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Composting the fines component of log sortyard residues

Contents

Abstract

This report discusses some options for composting the fines component of residues produced at log sortyards, including composting the fines with a readily available and inexpensive nitrogen source like fish processing waste. Based on the B.C. Agricultural Composting Handbook, FERIC calculated the sizing and capacity of a potential logyard fines composting facility. Costs associated with operating a composting site under various equipment ownership and utilization scenarios are presented.

Keywords

Logyard, Logyard residue, Fines, Utilization, Composting, Methods, Costs, British Columbia.

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Introduction

Since 1977, FERIC has studied and reported on the composition and utilization of logyard and sortyard residues in the Pacific Northwest. In this report, FERIC discusses some options for composting the fines component of these residues.

Operators of logyards and sortyards in British Columbia routinely separate and classify residues for the purposes of reclaiming the wood for chips, wood/bark for power boiler fuel, and rock for sortyard maintenance. Of these residues, up to 36% from paved yards, and up to 71% from unpaved yards, can be classified as fines (i.e., 8–35 mm in size) (Forrester and Preston 2002). This material is difficult to dispose of or utilize. One solution is to compost the fines (a carbon source) with a readily available and inexpensive nitrogen source. In coastal British Columbia, fish offal and chunder (processing residues and dead fish) are a good nitrogen source and can be obtained from fish farms and processing plants. In the interior of the province, sources of nitrogen may include: manure from dairy farms and feedlots; green waste from municipal collections and orchards; and municipal sewage sludge (bio-solids).

Handling and use of non-composted, screened sortyard fines has been documented by Mensch[1] and Venner et al. (2000). This material has been applied during the reclamation of agricultural lands, capping of landfills, and deactivation of forest roads and landings. Venner et al. (2000) also reported on the application of sortyard residues composted with seafood processing residuals.

The B.C. Agricultural Composting Handbook (British Columbia Ministry of Agriculture, Fisheries and Food 1996)[2] outlines four basic composting methods: passive windrow, turned windrow, aerated static pile, and in-vessel. The turned windrow method is appropriate for sortyard residues because the equipment and manpower required can be obtained from an adjacent sortyard. Compared to the passive windrow method, the shorter composting

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[1] Logyard debris management methods and wood fired boiler ash: publications and letters, compiled by Ron Mensch, Twin Creek Enterprises, Bonners Ferry, Idaho, undated (approx. 1998), unpublished.

[2] Hereafter referred to as the Handbook.

cycle of the turned windrow method allows a greater volume of composted material to be processed on a smaller area. The other two methods require a higher investment in equipment and manpower. The Handbook explains in detail the composting process, including examples of calculations to obtain material blending ratios, combined material moisture content, moisture content adjustments, and the porosity of the mixture to be composted.

This report describes the process of designing a composting operation, but does not deal with the mechanics of composting because this information is available from other sources. Also included as an alternative composting method is the AG-BAG system which composts mixed material in a tubular bag.

Before embarking on any composting project, it is necessary to be aware of all federal, provincial, and municipal regulations governing site selection and construction, composting methods, compost utilization, and pollution control. Of particular note are "The Organic Matter Recycling Regulation" B.C. Reg. 18/2002 (Province of British Columbia 2002) and the federal Fisheries Act (Government of Canada 2001), with Sections 34-42 administered by Environment Canada.

Objectives

The objectives of this study were to:

- Determine the area required for establishing a composting site designed to use fines derived from residues generated at a paved coastal B.C. log sortyard with a throughput of 250 000 m^3 of logs per year.
- Present costs associated with a composting operation under various equipment ownership and utilization scenarios.
- Examine compost utilization options.
- Look at various ways of implementing the above.

Results

Based on the Handbook, FERIC calculated the sizing and capacity of a potential logyard fines composting facility (Figure 1). Figure 2 illustrates a possible layout of a composing site. The area required to compost the fines and fish waste will be approximately 1.1 ha. This does not include a settling pond because most paved sortyards in coastal British Columbia should have provisions for rainwater runoff which could be expanded and modified to also serve as a leachate catchment basin.

