Depth, ft.

0

20'

40'

Clay, red sand, trace of gravel

Sand, very fine to coarse; interbedded with clay and gravel; trace of pebbles (compact and loose); reddish gray

Sandstone interbedded with siltstone, shale and conglomerate, thinly bedded

Sandstone, very fine-grained, greyish-yellow, clean
Sandstone, very fine to fine-grained, reddish-grey, dirty

Existing Land Surface

Welded cover

2" Access Pipe and Valve

Existing Land Surface

16" diam. Casing

Concrete Seal

Blank Casing 12" diam.

Machine-perforated Casing 3/16" x 3" Slots 16 Slots per linear foot $a$

CONSTRUCTION DIAGRAM TEST WELL 1

EMPIRE RANCH, ARIZONA
JOB ORDER

CLIENT: G. A. C. Properties Inc.

JOB LOCATION - COUNTY & CITY: Pima & Santa Cruz Counties, Arizona

JOB LOCATION - SUBDIVISION & BLOCK NO.: Empire Ranch

CLIENT P. O. NO.

JOB TAKEN BY: Mr. Dan Cooper

DOMESTIC CLIENT: ☑
PUBLIC CLIENT: ☐
NEW CLIENT: ☐
PRIVATE: ☑
EXISTING: ☑

NOTICE OF COMPLETION

JOBS IN EXCESS OF $10,000 FEE, ATTACH PROJECT CRITIQUE

DATE FIELD WORK COMPLETE: 

DATE OFFICE WORK COMPLETE: 

PRELIMINARY SUBMITTAL DATE (TO CLIENT OR OTHER AGENCY): 

FINAL SUBMITTAL DATE: 

BILLING REQUESTED BY PD OR PP AND DATE: 

BILLING DATE (BY ACCOUNTING): 

TOTAL FINAL BILL: $102,048.66

TOTAL FINAL JOB COST: $100,625.58

JOB FILE WEADED BY: 9-25-80

WORKING DRAWINGS, SCRATCH WORK, UNIDENTIFIABLE: 

PAPER, VOID & OBSOLETE DRAWINGS & CALCS DESTROYED: 

ALL TRACINGS & DRAWINGS REGISTERED: 

NO TRACINGS ON THIS JOB: 

DRAWING SIZES - CHECK SIZES REGISTERED WITH FILES: 

FIELD BOOK NUMBER:

PLACE ON NOTES:

FIELD NOTES BOUND:

FILES MICROFILMED:

NOTICE OF COMPLETION INITIATED BY:

TO: 

REC'D BY: 

JOB CLOSED - ACCOUNTING: 

DATE JOB CLOSED - FILES: 

REFERENCE NO.

WILSEY & HAM
September 30, 1971

Mr. Charles King
GAC PROPERTIES, INC.
7880 Biscayne Blvd.
Miami, Florida 33138

Dear Mr. King:

You have requested a statement as to the adequacy of water for the Empire Ranch Project.

Please be advised that, according to reports prepared in July 1970 by Geraghty & Miller, Inc., Consulting Ground-Water Geologists, Port Washington, New York; and Layne-Western Company, Inc. Kansas City, Missouri, "...that an adequate water supply currently exists in the planning area for the proposed land use development through a reasonable planning period".

Very truly yours,

WILSEY & HAM

Samuel M. Nash
Associate

SMN: sv

Enclosures

cc: Stew Staples, Jim Layne, Ron Calhoun
Memorandum

GAC Properties Services Inc

To: James R. Powell

City

From: Charles H. King, Jr.

City

Date: September 22, 1971

Subject: Empire Ranch - Well Locations

1/32 - 07/19 - 50

Attached is a map which I have plotted the well location information on.

As per my recent memo, we would like to have Well No. 6 relocated in the open space in S 3/5 at coordinates N 267,734 - E 907,105. Our surveyors have marked the new well on the ground for you as well as marking Well Nos. 4 and 5.

CHK:ls

Enc.

cc: R. Calhoun
P. Cella
S. Nash

RECEIVED
SEP 24 1971
WILSEY & HAM
GAC Utilities Inc

To Messrs: S. Staples, R. Larson
City Tucson

From Mr. James R. Powell

The attached materials were prepared for use as a "hand out" at your forthcoming informal meeting with the "Board of Supervisors".

Please review the same and feel the liberty to edit as required.

If you prefer some other type of "hand out" advise us.

JRP/caf
Attached

cc: Mr. Charles King w/encl.
    Mr. David Miller, Geraghty & Miller, w/encl.
    Mr. Ronald Calhoun, Wilsey & Ham, w/encl.
    Mr. Paul Cella, Cella, Barr, Evans and Associates, w/encl.
    Mr. Sam Nash, Wilsey & Ham, w/encl.
EMPIRE RANCH WATER SUPPLY
STUDY RESUME

In December, 1969, the firm of Geraghty & Miller, Inc., Consulting Geologists, Water Research Building, Port Washington, New York was retained to investigate ground water conditions on property owned by GAC Properties Inc of Arizona. The property has been referred to as the Empire Ranch Project and is in a partially enclosed basin located in Santa Cruz and Pima Counties, Arizona.

After preliminary studies of the project area a test well program was initiated in February, 1970.

The test well program included drilling three (3) new wells and closely investigating existing wells situated on the project lands, as delineated on the attached well location map.

The following observations were produced by the Geraghty & Miller Study and are recorded in the report furnished to the Santa Cruz County Planning and Zoning Commission on August 6, 1970:

(a) The current flows in Cienega Creek indicates an approximate surplus of water in the basin of 1.3 million gallons a day.

(b) The groundwater recharge of the basin is estimated at 4.25 million gallons per day.

(c) Alluvial deposits in the basin may be as much as 550 feet thick, but assuming an average thickness of 250 feet of saturated alluvial material, as much as 365 billion gallons stored therein.

(d) The consolidated deposits in the basin have an additional amount of water stored therein with the volume of the same currently unestimated. This aquifer can be expected to be under artesian conditions.

(e) The chemical quality of the groundwater when tested was found to be good and within acceptable limits as recommended by the U.S. Public Health Service of drinking water supplies.
Well yields in the basin have been estimated to range from 50 to 200 GPM, with the likelihood of wells in certain areas being developed at much larger yields.

GAC Utilities Inc of Arizona, franchised water utility for the Empire area, retained the services of Mr. Carl Nuzman, P.E., Groundwater Hydrologist, Layne-Western Company Inc, to review the water supply data for an additional appraisal of the adequacy of the supply and general observations concerning the same.

Mr. Nuzman's report was furnished to the Santa Cruz County Planning & Zoning Commission on August 6, 1970. The following observations were offered by Mr. Nuzman:

1. Present Water Use in the planning area is estimated at one (1) per cent of the available recharge or 42,000 gallons per day.

2. Only deep wells should be considered for the primary supply of potable water.

3. Based upon population projections, supplied by GAC Properties Inc of Arizona, it will be 93 years before an unbalance should occur in the basin hydrologic cycle, (see attached population curve and Water demand on Planning Area).

4. It is reasonable to anticipate that needs beyond those encompassed in the planning period can be met in some measure by new water harvesting methods, as the state of the science develops, by the mining of water from the basin or by the importation of water.

GAC Properties Inc of Arizona and the franchised water utility for the area propose to develop the water supply and distribution system in accordance with the recommendations and observations of their consultants, including future water supply explorations to greater depths, approximately 1500 feet, which will be an integral part of the supply well drilling program when initiated. It has been suggested that the review of geological date and reports from oil explorations of many years ago indicates there exists another large reservoir of water, which could further contribute to the planning area needs.

The input from the development program will be tabulated in report form at different intervals and shared with all concerned parties.

We anticipate no major problems in meeting the water supply and distribution needs of the Empire Ranch Project Area.
POPULATION PROJECTION FOR
EMPIRE - GONOITA PLANNING AREA

FIGURE 3
TOTAL WATER DEMAND ON PLANNING AREA

WATER DEMAND IN MILLION GALLONS PER DAY

existing natural recharge
4.25 NGPD

ground water recharge from direct use

total irrigation from deep wells

ground water recharge from septic tanks

reusable water

totally consumed and evaporated water

years

[Graph showing water demand projections from 1981 to 2011]
MEMORANDUM

WILSEY & HAM: To Dick Block - GAC Legal Dept.  Date March 24, 1971
Re.: Improvements by GAC to State Leased Lands  From Sam Nash /sv

This is in answer to memorandum from Stew Staples dated March 17, 1971, concerning forms to be filled out and returned to the State Land Department in connection with improvements made by GAC on State leased lands.

To my knowledge the only physical improvement made by GAC to State leased lands was the drilling of Well No. 3 during the test well drilling program. I have checked with Frank DeLuca of Geraghty & Miller to obtain the final construction costs for drilling this well. The well was drilled by A. A. McDaniel Well and Machine Company, Tucson, Arizona, at a total cost of $11,142.54. Also, Mr. Deluca informs me that the engineering costs in connection with this well were approximately $3,000. I have taken the liberty of adding this cost to the construction costs to be entered in column 3 of the attached form.

I have also checked with Jim Webb as to the possibility of GAC claiming improvements in the form of engineering, planning, and surveying services, etc. Jim's advice was to report only the physical construction.

Attached is a Xerox copy of the form filled out for Lease #1597 in Santa Cruz County. To my knowledge no physical improvements have been made to leased lands in Pima County.

Enclosures

cc: Stew Staples
    Charlie King
    Jack Martin
    Bob Young
    Ron Calhoun
To       Sam Nash

City

From     Stew Staples

City

Date     March 17, 1971

Subject  Attached Forms

Please arrange to have these forms completed and returned to Dick Block of our Legal Department so that he may have them returned to the State Land Department prior to March 31, 1971. If you have any questions, feel free to call me.

SLS/ap

cc:  D. Block
     C. King
     J. Martin
     R. Young
MEMORANDUM

WILSEY & HAM: To SMN

Re.: ____________________________ Date March 23, 1971

From RTC/1b
1137-0214-50

In further checking, it appears that Test Well No. 3 may cost approximately $14,000 plus pro rata share for professional services. In thinking back on that program, I recall, of course, that No. 3 Well was never completed - hence, the $14,000 sounds about right as opposed to the $20-$24,000 I mentioned earlier.
July 29, 1970

Mr. Jim Powell
GAC UTILITIES, INC.
Sheraton Four Ambassadors
801 South Bayshore Drive, Suite 1210
Miami, Florida 33131

Dear Jim:

Outlined below are the recommendations for the VIT Well to be drilled on the Empire Ranch. Included is a cost estimate for the drilling from the A.A. McDaniel Company, Tucson, Arizona. It is recommended that once approval for the site and depth have been obtained, specifications for the well be drawn and released to several contractors of sufficient plant for bids.

As discussed in previous letters, several recommendations were made concerning the depth and diameter of the well along with the beneficial information that will be obtained from the drilling. Included is a map showing the general location of the well. The exact location of the well can be spotted once information on flood and engineering aspects are formulated.

Our present interpretation of the geology is that a fault may exist in close proximity to the well site which would allow a higher than average yield from a well in the consolidated deposits.

The advantages of drilling the well in close proximity to the VIT complex are: (1) it is an area which we recommended as a test-production area where the development of high capacity wells may be possible; (2) the well could be used as the water supply for the VIT complex; (3) considerable savings could be realized because of the proximity of the well to the VIT site, i.e., a reduction in pipeline and horse-power requirements for the pump; and (4) this well could be used for construction purposes and also to serve the first group of houses that are
planned in the immediate vicinity if the yield is sufficient.  

