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Marshall, Arthur R., *The Kissimmee Okeechobee Basin*, December 12, 1972.

THE KISSIMMEE-OKEECHOBEE BASIN

A Report to the Cabinet of Florida

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December 12, 1972

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Second Edition

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I have just returned from south central Florida and the death-bed of an old friend. Although it has been definitely established that the death will be a boon to something called "progress", the sight was a most depressing one.

The about-to-be-deceased is a river, the Kissimmee River that wound for nearly 100 miles down to Lake Okeechobee. It twisted from a couple of lakes near Kissimmee, across great marshbanks, past cypress heads and live oak and cabbage palm hammocks.

Now under the assault of great, floating suction dredges and draglines -- seemingly enough of them to build another Panama Canal -- a straight-gut canal is being chopped through it, cutting its length in little more than half.

It is the more depressing to those who love their rivers au natural because this sort of thing has become a rapidly increasing pattern in a state where wooded streams once were a major natural asset.

Steven Trumbull in *THE MIAMI HERALD*, October 3, 1965

.....conservatively we can expect another million people in this belt of urbanization in the central part of the State [Daytona south to Lake Okeechobee]. It is probably going to go higher, and the doubling of the population of this State, which is predicted by Jerry Picard, the noted population expert in the ST. PETERSBURG TIMES this morning is that growth, a substantial portion of it, will be an expansion in the Orlando central area and which now will be connected with both coastal flanks of the State. This will be a continuous urbanization from the coast at St. Petersburg, east through Orlando and northeast to Daytona, impinging on the Green Swamp, impinging on the headwaters of the Reedy and the Kissimmee Rivers. . . .

So we have here an area which is the heartland of the State within which gigantic development is taking place and which is of direct concern to the future water supply of the peninsula from the Oklawaha south.

Carl Feiss in *Florida: The Seeds of Crisis*
Red Flag Charette, Findings and Recommendations
March, 1972

INTRODUCTION

ARTHUR R. MARSHALL:

Despite the stringent nature of our statements, my colleagues and I are on a conservative mission -- to try to restore some of the lost values of the Kissimmee basin and, in association with that, to try to prevent an Apopka-like collapse of Lake Okeechobee. Since the basin has been gutted and the Lake is already highly enriched, that is not going to be an easy task.

Arguments over the canalization of the Kissimmee River began while the work was being planned in the late 1950's and the turmoil really never stopped. Widespread complaints against these works were based on the destruction of the aesthetics of a natural meandering river and its rich marshes (a complaint heightened by the fact that natural rivers in south Florida are rare indeed), on the near decimation of popular fish resources, and on the vast reductions of wintering water fowl in the valley.

That such concerns did not originate entirely from sources beyond the design engineers is evidenced from an almost clairvoyant memorandum ([Appendix #1](#)) of October 4, 1957 to the Executive Director of the Flood Control District which stated:

The Kissimmee marsh has an ever increasing aesthetic value which is not provided sufficient protection under the present plan. Rapidly expanding population and land development in Florida, plus a dependence on the tourist trade, makes it especially necessary for this state to protect certain wild areas for the future. Improper development could destroy much of the value of this natural resource forever, and such destruction could conceivably spell the political doom of the Flood Control District.

That memorandum originated from Mr. Thomas Cunningham, at that time Director of the District's Division of Planning and Resources.

Since 1957, Florida has had a liberal education in the over-enrichment of fresh waters, now proven to be a

matter of concern for Okeechobee. This is of top importance to all Floridians, but especially to those of south Florida who now depend on it for their drinking water. It is also the prime dependable storage facility for south Florida, as in intermittent dry seasons, Okeechobee's waters are diverted via canals to ebbing coastal aquifers to combat salt intrusion, and to provide a ground water supply for direct pumpage into municipal water systems. These factors -- of deteriorating lake water quality and increasing dependency on the lake supply -- emphasize the gravity of our subject. Clearly, it is conservative to protect our waters, the most vital of all natural resources; it would be radical to do otherwise.

We were compelled to seek this Cabinet hearing because we are convinced that the water quality situation in Lake Okeechobee is tending rapidly toward irrevocable misfortune and because we recognize that no arm of state government other than the Cabinet has the sweep of authorities necessary to remedy the matter. Further, years of attempting to persuade other arms of government to alternate courses of action have not avoided the calamity facing south Florida now. It is now evident that the inaction of those years has brought us to a precipitous position in regard to Lake Okeechobee.

The Kissimmee-Okeechobee problem is regional in scope. At a minimum, its solution involves the Florida Cabinet; the Florida Legislature; the Department of Pollution Control; the Department of Administration, Division of Planning and Bureau of the Budget; the Department of Agriculture; the Florida Game and Fresh Water Fish Commission; the Trustees of the Internal Improvement Trust Fund; the Department of Natural Resources; and the Central and Southern Florida Flood Control District. Federally, the U. S. Army Corps of Engineers; the Environmental Protection Agency; the Department of Interior; the Department of Agriculture and its Soil Conservation Service; the Congress and the Administration also are involved.

A few special words about the Flood Control District. It obviously has had and still has a vital role in the issue. We recognize the necessity for its participation; but we recognize as well the inadequacies of its authorizations as weighed against the scope of the problem and the speed of action which is required. In news releases pertaining to the restoration work proposed for the public works project in the lower Kissimmee Valley, the District has emphasized that two additional feet of water placed seasonally in four or five subimpoundments will increase the aquatic life and bird life there. It will -- and all of us admire that. But it will do little to resolve the threats to the water quality of Lake Okeechobee, a truth which the District publicly admits ([Appendix, #2](#)).

The region of concern is the Kissimmee-Okeechobee drainage basin. It includes the chain of lakes in the upper valley, all situated in proximity to Orlando and the impact zone of Disney World; the now canalized lower Kissimmee; and other tributary areas surrounding Lake Okeechobee.

The lower Kissimmee River, which was canalized in the mid-60's as a part of the Central and Southern Florida Flood Control Project, plays a prominent role in the Kissimmee-Okeechobee problem -- prominent because many resented and still resent the destruction of a beautiful and productive river, because the Canal drained 65% or more of the valley's marshes, greatly reducing their fish and wildlife populations and nearly obliterating their ability to reduce the passage of nutrients to Lake Okeechobee, and because the Canal serves as a pipe in speeding the flow of wastes accumulated in the upper lakes to Okeechobee.

That Canal, like all drainage canals in south Florida, struck another hard blow. It opened up former marshlands for extensive real estate development, generating wastes where we can least tolerate them and elevating land prices so markedly that the public can consider land purchases only because failure to do so will jeopardize prime water supplies. This element is clarion-clear in the case of the Kissimmee Canal. The FCD estimates that it can purchase the lands to be re-flooded in four of their proposed subimpoundments along the Kissimmee Canal for about \$4 million -- about \$400 per acre. To buy the fifth impoundment -- in

the vicinity of River Ranch Acres development -- will cost about \$18 million or about \$4000 per acre.

This is a particularly important issue in the future of the lower Kissimmee Valley, for whatever reflooding we accomplish now will likely fix the limits of marshland development, whether or not we find later we need more marsh. By that time all adjacent lands will have been opened up to \$4000 per acre development -- all the way down the valley -- forever.

Prior to canalization, the lower Kissimmee River meandered down several braided channels or in high water flowed sluggishly southward over a flood plain up to three miles wide ([Figure 1](#)). It is now thoroughly regimented in its flow ([Figure 2](#)) if not so efficiently suited for producing fish and wildlife or in helping to maintain water of potable quality in Class 1 Lake Okeechobee.

UNREPRODUCIBLE

FIGURE 1: THE KISSIMMEE RIVER AND MARSHES PRIOR TO CANALIZATION

UNREPRODUCIBLE

FIGURE 2: THE KISSIMMEE RIVER AFTER THE INCURSION OF CANAL 38 LOOKING NORTH EAST S-65A.

Note oil banks and remnant of the river at mid-left.

At the John F. Kennedy Space Center, the National Aeronautics and Space Administration graciously assisted us in this presentation with several recent photo-prints of the Kissimmee area. A photo made from a Gemini satellite in November of 1966 ([Figure 3](#)) shows the succession of straight cuts which shortened the distance water must travel from 100 to about 50 miles in the reach between Lake Kissimmee and Lake Okeechobee. A more recent printout from imagery in the infrared spectrum made from an Earth Resources Technology Satellite in September, 1972 displays the stark scar made by the Canal ([Figure 4](#)). It is interesting to note that no other human artifact is readily discernible in this print -- neither farm nor city. Perhaps that offers us an alien scale of our doings.

UNREPRODUCIBLE

FIGURE 3: PHOTOGRAPH MADE FROM A GEMINI 12 SATELLITE;

note spoil banks of Canal 38 mid-right. (NASA photograph)

FIGURE 4: MOSAIC OF INFRA-RED IMAGERY SHOWING LAKE OKEECHOBEE AND MAJOR CANALS:

Caloosahatchee (C-43) at 7 o'clock; Kissimmee (C-38) at 11 o'clock; and the St. Lucie at 2 o'clock (ERTS-1 photograph)

HYDROLOGY

JAMES H. HARTWELL:

I would like to describe to you the streamflow characteristics of a natural stream and those of a stream that has been canalized. In particular, I would like to acquaint you with the flow changes that have resulted from the incursion of Canal 38, of the Central and Southern Florida Flood Control Project into the watercourse of the Kissimmee River between Lake Kissimmee and Lake Okeechobee.

The sinuous shape of the natural Kissimmee River was formed by variations in water flow caused by rainfall and topography. The flows set in motion erosion and deposition processes which continued unabated for eons. A broad, flat floodplain evolved which was interspersed with lakes and ponds -- the remnants of former watercourses left by the river's meanderings. This floodplain, subjected to inundation from river overflow, fashioned a wetland area up to 3 miles in width. Between Lake Kissimmee and Lake Okeechobee these intermittent wetlands comprised some 45,000 acres.

The completion of Canal 38, with its appurtenant water control structures (S-65, 65A, 65B, 65C, 65D, and 65E) has drastically altered the wetlands. Personnel of the Flood Control District have estimated that under present operating procedures only 8,000 acres of wetlands remain in a wet condition. Recently, the Central and Southern Florida Flood Control District (FCD) proposed that the operational water levels be raised at certain times during the year. By their estimate, this new water regulation change would inundate an additional 9,000 acres of former wetlands. Even if this change were instituted and it provided 17,000 acres of wetlands, this is a far cry from the original wetland acreage.

