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GOGA

MOUNTAIN LAKE
Presidio of San Francisco, California

"Can Lake Water be Used to Water
the Presidio Golf Course"

An Initial Study

Jack L. Chaffee, LLT, CE
Asst Fac Engr

February 1973

- initial study (p. 1)
- lake stocked (p. 3)
- * army's obligation (p. 10) - to maintain presidio in
- conclusion (p. 17) "park-like" condition

55-54

EXTRACT

MOUNTAIN LAKE - PSFC

"Can Lake Water be Used to Water the Presidio Golf Course"

The problem of using water from Mountain Lake to water the Golf Course grounds involves practicality and costs, ecological considerations, public and citizen pressures, and land titles and usage rights.

Changing one environmental factor of the area will have an effect on the overall ecology. The ecological reaction that changing the lake water level from the natural level will have depends upon the extent to which the levels are deviated.

A theoretical "normal level" is defined to be that level at which the water surface first makes contact with the base of the chain link fence that runs along the base of the southern shore. This "normal level" will be considered acceptable both ecologically and politically. Any water above this level shall be considered excess, and may be used for Course watering.

Although the lake is on government property, the civilian populace has utilized the area for many years, and ~~are~~ concerned about its appearance. Also, the Army has the responsibility to maintain the Presidio in a park-like appearance. ?

Ownership of the area and encroachments by the community have become interwoven. The boundary lines are not clearly defined on the ground, and add to the confusion of who has responsibility for the area.

The existing pump and water transport system is found to be adequate to meet the maximum watering needs of the Course.

The lake seems to be a surface exposure of the groundwater table. When water is needed, it is not available. And excess water is available only during the wet season. Storage of the 20 million gallons of water needed throughout the dry season is impractical.

It is recommended that for the next two years to record lake levels, and quantities of city water and total water used, and that lake water not be used during this period. Then, analyze the recorded facts, confirm or redefine the "normal level", and define any possible lake water usage. Continue to record data for further analysis.

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✓ all
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Statement of the Problem

The question of whether water from Mountain Lake can be used to augment present watering systems on the Presidio Golf Course, is quite involved. The answer involves practicality and costs, and is complicated by ecological considerations public and citizen pressures, and land titles and usage rights. Also, some of the data that would be useful in answering this engineering question has never been recorded, and must be speculated. Therefore, the problem is whether or not all of these factors can be interwoven to form a method of water usage that is acceptable to at least most people involved.

Sources of Information

This report is meant to be only an initial study. The information contained herein has been obtained through personal observation of the lake, interviews with employees of the DFAE and the Presidio Golf Course, and other sources as noted. Personnel who contributed information, and are recommended for further interviewing are listed in Appendix A. Some of the information from these personnel are only personal observations by them, but since nothing has been recorded, it is the best information available. Also, many of these personnel have been employed for ten or more years, and their personal observations are quite reliable.

The Lake and Surroundings

A description of the lake and surrounding area is presented here for the benefit of those who cannot make a personal visit. Initial observations were made in November 1972, and continued every week or so through January 1973. Maps and pictures in Appendix G.

Lake Description

The lake is shaped like a triangle, and is located along the southern boundary of the Presidio. The surface area is approximately four acres. Neither depth nor bottom contours have been recorded. Interviews produced estimates from 5 feet to 15 feet depth when the lake is at normal level. What "normal level" is will be discussed later. The water is dirty brown with a hint of olive drab green. There is no unpleasant odor to the water.

Water Sources

Water enters the lake from apparently three sources. Springs in the lake bottom provide a continuous supply of water from the water table. The only recorded evidence of the springs was found in a 1941 Water Treatment Plant Improvement report, kept on file at the Presidio Water Plant. However, many of the interviews supported this. The second source, surface runoff, is from Lobos Creek, the Presidio Golf Course, Mountain Lake Park, and culverts under Highway 1. Since the soil in the vicinity is quite sandy, much of the runoff penetrates the soil, enters the water table, and a portion enters the lake through the springs. Rainfall directly on the lake is the third source. There are no industrial or commercial wastes entering the lake.

Water Retention

The lake has no outflowing streams or drainage ditches. An overflow pipe has been reported, but not evidenced by personal observation. Even if this pipe still exists, it is unknown whether it is functional. Some water is lost through evaporation. Quantities have not been recorded, and vary depending on temperature, humidity, barometric pressure and the surface area of the lake. The means by which the bulk of the water is retained in the basin affects the "normal level" of the lake, and this will be discussed later.

Vegetation

Vegetation around the lake consists of eucalyptus trees, a few various coniferous trees, raspberry bushes, poison oak, and other various shrubs and grasses. Floating and surface vegetation is absent from the lake, at least in November through January. Excessive algae growth was not evidenced.

Mosses and fungi can be seen in the damp, shadowed areas.

Animals

No mammals were observed in the area. However, reports of deer and raccoons in the area were received from Golf Course personnel. Birds observed were seagulls, coots, mallards and other ducks. No reptiles or amphibians observed.

Although few animals were observed, it is not safe to assume that the area is devoid of other life. More likely is the idea that animals common to the area are present. Animals common to these lake-marsh environments are various rodents, possibly muskrats, gulls, ducks, killdeer, rails and sandpipers, perching birds, snakes, frogs, and salamanders.

Information on the fish in the lake was furnished by Mr Rudy Choun. The lake ⁽¹⁹⁷¹⁾ was stocked about two years ago with 200 Gambusia affinis. This is an omnivorous, live-young bearing, tropical fish native to southern Florida and Mexico. The lake was stocked for the purpose of controlling mosquito growth. Besides mosquito larvae, the fish also eat algae and its own young - if it can catch them. Carp in the lake is also reported.

Very few mosquitos were noticed, mostly in and around raspberry bushes along the northwest shore. Numerous other arthropods are most likely in the area.

Debris

The area was relatively free from debris. Few branches and other organic

material in the water had collected, mostly at the northern point of the lake. A few bottles, cans, and papers were evidenced along the shores caught among the reeds and branches.

Ecology

With this background of the area environment, the ecology of the area can be discussed. A complete ecological evaluation is beyond the scope of this report. It is sufficient to discuss the principles of the balance of nature, an open system, and action - reaction effects.

Balance of Nature

The lake area is the way it is because of the balance of nature. In other words the plants and animals that survive in the area are interdependent on each other for food, shelter, and protection. The area, depth, temperature, and chemical contents of the lake, the weather, the soil composition, and every other factor of the environment has some effect on the overall ecology. Food chains are established, populations reach levels that can adequately survive, and various species either thrive or die depending on their adaptability to the environment.

Action - Reaction

Whenever there is some action, or factor change to the ecological system, a reaction takes place. A food chain situation will serve as a good example. Suppose that for some reason the lake starts growing an unusually high amount of algae. An initial reaction might be that the Gambusia fish will increase in population from the food supply increase. Mosquito populations reach a low because there are more fish to eat the larvae. As the fish population increases, it soon reaches a point where crowding begins. Then growth levels off.

Suppose that the algae continues to grow faster than the fish can consume it. The crowding is compounded by the algae growth using some of the water previously occupied by fish. The fish population decreases, algae thrives and mosquitos start to increase their numbers. An extreme possibility might be that the fish become extinct from the lake, their decaying bodies and decaying algae turn the lake ^(absence of oxygen) anaerobic, and mosquitos grow to tremendous numbers. The final result being a mosquito infested, stagnant marsh. A more realistic end result would be a balance between the algae, fish, and mosquito populations. This new balance would be different from the original situation, however. This example is much more complex than shown. The mosquitos' food chain is ignored. The other organisms living in the lake were not mentioned. And what about the animals that rely on the lake for drinking water?

But changing one factor can change the balance, or maybe even upset it completely. Since ecological changes are always going on, how can a balance ever be reached? It cannot, at least in an open system. The balance can only be tended toward, or maybe balanced for a particular moment.

