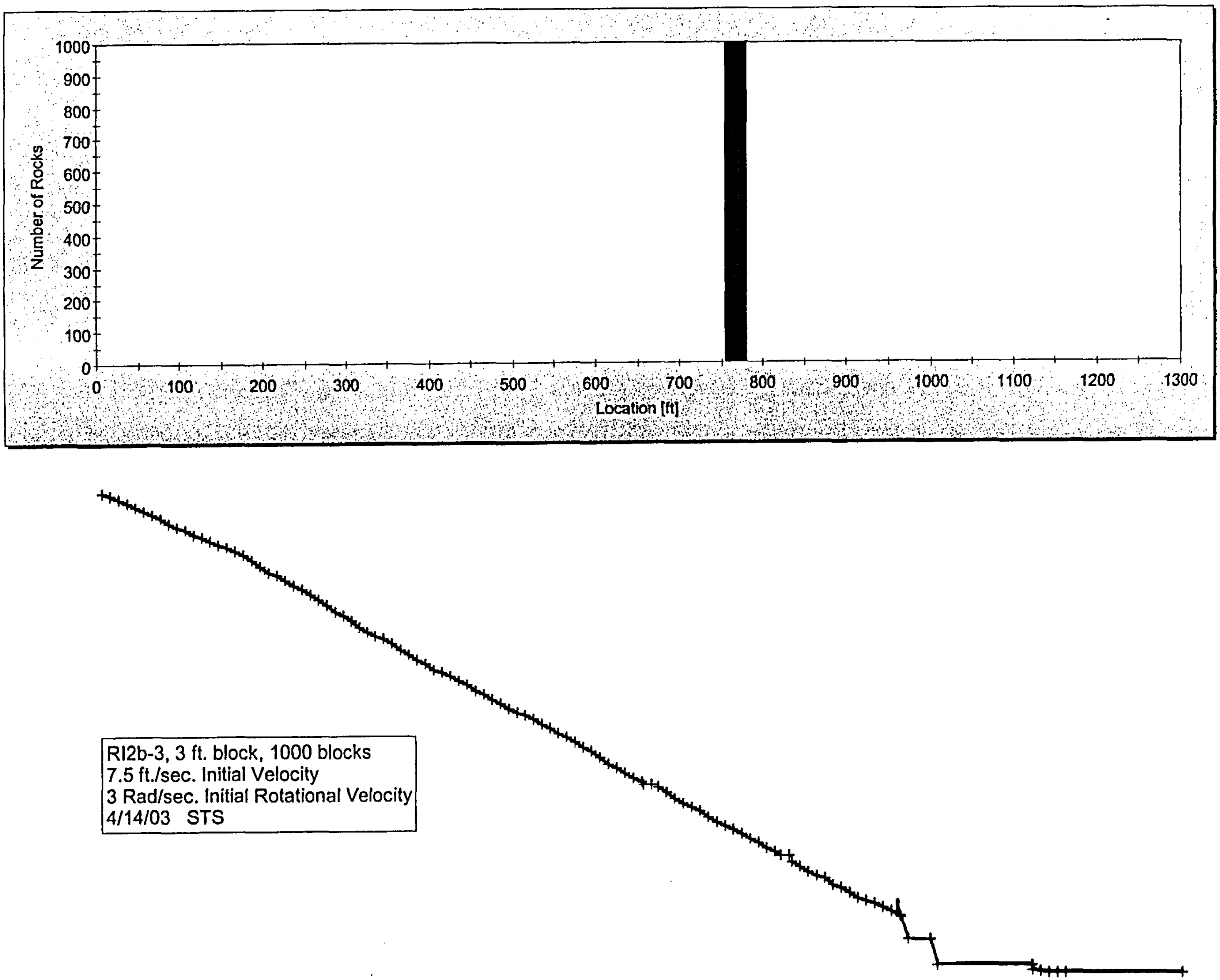
RI2a-10, 10 ft. block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

