FARALLONES

(Batch Type)

COMPOSTING TOILET

CONSTRUCTION AND MANAGEMENT NOTES

SHIT THROUGH HISTORY: A SHORT PHILOSOPHICAL DISCOURSE

"Deine eigene Scheisse stinkt nicht" . . . . . . Albert Einstein

Put yourself in the position of a future archeologist sifting through the material remains of our culture some hundreds of years from now. What will he make of the curiously shaped ceramic bowl in each house, hooked up through miles of pipe to a central factory of tanks, stirrers, cookers and ponds, emptying into a river, lake or the ocean?

"By early in the twentieth century urban earthlings had devised a highly ingenious food production system whereby algae were cultivated in large centralized farms and piped directly into a ceramic food receptacle in each home."

Our future archeologist would have to be a genius to guess at the destructiveness and insanity to present day "sanitary engineering."

Mix one part excrement with one hundred parts clean water. Send the mixture through pipes to a central station where billions are spent in futile attempts to separate the two. Then dump the effluent, now poisoned with chemicals but still rich in nutrients, into the nearest body of water. The nutrients feed the algae that soon use up all the oxygen in the water, eventually destroying all aquatic life that may have survived the chemical residues.

All this adds up to a strange balance sheet: the soil is starved for the natural benefits of human manure, garbage and organic materials that go down the toilet, the drain and to the dump. So agribusiness shoots it up with artificial fertilizers made up largely from petroleum. These synthetics are not absorbed by the soil and leach out to pollute the rivers and oceans. We each use 30 to 40 thousand litres of fresh water annually to flush away material that could be returned to the earth to maintain its fertility. Our excreta - not "wastes" but misplaced resources - end up destroying food chains, food supply and water quality in rivers and oceans.

Nations endure only as long as their topsoil. How did it happen that we devised such an enormously wasteful and expensive system to "solve" a simple problem? Excrement is the only substance of material value that we ever return to the earth. Indeed, our body "waste" is truly a resource out of place.

Wendell Berry suggests that primary criterion for a successful culture is to realize a balanced relation between the process of growth and the processes of decay. He notes that our society, which exclusively values growth and looks upon the processes and products of decay as "waste", is radically out of balance.

The way we handle shit also reflects our attitude towards the body and its function. The development of Mr. Crapper's water closet and urban sewer systems coincides with the ascendance of Victorian priggishness typified by clothing that disguised the body's true form from head to foot. The gleaming white functional bathroom was perfected in the twenties - a period noted for its crusade against "germs" - those nasty creatures in the Listerine ads. One wonders how the bacteria that sustain our lives ever survived the rhetoric of the antiseptic hygiene age.

East and West developed very different attitudes and practices in relation to the human body and its processes. In China and Japan, "night soil" has been scrupulously collected for centuries to fertilize the fields. A nineteenth century visitor to Japan tells us that in Hiroshima in the renting of poorer tenement houses, if three persons occupied a room together the sewage paid the rent of one. If five people occupied the same room no rent was charged. Farmers vied with each other to build the most beautiful roadside privy in hopes of attracting the favours of travelers who needed to relieve themselves.

Rational excreta disposal systems in the Orient grew out of its importance to agriculture. Carts traveled through the cities collecting the precious stuff and carrying it off to dung heaps where it decomposed. In the West no such practice ever existed. Chamber pots were emptied into the back yard or street. Some of the streets were designed so that gutters would carry off the filth during a rain. Most of the time, city streets were not pleasant places to be: it is easy to smell how shit got a bad name.

In nature, water carries off wastes, and excrement is just another nasty waste. Early sewerage systems emulated natural processes. The open gutters, washed clean only by rain, were gradually put underground to minimize the appalling stench and mess. In the 1800's, it was discovered that many then common epidemic diseases were transmitted through microorganisms in faeces, but by then the psychological and technological die was cast. The basically unsound practice of dumping excreta into any convenient body of water was rationalized. The flush toilet eliminated direct contact with excreta. The smell and mess were removed from city streets and put into underground pipes. Methods to "treat" sewage by settling out solids, adding chemicals to kill bacteria, and more recently, aeration to speed decomposition, were invented.

We assume that by "flushing and forgetting" we are rid of the problem when we have only compounded it by moving it to another place. Every tenderfoot camper knows not to shit upstream from camp, yet present urban culture provides us no alternatives. Estimates show that a quarter of all urban sewage is dumped into the water. In Oakland and San Francisco raw sewage has been dumped into San Francisco Bay during the rainy season because the sewage plants cannot handle the additional volume of storm drainage. The rivers, bays, and oceans around half of our urban areas are cesspools. The "waste" we seek so hard to ignore threatens to bury us.

FUNCTIONS

The compost privy has been designed to decompose human excrement and organic household waste in a safe and sanitary manner without the use of water or plumbing. The compost privy takes the place of the flush toilet, the septic tank and the garbage can.

ADVANTAGES

1. You can use the compost toilet where sewer hookups or septic tanks are unavailable or not practical.

2. The compost privy saves water normally flushed through the toilet, about half the annual domestic water consumption: 30,000 - 40,000 litres per person can be saved each year.

3. The compost privy chamber can be built by amateur builders using new, common materials and common tools for around $750*, (not including roof and upstairs walls nor any transport costs), a considerable saving over the usual flush toilet/plumbing/septic tank combination.
   (*June, 2001 estimate) This figure could be reduced considerably depending on your ability to scrounge and recycle.

4. The compost privy returns valuable nutrients and humus to the soil. Between 30 -60 cubic centimetres of humus are produced from each person's excreta in a year.

5. The compost privy allows you the use of the squatting position, which is the healthiest posture for defecation.

LIMITATIONS

1. The compost toilet does not receive wastewater other than urine. Household wastewater from sinks, bath and shower may be diverted into the garden, re-cycled through a solar still or emptied into a sump pit and leaching lines.

2. The proper operation of the privy requires your attention. You are managing a complex biological machine that has no moving parts.

3. The compost privy requires floor space of 1.2 x 2.4 metres with a 1.2 metre deep holding tank underneath that must be accessible on one side.

4. Compost privies have been designed by experts in public health and sanitation primarily for use in rural agricultural areas throughout the world. However, local building and health officials are likely to be unfamiliar with them, and reluctant to grant permits for their use. One purpose of this Bulletin is to provide local officials with evidence that the compost privy meets acceptable standards of public health and safety.

DESCRIPTION

The toilet consists of a two-chamber concrete box 1.6m x 1.1m x 2.2m outside dimension. Each chamber has a capacity of about 1.3 cubic metres. The plywood, or compressed fibro, top is fitted with an opening over each chamber to receive excrement, household wastes and additional high carbon content organic matter. Only one chamber is used initially. The front of the box has two removable plywood, or compressed fibro, doors with screened air inlet vents. A 100mm, or 150mm, PVC flue allows the passage of exhaust gases up and out. After a minimum of 6 months the first chamber can be closed down and the second chamber can be brought into use. Although not essential, the turning of the waste heap with a garden (or pitch) fork at this stage will aid the speed and effectiveness of composting. A similar timetable should be followed for the filling of the second chamber, thereby allowing a minimum of 12 months before the first chamber is emptied and the compost used in the orchard or flower garden. As an added factor of safety we recommend not using the compost directly in the vegetable garden.

THEORY AND PRACTICE OF OPERATION

Composting is the term applied to any man-managed process of bacterial decomposition which returns organic materials to the soil as humus. Two types of decomposition occur in nature through the action of bacteria and other microorganisms.

Aerobic decomposition occurs, for example, on the forest floor. Dead leaves, animal remains, faeces and other materials are stirred and broken up by animal and insect life. Bacteria that live in the presence of oxygen process the material through a series of chemical changes which reduce its mass to about one twentieth of its initial volume.
The results of the process are nitrogen-rich, earthy humus and carbon dioxide, both necessary to plant life. In nature, the process of building topsoil through aerobic decomposition is extremely slow. It takes hundreds of years to build an inch of topsoil.