It is estimated that drilling a well to 1,600 feet would take approximately 120 working days. The estimated minimum cost for drilling the hole and installing casing is on the order of $40,000. This does not include time or expenses to conduct a pumping test. Because this is virtually new drilling with many unknown factors involved, contractors will in all likelihood insist on a per hour rate. That is, the contractor will work on a per foot rate if the penetration does not fall below a certain footage per work day. When the rate of penetration does fall below a certain amount per day, then the hourly rate will apply. The estimated cost is strictly assuming a per foot rate for the entire depth. Attached is the McDaniel estimate.

The installation of a test pump and conducting a controlled pumping test after the well has been completed is estimated to cost on the order of $10,000. This estimate is based on the installation of a fairly large test pump capable of delivering up to 1,000 gpm. It is also based on installation and removal cost for a 500-foot setting and conducting a controlled test covering a total period of approximately 10 days.

Because of the recommended depth of the hole, it is advisable to start the top casing at no less than 16-inch diameter. This will allow some flexibility in controlling the diameter at the bottom of the hole. Hopefully, the bottom of the hole will be finished no less than 8-inch diameter.

Water samples should be collected at a fifty-foot interval as the hole is being drilled. The estimated cost for the chemical analyses is on the order of $1,000.

To help define and correlate the aquifers and geologic units, the hole should be electric and gamma-ray logged. This would also assist in defining zones containing highly mineralized water. If necessary, aquifers containing undesirable water quality can be sealed off by cement grouting.

If you have any questions on the above please feel free to contact me.

Sincerely,

Frank A. DeLuca  
Project Manager

cc:  R. Calhoun  
S. Nash  
S. Staples  
C. King
A. A. McDaniel
Well and Machine Company, Inc.
2838 Ruthrauff Road
Tucson, Arizona 85705

Proposal To:
Geraghty and Miller, Inc.
100 East Alameda Street
Suite 513
Tucson, Arizona 85701

Date: May 14, 1970

Gentlemen:

In compliance with your recent request, we are pleased to submit the following quotation for your consideration:

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drill Test Well Empire #4</td>
<td></td>
</tr>
</tbody>
</table>

Test well, drilled, cased, perforated and completed to the following specifications:

Drilling - 1600' of commercially straight hole to accept the required casing.

Casing - 16" casing will be used from the surface to 600'. From 600' reductions will be made as necessary to 1600' but in no case shall the well finish with smaller than 8" casing. All casing shall be prime quality material.

Perforation: Milled slots. The 16" casing shall be perforated from 20' below surface to the bottom with 8 rows of 3/16" x 3" cuts on 6" centers. The balance of the casing shall be perforated with 6 rows of 3/16" x 3" cuts on 6" centers to the bottom of the well.

Shoes - All necessary drive shoes will be furnished.

Development - The well shall be developed by alternate methods of bailing and surging for a period of 72 hours.

Total Price

A. A. McDaniel Well and Machine Co., Inc.

Accepted: ____________________

by ____________________
Gentlemen:

In compliance with your recent request, we are pleased to submit the following quotation for your consideration:

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Pumping</td>
<td>A line shaft turbine pump with a Diesel engine shall be installed. This unit shall have a capacity of 1000 GPM from 500' with a setting of 500'. Development by Pumping</td>
<td>The well shall be developed by continuous pumping and surging for a period of 60 hours. Well Test</td>
</tr>
</tbody>
</table>

TOTAL PRICE

A. A. MCDANIEL WELL AND MACHINE CO., INC.

Accepted: ________________________

by ____________________________
A. A. McDaniel
WELL AND MACHINE COMPANY, INC.
2836 Ruthrauff Road
Tucson, Arizona 85705

PROPOSAL TO: Geraghty and Miller, Inc.

DATE: May 14, 1970

Gentlemen:

In compliance with your recent request, we are pleased to submit the following quotation for your consideration:

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<tr>
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<th>DESCRIPTION</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The total estimated cost of this well, providing the drilling rate does not fall below 1 foot per hour of rig time. (Plus hourly rate for well test.)</td>
<td>$39299.</td>
</tr>
<tr>
<td></td>
<td>Should the penetration rate of drilling fall below 1 foot per hour for more than 2 consecutive days, the continuation of drilling shall proceed on an hourly basis the rate of which is $26.50 per hour.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Terms of payment - 90% of completed work due within 15 days of presentation of bill each month to completion. 10% withheld shall be paid on presentation of final bill.</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL PRICE

A. A. McDaniel Well and Machine Co., Inc.

Accepted: ____________________________  by ____________________________
Two Hydrological Survey firms, Geraghty & Miller with home office in Port Washington, New York and Layne Western Company Inc., headquartered in Kansas City, Kansas have studied the water situation in the Sonoyta basin, the site of GAC Properties Inc of Arizona Empire development. The purpose of their studies was to provide GAC independent appraisals of the adequacy of the water supply for the Empire Sonoyta Area, now and in the future.

In general it was anticipated that deep and loose, unconsolidated sand and gravel would be found in the Empire Ranch area. Instead tight, thin layers of sand alternating with silts and clays were found to exist to about 350 feet in depth. Most existing house and stock wells tap this upper ground water source. This underground area is referred to as the upper aquifer (an aquifer is any geological formation containing water.) It is estimated there is as much as 365 billion gallons of water stored in the upper aquifer within the basin. This amount alone could supply an equivalent instantaneous population of 180,000 people for a period of 33 years. To put it more graphically, it is the opinion of both hydrology firms that this is enough water to fill a 200 square mile lake 10 feet deep.

However, GAC will not tap this source of water for use in its Empire development. The upper aquifer will remain there, untouched, for use by local residents. It is also the source that will sustain the living things which are dependent upon this upper water supply.

Below the upper aquifer is a zone referred to locally as the "Bedrock" which is not really rock at all. These are deposits, older in geologic age, that are also composed of alternating layers of sand and clay but have been subjected to high pressure causing partial consolidation of these materials. It is this lower consolidated aquifer that has been explored to a depth of approximately 800 feet below ground level to date. This is the area which the Empire Project plans to use as its water source.

The latest studies by Geraghty and Miller and Layne Western Co. shows the lower aquifer contains a water storage capacity equal to or greater than the amount of water stored in the upper aquifer.
Further review of geological data, and reports from oil exploration of many years ago, indicated there exists yet another large reservoir of water at even greater depths.

All water at some point in time circulates through a never ending hydrologic cycle. Approximately six per cent of the average annual rainfall in the Empire Ranch area reaches the water table. The computed effective recharge rate is 4.25 million gallons per day.

A special population growth curve was prepared for the Empire Ranch Sonoita planning area to reflect proposed activities by GAC Properties Inc of Arizona. The total water demand in the planning area contemplates efficient management and reuse of water within the basin. Based on the population projection, (rate at which the project will grow), it will be 93 years before an imbalance could occur in the basin hydrologic cycle.

Only deep wells are recommended for use for the primary public water supply system.

It is the considered opinion of both hydrological firms that an adequate water supply currently exists in the planning area for the proposed land use development for the planning period.
OCCURRENCE OF GROUND WATER IN A
TYPICAL ALLUVIAL BASIN IN ARIZONA

CONFINED ARTESIAN AQUIFER

FLOWING WELL

PUMPED WELL

UNCONFINED AQUIFER
(DILUTED CLAY)

- RECHARGE PATTERNS

SEDIMENT
Figure 3

Population projection for Empire - Condota planning area.
July 15, 1970

FROM: Frank A. DeLuca

TO: Stew Staples

REFERENCE: Your Memo on Horizontal Wells

The use of horizontal wells is nothing new when taken into account its use in the United States, or for that matter, all over the world. Perhaps the novelty out here is that cattle watering wells on the order of 1 to 3 gallons per minute obtain sufficient water supplies from such small diameter wells without cost to the rancher.

You will note in the article that the wells are of small diameter, on the order of 1-1/2 to 2 inches, that the average yield is between 3 to 10 gallons per minute, and the average length of the well is on the order of 123 feet. The application of this system at the Empire Basin would be nullified simply because you would have to go to some steep walled areas of the basin which are located on the peripheral areas of the property and attempt to put your well below the water table and by gravity be able to derive 3 to 10 gallons per minute. Instead of taking on the order of 175 wells, we have just upped that figure to possibly millions. That's assuming we will obtain average yields of 3 to 10 gallons per minute.

If a system such as this were to be used, common headers leading to a central pumping station would require miles of pipeline. Not only that, the number of wells would eventually drain the saturated sediments so that we will eventually have to go to the standard vertical tube well.
To: J. F. Ring, S. Staples, C. King
From: J. R. Powell
Date: July 13, 1970

Subject: Empire Ranch

Please be advised that I have requested from Mr. Frank DeLuca, Gehauty & Miller a development recommendation for the "VIT" Well.

This recommendation is to be dual choice concept.

Part A. Being the development of a Well to meet the needs of the VIT center, campground facility and the early site development projections.

Part B. This would be the installation of a Well to meet the needs of Part A, but also including the test drilling of the "Bedrock" area to the depth of 1400'--1500'.

Mr. DeLuca is to furnish with the two recommendations the respective cost estimates. We are currently awaiting the input of the high water description of the creek area before physical location of the well site.

We shall keep you appraised of any developments.

JRP: caf
cc: R.R. Young
R. Calhoun
July 15, 1970

FROM: Frank A. DeLuca

TO: Stew Staples

REFERENCE: Your Memo, Via Jack Martin of June 16, 1970
Tucson Water Basin Study

With regard to the possible use of this study to fortify the Empire Ranch study, I believe it may have a negative effect. What we are trying to relate are apples and pears, and they just don't go together unless you are making a fruit salad.

The Tucson Basin Study takes into account certain aspects of water that are presently derived from the source area—the Empire Basin. What I would like to avoid, if at all possible, is the contention that the Empire Basin Development will deprive water to the city of Tucson.

We have discussed this at a number of meetings and I still feel that any comparison, relationship or analogy drawn between the Empire Basin and the Tucson city water supply will be detrimental. My recommendation, therefore, is to disregard it and avoid the issue if at all possible for the present.
GAC Utilities Inc

A unit of GAC Corporation
801 South Bayshore Drive
Suite 1210
Miami, Florida 33131
Telephone 305-373-7547

To    J. F. Ring, S. Staples, C. King
City

From  J. R. Powell

Date    July 13, 1970

Subject  Empire Ranch
         V. I. T. (Community Center Well)

Please be advised that I have requested from
Mr. Frank DeLuca, Gehauty & Miller a development recommendation for the "VIT" Well.

This recommendation is to be dual choice concept.

Part A. Being the development of a Well to meet the needs of the VIT center, campground facility and the early site development projections.

Part B. This would be the installation of a Well to meet the needs of Part A, but also including the test drilling of the "Bedrock" area to the depth of 1400'--1500'.

Mr DeLuca is to furnish with the two recommendations the respective cost estimates. We are currently awaiting the input of the high water description of the creek area before physical location of the well site.

We shall keep you appraised of any developments.

