5 May

Dear Peter, R/ 66-886-414

Here is a photocopy of the notes provided by Ray Flanagan of the original Farallones Institute compost toilet. Ray has redrawn the plans to include a couple of improvements.

Cheers,

Jabolt.

John Jeavons.

R/ Margaret re this + Keith Caster

The Farallones Institute
(Batch Type)

COMPOST TOILET

b. --4

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 which 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 eight to ten thousand gallons of fresh water 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 micro-organisms 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 can be built by amateur builders using common materials and common tools for less than $ 700,* a considerable saving over the usual flush toilet/plumbing/septic tank combination. * chamber only.

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 waste water other than urine. Household waste water 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 1.09m x 2.2m outside dimension. Each chamber has a capacity of about one cubic metre. The plywood top is fitted with an opening "squat plate " 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 doors with screened air inlet vents. A 90mm 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 that returns organic materials to the soil as humus. Two types of decomposition occurs in nature through the action of bacteria and other micro-organisms.

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 a nitrogen-rich, earthy humus and carbon dioxide, both necessary to plant life. In nature, the process of building topsoil thfough 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. Aeration is supplied by air flowing through the vents, over the pile and up the flue. Additional 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.

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, chopped dry grass or straw must be added after each use to keep the pile from becoming too wet.

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. 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 micro-organisms decomposing the pile is 30 parts of Carbon to each part of Nitrogen. Too much nitrogen or other absorbant 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 225 gm faeces (moist weight) plus 1100 litres urine. A yearly average equals about 145 kg faeces, 0.2 m3 urine. At 22 kg/litre and 3 litres/cubic metre, this equals 0.08 m3. faeces, 0.2 m3. 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 - 45,000 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!

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

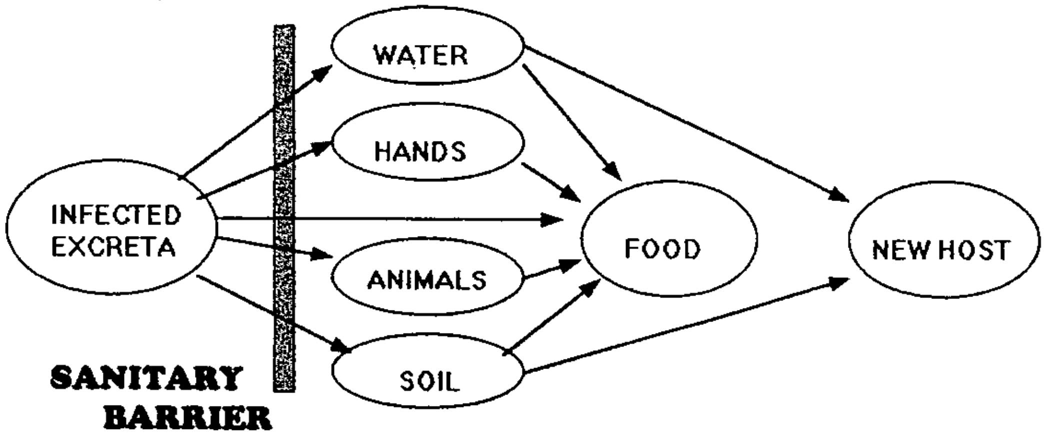
The high toilet seat may prevent complete evacuation. The natural position for defecation, assumed by primitive races, is the squatting position . . . . When the thighs are pressed against the abdominal muscles in this position, the pressure within the abdomen is greatly increased so that the rectum is more completely emptied. Our toilets are not constructed according to physiological requirements. Aaaron, Our Common Toilets, p.66

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

PUBLIC HEALTH CONSIDERATIONS

Diseases can be transmitted through micro-organisms (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 who 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 micro-organisms. "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 halved 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.

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 sawdust or straw and/or turn and mix the pile)
   * Too high nitrogen (add more sawdust 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 micro-organisms, 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.

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.