Anaerobic fermentation is a decomposition process produced through the action of bacteria that live without oxygen, as in a swamp, marsh or manure pile. Dead organic material goes through a series of chemical changes to produce humus, nitrogen, carbon dioxide and gassy by products that give the anaerobic process its distinctively unpleasant odour.

Aeration:

Aerobic bacteria live only in the presence of oxygen. To ensure good aeration from the start, place up to 300mm of loose, dry straw or grass over the bottom of the chamber. I use the best part of a bale of straw for each chamber. Aeration is supplied by air flowing through the vents, over the pile and up the flue. Additional, optional aeration can be supplied by turning the pile occasionally. Fold the outside layer into the centre. The more often the pile is turned, the quicker decomposition takes place under optimum conditions.

Priming the chamber

After adding the bedding straw you must introduce the microorganisms and insects necessary for composting to take place. Two or three buckets of topsoil and/or fresh compost spread on top of the straw will do the trick.

Adding worms:

Composting worms, such as Red Wrigglers or Tiger Worms, can be added to the chamber to encourage faster, more complete breakdown of the contents. Try a couple of fists full of worms in the active chamber once the organic matter has had a couple of weeks to build up. After swapping from one chamber to the other you may need to add some moisture to the maturing chamber from time to time so the worms don't dehydrate. This can be done by using the maturing side to urinate in. This has the added advantages of helping reduce the likelihood of an excess moisture build up in the active chamber and increasing the fill time for the chamber (extra dry bulking material is likely to be necessary when urinating in the active chamber).

Moisture content:
The ideal aerobic compost pile is moist but not wet, fluffy and loose, not dense and matted. Since faeces are 65-80% moisture, light dry material such as dry leaves, wood shavings, sawdust, shredded or screwed-up newspaper, chopped dry grass or straw must be added after each use to keep the pile from becoming too wet. If you live in a bush setting it may be possible to urinate outside the privy to avoid the pile becoming too wet, however, if you do urinate in the toilet it is important to add some of the above-mentioned dry bulking material.

Temperature:
The temperature at the centre of the aerobic pile can reach 70°C, and regularly reaches 63°C. Maintaining optimum temperature means the pile must be large enough to insulate its centre, and it can be turned to supply oxygen and incorporate freshly deposited material.

Size of pile:
The optimum size of an aerobic pile is a cubic metre. A smaller pile doesn't hold the heat well. In starting the composting process, additional organic materials should be added to build the pile as quickly as possible. A bed of straw, wood shavings, shredded paper or similar material about 30cm deep is recommended. Faeces should not compose more than a quarter of the total mass.

Nitrogen ratio
Organic material contains varying amounts of carbon and nitrogen. Faeces contain about 6% nitrogen, urine 15-18%. The optimum environment for the microorganisms decomposing the pile is 30 parts of Carbon to each part of Nitrogen. Too much nitrogen or other absorbent organic material slows or changes the process. Throw in a 500gm. coffee can of sawdust after each use of the privy.

CALCULATIONS

Faeces should constitute no more than 20-25% of the composting material. Human waste per person per day averages 225gm faeces (moist weight) plus 3 litres urine. A yearly average equals about 145kg faeces and $0.2m^3$ urine. At 22 kg/litre and 1,100-litres/cubic metre, this equals $0.08m^3$ faeces, $0.2m^3$ urine. Decomposition reduces this raw wet volume to one-twentieth its original volume, or about ***one cubic foot per person per year.*** (We use 30,000 - 40,000 litres of water per person per year to flush away what naturally reduces to something you could lug around in a 20 litre can!). Government sources say to size a privy at 80cc./person/year. Figuring a volume of other organic waste five times that of human waste, two 1m x 1m x 1m compartments would serve a family of four for a year and the unit in the attached plans should serve a family of five.

SQUATTING

The ideal posture for defecation is the squatting position, with the thighs flexed upon the abdomen. In this way the capacity of the abdominal cavity is greatly diminished and intra-abdominal pressure increased, thus encouraging the expulsion of the faecal mass. The modern toilet seat in many instances is too high even for some adults. The practice of having young children use adult toilet seats is to be deplored. Bekus, Gastro-Enterology, p.511

Man's natural attitude during defecation is a squatting one, such as may be observed amongst field workers or natives. Fashion, in the guise of the ordinary water closet, forbids the emptying of the lower bowel in the way Nature intended . . .. . . it is no over-statement to say that the adoption of the squatting attitude would in itself help in no small measure to remedy the greatest physical vice of

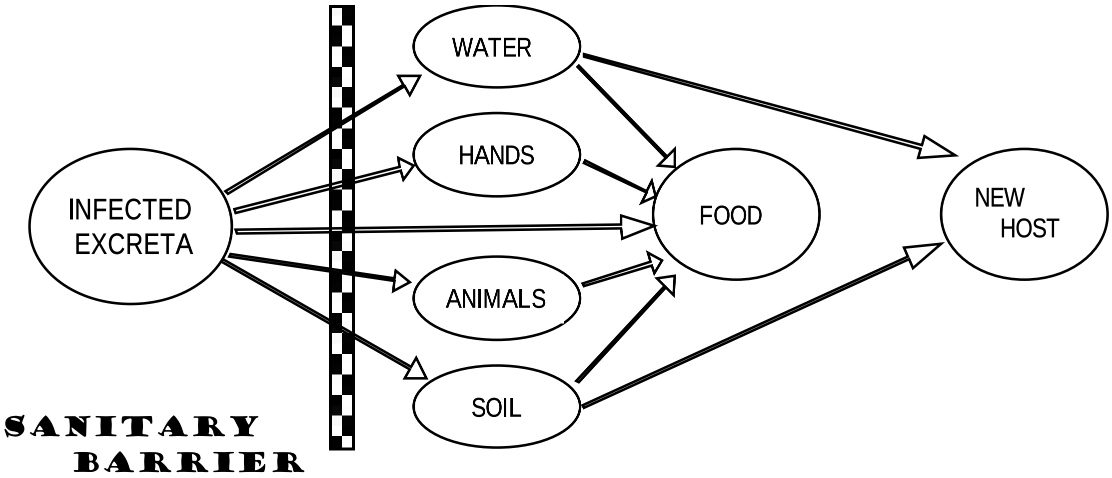
the white race, the constipation that has become a contentment.
Hornibrook, The Culture of the Abdomen, p.75

It should be mentioned in this connection that a very common cause for unsatisfactory results . . . is improper height of the toilet seat. It is usually too high. An ideal seat would place the body in the position naturally assumed by man in primitive conditions. The seat should be low enough to bring the knees above the seat level. Williams, Personal Hygiene Applied p. 374

Quotes on the virtues of squatting, from The Owner Built Home, Ken Kern

PUBLIC HEALTH CONSIDERATIONS

Diseases can be transmitted through microorganisms (pathogens) in human faeces. Faecal-born bacterial diseases include typhoid, para-typhoid and cholera. Protozoa found in faeces transmit amoebic dysentery and other intestinal ailments. Worm eggs and other intestinal parasites are also carried in faeces. Lack of basic precautions in the disposal of human excreta continues as a major cause for ill health in the world. The need for basic procedures to protect public health is very real.
Any acceptable method of excreta disposal must provide a barrier between raw excreta and possible means for the transmission of disease. Disease from the faeces of infected persons can be carried to new hosts through contact with soils, water animals, or hand. The chain of disease transmission is diagrammed below:



Faecal matter may directly pollute drinking water. Cholera epidemics in the Orient have been traced to the use of raw human manure as a fertilizer, washing into drinking supplies. Leaf and root vegetables grown in infected soil can transmit disease. Insects and rodents that come in contact with infected material transmit disease by contaminating foodstuffs. Unwashed hands that have been in contact with infected soil, water or faeces are a common carrier.