Beyond change of acreage, the construction of Canal 38 has made a drastic change in the regimen of water flow. Historically, after a rainfall, the flow would increase gradually and then recede slowly. The time to reach a peak flow would be several days after the cessation of rainfall. Today, the peak flow is usually reached on the day when the heavy rain falls, and, with the closing of the water control gates, the flow rapidly declines. These remarks describe simply the hydrology of canalization.

An example of the changes in flow into Lake Okeechobee that have resulted from the construction of Canal 38 are illustrated in [figure 5](#). The dotted trace shows the daily flow into Lake Okeechobee which occurred in October, 1953 -- prior to the canal construction. The peak flow of 17,600 cubic feet per second (cfs) on October 13th was the highest occurring during the entire period of measured natural flow - October, 1928 to September, 1962. For comparison, the solid trace

FIGURE 5: KISSIMMEE RIVER AT STRUCTURE 65E

Source: Records of U. S. Geological Survey and U. S. Weather Bureau.

is the daily flow in October, 1969 -- the highest flows that have occurred since the completion of Canal 38. It also should be noted that the peak flow of October 3, 1969 (23,500 cfs) occurred on the day of maximum rainfall, whereas, the peak on October 13, 1953, occurred 3 days after the cessation of rainfall. Also, note the rapid decline in flow after the peak in 1969, and the slower recession in 1953. Despite the changes in daily flow patterns, the total monthly inflows to Lake Okeechobee for the two years were somewhat the same. In 1953 about inches of rain produced an inflow of 724,000 acre-feet, and in 1969, 9 inches of rain produced 615,000 acre-feet.

A further comparison of flows can be made using information prepared by the Corps of Engineers in their *General Design Memorandum, Kissimmee River Basin, 1956*, the engineering design document for Canal 38.

This report describes the August, 1928 storm as "one of the most severe of known record." It further States (sic):

Torrential rains accompanying two tropical storms occurred throughout Central Florida during the period August 7-14 [1928]. In that period a total of 16.21 inches of rainfall was observed at St. Cloud, in upper basin. No streamflow or stage data are available to indicate the extent and severity of flooding in the Kissimmee Basin. However, it is estimated that a peak flow of about 20,000 cubic feet a second was discharged from Kissimmee River to Lake Okeechobee, exceeding any discharge since that time...

Both the 1953 and 1969 peaks were generated from about **4 inches** of rainfall with peak flows of 17,600 cfs and 23,500 cfs, respectively. The August 1928 storm with a reported **16 inches** of rain produced only a peak flow of 20,000 cfs. These comparisons show the dampening effect of runoff afforded by a natural stream system.

One might ask: What is wrong with providing works that move water much more rapidly into Lake Okeechobee? First, the wetlands do not remain inundated, and thus cannot perform their nutrient uptake function. This will be elaborated by others. Second, the speeded water flow, which acts as a transporting agent, rapidly discharges concentrated contaminants into the Lake, thus hastening the degradation of the Lake's waters. And, third, the large surges of flow cannot be readily discharged from the Lake, owing to insufficient conveyance capacity. Maintaining safe water levels in Lake Okeechobee has become uncontrollable at certain times of high water with the present canal system.

The proposal to raise the operational levels at structures 65 (A through E) needs elaboration. Presently, the water impounded above the various structures forms a reservoir with a nearly flat water surface. The gates are manipulated to maintain an "optimum" water level. When this level is maintained, only a small portion of the original wetlands, in short reaches just above the control gates, is inundated --- 8,000 acres by FCD estimate. The raising of the operation schedule two feet would add another 9,000 acres of under-water area. The new total of watered area would be 17,000 acres which compares with the original 39,000 acres of wetlands between S-65 and S-65E.

Neither the present operation of the S-65 gates nor the proposed operational change will reconstitute the original wetlands. Historically, these lands were subjected to periodic inundation, in season, with a flow through of water. Presently, the maintenance of nearly the same water level year round creates a pond whose ecosystem functions differently from that of natural wetlands. If the water level is raised two feet, or over eight feet, the result will be to merely increase the size of the ponds -- not to restore the viability of the wetlands.

To further illustrate this point, I refer you to [figure 6](#). At the top is a profile of the original river bank with the optimum and proposed schedule of water levels. The general downstream slope averages about one-half foot per mile. The upstream extent of the present, optimum water level at each gate is shown in the lower, shaded area. It extends only a short distance, in the canal, above each control structure. When the level is above the river bank, water spreads laterally onto the wetlands. By raising the regulation schedule 2 feet to the proposed, maximum level, the ponds would be extended further upstream, and area of floodplain inundation would be enlarged. Even with this change, more than one-half of the wetlands would still remain dry under the new regulation schedule, except for rainfall on the area.

A typical section across the Kissimmee Valley would show that the floodplain is very flat. This flatness is of importance, for when the water level in the canal exceeds the river bank height, the water readily spreads

over the former wetlands.

FIGURE 6: GENERALIZED PROFILE AND PLAN OF THE KISSIMMEE RIVER BETWEEN 3 S-65A and S-65E

Source: FCD data

The lower graph shows schematically the general area of inundation in plan view. Note again the large uninundated area.

Under the present regulation schedule, water levels are held within a few tenths of a foot of the optimum level nearly all of the time. The seasonal variation of high and low water levels in the wetlands is no longer present. This fluctuation, as well as a wet condition, is vital to the well-being of the wetlands. Neither the present nor proposed FCD operation of the S-65 structures will reconstitute the Kissimmee River wetlands.

EUTROPHICATION: PROCESS

DAVID S. ANTHONY:

LAKE OKFECHOBEE - POLISHING POND FOR EAST CENTRAL FLORIDA?

Often, a biologist or medical researcher studying the effects of a chemical or drug on living things finds that a little is essential, a bit larger amount may or may not be beneficial, but a real overdose has disastrous results. I believe you in political life have observed a similar set of phenomena applicable to taxes, laws, and regulations. Thus any presumed breach between our professions may be more imagined than real.

The waters of the Kissimmee-Okeechobee system are receiving an overdose of nutrients (such as the familiar fertilizer ingredients nitrogen (N) and phosphorus (P)). The warning signs of impending disaster are visible. If we continue overdosing the Kissimmee-Okeechobee system as we are now, the collapse of Lake Okeechobee is certain. Only the timing is uncertain.

A full treatment of this subject requires consideration of several questions, namely:

1. What disaster are we talking about?
2. What is causing it?
3. (Hopefully) what can we do about it?

THE DISASTER

(The technical term is eutrophication.)

Stated simply, the waters of the Kissimmee-Okeechobee system, due to man's activities are receiving an overload of nutrients, and Lake Okeechobee, acting quite normally as a nutrient trap, is storing much of what it receives. This is establishing the conditions for an explosive growth of plants in the lake -- algae, hyacinths, hydrilla - which will be followed by changes from sports fish to rough fish (such as gizzard shad), algal "blooms", bad odors; fish and animal kills have already occurred. All of these conditions and the attendant economic losses have been seen in nearby Lake Apopka.



When one considers the factors which tend to maximize plant growth in lakes, it is no wonder that Florida's lakes are especially vulnerable to the effects of added nutrients. The dominant factors maximizing aquatic plant growth are:

1. High levels of nutrients (such as N and P)
2. High light intensity
3. Warm temperatures
4. Time (long growing season)

As you can see, the last three of these factors are basically natural phenomena, not readily affected by man. Even a nutrient input into lakes is a natural phenomenon. That is, lakes naturally accumulate their nutrient supply and, over the span of thousands of years, may develop some of the symptoms described previously. That is, they may slowly become eutrophic through natural processes.

Man's activities, however, greatly increase nutrient inputs into waters. Other conditions here in Florida -- the warm, shallow lakes and the presence of exotic plants such as hydrilla insure that **man's activities maximally damage Florida's lakes**. Eutrophication occurs in decades instead of millenia (sic) and the waters of the Kissimmee-Okeechobee system are well on their way to such collapse.

THE CAUSE

As we have already indicated, the major source of trouble in Florida's lakes is a build-up of nutrients, which causes greatly excessive plant growth, that in turn leads to fish kills, algal "blooms", accumulations of organic ooze, etc.

The question is: Where are the nutrients coming from? This question may be answered either (sic) geographically, or on the basis of the activities ultimately producing the nutrients.

Geographic sources of nutrients: As indicated in [figure 7](#), the major input of nutrients to Lake Okeechobee in 1969-70 was via the Kissimmee River, with substantial input from rainfall, and from other tributaries.

FIGURE 7: NITROGEN INPUT INTO LAKE OKEECHOBEE

Source: U.S.G.S. "Appraisal of Chemical and Biological Conditions of of Lake Okeechobee, (sic) 1969-1970.

While these inputs have been enough to cause serious water quality problems already, the future is far more frightening. Although there were enough people contributing their nitrogen input to the Kissimmee drainage in 1970 to make it far and away the major source contributing to the eutrophication of Lake Okeechobee, by 1990 the population of this region is expected to be three times the 1970 population. Lake Okeechobee simply cannot stand three times the nitrogen input!

Activities of man producing nutrients: The usual sources of man-added nutrient input into the waters of a mixed urban-agricultural land use area (not necessarily in order of importance) are:

1. Sewage effluent
2. Agricultural runoff
 - a. from fertilizers

2. animal wastes
 3. from food processing
3. Urban runoff

The relative importance of these sources depends on the urban/rural ratio, on the efficiency of sewage treatment, and on agricultural practices the area . In an area experiencing an explosion in human population such as this region, we would expect sewage effluent to be quantitatively the most important source of man-added nutrients, with urban runoff not far behind. Further, the canalized Kissimmee River will squirt this load directly into Lake Okeechobee. Tragically, the spoil banks of the Kissimmee canalization project effectively prevent using the nutrient removal capabilities of the river marsh which lies only scant yards away, but walled off by the banks. Even worse, these same spoil banks have actually buried and destroyed substantial acreage of this valuable marsh. Dr. Lugo will discuss in greater detail the nutrient removal by marshes.

