Leave No Trace "Citizen Science" Study on Toilet Paper Decomposition Rates

Developed by Jeff Marion, Ben Lawhon, & Tom Banks[1]

Note: the scope of this study is restricted to the decomposition of toilet paper, not fecal waste.

When toilets are unavailable, the recommended "best practice" for solid human or pet waste disposal below tree-line is to place it in "cat-holes." A perennial question is what to do with toilet paper (TP), bury it or pack it out? More land managers are asking visitors to pack out their TP, in part because they commonly find TP in areas surrounding campsites and they believe buried TP decomposition rates to be too slow, particularly in areas with low rainfall. We suspect that some or perhaps many visitors are not making an effort to deeply bury human waste and leave TP on the surface. Even when buried, there may be a high rate of TP resurfacing, generally attributed to it being dug up by animals. Regardless, unburied TP is unsanitary trash that's visually offensive to all who see it. In summary, there is wide disagreement regarding the need for carrying out TP and better information is needed.

Leave No Trace practices are science-based to the extent possible. A published research study by Bridle and Kirkpatrick (2005) does provide relevant findings to guide Leave No Trace practice for TP disposal. This study examined the decomposition rates of bleached and unbleached TP, tissues, and tampons buried at 2 and 6 inches in 9 different environments across Tasmania. Relevant conclusions were: 1) TP and tissues decomposed almost completely within 2 years in 7 of the 9 locations; tampons would likely require 3 years (*Note:* some are made of synthetic fibers that would require far longer), 2) decomposition was poor at locations with very high rainfall or acidic peat soils, but was very good at locations with as little as 20 inches of rain per year, 3) of 750 burials, 34 (4.5%) surfaced from animal excavations or frost-heaving (30 of which had been buried only 2 inches deep), and 4) nutrient additions simulating the presence of feces and urine to some samples increased decomposition rates. Unfortunately there is reason to believe that the soils, environmental conditions, and decomposer organisms in Tasmania may be quite different from the U.S.

Current U.S. Leave No Trace guidance suggests that TP burial in most U.S. protected areas will likely decompose completely in 2-3 years and does not need to be carried out. Exceptions include soils that are too cold, dry, or wet to support decomposition, or rocky environments that lack soil. Burying TP deeply, by pushing it to the bottom of the cat-hole with a stick, is now strongly recommended to reduce the chance that it will surface before decomposing. Leave No Trace practices also recommend carrying out feminine hygiene products and disinfectant wipes due to their longer decomposition rates. We believe that asking visitors to carry out TP, which some to many visitors view as an "extreme" or at least objectionable and difficult practice, runs the risk of alienating them from considering and applying many other low impact practices. In other words, carrying out TP should be recommended only when truly necessary. Furthermore, visitors who are not digging cat-holes are likely to also ignore requests to carry out their TP – convincing them to dig cat-holes and bury TP deeply is likely an easier option.

We propose this Leave No Trace "Citizen Science" study to provide objective data to guide TP disposal practices in locations across the U.S. We invite land managers, outdoor organizations, and visitors to participate. In this document we provide procedures for burying TP and disposable flushable non-disinfecting wipes (no feces) that you can apply in the area you work or recreate to help provide relevant data. You will conduct your own experiment, collect some standardized data, and send it to the Leave No Trace Center for Outdoor Ethics so it can be posted on their website and analyzed to guide science-based TP disposal practices. Glance through these procedures to see if this is something you would like to do. If so, please visit this web-link after you've initiated your study to let others know of the location(s) you are investigating: *web-link*

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Study Duration

After starting the study, which can be done any time of year when the ground isn't frozen, we ask that you return once a year at the same approximate time (e.g., plus or minus 1-2 weeks), to dig up and evaluate decomposition of the items you buried. These annual evaluations can be stopped when all items are more than 75% decomposed. In most locations we expect the study will run 2 years, but could run 2-3 additional years.

