Gradient Measurement Field Trip:
310' Segment Of Applegate Trail At Mt. Sexton Pass

Malcolm Drake, Gradient Consultant
Jumpoff Joe Creek

Mike Walker, Co-Project Leader, Hugo Emigrant Trails Committee
Hugo Neighborhood Association & Historical Society (*Hugo Neighborhood*)

September 15, 2011

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Outline

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Photographs

Edited by Malcolm Drake; Karen Rose, Web Master, Hugo Neighborhood Association & Historical Society; and Mike Walker.

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I. PURPOSE

This field trip was a follow-up trip to several other trips to a 310' roadbed believed to be part of the Applegate Trail (Photo 1). The purpose of the trip was to measure the gradient of the trail segment. For comparison the gradient for I-5 on the south slope of Mt. Sexton toward Jumpoff Joe Creek is posted along I-5 at 6 percent (Appendix D).

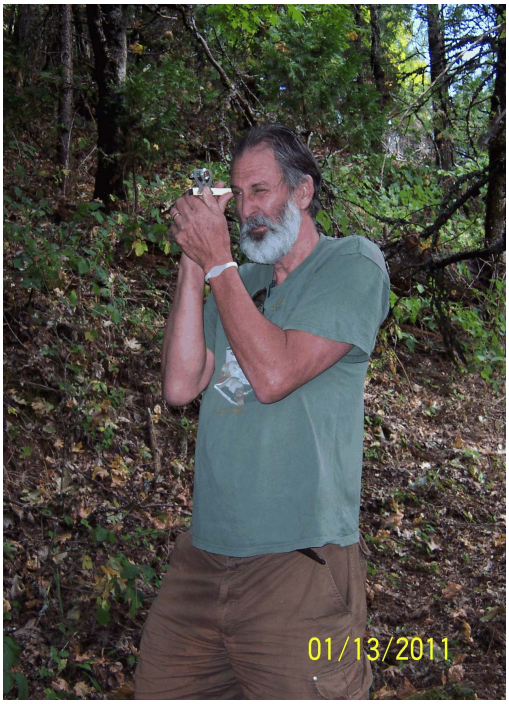

Photo 1. Drake Sighting With Abney Level

Purpose of Hugo Emigrant Trails Committee The goal is for the Hugo Emigrant Trails Committee (*Trails Committee*) to collect and record information about Hugo's emigrant trails, especially its two historic General Land Office (GLO) 1850s roads (i.e,. Applegate Trail), and to share this information through *Hugo History Day*, talks, hikes, group visits, training exercises, workshops, publications, and its web site.

- **Road from Willamette Valley to Jacksonville (JA) (route of the Applegate Trail)**
- **Road to Illinois Valley (IV) via Van Noys Ferry (route of the Applegate Trail from Widow Niday's place to ferry location on Rogue River)**

Hugo's two Applegate Trail routes of interest total approximately 32 miles (i.e., 11 miles IV Road and 21 miles JA Road) from Rogue River in the south to Grave Creek in the north (Map 1 is one of several maps at the *Hugo Neighborhood's* web site).

Home Page: Hugo Neighborhood Association & Historical Society
Web Page: http://www.hugoneighborhood.org/

Applegate Trail Web Page
Web Page: http://www.hugoneighborhood.org/applegat.htm

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1. *Hugo Neighborhood*. February 16, 2005. *Hugo Emigrant Trails Committee*, Brochure 2 in Emigrant Trails Series. Hugo, OR.
2. *Hugo Neighborhood*. February 16, 2005. *Public Outreach & Educational Brochure Program: Hugo's Emigrant Trails.* Brochure 1 in Emigrant Trails Series. Hugo, OR.

Participants On September 15, 2011 there were two participants on the field trip to measure the gradient of the Trail: Malcolm Drake, Gradient Consultant, and Mike Walker, Co-Project Leader, Hugo Emigrant Trails Committee.

Accomplishments Two gradient measurements were surveyed of the Applegate Trail - 310' Segment at Mt. Sexton Pass (Map 2; Section III).

II. RESOURCES

The creek next to the 310' segment of the Applegate Trail at Mt. Sexton Pass is locally known as Maple Creek. This creek is unnamed on the 1998 Merlin, Oregon Quadrangle.

A. 1923 Oregon Riddle Quadrangle

Goode, R. U., Geographer in Charge. Edition of 1904, Reprinted in 1923. *Oregon Riddle Quadrangle*. Department of Interior, U. S. Geological Survey. Scale 1:125,000. Contour 100'. Surveyed in 1901 - 1902.

At a scale of 1:125,000 and a contour of 100' it is difficult to estimate the Mt. Sexton Pass's elevation. The Sexton Mt. Pass is contained between the 2,000' and 2,100' Contours. The distance in a north-south direction between these contours is approximately 940'. This distance provides little useful information concerning the location of the summit except that it is relatively broad and flat.

There is a dot adjacent and east of the wagon road (i.e., Applegate Trail) exactly where we would expect the Smith house to be located (Section II.B.1).

B. 1940 Sexton Mt. Right-Of-Way Map

Oregon State Highway Department. August 1940. *Right of Way Map, Sexton Mt. Section. Pacific Highway, Josephine County*. Scale 1" = 100'. Part 1 of 2, Drg. No. 5B-28-11.

1. *John Smith Family: Hugo Pioneers*

Hugo Neighborhood Association & Historical Society and Josephine County Historical Society. January 13, 2008, Updated August 3, 2011. *John Smith Family: Hugo Pioneers*. Very Draft Brochure 73 in Hugo's Pioneers Brochure Series. Hugo, OR (Web published at http://www.hugoneighborhood.org/hugospioneerseriesbro.htm.