The purpose of laws regulating the design and construction of individual household excreta disposal systems is to make sure that an adequate sanitary barrier is provided so that public health is protected. Sanitation and public health experts have developed criteria and designs for a number of types of acceptable low cost systems that are in use throughout the world. The compost privy constructed and used as described in this Bulletin meets the following accepted criteria that insure a sanity barrier:

1. ***Excreta cannot come into contact with surface soil, surface water or ground water.***
In the composting privy, all waste materials, with the exception of "grey"(dirty) water from sinks and baths, goes directly into the concrete chamber ,which is sealed from contact with the ground. A concrete slab and curb prevents seepage. No water enters the system and the liquids in the pile escape as vapour through the vent or are oxidised by microorganisms. "Greywater" may be run into a holding tank to allow scum and grease to float to the top, and then dispersed through leaching lines or directly into the garden. Since water consumption is reduced by about 30% through the use of the privy, the number of metres of leaching line or holding capacity will be similarly reduced. 180 litres/person/day would be adequate.

2. ***Excreta cannot be accessible to insects or animals or children.***
The concrete design is impervious to penetration by pests. Insect screening at the vents prevents flies from entering. If the privy is freestanding from the house, it should be provided with a screen door. The main insect problem is flies, which can pass through a 3mm crack. Flies are attracted by smell and seek light. Sprinkling sawdust on fresh material, and of course, keeping the lid or cover down when the privy is not in use will prevent any fly nuisance. If you are adding kitchen scraps make sure you take all precautions to exclude insects from scraps prior to their addition to the toilet. Should fly infestation occur hydrated lime or wood ash can be sprinkled on the surface of the pile regularly, concentrating on areas where the larvae are most active, until the flies are eliminated. Alternatively, spray the flies and larvae with pyrethrum. Cockroaches can also be treated with pyrethrum but their entry to the chamber should not be possible if the chamber is properly sealed. Normal compost pile insects such as "slaters" are quite O.K. and shouldn't pose a health problem. If all of the above methods fail the last resort is to swap chambers, if the previous chamber has been maturing a minimum of 6 months, or empty the infected chamber and bury the contents.

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3. ***There should be no noticeable odour or unsightly conditions.***
There will be no odour if the design and operating instructions are followed carefully. Make sure the cover fits tight and the vent is unobstructed. If odour becomes noticeable it is due to one or more of the following reasons: -

- Pile is too small, or wrong proportions, unable to maintain hot temperatures
- Too wet (add more dry wood shavings or straw and/or turn and mix the pile, check liquid drain hole for any blockage)
- Too high nitrogen (add more wood shavings or straw, high C/N material - too much nitrogen smells like ammonia.)
- Anaerobic process will smell like rotten eggs. (Not enough oxygen - turn the pile)

4. ***Construction must be durable.***
The concrete provides a tight, sealed chamber, impervious to weather, bacterial action and other conditions.

5. ***Finished material must be free from pathogens and safe to build the soil.***
Laboratory and field experiments confirm that pathogens cannot survive the normally high temperatures of aerobic composting, nor do they survive very long in material that is allowed to age. Proper composting and lengthy exposure to the elements are the cornerstones to purification. Beyond this, only sterilizing all finished material with heat to kill all microorganisms, good and bad, can guarantee complete safety.

The test procedure followed to study pathogen survival is to inoculate a batch of material with known pathogens, follow specific composting and aging procedures, and then analyze the material in the laboratory.

Westerberg and Wiley (Applied Microbiology, Dec. 69) inoculated sewage sludge in an aerobic composter with polio virus, salmonella, ascaris eggs and candida albicans. The temperature of 47-55°C maintained for three days killed all indicator pathogens. Gotaas confirms similar experimental results, indicating that few organisms are able to survive temperatures of 50°C for more than an hour. He suggests that natural “biological antagonisms” in the pile negatively affect the survival of pathogens.

Other evidence indicates that simple aging kills pathogens. Rodale reports (Organic Gardening and Farming, Feb. 1972, p.45) experiments by Bernard Kenner of the Environmental Protection Agency (USA). Raw sewage inoculated with salmonella was applied directly to the soil. Indicator pathogens survived a maximum of 21 weeks.

SWAPPING CHAMBERS

When the first chamber is full it is closed down for a further minimum maturing period of 6 months. Each chamber should take from 6 to 18 months to fill depending on the number of users and the volume of other materials, such as kitchen scraps, which are used.

I recommend that one removes the access door and uses a pitchfork, or garden fork to turn the heap in order to incorporate fresh materials into the centre of the pile. If you don’t wish to turn the pile a less preferable option is to cover the pile with a good layer of sawdust, straw or soil. The maturing pile can tend to dry out in time. I like to keep the contents moist for more complete composting so we urinate in the maturing side.

The matured compost from the dormant chamber can be removed using a garden fork and in accordance with local health authority guidelines. Keep a bucket or two of the compost to prime the new pile once the chamber floor has been lined with straw or similar material. If you used worms hopefully they will retreat to the back corner and can be put aside and reintroduced to the chamber. You will need to lift the false floor to clear any compost, which has fallen through and make sure the vents in the back corners and the liquid drain are clear. Before closing the access door you need to lay down a fresh bed of straw etc. and put a couple of buckets of the newly removed compost back in as a primer. You can also lay some weed mat, shade cloth or geo fabric on top of the mesh (and lapping up against the baffle) to help prevent the composting material falling through and blocking airflow under the mesh.

These notes have been adapted from The Farallones Institute “Technical Bulletin No. 1 Composting Privy” .The attached plans have been modified from the original Farallones Institute design by Sim Van der Ryn, Tom Anderson and Ken Sawyer - prototype built in 1973.

The following is an excerpt from the

N.S.W. HEALTH DEPARTMENT GUIDELINES FOR WATERLESS COMPOSTING TOILETS: -

“ 26.1 REMOVAL OF COMPOST BY THE HOUSEHOLDER

Removal of the compost should be carried out in accordance with the following.

- The minimum composting period shall be as specified by the Local Authority approval. A statement to that effect must be included in the owner/operators manual.
- The composted material is to be disposed of by burial within the confines of the premises in soil, which is not intended to be used for the cultivation of vegetables or used in pastures where animals may graze. The minimum cover of soil over the composted material is 100mm.
- Composted material shall only be removed from the WCT during normal operation and through the access door provided for that purpose.
- Disposable gloves and a disposable dust mask shall be worn by the person removing the compost from the WCT.
- Material which has only been partially composted shall be removed from the WCT subject to the written consent of the Local Authority, which may issue instructions as to who may remove the material and the method of disposal of the material. Removal off-site requires the approval of the Local Authority.

26.2 DISPOSAL OF END PRODUCTS

26.2.1 Excess liquid from the WCT shall be treated and disposed of according to Local Authority requirements.

26.2.2 The composted end product shall be disposed of according to the above requirements and any additional Local Authority requirements.”

THESE PLANS ARE SUPPLIED ON THE UNDERSTANDING THAT THIS COMPOSTING TOILET SYSTEM HAS NOT BEEN APPROVED BY THE HEALTH DEPARTMENT OR ANY OTHER AUTHORITY IN N.S.W.

In N.S.W owner builders may be given conditional approval by local councils to build a composting toilet. The onus is then on the individual builder to prove that his/her unit is operating according to Health Dept. guidelines. It is recommended that you ask your local council for a copy of the state health department guidelines for waterless compost toilets, and any local regulations that may apply and familiarise yourself with them before submitting an application to build your toilet.

CONSTRUCTION NOTES FOR MODIFIED FARALLONES TYPE (BATCH) COMPOSTING TOILET

1st May, 2005

I have included some details for the room above the composting chamber with these plans as an example; however, there are no construction details or materials list included for the upstairs section, as there are many possible options for this part of the loo.

We first built one of these units at a forest retreat centre on our property over 27 years ago. The chambers are still in operation today, although the upstairs timber room has been replaced with ferro-cement due to termite damage. In the original design there is a single drop hole above the permanently “active “chamber. When this chamber is full the composting material is shoveled into the maturing chamber. The active pile has to be turned regularly. The addition of extra venting and a hole above both chambers has meant a much lower maintenance system.

I intend to update these plans and notes from time to time, as further innovations and useful information become known to me. I encourage anyone who uses these plans to contact me with any suggestions or comments, which may lead to the further enhancement of the design, the ease of construction of the toilet or cost savings.

