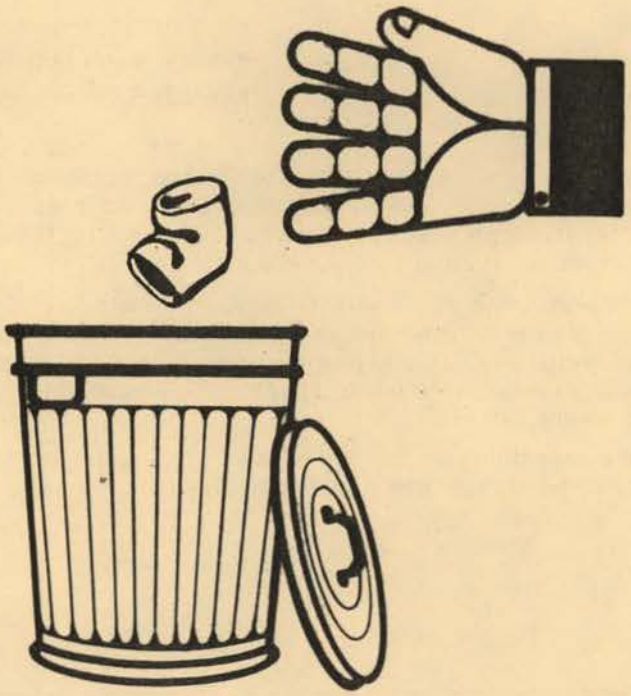
Bulletin No. 609

Cost of Public Service

Solid Waste Disposal



Cooperative Extension Service
University of Idaho
College of Agriculture

Contents

Introduction 3
Methods of Estimating Expenditures 4
Solid Waste Disposal 5
Estimating Solid Waste Disposal Cost 6
Estimating Growth's Impact on Solid Waste Disposal Expenditures 6
Worksheet — Estimating Solid Waste Disposal Expenditures 8
Worksheet — Estimating Population Growth's Impact On Solid Waste Disposal Expenditures 9
Community Information 10
Bibliography 10

This is one of eight bulletins supported by Title V of the Rural Development Act of 1972 on estimating costs of public service in Idaho communities of various size. The services covered in the series are:

- Education
- Fire Protection
- Police Protection
- Sewage Collection and Treatment
- Sheriff Protection
- Solid Waste Disposal
- Water Supply

A worksheet for estimating costs for each service area is designed to facilitate citizen use. Relationships are used to derive costs and are expressed in terms of state averages. You may use the standards as given to derive cost estimates for the services or change them to reflect the situation in your community.

Extension Bulletin 602, *Residential Growth: Its Benefits and Costs to the Local Community*, is used as a format for an overall look at what effects increases in the number of residential dwellings and people have on revenues for the public and private sector and on costs in the public sector. The estimation procedure is outlined for cities, counties and school districts.

This publication outlines a method of estimating your community's increased costs in solid waste disposal caused by population growth.

About the Authors

N. R. Rimbey is Extension range economist in the University of Idaho Research and Extension Center at Caldwell. N. L. Meyer is Extension economist in the UI Department of Agricultural Economics and Applied Statistics, Moscow.

Cost of Public Service: Solid Waste Disposal

N. R. Rimbey and N. L. Meyer

This publication presents a method of estimating expenditures for solid waste disposal and a method for estimating the impact of population growth on these expenditures. The cost estimates derived are based on relationships taken from various sources which approximate the actual situation in communities and counties. The relationships are based on state or national averages and can be changed to reflect the situation in your community. Worksheets are provided to help you in the estimation procedure.

Introduction

Idaho is currently one of the fastest growing states in the nation. This growth brings economic benefits such as increased tax revenue to the public sector, possibly more service-oriented jobs and increased spending in the private sector. This growth may also bring general social benefits such as meeting and interacting with people from different cultural backgrounds, more specialized health care and more cultural programs through schools and civic organizations.