Open System

An open system is one in which factors from outside the system can have an effect on it. In this case, the lake and surroundings is the system. Some of the outside factors are the weather, spring water, foreign animals wandering into the area, plant seeds and spores being transported by the wind or by surface runoff, and the effects of man. Pumping water from the lake is the particular effect, or action, of concern. The possibilities range from no pumping, thus no effect, to pumping the lake dry, thus destroying the existing environment.

The accepted solution would be somewhere in between such that some water could be used without upsetting the area drastically, and maintaining the area appearance acceptable to all concerned. Keeping the water level at some "normal level" seems to be an acceptable solution.

Normal Level

"Normal level" can be defined in any of a number of ways. It could be the average level of water throughout a given period, or the level at which the lake is at most of the time, or the level that is shown on Presidio maps, or some other arbitrary level. Since no water levels have been recorded, only a guess to what is normal can be made. For the purpose of this report, "normal level" shall be a level at which the lake is at most of the time. To make an educated guess of this level requires evaluating typical rainfall for this area, the physical appearance of the lake, and the complaint comments of citizens.

A typical Bay Area rainy season seems to be from early to middle November through early or middle February. The total rainy season lasting two or three months. Usually little rainfall is evidenced throughout the rest of the year. Rainfall from June 1971 through January 1973 is shown in Appendix F, page F-11. Excluding the rainy season and the following month to eliminate the consideration of unusually high levels, and excluding the month just before the start of the rainy season to eliminate the consideration of unusually low levels, then the "normal level" could be taken as the level throughout the other seven or eight months. That is from mid-February through mid-October.

Evidence around the lake will help define the "normal level". The vegetation growth along the shores provides a good indication of the water levels through-

out the year. Land vegetation under water indicates unusually high levels and muddy areas with aquatic growth indicates low levels. During the observations in the rainy season, there was considerable land growth under water. Maybe as much as five or six feet. A chain link fence along the southern part of the lake was completely submerged in places, and only about a foot of fence was exposed across the rest of the lake. The standard 6' fence was installed as a result of public pressure to keep children from the hazards of the lake. Surely, when installed, it was erected along the shore and not in the water. This indicates further that the lake is not at "normal level" during the rainy season. In final support of a "normal level" definition, evaluating the numerous paths in the area is helpful. These paths were most likely established when the weather was conducive to outdoor activity. Many paths around the lake lead into the water in November. Since people enjoy walking close to shores, probably most of these paths could be found to be quite close to the waters edge when the lake is at "normal level".

With these thoughts in mind, the "normal level" of the lake will be that level when the water surface first makes contact with the base of the chain link fence. Any water above this level may be pumped for use by the Golf Course, and will be considered as not having an adverse affect on the existing ecology.

Lake Types

Now that the "normal level" has been defined, it may be difficult, if not impossible, to maintain the lake at this level. The means of water retention in the basin will determine the degree of difficulty. Two means of retention come to mind.

Impermeable Basin

One is that the basin is impervious, or at least relatively so, to water passage through the basin. An explanation of how bacteria and decaying plants cause such an impermeable soil is explained in Appendix E, page E-1. However, when the water level rises above the "normal level" at which this impervious soil has been created, the water will seep into the porous soil and enter the water table. Thus, a maximum high-water level has been created, provided that inflow rate does not exceed the percolation rate. Lakes formed with water retention by this means are relatively independent of the water table, and may exist at elevations above the water table.

Permeable Basin

The second means of water retention in a lake is that the water table level determines the lake level. When a ground depression exists below the water table, the water is exposed and forms a lake. As the table rises and falls, so does the lake level. The lake level will not instantaneously be the same as water table level due to the lag time of the water seeping through porous soil. If the water table subsides below the depression, the lake will dry up. When the water table is exposed, water can be drawn from the lake just as from any other well.

Mountain Lake

Which of these two means applies to Mountain Lake? These facts are available for consideration: The impermeability of the soil in the basin is not known. However, decaying matter in the lake contributes to at least some impermeability

* The soil in the area is from silty-clay (slightly permeable) to sandy-silt (medium permeability). Sand along the south shore was commercially delivered. The lake basin is in the lowest part of the surrounding area. Springs enter the lake bottom. Personal observation every couple of weeks from November 1972 through January 1973 has revealed no visible change in the lake level. Rainfall for this period was 19.31 inches total, shown in Appendix F. Map 4 in Appendix G shows the watershed area and the subterranean flow through Mountain Lake in 1915. Evaluating these facts, Mountain Lake seems to be formed by surface exposure of the water table. The impact of this will be discussed when available water for sprinkling is considered.

Public Influence

Without polling the civilian community, it can only be assumed that the "normal level" defined will be acceptable to the citizens. A look at correspondence from civilians will help support this claim. No evidence has been found to indicate any complaint of too much water in the lake. But when the lake is low, the Post receives letters from concerned citizens, mostly from those living near the area along Lake Street. These letters and replies by the Post are included in Appendix C. The letters indicate that there is dissatisfaction when muddy and mucky areas on the shores are exposed. When the lake is at the "normal level" defined, there should be no such areas exposed, thus hopefully no basis for complaints.

The city owns and maintains Mountain Lake Park, which is bounded on the north by the Presidio and Mountain Lake. The existence of the park promotes activity around the lake. Boating and swimming are prohibited in the lake. The scenic

beauty of the area and hiking around the lake are enjoyed by civilians frequenting the park. When this natural beauty becomes unattractive during periods of low water level, the civilian populace is quick to remind the Post of this situation, and demands to know what will be done to remedy the situation. Again, the letters in Appendix C, and newspaper clippings in Appendix B, show this public concern for the lake. Although the citizens of the city may not have a legal "leg to stand on" concerning the lake, the pressure is on, and the Army's rapport with the city is at stake, along with the Army's obligation * to maintain the Presidio in a "park-like" condition. So this public concern should be evaluated and considered as justifiable.

Ownership and Encroachments

Some citizens are even confused about the ownership of the lake area. Their comments may be something like, "The Army is draining water from our lake!" This confusion is understandable though. The fencing arrangement in the area would seem to indicate that the lake is on city property. The Golf Course is fenced and the Highway 1 right-of-way is fenced, but the chain link fence across the southern shore appears to barricade the water only. There is no indication that the fence is to prevent hiking around the lake, or that it is a property boundary fence. Encroachments by the city in extending the park to the lake shore has reinforced the notion that the city has a right to the lake. A memorandum by Mr. H. A. Gale, Master Planning Office, about the encroachments is in Appendix D. The permissiveness by the Army to allow the city to use this land over the years has all but erased a defined boundary.

Excess Lake Water

With the ecological considerations, the public pressures, and the land titles and usage having been discussed, and at least a theoretically acceptable "normal level" been defined, the question of using any excess water can be pursued.

Hypothetical Excess Volumes

The first step is to determine the volume of any excess water, that is, any water above the defined "normal level", that might be available. The ground elevation of the base of the chain link fence was not recorded, and there is no U.S.G.S. Bench Mark in the immediate vicinity from which to make a quick elevation survey. By inspecting the maps that have the fence sketched and comparing to the contour lines, the base of the fence will be estimated to be 125' elevation. This will be accurate enough for calculation purposes.

Hypothetical excess volumes were calculated by assuming representative lake levels, as outlined in pages F-1 through F-4. Graph 1, Excess Water Volume vs Lake Elevation shows these values as plotted and connected by a smooth curve. Given either the lake elevation or the excess water volume, the other can be found using the graph. For example, suppose the lake level elevation is 131 feet. This is six feet above the "normal level" of 125 feet. The volume of excess water in the lake is read from the graph to be 8,000 x 1,000 gallons, or 10,700 x 100 cubic feet.

System Capabilities

The second step is to analyze the capability of the existing system to pump and transport water to the Golf Course grounds. Data concerning the system is contained in Appendix E.

