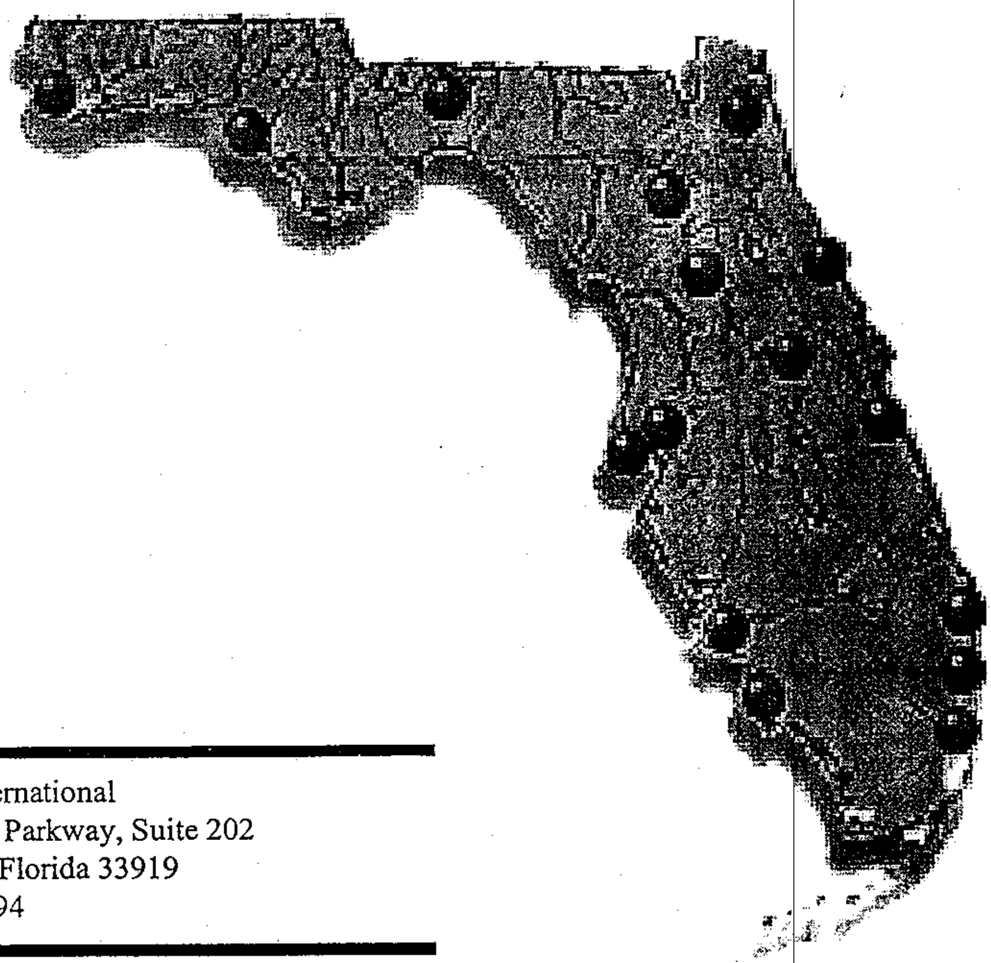
SEEPAGE MANAGEMENT

Report by the Technical Advisory Committee
Thomas M. Missimer, Chairman
to
The Governor's Commission for a Sustainable South Florida

September, 1997



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Seepage Management

September 1997

Report to the
GOVERNOR'S COMMISSION FOR A
SUSTAINABLE SOUTH FLORIDA
from the
TECHNICAL ADVISORY COMMITTEE

Seepage Management Presentation by the Technical Advisory Committee to the Governor's Commission for a Sustainable South Florida.

Report to the Commission for the TAC by Thomas M. Missimer, Chairman. Graphics in this report were prepared by Elizabeth P. Shawkey.

Seepage Management Presentation by the Technical Advisory Committee to the Governor's Commission for a Sustainable South Florida.

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Purpose

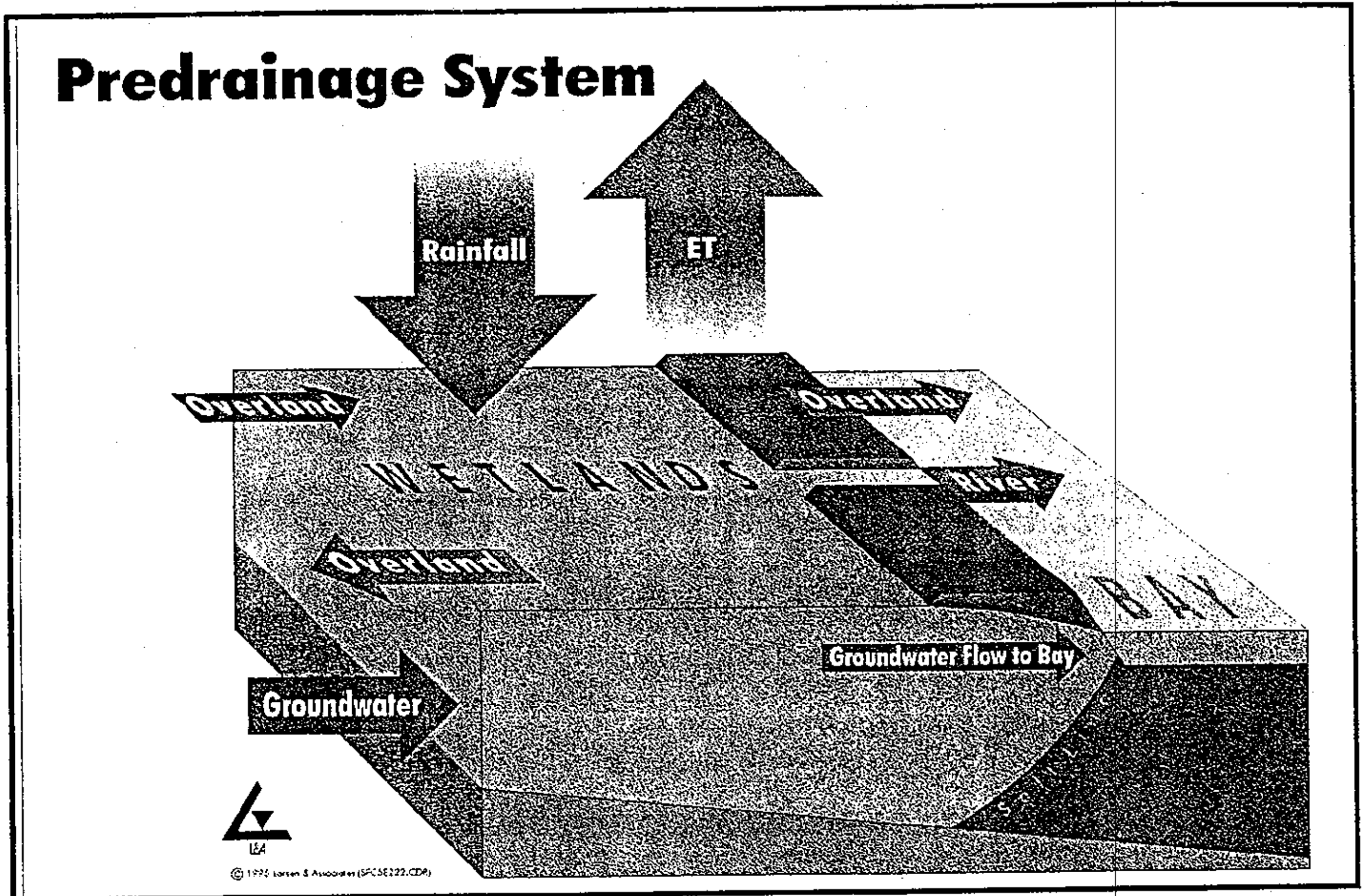
- To evaluate:
  - regional applicability
  - feasibility
  - uncertainty
  - impacts
  - costs
    - of seepage management

Seepage management techniques cannot be applied uniformly. Objectives of seepage management vary and include: 1) control, 2) reduction, 3) enhancement, or 4) maintenance of existing rates. The chosen management technique should be designed to meet the objectives and should have sufficient flexibility to deal with seasonal conditions.

THIS REPORT INCLUDES RECOMMENDATIONS TO THE GOVERNOR'S COMMISSION FOR A SUSTAINABLE SOUTH FLORIDA REGARDING SEEPAGE MANAGEMENT IN SOUTH FLORIDA

