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The Impact on Mexico of the Lining of the All-American Canal

J. Roman Calleros

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ABSTRACT

The proposed lining of the All-American Canal is a matter of profound concern in Mexico. The groundwater recharge will be significantly reduced affecting 121 wells in Mexico and more than 33,000 acres of farmland. The damages are estimated at more than $80 million per year. Mexico is urged to take a strong position opposing the lining project.

Mexico is disturbed by the plan to line the All-American Canal in the area known as Las Dunas for a stretch of almost 60 kms,[1] because it exactly coincides with the Northern area of deep wells on the Mexican side.

Technical personnel of the Imperial Irrigation District have estimated[2] that with the lining of only this section of the canal savings in the order of 100,000 acre-feet per year will be attained, which curiously enough is the volume that was agreed to be delivered to the Metropolitan Water District of Los Angeles.

The Chief of the Wells Department of the National Water Commission of the State of Baja California reports that their studies indicate[3] that 60 percent of the annual recharge of the subterranean aquifer of the Mexicali Valley is due to subterranean flows. The most important recharge contributions come from the Colorado River itself, and the northern border with the State of California with an annual contribution of almost 100 million cubic meters. Other recharge comes from Arizona in the amount of 70 million cubic meters per year and lastly the sandy mesa with 50 million cubic meters per year.

Notwithstanding the above, in the month of December of 1988, the Imperial Valley Irrigation District made public a document entitled *Water Conservation Implementation Plan* (*WCIP*), which among other aspects,

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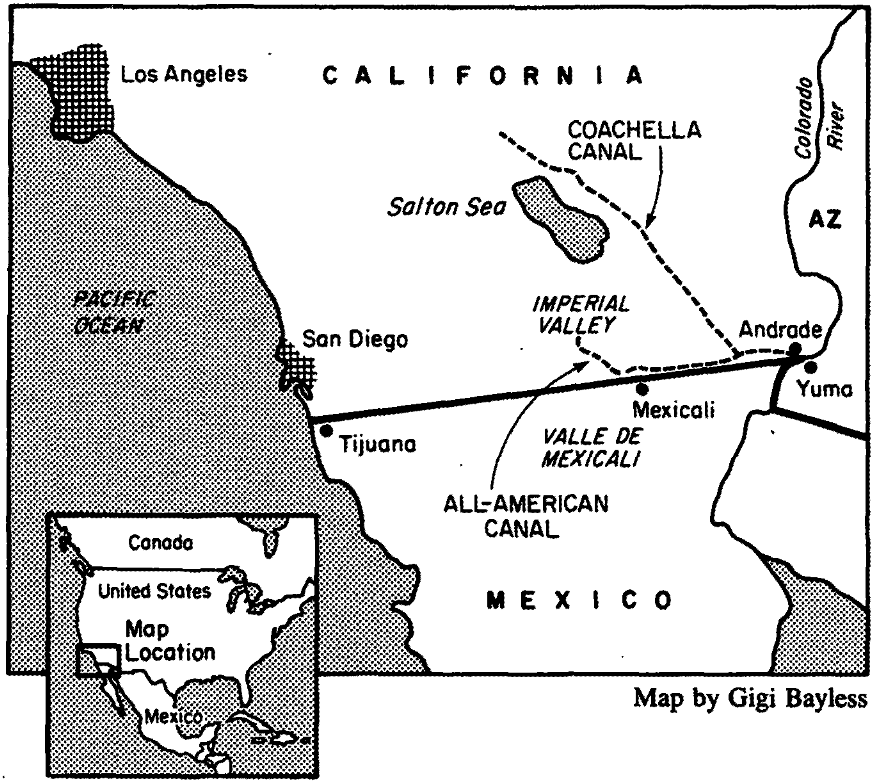
*J. Román Calleros, Investigador, El Colegio de la Frontera Norte, Mexicali, Baja California.