The existing system is comprised of three wells with pumps, one lake pump, two concrete storage tanks, one booster pump, numerous valves, water meters, three 6" feeder lines to the sprinkler lines, and an electric system to operate the entire system.

This complexity was designed to operate basically like this: The primary sources of water are the three wells. Each is pumped independently into the storage tanks, which are interconnected. When the wells do not produce enough water to keep the tanks full, water is pumped directly from the lake into the tanks. And if this is not enough, water from a city line is emptied into the tanks. Water is then pumped from the tanks into the sprinkler feeder lines by means of a booster pump. The booster pump is turned on manually as water is needed by the Golf Course, and has timing controls that can be set for automatic shutoff.

The system currently operates with one modification to the design. The lake pump is not presently being used. Public pressure over the past couple years has prompted this pump to be dormant at various times. Most recently, the lake pump has been shut off since July 1972.

Available Water Supply Limits

The whole system can be divided into three parts. The water sources (input); the pumps, tanks, valves, and pipes (transport media); and the water coming out of the sprinklers (output). Each part has a capability limit which might effect the maximum capability of the overall system. The principle that "a chain is only as strong as its weakest link" is applicable. The water sources might be the first limiting factor. If the wells and city lines (and the lake if it was used) could not supply enough water, the grounds would turn brown in the dry season. Even if the wells stop producing, or the well pumps break down, city water is still available in sufficient quantity to supply the needs as long as the Course can afford the cost. So, the city water supply will be considered to be a limitless supply as far as the Course needs are concerned.

Sprinkler Limits

Next consider any limits of the sprinklers. The adequacy of water to be sprinkled onto the lawns is dependent upon the number, size, and placement of sprinkler heads. These sprinkler parameters were surely analyzed by the design engineer before installation to insure proper and adequate distribution of water over the ground. The limits of the sprinklers should present no problems, provided they are maintained.

Water Transport Limits

Limits of the water transport operation is analyzed. The limitless supply is useless if it cannot be transported to the grounds at the rate needed. Assume that the booster pump was properly designed into the system such that water is not needed on the grounds at a rate greater than the pump furnishes. In other words, the booster pump will force water through the sprinklers at such a rate that the grass will not die for lack of water. The booster pump is a 100 horsepower, centrifugal pump with maximum efficiency of 800 gallons per minute. Is water available such that the pump could operate at maximum for 12 hours of watering at night? The procedure and calculations are in pages F-5 and F-6. As shown, the storage tanks will not be pumped dry at night if the city supply runs into the tanks during that same time. Also, the city supply will fill the tanks during the day in preparation for watering the next night. Further, the Course operates the booster pump at only about 500 gpm. Thus, the existing transport operation is much more than adequate.

Controls

Before attempting to utilize any excess water, a control system should be established so that water is not drawn below the "normal level". At present,

no such controls exist in the system other than visual observation. Visual observation will be impractical during the night watering. One method of automatically controlling lake pumping follows: Place the pump so that the end is at the "normal level". The pump could not possibly pump water from below this level. Equip the lake pump with pressure valves so that when the pump started "sucking" air, the pump would shut off.

It has been shown that the existing system is adequate to accommodate the maximum watering needs of the Course even if the only water source is the 4-inch city line. So, why bother considering water from the lake for use? Costs is the reason.

Costs

The third step in analyzing water usage feasibility is to consider the costs. The Course is interested in minimizing its expenses. About \$2000 is spent each month in operating expenses for grounds maintenance. This money comes from Golf Course non-appropriated funds. Looking at data, page F-11, it is seen that during the dry months for 1971 and 1972, the Course has spent roughly \$2800 and \$4500 respectively, for city water. The cost difference is not due to any significant difference in rainfall during the dry season in 1971 and in 1972. But rather, the fact that during the summer 1971, some water was being pumped from the lake, and in summer 1972 it was not. During months when water was purchased, the electric bill also increased, indicating the magnitude of electricity (in terms of dollar values) that the pumps use. This cost cannot be changed significantly whether the water comes from the lake or the city since the same booster pump is used for both sources. But if the water bill could be reduced, or elimi-

nated completely, the Course might save as much as 10 - 20% of its annual grounds maintenance expenses. Lake water is free, except for the pumping costs. If lake water, rather than city water, was used whenever possible to augment the wells, money could be saved. The savings would be directly dependent on the amount of water used.

The value of lake water shall be taken to be the same as city water, which is \$0.3176 per 1000 gallons. Calculations, page F-7, show the value of 5 - feet and 10 - feet of lake water above the "normal level", and Graph 2, page F-8, shows the dollar value of any water level above "normal level", up to 10 feet of excess. Knowing the feet of excess water, the value of an equivalent amount of city water can be read from the graph.

Combining Graph 1 and Graph 2, a useful tool is formed to find excess water elevations (or feet of water), excess volumes (in gallons or cubic feet), and water values. Knowing, or assuming, only one parameter, the others can be read from Graph 3, page F-9.

Lake Water Availability

The last step is to determine when excess water is available for use. Lake elevations have not been recorded, so only a "guestimation" of excess water can be made. Also, meter readings from the booster pump have not been kept, so the total amount of water used by the Course is not known. Only the amount of city water purchased is recorded. The amounts purchased each month and the monthly rainfall since June 1971 is tabulated on page F-11. Graph 4, page F-12, shows this data plotted. City water is purchased only when the wells fail to produce sufficient water. Comparing the rainfall curve with the periods when

water was purchased, it is seen that city water was used during the dry seasons. This makes sense. Looking more closely, the trend is that more water is purchased near the end of the dry season, and a lesser amount, if any, at the beginning. Assuming the two years plotted are representative of future years, water is most needed during the months of August through November.

Is water available during this four-month period? This is where the notion that the lake is a mere exposure of the water table has an impact on when water is available. During the dry seasons, and especially at the end of the season, the water table is lowest. The lake level is more likely to be below the "normal level" at this time than at any other time. But this is when water is needed most! Because the water table is low, the wells furnish less water. If the lake water is part of the water table, then pumping from the wells would also have an effect on the lake. The effect is most likely small since the lake is only a very small part of a much larger water table source.

* So pumping from the lake during the dry season does not seem to be possible if the "normal level" is to be maintained. The lake surface may even drop below this level without any pumping.

During the rainy season, there is excess water. At least this year there was. Maybe this water could be stored for use during the dry months. From June through October 1972, the Course purchased over nineteen millions gallons. This whole quantity would have to be stored at once. This is a lot of water. For comparison, the Presidio Water Plant has a processed water storage capacity of only one million gallons. Only indeed! Storing some 20 million gallons of water for use six months later seems to be impractical.

*
TL It appears that when water is needed from the lake, excess water is not available. And when there is an excess, it is not needed, and too bulky to store.

Final Comment

Much of the analysis of Mountain Lake was based on limited and partial data, outdated data, assumptions, and suppositions. From this, the past, present, and future situations were speculated. But until such data is recorded, compiled, and analyzed, which either alters, or proves these speculations true or false, the following recommendations are made:

RECOMMENDATIONS:

1. Record lake levels every two weeks for two years. This can be accomplished by placing a marker in the lake and taking readings. The marker should be installed so that it will indicate levels as much as ten feet above and ten feet below the anticipated "normal level". The marker should be anchored so that it will not settle, nor work loose from silt movements on the lake bottom, nor deviate from vertical from wave action. The marker should be calibrated in tenths of a foot.

Another possible method would be to establish a bench mark near the lake, and take survey stadia measurements on the lake surface. One suitable bench mark is located on the southern edge of the asphalt walkway through the park, at a point perpendicular to the middle of the southern shoreline. The marker is a brass disk set in concrete. It is a Corps of Engineer boundary marker placed by the 30th Engineer Group in 1958, labelled BNDY MK 1. The elevation is not recorded, but could be established by making a survey from the nearest U.S.G.S. Bench Mark. The lake readings can be taken relative to either sea level, or some [arbitrary established datum.

