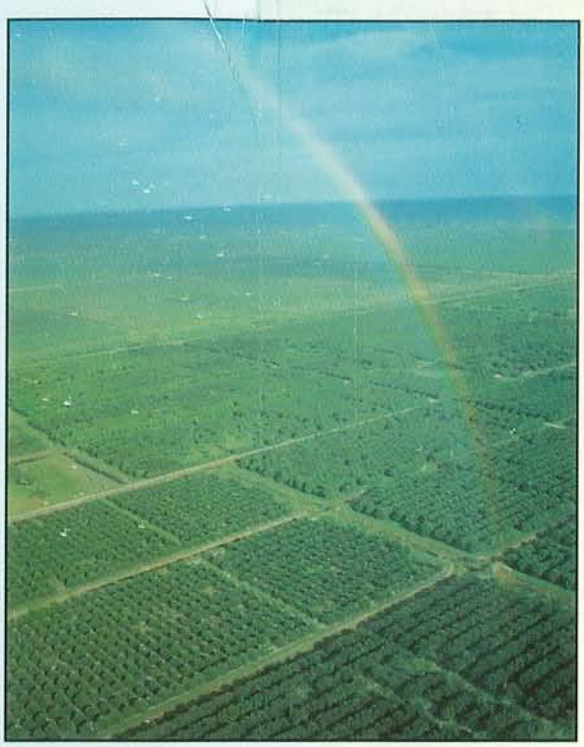
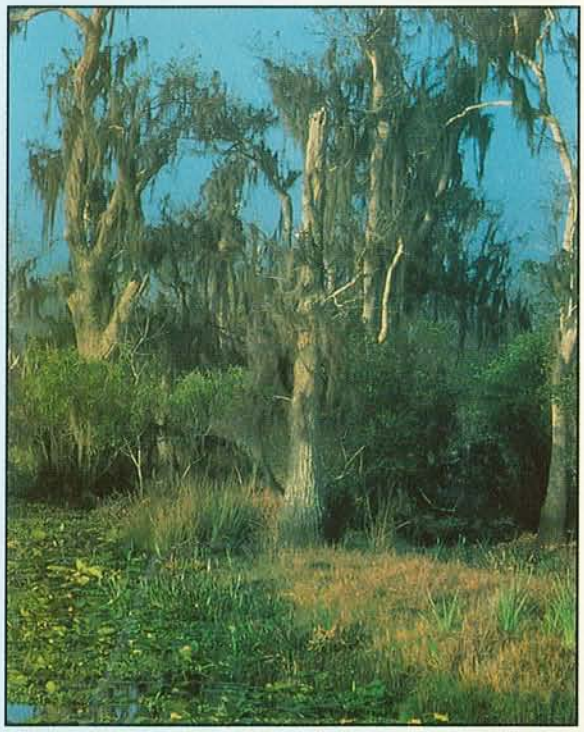






Lower West Coast WATER SUPPLY PLAN

APPENDICES

Volume III

Prepared by the Planning Department Staff

SOUTH FLORIDA
WATER MANAGEMENT DISTRICT

WEST PALM BEACH, FL

February 1994

LOWER WEST COAST
WATER SUPPLY PLAN

Volume III:
Appendices

by

Planning Department Staff

February 1994

South Florida Water Management District
Upper District Planning Division
West Palm Beach, Florida

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APPENDIX A

Selected Passages from the Florida Statutes and Administrative Codes

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187.201 State Comprehensive Plan Adopted

(8) WATER RESOURCES

(a) Goal. --Florida shall assure the availability of an adequate supply of water for all competing uses deemed reasonable and beneficial and shall maintain the functions of natural systems and the overall present level of surface and ground water quality. Florida shall improve and restore the quality of waters not presently meeting water quality standards.

(b) Policies. --

1. Ensure the safety and quality of drinking water supplies and promote the development of reverse osmosis and desalinization technologies for developing water supplies.

2. Identify and protect the functions of water recharge area and provide incentives for their conservation.

3. Encourage the development of local and regional water supplies within water management districts instead of transporting surface water across district boundaries.

4. Protect and use natural water systems in lieu of structural alternatives and restore modified systems.

5. Ensure that new development is compatible with existing local and regional water supplies.

6. Establish minimum seasonal flows and levels for surface watercourses with primary consideration given to the protection of natural resources, especially marine, estuarine, and aquatic ecosystems.

7. Discourage the channelization, diversion, or damming of natural riverine systems.

8. Encourage the development of a strict floodplain management program by state and local governments designed to preserve hydrologically significant wetlands and other natural floodplain features.

9. Protect aquifers from depletion and contamination through appropriate regulatory programs and through incentives.

10. Protect surface and groundwater quality and quantity in the state.

11. Promote water conservation as an integral part of water management programs as well as the use and reuse of water of the lowest acceptable quality for the purposes intended.

12. Eliminate the discharge of inadequately treated wastewater and stormwater runoff into the waters of the state.

13. Identify and develop alternative methods of wastewater treatment, disposal, and reuse of wastewater to reduce degradation of water resources.

14. Reserve from use that water necessary to support essential nonwithdrawal demands, including navigation, recreation, and the protection of fish and wildlife.

SELECTED PASSAGES FROM SECTIONS 373.016 - 373.246, F.S.

373.016 Declaration of policy

(1) The waters in the state are among its basic resources. Such waters have not heretofore been conserved or fully controlled so as to realize their full beneficial use.

(2) It is further declared to be the policy of the Legislature:

(a) To provide for the management of water and related land resources;

(b) To promote the conservation, development, and proper utilization of surface and ground water;

(c) To develop and regulate dams, impoundments, reservoirs, and other works and to provide water storage for beneficial purposes;

(d) To prevent damage from floods, soil erosion, and excessive drainage;

(e) To minimize degradation of water resources caused by the discharge of stormwater;

(f) To preserve natural resources, fish, and wildlife;

(g) To promote the public policy set forth in s. 403.021;

(h) To promote recreational development, protect public lands, and assist in maintaining the navigability of rivers and harbors; and

(i) Otherwise to promote the health, safety, and general welfare of the people of this state.

(3) The Legislature recognizes that the water resource problems of the state vary from region to region, both in magnitude and complexity. It is therefore the intent of the Legislature to vest in the Department of Environmental Regulation or its successor agency the power and responsibility to accomplish the conservation, protection, management, and control of the waters of the state and with sufficient flexibility and discretion to accomplish these ends through delegation of appropriate powers to the various water management districts. The department may exercise any power herein authorized to be exercised by a water management district; however, to the greatest extent practicable, such power should be delegated to the governing board of a water management district.

History.--s. 2, part I, ch. 72-299; s. 36, ch. 79-65; s. 70, ch. 83-310, s. 5, ch. 89-279.

373.019 Definitions.--When appearing in this chapter or in any rule, regulation, or order adopted pursuant thereto, the following words shall, unless the context clearly indicates otherwise, mean:

(1) "Department" means the Department of Environmental Regulation or its successor agency or agencies.

(2) "Water management district" means any flood control, resource management, or water management district operating under the authority of this chapter.

(3) "Governing board" means the governing board of a water management district.

(4) "Reasonable-beneficial use" means the use of water in such quantity as is necessary for economic and efficient utilization for a purpose and in a manner which is both reasonable and consistent with the public interest.

(5) "Person" means any and all persons, natural or artificial, including any individual, firm, association, organization, partnership, business trust, corporation, company, the United States of America, and the state and all political subdivisions, regions, districts, municipalities, and public agencies thereof. The enumeration herein is not intended to be exclusive or exhaustive.

(6) "Domestic use" means the use of water for the individual personal household purposes of drinking, bathing, cooking, or sanitation. All other uses shall not be considered domestic.

(7) "Nonregulated use" means any use of water which is exempted from regulation by the provisions of this chapter.

(8) "Water" or "waters in the state" means any and all water on or beneath the surface of the ground or in the atmosphere, including natural or artificial watercourses, lakes, ponds, or diffused surface water and water percolating, standing, or flowing beneath the surface of the ground, as well as all coastal waters within the jurisdiction of the state.

(9) "Ground water" means water beneath the surface of the ground, whether or not flowing through known and definite channels.

(10) "Surface water" means water upon the surface of the earth, whether contained in bounds created naturally or artificially or diffused. Water from natural springs shall be classified as surface water when it exits from the spring onto the earth's surface.

(11) "Stream" means any river, creek, slough, or natural watercourse in which water usually flows in a defined bed or channel. It is not essential that the flowing be uniform or uninterrupted. The fact that some part of the bed or channel has been dredged or improved does not prevent the watercourse from being a stream.

(12) "Other watercourse" means any canal, ditch, or other artificial watercourse in which water usually flows in a defined bed or channel. It is not essential that the flowing be uniform or uninterrupted.

(13) "Coastal waters" means waters of the Atlantic Ocean or the Gulf of Mexico within the jurisdiction of the state.

(14) "Impoundment" means any lake, reservoir, pond, or other containment of surface water occupying a bed or depression in the earth's surface and having a discernible shoreline.

(15) "Works of the district" means those projects and works, including, but not limited to, structures, impoundments, wells, streams, and other watercourses, together with the appurtenant facilities and accompanying lands, which have been officially adopted by the governing board of the district as works of the district.

(16) "State water policy" means the comprehensive statewide policy as adopted by the department pursuant to ss. 373.026 and 403.061 setting forth goals, objectives, and guidance for the development and review of programs, rules, and plans relating to water resources.

History.--s. 3, part I, ch. 72-299; s. 37, ch. 79-65; s. 1, ch. 80-259; s. 5, ch. 82-101; s. 6, ch. 89-279.

373.033 Saltwater barrier line.--

(1) The department may, at the request of the board of county commissioners of any county, at the request of the governing board of any water management district, or any municipality or water district responsible for the protection of a public water supply, or, having determined by adoption of an appropriate resolution that saltwater intrusion has become a matter of emergency proportions, by its own initiative, establish generally along the seacoast, inland from the seashore and within the limits of the area within which the petitioning board has jurisdiction, a saltwater barrier line inland of which no canal shall be constructed or enlarged, and no natural stream shall be deepened or enlarged, which shall discharge into tidal waters without a dam, control structure or spillway at or seaward of the saltwater barrier line, which shall prevent the movement of salt water inland of the saltwater barrier line.

Provided, however, that the department is authorized, in cases where saltwater intrusion is not a problem, to waive the requirement of a barrier structure by specific permit to construct a canal crossing the saltwater barrier line without a protective device and provided, further that the agency petitioning for the establishment of the saltwater barrier line shall concur in the waiver.

(2) Application by a board of county commissioners or by the governing board of a water management district, a municipality or a water district for the establishment of a saltwater barrier line shall be made by adoption of an appropriate resolution, agreeing to:

(a) Reimburse the department the cost of necessary investigation, including, but not limited to, subsurface exploration by drilling, to determine the proper location of the saltwater barrier line in that county or in all or part of the district over which the applying agency has jurisdiction.

(b) Require compliance with the provisions of this law by county or district forces under their control; by those individuals or corporations filing plats for record and by individuals, corporations or agencies seeking authority to discharge surface or subsurface drainage into tidal waters.

(3) The board of county commissioners of any county or the governing board of any water management district, municipality or water district desiring to establish a saltwater barrier line is authorized to reimburse the department for any expense entailed in making an investigation to determine the proper location of the saltwater barrier line, from any funds available to them for general administrative purposes.

(4) The department, any board of county commissioners, and the governing board of any water management district, municipality, or water district having competent jurisdiction over an area in which a saltwater barrier is established shall be charged with the enforcement of the provisions of this section, and authority for the maintenance of actions set forth in s. 373.129 shall apply to this section.

(5) The provisions of s. 373.191 shall apply specifically to the authority of the board of county commissioners, or to the governing board of a water management district, a municipality, or a water district having jurisdiction over an area in which a saltwater barrier line is established, to expend funds from whatever source may be available to them for the purpose of constructing saltwater barrier dams, dikes, and spillways within existing canals and streams in conformity with the purpose and intent of the board in establishing the saltwater barrier line.

History.--s. 2, ch. 63-210; ss. 25, 35, ch. 69-106; s. 25, ch. 73-190; s. 14, ch. 78-95; s. 40, ch. 79-65; s. 85, ch. 79-164.
Note.--Former s. 373.194.

373.036 State water use plan.--

(1) The department shall proceed as rapidly as possible to study existing water resources in the state; means and methods of conserving and augmenting such waters; existing and contemplated needs and uses of water for protection and procreation of fish and wildlife, irrigation, mining, power development, and domestic, municipal, and industrial uses; and all other related subjects, including drainage, reclamation, flood plain or flood-hazard area zoning, and selection of reservoir sites. The department shall cooperate with the Executive Office of the Governor, or its successor agency, progressively to formulate, as a functional element of a comprehensive state plan, an integrated, coordinated plan for the use and development of the waters of the state, based on the above studies. This plan, with such amendments, supplements, and additions as may be necessary from time to time, shall be known as the state water use plan.

(2) In the formulation of the state water use plan, the department shall give due consideration to:

(a) The attainment of maximum reasonable-beneficial use of water for such purposes as those referred to in subsection (1).

(b) The maximum economic development of the water resources consistent with other uses.

(c) The control of such waters for such purposes as environmental protection, drainage, flood control, and water storage.

(d) The quantity of water available for application to a reasonable-beneficial use.

(e) The prevention of wasteful, uneconomical, impractical, or unreasonable uses of water resources.

(f) Presently exercised domestic use and permit rights.

(g) The preservation and enhancement of the water quality of the state and the provisions of the state water quality plan.

(h) The state water resources policy as expressed by this chapter.

(3) During the process of formulating or revising the state water use plan, the department shall consult with, and carefully evaluate the recommendations of, concerned federal, state, and local agencies, particularly the governing boards of the water management districts, and other interested persons.

(4) Each governing board is directed to cooperate with the department in conducting surveys and investigations of water resources, to furnish the department with all available data of a technical nature, and to advise and assist the department in the formulation and drafting of those portions of the state plan applicable to the district.

(5) The department shall not adopt or modify the state water use plan or any portion thereof without first holding a public hearing on the matter. At least 90 days in advance of such hearing, the department shall notify any affected governing boards, and shall give notice of such hearing by publication within the affected region pursuant to the provisions of chapter 120, except such notice by publication shall be extended at least 90 days in advance of such hearings.

(6) For the purposes of this plan the department may, in consultation with the affected governing board, divide each water management district into sections which shall conform as nearly as practicable to hydrologically controllable areas and describe all water resources within each area.

(7) The department shall give careful consideration to the requirements of public recreation and to the protection and procreation of fish and wildlife. The department may prohibit or restrict other future uses on certain designated bodies of water which may be inconsistent with these objectives.

(8) The department may designate certain uses in connection with a particular source of supply which, because of the nature of the activity or the amount of water required, would constitute an undesirable use for which the governing board may deny a permit.

(9) The department may designate certain uses in connection with a particular source of supply which, because of the nature of the activity or the amount of water required, would result in an enhancement or improvement of the water resources of the area. Such uses shall be preferred over other uses in the event of competing applications under the permitting systems authorized by this chapter.

(10) The department, in cooperation with the Executive Office of the Governor, or its successor agency, may add to the state water use plan any other information, directions, or objectives it deems necessary or desirable for the guidance of the governing boards or other agencies in the administration and enforcement of this chapter.

History.--s. 6, part I, ch. 72-299; ss. 2, 3, ch. 73-190; s. 122, ch. 79-190.

373.0391 Technical assistance to local governments.--

(1) The water management districts shall assist local governments in the development and future revision of local government comprehensive plan elements or public facilities report as required by s. 189.415, related to water resource issues.

(2) By July 1, 1991, each water management district shall prepare and provide information and data to assist local governments in the preparation and implementation of their local government comprehensive plans or public facilities report as required by s. 189.415, whichever is applicable. Such information and data shall include, but not be limited to:

(a) All information and data required in a public facilities report pursuant to s. 189415.

(b) A description of regulations, programs, and schedules implemented by the district.

(c) Identification of regulations, programs, and schedules undertaken or proposed by the district to further the State Comprehensive Plan.

(d) A description of surface water basins, including regulatory jurisdictions, flood-prone areas, existing and projected water quality in water management district operated facilities, as well as surface water runoff characteristics and topography regarding flood plains, wetlands, and recharge areas.

(e) A description of groundwater characteristics, including existing and planned wellfield sites, existing and anticipated cones of influence, highly productive groundwater areas, aquifer recharge areas, deep well injections zones, contaminated areas, an assessment of regional water resource needs and sources for the next 20 years, and water quality.

(f) The identification of existing and potential water management district land acquisitions.

(g) Information reflecting the minimum flows for surface watercourses to avoid harm to water resources or the ecosystem and information reflecting the minimum water levels for aquifers to avoid harm to water resources or the ecosystem.

History.-- s. 55. ch. 89-169; s. 8, ch. 89-279.

373.0395 Ground water basin resource availability inventory.--Each water management district shall develop a ground water basin resource availability inventory covering those areas deemed appropriate by the governing board. This inventory shall include, but not be limited to, the following:

(1) A hydrogeologic study to define the ground water basin and its associated recharge areas.

(2) Site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development.

(3) Prime ground water recharge areas.

(4) Criteria to establish minimum seasonal surface and ground water levels.

(5) Areas suitable for future water resource development within the ground water basin.

(6) Existing sources of wastewater discharge suitable for reuse as well as the feasibility of integrating coastal wellfields.

(7) Potential quantities of water available for consumptive uses.

Upon completion, a copy of the ground water basin availability inventory shall be submitted to each affected municipality, county, and regional planning agency. This inventory shall be reviewed by the affected municipalities, counties, and regional planning agencies for consistency with the local government comprehensive plan and shall be considered in future revisions of such plan. It is the intent of the Legislature

that future growth and development planning reflect the limitations of the available ground water or other available water supplies.

History.--s. 6, ch. 82-101.

373.0397 Floridan and Biscayne aquifers; designation of prime ground water recharge areas.--Upon preparation of an inventory of prime ground water recharge areas for the Floridan or Biscayne aquifers as a part of the requirements of s. 373.0395(3), but prior to adoption by the governing board, the water management district shall publish a legal notice of public hearing on the designated areas for the Floridan and Biscayne aquifers, with a map delineating the boundaries of the areas, in newspapers defined in chapter 50 as having general circulation within the area to be affected. The notice shall be at least one-fourth page and shall read as follows:

NOTICE OF PRIME RECHARGE AREA DESIGNATION

The (name of taxing authority) proposes to designate specific land areas as areas of prime recharge to the (name of aquifer) Aquifer.

All concerned citizens are invited to attend a public hearing on the proposed designation to be held on (date and time) at (meeting place).

A map of the affected areas follows.

The governing board of the water management district shall adopt a designation of prime ground water recharge areas to the Floridan and Biscayne aquifers by rule within 120 days after the public hearing, subject to the provisions of chapter 120.

History.--s. 2, ch. 85-42.

373.042 Minimum flows and levels.--Within each section, or the water management district as a whole, the department or the governing board shall establish the following:

(1) Minimum flow for all surface watercourses in the area. The minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

(2) Minimum water level. The minimum water level shall be the level of ground water in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.

The minimum flow and minimum water level shall be calculated by the department and the governing board using the best information available. When appropriate, minimum flows and levels may be calculated to reflect seasonal variations. The department and the governing board shall also consider, and at their discretion may provide for, the protection of nonconsumptive uses in the establishment of minimum flows and levels.

History.--s. 6, part I, ch. 72-299; s. 2, ch. 73-190.

Note.--Former s. 373.036(7).

373.087 District works using aquifer for storage and supply.--The governing board may establish works of the district for the purpose of introducing water into, or drawing water from, the underlying aquifer for storage or supply. However, only water of a compatible quality shall be introduced directly into such aquifer.

History. *--s. 1, ch. 72-318; s. 1, ch. 82-46; s. 25, ch. 88-242; ss. 1, 2, ch. 89-279.*

Note.--*Repealed effective October 1, 1990, by s. 2, ch. 89-279, and scheduled for review pursuant to s. 11.611.*

[The repeal of this section by s. 2, ch. 89-279, was nullified by s. 11, ch. 90-217.]

373.171 Rules and regulations.--

(1) In order to obtain the most beneficial use of the water resources of the state and to protect the public health, safety, and welfare and the interests of the water users affected, governing boards, by action not inconsistent with the other provisions of this law and without impairing property rights, may:

(a) Establish rules, regulations, or orders affecting the use of water, as conditions warrant, and forbidding the construction of new diversion facilities or wells, the initiation of new water uses, or the modification of any existing uses, diversion facilities, or storage facilities within the affected area.

(b) Regulate the use of water within the affected area by apportioning, limiting, or rotating uses of water or by preventing those uses which the governing board finds have ceased to be reasonable or beneficial.

(c) Make other rules, regulations, and orders necessary for the preservation of the interests of the public and of affected water users.

(2) In promulgating rules and regulations and issuing orders under this law, the governing board shall act with a view to full protection of the existing rights to water in this state insofar as is consistent with the purpose of this law.

(3) No rule, regulation or order shall require any modification of existing use or disposition of water in the district unless it is shown that the use or disposition proposed to be modified is detrimental to other water users or to the water resources of the state.

(4) All rules and regulations adopted by the governing board shall be filed with the Department of State as provided in chapter 120. An information copy will be filed with the Department of Environmental Regulation.

History.--s. 11, ch. 57-380; s. 8, ch. 63-336; ss. 10, 25, 35, ch. 69-106; s. 8, ch. 76-243; s. 1, ch. 77-117; s. 14, ch. 78-95.

373.185 Local xeriscape ordinances.--

(1) As used in this section, the term:

(a) "Local government" means any county or municipality of the state.

(b) "xeriscape" means a landscaping method that maximizes the conservation of water by the use of site-appropriate plants and an efficient watering system. The principles of Xeriscape include planning and design, appropriate choice of plants, soil analysis which may include the use of solid waste compost, efficient irrigation, practical use of turf, appropriate use of mulches, and proper maintenance.

(2) Each water management district shall design, and implement and incentive program to encourage all local governments within its district to adopt new ordinances or amend existing ordinances to require Xeriscape landscaping for development permitted after the effective date of the new ordinance or amendment. Each district shall adopt rules governing the implementation of its incentive program and governing the review and approval of local government Xeriscape ordinances or amendments which are intended to qualify a local government for the incentive program. Each district shall assist the local governments within its jurisdiction by providing a model Xeriscape code and other technical assistance. A

local government Xeriscape ordinance or amendment, in order to qualify the local government for the district's incentive program, must include, at a minimum:

(a) Landscape design, installation, and maintenance standards that result in water conservation. Such standards shall address the use of plant groupings, soil analysis including promotion of the use of solid waste compost, efficient irrigation systems and other water-conserving practices.

(b) Identification of prohibited invasive exotic plant species.

(b) Identification of controlled plant species, accompanies by the conditions under which such plants may be used.

(d) A provision specifying the maximum percentage of turf and the maximum percentage of impervious surfaces allowed in a xeriscaped area and addressing the practical selection and installation of turf.

(e) Specific standards for land clearing and requirements for the preservation of existing native vegetation.

(f) A monitoring program for ordinance implementation and compliance.

The districts also shall work with local governments to promote, through educational programs and publications, the use of Xeriscape practices, including the use of solid waste compost, in existing residential and commercial development. This section may not be construed to limit the authority of the districts to require Xeriscape ordinances or practices as a condition of any consumptive use permit.

History.--s. 3, ch. 91-41; s. 3, ch. 91-68.

373.191 County water conservation projects.--The several counties of the state may cooperate with the division by engaging in county water development and conservation projects and may use county funds and equipment for this purpose and to do all other things necessary in connection with the development and conservation of the county's water resources consistent with the provisions of this law and the rules and regulations adopted pursuant thereto.

History.--s. 13, ch. 57-380; ss. 25, 35, ch. 69-106.

373.196 Legislative findings.--

(1) It is the finding of the Legislature that cooperative efforts between municipalities, counties, water management districts, and the Department of Environmental Regulation are mandatory in order to meet the water needs of rapidly urbanizing areas in a manner which will supply adequate and dependable supplies of water where needed without resulting in adverse effects upon the areas from whence such water is withdrawn. Such efforts should utilize all practical means of obtaining water, including, but not limited to, withdrawals of surface water and ground water, recycling of waste water, and desalinization, and will necessitate not only cooperation but also well-coordinated activities. The purpose of this act is to provide additional statutory authority for such cooperative and coordinated efforts.

(2) Municipalities and counties are encouraged to create regional water supply authorities as authorized herein. It is further the intent that municipalities, counties, and regional water supply authorities are to have the primary responsibility for water supply, and water management districts and their basin boards are to engage only in those functions that are incidental to the exercise of their flood control and water management powers.

(3) Nothing herein shall be construed to preclude the various municipalities and counties from continuing to operate existing water production and transmission facilities or to enter into cooperative agreements with other municipalities and counties for the purpose of meeting their respective needs for dependable and

adequate supplies of water, provided the obtaining of water through such operations shall not be done in a manner which results in adverse effects upon the areas from whence such water is withdrawn.

History.--s. 1, ch. 74-114; s. 43, ch. 79-65.

373.1961 Water production.--In the performance of, and in conjunction with, its other powers and duties, the governing board of a water management district existing pursuant to chapter 373:

(1) Shall engage in planning to assist counties, municipalities, and regional water supply authorities in meeting the water supply needs in such manner as will give priority to encouraging conservation and reducing adverse environmental effects of improper or excessive withdrawals of water from concentrated areas. As used in this section, regional water supply authorities are regional water authorities created under s. 373.1962 or other laws of this state.

(2) Shall assist counties, municipalities, and water supply authorities in meeting water supply needs in such manner as will give priority to encouraging conservation and reducing adverse environmental effects of improper or excessive withdrawals of water from concentrated areas.

(3) May establish, design, construct, operate, and maintain water production and transmission facilities for the purpose of supplying water to counties, municipalities, and regional water supply authorities. The permit required by part II of this chapter for a water management district engaged in water production and transmission shall be granted, denied, or granted with conditions by the department.

(4) Shall not engage in local distribution.

(5) Shall not deprive, directly or indirectly, any county wherein water is withdrawn of the prior right to the reasonable and beneficial use of water which is required to supply adequately the reasonable and beneficial needs of the county or any of the inhabitants or property owners therein.

(6) May provide water and financial assistance to regional water supply authorities, but may not provide water to counties and municipalities which are located within the area of such authority without the specific approval of the authority or, in the event of the authority's disapproval, the approval of the Governor and Cabinet sitting as the Land and Water Adjudicatory Commission. The district may supply water at rates and upon terms mutually agreed to by the parties or, if they do not agree, as set by the governing board and specifically approved by the Governor and Cabinet sitting as the Land and Water Adjudicatory Commission.

(7) May acquire title to such interest as is necessary in real property, by purchase, gift, devise, lease, eminent domain, or otherwise, for water production and transmission consistent with this section. However, the district shall not use any of the eminent domain powers herein granted to acquire water and water rights already devoted to reasonable and beneficial use or any water production or transmission facilities owned by any county, municipality, or regional water supply authority. The district may exercise eminent domain powers outside of its district boundaries for the acquisition of pumpage facilities, storage areas, transmission facilities, and the normal appurtenances thereto, provided that at least 45 days prior to the exercise of eminent domain, the district notifies the district where the property is located after public notice and the district where the property is located does not object within 45 days after notification of such exercise of eminent domain authority.

(8) In addition to the power to issue revenue bonds pursuant to s. 373.584, may issue revenue bonds for the purposes of paying the costs and expenses incurred in carrying out the purposes of this chapter or refunding obligations of the district issued pursuant to this section. Such revenue bonds shall be secured by, and be payable from, revenues derived from the operation, lease, or use of its water

production and transmission facilities and other water-related facilities and from the sale of water or services relating thereto. Such revenue bonds may not be secured by, or be payable from, moneys derived by the district from the Water Management Lands Trust Fund or from ad valorem taxes received by the district. All provisions of s. 373.584 relating to the issuance of revenue bonds which are not inconsistent with this section shall apply to the issuance of revenue bonds pursuant to this section. The district may also issue bond anticipation notes in accordance with the provisions of s. 373.584.

(9) May join with one or more other water management district, counties, municipalities, or regional water supply authorities for the purpose of carrying out any of its powers, and may contract with such other entities to finance acquisitions, construction, operation, and maintenance. The contract may provide for contributions to be made by each party thereto, for the division and apportionment of the expenses of acquisitions, construction, operation, and maintenance, and for the diversion and apportionment of the benefits, services, and products therefrom. The contracts may contain other covenants and agreements necessary and appropriate to accomplish their purposes.

History.--s. 2, ch. 74-114; s. 14, ch. 76-243; s. 7, ch. 82-101; s. 2, ch. 87-347.

373.1962 Regional water supply authorities.--

(1) By agreement between local governmental units created or existing pursuant to the provisions of Art. VIII of the State Constitution, pursuant to the Florida Interlocal Cooperation Act of 1969, s. 163.01, and upon the approval of the [1]Governor and Cabinet sitting as head of the Department of Natural Resources to ensure that such agreement will be in the public interest and complies with the intent and purposes of this act, regional water supply authorities may be created for the purpose of developing, recovering, storing, and supplying water for county or municipal purposes in such a manner as will give priority to reducing adverse environmental effects of excessive or improper withdrawals of water from concentrated areas. In approving said agreement the Governor and Cabinet, sitting as head of the Department of Natural Resources, shall consider, but not be limited to, the following:

(a) Whether the geographic territory of the proposed authority is of sufficient size and character to reduce the environmental effects of improper or excessive withdrawals of water from concentrated areas.

(b) The maximization of economic development of the water resources within the territory of the proposed authority.

(c) The availability of a dependable and adequate water supply.

(d) The ability of any proposed authority to design, construct, operate, and maintain water supply facilities in the locations, and at the times necessary, to ensure that an adequate water supply will be available to all citizens within the authority.

(e) The effect or impact of any proposed authority on any municipality, county, or existing authority or authorities.

(f) The existing needs of the water users within the area of the authority.

(2) In addition to other powers and duties agreed upon, and notwithstanding the provisions of s. 163.01, such authority may:

(a) Upon approval of the electors residing in each county or municipality within the territory to be included in any authority, levy ad valorem taxes, not to exceed one-half mill, pursuant to s. 9(b), Art. VII of the State Constitution. No tax authorized by this paragraph shall be levied in any county or municipality without an affirmative vote of the electors residing in such county or municipality.

(b) Acquire water and water rights; develop, store, and transport water; provide, sell and deliver water for county or municipal uses and purposes; provide for the

furnishing of such water and water service upon terms and conditions and at rates which will apportion to parties and nonparties an equitable share of the capital cost and operating expense of the authority's work to the purchaser.

(c) Collect, treat, and recover wastewater.

(d) Not engage in local distribution.

(e) Exercise the power of eminent domain in the manner provided by law for the condemnation of private property for public use to acquire title to such interest in real property as is necessary to the exercise of the powers herein granted, except water and water rights already devoted to reasonable and beneficial use or any water production or transmission facilities owned by any county or municipality.

(f) Issue revenue bonds in the manner prescribed by the Revenue Bond Act of 1953, as amended, part I, chapter 159, to be payable solely from funds derived from the sale of water by the authority to any county or municipality. Such bonds may be additionally secured by the full faith and credit of any county or municipality, as provided by s. 159.16 or by a pledge of excise taxes, as provided by s. 159.19. For the purpose of issuing revenue bonds, an authority shall be considered a "unit" as defined in s. 159.02(2) and as that term is used in the Revenue Bond Act of 1953, as amended. Such bonds may be issued to finance the cost of acquiring properties and facilities for the production and transmission of water by the authority to any county or municipality, which cost shall include the acquisition of real property and easements therein for such purposes. Such bonds may be in the form of refunding bonds to take up any outstanding bonds of the authority or of any county or municipality where such outstanding bonds are secured by properties and facilities for production and transmission of water, which properties and facilities are being acquired by the authority. Refunding bonds may be issued to take up and refund all outstanding bonds of said authority that are subject to call and termination, and all bonds of said authority that are not subject to call or redemption, when the surrender of said bonds can be procured from the holder thereof at prices satisfactory to the authority. Such refunding bonds may be issued at any time when, in the judgment of the authority, it will be to the best interest of the authority financially or economically by securing a lower rate of interest on said bonds or by extending the time of maturity of said bonds or, for any other reason, in the judgment of the authority, advantageous to said authority.

(g) Sue and be sued in its own name.

(h) Borrow money and incur indebtedness and issue bonds or other evidence of such indebtedness.

(i) Join with one or more other public corporations for the purpose of carrying out any of its powers and for that purpose to contract with such other public corporation or corporations for the purpose of financing such acquisitions, construction, and operations. Such contracts may provide for contributions to be made by each party thereto, for the division and apportionment of the expenses of such acquisitions and operations, and for the division and apportionment of the benefits, services, and products therefrom. Such contract may contain such other and further covenants and agreements as may be necessary and convenient to accomplish the purposes hereof.

(3) When it is found to be in the public interest, for the public convenience and welfare, for a public benefit, and necessary for carrying out the purpose of any regional water supply authority, any state agency, county, water control district existing pursuant to chapter 298, water management district existing pursuant to chapter 373, municipality, governmental agency, or public corporation in this state holding title to any interest in land is hereby authorized, in its discretion, to convey the title to or dedicate land, title to which is in such entity, including tax reverted land, or to grant use-rights therein, to any regional water supply authority created pursuant to this section. Land granted or conveyed to such authority shall be for the public purposes of such authority and may be made subject to the condition that in

the event said land is not so used, or if used and subsequently its use for said purpose is abandoned, the interest granted shall cease as to such authority and shall automatically revert to the granting entity.

(4) Each county or municipality which is a party to an agreement pursuant to subsection (1) shall have a preferential right to purchase water from the regional water supply authority for use by such county or municipality.

(5) In carrying out the provisions of this section, any county wherein water is withdrawn by the authority shall not be deprived, directly or indirectly, of the prior right to the reasonable and beneficial use of water which is required adequately to supply the reasonable and beneficial needs of the county or any of the inhabitants or property owners therein.

(6) Upon a resolution adopted by the governing body of any county or municipality, the authority may, subject to a majority vote of its voting members, include such county or municipality in its regional water supply authority upon such terms and conditions as may be prescribed.

(7) The authority shall design, construct, operate, and maintain facilities in the locations and at the times necessary to insure that an adequate water supply will be available to all citizens within the authority.

History.--s. 7, ch. 74-114; s. 1, ch 77-174; s. 35, ch. 79-5; s.1, ch. 86-22.

[1]**Note.**--Section 11, ch. 75-22 transferred powers, duties, and functions of the Department of Natural Resources relating to water management to the Department of Environmental Regulation.

373.207 Abandoned artesian wells.--

(1) Each water management district shall develop a work plan which identifies the location of all known abandoned artesian wells within its jurisdictional boundaries and defined the actions which the district must take in order to ensure that each such well is plugged on or before January 1, 1992. The work plan shall include the following:

(a) An initial inventory which accounts for all known abandoned artesian wells in the district.

(b) The location and owner of each known abandoned well.

(c) The methodology proposed by the district to accomplish the plugging of all abandoned wells within the district on or before January 1, 1992.

(d) Data relating to the costs to be incurred for the plugging of all wells, including the per-well cost and personnel costs.

(e) A schedule of priority for the plugging of wells, which schedule is established to mitigate damage to the ground water resource due to water quality degradation.

(2) Each water management district shall submit its work plan to the Secretary of Environmental Regulation no later than January 1, 1984. Thereafter, each water management district shall submit an annual update of its work plan until January 1, 1992, or until all wells identified by the plan are plugged, whichever is later.

History.-s. 8, ch. 83-310.

373.219 Permits required.--

(1) The governing board or the department may require such permits for consumptive use of water and may impose such reasonable conditions as are necessary to assure that such use is consistent with the overall objectives of the district or department and is not harmful to the water resources of the area. However, no permit shall be required for domestic consumption of water by individual users.

(2) In the event that any person shall file a complaint with the governing board or the department that any other person is making a diversion, withdrawal, impoundment, or consumptive use of water not expressly exempted under the provisions of this chapter and without a permit to do so, the governing board or the department shall cause an investigation to be made, and if the facts stated in the complaint are verified the governing board or the department shall order the discontinuance of the use.

History.--s. 2, part II, ch. 72-299; s. 9, ch. 73-190.

373.223 Conditions for a permit.--

(1) To obtain a permit pursuant to the provisions of this chapter, the applicant must establish that the proposed use of water:

(a) Is a reasonable-beneficial use as defined in s. 373.019(4);

(b) Will not interfere with any presently existing legal use of water; and

(c) Is consistent with the public interest.

(2) The governing board or the department may authorize the holder of a use permit to transport and use ground or surface water beyond overlying land, across county boundaries, or outside the watershed from which it is taken if the governing board or department determines that such transport and use is consistent with the public interest, and no local government shall adopt or enforce any law, ordinance, rule, regulation, or order to the contrary.

(3) The governing board or the department, by regulation, may reserve from use by permit applicants, water in such locations and quantities, and for such seasons of the year, as in its judgment may be required for the protection of fish and wildlife or the public health and safety. Such reservations shall be subject to periodic review and revision in the light of changed conditions. However, all presently existing legal uses of water shall be protected so long as such use is not contrary to the public interest.

History.--s. 3, part II, ch. 72-299; s. 10, ch. 73-190, s. 10, ch. 76-243; s. 35, ch. 85-81.

373.224 Existing permits.--Any permits or permit agreements for consumptive use of water executed or issued by an existing flood control, water management, or water regulatory district pursuant to chapter 373 or chapter 378 prior to December 31, 1976, shall remain in full force and effect in accordance with its terms until otherwise modified or revoked as authorized herein.

History.--s. 11, ch. 73-190; s. 3, ch. 75-125.

373.226 Existing uses.--

(1) All existing uses of water, unless otherwise exempted from regulation by the provisions of this chapter, may be continued after adoption of this permit system only with a permit issued as provided herein.

(2) The governing board or the department shall issue an initial permit for the continuation of all uses in existence before the effective date of implementation of this part if the existing use is a reasonable beneficial use as defined in [1]s. 373.019(5) and is allowable under the common law of this state.

(3) Application for permit under the provisions of subsection (2) must be made within a period of 2 years from the effective date of implementation of these regulations in an area. Failure to apply within this period shall create a conclusive presumption of abandonment of the use, and the user, if he desires to revive the use, must apply for a permit under the provisions of s. 373.229.

History.--s. 4, part II, ch. 72-299; s. 12, ch. 73-190.

[1]**Note.**--The reference to "s. 373.019(4)" was substituted by the editors for a reference to "s. 373.019(5)" to conform to the renumbering by s. 37, ch. 79-65.

373.2295 Interdistrict transfers of groundwater.--

(1) As used in this section, "interdistrict transfer and use" means a consumptive water use which involves the withdrawal of groundwater from a point within one water management district for use outside the boundaries of that district.

(2) To obtain a permit for an interdistrict transfer and use of groundwater, an applicant must file an application in accordance with s. 373.229 with the water management district having jurisdiction over the area from which the applicant proposes to withdraw groundwater and submit a copy of the application to the water management district have jurisdiction over the area where the water is to be used.

(3) The governing board of the water management district where the groundwater is proposed to be withdrawn shall review the application in accordance with this part, the rules of the district which relate to consumptive water use permitting, and other applicable provisions of this chapter.

(4) In determining if an application is consistent with the public interest as required by s. 373.223, the projected populations, as contained in the future land use elements of the comprehensive plans adopted pursuant to chapter 163 by the local governments within which the withdrawal areas and the proposed use areas are located, will be considered together with other evidence presented on future needs of those areas. If the proposed interdistrict transfer of groundwater meets the requirements of this chapter, and if the needs of the area where the use will occur and the specific area from which the groundwater will be withdrawn can be satisfied, the permit for the interdistrict transfer and use shall be issued.

(5) In addition to other requirements contained in this part, the water management district where the groundwater is proposed to be withdrawn shall:

(a) Furnish copies of any application, information, correspondence, or other related material to the water management district having jurisdiction over the area where the water is to be used; and

(b) Request comments on the application and the future water needs of the proposed use area from the water management district having jurisdiction over the area where the water is to be used. If comments are received, they must be attached to the preliminary notice of intended agency action and may not create a point of entry for review whether issued by the governing board or district staff.

(6) Upon completion of review of the application, the water management district where the groundwater is proposed to be withdrawn shall prepare a notice of preliminary intended agency action which shall include an evaluation of the application and a recommendation of approval, denial, or approval with conditions.

The notice shall be furnished to the district where the water is to be used, the applicant, the Department of Environmental Regulation, the local governments having jurisdiction over the area from which the groundwater is to be withdrawn and where the water is to be used, and any person requesting a copy of the notice.

(a) Any interested person may, within the time specified in the notice, notify in writing the district from where the groundwater is to be withdrawn of such person's position and comments or objections, if any, to the preliminary intended action.

(b) The filing of the notice of intended agency action shall toll the time periods contained in s. 120.60 for the granting or denial of a permit for an interdistrict transfer and use of groundwater.

(c) The preliminary intended agency action and any comments or objections of interested persons made pursuant to paragraph (a) shall be considered by the governing board of the water management district where the groundwater is proposed to be withdrawn. Following such consideration, the governing board shall issue a notice of intended agency action.

(d) Any substantially affected person who submitted a notification pursuant to paragraph (a) may request review by the department within 14 days after the filing of the notice of intended agency action. If no request for review is filed, the notice of intended agency action shall become the final order of the governing board.

(7) Notwithstanding the provisions of chapter 120, the department shall, within 30 days after its receipt of a request for review of the water management district's action, approve, deny, or modify the water management district's action on the proposed interdistrict transfer and use of groundwater. The department shall issue a notice of its intended action. Any substantially affected person who requested review pursuant to paragraph (6)(a) may request an administrative hearing pursuant to chapter 120 within 14 days after notice of the department's intended action. The parties to such proceeding shall include, at a minimum, the affected water management districts and the applicant. The proceedings initiated by a petition under s. 120.57, following the department's issuance of a notice of intended agency action, is the exclusive proceeding authorized for the review of agency action on the interdistrict transfer and use of groundwater. This procedure is to give effect to the legislative intent that this section provide a single, efficient, simplified, coordinated permitting process for the interdistrict transfer and use of groundwater.

(8) The department shall issue a final order which is subject to review pursuant to s. 373.114 or s. 120.68.

(9) In administering this part, the department or the water management districts may enter into interagency agreements. However, such agreements are not subject to the provisions of s. 373.046 and chapter 120.

(10) The state hereby preempts any regulation of the interdistrict transfer and use of groundwater. If any provision of this section is in conflict with any other provision or restriction under any law, administrative rule, or ordinance, this section shall govern and such law, rule, or ordinance shall be deemed superseded for the purposes of this section. A water management district or the department may not adopt special rules which prohibit or restrict interdistrict transfer and use of groundwater in a manner inconsistent with this section.

(11) Any applicant who has submitted an application for interdistrict transfer and use of groundwater which is pending on July 11, 1987, may have the application considered pursuant to this section. New permits are not required for interdistrict transfers existing on July 11, 1987, for the duration of the permits issued for such uses.

(12) If, after the final order of the department or final agency action under this section, the proposed use of the site designated in the application for groundwater production, treatment, or transmission facilities does not conform with the existing zoning ordinances, a rezoning application may be submitted. If local authorities deny

the application for rezoning, the applicant may appeal this decision to the Land and Water Adjudicatory Commission, which shall authorize a variance or nonconforming use to the existing comprehensive plan and zoning ordinances, unless the commission determines after notice and hearing that such variance or nonconforming use is contrary to the public interest.

(13) The permit required under this section and other sections of this chapter and chapter 403 are the sole permits required for interdistrict transfer and use of groundwater, and such permits are in lieu of any license, permit, or similar document required by any state agency or political subdivision pursuant to chapter 163, chapter 380, or chapter 381, and the Florida Transportation Code.

(14) When a consumptive use permit under this section is granted for water use beyond the boundaries of a local government from which or through which the groundwater is withdrawn or transferred and a local government denies a permit required under chapter 125 or chapter 153 for a facility or any infrastructure which produces, treats, transmits, or distributes such groundwater, the person or unit of government applying for the permit under chapter 125 or chapter 153 may appeal the denial to the Land and Water Adjudicatory Commission. The commission shall review the local government action for consistency with this chapter and the interdistrict groundwater transfer permit and may reverse, modify, or approve the local government's action.

History.--s. 1, ch. 87-347.

373.233 Competing applications.--

(1) If two or more applications which otherwise comply with the provisions of this part are pending for a quantity of water that is inadequate for both or all, or which for any other reason are in conflict, the governing board or the department shall have the right to approve or modify the application which best serves the public interest.

(2) In the event that two or more competing applications qualify equally under the provisions of subsection (1), the governing board or the department shall give preference to a renewal application over an initial application.

History.--s. 6, part II, ch. 72-299.

373.246 Declaration of water shortage or emergency.--

(1) The governing board or the department by regulation shall formulate a plan for implementation during periods of water shortage. Copies of the water shortage plan shall be submitted to the Speaker of the House of Representatives and the President of the Senate no later than October 31, 1983. As a part of this plan the governing board or the department shall adopt a reasonable system of water-use classification according to source of water supply; method of extraction, withdrawal, or diversion; or use of water or a combination thereof. The plan may include provisions for variances and alternative measures to prevent undue hardship and ensure equitable distribution of water resources.

(2) The governing board or the department by order may declare that the water shortage exists for a source or sources within all or part of the district when insufficient after is or will be available to meet the present and anticipated requirements of the users or when conditions are such as to require temporary reduction in total use within the area to protect water resources from serious harm. Such orders will be final agency action.

(3) In accordance with the plan adopted under subsection (1) the governing board or the department may impose such restrictions one or more classes of water uses as may be necessary to protect the water resources of the area from serious harm and restore them to their previous condition.

(4) A declaration of water shortage and any measures adopted pursuant thereto may be rescinded by the governing board or the department.

(5) When a water shortage is declared, the governing board or the department shall cause notice thereof to be published in a prominent place within a newspaper of general circulation throughout the area. Publication of such notice will serve as notice to all users in the area of the condition of water shortage.

(6) The governing board or the department shall notify each permittee in the district by regular mail of any change in the condition of water shortage.

(7) If an emergency condition exists due to water shortage within any area of the district, and if the department, or executive director of the district with the concurrence of the governing board, finds that the exercise of powers under subsection (1) is not sufficient to protect the public health, safety, or welfare; the health of animals, fish or aquatic life; a public water supply; or recreational, commercial, industrial, agricultural, or other reasonable uses, it or he may, pursuant to the provisions of s. 373.199, issue emergency orders reciting the existence of such an emergency and requiring that such action, including, but not limited to, apportioning, rotating, limiting, or prohibiting the use of water resources of the district, be taken as the department or the executive director deems necessary to meet the emergency.

(8) An affected party to whom an emergency order is directed under subsection (7) shall comply immediately, but may challenge such an order in the manner set forth in s.373.119.

History.- s. 10, part II,ch. 72-299;s. 14, ch.78.95; s. 11,ch.82-101; s. 10, ch.84-341.

SELECTED PASSAGES FROM SECTION 403.021

403.021. Legislative declaration; public policy

(1) The pollution of the air and waters of this state constitutes a menace to public health and welfare; creates public nuisances; is harmful to wildlife and fish and other aquatic life; and impairs domestic, agricultural, industrial, recreational, and other beneficial uses of air and water

(2) It is declared to be the public policy of this state to conserve the waters of the state and to protect, maintain, and improve the quality thereof for public water supplies, for the propagation of wildlife and fish and other aquatic life, and for domestic, agricultural, industrial, recreational, and other beneficial uses and to provide that no wastes be discharged into any waters of the state without first being given the degree of treatment necessary to protect the beneficial uses of such water.

(3) It is declared to be the public policy of this state and the purpose of this act to achieve and maintain such levels of air quality as will protect human health and safety and, to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state, and facilitate the enjoyment of the natural attractions of this state. In accordance with the public policy established herein, the Legislature further declares that the citizens of this state should be afforded reasonable protection from the dangers inherent in the release of toxic or otherwise hazardous vapors, gases, or highly volatile liquids into the environment.

(4) It is declared that local and regional air and water pollution control programs are to be supported to the extent practicable as essential instruments to provide for a coordinated statewide program of air and water pollution prevention, abatement, and control for the securing and maintenance of appropriate levels of air and water quality.

(5) It is hereby declared that the prevention, abatement, and control of the pollution of the air and waters of this state are affected with a public interest, and the provisions of this act are enacted in the exercise of the police powers of this state for the purpose of protecting the health, peace, safety and general welfare of the people of this state.

(6) The Legislature finds and declares that control, regulation, and abatement of the activities which are causing or may cause pollution of the air or water resources in the state and which are or may be detrimental to human, animal, aquatic, or plant life, or to property, or unreasonably interfere with the comfortable enjoyment of life or property be increased to ensure conservation of natural resources; to ensure a continued safe environment; to ensure purity of air and water; to ensure domestic water supplies; to ensure protection and preservation of the public health, safety, welfare, and economic well-being; to ensure and provide for recreational and wildlife needs as the population increases and the economy expands; and to ensure a continuing growth of the economy and industrial development.

7) The Legislature further finds and declares that:

(a) Compliance with this law will require capital outlays of hundreds of millions of dollars for the installation of machinery, equipment, and facilities for the treatment of industrial wastes which are not productive assets and increased operating expenses to owners without any financial return and should be separately classified for assessment purposes.

(b) Industry should be encouraged to install new machinery, equipment, and facilities as technology in environmental matters advances, thereby improving the quality of the air and waters of the state and benefiting the citizens of the state without pecuniary benefit to the owners of industries; and the Legislature should prescribe methods whereby just valuation may be secured to such owners and

exemptions from certain excise taxes should be offered with respect to such installations.

(c) Facilities as herein defined should be classified separately from other real and personal property of any manufacturing or processing plant or installation, as such facilities contribute only to general welfare and health and are assets producing no profit return ow owners.

(d) In existing manufacturing or processing plants it is more difficult to obtain satisfactory results in treating industrial wastes than in new plants being now planned or constructed and that with respect to existing plants in many instance it will be necessary to demolish and remove substantial portions thereof and replace the same with new and more modern equipment in order to more effectively treat, eliminate, or reduce the objectionable characteristics of any industrial wastes and that such replacements should be classified and assessed differently from replacements made in the ordinary course of business.

(8) The Legislature further finds and declares that the public health, welfare, and safety may be affected by disease-carrying vectors and pests. The department shall assist all governmental units charged with the control of such vectors and pests. Furthermore, in reviewing applications for permits, the department shall consider the total well-being of the public and shall not consider solely the ambient pollution standards when exercising its powers, if there may be danger of a public health hazard.

(9)(a) The Legislature finds and declares that it is essential to preserve and maintain authorized water depth in the existing navigation channels, port harbors, turning basins, and harbor berths of this state in order to provide for the continued safe navigation of deepwater shipping commerce. The department shall recognize the maintenance of authorized channel depths is an ongoing, continuous, beneficial, and necessary activity; and it shall develop a regulatory process which shall enable the ports of this state to conduct such activities in an environmentally sound, expeditious, and efficient manner.

(b) The provisions of paragraph (a) apply only to the port waters, spoil disposal sites, port harbors, navigation channels, turning basins, and harbor berths used for deepwater commercial navigation in the ports of Jacksonville, Tampa, Port Everglades, Miami, Port Canaveral, Ft. Pierce, Palm Beach, Port Manatee, Port St. Joe, Panama City, St. Petersburg, and Pensacola.

(10) It is the policy of the state to ensure that the existing and potential drinking water resources of the state remain free from harmful quantities of contaminants. The department, as the state water quality protection agency, shall compile, correlate, and disseminate available information on any contaminant which endangers or may endanger existing or potential drinking water resources. it shall also coordinate its regulatory program with the regulatory programs of other agencies to assure adequate protection of the drinking water resources of the state.

(11) It is the intent of the Legislature that water quality standards be reasonably established and applied to take into account the variability occurring in nature. The department shall recognize the statistical variability inherent in sampling and testing procedures that are used to express water quality standards. The department shall also recognize that some deviations from water quality standards occur as the result of natural background conditions. The department shall not consider deviations from water quality standards to be violations when the discharger can demonstrate that the deviations would occur in the absence of any man-induced discharges or alterations to the water body.

History.- s. 3, ch. 67-436; s. 1, ch. 78-98; ss. 1, 5, ch. 81-228; s. 4, ch. 84-79; s. 46, ch. 84-338; s. 11, ch. 85-269; s. 1, ch. 85-277; s. 8, ch. 86-186; s. 3, ch. 86-213.

SELECTED PASSAGES FROM SECTION 17-3.011

17-3.011. Findings, Declaration and Intent

(1) Article II, Section 7 of the Florida Constitution requires abatement of water pollution, and conservation and protection of Florida's natural resources and scenic beauty.

(2) Congress, in Section 101(a)(2) of the Federal Water Pollution Control Act, as amended, declares that achievement by July 1, 1983, of water quality sufficient for the protection and propagation of fish, shellfish, and wildlife, as well as for recreation in and on the water, is an interim goal to be sought wherever attainable. Congress further states, in Section 101(a)(3), that it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited.

(3) The present and future most beneficial uses of all waters of the State have been designated by the Department by means of the classification system set forth in this Chapter pursuant to Subsection 403.061(10), F.S. Water quality standards are established by the Department to protect these designated uses.

(4) Because activities outside the State sometimes cause pollution of Florida's waters, the Department will make every reasonable effort to have such pollution abated.

(5) Water quality standards apply equally to and shall be uniformly enforced in both the public and private sector.

(6) Public interest shall not be construed to mean only those activities conducted solely to provide facilities or benefits to the general public. Private activities conducted for private purposes may also be in the public interest.

(7) The Commission, recognizing the complexity of water quality management and the necessity to temper regulatory actions with the technological progress and the social and economic well-being of people, urges, however, that there be no compromise where discharges of pollutants constitute a valid hazard to human health.

(8) The Commission requests that the Secretary seek and use the best environmental information available when making decisions on the effects of chronically and acutely toxic substances and carcinogenic, mutagenic, and teratogenic substances. Additionally, the Secretary is requested to seek and encourage innovative research and developments in waste treatment alternatives that might better preserve environmental quality or at the same time reduce the energy and dollar costs of operation.

(9) The present and future most beneficial uses of groundwaters of the State shall be protected to insure the availability and utility of this invaluable resource. To achieve such protection, the groundwaters of the State are classified and appropriate specific water quality criteria for those classes are set forth in this Chapter.

(10) The criteria set forth in this Chapter are minimum levels which are necessary to protect the designated uses of a water body. It is the intent of this Commission that permit applicants should not be penalized due to a low detection limit associated with any specific criteria.

(11)(a) The Department's rules that were adopted on March 1, 1979 regarding water quality standards are designed to protect the public health or welfare and to enhance the quality of waters of the State. They have been established taking into consideration the use and value of waters of the State for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other purposes, and also taking into consideration their use and value for navigation.

(b) Under the approach taken in the formulation of the rules adopted in this proceeding:

1. The Department's rules that were adopted on March 1, 1979 regarding water quality standards are based upon the best scientific knowledge related to the protection of the various designated uses of waters of the State; and

2. The mixing zone, zone of discharge, site specific alternative criteria, exemption, and equitable allocation provisions are designed to provide an opportunity for the future consideration of factors relating to localized situations which could not adequately be addressed in this proceeding, including economic and social consequences, attainability, irretrievable conditions, natural background, and detectability.

(c) This is an even-handed and balanced approach to attainment of water quality objectives. The Commission has specifically recognized that the social, economic and environmental costs may, under certain special circumstances, outweigh the social, economic and environmental benefits if the numerical criteria are enforced statewide. It is for that reason that the Commission has provided for mixing zones, zones of discharge, site specific alternative criteria, exemptions and other provisions in Chapters 17-3, 17-302, 17-4, and 17-6, F.A.C. Furthermore, the continued availability of the moderating provisions is a vital factor providing a basis for the Commission's determination that water quality standards applicable to water classes in the rule are attainable taking into consideration environmental, technological, social, economic and institutional factors. The companion provisions of Chapters 17-4 and 17-6, F.A.C., approved simultaneously with these Water Quality Standards are incorporated herein by reference as a substantive part of the State's comprehensive program for the control, abatement and prevention of water pollution.

(d) Without the moderating provisions described in (b)2. above, the Commission would not have adopted the revisions described in (b)1. above nor determined that they are attainable as generally applicable water quality standards.

Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.704, 403.804, 403.805, F.S.

Law Implemented: 403.021, 403.061, 403.085, 403.086, 403.087, 403.088, 403.101, 403.141, 403.161, 403.182, 403.502, 403.702, 403.708, 402.802, F.S.

History: Formerly 28-5.01, 17-3.01, Amended and Renumbered 3-1-79, Amended 2-1-83, 10-4-89, 1-28-90.

SELECTED PASSAGES FROM CHAPTER 17-40

PART I GENERAL WATER POLICY

17-40.110 Declaration and Intent.
17-40.120 Department Rules.

PART II DEFINITIONS

17-40.210 Definitions.

PART III GENERAL PROVISIONS

17-40.310 General Policies.

PART IV RESOURCE PROTECTION AND MANAGEMENT

17-40.401 Water Use and Reuse.
17-40.402 Water Transport.
17-40.403 Water Quality.
17-40.405 Minimum Flows and Levels.
17-40.420 Surface Water Protection and Management

PART V WATER PROGRAM DEVELOPMENT

17-40.501 District Water Management Plans.

PART VI WATER PROGRAM ADMINISTRATION AND EVALUATION

17-40.601 Review and Application.

PART I GENERAL WATER POLICY

17-40.110 Declaration and Intent.

(1) The waters of the state are among its basic resources. Such waters should be managed to conserve and protect natural resources and scenic beauty and to realize the full beneficial use of the resource. Recognizing the importance of water to the state, the Legislature passed the Water Resources Act, Chapter 373, Florida Statutes, and the Air and Water Pollution Control Act, Chapter 403, Florida Statutes. Additionally, numerous goals and policies within the State Comprehensive Plan, Chapter 187, Florida Statutes, address water resources and natural systems protection.

(2) This Chapter is intended to clarify water policy as expressed in Chapters 187, 373, and 403, Florida Statutes, and to otherwise provide guidance to the Department and Districts in the development of programs, rules, and plans. Local governments shall consider state water policy in the development of their comprehensive plans required by Chapter 163, Florida Statutes,as required by Section 403.0891(3)(a), F.S.

(3) This Chapter does not repeal, amend or otherwise alter any rule now existing or later adopted by the Department or District. However, procedures are included in this Chapter which provide for the review and modification of Department and District rules to assure consistency with the provisions of this Chapter.

(4) It is the intent of the Department, in cooperation with the Water Management Districts, to seek adequate sources of funding to supplement District ad valorem taxes to implement the provisions of this Chapter.
Specific Authority: 373.026(7), 373.026(10), 373.043, 403.061(33), 403.805, F.S.
Law Implemented: 373.016, 373. 114, 403.061(33), 403.0891, F.S.
History: New 5-5-81. Previously numbered as 17-40.01. Amended 12-5-88. Previously numbered 17-40.001, Amended 8-14-90, 12-17-91.

17-40.120 Department Rules.

State water policy shall also include the following Department rules:
(1) Water Quality Standards, Chapter 17-3, F.A.C.
(2) Surface Water Quality Standards, Chapter 17-302, F.A.C.
(3) Surface Water Improvement and Management, Chapter 17-43, F.A.C.
Specific Authority: 373.026(7), 373.026(10), 373.043, 403.061(33), 403.805, F.S.
Law Implemented: 373.016, 373.114, 403.061(33), 403.0891, F.S.
History: New 8-14-90.

PART II DEFINITIONS

17-40.210 Definitions.

When used in this rule or any other rule of the Department or District, unless the context or content of such other rule requires a narrower, more specific meaning, the following words shall mean:
(1) "Aquifer" shall mean a geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield useful quantities of ground water to wells, springs or surface water.
(2) "Consumptive use" means any use of water which reduces the supply from which it is withdrawn or diverted.
(3) "Department" means the Department of Environmental Regulation.
(4) "Detention" means the delay of stormwater runoff prior to its discharge.
(5) "District" means a water management district created pursuant to Chapter 373, Florida Statutes.
(6) "Drainage basin" means a subdivision of a watershed.
(7) "Effluent", unless specifically stated otherwise, means water that is not reused after flowing out of any wastewater treatment facility or other works used for the purpose of treating, stabilizing, or holding wastes.
(8) "Florida Water Plan" means the State Water Use Plan formulated pursuant to Section 373.036, Florida Statutes, together with the water quality standards and water classifications adopted by the Department in Chapters 17-3 and 17-302, F.A.C.
(9) "Governing Board" means the governing board of a water management district.
(10) "Ground water" means water beneath the surface of the ground, whether or not flowing through known and definite channels.
(11) "Nutrient limitations" means those numeric values which establish a maximum or minimum allowable nutrient loading or concentration, as appropriate, for a specific nutrient. Nutrient limitations are established through an individual permit or other action within the regulatory authority of the Department or a District. These limitations serve to implement state water quality standards.
(12) "Reasonable-beneficial use" means the use of water in such quantity as is necessary for economic and efficient utilization for a purpose and in a manner which is both reasonable and consistent with the public interest.
(13) "Reclaimed water" means water that has received at lease secondary treatment and is reused after flowing out of a wastewater treatment facility.
(14) "Retention" means the prevention of stormwater runoff from direct discharge.

(15) "Reuse" means the deliberate application of reclaimed water, in compliance with Department and District rules, for a beneficial purpose.

(a) For example, said uses may encompass:

1. Landscape irrigation (such as irrigation of golf courses, cemeteries, highway medians, parks, playgrounds, school yards, retail nurseries, and residential properties);

2. Agricultural irrigation (such as irrigation of food, fiber, fodder and seed crops, wholesale nurseries, sod farms, and pastures);

3. Aesthetic uses (such as decorative ponds and fountains);

4. Groundwater recharge (such as slow rate, rapid-rate, and absorption field land application systems) but not including disposal methods described in Rule 17-40.210(15)(b), F.A.C.;

5. Industrial uses (such as cooling water, process water, and wash waters);

6. Environmental enhancement of surface waters resulting from discharge of reclaimed water having received at least advanced wastewater treatment or from discharge of reclaimed water for wetlands restoration;

7. Fire protection; or

8. Other useful purpose.

(b) Overland flow land application systems, rapid-rate land application systems providing continuous loading to a single percolation cell, other land application systems involving less than secondary treatment prior to application, septic tanks, and groundwater disposal systems using Class I wells injecting effluent or wastes into Class G-IV waters shall be excluded from the definition of reuse.

(16) "Secretary" means the Secretary of the Department of Environmental Regulation.

(17) "State Water quality standards" means water quality standards adopted by the Environmental Regulations Commission pursuant to Chapter 403, Florida Statues, including standards comprised of designated most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water use or classification, the Florida anti-degradation policy, and the moderating provisions contained in Rules 17-3 and 17-4, F.A.C.

(18) "State Water Use Plan" means the plan formulated pursuant to Section 373.036, Florida Statutes, for the use and development of waters of the State.

(19) "Stormwater" means the water which results from a rainfall event.

(20) "Stormwater management program" means the institutional strategy for stormwater management, including urban, agricultural, and other stormwater.

(21) "Stormwater management system" means a system which is designed and constructed or implemented to control stormwater, incorporating methods to collect, convey, store, absorb, inhibit, treat, use, or reuse stormwater to prevent or reduce flooding, over-drainage, environmental degradation and water pollution or otherwise affect the quantity and quality of discharges from the system.

(22) "Stormwater utility" means the entity through which funding for a stormwater management program is obtained, by assessing the cost of the program to the beneficiaries based on their relative contribution to its need. It is operated as a typical utility which bills services regularly, similar to water and wastewater services.

(23) "Surface water" means water upon the surface of the earth, whether contained in bounds created naturally or artificially or diffused. Water from natural springs shall be classified as surface water when it exits from the spring onto the earth's surface.

(24) "Water" or "waters in the state" means any and all water on or beneath the surface of the ground or in the atmosphere, including natural or artificial watercourses, lakes, ponds, or diffused surface water and water percolating,

standing, or flowing beneath the surface of the ground, as well as all coastal waters within the jurisdiction of the state.
(25) "Watershed" means the land area which contributes to the flow of water into a receiving body of water.
(26) "Wetlands" means those areas that are inundated or saturated by surface or ground water with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that requires saturated or seasonably saturated soil conditions for growth and reproduction, such as swamps, marshes, bayheads, cypress ponds, sloughs, wet prairies, wet meadows, river overflows, mud flats and natural ponds. This definition does not alter the Department's jurisdiction over dredging and filling activities in wetlands as defined in Section 403.911(7), F.S.
Specific Authority: 373.026(7), 373.026(10), 373.043, 403.061(33), 403.805, F.S.
Law Implemented: 373.016, 373.114, 403.061(33), 403.0891, F.S.
History: New 5-5-81. Previously numbered as 17-40.02. Amended 12-5-88. Previously numbered 17-40.020, Amended 8-14-90, 12-17-91.

