

Intellislope™ Installation Accuracy

Profile Accuracy

Tile's ability to drain requires higher elevation far from the outlet and relatively lower elevation at the outlet, allowing water to run downhill toward the outlet (Figure 1). Thus an important criterion for evaluating Intellislope is its ability to adhere to a desired tile installation profile. This technical note presents some representative data from our field testing. Data from a laser control system is also presented.



Figure 1: Water drains from the main outlet of a field tiled using Intellislope

Figure 2 is the profile generated from a typical Intellislope log. The X axis indicates progress along the installation path (run), and the Y axis indicates elevation of the installed tile at that run. Note that this graph does not depict the shape of the tile as it would appear when viewed from the side because the scale is highly rectangular, as opposed to square. This means that the vertical direction is highly exaggerated, or stretched. In this plot, the Y axis range is a fraction of a meter, whereas the X axis range exceeds 70 meters. Also note that the major divisions on the Y axis are 0.1 meter. This is convenient in that it is 10 centimeters, approximately 4", which is the inside diameter of 4" pipe. The major division thus provides a convenient means of normalizing the vertical direction for the pipe's diameter.

Intellislope logs a time sequence of a number of values including the target elevation (yellow line on the plot), current GPS altitude (red diamonds) and current estimated altitude (blue line). The estimated altitude is produced by the intellislope estimation algorithm by combining the GPS altitude with the slope sensor using a technique known as

