The Honolulu Artesian Water Supply

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INTRODUCTION

The annual water shortage and in particular the Kalihi Valley water famine of 1922 brought the matter of the city water supply to the attention of the local chapter of the American Association of Engineers. Discussion of the various phases of the problem led to the appointment of a special committee to investigate the status of the Artesian Water Supply.

A report was presented giving a brief of their findings and recommendations for action. As one outgrowth of the consideration of this report a series of articles was prepared and published serially in The Sunday Honolulu Advertiser for the purpose of giving as much publicity as possible to existing conditions. These articles, with the condensed committee report, are now published in pamphlet form for reference of those interested in remedying the present situation.

HONOLULU CHAPTER,
American Association of Engineers.
Honolulu, T. H., Nov. 24, 1922.

Mr. T. J. McGrath,
President, Honolulu Chapter,
American Association of Engineers.

Sir:—Conforming with your request that this committee investigate the present status of the artesian water supply of Honolulu, we submit the following report of findings and recommendations:

BRIEF OF THE FINDINGS

I. That the artesian water supply has been thoroughly and satisfactorily investigated by the Special Water Commission as shown by its report of January 13, 1917.

II. That the decrease in well-head and artesian supply reported by that Commission continues steadily and is largely due to preventable waste.

III. That the two recommendations of this Commission were excellent, but have been only partly acted upon.

IV. That the legislation resultant from this report, while not complete, could still be enforced for a great saving of the
present unseen wastage were funds appropriated for the purpose.

V.

That the total wastage is probably not so great as in 1916 for the following reasons:

(a) The growth of the city has caused the abandonment of a few wells formerly used for irrigation.

(b) Many wells have been recased, capped or otherwise repaired as a result of notices sent out by the division of Hydrography subsequent to the law passed by the 1917 Legislature.

VI.

That lack of enforcement of the legislation of 1884 has been the primary cause of most of the present wastage.

VII.

That action against wastage is now confined to cases reported to the Attorney General as constituting a nuisance.

VIII.

That funds provided the Division of Hydrography are not sufficient to allow supervision over this source of water supply.

IX.

That adequate protection of this fundamental necessity will require public support and considerable funds to stop the present disregarded wastage.

RECOMMENDATIONS

I.

That publicity be given these findings:

(a) By a series of newspaper articles.

(b) By transmitting them to various civic bodies.

(c) By requesting of these bodies the privilege of having speakers address them.

(d) By personal interviews with members of the Legislature.

II.

That advocacy be given legislation conserving present supply:

(a) By urging the appropriation of sufficient funds to stop the wastage now within the jurisdiction of the present laws.
(b) By urging that all Honolulu artesian wells, within the city limits as defined further in this report, be sealed immediately above the water-bearing strata prior to being abandoned, unless provision be made for access for purposes of inspection.

(c) By urging that a permit be required before drilling a well within this same area to insure proper registration and inspection.

(d) By urging the enactment of all the provisions of the legislation recommended by the Special Water Commission.

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The articles are the contribution of the Association of Engineers toward the solution of one of, if not the, most vital problems facing Honolulu—the problem of how to protect, conserve and make available the largest and best source of water which Honolulu has.

The articles set forth in condensed form:

1. The source, nature and extent of the artesian water supply.

2. The number and condition of the wells, and the use and waste of water therefrom.

3. The present critical condition of the artesian supply, as shown by investigations.

4. What legislation has been enacted concerning the artesian water system.

5. What makes the present situation of the artesian water system most critical.

6. What must be done to save the artesian water system from destruction.
THE HONOLULU ARTESIAN WATER SUPPLY, ITS SOURCE, NATURE AND EXTENT

Rainfall is the ultimate source of all our water supplies. We are all familiar with the surface streams, but the water entering the ground is more elusive and its path of progress to sea level remains a considerable mystery to all of us. This ground water has been divided into two natural classes according to its progress through the earth.

