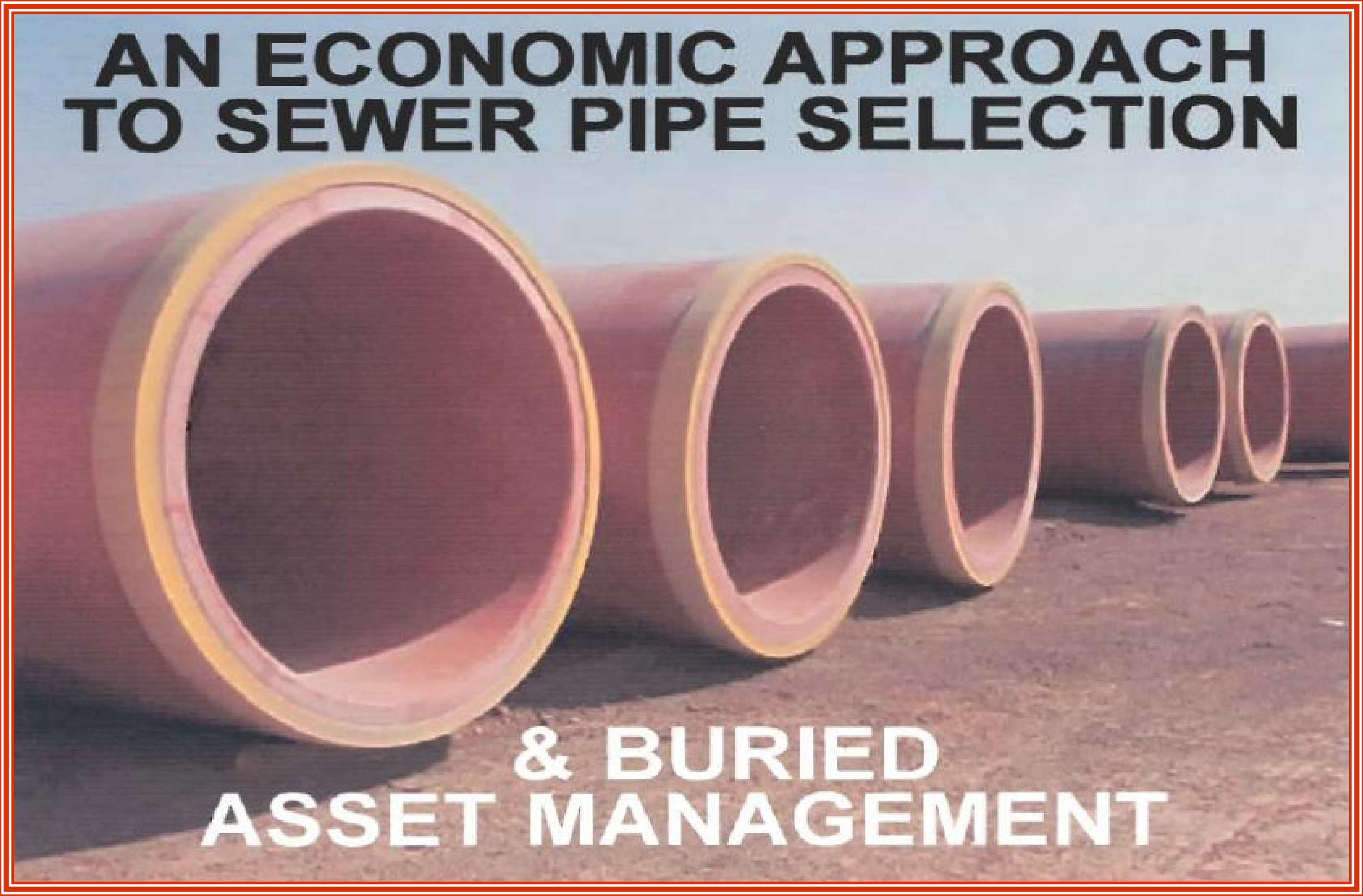

VITRIFIED CLAY PIPE:

The Right Choice For The Right Reasons

Shouldn't your sanitary sewer system be expected to last at least as long as all your other public works projects such as your court house, library and schools which you paid for through tax dollars? Choices made on price alone seldom yield the sought after value.

Nowhere is this choice more crucial than in gravity flow sanitary sewer work. Such sewers are usually the most expensive utilities to replace because they are laid beneath water and gas lines, telephone cables, electric services, sidewalks, curbs and gutters and paved roads.

Construction plays a major part in the original cost of these structures but an even larger part if they have to be replaced.

Today, with all of the available engineering knowledge and the means to make a sound economic decision, it makes good sense to spend a little more to gain the extended life and quality of service from your buried assets.

