Development Services

From Concept to Construction

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APPEAL SUMMARY

Status: Decision Rendered

Appeal ID: 21899	**Project Address:** 4237 SE 37th Ave (units A, B) and 4311 SE 37th Ave SE 37th Ave (units 1-32)
Hearing Date: 9/18/19	**Appellant Name:** Ole Ersson
Case No.: P-002	**Appellant Phone:** 5037105558
Appeal Type: Plumbing	**Plans Examiner/Inspector:** McKenzie James, Joe Blanco
Project Type: commercial	**Stories:** 2 **Occupancy:** R-2 **Construction Type:** wooden frame
Building/Business Name: Kailash Ecovillage	**Fire Sprinklers:** Yes - basement unit 17
Appeal Involves: Alteration of an existing structure	**LUR or Permit Application No.:** new appeal
Plan Submitted Option: pdf [File 1] [File 2] [File 3] [File 4] [File 5]	**Proposed use:** residential

APPEAL INFORMATION SHEET

Appeal item 1

Code Section	residential flush toilet connected to sanitary sewer
Requires	Kailash Ecovillage consists of a 32-unit multifamily apartment building, located at 4311 SE 37th Ave, Portland, consisting of 30 one-bedroom units and 2 two-bedroom units (units 1, 17). Units are numbered 1-32. In addition, there is an adjacent single-family dwelling, located at 4327 SE 37th Ave, Portland, with an attached ADU. Its units are numbered A and B. Currently, each residential unit has a flush toilet connected to the sanitary sewer. and meets current plumbing code requirements.
Proposed Design	Construction of a Compost toilet and urine diversion system meeting IAPMO WE-Stand is proposed to supplement or replace one or more of the existing flush toilets. WE-Stand, the state of the art 2017 IAPMO Water Efficiency and Sanitation Standard, requires no discharge of unsanitized, unprocessed, material into the environment. Attachments: ATAC recommendation 12-1. Composting Toilet and Urine Diversion System Operation and Maintenance Manual, designed to meet IAPMO WE-Stand and NSF-41 – submitted as part of ATAC application 12-1. Plans, sheets 1, 2, and 3. Sheet 1 shows the site plan for Kailash Ecovillage, showing location of the compost processor, urination station and urine storage tanks, setbacks from property lines, and garden areas where sanitized compost (fruit and ornamental gardens) and sanitized urine (all garden areas) may be

	used. It also shows unit plans for Unit 32 and Unit 3. Although it is two street addresses, Kailash Ecovillage comprises a single assessor tax account, namely R308457. Sheet 2 shows details for the compost processor, including its south elevation, urination station, urine storage tanks, and Unit B half bath with proposed supplemental compost toilet (commode) and existing flush toilet. No plumbing modification is proposed for Unit B. The additive bucket may be placed on the top of the existing flush toilet lid or in another location, such as under the sink. Sheet 3 shows details for Unit 32 bathroom and Unit A half bath showing proposed supplemental compost toilet (commode) and existing flush toilets. No plumbing modification is proposed for these two units. It also shows Unit 3 where the existing flush toilet is proposed to be replaced with a compost toilet (commode) by removing the flush toilet and capping its sewer connection. Note: it is also proposed to supplement other one-bedroom units (2, 4-16, 18-31) with compost toilets (commodes) at future dates, similarly to Unit 32, when requested by the resident. No plumbing modification would be performed. All one-bedroom units have similar dimensions and configuration, with 4 different plans sharing mirror symmetry. Units 3 and 32 represent 2 configurations. The remaining configurations are mirror images of these two units and therefore have similar fixture layout and dimensions, so these two units are representative of all the possible one-bedroom bathroom configurations and have adequate space to add a supplemental compost toilet (commode). Since the compost processor is rated for 19 full time adults (see manual), up to 19 units could be fitted with supplemental compost toilets (commodes).
Reason for alternative	water conservation; nutrient conservation and recycling; emergency preparedness (for when the sewer grid is no longer functional, such as after a natural disaster like a severe earthquake).

APPEAL DECISION

Replacement of flush toilet with composting toilet: Granted provided a plumbing permit is obtained to cap any removed fixtures and provided the existing plumbing lines remain in place and provided the 16 recommendations of the Alternative Technology Advisory Committee are followed.

Note: The decision may also be revoked if determined to present health or sanitary violations by Code Compliance.

The Administrative Appeal Board finds with the conditions noted, that the information submitted by the appellant demonstrates that the approved modifications or alternate methods are consistent with the intent of the code; do not lessen health, safety, accessibility, life, fire safety or structural requirements; and that special conditions unique to this project make strict application of those code sections impractical.

Pursuant to City Code Chapter 24.10, you may appeal this decision to the Building Code Board of Appeal within 90 calendar days of the date this decision is published. For information on the appeals process, go to www.portlandoregon.gov/bds/appealsinfo, call (503) 823-7300 or come in to the Development Services Center.

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To: **Ole Ersson**

From: **Alternative Technology Advisory Committee:**
Joshua Klyber (chair) Aron Faegre Bob Sweeney
Jeff Cordial David Posada

RE: **Application #12-1, Composting Toilet and Urine Diversion System– Final Recommendation**

Date: **March 27, 2019**

Summary of Proposal: The applicant requests that the Alternative Technology Advisory Committee review a composting toilet and urine diversion system designed according to the International Association of Plumbing and Mechanical Officials (IAMPO) WE-Stand (Water Efficiency and Sanitation Standard for the built environment) Section 403.0, "Composting Toilet and Urine Diversion."

Applicable Building Code Section(s): Section 104.3.4 of the 2017 Oregon Plumbing Specialty Code (OPSC) allows the building official to approve an alternative material or method of construction if the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of the OPSC. OAR 918-770-0320 allows the use of composting toilets that meet NSF Standard No.41. Although the use of IAPMO WE Stand has not been approved by the State of Oregon, the BDS Building Official received oral approval from the State Plumbing Chief on October 2, 2018, to use the WE Stand provisions as an alternate method. The Committee reviewed the proposal using the 2017 WE Stand Section 403.3-403.9 design, construction, performance, alteration and repair of composting toilets and urine diversion system, and the attached applicant-created User's Manual (see Attachment A). Please note that following the findings and recommendations of this Committee or the Bureau of Development Services Administrative Appeals Board does not waive any other state or federal requirements.

Committee Findings:

1. The commode may be located indoors in a residence or commercial building, including in existing lavatories where the current flush toilet is connected to a sewage system. Alternatively, commodes may be located outdoors in a suitable structure.
2. Indoor structures will remain plumbed for a water closet.
3. The compost processor can be located wherever active composting conditions can be easily maintained, such as a stand-alone outdoor structure. This type of system can supplement a permitted sewage system.

4. The system can supplement a permitted sewage system or be used as a stand-alone system replacing a traditional flush toilet. (Note: it is not a replacement for a sanitary system intended to process gray water from sinks, bathtubs, and showers.)
5. A plumbing permit must be obtained for graywater and other plumbing installations in house. Please note: per Oregon State law, human sewage may not be included in a graywater system. Any graywater system used on the site must be adjunct to, and not a part of, the composting toilet and urine diversion system.
6. Detailed plans for the commode (location in bathroom, volume, etc.) must be included.
7. A site plan, including where containers will be stored, location of plants, etc., that shows there is sufficient area for on-site distribution of the compost and treated materials, must be included.
8. A spillage plan must be created in accordance with the attached Operation and Maintenance Manual.
9. Protocols for adjusting the carbonation level of compost must follow the Operation and Maintenance Manual.
10. A diagram of vents used in each compost processor that uses a hinged roof to cover the compost must be provided.
11. Details with minimum space requirements and information regarding financial obligations must be provided.
12. Each step of the composting process outlined in the attached Operation and Maintenance Manual must be followed.
13. Minimum space requirements outlined in the Operation and Maintenance Manual will be maintained.
14. Dimensions of toilet/bucket including materials, cleaning, and replacement plan outlined in the Operation and Maintenance Manual will be followed.
15. Composting bins must be labeled and dated.
16. The house must remain owner-occupied or occupied by a long-term renter of no less than 6 months and may not be used as a short-term rental (short-term guests are fine). Testing of the compost must be done after the first batch any time there is a change of occupancy. If the house is not owner-occupied, the renter must be trained by the owner, which training shall be documented in the log described in paragraph 21 below.
17. The buckets and the lids for collecting human waste in the bathroom and transferring the waste to the compost bins must be labeled to avoid being used for any other purposes.
18. Only the type of buckets and lids (material, capacity, dimensions, examples of typical brand or product name) as outlined in the attached Operation and Maintenance Manual may be used.
19. Toilet seat height shall be consistent with the attached drawings.
20. The typical quantity of “carbon-rich additives” to be added to the toilet collection chamber (bucket) after each person’s use will be consistent with the attached Operation and Maintenance Manual.

21. The users of the system must maintain a log that documents the following: a) any change in ownership, owners' agent, or occupancy; b) training of any new users, including who conducted the training and the date of the training; c) new user start and end dates; d) test results for each bin; e) spills or major issues with the system and how those issues were remediated; f) the date each bin was filled and changed; g) the date the bin was distributed; and h) the location where the compost from the bin was distributed.
22. For multifamily applications, there must be information regarding who would be checking and dumping the toilet.
23. There must be evidence that the urine diversion system meets the We-Stand requirements, including pictures of tanks and information regarding the treatment (pasteurization or other method) and time limit of that treatment.
24. Urine must be collected from a dry urinal at a depot (urination station), which is collected and transferred to the larger sequestration tanks for six months prior to use.
25. For multi-family systems, it must be demonstrated that the system can handle the volume of expected waste, including compost processor capacity.
26. No bulk storage of the waste is allowed within the dwelling units.
27. There must be a sump pump and urine processing details that incudes what systems will be used, site-specific data, and calculations on production and processing.