PART III GENERAL PROVISIONS

17-40.310 General Policies

The following statement of general water policy shall provide a basis for Department review of water management programs, rules, and plans. Water management programs, rules and plans, where economically and environmentally feasible, not contrary to the public interest, and consistent with Florida law, shall seek to:
(1) Assure availability of an adequate and affordable supply of water for all reasonable-beneficial uses. Uses of water authorized by a permit shall be limited to reasonable-beneficial uses.
(2) Reserve from use that water necessary to support essential non-withdrawal demands, including navigation, recreation, and the protection of fish and wildlife.
(3) Champion and develop sound water conservation practices and public information programs.
(4) Advocate and direct the reuse of reclaimed water as an integral part of water management programs, rules, and plans consistent with protection of the public health and surface and ground water quality.
(5) Encourage the use of water of the lowest acceptable quality for the purpose intended.
(6) Utilize, preserve, restore, and enhance natural water management systems and discourage the channelization or other alteration of natural rivers, streams and lakes.
(7) Protect the water storage and water quality enhancement functions of wetlands, floodplains, and aquifer recharge areas through acquisition, enforcement of laws, and the application of land and water management practices which provide for compatible uses.
(8) Protect aquifers from depletion through water conservation and preservation of the functions of high recharge areas.
(9) Identify and protect existing and future public water supply areas and protect them from contamination.
(10) Mitigate adverse impacts resulting from prior alteration of natural hydrologic patterns and fluctuations in surface and ground water levels.
(11) Establish minimum flows and levels to protect water resources and the environmental values associated with marine, estuarine, freshwater, and wetlands ecology.

(12) Encourage nonstructural solutions to water resource problems and give adequate consideration to nonstructural alternatives whenever structural works are proposed.
(13) Encourage the management of floodplains and other flood hazard areas to prevent or reduce flood damage, consistent with establishment and maintenance of desirable hydrologic characteristics of such areas.
(14) Manage the construction and operation of facilities which dam, divert, or otherwise alter the flow of surface waters to prevent increased flooding, soil erosion or excessive drainage.
(15) Encourage the development of local and regional water supplies within districts rather than transport water across District boundaries.
(16) Restore and protect the quality of ground and surface water by ensuring high quality treatment for stormwater and wastewater.
(17) Develop interstate agreements and undertake cooperative programs with Alabama and Georgia to provide for coordinated management of surface and ground waters.
Specific authority: 373.026, 373.026(10), 403.0891, 373.043, 403.805, F.S.
Law Implemented: 373.016, F.S.
History: New 5-5-81. Previously numbered as 17-40.03. Amended 12-5-88. Previously numbered as 17-4.030, Amended 8-14-90, 12-17-91.

PART IV RESOURCE PROTECTION AND MANAGEMENT

17-40.401 Water Use and Reuse.

The following shall apply to those areas where the use of water is regulated pursuant to Part II of Chapter 373, Florida Statutes:
(1) No permit shall be granted to authorize the use of water unless the applicant establishes that the proposed use is a reasonable-beneficial use, will not interfere with presently existing legal uses of water and is consistent with the public interest.
(2) In determining whether a water use is a reasonable-beneficial use, the following factors will be considered:
(a) The quantity of water requested for the use;
(b) The demonstrated need for the use;
(c) The suitability of the use to the source of water;
(d) The purpose and value of the use;
(e) The extent and amount of harm caused;
(f) The practicality of mitigating any harm by adjusting the quantity or method of use;
(g) Whether the impact of the withdrawal extends to land not owned or legally controlled by the user;
(h) The method and efficiency of use;
(i) Water conservation measures taken or available to be taken
(j) The availability of reclaimed water for and the practicality of reuse, or the use of waters of more suitable quality;
(k) The present and projected demand for the source of water;
(l) The long term yield available from the source of water;
(m) The extent of water quality degradation caused;
(n) Whether the proposed use would cause or contribute to flood damage;
(o) Whether the proposed use would significantly induce saltwater intrusion;
(p) The amount of water which can be withdrawn without causing harm to the resource;
(q) Whether the proposed use would adversely affect public health; and
(r) Other relevant factors.

(3) Water shall be reserved from permit use in such locations and quantities, and for such seasons of the year, as is required for the protection of fish and wildlife or the public health or safety.
(4) Conservation of water shall be required unless not economically or environmentally feasible.
(5) As required by Section 373.0391(2)(e), F.S., the Districts shall designate areas that have water supply problems which have become critical or are anticipated to become critical within the next 20 years. The Districts shall identify such critical water supply problem areas during preparation of a District Plan pursuant to Rule 17-40.501, F.A.C., and shall adopt these designations by rule by November 1, 1991. A reasonable amount of reuse of reclaimed water from domestic wastewater treatment facilities shall be required within designated critical water supply problem areas unless such reuse is not economically, environmentally, or technically feasible. The Districts shall periodically update their designations of critical water supply problem areas by rule. Such updates shall occur within one year after updates of the District Plan prepared pursuant to Rule 17-40.501, F.A.C. After completion of the District Plan or updates pursuant to Rule 17-40.501, F.A.C., the Districts may limit areas where reuse shall be required to areas where reuse is specified as a remedial or preventive action pursuant to Rule 17-40.501(2), F. A. C. Any such limitation of areas where reuse shall be required shall be designated by rule.
(6) A reasonable amount of reuse of reclaimed water from domestic wastewater treatment facilities may be required outside of areas designated pursuant to Rule 17-40.401(5), F.A.C., as subject to critical water supply problems provided:
(a) Reclaimed water is readily available; and
(b) The district has adopted rules for reuse in these areas.
(7) The Department encourages local governments to implement programs for reuse of reclaimed water. These rules shall not be deemed to preempt any such local reuse programs.
(8) In implementing consumptive use permitting programs, the Department and the Districts are required under Section 187.101(3), F.S., to recognize the rights of property owners, as limited by law, to make consumptive uses of water from their land, and the rights of other users, as limited by law, to make consumptive uses of water, for reasonable-beneficial uses in a manner consistent with the public interest that will not interfere with any presently existing legal use of water.
(9) Permits authorizing consumptive uses of water which cause unanticipated significant adverse impacts on off-site land uses existing at the time of permit application, or on legal uses of water existing at the time of permit application, should be considered for modification, to curtail or abate the adverse impacts, unless the impacts can be mitigated by the permittee.
Specific Authority: 373.026, 373.043, 403.064, 403.805, F.S.
Law Implemented: 373.016, Part II, 373, F.S.
History: New 5-5-81. Amended 2-4-82, 12-5-88. Previously numbered as 17-40.04. Previously numbered as 17-40.040, Amended 8-14-90, 12-17-91.

17-40.402 Water Transport.

The following shall apply to the transfers of water where such transfers are regulated pursuant to Part II of Chapter 373, Florida Statutes:
(1) The transport or use of water across District boundaries shall require approval of each involved District.
(2) In deciding whether the transport and use of water across District boundaries is consistent with the public interest pursuant to Section 373.223, Florida Statutes, the Districts should consider the extent to which:
(a) Comprehensive water conservation and reuse programs are implemented and enforced in the area of need.

(b) The major costs, benefits, and environmental impacts have been adequately determined including the impact on both the supplying and receiving areas;

(c) The transport is an environmentally and economically acceptable method to supply water for the given purpose;

(d) The present and projected water needs of the supplying area are reasonably determined and can be satisfied even if the transport takes place;

(e) The transport plan incorporates a regional approach to water supply and distribution including, where appropriate, plans for eventual interconnection of water supply sources; and

(f) The transport is otherwise consistent with the public interest based upon evidence presented.

Specific Authority: 373.026, 373.043, 403.805, F.S.
Law Implemented: 373.016, Part II, 373, F.S.
History: New 5-5-81. Previously numbered as 17-40.05. Amended 12-5-88. Previously numbered 17-40.050.

17-40.403 Water Quality.

(1) Water quality standards shall be enforced pursuant to Chapter 403, Florida Statutes, to protect waters of the State from point and non-point sources of pollution.

(2) State water quality standards adopted by Department rule shall be a part of the Florida Water Plan.

Specific Authority: 403.061, 373.026, 373.043, 403.805, F.S.
Law Implemented: 373.039, 403.021, F.S.
History: New 5-5-81. Previously numbered as 17-40.06. Amended 12-5-88. Previously numbered 17-40.060.

17-40.405 Minimum Flows and Levels.

(1) In establishing minimum flows and levels pursuant to Section 373.042, consideration shall be given to the protection of water resources, natural seasonal fluctuations in water flows or levels, and environmental values associated with coastal, estuarine, aquatic, and wetlands ecology, including:

(a) Recreation in and on the water;
(b) Fish and wildlife habitats and the passage of fish;
(c) Estuarine resources;
(d) Transfer of detrital material;
(e) Maintenance of freshwater storage and supply;
(f) Aesthetic and scenic attributes;
(g) Filtration and absorption of nutrients and other pollutants;
(h) Sediment loads;
(i) Water quality; and
(j) Navigation.

(2) Established minimum flows and levels shall be a consideration where relevant to:

(a) The construction and operation of water resource projects;

(b) The issuance of permits pursuant to Part II, Part IV, and Section 373.086, Florida Statutes; and

(c) The declaration of a water shortage pursuant to Section 373.175 or Section 373.246, Florida Statutes.

Specific Authority: 373.026, 373.043, 403.805, F.S.
Law Implemented: 373.016, 373.042, 373.086, 373.175, 373.246, F.S.
History: New 5-5-81. Previously numbered as 17-40.08. Amended 12-5-88. Previously numbered 17-40.080.

17-40.420 Surface Water Protection and Management.

(1) Surface Water Protection and Management Goals. The following goals are established to provide guidance for Department, District and local government stormwater management programs:

(a) It shall be a goal of surface water management programs to protect, preserve and restore the quality, quantity and environmental values of water resources. A goal of surface water management programs includes effective stormwater management for existing and new systems which shall seek to protect, maintain and restore the functions of natural systems and the beneficial uses of waters.

(b) The primary goals of the state's stormwater management program are to maintain, to the maximum extent practicable, during and after construction and development, the predevelopment stormwater characteristics of a site; to reduce the stream channel erosion, pollution, siltation, sedimentation and flooding; to reduce stormwater pollutant loadings discharged to waters to preserve or restore beneficial uses; to reduce the loss of fresh water resources by encouraging the reuse of stormwater; to enhance ground water recharge by promoting infiltration of stormwater in areas with appropriate soils and geology; to maintain the appropriate salinity regimes in estuaries needed to support the natural flora and fauna; and to address stormwater management on a watershed basis to provide cost effective water quality and water quantity solutions to specific watershed problems.

(c) Inadequate management of stormwater throughout a watershed increases stormwater flows and velocities, contributes to erosion and sedimentation,overtaxes the carrying capacity of streams and other conveyances, disrupts the functions of natural systems, undermines floodplain management and flood control efforts in downstream communities, reduces ground water recharge, threatens public health and safety, and is the primary source of pollutant loading entering Florida's rivers, lakes and estuaries, thus causing degradation of water quality and a loss of beneficial uses. Accordingly, it is a goal to eliminate the discharge of inadequately managed stormwater into waters and to minimize other adverse impacts on natural systems, property and public health, safety and welfare caused by improperly managed stormwater.

(d) It shall be a goal of stormwater management programs to reduce unacceptable pollutant loadings from older stormwater management systems, constructed before the adoption of Chapter 17-25, F.A.C., (February 1, 1982), by developing watershed management and stormwater master plans or District-wide or basin specific rules.

(e) The concept of developing comprehensive watershed management plans in designated watersheds is intended not only to prevent existing environmental, water quantity, and water quality problems from becoming worse but also to reduce existing flooding problems, to improve existing water quality, and to preserve or restore the values of natural systems.

(2) Stormwater Management Program Implementation. As required by Section 403.0891, F.S., the Department, Districts and local governments shall cooperatively implement on a watershed basis a comprehensive stormwater management program designed to minimize the adverse effects of stormwater on land and water resources. All such programs shall be mutually compatible with the State Comprehensive Plan (Chapter 187, Florida Statutes), the Local Government Comprehensive Planning and Land Development Regulation Act (Chapter 163, Florida Statutes), the Surface Water Improvement and Management Act (Sections 373.451-.4595, F.S.), Chapters 373 and 403, F.S., and this chapter. Programs shall be implemented in a manner that will improve and restore the quality of waters that do not meet state water quality standards and maintain the water quality of those waters which meet or exceed state water quality standards.

(a) The Department shall be the lead agency responsible for coordinating the statewide stormwater management program by establishing goals, objectives and guidance for the development and implementation of stormwater management programs by the Districts and local governments.

(b) The Districts shall be the chief administrators of the state stormwater management program. Districts shall set regional stormwater management goals and policies on a watershed basis, including watershed stormwater pollutant load reductions necessary to preserve or restore beneficial uses of receiving waters. Such goals and policies shall be implemented through District SWIM plans, through preparation of watershed management plans in other designated priority watersheds and through appropriate regulations.

(c) Local governments shall establish stormwater management programs which are in accordance with the state and District stormwater quality and quantity goals. Local governments may establish a stormwater utility or other dedicated source of funding to implement a local stormwater management program which shall include the development and implementation of a stormwater master plan and provisions, such as an operating permit system, to ensure that stormwater systems are properly operated and maintained.

(3) Surface Water Management. The following shall apply to the regulation of surface water pursuant to Part IV, Chapter 373, Florida Statutes.

(a) The construction and operation of facilities which manage or store surface waters, or other facilities which drain, divert, impound, discharge into, or otherwise impact waters in the state, and the improvements served by such facilities, shall not be harmful to water resources or inconsistent with the objectives of the Department or District.

(b) In determining the harm to water resources and consistency with the objectives of the Department or District, consideration should be given to:

1. The impact of the facilities on:
   a. water quality;
   b. fish and wildlife;
   c. wetlands, floodplains, and other environmentally sensitive lands;
   d. reasonable-beneficial uses of water;
   e. recreation;
   f. navigation;
   g. saltwater or pollution intrusion, including any barrier line established pursuant to Section 373.033, F.S.;
   h. minimum flows and levels established pursuant to Section 373.042, F.S.; and
   i. other factors relating to the public health, safety, and welfare;
2. Whether the facilities meet applicable design or performance standards;
3. Whether adequate provisions exist for the continued satisfactory operation and maintenance of the facilities; and
4. The ability of the facilities and related improvements to avoid increased damage to off-site property, water resources, natural systems or the public caused by:
   a. floodplain development, encroachment or other alteration;
   b. retardance, acceleration or diversion of flowing water;
   c. reduction of natural water storage areas;
   d. facility failure; or
   e. other actions adversely affecting off-site water flows or levels.

(4) Minimum Stormwater Treatment Performance Standards.

(a) When a stormwater management system complies with rules establishing the design and performance criteria for stormwater management systems, there shall be a rebuttable presumption that such systems will comply with state water quality

standards. The Department and the Districts, pursuant to Section 373.436, F.S., shall adopt rules that specify design and performance criteria for new stormwater management systems which:

1. Shall be designed to achieve at least 80 percent reduction of the average annual load of pollutants that would cause or contribute to violations of state water quality standards.

2. Shall be designed to achieve at least 95 percent reduction of the average annual load of pollutants that would cause or contribute to violations of state water quality standards in Outstanding Florida Waters.

3. The minimum treatment levels specified in subparagraphs 1. and 2. above may be replaced by basin specific design and performance criteria adopted by a District in order to achieve the pollutant load reduction goals established in paragraph (c).

(b) Erosion and sediment control plans detailing appropriate methods to retain sediment on-site shall be required for land disturbing activities.

(c) The pollutant loading from older stormwater management systems shall be reduced as necessary to restore or maintain the beneficial uses of waters. The Districts shall establish pollutant load reduction goals and adopt them as part of a SWIM plan, other watershed management plan, or District-wide or basin specific rules.

(d) Watershed management goals shall be developed by the District for all watersheds within the boundaries of each District and shall be consistent with the SWIM Program and the EPA National Pollutant Discharge Elimination System (NPDES) program. The primary purpose shall be to reduce pollutant discharges from watersheds such that the water quality in receiving waters is restored or maintained consistent with applicable state water quality standards.

(e) Watershed specific stormwater pollutant load reduction goals shall be developed for older stormwater management systems on a priority basis as follows:

1. Goals shall be developed according to the schedule established by EPA for those waters receiving stormwater discharges from systems required to obtain NPDES stormwater permits.
2. Goals shall be developed by 1994 for SWIM water bodies that have an adopted SWIM plan and that do not receive stormwater discharges from systems required to obtain NPDES stormwater discharge permits.
3. Goals shall be developed for other watersheds by 1996. These goals shall be considered in local comprehensive plans submitted or updated in accordance with Section 403.0891 (3) (a), F.S.

Specific Authority: 373.026, 373.043, 403.061, 403.087, F.S.
Law Implemented: 163.3161-163.3243, 186, 187, 373.016, 373.046, 373.114, Part IV, 373, 403.061, 403.0891, F.S.
History: New 2-20-91.

PART V WATER PROGRAM DEVELOPMENT

17-40.501 District Water Management Plans.

(1) As required by Section 373.036(4), F.S., a water management plan shall be prepared by each District which is consistent with the provisions of this Chapter and Section 373.036, Florida Statutes. The District Plan shall include an assessment of water needs and sources for the next 20 years. The District Plan shall identify specific geographical areas that have water resource problems which have become critical or are anticipated to become critical within the next 20 years. Identification of critical water supply problem areas needed for imposition of reuse requirements

pursuant to Rule 17-40.401(5), F.A.C., may be accomplished before publication of the complete District Plan.
(2) Based on economic, environmental, and technical feasibility analyses, a course of remedial or preventive action shall be specified for each current and anticipated future critical problem.
(3) Remedial or preventive measures may include, but are not limited to, water resource projects; water resources restoration projects pursuant to Section 403.0615, Florida Statutes; purchase of lands; conservation of water; reuse of reclaimed water; enforcement of Department or District rules; and actions taken by local government pursuant to a Local Government Comprehensive Plan, local ordinance, or zoning regulation.
(4) District Plans shall also provide for identifying areas where collection of data, water resource investigations, water resource projects, or the implementation of regulatory programs are necessary to prevent water resource problems from becoming critical.
(5) By November 1, 1989, each District shall prepare a detailed plan of study for the preparation of the District Plan.
(6) District Plans shall be developed expeditiously and may be phased. All District Plans shall be completed no later than November 1, 1994.
(7) At a minimum, District Plans shall be updated every five years after the initial plan development.
Specific Authority: 373.026, 373.043, 403.805, F.S.
Law Implemented: 373.016, 373.033, 373.042, 373.106, 373.114, F.S.
History: New 5-5-81. Previously numbered as 17-40.09. Amended 12-5-88. Previously numbered 17-40.090, Amended 8-14-90, 12-17-91.

PART VI WATER PROGRAM ADMINISTRATION AND EVALUATION

17-40.601 Review and Application.

(1) This Chapter shall be reviewed periodically, but in no case less frequently than once every four years. Revisions, if any, shall be adopted by rule.
(2) Within 12 months after adoption or revision of this Chapter, the Districts shall have revised their existing rules for consistency with the provisions contained herein.
(3) District rules adopted after this Chapter takes effect shall be reviewed by the Department for consistency with this Chapter.
(4) At the request of the Department, each District shall initiate rulemaking pursuant to Chapter 120, Florida Statutes, to consider changes the Department determines to be necessary to assure consistency with this Chapter. The Department shall be made a party to the proceeding.
(5) District water policies may be adopted which are consistent with this Chapter, but which take into account differing regional water resource characteristics and needs.
(6) A District shall initiate rulemaking to consider implementation of programs pursuant to Sections 373.033, 373.042, 373.106, Part III, or Part IV of Chapter 373, Florida Statutes, where the Department or District determines that present or projected conditions of water shortages, saltwater intrusion, flooding, drainage, or other water resource problems, prevent or threaten to prevent the achievement of reasonable-beneficial uses, the protection of fish and wildlife, or the attainment of other water policy directives.
(7) The Department and Districts shall assist other governmental entities in the development of plans, ordinances or other programs to promote consistency with this Chapter and District water management plans.

(8) Duplication of water quality and quantity permitting functions should be eliminated where appropriate through delegation of Department responsibilities to Districts.
(9) The Department and Districts should assist educational institutions in the development of educational curricula and research programs which meet Florida's present and future water management needs.
Specific Authority: 373.026, 373.043, 403.805, F.S.
Law Implemented: 373.016, 373.033, 373.042, 373.106, 373.114, F.S.
History: New 5-5-81. Previously numbered as 17-40.10. Amended 12-5-88. Previously numbered 17-40.100.

APPENDIX B

County Land Use Maps

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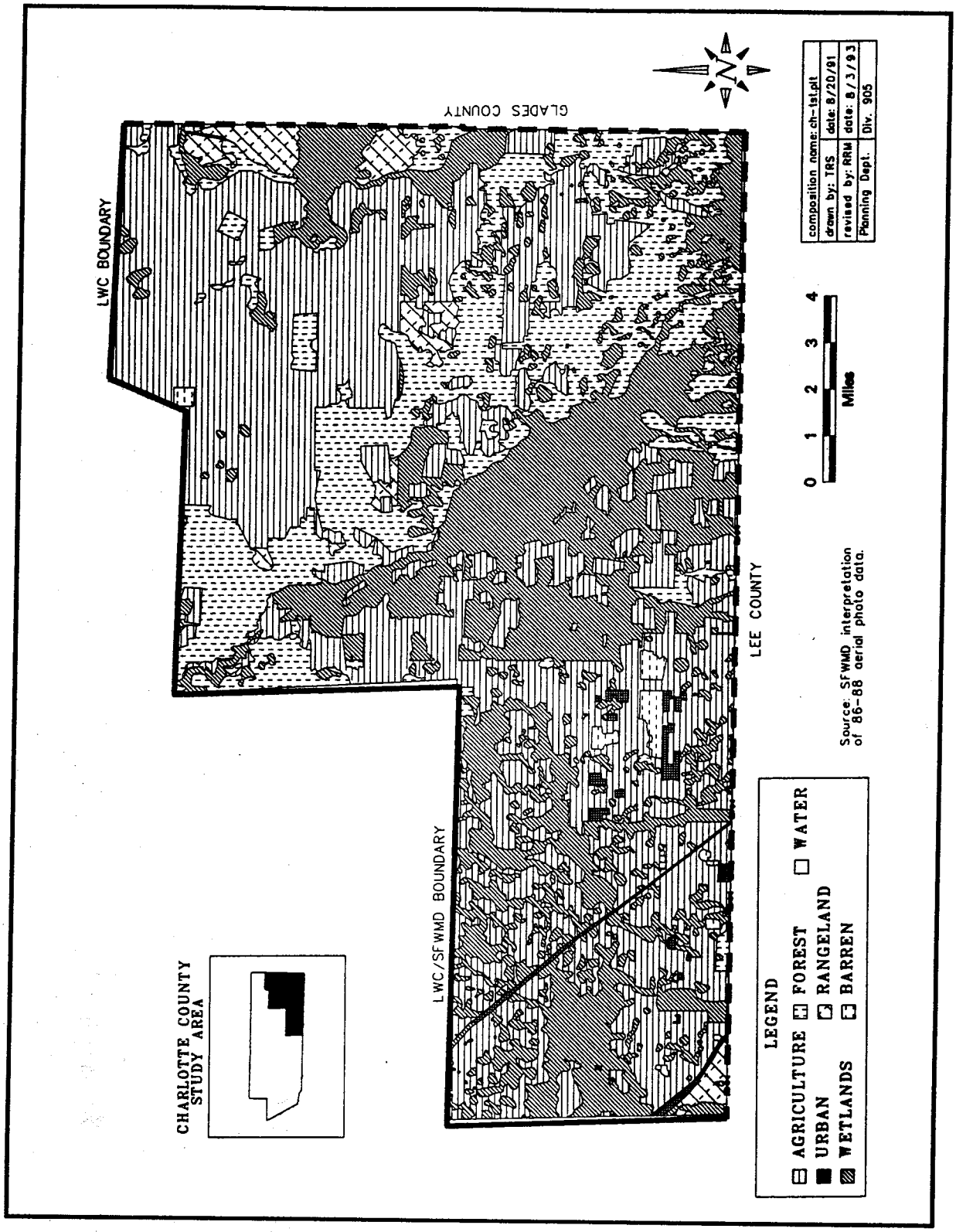


FIGURE B-1. Land Use in the Charlotte County Area.

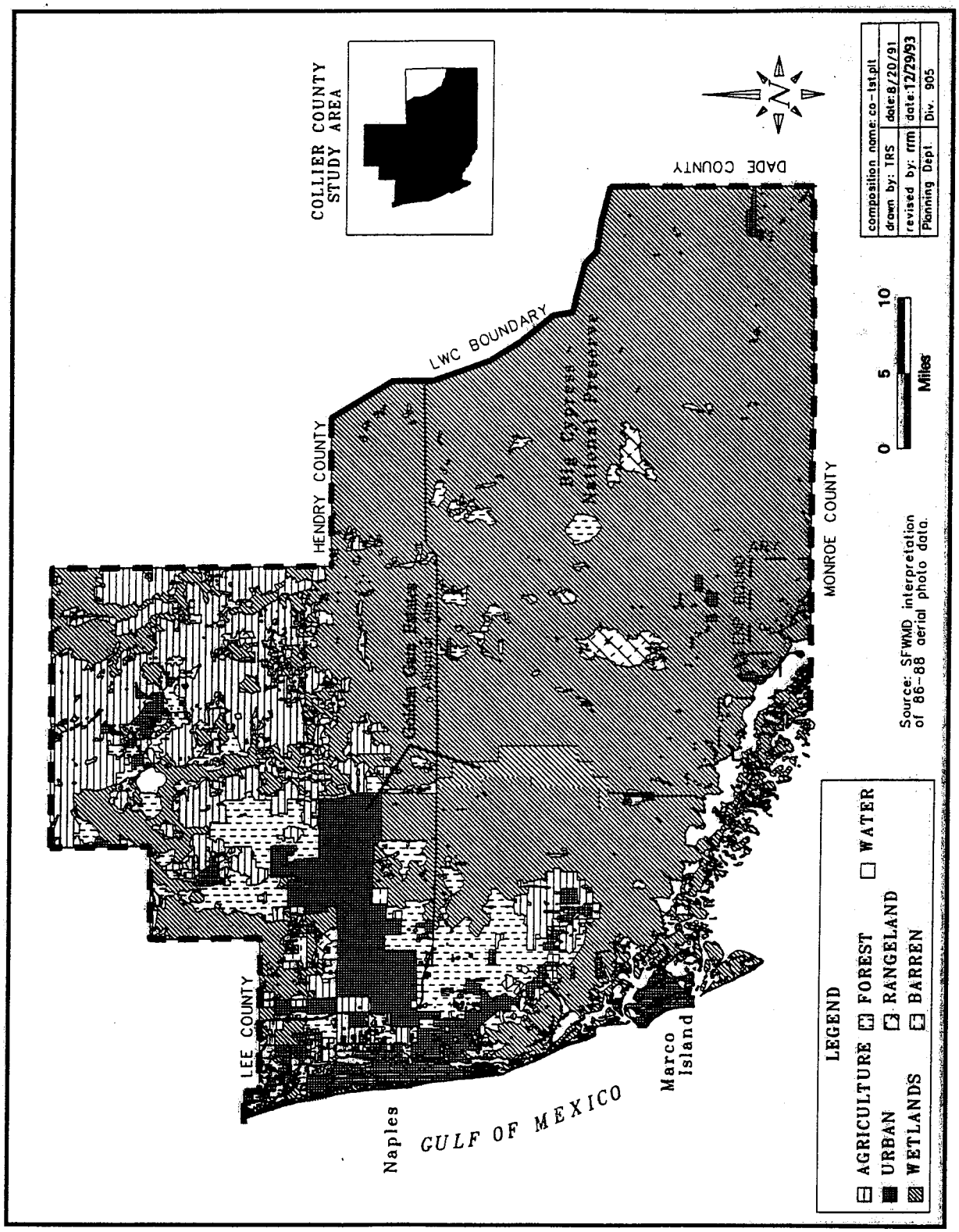


FIGURE B-2. Land Use in the Collier County Area.

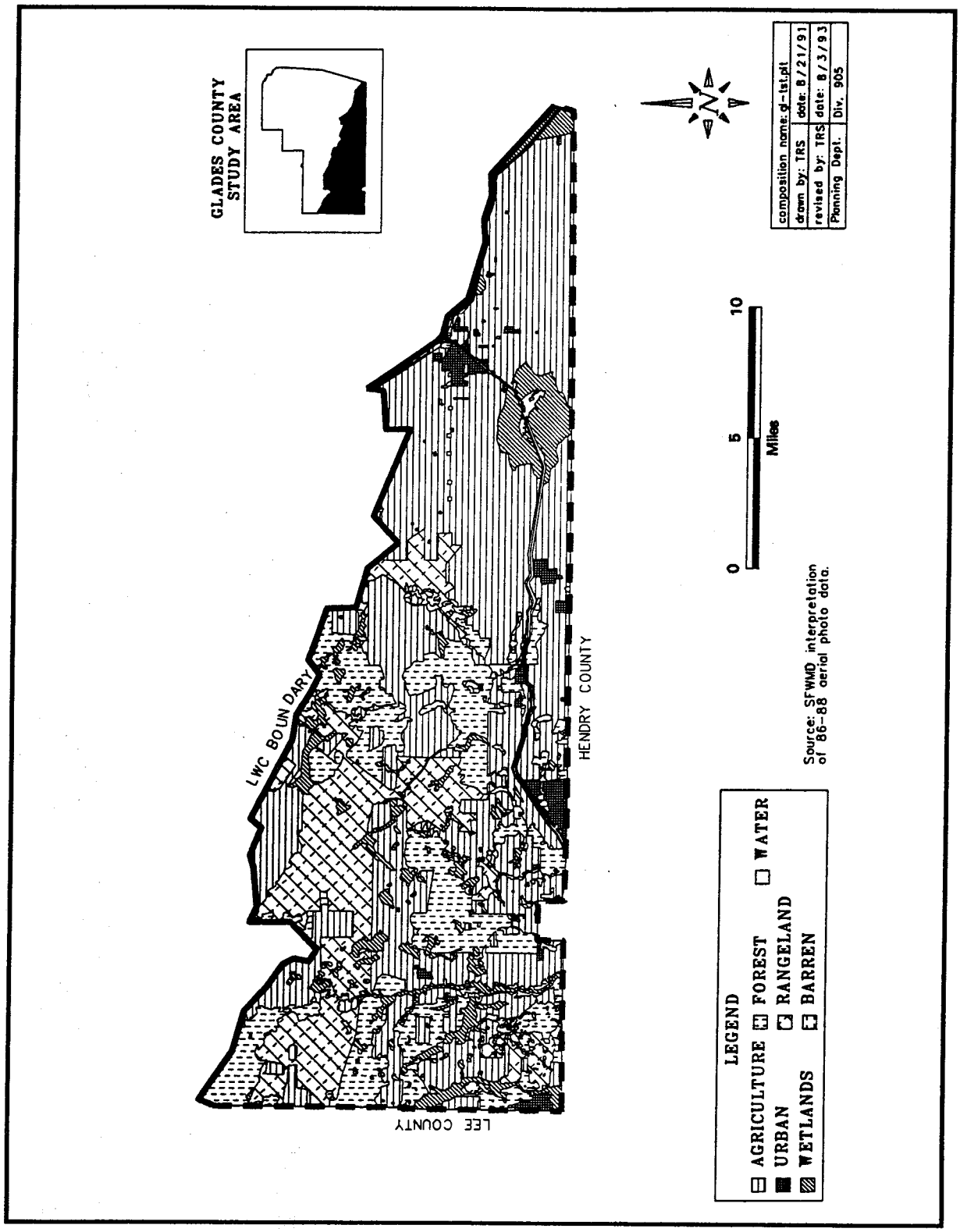


FIGURE B-3. Land Use in the Glades County Area.

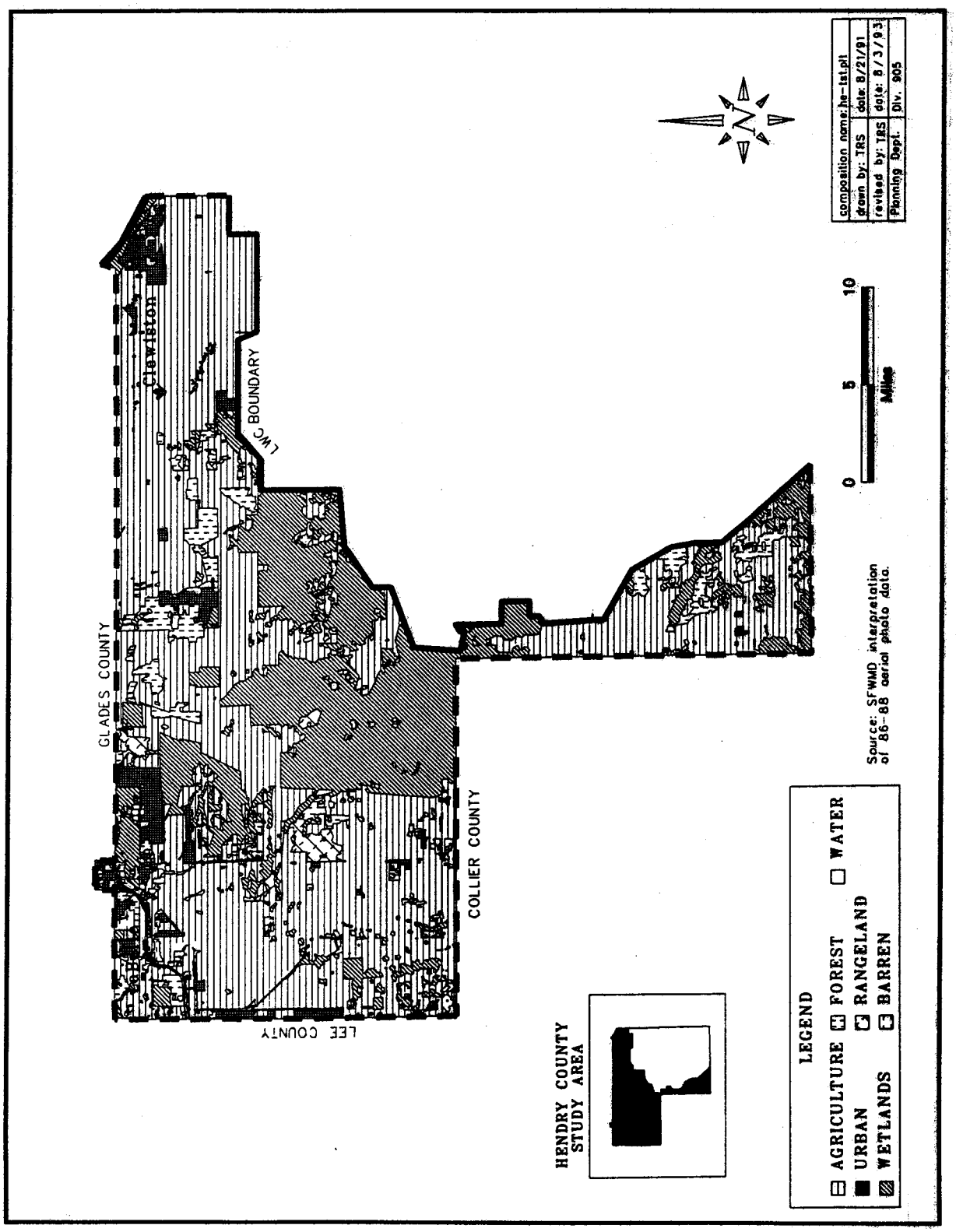


FIGURE B-4. Land Use in the Hendry County Area.

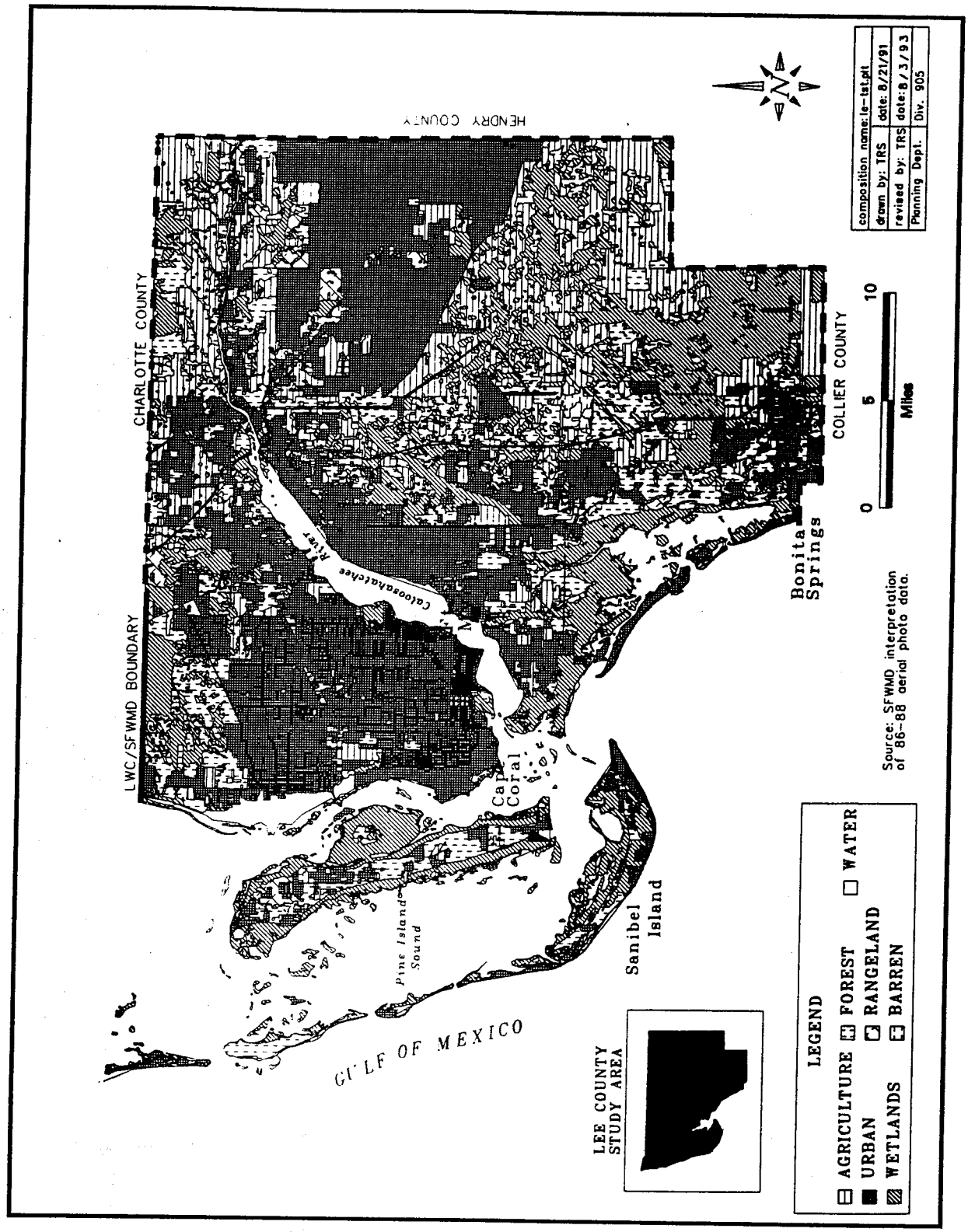


FIGURE B-5. Land Use in Lee County.

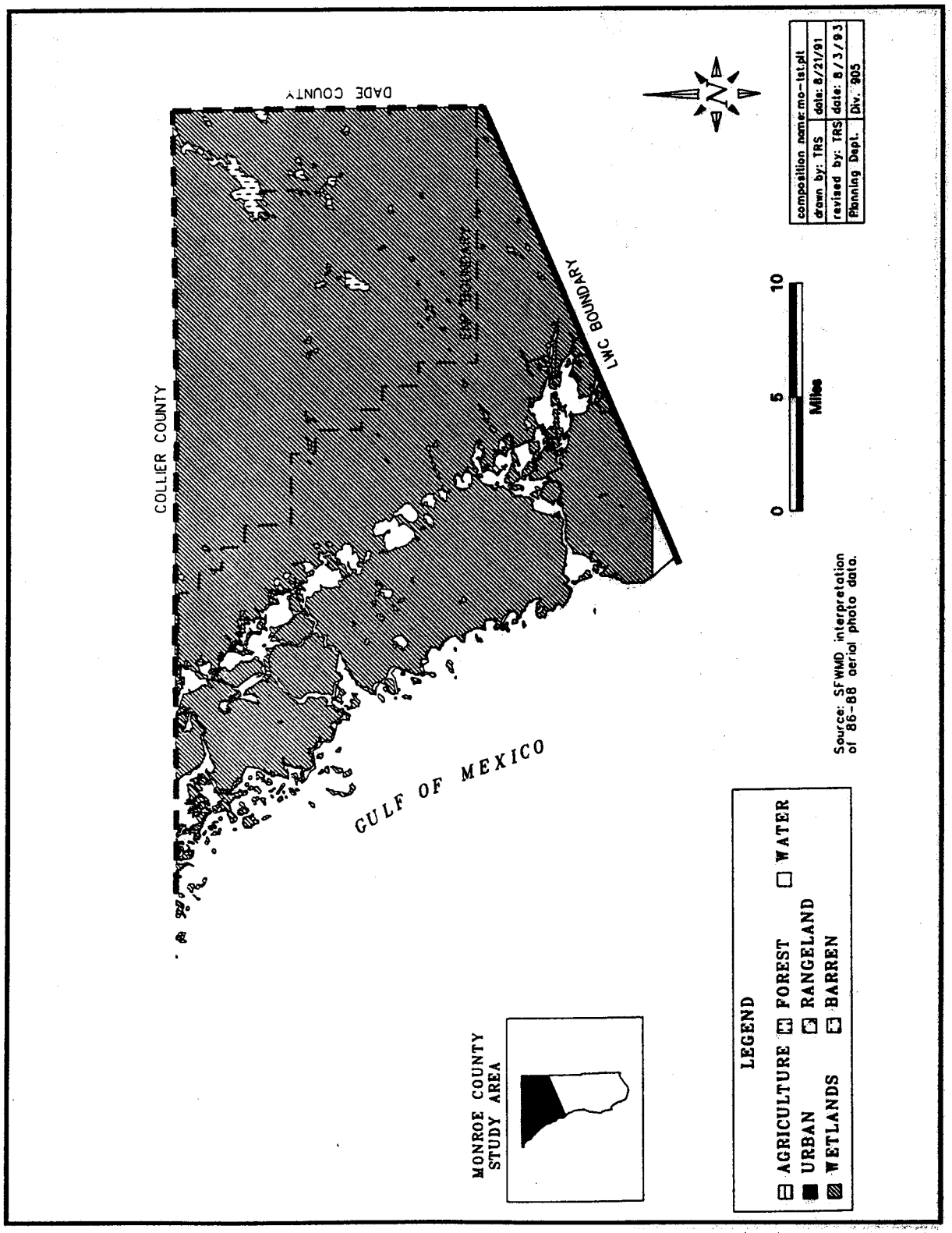


FIGURE B-6. Land Use in the Monroe County Area.

APPENDIX C

Rainfall Frequency Analysis

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RAINFALL ANALYSIS

A primary goal of the LWC Water Supply Plan is to identify areas of expected water supply shortage and the frequency with which those shortages may occur. Rainfall is responsible for nearly all surface water inflows and outflows in the planning area and is the single most important source of recharge to the Surficial Aquifer. Rainfall is also the single most important variable controlling the occurrence of water shortages in the planning area.

RAINFALL DISTRIBUTION

Rainfall is variable from county to county within the LWC Planning Area. To provide more precise input into the county-level ground water models, the rainfall data was broken down for Collier, Hendry, and Lee counties. The 52-year average annual rainfall for these counties ranges from 51.77 inches in Hendry County to 54.50 inches in Collier County. There is a wet period from May through October, and a dry period from November through April (Figure C-1). Both the maximum monthly average rainfall (9.34 inches in June) and the minimum monthly average rainfall (1.49 inches in December) occur in Collier County (tables C-2 to C-4).

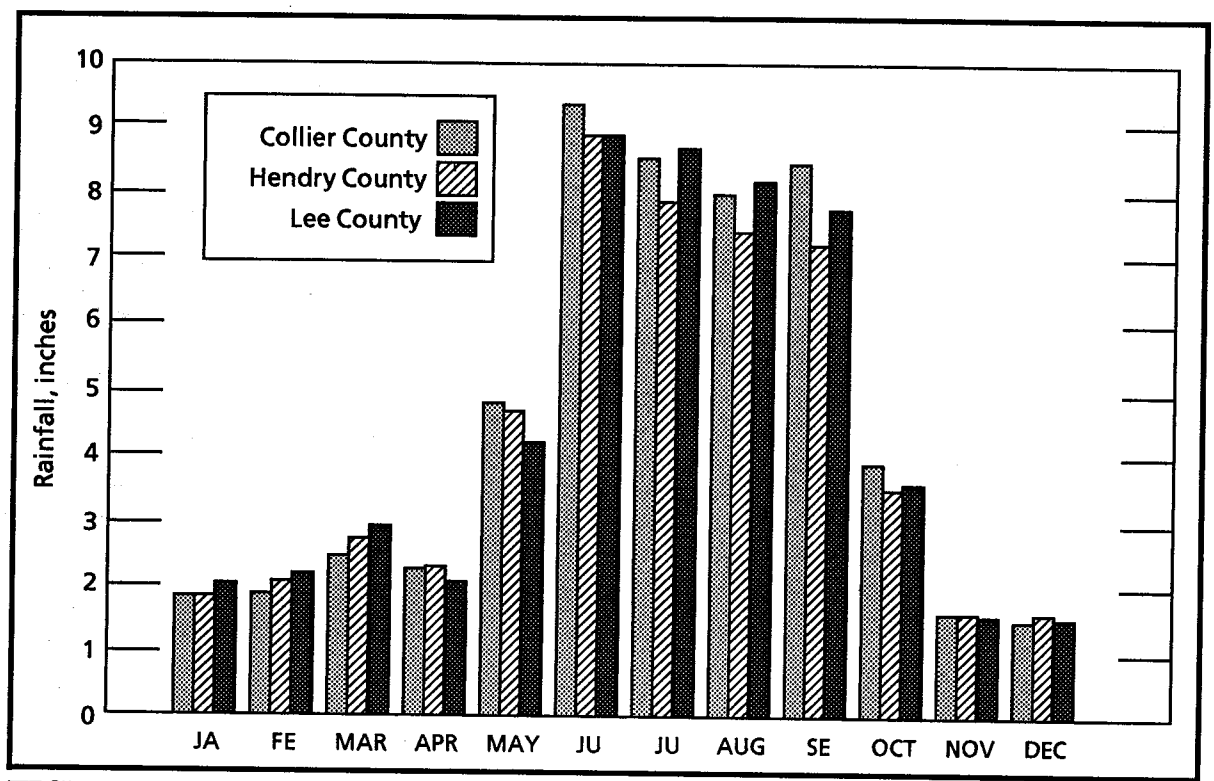


FIGURE C-1. Average Monthly Distribution of Rainfall in Collier, Hendry and Lee Counties, 1940-1991.

RAINFALL DATA PREPARATION

The District has a network of rainfall gaging stations which provide historical rainfall data. Long-term data for the county-level ground water models were obtained from 37 gaging stations with relatively long and reliable records. These rainfall gaging stations are identified in Table C-1 and are plotted in Figure C-2.

TABLE C-1. Monitoring Rainfall (MRF) Gaging Stations by County.

Map No.	Collier	Map No.	Glades	Map No.	Hendry	Map No.	Lee
18	MRF 6098	10	MRF 64/7043*	9	MRF 5001	1	MRF 5004
19	MRF 242	11	MRF 240	10	MRF 64/7043	2	MRF 227
20	MRF 6046			11	MRF 240	3	MRF 336
21	MRF 243			12	MRF 6044	4	MRF 250
22	MRF 5005			13	MRF 6039/7039**	5	MRF 232
23	MRF 375			14	MRF 63	6	MRF 6093
24	MRF 6047			15	MRF 247	7	MRF 206
25	MRF 6121			16	MRF 5006	8	MRF 5003
26	MRF 5010			17	MRF 5002/6118*	9	MRF 5001
27	MRF 5009			18	MRF 6098	12	MRF 6044
28	MRF 5014			20	MRF 6046	18	MRF 6098
29	MRF 6048			26	MRF 5010	20	MRF 6046
31	MRF 145			30	MRF 182	21	MRF 243
32	MRF 6054			31	MRF 145		

* Monitored by more than one agency.
** Monitored by more than one agency with hourly and daily readings.

The ordinary Kriging method for spatial analysis of monthly rainfall in South Florida was used to calculate the average rainfall for Collier, Hendry and Lee counties. Tables C-2 through C-4 list the resulting monthly rainfall between 1940 and 1991 for Collier, Hendry, and Lee counties. The monthly rainfall data verified by the daily value were used, and the stations with missing data were not included in the spatial analysis. The rainfall data prior to 1943 was not analyzed due to limited available data and rainfall stations. The rainfall data for 1940 through 1942 were based on the original Lower West Coast rainfall data which was published in Technical Publication 86-6, Frequency Analysis of SFWMD Rainfall (Sculley, 1986).

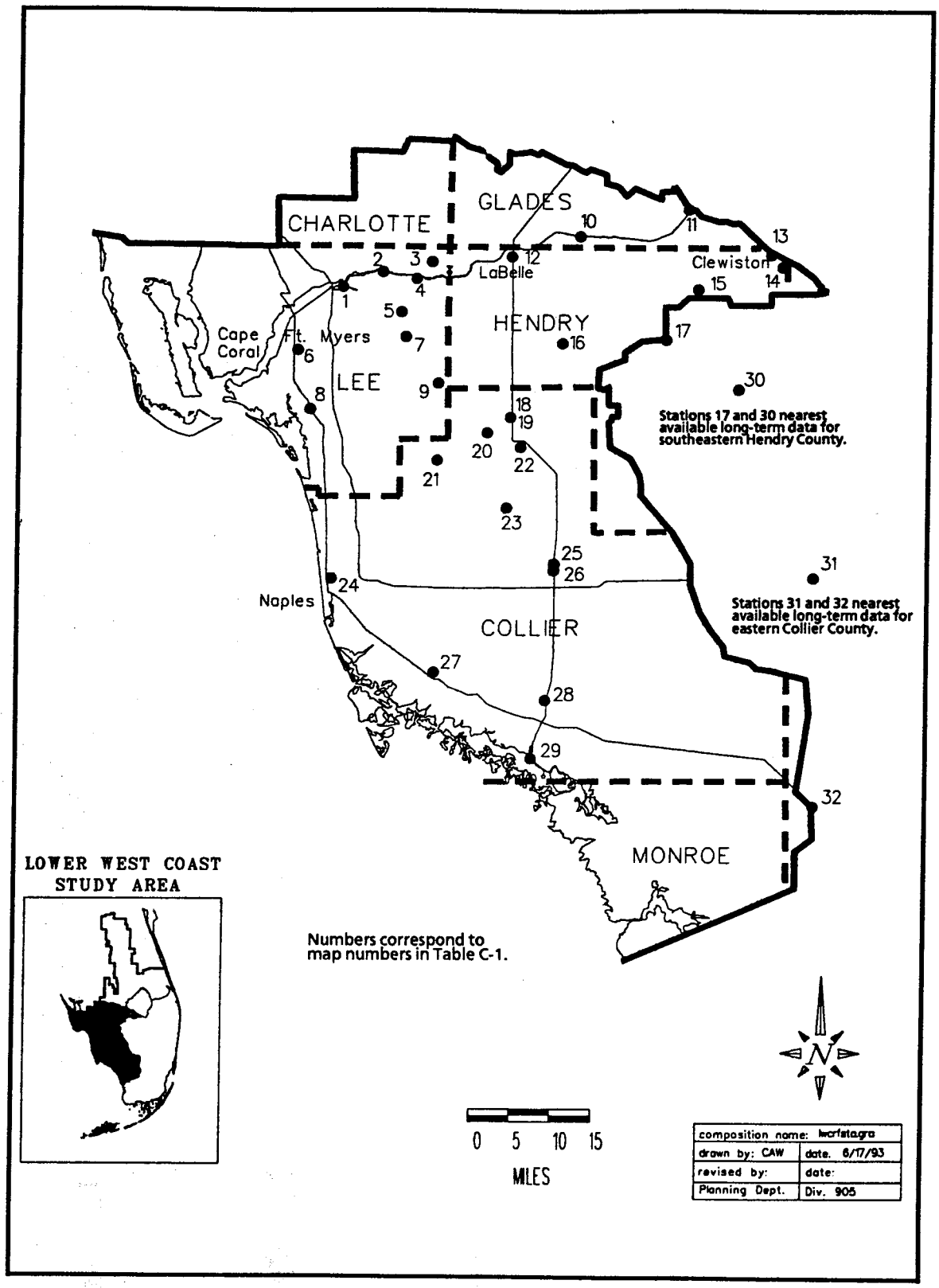


FIGURE C-2. Long-Term Rainfall Gaging Stations in the LWC Planning Area.

TABLE C-2. Monthly Mean Rainfall in Collier County.*

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUM
1940	3.19	3.32	3.24	1.46	2.21	9.72	4.41	8.00	14.54	0.46	0.10	4.91	55.56
1941	4.32	3.74	5.03	6.87	1.50	6.74	10.76	5.61	7.04	3.09	2.15	0.86	57.71
1942	2.27	2.93	2.77	3.80	2.62	11.66	6.54	6.80	5.29	0.28	0.55	1.78	47.29
1943	1.23	0.71	0.45	3.10	7.11	12.07	7.68	5.18	6.54	3.15	1.26	0.31	48.79
1944	0.93	0.25	0.98	3.43	4.61	5.02	7.06	8.54	4.50	4.64	0.19	0.85	41.00
1945	2.34	0.71	0.33	3.36	1.25	5.95	10.87	8.98	11.16	4.71	1.04	1.51	52.21
1946	0.89	0.95	0.94	0.77	8.14	8.48	8.19	7.80	8.24	1.28	3.61	2.15	51.44
1947	0.75	1.83	5.44	3.63	2.56	13.87	9.73	9.33	13.03	8.77	4.98	1.48	75.40
1948	2.34	0.20	0.30	2.75	3.60	4.29	9.25	6.25	16.44	4.24	0.59	0.47	50.72
1949	0.04	0.33	0.12	1.69	4.12	9.54	13.03	8.60	12.59	3.92	0.79	2.25	57.02
1950	0.05	1.12	0.58	1.45	2.95	4.21	9.48	7.24	6.60	3.98	1.17	2.24	41.07
1951	0.49	1.12	0.51	3.98	2.10	4.84	7.79	6.51	6.14	9.29	0.48	0.26	43.51
1952	0.89	5.22	2.26	0.90	3.45	5.79	7.93	4.21	9.51	8.52	0.96	0.66	50.30
1953	2.71	1.75	4.10	6.16	1.85	6.59	8.36	9.23	13.53	5.07	0.73	1.53	61.61
1954	0.29	1.58	3.82	5.91	7.44	8.30	7.66	7.23	9.41	2.14	1.63	1.08	56.49
1955	1.04	0.55	0.72	1.90	5.39	10.15	9.35	5.58	8.88	2.21	1.06	1.84	48.67
1956	1.52	0.76	0.71	3.31	6.43	3.69	5.23	6.52	5.72	6.28	0.78	0.38	41.33
1957	0.52	4.50	3.18	2.88	7.12	6.54	7.42	8.62	9.47	4.74	0.37	3.45	58.81
1958	7.05	1.46	5.33	1.26	10.54	7.79	8.08	7.77	6.07	4.29	0.47	3.69	63.80
1959	1.89	0.75	4.35	1.29	8.38	14.21	9.41	9.12	8.63	10.10	2.65	0.69	71.47
1960	0.33	1.44	2.54	4.77	3.77	8.48	15.07	7.45	14.41	5.59	2.85	0.83	67.53
1961	2.51	0.45	1.14	0.35	5.18	6.68	8.57	7.05	4.02	2.51	0.71	0.25	39.42
1962	1.03	0.45	2.81	0.83	3.20	14.50	6.12	8.26	13.77	3.23	1.81	0.38	56.39
1963	1.04	4.57	0.54	0.49	6.17	6.01	4.14	7.04	12.17	2.20	2.48	2.62	49.47
1964	1.92	1.99	1.89	2.44	3.50	9.91	6.77	9.06	6.68	4.68	0.98	0.87	50.69
1965	0.82	3.07	1.21	1.69	1.57	7.94	9.90	8.48	6.33	6.11	1.17	0.73	49.02
1966	3.83	2.02	0.65	3.17	4.47	15.39	9.39	6.74	7.29	3.42	0.40	0.67	57.44
1967	1.97	2.80	0.97	0.02	1.63	12.47	7.03	6.44	8.89	4.91	1.02	2.18	50.33
1968	0.75	2.94	1.49	0.26	9.34	15.22	9.25	6.10	9.13	7.09	2.26	0.57	64.40
1969	2.16	1.81	3.12	2.29	5.16	17.35	8.40	9.95	6.69	8.28	1.81	1.68	68.70
1970	2.94	2.52	15.21	0.03	6.10	8.82	8.59	7.50	7.65	4.21	0.18	0.09	63.84
1971	0.88	1.40	0.38	0.19	4.13	9.28	6.92	11.09	13.07	6.63	1.50	0.66	56.13
1972	1.84	3.97	3.87	2.21	6.64	13.05	5.27	9.29	5.96	1.89	5.36	1.66	61.01
1973	2.89	2.04	3.29	0.72	1.25	11.35	11.32	12.19	7.42	2.45	0.54	2.74	58.20
1974	0.17	0.33	0.32	1.06	5.68	17.45	11.01	8.78	6.28	0.57	3.11	1.39	56.15
1975	0.69	0.79	1.44	2.39	6.94	10.26	11.25	7.05	11.74	2.14	0.33	0.22	55.24
1976	0.57	1.80	1.04	2.90	11.04	10.97	6.33	8.17	10.38	3.17	1.52	2.20	60.09
1977	3.44	1.08	0.08	0.90	5.84	11.51	8.34	7.49	7.43	0.38	2.37	3.19	52.05
1978	2.61	2.93	3.58	2.58	4.15	9.38	9.23	7.36	6.88	2.64	1.27	3.26	55.87
1979	3.29	0.64	1.25	1.20	6.46	4.07	5.89	11.35	11.57	1.98	1.88	3.79	53.37
1980	3.29	1.20	1.93	4.39	4.88	3.10	7.58	9.69	6.62	0.91	3.76	0.71	48.06
1981	0.69	2.89	1.33	0.21	1.45	6.56	8.13	14.44	5.57	1.75	1.75	0.26	45.03
1982	0.68	1.46	3.38	6.14	7.14	19.90	9.54	8.12	7.06	3.97	1.19	1.22	69.80
1983	4.64	8.42	5.18	1.48	0.75	11.26	9.48	8.30	11.06	5.89	2.66	3.54	72.66
1984	0.30	2.15	3.82	0.69	6.17	4.50	7.96	6.81	9.08	1.51	1.70	0.22	44.91
1985	0.88	0.35	1.38	3.08	3.93	8.26	14.02	4.51	5.91	3.63	2.05	1.19	49.19
1986	2.42	1.94	3.76	0.94	1.88	14.35	4.98	9.09	3.78	4.52	0.96	4.56	53.18
1987	1.64	2.19	7.41	0.78	5.33	6.07	5.44	6.99	7.30	3.22	5.35	0.32	52.04
1988	1.50	1.62	2.09	1.03	3.76	6.58	10.01	9.16	4.44	0.91	2.31	0.58	43.99
1989	0.86	0.24	1.48	3.81	3.28	9.44	8.95	7.38	5.77	2.60	1.04	1.94	46.79
1990	1.36	1.81	1.31	1.44	5.89	7.08	8.13	9.58	5.85	3.89	0.72	0.14	47.20
1991	6.09	2.09	1.73	3.19	7.20	8.98	13.06	6.33	5.73	5.20	1.62	0.55	61.77
Sum	94.8	99.2	126.8	117.6	247.2	485.6	444.3	416.4	439.3	203.2	84.2	77.6	2,834
Mean	1.84	1.91	2.44	2.26	4.75	9.34	8.54	7.97	8.45	3.91	1.62	1.49	54.50

TABLE C-3. Monthly Mean Rainfall in Hendry County.*

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUM
1940	3.19	3.32	3.24	1.46	2.21	9.72	4.41	8.00	14.54	0.46	0.10	4.91	55.56
1941	4.32	3.74	5.03	6.87	1.50	6.74	10.76	5.61	7.04	3.09	2.15	0.86	57.71
1942	2.27	2.93	2.77	3.80	2.62	11.66	6.54	6.80	5.29	0.28	0.55	1.78	47.29
1943	0.61	0.39	1.23	2.84	7.73	9.75	7.36	5.91	5.18	2.25	0.97	0.56	44.78
1944	0.90	0.13	1.64	5.25	3.07	6.01	9.54	8.39	5.19	3.98	0.27	0.20	44.57
1945	1.81	0.79	0.31	1.82	1.24	8.10	11.50	8.35	8.70	5.19	0.30	1.13	49.24
1946	0.61	1.35	0.76	1.14	6.96	8.37	5.47	8.14	7.01	1.05	2.48	1.53	44.87
1947	0.76	1.79	7.64	2.04	4.22	13.87	6.64	10.28	15.80	3.36	2.10	1.00	69.50
1948	3.27	0.01	0.38	2.32	2.42	5.43	6.14	4.68	18.76	2.06	0.40	0.53	46.40
1949	0.08	0.26	0.43	2.14	2.85	10.51	10.51	10.06	9.19	0.78	1.08	1.88	49.77
1950	0.04	0.88	0.72	1.35	4.18	4.28	6.76	5.26	4.63	8.27	2.46	4.39	43.22
1951	0.70	1.82	1.04	4.25	3.09	6.50	12.93	8.47	8.08	11.10	1.31	0.17	59.46
1952	1.01	6.40	1.51	1.09	5.34	6.33	8.41	8.33	7.63	9.83	0.78	0.63	57.29
1953	2.28	2.39	2.39	4.07	2.66	11.76	8.46	12.12	12.47	7.26	0.57	1.50	67.93
1954	0.49	2.19	2.68	6.17	5.55	8.47	10.20	5.08	8.56	2.54	2.27	1.78	55.98
1955	2.06	1.26	1.09	1.27	6.26	10.49	7.15	4.74	6.31	1.77	0.69	2.20	45.29
1956	0.88	0.97	1.24	1.69	3.99	4.28	5.75	6.47	5.35	5.55	0.57	0.39	37.13
1957	1.67	4.46	4.99	3.44	8.16	7.52	7.27	6.36	8.99	2.79	0.69	6.23	62.57
1958	6.68	1.26	6.90	2.90	6.59	5.88	7.08	6.22	4.91	3.62	0.73	4.37	57.14
1959	1.61	1.27	5.54	1.44	6.49	11.58	9.00	8.90	9.34	10.39	1.71	0.85	68.12
1960	0.36	2.83	1.90	4.83	4.12	8.13	12.50	8.68	11.82	4.17	2.04	0.74	62.12
1961	2.92	1.45	2.65	1.07	6.99	4.79	5.75	5.95	2.66	1.21	0.67	0.34	36.45
1962	1.02	0.81	3.30	1.17	3.42	12.65	5.22	7.34	11.47	3.06	1.97	0.26	51.69
1963	0.85	3.66	0.40	0.38	6.53	7.17	2.72	6.30	6.28	1.17	2.20	3.28	40.94
1964	2.13	3.02	1.47	3.08	2.38	8.49	5.92	8.45	4.40	3.45	0.59	1.12	44.50
1965	0.58	3.74	3.05	1.47	1.85	12.20	10.00	7.46	5.66	6.30	0.68	1.10	54.09
1966	3.50	2.41	0.66	3.15	4.67	14.00	7.70	7.84	7.14	3.27	0.17	0.70	55.21
1967	1.54	3.58	0.59	0.03	1.86	11.76	7.56	5.35	7.27	3.88	0.32	2.16	45.90
1968	0.32	2.77	1.41	0.52	7.87	12.89	9.99	4.05	5.76	5.02	2.61	0.45	53.66
1969	1.75	1.96	5.20	1.34	3.92	10.56	6.57	7.65	4.96	7.99	1.73	2.38	56.01
1970	3.74	2.07	15.16	0.11	7.33	8.66	8.41	6.10	5.21	3.56	0.27	0.29	60.91
1971	0.83	1.47	0.36	0.32	4.55	9.87	7.70	6.83	9.25	4.75	1.46	0.72	48.11
1972	1.10	2.41	4.26	2.07	3.90	9.68	4.34	7.91	2.30	1.70	4.66	1.40	45.73
1973	2.57	2.66	3.15	0.97	2.79	8.10	10.26	9.13	5.62	2.23	0.35	2.13	49.96
1974	0.39	0.76	0.27	1.19	5.88	18.10	11.46	9.05	5.94	0.69	2.98	1.32	58.03
1975	0.35	0.94	1.16	3.29	7.99	11.01	9.78	5.94	10.05	3.60	0.49	0.40	55.00
1976	0.68	1.61	1.80	2.23	9.02	7.35	5.36	6.61	7.78	1.58	2.03	2.20	48.25
1977	4.04	1.05	0.35	0.39	5.45	6.80	6.21	7.37	6.76	0.86	4.10	2.85	46.23
1978	2.53	2.03	3.01	2.05	4.66	7.34	8.83	8.39	5.16	2.81	1.65	4.00	52.46
1979	4.14	0.44	1.68	2.50	6.42	3.47	4.67	8.78	12.73	1.50	3.06	3.60	52.99
1980	3.98	1.46	2.39	4.34	3.37	2.85	6.54	7.00	5.07	0.94	2.93	0.79	41.66
1981	0.62	2.17	1.47	0.22	1.69	6.07	5.24	11.92	3.46	1.19	3.07	0.20	37.32
1982	0.78	1.77	4.02	4.33	10.11	17.18	8.86	6.00	6.72	3.60	0.75	0.86	64.98
1983	3.90	8.38	5.44	1.59	1.64	12.68	5.76	7.76	7.04	5.40	1.84	3.54	64.97
1984	0.43	2.81	4.50	1.80	7.16	5.50	10.25	5.76	7.43	1.25	3.30	0.13	50.32
1985	0.73	0.36	1.83	5.23	3.30	7.58	11.30	6.47	7.20	2.82	1.58	1.56	49.96
1986	2.61	1.81	5.33	0.52	1.88	13.78	6.84	9.34	4.37	4.51	0.30	3.77	55.06
1987	2.52	2.45	6.64	0.40	4.40	6.02	5.98	4.94	7.76	4.34	7.01	0.23	52.69
1988	1.60	2.14	3.00	1.89	3.45	5.44	9.61	10.64	2.32	0.63	3.90	0.88	45.50
1989	1.14	0.25	3.01	4.09	3.09	7.96	8.04	7.15	5.53	3.00	0.65	2.23	46.14
1990	1.24	2.26	1.22	1.98	4.47	5.86	7.40	8.71	3.79	3.31	0.68	0.18	41.10
1991	7.03	1.87	2.61	3.86	8.07	9.26	9.93	6.85	4.48	3.60	2.32	0.31	60.19
Sum	97.2	107.0	144.8	119.8	241.4	460.4	408.6	385.9	376.4	183.0	84.5	83.0	2,692
Mean	1.87	2.06	2.79	2.30	4.64	8.86	7.86	7.42	7.24	3.52	1.63	1.60	51.77