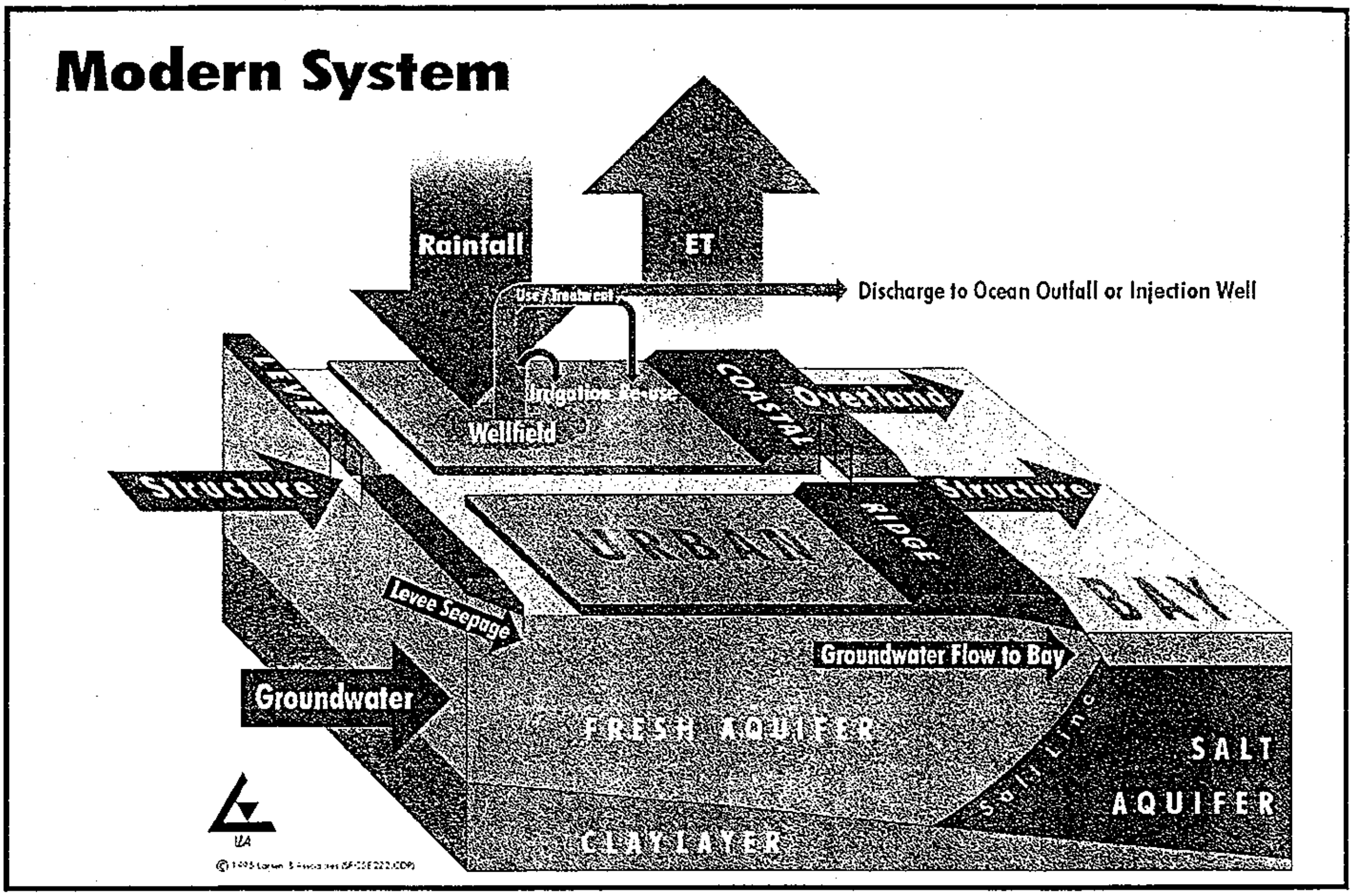
Review of the Everglades Water Budget

Placement of Seepage into Perspective



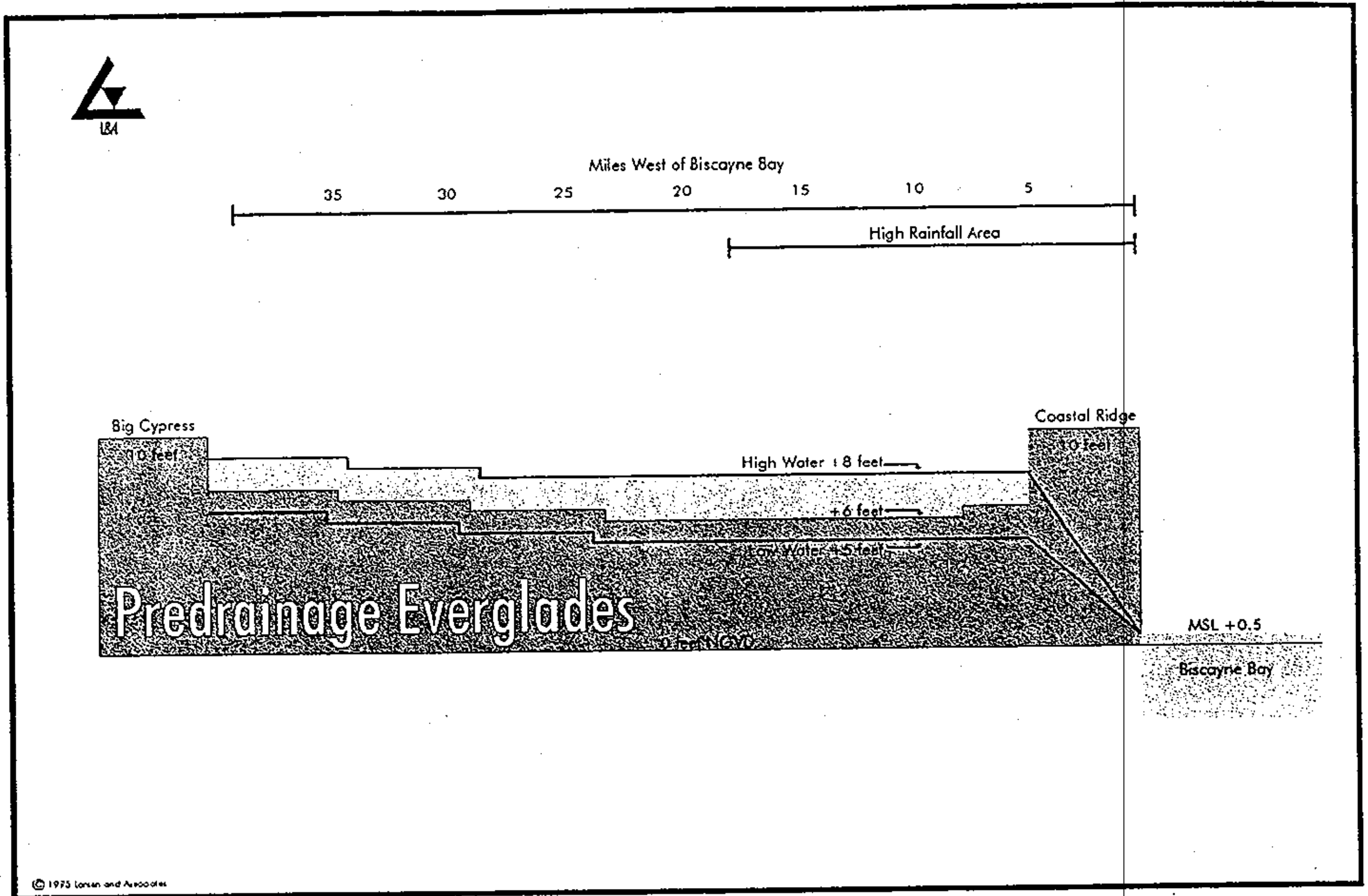
Dealing with the Uncertainty of Hydrologic Models

- All hydrologic models are uncertain and should be used with caution.
- The NSM model is more uncertain than the WMM model and its output should be used with more caution.Wherever possible, modelers calibrate the various parameters to known flows and data.
- All model results are checked for reasonableness. For example, inputs need to approximately equal outputs.
- An analysis of sensitivity to various parameters is carried out. In South Florida model results are especially sensitive to values selected for:
  - Evapotranspiration (ET)
  - Friction term for overland flow
  - Topography
- It was possible to compare the WMM model with actual data. Of course, there are no direct Predrainage hydrologic data available for the NSM so it is assumed that various parameters for ET and friction, for example, are the same as those in the WMM model.
- The Technical Advisory Committee has reviewed the issues of certainty and calibration and has



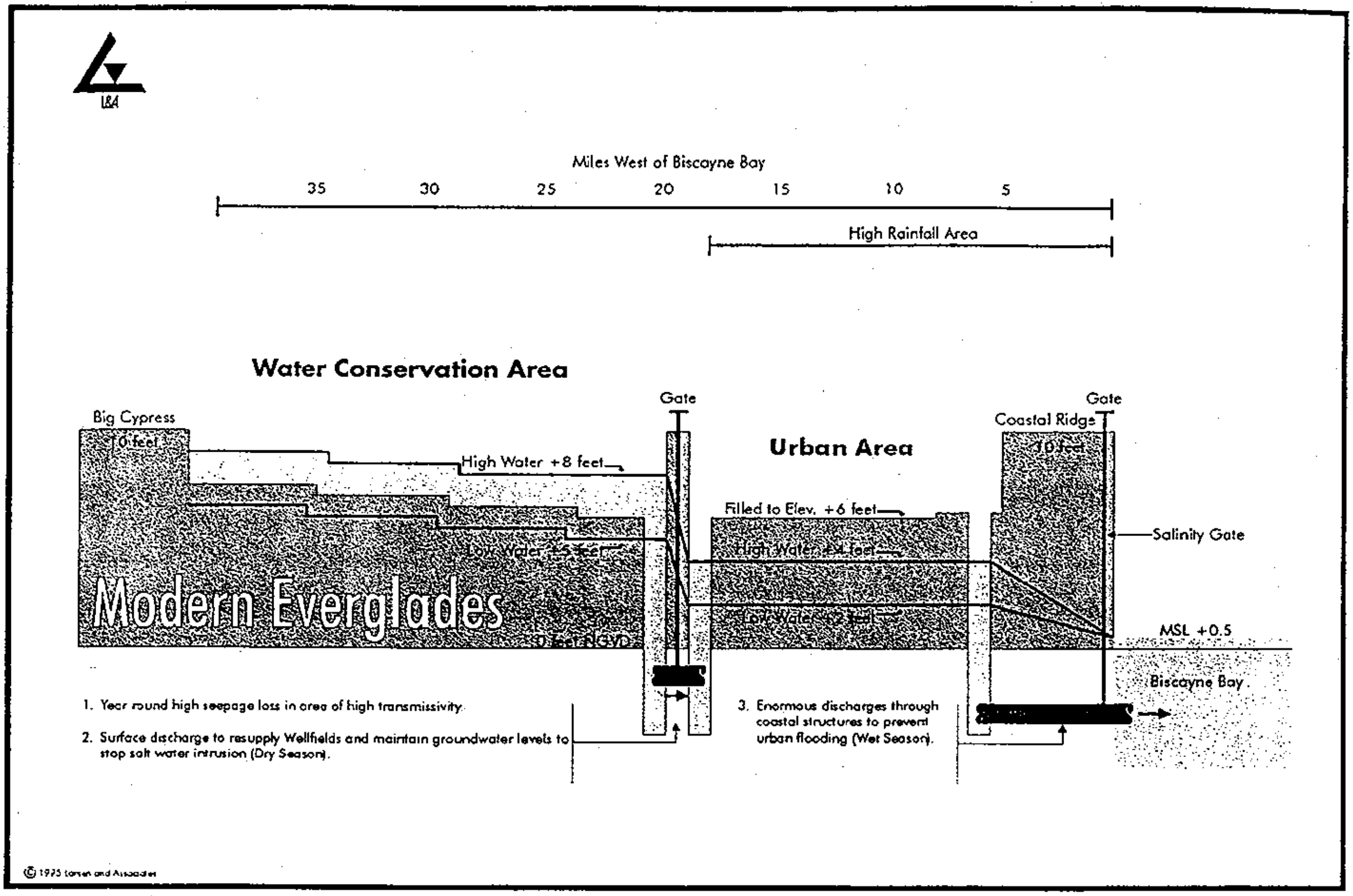
concluded that the NSM and WMM models represent the best available tools for evaluating relative change between Predrainage conditions and Modern conditions.

- In addition, the Committee concluded that the WMM model is very useful in evaluating relative change between various remedial alternatives.
- The Committee cautions, however, that the NSM model does not represent absolute Predainage hydrological conditions. For example, the NSM is based on rainfall between 1965 and 1990. Modern rainfall may be different than Predrainage rainfall.
- The slides show typical hydrologic components that apply to the NSM and WMM models.



Predrainage Cross Section

▸This schematic East-West cross section shows the Everglades extending from the Big Cypress Preserve on the west to the Coastal Ridge and Biscayne Bay on the east at a location just north of Tamiami Trail.