SEWAGE POLISHING POND ANALOGY

Downstream from some sewage treatment plants and directly connected to the Plant by a pipe is a pond. This body of water, in the jargon of the trade called a polishing pond, is normally a hideous green soup because it is filled with a rampant growth of algae. The bottom accumulates a fine, watery organic mud as the partially decomposed husks of dead algae settle out. The builders of the sewage plant put the polishing pond there precisely because the algae do grow, die and settle out, carrying with their bodies some of the excessive amount of nutrients in the sewage effluent. These unpleasant bodies of water are designed to function as a partial nutrient trap, but no one swims or fishes in them. In fact, they usually are fenced off behind high wire fences so no venturesome children or animals can even accidentally get to them.

On a very large scale, the Kissimmee-Okeechobee system is already beginning to serve as the polishing pond for east central Florida (all or parts of Orange, Osceola, Polk, Highlands, Okeechobee, Glades, and Palm Beach Counties). The excess nutrients from the people already there are causing excessive algal and other plant growth, the bottoms of lakes in the system are building up organic muds (ooze). Fish kills are becoming more frequent and the lakes are becoming more and more turbid.

Since the population of this region, centering on Disney World as it does, is expected to increase enormously in the next 20 years, the nutrient load on the Kissimmee-Okeechobee system can be expected to increase accordingly. All of the biological signs now present say that if we allow this to happen, **Lake Okeechobee will become the polishing pond for east central Florida.**

WHAT CAN WE DO?

We are between a rock and a hard place.

If we do nothing, fouling of Lake Okeechobee is certain, only the timing is in any real doubt. If we take half-measures to correct the situation, the costs will be very substantial, but the gains uncertain and temporary. If we take all of the measures necessary to have the greatest probability of success over a long time, the costs will be very great indeed, but the costs of not preventing the collapse of the Kissimmee-Okeechobee system will be far greater than even this. Mr. Marshall will explain and evaluate the options in greater detail, and will suggest some immediate actions to get on with the task.

How did we get into this bind?

Quite simply by not even coming close to paying the costs of growth over the years. Now, Mother Nature is demanding payment of past dues and payment on time or in advance for any future growth.

As a minimum, we will have to do all of the following if Lake Okeechobee is to continue as it must, to serve south Florida as its source of portable water, and if it is to continue as a great recreational resource.

1. We must reduce nutrient input into tributaries and into Lake Okeechobee.

This means advanced waste treatment for the whole present population of the Kissimmee- Okeechobee basin. Most especially, it means such treatment installed in advance and paid for in full by any future developments in the region. It also will require modification of agricultural practices to reduce agricultural runoff. Back-pumping of nutrient-rich agricultural runoff must cease.

2. We must remove nutrients from tributaries.

Since a serious nutrient input will come from urban runoff even if we have advanced treatment of all sewage, we must remove as much of the nutrients as possible before they enter the Lake. This can be done most efficiently by allowing the tributary waters to flow through extensive marshes in the area before they enter Lake Okeechobee. Dr. Lugo discusses this point in detail. This will involve purchase of control of the marshes and will require virtual elimination of the canalization of the Kissimmee River (now more properly called Canal 38).

The FCD proposal for a series of small, shallow subimpoundments will not deny the problems of Okeechobee -- as the District states. Taken by itself, even with present nutrient loads, this course of action will be at best a temporary expedient. Such small bodies of water would be rather quickly overwhelmed (eutrophied) by the nutrients, spilling the excess into Okeechobee. Further, such ponds, with their control structures, would present a great temptation to simply open the gates in periods of high water -- injecting a great slug of untreated nutrient-rich water directly into Lake Okeechobee.

3. We must remove nutrients from Lake Okeechobee.

Systematic harvesting of fish (consistent with its carrying capacity) from the Lake would remove significant quantities of nutrients. The Lake is currently greatly under-fished. Mechanical removal of noxious plants would also aid in nutrient removal.

SUMMATION

No one can say with certainty how much time these actions will buy for Lake Okeechobee as a valuable resource. We probably can buy a very great deal of time. What can be said with absolute certainty is that such actions will buy very much more time than is now remaining if nothing is done.

Because Okeechobee is already in early eutrophy, we are apprehensive about another significant parallel between it and Lake Apopka. In the latter case, a supercharge of nutrients was suddenly released from piles of rotting vegetation along the shore, plants which had been windrowed (sic) there by the 1947 hurricane which passed over that Lake. The high nutrient load already in Apopka before the hurricane made it a prime candidate for full-scale eutrophy. Nutrients leaching from the rotting plants triggered its collapse.

A similar situation also could occur in Okeechobee, though, perhaps from a different mechanism. Throughout the dry months of the year, wastes of all sorts accumulate through great areas of the basin. At some point of

time a sudden wash of these to Okeechobee with the onset of rains can suddenly trigger Okeechobee to severe eutrophication.

We know the situation is precipitous, that only prompt actions will suffice, and that time is short...and counting,

EUTROPHICATION: HAZARD

JOHN V. BETZ:

HAZARDS AND COSTS OF ALTERATIONS

I believe that all my colleagues would agree that the success or failure of our presentation hinges on our making to you a central point of paramount importance: that is, that the public works project which transformed the Kissimmee River in Canal C-38 will do great harm to many of the people it was intended to help.

We are not here solely to bother the ultimate executive authority of the State of Florida about a scientific abstraction called the "ecology of the Kissimmee-Okeechobee system," although this is important to us. Rather, because the natural ecology of the entire Kissimmee River simply is no more, the quality, the usability of the ultimate water supply of south Florida is now deteriorating rapidly. And in south Florida, the water supply is the key not only to the ability to make progress and profits, but also to sustain life.

The public-works projects linking the lakes, streams, and swamps of the Kissimmee basin to one another, and Canal-38 dug to link these with Lake Okeechobee, were intended to provide flood protection for urban and agricultural lands. They have accomplished that purpose. Bt (sic) speeding the runoff to Okeechobee they also have caused its water to become so contaminated, so impure, that it will be much less usable than it is even now, and usable only at far greater expense. Those who will suffer from the deprivation of usable water are not only the animals which formerly utilized the Kissimmee- Okeechobee ecosystem, it is also the 3 million plus human beings who will try to live a decent life in south Florida in the 1980's.

Put very simply, but I believe, realistically, the present and proposed canals on the upper Kissimmee basin lakes and streams serve as a funnel to collect the domestic sewage, the urban runoff, the agricultural wastes and the industrial effluents from booming central Florida into a single collection vessel, Lake Kissimmee. Thereafter, Canal-38 acts as a conduit which transports this waste rapidly, efficiently, and without purification directly into Lake Okeechobee, the perennial (sic) water supply for south Florida.

What was intended to help answer the coming water needs in south Florida has instead brought them to a crisis by forging a short circuit from the bathrooms and streets of central Florida to the major drinking-water reservoir of south Florida.

At the top of this funnel, in Orange and Osceola Counties alone, there are 53 sewage treatment plants which discharge their effluents into the Kissimmee drainage system. Of these 53 plants, less than half (only about 25 of them) clearly meet the minimal state requirements existing now. These 53 plants currently discharge over 27 million gallons a day of sewage which has had varying degrees of biochemical oxygen demand (BOD) and solids removal. In none of these plants, however, is nitrogen or phosphorus removal practiced. So from the two counties alone, all of the nitrogen and phosphorus of 27 million gallons of sewage enter the system

now. The permanent population of Osceola, Okeechobee, and Highlands Counties, and that portion of south Orange County drained by the Kissimmee can be expected to increase to almost 400,000 by 1980. If the 30,000 motel rooms and campsites in the Orlando area are full most nights, a total of 500,000 people will be then discharging at least 50 million gallons per day of sewage effluent toward Lake Okeechobee.

But sewage is the brightest part of the problem. We are coming, slowly, to realize that our standards for sewage treatment are inadequate, and it can be argued that eventually, maybe in 10 to 20 years, the sewage of most of the population of this area will be treated adequately and its nutrients largely stopped from entering the drainage into south Florida.

But again, sewage is only part of the problem. There is also the newly recognized specter called urban runoff, and it is precisely this water, unlike sewage, that the flood control canals were **designed** to catch and to transport. Contained in urban runoff are varying amounts of: trash, garbage, animal droppings, dead animals, insecticides, herbicides, fertilizers, dead vegetation, soaps and detergents, gasoline, oil, grease, brake fluid, transmission fluid, other lubricants, lead, mercury, cadmium, zinc, cyanide, arsenic, coliform bacteria, the bacilli of tetanus, gangrene, botulism, other common soil organisms, various viruses, and last but not least, just plain old dirt, whatever that may be.

In other words, urban runoff contains most of the things that sewage contains, plus a few sewage may not, in concentrations roughly equal to those in sewage. It is the best guesstimate of water quality experts that urban runoff increases the contaminant load from a developed area by about half again as much as the sewage from the same area.

The most pronounced difference between sewage and urban runoff, however, is its timing -- when it enters the system. Sewage is the conventional wastewater of the community, and to the degree that we are creatures of habit, the rate of flow, the types and concentrations of contaminants are, more or less, constant and predictable each day.

But urban runoff drains an urban area after rainfalls. It is exactly that water that drainage projects are **designed** to collect as rapidly as possible before it inundates built-up areas where it can no longer simply seep into the ground (sic). It is exactly this water that the actual or planned channels of Reedy Creek, Shingle Creek, Boggy Creek, and the Kissimmee Canal are **designed** to collect and to speed from central Florida into Lake Okeechobee.

Sewage usually flows into the system at a measured, constant rate at all times. But, under the present system, urban runoff will only contaminate the water supply of south Florida at certain sporadic, relatively unpredictable times: it will only hurt when it rains!

When C-38 was dug, thousands of acres of land were dramatically claimed for human benefit from the marshy valley. Thousands of cattle now roam this land. They browse year-round now on huge areas which would have been closed to them during the rainy season prior to the coming of the flood control projects which efficiently carry off any excess water shortly after the rain stops. Cows, like all other herbivores, consume prodigious amounts of food constantly. They spend a higher percentage of their time eating than we do sleeping. Inevitably, what goes in must come out, and milk and beef are not the only things which Florida cows produce in prodigious quantities. A large percentage of this material is efficiently washed off the land into C-38 and rapidly transported to Lake Okeechobee for polishing. Agricultural runoff, like urban runoff, is not a problem all the time. During dry times it accumulates almost harmlessly on the ground. Again, it only hurts when it rains.