Selecting Study Areas

We would like to obtain data from many different U.S. states and environmental settings, including a range of elevations. Locations that support a substantial amount of primitive camping where the cat-hole practice is advocated are preferable. Consider selecting multiple study sites one or two thousand feet apart in areas with a large elevation range. It's best to select flatter locations because this is where camping commonly occurs and the direction that steeper slopes face could affect study results. *Please do not select areas with:* rocky substrates that lack soil, soils that are seasonally or permanently wet or cold (e.g., wet soils, areas above tree line, permafrost), or soils that are extremely dry (deserts with rainfall < 12 inches/year). Your study areas need to be accessible locations that you can easily visit at approximately the same time each year, for 2-5 years (i.e., not deep in the backcountry). Though accessible, they should also be in places that receive little to no camping or visitor traffic, or disturbance from other human activities (e.g., logging) or natural forces (e.g., flooding, avalanches). Good locations can often be found within 100-200 yards from a pull-off along a road or off a low use trail near a trailhead parking lot. Finally, even though this is an extremely "low impact" study, we ask that you obtain permission from the land owner or manager before conducting your work.

Study Items

We propose two items for burial to examine their decomposition rates. Note that you will need to purchase the same brand and type of item to enable a valid comparison of decomposition rates. We've selected Charmin Ultra Soft unscented toilet paper and, optionally, Charmin Freshmates, disposable flushable wipes – a leading brand for both items that we expect are widely available across the U.S. Though optional, we recommend including the disposable flushable wipes in this study as they are becoming more popular and common in stores and their use is steadily expanding, including by campers. Note that this type of wipe is *not* antibacterial so it should decompose within 2-5 years, though their decomposition rate in cat-holes has not been investigated. If you cannot find or do not want to include this disposable wipe in your study it can be omitted. Note that these items will be buried *without* feces, urine, or a nutrient solution, so this study will yield slightly longer decomposition times than would be expected in an actual cat-hole.

Study Procedures

Materials Needed: Purchase and bring the toilet paper (TP) and disposable wipes (DW) of the brand and type noted. For digging we recommend a sturdy metal garden trowel (plastic cat-hole trowels may break), small shovel, or post-hole digger (easiest). Also bring a compass, tape measure, camera, two pens or pencils, two wire pin flags or hooked tent stakes, this manual with two data forms, a plastic trash bag, and a GPS device with new batteries (if you have one). Finally to mark each cat-hole, bring 10 large pieces of driveway gravel and 10 12-inch pieces of nylon string or parachute cord. Near the end of these strings tie 1 knot in 2 strings, 2 knots in 2 strings, 3 knots in 2 strings, 4 knots in 2 strings, and 5 knots in 2 strings.

Select your study area(s) based on the guidance above and locate two study plot sites approximately two feet square that you can easily dig cat-holes in and reliably relocate based on written descriptions, measurements, and photographs. Avoid soils with lots of rocks or roots. Here's an example that you would record on your data form:

Study Site Location: Walk down the Pine Mountain trail about 75 yards from the parking lot trailhead sign to a 15x10x6 ft boulder on the right side. Pass the boulder, turn right 90^{o}, and walk 50 yards through the woods to another boulder (6x8x4 ft). The center of the TP study plot is due east (90^{o}, uphill side) of this boulder, the DW plot is due west (270^{o}, downhill side). See photos taken of the large boulder on the trail and of each study plot

showing the dug cat-holes before they were filled in (small study site boulder is in the background of each plot photo for reference). The center of cat-hole # 5 (see diagram) for both plots is located exactly 3 ft from the closest edge of the boulder.

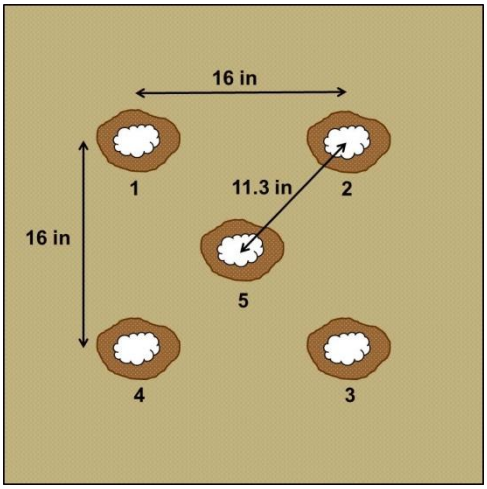


Figure 1. A study plot with 5 numbered cat-holes filled with TP or DW samples.

Select your study plot locations carefully in reference to permanent features, preferably large rocks or large healthy trees. If you have a GPS unit, record the study site location (use WGS84 datum if possible, but note the datum regardless). However, it's best to not depend on it to get back to the study site; written directions like the example, tied to permanent features are needed. *A GPS unit will only get you back to the general area of your plots and you may lose or forget to bring the GPS unit, coordinates, or photos.* Note that land managers do not like and/or have regulations governing the use of flagging tape or other markers and may remove them.