TABLE C-4. Monthly Mean Rainfall in Lee County.*

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUM
1940	3.19	3.32	3.24	1.46	2.21	9.72	4.41	8.00	14.54	0.46	0.10	4.91	55.56
1941	4.32	3.74	5.03	6.87	1.50	6.74	10.76	5.61	7.04	3.09	2.15	0.86	57.71
1942	2.27	2.93	2.77	3.80	2.62	11.66	6.54	6.80	5.29	0.28	0.55	1.78	47.29
1943	0.93	0.48	1.26	4.00	8.76	10.68	10.80	6.21	5.40	3.08	1.66	0.88	54.14
1944	1.28	0.01	2.30	3.80	3.35	5.66	8.68	8.47	3.70	4.89	0.28	0.22	42.64
1945	2.04	0.72	0.44	1.26	1.33	9.76	13.16	10.70	7.21	5.43	0.19	1.34	53.58
1946	0.59	1.62	0.68	0.93	6.96	9.83	6.53	7.93	6.56	1.45	2.35	1.14	46.57
1947	0.65	2.22	7.97	1.96	4.22	13.87	9.20	10.96	16.63	3.49	2.60	1.21	74.98
1948	3.59	0.02	0.54	2.33	2.42	5.43	8.58	4.73	15.42	2.57	0.54	0.66	46.83
1949	0.01	0.14	0.33	3.70	2.97	7.16	13.14	9.04	10.34	1.62	1.19	1.30	50.94
1950	0.01	0.68	0.58	0.85	2.80	4.01	7.42	5.66	5.24	3.98	0.54	1.28	33.05
1951	0.30	1.52	1.01	3.71	1.77	6.78	10.64	6.11	5.26	12.17	1.09	0.15	50.51
1952	1.16	4.79	1.65	0.85	3.85	5.03	7.84	8.13	8.80	9.39	0.92	0.53	52.94
1953	2.08	1.97	1.36	2.94	0.69	11.12	8.61	9.38	12.13	6.74	0.68	1.90	59.60
1954	0.36	2.21	2.48	4.50	4.60	7.56	9.47	5.41	7.65	2.24	2.30	1.91	50.69
1955	2.48	1.50	0.79	1.02	5.96	9.12	8.21	4.45	7.55	1.97	0.71	1.77	45.53
1956	0.86	1.17	1.43	2.75	5.14	4.00	5.77	7.57	6.37	5.67	0.92	0.46	42.11
1957	0.91	4.38	5.43	2.33	9.08	4.69	9.92	7.37	8.83	3.45	0.85	4.95	62.19
1958	5.72	1.32	7.55	2.53	7.00	6.94	7.59	5.15	6.73	4.00	1.40	3.87	59.80
1959	1.74	1.36	6.36	1.41	4.41	13.90	8.20	6.09	9.37	9.23	1.31	1.33	64.71
1960	0.32	3.25	1.61	3.39	3.45	6.05	14.70	7.41	14.24	3.72	1.64	0.77	60.55
1961	3.44	1.59	2.18	1.77	4.87	5.95	6.43	9.61	3.05	2.76	0.92	0.41	42.98
1962	0.89	0.44	3.27	1.34	1.20	14.64	6.66	10.75	12.74	3.23	3.02	0.49	58.67
1963	0.87	4.00	0.62	0.34	7.53	8.40	4.33	6.12	7.54	0.58	3.15	2.63	46.11
1964	2.72	3.08	1.67	1.76	1.22	7.40	5.35	9.52	6.13	2.14	0.43	0.84	42.26
1965	0.64	2.87	3.33	1.95	1.78	9.22	10.99	9.45	5.45	5.81	0.51	0.92	52.92
1966	3.29	2.17	0.56	3.34	3.70	13.00	7.03	7.35	8.55	2.34	0.23	0.65	52.21
1967	2.23	2.68	0.55	0.02	1.72	11.15	8.73	8.18	6.86	5.09	0.64	2.50	50.35
1968	0.26	2.09	1.23	0.52	7.96	14.66	11.36	6.72	6.06	5.39	3.07	0.25	59.57
1969	2.04	2.14	5.16	1.32	5.46	10.51	5.02	7.92	9.08	9.38	1.16	3.37	62.56
1970	4.91	3.14	18.71	0.16	6.87	9.79	9.34	5.43	7.48	3.15	0.70	0.49	70.17
1971	1.06	1.61	0.38	1.14	3.63	7.83	8.32	8.00	9.71	6.29	0.52	0.82	49.31
1972	1.97	3.13	5.14	1.46	4.03	11.43	5.94	9.86	4.14	1.51	6.63	1.43	56.67
1973	3.15	3.19	4.44	1.64	1.39	7.27	13.99	11.77	7.43	1.89	0.81	1.94	58.91
1974	0.24	1.26	0.52	0.72	5.52	17.18	12.50	9.40	7.06	0.32	2.12	1.39	58.23
1975	0.44	0.63	1.48	2.43	5.62	8.72	9.02	7.35	8.04	4.09	0.54	0.46	48.82
1976	0.30	1.36	1.57	1.82	5.89	8.52	6.84	6.66	7.78	1.80	2.42	1.99	46.95
1977	4.81	0.85	0.15	0.37	4.60	7.47	9.30	9.52	7.06	0.70	1.75	2.36	48.94
1978	2.87	2.57	3.41	1.94	3.85	8.75	10.12	8.16	4.75	1.88	0.90	4.09	53.29
1979	6.56	1.39	1.45	3.33	6.00	5.25	5.14	10.09	14.51	1.17	2.23	4.92	62.04
1980	3.31	1.54	3.08	3.22	4.69	2.08	7.77	10.71	6.50	1.75	3.28	0.60	48.53
1981	0.78	1.88	1.53	0.17	3.64	8.75	6.76	15.48	4.94	0.34	0.93	0.43	45.63
1982	0.78	2.40	3.60	3.47	6.61	14.70	8.15	7.13	7.21	4.18	0.61	0.81	59.65
1983	5.27	10.90	6.68	1.76	0.70	13.74	6.06	8.40	8.03	5.98	2.55	3.62	73.69
1984	0.34	3.42	5.80	1.30	6.18	6.49	11.31	6.72	6.60	0.97	2.80	0.27	52.20
1985	0.68	0.57	1.96	2.68	1.78	6.74	9.78	9.62	8.67	4.50	2.05	1.04	50.07
1986	2.15	2.12	4.15	0.62	2.74	13.77	6.55	10.37	5.17	2.75	0.40	4.55	55.34
1987	2.77	3.69	6.79	0.35	7.42	6.63	11.20	6.72	6.82	6.61	7.63	0.42	67.05
1988	2.01	1.83	3.37	1.46	2.61	5.46	8.22	12.05	3.15	0.98	3.47	0.67	45.28
1989	1.74	0.48	3.36	4.07	2.19	10.02	9.40	8.41	6.01	3.05	0.53	1.75	51.01
1990	0.27	3.05	1.43	1.76	4.37	6.08	7.89	9.13	5.42	2.78	0.52	0.13	42.83
1991	7.35	1.29	1.77	3.46	9.08	9.71	11.59	7.68	6.77	5.54	1.15	0.23	65.62
Sum	104.9	112.7	154.1	108.1	219.9	461.0	451.3	425.5	403.0	187.9	81.6	79.7	2,790
Mean	2.02	2.17	2.96	2.08	4.23	8.87	8.68	8.18	7.75	3.61	1.57	1.53	53.65

FREQUENCY ANALYSIS

The probabilistic distribution of rainfall in duration and seasonal trends is important when predicting areas of expected water supply shortage and the frequency with which those shortages may occur. This section presents the results of the rainfall drought analysis based on normal, two-parameter lognormal, three-parameter lognormal, two-parameter gamma, three-parameter gamma, Weibull, and Log-Pearson Type III distributions (Kite, 1977). The least rainfall amount of 1 through 12 months durations for each water year beginning November through following October were analyzed. The results of the rainfall drought frequency analysis are presented in tables C-5 through C-7 for Collier, Hendry, and Lee counties.

Next, a hypothesis test by Chi-square test method for the goodness of fit at 95 percent level was done for each frequency distribution. Table C-8 provides the acceptance or rejection of the frequency distributions which can be used in the rainfall analysis of the LWC Planning Area. For more information on the statistical frequency distributions used in this analysis, the reader is referred to G.W. Kite's "Frequency and Risk Analysis in Hydrology" (1977).

TABLE C-5. Rainfall Drought Frequency for Collier County.

Duration*	Probability of Drought Frequency (Rainfall in inches)						
	.005	.01	.02	.04	0.10	0.20	0.50
1 month							
NO2	0.00	0.00	0.00	0.00	0.00	0.12	0.48
LN2	0.03	0.03	0.04	0.06	0.09	0.14	0.33
LN3	0.00	0.00	0.01	0.04	0.10	0.17	0.38
GM2	0.00	0.01	0.02	0.04	0.09	0.16	0.38
GM3	0.15	0.16	0.17	0.17	0.17	0.19	0.32
WB2	0.01	0.02	0.04	0.07	0.16	0.30	0.81
LP3	0.05	0.06	0.07	0.09	0.13	0.19	0.36
2 months							
NO2	0.00	0.00	0.00	0.00	0.36	0.87	1.85
LN2	0.29	0.34	0.40	0.49	0.66	0.88	1.53
LN3	0.00	0.07	0.20	0.35	0.63	0.93	1.66
GM2	0.16	0.22	0.30	0.42	0.64	0.91	1.63
GM3	0.25	0.29	0.35	0.44	0.64	0.89	1.60
WB2	0.08	0.12	0.18	0.28	0.51	0.80	1.60
LP3	0.22	0.28	0.35	0.45	0.65	0.90	1.60
3 months							
NO2	0.00	0.00	0.00	0.00	0.97	1.93	3.75
LN2	0.60	0.71	0.84	1.02	1.38	1.83	3.13
LN3	0.00	0.00	0.15	0.56	1.25	1.96	3.52
GM2	0.36	0.49	0.66	0.90	1.35	1.90	3.34
GM3	0.45	0.56	0.71	0.92	1.35	1.88	3.30
WB2	0.22	0.32	0.47	0.70	1.19	1.80	3.40
LP3	0.43	0.54	0.70	0.91	1.34	1.87	3.32
4 months							
NO2	0.00	0.00	0.00	0.88	2.26	3.57	6.05
LN2	1.39	1.58	1.82	2.14	2.73	3.44	5.35
LN3	0.74	1.06	1.45	1.92	2.73	3.61	5.64
GM2	1.04	1.29	1.59	1.99	2.72	3.56	5.59
GM3	1.44	1.62	1.86	2.18	2.81	3.56	5.51
WB2	0.59	0.81	1.12	1.55	2.40	3.40	5.75
LP3	0.95	1.19	1.49	1.89	2.66	3.55	5.72
5 months							
NO2	0.00	0.00	0.00	0.83	2.94	4.92	8.70
LN2	2.03	2.31	2.66	3.11	3.96	4.97	7.67
LN3	1.28	1.69	2.19	2.81	3.90	5.10	7.98
GM2	1.46	1.81	2.25	2.82	3.87	5.07	8.02
GM3	1.65	1.96	2.35	2.88	3.87	5.04	7.96
WB2	0.71	1.00	1.42	2.01	3.21	4.65	8.13
LP3	1.71	2.02	2.42	2.92	3.90	5.03	7.91
6 months							
NO2	0.00	0.08	1.39	2.85	5.11	7.23	11.29
LN2	3.32	3.70	4.18	4.77	5.87	7.12	10.31
LN3	2.42	2.98	3.64	4.44	5.82	7.29	10.65
GM2	2.71	3.19	3.77	4.51	5.82	7.26	10.64
GM3	3.45	3.79	4.23	4.81	5.92	7.21	10.46
WB2	1.54	2.03	2.69	3.56	5.19	7.01	11.01
LP3	2.72	3.18	3.75	4.46	5.77	7.22	10.68

TABLE C-5. Rainfall Drought Frequency for Collier County (Continued).

Duration*	Probability of Drought Frequency (Rainfall in inches)						
	.005	.01	.02	.04	0.10	0.20	0.50
7 months							
NO2	2.83	4.13	5.56	7.14	9.60	11.90	16.30
LN2	6.55	7.12	7.79	8.62	10.08	11.68	15.46
LN3	5.13	5.99	6.96	8.10	9.97	11.86	15.88
GM2	5.91	6.59	7.40	8.38	10.06	11.82	15.74
GM3	5.87	6.57	7.38	8.37	10.06	11.83	15.75
WB2	3.94	4.82	5.89	7.23	9.51	11.81	16.40
LP3	5.75	6.44	7.26	8.24	9.97	11.78	15.82
8 months							
NO2	8.53	10.18	11.99	14.01	17.13	20.05	25.64
LN2	12.49	13.35	14.35	15.56	17.63	19.82	24.79
LN3	10.15	11.48	12.96	14.65	17.36	20.01	25.35
GM2	11.72	12.73	13.90	15.28	17.59	19.96	25.07
GM3	12.19	13.10	14.16	15.44	17.62	19.91	24.96
WB2	8.40	9.85	11.56	13.59	16.88	20.05	26.00
LP3	11.71	12.70	13.85	15.20	17.51	19.90	25.07
9 months							
NO2	16.11	17.87	19.79	21.92	25.23	28.34	34.27
LN2	19.70	20.74	21.95	23.37	25.75	28.20	33.56
LN3	17.99	19.37	20.91	22.68	25.52	28.30	33.94
GM2	18.95	20.14	21.50	23.09	25.70	28.31	33.80
GM3	21.35	22.03	22.87	23.94	25.87	28.03	33.19
WB2	14.56	16.48	18.66	21.14	25.03	28.60	35.00
LP3	19.51	20.59	21.83	23.27	25.72	28.21	33.62
10 months							
NO2	23.75	25.53	27.49	29.66	33.03	36.18	42.22
LN2	26.85	28.01	29.34	30.90	33.47	36.07	41.62
LN3	25.56	26.98	28.57	30.39	33.30	36.14	41.90
GM2	26.18	27.49	28.96	30.67	33.43	36.17	41.82
GM3	27.95	28.88	29.98	31.30	33.59	36.01	41.42
WB2	21.19	23.43	25.92	28.69	32.91	36.68	43.21
LP3	26.72	27.91	29.27	30.83	33.45	36.08	41.66
11 months							
NO2	30.35	32.27	34.38	36.72	40.34	43.74	50.24
LN2	32.28	34.59	36.09	37.83	40.69	43.57	49.65
LN3	31.39	33.09	34.98	37.11	40.47	43.69	50.04
GM2	32.65	34.11	35.75	37.64	40.69	43.70	49.85
GM3	32.70	34.15	35.78	37.66	40.69	43.69	49.84
WB2	27.09	29.65	32.46	35.56	40.22	44.33	51.35
LP3	32.46	33.93	35.59	37.47	40.58	43.63	49.87
12 months							
NO2	33.21	35.27	37.53	40.04	43.93	47.57	54.54
LN2	36.81	38.19	39.77	41.60	44.60	47.61	54.94
LN3	37.57	38.82	40.25	41.93	44.73	47.59	53.78
GM2	36.01	37.56	39.30	41.29	44.51	47.68	54.14
GM3	39.87	40.63	41.57	42.77	44.97	47.42	53.30
WB2	29.88	32.66	35.72	39.09	44.14	48.59	56.19
LP3	39.47	40.38	41.47	42.76	45.06	47.52	53.28

TABLE C-6. Rainfall Drought Frequency for Hendry County.

Duration*	Probability of Drought Frequency (Rainfall in inches)						
	.005	.01	.02	.04	0.10	0.20	0.50
1 month							
NO2	0.00	0.00	0.00	0.00	0.00	0.15	0.47
LN2	0.03	0.03	0.04	0.06	0.10	0.15	0.33
LN3	0.00	0.00	0.01	0.04	0.11	0.18	0.38
GM2	0.01	0.01	0.03	0.04	0.09	0.16	0.38
GM3	0.00	0.01	0.03	0.05	0.10	0.17	0.38
WB2	0.01	0.02	0.04	0.06	0.13	0.24	0.58
LP3	0.05	0.06	0.08	0.10	0.14	0.19	0.37
2 months							
NO2	0.00	0.00	0.00	0.00	0.24	0.85	2.01
LN2	0.27	0.32	0.39	0.48	0.67	0.90	1.61
LN3	0.00	0.00	0.12	0.29	0.60	0.94	1.78
GM2	0.13	0.19	0.27	0.39	0.63	0.93	1.75
GM3	0.33	0.35	0.38	0.45	0.62	0.86	1.65
WB2	0.06	0.10	0.15	0.25	0.47	0.78	1.67
LP3	0.25	0.30	0.37	0.47	0.66	0.91	1.64
3 months							
NO2	0.00	0.00	0.00	0.00	1.02	2.04	3.99
LN2	0.75	0.87	1.02	1.21	1.60	2.07	3.39
LN3	0.00	0.21	0.50	0.85	1.46	2.12	3.66
GM2	0.46	0.61	0.80	1.05	1.54	2.11	3.59
GM3	0.75	0.84	0.96	1.15	1.54	2.05	3.48
WB2	0.22	0.33	0.49	0.72	1.24	1.89	3.58
LP3	0.70	0.82	0.98	1.18	1.58	2.08	3.43
4 months							
NO2	0.00	0.00	0.32	1.23	2.65	3.98	6.52
LN2	1.59	1.80	2.07	2.41	3.05	3.81	5.82
LN3	0.56	0.98	1.46	2.03	2.99	3.99	6.20
GM2	1.23	1.50	1.83	2.26	3.04	3.93	6.06
GM3	1.03	1.33	1.71	2.18	3.02	3.95	6.11
WB2	0.73	0.99	1.34	1.82	2.75	3.82	6.26
LP3	1.17	1.43	1.75	2.17	2.98	3.91	6.15
5 months							
NO2	0.00	0.00	0.00	1.26	3.45	5.50	9.42
LN2	2.18	2.48	2.86	3.35	4.27	5.37	8.33
LN3	1.15	1.65	2.24	2.97	4.22	5.58	8.75
GM2	1.62	2.00	2.47	3.09	4.23	5.53	8.70
GM3	1.67	2.04	2.50	3.10	4.23	5.51	8.68
WB2	0.87	1.21	1.68	2.34	3.66	5.22	8.91
LP3	1.64	2.00	2.45	3.04	4.18	5.49	8.75
6 months							
NO2	0.00	0.18	1.57	3.11	5.51	7.76	12.05
LN2	3.42	3.83	4.33	4.97	6.15	7.50	10.98
LN3	1.94	2.64	3.46	4.43	6.06	7.76	11.50
GM2	2.79	3.30	3.93	4.71	6.12	7.68	11.34
GM3	2.78	3.30	3.93	4.71	6.12	7.68	11.34
WB2	1.67	2.20	2.90	3.83	5.57	7.50	11.74
LP3	2.70	3.20	3.81	4.58	6.03	7.63	11.44

TABLE C-6. Rainfall Drought Frequency for Hendry County (Continued).

Duration*	Probability of Drought Frequency (Rainfall in inches)						
	.005	.01	.02	.04	0.10	0.20	0.50
7 months							
NO2	2.48	3.87	5.39	7.09	9.71	12.16	16.86
LN2	6.45	7.04	7.74	8.61	10.15	11.85	15.93
LN3	5.04	5.93	6.95	8.14	10.11	12.11	16.39
GM2	5.80	6.51	7.36	8.39	10.16	12.04	16.24
GM3	5.18	6.03	7.02	8.19	10.14	12.13	16.40
WB2	3.83	4.72	5.83	7.20	9.59	12.02	16.91
LP3	5.21	5.98	6.91	8.02	9.99	12.05	16.53
8 months							
NO2	9.64	11.20	12.90	14.80	17.73	20.48	25.73
LN2	13.18	14.02	15.00	16.17	18.17	20.27	24.98
LN3	11.83	12.95	14.22	15.68	18.06	20.42	25.34
GM2	12.49	13.47	14.61	15.94	18.15	20.41	25.23
GM3	12.29	13.32	14.49	15.87	18.14	20.43	25.28
WB2	9.19	10.66	12.37	14.37	17.59	20.64	26.28
LP3	12.16	13.18	14.35	15.72	18.03	20.38	25.34
9 months							
NO2	15.84	17.57	19.45	21.55	24.79	27.84	33.66
LN2	19.19	20.22	21.41	22.82	25.18	27.62	32.95
LN3	**	**	**	**	**	**	**
GM2	18.51	19.68	21.03	22.60	25.17	27.76	33.19
GM3	18.18	19.43	20.85	22.48	25.15	27.79	33.26
WB2	14.31	16.19	18.33	20.78	24.59	28.11	34.39
LP3	18.08	19.31	20.72	22.33	25.04	27.72	33.30
10 months							
NO2	22.91	24.66	26.57	28.69	31.98	35.07	40.96
LN2	25.70	26.85	28.16	29.70	32.24	34.83	40.36
LN3	**	**	**	**	**	**	**
GM2	25.12	26.40	27.86	29.54	32.27	34.97	40.56
GM3	23.55	25.16	26.94	28.93	32.06	35.04	40.85
WB2	20.38	22.56	24.98	27.67	31.78	35.45	41.82
LP3	24.10	25.55	27.19	29.03	32.05	34.98	40.82
11 months							
NO2	27.35	29.33	31.48	33.88	37.60	41.08	47.74
LN2	30.56	31.87	33.36	35.10	37.98	40.89	47.10
LN3	**	**	**	**	**	**	**
GM2	29.88	31.34	32.99	34.89	37.98	41.03	47.31
GM3	29.62	31.14	32.84	34.80	37.95	41.05	47.37
WB2	24.45	26.96	29.74	32.83	37.52	41.70	48.90
LP3	29.33	30.87	32.61	34.58	37.82	40.99	47.44
12 months							
NO2	29.77	31.90	34.22	36.81	40.81	44.57	51.74
LN2	33.47	34.87	36.46	38.32	41.38	44.48	51.06
LN3	**	**	**	**	**	**	**
GM2	32.67	34.23	36.00	38.03	41.33	44.59	51.29
GM3	35.12	36.16	37.41	38.92	41.56	44.38	50.74
WB2	26.65	29.37	32.38	35.73	40.80	45.32	53.11
LP3	33.72	35.07	36.62	38.40	41.42	44.46	51.00

TABLE C-7. Rainfall Drought Frequency for Lee County.

Duration*	Probability of Drought Frequency (Rainfall in inches)						
	.005	.01	.02	.04	0.10	0.20	0.50
1 month							
NO2	0.00	0.00	0.00	0.00	0.00	0.13	0.47
LN2	0.01	0.03	0.04	0.06	0.09	0.14	0.33
LN3	0.00	0.00	0.01	0.04	0.10	0.17	0.38
GM2	0.00	0.01	0.02	0.04	0.09	0.16	0.38
GM3	0.15	0.16	0.17	0.17	0.17	0.19	0.32
WB2	0.01	0.02	0.04	0.07	0.16	0.30	0.81
LP3	0.05	0.06	0.07	0.09	0.13	0.19	0.36
2 months							
NO2	0.00	0.00	0.00	0.00	0.32	0.90	2.01
LN2	0.26	0.31	0.38	0.47	0.65	0.89	1.62
LN3	0.00	0.00	0.10	0.29	0.61	0.97	1.81
GM2	0.13	0.19	0.28	0.40	0.64	0.94	1.75
GM3	0.15	0.20	0.28	0.40	0.64	0.93	1.74
WB2	0.07	0.11	0.18	0.28	0.51	0.83	1.72
LP3	0.16	0.21	0.29	0.40	0.63	0.93	1.76
3 months							
NO2	0.00	0.00	0.00	0.00	0.93	2.00	4.06
LN2	0.68	0.80	0.94	1.14	1.53	2.01	3.40
LN3	0.00	0.11	0.41	0.78	1.41	2.10	3.71
GM2	0.41	0.55	0.73	0.98	1.48	2.07	3.62
GM3	0.49	0.61	0.78	1.01	1.48	2.05	3.58
WB2	0.20	0.31	0.46	0.69	1.20	1.86	3.61
LP3	0.53	0.66	0.82	1.04	1.49	2.04	3.55
4 months							
NO2	0.00	0.00	0.00	0.72	2.30	3.78	6.62
LN2	1.49	1.70	1.96	2.30	2.95	3.73	5.82
LN3	0.69	1.05	1.47	1.99	2.89	3.86	6.13
GM2	1.08	1.34	1.67	2.10	2.91	3.83	6.09
GM3	1.47	1.66	1.92	2.26	2.95	3.79	5.97
WB2	0.57	0.80	1.12	1.57	2.49	3.59	6.22
LP3	1.16	1.40	1.71	2.11	2.89	3.79	6.08
5 months							
NO2	0.00	0.00	0.00	0.00	2.57	5.00	9.63
LN2	2.06	2.36	2.73	3.22	4.16	5.28	8.35
LN3	1.58	1.96	2.43	3.03	4.12	5.37	8.56
GM2	1.36	1.73	2.21	2.83	4.00	5.37	8.78
GM3	1.75	2.04	2.43	2.96	4.02	5.30	8.65
WB2	0.57	0.84	1.24	1.83	3.09	4.67	8.73
LP3	1.91	2.22	2.62	3.13	4.13	5.31	8.46
6 months							
NO2	0.00	0.00	0.42	2.14	4.79	7.27	12.03
LN2	3.47	3.88	4.38	5.01	6.17	7.50	10.91
LN3	3.09	3.56	4.13	4.84	6.11	7.54	11.04
GM2	2.66	3.17	3.79	4.58	5.99	7.56	11.28
GM3	4.47	4.61	4.85	5.21	6.05	7.21	10.63
WB2	1.30	1.77	2.41	3.29	5.01	6.98	11.54
LP3	3.66	4.04	4.51	5.10	6.21	7.48	10.80

TABLE C-7. Rainfall Drought Frequency for Lee County (Continued).

Duration*	Probability of Drought Frequency (Rainfall in inches)						
	.005	.01	.02	.04	0.10	0.20	0.50
7 months							
NO2	0.23	1.81	3.54	5.46	8.43	11.22	16.55
LN2	5.80	6.38	7.07	7.93	9.48	11.21	15.44
LN3	5.16	5.86	6.68	7.68	9.42	11.29	15.65
GM2	4.93	5.64	6.50	7.54	9.37	11.33	15.81
GM3	6.70	7.08	7.59	8.27	9.61	11.22	15.38
WB2	2.89	3.70	4.73	6.06	8.47	11.03	16.45
LP3	5.52	6.14	6.88	7.79	9.43	11.24	15.57
8 months							
NO2	7.48	9.21	11.12	13.23	16.50	19.58	25.44
LN2	12.08	12.93	13.94	15.15	17.24	19.46	24.53
LN3	11.50	12.47	13.60	14.94	17.19	19.53	24.70
GM2	11.22	12.24	13.42	14.82	17.17	19.59	24.84
GM3	11.61	12.54	13.64	14.95	17.20	19.55	24.74
WB2	7.84	9.29	11.01	13.06	16.45	19.75	26.01
LP3	11.44	12.40	13.53	14.85	17.14	19.52	24.77
9 months							
NO2	15.38	17.21	19.20	21.41	24.84	28.06	34.21
LN2	19.45	20.50	21.71	23.15	25.55	28.03	33.47
LN3	**	**	**	**	**	**	**
GM2	18.62	19.83	21.21	22.82	25.46	28.13	33.72
GM3	19.59	20.60	21.77	23.18	25.56	28.05	33.50
WB2	14.12	16.07	18.29	20.85	24.86	28.57	35.26
LP3	19.63	20.65	21.83	23.21	25.58	28.02	33.42
10 months							
NO2	23.72	25.52	27.48	29.67	33.06	36.23	42.30
LN2	26.72	27.89	29.24	30.81	33.41	36.05	41.70
LN3	**	**	**	**	**	**	**
GM2	26.10	27.42	28.91	30.63	33.42	36.19	41.90
GM3	25.65	27.06	28.65	30.47	33.38	36.23	42.00
WB2	21.23	23.49	26.00	28.80	33.06	36.87	43.48
LP3	25.23	26.69	28.33	30.19	33.23	36.19	42.12
11 months							
NO2	29.00	30.99	33.16	35.58	39.31	42.82	49.52
LN2	32.28	33.61	35.12	36.87	39.77	42.70	48.90
LN3	**	**	**	**	**	**	**
GM2	31.60	33.08	34.74	36.66	39.76	42.82	49.11
GM3	31.57	33.05	34.72	36.64	39.75	42.82	49.12
WB2	26.10	28.69	31.56	34.73	39.52	43.77	51.08
LP3	31.32	32.83	34.53	36.46	39.65	42.77	49.16
12 months							
NO2	32.59	34.63	36.86	39.35	43.19	46.79	53.68
LN2	35.91	37.30	38.87	40.70	43.70	46.72	53.08
LN3	**	**	**	**	**	**	**
GM2	35.21	36.74	38.47	40.46	43.67	46.83	53.28
GM3	35.67	37.11	38.74	40.63	43.72	46.79	53.19
WB2	29.33	32.08	35.09	38.42	43.41	47.81	55.33
LP3	35.75	37.17	38.78	40.61	43.68	46.73	53.13

TABLE C-8. Results of hypothesis test of good fit by Chi-square test at 95% level for each frequency distribution.

Duration*	1	2	3	4	5	6	7	8	9	10	11	12
Collier												
NO2	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LN2	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LN3	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GM2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GM3	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WB2	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
LP3	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hendry												
NO2	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LN2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LN3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
GM2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GM3	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
WB2	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LP3	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lee												
NO2	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LN2	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LN3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
GM2	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GM3	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
WB2	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
LP3	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

***NOTE FOR TABLES C-5 THROUGH C-8:**

NO2	Normal Distribution
LN2	Two-Parameter Lognormal Distribution
LN3	Three-Parameter Lognormal Distribution
GM2	Two-Parameter Gamma Distribution
GM3	Three-Parameter Gamma Distribution
WB2	Weibull Distribution
LP3	Logpearson Type 3 Distribution

APPENDIX D

Ground Water Resources Graphics

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Table D-1. Temporal and Physical Relationship Between Major Aquifer Systems in the Lower West Coast Planning Area D-1

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AGE ESTIMATES OF BOUNDARIES (MYBP)	SERIES	STRATIGRAPHIC UNITS		HYDROGEOLOGIC UNITS		TRANS-MISSIVITY
0.01	Recent	Undifferentiated Deposits		Surficial Aquifer System	Water Table Aquifer	Figure D-1
	Pleistocene				Confining Beds	NA
3.2	Pliocene	Tamiami Formation			Lower Tamiami Aquifer	Figure D-2
5.0	Miocene	Hawthorn Group	Miocene Coarse Clastics	Intermediate Aquifer System	Upper Hawthorn Confining Zone	NA
			Peace River Formation		Sandstone Aquifer	Figure D-3
					Mid-Hawthorn Confining Zone	NA
			Arcadia Formation		Mid-Hawthorn Aquifer	Figure D-4
					Lower Hawthorn Confining Zone	NA
			Tampa Member	Floridan Aquifer System	Lower Hawthorn Aquifer/Tampa Producing Zone	NA
25.0	Oligocene	Suwannee Limestone			Confining Beds	
					Suwannee Aquifer	
37.0	Upper Eocene	Ocala Group				
43.0	Middle Eocene	Avon Park Formation			Deeper Eocene Aquifer(s)	NA
52.0						

NA = Either the unit is a confining zone, or insufficient data was available.
MYBP – Million years before present.

Dates are referenced to Decade of North American Geology Geologic Time Scale (Geology, 9-83).

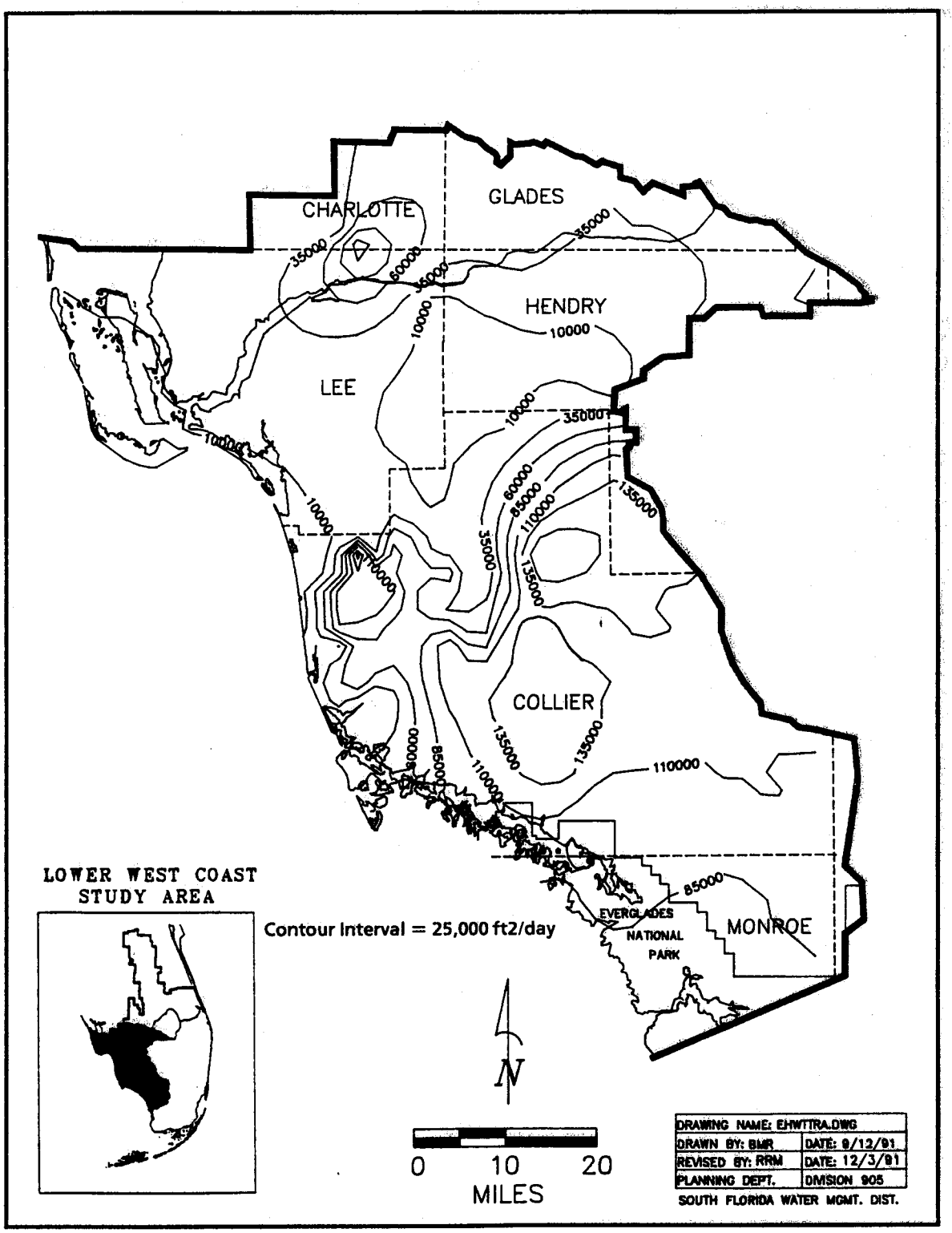


FIGURE D-1. Transmissivity of the Water Table Aquifer (ft^2/day).

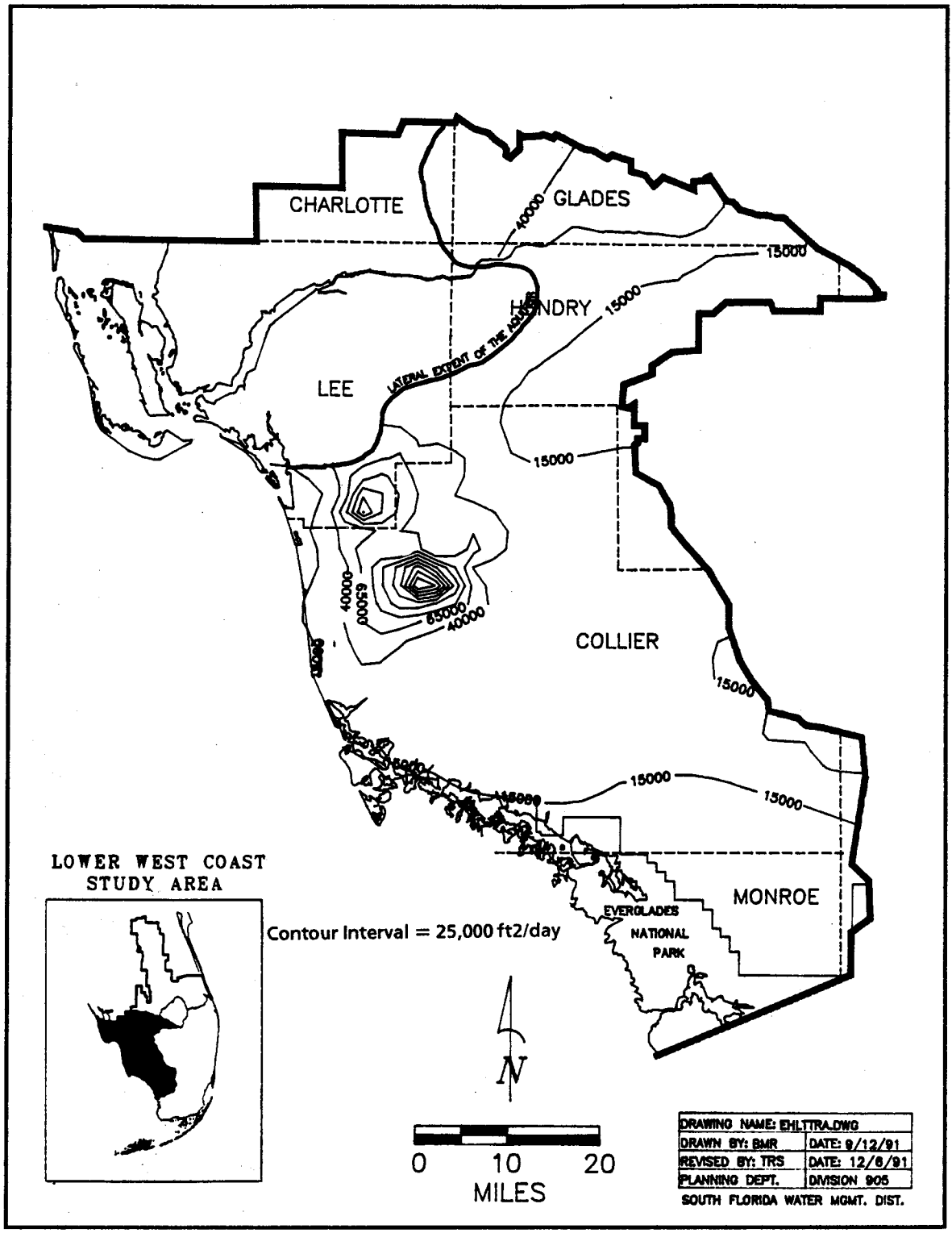


FIGURE D-2. Transmissivity of the Lower Tamiami Aquifer (ft^2/day).

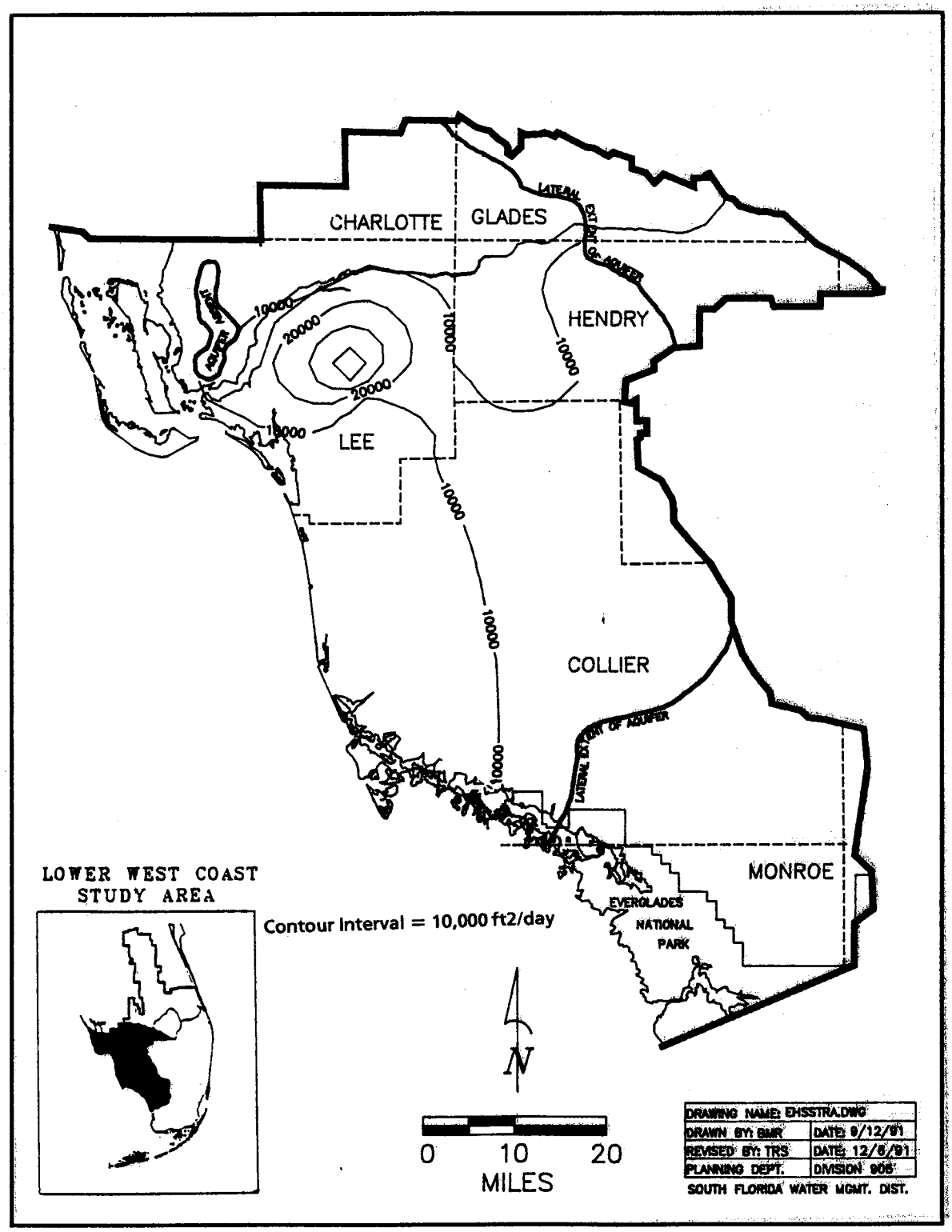


FIGURE D-3. Transmissivity of the Sandstone Aquifer (ft^2/day).

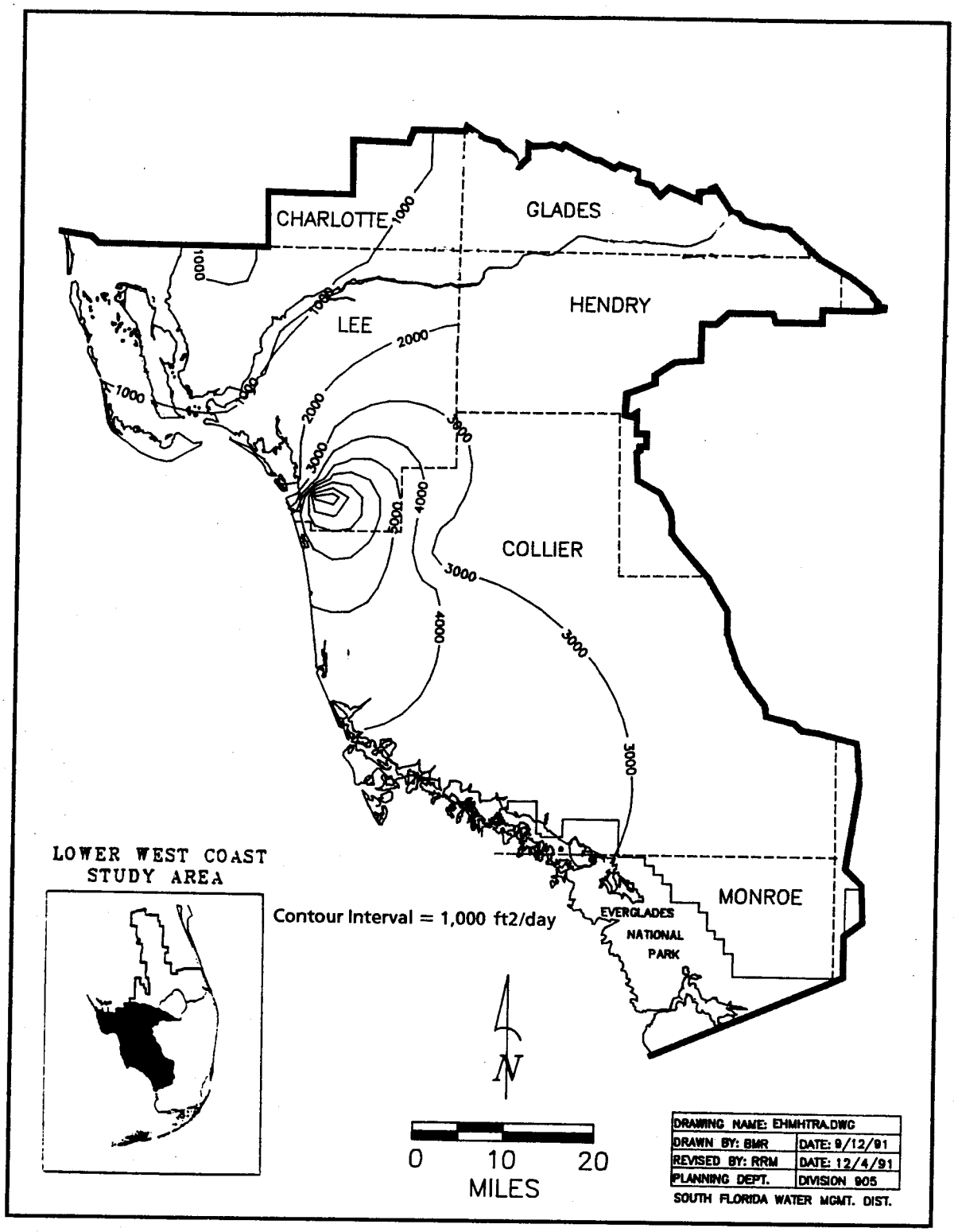


FIGURE D-4. Transmissivity of the Mid-Hawthorn Aquifer (ft^2/day).

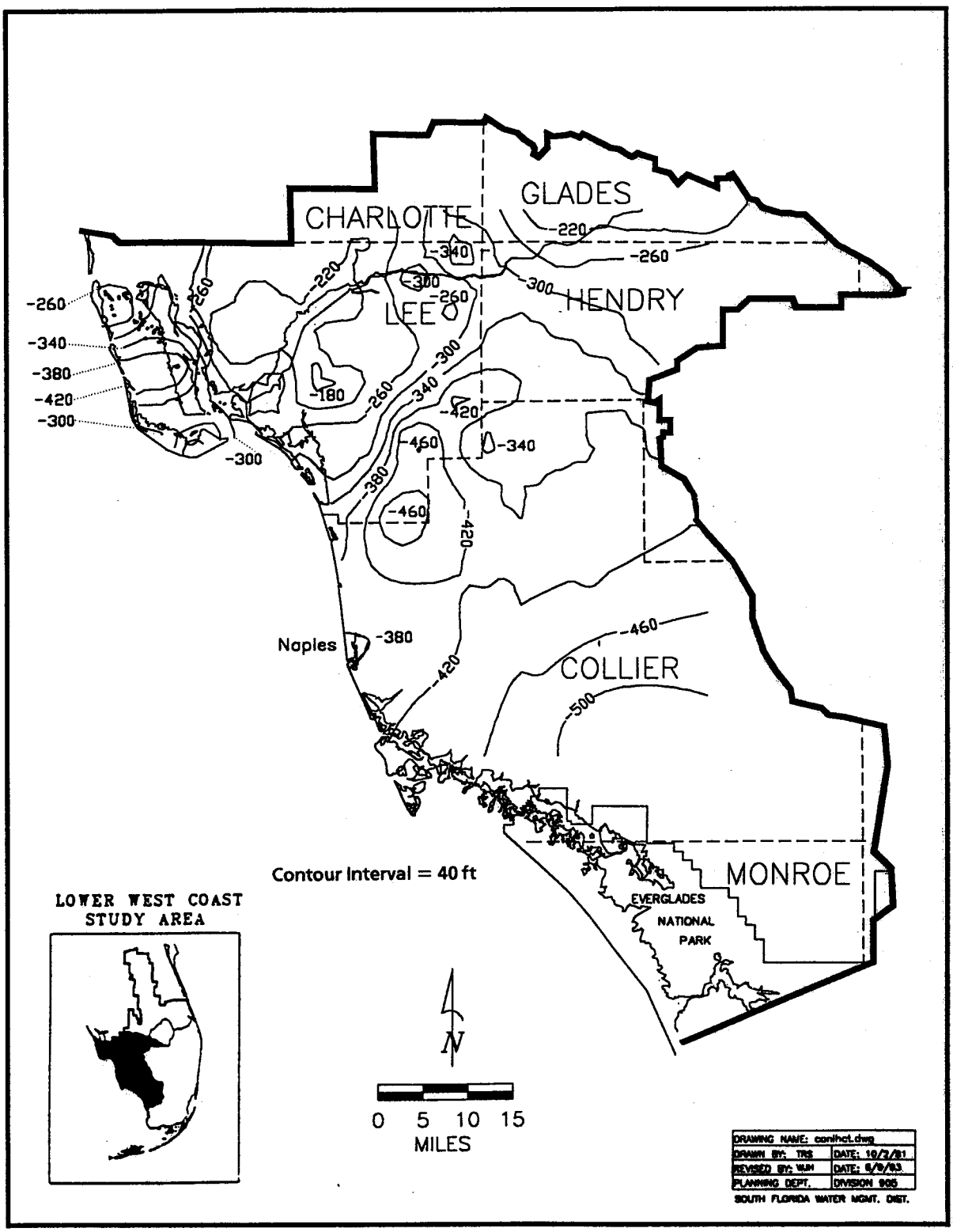


FIGURE D-5. Elevation (in feet, NGVD) of the Top of the Lower Hawthorn Confining Unit.

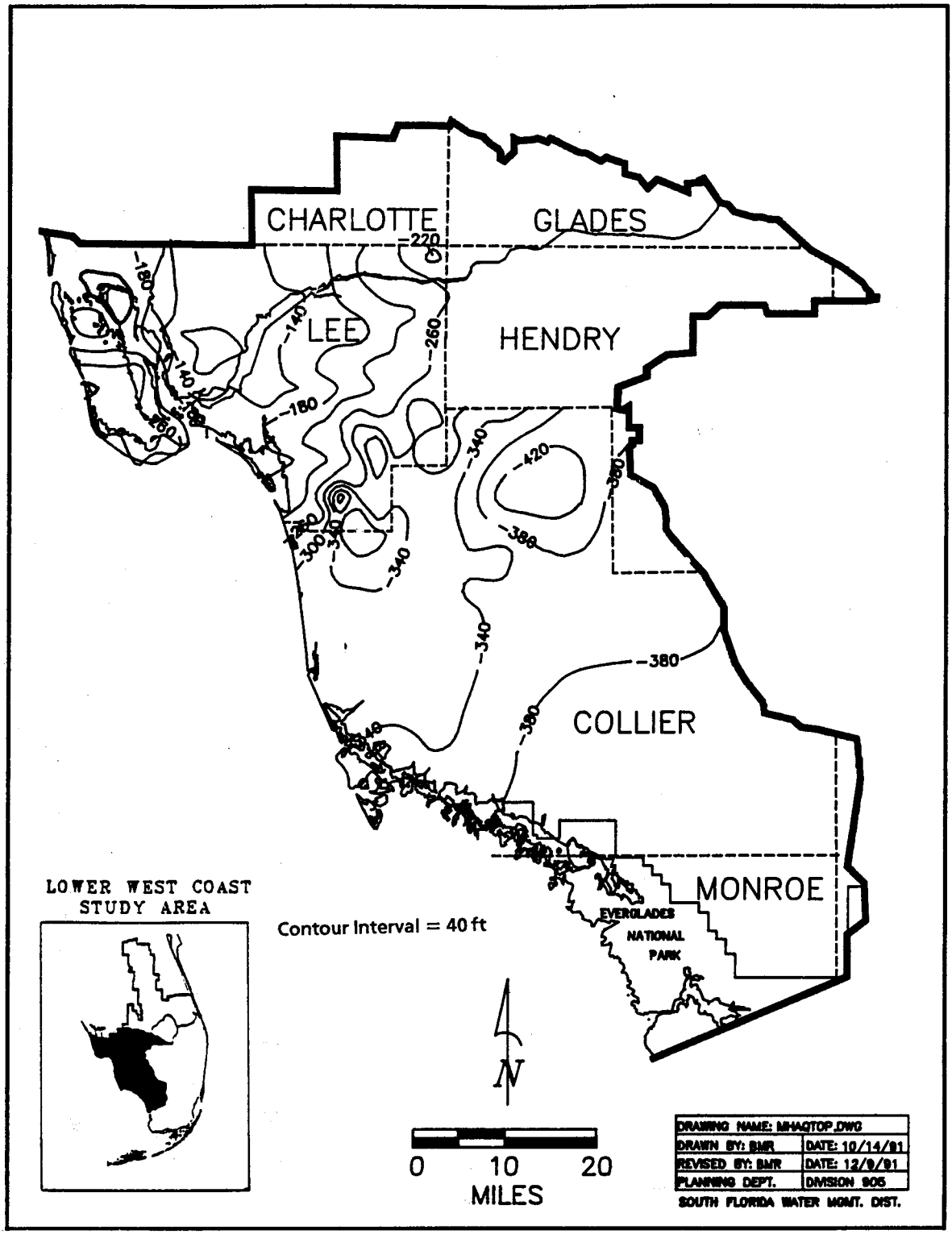


FIGURE D-6. Elevation (in feet, NGVD) of the Top of the Mid-Hawthorn Aquifer.

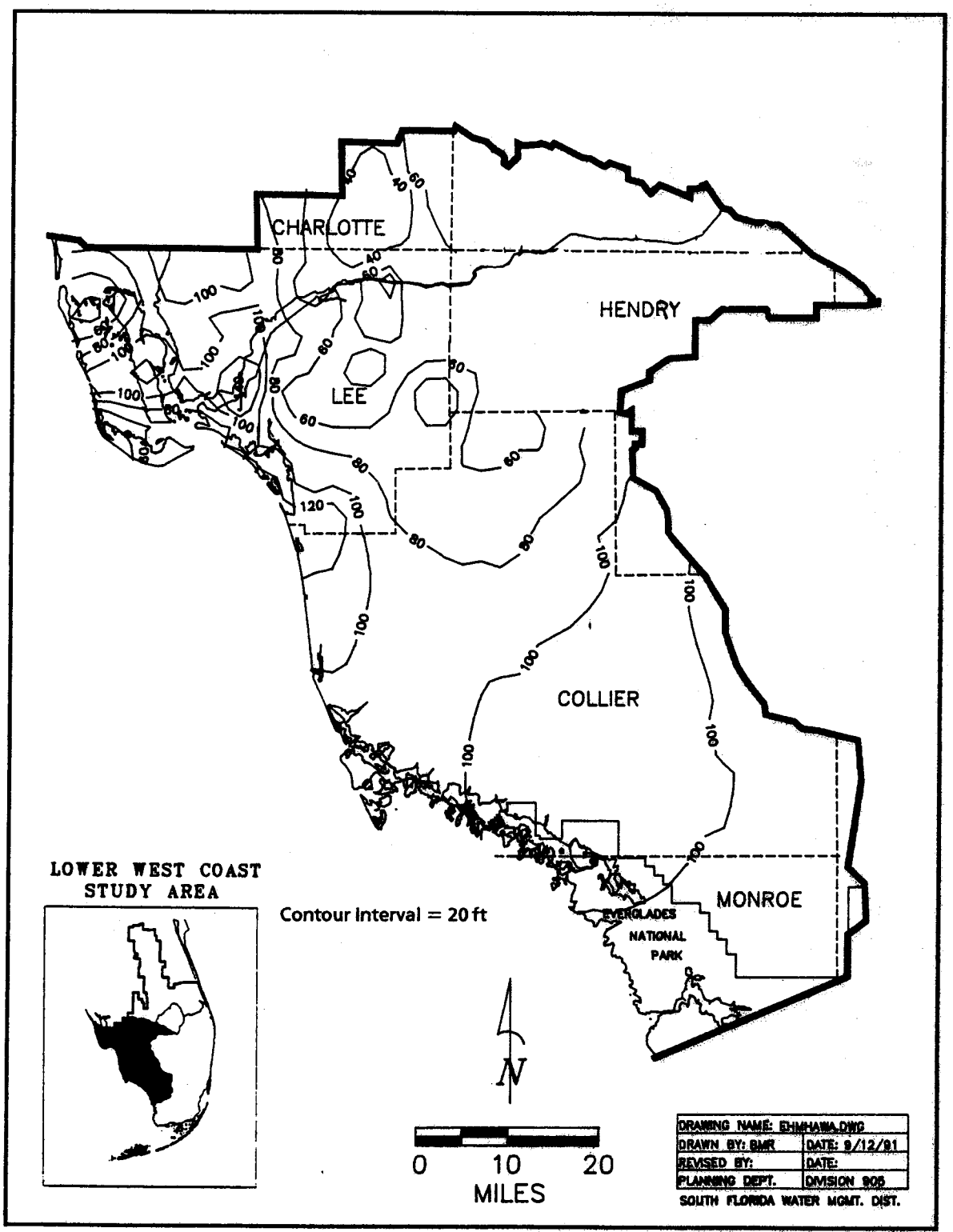


FIGURE D-7. Thickness (in feet) of the Mid-Hawthorn Aquifer.

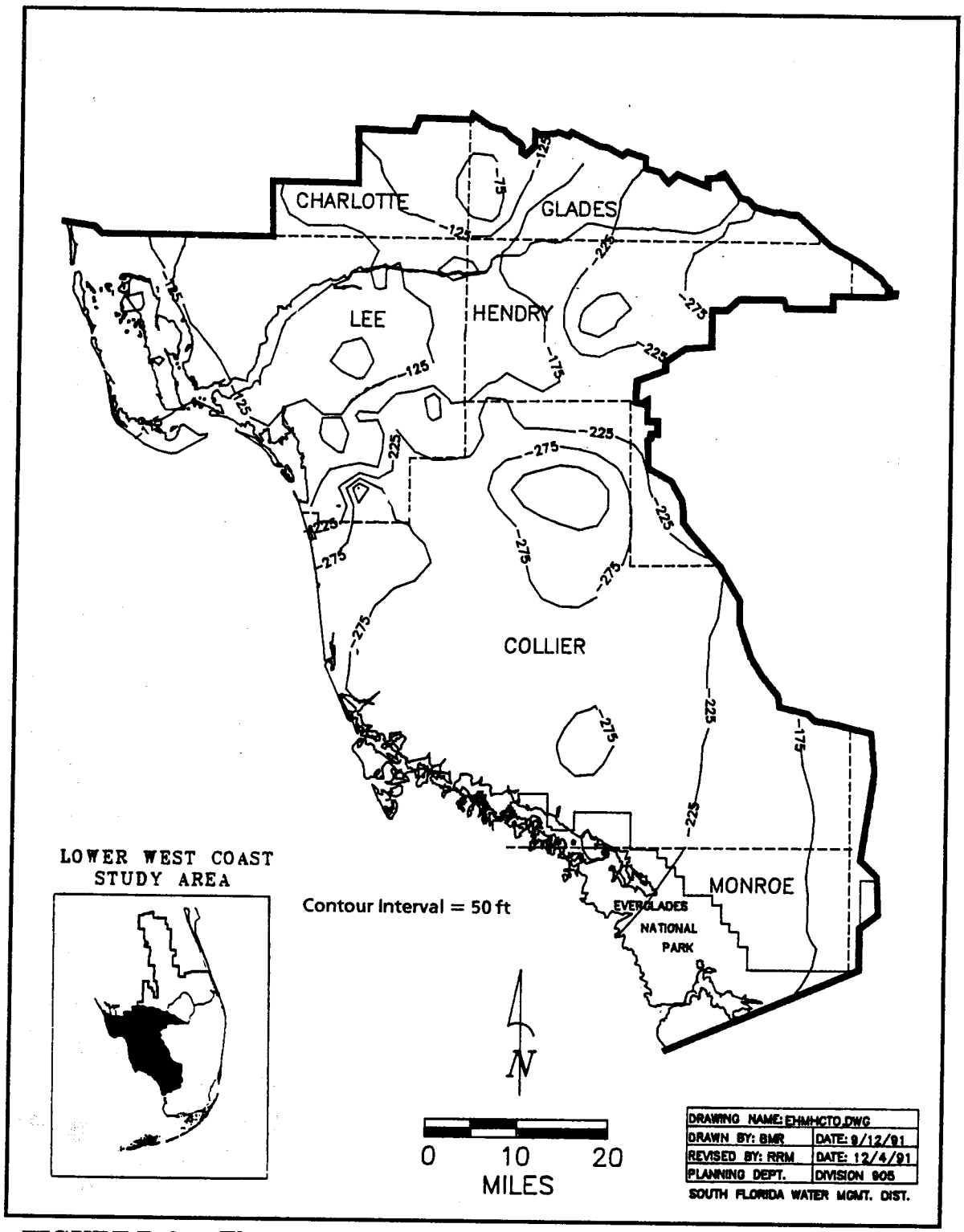


FIGURE D-8. Elevation (in feet, NGVD) of the Top of the Mid-Hawthorn Confining Unit.