Two Classes of "Ground Water"

Some of the water flows in subterranean channels whose general course may be fairly well determined. This forms the artesian supply. Other water merely percolates through some porous strata of material. This forms the common surface well supply.

Both types, due to the shape and structure of the earth's surface, may break out in the form of springs; but the latter especially has long been collected by man through the digging of wells.

The first class of percolating waters sometimes go to great depths and are the source of our artesian supplies.

Only with modern machinery has it been possible for man to reach this water, and it is well to emphasize that, like oil, it is not obtainable everywhere, but is only to be found where nature has provided an underground reservoir to receive and hold the water percolating to it.

What an Artesian Reservoir Consists of

In general this reservoir is simply a porous layer overlain by a water tight stratum of material, so placed as to slope upwards at the mauka side, sufficiently to allow the rain water to percolate down behind it at its upper end. The water thus entering is held under pressure by that following so that any opening made through the impervious strata will allow its escape to its natural level. Consequently the greater the pressure of the water behind, the higher will be the level which the water will seek upon escaping.

Honolulu's Great Natural Advantage

When nature built the site for the city of Honolulu she very considerately provided reservoirs directly underneath. The impervious strata forming their roofs are not so deep but that
wells may be drilled through it; and the strata are sufficiently tilted mauka so the heavy rainfall in the mountains has access to it and is stored in this basin under pressure sufficient to cause the water level to rise in the wells above the ground surface in most places.

Is Honolulu lucky to have such a supply? We'll say so.
Honolulu has, merely for the drilling, the purest water obtainable, while many cities have spent millions, both in bringing water for great distances; or in its daily mechanical or chemical treatment to make it fit for use!

What We Know About Artesian Reservoirs

What do we know about these artesian reservoirs?
Only the scraps of information obtained from the records of some of the wells drilled; their depth and flow and the changes in their water level.

Between Diamond Head and Red Hill, at Moanalua, there are apparently four separate and distinct artesian reservoirs. The water level of any of these basins is not appreciably influenced by the rainfall on, or draft from, any other basin.

It is impossible to define the exact limits of these reservoirs because of insufficient borings adjacent to their apparent limits. It is also possible that these limits are not closely defined and that there are areas between these basins in which the change in artesian head is gradual.

Location of the Artesian Reservoirs

Where are the artesian reservoirs? The four basins roughly are located as follows:

1—Diamond Head to somewhere between Manoa Stream and McCully street.
2—From that point to Pauoa Stream.
3—From Pauoa to Kalihi Stream.
4—From Kalihi Stream to Red Hill.

The Artesian Level

The level to which water will rise in these basins varies one from the other as much as six feet. Within each separate basin, both the water level and the amount of water flowing from the various wells, are perceptibly influenced by the draft from other wells located within the same basin.

The draft from wells located outside of the Honolulu city area proper, does not affect the city artesian supply to any appreciable degree.
Consumption is Exceeding Supply

What is the logical question then to ask concerning this supply under our city?

Just how much water have we, is the point to be raised? While the actual amount is difficult of determination, it is well established that the amount used has been steadily growing in excess of the supply!

What is being done to protect this big community asset?

We are waiting until overdraft, wastage and a scanty year's rainfall, produce a water famine of sufficient magnitude to arouse public sentiment to make adequate protection possible.

In the meantime, the Association of Engineers is seeking to arouse the people of Honolulu to the gravity of the situation and the compelling necessity of taking prompt and effective measures, both legislative and practical, to protect Honolulu from the disaster of a failure of the artesian water supply.

The medium adopted is publicity through this series of articles.
THE NUMBER AND CONDITION OF THE WELLS, AND
THE USE AND WASTE OF WATER
THEREFROM

From two in 1880, there has been a steady increase in the number of wells sunk to the artesian water supply. An average of four new ones each year for the entire period of 40 odd years, gives a fair idea of the rate of growth and number of artesian wells between Diamond Head and Red Hill, Moanalua, at the present writing. There are not nearly this number of wells in operation today, for some have been abandoned and others have worn out. This may sound strange, but well casings are far from everlasting and the ultimate life of many of the older wells has been reached.