From these considerations, it may appear that I am suggesting that the best thing that could happen to save the water quality in Lake Okeechobee under existing circumstances is an almost complete cessation of rain in the Kissimmee basin.

If we assume things remain as they are at present, and the trends of eutrophication described by Dr. Anthony continue, how may Okeechobee differ in not so many years from what it is now, or was a few years ago?

A natural, healthy lake has the following beneficial uses. They are:

1. A drinking water supply to those communities adjacent to it.
2. An emergency water supply reservoir for distant communities.
3. A recreation site for swimming, bathing, water-skiing, etc.
4. A habitat for the nesting and feeding of water birds.
5. A potentially valuable commercial and sports fishery.
6. A reliable water source for agriculture and industry.
7. A thing of beauty -- an opportunity for aesthetic re-creation which increases in importance to our urban masses even as it decreases in availability to them.

Let us examine some effects of extreme cultural eutrophication on these beneficial (sic) uses.

When a lake becomes grossly polluted through the process known as cultural eutrophication, its waters become unfit for human consumption unless unusually expensive and extensive purification procedures are employed.

It becomes enriched in disease-producing bacteria and viruses which must be killed or removed before the water is safe to drink. These include the bacteria of typhoid, dysentery, food poisoning, and many others. There may be viruses which cause aseptic meningitis, rashes, myocarditis, diarrhea, paralytic polio, respiratory infections, hepatitis, and several other exotic diseases.

Concentrations of nitrate and nitrite may at times be so excessive that ingestion of the water produces a blood disease called methemoglobinemia which can be fatal, especially to small children.

On occasion, pesticides, herbicides, heavy metals like mercury, lead, cadmium, and arsenic may accumulate in concentrations toxic to man and may pass through normal water treatment processes unless great care is taken.

Bacteria of the gangrene and botulism groups, which thrive in putrefying anaerobic mucks, and certain types of blue-green algae which are symptomatic of eutrophic lakes, may release soluble toxins not eliminated by treatment processes which screen out the causative organisms.

The water has color, odor, turbidity or, cloudiness which make it objectionable to drink. These can be removed through treatment, for a price which rises directly with the quantity of the color, odor, or turbidity.

There are certain combinations of pollutants which make water more difficult and expensive to treat than the sum of the pollutants occurring singly. Viruses, by themselves, can be removed reliably by careful chlorination. But when a water containing viruses also contains significant turbidity and/or ammonia, which are characteristic of polluted lakes, the viruses are protected from the disinfecting action of the chlorine. In such cases, far larger doses of chlorine must be applied for longer times to achieve the same probability of virus removal. The disinfection is thus less reliable and more expensive.

For these same reasons, the waters of the lake become much less useful as an emergency water supply. In times of drought in south Florida, the waters of Okeechobee are released via canals to flow to distant communities. Before being used, they may be diluted by other waters and may filter through the ground into the aquifers. In times past, both of these factors served to increase water quality before use. However, water in many of the canals of south Florida is now more polluted than that of Okeechobee and cannot serve to purify it by dilution. Further, many of the dangerous pollutants accumulating in Okeechobee now are either in true solution like the nitrates, pesticides, and heavy metals or of extremely small size such as the bacterial toxins and viruses. Once these reach certain critical levels, they will be found to persist through the crude filtration they receive on entering an aquifer, and become a component of the water pumped out of wellfields into municipal supplies.

All of the same problems which make a eutrophic lake undesirable as a source of drinking water also make it unsafe for human contact recreation such as swimming and skiing. In addition, no one enjoys wading through muck. Besides the painful but seldom serious "swimmer's ear" fungus common to many Florida waters, there is the much less understood, less common, amebic meningoencephalitis. The first American cases of this newly recognized disease entity were reported from Orlando. The hysteria caused by sporadic reports of the killer ameba is not justified, but in the words of Franklin A. Neva, M.D., writing in the *New England Journal of Medicine*:

The striking association of the great majority of cases of Amebic Meningoencephalitis with a recent history of swimming or diving in warm water of a high organic content is a matter for sober reflection. Study of environmental factors that influence the biology of amebas, such as encystment of **N. gruberi** by increased environmental carbon dioxide, may provide clues to the pathogenesis of human disease caused by free-living amebas. Is this another example of a new disease pattern that man creates by fouling his environment?

(*New England Journal of Medicine*, 282:450- 452. Feb. 19, 1970.)

Knowledge of the process of eutrophication only now is becoming widespread. For somewhat similar reasons, our knowledge of the hazards of the array of organisms, toxins, and chemicals I have described is with some notable exceptions, even more tardy, less sophisticated. We expose ourselves to them in a wide aura of ignorance. None the less, when their large numbers and their individual potentialities for harm are coupled with the fact of their increasing concentrations in polluted waters, the probabilities are sobering.

The Kissimmee valley and Lake Okeechobee in its coming condition can no longer support the abundant water fowl of previous years as shown in this table prepared from information supplied by the Florida Game and Fresh Water Fish Commission:

MONTHLY CENSUS FLIGHTS (Kissimmee River Valley between S.R. 60 and Lake Okeechobee)	
Before Canalization	Water Fowl Days*
1954-1955	164,362
1956-1957	115,472
After Canalization	
1970-1971	51,300

*Average number of waterfowl utilizing the River during the winter census period (November 1 - February 15).

Lake Okeechobee itself has been the scene in recent years of increasingly frequent bird kills. These are most often caused by the same organisms which can cause gangrene and botulism in human beings. These organisms thrive in the anaerobic bottom sediments and produce highly lethal toxins. Birds which filter these sediments for food or otherwise ingest them while capturing small animals, become paralyzed and die.

Pesticides, especially DDT and other chlorinated hydrocarbons, are now accumulating in the tissues of certain fish eating birds to the point of interfering with their reproductive processes. The slow extinction now closing about the bald eagle and the brown pelican threatens many other species as well.

Officers of the Florida Game and Fresh Water Fish Commission estimate the average annual value of the commercial fishery in Lake Okeechobee at a minimum of \$500,000. Perhaps more importantly, they estimate over 140,000 as the number of sport fisherman trips onto the lake in 1969. Increasing eutrophication will decimate these fisheries. Fish kills are becoming more frequent and larger as the condition of the Lake worsens. Spawning sites are being eliminated by accumulating muck and silt.

It is not at all likely that all fish life in Okeechobee will die off. What will happen though, has been seen so often before as to enable a foregone conclusion -- the disappearance of desirable fishes and their replacement by other fishes adapted to survive under eutrophic conditions -- large numbers of gar and gizzard shad.

We may also anticipate effects on other cold blooded animals. During the crisis in Lake Apopka a couple years ago, people asked: "But what could kill an alligator?" Now we know. And the same **Aeromonas** bacteria is present in Okeechobee and all other dirty waters. Only the conditions need be right, for the path Okeechobee has followed so far has paralleled Apopka in detail.

After all this, there will come the noxious aquatic weeds -- hydrilla, hyacinth, elodea, naiad, watermilfoil and all the others. These are the hallmark of the over-enriched lake in Florida. They will infest and spread and clog -- and, curiously enough, they will purify. They will compete for the nutrients which otherwise stimulate pea-soup blooms of algae. The water in the infestations of elodea and hydrilla will be the clearest in the lake. But they will clog passages and foul propellers, and will invite action by those who prefer to treat symptoms rather than diseases. For noxious aquatic weeds are so often a symptom in Florida.

Last to be considered are the aesthetic values. The lake I have been describing will be an unlovely thing. It will be offensive to all the senses: sight, touch, smell, taste, even hearing -- there will be few birds and many mosquitoes.

All of this has started to happen and it will continue moving inexorably to the conclusions we have outlined unless you gentlemen have the wisdom and the courage to break cleanly with past practices and take the steps to set it right.

Please let me leave you with the thought with which I began.

It is not alone the ecology of the Kissimmee-Okeechobee system which concerns us. Ecologies don't get thirsty. But the people of south Florida do. Two and a half million of them, and climbing every day.

MARSH ECOLOGY

ARIEL LUGO:

OPTIMIZING THE MANAGEMENT OF THE KISSIMMEE RIVER BASIN MARSHEs FOR MAXIMUM VALUE TO MAN

The Kissimmee River basin is a large regional ecosystem capable of sustaining a high diversity of plants, animals, and habitats. Prior to canalization, this potential was evident in its five major plant communities, its extensive fisheries, and the thousands of migrating waterfowl that formerly visited the region annually. At that time, the annual flooding of wetlands was responsible for the maintenance of the productivity of the region, the linkage between plant and animal communities, the maintenance of high water quality, the storage of excess waters and nutrients, and the overall moderating effect on seasonal climate of the area.

It is demonstrated in this paper that with the construction of Canal-38 many of the above trends were reversed, causing losses in wildlife and fisheries. Water quality deteriorated, and the dampening effects of the flood plain on water flows were eliminated. Today water quality deteriorates as one moves downstream, causing (sic) alterations to the ecology of Lake Okeechobee, and water discharges now show sharp peaks during the rainy period followed by very low discharges during the dry period. Utilizing some values from the scientific literature, it is demonstrated that marshes are capable of enhancing water quality by removing nutrients and heavy metals through the process of photosynthesis and by accelerating the sedimentation of suspended materials in the flood waters. By photosynthesis alone, about 1,500 acres of marshland are capable of storing all the nitrogen and about 25% of the phosphorus from the sewage of a population of 62,000 people. The process of sedimentation, which also occurs in marshes, will further increase the efficiency of nutrient and heavy metal removal. Since the Kissimmee River basin contains, or can be made to again contain, many thousands of acres populated by marshes, their value to society is very obvious.

Other roles of marshes which are discussed this paper: 1) Their high productive capacity, which places them among the most productive ecosystems in the world. This has value to man in the form of recreation, and environmental quality control. 2) Their water storage capacity during flood periods. 3) Their buffering service to an increasing urban population. 4) The role in lowering governmental costs when the area is protected from further development. 5) Their value in the future, when our knowledge of management and manipulation of nature becomes more sophisticated.