Ray Flanagan

MATERIALS LIST

Cement (40kg bags)	9 bags
Sand	0.7cubic m.
Gravel (20mm)	1.3cubic m.
Brickie’s sand	3 sacks
Trench mesh (3 bar F8)	17m
Reinforcing mesh (F72)	1.7m x 2.3m & 1.5m x 2.1m
Reinforcing bar (10mm)	6m x 2 *(optional)*
Threaded rod (gal.10mm)	2.4m + Nuts & washers x 20 each
Concrete blocks (20x10x40cm)	63 x full, 5 x ¾, 9 x ½, 10 x 1¼
Brick ties	5
PVC pipe (100 or 150mm)	6.5m
PVC (100 or 150mm) “T” joiner	1
PVC caps	2
Form ply (17mm)	2.4 x 1.2m
Gal. mesh (25x50mm)	2 x 1.2 x 2m
Silasec (waterproofing)	1 litre *(optional)*
Silicone sealant	1 x 300gm tube
Wastewater drains	50mm x 2 *(optional)*
PVC pipe (50mm)	to reach absorption trench
PVC (50mm) 90° bend	4
PVC (50mm) junction	1
Hammer drive metal anchor (30mm)	24
Aluminium angle (or gal. iron)	30 x 30mm x 2.5m
Plastic (20L) bucket etc for chutes	2
Fly wire	20 x 40cm
Rat wire	20 x 40cm
Ply or comp. fibro(12mm) bench top	2.05m x .68m + 2.05m x .375m *(optional)*
Fence droppers	6
Or lightweight Gal. Angle	6m

FOOTINGS [see page 17]

I would recommend a 30cm x 30cm concrete footing *, with two layers of three bar trench mesh, under the three external walls. The section across the front could be 20cm deep as it doesn't carry much of the load. The slab is thickened to 15cm under the dividing wall and is reinforced with steel mesh. The footings and slab should be poured in one piece. A number of 10mm starter bars, or threaded rod, can be set into the footings to tie in the block work. (See details under "Concrete Block Work". To accurately position your footings it is best to set up batter boards (or profiles) and use a line level and square. The slab and footings will use about 0.9 cubic metres of concrete.

**Council advice should be sought to ascertain the appropriate size footings for your particular soil type.*

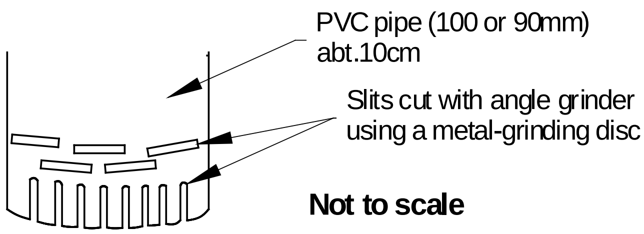
SLAB / DRAIN [see page 17]

The concrete slab floor should have a minimum fall of about 10mm from the rear to the access doors. Additionally, the slab in each chamber could slope inwards towards the drains to maximise the removal of excess liquid but keep edges and centre, where blocks are to be laid, at uniform height, if possible, to make block laying easier.

The drains are usually set into the slab when pouring. You will need to take the pipe through or under the footing. I use 50mm PVC or polyethylene pipe (any smaller and it could easily block up with sawdust etc. A similar drain hole arrangement to a bathroom floor or shower recess would work well. The drain hole should be towards the front of each chamber and either in the centre or in one corner of the chamber. Place them so that there is at least 50mm from the end of the blocks to the outside of the hole. This allows for a reasonable thickness of the curb at this point. A corner situation would make the sloping of the slab towards the drain less difficult. Alternatively they can be set into the curb so they exit almost horizontally.

You will need to use some type of screen over the drain holes to stop them blocking up with material, which may fall through the mesh floor. I use a short section of 90 or 100mm PVC pipe, with slots or holes to drain liquid. I place this over the hole and set it partly into the concrete curb as it is poured. This will hold it snugly in place.

WASTE WATER FILTER DETAIL



The drains should lead into an evaporation pit or *agricultural drain (a* drain of dimensions 400 x 300mm x 2 to 3m long containing slotted drainage pipe surrounded by course blue metal would suffice) or into an existing greywater system. If the waste is running into a septic tank, it is advisable to install an "S" trap in the line to prevent odours backing up into the toilet chamber.

CONCRETE BLOCK WORK [see Plan View "A" and "B" page16]

The outside walls are laid first. When setting out the wall lines on the footing, allow approx. 100mm between the blocks and the edge of the concrete to ensure blockwork will be centred on the footings. An easy method to mark out the corners of the chamber is to place one of the corner blocks on each corner at the correct distance apart, then use a long straight edge to adjust the blocks so the sides are all square to each other. Brick ties are inserted in each course of the back wall to tie in the centre-dividing wall. Galvanised threaded rod or cup head bolts (for fixing of chamber doors) must be inserted between the 1st and 2nd and the 4th and 5th courses. Bend the ends at least 45°, to stop them turning when tightening, and leave 40-50mm protruding. They

should be long enough to bend down into the cavity in the block. I fill the front cavity with cement or mortar to strengthen the bolts hold and to give a solid base for fixing the angle iron which houses the baffles. The mortar I use to lay the blocks is one part Portland cement and three to four parts brick layer's sand. A dash of detergent added to the water will act as a plasticiser, making the mortar easier to work.
When inserting threaded rod (for access door securing) chip out a small channel in the end block to allow the rod to sit down at least 1/2 its diameter to allow the block above to seat properly. Use a scutch* or cold chisel.

On some jobs (where extra strength is needed, as for an exposed site) I insert short (abt. 20cm above top of concrete) starter bars in the slab to coincide with the cavities in the blocks. You need to locate these accurately to avoid the later hassles of chipping off pieces of blocks or bending the bars. If you do need to bend a bar slip a length of iron pipe over the bar for leverage and a more acute bend. A scutch chisel will remove pieces from a block with less chance of cracking the block. A stronger, but more expensive, option is to use threaded rod. The rod is joined to the threaded starter bar using a joining nut. The rod could protrude above the block-work and tie in to the upstairs frame. Steel bars are not necessary if the chamber is built under an existing floor or on a site protected from strong winds. The threaded rod can be fixed after the slab has set using either epoxy glue or 'Loxins', that lock into a hole drilled in the concrete.

I place bars in the following positions (see Plan "B"): -

One on each of the wall ends - 10cm from end

Two near each back corner -30cm from the corner

One in centre of back wall - 120cm from either corner

Remember that the short side of a corner block has no cavity.

* *A masonry chisel with several small teeth*

After course one another length of steel bar can be inserted next to each starter bar. Each of the cavities is filled with concrete. Given the size of the cavities it is easier to fill them as the wall goes up rather than after all blocks are laid. Use 5mm aggregate, or better still, blue metal dust. Mix the metal (or crusher) dust 6:1 with cement - no sand is necessary. Use a short length of steel bar or similar to pack it down.

CHAMBER FLOOR

Each chamber has a steel mesh "floor" about 75 to 100mm above the slab to allow aeration under the compost pile. My preference is for galvanised mesh with 50mm x 25mm (or 25 x 25) bar spacing. However, if cost is a major consideration plain steel mesh is O.K. or corrugated iron (with holes to allow airflow). Both will corrode relatively quickly but can be replaced cheaply. Use a sufficient number of props to give the mesh adequate support but make sure there is plenty of space for the air to circulate. Over time fine compost will fall through the mesh and block the airflow underneath. Usually, by the time this happens, the heap is well on the way to humus and would no doubt continue the process regardless of the lower ventilation, albeit a little slower. I set the props in rows from front to back, leaving a clear area for scraping out compost that has fallen if I do wish to re-establish the underside ventilation. I usually lay a sheet of "geotextile fabric" weed mat or shade cloth on top of the steel mesh to help stop the fines from falling through.