However, this growth does not come without additional costs. Many communities and counties in Idaho are not prepared for this growth. The public sector (present residents) must handle the added costs of providing services to the new residents. For example, growth may create needs for a new sewage treatment plant, school buildings, fire and police facilities and equipment, water wells or reservoirs and garbage collection and disposal equipment. Sizable public expenditures may also be necessary for land acquisition and additional employees.

Areas can accommodate growth more easily if the public service infrastructure already exists. That means having excess capacity in the solid waste disposal system, sewage treatment facility, school system and police department and that other services can absorb the population increases without the need for major capital expenditures. Excess capacity in public services does not exist in many rural areas.

The increasing of service capability coupled with the movement toward government spending limitations poses a severe problem for many Idaho communities. "How can we accommodate the rapid population growth and additional service demands of residents and finance the services with reduced or 'frozen' revenues?" This is the most perplexing issue facing state and local government officials.

One possible alternative for local government officials is a program which would require new development to pay its "fair share" of the added service costs. Although this may seem to be a simple policy move, this action will require certain kinds of information. For example, information should be collected and analyzed to determine: the present costs of various services, the estimated costs for new residents, when expansion of which capital facilities will be needed (based on capacities of existing systems and projected growth rates), and what the existing policy of the governmental unit is concerning who should pay the additional costs.

Present costs of services are available in the annual audit report or annual budget of the unit of government. The policy aspect may require investigation of zoning regulations, building permit procedures or conversations with a city or county administrator.

The cost estimates presented here are based on relationships or standards that typify state or national averages. Standards for each service are presented with the intention that you will change or

modify them to fit the situation in your municipality. Worksheets, an abbreviated interest table and sources of information within the municipality are also given to help you in the estimation process.

A word of caution should be injected at this point. The cost figures presented here are **estimates** of actual costs and should be analyzed carefully before basing policies upon them. To help you critically evaluate costs, remember that the standards given should be changed when they prove inaccurate. Variations between actual and estimated costs may result from using average figures, topography of the area, the time lag between estimation and construction and a variety of other circumstances. Be advised, then, to use care in using the cost figures presented.

This publication was designed to give you, as a concerned citizen or government official, a **framework** for estimating the current costs of a public service. A method to estimate the added costs of population growth is also given. The service covered is solid waste disposal.

Methods of Estimating Expenditures

You can estimate costs several ways. The procedure used most often in fiscal impact studies is known as the average cost method. This involves:

1. Using the existing budget or audit report to derive current costs of services.
2. Dividing these costs by number of people or households served to determine a per capita or per household cost for each service.
3. Projecting this cost to new residents by multiplying the per capita or household costs by the number of new residents or houses.

This technique may be adequate for projecting the operation and maintenance costs of services but will severely underestimate the impact if capital expansion is needed. The problem lies in basing the estimates on past costs.

A more reliable method is using average cost figures and adding estimated capital costs. In other words, you can use average cost figures from the budgets as well as the estimated increases in capital costs to derive estimates of the impact on expenditures.

The most reliable (and costly) estimation method is conducting a detailed audit of each department within the municipality to determine the actual costs per household (or resident) and determining the anticipated date and cost of needed facilities expansion. This would involve a detailed study of each employee's duties, the anticipated equipment and personnel needs and the municipality's projected growth rates. This procedure is obviously very time consuming and expensive. However, it is the most reliable method to support local policies which require new development to pay for added service cost.

The following section outlines standards and procedures for estimating existing costs and added costs of development for solid waste disposal. This material should be used together with the information in Ext. Bull. 602, **Residential Growth: Its Benefits and Costs to the Local Community**, to derive estimates of the public benefits and costs of community growth.

Solid Waste Disposal

What are the costs of solid waste disposal? The basic processes of land disposal of solid waste involve waste collection at the population center, transportation directly to the landfill and processing at the landfill site. Refuse collection could either be a typical curbside, house-to-house route or a system where the people voluntarily take the refuse to a dumpster or canister at a central location where it can be hauled to the landfill site periodically. Processing of waste at the landfill site involves unloading the waste from trucks or canisters, spreading it over the landfill area and periodically covering it with dirt or other cover material. Spreading and covering the refuse involves the use of a bulldozer or tractor.