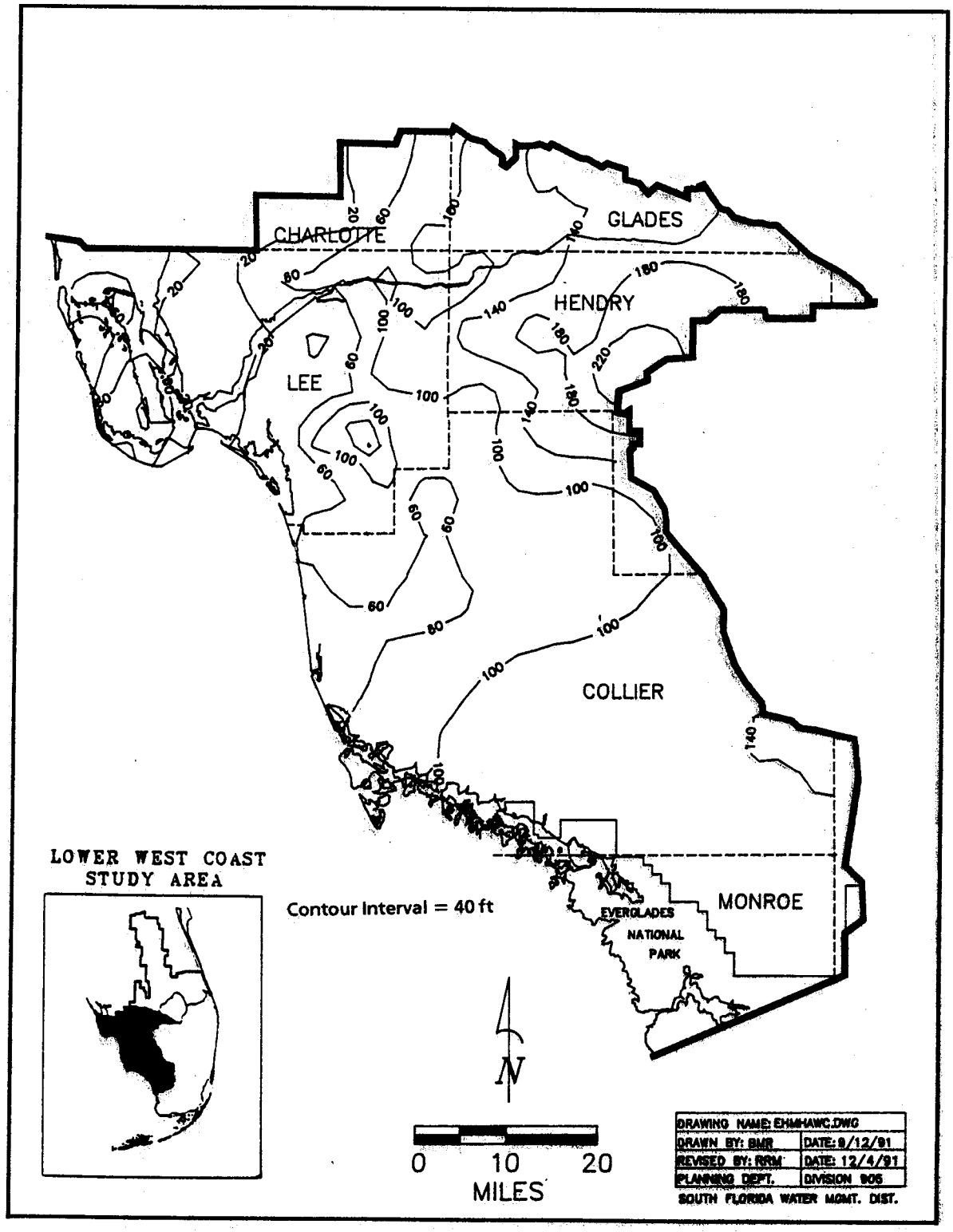


FIGURE D-9. Thickness (in feet) of the Mid-Hawthorn Confining Unit.

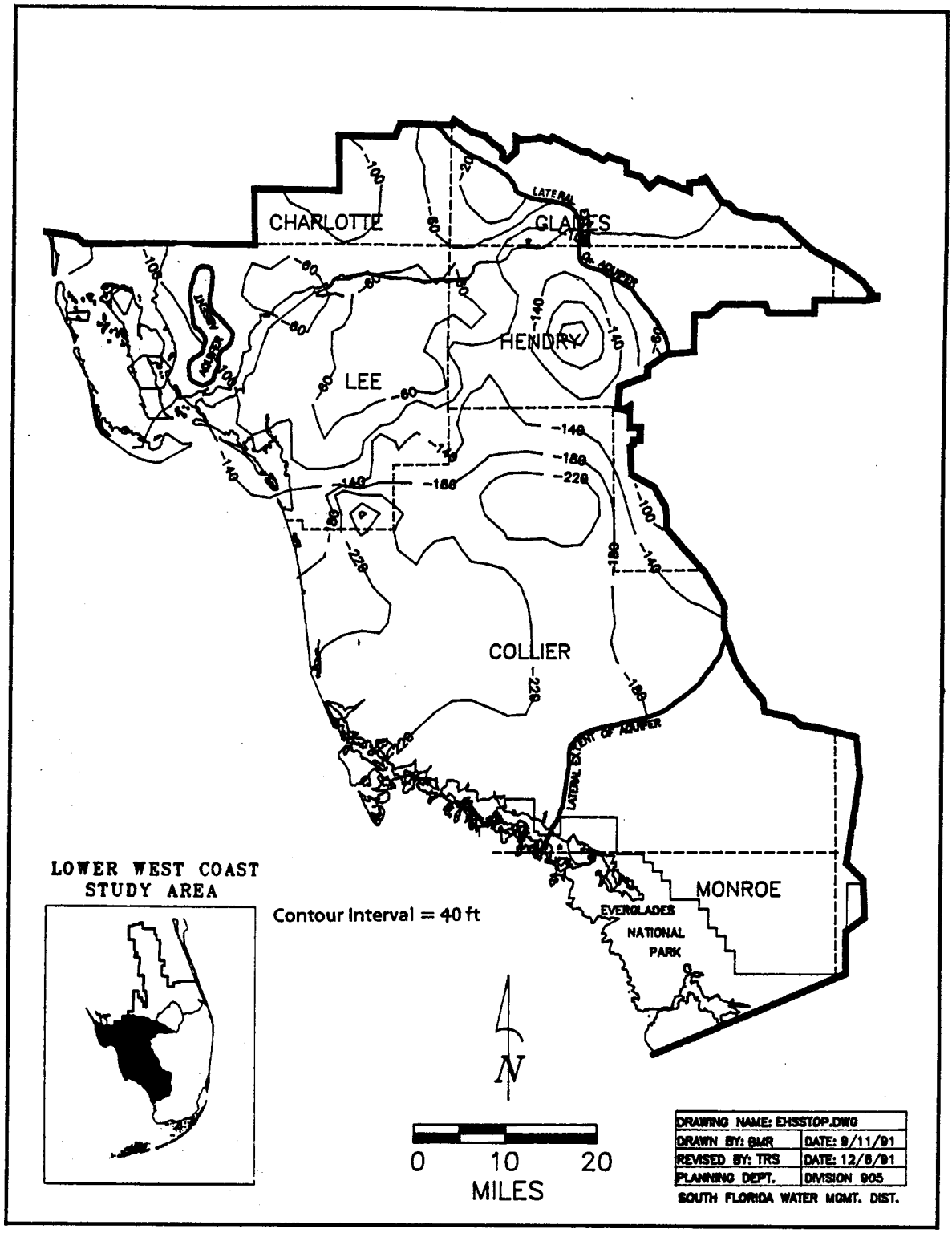


FIGURE D-10. Elevation (in feet, NGVD) of the Top of the Sandstone Aquifer.

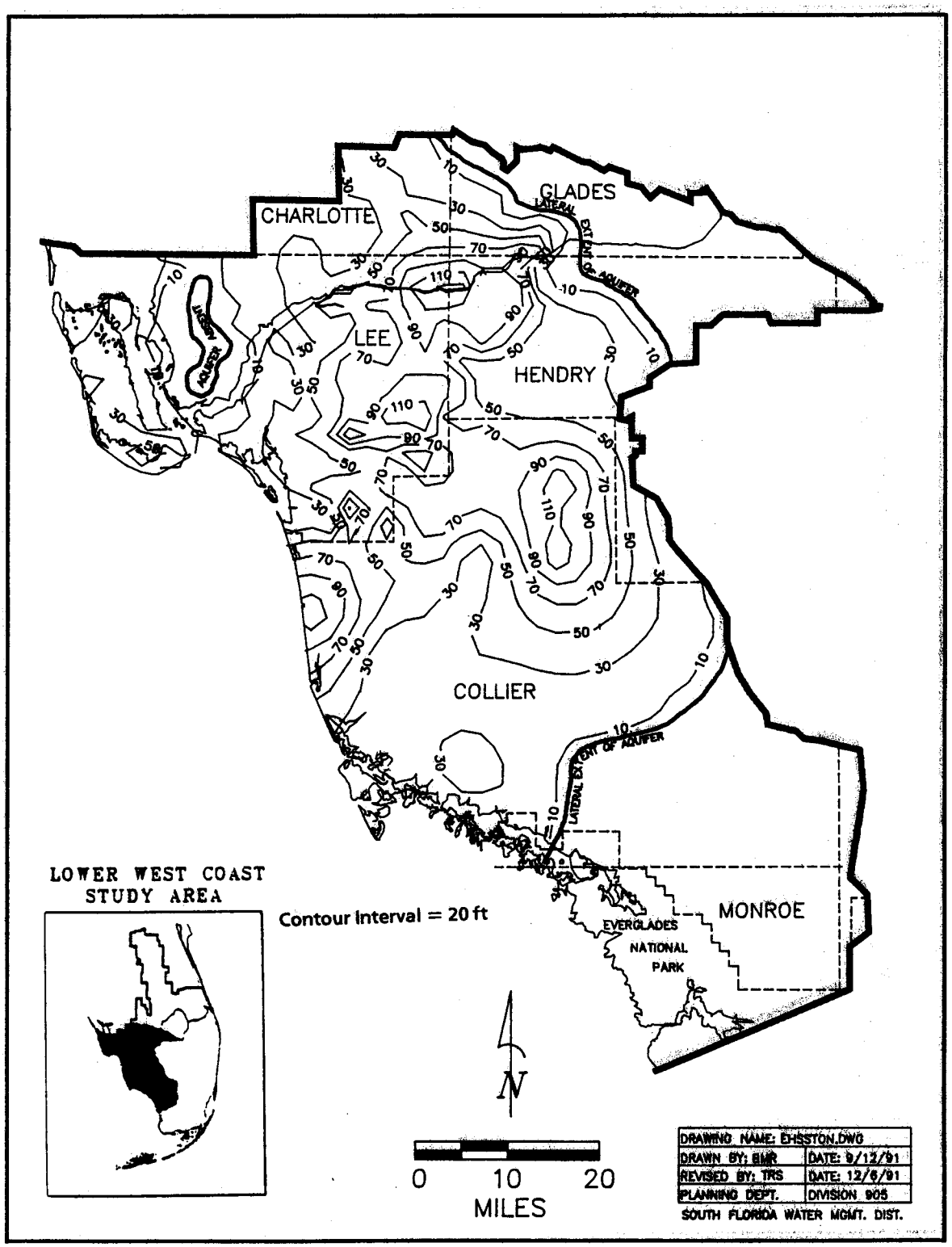


FIGURE D-11. Thickness (in feet) of the Sandstone Aquifer.

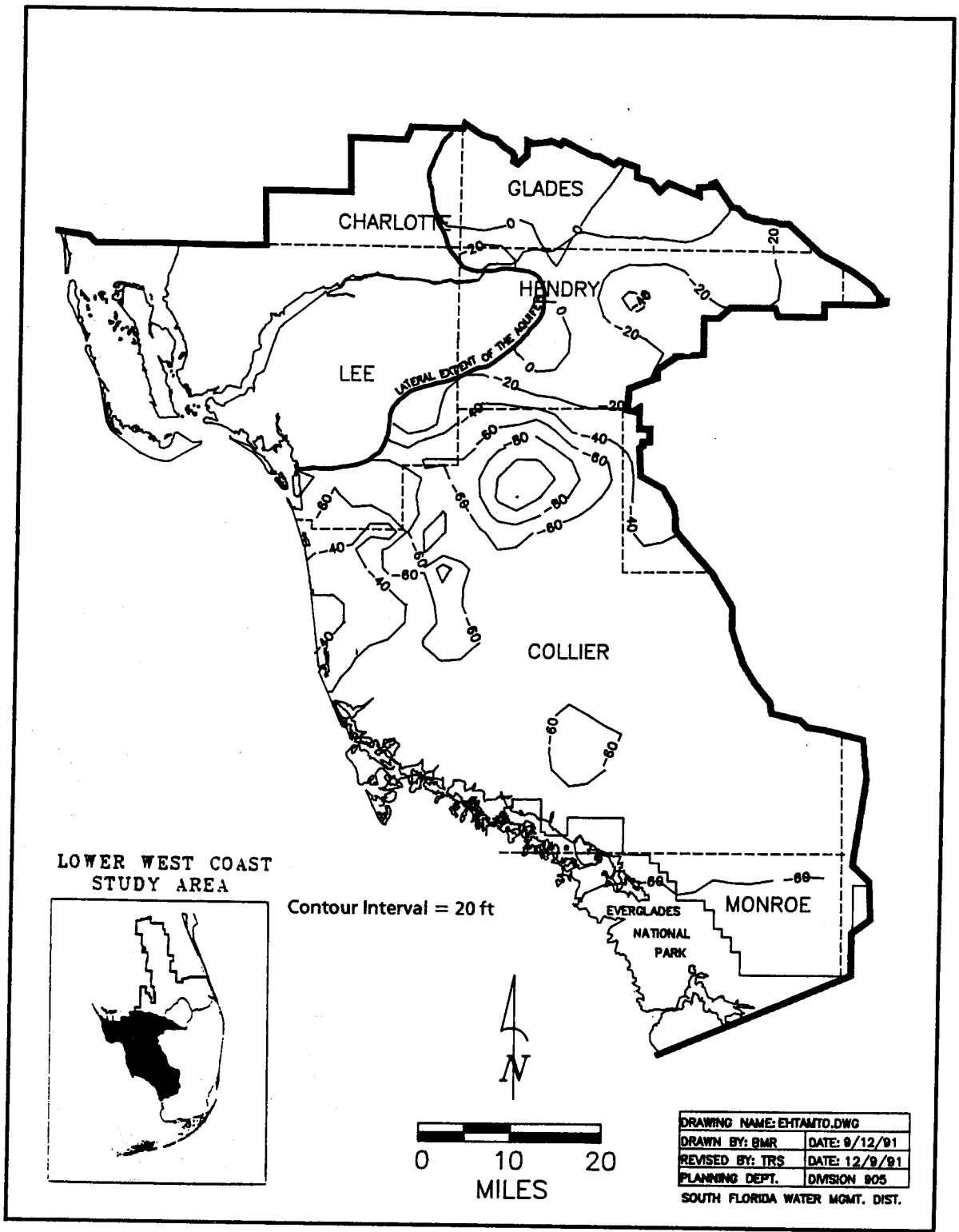


FIGURE D-12. Elevation (in feet, NGVD) of the Top of the Lower Tamiami Aquifer.

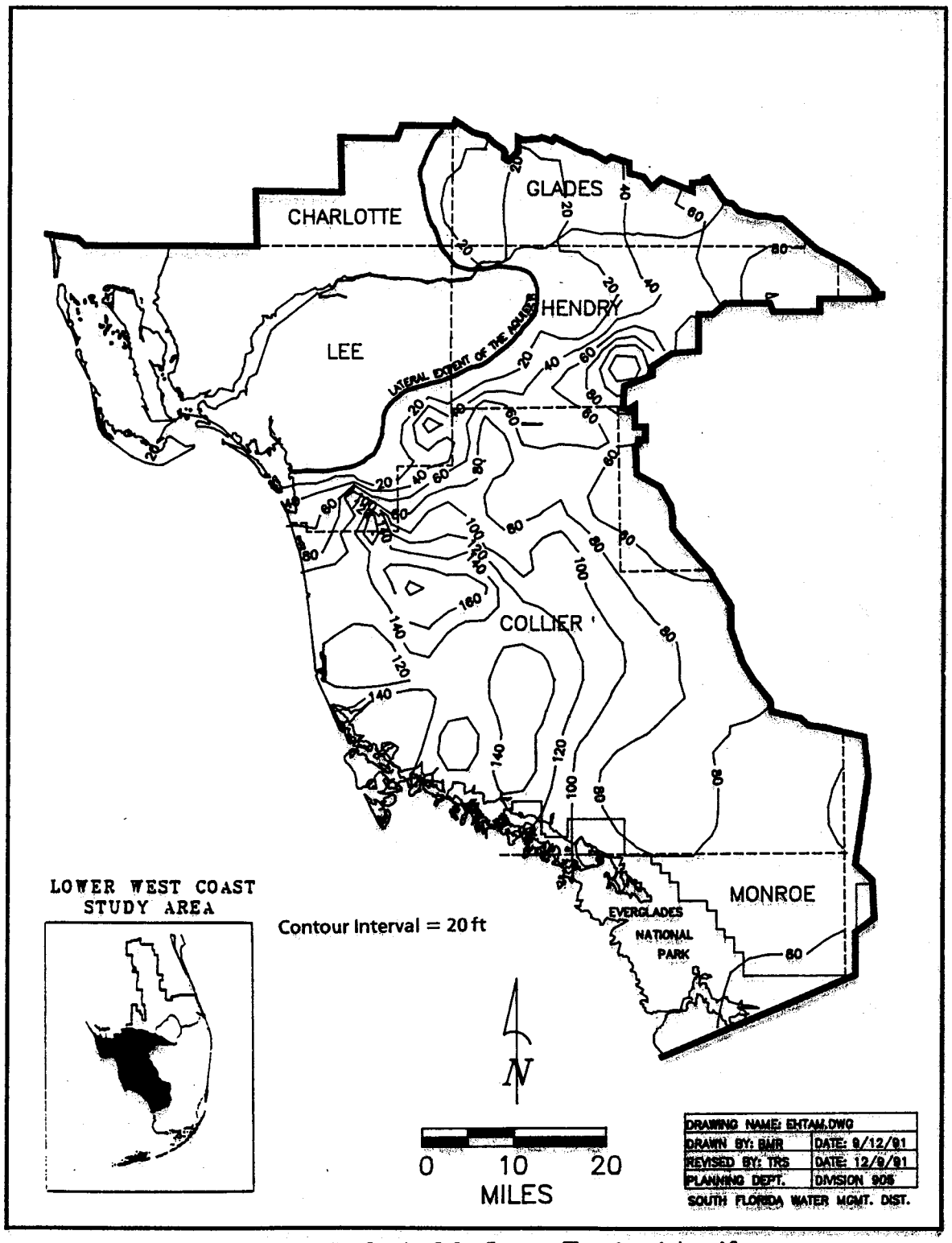


FIGURE D-13. Thickness (in feet) of the Lower Tamiami Aquifer.

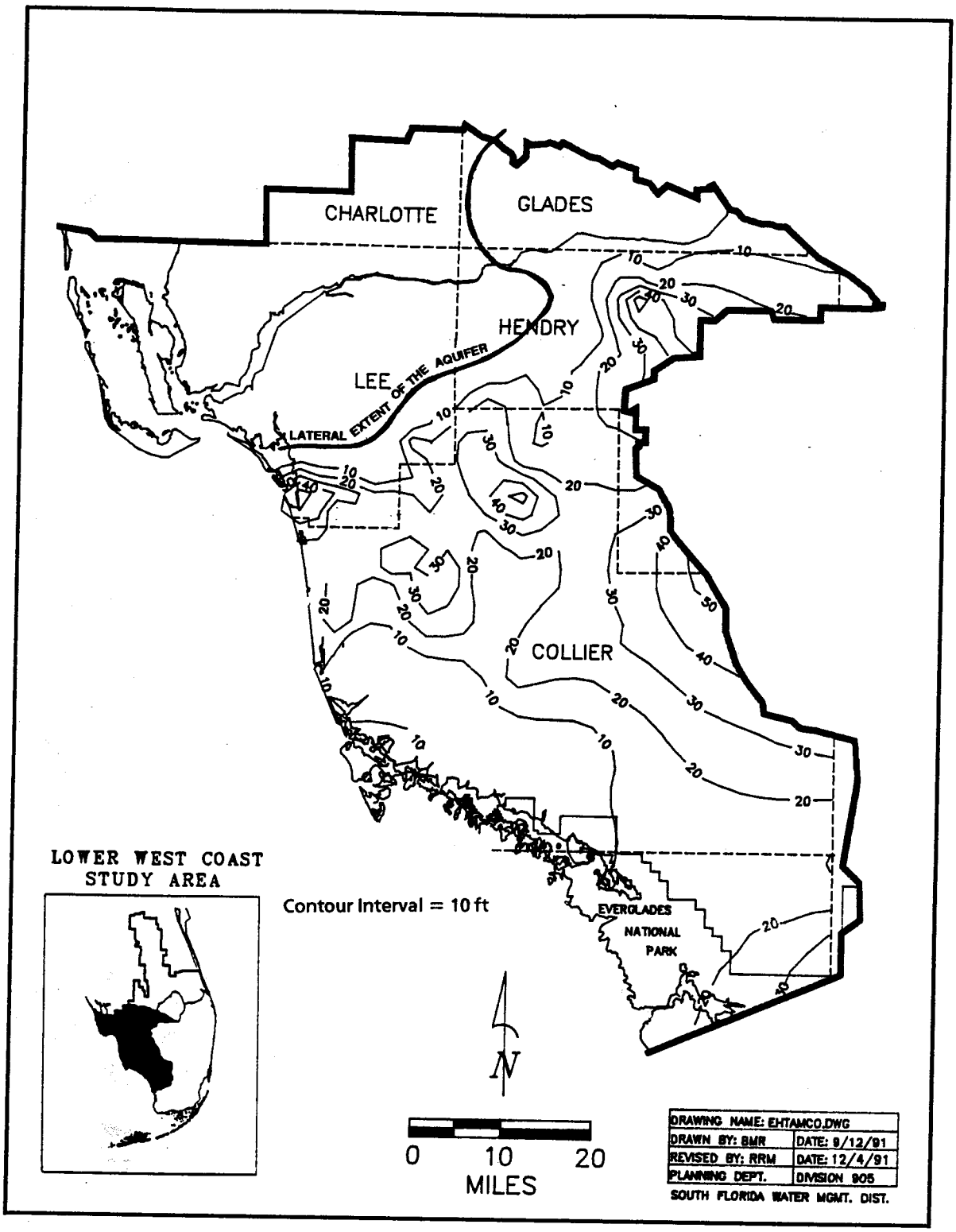


FIGURE D-14. Thickness (in feet) of the Lower Tamiami Confining Unit.

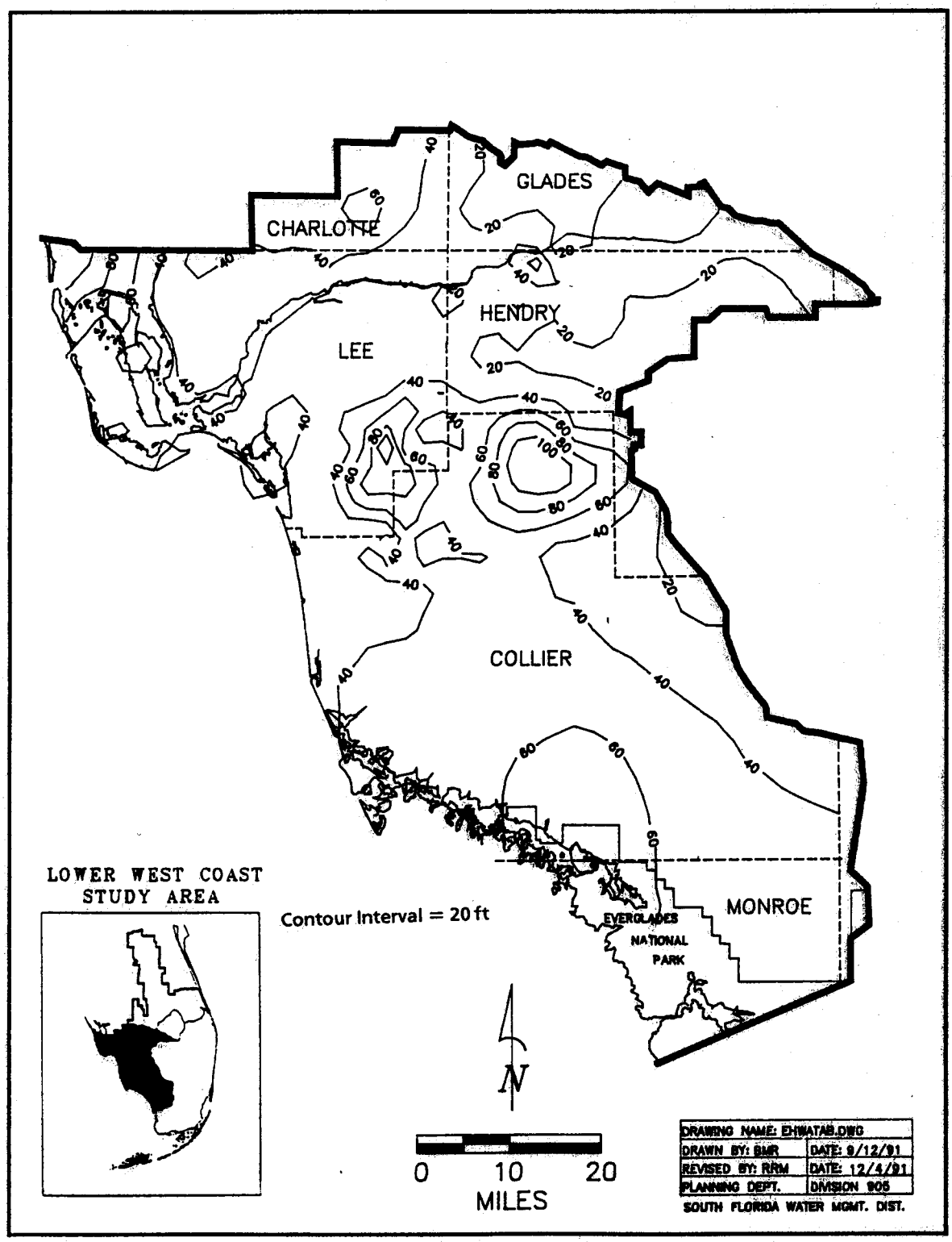


FIGURE D-15. Thickness (in feet) of the Water Table Aquifer.

APPENDIX E

Potable and Wastewater Treatment Facilities

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POTABLE WATER TREATMENT FACILITIES

Most potable water used in the Lower West Coast (LWC) Planning Area is processed by both large and small water treatment facilities. This section will focus on the larger and/or regional facilities because they are large enough to have an impact on the water resource. There are 29 existing large and/or regional facilities.

These water treatment facilities and proposed/future facilities are located mainly in the urbanized areas throughout the LWC Planning Area, as indicated on Figure E-1 and its corresponding key (Figure E-1a). More than half of the facilities are privately owned. Lime softening is utilized at 25 of the facilities, while membrane technology and/or electrodialysis is implemented at four of the facilities, and aeration only at one other. The total treatment capacity of these facilities is 135.99 million gallons per day (MGD), of which there was a 1990 average annual demand of 79.61 MGD. Key information for each utility is summarized in Table E-1.

Summary descriptions for each of the water treatment facilities located in the LWC Planning Area, are presented in this section. Each utility capsule contains the following information:

Raw Water Supply - This section states the SFWMD permit number with the issue and expiration dates, a summary of withdrawal facilities, and the SFWMD approved allocations. All well depths are measured from land surface.

Treatment Method - This section presents the Florida Department of Environmental Regulation (FDER) rated capacity, the method of treatment, the location of the treatment plant, and the 1990 average daily flow. The concentrate/brine reject disposal method, if a membrane or electrodialysis (ED) technology is used for treatment, is also provided.

In July 1993, the FDER was merged with the Florida Department of Natural Resources (FDNR) to form the Florida Department of Environmental Protection (FDEP). However, this appendix refers to the FDER because most of the utility data was collected prior to the merger.

Interconnections - This section describes water distribution system interconnections with other potable water distribution systems.

Proposed - This section states any current construction or permitting that is underway.

Future - This section presents projected utility flows (as provided by the utility) and known future treatment plant expansions and plans, including additional facilities and wellfields.

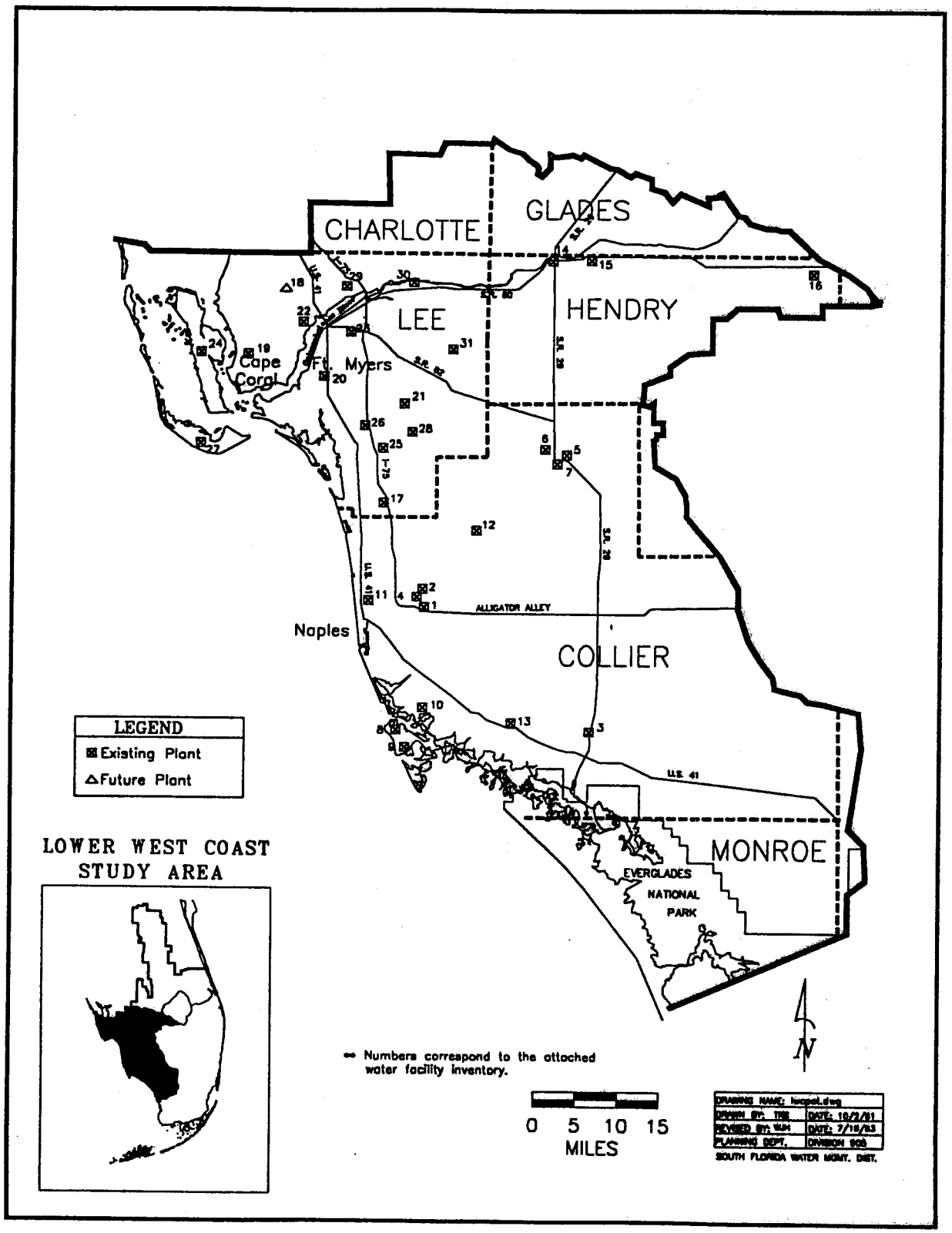


FIGURE E-1. Potable Water Treatment Facilities in the LWC Planning Area.

Lower West Coast Potable Water Treatment Plants

Map Number	Facility
Collier County	
1	Collier County Utilities (Golden Gate)
2	Collier County Utilities (North Naples)
3	Everglades City
4	Florida Cities Golden Gate
5	Immokalee Airport
6	Immokalee Carson Road
7	Immokalee Main
8	Marco Island (Lime softening facility)
9	Marco Island (RO facility - Unit 25 site)
10	Marco Shores
11	Naples
12	Orangetree
13	Port of the Islands
Hendry County	
14	La Belle
15	Port La Belle
16	U.S. Sugar
Lee County	
17	Bonita Springs
18	Cape Coral North
19	Cape Coral South
20	Florida Cities College Parkway
21	Florida Cities Green Meadows
22	Florida Cities Waterway
23	Fort Myers (Arcadia Street)
24	Greater Pine Island
25	Gulf Utility Corkscrew
26	Gulf Utility San Carlos
27	Island Water Association
28	Lee County Corkscrew
29	Lee County North
30	Lee County Olga
31	Lehigh Utilities

FIGURE E-1a. Key to Potable Water Treatment Facilities Map.

TABLE E-1. Potable Water Treatment Facilities in the LWC Planning Area.

Facility	FDER Rated Capacity (MGD)	1990 Average Daily Flow (MGD)	Method of Treatment			SFWMD Permit Number	Approved Annual Allocation (MGD)	Raw Water Source					
			Lime Softening	Membrane and ED Technology	Aeration			Water Table	Lower Tamiami	Sand-stone	Mid-Hawthorn	Floridan	Surface Water
Collier County													
Collier County Util.	24.00	10.18	X	X		11-00249-W	18.80		X				
Everglades City	0.86	0.10	X			11-00160-W	0.12	X					
FL Cities Golden Gate	1.22	0.86	X			11-00148-W	1.68	X					
Immokalee		2.50				11-00013-W	3.13						
Main WTP	1.25	b	X				a		X	X			
Carson Road	0.75	b	X				a		X				
Airport WTP	1.00	b	X				a		X				
Marco Island Util.	8.00	5.45	X	X		11-00080-W	7.00					X	X
Marco Shores	0.72	0.13	X			11-00080-W	a						X
Naples	30.00	17.35	X			11-00017-W	16.46		X				
North Naples	0.75	0.15	X			11-00193-W	0.95	X					
Orangetree Utilities	0.43	0.01	X			11-00419-W	0.44		X				
Port of the Islands	0.39	0.14	X			11-00271-W	0.29				X		
Hendry County													
Labelle	1.50	0.53	X			26-00105-W	0.70	X					
Port Labelle	0.50	0.18	X			26-00096-W	0.27			X			
US Sugar	6.00	2.85	X			26-00024-W	3.23						X
Lee County													
Bonita Springs	6.00	2.15	X			36-00008-W	3.35		X				
Cape Coral	14.00	8.44		X		36-00046-W	11.59					X	
FL Cities College Park	1.50	0.51	X			36-00150-W	9.17				X		
FL Cities Green Meadows	9.00	5.19	X			36-00150-W	a	X		X			
FL Cit Waterway	1.50	0.90	X			36-00152-W	1.28	X			X	X	
Fort Myers	12.00	6.22		X		36-00035-W	8.92	X					X
Greater Pine Island	1.50	0.88	X	X		36-00045-W	1.31				X	X	
Gulf Util Corkscrew	0.50	c		X		36-00122-W	2.37	X		X			
Gulf Util San Carlos	2.50	1.46	X			36-00122-W	a	X					
Island Water Assoc	4.70	3.00		X		36-00034-W	4.08					X	
Lee County Corkscrew	10.00	5.56	X			36-00003-W	10.00	X		X			
Lee County North	0.20	0.00			X	36-00178-W	0.20			X	X		
Lee County Olga	5.00	3.32	X			36-00003-W	3.42						X
Lehigh Utilities	2.50	1.55	X			36-00166-W	2.08			X			

a- Allocation is incorporated into previous permit reference.
b- 1990 average daily flow totaled for Immokalee.
c- Facility recently placed in operation.

COLLIER COUNTY

POTABLE WATER TREATMENT FACILITIES

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Collier CountyUtilities

SFWMD Permit Number: 11-00249-W
FDER PWS ID: 5114069

Raw Water Supply:
Raw water is withdrawn from 27 wells located in Golden Gate Estates along the Golden Gate Canal, between 7th Street and 2nd Street SE, and along Wilson Boulevard, between the Golden Gate Canal and 8th Avenue NE. The wells withdraw water from the lower Tamiami aquifer, are 12 and 16 inches in diameter, have total depths between 96 and 150 feet, and cased depths between 50 and 92 feet. The wells were drilled between 1983 and 1993. The wells have withdrawal capacities of 700 or a 1000 GPM. Specific well information is provided in Table E-2 and the location of the wells can be found in Figure E-2.

The current SFWMD permit was issued December 12, 1991 and expires December 12, 1996. The approved allocations are:

Annual Allocation	6.86 BGY (18.80 MGD)
Maximum Daily Allocation	31.77 MGD

The majority of the service area is in the Collier County reduced threshold area.

Treatment Method:
Treatment consists of a 12 MGD lime softening facility and a 12 MGD membrane softening facility. The 12 MGD lime softening plant is located in the NE quadrant of the intersection of County Road 951 and I-75 (Figure E-2). Based on some improvements, the FDER had approved a temporary upgrade to 16 MGD, until the membrane softening plant became operational. The 1990 average daily flow for this facility was 10.18 MGD with a maximum day flow of 13.89 MGD.

The 12 MGD membrane softening plant, completed and operational in the summer of 1993, is located in the vicinity of the intersection of Vanderbilt Road and County Road 951. The source water is from the existing wellfield, and concentrate disposal is by deep well injection.

Interconnections:
The distribution system has interconnects with the City of Naples at Pelican Bay, at the intersection of County Road 951 and Airport Road (12 inch), and at a location off Rattlesnake Road in East Naples (12 inch).

Proposed:
An aquifer storage and recovery project located at their Manatee Road finished water pump station has been completed by Collier County and is indicated on Figure E-2. The project will inject treated water into the lower Hawthorn aquifer during low demand periods and will be recovered to augment supplies during periods of high demand. A second ASR well is planned to be located at the membrane softening facility.

Future:
It is anticipated 8 MGD of RO skids will be added to the membrane softening plant. Investigations are being conducted to identify potential saline ground water sources.

Source:
Information obtained from Collier County Utilities and SFWMD water use permit files.

TABLE E-2. Collier County Utilities Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Planar Coordinates	296720 E 684150 N	298020 E 684100 N	298987 E 684110 N	300500 E 683852 N	301927 E 683811 N	301241 E 684117 N	301238 E 685300 N	301242 E 686469 N	301201 E 687688 N	301192 E 688864 N	301230 E 689925 N	301187 E 691095 N	301210 E 692054 N	301194 E 693198 N
Status	Active	Active	Active	Active	Active	Standby	Standby	Standby	Active	Active	Active	Active	Active	Active
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	96	100	100	102	108	101	106	106	114	112	137	133	130	131
Cased Depth (ft)	50	50	51	52	50	65	65	70	65	71	90	90	84	85
Well Diameter (in)	16	16	16	16	16	12	12	12	12	12	12	12	12	12
Pump Capacity (GPM)	700	700	700	700	700	700	700	700	700	700	700	700	700	700
Intake Depth (NGVD)	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35
Year Drilled	1983	1983	1983	1983	1983	1987	1987	1987	1987	1987	1987	1987	1987	1987

TABLE E-2. (Continued).

Well Number	15	16	17	18	19	20	21	22	23	24	25	26	27
Planar Coordinates	301167 E 694102 N	301181 E 695091 N	303912 E 683875 N	305184 E 683839 N	307663 E 684366 N	307675 E 685586 N	301946 E 683010 N	301928 E 681865 N	301896 E 680723 N	301903 E 679820 N	301846 E 678787 N	302865 E 678538 N	304193 E 678570 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	130	150	128	126	128	131	110	101	111	109	110	106	105
Cased Depth (ft)	84	92	78	80	83	83	62	62	59	58	65	65	61
Well Diameter (in)	12	12	12	12	12	12	12	12	12	12	12	12	12
Pump Capacity (GPM)	700	700	1,000	1,000	1,000	1,000	700	700	700	700	700	700	700
Intake Depth (NGVD)	-35	-35	--	--	--	--	--	--	--	--	--	--	--
Year Drilled	1987	1986	1991	1991	1991	1991	1993	1993	1993	1993	1993	1993	1993

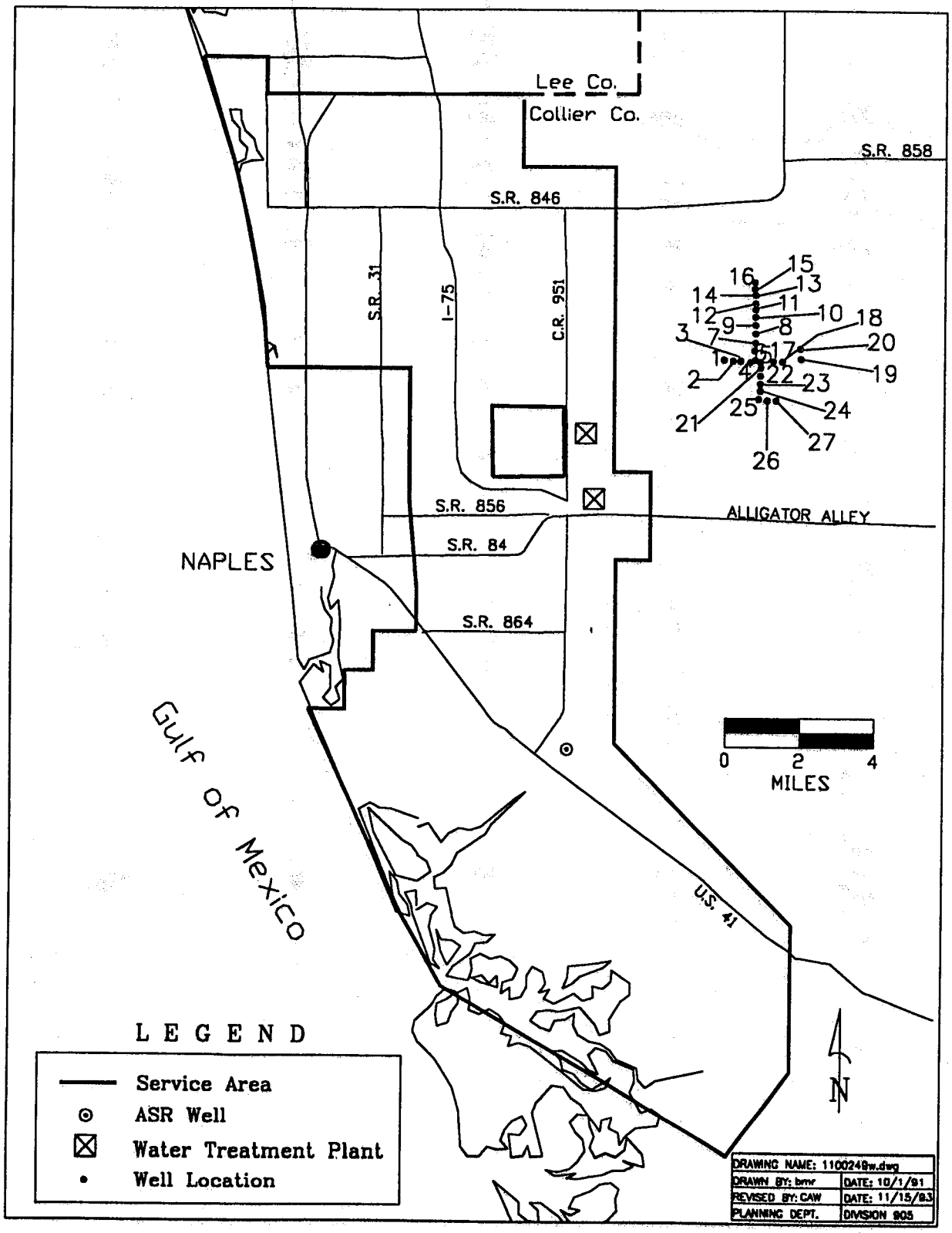


FIGURE E-2. Collier County Utilities Potable Water Supply Wells.

Everglades City

SFWMD Permit Number: 11-00160-W
FDER PWS ID: 5110089

Raw Water Supply:
Raw water is withdrawn from three wells located in Copeland. The wells, which were drilled in 1982, withdraw water from the water table aquifer. The wells have total depths of 25 feet and cased depths of 15 feet. The designed pumpage for each well is 200 GPM. Specific well information is provided in Table E-3 and the location of the wells can be found in Figure E-3.

The current SFWMD permit was issued September 10, 1992 and expires September 10, 2002. The approved allocations are:

Annual Allocation:	44.00 MGY (0.12 MGD)
Maximum Daily Allocation:	0.30 MGD

Treatment Method:
Treatment is provided by a 0.86 MGD aeration facility. The facility is located on Jane's Scenic Drive in Copeland (Figure E-3), from which the treated water is pumped approximately seven miles to Everglades City. The 1990 average day flow was 0.10 MGD.

Interconnections:
There are no distribution interconnections with other utilities.

Proposed:
N/A

Future:
The Everglades City Comprehensive Plan estimates that the average potable water demand in the year 2000 will be 0.10 MGD, based on a per capita flow of 163 GPD. The existing demand is at this projected flow.

It is anticipated the service area will be expanded to serve the Chokoloskee Island.

Source:
Information was obtained from Everglades City and SFWMD water use permit files.

TABLE E-3. Everglades City Potable Water Supply Wells.

Well Number	1	2	3
Planar Coordinates	381069 E 588666 N	380704 E 588667 N	380339 E 588668 N
Status	Active	Active	Active
Aquifer	Water Table	Water Table	Water Table
Total Depth (ft)	25	25	25
Cased Depth (ft)	15	15	15
Well Diameter (in)	8	8	8
Pump Capacity (GPM)	220	220	220
Intake Depth (NGVD)	-21	-21	-21
Year Drilled	1982	1982	1982

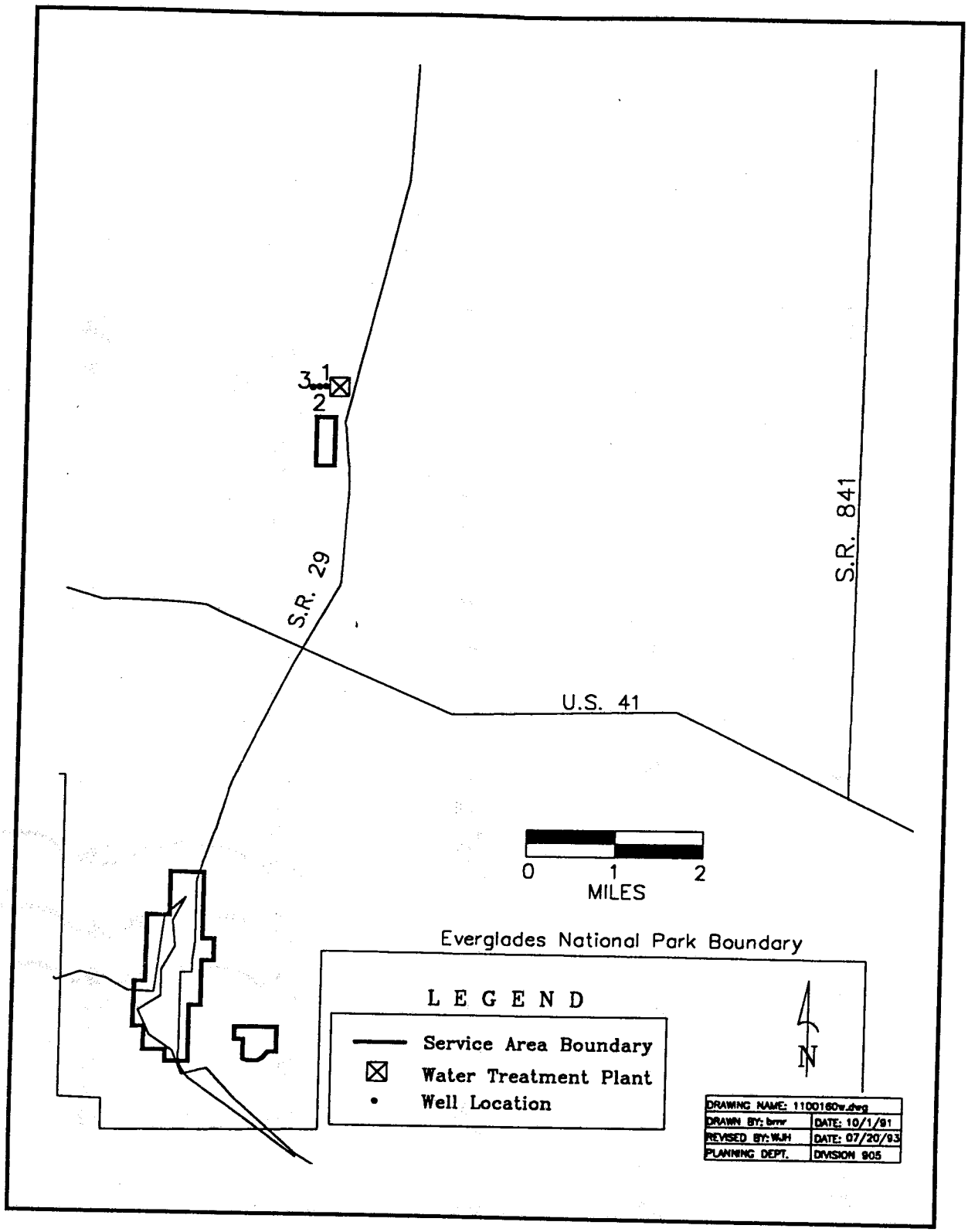


FIGURE E-3. Everglades City Potable Water Supply Wells.

Florida Cities Golden Gate Estates

SFWMD Permit Number: 11-00148-W
FDER PWS ID: 5110117

Raw Water Supply:
Raw water is withdrawn from six wells located in the water treatment facility area. The wells withdraw water from the water table aquifer, are eight inches in diameter, have total depths between 22 and 45 feet, and cased depths between 15 and 25 feet. The wells were drilled between 1964 and 1989 and have pumping capacities between 75 and 250 GPM. Specific well information is provided in Table E-4 and the location of the wells are identified in Figure E-4.

The current SFWMD permit was issued January 14, 1993 and expires January 14, 2003. The approved allocations are:

Annual Allocation (All sources)*:	614.00 MGY (1.68 MGD)**
Maximum Daily Allocation:	2.29 MGD**

* This includes sources listed in the proposed section below
** The permit divides the allocation into water table and lower Tamiami; for the purpose of this plan, withdrawals are from the water table aquifer.

Treatment Method:
Treatment is provided by a 1.22 MGD (FDER rated capacity) lime softening treatment facility. This facility is located at Treatment Plant Road off of 44th Street SW, Golden Gate (Figure E-4). The 1990 average daily flow was 0.86 MGD, and the maximum day flow was 1.10 MGD.

Interconnections:
There are no interconnections with other potable water distribution systems.

Proposed:
The current consumptive use permit allows construction of three additional water table wells in the vicinity of the existing wells. Specific well information on the proposed wells is located in Table E-4 and the location of the wells are identified in Figure E-4.

Future:
N/A

Source:
Information was obtained from Florida Cities Water Company and SFWMD water use permit files.

TABLE E-4. Florida Cities Golden Gate Potable Water Supply Wells.

Well Number	1	2	3	4	5	8	9	10	11
Planar Coordinates	274023 E 672142 N	272034 E 671957 N	272602 E 672102 N	272435 E 672105 N	272435 E 672324 N	272597 E 671749 N	273553 E 672955 N	273781 E 672955 N	273987 E 672955 N
Status	Active	Active	Active	Active	Active	Active	Proposed	Proposed	Proposed
Aquifer	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Total Depth (ft)	22	22	45	45	22	22	25	25	25
Cased Depth (ft)	15	17	25	25	15	15	15	15	15
Well Diameter (in)	8	8	8	8	8	8	8	8	8
Pump Capacity (GPM)	100	250	150	- 200	250	250	200	200	200
Intake Depth (NGVD)	-.8	-.9	-3.5	-3.4	-3.5	-3.5	---	---	---
Year Drilled	1964	1989	1967	1971	1982	1982	---	---	---

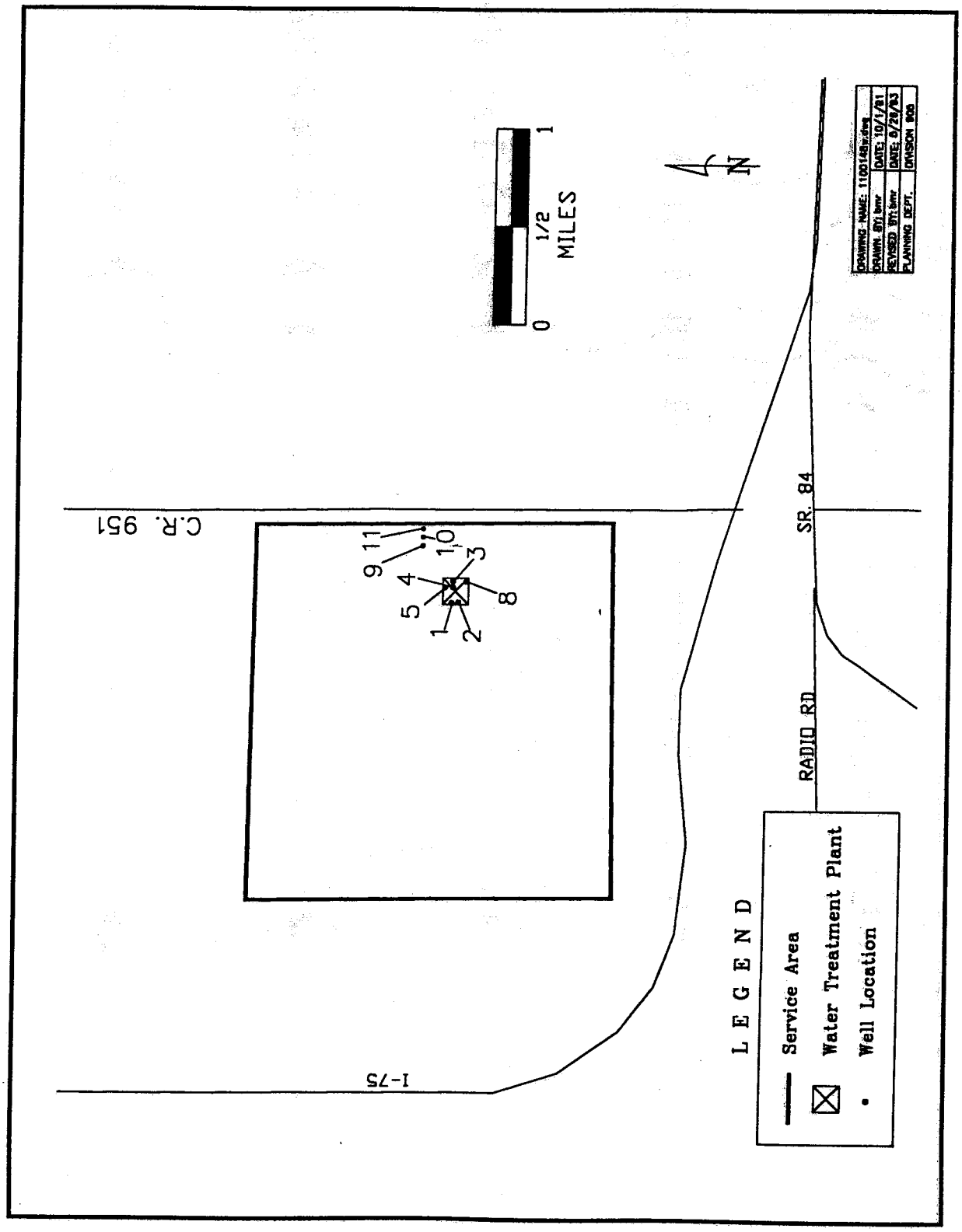


FIGURE E-4. Florida Cities Golden Gate Potable Water Supply Wells.

Immokalee Water & Sewer District

SFWMD Permit Number: 11-00013-W
FDER PWS ID: 5110142

Raw Water Supply:
Raw water is withdrawn from 13 wells located in the Immokalee Water & Sewer District boundary. Four of the wells withdraw water from the sandstone aquifer while nine withdraw water from the lower Tamiami aquifer. The sandstone wells are 4 and 8 inches in diameter, have total depths between 275 and 315 feet, cased depths between 230 and 250 feet and were drilled between 1966 and 1973. Withdrawal capacities are between 100 and 390 GPM. The lower Tamiami wells are 6 and 8 inches in diameter, have total depths between 175 and 225 feet, cased depths between 90 and 154 feet and were drilled between 1977 and 1992. Withdrawal capacities are between 220 and 340 GPM. Specific well information is located in Table E-5 and the location of the wells can be found in Figure E-5.

The current SFWMD permit was issued January 17, 1991 and expires January 17, 2000. The approved allocations are:

Annual Allocation:	1.14 BGY (3.13 MGD)*
Maximum Daily Allocation:	4.50 MGD

*This allocation includes withdrawals from facilities identified in proposed section below

Treatment Method:
Immokalee has three aeration water treatment plants which have FDER rated capacity's as follows:

Main (9th Street) WTP	1.25 MGD
Carson Road WTP	0.75 MGD
Airport WTP	1.00 MGD

The water treatment plants have a cumulative capacity of 3.00 MGD. The location of these facilities are shown in Figure E-5. The system 1990 average daily flow was 2.50 MGD and the maximum day flow was 2.80 MGD.

Interconnections:
There are no interconnections with other potable water distribution systems.

Proposed:
The current consumptive use permit allows construction of 4 additional Lower Tamiami wells which are indicated in Table E-5 and Figure E-5.

Future:
Demand projections estimate a 2010 average daily flow of 3.15 MGD, with a maximum day flow of 4.42 MGD.

Source:
Information was obtained from the Immokalee Water-Sewer District and their engineers, and SFWMD water use permit files.

TABLE E-5. Immokalee Potable Water Supply Wells.

Well Number	Main (9th Street) Water Treatment Plant							
	1	7	8	9	10A	11	12	13
Planar Coordinates	360094 E 754878 N	759634 E 754561 N	360231 E 755285 N	359944 E 754642 N	360016 E 754319 N	360216 E 754630 N	361131 E 755786 N	361445 E 756615 N
Status	Active	Active	Active	Active	Active	Active	Proposed	Proposed
Aquifer	Sandstone	Lower Tamiami	Sandstone	Sandstone	Lower Tamiami	Sandstone	Lower Tamiami	Lower Tamiami
Total Depth (ft)	275	225	315	275	175	278	200	200
Cased Depth (ft)	236	140	230	250	95	234	140	140
Well Diameter (in)	4	6	8	8	8	8	8	8
Pump Capacity (GPM)	110	300	300	240	300	390	--	--
Intake Depth (NGVD)	-237	-84	-231	-251	-96	-235	-141	-141
Year Drilled	1966	1985	1970	1971	1987	1973	--	--

TABLE E-5. (Continued).

Well Number	Carson Road Water Treatment Plant					Airport Water Treatment Plant			
	101	102	103	104	105	201	202	203	204
Planar Coordinates	352425 E 763614 N	352286 E 763870 N	352955 E 764177 N	352408 E 761216 N	352490E 760179N	365944 E 760365 N	366295 E 760377N	362406 E 760379 N	361277 E 760333 N
Status	Active	Standby	Active	Active	Proposed	Active	Active	Active	Proposed
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	200	--	210	210	200	187	187	155	200
Cased Depth (ft)	125	154	140	140	140	107	108	115	140
Well Diameter (in)	8	6	8	8	8	8	8	8	8
Pump Capacity (GPM)	240	340	220	300	--	320	320	300	--
Intake Depth (NGVD)	-126	-155	-141	-140	-141	-101	-101	-120	-141
Year Drilled	1977	1984	1986	1992	--	1986	1986	1992	--

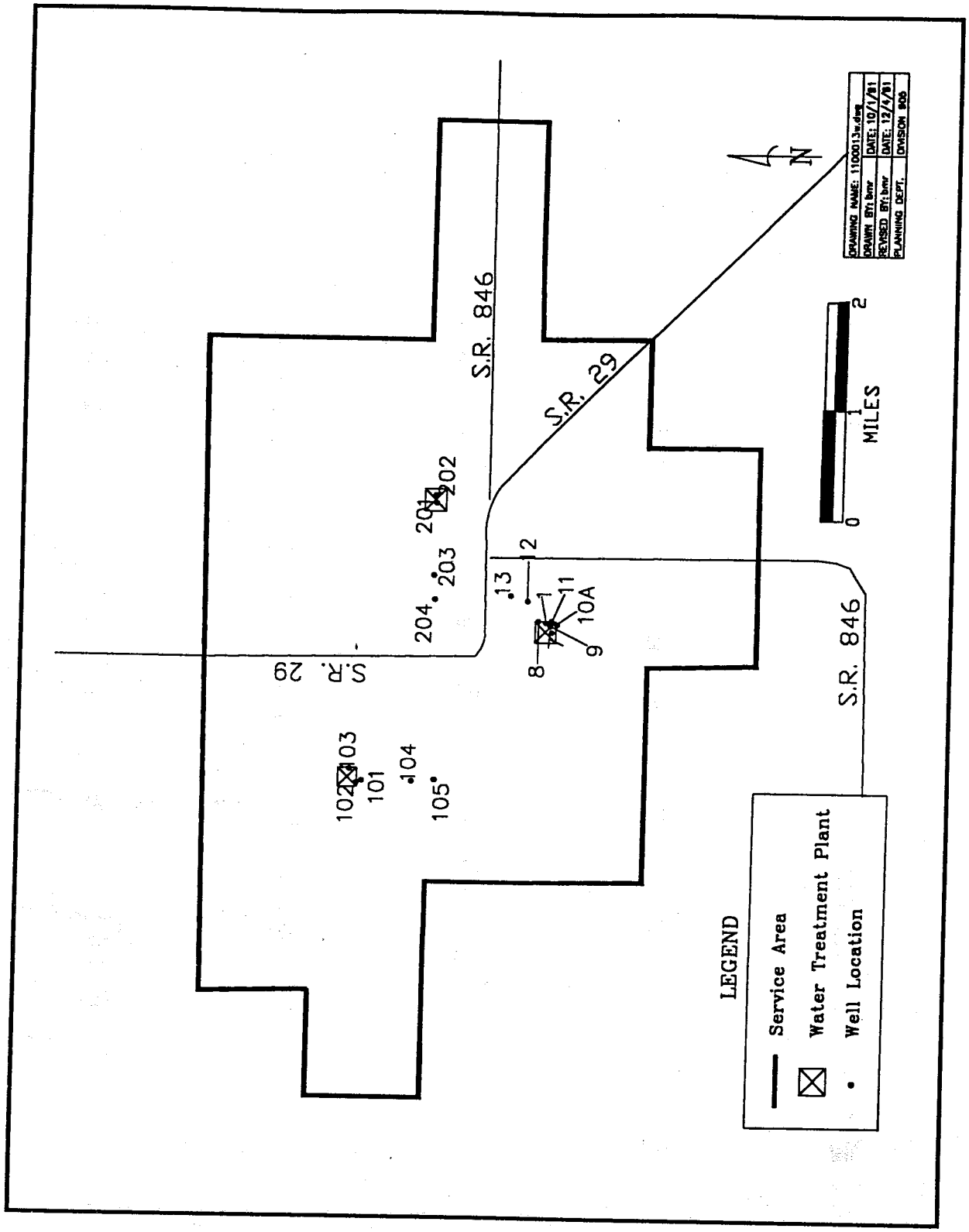


FIGURE E-5. Immokalee Potable Water Supply Wells.

Marco Island Utilities

SFWMD Permit Number: 11-00080-W
FDER PWS ID: 5110183

Raw Water Supply:
Raw water is withdrawn from sources of water located on the mainland called the Marco Island Lakes and infiltration gallery and from the lower Hawthorn aquifer via wells located on Marco Island. The Marco Island Lakes water supply consists of two lakes with areas of 27 and 19 acres. Water is withdrawn from the lakes and blended with water from the infiltration gallery prior to pumping it approximately 11 miles to the water treatment plant located on Marco Island. The infiltration galleries consist of a 4,000 and a 3,000 foot long gallery. Marco Shores utility withdraws water from the 11 mile raw water transmission system to supply their treatment facility. The lower Hawthorn wellfield consists of ten 10-inch diameter wells which were drilled between 1989 and 1992. The wells have total depths between 540 and 596 feet and cased depths between 378 and 415 feet. The withdrawal capacity of each well is 550 GPM. Specific well information is located in Table E-6 and the location of the Marco Island Lakes infiltration gallery lower Hawthorn wells can be found in Figure E-6. In addition, Marco Island has an agreement to purchase 1 MGD of treated water from Collier County Utilities to blend with their raw water, if necessary.

The current SFWMD permit was issued May 13, 1993 and expires January 17, 1996. The approved allocations are:

Annual Allocation:	
All Sources*	2.56 BGY (7.00 MGD)
Marco Island Lakes	1.93 BGY (5.30 MGD)
Infiltration Gallery	0.55 BGY (1.50 MGD)
Lower Hawthorn	1.97 BGY (5.40 MGD)
Maximum Daily Allocation	
All Sources*	10.78 MGD
Marco Island Lakes	5.30 MGD
Infiltration Gallery	1.50 MGD
Lower Hawthorn Wells	5.40 MGD

* This includes sources listed in the proposed section below.

