2nd Edition

Backcountry Sanitation MANUAL

Accessible Moldering Privy

APPALACHIAN TRAIL CONSERVANCY

USDA FOREST SERVICE

GREEN MOUNTAIN CLUB

NATIONAL PARK SERVICE

Backcountry Sanitation Manual

INSTRUCTIONS FOR USE

This manual has been designed to work as a digital document, both for economy of production and distribution and the ability for dynamic editing and updates. Below are tips for easier use of this document.

- The table of contents has interactive links to the text in order to more easily navigate to a chapter or desired information.
- To locate specific words within the text you may use the FIND tool in *Adobe Acrobat,* ctrl+F for PC, cmd+F on Mac.
- While this is a digital publication there will be many who will wish to print some or all of the text. All parts except the Appendices may be printed without scaling to fit your printer's margins. There are many larger pages in the Appendix, including diagrams and building plans. Consult your printer's manual for printing at a larger size.

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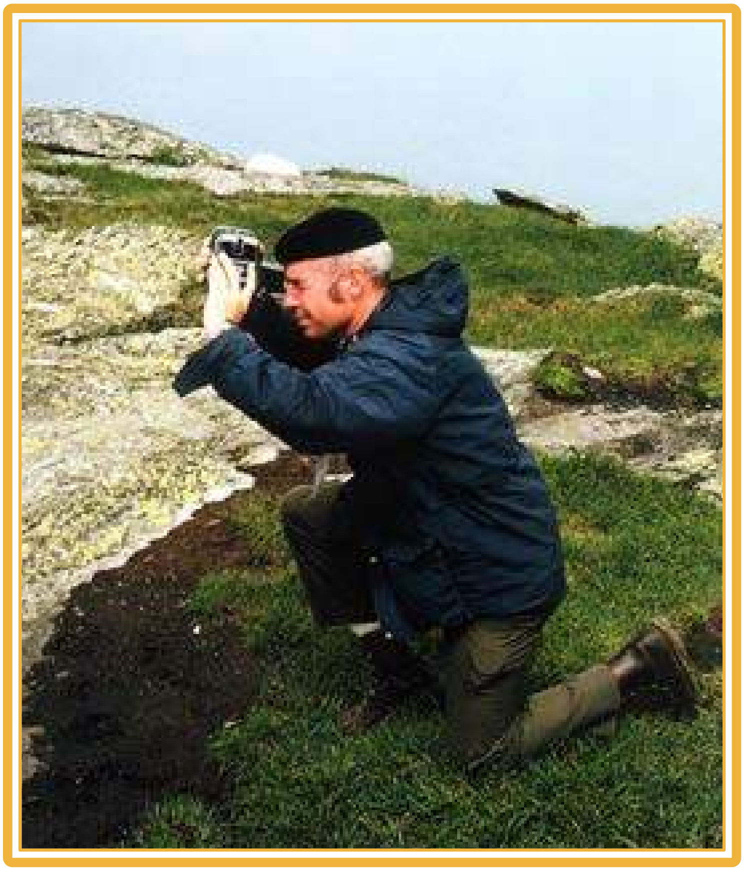
Dedication

The Appalachian Trail Conservancy's *Backcountry Sanitation Manual* is dedicated to Raymond E. Leonard, Ph.D., leader in the 1970s of the Backcountry Recreation Research Program of the U.S. Forest Service, based at the Forestry Sciences Lab in Durham, N.H. Ray, a native Vermonter and forestry scientist by training, pioneered research projects related to mitigating the impact of heavy use on backcountry recreation facilities in the Northeast. In particular, he provided leadership in the development of practical and effective "bin composters" that were the precursor of today's composting privies. Ray's work on composting preserved many cherished, high-elevation sites that might otherwise have been closed due to human waste complications.

Ray embraced cooperative work with the Appalachian Mountain Club, Green Mountain Club, and other outdoors organizations. His collegial style and broadly inclusive program provided a training ground for a generation of leaders in the trail community.

Larry Van Meter, *July, 2014*
ATC Executive Director 1981–86
Green Mountain Club Executive Director 1975–77
Forestry Technician, USFS Backcountry
Research Program 1973–74



Ray Leonard

Introduction to the Second Edition

***Robert Proudman,** Staff, Appalachian Trail Conservancy Staff*

The Appalachian National Scenic Trail is remarkable for many reasons. But one that may be little appreciated by the general public is the system of more than 270 primitive overnight sites that allow hikers to "sojourn" on the Appalachian Trail—to backpack for a weekend, a week, or for months at a time.

Those who choose the great pilgrimage between Springer Mountain and Katahdin will find a remarkable set of campsites, primitive three-sided shelters, and lean-tos about a day's hike apart between Georgia and Maine.

"Sojourning" was the word that ATC chairman Stanley A. Murray chose to describe the long walk when he wrote the first paragraph of the Definition of the Appalachian Trail in 1975:

"The Appalachian Trail is a way, continuous from Katahdin in Maine to Springer Mountain in Georgia, for travel on foot through the wild, scenic, wooded, pastoral and culturally significant lands of the Appalachian Mountains. It is a means of *sojourning* among these lands, such that the visitors may experience them by their own unaided efforts."

Many of the shelters and campsites were initially located and built near water supplies in the backwoods to accommodate thirsty hikers who, in the early-to-mid 20th century, might total a dozen campers per week at any one busy site. Sites were chosen not to withstand hordes of modern backpackers, but often for their location near streams, scenic lakes, or desirable Appalachian peaks popular among early "peak baggers."

While the A.T. was not initially completed until 1937, many legacy shelters and campsites were included where the A.T. followed older trails. Because of the relative antiquity of the A.T. by comparison to other national trails, shelters were deemed essential for extended hiking trips. In the first half of the 20th century, gear was heavy. Hikers carried canvas, steel, and cast-iron to camp and cook comfortably. Thus, shelters were the norm until mid-century, when light-weight aluminum alloys and nylon tents became available.

Hiker visitation surged in the late 1960s, with some shelters and campsites seeing 200 or more visitors per week. Forty to seventy visitors per night were not uncommon at some campsites in the Green Mountain and White Mountain National Forests. In 1971, visitation at Ice Water Springs Shelter in the Smoky Mountains exceeded 120 people per night on more than one occasion.

Solid wastes and refuse accumulated, pit toilets and privies overflowed, and wildlife problems became common. Bears, skunks, raccoons, and rodents were attracted to food smells, trash, and abandoned food containers. "Can pits"—the areas where discarded human trash was dumped by maintainers—overflowed.

Maintaining clubs and land managers in northern New England and in the Shenandoah and Great Smoky Mountains National Parks found themselves with a number of pest-ridden health hazards or "backcountry slums" that despoiled the beauties of the A.T. environment and violated public health codes and agency policies.

Clubs and land managers tackled the solid waste directly: The first "Carry In–Carry Out" campaign was begun in the same year as the first Earth Day, 1970. If a full can of beans was carried in, managers thought, certainly the empty can should be carried out. It was a novel idea at the time. Carry In–Carry Out programs and signs proliferated. Hiker peer-pressure grew, and the public followed, ensuring better behavior and—following can-pit clean-outs that took about ten years—virtually removing solid waste in the backcountry.

Human waste proved more intractable. How does one achieve modern standards of sanitation and cleanliness without the contemporary alternatives provided by road access, septic systems, leaching fields, plumbing, and electric power? The challenges seemed insurmountable.

Yet, Appalachian Trail clubs working with U.S. Forest Service scientists and others, developed ways to address those problems, including well-sited pit privies, haul-outs or fly-outs of waste, and—with aid from the Forest Service Backcountry Research Program—the reemergence of the ancient practice of composting.

Because the A.T. is often at the top of the watersheds it traverses, it is our obligation to all who live downstream to maintain pristine conditions and water quality and to achieve the NPS mission to "preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations."

Other important considerations for managing the Appalachian Trail include keeping the A.T. remote from roads, minimizing the use of expensive and impactful helicopter transport, and achieving workable, "smarter not harder" solutions for our corps of volunteer maintainers.

Interest in the field of backcountry sanitation management has grown exponentially both on and off the A.T., culminating in a worldwide conference in 2010 on remote waste management called *Exit Strategies* and a follow-up conference, *Sustainable Summits,* planned for the summer of 2014. These conferences featured land managers from as far away as Africa, New Zealand, and Japan. While many of the systems and technologies featured at the conference did not have direct applicability to the A.T., there was much interest and discussion of the moldering privy, and several participants were present who had implemented such systems in locations including the Upper Peninsula of Michigan, the backcountry of Colorado, and all the way up the Chilkoot Trail in Alaska. It is evident that our work on the A.T. is having a positive impact throughout the U.S. and beyond.

Since the first edition of the *Backcountry Sanitation Manual*, the most notable change to occur on the A.T. has been the widespread adoption and implementation of moldering privies, with the majority of the 31 A.T. maintaining clubs installing them on their Trail sections. The other major change has been the adoption of Federal accessibility guidelines for outdoor recreation. As a result, this second edition includes thorough updates of the chapters on safety, the moldering privy system, and accessibility. New case studies from up and down the A.T. have been added to the Appendix, as well as plans for accessible batch composting and moldering privies.

Other changes of note in the second edition:

- Some material deemed outdated or systems and techniques proven ineffective have been removed.
- Emphasis has been placed on the systems and techniques that, in the decade of field experience since the first edition came out, have proven to be most effective— many of these items have been bolded to call attention to them.
- The chapter on universal accessibility has been expanded.
- Many new photographs and building plans have been included.

We still believe that the field of backcountry sanitation is an evolving one, and this publication must continue to evolve with it. With improved technology for communication up and down the Trail and across the world, we expect the exchange of information among maintainers to increase. Having the *Manual* as an electronic document, we can continue to update it periodically as techniques and technology change.

This book is the second edition of what we have learned thus far. We hope you find it accurate and helpful in caring for what A.T. founder Benton MacKaye called our "Barbarian Utopia."

Forward

Wendy Janssen, *National Park Service, Superintendent, Appalachian National Scenic Trail*

I am pleased to present this second edition of the *Backcountry Sanitation Manual* to my colleagues in the 31 Appalachian Trail maintaining clubs, to public health officials in the 14 Trail states and their municipalities, and to the many Trail partners in state and federal government.

The Green Mountain Club and ATC have provided us yet again with proficient, expert guidance, now updated after more than a decade of careful testing and documentation. I am confident this manual will help ensure that the A.T. can continue to be enjoyed by millions of Americans and thousands of overnight backpackers with minimum negative effects on the environment and on the Appalachian Trail experience. With this information, club maintainers can more effectively build and maintain facilities that effectively treat human wastes in remote environments, keep backcountry water sources clean, and help ensure the health of Trail users, neighbors, and fellow citizens living downstream.

With a National Park System that now includes more than 400 units, the agency is familiar with the methods by which National Parks must treat backcountry human waste—from the lowly cat-hole and pit privy, to composters and dehydrators, to removal of waste to approved treatment facilities. As you might imagine, ATC's work fits into the spectrum of solutions offered among our parks, and ATC has reached out to others working in this and related disciplines. Parks that face sanitation challenges include those highest alpine parks (Denali, Rainier, and Glacier), river parks like Grand Canyon, where all wastes are removed (usually by users themselves), and our sisters in the national trails system who face similar challenges with remote congregations of backpackers at campsites (the Pacific Crest, Continental Divide, and Florida National Scenic Trails, among others).

My staff and I look toward the ATC, the A.T. clubs, and our agency partners to continue their important work developing accessible backcountry sanitation systems uniquely suited to the wet summers, cold winters, high visitation, and humidity of the Appalachian environment.

I offer readers my endorsement for this fine publication, and close with a request: That you learn from it, do your best to continue improving your facilities and ensure they meet ATC and NPS standards, that you strive for universal accessibility in your clever and unique designs, and that you practice Leave No Trace in all your activities.

July, 2014

What This Manual is About

Pete Antos-Ketcham, *Staff, Green Mountain Club Staff*

The ATC Backcountry Sanitation Manual addresses the management of human waste in the backcountry. Proper management of human waste protects hikers, the environment, and trail maintainers.

Resolving problems of backcountry sanitation is a continuous challenge for AppalachianTrail (A.T.) clubs and land managers. This manual was created in the belief that all remote recreation areas will benefit from an expanded discussion of backcountry sanitation. The Appalachian Trail Conservancy (ATC) hopes it will offer a step up for those who operate composting systems, as well as for those Trail clubs and land managers who have reached a crossroads in backcountry sanitation decisions.

This manual introduces a new, simpler, and often safer method of composting human waste in the backcountry—the moldering privy. It is a design that saves money and—even more importantly—labor. Whether volunteer or paid, labor has always been in short supply on the A.T. The moldering privy is suitable for the majority of sites that need better waste management than pit privies or cat-holes, and it is cheaper and easier to implement than other alternatives.

The approaches recommended here are distilled from the experiences of several hundred people operating composting toilets and other systems that have successfully resolved human waste problems at backcountry sites along the A.T. Primary emphasis has been placed on composting systems, because they have been the most successful in the majority of backcountry situations. However, other systems receive some attention, especially to provide comparisons with composting systems.

The Green Mountain Club and the Appalachian Mountain Club began using composting systems in the late 1970s, and their systems have undergone continual evolution and improvement. Several other A.T. clubs and land managers have used different composting systems with varying success. The most successful systems are presented in this manual.

If you read this manual through, you will discover a lot of repetition. This is intentional, because the manual is being posted online, where readers may download only the chapters that interest them. Therefore, each chapter must be self-contained, with as much relevant information as possible. Inevitably, this leads to repetition, although we have tried to minimize it by the use of cross-references to other chapters where appropriate.

The first four sections provide background for sanitation management. Section 1 covers the history of sanitation on the A.T. Section 2 explains why managing sanitation issues is important. Section 3 outlines the science of composting. Section 4 discusses the health and safety issues associated with composting. Much of the information on the science of composting and health and safety issues in Sections 3 and 4 was written by Pete Rentz, a Trail volunteer who is also a medical doctor.

Sections 5 and 6 cover the regulatory and permitting process, including compliance with ATC policy and local management plans, as well as requirements for universal access. These are as important as health and safety considerations. Local and state sanitation codes and permit requirements do apply to almost all new sanitation systems and old systems in trouble. Even though many are written for municipal or residential waste-water discharges, sanitation officials apply them to backcountry situations. Federal laws concerning accessibility to outdoor recreation facilities do apply to the Appalachian Trail. It is extremely important that you check with your regional ATC office, local A.T. club officers, local land-managing agency, and relevant local and state officials to learn how these regulations are interpreted and applied in the backcountry in your region.

Section 7 addresses the aesthetics of sanitation systems in the backcountry. The chapter is short, but the issue is vital, in view of the fact that hiking the Trail is, as much as anything, an aesthetic or even spiritual experience. An unattractive or obtrusive toilet facility can ruin the feeling of an otherwise pleasant overnight site.

Sections 8 through 10 form the bulk of the text. Section 8 focuses on the moldering privy system. Section 9 and 10 describe batch-bin systems in use on or near the A.T. Topics include collecting, storing, and composting human waste, sanitary procedures, spring and fall operations, and record keeping. Section 11 presents case studies of individual installations. Section 12 guides the process of deciding which system best matches your needs and resources. Section 13 covers management of gray water (wash water) and food waste.

This manual is not an installation or operation manual for the systems described. Each system, especially those commercially produced, has its own manual for installing and operating them correctly. This manual reviews each system to help maintainers decide which is best for them. The Appendix contains more information on each system.

This brief manual does not cover some backcountry waste problems, such as illegal garbage dumping and managing pack stock and pet wastes. In addition, it does not cover some methods of handling human waste in the backcountry that have been used in other parts of the country, such as vault toilets, incinerating toilets, and chemical toilets. Finally, some remote recreation areas can still rely on pit toilets or cat-holes. The capabilities of each backcountry site, the impacts imposed by visitors, and the capabilities of the managing entity must be carefully evaluated. Only then can a solution tailored to a specific site be developed.

As composting systems and techniques improve, so will this manual, which is why ATC chose to publish it online. As readers experiment with different systems, new information and techniques will develop. ATC will revise this manual periodically.

Much of the information and experience with composting systems has been developed on the Appalachian Trail in the Northeast, but we have tried to make this manual useful to all A.T. clubs. In April 2000, and again in August of 2011, I traveled to several sites along the A.T. to meet with regional ATC staff and local club volunteers and see composting systems in action. I saw composting efforts of other clubs and agency partners in operation in the field, and I learned something of the strengths and challenges of various A.T. clubs. If your questions are not addressed or your knowledge is omitted, we hope to hear from you so we can improve future revisions. Please send your comments and suggestions to ***sanitation@appalachiantrail.org.***

Never Apologize, Just Explain

Dick Andrews, *Volunteer, Green Mountain Club*

Trail maintainers should resist any suggestion that backcountry waste disposal systems are somehow substandard, but tolerable because they are in remote locations. If this attitude is accepted, it will diminish the Trail's prospects for continuing as a practical and enjoyable entity for future generations of hikers, since it will make the Trail dependent on continued tolerance of what is imagined to be substandard. Maintainers who do a conscientious job of managing human waste need not apologize for the results of their efforts.

No practical way of disposing of human waste in the backcountry is perfect, if perfection is defined as zero chance of pollution or dispersal of pathogens. However, when applied appropriately, all of the systems covered in this manual are adequate, even when compared to most household-sewage systems in rural and suburban areas.

By way of comparison, a septic system serving flush toilets, which is the usual benchmark for comparison of onsite sewage treatment systems, often leaves a lot to be desired. A septic tank does not actually treat sewage. It liquefies some solids, and separates the remaining solids from water. But, the water leaving a septic tank and entering a leach field is as contaminated with pathogens as the sewage going in. Treatment, if it takes place at all, occurs in the biologically active soil of the leach field, where the septic tank effluent is intended to be exposed to air and organisms that prey upon and compete with pathogens. Most dissolved solids are intended to be taken up as nutrients by plant roots. Sludge at the bottom of the tank and scum floating on the top must be periodically pumped out and treated elsewhere.

However, in actual septic systems, conditions often prevent proper treatment; inadequately treated sewage percolates down to the ground water or out to the surface. Many leach fields are too cold in winter for biological treatment, and dormant plants take up no nutrients in winter. Some leach fields are too deep for plants to reach, even in summer. Waterlogged soil, which prevents aerobic treatment, is common, either from weather-related flooding or from large inflows of water from extravagant use of toilets, showers, washing machines, and dishwashers. In private conversation, sanitary engineers estimate that more than half of all septic systems fail to work properly at least part of the time, even if the septic tanks are pumped when they should be and soils in the leach field have not become clogged. And septic tanks often are not pumped when they should be, and soils are often at least partly clogged.

Few people worry about these shortcomings, probably because malfunctions are out of sight unless sewage surfaces. Only in locations like Cape Cod, where large numbers of inadequate septic systems have threatened an important aquifer, is notice taken of the problem. It is unreasonable to insist on perfection in the backcountry when it is not required anywhere else. Many systems treating human waste in the backcountry are actually more effective than rural and suburban systems people live with every day, partly because human waste is not mixed with such a huge volume of water in the backcountry.

We should strive to improve backcountry sanitation even further, but we can be proud of the progress already made.

Acknowledgments for the Second Edition

The successful management of the Appalachian Trail is a result of many collaborations and partnerships. This relationship is often described as a three-legged stool with ATC, the Trail clubs (volunteers and staff), and the agencies holding up the seat (the Trail). All legs are needed for a functioning stool. The continued support and evolution of the *Backcountry Sanitation Manual* is no different—a project like this really does take a village.

In addition to everyone who helped make the first edition a success, I would like to thank the following for supporting the second edition:

At the Maine Appalachian Trail Club: Lester Kenway, President; Bruce Grant, Executive Committee Director; and Laura Flight, Executive Committee Director –Campsites. I appreciate all of the feedback that MATC has provided on the new accessible privy plans based on their experiences constructing similar units in Maine.

At the Appalachian Mountain Club: Sally Manikian, Backcountry Conservation Resource Manager; Eric Pedersen, former Huts Manager; Jim Pelletier, Chair of the Berkshire Chapter A.T. Management Committee; and Dave Boone, Trails Chair of the Connecticut Chapter Trails Committee. AMC staff and volunteers have been most supportive of this project and authored several case studies.

At the Dartmouth Outing Club: Rory Gawler, Assistant Director. The DOC installed an accessible moldering privy based on GMC's design and supplied great pictures and a write-up for the appendix.

At the Appalachian Trail Conservancy's New England Regional Office: Hawk Metheny, Regional Director. Hawk served as an author in both editions, as a much needed sounding board, and as my main point of contact and source of support for the revision of this manual.

At the Green Mountain Club: Dick Andrews, volunteer; Dave Hardy, Director of Trail Programs; Matt Wels, Construction Crew Foreman; and Jeff Bostwick, Burlington Section volunteer and designer of the original accessible privy on the A.T. at the Churchill Scott Shelter. Jeff put in significant time on both the first edition and second edition drafting plans and creating construction directions for the batch-bin and moldering privy designs that have become standard on the Long Trail/Appalachian Trail in Vermont. Like Jeff, Matt used his vast construction management and drafting skills to design and build the accessible privy at Happy Hill Shelter—the plans for which are now the USFS Region 9-approved Accessible Moldering Privy plans featured in this manual.

At the Blue Mountain Eagle Climbing Club, I'd like to thank Dave Crosby for continuing to keep in touch over the years and sharing with me his experiences tackling sanitation issues on the A.T. in Pennsylvania.

At the Potomac Appalachian Trail Club: John Hedrick, President; Dick Hostelly; and Charlie Graf. John and Dick were kind enough to give me a personal tour of their accessible moldering privy at the Gravel Springs Shelter in Shenandoah National Park.

At the Nantahala Hiking Club: Don O'Neal, Trail Manager. Don was very helpful in providing a case study of his club's experiences with the moldering privy.

At the Georgia Appalachian Trail Club: Darleen Jarman and Gary Monk. GATC was an early adopter of the moldering privy and has done extensive work replacing their pit toilets in Georgia and providing information and feedback on the process. Their efforts at developing accessible moldering privies have been helpful to clubs up and down the Trail. GATC's experiences are well documented in their case study.

At the U.S. Forest Service: Janet Zeller, National Accessibility Program Manager; Pete Irvine, Trails and Wilderness Specialist, George Washington and Jefferson National Forests; and, from the Green Mountain National Forest—Donna Marks, Safety and Occupational Health Specialist; Mary Brown, Region 9 Landscape Architect; Jennifer Wright, Appalachian Trail, Long Trail, and Wilderness Coordinator; Larry Walter, Surveyor and C-Certifier Sawyer. All of them were instrumental in supporting the development of the current USFS-approved accessible privy plans. Janet deserves special recognition for completely revising and updating the chapter on accessibility guidelines.

At the National Park Service: Appalachian National Scenic Trail, Wendy Jansen, Superintendent; Pam Underhill, former Superintendent; J. David Reus, Project Coordinator; and from the Klondike-Goldrush National Historic Park, Tim Steidel, Lead Protection Ranger. Once again, the *Sanitation Manual* project would not be possible without the financial assistance of the National Park Service.

At the Appalachian Trail Conservancy Mid-Atlantic Regional Office: Karen Lutz, Regional Director and Bob Sickley, Trail Resources Manager. Karen, Bob, and the MARO staff were my hosts for my second ATC privy tour in 2011. Bob deserves special recognition for arranging and conducting all field visits with me and for hosting me at his house.

Thanks also go to Geoff Goodhue of Clivus New England for his continued support of GMC's composting efforts both on and off the Trail.

A special thanks to former GMC and ATC Executive Director Larry Van Meter for his excellent dedication to the father of backcountry composting, Ray Leonard.

I'd like to give special thanks to the ATC's Bob Proudman, Director of Conservation Operations. Bob has been a mentor and friend throughout my career. It was his authoring of the AMC's and ATC's guides to trail design, construction, and maintenance that helped inspire me to take on this project. Throughout the production of both editions, Bob has been a constant supporter of backcountry sanitation because, as Bob is fond of saying, we all live downstream of the Trail.

This Second Edition would not have been possible without my editor, Susan Daniels, Conservation Coordinator at the Appalachian Trail Conservancy's headquarters in Harpers Ferry, West Virginia, and GMC AmeriCorps Group Outreach Specialist Thorin Markison, who served as the graphic designer for the project. This team is responsible for the significant structural and visual improvements to the second edition. Thanks to you both—this wouldn't have happened without you.

As with the first edition, there are many more people who deserve credit for making the Appalachian Trail the nation's premier National Scenic Trail then there is room for here—you have our heartfelt thanks.

Peter S. Antos- Ketcham, *Waterbury Center, Vermont (May 2014)*

Acknowledgments for the First Edition

Development of the sanitation systems described in this manual owes much to the work of hundreds of individuals over many years.

The initial design and testing of the batch-bin composting system was done by the Backcountry Research Program of the Northeastern Forest Experiment Station in Durham, N.H., under the leadership of Ray Leonard in the mid-1970s. The system has been further developed and refined by the Appalachian Mountain Club (AMC) and the Green Mountain Club (GMC) since then.

The moldering privy is the design of Appalachian Trail Conservancy (ATC) and Green Mountain Club (GMC) Volunteer Dick Andrews. Dick developed the idea of using red worms in a simplified composting toilet after he successfully used them in his Clivus Multrum at home. The first moldering privy was installed under Dick's supervision at Little Rock Pond Shelter on the Appalachian Trail in southern Vermont in 1996. Thanks also go to Scott Christiansen, Gilbert Patnoe, and Cheryl Vreeland of the Green Mountain Club's Laraway Section and Leo Leach and Jeff Bostwick of the Burlington Section for their help and assistance in the additional development and testing of the moldering privy, and in the moldering privy description in this manual.

This manual reflects changes and innovations along the Appalachian Trail since the last edition of GMC's *Manual for Bin Composting* was published in 1995.

Special credit is due to former Green Mountain Club Field Supervisors Ben Davis and Paul Neubauer, without whom the previous editions of the *Manual for Bin Composting* would not have happened. Much of the development of the GMC's composting toilet installations was due to Ben and Paul, and their interest in keeping the GMC at the forefront of backcountry sanitation technology. Largely because of the foundation their work provides, the GMC and ATC dare to hope that Trail volunteers and land managers will find the *ATC Backcountry Sanitation Manual* the best guide currently available.

I must extend special thanks to David Del Porto and Carol Steinfeld of the Center for Ecological Pollution Prevention (CEPP) of Concord, Mass. Their book, *The Composting Toilet System Book*, is at the forefront of information on composting human waste, including much that is useful in the

backcountry. Many other references were dated, so the publication of their book in 1999 was very timely. Many illustrations, components of several chapters, and the State-by-State Regulatory Contact list in the Appendix come from *The Composting Toilet System Book*. I can't recommend this book highly enough to complement the *ATC Backcountry Sanitation Manual*.

I'd like to thank Joseph Jenkins, author of *The Humanure Handbook: A Guide to Composting Human Manure*. The book and e-mail correspondence with the author, who has twenty-four years of experience composting human waste, significantly enhanced the *ATC Backcountry Sanitation Manual. The Humanure Handbook* should be on the bookshelf of anyone maintaining backcountry campsites and facilities.

This manual could not have been produced without the volunteer authors who wrote much of the material. I'd like to thank authors Dr. Peter Rentz M.D. of the AMC Massachusetts A.T. Committee; AMC Shelters Program Supervisor Hawk Metheny; AMC Huts Manager Chris Thayer; Paul Neubauer, a former GMC field supervisor, U.S. Forest Service ranger, and Randolph Mountain Club (RMC) caretaker; former GMC and RMC caretaker Paul Lachapelle; RMC Trails Chairman Doug Mayer; RMC Field Supervisor Anne Tommasso; ATC New England Regional Representative J.T. Horn; ATC New England Associate Regional Representative Jody Bickel; Pete Irvine, U.S. Forest Service liaison to the Appalachian Trail Park Office in Harpers Ferry, W.Va.; and GMC and ATC volunteer Dick Andrews.

At the Green Mountain Club in Vermont, I'd like to thank Trail Management Committee Chair Peter Richardson, Executive Director Ben Rose, former Director of Field Programs Lars Botzojorns, and current Director of Field Programs Dave Hardy for their support in the creation of this manual.

At the Appalachian Mountain Club's Pinkham Notch Visitor Center, I'd like to thank Director of Outdoor Program Centers Paul Cunha and Construction Crew Director Tom Bindas for their technical information on sanitation systems at the AMC huts and shelters in the White Mountains of New Hampshire. I'd also like to thank David Boone of the AMC's Connecticut Trail Committee for his assistance with information on the regulatory process that governs the installation of composting toilets on the A.T. in Connecticut. And I'd like to thank Steve Clark at the Maine Appalachian Trail Club for his input and knowledge as the club's designated "Privy Czar."

At the Blue Mountain Eagle Climbing Club, I'd like to thank Dave Crosby for showing me his club's composting efforts on the Trail in Pennsylvania and for providing me with information used in this manual.

At the Mountain Club of Maryland and the Potomac Appalachian Trail Club, my thanks go to Ted Sanderson, developer of the Pennsylvania composter, and Paul Ives for showing me their systems in Pennsylvania.

At the U.S. Forest Service, I'd like to thank Tim Eling at the Mt. Rogers National Recreation Area; Brenda Land at the San Dimas Technology Center; and Jeff Harvey at the Green Mountain and Finger Lakes National Forest for sharing knowledge accumulated from the National Forests on backcountry sanitation.

I'd like to thank George Minnigh at the Great Smoky Mountain National Park and Pam Underhill at the Appalachian Trail Park Office, both of the National Park Service. Thanks also go to the National Park Service and its challenge cost-share program for the financial support that made this project possible.

Thanks to Bill Wall and Ben Canonica of Clivus New England for sharing their knowledge and providing me with materials on the Clivus for the manual. I'd also like to

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At the Appalachian Trail Conservancy, thanks for energetic support—in addition to writing—go to New England Regional Representative J.T. Horn. I'd also like to thank ATC Board of Managers New England Vice Chair Brian Fitzgerald and Director of Trail Management Programs Bob Proudman (especially for his continual encouragement and support in the search for the "sanitation silver bullet"). Also: Mid-Atlantic Regional Representative Karen Lutz, Mid-Atlantic Associate Representative John Wright, Central and Southwest Virginia Regional Representative Mike Dawson, Southwest Virginia Associate Representative Teresa Martinez, Tennessee- North Carolina-Georgia Associate Representative Ben Lawhon, Bear's Den Hostel Manager Melody Blaney, ATC Editor Robert Rubin, and ATC Management Information Systems Specialist Hansen Ball.

I'd like to give special thanks to the ATC's Jody Bickel, associate regional representative for New England. Jody played many key roles in the development of this manual: volunteer author, associate editor, motivational coach (for helping me deal with the realities of deadlines), meeting facilitator, contact for the Appalachian Trail Conservancy, general source of information, and of course good cheer. Thank you, Jody, the *Sanitation Manual* will serve the Appalachian Trail well as a result of your efforts.

This manual would not have been possible without my editor, Dick Andrews, originator of the moldering privy system. Dick was *the* perfect editor for this project— not only because of his professional skills (he is a free-lance writer and editor by trade), but because of his twenty-seven-years of experience composting human waste at his home in southern Vermont. He was an invaluable source of technical information and ideas on this subject. He has also been a long-time ATC and GMC volunteer, and he was able to apply the volunteer perspective to the manual to make it as useful as possible to A.T. club volunteers. Thank you, Dick.

Finally, credit for this manual must be given to the many unnamed ATC maintaining club volunteers, ridgerunners, and caretakers who have toiled with few thanks to make composting on the Appalachian Trail work.

Peter S. Antos- Ketcham, *Waterbury Center, Vermont (March 2001)*

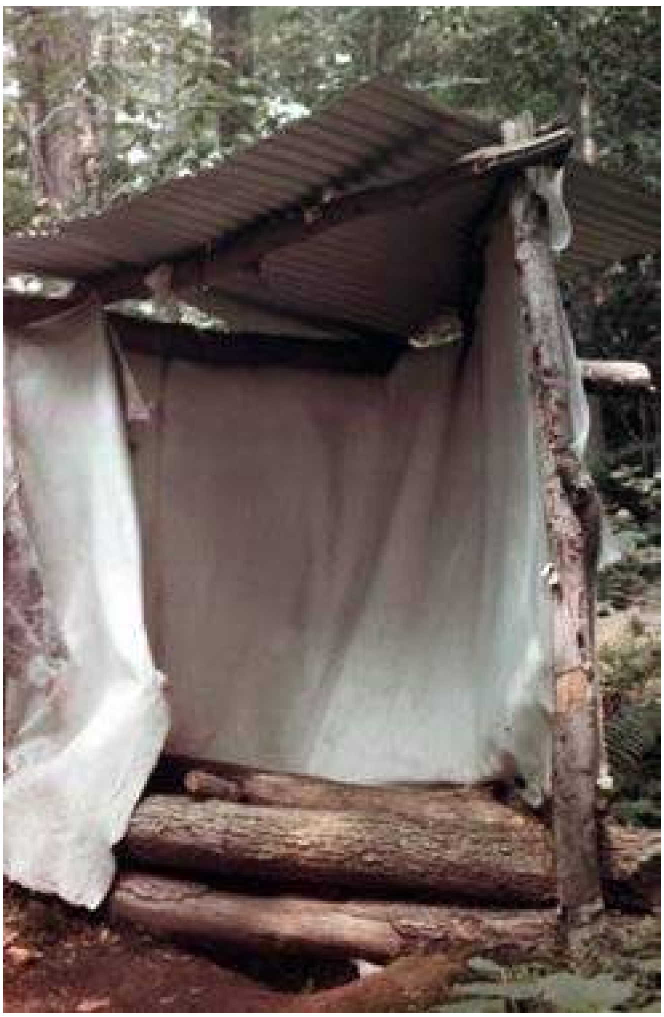
PART 1

Background for Sanitation Management

1 A Brief History of Northeastern Backcountry Use and Backcountry Sanitation Management

Pete Antos-Ketcham, *Staff, Green Mountain Club*

In the late 1960s and early 1970s there was a surge in use of backcountry facilities unlike anything land managers had ever seen. The number of people seeking primitive recreation in the mountains, particularly along the Long Trail in Vermont and the Appalachian Trail along the East Coast, had increased to about ten times that of the 1930s. By the mid-1970s, the most popular overnight destinations, such as upper elevation and backcountry pond sites, were receiving as many as seventy overnight visitors each week during the six-month hiking season. The volume of human waste increased proportionately from about one gallon per week per site to fourteen gallons per week, or more than three hundred gallons per season at some sites.



Primitive Outhouse Stratton Pond, 1973 - ***Lee Allen***

Many backcountry facilities in New England were developed between the 1920s and 1940s on upper mountain slopes to provide scenic views, refuges near summits, or idyllic getaways near the shorelines of mountain ponds. When many of those facilities were built, the number of visitors was low, averaging five persons per week per site. At those low levels of use, wastes in pit privies could probably be safely decomposed and assimilated by soil.

However, the severe limitations of those mountain sites became evident as the number of visitors increased. Most ridgeline campsites had poor, thin soils that precluded frequent digging of new pit toilets. Most campsites near ponds were located very close to shorelines, and locating new sites for pit toilets a safe distance from water was difficult without moving entire

Early Batch Composter - GMC Archives

campsites. At some sites, helicopters were used to fly waste out, but many people considered this practice too expensive and intrusive.

Watersheds were being polluted, human health was at risk, and the recreational experience at managed backcountry facilities was being eroded by unmanageable amounts of human excrement. Those problems prompted the development of alternative waste-management systems.

In the mid-1970s, the Backcountry Research Program of the USDA Forest Service Northeastern Forest Experiment Station in Durham, N.H., led by Ray Leonard, developed the batch-bin composting toilet system as an inexpensive and practical means of waste disposal for high-use backcountry sites. Since 1977, batch-bin systems have operated continuously at selected sites in the White Mountains of New Hampshire and the Green Mountains of Vermont, as well as in other areas. Along other parts of the Appalachian Trail, as use has increased, land managers and maintaining clubs also have begun to study and implement alternative waste-management systems at the more fragile and popular campsites.

Backcountry sites in New England are subject to a combination of especially wet and cold weather, thin and acidic soils, and a flood of backcountry recreationists from nearby urban areas, as the Green Mountains of Vermont and the White Mountains of New Hampshire are within a day's drive of 70 million people. In retrospect, it is no surprise that the inadequacy of traditional pit toilets became apparent there sooner than on many other sections of the Appalachian Trail. Consequently, the Green Mountain Club (GMC) and Appalachian Mountain Club (AMC) have played an active role in the evolution of alternative waste-management systems. Between them, the GMC and AMC now manage more than eighty-six backcountry campsites, and more than half of them have composting toilet systems.

Batch Bin System in use on Long Trail - GMC Archives

Following publication of the first edition of the *Backcountry Sanitation Manual* in 2001 by GMC and the Appalachian Trail Conservancy (ATC), many A.T.-maintaining clubs began installing and using moldering toilets along the Trail from Georgia to Maine with great success. This has expanded the number of clubs who are actively engaged in advanced waste management and increased the skill and knowledge base now available to land and trail managers.

The success of all of these efforts rests largely in the hands of dedicated and knowledgeable field staff and volunteers. Organizational commitment by the GMC, AMC, ATC, and their agency partners has ensured the continued success of this effort.

2 The Importance of Backcountry Sanitation Management

Pete Antos-Ketcham, *Staff,*
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2.1 Basic Questions

Almost all backcountry facilities can benefit from sanitation management. Improper disposal of wastes at fragile, heavily used remote recreation sites causes pollution of soil, ground water, and surface water, and it degrades the experience of the backcountry user.

"Everyone Lives Downstream of the Trail"
Lake Pleiad, Long Trail - ***Mark Trichka***

Ask the following questions when considering new or improved sanitation facilities:

- Is your organization governed by a Local Management Plan (LMP) or a Forest or Park Master Plan or similar document?
- If the answer is yes, does the plan specify a role for backcountry facilities and sanitation systems?

For example, as a member of the Appalachian Trail Conservancy (ATC), the Green Mountain Club (GMC) has an LMP to guide its management of the entire 445-mile Long Trail system in Vermont, which includes the Appalachian Trail. The GMC plan guides the development of overnight facilities and sanitation facilities in language derived from the ATC's *Local Management Planning Guide*. Chapter 2 (G) of the 2009 *Planning Guide* says:

Managing overnight-use areas constitutes an important part of Trail club efforts. Numerous factors must be considered in locating and designing overnight-use areas, including soils, vegetation, topography, expected visitor use, proximity to water, distances to roads and other overnight sites, and use of adjoining lands. Ideally, shelters and campsites should be spaced a modest day's hike apart, and they should be designed to contain the social and environmental impacts of overnight visitors within a confined area. Provisions also should be made for dependable water supplies and sanitation at each site.

And from Chapter 2 (I) Sanitation: ***Regardless of whether an established privy or dispersed disposal area is used to accommodate human waste, the area of each site should be monitored to ensure that sanitary conditions do not create environmental or health problems.***

All A.T. maintaining clubs are bound by ATC policy to provide for backcountry sanitation. However, the type of system is left to individual clubs, subject to standard decision-making criteria. Your organization may be guided by a similar policy, or it may be governed by a state, county, municipality, or land-managing agency. Land managers and Trail clubs should carefully consider the following goals when establishing a designated overnight facility and providing for its sanitation.

- *Protection of Water Quality*—This is a primary concern. Overnight facilities should ordinarily be located near a dependable source of drinking water. It is vital not to compromise the water source by improper disposal of human waste.
- *Prevention of Resource Damage*—Central waste systems reached by designated trails prevent the formation of bootleg trails and damage to vegetation. Sites with no facilities often have a myriad of bootleg trails to poorly chosen spots (for example, next to the shelter or tent site or near water supplies).
- *Protection of Aesthetic Quality*—Nothing makes an overnight facility less appealing than untreated sewage on the ground. Even where a toilet area is designated for disposal of human waste by the hiker in a cat-hole, waste is likely to surface unless there is a human presence (for example, a caretaker or ridgerunner). Also, if a privy smells bad, some hikers will avoid it and deposit their waste on the ground, often in improper or undesirable locations.

To tailor a solution to a particular site, it is necessary to evaluate the site's capabilities and the impacts of visitors.

2.2 HUMAN WASTE IN THE BACKCOUNTRY

Human waste in the backcountry takes four basic forms: sewage (fecal waste, urine, pet waste, and nonorganic contaminated trash), food waste, trash and litter, and fire waste.

Sewage—Sewage is the highest priority because it can spread disease. Traditional disposal methods such as pit privies and cat-holes often contaminate water, but they can be managed to minimize risks.

1. HUMAN FECAL WASTE—Human fecal waste in the backcountry is commonly deposited in the soil in pit-toilets and/or cat-holes, and, to a lesser extent, on the ground surface. The following methods for dealing with it are commonly employed:

Pit Toilet

Pit toilets—The traditional repository. (A pit toilet with no privy shelter is called a chum toilet.) Because anaerobic waste breakdown in a pit is slow, pathogens may remain viable for years. The waste in poorly placed privies can leach contaminants into the surrounding area years after use has ceased. However, pits work well when properly sited and not overused. The level of use must match local soil characteristics. If you are considering a pit toilet, contact your regional ATC office for information on siting and installation.

Modified pit toilets—These attempt to avoid anaerobic decomposition in favor of aerobic decomposition. Modifications include:

Regularly digging out pits to prolong their life. Wastes are then shallow-buried or composted.

Half-filling newly dug or newly emptied pits with dry leaves and duff. Users throw in additional organic matter after use. The outhouse is periodically tilted aside, providing access to mix and aerate the wastes if needed.

Cat-holes—These are almost always used where established toilet facilities are not provided. The user digs a small hole, about six inches deep, then covers the waste with soil. An excellent description of the proper cat-holing technique can be found at the Leave No Trace Center for Outdoor Ethics website at https://lnt.org/learn/principle-3.

Cat-holes are often improperly made, and wastes do not break down quickly, despite the old adage "bury it and it will be gone in two weeks." Studies by Temple and others have shown human pathogens remain viable for up to two years in cat-holes.

For the cat-hole method to be effective, users must break up wastes with a stick, mixing them thoroughly with duff within the cat-hole before covering with a mound of leaves and duff. This creates a minicomposting pile in the top layer of forest soil, which only works well if the soil that the cat-hole is dug in is biologically active and diverse with decomposer organisms. At higher elevations, many of these organisms may be absent.

Cat-holes are usually unsatisfactory as the sole means of waste disposal at designated facilities simply because the volume of waste is greater than the local environments ability to quickly and safely break the waste down and prevent water contamination. Most users make them improperly, despite educational efforts either on- or off-site. Some users even deposit wastes on the surface.

Even though a campsite or shelter has a designated waste management facility, it is important that maintainers post signage at trailheads and at backcountry facilities that instruct visitors on how to find and properly construct cat-holes should they need to construct one.

If you choose to designate cat-hole use at certain campsites, consult your regional ATC office for more information.

Temporary pit latrines—These are typically used by groups and also may create health hazards in heavily visited overnight sites, due to slow waste breakdown and poor placement. As with cat-holes, temporary latrines should be shallow, and wastes should be well-mixed with leaves and duff before being covered with a mound of leaves and sticks. Many groups mistakenly assume that the deeper the hole, the better.

Snow holes—These simple holes in the snowpack are a special situation. Although fecal wastes on snow are subject to solar breakdown and other effects of weathering, they may contaminate spring runoff, especially at sites next to water. Individual knowledge and willingness to make snow holes away from

Waste Barrels awaiting fly-out - AMC Archives water can reduce adverse impacts. However, provision of usable winter toilet facilities at sites with high winter use is the best option.

Composting toilets—These are a major improvement over the above methods of disposing of fecal waste. Site limitations such as shallow soils or high water tables, coupled with heavy use, have led to the development of batch-bin composting and moldering privies, as well as more expensive manufactured aerobic composting toilets.

In a composting toilet, raw wastes are held apart from the surrounding site until sufficiently decomposed to be spread over the forest floor. However, waste policy on federal land in the west frequently dictates that even treated waste be transported out of the backcountry.

Dehydration and incineration toilets—These are commercially available. Results have been mixed. Provision of fuel (usually propane) can be expensive and disruptive, and offensive odors have been reported in some cases.

Removal of wastes—Typically by user (waste bag, tube, portable toilet, *etc.*), helicopter, truck, or mule train, must be done where on-site management is not desirable or possible. Removal prevents contamination of a site, but on a large scale can be expensive and disruptive to backcountry visitors. User-dependent systems such as waste-removal bags can be effective provided there is intensive education on their use and proper disposal facilities provided for used waste bags in the frontcountry.

The improvement of waste pack-out products in recent years has made this option more viable for use in areas without waste facilities or adequate soils for cat-holing. Several of the leading pack-out products can be found in the store at the Leave No Trace website https://lnt.org/shop/outdoor-gear.

2. URINE—Urine is usually a hidden waste problem, aside from toilet paper and yellow snow. The urine of healthy individuals is ordinarily sterile, so the health hazards associated with urine in the backcountry are comparatively low.

Overnight users tend to urinate in the immediate vicinity of a backcountry facility or campsite. Some use privies and some do not. Urine in anaerobic systems such as a pit-toilets substantially increases offensive odors. Depending on the design, urine can be either an asset or a liability in aerobic composting systems, but odors are much less of a problem in either case.

Day users tend to urinate next to the trail and at privies at overnight sites.

3. DOG WASTE—This is a problem whenever dog owners do not clean up after their pets. Canine feces should preferably be packed out in a bag or disposed of using the cat-hole method. Tracking of dog feces into water supplies on hikers' shoes may contribute to the spread of waterborne pathogens such as *Giardia lamblia*.

4. NONORGANIC CONTAMINATED TRASH—Nonbiodegradable items, such as feminine hygiene products, are thrown into privies by careless visitors. In pit toilets such trash is generally left in the pit, taking up space and shortening the life of the pit. In composting systems it is generally retrieved and allowed to weather before being packed out.

Food waste—Food waste is tossed into the woods, dumped into privies, buried, burned, rinsed into surface water, or packed out, in the absence of on-site disposal systems. Ineffective disposal of food waste can offend other hikers, attract nuisance animals and insects, and pollute water. Trail clubs and land managing agencies should aggressively teach Leave No Trace outdoor ethics to hikers and backpackers and thus promote a "Carry In–Carry Out" policy for all nonsewage waste, including food.

Disposal by scattering—Can cause excessive nutrient loading to the water table where shallow soils provide little absorption of nutrients, and attracts nuisance animals. This practice should be discouraged by land managers.

Disposal in pit toilets—Undesirable due to putrefaction odors, fly attraction, and animal visitation (particularly bears).

Burying—Can promote decomposition of food wastes when they are actively mixed with soil in the hole. However, it is a not an ideal solution, because animals may dig up wastes.

Burning food wastes—Can be effective, but a wood fire must be very hot to completely consume the waste and avoid offensive odors. Most hikers do not have the skills or tools to accomplish this. In addition, wood is scarce at most campsites, and managers often discourage or prohibit wood fires to avoid scarring trees or the site.

Rinsing food wastes—Rinsing into surface waters obviously pollutes the water and should be prohibited.

Trash and litter—Problems with these are declining with widespread education about carry-in, carry-out practices.

Clean trash: Paper, plastic, foil, cans, and bottles. It is most prevalent in areas visited by day hikers and nonhikers.

Fishing lines and hooks: These present cleanup and wildlife entanglement problems at heavily used backcountry fishing areas.

Unsorted trash: Food, paper, nonorganic trash, *etc.* It is principally a problem at trailheads. Hikers often carry out food waste, but then put it in trailhead garbage cans, attracting animals that scatter garbage. Hikers should be instructed to take food waste home.

Washing wastes: Food, soap, toothpaste, and other hygienic wastes. These contaminate surface and ground water. The installation of washpits, coupled with Leave No Trace education about low-impact washing practices, has done much to alert hikers to the growing scarcity of pure drinking water and the need to keep water sources as clean as possible.

Dish washing in surface water is a widespread and undesirable practice. The use of washpits has done much to focus hikers attention away from the water source as the place to wash. However, washpits that are inappropriately sited, poorly constructed, or improperly maintained pollute surface and ground water at medium- to high-use overnight sites.

Hygienic wastes, particularly from hand washing after privy use, are a sanitary hazard. The waste system should separate privy users from surface water as much as possible. Sites with the privy and shelter on opposite sides of a watercourse are most prone to water contamination from hand washing.

Bathing, shaving, and toothbrushing: These pose contamination problems at all areas with surface water.

Fire wastes—These appear wherever fires are built. Fires built in undesignated places, such as on the ground, against tree trunks or in unauthorized fireplaces, cause additional damage. Cutting of live trees, excessive wood-gathering, peeling of birch bark, along with scorched inorganic trash, burn-scarred rocks, and charred wood, are other adverse impacts associated with backcountry fire use.

2.3 SUMMARY

New or improved waste-management systems must be chosen after analysis of site characteristics, available financial and labor resources, and current or projected use. Continuous educational efforts are essential for effective waste disposal. Backcountry users should have on-site information, from stewardship signs or field personnel, or information such as guidebooks or pamphlets to instruct them in proper backcountry waste-management techniques.

3 The Decomposition and Composting Process

Pete Antos-Ketcham, Staff, Green Mountain Club

3.1 Introduction

Pete Rentz M.D., Massachusetts A.T. Committee of the Appalachian Mountain Club—Berkshire Chapter

Ever since land animals appeared on Earth, feces and urine have been deposited on the ground. Microorganisms in the soil have evolved to take advantage of these nutrients. This process may be observed in any well-drained cow pasture where cattle eat grass, urinate, and defecate. Urine immediately sinks into the soil and is no longer evident minutes after it is deposited. Manure stays on the surface for several days or weeks, eventually decomposing and also disappearing, nourishing the grass in the process.

When this natural process occurs in a human-controlled environment, we call it *composting*. Composting is a method of waste management in which materials of biological origin are decomposed by common soil microorganisms to a state where they can be applied to the land with little environmental stress. By using compost as a soil amendment, soil properties are improved and nutrients are reclaimed by plants. Composting requires a container, oxygen, proper moisture, proper temperature range, aerobic organisms, and time.

Mechanisms of Decomposition—Decomposition can occur either under *aerobic* conditions (in the presence of oxygen), or under *anaerobic* conditions (in the absence of oxygen).

Aerobic decomposition is the primary decomposition process in porous upland soils, such as the cow pasture described above. The goal of composting is to ensure aerobic conditions as completely as possible. Rapid breakdown, moderate to high temperatures, lack of odors, and effective pathogen destruction typify well-managed backcountry aerobic-composting operations.

Anaerobic decomposition in the backcountry is characterized by slow decomposition, comparatively low temperatures, foul odors, and high pathogen survival. The key to an effective composting process is oxygen, which powers aerobic bacteria and poisons anaerobic bacteria. With oxygen, aerobic bacteria thrive and outcompete anaerobic bacteria, which have slower metabolisms.

3.2 Variables Affecting Composting

The physical and chemical properties of material being composted, and the temperatures attained, directly affect the rate and extent of microbial activity in the composting process. The most significant variables affecting the composting of human waste in the backcountry are listed here.

Size of substrate particles—The size of the substrate particles determines the surface area accessible to microbial attack. Smaller particles expose more surface to bacteria, leading to faster and more complete decomposition. Mixing wastes with ground bark or a similar bulking agent and breaking up clumps of raw sewage creates small compost fragments. This results in finished compost that is composed mostly of fine crumbly particles.

Voids between particles—Voids between particles comprise a significant fraction of compost volume. These air spaces are the main source of oxygen for the microorganisms which cause decay. Turning of the compost mass can reduce clumping and compaction, and bring fresh air into the interior of the pile.

Moisture content—The moisture content of compost is critical. Water is the solvent in which organic and inorganic constituents of cells are dissolved, and it serves as the medium for movement and interaction of various cellular substances.

A moisture content around sixty percent by weight is best for rapid aerobic composting. Below this, compost becomes too dry for rapid microbial growth, the compost process slows considerably, and pathogen encapsulation (conversion to a temporarily inactive form protected by a durable coating) is likely. Much above sixty percent, water begins to collect, and portions of the pile become anaerobic.

Maintaining suitable moisture content in a system is not difficult, as drainage of excess liquid tends to make the pile self-regulating.

All of the systems described in this manual can drain or can offer drainage of liquids. Pit toilets and moldering privies discharge their liquid directly into the soil. Moldering privies, however, have the advantage of allowing the liquid effluent to pass through both aerobic portions of the compost bed and the top biological layer of the soil, providing a high degree of treatment.

Batch-bin systems isolate liquid from the ground and absorb it with a bulking agent, generally bark mulch. A portion of the liquid is evaporated from the bin by the heat of the composting process. The remainder evaporates in the drying process.

The *beyond-the-bin* system drains liquid from the toilet and treats it in a filtering barrel before releasing it into the ground. Any remaining liquid is managed the same way as in the batch-bin system.

The commercial *continuous composters* described in the manual all have provisions to collect, store, and ultimately treat and discharge liquid, ideally by running it through a beyond-the-bin filter barrel.

Temperatures—*Temperatures* attained in composting depend on the configuration, size, and composition of the compost mass, its moisture content, and on its manipulation. Some water is necessary for aerobic bacteria, but too much moisture inhibits them and retards composting, which reduces the temperature.

Mesophilic composting, which occurs in moldering toilets, takes place when waste materials are added slowly. Temperatures may range from 10 to 45 degrees C. (50 to 112 degrees F.).

Thermophilic composting can follow mesophilic composting in a mass of uncomposted material large enough to conserve the warmth generated by mesophilic composting. Thermophilic, or heat-loving, bacteria take over, and temperatures may rise well above 50 degrees C. (120 degrees F.), to as much as 75 degrees C. (167 degrees F.). Thermophilic composting is the goal of batch-bin composting operations.

Every organism has a heat-tolerance limit, above which it perishes. Bacteria flourishing in the mesophilic range warm the pile to their own tolerance limits, and are replaced by thermophilic bacteria. Redworms and many other invertebrates that thrive in meosphilic composting generally do not tolerate temperatures in the thermophilic range. Eventually the upper limit of the thermophiles is reached, and activity slows and ceases. The temperature falls, and if oxygen and nutrients are again made available (*e.g.* by turning the pile), the temperature will rise again. Nutrient and oxygen availability, ambient temperatures, and pile insulation affect the rate and extent of heat buildup.

It is often assumed that the highest temperatures in the thermophilic range produce the highest rates of microbial activity. However, the range of greatest bacterial activity is between 35 degrees C. and 45 degrees C. (95 degrees F. to 112 degrees F.). This range corresponds with adaptation to the soil environment in hot climates. Up to 55 degrees C. (130 degrees F.) the rate of growth and reproduction is still very high, but it falls off markedly above 60 degrees C. (140 degrees F.), the limit of the range of thermophilic bacteria.

Sun and wind have little direct impact on the temperature in a composting chamber, but are worth considering for other reasons.

In most of the backcountry overnight sites along the Appalachian Trail, the sun is either obscured by mountain fog or by a dense canopy of trees. If selected shading trees can be removed, it may improve a composting area by keeping it dry and odor free, and it will help dry compost in a drying rack, but it probably will not enhance the composting process itself significantly.

At some sites in Pennsylvania, the canopy has been reduced around continuous composting toilet systems. The sloping tank and vent stack are painted a dark color to help absorb heat. The Mountain Club of Maryland has reported that solar gain helps to create draft in the vent stack, which helps draw fresh air into the pile and moisture and odor up the stack.

Wind can help to keep a composting area dry and to dry finished products. It also enhances the draft in manufactured continuous composting toilets, which can be desirable, but also can lower the temperature in the composting chamber too much.

The container is critical to reaching thermophilic composting temperatures. It must hold at least 160 gallons for self-insulating thermophilic composting. It is possible that an insulated container could be smaller, but this has not been established. Insulation is of no value in mesophilic composting, since heat is produced at a negligible rate.

Nutrient Elements—Microorganisms utilize a wide array of *nutrient elements*, most of which are present in human fecal wastes. Those used in larger amounts are called macronutrients, and include carbon (chemical symbol C), nitrogen (N), phosphorus (P), and potassium (K).

Nutrients are used in fixed proportions by any particular class of organisms, so a shortage of one nutrient may cause microbial activity to cease before other available nutrients are consumed. Destruction of pathogens is most effective when nutrients are approximately balanced so the composting process can utilize most or all of them. When composting human waste, an optimum balance is created by adding a bulking agent (*e.g.*, hardwood bark) high in carbon, since human waste contains the other macronutrients in appropriate proportions.

The ratio of carbon to nitrogen—the carbon: nitrogen (or C:N) ratio—is the key to nutrient balance. Understanding the C:N ratio is critical to the selection of bulking material, but achieving an effective C:N ratio is not difficult.

If the excess of carbon over nitrogen is too great (high C:N ratio), cell processes slow down. In that case, nitrogen is limiting. That happens when a bulking material of very high C:N ratio, such as sawdust, is used exclusively, or when too much of a bulking agent with a more moderate C:N ratio, such as hardwood bark, is added to the wastes. Given enough time, nitrogen is recycled and the excess carbon is metabolized to carbon dioxide, but the time required can be too long to be practical for batch-bin operations.

If the carbon is limiting (low C:N ratio), excess nitrogen is converted to ammonia until the nutrient balance is restored. That happens

Compost with Actinomycetes (White) at Spruce Peak Shelter LT/AT

Sewage and Hardwood Bark Mixture - GMC Archives

Sewage and Hardwood Bark mix steaming during the composting process - GMC Archives

when not enough bulking agent (such as hardwood bark) is added. A low C:N ratio typically encourages anaerobic conditions, and accounts for the odor of ammonia associated with anaerobic breakdown.

A C:N ratio between 25:1 and 30:1 is optimum for aerobic composting of human wastes. There is no convenient test to determine whether the C:N ratio is in this range. Fortunately, however, this is the approximate ratio which occurs when ground hardwood bark (C:N ratio of 100:1 to 150:1) is added in the quantity needed to regulate the moisture level of the compost. Modest departures from the ideal ratio will slow composting, but will not stop the process. If your compost has an earthy odor, it is close enough to the ideal ratio.

The C:N ratio of human urine is about 0.8:1, and that of raw sewage is about 7:1. The C:N ratio of food scraps is variable, but tends to be less than 15:1.

pH range—The *pH* of the compost is important, because decomposer microbes are intolerant of both acidic and alkaline conditions. The optimum pH range is between 6 and 7.5 (7.0 is neutral).

Fortunately, pH normally is not a concern for the compost operator if an appropriate bulking agent is used. Altering the pH of a compost pile by adding lime to the crib, tank, catcher, or composting bin (which makes the compost more alkaline) *is not recommended*. The result is an increase in ammonia production with its resultant loss of nitrogen. Use of peat moss to soak up excessive water tends to make the pile too acidic. Bark, wood shavings, leaves, and duff should be added if peat moss is used.

3.3 DECOMPOSER ORGANISMS

Aerobic bacteria, molds, fungi, and even protozoa found in soil use enzymatically moderated chemical processes requiring oxygen to progressively break down feces into water, carbon dioxide, nitrogen, and minerals. Antibiotics are produced by some of these microorganisms (actinomyces species) in a microscopic form of germ warfare. There is even a bacterium in soil (*Bdellovibrio bacteriovorus*) that attacks *E. coli*, a potential pathogen found in feces, and destroys it.

The process of transforming raw wastes to finished compost is the job of three major forms of soil organisms: bacteria, fungi, and actinomycetes. The aim of composting technology is to optimize conditions for growth of these organisms.

All three excrete enzymes that break down the large molecules of energy-rich organic compounds of sewage; smaller organic molecules and inorganic ions are then absorbed over the entire microbe cell surface. Energy is released, raising the temperature of the surroundings. The smaller absorbed molecules, such as sugars, alcohols, organic acids, and amino acids, provide usable energy and food for cell growth and reproduction.

Bacteria are single-celled organisms found everywhere. In terms of numbers, bacteria are the most prevalent organisms in the compost pile—a gram of compost can contain more than one trillion bacteria. They are responsible for the breakdown of a wide variety of compounds in the wastes, and for most of the heat released into the compost pile.

Fungi are multicellular organisms with extensive networks of branching filaments. They may make up the bulk of the compost mass during later stages of the compost process. They grow intermingled with actinomycetes, and they utilize similar substrates for energy and nutrient sources. Mature mushrooms often appear in compost. Like bacteria, both fungi and actinomycetes are most active at temperatures below 55 degrees C. (130 degrees F.).

Actinomycetes are single-celled, mostly aerobic organisms, closely related to bacteria, but structurally similar to fungi. They function mainly in the breakdown of cellulose and other organic residues resistant to bacterial attack. Several, such as *Streptomyces,* produce antibiotics. Actinomycetes are detectable visually as a silvery blue-gray powdery layer in the compost, and by their faint earthy odor.

Many common *soil animals* invade the compost pile as decomposition proceeds. Dindal (1976) found soil invertebrate populations in composted material to be the same as those in the surrounding forest system. Most are active burrowers and improve aeration. They feed on organic residues and microorganisms, in addition to each other, and further reprocess the wastes through digestion and defecation.

Some of the larger creatures commonly seen are beetles, collembolas (springtails), isopods, millipedes, mites, and slugs. Worms may burrow in compost at moderate temperatures. Second-phase decomposition in a drying rack or moldering crib that has been capped provides the most favorable habitat for these larger invertebrates.

3.4 CHARACTERISTICS OF HUMAN WASTE AFFECTING DECOMPOSITION

Feces are rich in anaerobic organisms, such as *E. coli*, *Bacterioides*, *Lactobacillus*, and *Klebsiella*, which typically account for about one-third the weight of the feces. These bacteria produce mercaptans and other volatile compounds that account for the unpleasant odor of feces.

Medical literature indicates that feces are produced by an adult at a rate of about 150 grams (5 ounces) per day, a figure which agrees well with the records of the Green Mountain Club (GMC). At our overnight sites with caretakers and batch-bin composting toilets, the average amount of waste produced by each person is 0.03 gallons (3.85 ounces) per day, or 0.2 gallons per week.

GMC backcountry shelter-use data tabulated by Davis & Neubauer (1995) showed that some overnight sites were collecting 14 gallons a week of waste, or more than 300 gallons a season. In 1999, Stratton Pond, GMC's most heavily visited site on the Appalachian Trail in southern Vermont, collected an average of 11 gallons of sewage per week. In the 20-week caretaker season, corresponding to the traditional five-month hiking season, this totaled 220 gallons of waste.

Urine is mostly water. Of the 1,200 grams produced daily by an average person, only 60 grams are solids, mostly nitrogen as urea. Though this urea is a fairly small percentage of urine by weight, it can be a major source of nitrogen in a compost operation.

Healthy people produce sterile urine. If, however, urine is allowed to percolate through feces, it becomes a contaminated witches' brew called leachate. Properly designed composting toilets can adequately treat this through an aerobic portion of the compost mass. But if a composting toilet is poorly designed, operated without enough bulking agent, or overloaded, leachate will be inadequately treated. It can then foul ground water and actually harm plants, so it requires special handling.

3.5 DECOMPOSITION IN TYPICAL BACKCOUNTRY TOILETS

Traditionally, people have used pit toilets or pit privies (commonly called outhouses) in the backcountry. Returning to our cow pasture comparison, this practice is an attempt to keep popular backcountry sites from resembling septic barnyards, or the even more objectionable feedlot. Outhouses protect privacy and keep feces in one spot, but the mass of feces and urine in the pit usually is anaerobic. Pit privies are appropriate and effective in a low-use situation where a new pit may be required every 4 to 6 years, although there is still the risk of groundwater contamination.

According to Franceys, pollution from a pit toilet can travel 15 meters (50 feet) from the pit in the direction of groundwater flow. In dry soil, Rybczynski tells us that pollution can travel from a pit toilet 3 meters (10 feet) vertically and 1 meter (3 feet) laterally. Complete decomposition of feces in an underground pit may require decades. Human pathogens may remain viable for decades in the cool, anaerobic conditions of the pit. If soil is shallow, or groundwater high, pathogens and nutrients can be transported from a site for many years after a pit has been abandoned. These facts preclude the use of pit toilets in many areas of the backcountry.

Composting systems, including composting toilets, require that feces remain aerated and in contact with soil organisms that can use oxygen to produce rapid decomposition. If there is too much moisture, oxygen cannot reach aerobic bacteria and they perish. If the volume of the fecal mass is too large compared to its surface, the same thing happens; the center of the pile “goes anaerobic,” and malodorous, slow, anaerobic decomposition occurs.

With insufficient bulking agent, urine can saturate compost, causing anaerobes to take over. Anaerobic decomposition of the nitrogen in urine produces unpleasant chemicals such as ammonia, which is poisonous in high concentrations and accounts for some of the noxious odor of a traditional outhouse.

Wood shavings in the moldering privy at Happy Hill Shelter - GMC

The nitrogen in urine requires a great deal of bulking agent to provide the additional carbon to achieve the optimal carbon:nitrogen ratio for composting of 25:1 and to avoid saturation. Unless the nitrogen is desired as a fertilizer, it is often undesirable to prematurely fill the chamber of a composting toilet or privy with the large volume of carbonaceous material needed at a high-use backcountry site.

To minimize the labor of handling bulking materials and emptying compost chambers, or if there is any uncertainty over the capacity of a composting toilet or privy to treat leachate, it is best to separate urine and feces by providing urinals or asking users to urinate in the woods or utilize a system such as the moldering privy where excess liquid can drain from the pile.

4 Health and Safety Issues

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*"Proper Sanitation is defined by the World Health Organization as any excreta disposal facility that interrupts the transmission of fecal contaminants to humans." (*The Humanure Handbook*, by J.C. Jenkins, 1999)*

4.1 Overview of Pathogens

Various harmful disease-causing organisms, called pathogens, can be present in feces. Even the normally occurring *E. coli* can behave as a pathogen if it is ingested in large volume, or if it contaminates a wound. Pathogens include diarrhea-causing *Salmonella* or typhoid bacteria, polio and hepatitis viruses, protozoa such as *Giardia lamblia* and *Entamoeba histolyticia*, and parasites such as hookworm and *Ascaris* (roundworm).

Most of these pathogens are killed by composting for several months, although *Ascaris* eggs can be resistant to composting conditions, and may remain viable for years in favorable soil conditions. If aerobic decomposition is so fast that the temperature in a composting mass rises substantially, destruction of pathogens is more rapid, and *Ascaris* eggs do not survive.

Hikers infected by *Ascaris* are probably rare in this country, although it would take a very expensive study to determine that with certainty. However, there is no control over who uses the backcountry toilets, and there is no practical method of monitoring the temperature in all parts of a composting chamber. Therefore, field workers must assume that *Ascaris* eggs are present in compost even after high-temperature decomposition, and they must follow the safety precautions and procedures outlined below.

Parasitic worms other than *Ascaris* are either tropical in habitat or not transmitted through feces, and are of little concern in temperate climates. *Giardia* and their cysts, amoebas, viruses, and pathogenic bacteria do not last long in the composting environment.

4.2 Conditions That Destroy Pathogens and Parasites

Substantial elimination of human pathogens, including parasites, is the primary goal of composting. A variety of interacting factors destroy pathogens; their importance differs in *mesophilic* (low temperature) and *thermophilic* (high temperature) composting.

The design and operation of a composting system depends on which type of composting is expected to dominate. Batch-bin and beyond-the-bin systems rely primarily on thermophilic composting for pathogen destruction, while moldering, or continuous-composting systems rely on mesophilic composting.

The following conditions destroy pathogens in composting systems:

1. *High temperatures* generated in the interior of a compost pile in thermophilic composting that exceed the upper limits of human pathogen tolerance.
   Human pathogens, adapted to a narrow range centered around body temperature (37 degrees C. or 98.6 degrees F.), are killed by exposure for several hours to temperatures in the range

of 50 to 60 degrees C. (122 to 140 degrees F.), or by exposure for several days to temperatures in the range of 40 to 50 degrees C. (104 to 122 degrees F.).

A properly managed compost pile, well-supplied with fresh material and large enough to retain its own heat, will have enough nutrients and oxygen to warm quickly into the thermophilic range. For specific information on optimum pile size and management of thermophilic composting, see the description of Batch-Bin Composting in Section 9.Thermophilic conditions are reached only in the interior of a pile. Therefore, in any system that depends on high temperatures for pathogen destruction, the pile must be turned to transfer the outside material to the interior. The greater the volume of waste, the better the pile self-insulates, and the higher the proportion of material that undergoes thermophilic conditions after each turning.

2. *Aerobiosis:* Most human-gut pathogens are "obligate anaerobes" (organisms that live only in the absence of oxygen). Aerobic conditions contribute to a lethal environment for them. Small particle size and thorough mixing ensure maximum oxygen exposure.

3. *Competition:* Hardy local soil microbes are better able to utilize the rapidly changing conditions in composting material in the competition for nutrients and attachment sites.

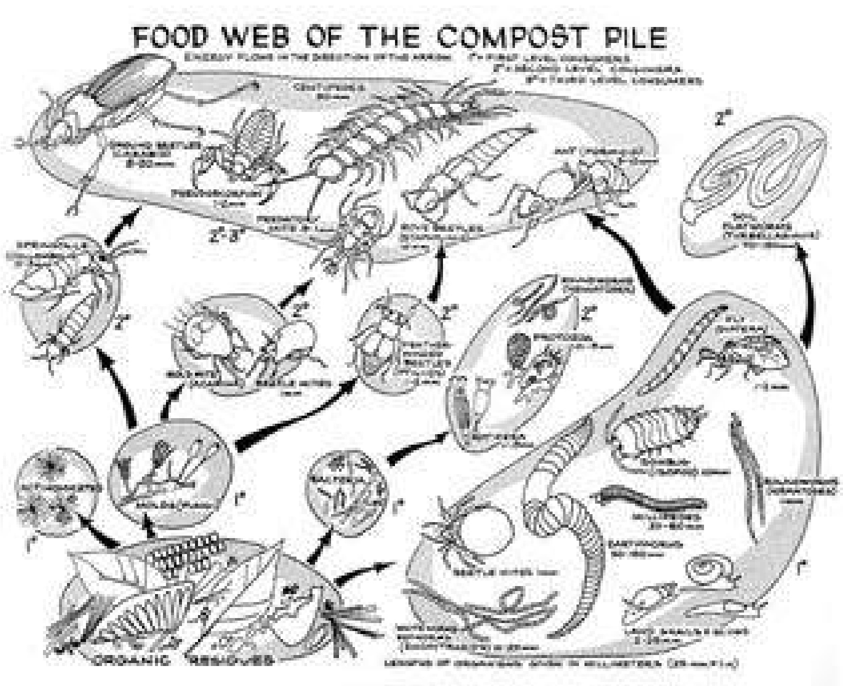
4. *Destruction of nutrients:* Human pathogens are generally more fastidious in their nutritional requirements and choice of substrate than nonpathogenic organisms. They are at a competitive disadvantage as nutrients to which they are adapted are consumed, oxidized, or otherwise altered.

5. *Antibiotics:* Produced by actinomycetes and fungi, these hinder the growth of many pathogens. Antibiotics play a larger role in the later stages of thermophilic composting processes, when the pile has cooled and stable mesophilic conditions favor fungi and actinomycetes.

6. *Time:* The length of exposure to inhospitable conditions takes a toll on human pathogen populations.

Time is critical in a moldering toilet or privy, and in commercially produced continuous-composting systems like the Bio-Sun or Clivus Multrum, because the temperatures in these systems are in the mesophilic range. The agents and mechanisms of low-temperature pathogen destruction need ample time to take effect. In a properly functioning compost pile, bacteria and viruses are generally inactivated over periods ranging from a few days to a few weeks. However, moldering systems generally provide a large factor of safety by holding wastes in aerobic conditions for months or even years.

Although composting occurs faster in batch-bin and beyond-the-bin systems, time is still necessary. In the first



Drawing by Dr. Dindal of SUNY College of Environmental Science, Syracuse, NY (thermophilic) stage, wastes are exposed to rapid aerobic composting conditions for three to six weeks. Most of the breakdown of waste materials and destruction of pathogens occurs in this phase. Aging at ambient temperatures on a drying rack provides a secondary decomposition period ranging from one month to one year, in which the compost stabilizes and shrinks further. If more time is allotted to the primary phase, less is needed in the secondary stage.

4.3 SAFETY PRECAUTIONS AND PROCEDURES

Although the ideal is to eliminate handling of raw sewage or reduce it to a minimum, campsite maintainers often work with raw sewage. Even finished compost cannot be considered absolutely safe, although it typically has pathogen concentrations comparable to those in ordinary forest soil. Strict sanitary procedures are essential. If caution and common sense are used, the likelihood of infection or illness is extremely low. The following precautions and procedures are essential in any operation composting human waste.

HANDWASHING:

- Regardless of what type of system you are using, hang a special wash jug near the outhouse, away from the shelter and washpit, and well away from surface water. Label the jug "FOR COMPOSTING ONLY." That wash jug should *never* leave the site.
- The best container for a wash jug is a one-gallon plastic milk jug with a small hole punched near the bottom. Put a small twig in the hole. When the jug is capped and the twig is in place, leakage is slow. With the cap loosened and the twig removed, a small stream comes out. That system allows you to wash and rinse hands thoroughly.
- Use a clean jug to pour wash water into the wash jug *before* you begin any aspect of the composting operation; never touch that clean jug after the point in the work in which your hands may have become contaminated.
- After handling any sewage container or performing any mixing or turning, always wash your hands well with water followed by an application of alcohol based hand sanitizer. Allow wash water from your hands to fall directly on the ground.

NOTE: *Washing your hands with cold water is not sufficient alone to ensure pathogen destruction and prevent contamination and/or infection. Antibacterial soap, while recommended in the past, is not effective without access to copious amounts of hot water. Alcohol-based waterless hand cleaner is the OSHA approved, hospital-used method for hand washing when sufficient resources for hand washing are unavailable,* e.g. *backcountry campsites. GMC has found Vionex or similar professional-grade hand sanitizer to be most effective, as it is designed for health professionals who are exposed to a broad range of waste or bloodborne pathogens.* ***However, hand sanitizers may not be effective against norovirus. If norovirus contamination is suspected, check with the health department or agency partner on recommended products. See Section 4.4 for more information on norovirus.***

If there is any debris on hands, it should be rinsed off with water away from water sources. If there is no debris, or after the debris is rinsed off, hands should then be washed thoroughly with Vionex or similar alcohol-based hand cleaner. A quarter-sized amount should be rubbed on to the hands until it is all absorbed. Be sure to wash the thumbs, in between the fingers and around the nail beds. If ever in doubt of how clean your hands are, there is nothing wrong with using Vionex or an equivalent product twice.

Personal Protective Equipment and Practices

- If possible, try to have a set of clothes that are only used for composting activities. If not, you can use a contractor bag to cover yourself when there is splash potential.
- Wear long pants.

- Long-sleeved shirts can be a problem, because the sleeves may be soiled by brushing against soiled objects. Roll the sleeves up snugly before you begin. Tuck in your shirttails so they won't dangle into or against a bin while you are turning compost. The same goes for long braids. Any clothing used for composting should be laundered in hot water separately from other clothing.

- During bug season, plan to do all work with your system early in the morning. Swatting bugs or scratching insect bites with soiled hands is foolish. Wear a bandanna to keep bugs out of your ears.

- **Always use rubber gloves.** The Green Mountain Club (GMC) and U.S. Forest Service (USFS) use heavy-duty Nitrile rubber gloves, available from medical-supply stores. Wash your hands and use Vionex even when you have used gloves. These nonlatex gloves are one of the most important barriers available to keep the pathogens of human waste away from our bodies. They should be put on before touching any contaminated component of composting. The only noncontaminated component is the fresh bark mulch that was just brought in. Every other component (including the trap door to collector, the drying rack, *etc.*) should be considered contaminated and should be touched only with gloves in place. When gloves are on, the order of steps should be planned such that the least contaminated things are touched first, and, once more-contaminated things have been touched, less-contaminated items are not touched again unless with fresh gloves. The idea is to prevent increased contamination. For example, if you go to check the outhouse and clean the toilet seat inside at the same time you are going to turn your compost, be sure to do the inside jobs first, and, after you have touched the turning fork and the compost bin, do not touch the outhouse door handle with those same gloves.

Old Composting PPE - eye protection is optional and respirator is not needed - GMC Archives

Gloves and Vionex - the basic safety equipment for composting

- Taking off the gloves should be done in a manner that prevents bare skin from touching contaminated glove surfaces. The best way to do this is easy: with one hand, grasp the palm of the other glove near the wrist. Pull away from the hand and then toward the finger tips so that the glove slides off. The removed glove should be balled up into the palm of the still-gloved hand. Once the glove is balled up, use a finger from the now ungloved hand and slide it along the inside of the wrist and under the other glove, then lift the contaminated glove so that it comes off the hand and flips inside out. The gloves should be stowed in a garbage bag for packing out. Hands should now be cleaned as described in hand-washing techniques.

- **Wear eye and face protection.** When there is high probability of sewage splash, consider wearing a plastic face shield. The key times to wear these are during bin emptying and the starting of compost runs. At those times, there is raw sewage that—if splashed—can lead to exposure to pathogens. The face shields are reusable if proper care is taken. One member of the group taking part in the activity should have double gloves on. That person should remove the outer pair of gloves when the initial work is done, and then gather the face shields from all members. Using the Vionex alcohol-based cleaning wipes, both sides of every shield should cleaned. The inner sides should all be cleaned first, and then the outer sides. If there is actual sewage splash on the shields, they should be rinsed off with water away from any drinking water source before use of the Vionex wipe. The used Vionex wipe should be disposed of with the used gloves, and each face shield should be placed in a separate gallon Ziploc plastic bag for later use. Safety glasses are a less expensive option, but not nearly as effective, so they should only be used if face shields are unavailable.

- Keep your fingernails short.

- Cover small cuts and blisters with Vaseline and a Band-Aid before you handle any potentially contaminated objects, such as tool handles or handles on collection and storage containers. Remove Band-Aids and wash thoroughly when you are done. Larger cuts are best covered with gauze and disposable gloves.

- If you cut or nick yourself while handling buckets or tools, *stop* and wash well with soap, water, and alcohol-based hand sanitizer. Bandage before finishing the job. Do not risk infection.

- Once you have begun interacting with your composting system, treat your hands as if they are completely soiled. No adjusting of clothes, resting of hands on hips or in pockets, folding of arms, *etc.* Keep your hands off your body, and touch nothing but tools, containers, and bulking agent.

Typical Pathogen Survival Rates at 20° to 30°C in Various Environments*

	Survival Time' in Days		
Pathogen	**Freshwater and wastewater**	**Crops**	**Soil**
Bacteria			
Fecal coliforms'	<60 but usually <30	<30 but usually <15	<120 but usually <50
Salmonella (spp.)'	<60 but usually <30	<30 but usually <15	<120 but usually <50
Shigella'	<30 but usually <10	<10 but usually <5	<120 but usually <50
Vibrio cholerae'	<30 but usually <10	<5 but usually <2	<120 but usually <50
Protozoa			
E. histolytica cysts	<120 but usually <15	<10 but usually <2	<20 but usually <10
Helminths			
A. lumbricoides eggs	Many months	<60 but usually <30	<Many months
Viruses			
Enteroviruses'	<120 but usually <50	<60 but usually <15	<100 but usually <20

*Adapted from Feachem et al. (1983).
' Includes polio, echo, and *Coxsackie* viruses
' In seawater, viral survival is less, and bacterial survival is very much less than in fresh water.
' *V. Cholerae* survival in aqueous environments is a subject of current uncertainty.

(Ron Crites and George Tchobanoglous, *Small and Decentralized Wastewater Management Systems* (United States: McGraw-Hill, 1998).

- If you accidentally splash raw sewage on yourself, wipe it off with dry bark powder or powdered charcoal, taking care not to scratch your skin. Then rinse with a stream of water and follow up with an application of alcohol-based hand sanitizer. Keep a small, open container of finely powdered bark or charcoal with you while you are working. Raw sewage can be removed the same way from shoes or clothing, which should later be washed.
- Be careful if small, springy branches, or underwear with elastic gets into the sewage containers, which does happen occasionally. Elastic can slingshot sewage at you with uncanny accuracy and alarming consequences.
- Keep your mouth closed when mixing sewage or when dumping sewage from one container into another. If sewage does splash in your mouth, rinse immediately with copious quantities of water, and do not swallow.
- Do not lean against any part of the composting system for leverage. Turn the compost in the bin without touching the bin at all.
- Be careful to keep tool handles away from the sides of the toilet or any container.
- Keep all tool handles clean by rubbing them with bark or duff after use. Mark all tools "FOR COMPOSTING USE ONLY" with paint or another permanent marker. It is best to lock composting tools away from visitors.
- Stand tools up carefully to keep the handles clean. As an extra precaution, hold tools well above where the metal tool head attaches to the wooden handle. The metal portion of the turning fork and shovel will become contaminated during each use.
- As a final precaution, *never touch finished compost,* no matter how "done" it appears. It *is* safe if properly handled. Areas where compost has been properly spread should pose no health risk to the operator. However, take reasonable precautions in moving through those areas (such as not walking in bare feet).

4.5 NOROVIRUS

Known or suspected outbreaks of severe gastroenteritis caused by norovirus (also called Norwalk virus) have occurred on the Appalachian Trail in recent years. Norovirus is highly contagious and is spread through person-to-person contact, by eating food that has been contaminated, by contact with surfaces that have been contaminated by the vomit or feces of an infected person, or even by particles that become aerosolized.

Norovirus symptoms occur one to two days after exposure to the virus and include nausea, vomiting, diarrhea, and stomach pain. Victims may vomit or have diarrhea many times a day and there is a risk of dehydration. Less common symptoms include low-grade fever, chills, headache, muscle aches, and tiredness. Although most people with the illness get better within a few days, they may still remain contagious for some time.

In 2014, ATC worked with the Centers for Disease Control and the Tennessee Department of Health to develop a poster for the A.T. informing hikers how to avoid contracting norovirus. If there is an outbreak suspected in your Trail club's section, consult with your ATC regional office and land-managing agency partner on whether signage should be posted.

Shelters and privies may become contaminated by hikers suffering from norovirus. In addition to following the safety precautions and procedures in Section 4.3 above, additional cleaning and disinfection may be needed if norovirus contamination of a privy or shelter is suspected. Check with the land-managing agency for their recommendations.

CLEANING

- Wear protective clothing (such as disposable gloves, apron, mask).
- Wipe up vomit or diarrhea with paper towels.
- Dispose of paper towel/waste in a plastic trash bag or biohazard bag.
- Use soapy water to wash surfaces.
- Rinse thoroughly with plain water.
- Wipe dry with paper towels.

DISINFECTING Prepare a chlorine bleach solution (make fresh solution daily using bleach with at least a 6 percent concentration of sodium hypochlorite) or use a disinfectant that has been shown to be effective against norovirus. The Centers for Disease Control has posted a list of EPA registered antimicrobial products effective against norovirus (http://www.cdc.gov/norovirus/preventing-infection.html), and other products are being developed.

For porous surfaces (wood, concrete, natural stone) use 1 2/3 cup bleach per gallon of water

- Allow surfaces to air-dry.
- Wash hands thoroughly with soap and water. Note that many hand sanitizers are not effective against norovirus.
- All clothing that may have been in contact with vomit or diarrhea should be washed with detergent, hot water, and bleach (if recommended), using the longest wash cycle, and then machine-dried.

4.4 HANTAVIRUS PULMONARY SYNDROME

Hantavirus pulmonary syndrome is a rare disease with a high fatality rate (36 percent). The disease is caused by a virus and is contracted by people coming into contact with rodent urine, droppings, or places where these animals have nested. Dried droppings or urine can be stirred up in dust and breathed in. Most cases have been reported in the western U.S., including ten cases with three fatalities reported by Yosemite National Park in the fall of 2012. In 1993, an Appalachian Trail hiker contracted hantavirus, apparently in Virginia. He was hospitalized in critical condition for several weeks but eventually recovered. Eight

GMC field staffer demonstrating safe composting techniques at Spruce Peak - GMC

Composting PPE - Masks are a good precaution if your sewage collector is very wet of the 14 A.T. states have had at least one reported case. Deer mice and other rodents are common in Appalachian Trail shelters and privies. Precautions should be taken to prevent contact with rodents and their urine and feces.

The first symptoms, which usually appear 1 to 3 weeks after exposure, are fever, muscle pain, and being tired. Some people also get headaches, dizziness, vomiting, or diarrhea. About 4 to 10 days later, people who have contracted infection begin to cough and have shortness of breath.

CLEANING SHEDS AND OTHER OUTBUILDINGS

Before cleaning closed sheds and other outbuildings, ventilate the building by opening doors and windows for at least 30 minutes. Use cross ventilation if possible. Leave the area during the airing-out period. This airing helps to remove infectious primary aerosols that might be created by hantavirus-infected rodents. In substantially dirty or dusty environments, additional protective clothing or equipment may be worn. Such equipment includes coveralls (disposable when possible) and safety glasses or goggles, in addition to rubber, latex, vinyl, or nitrile gloves.

CLEANUP OF DEAD RODENTS AND RODENT NESTS

- Wear rubber, latex, vinyl, or nitrile gloves.
- Spray dead rodents and rodent nests with a disinfectant or a chlorine solution, soaking them thoroughly. Wait 10 minutes before disturbing to ensure inactivation of the virus.
- Place the dead rodent or nest in a plastic bag, or remove the dead rodent from the trap and place it in a plastic bag. When cleanup is complete (or when the bag is full), seal the bag, place it into a second plastic bag, and seal the second bag. Dispose of the material in the double bag by burning it or discarding it in a covered trash can that is regularly emptied. Contact the local or state health department concerning other appropriate disposal methods.
- Clean up the surrounding area as described in "Cleanup of Rodent Urine and Droppings and Contaminated Surfaces."

DISINFECTING SOLUTIONS

Two types of disinfecting solutions are recommended to clean up rodent materials.

1. General-Purpose Household Disinfectant: Prepare according to the label, if not prediluted. Almost any agent commercially available in the United States is sufficient as long as the label states that it is a disinfectant. Effective agents include those based on phenols, quaternary ammonium compounds, and hypochlorite.
2. Hypochlorite Solution: A chlorine solution, freshly prepared by mixing 1½ cups of household bleach in 1 gallon of water (or a 1:10 solution) can be used in place of a commercial disinfectant. When using chlorine solution, avoid spilling the mixture on clothing or other items that might be damaged by bleach. Wear rubber, latex, vinyl, or nitrile gloves when preparing and using chlorine solutions. Chlorine solutions should be prepared fresh daily.

CLEANUP OF RODENT URINE, DROPPINGS, AND CONTAMINATED SURFACES

During cleaning, wear rubber, latex, vinyl, or nitrile gloves.

Spray rodent urine and droppings with a disinfectant or chlorine solution until thoroughly soaked. (See Cleanup of Dead Rodents and Rodent Nests.)

To avoid generating potentially infectious aerosols, do not vacuum or sweep rodent urine, droppings, or contaminated surfaces until they have been disinfected.

Use a paper towel to absorb the urine and pick up the droppings. Place the paper towel in the garbage.

After the rodent droppings and urine have been removed, disinfect items that might have been contaminated by rodents or their urine and droppings.

- Mop floors with a disinfectant or chlorine solution.
- Disinfect countertops, cabinets, drawers, and other durable surfaces with a disinfectant or chlorine solution.
- Spray dirt floors with a disinfectant or chlorine solution.
- Launder potentially contaminated clothing with hot water and detergent. Use rubber, latex, vinyl, or nitrile gloves when handling contaminated laundry. Machine-dry laundry on a high setting or hang it to air dry in the sun.
- Before removing the gloves, wash gloved hands in a disinfectant or chlorine solution and then wash bare hands in soap and water.

RECOMMENDATIONS FOR CLEANING HOMES OR BUILDINGS WITH HEAVY RODENT INFESTATIONS

Special precautions are indicated for cleaning homes or buildings with heavy rodent infestations. A rodent infestation is considered heavy if piles of feces or numerous nests or dead rodents are observed. Persons cleaning these homes or buildings should contact their Safety Officer or Public Health Consultant. These precautions also can apply to vacant dwellings that have attracted rodents while unoccupied and to dwellings and other structures that have been occupied by persons with confirmed hantavirus infection. Workers who are either hired specifically to perform the cleanup or asked to do so as part of their work activities should receive a thorough orientation about hantavirus transmission and disease symptoms and should be trained to perform the required activities safely.

If the building has been closed and unoccupied for a long period (weeks or months), ventilate the building by opening doors and windows for at least 30 minutes before beginning any work. The ventilation helps to remove aerosolized virus inside the structure. Use cross ventilation if possible. Leave the area during the airing-out period.

Persons involved in the cleanup should wear coveralls (disposable, if possible); rubber boots or disposable shoe covers; rubber, latex, vinyl, or nitrile gloves; protective goggles; and an appropriate respiratory protection device as detailed in “Precautions for Workers Frequently Exposed to Rodents.”

Personal protective gear should be decontaminated or safely disposed of upon removal at the end of the day. If the coveralls are not disposable, they should be laundered on site. If no laundry facilities are available, the coveralls should be immersed in liquid disinfectant until they can be washed.

Unless burned on site, all potentially infectious waste material from cleanup operations should be double-bagged in durable plastic bags and then discarded in a covered trash can that is regularly emptied. Contact the local or state health department concerning other appropriate disposal methods.

Persons involved in the cleanup who develop a febrile or respiratory illness within 45 days of the last potential exposure should immediately seek medical attention and inform the attending physician of the potential occupational risk of hantavirus infection.

Information courtesy of the Centers for Disease Control

http://www.nps.gov/yose/planyourvisit/hantavirus.htm

PART 2

Regulatory and Aesthetic Issues

5 Integrating Backcountry Sanitation and Local Management Planning

6 Introduction to the Regulatory Process

7 The Aesthetics of Backcountry Sanitation Systems

A well organized composting operation minimizes aesthetic impact

5 Integrating Backcountry Sanitation and Local Management Planning

Jody L. Bickel, *former Staff member, Appalachian Trail Conservancy*

The *Comprehensive Plan for the Appalachian Trail* (developed and signed by the National Park Service and the U.S. Forest Service in 1981) and the Memorandum of Understanding between the National Park Service and ATC (last renewed in 2004), which delegated certain management responsibilities to ATC and in turn to the Trail-maintaining clubs, assume that local management plans would be the cornerstones for cooperative management of the Appalachian Trail.

In 1987, the Appalachian Trail Conservancy (ATC) initiated the development of a local planning guide, with the intent of providing the Trail-maintaining clubs with a comprehensive reference document to aid them in the process of local planning. *The Local Management Planning Guide* has evolved from that initial concept and has two purposes: (1) to consolidate existing ATC and federal policies affecting Trail management into a single reference for clubs and cooperating agencies; and (2) to answer questions on how to prepare a local management plan and what to include in a plan. In other words, the Planning Guide is designed to be used as both an active tool and as a permanent reference of current policies for management of the Appalachian Trail. The Planning Guide was revised most recently in 2009 and is posted at **http://www.appalachiantrail.org/what-we-do/trail-management-support/volunteer_toolkit/local-management-planning**. ATC conservation and Trail management policies are posted at **http://www.appalachiantrail.org/what-we-do/trail-management-support/volunteer_toolkit/trail-management-policies**, including those adopted between updates of the Planning Guide.

Working with its agency partners and ATC regional staff, each of the 31 Trail-maintaining clubs prepares a local management plan, following the guidelines in the Planning Guide, for its section of the Trail. A club plan is reviewed and approved by the land-managing agency partner, the Regional Partnership Committee, and ATC staff, with the ATC regional director giving final approval for ATC. The plans should be updated at least every ten years.

When making decisions about backcountry sanitation management, volunteers should refer to the maintaining club's local management plan to ensure compliance with local standards and Trail-wide policy. For more information contact your ATC regional office.

6 Introduction to the Regulatory Process

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Janet A. Zeller, *National Accessibility Program Manager, USDA Forest Service*

6.1 Overview

Providing adequate facilities for the disposal of human waste along the Appalachian National Scenic Trail is a complex issue. Factors including the number of users, type of users (day hikers, overnighters, long-distance hikers), length of the annual use season, availability of nearby off-Trail facilities, type of terrain, availability of suitable overnight sites (both shelters and campsites), and other variables, all contribute to this complexity.

In many locations along the Trail, dispersed individual cat-holing of human waste in accordance with the principles of Leave No Trace outdoor ethics (information at www.LNT.org) is the current sanitation practice and is expected to be adequate and acceptable for the foreseeable future. In other locations, the concentration of use, particularly overnight use, on a limited number of sites—especially in fragile or sensitive ecosystems—dictates the need for more developed backcountry sanitation facilities.

6.2 CURRENT POLICIES ADDRESSING BACKCOUNTRY SANITATION

There is no "standard policy" among the various Appalachian Trail cooperative management partners addressing backcountry sanitation facilities. The current Appalachian Trail Conservancy (ATC) policy, as stated in the *Local Management Planning Guide* (2009 Edition) is that sanitation facilities should be provided at high-use shelters and popular campsites and that "privies or toilets [should be] located and designed to meet local conditions." Some clubs (*via* their local management plans) or ATC Regional Partnership Committees (RPCs) have additional policies.

For example, the mid-Atlantic RPC has resolved that all overnight shelter sites in its region should have developed sanitation facilities. Trail clubs in that region (from Shenandoah National Park in Virginia through New York) have worked for several years to develop waste facilities at existing shelters that do not have them.

The policies of federal and state land-managing agency partners vary, and often include general, agency-wide policy direction (for example, USDA Forest Service manuals and handbooks, National Park Service director's orders, and state agency equivalents). They often include additional, more specific policy for particular units (forests or parks), or for the Appalachian Trail (for example, national forest land management plans, national park general management plans, and state agency equivalents).

Both U.S. Forest Service and National Park Service policies state that wastewater facilities will be in compliance with the federal Clean Water Act. Both agencies strongly recommend the involvement of appropriate specialists (such as a public health service consultant or sanitary engineer) in determining the appropriate type of facility type, its design, and its siting. According to National Park Service policy, the following are suitable backcountry waste systems:

- Flush toilets
- Composting toilets
- Barrel toilets
- Evaporator toilets
- Incinerator toilets
- Pit privies (NPS Reference Manual 83)

The overriding legislation dealing with backcountry sanitation is the Clean Water Act of 1977, as amended, which gives the United States Environmental Protection Agency (EPA) the authority to regulate wastewater facilities in order to restore and maintain the integrity of the nation's waters. EPA delegates many of the permitting, administrative, and enforcement aspects of the law to state governments, who in turn work through local (county, township, or municipal) sanitarians and health departments. While federal agencies are not bound by most local and state laws and regulations, they are bound by the federal regulations pursuant to the Clean Water Act, which are administered by state and local agencies for the EPA.

6.3 A PROPOSAL

A proposal to develop a human waste management facility at a specific site may be advanced by any of the A.T. cooperative management partners—individual maintainer, local maintaining club, ATC, or land-managing agency partner. Often, a proposal for a human waste facility is part of a larger proposal to construct or reconstruct an overnight site. Once a proposal is advanced, all cooperative management partners should be involved in the decision: first, whether a human waste facility is necessary or desirable; and second, what facility is best suited to the location. ***ATC's policy on review and approval of management plans and project proposals*** applies to construction of new or replacement facilities and provides an approvals process.

Once a proposal for a sanitary facility has been developed by the management partners, land ownership at the specific site determines the direction that the approval process will take.

On federal lands, an environmental analysis of the proposal must be conducted in accordance with the National Environmental Policy Act of 1969 (NEPA), which requires activities be analyzed to determine their impacts on natural resources and the public.

In increasing order of complexity, the three levels of analysis are *categorical exclusion*, *environmental assessment*, and *environmental impact statement*. Most simple actions, like relocating or improving an existing privy, can be done under the easiest procedure, a categorical exclusion. Involvement of program-area specialists usually is required to ensure that the project will not adversely affect cultural resource sites or rare, threatened, or endangered species and that the project is compatible with other activities. Investigation of agency, state, and local requirements should be completed early in the NEPA process.

The National Park Service and the U.S. Forest Service have developed different policies to implement the requirements of NEPA that depend, in part, upon site-specific factors and the risk assessment of the decision-maker (such as the district ranger, the forest supervisor, the park manager, or the park superintendent).