The basic processes presented here are:

1. House-to-house collection of garbage.
2. Direct hauling from the community to the landfill site.
3. Spreading, compacting and covering the refuse with a bulldozer or tractor at the disposal area.

The following standards will help you in estimating the cost of solid waste disposal.

Standard 1 — Waste is generated at a rate of 4 pounds per person per day.

Standard 2 — Rear-loading "packer trucks" equipped with 20-cubic-yard compactors are used as collection and transportation vehicles. These trucks are capable of carrying 5 tons of refuse when loaded and make three round trips from the community to the disposal site each day. Each round trip is assumed to be 25 miles. One truck will serve populations up to 7,500, two trucks will be needed to serve populations to 15,000 and so on. The purchase price of the packer truck is $40,000.

Standard 3 — The size of the tractor-crawler used for spreading, compacting and covering the waste at the landfill will vary with the population (Table 1).

Standard 4 — An equipment shed and furnishings are provided to house the tractor-crawler and other equipment. It is assumed that this building will also have a space for a small office and will cost $5,000.

Standard 5 — Land required for the landfill site is calculated as follows:

a. For sites processing from 0 to 199 tons per day (populations of 99,500 and less), the land required will be 10 + 0.2828 (v) where v is the daily volume of solid waste in tons.
b. For sites processing from 200 to 1,700 tons per day, the land required will be .3393 (v) (Table 2).

These equations will give the acres of land required to operate a sanitary landfill using the trench method for 5 years. The cost of the land is assumed to be $250 per acre. The amount of land required and the total cost of the land for different populations are summarized in Table 2.

Standard 6 — Operation and maintenance of the tractor-crawler is $40 per hour. This figure includes the operator's wages as well as the normal operating expenses (fuel, oil filters, etc.). The tractor-crawler is capable of processing 5 tons of waste per hour.

Standard 7 — The packer truck has operation and maintenance costs of 61 cents per ton per mile.

Table 2. Land cost and acres required by population served.

Community population	Waste generated per day	Land required	Total cost of land
	(tons)	(acres)	
500	1	10.283	$2,570.70
1,000	2	10.566	2,641.40
1,500	3	10.848	2,712.10
2,000	4	11.131	2,782.80
2,500	5	11.414	2,853.50
5,000	10	12.828	3,207.00
10,000	20	15.656	3,914.00
15,000	30	18.484	4,621.00
30,000	60	26.968	6,742.00

Table 1. Tractor needs and costs by population served.

Population served	Waste generated per day	Track-type tractor	Purchase price	Machine capacity
	(tons)			(tons processed per day)
up to 15,000	up to 35	D4D	$38,470	0 to 25
10,000 to 35,000	25 to 90	D5	59,775	0 to 49
25,000 to 80,000	60 to 200	D6C	72,535	50 to 150
70,000 to 110,000	175 to 275	D7F	96,935	150 to 225
100,000 to 200,000	250 to 500	D8H	135,270	200 to 500
200,000 and up	500 and up	Variety	—	—

Note the overlapping of population ranges in this table. This reflect the ranges of the machine capacities and will allow communities to plan for the purchase of new or additional equipment.

Source: Mackey, R. Bruce, **Costs for Rural Community Services in Nevada: An Economic Engineering Approach,** Ag. Exp. Sta., Univ. of Nevada, Reno, January 1977.

Table 3. Amortization rates for different interest rates and loan periods.

Interest rate	Years					
	3	5	10	15	20	30
7	.381052	.243891	.142378	.109795	.094393	.080586
8	.388034	.250456	.149029	.116830	.101852	.088827
9	.395055	.257092	.155820	.124059	.109546	.097336
10	.402115	.263797	.162745	.131474	.117460	.106079
11	.409213	.270570	.169801	.139065	.125576	.115025
12	.416349	.277410	.176984	.146824	.133879	.124144
13	.423522	.284315	.184290	.154742	.142354	.133411
14	.430700	.291200	.191700	.162800	.150900	.142800
15	.437900	.298300	.199200	.171000	.159700	.152300

This table will help you calculate the annual payments on investments for community services. For example, the annual payments for a $40,000 loan at 10 percent interest rate for 15 years can be calculated:

Loan amount × amortization rate = annual payment
($40,000) (.131474) ($5,259)

An annual payment of $5,259 would pay the principal and interest on this loan and retire the debt in 15 years. If an interest rate and the time period for a loan are not listed in this table, your local bank can provide the figures.

