USING WASTE WOOD CHIPS TO TREAT DOMESTIC SEPTAGE

Report On Research/Demonstration System Testing Results

PREPARED FOR

THE TEXAS ONSITE WASTEWATER TREATMENT RESEARCH COUNCIL

BY

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For both cities and rural areas, one of the waste treatment issues that continues to be a problem is septage. Septage is, generally speaking, the wastewater and sludge in a septic tank. To those who have had problems with their septic systems, or wastewater treatment plant operators who work at the receiving stations for septage, some of the characteristics of this waste are well known.

Septage is frequently transported to, and discharged into, wastewater treatment facilities. Due to the high strength and characteristics of this type of waste (see Table 1 on the following page), it may cause problems with wastewater treatment operations. Many treatment facilities do not accept septage for this reason. The new federal regulations allowing for land application of septage have a number of site, crop, and pretreatment requirements which cause this option to be infeasible or undesirable in some cases. A significant amount of illegal dumping of septage reportedly occurs in many areas of the country.

ALTERNATIVE SEPTAGE TREATMENT SYSTEM DESCRIPTION

Recognizing the importance of developing low cost methods for the treatment and disposal of septage, and with the intent of promoting a beneficial reuse approach to septage treatment, Community Environmental Services, Inc. (CES) of Austin, Texas conducted a state-funded research project to develop such a system. The two-year project began in 1993 and was funded by the Texas Onsite Wastewater Treatment Research Council.

The project consisted of developing and demonstrating a method for dewatering and filtering septage which utilizes waste wood chips. The spent batches of wood chips and biosolids mixture were composted, and the filtrate from the treatment process demonstrated to be of a quality that would be suitable for certain types of reuse with very little additional treatment.

The pilot scale septage treatment set-up consisted of (1) a modified 40 yd3 solid waste roll-off unit, with a piping distribution system at the top and an underdrain system, (2) a pump tank with piping and valves leading to the two additional tanks, and (3) two 2100 gallon polyethylene tanks, one of which was used for holding wastewater to be recycled through the wood chip filter, with the other tank used to contain final filtrate from the process (see photographs of system set-up in Attachment 1). The septage treatment system was set up adjacent to the City of Manor, Texas' municipal wastewater treatment plant.

CES made arrangements with Roto-Rooter of Austin to transport domestic septage to the site, and to remove filtrate from the final filtrate holding tank for transport to the City of Austin's Walnut Creek WWTP, for final treatment. The spent wood chip and sludge mixture removed from the septage treatment unit were transported to and composted at the Texas Disposal Systems Landfill.

Raw septage was applied to the surface of the wood chips through a 4"-diameter perforated pipe. Filtrate was collected from the bottom of the wood chips by a system of PVC perforated pipes, and pumped into either the recycle tank, or the final filtrate holding tank. A manually controlled valve was used to direct the wastewater to either tank. The wastewater was recycled through the wood chip filter only once after the initial application to and collection from the chips.

TABLE 1
Typical Chemical And Physical Characteristics Of Domestic Septage*

Parameter	Conc. (mg/kg)	EPA's "EQ" Limits
As	4	41
Cd	3	39
Cr	14	1,200
Cu	140	1,500
Pb	35	300
Hg	0.15	17
Mo	--	18
Ni	15	420
Se	2	100
Zn	290	2,800
Total N	2 %	NA
Total P	<1 %	NA
pH	4 (Std. units)	NA
Grease	6-7 %	NA
BOD5	6,480 mg/L	NA
Total Solids	3-4 %	NA

* Source: US EPA Publication EPA/832-B-92-005, "A Guide to the Federal EPA Rule for Land Application of Domestic Septage to Non-Public Contact Sites".

Filtrate quality from the research unit was characterized to determine (1) the types of treatment and disposal approaches which would be suitable, and (2) what level(s) and type(s) of treatment would be necessary for the filtrate given the various treatment/disposal options. Laboratory analyses for certain constituents were performed at the Center for Environmental Research (CER) at Hornsby Bend, with other analyses performed by the Lower Colorado River Authority (LCRA) Environmental Laboratory.

The initial depth of wood chips selected for use in this process was based upon literature reporting results for dewatering sludge from the pulp and paper industry using a wood chip medium for filtration. When the research project was initiated, this was the only published data identified to provide this type of information. Although the characteristics for that sludge differ greatly from domestic septage, this was thought to be a reasonable first depth to use. A study of the optimal configuration for the pulp and paper industry project showed that a wood chip depth of four feet gave the best results.

The composting process was monitored to determine a suitable mixture of wood chips and filtered septage. The depth of chips needed to achieve adequate filtration was noted, while evaluating suitable mixtures of biosolids and wood chips for composting. It is necessary to have an acceptable C:N ratio for the waste solids, as well as moisture content.

RESEARCH RESULTS

This alternative treatment process appears to behave much as a "ripening" sand filter would. That is, when septage is applied to the surface of fresh wood chips, significantly less total suspended solids removal occurs as compared with the removal achieved after applying several batches of septage to the same bed of chips. A layer of sludge begins building up on the surface of the bed of chips as septage continues to be applied, and this enhances solids removal. However, as sludge accumulates, the time required to filter/dewater a given volume of septage tends to increase. As a part of the research project, operational techniques were considered in an effort to maximize both the removal efficiency and the throughput (flow) for this type of septage treatment system.

The pollutant constituents measured included total suspended solids (TSS) and total solids (TS) for both the raw septage and filtrate. Biochemical oxygen demand (BOD) testing was also performed for the filtrate. Some nitrogen testing of the filtrate was performed in order to further characterize its quality and suitability for various reuse/disposal options.

With one initial pass through the chips, and one recycle pass for each batch of raw septage, the percent removal of TSS for the filtrate ranged from 83.5% to 99.6%, with an average percent removal of 91.6%. Filtrate TSS values as low as 88 mg/L was measured for the process, with the highest filtrate TSS value measured at 2500 mg/L (the raw septage TSS for this batch was 48,000 mg/L).

The average BOD measured for the filtrate, with a single recycle pass through the system, was approximately 360 mg/L. Only one raw septage BOD measurement was made, with a value of 1790 mg/L. However, as shown in Table 1, BOD concentrations for raw septage may be very high. Table 2 presents laboratory results for the filtrate quality.

It was observed that the filtrate had very little odor (in contrast to the raw septage, which usually has a very strong odor). When each batch of spent wood chips and filtered solids was emptied from the treatment unit, there was also usually not very much odor associated with the mixture. The wood chips appeared to help control odors in the process.

TABLE 2
Laboratory Test Results for Filtrate from Septage Dewatering/Filtration Process

Parameter	Concentration/Value
BOD5	372
TSS	230
TKN	78.9
Ammonia	13.5
NO2/NO3	0.1
TOC	133.5
Total P	23.9
Total K	49.0
Total Calcium	145.7
Total Magnesium	23.3
Total Sodium	61.3
Conductivity (umhos/cm)	1410.0
pH (S.U.)	7.2

Values are averages of laboratory analyses, in mg/L unless specified otherwise.

For the first few batches of wood chips, the filtration process became very slow after a few inches of sludge had accumulated at the surface (about four to six inches). With a wood chip depth of approximately four feet, the ratio of wood chips to biosolids would be fairly high. Temperature readings for the windrows constructed from those batches remained low while moisture contents appeared to be acceptable, hindicating problems with those mixtures.