On nonfederal lands, analyses and approvals may be required by other agencies, and coordination with other state and local regulatory agencies may be necessary. The applicable state and local regulatory agencies vary from state to state. For example, state regulations in Maryland and Pennsylvania, which prohibit the direct ground contact of human waste in a constructed facility, preclude new pit privies. Concrete vault toilets and composting toilets with waterproof composting chambers meet the regulations. As of this writing, the ATC and the National Park Service's Appalachian Trail Park Office are working with partners to develop A.T.-specific guidance and regulations to permit the construction and use of the moldering privies in the mid-Atlantic region on the Appalachian Trail.

Construction of a replacement shelter and composting toilet in Pennsylvania in 1997 required approval of the concept and design of both the shelter and the toilet by the land manager (the Pennsylvania Game Commission), and separate approval of a permit for the composting toilet by the local township sanitary engineer.

In 2000, the Green Mountain Club (GMC) in conjunction with the University of Vermont and the Vermont Department of Forests, Parks, and Recreation restored the historic Butler Lodge on Mt. Mansfield. That project also included an upgrade of the batch-bin composting toilet system to a beyond-the-bin liquid management system. The project required submitting a wastewater permit application to the State of Vermont Agency of Natural Resources (ANR) Department of Water Supply and Wastewater Disposal. The GMC submitted an application and a thorough explanation of the system, based on the report developed by the Appalachian Mountain Club (AMC). A permit was issued. That was the first time the GMC had to apply for such a permit (see Appendix for the permit). In the years following the project at Butler Lodge, GMC has applied for and received several state permits (including Vermont's Land Use Planning Permit Act 250) for new installations. Aside from the state permits, local zoning permits also have been required.

The Appalachian Mountain Club installed moldering privies at several sites on the A.T. in Connecticut. In order to begin the process of getting regulatory acceptance of these systems, AMC wrote a letter to the State of Connecticut Department of Public Health. The club was placed in contact with the supervising sanitary engineer of the Environmental Engineering Section. The AMC submitted a letter of request accompanied by a detailed description of the moldering privy. The state approved the installation as long as several criteria were met and provided AMC with a letter spelling out the approval and requisite stipulations. The state's letter still serves as the AMC Trails Committee's means of notifying local health agencies of the acceptability of the system solicits their involvement in the review, testing, and approval of the units where applicable. (See Case Studies – Moldering Privies in Connecticut.)

The Appalachian Trail Conservancy, Smoky Mountains Hiking Club, and Great Smoky Mountains National Park partner to manage the seven moldering privies along the A.T. in the Park. Volunteers bring in mulch, harvested and chipped locally, by backpack and on horseback to prevent defoliation around privy sites. Those privies do not use red worms and rely completely on aerobic bacteria to break down human waste. No additional privies on the A.T. in the Park are planned at this time.

Determine all of the regulatory stakeholders that need to be involved in your proposed sanitation project!

The importance of this determination cannot be emphasized strongly enough. Management of the Appalachian National Scenic Trail is a partnership. Volunteers have always been—and continue to be—the cornerstone of the A.T., but they do not work alone. Since the 1920s, the U.S. Forest Service, the National Park Service, the states, and local communities have worked together to complete, preserve, and maintain the Trail.

The 1978 amendments to the National Scenic Trails System Act authorized the A.T. land acquisition program, which dramatically broadened and deepened this partnership. Today, volunteers work in a partnership that includes the Appalachian Trail Conservancy (ATC), local Trail maintaining clubs, and multiple government landowning agencies (NPS, USFS, state parks, Department of Transportation, local Trail communities, *etc.*).

Even more partners are involved in backcountry sanitation. These include state, county, and local health departments, state agencies in charge of natural resources and environmental conservation and protection, and state, county, or town-contracted engineers. Contact your ATC regional office for more information; addresses are in Appendix. Also see the Appendix for regulatory contacts, which include all of the stakeholders involved with permitting a sanitation system.

Some volunteers feel challenged by working in this larger partnership. Government and state agencies must comply with many laws, which sometimes slow the approval of a project. However, this partnership creates a system of checks and balances that ensures the overall best Trail management. It also provides the Trail management community access to a vast pool of talent and experience. Without everyone's commitment to work together, the health and preservation of the Trail could be threatened.

How do you learn what you need to know? The best way is from your club's leadership. The partners' rights and obligations are in each club's local management plan, itself authorized by federal agencies under the *Comprehensive Plan for the Management of the Appalachian Trail*. If you are not part of a Trail club, consult the Appalachian Trail Conservancy. ATC develops policies that ensure consistent and thoughtful management of the Trail and its corridor lands. ATC alternately supplies the bond to hold everything together and the lubricant to make the partnerships along the Trail work smoothly.

In any case, don't start any backcountry sanitation project on your own. Trail work on the A.T. often requires a formal authorization from the National Park Service, U.S. Forest

Service, or state, so always work with the blessing of your club and the ATC regional office, which can help coordinate projects.

For more information, see *Appalachian Trail Design, Construction, and Maintenance,* Second Edition, by William Birchard, Jr. and Robert D. Proudman.

6.4 ADDITIONAL REGULATORY CONSIDERATIONS

Along with the usual regulatory process for sanitation projects along the A.T. described above, the following situations require additional consideration before work begins:

Congressionally designated Wilderness—"Wilderness" is an additional congressional designation of some areas within several national forests and national parks that the A.T. traverses. New structures are prohibited in most designated federal Wilderness areas, in keeping with the Wilderness Act of 1964 and other Wilderness legislation. Existing Appalachian Trail structures in Wilderness are generally allowed to remain and be maintained, but complete reconstruction or new construction may be prohibited. It is prudent to consult the legislation establishing each Wilderness, because the legislation (and the committee language used to assist in its interpretation) usually varies from one Wilderness to another. Even if construction or reconstruction is permitted, use of vehicles and other motorized equipment generally is prohibited. Helicopter delivery of material and removal of waste may be permitted, but if so, it is strictly regulated. Contact your ATC regional office for more information; addresses are in Appendix D. Also see Appendix C for regulatory contacts, which can inform you of all of the stakeholders involved with permitting a sanitation system.

Special Areas designation—Designation of state or federal land areas as roadless areas, research natural areas, or other specially designated areas may limit the options for construction of facilities, or vehicular or air access to waste management facilities for maintenance.

Design approvals—Most agency land managers require that construction plans be developed for agency approval. Agency resources, including engineers and landscape architects, may be available or required to assist in design. Efforts spent on design approval, including accessibility and confined space considerations, can prevent or reduce problems during construction and operation of the facility.

Accessibility—Accessibility for people with disabilities must be considered in planning and designing all facilities on federal or state land, regardless of remoteness or difficulty of access to a site. Applicable legislation includes the Architectural Barriers Act of 1968, the Rehabilitation Act of 1973, and the Americans with Disabilities Act of 1990. Any facility constructed using federal funds or on federal lands must comply with all the applicable portions of the current accessibility guidelines, and all federal programs must provide for reasonable accommodation for persons with disabilities in all program areas. Accessibility requirements should be researched and applicable guidelines integrated in the development of a facility from the beginning.

Accessibility requirements for toilet facilities fall under the Architectural Barriers Act Accessibility Standards (ABAAS), regardless of their location. The Architectural and Transportation Barriers Compliance Board (Access Board) Accessibility Guidelines for Outdoor Developed Areas, including backcountry settings, were finalized and went into effect in November 2013 (see ***http://www.access-board.gov/guidelines-and-standards/recreation-facilities/outdoor-developed-areas/final-guidelines-for-outdoor-developed-areas***). Those guidelines apply to all federal agencies except the U.S. Forest Service, which had previously put in place its own legally mandated accessibility guidelines for outdoor recreation areas. Those are the Forest Service Outdoor Recreation Accessibility Guidelines (FSORAG), which includes the definition and details for pit toilets based on the ABAAS requirements, and the Forest

Service Trail Accessibility Guidelines. Both are available on the Forest Service accessibility webpage at ***www.fs.fed.us/recreation/programs/accessibility***. Agency land managers are the best source of current accessibility information.

Confined spaces—A backcountry sanitation facility with an access hatch, ladder, steep stairs, low head room, or other egress or exit restriction is a "confined space" as defined by the Occupational Safety and Health Administration (OSHA), and special regulations apply. Sanitation facilities, especially composting systems, may present these situations. The OSHA regulations are difficult to follow in backcountry situations, and the best practice is to avoid confined spaces when designing a backcountry sanitary facility. Agency land managers are the best source for information on confined space requirements.

Disposal of compost—The disposal of composted material is regulated by the EPA. In general, composted material should be considered "domestic septage," like that from a septic tank, unless temperature is monitored throughout the composting process, or pathogen tests of the finished compost categorize it as "Class A sludge." EPA regulations require that domestic septage be incorporated into the soil when placed on the land, while Class A sludge may be surface-applied without restriction. Remote backcountry composting toilets have been shown capable of producing Class A sludge even in the absence of high composting temperatures, and it is possible to obtain waivers from domestic land application requirements from the EPA-designated regulating agency.

Maintainer health and safety—Personnel, whether volunteer or employee, involved with the maintenance of backcountry sanitation facilities should be aware of current agency standards and use standard practices and appropriate protective equipment. Standards and practices vary by agency, and local land managers are the best source of current standards and practices. Standard maintenance practices and a job hazard analysis (JHA) should be written (not just oral) and available to all maintainers of backcountry sanitation facilities.

For more information on regulatory processes, contact your ATC regional office.

7 The Aesthetics of Backcountry Sanitation Systems

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Pete Antos-Ketcham, *Staff, Green Mountain Club*

7.1 Overview

Managers of the Appalachian Trail are increasingly challenged to provide both adequate sanitation facilities and a primitive experience. An overnight backcountry site can be overwhelmed by an imposing waste management system that can destroy the sense of solitude and isolation from civilization.

Trail managers should carefully consider the aesthetics of each potential sanitation system, along with issues such as accessibility, user types, and seasonal use patterns. Factors such as location, design, installation, and maintenance affect aesthetic impacts directly and also indirectly through their effects on user compliance. Designated "toilet areas" and throne-like toilets with large buildings and extensive equipment should be avoided if possible.

High use, particularly in fragile ecosystems, has encouraged development of more effective, but also more elaborate, waste management systems. These include commercially produced continuous-composting toilets (sometimes with solar-assisted warming and ventilation) and batch-bin composting systems. Such systems generally require a larger structure footprint, additional tools, compost bulking materials, and extraneous system supplies. Appropriate tools and supplies are necessary for system management, but an overabundance can create adverse aesthetic impacts.

7.2 GUIDELINES ON AESTHETICS

The Appalachian Trail Conservancy (ATC) provides guidelines on aesthetics in several documents, which should be used in addition to this manual. **Chapter 2 (J) of The *Local Management Planning Guide* (2009 edition)**, which details ATC and federal policy on Trail management, provides some guidance on aesthetics. It is quoted below.

In 1995, ATC adopted the following policy on managing the A.T. for a primitive experience:

The Appalachian Trail Conservancy should take into account the effects of Trail-management programs and polices on the primitive and natural qualities of the Appalachian Trail and the primitive recreational experience the Trail is intended to provide. Although these guidelines are intended to apply primarily to the effects of actions or programs on predominantly natural, wild, and remote environments along the Trail, they may apply to certain pastoral, cultural, and rural landscapes as well. Even in sections of the Trail that do not pass through remote or primitive landscapes, care should be taken not to inadvertently overdevelop or improve the Trail tread or facilities in these environments.

Trail improvements, including shelters, privies, bridges, and other facilities, should be constructed only when appropriate to protect the resource or provide a minimum level of public safety. Design and construction of these facilities should reflect an awareness of, and harmony with, the Trail's primitive qualities. Materials and design features should emphasize simplicity and not detract from the predominant sense of a natural, primitive environment. The Trail treadway, when constructed, reconstructed, or relocated, should wear lightly on the land and be built primarily to provide greater protection for the Trail footpath or Trail resource values. Trail-management publications should include appropriate references to the potential effects of Trail management activities on the primitive qualities of the Trail.

In developing programs to maintain open areas, improve water sources, provide sanitation, remove structures, and construct bridges, signs, Trailheads, and other facilities, Trail managers should consider whether a proposed action or program will have an adverse effect on the primitive qualities of the Trail, and, if such effects are identified, whether the action or program is appropriate.

The *Planning Guide* further states:

[Trail] Clubs also should consider the effects of individual management actions (such as bridges, relocations, or other developments) on the primitive character of the Trail. The remote recreational experience provided by the Trail and the resources that enhance this experience should be carefully considered and protected. The following questions can be used to help evaluate the potential effect of a policy, program, or project on the primitive quality of the Trail:

1. *Will this action or program protect the A.T.?*
2. *Can this be done in a less obtrusive manner?*
3. *Does this action unnecessarily sacrifice aspects of the Trail that provide solitude or that challenge hikers' skill or stamina?*
4. *Could this action, either by itself or in concert with other actions, result in an inappropriate diminution of the primitive quality of the Trail?*
5. *Will this action help to ensure that future generations of hikers will be able to enjoy a primitive recreational experience on the A.T.?*

— Local Management Planning Guide (2009 edition), Chapter 2 (J)

7.3 FACTORS IN LOCATING SANITATION FACILITIES

The *Checklist for the Location, Construction and Maintenance of Campsites and Shelters on the Appalachian Trail* is a listing of important factors to consider when locating and building new campsites and shelters, or for operating and maintaining older sites. Since most backcountry sanitation facilities are located at designated overnight- use areas, this document can serve as a useful planning tool. Contact your ATC regional office for more information.

Consider the following factors that affect the aesthetic impact of sanitation facilities:

TOILET LOCATION—If possible, choose an unobtrusive location, so the toilet will not dominate the site. To encourage user compliance, choose a dry site with a dry access route, and consider distance from camp area(s), rodent pests, and wind and sun exposure. Prevent numerous access trails to the toilet by clearing and marking one defined route.

ACCESSIBILITY—When an accessible privy is called for, utilize topography to the greatest extent possible so to minimize the size of and the need for ramps or sloped entries. Often, locations can be found that allow for an at-grade entrance to the privy (level transfer platform)–which is ideal. Take care to ensure that when such a site is located it does not compromise other key siting decision factors such as distance to camping, trails, and protection of drinking water supplies (sanitation).

NUMBER OF TOILET FACILITIES PER SITE—One facility is adequate for most shelters and campsites. Consider consolidating multiple existing systems. However, bear in mind that overloading a single facility during peak season may actually reduce user compliance.

TOILET DESIGN—Use rustic design and materials, subject to the need for durability (for example, use galvanized hardware and nails). When choosing materials for construction avoid manufactured building products (plywood, planed lumber, *etc.*) and favor rough-cut native wood whenever possible. When items such as plastic or metal bins and plastic pipe must be used, camouflage or disguise them through creative construction and installation. Native rough-cut lumber should be allowed to weather gray to help structures blend in. If a stain must be used, use a clear nonglossy stain and avoid colored stains and paints. Assure that the roof and flashing are flat, muted, and non-reflective. Avoid over-building the structure and sanitation area with unnecessary items, such as windows and benches.

CONTAMINATION PREVENTION—Small wild animals, such as mice, voles, and squirrels, as well as domestic pets, are tempted to explore sanitation management areas. Mice, in particular, like to use toilet paper—new and used—for nesting material, and will carry it into a nearby shelter. Install hardware cloth to block access to raw waste. Do not provide toilet paper for users. Although complete access prevention is not possible, keeping a clean, managed toilet located a decent distance from camp and cook areas will help. People are often very curious about structures in the backcountry. Generally, the less obtrusive a sanitation system is, the less attention it will attract. Although most people will keep their distance from the inner workings of a toilet, managers should guard against system disturbance by Trail visitors. Typical problems include use of bulking material (such as shavings or bark mulch) for fires, use of shovels and other sanitation tools around campsites, and disturbance of equipment (unlatched bins, *etc.*). Post low-impact signs at the management area explaining the hazards of the waste system. Cover tools and supplies with earth-toned tarps out of sight of the area. In high-use areas, consider padlocking all sanitation tools in a storage locker attached to or included in the toilet structure.

The *Local Management Planning Guide* (2009 edition) has additional information in Chapters 2 (G) Overnight Use Areas, and 2 (I) Sanitation.

PART 3

Descriptions of Systems

MATC Kennebec Crossing Moldering Privy

8 The Moldering Privy

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Dick Andrews, *Volunteer, Green Mountain Club*

8.1 Introduction

The moldering privy was experimental when the first edition of the *Backcountry Sanitation Manual* came out in 2001, but over the past decade and a half it has more than proven its effectiveness for the management of human waste in the backcountry, and even in some frontcountry locations, and has been adopted widely both on and off the A.T. Several trail clubs have replaced all of their pit toilets with moldering privies with great success. It is a much cheaper system than commercially manufactured composting toilets. The moldering privy requires less labor (not *no* labor), and exposes maintainers to less risk of infection than bin composting systems, and is much less polluting than pit toilets. It also eliminates the need to dig new pits, and it can serve a higher volume of users than pit toilets. The maximum use capacity of the moldering privy varies, but under the right conditions it may approach or equal the capacity of commercial composting toilets and batch-bin composting systems.

The moldering privy can serve as the perfect middle ground for maintainers. It combines the resource protection benefits of composting with less maintenance, expense, and risk than other systems featured in this manual.

Project background—The moldering privy was developed in a continuing research project by the Green Mountain Club (GMC) in conjunction with the Appalachian Trail Conservancy (ATC), the National Park Service Appalachian Trail Park Office (APPA), and the Vermont Department of Forests, Parks, and Recreation. The goal was to develop a waste management system to replace the traditional pit toilet and designated toilet (cat-hole) area with a system that manages human waste with less maintenance than other composting systems.

GMC drew upon the concept for the moldering privy from Dick Andrews (a GMC volunteer, composting toilet owner, and the original editor of this manual) as well as existing composting technologies and literature on the subject of sanitation in remote backcountry areas. Dick conceived of, and built, the first moldering privy on the Long Trail/Appalachian Trail at Little Rock Pond in the Green Mountains of Vermont in 1997 (see Chapter 11—Case Studies).

In 1999, with the assistance of its agency partners, GMC created a refined version of the moldering privy with plans for a lightweight outhouse suited to backcountry applications, and built four units on the Long Trail in northern Vermont. The GMC also produced a draft *Moldering Privy Manual and Design* in 1999.

In 2000, the GMC designed a double-chambered moldering privy, and installed three experimental double units on the Long Trail. The lessons we have learned and the improvements we made are presented in this chapter. In 2010, GMC began designing and installing universally accessible moldering privies as the latest iteration of the moldering design.

Other clubs have also experimented with the moldering privy concept. For information on the several A.T. clubs that now successfully use the moldering privy, see Chapter 11–Case Studies.

A moldering privy built by the Appalachian Mountain Club (AMC) Berkshire Chapter's Massachusetts A.T. Committee has been in operation for more than ten years now with excellent results. For details, see Chapter 11—Case Studies, Moldering Privy on the A.T. in Massachusetts. For other examples of other moldering systems operating along the A.T. and elsewhere in the U.S. also found in Chapter 11.

8.2 RATIONALE FOR DEVELOPMENT OF THE MOLDERING PRIVY

Batch-bin composting has worked well in many sites, but it requires a lot of labor, both by well-trained and sturdy people to manipulate the process, and by porters with strong backs to haul in the large amounts of bark mulch or other bulking agent needed to absorb liquid. Batch-bin composting also requires field personnel to handle raw sewage. With care, this can be done with reasonable safety, but it still poses a risk that is better avoided. In addition, batch-bin composting kills pathogens very effectively in waste that has reached a high temperature, but if part of the waste in a batch fails to heat sufficiently, pathogens will survive. In practice, the odds are high that part of the waste will escape high temperatures. The practice of finishing compost on drying racks was developed to address this limitation.

The moldering privy was inspired by commercially manufactured, continuous-composting toilets designed for households, with the realization that in most backcountry settings the soil—though sometimes thin—is adequate to absorb the relatively low volumes of liquid deposited in a waterless toilet. Thus, the watertight, bulky, and expensive composting chambers characteristic of commercially made composting toilets are not needed in the backcountry.

8.3 WHAT A MOLDERING PRIVY IS

What moldering is—Moldering means slow, or cool, composting. This is in contrast to quick, or hot, composting, which is the process on which a batch-bin composting system relies. As defined by Jenkins (*The Humanure Handbook,* 2005), to molder means "to slowly decay, generally at temperatures below that of the human body."

The temperature range of a moldering pile of waste is between 4 and 37 degrees C. (between 40 and 99 degrees F.). Temperatures below 4 degrees C. (40 degrees F.) do not accommodate the invertebrates and microorganisms that process fecal material. Temperatures above 37 degrees C. (99 degrees F.) are in the thermophilic range of composting, which is generally not possible without a large amount of fresh organic material and a lot of human manipulation of the pile. Waste is added too slowly in a continuously moldering toilet to provide enough fresh waste to reach a high temperature, and the moldering privy aims to avoid the labor of frequent manipulation of the pile.

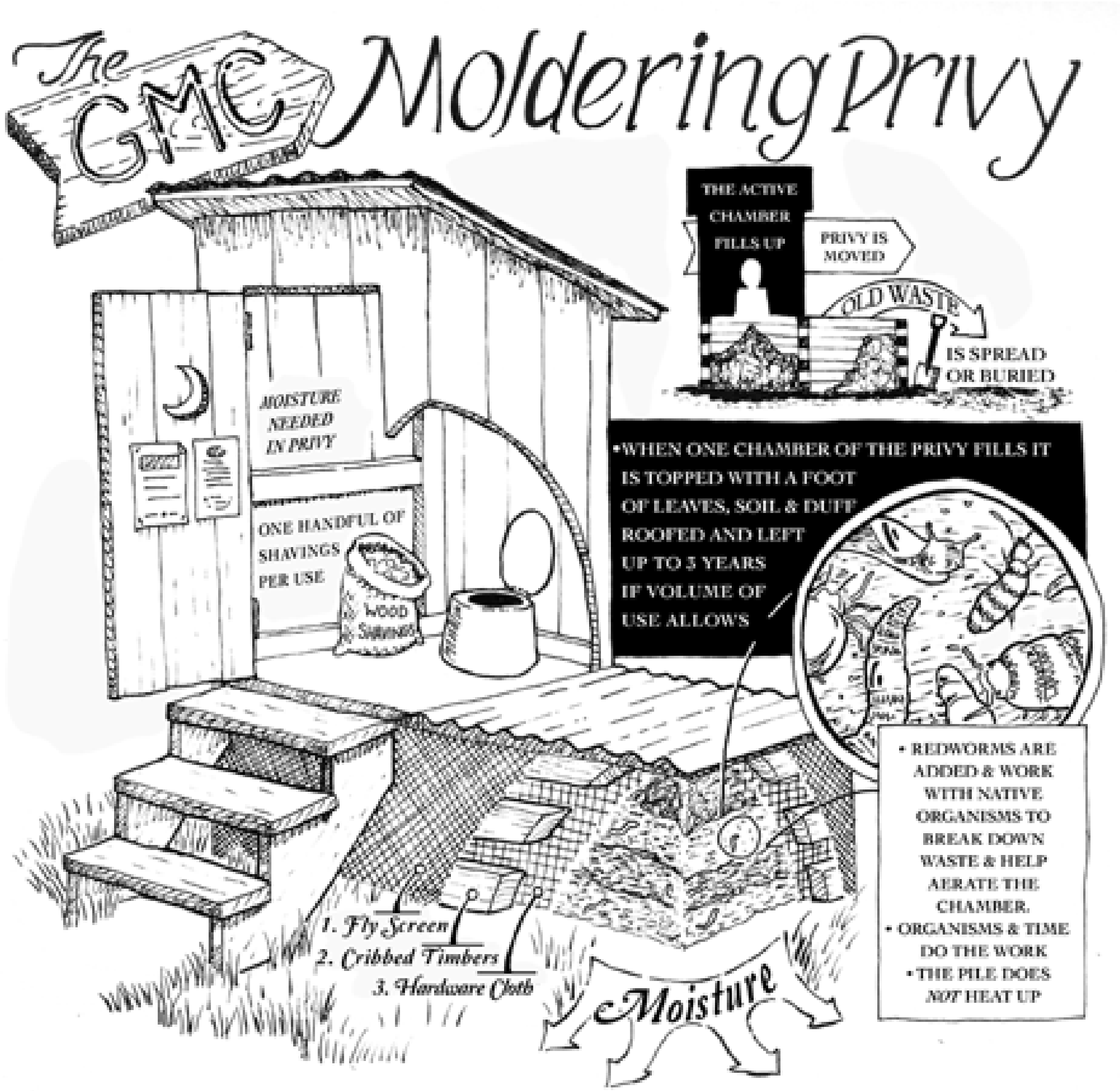
Below 20 degrees C. (68 degrees F.), decomposition slows as the temperature drops, until the pile is dormant below 4 degrees C. (40 degrees F.). The pile does not freeze at 0 degrees C. (32 degrees F.), because it contains dissolved salts and other minerals, but it does freeze below about -2 degrees C. (29 degrees F.). Composting organisms survive freezing, or they leave eggs or spores that survive freezing. When the temperature rises above 4 degrees C. (40 degrees F.) again, the organisms become active, or their eggs and spores hatch, and composting resumes.

How it is designed—A moldering privy consists of:

- A conventional privy shelter, or outhouse, on a foundation referred to as a crib.
- The crib sits above a shallow depression, only a few inches deep, that focuses liquids so they will percolate into the biologically active layer of the soil directly below the waste pile.
- The pile of human waste mixed with a bulking agent in the crib is above ground, so it cannot become waterlogged.

- Gaps between timbers in the cribbing are covered with metal hardware cloth and insect screening, to exclude animals, flying insects, and sunlight, but to allow infiltration of air. Hardware cloth must be used to exclude rodents, which sometimes take toilet paper and use it for nesting material. This can be a problem with any toilet other than a flush toilet.
- Native microorganisms and invertebrates, possibly supplemented by introduced red wiggler worms (also known as redworms or manure worms), do the real work of composting.

Many design variations are possible, and creative thinking will yield one to suit almost any condition. A double or even triple crib system can support a toilet building that can be slid back and forth among the cribs. Designs for accessible units eliminate moving the privy building altogether. In higher-use sites, a shelter can be moved among three, four, or more cribs to allow a year or more for complete composting before returning the shelter to the first crib. The addition of a drying rack or two can allow for much needed additional retention time for the finished product before burial or dispersal. Care must be taken to balance system effectiveness with overloading a backcountry site with too many structures.



The crib can be built in many ways. Early units used a pyramidal form that wider at the base than at the top. This shape is very stable; it holds more volume for a given height; it provides more soil surface at the base to absorb liquids; it facilitates banking duff or straw against the sides (which blocks light and drying breezes while admitting adequate air and helping to keep the pile warm in cool weather); and it reduces contact between the crib and the compost pile, which prolongs the life of the crib. Despite some of these advantages, a crib with vertical sides is easier to build, and more importantly, allows for access doors to be constructed for managing the waste pile when it is active. **The vertical-sided version of the Moldering Privy has been most widely adopted by A.T. clubs over the years and has proven to be more easily adapted to make them accessible.**

How it is used—Users are asked to add a small amount of *bulking agent* (planer shavings) with each use. The bulking agent need not be kept dry, as, unlike in batch-bin composting, it need not absorb liquid. If users add too much bulking agent, it will do no harm, except that the crib will fill faster. Occasional stirring of the pile, adding bulking agent if necessary, plus regular light watering to keep it moist is all that is needed to optimize composting. Moderate overwatering will do no harm, because excess water will simply seep into the soil. The inclusion of urine can help to maintain proper moisture balance depending on site use. **Maintainers should carefully analyze the use patterns of their privy and determine if urine inclusion will provide sufficient moisture or conversely if too much urine may cause odor problems.**

Unlike pit privies and batch-bin composting operations, which usually ask users to urinate in the woods (to reduce odors and to minimize the amount of bulking agent needed to absorb liquid), separation of urine from the compost mass is unnecessary in a moldering privy, which actually benefits from the liquid provided by urine. *This moisture is essential to prevent the pile from desiccating due to exposure to air and wind*. Early adopters of the moldering privy who excluded urine soon discovered that their waste piles were drying out rather than composting. The drying process can cause human pathogens to encapsulate and go dormant, surviving for long periods of time, and reactivate when favorable conditions are presented.

Double Chambered Moldering Privy Crib - note dark insect screening to help disguise the waste pile

A generous layer of bulking agent (six inches to a foot of planer shavings) is spread on the bottom of the privy crib when it is built, to ensure that liquids will filter through an aerated layer before reaching the soil. That layer is topped with some decomposed leaf litter, or forest duff, to introduce local decomposer organisms. Liquid that seeps through the pile will be contaminated with pathogens from feces, but if it percolates slowly enough through aerobic and active regions in the lower part of the pile, it will be treated by contact with air and aerobic microorganisms. If pathogens are not entirely eradicated in the composting pile, liquid receives further treatment in the biologically active upper layer of soil into which it seeps.

Capacity—the crib(s) can easily be made to enclose substantially more volume than the pit of a typical backcountry pit privy, and composting reduces the volume of waste, so moldering privies fill more slowly than most pit privies. In low-use sites, composting may be fast enough to keep up with use for many years, or even indefinitely.

If and when the crib does fill, the privy simply needs to be moved to the next crib. The old compost pile is mixed and leveled and then covered with light and porous organic material, typically half a foot or more of planer shavings, duff, or straw, and then topped by a roof system to exclude some moisture, rodents, and curious humans. The roof system is intentionally porous to admit rainwater to keep the pile moist. In very humid climates, the pile may stay damp enough to finish composting even if it is fitted with a solid cover. In dry climates, the covered pile may need occasional watering.

Recycling compost—When the second crib is full, ideally after a minimum of three years, the finished compost in the first crib can be removed and applied to the forest floor, either on the surface away from human traffic and water, or by shallow burial. If the cribs are filling up in three years or less, additional cribs may be necessary, and—if needed—a drying rack added to increase the amount of time the waste is exposed to the elements for finishing before burial/dispersal. If required by local regulations, compost can be dried and removed from the backcountry. With the right equipment, it also can be incinerated on the spot, yielding a small amount of sterile ash. The shelter is returned to the first crib, and the second crib is covered for further composting and aging. An incidental advantage of a privy on a raised crib rather than at ground level is that the outhouse door can be opened without clearing snow for much or all of the winter, so it is more likely to be used in winter. The pile will freeze in winter, but composting will resume when it thaws.

Use of bulking agent—Because there is no need for the bulking agent to absorb urine, much less bulking agent is necessary than in batch-bin composting. In the first edition of the *Sanitation Manual*, it was suggested that forest duff and or leaves could be used as a bulking agent. Time and experience have shown that in many cases forest duff is inadequate as a bulking agent and the harvesting of duff by toilet users can create unacceptable ground impacts in some areas. Forest duff, tends to compress and compact in the waste pile and could exclude oxygen and reduce liquid percolation. These factors reduce composting and increase odor. Planer shavings have proven most effective because they are light to carry and resist compaction. Both hardwood and softwood shavings work, although some people consider hardwood shavings superior. Feed stores sell baled shavings as bedding for horses and other livestock, or shavings may be available free or inexpensively at lumber mills. Carrying in a bulking agent, such as dry planer shavings is much less arduous than with batch-bin composting. At all but the highest use sites, a single bale of shavings will last an entire season. Bales of shavings are compressed such that a 2.5-cubic-foot bale contains 8.5 to 9 cubic feet of shavings and weighs less than 30 pounds. The bales are easily attached to a packboard or carried in by wheelbarrow or litter.

Several Appalachian Trail clubs have reported they have had problems with using planer shavings due to visitors taking the material for starting fires. It is recommended that a lockable structure/shed be built where shavings can be kept dry and safe from rodents and curious people. In order to reduce the number of structures in the privy area, this storage area can be incorporated into other existing structures or a drying platform. Other clubs have used 55 gallon drums with lockable lids to serve the purpose. Unlocked containers, particularly garbage cans will get used as garbage cans – this should be avoided. Whatever container is chosen must be lockable and watertight.

Like forest duff, sawdust (unless very coarse), hay, straw, and fresh leaves or conifer needles all tend to compact and form impermeable layers, so they are less satisfactory. Conifer needles also are likely to be too acidic, as is peat moss. Wood chips are usually insufficiently absorbent, and are hard to mix with hand tools.

Monitoring—The composting process in a moldering privy takes place at ambient temperature, so there is no need for monitoring and management of the process, except possibly for some turning and watering of the pile. It is essential to build the toilet bench or stool with a hinged top, so the whole top can be flipped up to make mixing or watering the pile easier and reduce contamination of the seat and floor. It is even better to build the outhouse with a removable toilet stool and chute or a trap door, such as many National Forest privies have, as it is easier to manipulate the pile through a hole at floor level. Working the pile from above is more ergonomically sound than from the rear.

Venting—There is no need to install a vent stack in a moldering privy shelter, because the permeable sides of the crib admit plenty of air, and obnoxious gases are not produced in aerobic composting. Vent stacks in pit privies normally do nothing useful anyway, since there is nothing to create a draft. They are installed in a tradition that began in the days of anaerobic urban cesspool privies that encountered such high levels of use that they produced large volumes of explosive methane (the principal constituent of natural gas). Methane is much lighter than air, so it readily rises up a vent stack and dissipates. Backcountry pit privies produce insignificant amounts of methane, so the vent stacks we are accustomed to seeing on them are ineffective and superfluous.

Redworms in moldering privies—Experience in composting toilets has shown that adding red wiggler worms substantially speeds and improves low-temperature composting and helps further reduce pathogens by enhancing the conditions needed for their destruction. The worms consume waste; aerate the pile, and spread microorganisms and spores throughout the pile. Worms also can tunnel through and aerate compacted layers if they develop in the pile. Red worms are unable to survive freezing, and therefore they must be reintroduced each spring. Predators such as shrews may sometimes eliminate introduced worm populations. Fortunately, composting will proceed even without worms, although it may be slower and require more manipulation of the pile. Unless their use is prohibited by land managers, it is highly recommended that worms be used and replaced annually in the moldering privy.

Trash—If trash tossed into a moldering privy is inconvenient to remove, it can be left there until composting is complete, and then removed. Because material in a moldering privy needs little or no handling until composting is finished, trash does not hinder the process as it does in batch-bin composting. Of course, trash takes up space in the crib, so it should be discouraged.

Food scraps introduced in a moldering privy actually would improve the composting process, by providing a more diverse nutrient supply for the composting organisms. However, they attract pests—flies, rodents, possums, skunks, raccoons and bears— so they are undesirable, and should be discouraged by stewardship signs.

8.4 ABOUT THE RED WIGGLER WORM

The red wiggler worm (*Eisenia foetida*, also called the redworm or manure worm) is the worm of choice to augment the biological robustness of your moldering privy. It is known throughout the country for the best attributes and habits for consuming organic waste.

For many years, people have kept worm bins in their homes to compost kitchen and other food waste year-round. Red wigglers are readily available by mail order from firms that supply gardeners and bait shops, and, once you have worms, you can easily raise as many as you need. Red wigglers reproduce quickly, and have a voracious appetite. Worm castings (their waste product) are a nutrient-rich, humus-like substance sought after by gardeners. The worms are excellent burrowers, and when introduced into the moldering privy help deliver oxygen to aerobic bacteria by tunneling and churning the waste pile. Other worm species also can be beneficial, and local worms may infiltrate your moldering privy spontaneously, but based on its experience, GMC recommends introducing the red wiggler or an approved indigenous worm species because they are so effective at enhancing decomposition.

Please note: Moldering privies that receive high amounts of urine may be too acidic to support red worm populations.

Note: red wiggler worms as an exotic species—Check with your ATC Regional Office and your local land managing agency to learn whether redworms are considered an exotic species that cannot be introduced. In the Great Smoky Mountains National Park, for example, the National Park Service considers redworms an introduced species, so moldering privies cannot use them. While composting will still occur without worms they are strongly recommended. If red wiggler worms are prohibited, contact your local land manager to see if there is a comparable indigenous worm species that would be permitted.

8.5 COMPARISON OF THE MOLDERING PRIVY WITH OTHER COMPOSTING TOILETS

The majority of the maintaining clubs along the Appalachian Trail have limited money and human resources, and therefore the need for an alternative system to the pit toilet and more costly bin or commercial composting systems is becoming increasingly apparent.

Earthworms

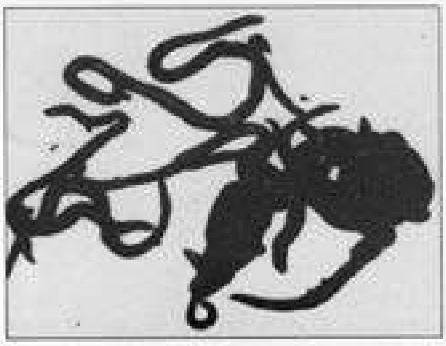
In the last 10 to 15 years, vermicomposting—using earthworms to hasten the breakdown of organic matter—has become popular.

Worms transform organic material in their digestive tracts, so that their fecal matter, called "castings," is rich in nutrients that are ready for plants. Equally important, by virtue of their ability to burrow deep and come to the surface often, earthworms provide deep aeration for soils and prevent compaction.

Earthworms are not very happy at the high temperatures that can occur in composting (over 100°F), nor can they tolerate low or high moisture levels, highly acidic (low pH) environments, or being in material that is often mixed, tumbled or chopped. So they will not be happy in many of the small composters. In large composters, they should help, especially in continuous composters, because of the compaction problems in these systems. Keep in mind that worms prefer kitchen scraps to excrement.

Some claims have been made that pathogens are killed by the enzymatic activity in worm's digestive tracts. Alas, it's not so. In fact, worms are potential carriers of certain pathogens, although this is uncommon in healthy populations.

The manufacturer of the AlasCan composting toilet system likes to use two or three types of worms found in compost piles: red worms (*Lumbricus rubellus*), brandling worms, or "red wigglers" (*Eisenia foetida*), and white worms (*Enchytraeids*). It's the red wigglers—sometimes called sewage worms—that are commonly used in larger-scale composting of organic wastes.



Worms from a composter.

Culturally, advocating adding worms to your processor may turn off many people. You might think twice before mentioning the worms in your system to guests.

And, no, worms will not crawl up through your toilet stool and surprise you. Worms don't like light, and will not leave moist organic matter for the cold, dry world of your bathroom.

Bottom line: Consider worms a compost helper but not a key player in your composting toilet system.

Worms can be purchased through many mail order garden suppliers as well as from worm growers that specialize in fast-acting worms. They usually run about $20 for two pounds. You may also find some regular earthworms in your yard waste composting pile.

Resources

Worm Digest is a newsletter that features all kinds of information on composting with worms, including suppliers: Worm Digest, Box 544, Eugene, OR 97440-9998; www.wormdigest.com.

Worms Eat My Garbage, a book by Mary Appelhof, discusses worm composters for kitchen wastes. (Flower Press: 1982)

Shelter use, particularly day use, is increasing and managers also are reporting a renewed increase in overnight use in recent years.

Several kinds of composting systems can replace pit toilets, but the moldering privy is especially useful in the backcountry.

- *Batch-bin systems* require a high level of oversight to function correctly. Despite what some bumper stickers suggest, much of composting doesn't just "happen." Batch bin systems require many hours of work each season by dedicated field staff and volunteers to ensure the process succeeds. Experience has taught us that an active presence at the site is needed weekly–if not daily—throughout the season. In addition, hundreds of pounds of hardwood bark mulch must be packed in to batch-bin system sites each season, a very arduous task.
- Organizations without paid field staff or extremely committed volunteers with lots of time cannot meet these requirements. There may be volunteers willing to get involved with batch bin composting, but there are generally not enough to meet the high demands of this system.
- In addition, batch-bin systems are best suited to sites with an extremely high volume of use. Starting a run in thermophilic (high temperature) composting requires a generous quantity of fresh waste, so it may not operate well at low- to medium-use sites. Batch-bin composting systems cost significantly more than pit toilets, and this cost may be out of reach to some clubs and organizations.
- *Continuous-composting systems*—Commercially manufactured composting toilets are even more expensive to install than batch-bin composting systems, although they can be cheaper in the long run at very high-use sites because of reduced labor requirements. Even in the long run, however, they are still substantially more expensive than the moldering privy.

  Additionally, large continuous composting toilet systems can be challenging to operate correctly in high-elevation, high-moisture environments.

Key advantages of a moldering privy—Compared to other composting systems, the moldering privy offers several substantial advantages:

1. *Convenience* The moldering privy eliminates the need to search for new pit sites and move the toilet frequently (sometimes a great distance). Many clubs have found that at old backcountry sites the best places for privy holes have already been used. More often than not, they are still contaminated, and can't be re-used. Pits can be contaminated and unpleasant for three to five years— or more—after being closed. Locating a new pit far enough away from the water source, yet not too far away from the facility as to discourage use, is a big challenge. The moldering privy solves this problem. The toilet can remain at the best site indefinitely. With a moldering privy, you can create a permanent spot for sanitation management, independent of soil depth.
2. *Reduced pollution* The moldering privy reduces the likelihood of water pollution and groundwater contamination.
   Many backcountry privies are in areas with seasonal high water tables, and consequently will have their pits filled with water for a third of the year, or more. That results in anaerobic conditions (which favor the propagation of human pathogens) and groundwater contamination that can be a threat to public health.
   The moldering privy sits on top of the surface of the soil and eliminates the need for a pit altogether. The composting mass cannot become waterlogged, so any liquid that drains through the pile is exposed to aerobic treatment before entering the soil.
3. *Reduced maintenance* The moldering privy reduces labor and maintenance needs and costs.

Once moldering privies are installed, most maintenance can be accomplished by one volunteer visiting the site three to four times a year, although more frequent attention may be needed at high-use sites.

The moldering privy relies more on natural processes than human manipulation of the excrement to facilitate its breakdown. Liquid separates by gravity out of the pile, so it requires no attention or effort.

Except where prohibited, the maintainer adds a cup of red worms to the pile once or twice a season to speed decomposition. He or she waters the pile if it becomes too dry. (Adding a drop or two of liquid biodegradable detergent to the water helps water penetrate a dry pile rather than run off the surface.) The maintainer and users add bulking agent to improve the porosity of the pile, balance the carbon to nitrogen ratio, and introduce organisms and fungi that will assist in the breakdown of the pile. The maintainer may keep a container full of bulking agent inside the outhouse to encourage people to deposit it on the pile.

The maintainer stirs the pile if it appears that the excrement and bulking agent are segregated. Stirring is usually required infrequently, especially if redworms are active (as opposed to every three or four days with other systems). At longer intervals, the maintaining organization moves the outhouse when the crib is full to another crib. Four people can easily move an outhouse from one freestanding crib to another; one person can do the job with some multi-chamber crib designs. Moves are seldom needed, except at high-use sites.

When waste is fully composted, the maintainer spreads it on the forest floor or buries it in a secluded area well away from water and the shelter or campsite. The procedure is the same as for batch-bin composting systems.

- *Reduced odor* The moldering privy reduces offensive odors.
  Pit toilets are anaerobic, and anaerobic bacteria produce strong odors when they break down waste, particularly when the waste mass is saturated with urine. Some hikers refuse to use pit toilets because of the odor.
  In contrast, the moldering privy is aerobic. It is not completely odorless, but when working properly its odor is not strong, and the primary component of the odor is earthy, which improves the experience of the hikers and campers. Thruhikers stopping at the Little Rock Pond Shelter (since removed), the site of the GMC's first moldering privy, regularly noted in the shelter log that the privy was the most pleasant one they had encountered since leaving Georgia.

- *Reduced cost* The moldering privy is comparatively inexpensive.
  A complete batch-bin style composting system (with or without a beyond-the bin liquid filter) can easily cost several thousand dollars. The moldering privy designs described in this chapter can generally be built for less, depending on whether pressure-treated lumber is used, whether the toilet building itself is replaced, and whether or not a ramp system is required to achieve accessibility.
  Manufactured composting-toilet systems, with the buildings housing them, can cost from $10,000 to as much as $80,000. (See Chapter 8—Case Studies, Appalachian Mountain Club Clivus Multrum Composting Toilet)

8.6 FREQUENTLY ASKED QUESTIONS ABOUT RED WIGGLER WORMS AND MOLDERING PRIVIES

The Green Mountain Club's experience using moldering privies has generated a good deal of interest in the technology. Here are some basic questions frequently asked of the system's developers:

Q: *Where can I get red wiggler worms?*

A: Red worms can be purchased from Uncle Jim's worm farm. http://redwigglerworms.com/

As of July 2014, the worms were sold in packages from as little as 250 worms up to 2000.

If you do it right, you should only have to purchase worms once. If you provide enough food and the right environment, the worms will reproduce and give you an annual harvest.

GMC maintains a supply of worms at its headquarters to be dispersed to various moldering privy sites along the Long Trail/ Appalachian Trail. Given the size of our trail system, volunteers host regional worm farms to reduce travel expenses.

Q: *How do I care for and maintain my supply of worms?*

A: We created worm bins out of five-gallon food-grade plastic buckets with lids. Buckets were available free or inexpensively from restaurants such as Dunkin Donuts, or from some hardware stores. We drilled holes in the lids for air, and in the bottoms for drainage (without drainage, worms will drown). Other people who raise worms prefer shallower containers than five-gallon buckets, but the buckets have worked for us.

We lined the bottoms of the buckets with shredded newspaper, and filled the buckets two-thirds full of garden soil. Commercial potting soil or other bedding materials may be preferable if your local soil tends to compact excessively.

We feed the worms food waste, placing it on the surface of the soil. Be careful not to supply too much food waste with high water content (many fruits and vegetables) at once. Water can accumulate faster than it can drain, and the worms will drown.

For more information on raising redworms, consult **Worms Eat My Garbage** by Mary Appelhof, 1982, Flower Press, 10332 Shaver Road, Kalamazoo MI 49002.

Q: *How many worms do I need to put in a moldering privy, and how often?*

A: We have not counted worms; you don't need to, either. Worms tend to cluster in balls in the worm bin. Each moldering privy should get a ball of worms about the size of a baseball. This ball of worms conveniently fits into an eight-ounce yogurt cup, which is an ideal container for transporting worms into a backcountry site, as long as transportation is quick.

You should only have to introduce worms once a season, in early spring when the pile has thawed out, unless the population dies. At low-elevation sites, moles, voles, mice, and other predators may eat some or all of your worms. This may be prevented by lining the bottom of the crib with hardware cloth. Since the composting environment is corrosive, the hardware cloth may need replacement when finished compost is removed from the crib.

Q: *If the bottom of the moldering privy is open to the soil, won't the worms leave?*

A: Only if conditions in the pile become unfavorable. The waste pile in the toilet will probably be the best habitat for worms in the area of the toilet. This should entice them—as well as attract other local desirable organisms—to stay.

Q: *Will the worms survive over the winter in the field?*

A: Probably not. In a cold climate, the waste mass will probably freeze all the way through. Unless there is enough soil so the worms can burrow below the frost line, they will die. Privies located in colder climates should plan on introducing new worms each season.

Q: *Should hikers and campers put food waste into the moldering privy?*

A: They should not, as food waste would take up valuable space and attract flies and other pests (including big ones like raccoons and bears) to the privy. Stewardship signs should instruct users to deposit nothing but human waste and toilet paper in a moldering privy.

Q: *What else do I need to know about keeping worms alive and working in a privy?*

A: Redworms are fairly self-sufficient creatures. The key to their survival is a favorable environment. Moisture in the pile and aeration provided by planer shavings must be monitored regularly. Since it is protected from rain by an outhouse, parts or all of the pile may dry too much, especially if air can blow freely through the privy crib or the privy is in the sun, so occasional light watering is helpful. Make sure your stewardship sign encourages users to pee in the outhouse to help keep the pile moist. Adding a drop or two of liquid biodegradable detergent will help water penetrate a dry pile rather than run off the surface.

If you keep the compost pile conditions favorable, the worms will thrive and increase their level of consumption of waste, reducing the need to service the unit as often.

Q: *What do I do with the finished compost?*

A: This will depend on local regulations. It also will depend on the quality and completeness of the composted material. The goal of a moldering privy system is to allow the waste to sit and slowly compost for as long as possible before burial or dispersal. When the time comes to empty a crib, thoroughly mix the contents of the crib and look for any signs of desiccated or uncomposted material. If any material didn't compost, it should be isolated and moved back into an active bin. The remaining compost, while appearing to be finished, should be placed on a drying rack for further curing or shallowly buried to ensure any possible remaining pathogens are isolated from people and animals. If the material is thoroughly composted, and surface spreading is permitted, then the material can be broadcast thinly on the forest floor far from trails, campsites, and surface water. Surface spreading should be done in early summer to encourage nutrient uptake by growing plants and prevent runoff into local water courses.

NOTE: Check with your local Trail club, ATC regional office, and land managing agency to learn of any constraints on disposing of compost. Some states may prohibit surface spreading, so compost must be trench-buried or packed out. GMC developed plans for a compost incinerator that may make it easier to comply with this kind of restriction. Dried compost also can be burned in an open wood fire where permitted and adequate fuel sources exist.

8.7 COMPONENTS OF THE GMC MOLDERING PRIVY SYSTEM

Primary Components—The basic GMC moldering privy system has two components:

MOLDERING CRIB The crib, made from dimensional lumber or landscaping timbers, creates the above-ground chamber where waste is stored and composted. The toilet shelter, or outhouse, sits on top of the crib. The crib confines the waste pile while allowing air and digesting organisms in and letting liquid drain out.

GMC generally has abandoned building single-crib designs as there is greater efficiency in constructing dual or triple crib systems from the beginning. The double-crib system contains two chambers that are 48 inches long by 48 inches wide by 30 inches deep. That provides eighty cubic feet, which is a lot of storage space. They may be either freestanding cribs or a unit with two or more chambers along which the outhouse can be slid. The latter system is easier for moving the privy along and allows for creative systems involving rails. It should be noted that some accessible model designs with a larger privy building can have larger cribs that allow easily for multiple chambers below, with the added benefit that a larger outhouse building means that it doesn't have to be moved.

After the crib in use is full, the outhouse is moved onto the next crib. Each season, red wiggler or indigenous worms are introduced into the piles by maintainers to speed decomposition. While the next crib is being filled, the first crib is capped—that is, covered with a layer of bulking agent or similar material, followed by a protective roof system attached to the top of the crib to prevent tampering. Thus covered, it continues to compost with fresh waste now excluded. The time it takes to fill a crib will vary with use. The general rule with moldering is the longer the better, as time is the key ingredient for composting and pathogen reduction.

The goal is to have enough cribs so that when they are full and need to be emptied, the oldest material is thoroughly composted throughout the pile. That will require at least two years under most circumstances.

The operator can enhance the composting process in filled cribs by turning piles with a spading fork periodically (though sparingly when using worms), adding additional carbon-based bulking agents like wood planer shavings, watering if needed, and continuing to introduce red worms each spring.

The outhouse is returned to the first crib after its composted material has been given a shallow burial in a dry, unfrequented spot, or if thoroughly composted, spread on the forest floor far from water, campsites, and trails.

OUTHOUSE GMC uses a lightweight outhouse, or privy shelter, with a 3- by 4-foot floor to make it easier to move, both to the backcountry site and from crib to crib. For an accessible outhouse the floor measures roughly 8 feet by 8 feet.

8.8 SOURCES OF MATERIALS

Different regions of the Trail present different challenges for obtaining materials to use in constructing moldering privies. The Green Mountain Club used the following sources:

MOLDERING CRIB—GMC bought cribbing material at a local lumberyard. We made our first moldering crib of 6- by 6-inch untreated cedar landscaping timbers, which were light to carry and easy to work with. Later we decided that a pressure-treated crib would last longer and reduce maintenance costs. However, the cedar crib has shown no signs of deterioration in three years. Presently, we use pressure treated (PT) wood only where it will come into constant contact with moisture. Otherwise, we use native hemlock and pine. Other A.T. clubs have used 2- by 4-inch and 4- by 4-inch lumber for building stacked crib structures that are very strong and much lighter to pack in than 6- by 6-inch timbers.

OUTHOUSE—GMC has bought lumber for outhouses at local lumber yards in Vermont. Our outhouses are not built of pressure-treated wood, as that was the choice of the volunteers who built them. Using PT lumber for the floor and lower parts of the outhouse in regular contact with moisture would lengthen its life and might save money in the long run, despite its greater cost. Otherwise, we recommend using untreated, locally available, rot-resistant wood. PT should not be used for ramps, stair treads, bench seats, or other components people come in contact with. Composite decking made from recycled plastic is an excellent choice for ramps and stair treads.

STEWARDSHIP SIGNS—An excellent waterproof and tear-resistant plastic paper (trade name ***Dura Copy***) available from the Rite in the Rain Company, has been employed at GMC sites. It or similar products are available online. Signs created on a computer can be printed directly onto Dura Copy. ***http://www.riteintherain.com/inventory.asp?CatId={B0F7882D-59FD-4176-BF18-40A5F3172AE4}***

MISCELLANEOUS COMPONENTS—GMC bought screening, hardware cloth, poultry staples, galvanized spikes, angle brackets, door handles, hooks and eyes, toilet seats, flashing, roofing, drill bits, *etc.*, at a local hardware store. Be sure to tell the store if your organization is tax-exempt.

8.9 CONSTRUCTION SPECIFICATIONS—ORIGINAL GMC SINGLE CRIB DESIGN

Note: The original design discussed here does not meet accessibility standards for structures on Federal Lands. Accessibility for people with disabilities must *be considered in planning and designing all facilities on federal or state land, regardless of remoteness or difficulty of access to a site. See Chapter 6 on the Regulatory Process for more information.*

The original GMC design for a moldering privy crib unit is 4 feet square, with vertical sides. The crib is built of 6- by 6-inch dimensional pressure-treated timbers, except some parts of the lowest course, which are 4- by 6-inch PT lumber. The finished height of the crib is 30 inches. The inside dimension is 3 feet square (4 feet minus the width of two 6-inch timbers). Many A.T. clubs have adopted this design but have chosen to use smaller dimension wood for the crib timbers. The resulting structures have been just as strong and have an added benefit of smaller air slots reducing the users' view of the pile beneath. These crib systems are much lighter to pack in and can be more easily modified to two or three crib designs than the large timber designs.

Non-Accessible Moldering Privy

The outhouse set atop the crib is 3 feet wide by 4 feet deep (nonaccessible design), and therefore spans the whole depth of the crib front to back. The base of the outhouse typically overlaps the sides of the crib by an inch or so, but the primary support of the outhouse is the front and rear of the crib. The top course of timbers is adjustable, so the crib can be used with existing outhouses of varying dimensions. Gaps can be covered by wood if necessary.

If the size of the top course of timbers is varied to fit an outhouse with smaller dimensions by trimming some of its parts, this will affect the pilot hole layout described below. For a larger outhouse, it is best to build a larger crib. However, we recommend against larger cribs and outhouses because the components are difficult to transport to backcountry sites. For simplicity, our standard square crib is described.

The jury is still out on the effects PT lumber on soil, which might absorb toxic compounds from treated wood. Biologically healthy soil absorbs liquid from a moldering privy and provides backup treatment if necessary, so PT lumber might provide durability and long-term economy at the expense of effective waste treatment.

To investigate the factors of toxicity, longevity, and cost, GMC has built experimental cribs either entirely of untreated hemlock, or with a bottom course of PT lumber and a hemlock top, or entirely of PT lumber. We will observe these cribs closely for differences in the apparent effectiveness of the biological community in consuming waste, factoring out other variables such as use levels and climate as well as we can. We may also test soils for residues from PT lumber.

Update: *After ten years in the field, the untreated cribbing has held together well largely due to its girth. However, with the move to multi-crib systems, GMC no longer uses untreated lumber for constructing cribs.*

If untreated cribbing lasts long enough, it would be a viable option for clubs with limited financial resources. For example, if the hemlock crib lasts for fifteen years, replacement of both the crib and the toilet could be done at the same time, allowing for one-time fund acquisition at each replacement cycle.

8.10 ADVANCE PREPARATION

GMC employed the following steps in advance of final construction of the single crib unit:

1. CUTTING THE CRIBBING—Untreated green hemlock was rough cut a full 6 inches square, weighing about 11 pounds per linear foot. The stock pieces ran between 12 and 13 feet long and were generally clear of knots, wane, and twist.

The 6- by 6-inch lumber (which is actually 51/2-inches square) or 4- by 6-inch lumber (actually 31/2 by 51/2 inches) PT lumber was 0.40 CCA treated for full ground contact, and varied greatly in weight depending on its storage conditions. After storage outside it can weigh twice as much as green hemlock. The lighter the material, the better, so we recommend covered storage. Both eight-foot and twelve-foot stock were used as available. This material rarely had as much as a quarter-inch overage in length.

The stock was laid out on blocking on the ground for cutting. For some of the hemlock material it was necessary to scribe and cut an end square before laying out the other pieces to be cut from the timber. The PT material was always square. The stock was cut freehand with a chain saw, and was scribed on two adjoining sides to give the sawyer both a square line and a plumb line to follow. The chain saw was a fairly rough cutting tool, having a 3/8-inch kerf, but cribbing pieces were generally within 1/2 inch to 3/4 inch of the desired length. If greater precision is desired, a skilled person with a sharp bow saw can cut to much closer tolerances without spending much more time.

The PT 4- by 6-inch stock, as well as other miscellaneous pieces (stair treads, cleats) were cut with a 12-inch miter saw when available. This produced very square ends, which helped assure a square shape for the base of the crib during assembly.

2. PILOT HOLES FOR SPIKING—Two systems were used to fasten the cribbing. In the early designs, every course of cribbing material was nailed to the course below using 10-inch galvanized spikes. In later designs, the corners of the crib were pinned in place atop each other using concrete reinforcing bar (rebar) set in predrilled holes. The second system was much faster to assemble in the field, but it required some additional drilling and more careful layout ahead of time. The rebar method of fastening cannot be used with a crib that is wider at the base than at the top, which is a major advantage of cribs with vertical sides.

In both systems, the base square is made of two 4-foot long pieces of 6- by 6-inch stock and two 3-foot long pieces of 4- by 6-inch stock. Those must be spiked together to provide a stable, rigid, bottom course. In addition, the two shorter members of the top course (36 inches long) are spiked to the course below to hold them in place. *It is always necessary to drill pilot holes for spikes to avoid splitting the lumber!* We also countersank the spikes about one inch for more equal penetration of the two pieces.

Pilot holes for spikes were always centered on cribbing pieces. The countersink for the spike head was first drilled using a 7/8-inch spade bit, to a depth of about one inch. A 12- by 5/16-inch twist shank bit was then used to finish the pilot hole through the piece.

NOTE 1: Only the countersink and pilot of one member were drilled in advance. The corresponding 5/16-inch pilot on the second member was drilled in the field at the time of assembly.

NOTE 2: The 3/8-inch spike shank was 1/16 inch larger than the 5/16-inch pilot.

NOTE 3: If the entire crib is to be spiked together, pilot holes in successive courses must be offset so that the spikes in upper courses will not hit the spikes in the course below.

3. PILOT HOLES FOR REBAR SUPPORTS—The rebar system requires that holes be drilled through both ends of each four-foot piece of cribbing. These holes must align well enough that the pieces of cribbing may be dropped on top of the standing rebar without bending or binding. Half-inch rebar was used, and 3/4-inch holes were drilled. The 1/4-inch overage accommodated some misalignment during assembly, but the finished product locked together very tightly.

Lay out holes as follows: Measure three inches in from one end of the timber, and draw a square line. Mark the center of the timber on this line. This will be the location of the first hole. If all the timbers were *exactly* 48 inches long, you could simply repeat the process at the other end of the same timber, and the distance between the holes would always be 42 inches. However, it is essential to keep the distance between the holes the same, despite variations in the length of the timbers as large as 3/4 inch. Therefore, measure 42 inches from the center of the first hole (or 45 inches from that end of the timber) and make another square line. Find the center point of the timber on that line, and it will be the location of the second hole. Drill pilot holes for rebar with a 3/4-inch spade bit, lengthened if necessary with a 6-inch hex-keyed extension so it will drill all the way through the timber. A 1/2-inch chuck electric drill speeds the process. Be sure to drill holes square to the top and bottom surfaces of the timber. Block timbers so the drill bit will not hit dirt or rocks.

When drilling rebar pilot holes it is useful to preassemble the crib. Begin by laying out the bottom pieces: two 4-foot pieces of 6- by 6-inch stock and two, 3-foot pieces of 4- by 6-inch stock in a tight square. Note that the 4-foot pieces will require *horizontal* countersinks and pilot holes for spikes (into the 3-foot pieces) as well as *vertical* rebar pilot holes. Once these two 4-foot pieces are prepared, mark them clearly, because they will be required early in the construction process. Continue the preassembly by reforming the base square and setting up the rebar. Carefully fit successive courses of 4-foot timbers on top of the base. Note that the next four courses of cribbing (eight pieces total) are all the same in forming a square crib with vertical sides.

NOTE: If the topmost course is to be square with the other courses, no modification is necessary. However, if the top course is to be stepped-in to accommodate the outhouse, modification of the pilot hole measurements in the two topmost timbers will be required.

Cutting the rebar—Cut four pieces of ½-inch rebar 30 inches long, using a hacksaw.

Tools used in the workshop—The following tools were used off-site to prepare the material for field assembly:

- Chain saw
- Speed square
- Tin snips (for cutting hardware cloth)
- Cordless drill and standard AC electric drill
- 12-inch miter saw (standard AC)
- Cordless circular saw
- Hacksaw

8.11 FIELD ASSEMBLY

Field assembly of prepared materials consists of finding a site for the unit, assembling the crib, providing screening, attaching the stairs, attaching the outhouse, and completing the finishing touches.

1. SITING THE UNIT—Locate a spot with a reasonable balance of the following factors:

Topography: A level spot is important. However, avoid places vulnerable to flooding. The moldering privy allows urine to drain into the soil below the crib, where it will be cleansed by the biologically active layer of the soil (the top six inches). Too much slope could cause urine to stream on the surface, which is unappealing and a potential health hazard.

Water table: If possible, dig test pits to determine the seasonal high water table at spots you are considering. Soil below the seasonal high water table usually has a tell-tale mottled appearance. Pick a spot with as much soil above the seasonal high water table as possible.

Sun and shade: Keeping the privy shaded in summer will increase the productivity of the worms and other soil creatures that prefer a dark, moist environment. (Banking duff, hay, or straw against the outside of the crib can help maintain the optimum temperature and moisture.) If possible, site the privy under deciduous trees so it is shaded during the summer and sunlit in winter, which will help prolong the life of the structure by melting snow and keeping it dry. Winter sun exposure also helps keep snow from blocking the door.

Water sources: Make every effort to stay at least 200 feet from all water and downhill from where hikers will collect drinking water.

Aesthetics: If possible, place the privy far enough away from the campsite to protect the camping experience, but not so far that people will not use it. This requires judgment, and possibly observation of camper and hiker behavior. The optimum distance is affected by things such as slope and footing of the approach trail (people often do not wear boots at night, so the approach trail should be relatively easy). Separation from the campsite also helps discourage winter vandals from considering it an easy source of firewood (this is no joke).

Prevailing winds: Try to locate where wind will usually carry odor away from the shelter and tenting areas. Locate away from areas prone to drifting snow in winter.

Privacy: Take advantage of trees or other forms of shielding from the shelter or tent site, but provide directional signs to the privy and a map inside the shelter. Face the outhouse door away from shelter opening and trails, unless the location is well shielded.

Logistics: Try to pick a place near a source of leaves and duff.

2. ASSEMBLING THE CRIB—The process in the field is simple once materials are on site and sorted.

Begin by locating the bottom course pieces. Stand the 4- by 6-inch pieces on end, and set a piloted 6- by 6-inch member atop them. Holding the assembly square, finish the spike pilot hole into the three-foot timber using the 5/16-inch drill bit, then spike this corner. Repeat the process for the other three corners. Check the assembled base for squareness by ensuring both diagonal corner-to-corner measurements are identical. Set the squared base onto the prepared site, check it again, insert the rebar, and add the remaining courses of four-foot timbers. Repeat the piloting and spiking process for the short pieces in the top course. Remove a couple of inches of soil from the bottom of

Access to waste pile is essential. Provisions must be made to do this without going through the toilet seat.

the crib, to create a depression to retain liquid long enough for it to seep into the soil. Pile this soil around the outside of the bottom of the crib.

If you plan to introduce redworms and you want to prevent predation by mice, voles, and the like (a problem more likely at lower elevations), line the bottom of the depression with hardware cloth.

3. SCREENING—The inside of the crib is lined with half-inch mesh hardware cloth, secured with 3⁄4-inch poultry staples. The hardware cloth may be cut into eight inch strips, which will cover the openings between timbers and use less material. The outside of the crib is covered with both the half-inch hardware cloth and dark-colored fly screening. The dark color helps shade the pile, keeping worms and other organisms active.

4. ATTACHING THE STAIRS—Stairs to the outhouse are made of commercial three-step pressure-treated stringers, and treads of either 2- by 8-inch or 2- by 10-inch PT lumber, 28 inches to 32 inches wide, depending on availability. Secure stringers and treads with 21/2-inch galvanized deck screws. Screws are better than nails, because they permit disassembly and attachment to another crib later. Support the stringers with a 2- by 4-inch pressure-treated cleat, or galvanized joist hangers or framing anchors. It may be necessary to enlarge holes to accommodate screws if the hardware was designed for nails.

5. ATTACHING THE OUTHOUSE—Use galvanized angle brackets or framing anchors to fasten the outhouse to the top course of timbers. Use galvanized screws (lag screws or deck screws work well) to facilitate future removal. Again, it may be necessary to enlarge holes to accommodate screws if the hardware was designed for nails.

6. FINISHING TOUCHES—A tube of aluminum flashing attached to the underside of the toilet seat acts as a splash guard and ensures the waste does not get caught on the cribbing or screen.

A stewardship sign on the inside and outside of the door should explain the system to the user and provide instructions. Maintainers will want to keep a small can, waste basket, or bucket inside the privy filled with bulking agent, and encourage hikers to keep it filled.

Tools used in the field—The following tools were used on-site to for field assembly:

- Cordless drill
- Drill bits: Spade bits: 3⁄4 inch (nail head countersinks) 3⁄4 inch (rebar holes); Standard twist shank drill bit: 5⁄16-inch x 10-inch (nail shank)
- Two-pound hand sledge
- Hammer
- Shovel
- Tape measure
- Level
- Weatherproof paper (for the outhouse stewardship signs)
- Staple gun (to attach screen and hardware cloth into place before nailing with poultry staples; also used to post outhouse stewardship sign)

8.12 EVOLUTION OF CURRENT GMC DESIGNS

Double Chamber Unit

The original GMC design of the moldering privy was a single, simple crib made from 6-inch by 6-inch timbers stacked and spiked together. The resulting unit was solid but also very heavy to transport in to backcountry sites. The unit's design also necessitated that the process be repeated at least one more time when the original crib unit became full.

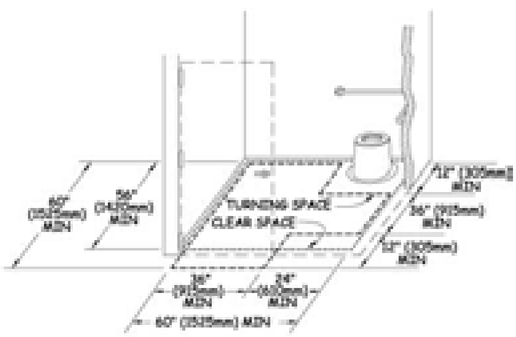
To remedy this, GMC developed a double-chambered (non-accessible) unit using smaller dimension wood. Rather than having the lumber stacked, the new unit derived its strength from using vertical 4- by 4-inch posts in the corners.

These are then tied together with horizontal 2- by 6-inch boards (see appendix for plans for a Double-Chambered Moldering Privy). The resulting unit created two chambers, each containing approximately 48 cubic feet. This design has held up well over the years but required the addition of diagonally attached 2-inch by 6-inch boards on the crib to prevent leaning—particularly when a heavier outhouse was used. This design could be easily modified to have additional cribs. The main design limitation is weight-bearing capacity of the crib for a larger toilet building, and as a result it has not been used for accessible moldering privies.

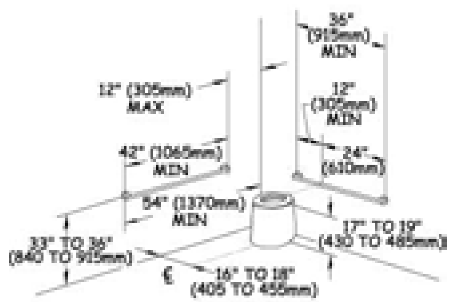
Other Appalachian Trail clubs have merged the original GMC design concept with the double chambered unit and produced some excellent designs. These have been achieved by stacking smaller dimension lumber much as GMC did with the 6- by 6-inch timbers. The benefits of using the smaller dimensions, such as 4- by 4-inch and even 2- by 4-inch, is that they are much lighter to carry and easier to fasten together. The lightness of the timbers allows maintainers to develop multi-bin systems quite easily. The other main advantage is the air slots are smaller in width (although you have more of them so there is no net loss of air flow) and this reduces the view of the pile to approaching users. The Massachusetts A.T. Committee of the AMC–Berkshire Chapter developed a creative stair system that detaches easily from this design for when the outhouse is moved to a new crib (see appendix for discussion, photos, and plans of these designs). This design was utilized to create an attractive three-crib unit on the Chilkoot Trail at the Klondike Goldrush National Historic Park (a full discussion and plans for this unit can be found at ***http://www.americanalpineclub.org/uploads/mce_uploads/Files/PDF/KlondikeMolderingToilets.pdf***).

Accessible Unit

GMC has installed several accessible moldering privies to date, each one slightly different from the others. The toilet building component of the unit is based on the accessible outhouse design for batch-bin systems that was installed at Churchill Scott Shelter in 2002, but it uses a moveable toilet seat to access the two chambers below (see appendix for plans). After several iterations, GMC staff worked with planners and architects on the Green Mountain National Forest to develop a standard design for use on the Forest (appendix for USFS Region 8 and 9 approved plans). and this design has now been built at Greenwall Shelter and Happy Hill Shelter—the latter design being the most current. The unit has a manufactured moveable toilet stool that can be placed over two different cribs. At the time of this writing, our most recent accessible moldering privy design for the National Forest allows for two chambers, each measuring 36 inches wide by 91 inches long by 24 inches deep, a similar capacity (96 cubic feet) to our non-accessible design. Adjustments may be made to increase the capacity through enlarging the cribs or adding additional cribs. A second design that is tailored to campsites with less steep terrain has a longer crib that is accommodated beneath the standard 5-foot by 5-foot accessible transfer platform. A key design consideration for any accessible privy is allowing for access to the piles for mixing and compost removal.



T - Turning Space in Outhouse



Grab Bars

Key Accessibility requirement - the 5'x5' transfer platform

A similar effort was undertaken by Trail clubs on the southern half of the A.T., working with their National Forest partners. The resulting design is now in use from Georgia to Virginia. The southern design features a toilet building that is essentially a roof with privacy screens. Nicknamed the "cabana," it has a more minimalist design that offers weight and cost savings in environments with less severe winters. This unit utilizes three cribs and boasts an impressive 194 cubic feet of storage in a design where the toilet building never has to be moved (See appendix for USFS Region 8 approved design).

Despite the larger profile of this structure, its overall aesthetic impacts to the site can be mitigated with proper siting and taking advantage of sloping topography and natural vegetative screening (see case study onThomas Knob Shelter in Virginia).

The accessible moldering privy design offers several advantages over non-accessible units. The most notable advantage is larger crib capacity, which allows for a higher volume of use without compromising the amount of time needed for complete composting. In many instances the crib capacity is large enough that the toilet building itself is never moved. The toilet stool is simply shifted from one crib to another. This can be a significant labor saver. The at-grade entrances and ramps used are much safer for users to negotiate, especially when wet or snow covered.

With those advantages in mind, many Trail managers are choosing to build accessible models, even if they are presently not required to do so, simply because the larger capacity unit functions better and the building does not have to be moved to change cribs.

By making recreational facilities universally accessible, they are open to all visitors and no future changes or efforts will be needed to guarantee this. It has been noted by Trail managers that with the increase in the number of retired baby-boomers visiting recreation areas, the need for greater accessibility of facilities will grow. Universal Access is fast becoming the basis for design and considered a best management practice for facility design at many recreation areas.

A note about toilet benches and risers: GMC and many other trail clubs are moving away from using traditional bench style seats in outhouses. The primary reason is that they can be difficult to build in a way that meets accessibility standards. Another key reason is sanitation and cleanliness. Wooden benches often get saturated with urine and can present surfaces where fecal matter can collect. With these reasons in mind, accessible plastic or stainless steel toilet risers such as the Romtec's - http://www.romtec.com/Accessories_and_Hardware/Waterless_Restroom_Accessories/Toilet_Risers__Urinals/.

Accessible Toilet Riser and Stainless Grab bars.
Also note clear T shaped turn around space.

A note about access ramps: Slope and length both impact the ease with which a wheelchair user can negotiate a ramp. The goal is to produce a ramp with the least possible slope, for greatest ease of use. Any surface with a slope greater than 1:20 (1 inch of rise for every 20 inches of run) is considered a ramp. Ramp slopes should preferably be from 1:16 to 1:20. The maximum slope of any new ramp is 1:12, and the maximum rise for any run is 30 inches.

A note about stairs and accessible privies: While there are guidelines on how stairs can be constructed that are considered accessible (***USFS Accessibility Guidebook for Outdoor Recreation***), it should be emphasized that they are a design solution of last resort if an at-grade entrance or ramp cannot be constructed. People in wheelchairs would be required to drag themselves up these stairs on onto the toilet building floor—a potentially unsanitary scenario. With proper site selection and design considerations, all but the most challenging backcountry sites would not need to use the accessible stair design.

9 Batch-Bin Composting

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9.1 Background

The batch-bin system was introduced to the Green Mountains of Vermont and the White Mountains of New Hampshire as a pilot project in waste management in the mid-1970s. The design and prototype were created by Ray Leonard of the U.S. Forest Service's Backcountry Research Project at the Northeastern Forest Experiment Station in Durham, New Hampshire.

The system was designed to provide forest, park, and trail managers with a method for human-waste management at remote recreation sites, generally high in the mountains. Thin and frequently saturated soils at many of these sites are unsuitable for pit toilets, which release untreated wastes that leach into groundwater. Disease-causing organisms, called pathogens, can travel up to five feet in fine, sandy soil and as far as 200 feet in soil of coarser fragments (McGauhey and Krone 1967)—even farther if the soil is very moist. The batch-bin system permits on-site management of human waste after safe decomposition in a leak-proof container.

Since their introduction, batch-bin composting systems have evolved somewhat differently in the Green Mountains and White Mountains, although the techniques are similar in both places and the results are the same.

The Green Mountain Club (GMC) system uses one large composting bin, and employs storage containers to accumulate enough waste to fill the bin. The Appalachian Mountain Club (AMC) system uses two to three smaller composting bins in sequence, and it uses no storage containers to accumulate sewage before a composting run starts. The GMC system uses a wooden drying rack to dry and age compost before sifting it through a screen, whereas the AMC system in the White Mountains dries compost right on a sifting screen. All AMC systems also incorporate beyond-the bin liquid separation, which keeps the mixture of sewage and bark mulch comparatively dry and reduces its volume.

9.2 How the Batch-Bin Composting System Works

How it functions—The batch-bin system functions as follows:

1. Wastes accumulate in a 70-gallon Rubbermaid or similar polyethylene leakproof container, called a "catcher," under the seat of a conventional outhouse with a modified bench. In the GMC system, the catcher is periodically emptied into one of two 32-gallon rectangular garbage containers for storage. In the AMC system, a compost run is started when the catcher is full.

   Each time people use the toilet, they add a handful of ground hardwood bark mulch (available from lumber mill debarking operations). Hardwood bark has the best carbon-to-nitrogen ratio and structural shape for composting. Other organic materials, such as peat moss, work, but poorly.

2. When both storage containers and the catcher are full, all of the sewage and bark mixture is transferred to a composting bin of 160 to 210 gallons. In Vermont, GMC uses a cylindrical 210-gallon plastic composting bin originally designed for aquaculture. It weighs about 45 pounds, and is four feet in diameter and 2.5 feet high.

   In the White Mountains in New Hampshire, the Appalachian Mountain Club uses a custom-made rectangular stainless steel composting bin of 150 gallons. The bin weighs 150 pounds empty. It is three feet high at the back, two feet high at the front, four feet long and three feet wide.

3. The wastes are thoroughly mixed with enough additional hardwood bark, and recycled compost if available, to soak up excess liquid. The material is completely mixed, broken up, and aerated with a turning fork, and the bin is almost full. This results in a carbon-to-nitrogen ratio of approximately 30:1 by weight, which is optimum for the composting process.

4. Now a "compost run" begins. During the run, no new wastes are added to the compost bin, and the pile is turned every four to five days. Waste breakdown occurs as local soil bacteria and fungi proliferate in the compost. Human pathogen destruction results from temperatures higher than 90 degrees F. (32 degrees C.) competition with hardy local microorganisms, and from processes such as oxidation and antibiosis, intrinsic to rapid aerobic decomposition (for more details, see Chapter 3—The Decomposition Process).

   A GMC run lasts four to six weeks, depending on ambient temperatures and operator skill and energy. The compost then goes to a storage platform, or drying rack, to further decompose and dry for six months to a year. An AMC run lasts two to four weeks in each composting bin (four to eight weeks total), and then the compost is put on a screen for drying, aeration and sifting.

Accessible Batch Bin Privy

5. After the material has sufficiently aged and dried, the mixture of humus and bark is sifted to capture bark chips that can be reused in the next run. Screening also catches any chunks of material that escaped decomposition. These can be broken up and placed in the next run. The screen is a five- by four-foot wooden frame on legs three or four feet off the ground. The best screening material is heavy gauge diamond-patterned expanded sheet steel. However, a double layer of quarter-inch hardware cloth also works.

6. Finally, some of the finished compost is recycled into the next run, which helps inoculate the run with beneficial organisms. The rest is scattered thinly over selected spreading sites, or buried if necessary to satisfy regulations.

9.3 COMPONENTS OF THE BATCH-BIN COMPOSTING SYSTEM

The following text describes the GMC system, and notes points at which it differs from the AMC system.

OPERATOR—The operator of the batch-bin composting system is its most important element. Mastery of the process requires resourcefulness. The operator must maintain an optimal aerobic environment for composting, which requires sensitivity to the variables inherent in a biological waste management system, and he or she must be prepared to deal with unforeseen difficulties.

Operating a compost pile is a continuous experiment. Try different handling procedures to see which are the most effective in the conditions where you work. Turn the compost pile with coworkers to ease the burden and share insights. Refer to the manual as you go. Keep accurate records so the next operator will know what to expect. Above all, keep a level head. No problem is insurmountable if you are patient, thoughtful and inventive.

OUTHOUSE—The batch-bin system uses a conventional outhouse, with the design modified to accommodate a 70-gallon catcher under the seat. The rear has a hinged door for removing the catcher, and the outhouse needs a solid platform extending far enough behind it to slide the catcher out easily. An existing outhouse can be used if it can be properly modified.

In some areas, regulations may require screened vent stacks, otherwise, they can be omitted. Screened vent stacks normally do nothing useful in a backcountry privy, since there is nothing to create a draft from the catcher or pit. They have been installed habitually because of a tradition begun in the days of urban anaerobic cesspool-style privies that produced high levels of dangerous methane. Methane is much lighter than air, so it readily rises up a vent stack and dissipates. Backcountry privies produce negligible amounts of methane. So the vent stacks we are accustomed to seeing on backcountry privies are ineffective and superfluous.

If you are building a new outhouse, plan it with a solid wooden floor and a platform extending behind the rear access door far enough to allow the catcher to slide all the way out of the outhouse. This makes moving and working with the catcher much easier. If an existing outhouse does not have a sturdy platform, it can be firmly secured to one.

If the distance from the underside of the privy bench to the top of the catcher is more than six inches, attach a short piece of metal flashing to the underside of the bench to guide waste into the catcher. This prevents waste from running down the inside of the front wall.

Winter access and maintenance are easier if the outhouse is elevated, so its front door and rear access door are off the ground and the catcher can be emptied if need be without interference from deep snow. In the White Mountains, operators make a point of composting as early and as late in the season as possible, and 70-gallon catchers have not required emptying during the winter. GMC also has found that 70-gallon catchers will not require emptying in the winter, as long as they are emptied before winter starts.

The outhouse should be kept clean and attractive, so visitors will use it rather than the woods. Keep a broom for sweeping the outhouse, and cleaning supplies for its seat. A small can of paint or stain is useful for covering graffiti as fast as it appears. Graffiti begets more graffiti.

Note: Buildings should not be swept if rodent droppings or nests are present (see Appendix xx—Hantavirus Pulmonary Syndrome).

CATCHER—In the past, 20-gallon heavy plastic cans were used as catchers at most GMC sites. However, 20-gallon catchers fill too fast at the heavily used backcountry campsites that need batch-bin composting, particularly in winter and by large groups. Twenty-gallon catchers often overflow during the winter and leave a mess for shelter maintainers in the spring. So AMC and GMC now use 70-gallon high density polyethylene (HDPE) tubs, and we recommend them, especially for any site receiving off-season use.

A 70-gallon catcher weighs more than 550 pounds when full, so it must be set on rails or on a platform extending at least five feet behind the outhouse so the operator can pull it all the way out without help.

The catcher should be low and wide rather than tall and narrow, because it is hard to shovel out a tall container and keep the shovel handle clean. The 70-gallon Rubbermaid stock tank used by AMC and GMC is 40.5 inches long by 32 inches wide by 24 inches high.

Industrial-grade HDPE is corrosion proof and durable. Rubbermaid stock tanks have built-drain plugs, which make it easy to attach a beyond-the-bin (BTB) liquid management system (see the Beyond-the-Bin section of this chapter for a diagram of the catcher with strainer plate attachment). If not broken, plastic will last 10 years or more. Twisting and lifting often breaks thin plastic containers, and they tend to crack in cold weather, so it is best to avoid inexpensive polyvinyl chloride (PVC) garbage cans or any plastic other than HDPE. (See Appendix xx—Sources of Material and Equipment.)

Most metal containers are poor choices. Stainless steel is good, but expensive. Catchers of other metals should be completely coated with roofing cement or some other durable coating. However, even a coated metal catcher will last only two to three years. Metal catchers with rounded bottoms are better than catchers with seams. Mixing wastes in metal catchers or storage containers other than stainless steel is not recommended, because scraping will remove the coatings and accelerate corrosion.

In the Great Smoky Mountains National Park, the Appalachian Trail Conservancy and local Trail clubs have tried using plastic garden wheelbarrows as catchers in privies, which makes it easier to transport waste to storage containers. But, the wheelbarrows don't hold much, so they must be emptied frequently, and they can overflow in winter or if subjected to large groups. Liquid tends to slosh out when the shallow wheelbarrows are moved. If liquid is to be drained for separate disposal, it must be filtered, because the urine is contaminated from being in contact with fecal matter. Wheelbarrows would be most effective at low-use sites visited often by adopters or other attendants.

A catcher larger than 70 gallons is too heavy for one person to slide out of the outhouse. It also may allow more sewage to accumulate than the compost bin can accommodate. In addition, the catcher may sit in the outhouse so long that it causes problems with flies and odors in the summer. Adding fresh and recycled bark, knocking over the "cone" of bark and feces, and keeping fresh feces covered with a thin layer of bark helps reduce flies and odors. However, there is no substitute for the routine transfer of waste from the catcher to a storage container (in the GMC system) or the first composting bin (in the AMC system) when necessary.

EMPTYING CATCHERS—If a site has received high off-season use, the pile in the collection container may be mounded into a cone. It may be necessary to push the pile down before sliding the container out, using a stick through the privy seat. Wash the privy seat well if it becomes contaminated. It is best to design the privy with a flip-up bench seat to provide more sanitary access to the catcher. It is also good to provide a rear door high enough so the catcher can be slid out of the outhouse to manipulate its contents.

Full Catcher

Once waste is in a storage container, do not add bark or turn it. The waste should remain inert until you are ready to compost it.

Once most of the sewage has been shoveled out of the catcher, you may want to dump the rest of the sewage and liquid into the storage container. But if sewage is poured from the catcher to the storage container, it may splatter, especially if urine has not been separated from feces. To reduce the chance of getting splashed, stand behind the collection container. Rest the edge of the catcher gently on the storage container. Pour carefully.

To help keep flies down, clean the catcher with several shovels full of fresh bark before replacing it in the outhouse. Put the bark used for cleaning in the storage can (in the GMC system) or the compost bin (in the AMC system).

Always double-check the catcher position after replacing it in the outhouse. Position the container as far forward as possible to keep urine from running over the front edge. Line the bottom of an empty catcher with three to four inches of fresh or recycled bark mulch to help to absorb liquids and reduce odor.

STORAGE CONTAINERS—The AMC system does not use storage containers. Wastes from the catcher are mixed with bark a bit at a time in a mixing bin, and then placed directly in the first composting bin. Therefore, what follows applies only to the GMC system.

Storage containers accumulate waste for a compost run, and provide storage for fresh waste during a run. They should be close to the outhouse, to ease transfer of waste and minimize spillage. Set storage containers on a level, secure, dry base, such as short boards. Stay away from sharp stones, which can puncture the bottoms. Avoid rolling the storage container on an edge, which can cause the plastic to split. It is best to leave the storage container in one place, adjacent to the outhouse and compost bin.

Sometimes people or animals investigate or knock over storage containers. In the Smoky Mountains, black bears have knocked over storage containers. ATC and local clubs have solved the problem by surrounding the composting areas with electric fences. In Vermont, GMC has had more trouble with people, who often think the storage containers are trash containers, and open them to deposit trash. Occasionally someone will maliciously knock over a container, spilling its contents. To counteract this, GMC has been building secure, ventilated lockers for storage containers and the bark-mulch supply.

Storage containers must be leak-proof, with secure lids. The GMC uses rectangular, 32-gallon Rubbermaid HDPE garbage containers. Their square shape resists warping under weight and pressure, their lids fit tightly, and their rims resist cracking when tipped over.

Galvanized steel garbage cans have been used extensively in the past, but they rust quickly. Fifty-five-gallon plastic or metal drums with tightly fitted lids work, but wastes in the bottom are difficult to remove, and the drums make the compost area look like a hazardous waste site. The volume of waste in storage also tends to be too great.

At least two storage containers are needed to hold the mixture of sewage and bark before and during a run. GMC has found that the contents of two 32-gallon containers plus the 70-gallon

Pros and Cons of Batch-Bin Composting

+	-
+ Highly effective pathogen mortality-- over >99.99% reduction	- External mixing agent required
+ Inert, soil-like end product	- Dedicated personnel
+ Inoffensive outhouse odor	- Moderate amount of infrastructure
+ Suitable for high use areas	- Moderate initial upfront cost
+ Capable of processing substantial volume in one season	- Annual operating cost
+ Visitor education and stewardship opportunity	

catcher, plus added bark to adjust the moisture content, are the ideal volume of sewage for composting in a 210-gallon compost bin. We try not to have many storage containers at the site, because that allows a backlog of sewage to develop, and increases the risk of animals or hikers knocking over the storage containers.

Keep storage container lids tightly secured with string or bungee cords to discourage the casually curious or litterbugs from lifting them. Label storage containers clearly with paint or marker: RAW SEWAGE—KEEP OUT! Check regularly for leaks, and replace leaking containers immediately.

Before any wastes are placed in a storage container, put several inches of bark and/or finished compost in the bottom to absorb liquid and reduce odors.

Do not mix bark mulch with sewage when transferring it to storage containers. However, you can put a layer of bark mulch and/or recycled compost on top of sewage to control odors. The goal is to prevent sewage from starting to compost before the planned start of a run, so there will be a large enough mass of fresh sewage and bark to create a good, hot run. Therefore, every effort should be made to keep the waste in the storage containers inert. This can be done by not mixing waste when transferring it from the catcher, not adding bark mulch, and by packing the storage containers as full as possible to reduce availability of oxygen.

If non-biodegradable trash has been thrown into the catcher, storage container, or compost bin and is contaminated, leave it there and let it go through the compost run. Then allow it to weather in a protected spot before packing it out.

COMPOST BIN—The bin is the key element, and the largest one, in the composting operation. A bin of 160 to 210 gallons is optimal to create self-insulating composting conditions. AMC and GMC have not used insulated bins, but they may be useful in some places.

The bin or bins should be near the outhouse and storage containers, if any, to facilitate waste transfer and minimize spillage. GMC has found that one large bin ordinarily is enough at an overnight site, especially if a beyond-the-bin system or another method separates liquid from solid waste. AMC always uses two bins, partly because usage at its sites is typically high and partly because the bins are smaller. At the four heaviest-use sites (1,700–2,000 overnight visitors during the summer caretaking season), AMC uses three bins.

Initially, bins were built of marine grade plywood, laminated inside and out with fiberglass and resin, but industrial HDPE bins are cheaper and better. Stainless steel is even more rugged, but also heavier and more expensive. Building a leak-proof plywood bin is difficult. In addition, fiberglass resin is a health hazard and requires approved breathing masks. HDPE is less likely to be consumed by porcupines than plywood coated with fiberglass, and porkies cannot damage stainless steel at all. Persistent porkies will chew through a fiberglass coating to get to the plywood inside.

NOTE: PORCUPINES —Because of their love of salt, porcupines can be a problem even with HDPE bins. If they are, removal of the offending animals is the best solution. If porcupines must be eliminated, check with your ATC regional office and the local land manager before taking any action. Removal of any creature may not be permitted in your area. Elimination options include live trapping or removal by hunting. If you cannot remove the porcupines and they continue to be a problem, you can enclose your composting system components inside a metal cage.

Aeration tubes once were thought necessary for composting, but they actually provide minimal aeration, and they hinder turning the compost. Do not add them to bins. The tube holes in the bin walls are points of weakness, and the edges are ideal places for animals to begin chewing into the bin.

The original bin design used a sliding front door, but it let water into the bins. Modern HDPE bins are only accessed from the top.

COMPOST BIN LID—In the past, GMC utilized custom fabricated plastic bins. Over time it was discovered that these tight fitting lids trapped and condensed evaporated moisture and rained it back on the pile. To solve this, plastic lids were replaced with wooden lids with metal roofing. These lids are composed of two sheet-metal roofing panels, overlapped and screwed to a two-by-four lumber frame to make a sturdy top. The two-by-four frame is set on end to allow carbon dioxide and water vapor to escape without letting rain or snow in. All exposed edges are crimped and nailed or screw down. The lid is then reinforced with diagonal bracing to withstand winter snow loads and is secured with rocks to prevent the wind from lifting it off. We hope the dark colored metal roofing will attract some solar warmth. (See Appendix for plans to construct a wooden bin lid.)

All of the AMC's stainless steel bins are fitted with framed plywood lids, which are covered with plastic for waterproofing when left through the winter. A lid should be sturdy to withstand falling branches and snow. A lid of marine-grade plywood, reinforced with slats to prevent warping, will last many years, but is heavy to pack in and maneuver.

Fiberglass and plastic solar panels are not recommended, because they crack easily under snow loads, a sharp blow, or a sudden twist, and they provide only a small amount of heat from the sun in comparison to the heat generated by microbial growth.

TRANSPORTING THE COMPOST BIN TO THE SITE—AMC has flown all of its compost bins to its sites. HDPE compost bins weigh only 60 to 100 pounds, but they are awkward to pack to remote sites. Since the tubs are cylindrical, they can be rolled on easy terrain. Two to four people can carry a bin upside down or lashed to a homemade stretcher. One person can carry a bin on a wooden packboard by resting the rim on the top of the packboard and grabbing the sides with his or her arms.

POSITIONING THE COMPOST BIN—Stainless steel bins have strength enough to sit directly on leveled ground.

An HDPE compost bin may be placed directly on flat level ground, on pressure treated two-by six-inch boards, or on a sturdy platform of pressure-treated two- by six-inch lumber. Note that a full bin can weigh more than 1,700 pounds.

It is better to set the corners of a platform securely on large, flat rocks, however, it is convenient to put the bin on a raised platform of wood or earth, and this is especially useful if the site is wet. Pack the ground on which the bin or wooden bin platform will sit with mineral soil or fine stream gravel to provide a solid base. Set the empty bin or platform on the ground and try to rock it back and forth. Then tilt it aside to look for compressed soil indicating high spots that could weaken a bin. Shave these down until the impression of the bin or platform on the ground is uniform, if it will sit directly on the ground.

DRYING RACK—The drying rack (or "screen" for the AMC process) is the third stage in composting. On GMC's rack, composted

Stainless sifting screen - AMC

sewage dries for six months to a year, and any surviving pathogens are destroyed by continued exposure to unfavorable environmental conditions. In both systems the drying process also enables the operator to sift material to reclaim bark mulch and remove trash from it.

The drying rack gives the operator a great deal of control over composting. Uncertainty about whether the compost is done—that is, whether pathogens have been reduced to an acceptable level—is eliminated by aging the material on the rack.

The compost drying rack should be near the composting bin to make transfer easier. The best shape for the drying rack is that of a small three-sided lean-to. (See Appendix xx–Drying Rack Plans.) For a site that does one to two runs a season, a six- by four-foot rack is good. The rack can be made from untreated lumber, since the compost has no liquid draining from it. Two- by six-inch boards make a long lasting platform deck.

Higher walls in the back of the rack increase storage capacity. The front should be open. You can use local logs for the base, but rot-resistant or pressure treated dimensional lumber is better. Provide a sturdy roof, sloped to shed water, with ample room beneath for air flow. Metal roofing is inexpensive, easy to pack in and install, and lasts 25 years or more.

Do not use plastic sheeting to cover the platform—it punctures, rips, and scatters, and it traps moisture on the surface of the compost.

Examine the deck for repair whenever the rack or a portion of the rack is emptied. Replace rotted boards or resurface the deck if needed. When resurfacing the deck of the rack, nail new boards directly on top of old boards, giving a double thickness.

Use only a designated and labeled or color-coded shovel (red is recommended for potentially contaminated tools) to transfer compost to the drying rack at the end of a run. Turn compost on the rack *regularly* with a designated fork to enhance further breakdown. Adding leaves and duff at this stage introduces additional soil invertebrates to the compost, which helps speed it toward maturity.

SIFTING SCREEN—AMC makes the base of its drying rack from a screen, so material sifts as it dries. The screen is elevated on legs, and has a frame above it so it can be covered by a tarp in wet weather. The tarp is removed in dry weather to speed drying.

GMC uses a separate sifting screen before spreading finished compost in the woods. The GMC screen is a simple wooden frame approximately five by four feet, three or four feet off the ground, covered with a double layer of heavy-gauge quarter-inch hardware cloth or heavy-gauge diamond-patterned expanded sheet steel. A tarp beneath the screen captures screened compost. Locate the sifting screen on dry, level ground adjacent to the drying rack.

In the GMC system, compost is sifted when it has been sitting in the drying rack for six months to a year and appears dry. Use a shovel designated for clean material (a green handle is recommended) to place compost on the screen. In the AMC system, compost dries quickly because it is exposed to air both above and below, and is raked frequently. Drying and sifting are complete in two to four weeks.

Rake compost gently back and forth with an ordinary garden rake to cause the finer compost particles to fall through the screen. Bark mulch and any chunks of uncomposted sewage that managed to make it through the system remain on the screen. Place sewage chunks back in the composting bin with the catcher/storage container shovel (red handle), and break them up so the sewage will be adequately composted in the next run. Bark mulch to be recycled can be placed back into the drying rack. This composted bark mulch has a pleasant earthy odor, and it is useful as a substitute for fresh bark when lining the catcherl after emptying it.

Screened compost is ready to be spread in the woods (see section 9.6 below: The Finished Product) or recycled into the next run if room permits.

The remaining chips are thoroughly dried, and bagged with special color-coded labels to indicate they are to be recycled by the caretaker. They should *not* be placed in the outhouse for users to add to waste.

TRANSPORT CONTAINERS—Two five-gallon plastic buckets with handles are useful for transporting finished compost to be spread. The buckets need not be leak-proof, as they will hold only compost. Keep them labeled and removed from the site, or they will be used as trash receptacles.

COMPOSTING TOOLS—Each of the two phases of the composting process requires its own set of tools to prevent spreading pathogens to finished compost.