CONSTRUCTION NOTES FOR MODIFIED FARALLONES TYPE (BATCH) COMPOST TOILET

FOOTINGS

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

SLAB / DRAIN

The concrete slab floor should have a minimum fall of about 10 - 12mm from the rear to the access doors. Additionally, the slab in each chamber should slope inwards towards the drain, if you choose to install one to carry off excess liquid. The drain must be set into the slab when pouring and should be a minimum of 30mm diameter (any smaller and it could easily block up with sawdust etc.). The drain should lead into an evaporation pit or *agricultural drain (a* drain of dimensions 300 x 300mm x 3 to 5m long containing ag. pipe surrounded by course blue metal would suffice). A similar drain hole arrangement to a bathroom floor or shower recess would work well. The drain hole should be at the front of each chamber and either in the centre or in one corner of the chamber. A corner situation would make the sloping of the slab towards the drain less difficult.

CHAMBER FLOOR

Each chamber has a steel mesh "floor" about 75mm above the slab to allow aeration under the compost pile. My preference is for galvanised mesh with 75mm x 50mm bar spacing. However, if cost is a major consideration plain steel mesh is O.K. but will corrode quite quickly. 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.

UPPER FLOOR

The floor of the upper room can be constructed from fibre cement sheeting for extra durability, if your budget can stand the cost,(you wont need to paint this with bitumen). Alternatively, a suspended concrete slab floor can be poured on top of the compost chambers. This will require about an extra 0.35cu.m of concrete but should work out cheaper than timber framing and more durable in the moist environment and therefore less maintenance. The main disadvantages of a slab floor are :

(1) extra venting is needed as per Section AA'
(2) difficulty in inspecting the whole compost pile through the drop hole.

The slab can be supported by formply propped in place until the concrete sets, or a sheet of 5mm fibre board can be laid on top of the block walls. Some temporary supports will be needed for the fibre board but the board 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 fibre board 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 board. A cheaper option to the fibre board or formply is old corrugated iron sheeting cut to size and supported by temporary props. Galvanised threaded rod should be set into the slab for fixing the timber frame.

COMPOST CHAMBER

When laying the concrete blocks brick tor (reinforcing wire) can be added, between say the 2nd and 3rd course and the 4th and 5th course, for extra strength.
Paint all surfaces, apart from the slab, with brushable bitumen sealer (such as Hydroseal) to minimise rot from exposure to decomposing materials and moisture.

BAFFLES

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 welded steel frame is ideal. The slats that hold the baffles in place can be hardwood, however, galvanised steel angle would be a better choice.

SEAT

I believe the bench height 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.
If you choose the suspended concrete floor option you will need a chute to connect the seating/squatting bench to the slab. A large plastic bucket or garbage bin (34cm, 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. If the bucket is tapered put the smaller end up so there is less likelihood of accumulating crud on its wall.
A round cover could be cut for the bench for the slab option or if you stick to the rectangular hole make sire 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. Squatting would become more difficult if the seat could not be lifted clear of the bench.