Finally, this paper explores some ideas about the philosophy of ecosystem management. Regional management, with mechanisms to avoid conflicting uses and over-exploitation of the region is advocated. When a region is put to work to its maximum biological potential, that region will maintain itself with little help from man. At this point, the region is said to have its maximum value to man and society (sic) in general.

THE BASIN

The Kissimmee River basin is a large area (3,000 square miles) with a high diversity of plants, animals, and habitats. Like any other basin, the Kissimmee River basin is linked to surrounding ecosystems by the inward and outward flows of water, chemical substances, and organisms. [Figure 8](#) is a schematic representation of the basin with its original meandering river, showing the major movements of water, chemicals, and organisms. These inputs and outputs, as they are called, are listed in table 1.

FIGURE 8: KISSIMMEE WATERSHED SCHEMATIC

TABLE 1

Substance	Form of Input	Form of Output
Water	Rain, Runoff, and ground water	Runoff, ground water and evaporation
Plant nutrients	Agricultural fertilizers, sewage, animal waste, and with water inputs	Harvest of animals and plants, with water outputs, and volatilization of certain compounds.
Heavy metals	Agricultural activities, urban runoff, and with water inputs.	With water outputs, and with suspended organic matter in water.
Organic matter	Wildlife migrations, with water inputs, urban and animal waste, and plant photosynthesis.	Wildlife migrations, with water outputs, oxidation, and fires.
Organisms	Migrations (air and water)	Migrations (air and water)

Without intrusion of man, these substances and organisms entered the region, remained trapped (Table 2) within the basin for a certain period of time, and then left the region, each with a characteristic intensity and periodicity.

TABLE 2

Substance	Location where it is trapped
Water	in lakes, canals, the marsh, vegetation, and peat.
Nutrients	in sediments, peat, vegetation, water and wildlife.
Heavy metals	in organic sediments, peat, and vegetation.
Organisms	in their various habitats.

The net result of all this dynamic activity is the process of life itself which in the Kissimmee River basin was expressed before canalization in the five major communities depicted in [Figure 9](#). Each of these communities (mixed marsh, mixed swamp, wet and dry prairie, pine flatwoods, and upland

FIGURE 9: VEGETATION MAP OF KISSIMMEE BASIN

Source: U.S. Fish and Wildlife Service

forests) is adapted to a particular set of environmental (sic) factors dictated by the periodicity of climate in the basin and by its interaction with the topography of the land. Since the climate is seasonal, and the periodic flooding of the river altered the topography of the land, the communities of the basin were linked to each other, and adapted to the oscillations of their natural environments. In wet periods the marshes would expand at the expense of the drier sites while during dry periods, drier communities expanded their territories at the expense of the wet marshes.

Large flocks of migrating waterfowl would visit those communities with the highest food production and thus their feeding areas would change as the local conditions changed. The result of these oscillations in the community structure and function is a region which has room for high diversity of species of organisms each adapted to a particular set of environmental circumstances. When the conditions that favor "species X" are

present, that species will become abundant and when the conditions change, another species flourishes while "species X" become less abundant. Only nature is capable of tuning such a complex machinery so that all species are allowed to survive through periods of stress and to flourish when the conditions for growth are favorable.

THE MANAGEMENT

When managing such an intricate ecological system it is imperative to remember that all communities, and all the components of the system are somehow interrelated by the dynamic flow of water, chemical substances and organisms. Actions on one part of the region will have repercussions on another part which one had no intention of altering. Since each species and community of plant and animals is by definition different from each other and adapted to do a unique job in the regional system, it follows that the proper management of a large and diverse system such as the Kissimmee River basin would involve maximizing the natural capabilities of the biological and physical system. By this I mean that a manager maximizes those properties of the system which the system does best, and avoids asking the system to do something it is not adapted to do, or worst yet, utilizes the system for objectives which degrade the intrinsic assets of the system.

Natural ecological systems are centers of biological activity whose main product is the support of life on earth. As a result of this activity, all living creatures, including man, benefit. To maximize this life-support role is to maximize the value of the system to society. But care should be taken to avoid two common pitfalls of bad ecosystem management: 1. Use of an area for conflicting uses. An example of this is an attempt to manage the same waterway for rapid water discharge and for fishing. These are conflicting uses, incompatible with each other. 2. Over management of a system requiring a system to do more than it is adapted to do. This can take the form of overhunting, overfishing, overgrazing, etc.

Proper management involves (1) A regional approach to include all the interacting communities; (2) The utilization of the system's natural adaptations to the local conditions so that its value may be maximized at minimal cost; (3) The planning of compatible uses to avoid conflict of objectives; (4) The control of the intensity of use to avoid exploitation and deterioration of the resource. When these are followed, the region is put to work to its maximal potential and it is said to have its maximum value to man. Table 3 contains some uses which can be properly planned for maximizing the value of the restored Kissimmee River basin.

TABLE 3

MANAGEMENT ALTERNATIVES FOR THE KISSIMMEE RIVER BASIN ECOSYSTEM
<ol style="list-style-type: none"> 1. High water quality for human consumption. 2. Water for recreational (sic) use. 3. A limited transportation waterway. 4. A meandering river wildlife refuge. 5. An area for personal agriculture and ranching use. 6. A place to build limited human dwellings. 7. A waste processing area. 8. A basin for atmospheric cleaning and oxygen regeneration. 9. An area to preserve live genetic material for future use 10. and experimentation. 11. An historical site for the enjoyment of future generations. 12. A living laboratory for the study of the ecological laws of nature.

13. A buffering and relaxation area to surrounding high density human populations.

CANAL – 38

The construction of a deep canal through the heart of the Kissimmee River basin is contrary to the expressed philosophy of ecological management because such a structure disrupts many of the natural mechanism that link the plant communities of the region; it converts the area into a series of independent communities which now must readapt to new regimes and in the process lose much of their value to man. The deep canal not only disengages the communities of the region but it also adds an element of shock to the region in the form of sharp peaks of water discharge which did not exist before and to which the region is not adapted. Compare water flows at high water in the canal versus the natural river in Figure 5. [Figures 5](#) and [10](#) show how the region is flushed of many of its chemicals, water, and organisms as the result of these sharp surges in discharge caused by Canal -38. The magnitude of the Canal's effect on the system may be explained by discussing the role of marshes in the regional ecosystem.

FIGURE 10: MAN IN THE KISSIMMEE WATERSHED

THE MARSH

For our purposes, we may define a marsh as a community of grassy vegetation adapted to frequent flooding. The seasonal flooding of the marsh brings with it sediments rich in plant nutrients which are deposited in the marsh as the plants offer resistance to water flow and force flood waters to lose velocity. In Florida, where the growing season is long, and the temperatures of the air favorable, marshes are very productive because they couple the Florida climatic conditions with the abundant water and nutrient supplies from the river. In fact, marshes and swamps are among the most productive systems of the world.

As a result of their adaptations (sic) to seasonal flooding and high productivity, marshes become areas of ideal habitat for wildlife and a great number of plant species. This results in high biological diversity and activity. The movement of water and animals links both flanks of the marsh to the river and to the prairies and drier sites. The question of interest is their role in controlling environmental quality, and their service and value to man.

DIRECT ROLE OF MARSHES ON MAXIMIZING REGIONAL VALUE TO MAN

One of the most controversial issues is the role of marshes in the removal of nutrients from water, i.e., their control of water quality. One reason for the controversy is the inadequacy of past and current research. However, one might search the literature and with some calculations, assumptions, and presentations of the data, obtain enough evidence on their role in water quality control to demonstrate their value to man.

[Figure 11](#) (next page) shows the deterioration of water quality as one moves south from Lake Tohopekaliga through the Kissimmee-Okeechobee basin. The rapid flow of water laden with nutrients into Lake Okeechobee is one of the main factors which accounts for the deterioration of these waters. Once nutrients enter a lake, its physical and biological configurations will tend to retain them in the basin. Table 4 compares water quality in

FIGURE 11 : MEDIAN WATER QUALITY VALUES
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Source: U.S. Department of Interior, "Appraisal of Water Quality Needs and Criteria for Everglades National Park", 1971.

TABLE 4

COMPARISON OF WATER QUALITY IN MARSH AND CANAL WATERS WITH THOSE U.S. WATERS WITH THE HIGHEST REPORTED QUALITY.
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Chemical substance	5% of U. S. waters have their value or less (mg/1)	Canals mean values (mg/1)	Marsh lands mean values (mg/1)
Nitrate	0.2	0.4	0.3
Sulfate	11.0	40.0	1.0
Calcium	15.0	60.0	7.8
Dissolved Solids	72.0	393.0	54.0
Iron	0.0	0.05	0.03

Data on canals and marshlands from Loxahatchee National Wildlife Refuge Area from Appraisal of water quality needs and criteria for Everglades National Park, USDI NPS. May, 1971.
--

canals, marshes, and those United States waters reported to have the highest quality (top 5%). Notice that the water quality in marshes is above the quality of the best waters in the United States. Canals, which are either devoid of vegetation or have large volumes of runoff water flowing through them, are reknowned (sic) for their poor water quality. Many times, toxic heavy metals are found in these waters, particularly near agricultural and urban areas, and these chemicals further deteriorate water quality.

Table 5 shows the concentration of these metals in canal and marsh waters in undeveloped areas. Notice that land development is accompanied by rapid deterioration of water quality. Marshes aid in water quality by actively taking up nutrients and heavy metals from the water and by reducing water flow and thus inducing sedimentation of suspended matter. Data on rates of sedimentation were not available. However, Table 6 contains data on the differential storage of heavy metals by plant parts as compared to the amounts in the suspended matter fraction of the water.