Field Procedures: Refer to Figure 1 and dig 5 cat-holes for each study plot (4x4x5 inches) in the arrangement shown, measuring to determine the cat-hole locations. We recommend putting all excavated soil on a trash bag so you can "Leave No Trace" of your activity. Be sure to make each cat-hole 5 inches deep (I expect most visitors are shy of the recommended 6 in depth). In the TP plot, fold 10 squares of TP to 10 layers (4x4 in) and place at the bottom of each hole. In the DW plot, open two disposable wipes fully and fold each twice into four layers, stack these (now 8 layers) and place them at the bottom of each hole. Take reference photos now, including within the view your permanent reference rock or tree in the background to aid in identifying your plot locations. Record the photo number on each respective data form. Also measure and record on the data form the actual distances (nearest inch) between the centers of each pair of the outer cat-holes, and the distance and compass bearing from the reference rock or tree to the center of cat-hole #5 (see Figure 2). Complete entries on the rest of the data form.

Next place the non-knotted end of the appropriate string (1 knot for cat-hole 1, … 5 knots for cat-hole 5) in the bottom center of each cat-hole and fill all cat-holes with soil with the knotted portion above ground in the center of the hole. Place a piece of gravel next to each string and then naturalize the surface by dispersing organic litter over the area. When you return each year the strings or rocks should help you identify where to find and dig each cat-hole. However, your plot location description and photos should be sufficiently detailed so you can relocate all cat-holes in case the marker rocks and strings disappear.

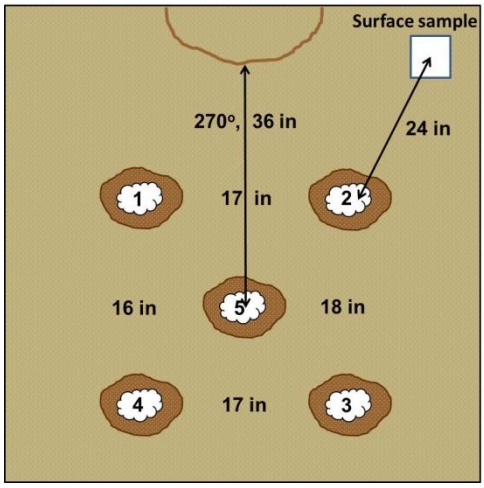


Figure 2. Label this diagram on your field form with: 1) actual distances between cat-hole centers, 2) distance and compass bearing from your permanent rock or tree to the center of cat-hole #5, and 3) distance and direction from one of your cat–holes to the surface TP or DW sample.

In a spot near each TP or DW plot, clear the surface organic litter away and place another 10 sheets of folded TP or 2 sheets of folded DW flat on the ground surface and pin it in place with a wire pin flag or hooked tent stake. Then lightly cover it with organic litter, only enough to barely hide it from view. These samples will be evaluated to examine decomposition rates on surfaced-disposed TP and DW.

When you return home, place an identical folded TP sample in a plastic ziplock bag and a thoroughly dried DW sample in another ziplock bag. Your annual decomposition evaluations will be made against these reference "control" samples.

Annual Evaluations: Add reminders to your e-mail, work, and home calendars to return once a year to perform evaluations at each study area and study plot. These should be conducted with 1-2 weeks before or after the original burial date. Be sure to bring this manual and data forms, trowel, measuring tape, writing implements, labeled prints of your plot location photos, some spare 2-inch rocks and nylon string, compass, trash bag, your "control" TP and DW samples, and a GPS device with new batteries and coordinates/datum information (if used).

Relocate each study area and plot, and then carefully dig up cat-hole # 1 at the end of year 1, cat-hole #2 at the end of year 2, and so on. Put the soil and excavated TP or DW on the plastic bag and carefully remove any soil from the TP or DW sample. Compare the buried sample to your reference "control" samples in the plastic bags. Evaluate each buried sample to determine the amount of decomposition that has occurred by choosing the closest rating below, record your evaluation on the form in the appropriate location. On each form be sure to circle the item being evaluated – either TP or DW. When done, fill in the hole with soil and cover with organic litter. Also locate and rate the TP sample placed on the surface of the ground under organic litter. Uncover, evaluate, and if still present return organic litter to barely hide the sample so it can be rated again next year.

Rating: 1=no decay, 2=1/4 decayed, 3=1/2 decayed, 4=3/4 decayed, 5=all decayed.