Standard 8 — All equipment and buildings have 10-year life spans and can be financed at 10 percent. Land is financed at 10 percent for 5 years.

The land's salvage or resale value has not been considered in this analysis. The salvage value will be dependent upon local conditions and markets. For example, land where a sanitary landfill has been completed may be sold for use as farmland, housing development or other uses. The value of the land will be dependent upon its suitability for development, farming or other uses. Salvage value of equipment and buildings is 10 percent of purchase price.

Estimating Solid Waste Disposal Cost

Using the eight standards given you can estimate the cost of providing solid waste disposal service for a community of a given size. As an example, consider a community with a population of 1,000 people.

Step 1 — Estimate the number of tons of waste generated by the population (Standard 1):

1,000 population × 4 lb person/day =
2 tons day or 730 tons/year

Step 2 — Estimate equipment needs and costs as follows:

1 packer truck at $40,000 (Standard 2).
1 tractor-crawler at $38,470 (Standard 3, Table 1).
1 equipment shed office at $5,000 (Standard 4).

Step 3 — Estimate land needs and costs as follows:

10.566 acres of land at $2,641.40 (Standard 5, Table 2).

Step 4 — Calculate the annual ownership costs of the equipment and land:[1]

Packer truck: ($40,000 purchase price - $4,000 salvage value × .162745 (amortization rate for 10 years at 10 percent loan rate) =	$ 5,859 year
Tractor crawler ($38,470 - $3,847 salvage value) × .162745 =	5,635 year
Equipment shed ($5,000 cost - $500 salvage value) × .162745 =	732 year
Land $2,641.40 cost × .263797 (5 years at 10 percent) =	697 year
	$12,932 year

Step 5 — Calculate operating and maintenance costs of packer truck (Standard 7):

Packer truck: 730 tons year × 25 miles trip =
18,250 ton miles year × 61 cents per ton mile =
$11,133 total annual operating and maintenance costs of packer truck.

Step 6 — Calculate operating and maintenance costs of a tractor-crawler (Standard 6):

Tractor-crawler: 730 tons year ÷ 5 tons processed hr =
146 hours of operation. 146 hours × $40 hour operation cost =
$5,840 annual operation cost of tractor

Derive the total annual cost of the solid waste disposal system for 1,000 people by adding the ownership costs and operating and maintenance costs. The total annual cost would be **$29,896** or **$29.90** per capita. Cost estimates for other populations are presented in Table 4.

Estimating Growth's Impact On Solid Waste Disposal Expenditures

The standards can also be used to estimate the impact of population growth on a community's solid waste disposal expenditures. For example, consider the community of 1,000 people experiencing rapid population growth expected to add 1,000 new residents. What will be the expected impact of this growth on solid waste disposal costs?

Step 1 — There will be more garbage to haul and process. Using the figure of 4 pounds of waste per person per day (Standard 1), an estimated 2 tons

[1]Table 3 shows how to use amortization rates in calculating annual payments.

Table 4. Estimated solid waste disposal expenditures by population served.