While dumping the wood chips and captured biosolids mixture from the dewatering unit, it was observed that there appeared to be very little clogging of the lower two to three feet of chips, when a depth of four feet was used. Therefore, it was thought that a lesser depth might be used effectively, at least for the first filtration pass. This would lower the ratio of wood chips to biosolids, and hopefully provide better results from the composting process. The next batch of chips tested was approximately two to two and a half feet in depth. As expected, this depth showed significantly higher TSS levels for the filtrate.

Based on observations for the total volume and numbers of batches of septage applied to each batch of wood chips, and the time required for filtration/dewatering of the septage, it appeared that between 10,000 and 15,000 gallons of raw septage could be applied to a four-foot deep batch of chips before it would be necessary to dump and reload the unit with fresh wood chips. If a significant amount of time elapsed between times that septage was applied to the chips, the time for filtration increased significantly due to drying and hardening of the layer of biosolids collected on the surface of the chips, and the total quantity which could be applied per batch of chips tended to decrease.

It was observed that a significant amount of corrosion was occurring on the interior of the septage filtration/dewatering unit, so it would be recommended that a plastic coating or lining be used on the inside of a unit used for this type of treatment process. For the pilot scale set-up, significant labor was required for certain tasks, particularly those associated with the loading and unloading of wood chips in the treatment unit. Fot the purposes of providing recommendations for and designing a full-scale system using this type of treatment process, some further modifications to the treatment unit should be considered for mechanizing the process so that less labor is required. Costs for these types of mechanical improvements would need to be developed to better evaluate the overall cost-effectiveness of this treatment method, as compared with others.

In order to beneficially reuse the filtrate from the process, it may be desirable to dispose of it in some type of surface or subsurface land treatment system. Some additional pretreatment would likely be necessary prior to land disposal. Various natural treatment processes were considered for this option, with that conceptual analysis presented in the next section of this report.

CONCEPTUAL DESIGN OF PRETREATMENT AND FINAL LAND DISPOSAL SYSTEM FOR FILTRATE

This section of the report presents a conceptual design for the treatment and disposal of the liquid fraction (filtrate) from the septage dewatering/filtration process using a combination of natural and land treatment (beneficial reuse) processes. Based upon data collected for the filtrate quality, an evaluation of the pretreatment requirements prior to land application was made. The goal of this analysis is to determine an appropriate effluent loading rate for a land treatment system for the filtrate from the septage dewatering process, based on (1) the filtrate characteristics presented in Table 2 for laboratory results, (2) a hypothetical natural pretreatment system prior to final land treatment/disposal, (3) hypothetical soil and climate conditions which are typical of those found in eastern Travis County, and (4) a selected vegetative cover for the land treatment system.

Currently, at the City of Austin's Hornsby Bend Sludge Treatment Facility, both sludge composting and effluent irrigation systems are operating successfully. Both of these components would ideally be a part of a full scale septage treatment system which utilizes this alternative septage treatment process. The assumptions made in the analysis for soil and other geographic conditions are consistent with those found at the Hornsby Bend Facility.

A land-limiting constituent (LLC) type of analysis was used in determining pretreatment requirements for the effluent prior to land application of the filtrate, and acceptable effluent loading rates for the conceptual design of the land treatment system. Parameters considered in the LLC analysis included nitrogen, phosphorus, potassium, water, sodium adsorption ratio (SAR), and heavy metals.

Concentrations for nitrogen, phosphorus and potassium used in the analysis were from Table 2 above. Table 3 below gives typical values from EPA literature for heavy metal concentrations for domestic septage as compared with domestic sludge. The suggested design values for septage were used for the LLC analysis for heavy metals. Table 4 gives typical values for heavy metals concentrations in domestic septage on a dry weight basis, along with the "EQ" (exceptional quality) limits published by the US EPA under the federal 503 regulations for sludge management.

As may be noted from Table 2, the concentrations of TSS, BOD, and TKN for the filtrate from the septage dewatering process are relatively high. Some preliminary land-limiting constituent (LLC) analyses were performed in order to determine, based upon no pretreatment prior to land application, what the LLC would be for the given conditions. It was determined that nitrogen would be the LLC (with certain assumptions made about the immobilization of phosphorus for the assumed soil conditions) if no pretreatment were used. Approximately nine times as much land would be required, based upon nitrogen, as compared with the land requirements based a water balance for the site. It was therefore determined that pretreatment processes should be developed for the system which would provide the following:

1) Significant nitrogen removal
2) Preferably some phosphorus removal, even if only through plant uptake
3) TSS reduction
4) Equalization and storage for both fluctuations in daily flows, and for days during which the system would not be operating (O&M, mowing, rainy and/or cold weather, etc.)

TABLE 3

Heavy Metal Concentrations In Septage Compared To Typical Domestic Wastewater Sludges

Parameter	Septage United States Average Values mg/L	Suggested Design Values for Septage mg/L	EPA Mean Domestic Sludge Values mg/L
Al	48.	50.	48.
As	0.16	0.2	0.16
Cd	0.27	0.7	0.71
Cr	0.92	1.0	1.1
Cu	8.27	8.0	6.4
Fe	191.	200.	200.
Hg	0.23	0.25	0.28
Mn	3.97	5.	5.
Ni	0.75	1.	0.9
Pb	5.2	10.	8.4
Se	0.076	0.1	0.1
Zn	27.4	40.	49.

Source: Handbook - Septage Treatment and Disposal (EPA - 625/6-84-009)

TABLE 4
Typical Heavy Metals Concentrations For Domestic Septage And EPA's 503 "Eq" Limits

Parameter	Conc. (mg/kg)	EPA's "EQ" Limits
As	4	41
Cd	3	39
Cr	14	1,200
Cu	140	1,500
Pb	35	300
Hg	0.15	17
Mo	--	--
Ni	15	420
Se	2	100
Zn	290	2,800

Source: US EPA Publication EPA/832-B-92-005, "A Guide to the Federal EPA Rule for Land Application of Domestic Septage to Non-Public Contact Sites".

In addition it was necessary to consider such factors as algae control and/or removal, odor control, land availability, system maintenance requirements, and capital costs in selecting an appropriate pretreatment process(es).

The selected conceptual pretreatment system consisted of an aerated pond followed by a lemna pond. The effluent from the lemna (duckweed) pond would be pumped to the final treatment/disposal (effluent irrigation) system. Nitrogen removal was modeled for each of the two pond systems. The influent concentration of total nitrogen for the first of the two ponds was assumed to be 79 mg/L (Table 2). Based on acceptable models for each of the two ponds (MOP FD-16, and Natural Systems for Waste Management and Treatment, Reed, Middlebrooks and Crites), effluent nitrogen from the first pond was estimated to be approximately 57 mg/L, with an effluent nitrogen concentration of 30 mg/L from the second (lemna) pond. A 20-day detention time was used for the lemna pond.

To estimate an appropriate loading rate and identify limitations for final land treatment/disposal, it is necessary to either make certain assumptions about site conditions or conduct a site evaluation. In this case, a specific site was not available to the project for use as a land treatment site for the filtrate from the process, so a hypothetical set of conditions was used that would be realistic for eastern portions of Travis County where the septage treatment research unit was set up and tested.

An LLC analysis was carried out for final land treatment/disposal using as a basis the average laboratory results for the filtrate from the septage treatment process (Table 2). The nitrogen concentration used however was that estimated for the effluent from the pond pretreatment system. It was assumed for the conceptual design and LLC analysis that coastal bermudagrass would be used as the crop for the land treatment area, since it is a commonly used local crop with a number of advantages for use on wastewater effluent irrigation sites. A summary of the results from that analysis is provided below.