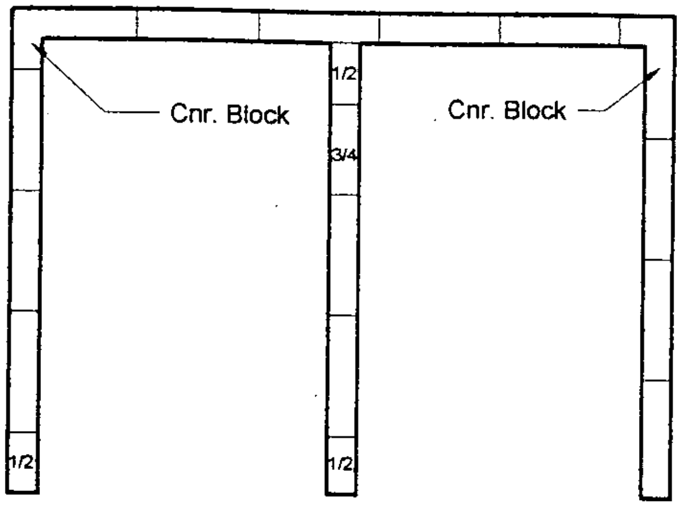
FLUE

The flue should be screened to prevent flies from entering. If the lower ends of the flue are screened this will also isolate the two chambers to prevent cross infection should one chamber become fly blown.
In the slab floor option the upper set of flue pipes will help alleviate condensation on the hole cover. The flue shown in PLAN VIEW "B" is contained within the upper room. Depending on personal preference the flue could pass through the back wall, either above or below the squat bench similar to "Option 1". Likewise the external flue in "Option 1" could run up the inside of the wall if preferred.

VENT PIPES

The by-pass vent pipes in the back corners of the chambers will need to be attached to the chamber. The lower end can be wired to the mesh floor. The top can be wired to nails fixed to the timber frame (Option 1) or a couple of masonry nails fixed to the chamber wall. Make sure that the props for the mesh floor do not obstruct the flow of air up the vents.

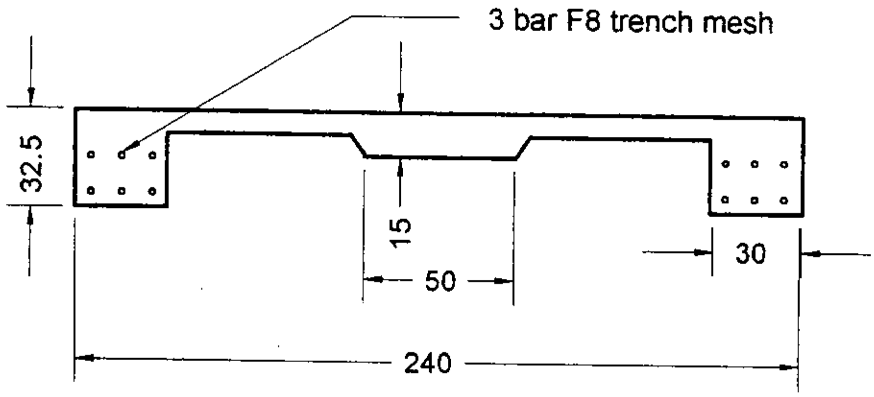
Construction notes and plans for the modified Farallones compost toilet were prepared by Ray Flanagan.



PLAN VIEW "C"

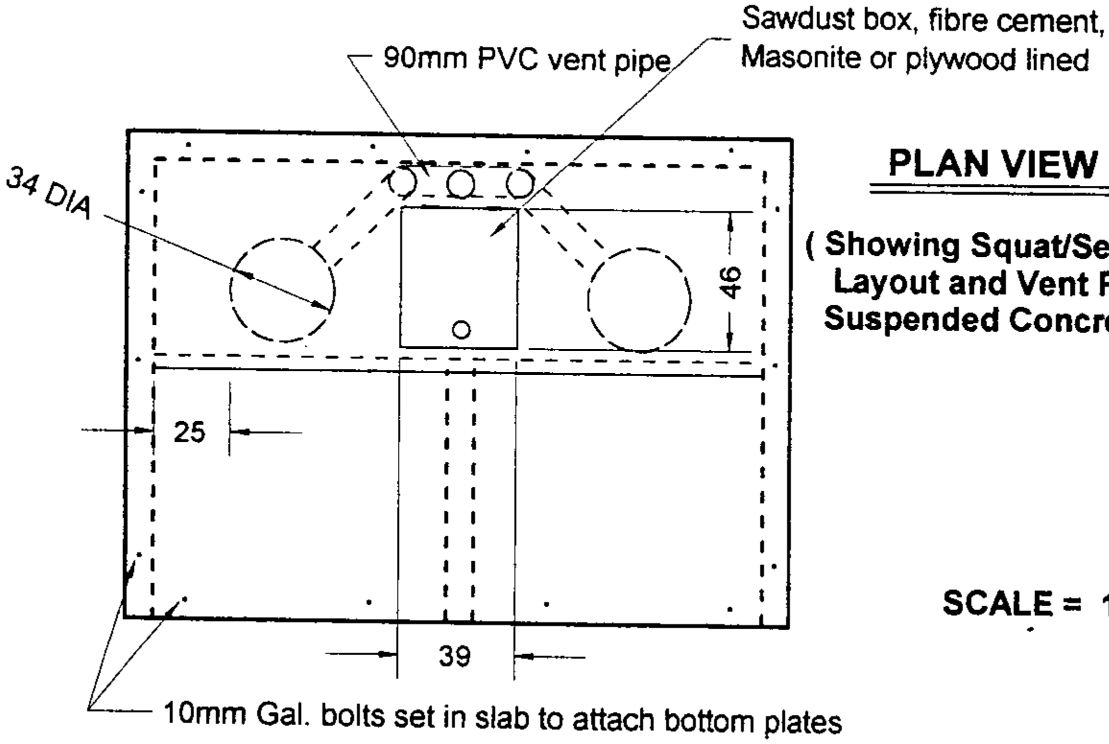
(Showing Block Layout - 2nd & 4th Courses)