TABLE 5

Dissolved-metal content in canal waters of developed and undeveloped areas in south Florida. (Data from R. C. Harriss, 1971).
--

Metal	Undeveloped Area*	Developed Area*	Developed Undeveloped
Manganese	4.2	29.0	6.9

Cobalt	0.8	34.0	42.5
Cooper	1.4	4.7	3.4
Zinc	1.7	14.6	8.6
Cadmium	0.4	2.8	7.0
Lead	0.7	12.0	17.1

*All values in ug/l

TABLE 6

CONCENTRATION OF ELEMENTS FOUND IN
SUSPENSION AND IN PLANT PARTS
* parts per trillion ** parts per million
Data from Harriss, Matraw, Horvath, and Andren, 1971

Element	Suspended Matter	Plant (shoot leaves)	Roots
Iron	5.5 ppt*	0.89 ppt*	4.89 ppt*
Manganese	60.1 ppm**	163.4 ppm*	259.4 ppm*
Cooper	37.0 “	5.0 “	8.2 “
Nickel	15.0 “	7.0 “	5.4 “
Cobalt	10.4 “	6.3 “	9.7 “
Lead	12.7 “	13.3 “	16.8 “
Cadmium	6.8 “	0.84 “	1.05 “
Zinc	74.1 “	63.4 “	49.2 “

It is important to note the following points: 1. When the marsh induces sedimentation, a large fraction of those heavy metals in suspension and often a substantial fraction of the phosphate will be retained in the organic sediments of the marsh. Once there, these metals will remain in such storage for a long time period. 2. The magnitude of heavy metal absorption is, different for different plant parts and for different metals. For this reason plant diversity is important. Each plant species will absorb a different metal type at a different rate. When one eliminates a species, one destroys its particular buffering capability.

The mechanism by which plants absorb nutrients and heavy metals is the process of photosynthesis which is also responsible for the organic productivity of the marsh. In Table 7 I have included estimates of the rate of organic production in a marsh, as well as the marsh's nutrient storing capacity and capacity to remove nutrients during the growing season. These data have been extrapolated to the Kissimmee River basin.

TABLE 7

The storage and uptake of nutrients in marsh species and peat, and the inputs of man
into the Kissimmee River Basin.

Ecosystem Component		AQUATIC PLANTS	SAWGRASS	PEAT
Weight-tons/acre		10	4.8	200
Standing crop of nutrients tons/acre	N	0.155	0.035	6.36
	P	0.020	0.001	1.0
	K	0.248	-	.016
Productivity of organic matter-tons/acre/year		28	13	0.04
Uptake of nutrients tons/acre/year	N	0.43	0.095	0.0016
	P	0.07	0.004	0.0002
	K	0.90	-	0.00004
Additions by Man*: tons/acre/year				
N	P			
0.103	0.192			

*Based on five sewage plants (see Table 8)

Table 7 also gives rates of sewage input to the basin so that we may determine the role of the marshes with respect to nutrient removal. For purposes of calculation, we assumed 1500 acres of marsh as the unit receiving all the sewage effluent. Obviously, much more acreage could be so employed. This comparison demonstrates that through plant production alone, 1500 acres of marsh can utilize nearly all the nitrogen and 25% of the phosphorous from the total nutrient input of effluents from sewage plants serving 62,000 people. The addition of the sedimentation value during floods will greatly increase this figure. These figures are only rough estimates; the assumptions and data sources are included in Table 8.

TABLE 8

Data and assumptions utilized in calculating the nutrient uptake and storage in marshes.
<ol style="list-style-type: none"> 1. The weight of aquatic plants was obtained from Boyd, 1970-a; for sawgrass from K. Stewart, unpublished; for peat from Bayley and Odum, 1971. 2. The standing crop of nutrients was obtained by multiplying the weight of the plants or peat by the % nutrient composition. The % nutrient composition was obtained from Boyd (1970-a,b,c,d,e) for aquatic plants, from K. Stewart (unpublished) for sawgrass, and from Davis (1946) for peat. 3. The estimates of productivity were obtained from Boyd, 1971, for aquatic plants, and from Bayley and Odum, 1971, for sawgrass and peat. 4. The uptake of nutrients was calculated by multiplying the productivity figure by the % nutrient

composition. It was assumed that the growing season was 250 days.

5. The addition of nitrogen and phosphorus by man was calculated from the annual data given by Wegener and Holcomb, 1972 for five sewage plants near Lake Tohopekaliga and assuming that there are 1,000 acres of wetlands in the Kissimmee River Basin.
6. Some of the original data before conversion to short tons:

For aquatic Plants: P is 0.20% of dry weight; N is 1.55% of dry weight; K is 2.48% of dry weight

For peat: P is 0.5% of dry weight, N is 3.18% of dry weight; K is 0.08% of dry weight

A mean input of sewage to the Lake Tohopekaliga area is: for N 310,551 lbs/year; for P 579,530 lbs/year

The sewage plants were: Orlando #2, S.W. Orange County, Kissimmee, Kissimmee Highlands, and St. Cloud

While I think that the role of the marsh has been underestimated, we need research in both areas to verify these figures. Other direct values of marshes which are discussed by others in this volume are:

1. **Water storage during periods of flood stage.** This serves to excess water during flood conditions, to remove sediments from the water, and to reduce sharp peaks of water discharge through the main canal . Lengthened stay of water in the marsh yields more benefits per volume of water in contrast to present conditions when the water rushes to Lake Okeechobee. Some of these benefits of stored water are higher plant productivity, milder temperatures, and more time for water purification.
2. **Wildlife maintenance.** Because of its plant diversity and high productivity, a natural marsh sustains a higher diversity of wildlife than a man-managed system. Man may maximize the number of individuals of a given species as is now advertised for the Kissimmee basin but these are surges similar to the increases in the fisheries of new impoundments. On a long term basis, the natural marsh supports more species on a sustained basis. [Figures 12](#) and [13](#) show populations of fisheries before and channelization.

FIGURE 12: GAME FISH RECOVERY SUBSEQUENT TO STREAM ALTERATION

Source: Bayless and Smith, "Effects of channelization upon fish populations of lotic waters in eastern North Carolina,".1965.

FIGURE 13: FISH CAPTURED IN WIRE TRAPS

Source: Florida Game and Fresh Water Fish Commission, Recommended Program for Kissimmee River Basin, 1957.

INDIRECT BENEFITS FROM PROPER MANAGEMENT OF MARSHES

By properly managing the region and the marsh, man will derive larger benefits which are indirect

consequences of the natural function of the area. Four of these are:

1. **Buffering of Lake Okeechobee and surrounding urban areas:** The marshes of the Kissimmee River basin will buffer Lake Okeechobee from high inputs of nutrients, heavy metals, and sediments, and from the shocking high water discharges characteristic of the current Canal-38 situation. When one looks to the present and potential developments in these regions of Florida, the potential role of the marshes as buffers of man's activities becomes very significant. Failure to protect these buffer zones will result in increasing deterioration of water quality, higher costs of water treatment, and more uncertainty in the minds of the people and governments of south Florida about the health of their water supply.
2. **Recreation:** These are side effects of any natural facility but particularly of the Kissimmee River basin due to its size and diversity. needs to look at the documented populations of wildlife and fisheries prior to the construction of Canal-38 to appreciate the potential of the region. Given enough time, ecological succession will restore the productivity of the land to its original high values. With proper management and vision the area will be of value to the increasing number of naturalists and sportsmen in our State.
3. **Lowering of population demands in the area:** As areas are developed, not only does the surrounding water quality deteriorate, but the area's capacity to support and absorb further growth also deteriorates as the natural systems are destroyed, As this occurs, man must protect the environment at a high cost in the form of dollars, effort, time, and a lower life quality. If the Kissimmee marshes are restored to protect local environmental quality and to buffer Lake Okeechobee and surrounding urban zones, fewer areas will be developed. As a result, costs of government will be reduced, and life quality enhanced. This is a significant ancillary benefit.
4. **Options for the future are left open:** Restoration of the Kissimmee River basin marshes will return the area to its original function and production. This will reopen our options for future management and land use. As time goes on, our knowledge of ecosystem management will increase and we will become more sophisticated in techniques maximizing the value to Floridians of this region of our state. With the great and growing pressures of population, that sophistication will become increasingly vital.

SUMMATION

It is clear that the Kissimmee River basin under its present land use policy is not supplying the maximum benefits it can provide to the people of Florida. Its communities have been decoupled, its capacity to support life decreased, its water quality deteriorated, and the number of different uses diminished. To restore its potential high value to man , communities must be reintegrated into the original unified system of the basin; periodic water fluctuations must be reinstated, and marshes restored. As nature takes its course this region will restore itself to high production, higher water quality, more wildlife, greater diversity and value to man.

Conclusions and recommendations.

The facts that canalization of the lower Kissimmee River essentially destroyed its aesthetic values and eliminated most of its fish and wildlife resources are readily understood because those consequences were visible and abrupt.

The fact that canalization of the lower river and other major developments in the Kissimmee-Okeechobee

basin have materially worsened the water quality problem in Lake Okeechobee is not so readily comprehended because the issue involves complex processes.

To understand Okeechobee's difficulties, one must examine at least three interrelated phenomena.

The first is the Lake's nutrient budget. It is like all budgets, so much in, so much out, and so much remaining.

A related phenomenon is that of nutrient accumulation. This refers to the fact that surface-fed lakes such as Okeechobee tend to trap, physically and biologically, the nutrients which they receive. This phenomenon is analogous to the way in which persistent pesticides are accumulated or magnified -- the jargon is biomagnified -- up the successive levels of food chains.

The process of biomagnification is no great mystery -- it is in fact commonplace. All living organisms -- plant and animal and you and I -- are biomagnifiers of the many chemical constituents which yield life. We are very late in comprehending the analogous fact that ecosystems such as lakes are also magnifiers. This has been a failing of obviously great moment as we consider the losses and costs associated with accumulations of wastes in Boca Ciega Bay, Lake Apopka, Lake Tohopekaliga, and now Lake Okeechobee.

Conceptually, these processes advance in many fresh water surface-fed lakes in Florida as shown in [Figure 14](#).

FIGURE 14: LAKE EUTROPHICATION PROCESS

For a period of decades we can add wastes to a lake and detect no visible difficulties, no particular evidences of stress. Sometimes the slight enrichment of this period invigorates a lake, e.g., fishing may be improved. Even the most extensive chemical data collected in this period are likely to elude any far-seeing interpretations. Lake Apopka, so long studied, was a classic example of this fact. This predicament is quite comparable to our inability to predict the onset of concern occasioned by long-term smoking. The best we can do in the early decades in either case is to respect the probabilities of the **process**.

As the nutrient budget grows in a lake, stress begins ultimately to accelerate. Early expressions of this are increasing turbidity of the water and localized blooms of floating algae. If the nutrient loading continues, a period of exponentially increasing stress sets in -- at which time greater blooms of algae occur, tending to displace the normal emergent and submergent vegetation of the shallows.