Commitment to Permanence

It all begins with a commitment to permanence. Communities must adopt an attitude that material choice decisions must be based upon long-term factors. ***The low bid is not always the best bid.***

An analysis of the factors shows that the responsibility for long life and low cost maintenance rests firmly with the pipe material chosen and the quality of installation.

If you are the one who has to choose…
make the choice you can live with.

AVERAGE % OF TOTAL SEWER COST REPRESENTED BY THE SEWER PIPE

Represents cost of pipe — Represents all other costs

Pipe Diameter	Trench Depth			
	1' - 10'	11' - 16'	17' - 24'	25' and Over
8"	% 10	% 8	% 5	% 4
10"	12	10	8	5
12"	15	12	10	8
15"	20	15	12	10
18"	25	20	15	12
24"	30	25	20	15
30"	35	30	25	20
36"	40	35	30	25
42"	45	40	35	30
48"	50	45	40	35

Economic Analysis of Sewer Construction Costs

THE LOWEST BID IS NOT ALWAYS THE BEST BID. THE DIFFERENCE IN DURABILITY OF MATERIALS MUST BE WEIGHED AGAINST DIFFERENCE IN COST. THE ADDITIONAL COST OF REPLACING LIMITED-LIFE SEWER PIPE MUST BE TAKEN INTO ACCOUNT AT THE TIME OF THE INITIAL INVESTMENT.

Based on these statements, a hypothetical example points to the process that must be used by an engineer, a city councilor any other agency in deciding which bid, and therefore which material, should be subjected for ward. For example, assume bids for sewer construction are received at Your Town, U.S.A. as follows:

Vl1rified Clay Pipe ....$1 ,000,000
Limited-Life Pipe................................900.000
Cost Differentia!...............................$100,000

The goal is to select the bid which will provide the greatest value when compared in accordance with the accepted principles of engineering economics.

The first decision concerns the service life of the sewer project. 100 years is generally accepted as the minimum service life for a sewer system.

Since clay pipe has a proven record against deterioration and disintegration caused by the corrosive elements found in sanitary sewage, there need be no future construction or replacement costs associated with clay pipe.

On the other hand, the limited-life pipe bid was lower in cost but this pipe material is subject to failure from a host of uncontrollable causes (abrasion, deterioration, rust, corrosion, decay, chemical decomposition, deflection and embrittlement).

Not only do the materials have significantly different service lives, but the cost of replacement will be greater than the original bid price because of inflationary construction trends.

A common method used to compare the cost of two or more competing products is the Least Cost Analysis.

The following equation provides a method for making this comparison.

Equation 1

$$EC=P\{1+[(1+I)/(1+i)]^{n}+[(1+I)/(1+i)]^{2n}\ldots+[(1+I)/(1+i)]^{mn}\}$$

Where:

- EC = Effective Cost (Current dollars)
- P = Bid Price (Current dollars)
- I = Inflation Rate over the period
- i = Interest Rate over the period
- n = Service Life of the material (years)
- m = Number of times the material with the limited life must be replaced to equal the longer service life material.

The material with the lowest total Effective Cost is the most economical.

A difficulty in using Least Cost Analysis involves the predicting of the future rates of Inflation and interest. There is, however, a relationship between the inflation rate and the interest rate which, due to market factors, is reasonably fixed over long periods of time.[1]

TABLE 1 – HISTORICAL INTEREST – INFLATION DIFFERENTIALS[1]

Time Period	Federal (Treasury Bonds) [2]	State/Local (Municipal Bonds) [3]	Private (Prime Rate) [4]
1955-1964	3.13	2.41	3.46
1965-1974	0.68	0.58	1.23
1975-1984	3.32	1.39	4.58
1985-1994	6.76	5.60	6.92
1995-2004	3.71	3.28	5.08
1955-2004	3.52	2.42	4.25

Notes:

1. Differentials represented average differences between stated interest and the inflation rates taken from the Producer Price Index for the indicated period.
2. Based on 30-year T. Bond rates for the years 1977-2001 end adjusted data for the missing years between 1995-2004. The adjusted data are based on the average differences between 10 and 30 years bonds over the time period where both are available.
3. Municipal Bonds rates taken from the Federal Reserve State and Local General Obligation 20 year bond index.
4. Prime rate taken from Table B-73 of the Economic Report of the President "Bond Yields and Interest Rates, 1929-2004."

[1]Taking the Guesswork out of Least-Cost Analysis, W. O. Kerr. Ph. D. and B. A . Ryan. Arthur Young & Company. Updated by NCPI - September. 2005.

Although the inflation rate may be similar for different levels of government or the private sector, the interest rate can vary according to the borrower's source of funds.