Final Committee Recommendation:

Based on these findings, the Alternative Technology Advisory Committee recommends approval of the use of this technology for residential or commercial purposes.

Please note: The Bureau of Development Services and the Administrative Appeal Board are not bound by the recommendations of the Committee. A favorable recommendation of a technology by the Committee does not guarantee approval of a building code appeal.

Further instructions for the applicant:

You may submit your plumbing code appeal to use this technology in a site-specific project at any time by following the instructions found on the BDS website. A plumbing code appeal must be approved by BDS to be able to use this technology in a project. Please submit a copy of this Committee recommendation with your appeal application. Please contact the Appeal Board Secretary at (503) 823-7335 if you have any additional questions about the appeal process.

Composting Toilet and Urine Diversion System Operation and Maintenance Manual

designed to meet IAPMO WE-Stand and NSF-41 requirements

Ole Ersson, December 2018

Table of Contents

introduction

Why build and operate a supplemental composting toilet system when a functional sewage system already exists that treats human excreta?

Centralized sewer systems and septic tanks with drain fields have many important shortcomings. They:

1. waste the valuable nutrient flow,
2. are energy and potable water intensive,
3. require functional electric power,
4. are subject to failure when overloaded, as during rain events when combined with storm sewers,
5. are subject to catastrophic failure in a natural disaster, and
6. discharge pathogens, nitrogen, minerals, and possibly heavy metals, into the environment.

Composting toilet systems are a waterless form of ecological sanitation that addresses all those concerns. They work by turning excreta and toilet paper, combined with a high carbon bulking additive, all of which is termed ETPA, and with or without normal household and garden compostables, into humus, and urine into a treated fertilizer. Ideally, they are an integral part of sustainable agricultural systems. These systems:

1. exploit the nitrogen and mineral nutrient flow,
2. use no electrical power, drinking water, or fossil fuels,
3. never discharge pollutants into the environment,
4. have low capital and maintenance costs and are easy to maintain,
5. destroy pathogens, and
6. are more robust in natural disasters, such as earthquakes, than those having sewer pipe networks.

This *Operation and Maintenance Manual* describes a state-of-the-art composting toilet and urine diversion system designed to meet the exacting IAPMO WE-Stand and NSF requirements. It will help the user to become familiar with the whole nutrient recycling process, and instruct about best practices, so that users can make top quality compost and treated urine fertilizer to enrich the gardened landscape.

the commodes

Composting toilet systems collect excreta in commodes that contain a receptacle to hold the excreta. A high carbon bulking agent, called the additive, is added after each use that seals the excreta from the air, preventing odors and balancing the nutrients, so they can later be properly composted in a separate compost processor. Commodes are constructed using sealed fir, pine, and other woods for the cabinet, and plywood for the lid. They use a standard toilet seat. The design is inspired by the Loveable Loo™, as shared by Joe Jenkins on his website http://humanurehandbook.com/ . All wood is sealed with a waterproof finish to protect the wood, creating a smooth, non-absorbent and easily cleaned surface. All hardware is non-corrosive stainless steel. To make the commode more stable, it may be attached to the floor with stainless brackets.

(a) (b) (c) (d)

Figure 1. A compost commode with an adjacent container of cover material (a). Commode top opened to show collection container inside (b). A near full capacity container ready to transport to the compost processor (c). Stainless brackets attached to the floor can stabilize the commode location (d).

Table 1. The Commode Materials List

Commode	Design inspired by the Joseph Jenkins Loveable Loo™
Cabinet	Sealed fir, pine, or other common woods capable of holding a 5-gallon container; dimensions: 15” wide, 20” deep, 15” tall
Lid	Plywood
Toilet Seat	Standard, compression molded plastic; height from floor: 16”
Container	5-gallon with lid (excreta collection device)
Features, recommendations	• Waterproof, sealed wood • Easy to install, permanent, odor free • No electricity, water, plumbing connections required • Inexpensive

The cabinet is designed to hold a container, such as a 5-gallon bucket, which is the collecting device. A batch of several containers of ETPA can be combined into the compost processor at once. This will give the compost sufficient mass to reach hot, pathogen-killing, temperatures. The commode cabinet and adjacent container require only a very small footprint on a floor and can be installed without electricity, water, or a plumbing connection. They can be installed in almost any location. Several commodes can be accommodated by a single compost processor.

Keeping the commode out of direct sunlight and keeping it dry & clean will prevent warming the toilet and possible condensation.

cover material

The cover material, or additive, is used to cover deposits in the container. It should be carbon rich, absorbent and chemical free. For example:

- Finely chipped wood and leaves
- Untreated sawdust (semi broken down is best)

- Dry leaves, ideally shredded
- Shredded paper
- Coffee bean or cereal hulls
- Untreated wood shavings

A mixture of fine and coarse materials, ideally with a 3-dimensional structure, is best because the fine materials will break down more easily and the coarse materials will allow oxygen to penetrate into the compost but at the same time prevent the movement of odors as well as potential invaders like flies. For example, flat materials alone, like shredded paper and leaves, can form mats, which retard oxygen flow. Hence, it is best to mix these with other courser materials.

(a) (b) (c)

Figure 2. A scoop makes a fine tool for covering commode deposits (a,b); finely chipped tree trimmings make an ideal cover material and are widely available at low or no cost in many environments (c).

using the commode

- When starting a new container put about four cups of cover material in the empty container.

- Add excreta, with or without urine and toilet paper, then place several cups of additive in the commode to completely cover deposits. If solids are added, the cover material surface should be leveled after each use by pressing down after covering. This will minimize the amount of cover material needed to adequately cover deposits and effectively prevent *any* odors and attraction of pests such as flies. If liquids are added, just make sure no surface liquid is visible.

- When done, replace the commode cover in closed position.

- **NEVER** put any chemicals, anti-bacterial products, bleach, deodorizers or anything inorganic into the toilet, as these may disrupt the composting process by harming the beneficial microbes.

- Household and garden compostables, such as kitchen scraps or weeds, may also be added.

Figure 3. The cover material surface should be leveled after each use by pressing down after covering.

the compost

Just like regular garden compost, excreta compost needs oxygen, moisture, and a balance of carbon and nitrogen to work optimally.

Excreta, as well as most other household compostables, is relatively high in nitrogen, so the additive used should be rich in carbon, to create a balance.

It is fine to use excreta composting systems to compost small quantities of other materials such as chopped garden weeds, and all the usual things that go into a healthy compost bin. Because of the high degree of sanitary hygiene insured by the compost system design, pet waste and even animal carcasses, can also be safely composted. There is no need for lime or ash, and these may inhibit microbial activity.

the compost processor

This manual describes a state of the art compost processor. It consists of several large bins, arranged in modules of three. Its walls are constructed of durable concrete blocks and the bottom is constructed of a lipped concrete pad sloped toward a drain in the center to collect any liquid that results from composting, called leachate. Ventilation openings are screened with wire mesh to prevent insects, birds, and rodents from entering the compost processor. Modules may be arranged in a gated courtyard that keeps uninvited visitors out. The use of concrete blocks makes for durable and vermin proof construction as well as insulating the compost inside from cooler outside temperatures. All the bins have a sloped roof that prevents rain from entering the compost processor and keeps out vermin. In one style, the roofs can be propped open during the adding or removing of compost. A style that has an immobile roof above the entire configuration will require the same type of ventilation screen to be used to cover each bin. Leachate from each bin collects in a sump area and is recycled back into the compost processor, by simply pouring it over the top, with each new batch of added compost. This helps maintain the proper moisture level for healthy composting, as well as preventing potential pathogens from entering local soil and ground water. Leachate needs to be recycled whenever adding fresh compostables.

Figure 4. The compost processor with bin lids that also serve as a roof propped open for inspection and servicing. Notice the gate, screened vents, and pile of extra cover material at the front. A faucet with hose and sprayer is convenient for cleaning each batch of containers.

adding to the compost processor

When starting a new compost bin, first put a 4" thick layer of coarse dry absorbent organic material on the concrete pad, with a 4" layer also on the perimeter of the bin as high as the ETPA that will be added in the center. One can use the same additive as for indoor cover material. Courser material will also work well. This will help to soak up any liquids that seep through the bin. It also insulates the center of the bin to keep it warmer. This layer can be thick as it will settle once the compost is piled on top. Dry straw, dry leaves, chopped garden vegetation, and weeds are all good options.

Before emptying the commode containers into the processor, make a small depression in the center of a bin using the dedicated shovel stored in this area and then put the ETPA and other compostables into the middle. Some recommend gloving during this process. The goal is to create a protected 'nest' of ETPA in the center of the compost bin. Place a 4" layer of cover material around the edges to insulate the center of the bin.

(a) (b) (c)

Figure 5. A batch of 11 containers (a). Containers with lids removed (b), ready to add to the compost processor. A depression is made in the center of a bin by pulling back the cover material in the center (c).