**The *Natural Resources Journal* has not been in a position to verify the studies cited, and the citation form used herein does not conform to the normal *NRJ* style. Nonetheless, it is thought that the information and Mexican perspective would be of interest to the reader.

1. 37 miles. Translator's Notes (TN). Translated by Lic. Rodrigo Labardine.
2. Personal Interview.
3. *Colloquy about Water Problems for Agricultural Uses*, El Colegio de la Frontera Norte, 1989.



Map by Gigi Bayless

estimated that with nothing more than the lining of the irrigation system canals it would be possible to secure the volume that was being ceded to the Metropolitan Water District.[4]

The Bureau of Reclamation[5] reports that in the Coachella Valley located to the north of Imperial, the principal canal, in a 49-mile stretch (79 km), was concrete-lined in 1980 from which water savings of 132,000 acre-feet (163 Mmc) are currently realized per year as a result of blocking seepage in that area.[6] It is necessary to note that with the lining of the All-American Canal project, a 20-mile (32 km) lining for the Coachella Canal has been included. The Imperial Irrigation District itself has been developing tests for the lining of the canals in conditions of continuous operation, i.e., to lay prefabricated concrete slabs and seal them with a

4. Table A of the Appendix of the WCIP.
5. *Id.*
6. Arizona Bureau of Reclamation Technical Bulletin, 1989.

special cement to be used in water without interrupting the water deliver service.

To carry out this continuous lining above, two types of machines have been manufactured for the purpose. The first using a system of laser-ray operated blades to maintain the level and cut and form the new current bedding at a depth of 1.2 meters. This will allow it a greater conduction capacity with a uniform topographical level. The second machine places slabs of concrete over a previously installed plastic. To date, one year after the tests were initiated, much information has been gathered. However, the data procured has not been totally encouraging because tests have shown, at least for the time being, that the placement of the concrete slabs cannot be accomplished because the speed of the current and the sandy texture do not allow the ground level to be maintained satisfactorily. Therefore, the experimental tests are still continuing. Also, since the Bureau of Reclamation is a federal agency, the project will be delayed pending the completion of environmental impact statements.

The situation is serious because we are approaching a problem with international consequences. This is true because the lining will cut off significant recharge of the aquifer. The impact will be evident and immediate on the Mexican well field in the northern part of the irrigation district which covers an area of 13,500 hectares,[7] served by 121 wells. Of these wells, 78 are handled by the federal government and 43 are private property. The number of wells, as well as the affected area, were determined by analyzing the influence area of each well and the variation of static levels in the zones that the National Water Commission has been studying for a number of years in the area of the irrigation district.

In accordance with the records of the Ministry of Agriculture and Water Resources (SARH), average reported volumes in the period 1988–1989 in federal and private wells respectively are 147 and 144 liters per second. The number of users that would be affected is 675. Each one of them has a water right to irrigate the equivalent to 20 hectares[8] per year for the irrigation crops.

Among the principal crops raised are: alfalfa, cotton, wheat, and fruits. Estimates of economic damages due to the loss of All-American Canal recharge waters have been based on average crop returns (see Table 1).

The above data was drawn from statistical data gathered by the National Water Commission in Irrigation District 14 of the Colorado River.

The damages resulting from reduced recharge will be substantial in the affected areas. They have been calculated to surpass $80 million per year (see Table 2).

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7. 33,358 acres. TN.
8. 425.5 acres. TN.

TABLE 1. Economic Effect by Damage to Crops.

Crops	Area	Income/Ha (Pesos)*	Income/Ha (Dollars)	Total Income (Dollars)
Wheat	5,229	1.737	689	3,602,781
Alfalfa	1,333	3.249	1,140	1,519,620
Cotton	5,660	3.073	1,078	6,101,480
Asparagus	214	9.241	3,300	706,200
Fruits	60	60.861	2,450	147,000
Various	942	7.062	2,478	2,334,276
TOTAL	13,438	31.223	11,135	14,411,357

Source: Statistics Department of NWC, 1990.
* = Millions of pesos.