Modern Cross Section

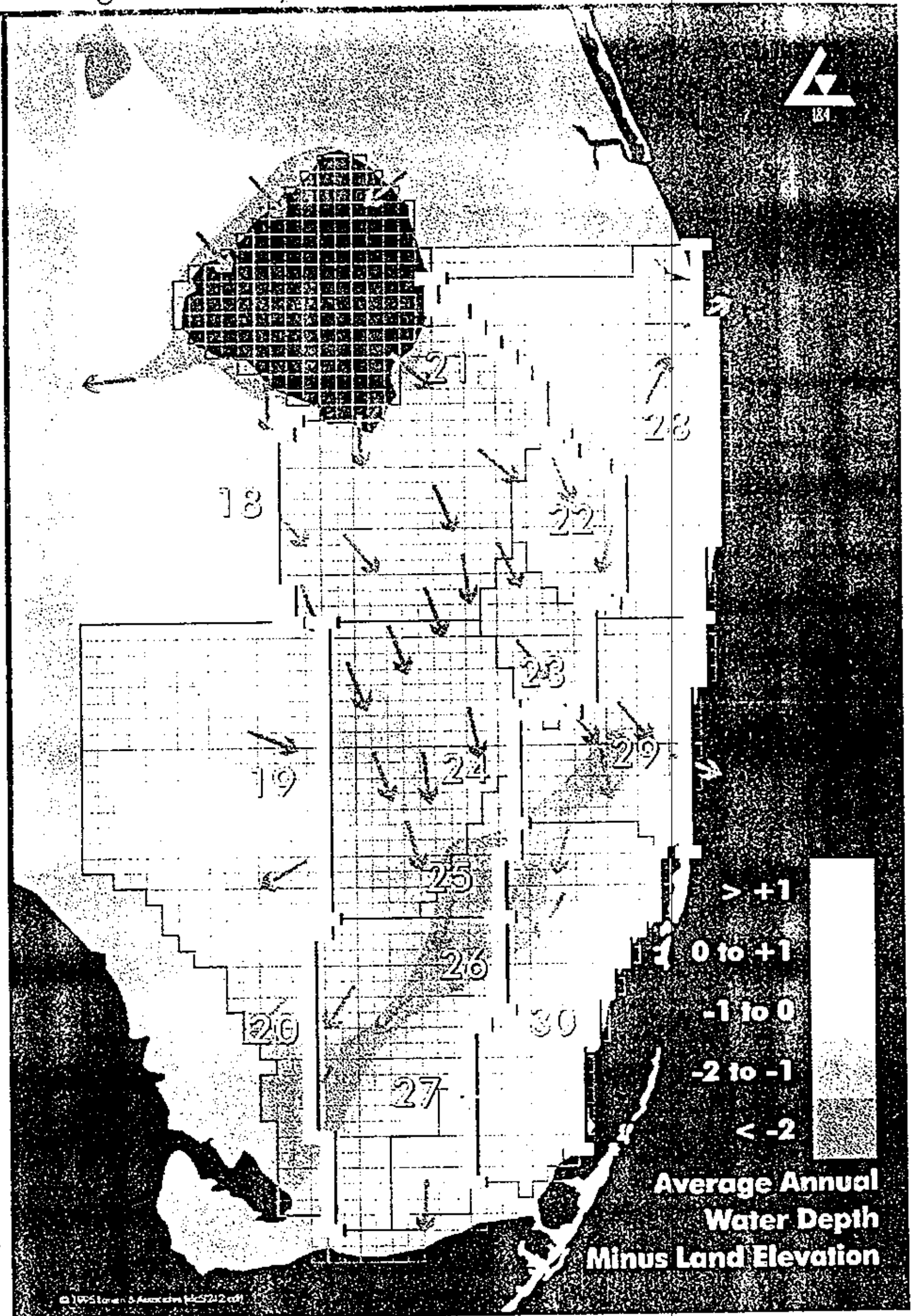
▸This cross section shows the portion of the area that has been drained for urban purposes.

▸Water levels in the urban areas need to be maintained within a narrow band:

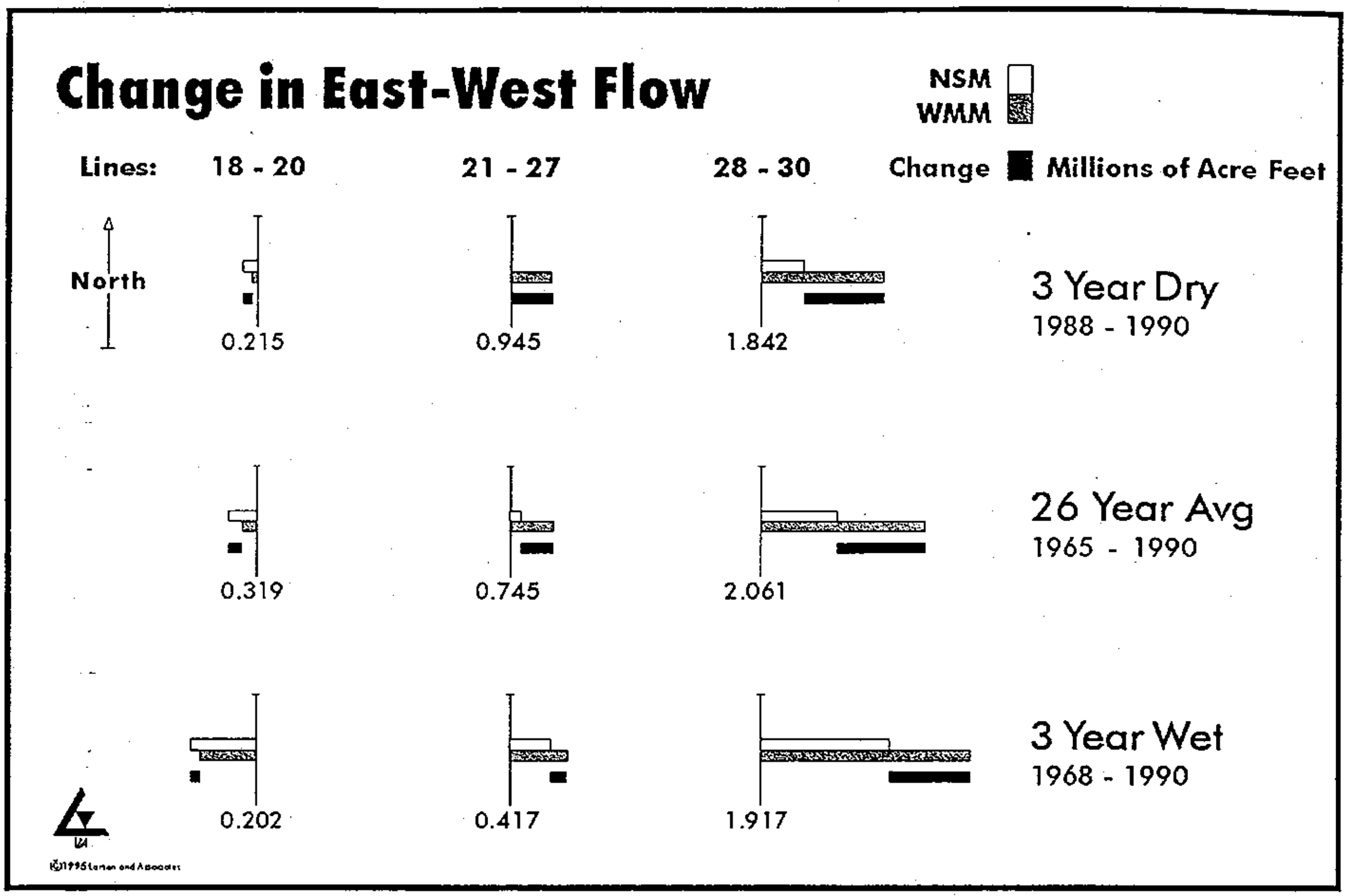
- No lower than 2 feet above sea level (which is slightly higher than high tide levels in Biscayne Bay).
- If urban water levels are below 2 feet, then supplemental water must be supplied from the WCAs.
- No higher than 4 feet above sea level (which provides approximately 2 feet of groundwater free-board above the water table) to accommodate events of high rainfall.
- If urban water levels are above 4 feet, then salinity gates must be opened to release water from the urban area to the Atlantic Estuaries.

▸The difference in water levels between the WCAs and the Urban Areas promotes uncontrolled seepage under the North-South Levee from the WCA to the urban area.

Change in East-West Flows Throughout the System

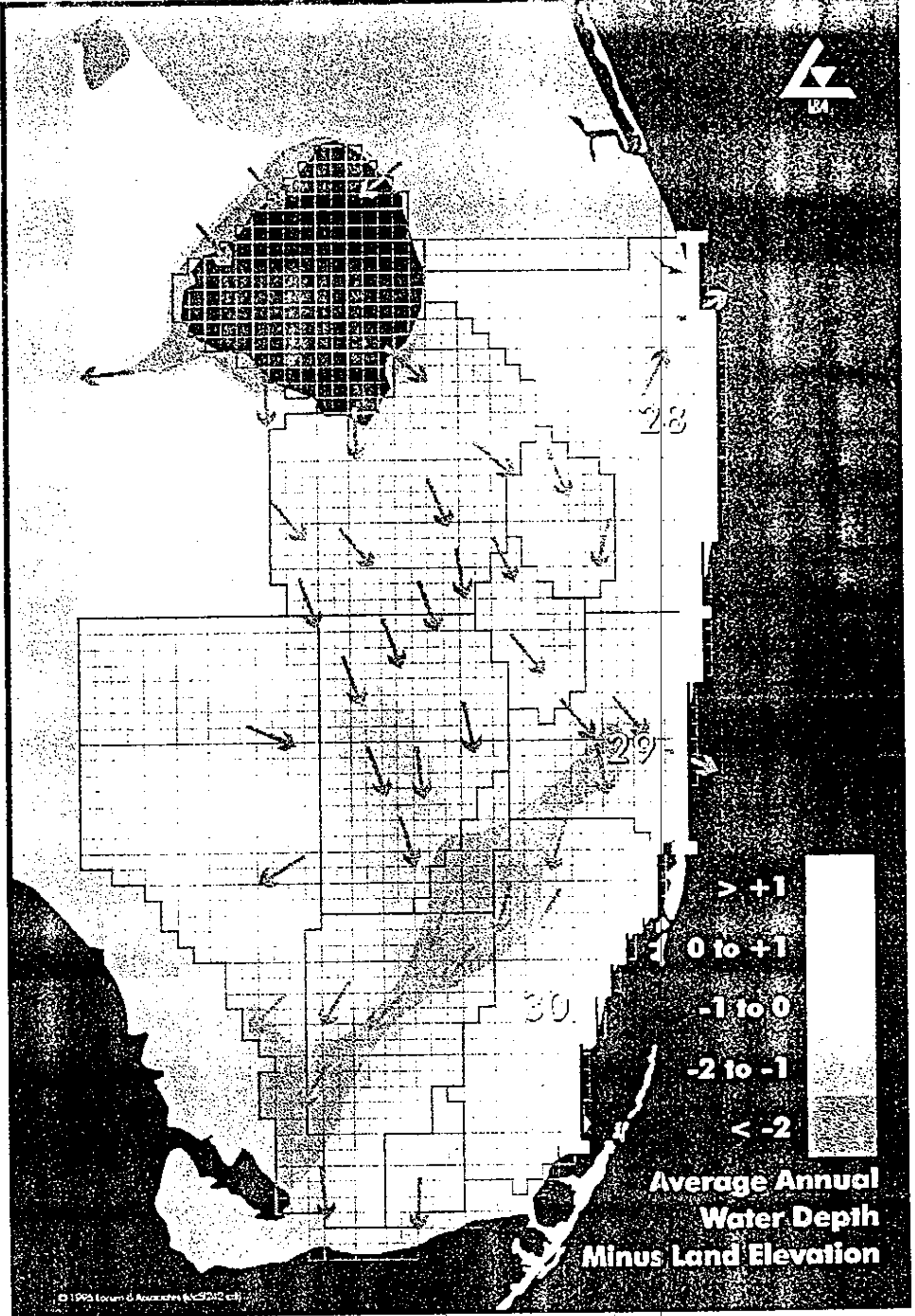


- Please notice that flows across the North-South Levee and flows to the Atlantic Estuaries have changed greatly from Predrainage times.
- The models show an increase of approximately two million acre feet of annual flow [1,842,000:dry, 2,061,000:avg, 1,917,000:wet] to the Atlantic estuaries adjacent to Palm Beach, Broward, and Dade Counties.
- The models show an increase of [945,000:dry, 745,000:avg, 417,000:wet] in easterly flows across the entire North-South Levee. This change results from the following factors:
  - The 1950 C&SF Project system drains urban areas next to remaining wet natural areas in an area where the aquifer is extraordinarily transmissive. The difference in water levels between the two areas creates a groundwater gradient that always slopes down to the east resulting in uncontrolled groundwater flow where none existed in Predrainage times. The flow rate is proportional to the difference in water elevation between the Water Conservation Areas and the urban areas. This seepage flow is, therefore, likely to be at a maximum during the wet season when the urban areas don't need the excess water.
  - In the dry season, on the other hand, the urban areas do require supplemental water from the Water Conservation Areas to hold back salt water intrusion as well as to supply [illegible]



wellfields. This water flows to the urban areas by uncontrolled groundwater seepage as well as by canals and gates that link the two areas.