Depending on the dimensions of the fines screened from the sortyard residues, it may be necessary to add some coarse material (e.g., wood chips or hog fuel) during the turning process to maintain porosity in the composting material. The use of a compost turner will accelerate the break up of the larger fractions in the material.

In most areas of coastal British Columbia, maintaining the required moisture content should not be a problem. If an overabundance of moisture is likely, it is critical that the composting pad is constructed to allow excess moisture and rainwater to drain into a catchment basin where it can be recycled onto the composting piles if necessary.

The AG-BAG system[3] (Figure 3) is an alternative to the turned windrow method. In this system, the mixed ingredients, plus a bacterial innoculant dissolved in water, are fed mechanically into a tubular bag with sealed ends and left to compost. The bag is

[3] The AG-BAG system is a product of AG-BAG International in Warrenton, Oregon.

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Step 1 Assume

- Sortyard throughput = 250 000 m^3/year
- Residues generated at 10% of volume = 25 000 m^3/year [b]
- Fines generated at 30% [b] of residue volume = 7 500 m^3/year (208 m^3/week) [c]

Step 2 Assume

- Three times the volume of fines to fish waste required to achieve correct C:N ratio. [d]
- 50% shrinkage after active composting.
- 6 weeks active composting phase.
- Windrows: 3.7 m across base, 1.2-m high, and contain 3 m^3 of material per m of length.
- Curing will require 4 weeks.
- Curing piles: 5.5 m across base, 1.8 m-high, and contain 6.75 m^3 of material per m of length.
- Up to 9 weeks in storage, piles 2.4-m high.

Step 3 Calculate the size of composting windrow

- Volume of fines per week = 208 m^3 / week
- Volume of fish waste required = 70 m^3 / week
- Total volume = 278 m^3 / week
- Windrow length required = 278 m^3 ÷ 3 m^3/m = 93 m (or 2 @ 47 m)

Will require 12 windrows (2 per week), 47-m long, to cover the 6-week active composting phase.

Step 4 Calculate the size of curing pile

- Volume to be cured/week = 278 m^3 × 50% shrinkage = 139 m^3/week
- Pile volume = 4 weeks × 139 m^3 = 556 m^3
- Pile length = 556 m^3 ÷ 6.75 m^3/m = 84 m (or 2 @ 42 m)

Step 5 Calculate the size of storage pile

- Volume to be stored = 9 weeks x 139 m^3 = 1251 m^3
- Pile size = 1251 m^3 ÷ 2.4 m = 521.25 m^2 = 10 m × 53 m
  (or 2 piles 10 m × 27 m)

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[a] Based on Composting Factsheet No. 382.500-6, B.C. Agricultural Composting Handbook.
[b] Forrester(1996).
[c] Assuming 36 weeks per year.
[d] Nicholls et al. (2002).

Figure 1. Sizing a compost facility[a] for fines and fish waste.

