that no tuberculation will occur where the internal lining of the pipes is properly protected. Rust tuberculation means the gradual diminution of the pipe thickness, and consequent weakening.

There are, however, other incrustations which are not dependent upon the amount of protection to the pipe surface, but such as may be due to alkalinity. Hard water is caused, principally, by the presence of salts of magnesium and calcium. The carbonates and bicarbonates of these salts produce temporary hardness; permanent hardness on the other hand is produced by the sulphates, chlorides, and nitrates of these salts. In the case of the salts producing permanent hardness, we have the incrustations found in boilers due to evaporation of the water leaving the salts behind; these do not affect the distributing mains. In the case of the salts producing temporary hardness, however, we find that the carbonates are soluble in the presence of carbonic acid, and form incrustations of crystallized scale of calcium carbonate. This scale is found in large quantities in some places, depending upon the quantity of bicarbonate of lime and carbonic acid in the water. The usual method of removing temporary harness is to add milk of lime according to "Clarke's" process for softening water.

Biological formations, due to organisms, are frequently found as growths in water mains and concrete or brick conduits, and exist as "Sponge"; "Pipe moss"; "Ferruginous slime"; etc. These, as well as, curtailing the diameter of the pipes and reducing pressure, cause impalatable conditions, and even foul odours from the water. The most serious of these growths is that known as "ferruginous slime", which is the product of certain iron organisms known as the "Grenothrix group". The deposit is generally black, or red, or of a dirty yellow, or brown color; and flocculent masses may often be seen floating, which have become disengaged from the pipes. The writer has seen this deposit lining a water main to over an inch in thickness. The iron which is contained in the slime is not due to the pipes, but is entirely due to iron in the water, and has nothing to do with the question of rust formation; as it may form in brick or concrete conduits, as stated above. It just as readily forms in coated pipes as uncoated, and it is for this reason that many do not consider it necessary to use coated pipes, confusing this organic iron growth with rust. The writer has had occasion to make several observations and experiments in connection with this particular growth and concludes that it is due to a combination of iron in solution, and organic impurities in the water. The growth is more common in connection with ground waters, and in this continent has made itself evident at Jamestown, N. Y., Brookline, Waltertown, and other places in Massachusetts. It is also very common in the surface waters of English towns, especially in the waters from the Pennine Range of Hills. I regret that I have not yet had an opportunity of studying the waters of this Province in order to make a systematic examination as to their relation to the particular growths with which I am dealing. This, however, is something for the future, and I have no doubt that many of you are practically acquainted with many of the growths noted.

Sponge or Spongidae is the chief cause of many waters becoming foul in Autumn time. It dies during the Autumn, and in the process of decay imparts an unpalatable taste and odour to the water. It is really a fresh water sponge. They are usually found on the tops and sides of pipes. They only occur in connection with surface waters, more especially in the case of lake water.

Pipe moss forms an extremely common growth in water mains, and may take the form of matting, covering large areas to considerable thickness. It is very permanent and is not usually found floating, as may be the case with the iron and sponge. It has all the appearance of moss, and may take the form of branching, thread-like filaments.

All of the above forms of organic growths "Ferruginous slime", "Sponge", and "pipe moss" can be readily removed by scraping, or can be prevented from forming by filtration. Filtration is really the permanent method of providing against organisms entering a water supply.

Sedimentary deposits are too well known, and require little explanation. Such are common when the water is obtained from rivers or turbid sources. Mud, sand, and clay are their chief constituents.

The above incrustations may be again summarized along with remedies required for their prevention or removal.

Incrustations	Prevention	Remedy
Rust tuberculation or rust nodules	Well coated pipes	Scraping the mains.
Incrustation due to alkalinity	Treatment with milk of lime (Clarke's process)	Scraping the mains.
Biological growths	Filtration	Scraping the mains.
Sedimentary deposits.	Sedimentation in basins with, or without, coagulents	Flushing and scraping the mains.

Now, even after taking all the preventive measures necessary with many waters, it will be found that mains will still have a tendency towards incrustation. The question, therefore, arises as to whether money would not be well spent in the first instance in providing sufficient means of control over a water system to allow any length of main to be readily cleaned out at any time. The usual method of providing control is by means of hatch boxes placed at intervals on the lengths of mains. These allow of an opening to the main being made without cutting into it and breaking into the roadway. Scraping machines, of which there are many in the market, are simply cutting tools which are forced through the pipes by the pressure of the water, and have the effect of increasing the pipe diameter to the original bore. The percentage of pressures gained at various places in England immediately after scraping the mains, varies from 7 per cent. on a 6 inch. main in Thurso up to 300 per cent. on the same sized main in Omagh.

At Halifax, N. S., Canada, the effect of removing incrustation was most marked. The mains there are scraped out yearly. The first operation occurring in 1880 brought about 34.2 lbs. per sq. in., pressure at 25 hydrants at which the nozzles previously showed no signs of water. In 1881 the same hydrants showed 43.5 lbs., and in 1882, 52.4 lbs. The Engineer reported that the mains were all heavily tuberculated, in some instances the incrustation being 1.½" thick. Similiar experience was gained at St. John, N. B., and at Boston, Mass. Scraping the pipes more than doubled the supply of water. It is quite practical to remove the whole of rust or other growths from mains without injuring the original coating of the pipes.

Mr. N. S. Hill, before the American Works Association, has recently given some interesting figures upon the cost of scraping water mains. He takes for example a 6" main to cost $1.00 per foot, and to require replacing with another main of the same size in 20 years, owing to the increased consumption and the effects of tuber-