2. Record the total amount of water used by the Course every two weeks for two years. There exists a meter at the booster pump which can be utilized.
3. Continue to record quantities of city water purchased by the Course, and the water costs. Isolate the electricity costs to operate the pumps, if possible.
4. Do not use any water from the lake during the two-year period. Pump only from the wells, and augment with city water as needed.
5. Search for any lake outflow other than seepage and evaporation. If any surface outflow, record the maximum possible lake level.
6. After two years, analyze the data compiled. Redefine a new "normal level", or confirm the one already defined. Compare quantities of city water purchased and quantities of any excess lake water. Compare rainfall periods and periods of water usage, both total water and city water. Compare rainfall and lake levels.
7. After analyzing the recorded facts, define any possible lake water usage and establish controls.
8. Continue to record data, and periodically analyze it.

Personnel from which information obtained and to be contacted for further research.

DFAE personal

- | | |
|-----------------|---|
| 1. Mr. Lane | - Utilities |
| 2. Mr. Cline | - Engineering Services |
| 3. Mr. Landon | - Master Planning |
| 4. Mr. Freeman | - Utilities |
| 5. Mr. O'Neill | - Utilities |
| 6. Mr. Chou | - Agronomy - science of soil management
4. production of field crops |
| 7. Mr. Leason | - Water Plant |
| 8. Mr. Gale | - Engineering Services |
| 9. Mrs. Roberts | - Real Estate |

PSF Golf Course - personnel

1. Mr. Kahn - Director
2. Mr. Buckley - maintenance

Other-

1. Mr Hackett - S.F. Water Dept 558-4108
2. Mr Crouder - Sacramento District Engr, Survey Branch
916-449-3364
3. Mr Sarlin - S.F. District Engr, Survey Branch
556-3656

[List of People Interviewed]

A-1

Soviet scientists waterproof ponds

By G. Abelashvili*

The Soviet Union is rich in water resources. Unfortunately, however, some parts of the country suffer from water shortage. Among the reasons is that 60 percent of the annual runoff of rivers is accounted for by spring floods and high water; in mountainous areas the percentage is even higher.

How to retain and accumulate these millions of gallons of water is a problem. Large and small reservoirs are built for irrigation, for fish and poultry farming; many ponds serve as settling basins for industrial liquid waste, protecting the rivers from pollution.

But soil often lets water seep through. For instance in the central chernozem areas of Russia, ponds total about 105.7 billion gallons. Water losses due to filtration and evaporation in summer reach 34.3 to 39.7 billion gallons. Many of these ponds and lakes lose within 10 or 30 days all the water accumulated during the spring floods. A pond in spring, disappears in the summer.

Many control methods have been suggested: waterproofing materials such as concrete or polymer films and chemical reagents. Unfortunately, concrete is too expensive to be used to coat the bottoms and walls of ponds, and polymer films are quickly damaged by rodents and plants.

Recently a new solution to the problem has been explored. Two scientists at the Georgian Hydraulic Engineering and Land Reclamation Research Institute, S. Voznesensky, D. Sc. (Agr.), and S. Khlebnikov, Cand. Sc. (Tech.), turned their attention to bogs. Bogs are ideal water reservoirs. The green soil saturated with stagnant water is impermeable. This soil is called gley.

Back in 1905 the famous soil scientist G. Vysotsky believed that microorganisms played the main role in gley formation. The microorganisms in the bog, he thought, are short of oxygen, and they try to take it away from soil particles and decaying plants.

*Candidate of Science (Tech.) Furnished by Novosti Press Agency, Moscow, USSR, and information department, Embassy of the USSR, Washington, D.C.

The growth of bacteria and the decay of plants without access of oxygen results in changes in the structure of the soil. The ground becomes less porous. It turns greenish and bluish-gray and becomes a structureless, entirely water-proof plastic mass.

The Georgians placed loose, water permeable soil in a glass cylinder. A layer of several centimeters of straw and reed leaves was put on top and covered with a layer of soil of the same thickness. Water was circulated through the cylinder the day round.

At first the water passed through the soil-vegetation layers freely, but about the tenth day the soil started turning bluish-gray. Within three or four months the water permeability of the column diminished to a hundredth. Not a drop passed through the ground.

Studies were made in pits and canal sections, in production conditions and in water bodies in Georgia, the Kursk Region and the Nogai Steppe. Now a simple and inexpensive biochemical method reducing water losses from ponds and water bodies for a wide range of purposes can be recommended.

A layer of vegetation is spread by bulldozers on the soil surface. The best thing to use is dry vegetable material rich in cellulose: straw, hay, weeds, potato and beet haulm, hemp waste, reed leaves, and spoiled silage. The average is six or eight pounds a square meter. The vegetation layer is then covered with a six to eight-in.-thick protective layer of ground. Then the water is let in.

In this laminated screen the vegetation serves as a source for the development and vital activity of anaerobic bacteria, which create the water-impermeable layer.

In the southern areas of the Soviet Union one to two-inch thick layers of gley have formed in a couple of months. In three years gley has become a foot thick. The bacteria work untiringly, preserving millions of gallons of water for agriculture and industry. ☐

WATER & SEWAGE WORKS, August, 1972

Structures in Mountain Lake area¹
Nonpotable water

Bldg number	Designation	Year built	Est. 1:50	Stories	Capacity and/or square feet
T-316	Water pump	1939	1992	1	26 SF
T-318	Pump house (well #3)	1964	1988	1	310 SF
T-319	Pump house (well #1)	1959	1988	1	54 SF
T-322	Water reservoir tank #1	1956	1989	NA	72,000 gal
T-323	Water reservoir tank #2	1958	1991	NA	136,000 gal
T-324	Pump house (lake pump)	1956	1988	1	49 SF
T-348	Water pump (well #2)	1959	1984	1	350 TG ² 103 SF

¹ data from Building Information Schedule, PSFC, revised 10 Mar 72, pp. 24, 25, 27.

² TG - thousand gallons per 24-hour day

Planimeter data:

make: Filotecnica Salmoiraghi
model: 236/A
serial number: 85151

tracer arm set at 10 thousandths of a square inch.

Map data:

Presidio of San Francisco Sectional #3 1 Nov 70
drawing number: ESSM-10603
Master Planning Office, DFAE, PSF

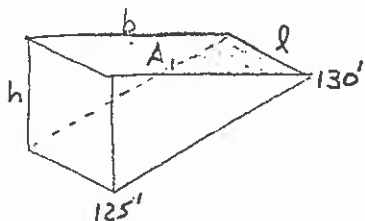
scale: 1 inch = 100 feet $\Rightarrow 1 \text{ in}^2 = 10,000 \text{ ft}^2$

Planimeter Readings:

125' (contour interpolated)	130' (lake contour)	135'	140'
1513 1508 1514 <u>1508</u> 4 16043	2008 2002 1992 <u>1998</u> 4 18000	2430 2413 2415 <u>2427</u> 4 19685	3001 3017 3011 <u>3014</u> 4 12043
15.1075 in ² $\times 10,000 \frac{\text{ft}^2}{\text{in}^2}$	20.00 in ² $\times 10,000 \frac{\text{ft}^2}{\text{in}^2}$	24.2125 in ² $\times 10,000 \frac{\text{ft}^2}{\text{in}^2}$	30.1075 in ² $\times 10,000 \frac{\text{ft}^2}{\text{in}^2}$
<u>151,075 ft²</u>	<u>200,000 ft²</u>	<u>242,125 ft²</u>	<u>301,075 ft²</u>
$= A_{125} = A @ 125'$	$= A_{130} = A @ 130'$	$= A_{135} = A @ 135'$	$= A_{140} = A @ 140'$

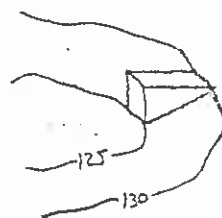
Volume calculations:

