broadly correlated within an optimum range for a plant species.

Addition of lime to raise the pH value, or sulfur to lower it, are probably the most generally recognized methods to manage soil pH. In limited cases, addition of acid organic compost to a soil can also be used to lower pH.

The reserve acidity, or buffer pH, provides resistance to immediate pH change in the soil solution. If other factors remain equal, the buffering capacity of a soil solution will remain at a capacity consistent with the exchange capacity of the soil.

To affect a pH change in an acidic soil, both active and reserve acidity must be considered. Active acidity is the obvious pH resulting from a measurement of the soil solution. Reserve acidity is more complex. It consists of hydrogen and aluminum ions held on the soil colloidal surfaces. As the hydrogen ions making up the active acidic portion are neutralized, these colloidal ions move outward and become active. Reserve acidity is generally much greater than active acidity and plays a greater role in deciding the amount of material to apply to affect a change in pH.

Cation exchange capacity

Cation exchange capacity, as well as clay type and content, and organic matter content can be interpreted to give an idea of the buffering capacity of a soil.

Cation exchange capacity (CEC) is a measure of positively charged ions that are held to the organic and clay colloidal surfaces. The CEC varies with the amount of organic matter and the amount and type of clay. Soils with more clay and organic matter tend to have higher CEC's.

CEC is measured in milliequivalents per 100 grams of soil or material being measured. A milliequivalent is one milligram atomic weight of hydrogen or the amount of another ion that will displace that amount of hydrogen. A soil with a CEC of one milliequivalent will exchange one mg of hydrogen or its equivalent for every 100 grams of soil. A hectare (2.47 acres) of soil to a depth of 15 centimeters (6 inches) could absorb 22 kilograms (48.5 lbs.) of exchangeable hydrogen or its equivalent.

Calcium has two positive charges compared to one for hydrogen. Its atomic weight is 40. Twenty (40 /2) milligrams of calcium are thus required to replace one milligram of hydrogen. 22 kilograms (a factor of 1,000,000) would require 1100 kilograms of calcium carbonate ($CaCO_3$, ordinary limestone).

When applying limestone to established turf, it is recommended that no more than 25-50 pounds of finely ground material, more if coarse, be applied. On highly acidic soils with established turf, it is recommended that limestone be added over a period of two, three or more years to avoid the detrimental effects of a large amount at once.

While limestone application rates are generally recommended according to soil texture, there can be extreme variation between soil types with similar textures. Sands and sandy loams can have a CEC ranging from 2-17 milliequivalents. Loams and clays can range from 8-60 milliequivalents.

A county soil survey map, available from the Soil Conservation Service (if your county has been mapped) will indicate the soil series and expected CEC. Management practices will have affected the rate.

Humus and clay

Clays make up the inorganic portion of soil and humus makes up the organic portion. Together they make up the colloidal portion of the soil.

The amount of humus in a soil can significantly influence its characteristics. Humus contributes directly to better physical properties, improves nutrient availability, and imparts a higher cation exchange capacity.

Humus is made up basically of two types of complex compounds: those resistant to further decomposition; and those that have been synthesized by microorganisms and are held as part of their tissue structure. Because of the relative resistance to microbial breakdown, the nutrients held in the humus are resistant to ready solution and provide a long term release of nutrients.

The cation exchange capacity of humus can range from 150 milliequivalents per 100 grams to 300 milliequivalents. Thus the greater the humus content of a soil, the greater its influence will be on CEC.

Clays play a significant role in determining CEC of a soil. The silicate clays are more typical of the temperate regions and of the more productive agricultural soils.

The silicate clays are broken down into classifications based upon the relationship of aluminum and silicon layers within the clay structure. A 1:1 type clay, such as kaolinite or halloysite, lends the least to soil properties. CEC of kaolinite is expected to range within 3 to 15 milliequivalents. Montmorillionite, a 2:1 (two aluminum layers sandwiching a silicon layer) expanding type of clay commonly ranges between 80 and 100 milliequivalents and lends substantial character to a soil due to its swelling and shrinking capabilities. Ilite is a 2:1 non-expanding type of clay and falls within an intermediate range, commonly having a CEC of 15-40 milliequivalents.

Organic matter (humus) and nitrogen availability share a close relationship. Carbon is a significant part of organic matter. Because both plants and microorganisms maintain a rather definite carbon:nitrogen ratio, it is important to consider the balance when making an addition of organic matter to improve a soil's condition.