UPPER FLOOR

A concrete slab floor is poured on top of the compost chambers. This will require about an extra 0.3cu.m of concrete.
The slab can be supported by formply propped in place until the concrete sets, or a sheet of 4.5mm moisture resistant fibre cement sheeting can be laid on top of the block walls. Some temporary supports will be needed for the sheeting but it is not removed. A space should be left around the edge of the blocks so that the slab can key in to the walls. The sheeting needs only to overlap the blocks by about 30mm. It is probably easier to cut out the drop holes and holes for the vents before

installing the sheeting. A cheaper option to the fibre cement or formply is corrugated iron sheeting cut to size and supported by temporary props. Alternatively the iron could overlap the blocks and be left in place. Short lengths of threaded rod can be set into the slab to attach the upper timber frame. These should have a near 90° bend at the end.
The side supports for a poured concrete upper floor could be 125 x 50mm (or 37mm) timbers propped in each corner. Overlap the top of the block-work by 25mm. The side pieces are cut to the same length as the chamber and the front and back extend past the chamber by about 10cm either end. The corners can be nailed together or I use a length of 10mm threaded rod which passes through the end of each of the longer timbers to pull them together. If there is any bowing of the longer pieces (unlikely with 50mm thickness) you may need a diagonal prop or stay attached to a peg in the ground and nailed to the formwork. If you use plywood formwork underneath make sure there is adequate clearance at the sides of the forms for them to be lowered and removed. Any gaps between the formply and block-work must be covered with duct tape or plastic as the forms will jam if concrete runs into the cracks. The props under the formply are easier to remove if in two parts - for example, cut the props a few centimetres less then necessary and build them up with small blocks or run a bearing timber between sets of props (see Plan "C" page 17).

A sheet of heavy (15mm) compressed fibre cement could be used on top of the chamber as an alternative to the concrete.

F72 reinforcing mesh should be used for strength. Cut out around the drop holes and the flue hole. I usually wire in a few steel bar off-cuts to the mesh around the holes. The holes can be formed by making a 10cm wide ring from sheet metal pop riveted, or taped, together, as an alternative to the plastic bucket. The advantages are - easier to screed the slab to a uniform thickness and hole can be made any diameter. I prefer a larger hole (up to 40cm) - uses less concrete and the chute can be wider (less cleaning) However, regulations require a max chute diameter of 190mm. Commercial C.T.s often have a larger chute with a pedestal tapering down to 190mm.

An alternative to bolting bottom plates to the slab as a starter for the throne room: - set post anchors (stirrups) into the wet concrete or drill and use concrete anchor bolts later.

If the chamber is to be built under an existing floor it is advisable to finish the blocks short of the floor by at least 20cm to create a termite barrier. The top could be sealed using a sheet of compressed fibre cement with the drop holes and vent holes cut out. A sheet metal chute, preferably stainless steel, or plastic pipe, would bridge the gap between the floor and each of the chambers. Six-millimetre sheeting can be used with a number of wooden supports above. The fibre cement is nailed to the timber to provide support.

COMPOST CHAMBER

The curb is formed by pinning a piece of timber, 40 to 50mm high, across the front of the 2 chambers. I use a crusher dust and cement mix (6:1). Make sure the timber is not bowed or it could be difficult to seal the doors properly. I simply batter the inside edge, until the curb is about 100mm thick, so there is a gentle curve to make scraping out the chamber easier. You will need about 1½ buckets of concrete.
The internal surfaces, apart from the slab, can be painted with a moisture-proofing sealer (such as “Bondcrete”) to seal in any moisture. Alternatively, for a more durable option, a cement render containing “Silasec” or similar sealer can be plastered on the walls and floor. The render is 6 parts sand, 1 cement and 1 lime. Mix Silasec 5:1 with water and add to the dry mix. The blocks need to be wet down before rendering and the render (2 to 5mm thick) applied with a steel plasterer’s trowel. Fine plasterer’s sand is best for this job but sieved brickie’s sand is O.K.
I use 17mm Formply (pre-painted) for the chamber doors as it handles the moist environment well. It isn’t worth trying to scrimp on the doors. Thinner ply may buckle and be difficult to seal properly. If the ply is bowed let the bow face inwards. The tightening of the bolts will usually straighten the ply. I have also used 9 and 12mm compressed fibro sheeting. I cover the vent holes with vermin wire then a layer of fly wire, or fine stainless steel mesh. I hold the wire down with either aluminium angle or rigid plastic strips and stainless steel screws. The doors should sit 5 or 10mm above the slab so they don’t get ‘wet feet'. The doors are 1.085m wide x 1.05m high.

BAFFLES (see page16)

The baffles can be constructed from a variety of materials, depending on your budget. A hardwood frame with chicken or bird wire attached is a fairly cheap option. Forget softwood unless it is chemically treated for rot resistance. A light gauge galvanised steel angle frame can be joined with pop rivets. Wire this to a sheet of gal. mesh (the off-cuts from the floor should be large enough) and you have a durable baffle. As with the floor mesh, fine wire sheeting or shade cloth can be attached to the mesh to minimise the amount of fine compost falling through. A good height for the baffles is about 55cm, however, I have come down to 50cm in order to get the most out of a sheet of mesh and avoid cutting into a new one.

The slats that hold the baffles in place are lightweight galvanised steel (30 x30 x 2.5mm) or aluminium angle. These are easily fixed to the blocks using “hammer drive anchors” or plastic plugs and galvanised or stainless steel screws. The front ones can be about 30 to 35cm long and the rear ones about 20cm.

SEAT

I believe the bench height shown in the plans is a good compromise to facilitate both squatting and sitting. A wooden or plastic toilet seat can easily be attached behind the drop hole and can be swung back against the wall when not in use.

High density Styrofoam stick-on strips can be used around the edges of the hole covers to give them a good seal. You can buy 12mm wide by 6mm thick strips from a motor trimmer’s or use a strip of foam used in concrete expansion gaps. It can be cut using a sharp knife and glued on using silicone sealant.

You will need a chute to connect the seating/squatting bench to the concrete slab. Here are some options :-

- A large plastic bucket (20cm, or more, diameter), with the lower end removed, works well. The bucket is set in position while the slab is poured. The point where the bucket joins the seating bench should be sealed to prevent insect entry.
- A strip of flat, galvanized, colour bonded or stainless, steel riveted into a tube shape.
- A 25 or 30cm diameter sewer pipe. Some plumbing supply stores will sell these by the metre.

A larger chute will usually require less cleaning.

A round cover could be cut for the bench or if you stick to the rectangular hole make sure it is not longer than the width of the chute. You could use the toilet seat **only** for either option but the seat would require some modifications so that it creates a fly proof seal. Some wooden seats are easier to modify, but less moisture tolerant than plastic. Squatting would become more difficult if the seat could not be lifted clear of the bench. An alternative to the squat bench running the full length of the upper room is a pedestal, which fits tightly over the hole. The pedestal is simply moved across to the active chamber and a cover (plywood?) made for the hole of the maturing chamber. Construction can be from timber or any number of other materials but the inner chute should fit neatly into the hole in the concrete to ensure fly exclusion.

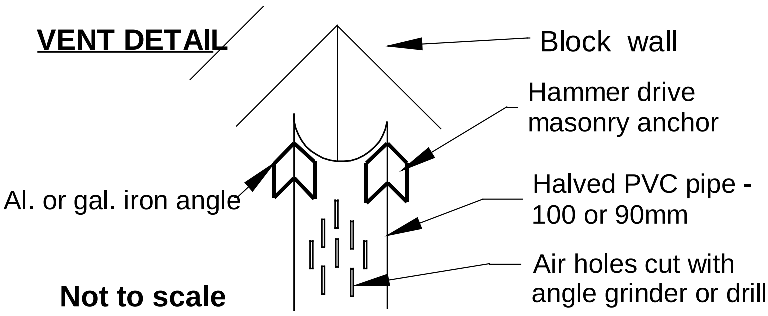
FLUE

The flue, or vent can be 100mm PVC storm water pipe or, if your budget can handle it, I would recommend a 150mm flue to create a really good draft. I have recently begun to use this size pipe in the hope of eliminating condensation on the toilet seat but have yet to see the results. The fittings for 150mm pipe are expensive so I have eliminated all but the top “T” by leaving out one of the blocks in the last course of the centre wall. The flue enters the slab above the gap created by the missing block so as to service both chambers. You may want to screen the gap between the chambers to prevent cross infection should one chamber become fly blown. The flue should be screened to prevent flies from entering. Cut a hole in the cap leaving about 5mm around the outside, then cut a piece of fly wire to fit the cap.