TOTAL BLOCK NUMBERS
69 x full size (100 x 390 x 195)
5 x three quarter size
12 x half size
4 x corner



FOOTINGS

(Cross Section)

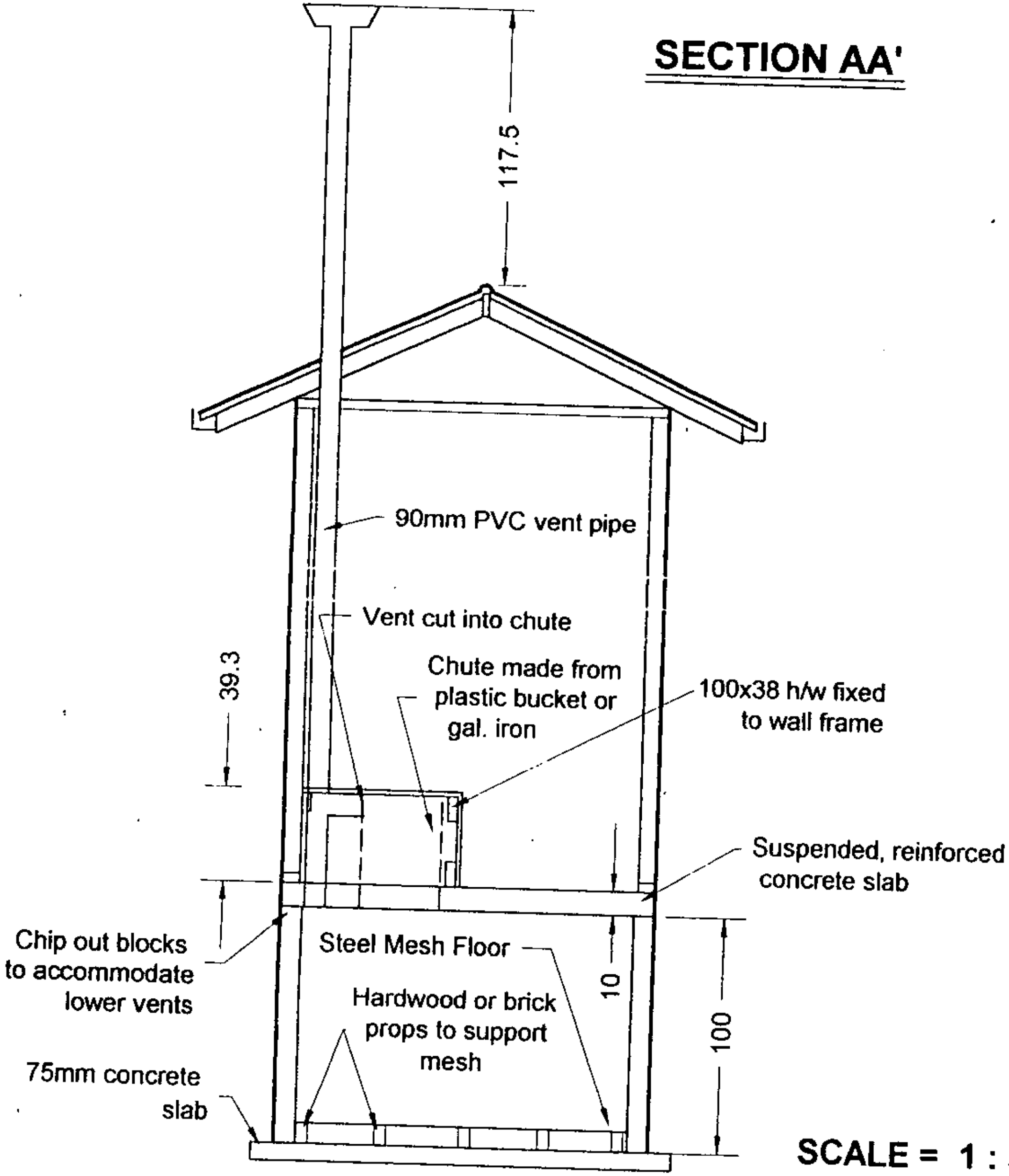