What Artesian Water is Used for in Honolulu

How is the water used? The point to be borne in mind all the time, and especially while discussing this subject, is that the total use or draft on this supply has been steadily growing, in excess of the natural replenishment.

The biggest individual user of this water is the city water department, which pumps from 18 to 20 million gallons of water each day into the distribution system.

Probably agricultural interests come next, with the water used for irrigating rice and taro patches within the city limits.

Then there are the industrial concerns needing water for condenser and other mechanical purposes and lastly the wells used for private water supplies.

How the Water is Wasted

How is the water wasted? The question of wastage should be considered from two viewpoints.

First, the water under control of various interests that either use it to excess or waste it after use.

Second, the water that is a total loss to all, through leakage.

The first type of waste needs little more than mention, as it is waste that may be controlled whenever sufficient public need for its conservation is felt.

It is illustrated in the use of water for irrigation, where wells are allowed to flow wide open all the time, regardless of whether crops are growing or not. Also in the excessive use when there is need of it. Then there are the industrial establishments.
that are using the water for condenser and other practical purposes, who afterwards waste the water into the sewers through lack of arrangements for its conservation.

Next the private domestic supplies which, through direct ownership, are operated for the owner’s specific interest, regardless of the public need.

An Unseen Waste “Loaded With Trouble”

The next type of waste cannot be emphasized too strongly, for it is loaded with trouble.

To begin with, it is not readily seen. Its insidious nature is hard to impress upon the public. It is a waste that is continually growing and each year unchecked will make it more of a problem to ultimately control.

Now leakage is not so bad where it can be seen, for some time attention will be called to it and the leak stopped. With our artesian supply, however, this leakage is not now, nor ever will be, directly seen as such.

That is where the insidious feature comes in, for people must be shown.

This leakage can, and has been measured beyond question or doubt, however. It occurs in wells whose casings have worn out. It is made manifest at the surface by the water level suddenly dropping and frequently the well’s ceasing to flow.

This last term is a sad misnomer. The same flow continues from the artesian reservoir; but instead of coming out of the mouth of the well, as formerly, it passes through the holes in the casing and escapes into the coral beds below the surface.

“But it is still in the ground and not wasted,” they say.

Unfortunately it is completely wasted, as the water in the coral beds does not rise to the surface and is therefore no longer within our reach.

About a Quarter of all Honolulu’s Artesian Wells Flowing to Waste

Is there much of this wastage?

Approximately there are forty wells in Honolulu that are not being used, or about one quarter of the total number.

With few exceptions, these wells were abandoned because the water level fell, so that they either would not directly flow, or could not be pumped.

This means one of two things: Either the water level has lowered in that particular basin, or else the casings have worn out and the water is escaping under ground.
The question of which is happening can be easily settled by comparing the water level of the particular well in question with that of those adjacent.

But still, the number of wells now leaking is a minor matter. The great danger arises from the fact that every abandoned well, whether now leaking or not, is a potential source of waste. Sooner or later, the casings will wear out, and they will join the class of leaky wells wasting their entire flow underground.

Every Abandoned Well is a Source of Danger

What makes the condition of these wells most serious? A known leaking well is bad enough; but what adds to the danger of the situation is the fact that Honolulu is rapidly growing and that these abandoned wells are located in the path of progress and are being covered over and the land built upon. Even their whereabouts is being lost sight of. This means that every well so lost sight of becomes a perpetual waste to a supply that is becoming more precious each year with the natural increase in demand.

Amount of Present Waste

Is loss from this source serious now? It is! Three years ago it was figured that from thirty abandoned wells the wastage equalled about 65 per cent of the total amount the city was pumping.

This figure was obtained by actual measurements of over half of the wells considered.

At the present time some of these wells have been repaired, but how many wells have taken their place no one knows.

Practically Nothing Being Done to Stop Waste

What is being done to stop abandoned wells from becoming a perpetual loss?

Practically nothing!