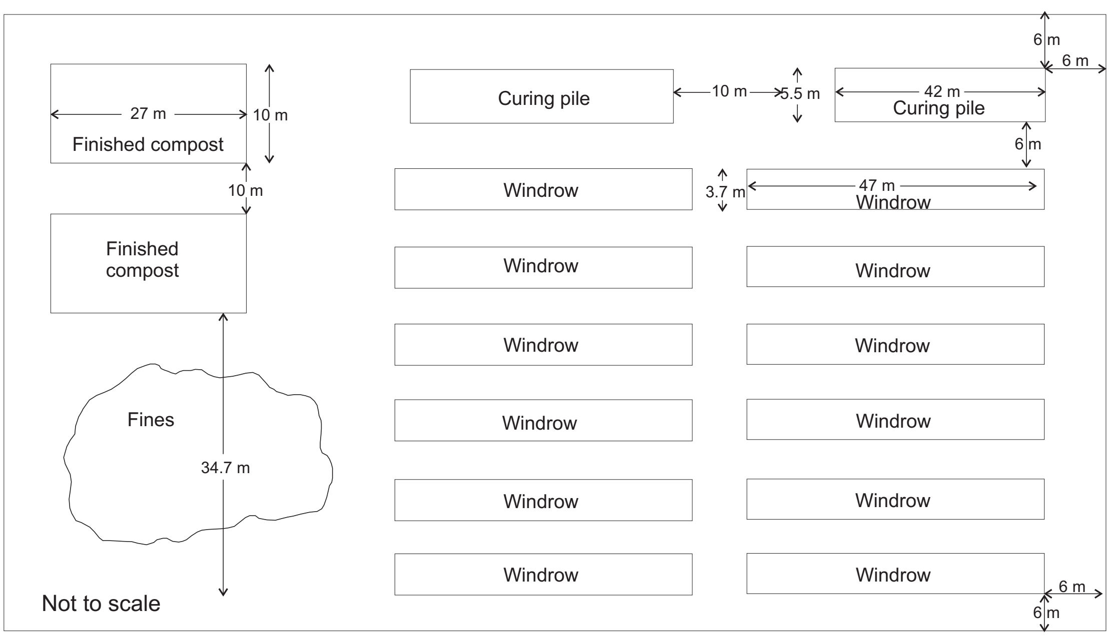

Figure 2. Composting site layout.

Figure 3. The AG-BAG composting system.

Figure 4. Aeration pipe for the AG-BAG system.

aerated (Figure 4) to assist the composting process. This will require a power source to operate the blower.

Equipment required and cost estimates

Assuming that this composting facility is located adjacent to a log sortyard, obtaining the part-time use of a front-end loader to mix and windrow the fines and fish waste should pose few problems. For comparative purposes, the costing analysis (Appendix I) includes a dedicated front-end loader as a scenario.

In order to minimize the use of the front-end loader and maximize windrow aeration, a self-powered loader-mounted compost turner is included in the costing scenarios. An allowance for a moisture meter and a compost monitor are also included. The latter measures compost temperature, oxygen, and carbon dioxide levels, and the accumulated data can be downloaded to a computer for analysis. From this information, the optimum conditions for windrow turning can be obtained. This equipment can also be used to monitor the AG-BAG system.

Table 1 shows the cost/m^3 of finished product for various equipment ownership and utilization scenarios for the turned windrow method. The lowest cost (\$27.58/m^3) assumes that a composting pad is in place, or one is not used, while the highest (\$48.20/m^3) employs a dedicated front-end loader for all composting activities including windrow turning. If the costs associated with a compost turner are shared with another facility to maximize turner utilization, a cost of \$32.56/m^3 results. The AG-BAG system costs are shown in Table 2. Cost sharing of the bagging mechanism reduces the cost for this system from \$24.79 to \$17.37/m^3. The addition of a mixer would add about \$2.00/m^3 to each scenario.

Table 1. Costs for turned windrow system

				Dedicated front-end loader		Shared compost turner		No composting pad	
	Hourly cost ($/h)	Time used (h/y)	Total annual cost ($/y)	Time used (h/y)	Total annual cost ($/y)	Time used (h/y)	Total annual cost ($/y)	Time used (h/y)	Total annual cost ($/y)
Front-end loader	130.40	720	93 888	1 440	187 776	720	93 888	720	93 888
Compost turner	122.63	360	44 147			360 [a]	15 660	360	44 147
Concrete pad	37.08	1 440	53 395	1 440	53 395	1 440	53 395		
Total cost ($)			191 430		241 171		162 943		138 035
Compost production (m^3)			5 004		5 004		5 004		5 004
Compost cost ($/m^3)			38.25		48.20		32.56		27.58

[a] Cost is adjusted to reflect sharing with other facilities. Hourly rate of $43.50 was used.

Table 2. Costs for AG-BAG system

			AG-BAG system		Shared AG-BAG system		
	Hourly cost ($/h)	Time used (h/y)	Total annual cost ($/y)	Total annual cost with mixer [a]	Time used (h/y)	Total annual cost ($/y)	Total annual cost with mixer [a] ($/y)
AG-BAG system [b]	51.23	1 440	73 771	73 771	720 [c]	36 886	36 886
Front-end loader	130.40	300	39 120	49 083	300	39 120	49 083
Labour	31.02	360	11 167	11 167	360	11 167	11 167
Total cost ($)			124 058	134 021		87 172	97 136
Compost production (m^3)			5 004	5 004		5 004	5 004
Compost cost ($/$m^3$)			24.79	26.78		17.37	19.41

[a] The mixer cost of $33.21/h is added to the front-end loader cost.
[b] Includes pod, air hose, and monitoring equipment.
[c] Reflects sharing with other facilities.