Some manures can have a C:N ratio as high as 100:1, compared with a normal soil ratio in the range of 10:1. When such a manure is added to a soil, general decay organisms become more active. Organisms responsible for nitrification become relatively inactive.

The decay organisms utilize nitrogen and produce carbon dioxide. As a result of the decay organisms demand for nitrate, little is available for uptake by plants.

As decay of the soil additive continues, carbon is lost and nitrogen retained in the tissues of the organisms until a stable C:N ratio is once again achieved.

Nitrifying organisms resume activity as the decay organisms demand for nitrate falls off. Meanwhile, the soil has become richer in both nitrogen and humus.

Duration of the process depends upon conditions which might favor or prolong decay.

Optimum temperature range for decay organisms is between 40 and 50 degrees C. Moisture is

GET A GATOR!

With a DITCH WITCH ALLIGATOR CHAIN, you've got a Trencher that can chew through ROCK and FROZEN terrain.

Standard Ditch Witch digging chains are built to handle tough trenching . . . but some conditions are just too tough for regular digging chains and teeth. That's why Ditch Witch developed Alligator Chain. It makes trenching practical in many conditions that used to be considered untrenchable! Rock formations, coral, frozen earth, ice . . . this 'Gator's toughness will meet most any trenching challenge. There are Alligator Chain systems to fit all Ditch Witch trenchers from 30-HP class up. For the name of your nearest dealer, call Toll Free (800) 654-6481.

Alligator Chain Bit. Other Conical Bit.

Compare! Ditch Witch Alligator Chain insert bits are hard-surfaced with 38 grams of abrasion-resistant tungsten carbide for longer life, more production. Ordinary bit, at right, has only 9 grams of tungsten carbide.

Circle **105** on free information card

DITCH WITCH®

DITCH WITCH® HAS THE ANSWER!

FREE CHAIN FACTS BROCHURE

Mail this coupon for a free brochure on our complete line of chains and saws, plus tips on their operation and maintenance.

Name _____

Company _____

City _____

State _____ Zip _____

Mail to Charles Machine Works, Inc.
Post Office Box 66, Perry, Oklahoma 73077

necessary, but must be balanced against an adequate oxygen supply. Soil reaction should be at a near neutral pH.

If an organic substance to be added is poor in nitrogen content, it may be necessary to supply more nitrogen as a substrate for the decay organisms. Legume tissues are rich in nitrogen, but certain straw residues are poor. In such a case, addition of supplemental ammonium or nitrate will enhance the rate of decomposition.

Nitrogen

Nitrogen is the most widely applied element, yet application is often based on color characteristics, root or shoot growth, or other general indications of less than optimum plant growth. However, nitrogen will not lend as great an effect if other essential nutrients are limited. Growth is generally limited by the contributing factor present to the least degree.

Nitrogen has in the past been recognized as the nutrient required in the greatest amounts, with the exceptions of carbon, hydrogen, and oxygen. Trends have been, however, to reduce the amount of applied nitrogen in relation to the amount of applied potassium. It has been recently suggested that nitrogen be applied on a 1:1 ration basis with potassium. Twenty-some years ago, a 4:1 ration was recommended.

Nitrogen is absorbed from the soil primarily in the nitrate form, although turfgrasses can absorb the ammonia form. The amount of available nitrogen in the soil is usually not a true measure because availability can change rapidly.

Tests are available, however, for nitrates present in plant tissues, and nitrate, ammonia, and organic forms of nitrogen in the soil. It would seem that these tests might be correlated to give an accurate indication of the amount of nitrogen readily available and taken up by the plant.

A large supply of organic nitrogen and a small supply of nitrate and ammoniacal nitrogen would indicate that another factor, beside nitrogen, is limiting its conversion to readily available forms. Supplemental fertilization with a quickly available form of nitrogen could offset these effects while a program to manage the overall soil for better microorganism activity could be instituted.

There are variations due to climate, soil types, testing procedures, etc. The purpose of the above is merely to suggest that an overall picture of nitrogen in the plant and soil would give a definite insight to management techniques.