PLAN VIEW "B"

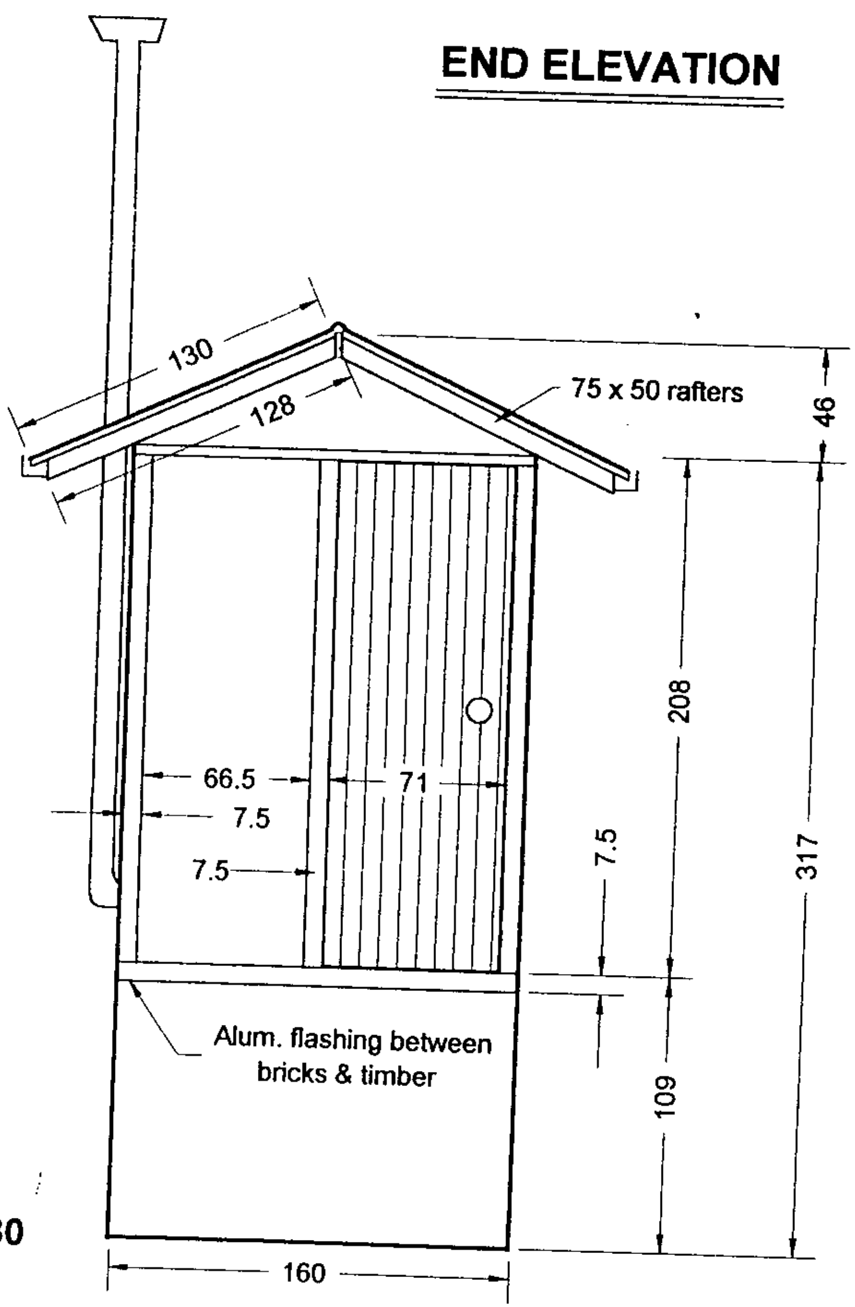
(Showing Squat/Seating Bench Layout and Vent Pipes for Suspended Concrete Floor)