Wastewater Constituent	Acceptable Loading Rate per Acre of Land (Gallons/Acre/Day)
Water Loading (Based on a Water Balance)	**13,636**
Total Nitrogen	**3,896**
Total Phosphorus (assuming 50% available)	**852**

Assumptions:
- Minimum site soil permeability of 0.63 inches per hour;
- Climate conditions characteristic of those in eastern Travis County; and
- All organic nitrogen applied is available during the first year of application;
- It is assumed that no significant phosphorus removal occurs in the ponds.

For the above constituents and assumptions, phosphorus appears to be the land-limiting constituent for the filtrate, using the pond system for pretreatment. Possible constraints and wastewater loading limitations were also evaluated for heavy metals, sodium adsorption ratio (SAR) and conductivity. Those results are summarized below.

Sodium Adsorption Ratio (SAR): The SAR for this wastewater was estimated to be approximately 6.7, which is well below the recommended limit;

Conductivity: Using the information from Table 3 in the TAC Chapter 309, the measured conductivity for this wastewater, if applied to coastal bermudagrass, is well within acceptable limits;

Heavy Metals: Using the Suggested Design Values for Septage from Table 3 above, and the EPA's cumulative loading rate limit for the heavy metals, and estimate was made of the number of years that this wastewater could be applied to the site, to identify any design life constraints for those constituents:

Arsenic:	152 years	(0.27 kg/ha/yr applied)
Cadmium:	42 years	(0.93 kg/ha/yr applied)
Chromium:	2,256 years	(1.33 kg/ha/yr applied)
Copper:	140 years	(10.7 kg/ha/yr applied)
Lead:	23 years	(13.3 kg/ha/yr applied)
Mercury:	50 years	(0.34 kg/ha/yr applied)
Nickel:	316 years	(1.33 kg/ha/yr applied)
Selenium:	752 years	(0.13 kg/ha/yr applied)
Zinc:	52 years	(53.4 kg/ha/yr applied)

For the above heavy metals, all metals loading rates were within acceptable EPA limits. The acceptable cumulative loading for each metal gave a site life of greater than 20 years, which would be a reasonable design life (Lead gave the shortest cumulative loading life - 23 years).

Overall, the filtrate quality from the septage filtration process appears to be very acceptable for beneficial reuse through land treatment and disposal, particularly if pretreatment is provided that reduces nitrogen levels. If the loading rate based on nitrogen were used, there would appear to be an excess of phosphorus (above crop uptake levels). However, for sandy clay loam soils, the phosphorus retention capacity of this type of soil (based on adsorption isotherm data for these types of soils in a Michigan study) is such that there would not likely be a problem with phosphorus leaching from the site. Therefore, since nitrogen would then result in the largest land area requirements, the LLC analysis for the filtrate from the septage process indicates that pretreatment for nitrogen reduction prior to final land disposal would be useful for reducing land area requirements. Other wastewater constituents for this wastewater appear to be within acceptable limits for beneficial reuse of the pretreated filtrate.

APPLICABILITY OF THE PROCESS

The advantages of this type of process include:

(1) If it is desirable and feasible to beneficially reuse the composted biosolids (ie., if there is a local permitted facility for biosolids composting), the filtration medium for this process is a material commonly used as a bulking agent and carbon source for the composting process. So the same material is being used for filtration that would later be added anyway to the biosolids for composting.

2) Use of this type of process would significantly reduce loading to centralized wastewater treatment plants that receive domestic septage. In addition, sludge loading and production would be reduced.

3) If this or a similar process were used for mobile septage dewatering units, this could result in cost savings in a variety of ways, including hauling costs, and wear and tear on roads from tank trucks carrying raw septage.

Overall, the results obtained from the research project were very encouraging. Based upon the results obtained from this septage treatment system, the filtrate quality for this process could likely meet municipal pretreatment requirements, thus making it suitable for discharge into and treatment at a municipal wastewater treatment facility without industrial wastewater surcharges (if they exist for the particular municipality). Therefore, if it were not possible to beneficially reuse the filtrate through a land treatment/disposal system such as the one described in the conceptual design above, the process could be used for pretreatment of septage prior to final treatment at a municipal treatment facility. Results for BOD and TSS indicate that, in order to meet local pretreatment requirements for discharge into a collection system, it might be necessary to use two wood chip filtration/dewatering units in series, with the second serving as more of a "polishing" unit. The first unit would remove most of the solids, and require more frequent emptying and replenishing with wood chips.

Ideally, the spent wood chips and biosolids would be composted and beneficially reused. If there were not a permitted sludge composting facility available within an acceptable distance to compost this waste, and if it were found to be cost-effective, then the mixture could be landfilled (as long as the applicable regulatory requirements are met).

Throughout the research project, consideration was given to the possibility of using this process in mobile septage dewatering units. A mobile unit would pump septage from the septic tank, process/filter the wastewater in a truck-mounted treatment unit, and return the filtrate/effluent to the septic tank. This would greatly reduce the quantity of waste hauled away for final treatment and disposal, and those associated costs. As an alternative, it might be feasible to set up transfer stations in various locations to receive the raw septage for pretreatment at those sites, and haul the batches of filtered solids and medium (wood chips in this case) to a centralized facility for composting or other type of treatment/processing. Filtrate from the septage pretreatment process at the transfer station(s) would likely be of suitable quality for discharge to a collection system.

Since the completion of this project, an article was published in Biocycle magazine about a similar process being used for both transfer station pretreatment and mobile dewatering units in several Norwegian communities and rural areas (June 1996 - "Septage Dewatering and Composting in Norway"). A copy of that article is included with this report (Attachment 2). The first type of operation discussed in the article is a pretreatment facility in which septage hauled to the facility is dosed with polymer and screened. Filtrate collected in the bottom of the treatment unit discharges to a public sewer system, and the screened sludge is emptied from the unit after several truckloads of septage and mixed with bark for composting at a nearby landfill site. The second operation discussed in the article is similar, but is a mobile dewatering unit. The dewatering unit either stores the filtrate for subsequent treatment and disposal elsewhere, or returns it to the septic tank.

In general, the full-scale operations in Norway demonstrate the feasibility of looking to this type of process for the pretreatment of sludge and septage, with beneficial reuse of the filtered biosolids. Depending upon specific local conditions, it may also be feasible to beneficially reuse the filtrate from the process. The process used in the Norwegian applications uses polymer to enhance solids removal, or filtration. For mobile dewatering operations it may be necessary to use polymers to achieve better effluent quality, given the need to minimize time required at each site for filtration runs, and to produce a reaonably low suspended solids concentration if the filtrate is to be returned to the customer's tank. The use of polymers can be expensive over time, depending upon dosages, so the need for their use should be carefully examined for the particular application and treatment design.