Phase One: This shovel and fork are used for material in the catcher and the storage container, for starting a run, and for transferring the material from composting bins. Tools used in each of these steps contact waste potentially contaminated with a significant level of disease-causing pathogens. Therefore, these tools should have a red handle or should be wrapped with red tape—red is a universal sign of danger. Ideally, these tools should be stored by hanging them from a branch or nail on a tree exposed to the weather near the rear of the outhouse. If you have a problem with hikers using or disturbing the tools, they can be stored in a secure locker.

Ground Hardwood Bark Mulch - Ideal for fast hot composting systems

Phase Two: This shovel, rake, and fork are used for material in the drying rack and the sifting screen, and for spreading finished material from the transport buckets. This material has been through a compost run with high temperatures and/or has sat on the drying rack or screen, so it is either lightly contaminated or free of pathogens. These tools should have a green handle or be wrapped in green tape—green is a universal sign of safety. These tools also should be stored by hanging them from a branch or nail on a tree near the drying rack, unless hikers tend to use or disturb them.

To avoid contaminating the finished compost, tools must not be mixed up. If you break a tool, suspend operations until you can replace it.

The *turning fork* is the flat-tined spading fork variety, as opposed to the round-tined type. Flat tines let you pick up the waste and compost for mixing. Take care not to puncture the containers or the bin with the points. AMC turning forks are welded to steel pipe handles for longer life.

A *long-handled shovel* is very useful for mixing raw wastes, because it can more easily chop the wastes than the turning fork. It is also used for transferring wastes from the collection container to a storage container and from the storage container to the bin.

An ordinary *garden rake* is useful for sifting finished compost.

Clean the red tools after every use by wiping them with bark or finished compost, holding them above the compost bin. Hang them outside (handles up) if possible to facilitate cleaning by weathering. Wipe wood handles at least once a year with boiled linseed oil.

BARK MULCH (bulking agents)—Bulking agents are materials that provide carbon, aeration, and structure to the compost pile. Hardwood bark mulch is the best bulking agent for composting human wastes in the batch-bin composter.

Fine bulking agents such as peat moss, sawdust, or ground dried leaves and duff are unsatisfactory because they compact and exclude air. Bark mulch is durable, and its chips are the right size to break up sewage and create air channels throughout the compost pile. The structure provided also creates good surface areas for decomposer organisms to thrive on.

The carbon-to-nitrogen (C:N) ratio of hardwood bark varies, depending on the type of tree and the age of the bark. Fresh hardwood bark has a C:N ratio in the range of 100:1 to 150:1. Older, dried bark has a C:N ratio of between 150:1 to 350:1, due to nitrogen loss. At the C:N levels in old dry bark the compost process is generally not impeded, because the bark is drier and less is needed to soak up water. In contrast, sawdust has a C:N ratio of nearly 500:1—high enough to bring decomposition to a standstill.

Bark for composting works best when fresh from the sawmill. However, it is much more convenient to bag and store bark in the fall to have on hand for the spring, and to distribute bark when personnel and transportation are available. Bark stored under cover over the winter is drier, and thus lighter to pack to compost sites.

Selecting bark at the mill requires judgment. The size of the bark chips is the most important criterion. Look for chips at least one to two inches long, which break up sewage well, but less than four inches, because longer chips are hard to turn in the compost bin.

Also, find the conveyor carrying fresh bark from the debarker. Fresh bark is often the lightest, because it has not sat outside soaking up water. If the pile is wet, try digging down a few inches. You may find a drier layer beneath. If you can't find chips of the right size in the fresh bark, look elsewhere in the storage pile, even if you have to take wet bark.

Often, a foot or so into the pile, the bark is vigorously decomposing. Although this decomposing bark is fairly moist, it works very well for composting human wastes.

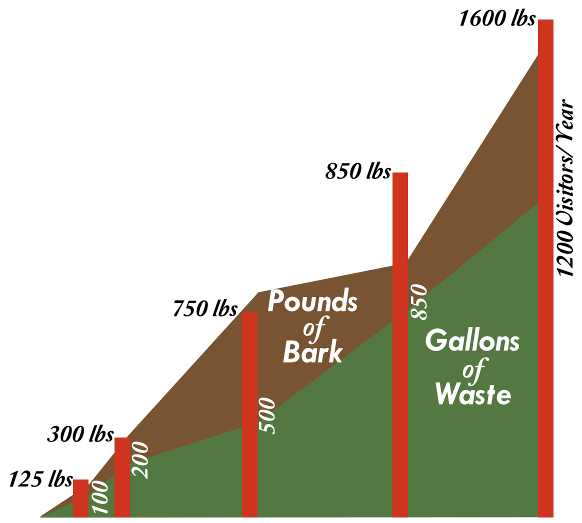
When ordering bark by the yard, the general ratio is that one yard of bark mulch is ten 50-pound bags of bark.

Use a turning fork to scoop bark into bags. Shovels work, but are difficult to push into the bark pile. Tie the bags off with string or plastic lock-ties or metal bag ties. Use slip knots that can easily be untied in the field—no one wants to dig out a pocket knife in the middle of a composting operation.

GMC has found that used coffee bags or feed bags are great for mulch. They are durable, and allow mulch to breathe and dry. They hold 40 to 60 pounds of bark, or about 75 pounds of damp bark, which is the maximum weight for packing into a backcountry campsite. AMC uses white feed bags lined with garbage bags. (See appendix for ordering information on feed bags.)

Estimating the amount of bark to supply to a site depends on the level and type of use. Day use means more urine in the catcher if urine is not separated from solid waste. The volume of bark needed also depends on the moisture level of the bark. Dry bark will absorb more waste water than damp bark. Keeping an accurate record of bark use in all phases of the operation will help you plan your bark supply in the future.

The following table is based on varying use levels at several Green Mountain Club sites with batch-bin composters:



Bark Amounts at GMC sites

As you can see, bark use and sewage quantity are not directly proportional to overnight use. Day use, bark moisture content, liquid input, and the quantity of old compost and bark recycled back into the system affect the amount of bark needed.

Keep a supply of bark on the site under cover: in the shelter, under the outhouse or the drying rack, or raised off the ground and covered with roofing. This allows the bark to dry as water vapor escapes through the porous bag. If bark cannot be not stored under cover, line the feed bags with plastic garbage bags to keep the bark from absorbing more moisture. Do not place bags of bark on plastic sheeting, which will tend to collect moisture that will soak into the bark.

Stay several bags ahead of what you need. Leave several bags over winter at the site for use in the spring. Hide your stored bark supply or prominently label it "Fecal Compost Material" to prevent disturbance by visitors. See below for information on transporting bark to the site.

Keep a container of bark in the outhouse at all times. GMC has found that at sites with an attendant, it is best to keep a small can of mulch in the outhouse and fill it each day. This takes less space than a feed bag, is more convenient for users (floppy bags are awkward to empty), and encourages users to throw in the right amount of mulch.

Post a sign instructing users to throw in a handful of bark after each use of the privy. At high-use sites, the operator should add bark during the day if more is needed.

THERMOMETER—A long probe thermometer is useful for monitoring the compost process. The AMC records the temperature in both compost bins daily at approximately the same time each day and tracks this data during a compost run. This is helpful, but not necessary. There are many other composting indicators a maintainer can easily detect without a thermometer. However, to guarantee maximum pathogen reduction it is helpful to be sure temperatures are frequently reaching the thermophilic range.

Store thermometers under cover to keep water from seeping into their housings. Composting thermometers should not spend the winter in the field. Recalibrate occasionally, following the manufacturer's instructions.

CLEAN-UP STATION—On the first visit to the site each year, bring plenty of Nitrile gloves and a bottle of waterless antiseptic hand sanitizer to establish the clean-up station for the season.

See Chapter 4 (Health and Safety) for a complete discussion of personal sanitation and safety precautions.

One of the main challenges of operating a batch-bin or beyond-the-bin composting system is transporting bulking agent to the site. The pros and cons of each option are discussed below.

9.4 BULKING AGENT TRANSPORT OPTIONS

PACK IT IN: Volunteers or seasonal field staff pack mulch in to the site on packboards or pack frames.

The *main advantage* of this method is low cost, if volunteers are available. Paid seasonal staff are not an option for most clubs. Packboards cost from nothing (old pack frames) to $300, and last a long time. Packing is the easiest system to institute, and all sites are accessible on foot.

The *main disadvantage* is that it is a lot of hard work, so bark mulch at the site may run out. Many excellent trail and shelter volunteers can not carry loads of mulch. Even vigorous club members may refrain from volunteering to avoid the possibility of being solely responsible for supplying bark mulch.

If you depend on volunteers, and they are unable or unwilling to support your composting system, it will fail. The GMC uses large volunteer groups (typically a camp or college group) to pack in bark mulch. This keeps individual shelter volunteers happy, and the packers can carry lighter loads and make fewer trips.

Some clubs sled mulch in during the winter, and report that it is easier and more pleasant than backpacking. To our knowledge, A.T. clubs have not tried pack animals, dogsleds, or wheeled devices. Wheeled devices, even muscle powered, are illegal in federally designated Wilderness areas and on A.T. lands owned by the National Park Service. They also may be regulated on other classifications of federal or state land. Some exceptions may be made for Trail management purposes. Check with your regional ATC office and with the land-managing agency.

DRIVE IT IN: If you have legal road access, an ATV/UTV or a four-wheel-drive vehicle, and the money to run it, getting bark to the site is easy. Snowmobiles may be feasible in some locations. The *main advantage* is that it saves work, making it easier to recruit and keep volunteers.

The *main disadvantage* of vehicle transport is the potential to destroy the primitive experience of the A.T. Nothing degrades a hiker's experience more than the arrival of a motor vehicle. In addition, regular vehicle access may encourage drivers of ATVs or vehicles to use the route illegally. Maintaining the route and the vehicle can be expensive, unless provided by volunteers or the land manager. To minimize disruption, schedule vehicle visits when use of the site is lowest and disturbance of plants and animals will be least. *Be sure to contact your ATC regional office and the local land manager to see whether vehicle access is legal and feasible.*

Bell Jet Ranger: Lift Capacity 800lbs

FLY IT IN: Paradoxically, the easiest and the hardest way to get bulking agent to a site is a helicopter. The only A.T. club to use this method is the Appalachian Mountain Club in New Hampshire. With 90,000 members, AMC is the largest A.T. club. The club has a full time trails department staff to manage the airlift budget and the split-second logistics required to use a helicopter efficiently. AMC is fortunate to have the means to use a helicopter, because the exceptionally high use of their campsites and the rugged terrain of the White Mountains make it impossible to pack in enough bark, even with volunteer groups augmenting their paid seasonal staff.

The *main advantage* of airlifting is the ability to supply a season's bulking agent in one trip. If your sites have extremely high use, too little soil for a moldering privy (which can use lightweight shavings or local forest duff), and are very hard to reach, airlifting could be your best or even only option. A small club could afford an airlift if it could get the use of a helicopter donated by a helicopter company or the local National Guard.

The *main disadvantage*, of course, is high cost. Helicopters rates are impacted by numerous variables so for the most accurate cost estimate contact the company. There also may be legal restrictions.

If you are considering airlifting any materials or supplies, contact your ATC regional office and the local land manager to see if it would be legal and feasible.

9.5 OPERATION OF THE SYSTEM

A compost run with three thermophilic temperature cycles and six turnings takes four to six weeks. Climate determines the maximum number of runs per year. At mountain sites in the Northeast, the compost season runs from mid-May through mid-September, generally 15 to 18 weeks.

Capacity—Capacity depends on the number of compost bins and the available labor, bark, and spreading areas. One 210-gallon bin can compost 130 gallons of bark and sewage mixture per run, although skilled composter operators may be able to boost capacity to 160 gallons per run.

Waste Homogenized with bark in catcher

The number of compost bins needed at a site depends on:

1. The number of overnight and day visitors per year.
2. The liquid content of the wastes collected. High day use results in a higher proportion of urine, unless urine is separated from solids.
3. The length of the compost season.
4. The capacity of the drying rack. A sewage backlog may force a shortening in the length of a run, calling for more time on the drying rack. Hence, more storage capacity for secondary decomposition can increase overall capacity. (In the AMC system, the use of two to three composting bins in sequence permits frequent composting runs, and eliminates the problem of sewage backlogs.)
5. How often the site and the system are maintained. If there is less maintenance and oversight, an extra bin may be needed to provide adequate storage of wastes and to allow a longer retention time for waste in the system. A system with less maintenance will not reach thermophilic temperatures as reliably, so it will need a longer period of secondary treatment in a second bin and then on the drying rack.

At mountain sites with an 18-week composting season, one bin and one drying rack should be adequate for 450 to 500 overnight visitors per season. A site in the southern Appalachians, with a longer composting season and higher temperatures during the season, could handle more visitors with one bin.

With a beyond-the-bin (BTB) system or another way of segregating urine, the number of visitors one bin can accommodate is greatly increased because the amount of bark mulch needed to absorb liquids is reduced. AMC uses BTB systems at every site; that, plus daily attention to the process and the use of two compost bins, accommodates high volumes of visitors.

Where two or more bins are required, they should be located side by side to facilitate waste transfer from bin to bin.

Filling the bin—If the compost bin is empty or new, add several inches of finished compost, recycled bark, fresh hardwood bark, crumbled dry leaves, or peat moss to the bottom. That absorbs liquid, and reduces odor. Including forest duff or recycled compost or bark chips inoculates fresh waste with decomposer organisms.

If a run has been completed, leave the bottom six inches of material in the bin. AMC and GMC compost operators call this bottom layer the "mank" layer. It is generally too wet, potentially still pathogenic, and not decomposed enough to be transferred out of the compost bin. Instead, it must be thoroughly mixed into the waste to be composted in the next run. Add some duff or recycled compost or barks chips to inoculate the fresh waste with decomposer organisms.

If a liquid separation method such as the beyond-the-bin system is used, there should be little or no mank layer. In that case, leave the bottom three inches of finished compost to help inoculate and start the next run.

Add sewage to the bin. In the bin, mix it with recycled compost, recycled bark mulch and fresh bark mulch to the point where the wastes will not drip. The sewage bark mixture should be glistening, not dripping.

Do not pour wastes into the compost bin. It is most efficient to have one person add a shovel full of sewage and another person add a shovelful or two of bark or a shovelful of old compost, and chop and mix the wastes well. Each new addition of fresh wastes is thus broken up and mixed with bulking agent as it is added. All mixing must be thorough.

Do not heap a large quantity of waste in the bin and then try to mix the entire batch. This saves no time, mixing is less thorough, and more moisture drains downward.

In the AMC system, sewage from the catcher is mixed with bark mulch a little at a time in a separate mixing bin, and then transferred into the first compost bin. This enables very thorough mixing of the material, ensuring a fast start and a high temperature during the composting process.

At low-use sites with infrequent attendance, wastes tend to dry as water settles to the bottom of containers or is absorbed by bark mulch. When transferring such dry waste, mix it with recycled compost from the drying rack rather than bark. Compost usually has a higher moisture content than fresh bark, so this will help keep the mixture moist.

It is essential to break up any clumps of raw sewage during the waste transfer. If small clumps of raw sewage are allowed to tumble around in the bin, they will dry slightly on the outside and resist decomposition. Then pathogens can survive to contaminate the finished compost. Be alert and break up any remaining clumps during the first two turnings, while the pile is still moist and before the clumps harden.

Shake each forkful of fledgling compost when starting the run to find any sewage clumps. Small balls of sewage will generally roll down any slope in the compost pile. Use the side of the fork or side of the shovel to crush and cut these up.

Plan ahead: Make sure your compost bin is ready to receive sewage and start a run when both storage containers are filled and the catcher begins to fill up.

Turning the compost pile—Thorough mixing gets the pile off to a good start and assures aerobic conditions. Adequate mixing at any stage is not difficult if the waste has the right moisture content. Don't rush. Spend enough time when turning the compost pile, breaking up clumps and regulating moisture.

Add bark mulch or dry finished compost if the pile is too wet, or add water if it gets too dry. Keep the pile moist and steaming. *Usually, the pile will self-regulate to the proper moisture level as excess moisture drains to the bottom and forms the mank layer.* Keep the moisture level at the point where water only saturates the bottom six inches of mank. This is the ideal moisture level. If the pile is too wet, you can remove the lid on dry sunny days to let the pile dry.

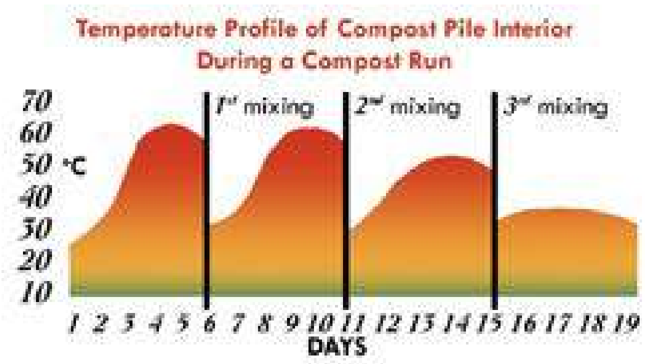
Do not allow the pile to get too dry. Under dry conditions the process slows way down, and some harmful micro-organisms may "encapsulate," forming durable hard outer coatings that protect them from attack by environmental conditions. *Dry compost does not equal done compost.*

Guard against adding too much bark. After a few days, wood splinters in the bark begin to soak up moisture in the compost, and the pile will become slightly drier. In addition, an actively turned pile will also lose moisture as water vapor escapes.

After the first few turnings of a full bin, leave the mank layer alone. *Do not mix the lower region of the bin where moisture has collected into the upper part of the pile—you will contaminate it with pathogens.*

To turn the pile, dig out a corner, taking care to leave the mank layer intact, and heap material in the back of the bin. Dig a new hole next to the first, turning and fluffing the compost as you fill the original hole. Work your way around the bin, digging and filling as you go. Include the center of the pile. During a run, all portions of the pile, including the center, are actively mixed together. Add more bark, recycled compost or recycled bark as needed. Turning may be a challenge if the bin is nearly full, but it is essential to expose the pile thoroughly to air.

Turn the pile early in the morning to avoid blackflies and mosquitoes, or turn during a light drizzle. Slapping bugs or scratching bites is unsanitary once composting operations have begun. Wearing long pants, a long-sleeved shirt rolled to the elbows, and a head net also helps.



The compost run—A compost run converts raw sewage to a finely textured humus-like material. Add no more new sewage to the compost bin after a run starts, because that would recontaminate the compost. A progression of changes mark the run. The temperature of the compost moves into the upper reaches of the mesophilic range, or 35 to 45 degrees C. (95 to 112 degrees F.), where the most intense microbial activity takes place. The temperature then passes into the range of thermophilic microbes (chiefly bacteria)— 45 to 75 degrees C. (112 to 167 degrees F.). As the upper temperature limit is reached, oxygen and readily available nutrients are depleted, and the temperature falls. Mesophilic fungi and actinomycetes begin to decay the most resistant compost components.

Turning the pile every four to five days exposes new nutrient sources, and brings oxygen again to the pile interior. Bacterial growth is reinvigorated, and the temperature climbs again until nutrient and energy supplies are exhausted. Nutrient and energy sources in the compost are depleted more rapidly with successive turnings. The temperature peaks get lower and lower as the pile stabilizes.

The C:N ratio begins to decline as carbon is lost as carbon dioxide. The volume of the pile diminishes due to loss of carbon—a 30 percent reduction in pile size is not uncommon under favorable conditions. Nitrogen is largely recycled. Although some is lost as ammonia, the rate of loss is much less than that of carbon.

The formation of humic acids and related organic molecules darkens the color of the pile noticeably as the process advances. Due to adsorption and assimilation of waste compounds, unpleasant odors disappear early in the process.

Starting the compost run—Although a run can be conducted by one person, especially if the operator is trained and experienced, it is generally better to have two or more people. Two people are more likely to mix materials thoroughly without becoming tired. In addition, while one person is mixing another can tend to other jobs, such as spreading finished compost, raking compost on the drying rack or screen, replacing the sewage catcher, cleaning the outhouse and supplying it with bulking agent, and setting up the wash station. Finally, doing the job with two people enables one of them to stay clean and uncontaminated if a job requires a clean pair of hands.

To ensure rapid waste breakdown and high temperatures, start a run with a large addition of fresh wastes and hardwood bark. A full catcher (50 to 70 gallons of sewage) works well in the GMC system. In the AMC system, a run is always started with a full bin of new material. Once the catcher of raw sewage is mixed with bulking agent, the compost run has begun, and no new sewage wastes are added during the run.

Transferring compost from bin one to bin two - AMC

Stored waste—Significant decomposition can occur while sewage is stored before the start of a run. Sometimes high temperatures are reached several times during storage. Premature composting depletes many nutrients, so the final run may not get hot enough without a large batch of new sewage. The result of trying to conduct a run without enough new sewage will be incompletely composted and contaminated material. This problem does not arise with the AMC system, which does not employ storage containers.

Large quantities are easier to compost than small ones. Pathogen destruction is more reliable, because a large pile self-insulates and achieves high temperatures. GMC uses 210-gallon bins to ensure a high temperature, and AMC uses 160-gallon bins. In either case, the key is to compost one large batch of sewage—as much of it fresh as possible—at a time.

At low-use sites, too little waste may accumulate in a season for a compost run, which is why the GMC began to use storage containers. Now, by using the 64 gallons worth of storage and the 70-gallon catcher, a high temperature batch run can be done even if it takes more than one season to collect enough waste.

Quantities—Using a 210-gallon composting bin, up to 160 gallons of sewage can be composted in one run, using several hundred pounds of bark or a mixture of bark, recycled bark, and compost. Breaking up clumps, regulating moisture, and ensuring thorough mixing is more time consuming with higher volumes, but it produces a better result. With less than 100 gallons, reaching thermophilic conditions may be difficult, unless the volume of use at the site is high enough that all of the sewage in the catcher is fresh enough to mix with ample bark mulch.

Once the storage containers and catcher have been emptied, the compost bin should be full to within several inches of the top. For slightly smaller quantities of sewage, older compost can be added as an insulating layer around the outside of the bin. The temperature of the pile should always be monitored if possible to make sure it is reaching thermophilic range.

Mixing—After the final addition of raw sewage and bark, turn and mix the material to be composted very thoroughly when starting the compost run. This provides good starting conditions.

The AMC system requires no initial mixing in the compost bin, since sewage is mixed with bark in a mixing bin as it is transferred to the compost bin.

Allow the compost to sit through the first temperature rise, which will probably take about five days. Active aerobic composting will create a rapidly changing environment unfavorable to human pathogens. As oxygen and nutrients in the pile interior are exhausted, the pile will settle slightly. If possible, use a probe thermometer to observe and confirm the temperature rise, peak, and decline.

Turn the pile again when the temperature begins to drop to reinvigorate the compost process. If you do not have a thermometer, turn the pile after five days.

Turning the pile "inside out"—The outer layers of compost will not be exposed to the high temperatures of the interior, and they will need to be switched with the compost in the center. This is called turning the pile inside out. The sides and top layer are heaped into the center as the old center material is built up around them and become the new sides.

Finished Compost - AMC

The following technique works well:

1. Dig a hole in the outer layer to within six inches of the bottom.
2. Heap this compost to one side.
3. Dig an adjacent hole in the center portion of the pile and use this compost to fill the outside hole.
4. Dig a new outside hole to fill the center hole.
5. Continue working around the bin until all the center is moved to the outside. The goal is to turn the entire pile inside out after each composting cycle. Since some mixing of outsides and center compost does occur, repeat inside-out mixing as many times as the run permits.

Six turnings of the compost during a run should be the minimum. The longer the wastes can be decomposed in the bin, the shorter will be the time needed on the drying rack for additional decomposition. A shorter run requires a longer rest on the drying rack for the compost.

Thermophilic conditions—Achieving thermophilic conditions is *not* essential to reducing the volume of waste, but it *is* crucial to pathogen destruction. If thermophilic temperatures are not achieved during a run, or it is uncertain whether they have been achieved, compost should sit on the drying rack at least a year.

The AMC has found that reaching thermophilic conditions is assured at high-use sites where the ample supply of fresh sewage is thoroughly mixed with bark mulch before placing it in the first composting bin. Under those conditions, a separate rack for drying and aging is not necessary.

Two bins permit a variety of strategies to manage large volumes of wastes. A run can start in one bin, while the second is completing a run. And, as in the AMC system, transferring material from bin to bin can simplify turning inside out.

9.6 THE FINISHED PRODUCT

When is compost done? Unfortunately, definitive tests are expensive laboratory procedures, and composting, being a natural process, does not lend itself well to simple field tests. However, a little experience in watching changes in temperature, color, odor and moisture content enables an operator to reliably judge completion of the process.

Heat, competition, aerobiosis, antibiosis, destruction of nutrients, and time are the main agents and mechanisms of pathogen destruction. A well-managed compost pile goes through several heat cycles during a run. The best on-site determination of compost stability is a final drop in temperature after thermophilic conditions have been reached several times.

A final drop in temperature may be difficult to detect, because each run behaves differently. Fortunately, the smell and visual appearance of the compost are excellent indicators of stability and safety.

At the end of a run, the compost should be loose and crumbly, with a uniform texture. There should be no clumps or balls of sewage. The odor should be faintly earthy, indicating the presence of actinomycetes. Its color should be the dark brown-black of rich humus. The compost should be moist, not wet or dry. In general, finished compost looks like rich organic soil mixed with partially decayed bark mulch.

Spreading Finished Compost—Finished and sifted compost can be spread carefully on the forest floor. The top six inches of the soil acts as a dynamic living filter made up of plant roots, decaying plant matter, abundant soil microorganisms, and active invertebrate populations. Nutrients and residual energy-rich compounds in the compost are quickly assimilated into this soil layer during the warmer months.

Because there is always some chance of pathogen survival, select spreading sites and handle compost with caution. Try to avoid nutrient loading of the water table, surface water contamination from runoff, and human contact with spreading sites. Fortunately, bin composting (and aging on a drying rack if conditions require it) normally create stable and safe compost, which, if properly managed and disposed of, presents little environmental stress or hazard to human health.

NOTE: Check with your local Trail club, ATC regional office, and land managing agency to learn of any constraints on disposing of compost. Some states may prohibit surface spreading, so compost must be trench-buried or packed out. GMC has developed plans for a compost incinerator that may make it easier to comply with this kind of restriction. Where permitted, dried compost also can be burned in an open wood fire.

Keep an area map showing compost spreading zones, to enable new operators and volunteers to locate the areas used for spreading.

When you choose an area to spread compost, look for flat ground or a gentle slope with at least one foot of well-drained soil and actively growing herbaceous ground plants. Avoid areas with compacted soil such as old tent sites. Water generally flows off the surface of such sites, which should first be revegetated. Cover with leaves, duff, and branches to initiate recovery.

Be prepared to carry compost well away from the overnight site. Some sites may require carrying the compost for several tenths of a mile for spreading.

Do not spread compost within 500 feet of ponds and streams. Avoid natural drainages, even if they appear dry. They are often indicators of subsurface flow, and they will be wet if it rains. Avoid marshy areas, as groundwater will be near or at the surface. Never spread within 1,000 feet upslope of any drinking water source.

Spread compost only in the summer. Dissolved minerals and residual pathogens are much more likely to be leached into water at other times of year. Try not to spread compost during or immediately before a rainstorm. This will allow extra time for assimilation into the soil.

Spreading compost, like starting a run, is best done with two people, both to facilitate carrying the compost to the spreading site, and to speed the process. Five-gallon grout buckets are good for carrying compost. A 20-gallon can is the largest container two people can carry any distance. It is better to use smaller containers and avoid fatigue, which creates the temptation not to travel far enough.

Feed sacks or coffee bags can also be used, either filled with compost or used as slings carried by two people on each end. However, moving compost with bags is not as clean as transport in a can or bucket.

Set the can or bag with compost on the ground at the edge of the selected spreading area. Scoop up a shovelful at a time and scatter it thinly over the ground to prevent overloading any spot with nutrients. Throwing the compost into the branches of small trees helps scatter it. Do not dump compost, fling a large quantity from the container, or drop shovelfuls on the ground in small heaps. Ensure clean working procedures.

9.7 COMPOSTING RECORDS

Accurate record keeping is important, both to the success of a long term operation and to orienting new operators. Many problems can be easily avoided if information is passed along in a useful manner. In addition to filling out the record forms, each operator should write a report summarizing the operation and problems encountered during the season, and recording the status of compost system at the start of winter.

How to fill out the composting record form—Composting record forms indicate the actions taken regarding the compost bin and drying rack. It is not necessary to record each time you empty the collection container into a storage container, although this can be useful for scheduling visits to composting sites. Record actions such as mixing the wastes in the storage container in the "Comments" column.

1. *Date*—The record form should be filled out only when something is done to the compost bin or drying rack, such as adding sewage or bark, turning and mixing, removing compost, *etc*.
2. *# Visitors*—This should not be a cumulative figure. Record the number of overnight visitors from date to date, including the site attendant(s), if any. Note in the comments the approximate number of day users.
3. *Sewage Input*—This is the volume of raw sewage added to the bin, in gallons or liters. Estimate the quantity by the fullness of the catcher and storage containers. Subtract the volume of bark that you have added to the catcher or storage containers, so you have computed the net volume of raw sewage.
4. *Bark Input*—Again, this is the amount of fresh bark added to the bin, by the operator when a run was begun. Estimate the weight and record in pounds or kilograms.
5. *User-Added Bark*—Record the quantity added by users in the outhouse, and the amount added to the collection container by the operator. This column is totaled up and added to the total bark input column when a run begins. Record it as often as necessary—generally as a bag is used up in the outhouse.
6. *Recycled Compost Input*—Record here the quantity of old compost or recycled chips added to the bin and mixed with the fresh wastes.
7. *Date Full*—This is the date that a run begins. After this, no fresh sewage is added until the completion of the run.
8. *Total Sewage Input*—Add up the number of gallons of new sewage collected since the end of the last run. Do not include mank left in the bin from the previous run.

9. *Total Bark Input*—Add up the pounds of fresh bark added to the bin when the last run was begun plus the pounds of user added bark which have also been added to the catcher. Again, do not consider recycled compost or bark mulch used as bulking agent or mank left over from the last run.

10. *Pile temperature*—If a thermometer is used, record temperatures daily. If no thermometer is used, estimate temperature and record as thermophilic (*thermo*) or mesophilic (*meso*).

11. *Turning Dates*—Record each date the pile is turned during the run.

12. *Date Complete*—This is the date the run is over and the finished compost is transferred out of the bin. Fill the entire line to give a summary of the run. Under "Turning Dates," record the number of turnings. If a second run is begun on the same day, begin a second line to record this new operation.

13. *Compost Transferred to Drying Rack*—Record in gallons or liters the approximate volume of compost which is transferred to the drying rack.

14. *Observations and Comments*—Be as specific as possible. Things to record here include: pile turned and mixed; pile moisture, color, and odor; temperature status; amount of old compost added to the process; problems encountered; presence of fungi or actinomycetes; presence of invertebrates; status of compost on the drying rack; information on spreading compost (where, how much—an area map is helpful), *etc.*

9.8 SPRING START-UP PROCEDURES

Before the hiking season begins, the project leader should visit each site with field personnel or volunteers to empty the catcher and plan for the composting season.

Generally, all that is needed on the first visit, if the storage containers were left empty the previous fall, is to empty the catcher and scour the site for wastes deposited on the snow by thoughtless winter users. Use the red-handled shovel to add this waste to the storage container.

Take antibacterial soap and a wash jug with you on the first trip, because there may be none at the site.

Typical problems to be dealt with in the spring may include a large amount of accumulated wastes to be composted; fecal wastes from snow holes on the snow and the ground; and the bin lid knocked off during the winter, letting water into the bin.

Securely fastened lids should stay on bins. However, they can still be knocked off by falling trees, and determined vandals can defeat any fastening system, so it is best not to leave material in composting bins over the winter.

You may find a soupy mess if storage container lids were knocked off during the winter, or the storage containers were knocked over. You may find bark burned or thrown in the snow over the winter, trash in the storage container or collection container, and so forth.

Review the records and the report of the previous operator for existing problems. Look for new problems. Develop a waste handling and management timetable with the individual operators.

The plan of action for each site should address:

- *The catcher*: Does it need to be emptied immediately? (It generally does in the spring.) Does it need replacement? When? *Etc.*
- *The compost bin*: Is it full? (It is best to leave it empty the preceding fall.) Is compost ready for transfer to the storage platform? Does it need more wastes before starting a run? Does it need bark? Turning? *Etc.*

- *The storage containers*: Are they full? When will they be full? Do they need replacement? When? *Etc.*
- *The drying rack*: When will space on the rack be needed? Is compost ready for sifting? Does it need new siding, bottom boards, roof? *Etc.*
- Evaluate all other components of the composting system, including shovels, other tools, plastic wash jug, antibacterial soap, probe thermometer.

An example of a spring action plan might be:

- Spread last year's compost from half of the storage platform
- Repair platform
- Turn and mix remaining compost on the drying rack for further aging
- Begin a run with the new wastes

Plan a follow-up visit by the project leader, particularly for first-year compost operators. Problems at the site may require immediate attention.

Overwintered compost from a drying rack can be recycled into the catcher and compost bin to minimize bark use. Turn and aerate it directly on the drying rack with the green fork to speed aging. Remember that compost absorbs less moisture than fresh ground hardwood bark.

Evaluate and anticipate compost accumulation on the drying rack, and plan a spreading schedule. Rapid plant growth and actively growing ground microbes and soil flora and fauna create optimum spreading conditions in midsummer. Plan ahead.

In the Northeast, mud season is generally a month of low waste accumulation, so try to get as far ahead as possible. If large volumes of waste are anticipated at a mediumto high-use site, try to run the previous winter's waste with enough new sewage to have a four-week run done by the July 4 weekend.

Use June to get a few extra bags of bark on site. Stay several bags ahead at all times, so extra bark will be on site at the end of the season for the next year.

Never panic; just get the job done.

9.9 END-OF-THE-SEASON PROCEDURES

Because the AMC system uses two to three bins, one will be available to start composting in the spring, or as a repository for sewage if the catcher fills during the winter, even if the other bin has been left full during the winter. Freezing of the comparatively dry compost does not damage composting bins. However, with any system it is best to leave all bins empty during the winter. Otherwise, users of the site are apt to find a way to remove lids, allowing a nicely finished bin of compost to become waterlogged and mixed with trash. The bins are covered with watertight lids tied in place. The drying screen is left empty, with the tarp flat on the screen and held in place with rocks.

In the GMC system, schedule your last run of the season so the compost bin can be emptied before winter starts.

Leave the catcher empty to allow for late fall and winter accumulation. Disconnect the beyond-the-bin or other liquid separation system if one is present before temperatures fall below freezing.

Late fall is not a good time to spread compost. Leave it on the drying rack or screen— or the second bin in the AMC system—until the next summer.

In the GMC system, provide space on the drying rack to accept compost from a fall run, so the compost bin will be empty (except for the mank layer) through the winter. To do that, spread compost from the rack as early in the fall as possible, but no later than mid-September. Compost stored over the winter on a rack is generally ready for spreading or recycling as early as mid-June if it is turned several times.

Outhouses, particularly those depending on composting, benefit from attention in winter, unless there is no winter use. Regular visits to batch-bin composter sites in the winter are desirable. Solicit shelter adopters or other volunteers to check the storage containers, shovel snow from the outhouse door and the rear access door, and empty the catcher if it fills. Often former caretakers will be willing to do this, and some hikers also may be willing. Demonstrate procedures to volunteers in the fall, and post signs at the outhouse with instructions.

In the GMC system, at least one of the storage containers should be left empty. That will allow the catcher to be emptied in the fall, winter and spring.

Leave several bags of bark on site, under cover if possible. The GMC has found six bags is the ideal amount to get things rolling in the spring: two for use in the outhouse by hikers, and four for use in starting the first run of the next season. There is enough to do in the spring without having to pack in six bags of bark to deal with winter wastes.

A brief report should be added to the compost records and sent to the shelter adopter, if there is one, and to the maintaining club. Point out problems encountered, how they were dealt with, and what to expect. Evaluate all parts of the batch-bin system.

Secure the compost-bin lid with rope and stakes or with several heavy rocks. If the area is subject to high winter use, consider placing hooks on the lid or locking it down with carriage bolts to keep the curious and litterbugs from peeking inside. GMC has learned that secure fastening of lids is vital. Looking for the dumpster they have been hoping to find all along the Trail, hikers often do not realize what is in the bin, despite signage. When they finally pry the lid off, they are horrified by the contents and leave without replacing the lid. Then the bin fills with contaminated water which must be bailed in the spring and carefully dumped in a sump hole away from water, facilities and trails.

Be sure the roof on the drying rack is intact and secure. Scan the area for dead trees that could fall on the composting operations and outhouse, and, if necessary, remove them.

Store composting tools where they may be easily retrieved: hanging from trees near the drying rack and outhouse, unless experience indicates they must be in a secure locker. Record where the tools are stored. Bring the thermometer indoors for the winter.

9.10 WINTER OPERATING PROCEDURE (USUALLY OPTIONAL)

Winter is a time of suspended decomposition. Human fecal waste in pit privies, catchers, and storage containers breaks down extremely slowly, if at all. No composting is done in winter, but if a site receives heavy winter use, a midwinter emptying of the catcher may be necessary.

GMC and AMC have found that their new 70-gallon catchers do not overflow during winter if they are emptied in late fall, so their sites no longer need winter visits. If a site has such high winter use that a 70-gallon catcher is overwhelmed, winter attention will be necessary, unless it is possible to convert to an even larger catcher.

When checking shelters or campsites used in the winter, check for defecation on the snow and in snow holes near or above the water supply, and shovel any feces found into a storage container. Make sure the outhouse door is free of snow and ice and that the catcher has not overflowed, driving people outside. Make sure there is enough bark in the outhouse.

Wastes left on top of snow are partially broken down by weathering and sunlight, but wastes left in deep snow holes will emerge in late spring. When the snow melts, human wastes may directly enter surface water. Spring runoff contamination potential is highest at overnight shelters next to water.

For emptying the catcher in winter, you need old leather work mittens, a snow shovel, a one-quart tin can, soap, and a small camping stove. The can, soap, and stove are for hand washing (a Thermos of hot water can be substituted for the stove). Find the composting tools, both red and green. They should be hanging on trees near the drying rack and the outhouse. Check the records before you start.

Shovel a path to the outhouse, shovel out the outhouse, and shovel a path to the storage containers. Check the storage containers to see whether they will hold more waste. If not, check the bin to see if wastes can be placed directly in the bin. This is a last resort, because it complicates emptying the bin and starting a run early the next season.

Keep your Nitrile gloves and antiseptic handwash inside your jacket until needed to prevent freezing.

Remove the catcher from the outhouse, being careful not to twist it or bend it. If urine has run down the front, the catcher may be frozen in. If so, use the tip of the red shovel to pry it up. Several sharp blows with a board to the gap between catcher and outhouse will generally free it. Be careful: Plastic breaks easily when very cold. Hot water can be used to melt the troublesome ice, if you can make enough of it.

Check to be sure the bottom of the catcher is intact. (If it is not, transfer all accumulated waste to a storage container. Leakage should be mopped up with bark mulch and also placed in a storage container. Use a five-gallon bucket as a temporary substitute catcher, and plan to replace the catcher immediately. Place the old catcher in a secluded spot in the woods to weather for a year before packing it out.)

Place the catcher next to the storage containers. Transfer the waste to the storage containers. If the material is not entirely frozen, it can be shoveled directly into the storage container. Otherwise, use the red shovel (not the fork) to shave the wastes, one thin layer at a time. This generally works well, but it is time consuming (one-and-a-half to two hours for 70 gallons of waste). Sometimes, if plenty of bark was left in the bottom of the catcher, the block of waste will slip right out.

Pick up any shavings or chips of waste from the snow with the red shovel, and put them in the storage container. Secure the covers of the storage containers to keep trash from being deposited in them.

Replace the catcher in the outhouse, taking care to line it up properly. Usually it should be as far forward as possible, to keep urine from running over the front edge and freezing the catcher to the outhouse. Close the rear door securely. Loosen the bark in the container in the outhouse, and line the bottom of the catcher with three inches of bark to absorb liquid and reduce odor.

Replace the red shovel. Wash up. Record data in the record book. Post new signs if needed.

10 Liquid Separation in Composting Systems (AMC's Beyond-the-Bin System)

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Sally Manikian, *Staff, Appalachian Mountain Club*

Pete Antos-Ketcham, *Staff, Green Mountain Club*

10.1 When to Use a Beyond-the-Bin-System

One of the biggest drawbacks to a conventional batch-bin composting system is the challenge of transporting bark mulch to a backcountry location. Backpacking, helicopters, and pack stock involve labor and expense that rise to formidable levels at remote sites that encounter high use.

The beyond-the-bin (BTB) system was developed by the Appalachian Mountain Club in 1995 to reduce the amount of hardwood bark being flown or packed to its fourteen remote backcountry campsites, all of which use composting toilets. Those sites collectively average more than 15,000 users per year. Two BTB systems were installed in 1995, four in 1996, four in 1997, two in 1998, and one in 2007 for a total of thirteen. The remaining site sees comparatively low use and does not warrant the conversion.

With thirteen sites using the BTB system there has been a reduction in bark consumption of 30 to 35 percent. In 2011, the AMC shelter program airlifted more than 300 fifty-pound bags of bark. Some sites use more than 30 bags per season. Without the BTB system, demand for bark would have been more than 600 bags (15 tons), with the most popular sites needing more than 60 bags. The Bell Jet Ranger helicopter used for airlifting carries 800 pounds and costs well over a thousand dollars an hour.. Saving more than 200 bags of bark has significantly reduced airlift costs, and has also reduced noise and visual impact on backcountry visitors.

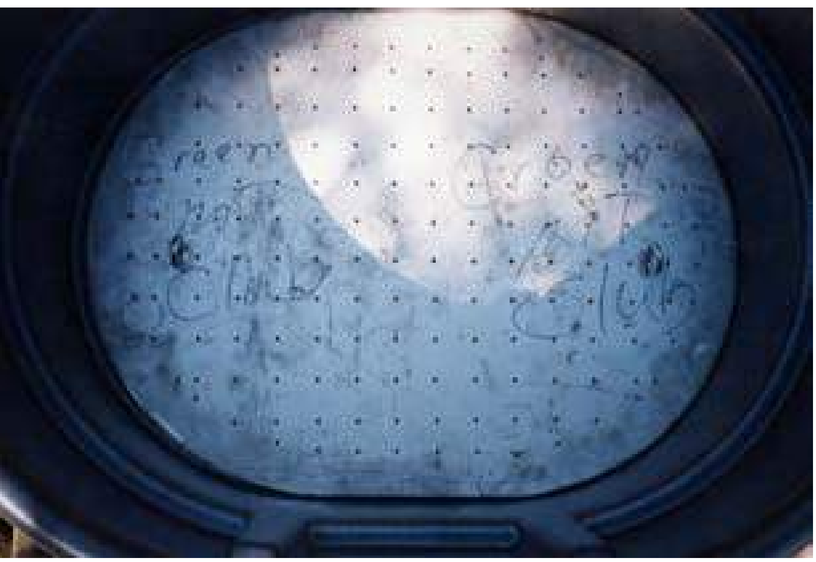
10.2 Overview

Traditional batch-bin composting systems collect urine and feces in a collector vessel, or catcher, under the outhouse seat. In the BTB system, a sturdy strainer plate is installed in the collector as a false bottom, so solids remain on top and liquids pass through the strainer. A fitting and drain hose at the bottom of the chamber below the strainer carry the effluent to a filter barrel filled with anthracite coal and septic stone, where it is treated safely and dispersed into the soil through perforations (see Figure 10.x). This substantially reduces the amount of liquid in the collector.

The ideal moisture content for composting is around 60 percent. Coincidentally, the average moisture content of human fecal matter is 60 to 70 percent. But urine raises the moisture content, so additional bark is needed to absorb the liquid.

In addition, the ideal carbon-to-nitrogen ratio (C:N ratio) for composting is thirty parts carbon to one part nitrogen by weight, or 30:1. Fecal matter has a C:N ratio of about 8:1, and hardwood bark has a C:N ratio of about 150:1. When mixed in the ratio of about two parts bark to one part waste, the desired C:N ratio of 30:1 is achieved. However, excessive urine raises the nitrogen ratio, so that more bark, with its higher carbon ratio, is needed to offset the urine's higher nitrogen level. Traditional batch bin composters generally require three parts bark to one part waste to achieve the desired 30:1 C:N ratio.

Signs and on-site managers asking users not to urinate in the outhouse help achieve some reduction in the amount of urine. Even then, however, human biology and anatomy, combined with the preference of some users to urinate in private, inevitably add some urine to the catcher, especially in high-use areas.



Strain Plate

Filter Barrel

10.3 BENEFITS AND DRAWBACKS

Additional benefits—The beyond-the-bin system has benefits beyond conserving bark. Handling raw sewage is inherently unpleasant and risky, and excessive liquid makes it much worse. Removing liquid lessens spillage, reducing risk to both the operator and the environment.

Another advantage is improved recycling of mulch. The BTB system creates drier compost, so less bark decomposes and more is recovered by sifting.

Separating liquid also reduces odors. Most offensive odors are due to ammonia and other products of anaerobic decomposition, especially when urine is mixed with feces. The BTB systems have a slightly musty odor that is not nearly as offensive as pit privies or the occasional catcher in traditional bin-composting systems. This encourages hikers and campers to use the outhouse rather than the forest floor as long as the toilet seat, hopper, and outhouse floor are kept clean.

Installing a BTB system is not complicated, requiring only basic carpentry and plumbing skills. Fortunately, the slight slope needed to make liquids flow downhill is usually available with little or no modification to the landscape. Since the system is driven by gravity, only the plumbing parts require routine maintenance and repair.

Unless the compost in a traditional composter has the perfect water content, which is not often the case, the bottom of the bin accumulates a layer of wet, non-composted sewage with a distinctive odor that operators call "mank." After the compost layer above is removed, bark is mixed with this layer to absorb the liquid and restart proper composting. Mank seems to accumulate because liquids settle through the pile, and it is virtually eliminated in the beyond-the-bin system.

Drawbacks—The moderately higher initial investment is the biggest drawback to the BTB system. It requires a collection tank, strainer plate, plumbing parts, and filtration system. However, the savings in labor and mulch transport soon offset these expenses.

BTB Barrel

Barrel Opened - Splash Rock

If funds are limited, the system can be set up in stages. The strainer, plumbing, and filtration system can be installed later in a batch-bin composting system as long as clearance for the collection tank is provided in the initial construction, and a 70-gallon Rubbermaid catcher is installed.

One other drawback is that the compost may be harder to mix. When solids and liquids are combined, the liquid helps soften the solids, sometimes even dissolving them completely. In the BTB system, clumps of sewage tend to stay bonded, so breaking down solids is more laborious, and diligence and attention to detail are required to properly mix the material. However, the compost pile requires fewer turnings. Therefore, the total work of turning the pile is about the same for the two systems.

GMC has had issues at some medium use sites with the sewage bark mixture in the collector/catcher under the seat drying out and becoming extremely difficult to break apart and homogenize. Small amounts of water can always be added to soften the waste mixture prior to mixing. Additionally, the BTB unit can be disconnected and stored and then reconnected if use levels and types of use increase. Before deciding to use a BTB system make sure your backcountry site has the volume and type of use necessary for effective operation.

The BTB system has slightly higher visual impact because of the drain pipe and filter barrel, but careful design and attention to detail during construction can help. Pipes can be buried or routed through brush. The filter barrel can be almost completely buried, since only the cover need be accessible for monitoring and periodic replacement of the filter medium.

Special Considerations—A sturdy, portable, intermediate mixing container is a useful component in the beyond-the-bin system for proper mixing of sewage and bark. In traditional batch-bin composters, sewage is usually mixed in the compost bin. Since extra effort is needed to break up sewage balls and clumps in a BTB system, the mixing container must be strong to withstand vigorous shovel and pitchfork handling. Stainless steel and thick plastic containers work well and there may also be other possibilities.

As with most compost systems (the moldering privy is an exception), dry bark is vital. Thorough drying before bagging and dry storage on site are crucial. Store your dry bark in synthetic feed bags lined with plastic bags under a tarp.

The filtration system should be disconnected after the final compost run of the season to prevent freezing and splitting the drain pipe in winter. A quick-disconnect fitting on the pipe simplifies this.

After 19 years of use in the White Mountains, the system parts have required no repair, but pipe fittings have required annual tightening.

Filter materials may eventually need replacement. AMC tested its systems after five years, and the tested effluent from the first system met the standards required for backcountry dispersal.

10.4 DRYING THE END PRODUCT

Screens dry and sift the finished product. Raised four-foot by eight-foot screens made of half-inch by #18 expanded stainless steel or galvanized metal are mounted on a frame of pressure-treated 2- by4-inch lumber. Compost is spread on the screens from the second compost bin and allowed to dry for several days. Next, the material is sifted using shovel, spading fork, or gloved hand, so the fine humus falls through the screen and intact bark stays on top.

The humus is gathered in buckets or feed bags and carried away from the campsite for dispersal and broadcast on the forest floor. Bark remaining on the screen is allowed to dry further, and then bagged in plastic-lined feed bags to be re-used in subsequent compost runs. (Do not put recycled bark in the outhouse; use only new, clean bark there.) The drying screens are covered with tarps nightly and during inclement weather. The tarp is supported by a raised ridgepole of 2- by 4-inch lumber.

Screens increase the reusability of bark significantly, further reducing the need to transport more bark to remote sites.

BTB Strain Plate

Strain plate primed with bark mulch

10.5 INSTALLATION

Three or four people can install a BTB system in a couple of days. A brief description of the installation process follows. More detailed instructions are available from AMC (see appendix for contact information).

Elevation Change—First, determine whether your site has adequate slope for a gravity-fed filter system; it must be at least 1/8 inch per foot, though a steeper angle is better. If necessary, the outhouse base and collector support rails can be raised to gain elevation.

Rails for sliding out catcher - AMC

Size of collector housing—AMC uses 70-gallon catchers in its privies to accommodate a high volume of visitors. Some of its sites in the White Mountains of New Hampshire average twenty visitors per night, with peak nights having more than sixty. The catcher is 24 inches tall, and weighs more than 550 pounds when full, so it requires a substantial housing. Our outhouse bases sit on a foundation of pressure-treated 6- by 6-inch lumber. The catcher sits on a pair of rails of pressure-treated 4- by 4-inch lumber for easy extraction through the access hatch. If the BTB system is to be installed in an existing composting system, outhouses can be retrofitted, or a collection unit with a lower height might be adapted or modified.

Strain Plate Removed

We have designed a base to fit a standard four- by four-foot outhouse supported by timbers of 6- by 6-inch lumber stacked in five or six layers and secured with hundred-penny nails. All lumber can be cut in the frontcountry and then transported to the site. The timbers are best cut with a sharp chain saw by a skilled sawyer.

Plumbing parts are readily available, and some preassembly can be done in the shop to ensure all pieces are accounted for and fit together. The filter barrel perforation holes are also best drilled before transporting to the backcountry, although they can be drilled on site with a cordless drill. Approximately 75–100 pounds of septic stone is required, along with five or six 50-pound bags of fine grade anthracite coal. These materials are widely available.

The majority of the installation time and effort will go into building the outhouse and its base.

Distance from Water—The filter should be at least 100 feet from any pond, lake, or stream, and more is better. If this is not possible, install a second barrel connected by a hose to the filter barrel (which must not be perforated) to collect liquids, which can be pumped or bailed for disposal in a better spot. Use sturdy capped jugs to carry the filtered effluent.

Regulations—Local and/or state authorities may call for specific designs for final distribution of liquid effluent, however, that should not be required for a BTB system. It is important to remember the very small flow being treated. Most authorities are accustomed to flows in the hundreds of gallons per day generated by conventional flush systems, not the quarts per day from a waterless composting system. Be sure to clearly explain this fact and to describe the BTB system as a vast improvement over the pit privy being replaced.

10.6 CONCLUSION

The beyond-the-bin composting system is a substantial improvement over a conventional batch-bin composter, especially in high-use areas. The moderate initial financial investment will be quickly repaid through reduced bark transportation, higher quality end product, less odor, and a safer and more pleasant experience for composting personnel.

PART 4

Installations

Moldering Privy with Accessible Ramp- A.T. Connecticut

11 Case Studies

11.1 Moldering Privy on the Grafton Loop Trail in Maine

Sally Manikian, *Staff, Appalachian Mountain Club.*

AMC maintains four low-use and very primitive sites on the Grafton Loop Trail (GLT) in Maine. The GLT, built from 2001–2008, is a trail designed as backpacking loop only, with no side access trails aside from where the trail overlaps with the A.T. across Old Speck Mountain and the Baldpates. The campsites have either two platforms or three to four smaller tent pads, a cook area, bearbox, and a moldering privy.

The moldering privy technique is a good fit for these campsites for three reasons. The primary one is use. The use is very low, and there is not as pressing a need to compost as quickly as at the high-volume AMC backcountry campsites elsewhere in Maine and New Hampshire. The second reason concerns the natural resources itself. The moldering privy, compared to the pit toilet, is a safe composting option that ensures full breakdown and minimal impact to the soil and surrounding area. The third reason regards the resources required to maintain the privy, in terms of physical and staff resources. The moldering privy does not require dependency on an airlift, unlike other AMC backcountry toilet systems. The moldering privy requires minimal annual maintenance from summer seasonal staff. In the AMC backcountry campsite program, the GLT campsites fall under the purview of the Mahoosuc rover, already responsible for four higher-use campsites in the Mahoosucs in New Hampshire and Maine. The rover visits those sites once or twice a year.

The four GLT privies vary modestly in the actual outhouse design (dutch doors, latchstrings, steps that can be moved by removing a few bolts), but the basic concept is the same as moldering privies explained elsewhere in this manual. A basic four by four outhouse, with plastic Romtec toilet riser, sits on top of a framed double-chamber. The sides of the frame, including the wall that divides the two chambers, are formed of 2 by4 vertical timbers holding in place hardware cloth, allowing for ventilation. The pile sits directly on the ground. The two chambers are accessed by a hinged door on either end.

AMC provides planer shavings for the user to add. Planer shavings are light to carry, free from our construction and maintenance shop, and add carbon which assists in breakdown. The GLT sites use one bag of shavings roughly every two years. When the rover visits the site annually, the pile is stirred and mounded. Since the GLT privies vary in age from six years to one year, we have not had to move one of the outhouses to the second chamber yet, while we anticipate we will in the next two years. In the oldest pile (roughly six years) the majority of the pile has turned into humus. The level of use indicates that the pile will have 12 to 16 years to compost from its first deposit to 6 to 8 years for its most recent deposit.

The GLT sites, due to low use, have not seen complications to composting caused by excess urine. While it is still early in the life-cycle of the moldering privies on the GLT, based off use thus far and the success of the moldering privy elsewhere on the Appalachian Trail, the AMC has been very pleased with the decision to use the moldering privy on the GLT.

11.2 Airlift Haul-Out Systems at the AMC in New Hampshire

Eric Pedersen, *former Staff, Appalachian Mountain Club*

The Appalachian Mountain Club (AMC) uses helicopters to airlift out solid waste produced from our composting and direct deposit toilets. AMC's eight huts, spaced about a day's hike apart, are located near or above timberline, where there is little or no soil. The White

Mountains have such a severe climate that they have pockets of permafrost and have recorded the world's highest surface-wind velocity. The staffed and fully enclosed huts provide meals and bunkroom-style shelter for 36 to 90 people.

Because the huts see a very high concentrated use along with a short season of warm temperatures, the level of solid-waste composting is not at the same level that you would see in lower elevations that have more regular use. With conditions not being ideal in the huts for composting, the solid waste that is produced is shoveled into 55-gallon barrels and airlifted out every year. On average, each hut produces eight to ten barrels of solid waste that is airlifted out and treated at a local sewage treatment plant for a fee.

Maintenance includes buying and retrofitting suitable barrels and buying equipment for safe removal of barrels. A good relationship with a local treatment facility is essential. It is important to keep seasonal vegetation trimmed in the area to facilitate the loading and storage of waste barrels and for safe airlift operations. The ground must be kept level to prevent barrels from falling over.

11.3 DIRECT DEPOSIT SYSTEMS AT THE AMC HIGH MOUNTAIN HUTS IN NEW HAMPSHIRE

Eric Pedersen, *former Staff, Appalachian Mountain Club*

The Lakes of the Clouds Hut (in 2005) and the Madison Spring Hut (in 2011) were changed from a flush toilet system to a direct deposit system. This change eliminated the use of water to transport waste to the septic system and greatly reduced the amount of liquid that needs to be treated. Because both huts are above timberline, have a very short composting season, and see a great amount of use, we decided to use a simple system that separates liquids from solids but does not provide any active composting. The system uses large stainless-steel bins located under the toilets that collect solid waste and filter liquids through pipes in the bottom of the bins. The liquids travel through similar septic systems that the other huts have, and all solid waste is shoveled into 55-gallon barrels and airlifted out.

For all systems, cleanliness of the toilet area and the rest of the system, and diligence in maintenance, are essential. Every day, the caretaker cleans the system and walks the entire line to ensure function and integrity. Annual maintenance by our construction crew includes periodic changing of the septic field leaching materials (we typically change an inch or two of filter material each year) and close monitoring of every component, including the amount of water used and the quality of the discharge.

Solids also must be shoveled from the septic tank at the start of each season and once midway through the season, for removal and disposal at a sewage treatment plant.

11.4 THE APPALACHIAN MOUNTAIN CLUB CLIVUS MULTRUM COMPOSTING TOILET IN NEW HAMPSHIRE

Eric Pedersen, *former Staff, Appalachian Mountain Club*

The Appalachian Mountain Club (AMC) has increasingly relied on Clivus Multrum technology in recent years to provide sanitation at our high-elevation huts in the White Mountains of New Hampshire. The eight huts, spaced about

AMC's Madison Springs Hut utilizes a dewatering system a day's hike apart, are located near or above timberline, where there is little or no soil. The White Mountains have such a severe climate that they have pockets of permafrost and have recorded the world's highest surface wind velocity. The staffed and fully enclosed huts provide meals and bunkroom-style shelter.

Since 1997, we have installed Clivus Multrum continuous composting toilets at Carter Notch, Mizpah Spring, Zealand, Galehead, Greenleaf, and Lonesome Lake Huts with great success. The success of this innovative technology at backcountry locations serving 36 to 60 guests per night is promising for applications in the frontcountry as well.

Construction costs varied, depending on the size of the system and whether it could be installed in an existing structure. Costs ranged from $60,000 at Carter Notch, Galehead, and Lonesome Lake (for four toilets at each hut), to $85,000 at Mizpah Spring (for six toilets). Though there is significant investment upfront, we have found these systems cheapest to operate at high-use sites in the long run.

In ideal conditions, the waste mass is similar to a garden compost pile. The chambers are sized so that waste is mostly composted in the two or more years it takes to appear in the lower hatch. In ideal conditions, the end-product can be reduced to only five percent of its original volume, has the odor, appearance, and bacterial content of topsoil. See the schematic of our Clivus in the Appendix.

The vent on the composter, assisted by a solar-powered electric fan, creates a draft that pulls air into the compost, up the air ducts, throughout the waste pile, and out the stack. Oxygen in the air reaches the middle of the pile and supports the slow decomposition process and the treatment of the liquids. Air is also drawn down the fixtures, especially when a toilet is opened. That oxygen supports the rapid breakdown that takes place at the surface of the pile. The downdraft also prevents odors from entering the toilet room.

The caretaker sprinkles planer chips (produced as a byproduct by mills that plane lumber) on top of the pile each day, and turns the pile periodically. That adds bulk, surface, and keeps the pile "fluffy" so aerobic organisms will grow. Once a month in the summer, our construction crew adds a commercially produced "bacterium" solution. That is intended to help the naturally growing soil bacteria, mold, and other organisms thrive. The organisms consume the waste and produce mostly carbon dioxide (CO_2) and water vapor, which is carried away by the draft.

Liquid that appears in the sump reached by the lower hatch has changed biochemically to a stable fertilizer and salt solution. All remaining liquid that is separated from the solids is filtered through a system of septic tanks, dosers, and leach fields. The initial septic tank separates any additional solids from the liquids and is connected to an automatic doser that equally distributes all liquids evenly across the leach field. When the appropriate water level is reached in the tank, the doser dumps the contents of the tank onto the leach field.

Our first leach fields were filled with sand, but new ones use black anthracite coal flakes instead. The grains of coal are more uniform in size and offer more surface area per grain, and coal is much lighter to airlift in to the location. The wastewater is sprayed on the top of the field, and as the water settles through the filtering medium, the remaining solids are removed. Pick-up pipes in the bottom of the leach field gather the filtered, treated water and carry it on down the system. Bacterial decomposition is active and important here also.

The final disposal system, which discharges the treated water, varies system by system. Some use plain perforated pipe; others use a chlorinator, doser (manual or automatic), and perforated pipe to disperse the liquid into the soil

From the user's point of view, the Clivus works just like an outhouse. However, the continuous flow of air can sometimes dry the surface of the pile, so there is a danger of fire from a match or cigarette dropped into the compost chamber. Also, people may be tempted to use the toilet to dispose of garbage instead of carrying it out. Signage and the diligence of staff help avoid those problems. We have also found the unit must be cleaned daily to ensure guest satisfaction as well as proper functioning of the system.

11.5 RANDOLPH MOUNTAIN CLUB COMPOSTING TOILET SYSTEM IN NEW HAMPSHIRE – RETROFITTING A LARGE CONTINOUS COMPOSTER TO A BATCH BIN SYSTEM

Sally Manikian, *Appalachian Mountain Club Staff, former Caretaker and Board Member, Randolph Mountain Club*

Pete Antos-Ketcham, *Green Mountain Club Staff , former Caretaker, and current Board Member, Randolph Mountain Club*

About the Randolph Mountain Club—Founded in 1910, the Randolph Mountain Club (RMC) maintains a network of 100 miles of hiking trails (including 2.2 miles of the A.T.) and four shelters on the northern slopes of the Presidential Range on the White Mountain National Forest in New Hampshire and on the Crescent Range in the town of Randolph, New Hampshire. The club has approximately 500 members, and is managed by an active volunteer board of directors. The RMC is funded by dues and donations from members, cost-challenge trails contracts with the U.S. Forest Service, and other state and local grants.

RMC's four shelters consist of two cabins near treeline on Mount Adams: Crag Camp, with a capacity of twenty, and Gray Knob, with a capacity of ten. There are also two Adirondack-style shelters, The Perch and The Log Cabin, each with a capacity of ten. Overnight fees, $7 at the shelters and $13 at the cabins, are set to cover the basic operating expenses of the cabins. The RMC is dedicated to keeping fees as lowas possible.

Two caretakers, based at Gray Knob and Crag Camp, manage the four shelters during the summer. During the rest of the year, one caretaker is in residence at Gray Knob. The club also has two trail crews, which perform basic maintenance and erosion control projects. In the summer, a field supervisor oversees the caretakers and trail crews, and acts as a liaison to the board of directors.

History of RMC Sanitation Efforts

RMC has used several techniques to dispose of human waste. Pit toilets were used at all camps until visitation began to rise in the 1980s. In 1977, the club had 2,272 visitors among its camps. By 1995, that number had more than doubled to 4,923.

Log Cabin Privy

Perch Composting Set Up

Turning Compost at the Perch

Sifting finished compost

A thermophilic batch composting system, based on methods tested and used at several Appalachian Mountain Club (AMC) and Green Mountain Club (GMC) sites, was adopted at Crag Camp in the early 1980s. It was satisfactory for a few years, but required well-trained labor and a large volume of wood chips. As a volunteer organization, the RMC had difficulty maintaining the level of experience and could not absorb the cost of airlifting bark. Visitors were asked to not urinate in the toilet, but instead to use the nearby woods. During the '80s, as Crag Camp became increasingly popular year-round, the system was eventually overwhelmed.

At Gray Knob, a dehydrating toilet had been installed in the mid-1980s, replacing a pit toilet. The toilet dehydrated solids while draining untreated blackwater onto the soil surface. Within a few years, however, the toilet was nearing its capacity, the system was not adequately dehydrating the solids, and the toilet was serving only as a collection and storage system. Thus, the RMC faced the prospect of routinely flying out untreated solids, which would prove expensive and intrusive. Therefore, the RMC decided a new toilet system was required at Gray Knob.

Evaluation of options—Beginning in 1994, RMC undertook a study of all available waste-management options for its facilities. RMC's study was headed by Paul Lachapelle, then a caretaker for the club; options included flying out raw waste *via* helicopter, continuing direct burial, propane-fired systems, and thermophilic or mesophilic composters.

The club faced a major challenge: to effectively and affordably manage increasing volumes of human waste throughout the year, with minimal skilled supervision and intrusion in the wilderness in a notoriously harsh environment. RMC settled on a continuous-composting toilet to manage waste on-site because it would eliminate costly and intrusive helicopter flights and the transport of the large amounts of wood chips required for a batch-composting system.

RMC decided to install a continuous-composting toilet manufactured by Bio-Sun Systems of Millerton, Pennsylvania. Although there are numerous commercial composting toilet manufacturers, this model was chosen for several reasons: First, it has a large access door to facilitate maintenance of the pile. Second, more air contacts the waste surface, since the waste is suspended on a perforated liner, and air can circulate below the waste pile as well as above. Lastly, its one-piece tank is made with 5/16-inch rib-reinforced, high-density polyethylene, so it is extremely sturdy. The volume of the tank is 1,000 gallons, or 130 cubic feet. The toilet seat is directly above the sealed tank. A fan powered by a solar panel in an exhaust vent draws air through the system. During construction, RMC stained the box around the tank black, in order to increase heat absorption. A thermometer mounted in the tank monitors the ambient air temperature, and another thermometer in the waste pile records temperatures there.

Installation and initial modifications of the Bio-Sun toilets—The Crag Camp Bio-Sun toilet was installed in 1995. Two other Bio-Suns, at The Perch and Gray Knob, were added over the ensuing three years. The average cost of the units, including materials, construction, helicopter time, and installation, was $12,000. Funding came primarily from RMC member dues, donations, and overnight fees collected at the facilities. Generous grants from the Appalachian Trail Conservancy, the Davis Conservation Foundation, and the Reavis Foundation enabled RMC to bridge a financial gap, and complete the projects.

During the first year with the Crag Camp Bio-Sun, liquid levels slowly began to climb in the composter. RMC installed several high-tech solutions to reduce liquid accumulation, including a "Vapor Core" system, in which a solar-powered motor spun an impeller that created droplets that could be vaporized in the exhaust stack. The system worked when installed, but was almost immediately plagued with breakdowns in the harsh mountain environment and subsequently abandoned.

Due to the consequent liquid accumulation, there was minimal aerobic composting, and anaerobic conditions led to increased odors. The following summer, RMC added a "beyond-the-bin" liquid treatment system, in which liquids flow out of the composter into a 55-gallon plastic drum, where they are filtered through alternating layers of activated charcoal and gravel. The liquid problem was improved. Beyond-the-bin systems were incorporated into the design of the Bio-Sun toilets when they were subsequently installed at the Perch in 1996 and at Gray Knob in 1997.

In 1999, RMC added a galvanized-screen drying rack to the process. The rack enabled caretakers to isolate the end product. In 2000, drying racks were added to the Bio-Suns at The Perch and Gray Knob. The design for the racks was taken from the AMC shelter program. Older, composted material was removed from the bin and spread out on the rack for two to three weeks, depending on the weather. It is then buried in the woods, 200 feet or more from the cabin.

NOTE: *Many state regulations require burial of finished compost at a depth that varies from state to state, so check with your regional ATC office and state agency. Most rules say the material must be buried under six to twelve inches of soil in a dry, well-drained area at least 500 feet from campsites, shelters, trails, and water supplies.*

Because the pathogen content of finished product is seldom checked in the field, it is always possible that some pathogens survive composting. Therefore, all necessary precautions should be taken when returning compost to the environment. When selecting a site for burial, always consider all potential contamination avenues, including water, trails, and animal transport to water or shelters.

Current Status of RMC Systems: The Bio Sun 15 years later

In the 15 years since their installation, this high-capacity, continuous composting style system has not worked as was hoped, and this is evident in a series of retrofits that ultimately led to the overall conversion to the batch-bin system.

As was noted above, due to excessive liquid build up, the first retrofit included a beyond-the-bin filtration system in 1998–2000. Second, the RMC built drying racks to further the drying process of finished end product. Third, the solar fans became unreliable and impossible to repair with overturning volunteers so their use was discontinued. Fourth, the RMC added smaller composting bins (75 gallons) at all sites to even further aid in breaking down of waste. While helpful, none of these modifications added up to a completely workable system.

The reason why a large continuous composting system failed to work for the RMC is primarily the environment. Gray Knob, for example, is north facing, is in the fog 270 days out of the year, averages 47 degrees Fahrenheit, and sees peak use in January and February. The result was a giant frozen waste pile that failed to break down in a typical short composting season (June to September). The units do not have significant enough housing around them to protect them from the elements, nor do they have ready access to heat and electricity needed to facilitate composting such large volumes of waste under these conditions.

In 2006, the RMC replaced the Log Cabin pit toilet with a beyond-the-bin batch composting system styled after GMC and AMC systems.

In 2009, the RMC began a multiyear project to streamline and retrofit the three Bio-Sun toilets wholly to the batch-bin technique. Drawing on the experience of the AMC and the GMC, the RMC system uses 210-gallon composting bins (as used by the GMC) and HDPE collection (catcher) bins (as used by the AMC) to mix and compost the waste in small batches before transferring it to the composting bin. At Gray Knob and the Perch, large work platforms were added to provide a stable and safe work surface for maintainers.

Current Operation of Toilet System: The technique is the same as the batch-bin process described above, with the only modification being that instead of waiting for the collector/catcher to fill; the RMC caretaker completes a run annually at the two cabins, and every two to three years at the Perch. The Bio-Sun now essentially is acting as a 500-gallon collector/catcher. This large volume for a collector/catcher actually proves advantageous to RMC as the bulk of the visitor use occurs in the noncomposting months of November through April.

The switch-over to the batch bin system has committed the RMC to airlifting bark, but the low number of composting runs at each site has made it possible to airlift every other year.

As the RMC is a volunteer-led organization, the club also wrote a detailed composting manual (in conversational language) to help future volunteers and field staff and serve as the institutional knowledge of the system.

The multi-year project was funded in part by the Neil and Louise Tillotson Fund, of the New Hampshire Charitable Foundation. The cost of the modification was less than $10,000 for all three retrofits; airlift was the most significant expense.

Conclusion—Use of the club's facilities by backpackers has continued a downward trend in recent seasons from the average high of 4,500 back in the early part of the decade. Day use is growing and following the trend seen by other clubs and land managers in the northeast. This is, indicated most visibly by overflowing trailhead parking areas in the valley. Interest in winter use has stayed steady and continues to fill up the collectors/catchers at a time of year when composting toilets can act only as storage bins. Recent analysis of use of the camps shows that, as in the late 1990s, use is distributed almost uniformly through the year.

Winter is a challenge for any composting toilet. Below 40 degrees F., there is essentially no biological decomposition. The system must be large enough to accommodate an entire winter's accumulation of waste with no reduction in volume until spring, because it is impractical to remove frozen waste. Winter maintenance consists of knocking down the frozen cone below the toilet chute and continuing to add bulking agent.

Average overnight visits broke down as follows:

16 percent in winter (January, February, and March)

20 percent in spring (April, May, and June)

45 percent in summer (July, August, and September)

19 percent in fall (October, November, and December).

As of 2014, the club had three operating Bio-Suns systems. The Log Cabin, has a batch-bin system with a beyond-the-bin filtration system.

11.6 MOLDERING PRIVY ON THE A.T. AT LITTLE ROCK POND SHELTER IN VERMONT

Dick Andrews, *Volunteer, Green Mountain Club*

The first experimental moldering privy on the Trail was installed at Little Rock Pond Shelter in the Green Mountain National Forest in Vermont in September 1997, under the supervision of Dave Hardy, then field supervisor, and now trails director, for the Green Mountain Club (GMC), with help from me.

The shelter and privy have since been removed. All camping at Little Rock Pond was consolidated at a new Little Rock Pond Shelter and an upgraded tent site near the pond in the summer of 2010.

The moldering privy built in 1997 replaced a pit privy located on a steep slope—actually, an ancient talus slope with thin soil, where finding new places to dig pits was extremely difficult. The outhouse at the site was in poor condition, so we replaced it with a new one prefabricated by a GMC volunteer. More than a dozen volunteers on a freshman orientation outing from Harvard College helped carry materials about three quarters of a mile up a stiff grade on a side trail to the site, and helped build the moldering privy.

After removing the old outhouse, we backfilled the nearly full pit to within a few inches of the top with soil. We then built a crib over the original pit, using six timbers of 8 by 8-inch white cedar landscaping lumber, in three courses of two timbers per course, resulting in horizontal gaps of eight inches in the crib.

The timbers were excellent for the purpose: light to carry and easy to work, but sturdy and decay-resistant. They were fastened with long spikes without pre-drilling holes.

The timbers varied in length from four feet long to somewhat more than six feet long. To maximize the volume in the crib and minimize waste of the timbers, we built the crib in the form of a stepped truncated pyramid, wider at the base than at the top. This also added stability. The finished crib was two feet high, providing somewhat more than two vertical feet for waste accumulation, counting the depression below the crib and the elevation of the floor of the outhouse above it. Total volume in the crib was about 40 cubic feet.

After stapling hardware cloth and insect screening over the gaps in the crib and sending volunteers far and wide for forest duff, we placed about eight inches of duff in the bottom of the crib, and banked duff against its sloping sides. We assembled the outhouse on top of the crib, lightly toenailing it in place to ease removal when the crib filled. The design of the outhouse was conventional, with a seat on a wooden bench at the rear of the structure. We did not install a vent, since the porous duff banked against the crib allowed ample ventilation while excluding light and insulating the compost pile somewhat against temperature variations. The last step was the installation of a few steps to reach the door of the elevated outhouse.

Then as now, Little Rock Pond had a caretaker in summer, and the caretaker kept the privy supplied with bulking agent, which is essential for proper composting of human waste. We started using bark mulch, but switched to softwood shavings (eastern white pine, available at agricultural supply stores), which were lighter to backpack to the site, easier to manipulate in the pile, and easier and more attractive for users to handle. A nine-cubic-foot bale, compressed to a package 12 by 18 by 28 inches, weighed 35 pounds and cost about $3. It was enough for more than 1,000 uses, at one cup per use. Users were asked to add a handful of shavings each time they use the privy.

The caretaker kept an eye on the compost pile, stirring with a stick and watering with a garden watering can through the toilet opening as needed to keep the pile leveled, aerated, and moist. Each season the GMC introduced an eight-ounce container of redworms to enhance composting in the pile. The club propagated its own worms in plastic buckets at headquarters in Waterbury Center, Vermont.

Composting worked very well in the moldering privy. As of the end of the 2000 hiking season, the crib had plenty of room for additional use. In the privy's first full season (the summer of 1998), A.T. thru-hikers repeatedly wrote in the shelter log book that the moldering privy was the nicest smelling outhouse between there and Georgia. Reviews continued to be complimentary. The privy was not odorless, but the odor was usually earthy, as long as the pile was at least lightly covered with shavings.

Our original plan was to build a second crib when the first one filled, and to move the outhouse to it. This is an easy job for four people using a couple of 2 by 4s temporarily nailed to the walls of the outhouse as handles. The first crib would have been covered with a layer of forest duff (protected from dogs or other animals by a hardware cloth cover) and left to weather and finish composting until the second crib was full. Then it could be emptied, and the compost scattered on the forest floor at an appropriate distance from water, trails and the shelter site. When the second crib filled, the outhouse could be replaced on the first crib. However, even by 2010, the crib had not filled, and we never had to build a second crib.

11.7 AT HOME WITH THE CLIVUS MULTRUM IN VERMONT

Richard Andrews, *Volunteer, Green Mountain Club*

The Clivus Multrum is a commercially manufactured, self-contained, continuous composting toilet. It relies on mesophilic, or low-temperature, composting, which is often called moldering to indicate that it takes place with no significant temperature rise. Developed in Sweden, the design was licensed to Clivus Multrum USA for manufacture and sale in this country in the early 1970s.

I have had extensive experience with the Clivus Multrum, since I installed the fifth one manufactured in the United States (serial #005) in my home in 1974. My wife and I used it continuously from then until we sold the home in 2003. I also sold Clivus Multrums for several years in the 1970s, and I have observed many installations, both successes and failures.

Although the Clivus Multrum worked well for me, I consider it unsuitable for most backcountry situations. Of course, its shortcomings in the backcountry also apply to some degree to all composting toilets that resemble it.

At several thousand dollars a unit, the Clivus Multrum is too expensive for many backcountry situations. More important, it must be sheltered from the weather, and it requires warm temperatures to have reasonable capacity. The rate of activity of the decomposing organisms in a Clivus Multrum approximately doubles with each 20-degree Fahrenheit increase in temperature. Thus, the capacity of a Clivus Multrum doubles from 40 degrees Fahrenheit to 60 degrees, and doubles again from 60 to 80 degrees. The building required to shelter and warm a Clivus Multrum multiplies the cost of an installation. Insulation alone cannot provide warmth, because the slow decomposition process creates insignificant heat.

Although the designers of the system intended it to evaporate all liquid, in practice this happens only under ideal conditions, such as installations in the warm and dry climate in the American Southwest. In most other places, evaporation is incomplete, so liquid accumulates in the bottom of the tank, and must be dealt with. Since a Clivus Multrum composting tank is an impervious container, the system requires a good draft in its ventilation stack to work properly, and this is often difficult to ensure in the backcountry. The composting tank is bulky and hard to transport. Finally, if users ignore instructions and introduce trash, it is difficult to reach and remove.

Design of the Clivus Multrum—The Clivus Multrum is a large (in our case, approximately four feet wide by ten feet long by seven feet tall) fiberglass-reinforced resin tank with a bottom sloping at 30 degrees. Early versions of the tank were not insulated, but modern versions include a layer of foam plastic insulation to conserve warmth. However, material that can be biologically metabolized to produce heat is introduced into continuous composting toilets at a low rate, so the generation of heat occurs at a low rate. In addition, the minimal heat of decomposition is steadily removed by evaporation and ventilation. As a result, there would be no significant temperature rise even if the tank were perfectly insulated, so insulation is of questionable value.

Air channels built into the tank ensure that no part of the compost pile is far from air. A vertical chute connects to a toilet seat on a floor above the highest portion of the tank. A bulking agent, such as wood shavings, is added through the toilet chute regularly to keep the pile aerobic. A vent with a fan removes odors, water vapor, and other gases produced by composting, such as low concentrations of carbon dioxide (and methane and ammonia if parts of the pile become anaerobic). A second vertical chute may be included for food waste in homes where the kitchen is conveniently located.

The tank must be placed on a platform sloping at 30 degrees, an angle intended by designers to cause compost to tumble in slow motion toward a cleanout door above the lowest portion of the tank. Most users find that the compost does not move by itself, but the slope does make it easier to pull compost toward the cleanout door for removal.

Water that does not evaporate and dissolved solids collect in the bottom of the tank, and must be drained or pumped periodically. Since some evaporation does take place even under unfavorable conditions, the liquid is a concentrated solution of the salts contained in urine, plus whatever else is leached out of the compost pile. Research by Clivus Multrum indicates that the liquid is bacteriologically benign as long as it has percolated slowly through aerobic portions of the compost pile, and the company says that lack of odor in the liquid indicates it is stable and has been adequately treated. This is only possible if use of the toilet does not exceed its capacity. Since use levels may exceed capacity without continuous monitoring and control, it is generally considered wise to handle the liquid as if it were blackwater (untreated sewage).

Small portions of the compost pile in a Clivus Multrum may become anaerobic from time to time. This is not considered a problem as long as most of the pile is aerobic, because material will generally move out of the anaerobic region into aerobic conditions, where pathogens will be attacked and largely eliminated.

Clivus Multrum has arranged for analysis of compost produced by its composting toilets. The results indicate that elimination of pathogens is not perfect, but the concentration of pathogens in the finished product is comparable to that in typical soil. Blind bacteriological tests cannot distinguish the compost produced by a properly functioning Clivus Multrum from a soil sample.

Flies are sometimes a problem, especially in a new installation in which a balanced ecosystem has not established itself. Once a Clivus Multrum is working properly, soil invertebrates consume fly eggs before they can hatch, although the predators may occasionally fall behind if a lot of food waste contaminated by fly eggs is introduced at once. Flies may also be a problem if the surface of the compost gets too dry, which can be cured by occasional light spraying with water.

Our experience—Our Clivus Multrum was used by an average of two people. The house was sometimes vacant for a month or two when we traveled, but we also had visitors, and occasionally as many as three other people lived with us for several months at a time. Often the house was occupied all day, while most overnight backcountry sites are vacant much of the day—and 24-hour occupation produces more human waste than a simple overnight. Thus, our average usage was equivalent to a campsite with a use level of 800 to 1,000 overnights annually.

The toilet and food waste chutes were on the first floor of the house. The composting tank was in an unheated basement. For fifteen years we had no electricity other than that provided by a small wind generator. In our mountain location, the temperature in the basement varied between 34 degrees F. in midwinter and 58 degrees F. in midsummer. Clivus Multrum USA specified that the composting tank should be in a space averaging at least 60 degrees F., a temperature our basement never even reached for that first fifteen years. Similarly, an average annual temperature of 60 degrees or more will not be reached outdoors in the backcountry except in the warmest locations. However, since our tank was sized for continuous use by four people, the composting process worked fast enough to keep up with input. In mesophilic composting, time, warmth, and volume can substitute for each other.

Clivus Multrum USA said a fan in the vent stack was essential, but with such a small supply of electricity, natural ventilation was our only possibility. I installed a stack reaching the peak of our story-and-a-half house, giving a vertical rise of about twenty-three feet from the top of the composting tank. This provided excellent draft in winter, when the basement air was warmer than the outdoors, but little or no draft in summer, when the basement was cooler than the outdoors. Yet in midsummer, the basement was as warm as it would get, so the composting process would be at its annual peak, requiring the maximum supply of air. Something had to be done.

I installed a rotating turbine ventilator designed to enhance draft from wind, which worked well in summer. But water vapor from the tank formed unbalanced accumulations of ice on the turbine on quiet days in the winter, causing a terrible racket when the wind rose. So I replaced the rotating ventilator with a stationary draft-enhancing chimney cap.

Our house was on an exposed location at an elevation of 2,000 feet, and the climate was colder 35 years ago than it is now, so ice accumulated for long periods. We experienced intervals as long as three weeks of subzero weather, with almost constant wind, and periods of windy subfreezing weather much longer than that. The new cap was quieter, but with a prolonged steady wind, ice still formed in its downwind portion, eventually plugging the exhaust route. When this happened, the wind drove through the open upwind passages of the vent cap and down the vent stack, reversing the draft, chilling the composting tank, and forcing odors into the house. The only cure was to plug the vent stack until a thaw arrived. This caused no problem, because the composting process was largely dormant in such chilly conditions, so it required next to no air.

After fifteen years, we connected to the electric grid. We then could have running water and a water heater. As a result of the water heater and a warmer climate, the basement ran 10 degrees F. warmer throughout the year than it had before. I vented the propane-fueled water heater into the Clivus Multrum vent stack, which warmed the stack and provided draft for reliable ventilation in summer, and also prevented ice accumulations in the vent cap in winter. This proved the ultimate solution to our toilet ventilation problem, and also avoided the need for an electric vent van and a separate vent for the hot water heater.

In the first couple of years we used the Clivus Multrum, flies were occasionally a problem. A few times they got so bad that I reluctantly hung pesticide strips above the compost pile in the tank. As biological activity in the compost pile increased and became more diverse, flies became much less of a problem. The surface of the compost pile became a seething busyness of sowbugs, rotifers, and other composter's helpers. Flies were also controlled by using ample bulking agent and keeping the surface of the compost pile moist, which I did by spraying it with a little water once a week. The tank produced some moths when we went on a two-month vacation in the very dry summer of 1999, but they were gone within a week of thoroughly wetting the pile upon our return.

Liquid always accumulated in the lower end of the composting tank. In the early years, I bailed it, carried it outdoors in buckets, and poured it on the lawn. For a while I installed a hand-powered bilge pump sold by Clivus Multrum to transfer the liquid into buckets, but it plugged easily, and soon broke. When we got electricity, I bought an electric sump-and-bilge pump that could handle salt water, installed it in the tank, and piped the liquid into our septic tank, which disposed of gray water from our sinks, shower, and washing machine. I operated the pump once a week and it worked well. We stopped gardening soon after building the house, because our next door neighbor had poor fences for livestock that would devour a garden in fewer than five minutes, but acquaintances who did garden sometimes asked for jugs of "Clivus tea," which they said was a super fertilizer.

We tried various bulking agents: partially rotted leaves from the forest floor, sawdust, and pine shavings. Leaves tend to form impervious mats, and sawdust also tends to compact. The same is reported of grass clippings, hay, and straw. Pine shavings were the best bulking agent we tried, remaining comparatively loose and aerated even when wet. We added about one quart per day of pine shavings, so a nine-cubic-foot bale, costing $3, lasted us nine months. The shavings also were fragrant and unobjectionable even if some spilled on the bathroom floor. Some owners of Clivus Multrums use peat moss as a bulking agent, but I have had no experience with it. Some composters report hardwood shavings are better than softwood, but pine shavings worked for us, and they were available locally at agricultural supply stores, which sell them as bedding for livestock.

In the early years, I removed compost through the clean-out door once a year or once every other year. The material was, as Clivus Multrum advertised, brown, crumbly and odorless. Peach pits and fragments of bone survived composting, but eggshells, corncobs, peanut shells and toilet paper vanished. I disposed of the compost by dumping it in our fifteen acres of woods. I did not keep good records of the amount of compost produced, but I typically removed six five-gallon buckets in a cleaning.

In 1992, I bought a pound of red wiggler worms (also called redworms or manure worms), and put them in the Clivus Multrum. In addition to consuming organic material, the worms aerate and mix the pile, and carry fungus spores and other microorganisms around the pile. They made a remarkable difference. In fact, I did not remove any material from the compost tank in the first eight years after I introduced the worms, and only a little after that.

Despite the slope of the bottom of the tank, material did not move from the top of the tank to the lower end by itself. It built up beneath the toilet chute, so about once a month I used a long stick to shove fresh material down into the lower portion of the tank. That would probably have been a less frequent chore if I had removed compost from the lower end of the tank more often, thereby increasing the slope of the top surface of the pile. But shoving material with a stick was less work than removing compost, so human inertia won most of the time.

11.8 PROTOTYPE WOOD-FIRED COMPOST INCINERATORS IN VERMONT

Dick Andrews, *Volunteer, Green Mountain Club*

Some jurisdictions do not allow composted human waste to be applied to land. In those places, the product of composting systems must be removed from a site. Unfortunately, that requirement offsets much of the potential advantage of treating human waste by composting at backcountry sites.

To make composting useful while meeting such requirements, incineration of compost is an obvious possibility. No pathogen could survive combustion at high temperatures. Many biological nutrients would be destroyed as well, and if the remaining ones were a concern, a small amount of dry ash is much easier to transport away from a backcountry site than a large amount of damp compost.

Incineration of uncomposted human waste has taken place at some backcountry sites, particularly at heavily used sites in the West. However, manufactured incinerator toilets are expensive and intrusive. They also require large amounts of liquefied petroleum fuel (propane or butane), which is a continuing expense, a questionable use of a nonrenewable resource, and a transportation and aesthetic headache. Reports indicate the incinerator toilets can be smelly as well.

In contrast, a practical wood-fired incinerator is an appealing prospect for forested backcountry sites in the East, where modest or even ample amounts of downed wood are often available nearby—especially if the incinerator can use damp or green wood. And burning compost on infrequent occasions should be much less smelly than incinerating fresh sewage with each use of a toilet.

With this in mind, I have built two experimental compost incinerators, which I describe below. Each one successfully burned compost from my household Clivus Multrum composting toilet, using green wood as the supplementary fuel. Except for a short time immediately after ignition, the smoke was either invisible or largely steam, indicating reasonably clean combustion. Odor was negligible—essentially the aroma of wood smoke. The product was a fine, white ash. Even bones could be crumbled to white powder between one's fingers after going through the incinerator (the Clivus Multrum composts kitchen garbage as well as human waste).

Neither prototype was suitable for regular use at a backcountry site; they were too small and flimsy. But they did demonstrate that incineration of damp compost is possible with a simple device and a modest supply of low-grade wood. Scaling up to a practical size is unlikely to be a problem, since the chief goal is high-temperature combustion, which is easier to achieve in a large fire than a small one.

The first prototype incinerator consisted of three concentric lengths of stovepipe. The combustion chamber was two two-foot sections of eight-inch diameter pipe (four feet long overall), standing vertically and stayed with three guy wires to prevent tipping over. Air inlets with a total area of about ten square inches were cut in the sides at the bottom, and a woven wire grate was installed six inches above the bottom.

One two-foot section of ten-inch diameter stovepipe stood outside the combustion chamber forming a preheater, so incoming air had to travel down through the one-inch space between the two pipes before entering the air inlets in the combustion chamber. It both preheated the combustion air and reduced heat losses from the combustion chamber, creating a very hot fire on the grate.

A four-foot length of six-inch stovepipe was suspended centered in the combustion chamber, with the bottom six inches above the grate. That was the fuel magazine.

To use the incinerator, I dropped wads of crumpled paper down the fuel magazine until it was about half full, and then dropped in a flaming wad of paper, followed by dry kindling and then a few sticks of dry wood, cut to a length of about three inches. Once that fire was burning well, I followed it by dropping in sticks of green wood, also about three inches long. Once a good fire was established, I scooped a fuel mixture consisting of equal weights of green wood chunks and damp compost into the fuel magazine. That mixture fed by gravity into the fire as fuel burned away on the grate at the bottom. Ash fell through the grate onto the ground below. After I stopped adding fuel, the fire burned until the fuel was consumed—as long as the wood-and-compost mixture did not hang up, or jam, in the fuel magazine.

Because the fuel magazine was full of a mixture of compost and wood chunks, smoke from the fire could not rise easily through the magazine. Most smoke was forced to travel up through the one-inch annular space between the fuel magazine and the combustion chamber. Thus, the fuel magazine was surrounded by hot stack gases, which partially dried and preheated the compost-fuel mix before it reached the fire. When not stoking the incinerator, I covered the top of the fuel magazine with a small piece of sheet steel to completely prevent smoke from smoldering portions of the fuel load from escaping without going through the hottest part of the fire.

This prototype was not problem-free. The chief difficulty was that the mixture of compost and wood sometimes jammed in the vertical, gravity-feed fuel magazine.

I guessed that a tapered fuel magazine, wider at the bottom than at the top, would solve this problem. My second prototype confirmed this guess. The design was the same in principle as the first, but I made the second prototype of light-gauge galvanized steel, formed into vertical stacks (fastened with sheet metal screws) with square rather than circular cross sections. The fuel magazine, again four feet long, was six inches square at the top and eight inches square at the bottom. The combustion chamber, also four feet long, was ten inches square, and the outer preheater was twelve inches square, and, as before, two feet long.

I fired the second prototype just as the first, and it worked perfectly: the modest taper in its fuel magazine prevented fuel jamming. The somewhat larger size increased its capacity and made the fire even hotter.

Undoubtedly the design could be improved in many ways, but it is clear that on-site compost incineration is feasible in any situation where it would satisfy sanitation regulations.

11.9 ACCESSIBLE COMPOSTING PRIVIES ON THE A.T. IN VERMONT

Pete Antos-Ketcham, Staff, Green Mountain Club

The Green Mountain Club (GMC) built its first accessible privy at the Churchill Scott Shelter on the west side of Pico Peak back in 2002. This was the first new shelter constructed on the recently completed relocation of the Long Trail/Appalachian Trail (LT/AT) to a permanently protected corridor. The construction of the shelter was the capstone project to this major relocation of the LT/AT in Vermont. As GMC was building facilities on new ground, the shelter and all associated structures would be required to meet accessibility guidelines under the Federal Architectural Barriers Act (ABA) of 1968.

The shelter and tent platform would be able to meet compliance guidelines relatively easily by making the height of the floor deck between 17 and 19 inches from the ground. This height allows for the horizontal transfer from someone seated in a wheelchair to the shelter or tent platform.

The outhouse, however, would prove to be more of a design challenge. There was concern that to be compliant with the law, the new outhouse would have a very large physical footprint, potentially creating an aesthetic impact troubling for some visitors. This was one of the larger concerns of both GMC volunteers and staff. While it was agreed that we were committed (and required) to meet universal design requirements, the aesthetic concern remained. To meet the design challenge presented to us, we engaged a team of volunteers headed up by Jeff Bostwick of the GMC's Burlington Section to develop, design, and implement this new first of its kind accessible outhouse for the LT/AT.

The first step was designing the access to the structure. In order for someone in a wheelchair to enter, the structure requires a level 5 by 5-foot transfer platform. This platform can be accessed at grade (if the topography allows), with a ramp, or with stairs made to accessible standards. Stairs are considered the option of last resort, as they are a less sanitary and a less dignified option, with mobility impaired users having to drag themselves up to use the toilet. Stairs can only be permitted when the backcountry site allows for no other option (*i.e.*, no slope). For required ramp and stair specifications (see the U.S. Forest Service's Accessibility Guidebook for Outdoor Recreation and Trails).

With the knowledge that building a ramp had the potential to increase the footprint of the structure, we were fortunate that the area topography would allow of the use of an at-grade entrance, thus solving the potential aesthetic issue that could have resulted from a ramp.

The next effort was to design an outhouse that was no bigger than it needed to be while still meeting the required specifications. This was achieved by using the "T" clear space turning radius principle of accessible toilet design. This creates a travel space inside the privy, allowing someone in a wheelchair to enter the building perpendicular to the toilet riser and then back up alongside and parallel to toilet riser to transfer on to it. This design allows for the required access but doesn't require a large amount of floor space to achieve (see accessible outhouse plans in the Appendix). This allowed us to construct a 6 by 8-foot outhouse—a standard outhouse is generally 3 feet by 4 feet) with a height of 10 feet on the high side of the roof.

The Churchill Scott Shelter uses a batch-bin composting system. We used the slope we built on not only to create an at-grade entrance, but also an area below the floor for the waste collector under the seat. This same design principle was then easily adapted to create a fixed multi-chamber moldering toilet. (See Appendix for plans and an article about this project.)

After the success at Churchill Scott, GMC built a similar batch-bin composting model at Bromley Shelter. The club then tackled the upgrade and conversion of existing pit privies into accessible moldering privies. With the Churchill Scott privy, we now had a basic set of plans that allowed us to adapt the concept of accessibility and universal design into structures that were in keeping with the rustic design ethic that is part of the Trail experience.

Our first accessible moldering project was the replacement of the privy at Goddard Shelter on Glastonbury Mountain as part of the replacement that shelter in 2005. Working with staff from the Green Mountain National Forest and volunteer Paul Austin from GMC's Bennington Section, the Jeff Bostwick privy building design was modified so the privy could be permanently mounted over two large moldering cribs. To switch cribs, the toilet riser would be moved to the adjacent hole. The final structure was 8 by 8 feet.

The Goddard privy employed a pyramid-shaped crib system made from stacked pressure-treated four-foot by four-inch timbers. The pyramid base allowed for increased storage capacity and a very stable base. Access was achieved with a nearly at-grade ramp. Some notable features include a translucent Lexan roof and a premade plastic toilet riser rather than a bench seat. The main disadvantage we discovered was that the pyramid base was not easy to modify to accommodate access doors for manipulating the pile—the only option was to go down through the floor from above, which we have discovered is difficult and less effective.

With the completion of this project we now had a good working template for an accessible moldering privy. Work was still needed to see if a design could be developed that met the requirement of the 5 by 5-foot "T" turning radius while working to keep the building footprint as small as possible. As we discovered, aesthetics were not the only concern with the size of the structure, cost was also a consideration—the larger the building, the greater the cost in materials. We were in search for a design that was accessible, aesthetically pleasing, and would be affordable for all Trail clubs along the A.T.