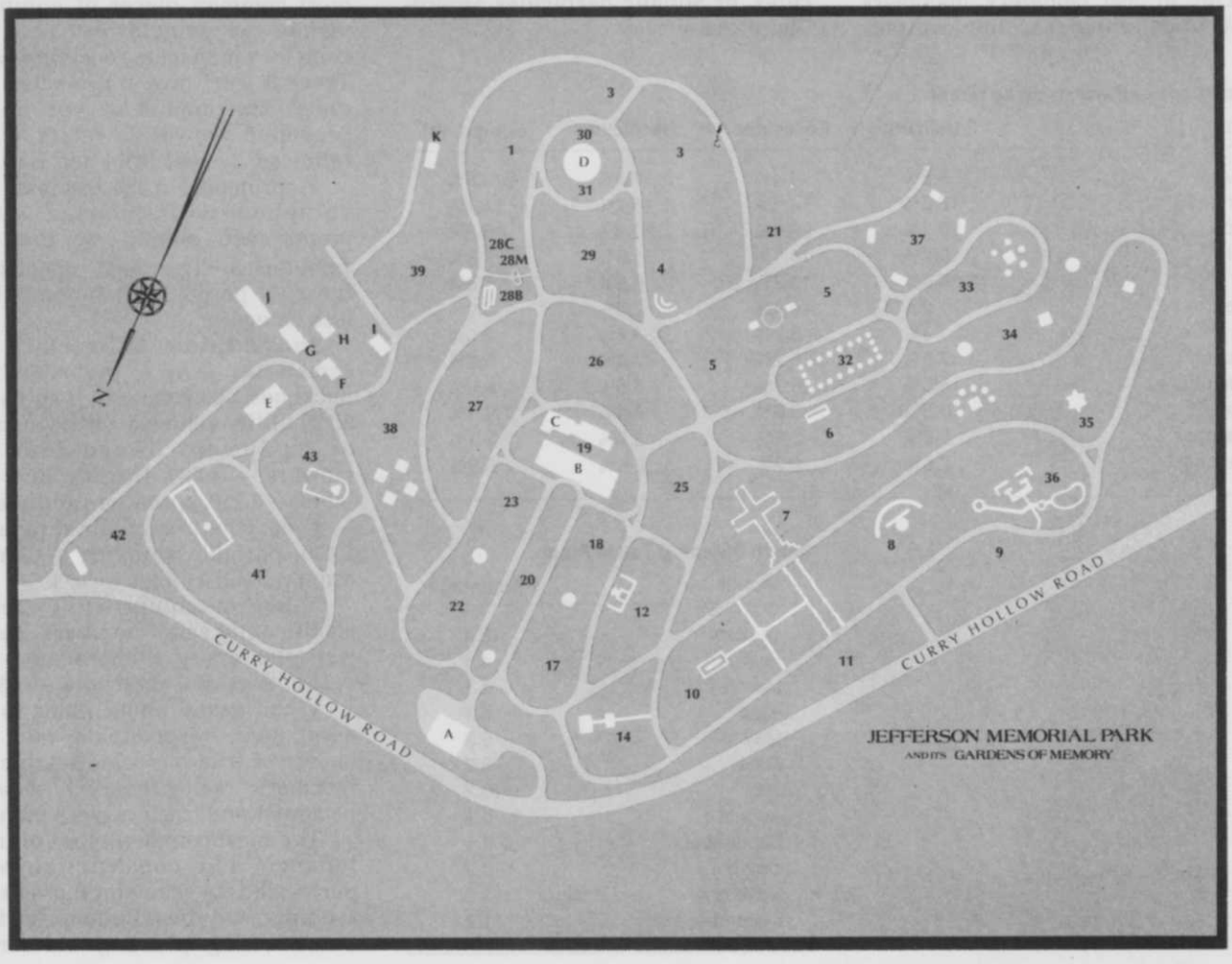
Phosphorus, potassium, sulfur, calcium, iron, magnesium, boron, manganese, copper, zinc, molybdenum, and chloride are essential nutrients. Soil and tissue tests generally provide an accurate indication of the supply of these.

There are also many other soil properties that might be tested for and integrated into a management program. Some properties lend themselves only to an understanding of the productivity of a soil and are not economical to try to change. Soil function and plant growth are dynamic and rapidly change in relationship to their qualities and needs. Understanding them allows a grounds manager to cope with them and satisfy those needs to achieve the goals of a management program. *Ron Morris*

WT&T

PROFILE

CEMETERY AND MEMORIAL PARK MANAGEMENT



CEMETERIES STRIVE HARDER TO CONTROL MAINTENANCE COST

The importance of maintenance costs in cemetery management is increasing steadily, even though less than 25 percent of the cemetery managers polled by Weeds Trees & Turf currently have a separate maintenance budget.