JRP: caf
cc: R.R. Young
R. Calhoun
To: Charles King
From: J. Tefel
Subject: Water Re-Use, Arizona

Date: 7-8-70

Refer To: Herman Bouver, Ph.D.
Chief Hydraulic Engineer
FRS, Soil & Water Conservation
U.S. Water Cons. Laboratory
4331 East Broadway
Phoenix, Arizona 85040
CLEAR WATER FROM WASTES

Gravely-covered basins called plant-soil filters may be one answer to the need for multiple reuse of water. Predictions are that multiple reuse of water will be necessary by 1980 when water consumption for all uses in the nation will equal or exceed the recoverable streamflow and ground water supply.

Soil and hydrologic conditions permitting, plant-soil filters can cleanse for unrestricted irrigation, recreation, or even human use 300-acre feet or more of secondary sewage effluent per year per acre of filter. And the filters could do it at a fraction of the cost of equivalent chemical treatment. Unlike chemically treated effluent, the renovated water has lost its identity as sewage effluent and has become ground water.

These are facts learned from a pilot project dubbed Flashing Meadows in the first 2 years of operation near Phoenix, Ariz. (AGR. RES., Nov. 1967, p. 4). Effluent from the sewage treatment plant at Phoenix is discharged into a dry river bed and some of the effluent is pumped into the basins for the study. The project is a cooperative effort of ARS, the Salt River Project (irrigation district), and the Federal Water Pollution Control Administration.

Cities now usually treat raw sewage to varying degrees, then discharge it into rivers. There, the nitrogen content of the effluent can be a pollution problem. Nitrogen and phosphorus promote prolific growth of algae.

A plant-soil filter system of some 1,000 acres could handle all of the secondary effluent from Phoenix and adjacent cities—a projected 300,000 acre-feet annually by the year 2000. What’s more, the reclaimed water is less costly than most water purchased from irrigation districts. Plant-soil filter costs run about $5 per acre-foot while chemical treatment runs to about $50 per acre-foot. Costs vary on water from irrigation districts but some run $10 per acre-foot or even higher.

The Flashing Meadows Project...
Left: Bouwer operates electrical analog to determine the properties of ground water reservoirs. He also used analog to design the prospective system for Phoenix area (10692EZ1-12).

Right: Ectomycorrhizae measure water pressure with tensiometer. Driller tells where chugging occurs; how fast soil drains when basin is dry; and how long it takes infiltration to revert basin (10692EZ1-12).

consists of six parallel recharge basins 20- by 70-feet each.

The grass eliminates some of the suspended matter and at the same time, shades the bottom, cutting down on algal growth. It also provides an anchoring place for aerobic bacteria (active in the presence of oxygen) that digest organic substances in the water.

Under the aerobic conditions at the beginning of the inundation period, micro-organisms oxidize the ammonium (NH₃) in the effluent to nitrate (NO₃). When all of the oxygen has been consumed by the aerobic micro-organisms and the grass roots, anaerobic (no free oxygen present) conditions set in and bring on the denitrifying activity. Under those conditions, certain micro-organisms get the oxygen for their metabolism from the nitrate, forming nitrogen gas which escapes to the atmosphere.

ARS hydraulic engineer Herman Bouwer, who is directing the project, says that 90 percent of the nitrogen can be removed from the effluent during alternate cycles of 14 days wet, 10 days dry. The dry-up period serves two purposes—(1) it restores the infiltration rate which drops during a long inundation period due to soil clogging and (2) it brings oxygen into the soil profile to aid in nitrification and digestion of organic material.

Bouwer and coworkers have found that basins seeded with common Bahiam grass more effectively remove nitrogen than do ungrassed plots. Although plant uptake of nitrogen as a nutrient has little to do with its removal, the plants may add more organic material to the water for use by denitrifying micro-organisms under anaerobic conditions. Also, consumption of oxygen by plant roots could speed the onset of anaerobic conditions necessary for nitrogen removal.

About 90 percent of the phosphorous is removed by adsorption to soil particles or by precipitation into the soil profile.

The biochemical oxygen demand in raw sewage runs about 200 ppm. Secondary sewage carries about 20 ppm, while plant-soil filters clean the secondary sewage to about 0.2 ppm—as clean as most ground water and unpolluted stream water.

Although most of the fecal coliform bacteria and viruses in the effluent die out while traveling vertically through the first 5 to 10 feet of soil, Bouwer suggests that pumps be placed at least 500 feet from the basins to make certain the water is usable. It should take at least a month for the water to travel from the basins to the pump. This time and distance of underground travel is also desirable for improving taste and odor, Bouwer says.

Along with optimum design and management, other criteria necessary for the proper functioning of recharge basins are that the water table below the recharge basins be at least 5 feet deep and that precautions be taken to minimize the spread of reclaimed water into the aquifer.

Ultimately, salt may be a problem with reclaimed water. Each time the water goes through a cycle of domestic use it picks up about 300 ppm salt. Water in the Phoenix area starts out at about 600 ppm. When the salt content reaches 1,000-1,500 ppm after several cycles of use, it will probably have to be blended with other "fresh" water or desalinized.

Below: Bouwer demonstrates fine texture of sand in Salt River bed. Good goes down 3 feet; coarse sand and gravel go 250 feet deeper—an ideal combination for recharge basin studies (10692EZ3-12).

Above: Clarence Lance takes air sample for analysis from columns filled with soil from recharge basin. Analysis will determine how much oxygen is needed by bacteria to decompose organic wastes (10692EZ1-24).
June 25, 1970

Job No. 1137-0214-50

REGISTERED MAIL

Mr. Jim Powell
GAC Utilities
801 South Bayshore Drive
Suite 1210
Miami, Florida 33131

Dear Jim:

Attached is a copy of Garaghty & Miller's draft report for the Empire Ranch. I have made a preliminary review of this report and have had one discussion with Frank Deluca in New York about some initial questions that we have raised. We are continuing our review and analysis but am forwarding a copy to you prior to completing our reviews so that you may use whatever information you need at this time. Please give me any comments you might have for incorporation into the final published report, if and when a final report is deemed advisable to be printed.

Very truly yours,

R. T. Calhoun
Vice President

RTC: lb
cc: Mr. Charles King
Enclosure
June 25, 1970

Job No. 1137-0214-50

Mr. Frank DeLuca
Geraghty & Miller
44 Sintsink Drive East
Port Washington, New York 11050

Dear Frank:

Attached is a copy of our preliminary population projections for the GAC portion of the Empire-Sonoita planning area. You will note, the projection is for just the GAC holdings as no reasonable basis of projections are available for the other lands within the planning area. Also enclosed is a copy of our transmittal letter forwarding this curve to GAC, which explains some of the thinking that went into preparation of this curve.

Please calculate the year in which the recharge capability of the basin just equals the annual demand of the people within the basin so that we may compare with our method of calculation. I would appreciate you calling Ralph Voice here in our Arcadia Office some time Monday with your calculations so that he may discuss them with you.

Very truly yours,

R. T. Calhoun
Vice President

RTC:lb

cc: Ralph Voice

Enclosure
June 25, 1970

Job Number 6-1137-0214-50

Mr. Charles King
GAC Properties, Inc.
Biscayne @ 79th Street
Miami, Florida 33138

Dear Charles:

A review of the cost to date on the test valve program shows a total cost expended through mid June 1970 of approximately $83,138. Frank De Luca of Geraghty & Miller has estimated their cost to complete preparation of the report to GAC, printing of the report and one trip to Arizona to require approximately $3500 to $4000 additional. This would bring the cost upon completion to a total of $86,500 to $87,000.

The original budget on this job was set up at $98,000 consisting of $90,000 for test well drilling and consultation by Geraghty & Miller during the test well program and $8,000 for assistance as required during any required discussions with the State Health Department and submittal of supplemental data.

Very truly yours,

R. T. Calhoun
Vice President

RTC/kh

Copies to:  Sam Nash
            Jim Powell
            Stewart Staples
Water Supply -
BASIC ECONOMIC AND SOCIAL RESOURCE

by Rich Johnson
Executive Director, Central Arizona Project Association

The Central Arizona Project, after 23 years in the planning stage, was authorized by the U. S. Congress as a multiple-purpose water resource project in September of 1968.

When completed, about 1980, the Project will make it possible for Arizona to put to beneficial use most of the remainder of the State's 2.8 million acre-foot allocation of mainstream Colorado River water. An average of about 1.2 million acre-feet will be diverted annually from the River at Lake Havasu behind Parker Dam and delivered via a 375-mile aqueduct system to farm and city users primarily in the central valley counties of Maricopa, Pinal and Pima.

The State's two major cities - Phoenix and Tucson - as well as about 20 smaller towns are located in this area, which has a combined population of about 1,337,000. The area also includes about 754,000 acres of irrigated farm land.

At present the total water supply of the area is produced from surface water runoff stored in reservoirs on the Gila, Salt, Verde and Agua Fria rivers; and from groundwater reserves pumped from deep wells.

Depletion of the groundwater resource to meet progressively greater needs has been a growing problem for many years, and the Central Arizona Project is designed to slow the rate of annual depletion. In light of that purpose, delivery of Central Arizona Project water for agricultural use will be limited to lands having a recent history of irrigation. This restriction will prevent development of new farm lands using Project water, and help to sustain production on lands already developed.

The Project plan earmarks at least one-third of water deliveries for domestic municipal and industrial uses in keeping with the urban population growth and the expansion of manufacturing.

It is impossible to put an explicit dollar value on water in an arid region like Arizona. Water is a resource rock upon which the total economy is built. If the present annual use of water per year in the State is viewed in relation to annual personal income, then the approximately 6,000,000 acre-feet of water used in Arizona is basic to an income of about $5,000,000,000. The equation is at least indicative of the value of the Central Arizona Project's 1.2 million acre-feet of delivered water.

The value of water is never static, however. As its end use changes, so does its value, and in Arizona the end use is gradually but surely changing from the lower per unit productive value of agricultural irrigation to the higher value of manufactured goods and the imponderables of domestic municipal use.

Another way of assessing the value of the Project's impact on Arizona's economy is to know the investment required for its construction. The cost estimated by the Bureau of Reclamation on the basis of 1968 prices is $832,000,000 over a ten-year construction period. (It is important to note that under Reclamation Law more than 80% of the construction costs of the Project will be repaid by those who benefit directly.)

Of the $832,000,000 cost of construction, $360,000,000 will be paid in wages. Approximately 36,000 man-years of labor will be required. Equipment, materials and supplies will cost an estimated $418,000,000, of which $105,000,000 will be spent within Arizona, and $313,000,000 distributed among suppliers in other states from the east to the west coasts.

The permanent costs of operation, maintenance and repair after construction is completed will be about $9,000,000 per year, of which some $8,000,000 will be for wages and equipment and supplies obtained in Arizona.

Separate from, but partly associated with the water Project as a source of water pumping power, is a new thermal electric generation plant in northern Arizona which is being constructed by a consortium of public and private power utilities at a total cost of nearly $400,000,000. Plan for transmission system.

In addition to both of these, the Project Act authorizes the loan of up to $100,000,000 for construction of distribution and drainage facilities.

Together these construction jobs add up to a very large direct impact on Arizona's economy during the 1970 decade. Beyond that there is the immeasurable value of an assured water supply when new capital investments are contemplated for Arizona by new and old industries.

While Central Arizona Project water deliveries are planned primarily for the needs of people in the most heavily populated and industrialized central and southern parts of the State, the
plan and the authorizing Act provide for indirect augmentation of water supply in the higher elevation communities of the Arizona northlands.