> **1877** "*John and Susan took up a one hundred and sixty acre homestead in a meadow on the north side of Sexton Mountain. This meadow is where the present Interstate 5 freeway cut is located. At the time they homesteaded, the overland stage road ran through this property. John and Susan farmed their homestead until just after the turn of the century.*" (McLane, Larry L. 1995. *First There Was Twogood.* Sexton Enterprises. Sunny Valley, OR).

1896 Hugo Homestead On September 16, 1896 John S. W. Smith was issued a homestead patent for 160 acres in Hugo, Oregon (Patent No. 3749).

2. 1940 *John Smith Family's Barn & House*

The following measurements (Table 1) are from the quarter corner of sections 22 and 23 as depicted on the 1940 Drawing. No. 5B-28-11. The quarter corner as measured from section corner for sections 14, 15, 22, and 23 was 2,665' on the 1940 Drawing No. 5B-28-11.

Table 1. Measurements of Smith Buildings to 1/4 Section for Sections 22 and 23[1]

Buildings[2]	Dimensions	Distance fm 1/4 Corner.[3]	Comments
Barn	25' x 42'	750' E; 340' N	Assumption: Old Smith barn
Ch. Ho.	10' x 10'	1,075' E; 570' N	
Ho. 1	40' x 32'	975' E; 460' N	Assumption: Old Smith house
Ho. 2	15' x 25'	1,050' E; 430' N	
Gar.	12' x 15'	960' E; 390' N	
Ho. 3	25' x 25'	960' E; 310' N	
Hog Ho.	12' x'10'	1,195' E; 475' N	
Weather Bld	6' x 8'	835' E; 185' N	U.S. Weather Bureau Storage Building

1. Oregon State Highway Department. August 1940. *Right of Way Map, Sexton Mt. Section. Pacific Highway, Josephine County*. Scale 1" = 100'. Part 1 of 2, Drg. No. 5B-28-11. The houses were probably part of the Mt. Sexton Summit Auto Court (http://www.hugoneighborhood.org/autocamp.htm). The barn and House No. 1 were probably the old Smith homestead.
2. Building: Ch. Ho. = ?? house; Ho. = house; gar = garage.
3. Distance is from Quarter corner of sections 22 and 23 as measured to approximate center of building.

Roads

Eastern Up Ridge Road is located on Drawing. No. 5B-28-11 and the 1998 Merlin Quad.

Western Up Ridge Road is located on Drawing. No. 5B-28-11 and found on ground.

It is highly probable that the 310' Segment Of Applegate Trail At Mt. Sexton Pass is located on Drawing. No. 5B-28-11. If so, its southern boundary is located from the 1/4 corner of sections 22 and 23: 505' East and 585' South.

The structures identified on the 1941 Drawing. No. 5B-28-11 were all on the north side of Mt. Sexton Summit. These structures themselves had some distance between them. For example, there was 245' in a north-south direction from the Ch. (Children's?) House to the House. No. 3 and 455' in an east-west direction between the barn and the Hog House.