SCALE = 1 : 25

SECTION AA'

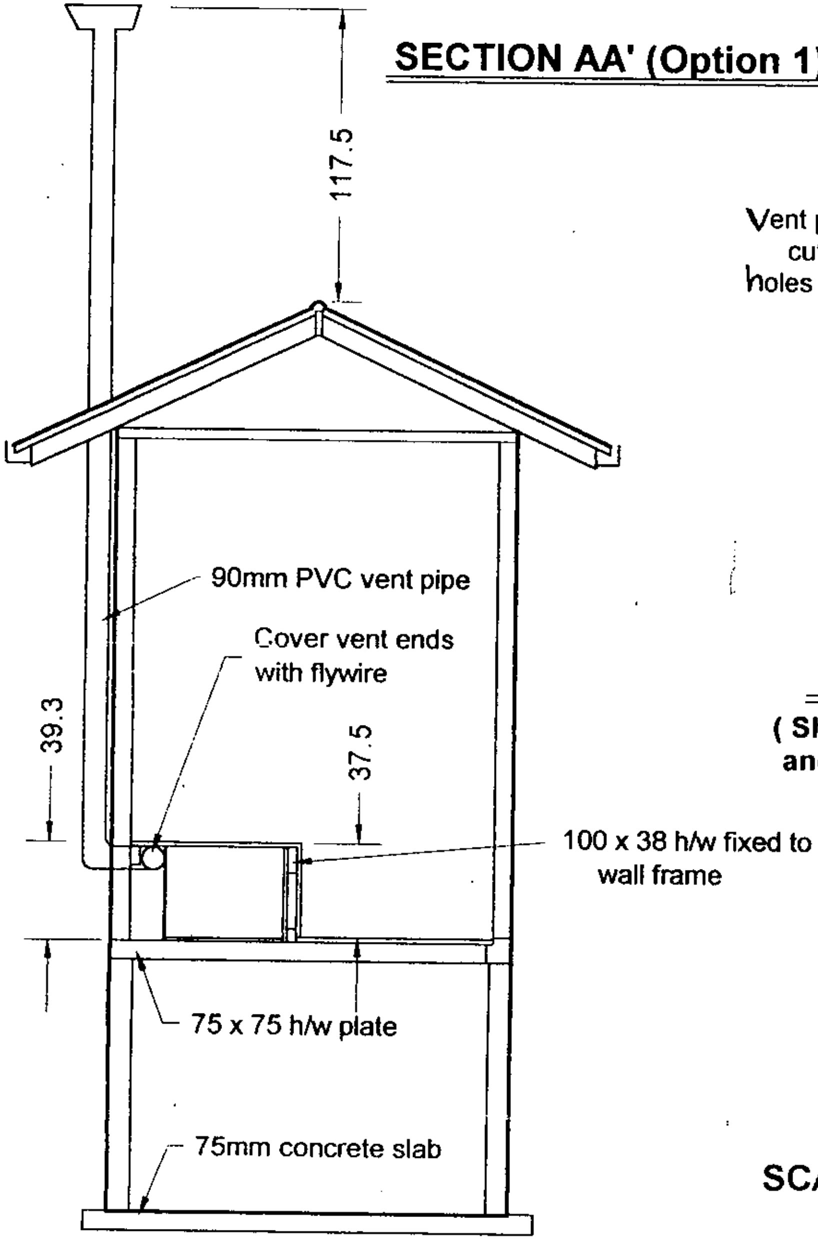


END ELEVATION



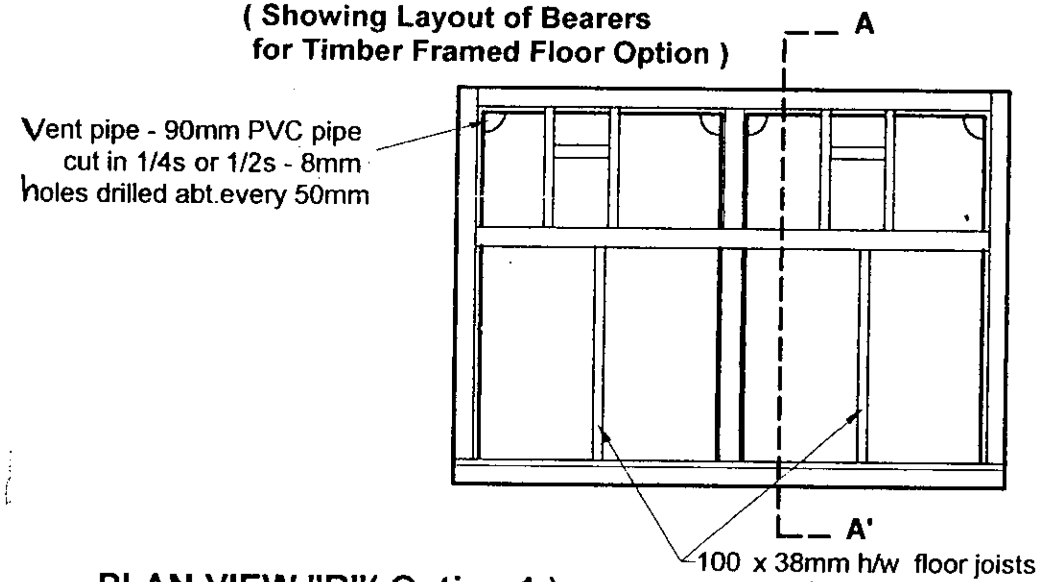