This would be accomplished by exchanging Colorado River water delivered via the Project aqueduct in central Arizona for a corresponding amount retained by users higher up on the States internal watersheds.

That principle of water exchange cannot only relieve some chronic water supply problems of northern county cities and towns, but also make possible the ultimate implementation of planning for recreation water impoundments by the Arizona Game and Fish Department. Such relatively small-scale impoundments will serve the growing recreation needs of the people in central Arizona, and enhance the recreation oriented economies of the areas in which they are located.

With the Project in operation after 1980, central Arizona will have one of the most sophisticated and elective water supply systems in the world. There will be three sources to draw from - surface runoff water stored in reservoirs on the Gila, Salt, Verde and Agua Fria rivers, groundwater reserves, and Colorado River water delivered via the Central Arizona Project aqueduct.

These three sources can be drawn upon by management decision for varying amounts and different proportions of the total demand, depending upon variations in the quantities available from the two stored surface water sources - reservoirs on internal streams, and Lake Mead on the Colorado River. Withdrawal of groundwater can be reduced when surface water supplies are relatively abundant, thus permitting more recharge to accumulate in groundwater aquifers for use in periods when surface water is less abundant.

In addition to these three primary sources, about 50% of all Central Arizona Project water delivered for urban municipal use will be returned as sewage effluent and available for treatment and reuse for appropriate beneficial purposes.

This availability of water production source alternatives puts central Arizona in an enviable position; in fact, a better position than that of most regions of normally more abundant water where the total dependency is upon a single developed source of supply.

Before the Central Arizona Project can go on the line, of course, it must be completed in steel and concrete. At present it is an engineering plan on the drawing boards of the Bureau of Reclamation. Final advance planning leading to the awarding of construction contracts could not be started until the Project had been authorized by the Congress. Following authorization at the end of 1968 the process of advance planning began in only a limited way until the Congress appropriated $1,100,000 for the purpose in December of 1969. This was a little less than half the amount that could have been used to good advantage in the fiscal year ending on June 30 of this year, but it was a satisfactory beginning in light of the competition for a very tight supply of money.

For the fiscal year which begins on July 1, 1970, the Nixon Administration has recommended an appropriation of $3.1 million for the Central Arizona Project. That amount includes $200,000 which was withheld from the current year's appropriation by the Bureau of the Budget.

Of the $3.1 million recommended for appropriation about $2.25 million is earmarked as the Federal Government's 1970-71 obligation towards the cost of constructing a thermal electric generation plant from which energy will ultimately be made available for pumping Colorado River water via the CAP aqueduct. This would leave about $900,000 for continuation of CAP diversion and aqueduct advance planning. This is not regarded as adequate funding to meet the requirements if CAP water deliveries are to begin in 1980.

For this reason, Governor Jack Williams recommended that the State Legislature appropriate $685,000 on a reimbursable basis to supplement funds appropriated by the Congress. In response to the Governor's recommendation H. B. 205 was subsequently introduced, and is now in process.

Although no serious question has ever been raised concerning marketability of all the water to be made available by the Central Arizona Project, it became necessary after the Project was authorized to begin determination of how the water would be allocated among those who would want to sign delivery contracts with the Secretary of the Interior. On January 6, 1968, the Secretary asked that potential contractors file "expressions of interest" with the Bureau of Reclamation.

As of March 11, 1970, a total of 42 of these "expressions of interest" had been filed, and collectively they indicated a market for 4,208,697.5 acre-feet of CAP water. That is roughly four times the amount of water that is likely to be available for average annual delivery via the CAP. Approximately 700,000 acre-feet of the total interest expressed is for urban municipal usage.

Obviously from this evidence the problem of marketing CAP water will be one of allocating 1.2 million acre-feet of water in a market four times greater than the available supply is capable of serving; and doing it on a basis of equitability and maximized benefits to the State.

The Arizona Interstate Stream Commission, which was authorized several years ago to advise the Secretary of the Interior in connection with CAP water delivery contracts, has a research program under way to develop water allocation guidelines on the basis of need and benefits. This work is being done under direction of the Commission's staff, headed by State Water Engineer Wesley E. Steiner, and the consulting firm of Dunlap and Associates. The Studies involve linear mathematical programming of data in a systems analysis giving weight to the many economic and social effects of water allocation.

Related to this responsibility the Commission has also established a Water Allocation Advisory Board open to membership representing any and all potential users of water in the State of Arizona.

The question of water supply in the Colorado River for the CAP has been raised at various times, and it is a significant question. In authorizing the Project, the Congress was assured by Federal water experts that the supply of water in the River, with the storage reservoirs at Hoover and Glen Canyon dams, will be sufficient until about 1995 or 2000 to meet legal delivery requirements under anticipated development conditions.

The authorizing Act (P.L. 90-537) also directs the Secretary of the Interior to "conduct full and complete reconnaissance investigations for the purpose of developing a general plan to meet the future water needs of the Western United States."

His final report is to be submitted on or before June 30, 1977. Furthermore, the ACT provides that satisfaction of requirements of the Mexican Water Treaty from the Colorado River constitutes a national obligation which shall be the first obligation of any water augmentation plan planned. Relieved of the burden of the Mexican Water Treaty obligation, the supply of water in the Colorado River will be adequate for all presently existing or authorized deliveries to the Colorado River states, according to the best authorities.

For the present and the short-term future, the economic values of the Central Arizona Project are primarily in terms of preserving agricultural productivity and land values, the tax base associated with those values, and the great variety of business activities associated with farm crop production.

In 1968 cash receipts for fruits and vegetables marketed from Arizona irrigated farms exceeded $127,000,000. Total
irrigated farm crop income was more than $300,000,000, making this industry one of the most important to the State.

The trend in Arizona, however, is toward urbanization of land which appears to have a dependably available supply of water. The City of Phoenix which occupied only 17.1 square miles in 1950, now includes 247.7 square miles in its corporate limits. The City's metropolitan area now has a population of nearly a million people, using more than 200 gallons of water per day per capita, according to estimates prepared by the Arizona Interstate Stream Commission.

The City of Tucson has experienced a similar rate of growth, with accompanying increases in municipal water usage.

The fact that the Central Arizona Project aqueduct, after reaching the Salt River Valley, will traverse the 100-mile stretch of land between Phoenix and Tucson increases the probability that this corridor will be extensively urbanized. In
the process of this development the economic and population impact upon Pinal County, lying between Phoenix and Tucson is bound to be highly significant.

This potential development offers Arizona a unique opportunity for long-range community planning to achieve a model urban environment. A substantial part of the land in the area between Phoenix and Tucson is in State ownership making it possible to manage its development according to a master public policy plan. The corridor can be segmented with appropriately spaced regional parks to provide open space and recreation facilities. Urban community water system effluent can be reused for recreation purposes and, with proper treatment, for irrigating farm green belts separating industrial park sites from residential areas. Rights of way for utilities such as power and a mass transportation system can be established well before they are required.

By taking these planning steps now, it will be possible to reduce the spectre of overcrowding of people in Phoenix and Tucson, to reduce the concentration of air pollutants which are associated with such overcrowding of people and their traffic congestion.

In short the Central Arizona Project aqueduct presents a very real opportunity for Arizona to develop a model urban-rural environment linking its two largest cities.

ABOUT THE AUTHOR

Mr. Johnson came to Arizona in 1945 from Michigan. He was a sociology major at Alma College, but after graduation began his working career as a newspaper man in Detroit. He continued in that field as associate editor and editor of Arizona Farmer magazine until 1957, when he became executive director of the Central Arizona Project Association.

In 1966 he moved to the Arizona Interstate Stream Commission as its executive director until last year when he returned to again head the staff of the Project Association. He is also president of the Arizona State Reclamation Association, and a past chairman of the Arizona Water Resources Committee.
Memorandum

C. H. King

J. R. Powell

To: C. H. King

Date: June 19, 1970

From: J. R. Powell

Subject: Empire Ranch - Water Supply Report

This is to confirm our understanding that the subject report is to be completed and reviewed by Mr. Ron Colhoun around the date of 6/28/70.

After Ron has reviewed the same, he will forward the report to us in Miami (GAC Utilities).

After my review of the same, I will share with you the report forwarded, my comments, and a proposal for going forward with the VIT well.

I do not see a specific need at this time for the return of Mr. Deluca to Arizona to "locate the well site", as indicated by Ron's letter of 6/10/70.

JRP: dfb

cc: J. King
R. Young
R. Colhoun

RECEIVED

JUN 25 1970

WILSEY, HAM
June 10, 1970

File No. 1137-0214-50

Mr. Charles King
GAC Properties, Inc.
Biscayne at 79th Street
Miami, Florida 33138

Dear Charlie:

Attached is Geraghty & Miller's recommendation for location of the next well in Pine County to serve the needs of the VIT complex.

In talking with Frank DeLuca today he tells me that there is some flexibility in locating this well to accomplish what he wants to in this next well. I suggest that after a field investigation and a proposed final site is selected that we double check with him for his final concurrence. Ideally, we can wait for Frank's next trip to Tucson which may be within the next two or three weeks and review the proposed location with him then.

Frank also mentioned that he believes this next well should be a 16-inch casing to gain maximum flexibility for possible deeper drilling in the future (maybe in excess of 1000 feet) and secondly, to allow placement of larger pump equipment if significant quantities of water are found.

We can provide you with the incremental increase in cost between a 12 inch and 16 inch hole prior to making the final decision. Initially, it appears to be a very small, insignificant increase in comparison to the possible benefits to be gained.

Very truly yours,

R. T. Calhoun
Vice President

RTC/bt

cc Mr. Sam Nash
    Mr. Stew Staples
    Mr. Jim Powell
    Mr. Frank DeLuca
Mr. R. T. Calhoun  
44 East Foothills Blvd.  
Arcadia, California 91006

Re: Job No. 1137-0214-50  
Empire Ranch Water Resources Study

June 9, 1970

Dear Ron:

Reference is made to your letter regarding the test well program at Empire Ranch. The following is a brief summary as things presently stand.

1. The three test wells have been sealed with cement grout between the 16-inch and 12-inch diameter casing to a depth of 10 feet below land surface. A welded cap has been installed on the three wells. The only other physical requirement presently needed for the well is to lay a 6' x 6' x 1' thick concrete pad with the well casing in the center. Since this can be accomplished with a minor expenditure of time and labor, it can be finished off at any time. The pad has not been installed simply to check the cement seal and construction of the well because of the flowing water conditions.

2. Pumping tests were conducted on Wells 1 & 2 with the use of a deep well turbine pump. A bailer test was conducted on Well 3 which was sufficient to compute a range of discharge for the well and the necessary steps required to convert the test well to a production well.

3. Water samples were not submitted to the State Health Department because the data from the individual samples obtained during the drilling indicated the water contained some chemical constituents in excess of the recommended limits. In order to determine the final water quality it was necessary to wait until the well was developed and pumped. Now that the quality has been determined, a sample can be obtained at any time from the flowing wells simply by opening the valve at the well head and allowing the water to free-flow for a day or two. Well 3, is not flowing therefore a sample would have to be obtained by bailing or after a pump has been set.
4. At present a draft copy of the report is being put together. Assuming everything goes smoothly, a copy should be out to you by the end of next week.

5. The following is a breakdown of funds expended on the Empire Project Water Resources study as of the end of May, 1970.