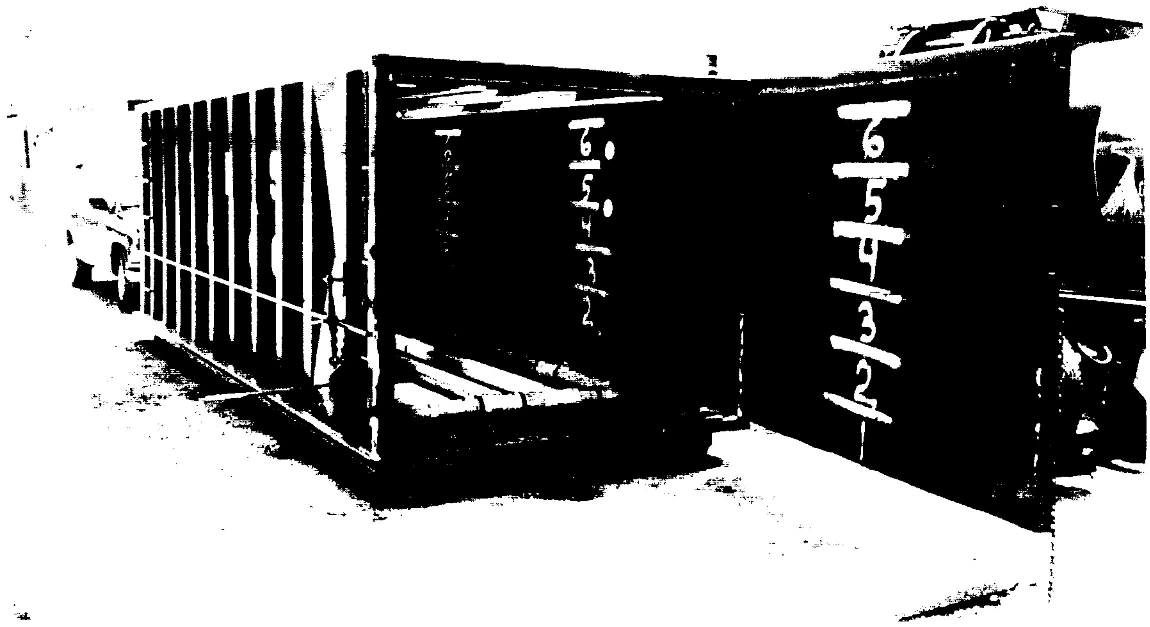
Since the early 1990's, in anticipation of and following the promulgation of the 1993 federal rules for sludge and septage management (40 CFR Part 503), communities and rural areas have been much more actively seeking lower cost ways of effectively handling their sludge and septage. It is commonly recognized as desirable to beneficially reuse biosolids and their liquid sidestreams whenever it is feasible to do so. The filtration/dewatering process tested in this project is one of the processes that might be considered for use in pretreating septage and/or sludge prior to composting and beneficial reuse.

Attachment 1

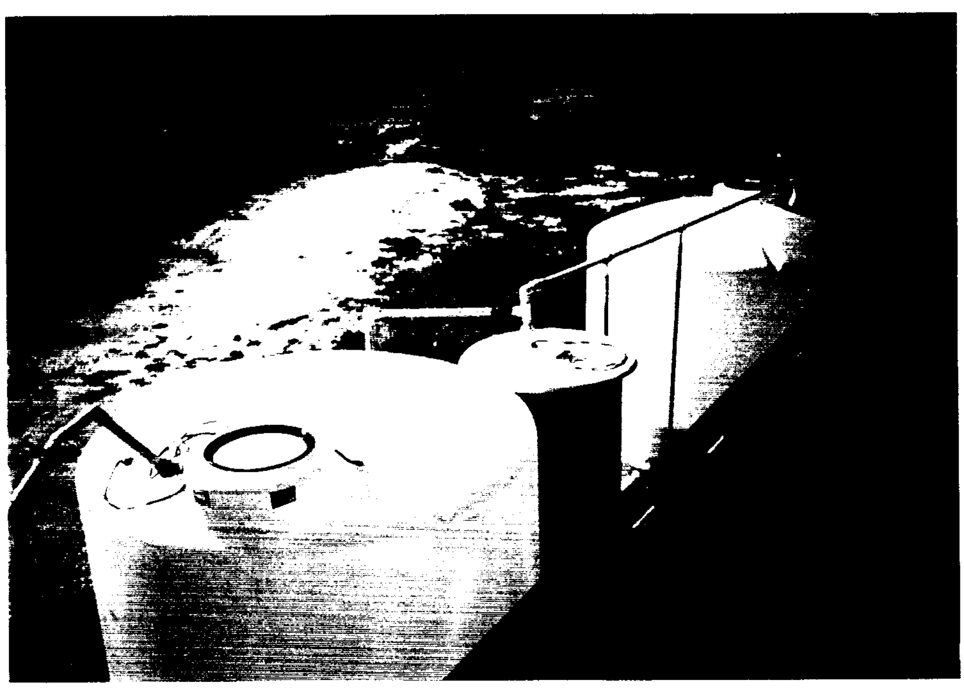
Research/Demonstration Project Photographs

Overview of septage filtration/dewatering system set-up at Manor, Texas WWTP site.

Septage dewatering system set-up. Polyethylene tank at left is final filtrate holding tank. Middle (smaller) tank is pump tank. Tank at right is filtrate recycle tank, containing filtrate that will be recycled through wood chip filter.

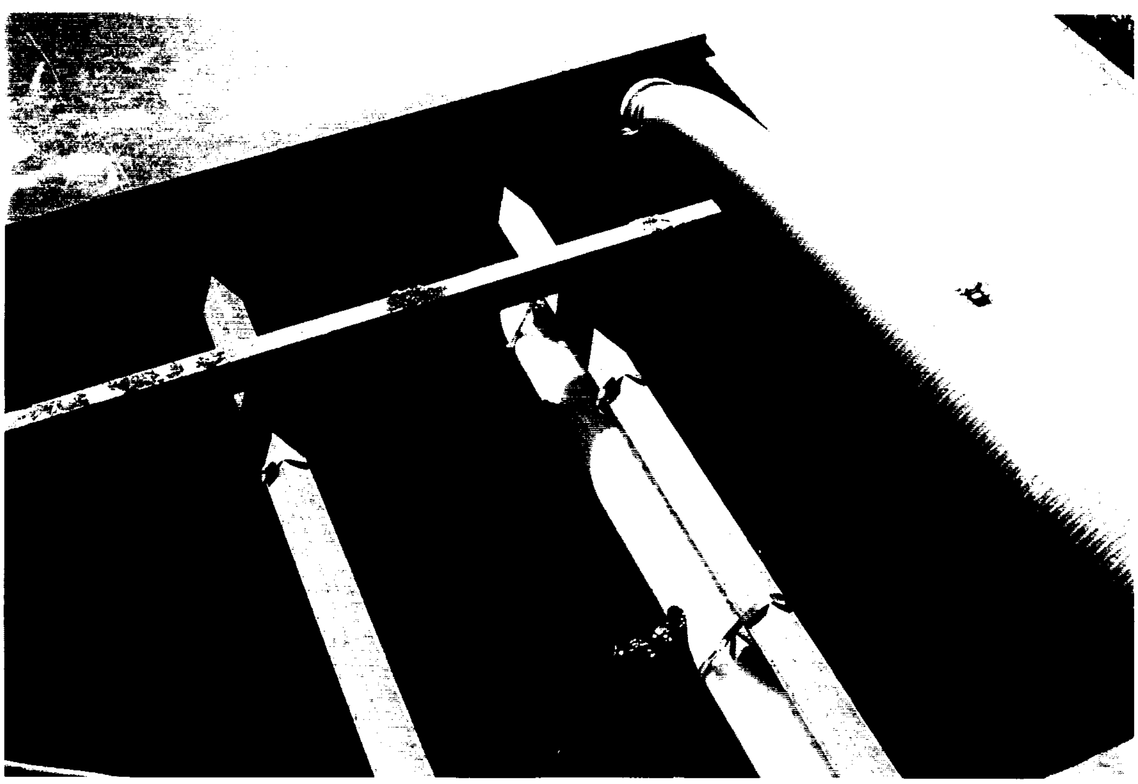


View of interior of wood chip dewatering/filtration unit. It was constructed using a modified roll-off solid waste unit, with piping installed to distribute the septage, and collect and recycle filtrate.