Changes in Flows at Lines 28, 29, and 30 Discharges to the Atlantic Estuaries



►The dramatic increase in surface flow to the Atlantic Estuaries is largely delivered by way of drainage canals cut through the Coastal Ridge. The reasons for the increase in flow are:

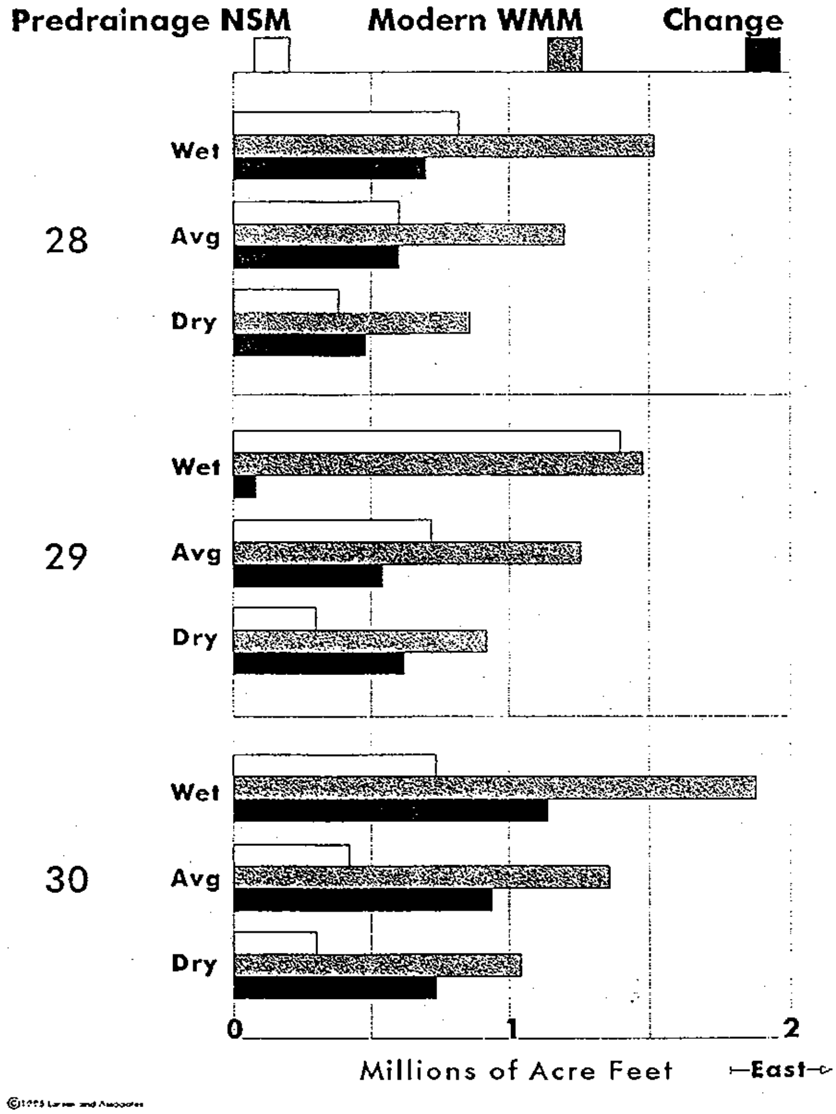
- To provide drainage of former wetlands, now urbanized, we need to continually get rid of the water that formerly made wet the wetlands located west of the Coastal Ridge.
- Drainage lowers the water table which in turn significantly reduces the rate of evapotranspiration. Because ET is reduced and rainfall remains essentially unchanged, a larger portion of the rainfall must be discharged than before drainage. Therefore, the volume of runoff from a drained wetland is much greater than before drainage.
- In addition, because features of urbanization such as pavements and rooftops significantly decrease the ability of water to infiltrate into the ground, there is more and faster surface discharge than if the land was simply drained, as would be the case for agriculture. However, these effects of urbanization can be reduced with good engineering design that provides retention and storage of storm water.
- Canals move enormous quantities of water rapidly when compared with pre[illegible]

overland and groundwater flows.

- In the transmissive rock of Dade and Southern Broward Counties, the canals that drain the urban areas also intercept a major portion of the uncontrolled seepage from the Water Conservation Areas and from Everglades Park.
- In addition, drainage changes the rate of surface discharge generally resulting in more and faster runoff.
- Wellfield pumpage and disposal of effluent to ocean outfalls or injection wells contributes to the change.

►Therefore, the two million acre foot increase in flows to the Atlantic Estuaries results from the combined effects of drainage and wellfield pumpage of the urban areas themselves and from seepage from the Water conservation Areas and Everglades Park in an approximate 50-50 split.

Change in Flows at Lines 28, 29 and 30



Changes in Flows Due to Urbanization

- Changes in flows across the North-South Levee.
- Changes in flows to the Atlantic Estuary of approximately 2 million Acre Feet.
- May indicate the quantity of water available for future Everglades, urban and agricultural water supply.

Introduction

- What is seepage?
- How does seepage occur?
- Is it important to manage seepage?
- Seepage management techniques.
- Application of seepage management techniques.

Introduction (Continued)

- Relative costs of various seepage management techniques
- Conclusions
- Recommendations
- References

This is a consensus document, representing the opinions of the Technical Advisory Committee developed between June 1996 and the present.

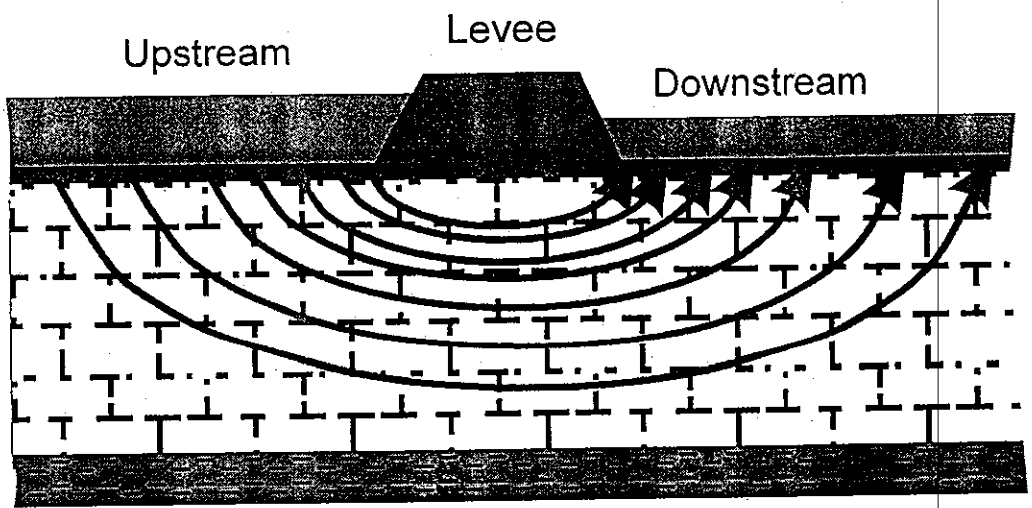
In the presentation we will first explain the issues involved in the causes of seepage and seepage management. We will discuss the objectives of seepage management. We will then discuss the various technically feasible methods and applications of methods for seepage management. We will end with our conclusions and recommendations.

What is Seepage?

- Seepage is a quantity of water flowing through porous material from one location to another.

Seepage is controlled by water level differences (head difference) and the hydraulic conductivity (permeability) of the barrier. There are a number of other factors that influence the water levels and ultimately, the seepage rates.

How Does Seepage Occur?



Seepage Beneath a Levee

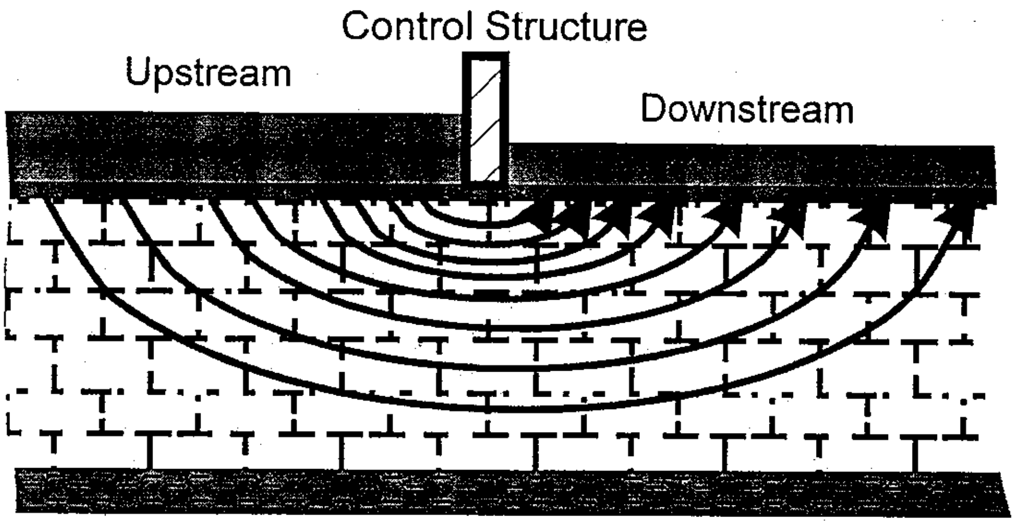
Seepage is groundwater flow caused by the difference in water levels between two adjacent areas.

The rate of seepage from a surface-water body is controlled by the transmissivity of the aquifer, the hydraulic gradient (difference in water levels divided by the distance), and the separation between the body with a higher water level and that with a lower water level.

The rate of seepage is also controlled by the design and operation of the levee and canal system (control of the hydraulic gradient).

Diagram not to scale.

Seepage Beneath a Control Structure



Is it Important to Manage Seepage?

- The TAC concludes that seepage is an important issue and should be managed to varying degrees depending on the local situation.

Seepage Management Strategies are Dictated by Local Situations

- Key factors requiring evaluation are:
  - hydrology and geology (hydrologic characteristics)
  - land use (conflicts)
  - wellfield locations
  - urban canal systems/drainage management
  - natural systems management

Potential Negative Effects of Seepage

- Rapid and large loss of water through the ground causing adverse environmental effects
- Increases flood potential
- Seepage is a significant component (loss component) of the water budget in the Everglades

Potential Negative Effects of Seepage (Continued)

- Assuming two million acre-feet of increased flow (TAC Water Budget, 1995) to the Atlantic is caused by cumulative effects of urbanization, about one-half is due to seepage out of the Everglades

Potential Positive Effects of Seepage

- Recharge to aquifers and wellfields, saltwater intrusion control
- Maintenance of downstream natural systems and estuaries

Seepage Management Techniques-Type A

Control of Seepage

- Groundwater barriers
- Parallel levees
- Step-down impoundments and step-down control structures
- Hydraulic barriers created by pumping or injection

Seepage Management Techniques-Type B

Recovery of Seepage

- Back-pumping
  - across control structures
  - from toe canals across levees
  - from toe canals to between parallel levees
  - from one impoundment to another (upgradient)

Technical Feasibility of Seepage Management Methods in South Florida

Seepage management must be an integral part of the planning and design of all water resources and restoration projects, such as the Everglades Restoration, the Stormwater Treatment Areas (STA's), water preserve areas, and the lake belts.