The 1990 average daily withdrawal was 5.12 MGD with a maximum day withdrawal of 7.61 MGD. Modeling by the utilities consultants indicates that a safe yield of 6.80 MGD from the lakes and infiltration galleries during critical dry periods could be realized.

The service area of this utility is in the Collier County reduced threshold area.

Treatment Method:
Treatment consists of an 8 MGD (FDER rated capacity) lime softening plant and a 4 MGD (FDER rated capacity) recently constructed reverse osmosis (RO) plant. These facilities are located on Marco Island (Figure E-6). The RO plant has a 75 percent efficiency and brine disposal and is by deep well injection in the boulder zone. The 1990 average daily water demand was 5.45 MGD and the maximum day water demand was 7.49 MGD.

Interconnections:
There are no interconnections with other potable water distribution systems.

Proposed:
The current permit approves withdrawal from a rock pit known as the "Dude" pit. The Dude pit is an existing rock mining pit located on the mainland from which water will be will withdrawn and pumped to the existing mainland facilities for blending and pumping to the water treatment plant.

The SFWMD approved allocations for the Dude Pit are:

Annual Allocation:	1.46 BGY (4 MGD)
Maximum Daily Allocation	4.00 MGD

The lease for the Marco Island Lakes expires the end of 1994. It appears this lease will not be renewed. Marco Island has approached the City of Naples on the availability of additional water from the City's East Golden Gate wellfield. A study is being conducted to indicate if an additional 7 MGD of water could be withdrawn from the wellfield, which would be needed by 1995.

Future:
The 1991 master plan indicates the ultimate potable demand of Marco Island is 16 MGD, and Marco Shores will ultimately use approximately 3 MGD, for a total demand of 19 MGD. The projected finished water demand for the year 2000 is 10.65 MGD for Marco Island and 0.79 MGD for Marco Shores. To meet this demand, additional raw water is proposed to be obtained from the "160 acre" site on the mainland and additional lower Hawthorn wells on the island. The 160 acre site, shown in Figure E-6, should be implemented by 1996. The additional wells will also be provided by 1996.

Treatment will be provided by expansions of the existing facilities. A portion of the existing lime softening plant will be modified/demolished to allow expansion of the wastewater treatment facility and a new 5 MGD lime softening facility will be constructed. The 5 MGD expansion is to be completed by 1996 for a total and ultimate lime softening capacity of 10 MGD. The RO facility will be expanded to its ultimate capacity of 6 MGD by year 2000.

Source:
Information was obtained from SSU Services (Marco Island Utilities) and SFWMD water use permit files.

TABLE E-6. Marco Island Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Planar Coordinates	265394 E 579148 N	265629 E 578733 N	265777 E 578991 N	265936 E 578742 N	265493 E 580408 N	265921 E 583022 N	264076 E 583991 N	264263 E 585988 N	266795 E 585201 N	267392 E 584194 N	267464 E 586312 N	270425 E 582078 N	266283 E 583037 N
Status	Existing	Existing	Existing	Existing	Exisitng	Existing	Existing	Existing	Existing	Existing	Future	Future	Future
Aquifer	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn
Total Depth (ft)	565	574	548	547	540	596	573	574	546	580	600	600	600
Cased Depth (ft)	380	395	390	392	388	413	413	378	405	423	380	380	380
Well Diameter (in)	10	10	10	10	10	10	10	10	10	10	10	10	10
Pump Capacity (GPM)	550	550	500	550	550	550	550	550	550	550	500	500	500
Intake Depth (NGVD)	-110	-110	-110	-110	-120	-100	-100	-100	-100	-100	-100	-100	-100
Year Drilled	1991	1989	1989	1991	1991	1991	1991	1992	1992	1992	--	--	--

Marco Shores

SFWMD Permit Number: 11-00080-W
FDER PWS ID: 5110182

Raw Water Supply:
Raw water is withdrawn from the 11 mile Marco Island raw water supply transmission main which is in the vicinity of Marco Shores. Raw water and permit information is discussed in the Marco Island utility description.

The 1990 average daily raw water demand was 0.11 MGD with a maximum day raw demand of 0.24 MGD.

The service area for this utility is in the Collier County reduced threshold area.

Treatment Method:
Treatment consists of a 0.72 MGD (FDER rated capacity) lime softening plant. This facility is located in Marco Shores (Figure E-6). The 1990 average daily demand was 0.13 MGD with a maximum day demand of 0.24 MGD.

Interconnections:
There are no interconnections with other potable water distribution systems.

Proposed:
See Marco Island.

Future:
The 1991 Marco Island master plan indicates the ultimate potable demand for Marco Shores will be 3 MGD. The year 2000 projected finished water demand is 0.79 MGD for Marco Shores.

Source:
Information was obtained from SSU Services (Marco Island Utilities) and SFWMD water use permit files.

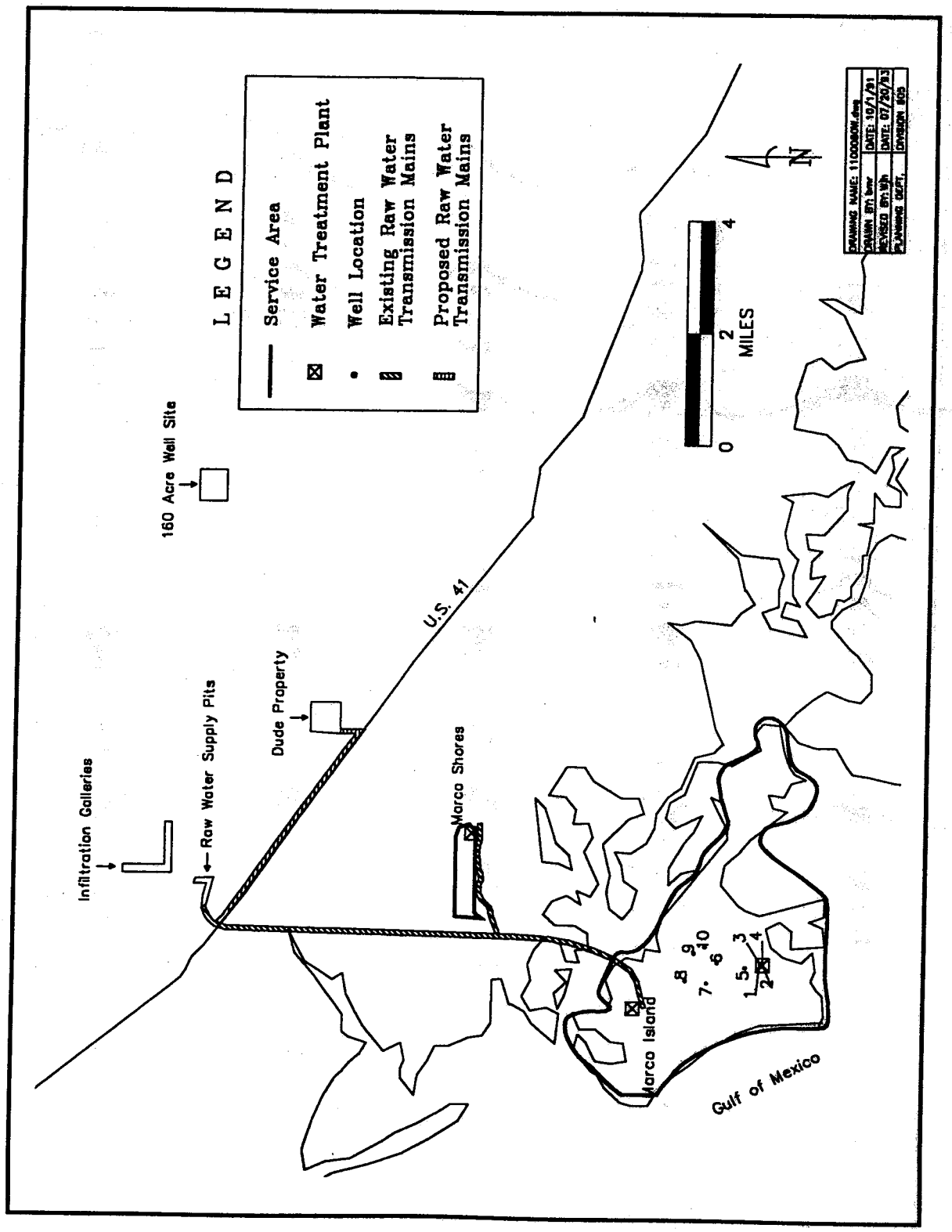


FIGURE E-6. Marco Island and Marco Shores Utilities Potable Water Supply Sources.

Naples

SFWMD Permit Number: 11-00017-W
FDER PWS ID: 5110198

Raw Water Supply:
Raw water is withdrawn from two wellfields known as the Coastal Ridge and East Golden Gate wellfields. The Coastal Ridge wellfield consists of 42 wells with diameters of 8 and 16 inches withdrawing from the lower Tamiami aquifer. The wells have total depths between 40 and 96 feet, cased depths between 24 and 85 feet, and were drilled between 1953 and 1975. Each well has a withdrawal capacity of 350 GPM.

The East Golden Gate wellfield consists of twenty-four 14-inch diameter wells withdrawing from the lower Tamiami aquifer. The wells have total depths between 70 and 137 feet, cased depths between 37 and 51 feet and were drilled between 1978 and 1987. Withdrawal capacities are between 600 and 1000 GPM.

Specific well information is located in Table E-7 for the Coastal Ridge wellfield and Table E-8 for the East Golden Gate wellfield. The location of the wells can be found in Figure E-7.

The current SFWMD permit was issued April 13, 1989 and expires February 9, 1994. The approved allocations are:

Annual Allocation	6.01 BGY (16.46 MGD)
Maximum Daily Allocation	
Combined-Both Wellfields	22.55 MGD
Coastal Ridge Wellfield	11.60 MGD
East Golden Gate Wellfield	22.55 MGD

The 1990 average daily withdrawal from the Coastal Ridge and East Golden Gate wellfields were 2.55 MGD and 14.80 MGD, respectively.

The service area is in the Collier County reduced threshold area.

Treatment Method:
Treatment consists of a 30 MGD (FDER rated capacity) lime softening plant. This facility is located at 1000 Fleischmann Boulevard, Naples (Figure E-7). The 1990 average daily flow was 17.35 MGD, with a 1988 maximum day flow of 24.70 MGD.

Interconnections:
The distribution system has interconnects with Collier County Utilities at Pelican Bay, at the intersection of County Road 951 and Airport Road (12 inch), and at a location off Rattlesnake Road in East Naples (12 inch).

Proposed:
A water system master plan is being developed. In addition, a study of the East Golden Gate Wellfield is being conducted to investigate the possibility of supplying raw water to Florida Cities Golden Gate (0.20 MGD) and to Southern States Utilities-Marco Island (3 MGD initially; 6.2 MGD in 1996).

Future:
The existing facilities are assumed to be sufficient to provide water to the city at build-out. The developments of Pelican Bay, Sutherland Center, Wyndemere, and Pine Ridge Industrial Park, which were previously served by the City of Naples, are now served by Collier County Utilities.

Source:
Information was obtained from the City of Naples Utilities Department and SFWMD water use permit files.

TABLE E-7. Naples Coastal Ridge Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Planar Coordinates	240214 E 669124 N	240486 E 670084 N	241052 E 670119 N	240450 E 670876 N	240452 E 672048 N	240421 E 673246 N	240438 E 674130 N	240414 E 675227 N	240373 E 676451 N	240378 E 677712 N	240384 E 678802 N	240319 E 679643 N	240365 E 680279 N	240356 E 680986 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	90	87	89	82	82	82	89	80	40	87	87	83	83	83
Cased Depth (ft)	56	57	56	53	54	51	60	58	24	54	64	64	63	64
Well Diameter (in)	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Pump Capacity (GPM)	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Intake Depth (NGVD)	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44
Year Drilled	1958	1958	1958	1962	1962	1962	1964	1964	1964	1964	1965	1965	1965	1965

TABLE E-7. (Continued).

Well Number	15	16	17	18	19	20	21	22	23	24	25	26	27
Planer Coordinates	240331 E 681654 N	240421 E 682957 N	240317 E 683628 N	240441 E 684587 N	240558 E 685563 N	240688 E 686759 N	240802 E 687777 N	240997 E 688986 N	241179 E 690454 N	241273 E 691515 N	241410 E 692494 N	241573 E 693582 N	241678 E 695331 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	83	80	85	85	85	85	85	85	85	85	85	85	85
Cased Depth (ft)	64	--	61	61	61	62	61	61	61	63	62	62	61
Well Diameter (in)	8	16	8	8	8	8	8	8	8	8	8	8	8
Pump Capacity (GPM)	350	350	350	350	350	350	350	350	350	350	350	350	350
Intake Depth (NGVD)	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44
Year Drilled	1965	1968	1969	1969	1969	1969	1969	1969	1971	1971	1971	1971	1971

TABLE E-7. (Continued).

Well Number	28	29	30	31	32	33	34	1A	2A	3A	4A	5A	6A	7A	8A
Planar Coordinates	326560 E 693901 N	241890 E 684184 N	242086 E 685065 N	241785 E 683217 N	243029 E 683196 N	244283 E 683181 N	245174 E 683233 N	238742 E 666811 N	239027 E 666456 N	238253 E 666444N	239774 E 667327 N	238628 E 665861 N	239623 E 666175 N	237738 E 666163 N	237747 E 665513 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	85	85	--	--	--	--	--	96	85	76	73	--	95	85	86
Cased Depth (ft)	61	61	--	--	--	--	--	85	58	55	50	--	74	70	68
Well Diameter (in)	8	8	8	8	8	8	8	6	8	--	6	6	10	10	10
Pump Capacity (GPM)	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Intake Depth (NGVD)	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44
Year Drilled	1971	1971	1975	1975	1975	1975	1975	1953	1953	1953	--	1956	1968	1968	1968

TABLE E-8. Naples East Golden Gate Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8	9	10	11	12
Planar Coordinates	326434 E 695331 N	326560 E 693901 N	326456 E 692573 N	326456 E 691246 N	326486 E 689952 N	326466 E 688600 N	326509 E 687298 N	326502 E 685936 N	326480 E 684639 N	326489 E 683296 N	326546 E 681992 N	326549 E 680655 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	71	93	80	81	98	101	109	133	82	131	112	100
Cased Depth (ft)	42	48	39	42	42	42	47	42	42	42	37	37
Well Diameter (in)	14	14	14	14	14	14	14	14	14	14	14	14
Pump Capacity (GPM)	500	500	500	700	900	700	900	900	700	700	600	700
Intake Depth (NGVD)	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44
Year Drilled	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1981	1981

TABLE E-8. (Continued).

Well Number	13	14	15	16	17	18	19	20	21	22	23	24
Planar Coordinates	326575 E 679305 N	326581 E 677959 N	326581 E 676639 N	326478 E 697851 N	326460 E 699130 N	362437 E 700467 N	326519 E 701486 N	326489 E 703096 N	326410 E 704185 N	321159 E 689867 N	321608 E 691208 N	321221 E 692561 N
Status	Active	Active	Standby	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	100	80	70	137	117	100	85	86	78	100	100	100
Cased Depth (ft)	40	38	38	39	40	39	42	46	51	40	40	40
Well Diameter (in)	14	14	14	14	14	14	14	14	14	14	14	14
Pump Capacity (GPM)	700	700	---	1000	1000	1000	1000	1000	600	700	700	700
Intake Depth (NGVD)	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44	-44
Year Drilled	1981	1981	1981	1981	1981	1981	1985	1985	1985	1987	1987	1987

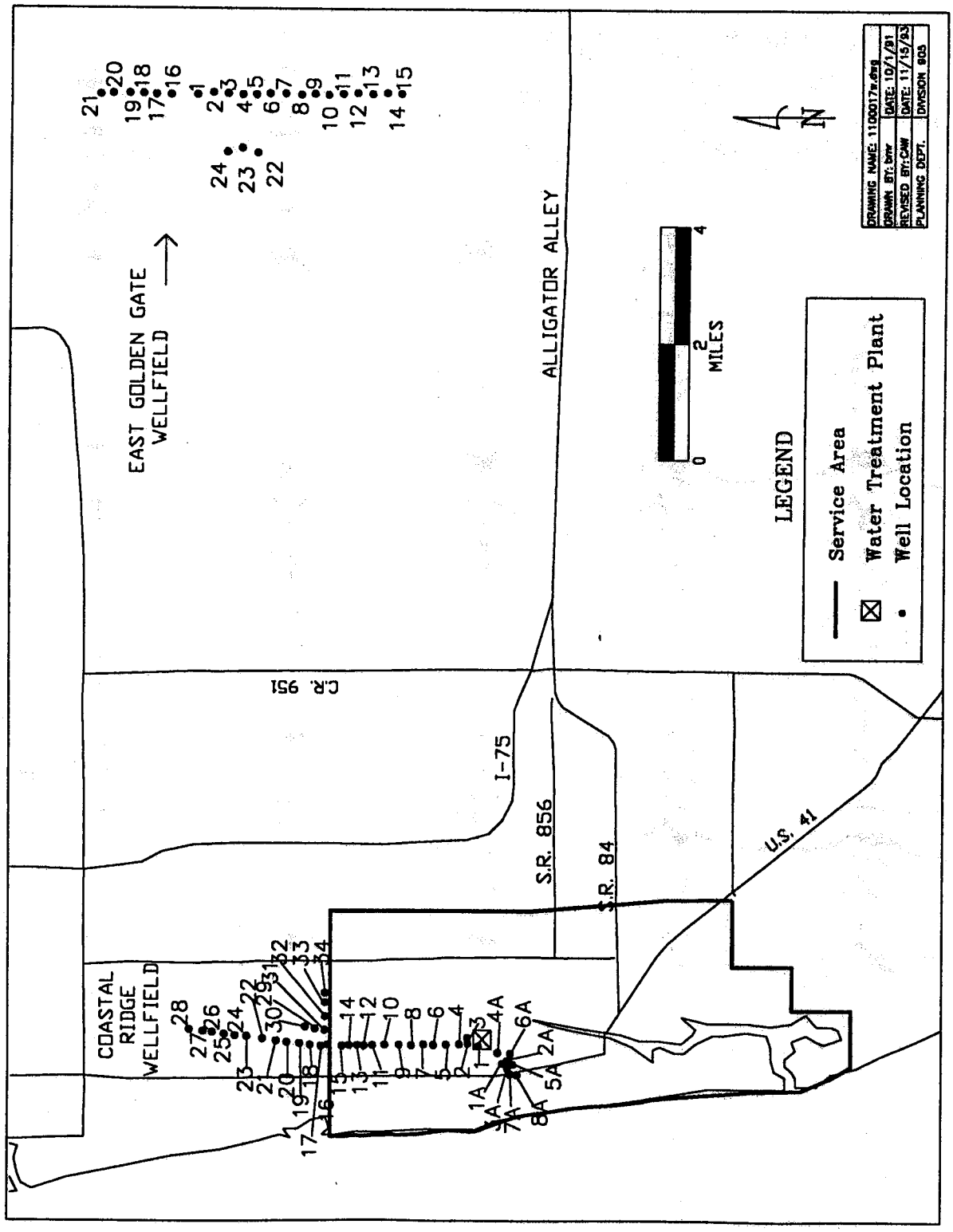


FIGURE E-7. Naples Coastal Ridge and East Golden Gate Potable Water Supply Wells.

North Naples Utilities

SFWMD Permit Number: 11-00193-W
FDER PWS ID: 5114059

Raw Water Supply:
This system was purchased by Collier County Utilities and removed from service in the summer of 1993. Raw water was withdrawn from two 10-inch diameter wells located in the Quail Creek development. The wells withdrew water from the water table aquifer, had total depths of 35 and 40 feet, and cased depths of 20 and 18 feet, respectively. The wells were drilled in 1980 and 1981 and had withdrawal capacities of 300 GPM. Specific well information is given in Table E-9 and the previous location of the wells can be found in Figure E-8.

The current SFWMD permit was issued November 3, 1988 and expires November 3, 1993. The approved allocations are:

Annual Allocation:	345.20 MGY (0.95 MGD)
Maximum Daily Allocation:	1.30 MGD

The service area is located in the Collier County reduced threshold area.

Treatment Method:
Treatment was provided by a 0.75 MGD (FDER rated capacity) lime softening treatment facility. This facility was located southeast of the Quail Creek Country Club (Figure E-8). The 1990 average daily flow was 0.15 MGD, and the maximum day flow was 0.25 MGD. The water distribution system was connected to Collier County Utilities in the summer of 1993.

Interconnections:
There were no interconnections with other potable water distribution systems.

Proposed:
N/A

Future:

This facility was abandoned in the summer of 1993.

Source:
Information was obtained from North Naples Utilities, Inc. and SFWMD water use permit files.

TABLE E-9. North Naples Potable Water Supply Wells.

Well Number	1	2
Planar Coordinates	263238 E 711348 N	263138 E 710925 N
Status	Deactivated	Deactivated
Aquifer	Water Table	Water Table
Total Depth (ft)	35	40
Cased Depth (ft)	20	18
Well Diameter (in)	10	10
Pump Capacity (GPM)	300	300
Intake Depth (NGVD)	-15	-13
Year Drilled	1980	1981

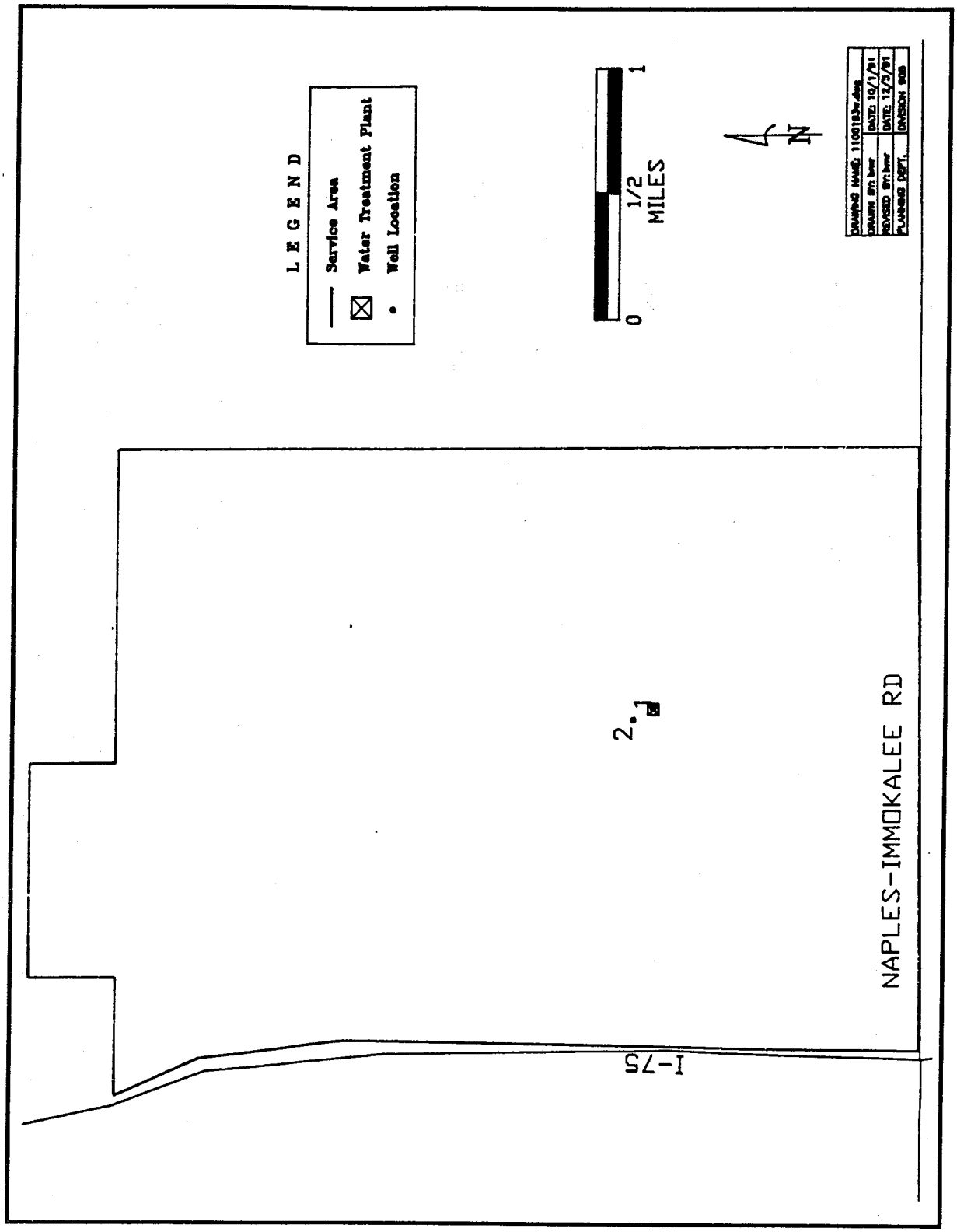


FIGURE E-8. North Naples Potable Water Supply Wells.

Orangetree Utility Co.

SFWMD Permit Number: 11-00419-W
FDER PWS ID: 5114085

Raw Water Supply:
Raw water is withdrawn from two wells located north of Oilwell Road and east of Immokalee Road (County Road 846). The wells, which were drilled in 1987 and 1988, withdraw water from the lower Tamiami aquifer and are 12 inches in diameter. They have total depths of 100 feet and cased depths of 78 and 75 feet. The design pumping capacities are 500 gallons per minute. Specific well information is given in Table E-10 and the location of the wells are shown in Figure E-9.

The current SFWMD permit was issued September 10, 1987 and expires September 10, 1997. The approved allocations are:

Annual Allocation:	158.78 MGY (0.44 MGD)
Maximum Daily Allocation:	0.65 MGD

The service area is located in the Collier County reduced threshold area.

Treatment Method:
Treatment is provided by a 0.43 MGD (FDER rated capacity) lime softening facility. This facility is located north of Oilwell Road, one mile east of County Road 951 in Collier County (Figure E-9). The 1990 average daily flow was 0.006 MGD and the maximum day flow was 0.011 MGD.

Interconnections:
There are no distribution system interconnections with other utilities.

Proposed:
N/A

Future:
The estimated maximum project demand is 0.92 MGD and is anticipated to take place prior to 2010. It is anticipated that two additional wells (one production and one standby) will be constructed in the vicinity of the existing wells as demands increase. The anticipated future treatment method is lime softening. This system will eventually be absorbed into the Collier County Utility system.

Source:
Information was obtained from Wilson, Miller, Barton & Peek, Inc. for the Orangetree Utility Co., and SFWMD water use permit files.

TABLE E-10. Orangetree Potable Water Supply Wells.

Well Number	1	2
Planar Coordinates	308907 E 712671 N	307954 E 713652 N
Status	Active	Standby
Aquifer	Lower Tamiami	Lower Tamiami
Total Depth (ft)	100	100
Cased Depth (ft)	78	75
Well Diameter (in)	12	12
Pump Capacity (GPM)	500	500
Intake Depth (ft)	--	--
Year Drilled	1987	1988

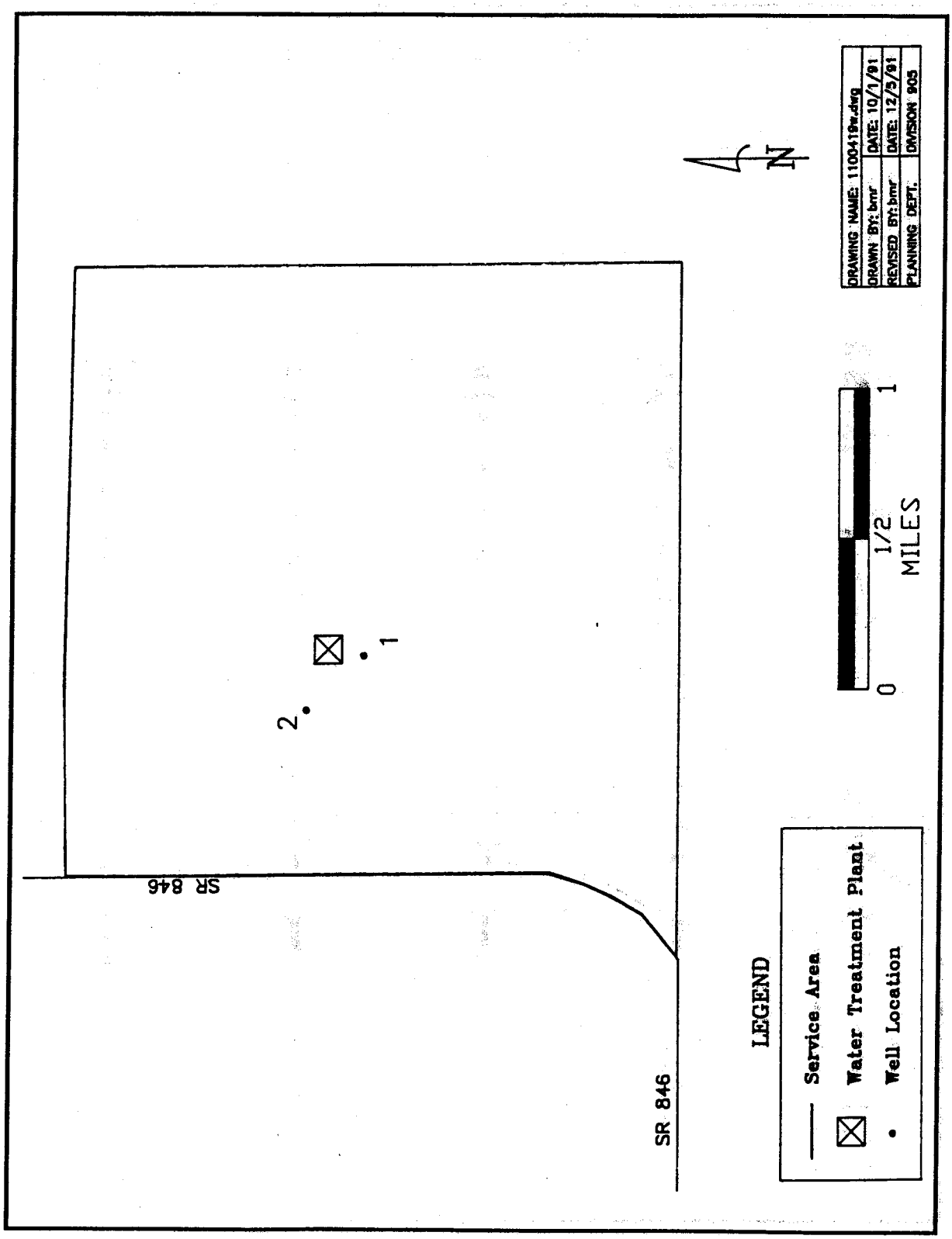


FIGURE E-9. Orangetree Utility Potable Water Supply Wells.

Port of the Islands

SFWMD Permit Number: 11-00271-W
FDER PWS ID: 5110230

Raw Water Supply:
Raw water is withdrawn from two wells located northeast of the Port of the Islands development in Section 2, Range 52S, Township 28E. The wells withdraw water from the mid-Hawthorn aquifer, have total depths of 380 feet, and cased depths of 300 feet. The wells were drilled in 1966. The pumping capacities are approximately 300 GPM. Specific well information is provided in Table E-11 and the location of the wells can be found in Figure E-10.

The current SFWMD permit was issued October 11, 1984 and expires October 11, 1994. The approved allocations are:

Annual Allocation:	105.00 MGY (0.29 MGD)
Maximum Daily Allocation:	0.43 MGD

The service area is located in the Collier County reduced threshold area.

Treatment Method:
Treatment is provided by a 0.39 MGD aeration facility. The facility is located north of U.S. 41 in the Port of the Islands development (Figure E-10). The 1990 average daily flow was 0.14 MGD and the maximum day flow was 0.22 MGD.

Interconnections:
There are no distribution interconnections with other utilities.

Proposed:
A 0.50 MGD lime softening water treatment facility will be constructed in late 1993.

Future:
The existing facility is anticipated to serve the area's build-out capacity. A facility expansion is not anticipated.

No additional construction/expansion of this facility is proposed. However, one additional well may be drilled in the same proximity of the existing wells at a later date.

Source:
Information was obtained from the Port of the Islands Community Improvement District and SFWMD water use permit files.

TABLE E-11. Port of the Islands Potable Water Supply Wells.

Well Number	1	2
Planar Coordinates	341288 E 597909 N	342232 E 597959 N
Status	Active	Active
Aquifer	Mid-Hawthorn	Mid-Hawthorn
Total Depth (ft)	380	380
Cased Depth (ft)	300	300
Well Diameter (in)	6	6
Pump Capacity (GPM)	300	300
Intake Depth (NGVD)	-300	-300
Year Drilled	1966	1966

Note: Wells alternated every two weeks.

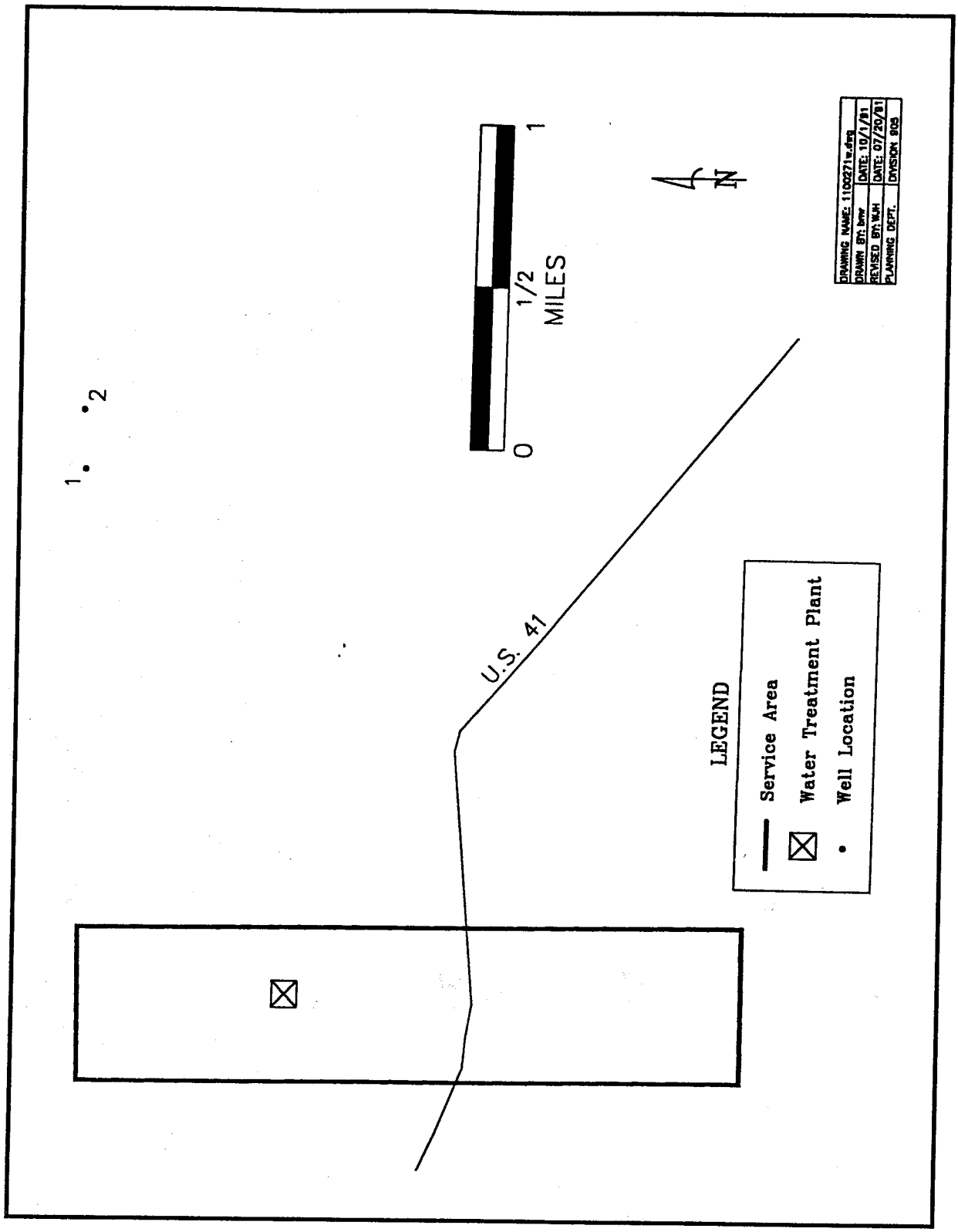


FIGURE E-10. Port of the Islands Potable Water Supply Wells.

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HENDRY COUNTY

POTABLE WATER TREATMENT FACILITIES

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City of La Belle

SFWMD Permit Number: 26-00105-W
FDER PWS ID: 5260050

Raw Water Supply:
Raw water is withdrawn from seven wells located in and around the City of La Belle. The wells are incorporated into two wellfields known as the water treatment plant and the city wellfields. The wells, which were drilled between 1930 and 1989, withdraw water from the water table aquifer and are 6 and 12 inches in diameter. They have total depths between 24 and 32 feet and cased depths between 20 and 25 feet. The design pumping capacities are between 140 and 290 GPM. Specific well information is given in Table E-12 and the location of the wells can be found in Figure E-11.

The current SFWMD permit was issued January 8, 1989 and expires December 31, 1997. The approved allocations are:

Annual Allocation:	255.50 MGY (0.70 MGD)
Maximum Daily Allocation:	
Water Plant Wellfield	0.60 MGD
Both Wellfields	1.40 MGD

The 1990 average daily withdrawal was 0.56 MGD with a maximum day of 0.88 MGD.

The service area is located in the Hendry County reduced threshold area.

Treatment Method:
Treatment is provided by a 1.50 MGD (FDER rated capacity) lime softening treatment facility. This facility is located at the intersection of Main Street and Euclid Avenue, La Belle (Figure E-11). The 1990 average daily potable water demand was 0.53 MGD and the maximum day flow was 0.79 MGD.

Interconnections:
This facility has one 6-inch interconnection with Port La Belle Utilities at the intersection of Seminole Avenue (not existing) and Ford Road.

Proposed:
N/A

Future:
The city's comprehensive plan projected a year 2010 average water demand of 1.16 MGD based on a 125 GPD per capita.

Source:
Information was obtained from the City of La Belle consumptive use permit, the City of La Belle comprehensive plan, and SFWMD water use permit files.

TABLE E-12. La Belle Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7
Planar Coordinates	348623 E 874231 N	348603 E 873963 N	348609 E 873626 N	348610 E 873325 N	356274 E 881524 N	356293 E 881869 N	356692 E 881535 N
Status	Active	Active	Active	Active	Active	Active	Active
Aquifer	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Total Depth (ft)	26	26	26	26	24	32	30
Cased Depth (ft)	20	20	20	20	20	25	25
Well Diameter (in)	12	12	12	12	6	6	6
Pump Capacity (GPM)	290	140	290	290	250	250	250
Intake Depth (NGVD)	-15	-15	-15	-15	-18	-20	-20
Year Drilled	1978	1981	1978	1981	1930	1930	1989

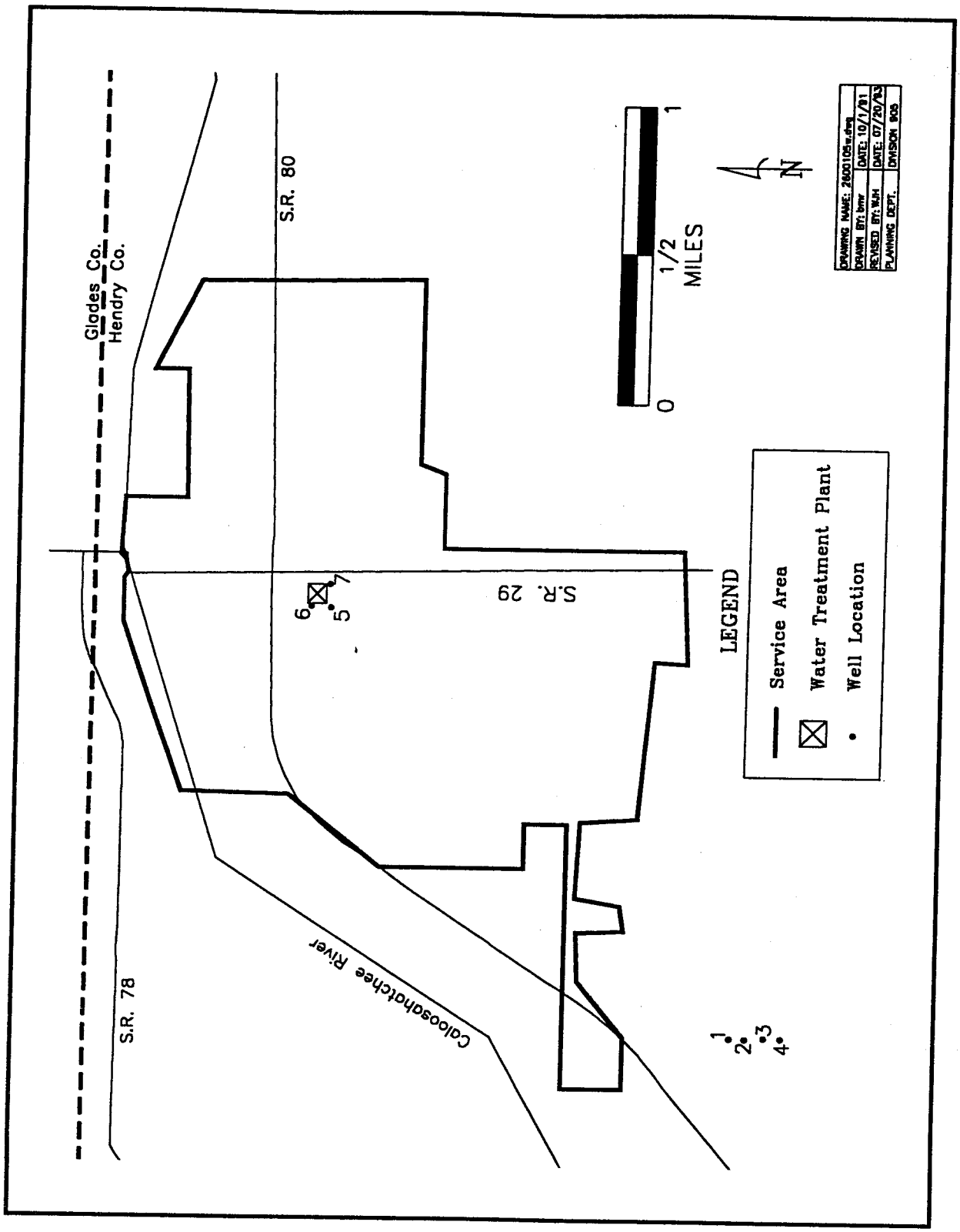


FIGURE E-11. City of La Belle Potable Water Supply Wells.

Port La Belle Utilities

SFWMD Permit Number: 26-00096-W
FDER PWS ID: 5260226

Raw Water Supply:
Raw water is withdrawn from two wells located in the Port La Belle utility area. The wells, which were drilled in 1973 and 1983, withdraw water from the sandstone aquifer and are 8 and 14 inches in diameter. They have total depths of 300 and 283 feet, and cased depths of 250 and 220 feet, respectively. The withdrawal capacities are 450 and 500 GPM. Specific well information is provided in Table E-13 and the location of the wells can be found in Figure E-12.

The current SFWMD permit was issued May 12, 1988 and expires May 12, 1997. The approved allocations are:

Annual Allocation:	98.20 MGY (0.27 MGD)
Maximum Daily Allocation:	0.80 MGD

Treatment Method:
Treatment is provided by a 0.50 MGD (FDER rated capacity) lime softening treatment facility. This facility is located at Cedarwood Parkway and State Road 80, Port La Belle (Figure E-12). The 1990 average daily flow was 0.18 MGD and the maximum day flow was 0.26 MGD.

Interconnections:
This facility has one 6-inch interconnection with City of La Belle at the intersection of Seminole Avenue (not existing) and Ford Road.

Proposed:
The developers of Port La Belle are proposing to reduce the original size of the development by 22,000 acres, which will substantially reduce the number of dwelling units.

Future:
N/A

Source:
Information was obtained from General Development Utilities, Inc., and SFWMD water use permit files.

TABLE E-13. Port La Belle Potable Water Supply Wells.

Well Number	1	2
Planar Coordinates	377250 E 883997 N	377250 E 884598 N
Status	Active	Active
Aquifer	Sandstone	Sandstone
Total Depth (ft)	300	283
Cased Depth (ft)	250	220
Well Diameter (in)	8	8
Pump Capacity (GPM)	450	500
Intake Depth (ft)	64	53
Year Drilled	1973	1983

Note: Wells alternated monthly.

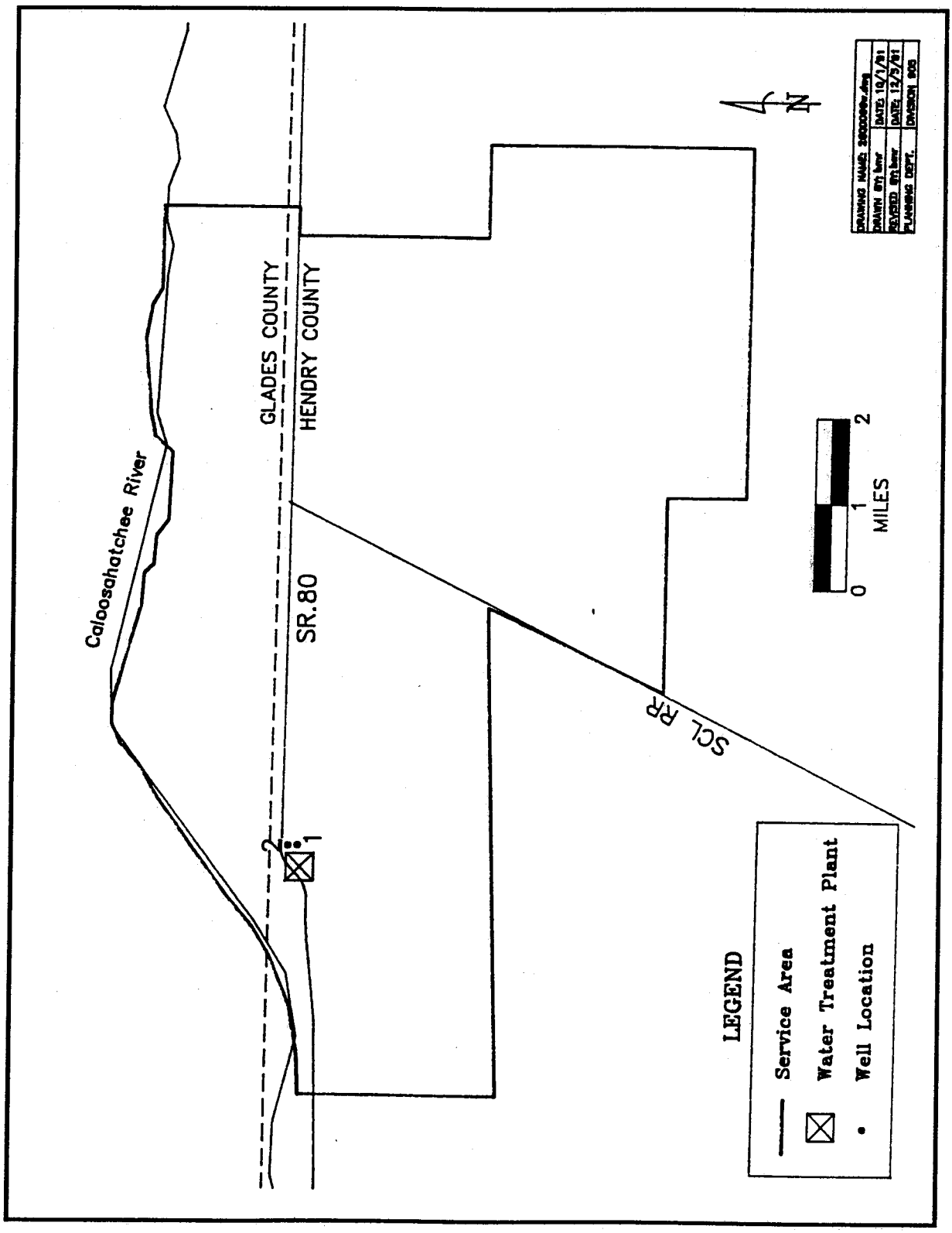


FIGURE E-12. Port La Belle Potable Water Supply Wells.

U.S. Sugar Corporation

SFWMD Permit Number: 26-00024-W
FDER PWS ID: 5260297

Raw Water Supply:
Raw water is withdrawn from Lake Okeechobee via an intake structure located in the lake north of Clewiston.

The current SFWMD permit was issued December 12, 1985 and expires December 12, 1995. The approved allocations are:

Annual Allocation:	1.18 BGY (3.23 MGD)
Maximum Daily Allocation:	6.46 MGD

Treatment Method:
Treatment is provided by a 6 MGD (FDER rated capacity) lime softening treatment facility. This facility is located one mile south of downtown Clewiston (Figure E-13). The 1990 average daily flow was 2.85 MGD and the maximum day flow was 5.92 MGD. This facility serves the Sugar House, the City of Clewiston and the South Shore Water Association.

Interconnections:
There are no interconnections with other potable water distribution systems.

Proposed:
N/A

Future:
The 1989 facilities plan projects that the maximum day demand will increase to 5.21 MGD by year 2000 and 5.33 MGD by the 2010. An expansion of this facility is not anticipated unless regulations become more stringent and dictate a need to increase treatment.

Source:
Information was obtained from the United States Sugar Corporation and SFWMD water use permit files.

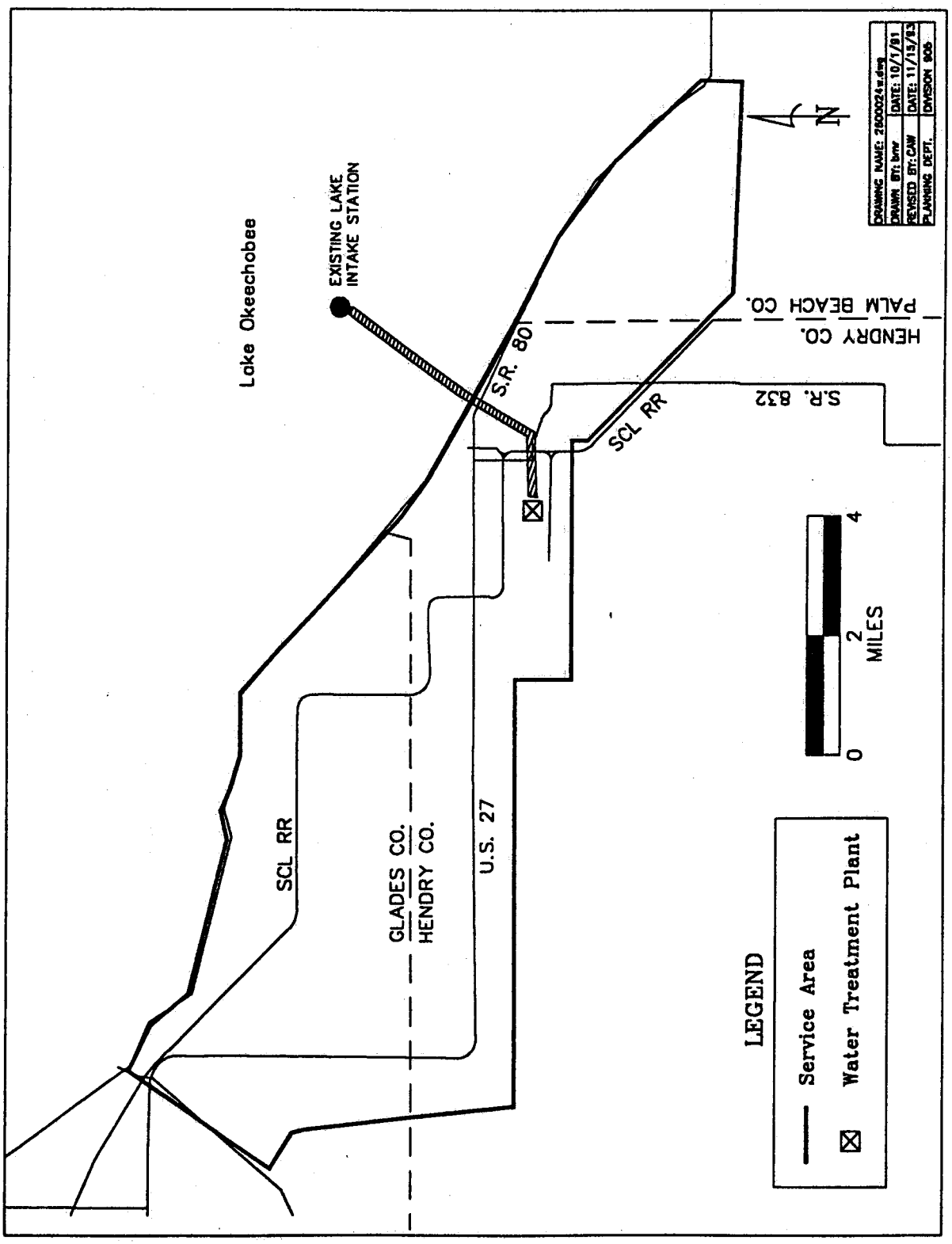


FIGURE E-13. U.S. Sugar Water Treatment Plant.

LEE COUNTY

POTABLE WATER TREATMENT FACILITIES

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Bonita Springs Utilities

SFWMD Permit Number: 36-00008-W
FDER PWS ID: 5360025

Raw Water Supply:
Raw water is supplied from the east and west wellfield. The west wellfield is operational while the east has been permitted but not yet constructed. It is described in the proposed section. The west wellfield consists of 16 wells located along the north-south line in sections 18, 19, 30, and 31 of Township 47S, Range 26E. The wells, which were drilled between 1971 and 1988, withdraw water from the lower Tamiami aquifer and are 8 and 12 inches in diameter. They have total depths between 80 and 115 feet and cased depths between 58 and 85 feet. The design pumping capacities are between 125 and 350 GPM. Specific well information is provided in Table E-14 and the location of the wells are identified in Figure E-14.

The current SFWMD permit was issued April 15, 1993 and expires April 15, 1998. The approved allocations are:

Annual Allocation:	1.22 BGY (3.35 MGD)
West Wellfield	0.98 BGY (2.69 MGD)
Maximum Daily Allocation:	4.73 MGD
West Wellfield:	3.18 MGD*

*Prior to completion of East Wellfield -- 3.81 MGD allowed until that time.

The service area is located in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 6.00 MGD (FDER rated capacity) lime softening treatment facility. This facility is located at 11860 East Terry Street, Bonita Springs (Figure E-14). The 1990 average daily flow was 2.15 MGD and the maximum day flow was 3.00 MGD.

Interconnections:
There are no interconnections with other potable water distribution systems.

Proposed:
The current consumptive use permit allows construction of eight additional supply wells in the proposed East Terry Street wellfield as indicated on Figure E-16. The wells will be operational by the middle of 1994. This wellfield will allow some operational flexibility by distributing ground water withdrawals between the existing and proposed wellfields during the dry and wet seasons and minimize saltwater intrusion. Specific well information on the proposed wells is located in Table E-14 and the location of the wells are identified in Figure E-14.

Future:
The projected water use by the utility for this system is anticipated to increase to 3.84 MGD on average by 2001. Two future expansions of 3 MGD each for a total facility capacity of 12 MGD can be accommodated at this site as demand dictates. The method of treatment will be lime softening.

Source:
Information was obtained from the Bonita Springs Water System, Inc. and SFWMD water use permit files.

TABLE E-14. Bonita Springs Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8	9	10	11	12
Planar Coordinates	252928 E 735224 N	252837 E 734311 N	252843 E 733364 N	252887 E 732518 N	252929 E 731571 N	252970 E 730686 N	252944 E 736127 N	253064 E 737561 N	253088 E 738541 N	252925 E 739369 N	253003 E 729812 N	253192 E 740872 N
Status	Standby	Standby	Standby	Standby	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	80	80	80	80	80	80	97	85	85	90	97	105
Cased Depth (ft)	64	65	65	64	64	58	66	70	70	66	67	72
Well Diameter (in)	8	8	8	8	8	8	12	8	8	12	12	12
Pump Capacity (GPM)	---	---	---	---	350	150	250	125	150	300	350	325
Intake Depth (NGVD)	-60	-60	-60	-60	-60	-60	-60	-60	-60	-60	-60	-60
Year Drilled	1971	1971	1971	1971	1971	1971	1983	1979	1979	1983	1983	1988

TABLE E-14. (Continued).

Well Number	13	14	15	16	17	18	19	20	21	22	23	24
Planar Coordinates	253211 E 742037 N	252644 E 742940 N	252590 E 743963 N	252563 E 745032 N	263387 E 732215 N	263387 E 732617 N	263387 E 732986 N	263337 E 733456 N	263761 E 731827 N	263761 E 731346 N	263395 E 731046 N	263414 E 730578 N
Status	Active	Active	Active	Active	Proposed	Proposed	Proposed	Proposed	Proposed	Proposed	Proposed	Proposed
Aquifer	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami	Lower Tamiami
Total Depth (ft)	110	115	115	115	100	100	100	100	100	100	100	100
Cased Depth (ft)	78	80	85	85	70	70	70	70	70	70	70	70
Well Diameter (in)	12	12	12	12	12	12	12	12	12	12	12	12
Pump Capacity (GPM)	325	325	325	325	700	700	700	700	700	700	700	700
Intake Depth (NGVD)	-60	-60	-60	-60	---	---	---	---	---	---	---	---
Year Drilled	1988	1988	1988	1988	---	---	---	---	---	---	---	---

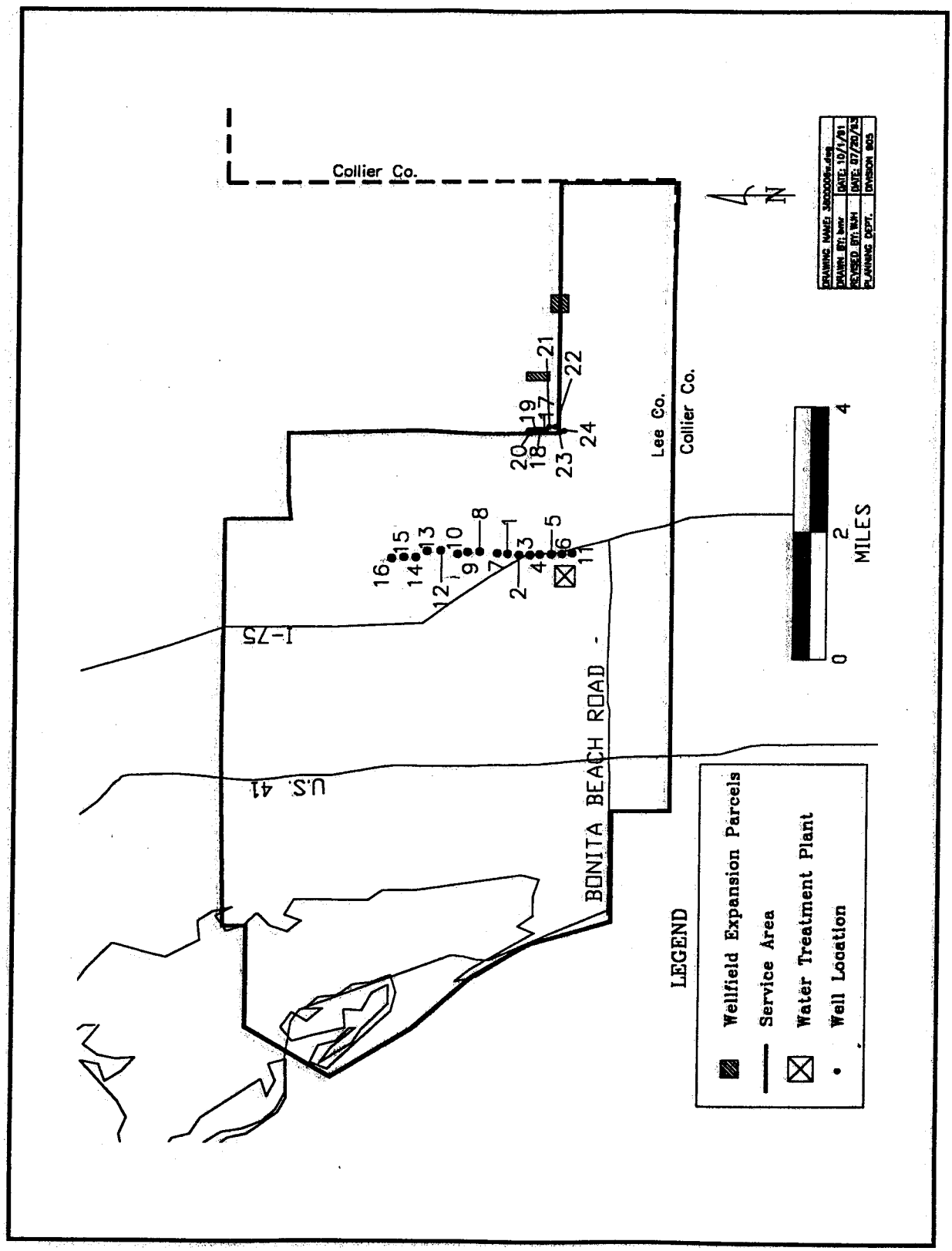


FIGURE E-14. Bonita Springs Potable Water Supply Wells.

Cape Coral

SFWMD Permit Number: 36-00046-W
FDER PWS ID: 5360325

Raw Water Supply:
Raw water is withdrawn from the lower Hawthorn aquifer via 23 wells located in Cape Coral. The wells are 10 and 12 inches in diameter, have total depths between 642 and 900 feet, cased depths between 345 and 600 feet and were drilled between 1975 and 1990. Withdrawal capacities are between 200 and 850 GPM. Specific well information is given in Table E-15 and the location of the wells can be found in Figure E-15.

The current SFWMD permit was issued May 14, 1992 and expires May 14, 1997. The approved allocations are:

Annual Allocation	4.23 BGY (11.59 MGD)
Maximum Daily Allocation	14.25 MGD

The service area is in the Lee County reduced threshold area and is designated as an Area of Special Concern.

Treatment Method:
Treatment consists of a 14 MGD (FDER rated capacity) reverse osmosis water treatment facility. This facility is located at 3300 SW 20th Avenue, Cape Coral (Figure E-15). The RO plant has an efficiency of 85%, with brine reject disposal via a surface water discharge to a lake which is part of the Cape Coral tidal canal system. The 1990 average daily flow was 8.44 MGD, and this facility had a maximum day flow of 12.30 MGD in 1988.

Interconnections:
The water distribution system has one interconnect with Florida Cities Waterway Estates at Hancock Bridge Parkway and 24th Avenue (10 inches). In addition, an 8-inch interconnect will be available with the Pine Island Water Association in 1994.

Proposed:
An additional water supply well is anticipated to be drilled in 1993. This well is approved by the previously stated permit. The proposed well information is given in Table E-15 and the location of the well can be found in Figure E-15.

Future:
Utility flow projections for this facility estimate a 1993 average daily potable water demand of 9.75 MGD, and a maximum day demand of 11.70 MGD if water is available throughout the city based on population projections and per capita flow estimates. Additionally, the ultimate build-out (estimated to be in 40 years) potable water demand projection is 36 MGD average daily flow with a maximum day flow of 43 MGD. To meet this demand, it is planned to expand the existing facility to 22 MGD. Planned expansions have been postponed as the result of WICC (see Wastewater Cape Coral Everest), and construct a new north treatment facility at a future date which will have an ultimate capacity of 21 MGD. The treatment method will be RO. The new facility will be supplied by a new wellfield withdrawing from the lower Hawthorn and Suwannee aquifers located on Diplomat Parkway. A raw water withdrawal of 46.5 MGD is necessary to meet the projected 36 MGD demand. The

location of the proposed water treatment facility and wellfield is indicated in Figure E-15.

Source:
Information was obtained from the City of Cape Coral-Utilities Department and SFWMD water use permit files.

TABLE E-15. Cape Coral Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8	9	10	11	12
Planar Coordinates	167540 E 821817 N	167456 E 821564 N	167498 E 821352 N	166314 E 821902 N	165680 E 821944 N	165004 E 821944 N	170668 E 820252 N	170669 E 817756 N	170627 E 815176 N	167244 E 818645 N	168541 E 833016 N	170246 E 832977 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn
Total Depth (ft)	745	685	705	700	765	900	752	752	748	748	762	742
Cased Depth (ft)	362	347	345	350	345	362	357	345	350	350	600	599
Well Diameter (in)	10	12	12	12	12	12	12	12	12	12	12	12
Pump Capacity (GPM)	540	600	850	500	500	200	425	490	470	500	550	560
Intake Depth (NGVD)	-70	-70	-70	-70	-70	-70	-95	-95	-95	-95	-80	-80
Year Drilled	1975	1975	1975	1975	1975	1975	1982	1982	1982	1982	1984	1984

TABLE E-15. (Continued).