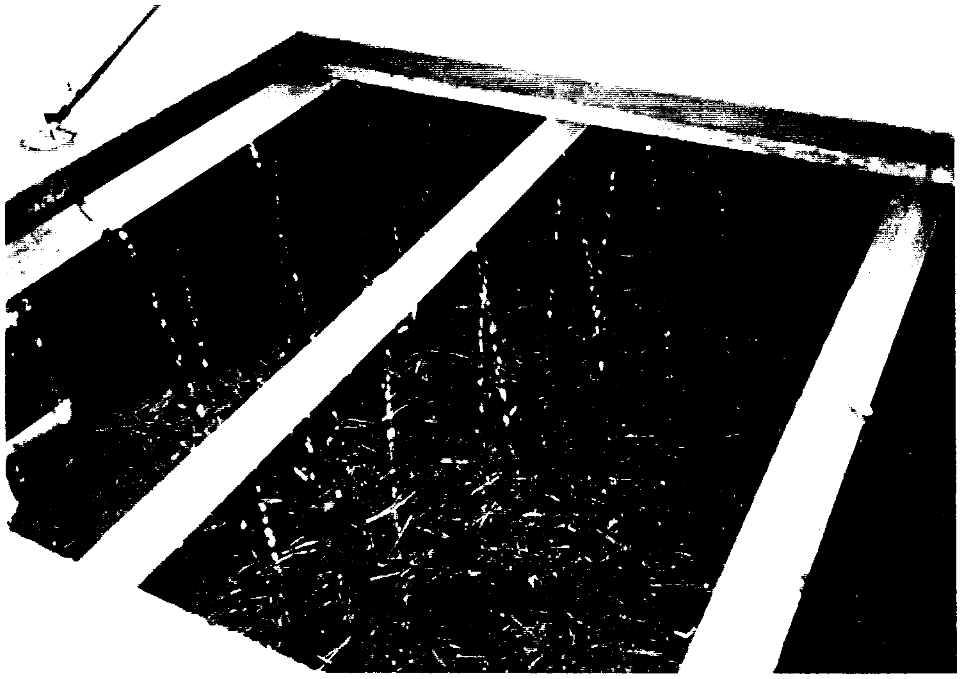


Top view of septage filtration/dewatering research unit, showing access ports installed to load wood chips and connect pressure hose to piping from septage tank trucks.

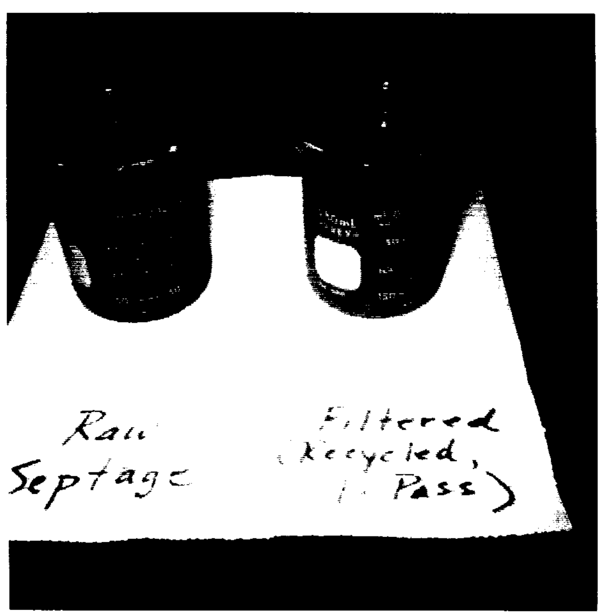
Roto Rooter tank trucks delivering raw septage to research unit at the Manor, Texas WWTP site.



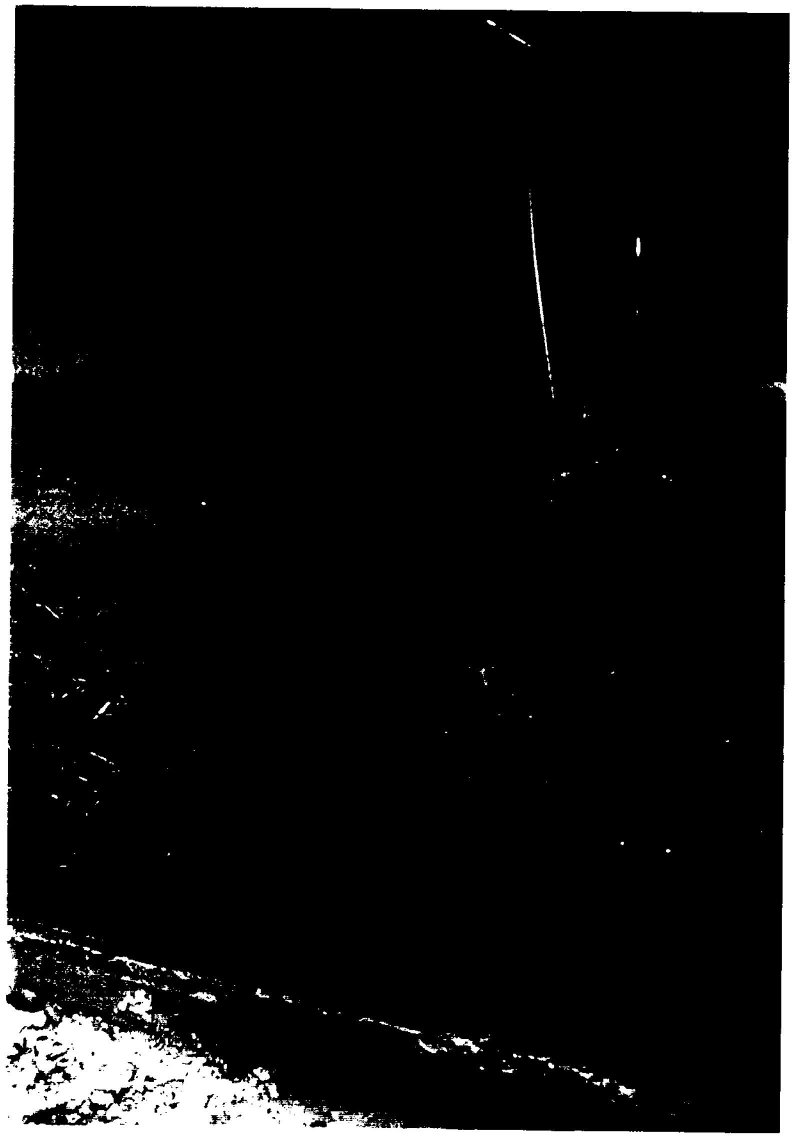
Raw septage being pumped from tank truck through distribution pipe and applied to surface of wood chip filter medium in treatment unit.



Filtrate from initial pass through wood chip filter being re-applied to surface of wood chips (recycle filter run).