1. Volume (V_1) between 125' and 130' contours:

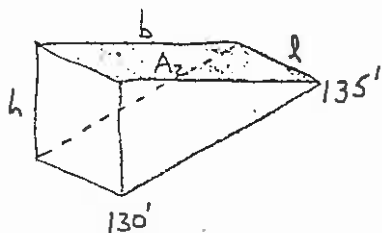


$$\begin{aligned} A_1 &= A_{130} - A_{125} = b l \\ &= 200,000 - 151,075 \\ &= 48,925 \text{ ft}^2 \end{aligned}$$

$$\begin{aligned} V_1 &= \left(\frac{1}{2} b h \right) l \\ &= \frac{1}{2} h (b l) \\ &= \frac{1}{2} (5) (48,925) \\ &= 122,313 \text{ ft}^3 = V_1 \\ &\quad \times 7.48 \text{ gal/ft}^3 \\ &\quad \hline 915,000 \text{ gal} = V_1 \end{aligned}$$



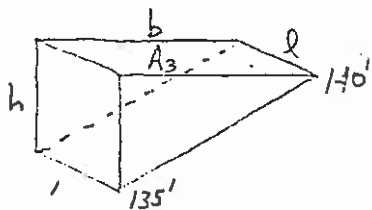
2. Volume (V_2) between 130' and 135' contours:



$$\begin{aligned} A_2 &= A_{135} - A_{130} = b l \\ &= 242,125 - 200,000 \\ &= 42,125 \text{ ft}^2 \end{aligned}$$

$$\begin{aligned} V_2 &= \left(\frac{1}{2} b h \right) l \\ &= \frac{1}{2} h (b l) \\ &= \frac{1}{2} (5) (42,125) \\ &= 105,313 \text{ ft}^3 = V_2 \\ &\quad \times 7.48 \text{ gal/ft}^3 \\ &\quad \hline 788,000 \text{ gal} = V_2 \end{aligned}$$

3. Volume (V_3) between 135' and 140' contours:

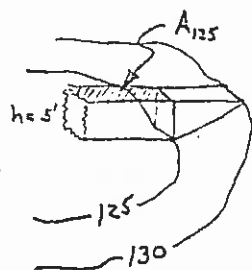


$$\begin{aligned} A_3 &= A_{140} - A_{135} = b l \\ &= 301,075 - 242,125 \\ &= 58,950 \text{ ft}^2 \end{aligned}$$

$$\begin{aligned} V_3 &= \left(\frac{1}{2} b h \right) l \\ &= \frac{1}{2} h (b l) \\ &= \frac{1}{2} (5) (58,950) \\ &= 147,375 \text{ ft}^3 = V_3 \\ &\quad \times 7.48 \text{ gal/ft}^3 \\ &\quad \hline 1,106,000 \text{ gal} = V_3 \end{aligned}$$

Volume calculations cont:

4. Volume (V_4) of 5' depth of water when lake surface at 130' contour.

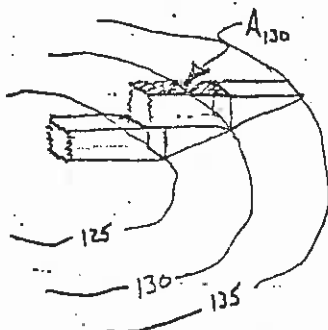


$$\begin{aligned} A_{125}(h) &= 151,075 \text{ ft}^2 \times 5' \\ &= 755,375 \text{ ft}^3 \\ &\quad \times 7.48 \text{ gal/ft}^3 \\ \hline &5,650,000 \text{ gal} \end{aligned}$$

$$V_4 = V_1 + (A_{125})(h)$$

$$= 915,000 + 5,650,000 = 6,565,000 \text{ gal} = V_4$$

5. Volume (V_5) of 10' depth of water when lake surface at 135' contour.



$$\begin{aligned} A_{130}(h) &= 200,000 \text{ ft}^2 \times 5' \\ &= 1,000,000 \text{ ft}^3 \\ &\quad \times 7.48 \text{ gal/ft}^3 \\ \hline &7,480,000 \text{ gal} \end{aligned}$$

$$V_5 = V_4 + V_2 + A_{130}(h)$$

$$= 6,565,000 + 788,000 + 7,480,000 = 14,833,000 \text{ gal} = V_5$$

6. Volume (V_6) of 15' depth of water when lake surface at 140' contour.

$$A_{135}(h) = 242,125 \text{ ft}^2 \times 5'$$

$$= 1,210,625 \text{ ft}^3$$

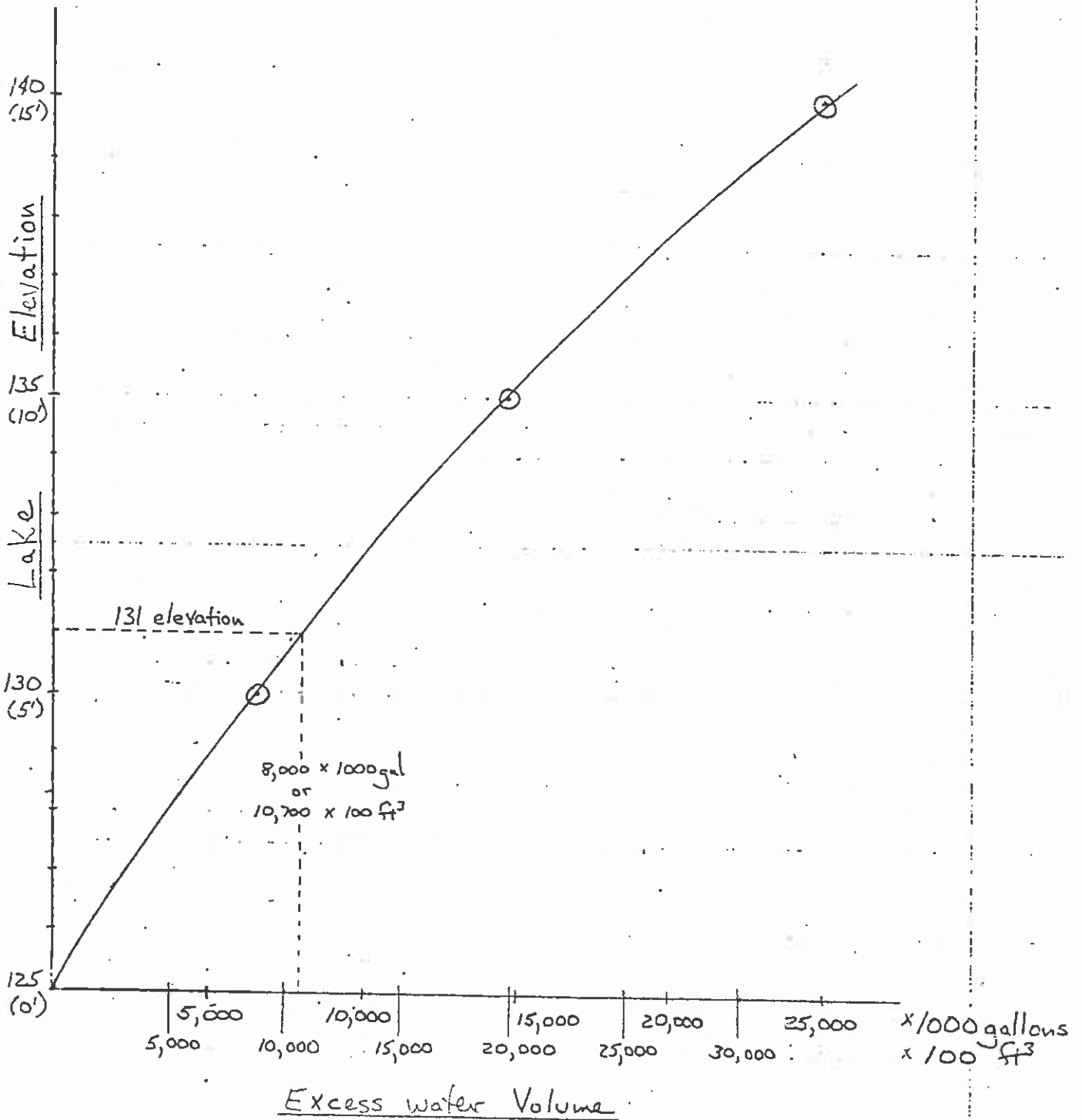
$$\begin{aligned} &\quad \times 7.48 \text{ gal/ft}^3 \\ \hline &9,055,000 \text{ gal} \end{aligned}$$