What is more, nothing will be done until the public is first aroused to the fact that Honolulu's chief source of water supply is being frittered away at a rapidly increasing rate!

Second, until legislation is enacted, enabling the compelling of owners to stop the waste from private wells, or;

Third, the provision of public funds is made, with which to stop the waste.
THE PRESENT CRITICAL CONDITION OF THE ARTESIAN SUPPLY AS SHOWN BY INVESTIGATION

Like a good many investigations, a wealth of information has been collected and published regarding the artesian supply, but few of the real features have been retained in the public memory.

One outstanding fact, however, should be retained when all else is forgotten, concerning the Honolulu artesian water supply, and that is, that the draft on the supply has long been more than the inflow.

Sufficient evidence has been obtained to convict and hang old Mr. Waste, but still he is allowed to live and prosper in our midst.

Steady Fall of Artesian Level

The feature most frequently mentioned, and quite a true barometer of existing conditions, is the steady drop in the water level of the various artesian basins.

Studies have shown that while these water levels fluctuate, both with the months and years, yet their general tendency is ever downwards.

The longest obtainable record, that at the Oahu college well, shows a water level of 42.8 feet above sea level in 1890, while a continuous record from 1899 shows a low level of 25.5 feet in October of 1920. The average mean fall for this last period of 23 years is about 9.4 feet, or at a rate of .4 feet per year.

As near as can be foretold now, this rate will decrease as the level falls, so that past estimates of exhaustion within fifty years may be too pessimistic.

Still the danger is there.

Living Beyond Our Income

This condition points to only one conclusion; that we are living beyond our income and drawing on our capital, and the only course of safety lies in revision of the family budget and living within its means.

Criminally Reckless Waste of Water

Investigations show that this is entirely possible, for at the present time we are extremely lavish if not criminally reckless in our expenditure of this water supply nature is storing for us.
See what figures show in regard to the draft on this supply.

Back in 1916, from all available records, it was figured 57 million gallons per day could be pumped under normal existing pumping plant capacity from all wells within the Honolulu city area.

At that time the mean daily draft from three of the four basins, from May to October, was estimated at 40 million gallons, with the city taking about 12 of this. Even with the marked increase in rainfall at that time, the water level of the basins stood lower than in the past, plainly showing this pumping to be an overdraft.

**Slow Suicide—Regulation or Disaster are Inevitable**

In 1919 study of thirty abandoned wells, with actual measurement of a goodly number, showed a total loss of about 10 million gallons a day, due to leakage, compared with 16 million the city water works were then pumping and possibly 25 million industrial and agricultural interests were taking.

An absolute wastage of 20 per cent and a possible misuse of another 50 per cent represent quantities so large that to ignore them is slow suicide. These facts can lead to but one conclusion, for where waste and possible misuse constitute such a large proportion of a total natural resource vitally needed by all, some regulation of its use must be made or disaster is inevitable.

**Difficulties of Regulation**

Past investigations have shown that artesian regulation involves not a few legal difficulties, due to the question of ownership of this supply.

With surface waters flowing in streams, the problem of ownership has been thoroughly threshed out by a long series of previous settlements.

With the underground waters, however, especially artesian supplies, this is not so true; as the whole field is relatively new and untried.

They apparently form a class of percolating waters in definite water bearing strata that have no well defined subterranean channels, and are subject to the common law rule—that such waters belong to the owner of the surface, like rock and minerals found there.

Our own supreme court has ruled (though by way of dictum only) that subterranean waters to be the subject of rights must, like surface waters, flow in well-defined channels.
A Minnesota Ruling

A Minnesota ruling of 1908, however, holds that pumping by or on behalf of a municipality from an artesian basin for the purpose of furnishing water to its inhabitants for domestic purposes, does not constitute an artificial taking or use as distinguished from the right enjoyed by private well owners and that both stand upon the same basis, subject to the rules of correlative rights.

Regulation of the water supply from private sources thus appears to be quite a problem and one that will have to be met when the community need forces some conserving regulation on the private owners.