Collecting several containers and putting them in all at once is recommended. This is called 'batching' and insures the compost will reach high temperatures adequate to kill pathogens quickly. Batches may be added as frequently as desired, but one batch every two weeks is recommended. Such a technique reliably develops temperatures as high at 165 degrees F (74 degrees C) within several days of adding a new batch, powered by the metabolism of thermophilic organisms. These initial high temperatures literally cook the compost, then continue for weeks due to the insulating properties of the perimeter cover, the compost, and the air spaces in the center of the concrete blocks. Very gradually, over several months, the temperature falls back to ambient temperature. Please refer to the Appendix to show performance data obtained from a typical system of this design.

Once the containers have been dumped into the center of a bin, rinse the containers clean in the cleaning area, gently scrubbing the sides of the container with a soft brush if necessary, and pour the rinse water into the center of the bin as well. A fine spray bottle, or hose nozzle, and a soft brush all work well. Soap may be used, or a light spray of 10% bleach/water solution to sanitize the containers, although this is generally not necessary. If it is a sunny day the containers can be left out in the sun to dry, sanitize, and deodorize by the ultraviolet radiation in sunlight.

Then, empty the standing leachate into the bin and rinse the tools. Usually there is one to two containers of rinsate and leachate per ten containers added.

(a) (b) (c) (d)

Figure 6. (a) The bin as it appears after a batch of material is added in the center of the bin. It is surrounded by cover material around the perimeter that insulates the center. (b) A hose and spray nozzle are helpful to clean the containers. The rinse water from containers (c) as well as leachate from all the bins (d) is added with the new material.

Cover the new material completely with a 4-6 inch thick layer of the same cover material as used indoors. Alternately, use some of the completed compost from prior batches. Make sure to have plenty of cover material on hand to cover immediately after transfer to the compost processor. Finally, replace the compost cover to seal the bin.

(a) (b) (c) (d)

Figure 7. New material has been well covered (a), and a compost thermometer inserted (b). Once the containers have drained, they are placed upright in the sun to dry, deodorize, and sanitize (c). When a bin is finished, it is labeled (d).

Subsequent batches are added to the current composting bin in a similar fashion. First draw back the cover material to the perimeter of the bin. Then, put the contents of the new containers into the center of the bin. At this time add any rinse water and leachate that has drained into the sump area. Finally, add another fresh layer of cover material to the sides and on the top.

When the bin is full, make sure it is well covered, label its date, and leave it alone without adding any more ETPA, rinsate, or leachate for at least one year. As the compost ages it will shrink approximately 50% as the material inside breaks down and finally cools to ambient temperature.

It is important when emptying containers to choose a time early or late in the day when it is cool. This will minimize exposure to flying insects during the emptying process. This really is the only time in the process when there are any odors.

spillage plan

Filled receptacle buckets are securely lidded before transfer so spillage risk is minimized. However, should such an unlikely spill occur:

1. the contents are replaced into the bucket, including any surface liquid, by absorbing with material such as toilet tissue or paper towels, which is also composted,
2. if indoors, disinfect the floor with alcohol and proceed with regular composting,
3. if outdoors, add any affected soil to the bucket for regular composting.

If urine spillage occurs, such as during transfer from one container to another, collect any surface liquid with absorbent material such as paper towels or toilet tissue, then transfer to a bucket to compost in the usual fashion. If outdoors, collect any affected soil with a shovel and add to an ETPA bucket for usual composting.

using the compost

After at least 12 months have passed, the compost may be used in the garden. This is the time to perform pathogen testing. Transferring all the compost from a bin at one time, so it can be emptied and prepared for re-use, is recommended.

To facilitate emptying a bin, remove the board covering the top of the blocks, then several blocks in the front. This allows stepping inside. A fine-toothed pitchfork, also called a silage fork, is helpful to transfer most of the compost into a wheelbarrow. The compost will have settled about one third from the original height. The top layer tends to be fluffier and drier while the bottom layer is denser and moist, just like forest duff. One typically gets nine large wheelbarrow loads of sweet smelling compost from a finished bin.

After emptying the bin, replace the blocks and the top board, and the system will be back to normal configuration.

Use the compost by digging it into an ornamental part of the garden or under fruit trees and covering with a 3” layer of soil or mulch.

(a) (b)

Figure 8. After 12 months have passed, the compost will be finished (a). Its volume will have shrunk about 50%. Several blocks in the front of the bin are temporarily removed to facilitate emptying the bin. A bin contains about 9 wheelbarrow loads of compost (b).

(a) (b) (c)

Figure 9. The lower compost is denser and moister (a). This bin is now emptied (b). The leach drain grate is visible in the center. Once the bin is emptied, the blocks and board are replaced and the bin is ready for new compost (c).

(a) (b) (c)

Figure 10. A fruit tree is chosen to receive compost (a). Compost is spread around the tree trunk 4” thick, taking care to leave a gap around the trunk (b). Finally, a 3” layer of mulch is applied to cover the fresh compost (c).

compost processor system design

This section of the manual discusses the design and some construction details of the compost processor.

The system has been designed according to the International Association of Plumbing and Mechanical Officials (IAPMO) Water Efficiency and Sanitation Standard (WE-Stand). The most important performance characteristics of the system specified by this code require the following for the composting system:

- The system may be comprised of separate collecting devices and a compost processor.
- All system parts are constructed of durable, non-corrosive, materials.
- The compost processor must be covered, if outdoors, to prevent any rain from entering.
- There will be no discharge of composting leachate into the environment.
- The compost processor will be enclosed and adequately ventilated in a fashion that does not allow vermin such as insects and rats to enter.

We-Stand requirements exceed the NSF-41 requirements for water-tightness and bacteriological tests, a frequent requirement for commercial composting toilets.

This prototype compost processor has been constructed around a gated courtyard and consists of 9 bins in three modules of three bins. Each 3-bin module may share a common roof. Alternatively, a single roof could cover the entire configuration. The outer dimensions of the compost processor are approximately 25'x19'. Standard 8x8x16 inch concrete building blocks were used for their low cost, durability, ease of construction, and ability to insulate the compost inside. The interior dimension of each bin is 48"x48"x44", or approximately 2.2 cubic yards. The bottom of each bin is constructed of a waterproof 4-inch-thick concrete pad with a sloped floor with a drain grate in the center. Each pad has a perimeter lip that extends 4 inches above the pad floor. 2" ABS piping has been installed, with the usual ¼" per foot slope, to transport any compost liquid (leachate) from each bin to a common sump area where it can be recycled into the currently used compost bin. At the top of the blocks, a wooden sill plate is constructed to hold the hinged roof structure. The roofing material can be corrugated galvanized steel. Each bin has an air vent of approximately 70 square inches that is screened to prevent the passage of insects and other vermin. A hinged roof area can be propped open during use and has a slight slope to shed rainwater to the outside of the courtyard.

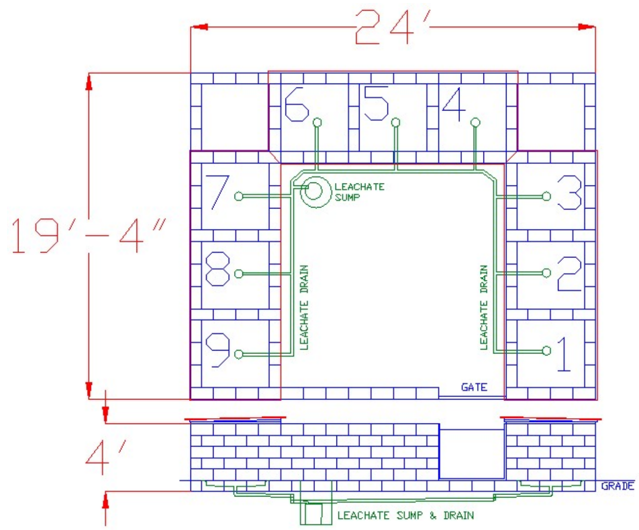


Figure 11. Prototype Compost Processor Schematic. Top: plan, bottom: south elevation. In this design, each set of three bins has a shared roof (outlined in red) that props open for use. All bins have a drain (green) in the center of their bottom concrete pad, which drains to a common leachate sump. Leachate is recycled to the current bin during the addition of each batch of new compost. Systems can also have a single elevated roof, in which easy bin will have separate cover.

Table 2. Prototype Compost Processor Features and Materials List

Compost Processor Features	
Bins (nine count, three modules)	• Dimensions ○ Exterior (~25'x19') ○ Interior (48"x48"x44" ~= 2.2 cubic yards) • Walls ○ Durable, low-cost, 8"x8"x16" concrete blocks (insulation) ○ Vermin proof ○ Wooden sill plate for roof support (located on top of walls) • Bottom ○ Sloped concrete pad ▪ 4" above pad perimeter lip ○ Waterproof ○ Center drain grate (leachate collection) • Roof Assembly (sloped) ○ Corrugated, galvanized steel ○ Rain accumulation prevention ○ Vermin mitigation ○ Hinged ○ 3-bin module shares a common roof
Sump area (plumbing)	Leachate collection includes drain grate, sump enclosure, lid 2" ABS piping with ¼" per foot slope, 2" ABS fittings Contamination prevention of local soil and groundwater
Ventilation	Wire mesh screen air vent (hardware cloth) Vermin and insect management ~70 in^2
Security	Gated courtyard (hinged and latched)

(a) (b) (c) (d)

Figure 12. The bottom of each bin consists of a 4” thick, 48”x48” waterproof concrete pad sloped toward a drain in the center (a). The edge of this pad has a 4” tall lip to channel all leachate to the center drain (b). This photo shows the drain plumbing prior to placement of the vapor barrier and pouring the concrete pad (c). A 6mil vapor barrier was placed under each concrete pad (d). The drain outside Bin 1 has a cleanout.