GMC's next projects were conversions of existing pit toilets into an accessible moldering privies. We built another pyramid-style unit at Congdon Camp and we installed a "cabana" style accessible moldering privy based on the USFS Region 8 (Southern Region) approved plans at Skyline Lodge (see Appendix for Region 8 plans). Experience from operating these systems led us to look at developing a new set of plans that would be approved by the Green Mountain National Forest as well as the USFS Region 9 (Eastern Region) and be designed for the higher elevations and climates of the northern part of the A.T. A key goal again was to get the outhouse down to the smallest size permissible, which we determined was 6 feet by 7½ feet. We also learned that while a pyramid shaped crib was great for the amount of waste it could hold, the size of the crib and the accessible privy building made it extremely difficult to access the waste pile to level it, manage it, and remove waste. This new unit would feature a standard box-shaped crib, a translucent Lexan roof, polyethylene toilet riser, and stainless steel grab bars, among other improvements. A major challenge with the Greenwall site was that the terrain was nearly level. In the end, this left us no choice but to use accessible stairs (see Appendix for accessible stair specifications). The use of stairs should always be a last resort as they are the least sanitary and pleasant means for someone in a wheelchair to access an outhouse. While we were pleased overall with how the building design turned out with the Greenwall privy, more work was needed to improve the efficiency of the crib system, as well as improve the design to facilitate at-grade access.

In 2012, GMC received a grant from ATC to replace the privy at Happy Hill Shelter on the A.T. near Norwich. The site had a non-accessible moldering privy that was full and in need of replacement. The Happy Hill site was relatively flat, so a location was selected adjacent to the existing privy, where the topography could be used to reduce the need for a long sloped access. Working with staff from the Green Mountain National Forest and ATC, GMC staff worked to develop a new set of plans that would incorporate many of the desired changes and improved features we had developed through the construction of the previous accessible privies. Some of these key improvements would include:

- Using composite decking for ramp/stairs and transfer platform to reduce slipping hazards.
- Simplifying the door bracing to two horizontal and one diagonal.
- Increasing the crib size to ten courses of pressure treated (PT) 4 by 4s under the building with a 1 by 6 PT divider (not plywood, as too many things in the forest like to eat it) for the moldering cribs.
- If more space is desired, the crib could be extended out under the transfer platform. If this is done, additional access doors will need to be added to manage the waste.
- The fine mesh and hardware cloth interior screening should be fastened to the cribbing with hammered staples.
- A Lexan roof should be used to eliminate the need for a front window, but side windows should be kept for internal ventilation.
- The side windows should be shortened to be triangular under the roofing and covered by fine mesh and hardware cloth.
- The roof overhang should be 4 to 6 inches all the way around.
- Siding should be ship-lap with a turpentine/linseed oil coating as a preservative (this mixture also has the added benefit of darkening new wood, helping it look weathered, and reducing visual impacts).

- Interior flooring should be tongue and groove; holes for toilet riser should be cut in floor at time of construction; cover unused hole with strong sheet metal so entire floor space is available for accessibility.
- Add doors to the side as well as the rear of crib to allow access to the waste pile for leveling and mixing and to facilitate removal of compost.
- After removing hazard trees during the summer, construction began in earnest in the early fall. The outhouse was prebuilt at the ATC office in nearby West Hartford and then transported to the site using trucks, a tractor, and a crew of volunteers who hand-carried the lumber the remaining distance in to the shelter. The project was completed shortly thereafter, and the old privy was boarded up to allow the waste pile to decompose further before decommissioning the outhouse.

In general, GMC was very pleased with the design and new improvements. However, there was one error made that needed to be corrected. As you can see from the photos here, the sloped entrance leads directly to the door and there is no level transfer platform. This is a fundamental component and requirement of an accessible privy and is now included in the plans in this manual. The purpose of the level transfer platform, which must at a minimum be 5 by 5 feet, is to allow someone in a wheelchair to be able to come to a rest and use their hands to open the privy door without concern of rolling back down a sloped entrance. The transfer platform can either be constructed with lumber or can be achieved by placing the privy such that the topography allows for a level at grade entrance. With a natural platform, it may be necessary to provide for soil retention (using either rock or wood cribbing), drainage, and to place crush or gravel to ensure the transfer platform remains dry and stable.

With the additions of the aforementioned modifications, insights learned during the design and construction of the Happy Hill Privy, and the approval of agency partners, GMC now has an accessible moldering privy design that can be utilized along the A.T. as well as other remote recreation areas. (See Appendix for the USFS Region 9-approved accessible moldering privy plans.) These plans represent the current level of GMC's research and development. As further refinements and changes are made, this manual will be updated.

11.10 MOLDERING PRIVIES ON THE A.T. IN MASSACHUSETTS

Jim Pelletier, Chair Massachusetts A.T. Management Committee, Appalachian Mountain Club

There are 15 overnight sites along the A.T. in Massachusetts, each of which has at least one privy. With the exception of two of the privies at Upper Goose Pond Cabin, they are fairly standard single hole affairs that originally were set over a dug pit and moved to a freshly dug pit when the hole filled with fecal matter. The privy outhouses are of framed construction with a pitched roof and 4 by 4-foot exterior dimensions. Some overnight site locations are quite rocky and it is difficult to find a good spot to dig fresh pits. Also, the Committee noted at some high use sites the privy pits filled quickly requiring frequent relocation to freshly dug pits. For these reasons, the Committee decided to take a different approach using an above-ground moldering privy.

To construct an above-ground moldering privy crib, a suitable location is first found and an area approximately 5 feet by 9 feet is cleared of organic material and leveled. A crib is then constructed on top of this area using pressure treated 2 by 6s laid flat on the ground in a 4 by 8-foot rectangle, building up the height of the whole affair by laying on additional alternating layers of 2 by 6s log-cabin style. Two by 6s are also stacked across the middle of the 8-foot span splitting the 4 by 8 crib into two sections with an internal dimension of approximately 3 by 3 feet. The 1½-inch gaps between the alternating courses of 2 by 6 along each side provides for ventilation of the pile. The height of the crib is typically built up to 18 inches. In the more recent installations, 2 by 4s were used between the top and bottom layers in lieu of the 2 by 6s to save costs and for easier transport of materials. Two by 6s are used for the bottom-most layer to provide a broad bearing surface and on the top layer to provide a wide support for the outhouse itself. The inside of the two cribs thus created are lined with insect screen and backed up with hardware cloth to keep insects out and protect the insect screen respectively. The outhouse is then set over one of the two cribs and the resting crib is covered with a 4 by 4-foot sheet of plywood, slightly pitched to shed water. A lawn rake and five-gallon bucket are provided for harvesting and storing duff. In this manner, existing outhouses can be easily converted from pit type to moldering type privies.

Completed Mass AMC Moldering Privy

Moveable Staircase

Operational instructions are posted on the inside of the outhouse door for the users to read and (ideally) practice. Users are encouraged to pee outside away from the privy. After use a handful of forest duff (from the five-gallon bucket provided in the privy) is deposited on the pile. Users are encouraged to refill the bucket when it is empty, and instructions on how to gather duff are provided. Ridgerunners and campsite adopters also fill duff buckets as needed. Periodically the pile is leveled and spread to the corners of the crib using a spading fork. This provides for efficient use of the crib volume and lengthens the time the privy can be used over a given crib. Decomposition in the resting crib is encouraged by mixing the pile of refuse and duff with a spading fork or shovel, typically once per season. We have found no need to add red worms or other accelerants to hasten decomposition of the waste.

When the crib under the outhouse is full, or nearly so, the cover on the resting side is removed and the decomposed material dug out and spread over the forest floor, at an appropriate distance from the campsite and water supply. This decomposed material is typically soil and is full of tiny roots. Although toilet paper decomposes completely, the material inevitably contains some man-made items that do not decompose. There is *no* evidence of feces remaining. The man-made materials are separated out before the material is broadcast and carried out as trash. The overall volume of decomposed material to be removed is well less than half the full volume of the crib. With the resting pit cleaned out, the privy is shifted over to the empty crib. Several buckets of duff are added to the now uncovered full crib and the contents mixed before placing the cover over the new resting crib.

Formal records of privy operations have been kept since 2003. As of the end of 2011, five overnight sites retained dug pit privies. These sites are low use and have soils easily dug for new pits. Pits at these locations are lasting a minimum of eight years, with three of the pits still in use after at least eight years. Nine of the remaining ten sites use moldering above-ground cribs as described above. While records of the earliest use of moldering privy cribs were not found, it appears the oldest of these is at least nine years old. On average these privies are shifted to the resting side after emptying it every two years. Some have been shifted at less than two years as a matter of convenience, and one has yet to be shifted after four year's use.

The privy facilities at Upper Goose Pond Cabin are a mix of the old and new. One old pit privy remains and has not been moved as best I know in the last ten years. In addition, there are two above-ground moldering privies similar to the above. The difference is that they are somewhat wider and are "two holers," with the second hole for urine only. The urine is piped to a small "field" behind these privies. This arrangement prevents the saturation of the fecal pile with urine, which would halt the aerobic decomposition process. Each year the resting side of these privies is emptied and the privies are shifted. Interestingly, the cribs for these privies were built from 6 by 6 timbers, and do not have as much air circulation as the cribs described above. This does not seem to significantly affect the rate of decomposition of the resting side of these privies. The other difference between these moldering privies and the others is that planer shavings are brought in for use as a bulking agent, as local duff resources were becoming depleted in this high use area

The Committee has been pleased with the performance of the moldering privies. The odors and flies associated with pit privies are greatly reduced, and the problem of finding new pit sites to dig has been eliminated. Although the moldering crib privies require monitoring and periodic shifting, this has not been a significant drain on volunteer resources.

Below is the original contribution from AMC Massachusetts from the first edition of the ATC Backcountry Sanitation Manual.

Pete Rentz, M.D., *Trails Chairman Massachusetts A.T. Committee, Appalachian Mountain Club*

The ideal composting system would be safe for users, safe for maintainers and the environment, easy to use, durable, and lightweight for ease of transport. It also would be economical, and the composting process would use a readily available bulking agent. In Massachusetts, we have been experimenting for several years with a design for a moldering privy that attempts to achieve those goals.

We started with our basic four by four-foot privy, which we know how to transport and build, and placed it on a cribwork of 6 by 6 timbers that form two composting chambers. We have found that even in a high-use situation, a nine-cubic-foot chamber will require more than a season to fill with feces, organic material, and toilet paper. When this occurs, the privy is simply shifted to the empty adjacent chamber. Thus, composting occurs for a minimum of one year, and in some cases two or three years. During that time the volume of compost typically halves, and the end product is not much different in appearance and smell from the original carbon-rich forest duff (partly decomposed leaf litter) that we use for a bulking agent.

We use duff for the carbonaceous composting material because it is free, it is available everywhere in the woods without need for transport, and it does not introduce foreign substances into the natural environment. Duff is also desirable because it is finely divided and fluffy, and because it contains a rich assortment of aerobic soil bacteria, molds, and fungi.

Since the composting crib is in contact with the soil, earthworms will be found in the compost. We have tried to introduce red wiggler manure worms (*Eisenia foetida*), but have not seen any indication that they speed the composting process. In fact, they disappear soon after they are introduced, and may only serve as a feast for shrews.

We have tried urine diversion, and have found that it is important for our high-use moldering privies to prevent saturation of the compost pile. The composting chamber of a low-use moldering privy fills only every two years; in this situation, the urine appears to evaporate or percolate through the compost pile to the soil satisfactorily.

Urine diversion is accomplished by creating a "two-holer," with one seat for urination only. The urine basin is a six-quart stainless steel mixing bowl fitted with a sink drain that is plumbed to a length of half-inch internal diameter, thick-walled clear plastic tubing. The end of the tubing is perforated and is placed in a small leach pit containing landscape fabric, gravel, and anthracite coal. The urine diversion apparatus adds about $100 to the cost of our privy.

There is no odor associated with the leach pit. However, it is good to flush the basin and tube periodically with a quart of clean water. Beyond this ordinary cleanliness, disinfection of the plumbing with chlorine solutions has not proven necessary. The urine diversion feature mainly serves women; men are encouraged to urinate on trees at a decent distance from the shelter.

We have tried covering the composting chamber with a weather-resistant board, but it has proven to be unnecessary. The cover doesn't seem to make much difference to the composting process. Rain and evaporation seem to balance each other in our uncovered chamber experiment. The cover is mostly for aesthetics, and a layer of dry leaves appears to be equally good for this purpose.

Mixing is performed yearly with a spading fork. This aerates the compost, and breaks up tree roots that might otherwise infiltrate the compost. The final product, about four cubic feet of humus, is carried a short distance in five-gallon plastic buckets to a disposal area where it is buried in a spot away from foot traffic and downhill of any water source.

Those procedures require about one hour of maintenance activity each year per privy, not counting the harvesting of duff, which is usually performed by the users in accordance with simple instructions. Compare that to the three to four man-hours necessary to re-dig a pit privy and move it.

We ask users to deposit one handful of duff per use of the toilet. An instructional sign directs hikers to places to collect duff, and asks them to try to collect duff with deciduous leaves that have begun to decay and are rich in decomposing organisms. It directs them not to dig deep enough to create holes that could cause erosion. It is good to keep a small rake for collecting duff, since that encourages harvesting the renewable upper layer rather than digging into the soil. The sign also instructs hikers not to harvest in a spot already harvested.

Flies and other vectors have not been a significant problem. The composting privy is sweeter-smelling than the pit privy it replaces, and appears to attract fewer insects.

11.11 MOLDERING PRIVIES ON THE A.T. IN CONNECTICUT

***Dave Boone**, Chairman, AMC-CT Chapter Trails Committee*

In 2000, the Appalachian Mountain Club-Connecticut Chapter (AMC-CT) Trails Committee decided to replace all pit privies at all our A.T. campsites with a more ecologically appropriate disposal method. We were aware of the work being done by the Green Mountain Club in the use of moldering privies, and felt this technology would be a good one for Connecticut.

Our first step was to determine which of our 24 privies should be converted sooner rather than later. A weighted score was developed for each location, based on: 1) the age of the existing privy building; 2) the length of time since the privy had been relocated; 3) the environmental sensitivity of the site, based on depth to ledge and groundwater elevation; and 4) the numbers of users at each

10 Mile Shelter Moldering Privy

Brassie Brook Shelter

site, based on estimates from our ridgerunners. We then also estimated the annual "loading" for each site based on the visitor use estimates, in an effort to verify that that the usage would not overwhelm the capability of the moldering technique: We assumed the molderer would be able to treat 45 gallons of waste per season. This analysis convinced us that the moldering privy method was the most appropriate method for the conditions in Connecticut, and had the further benefits of being lower maintenance and easy for volunteers to manage. We also asked and received an approval to use the moldering privies, including introducing red worms, from the State of Connecticut Department of Public Health.

Our first molderer was constructed at our Stewart Hollow campsite in 2001. Our construction plans since that time have been refined, but basically remain as side-by-side nine-cubic-foot bins. The first constructed bin did not require to be switched over until 2006. This time frame seems to be typical for all our sites. We have since stopped using the red wiggler worms, as their use has come to be seen as the introduction of nonnative species. We initially also used pine shavings as the bulking agent, but now use naturally occurring duff. The main reason for the switch was that the shavings were being used as tinder (fires are not permitted anywhere on the A.T. in Connecticut), and further, the containers where the shavings were stored were being used as trash cans. Another refinement was the provision of access panels to the bin to facilitate stirring. This responsibility has been included as a section maintainer role, provided the maintainer is agreeable. Guidance was produced

Iinterior of accessible Privy

Moldering Privy Crib Access

and equipment provided to those maintainers agreeable to "stir" a few times during the season. This guidance can be seen in the Appendix.

Over the past decade, we have essentially met our goal of converting all our pit privies. We now are retrofitting some of our earlier attempts to make them more accessible, replacing privies buildings with privacy panels, and installing the access panels where not originally installed. The project has proven to be a vast improvement in campsite waste management.

11.12 FIELD REPORT: COMPOSTING TOILET DESIGN AND OPERATION ON THE A.T. IN PENNSYLVANIA.

***David Crosby**, former Shelters Chairman, Blue Mountain Eagle Climbing Club (BMECC)*

There are currently only two batch-bin style composting toilets in operation along the Appalachian Trail in Pennsylvania: one is located at the Eagle's Nest Shelter, and the other one is at the William Penn Shelter. The Eagle's Nest composter is the older of the two, and although they look different *physically*, the two systems are, in fact, identical in their function. They both allow the rapid on-site processing of a virtually unlimited amount of human waste into a stable, humus-like product that can safely be turned out onto the forest floor without fear of spreading disease or pollution.

The basic system has several components. The part that everyone recognizes is the toilet building, which contains a collection container under the seat. (This container can be of any convenient size; the one at Eagle's Nest is about 35 gallons.) There is also a composting bin, a compost storage platform, and a compost spreading site. A hardwood-bark-chip storage area, a mixing barrel, and a wheelbarrow and pitchfork complete the basic system. (This system was designed to operate *without* club personnel being on-site "24-7" during the composting season.)

The process itself is simple. Using human waste, *hardwood* bark chips, water, and oxygen, the naturally-occurring *aerobic* (oxygen-using) bacteria in the soil are encouraged to rapidly multiply and devour the nutrients within the compost, while generating such high temperatures that the pathogens within the pile are either starved or cooked! (No softwood bark is used, because softwood bark contains naturally-occurring bacteriostats that will shut down the system.) Once the system is operational, the ammonia-like odor that is commonly associated with older "pit-privies" and most sealed-vault privies is absent, since this odor is generated only by *anaerobic* decomposition (in the absence of oxygen).

Toilet users are asked to "flush" by tossing a handful of bark chips down the hole (this helps to absorb excess liquid, and it also helps to limit odors). When the collection container under the seat is nearly full, it is removed from underneath. The waste and bark chips that have already been deposited by the users are transferred to the mixing barrel (a few pitchfork-fulls at a time), where they are mixed thoroughly with additional bark chips at the approximate ratio of one part waste to three to five parts bark chips. (This helps to adjust the carbon/nitrogen ratio to a level where the digesting bacteria can thrive and work. At the same time, the chips act as both an absorbent and a bulking agent, soaking up excess urine and providing air-spaces within the pile.) When the mixing barrel is nearly full, the material is transferred to the composting bin, and the process is repeated until the collector is emptied. The collector is replaced under the seat (with an inch or two of fresh bark chips at the bottom to absorb new liquids), and the composter is covered and locked down to prevent unauthorized access.

The composter is allowed to operate for about a week; during this time, the temperatures at the core of the compost pile begin to climb from "ambient" through 120° (during the first three days) up to 140° to 160° (during the last half of the week). Pathogens within the compost pile begin to be killed off by a combination of these high temperatures and "competition for nutrients" with the bacteria that are producing these high temperatures. At the end of the week, the compost bin is opened, and the compost pile is "turned inside-out," so that the material that has been composted at high temperature near the core of the pile is moved to the outer areas of the pile (to act as insulation) and the part of the pile that was near the outside is moved into the core, so that it can compost at high temperature. At this time, if the pile needs water (if it appears dry or powdery), or if the pile needs bark chips (if it appears soggy in places), these adjustments can be made. Then, the bin is covered and locked, and it is allowed to operate for another week. This two-week cycle constitutes a "run," and four to six runs are needed for each pile.

At the end of this time, the pile is turned out onto the compost storage platform, where it is allowed to age for twelve to eighteen months under cover, during which time local soil microbes and invertebrates invade the pile to complete the composting process. After this, the compost is turned out onto the forest floor as a safe, stable humus-like product.

The system is very flexible, both in terms of siting and of capacity. The Eagle's Nest system was built on a large flat area with steps up to the "throne room" and had a second composting bin added after several years of operation. The William Penn system was built into an embankment that puts the operator on a slightly lower level than the user, and was designed with a second bin for added capacity. Bags of bark chips are brought in to the site yearly (part of this importation is by vehicle and the rest is by wheelbarrow); they are stored on-site until used.

Care should be taken during the design of this system to allow the operators enough room to move around the area so that the contamination of clothing does not become an operational issue. Also, make certain that there is enough space under the seat for a collector that will hold a large enough volume of waste so that the operator will NOT have to empty it more than a few times a year, since this is the most objectionable part of the process! The area under the seat should be lockable. A sign on the compost storage platform (warning the "casual passerby" that there is human waste stored on the platform) may also be helpful. The compost spreading site should be situated away from normal traffic areas. If the absence of water on-site during the composting season is anticipated, rainwater collection (using rain gutters and downspouts and a rain barrel) should be considered.

BMECC has been using Rubbermaid containers for the collectors, the mixing barrels, and the composting bins since the first unit was brought on-line in 1988. While the large 20-bushel utility truck makes a slightly-smaller-than-ideal composting bin, it requires no construction except for a solid lid, it is very easy to install, and it is extremely durable. *(Note: The writer is currently employed by Rubbermaid Commercial Products, but was not so employed when these systems were designed and built.)*

11.13 MOLDERING PRIVIES IN MARYLAND

Charlie Graf, Privy Chair Emeritus, and John Hedrick, President, Potomac Appalachian Trail Club (PATC)

PATC's interest in moldering privies began about ten years ago with the publication of the ATC *Backcountry Sanitation Manual*. Initially it took some discussion with the appropriate state agency to obtain permits to construct two moldering privies at Annapolis Rocks in Maryland. This area is a high-use campground accessed from the Appalachian Trail. By the end of 2012, PATC will have 22 moldering privies installed along the A.T., at rental cabins, and at other trail shelters in four states.

One privy at Annapolis Rocks was a standard size PATC privy and the other a newly designed universally accessible privy. The standard size PATC privy building has been in use for more than 30 years. It is four foot square with a 16-inch front porch and is prefabricated off

Annapolis Rocks - Upper Privy

Annapolis Rocks - Lower Privy

site for easy transport to the privy site. It has served PATC very well over the years and several privies still in service are more than 35 years old. The privy is inexpensive, attractive, easy to maintain, effective, and durable.

The accessible privy is similar to the standard privy in design but is expanded by two feet in width and depth. It has a riser for the toilet seat instead of the usual bench and the riser can be switched from side to side as the waste material builds up below the seat. The original version that was built at Annapolis Rocks has a swinging door that opens in and out to facilitate the passage of a wheelchair in both directions.

Our composting crib is built of pressure treated 4 by 4-inch timbers to a height of 35 inches and is 4 feet by 8 feet on the sides. It is divided in the center by additional cribbing of 4 by 4s, providing two equal size compositing bins with a volume of 30 cubic feet each. Both bins are covered inside and out by screen wire and by ¼-inch hardware cloth to exclude insects, mice, and other critters. This system has proven to be most effective and has been accepted for use in Shenandoah National Park (SNP). We will have installed eight standard size moldering privies and one accessible privy in the park by the spring of 2012.

Our moldering privies at Annapolis Rocks have been in use for about ten years. They were both shifted to the second bin after six years of use. Throughout the first six years the privies were closely monitored and the "stalagmite" that builds up under the seat was knocked down periodically and the material evenly distributed throughout the bin. To all appearances the material broke down very rapidly into black crumbly top soil. At no time did we experience any unpleasant odors from either of the privies. Since the buildings have been shifted onto bin number two, the overseer has checked the bin material and added water when needed. The material is fully composted and will be removed and dispersed in the forest away from foot traffic and water sources.

Our spare bin is covered with a sloping roof and empty bins are used for storage of bulking material and tools. The cover is constructed in such a manner to exclude vermin and the hiking public.

PATC generally uses compressed wood shavings that are obtained from farm stores where it is sold as animal bedding material. We have also used forest duff, which appears to work fairly well. We experimented with shredded bark and wood chips in Shenandoah National Park and found them to be too coarse and sometimes too wet. Users also tended to use too much bulking material when the shredded bark and wood chips were provided.

PATC uses red wiggler worms in most of our privies outside SNP and the worms are renewed each spring. SNP will not allow the introduction of an "exotic invasive" species into the park. It appears that the worms process large amounts of waste material very rapidly and increase the efficiency of the composting. We ask users to deposit a handful of bulking material per use and an instructional sign is installed inside each privy. We have not found that a urine diversion system offers a significant advantage to the process.

11.14 FIELD REPORT: MOLDERING PRIVIES IN VIRGINIA: THOMAS KNOB SHELTER ON MOUNT ROGERS, VIRGINIA

Dave Hardy, *Staff, Green Mountain Club*

Editor's Note: In 2011, just after the ATC biennial in Emory Virginia, Dave Hardy, GMC's Director of Trail Programs along with ATC's Bob Proudman and Hawk Metheny visited the accessible moldering privy at nearby Thomas Knob Shelter on the A.T. in Mount Rogers National Recreation Area on the George Washington/ Jefferson National Forest. This privy is based on the USFS Region 8-approved accessible moldering privy design affectionately known as the "Cabana." Plans for this style of privy may be found in the Appendix.

Location: Thomas Knob Shelter is located on the edge of the Lewis Fork Wilderness near a side trail to summit of Mount Rogers, Virginia's highest peak. The shelter is located at high-elevation site and is very popular year-round.

Site Background: The shelter was built 1991. The previous waste management system was a commercially made continuous composting system with a solar powered ventilation and aeration system which never worked as well as it could have. A moldering privy was installed in 2006 with the assistance of the U.S. Forest Service and ATC's Konnarock Trail Crew.

Aesthetics: There is superior use of the surrounding forest to minimize the visual impact of this two-bin accessible moldering privy.

Finished Compost Management: Our 2011 site visit showed that finished compost was not broadcast in the surrounding forest but rather piled a short distance away from the moldering cribs. The same tight clumping of trees that aids concealment of the building appears to have presented a problem for volunteers to spread finished composted. Some judicious clipping has been done to facilitate future compost spreading behind the privy.

Privy Design: This privy is a USFS Region 8 approved "cabana" style accessible moldering privy. With the current level of use, it appears as though the active crib may require emptying after a single season of use. Under this system, in year one the active crib fills up and has one year to sit and compost while the second crib fills up. The non-active crib gets emptied after just one year of composting because the other bin is full.

Analysis: One year is generally considered not enough time for a human waste to passively breakdown and sufficiently eliminate pathogens. Best practices for moldering privies suggest a minimum of three years of composting with no new waste being added before it can be spread into the forest. A careful understanding of actual site-use data may be required to ensure appropriate privy capacity.

Recommendations:
Option 1 (recommended): Add additional capacity to the present privy.

Thomas Knob Accessible Privy
Reg 8 Cabana Design

Moldering Crib - note
plastic riser placement

Finished compost ready to
be dispered or buried

This accessible privy is missing the T-Turn around clear space

This accessible privy is missing a transfer platform

The Region 8 moldering design shows two 5½ by 5½ -foot bins. These bins can be divided in half to make two bins per end, or divided in thirds lengthwise to make three bins (or even six). The position of the toilet riser over these bins can be designed so that movement of the throne can be easily done with any those configurations. This can allow for additional crib space to be achieved without increasing the footprint of the structure. This may be the preferred option, as site and regulatory constraints could make adding an additional bin difficult.

Option 2: Construct a drying rack/screen.

The benefit of this is that it would allow managers to provide for additional composting time for waste material if it comes out of the moldering crib sooner than the minimum recommended time of three years. However, the site is close to a Federal Wilderness boundary and the U.S. Forest Service may not want to add additional infrastructure. There is also the consideration that this is an additional step for volunteers to take and requires careful handling of partially treated waste.

Option 3: Build a second privy system.

Considerations: See Option 2 for infrastructure concerns that would likely preclude this option.

Option 4: Increase waste capacity by increasing height of cribs.

Considerations: Current crib height allows for accessible sloped-access entry. This would likely create additional height, causing the sloped access to exceed eight percent grade. There is not nearly as much space gained as with the addition of more crib space. This could be a cost-effective option, but likely would be ruled out owing to accessibility requirements. We also find sloped ramps to be slippery when wet or icy.

Sloped Access Construction Comment: As noted in Chapter 8 on Moldering Privies, GMC has moved to composite decking with pressure-treated (PT) framing for additional durability and structure longevity in the field. PT exposed to ultraviolet light degrades quickly with checking and splitting and also develops a biological community on its surface that in wetter climates can make it slippery and hazardous. Composite decking now comes with wood grain patterns and avoids all the problems that pressure-treated wood develops in forest applications. Check with your regional ATC office before using manufactured and nonnative building materials on the A.T.

11.15 FIELD REPORT: MOLDERING PRIVIES IN NORTH CAROLINA

***Don O'Neal**, Trail Manager, Nantahala Hiking Club*

Nantahala Hiking Club (NHC) has been using three versions of the same moldering privy. The basic design is covered by a single roof, with a movable seat or pedestal over a large divided containment area. The larger model is working best for us. The privy has a single movable pedestal with flooring covering the unused containment area, allowing for an easily removed cover to allow adequate working space (3 by 3 feet) to move/remove compost. The containment area is 3½ by 3½ by 4 feet, which is more than adequate for the traffic we are experiencing. We have left a door in the cribbing to be opened from the bottom rear to allow for spreading of the fecal cone to ensure better composting and less cone build up.

NHC continues to use a cup of leaves or duff for the bulking agent. The club is encouraging visitors to use the woods for urination. Red worms were used only one season, but did not seem to make a difference in the composting of materials. Our local weather and soil conditions contribute greatly to the efficiency of our privies. Odor is not a problem unless hikers do not use the leaves and duff. After one year, the fecal cone is well composted with minimal toilet paper left. The compost spread in the nearby woods cannot be distinguished from forest soil on inspection.

The challenges with this system for NHC are as follows:

1. Getting the privies in place—more material to haul.

2. Trash in the containment area. Personal hygiene products and plastic are a constant problem, and large plastic bags inhibit composting.

3. Using duff as a bulking agent. Lots of hikers do not take the time to replace leaves and duff.

4. Insects as rule have not been a problem if duff used. A more serious problem has been discovering white-faced hornets had nested in the privies.

Despite early skepticism by some, overall NHC has been very pleased and impressed with the functioning of the privies. The privies that work best are the ones with the largest cribs and get an occasional stirring.

11.16 FIELD REPORT: MOLDERING PRIVIES IN GEORGIA

Darleen Jarman, *Conservation Director, Georgia Appalachian Trail Club*

The Georgia Appalachian Trail Club (GATC) built its first moldering privy in 2001. Prior to that, we had traditional pit privies at many of our shelters, but no privies at others. We decided to try a moldering privy to see if it would be less labor intensive, have fewer odors, and be less damaging to the forest. Our first moldering privy was built with our traditional outhouse placed over one of two adjoining four by four by three foot cribs constructed of 4 by 4 timbers. When the crib became full, we slid the outhouse over the second, empty crib, and covered the full crib with a sheet of plywood. While the second crib was filling, the first one moldered, and the waste pile shrank to half of its original height. When the second crib became full, we emptied the first one by digging a shallow trench, approximately six inches deep, away from the privy, and spread the moldered waste in the trench. We then covered the trench with the removed soil, allowing the waste to finish decomposing.

We were curious about the amount of fecal bacteria that remained in the moldered waste when it was removed from the crib. A GATC member who was a professor at North Georgia State College and University tested it for us. The first crib, which took 31 months to fill and sat idle for 21 months, had a fecal bacteria count lower than that allowed in

Two access doors allow for easy and sanitary leveling of the waste pile recreational water. The second crib, which took 21 months to fill and sat idle for 14 months, had a fecal bacteria count close to zero.

Since the first moldering privy appeared to be working well, in 2004 we began building them at our other shelters. The design of the upper structure was changed to conform to mandated accessibility guidelines. The cribs remained three feet high but were enlarged to five by five feet, and the floor of the outhouse was also enlarged to five by five feet. Privies of this design were built in 2004 at five of our shelters.

In 2005 as we planned for more moldering privies, the Region 8 office of the U.S. Forest Service joined the process and made suggestions about changing the design of the privies to make them more attractive and more durable. The crib structure remained ten by five by three feet, but the upper structure was designed with an external wall surrounding the entire structur, rather than just half, and with a roof covering the entire structure. As privies with this design were built at our remaining shelters, several modifications were made over time to minimize the amount of labor needed to shift between the bins and to make it easier for maintainers to access the waste piles for leveling. Hinged panels were added to the floor in front of and beside the riser so the leveling could be done without going through the toilet seat. All of our 14 privies have been modified to conform to this design. Another change we are implementing is adding metal hardware cloth and screen on the outer edges of each crib. In the privies where plastic or nylon hardware cloth and screen were used, animals ate or dug through the barrier and gained access to the waste pile.

GATC uses wood chips as the bulking agent in our moldering privies, taken to the site by the privy maintainers. A sign is placed in each privy asking users to place a small handful of chips into the privy after each use. Transporting the chips to each privy is a big job for the maintainers, especially at the more remote or more heavily used privies. In recent years, we have placed

moldering bin new contents awaiting breakdown

GATC volunteers removing finished compost

one or two 55-gallon drums at each privy and have enlisted the help of various groups of people to fill the drums. We considered using leaves and forest duff obtained around each privy rather than wood shavings, but decided against that because of the damage to the forest floor that would result. Some of our maintainers have added red wiggler worms to the privies. That use has not been consistent, and we have seen no evidence of the worms remaining when we have emptied the moldered bins.

In each privy we post a sign with instructions for use. These instructions include adding a small handful of chips and closing the lid

GATC Gooch Mountain Accessible Privy Reg 8 Design

of the riser after use. Initially we also asked users to "pee in the woods" rather than in the privy. We were concerned about the additional odor created by the urine and about the pile becoming too wet. After several years of use and after consulting with other privy operators along the A.T., we removed the directive about no urine in the privy. The waste piles have not become too wet, and there is little odor unless there has been recent use of the privy.

In the past two years, we have seen increased use at several of our privies. At two of them, the bin in use is almost full, and the moldering bin has not had enough time to finish the process. We do not like the two options available to us—emptying a bin that has not decomposed or closing the privy and encouraging hikers to "cat hole." We have petitioned the Forest Service for permission to increase the footprint of these two privies by adding a third crib and enlarging the upper structure consistent with the new dimensions of fifteen feet by five feet. We are optimistic about making this change in 2012.

We know that factors that contribute to the decomposition process include temperature and moisture as well as amount of use. It appears that heavy use is the factor causing our problem at these two privies. They are located in the first 20 miles of the A.T. and are popular throughout the year as well as during thru-hiker season. A crib can be half-filled in March and April, and when moderate use continues throughout the summer and fall and into early winter, there is not enough time for the waste pile in the other crib to fully molder. With the increasing popularity of this section of the Trail, we are hoping to be able to deal with this heavy use and to keep our moldering privies functional.

Moldering privies have eliminated the deep holes full of undecomposed waste around our shelters that we experienced with pit privies, but they have not reduced the amount of labor needed for privy maintenance. Section overseers regularly carry wood chips to the privies and occasionally have to level the waste piles. Groups of workers are needed to shift bins just as were needed to dig holes for pit privies. A big advantage of moldering privies, however, is that their odor is less than that of pit privies, and they are kinder to the forest. GATC remains committed to the use of moldering privies, and we will continue to work around any challenges that develop in the future.

12 The Decision-Making Process

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This chapter has three portions.

1. Section 12.1 is a general discussion of the process of determining the best option for disposal of human waste at a backcountry site.
2. Section 12.2 is a case study showing how a particular consideration—the feasibility of depending on volunteers for operating a demanding sanitation system— affects the choice of a system.

3. Finally, Section 12.3 is a matrix listing the characteristics of various backcountry sanitation systems. The matrix is intended as a systematic guide to deciding which system is best for your site.

12.1 DETERMINING THE BEST OPTION

The decision to provide sanitation facilities at a backcountry campsite is a major one for Trail maintainers, clubs, and land-managing agencies. Providing sanitation facilities requires a substantial expenditure of time and resources, both financial and human, for maintenance during the life of the system as well as for its planning and installation.

The challenge is to choose which system best balances the needs and limitations of the site, the needs and limitations of the maintaining organization, and any related impacts.

Sites for advanced sanitation systems—Any site where wastes accumulate faster than they break down in cat-holes or pit privies is a candidate for an enhanced backcountry sanitation system. The site must be able to absorb wastes left by hikers and campers, or wastes must be removed from the site, to ensure that the natural resource is not damaged and public health and safety are not compromised.

An enhanced sanitation system is recommended for sites that receive more than about ten overnight visitors per week, or the equivalent, and that have any of the following conditions:

1. Soils that are shallow (less than four feet to bedrock, hardpan, or seasonal high water table).
2. Soil that is poorly drained—that is, it is fine textured (such as silt or clay) or a bog soil.
3. A location that is closer than 200 feet to ponds or streams.

An enhanced backcountry sanitation system may also be advisable for sites where soils are adequate for pit privies, but use is high enough that pits are filled and the toilet is moved frequently, and where the number of pits threatens groundwater—or where it is becoming difficult to find unused sites for pits. Advanced backcountry sanitation systems are unnecessary if use is very low (less than 100 persons per season). A simple enhanced system, such as a moldering toilet, could succeed with attention only once or twice a year. However, it is inadvisable to attempt a more complex sanitation system without enough volunteers or field personnel to operate the system. Some enhanced systems require maintenance at least two times a month, unless usage is very low. Weekly or even daily attention may be required with some systems at high- to very high-use day and overnight sites.

Site Examination—A site must first be evaluated to consider access to the site, placement of facilities, suitability for handling of sewage and compost and for storage of bulking agent, tools, and other items, and for its capacity to absorb finished compost with acceptable impact.

Examine and map the surface water flow on the site, and try to identify subsurface flows. Identify areas suitable for spreading composted sewage.

Topography may limit where you can put certain kinds of toilets, and that may influence or determine which type of system is appropriate. Toilets should be as far from the water source as possible, which dictates siting them in the opposite direction from water. System components should be near but behind the outhouse, so hikers will not have to walk past composting operations to use the privy.

If the site is wet, the outhouse and any components should be placed on platforms. A consistently wet site precludes some systems, particularly a moldering privy. The area should be ditched, to direct surface and shallow subsurface flows around and away from installations such as an outhouse, bin, and storage platform. The trail to the outhouse should be hardened, and large flat rocks or other firm surfaces should be provided for maintainers to stand on while working on the system.

12.2 THE ROLE OF VOLUNTEERS AND FIELD STAFF IN MAINTENANCE OF A REMOTE BATCH-BIN COMPOSTING SYSTEM ON VERMONT'S LONG TRAIL

Paul Neubauer, *former Staff, Green Mountain Club*

On the Appalachian Trail in southern Vermont, the Brattleboro Section of the Green Mountain Club (a section is a semiautonomous chapter of the club) maintains a batch-bin composting system at Spruce Peak Shelter. The section has managed to maintain the system, but it has been a challenge. Another club considering installing a demanding sanitation system should consider carefully whether its members are up to the job.

The arrangement at Spruce Peak Shelter could be replicated elsewhere on the A.T., especially where ridgerunners employed by the Appalachian Trail Conservancy (ATC) or the land-management agency patrol nearby. The Mountain Club of Maryland and the Blue Mountain Eagle Climbing Club in Pennsylvania have established such relationships to maintain batch-bin and Clivus Minimus composting systems.

Spruce Peak shelter has become increasingly popular with both thru-hikers and day- hikers, so the sewage volume has surged. To cope with this, GMC's field staff helped the section install a 70-gallon catcher in the outhouse to avoid overflows when the volunteer operator can't get to the site frequently. The section cooperates with GMC's seasonal field staff, which is stationed nearby, to ensure that the batch-bin system is checked and serviced properly.

This experience has shown that getting a system up and running is daunting for a volunteer group, partly because most of the members generally do not have prior experience with such installations. After installation, it is a major group effort to maintain the structures and transport the bulking agent (bark, shavings, and/or other materials).

However, if no major repair work is required and there is storage for a large stockpile of bulking agents to accommodate the irregular availability of volunteers, a batch-bin composting system can be maintained by a dedicated individual volunteer or group, provided use of the site does not exceed 100 to 150 overnights per season. There also must be a large catcher in the privy and reasonable access to the site.

The big challenge comes when a batch of compost is being run through the process, and the pile should be turned every three to five days. If a maintainer cannot visit the site regularly during a run, he or she must allow more composting time to assure effective treatment of the sewage. This may require ample storage capacity to accumulate sewage awaiting the next run.

Turning at longer intervals increases the chance that some sewage will not be subjected to a sufficient period of high temperatures. However, if a system at a low- to medium-use campsite is well-managed, lengthening the compost run period and increasing the time the compost is retained on drying racks can compensate for this.

Of course, volunteer operation of a batch-bin composting system is impossible if a club chooses to prohibit volunteers from handling sewage.

12.3 BACKCOUNTRY SANITATION SYSTEM DECISION MAKING MATRIX

Definition of terms—The matrix below is a guide to the process of deciding which sanitation system is suitable for a backcountry site. Each system is discussed according to the following terms:

Principle at work—The biological process operating in the system. See Section 3 of this manual, "The Decomposition Process." On the A.T. there are two types of anaerobic systems, four types of low-temperature aerobic systems (moldering, or slow composting), and two types of high temperature aerobic systems (thermophilic, or rapid composting).

Site preferences—Topographical and other site factors affecting the choice of system: size, slope, ground type (*e.g.*, ledge or boulders) and moisture content, tree cover, orientation requirements (*e.g*,. facing south), road access. See Section 3 of this manual, "The Decomposition Process," along with Sections 7–11 and the listings of clubs and manufacturers in the Appendix.

Environmental limitations—Limiting weather conditions, soil qualities, or energy requirements such as wind or sun. See Sections 7–11 of this manual, and the listings of clubs and manufacturers in the Appendix (except for pit privy, vault toilet, and Penn. composter).

Level of use tolerated—System capacity, the factors that affect it, and how system effectiveness may change with increasing use. See Sections 7–11 of this manual, and the listings of clubs and manufacturers in the Appendix.

Breakdown process—The effect of the principle at work on the system's operation. For example, whether the system requires a short or long retention time of composting material. See Section 3 of this manual, "The Decomposition Process."

Regulatory issues—Permits and environmental assessments, such as National Environmental Protection Act (NEPA), required by local, state, and federal authorities; approvals required from local clubs, land managers, and ATC. See Section 5 of this manual, "The Regulatory Process."

Sanitation issues—Risks of contamination to the operator, the hiking public, and the area's natural resources. Tolerance for error in operation. Requirements for handling raw material and removing finished material. See Section 4 of this manual, "Health and Safety."

Aesthetic issues—Impacts of the system on the experience of site visitors. See Section 6 of this manual, "Aesthetic Issues."

Installation issues—Complexity of installation and skills required. Transportation requirements (such as helicopter, truck, pack stock, backpacking). Structures required for housing components. Auxiliary components, such as a liquid management system or drying rack. See Sections 7–11 of this manual, and the listing of clubs and manufacturers in the Appendix.

Cost of installation—The basic cost of the components of each system. Additional costs of permits, labor, transportation, and construction also must be considered. See Sections 7–11 of this manual, and the listing of clubs and manufacturers in the Appendix.

Labor for installation—Requirements for paid and volunteer labor for installation of the system. See Sections 7–11 of this manual, and the listing of clubs and manufacturers in the Appendix.

Operation issues—Frequency and type of attention required. See Sections 7–11 of this manual, and the listing of clubs and manufacturers in the Appendix.

Cost of operation—The daily, weekly, monthly, and yearly costs. These might include additives, biological accelerants (*e.g.*, enzymes or red worms), and bulking agents (*e.g.*, bark mulch, shavings or duff); energy (*e.g.*, solar systems or batteries); and replacement parts (*e.g.*, fans, mixing blades, pumps, *etc.*). See Sections 7–11 of this manual, and the listing of clubs and manufacturers in the Appendix.

Labor for operation—Requirements for paid and volunteer labor for operation; need for a service provider from the manufacturer of the system. See Sections 7–11 of this manual, and the listing of clubs and manufacturers in the Appendix.

HOW IT WORKS Dig as deep a hole in the ground as possible while staying 18 20” above the seasonal high for the water table. Then mount a simple structure on top. Waste collects in the pit. When the pit fills, the privy is moved and the hole is covered.
Anaerobic and malodorous breakdown of pathogens in pit may take decades to fully decompose.

SITE A dry site in which to dig the pit, with deep soils and a low water table.
Environmental factors that challenge use: Little or no soil, a ledge, a high water table, soils that don’t drain well, and steep slopes; clay soils that do not drain at all.

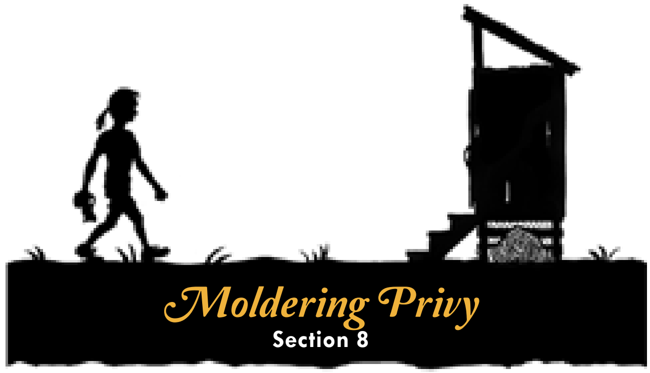
LEVEL OF USE <500 visitors/ season. Varies with size of pit and ability to dig new pits and move privy.

REGULATORY ISSUES Some states do not permit pit toilets, others may have regulations regarding pit construction. Check with your ATC regional office. The USDA Forest Service and National Park Service must comply with NEPA.

SANITATION ISSUES Must be well vented and screened to prevent odor and flies. May cause ground water contamination. Pits must be properly capped with three to four feet of soil when full.

INSTALLATION From $200 $600 in lumber and supplies. Two to three days of labor to build the structure. A day’s work to dig the pit. Transportation to the site.

LABOR Privy must be moved periodically. The size of the pit and the frequency of use determine the need to move pit.



HOW IT WORKS An above ground chamber (crib) is constructed to collect the waste. Liquids drain through the pile and into the soil, thus allowing oxygen to access the waste so aerobic decay can take place. Pathogen reduction is achieved by retention time in the system, not heat. Breakdown and pathogen reduction is enhanced by local decomposers and the addition of red wiggler worms.

SITE A dry, level site is preferable. Locate the unit on ground with more than 4” of soil to help absorb liquids. Trees help to shade the unit and keep the pile moist and the worms happy.
Cannot be located on ledges, swampy or wet ground, high water table, or nearer than 200 feet to water.

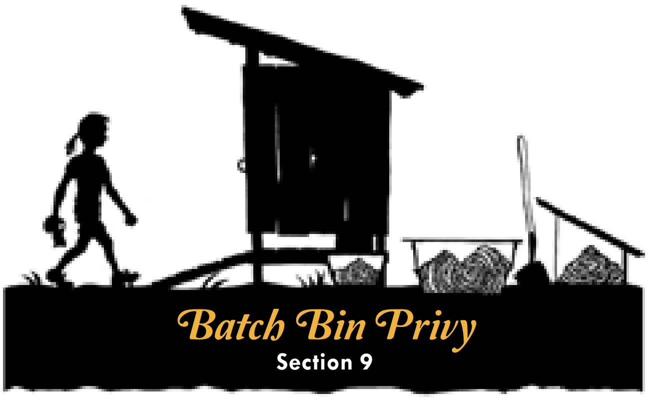
LEVEL OF USE <500 visitors/ season.
They could be used at a higher use site if enough cribs were constructed.

REGULATORY ISSUES System remains experimental: Has been approved for where it has been implemented. Check with the appropriate land manager and ATC regional office before installing.

SANITATION ISSUES The goal is to have enough storage capacity to allow a long retention time for the waste in the crib—six months to a year ensures the greatest level of pathogen reduction. Health hazard to the maintainer is a potential risk.

INSTALLATION $400 to $1000 in materials.
Crib work must be constructed properly for efficient and safe function.

LABOR Minimal. Periodically packing in compressed wood shavings and red worms should be added every spring. Maintainers should visit the unit periodically to make sure enough wood shavings are being added and to knock over the waste cone and mix the pile.



Batch Bin Privy
Section 9

HOW IT WORKS Sewage is caught in a collector (catcher). It is then mixed with hardwood bark chips by hand and put into a bin where it is composted. Pathogens are primarily killed by exposure to high temperatures. Remaining byproduct is placed on a platform (drying rack or screen) to cure and then is eventually scattered and some bark chips re used.

SITE Can be adapted to a variety of site conditions. Environmental factors that challenge use: extreme slope combined with ledge; extreme cold (where the average mean temperature never gets above 40 degrees Fahrenheit.

LEVEL OF USE High: in excess of 1,000 overnight visitors during the typical hiking season of twenty weeks. To accommodate higher use, a second compost bin and drying rack/screen can be added; a beyond the bin system can be added to reduce amount of bark mulch needed and thus volume.

REGULATORY ISSUES Should not require NEPA documentation, but check with the appropriate land manager and ATC regional office before installing.

SANITATION ISSUES Tests indicate that a "run" that is done properly leaves few pathogens. Health hazard to the operator is a potential risk. Low tolerance for error in operation.

INSTALLATION $1000 to $3,000. Must purchase a "catcher," one or more compost bins, and a sifting screen. Depending on the system used, two storage cans must also be purchased and a drying rack/screen built.

LABOR Labor intensive. Requires operator to mix and turn waste by hand. High use sites may need to be composted biweekly, which takes several hours. Ongoing transport of bark chips to site as a bulking agent is required.

Beyond the Bin
Section 10

HOW IT WORKS Same concept as the batch bin composting, but uses a special system to drain the liquids off and then treat them. That reduces the amount of bark required and the risk to the operator from "splash back." Pathogens are primarily killed by exposure to high temperatures (100 degrees Fahrenheit and up).

SITE Can be adapted to a variety of site conditions. A slope is preferable to get gravity flow of liquid to the filtering barrel.

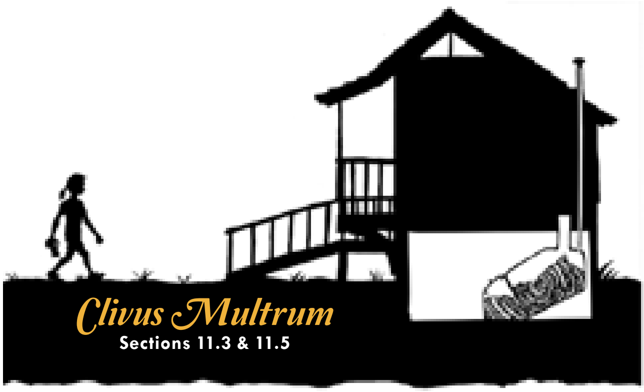
LEVEL OF USE High: in excess of 1,000 overnight visitors during the typical hiking season of twenty weeks.

REGULATORY ISSUES Should not require NEPA documentation. May require a state wastewater permit. Check with appropriate land manager and ATC regional office before installing.

SANITATION ISSUES Tests indicate that the liquid that is separated out is treated sufficiently to be released into the ground. Hazards for the operator are still present. Appropriate precautions are advised. Low tolerance for error in operation.

INSTALLATION $2000 to $3000, $1,000 more than batch bin. Complex installation that requires some basic plumbing experience. Otherwise, same as batch bin.

LABOR Labor intensive, same as batch bin system. Beyond the bin reduces the bark consumption by a third. The piping must be disconnected in the winter months where freezing is an issue and reconnected in spring. Replacement of filter components is labor intensive, but fortunately is infrequent.



HOW IT WORKS A commercial system sold by the Clivus New England Co. of North Andover, Massachusetts. Waste is collected in a large, ventilated, waterproof tank with an incline that stimulates self turning as the waste decomposes. Wood shavings, biological enzymes, redworms and bark chips are added to accelerate breakdown. Liquids must be drained and treated. Pathogen reduction is achieved through retention time in the system, not heat.

SITE May require excavating a substantial area for installation. Could be difficult to site on very steep slopes or ledge. Some systems need a power supply; in a backcountry setting photovoltaics may be needed, therefore having exposure to sun is critical. System needs soil to drain treated effluent into, or a collection system and means to transport collected leachate away for safe disposal.

LEVEL OF USE 500 or more overnight visitors a season. Contact Clivus New England for more specific information.

REGULATORY ISSUES Will require NEPA compliance. Check with appropriate land manager ATC regional office before installing.

SANITATION ISSUES A proven technology with minimal sanitation issues.

INSTALLATION Several thousand to upwards of $20,000. Complex installation that will require an airlift to a remote site. A substantial building is required to house unit.

LABOR Regular but low Weekly maintenance is called for by adding bark chips /shavings and enzymes and “knocking down the cone.”

HOW IT WORKS Waste goes into a sealed vault made of concrete or other impervious material. Waste is pumped out when full. Pathogen reduction is achieved by “treatment” of the effluent at a municipal sewage treatment plant.

SITE Road access is required. Other possibilities could be the removal of waste from vaults with aircraft or ATV. Those two would require a trail or clearing of an area for landing a helicopter.

LEVEL OF USE High, depending on use levels, size of vault, and frequency of cleaning.

REGULATORY ISSUES Must be an approved design. Federal agencies must comply with NEPA.

SANITATION ISSUES Should be an approved design that is totally contained.

INSTALLATION Several thousand dollars Must be done by contractor with experience and heavy equipment. Heavy equipment is required to dig hole and install tank. Installation costs.

LABOR Regular pumping by a licensed septic hauler must be scheduled, Several hundred dollars each time.

13 Gray Water Management in the Backcountry

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Dick Andrews, *Volunteer, Green Mountain Club*

Eric Pedersen, *former Staff, Appalachian Mountain Club*

13.1 What Gray Water Is and Why It Needs Management

Gray water is waste water that has not come into contact with feces or urine. It includes food waste, soaps ,and detergents, and hygienic wastes (see descriptions below). Typically gray water is free of pathogens. But, there are exceptions, which is why it needs management.

- •C ampers and hikers should always wash their hands after bowel movements. *Therefore, gray water may contain pathogens, so it is a potential hazard to campsite managers and users, and it may contaminate surface and ground water.* When you may come into contact with gray water, take the same safety precautions you would when managing raw sewage.
- •G ray water can ruin backcountry water sources aesthetically. There is nothing less appealing than dipping a cup into a spring with gobs of floating oatmeal, or a campsite spattered with toothpaste and spit.
- • Gray water also can biologically alter backcountry ponds and streams. Nutrients can contribute to plant and algal blooms that rob aquatic animals of oxygen when excess plants and animals die and decompose. Michael J. Caduto, in *Pond and Brook,* defines this process, called *eutrophication,* as "the over-fertilization of aquatic ecosystems resulting in high levels of production and decomposition. Eutrophication can hasten the aging process of a pond or lake due to the rapid buildup of organic remains."

Usually hikers and campers create so little gray water that this threat is minimal. However, their gray water could add to other human-caused sources of nutrients (old outhouse pits, for example) and natural sources to hasten eutrophication.

13.2 Sources of Gray Water in the Backcountry

A properly sited designated washing area, washpit, or gray-water management system, coupled with the education about low-impact washing practices described in the Leave No Trace ethic, can alert backcountry users to the growing scarcity of pure drinking water, the threat of eutrophication, and the need to keep finite potable backcountry water sources as clean as possible.

Dish washing—Dish washing in water sources water is a widespread undesirable practice that disperses food residues and nutrients from soap or detergents. Designated washing areas and gray-water management systems have helped teach hikers not to wash dishes in drinking water sources. However, inappropriately sited, poorly constructed, or improperly maintained sites and systems can themselves create point sources of surface and ground water pollution at medium- to high-use overnight sites.

Hand washing—Hygienic waste water comes from hand washing after bowel movements, and must be considered at all backcountry sites with toilets. Sanitation systems should separate toilet users from water, especially drinking water collection points, as much as possible. Sites with the toilet and shelter on opposite sides of watercourses tempt users to wash their hands in streams after using the toilet.

Toiletry—Bathing, shaving, and toothbrushing can contaminate water, especially when soaps, shaving creams, and toothpastes are used.

13.3 MANAGEMENT OPTIONS FOR GRAY WATER

Fire ring—A designated fire pit can be used to dispose of limited amounts of gray water where fires are legal. A washpit is better, but campers at a site without a washpit may be encouraged to use the fire pit.

Charcoal helps absorb odors and filter effluent, and the next fire will burn food particles too small to be packed out. However, this technique should be discouraged where bears and other animals have been habituated to human food. The fire will not eliminate all odors, and remaining odors will attract problem animals. Signage should always remind campers to pack out all food scraps. The sign might suggest that food scraps can be essentially eliminated by cooking a little less than you want to eat, scraping pots and dishes clean, and then filling up on snacks.

Designated washing area and washpit—All washing should take place well away from surface water. At a lightly or moderately used site, wash water should be scattered over a broad, designated washing area for maximum biological assimilation. However, at high-use sites washpits should be provided to discourage users from washing in or near water supplies.

Wash Water Trickle Filter—An upgrade to the traditional washpit (see full description below). It consists of a bottomless and topless wooden box that sits over a small sump dug in the ground. The box is filled with woodchips. Its main advantage is that it does not clog as easily as rocks in a washpit can, and the woodchips have more surface area and are more likely to develop a community of microorganisms capable of some removal of organic matter in the gray water.

13.4 DESIGNATED WASHING AREAS

Siting and establishing a designated washing area—Most overnight sites need only designated washing areas to keep them attractive and clean.

1. Site a designated washing area on the opposite side of the campsite or shelter from the site's water source, so the washing area will be convenient, but as far as possible from drinking water.

2. Pick a well-drained spot with plenty of soil. Look for vigorous undergrowth, which indicates biologically active soil, so gray water will be utilized by plants as much as

Gray Water Trickle Filter - note side tables for holding dishes

Bark Chips for Trickle Filter

possible. Avoid gullies with slopes to surface water. If necessary, divert surface water away from the washpit by ditches or waterbars.

3. Try to choose an area that is unlikely to expand and increase its adverse impact on the site. When possible, pick a spot that is already degraded. For example, try turning an illegal tenting area into the dishwashing area, if it meets the other criteria of a good spot.

4. Make the area easy to find. Mark it with signs, build a trail to it, and post an area map delineating the washing area.

5. Post an obvious sign asking campers to pack out all food waste and to minimize their use of soaps or detergents, because they pollute the backcountry.

Washpit construction and maintenance—Consider the following guidelines when building and maintaining a designated washpit:

1. Site a new washpit on the opposite side of the campsite or shelter from the drinking water source. This increases the likelihood that dishes, *etc.*, will stay away from the water source. If possible, make sure the washpit is visible from the shelter.

2. Pick a well-drained spot with plenty of soil. Avoid gullies with slopes to surface water. If necessary, divert surface water away from the pit with ditches or waterbars.

3. Dig a hole at least six inches deep—up to eighteen inches deep if soil depth permits—but not to bedrock or hardpan. An impervious bottom will not properly filter wash water.

4. If the soil is shallow (less than twelve inches deep), dig a runway leading from the primary pit to a second pit.

5. Fill all pits and runways loosely with flat rocks standing on edge. Use larger rocks near the bottom, smaller rocks toward the top. Leave plenty of spaces between the rocks so the pit will not silt up quickly. Cover secondary pits and runways with large flat rocks to prevent them from filling with dirt, leaves, and other debris.

6. Ring the washpit with large flat rocks for users to set pots on and to stand on, because soil compaction around the pit quickly leads to the formation of puddles.

7. Mount an obvious "DO ALL WASHING HERE" sign on a post adjacent to the pit. Hang an instruction sign on the post.

8. Place a fine-mesh hardware-cloth screen in a frame made of pressure-treated lumber covering the washpit to exclude food scraps. Even better, provide a durable metal colander with instructions to campers use it to strain wash water.

9. Re-dig and re-rock all pits and runways at least once a year, depending on use levels. Silt, food particles, and grease will eventually clog the pit, although the evil day can be put off by regularly dumping a generous amount of boiling water into the pit. Because washpits tend to be anaerobic when clogged, odors are very strong when a pit is dug up. Wash the rocks in a five-gallon bucket and replace them. Then pour the water in the bucket into the pit for disposal, following with hot water if possible.

10. Information on the instructional sign should remind hikers:

- Except for washing dishes and for hand washing after bowel movements, soap and detergents are not necessary in the backcountry. The use of shaving cream should be minimized.
- Wash nothing in streams, ponds, or lakes.
- Pack out all food scraps. Food scraps can be essentially eliminated by cooking a little less than you need and scraping the pot and dishes clean, then fill up on snacks.
- Do not dispose of grease in the pit.

- Use as little soap and water as possible to avoid overtaxing the pit.

13.5 GRAY WATER CHUTES

A gray-water chute is simply a riser that caps a washpit. Chutes are especially useful at sites that receive significant snow and winter use, because campers can find the riser as long as it is taller than the snowpack. Deep snow usually protects the ground and washpit from freezing, so the washpit will work through the winter.

Chutes also help identify washpit sites, and promote their use. On the other hand, chutes can be obtrusive, so artful placement behind at least some natural screening is desirable.

A chute should be made of durable rust-resistant metal, or wood covered with metal to keep animals from chewing it or vandals from burning it. The top of the chute should expand like a funnel and have screen cover. This generous surface area provides placement for a dishpan or camping stove, so dishes can be washed in hot water to minimize the use of soap or detergent. For gray-water chute plans, contact the AMC Huts Department.

Regular maintenance is vital—Remember that washpits and gray-water chutes require inspection and maintenance annually, if not more frequently. Consider carefully whether gray-water systems actually are necessary, and whether your club can monitor and maintain them properly. Designated washing areas are adequate for most sites.

13.6 WASH WATER TRICKLE FILTER

***Dick Andrews**, Volunteer, Green Mountain Club*

Wash water, also called gray water, is a much less serious potential pollutant in the backcountry than human waste. Its load of pathogens and solids is much lower, and the amount produced even at a heavily used site is much smaller than at a typical residence. Still, it should be managed.

In the old days of regular and large campfires, campers were sometimes encouraged to dump wash water into the ashes after the fire went out. This would help ensure the ashes were cold, and the next fire would sterilize any residue. More recently, it has been suggested that except possibly at the most heavily used sites, disposal of gray water by flinging it into the bushes well away from camp and surface water would be adequate, as surface deposits would quickly dry and be consumed by small organisms.

However, most campers do not carry gray water far enough from camp, and dishwater almost always contains bits and sometimes even chunks of food that attract nuisance animals. Thus, common practice at backcountry shelters and tent sites has been to provide a wash pit, loosely filled with rocks and topped with a screen to catch food bits. A sign asks campers to remove the intercepted bits of food from the screen and pack them out.

The downside of this practice is that eventually the spaces between the rocks become clogged, principally with grease. Either a new pit must be built, or the rocks removed from the old pit, cleaned, and replaced. Cleaning rancid grease from rocks and disposing of it is a very smelly job and one that site caretakers heartily dislike.

The trickle filter described in this article has served the Green Mountain Club successfully at several sites on the Long Trail and the Appalachian Trail for four to eight years, with high marks by site maintainers. It consists of a bottomless and topless wooden box a foot to a foot-and-a-half high, with the interior sixteen inches square viewed from the top. For long life, two-inch pressure-treated lumber is good.

The box is placed atop a shallow depression in the forest floor that catches water draining from it and lets it seep into the ground. Its sides are lined inside by a 20-gallon plastic trash bag with its bottom removed, so if water backs up it is less likely to ooze out through cracks between the boards of the box. A couple of stakes driven into the ground next to the box, with the tops screwed to the box, lessen the chance it will overturn. The box is topped with a removable screen, generally hardware cloth (for strength) overlaid by window screen, which is fine enough to catch even small bits of food. The screen frame should be screwed to the box in a way convenient for removal to accommodate maintenance.

The box is filled with wood chips to within a few inches of its top. With regular use in the Eastern climate the wood chips stay wet and comparatively cool, so grease dispersed in warm wash water poured through the screen congeals as a coating on the chips as the water drains through them. Worms and other small organisms soon colonize the wood chips and consume the grease, as long as air spaces remain between the chips.

In time, the wood chips decay or clog, and must be replaced. This time is indicated when a quart of water poured through the screen does not drain promptly. Packing in a load of dry chips is light work, and the old decayed chips can be scattered on the ground away from the site. The club has begun to experiment with wood shavings, which are even lighter to pack in than chips, but we can not yet say for sure that they are satisfactory. Other biodegradable materials might also work well.

Making the wash-water filter convenient encourages campers to use it. We generally provide a couple of short upended logs to sit on, and include a couple of shelves on the frame that holds the screen, to hold dishes and pots. This inclines campers to wash dishes at the filter.

For sites with higher use than ours, either a larger box or multiple boxes would be satisfactory, although different sizes might require different methods of plastic lining. Generally a larger installation can be expected to work even better than a small one, but we do not recommend anything smaller than the ones we have used. At sites with significant winter use, consider making the box tall enough to stand above the expected snow pack. Even if it freezes for some of the winter season, it will still work at least part of the time.

13.7 GRAY WATER MANAGEMENT AT APPALACHIAN MOUNTAIN CLUB HUTS

Eric Pedersen, *former Staff,*
Appalachian Mountain Club

Appalachian Mountain Club (AMC) huts in the White Mountains of New Hampshire use several methods for dealing with gray-water waste generated by kitchen and bathroom sinks. In some cases, gray water is combined with toilet effluent for treatment.

Huts where sewage is airlifted out by helicopter, and those with composting toilets, have running water in the kitchen and in the toilet rooms for washing and drinking. Those huts have grease traps and septic systems for kitchen and lavatory sink water. After gray water leaves a grease trap, it typically goes through a prefilter, an automatic doser, and an open valve to a filter tank and leach field.

Every hut but one has a grease trap with a capacity of 1,000 gallons. Lakes of the Clouds Hut, with a capacity of more than 90 guests, has a 1,500-gallon grease trap.

Caretakers clean grease traps daily by skimming and removing the contents. They check prefilters to guard against overflowing, and check dosers to ensure the flappers swing freely. Leach fields are rotated weekly by opening or closing valves beyond the automatic doser. Each hut has from one to four sets of filter tanks and leach fields; only one field or tank is used at a time. Conforming with state requirements, the AMC is eliminating chlorine-based dosing systems, and is changing to simple doser systems.

Zealand Falls Hut, Lonesome Lakes, and Carter Notch Hut have gray-water chutes, which are essentially dry wells (a washpit with a waist-high metal chute and screen—see above description), for disposing of dish water in winter. They are left idle through the spring, summer, and fall, which allows them to dry and prevents odor. Caretakers are responsible for maintaining screens so trash and food do not go down the chutes, and for seeing that grease is excluded, because it will not decompose under the anaerobic conditions typical of the pits.

Though the AMC has used a variety of methods of disposing of gray water, the club strives for subsurface disposal through perforated pipes conforming to state codes, because of the ease of maintenance and monitoring.

For further information on the gray water systems used by the AMC, contact the AMC Huts Department (see Appendix for contact information).

13.8 REGULATORY ISSUES

Some states may require consultation or permits in the process of establishing a gray-water management area or system. Check with your ATC regional office before establishing an area or system. See the Appendix for contact information for regional offices and regulatory agencies.

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A Glossary of Terms

Dick Andrews, Volunteer, Green Mountain Club

ACTINOMYCETES Single-celled, mostly aerobic organisms, closely related to bacteria, but structurally similar to fungi. They function mainly in the breakdown of cellulose and other organic residues resistant to bacterial attack. Several, such as Streptomyces, produce antibiotics.

AEROBIC Requiring the presence of air or free oxygen for life.

ANAEROBIC Living in the absence of air or free oxygen.

BACTERIA A numerous class of both aerobic and anaerobic microscopic organisms. They may be harmful or beneficial Some cause disease in humans and animals; others fix nitrogen from the air and decompose toxic wastes. Aerobic bacteria are active in composting.

BATCH-BIN The technique of composting organic material in large, covered waterproof containers at elevated temperatures, one batch at a time.

BEYOND-THE-BIN A refinement of batch-bin composting in which liquid is separated from solids and treated separately.

BIOLOGICALLY ACTIVE SOIL LAYER Soil near the surface of the ground in which organic material is abundant and many organisms live, including but not limited to bacteria, fungi, worms and insects. This soil layer typically is moist, but loose enough to contain many small air-filled voids.

BULKING AGENT A material added to dense, wet and/or nitrogen-filled organic materials to facilitate composting. Bulking agents typically are high in carbon, are capable of absorbing liquid, and are finely divided to provide a lot of surface area. They have enough strength to resist compaction and provide numerous small air pockets, but do not tangle or otherwise impede mixing. In some cases it is useful if the bulking agent contains splinters or other strong, sharp pieces to help chop wet wastes during mixing. Examples of bulking agents useful in composting human waste include bark mulch, shavings, forest duff, and chopped straw.

CHUM TOILET A toilet without a shelter to provide privacy or protection from weather. Chum toilets typically have been installed at pit privies, but they can also be installed on moldering privies, vault privies and any other type of toilet that needs no protection from the weather.

COMPOSTING The decay or decomposition of organic material by the action of fungi, micro-organisms and invertebrates in the presence of air. Bulk is substantially reduced, and the end product is a humus-like material with an earthy odor.

CONTINUOUS COMPOSTING Composting in which organic material is added a little at a time and in which decomposition proceeds at a rate approximately equal to the rate of addition of wastes. Since the rate of adding waste is usually slow, an elevated temperature does not normally occur, although it could happen in a large compost pile that is receiving new waste at a high rate.

FUNGI Plants, both microscopic and visible, which do not have chlorophyll, and therefore cannot synthesize their food from air, water and sunlight. Fungi live on dead or living organic matter, and include mushrooms, mildews, molds, rusts and smuts. They are a principal agent of decomposition during composting.

LEACHATE Liquid which has percolated through a porous mass, dissolving some of the solids in the mass on the way. In systems composting human waste, leachate is formed when urine or rain water percolates through feces and/or bulking agents. It may or may not contain pathogens, depending on the conditions under which it formed.

MESOPHILIC Growing best at moderate temperatures, from 10 degrees C. to 40 degrees C. (50 degrees F. to 104 degrees F.). Mesophilic organisms also will grow between 4 degrees C. and 10 degrees C. (40 degrees F. to 50 degrees F), and between 40 degrees C. and 45 degrees C. (104 degrees F. to 112 degrees F.), but at these temperatures they grow more slowly.

MOLDERING PRIVY A mesophilic continuous -composting toilet in which human waste and bulking agent are deposited directly on a pile contained in a crib beneath the toilet but above ground level, separated by screening or other barriers from insects or other disease-carrying vectors, and decomposes at ambient temperature. Redworms (also known as manure worms) may be added to speed composting.

PARASITE An animal or plant that lives in an organism of another species, known as the host, from which it obtains nourishment. Except in symbiotic relationships, parasites impair the health of the host.

PATHOGEN Any disease-producing organism.

PATHOGEN ENCAPSULATION A process in which pathogens form durable hard outer coatings that protect them from damage by adverse environmental conditions. PH A numerical representation of the acidity or alkalinity of a solution. A pH of 7 indicates a solution neither acidic nor alkaline; lower numbers indicate acidity, and higher numbers indicate alkalinity. Each unit up or down indicates a tenfold change in the strength of acidity or alkalinity. Composting is inhibited if the pH is too high or too low.

PIT PRIVY A toilet in which feces and urine are deposited directly into a pit in the ground.

PROTOZOA Microscopic animals consisting of one cell or a small colony of similar cells. Some species cause serious intestinal diseases in people.

SEPTAGE (DOMESTIC) Sewage generated by households. Domestic septage contains human waste and wash water, but not industrial or commercial waste.

SUBSTRATE The base or material on which an organism lives. In composting, it is mostly the pieces of bulking agent.

THERMOPHILIC Growing best at elevated temperatures, from 45 degrees C. (112 degrees F.) to as high as 75 degrees C. (167 degrees F.).

VAULT TOILET A toilet in which feces and urine are deposited into a waterproof vault, or tank, which is periodically pumped out. The sewage is then hauled to a central sewage plant for treatment.

WATERSHED The area drained by a stream or river.

WATER TABLE The upper surface of ground water. Below the water table, the soil or rock is saturated with water; above the water table, soil may be moist, but it includes small voids filled with air.

B Troubleshooting and General Composting Tips

Pete Antos-Ketcham, Staff, Green Mountain Club

B.1 Troubleshooting Batch-Bin and Beyond the- Bin Systems

Below are descriptions of the most common problems in composting systems. Potential causes are listed after each problem, followed by recommended or suggested solutions. Problems affecting batch-bin and beyond-the-bin composting systems are addressed first, followed by those affecting continuous composting systems. Finally, there are a few general composting hints.

PROBLEM: The temperature of the compost pile won't climb into the mesophilic or thermophilic range.

Cause 1: Too much decomposition occurred while material accumulated in storage cans, so the final addition of sewage from the full catcher was not enough to send temperatures into the mesophilic or thermophilic range. (That does not happen with the AMC system, since storage cans are not part of the system.)

Solution: Do not re-contaminate the pile with more fresh sewage. Turn and mix the center portion only, and adjust moisture by adding water if the pile is too dry, or adding bulking agent if it is too wet. Allow composting to run again for as long as possible, at a lower temperature if need be. If storage capacity permits, add several extra turnings to the run. Store compost on the drying rack for additional aging.

Cause 2: Compost left in the bin over winter has decomposed and lost enough nutrients to keep the pile from heating. (That situation is of no concern in the AMC system, since compost is left over winter in only one bin, and it has already been through one or more cycles of heating in the first bin.) If the compost does not appear finished, proceed as for Cause 1. If the compost does appear finished, add no fresh sewage; transfer the most composted portions to the drying rack or screen, and continue to turn it on the rack.

Cause 3: The pile is too dry. Water in the waste may have been absorbed by excessive bulking agent in the catcher, storage container or compost bin.

Solution: Adjust moisture in the pile, and allow the compost to run again. Use compost from the bin in place of bark when mixing and breaking up any new wastes. Add water if needed. Water can be sprinkled on, or the bin lid can be removed during light rain (do not leave the bin unattended with the lid removed, or a downpour could reverse the problem). The ideal moisture level is just below that at which water will appear on the bottom of the bin.

Cause 4: The pile is too wet. This also tends to compact the pile, reducing oxygen availability. The wastes may have been too wet to begin with; there may not have been enough bulking agent; the bulking agent may have been the wrong kind or too wet; or a lid may have been displaced by wind, curious hikers or some other cause, letting rain or snow into the system.

Solution: Soak up excess water by adding dry bulking agents to the wettest part (usually the lowest point in the bin). Peat moss is more absorbent than hardwood bark mulch, so it will not bulk up the pile as much as bark mulch, but it is a poor composting substrate, and should be used only as a last resort.

If bark or peat moss are not available, add old dry compost (you can spread compost on the bin lid to dry on windy, sunny days), well crumbled dry leaves, or sawdust. If need be, remove a drier portion of the pile to make room in the bin for more bark or peat moss. If sawdust is used, allow several days for full absorption, or the bin can easily become over dried. Because the carbon/nitrogen (C/N) ratio may be pushed too high by a large volume of sawdust, fresh green plants or a little fresh sewage should be added to the compost to increase the nitrogen content.

Under extreme circumstances, bail the water out. Use a five-gallon plastic bucket, dig a sump in deep dry soil well away from the site, water and trails, and pour the contaminated water a little at a time into the sump.

Secure the bin lid if it is easily dislodged. Several large rocks may help hold it in place. Small hooks can be used, but they can scratch the operator. The GMC drills holes through the bin lid and the lip of the composting bin and fastens the lid to the bin with carriage bolts to deter unwanted opening during the winter. The AMC has a fitted 60-pound plywood lid that is tied down in winter.

Cause 5: The pile of sewage is too small to self-insulate.

Solution: Continue storing wastes, and when an appropriate amount has been gathered (based on the remaining room in the compost bin—you want your bin filled almost to the brim), attempt to re-ignite the biological furnace and get the run going again.

PROBLEM: There is a backlog of sewage in the middle of processing a compost run.

Causes: Not enough storage capacity; an unexpected surge of use; a slow composting run.

Solution: In the GMC system: add another 32-gallon storage container to the site. In the AMC system: add another composting bin. Begin a second run with a batch of fresh sewage.

PROBLEM: Raw sewage has been inadvertently added to a bin full of finished compost.

Causes: Winter users, or unwitting help, dumped the catcher into the bin. The run may have been completed in fall and left in the bin, but records were not passed on to spring operator.

Solutions: If the sewage has been dumped on but not mixed with finished compost, remove visible raw sewage to the storage cans (in the GMC system) or to the empty compost bin (in the AMC system). Remove to the drying rack those portions of the compost pile which are composted but have not been in contact with raw sewage. Create enough space in the bin to add a batch of fresh sewage and do a run (in the GMC system), or start a run in the empty bin (in the AMC system).

If sewage has been mixed with finished compost, and there is not enough new sewage to constitute a batch, remove enough compost from the bin to add a batch of fresh sewage and begin a run. Put the removed (but re-contaminated) compost in an extra storage can if possible; otherwise, put it on the drying rack, separated from other compost stored there. Use this re-contaminated compost to top the working pile, or recycle it back into the bin in the next run.

PROBLEM: Compost wintered in the bin appears stable, but the bottom is wet.

Causes: Water may have gotten in as a result of the lid of the compost bin being askew, or wastes may have been wet when left in the fall.

Solution: Check the previous fall's records to determine the status of the compost. Transfer drier portions of compost to the drying rack or to storage cans to make room for a batch of fresh sewage. Use this drier compost as insulation on top and sides of the bin if needed to fill the bin in the next run. Recycle any remaining compost through the bin in future runs.

PROBLEM: The bin leaks.

Causes: A hole was punched in the bottom by the turning fork; porcupines have chewed a hole in the bin, etc. (This does not happen with the AMC's stainless steel bins.)

Solution: Patch the hole(s). The bin must first be emptied. Use whatever containers are readily available to hold the contents; pack more in if necessary. Clean and dry the interior and locate the hole(s).

The best way to patch a bin is with a high quality outdoor silicone caulking compound. Apply the compound generously to both sides of the hole. Apply several layers, with ample curing time between applications. Smooth the inside to prevent the turning fork from catching on the caulk and pulling it out. If possible, cover the caulking compound with a waterproof sealing paint or with an epoxy-resin compound which will be hard when dry. The outside can be sealed with roofing cement. If the hole can't be patched, replace the bin.

PROBLEM: Water appears mysteriously in the bin.

Causes : The lid leaks, or a small leak has developed in the bottom of the bin, and water is seeping *in*.

Solution: Examine the lid for leaks; repair any you find. Drain water from the compost operation by ditching around the bin, finish the run, and patch the hole in the bin as described above. Build a platform for the bin, and place the bin on the platform.

B.2 TROUBLESHOOTING MOLDERING PRIVIES AND CONTINUOUS COMPOSTING SYSTEMS

PROBLEM: There is an odor of fresh waste in or around the system.

Cause 1: Insufficient or inappropriate bulking agent is mixed with the waste.

Solution: Dense, wet waste in the composting chamber is evidence of insufficient or inappropriate bulking agent. Supply a larger scoop for users to add bulking agent with each use, or have an attendant add bulking agent periodically, stirring the waste pile if necessary to mix the bulking agent into the pile. Make sure the supply of bulking agent does not run out.

Cause 2: Inadequate ventilation.

On commercially made and owner-built continuous composters with waterproof tanks, a common cause of odor in the toilet room is improper installation of the ventilation stack, or a broken vent stack. Air can then flow down the vent stack and into the compost chamber and then back up the toilet chute.

Solutions: To check ventilation, hold a smoldering splinter, blown-out match or a lit cigarette near the toilet seat and observe the flow of smoke. *(Take care not to drop any source of ignition into the compost tank or chamber.)* If smoke does not go down the toilet chute, there is not enough draft, which allows odors to rise up the toilet chute and out the seat.

Does the toilet room have good ventilation? There must be some way for air to enter the room, or it cannot flow down the toilet chute when the toilet seat is opened. However, make sure that there are no windows or other openings in the ceiling or in the walls, especially on the lee side of the outhouse, where they will tend to suck air out of the toilet room. The only openings should be small and near the floor, ideally on the windward side. In windy locations with changeable wind direction, try installing lightweight hinged flaps hanging downward on the inside of ventilation openings in the toilet room, so they will open when wind blows inward, but close when air tries to leave the room.

Make sure the top of the vent pipe is not blocked. A rain cap may have fallen down over the top of the pipe. Insect screening may have become clogged (sometimes with dead cluster flies!). Try to locate insect screening on the outside of the rain cap so it will not restrict air flow, and it will be washed by rain. If odor appears in winter, check the downwind portion of the vent cap for frost buildup (which clogs the outlet of the vent and causes wind to drive downward into the vent), and remove the frost if possible.

If there is a fan, is it running? Be sure it is installed to blow in the right direction, and that the vent pipe is continuous. If your system has a fan and the fan is not working, it may be acting as an obstruction to the flow of air.

In a unit without a fan, try raising the stack higher above the roof and adding a cap designed to enhance draft in wind. Adding a turbine ventilator to the top of the stack (instead of a cap) may help, although turbines tend to freeze in winter.

Is the exhaust vent as straight as it could be? Just like a chimney from a wood stove, your best draft will come if there are minimal elbows or turns in the pipe.

Make sure the toilet seat is closed when not in use; post a sign in the outhouse to that effect.

Make sure the outhouse door is kept closed, especially if it is on the downwind side of the building. Post a sign asking hikers to keep the door closed, or install an automatic door closer.

Make sure trees and seasonal vegetation are kept clear of the air intake areas and the exhaust stack. Tall trees near the toilet building can reduce draft. It may be possible to remove a few nearby trees. Check first with your ATC regional office and the land manager.

If the smoke test indicates air is flowing down the toilet chute but there is still an odor, you may need to check for leaks and improperly fastened pipes and fittings. If found, repair them.

Be sure the inspection door and emptying hatch on the compost chamber are closed tightly, all air vents are open and unblocked, and there is a way for air to enter the space sheltering the compost chamber.

If problems persist, one last thing you could try is to block the supplemental air inlets to see if that forces more air to be drawn down through the toilet chute.

PROBLEM: There is a strong odor of sewage or rotten eggs.

Causes: Strong odors of this nature indicate the system may have become anaerobic (due to compaction or liquid build-up) or that there is an imbalance of nutrients within the pile.

Solutions: Increase aeration to increase the level of oxygen in the pile, and facilitate the evaporation of liquids, by adding more bulking agent, and perhaps red worms and/or compost enzymes.

Often odors can be neutralized by covering the compost pile with a healthy layer of bulking agent. Make sure there is a sign in the outhouse instructting hikers to add bulking agent after each use, and provide a larger scoop if they are not using enough. Urine mixed with feces can increase objectionable odors, , especially ammonia, when drainage from the pile is insufficient. Separating urine or excluding it can reduce odor. If you choose the latter plan, check the pile regularly and sprinkle it with water if it appears dry. A properly sited and constructed moldering privy should not suffer from this as liquids percolate away from the pile into the soil. In most cases operators of moldering privies have problems with their piles drying out. A drop or two of biodegradable hand dishwashing detergent in the water helps it penetrate the pile rather than run off the surface.

Compost toilet manufacturers sell filters, generally containing granulated activated carbon, that can scrub odors from compost exhaust, but this requires forced ventilation with a fan.

Cold wood ash is a useful and free odor control additive readily available at many backcountry campsites. If fires are not permitted at your site, wood ash can be packed in—not much is needed. *Be certain the ash is cold. Even a single spark can cause a destructive fire.* Add ash *lightly* to the pile to avoid forming an impenetrable layer of ash or contributing to organic concrete (see below).

Other options are livestock odor-control additives, oxidizing agents, absorbents, and digestive deodorants. Contact your local agricultural extension office for more information. However, be cautious: some of these products may be incompatible with the health of decomposer organisms. Also, the land management agency may not permit these substances.

PROBLEM: The composter doesn't seem to be filling up, even after a year of use.

Cause: Low use of the system. This is usually not a problem on the Trail, because these systems are generally located at heavily used sites. At lightly used sites with a large composting chamber, it may take several seasons before the system has any composted material to empty. Consider this a blessing! Material is decomposing as fast as it is being added, and the composting process is working very well.

Solution: None needed.

PROBLEM: Material isn't completely composted.

Cause: This is a major concern. In most cases, the cause is improper management of the composting process—insufficient warmth, air or moisture; premature removal of material; or inadequate capacity in the system.

Solutions: Avoid overloading the system. The rating of each manufactured composting system depends on a certain minimum temperature. Most systems base their capacity ratings on a temperature of 65 degrees F. (18 degrees C.) or higher, and capacity usually is drastically reduced at lower temperatures.

An overloaded system develops a saturated compost mass. There is visible standing liquid, and the material drips when it is handled. There also may be a strong odor of rotten eggs, a sure sign that the pile has gone anaerobic. Composting slows or stops entirely, and a soupy mixture of solid and liquid accumulates.

Reducing the urine load may solve the problem. Increased evaporation also may help: check the exhaust stack for blockage, and be sure the fan (if present) is working. Try adding more bulking agent, or install a urine diverting toilet and urinal, and manage urine separately. If there is a heating element (unlikely on the A.T., unless your system is at a trailhead), check to see if it is operating properly.

In moldering privies or commercially produced toilets with large compost chambers, liquid drains away, so upper layers of the pile may get too dry, and the composting process will stop. If this happens, water the pile regularly with a spray bottle or a watering can. A drop or two of biodegradable hand dishwashing detergent in the water helps it penetrate the pile rather than run off the surface.

Some systems now include liquid leachate re-spraying systems. This practice is not recommended, because the leachate (urine percolated through the composting mass) contains concentrated salts, ammonia, etc. that hinder the growth of decomposer organisms. Other systems include fresh water sprinkler systems. These are useful if they can be operated manually. Some have moisture sensors, and automatically spray the pile when it becomes too dry. Unfortunately, this is seldom practical on the A.T.

If you must remove uncomposted material, you have several options:

- •P lace it in storage containers, hold it until you stabilize your composting system, and then run the material through the system again.
- • Nearly finished material can be placed on a drying rack for aging.
- •B ury material at a shallow depth well away from trails, water, and camping areas, or incinerate it.
- If you must dispose of partially finished material more than once, you need to analyze your system, and make changes or implement a system that will work correctly.

PROBLEM: Organic concrete forms in the unit.

Causes: A common cause is compaction of the compost pile due to infrequent removal of finished material.

The mixture of the salts, urine, excrement, toilet paper, and bulking agent may be both too dense and too dry. This is can be aggravated by too much heat in commercial systems with heating elements, a contributing factor unlikely in the backcountry.

Some bacteria and fungi naturally produce a material called *glomulin*, which acts like a glue to hold together particles. On the forest floor or in gardens, this is a naturally occurring process that is important in producing soil structure.

Concrete-forming bacteria working in the presence of certain minerals in excrement and some bulking agents can create additional organic concrete materials. An example of this is bacteria that use urea (a component of urine) as their source of nitrogen. As they break down the urea, they create ammonia and ammonium hydroxide, which react with calcium, yielding calcium carbonate, the principal constituent of limestone and concrete.

Solutions: Keep composting material uniformly moist and porous. Mixing is crucial.

However, in large continuous composters it is difficult to reach the lower parts of the pile. Therefore, it is essential to remove finished material as it accumulates in the cleanout chamber, so compost mixes as it tumbles toward the cleanout door. Remove finished product at least once every two years if you have a large, single chamber composter.

If the material you remove doesn't appear to be fully done, it can be placed on a drying rack for additional aging and treatment.

Try to manage heat input so it evaporates some water, but keeps the pile moist. However, too much heat is highly unlikely on the Appalachian Trail. Instead, excessive liquid is more likely. In this case, consider a system to drain and treat excess liquid, yet keep the pile moist.

Once it has formed, organic concrete is difficult to deal with. Break it up with a turning fork or other long handled tool, remove it, and try to work it back into the system after it has softened with exposure to fresh waste and moisture. If it doesn't soften, it will have to be incinerated or buried away from water, trails, shelters, and campsites.

B.3 GENERAL COMPOSTING TIPS

Pay attention to moisture. Moisture is in the optimum range when a shovelful of material appears moist and glistening, like a wrung-out sponge. It should not drip, and no visible standing liquid should be present in the pile. If you want to be more precise, you can use a moisture meter. Follow the instructions for the meter, and check different parts of the pile and various depths. However, excellent results are possible without a meter.

Keep the toilet and chute clean. Clean surroundings encourage hikers to use the toilet rather than the woods. A little biodegradable soap or detergent and warm water (don't forget to pack in your Thermos or camp stove for heating water) will not harm the composting process. Actually, this mixture is beneficial, because it reduces the surface tension of water in the pile, which helps water penetrate areas that might otherwise become too dry. It also can help make organic molecules and nutrients more available to decomposers by enabling modest amounts of water to penetrate materials more thoroughly.

However, never introduce chemicals, disinfectants, bleach or other poisons into the compost pile. These kill *beneficial* organisms as well as the pathogens you are trying to eliminate. If you use them to clean the toilet seat and the area around it, dispose of them elsewhere.

Ammonia and water is a good cleaning solution compatible with composting. Most compost piles produce some ammonia on their own, and a little more does no harm.

A 3-percent solution of hydrogen peroxide, available at drug stores, is a disinfectant reasonably compatible with composting. Apply it to a rag or sponge, and wipe down the surfaces of the system. If a little gets down the toilet, it may be a little hard on the first organisms it encounters, but as it becomes diluted through dispersal, it will add beneficial oxygen to the system.

Discourage hikers from depositing food waste in the composting system. Place signs asking folks to pack out all garbage. Food waste adds nutrients to the compost pile, but this minor advantage is overwhelmed by the evil of attracting wildlife to the pile. Also, it is a short step from food wastes to bottles, cans, plastic bags and foil packages.

If food attracts rodents to a composter, they may get contaminated with fresh sewage, and then travel to the campsite or shelter. Do all you can to avoid attracting wildlife, and block any way animals might enter contaminated portions of the composting system.

C About the Organizations Behind this Manual

THE APPALACHIAN TRAIL CONSERVANCY

The Appalachian Trail Conservancy (ATC), established in 1925, is a national not-for-profit corporation that is both a confederation of the 31 local organizations with assignments to maintain the Appalachian Trail and a membership organization with support from all 50 states and more than 15 other countries. Under agreements that date back to the 1930s, buttressed by federal legislation in 1968 and 1978, ATC leads a cooperative-management system for the Trail that equals the National Park Service and USDS Forest Service at national, regional, and district levels, a variety of agencies in 14 states, a few other federal agencies, and even some county and town agencies.

That "management" charge for more than 250,000 acres of public lands extends far beyond enhancing the user's experience and keeping the footpath open and facilities safe—to safeguarding the boundaries and monitoring the health of hundreds of rare, threatened, and endangered species between the Trail and the corridor's edge. Details on this multifaceted work can be found throughout this site.

Our mission is to preserve and manage the Appalachian Trail – ensuring that its vast natural beauty and priceless cultural heritage can be shared and enjoyed today, tomorrow, and for centuries to come.

Our vision is to connect the human spirit with nature – preserving the delicate majesty of the Trail as a haven for all to enjoy. We are committed to nurture and protect this sacred space through education and inspiration. We strive to create an ever-expanding community of doers and dreamers, and work to ensure that tomorrow's generations will experience the same mesmerizing beauty we behold today.

An all-volunteer staff in Washington, D.C., managed the organization for its first four decades. With central offices in Harpers Ferry, WV, a quarter-mile from the Trail since 1972, the ATC today has a governing body of 15 volunteers, close to 40,000 individual members, an annual budget of $7.3 million, a full-time staff of about 45 in six locations (along with more than a dozen part-time and seasonal employees), and total assets of about $12 million, including almost 40 properties along the Trail.

APPALACHIAN TRAIL CONSERVANCY
P.O. Box 807 799 Washington St.
Harpers Ferry WV 25425
(304) 535-6331
www.appalachiantrail.org

THE APPALACHIAN MOUNTAIN CLUB

The Appalachian Mountain Club (AMC) is the oldest conservation club in the United States, with more than 100,000 members. Since 1876, the AMC has helped people experience the majesty and solitude of the Northeast outdoors. The AMC offers more than 100 workshops annually on a variety of outdoor subjects and many guidebooks and maps. The AMC maintains visitor centers, backcountry shelters and huts, and hiking and cross country ski trails in the White Mountains of New Hampshire and the Berkshires of Massachusetts and Connecticut as well as visitor centers throughout the Northeast from Maine to New Jersey. AMC maintains over 1,800 miles of hiking trails in the northeast including over 350 miles of the Appalachian Trail in five states. The club's mission is to promote the protection, enjoyment, and understanding of the mountains, forests, waters, and trails of America's Northeast and Mid-Atlantic regions.

APPALACHIAN MOUNTAIN CLUB HEADQUARTERS
5 Joy St.
Boston MA 02108
(617) 523-0636
www.outdoors.org

PINKHAM NOTCH VISITOR CENTER
361 Route 16, Pinkham Notch Visitor Center
PO Box 298
Gorham, NH 03581
(603) 466-2721

THE GREEN MOUNTAIN CLUB

Established in 1910 to build the Long Trail, the Green Mountain Club (GMC) is a private, nonprofit organization with more than 10,000 members. Vermont's historic Long Trail, the first long-distance hiking trail in the United States, was the inspiration for the Appalachian Trail. The GMC is dedicated to maintaining, managing and protecting Vermont's Historic Long Trail System, which includes 70 overnight facilities and 146 miles of the Appalachian Trail, and advocating for hiking opportunities in Vermont. Every year, more than 1000 volunteers work so that future generations may enjoy the 445 mile Long Trail System.

GREEN MOUNTAIN CLUB
4711 Waterbury-Stowe Rd.
Waterbury Center VT 05677
(802) 244-7037
gmc@greenmountainclub.org
www.greenmountainclub.org

THE RANDOLPH MOUNTAIN CLUB

Founded in 1910, the Randolph Mountain Club (RMC) maintains a network of 100 miles of hiking trails and four shelters on the northern slopes of the Presidential Range on the White Mountain National Forest in New Hampshire, and on the Crescent Range in the town of Randolph NH. The club has approximately 500 members, and is managed by an active volunteer board of directors. The RMC is funded by dues and donations from members, cost challenge trails contracts with the US Forest Service, and other state and local grants.

RMC's four shelters consist of two cabins near treeline on Mount Adams: Crag Camp, with a capacity of 20, and Gray Knob, with a capacity of 15. There are also two Adirondack-style shelters, The Perch and The Log Cabin, each with a capacity of 10. Overnight fees, ranging between $8 and $12, are set to cover the basic operating expenses of the cabins. The RMC is dedicated to keeping fees as low as possible.

Caretakers at Gray Knob and Crag Camp manage the four shelters during the summer. During the rest of the year, one caretaker is in residence at Gray Knob. The club also has two trail crews, which perform basic maintenance and erosion control projects. In the summer, a field supervisor oversees the caretakers and trail crews, and acts as a liaison to the board of directors.

RANDOLPH MOUNTAIN CLUB
Attn: Camps Chair
Randolph NH 03570
campschair@randolphmountainclub.org
www.randolphmountainclub.org

APPALACHIAN TRAIL PARK OFFICE

The Appalachian Trail Park Office (APPA) is the National Park Service (NPS) office charged with carrying out the Secretary of the Interior's responsibilities for oversight and administration of the Appalachian National Scenic Trail under the National Trails System Act.

Equivalent to the Park Superintendent's office in a traditional national park, ATPO is directed by a Park Manager. Under the unique cooperative management system for the A.T., many traditional park-management responsibilities have been delegated to the Appalachian Trail Conference and its member clubs. ATPO has retained responsibility for the non-delegated functions, and has broad authority for coordinating protection and management efforts along the entire length of the A.T. ATPO works closely and cooperatively with ATC, the 31 A.T. Clubs, other NPS units, the USDA Forest Service, other federal agencies, and state agencies within the 14 Trail states.

APPALACHIAN TRAIL PARK OFFICE
P.O. Box 50
Harpers Ferry, WV 25425
(304) 535-6278
http://www.nps.gov/appa/index.htm

ECOWATERS PROJECT (FORMERLY THE CENTER FOR ECOLOGICAL POLLUTION PREVENTION)

The Center for Ecological Pollution Prevention (CEPP) develops, promotes and demonstrates better waste management technologies, with an emphasis on source separation and utilization approaches. The CEPP graciously allowed the GMC and ATC to utilize information and illustrations from their book *The Composting Toilet System Book (CEPP, 1999)*.

ECOWATERS PROJECTS
24 William Street, #2
New Bedford, MA 02740
Telephone: 978-318-7033
Email: *info@ecowaters.org*
http://www.ecowaters.org/

JENKINS PUBLISHING

Publisher of *The Humanure Handbook*.

The author, Joseph Jenkins, and his book were an invaluable resource for the production of this manual.