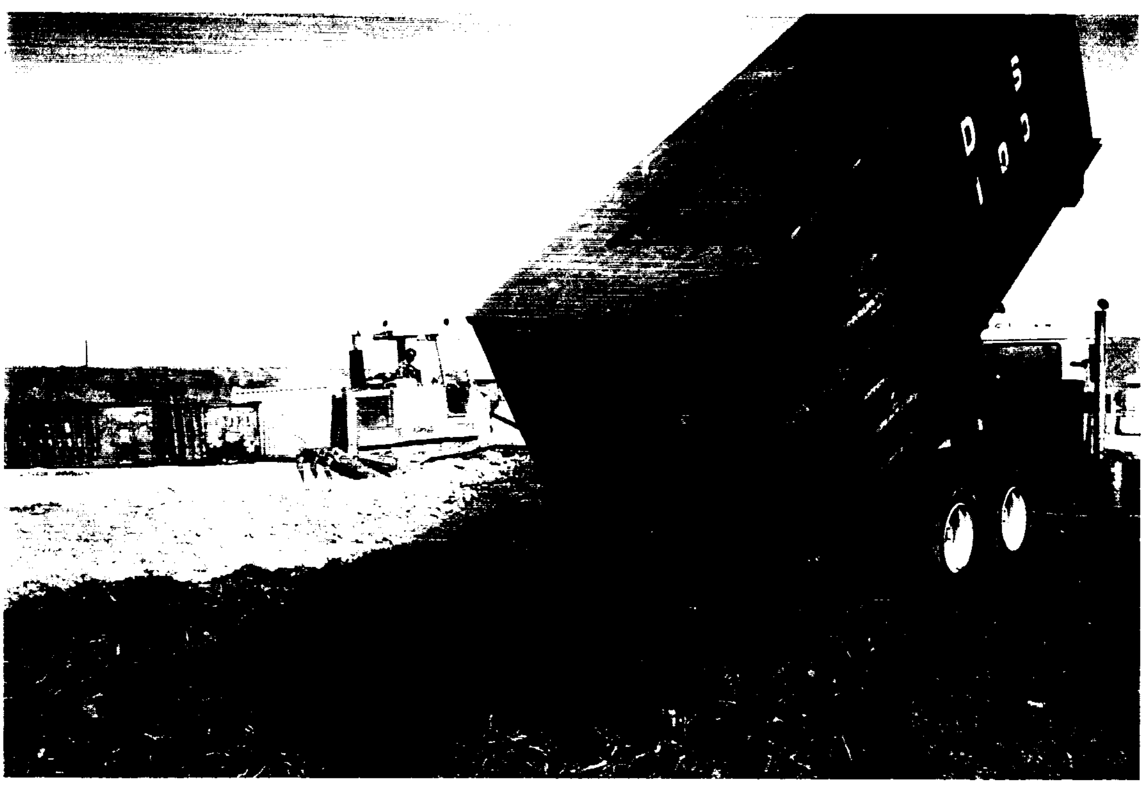


Visual comparison of raw septage with filtrate from initial pass through wood chip filter.

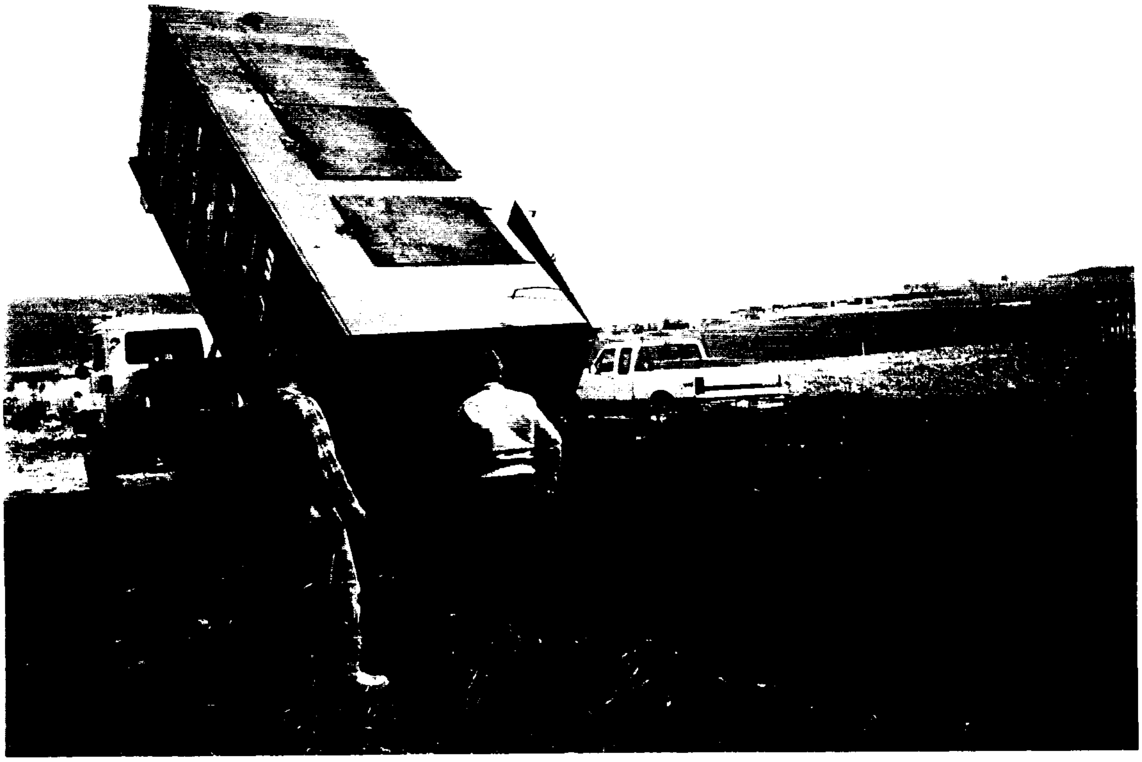


View of sludge blanket on surface of wood chip bed in septage treatment unit. A depth of about four to six inches of sludge/biosolids accumulated before it was necessary to empty the unit and refill with fresh chips.

Wood chips and biosolids being emptied from roll-off treatment unit at composting site at the Texas Disposal Systems (TDS) Landfill.