Product utilization

Prior to spreading, the composted material should be tested to determine nutrient composition. In conjunction with knowledge of the site requirements, this will allow an application rate to be calculated (see Handbook for calculation). Finished compost can be used for logging road rehabilitation (Forrester1998a and b) where it can assist in re-establishing native ground cover prior to tree planting. The same principles also apply to landings and possibly cutbank stabilization. Care must be taken when applying composted material to avoid placing it in, or too close to, waterways (e.g., streams).

In some instances, there may be potential for selling the compost for landscaping depending on the proportion of inorganics (pebbles and sand) present in the original fines. In coastal British Columbia, the sortyards and composting operations are remote, and sales of compost are generally not commercially viable.

Implementation

Constructed compost site

For the purposes of this report, the composting site would be located adjacent to a log sortyard to utilize its manpower and equipment, and for the proximity to the carbon source (fines). A centrally located site serving a number of sortyards is also a possibility, but hauling the fines would be required, as would dedicated manpower and equipment.

When applying the Handbook's formula to a scenario in the interior of British Columbia, the higher mineral content of the fines—up to 74% (Forrester 1999)—will have to be taken into account by adding carbonaceous material to the mix in order to obtain the desired carbon / nitrogen ratio.

In all composting operations odour management is critical. When using fish processing residuals as a nitrogen source, it becomes even more of a concern as this material may have been in the transport totes for some time, becoming progressively more malodorous. Mixing, windrowing, and capping with cured compost should help reduce the odours.

When constructing a composting pad, adequate drainage and a run-off basin are necessary to collect run-off rainwater and leachate. Water from the basin can be pumped back onto the windrows during dry weather. The basin must be lined so this water cannot percolate into the natural ground water supply.

Another critical consideration is a fresh water source. This water is needed to clean the front-end loader after initial mixing of materials, to supplement water for moistening the windrows if the catchment basin is low, and for use in case of fire.

Because of the generally high rainfall in coastal British Columbia, a February to October composting season would avoid the period with heaviest precipitation. Covering the piles with tarps during wet periods would also help to maintain the desired moisture content of the composting material. However, covered piles can become anaerobic and odoriferous, and would therefore have to be turned more frequently.

AG-BAG composting site

The AG-BAG system does not require much development on its site. Flat ground with a 1–3% slope and space to lay out the 61-m long by 1.5-m diameter pods (bags) is adequate. By locating the site next to an established sortyard, equipment and manpower are readily available, as is the carbon source (fines). Electricity will also be required for the aeration system.

Odour management is not as critical with this system as with windrowing because the composting material is contained in the pod. The correct moisture content to start, as well as the forced air system and monitoring, will prevent anaerobic conditions from developing. The only odour problems will occur during mixing and can be mitigated by planning.

As with the windrow site, a freshwater source is critical in order to keep equipment clean and reduce the fire hazard. Wet or hot weather will not affect these pods. Although the pods are not reusable, they can be recycled or used as tarps to cover finished compost or incoming fines.

Figure 5. Compost mixed with pulled-back sidecast.

Figure 6. Excavator restoring original slope to deactivated logging road.

Figure 7. Agricultural spreader for distributing composted material.

Utilization of compost

Distribution of the cured compost will depend to some extent on its final use. A method observed in Washington State (Forrester 1998a and b) involved dumping piles of the compost along a road (Figure 5) to be deactivated, where it was mixed with the recovered sidecast by an excavator restoring the natural slope profile (Figure 6). On a de-commissioned spur road on northern Vancouver Island, two methods were tried after the compost had been hauled to the site by a gravel truck. One method involved the use of an agricultural spreader (Figure 7) laying the material down after the surface had been lightly ripped with a front-end loader. In the second method, the loader distributed the compost (Figure 8).

The front-end loader also proved effective for spreading composted material on an eroding cut face. All the Vancouver Island sites were seeded with a variety of forbs and herbs. The Washington sites were seeded with winter wheat and then covered with straw to help retain moisture and protect the seeds from birds. Winter wheat re-seeded itself for only two additional seasons, allowing native plants from the adjacent areas to colonize the sites.