SCALE = 1 : 30

SECTION AA' (Option 1)



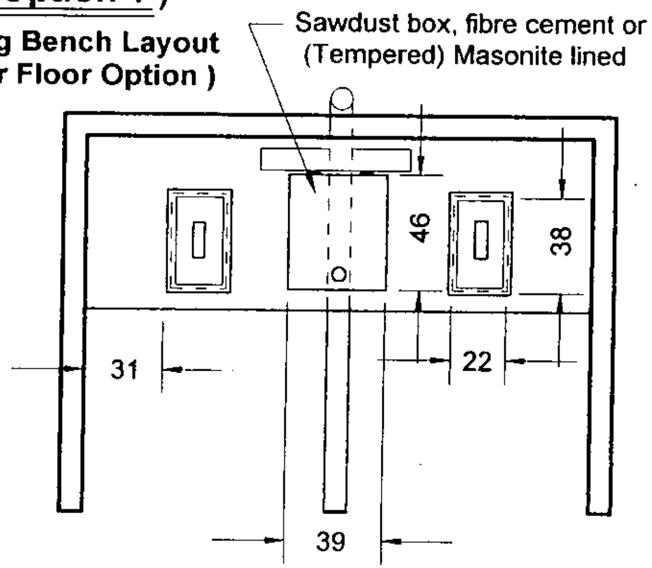
PLAN VIEW "D"