The flue shown in Section AA” is contained within the upper room. A straight flue vents best. If necessary the flue could pass through the back wall. Use 45° bends if possible. Painting the exposed part of the flue with black paint will increase the draft.

VENT PIPES (see page 15 & 16)

The by-pass vent pipes in the back corners of the chambers will need to be attached to the chamber. The best method I have found is to attach a couple of 4cm lengths of 4 x 4cm gal. Iron, or aluminium angle, to either side of the pipe to pin it in place. I place these towards the top of the vent so that when the floor mesh is removed the vents can slide down clear of the angle. Make sure that the props for the mesh floor do not obstruct the flow of air up the vents.



EXPANDED CAPACITY

The chamber size can easily be expanded to cope with more bums. You could lay an extra course or more of blocks or increase the width and/or breadth by anything from ½ up to 2 blocks.

Construction notes and plans for the modified Farallones compost toilet was prepared by: -

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PLAN VIEW "A"

(Showing Block Layout - 1st, 3rd & 5th Courses)

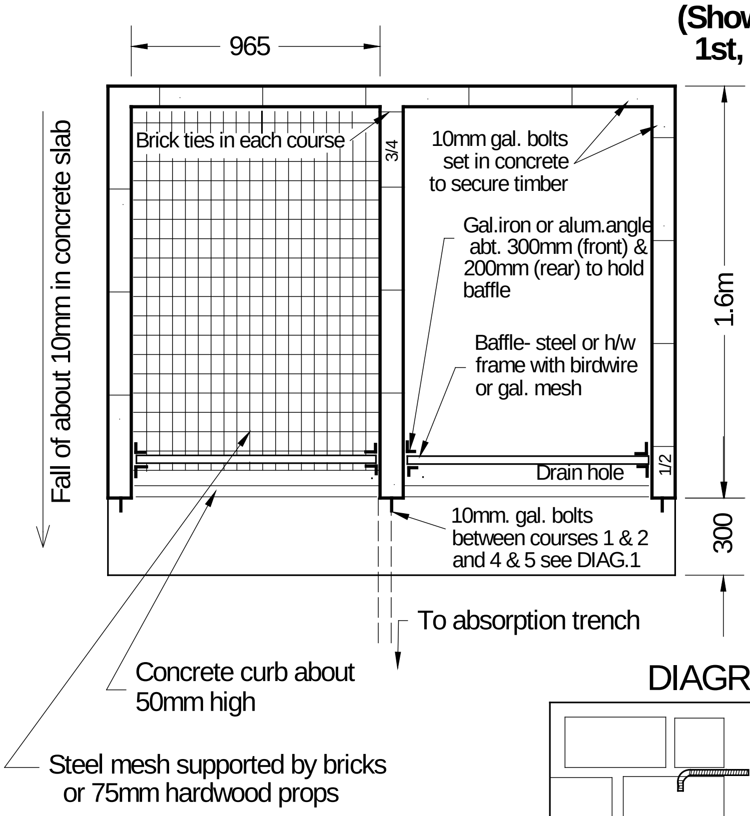
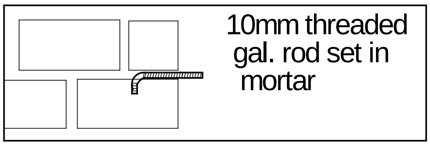
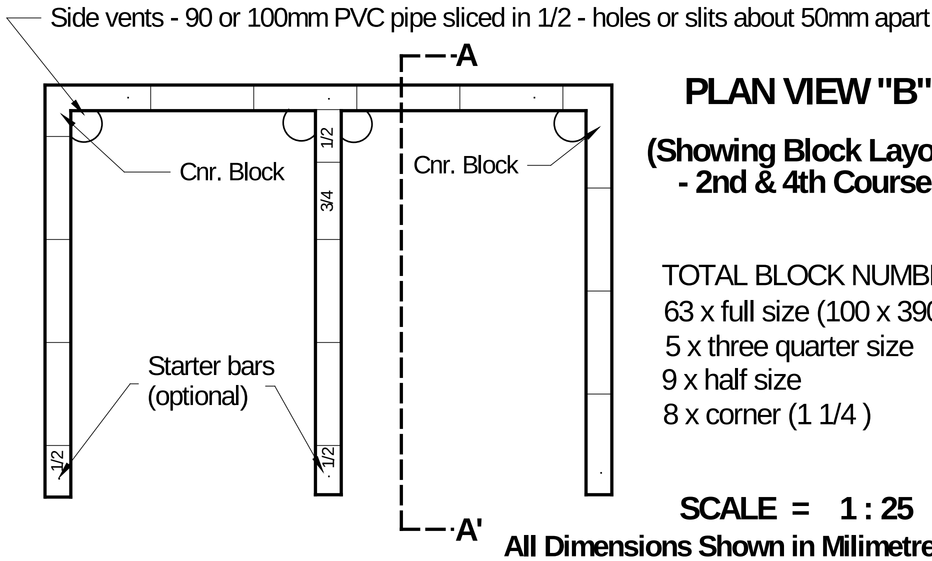


DIAGRAM 1





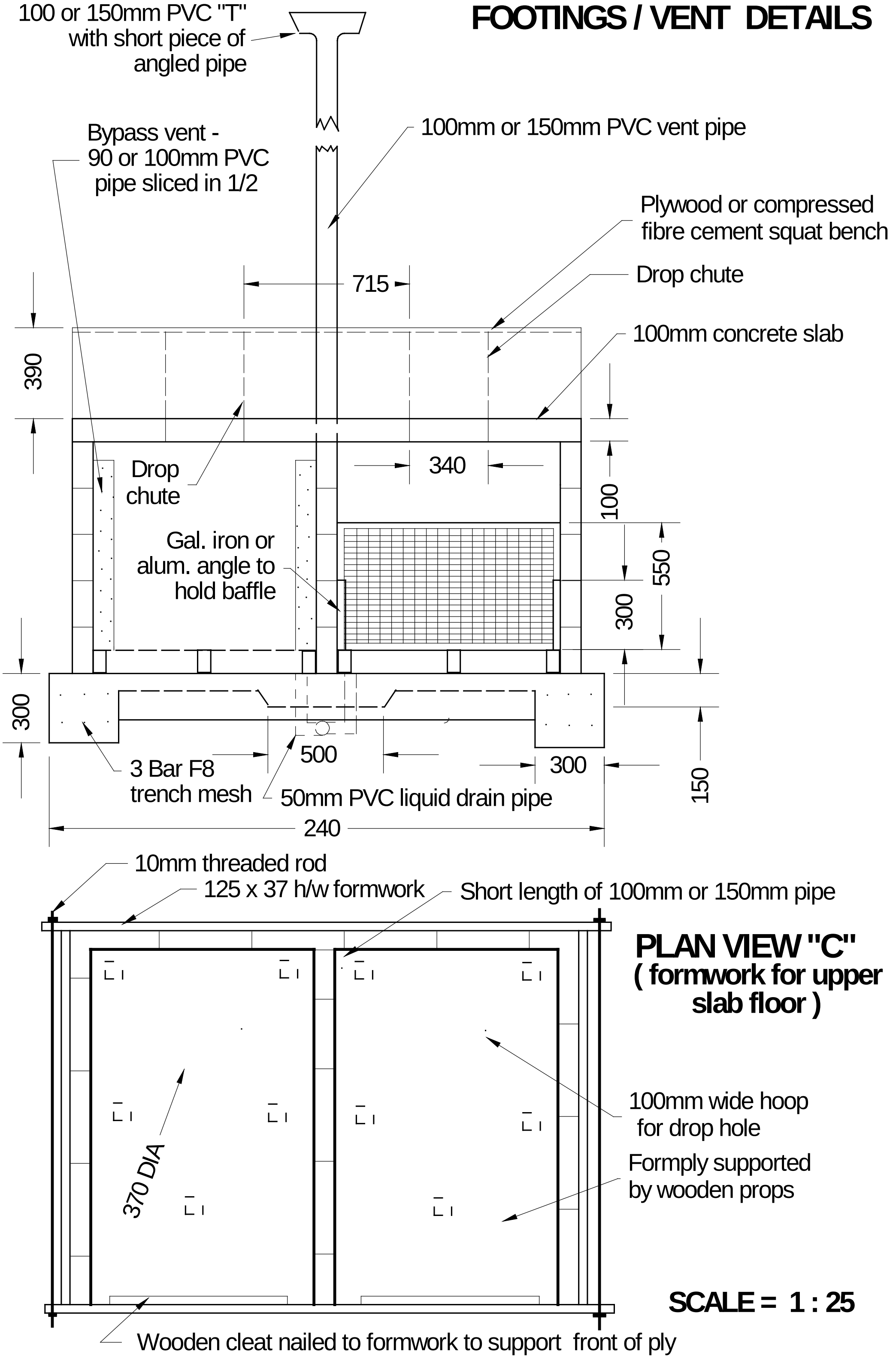
PLAN VIEW "B"