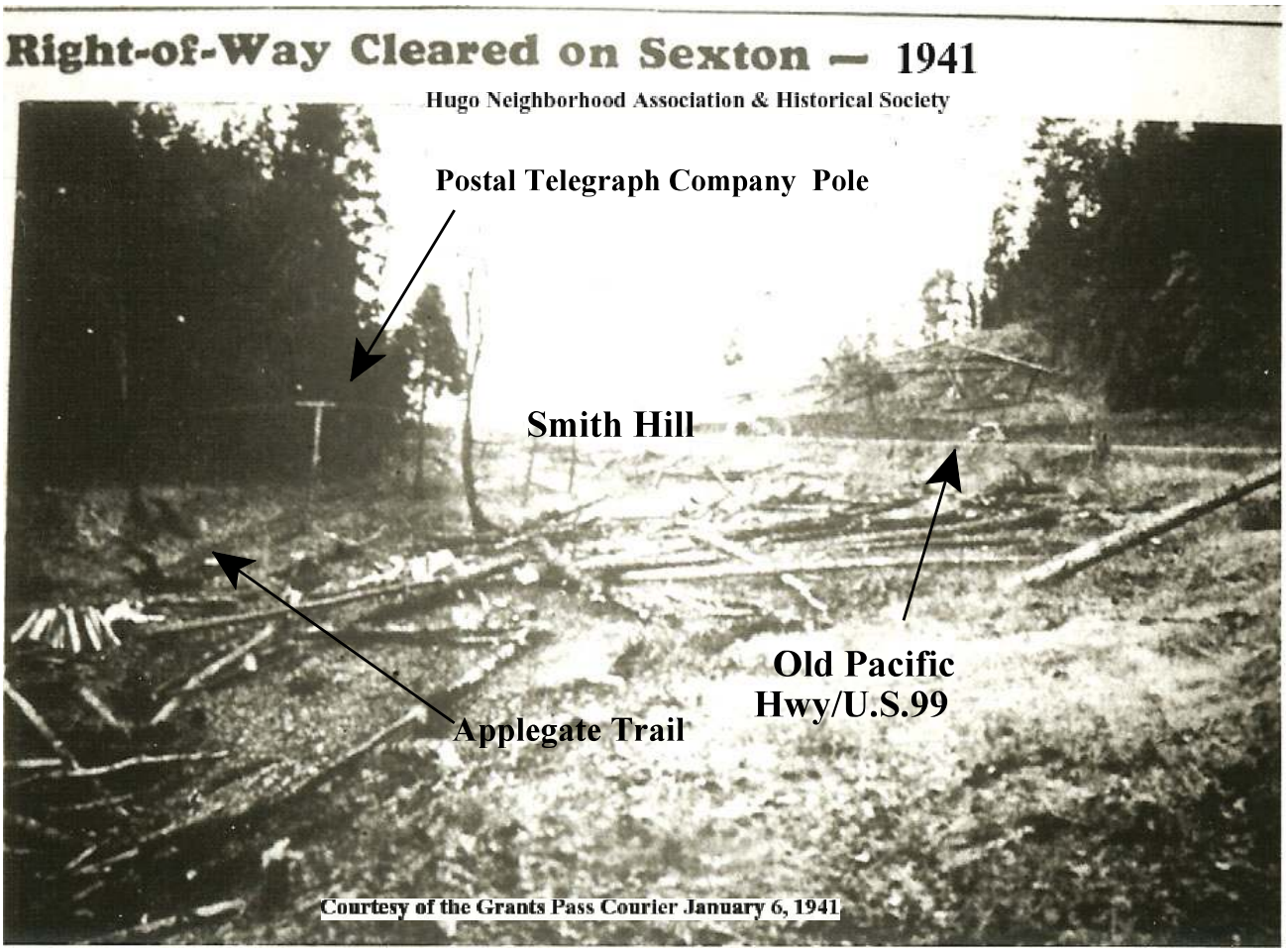

Photo 2. Right-Of-Way Cleared On Mt. Sexton Pass: 1941
Courtesy Of Grants Pass Courier

1941 The "*Right-of-way Cleared on Sexton*" photo is courtesy of the *Grants Pass Courier* from its January 6, 1941 edition (Grants Pass Courier. January 6, 1941. Front Page, Right-of-Way Cleared on Sexton. VOL. XXXI., No. 91. Grants Pass, OR). The following is the caption to the photo (Photo 2):

"*The residence* [**John S. W. Smith** homesteaded in 1877; he was issued a homestead patent for 160 acres in Hugo, Oregon September 16, 1896 (Patent No. 3749)] *overlooking the Pacific highway summit* [**Smith Hill**] *on the shoulder of Mt. Sexton has been razed, and trees are being felled for 1.92 miles of new construction soon to take place there. Here is a view toward the summit from the Grants Pass side showing the steep, old dirt road on the left* [**Applegate Trail**],

the curving present highway on the right [**Old Pacific Highway/U.S. 99**], *and the felled trees on the right-of-way of the new work. The highway summit will be lowered several feet by a deep cut. (Courier Photo and Engraving.).*" Photo 3.

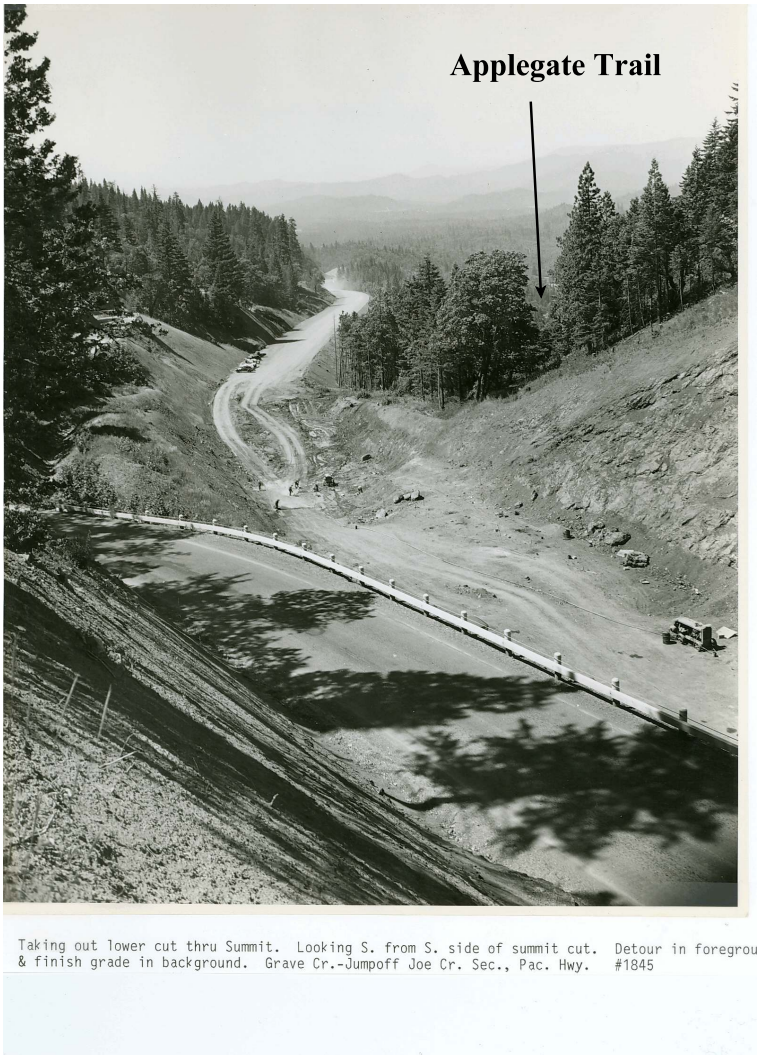

Photo 3. Looking South From Mt. Sexton Summit On Old Pacific Highway: 1941
Courtesy of Oregon Department Of Transportation

Postal Telegraph Company Lines were built through Josephine County around 1886 - 1887. The PT company operated the line until they had six-pin cross arms. The neat thing about the postal line was in the middle of WWII they merged with Western Union and the lines were left in place and they disintegrated into the ground. Howard Banks, Insulator Expert, identified a down pole at the south end of the road segment as a Postal Telegraph Company pole part of a line from the 1886 - 1887 when everything was pole to pole (Photo 2).