Well Number	13	14	15	16	17	18	19	20	21	22	23	24
Planar Coordinates	171873 E 833093 N	172842 E 833132 N	174236 E 833171 N	171472 E 821987 N	172445 E 821987 N	174432 E 822071 N	177053 E 822071 N	178448 E 822071 N	179632 E 822240 N	181239 E 822156 N	175709 E 833248 N	167223 E 833054 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Proposed
Aquifer	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn
Total Depth (ft)	765	702	722	707	700	722	702	720	720	642	652	760
Cased Depth (ft)	589	520	558	456	440	495	515	500	515	515	420	560
Well Diameter (in)	12	12	12	12	12	12	12	12	12	12	12	12
Pump Capacity (GPM)	625	515	620	600	575	525	755	600	600	475	700	700
Intake Depth (NGVD)	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80
Year Drilled	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1990	---

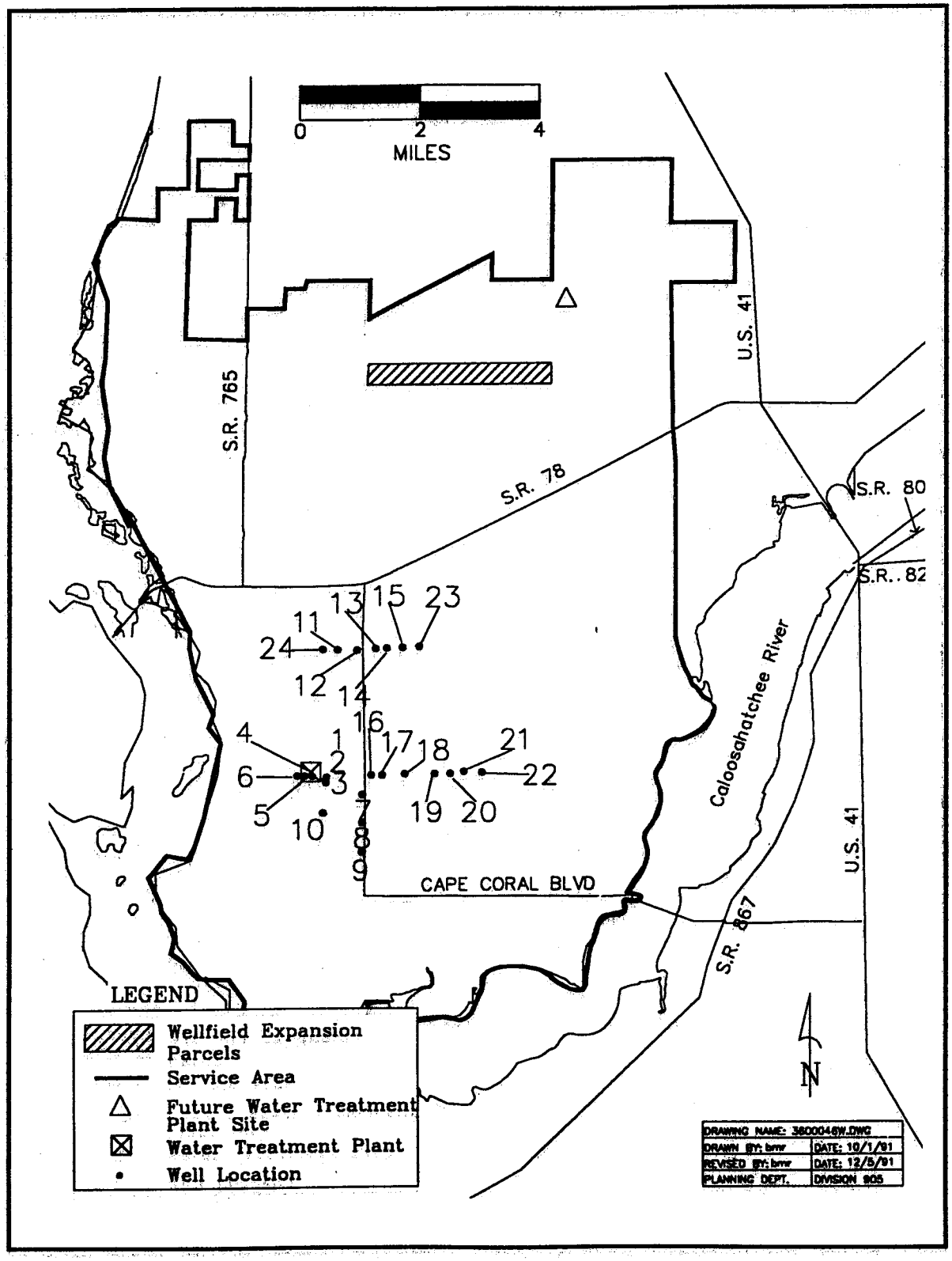


FIGURE E-15. Cape Coral Potable Water Supply Wells.

Florida Cities College Parkway

SFWMD Permit Number: 36-00150-W
FDER PWS ID: 5360070

Raw Water Supply:
Raw water is withdrawn from 14 wells located in the vicinity of Cypress Lake Drive and College Parkway. The wells, which were drilled between 1970 and 1974, withdraw water from the mid-Hawthorn aquifer, and are between 8 and 12 inches in diameter. They have total depths between 220 and 285 feet, and cased depths between 100 and 220 feet. The design pumping capacities are between 80 and 150 GPM. Specific well information is given in Table E-16 and the location of the wells are identified in Figure E-16.

The current SFWMD permit was issued May 13, 1982 and expired May 13, 1992. The approved allocations are:

Annual Allocation*	3.35 BGY (9.17 MGD)
Maximum Daily Allocation	1.50 MGD

* The annual allocation includes withdrawals from the Florida Cities Green Meadows wellfield.

The 1990 average daily withdrawal was 0.53 MGD with a maximum day of 0.63 MGD.

The service area is located in the Lee County reduced threshold area.

Treatment Methods:
Treatment is provided by a 1.50 MGD (FDER rated capacity) lime softening treatment facility. This facility is located south of College Parkway and east of Summerlin Road in Fort Myers (Figure E-16). The 1990 average daily flow was 0.51 MGD and the maximum day flow was 0.62 MGD.

Interconnections:
There are three interconnections with two other potable water distribution systems. Two interconnections are with Lee County at Cypress Lake Drive and McGregor Boulevard (4 inches), and at U.S. 41 (Tamiami Trail) and Hendry Creek Drive (6 inches). One interconnect is with Gulf Utilities at Alico Road and Oriole Road.

Proposed:
An application is being processed by the SFWMD to construct 10 additional supply wells (5 sandstone aquifer and 5 water table wells) in the Green Meadows wellfield as indicated on Figure E-17. As a percent of pumpage, 70-75 percent of the water will come from the Sandstone aquifer while 25 to 30 percent will come from the water table aquifer. An increase in the annual allocation to 4.64 BGY (12.70 MGD - 11.20 MGD from Green Meadows wellfield and 1.5 MGD from Cypress Lakes wellfield) is requested. It is projected that a water demand of 12.00 MGD will exist by 1997. Specific well information on the proposed wells is located in Table E-17 and the location of the wells are identified in Figure E-16.

Future:
No future plans are available.

Source:
Information was obtained from the Florida Cities Water Company and SFWMD water use permit files.

TABLE E-16. Florida Cities College Parkway (Cypress Lakes) Potable Water Supply Wells.

Well Number	2	3	4	5	6	7	8
Planar Coordinates	213510 E 804977 N	213009 E 804654 N	212574 E 805016 N	213811 E 806716 N	213573 E 806315 N	214806 E 807725 N	214345 E 807719 N
Status	Active	Reserve	Active	Active	Active	Active	Reserve
Aquifer	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn
Total Depth (ft)	230	220	220	238	260	220	224
Cased Depth (ft)	126	135	100	116	126	126	130
Well Diameter (in)	8	8	8	8	8	8	8
Pump Capacity (gpm)	100	*	100	80	70	100	110
Intake Depth (ft)	--	--	--	--	--	--	--
Year Drilled	1970	1974	1973	1969	1973	1972	1972

TABLE E-16. (Continued).

Well Number	12	13	14	15	16	17	18
Planar Coordinates	212754 E 807693 N	212319 E 807719 N	212345 E 808177 N	212535 E 809122 N	212897 E 810155 N	212436 E 810057 N	810170 N 210936 N
Status	Reserve	Reserve	Active	Reserve	Reserve	Active	Reserve
Aquifer	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn
Total Depth (ft)	220	220	220	220	220	285	280
Cased Depth (ft)	120	126	130	120	130	220	220
Well Diameter (in)	8	8	8	8	8	8	12
Pump Capacity (gpm)	*	*	90	*	*	120	*
Intake Depth (ft)	--	--	--	--	--	--	--
Year Drilled	1972	1972	1967	--	1974	1973	1973

* Pumps not installed.

Florida Cities Green Meadows

SFWMD Permit Number: 36-00150-W
FDER PWS ID: 5360313

Raw Water Supply:
Raw water is withdrawn from 27 wells located in the vicinity of sections 33 to 36 of Range 26E, Township 45S, and sections 31 and 32 of Range 27E, Township 45S. Fourteen of the wells withdraw water from the water table aquifer, while 13 withdraw water from the sandstone aquifer. The water table wells are 10 inches in diameter, have total depths between 24 and 43 feet, cased depths between 17 and 23 feet, and were drilled between 1983 and 1991. Withdrawal capacities are 200 GPM per well. The sandstone wells are between 10 and 16 inches in diameter, have total depths between 92 and 245 feet, cased depths between 84 and 105 feet, and were drilled between 1974 and 1991. Withdrawal capacities are between 350 and 500 GPM. Specific well information is provided in Table E-17 and the location of the wells are identified in Figure E-16.

The current SFWMD permit was issued May 13, 1982 and expired May 13, 1992. The approved allocations are:

Annual Allocation*	3.35 BGY (9.17 MGD)
Maximum Daily Allocation	15.53 MGD

* The annual allocation includes withdrawals from the Florida Cities Cypress Lakes wellfield.

The 1990 average daily withdrawal was 4.89 MGD with a maximum day of 5.94 MGD.

The service area is located in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 9 MGD (FDER rated capacity) lime softening treatment facility. This facility is located approximately eight miles east of U.S. 41 and north of Alico Road, Fort Myers (Figure E-16). The 1990 average daily flow was 5.19 MGD and the maximum day flow was 6.26 MGD.

Interconnections:
There are three interconnections with two other potable water distribution systems. There are two interconnections with Lee County at Cypress Lake Drive and McGregor Boulevard (4 inches) and U.S. 41 (Tamiami Trail) and Hendry Creek Drive (6 inches). The remaining interconnect is with Gulf Utilities at Alico Road and Oriole Road.

Proposed:
An application is being processed by the SFWMD to construct 10 additional supply wells (5 sandstone aquifer and 5 water table wells) in the Green Meadows wellfield as indicated on Figure E-16. As a percent of pumpage, 70-75 percent of the water will come from the Sandstone aquifer while 25-30 percent will come from the water table aquifer. An increase in the annual allocation to 4.64 BGY or 12.70 MGD (11.20 MGD from Green Meadows wellfield and 1.5 MGD from Cypress Lakes wellfield) is requested. It is projected that a water demand of 12.00 MGD will exist by 1997.

Specific well information on the proposed wells is located in Table E-17 and the location of the wells are identified in Figure E-16.

Future:
Future plans are not available.

Source:
Information was obtained from the Florida Cities Water Company and the SFWMD water use permit files.

TABLE E-17. Florida Cities Green Meadows Potable Water Supply Wells.

Well Number	1	1D	2	2A	3	3A	3B	4	4A	5	5A	6	6A
Planar Coordinates	262853 E 792637 N	262853 E 792637 N	263821 E 792182 N	263821 E 792182 N	263755 E 792923 N	263755 E 792923 N	263755 E 792923 N	265650 E 792218 N	265650 E 792218 N	267947 E 792224 N	267947 E 792224 N	270742 E 792196 N	270742 E 792196 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table	Water Table	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table
Total Depth (ft)	180	40	190	38	190	42	42	185	43	180	24	235	24
Cased Depth (ft)	170	14	110	20	100	17	22	105	20	102	20	90	20
Well Diameter (in)	10	10	10	10	16	10	10	16	10	16	10	16	10
Pump Capacity (gpm)	500	500	500	500	500	500	500	500	500	500	200	350	200
Intake Depth (ft)	--	--	--	--	--	--	--	--	--	--	--		--
Year Drilled	1974	1983	1974	1983	1975	1983	1983	1975	1983	1981	1991	1981	1991

TABLE E-17. (Continued).

Well Number	7	7A	8	8A	9	9A	10	10A	11	11A	12	12A	13	13A
Planar Coordinates	273351 E 792329 N	273351 E 792329 N	275758 E 792218 N	275758 E 792218 N	278055 E 792224 N	278055 E 792224 N	280850 E 792196 N	280850 E 792196 N	283459 E 792329 N	283459 E 792329 N	286224 E 792184 N	286224 E 792184 N	288850 E 792305 N	288850 E 792305 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table
Total Depth (ft)	170	45	190	42	230	42	200	40	210	40	90	25	92	25
Cased Depth (ft)	90	21	90	20	91	20	90	20	90	20	84	20	84	20
Well Diameter (in)	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Pump Capacity (gpm)	500	200	500	500	500	500	500	200	500	200	200	200	500	200
Intake Depth (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Year Drilled	1981	1991	1989	1989	1983	1983	1990	1990	1990	1990	1991	1991	1991	1991

TABLE E-17. (Continued).

Well Number	15	15A	16	16A	17	17A	18	18A	19	19A
Planar Coordinates	262813 E 794767 N	262813 E 794767 N	262746 E 797339 N	62746 E 797339 N	265569 E 797317 N	265569 E 797317 N	267975 E 797329 N	267975 E 797329 N	270655 E 797309 N	270655 E 797309 N
Status	Proposed	Proposed	Proposed	Proposed	Proposed	Proposed	Proposed	Proposed	Proposed	Proposed
Aquifer	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table	Sand-stone	Water Table
Total Depth (ft)		40		40		40		40		40
Cased Depth (ft)		20								
Well Diameter (in)	10	10	10	10	10	10	10	10	10	10
Pump Capacity (gpm)	500	200	500	200	500	200	500	200	500	200
Intake Depth (ft)	--	--	--	--	--	--	--	--	--	--
Year Drilled	--	--	--	--	--	--	--	--	--	--

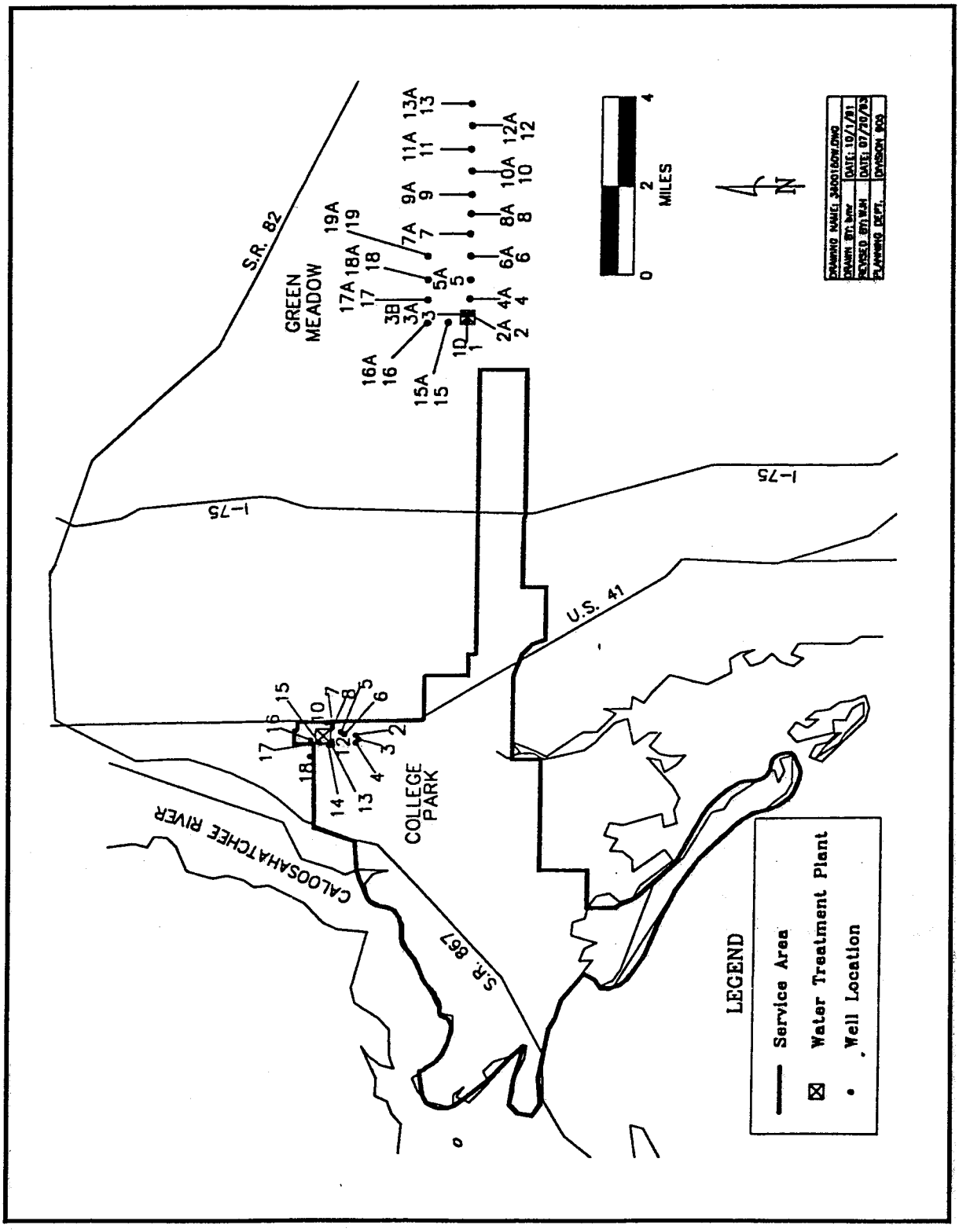


FIGURE E-16. Florida Cities College Parkway (Cypress Lakes) and Green Meadows Potable Water Supply Wells.

Florida Cities Waterway Estates (North System)

SFWMD Permit Number: 36-00152-W
FDER PWS ID: 5360303

Raw Water Supply:
Raw water is withdrawn from 18 wells located in the Waterway Estates development and in North Cape Coral. The wells withdraw water from the water table aquifer and mid- and lower Hawthorn aquifers. They are 6-to-10 inches in diameter, have total depths between 45 and 600 feet, and cased depths between 15 and 300 feet. The wells were drilled between 1957 and 1991and have withdrawal capacities between 25 and 125 GPM. Specific well information is given in Table E-18 and the location of the wells are identified in Figure E-17.

The current SFWMD permit was issued March 14, 1991 and expires April 12, 1995. The approved allocations are:

Annual Allocation:	467.60 MGY (1.28 MGD)
Maximum Daily Allocation:	1.68 MGD

The 1990 average daily withdrawal was 0.99 MGD with a maximum day of 1.13 MGD.

The service area is located in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 1.50 MGD (FDER rated capacity) lime softening treatment facility. This facility is located north of St. Clair Avenue and west of Orange Grove Boulevard, North Fort Myers (Figure E-17). The 1990 average daily flow was 0.90 MGD and the maximum day flow was 1.03 MGD.

Interconnections:
There are three interconnections with two other potable water distribution systems. Two interconnections are with Lee County at U.S. 41 and Pondella Road (6 inches) and the other at Pondella Road and Hancock Creek (6 inches). The other interconnect is with Cape Coral Utilities at Hancock bridge Parkway and 24th Avenue (10 inches).

Proposed:
N/A.

Future:
Various ground water sources are being considered for future water supply as well as purchasing water from Cape Coral.

Source:
Information was obtained from the Florida Cities Water Company and SFWMD water use permit files.

TABLE E-18. Florida Cities Waterway Estates Potable Water Supply Wells.

Well Number	1	2	3	4	6	8	9	10	11
Planar Coordinates	199921 E 842805 N	199906 E 842969 N	199812 E 842866 N	199801 E 843132 N	199812 E 842274 N	199230 E 842169 N	200714 E 842060 N	199898 E 843312 N	198474 E 843717 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Water Table	Water Table	Mid-Hawthorn	Water Table	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn
Total Depth (ft)	45	57	120	48	225	113	230	235	230
Cased Depth (ft)	--	--	--	15	124	13	125	135	133
Well Diameter (in)	8	8	6	8	8	8	8	8	10
Pump Capacity (GPM)	89	70	25	89	80	89	80	25	80
Intake Depth (NGVD)	-42	--	-105	-30	-115	-30	-126	-126	-126
Year Drilled	1957	1957	1966	1966	1971	1976	1971	1972	1983

TABLE E-18. (Continued).

Well Number	12	13	14	15	D-1	D-2	N-1	N-2	N-9
Planar Coordinates	199097 E 843658 N	200267 E 843524 N	200683 E 843504 N	199472 E 846549 N	199911 E 842693 N	200311 E 842693 N	191844 E 854119 N	192409 E 852169 N	192343 E 852960 N
Status	Active	Active	Active	Active	Active	Standby	Active	Active	Active
Aquifer	Water Table	Water Table	Mid-Hawthorn	Mid-Hawthorn	Lower Hawthorn	Lower Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn
Total Depth (ft)	60	80	230	208	600	600	240	240	225
Cased Depth (ft)	40	50	165	160	300	295	140	140	164
Well Diameter (in)	10	10	10	10	4	12	8	8	10
Pump Capacity (GPM)	60	60	80	40	Flowing	Flowing	80	125	125
Intake Depth (NGVD)	-30	-62	-105	-105	--	--	-105	-126	-126
Year Drilled	1983	1983	1983	1988	1987	1991	1970	1975	1975

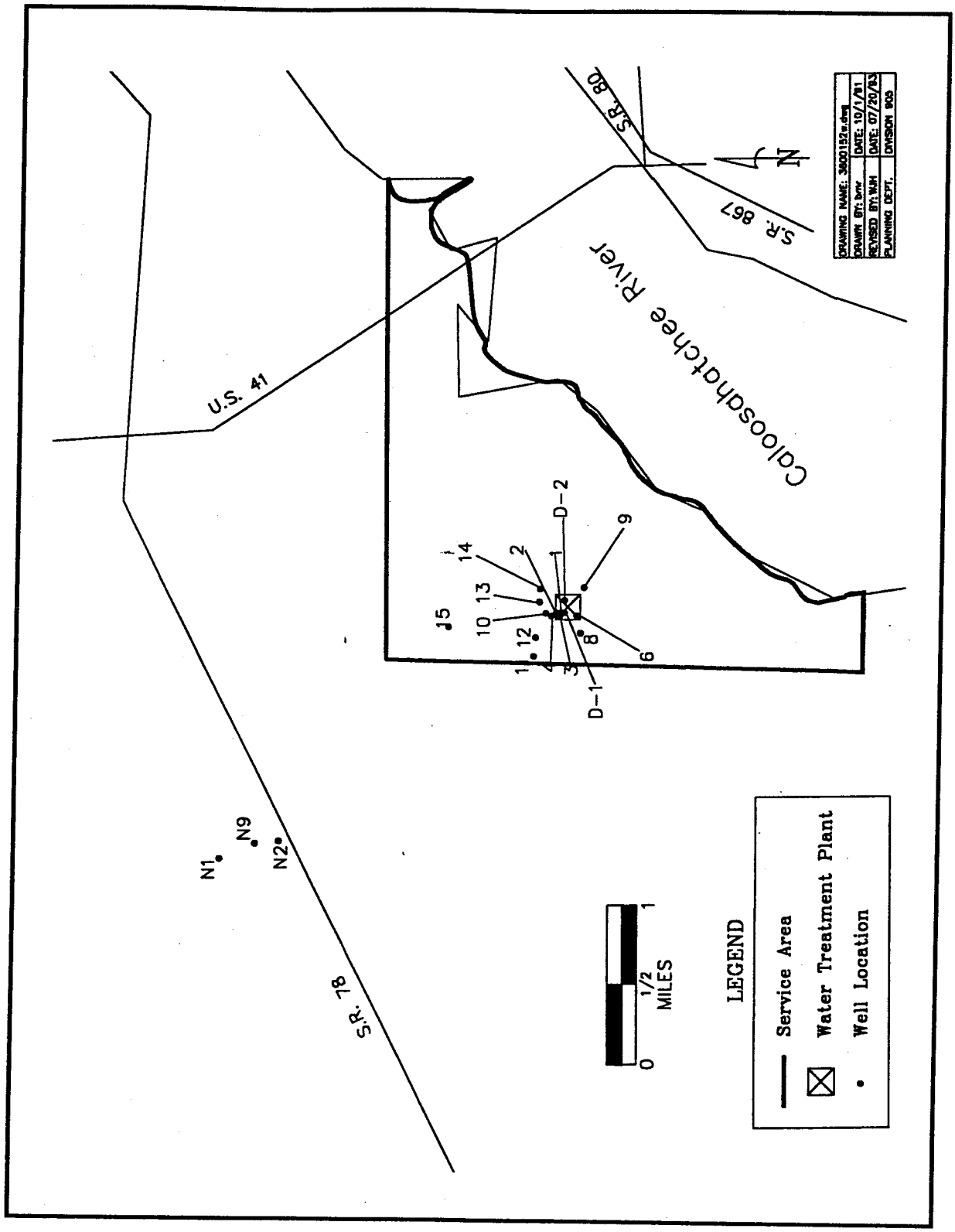


FIGURE E-17. Florida Cities Waterway Estates Potable Water Supply Wells.

Fort Myers

SFWMD Permit Number: 36-00035-W
FDER PWS ID: 5360102

Raw Water Supply:
Raw water is withdrawn from 20 wells located on a 534 acre city-owned site west of Oritz Avenue, between Anderson Avenue and Colonial Boulevard, and north of Eastwood Golf Course. The wells, which were drilled in 1991, withdraw water from the water table aquifer and are 12 inches in diameter. They have total depths between 20 and 34 feet, cased depths between 6 and 13 feet and the withdrawal capacity of each well is 460 GPM. The wellfield is recharged with water from the Caloosahatchee River (C-43) via a river intake structure located three-quarters of a mile east of the W.P. Franklin Lock and Dam. The structure consists of two 10 MGD vertical turbine pumps, a 13-mile pipeline, and a network of canals that distribute the river water throughout the wellfield. The recharge system is operated to maintain the water level in the wellfield between 36 and 48 inches below the ground surface. Specific well information is provided in Table E-19 and the location of the wells are indicated in Figure E-18.

The current SFWMD permit was issued October 15, 1992 and expires October 15, 1997. The approved allocations are:

Surficial Aquifer	
Annual Allocation:	3.26 BGY (8.92 MGD)
Maximum Daily Allocation:	12.48 MGD
C-43 Withdrawal	
Annual Allocation:	3.26 BGY (8.92 MGD)
Maximum Daily Allocation:	17.47 MGD

The 1990 average daily wellfield withdrawal was 6.22 MGD with a maximum day of 9.98 MGD.

The city's service area is located in the Lee County reduced threshold area and is an area of special concern.

Treatment Method:
Existing treatment is provided by a 12 MGD (FDER rated capacity) membrane softening nanofiltration water treatment facility which has a 90 percent efficiency. Concentrate from this process is used for irrigation of the Eastwood Golf Course. This facility is located at the wellfield site (Figure E-18). The 1990 average daily water demand was 6.22 MGD and the maximum day flow was 9.98 MGD.

Interconnections:
The potable water distribution system has four interconnections with Lee County. They are:

Location (City of Fort Myers)	Size (inches)
Armeda Avenue & Prospect Street	6
Collins Street & Evans Avenue	8
Colonial Boulevard & Metro Parkway Boulevard	10
Nuna Avenue and New York Avenue	6

Proposed:
N/A

Future:
The 1987 water system master plan update projected a year 2010 average daily water demand of 22.20 MGD with a maximum day flow of 31 MGD, based on typical local unit flows and projected unit growth for the area. A study of the existing wellfield indicates that it can produce a feasible production rate of 22.50 MGD with approximately 19.50 MGD of river water to the recharge canal system. The system would include a total of 33 wells and modifications to the river recharge system including additional pumping capacity and recharge canals. When the system capacity exceeds the ultimate capacity of the existing wellfield, a southeast wellfield site is proposed to be developed. This site is located in southeast Lee County, south of State Road 82 (Figure E-18). Membrane softening is proposed for future treatment plant expansions.

An expansion of this facility to 20 MGD is projected to be needed by 1995.

Source:
Information was obtained from the City of Fort Myers and SFWMD water use permit files.

TABLE E-19. Fort Myers Potable Water Supply Wells.

Well Number	2	3	4	5	6	7	8	9	10	11
Planar Coordinates	233700 E 837407 N	233137 E 837649 N	233400 E 837023 N	232928 E 837204 N	233052 E 836748 N	232510 E 836784 N	232749 E 836368 N	232152 E 836437 N	232378 E 836026 N	233418 E 836593 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Total Depth (ft)	31	26	31	27	29	29	29	28	30	34
Cased Depth (ft)	10	10	8	8	10	13	10	11	10	9
Well Diameter (in)	12	12	12	12	12	12	12	12	12	12
Pump Capacity (gpm)	460	460	460	460	460	460	460	460	460	460
Intake Depth (ft)	---	---	---	---	---	---	---	---	---	---
Year Drilled	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991

TABLE E-19. (Continued).

Well Number	12	13	15	16	17	27	28	30	31	33
Planar Coordinates	233875 E 836436 N	233647 E 836077 N	233735 E 835653 N	233468 E 835290 N	232937 E 835446 N	231795 E 836089 W	232704 E 837627 N	233317 E 835752 N	232846 E 835939 N	233727 E 836837 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Total Depth (ft)	30	26	26	29	27	27	20	31	31	28
Cased Depth (ft)	10	10	11	9	10	12	6	9	10	9
Well Diameter (in)	12	12	12	12	12	12	12	12	12	12
Pump Capacity (gpm)	460	460	460	460	460	460	460	460	460	460
Intake Depth (ft)	---	---	---	---	---	---	---	---	---	---
Year Drilled	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991

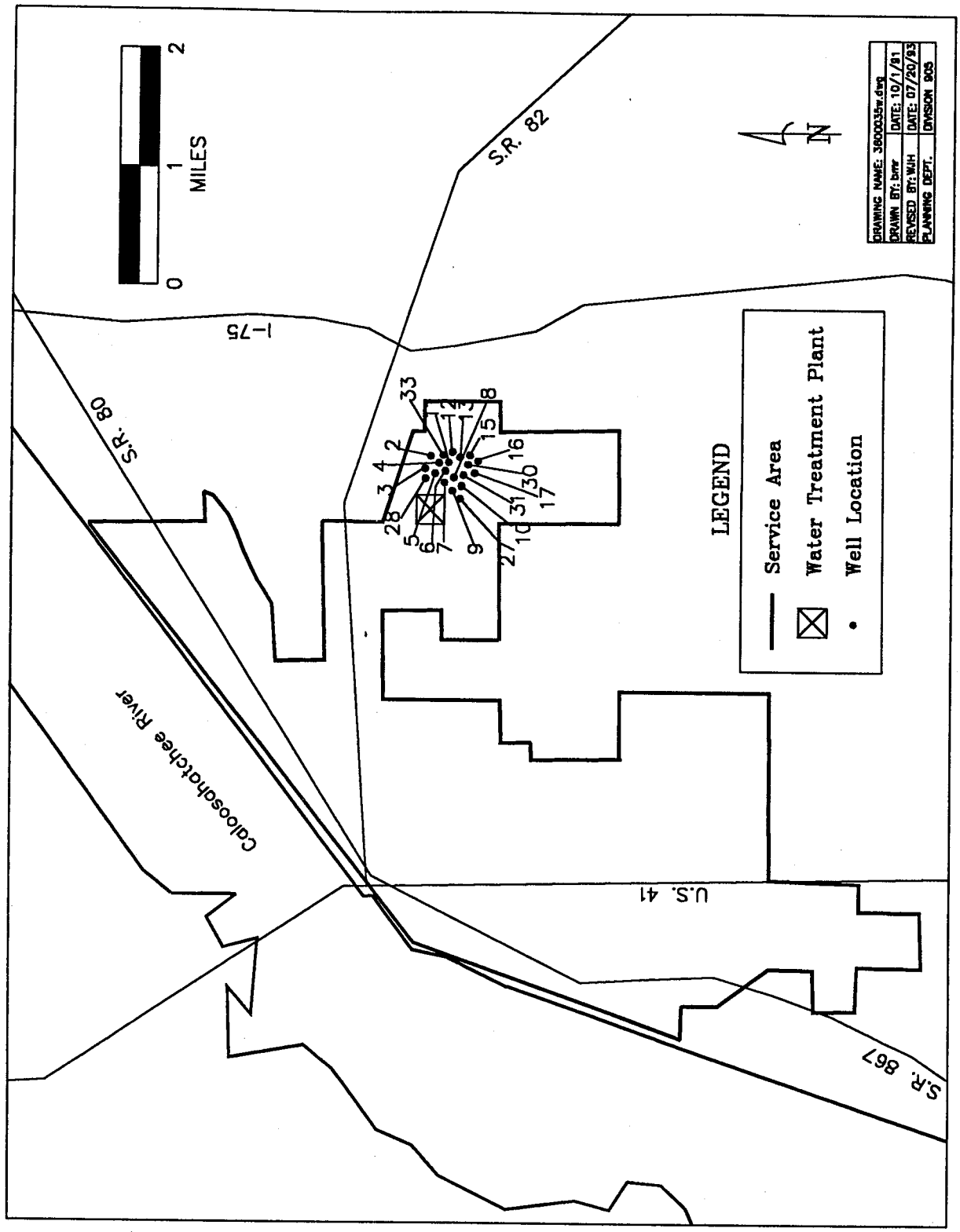


FIGURE E-18. Fort Myers Potable Water Supply Wells.

Greater Pine Island Water Association

SFWMD Permit Number: 36-00045-W
FDER PWS ID: 5360322

Raw Water Supply:
Raw water is withdrawn from three lower Hawthorn aquifer wells located on Greater Pine Island. The wells have total depths between 737 and 770 feet, cased depths between 563 and 598 feet and were drilled in 1991 and 1992. Withdrawal capacities are 825 GPM per well. Specific well information is located in Table E-20 and the location of the wells can be found in Figure E-19. Previously, raw water is withdrawn from eleven wells located in Cape Coral. Two of the wells withdrew water from the lower Hawthorn aquifer while nine withdrew water from the mid-Hawthorn aquifer. The lower Hawthorn wells had total depths of 750 and 850 feet, cased depths of 450 and 350 feet, and were drilled in 1981 and 1978. Withdrawal capacities were 750 and 780 GPM. The mid-Hawthorn wells had total depths between 280 and 290 feet, cased depths between 82 and 86 feet and were drilled in 1965. Withdrawal capacities were between 90 and 120 GPM. This wellfield was deactivated in April of 1993 following startup of the water treatment facility and wellfield. The wells have been plugged and abandoned.

The current SFWMD permit was issued December 12, 1991 and expires December 12, 1996. The approved allocations are:

Annual Allocation	
Cape Coral Wellfield	
All Sources	479.35 MGY (1.31 MGD)
Mid Hawthorn	165.35 MGY (0.64 MGD)
Lower Hawthorn	314.00 MGY (0.71 MGD)
Island Wellfield	479.35 MGY (1.31 MGD)
Maximum Daily Allocation	
Cape Coral Wellfield	
All Sources	1.78 MGD
Mid Hawthorn	0.70 MGD
Lower Hawthorn	1.08 MGD
Island Wellfield	1.78 MGD

The 1990 average daily raw water withdrawal was 1.20 MGD with a maximum day of 1.55 MGD.

The service area is in the Lee County reduced threshold area.

Treatment Method:
Treatment consists of a new 1.50 MGD (FDER rated capacity) reverse osmosis (RO) water treatment facility. This facility was activated in April of 1993 and is located on Greater Pine Island. The location of this facility is shown in Figure E-19. The RO treatment facility has an efficiency of 85 percent with concentrate disposal via percolation ponds on the treatment facility site. Blend water percentages will be 12 percent initially, declining to approximately 8 percent in 2001.

The 1990 average daily flow was 0.88 MGD, with a maximum day flow of 1.30 MGD.

Interconnections:
There is an abandoned Island Water Association 10-inch water line traversing Pine Island Sound which may be converted to an emergency interconnect. In addition, an 8-inch interconnect will be available with the City of Cape Coral in 1994.

Proposed:
N/A

Future:
Utility flow projections for this facility indicate a 2001 average daily raw water withdrawal of 1.45 MGD with a maximum day withdrawal of 1.85 MGD. The proposed construction and expansion schedule for this facility includes three 0.50 MGD expansions in 1999, 2005, and 2010.

Source:
Facility information was obtained from The Pine Island Water Association, Viro Group, Inc. (a division of Missimer & Associates), and SFWMD water use permit files.

TABLE E-20. Greater Pine Island Potable Water Supply Wells.

Well Number	2	3	4	6	7	9	10
Planar Coordinates	168467 E 839489 N	168146 E 840105 N	168058 E 841311 N	168962 E 838851 N	169500 E 838864 N	169043 E 837862 N	169798 E 837456 N
Status	Plugged	Plugged	Plugged	Plugged	Plugged	Plugged	Plugged
Aquifer	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn	Mid-Hawthorn
Total Depth (ft)	280	280	290	290	290	280	280
Cased Depth (ft)	85	84	84	84	84	86	82
Well Diameter (in)	6	6	6	6	6	6	6
Pump Capacity (gpm)	100	100	110	110	120	90	100
Intake Depth (ft)	60-70	60-70	60-70	60-70	60-70	60-70	60-70
Year Drilled	1965	1965	1965	1965	1965	1965	1965

TABLE E-20. (Continued).

Well Number	11	12	RO 2	RO 3	RO 4	RO5	RO 6	RO 7
Planar Coordinates	168310 E 837898 N	169801 E 838203 N	161793 E 839108 N	161810 E 838918 N	137237 E 823434 N	136918 E 823301 N	136782 E 823448 N	137145 E 823190 N
Status	Plugged	Plugged	Plugged	Plugged	Active	Active	Active	Future
Aquifer	Mid-Hawthorn	Mid-Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn
Total Depth (ft)	280	280	850	750	739	770	737	--
Cased Depth (ft)	85	84	350	450	583	563	598	--
Well Diameter (in)	6	6	12	10	12	12	12	--
Pump Capacity (gpm)	110	90	750	780	825	825	825	--
Intake Depth (ft)	60-70	60-70	60-70	60-70	55	55	77	--
Year Drilled	1965	1965	1978	1981	1991	1991	1992	--

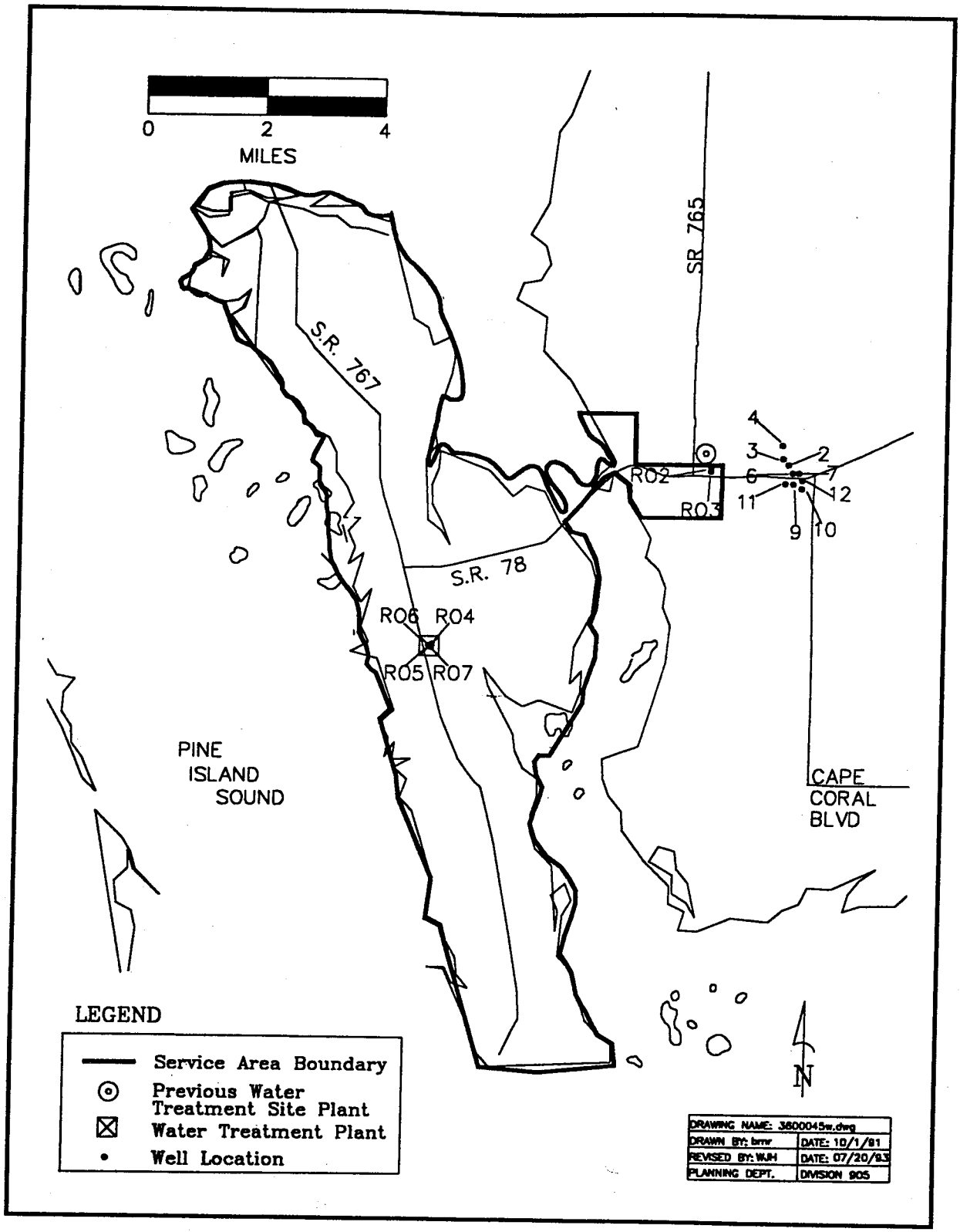


FIGURE E-19. Greater Pine Island Potable Water Supply Wells.

Gulf Utility Corkscrew

SFWMD Permit Number: 36-00122-W
FDER PWS ID: 5364097

Raw Water Supply:

Raw water is withdrawn from 12 wells located in northern Estero. The wells withdraw water from the water table and sandstone aquifers. There are 11 water table wells which are 16 inches in diameter, have total depths between 30 and 42 feet, cased depths between 16 and 22 feet, and were drilled in 1988. The withdrawal capacities are 450 GPM each. There is one sandstone well which is 6 inches in diameter, has a total depth of 123 feet, a cased depth of 83 feet, and was drilled in 1990. The withdrawal capacity is 60 GPM. Specific well information is given in Table E-21 and the location of the wells are identified in Figure E-20.

The current SFWMD permit was issued July 11, 1991 and expires July 11, 1996. The approved allocations are:

Annual Allocation:*	865.00 MGY (2.37 MGD)
Maximum Daily Allocation:	
All Sources:*	3.15 MGD
Water Table Aquifer:	1.05 MGD
Sandstone Aquifer:	0.35 MGD

* The annual allocation includes withdrawals from the Gulf Utility San Carlos wellfield and from wells identified in the proposed section.

The service area is located in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 0.50 MGD (FDER rated capacity) membrane softening treatment facility. The location of this water treatment plant is shown in Figure E-22. This facility has an efficiency of 80 percent. Concentrate disposal is via blending with the reclaimed water from the Gulf Utility Three Oaks wastewater treatment facility which is utilized for irrigation on the Village of Country Creek and Vines golf courses. This facility was placed into service recently. No flow information is available.

Interconnections:
The service area has two existing interconnects with Florida Cities Water Company's South system at Lee Road and Alico Road and the other along Island Park Road.

Proposed:
The referenced permit approved four additional sandstone aquifer wells. These wells will be six inches in diameter, have total depths of 125 feet and cased depths of 85 feet. The withdrawal capacity will be 60 GPM. Specific well information is located in Table E-21 and the location of the wells are identified in Figure E-20.

Future:
This facility will have an ultimate capacity of 3 MGD. To achieve this, five 0.50 MGD expansions are projected to occur in 1993, 1996, 1999, 2002 and 2005.

The water demand for the Gulf Utility service area is projected to increase to 3.15 MGD average daily demand with a maximum day demand of 4.20 MGD by 2001.

Source:
Information was obtained from Gulf Utility and SFWMD water use permit files.

TABLE E-21. Gulf Utility Corkscrew Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8
Planar Coordinates	252898 E 761653 N	252870 E 761218 N	252882 E 760767 N	252959 E 760289 N	252915 E 759887 N	252900 E 759230 N	252153 E 759049 N	251673 E 759136 N
Status	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
Aquifer	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Total Depth (ft)	31	40	40	39	42	32	39	30
Cased Depth (ft)	16	19	19	19	20	22	19	20
Well Diameter (in)	16	16	16	16	16	16	16	16
Pump Capacity (GPM)	450	450	450	450	450	450	450	450
Intake Depth (ft)	--	--	--	--	--	--	--	--
Year Drilled	1988	1988	1988	1988	1988	1988	1988	1988

TABLE E-21. (Continued).

Well Number	9	10	11	12	17	18	19	20
Planar Coordinates	251130 E 759144 N	250368 E 759173 N	249603 E 759182 N	252760 E 766565 N	252060 E 764694 N	252201 E 761793 N	252197 E 759239 N	250986 E 759161 N
Status	Existing	Existing	Existing	Existing	Proposed	Proposed	Proposed	Proposed
Aquifer	Water Table	Water Table	Water Table	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
Total Depth (ft)	30	30	30	123	125	125	125	125
Cased Depth (ft)	21	18	17	83	85	85	85	85
Well Diameter (in)	16	16	16	6	6	6	6	6
Pump Capacity (GPM)	450	450	450	60	60	60	60	60
Intake Depth (ft)	--	--	--	--	--	--	--	--
Year Drilled	1988	1988	--	1990	--	--	--	--

Gulf Utility San Carlos

SFWMD Permit Number: 36-00122-W
FDER PWS ID: 5360243

Raw Water Supply:
Raw water is withdrawn from four wells located in San Carlos Park. The wells, which were constructed in 1980 and 1984, withdraw water from the water table aquifer, are 8 inches in diameter, have total depths between 40 and 45 feet, and cased depths between 18 and 22 feet. The withdrawal capacities are between 211 and 283 GPM. Specific well information is provided in Table E-22 and the location of the wells are identified in Figure E-20.

The current SFWMD permit was issued July 11, 1991 and expires July 11, 1996. The approved allocations are:

Annual Allocation: *	865.00 MGY (2.37 MGD)
Maximum Daily Allocation:	
All Sources:*	3.15 MGD
Water Table Aquifer:	1.75 MGD

* The annual allocation includes withdrawals from the Gulf Utility Corkscrew wellfield.

The service area is located in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 2.50 MGD (FDER rated capacity) lime softening treatment facility. The location of this water treatment plant is shown in Figure E-20. The 1990 average daily flow was 1.46 MGD.

Interconnections:
The service area has two existing interconnects with Florida Cities Water Company's South system at Lee Road and Alico Road and the other along Island Park Road.

Proposed:
N/A

Future:
The water demand for the Gulf Utility service area is projected by the utility to increase to 3.15 MGD average daily demand with a maximum day demand of 4.20 MGD by 2001. To meet this demand, a new membrane softening treatment facility known as Gulf Utility Corkscrew has been constructed in Estero.

Source:
Information was obtained from Gulf Utility and SFWMD water use permit files.

TABLE E-22. Gulf Utility San Carlos Potable Water Supply Wells.

Well Number	13	14	15	16
Planar Coordinates	239211 E 780782 N	239199 E 781178 N	239198 E 781825 N	239210 E 782620 N
Status	Active	Active	Active	Active
Aquifer	Water Table	Water Table	Water Table	Water Table
Total Depth (ft)	41	45	40	40
Cased Depth (ft)	19	22	18	19
Well Diameter (in)	8	8	8	8
Pump Capacity (GPM)	283	266	283	211
Intake Depth (ft)	--	--	--	--
Year Drilled	1980	1984	1980	1980

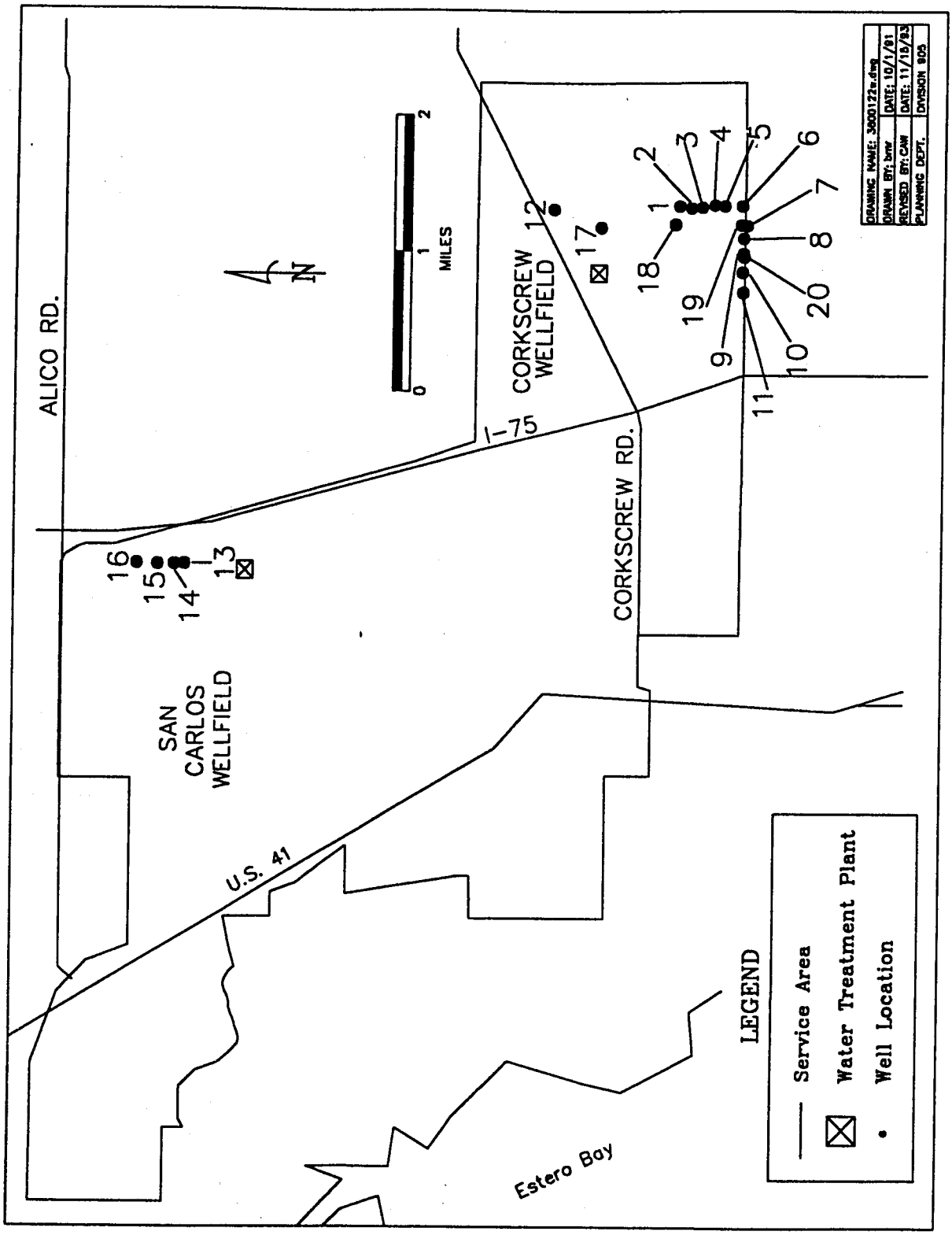


FIGURE E-20. Gulf Utility Corkscrew and San Carlos Potable Water Supply Wells.

The Island Water Association

SFWMD Permit Number: 36-00034-W
FDER PWS ID: 5360146

Raw Water Supply:
Raw water is withdrawn from 19 wells located on Sanibel Island. The wells, which were drilled between 1973 and 1991, withdraw water from the lower Hawthorn and Suwannee aquifers, are 4 to 12 inches in diameter, have total depths between 574 to 770 feet, and cased depths between 440 and 668 feet. The withdrawal capacities range from 30 to 525 GPM. The lower Hawthorn aquifer was used for raw water supply to the electrodialysis (ED) plant and the Suwannee aquifer is used for raw water supply to the reverse osmosis plant as well as a portion of the ED raw water supply. Specific well information is provided in Table E-23 and the location of the wells can be found in Figure E-21.

The current SFWMD permit was issued December 10, 1992 and expires December 10, 1997. The approved allocations are:

Annual Allocation:	1.49 BGY (4.08 MGD)
Maximum Daily Allocation:	6.16 MGD

Three of the wells are designated as reserve while one is indicated as standby. Reserve wells do not have pumps installed and would require some modifications to make them operational, while standby wells are operational, but not utilized on a regular basis.

This service area is in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 4.7 MGD reverse osmosis plant (FDER rated capacity). The reverse osmosis plant was recently modified to increase its capacity to 4.7 MGD. The facilities are located at the intersection of San-Cap Road and Rabbit Road on Sanibel Island (Figure E-21). The brine reject is disposed via an outfall 600 feet offshore into the Gulf of Mexico. The combined treatment plant efficiency is approximately 80 percent. The 1990 finished water system average daily flow was 3 MGD (0.53 MGD ED, 2.47 MGD RO) and the maximum day flow was 4.68 MGD. There was a 1.17 MGD electrodialysis plant that has been removed from service and its capacity will be replaced via expansion to the RO capacity.

Interconnections:
An existing abandoned 10-inch water supply main with the Pine Island Water Association's system is proposed to be converted to an emergency interconnect. The feasibility of this is being evaluated.

Proposed:
Three additional Suwanee wells are permitted and planned to be drilled in 1995.

Future:
Additional water supply for increased demands is proposed to come from four Suwannee wells located in the vicinity of the existing wells (Figure E-21). The existing treatment facility is considered adequate to serve buildout water demands.

Source:
Information was obtained from The Island Water Association and SFWMD water use permit files.

TABLE E-23. Island Water Association Potable Water Supply Wells.

Well Number	H3	H5	H6	H7	H8	H9	H10	H12	H13	H14	H15
Planar Coordinates	137154E 768267N	140823E 766912N	142055E 766627N	142988E 766519N	143984E 766434N	144722E 766489N	145417E 766684N	134684E 769432N	138608E 766919N	133011E 769760N	122708E 776511N
Status	Active ED	Active ED	Reserve	Reserve	Standby	Active ED	Active ED	Active ED/RO	Active ED	Active ED	Reserve
Aquifer	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn	Lower Hawthorn
Total Depth (ft)	651	676	700	702	678	675	625	650	588	605	610
Cased Depth (ft)	561	508	647	642	508	504	500	610	502	505	440
Well Diameter (in)	4	6	6	6	6	6	10	10	10	8	10
Pump Capacity (gpm)	250	30	250	250	250	250	350	250	130	250	250
Intake Depth (ft)	80	80	--	--	80	80	80	140	140	140	140
YearDrilled	1973	1975	1975	1975	1975	1975	1975	1977	1982	1988	1978

TABLE E-23. (Continued).

Well Number	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Planar Coordinates	136902E 767590N	137228E 767612N	136777E 767752N	135193E 768752N	129774E 770938N	130436E 770938N	130182E 769923N	124739E 774373N	122794E 776983N	122601E 777271N	122413E 777572N
Status	Active RO	Active RO	Active RO	Active ED/RO	Active ED/RO	Active RO	Active RO	Active RO	Proposed RO	Proposed RO	Proposed RO
Aquifer	Suwannee	Suwannee	Suwannee	Suwannee	Suwannee	Suwannee	Suwannee	Suwannee	Suwannee	Suwannee	Suwannee
Total Depth (ft)	716	696	705	720	770	770	770	750	750	750	750
Cased Depth (ft)	660	661	660	668	664	649	639	618	620	620	620
Well Diameter (in)	12	8	10	10	10	10	10	10	10	10	10
Pump Capacity (gpm)	525	525	525	525	525	525	525	525	525	525	525
Intake Depth (ft)	140	140	140	145	160	160	160	160	160	160	160
Year Drilled	1978	1979	1981	1984	1985	1988	1988	1991	---	---	---

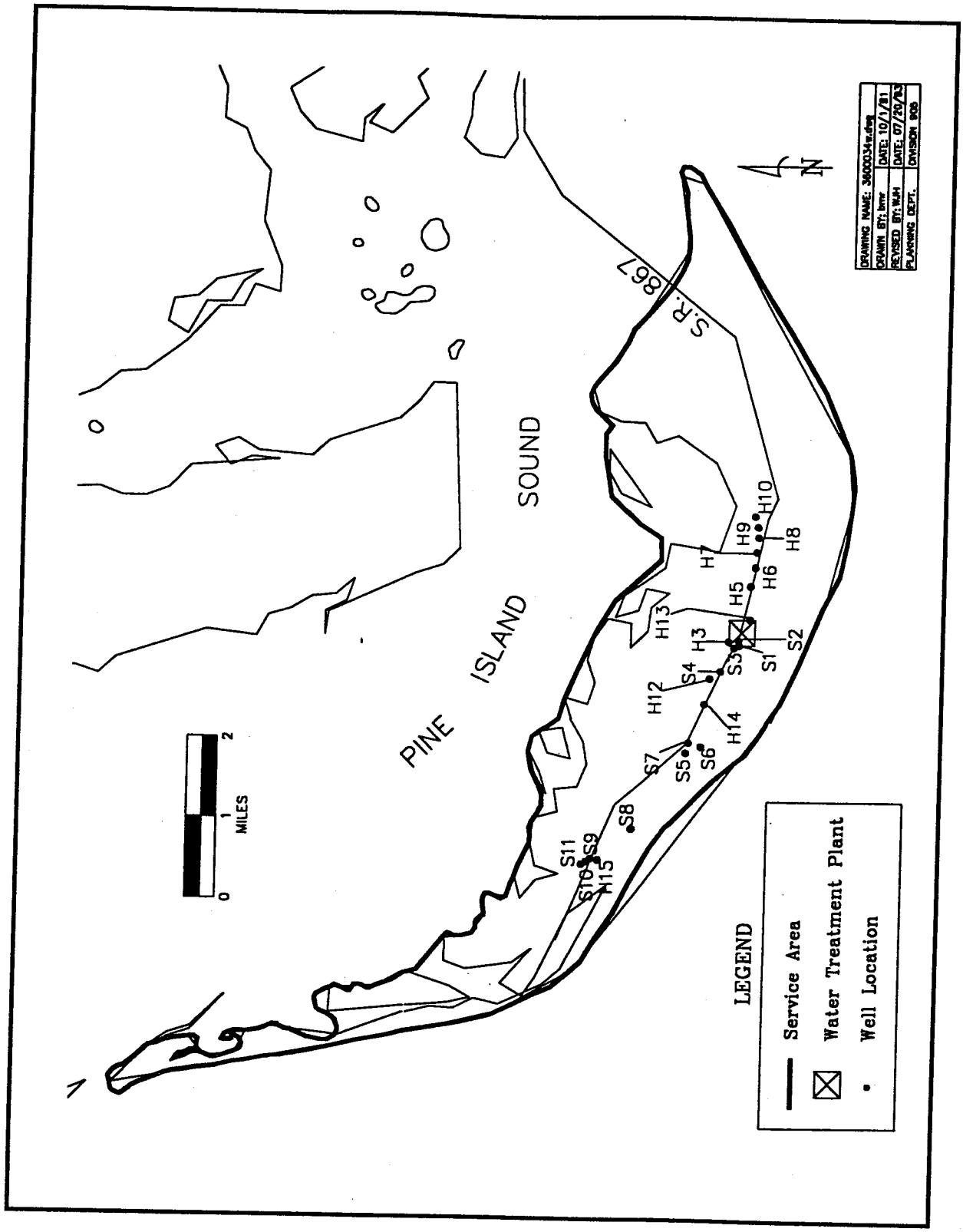


FIGURE E-21. Island Water Association Potable Water Supply Wells.

Lee County Utilities Corkscrew

SFWMD Permit Number: 36-00003-W
FDER PWS ID: 5364048

Raw Water Supply:
Raw water is withdrawn from 23 wells located in the vicinity of the water treatment plant in the southeastern portion of the county. The wells withdraw water from the sandstone and water table aquifers, and are 12 inches in diameter. There are 17 water table wells that have total depths between 105 and 150 feet, cased depths between 35 and 60 feet, and were drilled in 1980 and 1982. The withdrawal capacity of each water table well is 500 GPM. There are six sandstone wells that have total depths between 205 and 300 feet, cased depths between 135 and 210 feet, and were drilled in 1980. The withdrawal capacities of each sandstone well is 350. Specific well information is provided in Table E-24 and the location of all wells can be found in Figure E-22.

The current SFWMD permit was issued January 7, 1982 and expired January 7, 1992. The approved allocations are:

Annual Allocation:	3.65 BGY (10.00 MGD)
Maximum Daily Allocation:	19.10 MGD

The service area is located in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 10 MGD (FDER rated capacity) lime softening treatment facility. This facility is located at 16101 Alico Road, Fort Myers (Figure E-22). The 1990 average daily flow was 5.56 MGD, with a maximum day flow of 8.58 MGD.

Interconnections:
The water distribution system has eight interconnects, four with Fort Myers and four with Florida Cities Water Company. They are:

Location	Size (inches)
City of Fort Myers	
Armeda Avenue & Prospect Street	6
Collins Street & Evans Avenue	8
Colonial Boulevard & Metro Parkway Boulevard	10
Nuna Avenue and New York Avenue	6
Florida Cities Waterway Estates (North System)	
U.S. 41 & Pondella Road	6
Pondella Road & Betmar Boulevard	6
Florida Cities South Fort Myers	
U.S. 41 & Old Gladiolus Drive	6
McGregor Boulevard & Cypress Lake Drive	4

In addition to these, interconnects also exist between this facility and the Lee County Olga service area.

Proposed:
An application to modify this permit is under review by the SFWMD. Lee County indicates that their 1998 annual potable water demand is expected to increase to 13.37 MGD. The demand is expected to be satisfied by 3.42 MGD from the Olga water treatment plant and 9.95 MGD from the Corkscrew water treatment plant. The

application requests the current allocations except for an increase of 0.30 MGD in maximum day at Corkscrew.
This application also proposes to expand the Corkscrew wellfield with the addition of eight wells. The wells will be located in four clusters, with each cluster consisting of one sandstone well and one water table well. Specific well information is located in Table E-24 and the location of these wells are identified in Figure E-20. The purpose of the wellfield expansion is to limit expected drawdowns in the water table aquifer to less than one foot under existing wetlands, while increasing the water supply as needed to meet projected demands.

The county is also planning to construct a second river crossing to serve the north Fort Myers area. The pipeline will be attached to the Edison Bridge, which is under construction. The primary source of water for this pipeline will be the Corkscrew facility.

Future:
The Department of Lee County Utilities' 20-Year Master Plan dated November 1991 indicates that the Corkscrew facility will have an ultimate capacity of 25 MGD. This will be accomplished through an immediate expansion to 15 MGD and expansions to 20 MGD and 25 MGD in 1997 and 2007, respectively. The 5 MGD immediate expansion has been delayed pending development of the LWC Water Supply Plan. The proposed treatment process will remain lime softening and the raw water source will be through expansion of the existing wellfield. The wellfield will consist of an additional 25 wells (16 water table and 9 limestone wells) to the existing wells located in a 16 square mile area south of the existing wellfield. It is proposed that 75 percent of the water will come from the water table aquifer while the remaining 25 percent will come from the sandstone aquifer.

The Olga treatment plant is proposed to remain at 5 MGD. Lee County is investigating the feasibility of constructing an artificial aquifer recharge system and wellfield in the Lehigh Acres area which would utilize water from the Caloosahatchee River. The utility believes that the proposed wellfield would be a more reliable source of water during drought periods.

The plan also proposes to construct a new treatment facility in the North Fort Myers area north of the river and east of U.S. 41. The initial capacity will be 5 MGD, when constructed in 2000, and will later be expanded to 10 MGD after 2010. The treatment process will be desalination with raw water from the lower Hawthorn. The wellfield will ultimately consist of 18 production wells and a withdrawal of 12 MGD.

Source:
Information was obtained from the Department of Lee County Utilities and SFWMD water use permit files.