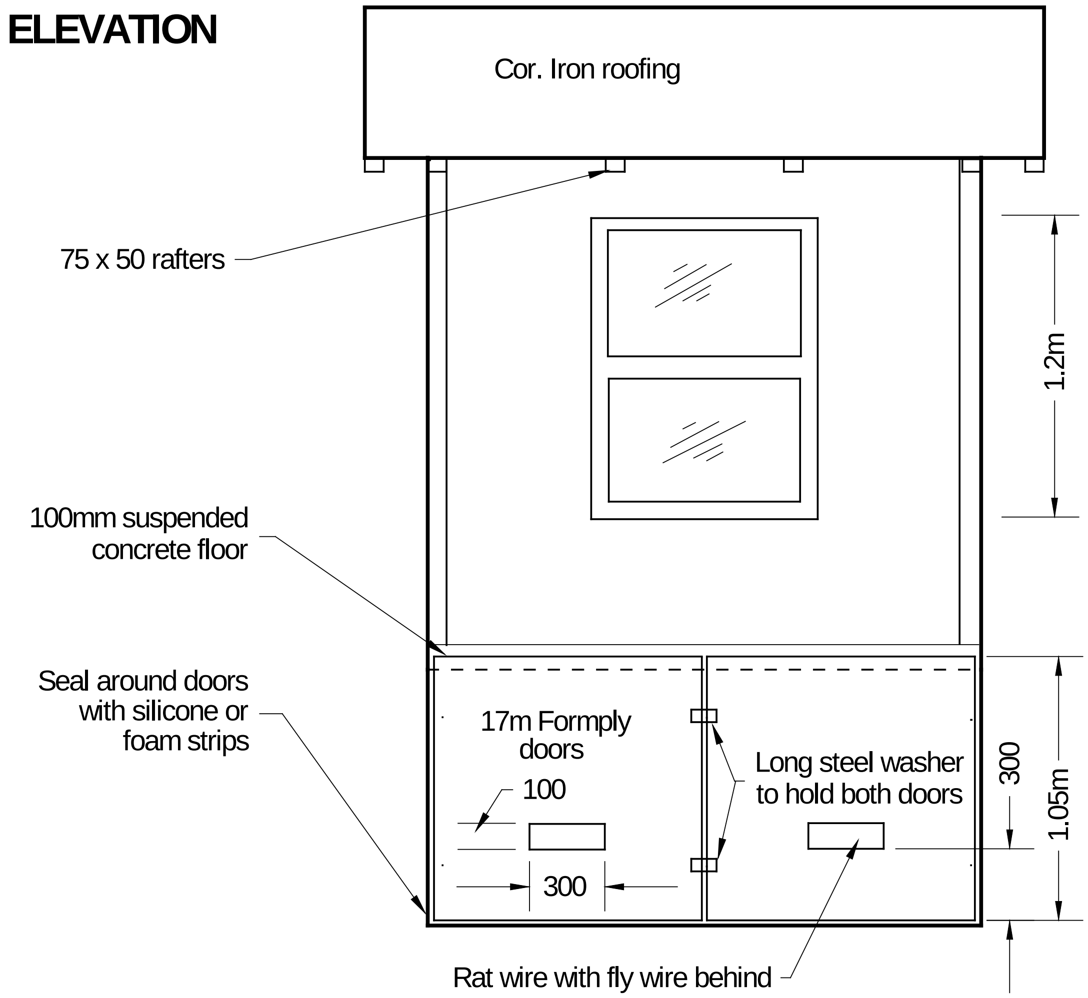
(Showing Block Layout - 2nd & 4th Courses)

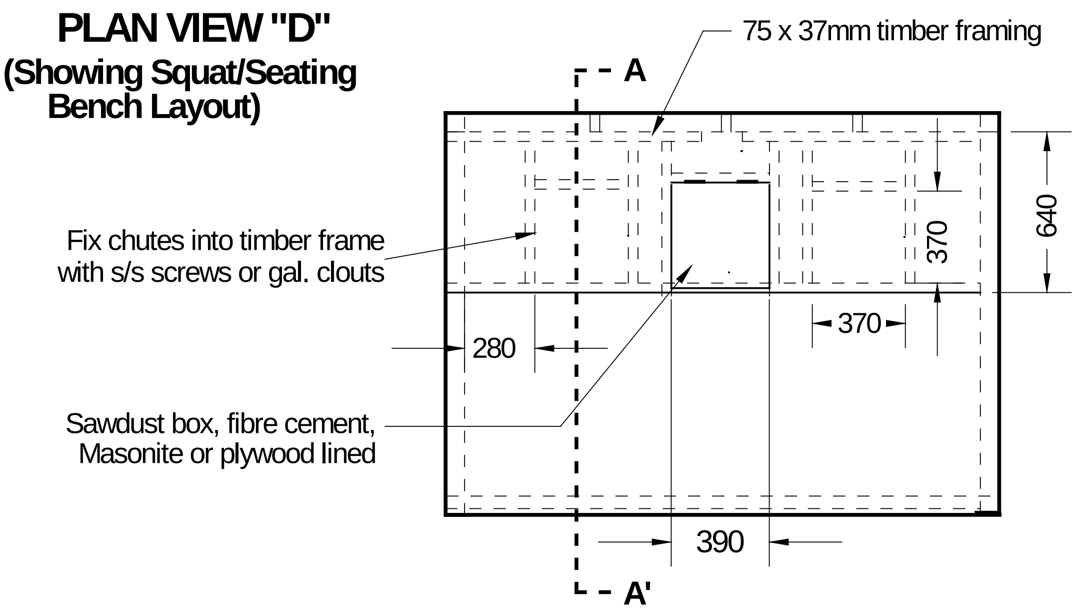
TOTAL BLOCK NUMBERS
63 x full size (100 x 390 x 195)
5 x three quarter size
9 x half size
8 x corner (1 1/4)