Hugo Neighborhood Association & Historical Society and Josephine County Historical Society. April 21, 2010. *JR Of Applegate Trail: 1886 - 1887 Postal Telegraph Line At Mt. Sexton Pass*. Hugo, OR. This brochure is web published on the Hugo Neighborhood's web page at http://www.hugoneighborhood.org/hugospioneerseriesbro.htm.

Hugo Neighborhood Association & Historical Society and Josephine County Historical Society. April 21, 2010. *JR Of Applegate Trail: 1941 At Mt. Sexton Pass*. Hugo, OR. This brochure is web published on the Hugo Neighborhood's web page at http://www.hugoneighborhood.org/inventorybrochures.htm.

C. 1954 USGS Glendale, Oregon Quadrangle

1954 Mt. Sexton Pass At a scale of 1:62,500 and a contour of 80" it is difficult to estimate the Mt. Sexton Pass's elevation. The Sexton Mt. Pass is contained between the 1,920' and 2,000' contours. The distance in a north-south direction between these contours is approximately

1,584'. This distance provides little useful information concerning the location of the summit except that it is relatively broad and flat.

Rat Creek This USGS Glendale map is a surveyed map with features accurately located. The 1954 USGS topo clearly identifies Rat Creek flowing north into Grave Creek. An East Fork of Rat Creek is identified. The upper stretch of Rat Creek on an east-west alignment in the center of Section 14 (on the east side of today I-5) is also identified. The south fork of Rat Creek is unnamed without it being identified as a perennial stream on the map. However, the north-south drainage of the South Fork Rat Creek is clearly identified by the topography contours with several summer field trips verifying the stream was active.

Bummer Creek The 1954 USGS topo identifies Bummer Creek with two unnamed tributaries, one of which is the creek by the 310' segment of the Applegate Trail in section 23 and the other unnamed tributary goes through the Kennison Reservoir in section 28.

D. 1998 Merlin, Oregon Quadrangle & 1996 Sexton Mountain, Oregon Quadrangle

1998 Mt. Sexton Pass At a scale of 1:24,000 and a contour of 40' the 1998 Mt. Sexton Pass's elevation can be estimated. The Sexton Mt. Pass is contained between the 2,000' and 1,960' contours. The ODOT highway sign at Mt. Sexton Pass identifies the elevation at 1,960'. The National Weather Service Forecast Office identifies it as 1,956'. The distance in a north-south direction between these contours is approximately 400'. This distance provides little useful information concerning the location of the summit except that it is relatively broad and flat.

Rat Creek These two USGS topographic quadrangles in Josephine County, Oregon are 7.5 minute topographic maps with a scale of 1:24,000 and a contour interval of 40 feet.

The 1998 Merlin, Oregon Quadrangle is a surveyed map with features accurately located. The 1998 USGS topo clearly identifies Rat Creek flowing north into Grave Creek. An East Fork of Rat Creek is identified. The upper main stem of Rat Creek on an east-west alignment in the center of Section 14 (on the east side of today I-5) is also identified. The south fork of Rat Creek is unnamed without it being identified as a perennial stream on the map. However, the north-south drainage of the South Fork Rat Creek is clearly identified by the topography contours with several summer field trips verifying the stream was active.

The 1996 Sexton Mountain, Oregon Quadrangle is a surveyed map with features accurately located. The 1998 USGS topo identifies an East Fork of Rat Creek and the main stem of the upper stretch of Rat Creek on an east-west alignment in the center of Section 14 (on the east side of today I-5).

Bummer Creek The 1998 Merlin, Oregon Quadrangle identifies Bummer Creek with three unnamed tributaries, one of which is the creek by the 310' segment of the Applegate Trail in section 23, another unnamed tributary which originates in section 22, and the third other unnamed tributary goes through the Kennison Reservoir in section 28.

E. 1970 Rogue Drainage Basin Map

State Water Resources Board. 1970. *Rogue Drainage Basin, Oregon*. Map No. 15.6. Salem, OR

Walker feels that Map No. 15.6 is a very detailed map and the only one he has found that identifies and locates Antler Creek which is a tributary of Jumpoff Joe Creek (very close and upstream from Schoolhouse Creek) and Maple Creek which appears to be the unnamed south fork of Rat Creek. It is also much more comprehensive in identifying springs and reservoirs.

Photo 5. Drake's Abney Level

Bummer Creek is identified with its headwaters being the creek next to the 310' segment of the Applegate Trail at Mt. Sexton Pass which is locally known as Maple Creek. This creek is unnamed on the 1998 Merlin, Oregon Quadrangle. The unnamed tributary of Bummer Creek that passes through the Kennison Reservoir in section 28 is also unnamed.

There are three springs (quotes from map follow: "Olden Spr, Canteen Spr, and Maple G Spr") identified in the very NE corner of section 27. These springs are not identified on the 1954 Glendale, Oregon Quad nor the 1998 Merlin, Oregon Quad.

III. MEASUREMENTS

Malcolm has his own K-E Abney Level or surveyor level. The Abney Level is a device that can be used for measuring slope. It can also be used to determine the heights of trees, poles, overhead wires and the like, to measure ground elevations, to reduce measurements made on a slope to their horizontal equivalents, and to run lines of levels.

Malcolm stated, "The Abney Level is potentially very accurate, and it is also hard to use accurately because the bubble bounces around unless you hold it real steady. To get a good reading you have the hold the level for quite a long time." "The Abney has a bubble level. The fluid inside of the bubble has some material, probably oil, which makes the bubble slow to move. This instrument has been around since the 1870s."