Russell Rager, director of Washington Park Cemetery East of Indianapolis, told 1,200 cemetery mangers at a recent joint meeting of the National Association of Cemeteries and the American Cemetery Association in Chicago, "Only a few cemetery managers are budgeters. Few of them keep an overall budget based upon departmental budgets prepared by subordinates. A cemetery operation should have a sales budget, an administrative budget, and a maintenance budget if it is to achieve its maximum potential in terms of profit."

Out of 990 cemetery managers sent questionnaires, 167 replied. Based upon their returns, larger cemeteries dominated. The average acreage managed by respondents was 98 acres, with 72 acres of developed area. An average of 72.5 percent of the grounds is actively maintained, indicating that more than 25 percent on average is held in reserve.

Full-time staff for maintenance averaged five persons, with three persons part-time and five on a seasonal basis.

Of the 25 percent who keep separate maintenance budgets, the average was $47,600, or $660 per acre maintained ($47,600 divided by 72).

Fertilizer, sod, and trees are the largest non-equipment expenses. Herbicides and insecticides are the next highest non-equipment expenses. Cemetery managers do not use significant amounts of soil fumigants, growth regulators, fungicides, or aquatic herbicides according to the survey.

Percentage of Purchasing by Month.

Month	Fertilizers	Pesticides	Herbicides	Equipment
January	5.5%	4.4%	7.4%	18.8%
February	16.0%	14.1%	16.2%	11.7%
March	20.5%	20.7%	21.3%	18.2%
April	9.5%	14.1%	11.8%	7.8%
May	5.0%	13.3%	6.6%	5.8%
June	2%	10.4%	7.4%	3.9%
July	3%	3.7%	4.4%	2.6%
August	7.5%	5.2%	7.4%	3.2%
September	15.5%	6.7%	6.6%	5.8%
October	10.5%	3.0%	4.4%	9.1%
November	2.5%	2.2%	3.7%	7.1%
December	2.5%	2.2%	2.9%	5.8%

Month Planning Takes Place.

Month	Percentage
January	18.4
February	4.1
March	5.1
April	5.1
May	9.2
June	9.2
July	10.2
August	4.1
September	3.1
October	8.2
November	12.2
December	11.2

The cemetery managers indicated they plan maintenance expenditures from October through January, and in July. They place orders for chemicals mainly from February through April, with a second order in August or September.

Equipment orders are placed earlier, from January through March with another buying period in September through November. The majority of products are purchased from local suppliers, especially equipment.

The average annual seed purchase by the managers was 600 lbs. The seed is used to some extent every month except January, with surges in April, May, September and October. Twenty percent indicated brand or cultivar type, mainly the larger cemetery managers.

Self-propelled mowers are the most common pieces of equipment owned by cemeteries. The 1,250 cemetery managers receiving Weeds Trees & Turf own a projected 4,450 units. The dominant type of self-propelled mower is rotary (3,580), followed by reel (830) and flail (45).

A projected 3,375 tractors, 1,500 equipped with mowing attachments, are owned by the 1,250 cemeteries. The vast majority of these (87 percent) are in the 60 hp or less category.

In addition to tractors, the cemeteries own a projected 1,380 backhoes, 800 front end loaders, and 2,150 utility vehicles. Other numbers of equipment owned are: trim mowers — 4,280, flexible line trimmers — 2,210, spreaders and seeders — 1,900, compressed air sprayers — 1,430, portable spraying systems — 530, and sod cutters — 475.

Types of equipment owned in significantly small numbers are tree transplanters — 10, aerators — 216, verticutters and thatchers — 550.

When asked about plans to buy equipment, respondents said purchases of trim mowers, flexible line trimmers, self-propelled mowers, backhoes and tractors were planned.

The most common types of maintenance and construction work performed by cemetery crews are seeding, sod installation, fertilization, mowing, planting and care of

ornamentals. Jobs performed most often by outside contractors are tree trimming and pest control, and drainage installation.