(Showing Layout of Bearers for Timber Framed Floor Option)



PLAN VIEW "B"(Option 1)

(Showing Squat/Seating Bench Layout and Venting for Timber Floor Option)



SCALE = 1 : 30

PLAN VIEW "A"

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

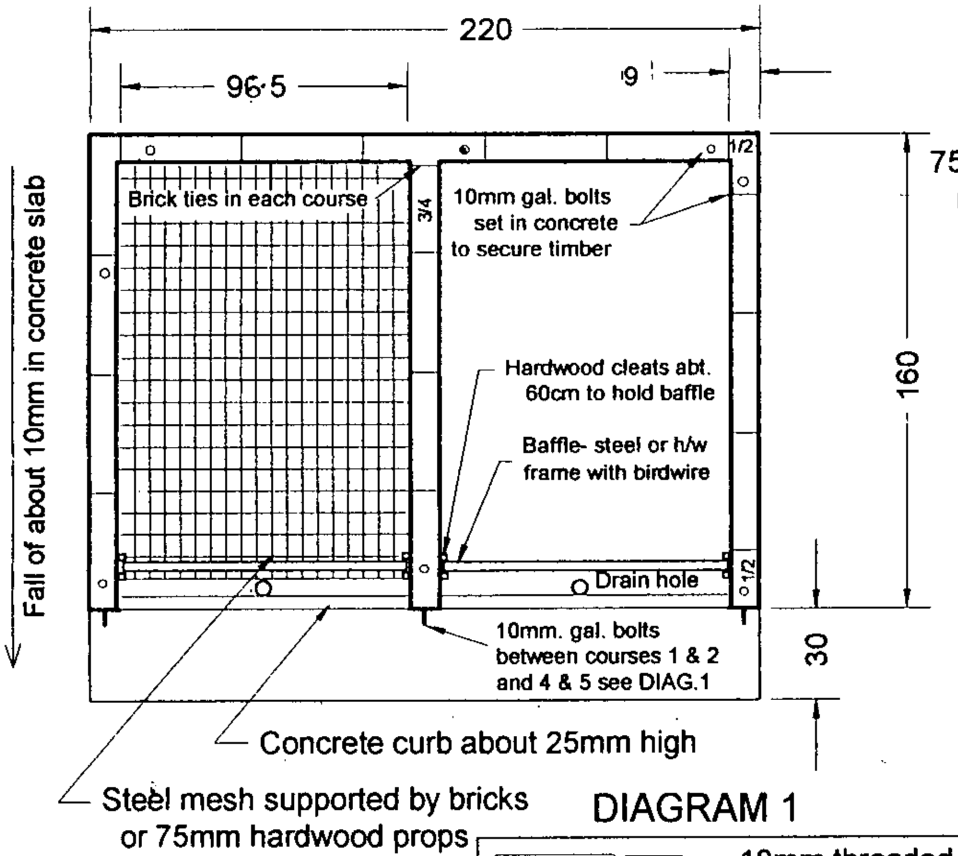
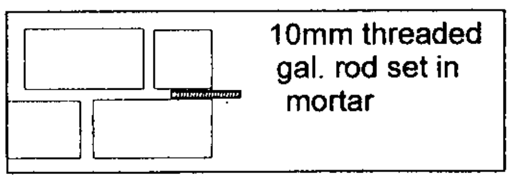


DIAGRAM 1



SCALE = 1 : 25

All Dimensions Shown in Centimetres

ELEVATION