Horizontal Location of Rock End-points

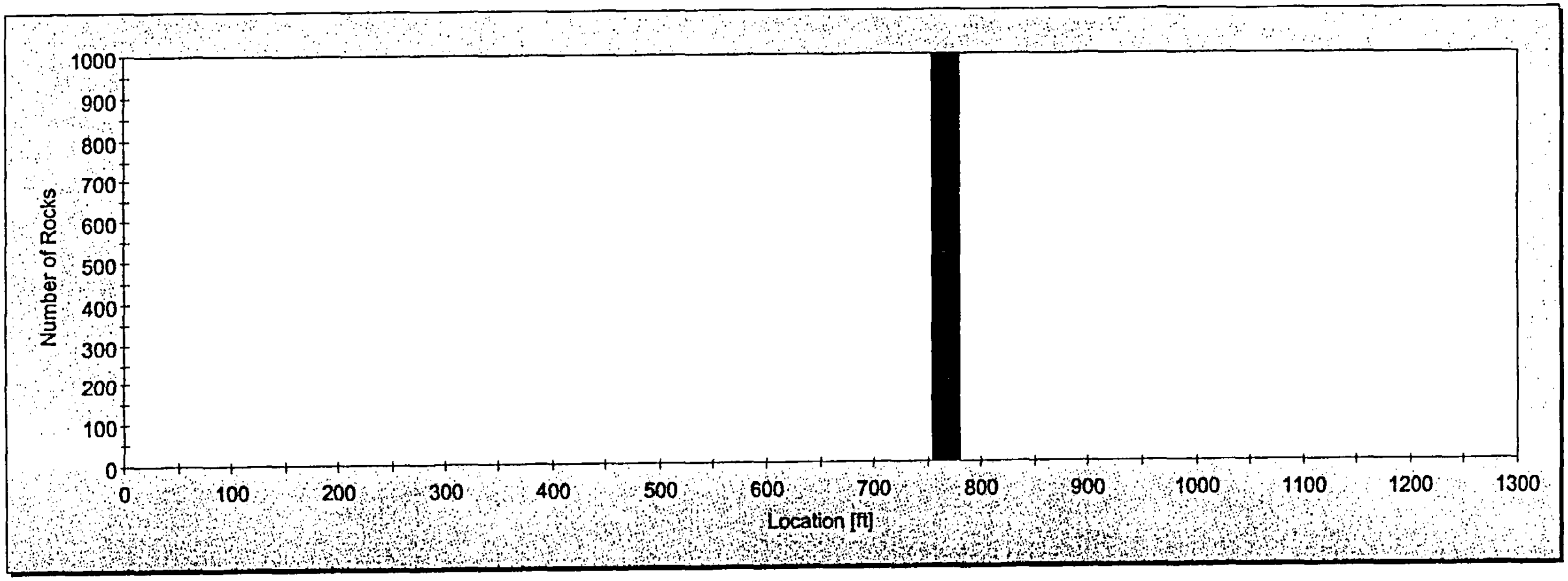


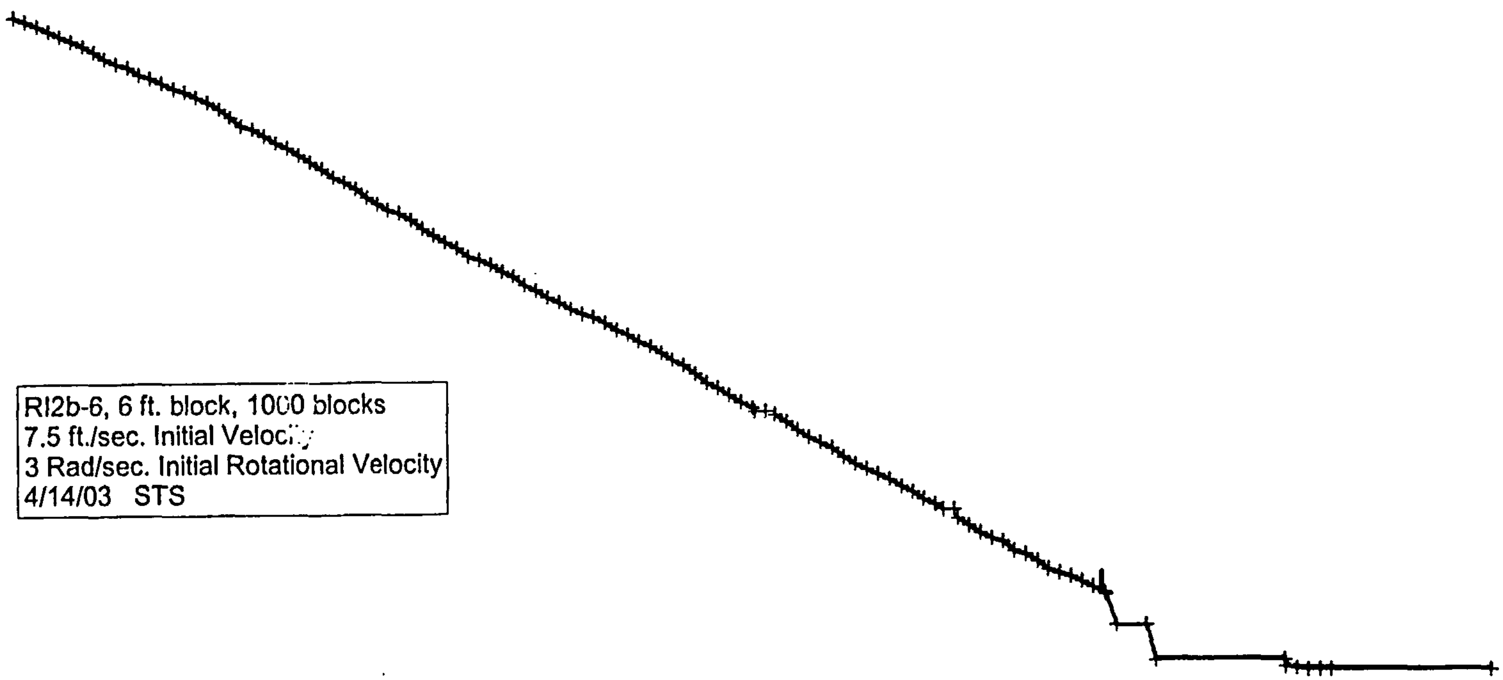


Horizontal Location of Rock End-points



Horizontal Location of Rock End-points





RI2b-6, 6 ft. block, 1000 blocks
7.5 ft./sec. Initial Velocity
3 Rad/sec. Initial Rotational Velocity
4/14/03 STS

Horizontal Location of Rock End-points