TABLE E-24. Lee County Corkscrew Wellfield Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8	9	10	11	12
Planar Coordinates	269765 E 773808 N	271683 E 774278 N	273369 E 774752 N	269867 E 770126 N	271720 E 770076 N	273462 E 770075 N	269827 E 771103 N	270692 E 771140 N	271625 E 771164 N	272496 E 771175 N	273381 E 771225 N	269716 E 770131 N
Status	Out of Service	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Total Depth (ft)	205	250	270	295	295	300	135	140	140	150	145	140
Cased Depth (ft)	135	160	180	185	205	210	45	50	55	60	55	50
Well Diameter (in)	12	12	12	12	12	12	12	12	12	12	12	12
Pump Capacity (gpm)	350	350	350	350	350	350	500	500	500	500	500	500
Intake Depth (ft)	100	100	100	100	100	100	40	40	45	45	45	45
Year Drilled	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980

TABLE E-24. (Continued).

Well Number	13	14	15	16	18	19	20	21	22	23	24
Planar Coordinates	270709 E 770157 N	271596 E 770100 N	272486 E 770094 N	273357 E 770073 N	270504 E 773165 N	271578 E 773135 N	272459 E 773186 N	270427 E 773948 N	271476 E 774207 N	272349 E 774477 N	273114 E 774721 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Out of Service	Active	Active
Aquifer	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Total Depth (ft)	140	150	145	150	115	120	120	105	110	115	120
Cased Depth (ft)	50	55	55	60	45	50	50	35	40	45	50
Well Diameter (in)	12	12	12	12	12	12	12	12	12	12	12
Pump Capacity (gpm)	500	500	500	500	500	500	500	500	500	500	500
Intake Depth (ft)	45	45	45	45	40	45	45	30	35	40	45
Year Drilled	1980	1980	1980	1980	1982	1982	1982	1982	1982	1982	1982

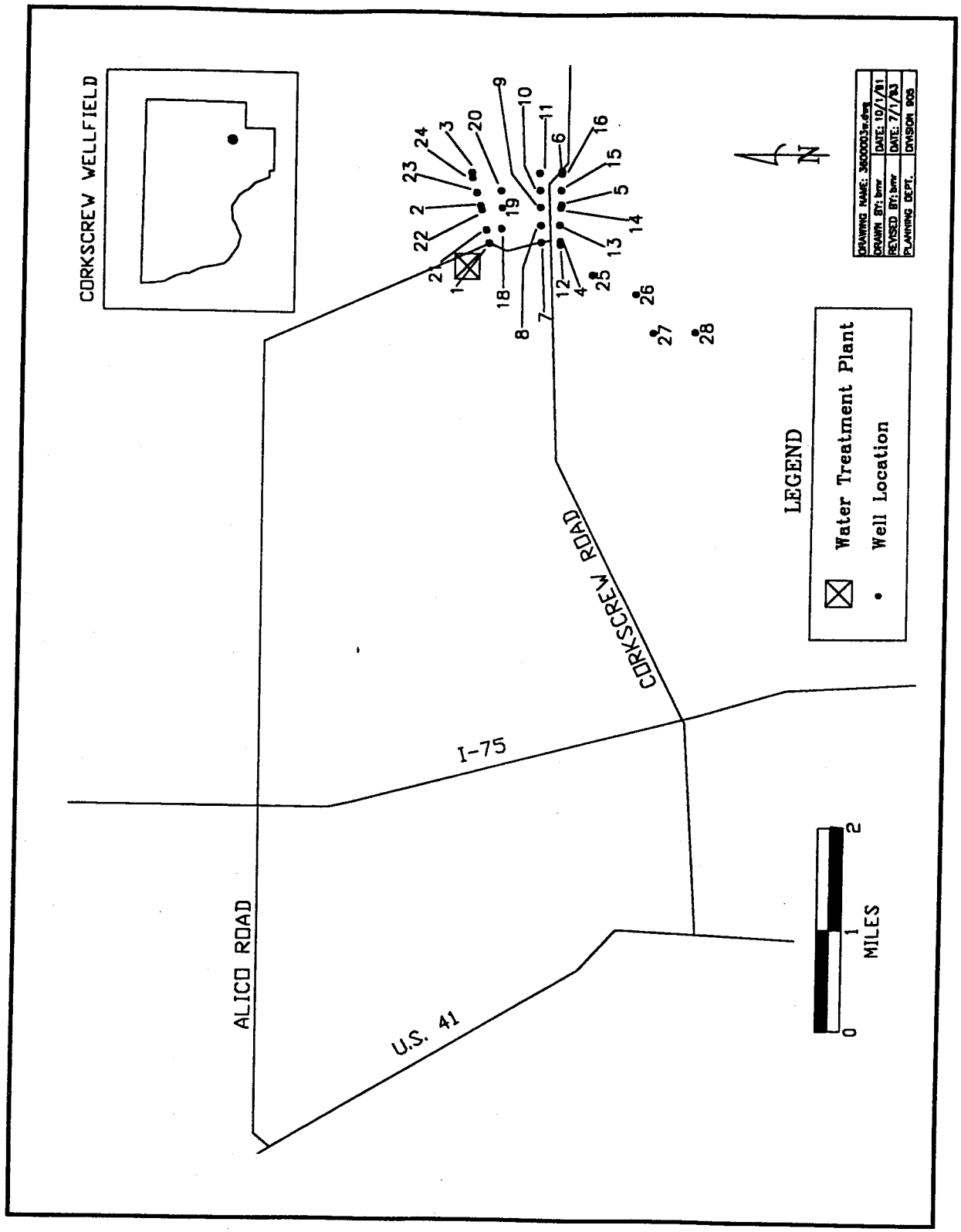


FIGURE E-22. Lee County Corkscrew Potable Water Supply Wells.

North Fort Myers Emergency Wellfield and Treatment Facility

SFWMD Permit Number: 36-00178-W

Raw Water Supply:
Raw water is withdrawn from two wells located at the 2 million gallon finished water reservoir in North Fort Myers. The wells withdraw water from the sandstone and mid-Hawthorn aquifers, are 8 inches in diameter, have total depths of 198 and 105 feet, and cased depths of 138 and 64 feet, respectively. The wells were drilled in 1979. The design pumping capacities are 15 and 125 GPM, respectively. Specific well information is given in Table E-25 and the location of the wells can be found in Figure E-23.

The current SFWMD permit was issued August 11, 1988 and expired January 7, 1992. The approved allocations are:

Maximum Daily Allocation: 0.20 MGD

It is further allocated that a maximum day withdrawal of 0.18 MGD from the mid-Hawthorn and 0.02 from the sandstone has been allocated. An annual allocation is not stated because the wells are for emergency short-term use only. This facility is to be used only when the Olga water treatment plant cannot deliver enough water to the 2 million gallon reservoir.

Treatment Method:
This is an emergency facility which consists of an aeration treatment process, with the finished water blended with water from the Olga plant in a 2 million gallon storage tank. This facility is located at the intersection of Old Bayshore Road and Bayshore Road in North Fort Myers (Figure E-23). This system has not been used in the past couple of years.

Interconnections:
This is an emergency facility only. Interconnects for the distribution system can be found in the Lee County Utilities Olga and Corkscrew utility capsules.

Proposed:
An application to modify their permit is under review by the SFWMD. Lee County indicates their 1998 annual potable water demand is expected to increase to 13.37 MGD with a maximum day of 19.36 MGD. The demand is expected to be satisfied by 3.42 MGD from the Olga WTP and 9.95 MGD from the Corkscrew WTP. The North Fort Myers facilities are proposed to remain as a backup system. The application requests the current allocations except for an increase of 0.30 MGD in the maximum day at Corkscrew.

The county is also planning to construct a second river crossing to serve the North Fort Myers area. The pipeline will be attached to the Edison Bridge, which is under construction. The primary source of water for this pipeline will be the Corkscrew facility.

Future:
The Department of Lee County Utilities 20-Year Master Plan dated November, 1991 indicates a new treatment facility will be constructed in the North Fort Myers area north of the river and east of U.S. 41. The initial capacity will be 5 MGD constructed in 2000 which will later be expanded to 10 MGD after 2010. The treatment process

will be desalination with raw water from the Lower Hawthorn. The wellfield will ultimately consist of 18 production wells and a withdrawal of 12 MGD.

Source:
Information was obtained from the Department of Lee County Utilities and SFWMD water use permit files.

TABLE E-25. Lee County North Fort Myers Emergency Facility Potable Water Supply Wells.

Well Number	1	2
Planar Coordinates	226702 E 865374 N	226675 E 865253 N
Status	Active	Active
Aquifer	Mid-Hawthorn	Sandstone
Total Depth (ft)	198	105
Cased Depth (ft)	138	64
Well Diameter (in)	8	8
Pump Capacity (GPM)	125	15
Intake Depth (ft)	60	60
Year Drilled	1979	1979

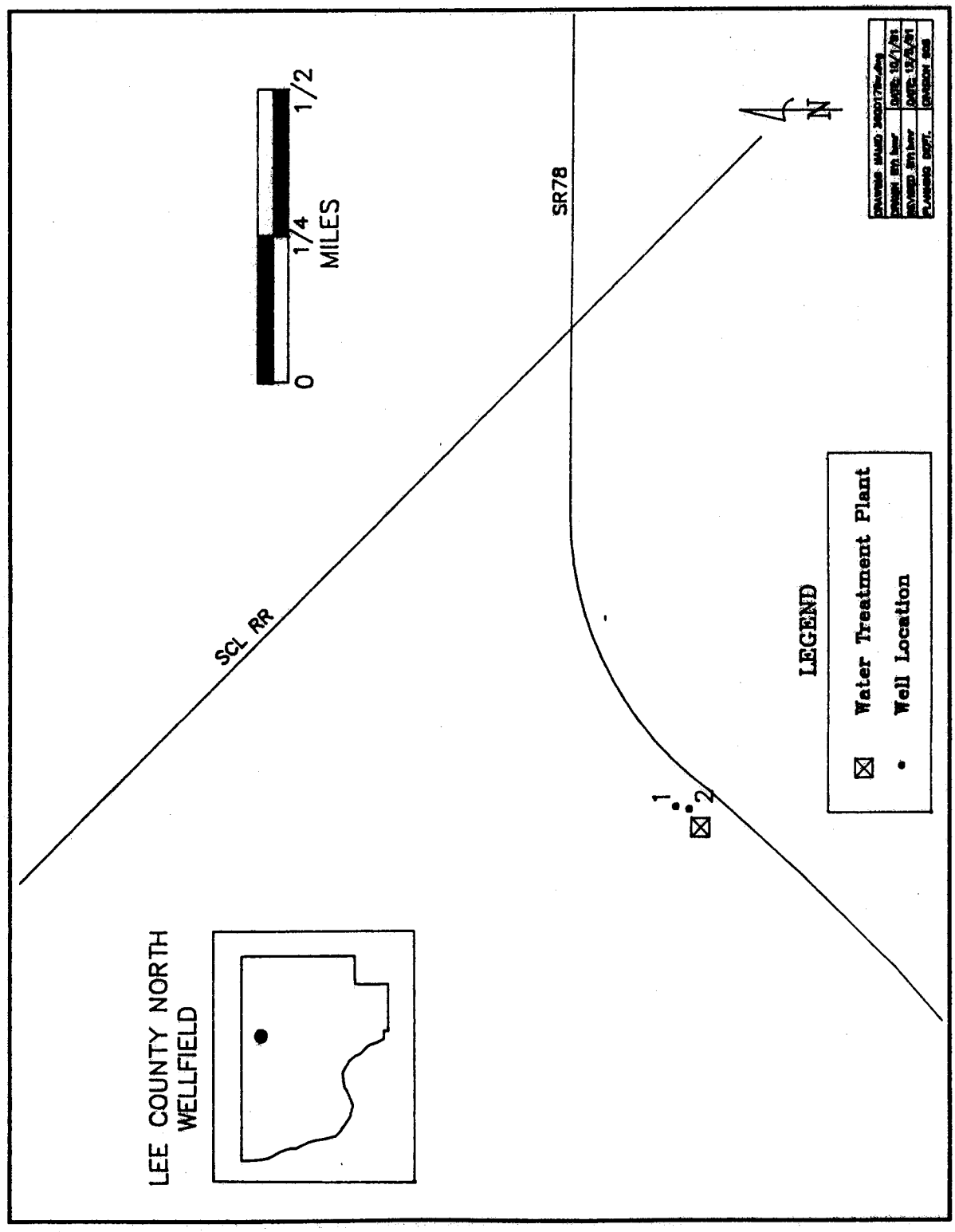


FIGURE E-23. Lee County North Fort Myers Emergency Facility Potable Water Supply Wells.

Lee County Utilities Olga

SFWMD Permit Number: 36-00003-W
FDER PWS ID: 5360170

Raw Water Supply:
Raw water is withdrawn from the Caloosahatchee River (C-43) via a river intake structure located approximately three-quarters of a mile east of the W.P. Franklin Lock and Dam.

The current SFWMD permit was issued January 7, 1982 and expired January 7, 1992. The approved allocations are:

Annual Allocation:	1.25 BGY (3.42 MGD)
Maximum Daily Allocation:	5.00 MGD

The service area is located in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 5 MGD (FDER rated capacity) lime softening treatment facility. This facility is located at 1450 Werner Drive, Alva (Figure E-24). The 1990 average daily flow was 3.32 MGD, and the maximum day flow was 5.16 MGD.

In addition to this facility, an emergency facility is located in North Fort Myers. The emergency facility consists of two supply wells and an aeration treatment process. The finished water from the emergency facility is blended with water from the Olga plant in a 2 million gallon storage tank. This facility is used only when the Olga water treatment plant cannot deliver sufficient water to the 2 million gallon reservoir. It has not been utilized in the past couple of years.

Interconnections:
This facility serves the northern portion of the Lee County service area, but is interconnected with the Lee County South service area and transfer of water between the two is on an as needed basis. The system (North and South) has eight interconnects, four with Fort Myers and four with Florida Cities Water Company. They are:

Location	Size (inches)
City of Fort Myers	
Armeda Avenue & Prospect Street	6
Collins Street & Evans Avenue	8
Colonial Boulevard & Metro Parkway Boulevard	10
Nuna Avenue and New York Avenue	6
Florida Cities Waterway Estates (North System)	
U.S. 41 & Pondella Road	6
Pondella Road & Betmar Boulevard	6
Florida Cities South Fort Myers	
U.S. 41 & Old Gladiolus Drive	6
McGregor Boulevard & Cypress Lake Drive	4

Proposed:
An application to modify this permit is under review by the SFWMD. Lee County indicates that their 1998 annual potable water demand is expected to increase to 13.37 MGD. The demand is expected to be satisfied by 3.42 MGD from the Olga water treatment plant and 9.95 MGD from the Corkscrew water treatment plant. Maximum month and maximum day demands are expected to be 15.24 and 19.36 MGD, respectively. The current allocation is being requested for the Olga facility.

The county is also planning to construct a second river crossing to serve the North Fort Myers area. The pipeline will be attached to the Edison River Bridge, which is under construction. The primary source of water for this pipeline will be the Corkscrew facility.

Future:
The Department of Lee County Utilities' 20-Year Master Plan, dated November 1991, indicates that the Olga treatment plant will remain 5 MGD. The county is investigating the feasibility of constructing an artificial aquifer recharge system and wellfield in the Lehigh Acres area which would utilize water from the Caloosahatchee River. The utility believes that the proposed wellfield would be a more reliable source of water during drought periods.

Source:
Information was obtained from the Department of Lee County Utilities and SFWMD water use permit files.

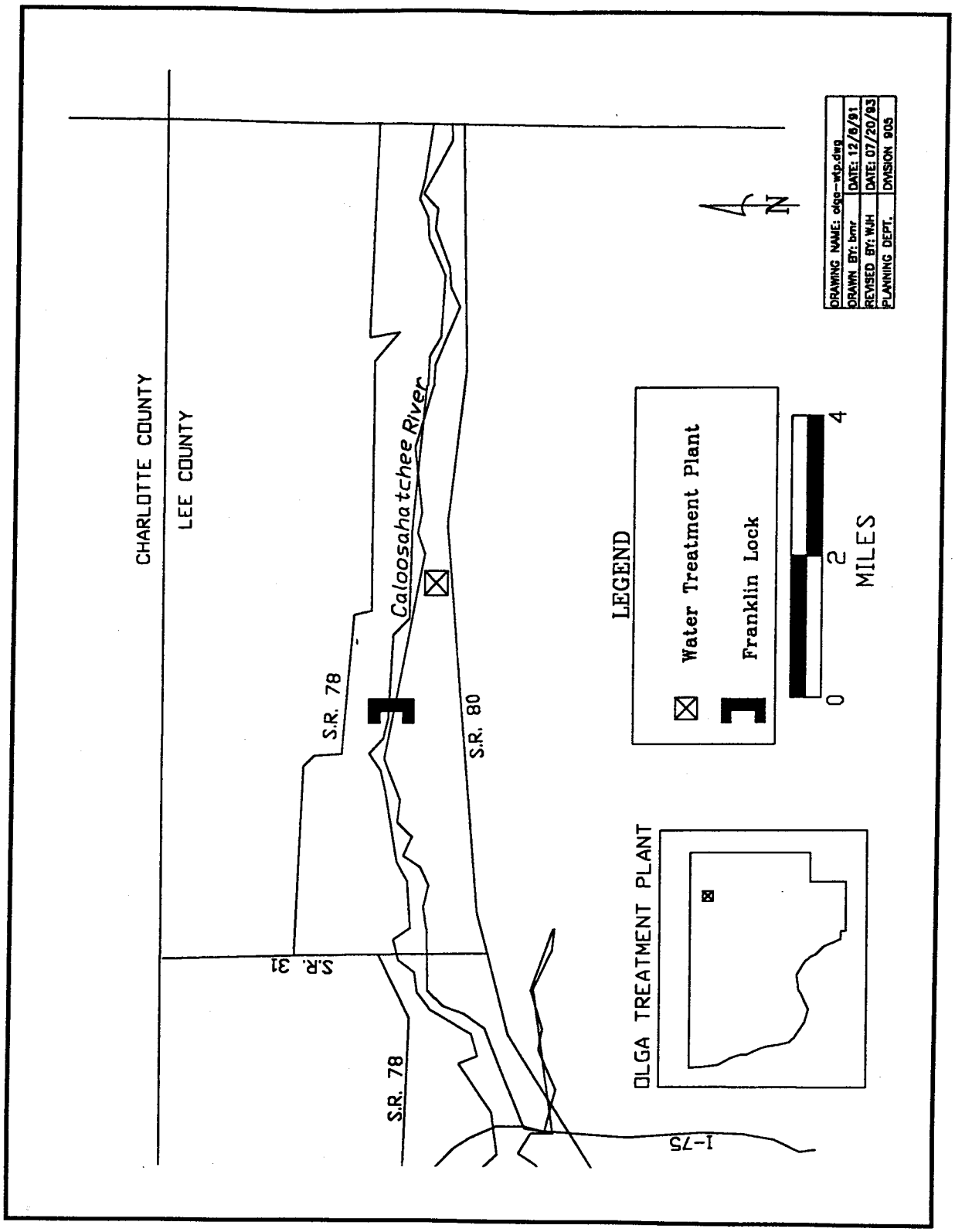


FIGURE E-24. Lee County Olga Water Treatment Plant.

Lehigh Utilities

SFWMD Permit Number: 36-00166-W
FDER PWS ID: 5360172

Raw Water Supply:
Raw water is withdrawn from 10 wells located in the Lehigh Utilities service area. The wells, which were drilled between 1955 and 1989, withdraw water from the sandstone aquifer, are 6 and 8 inches in diameter, have total depths between 62 and 85 feet, and cased depths between 50 and 63 feet. The withdrawal capacities are between 100 and 350 GPM. Specific well information is provided in Table E-26 and the location of the wells can be found in Figure E-25.

The current SFWMD permit was issued June 13, 1991 and expires June 13, 1996. The approved allocations are:

Annual Allocation:	759.00 MGY (2.08 MGD)
Maximum Daily Allocation:	2.74 MGD

The 1990 average daily withdrawal was 1.28 MGD, with a maximum day withdrawal of 1.81 MGD.

The service area is located in the Lee County reduced threshold area.

Treatment Method:
Treatment is provided by a 2.50 MGD (FDER rated capacity) lime softening treatment facility. This facility is located at 305 Coolidge Avenue, Lehigh Acres (Figure E-25). The 1990 average daily flow was 1.23 MGD, and the maximum day flow was 1.55 MGD.

Interconnections:
There are no interconnections with other potable water distribution systems.

Proposed:
Development of a water supply master plan is anticipated to be completed this year.

Future:
It is estimated that the average daily demand will increase to 2.08 MGD, with a maximum day demand of 2.89 MGD by 1996.

Source:
Information was obtained from Lehigh Utilities, Inc, Southern States Utilities and SFWMD water use permit files.

TABLE E-26. Lehigh Utilities Potable Water Supply Wells.

Well Number	1	2	3	4	5	6	7	8	9	10
Planar Coordinates	292448 E 826739 N	291046 E 825234 N	289213 E 825043 N	290225 E 827102 N	290943 E 826578 N	289426 E 826282 N	292688 E 824835 N	290591 E 824057 N	289309 E 823634 N	291115 E 823841 N
Status	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Aquifer	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Sand-stone	Sand-stone
Total Depth (ft)	65	69	68	85	66	62	85	80	80	80
Cased Depth (ft)	50	52	58	50	54	52	57	62	63	60
Well Diameter (in)	6	6	8	8	8	8	8	8	8	8
Pump Capacity (gpm)	150	150	200	150	150	100	200	250	200	350
Intake Depth (ft)	--	--	--	--	--	--	--	--	--	--
Year Drilled	1955	1962	1970	1970	1962	1970	1970	1970	1970	1989

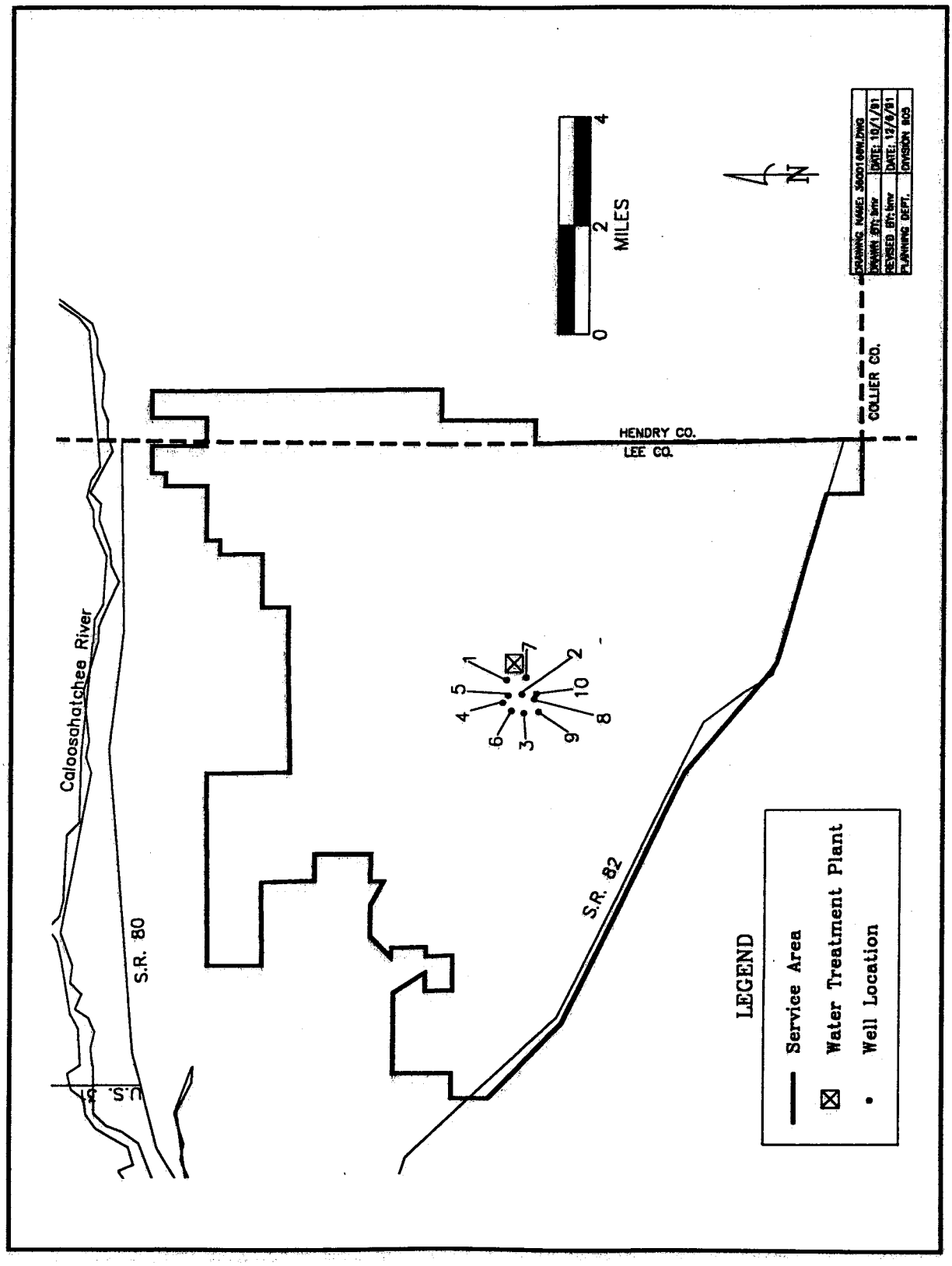


FIGURE E-25. Lehigh Utilities Potable Water Supply Wells.

LOWER WEST COAST PLANNING AREA

WASTEWATER TREATMENT FACILITIES

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WASTEWATER TREATMENT FACILITIES

The primary means of wastewater treatment in the Lower West Coast Planning Area is through wastewater treatment facilities and septic tanks. There are approximately 350 existing FDER regulated wastewater treatment facilities in the LWC Planning Area, 21 of which have a FDER rated capacity of 0.50 million gallons per day (MGD) or greater. This discussion focuses on these 21 facilities because they have sufficient flows that could have a positive impact on the water resource through reuse. These facilities are large enough to allow economy of operation in support of a regional reuse program. Many are also located in areas in close proximity to potential reclaimed water users.

These existing and future facilities are located in most of the urbanized areas throughout the LWC Planning Area, as indicated on Figure E-26. More than half of the facilities are municipally owned. All the facilities utilize the activated sludge treatment process. The reclaimed water/effluent disposal methods consist of discharge to surface waters, deep well injection, and reuse via green space irrigation and ground water recharge. These facilities have a total rated capacity of 85.74 MGD and are identified by facility name in Table E-27. The table lists the average daily flows (ADF) and the method of disposal in 1990 for each facility. The 1990 ADF for these facilities was 41.76 MGD.

The wastewater flows for these facilities are projected to increase to approximately 146.55 MGD by the year 2010. As regulatory criteria are becoming more stringent for surface water discharge, the utilities should start planning for effluent/reclaimed water disposal in an environmentally acceptable way. General descriptions of the disposal methods follow:

Disposal Methods

Surface Water Discharge

This method of effluent disposal consists of disposing the effluent through a pipeline to a receiving surface water. Effluent prior to disposal is required to have received at least secondary treatment (20 mg/L carbonaceous biochemical oxygen demand [CBOD], 20 mg/L total suspended solids [TSS] or 90 percent removal, whichever is more stringent) and basic level disinfection. Additional levels of treatment may be required and are based upon the characteristics of the effluent and the receiving water, as well as other regulatory requirements and standards. Effluent standards from this method are known as water quality based effluent limitations (WQBELs). A WQBEL is a means of determining the available assimilative capacity of a water body and setting effluent limits utilizing appropriate procedures for simulation and prediction of water quality impacts. WQBELs are established to ensure that water quality standards in a receiving body of water will not be violated (Chapter 17-650, F.A.C.).

As regulatory requirements become more stringent, many of the dischargers may choose to find an alternative means for effluent disposal. In addition, any new discharge or expansion of an existing discharge must justify compliance with the state's antidegradation requirements prior to issuance of a permit for such a discharge. The antidegradation rule requires a utility proposing to construct a new discharge, or expanding an existing discharge, to demonstrate that an alternate

disposal method such as reuse of domestic reclaimed water is not feasible in lieu of a discharge to surface water, and that such a discharge is clearly in the public interest. A summary of the state's antidegradation rule is provided in Figure E-27.

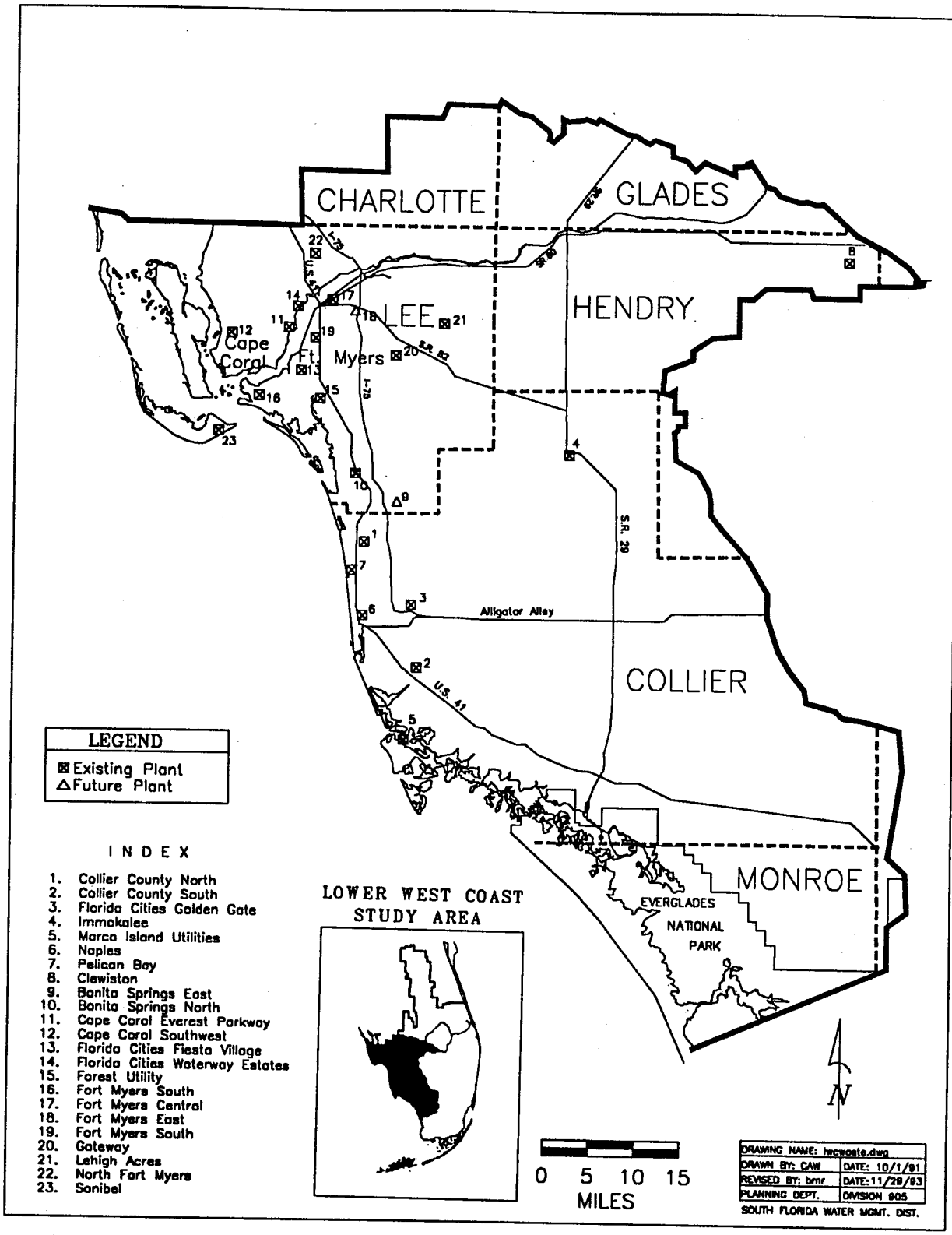


FIGURE E-26. Wastewater Treatment Facilities in the LWC Planning Area.

TABLE E-27. LWC Planning Area Wastewater Treatment Facilities (≥0.50 MGD).

Facility	FDER Rated Capacity (MGD)	1990 Average Daily Flow (MGD)	1990 Disposal Method			Chloride Concentration (mg/L)	Year 2010 Projected Flow (MGD)
			Deep Well Injection (MGD)	Surface Water (MGD)	Reuse (MGD)		
Collier County							
Collier County North	4.50	2.20			2.20	265	11.43
Collier County South	8.00	2.31			2.31	c	17.92
FL Cities Golden Gate	0.75	0.67			0.67	c	0.88
Immokalee	2.50	1.58			1.58	c	2.23
Marco Island	3.50	2.30			2.30	252	4.15
Naples	8.50	5.49		2.33	3.16	263	7.30
Pelican Bay	1.00	0.80			0.80	c	a
County Subtotal	**28.75**	**15.35**	**0.00**	**2.33**	**13.02**		**43.91**
Hendry County							
Clewiston	1.16	0.79			0.79	c	1.23
County Subtotal	**1.16**	**0.79**	**0.00**	**0.00**	**0.79**		**1.23**
Lee County							
Bonita Springs West	2.40	0.07			0.07	c	6.27
Bonita Springs East	b	b				c	e
Cape Coral Everest	7.30	6.27		6.27		300-700	11.90
Cape Coral Southwest	7.00	d				c	5.50
FL Cities Fiesta Villages	2.50	1.71		1.11	0.60	211	2.00
FL Cities Waterway Estates	1.00	0.82		0.82		245	1.36
Forest Utilities	0.50	0.30			0.30	c	0.70
Fort Myers Beach	6.00	2.43			2.43	241	5.63
Fort Myers Central	11.00	6.21		6.21		244	11.00
Fort Myers East	b	b				c	10.00
Fort Myers South	12.00	5.86		5.86		170	24.00
Gateway	1.00	0.01			0.01	c	5.50
Lehigh Utilities	1.88	1.17			1.17	c	4.55
North Fort Myers	2.00	0.21	0.08		0.13	207	11.45
Sanibel	1.25	0.56			0.56	c	1.55
County Subtotal	**55.83**	**25.62**	**0.08**	**20.27**	**5.27**		**101.41**
Lower West Coast Total	**85.74**	**41.76**	**0.08**	**22.60**	**19.08**		**146.55**

a- Facility 2010 projection incorporated into Collier County North.
b- Proposed/future facility.
c- Chloride concentration not available.
d- Initiated operation after 1990.
e- Facility 2010 projection incorporated into Bonita Springs West.

Florida's Antidegradation Standards

In reviewing a permit application for a surface water discharge, the Florida Department of Environmental Regulation must assure the application is consistent with the antidegradation policy set forth in Section 17-3.041, Florida Administrative Code (F.A.C.) prior to issuance of a permit. Such that, when reviewing a permit application for a surface water discharge, the following criteria must be reviewed:

1. Whether water quality standards will be violated.
2. Whether "existing uses" are being maintained.
3. Whether the proposed(new or expanded) discharge is "necessary or desirable under federal standards and under circumstances which are clearly in the public interest."
   This requires consideration of:
   a. The balancing test
      The benefit to the public health, safety, and welfare is to be balanced against whether the discharge will adversely affect fish and wildlife, endangered species, or their habitats; whether the proposed discharge will adversely affect recreation or marine resources; and whether the proposed discharge is consistent with any applicable SWIM plan.
   b. The options review
      This requires the applicant to demonstrate that neither of the following is economically and technologically reasonable:
      1) Reuse of domestic reclaimed water.
      2) Certain other options other than the proposed discharge that would eliminate or minimize the need to lower water quality (those others being reuse, use of other discharge locations, or land application).

FIGURE E-27. Surface Water Discharge Antidegradation Standards.

In addition, Lee County has adopted an ordinance (number 90-53) which addresses the regulation of wastewater discharges into surface waters of Lee County. It provides for the conservation of the county's water resources by mandating reuse of treated wastewater. The ordinance states that all wastewater discharges into surface waters of the county shall do so only pursuant to the specific terms and conditions of a Lee County wastewater discharge permit. It is the purpose and intent of Lee County to provide for discharges of treated wastewater only as an alternate or emergency method of disposal to a reuse system. The ordinance contains a municipal option, that excludes all areas within incorporated limits of any municipality from the provisions of this ordinance upon formal prior notification by resolution to Lee County that the municipality is exercising such option prior to January 1, 1991. The ordinance became effective on October 26, 1990. All municipalities exercised the municipal option. Therefore, this ordinance impacts the two Florida Cities wastewater treatment facilities.

In Lee County, five facilities utilize discharge to the Caloosahatchee River for effluent disposal, while one facility in Collier County discharges a portion of its effluent to the Gordon River. All these facilities provide, or are in the process of providing, advanced wastewater treatment which results in the reduction of nutrients in the effluent. Effluent disposal via discharge to surface waters accounted for 54 percent (22.60 MGD) of effluent disposal in the LWC Planning Area in 1990.

A WQBEL determination was conducted by FDER on the stretch of the Caloosahatchee River between Beautiful Island and Shell Point (Baker, 1990). This

section of the river has five major treated wastewater point source dischargers: (1) the City of Cape Coral, (2) the City of Fort Myers South, (3) the City of Fort Myers Central, (4) Florida Cities Fiesta Village, and (5) the Florida Cities Waterway Estates wastewater treatment facilities. At the time of the report, the rated capacities of these facilities were 7.3 MGD, 12 MGD, 11 MGD, 5 MGD and 1.08 MGD, respectively. The WQBEL was conducted to determine the impact of the proposed increases in discharge from these facilities on the river's water quality. Computer modeling indicated that, with the discharge at the current effluent quality and the relocation of two points of discharge (City of Cape Coral and Florida Cities Waterway Estates), the proposed increases will not contribute to violations of Class III water quality standards. The increases will utilize the entire reserve capacity of the system. The five facility capacities that were modeled were 14.6 MGD, 13 MGD, 11 MGD, 5 MGD and 1.5 MGD, respectively.

Deep Well Injection Class I Wells

This method of disposal consists of injecting secondary treated (20 mg/L CBOD, 20 mg/L TSS) effluent (no disinfection required) through a steel conduit (casing) to the "boulder zone," a fractured cavernous carbonate sequence formation found at depths ranging from 3000-3300 feet below the ground surface in the LWC Planning Area. There is one existing facility, North Fort Myers, which utilizes deep well injection for a portion of its effluent disposal. It also serves as an alternative means of disposal for the reuse system. Disposal by deep well injection accounted for only 0.2 percent (0.08 MGD) of the effluent disposal in 1990. Marco Island Utilities recently completed a deep well injection system for concentrate disposal for their reverse osmosis water treatment facility. The deep well will also serve as a backup disposal method to their reuse system.

Reuse

This method of disposal consists of utilizing treated wastewater (reclaimed water) for a beneficial purpose. Various methods of reuse are identified in the reuse section of this report. There are 16 facilities in the LWC Planning Area that reused all or a portion of their 1990 flows. In 1990, reclaimed water was utilized for golf course, residential lawn, park and green space irrigation, and for ground water recharge via percolation ponds. Many of the facilities utilize their reclaimed water/effluent for plant process water, and some for irrigation of the utility site (which also could be considered reuse). In 1990, 46 percent (19.08 MGD) of the treated wastewater was reused. Over 27 golf courses in the planning area utilized reclaimed water for irrigation in 1990.

Effluent disposal via discharge to surface waters and deep well injection result in net loss from the water supply inventory. These methods of effluent disposal accounted for 22.68 MGD of water lost from the water supply inventory. Most of the facilities utilizing these methods of effluent disposal could have potentially made reclaimed water available for reuse with the addition of filtration and associated chemical feed facilities, disinfection, and reclaimed water monitoring equipment at the treatment plant. The facilities would have to justify a facility reliability of Class I, or an equivalent, which may exist via their existing method of disposal. The existing method of effluent disposal may also be viable as an alternative means of disposal, which may negate the need for regulatory mandated system storage. Additional information on reuse can be found in the wastewater reuse discussion in Chapter V and Appendix I.

Summary Descriptions of Existing Wastewater Facilities

Summary descriptions for each of the wastewater treatment facilities in the LWC Planning Area, from which the previously summarized information was obtained, are presented in the following section. Each utility capsule contains the following information:

Treatment/Disposal - This section states the current FDER rated capacity, method of treatment and disposal, the 1990 average daily flow, and the reclaimed water/effluent chloride concentration.

Address - This section provides the treatment plant address or location.

Reuse Feasibility - This section states what would be generally required for the treatment facility to produce reclaimed water for public access irrigation and any known constraints.

Proposed - This section states any current construction or permitting that is occurring.

Future - This section provides the projected flows and known future treatment plant expansions and plans, including new additional facilities.

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COLLIER COUNTY

WASTEWATER TREATMENT FACILITIES

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Collier County North

Treatment/Disposal:
There is an existing 4.50 MGD activated sludge (contact stabilization and oxidation ditch) wastewater treatment plant with reclaimed water disposal by reuse via golf course irrigation and ground water recharge via 50 acres of percolation ponds. Irrigation with reclaimed water has been implemented on the following golf courses:

Site
Imperial G. C.
Audubon G.C.
Palm River G.C.
Collier Reserve G.C.

Reclaimed water in excess of these demands are delivered to Pelican Bay for reuse.

The 1990 average daily flow was 2.20 MGD. The typical average reclaimed water chloride concentration is 265 mg/L.

Location:
State Road 846 and Coastline Railroad, Naples.

Reuse Feasibility:
This facility currently produces reclaimed water for public access green space spray irrigation and for ground water recharge via percolation ponds. This facility is designed to provide reclaimed water for public access irrigation at its design capacity.

Proposed:
A 3.00 MGD expansion is under construction. Reuse will be the method of disposal.

Future:
The utility master plan projects the average daily wastewater flows will increase to 11.43 MGD by 2010. This facility is anticipated to be expanded by an additional 3 MGD in 1995, 1998, and 2003, for a total treatment plant capacity of 12.50 MGD which will be sufficient through 2010. Future reclaimed water disposal is proposed to be reuse. The ultimate build-out wastewater generation for the service area is projected to be 32.24 MGD.

Source:
Information provided by Collier County Utilities.

Collier County South

Treatment/Disposal:
There is an existing 8 MGD activated sludge (oxidation ditch) wastewater treatment plant with reclaimed water disposal by reuse via golf course irrigation and ground water recharge via 50 acres of percolation ponds. This facility was placed into operation in early 1991 and replaced three subregional facilities. This facility provides reclaimed water for spray irrigation to the following golf courses:

Site	
Foxfire G.C.	Windstar G.C.
Glades G.C.	Countryside G.C.
Turtle Cove G.C.	Riviera G.C.
Lely Royal Palm G.C.	

The 1990 total average daily flow of the three subregional facilities was 2.31 MGD.

Location:
5600 Warren Street, Naples.

Reuse Feasibility:
This facility currently produces reclaimed water for public access spray irrigation via golf course irrigation and ground water recharge via percolation ponds. This facility is designed to provide reclaimed water for public access irrigation at its design capacity.

Proposed:
The following golf courses plan to implement irrigation with reclaimed water in the future:

Site	Type	Estimated Irrigation Demand (MGD)
Lely Hibiscus G.C.	Golf Course	0.50
Lakewood G.C.	Golf Course	0.41
Lely Resort	Golf Course & Residential	--

Future:
The utility master plan projects the average daily wastewater flows will increase to 17.92 MGD by 2010. Future reclaimed water disposal is proposed to be reuse. The ultimate build-out wastewater generation for the service area is projected to be 37.50 MGD.

Source:
Information provided by Collier County Utilities.

Florida Cities Golden Gate

Treatment/Disposal:
There is an existing 0.75 MGD activated sludge (contact stabilization) wastewater treatment plant with reclaimed water disposal by reuse via ground water recharge by percolation ponds. The 1990 average daily wastewater flow was 0.67 MGD.

Location:
4931 32nd Avenue Southwest, Golden Gate.

Reuse Feasibility:
This facility is currently reusing reclaimed water for ground water recharge via percolation ponds. The facility is providing secondary treatment with basic level disinfection. If public access spray irrigation is pursued, filtration and an associated chemical feed system, disinfection facilities and reclaimed water monitoring equipment would have to be constructed pursuant to Chapter 17-610, F.A.C. In addition, Class I reliability or an equivalent will have to be provided. This may exist via the existing method of reclaimed water disposal.

Proposed:
A 0.50 MGD expansion is under design. The method of disposal will be percolation ponds. Construction of this facility is anticipated to be completed by spring of 1994.

Future:
No flow projections or future facility plans are available. Based on SFWMD potable water flow projections and a 78 percent return factor in 1990, the 2010 wastewater flows are estimated to be 0.88 MGD.

Source:
Information provided by Florida Cities Water Company.

Immokalee

Treatment/Disposal:
There is an existing 2.50 MGD activated sludge (oxidation ditch) wastewater treatment plant with reclaimed water disposal by reuse via restricted public access spray irrigation on approximately 190 acres of hay fields. The 1990 average daily flow was 1.58 MGD.

Location:
1020 Sanitation Road, Immokalee.

Reuse Feasibility:
The existing and expanded proposed method of reclaimed water disposal is reuse pursuant to Chapter 17-610, F.A.C. The facility is providing secondary treatment with basic level disinfection. If public access spray irrigation is pursued, filtration and an associated chemical feed system, disinfection facilities and reclaimed water monitoring equipment would have to be constructed pursuant to Chapter 17-610. In addition, Class I reliability or an equivalent will have to be provided. This may exist via the existing method of reclaimed water disposal.

Proposed:
Increase the sprayfields to the permitted 364 irrigated acres of a total 550 acre site.

Future:
Flow projections estimates average daily flows will increase to 2.23 MGD by 2010 with a maximum month average daily flow of 2.61 MGD.

Source:
Information was provided by the Immokalee Water-Sewer District and their engineers.

Marco Island

Treatment/Disposal:
There is an existing 3.50 MGD activated sludge (contact stabilization) wastewater treatment plant with reclaimed water disposal by reuse via golf course irrigation and ground water recharge via 34.6 acres of percolation ponds. Irrigation with reclaimed water is implemented at the following locations:

Site	Type	1990 ADF (MGD)
Marco Island G.C.	Golf Course	0.16
Marco Shores G.C.	Golf Course	0.23

The deep well injection system constructed for concentrate disposal for the recently completed reverse osmosis water treatment facility will serve as a backup disposal to the reuse program.

The 1990 average daily flow was 2.30 MGD. The typical average reclaimed water chloride concentration is 252 mg/L.

Location:
100 Winward Drive, Marco Island.

Reuse Feasibility:
This facility currently produces reclaimed water for public access spray irrigation on two golf courses and ground water recharge via percolation ponds.

Proposed:
N/A

Future:
The existing facility is anticipated to have sufficient capacity through 1995, at which time a 0.75 MGD expansion is projected. The expanded capacity will be adequate through 2001, at which time an additional 1.75 MGD expansion is planned. These expansions will utilize deep well injection for effluent disposal. The 2010 projected average daily wastewater flow is 4.15 MGD. The 2010 maximum monthly daily flow is 5.21 MGD. Since the service area is seasonal, the additional treatment capacity is necessary.

Source:
Information provided by Southern States Utilities.

Naples

Treatment/Disposal:
There is an existing 8.50 MGD activated sludge (conventional) wastewater treatment plant with reclaimed water/effluent disposal by golf course, park, right-of-way, and common area spray irrigation and discharge to the Gordon river. Irrigation with reclaimed water is implemented at the following locations:

Site	Type	1990 ADF (MGD)
Royal Poinciana	Golf Course	0.36
Wilderness Country Club	Golf Course	0.35
Bears Paw	Golf Course	0.24
Naples Beach Club	Golf Course	0.27
Country Club of Naples	Golf Course	0.26
Hole-in-the-Wall	Golf Course	0.24
Quail Run	Golf Course	0.15
Moorings Country Club	Golf Course	----
High Point Golf & Tennis	Golf Course	0.13
Moorings Park	Green Space	----
Fleishman Park	Green Space	----
Naplescape	Green Space	----

The 1990 average daily wastewater flow was 5.49 MGD. On an annual basis, approximately 60 percent of the wastewater flow is reused. The average chloride concentration is 263 mg/L.

Location:
1400 3rd Avenue North, off Goodlette Road, Naples.

Reuse Feasibility:
This facility is designed to produce 8.50 MGD of reclaimed water for public access irrigation. Additional users are being sought.

The City of Naples Comprehensive Code requires all new developments of 10 acres or more to connect to the reclaimed water system if it is available as a condition of connection to either the city's potable water or sewer system.

Proposed:
By the end of 1994, the City anticipates providing reclaimed water to the Commons, a 3.5 acre recreational area, at the Middle School and additional median strips. A wastewater and reclaimed water master plan are under development.

Future:
Flow projections estimates an average daily flow of 7.30 MGD in 1998. Additional users of reclaimed water are being sought.

Source:
Information supplied by the City of Naples.

Pelican Bay

Treatment/Disposal:
There is an existing 1.00 MGD activated sludge (extended aeration) wastewater treatment plant with reclaimed water disposal by golf course and landscape spray irrigation. The reclaimed water is discharged to on-site irrigation water holding facilities from which irrigation water is obtained for the development's irrigation system. The irrigation system radiates throughout the development for golf course, residential, and other green space irrigation. The 1990 average daily wastewater flow was 0.80 MGD.

Location:
Intersection of Pelican Bay Boulevard and Gulf Park Drive, Naples.

Reuse Feasibility:
This facility is currently producing reclaimed water for reuse via public access irrigation on golf course, residential, and other green space.

Proposed:
This facility will be taken out of service when the connection to the Collier County system occurs (within two years). Collier County Utilities will continue to deliver reclaimed water to Pelican Bay at a volume equal to or greater than their wastewater flows.

Future:
Collier County projects flows from this service area will increase to 2.19 MGD by 2010.

Source:
Information was obtained from SFWMD consumptive use permitting information, Collier County Comprehensive plan, and Collier County Utilities.

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HENDRY COUNTY

WASTEWATER TREATMENT FACILITIES

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Clewiston

Treatment/Disposal:
There is an existing 1.50 MGD activated sludge (oxidation ditch) wastewater treatment plant with reclaimed water disposal by reuse via restricted public access spray irrigation on 148 acres of grass fields used for hay cultivation. This facility is limited to 1.16 MGD due to the reclaimed water disposal capacity. The spray fields contain underdrains that discharge to a perimeter ditch; the perimeter ditch discharges to the Sugarland District canals and ultimately to the Caloosahatchee River. The 1990 average daily flow was 0.79 MGD.

Location:
Feed Lot Road, Clewiston.

Reuse Feasibility:
The existing and expanded proposed method of reclaimed water disposal is reuse pursuant to Chapter 17-610, F.A.C. The facility is providing secondary treatment with basic level disinfection. If public access spray irrigation is pursued, filtration and an associated chemical feed system, disinfection facilities and reclaimed water monitoring equipment would have to be constructed pursuant to Chapter 17-610. In addition, Class I reliability or an equivalent will have to be provided. This may exist via the existing method of reclaimed water disposal.

Proposed:
N/A

Future:
Projected average daily flows for the City of Clewiston for the year 2000 are 0.99 MGD. The existing facility is adequate provided additional disposal capacity is constructed. Flow projections, based on the average yearly flow increases from 1988 to 2000 in the city's comprehensive plan and projected to 2010, indicate that an average daily wastewater flow of 1.23 MGD in 2010 can be expected.

Source:
Information provided by the City of Clewiston.

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LEE COUNTY

WASTEWATER TREATMENT FACILITIES

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Bonita Springs Utilities

Treatment/Disposal:
There is an existing 2.40 MGD activated sludge wastewater treatment plant with reclaimed water disposal by reuse via public access spray irrigation of golf courses, residential properties and other green areas in the Bonita Bay area. The 1990 average daily wastewater flow was 0.07 MGD.

Location:
On new U.S. 41 and south of old U.S. 41.

Reuse Feasibility:
This facility is currently reusing reclaimed water for public access spray irrigation.

Proposed:
Continue to extend forcemains into areas that are served by package plants. Approximately 35 package plants have connected to the system.

Future:
The 1990 master plan has been developed to provide regionalized wastewater collection, treatment, and disposal to this area by the Bonita Springs Utilities in compliance with the Lee County Comprehensive Plan and the 201 Facilities Plan. Wastewater treatment and disposal in the Bonita Springs area is currently provided by approximately 70 package wastewater treatment plants. Areas not serviced by these package plants are served by on-site septic tanks.

The master plan consists of a two treatment plant approach in the BSWS franchised area. The plants are referred to as the Bonita Springs North (BSN) and Bonita Springs East (BSE) plants. The BSN described above is planned to have an ultimate capacity of 6.00 MGD, which will be achieved through two 2.00 MGD expansions.

The BSE would involve the construction of a 2.00 MGD plant located East of I-75 and North of Bonita Beach Road. This facility is proposed to have an ultimate capacity of 6.00 MGD, which will be achieved through two 2.00 MGD expansions. This facility is not scheduled to be constructed at the time of this writing.

Projected wastewater flows for the franchised area are anticipated to ultimately increase to 10.03 MGD seasonally and 6.27 annually. To accommodate these flows, 2.00 MGD expansions are proposed to be completed by 1997, 2001, 2005 and 2012 and will be based on need. Expansions are not differentiated between the two plants and only pertains to the treatment capacity of the system.

Reclaimed water disposal will be reuse via public access irrigation of golf courses, residential areas, and other green space. The initial 3.00 MGD of reclaimed water produced is contracted to Bonita Bay for golf course, lawn and other green area irrigation. Other potential users are:

Site	Estimated Irrigation Demand (MGD)
Parklands	0.60
Worthington	0.60
Hunters Ridge	0.60

Spanish Wells	0.60
Bonita Springs Golf & CC	0.60
Spring Creek	1.58
Pelican's Nest	0.72
Ridgewood GC	0.36
Coconut Road GC	0.58

Source:
Information provided by the Bonita Springs Utilities.

Cape Coral Everest

Treatment/Disposal:
There is an existing 7.30 MGD advanced wastewater treatment plant with effluent disposal by surface water discharge to the Caloosahatchee River via a 24-inch outfall. The 1990 average daily flow was 6.27 MGD. Effluent chloride concentrations are between 300 and 700 mg/L.

The City initiated operation of a system in early 1992 to provide reclaimed water for public access irrigation on residential lawns and other green space via a secondary water line as part of the Water Independence for Cape Coral program (WICC). As part of the WICC, reclaimed water and canal water is used as supply sources for the secondary system, which will be distributed throughout the city for residential lawn and other green space irrigation. Approximately 10,000 properties are connected to the system. The surface water discharge will serve as a backup to the secondary system. They will continue to connect additional users to the secondary system. A secondary water demand of 36.80 MGD is projected in 1993 and a 116 MGD at build-out.

The city is also constructing a wastewater collection system that will serve many of the areas that are currently served by septic tanks.

Location:
1800 Everest Parkway, Cape Coral.

Reuse Feasibility:
This facility currently provides irrigation on residential lawns and other green space in Cape Coral. Expanded wastewater flows will be reused in this manner.

Proposed:

An expansion of this facility to 14 MGD is under design. It is planned to begin construction in early 1994 with completion in 1996.

Future:
Projected wastewater flows for this facility estimate a year 2000 flow of 8.40 MGD, with a maximum month of 10 MGD, and a year 2009 flow of 11.90 MGD with a maximum month of 14.30 MGD.

Source:
Information provided by the City of Cape Coral.

Cape Coral Southwest

Treatment/Disposal:
This facility, which initiated operation in the summer of 1993, consists of a 7.00 MGD advanced wastewater treatment plant with reclaimed water disposal via WICC secondary system (see Cape Coral Everest). This facility is connected to the surface water discharge outfall which will serve as backup to the WICC program.

This facility will serve the Cape Coral southwest service area.

Location:
This facility is located adjacent to the existing water treatment plant which is located at 3300 SW 20th Avenue, Cape Coral.

Reuse Feasibility:
This facility currently provides irrigation on residential lawns and other green space in Cape Coral. Expanded wastewater flow will be reused in this manner.

Proposed:
N/A

Future:
Projected wastewater flows for the year 2000 are 3.90 MGD with a maximum month of 4.60 MGD, and a year 2009 flow of 5.50 MGD with a maximum month of 6.60 MGD. This facility is anticipated to be expanded to 14 MGD in the future as the flows necessitate additional capacity.

Source:
Information provided by the City of Cape Coral.

Florida Cities Fiesta Village

Treatment/Disposal:
This is an existing 2.50 MGD activated sludge advanced wastewater treatment plant with reclaimed water/effluent disposal by reuse via golf course irrigation and discharge to the Caloosahatchee River via a 24-inch outfall. Irrigation with reclaimed water is implemented at the following locations:

Site	Type	1990 ADF (MGD)
Cypress Lake	Golf Course	0.29
Myerlee	Golf Course	0.17
The Landings	Golf Course	0.28*

*Six month average - initiated reuse in July, 1990.

The 1990 average daily flow was approximately 1.71 MGD. The discharge to the river averaged 1.11 MGD for 1990. The typical average reclaimed water/effluent chloride concentration is 211 mg/L.

Unequipped structures are in place which will allow the plant's treatment capacity to be increased to 5.0 MGD.

Location:
1366 San Souci Drive, Fort Myers.

Reuse Feasibility:
This facility currently produces reclaimed water for public access spray irrigation on three golf courses with the excess effluent discharged to the Caloosahatchee River. This facility is designed to produce reclaimed water for public access irrigation at its design capacity.

A master plan for the potential reuse within this service area was developed in October, 1991. The plan identified potential reuse customers, reclaimed water demands and transmission piping. The plan divided the potential reuse program into two phases. Phase I will consist of serving several users along the outfall pipe which have a potential reclaimed water demand of approximately 0.20 MGD. Phase II potential customers include the Village of Seven Lakes and the Golf View Country Club golf courses and several other smaller uses which have a potential reclaimed water demand of approximately 1.14 MGD. A permit has been received for Phase I and implementation is underway. The utility is investigating potential options to implement Phase II of the program in addition to sufficient quantities of reclaimed water becoming available to support the phase.

Proposed:
Implementation of Phase I of the reuse plan.

Future:
No flow projections or future facility plans are available. Based on SFWMD potable water flow projections and a 73 percent return factor for this facility and the Fort Myers Beach wastewater facility in 1990, the 2010 wastewater flows are estimated to be 2.75 MGD.

Source:
Information provided by the Florida Cities Water Company.

Florida Cities Waterway Estates

Treatment/Disposal:
There is an existing 1 MGD activated sludge advanced wastewater treatment plant with effluent disposal by surface water discharge to the Caloosahatchee River via an 18-inch outfall. The 1990 average daily flow was 0.82 MGD. The typical average effluent chloride concentration is 245 mg/L.

Location:
1667 Inlet Drive, North Fort Myers.

Reuse Feasibility:
This facility is designed to provide advanced wastewater treatment. For this facility to provide reclaimed water for public access spray irrigation in accordance with F.A.C. Chapter 17-610, filtration and associated chemical feed system, disinfection facilities and reclaimed water monitoring equipment would have to be constructed. Much of this equipment may exist as part of the existing treatment facility with the exception of the reclaimed water monitoring equipments. It is assumed that an equivalent to Class I reliability exists via the existing disposal method, which could also serve as an alternate means of disposal to the reuse system.

A master plan for the potential reuse within this service area was developed in October, 1991. The plan identified potential reuse customers, reclaimed water demands and transmission piping. Potential customers include the Lochmoor Country Club and El Rio golf courses and several other smaller uses which have a potential reclaimed water demand of approximately 0.70 MGD. The utility is investigating potential options to implement the program.

Proposed:
A 0.30 MGD expansion is under design for this facility. The proposed method of effluent disposal is surface water discharge.

Future:
No flow projections or future facility plans are available. Based on SFWMD potable water flow projections and a 91 percent return factor in 1990, the 2010 wastewater flows are estimated to be 1.44 MGD.

Source:
Information provided by the Florida Cities Water Company.

Forest Utility

Treatment/Disposal:
An existing 0.50 MGD activated sludge (complete mix) wastewater treatment plant with reclaimed water disposal by reuse via golf course irrigation on the Forest Golf Course. The 1990 total plant average daily flow was 0.30 MGD.

Location:
Deer Run SW at Forest subdivision, Fort Myers.

Reuse Feasibility:
This facility currently produces reclaimed water for public access spray irrigation on the Forest Golf Course. This facility is designed to provide reclaimed water for public access irrigation at its design capacity.

Proposed:
N/A

Future:
The franchise area is projected to have a build-out wastewater flow of 0.70 MGD. There are no immediate plans for expansion at this time.

Source:
Information provided by Forest Utilities.

Fort Myers Beach

Treatment/Disposal:
There is an existing 6 MGD activated sludge (conventional) wastewater treatment plant with reclaimed water disposal by reuse via golf course, residential, and green space irrigation and ground water recharge via percolation ponds. Irrigation with reclaimed water is implemented at the following locations:

Site	Type	1990 ADF (MGD)
Rivers Edge	Golf Course	0.52
Kelly Greens	Golf Course	0.19
Shell Point	Green Space	0.09
Health Park	Green Space	0.20
Bayside Estates	Green Space	0.10
McGregor Park	Green Space	0.01
Davis Court	Green Space	0.005

The 1990 average daily wastewater flow was approximately 2.43 MGD. The typical average reclaimed water chloride concentration is 241 mg/L.

Location:
17155 Pine Ridge Road, Fort Myers.

Reuse Feasibility:
This facility currently produces reclaimed water for public access spray irrigation on two golf courses, for residential and green space irrigation at six developments, and ground water recharge via the county's percolation ponds. Additional reuse sites will come online when development increases and there is sufficient reclaimed water available.

Proposed:
Seeking additional reclaimed water users.

Future:
The existing facility is anticipated to have sufficient capacity through 1998, at which time a 1.50 MGD expansion is projected. The expanded capacity will be sufficient at least through 2005. Annual average daily wastewater flow is projected to increase to 4.86 MGD with an average maximum month daily flow of 7.10 MGD by 2005. Utilizing a 3 percent increase annually, the 2010 average daily flow will increase to 5.63 MGD by 2010.

Source:
Information provided by Department of Lee County Utilities.

Fort Myers Central

Treatment/Disposal:
There is an existing 11 MGD activated sludge advanced wastewater treatment plant with effluent disposal by surface water discharge to the Caloosahatchee River via a 36-inch outfall pipe. The 1990 average daily flow was 6.21 MGD. The average effluent chloride concentration is 244 mg/L.

Location:
1501 Raleigh Street, Fort Myers.

Reuse Feasibility:
This facility is designed to provide advanced wastewater treatment. For this facility to provide reclaimed water for public access spray irrigation in accordance with Chapter 17-610, F.A.C., filtration and associated chemical feed system, disinfection facilities and reclaimed water monitoring equipment would have to be constructed. In addition, Class I reliability or an equivalent will have to be justified. This may exist via the existing effluent disposal method. The City of Fort Myers developed a Reclaimed Water Master Plan. This 1992 document is intended to provide long range guidance to the City on developing and implementing its reclaimed water system. The plan is designed to achieve certain goals with associated resulting benefits in the areas of water resource management, environmental impacts, beautification and economic impacts. The plan identified a potential reclaimed water demand within the entire Fort Myers service area of 16.8 MGD during wet weather and 28 MGD during dry weather. Potential uses include cooling water at the resource recovery facility and irrigation of golf courses, residential lawns, nurseries, parks, schools and other green space. The implementation plan is broken down into phases with Phase I requiring three to five years.

The City of Fort Myers requires all new developments of 10 acres or greater to install a dual water distribution system with the anticipation of reclaimed water being made available in the future.

A 2.0 MGD reuse facility is being designed. Initial use includes 1.0 MGD for cooling water at the resource recovery facility, irrigation water for the City nursery, the Fort Myers cemetery, and ballfields, and additional users of the remainder are being sought.

Proposed:
N/A

Future:
The build-out average daily wastewater flow (ADF) from the Fort Myers service area, which includes a portion of unincorporated Lee County, is projected to be 44.40 MGD and is anticipated to be reached in 2007. It is projected that the 2007 ADF from the Central system service area will be 20.90 MGD, and 23.50 MGD from the South service area. This site is very limited and expansion of this facility is questionable. It is stated that a 6 MGD expansion may be able to be accomplished; however, it is more likely that additional flows will be diverted to the South system, or a new eastern wastewater treatment facility will be constructed.

Source:
Information provided by the City of Fort Myers.

Fort Myers South

Treatment/Disposal:
There is an existing 12 MGD activated sludge advanced wastewater treatment plant with effluent disposal by surface water discharge to the Caloosahatchee River via a 42-inch outfall pipe. The 1990 average daily flow was 5.86 MGD. The average effluent chloride concentration is 170 mg/L.

Location:
1618 South Drive (Bowling Green Boulevard), Fort Myers.