Feasibility of Any Seepage Management Method is Dependent on the Objectives Set Prior to Design and Construction

Evaluation for South Florida

For

Technical Feasibility, Flexibility, Reversibility and Experience

High/Medium/Low

For

Size Application and Land Area Required

Large/Medium/Small

Technical feasibility was evaluated by assessing a number of factors, including: hydrologic and geologic conditions in South Florida, construction methods that could be used, impacts to the aquifer system, potential impacts to down-stream land and water uses, and others.

Explanation of Scales

Large (L) =	Greater than 5 miles (regional)
Medium (M) =	1000 feet to 5 miles
Small (S) =	Less than 1000 feet (local)

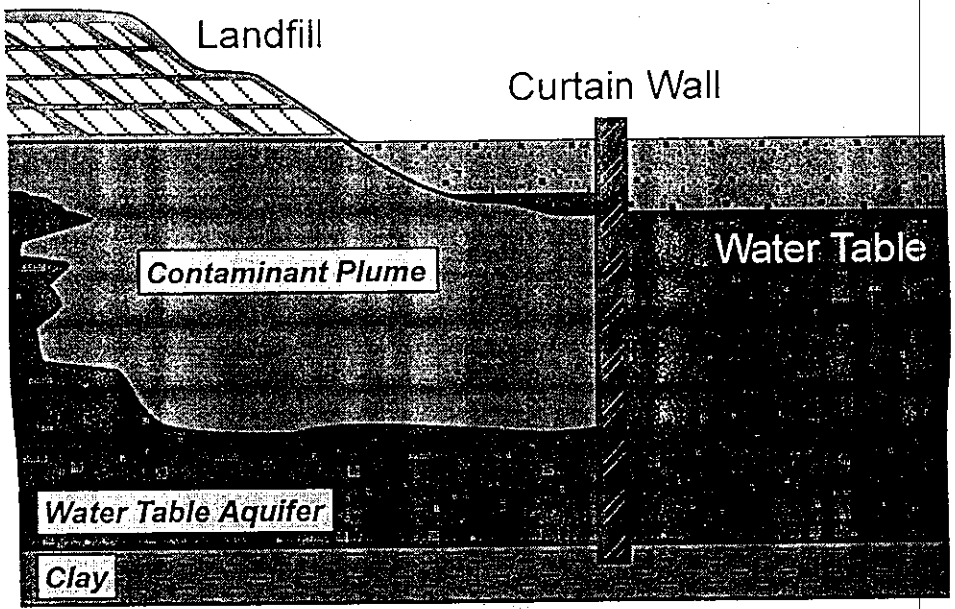
Seepage Control Methods

Groundwater (Seepage) Barriers

- Curtain walls (driven sheet piling)
- Slurry walls
- Grout curtains

The primary objective of installing most groundwater barriers is to reduce or eliminate seepage. There is flexibility in the design of groundwater barriers to cut off all flow or only part of the flow, depending on the permeability of the barrier and the thickness of the aquifer sealed. For example, if an aquifer is 100 feet thick and there is a desire to allow some seepage, the barrier could be installed to a lesser depth. Also, additional flexibility could be achieved by combining the use of a barrier with a control structure to allow only the desired quantity of water to pass over or through the barrier.

Curtain Walls



A curtain wall constructed of sheet piling or by emplacement of a plastic sheet can be an effective groundwater barrier to depths of about 20 feet or perhaps deeper depending on the local geology. It is constructed by driving or jetting the sheet piling to the design depth.

Curtain walls are used in South Florida for relatively small applications. Some examples are for the containment of plumes adjacent to landfills and other sources of groundwater contamination. They are also used to prevent seepage during the installation of lift stations used in wastewater collection systems.

Diagram not to scale.

Curtain Walls
(Driven Sheet Piling)

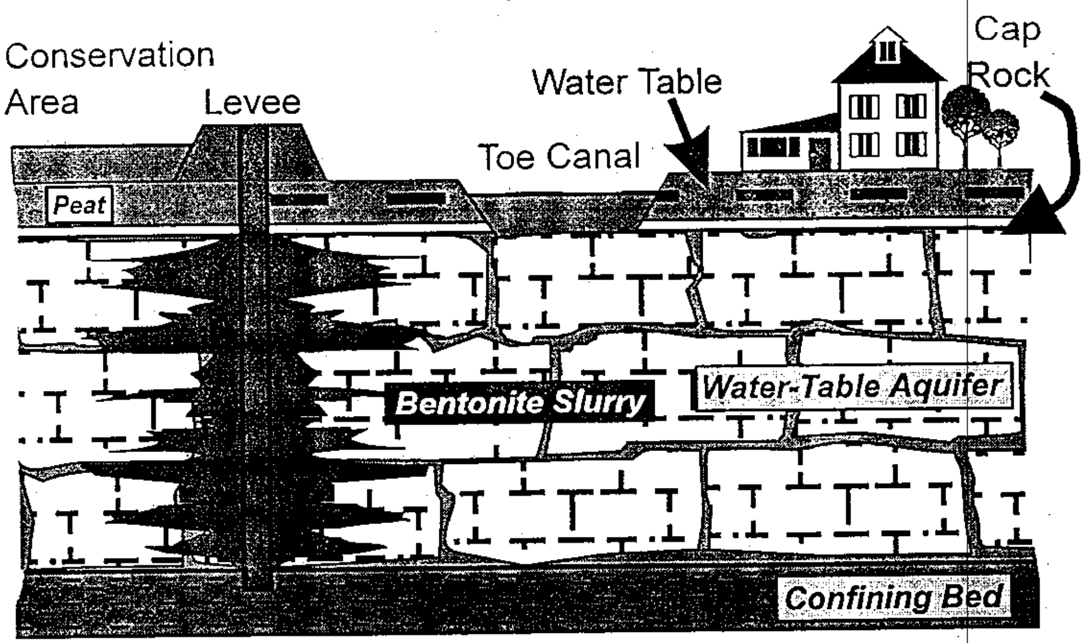
CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility			H
Operational flexibility			M/L
Reversibility			M/H
Land area required			S
Experience with technology			H

Curtain walls have been used in South Florida for small applications, such as sea walls, sheet-piling to install lift stations (small-scale seepage control), sheet-piling adjacent to and beneath control structures to help control seepage, and to stop the spread of contamination from landfills and other sites. The current applications will continue, but use of the technology for larger scale seepage control problems is not feasible.

Problems

* depth limitations
* lack of flexibility
* applies to small situation only

Slurry Walls



Slurry walls are commonly installed by digging or drilling a narrow trench to the design depth and while the drilling is being conducted, a slurry of bentonite (clay) is simultaneously injected into the trench. Slurry walls are normally about 2 feet in width and can be installed to a depth of up to 300 feet (depth can be greater depending on the geology and equipment available for construction). A slurry wall can be constructed to provide virtually no seepage or a variable degree of seepage, depending on the desired depth and local geology. Another suggestion is to dig a trench and fill it with other fine-grained materials.

Diagram not to scale.

Slurry Walls

CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility	M/L	M/L	
Operational flexibility	L	L	
Reversibility	L	L	
Land area required	*S*	*S*	
Experience with technology	L	L	

Slurry walls have been used in Florida at a number of locations primarily for control of contamination. Some of the installations are rather large, such as those in the central Florida phosphate mining district. Applications of this technology can range from medium distances adjacent to a control structure to large distances adjacent to levees. The design of a slurry wall along the lower East Coast will require some type of scaled test program before the technology can be applied to larger problems. Operational flexibility can be greatly increased by using the technology in combination with other methods.

Problems

* lack of experience
* lack of flexibility (if stand alone)
* lack of reversibility
* feasibility site-specific (geology dependant)
* unknown downstream impacts

Combining Seepage Control Methods to Produce Flexibility

Groundwater barriers can be constructed that provide permanent control of all or part of the seepage. The problem with the "stand-alone" groundwater barrier is that it is permanent and does not provide flexibility in the management of down gradient water levels and flows. If a groundwater barrier is placed beneath a levee containing a series of control structures connected to a down-gradient canal (toe canal), the entire system would be totally flexible. When no seepage is wanted, the control structure would remain closed. When water is needed on the down-gradient side of the barrier, the control structures would be opened. The degree of flexibility required could be incorporated into the design, such as increasing the number of control structures.

Slurry Walls with Control Structures

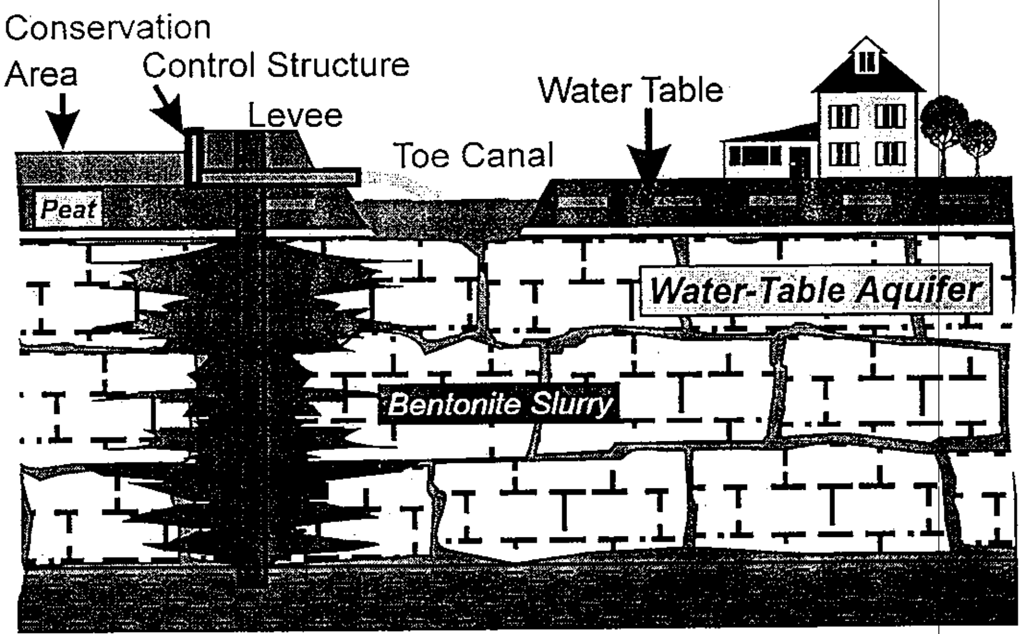
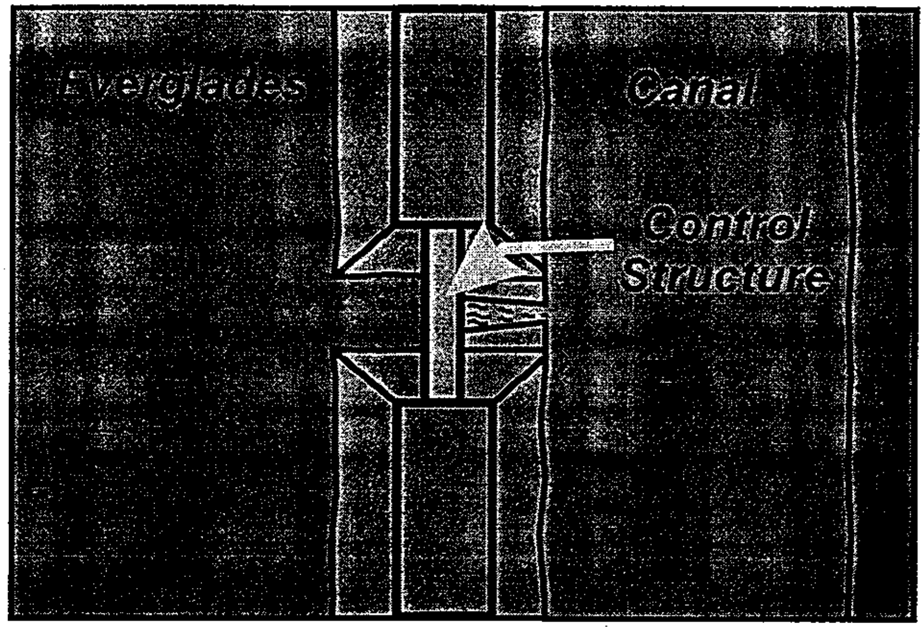


Diagram not to scale.