What is being done about these investigations? We, the Engineers' association, are trying to secure funds to continue them so as to be prepared to meet the situation when definite action has been decided upon.
LEGISLATION, EXISTING AND NEEDED, TO ADEQUATELY REGULATE THE ARTESIAN SYSTEM

After the presence of the artesian area under the city had been pretty well established, the rate of increase in the number of wells drilled was very marked.

It soon became evident that some control should be exercised and as a result, in 1884, some commendable laws were enacted with a view to the conservation of the artesian supply.

At that time, there were probably not over forty wells drilled and strict compliance with the new laws then and afterwards would have eliminated a goodly share of today's waste.

What the Limitations Were

The law provided that every flowing well should be capped so as to give complete control over the flow. Further, that no water should be allowed to run to waste unless it was first used for irrigation, domestic or other useful purposes. It could also be used for driving machinery, provided it was utilized afterwards for the above purposes.

The law also provided a fine for violation of these provisions and gave authorized officials the right to inspect without warrant any premises where artesian water was used.

Report of the Artesian Commission

To what extent these laws were enforced is not known; but enough agitation was aroused over conditions in 1915 to cause the legislature of that year to appropriate funds for the appointment of a special water commission to thoroughly investigate the whole situation. This was done and a comprehensive review of their findings and recommendations was published in January, 1917.

As a result new laws were enacted that year, which, with one omission, embodied practically all the recommendations of the commission, including an appropriation of $1200 to continue their investigations.

What the New Law Provided

These new laws added several features to the existing laws. They clearly defined both what constitutes an artesian well and what constitutes wastage of water therefrom.
This last is of great importance as it specifically includes as wastage the permitting of water to reach any porous substratum before coming to the surface of the ground.

The laws also state that wells not cased, capped or furnished with valves to readily and effectively control the flow, constitute a public nuisance, and that the owner or person in charge permitting this nuisance is guilty of a misdemeanor, punishable by fine of not more than fifty dollars. Also each day's continuance of such waste after notice by proper authority shall constitute a new offense.

Further provision was made that any person boring, or causing to be bored, an artesian well shall keep an accurate record of the depth and thickness of the different strata penetrated, and within ninety days of the last day of boring file such record in the office of the superintendent of hydrography.

Law of Value if Effectively Enforced, But There is a Weak Point

Now these laws constitute a big step towards conservation, provided public sentiment and funds are sufficient for their enforcement.

With the law enforced it is possible to have all wells mechanically equipped to prevent wastage; to have leaky wells recased or plugged, and to stop wilful waste, providing it can be shown the water in question is "serving no useful purpose."

This last phrase is the stumbling block, for "useful purpose" may cover a multitude of cases—perhaps technically, or slightly useful, within the wording of the term, and yet constituting an absolute waste when that particular water is needed for the public supply.

Under this status, no matter how scarce the water supply may be, any landowner is within his rights to drill a well and use the water in any manner he sees fit, even though the useful purpose consist in filling a pond to raise fish and water lilies.

Cases which would be more reasonable are those where the water is used in large amounts for irrigation of rice and taro or private gardens, or in industry where potable water is turned directly into the sewers after having served in some mechanical process, such as cooling water in steam condensers.

Additional Regulation Needed

It can readily be seen that with a public necessity for drinking water such owners should be obliged to submit to regula-
tion limiting the use of the water for less important purposes, in the interest of the common good.

This point was given consideration in the report of the water commission, but their provision to cover this feature was omitted in the enactment of the new legislation. The omitted provision in question provided, in substance, that the use of any water from an artesian well within the area which is or may be served by the city water works, cannot be used in an amount greater than, or at a time period other than, that fixed for domestic or garden irrigation use of water from such water works, by regulation prescribed under authority of the board of supervisors.

Probably the main objection to this provision, causing its failure of passage, was the limitations thereby placed upon private ownership of this water and its too general application, inasmuch as no specific area to be thus treated was set forth.

What can be done towards improved legislation?