JENKINS PUBLISHING
143 Forest Lane, Grove City, PA 16127
Phone: 814-786-9085
Fax: 814-786-8209
mail@josephjenkins.com
www.josephjenkins.com

D Contact List April 2014

D.1 APPALACHIAN TRAIL CONSERVANCY AND REGIONAL OFFICES

APPALACHIAN TRAIL CONSERVANCY
P.O. Box 807
799 Washington St.
Harpers Ferry WV 25425
(304) 535-6331
www.appalachiantrail.org
Director of Conservation: Laura Belleville
Director of Conservation
Operations: Bob Proudman

ATC NEW ENGLAND REGIONAL OFFICE
At the Kellogg Conservation Center
P.O. Box 264
South Egremont, MA 01258
(413) 528-8002
Fax: (413) 528-8003
atc-nero@appalachiantrail.org
Regional Director: Hawk Metheny
hmetheny@appalachiantrail.org

ATC MID-ATLANTIC REGIONAL OFFICE
4 East First Street
Boiling Springs, PA 17007
(717) 258-5771
Fax: (717) 258-1442
atc-maro@appalachiantrail.org
Regional Director: Karen Lutz
klutz@appalachiantrail.org

The Mid-Atlantic Regional Office is a good source of information on how to work effectively with strict state regulators when contemplating sanitation system upgrades on the A.T. Pennsylvania has stringent regulations for management of human waste in the backcountry.

SOUTHWEST AND CENTRAL VIRGINIA REGIONAL OFFICE
5162 Valleypointe Parkway
Roanoke, VA 24019
Phone: 540.904.4393
Fax: 540.904.4368
atc-varo@appalachiantrail.org
Regional Director: Andrew Downs
adowns@appalachiantrail.org

ATC TENNESSEE, NORTH CAROLINA, AND GEORGIA REGIONAL OFFICE
P.O. Box 2750
160A Zillicoa Street
Asheville, NC 28802
(828) 254-3708
Fax: (828) 254-3754
atc-gntro@appalchiantrail.org
Regional Director: Morgan Sommerville
msommerville@appalachiantrail.org

D.2 APPALACHIAN TRAIL PARK OFFICE

NPS APPALACHIAN TRAIL PARK OFFICE (APPA)
PO Box 50
Harpers Ferry, WV 25425
304-535-6278
304-535-6270 (FAX)
appa_park_office@nps.gov
Wendy Janssen, Superintendent

D.3 TRAIL-MAINTAINING CLUBS

APPALACHIAN MOUNTAIN CLUB HEADQUARTERS
5 Joy St. Boston MA 02108
(617) 523-0636
www.outdoors.org

AMC MASSACHUSETTS AT MANAGEMENT COMMITTEE
Attn: Trails Chair
AMC Connecticut Chapter Trails Committee
5 Joy St. Boston MA 02108
(617) 523-0636
www.outdoors.org

AMC PINKHAM NOTCH VISITOR CENTER
Attn: Huts Manager and Backcountry Resource Conservation Manager
361 Route 16, Pinkham Notch Visitor Center
PO Box 298
Gorham, NH 03581
(603) 466-2721

GREEN MOUNTAIN CLUB
Attn: Director of Trail Programs
4711 Waterbury-Stowe Road
Waterbury Center, VT 05677
(802) 244-7037
Fax: (802) 244-5867
gmc@greenmountainclub.org
www.greenmountainclub.org

MAINE APPALACHIAN TRAIL CLUB
Attn: Campsite Committee
P.O. Box 283
Augusta, ME 04332-0283
info@matc.org
www.matc.org

NANTAHALA HIKING CLUB
Attn: Trail Manager
173 Carl Slagle Road
Franklin, NC, 28734
sh28734@gmail.com
http://www.nantahalahikingclub.org/

POTOMAC APPALACHIAN TRAIL CLUB
Attn: Trails Management Coordinator
118 Park Street, S.E.
Vienna, VA 22180-4609
(703) 242-0315
Fax: (703) 242-0968
info@patc.net
www.patc.net

RANDOLPH MOUNTAIN CLUB
Attn: Camps Chair
Randolph NH 03570
campschair@randolphmountainclub.org
www.randolphmountainclub.org

BLUE MOUNTAIN EAGLE CLIMBING CLUB
Attn: Shelter Chair
P.O. Box 14982
Reading, PA 19612-4982
info@bmecc.org
www.bmecc.org

GEORGIA APPALACHIAN TRAIL CLUB
Attn: Trails Supervisor
P.O. Box 654
Atlanta, Georgia 30301
(404) 494-0968
gatc-trail-supv@charter.net
http://joomla.georgia-atclub.org/index.php

D.4 REGULATORY CONTACTS FOR THE APPALACHIAN TRAIL, LISTED BY STATE

Compiled by *Pete Antos-Ketcham* at the Green Mountain Club.

Please use this contact list for general purposes only. Many parties must be consulted before a backcountry sanitation system can be installed, and regulations and the agencies enforcing them often change. Please contact your ATC regional office for more detail.

Sometimes local health officials have the authority to make final decisions. If they deny permission for a backcountry sanitation system, check with state officials, especially if they are familiar with innovative sanitation systems. Many composting toilet projects in residential areas are approved this way.

The following information comes to the ATC courtesy of David Del Porto and Carol Steinfeld, authors of *The Composting Toilet System Book*. Del Porto and Steinfeld sent out a questionnaire in 1999 to every state, and followed it with several phone calls. Some states were not forthcoming, so the information may be incomplete. Also, Del Porto and Steinfeld asked mainly about frontcountry and residential applications of composting toilet system technology, so make sure you ask about regulations concerning the backcountry. For the second edition of the manual, an online search was conducted to update all contact information.

It is best to consult your local club leadership, your ATC regional office staff, and the local land manager(s) first, to learn the best way to approach regulatory officials. Then call your state department of health or environment protection agency.

For More Information on Regulations

The National Small Flows Clearinghouse (NSFC)—NSFC, sponsored by the U.S. Environmental Protection Agency, offers a free list of state contacts for onsite systems, as well as a regulations repository. For a fee you can get your state's onsite system approval regulations, although you will have to determine the which requirements are relevant on your own. Call (800) 624-8301.

According to the clearinghouse, "homeowners and developers may have a hard time getting approval for some systems because of inflexible regulations or because health officials are unaware of certain alternative system designs or have questions concerning their performance, operation or maintenance." The clearinghouse offers many technical bulletins and publications about onsite and small community systems (Del Porto & Steinfeld, *The Composting Toilet System Book* pp. 202).

NATIONAL SMALL FLOWS CLEARINGHOUSE
c/o National Environmental Services Center (NESC)
Box 6893, West Virginia University
Morgantown, WV
26506-6893
(800) 624-8301 ext. 3 - phone toll-free
(304) 293-4191 - phone
(304) 293-3161 - fax
info@mail.nesc.wvu.edu

The National Sanitation Foundation (NSF)—NSF International, Inc. is an independent, nonprofit organization that develops standards for public health technologies, including sanitation systems. The group works closely with the American National Standards Institute (ANSI) to develop standards of performance. NSF is internationally recognized by regulators, who will usually approve a product or system listed or approved by the NSF.

Commercially made composting toilets are tested against ANSI/NSF 41-1998 Non Liquid Saturated Treatment Systems. This test covers a wide range of specifications, but most importantly it covers pathogen testing. For more details on what specifi- cations and pathogens are tested, see pg. 202 in the *Composting Toilet System Book* by Del Porto and Steinfeld.

Listing by NSF almost guarantees that a state or local regulator will approve a commercially designed composter.

NSF INTERNATIONAL
P.O Box 130140
789 N. Dixboro Road
Ann Arbor, MI 48105, USA
(734) 769 8010
Fax: 734 769 0109
Toll Free USA: (800 673 6275)
info@nsf.org
www.nsf.org

Local Certifying Agencies Some states, such as Massachusetts, have developed their own testing facilities, and offer their own state approvals.

Call your regional ATC field office to see if your town, county or regulators have pertinent regulation information on sanitation systems.

When discussing a proposed backcountry sanitation system with regulators, always bring as much literature on your proposal as you can, to help educate them. Often they are unaware of technologies suitable for the backcountry, and if you give them information and time to absorb it, they may become remarkably cooperative—possibly even helpful and grateful.

For example, the Green Mountain Club had to apply for a wastewater permit when installing a beyond-the-bin system at Butler Lodge on Mt. Mansfield in Vermont. When the permit administrator was given the Appalachian Mountain Club's Manual for the beyond-the-bin system, which was designed by a licensed septic designer, the GMC received its permit.

State Regulatory Agencies

GEORGIA
Georgia Department of Human Resources
Environmental Health Section
2 Peachtree St. NW Atlanta, GA 30303-3186
(404) 657-6534

Composting toilets (commercially manufactured) must be NSF or equal certified. Systems certified by an engineer may be approved as an experimental system. Check with the ATC Georgia, North Carolina, Tennessee Regional Office before contacting the state with a sanitation project request.

Tennessee
Tennessee Department of Environment and Conservation
Division of Groundwater Protection
312 Rosa L. Parks Ave - Tennessee Tower - 2nd Floor
Nashville, TN 37243
(615) 532-0109
http://www.state.tn.us/environment/

Composters must be listed with NSF up to standard 41. A non-traditional gray water system could be applied for as experimental. Check with the ATC Georgia, North Carolina, Tennessee Regional Office before contacting the state with a sanitation project request.

NORTH CAROLINA

Environmental Permit Information Center
P.O. Box 29583,
Raleigh, North Carolina 27626-0583
Phone: (888) 368-2640 or (919) 733-1398
e-mail: ***epic@p2pays.org***
http://www.p2pays.org/epic/

Composters may be permitted if you can present plans and/or manufacturer's specifications to the permitting officials. Gray water must be disposed of subsurface (although some alternatives have been approved). Check with the ATC Georgia, North Carolina, Tennessee Regional Office before contacting the state with a sanitation project request.

VIRGINIA

Virginia Office of Environmental Health Services
Environmental Health Services
109 Governor St., 5th Floor
Richmond, VA 23219
(804)-864-7473
http://www.vdh.virginia.gov/EnvironmentalHealth/

A composting toilet that meets NSF Standard 41 can be approved for a site in Virginia wherever a pit privy can be used. The regulations can be found on the state's web site listed above. Check with the ATC Virginia Regional Office before contacting the state with a sanitation project request.

WEST VIRGINIA

Environmental Health Services
Public Health Sanitation Division
Office of Environmental Health Services
Public Health Sanitation Division
350 Capitol Street, Room 313
Charleston, WV 25301-3713
Phone: (304) 356-4288 or (304) 356-4281
Fax: (304) 558-1071
http://www.wvdhhr.org/phs/

Composting toilets and gray water systems are addressed in West Virginia Interpretive Rules (BoH) which was updated by Title 64, Series IX, and apply to local boards of health. They will require design data sheet and plans for the system you are proposing. Check with the ATC Mid-Atlantic Regional Office before contacting the state with a sanitation project request.

MARYLAND

Maryland Department of Environment
Water Management Administration
1800 Washington Blvd., Baltimore, MD 21230.
(410)-537-3000
mde.webmaster@maryland.gov
http://www.mde.state.md.us/Pages/Home.aspx

NSF listing will approve a commercially designed composter. Gray water management systems are approved on a case by case basis under the Innovative and Alternative Program (make sure you inquire about this program and see if owner built composters can get approval). Check with the ATC Mid-Atlantic Regional Office before contacting the state with a sanitation project request.

PENNSYLVANIA

Department of Environmental Resources
Division of Certification, Licensing and Bonding
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17101
Phone: 717-783-2300
http://www.portal.state.pa.us/portal/server.pt/community/dep_home/5968

Pennsylvania is known among AT maintainer circles for the toughest regulations on the Trail. However, the Mountain Club of Maryland and the Blue Mountain Eagle Climbing Club have successfully gotten composters approved in the past. The main challenges are how to treat leachate and gray water. Check Msection 73.1 (V) of the Pennsylvania Code, Title 25, which addresses composting toilets. Check with the ATC Mid-Atlantic Regional Office before contacting the state with a sanitation project request.

NEW JERSEY

New Jersey Department of Environmental Protection
Division of Water Quality
Bureau of Nonpoint Pollution Control
Mail Code: 401-02B
PO Box 420
401 E. State St., 3rd Floor
Trenton, NJ 08625-0420
Tel. (609) 292-0407
Tel. (609) 633-7021
Fax (609)-984-2147
http://www.nj.gov/dep/dwq/bnpc_home.htm

Apply at the county level. Composting toilets are subject to Chap. 199 of the New Jersey code for individual onsite systems. Composters require approval of building codes and local health departments. Composters and gray water systems must comply with the Uniform Plumbing Code. Check with the ATC Mid-Atlantic Regional Office and the New Jersey Field Representative of the New York- New Jersey Trail Conference before contacting the state with a sanitation project request.

NEW YORK

New York State Department of Health
Bureau of Community Environmental Health and Food Protection
c/o New York State Department of Health
Corning Tower
Empire State Plaza,
Albany, NY 12237
bcehfp@health.state.ny.us
https://www.health.ny.gov/environmental/indoors/food_safety/

Composters must be NSF listed and have a five-year warranty (this obviously applies to commercially designed systems). Currently New York is approving the installation of more than 100 composters for a lakeside community so this state may be very amenable to owner-built composting toilet systems, provided they have a well-thought-out, tested plan and have been approved in other states. Check with the ATC Mid-Atlantic Regional Office and the New York-New Jersey Trail Conference before contacting the state with a sanitation project request.

CONNECTICUT

Connecticut Department of Energy and Environmental Protection
Permits & Enforcement
79 Elm Street
Hartford, CT 06106-5127
Phone: (860)-424-3000
deep.webmaster@ct.gov
http://www.ct.gov/deep/site/default.asp

Local and state health departments have been designated by the DEP to permit onsite systems. Plans must be certified by a professional engineer. Check with the ATC New England Regional Office before contacting the state with a sanitation project request.

MASSACHUSETTS

Executive Office of Environmental Affairs
Department of Environmental Protection
1 Winter Street
Boston, Massachusetts 02108
Phone: 617-292-5500
http://www.mass.gov/eea/agencies/massdep/

Composting toilets are generally approved. Gray water systems are also generally approved if submitted to the state by a professional engineer or a registered sanitarian. Check codes 310 CMR 15.289(3) (a) of the State Environmental Code and 240 CMR 2.02 (6)(b) Basic Principles of the Uniform State Plumbing Code.

Pete Rentz (one of the first edition's original authors) and the Appalachian Mountain Club (AMC) Berkshire Chapter Massachusetts Appalachian Trail Committee have installed several moldering privies. (For a case study of this system, see Chapter 8, Case Studies.) Contact the AMC Berkshire Chapter to get a copy of their Moldering Privy Manual.

Check with the ATC New England Regional Office before contacting the state with a sanitation project request.

VERMONT

Vermont Department of Environmental Conservation
Drinking Water & Groundwater Protection Division
1 National Life Drive, Main 2
Montpelier VT 05620-3521
Phone: 802-828-1535;
Toll Free In-State: 1-800-823-6500
Fax: 802-828-1541
http://wastewater.vt.gov/

The Green Mountain Club (GMC) has many batch-bin, beyond-the-bin, and moldering privies in the backcountry of Vermont. In general, all that is needed is the permission of the land managing agency. This is the US Forest Service on the Green Mountain National Forest or the Vermont Department of Forests, Parks and Recreation on state lands. Check with the GMC Field Office and the ATC New England Regional Office before contacting the Forest Service or State with a sanitation project request.

NEW HAMPSHIRE

New Hampshire Department of Environmental Services
Wastewater Engineering Bureau
29 Hazen Drive; PO Box 95
Concord, NH 03302-0095
Phone: (603) 271-3503
Fax: (603) 271-4128
http://des.nh.gov/organization/divisions/water/wweb/

New Hampshire approves composting toilets, and the Appalachian Mountain Club (AMC) has many composting toilets on the A.T. Gray water systems are approved on a case-by-case basis. AMC has several alternative gray water management systems. Check with the AMC Trails Department and the ATC New England Regional Office before contacting the state with a sanitation project request.

MAINE

Maine Division of Environmental Health
Subsurface Wastewater Unit
286 Water Street, 3rd Floor
Augusta, ME 04333
Fax: (207) 287-4172
http://www.maine.gov/dhhs/mecdc/environmental-health/plumb/index.htm

Maine is generally friendly to composting toilets. The Maine Appalachian Trail Club (MATC) has installed AMC-styled beyond-the-bin and GMC-styled batch bin composters, and moldering privies. Commercial systems must generally be NSF listed. Check with the ATC New England Regional Office before contacting the state with a sanitation project request.

D.5 OTHER ORGANIZATIONS

DAVID DEL PORTO AND CAROL STEINFELD

Ecowaters Projects
24 William Street, #2
New Bedford, MA 02740
Telephone: 978-318-7033
info@ecowaters.org
www.ecowaters.org

JOSEPH JENKINS C/O JENKINS PUBLISHING
143 Forest Lane, Grove City, PA 16127
Phone: 814-786-9085
Fax: 814-786-8209
mail@josephjenkins.com
www.josephjenkins.com

D.6 COMMERCIAL COMPOSTING TOILET MANUFACTURERS

Companies in the following list have supplied information used in this manual, but the list is not an endorsement of them or their products. There are many other companies in this business, and a more complete listing can be found in *The Composting Toilet System Book, by David Del Porto and Carol Steinfeld. (*See the Bibliography, also in the Appendix, for information on the book.)

CLIVUS NEW ENGLAND, INC.
PO Box 127
North Andover, MA 01845
Phone: 978.794.9400
Fax: 978.794.9444
http://clivusne.com/index.php

Clivus Multrum New England, Inc. is the East Coast distributor of Clivus Multrum Systems. Clivus New England has several composting systems. They provide consultation, turnkey systems, and in some instances, maintenance services. Even if you are not considering a Clivus, it is worth calling and getting an information package. To see Clivus systems in operation on the A.T., contact the Appalachian Mountain Club's Pinkham Notch Visitor Center or Green Mountain Club's Visitor Center (see above for listing).

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Campbell, S. 1975. *Let it Rot! The Home Gardeners Guide to Composting*. Storey Communications, Inc. Pownal, VT.

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Dindal, D.L. 1972. *Ecology of Compost: A Public Involvement Project.* New York State Council of Environmental Advisors and the State University of New York College of Environmental Science and Forestry. Syracuse, NY.

Dindal, D.L. 1980. *Life within the Composting Toilet—Individual Onsite Waste Management Systems.* McClelland, N.I. Editor. Ann Arbor Science Publishing, Ann Arbor, MI.

Goldstein, J. 1977. *Sensible Sludge*. Rodale Press, Emmaus, PA. 184 pp.

Golueke, C.G. 1977. *Biological Reclamation of Solid Wastes*. Rodale Press, Emmaus, PA. 249 pp.

Grant, N. M. Moodie, and Weedon C. 1996. *Sewage Solutions, Answering the Call of Nature*. Centre for Alternative Technology Publications. Wales, UK

Harper, P. 1998. *Fertile Waste*. Centre for Alternative Technology Publications. Wales, UK.

Jenkins, J.C. 2005. *The Humanure Handbook: A Guide to Composting Human Manure.* Third Edition. Jenkins Publishing, Grove City, PA.

Leonard, R.E, E.L Spencer, and H.J. Plumley. 1981. *Backcountry Facilities: Design and Maintenance*. Appalachian Mountain Club, Boston, MA. 214 pp.

Pacey, A. *Sanitation in Developing Countries*. John Wiley & Sons Ltd. Great Britain. 238 pp.

Poindexter, J.S. 1971. *Microbiology, An Introduction to Protists*. The MacMillan Company, New York. 582 pp.

Ryn, S.V. 1978. *The Toilet Papers—Recycling Waste and Conserving Water*. Ecological Design Press. Sausalito, CA.

Stoner, C.H. 1977. *Goodbye to the Flush Toilet*. Rodale Press, Emmaus, PA. 285 pp.

Martin, J.P. and D.D. Focht. 1977. Biological Properties of Soils. pp. 115-162. In L.F. Elliot and F.J. Stevens, co-editors. *Soils for the Management of Organic Wastes and Waste Waters*, SSSA, ASA, CSSA, Madison, WI.

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Dindal, D.L. 1985. Soil animals and soil fabric productions: facts and perceptions. *Quaestiones Entomologicae* 21:587-594.

Dindal, D.L. 1978. Soil organisms and stabilizing wastes. *Compost Science* 19(4) : 8- 11.

Goleuke, C.G. 1982. When is compost “safe?”. *BioCycle* 23(2) : 28-36.

Golueke, C.G. 1983. Epidemiological aspects of sludge handling and management—Part II. *BioCycle* 24(4): 50-57.

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Leonard, R.E. and H.J. Plumley. 1979. Human Waste Disposal in Eastern Backcountry. *Journal of Forestry* 77(5): 349-352.

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Land, Brenda. May 1995. *Remote Waste Management*. USDA Forest Service, San Dimas Technology and Development Center. (#9523 1202-SDTDC)

MANUAL

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F Examples of Current Outhouse Stewardship Signs

Following Pages

SAVE THE MICROBES

IF YOU CAN, PLEASE PEE OUTSIDE TO HELP THE MICROBES DO THEIR JOB AND REDUCE ODORS.

THANK YOU!

DANGER

DO NOT ENTER

**FOR YOUR HEALTH,
THE GMC ASKS THAT YOU
NOT ENTER THE
COMPOSTING AREA.**

**HUMAN WASTE IS STORED
AND PROCESSED HERE BY
THE CARETAKER**

**EXPOSURE WITHOUT
PROPER PRECAUTIONS CAN
BE HARMFUL TO YOUR
HEALTH**

Please, help us maintain the efficient operation of this composting toilet by

NOT DEPOSITING GARBAGE IN TOILET !!

(Including feminine hygiene products, plastics, foil or cigarettes)

Garbage interferes with the composting process and must be removed by the caretaker

---

CLOSE TOILET SEAT and *LATCH DOOR* when finished

Thank you for your cooperation !!

RMC

Randolph Mountain Club
Randolph, New Hampshire 03570

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

Do's and Don'ts

Do:

- Keep the toilet seat cover down and/or keep the waste valve to the toilet when not being used, to prevent odors
- Put toilet paper down the toilet (paper used for urine only could be excluded)
- Put a handful of organic bulking agent down the toilet periodically
- Use a mild soap when cleaning the toilet seat area
- Bury finished compost in a shallow hole or trench around the roots of nonedible plants

Don't:

- Throw trash, cigarettes, matches or burning material into the toilet
- Use harsh chemicals, chlorine bleach or toxic chemicals in the washbasin, shower or the toilet
- Pour lots of water down the toilet
- Empty composter until it is ready

Please help us keep Prickles and friends out of the building by shutting the door behind you.

Thank you!

GREEN MOUNTAIN CLUB
LONG TRAIL
1910
VERMONT

This is a PIT PRIVY

Please PEE IN THE WOODS WHEN POSSIBLE, as this will reduce that "near the outhouse" smell.

Leave only sewage and toilet paper.

Please PACK OUT TRASH, including all feminine hygiene products, food waste, wrappers, etc. Trash fills up the pit too fast and we're running out of digging room.

Please CLOSE THE LID to keep the flies away.

Please LATCH THE DOOR to keep the critters out.

THANK YOU VERY MUCH!

If you have any questions or comments about this privy, or about our backcountrty facilities in general, please contact:

The Green Mountain Club
4711 Waterbury – Stowe Road
Waterbury Center, VT 05677
(802) 244-7037
gmc@greenmountainclub.org

This is a MOLDERING PRIVY

Leave only sewage and toilet paper.

Please PACK OUT TRASH, including all feminine hygiene products, food waste, wrappers, etc.

Please THROW IN A HANDFUL OF WOOD SHAVINGS to help reduce odors and improve decomposition.

Please CLOSE THE LID to keep the flies away.

Please LATCH THE DOOR to keep the critters out.

THANK YOU VERY MUCH!

Under you, redworms and other common soil microorganisms decompose the sewage in mesophilic (low temperature) and aerobic (using oxygen) conditions above the ground level. This is why the outhouse is elevated. Pathogens are reduced by bacterial and invertebrate competition. Peeing in the privy helps to maintain the necessary moisture balance to aid in decomposition.

If you have any questions or comments about this privy, or about our backcountrty facilities in general, please contact:

The Green Mountain Club
4711 Waterbury – Stowe Road
Waterbury Center, VT 05677
(802) 244-7037
gmc@greenmountainclub.org

WELCOME TO THE
GOOCH MOUNTAIN MOLDERING PRIVY

This composting system is maintained by the Georgia Appalachian Trail Club. Proper disposal of human waste is one of our primary concerns in the backcountry. Please help us run this system effectively:

- **PACK OUT YOUR TRASH** – including tampons and applicators, maxi pads, diapers, food waste, food containers, etc.
- **THROW IN A SMALL HANDFUL OF WOOD CHIPS OR LEAVES AFTER USE** – this also keeps odors down and assists in the decay of the waste.
- **CLOSE THE LID AFTER USE**

THANK YOU

In this privy, red worms and other soil microorganisms decompose the waste mass of mixed leaves and human manure in aerobic conditions (using oxygen) above the ground level. This is why the outhouse is elevated. Pathogens are destroyed by bacterial and invertebrate competition. If you have questions or comments about this subject, please contact the Georgia Appalachian Trail Club at 404-634-6495 or visit www.georgia-atclub.org

This is a COMPOSTING PRIVY

Please PEE IN THE WOODS WHEN POSSIBLE, as this will reduce odors and improves the moisture balance to help waste decompose.

Leave only sewage and toilet paper.

Please PACK OUT TRASH, including all feminine hygiene products, food waste, wrappers, etc.

Please THROW IN A HANDFUL OF BARK MULCH to help reduce odors and improve decomposition.

Please CLOSE THE LID to keep the flies away.

Please LATCH THE DOOR to keep the critters out.

THANK YOU VERY MUCH!

Composting sewage is a method of backcountry sanitation management in which sewage breaks down under thermophilic (high temperature) conditions.
If you have any questions or comments about this privy, or about our backcountrty facilities in general, please contact:

The Green Mountain Club
4711 Waterbury – Stowe Road
Waterbury Center, VT 05677
(802) 244-7037
gmc@greenmountainclub.org

This is a BEYOND THE BIN COMPOSING PRIVY

You may PEE IN THE PRIVY, but peeing in the woods extends the life span of the system.

Leave only sewage and toilet paper.

Please PACK OUT TRASH, including all feminine hygiene products, food waste, wrappers, etc.

Please THROW IN A HANDFUL OF BARK MULCH to help reduce odors and improve decomposition.

Please CLOSE THE LID to keep the flies away.

Please LATCH THE DOOR to keep the critters out.

THANK YOU VERY MUCH!

Composting sewage is a method of backcountry sanitation management in which sewage breaks down under thermophilic (high temperature) conditions.
If you have any questions or comments about this privy, or about our backcountrty facilities in general, please contact:

The Green Mountain Club
4711 Waterbury – Stowe Road
Waterbury Center, VT 05677
(802) 244-7037
gmc@greenmountainclub.org

INSTRUCTIONS FOR USING THE MOLDERING PRIVY

Using the Privy: After defecation (pooping), take a handful of duff from the pail provided and drop it over your deposit. Toilet paper also goes in the hole. If possible, urinate (pee) on trees at a decent distance from the shelter, rather than depositing liquid urine on the moldering pile. Close the lid and privy door on departure.

Harvesting Duff: If the bucket for duff is empty, more duff must be harvested. This is not a hard job, and shouldn't take more than 10 minutes. Take the duff bucket and the rake out in the woods at least 100 yards. Gently rake the loose leaves and sticks from a patch of ground about 4 feet square. Now rake harder. The fine, fluffy, brown material you are raking up is duff, mostly partly decayed leaves, but not yet organic soil. Collect enough duff to fill the bucket. Now gently rake the leaves back over the area so the disturbance is not obvious.

Theory: The conventional pit-privy uses anaerobic decomposition to deal with the deposited wastes, a very slow process which may take decades. Depending on usage, the pit may have to be re-dug every 2-4 years.

The moldering privy is a semi-composting privy, which uses aerobic decomposition. This is a relatively speedy process having the potential for consuming the objectionable portion of solid waste in a season or two and producing only sweet-smelling compost which is no longer a biohazard. In order for this to occur, duff, which is rich in aerobic microorganisms, is added to the feces. The fluffy nature of the duff allows air to penetrate the pile. If too much moisture from rain or urine saturates the pile, it goes anaerobic and gives off foul smelling gasses.

The composting pile is turned several times in order to break up solid portions and to further aerate it. The privy is moved back and forth on its base each season, or when one chamber fills up, to allow access to the chamber, which has been filled. Compost is disposed of beyond the watershed used as a water source after at least 1-2 years of moldering. At this time human pathogens have been consumed by the process and the compost no longer looks or smells bad.

G Sources of Materials for GMC Batch-bin System

POLYETHYLENE, ROUND, AQUACULTURE TANKS 210, 250, 400 GALLONS 25 YEAR LIFE EXPECTANCY GMC uses 210 gallon size for new and replacement bins.

TERRACON CORPORATION
5 Boynton Road
Holliston, MA 01746
Attn: Sales Manager
T: 508-429-9950 x2025
F: 508-429-8737
Website: www.terracon-solutions.com
Part #: SCC00210A
This is the current supplier to GMC and RMC of the 210 gallon polyethylene compost bin.

70 GALLON STOCK TANK WITH BUILT-IN DRAIN PLUG.

UNITED STATES PLASTIC CORP.
1390 Neubrecht Road
Lima, Ohio 45801-3196
Phone: 1-800-809-4217
Fax: 1-800-854-5498
http://www.usplastic.com/

CONSOLIDATED PLASTICS COMPANY, INC.
4700 Prosper Dr.
Stow, OH 44224
(800) 362-1000
Fax: 800.858.5001
http://www.consolidatedplastics.com/

32 GALLON SQUARE STORAGE CANS

Obtain or Order from your local hardware store or garden supply center (These are typically used as trash cans.)

AMC STYLE PACKBOARD SUPPLIES

PAGE BELTING COMPANY
104 High Street
Boscawen, NH 03303 USA
Tel: (603) 796-2463
Fax: (603) 796-2509
Toll Free: (800) 258-3654
Email: info@pagebelting.com
http://www.pagebelting.com/history.html

LEATHER HARNESS PIECES

FORTUNE CANVAS
256 Read Street
Portland, ME 04103
Phone: (207) 797-0100
Fax: (207) 797-4194
http://www.fortunecanvas.com/

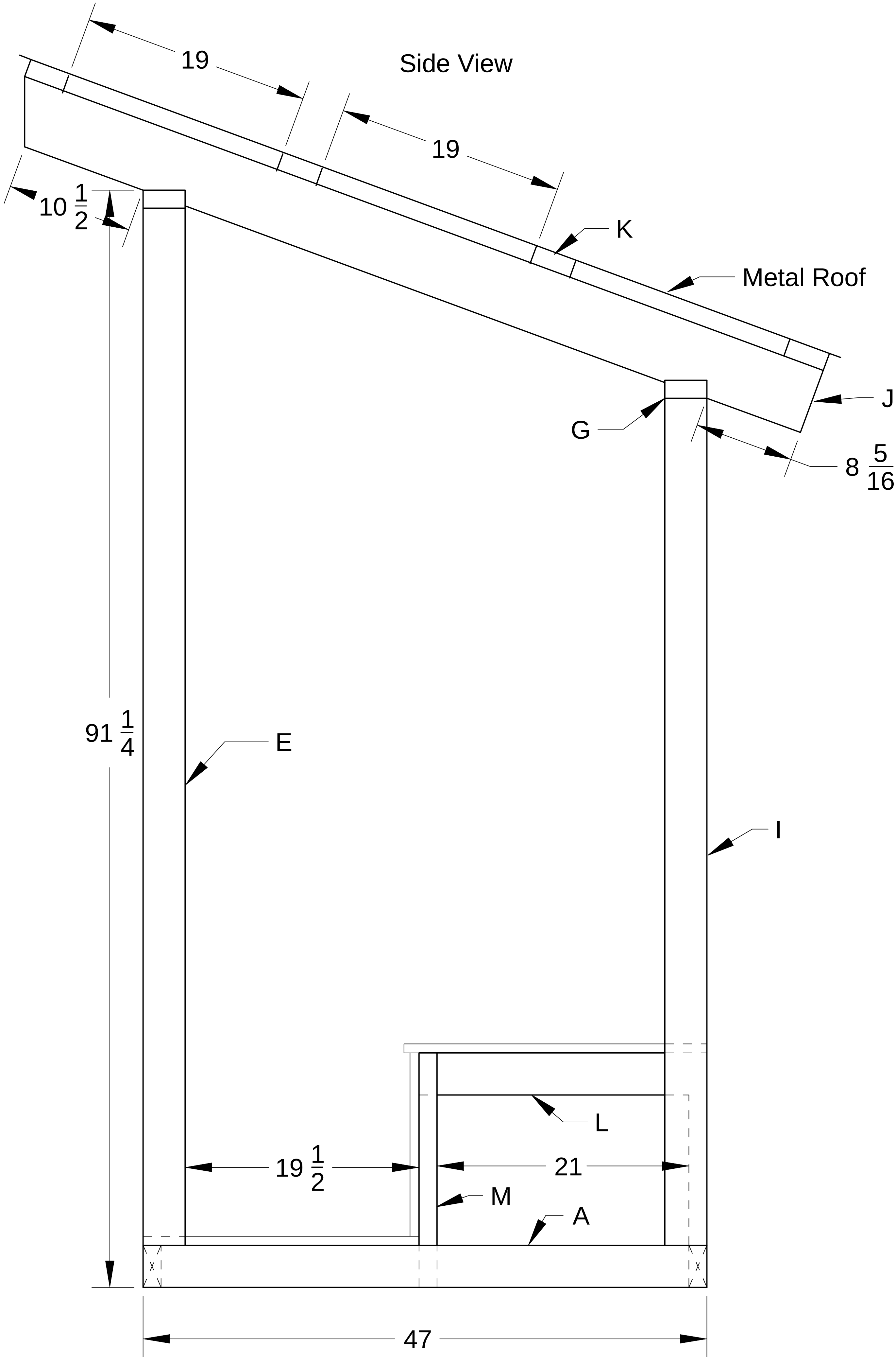
(AMC packboard corset)

COMPOSTING THERMOMETER SCALE - 200 TO 2200 DEGREE RANGE

JOHNNY'S SELECTED SEEDS
955 Benton Avenue
Winslow, Maine 04901
Phone: 1-207-238-5327
Email: rstore@johnnyseeds.com
http://www.johnnyseeds.com/

H Plans for a Double-Chambered Moldering Privy (non accessible)

Following Pages



Side View
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19
10 1/2
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Metal Roof
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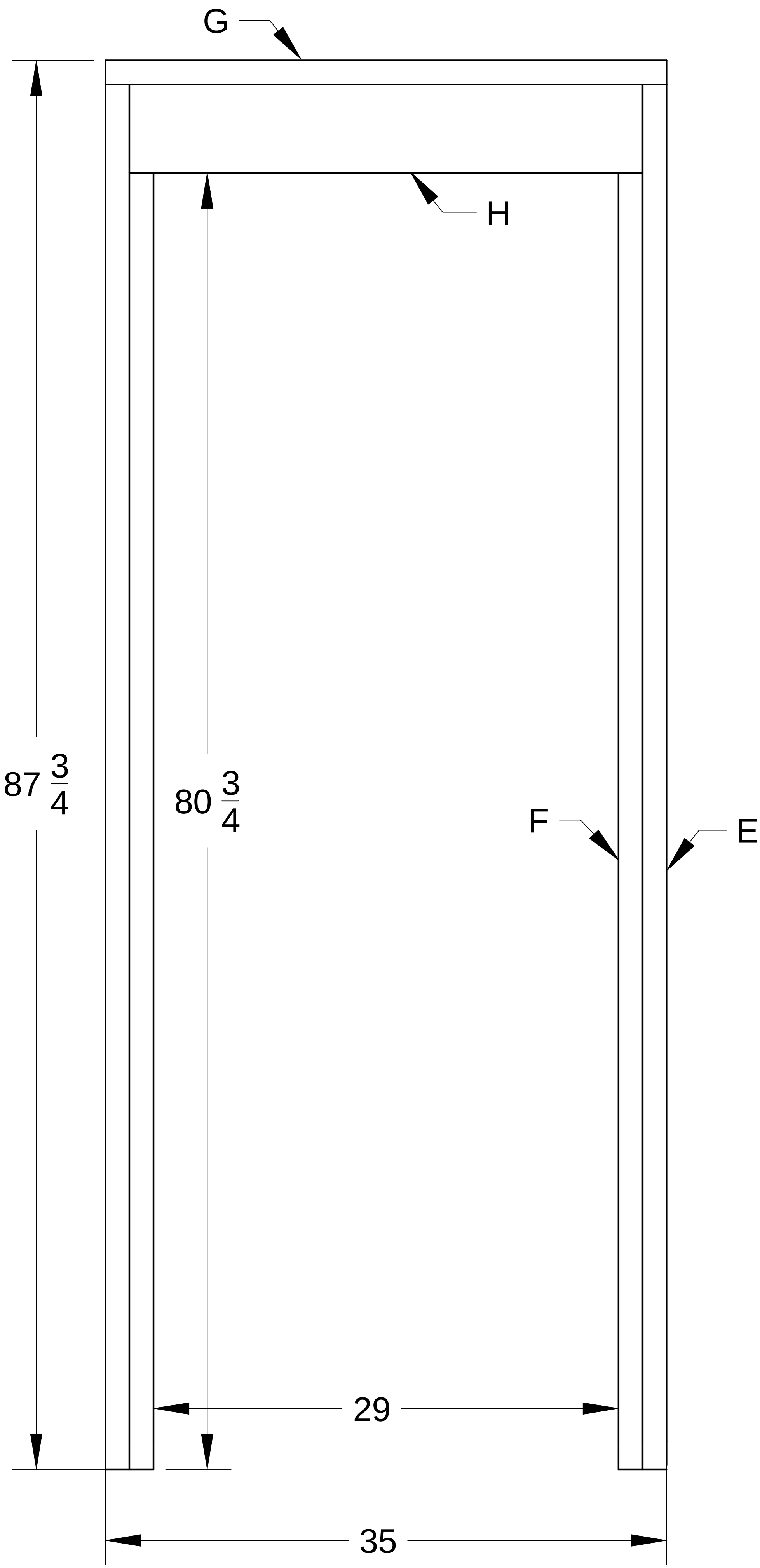
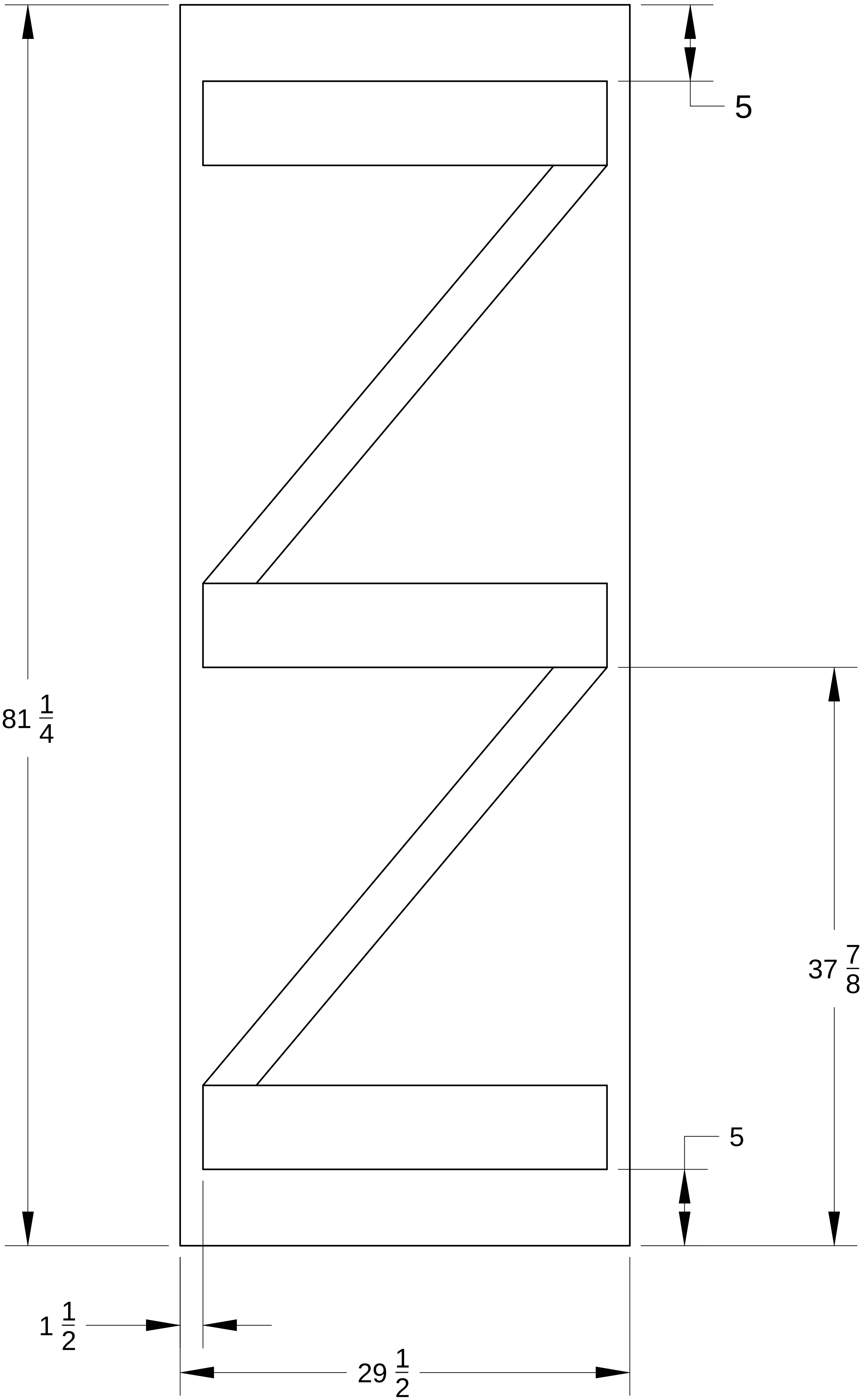
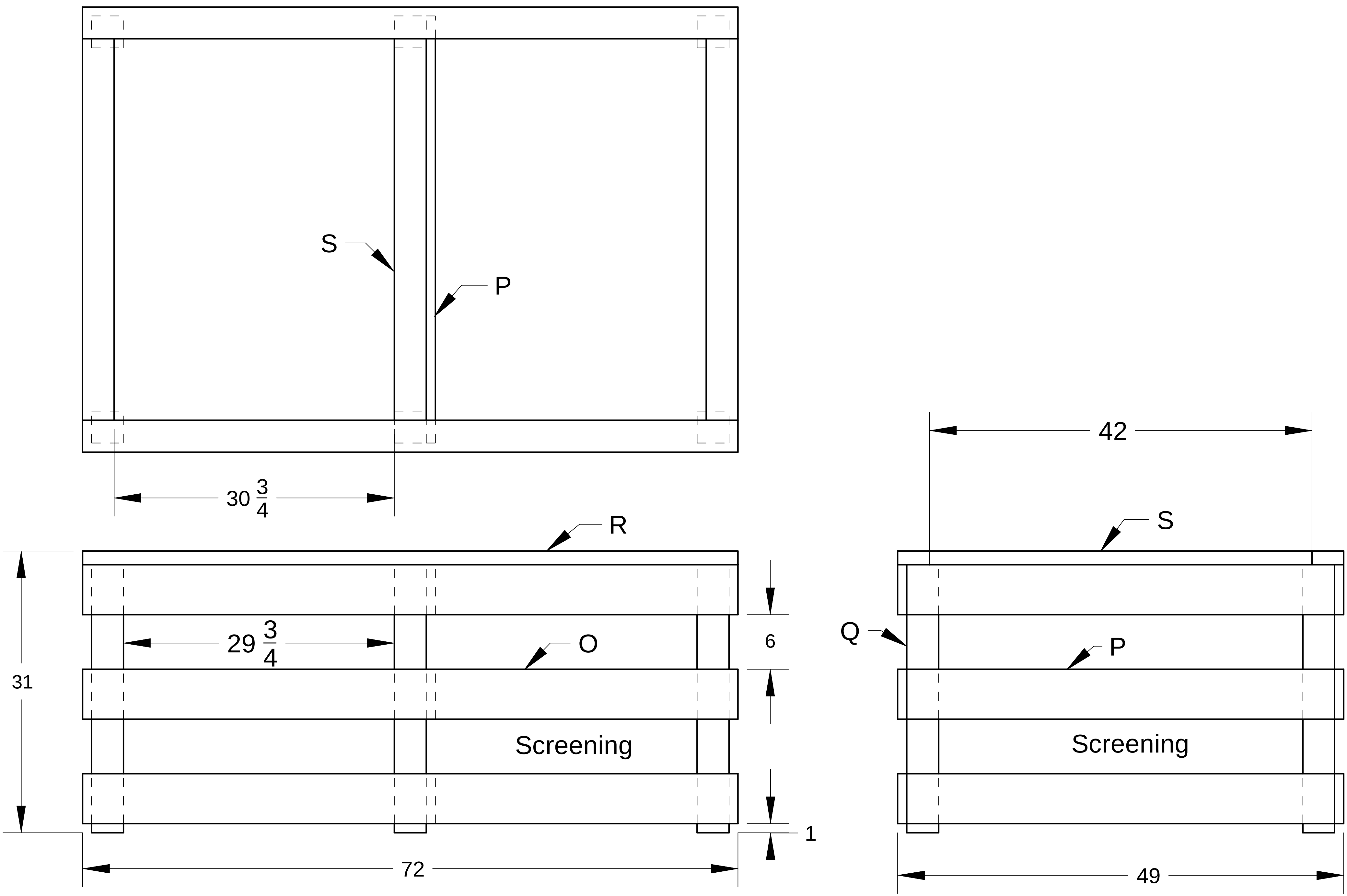
Front View



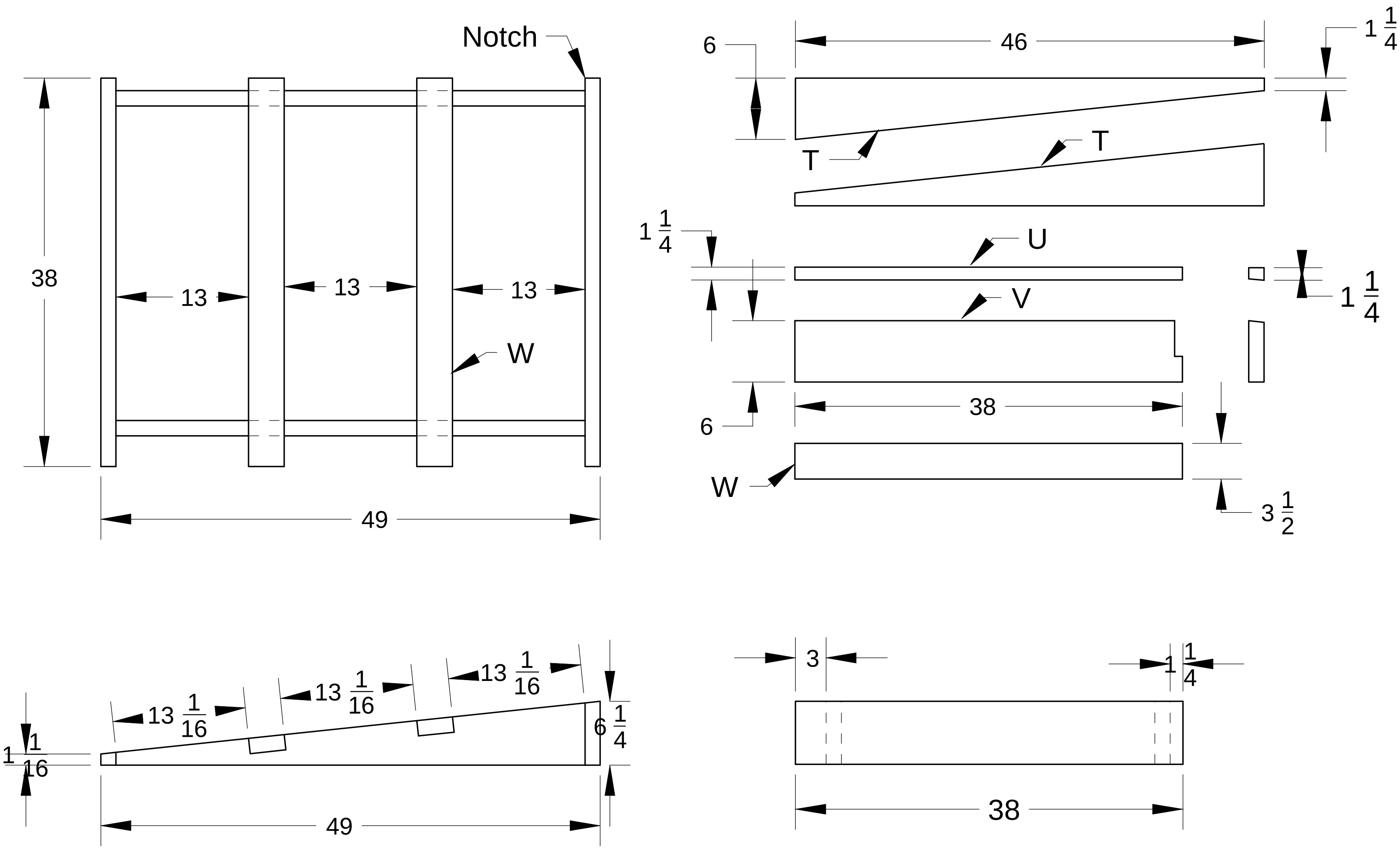
Door View



Crib View



Cover View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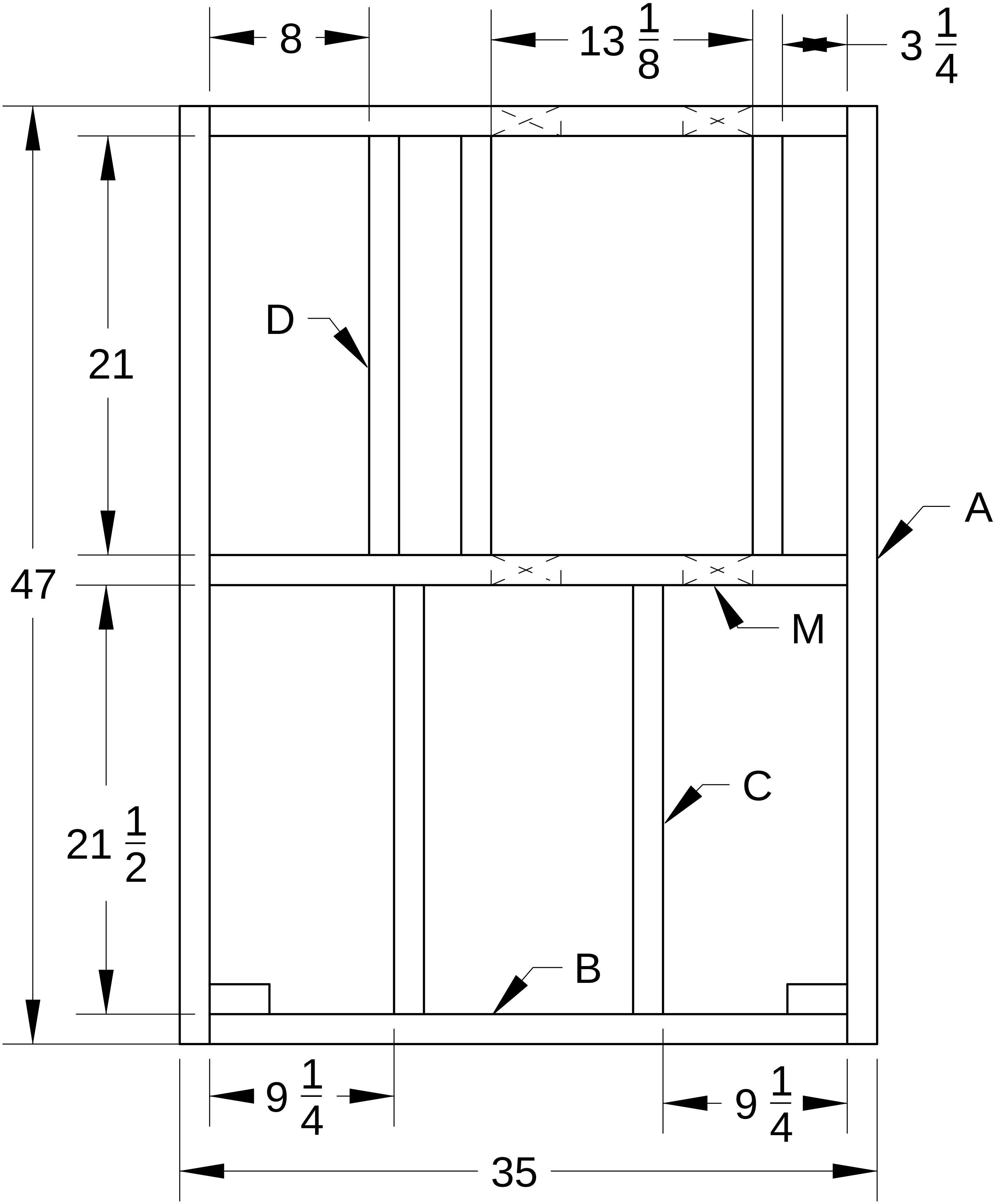
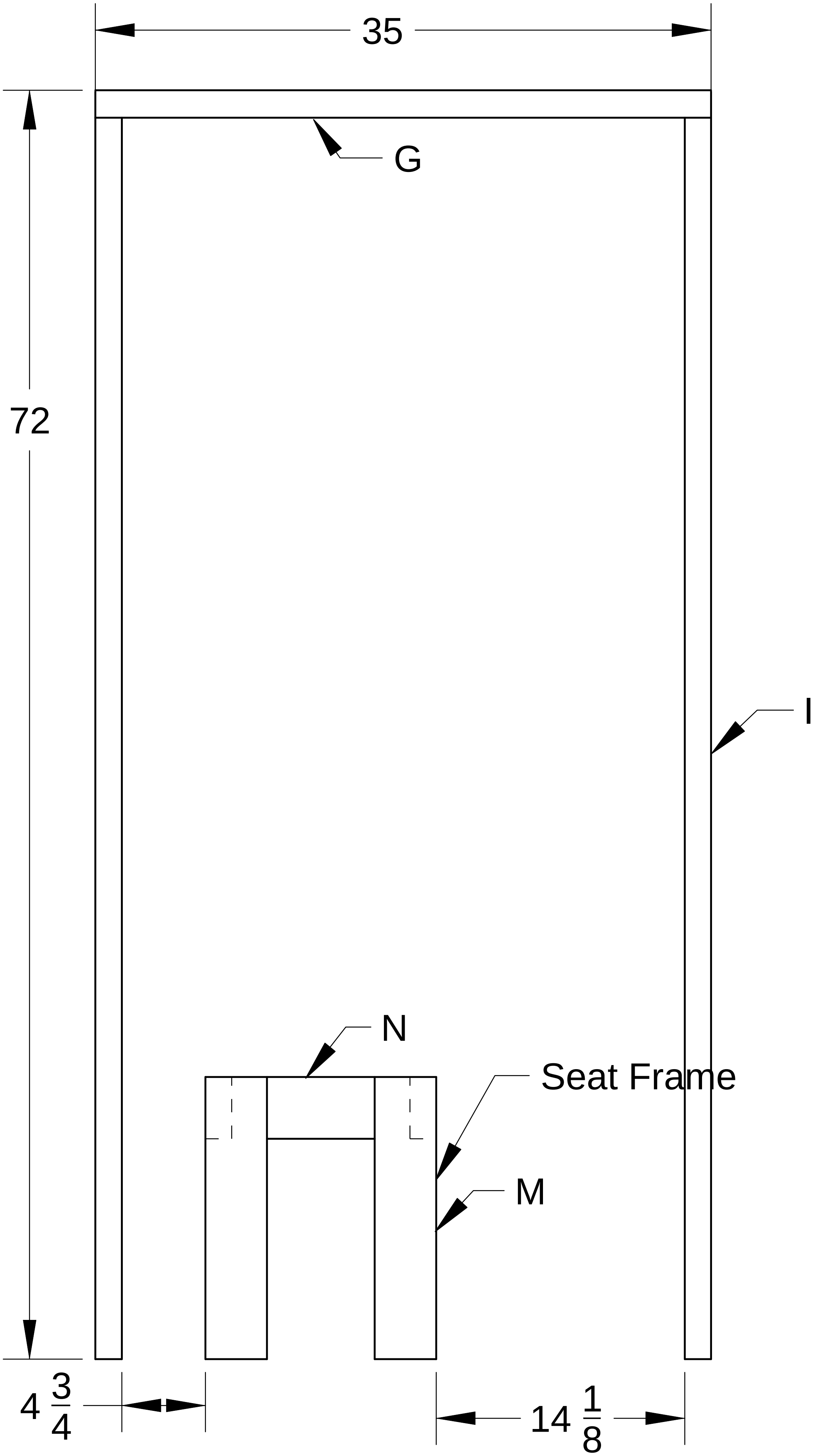
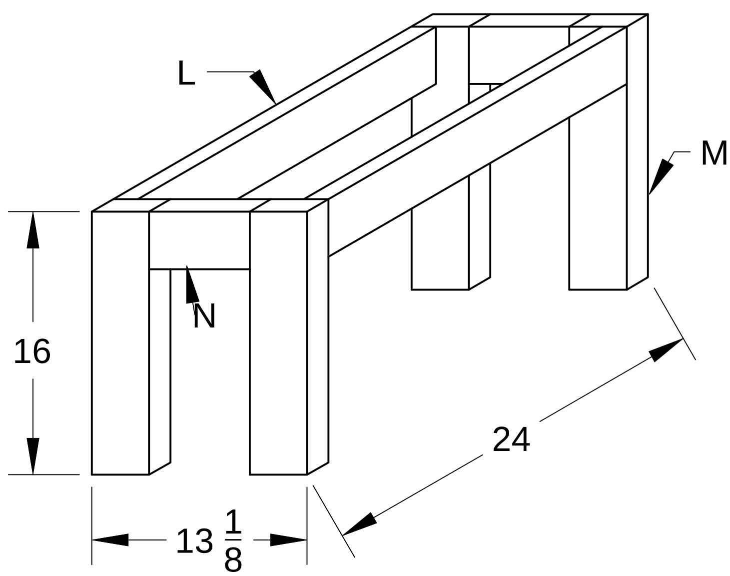
Base View



Back View



Seat Frame



I Plans for a Drying Rack

Following Pages

Green Mountain Club
Drying Rack
List of Materials

(all wood should be treated, either ACQ or PTF)

2 2"x4"x8' for back uprights

2 2"x4'x10' for front uprights

3 2"x4"x12' for floor joists and roof supports

2 2"x6"x8' for top and bottom side beams

4 5/4"x6"x12' for 4 front and back beams, 4 back wall boards

9 5/4"x6"x8' for floor and side walls

1 5/4"x6"x8' for one side wall board and sliders

1 2"x2"x10' for sliders and handles

* galvanized metal roofing to cover 5' x 6'-6"

* 1 lb 2 ½" galvanized screws

* 3 lbs 2" galvanized screws

* 12 2"x4" joist hangers

* 1 box joist hanger nails

* 1 lb galvanized roofing screws

16 3/8"x3" galvanized lag screws

16 3/8"x3 ½" galvanized carriage bolts

16 3/8" galvanized nuts

32 3/8" galvanized washers

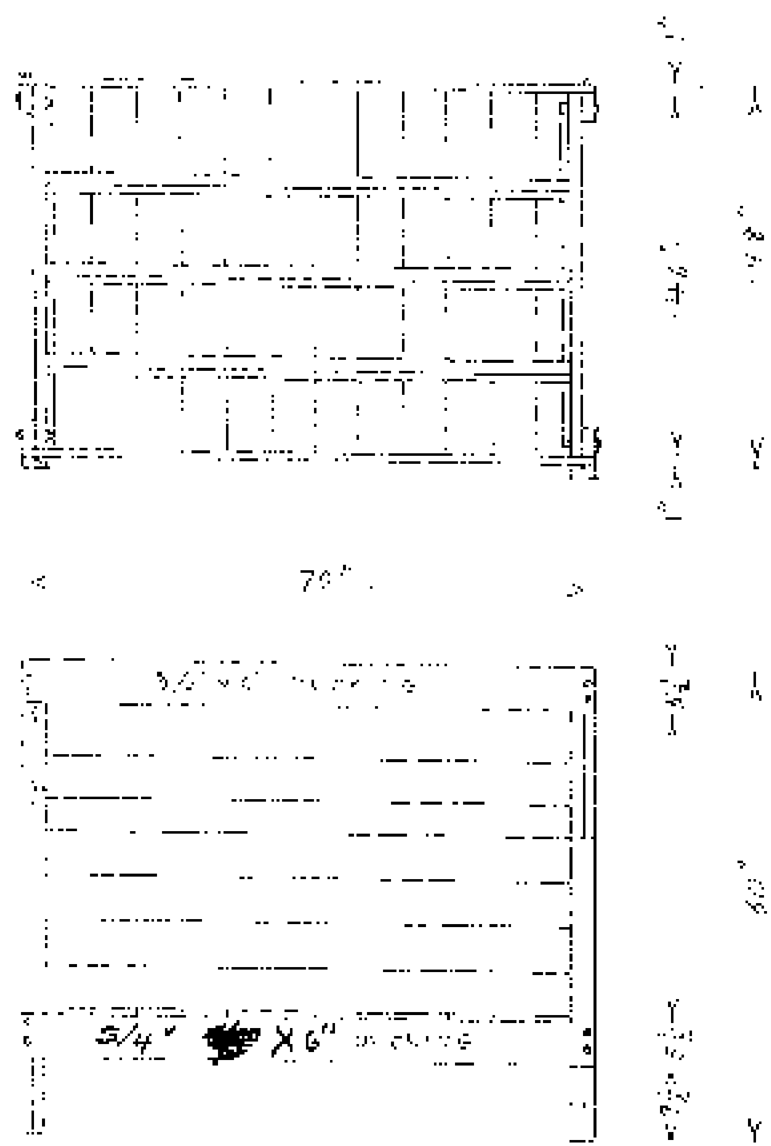
* DO NOT BUY THESE ITEMS WITHOUT FIRST CHECKING THE BINS NEAR THE LADDERS IN THE NORTH BARN, AND IN THE LOFT. THERE ARE PROBABLY SOME OF THESE ALREADY ON HAND THERE.

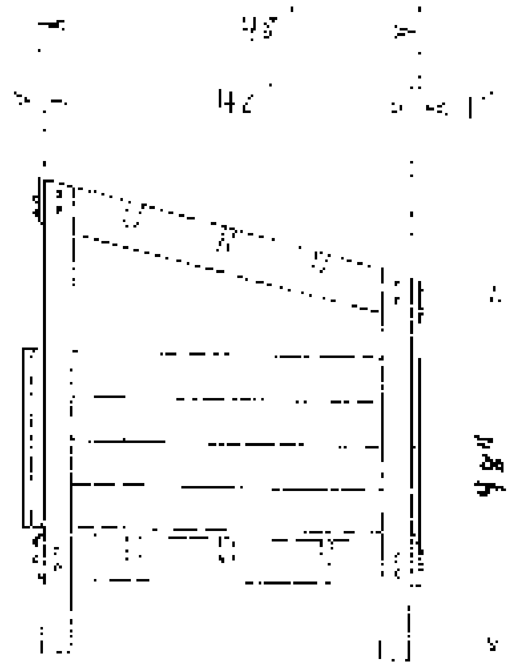
GREEN MOUNTAIN CLUB

DRYING RACK

FRAME ASSEMBLY
SCALE: 1/2" = 1'-0
DATE: 08-04-04

AFTER ASSEMBLING FRAME, INSTALL FLOOR BOARDS, THEN SIDE BOARDS, THEN BACK BOARDS





GREEN MOUNTAIN

DETAILS

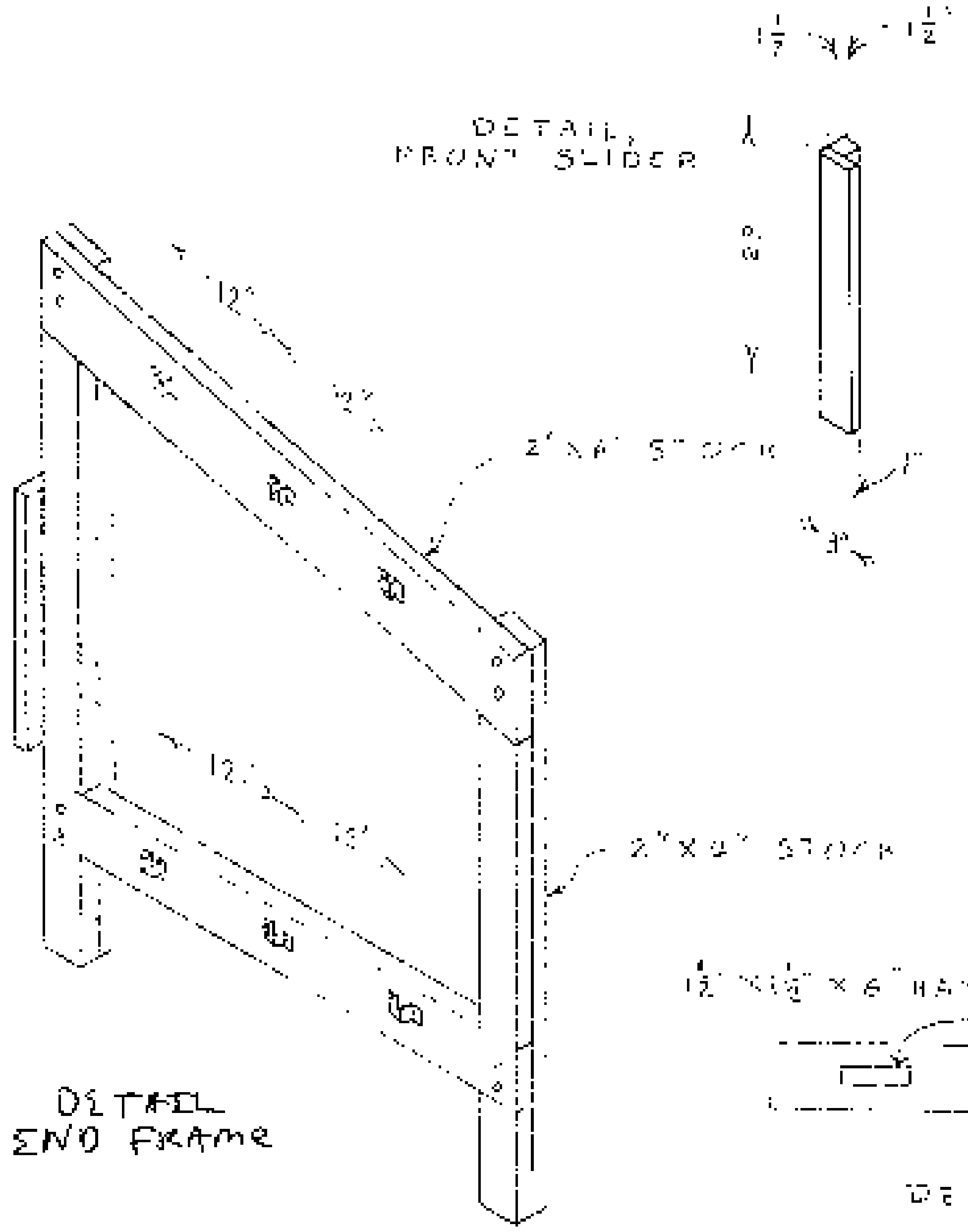
FLOOR & ... SUPPORTS:
2" X ... X 66"

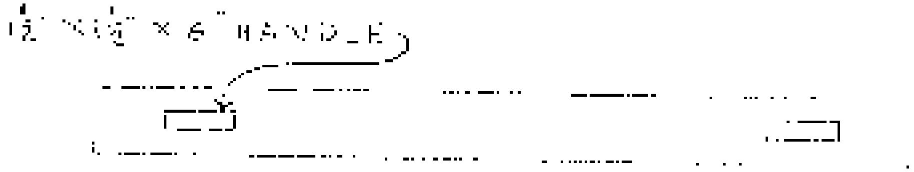
FLOOR ...
5/4" X 6" X ...
2 REQ.

SIDE BOARDS
5/4" X 6" X ...
2 REQ.

BACK BOARDS
7/4" X 6" X ...
REQ.

REMOVABLE FRONT ...
5/4" X 6" X 68 ...
4 REQ.





DETAIL, FRONT BOARD

J Diagram of a Washpit

A washpit is composed of a 12" deep hole filled with rocks of varying sizes. It is best to place smaller rocks and gravel towards the bottom of the pit and larger rocks towards the top. On the top of the pit is a wooden frame covered with hardware cloth and screen. This filter will prolong the life of the pit and allow people to pack out their food waste. If you can't dig a 12" deep hole, you will have to construct a runway that leads to a second pit or consider using a designated dishwashing area (see Section 13 for more info).

Following Pages

WASHPIT

- PLEASE WASH AND RINSE YOUR DISHES HERE; NOT AT THE WATER SOURCE
- PACK OUT ANY FOOD SCRAPS LEFT ON SCREEN
- PLEASE AVOID SOAP

THANK YOU

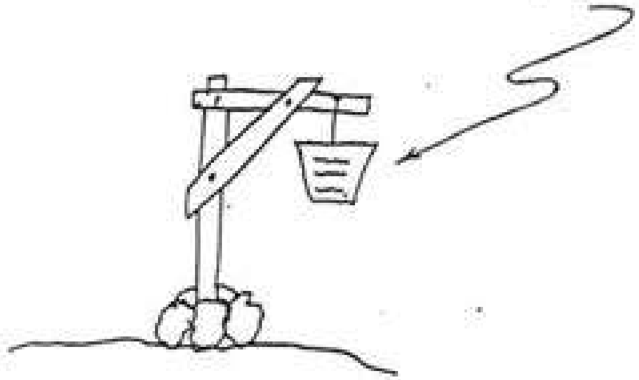
GREEN MOUNTAIN CLUB
LONG TRAIL
1910
VERMONT

DISH-WASHING PROCEDURE

This method will prevent water supply contamination by soap and food. plus will insure a cleaner shelter area.

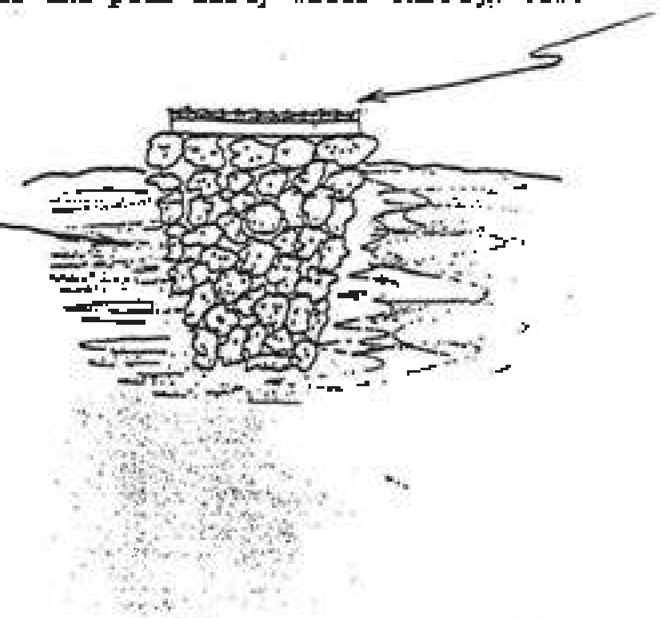
WHAT YOU DO . . .

1. Bring water from the stream to wash area.



2. Wash dishes and pour dirty water through screen

3. -the water will leach through the stones in the dry well



4. What You Do Last:

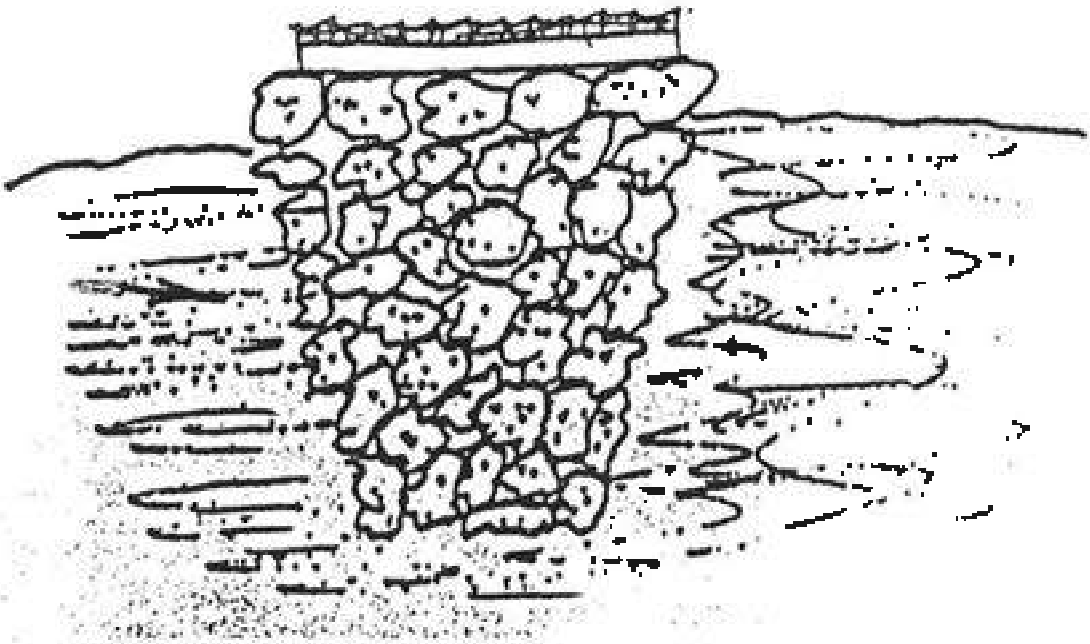
- Once you have poured all of your gray water through the screen into the washpit,

- Scrape off all remaining food scraps and residue and pack these out with your garbage. This will reduce odor as well flies and animals from being attracted to the washpit.

Thanks for helping to protect backcountry water quality and the experience of other shelter users.

The Green Mountain Club, Inc.
[illegible] Waterbury Stowe Road
Waterbury Center, Vermont 05677

Founding and Maintaining Vermont's Long Trail Since 1910



Washpit

A washpit is comprised of a 12" deep
hole filled with rocks of varying sizes.
It is best to place smaller rocks and gravel
towards the bottom of the pit and larger
rocks towards the top. On the top of the pit
is a wooden frame covered with hardware cloth
and screen. This filter will prolong the life of
the pit and allow people to pack out their
food waste. If you can't dig a 12" deep hole,
you will have to construct a runway that leads to a second
pit or consider using a designated dishwashing
area (see chapter 10 for more info.).

K Backcountry Sanitation: A Review of Literature and Related Information

Paul R. Lachapelle, *former Staff, Green Mountain Club*

K.1 INTRODUCTION

Sanitation issues associated with recreational activities are often difficult to resolve, particularly in cold climates. Managers and users need information, but literature on sanitation in backcountry settings is scarce, and information on sanitation is often hidden in general outdoor and recreation-related literature.This chapter provides a review of literature, case studies, proceedings and related works dealing with sanitation as it applies to recreation and backcountry use, and presents a chronicle of related research on water quality, recreation and sanitation infrastructure.

K.2 THE EARLIEST RESEARCH

Backcountry sanitation research began in the mid 1970's in response to increased visitation at backcountry sites with low assimilative capacity for human waste. Researchers under the direction of the U.S. Forest Service (USFS) Northeastern Forest Experiment Station in Durham, NH, began to investigate methods of treating and disposing of human waste on-site using a batch (also termed bin or thermophilic) composting system.

Some of the earliest studies, including the work of Fay and Walke (1977), Ely and Spencer (1978), Leonard and Fay (1978), Fay and Leonard (1979) and Plumley and Leonard (1981) detail the batch composting method using a fiberglass-covered plywood bin intersected with perforated PVC (polyvinyl chloride plastic) tubes to increase aeration. The technique used in these early trials was adopted at many sites in New England, and has remained a viable method for managing high volumes of human waste in the backcountry.

Contemporary bin composting systems often use high-density plastic containers and liquid treatment devices detailed later in this chapter.

Early studies established that, "(A) bark-sewage mixture can be composted to produce a pathogen-free substance " (Fay and Walke 1977:1) in which "(T)he final product of the compost process is a dark brown, humus-like substance that can be scattered on the forest floor" (Fay and Leonard 1979:37-38).

Leonard and Fay (1978:6) said the composting process was "...as much an art as it is a science," explaining, "(T)he temperature of a compost pile is probably the best indicator of good, aerobic composting."

Ely and Spencer (1978:9) tested the end-product from the batch composting system and found that "...enteric disease-causing organisms (which generally occur in smaller numbers) [sic] could also survive the compost process," and further refined the process by incorporating a drying rack to make the end product safer. "(T)o obtain an end product containing little or no enteric organisms, a six to twelve month holding period is recommended. ...(H)igh pile temperatures are not a guarantee that each and every undesirable organism has been sufficiently exposed to a fatal wet heat. For this reason, composted material should be handled with care at all times."

Leonard and Plumley of the USFS (1979:351, 352) detail the use of both batch composters and a Clivus Multrum continuous composting toilet at several sites in the White Mountain National Forest in New Hampshire. They comment, "(C) omposting systems may be cheaper than the fly-out system or chemical toilets. ...A comparison of total costs over a period of 10 years indicates that composting can be cheaper than other methods despite the additional maintenance time required."

The authors concluded that the batch system offered numerous advantages to other human waste treatment and disposal systems: (1) batch systems are effective in reducing (but not necessarily eliminating) both the volume and pathogenic characteristics of human waste; (2) batch systems can be utilized at diverse backcountry locations; and (3) batch systems offer a cost-effective and economical method of human waste disposal at backcountry sites.

Cook, (1981) also of the USFS, began research of composting toilets in the same period, and described and evaluated the use of 33 bin composters and continuous composting toilet systems in five backcountry locations in the United States. After laboratory tests of fecal coliform content of the end-product from these toilets, Cook (1981:95) found that "(N)either bin nor continuous composting was capable of reducing fecal coliforms to recommended levels," but added, "(I)f the waste after composting can be shallow buried at or near the site [and] results in no detrimental health effects to the public, then perhaps the system of composting can be considered in selected areas."

Passive solar-assisted continuous composting toilet have been used in numerous locations. Franz (1979) and Ely and Spencer (1978) document the use of a Soltran model continuous composting system using large solar panels and an insulated heat storage area to aid the composting process at several sites in the White Mountains of New Hampshire. These units have since been removed because of the expense of installation and maintenance, and their failure to accelerate composting.

Leonard and others (1981) detail sanitation techniques at backcountry sites, including individual disposal, pit toilets, haul-out systems, chemical toilets, advanced composting systems and waterborne waste disposal using filtration and spray disposal systems.

K.3 DEVELOPMENT OF METHODS AND RESEARCH

The National Park Service (NPS) began an active research program in the mid 1980s with the investigation of a dehydrating system and nine Clivus Multrum continuous composting systems in "remote sites that lack power, water, soil depth and vehicle access" in several national parks in the United States (Jensen 1984:1-1). The report states that "(A)ll the compost toilets were found to require a liquid disposal system ...None of the ventilation systems were operating as designed ...Compost systems operating at less than 50% of the recommended loading rate appeared to function with a minimum, or no attention to the process [and] ...None of the units demonstrated the sliding of the solid material on the inclined bottom of the tank." (Jensen 1984:1-1). The dehydrating toilet detailed in the report is a Shasta model and "...required modifications to provide satisfactory performance, [since] drying the large accumulation of solids was not successful" (Jensen 1984:1-2).

The National Park Service also commissioned a study and report on the use of nine batch composting system in North Cascades National Park in Washington (Weisburg 1988) to determine the feasibility of this technique in high-use humid environments.

Further refinement of the batch system was conducted by the Green Mountain Club in Vermont, which coordinated four editions of the "Manual for Bin Composting and Waste Management in Remote Recreation Areas" beginning in 1977, and most recently updated by Pete Ketcham, Field Supervisor of the Green Mountain Club, as part of this Backcountry Sanitation Manual (2001). This edition details the compost process, the operation of the batch system and troubleshooting techniques.

It includes schematics of the composting bin, drying rack and outhouse structure, and lists suppliers of plastic bins useful for composting.

Additional refinements to the batch system include the availability of a commercial bin manufactured by Romtec employing a small solar glazing to increase passive solar gain (Drake 1997). Refinements to continuous composting systems include Phoenix composters with tines to mix waste (Land 1995 a) and Bio-Sun Systems continuous composting toilets with large access doors and geotextile fabric to support waste above the floor of the chamber to increase aeration (Lachapelle 1996).

Increasing backcountry use also prompted research relating on the breakdown of fecal coliform and other bacteria using the "cathole" method. Temple and others (1982:357), in their study of shallow catholes in the Bridger Mountains of Montana, "disappointingly" found that even after a year, "(B)acterial numbers remained on a plateau [meaning pathogen levels had not significantly decreased and] ...Depth of burial made no difference."

In the 1980s numerous empirical studies were conducted on water quality in backcountry recreation settings (Silsbee and Larson 1982; Tunnicliff and Brickler 1984; Carothers and Johnson 1984; Bohn and Buckhouse 1985; Suk and others 1986; Flack and others 1988; Aukerman and Monzingo 1989). These studies document bacterial contamination of backcountry surface water, the increase of giardiasis in backcountry waters and methods of examining and quantifying water quality. They reinforced the importance of hygienic behavior in the backcountry.

Solar dehydration has been investigated as a potential backcountry sanitation method by the Forest Service and the Park Service. It has been used with varying success on Mt. Whitney in California (McDonald and others 1987) and in Mt. Rainier National Park in Washington (Drake 1997). In addition, the surface water runoff from the dehydrating toilet at Mt. Rainier was tested by Ells (1997), who was not able to document water contamination. However, the dehydrated end product from these toilets is often high in pathogens, difficult to handle and cannot be disposed of on-site.

K.4 WORKSHOPS AND PROCEEDINGS

Numerous conferences and workshops have focused either peripherally or specifically on waste management options in the backcountry. The Alpine Club of Canada (ACC) held the symposium "Water, Energy and Waste Management in Alpine Shelters" in 1991 at Chateau Lake Louise, Alberta, the first meeting on backcountry waste management. The proceedings describe waste management technologies at various ACC backcountry sites, including septic and gray water systems, fly-out systems and incineration systems (Jones and others 1992).

The "Backcountry Waste Technology Workshop" held March 30-31, 1993, at Mt. Rainier National Park in Washington hosted about 25 participants from Canadian and United States organizations. It considered professional experiences with pit and vault toilets, composting, dehydration, and fly-out and carry-out techniques (Mt. Rainier National Park 1993). Workshop participants identified a need for a document covering design considerations for backcountry waste systems and a need to give higher priority to management of and budgeting for human waste. The agenda was continued the following year in Yosemite National Park in California with a workshop that resulted in a document on continuous composting toilets and issues of compliance, design, construction, operation and maintenance (Yosemite National Park 1994).

The conference "Environmental Ethics and Practices in Backcountry Recreation" in Calgary, Alberta, in 1995, sponsored by the Alpine Club of Canada, contained a session on backcountry waste management, and produced a proceedings of conference papers

(Josephson 1997). The proceedings contain an analysis by Drake (1997), who documents the use of a "blue bag" policy for an individual pack-out requirement on several of the popular climbing routes of Mt. Rainier. Drake reports that compliance is much lower than expected.

In 2000, the Australian Alps Best Practice Human Waste Management Workshop was held in Canberra, Australia and hosted by the Australian Alps National Parks. The proceedings contain more than 30 papers covering such subjects as personal carry-out techniques using "pootubes," and accounts from site managers in Australia and New Zealand of on-site and off-site treatment and disposal techniques including composting, septic and vermiculture systems (which use worms to aid decomposition of waste) (Australian Alps National Parks 2000).

K.5 CURRENT STATE OF KNOWLEDGE

Recent research on perceptions of backcountry waste issues reveals that 25 percent of National Park Service managers find human waste to be a common problem in many or most areas, and 43 percent consider it a serious problem in a few areas (Marion and others 1993). In their study of social and ecological normative standards, Whittaker and Shelby (1988) found that the standard for human waste represented a no-tolerance norm, in which 80 percent of the respondents reported that it was never acceptable to see signs of human waste.

Voorhees and Woodford (1998) document the recent controversy over the expense of several continuous composting toilets in Delaware Water Gap National Recreation Area in New Jersey and Pennsylvania and in Glacier National Park in Alaska. The authors argue that although the project was widely criticized, by using environmentally- sensitive materials the structure actually minimized the life-cycle cost of the facility (Voorhees and Woodford 1998:63).

Further refinements of bin composting have been investigated by the Appalachian Mountain Club White Mountain Trails Program with funding from the Appalachian Trail Conference and the National Park Service. The resulting document describes the "Beyond the Bin Liquid Separation System" used to treat excess liquid from the standard batch-bin composting system (Neubauer and others 1995).

The U.S. Forest Service has continued its commitment to an active research program, particularly through its Technology and Development Center in San Dimas, California, including two documents by Land (1995a,b) describing various bin and continuous composting toilets and other remote waste management techniques.

In addition, the Aldo Leopold Wilderness Research Institute has been active in research on visitation management and low-impact recreational practices, including sanitation in federally designated Wilderness in the US (Cole 1989; Cole and others 1987). Lachapelle (2000) examines human waste treatment and disposal methods in designated Wilderness, and supplies a decision-making matrix and flow chart to help managers consider the pros and cons of various backcountry waste management techniques and their social and biophysical implications.

It is now possible to use DNA testing to reveal the sources of fecal coliform colonies in backcountry water sources. This technique has been used to document human fecal contamination in high-use backcountry areas of Grand Teton National Park in Wyoming (Tippets 1999, 2000).

Studies directed by the USFS examine the use of a passive solar device to further treat and inactivate the end product of composting toilets. These studies indicate that a solar "hot box" can pasteurize compost and save transport and disposal costs, while providing more safety for field personnel (Lachapelle and Clark 1999; Lachapelle and others 1997).

Most recently, Cilimburg and others (2000) have produced a comprehensive examination of various backcountry waste management practices with a focus on past studies of the pathologies of water contamination and their implications for recreational activities.

Many books describe commercial composting toilets and other methods of disposal and treatment of human waste in the backcountry. These include the books by Meyer (1994), who explores anecdotal and often amusing accounts of handling human waste in the backcountry; Hampton and Cole (1995), who describe waste treatment and disposal techniques in a variety of environmental situations; Del Porto and Steinfeld (2000), who detail choosing and planning a composting toilet systems with a focus on commercial systems and related state statutes; and Jenkins (1999), who describes a more homemade approach to batch composting.

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L The Application of a Solar Hot Box To Pasteurize Toilet Compost In Yosemite National Park

Paul R. Lachapelle & John C. Clark, *November 11, 1998*

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Land managers today are continually searching for sustainable backcountry management techniques while decreasing operational expenditures and the use of human resources. The public is also increasingly concerned about expedient backcountry infrastructure projects including the construction of innovative toilet facilities (Voorhees & Woodford, 1998). Past research has documented composting toilet technologies as a low-cost, efficient and sustainable method of backcountry human waste treatment (Davis & Neubauer, 1995; Land, 1995 a,b; Yosemite NP, 1994; Mount Rainier NP, 1993; Weisberg, 1988; McDonald *et al.* 1987; Jensen, 1984; Cook, 1981; Leonard *et al.,* 1981).

While considerable research has demonstrated the operation and maintenance of composting toilets in the backcountry, few studies have explored proper methods of composting toilet end-product disposal. In 1996, the USDA Forest Service, San Dimas Technology and Development Center and the USDI National Park Service, Yosemite National Park, conducted a cooperative study in the development and operation of a passive solar insulated box (termed the "Hot Box") to treat the endproduct from composting toilets used by hikers in the backcountry.

The study demonstrated that the Hot Box could consistently meet U.S. Environmental Protection Agency heat treatment requirements and produce a class A sludge that could be surface-applied as outlined in 40 Code of Federal Regulations (CFR) Part 503 (Lachapelle *et al.* 1997). According to the regulation, this heat treatment is a function of time and temperature. The study demonstrated that the time-temperature requirement could consistently be met in Yosemite NP, an area that proved ideal because of high ambient air temperatures and consistent sunlight throughout much of the summer.

Field staff at Yosemite NP tested the application of the Hot Box to pasteurize large quantities of end-product during the summers of 1997 and 1998. Field staff report that the Hot Box operated well and required minimal labor under optimal conditions.

All of the end-product removed from backcountry toilets in Yosemite NP was previously sealed in plastic bags, deposited into designated dumpsters and then thrown away in a local landfill. The end-product is now surface-applied out of the park in local flower gardens near the park headquarters in El Portal.

Background

The development of backcountry composting toilet methods resulted from the need to reduce impacts including surface water pollution at overnight sites. Research of backcountry composting systems began in the mid-1970's and focused on sites with up to 2,000 overnight visitors per season (Fay & Walke, 1977; Ely & Spencer, 1978).

Composting technologies became increasingly popular as research documented the ineffective break-down of coliform bacteria using the "cat-hole" disposal technique (Temple *et al.* 1982) and as certain composting toilet technologies were shown to be a low-cost solution for human waste treatment and disposal (Leonard & Fay, 1979; Leonard & Plumley, 1979). Thermophilic composting (also termed batch or bin) and mesophilic composting (also termed moldering or continuous) have been used with varying degrees of success in numerous National Parks (Yosemite, Mt. Rainier, Olympic, Grand Canyon) and National Forests (White Mountain, Green Mountain).

The aim of any composting technology is to optimize conditions for microbial growth. Combining the proper amount of carbon (also termed bulking agent and usually consisting of woodchips or shavings), moisture, ambient heat and oxygen enhances the living conditions within the compost pile for natural oxygen-using microorganisms (aerobes). These aerobes use human waste as a food source and consequently, the waste decomposes over time into a soil-like substance. Disease-causing organisms (pathogens) within the human waste are reduced or eliminated due to competition, natural antibiotics, nutrient loss and heat.

The human waste and the carbon are in most cases manually mixed in an enclosure or sealed bin. The term *end-product* refers to the composted woodchips and human waste. The composting process functions optimally with a carbon to nitrogen ratio of 25-35:1 and a moisture content of 60% (Davis & Neubauer, 1995).

The aim of thermophilic composting, which requires frequent mixing (several mixes per week) and high woodchip input (approximately 1 kg of carbon to 1 liter of human waste), is to kill pathogens quickly and with hot temperatures. These temperatures result from microbial activity and can exceed 45 degrees C. Once a sufficient amount of human waste has been collected, a compost "run" is started and can take up to several weeks to complete.

Mesophilic composting in comparison is a long-term method that can take years to effectively reduce pathogens within the waste. Additionally, the frequency of mixing and the amount of carbon added are considerably lower than thermophilic methods with temperatures within the waste pile ranging between 10 degrees C to 45 degrees C.

However, complete pasteurization of composting toilet end-product by either treatment method can never be guaranteed and depends on the quality of maintenance and site conditions. Heat treatment, such as the Hot Box can provide, is one method to ensure pathogen reduction and meet 40 CFR Part 503. Consequently, the Hot Box can help in a number of ways.

First, if land management policy dictates that the end-product can be surface-applied at the backcountry toilet site, significant savings in transportation costs could result. Additionally, the biophysical and social impacts from using either pack animals or helicopter resources could be reduced.

Second, while land management policy may dictate that the end-product be transported outside of a protected area boundary, heat-treated compost is less of a health and safety issue to field staff. Since, for example, a fundamental tenet of the Wilderness Act states that the wilderness area be "protected and managed so as to preserve its natural conditions" (Wilderness Act of 1964, Sec 2c), surface-applied compost in these areas could be problematic. Unquestionably, increased nutrient levels resulting from on-site disposal could upset natural species assemblages by shifting the competitive advantage to invasive non-native plant species. However, end-product that is heat-treated in the backcountry would be a considerably lower health hazard to field staff regarding accidental spillage during transport or disposal.

Third, if the end-product cannot be surface-applied at the site and the Hot Box cannot be used in the field because of staffing or ordinance issues, landfill disposal savings could result. Lastly, the treated end-product could be reintroduced into the composting toilets as bulking agent which would reduce the amount of additional bulking agent needed.

Hot Box Description and Application

The Hot Box is a nearly air-tight container that allows the sun's short-wave radiation or light energy to pass through the glazing. The contents of the Hot Box absorb the light energy and convert it to long-wave radiation or heat energy which becomes trapped inside the box.

The 1996 USFS/NPS study demonstrated that temperatures of over 100 degrees C (212 degrees F) can be reached and temperatures of 88 degrees C (190 degrees F) can be sustained for several hours.

The outside walls, floor and removable tray are fabricated from an approximately .5 cm thick aluminum sheet. A single transparent Lexan® Thermoclear polycarbonate sheet is used as the solar glazing and is bolted at an angle specifically designed to maximize the angle of incidence during the summer solstice for the chosen latitude (at Yosemite NP, 38 degrees north latitude, a 15 degree angle was chosen). This angle could be adjusted for other locations. The inside walls and floor are insulated with 5 cm poly-isocyanurate closed-cell foam. A door is positioned at the back of the Hot Box in order to gain access to the tray. The original Hot Box measured 122 cm x 94 cm x 69 cm at the highest end and 46 cm at the lowest end.

Four new Hot Box's, measuring 122 cm x 122 cm x 61 cm at the highest end and 20 cm at the lowest end have recently been built and appear to be more efficient because of their larger glazing and decreased internal air volumes.

Yosemite NP field staff operated the Hot Box during the 1997 and 1998 summer seasons at the park headquarters in El Portal. Yosemite contains 6 backcountry composting toilets that collectively produce approximately 20 cubic meters (700 cubic feet) of end-product. Since most of the backcountry composting toilets are located in federally designated wilderness areas, the end-product has been transported outside of the boundaries. End-product is transported in double plastic bags by pack animals to trailheads and then trucked to El Portal. Approximately 9 cubic meters (300 cubic feet) was pasteurized in 1998. Field staff emptied a portion of the bags into the Hot Box tray and allowed the compost to pasteurize for up to one week. It took one operator one-half hour per day two days per week to process approximately one cubic meter (30 cubic feet) of end-product.

The 1996 USFS/NPS study concluded that end-product pile depths in the tray of 12 cm or less and two and one-half hours of direct sunlight with ambient air temperatures exceeding 28 degrees C (83 degrees F) were most effective at meeting the time-temperature requirement. Additionally, a moisture content of 60 percent or less allowed for maximum temperature attainment.

Field staff would mix the end-product in the Hot Box tray several times during the heat-treatment process to ensure thorough pasteurization. After pasteurization, the finished compost was again bagged and brought to local flower gardens and spread thinly on the surface. Operators reported that the pasteurized compost resembled mulch and not human waste in both texture and odor and was therefore more tolerable to work with.

Conclusion

The passive solar Hot Box has been used for two field seasons in Yosemite NP, a location shown to be ideal to effectively pasteurize the compost from backcountry toilets. This application stems from the 1996 USFS/NPS study that demonstrated the use of the Hot Box as an effective method of composting toilet end-product pasteurization. Field staff report that the developed Hot Box technology required a minimum level of attention and maintenance by the operator and produced a compost that is dryer and appears less offensive to handle and transport. It is anticipated that further use of the Hot Box will refine design and performance imperfections.

While stringent regulations may negate the possibility that finished compost be surface-applied in wilderness and national park areas, the Hot Box holds tremendous potential to save either transportation costs and associated impacts in areas where the end-product can be surface-applied on-site, or disposal costs where the end-product must be transported and disposed off-site. Conceivably, this passive technology can serve as a sound and sustainable backcountry management technique, alleviating impacts, costs and extensive use of human and animal resources while providing an added safety margin to field personnel.

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M Examples of Regulatory Correspondence

Figure N.1—Copy of the wastewater permit issued to the Green Mountain Club in 2000 for the installation of a beyond-the bin system at Butler Lodge on the Long Trail. This situation was a great example of how a state agency, unaware of composting technology, learned about it when the Green Mountain Club provided a credible plan and specifications for the system. The state subsequently approved the system. Letter from the Green Mountain Club.