TABLE 2. Total Effect Costs.

Damaged Item	Quantity	Cost (Dollars)
Pumping Wells	121	9,680,000
Agricultural Lands	13,500	47,358,000
Crops	Various	14,411,357
Labor	2,700	9,336,000
TOTAL		80,785,357

Notes:
1. Cost of wells is $80,000 per well.
2. Price per hectare of land is $3,508.000.
3. Costs of crops are taken from Table 1.
4. Four employees were taken as basis per year/per tract, and employed with two and one-half minimum salaries per employee.

Also, one of the effects that should be detected immediately would be an increase in the salinity level in the water of the aquifer. The quality of the aquifer's water will be impacted by reducing the All-American Canal subterranean volume flows. These flows allow a greater dilution effect with water that is systematically recycled to provide a washing action of the soil in the irrigation of agricultural crops. Diminution of the volume of the groundwater will accelerate the increase in salinity since the proportions of recycled water are approximately 40 percent of the total volume of water used for washing.

Also, there will be less groundwater to be used to dilute surface water deliveries from the Colorado River that Mexico receives at Morelos Dam, and this groundwater will be of a lower quality. This situation truly represents a danger for Mexico because in accordance with observations taken by several researchers,[9] the salinity tendency of the Colorado River water has an ascending character as more water is diverted upstream leaving less for dilution. Using 1902 through 1989 as a base period, it was possible to estimate, using regression techniques, that by the year 2010 the salinity of the water that Mexico will receive through the Morelos Dam will be 1150 ppm, which is the upper limit for usable water for agriculture.

Another immediate impact will be the lowering of the aquifer's static levels.[10] This will translate into a reduction in the aquifer exploitation capacity and consequently in a gradual elimination of wells that operate in the area and in diminution of extracted volumes in other wells, in amounts not yet ascertainable.

FINAL COMMENTS

We must not forget that salinity is a natural phenomenon that has been affecting the Colorado River during the past 90 years in a rather considerable manner. In the very near future, the salinity levels that the Imperial Valley receives will increase as diversions increase upstream in the United States, and that concentrations in the range of 1,300 to 1,500 ppm can barely be tolerated by the soil and crops that do not have an artificial drainage, i.e., all the crop land in the Mexicali Valley.

Even though there have been delays due to problems in the lining technique and the environmental impact assessments (ironically limited to effects on the American side only), nonetheless lining the All-American is imminent because the financing will be available to carry it out.

A real threat hangs over Mexico; because of the growing need for water for Los Angeles and San Diego there still may be a real need to line the All-American.

In a statement made to a Baja California newspaper, the supervisor for the First Imperial District, Mr. Luis Legaspi, said: "At present, many cities in California have a serious problem due to lack of water and are searching for feasible solutions, first of all to get the water from the Imperial Valley. Notwithstanding that the Colorado River currently has enough water for everybody, the fact that Arizona won the legal dispute over California in the Supreme Court allows the cities of Phoenix and Tucson to begin taking water from the Colorado, limiting availability to users currently enjoying such benefit."[11]

9. Bernal, R. F. y Cervantes, R. M., 1990.
10. Springall, G. Gr., 1970; UNAM, Hydrology, First Part, pp. 112 and 113.
11. *La Voz de la Frontera*, April 9, 1987, p. 2-a.

As San Diego and Los Angeles grow, even more water may be transferred from the Imperial Irrigation District.

When the author asked a representative of the Metropolitan Water District of Los Angeles as to his opinion regarding any international repercussions that the lining of this canal might have, he answered: "That is of no concern to us because the United States has no agreement with Mexico concerning the use of subterranean water."[12]

This statement, should we take it at face value, would represent a problem of international dimensions even if our country has not signed an agreement with the United States concerning groundwaters. Mexican interests will be damaged by the proposed alterations to the hydraulic works present in the Imperial Valley. This is a flagrant violation of Section 6 of Minute 242. Mexico must energetically protest at the highest level, i.e., from president to president as is the custom in these recurring controversies along the northern Mexico border.