Little until public appreciation of the situation is sufficient to cause some adequate form of regulation to be adopted.
WHAT MAKES THE PRESENT SITUATION OF THE ARTESIAN WATER SYSTEM MOST CRITICAL IS THAT THE SUPPLY IS BEING OVERDRAWN

There has been much publicity given each year, during the summer drought, to the artesian supply, with especial emphasis stressed on the gradual lowering of water level and the possibilities of the presence of a high salt content, as exhaustion of the supply is approached. This is all true and points directly to the outstanding feature that the artesian supply is being overdrawn!

What Must Be Done First?

When the fact of overdraft is established, the part of wisdom is to analyze the situation and determine upon what waste can be first eliminated to correct this condition.

In this particular problem there are two wastes which can be eliminated without injury to anyone. The first, to regulate the use of privately owned wells. This will be certain of adjustment whenever the shortage reaches such a point as to spur public action.

The second, presence of leaky wells. This one cannot be delayed without increasing danger and loss to all.

It is well to call attention here to the fact that in using the term "leaky well" not only is meant the well without cap, or with defective valve, or bad service connections, but more especially the well whose casing has worn out underground, and which is allowing the water to escape, unseen through some porous strata to the sea.

Why Action Should Be Taken Now

The need for immediate action is not because it cannot be done ten years hence; but because today it can be done immeasurably cheaper and with much greater certainty of complete success. This is true for a number of good reasons.

To begin with, most of the information concerning artesian wells is being carried about in the heads of individuals with memories no better than those of the most of us, who are also subject to transfer and death. Particularly with the older wells many facts are now gone.

This means that much time and labor will be required to unearth these facts, for the whereabouts of many of the older wells are today a matter of speculation.
Another reason is the fact that with the rapid growth of the city old wells are being abandoned and covered up, while in some cases buildings and improvements are being erected directly over them. In many cases these wells had long been so leaky as to be incapable of use before abandonment. The leak will therefore remain a constant drain on the artesian supply until the well is found and sealed.

It is quite obvious that steps for sealing such wells should be taken prior to the improvements, and equally evident that with the lapse of time it will be more difficult to locate such wells for sealing.

**Well Casing Is Giving Out**

Another reason for action now is that the present time marks the full length of life for the casings of many of the old wells.

The all too common notion that when once a well has been drilled and cased all expense ceases, is false. Maintenance charges against a well should be borne in mind, just as much as in considering any other construction.

The valves and service connection wear out and just as surely the casing in the ground will too.

A smaller casing will have to be inserted inside the old; but all too frequently this is considered too expensive, and so the well is said to have "ceased to flow," and has been abandoned to become a perpetual drain on and waste of the artesian supply, not only as far as the owner is concerned, but of the entire basin on which it is located.

Another bad feature of the abandoned well is that even should the casing be sound at the time of its abandonment, it will eventually rust out and then be in the same class with its mates.

Today there are possibly forty wells in Honolulu that have been abandoned, making either now, or in the near future, a waste of their entire capacity.

Were this waste piped up to public view, and then turned into a sewer, public sentiment would demand its instant shutting off.

With the same loss out of sight, although clearly proved as existing, the public will wait until their own supply is curtailed before any great protest is entered.

A point to be remembered is, that if this underground leakage, which is a complete loss, were stopped, the time when it will become necessary to regulate private use, and subordinate it to public need, can be postponed much longer.

What is the only sensible, practical thing to do?
Locate, immediately, all existing wells and see that no more are drilled without accurate record being made of their site.

See that all abandoned wells are sealed directly above the water bearing strata, so that there will be no leakage from the artesian basin.

Inspect wells that are operating to see that they do not develop leaks.

This will largely stop the present insidious waste, dangerous because it is unseen and has to be hunted out.

What is being done? We are trying to get the public to see the vital need so that funds will be provided to do the work that must be done if Honolulu is to avoid the disaster of the destruction of the principal water supply.
WHAT WILL BE THE FINAL HANDLING OF THIS SUPPLY?