<table>
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<th>Description</th>
<th>Amount</th>
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<td>Geraghty &amp; Miller Services</td>
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<tr>
<td>Geraghty &amp; Miller Expenses</td>
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<td>Sub-Contractor's fees</td>
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<td><strong>Total</strong></td>
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I recently sent you a letter regarding the VIT well site with a location map. To assist in the well-pump installation and drilling, I would suggest that the well casing installed should be no less than 16-inch diameter. The casing size can be reduced as the drilling progresses perhaps at a depth of about 500 feet, depending on the materials encountered during the drilling.

If you have any questions regarding any of the above, please do not hesitate to contact me.

Very truly yours,

GERAGHTY & MILLER, INC.

FAD:JJ
C.C.: Mr. Sam Nash

Frank A. DeLuca
Project Manager
June 8, 1970

Mr. R. T. Calhoun
Wilsey & Ham
44 East Foothill Blvd.
Arcadia, California 94404

Re: Empire Ranch – VIT Well Locations

Dear Ron:

As you requested in our phone conversation of June 4, enclosed please find location map of a well site for the VIT complex. You will note that the location is near the Gardner Canyon wash to the north of the proposed site.

The physical location should be such to reduce the possibility of flooding during rain storms. The controlling factor of depth should be based on the materials penetrated by the borehole. Our present interpretation of the bedrock is that a fault may exist in close proximity to the site which may allow a higher than average yield from a well in the rock.

The water requirements for the VIT unit at present has not been completely firmed. The yield of the well along with peak demand will determine the storage facility needed at the site.

The well should be drilled under close supervision and water samples should be obtained for chemical analyses.

If you have any questions regarding the above, or if we can be of assistance please contact us.

Sincerely,

GERAGHTY & MILLER, INC.

Frank A. DeLuca
Project Manager

FAD:me
Encl.

cc: Sam Nash
May 26, 1970

Job No. 1137-0214-50

Mr. Frank DeLuca
Bereghy & Hiller
C/O Willey & Hill
100 Almadia
Tucson, Arizona 85701

Dear Frank:

In accordance with our discussions in Tucson last week, this will confirm our direction to you for the next phase of activities on the test well program.

A. Instruct the contractors to install a safety seal on each of the three wells in accordance with Arizona law and sound safety procedures.

B. Complete the production tests on Test Well No. 3.

C. Submit water samples to the Health Department for their analysis and report.

D. Prepare a draft copy of your final report for review at the earliest opportunity. An outcome of this final report will be presumably the preparation of a second report for submittal to the State Health Department.

E. Please forward to me at the earliest opportunity your estimate of the funds expended to date and required for completion of the work items defined above.

Very truly yours,

R. T. C. Ihoun
Vice President

ATC 15

cc: Mr. Sam Nash
May 15, 1970

Mr. R. T. Calhoun
WILSEY & HAM
44 East Foothill Blvd.
Arcadia, California 91006

Dear Ron:

As requested at the meeting of May 13, in Tucson, Arizona, we are submitting an interim recommendation for the continuing program of studying the water resources for the Empire Ranch Property. At present we would prefer to complete the program as initially outlined and contracted, i.e., to complete the test drilling and test pumping on the three wells on the Empire Ranch. A final report will be submitted based on our present findings and understanding of the geology and hydrology of the Empire Basin along with recommendations.

This letter will serve to alert you for planning purposes and to obtain the necessary approvals for the following recommended program. If approval is received for this recommendation, an addendum would be added to the report on the results obtained.

No information is available on the aquifer deeper than the topmost sandstone and shale of Cretaceous age. Therefore, this recommendation is to obtain the necessary approvals to carry a well or wells as soon as possible to a deeper depth.

To obtain some of the data, options are presently open to us. They are: (1) to deepen Well No. 3 from its present depth of 740 feet to 1,600 feet, (2) to drill a completely new well near the VIT complex, and (3) to carry both wells to the 1,600 foot depth. The advantages of deepening Test Well No. 3 arc as follows: (1) there will be considerable savings in time and money simply because the well is presently 740 feet deep, and (2) we will benefit from the geological and hydrological information and possibly interpolate it for a good portion of the southern piece of the property.
Test Well No. 3 is located on leased property which means that some monies are already invested in the property not owned by GAC. The estimate for drilling contractors fees committed to date is on the order of $9,500. This does not include additional work to be performed before the completion of the well. For example, a pumping test has not been conducted on the well, consequently, no money has been spent on development and testing.

The advantages for drilling the well in close proximity to the VII complex are: (1) it is an area which we intend to recommend as a test-production area where the development of high capacity wells may be possible, (2) the well could be used as the water supply for the VII complex, (3) considerable savings could be realized because of the proximity of the well to the VII site, i.e., a reduction in pipeline and horse-power requirements for the pump, and (4) this well could be used for construction purposes and also to serve the first group of houses that are planned in the immediate vicinity if the yield is sufficient. An overall advantage to carrying both wells to a greater depth could be all of the above reasons and advantages noted in options 1 and 2.

If a decision is reached to deepen only one hole, the recommended site would be in Gardner Canyon, adjacent to the VII site. It is estimated that drilling a well to 1,600 feet would take approximately 120 working days. The estimated minimum cost for drilling the hole and installing casing is on the order of $40,000. This does not include time or expenses to conduct a pumping test. Because this is virtually new drilling with many unknown factors involved, contractors will in all likelihood insist on a per hour rate. That is, the contractor will work on a per foot rate if the penetration does not fall below a certain footage per work day. When the rate of penetration does fall below a certain amount per day, then the hourly rate will apply. The estimated cost is strictly assuming a per foot rate for the entire depth.

The installation of a test pump and conducting a controlled pumping test after the well has been completed is estimated to cost on the order of $10,000. This estimate is based on the installation of a fairly large test pump capable of delivering up to 1,000 gpm. It is also based on installation and removal cost for a 500 foot setting and conducting a controlled test covering a total period of approximately 10 days.

Because of the recommended depth of the hole, it is advisable to start the top casing at no less than 16-inch diameter. This will allow some flexibility in controlling the diameter at the bottom of the hole. Hopefully, the bottom of the hole will be finished no less than 8-inch diameter.
Water samples should be collected at a fifty-foot interval as the hole is being drilled. The estimated cost for the chemical analyses is on the order of $1,000.

To help define and correlate the aquifers and geologic units, the hole should be electric and gamma-ray logged. This would also assist in defining zones containing highly mineralized water. If necessary, aquifers containing undesirable water quality can be sealed off by cement grouting.

It is difficult to determine the Geraghty & Miller, Inc. consulting fees at this time. The fees would be based on the amount of supervision required to complete the hole successfully. For budget purposes, an estimated $25,000 covering total supervision should be used.

If you have any questions on the above please feel free to contact me.

Sincerely,

Frank A. De Luca
Project Manager

FAD: sv

cc: Charles King
    Jack Martin
    Jim Powell
    Stew Staples
    Sam Nash
    Paul Cella
Write Report now. Available about June 30th.

**U IT**
1) 740 to 1600 ft.
2) Area for future Test/Production
3) Water Supply for U IT
4) Sewers for U IT
5) Sewers for Housing
6) 120 day 5/28 to 9/28
7) Estimated Cost:

**Min**
- Drilling & lining: $40,000
- Pump Test: $10,000
- Water Samples: $1,000
- Consulting Service: $15,000
- Total: $76,000
- Savings from #3 & 4: $24,000
- Budget for U IT: $44,000
- Additional costs:

**Test #3**
1) Complete New Well
2) Cost to date: $9,500
3) Check State pay from $9,500 if not productive well.
4) $20,000 Min. to drill & case 740 to 1600.
Mr. R. T. Calhoun
WILSEY & HAM
44 East Foothill Blvd.
Arcadia, California  94404

Dear Ron:

Re: EMPIRE RANCH WATER RESOURCES STUDY

Summarized below are some of the preliminary findings to date of the hydrologic and geologic factors of the Empire Ranch Property. Included are results of the test drilling program to date and some recommendations which should be acted on as quickly as possible.

There are at present three, test-production wells being drilled in a roughly north-south profile on the property. The wells have been drilled to accept 12-inch-diameter casing to a depth necessary to prevent caving of material. Where possible, less than the total depth of the hole has been cased.

Test Well No. 1, the northern most well, has been drilled to a depth of 749 feet and has been completely cased with 12-inch-diameter pipe. The casing is machine slotted below a depth of 20 feet. Consolidated rock was encountered at a depth of 530 feet at which time a change in the static water level occurred. At the present time a pumping test is in progress. The rate of discharge for the test is 700 gpm (gallons per minute) and at this time not enough data has been collected to determine the optimum yield of the well.

The unconsolidated material above the bedrock consists of sand, gravel, clay and rock fragments. The permeability of the unconsolidated material is interpreted to be quite low. The bedrock consists of sandstone and shale, with beds alternating between tight, compactly cemented and loose with very little cemented layers. The fracturing of the rock is the key to the amount of water transmitted to the well.
Test Well No. 2, located southwest of Well No. 1, has been drilled to a depth of 845 feet. Blank casing has been installed to a depth of 331 feet. The unconsolidated material was clay with some small lenses of sand. The casing was not perforated because of the clay content and the relatively thin zones of sand. Competent bedrock was encountered at a depth of 340 feet, associated with a change in the static water level.

A controlled pumping test was conducted on the well for approximately seven days. Initially the pumping rate was 250 gpm with a prepumping static water level of approximately 9 feet above land surface. After 2 days of pumping at the 250 gpm rate, the water level declined to approximately 230 feet. It became apparent that the yield could not be maintained without dewatering the well beyond the depth of the pump bowls. Therefore, the pumping rate was reduced to 150 gpm.

At this rate of discharge the water level recovered to 190 feet and then started downward again. The rate of decline was roughly parallel to the early decline plotted at the higher discharge rate. The discharge rate was again reduced to 90 gpm in an effort to ascertain optimum yield of the well. Throughout the rest of the pumping period of slightly over 50 hours, the water level continued to recover. It was estimated that several days of continuous pumping would be required to allow the water level to recover sufficiently before any affect could be noted at the 90 gpm discharge rate. The optimum yield of the well is on the order of 75 gpm. However, the problem of mutual well interference and mining of water may reduce the ultimate yield of the well significantly. In other words, as additional development of the water resources in the same aquifer takes place, the pumping of other wells may drastically affect the water level in wells in the same aquifer. The overall regional depression of the water level must also be considered after pumping has taken place for a long period of time.

Test Well No. 3 is presently at a depth of 740 feet in weathered sandstone and shale. The thickness of the unconsolidated deposits is interpreted as being in excess of 500 feet. The unconsolidated deposits contained a great deal of clay and although saturated, it is felt that the materials would not have a high transmissibility and the well at present can be expected to have a low yield. The static water level has not varied in the well.

The immediate recommendation for this well is to continue the drilling beyond the preselected depth of 800 feet. It is apparent
that a relatively small amount of information can be obtained by stopping the drilling at this point. A great deal more can be learned by the small expenditure of time and effort.

In addition to following the well drilling program, attempts have been made to refine information regarding some of the recharge areas. This involves a great deal of interpretation based on very little factual data. A rough surface geology outline was completed in an attempt to delineate zones of recharge.

Based on our present knowledge of the geology and hydrology of the Empire Basin, large capacity wells on the order of 200-500 gpm can only be developed in limited localized areas. To delineate these areas a comprehensive study would have to be undertaken. One part of the study to be acted on immediately is to deepen Test Well No 3 to a depth where meaningful information can be obtained.