(a) (b) (c)

Figure 13. Drains. All the drains are tied together and lead to a common sump (a). This photo shows the drains for bins 3, 4, 5, and 6 (b). The leachate drain has a shutoff valve in the sump area (c).

(a) (b) (c)

Figure 14. Detail showing the sill plate attached to the top row of blocks (a). The roof framing is then attached to the sill plate with hinges (b). The roof is sloped slightly to the outside of the courtyard to shed any rain (c).

(a) (b) (c)

Figure 15. Two views of the compost courtyard showing the bins with roofs down (a), and propped open (b). Each roof segment has a latch to discourage casual opening or by the wind (c). The roofing lies directly on ribbed foam cut to match roof corrugations.

Figure 16. Helpful Tools. (From Top) silage fork with narrowly spaced tines, very useful for moving wood chips, sawdust, etc.; compost thermometer, container cleaning brush, flat shovel. These tools are stored in the gated transfer area.

urine diversion

Urine can be added without problem to commodes and to the compost processor. In fact, the high nitrogen content of urine can result in faster composting.

However, urine needs little further processing to enable the nutrients to be delivered to growing plants. Approximately 75% of excreted nitrogen is found in urine. In addition, valuable potassium, phosphorus, and other minerals are excreted in urine in a form immediately usable by plants. For that reason, it can make sense to segregate urine from the fecal excreta which requires more advanced processing. Segregation requires only a very small amount of water for rinsing containers.

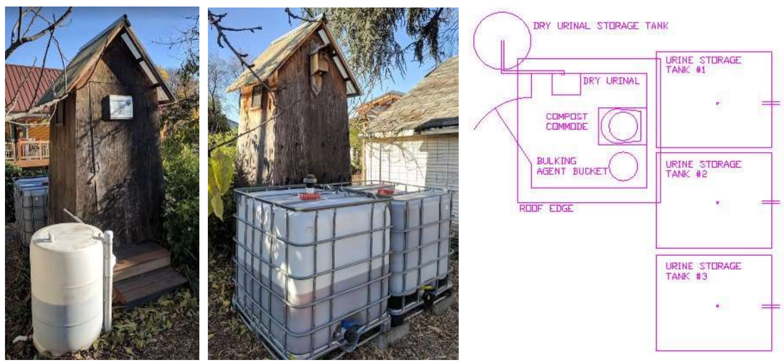
IAPMO WE-Stand encourages urine recycling through diversion. Sequestration for 6 months is the only treatment required for urine, due to its high intrinsic pH. The following represents a typical state of the art urine storage system. There are few fixtures needed since urine is easily collected in simple capped, labeled bottles.

A typical system consists of a minimum of two tanks to allow accumulation and storage of urine and smaller bottles (typically, 2 quarts or liters) for collection in the privacy of one's residence prior to transfer to the tanks. Alternately, a simple dry urinal that collects urine in a tank and is rinsed after use to prevent odors, works well. Sequestration tank sizes are designed to accommodate the expected flow and storage for six months. Each tank is equipped with a label to indicate when it was filled. It then sits undisturbed for six months to neutralize any potential pathogens. In the meantime, subsequent tanks are filled. Once six months passes, the first tank contents are distributed to the base of plants and the plant and soil surface rinsed to avoid any odors and dilute the urine. It can then be refilled. Treated urine can be used in any garden area, including on vegetables, although it is recommended to avoid harvesting within 30 days of urine administration.

Alternately, the United States Environmental Protection Agency (EPA 932-F-99-068, *Septage Treatment/Disposal*) permits more rapid sterilization of urine with alkali (lime) at the rate of 25 pounds per 1000 gallons for thirty minutes.

The large tank capacity and salinity of urine prevent freezing in mild climates. Urine freezes at 23° F and expands 9% when frozen. For this reason, the tank should be filled only to 90% of capacity when any freezing weather is possible. In very cold climates, where extended freezing weather is expected, freezing protection needs to be provided such as by insulation, heating, or underground storage.

Here is an example system with an outdoor “Urination Station” containing a dry urinal and composting commode. Adjacent are one 55-gallon tank for the dry urinal and three 275 gallon Intermediate Bulk Container (IBC) tanks (made of HDPE) for long term urine sequestration. Urine is transferred from the smaller urinal storage tank to the long-term storage for sequestration prior to use.



(a) (b) (c)

Figure 17. An outdoor “Urination Station” with dry urinal and compost commode makes a convenient rest room facility. The short-term urine storage tank for the dry urinal is seen in the foreground (a). Photo of the rear showing 2 long term urine storage tanks (b). Only two tanks are seen in this photo; systems can have as many as are needed to accommodate the expected flow. The plan of the Urination Station shows the inside of the 4’x4’ structure with location of dry urinal and commode and the outdoor tanks (c).

(a) (b) (c)

(d) (e) (f) (g)

Figure 18. Long-term urine storage requires at least two tanks. Two IBC tanks (275 gallon, 1041 liter) fitted with a capped urine funnel on the top port (a, b). Adding urine from a bottle (c). The tank’s bottom discharge port (d) can be fitted with a convenient adapter (e) to facilitate transfer to a distribution container (f). When a tank is full, it is labeled with the date (g).

(b) (b) (c)

Figure 19. A dry urinal works well to collect urine (a). Rinsing after each use with a small amount of water will prevent odors. When installed outdoors, no trap is needed, just a sloped pipe to a storage tank (b). The tank is fitted with a pressure release at the top and a drain spigot at the bottom (c) for transferring the contents to the sequestration tank.

system capacity

Compost processor capacity. Typically, one adult fills one commode collecting container, containing 4 gallons of ETPA, per week. Each compost processor bin, with dimensions 4'x4'x44", has a volume of 59 cubic feet. With 20% shrinkage of material during the filling period due to the initial rapid composting, each bin will accommodate 64 cubic feet (at 7.5 gallons per cubic foot, 480 gallons), or 120 4-gallon buckets of ETPA, in addition to the additive used during the bin filling process.

Nineteen full time adults would be expected to create 76 gallons per week of ETPA, and hence fill one bin in 6.3 weeks. A 9-bin system would then be filled in 57 weeks, fulfilling the WE-Stand one year humus sequestration requirements.

This design can be easily adapted for installations having fewer, or more, bins. For example, a smaller installation could be designed with a single module of three bins that share one roof that could serve 4 adults comfortably with a one-year composting time. Four adults will fill 4 buckets per week. One bin will therefore be filled in 120/4, or 30, weeks. Three bins will be filled in 90 weeks, with a 60-week period separating the completion of the first bin and the completion of the third bin, just over the required one year humus sequestration time.

A system with two three-bin modules would be expected to accommodate 11 full time adults: each bin will be filled in 120/11, or 11, weeks. Six bins would therefore be filled in 66 weeks, with 55 weeks separating the completion of the first and last bins.

A system with four three-bin modules would be expected to accommodate 25 full time adults: each bin will be filled in 120/25, or 4.8, weeks. Twelve bins would therefore be filled in 57.6 weeks, with 52.8 weeks separating the completion of the first and last bins.

Humus production and use calculations. The compost typically diminishes in volume by 50% during the composting phase. For a 9-bin system, this means approximately 32 cubic feet of compost will be available per 19 users every 6.3 weeks. Spreading the compost 4" (1/3 foot) deep will therefore require an area of 32 *3 square feet, approximately 10'x10', every 6.3 weeks, or about 800 sq ft per year. With eleven users of a 6-bin system, one bin will be available every 11 weeks, decreasing the distribution area to approximately 500 sq ft per year. For a 3-bin system, only 170 sq ft will be required, and for a 12-bin system, 1080 sq ft will be required.

Urine storage and use calculations. Typically, with full time use, one adult will generate approximately 1.5 quarts (0.375 gallons) of diverted urine per day.

A urine storage area of three 275 gallon IBC tanks, each containing 250 gallons of urine storage, is sized to accommodate 7 persons, who will fill a tank every 14 weeks: 250/(7 persons @ 0.375 gallons/day/person)/7 weeks/day = 13.6 weeks. By the time the third tank is full, the first tank has sat at least 6 months and is ready to use. One additional tank will be ready every 13.6 weeks, for a total of 958 gallons per year.

A urine storage area of two 275 gallon tanks will be able to accommodate 3 full time users. (250 gallons / 180 / 0.375 = 3.7). Three users will fill the tank in 250/(3* 0.375)/7 = 32 weeks, well over 6 months.

A urine storage area of 4, 5, and 6 tanks will serve 11, 14, and 18 users, also with the required 6 month storage.

Urine is typically applied to a landscape with crops that have high nitrogen demand, such as rows of sweet corn or hills of cucurbits such as squash or pumpkins, at the rate of 1 gallon per 5 lineal feet of row twice in the growing season or 1, 2, and 3 gallons per cucurbit hill at one month intervals. Green leafy vegetables such as kale have similar requirements to corn and can be double cropped using winter gardening in Oregon's mild climate. With row spacing of 2', or 1 hill per 25 sq ft, a 10'x10' intensively cultivated vegetable patch can accommodate about 24 gallons per season for 2 crops, or total of 48 gallons per 100 sq ft plot, per year.