$$V_6 = V_5 + V_3 + A_{135}(h)$$

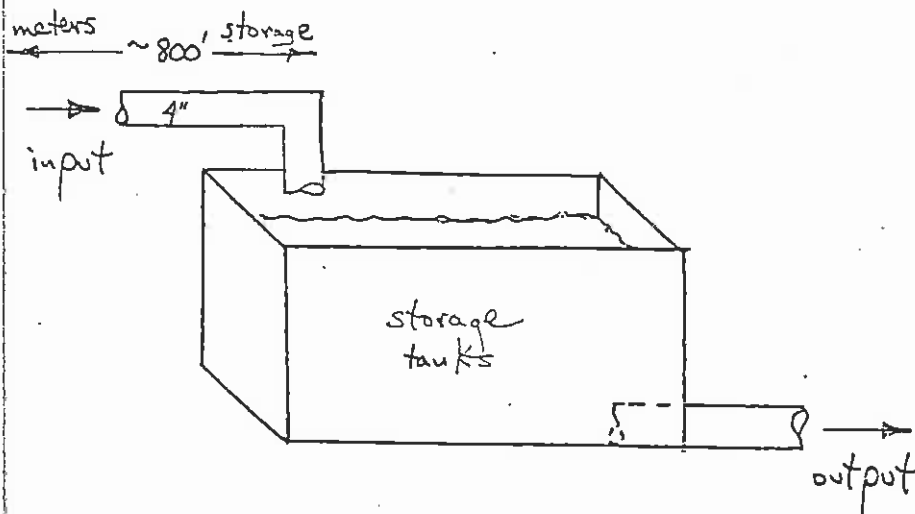
$$\begin{aligned} &14,833,000 \\ &1,106,000 \\ &9,055,000 \\ \hline &24,994,000 \text{ gal} = V_6 \end{aligned}$$

Graph 1

Excess water Volume vs Lake Elevation



(see p. 11.)



Input (I):

$$\begin{array}{r} 385' \\ - 150' \\ \hline 235' = \text{head } H \end{array}$$

x .434 constant calculated by S.F. Water Dept
to find pressure

102 psi
in 4" line at meters, near 10th Ave

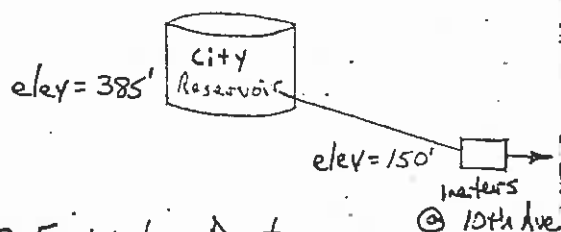


Table extract from Permutit Water Conditioning Data Book:

Discharge of pipes (in gpm) - free discharge from horizontal pipes against no backpressure (no valves or fittings included); 17 year pipe; C=100.

psi	size	Length in feet					
		25	50	100	200	400	1000
60	4"						
80						725	445
100						820	500

Using the table for 4" line, 100 psi, and interpolating for 800 feet pipe length:

$$\begin{array}{r} 820 \text{ gpm @ } 100' \\ - 212 \text{ gpm drop @ } 800' \end{array}$$

approx 608 gpm = I

$$\begin{array}{r} 820 \quad 1000 \\ - 500 \quad - 400 \\ \hline 320 \div 600 = 5.3 \text{ gpm drop per linear foot} \end{array}$$

$$\begin{array}{r} 100 \text{ ft} \\ \times 5.3 \text{ gpm/ft} \end{array}$$

212 gpm drop per 100'

Storage (S):

$$\begin{aligned} 50' \text{ } \phi \text{ tank, } 11'-0'' \text{ deep} &= 160,000 \text{ gal} \\ 35' \text{ } \phi \text{ tank, } 9'-6'' \text{ deep} &= 69,000 \text{ gal} \end{aligned}$$

$$229,000 \text{ gal} = S$$

Output (Q):

Output equals maximum efficiency of the Centrifugal booster pump, 100 HP, 220 V.:

$$Q = 800 \text{ gpm} \quad (\text{from water supply facilities diagram})$$

Since the maximum possible input is less than the maximum output, if the tanks are drained at maximum output for 12 hours during the night, will the input during the night be sufficient to keep the tanks from emptying? And will the input during the following 12 hours of day fill the tanks for use the second night?

1. Will the tanks become empty? Assume the input and output are started simultaneously, and continue at max for 12-hours.

$$\begin{aligned} 608 \text{ gpm} &= I \\ \times 60 \text{ min/hr} \end{aligned}$$

$$\begin{aligned} 36,480 \text{ gal/hr} \\ \times 12 \text{ hr} \end{aligned}$$

$$\begin{array}{r} 72960 \\ 36480 \\ \hline \end{array}$$

$$137,760 \text{ gal input/12 hr}$$

$$+ 229,000 \text{ gal storage}$$

$$666,760 \text{ gallons available/12 hr}$$

$$\begin{aligned} 800 \text{ gpm} &= Q \\ \times 60 \text{ min/hr} \end{aligned}$$

$$\begin{aligned} 48,000 \text{ gal/hr} \\ \times 12 \text{ hr} \end{aligned}$$

$$\begin{array}{r} 96000 \\ 48 \\ \hline \end{array}$$

$$576,000 \text{ gal output/12 hr}$$

Gallons available exceeds
gallons output

$\therefore$ the tanks will not empty.

2. Will the input fill the tanks during the day? As shown above, the possible gallons input/12 hrs exceeds storage capacity $\therefore$ the tanks will fill during the day.

Water value: (comparative value of equal quantity of city water)

S.F. charges \$0.3176/1000 gal to Presidio for city water¹

Golf course receives first 50,000 gal @ meter charge = \$32.90

Assume normal lake level = 125' contour

1. Assume water at 130' and 5' of water can be used, then water value (excluding pumping costs) would be:

$$\text{Value of 5' water} = [(V_4 - 50,000 \text{ gal}) \times \frac{\$0.3176}{1000 \text{ gal}}] + \$32.90$$

$$\begin{array}{r} 5,650,000 = V_4 \\ - 50,000 \\ \hline 5,600,000 \\ \times 0.3176/1000 \text{ gal} \\ \hline 1779.33 \end{array}$$

\$1812 = Value of 5' of water between 125' and 130' contours

2. Assume water at 135' and 10' of water can be used, then water value (excluding pumping costs) would be:

$$\text{Value of 10' water} = [(V_5 - 50,000 \text{ gal}) \times \frac{\$0.3176}{1000 \text{ gal}}] + \$32.90$$