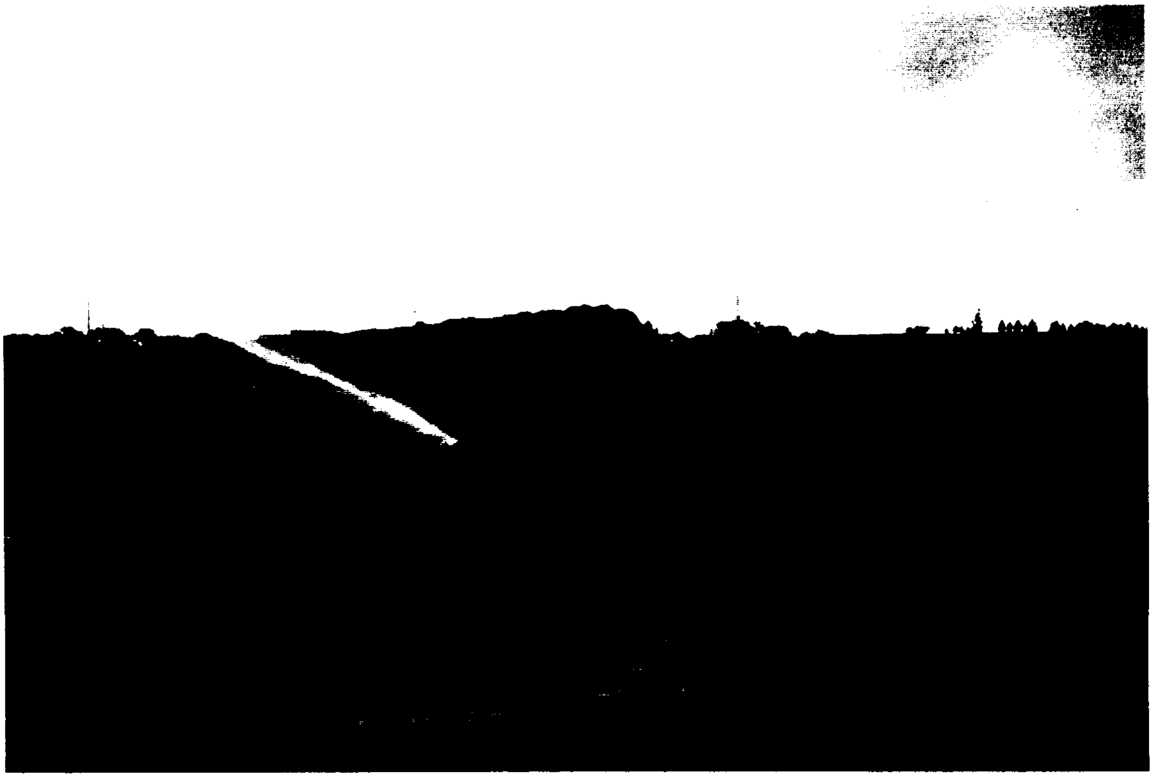


Wood chips and bioslids being emptied from roll-off unit for composting.



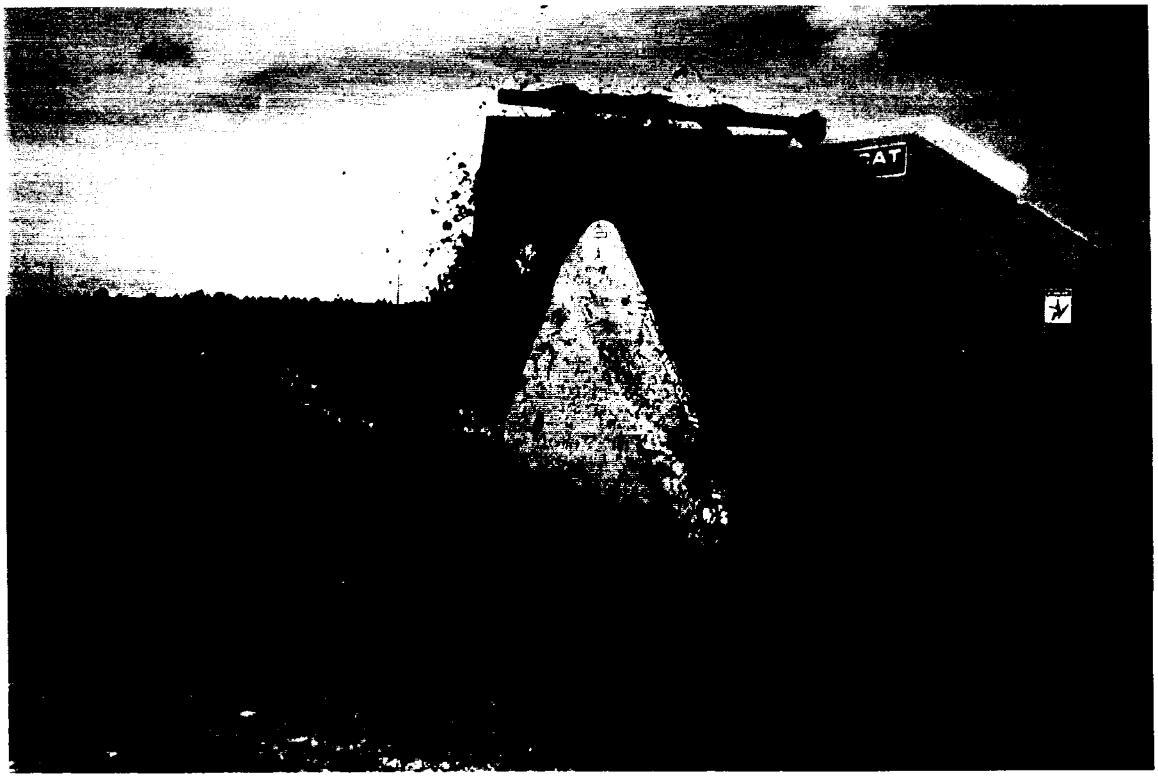
Wood chips and biosolids being emptied from roll-off treatment unit to form a windrow for composting at the TDS site.

Wood chips and bioslids formed into a windrow for composting.



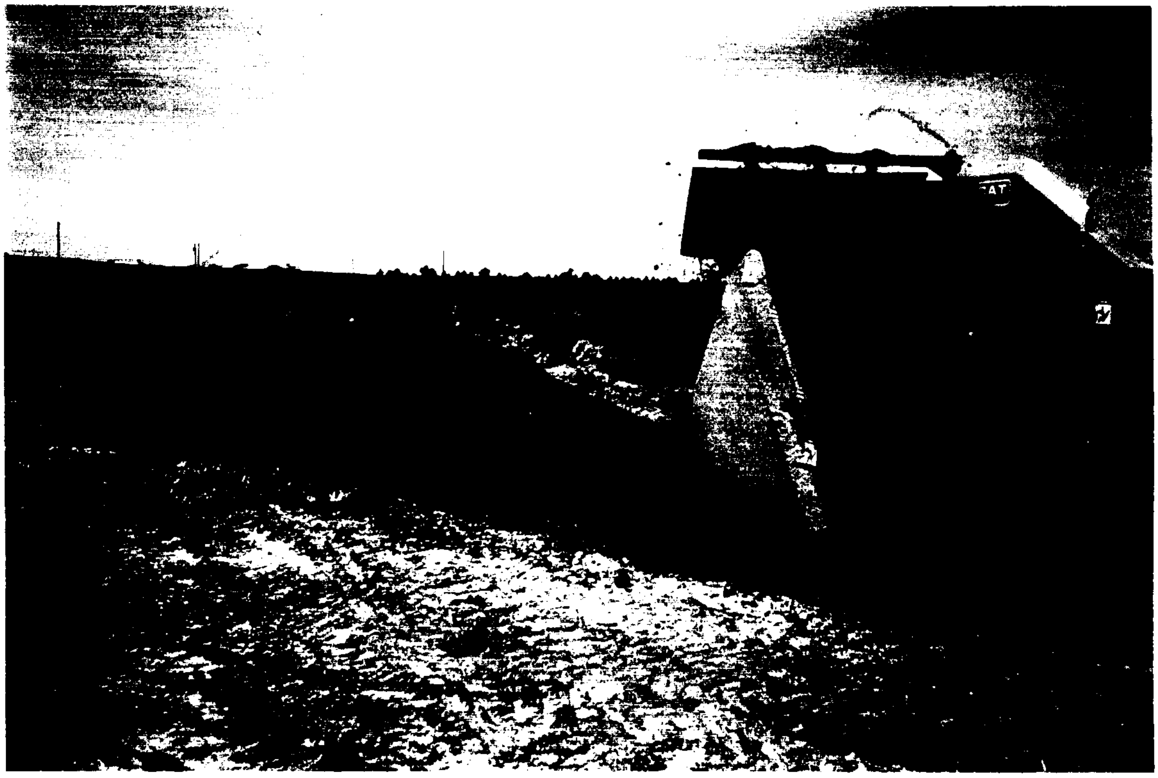
Water being applied to composting wood chips and biosolids to increase moisture content to acceptable level for composting process.

Windrowed compost pile prior to being turned.



Composting wood chips and bioslids being turned.

Alternate view of composting pile being turned.



Composting pile being turned.

View of windrowed composting pile being turned.