Summary, system capacities per compost bin and urine tank. Here is a table showing the number of persons who can be accommodated by different numbers of compost processor bins and urine storage tanks.

Table 3. System capacities as a function of compost bins

# 3-bin modules	# compost bins	# full time users accommodated	Bin fill time, in Weeks/bin	System fill time, weeks	Humus production per year, sq ft, at 4" depth
1	3	4	30	90	170
2	6	11	11	66	500
3	9	19	6.3	57	800
4	12	25	4.8	58	1080

Table 4. System capacities as a function of urine storage tanks

# IBC urine tanks (250 gallons)	# full time users accommodated	Tank fill time, weeks	System fill time, weeks	Tanks filled/year	Urine/year, gallons	Garden area required for urine distribution, sq ft, per year
2	3	32	64	1.6	411	856
3	7	14	42	3.8	958	1996
4	11	8.6	34.4	6.0	1506	3137
5	14	6.8	34	7.7	1916	3992
6	18	5.3	32	9.9	2464	5133

compost processor materials cost

A breakdown of the approximate costs of materials for the compost processor at the time of installation follows:

1. **Per 3 bin module, includes blocks, concrete, roof assembly:**

   \$(326+81+5+24+50+70+15+28+60+30+12+3) = \$704 (concrete blocks 272 @ \$1.2 = 326; concrete 27 bags @\$3 = 81; 2"X2" lumber: 5.3' =5.3' @ \$5/10' = \$5; 2"x4" lumber: 26.7' @ \$8/12'

= $24; 2”x6” lumber: 46.6’ @ $1/’ = $50; Roofing sheets: 2’wide x 6’ long: 7 = 3.5 2’x12’ sheets @ $20/sheet = $70; roof screws 2 packs @ $7.5 = $15; roof gaskets 5 packs @ $5.5 = $28; anchor bolt hardware: 12 @$5 = $60; hinges: 6 @ $5 = $30; corner braces: 6@ $2 = $12; latches: 1 @ $3 = $3)

2. **Plumbing materials, for three modules:**

   $ 70+40+45+20+20+15 = $210 (ABS 2” pipe: 70’ @$1 = $70; ABS 2” fittings: 20 @$2 = $40; Drain grates: 9 @ $5 = $45; Sump barrel: $20; Sump lid: $20; ¾” valve: $15)

3. **Miscellaneous costs:**

   $ 10+5+5= $20 (¼” hardware cloth: 1 roll @ $10; roofing screws: 2 packs @$7.5 = $15; gate hinge1 @ $5 = $5; gate latch 1 @ $5 = $5)

The total materials cost for a single 3-bin module described in this manual is: $704, not including the plumbing and miscellaneous parts. Therefore, the three module system described in this manual is 3*$(704+210+20) = $2342, or slightly less than $800 per 3 bin module.

find out more

The *Humanure Handbook* by Joe Jenkins is an additional resource on excreta composting and is available for purchase or can be viewed for free at www.humanurehandbook.com. The website also has a wealth of other useful videos, instructions and links.

appendix: system performance data

This section covers performance data from an experimental system of this design. Included are bin capacity measurements, temperature readings inside the compost bins, and results of pathogen monitoring of the system.

Compost processor capacity. This experimental system has been in use since March 18, 2014 and records show the capacity model mentioned above to be an accurate model of system performance. Logging of bucket and bin completion corroborates that each bin can hold approximately 120 buckets of ETPA.

Temperature data. To demonstrate the rapid onset and sustained high compost bin temperatures maintained in the compost processing area, weekly compost temperatures were monitored for two bins, measured at the center of the bin, at the perimeter of the bin, and 4" (inches) inside the perimeter.

Table 5. Bin #4 – Compost temperatures, weekly temperatures (°F) - Bin fill date 6/20/2015

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Center	160	150	134	132	131	128	128	120	96	90	77	80	75
4" inside perimeter	130	126	110	100	100	90	89	82	80	76	58	65	60
Perimeter	90	100	90	80	80	80	80	75	72	70	52	63	56
Date (Year 2015)	6/27	7/4	7/12	7/18	7/25	8/5	8/9	8/15	8/22	9/1	9/6	9/12	9/19

Given the rapid onset of high (pathogen killing) temperatures as noted by weekly monitoring, daily temperatures after adding a batch of compost, including the last batch, were then monitored. As the materials compost there is significant shrinkage and settling of the compost, as well as oxidation (and gasification, as water vapor and carbon dioxide). For this reason, a bin can be topped several times.

Table 6. Bin #6 – Compost temperatures, daily log (°F)

Days after filling	Before topping	1	2	3	4	5	6	7	8, 9, 10, 11	12	13, 14
Center	95	146	146	145	140	139	139	129	129	127	126
4" inside perimeter	70	100	110	116	110	109	105	107	109	109	109
Perimeter	68	80	85	90	94	88	86	90	92	91	91
Date	9/27/15	9/28	9/29	9/30	10/1	10/2	10/3	10/4	10/5-8	10/9	10/10-11

Daily temperatures after the bin was topped a second time (10/12/15):

Table 7. Bin #6 – Compost temperatures, daily log (°F)

Days after filling	Before topping	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Center	126	96	144	152	148	143	141	140	140	140	140	137	135	133	131
4" inside perimeter	109	110	114	114	113	113	113	113	113	111	110	109	108	108	107
Perimeter	91	96	98	98	97	97	98	98	97	97	95	94	92	92	91
Date	10/11/2015	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Daily temperatures after the bin was topped a third and final time (10/25/15):

Table 8. Bin #6 – Compost temperatures, daily log (°F)

Days after filling	Before topping	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Center	131	87	118	154	165	167	164	160	156	153	151	150	150	149	147
4" inside perimeter	107	118	130	135	135	133	132	130	129	127	125	124	123	122	121
Perimeter	91	77	80	82	83	85	84	84	83	82	81	80	79	79	78
Date	10/25/2015	26	27	28	29	30	31	11/1	2	3	4	5	6	7	8

To confirm the sustained high temperatures, monitoring of weekly temperatures continued for an additional nine weeks.

Table 9. Bin #6 – Compost temperatures, weekly log (°F) - Bin completed 10/25/2015

Week	0	Peak (Day 5)	1	2	3	4	5	6	7	8	9 Final check
Center	131	167	160	147	139	135	130	108	97	70	60
4" inside perimeter	107	133	130	121	113	105	91	73	71	63	56
Perimeter	91	85	84	78	72	65	56	49	49	45	40
Date	10/25	10/29	11/1	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27

Pathogen testing of compost. Compost samples were tested with the Micrology Labs Coliscan test for E. coli and total bacteria. To demonstrate pathogen elimination for all compost, each bin of compost has been tested, so far for the first 18 bins. Nine additional tests are planned.

Table 10. Pathogen testing of finished compost before emptying

Bin #	9	8	7	3	2	1	4	5	6
Date Bin completed	5/3/14	7/27/14	10/12/14	8/22/15	8/22/15	8/22/15	8/22/15	8/22/15	10/15/15
Pathogens Detected (fecal coliforms)	None (0 cfu/ g*)	None	None	None	None	None	2100 cfu/g	None	None
Test date	5/25/15	6/28/15	6/28/15	10/5/15	10/5/15	10/5/15	5/31/16	5/31/16	5/31/16

*cfu/g = colony forming units per gram of tested compost

Bin #	1	2	3	4	5	6	7	8	9
Date Bin completed	1/24/16	3/12/16	5/7/16	7/11/16	7/29/16	9/25/16	1/20/17	1/20/17	3/5/17
Pathogens Detected (fecal coliforms)	None	None	None	None	None	None	None	20cfu/g	None
Test date	5/5/17	5/5/17	5/5/17	5/5/17	5/5/17	5/5/17	12/15/17	12/15/17	12/15/17