Figure N.2—A copy of a letter written by the Appalachian Mountain Club's Connecticut Chapter Trails Committee to State of Connecticut's Department of Public Health when seeking permission to install moldering privies on the A.T. in Connecticut. This is an excellent example of one of the key steps in the process of seeking approval for the installation of a sanitation management system on the A.T. Please keep in mind that in other states the process may require writing more than one letter to the state, and may also include town and county health departments." Letter from David Boone, Connecticut Chapter Trails Committee of the Appalachian Mountain Club.

N.3 – Copy of the wastewater permit issued to the Green Mountain Club in 200X for the installation of a batch-bin system with end product compost incineration unit at Churchill Scott Shelter on the Long Trail/Appalachian Trail.

Following Pages

State of Vermont

Water Supply and Wastewater Disposal Permit

CASE NO.: WW-1-0919
APPLICANT: The Green Mountain Club, Inc.
ADDRESS: Attn: Peter Kricham
4711 Waterbury-Stowe Road
Waterbury Center, VT 05677
&
United States of America
Don Owen, National Park Service
Harpers Ferry Center
Harpers Ferry WV, 25425

LAWS/REGULATIONS INVOLVED
10 VSA, Chapter 61, Water Supply and Wastewater Disposal, and
Environmental Protection Rules
Chapter 1, Subchapter 4 and Subchapter 7
Appendix 1-A
Chapter 21, Water Supply

(1) This project consisting of a backcountry shelter and tent platform without plumbing but with composting privy, located on Long/Appalachian Trails in Killington, Vermont is hereby approved in accordance with the requirements of the regulations named above, subject to the following conditions:

(2) The project shall be completed as described on the plans and/or documentation (Proposed Pico West Campsite Site Plan received 20 March 2002 and VT Dept of Forest, Parks, and Recreation, A Study of System Improvements to Traditional Batch Composting, dated 1995, Appalachian Mountain Club) which have been stamped "approved" by the Division of Wastewater Management. The project shall not deviate from the approved plans without prior written approval from the Division of Wastewater Management.

(3) There shall be no domestic water system connected with this project without prior approval of the Wastewater Management Division. The existing intermittent seep will have signs posted to clearly mark that the seep is nonpotable and the water must be boiled, filtered, or chemically treated before consumption.

(4) This project is approved as an innovative composting system, as described in section 1-203 of the Environmental Protection Rules, to address wastewater disposal at the campsite. No other method of disposing of wastewater is approved.

(5) A copy of the approved plans and this Water Supply and Wastewater Disposal Permit shall remain on the project during all phases of construction and, upon request, shall be made available for inspection by State or local personnel.

(6) By acceptance of this permit, the permittee agrees to allow representatives of the State of Vermont access to the property covered by the permit, at reasonable times, for the purpose of ascertaining compliance with Vermont environmental/health statutes and regulations, and with this permit.

(7) In the event of a transfer of ownership (partial or whole) of this project, the transferee shall become permittee and subject to compliance with the terms and conditions of this permit.

(8) This permit does not constitute Act 250 approval (Title 10 V.S.A., Chapter 151). The permittee is hereby reminded to procure all relevant State and local permits, including interior plumbing approval from the Vermont Department of Labor and Industry, prior to proceeding with this project.

(9) This permit shall in no way relieve the permittee of the obligations of Title 10, Chapter 48, Subchapter 4, for the protection of groundwater.

Christopher Recchia, Commissioner
Department of Environmental Conservation

Marsha J. Thompson
Assistant Regional Engineer

Dated at Rutland, Vermont, 21 March 2002

cc: Div
Town Planning, Killington
Act 250
Labor & Industry

State of Vermont

AGENCY OF NATURAL RESOURCES

WATER SUPPLY AND WASTEWATER DISPOSAL

LAWS/REGULATIONS INVOLVED: 10 V.S.A., Chapter 64, Water Supply and Wastewater Disposal and Environmental Protection Rules.
Chapter 1, Small Scale Wastewater Treatment and Disposal Rules
Subchapter 4, Water Supply and Wastewater Disposal
Subchapter 5, Sewage Disposal
Appendix A, Design Flows
Chapter 21, Water Supply

CASE No: WW-5-1542 — PIN No. EP83-0001

APPLICANT: University of Vermont
Attn. Rick Paradis

ADDRESS: 153 South Prospect Street
South Burlington, VT 05401

This project, consisting of the construction of a composting toilet facility at Butler Lodge, located in Mt. Mansfield State Forest, Stowe, Vermont, is hereby approved under the requirements of the regulations named above, subject to the following conditions:

1. GENERAL CONDITIONS

1.1. The project must be completed as described on the plans and/or documents listed as follows:
Butler Lodge Toilet Site Plan, Dated 12/91, VT Department of Forests, Parks, & Recreation.
A Study of System Improvements to Traditional Latrine Composting. Dated 1995, Appalachian Mountain Club.
and which have been stamped "APPROVED" by the Wastewater Management Division. No alteration of these plans and/or documents shall be allowed except where written application has been made to the Agency of Natural Resources and approval obtained.

1.2. A copy of the approved plans and the Water Supply and Wastewater Disposal Permit shall remain on the project during all phases of construction and, upon request, shall be made available for inspection by State or Local personnel.

1.3. No alterations to the existing building other than those indicated on the approved plans which would change or affect the water supply or wastewater disposal shall be allowed without prior review and approval from the Wastewater Management Division.

1.4. This authorization does not relieve you, as applicant, from obtaining all approvals and permits as may be required from the Department of Labor and Industry (phone 479-4434) and local officials PRIOR to construction.

1.5. By acceptance of this permit the permittee agrees to allow representatives of the State of Vermont access to the property covered by the permit, at reasonable times, for the purpose of ascertaining compliance with Vermont environmental and health statutes and regulations and with the permit.

1.6. This permit shall in no way relieve you of the obligations of Title 10, Chapter 48, Subchapter 4, for the protection of groundwater.

2. WATER CONDITIONS

2.1. There shall be no domestic water system connected with this project without prior written approval from the Wastewater Management Division.

3. SEWAGE DISPOSAL CONDITIONS

3.1. This project is approved as an innovative composting system, as described in section 1-203 of the Environmental Protection Rules, to address waste water disposal at Butler Lodge. The system is designed to reduce the impact of an inadequate wastewater disposal system at the existing lodge. As such, the Wastewater Management Division grants variances under section 1-202 of the Environmental Protection Rules.

(CONTINUED)

3.2 The construction of the composting toilet system shall be done in accordance with the approved Appalachian Mountain Club specifications. Representatives of the Green Mountain Club shall submit written documentation verifying proper construction of the system. Any variations required during construction shall be described including the need for the variance and the solution.

3.3. The system shall be maintained in accordance with the Appalachian Mountain Club specifications and a maintenance log shall be maintained at the site. During maintenance exposure to all pathogen containing waste shall be minimized and reasonable human and environmental protection required. Prior to the removal and burial of composted waste representatives of the Green Mountain Club shall contact the Wastewater Management Division so a representative from that office may have the option of reviewing and approving the burial site.

3.4 Compost burial sites shall be oriented to avoid exposed bedrock, wetland areas, [illegible] or environmentally sensitive areas, and areas commonly accessible to hikers.

Canute Dalmasse, Commissioner
Department of Environmental Conservation

By ______________________ 9/25/2000
Donald Wernecke, Regional Engineer

CC Green Mountain Club
Stowe Planning Commission
VT Dept. of Labor & Industry
Central Office of Wastewater Management Division

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

January 29, 2001

David Boone
CT Chapter AMC Trails Committee
370 Gilead Street
Hebron, CT 06248

RE: INSTALLATION OF SHALLOW RED WORM MOLDERING PRIVIES

Dear David:

I have received your letter dated January 11, 2001 requesting clarification as to whether installation of shallow privies which take advantage of red worm moldering to assist in the decomposition process are acceptable for use in Connecticut. As you know, Section 19-13-B103f of the Connecticut Public Health Code does make provisions for construction of non-discharging sewage disposal systems that do not require use of a water supply.

Based upon the description and information, which you submitted concerning this privy, it appears installation would be, suitable in Connecticut provided the bottom of such privy was located at least 18 inches above maximum ground water levels and 4 feet above ledge rock. Installation of privies would still be subject to review and approval by local health agencies. Soil testing could be simplified to crowbar borings to confirm depths to bedrock and shallow post hole excavations to log color, soil characteristics and ground water potential if not excavated during the wet time of the year. The important aspect of any privy is to maintain the structure free from insects, rodents and other animals. The screening should be of adequate strength and opening size to deny access for both insects and animals. We understand the application of red worms is beneficial in speeding up the decomposing process. This will reduce the frequency for privy relocation, as pit privies tend to fill up in time thereby requiring abandonment and relocation to a new pit.

Please feel free to use this letter as a means of notifying local health agencies as to the acceptability of this process and their involvement in the review, testing and approval of such units where applicable.

If you have any questions or would like to further discuss the red worm privy, please contact me.

Very truly yours

Frank A. Schaub
Supervising Sanitary Engineer
Environmental Engineering Section

FAS/jm

n/sewage/letter/red worm1

Phone: 860-509-7296

Telephone Device for the Deaf (860) 509-7191
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United States Department of the Interior

NATIONAL PARK SERVICE
Appalachian National Scenic Trail
Harpers Ferry Center
Harpers Ferry, West Virginia 25425

IN REPLY REFER TO:

January 23, 2002

Mr. Pete Ketcham, Field Supervisor
Green Mountain Club
4711 Waterbury-Stowe road
Waterbury Center, Vermont 05677

Pete
Dear Mr. Ketcham:

We have reviewed your proposal for a "Beyond the Bin" composting privy as part of the proposed Pico West Campsite project, which would be constructed on National Park Service lands on the western shoulder of Pico Peak in the Town of Killington, Vermont. The proposal is technically sufficient and appropriate for the site. We heartily endorse the project as the best means of providing sanitation facilities for hikers along this section of the Appalachian Trail/Long Trail.

Sincerely,

Pamela Underhill

Pamela Underhill
Park Manager

cc: J.T. Horn, Bob Proudman

N Articles from ATC's Newsletter, *The Register*

GMC Improves Sewage Management Along Long Trail

Pete Antos-Ketcham

From *The Register*, vol. 23, number 4 (Winter 1999).

During the 1999 field season, the Green Mountain Club (GMC) enhanced backcountry waste management at several sites on the northern portion of Vermont's Long Trail through several innovations in both technology and technique.

"Beyond the Bin" (BTB) liquid-separating composting toilets were built at both the base of Camels Hump and at Taft Lodge, located just below the summit of Mt. Mansfield, Vermont's highest peak (4,395'). In addition, moldering privies were constructed at Taylor Lodge, Jay Camp, Laura Woodward Shelter, and Shooting Star Shelter. Those projects were made possible by an outpouring of dedicated volunteers and funding from the Vermont Department of Forests, Parks, and Recreation, the National Park Service, and the Appalachian Trail Conference.

Like many overnight sites along the Appalachian Trail (A.T.), local environmental conditions on the Long Trail in northern Vermont present challenges to maintainers trying to manage sewage. Those conditions include thin, poor soils, cold temperatures, high ambient air moisture, and heavy use. Conditions such as those, coupled with a lack of field staff or volunteers, make dealing with sewage effectively nearly impossible. The preferred method of dealing with sewage traditionally has been the pit privy, which still represents the majority of waste-management systems on both the Appalachian Trail and Long Trail. At most sites where the use is low to moderate throughout the season, a pit privy is still the best option. However, when use increases, particularly at those sites with marginal environmental conditions, pit privies fill up and become major headaches.

At many shelter sites, wastes decompose slowly simply because the pit extends well below the biologically active layer of the forest floor (typically the first six inches) or this layer does not exist at all. The waste that accumulates decomposes so slowly that the rate of input from users exceeds the level of decomposition, and the pit *208* eventually will fill up. At many sites, there are no longer places to dig pits. Something must be done to provide adequate sanitation facilities or the future of these overnight sites will be jeopardized. For clubs wishing to develop new overnight sites and facilities, ATC direction requires that the proposed site be able to manage sewage in a way that protects the Trail experience for users, the health of visitors, and the area's resources. With public use on the rise, finding qualified sites is becoming increasingly difficult.

Recently, moldering privies have emerged as a possible alternative for those challenging management situations. GMC, along with several other A.T.-maintaining clubs, has been experimenting with them. Longtime GMC volunteer Dick Andrews constructed the first prototype moldering (slow-composting) privy on the Long Trail/ Appalachian Trail in Vermont at Little Rock Pond Shelter in 1995. A moldering privy utilizes the biologically active, upper six inches of the soil to better advantage by doing away with a pit entirely. Instead, the waste pile sits in a wooden crib constructed on the surface of the soil (see photo). With the waste pile above the ground, a variety of desirable common soil decomposers are attracted to it. Intense scavenging and competition created in the pile by these organisms helps destroy disease causing pathogens. The pile also receives a lot of aeration from air slats built in the wood cribbing. This higher level of oxygen helps reduce odors. Liquid is allowed to seep into the soil, where it is naturally treated by soil decomposers.

To further aid the decomposition process, field staff and maintainers introduce red-wiggler worms, which have a voracious appetite for wastes of all kind. The worms are particularly useful at colder, high-elevation sites with thin/ poor soils, where the local population of soil decomposers is low. The worms are available from most garden-supply companies. Because the worms will not survive winter freezing, GMC has been "growing" its own worm supply at GMC headquarters. The worms are distributed to volunteers for introduction into toilets each spring.

The above-ground crib (4' x 4' x 30") is constructed using 6" x 6" timbers of either pressure-treated or a rot-resistant wood, such as hemlock, stacked to create air slats to promote thorough ventilation. Air slats are covered on both sides with 1/4" hardware cloth and fine-mesh fly screening that helps to keep the waste in and debris and undesirable creatures out. Systems ranged in price from $90 to $400 per unit, depending on whether the privy building needs replacing.

After two seasons of planning and fund-raising, "Beyond the Bin" (BTB) technology arrived at Taft Lodge on Mt. Mansfield and at the Monroe trailhead at Camels Hump. The BTB was originally developed through a challenge cost-share grant to the Appalachian Mountain Club (AMC) in 1995. AMC, along with former GMC Field Assistant Paul Neubauer, constructed the first BTB along the AMC-maintained portion of the A.T. in New Hampshire. Today, nearly all of AMC's shelter sites along the A.T. have BTB systems.

The BTB is a modification of the GMC's batch-bin method of composting. The system adds a perforated, stainless-steel straining plate in the outhouse waste catcher that allows all liquids to be gravity-separated away from the solids. Once separated, the liquid then flows through a hose to a filter barrel (see photo). The 55-gallon barrel contains layers of anthracite coal and washed septic stone. A biological community will develop in the barrel that will consume pathogens and organic material in the liquid as it percolates through the barrel, before being discharged into the ground.

The main advantage of that system is a drastic reduction in the amount of wood chips needed for composting, which also significantly reduces the volume of sewage that needs to be composted. In batchbin systems, excess liquid needs to be sopped up with hardwood bark mulch or wood chips, which soaks up the moisture but expands the volume of the waste. This season, GMC caretakers composted approximately 630 gallons of sewage with the batch-bin system at Taft Lodge, due to the presence of copious amounts of liquid. The BTB should reduce sewage volumes by up to two-thirds annually. In addition, the drier sewage will compost at higher temperatures, producing a stable, pathogen-free end-product that can be safely spread in the woods without threatening the area's water quality.

After two months of operation, caretakers in the field reported a dramatic reduction in the amount of sewage they have had to compost, as well as a decrease in odors from their privies. During the 2000 field season, plans are to retrofit more privies to moldering systems and to modify other existing batch-bin composters over to BTB systems. A batch-bin system with a BTB filtering component will cost between $800 and $1,500. The entire BTB system weighs about 600 pounds and requires many volunteers, to transport to backcountry sites. The BTB is one of the more effective waste-management systems that has been used on the A.T. in New England. The cost is higher than a moldering privy, and it does require frequent maintenance and tending, so it may not be appropriate for some clubs or organizations with smaller budgets or labor forces. Funding for the BTB projects was made possible through generous grants from the Vermont Department of Forests, Parks, and Recreation, the Burlington Section of GMC, and Concept II (a local business) from Morrisville, Vt.

GMC is using the knowledge gained to develop a moldering-privy manual, which will be available in February. Thanks to an NPS challenge cost-share, a backcountry sanitation manual for Trail maintainers will be completed by 2001.

Pete Ketcham is Director of Operations for the Green Mountain Club. He also has worked with the Appalachian Mountain Club and Randolph Mountain Club in New Hampshire as a backcountry hut naturalist and facility caretaker.

A version of this article was printed in the Spring 1999 issue of the Long Trail News, GMC's quarterly newsletter.

For more information on backcountry waste management, contact Pete Antos-Ketcham at the Green Mountain Club; 4711 Waterbury-Stowe Road, Waterbury Center, Vermont 05677; (802) 244-7037 ext. 17; or **pantosketcham@greenmountainclub.org.**

A Privy, is a Privy, is a Privy—Or is It?
A Backcountry Sanitation Primer for the Appalachian Trail

Pete Antos-Ketcham
From ATC's *The Register* (Summer 2007)

Human-waste management on the A.T. has changed much from the days of the simple pit privy. Today's systems are designed to better protect the environment, but each type requires different steps to make them work properly. Hikers may be confused about the varying types of privies, so Trail managers should post signs in each privy explaining proper use and provide bark mulch or wood chips for hikers to use as needed.

Pit Privy—Campsites with minimal day and overnight use are generally still equipped with the basic pit privy. To make them work as well as possible, hikers are asked to urinate in the woods and drop in a handful of leaves when finished to reduce the familiar unpleasant odor.

Moldering Privy—The newest system to be used on the Trail, the moldering privy was introduced at Little Rock Pond Shelter in 1997 by Green Mountain Club volunteer shelter maintainer Dick Andrews. A moldering privy has a distinct appearance that lets the user know that it is clearly a different type of toilet. A ramp or set of stairs leads up to the door, and the privy sits atop a three-foot tall, screen-covered wooden box called a crib. Waste falls into the crib to rest on the forest floor, where it decomposes. Because of abundant exposure to wind, this is the one exception to the request to keep urine out of a privy; in fact, it helps the pile stay moist and degrade. After use, users "flush" with the wood shavings provided.

Batch Bin/Beyond the Bin (BTB) Composting Privies—In high-use areas like the Smokies, the Mid-Atlantic, and New England, hikers may find batch-bin or "beyond the bin" composting privies. This technology has been used in northern New England since the hiking boom of the 1970s. These systems are distinct because the privy site has steel or plastic bins and wooden drying racks for finished compost. Hikers are asked not to urinate in these privies as it creates unpleasant odors and hampers the composting process by making it too wet. Bark mulch is provided to absorb moisture and reduce odors. Some BTB systems may become too dry, so this practice may vary.

To learn more about backcountry sanitation on the A.T., check out the Green Mountain Club and ATC's Backcountry Sanitation Manual on ATC's Training and Resources Web page www.appalachiantrail.org/trainingandresources.

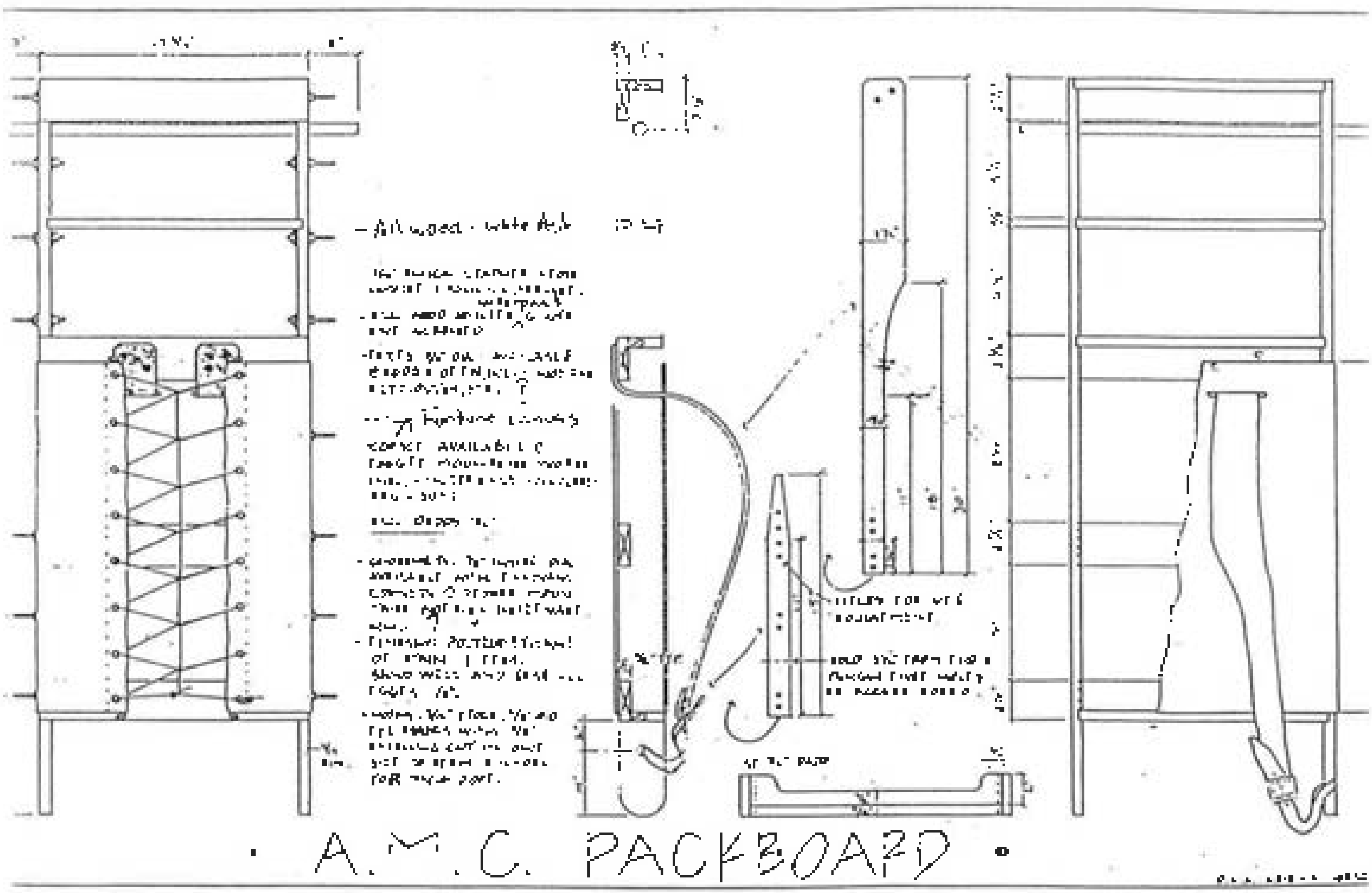
Pete Antos-Ketcham is education coordinator and facilities manager for the Green Mountain Club and a member of ATC's Stewardship Council. Along with Dick Andrews, he is editor and author of the Backcountry Sanitation Manual.

O Plans for a Wooden Packboard

Following Pages

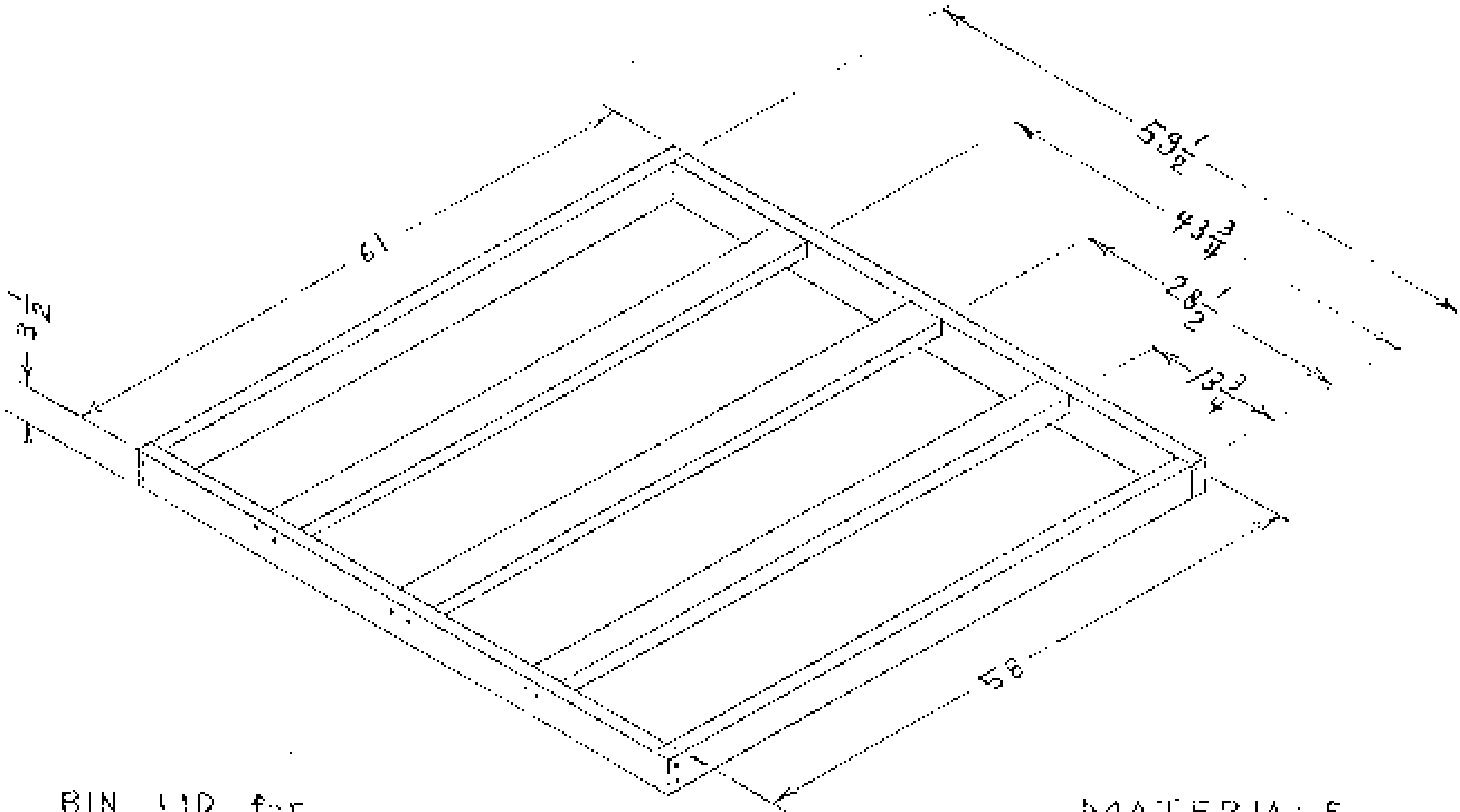
Packboard

Plans by the Appalachian Mountain Club



P Plans for a Compost Bin Lid

Following Pages



BIN LID for
ROUND BIN

MATERIALS

7 2"x4"x 10'
10 3" GALVANIZE DECK SCREWS
CORR. STEEL ROOFING TO
COVER
1/4 lb ROOFING SCREWS

Q USFS Region 8 Accessible Moldering Privy Plans

Following Pages

Materials Listing
Moldering Privy
3/3/2006

Connectors

Model	Count	Unit Cost	Cost	Use
A44	12	$2.57	$30.84	Secure rails to columns
BC4Z	18	$4.97	$89.46	Secure columns to crib. Use 3 per column
DJT14Z	12	$1.73	$20.76	Secure Panels to columns
LUS44Z	8	$1.15	$9.20	Joist Hangers for 4x4s
LUS24Z	4	$0.72	$2.88	Joist Hangers for 2x4s
AC4Z	12	$5.43	$65.16	Secure roof 4x4 to columns
H2.5AZ	24	$0.48	$11.52	Secure rafters to roof 4x4s
			$0.00	
Total Connectors			**$229.82**	

Wood Materials

4x4x12'	35	$13.97	$488.95
4x4x8'	4	$6.97	$27.88
Plywood 3/4x4x8	7	$37.97	$265.79
Plywood 1/2x4x8	4	$27.97	$111.88
2x4x8'	12	$2.97	$35.64
1x6x12'	14	$6.97	$97.58
1x4x12'	7	$4.69	$32.83
Total Wood			**$1,060.55**

Accessories

Grab Bar	2	$40.00	$80.00
Toilet Riser with Lid	1	$225.00	$225.00
Screws	2	$30.00	$60.00
Roofing-Metal	1	$150.00	$150.00
Total Accessories			**$515.00**

Total Cost **$1,805.37**

Materials Prices as of 3/3/2006 from Home Depot, Midtown Atlanta

MOULDERING PRIVY

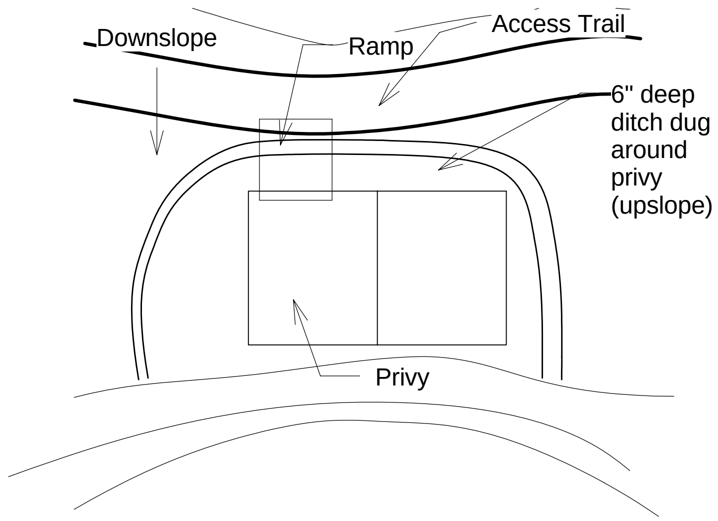
Siting Notes:

Proper siting will optimize the functioning of the privy, provide for privacy, and encourage use.

The Mouldering Privy is designed for the waste pile to sit above ground, not in a pit. The grade within the crib, however, should be slightly concave to contain the pile.

The ground around the privy should slope away from the crib and should direct water around the privy.

Construction Notes



1 Siting
1" = 10'-0"

Structural Column Schedule				
Type	Length	Cost	Count	Volume
4x4	10' - 0"	55.88	4	0.85 CF
4x4	11' - 6 1/2"	55.88	4	0.98 CF
Grand total: 8		111.76		

Structural Framing Schedule				
Type	Cut Length	Cost	Count	Volume
4x4	3' - 5"		7	0.29 CF
4x4	4' - 11"		8	0.42 CF
4x4	5' - 6"		17	0.47 CF
4x4	8' - 0"		4	0.68 CF
4x4	12' - 0"		12	1.02 CF
Grand total: 48				

2 3D of Privy

3 3D Structure

3/3/2006 1:02:15 PM

U.S. FOREST SERVICE
SOUTHERN REGION

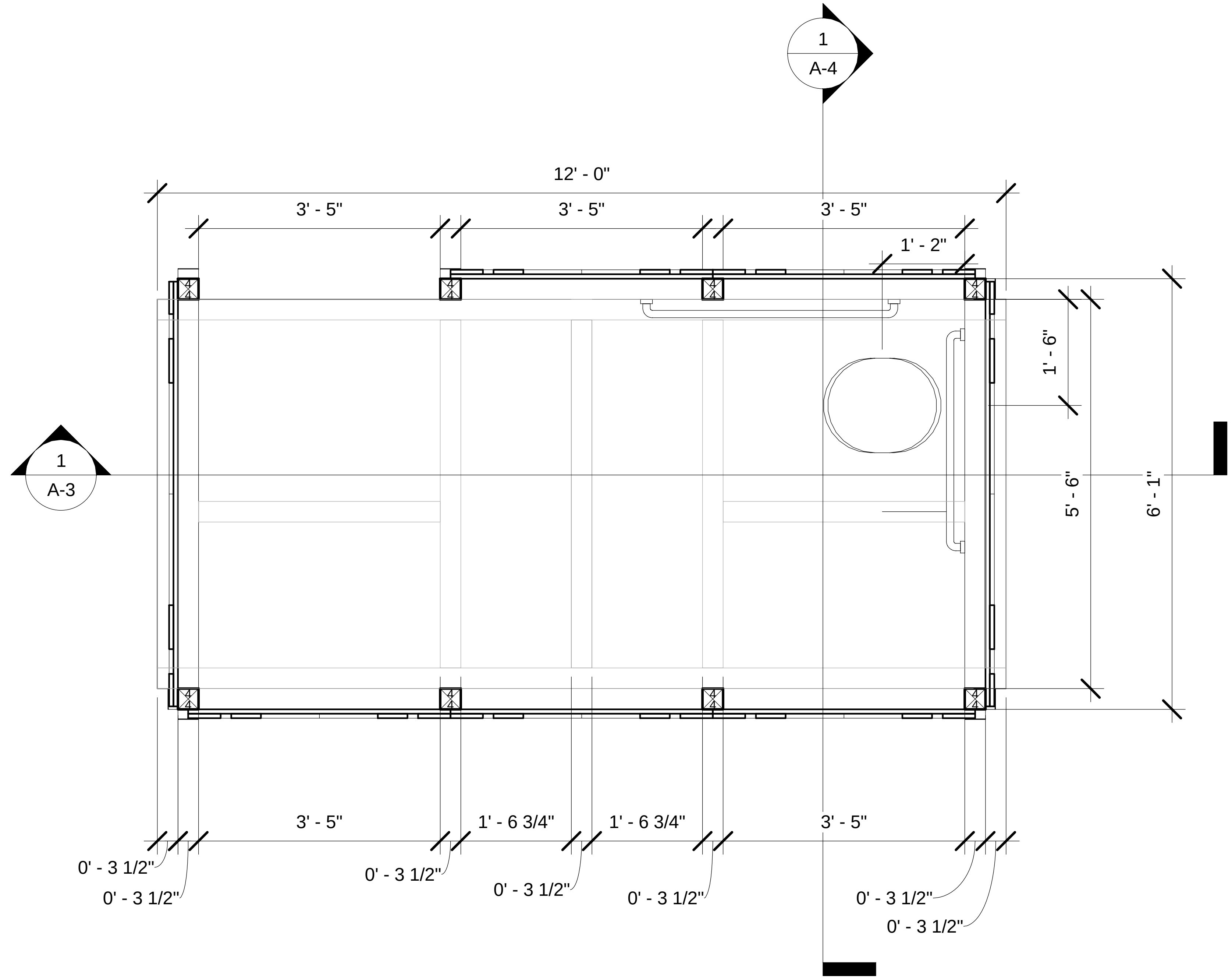
George Kulick, Director of Engineering

Moldering Privy

CHECKER: Checker
DESIGNER: Designer

Sheet Name
Schedules

G-1



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U.S. FOREST SERVICE
SOUTHERN REGION

George Kulick, Director of Engineering

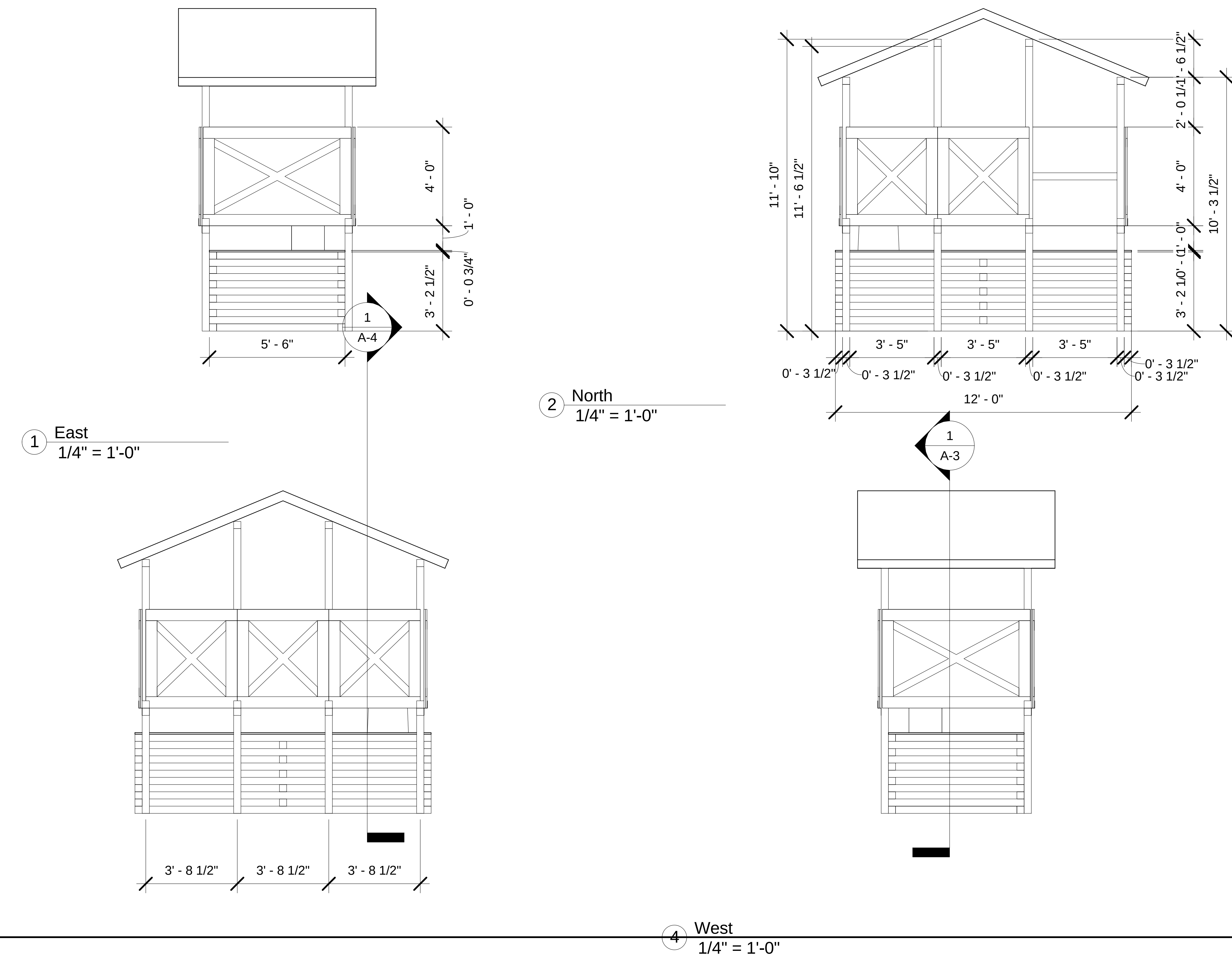
Moldering Privy

CHECKER: Checker
DESIGNER: Designer

Sheet Name

Plan

A-1



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U.S. FOREST SERVICE
SOUTHERN REGION

George Kulick, Director of Engineering

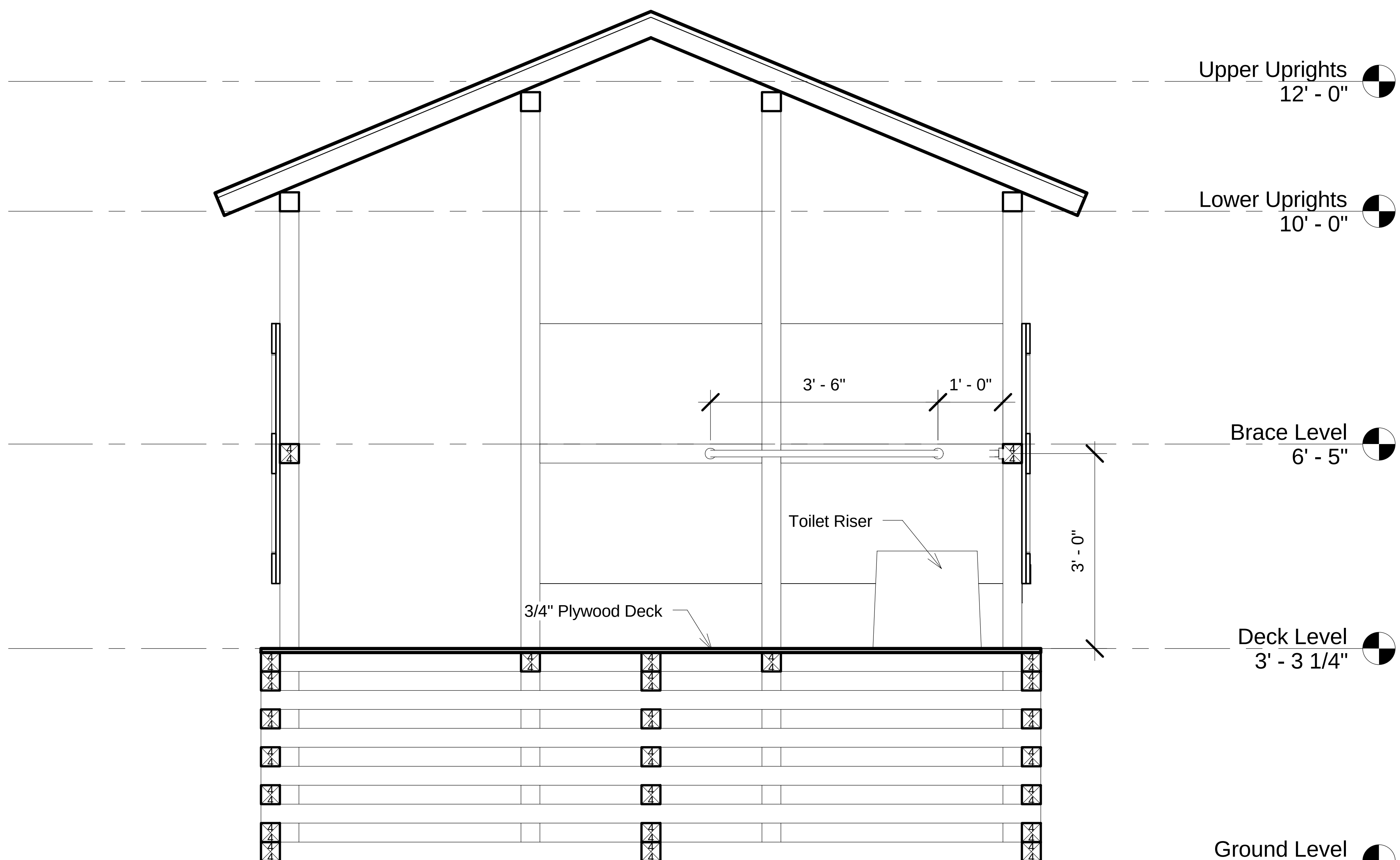
Moldering Privy

CHECKER: Checker
DESIGNER: Designer

Sheet Name

Unnamed

A-2



U.S. FOREST SERVICE
SOUTHERN REGION

George Kulick, Director of Engineering

Moldering Privy

CHECKER: Checker
DESIGNER: Designer

Sheet Name

Long Section

A-3

1 Long Section
1/2" = 1'-0"

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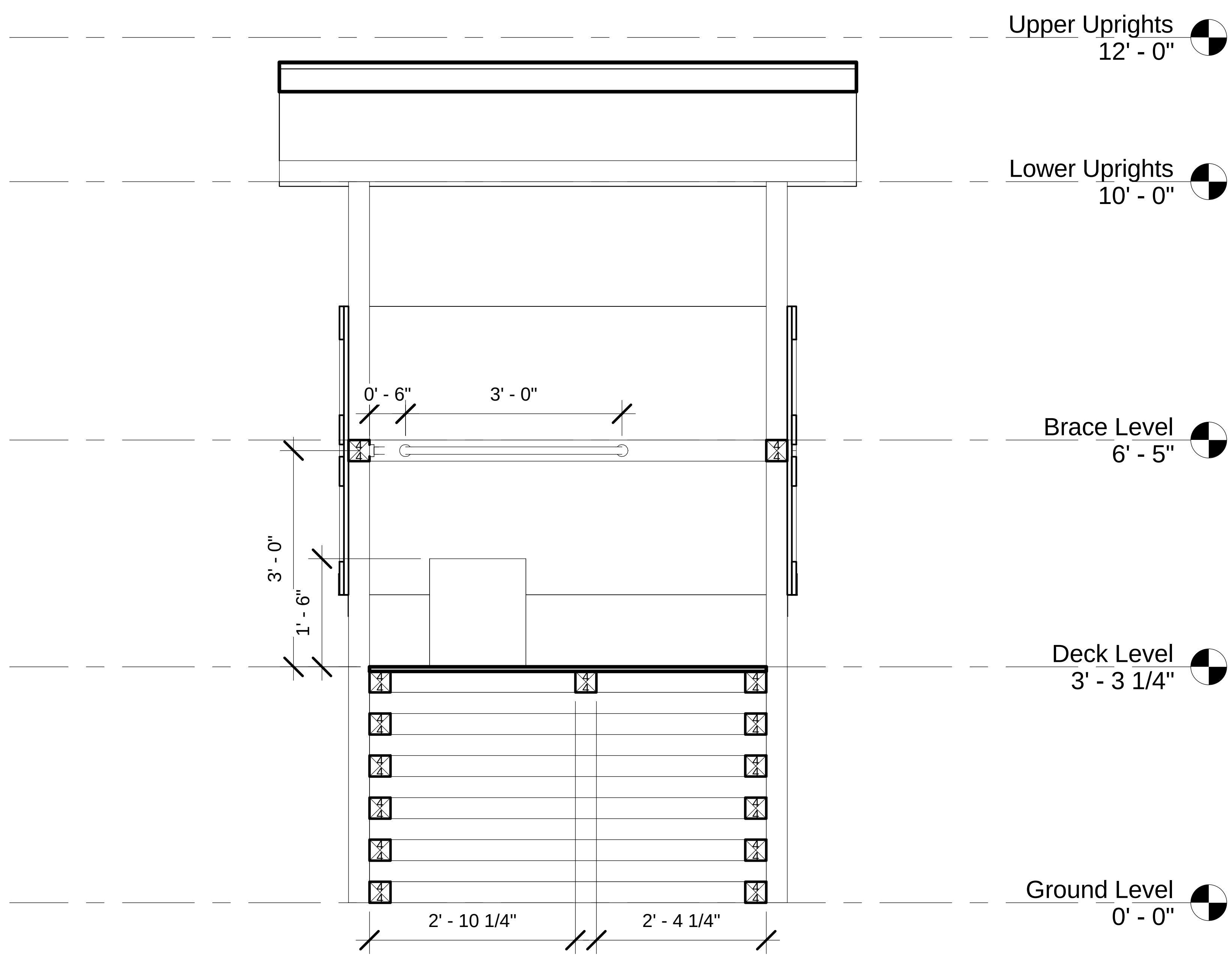

U.S. FOREST SERVICE
SOUTHERN REGION

George Kullick, Director of Engineering

Moldering Privy

CHECKER: Checker
DESIGNER: Designer

Sheet Name

Short Section

A-4

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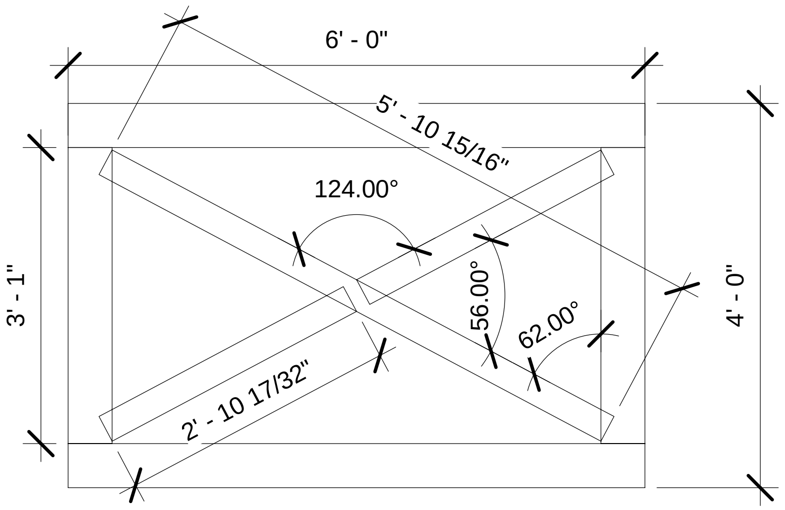
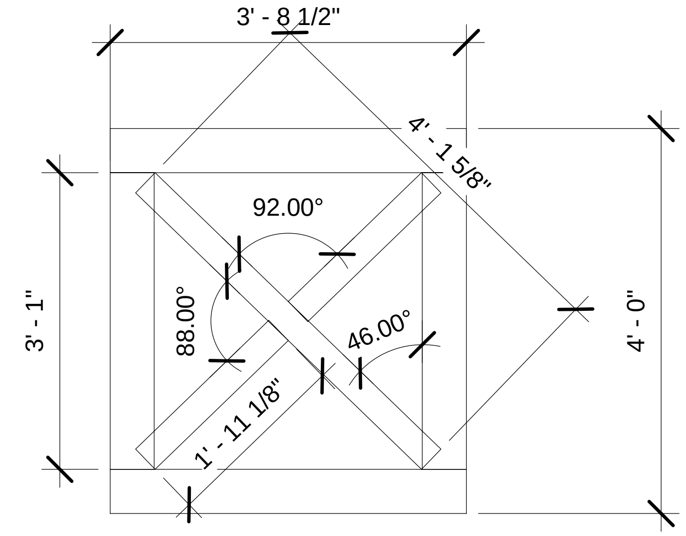
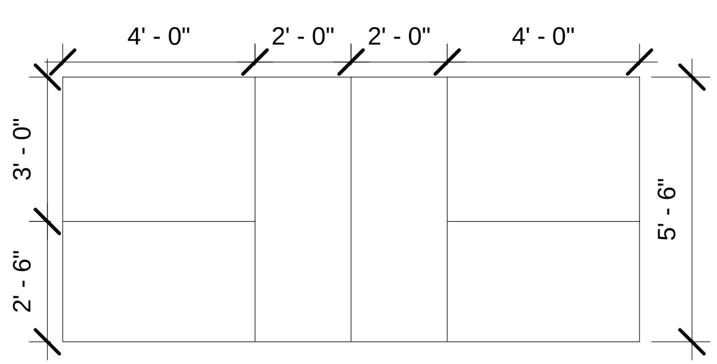


1 End Panel
1/2" = 1'-0"



2 Side Panel
1/2" = 1'-0"



3 Floor Decking Plan
1/4" = 1'-0"

3/3/2006 1:02:12 PM

U.S. FOREST SERVICE
SOUTHERN REGION

George Kulick, Director of Engineering

Moldering Privy

CHECKER: Checker
DESIGNER: Designer

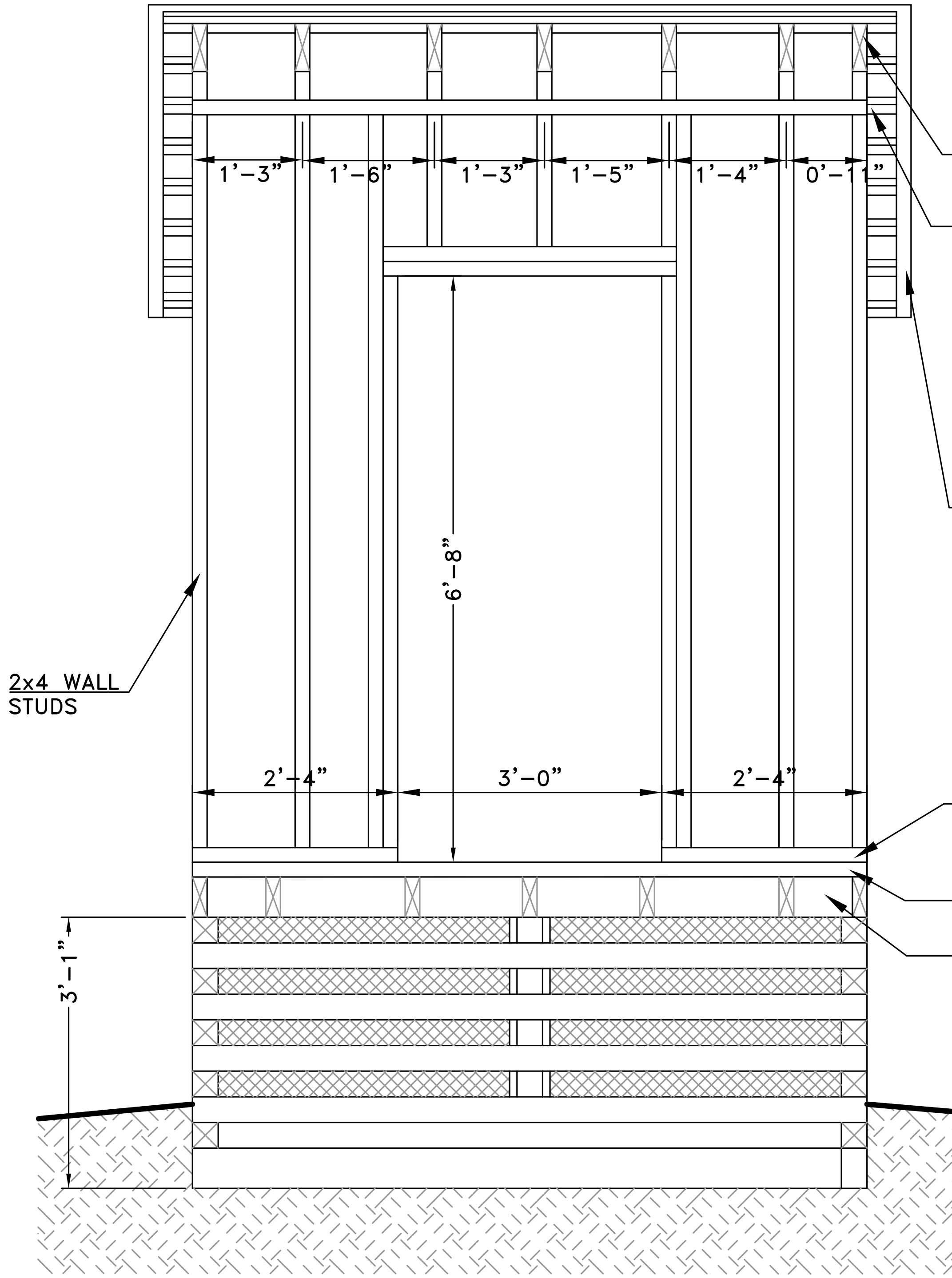
Sheet Name

Panels

A-5

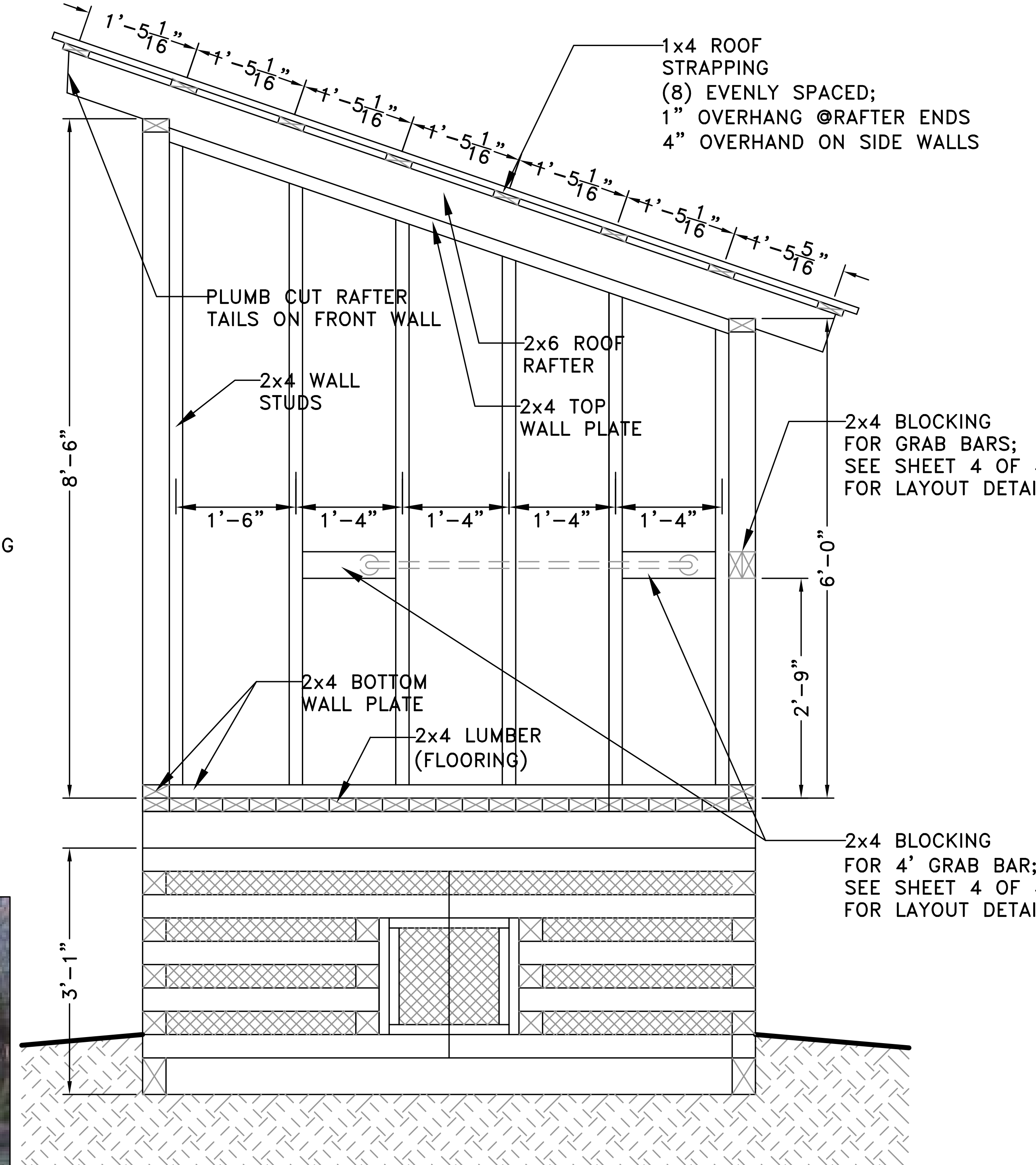
R USFS Region 9 Accessible Moldering Privy Plans

Following Pages



FRONT ELEVATION
WALL /ROOF FRAMING

FRONT/BACK WALL BRACING



SIDE ELEVATION
WALL/ROOF FRAMING

MOLDERING PRIVY MATERIALS LIST (WALL / ROOF FRAMING)

QTY.	ROUGH LUMBER--WALL FRAMES	QTY.	ROUGH LUMBER--ROOF FRAMES
8	2 x 4 x 10'-0"	7	2 x 6 x 12'-0"
29	2 x 4 x 8'-0"	8	1 x 4 x 10'-0"

OTHER MATERIALS		OTHER MATERIALS	
10 LBS.	16D GALVANIZED NAILS (WALL FRAMES)	10 LBS.	16D GALVANIZED NAILS (ROOF FRAMES)
1	6' STAINLESS STEEL GRAB BAR OR (2) 36" STAINLESS STEEL GRAB BARS	2 LBS.	10D GALVANIZED NAILS
		5 LBS.	1-1/2" ROOFING SCREWS
2	42" STAINLESS STEEL GRAB BARS	12'	CLEAR CORRUGATED PLASTIC ROOFING (LEXAN) (4) 3' WIDE LENGTHS OR (6) 2' WIDE LENGTHS
1	TOILET RISER		

CONSTRUCTION NOTES*

1. ASSEMBLE & RAISE BACK WALL ON FLOOR DECK; SECURE WITH 2 BLOCKS OF WOOD SCREWED TO FLOOR AND DIAGONAL BRACE FROM EACH BLOCK TO WALL. USE LEVEL TO PLUMB WALL WHILE FASTENING BRACE. SEE INSET PICTURE ABOVE.
2. ASSEMBLE & RAISE FRONT WALL ON FLOOR DECK, CENTERING DOOR OPENING ON CONTINUOUS WALL PLATE. RAISE WALL AND SECURE AS IN STEP 1. AT DOOR OPENING, REMOVE WALL PLATE SECTION SO THAT DOOR CAN SWING FREELY.
3. FRONT WALL AND BACK WALL MUST BE PLUMB IN TWO DIRECTIONS BEFORE PROCEEDING TO SIDEWALLS.
4. FOR SIDEWALLS, USE SLIDING "T" BEVEL (OR OTHER ANGLE FINDING TOOL) TO ESTABLISH ANGLE TO CUT TOP WALL PLATES. ANGLE **WILL** BE SAME FOR ALL 4 ANGLE CUTS IN TOP PLATES. IF SLIGHT VARIATIONS OCCUR, "SPLIT THE DIFFERENCE" TO FIND SAME ANGLE FOR ALL 4 CUTS.
5. INSTALL TOP WALL PLATES WITH SCREWS AND BOTTOM WALL PLATES WITH NAILS.
6. INSTALL STUDS PLUMB AND 16" OC STARTING AT THE FRONT (TALLEST) AND WORKING TO BACK.
7. FASTEN 2x4 BLOCKS BETWEEN STUDS FOR GRAB BARS (SEE PLANS). LOCATE GRAB BARS AS SHOWN IN PLAN. INSTALL SIDING AND CORNER BOARDS NEXT--SEE SHEET 4 OF 4.
8. TO MAKE RAFTERS: SQUARE EACH 2x6 RAFTER AT ONE END. TAKE ONE RAFTER, MEASURE AND MARK 12" ON ONE EDGE FROM SQUARED END. HOLD RAFTER AGAINST BUILDING WITH 12" MARK EVEN WITH BACKSIDE OF BACK WALL AND BOTTOM OF RAFTER EVEN WITH TOP FRONT EDGE OF BACK WALL AND FRONT WALL TOP PLATES. SCREW RAFTER TO ONE SIDE OF BUILDING. CAREFULLY TRACE TOP WALL PLATES ONTO RAFTER. UNSCREW AND REMOVE RAFTER. MEASURE AND MARK 12" FROM FRONT WALL MARK ON BOTTOM EDGE OF RAFTER. USE ANGLE FINDER TO MARK PLUMB LINE FROM 12" MARK, ANGLE SHOULD BE SAME AS ANGLE OF TOP WALL SIDE PLATES. CUT ALL PENCIL LINES ON RAFTER. **THIS IS YOUR PATTERN.** USE THIS RAFTER TO TRACE ALL CUTS ON ALL RAFTERS BEFORE CUTTING NOTCHES INTO RAFTERS.
9. INSTALL RAFTERS AS SHOWN ON PLANS
10. INSTALL ROOF STRAPPING PERPENDICULAR TO RAFTERS, EVENLY SPACED, WITH 1" OVERHANG ON RAFTER ENDS AND 4" OVERHANG ON SIDE WALLS.

*SEE SHEET 4 OF 4 FOR SIDING AND DOOR NOTES

NOTES

FOREST SERVICE OUTDOOR RECREATION ACCESSIBILITY GUIDELINES (FSORAG) AND THE FOREST SERVICE TRAIL ACCESS GUIDELINES (FSTAG)WERE USED TO DETERMINE THE STANDARDS AND GUIDELINES FROM WHICH THIS ACCESSIBLE MOLDERING PRIVY WAS DESIGNED.

No.	Revision/Issue	Date
4		
3		
2		
1		

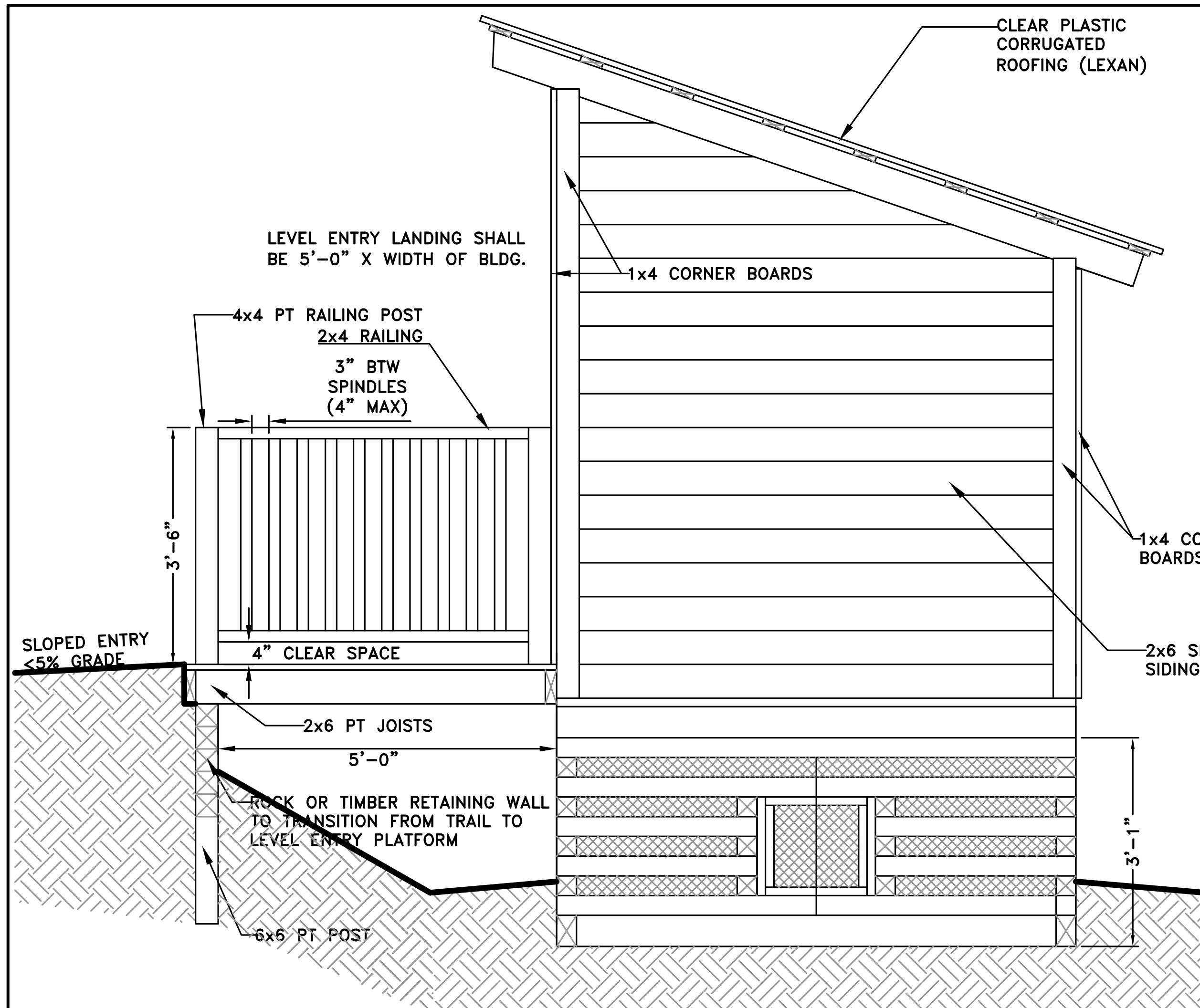
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
EASTERN REGION
REGION NINE

Project Name: Accessible Moldering Privey

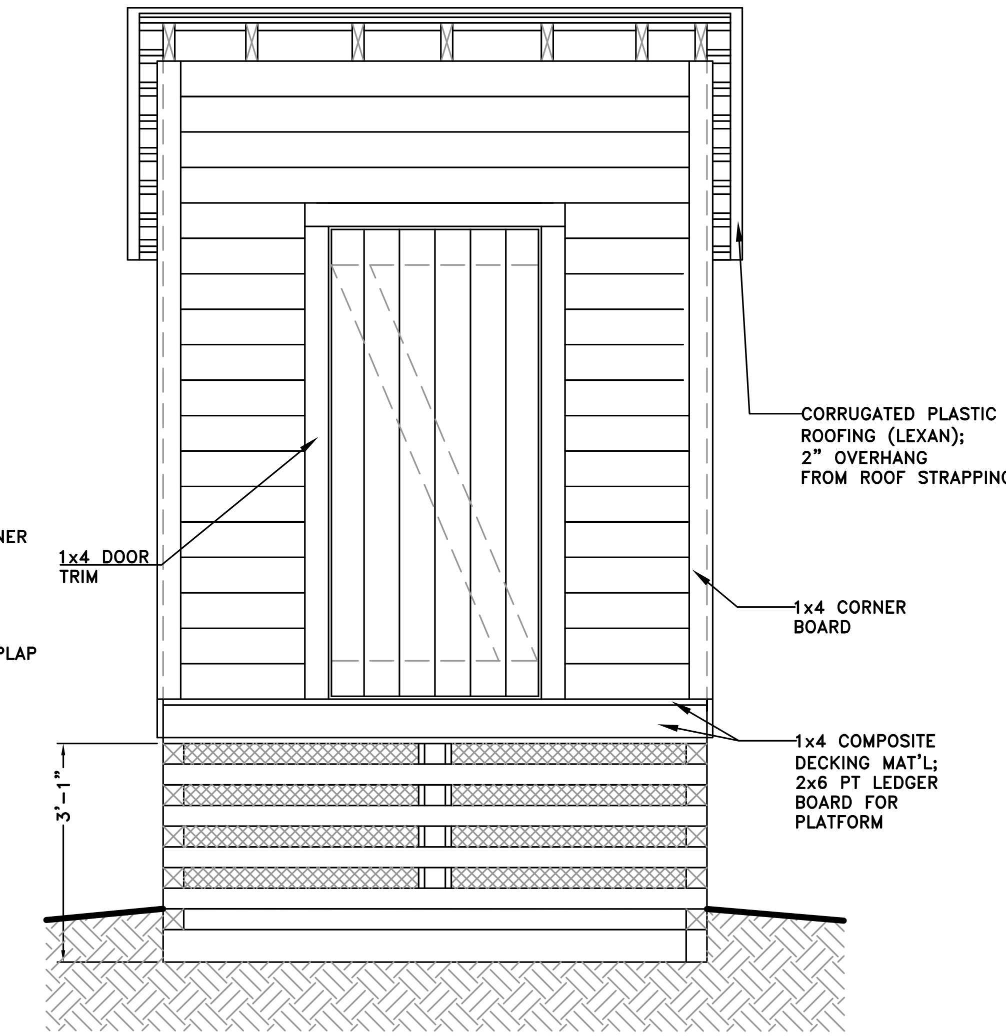
Designer:

Drawing Title: WALL & ROOF FRAMING

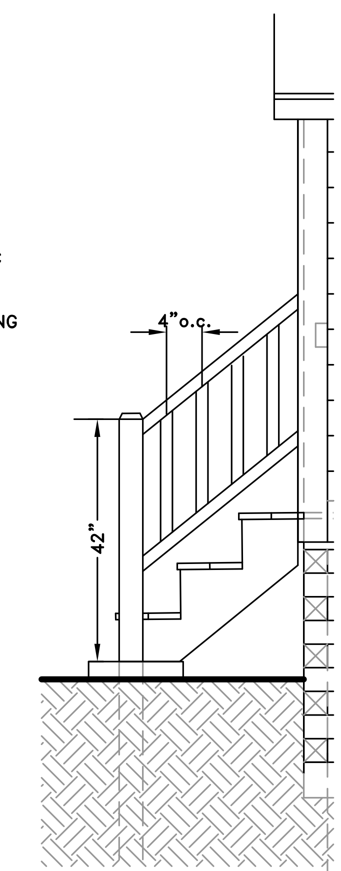
Drawn: MEB	Project No.
Checked	Drawing Sheet No.
CAD Archive No.	
Date: 12/20/2012	
Scale: 1/2"=1'-0"	Sheet 3 of 4



SIDE ELEVATION
SIDING/CORNER BOARDS
LEVEL ENTRY PLATFORM



FRONT ELEVATION
WALL /ROOF FRAMING



STAIRS & RAILING

MOLDERING PRIVY MATERIALS LIST
(SIDING/CORNER BOARDS/DOOR)

QTY.	ROUGH LUMBER
75	1 x 6 x 8'-0" SHIPLAP SIDING
8	1 x 6 x 8'-0" (DOOR)
3	1 x 4 x 8'-0" (DOOR TRIM)
4	1 x 4 x 10'-0" (CORNER BOARDS)
4	1 x 4 x 8'-0" (CORNER BOARDS)

OTHER MATERIALS

30 LBS.	10D GALVANIZED NAILS (SIDING)
1 LB.	10D GALVANIZED NAILS (CORNER BOARDS)
1 LB.	1-1/2" WOOD SCREWS
2	HINGES W/SCREWS
2	LATCHES, CLOSURES

LEVEL ENTRY PLATFORM

QTY.	PRESSURE TREATED LUMBER
2	2 x 6 x 8'-0" (LEDGER BOARDS)
4	2 x 6 x 10'-0" (JOISTS)
1	6 x 6 x 8'-0" (DECK POSTS)
4	4 x 4 x 3'-6" (RAILING POSTS)
4	2 x 4 x 5'-0" (TOP AND BOTTOM RAIL)
16 +/-	2 x 2 x 2'-10" (SPINDLES)

OTHER MATERIALS

30 LBS.	10D GALVANIZED NAILS (SIDING)
1 LB.	10D GALVANIZED NAILS (CORNER BOARDS)
1 LB.	1-1/2" WOOD SCREWS
2	HINGES W/SCREWS
2	LATCHES, CLOSURES

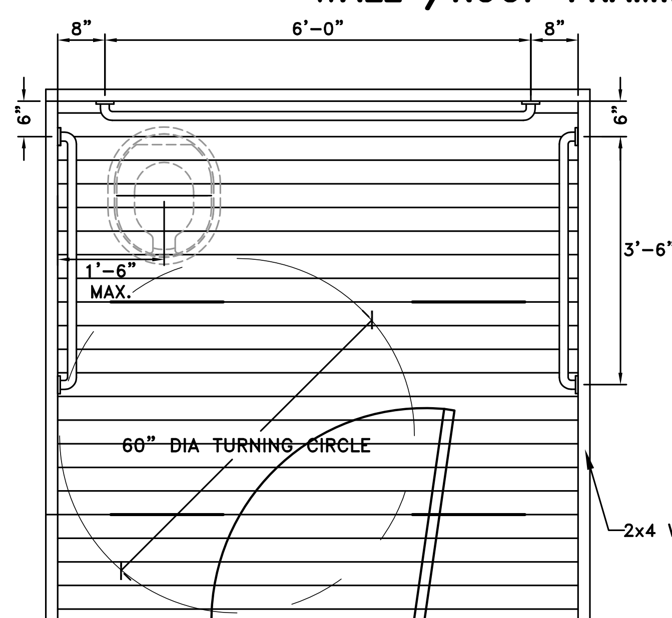
CONSTRUCTION NOTES

SIDING AND CORNER BOARDS

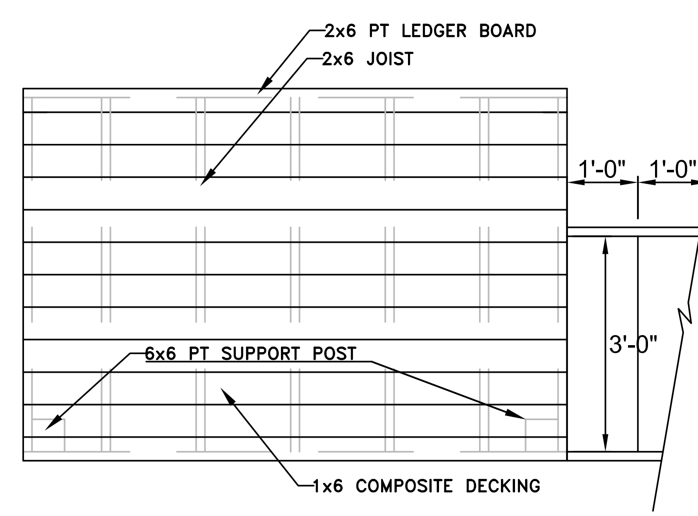
1. INSTALL SIDING SO THAT BOTTOM EDGE OF FIRST SIDING BOARD IS 1" BELOW BOTTOM EDGE OF FLOOR BOARDS (COVERING ENDS).
2. INSTALL SIDING ON FRONT WALL EVEN WITH TOP OF FLOOR BOARDS TO ALLOW FOR INSTALLATION OF LEDGER BOARD AND DECKING FOR LEVEL ENTRY DECK.
3. CHECK FOR LEVEL EACH SIDING COURSE; MAKE MINOR ADJUSTMENTS ACCORDINGLY EVERY FOUR OR FIVE COURSES.
4. ENDS OF SIDING BOARDS AT CORNERS NEED NOT BE PERFECT, THEY WILL BE COVERED WITH CORNER BOARDS.
5. INSTALL VERTICAL 1x4 CORNER BOARDS AT EACH CORNER OF BUILDING TO PROTECT ENDS OF SIDING BOARDS.

DOOR

1. CONSTRUCT DOOR WITH 6 VERTICAL 1x6 BOARDS FASTENED TOGETHER WITH HORIZONTAL 1x6 BOARDS AT TOP AND BOTTOM AND A 1x6 BOARD FASTENED DIAGONALLY FROM TOP CORNER TO BOTTOM CORNER. TOP, BOTTOM AND DIAGONAL BOARDS SHOULD BE INSTALLED ON INSIDE OF DOOR WITH 1-1/2" SCREWS.
2. BUILD DOOR APPROXIMATELY 1/2" SMALLER THAN DOOR OPENING TO PREVENT DOOR FROM JAMMING.
3. INSTALL DOOR WITH EQUAL SPACING AROUND EDGES BY INSERTING SMALL SHIMS UNDER DOOR WHILE FASTENING.



FRONT
PLAN VIEW
TOILET RISER & GRAB BARS



PLAN VIEW
LEVEL ENTRY PLATFORM

FOR ACCESSIBILITY TOILET BUILDING SHALL BE CONSTRUCTED WITH A LEVEL ENTRY PLATFORM AND SLOPED PATH TO PLATFORM. PLACE BUILDING ACCORDINGLY TO ACCOMODATE SPECIFIC SITE. IF NECESSARY, ADD STEPS TO ONE SIDE OF PLATFORM.

NOTES

FOREST SERVICE OUTDOOR RECREATION ACCESSIBILITY GUIDELINES (FSORAG) AND THE FOREST SERVICE TRAIL ACCESS GUIDELINES (FSTAG) WERE USED TO DETERMINE THE STANDARDS AND GUIDELINES FROM WHICH THIS ACCESSIBLE MOLDERING PRIVY WAS DESIGNED.

No.	Revision/Issue	Date
4		
3		
2		
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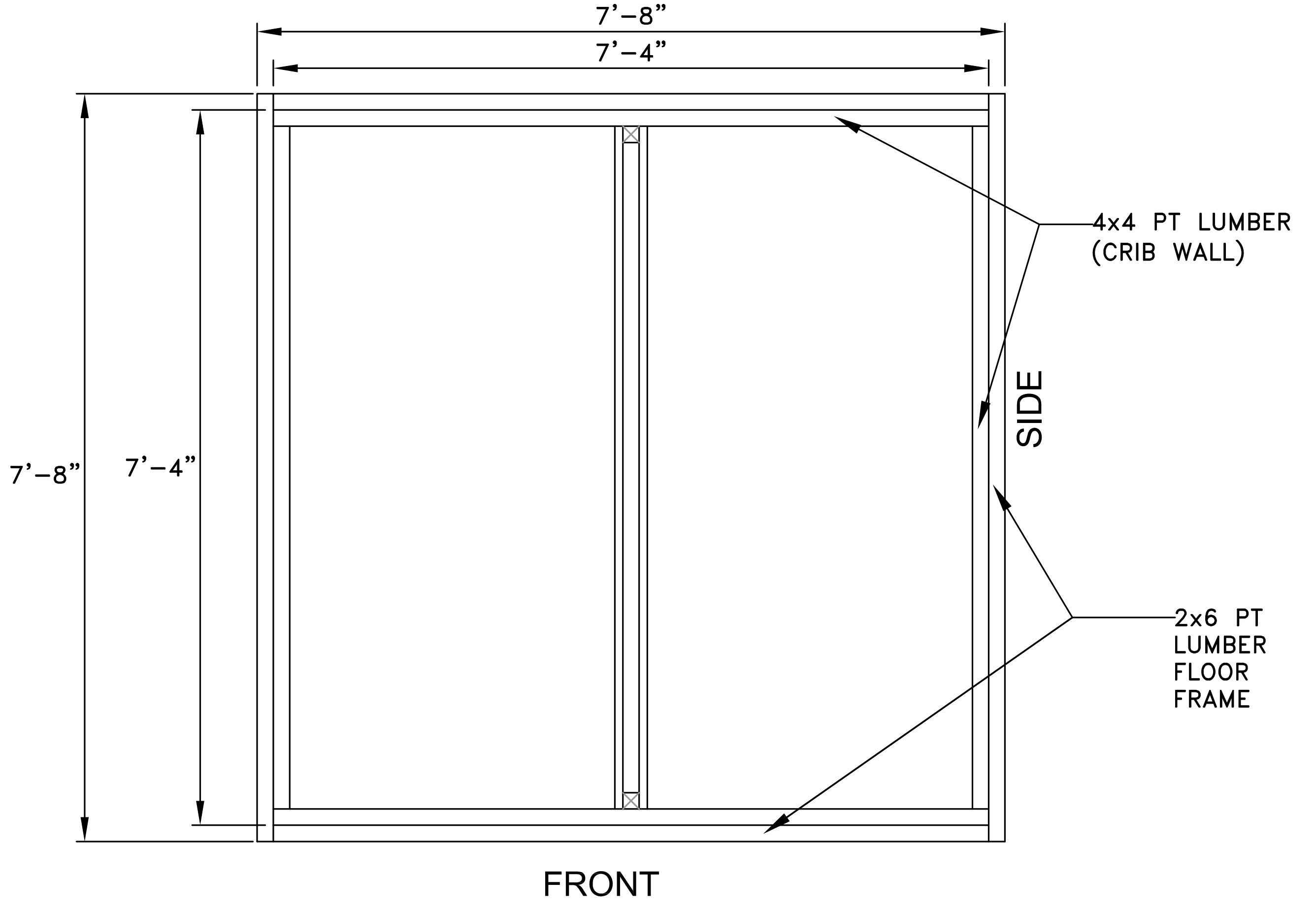
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION NINE

Project Name: Accessible Moldering Privey

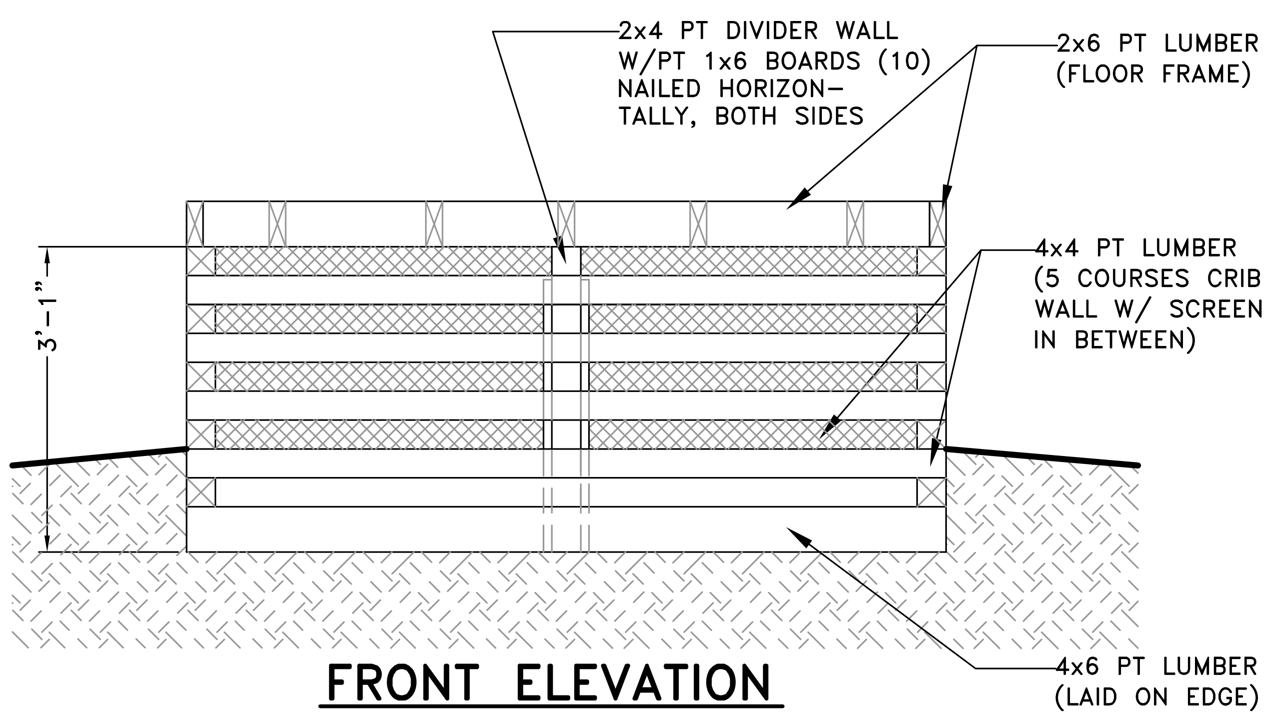
Designer:

Drawing Title: SIDING / MISC.DETAILS

Drawn: MEB	Project No.
Checked	Drawing Sheet No.
CAD Archive No.	
Date: 12/20/2012	
Scale: 3/8"=1'-0"	Sheet 4 of 4



PLAN VIEW
MOLDERING BIN FRAME



FRONT ELEVATION
MOLDERING BIN

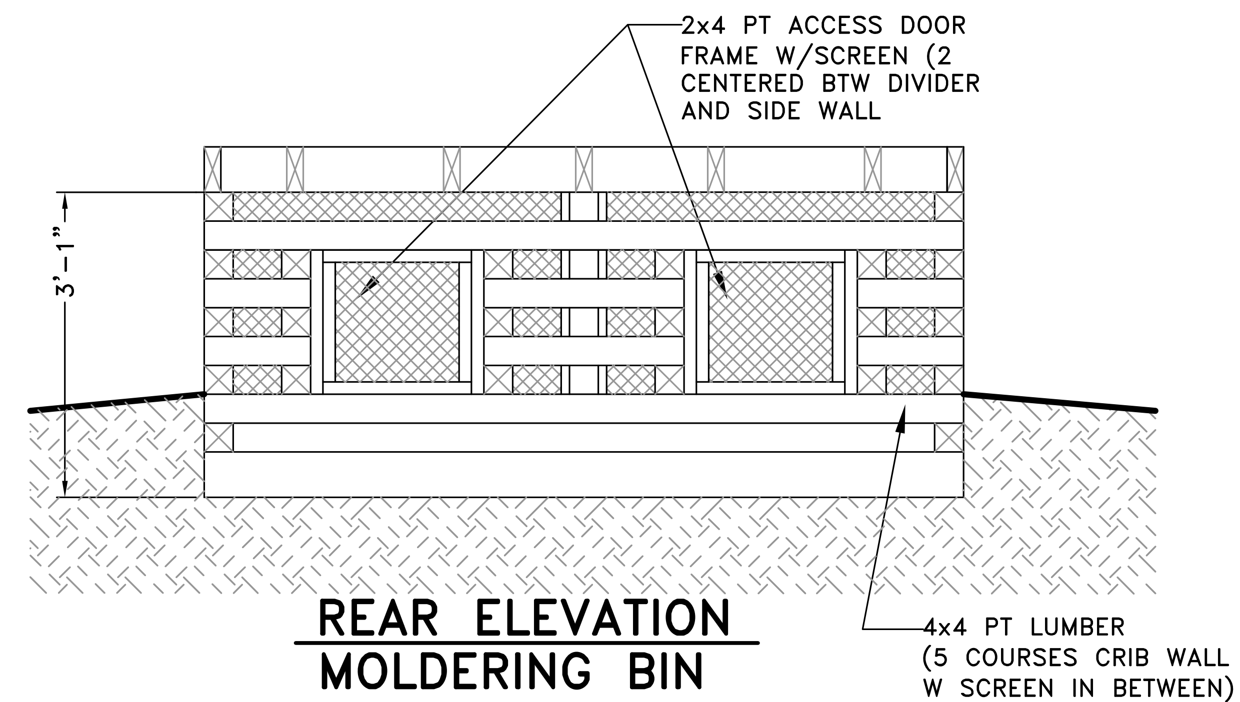
MOLDERING PRIVY MATERIAL LIST (CRIB BASE)

QTY.	PRESSURE TREATED LUMBER	QTY.	OTHER MATERIALS
2	4 x 6 x 7'-8"	1	ROLL OF SCREEN
2	4 x 6 x 7'-1"	1	ROLL OF 1/2" HARDWARE CLOTH
18	4 x 4 x 7'-8"		
2	4 x 4 x 7'-1"	10 LBS.	6" SCREWS OR NAILS
24	4 x 4 x 3-1/2"	2 LBS.	12D GALVANIZED NAILS
8	2 x 4 x 8'-0"	3 LBS.	3/4" FENCE STAPLES
10	1 x 6 x8'-0"		

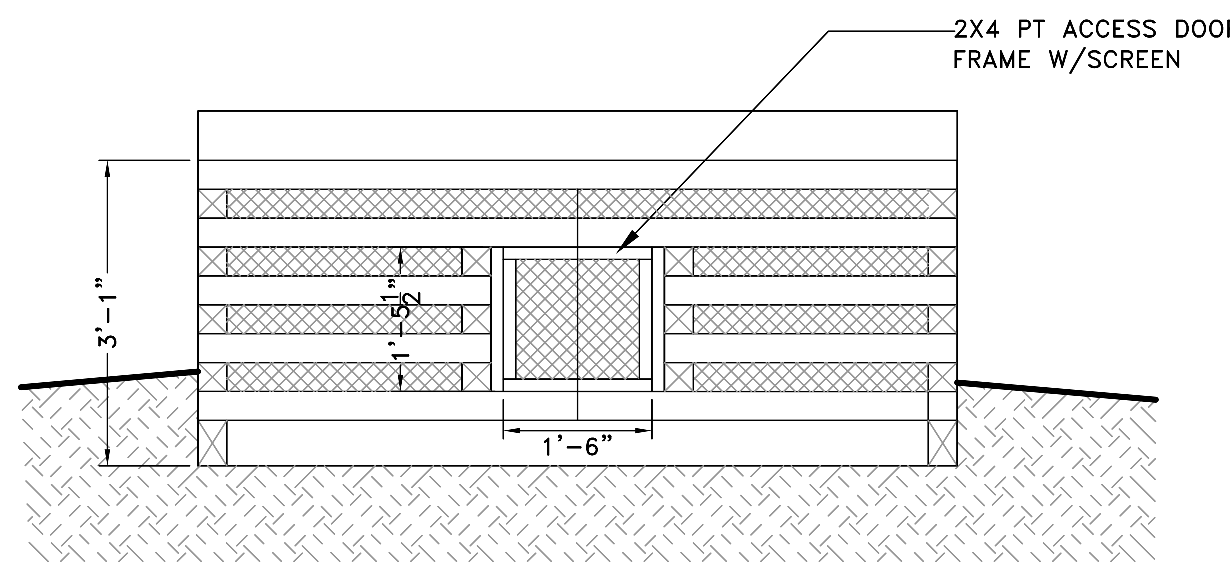
1. BOTTOM (FIRST) COURSE OF TIMBERS SHALL BE 4 x 6 ON EDGE.
2. FIRST AND SECOND COURSE OF CRIB SHALL BE APPROXIMATELY BELOW GROUND LEVEL.
3. FIRST TWO COURSES OF CRIB ARE FOUR SIDED--(2) 4 x 4 x7'-8" & (2) 4 x 4 x 7'-1" TO MAKE A SQUARE, JOINTS OF 2ND COURSE OFF-SET FROM JOINTS OF 1ST COURSE.

CONSTRUCTION NOTES CONTINUED

4. REMAINING COURSES OF CRIB SHALL BE TWO PIECES PER COURSE ALTERNATING "LOG CABIN" STYLE TO ALLOW FOR SPACES BETWEEN COURSES.
5. CONSTRUCT ENTIRE CRIB W/O ACCESS OPENINGS; AFTER COMPLETION OF CRIB, CUT ACCESS OPENINGS. USE A LEVEL TO MARK "PLUMB" LINES FOR ACCESS DOOR;INSTALL SPACER BLOCKS 3-1/2"x3-1/2" BETWEEN COURSES ON EDGE OF OPENINGS ALLOWING 1-1/2" FOR 2 x 4 ACCESS DOOR FRAME PIECES AS SHOWN ON PLAN ELEVATIONS.
6. CONSTRUCT DIVIDER WALL WITH PT 2 x 4'S CENTERED ON FRONT AND REAR CRIB WALLS (SEE PLAN); NAIL PT 1 x 6'S HORZONTIALLY FROM GROUND TO TOP OF 9TH COURSE (ENOUGH ROOM TO FOR AIR FLOW.
7. INSTALL 1/2" HARDWARE CLOTH, THEN SCREEN AROUND INSIDE OF CRIB AND ACCESS DOORS BEFORE BEGINNING FLOOR FRAME.



REAR ELEVATION
MOLDERING BIN



SIDE ELEVATION
MOLDERING BIN

NOTES

FOREST SERVICE OUTDOOR RECREATION ACCESSIBILITY GUIDELINES (FSORAG) AND THE FOREST SERVICE TRAIL ACCESS GUIDELINES (FSTAG) WERE USED TO DETERMINE THE STANDARDS AND GUIDELINES FROM WHICH THIS ACCESSIBLE MOLDERING PRIVY WAS DESIGNED.