Attachment 2

Copy of June 1996 Biocycle Article
"Septage Dewatering and Composting in Norway"

MOBILE METHODS

SEPTAGE DEWATERING AND COMPOSTING IN NORWAY

Outside of developed cities and towns, on-site systems are the prevailing technology for treatment of domestic wastewater. As a result, many rural areas use a low cost approach to septage handling, with composting of dewatered solids.

M.D. Giggey, Ø. Rasmussen, L. Bjørnstad and N.G. Schrøder

NORWAY'S population of 4.5 million is spread over 320,000 square kilometers. Outside of the developed cities and towns, most Norwegians rely on on-site treatment of domestic wastewater. Widely dispersed villages, with steeply sloping terrain and shallow soils, pose problems for both low cost municipal sewer systems and for on-site disposal of wastewater. Many rural areas use a low cost approach to septage handling, with composting of the dewatered solids.

A good example of the use of an innovative system can be found in Vennesla, an industrial town of 12,000 people located about 15 kilometers north of Kristiansand near Norway's southern tip. Approximately 85 percent of the population is served by public sewers with treatment of wastewater at the Odderøya plant in Kristiansand. The remaining 700 homes use on-site disposal systems. Septic tanks are pumped by a private contractor who delivers the septage to a receiving station near the municipal landfill.

Septage trucks are emptied into a Moos dewatering container housed in a small wood frame building. The septage is automatically screened and conditioned with polymer as it enters the container. A nylon filter fabric inside the container is supported by a steel frame. Most of the water in the septage flows through the fabric, leaving a sludge cake of 15 to 20 percent solids. The filtrate collects in the bottom of the container and flows into the public sewer system.

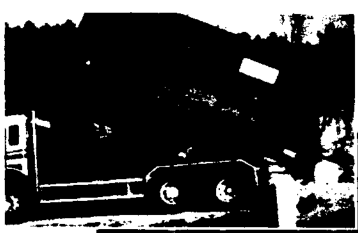
After several truckloads of septage are dewatered, the sludge cake must be emptied from the container. It is pulled from its enclosure and put onto a roll-off truck, then transported and discharged at the composting area at the adjacent landfill. The sludge cake is blended with softwood bark obtained from a local paper mill and the mixture is placed in windrows. The material remains in the windrows for about 12 months; piles are turned several times during this period by a front-end loader. Leachate is collected and treated in an on-site anaerobic pond.

The septage receiving and dewatering facilities were built in 1989/1990 at a cost of 1.5 million Norwegian kroner (about $230,000 US). Starting in mid 1996, the dewatered sludge from this facility will go to the new Støleheia agitated bin composting plant in Kristiansand (see sidebar).

MOBILE DEWATERING AND COMPOSTING ON ASKØY

Askøy is an island with a population of about 20,000 near Bergen on Norway's western coast. Although connected to the mainland by bridge, it has no public sewer system. Some homes use conventional septic tank and leaching field systems. Many homes and businesses are connected to common septic tanks with ocean discharge. Since most of the island is bare rock, and the surrounding ocean waters are deep and well mixed, discharge of primary effluent is considered an acceptable practice.

The Norwegian government has mandated that septic systems be pumped every two years. Homeowners receive a notice from the local government requiring that the septic tanks be exposed one to two weeks prior to the scheduled pumping. Systems are selected for pumping based on their location to



Photos courtesy of Wright-Pierce Engineers

Septage from homes in Vennesla is dewatered in a container housed in a wood frame building. When full, the container is transported and discharged at the composting area at an adjacent landfill (inset).

COMPOSTING PLANT IN START-UP

THE Renovasjonsselskapet for Kristiansandregionen (RKR) opened it Støleheia cocomposting plant in April, 1996. This regional solid waste district serves the communities of Kristiansand, Vennesla, Søgne and Songdalen on the southern tip of Norway, with a combined population of 90,000. The plant includes a covered storage area for raw feedstocks, an enclosed nine bay Longwood Manufacturing agitated bin composting system, an enclosed curing building, and a paved pad for long-term compost storage. The facility also utilizes a Morbark tub grinder and two SSI mixers. The incoming residuals include biosolids from five nearby wastewater treatment plants, source separated organics from homes and businesses, and softwood bark from area paper mills.

The region began a source separation program in 1995, with curbside pick up of three streams (a green bin for paper, grey bin for material to be landfilled, and a brown bin for household organics). After initially experimenting with kraft liner bags for the organics bins, the communities recently switched to a corn starch based plastic bag. Design engineers for the project are Wright-Pierce and Unico, a Norwegian firm.

minimize travel time for the mobile dewatering vehicle.

A contract for septage handling has been awarded to Leif Bjørnstad, a local dairy farmer who uses a Moos mobile dewatering truck. The dewatering system is similar in concept to the stationary unit in Vennesla, but includes a filtrate storage section. The contents of a septic tank are displaced by vacuum into the tank of the truck. The septage is then dosed with polymer and discharged into the truck's dewatering system. Filtrate passes through the filter fabric and flows by gravity into the filtrate tank on the truck. When servicing larger systems, the filtrate is discharged back into the septic tank before the truck leaves the site. For smaller septic tanks, the dewatering can occur while the truck is en route to the next service site, where the filtrate is discharged.

After dewatering about 40 to 50 m^3 of septage (11,000 to 14,000 gallons), the accumulated sludge cake, at 15 to 20 percent solids, must be unloaded. The truck returns to Bjørnstad's dairy farm in the village of Herdla, on the extreme northwestern point of the island. The cake is dumped from the truck into a receiving bin within the 1000-m^2 (10,000 sq. ft.) barn where first stage composting takes place. The sludge cake is mixed with softwood chips and placed in windrows within the barn. The windrows stay in the barn for about two months, with occasional turning, before being placed in outdoor windrows for another eight to 10 months. The finished compost is screened and used for landscaping in the Bergen area.

The Bjørnstad composting operation is located only 30 meters from the fjord, and about 300 meters downhill from the village church. Odors are experienced only during turning of the windrows, and are noticeable at the church only under rare, unfavorable weather conditions.

Bjørnstad receives payment of 920 Norwegian kroner (about $140 US) for each tank pumped. This payment comes directly from the local government, which incorporates the charges into the local property taxes. His mobile dewatering vehicle services about 2,000 tanks per year. Each work day, the two person crew can normally dewater 12 to 15 tanks, depending on their size and ease of access.

COMPARATIVE ECONOMICS

There are about 40 mobile septage dewatering trucks in use in Norway, and about 25 stationary dewatering containers. Operators of the mobile units receive about 600 to 1,000 Norwegian kroner ($90 to $150/tank US at the current exchange rate) for each tank pumped. This payment covers transportation between systems, pumping, dewatering and composting or landfilling. In many places in the U.S., a septic tank pumper charges $50 to $100 for pumping and transport to the nearest disposal location. Wastewater treatment plants generally charge about $50 to $100 for septage treatment per thousand-gallon tank. Taken together, the U.S. costs range from $100 to $200 per thousand gallons. The Norwegian practice is relatively competitive, despite the often widely dispersed population, due to the simplicity of the composting process, the low cost dewatering system, and the ability to minimize transportation costs by scheduling a single day's work all in the same neighborhood, without the need to return to the composting facility until the end of the day. ■

On the island of Askøy, septage is dewatered in a mobile unit mounted on a truck. After dewatering about 11,000 to 14,000 gallons, the accumulated cake is unloaded in a barn on a dairy farm (inset), mixed with wood chips and composted in windrows.

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