Drake was hired for very minimum wage by the Hugo Emigrant Trails Committee to measure the slope of the old road (i.e., Applegate Trail - 310' Segment at Mt. Sexton Pass).

The procedure is that Mike will be standing downslope approximately 50' with a pole which has orange tape at the height of Malcolm's eyes.

Photo 6. ODOT Stake No. 826 At Big Tree

Malcolm will sight through the Abney's eyepiece the orange ribbon on the pole until he sees the bubble centered on the horizontal line that appears in the center of the Abney's field of view at his eye height while sighting downslope to orange ribbon on the pole Mike is holding. Malcolm while holding the Abney will adjust the meter scale which on this model will indicated the slope in degrees. Malcolm uses a trig table to convert degree of slope to percent slope.

Malcolm estimated the slope was going to be 6 - 7 degrees slope. He was right on.

A. Gradient Shot # 1

Shot Location # 1 was located approximately 15' south of the fallen log at the north end of the Trail segment. Mike traveled downhill to a location close to the "Big Tree".

Sight Location # 1 Mike held the ranging pole about 5' downhill from the Big Tree (Sight Location # 1 at ODOT stake number 824; Photo 6) in a line of gradient for Malcolm to take the gradient shot (Photo 7). Malcolm paced off the distance from Shot 1. The distance between Shot Location # 1 and Sight Location No. # 1 is 66'.

Mike was using a cedar staff he had brought from home. It was used as the ranging pole and marked with orange tape at the eye height of the level user (Malcolm Drake).

Gradient Degrees: 6 Degrees/11 Percent

Six (6) degrees was the gradient shot by Malcolm between Shot Location # 1 and Sight Location # 1 (6 degrees down from horizontal).

Malcolm used a standard trig table DEG (degree; Photo 8), TAN (tangent which is the same as percent when used for this purpose).

Six (6) degrees gradient or slope is 11% gradient or slope.

Photo 7. Drake Taking Abney Sighting From Big Tree

Malcolm explained, “To give a comparison, a 45 degree slope equals 100 percent slope.” Because it is 100' out and 100' up.”

Photo 8. Trig Table For Converting Degrees To Percent Slope

B. Gradient Shot # 2

Shot Location # 2 was Sight Location No. # 1 about 5' downhill from the Big Tree.

Sight Location # 2 was 84' downhill on the trail segment from Shot Location # 2 (Photo 9).

Gradient Degrees: 7 Degrees/12 Percent

Seven (7) degrees was the gradient shot between Shot Location # 2 and Sight Location # 2 (7 degrees down from horizontal). Malcolm believes these data are correct within one degree or so. Seven (7) degrees gradient or slope is 12 % gradient or slope

Photo 9. Walker Holding Ranging Pole

Photo 8. Trig Table For Converting Degrees To Percent Slope
Photo 9. Walker Holding Ranging Pole

IV. SUMMARY

In summary, two grades were surveyed for the 310' Segment Of Applegate Trail At Mt. Sexton Pass.

A. Gradient Degrees: 6 Degrees/11 Percent

Six (6) degrees was the gradient Shot Location # 1 and Sight Location # 1 (6 degrees down from horizontal). Six (6) degrees gradient or slope is 11% gradient or slope. The distance between Shot Location # 1 and Sight Location No. # 1 is 66'.

B. Gradient Degrees: 7 Degrees/12 Percent

Seven (7) degrees was the gradient shot between Shot Location # 2 and Sight Location # 2 (7 degrees down from horizontal). Seven (7) degrees gradient or slope is 12 % gradient or slope. Sight Location # 2 was 84' downhill on the trail segment from Shot Location # 2.

V. FUTURE WORK

A. Future Project

Measure the distance **(d)** from the north end of the 310' segment of the Applegate Trail at Mt. Sexton Pass (area where Malcolm shot the gradient **(A)**) to an area on I-5 where we think the old original Mt. Sexton Pass was located **(B)** (Photo 2).

Calculate/Estimate the elevation of the north end of the 310' segment **(A)** and the elevation of the original pass summit **(B)**.

Do some algebra and project gradient (i.e., 6 - 7 degrees, Section III) from **(A)** to **(B)**.

B. Locations

1. Summit Of Mt. Sexton Pass (Location B)

Based upon topography maps and the 1940 Drawing. No. 5B-28-11, we presently assume the summit topography was relative broad and flat. Therefore, we would expect the actual height of the summit would be lower than that shown in Figure 1. In other words, the value calculated for DELTA h in that figure would be too large.

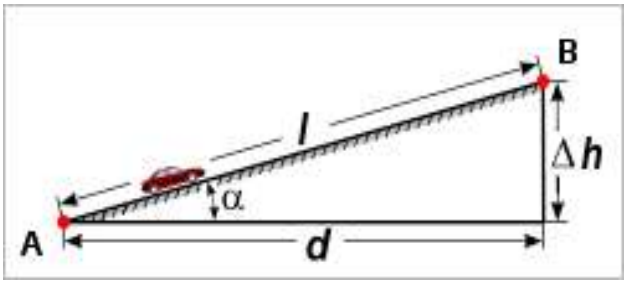

Figure 1. Grade Of Topographic Feature

The structures identified on the 1940 drawing were all on the north side of Mt. Sexton Summit. These structures themselves had some distance between them. For example, there was 245' in a north-south direction from the Ch. (Children?) House to the House No. 3 and 455' in an east-west direction between the barn and the Hog House.

At a scale of 1:125,000 and a contour of 100' it is difficult to estimate the Mt. Sexton Pass's elevation from the 1923 Oregon Riddle Quadrangle. The Sexton Mt. Pass is contained between the 2,000' and 2,100' contours. The distance in a north-south direction between these contours is approximately 940'.