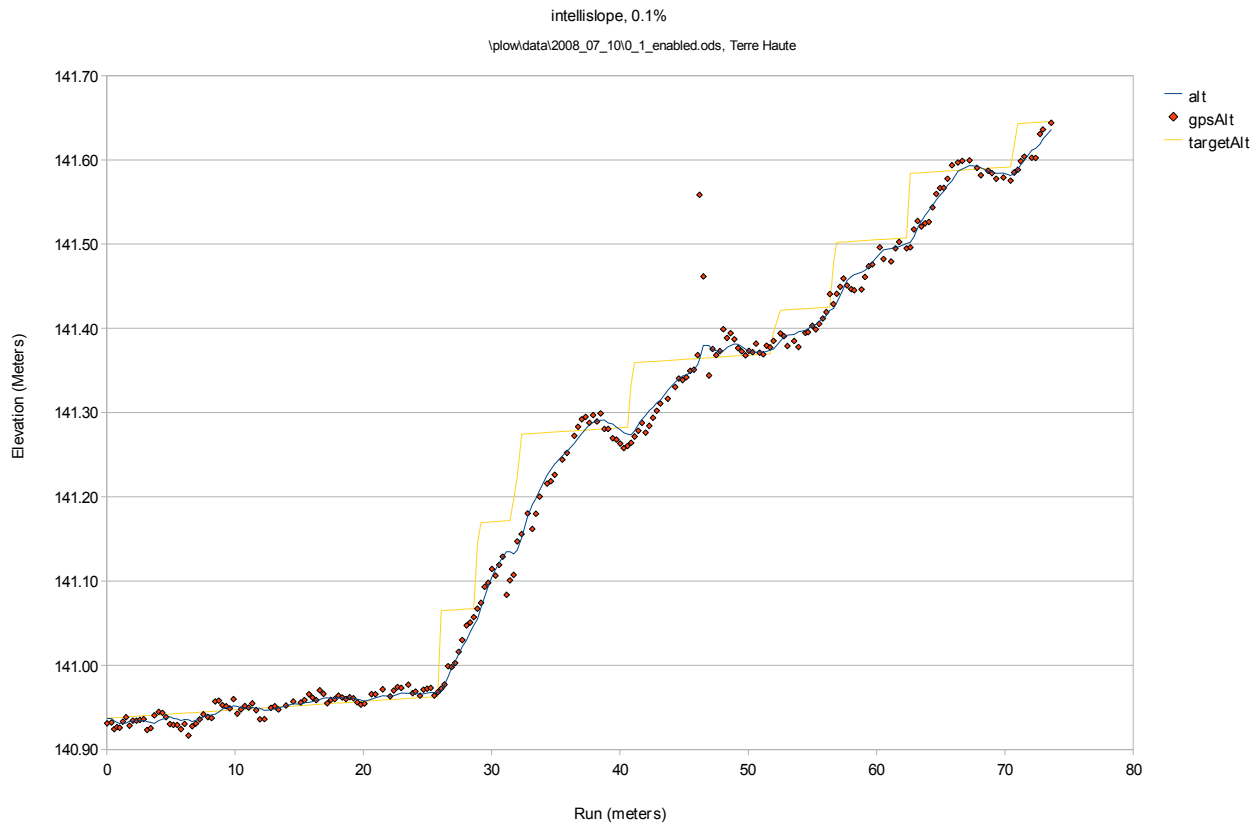


Figure 2: Intellislope tile installation log, Leica Mojo RTK GPS.

Kalman filtering. This technique allows noise in the GPS elevation to be attenuated, based on the physics of plow motion and its known pitch orientation provided by the pitch sensor. In Figure 2, the yellow line denotes the target elevation that intellislope is aiming at. Notice it begins following a straight line with 0.1% grade, and then experiences a series of step-like jumps. These jumps are grade breaks initiated by the operator in the cab. These behave similarly to grade breaks created with a laser control system, except no mast or motor is involved in Intellislope.