Slurry Wall with Control Structure--Top View



Slurry Walls with Control Structures

CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility	M/H	M/H	
Operational flexibility	H	H	
Reversibility	L	L	
Land area required	*S*	*S*	
Experience with technology	L	L	

Slurry walls with control structures and canals would provide a very flexible method of seepage management. The slurry wall could eliminate all or part of the seepage and the control structures could be used to manage the downstream impacts. A properly designed test program would be necessary before any large-scale used should be proposed.

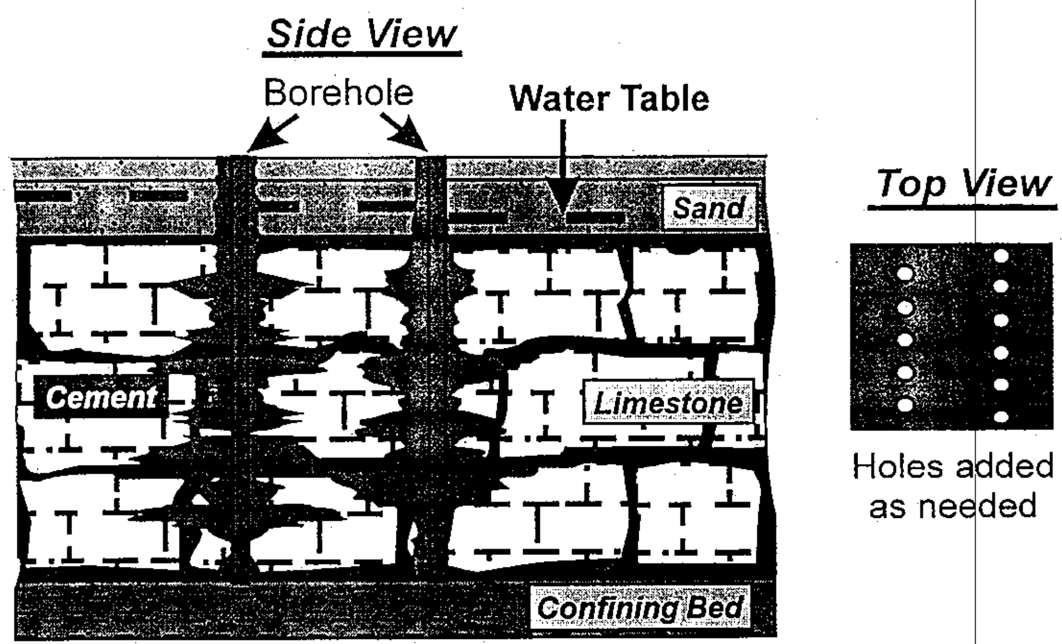
Problems:

* no experience

* no testing

* unknown downstream impacts

Grout Curtains



Grout curtains are installed by drilling a series of closely spaced holes and injecting cement grout under high pressure. Commonly, there are several rows of holes drilled to reduce the seepage. Since there is some uncertainty concerning the number and spacing of holes required to meet the design objectives before beginning construction, there is flexibility to add grouted holes at closer spacing or add a row of additional grouted holes during or after construction.

Diagram not to scale.

Grout Curtains

CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility		M	H
Operational flexibility		L	M
Reversibility		L	L
Land area required		*S*	*S*
Experience with technology		L	H

Grout curtains have been used in South Florida for control of seepage at lift station and pumping station sites. The large scale use of the technology in South Florida may not be feasible, because of the high permeability and the volume of cement that would be required to eliminate seepage. Operational flexibility can be greatly increased by combining with another technique.

Problems

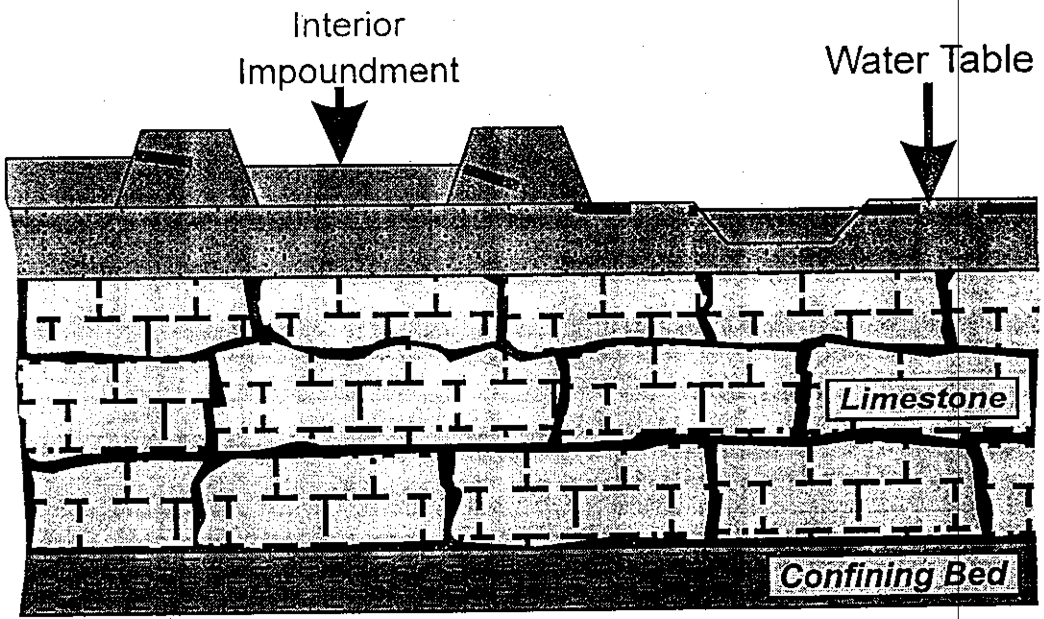
* permeability too high

* porosity too high

* poor flexibility/reversibility

* lack of experience

Parallel Levees



The purpose of a parallel levee design is to reduce the hydraulic gradient. The number of levees is an important factor in the control of the gradient and the seepage rate. Again, the overall objective of this seepage control method is to step-down surface water levels to reduce seepage rates.

Diagram not to scale.

Parallel Levees

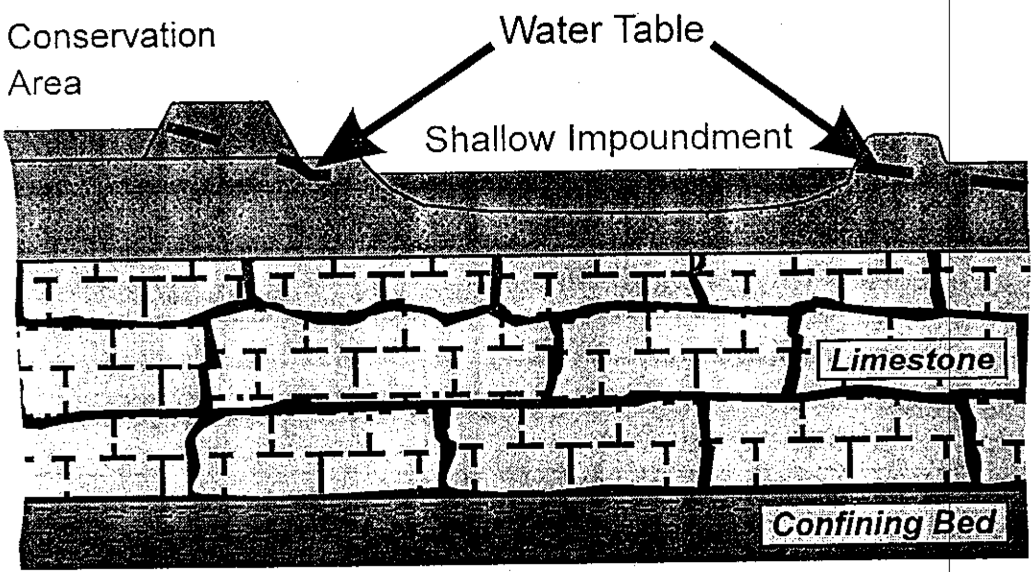
CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility	H	H	
Operational flexibility	L	L	
Reversibility	H	H	
Land area required	*L/M*	*M*	
Experience with technology	M	M	

Parallel levees can be used to reduce the hydraulic gradient only in areas where there is surface-water flow between the levees. There must be surface water upstream of both levees. This flow may be sheet flow, emergent groundwater flow from seepage, or ponded rainwater. The parallel levee concept is similar to the impoundment, but usually is smaller in area. Wet condition operational flexibility can be increased by adding control structures and canals.

Problems

* land area can be large (distance between levees)
* not much flexibility (without control structures)

Step-Down Impoundments



There are a number of concepts involving step-down impoundments. The concept involves a reduction of the hydraulic gradient (slope) at the Everglades boundary. These impoundments contain a mix of open water and wetland areas. One objective in all cases is to lower the gradient from the conservation areas eastward to the urban area.

Diagram not to scale.

Step-Down Impoundments

CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility	H	H	
Operational flexibility	L	L	
Reversibility	H	H	
Land area required	*L*	*M*	
Experience with technology	M	M	

There are a number of surface-water impoundment types that could be used for seepage management among multiple purposes. The only difference between the parallel levees and step-down impoundments is they are potentially irregular in shape and generally greater in width and may include a supplementary water source. Step-down impoundments are effective for seepage control when surface-water levels are high and it is wet.

Problems

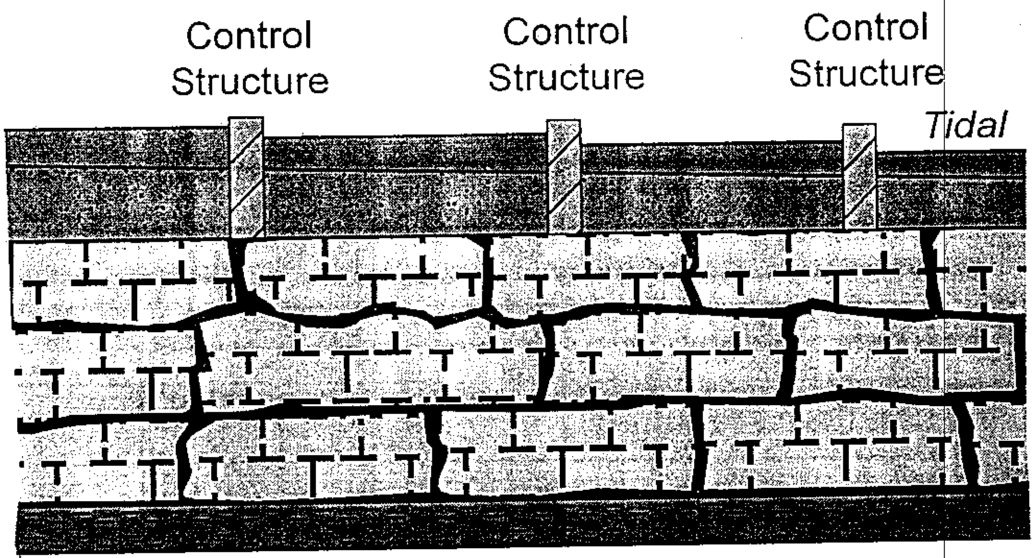
* seepage rates for deep lakes-too high

* shallow lakes water budget-high evapotranspiration

* water quality

* potential flood control

Step-Down Control Structures
(Cross-Sectional View)



The concept of placement of control structures in drainage and conveyance canals to lower the hydraulic slope of the water already has been implemented in many canal systems in South Florida. On the east side of the levees it can be used to lower the head difference between the Everglades and the urban area and therefore, be part of a seepage control plan.