At a scale of 1:24,000 and a contour of 40' the 1998 Mt. Sexton Pass's elevation can be estimated from the 1998 Merlin Quad. The Sexton Mt. Pass is contained between the 2,000' and 1,960' contours. The ODOT highway sign at Mt. Sexton Pass identifies the elevation at 1,960'. The National Weather Service Forecast Office identifies it as 1,956'. The distance in a north-south direction between these contours is approximately 400'. However, this is the lower cut elevation.

GPS marks will be taken of elevation at present 2011 U.S. 99 at top of Mt. Sexton Pass. The elevation will probably not be accurate enough for our purposes, but it is another relative index.

2. 310' Segment Of Applegate Trail At Mt. Sexton Pass (Location A)

It is highly probable that the 310' Segment Of Applegate Trail At Mt. Sexton Pass is located on Drawing. No. 5B-28-11. If so, its southern boundary is located from the 1/4 corner of sections 22 and 23: 505' East and 585' South.

Investigate surveys and/or monuments associated with buried utility right-of-way (ROW) at end of 310' Segment Of Applegate Trail At Mt. Sexton Pass.

GPS marks will be taken of elevation at 310' segment of Applegate Trail at Mt. Sexton Pass. The elevation will probably not be accurate enough for our purposes, but it is another relative index.

C. Distances

1. Elevation Between the Original Mt. Sexton Summit and the 310' Segment Of Applegate Trail At Mt. Sexton Pass (h)

According to Harrington, the original summit was 2,046' "*According to a sign that was there when Harrington visited in November, 1933, the elevation of the pass was 2,046'.*"[1]

2. Horizontal Distance Between the Original Mt. Sexton Summit and the 310' Segment Of Applegate Trail At Mt. Sexton Pass (d)

A reasonable approximation for this distance would be to take measurements along the I-5 ROW from the estimated original Mt. Sexton Summit and the 310' Segment Of Applegate Trail At Mt. Sexton Pass.

3. Slope Distance Between the Original Mt. Sexton Summit and the 310' Segment Of Applegate Trail At Mt. Sexton Pass (l)

This distance will be calculated.

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1. Harrington, John Peabody . 1981 *The Papers of John Peabody Harrington in the National Anthropological Archives of the Smithsonian Institution 1907-1957.* Reel number 28. Kraus International Publications. Millwood, New York.

D. Hypothesis

Alternative 1. Great if the gradient calculated from the two Abney Level gradient surveys for the 310' Segment Of Applegate Trail At Mt. Sexton Pass identifies Location B. However, it is assumed that this will not occur because the summit is so broad.

Alternative 2. Something Wrong if the gradient calculated from the two Abney Level gradient surveys for the 310' Segment Of Applegate Trail At Mt. Sexton Pass identifies Location B at a higher elevation than the known original summit elevation.

Alternative 3. O.K if the gradient calculated from the two Abney Level gradient surveys for the 310' Segment Of Applegate Trail At Mt. Sexton Pass identifies Location B at a lesser elevation than the known original summit elevation.

VI. FIELD TRIP MINUTES

Malcolm Drake and Mike Walker finalized the minutes on October 4, 2011

Sincerely,

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Hugo GLO Field Review SubCommittee
Hugo Neighborhood Association & Historical Society

Hugo Native American Team
Hugo Neighborhood Association & Historical Society

Thomas Doty, Storyteller
Doty & Coyote: Stories from the Native West

APPENDIX A. ABNEY LEVEL

Abney level - a surveying instrument consisting of a spirit level and a sighting tube; used to measure the angle of inclination of a line from the observer to the target - among other purposes..

Surveyor's level - surveying instrument consisting basically of a small telescope with an attached spirit level rotating around a vertical axis; for measuring relative heights of land

Wikipedia, the Free Encyclopedia Downloaded the following from Wikipedia, the free encyclopedia on September 16, 2011 (http://en.wikipedia.org/wiki/Abney_level).

> "A **Topographic Abney Level** is an instrument used in surveying which consists of a fixed sighting tube, a movable spirit level that is connected to a pointing arm, and a protractor scale. The Topographic Abney Level is an easy to use, relatively inexpensive, and when used correctly an accurate surveying tool. The Topographic Abney Level is used to measure degrees, percent of grade, topographic elevation, and chainage correction. By using trigonometry the user of a Topographic Abney Level can determine height, volume, and grade. The Topographic Abney Level is used at the eye height of the surveyor and is best employed when teamed with a second surveyor of the same eye height. This allows for easy sighting of the level and greater accuracy. A **ranging pole** can be marked at the eye height of the level user or the approximate location of the eye height (i.e. chin, nose, top of head) of the level surveyor must be know of the ranging surveyor."

APPENDIX B. GRADIENT

Wikipedia, the Free Encyclopedia Downloaded the following from Wikipedia, the free encyclopedia on September 19, 2011 (http://en.wikipedia.org/wiki/Gradient; http://en.wikipedia.org/wiki/Grade_(slope)).

For the measure of steepness of a road, Grade (slope). For the measure of steepness of a line, see Slope. For other uses, see Gradient (disambiguation). In vector calculus, the gradient of a scalar

field is a vector field that points in the direction of the greatest rate of increase of the scalar field, and whose magnitude is the greatest rate of change.

Grade This article is for the grade of a topographic feature or constructed element, for other uses see: Slope (disambiguation). The grade (also called slope, incline, gradient, pitch or rise) of a physical feature, topographic landform or constructed element, refers to the amount of inclination of that surface to the horizontal. It is a special case of the gradient in calculus where zero indicates gravitational level. A larger number indicates higher or steeper degree of "tilt". Often slope is calculated as a ratio of "*rise*" to "*run*", or as a fraction ("*rise* over *run*") in which *run* is the horizontal distance and *rise* is the vertical distance. [Almost the same as "percent slope"; when the rise is divided by the run, then multiplied by 100, that equals the percent slope.]