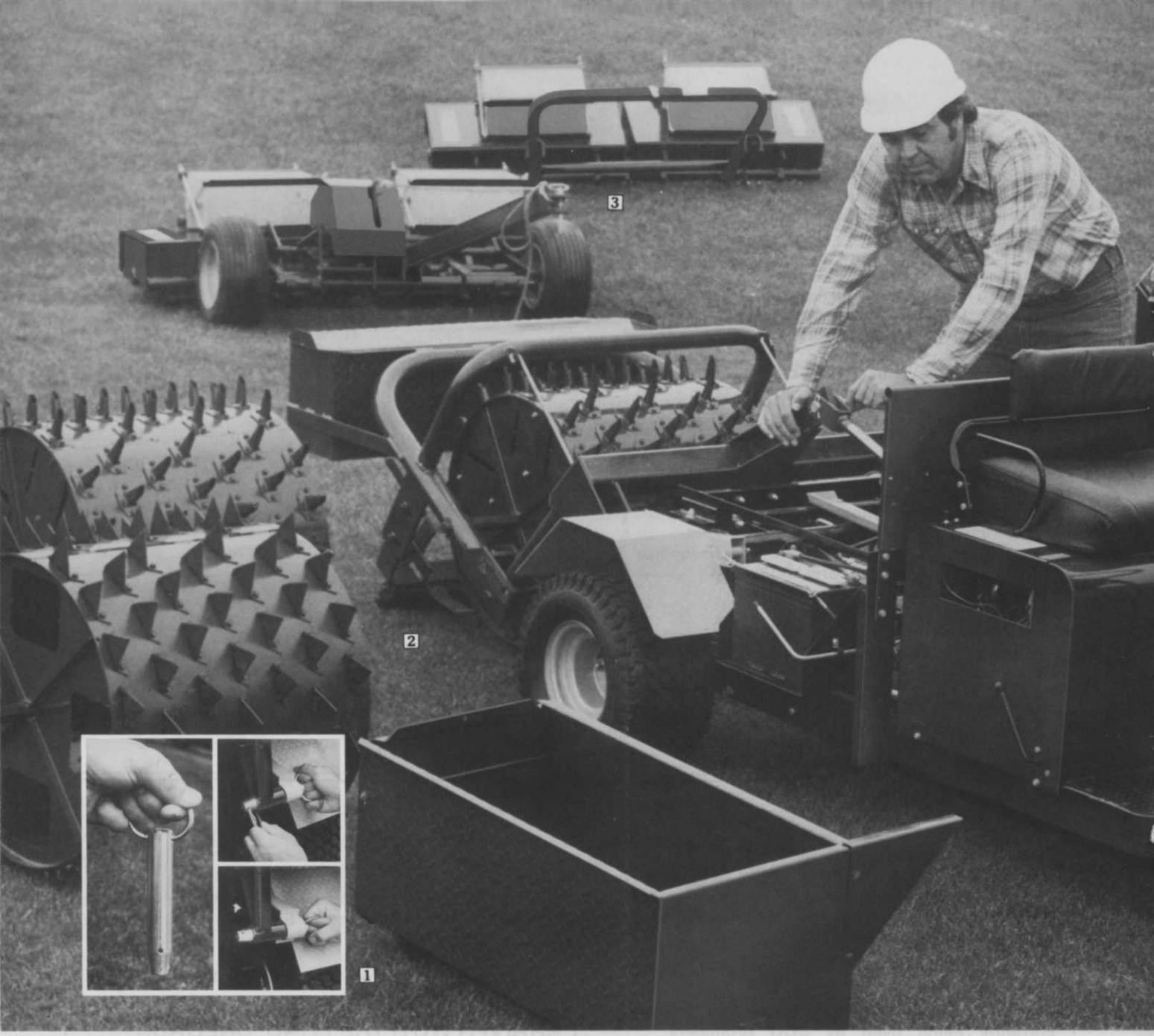
Some interesting comments made by respondents are:
"We are in the process of turning our herbicide, fungicide, and insecticide work over to a commercial spray firm."
"Survey will make us look like a small market, yet we spend thousands of dollars per year for equipment made for a homeowner or obstruction-free golf course."
"We are forced to construct or adapt equipment to meet our needs."

According to the National Association of Cemeteries, there are 10,000 actively managed cemeteries in the United States. John Neal, president of Jefferson Memorial Park in Pittsburgh and past president of NAC, estimates that roughly 2,000 of the 10,000 are highly maintained. He also pointed out that there are many more small church and town cemeteries not included in the 10,000 figure.