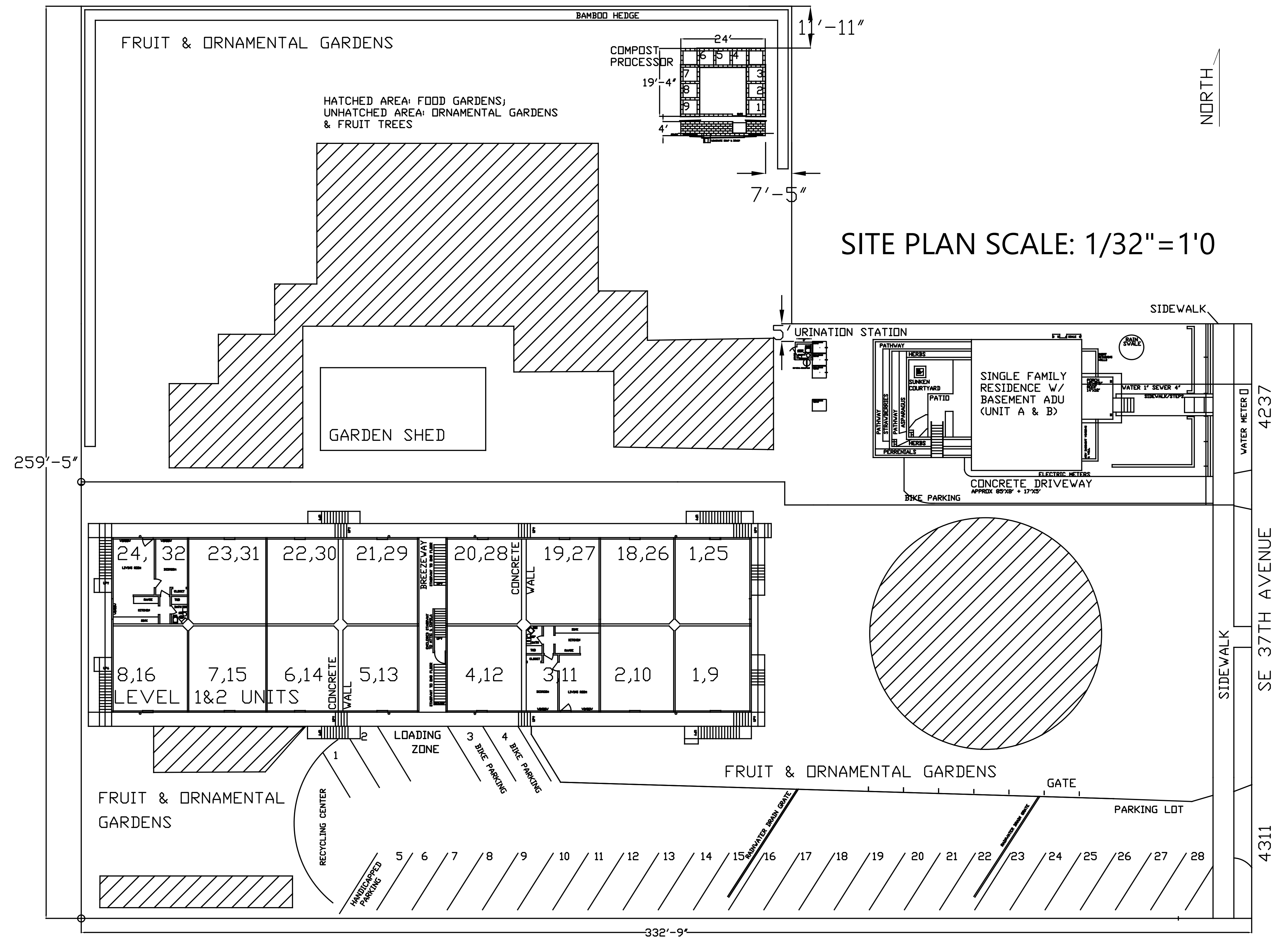
Bin #	1	2	3	4	5	6	7	8	9
Date Bin completed	9/27/17	9/27/17	3/16/18						
Pathogens Detected (fecal coliforms)									
Test date									

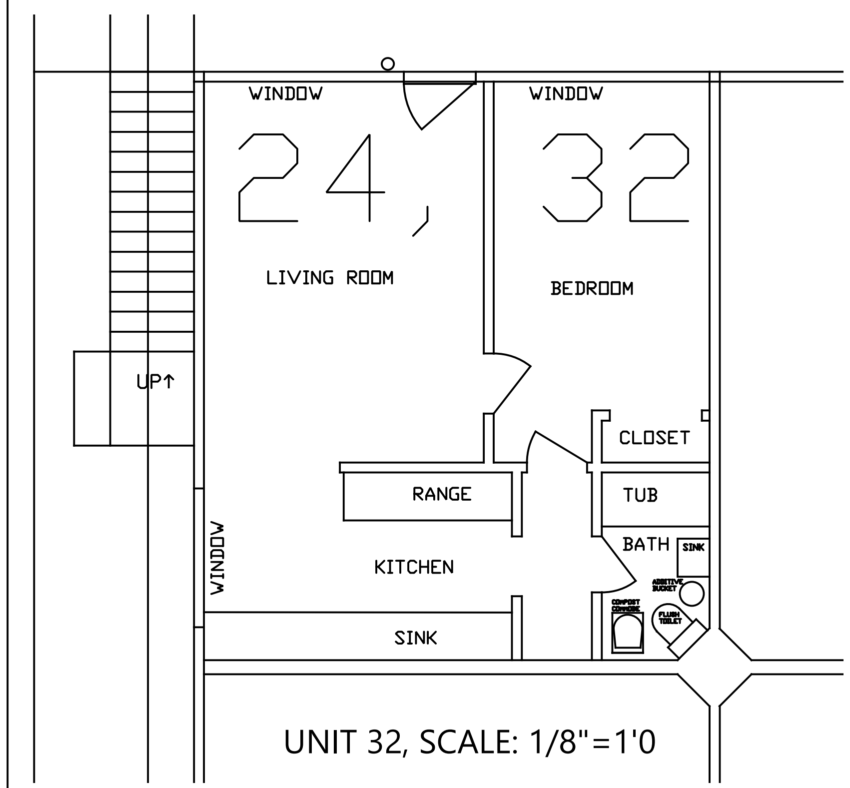
The only time significant fecal coliforms have been detected was when a bin was tested after leaving it open for several months while emptying. At that time, evidence of mice excavation was noted in the compost prior to testing. The compost likely contained murine fecal material.

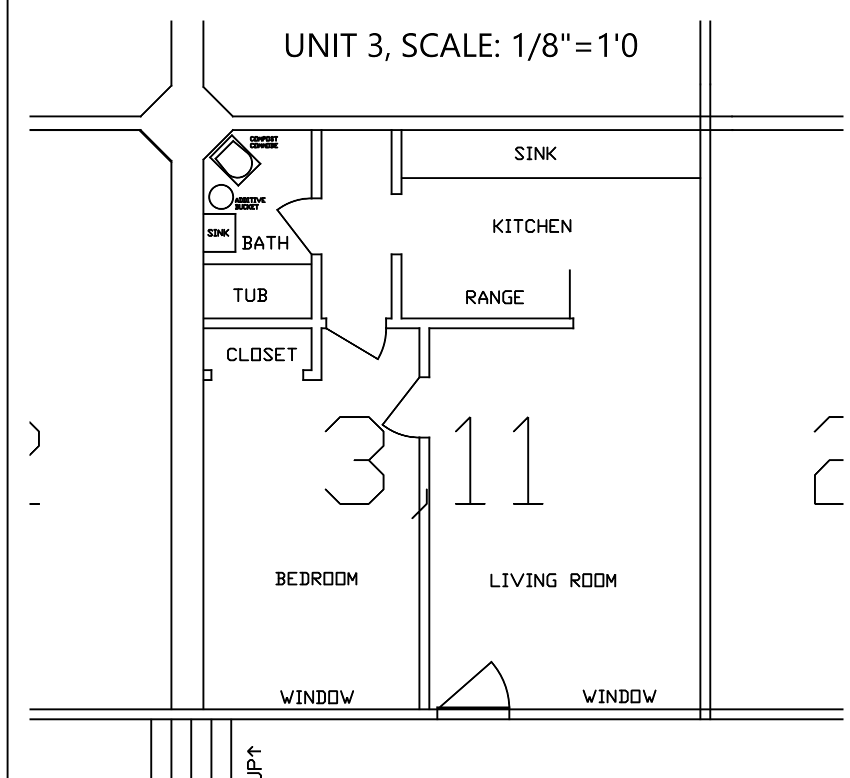
Otherwise, pathogen testing of all produced compost has demonstrated a high-quality product, exceeding the US Environmental Protection Agency pathogen standards for exceptional quality (Class A) biosolids (<1000 fecal coliform cfu/g), permitting application on any crops.

Therefore, these initial data, now spanning more than four years of performance, demonstrate clearly the high temperatures reliably reached in this batch compost processor, with subsequent pathogen elimination. Data gathering will continue in order to gauge performance. If system performance continues with similar results once three passes have been made through all the bins, further testing may no longer be necessary.

Pathogen testing of urine. Coliscan was also used to test urine for bacterial growth. On 4/7/2018, two months after the large urine storage tanks were installed, a one-week old urine sample showed significant bacterial growth, including large quantities of E. coli. However, two-month old urine, in a tank still being added to, showed no E. coli but small quantities of some non-coliform bacteria. The two samples had a pH of 9.5. This demonstrates the dramatic reduction of bacteria in aging urine. Six month aged urine has not yet been tested.