Grade or slope is applied to measuring existing physical features (such as canyon and hillsides, stream and river banks and beds), or in designing and engineering new elements for construction (such as roads, landscape and garden grading, roof pitches, railroads, aqueducts, and pedestrian handicapped-bicycle circulation routes).

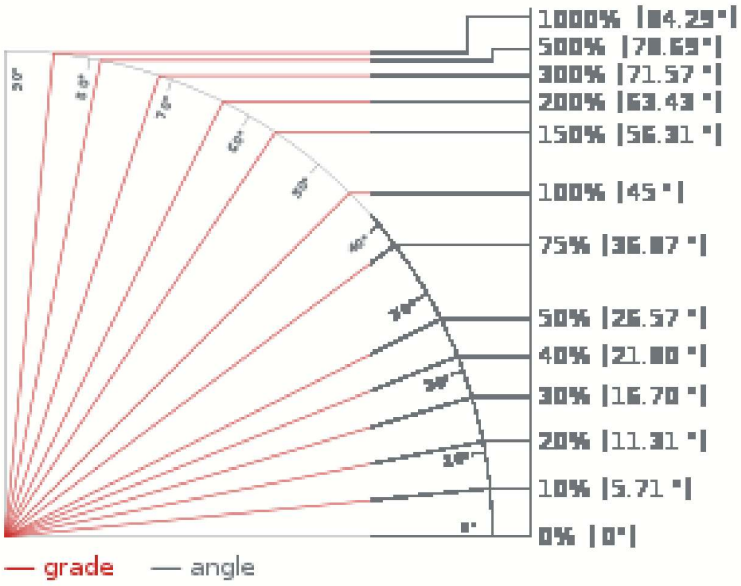


Figure 2. Grade and Percentage

There are several systems for expressing slope:

1. as an *angle* of inclination to the horizontal. (This is the angle α a opposite the "rise" side of a triangle with a right angle between vertical rise and horizontal run.) [For what it's worth, it does not have to be a right triangle.]

2. as a *percentage*, the formula for which is [100 rise/run] which could also be expressed as the tangent of the angle of inclination times 100. In the U.S., this percentage "grade" is the most commonly used unit for communicating slopes in transportation (streets, roads, highways and rail tracks), surveying, construction, and civil engineering.

3. as a *per mille* figure, the formula for which is [1000 rise/run] which could also be expressed as the tangent of the angle of inclination times 1000. This is commonly used in Europe to denote the incline of a railway.

4. as a *ratio* of one part rise to so many parts run. For example, a slope that has a rise of 5 feet for every 100 feet of run would have a slope ratio of 1 in 20. (The word "in" is normally used rather than the mathematical ratio notation of "1:20"). This is generally the method used to describe railway grades in Australia and the UK.

Any one of these expressions may be used interchangeably to express the characteristics of a slope. Grade is usually expressed as a percentage, but this may easily be converted to the angle αa from horizontal since that carries the same information.

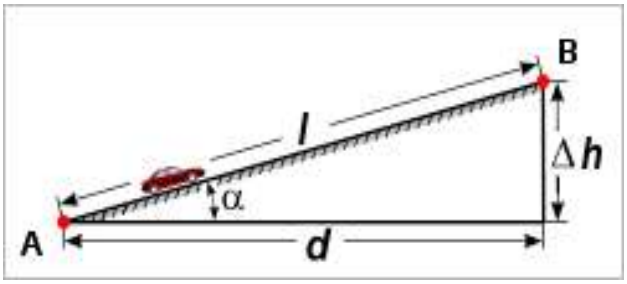


Figure 1. Grade Of Topographic Feature

There is a method in which slope may be expressed when the horizontal run is not known: rise divided by the hypotenuse (the slope length). This is *not* a usual way to measure slope. This follows the sine function rather than the tangent function and this method diverges from the "rise over run" method as angles start getting larger (see small-angle formula).

APPENDIX C. MALCOLM DRAKE'S ABNEY LEVEL

There is a good web resource that describes Drake's K-E Abney Level at: Abney Level Manual: http://www.surveyantiques.com/content/k_e/Keuffel_Esser_Abney_Manual/k_e_abney_level_manual-viewer.htm

Malcolm references the reader to pages 15 - 18 of the above manual. Malcolm feels these five pages are descriptive of how his Abney works. His Abney is the Abney Reflecting Level (either a K&K Nos. N5710 and N5710P). The following information is from page 18 of the referenced Abney Level Manual.

> "The bubble and index arm are regulated by the large knurled disc and are locked in position by the small knurled knob. The eyepiece slide can be extended to accommodate the observer's eyesight. The arc extends to 90". The instrument may be used as a contact level or as a surface clinometer."
>
> "Adjustment. Only the bubble adjustment is required for this instrument. Except that only one screw is used to regulate the buddle, the adjustment is performed exactly as describe for the Topographic Abney." [pages 15 - 17]
>
> "The adjusting screw is at that end of the bubble tube which is nearest the eyepiece. A small horizontal brass screw in the end of the tube also identifies the end at which the adjustment is made. The screw at the other end must be kept tight."

APPENDIX D. LOCAL MOUNTAIN GRADE INFORMATION

No information is intended to tell you how to navigate a mountain grade.

Question: What does the (%) percentage grade mean?

Answer: It refers to how many feet you'll descend/ascend per 100 horizontal foot of roadway. On a 5% grade, you'll descend/ascend 5 feet per 100 horizontal feet of roadway.