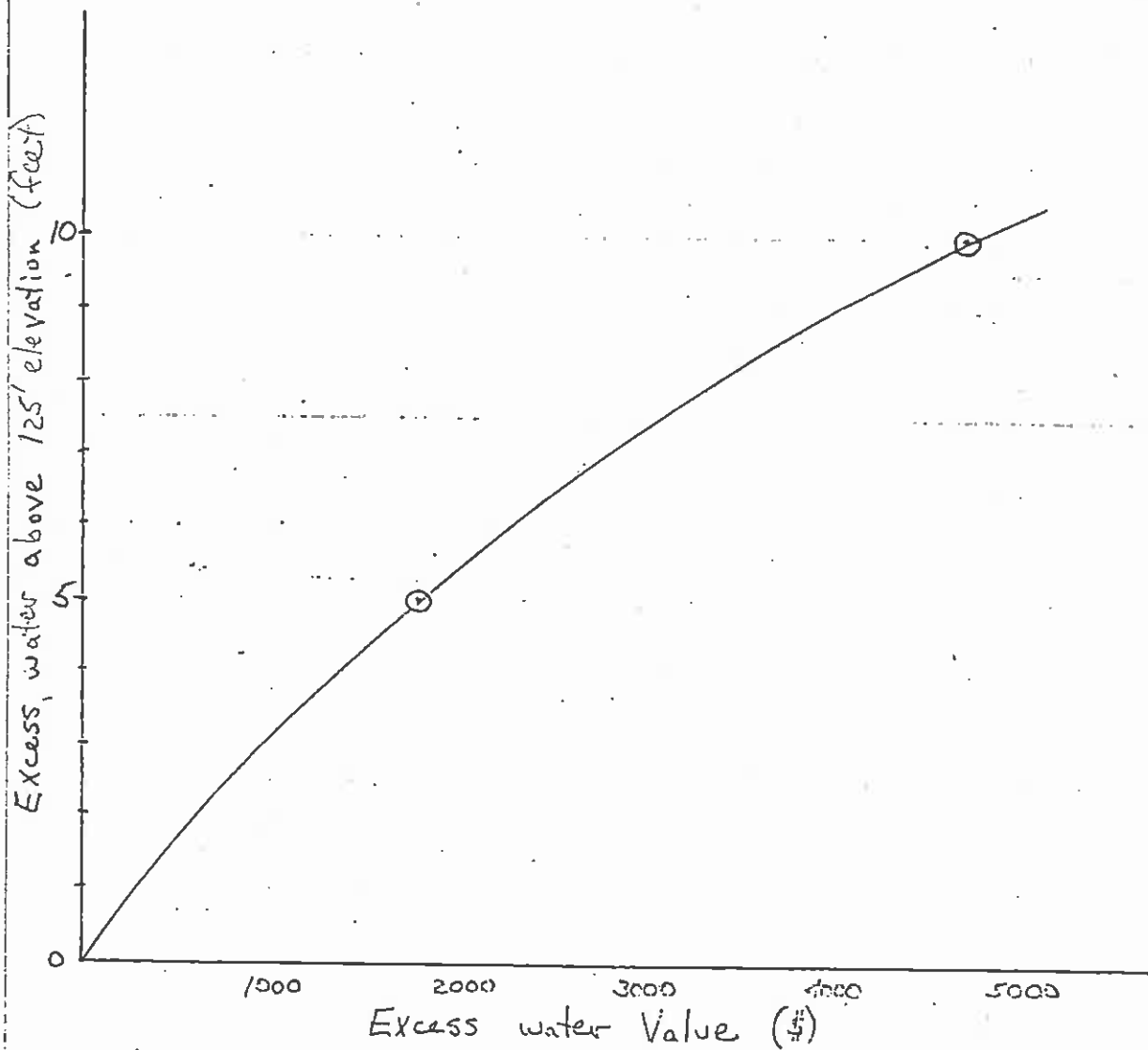
$$\begin{array}{r} 14,833,000 = V_5 \\ - 50,000 \\ \hline 14,783,000 \\ \times 0.3176/1000 \text{ gal} \\ \hline 4711.33 \\ + 32.90 \\ \hline 4744 \end{array}$$

\$4744 = Value of 10' of water between 125' and 135' contours

¹Rate obtained from Utilities Division, DFAE, PSF

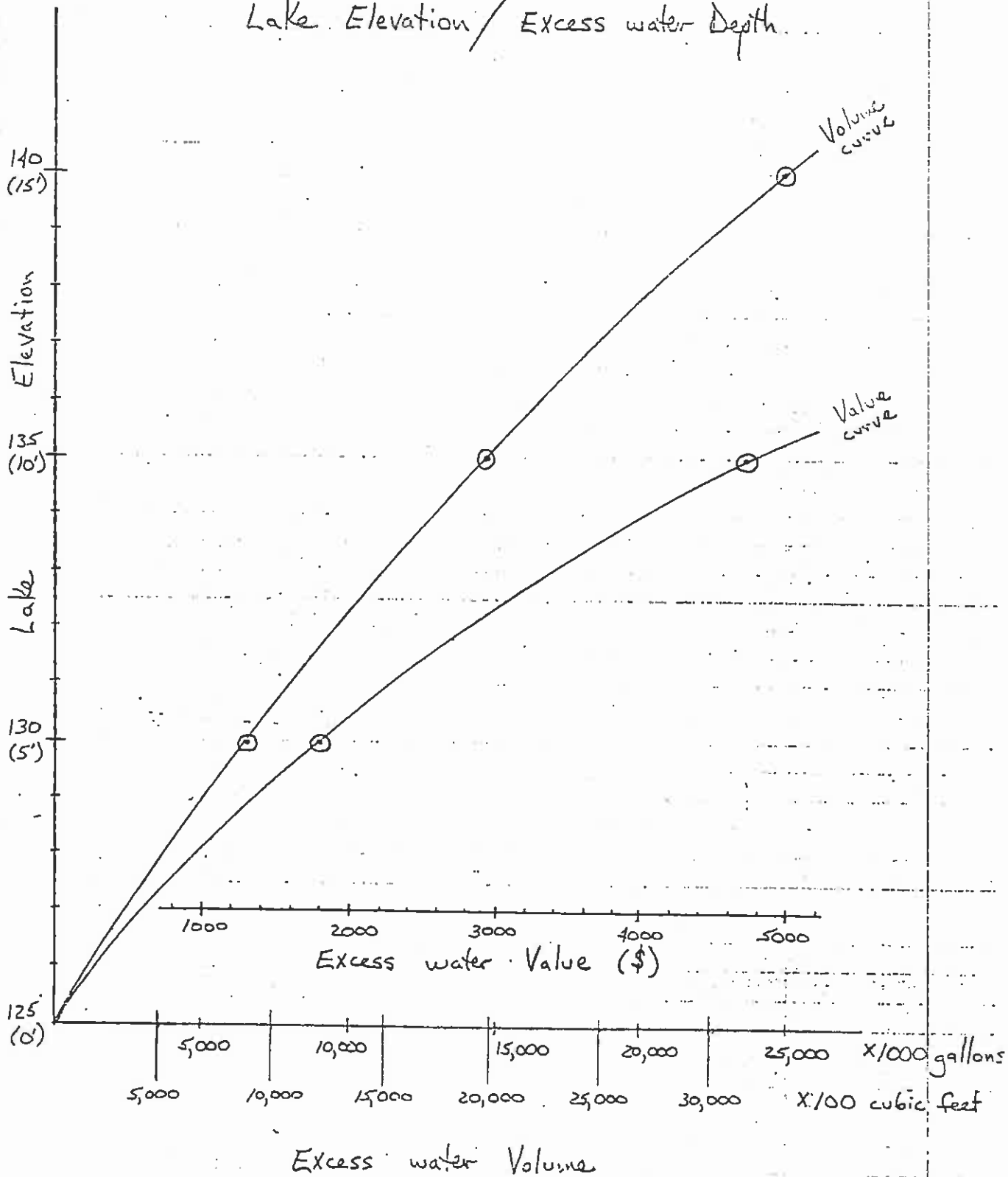
Graph 2

Excess water Value vs Excess water Depth



Graph 3'

Excess water Volume / Excess water Value
VS
Lake Elevation / Excess water Depth

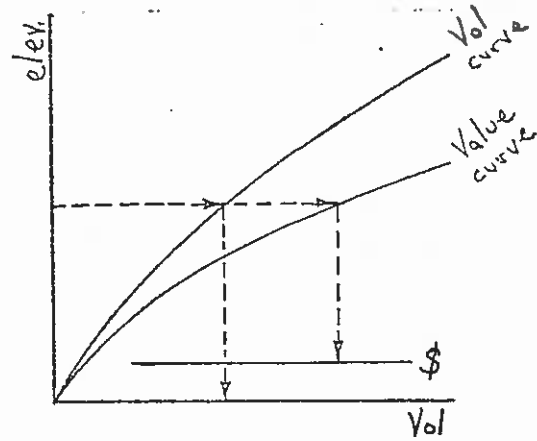


'Graph 3 is a composite of Graph 1 and Graph 2.