No.	Revision/Issue	Date
4		
3		
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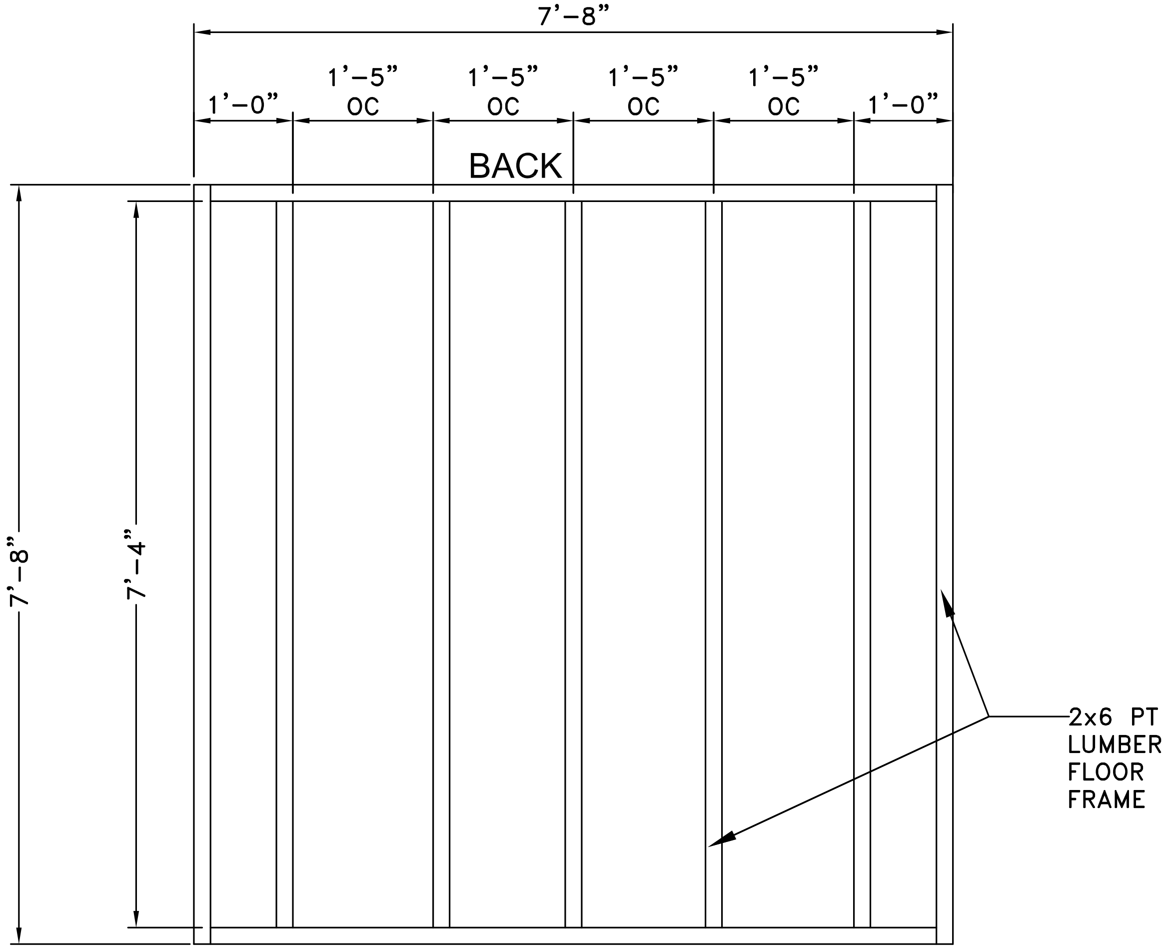
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
EASTERN REGION
REGION NINE

Project Name: Accessible Moldering Privey

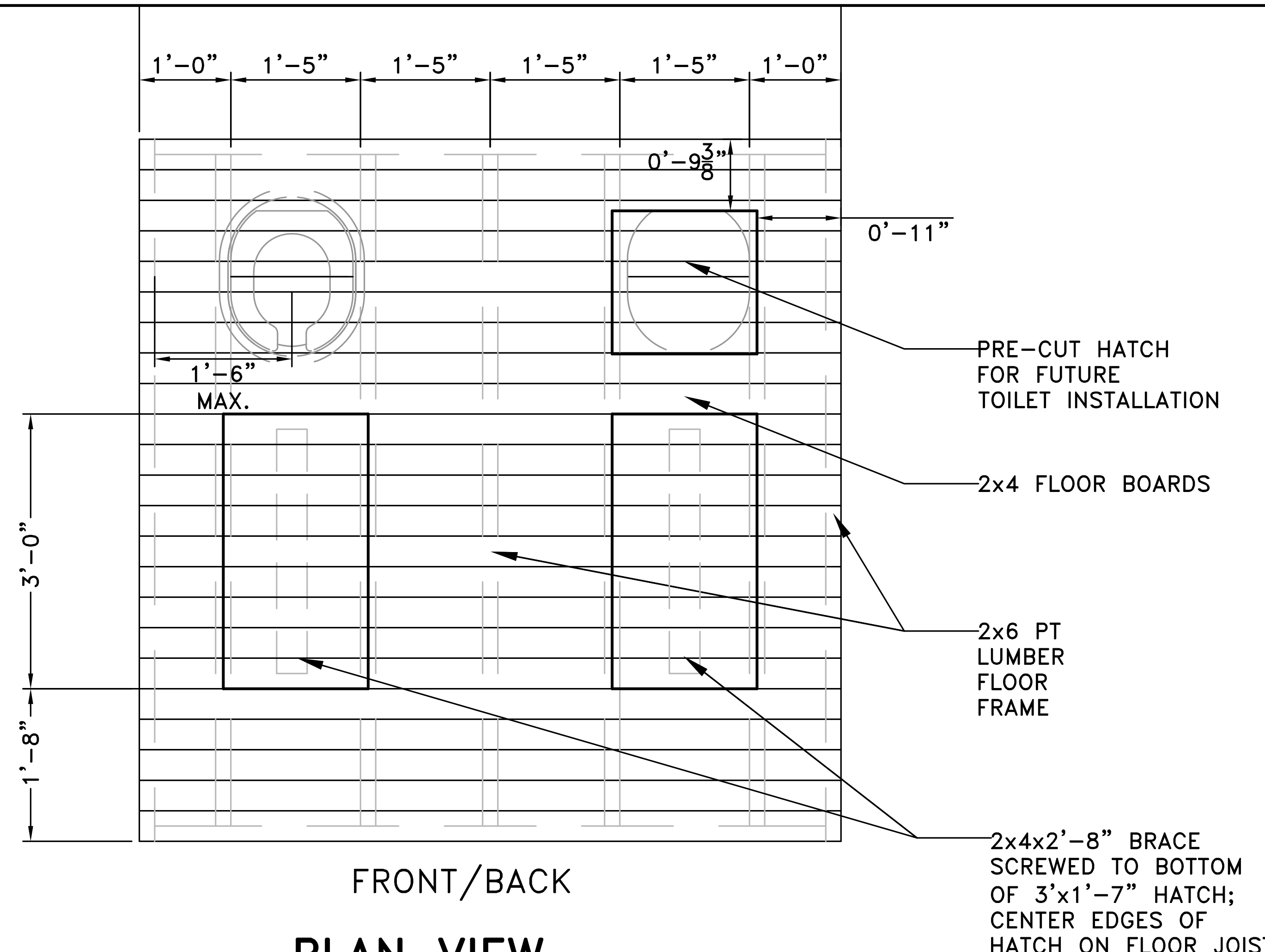
Designer

Drawing Title: Moldering Bin

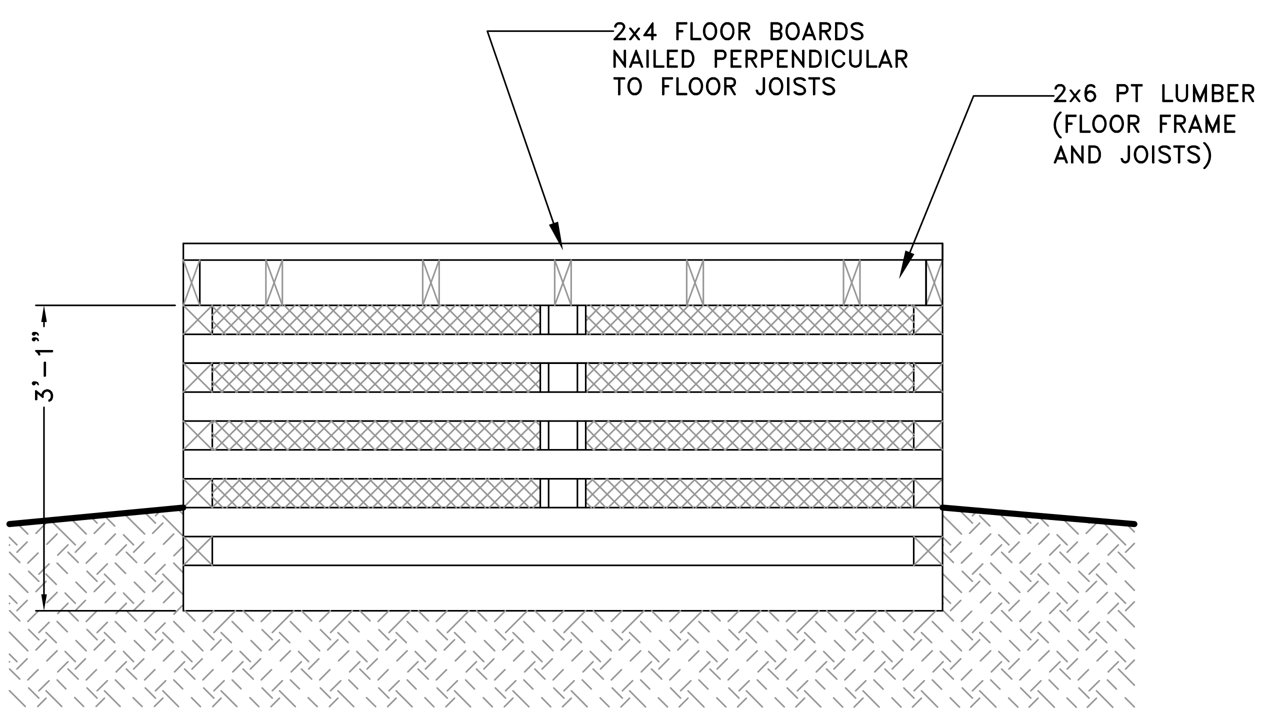
Drawn: MEB	Project No.
Checked	Drawing Sheet No.
CAD Archive No.	
Date: 12/20/2012	
Scale: 1/2"=1'-0"	Sheet 1 of 4



PLAN VIEW
FLOOR FRAME



PLAN VIEW
FLOOR FRAME



FRONT ELEVATION
FLOOR JOISTS & FRAME ON CRIB

MOLDERING PRIVY MATERIAL LIST (FLOOR FRAME AND FLOOR)

QTY.	ROUGH LUMBER
9	2 x 6 x 8'-0"
23	2 x 4 x 8'-0"

OTHER MATERIALS	
5 LBS.	16D GALVANIZED NAILS (FLOOR FRAME)
20 LBS.	16D GALVANIZED NAILS (FLOOR)

CONSTRUCTION NOTES

1. INSTALL 2 x 6 JOISTS PERPENDICULAR TO DIRECTION OF ENTRY AS SHOWN IN PLAN VIEW.
2. VERIFY DIMINSIONS OF TOILET RISER BEFORE CUTTING FLOORING. CENTER OF TOILET RISER SHALL BE 16"-18" MAX. MEASURED FROM EDGE OF INSIDE WALL. TOILET OPENING IN FLOOR SHALL BE CENTERED BETWEEN JOISTS.
3. INSTALL FLOOR BOARDS.
4. FLOOR HATCHES SHALL BE INSTALLED W/EDGES CENTERED ON JOISTS.

NOTES

FOREST SERVICE OUTDOOR RECREATION ACCESSIBILITY GUIDELINES (FSORAG) AND THE FOREST SERVICE TRAIL ACCESS GUIDELINES (FSTAG) WERE USED TO DETERMINE THE STANDARDS AND GUIDELINES FROM WHICH THIS ACCESSIBLE MOLDERING PRIVY WAS DESIGNED.

No.	Revision/Issue	Date
4		
3		
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U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION NINE

Project Name: Accessible Moldering Privey

Designer:

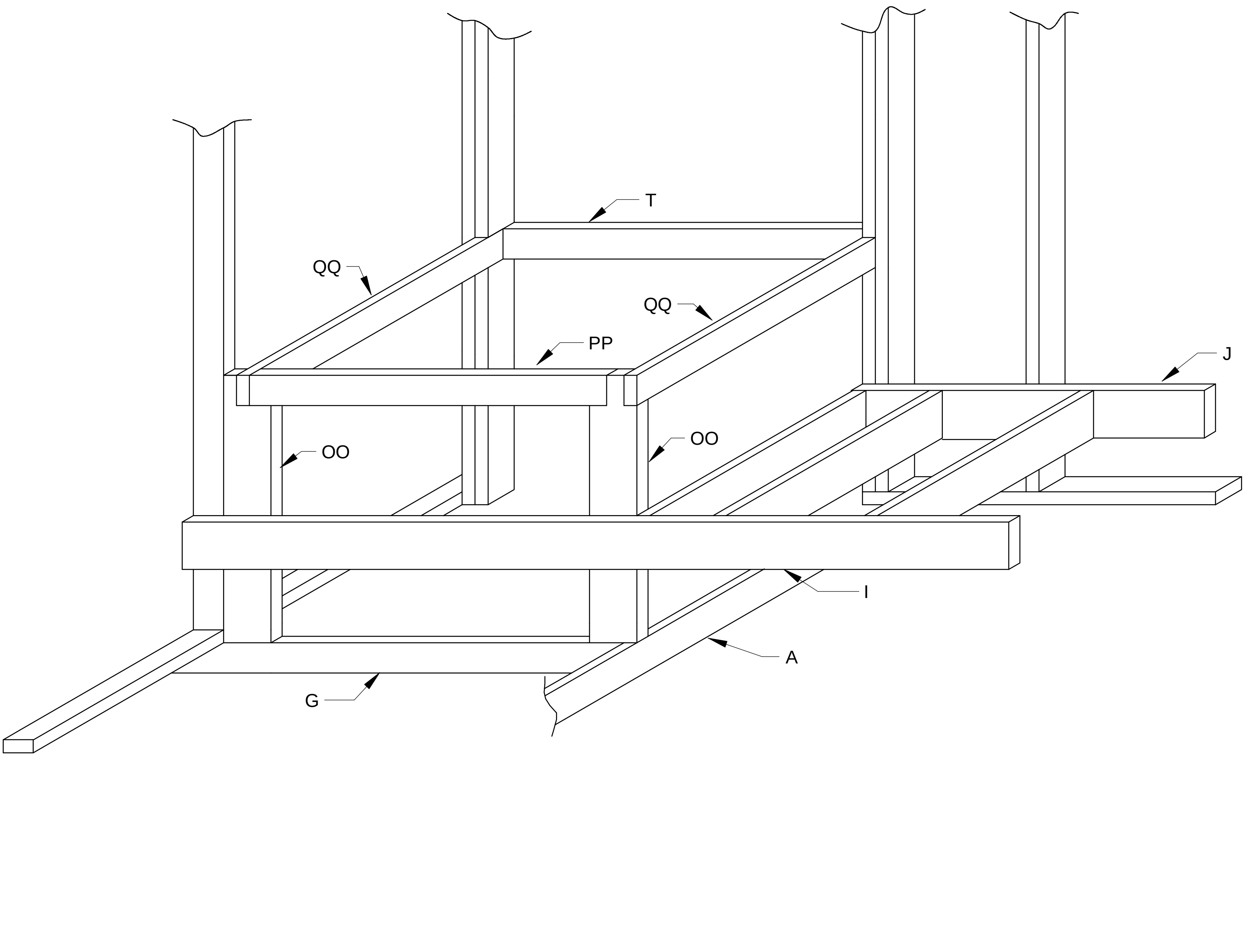
Drawing Title: FLOOR FRAMING

Drawn: MEB	Project No.
Checked	Drawing Sheet No.
CAD Archive No.	
Date: 12/20/2012	
Scale: 1/2"=1'-0"	Sheet 2 of 4

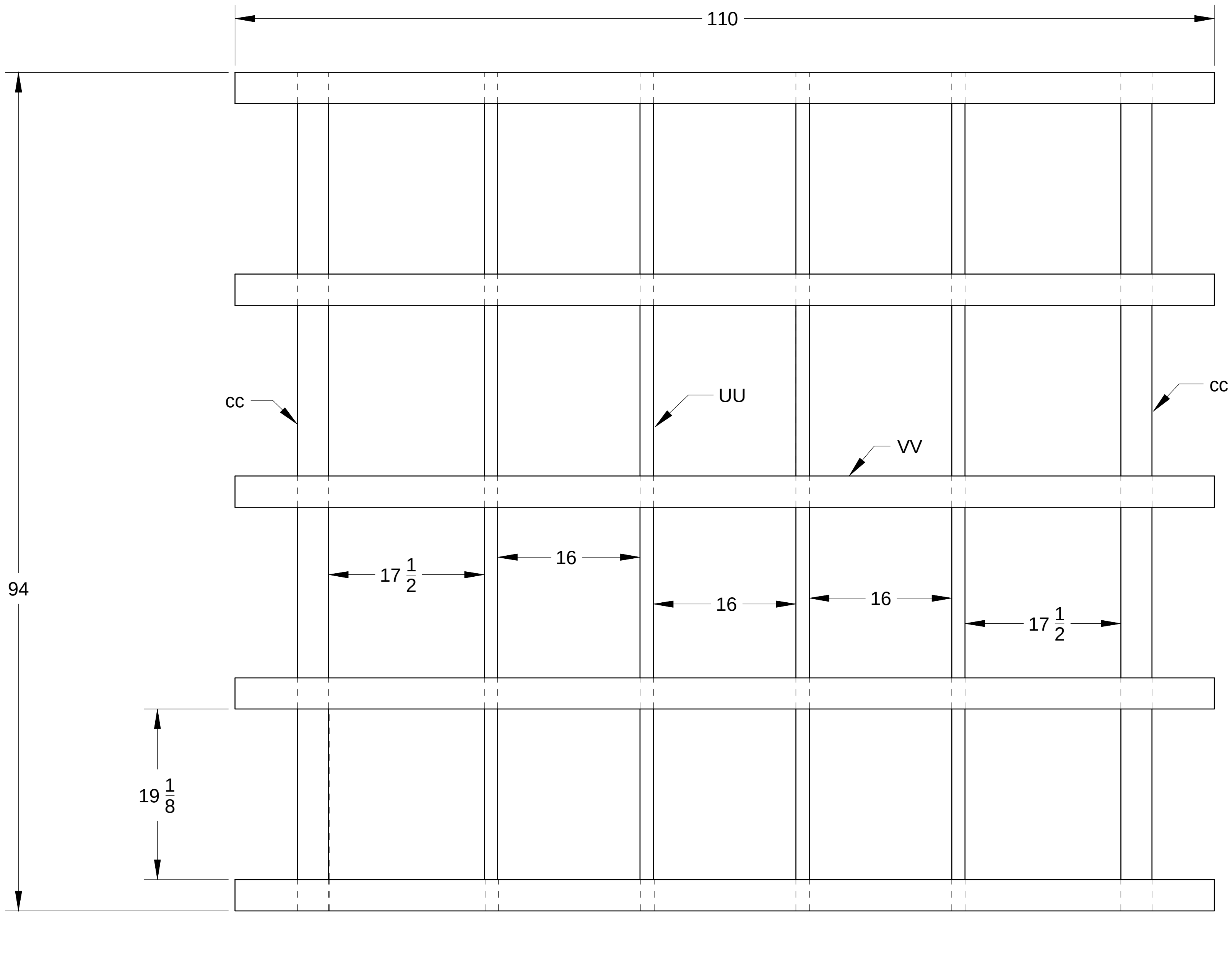
S Accessible Batch Bin and Moldering Privy Plans

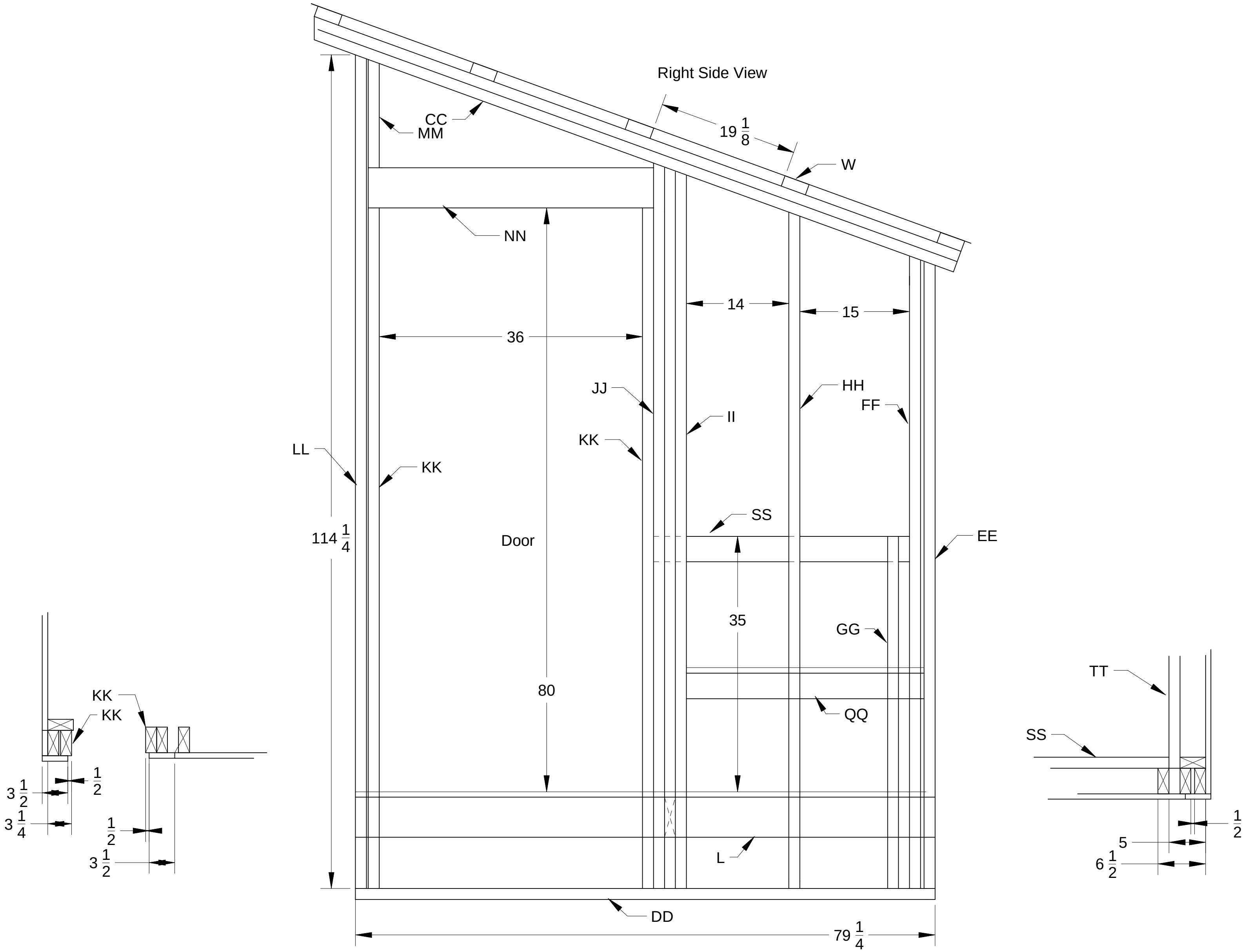
Following Pages

Seat View



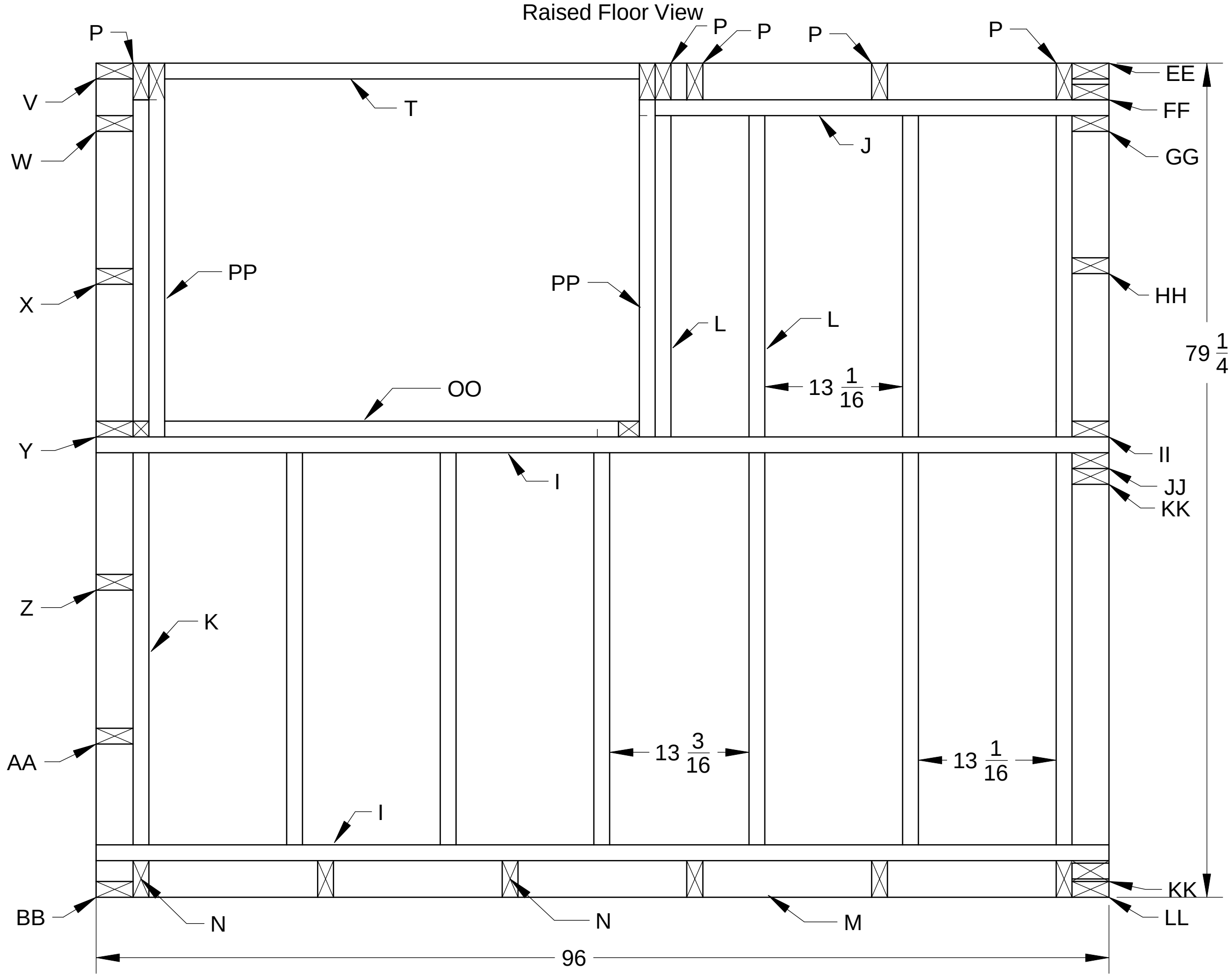
Roof View



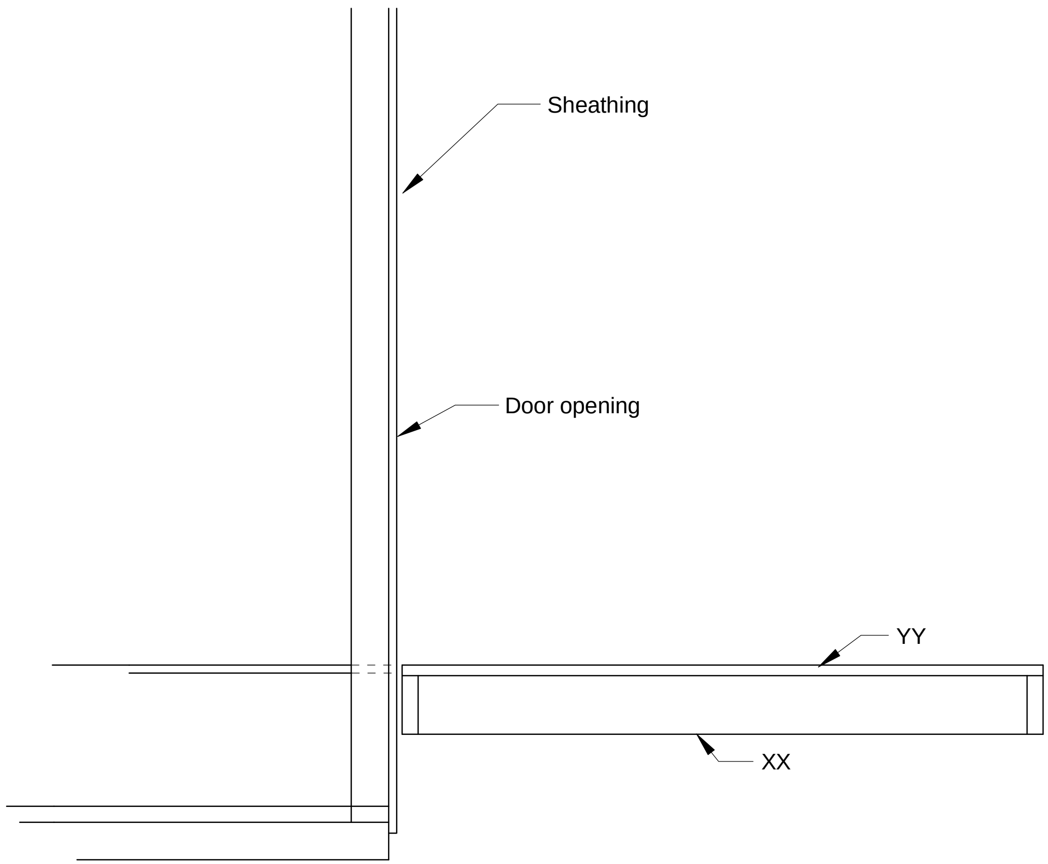


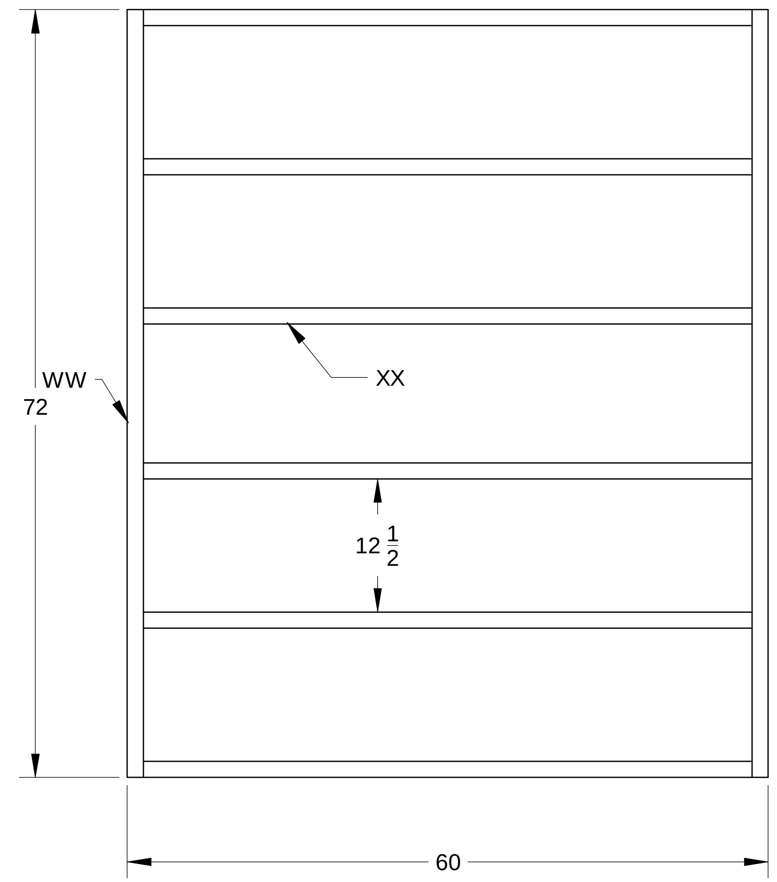
Right Side View
19 1/8
W
CC
MM
NN
14
15
36
JJ
HH
FF
II
KK
LL
KK
SS
EE
114 1/4
Door
35
GG
80
QQ
L
DD
79 1/4
KK
KK
3 1/2
1/2
3 1/4
1/2
3 1/2
TT
SS
1/2
5
6 1/2

Raised Floor View

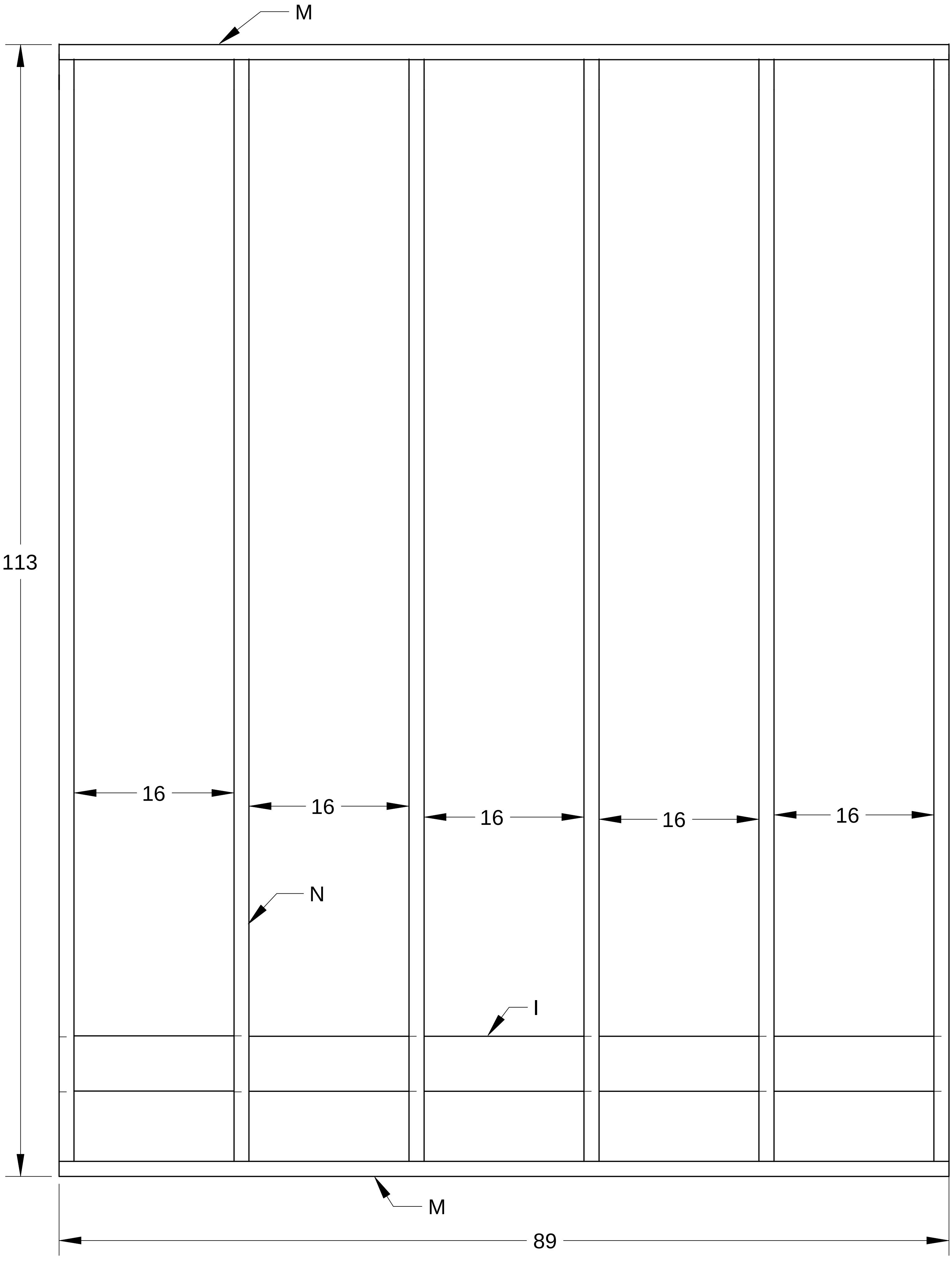


Porch View

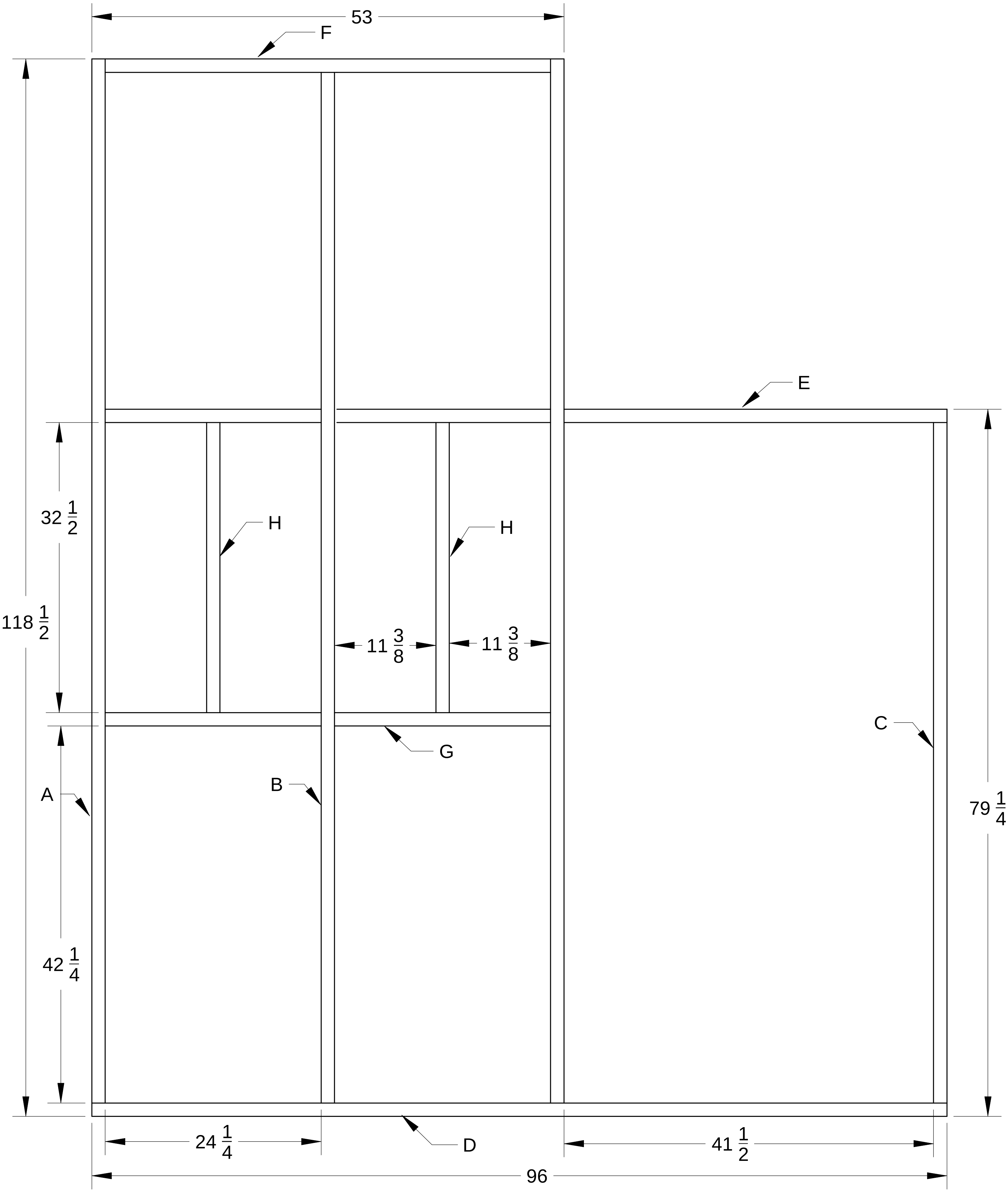




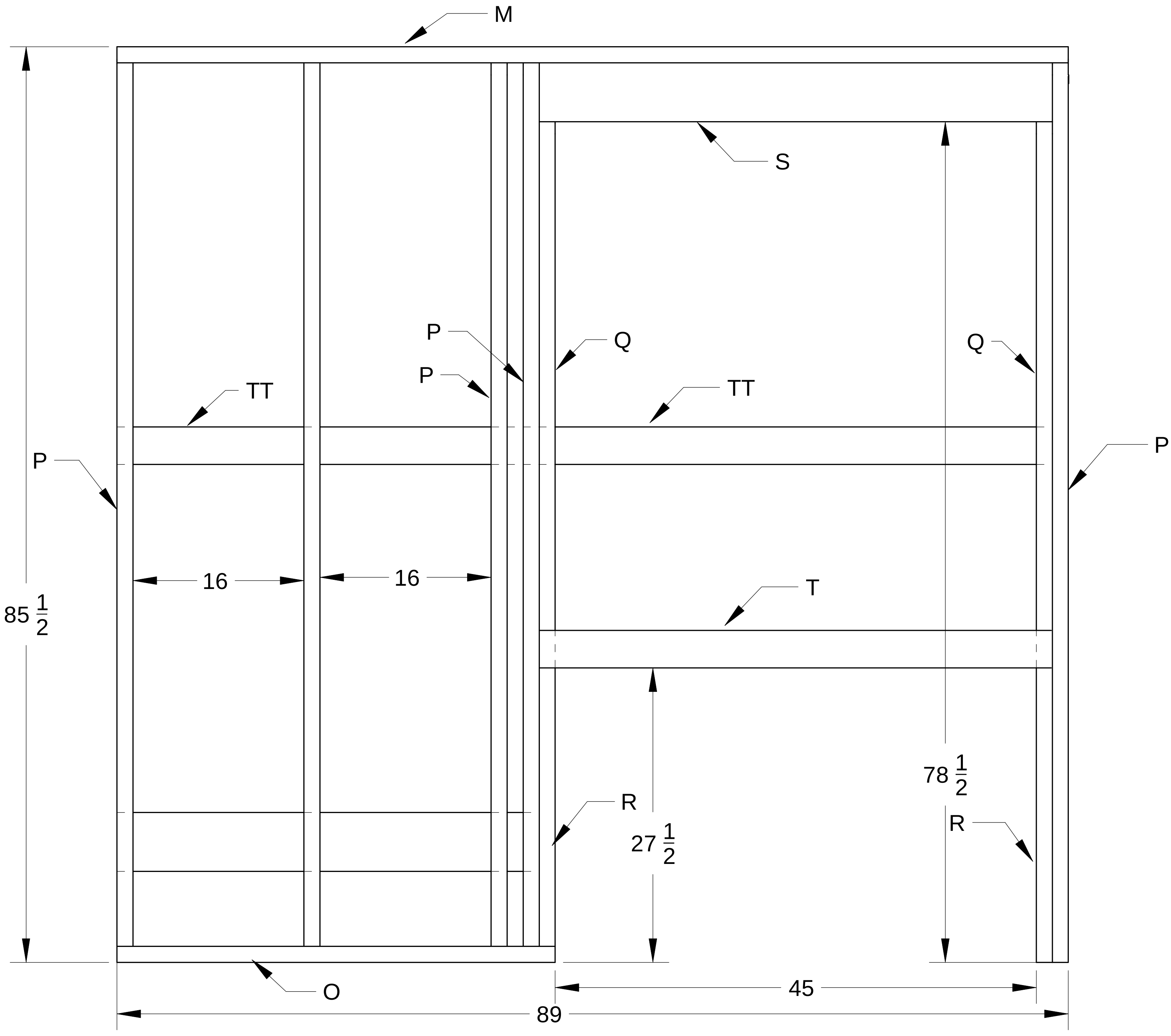
Front View

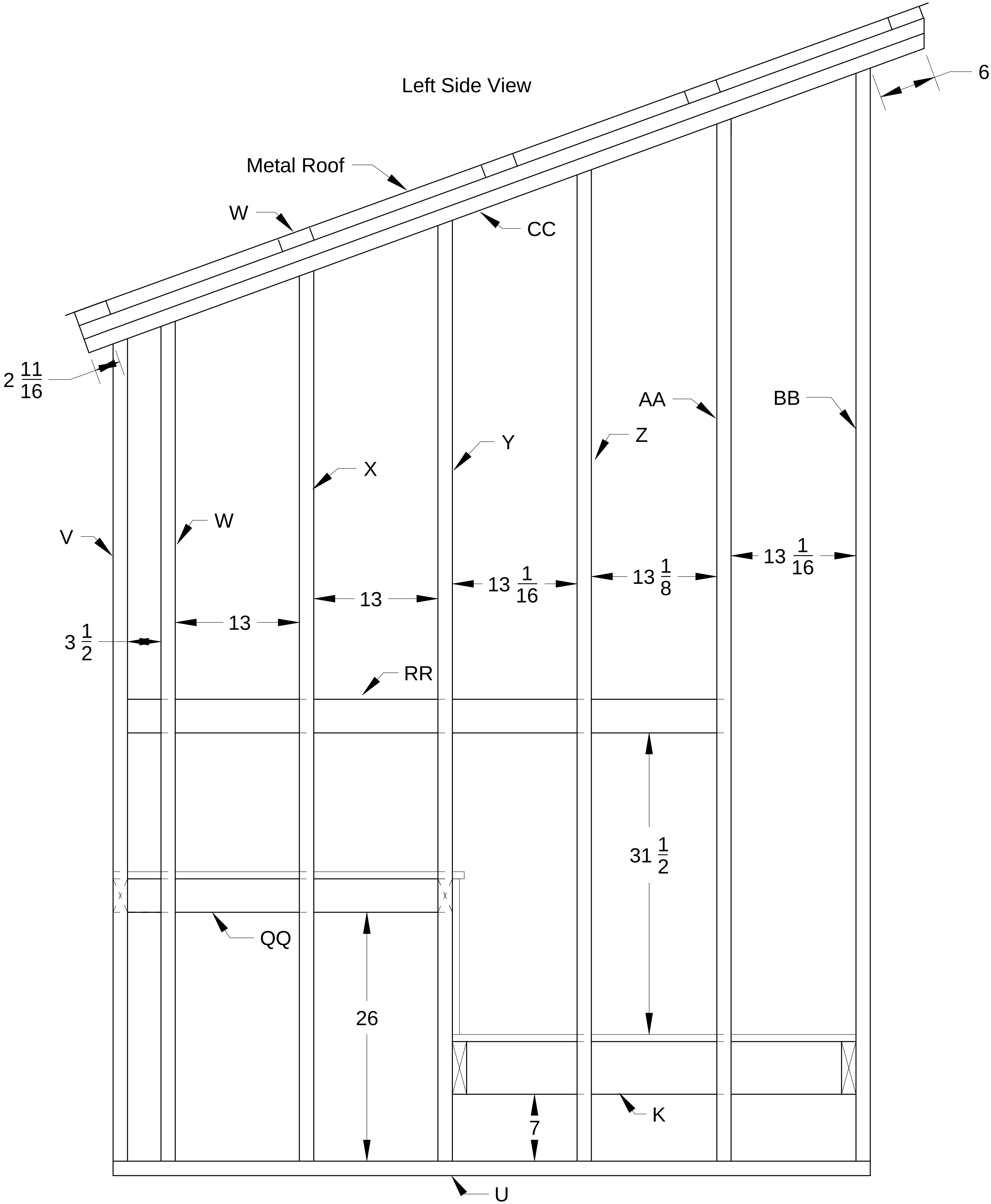


Base View



Back View





Left Side View
Metal Roof
W
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6
2 11/16
AA
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13 1/8
13 1/16
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13
3 1/2
RR
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K
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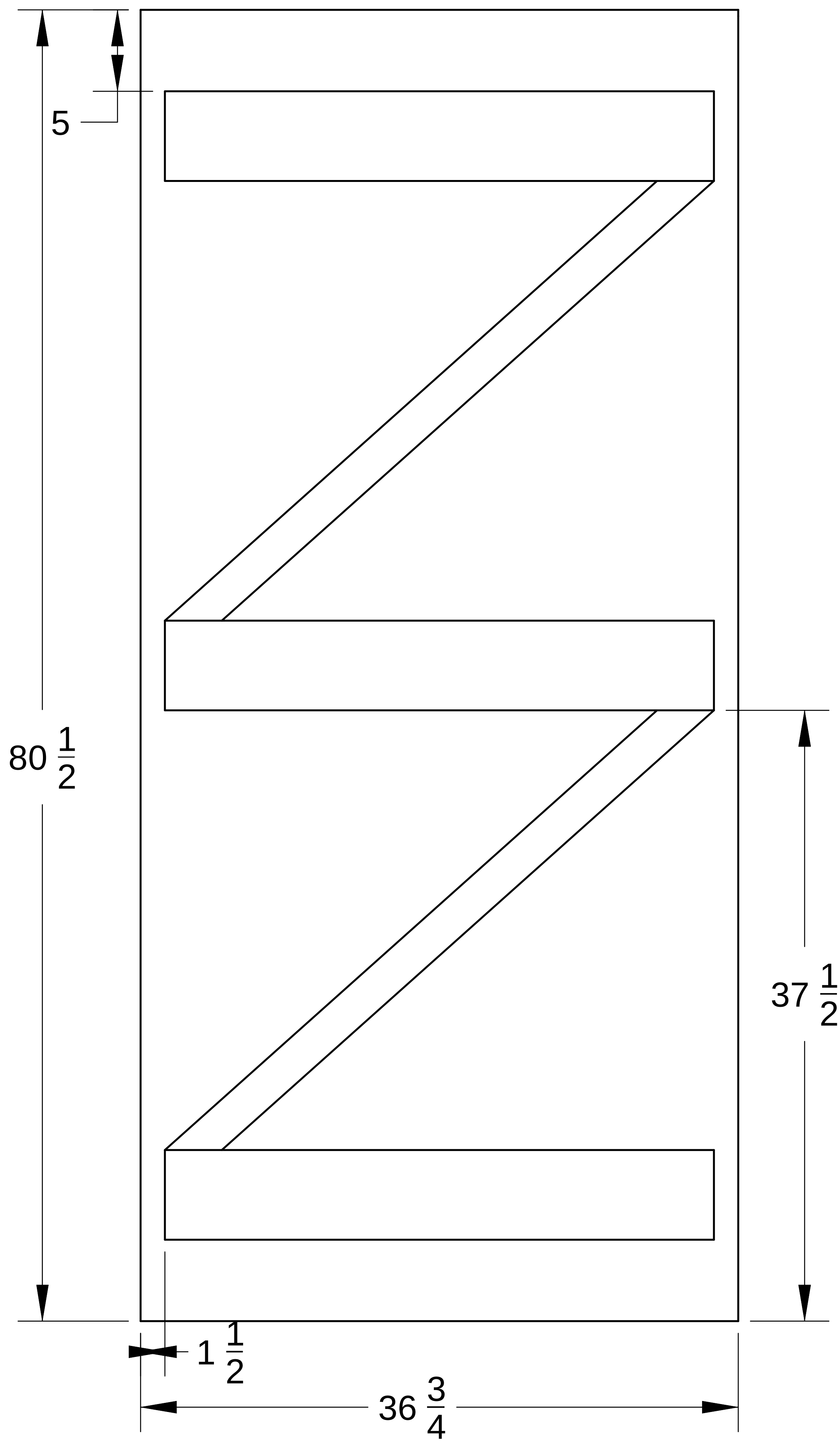
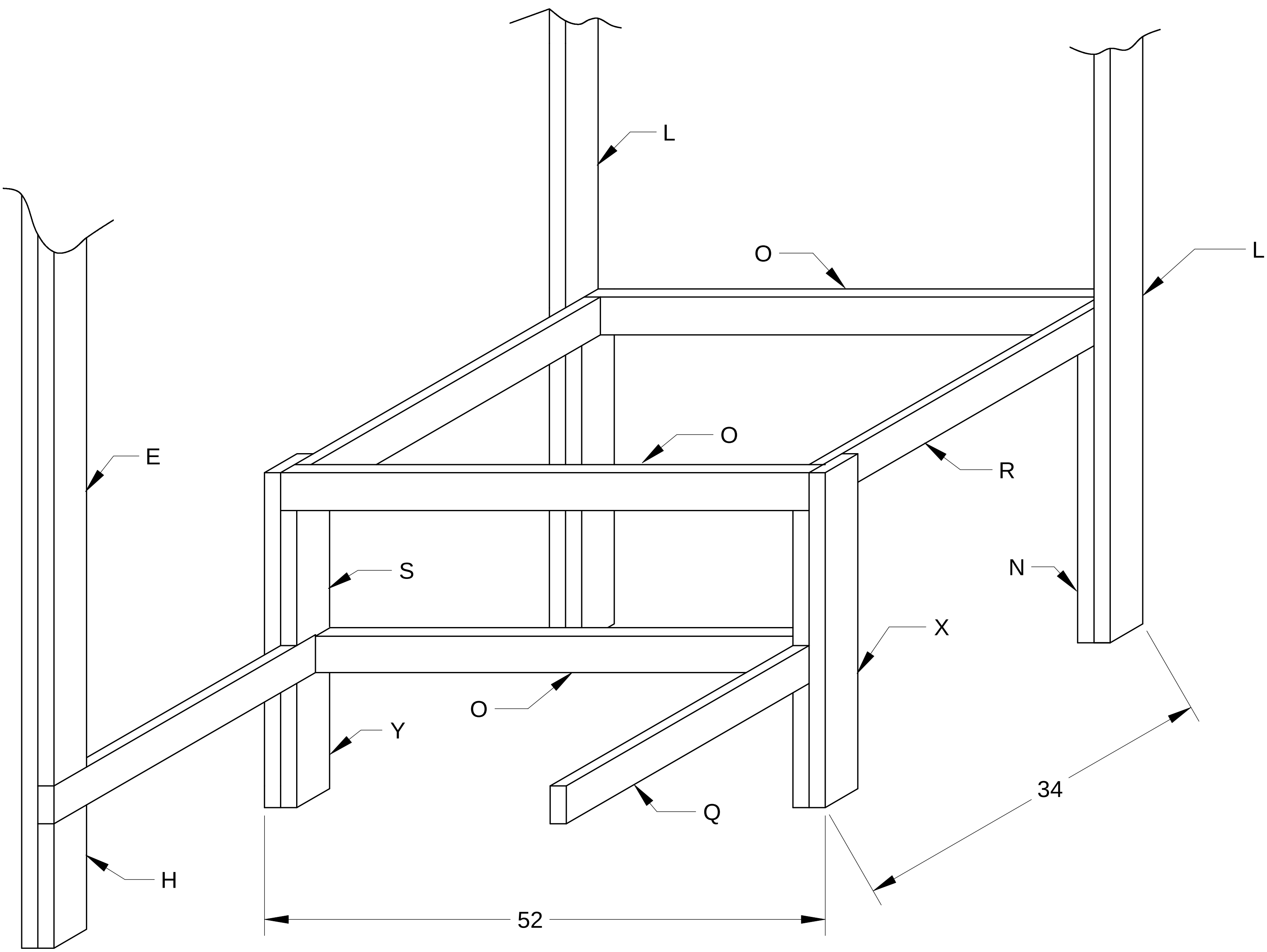
Door View

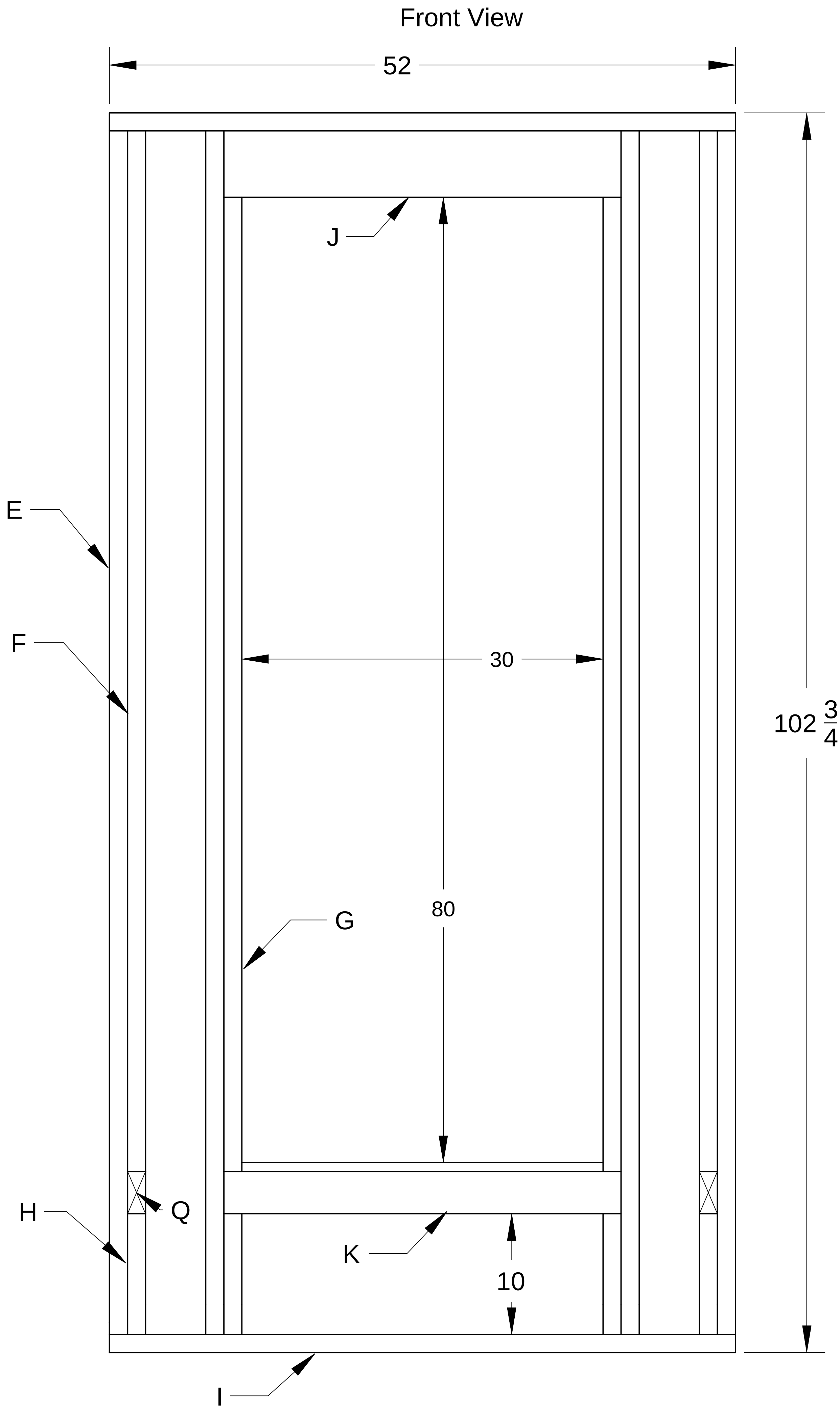


T Plans for a Batch Bin/ Beyond the Bin Outhouse (non-accessible)

Following Pages

Seat View




Front View
52
102 3/4
J
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F
G
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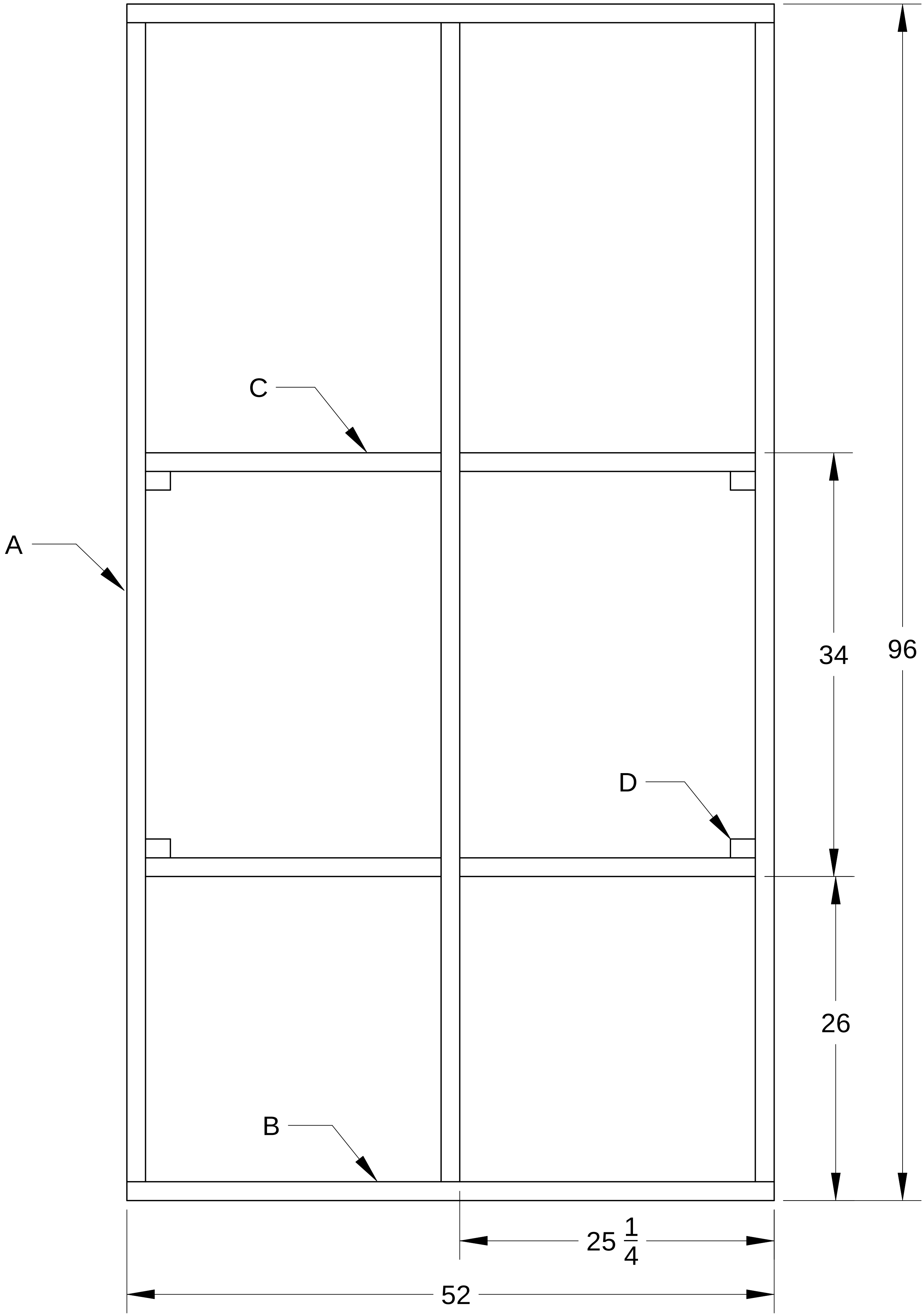
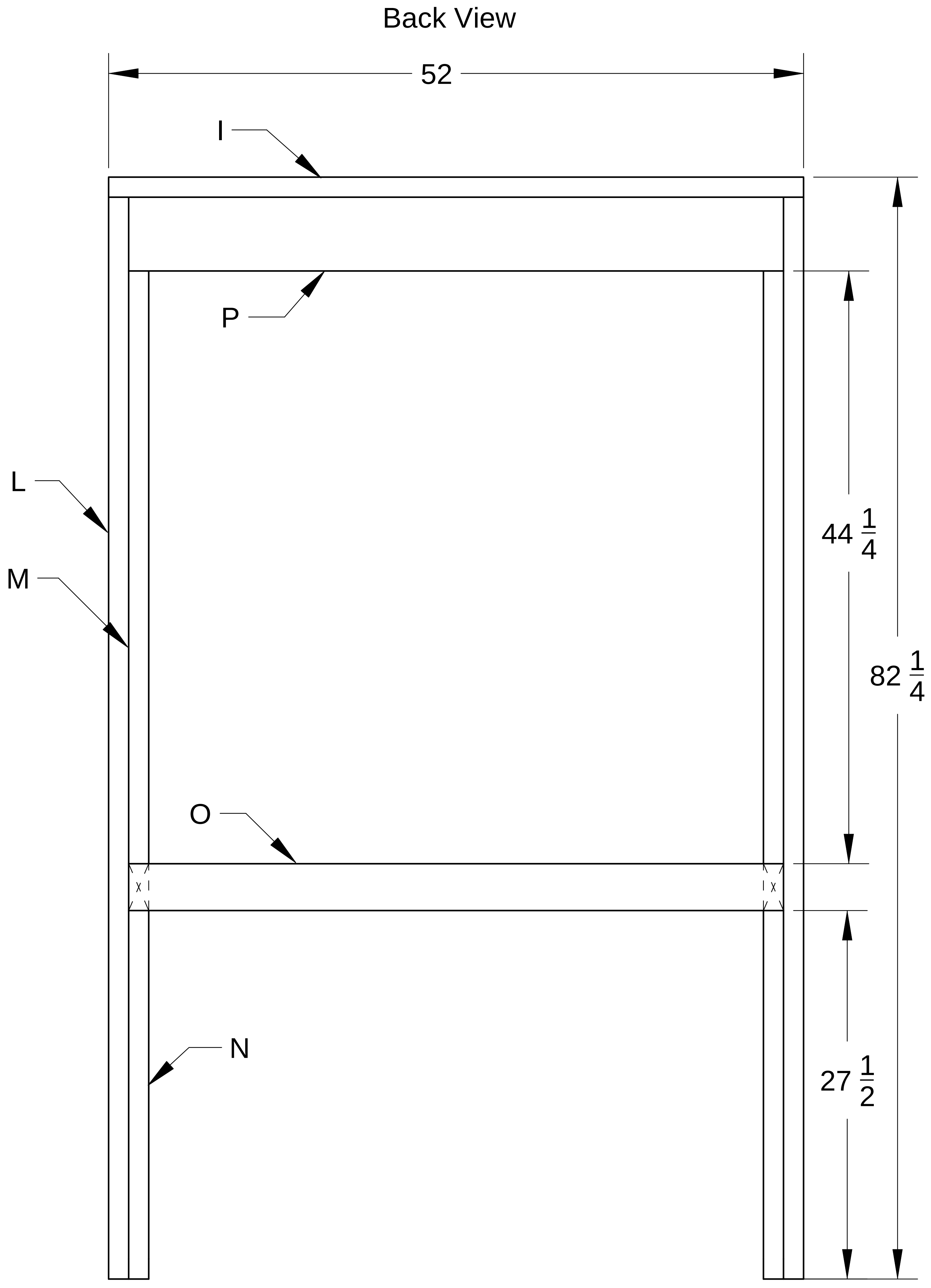
Base View





Back View
52
I
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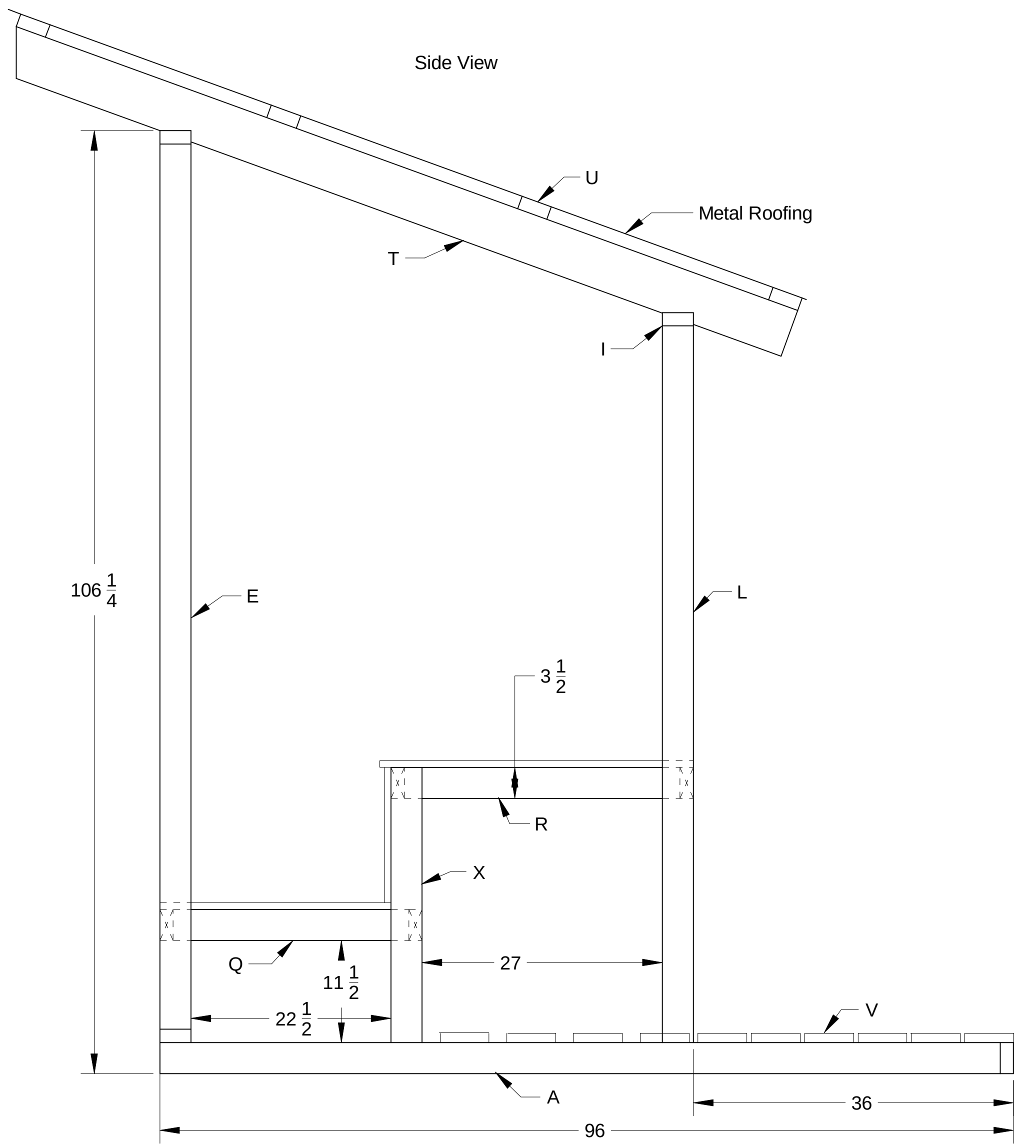
44 1/4
82 1/4
27 1/2


Side View
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Metal Roofing
T
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L
3 1/2
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X
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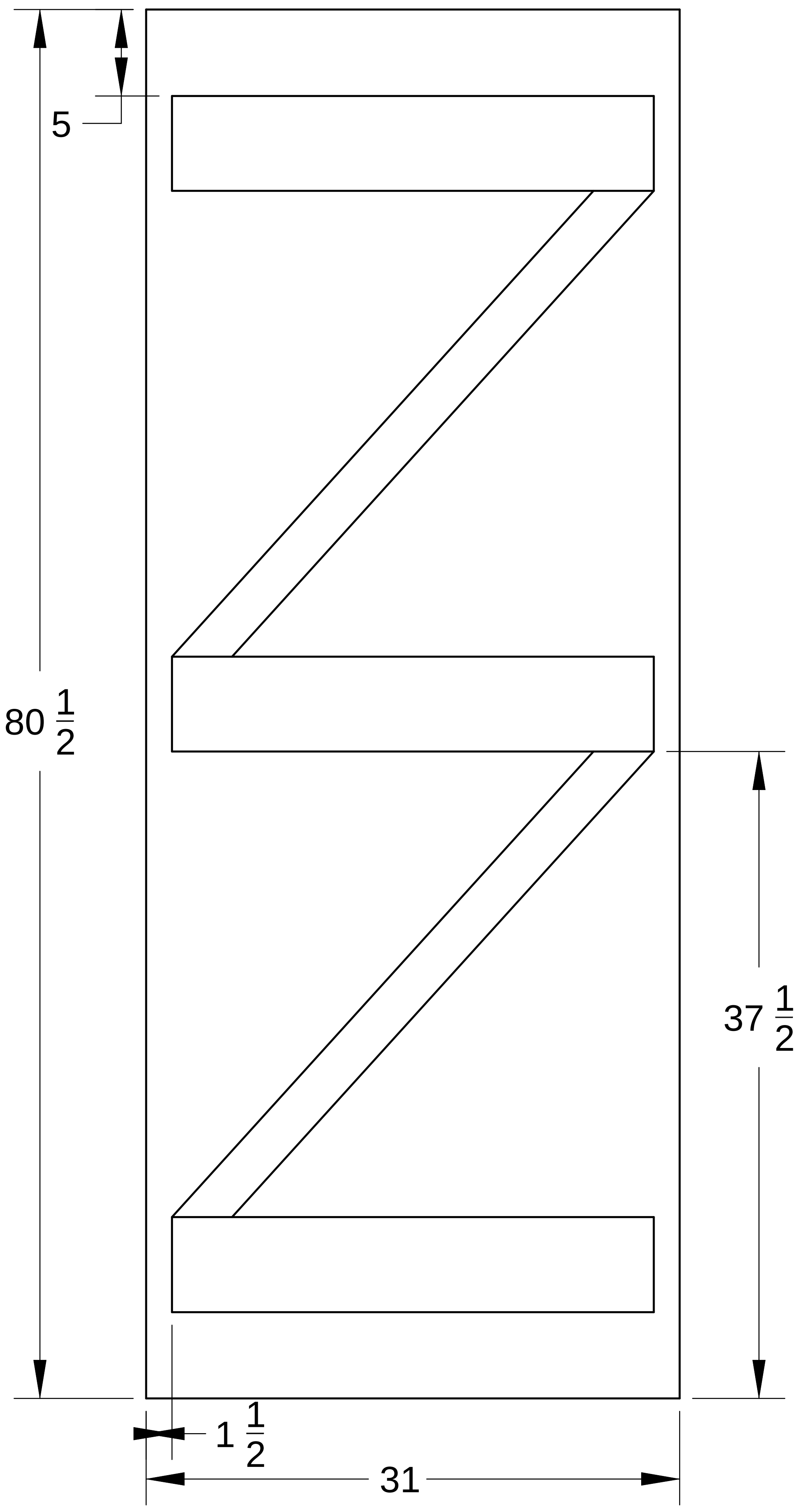
11 1/2
22 1/2
V
A
36
96

Door View



U Examples of Waste Managment Record Keeping

Following Pages

GATC PRIVY LOGGER PROJECT

The Georgia Appalachian Trail Club (GATC) maintains 14 privies along the Approach Trail (1) and Appalachian Trail (13) in Georgia. In 2006 GATC commenced installing privy logger systems in eight privies in a cooperative program with the USFS Technology & Development Center, San Demas, California. Since that time GATC volunteers have downloaded these loggers 83 times and reported the results to San Demas. Those results are shown on the "Privy Logger Results" attachment.

During that time period the following activities of maintaining and transporting wood chips have been conducted by GATC maintainers:

Springer Mountain:	Chips Used Per Year 100 gallons Active Bin Shifted 1/2009 Active Bin Shifted and Moldered Bin Emptied 12/2010 Logger Installed on an Active Bin 2/2007 Privy Constructed 4/2004
Stover Creek:	Chips Used Per Year 55 Gallons Active Bin Shifted 1/2009 No Bin Emptied Logger Installed When Privy and Shelter Went into Service 6/2007; Shelter and Privy Built 10/2006
Hawk Mountain:	Chips Used Per Year 220 gallons Active Bin Shifted 6/2008 No Bin Emptied Logger Installed When Privy Constructed 10/2006
Wood's Hole:	Chips Used Per Year 110 Gallons Active Bin Shifted 11/2009 No Bin Emptied Logger Installed on Active Bin 10/2006 Privy Constructed 6/2004
Blood Mountain:	Chips Used Per year 55 Gallons No Bin Emptied or Shifted Privy Constructed 9/2004
Low Gap:	Chips Used Per Year 30 Gallons Active Bin Shifted 8/2009 No Bin Emptied Logger Installed on Active Bin 11/2006 Privy Constructed 9/2006
Deep Gap:	Chips Used Per Year 30 Gallons Active Bin Shifted 4/2007 Active Bin Shifted and Moldering Bin Emptied 12/2010

Logger Installed on Active Bin 11/2006
Privy Constructed 10/2004

Tray Mountain: Chips Used Per Year 30 Gallons
Active Bin Shifted 6/1/2009
No Bin Emptied
Logger Installed on Active Bin 11/2006
Privy Constructed on 8/2006

All privies are of two bin construction with one bin moldering and the other active. Shifting bins involves reversing the structure above the crib and below the roof. Two logger locations are in Wilderness designated forest and do not have roofs: Low Gap, and Tray Mountain. The use of "gallons" as the measure of chips used avoids differences in weight due to wet versus dry material. Each privy has a 55 gallon barrel for chip storage. GATC maintains a work report data base. The following data was collected for all privy (14 privies) maintenance including chip delivery and logger downloading.

Fiscal '08	565
Fiscal '09	308
Fiscal '10	443
Total	1306

Average hours per year on privy maintenance 435

The project ran from June 2006 through December 2010.

Project Managers
Lawson Herron
Gary Monk

12/28/2010

SEASONAL WASTE GENERATION-2000 SEASON

assumptions: 1 person=0.03 gpd

	reported totals	# days reported	avg.# users/day	avg. gpd	total generation(gal)
SAGES	815	79	10.3	.31	24.45
PARADISE	36	9	4	.12	1.08
BRASSIE BROOK	61	8	7.6	.23	1.83
BALL BROOK	43	7	6.1	.18	1.29
RIGA	171	28	6.1	.18	5.13
PLATEAU	55	8	6.9	.20	1.65
LIMESTONE	57	16	3.5	.11	1.71
BELTERS	25	7	3.6	.11	0.75
SHARON MTN.	5	4	1.3	.04	0.15
PINE SWAMP	62	13	4.7	.14	1.86
CAESAR BROOK	10	8	1.3	.04	0.30
SILVER HILL	22	9	2.4	.07	0.66
STONY BROOK	0	1	-	-	-
STEWART HOLLOW	153	16	9.6	.29	4.59
MT. ALGO	146	20	7.3	.22	4.38
SCHATICOKE	9	6	1.5	.05	0.18
10 MILE SHELTER	75	23	3.2	.10	2.25
10 MILE CAMP	169	23	7.3	.22	4.38
10 MILE GROUP	36	10	3.6	.11	0.75

AVERAGE TOTAL WASTE GENERATION-2000 SEASON

RANK	LOCATION	PREVIOUS RANKING	ESTIMATED ANNUAL LOAD(GAL)
1	SAGES	5	37.2
2	STEWART HOLLOW	2	34.8
3	BRASSIE BROOK	3	27.6
4	MT. ALGO	3	26.4
4	10 MILE CAMP	4	26.4
5	PLATEAU	4	24.0
6	BALL BROOK	2	21.6
6	RIGA	3	21.6
7	PINE SWAMP	2	16.8
8	PARADISE	5	14.4
9	LIMESTONE	1	13.2
9	BELTERS	2	13.2
9	10 MILE GROUP	4	13.2
10	10 MILE SHELTER	4	12.0
11	SILVER HILL	5	8.4
12	SCHATICOKE	3	6.0
13	SHARON MTN	3	4.8
13	CAESAR BROOK	3	4.8
14	STONY BROOK	6	---

Prioritization of Privy Replacement
Connecticut Section, Appalachian Trail
4-4-00

Purpose

Twenty-one camping zones and two hiker parking areas along the Connecticut section of the Appalachian Trail are served by twenty-four pit privies or "chums". The Trails Committee of the Connecticut Chapter AMC is a managing agency for this section of the AT. In an effort to reduce environmental impact and the volunteer labor associated with managing wastes, it is the Committee's intention to replace the pit privies with red worm privy "technology" or other sound sewage disposal methods over time. Ideally, two per year could be converted to the newer technology. This paper attempts to prioritize the replacements based on several considerations.

Method

Weighted scores were developed for each privy based on 1) the date the structure was constructed or replaced, 2) the length of time since last relocated, 3) the environmental sensitivity of the site based on soil conditions, and 4) the total number of users at the site over the last three years. A total score for each privy was used as an indicator of the importance of replacement.

Results

Priority One	Limestone Springs	(score=15)
Priority Two	Ball Brook Group	(score=14)
	Belters	
	Pine Swamp	
	Stewart Hollow	
Priority Three	Brassie Brook	(score=13)
	Riga	
	Sharon Mountain	
	Mt. Algo	

	Schaticoke	
Priority Four	Ball Brook	(score=12)
	Plateau	
	10-Mile Group	
	10-Mile Camp	
	10-Mile Shelter	
Priority Five	Sages "A"	(score=11)
	Paradise	
	Silver Hill	
Priority Six	Sage's "B"	(score=10)
	Undermountain	
	Stony Brook	
Priority Seven	Ceasar Brook	(score=9)
	Stony Brook Group	
Priority Eight	Route 41	(score=6)

Data

Ranking Weights

Age

0-5 years	1
6-10 years	3
11-15 years	5

Movement = (years since last moved) x (times moved)

0-2	1
3-5	2
6-9	3
>10	4

Soil Suitability (based on SCS ratings for soil series mapping)

slight	1
moderate	3
severe	5

<u>Usage</u> (total of last three years)

<50	1
51-100	2
101-200	3
201-400	4
>400	5

Location	Age Score	Movement Score	Environment Score	Use Score
Sages "A"	1	2	3	5
Sages "B"	1	1	3	5
Paradise	3	4	3	1
Undermountain	1	4	5	---
Brassie Brook	3	3	3	4
Ball Brook	3	3	5	1
Ball Brook Group	3	3	5	2
Riga	3	3	3	4
Plateau	3	3	5	1
Route 41	3	2	1	---
Limestone Spring	1	6	5	3
Belters	5	4	3	2
Sharon Mountain	5	2	3	3
Pine Swamp	3	4	5	2
Ceasar Brook	3	2	3	1
Silver Hill	1	1	5	4

Stony Brook Group	3	2	3	1
Stony Brook	3	1	5	1
Stewart Hollow	3	2	5	4
Mt Algo	3	3	3	4
Schaticoke	5	2	5	1
10 Mile Group	3	3	3	3
10 Mile Camp	3	2	5	2
10 Mile Shelter	1	1	5	5

Data Sources

Connecticut Trail Assessment 1/4/99, CT Chapter AMC Trails Committee
Soil Survey of Fairfield County, USDA Soil Consrvation Service
Soil Survey of Litchfield County, USDA Soil Conservation Service
Soil Interpretations for Waste Disposal, David E. Hill, CT Agricultural Experiment Station
Ridgerunner Annual Reports for 1996, 1997, 1998, AMC Regional Program Office, Lanesborough

Prepared by D. Boone, 4-4-00

V Dartmouth Outing Club Region 9 Accessible Moldering Privy

Following Pages

Ore Hill Privy Report
Prepared by Katie Jacobs, Summer 2013

Overview:
The previous privy at Ore Hill was in a sorry state (lacking a door, fairly full and generally dilapidated), so a new ADA-compliant privy was constructed to replace it. The old privy was torn down; anything burnable was burned, the old moldering bin was covered with the old metal roof and camouflaged with leaves and branches. A crew of four completed the project in two weeks.

Logistics:
The very first day, we used the entirety of Summer Crew (14 people) plus Rory to take lumber and supplies up to the site (~0.6mi. from Cape Moonshine Road). 126 person hours were needed to move supplies alone. All lumber (pre-cut) and building supplies were provided by LaValley's. This was an excellent idea in theory, because we definitely would have had a very hard time figuring out exactly what we needed on our own, but was not completely perfect due to the fact that the architectural plans supplied by the Forest Service and accompanying Supplies List were not always consistent and/or accurate, so some trips to the hardware store did end up being necessary.
During construction, the crew camped at the Ore Hill campsite. This was extremely convenient for working, though about once each day someone did need to go to the hardware store and/or go charge up batteries for the power drills and skill saw (a vehicle was kept at Cape Moonshine Road, parked off the road). Tools and supplies were also kept at Ore Hill. Carpentry tools and 1-ply siding were kept under a tarp; pressure treated wood and other materials were left out. The crew was kept the same from Week 1 to Week 2 because the knowledge and experience accrued in the first half of the project greatly improved the efficiency of the second half. Not including carrying up supplies, and assuming 9 work hours per day, 324 person hours were spent on this project.

Tools Used:
- 1 chainsaw
- Chainsaw PPE
- 4 shovels
- 2 pulaskis
- 1 pick mattock
- 2 rock bars
- 1 pair of loppers
- 1 tarp
- 1 bow saw
- Carpentry tools:
    - Hammers
    - Level
    - 3 battery-power drills and drill bits

- 1 battery-power skill saw
- Carpentry squares (large and small)
- Pencils
- Carpentry hand saw
- Socket wrench
- 1 crow bar
- 1 flat bar
- 1 cat's paw
- Wire cutters
- Pliers
- 3 tape measures
- 1 chisel
- 1 step ladder

Work Accomplished:
Week 1: Site cleared and leveled. Forest Service Ranger felled 3 large trees to allow more sunlight on the moldering bin. Moldering bin/foundation and floor completed, walls framed.
Week 2: Roofing and siding completed. Deck/ramp built and land manipulated to make ramp accessible. Stairs built. Doors and signs completed. Toilet riser installed.

Observations/Recommendations:
Considering that none of us had any real carpentry experience before this summer, I think this project went fairly well. If we'd had someone who really knew what they were doing, I'm sure we could have gotten it done a lot faster. As it was, we ended up spending quite a bit of time putting our heads together figuring out various things. Another huge hindrance was the quality of the Forest Service plans. They were confusing and inconsistent, and the supplies list was clearly made by someone who knew next to nothing about carpentry. For example, all the calculations for 2x4s assumed that 2x4s are 4 inches wide *after* being planed. The crew size of 4 was excellent; any larger and it would have become a real cluster.

Future Work:
The privy itself is completed (the logbook should be checked on and replaced as necessary!) and the Forest Service person we spoke to did not have any further recommendations for the campsite.

Photos:

After digging out the site for the moldering bin.


The completed moldering bin and six posts.


Completed floor and sill.


Walls framed!


Roof and deck added.

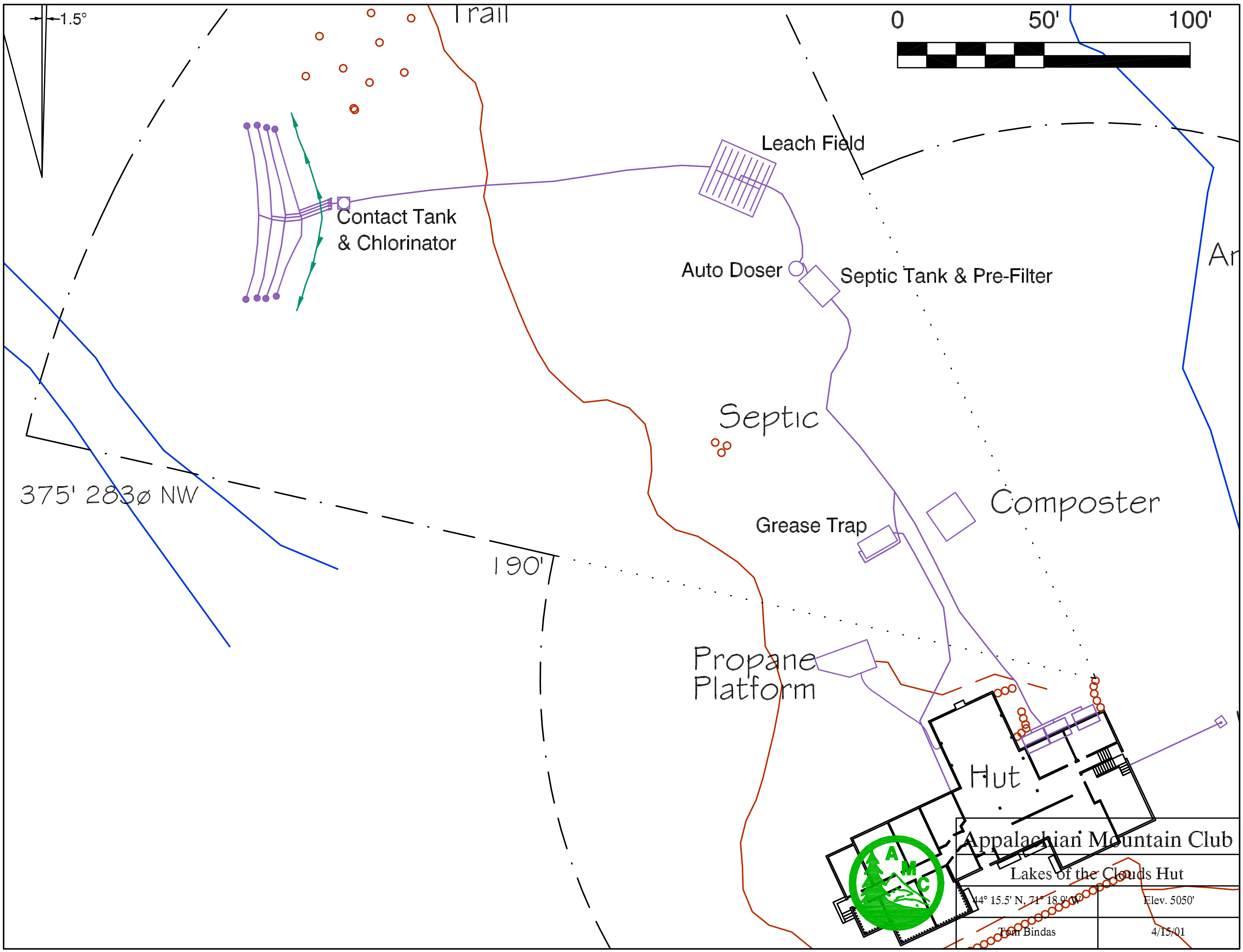

Siding and earth ramp added.

All done!

The devil is in the details!

W Huts AMC Clivus Operations

Following Pages



1.5°
Trail
0
50'
100'
Leach Field
Contact Tank
& Chlorinator
Auto Doser
Septic Tank & Pre-Filter
Septic
375' 283ø NW
Composter
Grease Trap
190'
Propane
Platform
Hut
Appalachian Mountain Club
Lakes of the Clouds Hut
44° 15.5' N, 71° 18.9' W
Elev. 5050'
Tom Bindas
4/15/01

CLIVUS COMPOSTER

From a guest service point of view the Clivus works just **like an outhouse**. The guest hovers their hind quarters over the chute and makes a deposit. No fuss no muss. No water.

There is a danger that someone will start a **fire** in a Clivus with a match, or cigarette. (the planer chips and dried shit are quite flamable once they get going.)

There is also a problem, as with outhouses, with **trash**. Soda cans and soiled laundry don't contribute to the composting process. Remove trash, package correctly and pack out. Another potentially big problem is **flys**. If the environment is right the bacteria added to eat the waste should also munch the fly eggs; and the spiders should munch the flys. If you notice flys in the bathroom, take out a screen or two and "shoo" them out. Also hang and maintain sticky strips, and swat at will. If the flys become a problem for the guests, CC can 'bomb' the whole thing and give you a fresh start, but the preditors will be killed also and everything will have to start over. If the fans run properly the flys should not be interested since the Clivus won't smell.

The **Fans** should run 24 hours a day all summer. (There is, typically, a "breaker" at the electrical control panel that runs the fans & lights in the bathrooms. See: Electric Systems, most of the bathroom lights are LED bulbs that cost about $30 each! and use very little power)

The main things that the caretakers will be doing is to:

- **Add 'planer chips' (not bark chips)** at the rate of "2 gallon per 100 uses" Another, better "metric" is to add a gallon for each roll of toilet paper used. (add a few scoops each day at cleaning time) (**Be carefull not to get any bleach or disinfectant into the Clivus as this will kill the process!**).
- Occasionally **mixing, and monitoring** (weekly) the pile.
- Each week in the summer use the hose and sprayer to **soak down the mass** in the upper chamber, under the seats (spray for approx 3 min).
- Make sure that the 'dam' continues to prevent 'raw' poops and 'stuff' from tumbling down to the lower chamber. Note: keeping the pile damp also **lessens the chance of fire**. A damp, humid environment with plenty of air flow is perfect.

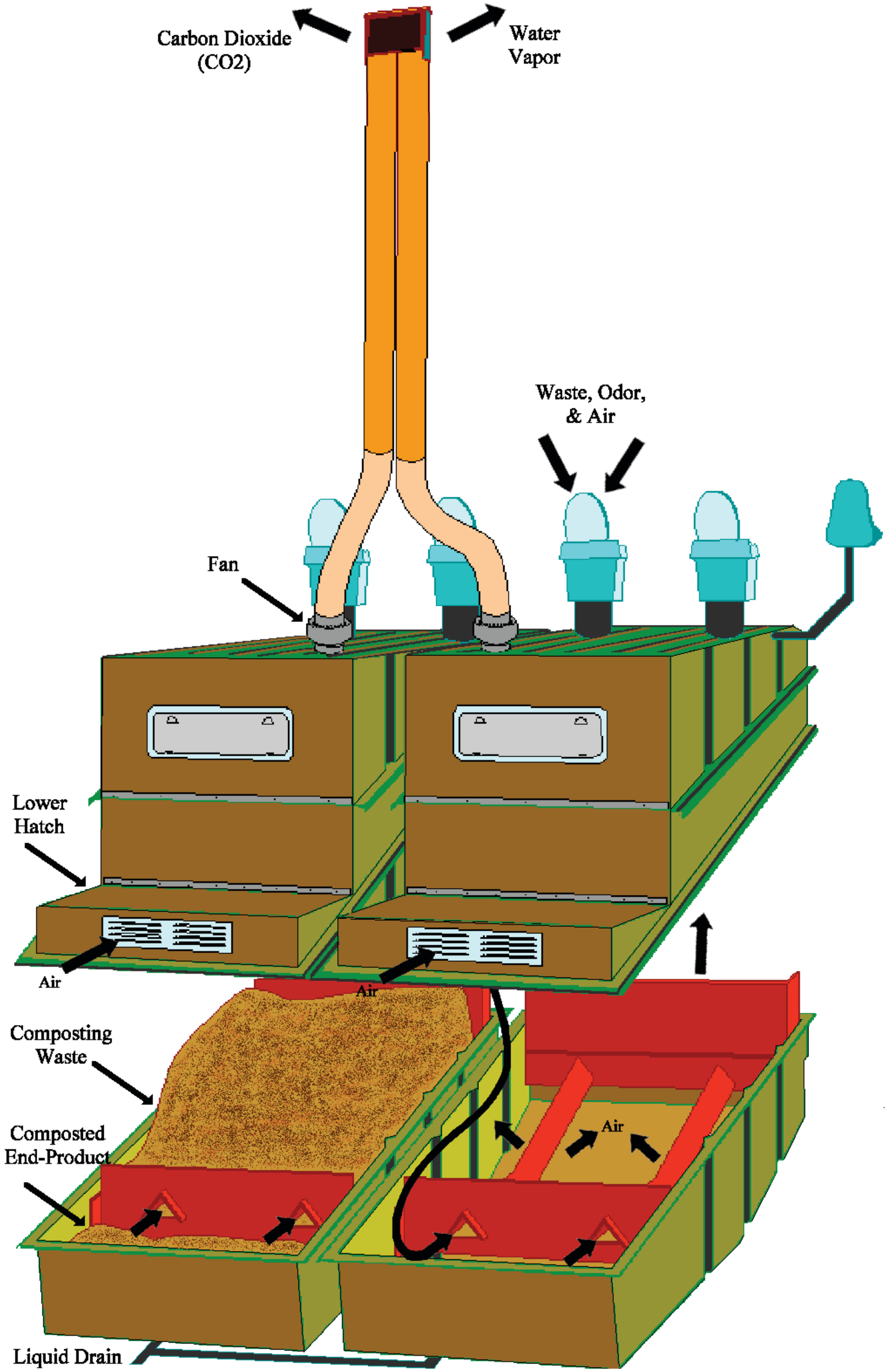
CLIVUS SCHEMATIC

This schematic (over) shows the Composting bins as if they were opened. The mass is similar to a garden compost pile. By shoveling out a small amount of composted final product each year CC creates a void which causes the waste in the pile to slowly slide down the inclined back of the bin as it decomposes. The bins are sized so that the waste is completely composted in the two or more year's time it takes to appear in the lower hatch. This end-product, reduced to only 5% of its original volume, has the odor, appearance, and bacterial content of topsoil. The liquid, which appears in the lower hatch, has changed biochemically to a stable fertilizer and salt solution which meets quality standards for swimming water!

In a Clivus®, disease-causing organisms are not killed by heat. Rather, they die because conditions in the pile are not favorable to their growth, and because the very active population of decomposer organisms consumes them.

The vent on the composter, assisted by a solar powered electric fan, creates a draft that pulls air into the compost, up the air ducts, throughout the waste pile, and finally pushes the air out the stack. The oxygen that reaches the middle of the pile supports the slow decomposition process and the treatment of the liquids. Air is also drawn down the fixtures, especially when a toilet lid is opened. This oxygen supports the rapid break down that takes place at the surface. This down draft also prevents odors from entering the toilet room.

The caretaker sprinkles “planner chips” on top of the pile each day. This adds bulk, surface, and keeps the pile “fluffy” so that the Aerobic (air) organisms will grow. Once a month in the summer CC adds a “bacterium” solution. This is to ensure that all of the naturally growing soil bacteria, mold, and other organisms are thriving. The organisms eat the waste and produce mostly Carbon dioxide (CO_2) and water vapor which is carried away by the draft.



X AMC Massachusetts Moldering Privy

Following Pages

AMC Mass – Moldering Privy Crib Construction

The crib is constructed of 8' pressure treated 2X6's and 2x4's. The crib is a 4ft x 8ft two-chambered box that the outhouse can be slid back and forth from one side to the other. The crib rests on the ground on the first course of 2x6.

Construct in the following steps:

1. Determine the location for the crib/privy and clear the ground of organic matter. A good flat area is needed, away from water sources. Uneven sites can be used, if the crib is shored up on rocks or partially excavated into a hillside. Crib must be completely level and stable (see photo #1)
2. Start with a full layer of 2X6's laid to create a 4ft x 8ft rectangle
3. Install 4' cross pieces--one at each end and one in the middle to create the beginnings of 2 4ft x 4ft chambers. Nail to the 2x6 with 10 penny galvanized nails.
4. Then install two 8' pieces of 2 x 4 on the long sides of the crib. Nail to the 4ft pieces with 10 penny galvanized nails. (See photo #2)
5. Continue building up the crib with alternating 4ft and 8ft pieces to the desired height--10" to 18", or 7 to 12 layers depending on the anticipated waste volume and frequency of shifting the privy. Finish off the top layer with a full layer of 2x6 for a nice smooth top for sliding the outhouse.
6. Line the inside of the crib with fiberglass window screen to deter insects. Then protect the window screen from shovels with a layer of hardware cloth inside of that. (see photo #3)

With the crib completed, move the lift the outhouse on top of the crib right or left side as desired. 2x6's can be fastened to the outhouse and used to carry and lift it into position. (see photo #4) Place steps or stones as needed for entry*. (Photo #5)

Build a cover for the resting side of the pit from a 4' X 4' piece of 1/2" exterior grade plywood. Nail the plywood to 3 pieces of 2X4 tapered from the full width (3 ½") to ~1" to provide a pitch to the "roof". Paint or stain the exterior and place the roof in position over the resting side of the crib. A moderate sized rock will help keep curious animals out of the resting material.