Annual Expenditures

Item	Median	% with Non-Zero Response	Mean	Projection to 1,250 Readers
dry fertilizer	$700	88.1%	$1,150	$1,260,000
post-emergence herbicide	$300	54.1%	$499	$335,000
pre-emergence herbicide	$300	41.1%	$550	$280,000
aquatic herbicide	$100	15.5%		
insecticide	$200	57.7%	$525	$376,000
systemic fungicide	$200	4.8%		
contact fungicide	$100	10.4%		
wetting agents	$50	20.4%		
growth retardants	$200	23.6%	$320	$ 93,600
Soil fumigants		4.8%		
sod	$800	49.5%	$1,624	$997,000
trees	$500	76.5%	$898	$852,000
ornamentals	$500	73.1%	$748	$678,000

Cemetery management is a cost conscious business, yet the cemetery market is a significant part of the Green Industry. Better budgeting practices and an increased interest in plant management can significantly improve the condition of all size cemeteries and perhaps help manufacturers to serve them better. **WTT**



CUSHMAN. MORE THAN TRANSPORTATION,

With the Cushman 3- or 4-wheel Turf-Truckster® vehicle, you get a lot more than proven, economical turf transportation. You get the heart of a system that lets you do eight important turf jobs with one versatile power unit.

1 PIN-DISCONNECT

The secret of this versatility is the Cushman Pin-Disconnect system. Just put the attachment you need on the Turf-Truckster chassis, secure it with the large pull pins and you're ready to go. No special tools, no trailer to tow, no equipment to load and unload at the site.

2 GREENSAVER® AERATOR

The efficient, low-cost way to quickly aerate greens, tees or other turf areas. The Greensaver drum aerator attaches easily to either Turf-Truckster equipped with hydraulic system and dump kit. Three interchangeable drums let you use 1/2" or 3/8" coring tines, as well as slicing tines. You change drums according to varying soil conditions. The coring drums collect cores as you aerate up to 10 times faster than walk-type units.

3 SPIKERS

The Cushman Quick Spiker attaches to a Turf-Truckster with PTO, hydraulic system and dump kit. You spike a precise 57-inch swath, even over undulating ground, and raise or lower the unit hydraulically. The Trailing Spiker gives you the same width and precise results, but its built-in lifting mechanism is controlled by a pull rope.