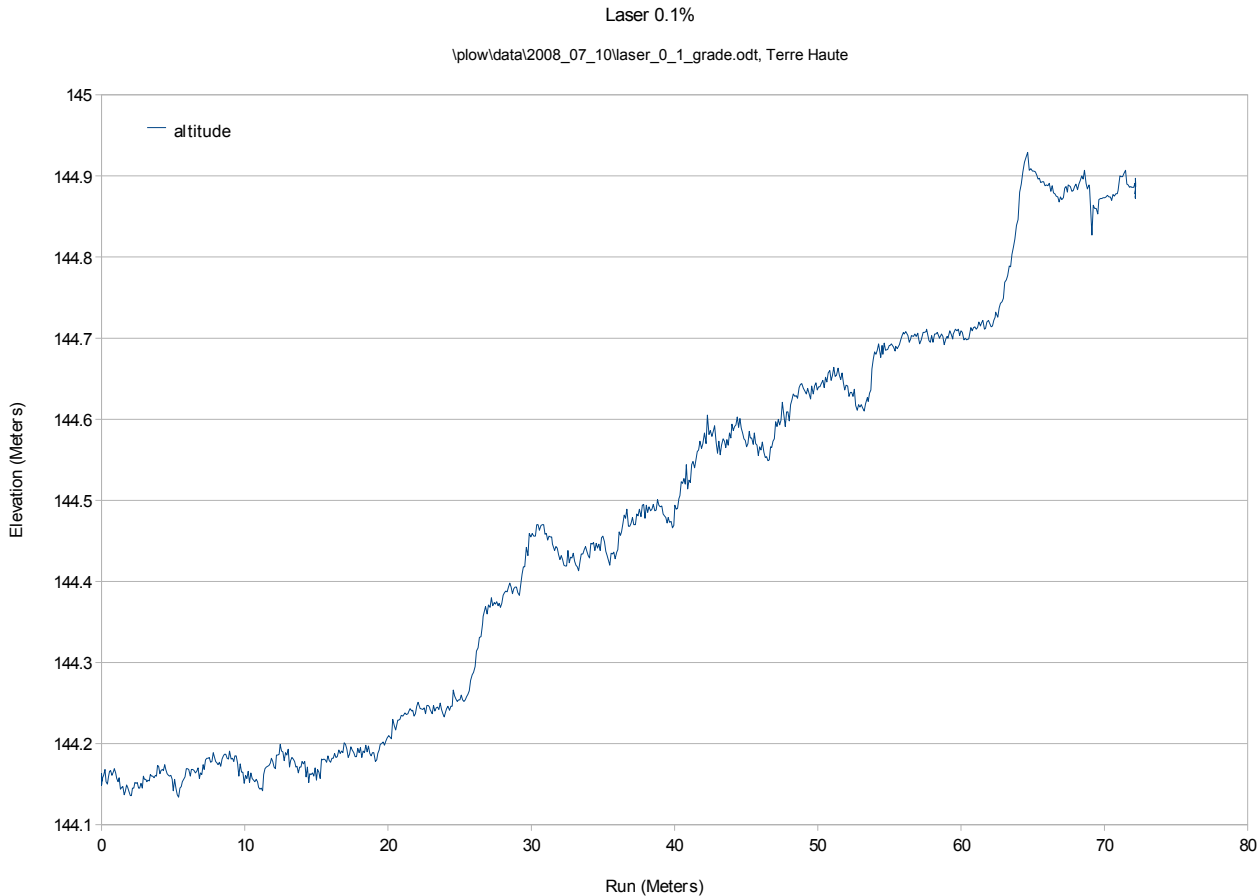


Figure 3: Laser installation profile logged with Leica Mojo RTK GPS.

A similar profile in Figure 3 was created while operating the same plow under laser control under similar circumstances. In both Intellislope operation and in gathering the data shown in Figure 3, the GPS antenna is mounted on the plow shank, roughly over the pivot as shown in Figure 5. Here there is only one line, the GPS elevation. The laser was set for 0.1% grade, and as on the intellislope run, a number of grade breaks were made.

One observes in both Figures 2 and 3 that the start of the run is the lowest point, and the elevation rises, approximating the target profile. In both the intellislope and laser installations, the installed tile slopes upward as installation progresses, with the exception of small, short

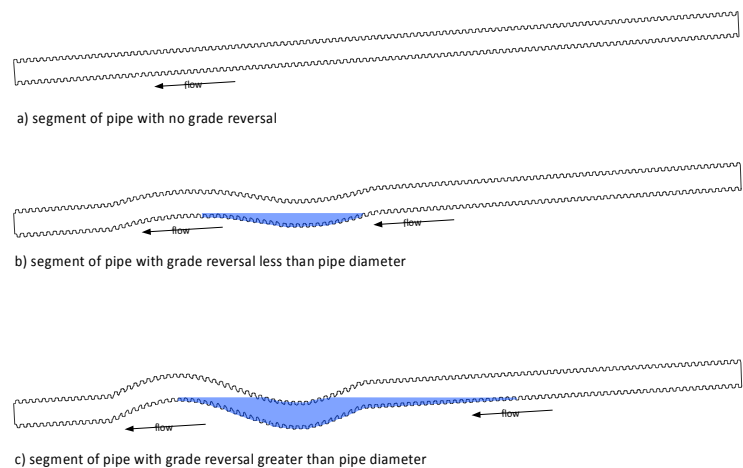


Figure 4: Grade reversals

grade reversal sections where the profile deviates an inch or sometimes more from an ideal profile. Figure 4 visualizes the effect of such small grade reversals. The net effect on the ability of the tile to drain is presumably small or none.

Depth Accuracy

Installing tile at the correct depth is also an important performance criterion. Tile installed too deep can be buried in impermeable clay and thus can be unreachable by surface water. Intellislope's AutoTile feature creates a profile which hugs an operator-specified depth to the extent permitted by grade constraints. The control system targets this profile without any operator intervention. AutoTile creates a log of the surveyed ground, allowing it to be plotted along with the installation profile as in Figure 6. This data was logged by an Intellislope beta tester in spring 2008 using Outback RTK GPS.



Figure 5: Mounting of Leica RTK GPS antenna. Other antennas were not used in the data presented here.