SCALE = 1 : 25
All Dimensions Shown in Milimetres

FOOTINGS / VENT DETAILS

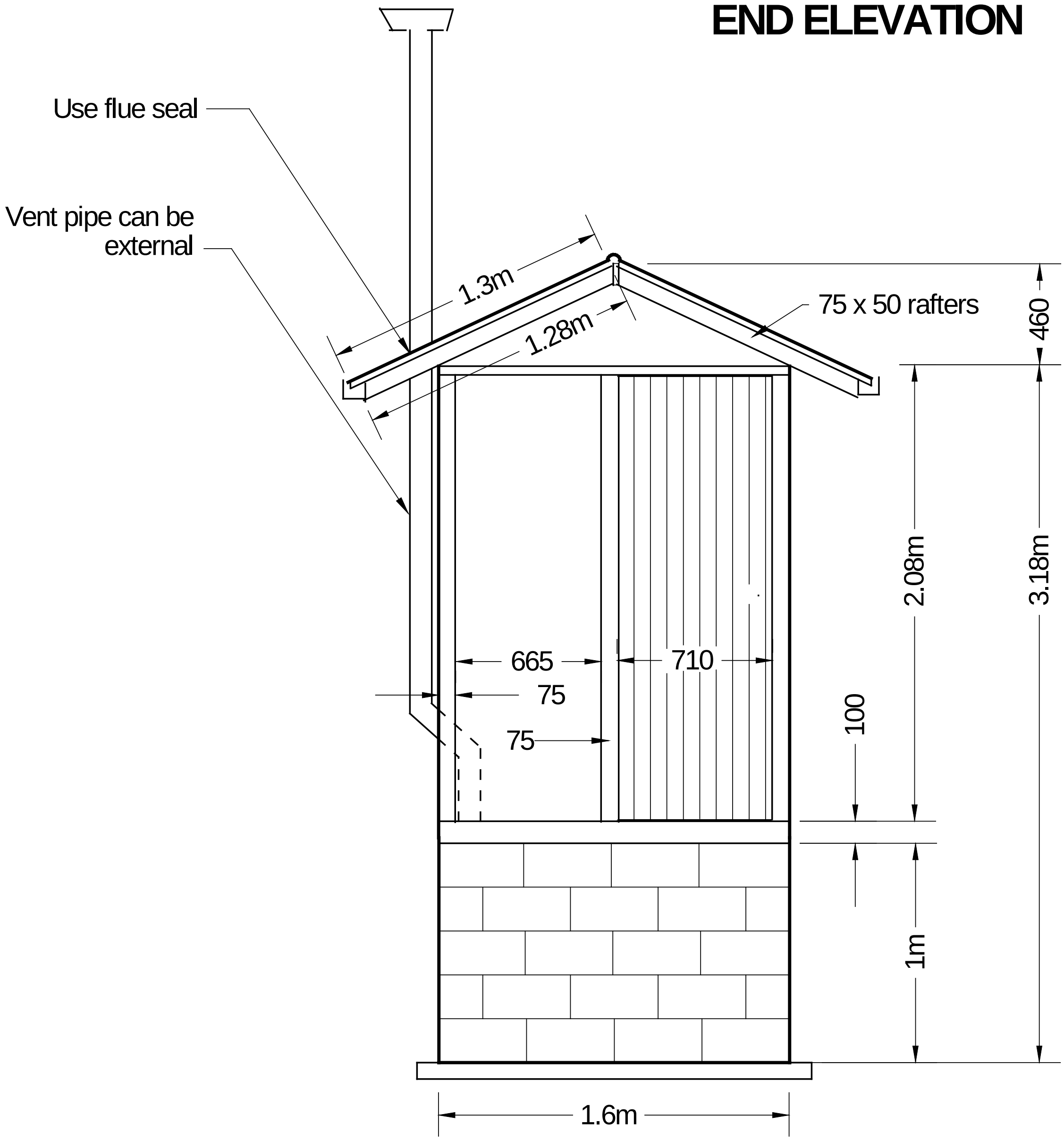


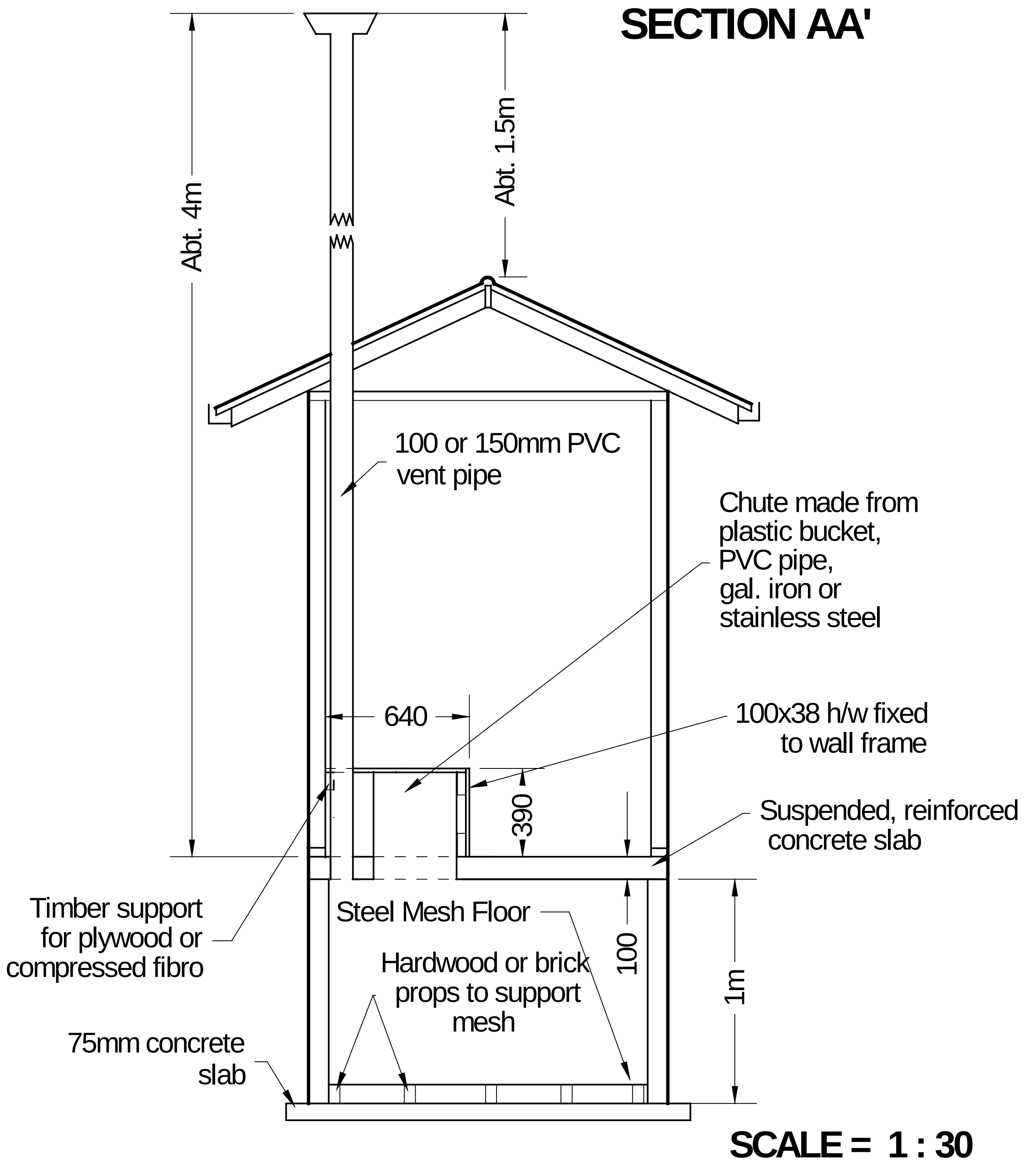

ELEVATION
Cor. Iron roofing
75 x 50 rafters
100mm suspended concrete floor
Seal around doors with silicone or foam strips
17m Formply doors
100
300
Long steel washer to hold both doors
300
1.2m
1.05m
Rat wire with fly wire behind


PLAN VIEW "D"
(Showing Squat/Seating Bench Layout)
75 x 37mm timber framing
A
A'
Fix chutes into timber frame with s/s screws or gal. clouts
280
Sawdust box, fibre cement, Masonite or plywood lined
370
370
640
390

SCALE = 1 : 30

END ELEVATION




SECTION AA'
Abt. 4m
Abt. 1.5m
100 or 150mm PVC vent pipe
Chute made from plastic bucket, PVC pipe, gal. iron or stainless steel
640
100x38 h/w fixed to wall frame
390
Suspended, reinforced concrete slab
Timber support for plywood or compressed fibro
Steel Mesh Floor
Hardwood or brick props to support mesh
100
1m
75mm concrete slab
SCALE = 1 : 30