Population	Tons/ year	Annual cost — tractor	Annual cost — packer trucks	Annual cost — equip. shed	Annual cost — land	Oper. & maint. — tractor	Oper. & maint. — packer	Total annual cost	Annual cost per capita	Annual cost per ton
500	365	$ 5,635	$ 5,859	$732	$ 678	$ 2,290	$ 5,566	$ 21,390	$42.78	$58.60
1,000	730	5,635	5,859	732	697	5,840	11,133	29,896	29.90	40.95
1,500	1,095	5,635	5,859	732	715	8,760	16,699	38,400	25.60	35.07
2,000	1,460	5,635	5,859	732	734	11,680	22,266	46,906	23.45	32.13
2,500	1,825	5,635	5,859	732	753	14,600	27,831	55,410	22.16	30.36
5,000	3,650	5,635	5,859	732	846	29,200	55,663	97,935	19.59	26.83
10,000	7,300	8,755	11,718	732	1,033	58,400	111,352	191,990	19.20	26.30
15,000	10,950	8,755	11,718	732	1,219	87,600	166,988	277,012	18.47	25.30
30,000	21,900	10,624	23,435	732	1,779	175,200	333,975	545,745	18.19	24.92

"new" garbage will be processed each day. On an annual basis, an additional 730 tons of waste will be generated.

Step 2 — No charge will be needed as far as equipment is concerned. The packer truck and tractor-crawler are capable of handling the added waste (Standards 2 and 3). There will also be little difference in the land required and the total cost of land. Ten and one-half acres at a cost of $2,641.40 were required for 1,000 people, and a little more than 11 acres at a cost of $2,782.80 will be needed for 2,000 people. The difference in the annual cost of the land would be $37.30 [($2,782.80 - $2,641.40) × .263797] amortization rate for 5 years at 10 percent loan rate. There would also be no difference in the cost of the equipment shed.

Step 3 — The real differences in costs will occur in the area of operation and maintenance. Assuming that all of the additional waste is hauled by packer trucks in the same pattern as stated in Standard 7, the operation and maintenance costs will double, from $11,133 to $22,266.

Step 4 — The tractor-crawler costs would also double, assuming the same operating procedure as stated in Standard 6. The operating and maintenance costs of the tractor would increase from $5,840 to $11,680.

The total annual cost would rise by $17,010 to $46,906. The cost, though, would drop to $23.45 per capita. Per capita costs have decreased because excess capacity in the truck and crawler packer is being used.

WORKSHEET
Estimating Solid Waste Disposal Expenditures

A. _____
Community population

B. _____ = (4 × 365
Tons solid waste generated annually — Waste per person per day (Standard 1) — days
× _____) ÷ 2,000
(A) Population — pounds/tons

C. _____ = (_____ × _____
Annual capital cost packer trucks — Number trucks (Standard 2) — Price per truck (Standard 2)
× _____)
Amortization rate (Table 3)

D. _____ = (_____ × _____)
Annual capital cost tractor-crawler — Purchase price (Standard 3, Table 1) — Amortization rate (Table 3)

E. _____ = (_____ × _____)
Annual cost equipment shed — Purchase price equipment shed (Standard 4) — Amortization rate (Table 3)

F. _____ = (_____ × _____)
Annual land cost — Land purchase price (Standard 5) — Amortization rate (Table 3)

G. _____ = (_____ × _____
Annual operating and maintenance cost packer truck — (B) Tons solid waste generated annually — Round trip miles
× _____)
Cost per ton mile (Standard 7)

H. _____ = (_____ × 5)
Annual operating and maintenance cost tractor-crawler — (B) Tons solid waste generated annually — Tons per hour capacity (Standard 6)
× $40
Per hour operation and maintenance cost (Standard 6)

I. _____ = _____ + _____
Total annual operating cost — (C) Annual capital cost packer trucks — (D) Annual capital cost tractor-crawler
+ _____ + _____
(E) Annual cost equipment shed — (F) Annual land cost
+ _____ + _____
(G) Annual operating and maintenance cost packer truck — (H) Annual operating and maintenance cost tractor-crawler

J. _____ = (_____ ÷ _____)
Annual cost of solid waste per capita — (I) Total annual operating cost — (A) Population

K. _____ = (_____ ÷ _____)
Annual cost per ton solid waste — (I) Total annual operating cost — (B) Tons solid waste generated annually

WORKSHEET
Estimating Population Growth's Impact On Solid Waste Disposal Expenditures