Following the bloom of the algae, their dead and dying husks cascade to the bottom, further clouding the water and blanketing the bottom rapidly with organic ooze. Because the masses of dying algae consume much of the dissolved oxygen in the water, intermittent fish kills result. Some algal masses float, especially in the quieter backwaters, with an odor characteristic of sewage.

Ultimately gross shifts in species occur in the lake -- from its normal aquatic vegetation to massive blooms of green algae and later to blooms of blue-green algal species. Spreads of the exotics hyacinth and hydrilla which, unlike native plants, can compete with algae are common at this time. [Figure 15](#), an infrared NASA color photograph of Eagle Bay on the north shore of Okeechobee, is an example of the success of such competition by hydrilla.

UNREPRODUCIBLE

FIGURE 15: INFRA RED COLOR PHOTOGRAPH OF EAGLE BAY, LAKE OKEECHOBEE,

SEPTEMBER, 1972, DEPICTING HYDRILLA INFESTATION

Photograph by NASA Kennedy Space Center)

Algal blooms and mud bottoms favor the expansion of the rough fish, gizzard shad. This species becomes very dominant in an enriched lake, displacing the more desirable sunfishes -- blue gill and black bass.

Enriched lake waters serve as rich culture mediums for the bloom of a host of undesirable bacteria and viruses, as Dr. Betz has explained.

It is a strange but quite common circumstance that gross alterations of many natural habitats incidentally disfavor species and conditions which we value, and favor many which we do not. Thus, marsh-bordered blue gill-black bass lakes are converted by discarded wastes to algae-dominated gizzard shad-garfish lakes; clear lakes become murky, sand bottoms become mud-covered.

It is especially important to note the relatively short term of the period in which nutrient stress rises exponentially. We can ignore inputs of wastes by man for 60 or 70 years or more -- while having endless debates on their meaning -- to find ourselves suddenly confronted with the rash of symptoms characteristic of a nutrient-stressed lake. Though no one can say how quickly that condition will reach the ultimate critical zone, we can be sure it will happen in a relatively short period, perhaps 10 or 15 years. The addition of a given quantity of nutrients in the period of rapidly rising stress produces a much greater effect than the same quantity would product in the long benign period; ecologic (sic) magnification feeds on itself. This is the precipitous condition of Lake Okeechobee. This situation can be compared to a five-foot rise of water on a six-foot man; he can enjoy that five feet, but he will suffer with the sixth.

It is not trivial to mention that once a lake has become critically eutrophic, correction may be either impossible or arduous and costly, as evidenced by Lake Apopka.

The flood Control District Board has stated today its conviction that Okeechobee is now in an early eutrophic state. This represents progress for a lengthy debate has finally expired.

Where do we go from here?

If we do nothing significantly different from what we have, Lake Okeechobee will soon join ranks with Lake Apopka with all that entails. Further, since Okeechobee waters are at times passed via canals to Conservation Area 2 -- the most efficient storage pool in the Everglades -- a serious water quality problem already existing there may be worsened. Conservation Area 2 now has 8 to 10 inches of organic ooze blanketing about two thirds of its bottom.

We can choose new courses which must be innovative and prompt if they are to succeed. To accept the challenge is advisable only in terms of the consequences of failing to accept it. Those consequences involve the health, safety, and welfare of more than two million south Floridians. Against a background of traffic jams, droughts, dirty air, polluted bays and canals, broken neighborhoods, crime, exponentially rising costs, and deteriorating services, they need no more stress.

We must put a buffer system, whatever that entails, between the wastes of central Florida and Lake Okeechobee.

Our convictions on these matters compel us to recommend that:

1. Governor Askew immediately appoint a Water Quality Master for the Kissimmee-Okeechobee basin. The person appointed must already understand ecosystems and eutrophication processes and must be vigorous in prosecution of his duties . He must be responsible to the Governor as Florida's Chief Planning Officer and be supported by the authority of that office.
2. Key state employees be assigned on an as-needed basis to assist the Water Quality Master for the duration of his assignment. When serving in such capacity, these people must be relieved of their normal duties and obligations to the specific purposes of their agencies.
3. As representative of the Governor, the Water Quality Master be given license to obtain assistance from all agencies of government which have knowledge, responsibility or capability to assist in resolving the water quality problems of the Kissimmee-Okeechobee basin and must be empowered to utilize (sic) the services of others in the private sector.
4. The Water Quality Master be provided funds sufficient to accomplish the responsibilities assigned to him.
5. The Cabinet include costs of renovation works needed in the Kissimmee-Okeechobee basin in its public works budget submission. Individual Cabinet members as appropriate should seek other needed technical and financial federal aid in areas other than public works.
6. The Legislature prescribe state policy in regard to restoration of the lower Kissimmee River.
7. The Cabinet instruct all agencies and interests that protection of water quality in the basin will be a major consideration in their deliberations and that in accord with this no further canalization of streams or destruction of marshes and swamps will be approved in the basin.
8. The Cabinet instruct the design engineers to develop plans for reflooding the historic marshes of the lower Kissimmee Valley, to include restoration of its fluctuations and its flow-gradient in lieu of subimpoundments and that specific attention be given to removing or reshaping the massive spoil areas which occupy over two thousand acres of former marshlands. Such plans shall consider the need for flood prevention in the upper valley.
9. The Governor reconsider the order of priorities in regard to the Water Basin Management Plans (EPA and Florida) so as to elevate the problems of the Kissimmee-Okeechobee basin.
10. The entire program be regarded as a means of reversing the process which has reduced the quality of water in Lake Okeechobee to its present condition, and that the program center on actions rather than studies and monitoring.

We further recommend that the Water Quality Master:

1. Proceed to locate and map within three months all sources and amounts of nutrients and other pollutant inputs -- urban, industrial, and agricultural -- to the Kissimmee Lakes, the Kissimmee canal and Lake Okeechobee.
2. Develop means to halt, divert, or treat to the greatest extent possible, all wastes entering the basin, using the best knowledge and technological and legal means available to do so.
3. Develop a plan to fluctuate the lakes of the upper Kissimmee basin on a regular basis consistent with

other reasonable uses in order to remove a significant portion of accumulated organic oozes through atmospheric oxidation, using the lessons of Lake Tohopekaliga.

4. Develop plans to harvest fishes, both sport and commercial, in accordance with the dictates of sustained yield concepts, as a nutrient- removal device,
5. Develop plans for control of noxious vegetation, determining when such control shall be regarded as essential and prescribing methods to be employed. Because of the need to remove nutrients and of the hazards of applications of chemicals to aquatic life and to drinking water supplies, physical removal of unwanted vegetation should be emphasized.
6. Report all appropriate findings and recommendations to this Cabinet for their action.

I especially wish to acknowledge here the kind assistance which NASA and the Interior Department have given to us in this matter and further to say that while their contribution to this problem was short-term and therefore necessarily limited, my colleagues and I believe that the contributions they can make in solving future environmental problems, as they develop techniques and applications, promise to be very great.

Finally, time allows us only to base our actions on the obvious; we can no longer afford to be entangled in the obscure -- if south Florida is to avoid an irredeemable loss.

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U. S. Environmental Protection Agency

APPENDIX #1

MEMORANDUM

October 4, 1957

TO: Executive Director

FROM: Division of Planning and Research

SUBJECT: Lower Kissimmee Valley Water Control Project (C-38)

I. Introduction

It recently became evident that in order for this District to intelligently evaluate the recommendations by the Corps of Engineers, U. S. Fish and Wildlife Service, and the Florida Game and Fresh Water Fish Commission concerning the improvement of the Lower Kissimmee Valley, it would be necessary to have additional information on the area. Accordingly, this report concerning the land capability of the present flood plain and the effects of the proposed project on land use and land owners in the valley was undertaken.

This Memorandum is concerned only with that portion of the Kissimmee River flowing between Lake Kissimmee and Lake Okeechobee, its flood plain which averages **approximately 1.2 miles in width and 60 miles in length**, and any of the adjoining lands which would be affected in either a beneficial or detrimental manner by the project. It contains certain statements which while not relating to land use per se, are significant in providing insight into the general problem under consideration.

Information in this report was obtained by interviews with landowners, fish camp operators, real estate agents, County agricultural Agents, Soil Conservation fieldmen, and material on the project published by the Corps of Engineers, U. S. Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission.

After a rather intensive study of the subject, the following conclusions were reached:

1. The majority of the landowners are relatively uninformed about the project and although there is general agreement on the desirability of some sort of improvement, most are worried about its effect on their interests.
2. The present utilization of the Kissimmee marsh is mainly as unimproved pasture and in its present state is estimated to **be approximately twice as valuable for amount of unimproved upland**. The recreational usage (mainly for duck hunting and bass fishing) is of less importance economically at the present time.
3. Although the engineering on the proposed project may be excellent, its application does not appear to be geared to the needs and desires of the people in the area. A basic conflict is evident between wildlife and agricultural interests and in order to be acceptable **in fact**, to either group, a number of adjustments will be required in the present plan.

2. Uninformed Public

A decided lack of and desire for information about the project was evidenced by a large proportion of the people contacted. This is not surprising considering that at this time no definite plan has been decided upon; however, even the most general purposes and expected results of the project are not understood by the majority of the public.

The most widespread fears and misconceptions discovered were as follows:

1. All factions appear to fear that the project has been turned into a "political football" and their interests are to be sacrificed for the benefit of the cattlemen, wildlife interests, Everglades Agricultural Area, or the Upper Kissimmee Valley.
2. Smaller landowners feel that they will not be consulted and their interests will not be considered.
3. Sportsmen are concerned with possible destruction of the wildlife and esthetic beauty of the valley.
4. A few feel that the canal will dry up the valley, and most do not understand that the proposed improvement will eliminate the majority of the fluctuation and control the river at a desirable level.

In spite of the above, not one person was found who was dead set against all types of improvement. Most favored the project, but mentioned certain reservations and qualifications.

3. Land Capability of the Flood Plain

Under present conditions, the flood plain is of limited usefulness for the purposes of both recreation and native range. Water level fluctuation is continuous with a difference of maximum and minimum levels averaging about 12 feet over the course of the river. In general, high water favors use of the river for recreation, while low stages improve both the amount; and quality of forage available on the flood plain.