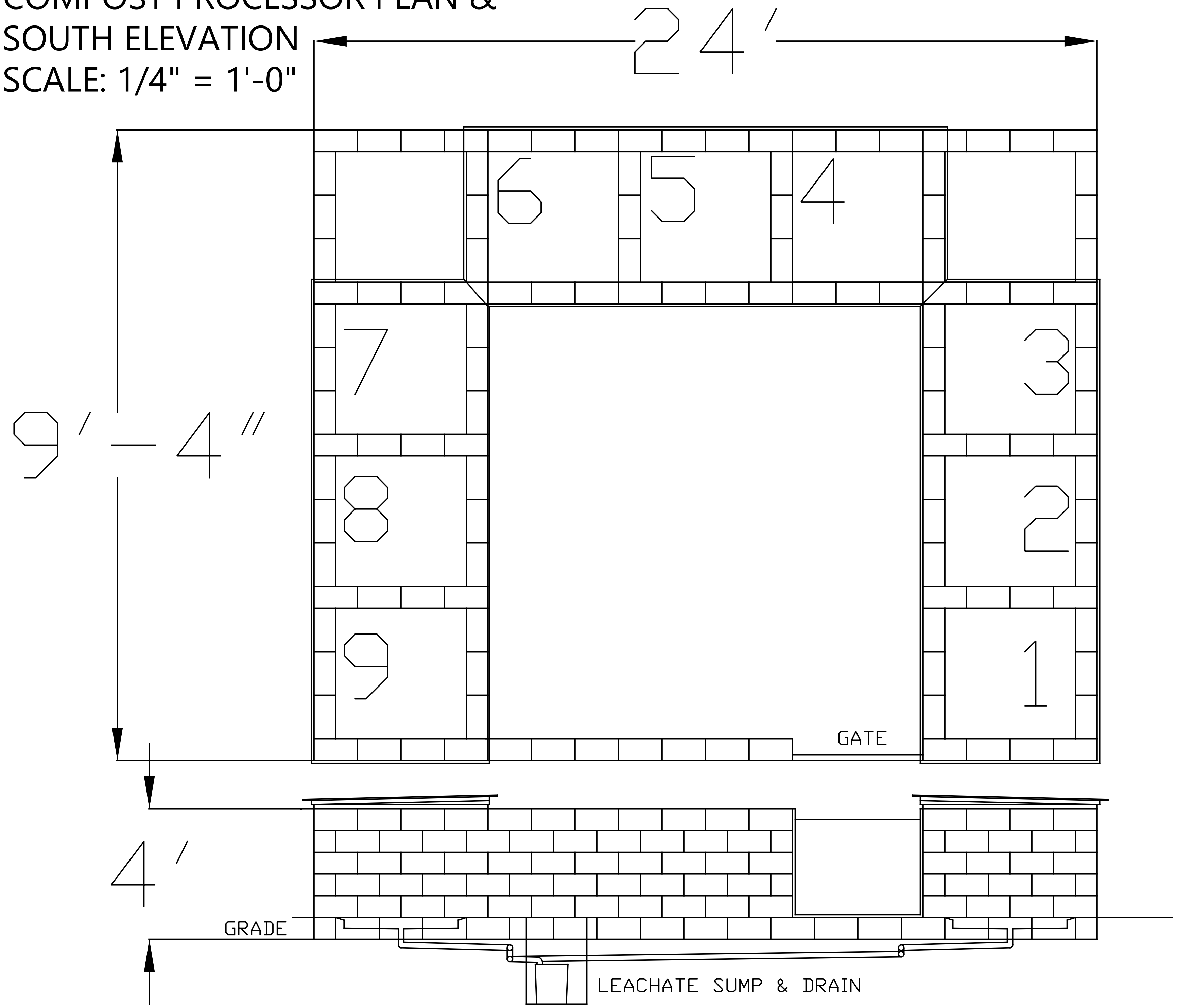
KAILASH ECOVILLAGE IAPMO WE-STAND COMMUNITY COMPOSTING TOILET & URINE DIVERSION SYSTEM

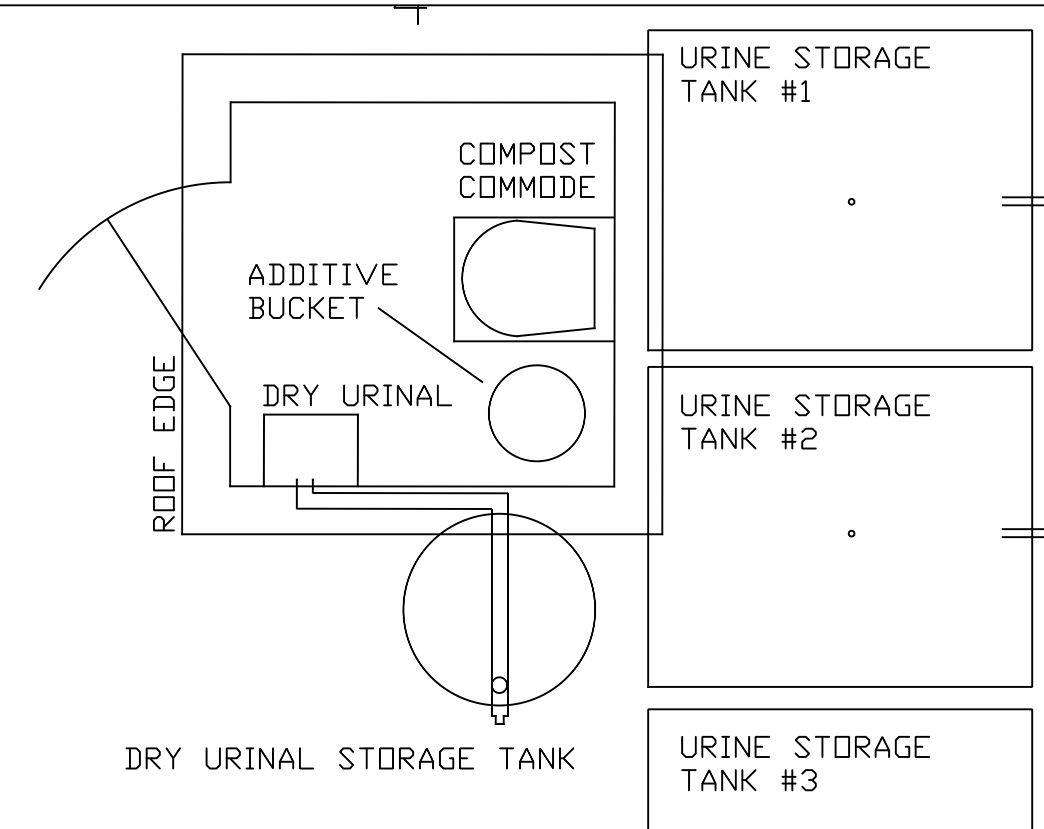
PROJECT: COMPOSTING TOILET & URINE DIVERSION SYSTEM
ADDRESS: 4237, 4311 SE 37TH AVE, PORTLAND OR 97202 R308457
OWNER & PROJECT MANAGER: OLE ERSSON

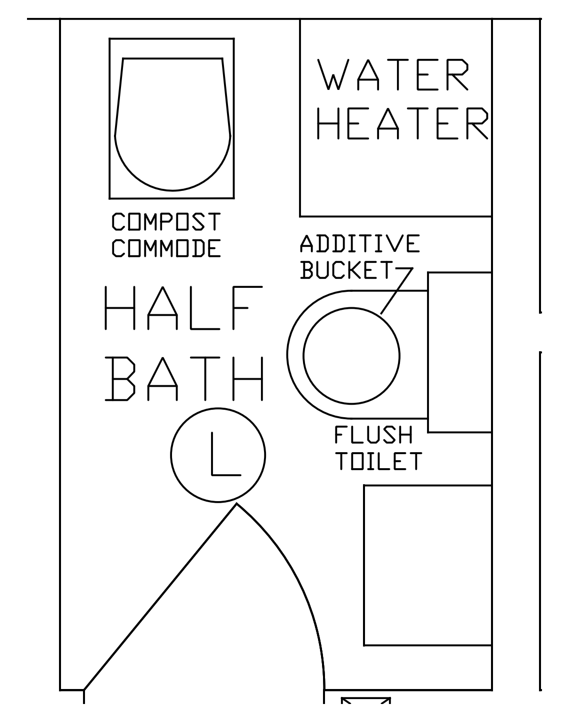
SHEET 1:
SITE PLAN, SHOWING COMPOST PROCESSOR. URINATION STATION, FOOD GARDEN AREA, MAIN BUILDING WITH UNITS 3 & 32, & PROPERTY LINE SETBACKS; DETAILS OF UNIT 32 & 3.

SHEET:
1 OF 3

COMPOST PROCESSOR PLAN & SOUTH ELEVATION
SCALE: 1/4" = 1'-0"







4237 UNIT B HALF BATH

SCALE:
1/2"=1'0

OUTDOOR URINATION STATION.

KAILASH ECOVILLAGE IAPMO WE-STAND COMMUNITY COMPOSTING TOILET & URINE DIVERSION SYSTEM

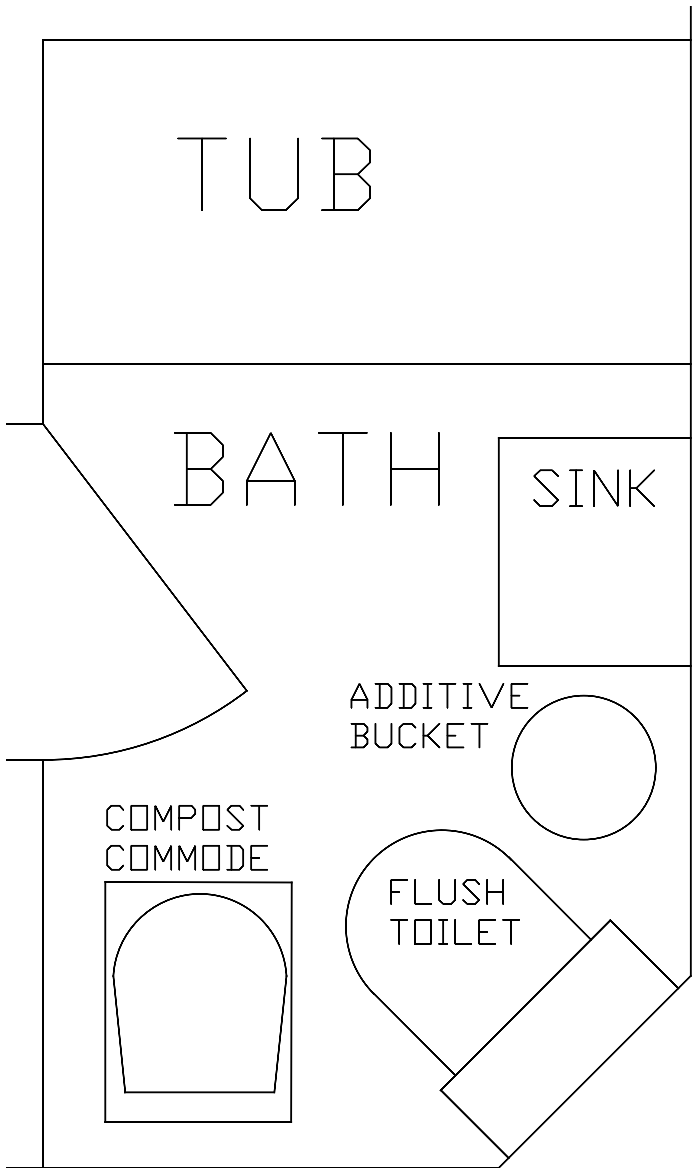
PROJECT: COMPOSTING TOILET & URINE DIVERSION SYSTEM
ADDRESS: 4237, 4311 SE 37TH AVE, PORTLAND OR 97202
OWNER & PROJECT MANAGER: OLE ERSSON