Summary and conclusions

Composting the fines component of log sortyard residue with an appropriate and inexpensive nitrogen source is an alternative to land filling or direct land application. In this report, FERIC discussed how it used a template developed by the British Columbia Ministry of Agriculture, Fisheries and Food to design a composting operation for a coastal log sortyard processing 250 000 m^3 of logs per year. If this yard realized 10% residuals with 30% of these as fines, an area of 1.1 ha would be required to compost the fines with fish waste. Approximately 5 000 m^3 of compost would be produced using the turned windrow method, at costs ranging from \$27.58 to \$48.20/m^3 for scenarios using various equipment ownership and utilization assumptions. Using the AG-BAG composting system, which does not require a hard surfaced pad, costs ranged from \$17.37 to \$24.79/m^3, again depending on equipment ownership and utilization.

The finished compost can be used for rehabilitating logging roads, landings, and cutbanks. Depending on the location of the composting facility and quality of the compost, there may be potential for local commercial sales.

Although composting the fines generated at a log sortyard comes at a cost, the cost can be mitigated by partnering with other residue generators, e.g., fish farms, to manage various waste streams.

Figure 8. Front-end loader spreading composted material.

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Appendix I

Machine costs[a] ($/scheduled machine hour (SMH))

	AG-BAG system	Mixer	Compost turner	Concrete pad	Front-end loader
OWNERSHIP COSTS					
Total purchase price (P) $	84 920	120 000	150 000	565 000	420 000
Expected life (Y) y	5	5	10	20	8
Expected life (H) h	7 200	7 200	3 600	28 800	11 520
Scheduled hours/year (h) = (H/Y) h	1 440	1 440	360	1 440	1 440
Salvage value as % of P (s) %	30	30	30	10	30
Interest rate (Int) %	6.0	6.0	6.0	6.0	6.0
Insurance rate (Ins) %	3.0	3.0	3.0	3.0	3.0
Salvage value (S) = ((P • s)/100) $	25 476	36 000	45 000	56 500	126 000
Average investment (AVI) = ((P + S)/2) $	55 198	78 000	97 500	310 750	273 000
Loss in resale value ((P-S)/H) $/h	8.26	11.67	29.17	17.66	25.52
Interest ((Int • AVI)/h) $/h	2.30	3.25	16.25	12.95	11.37
Insurance ((Ins • AVI)/h) $/h	1.15	1.62	8.12	6.47	5.69
Total ownership costs (OW) $/h	11.71	16.54	53.54	37.08	42.58
OPERATING COSTS					
Fuel consumption (F) L/h	1.0	-	25.5	-	30.0
Fuel (fc) $/L	0.45	-	0.45	-	0.45
Lube & oil as % of fuel (fp) %	15	-	15	-	15
Annual tire consumption (t) no.	1.0	-	-	-	1.0
Tire replacement (tc) $	200	-	-	-	6 860
Annual operating supplies (Oc) $	38 988	-	5 120	-	-
Annual repair & maintenance (Rp) $	16 984	24 000	15 000	-	49 070
Operator wages (W) $/h	-	-	0.00	-	24.24
Wage benefit loading (WBL) %	-	-	-	-	38
Fuel (F • fc) $/h	0.45	-	11.48	-	13.50
Lube & oil ((fp/100) • (F • fc)) $/h	0.07	-	1.72	-	2.03
Tires ((t • tc)/h) $/h	0.14	-	-	-	4.76
Operating supplies (Oc/h) $/h	27.07	-	14.22	-	-
Repair & maintenance (Rp/h) $/h	11.79	16.67	41.67	-	34.08
Wages & benefits (W • (1 + WBL/100)) $/h	-	-	-	-	33.45
Total operating costs (OP) $/SMH	39.52	16.67	69.09	-	87.82
TOTAL OWNERSHIP AND OPERATING COSTS (OW + OP) $/SMH	51.23	33.21	122.63	37.08	130.40

[a] These costs are estimated using FERIC's standard costing methodology for determining machine ownership and operating costs for new machines. The costs shown here do not include supervision, profit and overhead, and are not the actual costs for the contractor or the company studied.