The Florida cattleman has two basic and very real problems, a shortage of winter grazing due to frosts and lack of winter rainfall, and the extremely low average soil fertility. For years cattlemen along the river have relied upon the Kissimmee marsh to furnish a large portion of the required forage during the winter months. Also, the majority of the flood plain has a **peat or peaty muck soil** with the inherent fertility lacking in the upland prairie or flatwoods soils and as a result, furnishes at **least as much forage per acre annually as upland native range** in spite of the fact that it is under water the majority of the time.

Because of these two advantages, there have been a number of attempts to control the water and introduce improved grasses on the flood plain. Of the approximately 4,350 acres of lowland on which development has been attempted, only 600 acres appear even partially successful in controlling high water, and agricultural technicians in the area doubt that even these have been economical. This rather large scale attempted development under adverse conditions serves to point up the value which the cattlemen place upon the flood plain and its potential usefulness when the river is brought under control.

Recreational development along the river consists of 10 or 11 fish camps and a limited number of private camps and homesites on the higher banks overlooking the main stream. The areas now utilized

for recreation are generally the least desirable from the cattleman's point of view since woodland, high bluffs, river channel, and cut off meanders produce little of value for cattle feed. Under natural conditions, recreational and residential use could be expected to greatly increase in the future due to the population pressure on available water front property and the increased amount of leisure time and money available to the general public for recreational purposes.

Although some inflation is apparent in land values along the river, it appears that the long term recreational possibilities are being ignored by the average cattleman and should the river be improved with no provision for recreation it would undoubtedly be a long range economic loss to these large landowners whether they realize it or not. Present inflationary tendencies in land values are caused by the following factors:

1. The widespread speculation along both coasts of Florida has spread inland with a wave like action to the point that most range land has a price tag considerably higher than warranted by its beef producing ability.
2. Dairy farms, which have been driven out of the Lower East Coast of Florida by high land values, are settling in the Lower Kissimmee Valley and can afford to pay high prices for their land.
3. There are very few small ownerships along the river, and since the demand for such plots is greater than the supply, high land directly on the channel with good access to highways is bringing in excess of \$1,000 per acre.

Future value of the land for recreational and residential purposes, which in many cases will be its highest and best use, will be determined by the following factors:

1. Maintenance of a desirable water level for fish and waterfowl.
2. Preservation of esthetics while improving channel.
3. Location in relation to highways and access roads.
4. Elevation of the land and existence of desirable vegetation.

Since it is obvious that under project improvement very little of the flood plain can serve both ranching and recreational interests, some arbitrary decisions will have to be made concerning:

1. Water levels
2. Amount of land to be preserved for recreation
3. Location of these recreational areas

It goes without saying that long range economic land use and political aspects, as well as the engineering viewpoint, must be given serious consideration.

4. Weaknesses of Present Proposals

From a land use aspect, the project as presently proposed certainly leaves much to be desired. A large portion of the land, which it is proposed to inundate, is valuable to its present owners as winter pasture,

while a number of the existing fish camps and private residences will find themselves left relatively high and dry. Naturally, in any project with the scope of this one, a few people can be expected to be hurt for the benefit of the majority, but it is felt that in this case some adjustments should be made to soften the detrimental effects.

The water level to be maintained at the structures and its resultant water table in the surrounding land is the key to the land use problem in the flood plain. High water levels somewhere between normal or median river stages and flood peak stages benefit recreational interests, while a water table of between 14 and 30 inches below the surface of the flood plain is optimum for agriculture. Present proposals permit **overdraining the flood plain** just below each of the five structures **to levels approaching the worst droughts on record** while providing a disappointingly shallow depth in the proposed "lakes". Also, the acreage of these inundation areas is estimated by this to be closer to 7,000 than 10,000 acres, and final results are expected to be extremely disappointing to the Florida Game and Fresh Water Fish Commission, although they have expressed their general satisfaction with the present plan.

The Kissimmee marsh has an ever increasing esthetic value which is not provided sufficient protection under the present plan. Rapidly expanding population and land development in Florida, plus a dependence on the tourist trade, makes it especially necessary for this state to protect: certain wild areas for the future. **Improper development could destroy much of the value of this natural resource forever, and such destruction could conceivably spell the political doom of the Flood Control District.** Therefore, it is imperative that considerable thought be given to canal location, spoil placement, and maintenance of the bypassed river channels, especially in the inundation areas. **It would be more desirable to err by setting water level too high than too low as pool elevations can be adjusted downward, whereas it is practically impossible to raise them.**

V. A New Proposal

After considerable study, this division is convinced that adjustments in the project are desirable from the standpoint of land use. Although this plan may not be feasible in its entirety from an engineering point of view, its effects on land use certainly warrant its receiving serious consideration.

It is believed that four structures located as indicated on the attached map will maintain sufficient water control while providing the following advantages :

1. Elimination of one structure would dispense with the nuisance and cost of additional lockage and save the cost of the structure itself, or approximately \$800,000.
2. Location of structures at narrower points on the flood plain would decrease the length of tieback levees by about 20%.
3. Location of two structures at highway crossings might result in additional savings by dual usage of highway embankments and particularly at State Road #70 where a new bridge will be necessary in the near future.
4. Location at highway crossing, where possible, should decrease costs of construction while maintaining or improving the recreational and residential utilization already concentrated at these points of access.
5. Increased maximum pool depths will improve recreational and residential attractiveness and

enlarge the inundation areas while eliminating approximately one fifth of the marginal wet land at the upper ends of the lakes which is practically useless for agriculture or recreation.

6. No inundation of diked and developed land is necessary which should enable land to be purchased more cheaply.
7. Location of two of the structures at major highways, and one on land owned by the U. S. Government, should receive the backing of most of the wildlife interests along the river and at the same time generally mollify the damage to the cattle interests.

The disadvantage to our proposal would be:

1. A slightly (sic) degree of water control which is not as detrimental as it would first appear. Much of the flood plain lands, which will benefit by drainage, are peat and muck soils and some of what seems to be overdrainage will be necessary in order to have an optimum water table after an initial subsidence of about 6 inches upon development and 1 foot every 10 years thereafter.

Additional details of this proposal are available in the office of the Planning and Research Division.

VI. Recommendations

1. Since many of the landowners now view the project with doubt and suspicion, it is recommended that an educational program be set up to include additional personal contacts, public meetings and news releases. Also, it is considered important to include landowners in meetings in the planning stages of the project rather than just gathering them together solely to inform them of what the District intends to do.
2. Since the Kissimmee marsh is, even in its present condition, important to the rancher as a source of winter and drouth (sic) pasture, and therefore extremely valuable as a balance for his upland acreage, it is recommended that the District make every effort to correct the false assumption on the part of other agencies that the land is useless.
3. Since the projects previously proposed do not appear to be geared to the needs of the people in the adjoining areas, it is recommended that additional study be given to the problem in order to fit the engineering to the highest and best use for the land, while at the same lime protecting a portion of this great natural resource for the public interest.

ASC/et
Attachment

MAP OF KISSIMMEE RIVER AND ADJACENT AREA

APPENDIX #2

FINDINGS AND RECOMMENDATIONS
OF THE

GOVERNING BOARD
CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL DISTRICT
AS THE RESULT OF
PUBLIC HEARING CONCERNING ALLEGED ENVIRONMENTAL DAMAGE
RESULTING FROM CHANNELIZATION OF THE KISSIMMEE RIVER
November 15, 1972

Findings

1. It is abundantly clear from the testimony that the problems associated with the Kissimmee Basin and Lake Okeechobee (the Lake already being in a state of early eutrophication) go far beyond the existing responsibility and authority of any single agency of government.
2. The chief concern of those testifying relates to the degradation of water quality. This is a serious and perplexing problem.
3. Land use must be regulated in the Basin; and the products of rapid urbanization and improved agricultural lands, which contribute to degradation of water quality, must be controlled.
4. Total restoration of the Kissimmee River marshes, primarily as the tool for water quality management and enhancement, may or may not be an effective solution by itself in view of other possible grave consequences, especially flood control. In any event, pollution inputs at the source must be controlled through a fully implemented land and water management plan. The estimated cost to acquire all of the lands in the flood plain of the Kissimmee River, and to eliminate the present conveyance channel and negate the function of the control structures and locks, is estimated to be \$88,000,000. The benefit-cost factors involved in major restoration will have to be carefully weighed.
5. The staff of our District is to be complimented for its efforts during the past two-and-one-half years resulting in the plan described by Mr. Morgan to improve, within the limits of the works of the Project, the environmental quality of the Kissimmee River.

Recommendations

1. A program should be immediately initiated to correct existing pollution sources in the Kissimmee Basin. Adequate restrictions should be placed on any new facilities which will discharge into the waters of the basin.
2. A program should be initiated to plan and control all land and water use activities in the basin. Particular emphasis should be given to treatment of agricultural and urban runoff, sewage effluent, and industrial discharges. Acceleration of land and water use planning and control within the State plan is mandatory.
3. It is essential to implement the first two (2) recommendations above, before or concurrent with, further restoration of the Kissimmee marshes, beyond that recommended by the Flood Control District staff. A study should be initiated to determine if additional restoration will be needed and to what extent. In this conjunction, it is recommended that an interdisciplinary team be established to assist in making such determinations. In conjunction with the study, and as a part of it, there should be an extensive

monitoring program of water quality in the Kissimmee Basin and Lake Okeechobee to determine the effectiveness of pollution control at the source and land and water use regulations.

4. Because of the presently divided responsibility for water quantity and land use planning, among several agencies and subdivisions of government, it is recommended that authority in the Kissimmee basin for these necessary elements of land and water management be given administratively, if possible, and legislatively, if necessary, to the Flood Control District. This is the best means of accomplishing the overall task of land and water planning and management in the Kissimmee basin.
5. If the task of land and water management in the basin is to be accomplished properly, it will be necessary to confer upon the District the power of eminent domain with sufficient latitude to fulfill the objectives of the program. Furthermore, it appears that Chapter 72-317, Laws of Florida (The Environmental Land and Water Management Act of 1972), will have to be strengthened to confer the power of eminent domain where it may be necessary to acquire lands in areas of critical State concern.

PREPARED BY: Messrs. Clark, Padrick, DeGrove, and Marshall