Diagram not to scale.

Step-Down Control Structures

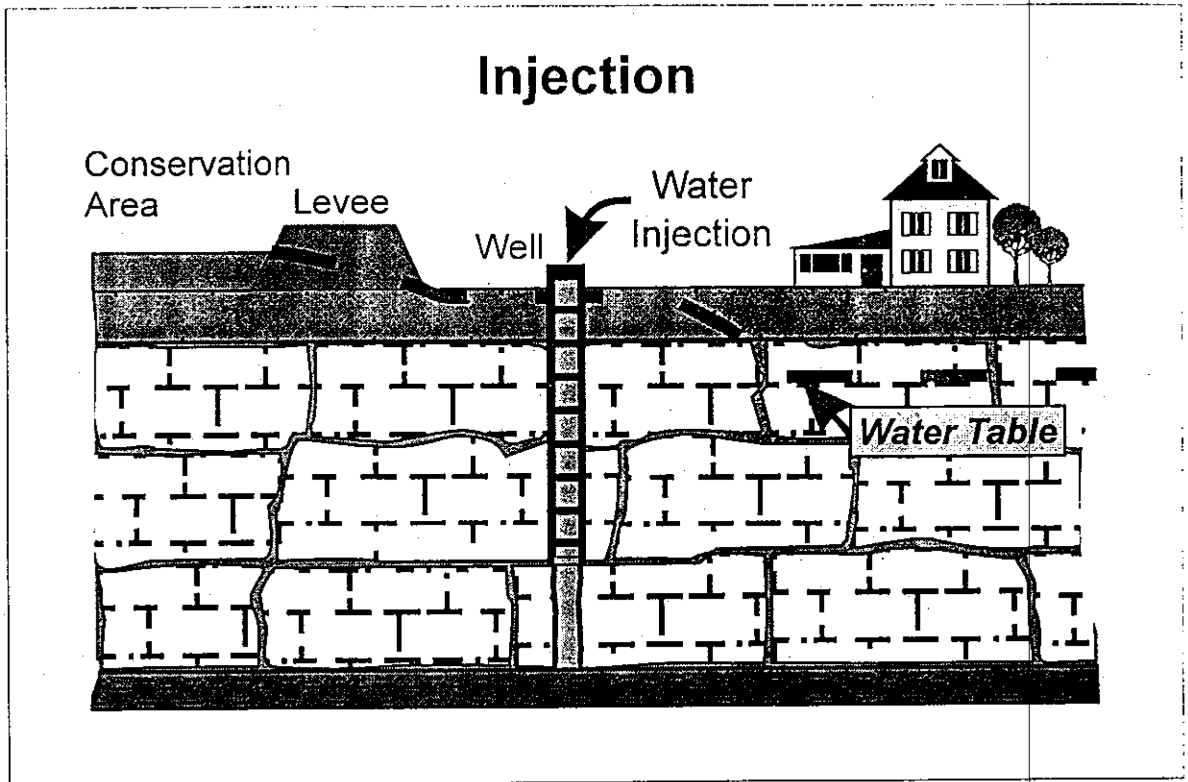
CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility	H	H	
Operational flexibility	H	H	
Reversibility	H	H	
Land area required	*M*	*M*	
Experience with technology	H	H	

The only feasible applications for step-down control structures in canals for seepage control are in the canals east of the Everglades levee or downstream of other levees.

Problems

* potential flood control problems

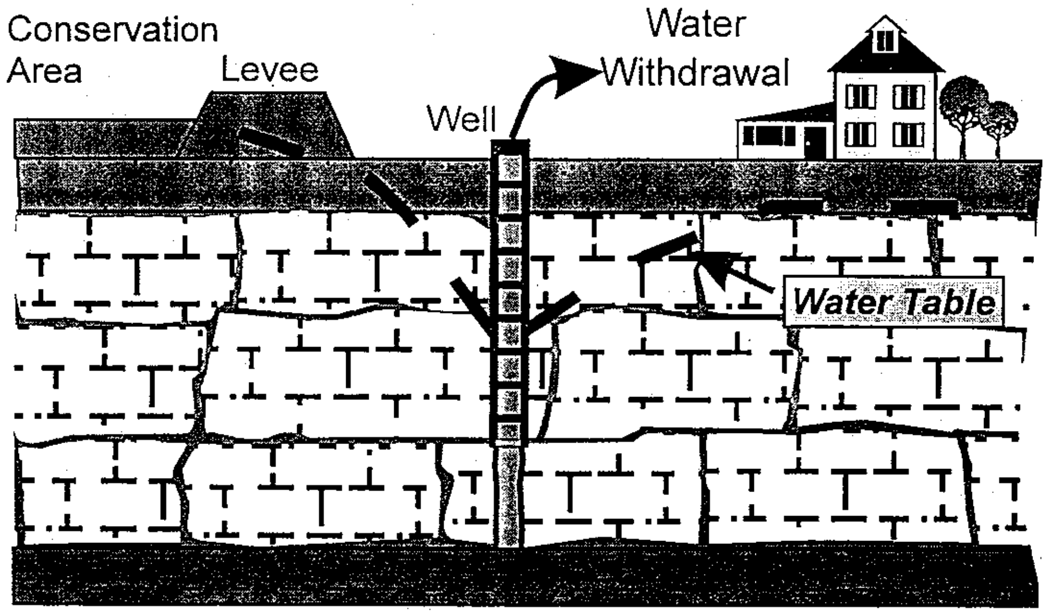
Hydraulic Barriers by Pumping or Injection



Since seepage rates are a function of the hydraulic gradient across a levee or barrier of some type, any method that changes the slope of the hydraulic gradient correspondingly affects the rate of seepage. The outflow of water from an area can be controlled by creation of a mound of water by injecting water into the aquifer adjacent to the down-gradient side of a levee. This method can be used to control seepage as well as to reduce saltwater intrusion.

Diagram not to scale.

Withdrawal



The creation of a trough in the water-table aquifer can also be used to reduce the impacts of seepage. A trough can be created by pumping the aquifer using a number of possible configurations, such as a linear wellfield, a horizontal well system, or construction of an underdrain system. The placement of a municipal wellfield adjacent to a levee system can both provide a source of water supply and at the same time control the impacts of seepage. In this case the rate of seepage is purposely increased rather than decreased.

Diagram not to scale.

Hydraulic Barriers Created by Pumping or Injection

CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility		L	M
Operational flexibility		H	H
Reversibility		H	H
Land area required		S	S
Experience with technology		M	M

Use of this technology for managing seepage control is limited. The injection of stormwater runoff or treated wastewater along the levee to reduce the hydraulic gradient may be possible, but water quality issues must be evaluated. The downstream impacts of seepage are managed in certain cases by the location of public supply wells, which serve a dual purpose.

Problems

* does not work (injection) in high permeability sediments
* finding high quality water for injection
* permitting issues

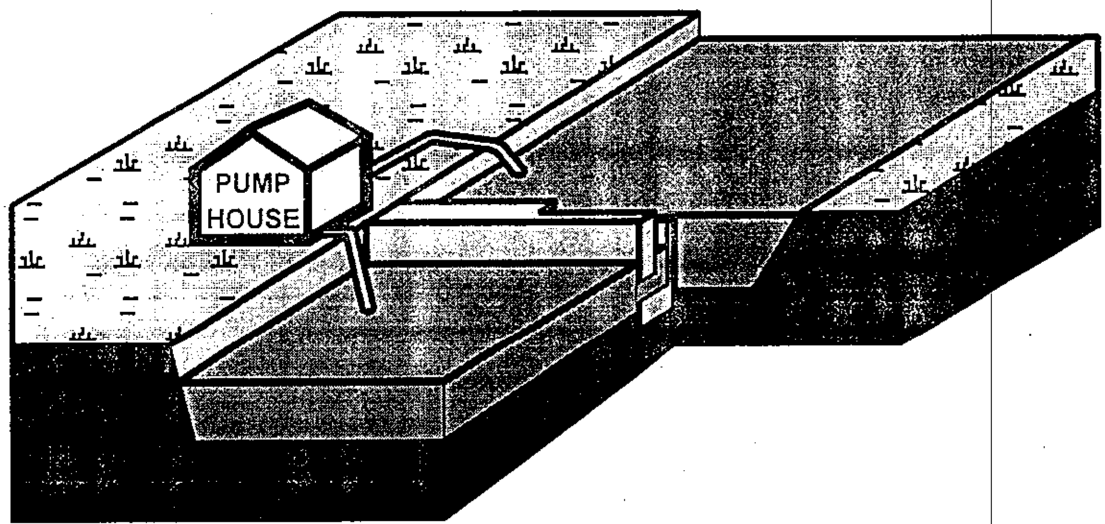
Seepage Recovery by Back-Pumping Methods

Water Quality Issue

The quality of the water to be back pumped must meet acceptable standards for the reception area whether natural or man-made.

There are a variety of different water quality standards that apply to various receiving water bodies. In the case of back-pumping across a control structure in a canal, the water on the down-stream side must be freshwater. If back-pumping is going to be into the Everglades or another natural area, the water must meet the appropriate standards. Considerable caution must be used when back-pumping into the recharge area of public water supply wells and reservoirs.

Back-Pumping Across Control Structure



Control structures are commonly used to hold back water in ditches or canals from discharging directly into either tidal waters or into a lower elevation surface-water body. The seepage around or under a control structure can be recovered in certain circumstances by back-pumping. This is a localized seepage control method, but very large quantities of water can be recovered.

Diagram not to scale.