How to use Graph 3 - examples:

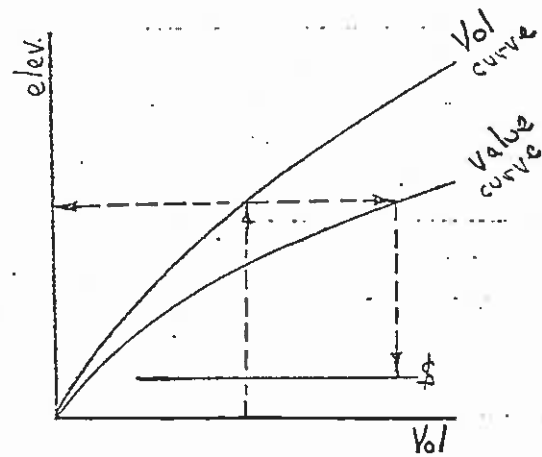
given: elevation

find: excess volume
and value



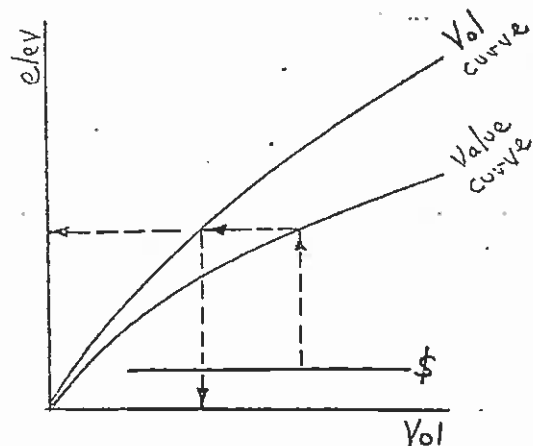
given: volume

find: excess feet
and value



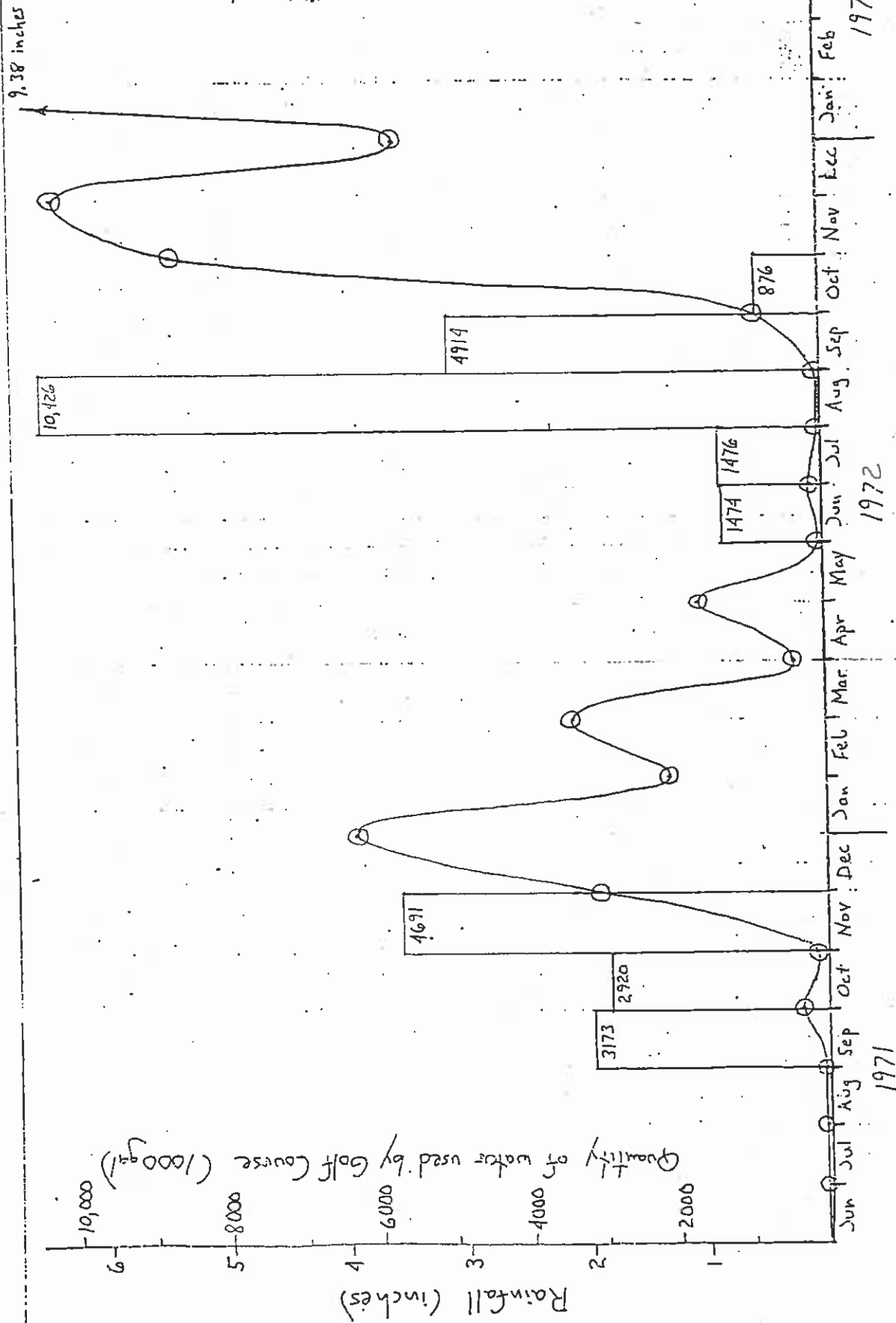
given: value

find: excess feet
and volume



Graph 4

Rainfall and Water Purchased



	PSF Golf Course ¹		Utilities	Rainfall ³	
	City water purchased cost ²	Qty ² (100 ft ³)	(electricity)	(inches)	Qty (1000 gal)
71 Jun	\$ 32.90	0	\$ 935.61	trace	
Jul	32.90	0	1,135.20	0.01	
Aug	32.90	0	828.51	0.01	
Sep	818.05	4242	1,556.57	0.22	3173
Oct	750.00	3900 (estimated)	634.80	0.11	2920
Nov	1,192.94	6271	1,508.00	1.92	4691
Dec	32.90	0	244.20	3.93	
72 Jan	32.90	0	225.66	1.32	
Feb	32.90	0	235.54	2.13	
Mar	32.90	0	304.10	0.23	
Apr	32.90	0	503.61	1.07	
May	39.97	0	1,009.45	trace	
Jun	\$69.25	1970	1,385.08	0.11	1474
Jul	418.37	1973	1,311.11	0.01	1476
Aug	2,245.45	13,939	3,063.31	0.04	10,426
Sep	1,160.73	6570	1,868.40	0.54	4914
Oct	261.58	1171	659.11	5.41	876
Nov	32.90	0		6.40	
Dec	32.90	0		3.53	
73 Jan	32.90	2		9.38	

¹ Data from Mr Kahn, PSF Golf Course.

² Golf course receives first 50,000 gallons for water charge of \$32.90.

³ Rainfall data measured at Federal Bldg, S.F. by U.S. Govt. Commercial Expt.