The differential for Federal funds is derived from long-term U.S. Treasury instruments. State and local government is generally related to municipal bond rates and the private sector is based upon the prime rate. The historical interest/inflation differentials are shown in Table 1 for each of the borrowing sectors.

The Average Inflation-Interest Factors shown in Table 2 are based on the term (1+I)/(1+i) in Equation 1 for the stated differentials from Table 1.

TABLE 2 – AVERAGE INFLATION-INTEREST RATE FACTORS

Sector	19-52004
Federal Projects	0.9672
State/Local Projects	0.9771
Private Projects	0.9604

Note: The average Inflation-Interest Factor is computed for the differentials shown in Table 1 for the period 1955-2004

Using these historic average inflation rate/interest rate factors in Equation 1 provides a very practical basis for least cost comparisons and greatly simplifies the analysis.

Example No.1 - Both VCP and limited life pipe were bid on a project. Including engineering and administration the bid price for VCP was $1,000,000 and limited life pipe was bid at $900,000.

Determine the most economical bid using Least Cost Analysis. The service life of VCP is 100 years based upon demonstrated service.[2] The service life of limited life pipe has been extrapolated to 50 years. Assuming that the project was funded by state local government, an average inflation/interest rate factor of 0.9771 is chosen from Table 2.

Since VCP has a service life expectancy greater than 100 years, the Effective Cost in today's dollars is $1,000,000. Using Equation 1, the Effective Cost of limited life pipe is $1,179,000. VCP has a cost advantage of$179,000.

Solution No.1

$$EC = P\{1+[(1+I)/(1+i)]^{n}\}$$
$$EC = \$900{,}000\ [1+(.9771)^{50}]$$
$$EC = \$900{,}000(1+.31)$$
$$EC = \$900{,}000(1.31)$$
$$EC = \$1{,}179{,}000$$

Example No.2 -If the job in Example No.1 had been federal, with all other things being equal, the cost advantage of VCP over limited life pipe would be $71,000 when using an inflation/interest rate factor of 0.9672.

Solution No. 2

$$EC = P \{1+[(1+I)/(1+i)]^{n}\}$$
$$EC = \$900,000\ [1+ (.9672)^{50}]$$
$$EC = \$900,000(1+.19)$$
$$EC = \$900,000(1.19)$$
$$EC = \$1,071,000$$

Example No.3 - Assume that the project was privately funded and the life expectancy of the limited life pipe was only 25 years. Using Equation 1 and an inflation/interest rate factor of 0.9604 from Table 2, the Effective Cost of the project would be $1,386,000 which is $386,000 greater than the cost of VCP.

Solution No.3

(25 year pipe must be replaced 3 times over the 100 year plus life expectancy of VCP)

$$EC = P \{1+[(1+I)/(1+i)]^{n}\} + [(1+I)/(1+i)]^{2n}...+ [(1+I)/(1+i)]^{mn}\}$$
$$EC = \$900.000\ [1+ (.9604)^{25}] + (.9604)^{50} + (.9604)^{75}]$$
$$EC = \$900,000(1+.36 + .13 + .05)$$
$$EC = \$900,000(1.54)$$
$$EC = \$1,386,000$$

Summary - Sewers are expensive to build and they are even more costly to replace. The Life Cycle solutions presented here do not include all of the future costs of replacing a sewer line constructed of limited life material. The future replacement cost will be considerably greater than shown due to the need to design, reconstruct or bypass new infrastructure which may have been constructed after the original sewer line installation.

This publication does not fully address set aside requirements or future replacement costs if set aside requirements are not implemented. The set aside requirement is the difference between the initial project cost and the Effective Cost in today's dollars. For a more detailed explanation and application of these factors, the reader is directed to LEAST COST, a computer program available without charge from the National Clay Pipe Institute.

[2] USEPA Regulations: 40 CFR PL 35, Subpt App. A(1991). Cost-effectiveness Analysis Guidelines…(g) Useful life (1) the treatment works' useful life for a cost-effective analysis shall be as follows"… Waste water conveyance structure (includes collection systems, outfall pipes, interceptors, force mains, tunnels, etc.)-50 years…(2) Other useful life periods will be acceptable when sufficient justification can be provided."

LIFE CYCLE COST FOR DRAINAGE STRUCTURES by John C. Potter, Geotechnical Laboratory; Department of the Army, Waterways Experiment Station, Corps of Engineers, PO BOX 631, Vicksburg, Mississippi 39180-0631. "Clay pipe is perhaps the most inert of the common pipe materials in terms of corrosion, and it is very resistant to abrasion. A 100-year service life may be assumed for most clay pipe installations."