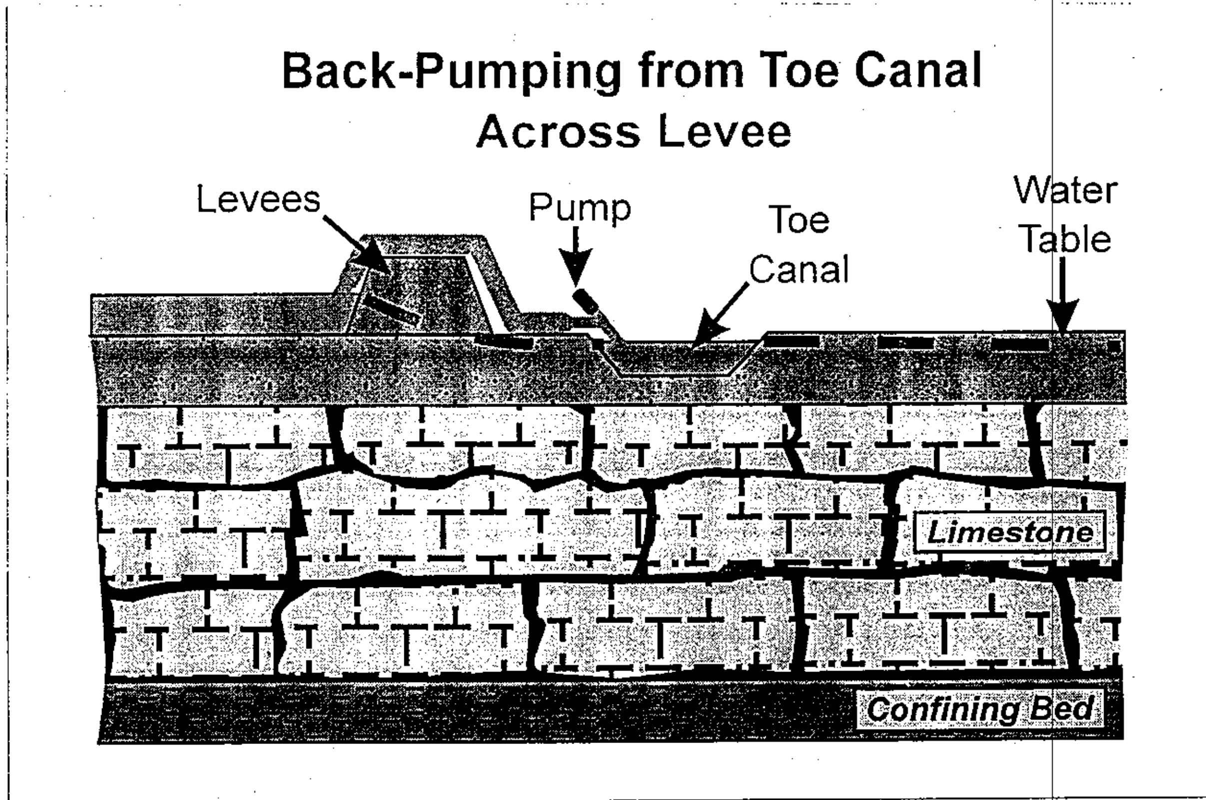
Back-Pumping Across Control Structures

CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility			H
Operational flexibility			H
Reversibility			H
Land area required			*S*
Experience with technology			H

This seepage management method is commonly used to recover seepage around or under control structures. It can be used at a wide variety of locations where there is acceptable water quality. In certain cases, pumping may be limited to only those times of the year when water quality is acceptable.

Problems

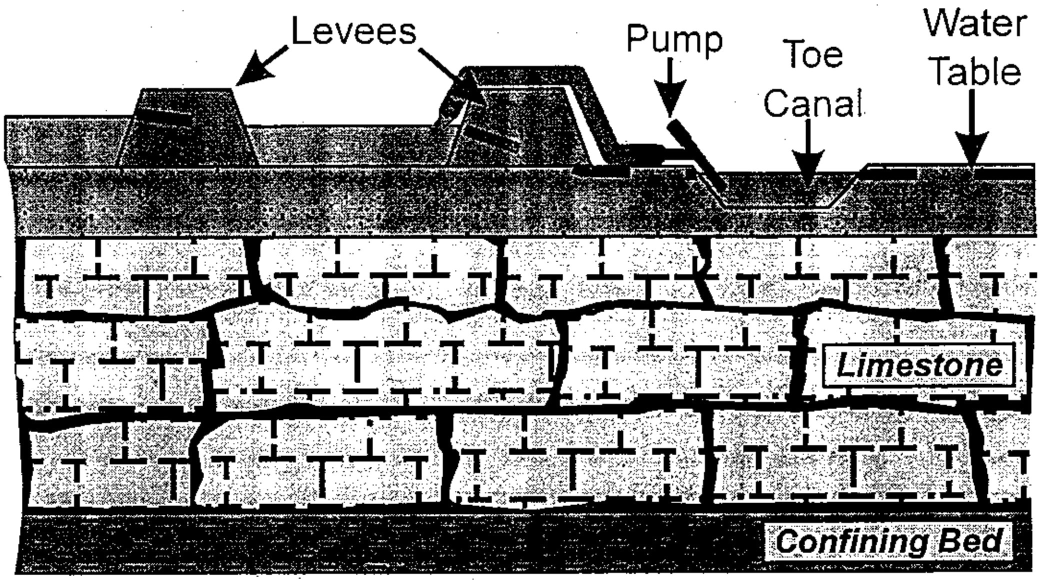
* seasonal water quality variation down-stream of structures.



The simplest barrier to surface-water flow is a levee or dike, which allows the buildup of water on the upstream side of the dike. As the water level difference between the upstream and downstream (or gradient) increases, the rate of seepage increases beneath the dike. In order to control the impacts of seepage on the down-gradient side of the levee a toe canal is commonly constructed to intercept all or part of the seepage. The concept shown here is to recover all or part of the seepage from the upgradient area by back-pumping water from the toe canal back across the levee. The feasibility of the method is dependant on the quantity (rate) of seepage and the quality of water in the toe canal.

Diagram not to scale.

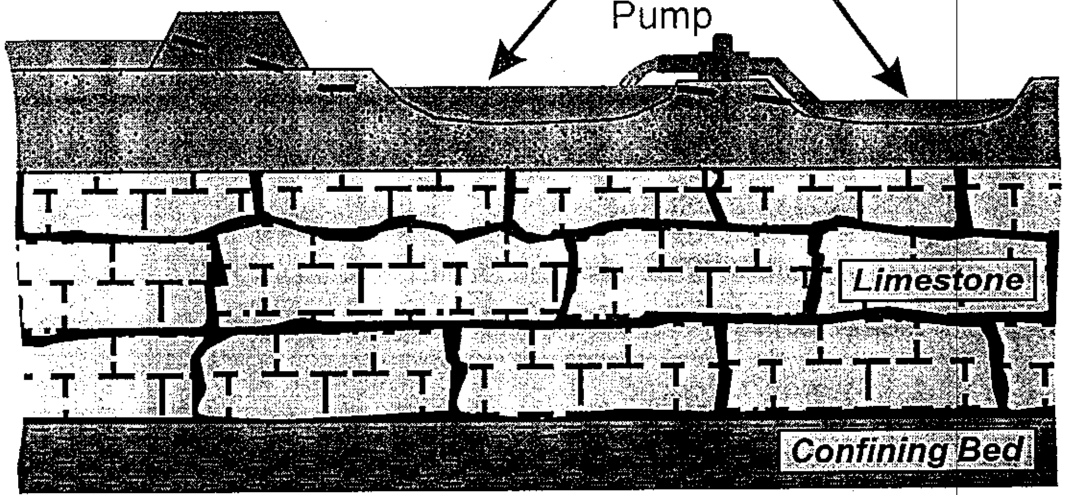
Back-Pumping from Toe Canal to Between Parallel Levees



Back-pumping from a toe canal on the down-gradient side of the parallel levee system is a good way to reduce the hydraulic gradient and in turn, reduce seepage.

Diagram not to scale.

Back-Pumping from One Impoundment to Another



This type of seepage recovery is based on a series of impoundments, located east of a levee. The hydraulic gradient between the Everglades and the eastern-most impoundment would be controlled by back-pumping from the down-gradient impoundment back into the next higher impoundment. The success of this system is based on the seepage rate between impoundments. If the impoundments would be deep and penetrate a large thickness of the Biscayne Aquifer, the magnitude of back-pumping may be too large to allow economic operation of the system. If the impoundments are shallow wetlands, the water budget of the "impoundments" would require analysis to assess enhanced evapotranspiration losses. Also, the quality of water to be back-pumped would be an issue of concern.

Diagram not to scale.

Back Pumping From -

1. Toe Canals Across Levees
2. Toe Canals to Between Levees
3. One Impoundment to Another
4. Quarry Lake to Canal or Impoundment

CRITERIA	RATING		
	Large	*Medium*	*Small*
Technical feasibility	H	H	
Operational flexibility	H	H	
Reversibility	H	H	
Land area required	*S*	*S*	
Experience with technology	H	H	

There is potential wide-spread application of this method, where the seepage rate is sufficiently low to allow economic pumping. In areas where the permeability is high and the seepage rate is high, the pumping capacity necessary may be too high to allow economic back-pumping.

Back-pumping into parallel levees is the same as back-pumping into an impoundment. This has a wide-spread potential application, because there may be less concern about water-quality compared to direct back-pumping into the conservation areas.

Back-pumping between impoundments has been used within residential developments in South Florida to supplement irrigation and to manage stormwater. Back-pumping could be used to balance the water budget of the shallow impoundments.

Problems

- Water quality concerns
- Permitting issues
- for 1: Land area small
- for 2: Land area medium
- for 3: Land area large

Economic Considerations for Seepage Management

In order to assess the economic viability of any seepage control option, the objectives of seepage management must be defined.

The approach to a proper economic assessment for seepage control at any given location is to first assess what technical options are available based on some general objectives and the local hydrogeologic conditions. Then, some very specific goals and objectives must be set, such as what level of flexibility is required, how much seepage must be controlled or recovered, and what water quality criteria must be met.

Types of Project Costs to be Assessed

- Capital Costs (design and construction)
- Operating Costs

General Economic Principles

- Groundwater barriers have high capital costs and low operating costs
- Seepage recovery systems have relatively low capital costs and high operating costs
- Impoundments combining methods will be a blend of costs that may be more difficult to define

Cost of Groundwater Barriers

- Slurry walls to depth of 100 feet
  - Cost per 1 mile = $3 to $6 million

- Control structures
  - Cost per 1 mile = $0.25 to $0.5 million

Long term maintenance = low

Cost of Backpumping

- Capital Cost = \$20.00 to \$30.00 / acre-ft.
- Maintenance Cost = \$1.00 to \$2.00 / acre-ft.
- Pumping Cost = \$0.80 to \$1.00 / acre-ft.

Conclusions

Seepage has become a very significant part of the South Florida water budget.

A large part of present day seepage is primarily the result of levee construction and flood control drainage.

Other contributing factors include wellfield pumpage, individual wells, and other land uses that alter the water levels.

Seepage loss from the Everglades alone is estimated to be about 1,000,000 acre-feet per year.

(TAC, 1995, Everglades Water Budget).

Conservation of seepage MUST be a critical part of future restoration and water-supply projects. Everglades restoration cannot be accomplished without improving seepage management.

Technologies for seepage management are available for a variety of hydrogeologic conditions in South Florida.

The optimal mix of technologies to be applied for seepage management is site-specific.

In order to maintain replenishment of water-supply sources, flood protection, groundwater levels, and estuarine protection, the seepage management techniques applied must be flexible.

Adequate hydrogeologic information is currently not available to develop a detailed seepage management strategy.

The existing water management system is not sufficient to manage seepage (reduce losses at critical times).

Any seepage management strategy developed must: 1) prevent significant downstream impacts to urban and agricultural water supplies, flood control, wetlands, and estuarine systems, and 2) if possible, augment regional water supplies.

The potential benefits of a slurry wall for regional seepage management merit BOTH field testing and modelling of this technology.

Selection of a seepage management technology should include the tradeoffs of capital cost vs. operating costs during the lifespan of the facility.

In areas where the permeability is high and the seepage rate is high, the pumping capacity necessary may be too high to allow economic back-pumping.

Recommendations

The Governor's Commission should recommend to the U.S. Army Corps of Engineers and the SFWMD that seepage management be elevated in priority, specifically considered, and addressed in ALL water management plans.

The Governor's Commission should recommend to the U.S. Army Corps of Engineers and the SFWMD to allocate funds in the next fiscal year for demonstration projects for those technologies that have a sound scientific/engineering basis or that have been shown to work in other situations in Florida or in situations similar to those that occur in South Florida.

Perform a demonstration project for investigation of the slurry wall seepage management technique, including an assessment of downstream impacts.

Collect comprehensive new hydrogeologic data (e.g. cores, head, and flow data) for evaluation of seepage management strategies and their impacts.

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