A grade has a *percentage* and a *length*. For example, let's take a 6% grade that is 10 horizontal miles long. This means that for every 100 horizontal foot of roadway, you are going to drop 6 feet. For each 1% of grade you'd descend 52.8 feet, since 5,280 feet equals one mile.

The drive along Interstate 5 offers scenic views of the mountains and valleys as it climbs Stage Road Pass, Smith Hill Summit, and Sexton Mountain Pass. There are several stretches of five and six percent grades on these passes.

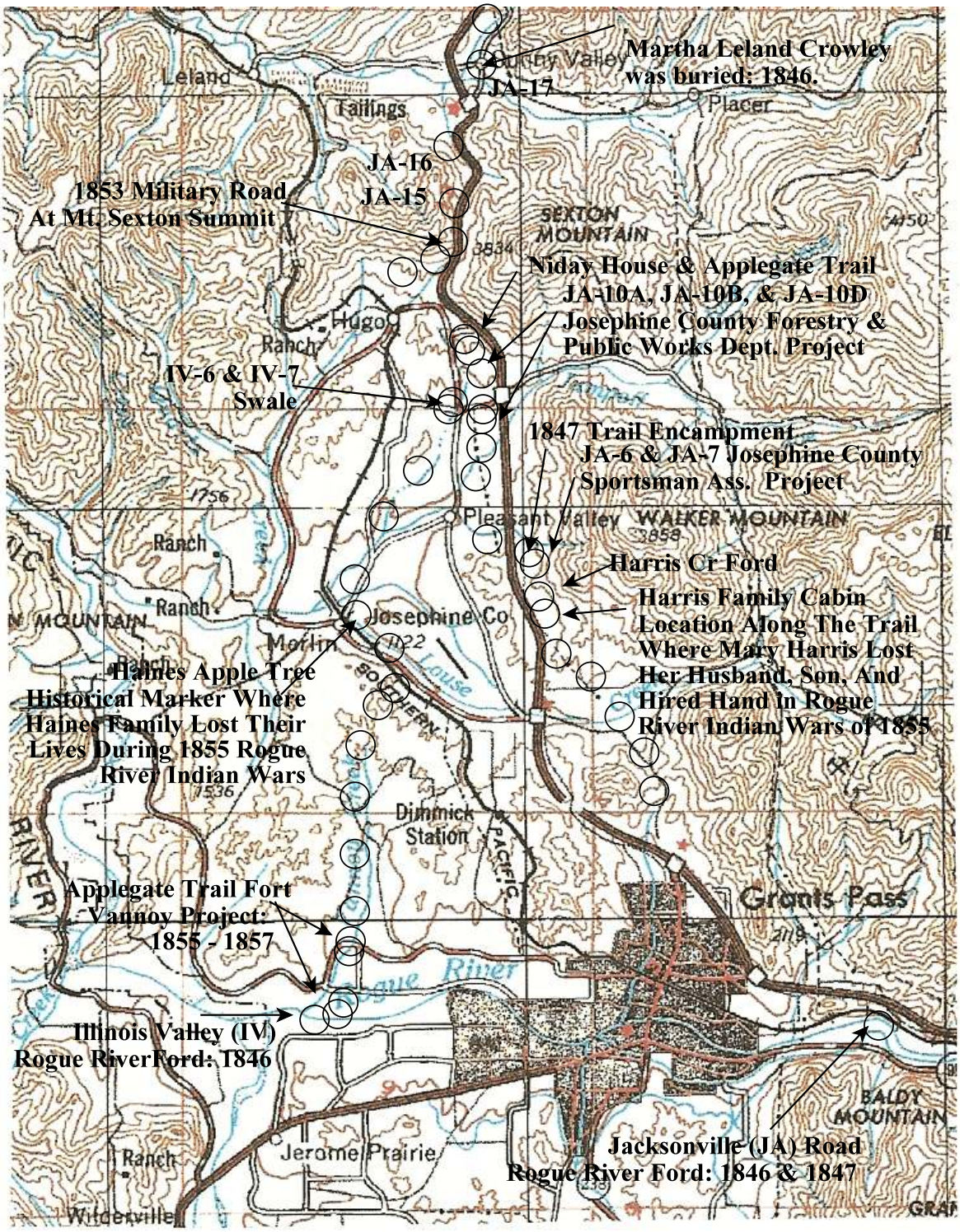
Mountain Directory books tell you where the steep grades are, how long they are, how steep (%) they are, whether the road is two lane, three lane, or four lane, if there are escape ramps, switchbacks, sharp curves, speed limits, etc.

Pass Name	Elevation*	I-5 Gradient
Canyon Creek:	Elevation: 2,020'*	Grade: ??
Stage Road Pass	Elevation: 1,830'*	Grade: ??
Smith Hill Summit	Elevation: 1,730'*	Grade: ??
Sexton Mountain Pass	Elevation: 1,956'*	Grade: Zero (0) percent
Sexton Mt. Pass Grade Toward Jumpoff Joe		Grade: Six (6) percent

* Elevations are from the National Weather Service Forecast Office. Downloaded September 20, 2011 from http://www.wrh.noaa.gov/pqr/elevations_cascades.php.

The elevation at Mt. Sexton Pass according to a sign at its summit is 1,960'. This is a difference of four (4) feet from the National Weather Service Forecast Office elevation.

Map 1. Hugo Applegate Trail Project Area



Map 2. 310' Segment of Applegate Trail at Mt. Sexton Pass
(HNA&HS No. OR-JA-00-34-06-23-Mt. Sexton Pass)
(1998 USGS Base Map)