SHEET 2:
DETAIL OF COMPOST PROCESSOR, URINATION STATION, & 4237 UNIT B HALF BATH SHOWING PLACEMENT OF SUPPLEMENTAL COMPOST COMMODE & ADDITIVE BUCKET

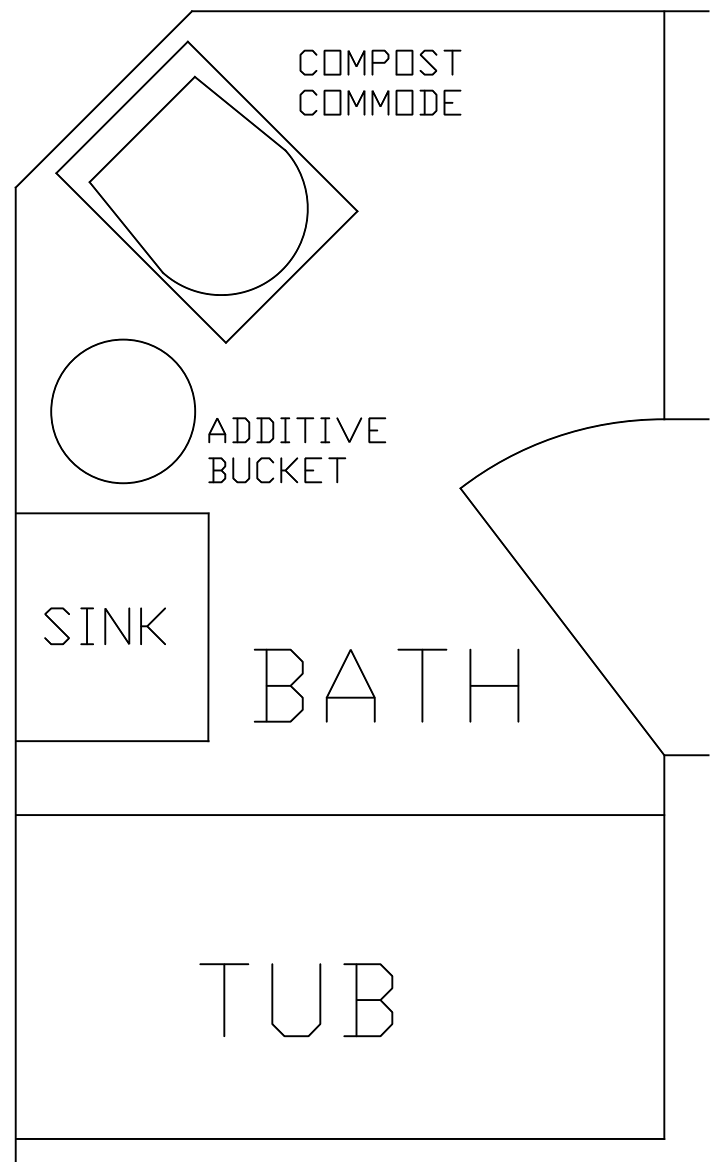
SHEET:
2 OF 3

4311 UNIT 32 & UNIT 3 BATHROOMS; TYPICAL OF ALL 1-BEDROOM BATHROOMS

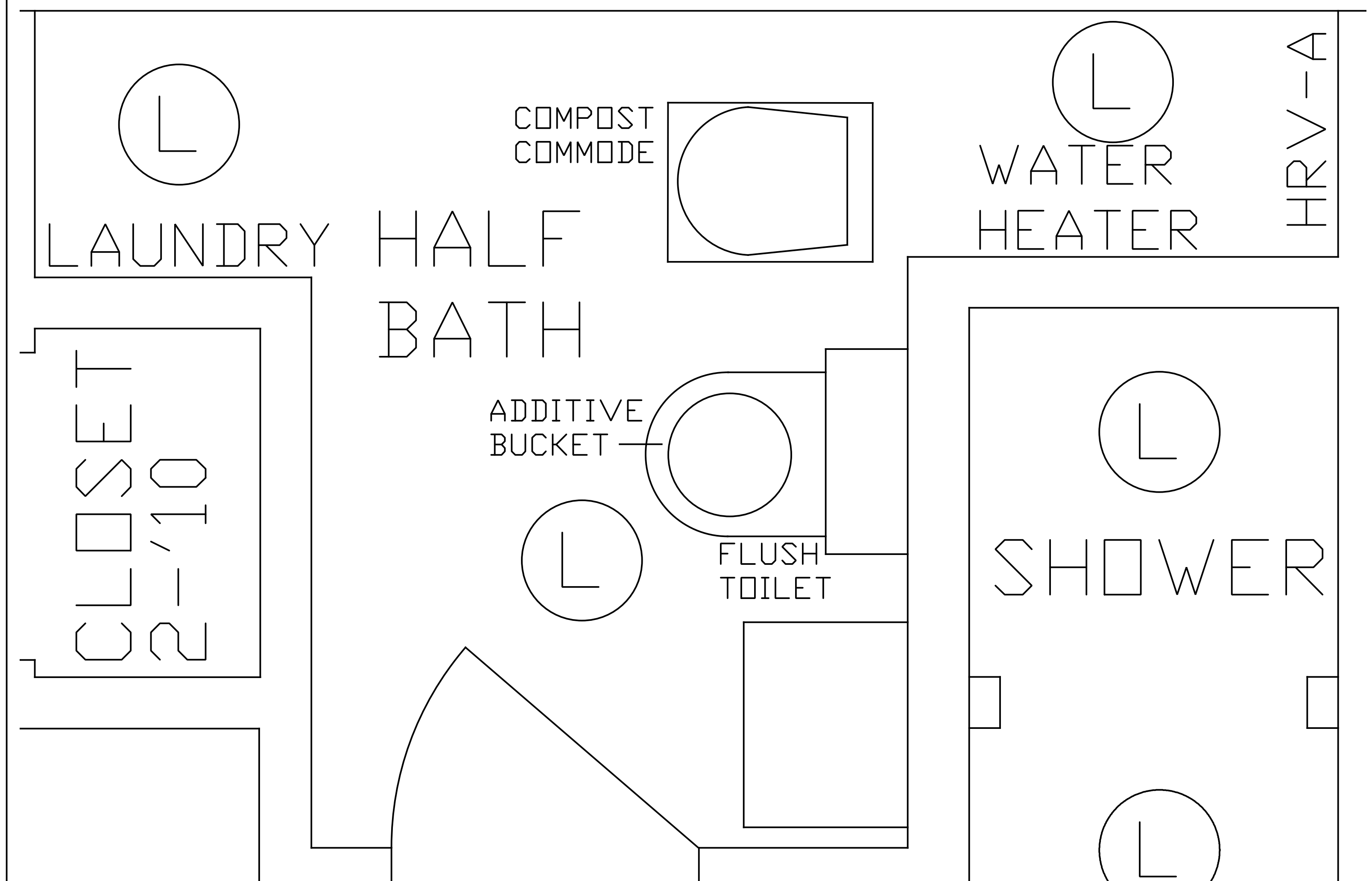
UNIT 32: SUPPLEMENTAL COMPOST COMMODE.



UNIT 3; MODIFIED TO REMOVE FLUSH TOILET TO MAKE SPACE FOR COMPOST COMMODE.



4237 UNIT A HALF BATH: SUPPLEMENTAL COMPOST COMMODE PLACED NEXT TO FLUSH TOILET; ADDITIVE BUCKET SITS ON TOP OF EXISTING FLUSH TOILET LID.



KAILASH ECOVILLAGE IAPMO WE-STAND COMMUNITY COMPOSTING TOILET & URINE DIVERSION SYSTEM

SCALE: 3/4" = 1'-0"

PROJECT: COMPOSTING TOILET & URINE DIVERSION SYSTEM
ADDRESS: 4237, 4311 SE 37TH AVE, PORTLAND OR 97202
OWNER & PROJECT MANAGER: OLE ERSSON

SHEET 3:
DETAIL OF 4311 UNIT 32 BATH & 4237 UNIT A HALF BATH SHOWING PLACEMENT OF SUPPLEMENTAL COMPOST COMMODE AND ADDITIVE BUCKET NEXT TO EXISTING FLUSH TOILETS; 4311 UNIT 3 FLUSH TOILET REPLACED BY COMPOST COMMODE.

SHEET:

3 OF 3