A. _____
Number new residents

B. _____ = (_____ × 4
Additional refuse (tons/year) (A) Number new residents Pounds waste per person per day (Standard 1)

× 365) ÷ 2,000
days pounds/ton

C. _____ = (_____ × _____
Additional annual capital cost packer trucks Number additional trucks (Standard 2) Price per truck (Standard 2)

× _____)
Amortization rate (Table 3)

D. _____ = (_____ - _____)
Additional annual capital cost tractor-crawler Purchase price new equipment (Standard 3, Table 1) Trade in value old equipment

× _____
Amortization rate (Table 3)

E. _____ = (_____ - _____)
Additional annual land cost Land required for total population (Standard 5, Table 2) Land required for previous population (Standard 5, Table 2)

× _____ × _____
Land purchase price (Standard 5) Amortization rate (Table 3)

F. _____ = (_____ × _____
Additional annual operating and maintenance cost packer truck (B) Additional refuse (tons/year) Round trip miles

× _____)
Cost per mile per ton (Standard 7)

G. _____ = (_____ ÷ 5)
Additional annual operating and maintenance cost tractor-crawler (B) Additional refuse (tons/year) Tons/hour capacity (Standard 6)

× $40
Per hour operation and maintenance cost (Standard 6)

H. _____ = _____ + _____
Total annual additional cost (C) Additional annual capital cost packer truck (D) Additional annual capital cost tractor-crawler

+ _____ + _____
(E) Additional annual land cost (F) Additional annual operating and maintenance cost packer truck

+ _____
(G) Additional annual operating and maintenance cost tractor-crawler

I. _____ = (_____ ÷ _____)
Additional annual cost of solid waste per capita (H) Total annual additional cost (A) Number new residents

J. _____ = (_____ ÷ _____)
Cost per additional ton solid waste (H) Total annual additional cost (B) Additional tons solid waste per year

Community Information

- The county sanitation officer should be able to answer many of the technical questions involving solid waste disposal (capacity of the disposal site, possible areas where disposal is feasible in the future and so on).
- The city and county budgets may also have helpful information.
- Local banks and financial institutions will be able to provide information on loans, interest rates and other considerations related to financing equipment and buildings.
- Local equipment dealers will be able to provide cost estimates for tractors and trucks.
- If the local garbage system has been contracted to a private sanitation firm, the firm may be willing to provide information on the system's operation.

Bibliography

Brunner, Dick R., and D. J. Keller. 1972. Sanitary landfill design and operation. U.S. Environmental Protection Agency.

Grissom, Curtis L., and William E. Hardy, Jr. 1974. Planning for community service in rural areas — a regional approach to solid waste management. Ag. Exp. Sta., Auburn Univ.

Mackey, R. Bruce. 1977. Costs for rural community services in Nevada — an economic-engineering approach. Ag. Exp. Sta. Bull. T21, Univ. of Nevada, Reno.

Salkin, Michael S. 1975. Solid waste planning — components and costs for a rural system in Southeast Oklahoma. Ag. Exp. Sta., Oklahoma State Univ.

Southeastern New Hampshire Regional Planning Commission. 1972. Solid Waste 8.

Cost of Public Service: Solid Waste Disposal is the seventh in a series of bulletins on estimating costs of public service in various size Idaho communities. Other bulletins in that series available from the University of Idaho Agricultural Information Department are as follows:

EXT 602	Residential Growth: Its Benefits and Costs to the Local Community	50 cents
EXT 604	Cost of Public Service: Education	25 cents
EXT 605	Cost of Public Service: Fire Protection	25 cents
EXT 606	Cost of Public Service: Police Protection	25 cents
EXT 607	Cost of Public Service: Sewage Collection and Treatment	25 cents
EXT 608	Cost of Public Service: Sheriff Protection	25 cents
EXT 610	Cost of Public Service: Water Supply	25 cents

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, H. R. Guenthner, Director of Cooperative Extension Service, University of Idaho, Moscow, Idaho 83843. We offer our programs and facilities to all people without regard to race, creed, color, sex or national origin.

750 12-81

25 cents per copy