Test Well No. 3 can at present be expected to have a relatively low yield, however this yield undoubtedly could be increased by drilling deeper in an attempt to intersect fractures in the bedrock which would transmit water to the well. In other words, if the overall evaluation of the southern portion of the property were based on the present data from Well No. 3, a very limited supply of water would surely be representative for the area. If, however, the well were deepened and different hydrologic conditions were encountered, the generalized interpretation would have to be changed.

The VIT complex to be constructed will require a water supply system. The water supply can be obtained either from an existing well or by drilling a new well. The latter is the recommended course for a two-fold purpose. To install a pipeline from any of the existing wells along with the necessary hardware would be as expensive as drilling a new well. In addition, a test well location to be recommended in Gardner Canyon is in close proximity to the proposed VIT complex site.

The above is a brief outline of the water resources study to supply you with background information for the meeting scheduled May 13 in Tucson, Arizona.

Sincerely,

Frank A. DeLuca
Project Manager

cc: Jack King
Dan Cooper
Stew Staples
Sam Nash
GERAGHTY & MILLER, INC.
CONSULTING GROUND WATER GEOLOGISTS
100 East Alameda, Suite 513
Tucson, Arizona 85701
Telephone 602 624 1847

10 April 1970

File 1137-0214-50

Mr. R. T. Calhoun
WILSEY & HAM
44 East Foothill
Arcadia, California

Dear Ron:

Re: Empire Ranch Test Drilling Program

The deadline for the ground water resources study of the Empire Ranch has been set for April 30, 1970. Regarding this, I wish to ask for an extension of approximately 4 weeks to complete the program and obtain needed information.

The advantages derived if an extension is granted are numerous. For one, we will be running a pumping test on Well No. 2 next week and a pumping test on Well No. 1 the following week. We will have to submit samples to the Health Department for analysis and approval. The problem arises, as has happened in the past with Rio Rico, in obtaining the results of the water sample analyses, this takes approximately 4 weeks. Apparently they have a backlog of water samples to analyze, and no amount of rushing can move the samples up for an earlier completion of analyses.

In addition to the water sample problem, we would like to complete the drilling and testing on Well No. 3. We probably won't have the chemical analyses back on that well; however, we will have the hydrologic data pertaining to the aquifers at that well site. As you know, the wells for all practical purposes are in different materials, at least as far as the alluvial material goes. For example, we have found a great deal of sand and gravel in Well No. 1, whereas almost the entire overburden in Well No. 2 has been clay. Well No. 3, on the other hand, penetrated a great deal of sand and gravel in the alluvial material; however, the cementing material is a calcium carbonate as opposed to a silica cement in Well No. 1. The cementing material of the wells is completely different and will definitely influence the transmissibility and storage factor of the aquifers.
I therefore feel we would probably have a stronger case and a more meaningful water supply picture after we complete Well No. 3. This will lend greater support to our projection of water supplies based on the population curve.

Sincerely,

Frank A. DeLuca

FAD:sv
April 9, 1970

Mr. Ron Calhoun
Wilsey & Ham
44 East Foothill Blvd.
Arcadia, California 91006

Dear Ron:

Enclosed is our statement of charges for March 1970. We would appreciate your pushing this along because it involves considerable expenses owed to subcontractors.

Many thanks.

Sincerely,

GERAGHTY & MILLER, INC.

David W. Miller

DWM:me
Encl.
Mr. Ron T. Calhoun  
WILSEY & HAM  
44 East Foothill  
Arcadia, California  91006  

Dear Ron:  

Enclosed is the estimate from the McDaniel Well Drilling Company to rehabilitate the Enzenberg Well No. 1. If you recall, this is the irrigation well that we conducted a pumping test on, and I have suggested this may be a good supply well for the V.I.T. complex.  

You will note the estimate is just for the concrete sealing and pad to meet the State Health Department standards. We do not know the condition of the pump or the well casing. The pump, by all means, should be changed to meet the requirements of the V.I.T. complex as to water supply needs and head requirements. The present engine on the well is in sad disrepair and if GAC decides the well can be used for the V.I.T. complex, I suggest that an electric motor be installed to drive the pump.  

I don't know what the water requirements for the V.I.T. complex may be, but I would venture to say that a 200 gallon per minute supply would be more than ample.  

If you have any questions on the above or the estimate bill, please contact me.  

Sincerely,  

Frank A. DeLuca  

FAD:sv  

Enclosure  

cc: Sam Nash
Central

A. A. McDANIEL
WELL AND MACHINE COMPANY, INC.
2838 RUTHRAUFF ROAD
TUCSON, ARIZONA 85705

PROPOSAL TO: Geraghty and Miller, Inc.
100 E. Alameda St., Suite 513
Tucson, Arizona 85701
Attention: Frank A. DeLuca

DATE April 3, 1970

Gentlemen:

In compliance with your recent request, we are pleased to submit the following quotation for your consideration:

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rehabilitate Enzenberg Well # 1 to meet current State Health Department Standards</td>
</tr>
<tr>
<td>1</td>
<td>Dismantle and remove engine and discharge pipe</td>
</tr>
<tr>
<td>1</td>
<td>Demolish and remove existing concrete pad</td>
</tr>
<tr>
<td>1</td>
<td>Excavate around existing 20&quot; casing to a depth of 10' and pour grout seal</td>
</tr>
<tr>
<td>1</td>
<td>Form and pour regulation size concrete base</td>
</tr>
<tr>
<td>1</td>
<td>Raise pump to remove existing timber supports and set on concrete base with calking compound</td>
</tr>
</tbody>
</table>

Estimated Cost

$720.00

The above estimate does not include any maintenance or re-design of the existing pump. For use as a water supply, we definitely feel that this pump should be converted to electric drive and that it will have to be pulled and a new set of bowls designed for it to produce water under pressure for a hydro-pneumatic system.

A. A. McDANIEL WELL AND MACHINE CO., INC.

Accepted: ____________________________

by ____________________________
April 1, 1970

File No: 1137-0214-50 ✓

Mr. David Miller
Geraghty & Miller
44 Sintslink Drive East
Port Washington, New York 11050

Dear Dave:

As Frank has probably mentioned to you by now, we had a meeting in Tucson last week with Jim Powell of GAC Utilities to discuss the goals and objectives for the test well program and its relationship to the required State approvals. Apparently, there had been a lack of communication within the GAC organization and Jim Powell had not been brought up to date on all of the background information leading to the implementation of the test well program. Jim's basic concern seemed to revolve around his interpretation of an apparent statement you made at one of our early meetings in Tucson. In his recollection, you said something along the lines that, "A test well program would not modify the conclusions of your initial feasibility report of last December but would only serve to determine the best way to remove the water from the underground aquifers." I frankly don't recall this statement or any discussion quite like this but in any case, apparently Frank now feels that the results of the test well program to date do, in fact, serve to modify some of the preliminary findings of the original report.

Based on Jim's recollection of your statement, he further goes on to ask: "What are the goals of the test program?"; "Can the test program be modified to reduce the overall cost?"; and, "What are the current costs and scheduled completion date for the program?"

We provided him with the appropriate background information and letters, which along with Frank DeLuca's and my letters of March 27, should bring Jim up to date. I checked with Dan Cooper today and he concurs one-hundred percent with the program as originally and currently conceived.

The second broad subject relative to water and the testing program, dealt with the relationships to be maintained with the State Health Department. Again, this was a matter of misunderstanding and lack of communication. The direction now is that GAC Utilities will take responsibility for gaining the necessary approvals for utilities, which presumably will
Include water, sewer, electrical, gas, and telephone. The Consultant Team will, however, be asked to present their own findings and conclusions rather than us giving our information to a GAC Utilities Representative and having him take it in our absence and present it to the various authorities. This is the way that we would all like it I am sure, and establishes, I believe, the best relationships between the client, the approving agencies, and the Consultant Team.

There was some concern on the part of some of the GAC Representatives that the field trip held last week on the Empire Ranch with Frank Lord and some of the County Representatives was poorly timed and not properly scheduled since a GAC Utility Representative could not be at the meeting. In the final analysis, though, I think they all agree that this was a successful meeting since it was only for purposes of showing them the method of analysis and testing and was not intended to give them any definitive conclusions or partially analyzed data.

As I mentioned earlier, I am sure Frank has passed all this on to you but I thought you might be interested in hearing how I viewed the current discussions and activities. As you can see, all this has centered around Geraghty & Miller activities and Frank's work in Tucson. Both GAC and myself think Frank is very capable of handling the job at hand and is controlling the activities of the testing program extremely well. We all feel that the results will be very dependable as a result of yours and Frank's efforts. Thus, the question has been whether the program should have been undertaken at all. I feel now that everyone is on the same wave length and concurs with the current program.

Best regards,

R. T. Calhoun
Vice President

RTC: 1b

cc: Sam Nash
    Frank Deluca
March 31, 1970

File No: 1137-0214-50

Mr. Dan Cooper
GAC Properties, Inc.
Biscayne at 79th Street
Miami, Florida 33138

Dear Dan:

Until the number of dwelling units the available water within the Empire Ranch will support is known, it appears to me that it might be worthy of discussion to evaluate the extent of additional lands that should be acquired.

The cash flow studies now underway should shed some light on this question from a profitability point of view, and shortly the results of the well testing program will enlighten us all as to the capability of the underground aquifers to support a density that we all can defend. In the meantime, though, it may be worthwhile to reevaluate our current knowledge with Jim Webb, Harlo Yurin, Geraghty & Miller, and others as appropriate. It would be a shame to buy more land than can be developed in the most profitable manner possible.

Very truly yours,

R. T. Calhoun
Vice President

RTC:1b

cc: Mr. Stew Staples
    Paul Calla
    Sam Nash
    Frank Deluca
As we talked last week, I would appreciate it if you would work closely with Frank DeLuca to have a continually accurate accounting of the status of all costs that have been obligated relative to the well drilling program and the various contractors that may be involved in this phase of work.

For example, we know that there are three test well contractors on the site for an aggregate estimated cost of $64,000, plus an unknown cost (at least to me) for the pump testing for the existing wells, and possibly some costs from the chemical labs for the water quality testing that has been going on. This, in conjunction with making sure that Frank has a written authorization for phases of his work, will assure that we are not incurring cost obligations without our full knowledge and agreement.
GEOLOGY OF THE EMPIRE VALLEY

The Empire Valley lies in the Basin and Range physiographic province and is bordered by two northwest-southeast mountain groups, the Santa Rita and Whetstone Ranges. The formation of the geologic elements in this region date back approximately one-half billion years to the start of the Paleozoic era. At this time, and throughout most of Paleozoic time, shallow seas covered the region and a few hundred to a few thousand feet of marine limestone, sandstone and shales were deposited. At the close of the Paleozoic, there was a gradual uplift, tilting and erosion of the previously deposited rock units.