What to do if a sample surfaced or is missing: If the sample surfaced or is missing record which sample it was (TP or DW) on the form. Dig up and evaluate the next numbered cat-hole and record that value for the current year, making a note about this on the form. Remember to do this each consecutive year for this study plot, note that each surfaced/missing sample will decrease your study duration by a year.

Reporting Your Findings

Upon your return from starting a study please visit the Leave No Trace website to enter your contact information and the name of your study area(s), nearest City, State, and elevations. This will alert others of your study area – some duplication is fine but there's no need for more than a few study areas in each region.

At the end of each year please return to the Leave No Trace website to enter your findings. If you have study plots with decomposition rating values for year 2 of 1 - 3 please continue the study until your rating values reach 4 or 5. When that happens, or after year 5, please return again to the website and record your final values.

We want to "***Thank You***" for participating in this Citizen Science Study. Your results will help support science-based Leave No Trace practices.

References

Bridle, Kerry, and Jamie Kirkpatrick. 2005. An analysis of the breakdown of paper products (toilet paper, tissues and tampons) in natural environments, Tasmania, Australia. *Journal of Environmental Management* 74:21-30.

Leave No Trace Toilet Paper Decomposition Rate Data Form

Investigator's Name: _____ E-mail: _____

Phone: _____ Start Date for Study: _____ (mo/day/year)

Name of Protected Area or Private Land: _____ Item Buried: TP or DW (circle)

Study Area Location: _____

_____

_____

_____

_____

_____

GPS Coordinates: _____ Datum: _____

Elevation of Plots: _____ ft (use a GPS or topo map)

* For next two go to: http://www.usclimatedata.com/ - select state and nearest city to your plots to get:

Average Temperature: _____ °F

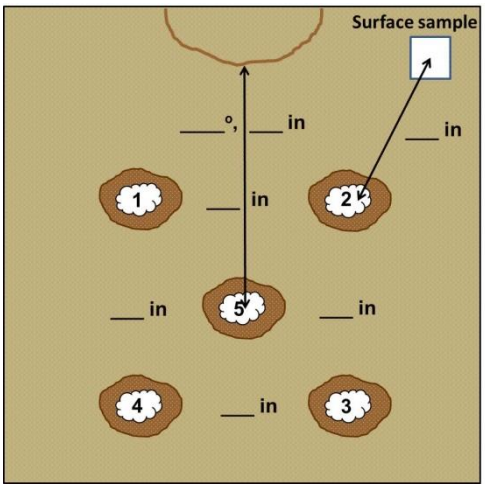
Average Annual Precipitation: _____ inches

Nearest City & State: _____

Measure and record data on figure to right: ___ done

Photo number: _____

Notes:



Item Buried	Cat-hole & Year				
	1	2	3	4	5
TP *or* DW (circle)					
Sample Surfaced					
Surface Sample					

Rating: 1=no decay, 2=1/4 decayed, 3=1/2 decayed, 4=3/4 decayed, 5=all decayed.

Addendum for Additional Plots to Investigate Efficacy of the "Stir Method" and Antimicrobial Wipes

If you are willing to do some extra work we could use data from perhaps 10-20 locations around the country to investigate decomposition rates for:

1) The "**Stir Method**" – pour ½ quart of water into each cat-hole with the standard 10 folded pieces of TP in it and stir for 30 seconds while adding two handfuls of soil. Then fill in the hole completely with string and rock and naturalization as done in the standard procedures. We expect that this practice may substantially increase decomposition rates.

2) **Disinfecting Wipes** – many visitors use disinfecting wipes at their cat-hole, this option will evaluate decomposition rates for this type of wipe (which we currently recommend that visitors pack out). We used the following brands but others can be tested – record the brand name and active ingredient on your form. Open them up fully and fold them into quarters – you can bury two types in each hole, separated by about 1.5 inches of space. We expect the antimicrobial agent to substantially slow decomposition, hence the current LNT practice of carrying them out. It will likely be necessary to continue this plot for the full 5 years.

> Wet Ones Antibacterial Hand Wipes, Active ingredient: Benzethonium Chloride 0.3% (antiseptic)
> Redi Wipes Hand and Face, Active ingredient: Benzalkonium chloride (mild antiseptic)

Complete data forms for these two additional plots, noting the item(s) buried and information from the wrapper on the type of disinfectant contained within the item.