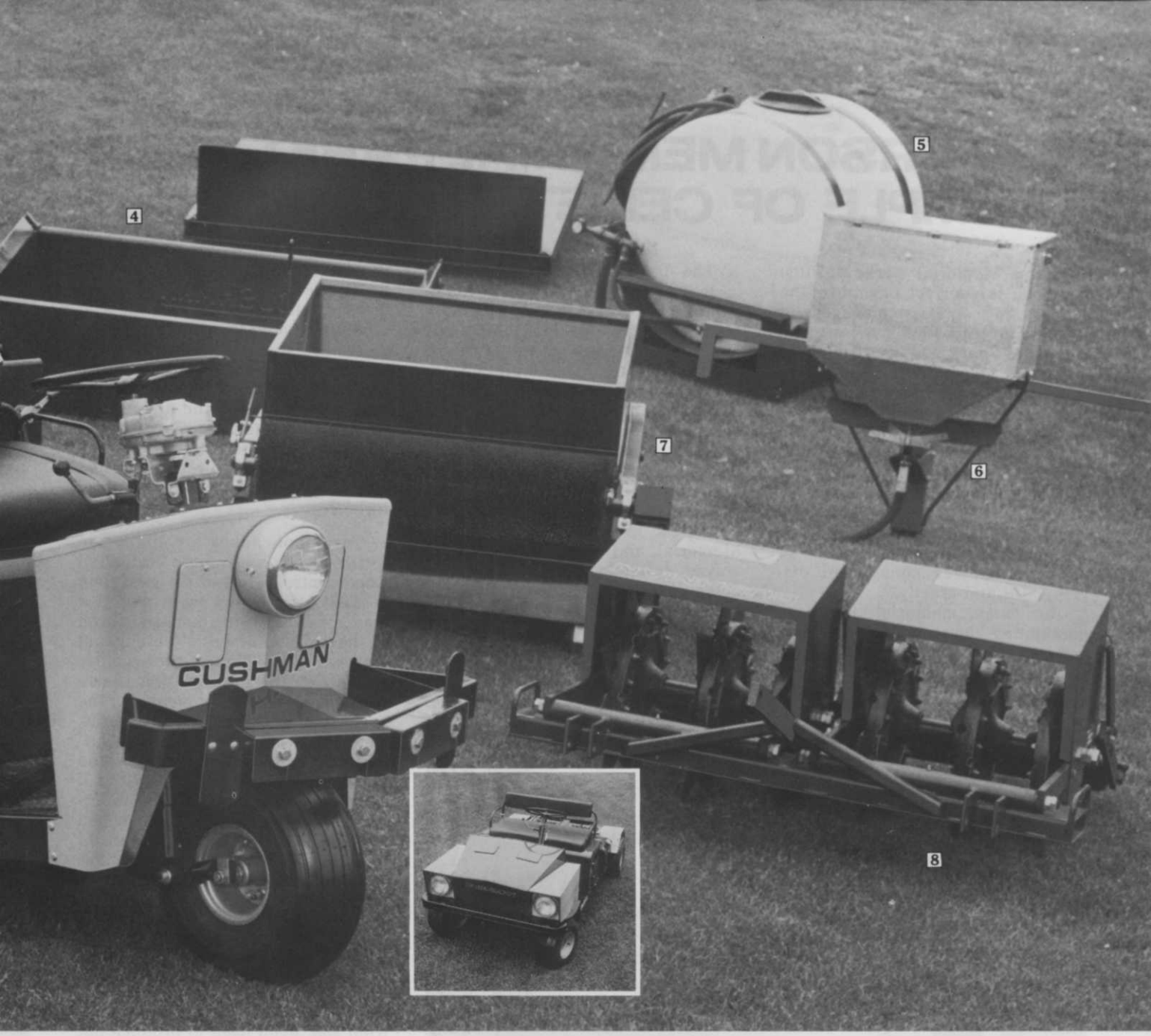
4 SHORT BOX & FLATBED/BOX

These hauling and dumping attachments are mounted quickly with two pull pins. Bolt-on sides and tailgate convert the flatbed to a dump box. Both boxes can be dumped easily with either a manual or powered hydraulic dumping package. And either box is capable of hauling up to 1,000 lb. payloads.*

5 SPRAYER

Use this versatile attachment to spray greens, hard-to-reach roughs, fairways, trees, bushes. The polyethylene tank holds up to 100 gallons of chemical solution. The three-way boom provides an accurate spray for proper application and less chemical waste. The Turf-Truckster transmission and variable speed governor assure uniform ground speed. And the optional handgun lets you "fog" an area or spray up to 40′ in the air.

*Rating for vehicle equipped with 9.50-8 rear tires.



WE GIVE YOU A TOTAL TURF-CARE SYSTEM.

6 SPREADER/SEEDER

The Cushman Cyclone Spreader/Seeder mounts on either the Short Box or the Flatbed/Box with a hopper that holds up to 300 pounds. All controls can be operated from the driver's seat, to broadcast over areas up to 40 feet wide, depending on materials.

7 TOP DRESSER

The Cushman Top Dresser eliminates the need for self-powered units and time-consuming walking. The moving bed and rotating brush operate at a controlled speed to maintain an even spreading pattern over a 31-1/2 inch swath. The big hopper can hold up to 1,000 pounds of material, from rock salt to fine, powdered materials.

8 QUICK AERATOR

The Cushman Quick Aerator is designed to slice greens and aerate fast. It attaches to either Turf-Truckster with just three pull pins. And is hydraulically lifted from the driver's seat for easy movement from green to green. Three tine types are available for varying soil conditions: slicing, coring (two sizes) and open spoon.

CUSHMAN RUNABOUT

The economical answer to basic transportation and light hauling requirements. The new 18-hp Runabout now carries two men, plus equipment and supplies, while the 12-hp model carries one man. Both feature a big pick-up box, exceptional maneuverability, and 3-speed transmission. The Cushman Runabout is the way to help your men do more work, and less walking.

Ask your Cushman Turf Dealer to show you all the time- and money-saving advantages of his turf-care equipment. Unlike other companies, Cushman gives you more than transportation. We give you a total turf-care system.