At the beginning of the Mesozoic era, subsidence of the land occurred and the accumulation of sediments during this time included lava flows and ash falls associated with the volcanic activities along fracture zones at the border of the unstable crustal blocks. This roughly can be compared to the present vulcanism observed in peripheral areas of the Pacific such as Indonesia, the Japanese Islands and our Aleutran chain. By the close of the Mesozoic, 5,000 to 18,000 feet of limestone, shales and sandstone had been deposited in the ocean trough beyond Globe and through the southeast corner of the state. In early Cenozoic time the region was uplifted, tilted, eroded and huge faults were created along which massive blocks of rock moved. See Figure 1. Some of these faults occurred in a horizontal rather than a vertical plane and are called thrust faults. The blocks of rock, sometimes miles long, were pushed up and out across other rock masses forming the present day ranges. Although the preceding description sounds as if events followed one another in catastrophic sequence, it must be remembered that viewed in the perspective of geologic time, these events were fairly rapid in sequence although there were probably hundreds of thousands of years between significant and identifiable events. See Table 1.

The remainder of the Tertiary period was characterized by minor faulting in the Basin and Range area, some volcanic activity along fracture systems and the accumulation of the fanglomerate deposits within the basins. These deposits range from coarse, unconsolidated
materials to well-cemented conglomerate and mudstones. Minor uplifts and faulting influenced the heterogeneous nature of the deposits and partially explains the formation of several levels of erosion and the occurrence of interbedded lenses of fine and coarse material. In recent times the mountains and basins continue to be modified by erosional processes and the Empire basin area has a probable thickness of Post Cenozoic uplift, unconsolidated gravels, sands and clays on the order of several hundreds of feet.

HYDROLOGY

The source of recharge to the ground water is the precipitation that falls in the valley and on the surrounding highlands. The precipitation in the valley proper averages approximately 15 inches per year. However, in the highlands, the surrounding mountainsides to the east, west and south, the precipitation is as much as 30 inches per year.

Winter rainfalls usually begin in November and continue with many interruptions through February. Summer rainfall is concentrated in the months of July, August and September. Rainfall periods are usually brief, can be intense, and individual storms are scattered through a particular region.

Figure 2 is a hypothetical cross section showing the relationship between the geologic environment and aquifer hydraulics. As can be seen, different type wells can be developed for water supplies in the region. For example, water-table wells can be encountered in both bedrock in the highlands and shallow alluvial conditions in the valley. In the deeper wells in the valley, artesian conditions can exist causing wells to flow or have water levels above the normal water-table conditions.

Wells drilled in the bedrock can characteristically be expected to have low yields. The wells drilled in the shallow water table in the valley floor are typically used for stock watering purposes. These wells can also be expected to have a fairly low yield. Deep artesian wells flow as indicated by the present drilling of Test Well No. 2. In addition, a deep aquifer well may be under artesian conditions with a piezometric head not high enough to cause the well to flow, but higher than the actual water-table level. This is the case in Test Well No. 1. The normal water table was encountered at a depth of 20 feet and the actual static water level in the well is presently two feet below land surface.
As mentioned before, the source of recharge is the precipitation and the runoff from the surrounding highlands. The nature of the unconsolidated and consolidated rock indicates that there is a tremendous amount of water in storage which can be tapped by wells. In the consolidated rock, water is stored and transmitted through the fractures and cracks that have developed through geologic forces. In the unconsolidated deposits, water is stored and transmitted through the pore spaces that exist in the material. Normally, the water storage and transmittal factors are much higher in the unconsolidated sands and gravels than those found in the consolidated rock.

The variable nature of the deposits which range from silt size to boulder size will control the storage and transmitting factors of the aquifers. For example, in a fairly thick lens of homogeneous sand or gravel, storage and transmittal components can be expected to be very high. Conversely, in heterogeneous materials containing thick lenses of clay, storage and transmittal factors are very low. Therefore, the yield of an individual well depends on the aquifer material encountered and the thickness and aerial extent of the aquifer. In consolidated rock, the yield of a well depends on the number and interconnection of the fractures the borehole intersects below the water-table.

The approach to developing the required water supply is one of a carefully monitored test drilling program and the defining of the geologic and hydrologic parameters involved. After the wells have been completed to their desired depths, controlled pumping tests will be conducted to determine the aquifer coefficients. In addition to the test drilling program, a careful monitoring of the water quality has been conducted as the wells are being drilled. In other words, water samples have been obtained from various depths as the drilling progresses.

Since the water quality of the final supply will be a mixture of water from different depths, the blending of this water as the well is being pumped will control the ultimate quality delivered. This quality will be determined by collecting samples during the pumping test for chemical analyses.
<table>
<thead>
<tr>
<th>Era</th>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>Quaternary</td>
<td>2 million yrs</td>
<td>Erosion of mountain ranges and deposition of gravel, sand and clay in basins; faulting and igneous activity</td>
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<tr>
<td></td>
<td>70 million yrs</td>
<td>Uplift of land forming present mountain ranges with thrust faulting - beginning of deposition in intermontane basins, i.e., fanglomerates</td>
</tr>
<tr>
<td>Cenozoic Era</td>
<td></td>
<td>Subsidence of land and deposition of marine sediments 5,000 to 15,000 feet accompanied by interbedded volcanic rocks</td>
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<tr>
<td></td>
<td></td>
<td>Uplift of land, tilting of beds, some faulting and erosion</td>
</tr>
<tr>
<td></td>
<td>500 million yrs</td>
<td>Subsidence of land and deposition of limestone shale and sandstone under shallow marine conditions</td>
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<td>Paleozoic Era</td>
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March 19, 1970

Job No. 1137-0214-50

Mr. Frank DeLuca
Geraghty & Miller, Inc.
C/O Wilsey & Ham
100 East Alameda
Tucson, Arizona 85701

Dear Frank:

After our discussions in Tucson last week relative to your March 6 letter to Sam Nash, I talked with Dave Hiller in New York.

We agreed, in our conversation, that in light of Wilsey & Ham's contract with GAC Properties, Inc. and the needs of Geraghty & Miller that all invoices from subcontractors to Geraghty & Miller relative to the test well program and pump testing program would be marked up one and one-half percent to cover costs of financing the payment of their bills within ten days of receipt by Geraghty & Miller.

Dave indicated that he would resubmit his latest bill to us, marking up the contractor's invoice to Geraghty & Miller at the rate of one and one-half percent instead of the previously submitted bill which had a markup of five percent.

Very truly yours,

R. T. Calhoun
Vice President

RTC:1b

cc Mr. Dan Cooper
    Mr. Dave Hiller
    Mr. Sam Nash
March 9, 1970

File No. 1137-0214-50

Mr. Frank DeLuca
Geraghty & Miller
c/o Wilsey & Ham
100 East Alameda
Tucson, Arizona

Dear Frank,

Based on the recommendations in your letter of March 6, 1970, you are hereby authorized to continue drilling in Test Well #2 beyond the presently authorized depth of 800 feet to a maximum of 1100 feet.

This authorization is based on the assumption that only one pump test at the maximum depth will be accomplished, and the savings in the two unused pump tests included in the original estimate will be converted to the dollars to drill the additional depth in this Test Well.

When you reach 1000 feet, please contact me to reconfirm the authorization to proceed the additional 100 feet to the maximum current authorization of 1100 feet.

Very truly yours,

R. T. Calhoun
Vice President

RTC/bt

cc Mr. Dan Cooper
    Mr. Stew Staples
    Mr. Sam Nash
March 6, 1970

Mr. Sam Nash
WILSEY & HAM
100 East Alameda, Suite 513
Tucson, Arizona 85701

Dear Sam:

Would it be possible to obtain a letter from you or Ron regarding the payment of the well drilling contractors. That is, GERAGHTY & MILLER will pay the contractors, add a 5 per cent override and in turn will bill WILSEY & HAM. I believe this is the procedure we discussed over the phone several times.

In addition, could you get us a letter stating our rental fees and so on regarding the use of this office.

Sincerely,

Frank DeLuca

FDL:sv
March 6, 1970

Mr. Ron Calhoun
WILSEY & HAM
44 East Foothill Boulevard
Arcadia, California 91006

Dear Ron:

In reference to the test drilling program at the Empire Ranch, I would like to make a recommendation at this point to be acted on as quickly as possible. In my letter and my telephone briefing to you for the Miami meeting, I stated that the material we are penetrating in Test Well No. 2 can be considered a very poor aquifer. However, you will note in my comments that we are picking up an increasing amount of sand content as we drill deeper.

At this time I would request that we not stop the drilling at the pre-selected 800-foot depth, but continue to drill to a point where we will have aquifer material. The increase in sand content is one of the reasons that continued drilling should be considered. I would not venture to say what depth we should go to, but most certainly would like to see one well encounter the crystalline or marine sedimentary bedrock known to exist in that valley.

In my estimate to you for the cost of the wells, the price included the pump testing of a minimum of three different sections. I would say that if we drill to a 1,000-foot level and conducted only one pump test, which is at this time warranted by the materials we penetrated, the price of the test well program for that well would be the same.

I think it would be to our advantage to have three good wells and the data from these wells to present to the State for a water supply approval rather than having to show them the results of a test well that shows a rather nominal aquifer condition. Since the drilling rig has broken down we have a few days in which to act on this before we reach the 800-foot level. The well is presently at a depth of
710 feet and the drilling equipment should be back in operation the afternoon of the 6th. If you would care to discuss this over the phone, I can arrange to contact you as soon as you return from Miami.

I don't know what it would take at this time to get approval from GAC to drill deeper, but I certainly recommend that we explore every avenue to obtain this permission.

Sincerely,

GERAGHTY & MILLER

Frank DeLuca

FDL:sv

cc: Sam Nash
27 February 1970

Mr. R. T. Calhoun  
Wilsey & Ham  
44 E. Foothill Blvd.  
Arcadia, California 91006  

Re: Empire Ranch - GAC Properties, Inc. Test Drilling Program

Dear Ron:

In compliance to your letter of 18 February, and our subsequent telephone conversation regarding the meeting in Miami, Florida, outlined below is a summary of the results of the test drilling program to date. In addition, I have attached the results of the chemical analyses we have obtained to date.

Test Well No. 1 is located within the NE\(\frac{1}{4}\) of the SW\(\frac{1}{4}\) of the NE\(\frac{1}{4}\) of Sec. 3, T19S, R17E, G5SRB&M. This well is contracted to the A. A. McDaniel Well and Machine Co. of Tucson, Arizona. Drilling commenced on 22 January, and as of 27 February, the depth of the hole was 450 feet. The material penetrated consists of sand, gravel and clay with streaks of hard cemented zones. The cemented zones have reduced the average penetration rate, which is falling between 12 to 18 feet per day.

At the present time the material we are drilling through is quite hard, necessitating the change of drill bits and dressing of the cutting edge. To speed up the operation two (2) drill bits are at hand and the changing time is a little over one hour. In this manner, the drilling continues while the used bit is being dressed and re-edged.

If the present rate of penetration is maintained, or falls off to a slower rate, we may not be able to complete the 800 feet of penetration and final testing of the well before the scheduled meeting with the State. As I see it, we have two alternatives, either stop drilling and settle for a hole of less penetration to allow enough time to testing and evaluating the data, or continue the drilling and set a new target date.

Because we are in virgin territory as far as obtaining information from wells with any depth, in addition to water quality data, serious consideration should be given to the collection and analyses of all the data possible. At present all the three wells are penetrating strata completely different from each other, as was expected. This can be discussed in our phone conversation scheduled for Monday afternoon, 2 March.

The results of the chemical analyses obtained to date can be seen on the attached sheet. The water is of reasonably good quality, however, the fluoride content is rather high. Since the recommended limits and maximum allowable
concentrations vary inversely with mean annual temperature, I am attempting to refine the temperature data in the Empire Ranch vicinity.