Collect a full bucket of duff and place it in the privy along with a rake to collect duff in the future. Duff is harvested from the forest floor and contains a mixture of dirt, roots, twigs and fallen leaves (see photo # 6). A trowel in the bucket and some TP in a coffee or old paint can with a lid is also a welcome touch for hikers.

Lastly, post a laminated copy of: "Instructions for Using the Moldering Privy" outside the privy door at a convenient height for users to read and the place is open for business!

Monitor the use of the privy, knocking down the pile and spreading waste to the corners of the active crib as needed. When the crib is nearly full, remove the cover of the resting side and slide the outhouse over. Generally best to have 2-3 people for this manuver to avoid tipping the outhouse over or sliding it off of the crib.

Prepared By: Jim Pelletier, 2007 revised by Cosmo Catalano, 2012

AMC Mass – Moldering Privy Crib Construction

Add more duff to the full side (now becoming the resting side) if it looks a little wet, and turn with a spading fork. Cover and let molder for a year or more. When ready the composted waste will have no smell, and appear to be fairly dry and crumbly.

Remove any undigested material and pack out. Spread compost widely away from water sources and campsites.

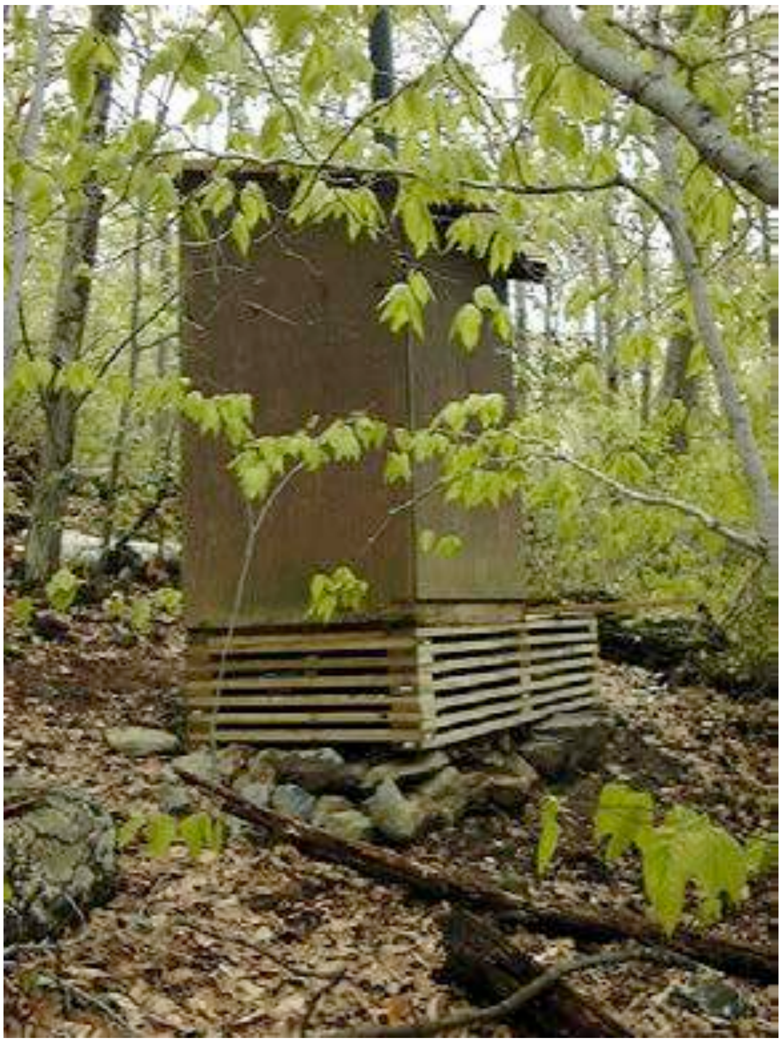


Photo 1. Crib set on rocks to compensate for sloping site.

AMC Mass – Moldering Privy Crib Construction

Photo #2. Crib assembly has begun.

Photo #3. Lining the crib with screen.

Prepared By: Jim Pelletier, 2007 revised by Cosmo Catalano, 2012

AMC Mass – Moldering Privy Crib Construction

Photo #4. Existing outhouse ready to carry to crib location.

Photo #5. Project completed.

Prepared By: Jim Pelletier, 2007 revised by Cosmo Catalano, 2012

AMC Mass – Moldering Privy Crib Construction

Photo #6 Example of Duff

*A word about Universal Design (Handicapped Accessibility). Because the outhouses are not being re-built or newly constructed, the land manager (Mass Department of Conservation and Recreation) does not consider it necessary to create a fully accessible structure for this project, as it does not meet the threshold to be considered new construction. If Universal Access was required, the outhouse would be built new and dimensioned to meet current USFS requirements for universal access. The crib would then need to be sized accordingly, but the same materials and process could be used. Depending on the overall height of the crib and terrain at each site, a ramp or other accessible may also need to be constructed. Consult your local land management partner before undertaking this type of project.

Y AMC Connecticut Moldering Privy

Following Pages

SEASONAL WASTE GENERATION-2000 SEASON

assumptions: 1 person=0.03 gpd

	reported totals	# days reported	avg.# users/day	avg. gpd	total generation(gal)
SAGES	815	79	10.3	.31	24.45
PARADISE	36	9	4	.12	1.08
BRASSIE BROOK	61	8	7.6	.23	1.83
BALL BROOK	43	7	6.1	.18	1.29
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9	BELTERS	2	13.2
9	10 MILE GROUP	4	13.2
10	10 MILE SHELTER	4	12.0
11	SILVER HILL	5	8.4
12	SCHATICOKE	3	6.0
13	SHARON MTN	3	4.8
13	CAESAR BROOK	3	4.8
14	STONY BROOK	6	---

MAINTAINER' S "PRIVY PROTOCOL" FOR MOLDERING PRIVIES

Recent experience with moldering composting privies, both in Connecticut and elsewhere on the AT, have led to techniques and methods which serve to better deal with waste management and environmental stewardship. Some of the concepts that have developed include:
-a slight amount of moisture is necessary for the composting process to occur. For this reason, we no longer ask users to "pee in the woods, not the privy".
-the red wiggler worms, although helpful because of the way they "aerate" the pile, are not necessary for composting. In fact, many managers feel this constitutes the introduction of an invasive species into the AT environment.
-the pile, however, does need to be aerated to prevent "fossilization".
-pine shavings are recommended as the best bulking agent, as opposed to the pine bark we have been using. The bark is considered to be too acidic.
-in accordance with ATC and NPS policies, we will continue to strive to make the privies "handicapped accessible".

In an effort to manage our molderers in accordance with the most current thinking, the Trails Committee is instituting the following changes, and the assistance of individual section maintainers where moldering privies are located is appreciated:

- "Stewardship" or "User" instructions for pit, vault, and moldering privies at each type of privy will be posted, to educate users as to the "nuances" of what they are sitting in.
- The pile will have to be manually aerated occasionally. (Three times/season). Dedicated pitchforks will be obtained for this work. The fork will be labeled "'biohazard" and hidden in the woods from a nail in a tree. This hanging storage will also allow rain to wash off any residual.
- Maintainers agreeing to perform this task will be issued disposable gloves and antibacterial lotion. Latex or nitrile disposable gloves must be worn during turning
- Bio-accelerant will be added to the pile at the beginning of each season to "kick start" the composting process.
- A small garbage can will be placed near the fork hang which will contain a stockpile of pine shavings. The maintainer should see that the mulch container inside the privy contains wood shavings. The garbage can must be located (hidden)—experience has shown that if the container is located near the privy, users will use it for solid waste disposal.
- Notify the Trails Committee chair or Waste Management Coordinator when the bin is full.

If a section maintainer is unwilling or unable to do the tasks mentioned above, please inform the Trails Chair or other member of the Trails Committee, so other arrangements can be made to manage the privy throughout the season.

4/5/06

Z Accessible Toilet Riser

Following Pages

ROMTEC
www.romtec.com

Romtec, Inc.
18240 North Bank Rd.
Roseburg, OR 97470
541-496-3541 • Fax: 541-496-0803
info@romtec.com

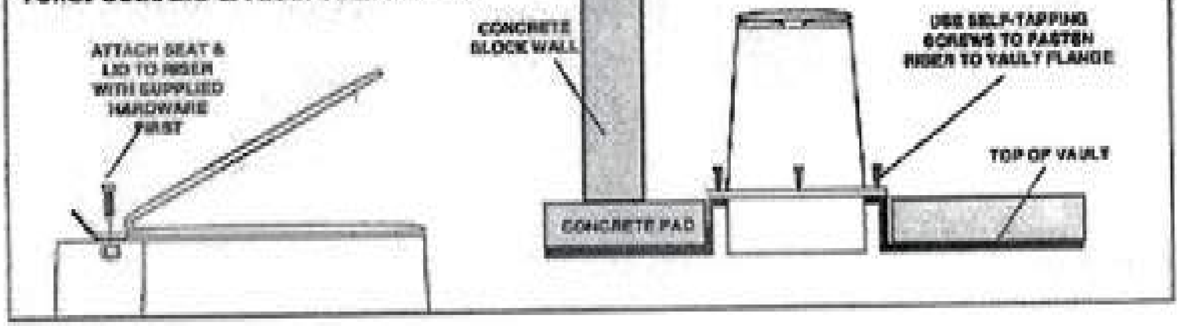
PRODUCT INSTALLATION

Cross-Linked Polyethylene Toilet Riser

INSTALLATION PROCEDURE - In Romtec Cross-Linked Polyethylene Vault

The Romtec Toilet Riser is installed through the fitting in the top of the Romtec cross-linked polyethylene vault. 1) Install the toilet seat/lid before installing the riser. 2) Clean any concrete or dirt from the top of the black vault flange. 3) Slip the toilet riser into the top of the vault until the riser flange fits snugly against the vault flange surface. 4) Use four stainless steel screws to fasten the riser to the vault. No sealant is required.

Toilet Seat/Lid & Riser Attachment



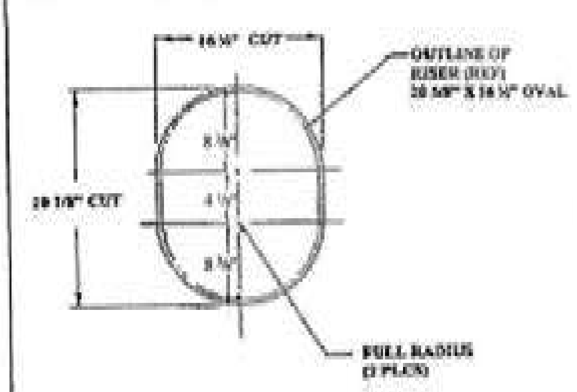
INSTALLATION PROCEDURE - In Concrete Vault

The Romtec Toilet Riser is installed through an opening in the top of the concrete vault. 1) Install the toilet seat/lid before installing the riser. 2) Clean any concrete or dirt from the top of the slab. 3) Apply a bead of silicone sealant to the bottom surface of the flange on the near the base of the riser. 4) Slip the toilet riser into the top of the vault until the riser flange fits snugly against the concrete slab surface. 5) Press down firmly on the riser to seat the sealant into the concrete.

CONCRETE VAULT OPENING DIMENSIONS

The dimensions of the opening in the top of the concrete vault are shown in the drawing on the right.

Toilet Riser Plan Dimensions



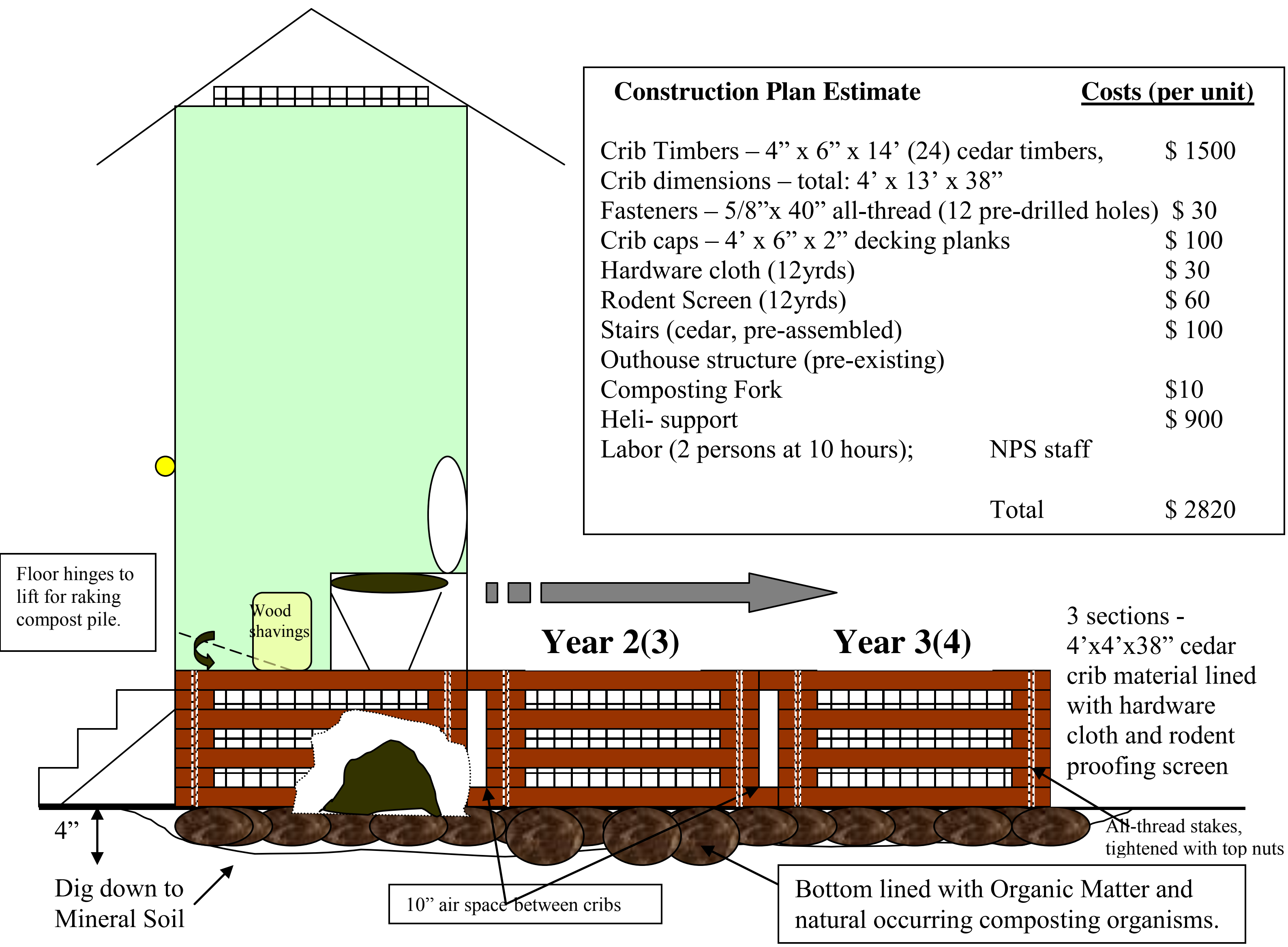
AA Moldering Privies on the Klondike Trail Alaska

Following Pages

Multi-year Crib Moldering Privy Synopsis

The moldering privy design was first implemented on the Appalachian Trail in Vermont in 1997 by the Green Mountain Club (GMC) in cooperation with the National Park Service and others. Trail organizers have since installed many others along the trail in several states. The slow composting design was manufactured to produce safe composted end product from human waste in cool and moist climates, where temperatures exceed 40 degrees Fahrenheit during the use season. GMC studies show that many single unit cribs did not have to be harvested until after six or more seasons of use. They recommend one privy per 1000 users. The moldering privy can use existing traditional outhouse designs placed on a cedar or treated crib. The surface 3” of soil and duff beneath the crib are removed and a mixed layer of organic matter is deposited in the depression prior to installation. As users deposit waste into the crib, they place a handful of leaves and duff at the same time or rangers can deposit some daily. GMC bought compressed bails of wood shavings for 3$/bail that provided for 1000 uses each. Shredded bark (such as that produced in a commercial debarking operation) is suggested as the best composition size, approximately 2”-3” pieces. Periodically, rangers will level the pile through a floor access door using a composting rake or spade. As long as the duff material is added, the pile maintains a light earthy odor. AT users consistently reported that the moldering privy was the “best smelling toilet from Georgia to Vermont.” The 3 crib design allows for skidding the outhouse from one crib to the next as the prior crib fills up. Optimally, this design should allow for 3 – 6 years (maybe longer with two or three toilets) of slow composting before the first crib has to be emptied. The prior crib is topped with a generous layer of duff, capped to prevent falls by users, and stirred once per year until fully composted and ready for removal. Dry composted contents can be flown out and incinerated along with City sludge disposal. **GMC contact:** Pete Ketchum or Dick Andrews at 802-244-7037.

Construction Plan Estimate		**Costs (per unit)**
Crib Timbers – 4” x 6” x 14’ (24) cedar timbers,		$ 1500
Crib dimensions – total: 4’ x 13’ x 38”		
Fasteners – 5/8”x 40” all-thread (12 pre-drilled holes)		$ 30
Crib caps – 4’ x 6” x 2” decking planks		$ 100
Hardware cloth (12yrds)		$ 30
Rodent Screen (12yrds)		$ 60
Stairs (cedar, pre-assembled)		$ 100
Outhouse structure (pre-existing)		
Composting Fork		$10
Heli- support		$ 900
Labor (2 persons at 10 hours);	NPS staff	
	Total	$ 2820



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Tri-Crib Moldering Privy Sanitation Manual

Prepared by Tim Steidel, Lead Protection Ranger, Klondike Gold Rush NHP

Justification for This Approach

The Chilkoot Trail continues to receive just over 3000 visitors each year between May and September. The highest concentrations of these visitors congregate at Sheep Camp, the last camp area before the steep ascent over the Chilkoot Pass. This campground is located adjacent to the meandering glacial fed Taiya River and the ground surface averages three to four feet above the water table. On the opposite side of the campground from the river, numerous dry and seasonally flooded backwater sloughs infiltrate the terrain. The combination of concerns regarding significant cultural sites and close proximity to ground water sources have resulted in limited options for human waste disposal.

Currently, the park is using pit privies in all of the campgrounds for human waste disposal. This toilet system has been implemented on the Chilkoot Trail for over thirty years. Finding unused ground for new pits that aren't near a water source or jeopardizing cultural sites is an increasingly difficult proposition. The waste remains in the environment and continues to pose a pathogenic water resource threat for an indefinite period of time.

The park continues to research alternative human waste disposal methods for the backcountry. While this research continues, park management has decided to pursue a more responsible toilet system for Sheep Camp using a design first implemented by the Green Mountain Club on the Appalachian Trail in Vermont in 1997. While this system is still in the research phase, early indicators suggest effective results. The "moldering" crib privy utilizes slow composting principles and involves a *low installation cost* and *minimal maintenance* to operate. The following installation and maintenance plans further describe a three crib modification design that will allow for more moldering time in a cooler climate, where Sheep Camp averages high temperatures in the mid-60s during peak use (similar temperatures exist at the sites of the moldering privies in Vermont; Pete Ketchum 2004').

Some key *advantages* of the moldering privy over the pit privy include:

- Less digging and disruption to the ground and potential buried artifacts
- Less threat to the ground water

- Removal of the end waste product; incinerated off-site as complete or partially composted human waste
- Other moldering units used on the AT have resulted in better, more earthy odors than the pit privies
- Less moving of toilets; utilizes a simple skid process on rotational crib sections
- Building of a new toilet structure is not necessary, as the existing pit toilet structures can be reused

Some *disadvantages* to be considered are:

- Cribs may require replacement every 10 to 15 years
- Heli-sling transport of end product may be necessary every two to three years for incineration after first cycle of composting is complete (anticipate 3-6 years before first harvest)
- More frequent monitoring of the moisture content and aeration of the moldering pile
- Potential for introducing exotic plant seed in mulch, if not selectively chosen or allowed to spill outside of the crib and storage containers.

Larger industrial alternative toilet designs are being researched, such as a commercial evaporative toilet. However, these systems involve substantially higher costs and greater energy input to operate a constant fan ventilation system. Installation of such a system on the Chilkoot Trail may be years away.

Park management recognizes that any alternative toilet design on the Chilkoot Trail will be experimental until the results of the first end product harvest are evaluated. The following work plan describes the moldering privy installation and maintenance procedures in detail.

Work Plan

While the Green Mountain Club staff recommended one moldering privy per 1000 uses, the park decided to install two moldering privies during the evaluation period beginning in May 2005. Though Sheep Camp receives an estimated 3000 uses across a short and intense eight week period, two existing pit toilets are still being used and all four will lay dormant for the majority of the year. Early observations of hiker use seem to suggest a preference toward the moldering privies. This preference may be influenced by the "newness" of the moldering privies and the education about the facility provided through the Trail Center and the Sheep Camp evening program.

<u>Installation</u>

Site Preparation: An area of higher ground (minimum of 4' between surface and ground water table) was identified near the existing north toilet site of the campground and more than 100' from the river. The tri-crib footprints were flagged and vegetation removed. Two 4' x 13'x 4" areas of surface soil were removed to mineral soil. The bottom of the depressions were filled with sand to within 2 inches of the normal ground surface in preparation for the crib placement.

Cribs: Each crib is constructed of 4" x 6" cedar timbers, 7 timbers high (positioned 6" on vertical - See sketch for complete dimension detail). Crib sections were pre-fabricated in Skagway and slung in pieces, into Sheep Camp for final assembly. Cribs were pre-drilled for 5/8"x40" allthread bolt inserts at each section corner using a 1"x 4" block as a pilot hole template. Four 16'x 6"x 6" timbers were used as continues top and bottom beams for increased support and ease of leveling of the cribs. The 6" air spaces between timbers were lined with 1"x1/8" hardware cloth and 1" x 1/2" heavier gauge hardware screen. While darker colored material was sought after to help conceal the crib contents, none was available locally. A dark colored outer screen will be added to the crib structures to help visually conceal the contents.

Toilet: One of the existing toilet structures was placed on the first crib section. The toilet design used was light enough that once placed on top of the cribs, two people could easily slide the structure into place over the crib opening. Remaining open sections were capped with 4'x 6"x 2" decking planks. Each crib was capped with a series of decking planks attached together, so one crib cap could be removed as a unit separately from the others. Deck planks were installed with ½" gaps between each board, so as to allow for aeration and rain water penetration. Cedar steps were constructed and attached last.

Maintenance and Monitoring

Prior to the first use, a layer of bark mulch was spread throughout the bottom of the first crib to be used. This should introduce a healthy crop of microbial organisms to begin the composting process. The bark mulch originated from trees chipped from inside the park in Dyea. Mulch will be stored and collected in areas that are not known to have a high density of exotic plants, so as to reduce the chance for spread of exotic weed species. In addition, mulch will only be collected from the layers above the bottom two inches of the mulch pile. Bark mulch will be stored inside of the gravel bags and efforts will be made to insure mulch is not spilled outside of the crib during transfers from the storage container. A five gallon bucket of bark mulch is kept available to the user just inside the door of the toilet structure. Each user is instructed to deposit one handful of bark mulch into the hole following use.

Ranger staff at Sheep Camp will maintain the toilets on the same daily cleaning schedules as the pit toilets with additional monitoring duties for the composting study. Field rangers and trail staff involved with the maintenance and harvest of the compost will adhere to procedures established for waste disposal (Appendix 1 – Job Hazard Analysis and Safety Plan). During each cleaning visit, the ranger will monitor the level of bark mulch deposited by users and if it appears an inadequate amount of organic matter is in the compost, the ranger will deposit an adequate amount of bark mulch. The bark component should not be so thick so as to inhibit air movement through the pile, nor so thin that odors are a concern or the waste pile becoming compacted. The moisture content will also be visually monitored and adjusted as necessary. If the compost becomes too wet, more dry bark mulch should be added. If the compost becomes too dry, river water should be slowly added to the pile and stirred. Liquids should never be allowed to puddle or drain from the crib openings.

Rangers will record daily and weekly data observations on the data report form (Appendix 2). Each morning rangers will use a temperature probe to record temperatures from within the center of the compost pile and the air temperature within the crib (Appendix 3). Once per shift during camp days, the Sheep Camp Ranger will record morning and mid-afternoon temperatures of the piles. In reference to stirring or raking the pile, the two moldering privies will have separate stirring schedules to determine the most effective rate. The south privy will be turned-over weekly during camp days. The north privy will be turned monthly on or around the 15th of each month during the hiker season. In the off-season the compost pile will lie dormant as temperatures drop below 40 degrees Fahrenheit.

At the end of the season, a healthy covering of wood shavings will be spread across the pile. If acidity level becomes too high or odors cannot be controlled with bark mulch, wood ash from the wood stoves can be mixed into the pile or a light film spread across the top surface. As the crib approaches becoming full (not completely filled), the toilet will be skidded over the next crib and the 1st crib will be capped with the deck planks from the second crib. For the remaining time, until the 1st crib must be harvested to allow its use again, the compost pile will be stirred at the beginning and end of each hiker season. The temperature may continue to be monitored to determine the effectiveness of the composting process.

Education

The park recognizes that education of the hikers and users will be a key element in the success of the moldering composting process. Concise interpretive signs will be developed by NPS interpretive staff and placed inside of each privy. In addition, the moldering process will be explained to hikers at the Trail Center when permits are obtained and again reinforced at the Sheep Camp evening ranger program. Users will be given every opportunity to receive education about not depositing garbage, food or personal sanitary items in the privy that may reduce effectiveness of the composting process or create a bear attraction.

Harvest and Disposal of End Product

The National Park Service policies do not allow human compost to be dispersed inside of National Parks, which is consistent with DO 83 Public Health codes (Appendix 4). The City of Skagway does incinerate human waste sludge on a regular basis in the city incinerator. For a fee, they will accept our compost waste and incinerate it. When the time comes to harvest the compost from the crib, the dry waste will be shoveled into used gravel bags and flown out for disposal. (Note: An advantage of this system over standard fly-out toilet systems is the lack of weight and mess associated with liquid waste removal.)

Upon removal of the end product, the crib will be available for another moldering composting cycle. The toilet will be replaced over the recently emptied crib, while the remaining covered cribs complete their respective moldering cycles.

Appendix 1: Job Hazard Analysis / Safety Plan

Job Hazard Analysis (JHA) **Moldering Privies**		Date: 6/28/2005	**New JHA** / Revised JHA
Park Unit: **KLGO**	Division: **Rangers**	Branch: **Backcountry**	Location: **Sheep Camp**
JOB TITLE: **Trail Ranger**		JHA Number:	Page 1 of 1
Job Performed By: **Field Staff**	Analysis By: **Tim Steidel**	Supervisor: **Reed McCluskey, Chief Ranger**	Approved By: **Jim Coreless, Supt.**

Required Standards and General Notes:	Minimum 100' horizontal separation from water sources and 4' minimum vertical separation. Complete Hepatitus B vaccinations for field staff handling wastes.
Required Personal Protective Equipment:	Rubber gloves; surgical type masks not required, but available. Hearing protection, eye protection, and chaps for use with chainsaws.
Tools and Equipment:	Composting rake with minimum of four foot long handle. Composting Thermometer with 3 meter solid probe. Harvest shovels and gravel bags.

Sequence of Job Steps	Potential Hazards/Injury Sources	Safe Action or Procedure
Construction and Installation	Aircraft accident/emergencies Lifting outhouse onto crib	Adhere to Aviation Safety Plan Use minimum of four persons with proper lifting techniques.
Daily/Weekly Maintenance	Contact with Biological Contaminants	Use proper PPE and tools supplied. Maintain appropriate innoculations Wash hands thoroughly with soap and warm water and/or use waterless hand sanitizers. Rinse contaminated tools into the crib with water and store out of contact with public. Decontaminate w/ bleach water.
Harvest of Final Waste Product	Aircraft accident/emergencies Contact with Biological Contaminants	Adhere to Aviation Safety Plan Use proper PPE and tools supplied. Maintain appropriate innoculations Wash hands thoroughly with soap and warm water and/or use waterless hand sanitizers.
	Skidding of outhouse structure	Use minimum of two persons or mechanical advantage with stabilizers.

Appendix 2: Moldering Privy Daily Compost Monitoring Data Sheet

Moldering Privy Compost Daily Monitoring Data Sheet year 2005

Privy #	**Date** mm/dd/yy	**Time** (24hr)	**Out Air** Temp. *F*	**Crib Temp.** Inside Crib *F*	**Compost Temp.** Center of Pile *C*	**Moisture Content** Too Dry	Too Wet	**Bark Mulch Added** (gal)	**Water added** (y/n)
1*South*									
2*North*									
1*South*									
2*North*									
1*South*									
2*North*									
1*South*									
2*North*									
1*South*									
2*North*									
1*South*									
2*North*									
1*South*									
2*North*									
1*South*									
2*North*									

Air Temperature - Record Air Temperature from Ranger Station Weather Station in Fahrenheit.

Crib Temperature - Temperature of air inside of crib, but above the compost pile in Fahrenheit.

Compost Temperature - Temperature from center of compost pile. Take three samples from different regions of the pile and record avg. temp in Celsius.

Moisture Content - If compost pile appears too wet or internal temperature is < 50 C, add bark mulch. If too dry or internal temp is > 60 C add water.

Bark Mulch - Record amount added by Ranger; number of handfuls or # gallons if 1 gallon or more.

8 Day Shift Summary

	Weekly Compost Temperature AM	PM	Pile Rotated (Y/N)	Avg Daily Air Temp (Fahrenheit)	Avg Daily Compost Temp (Internal Probe - Celsius)	# Gallons Bark Mulch Used
North					0	
South				0	0	

Appendix 3: Composting by Temperature, Excerpt from Alberta Agriculture, Food and Rural Development

What Should Temperatures Be?

The compost temperature increases due to the microbial activity, and the change is noticeable within a few hours of forming a windrow. The temperature usually increases rapidly to 50 to 60°C, and this is the level where the temperature is maintained for several weeks. This period is called the active composting stage. The temperature gradually drops to 40°C as the active composting slows down and the curing stage begins.

Composting essentially takes place within two temperature ranges: 10 to 40°C and higher than 40°C. Temperatures above 40°C are desirable because these higher levels destroy more pathogens, weed seeds and fly larvae in the manure. Composting temperatures of 45 to 65°C, when extended for more than a two-week period, are able to kill pathogens and destroy the viability of weed seeds.

Table 1. Temperature indicates stage in composting process

Temperature	Indicates	Action
50 - 60°C	Active stage	Monitor temperature
> 60°C	1. Low to moderate moisture 2. Microorganisms are working hard and generating damaging heat	Add moisture and turn windrow Turn to accelerate heat loss
< 50°C	1. Insufficient oxygen/aeration 2. High moisture content	Turn to increase oxygen Add dry material
~ 40°C with no response from above actions	Material is entering the curing stage	Monitor temperature

What is Temperature Telling Me?

Temperature is a very good indicator of the process occurring within the composting material (Table 1). Temperatures can exceed 65°C, but many micro-organisms begin to die, which stops the active composting stage.

Heat loss occurs primarily because of water evaporation from the pile. Allowing the moisture content to fall too low will increases the chance of reaching the damaging high temperatures.

During the active composting stage, the temperature should be monitored daily. A sustained drop in temperature indicates the end of the active composting stage. The failure of a cooled compost windrow to reheat after turning indicates that decomposition has slowed enough for the compost to be cured.

How do I Measure Temperature?

It is important to measure the temperature as close to the centre of the composting material as possible. Typically, a thermometer with a 1 m long probe is sufficient to achieve this goal (Figure 1). The temperature can vary within the material, so it is important to measure the temperature in a variety of locations.

Figure 1. Probe to measure compost temperature (Fahrenheit).

Where Can I Find These and How Much Do They Cost?

Buyers should research their needs and the products available before making a purchase. Providing possible supplier names and product descriptions below does not constitute an endorsement of any kind by Alberta Agriculture (Table 2).

Table 2. Probes for compost temperature monitoring				
Supplier	**Instrument**	**Probe Length**	**Readout**	**Approx. cost**
Wika Instruments 3103 Parsons Road Edmonton, Alberta (780) 463-7035	Bimetal temperature probe	12 - 36 inches	3 inch dial	$100 CDN
ReoTemp 10656 Roselle Street San Diego, CA 1-800-648-7737	Bimetal temperature probe	24 - 72 inches	3 - 5 inch dial	$100 - 250 US
	Handheld digital thermometer	Purchase separate		$150 - 280 US
	Thermocouple probe	36 - 60 inches	Needs digital display	$200 - 270 US
	Solar digital compost thermometer	24 - 72 inches		$180 US
Omega Engineering Inc. 1 Omega Drive Stamford, CT 1-800-848-4286	Stainless steel probe	12 - 72 inches	3 inch dial	$100 - 200 US
CE Franklin 5305 - 64 Avenue Taber, Alberta (403) 223-1111	Stainless steel probe	36 inches	5 inch dial	$155 CDN

To order a copy of the *Manure Composting Manual*, Agdex 400/27-1, contact:
Alberta Agriculture, Food and Rural Development
Publications Office
Telephone: toll-free 1-800-292-5697

For more information, contact:
Virginia Nelson, M.Sc., EIT
AgTech Centre, Lethbridge
Telephone: (403) 329-1212
Fax: (403) 328-5562

Appendix 4: Approved NPS Compliance Stipulations

1. Implementation of the project follows the project proposal described above, with the following additions as requested by compliance reviewers. Final siting was determined cooperatively between maintenance and archaeological staff.

   a. Installation: Three layers of barrier cloth and aluminum screening were installed on the insides of the crib sections to discourage rodents.

   b. Site Preparation: Within Sheep Camp areas that provide for a minimum of 4 feet between ground surface and the water table at it's highest elevation. An approximate 3 x 14 foot area was excavated down approximately 4 inches to reach mineral soil. Crib sections were positioned over the depression with separation between the crib sections (approx 10") to provide for air flow. The top and bottom timbers were positioned spanning the air gaps for final connection of the crib section units. The interior of the crib base was covered with a generous layer of organic material and bark mulch.

   c. Toilet: Two of the existing toilet structures not currently being used were placed on the first crib sections of each crib structure. Empty crib sections were capped with 2" x 6" planks fastened together with ½' gaps as a unit of each crib cap. This will expedite cap removal and replacement.

   d. Storage Bin: An appropriate, waterproof, storage bin will be provided for the bulking agent (bark mulch) for on-site storage. Five gallon buckets were placed in each outhouse for storing public use quantities of mulch.

   e. Trash: Separate trash cans were not made available within the toilet structures, in keeping with the park's pack-it-in, pack-it-out policy.

   f. Maintenance: Rangers will perform daily maintenance visits as previously performed with the pit toilets. Visitors will regulate the bark mulch deposits on an as used basis (one handful per use). Bark mulch will be collected from recently shredded trees and branches and care will be exercised to not intermingled bark mulch with soil nor subject it to likely contamination from exotic plant seed. For the purposes of the study, one privy compost pile will be turned weekly and the other monthly to determine the most feasible and effective turning schedule. Internal compost temperatures will be collected and recorded using a one meter composting temperature probe. Moisture will be monitored by visual assessment and temperature analysis (appendix 3). Acidity will be monitored by monitoring gas and odor emissions. If the compost becomes "sour", wood ash and additional organic matter will be added to raise the ph of the compost.

g. Visitor Education: Temporary instructional signs were placed inside of each privy following installation. More interpretive and graphically designed exhibits will be developed and placed in the privies this season.

h. A job hazard analysis and safety plan was prepared for staff handling human waste (Appendix 1). Staff are required to follow all appropriate health safeguards required for the handling of human wastes. Rangers are currently getting their series of Hepatitis B immunizations and are current with tetanus immunizations.

i. Harvest and Disposal: Final harvest of composted human waste will be transferred to a watertight container, suitable for external sling transport by helicopter to Skagway, and disposed in the City incinerator in accordance with DO 83 Public Health as follows:

  - All waste shall be disposed of in a manner consistent with park policy and all applicable health and environmental regulations.

  - In environmentally sensitive areas such as river corridors, human feces and other solid waste shall be transported to an approved offsite disposal facility unless fixed facilities, which conform, to all applicable rules and regulations are available onsite.

  - Urine may be disposed of onsite unless prohibited by law.

  - Solid waste should not be burned unless such burning is in compliance with all applicable rules and regulations.

2. The project is considered a pilot project for the NPS in Alaska. Ranger staff will keep appropriate records of the composting toilet in order to allow an evaluation of its function in the KLGO climate. Identifying the appropriate elements to record should be coordinated with the ARO waste management staff and/or the NPS Public Health Service staff. Some appropriate elements include: Date, minimum and maximum temperatures, precipitation, humidity and routine additions of shavings and stirrings, acidity levels of the composted pile, and so forth.

3. Protection staff shall be responsible for developing the Maintenance Plan and will perform daily maintenance, monitoring, and scheduled stirrings of the waste. Protection staff shall maintain records of immunization for staff handling human wastes.

AB Accessibility Requirements as of 2013

Following Pages

Pit Toilets in General Forest Areas

Generally, pit toilets are located in remote, undeveloped areas. They are provided primarily for resource protection, rather than for visitor convenience and comfort. Pit toilets are primitive outhouses that may consist simply of a hole dug in the ground covered by a toilet riser (figure 84). The pit toilet riser may or may not be surrounded by walls and may or may not have a roof. Pit toilets may be permanent installations or they may be moved from one location to another as the hole is filled or the area has become overused. Waste disposal in pit toilets may be directly into the ground (pit) or may include moldering or composting processes.

Figure 84—A fiberglass riser for a pit toilet in the Boundary Waters Canoe Area.

Designers should not confuse pit toilets provided in general forest areas (GFAs) with toilets provided in recreation sites. Pit toilets are **only** provided in general forest areas and are NEVER appropriate in a recreation site with a Forest Service recreation site development level of 3 or higher.

DESIGN TIP—It's Not a Pit Toilet if It's Not in a General Forest Area

Vault toilets, flush toilets, and composting toilets are all common in recreation sites. They are not considered pit toilets and they must meet the ABAAS requirements for toilet buildings. Regardless of the waste disposal system or design of the building, toilet buildings that aren't in GFAs and that have one riser must comply with section 603 of the ABAAS requirements for toilet and bathing rooms. Toilet buildings that aren't in GFAs and that have multiple risers must comply with the requirements of section 604 of the ABAAS. Designers should be careful not to confuse the requirements for toilet stalls with those for single riser toilet rooms. Each toilet building in a

recreation site also must comply with the requirements for grab bars, controls, and dispensers.

If pit toilets are provided in GFAs, each one must meet the requirements described below. Pit toilets in GFAs don't have to be connected to ORARs.

The design of pit toilets varies widely depending on the setting, the amount of expected use, and the system used to manage the waste. If an accessible pit toilet has walls, a floor, a door, or a roof, these components must comply with the appropriate provisions of the ABAAS. If the pit toilet has a riser and toilet seat, the total height of that seat and the riser it rests on must be 17 to 19 inches (430 to 485 millimeters) above the ground or floor.

If there are sturdy walls around the pit toilet riser, standard riser dimensions, placement, and grab bars are required as shown in ABAAS sections 603, 604, and 609. Grab bar size, strength, finish, and position requirements are explained in Grab Bars. Grab bar location requirements for pit toilets are explained below.

Grab bars must comply with the reach ranges required in ABAAS section 308 and explained in Reach Ranges and Operability Requirements. As required in ABAAS section 604.5, grab bars for toilets must be installed in a horizontal position, 33 to 36 inches (840 to 915 millimeters) above the finished floor, measured to the top of the gripping surface.

The grab bar beside the riser must be at least 42 inches (1,065 millimeters) long, located no more than 12 inches (305 millimeters) from the wall behind the toilet, and extend at least 54 inches (1,370 millimeters) from the rear wall. The grab bar behind the riser must be at least 36 inches (915 millimeters) long and extend from the centerline of the water closet at least 12 inches (305 millimeters) on the side closest to the side wall grab bar and at least 24 inches (610 millimeters) on the other side (figure 85).

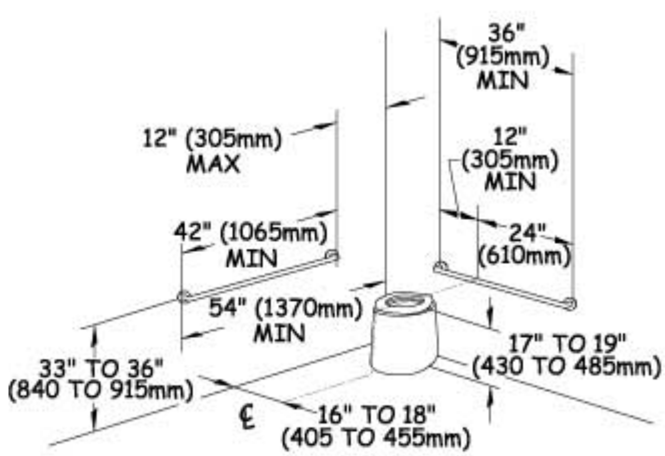

Figure 85—The requirements for grab bars in pit toilets.

For pit toilets enclosed by walls, the back of the riser must be against the wall behind the riser. A clear floor space that is at least 60 inches (1,525 millimeters) wide and 56 inches (1,420 millimeters) deep is required around the toilet. If there is a condition for departure, the space can be reduced to 56 by 48 inches (1,420 by 1,220 millimeters).

Of the required width of clear floor space, only 16 to 18 inches (405 to 455 millimeters) can be on one side of the centerline of the riser, and the rest must be on the other side. Turning space of at least 60 inches (1,525 millimeters) in diameter or "T" shaped with a minimum 60- by 36-inch (1,525- by 915-millimeter) "arm" and a minimum 36-inch- (915-millimeter-) wide by 24-inch- (610-millimeter-) long "base" is also required. Portions of the turning space may overlap the toilet clear floor space or be located directly outside the entrance (figure 86).

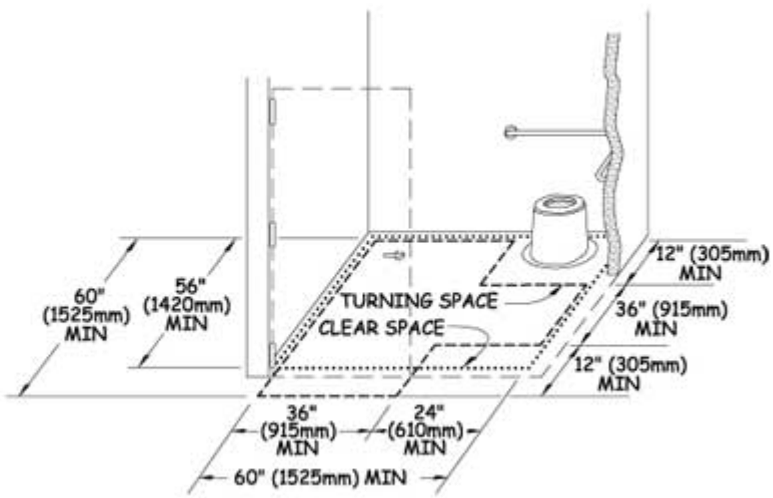

Figure 86—The requirements for a "T" turning space in a pit toilet.

If walls are provided, doorways or wall openings that provide entrance to the toilet must have a minimum clear width of 32 inches (815 millimeters), in compliance with ABAAS section 404.2.3. Door swings can't obstruct the clear floor space inside the pit toilet. Doors that open out or slide are space-efficient ways to provide the required interior clear space. Door hardware such as handles, pulls, latches, and locks must comply with the provisions for reach ranges and operability specified in ABAAS sections 308 and 309 and explained in Reach Ranges and Operability Requirements.

If the pit toilet has lightweight privacy screens or has no walls, the riser should have vertical or nearly vertical sides, a flat area on each side of the seat that is about 3 inches (75 millimeters) wide, and a seat cover that also functions as a back rest. For safety, grab bars must not be mounted on lightweight privacy screens that won't support 250 pounds (1,112 newtons). A clear floor or ground space that is at least 60 inches (1,525 millimeters) wide and 56 inches (1,420 millimeters) deep is required.

Of the required width of clear floor space, only 16 to 18 inches (405 to 455 millimeters) can be on one side of the centerline of the riser, and the rest must be on the other side. The depth of the clear space is measured from the back of the riser and extends in front of the riser (figure 87). If there is a condition for departure, the space can be reduced to 56 by 48 inches (1,420 by 1,220 millimeters).

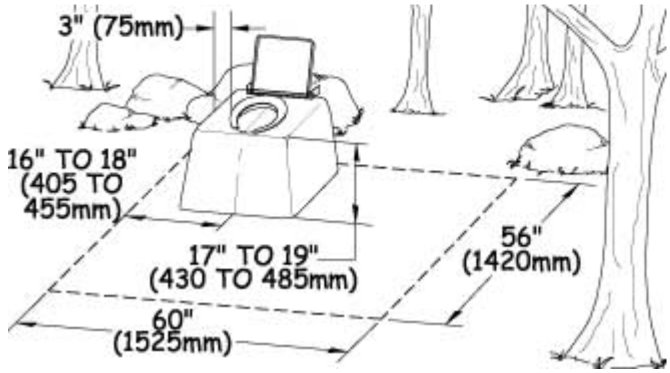

Figure 87—The requirements for clear space at an unenclosed toilet.

CONSTRUCTION TIP—Privacy Screens

Lightweight privacy screens are sometimes provided for pit toilets in remote general forest areas. Screens may be provided in areas that have heavy visitor use but where walls or sturdier enclosures would significantly change the recreational setting or adversely impact significant natural features, or where it is difficult and expensive to pack in conventional construction materials. These screens may be made from tent fabric or other thin materials, and have only enough structural strength to stay upright.

Because privacy screens don't have enough strength to support a 250-pound (1,112-newton) load on grab bars, grab bars should never be attached to them. Imagine the consequences if a screen and the grab bar attached to it fell over when a person tried to use it to transfer to a toilet! Instead of attaching grab bars to screens, the screens should be positioned outside the clear area required for unenclosed toilets, so people can use the toilet without needing grab bars.

Whether the pit toilet has walls or not, the slope of the turning space and the clear floor or ground space generally can't exceed 1:50 (2 percent) in any direction. The slope can be up to 1:33 (3 percent) in any direction where required for proper drainage. The surface must be firm and stable and made from a material that is appropriate to the setting and level of development. Slope or surface requirements don't have to be met where a condition for departure exists.

The entrance to each pit toilet should be located at ground level. If this isn't feasible, because of the toilet's operation and maintenance requirements, a trail complying with Forest Service Trail Accessibility Guidelines (FSTAG) section 7.3 must be provided between the ground and toilet entrance. FSTAG section 7.0 explains the requirements for trails to "associated constructed features" such as pit toilets. If the pit toilet must be located above the ground and a trail isn't feasible because of a condition for departure, steps are permitted—but only as a last resort.

Composting and moldering toilets have a "basement" area where waste is processed. The need to service the area under the riser may make it difficult to provide a ground level entrance to the toilet. In other areas, surface bedrock, permafrost, or other ground conditions make it tough to dig a pit. Table 3 will help designers avoid steps at toilet entries and may trigger other creative ideas for accessible entries.

The need for steps may be eliminated altogether if enough time is spent on site selection. For instance, a sloping site may allow the maintenance "basement" to be accessed from the downhill side, while providing a ground-level entrance to the toilet on the uphill side (figure 88).

Figure 88—The two accesses to an uphill-downhill composting toilet.

Table 3—Pit toilet entry decision aid.
Text version of table

Are steps needed for this pit toilet?	Is maintenance access to a waste processing area below the riser needed? Is digging a pit into the ground impractical?	No →	Provide ground-level entrance.
	Yes ↓		
	Have all options for a ground-level entrance been exhausted?	No →	Look at the site again. Is excavation, placement of the building on a slope, or addition of fill material at the entrance feasible to allow a ground-level entrance?
	Yes ↓		
	As an **absolute** last resort, provide steps in accordance with FSORAG section 6.6.9.		

DESIGN TIP—Toilet Steps Should Be a Design Solution of Last Resort

If steps are used, keep in mind that a person using a wheelchair will have to get out of the wheelchair and transfer up the steps onto the pit toilet floor. Since pit toilet floors are seldom cleaned regularly, it is easy to imagine how dirty and disgusting this would be. Avoid steps if at all possible! Think about it—would you want to make that trip?

If steps can't be avoided, they must meet specific requirements that aren't the same as standard building code requirements. The treads must be at least 14 inches (355 millimeters) deep and 36 inches (915 millimeters) wide and no more than 9 inches (230 millimeters) high.

Practically speaking, the deeper the tread, the shallower the rise should be for comfortable use. With a 14-inch (355-millimeter) tread, a 6-inch (150-millimeter) riser is preferable, even though up to 9 inches (230 millimeters) is allowed. A level, clear ground space that is 30 by 48 inches (760 by 1,220 millimeters) must be provided along one unobstructed side of the steps.

One of the steps must be 17 to 19 inches (430 to 485 millimeters) above the clear ground space so that a person in a wheelchair can transfer onto it. Single steps are hazards that should be avoided; at least two steps, but preferably three, should be used. Although it's not mentioned in the FSORAG, be sure that a door swing doesn't block access from the step someone uses when transferring from a wheelchair.

Access Board Issues Final Guidelines
For Federal Outdoor Recreation Sites

Issue: On September 26, 2013, the U.S. Access Board has issued new accessibility guidelines for national parks and other outdoor areas developed by the federal government. These guidelines address access to trails, picnic and camping areas, viewing areas, beach access routes and other components of outdoor developed areas on federal sites when newly built or altered. They also provide exceptions for situations where terrain and other factors make compliance impracticable. The requirements become mandatory on November 25, 2013 as part of the Architectural Barriers Act Accessibility Standards (ABAAS), which apply to facilities that are built, altered, or leased with federal funds. The final rule also applies to nonfederal entities that construct or alter recreation facilities on federal land on behalf of the federal agencies pursuant to a concession contract, partnership agreement, or similar arrangement.

The Access Board's news release goes on: "The Board is eager to release these guidelines, which were long in the making, to explain how access to the great outdoors can be achieved," states Access Board Chair Karen L. Braitmayer, FAIA. "The greatest challenge in developing these guidelines was balancing what's needed for accessibility against what's possible in natural environments with limited development."

The Forest Service Outdoor Recreation Accessibility Guidelines (FSORAG) and the Forest Service Trail Accessibility Guidelines (FSTAG) are the legally enforceable standards for use on the National Forest System for the facilities and features addressed in those guidelines. They have been updated to incorporate the ABAAS developed by the Access Board. They also ensure the application of equivalent or higher guidelines, in order to comply with other existing Forest Service policies, including universal design, as well as agency terminology and processes.

Background: Thanks to leadership from ATC staff and federal partners, especially the Forest Service's National Accessibility Program Manager Janet Zeller, the ATC and Trail-maintaining clubs have long been made aware of and have been invited to become involved with understanding and participating with our governmental partners to improve long-standing federal direction in the Architectural Barriers Act, as well as the Americans with Disabilities Act. We have come to learn that these and related laws represent broad societal aspirations to achieve civil rights associated with improving access, participation and fairness for all our citizens. With respect to the ABAAS, access for people with disabilities will be improved in our national parks and forests.

The final Outdoor Developed Areas Accessibility Guidelines (ODAAG) originate from recommendations prepared by an advisory panel chartered by the Access Board— the Outdoor Developed Areas Regulatory Negotiation Committee (1997–1999). The Committee consisted of 27 members with representatives from parks and outdoor recreation associations, disability groups, state and federal land management agencies, and other affected interests. ATC had two representatives on the Committee: then Executive Director Dave Startzell and Peter Jensen, principal of Peter S. Jensen and Associates. The draft guidelines were made available for public comment twice and finalized according to the feedback received, including reviews by ATC. The new rule applies only to national parks and other federal sites, but the Board plans to follow up with rulemaking to address nonfederal sites (*e.g.,* state and local entities) under the Americans with Disabilities Act (ADA) at a later date.

Considerations for ANST:
ATC History: The ATC adopted a resolution in November 1995 that supports the concept of accessibility within the ANST "provided that modifications are not made that would detract from the primitive recreational environment and experience." The ATC *Local Management Planning Guide* (*LMPG*, Revised

April 2009) reference document for Trail clubs highlights accessibility as a "permanent part of the list of design considerations for trails and facilities." [*LMPG*, Chapter 2(B)]. In 2007, the ATC published a manual titled *Increasing Opportunities for Access on the Appalachian Trail: A Design Guide* to aid Trail clubs and agencies with universal access considerations. A comprehensive baseline accessibility assessment of shelter sites along the length of the A.T. was conducted in 2006. In response to increasing demand for accessible Trail segments, ATC Trail clubs have modified short sections of the A.T. in New York, Connecticut, Vermont, and Tennessee. There is also a continuing effort by NPS-APPA and ATC-HQ to identify additional segments of Trail which are currently or may be easily modified to be accessible. The GATC is collaborating on an initiative with the Centers for Disease Control (Atlanta office) to determine whether accessible trails can be recommended as an implementation strategy in a forthcoming Surgeon General's "Call-to-Action on Walking."

With the federal government shutdown, ATC has not had any opportunities dialog with the NPS, USFS or the Access Board about the new rule.

Selected Highlights:

- Reference ABA Chapter 2 and ODAAG Chapters 1011–1019 (follow links above) for relevant information about scoping and technical requirements, plus definitions of pertinent constructed features, including trails, found within the ANST. **NOTE:** FSTAG and FSORAG meet or exceed these requirements and, therefore, are enforceable on National Forest lands. It is unknown at this time if and to what extent NPS may modify ODAAG.

- ODAAG allows exceptions to the Rule if certain conditions are evident (Chapter 1019). These will be of especial interest to ATC and Trail clubs when managing the ANST. Departures are allowed where compliance is not practicable because of terrain or prevailing construction practices, compliance would conflict with other federal, state, and local laws (*e.g.,* Endangered Species Act), or compliance would fundamentally alter the function or purpose of the facility or the setting. (Determining "exceptions" based on perceptions of and biases about disability is discriminatory and is not allowed.)

- Documentation is required where a condition for exception prohibits full compliance with a specific technical requirement, per Section F201.4.1. The documentation must include the reason that full compliance could not be achieved and must be retained with the project records. In addition to the reason for the exception, documentation can include the date the decision was made and the names and positions of the individuals making the decision. A form is provided to address trail and beach access when a **FULL exception** is considered. The form is available on the Access Board website and must be submitted to them for review.

- Where new trail information signs are provided at trailheads on newly constructed or altered trails designed for use by hikers or pedestrians, the signs shall comply with 1017.10. Trailhead signage shall include the following information: length of the trail or trail segment; surface type; typical and minimum tread width; typical and maximum running slope; and typical and maximum cross slope. Implication: There will need to be some methodology [*e.g.,* Universal Trail Assessment Process (UTAP)] for determining this information.
- As before, routine and periodic maintenance and repair of facilities and features aren't bound by the guidelines. The guidelines only apply to NEW and ALTERED outdoor developed areas.

- In the FSORAG, it was noted that: "(w)here existing individual site furnishings are altered or replaced, the floor or ground surface under or around them is not required to be altered solely because an

> accessible furnishing has been placed in that site...until the surface and slope alteration is the focus of work in that site." (FSORAG Technical Provision 1.0 Application)

“Site furnishings" aren't defined, but probably refer to picnic tables, benches, fire rings, and the like. Staff would like to clarify what this means with respect to replacement of such furnishings on the ANST (within National Forest Lands, at least). For example, could a table be replaced with an accessible one without ensuring a 30" x 48" clear, level, landing area UNLESS part of the work involved altering the ground on which the table will sit.

ADVISORY: There may be inaccuracies presented here. Contact the appropriate federal agency accessibility program manager/representative if questions remain about specific interpretation and application of the ODAAG within the ANST.

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This ATC report has been prepared from a news release from the Architectural and Transportation Barriers Compliance Board, otherwise known as the Access Board, an independent federal agency. For more info about the Architectural Barriers Act (ABA): www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-aba-standards.

The Federal Register published this new rule on September 26, 2012. See: http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-22876.pdf.

American Trail’s webpage may be the best in providing an overview of these changes: http://www.americantrails.org/resources/accessible/access-board-guidelines.html

AC USFS Job Hazard Analysis for Backcountry Sanitation

Following Pages

FS-6700-7 (11/99)

U.S. Department of Agriculture Forest Service	1. WORK PROJECT/ACTIVITY Handling raw sewage at remote privies	2. LOCATION Green Mountain and Finger Lakes National Forests	3. UNIT All
JOB HAZARD ANALYSIS (JHA) References-FSH 6709.11 and -12 (Instructions on Reverse)	4. NAME OF ANALYST Fred Putnam, Jr. Dick Trono, R.N.	5. JOB TITLE Safety and Occupational Health Specialist Occupational Health Coordinator	6. DATE PREPARED July 17, 2008

7. TASKS/PROCEDURES **(List them in the order they will occur)**	8. HAZARDS **What will happen and to whom under what circumstances?**	9. ABATEMENT ACTIONS Engineering Controls * Substitution * Administrative Controls (state if you considered these) Training * PPE **Be specific – who needs to do what?**
Provide training	Lack of training/orientation leads to personal injury	• Project/activity supervisor shall ensure that all workers involved in handling human wastes are trained/oriented on the hazards and abatement actions outlined below. • Project/activity supervisor shall ensure that all workers be alert to and communicate unanticipated hazards not listed below. • Repeat training whenever a new employee or volunteer begins this type of work or when site conditions or work processes change.
Carrying buckets of human wastes or changing composting bins and disposing of composted waste in moldering privys	Disease can be transmitted to you if you are exposed to human feces, urine, blood, and body fluids or come in contact with contaminates when removing PPE after handling wastes, changing bins, or disposing of composted waste.	Prior to starting this job: • Receive bloodborne pathogen training: follow recommendations of medical professionals • Obtain full series of Hepatitis A+B vaccine • Obtain tetanus immunization To handle wastes or compost: • Ensure that all exposed skin is covered and protected • Wear rubber gloves at least elbow length. • Wear disposable surgical gloves inside the rubber gloves. • Wear face shield to protect eyes from possibility of splattering waste • Hold waste buckets five- six inches above leaching pit to avoid spillage and splash from the buckets. • If maintaining a composting toilet and if there is dry and dusty particulate matter associated with the contents of the composting bins, wet it down

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		slightly to eliminate airborne particles that could be inhaled. • After use, wrap the buckets in large trash bags for transport back to vehicles. • Wrap hand tools “contaminated” in the transfer of compost in trash bags for transport. • Rinse tools used for cleaning in a bleach solution as specified below. Follow these procedures to remove PPE and clean equipment: 1. At the vehicles, rinse buckets and hand tools in a solution of bleach mixed a ratio of one part bleach to four parts water. Transport water to the site (or the place where your vehicle(s) will be parked in portable water containers. 2. Use a brush, such as a toilet cleaning brush to clean the waste residue from the buckets while cleaning them with the bleach solution. 3. After cleaning equipment, dip outer gloves while still on into bleach solution. Be careful to peel off gloves inside-out, touching only the inside of the gloves. Drop gloves inside bleach solution. 4. Remove eye/face protection and rinse in bleach solution. 5. Remove surgical gloves inside outer gloves. Dispose of in dumpster. 6. Remove all items from bleach solution and hang to dry. 7. Use waterless hand wash i.e. Purell hand sanitizer and wash thoroughly upon return to office.

FS-6700-7 (11/99)

U.S. Department of Agriculture Forest Service	1. WORK PROJECT/ACTIVITY Handling raw sewage at remote privies	2. LOCATION Green Mountain and Finger Lakes National Forests	3. UNIT All
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7. TASKS/PROCEDURES **(List them in the order they will occur)**	8. HAZARDS **What will happen and to whom under what circumstances?**	9. ABATEMENT ACTIONS Engineering Controls * Substitution * Administrative Controls (state if you considered these) Training * PPE **Be specific – who needs to do what?**
Emergency response	Lack of emergency response plan causes delays in obtaining emergency medical treatment	• Provide the following information in this JHA, document on your tailgate safety meeting form, and share with all project participants: 1. Means of communication (radio, cell, satellite) 2. Primary contacts (rescue squad, F.S. dispatcher, relay person) 3. Travel routes for emergency responders 4. Location of closest medical facilities 5. How to contact them (phone #s)

REVIEWED BY SAFETY OFFICER	TITLE	DATE
	Safety and Occupational Health Specialist	
10. LINE OFFICER SIGNATURE	11. TITLE	12. DATE

Previous edition is obsolete (over)

JHA Instructions (References-FSH 6709.11 and .12)

The JHA shall identify the location of the work project or activity, the name of employee(s) involved in the process, the date(s) of acknowledgment, and the name of the appropriate line officer approving the JHA. The line officer acknowledges that employees have read and understand the contents, have received the required training, and are qualified to perform the work project or activity.

Blocks 1, 2, 3, 4, 5, and 6: Self-explanatory.

Block 7: Identify all tasks and procedures associated with the work project or activity that have potential to cause injury or illness to personnel and damage to property or material. Include emergency evacuation procedures (EEP).

Block 8: Identify all known or suspect hazards associated with each respective task/procedure listed in block 7. For example:

a. Research past accidents/incidents.

b. Research the Health and Safety Code, FSH 6709.11 or other appropriate literature.

c. Discuss the work project/activity with participants.

d. Observe the work project/activity.

e. A combination of the above.

Block 9: Identify appropriate actions to reduce or eliminate the hazards identified in block 8. Abatement measures listed below are in the order of the preferred abatement method:

a. Engineering Controls (the most desirable method of abatement). For example, ergonomically designed tools, equipment, and furniture.

b. Substitution. For example, switching to high flash point, non-toxic solvents.

c. Administrative Controls. For example, limiting exposure by reducing the work schedule; establishing appropriate procedures and practices.

d. PPE (least desirable method of abatement). For example, using hearing protection when working with or close to portable machines (chain saws, rock drills, and portable water pumps).

e. A combination of the above.

Block 10: The JHA must be reviewed and approved by a line officer. Attach a copy of the JHA as justification for purchase orders when procuring PPE.

Blocks 11 and 12: Self-explanatory.

Emergency Evacuation Instructions (Reference FSH 6709.11)

Work supervisors and crew members are responsible for developing and discussing field emergency evacuation procedures (EEP) and alternatives in the event a person(s) becomes seriously ill or injured at the worksite.

Be prepared to provide the following information:

a. Nature of the accident or injury (avoid using victim's name).
b. Type of assistance needed, if any (ground, air, or water evacuation).
c. Location of accident or injury, best access route into the worksite (road name/number), identifiable ground/air landmarks.
d. Radio frequencies.
e. Contact person.
f. Local hazards to ground vehicles or aviation.
g. Weather conditions (wind speed & direction, visibility, temperature).
h. Topography.
i. Number of individuals to be transported.
j. Estimated weight of individuals for air/water evacuation.

The items listed above serve only as guidelines for the development of emergency evacuation procedures.

JHA and Emergency Evacuation Procedures Acknowledgment

We, the undersigned work leader and crew members, acknowledge participation in the development of this JHA (as applicable) and accompanying emergency evacuation procedures. We have thoroughly discussed and understand the provisions of each of these documents:

SIGNATURE	DATE	SIGNATURE	DATE

SIGNATURE DATE		SIGNATURE DATE		SIGNATURE DATE		SIGNATURE DATE	

AD National Park Service Report on Human Waste Management

Following Pages

Abstract Title:

A Descriptive Study of Human Waste Collection and Disposal Alternatives Used in the National Park Service (NPS) Backcountry

The National Park Service hosts nearly 300 million visitors to the National Parks each year. Human waste is easily processed and treated where there is power, water, and plumbing, however the more then 2,000,000 annual visitors to the National Park Service (NPS) backcountry campers are entering pristine areas where it is not always feasible or desirable to construction flush toilet systems. The Mission of the NPS is to preserve "…unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. Based on this mission removing waste and a "leave no trace" policy is essential in backcountry settings. Siting and maintaining these "backcountry" wastewater disposal systems is complex, expensive and sometimes physically challenging. Typically the only alternative is to create a collection site where the human waste must be physically removed and transported by backpackers, horse, or helicopters during and after the visitor season has ended. Each site is evaluated for impact to the environment and feasibility of removal.

Human feces can pose a problem not just from a public health perspective, but will also introduce unnatural nutrients into the environment if not contained/removed. To monitor these activities and provide public health consultative services the USPHS entered into a Memorandum of Agreement in November of 1955 with the Department of the Interior. This has allowed the NPS to provide routine monitoring and oversight of wastewater collection and disposal within the National Parks.

The methods by which the National Parks treat the backcountry human waste ranges from cat holes, pit privy, carry out (bagged waste packed out) or more complex system such as composting toilets, dehydration or evaporative toilets, septic tanks, centralized collection sites (river trips), and treatment plants. Waste from these treatment/collection sites are routinely (monthly or annually) removed and transported back to an approved wastewater treatment facility. The amount of waste removed is based on several factors.

In the remote locations where waste is removed, the reduction of weight is essential to the successful operation of these systems. The reduction of weight will allow for less frequent transportation and reduced labor costs. Design of the facility must be compact and durable for installation. The design of the facility must also take into account worker protection during the waste removal and transport operation such as no confined spaces. Methods to reduce weight typically involve separation, dehydration, or evaporation. Solar energy is used to either heat the container or via photovoltaic power operate a fan that pulls in air to remove the moisture and reduce the weight.

Parks have spent much money, time and effort, installing and maintaining these systems so that backcountry visitors and the parks natural environment are protected. This is part of the mission of the Park Service and the USPHS to prevent disease transmission and provide an unimpaired natural and cultural resource.

Author

CDR John Leffel, REHS, MPH
USPHS Environmental Health Officer
Regional Public Health Consultant
National Park Service

Introduction

The National Park Service (NPS) hosts nearly 300 million visitors to the 384 National Parks each year. One of the popular activities while visiting the National Parks is hiking and camping in the more remote areas. These remote areas are typically several miles from modern conveniences such as flush toilets and treated drinking water. Human waste is easily processed and treated where there is power, potable water source, and permanent structures, however in the backcountry it may not be feasible or desirable to construction traditional sewerage systems. Public sewers and treatment plants are not necessarily the indicated or universal solution for all situations. Their construction, operation, maintenance, and repair costs can be prohibitive or impractical.[1] The mission of the National Park Service is "...to promote and regulate the use of the...national parks...which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." [2]

The National Park Service (NPS), located in the Department of the Interior is responsible for sites including National Parks, National Monuments, National Preserves, National Historic Sites, National Historical Parks, National Memorials, National Battlefields, National Cemeteries, National Recreation Areas, National Seashores, National Lakeshores, National Rivers, National Parkways, and National Trails.

- In 2002, the total combined area of all the NPS sites was greater than 84 million acres – only slightly smaller than the state of Montana.[3]
- Visitation records indicated that over a 11-year period there have been 3,035,411,765 **recreational visitors** to the NP of that 22,970,740 were **backcountry campers** for an annual backcountry visitation average of 2,088,249 (see attachment 1 & 2). In 2003 there were 1,816,088 backcountry campers in the National Parks.[4]

To manage this huge resource, the NPS developed a unique system called the "Directives System" which are detailed written guidance manuals to help managers make day-to-day decisions. The Directives System consists of Director's Orders, Handbooks and Reference Manuals, in addition to Management Policies. There are three (3) levels of guidance documents in the directives system:

- Level 1, Management Policies, and Level 2, "Director's Orders," are specific to the NPS and are issued under the Director's signature.
- Level 3 consists of all other professional material (e.g., handbooks, and reference manuals) to assist employees in performing their duties. These materials often include procedural details Director's Orders, and are named and numbered to correspond with the appropriate Director's Orders (currently numbered 1-94).[5]

Public Health Program

In order to implement these policies particularly in the area of public health the NPS sought the services of the US Public Health Service (USPHS). The NPS and USPHS entered into a Memorandum of Agreement (MOA) in November of 1955 with the Department of the Interior. This has allowed the NPS to provide public health consultative services to the National Parks regarding specific aspects of public health. Prior to the MOA, there were earlier accounts of USPHS Commissioned Corps officers assisting the NPS as far back as 1918. The first documented work is a copy of a hand written journal by a USPHS officer who traveled to Yellowstone in 1918 to conduct a survey of drinking water sources.[6] The location of the regional consultants is based in large part, on the requirements as set forth in the current interagency agreement between the NPS and the Division of Commissioned Personnel (DCP) of the USPHS. The core program covers drinking water, wastewater, food safety, recreational water (bathing beaches, spas, and hot tubs), illness and disease, and backcountry operations.

Ten USPHS officers are detailed to the NPS public health program. The officers are located in Washington D.C., the Northeast Region, National Capital Region, Southeast Region, Midwest Region, Inter-Mountain West Region, Pacific West and Alaska Region, and 2 field offices. The NPS also has permanent and seasonal "Park Sanitarians" that cover one or two of the larger National Parks. There are also USPHS officers in the NPS that are detailed to individual parks or regions that assist with engineering, hazardous waste, concessions, and risk management activities. Each of the public health program USPHS officers covers several states and travels extensively. Once a site is visited a report is written for the Park Superintendent identifying public health concerns and offering recommendations. In the case of backcountry operations the officers travel and inspect these systems as time and travel permits. Once the Park receives the report and or is informed of a public health concern a project proposal may be developed or the condition may be corrected with park resources. Depending upon individual Park funding, many necessary project proposal are developed and electronically entered into a project management information system and competes for funding with other projects.

Backcountry Operations and NPS Requirements

Operations

Due to the nature of the term "backcountry" these sites are difficult or have some uniqueness that makes traveling via the family car impossible. The NPS defines the Backcountry as "one or more primitive or wilderness areas which are reached primarily by hiking, boating, or horseback."[7] Visitors typically travel in the NPS backcountry via foot (snowshoes, cross country skiing, mountaineering), bicycle, water craft (white water rafting), mule, and horseback. Whenever there is human access into the backcountry, the problem of safely collecting and disposing of human waste must be addressed. There are several methods by which the NPS collects/treats the backcountry human waste. These methods are; simple such as cat holes, pit privy, carry out (bagged waste packed out) or more complex system such as composting toilets, dehydration or evaporative toilets, septic tanks, centralized collection sites (river trips), and treatment plants.

The cat hole and pit privy wastes are not typically removed from the backcountry. All of the other methods such as carry out; some pit privy, compost, solar/evaporation, septic tank and conventional sewage treatment systems will remove the final waste product. The final waste product may be either treated or untreated depending upon the collection method (pit privy or composted). This waste is routinely (monthly - annually) removed and transported back to an approved wastewater treatment facility or an approved landfill. The amount of waste removed is dependent upon the number of people using a site and the frequency with which the site requires cleaning. Some popular backcountry trails require that the waste is removed from toilets along the trail and transported by horses, mules, Llamas, backpackers on a monthly basis. If this waste were not removed monthly the contents would overflow and become a public health concern. Other sites have had a properly operating toilet system for years without removing the waste such as composting, dehydration, and evaporative toilets.

For the sites that must remove waste routinely (Yosemite, Yellowstone, Mount Rainier) reduction in weight and not complete treatment is the primary concern. The reduction of weight will allow for less transportation and labor costs. Also, worker protection is essential during the waste removal and transport operation. Methods used to reduce weight, particularly in the mountains are dehydration or evaporation. Dehydration is *the removal of water from a substance or compound*. This is typically done by separation of the solid waste from the urine. The methods tend to be simple such as holes drilled into a container and the liquid drains into a drainfield. Or it can be an engineered design such as the DEVAP ™ 2000. Evaporation is the *process of drawing water off in the form of a vapor* such as the evaporator vault; a solar aided fan, or solar heating of a liquid.

Parks have spent much money, time and effort, installing and maintaining these systems so that the parks will be unimpaired for the enjoyment of future generations. The NPS and its staff are very devoted to the health and safety aspect and it is the mission of the regional public health consultants to inspect these facilities. The public health consultants provide the NPS operations and maintenance staff a reliable source for advice on public health issues associated with backcountry operations.

NPS DO 83 Backcountry Requirements

The NPS guidance documents for public health (food, water, waste sanitation, illness & vectors, pools, beaches, and hot spas) are stated in Directors Order (DO) 83. The backcountry accepted public health practices are outlined in DO-83, Reference Manual (RM) 83 B and H. Visitors may also visit a very user friendly web site http://www.nps.gov/public_health for more information.

The DO 83 Reference Manual (RM) 83B identifies the regulations and directs Park managers to "*…reduce the risk of waterborne diseases and provide safe wastewater disposal by ensuring wastewater systems are properly operated, maintained, monitored, and deficiencies promptly corrected." The regulations cited are (1) the Clean Water Act, as amended (33 U.S.C. 1251 et seq.); (2) The Primacy Agency requirements; or (3) this NPS wastewater policy, whichever is most stringent*."[5] The RM 83 also identifies systems that are suitable for backcountry operations. Suitable systems include "*flush toilets; composting toilets; barrel toilets; evaporator toilets; incinerator toilets and pit privies*." However, the use of pit privies is considered a temporary option (see attachment 3). Some park policy allows for the use of "cat holes" because there are no other means available to dispose of human waste.

There is also guidance on adequate sanitation facilities for remote activities such as river rafting, horseback riding, backcountry biking, backpacking and similar activities. In accordance with RM-83, Reference H "*in environmentally sensitive areas such as river corridors, human feces and other solid waste shall be transported to an approved offsite disposal facility unless fixed facilities which conform to all applicable rules and regulations are available onsite. Urine may be disposed onsite unless prohibited by law. However, all waste shall be disposed of in a manner consistent with park policy and all applicable health and environmental regulations*."[5]

Treatment and Description

Cat Holes

A person typically digs a hole at least 6” deep (15 centimeters) and at least 100 feet (30 meters) away from water (lake, stream, river). Decomposition of fecal matter is increased if it is mixed with the soil. Toilet paper is slow to decompose and may be dug up by animals therefore some backcountry operations require users to collect toilet paper in a separate container and haul it out for disposal in a public wastewater system or vault toilet. This is a typical alternative for lightly used trails and is common in Denali.

Pit Privy

Sanitary pit privies are buildings (wood, logs or native rock construction); built over either earthen or concrete lined holes at least 5 feet deep that don’t extend more then 2 feet from the above the ground water. These are located at least 100 feet downgrade from a water supply or from a lake/river/stream.[8] The fecal material is collected in the bottom of the pit. The privy has a ventilation system, self-closing doors and insect screens. As was mentioned earlier this method of collection and disposal is the cheapest for maintenance and construction. Once the pit is full, the contents are covered with at least 2 feet of native topsoil. If removed, the fecal matter is placed in container(s) and hauled out to an approved wastewater treatment plant.

Another type of privy is called a drum privy. This consists of a toilet seat and building structure placed over a removable drum or small fiberglass vault. The drum or vault is replaced when it is full and the full container is removed from site by helicopter or ATV. These containers can serve approximately 150 – 200 visitors before being emptied.

Carry out

There are basically 3 types of containers. There are bag containers, simple containers, and complex containers. Plastic bags require a collection container.

Bag Containers

- At Mt. Rainier National Park plastic “blue bagged” waste is collected from backcountry hikers and collected in specially labeled 55-gallon drums. The blue-bagged wastes are boxed and labeled as infectious waste and incinerated at a facility in Morton, Washington. The bagged waste was historically fed into the NPS operated wastewater treatment plant and macerated (Muffin Monster) until 1992. The problem with this process was the contents of the bags when compressed in the muffin monster, “popped like a balloon” or clogged the equipment. Disposal options for bagged waste is difficult and costly. Landfills and most treatment plants do not take it so most bagged wastes are incinerated.
- There are bagged waste systems such as the “rest stop” and “wag bag”. The wag bag system absorbs all the liquid much like a diaper and can be landfilled. The key to land application is there must not be any free flowing liquid.

Simple Containers

- **Grand Canyon River Trips**

Simple containers include pickle pails (5-gallon buckets with tight fitting lids) rocket boxes (20-mm ammo cans), 55 gallon drums, scat packer, brief relief, and clean mountain cans. The pickle pails and rocket boxes are common devices seen on the river trips in the Grand Canyon. Once the containers are full the contents are dumped into a centrally located septic tank system during or at the end of the river trip. The containers are rinsed and sanitized for use on the next trip. The septic tanks are pumped as needed by a septic tank pumper and delivered to a wastewater treatment plant (usually inside the National Park).

- **Denali Clean Mountain Cans**

The Clean Mountain Can (CMC) had its beginnings in 2001. Through financial support from the American Alpine Club, and the NPS Paul Becker of Geo Toilet Systems and Park Ranger Roger Robinson designed 50 prototype cylinders (1-3/4 gallon). The CMC was distributed to anyone wishing to volunteer and attempt to remove his or her human waste. In that first year, twenty-one groups used the CMC. In just three years, the program has grown to over 400 CMCs being used throughout the Alaska Range. Rainier Mountaineering Inc. purchased 50 of their own CMC using them in addition to ones borrowed from the park service. Two RMI guided expeditions (17 clients and guides) used CMC for their entire climb. For the third year, the American Alpine Institute continued to use CMC all the way on their West Buttress guided ascents (3 climbs which included 25 clients and guides). The original ones were considered too heavy and were not equipped with vents so the contents were vacuum-sealed when brought down from 17,000 ft. The prototype was modified with a 2-way vent, the weight was reduced, and the height of the can was lowered. The opening is covered with a gasketed lid and for comfort is supplied with a disposable foam ring (the CMC cost $50 each).

In 2003 almost every climber ascending up to the heavily used 17,200 foot high camp on the West Buttress removed his or her waste using a CMC. Of these, 148 carried their human waste all the way back to basecamp. These 148 climbers received the 2003 Denali Pro pin. The remaining climbers turned in their CMC to the rangers at the 14,200-foot camp. From there rangers were responsible for transportation via sled or helicopter to Talkeetna, Alaska for collection by a septic service. The CMC was featured in an article in Alaska Magazine.

Denali National Park has implemented strict ‘Climb Clean’ policies and uses ranger presence at the 17,200-foot high camp to enforce this policy. The high camp was once heavily contaminated with human waste and garbage. Prior to the implementation of the CMC human waste was collected in a bagged lining of a bucket. When the bag was full it was tied, removed from the bucket and thrown into a crevasse. Due to the efforts of the Park almost all-human waste is carried off. Only a few climbers still pollute, those caught are fined $100 dollars.

In 2004, the Park plans to distribute the CMC from Talkeetna, the 7,200-ft camp, and 14,000-ft camp to be carried up and down the mountain with the primary focus for their use at high camp (17,000 ft). The Park will also encourage all other climbers that fly into remote glacier strips to use them for their base camps. This has been a challenge due to the bush pilots reluctance to allow the device into the plane. Now to appease the pilot’s concerns the CMC is double bagged during flight.

The CMC is steam cleaned and disinfected with bleach by hand at Shamrock Septic in Wasilla, Alaska for approximately $8.50 each. The devices are ready to be reused in approximately 2-3 weeks from time of drop off. The new users receive a clean sanitized device and a new foam ring. An alternative cleaning service is being researched due to the slow turn around time of the septic service. One of the options is the SCAT machine. This is a device manufactured by Frenchglen Blacksmiths in Frenchglen, Oregon. It works like a large dishwasher and can clean and sanitize a pickle pail, rocket box or a CMC within a 2-minute cycle. The cost of the unit is in the thousands of dollars however.

Complex Containers

Complex containers are commercial units that can be emptied and cleaned at trailer dump stations. These devices are equipped with fittings that allow them to be drained and rinsed with standard trailer dump station equipment such as the Jon-ny Partner with lid. [9]

- The Ostrander Ski Hut **in Yosemite at the** request of the National Park Service closed the septic system during the 1999-2000 winter season. The guests began to use the "Jon-ny Partner" system. This is a portable toilet with the funnel and hose attachment. The Jon-ny Partner can be emptied at an approved recreational vehicle dump station or at an authorized disposal site. This product has an aluminum tank for easy cleaning and disinfection. Jon-ny Partner is equipped with a 5-pound pressure relief valve for the release of gas pressure. The tank, lid and collar clamp weighs approximately 22 pounds. This product is approximately 12 inches wide, 17 inches long and 16 inches tall without the seat in place.

There are other variations of these systems on the market and are used on river trips and by private boaters (rocket box, pickle pail etc.).

Composting Toilets

Compost toilets use an aerobic process in a digester tank to decompose the human waste into compost. Properly treated final composted material has no offensive odor or texture. Compost toilets currently in use include several commercially manufactured digester tanks, site fabricated digester tanks, and combination holding tank/batch composter. If the operation and maintenance schedule is followed, and the system was sited properly, a composting toilet depending on usage may last 10 years before cleaning is necessary. The NPS public health program has adopted a flow chart to assist parks to decide if a composting toilet is the correct application. Composting is not possible in certain locations and is dependent upon proper operating conditions and routine maintenance. Typically a bin of wood shavings (Carbon source) is located near by and the user is instructed via signs to pour one cup of wood shavings into the reactor after each use. For complete composting to occur it requires proper time, moisture, oxygen, temperature, pH, a proper carbon to nitrogen ratio, and routine maintenance. The requirements are a moisture content of 45% to 75%, oxygen via stirring or mixing every 100-500 uses, a temperature range of 20°C – 55°C (68° – 131°F), pH range of 5.5 – 7.5 and a carbon to nitrogen ratio of 20 – 25 parts carbon to 1 part nitrogen. [10]

Compost digesters are manufactured by Romtec, Cluivus Multrum, Phoenix, Bio-Sun Systems, Inc. and also by individual parks throughout the NPS backcountry. The downfall of the composted waste is that it must be treated as domestic septage for further treatment, unless it is documented to meet 40 CFR 503 requirements as a class A or Class B sludge. The product may be burned, buried, removed from the site for further treatment, or (with a permit or permit waiver) used as a fertilizer, soil amendment or biosolids.[10] The NPS does not typically allow the placement of sewage sludge on Park land due to the added nutrient content (NPS DO).

Yosemite has several composting toilets in their backcountry that are cleaned-out monthly. A crew takes a team of mules into the backcountry and removes the waste from the compost toilets and places the contents into sealed containers. The containers are then transported back into the front country and deposited in a wastewater treatment facility within the Park for treatment. The containers are washed/sanitized and used again the following month. This as you might imagine is a labor-intensive effort for the Park.

Dehydrating Toilets

The purpose of dehydrating toilets is to separate the liquid from the solid portion. As discussed earlier the reduction in weight will reduce maintenance cost substantially. The maintenance costs are due primarily to how often the site is visited (some take 1-2 days of travel each way) and waste transportation (helicopter, mule, and backpack) costs. Therefore the dehydration process not only reduces the frequency but also reduces the cost in energy. Dried sludge has very little offensive odors and may be transported by humans, pack animal, ATV, or helicopter.[11] The options include commercial basket type, site modified commercial basket type, dehydrating/composting units, and self constructed units.

Mount Rainier and Mt. Whitney

- Mount Rainier uses the dehydrating unit at the 10,000-foot level located in Camp Muir. Waste is deposited into the unit and the liquid portion is separated and drains into a drainfield. The low moisture content of the high altitude air and sunshine may reduce the contents in the toilet 75% by volume. At the end of the visitor season the solid material is *shoveled* into 55-gallon drums and removed by helicopter.[12]

- A similar system is used on the 14,495-ft peak of Mt. Whitney where a 2-container 55-gallon drum separates the liquid portion from the solids. The liquid is removed by evaporation and the contents of the 55-gallon drum are removed by helicopter once per year.

- New Technology - The company Biological Mediation Systems Inc. manufacturers the DEVAP ™ 2000 waste reduction system. This system is being used in the NP. The DEVAP ™ 2000 uses site specific planning and is engineered accordingly based on elevation, temperature, and humidity information. Several Parks are using these products with good results. Mt. Rainier in 2003 is experimenting with a DEVAP ™ system and results of this study are still pending. The intent was to eliminate the leachate from flowing to the drainfield.

Evaporative Toilets

These systems are typically driven by mechanical or solar means. The systems operated with forced air or heat from the sun evaporating the water from the waste.

Rocky Mountains NP

This park has an older “park constructed” evaporative toilet (Shasta toilet) that dries the fecal matter on a tray and uses swamp cooler pads to evaporate the urine. When it is time to clean the site the park uses Llamas to load and remove the waste product for final disposal in the city wastewater treatment plant. The Llamas are easier to maintain and do not damage the trails like a horse or mule.

Evaporative Vault

Some of the Parks are using an evaporative vault designed by BMS called the outback. This works on the basis of forced air movement and reduces the weight and volume significantly. The forced air system can be operated by solar or conventional power. These systems are used in Arches NP, Curecanti NRA, and Zion NP.

Septic tank and drainfield systems

The Park maintains centrally located septic tanks drainfields where river outfitters and boaters can dispose of the collected sewage for treatment. The park service may either pump the tanks with a septic pumper service or operate a barge that pumps the sewage from the septic tank. These systems are checked on a routine (yearly) basis as per NPS DO 83B. The solids are disposed of either in a wastewater treatment plant in the Park or hauled off site to an approved wastewater treatment facility.

Parks use conventional systems in the backcountry on a seasonal basis such as concession facilities, research camps, and backcountry camping. Of course the ability to have power (solar, electrical, propane) and drinking water is necessary for this system. Sites include that use septic systems in the backcountry are located in Alaska, Everglades NP, Yellowstone, and Yosemite

Examples of barged waste include Ross Lake resort located in North Cascades, shore side septic tanks at Lake Roosevelt National Recreation Area (NRA), and floating toilets in the Big Horn Canyon NRA in MT/WY.

Wastewater Treatment Plant

These may not seem like a viable solutions in remote sites, however there are places such as Phantom Ranch in the Grand Canyon, Glacier Bay (Gustavis), Alaska, and Stehekin, Washington that require advanced treatment due to poor soils or discharge requirements. These sites all have access to power.

Examples

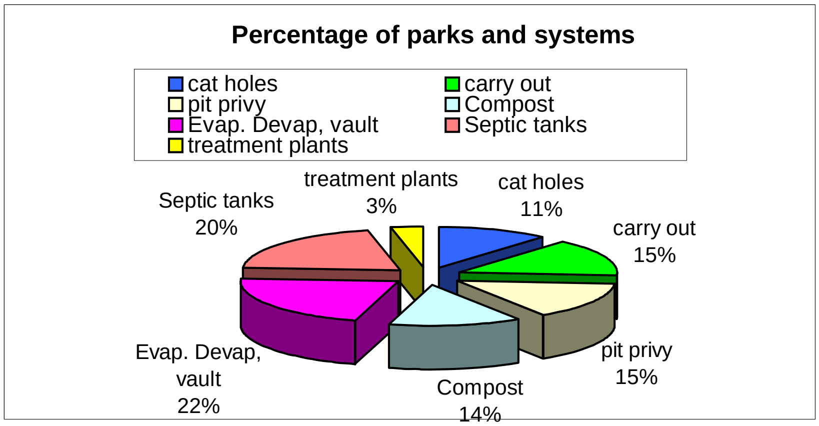
- Phantom ranch is located at the bottom of the Grand Canyon approximately 14 miles from the North Kaibab Trailhead. Power and potable drinking water is available as well as a family style restaurant. Sludge is dewatered and removed via pack animals. On the north rim the Park uses an activated sludge plant that is deactivated in the winter and restarted in the summer. During the winter a septic tank with drainfield system is used because the wastewater flow is minimal. In the spring the park transports activated sludge starter from Page, Arizona.

- Glacier Bay Alaska (Gustavis) is isolated with access by boat or plane. The park operates an activated wastewater treatment plant that discharges filtered effluent into the bay under a strict NPDES permit. The solids are de-watered, bagged, and incinerated. The ash is then deposited in the landfill.

- Stehekin landing in the North Cascades has a chemical treatment plant. The town of Stehekin is located approximately 40 miles north of Chelan on Lake Chelan. Access is either by plane, boat or access via a road system in Canada. This is a permitted treatment plant that deposits effluent in a drainfield and solids are either dried on sand beds or pumped by a septic tank contractor in Canada.

Results and Conclusion

Results of this survey indicate that there is not one overall fix for backcountry wastewater collection and disposal. Of the Parks surveyed in this study about half used more then one method to collect human waste, with some using a combination of 3-4 methods. As of this date (4/29/04) I have collected data from a total of 52 National Parks (estimated that 102 National Parks have backcountry operations). Of those 52 NP the breakdown for backcountry collection/treatment is as follows: 11% use cat holes, 15% use carry out method, 15% use pit privies, 14% use composting, 22 % use evap/devap or vault, 20 % use septic tank systems, and 3% use conventional sewage treatment. [13]



As more information is collected in my backcountry waste survey I am sure that the percentages will change. As stated earlier, I have surveyed approximately 50% of the more then 102 parks that had recorded backcountry camping activities in 2003. Of the 52 parks that were surveyed, 27 are using a combination of the backcountry waste disposal alternatives available to them. The choice for the method is dependent on the geography, accessible location, availability of drinking water, availability of power, climate conditions, capital and operation costs. Based on the different climatic and geological conditions apparent in the larger parks this is not surprising. For example Denali with 9,375 square miles is larger then the state of Vermont. The Grand Canyon has 1,904 square miles, Yellowstone has 3,400 square miles and Yosemite covers 1,170 square miles. Transportation costs are a large factor in operation and maintenance costs for these 4 parks. The parks continue to experiment with new technology for backcountry operations however as was detailed in this survey, the driving factor in the backcountry is dependability and simplicity. An “out of order” sign posted on a backcountry toilet is not an acceptable practice. If the system is not operational, visitors will use unacceptable means and cause pollution to the environment and public health problems. I hope the information provided in the descriptive study will help inform the public on the options and characteristics of backcountry disposal methods. I would like to thank the Public Health Program staff for their assistance in collecting this information. The contents of this descriptive study are not to be used as an endorsement for any particular company by the National Park Service or the Public Health Program.

ATTACHMENTS

ATTACHMENT 1

Visitation information:

National Park System: Summary for Jan-Dec, 2002													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	2002	277,299,880	143,979,564	421,279,444	3,463,606	1,071,953	3,357,513	2,404,824	5,762,337	1,906,473	2,499,515	358,445	15,062,329

National Park System: Summary for Jan-Dec, 2001													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	2001	279,873,926	144,428,625	424,302,551	3,574,734	1,008,618	3,326,852	2,404,840	5,731,692	2,032,886	2,925,293	320,164	15,593,387

National Park System: Summary for Jan-Dec, 2000													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	2000	285,891,275	143,961,848	429,853,123	3,678,262	999,658	3,395,816	2,501,401	5,897,217	1,935,276	2,861,861	353,456	15,725,730

National Park System: Summary for Jan-Dec, 1999													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	1999	287,130,879	149,164,999	436,295,878	3,676,049	1,101,517	3,544,605	2,652,773	6,197,378	1,968,930	2,974,795	364,546	16,283,215

National Park System: Summary for Jan-Dec, 1998													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	1998	286,762,265	148,897,805	435,660,070	3,612,940	1,078,800	3,457,825	2,630,972	6,088,797	2,056,747	2,770,478	563,326	16,171,088

National Park System: Summary for Jan-Dec, 1997													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	1997	275,236,335	142,925,014	418,161,349	3,562,564	1,023,736	3,589,246	2,707,618	6,296,864	2,169,296	2,751,915	571,148	16,375,523

National Park System: Summary for Jan-Dec, 1996													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	1996	265,796,163	134,030,276	399,826,439	3,754,573	1,000,473	3,680,310	2,771,704	6,452,014	2,124,793	2,772,849	510,321	16,615,023

National Park System: Summary for Jan-Dec, 1995													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	1995	269,564,307	118,239,606	387,803,913	3,775,377	1,070,638	3,866,306	3,158,355	7,024,661	2,189,727	2,787,243	464,709	17,312,355

National Park System: Summary for Jan-Dec, 1994													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	1994	268,636,169	111,519,877	380,156,046	3,904,754	756,929	4,240,237	3,414,597	7,654,834	2,363,827	3,619,324	472,899	18,772,567

National Park System: Summary for Jan-Dec, 1993													
Totals:	Year	Recreation Visits	Non-Recreation Visits	Total Visits	Lodging	Camp-grounds	Tent Campers	RV Campers	Total RV/Tent Campers	Back-country Campers	Misc. Campers	Non-Rec Overnight Stays	Total Overnight Stays
	1993	273,120,925	114,586,143	387,707,068	3,958,637	736,308	4,102,758	3,394,148	7,496,906	2,406,697	3,111,802	478,338	18,188,688

ATTACHMENT 2

Visitation Information

Year	Backcountry camping	Recreational visits	Percentage
1993	2,406,697	273,120,925	0.881
1994	2,363,827	268,636,169	0.880
1995	2,189,727	269,564,307	0.812
1996	2,124,793	265,796,163	0.799
1997	2,169,296	275,236,335	0.788
1998	2,056,747	286,762,265	0.717
1999	1,968,930	287,130,879	0.686
2000	1,935,276	285,891,275	0.677
2001	2,032,886	279,873,926	0.726
2002	1,906,473	277,299,880	0.688
2003	1,816,088	266,099,641	0.682
total	**22,970,740**	**3,035,411,765**	0.757
average	**2,088,249**	**275,946,524**	0.757

ATTACHMENT 3

Grand Canyon National Park proposes to replace and/or rehabilitate and maintain eleven toilets in the backcountry and seven toilets in the Cross-Canyon corridor in the inner canyon of Grand Canyon National Park. There is an immediate need to address the condition of backcountry toilets in the Park and the Park's toilet maintenance program. The proposal is needed to address the following management concerns: Many of the existing backcountry toilets are substandard and pose safety and health risks for Park personnel and visitors and many of these toilets are difficult to maintain and are not conducive to regular routine maintenance. An evaluation of the backcountry and corridor toilet maintenance program in one document provides an opportunity to adequately analyze impacts of the program. This includes a "Minimum Requirement Analysis" for potential impacts to proposed wilderness.

This Environmental Assessment evaluates three alternatives for addressing the purpose and need for action, including a no action alternative and two action alternatives. Both action alternatives include: 1) replacement of existing pit toilets at six backcountry sites with aboveground vault toilets, 2) transportation of these vault units into the backcountry via helicopter and 3) improved cyclic maintenance of all backcountry and corridor toilets throughout the year. The preferred alternative, Alternative B, also includes helicopter use for periodic emptying/removal at 11 sites and mule and/or boat use for six sites. Alternative C proposes helicopter use for periodic emptying at three sites and a combination of mules, boats or backpack transport for periodic emptying at the remainder of the sites.

Neither action alternative would have measurable impacts to air quality, soils, water, vegetation, floodplains, wetlands, general wildlife populations, wildlife species of interest, environmental justice, prime and unique farmland, or the socioeconomic environment. Neither action alternative would result in alteration of areas proposed for wilderness designation or wilderness boundaries. Long-term impacts to visitor experience from either action alternative would be moderate in intensity and beneficial while short-term impacts would be moderate and adverse. Impacts to park operations from either action alternative would also be long-term, beneficial and moderate in intensity due to pit toilet replacement, but adverse impacts that were long-term and moderate in intensity are also expected from implementation of Alternative C. Impacts to special status species would range from negligible to moderate and would be adverse. Impacts to soundscape would be minor to moderate in intensity and generally short-term for the preferred alternative and minor in intensity and short-term for Alternative C. Both minor beneficial long-term impacts and minor adverse long-term impacts to cultural resources would occur from implementation of either action alternative. **Public Comment period for the EA/AEF ended May 9, 2003.**

This Environmental Assessment/Assessment of Effect (EA/AEF) is available as a PDF file. PDF files retain the look and feel of the original document (including typography, page layout, and graphics).

Resources

1) Michael G. McGarry, *Sanitary sewers for undeveloped countries-necessity or luxury?,* Civil eng. 1978, pp 70-75.
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4) National Park Service Public Use Statistics Office, visitor information 2003
5) National Park Service, Directors Order.
6) National Park Service Public Health Program web site (*http://www.nps.gov/public_health)*.
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8) Joseph Salvato, *Environmental Engineering and Sanitation*, 4th ed., 1992.
9) *Source Remote Waste Management*, Brenda Land, National Forest Service 1995.
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12) Remote Waste Management, US Dept. of Agriculture Forest Service, Brenda Land, May 1995.
13) Public Health Program Survey information

Web Sites:

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http://www.nps.gov/public_health
http://www.uvm.edu/~rlachape/sites-mtr.htm
http://www.uvm.edu/~rlachape/man-rmc.htm