Circle **103** on free information card

CUSHMAN®
Turf Care Equipment

OMC-Lincoln
A Division of Outboard Marine Corporation
P.O. Box 82409, 3339 Cushman
Lincoln, Nebraska 68501

JEFFERSON MEMORIAL PARK: EXAMPLE OF CEMETERY CHANGES

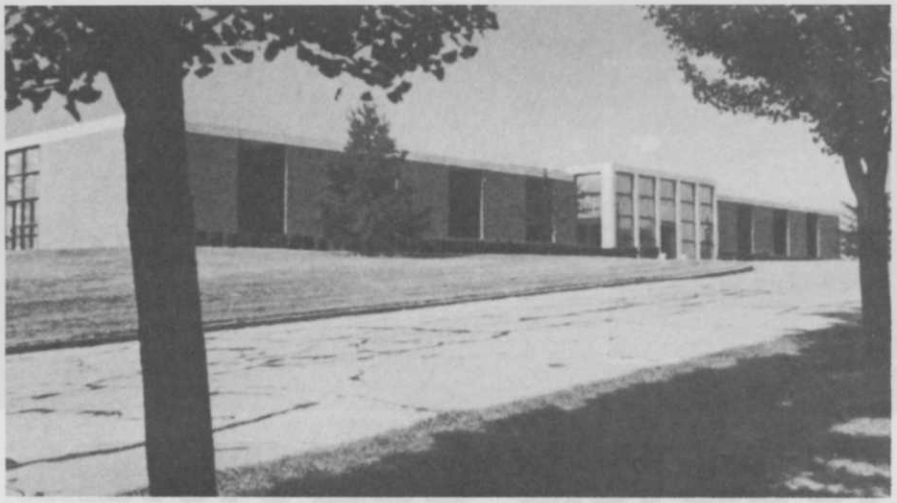
Jefferson Memorial Park in Pittsburgh, Pa. is a perfect example of the changes in cemetery management since the mid-1920's when the memorial park, a profit-making business, started breaking away from traditional cemeteries.

Cemetery managers before that time were chiefly concerned with maintenance of monuments and grounds. They were employed by churches or community boards to provide a respectful and attractive location for burial of local citizens. The concept of pre-need selling of burial sites was considered disrespectful and greedy.

But today, memorial parks are dominating the cemetery business and traditional cemeteries are trying some of their techniques.

The basic differences between memorial parks and traditional cemeteries, explains Jefferson Memorial park President John Neal, are pre-need selling and surface markers instead of monuments. Owners of memorial parks run them as profit making enterprises. They also have made improvements in burial techniques and cemetery maintenance, because they usually handle more interments than traditional cemeteries, more than 100 per month at Jefferson Memorial, and larger acreage is involved. Jefferson Memorial has 150 acres of its 325 developed and requires a staff of 25 to operate and maintain. The maintenance budget alone is nearly $150,000 this year.

"It is like a small city, with 5½ mi. of asphalt roadway, its own drainage and irrigation lines, divided into areas, or gardens, with various religious themes," Neal says. "We have a small greenhouse and nursery. We used to grow our own sod, and we maintain all but the largest trees and all the turf." However, Neal wants his staff to improve its knowledge of turf and tree maintenance and has hired a trained agronomist to assist the general foreman.



The attractive and modern mausoleum (above) rests on a hill on the rolling cemetery. One of many garden pathways (right) lined with ornamentals.

Turf applications are limited to fertilization and some selective weed control. Most of the staff time is spent establishing grass over new graves and repairing damage caused by heavy equipment. "Throughout the year, regardless of the weather or the condition of the turf, you've got to take heavy equipment over the grass to dig graves, install vaults, close the grave and repair the surface," Neal states. "It's terrible on the turf in the spring and fall when it is so wet. Relatives don't understand when a grave's turf is damaged because of the emotional nature of burial. Damage has to be repaired as soon as it happens."

Neal's maintenance staff uses a Reinco hydraulic mulcher to achieve quick cover of new graves. "We got the idea of hydromulching from another cemetery manager in upstate New York," Neal said. "We tried sod, even used to produce our own. We'd buy two trailer truck loads every spring and we'd lose a third of it because of dry weather before we could use it all."

Jefferson Memorial has a wide assortment of cutting equipment. Large rotaries and tractor-drawn gang mowers dominate. Neal sees a problem with equipment designed for the golf course when used for hilly cemeteries. "Small tractors engineered with dual wheels work best on hills," Neal claims. "Flotation tires are fine on level turf but very unstable on wet or snow covered slopes. We also find drive shafts are not built in many cases to take steeper slopes or for turning on an incline. Unfortunately, few manufacturers are making equipment to meet our needs. If they don't engineer the axle for dual wheels,