Intelligent discussion of the artesian water supply or forecast of the future, is difficult. Available information is insufficient to foretell what effect now unknown circumstances will have on the trend of events; even a trend that from our present viewpoint seems inescapable.

Overdraft Now Exists

To anyone willing to study the established facts, it is evident that overdraft exists in no small amount and that it is gradually reducing the water levels in the various artesian basins under our city.

Despite marked fluctuations, due to heavy rainfall, the lowering of the level to which the artesian water rises, amounts to nearly half a foot per year. It has caused some wells to already cease to flow and the water in others to be beyond the reach of pumps.

What Inaction Means

It is likewise evident that, with inaction, this overdraft will increase in amount.

Increased wastage through steady deterioration in existing wells, and increased draft due to continued growth of the city, are as certain of fulfilment as any prediction that can now be made.

Failure to take action against this growing overdraft will inevitably result in final total loss.

The diminishing supply will come to a level beyond the reach of our pumps, if, indeed, it is not rendered unfit for use prior to that time by admixture of sea water.

This overdraft must cease or the city will be compelled to seek other sources of water supply.

This will mean catching the surface runoff from the areas mauka of the city—an inadequate supply in itself. Additional water will therefore have to be obtained from outlying districts.

Water Will Have to be Taken from Outlying Districts

Serious trouble will arise here in that this water is already largely used for irrigating crops upon whose continued growth the prosperity of the city depends.
Also, any appropriation of the water not now being used, will limit any future expansion of the agricultural interests with corresponding ill effect upon the city.

Certainly such an ultimate situation should be avoided if possible; and the only remedy within our control is that of stopping the present wastage. This will mean reduction of the wastage of artesian water until the draft does not exceed the inflow. Then other developments can follow in the order named above, as more water is needed to supply the city.

Imminent Danger is at Hand

Elimination of wastage cannot be accomplished without regulation. This will probably not come about as the result of one step, for only imminent danger of total exhaustion will ever do away with all wastage and allow complete regulation.

But imminent danger is at hand, and efforts to secure adequate regulation should be made promptly.

Regulation must cover the sealing of abandoned wells and the conservation of the flow of private wells, through public control.

There are numbers of abandoned wells today that need sealing or recasing, operations that may cost several thousand dollars each, dependent upon the condition of the well.

Financial Difficulties

Some of these wells have been in this condition for a long period of years. In particular instances the present owners are financially unable to stand this expense. Some of these wells, too, belong to owners who have purchased their property ignorant either of the well's presence, or of their liability to make the well comply with the law.

Any action instituted in such cases would do some injustice and still no legitimate argument can be advanced for the public relief of the owners unless their rights to the water under their land be surrendered for all time.

The public would then acquire title to this particular water and its wastage would be stopped. This would result in all abandoned wells being sealed, or properly maintained.

Where the owner is unwilling to give up his rights, present legislation should be enforced to insure proper maintenance.

In either case, the desirable feature would be secured of having the present underground wastage stopped.

Such action would also tend to postpone the time when the scarcity of water will force some regulation of the present unrestricted use of privately-owned wells.
Public Ownership Ultimate Solution

The ultimate solution will be public ownership of this artesian supply, so that all users will be on the same basis, subject to whatever regulation necessity may warrant.

This should be the natural outcome, before any large amount of public funds is expended in securing other supplies.

The basis of all such developments will be the amount of water needed above that which can be safely furnished by the artesian areas.

Should it prove more economical to secure all water possible by gravity, from the area mauka, rather than by pumping, do so. But at the same time remember the limitations of the total available water, and conserve the artesian waters as a basic supply that must not be overdrawn.

The Best Policy to Follow

What is the best policy to follow at present?

Our suggestions are to get the already established facts well in mind; give them careful consideration; determine the most practical way of overcoming the present situation and then see that the wheels are started for accomplishing results.

In the meantime we are trying publicity to secure enough public support to provide funds sufficient to keep in touch with the well situation, so that information will be available when definite plans of procedure are adopted.