Our negotiators will have to be assertive and persistent in dealing with the United States on this matter. It is imperative that, as of today, our authorities begin gathering and expanding the technical information base. It will be necessary to utilize a panel of experts in subterranean hydrology and other fields related to border matters in order to evaluate the conditions of current and potential use of our subterranean water along all the border region. This information base is extremely important for our representatives because it will allow them to negotiate on the basis of objectively verifiable data.

Mexican officials have been informed in various ways of the seriousness of the problem. However, they have only responded that for the time being there is no lining plan for the All-American; they should not wait until the problem is at its crisis point and then start their protests. This has happened before in the 1960s regarding the salinity of the Colorado. The Colorado River salinity problem began in 1956 and nobody said a word.

APPENDIX

Description of the Area

The area represented by the Imperial and Mexicali Valleys is located in the area called the Saltón Trough.

The subterranean water system, beneath the Yuma and Mexicali Valleys, is part of an enormous aquifer composed of permeable alluvial material deposited by the Colorado and Gila Rivers that gave birth to the Colorado River's delta.

12. Private Conservation with Representative of Metropolitan Water District, 1991.

The Colorado Delta aquifer is beneath the border states of California, Arizona, Sonora and Baja California.[13]

The area's general geomorphology encompasses seven principal formations, which are:

1. Mountains and hills
2. Old river deposits
3. Exposed slopes of Pie de Cerro
4. Non-exposed slopes of Pie de Cerro
5. River terraces and mesas
6. Dunes
7. Valleys

The subterranean water storage is principally carried through highly permeable strata that basically consists of the following two terrain subdivisions:

1. low water content rocks of the Tertiary period, and
2. deposits that contain water of the Pliocene-Oligocene.

The fine material in the top that forms the stratum located in the extreme top of the recent alluvial deposit that lies beneath the valleys and small tracts is a sand dune zone that has focused our attention here. In accordance with the geohydrological study carried out by the Department of Water Resources of the Resources Agency, in bulletin 143-7 of 1970, this dune zone has a depth of 100 meters[14] in the sandy strata, where it is estimated that the principal flows are located precisely between that depth and the surface.

Hydrological Classification of the Aquifer

The main characteristics that define an aquifer that allow determination and a quantitative analysis of its response to changes in overflow or its exploitation are the transmissibility (T) and the storage coefficient(s).

The area's values for T vary from 12,409 cubic meters (m^3) to 99,972 m^3/day/m,[16] i.e., the highest terrain transmissibility values are present in this area representing a greater exploitation potential of the aquifer but is also of greater affect should the lining works be initiated.

The area's storage coefficient values from .18 to .31, and is precisely the pumping zone of the Yuma and Mexicali Valleys where the .31 and .18 values are respectively reported.

Based upon said storage coefficient values, exploitation of this whole area's subterranean aquifer is indicated as completely feasible.

13. Trava, J. L., 1987.
14. Approximately 110 yards. TN.
15. 438,220 cubic feet (ft^3) to 3,530,478 ft^3. TN.
16. 2,629,318 ft^3/day/m to 3,530,478 ft^3/day/m. TN.

Transmissibility values and storage coefficients for the delta area of the Colorado area shown in Table 3.[17]

TABLE 3. Transmissibility Values and Storage Coefficients for the Colorado Delta.

Delta Zones	Transmissibility Gallons Thousands day/ft	(T) Meters^3 Thousands day/m	Storage Coefficient(s)
Las Dunas	600–800	75.4–99.3	0.18
Pilot-Knob	200–400	24.8–49.6	0.18
Reserv. Bard	500–800	62.0–99.3	0.31
Yuma Valley	100–500	12.4–62.0	0.31
Yuma-Mesa	500–1,000	62.4–124.0	0.18

Source: OLMSTED et al., Geohydrology of the Yuma Area, Arizona and California [5,1973].