Test Well No. 2 is located within the NE_{4} of the NW_{2} of the NW_{4} of Sec. 17, T19S, R17E, G&SRB&M. The drilling is contracted to Roscoe Moss Weber Drilling Co. of Phoenix, Arizona. Drilling commenced on 28 January and as of 27 February the depth of the hole was 640 feet. The material penetrated is clay, however, there is an increase in the amount of fine sand material.

The 12 inch diameter casing is to a depth of 313 feet, and efforts to continue driving it deeper have been unsuccessful. If we cannot drive the casing deeper we have the alternative to under-ream the hole or use a smaller diameter casing.

At present, I would like to reserve the selection of solution and base it on two factors; the performance and hydraulic characteristics of the aquifer, and the economics involved in the alternatives.

At the present time the material penetrated can not be expected to have a high water yield. There is some doubt as to whether the casing can be perforated and still control the amount of fine grained material from entering the well.

The water quality based on the results on hand is good. The fluoride content appears to represent no problem.

Test Well No. 3 is located within the SW_{4} of the SW_{4} of the SW_{4} of Sec. 2, T20S, R17E, G&SRB&M and is contracted to McDaniel Well and Machine Co. Drilling was started 20 February, and as of 27 February the depth of the hole was 120 feet. The driller reports the drilling is quite hard. This is substantiated by the samples we have collected. The material consists of sand, gravel, boulders and clay.

We have not obtained any results from the laboratory regarding the chemical analyses of the water.

The conversion of the wells from test to production wells will be after the wells are completely tested. This involves complying with the Health Dept. rules. Initially the wells will be completed with a concrete base and seal between the outer and inner casing. Prior to being placed in service the wells must be equipped with sanitary seals. The estimated cost is about $500 per well.

If you have any questions regarding the above, I will be calling you Monday afternoon.

Very truly yours,

Frank A. DeLuca

FAD:mc
<table>
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<tr>
<th>Field No.</th>
<th>30'</th>
<th>80'</th>
<th>230</th>
<th>280</th>
<th>150'</th>
<th>200'</th>
<th>315'</th>
<th>350'</th>
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<td>300</td>
<td>397</td>
<td>367</td>
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<tr>
<td>Soluble Salts ppm.</td>
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<td>359</td>
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<td>EC x 10^3</td>
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<td>0.421</td>
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<tr>
<td>Calcium ppm.</td>
<td>28</td>
<td>36</td>
<td>49</td>
<td>47</td>
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<td>Magnesium ppm.</td>
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<td>6</td>
<td>6</td>
<td>2</td>
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<td>Sodium ppm.</td>
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<td>63.1</td>
<td>40</td>
<td>52</td>
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<td>Chloride ppm.</td>
<td>8</td>
<td>12</td>
<td>20</td>
<td>20</td>
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<tr>
<td>Sulfate ppm.</td>
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<td>30</td>
<td>48</td>
<td>50</td>
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<td>Carbonate ppm.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Bicarbonate ppm.</td>
<td>22.4</td>
<td>22.4</td>
<td>259</td>
<td>210</td>
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<tr>
<td>Fluoride ppm.</td>
<td>1.4</td>
<td>1.4</td>
<td>0.4</td>
<td>0.6</td>
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<tr>
<td>Nitrate ppm.</td>
<td>1.0</td>
<td>1.2</td>
<td>1.0</td>
<td>1.0</td>
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<td></td>
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</tr>
<tr>
<td>Nitrogen (N) #/A. ft.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Boron ppm.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hardness gr./gal.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SAR</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.0</td>
<td>7.2</td>
<td>7.7</td>
<td>8.0</td>
<td></td>
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<tr>
<td>Fe</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td>0.10</td>
<td>0.0</td>
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</table>
INTER-OFFICE MEMORANDUM

TO: Frank DeLuca
FROM: Stew L. Staples
SUBJECT: Test Well #3

DATE: 18 February 1970

It is my understanding that your recommendation of the approximate location of the third test well is at the southwest corner of Section 35, T19S, R17E, G&SRB and further that the actual well site can be shifted so as to fall on deeded or leased land.

After our discussion with Messrs. Webb, Nash and Yrun it is our recommendation that the well be placed on the leased land. At this time the well can be located without any major interference to the general land use plan. You should, of course, have the field crews survey the site and provide all concerned with the coordinates as soon as possible.

SLS:mc

cc: R. Calhoun
D. Cooper
J. Martin
S. Nash
M. Yrun
February 18, 1970

File No. 1137-0214-50

Mr. Frank DeLuca
Geraghty & Miller
c/o Wiséy & Ham
100 East Alameda
Tucson, Arizona 85701

Dear Frank:

Thank you for your memorandum of February 13th relative to your current program for testing and evaluating groundwater resources at the Empire Ranch. This is exactly what we were looking for at this time, and we will keep you posted of any comments received from GAC Properties, Inc.

A few procedural thoughts come to mind in reviewing your report which I would appreciate your following as you proceed with the various phases of work:

In your Paragraph No. 1-C, please advise us of the location of the selected key wells and your schedule for conducting the pump tests so that we can get proper clearance on the Empire Ranch from GAC Properties, Inc. and Mr. Boice. Please coordinate this through Sam Nash, with copies of the information to me here in Arcadia. Also, please be sure to advise Sam Nash and Frank Boice of any possible temporary, adverse affects on other wells in the immediate vicinity of the selected wells during the testing program that may affect the production of the other existing wells during the testing program.

Relative to Paragraph No. 3-C, after your field location of the third test well please send me a map showing its general location, with a copy to Sam Nash. This will confirm my previous oral authorization for you to enter into final contract negotiations with the well driller for the third test well. As with the first two test well contracts, please coordinate the contract for the third well with Sam Nash.
Paragraph No. 3-G: I would appreciate your expansion of the conversion process relative to when it needs to be done and whether or not the estimated costs of $20,000 and $24,000 for the test wells includes the conversion process. It is my understanding that the conversion would take place after completion of the testing program at a cost not included in the original contract with the well driller. However, you may have had some additional thoughts in this regard which I would be interested in hearing about.

You mentioned in your report a population of 75,000 people which is consistent with your first report. However, we are planning for a population of approximately 150,000 on the Ranch on the basis that the rate of growth will be quite slow. In subsequent conversations with Dave Miller, after submitting his initial report, we collectively concluded that based on the volume of water within the Empire Ranch Basin and a very preliminary projection of population growth that this available groundwater would supply the population needs of the project for 50 to 60 years. One of our main theses in discussions with the State Health Department is to demonstrate to them that it is not necessary to guarantee a water supply in perpetuity for an instant total population on the property, but rather to have them recognize that the available water will accommodate the needs of an orderly growth of the Ranch for many decades into the future. We do recognize that our present estimate of 150,000 people may be modified based on the results of your current test well program, but in the meantime, we want to think in terms of something approaching 50,000 dwelling units and 150,000 people. Sam Nash can fill you in, in more detail, on our thinking in this regard.

Lastly, Dave Miller may not have had the chance to pass on to you the request of GAC Properties, Inc. that all correspondence and communications relative to the Empire Ranch project are to be through Wilsey & Ham who is acting as the prime consultant for all matters dealing with the development of the Ranch. The day-to-day operation will be coordinated through Sam Nash in Tucson, but all recommendations and policies and communication with GAC Properties, Inc. must come through me until further notice to assure an orderly scheduling of work and completeness of communication and authorization of work programs.

Very truly yours,

R. T. Calhoun
Vice President

RTC/bt

cc Mr. Dan Cooper, GAC Properties, Inc.
Mr. Sam Nash
Mr. Dave Miller
Mr. Stewart Staples
February 16, 1970

File No. 1137-0214-50

Mr. Frank DeLuca
Garaghty & Miller
c/o Wilsey & Ham
100 East Alameda - Suite 513
Tucson, Arizona 85701

Dear Frank:

For accounting purposes, I would appreciate it if you would separate your costs on your invoices in the following manner:

1) Those costs related to coordinating the test well program and pumping tests on the test wells and existing wells, and

2) the actual writing of the report, summarizing the results of the test well program for use in gaining the State Health Department approvals.

In writing your report, I would like you to give serious consideration to the inclusion in your report of a section discussing new techniques and possibilities for Empire Ranch, such things as reclamation of waste water, the State of Arizona Water Project, a major pipeline network transmitting desalinized sea water, etc. All may be possibilities for increased water supplies, 30, 40 or 50 years from now when the Empire Ranch's population will be nearing its planned ultimate population. When we next get together, I will expand on my thinking in greater detail on this.

Sincerely,

R. T. Callhoun
Vice President

RTC/bt

cc  Mr. Sam Nash
    Mr. Dave Miller
1) Received authorization to hold well driller on standby basis for two or three days past February 16th or until such time as GAC grants final approval of Test Well #3.

2) Received authorization to fly the 100-scale topographic mapping on February 16th.

3) Dan Cooper will plan on being in Arcadia on February 19th.

4) Dan Cooper agreed with the concept of adjusting the boundary on all future maps to reflect a study area boundary and not necessarily an ownership boundary.

5) Plan on preparing 15 reports for the March 4th meeting.

6) Does not need colored photographs of February 4th exhibits if they are to be included in the March 4th report.
January 30th, 1970

Mr. Ronald T. Calhoun
44 East Foothill Blvd.
Arcadia, California 91006

Dear Ron:

As you requested, we have outlined below a very rough budget estimate for work at the Empire Ranch. The costs that we listed involve only the consulting services, drilling, and testing necessary for obtaining the data for presentation to various state agencies concerned with the feasibility of the proposed Empire project. Of course, this information is also critical to GAC and Wilsey & Ham for design of the utilities to serve the proposed community.

A) Drilling Contractors: This includes the construction of two test wells at Empire Ranch, assuming detailed pumping tests at three intervals in each well. The estimate is $20,000 for the first well and $24,000 for the second. It should be kept in mind that the two test wells can be used as permanent facilities. In addition, a contractor may be retained to furnish the necessary equipment for conducting pumping tests on existing stock wells. We estimate this cost to be on the order of $6,000.

Thus, the total for drilling and testing is estimated to be about $50,000 for this phase of the work.

B) Consulting Services: We estimate that Geraghty & Miller consulting services involving planning and supervision of test drilling and pumping tests; collection of essential data on water quality and overall availability of water resources; and preparation of reports, memorandum, etc., for GAC, Wilsey & Ham, and the various state agencies will be on the order of $15,000. This figure includes both per diem time and out of pocket expenses.

In summary, therefore, we estimate the total budget for this initial phase of the work to be on the order of $65,000 to $75,000, taking into account a reasonable safety factor.

I hope this satisfies your needs for now. Please let me know if you have any questions, and of course I am available for discussion at any time.

Sincerely,

GERAGHTY & MILLER, INC.

David W. Miller

DWM: jj
C.C.: Mr. Ron Calhoun
Wilsey & Ham
100 East Alameda Street
Tucson, Arizona 85701
FIGURE 1

HYPOTHETICAL CROSS SECTION
BASIN AND RANGE PROVINCE
RELATIONSHIPS BETWEEN BASIN FILL
DEPOSITS AND BEDROCK GEOLOGY

LEGEND
- Coarse-grained conglomerates (Valley fill)
- Major Thrust Fault
- Bedrock Erosional Surface
- Present Land Surface
- Former Land Surface (Pre-erosion)
- Igneous (Crystalline) Rock

NOT TO SCALE