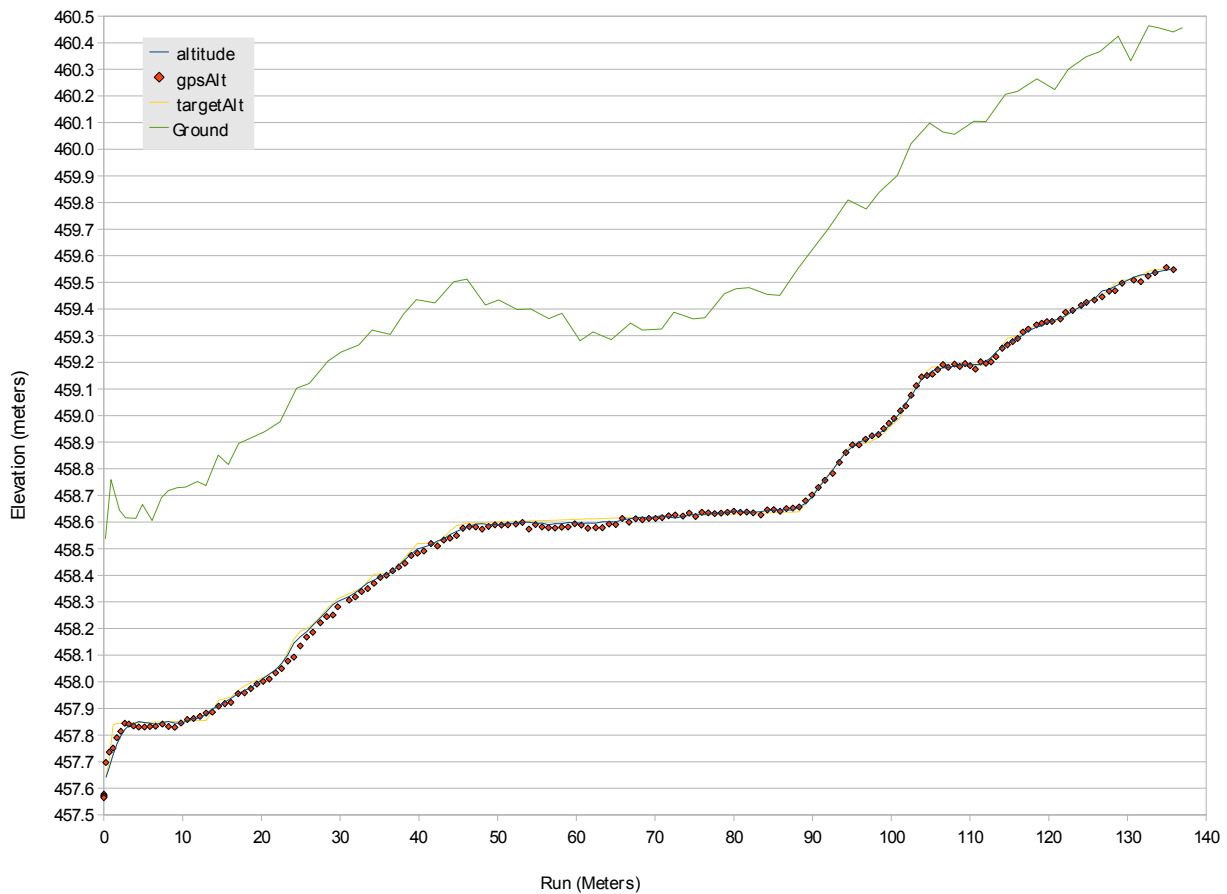


Figure 6: AutoTile installation profile

Observe that the depth remains roughly constant, following the grade of the ground. In the middle section from 50 to 80 meters where the ground experiences negative grade, the target profile maintains the operator-specified minimum grade. When the ground's natural grade turns positive at about 90 meters, the target profile resumes following the ground at the target depth. Achieving a similar installation profile with a laser control system would require the operator to continually grade break to keep the depth constant. Such constant attention and intervention causes operator fatigue, and is limited by the necessity of diverting attention from operation and navigation of the tractor.

One would also have to stop installation and relocate the laser tripod several times because the mast accommodates 5' of grade breaking before the laser receiver must be repositioned and the tripod relocated.

Conclusions

Intellislope installation accuracy is observed to be similar to laser when operated with an RTK GPS signal and when the system is well calibrated. Both typically exhibit grade reversals over the course of a tile's installation. Anecdotes related to Intellislope-installed tile performance such as observed flow from the main during rain and field access times following the historic rains of spring 2008 support a favorable evaluation of tile performance. Intellislope's AutoTile makes installation at a desired depth feasible and less labor intensive than with a laser control system.

Gradient Inc.
3260 Red Barn Road
Terre Haute, Indiana 47805

<http://www.intellislope.com>
phone 888-764-5629

gradient

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