Subterranean Water Movement

In accordance with reports given by Trava (1987), based on the static levels in the year of 1939[18] water movement was observed in a clear westward direction in the river's border zone changing later to a southward direction. In what today is the wells area in the Mexicali Valley, static levels of the aquifer fluctuated between the 37 and 17 meters[19] above sea level.

Using a T value of 9,928 cubic meters (CM) per day per meter and a gradient of .76 m per km, subterranean water volume that drained towards Mexico was estimated at approximately 90 million annual cubic meters. These figures that are quite proximate with reported data from the Imperial Valley District.

By 1960, water movement in the river's border area was, in general, still in a westward direction, but situated now in the northern area, water movement direction had a greater tendency towards the south, approximately in a 25-mile (40 kilometer) distance from Pilot Knob to dam number 3 of the All-American Canal, due to filtrations originating from the All-American itself.

From such reading it is concluded that even before 1960, the All-

17. Trava, 1987.
18. In 1939, the All-American Channel was under construction therefore the subterranean flows had not yet been modified.
19. 121 and 56 feet. TN.

American contribution to the Mexicali Valley aquifer was an important source of external recharge.[20]

By the year 1965, the contour of water levels in the All-American area were perfectly defined with a tendency to a southward direction.

In order to evaluate the Mexicali Valley subterranean aquifer variations in the Ministry Agriculture and Hydraulic Resources (SARH) annually effectuates a total stoppage of wells located in Irrigation District 14 in the first days of the month of February. Level readings are conducted in 204 observation wells previously selected.[21] With this generated information, the depth of the static levels, direction of subterranean flows, and variation of feasible annual exploitation volumes can be ascertained. In accordance with this information, we can appreciate that the depth of static levels in the oldest exploitation area has varied from 4 m to 10 m.[22] These curves of depth levels flow in a west-east direction.

The study[23] finds that in wells GI-12, GI-23, 7-Lesser and GI-13, located in the north area of the Irrigation District, by the foothills and to the west of the Andrade Sandy Mesa and parallel to the border line with the United States of America, the artesian phenomenon (water comes to the surface on its own) persists, due to the subpressures of subterranean currents originating in the north section in the border with the United States of America.

In fact, due to these flows, some of the subsurface-type, it was necessary to construct an open-to-sky drainage, parallel to the border with a 5 meter[24] depth, that was capable of intercepting water currents.

In accordance with SARH data, the average volumes that have been intercepted with this unique drainage have varied from 1.0 cubic meters per second (mcs) to 4.95 mcs. Calculated in annual periods this volume by itself has represented a flow that varies from 56.76 million cubic meters (Mmc). To this volume we would have to add water that is not captured or intercepted by the Andrade sandy mesa drainage in order to really know the volume that derives from subterranean flows of the northern area.

From studies conducted it was possible to determine that the following three flows of subterranean water exist:

1. North to south flow, following a course parallel to the river's bed.
2. The second flow is located in the San Luis Mesa flowing north to south, draining into the California Gulf.
3. The third flow is registered in the Andrade Sandy Mesa with an

20. Trava, p. 20, 1987.
21. Paredes, 1990.
22. 13.1 to 32.9 ft. TN.
23. SARH, 1990.
24. 16.4 ft. TN.

east to west direction neighboring the international border with the United States and going through the artesian wells.

In the same study, SARH states that static levels do not exist below sea level in either of the subterranean water pumping zones. That may indicate a severe extraction restriction notwithstanding the annual pumped volume whose last 15 years average has been very close to 1,000 million m^3 (752.6 Mmc), slightly above the recommended volume which is 700 Mmc. This volume was calculated based on the geohydrological study conducted in 1978 by the Agriculture and Hydraulic Resources Secretariat.

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