Reuse Feasibility:
This facility is designed to provide advanced wastewater treatment. For this facility to provide reclaimed water for public access spray irrigation in accordance with Chapter 17-610, F.A.C., filtration and associated chemical feed system, disinfection facilities and reclaimed water monitoring equipment would have to be constructed. In addition, Class I reliability or an equivalent will have to be justified. This may exist via the existing effluent disposal method. The City of Fort Myers developed a Reclaimed Water Master Plan. This 1992 document is intended to provide long range guidance to the City on developing and implementing its reclaimed water system. The plan is designed to achieve certain goals with associated resulting benefits in the areas of water resource management, environmental impacts, beautification and economic impacts. The plan identified a potential reclaimed water demand within the entire Fort Myers service area of 16.8 MGD during wet weather and 28 MGD during dry weather. Potential uses include cooling water at the resource recovery facility and irrigation of golf courses, residential lawns, nurseries, parks, schools and other green space. The implementation plan is broken down into phases with Phase I requiring three to five years.

The City of Fort Myers requires all new developments greater than 10 acres to install a dual water distribution system with the anticipation of reclaimed water being made available in the future.

Proposed:
N/A

Future:
The 1988 sanitary sewer system master plan update indicates the build-out average daily wastewater flow (ADF) from the Fort Myers service area, which includes a portion of unincorporated Lee County, to be 44.40 MGD and is anticipated to be reached in 2007. It is projected the 2007 ADF from the South system service area will be 23.50 MGD and 20.90 MGD from the Central system service area. When needed, it is proposed to expand this facility to its ultimate capacity of 24.00 MGD. This expanded capacity is anticipated to be utilized by year 2001. To treat the projected 2007 beyond 24.00 MGD, it is proposed to construct an Eastern facility which will have an ultimate capacity of 10 MGD with no expansion to the Central facility. A possible location for an Eastern facility is at a city-owned site on the east side of Oritz Road, south of and including the former Red Cross Center.

Source:
Information provided by the City of Fort Myers.

Gateway Utility

Treatment/Disposal:
There is an existing 1.00 MGD activated sludge (contact stabilization) wastewater treatment plant with reclaimed water disposal via public access spray irrigation of the development's common areas and residences. The 1990 average daily flow was 0.01 MGD.

Location:
13240 Commerce Lakes Drive, Fort Myers.

Reuse Feasibility:
This facility is designed to reuse via public access spray irrigation all reclaimed water generated from this facility via irrigation of the development's residential lots, rights-of-way, park, schools, and common areas. One existing golf course and two proposed golf courses will use well water for irrigation as a result of insufficient quantities of reclaimed water. A dual water system is planned for the entire development.

Proposed:
N/A

Future:
The development that is served by this facility is estimated to be built-out in 40 years with an ultimate projected wastewater flow of 6.50 MGD. The existing facility is expected to be sufficient for the first 7 years of development. Future expansions of 1 MGD, 2 MGD and 2.50 MGD with a deep well being constructed as back-up to spray irrigation, are proposed to meet future demands. At build-out, it is expected that an additional 5.70 MGD of irrigation water beyond the 6.50 MGD of reclaimed water will be needed to meet the irrigation demands of the development.

Source:
Information supplied by Gateway Utilities.

Lehigh Utilities

Treatment/Disposal:
There is an existing 2.48 MGD activated sludge (contact stabilization) wastewater treatment plant limited to 1.88 MGD because of reclaimed water disposal with reclaimed water disposal by reuse via golf course spray irrigation and ground water recharge by percolation ponds (13 acres). Irrigation with reclaimed water has been initiated on the Admiral Lehigh Golf Course (North). It is anticipated the golf course will use an average of 0.40 MGD of reclaimed water. The 1990 average daily wastewater flow was 1.17 MGD.

Location:
End of Construction Road, Lehigh Acres.

Reuse Feasibility:
This facility is currently reusing reclaimed water for golf course irrigation on the Admiral Lehigh Acres Course (North) and for ground water recharge via percolation ponds. Reuse is the proposed disposal method for future flows, via public access irrigation and percolation ponds.

Proposed:
N/A.

Future:
The 1993 master plan for this facility projects a 2010 average daily wastewater flow of 4.55 MGD with reuse as the preferred disposal method. The plan also anticipates the construction of three other treatment facilities within the service area.

Source:
Information provided by Lehigh Utilities, Inc.

North Fort Myers

Treatment/Disposal:
There is an existing 2 MGD activated sludge (oxidation ditch) wastewater treatment plant with reclaimed water/effluent disposal by golf course spray irrigation and deep well injection. Irrigation with reclaimed water has been initiated on the Riverbend and Six Lakes Golf Course and at the Sabal Springs development. The 1990 average daily flow was 0.21 MGD, of which 0.13 MGD was reused. The average reclaimed water/effluent chloride concentration is 207 mg/L.

Location:
West of Jolson Road, north of Tucker Lane, Suncoast Estates in Lee County.

Reuse Feasibility:
This facility is currently producing reclaimed water for public access spray irrigation at various sites. It is the utility's intention to maximize reuse as additional sites become available.

Proposed:
This facility serves an area that is currently served by 35 "package" plants, 16 community septic tanks and 10,000 private septic tanks which are proposed to be abandoned when regional wastewater collection becomes available.

Future:
This facility's service area is estimated to have a 2010 wastewater flow of 11.45 MGD. Plant expansions are conceptually to be accomplished by a two phase expansion to 10 MGD consisting of two separate 4 MGD expansions. The first expansion is to be completed by 1995 and second by 2000. Reclaimed water/effluent disposal will be by reuse via spray irrigation on golf courses and by deep well injection.

Source:
Information supplied by Post, Buckley, Schuh & Jernigan for North Fort Myers Utilities.

Sanibel Island

Treatment/Disposal:
There is an existing 1.25 MGD activated sludge (contact stabilization) wastewater treatment plant with reclaimed water disposal by reuse via golf course spray irrigation and percolation ponds. Reclaimed water is utilized for irrigation on the Beachview and Dunes Golf Club golf courses. The 1990 average daily flow was 0.56 MGD.

Location:
930 Donax Street, Sanibel.

Reuse Feasibility:
This facility is currently producing reclaimed water for golf course irrigation at the Beachview and Dunes Golf Club golf courses. It is stated that these golf courses have disposal capacity's of 0.98 MGD and 1.27 MGD, respectively which exceeds the capacity of the plant.

Proposed:
This facility is being expanded to 1.60 MGD. Construction is anticipated to be complete in the summer of 1994. Treatment type will be modified to conventional and reclaimed water disposal will remain the same.

Future:
The expanded facility is anticipated to be adequate to serve the build-out population of the service area. Disposal will be via the existing facilities.

Source:
Information provide by the Sanibel Sewer System and the City of Sanibel.

APPENDIX F

Wetlands and Environmentally Sensitive Areas

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FACTORS AFFECTING WETLANDS AND ENVIRONMENTALLY SENSITIVE AREAS

Factors which influence wetland systems and environmentally sensitive lands include hydrology, fire, geology and soils, climate, and ecological succession. This section presents an overview of each of these factors.

Hydrology

Hydrology is the single most important determinant for the establishment and maintenance of specific types of wetlands and wetland processes (Mitsch and Gosselink, 1986). Hydraulic inflows and outflows, such as precipitation, surface runoff, ground water inputs, and in some cases, tides and river flooding, provide the energy to transport nutrients and other organic material to and from wetlands. Water depth, hydroperiod, flow patterns, stage, duration, frequency of flooding and water quality all influence the biochemistry of wetlands and ultimately, the species composition and type of wetland community that develops. The hydrology of a wetland acts both as a limit and a stimulus for determining the numbers, types (species), and growth rates of flora and fauna that can live within a specific wetland. For example, the growth rates of pine trees appear to be affected by water table depths. Slash pine growth rates in flatwoods generally increase in proportion to the depth to the water table, indicating the inhibitory effect of excessive moisture (Duncan and Terry, 1983). At the other extreme, tree growth can be limited by a lack of available moisture during the dry season (Haines and Gooding, 1983). Hydrology also strongly affects aquatic primary production, organic accumulation, and the cycling of nutrients (Mitsch and Gosselink, 1986).

Precipitation

The LWC Planning Area experiences wide variations in annual rainfall, resulting in flooding and extended drought periods. During heavy rainfall years, there is overland flow and discharge to the ocean. During extended drought years, however, the natural system is stressed by saltwater intrusion, increased frequency of fires, loss of organic soils, and invasion of wetlands by exotics. The region averages about 53 inches of rainfall annually, with approximately two-thirds falling during the summer months (Duever *et al.*, 1986). During the dry season (November-April), precipitation is governed largely by large-scale winter weather fronts which pass through the region roughly every seven days (Bradley, 1972). Rainfall from these fronts exhibit a uniform distribution pattern as compared to precipitation derived from the highly variable, convective-type thundershowers which are characteristic of the wet season (May-October).

Evapotranspiration

Evapotranspiration (ET) is the combined process of evaporation from land and water surfaces, and transpiration from plants. ET rates vary as a function of solar radiation, air and water temperature, relative humidity, wind velocity and duration and the type and density of vegetation (Duever *et al.*, 1986). In South Florida, ET ranges from 70 to 95 percent of annual rainfall. During the dry season and drought years, ET exceeds rainfall inputs (Klein *et al.*, 1975). Temperature is often regarded as the most important factor controlling ET. Minimum ET rates occur during the winter months of December and January, with highest values experienced during the spring months of April and May. Typical ET values for South Florida range from 40 to 45 inches a year, up to a maximum of 60 inches a year (Parker *et al.*, 1955). ET

rates frequently account for virtually all water losses in a wetland because of their slow rate of flow and high surface area to depth ratio (Mitsch *et al.*, 1988). As a result, ET plays a very important role in the development of any hydrologic model that might be developed for a particular wetland system and is usually the most difficult parameter to estimate. Wetlands have higher ET rates than other habitats largely because they store water near the ground surface where it can be lost to the atmosphere (Duever, 1988).

Hydroperiod

Hydroperiod refers to the annual period of water level inundation, specifically the length of time (duration) that a wetland contains water above ground level. Figure F-1 presents examples of typical hydroperiods experienced by three different South Florida plant communities. Duever *et al.* (1986) reports that hydroperiod is the dominant factor controlling both the existence, plant community composition and succession of South Florida wetland systems. Hydroperiod is often expressed in terms of the range of the number of days that a wetland is normally inundated. For example, in the Big Cypress Preserve, Duever *et al.* (1986) reports that freshwater marshes are usually found on sites having a hydroperiod of 225 to 275 days per year, as compared to a pond system which is inundated year round. Each wetland type is thought to have a hydrologic signature that describes the rise and fall of water levels from year to year (Mitsch and Gooselink, 1986). Duever *et al.* (1986) found that work conducted at Corkscrew Marsh "has clearly shown that the distribution of undisturbed upland, marsh, swamp and shallow aquatic habitats are largely a function of a site's hydroperiod." In contrast, O'Brian and Ward (1980) state that from a hydrological point of view, the most significant feature of a wetland is the level of the ground water table. They point out that the depth to the ground water table is more significant than the hydroperiod or time the wetland is flooded.

Water Level Depth and Timing

In South Florida's freshwater wetlands, wading bird nesting success is highly dependent on present and past water level conditions, which influence the amount and availability of wading bird prey items, such as crayfish and small forage fish (Kushlan, 1976, 1978, 1979, 1980, 1986; Powell, 1987; and Frederick and Collopy, 1988). Ecological studies of Southwest Florida wetlands have found a direct relationship between numbers of wading bird breeding attempts and the amount of rainfall preceding the breeding season (Ogden *et al.*, 1980, 1987). Kahl (1964) found that the timing and initiation of wood stork breeding attempts was predictable from the measurement of marsh surface water levels. Kushlan *et al.* (1975) found that wading bird nesting success was directly related to the rapid winter/spring recession of water levels (drying rate) of South Florida wetlands. Therefore, maintenance of appropriate water depths and timing of wetland water level fluctuations is a critical factor in determining wading bird nesting success.

Topography

In general, wetlands in temperate and tropical regions tend to develop in areas of low topographic relief and high rainfall inputs. Topography also controls the shape and size of watersheds, and affects the timing and quantity of runoff. Topography is also an important factor in controlling the vertical and horizontal extent of seasonal water level fluctuations within a wetland. In the Big Cypress swamp, Duever *et al.* (1986) found that wetlands dominate much of South Florida because: (1) the flat topography reduces runoff to a minimum, (2) high rainfall during the warm part of

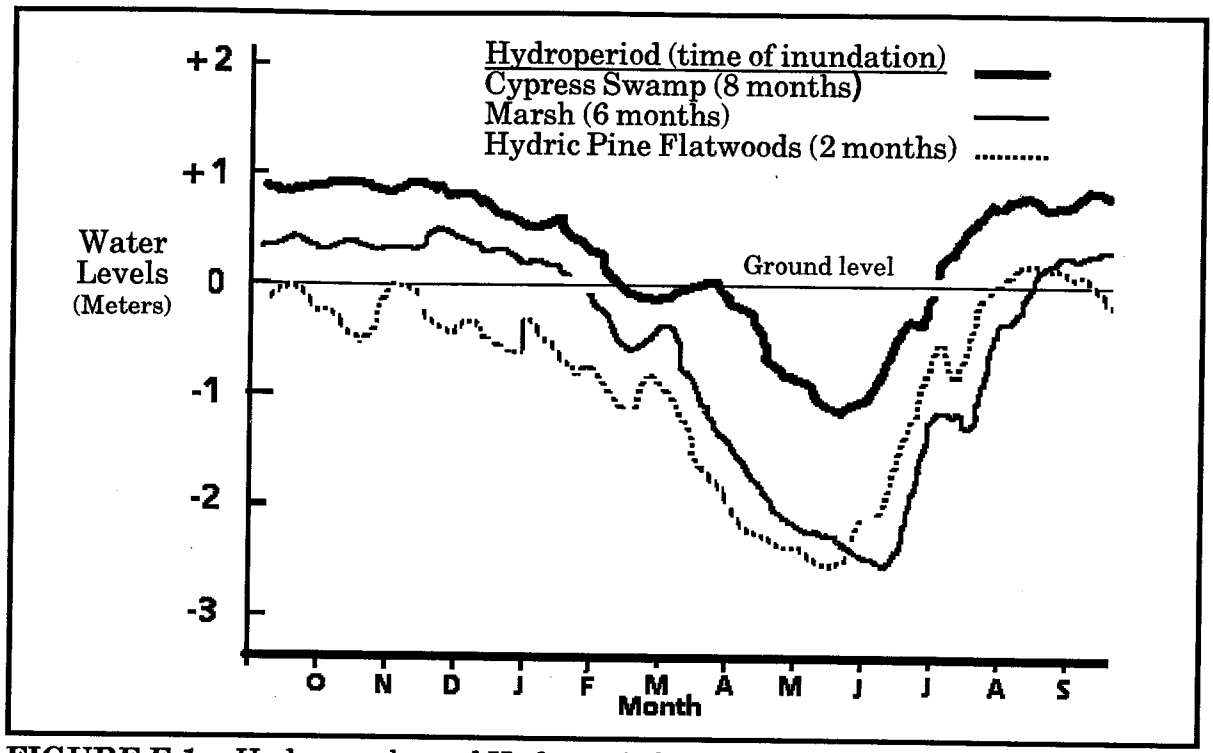


FIGURE F-1. Hydrographs and Hydroperiod Ranges for for Three Different South Florida Vegetation Types. (From Duever *et al.*, 1986).

the year compensates for high ET losses, and (3) low ET rates during the the cool part of the year approximates rainfall inputs. At the site-specific level, wetlands are determined by the depth and duration of inundation, which in turn are influenced by site microtopography (differences in water depth of only a few centimeters), soil type, and vegetation cover (Duever *et al.*, 1986).

Vegetation Type

Vegetation type can affect the hydrologic cycle of a wetland, primarily through ET. Vegetation also influences water movement and water quality. Plant leaves, leaf litter and attached periphyton (algae) communities tend to impede water flow which: (1) increases the period of inundation, (2) reduces surface water runoff and erosion, (3) allows more time for aquifer recharge, and (4) assimilates nutrients and chemical exchanges between the soil vegetation and water (Duever *et al.*, 1986).

Tropical Storms and Hurricanes

Hurricanes, tropical cyclones which generate winds in excess of 75 miles per hour, are recurrent events in South Florida and are important physical processes which affect the regional ecology (Craighead and Gilbert, 1962). Southwest Florida has been identified by the National Weather Service as one of the most hurricane-vulnerable areas of the United States. Hurricanes normally cause the greatest amount of damage when wind velocities average greater than 111 miles per hour. Such storms have passed within 100 miles of Fort Myers on the average of once every five-and-one-half years from 1900 to 1985 (SWFRPC, 1990).

Coastal flooding from tropical storms or tropical depressions occur commonly within the LWC Planning Area, causing flooding in low-lying areas, along barrier islands, and near river and bay systems (SWFRPC, 1990). Although these storms are destructive to life and property, they appear to be an important component of the region's natural hydrological cycle, often occurring following several drought years to replenish surface and ground water sources. These storms also appear to be an important source of fresh water and nutrient inputs into Florida Bay (Meeder and Meeder, 1989).

Fire

Fire is also an important factor controlling the species composition, distribution and succession of wetland communities in the LWC Planning Area. Within the constraints of wetland hydrology, fires occur with variable frequency and severity affecting plant succession.

Theoretically, hardwood hammocks represent the climax plant community for South Florida (Alexander and Crook, 1973; Wharton *et al.*, 1977; Duever, 1984). Hammocks develop when fire is absent or infrequent, and organic soils are allowed to build up over time to support the succession of hardwoods (Figure F-2). However, fire is a common component of the South Florida landscape. In the Everglades, fires occur, on the average, every seven years. Few areas escape fire; thus hammocks are relatively uncommon and occur only on elevated sites where fire is infrequent. Most sites which are high enough to support hammocks are occupied by pine flatwoods which are tolerant of periodic fire (Duever, 1984).

Wetlands are subject to fires during the dry season. Marshes which dry out and burn with enough frequency do not allow the establishment of cypress forests. Cypress dominated wetlands occur on wetter organic soils which burn less frequently. Before man settled the region, the majority of fires were caused by lightning strikes during the wet season. As more people moved to the region, more fires occurred during the winter dry season. These fires are typically more severe and extensive since they occur during the dry season when wetland soils are dry.

Geology and Soils

The primary geological feature that controls regional hydrology is the permeability of the underlying rock. Limestone with deposits of quartz sand, clay and shell comprise the underlying aquifer. A more detailed description of the region's geology and underlying aquifer system is found in Chapter III.

Two primary factors which affect the hydrogeology of wetlands are the porosity and permeability of its underlying soils (Duever, 1988). A highly porous soil can hold or store large amounts of water, while a highly permeable soil allows water to flow to the underlying aquifer. The high capillary action of peat or clay soils enable wetlands to store large quantities of water, somewhat similar to how a sponge takes up water.

Some wetlands contain perched water tables. A perched water table exists where a saturated soil layer is found above a water table and is separated from it by an unsaturated zone (Freeze and Cherry, 1979). This can occur where a relatively impermeable clay or organic soil layer is present near the ground level and restricts the downward movement of water. Perched water tables come in various sizes and can influence surface water levels over large areas or have only local, temporary

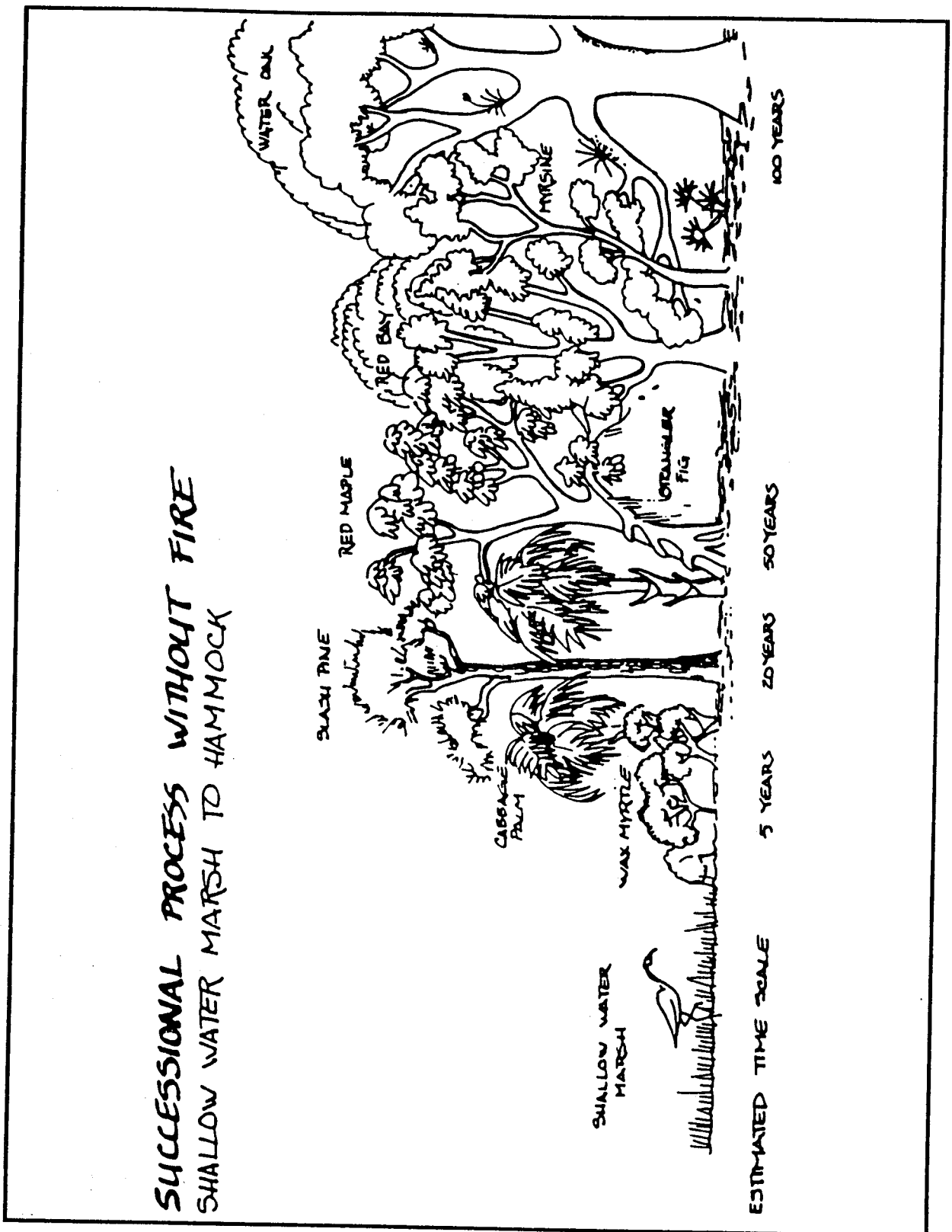


FIGURE F-2. South Florida Successional Pattern without Fire: Shallow Water Marsh to Hammock (From Wharton *et al.*, 1977).

effects (Duever, 1988). A common misconception is that wetlands can only occur on sites containing a perched water table. Although this may be the case in some areas, Duever's (1988) experience in Southwest Florida indicates that wetland water levels coincide with the regional water table. Situations which at first appeared to be a perched water table turned out to represent unusual or transient conditions.

Climate

In addition to hydrology and fire, climate also plays an important role in controlling plant community succession. The areal extent, species composition, and existence of wetlands are all affected by long-term climatic changes. In addition to normal cyclic drought and flood conditions, long-term cycles have the ability to produce gradual, and nevertheless, major shifts in the normal year-to-year range of hydrologic conditions. As climatic cycles become wetter, wetlands will tend to cover larger areas of the landscape. Wetland communities would also tend to become more diverse as a result of the presence of greater ranges of hydroperiods on different topographic sites. A wetter climate might also increase the rate of peat accretion in wetlands, thus encouraging the development of edaphic plant communities. Long-term drier conditions might produce the opposite effects. A wetter or dryer climate might also affect the frequency of fire, shifting plant community succession. A major difficulty in managing wetlands is our inability to distinguish between shifts in hydrologic conditions that result from man's activities and those that result from occasional natural events or long-term shifts in climate (Duever, 1984).

Succession

Overdrainage of wetlands and reduction of hydroperiod length directly influences the direction of plant community succession within a wetland. McPhearson (1973) reported that "differences of only a few inches in depth or changes in period of inundation will determine, in time, what plant communities are present [in the Everglades]." Numerous investigators have documented changes in the species composition of South Florida plant communities resulting from altered water level conditions (Davis, 1943; Loveless, 1959; Kolipinski and Higer, 1969; Dineen, 1972, 1974; Alexander and Crook, 1973, 1988; Schortemeyer, 1980; Worth, 1983). Duever *et al.* (1976) used fire frequency and hydroperiod data to establish a basis for the occurrence of plant community succession in Corkscrew Swamp. This relationship is presented in Figure F-3. The successional relationships of South Florida wetland and upland plant communities have also been discussed by Alexander and Crook (1973), Craighead (1971), Davis, (1943), Wharton *et al.* (1977), and Duever, *et al.* (1986). These data are useful for making a general assessment of the direction that succession may take as a result of increasing or decreasing hydroperiod in a Southwest Florida wetland.

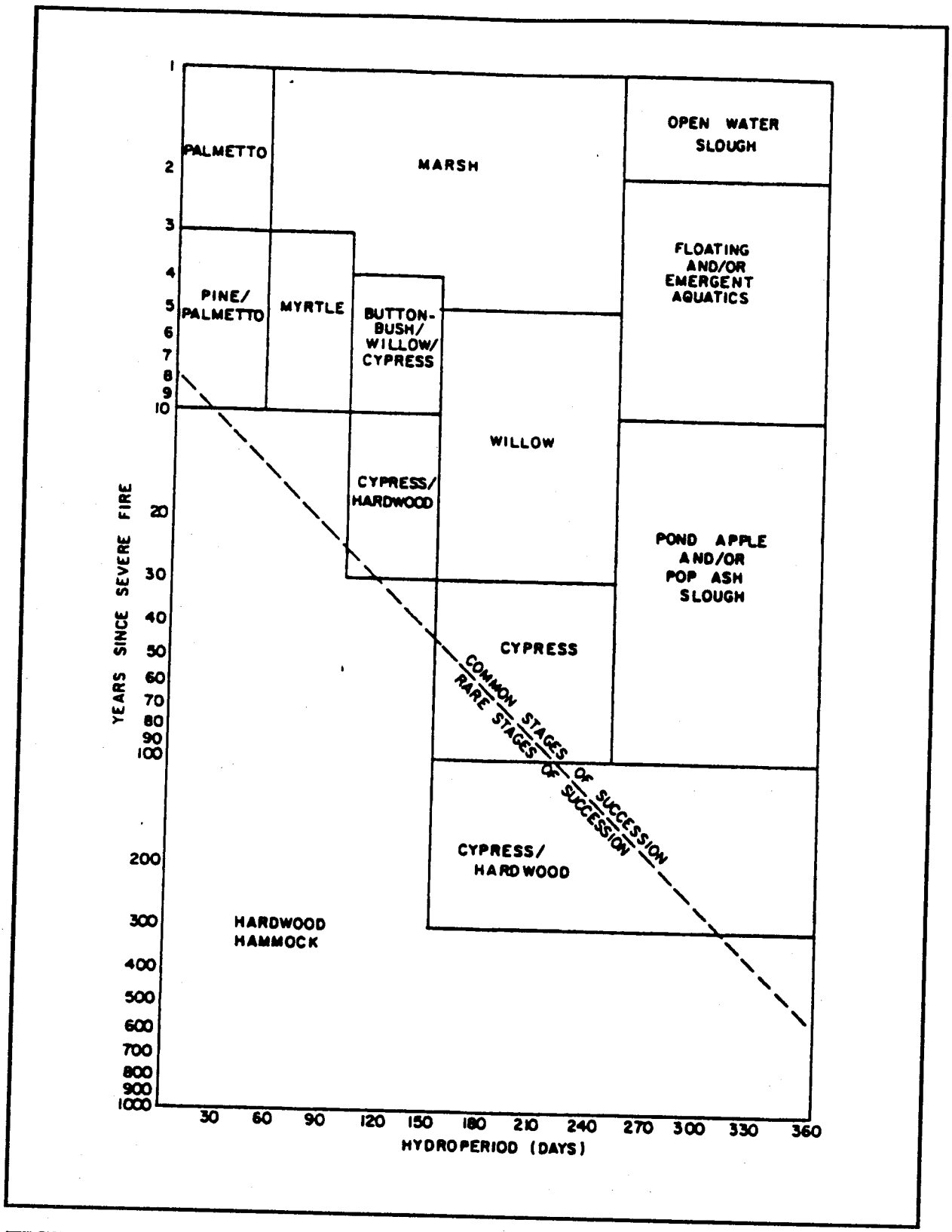


FIGURE F-3. Successional Patterns and Rates within South Florida Inland Plant Communities (From Duever *et al.*, 1984).

REGIONAL ENVIRONMENTAL ISSUES

Loss of Wetlands

According to the U.S. Fish and Wildlife Service (1990), Florida has lost over 9.3 million acres of wetlands between 1780 and 1985, a 46 percent loss. During the 1970s and 1980s, despite strict environmental regulations, Florida lost, on average, over 26,000 acres of wetlands annually, which is the equivalent of losing 70 acres of wetlands each day. Almost all of these losses are the result of conversion of wetlands to agriculture, urban and other built-up areas (Frayer and Hefner, 1991). It was estimated that in 1780, Florida had over 20.3 million acres of wetlands; the state now has less than 11 million acres. Florida's losses represent over 15 percent of the national loss annually (U.S. Congress, 1984).

In Southwest Florida, large-scale loss of wetlands occurred during the 1960s and 1970s. Urban and agricultural development has affected both the quantity and quality of remaining wetlands. In Lee County, continued urban growth has altered the county's natural systems over the past 50 years. In the northwest portion of the county, the peninsula now occupied by the City of Cape Coral originally consisted of sloughs, marshlands, and seasonal ponds. Almost all of this original habitat has been lost to development. Lehigh Acres, another large-scale residential development located in the eastern part of the county, has also resulted in the ditching and draining of thousands of acres of the original wetland/upland mosaic. Other parts of the county have been converted to cropland and improved pasture.

In Collier County, a single large development, Golden Gate Estates, attempted to drain 110,000 acres of pristine forested and emergent wetlands. This project dug 183 miles of canals, constructed 813 miles of roads, and sold over 50,000 individual lots to buyers worldwide (Frayer and Hefner, 1991). Construction of two primary canal systems, the Golden Gate Canal and the Faka Union Canals, disrupted natural drainage patterns and lowered ground water levels to control flooding and make land suitable for development (Klein *et al.*, 1970; Carter *et al.*, 1973; McPherson *et al.*, 1976). Along the coast of Collier County, south of Naples, a large resort community was built on Marco Island. Construction of this community converted approximately 5,300 acres of mangroves and uplands to finger canal subdivisions. Collier County has also experienced a large amount of growth along its northern coastal area. This growth has the greatest impact on the estuarine communities affected by the alteration of both the quantity and quality of the freshwater runoff they receive. Construction of Alligator Alley (State Road 84), Tamiami Trail (U.S. 41), I-75 and State Road 29 have all impacted historical surface water flow patterns throughout the LWC Planning Area. Heavy use of these roads is a threat to several species of endangered wildlife, including the Florida panther.

The Corkscrew Regional Ecosystem Watershed (CREW) lands represent more than than 50,000 acres of environmentally sensitive wetlands and uplands located in Collier and Lee counties. The CREW lands contain five major wetland systems: (1) Flint Pen Strand, (2) Corkscrew Marsh, (3) Corkscrew Swamp Sanctuary, (4) Bird Rookery Swamp and (5) Camp Keis Strand. This area probably represents the largest remaining hydrologically intact wetland ecosystem in South Florida and provides important wildlife habitat to a number of rare, threatened and endangered species.

Potential impacts to CREW include: (a) the possibility of lowered ground water tables and impacts to wetlands as a result of county and municipal wellfield

development within the watershed, and (b) lowered water table elevations, degraded water quality, and associated wetland impacts caused by the expansion of the citrus and vegetable industries. If properly managed, these lands have the potential to provide a number of benefits to the region. Preliminary data suggests that CREW may offer some degree of water supply for Lee and Collier counties, along with the potential for providing drainage, flood storage and water quality improvements for surface waters discharged to downstream estuaries. The District is currently conducting a hydrologic evaluation of the CREW watershed.

Developments of Regional Impact

Several large developments of regional impact are currently being considered for approval. These proposed developments have the potential to alter surface water flow patterns, deplete ground water supplies, cause alteration of wetland hydroperiods, encourage exotic plant invasion, and impact existing wildlife habitat.

Southwest Regional Airport Expansion

Lee County is currently planning to expand the existing regional airport located in the central portion of the county. Expansion plans call for runway improvements, construction of roads and parking lots, rental car and commuter aircraft parking, a new concourse and associated support facilities. This proposal would impact a minimum of 400 acres of wetlands (Memorandum dated November 12, 1991 from Chip Merriam, Government Assistance, SFWMD, Ft. Myers area office).

Alico DRI

The Alico DRI is an 11,000 acre conceptual plan to develop a 20,500 dwelling units, integrating a mix of industrial, commercial, office, residential, public open space, and recreational land uses. The project has the potential to impact 1,310 acres of wetlands, consisting primarily of cypress wetlands, freshwater marshes, and wet prairies. Environmental concerns focus upon: (a) potential drainage of wetlands and loss of wildlife habitat as a result of wellfield drawdowns, (b) impacts associated with drainage and development, (c) potential water quality impacts to the Estero River and Six Mile Cypress Basin, and (d) the encouragement of more urban sprawl within the central portion of the county, which has the potential to further fragment remaining wildlife habitat.

Gulfview-New Town

The proposed project is a 7,000 acre mixed residential and commercial development. Approximately 1,300 acres of property will be within the Flint Pen Strand as identified by the Save Our Rivers CREW Project. Lee County has proposed the establishment of several wildlife corridors within the county to reduce the detrimental effects of habitat fragmentation; one of these corridors is proposed for this project.

Relocation of Citrus to Southwest Florida

The conversion of upland and wetland habitat to citrus in Hendry County, western Glades, eastern Lee and Charlotte, and northern Collier counties is threatening the area's water resources and remaining wildlife habitat. In the early 1980s, a series of devastating freezes caused serious damage to Central Florida's citrus industry. As a result, many citrus growers have recently migrated to

Southwest Florida, seeking to reduce the risk of freeze damages to their crop. This has resulted in a major shift in the geographical distribution of citrus within Florida.

Based on the number of trees in the ground, Hendry County now ranks as Florida's number one citrus county, and ranks third in total citrus acreage. Since 1980, citrus acreage in the region has nearly doubled to its current level of 126,000 acres (Table F-1). Much of this growth has occurred in the past three years (Behr, 1989). According to Florida Gulf Citrus News (1990), citrus growers within the Southwest Florida area planted over 7,000 citrus trees on 40 acres each day during 1988 and 1989. This trend is expected to continue through the next decade, with a projection of up to 80,000 hectares (197,680 acres) in citrus production by the year 2000 (Land, 1988). The on-tree value of this production is estimated to be $380 million dollars annually, given current citrus prices (Behr, 1989).

TABLE F-1. Citrus Acreage and Trees, 1990.

COUNTY	ACRES	TREES
Hendry	73,754	10,387,900
Collier	23,565	3,204,100
Charlotte	11,718	1,241,000
Lee	9,692	1,169,300
Glades	7,523	890,000
Gulf Total	126,252	16,892,300

Source: Florida Gulf Citrus News, 1990.

Impacts on Wetlands

Citrus development requires extensive drainage of the land and lowering of the water table during the wet season to support the growth of crops. Much of the east-central portion of the LWC Planning Area is currently cattle rangeland (improved and unimproved pasture and native rangeland). The drainage requirements for rangeland, however, are significantly different from those required to operate a citrus grove. Pasture and rangeland are typically drained by shallow ditches placed at wide intervals because native grasses can survive long periods of flooding. In contrast, citrus groves are very sensitive to saturated water table conditions and require rapid drainage. As a result, the typical citrus operation requires a rather elaborate and responsive drainage/irrigation system, which includes high capacity wells, pumps, reservoirs, ditches, levees and dikes. Impacts caused by the drawdown of the water table beneath adjacent wetlands is a concern as the industry expands its operation within the region (University of Florida, IFAS, 1991).

Impacts on Uplands

There is a concern that the magnitude and scale of citrus development has the potential to replace most of the remaining upland communities such as flatwoods and xeric scrub habitats which are native to the region. Conversion of large areas of uplands to citrus within Hendry, Lee and Collier counties may significantly affect the regional ecosystem and its remaining wildlife habitat, which borders two federally protected areas (i.e., the Big Cypress National Preserve, Everglades National Park,

and the Florida Panther National Wildlife Refuge). Some of this development is occurring in areas occupied by threatened or endangered species such as the Florida panther, black bear, red-cockaded woodpecker, gopher tortoise, gopher frog or Florida scrub jay. As illustrated in Figure F-4, much of the Florida panther's range is threatened by citrus development.

Large-scale citrus development is also a source of concern for the natural hydrology of the area. The pumpage capacity required to efficiently operate a typical citrus grove can produce large distortions in the predevelopment surface water hydrology of surrounding areas, thus affecting adjacent wetlands as well as hydric hammock and hydric pine flatwoods areas. Drainage of uplands and wetlands, and loss of surface water storage areas, may also affect ground water recharge rates and impact future water supplies. In addition, significant amounts of fertilizers and pesticides are used in the operation of a typical citrus grove. These contaminants have the potential to be transported off site in drainage waters to downstream receiving waters. Relatively little is known concerning the water quality impacts of a citrus grove operation on adjacent land uses or water bodies.

Impacts of Ground Water Drawdowns on Wetlands

Expansion of existing county and municipal wellfields in central Collier, southeastern Lee and Hendry counties, and the associated effects of lowering regional ground water tables is a concern for existing wetland systems within the LWC Planning Area.

Relatively little information exists which describes the impact of large-scale agricultural wellfield drawdowns on wetland systems in the LWC Planning Area. Regulatory agencies, such as the SFWMD, face a difficult problem in developing scientific rationale for quantifying the effects of ground water pumpage on wetlands (Watson., 1990), specifically the depth which the water table can be lowered before an impact can be detected within a wetland. The majority of available information presented below has been derived from municipal wellfield drawdown studies.

The effects of municipal wellfield drawdowns on wetlands have been well documented by the Southwest Florida Water Management District (Rochow, 1982, 1983, 1984, 1985; Rochow and Dooris, 1982; Dooris *et al.*, 1990; Watson *et al.*, 1990; Rochow and Rhinesmith, 1991). Over a 15-year period, the SWFWMD has produced more than a dozen technical reports from their wellfield monitoring program concerning the effects of ground water withdrawals on wetland ecosystems. In general, these data indicate that long-term wellfield drawdowns greater than one foot result in "unacceptable ecological change" to wetland communities. These changes (from Dooris *et al.*, 1990) include:

- Invasion or establishment of terrestrial plant species creating a "disturbed" appearance and potentially allowing for invasion by exotics
- In severe cases, lowered water table elevations have caused cypress tree mortality and loss of canopy cover
- Increased susceptibility to damage by fire and increased numbers of destructive fires causing changes to community structure
- Loss of organic soils and increased soil subsidence.
- Loss of wildlife habitat and wildlife resources.

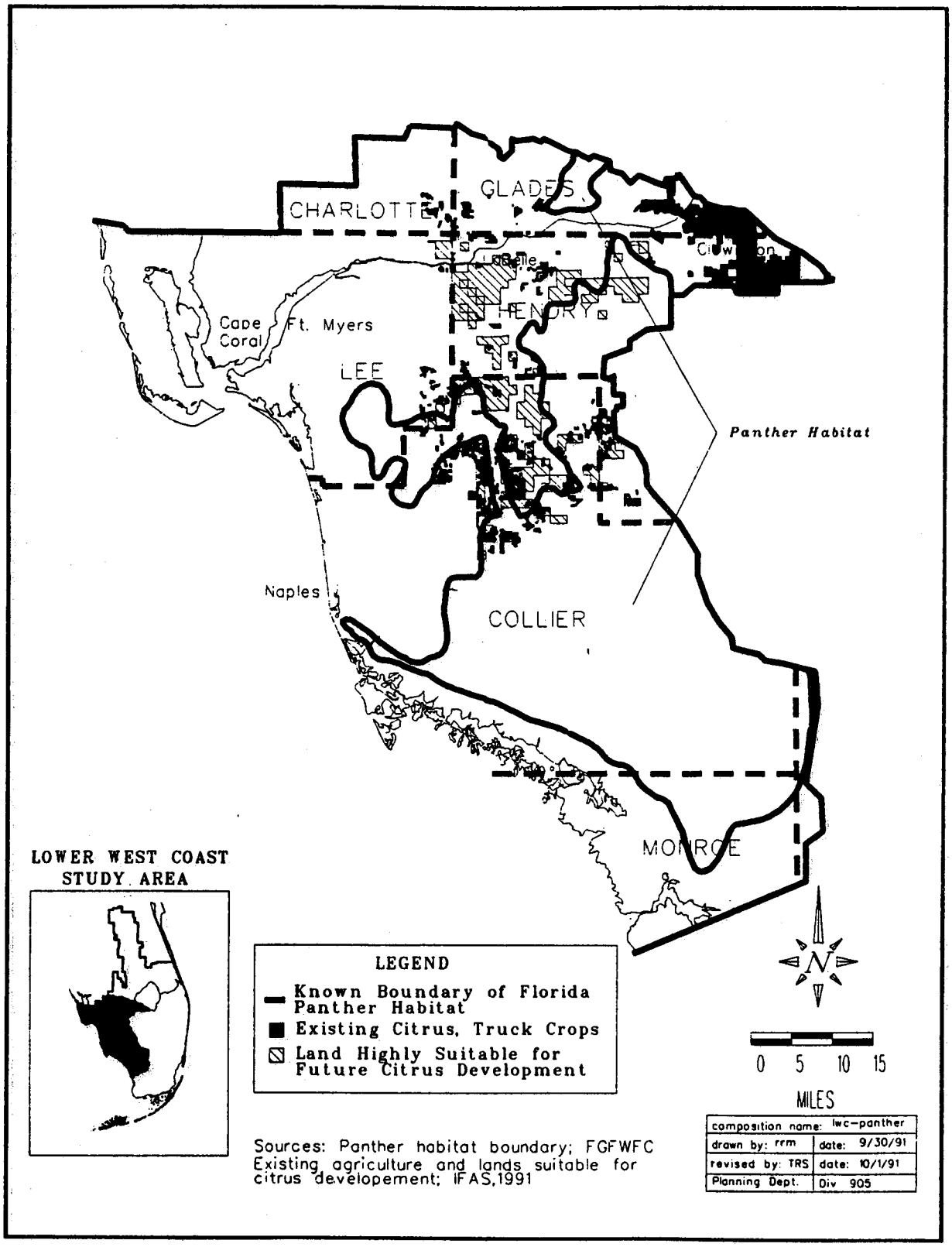


FIGURE F-4. Florida Panther Habitat and Permitted Citrus in Southwest Florida.

Hydrological and biological monitoring of the Starkey Wellfield has shown that a 0.6 foot water table drawdown corresponded to a noticeable replacement of wetland plant species with those more adapted to upland sites (T.F. Rochow, 1989).

In the LWC Planning Area, relatively little work has been directed towards determining the effects of wellfield drawdowns on wetland ecology. The majority of available information has focused upon the ecological impacts of lowered water tables caused by drainage canals. In a study of the Big Cypress Swamp, Carter *et al.* (1973) described the impacts to cypress wetlands from drainage. Burns (1984) studied the effect of declining water levels within a Fakahatchee Strand cypress community. Results showed that lowering of the water table by an average of 50 cm (1.6 ft.) significantly decreased biomass and net production of the cypress strand. Within this same strand system, Carter *et al.* (1973) and Burns (1984) found a tenfold decrease in primary productivity, extensive thinning of the cypress forest canopy, and a reduction in the rate of forest litter decomposition, leading to buildup of fuel for destructive wildfires. Related observations in the Big Cypress Swamp indicate that extensive dewatering of certain areas of the swamp over the past three decades has led to widespread invasion of cypress communities by slash pine, red maple and red bay. In areas that were previously lumbered and burned, willow is the dominant canopy species for decades to come (Duever *et al.*, 1984). In southeast Florida, recent data published by Hofstetter and Sonenshein (1990) showed vegetative changes that occurred from 1978 through 1986 in an Everglades wetland (Northwest Wellfield, Dade County). Results of the study show that wellfield drawdowns shorten hydroperiod, decease herbaceous marsh vegetation in favor of woody vegetation and allow for invasion by melaleuca.

Loss of Aquatic Productivity

Wetlands are known as one of nature's most productive ecosystems. For the greater portion of the year, wetlands are flooded and therefore function essentially as an aquatic system. Typically, 75 to 85 percent of the annual precipitation occurs during the months of June through October. Since Southwest Florida wetlands depend upon rainfall as their major source of inflow water, water levels within wetlands systems closely follow seasonal rainfall patterns. Maximum water levels occur near the end of the wet season (October - November) while water levels generally decline during the dry season, reaching lowest levels during April and May. The majority of animals which inhabit Southwest Florida are adapted to this annual cycle. The reproductive success of several key species is closely tied to the rate of water level recession and the concentration of food resources that occurs during the dry season (Ogden *et al.*, 1987; Robertson and Kushlan, 1974).

The presence of surface water within a wetland is essential for maintaining wetland aquatic productivity, i.e., the growth and reproduction of aquatic organisms such as insects, small forage fish, amphibians, crayfish, freshwater shrimp, snails and other invertebrates that form the basis of the food chain for higher trophic level organisms such as amphibians, reptiles, wading birds and raptors which utilize these wetlands (Kahl, 1964; Kushlan,1976, 1978; Frederick and Collopy, 1988). Overdrainage of wetlands by ground water withdrawals or surface drainage directly impacts this annual cycle by reducing wetland size, as well as the amount, number and kinds of microorganisms produced by wetlands. Therefore, large-scale drainage of wetlands has a great potential to impact the regional food supplies, breeding and nesting areas for many species of wildlife.

Decrease in Wetland Size

The most obvious impact of reducing water levels is a decrease in size of the wetland. This is especially true of shallow, low gradient wetlands which may be completely eliminated. Decrease in wetland size reduces the available wildlife habitat and the area of vegetation capable of nutrient assimilation. It also reduces the water surface area, and corresponding ET and evaporation rates, which can have an influence on the rain cycle and regional climatic conditions.

Degradation of Fish and Wildlife Habitat

A decrease in wetland size reduces the available wildlife habitat. The accompanying changes in vegetative composition and diversity, and loss of aquatic productivity impacts the breeding and nesting areas for many species of wildlife.

Invasion by Exotic Plants

Invasion by exotic plants such as melaleuca and brazilian pepper is encouraged by changes in the depth and/or duration of wetland water levels. Melaleuca adapts well to alternating flood and drought conditions, and can form thick, monotypic stands that have very little wildlife value. Melaleuca also exhibits a high rate of ET and is very tolerant of fires, sprouting readily from the root stock after burning. The threat from this aggressive and difficult to control species argues strongly against allowing any further decreases in water levels or hydroperiods in the wetlands.

Alteration of Historical Surface Water Flows

Changes in water levels can also affect surface water flow patterns within and between wetlands. Reductions of the amount of surface water flow from wetlands can also have a negative effect on the salinity balance in estuarine habitats. This can be detrimental to the productivity of seagrass beds, oyster bars, and other valuable coastal environments.

Soil Subsidence and Increase in Fire Potential

With the impact on wetland water budgets that occurs from wellfield drawdowns comes an increase in the frequency and severity of wildfires. Fires are part of the natural process that recycles nutrients from accumulated plant material back into the soil. They are prevalent in the dry season, especially during drought years. Normally, the soil remains wet almost to the surface, protecting the roots of wetland vegetation from damage. When the water table is depressed to unnaturally low levels, the muck soils that underlay many of South Florida's wetlands dry out and become flammable. Resulting muck fires kill natural wetland vegetation, which is replaced by less desirable, weedy species. Even in the absence of fire, overly drained muck oxidizes and breaks down, which can lead to vegetation changes and degradation of wetland function.

Saltwater Intrusion

Wetlands in coastal areas may experience vegetative changes in response to salinity changes. For example, cypress, maple, and other freshwater species can be killed by increased salinity resulting from decreased inflows of fresh water. One way to deal with this situation would be to establish minimum flows, which could lead to constraints on water supply development upstream.

Other Impacts

There are numerous other activities which affect wetlands that are outside the scope of this report, but may contribute to the cumulative impact on wetland systems (Larson, 1976; Carter *et al.*, 1973; University of Florida, Center for Government Responsibility, 1982; Rochow, 1989; CH_2M Hill, 1988):

- Outright filling and conversion to residential, commercial, industrial, or agricultural uses
- Drainage for pasture
- Rock mining
- Peat mining
- Chemical or biological pollution
- Impounding
- Dumping
- Recreational misuse and overuse
- Noise pollution

Impacts of Ground Water Drawdowns on Uplands

Little is currently known about the hydrologic requirements of upland communities. However, it is known that the water table levels beneath an upland play an important role in defining the vegetative structure and composition of an upland community. Impacts to uplands from water table withdrawals are similar to those encountered by wetlands, such as increased frequency of fire caused by reduced moisture conditions stemming from lower than normal water table elevations. Most natural environments in South Florida depend on appropriate fire regimes to maintain their ecological integrity. Those upland communities that are on the highest and lowest water tables may prove to be the most sensitive to water table level change. Monitoring of upland parameters is needed to provide a better understanding of wetlands.

impacts of Ground Water Drawdowns on Estuarine and Marine Habitats

Although estuarine and marine habitats are not specifically addressed in the water supply model developed for the LWC Water Supply Plan, these sensitive environments need to be considered whenever management scenarios have the potential to affect freshwater releases to tidewater. The degree of salinity as well as volume, distribution, circulation, and temporal patterns of freshwater discharge all contribute to the character of these systems. In many ways, salinity is a master ecological variable that controls important aspects of community structure and food web organization in coastal systems (Myers and Ewel, 1990). Salinity patterns affect productivity, reproduction cycles, population distribution, community composition, predator-prey interactions, and food web structure in the inshore marine habitat. Disruption of the food web resulting from a salinity imbalance would also have a detrimental impact on commercial and recreational fishing industries. Other aspects of water quality, such as turbidity, dissolved oxygen content, nutrient loads, and toxins also affect functions of these areas (Environmental Coalition of Broward County, 1987; U.S. Department of Agriculture, 1989; Myers and Ewel, 1990).

Impacts on Wading Birds

The interior freshwater marshes of South Florida are important habitats because of their importance as feeding and nesting areas for a number of endangered or threatened species (wood stork, sandhill crane), or species of special concern (little blue heron, snowy egret, Louisiana heron, least bittern, limpkin). The future of these species is ultimately linked with maintaining healthy, viable wetland systems (Ogden, 1978).

Wading bird species commonly feed upon small fish (1 to 6 inches long) in waters typically 6 to 10 inches deep. Although wood storks and white ibis display different feeding techniques, both species are tactile foragers, meaning they feed by touching prey with their bill and swiftly snapping it shut to catch food. This specialized feeding technique requires a greater concentration of fish than needed by other wading birds, which feed primarily by sight. Therefore, wood stork and white ibis foraging success is affected in situations where total numbers of available fish are reduced as a result of wetland drainage or altered hydroperiods, as compared to wading bird species which feed primarily by sight.

Populations of wading birds have experienced large declines in South Florida. Factors which have led to decreased population levels include loss of habitat, alteration of historical water levels and hydroperiod, increased fire frequency, and overhunting. In some cases, species which inhabit wetland areas have been adversely affected by water management actions which were intended to provide for their protection.

Robertson and Kushlan (1974) estimated the total population of wading birds to be as high as 2.5 million in 1870, declining to less than 500,000 in 1910 as a result of plume hunting. Restrictive hunting legislation enabled populations to increase to an estimated 1.2 million by 1935. Since that time, total populations have declined to levels about 10 percent of the levels recorded during the 1930s (Collopy and Federick, 1986). Ogden (1978) states that the rapid decline in wading bird populations over the last three to four decades is the result of repeated nesting failures caused by inadequate food production. This can be attributed to marshland destruction and altered hydroperiods. Lowered water levels cause shortened reproductive periods for fish and aquatic invertebrates, and increase the frequency of destructive fires. Unusually high water levels during the nesting season cause food resources to be dispersed and unavailable during the critical nesting season.

The status of the endangered wood stork is of particular concern because it nests within the LWC Planning Area (Corkscrew Swamp). Historical populations of wood storks have sharply declined in South Florida. This decline is estimated to be about 80 percent between 1960 and 1980 (Ogden *et al.*, 1987). Population levels averaged about 2000 pairs until 1960, although much variation occurred (Robertson and Kushlan, 1974; Ogden *et al.* 1987). Numbers continued to decline during the 1970s and 1980s after construction of water management structures which delivered water to Everglades National Park (Ogden *et al.*, 1987). Ogden *et al.* has argued that the decline of wading bird populations within Everglades National Park was the result of alteration of the timing and distribution of surface water discharged into the Everglades since the 1960s. The authors indicate that the new water delivery schedule regime resulted in delayed and incomplete dry season drawdowns, which delayed wood stork nesting to the point where the nesting period extended into the wet season, and the adults could no longer obtain a sufficient concentrated food supply to support their young. Water management actions which allowed flood

releases to the Everglades reversed the annual cycle of declining water levels and dispersed prey concentrations. Loss of peripheral wetlands, due to urban and agricultural development, is also thought to be the a major factor for nesting failures of many wading bird species.

Impacts on Rare, Threatened, or Endangered Species

Loss of habitat and habitat fragmentation are the major causes of the decline in a number of listed rare, threatened or endangered (RTE) wildlife species in South Florida. Reduction in population is due largely to conversion of natural habitats to agricultural and urban uses. Some species, such as the Florida panther and black bear, require large expanses of land to successfully survive as a breeding population. Other species are restricted to one particular type of habitat, such as the Florida scrub jay (pine/oak scrub) or red-cockaded woodpecker (mature pine flatwoods). Listed RTE species within the LWC Planning Area depend on both wetland and upland communities for survival. For example, the Florida panther inhabits uplands, but it frequents wetlands. The reverse is true for other species, such as the wood stork.

Agricultural and urban development have gradually fragmented and reduced the quality and size of existing wildlife habitat. Continued fragmentation of upland and wetland ecosystems has the potential to cause problems for the survivorship of many species. Table F-2 presents a list of the rare, threatened, and endangered species and species of special concern that are found within the LWC Planning Area. The following is a summary of selected species listed in the table.

Florida Panther (*Felis concolor coryi*)

A federally listed endangered species, the Florida panther has been given a high priority status to be saved through the Florida Panther Recovery plan (U.S. Fish and Wildlife Service, 1987). The panther requires a large territorial range, which is rapidly disappearing due to the expansion of agricultural and urban developments. This continued "loss and fragmentation of native landscapes in Southwest Florida will reduce the ability of panthers to function normally and will exacerbate problems associated with low numbers" (Maehr, 1990). Maehr also observed that while wetlands are an important habitat to panthers, they appear to prefer native upland forest habitats in Southwest Florida. The survival of the panther is closely correlated to the preservation of large tracts of contiguous and suitable habitats. Additional habitat losses may be incurred by changes in the hydrology of wetlands and uplands due to drawdown effects from wellfield operations.

Red-Cockaded Woodpecker (*Picoides borealis*)

Also a federally listed endangered species, the red-cockaded woodpecker was once common in the region within mature pine forest habitat. However, logging for timber and clearing for agriculture has significantly reduced this habitat, affecting the woodpecker population size and range. This woodpecker is the only woodpecker species to excavate a nesting cavity in a mature living pine tree, and therefore requires a mature stand of pines for successful nesting. In addition, the woodpecker lives in groups, referred to as clans, that may be as large as nine individuals. Their territories vary in size up to 250 acres, with areas of utilization up to 1000 acres. Soils which support mature pine forests are subject to conversion to agriculture and urban development. Hydrological changes from wellfield development may cause the further loss of pine forest habitat by increased fire frequency.

Florida Scrub Jay (*Aphelocoma coerulescens*)

The Florida scrub jay is a threatened species that lives within a very restricted habitat range, permanently residing in upland scrub communities. These scrub communities exist on historic sand dunes, and are vanishing due to urban developments and conversion to citrus groves. The protection of this habitat is critical for species survival.

Gopher Tortoise (*Gopherus polyphemus*)

A species of special concern, the Gopher tortoise lives in a variety of habitats. The major cause for decline of tortoise populations has been the conversion of native habitat to agriculture and urban development. In the process of clearing the land, the tortoise is often killed by suffocation due to burial within their burrow. Highway mortality also significantly contributes the decline of this species in Lee County (Lee County, 1989). Gopher tortoise burrows are also utilized by over 80 different wildlife species, such as the Eastern Indigo snake (threatened species) and the Gopher frog (species of special concern).

TABLE F-2. Selected, Threatened, Endangered, and Species of Special Concern within the Lower West Coast Planning Area.

SPECIES	FGFWFC	USFWS
Amphibians and Reptiles		
American alligator *Alligator mississipiensis*	SSC	T(S/A)
Eastern indigo snake *Drymarchon coralis couperi*	T	T
Gopher frog *Rana aerolata*	SSC	UR2
Gopher tortoise *Gopherus polyphemus*	SSC	UR2
Florida pine snake *Pituophis melanoleucus mugitus*	SSC	UR2
Birds		
Audubon's crested caracara *Polyborus planus audubonii*	T	T
Bald eagle *Haliaeetus leucocephalus*	T	E
Burrowing owl *Athene cunicularia*	SSC	
Florida sandhill crane *Grus canadensis pratensis*	T	
Florida scrub jay *Aphelocoma coerulescens*	T	T
Limpkin *Aramus guarauna*	SSC	
Little blue heron *Egretta caerulea*	SSC	
Osprey *Pandion haliaetus*	SSC (Monroe Co.)	
Red- cockaded woodpecker *Picoides borealis*	T	E
Roseate spoonbill *Ajaia ajaja*	SSC	
Snowy egret *Egretta thula*	SSC	
Southeastern American kestrel *Falco sparverius paulus*	T	UR2
Tricolored heron *Egretta tricolor*	SSC	
Wood stork *Mycteria americana*	E	E

E = Endangered.
T = Threatened.
SSC = Species of Special Concern.
UR2 = Under review for listing, but substantial evidence of biological vulnerability and/or threat is lacking.
T (S/A) = Threatened due to similarity of appearance.
Source: SWFRPC, 1990.

TABLE F-2. (Continued).

SPECIES	FGFWFC	USFWS
Mammals		
Big Cypress fox squirrel *Sciurus niger avicennia*	T	UR2
Everglades mink *Mustela vison evergladensis*	T	UR2
Florida black bear *Ursus americana floridanus*	T	UR2
Florida mouse *Podomys floridanus*	SSC	UR2
Florida panther *Felis concolor coryi*	E	E
Round-tailed muskrat *Neofiber alleni*		UR2
West Indian manatee *Trichechus manatus*	E	E

E = Endangered.
T = Threatened.
SSC = Species of Special Concern.
UR2 = Under review for listing, but substantial evidence of biological vulnerability and/or threat is lacking.
T (S/A) = Threatened due to similarity of appearance.
Source: SWFRPC, 1990.

APPENDIX G

Methodology for Urban and Agricultural Demand Projections

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URBAN DEMAND

Public Water Supply and Domestic Self-Supplied

Public water supply (PWS) and domestic self-supplied demand projections have been developed for the Lower West Coast Planning Area for the period through 2010. Water supply demands were projected by multiplying population projections by per capita water use rates. The population projections for each potable water service area were based on data from the local comprehensive plans. Per capita water use rates were determined based on 1990 population data from the U.S. Bureau of the Census and the water pumpage for each utility as reported by U.S. Geological Survey (USGS).

The regional water utility service areas used in this analysis were generalized from the service areas defined in the utilities' water use permits. It was assumed that all population growth within the service areas will be connected to a public water supply system. However, as Figure II-4 in the background document shows, there are large areas that are not within utility service areas. In order to account for these areas (which are assumed to be self-supplied), they are referred to as "Planning Areas" in the population and demand estimates and projections.

Population

1990 Estimates. U.S. Census data for 1990 was used as the basis for the 1990 population (Table G-1). Block group level information was used as the basic unit of analysis. Total population, total housing units, occupied housing units, and persons per occupied housing unit were from the 100 percent Census data (Strategic Mapping, 1992). The total units connected to a public water system and total units self-supplied were from the STF3A sample census data (U.S. Bureau of the Census, 1992). Estimates of occupied units connected to public water systems and occupied units that are self-supplied for each block group were calculated. It was assumed that the percentage of units occupied for public water system connected and self-supplied units was the same as the percentage for all units. Population served by PWS and those who are self-supplied was calculated by multiplying the occupied units by the persons per occupied unit value for the respective block group.

The geographic areas represented by the Census block groups and the utility service areas were input as polygon coverages into the SFWMD GIS (using ARC-INFO Version 6.1.1 software). Population density for those served by PWS and those self-supplied were calculated for each block group assuming a uniform density within each block group. The two coverages were joined to create a new polygon coverage with the attribute data from the two original coverages. Population estimates of PWS served and self-supplied were then recalculated for the new polygon coverage by multiplying the area of the polygon by the population density. The populations for each service area were then totaled.

The results were reviewed and then modified to overcome limitations of the assumptions used. The service areas used in this analysis are generally larger than the block groups. Assuming that population is evenly distributed throughout a block group was generally not a problem in this analysis. However, there are instances where this assumption is a problem. The spatial size of block groups is much larger in areas of less development than those areas which are more heavily developed. In certain areas where urban densities are adjacent to very low intensity development or undeveloped areas and where the block group is split by a service area boundary, it

TABLE G-1. Estimated and Projected Population in the LWC Planning Area.

City	Census Data (1990)*	Comp. Plan Data (2010)**
Collier County Area:		
Collier Unincorporated	132,273	266,807
Naples	19,505	26,000
Everglades	321	662
COLLIER CO. AREA TOTAL	152,099	293,469
Hendry County:		
Hendry Unincorporated	16,985	26,790
Clewiston	6,085	7,355
La Belle	2,703	7,465
HENDRY COUNTY TOTAL	25,773	41,610
Lee County:		
Lee Unincorporated	209,448	373,212
Fort Myers	45,206	110,962
Cape Coral	74,991	147,820
Sanibel	5468	8,522
LEE COUNTY TOTAL	335,113	640,516
REGIONAL TOTAL	512,985	975,595

Source: *U.S. Bureau of the Census, 1992. **City of Cape Coral, 1990; City of Clewiston, 1990; City of Everglades City, 1990; City of Fort Myers, 1988; City of La Belle, 1990; City of Naples, 1989; City of Sanibel, 1988; Collier County, 1989; Hendry County, 1989; and Lee County, 1989.

is possible to under-estimate the population in the developed area and to over-estimate the population in the less developed area. In such areas, adjustments to the population estimates were made. For example, the block groups in the Immokalee area are large and cover the urban area and the surrounding rural areas. The Immokalee Utility service area splits these block groups. An adjustment was made to assume that all PWS served population in these block groups were served by Immokalee Utilities. Conversely, an adjustment was also made for the self-supplied population in these block groups to assume that all self-supplied in these block groups were in the East County Area. The GIS analysis evenly distributed the population over the entire block groups, when in fact the population is concentrated in a small portion of the block groups. The results of the GIS analysis were reviewed and adjustments were made in these instances.

2010 Projections

Local comprehensive plan population data were used as the basis for population projections for 2010 (Table G-1). The geographic distribution of the 2010 population was determined using Traffic Analysis Zone (TAZ) population projections for the portion of the region covered by TAZs. The geographic distribution of the 2010 population for areas not covered by TAZs was determined from information in the individual county's comprehensive plans. Total population was controlled to the total from these local government comprehensive plans.

The geographic areas represented by the TAZs, cities and the utility service areas were input as polygon coverages into the SFWMD Geographic Information System (using ARCINFO Version 6.1.1 software). The TAZ coverage for Collier County was modified to include additional areas whose population was based on comprehensive planning area information. Population density was calculated for each TAZ assuming a uniform density within each zone. The coverages were joined to create a new polygon coverage with the attribute data from the original coverages. Population estimates were then recalculated for the new polygon coverage by multiplying the area of the polygon by the population density. The populations for each service area were then totaled and controlled to local comprehensive plan projections totals. Since Hendry County does not have TAZs, it was assumed that the 2010 population distribution was the same as those calculated in the 1990 Census analysis.

Per Capita Rates

Per capita water use rates for each utility were estimated by dividing (a) raw water pumped by (b) the population served by public water supply utilities. Raw water withdrawal data was provided by the USGS. Population and the number of individuals served by the utilities were determined by the above-mentioned methodology. Per capita rates were estimated for 1990. Self-supplied water use rates for 1990 were assumed to be the same as the utility in that service area. The per capita rates for the planning areas were assumed to be the same as the PWS per capita rates for the appropriate County Utility service area.

In estimating the per capita water rates for 1990, water used by seasonal residents was included in the pumpage data. Irrigation demand for PWS served households using private well water for their irrigation was not estimated.

Demand

Demand was defined as population times per capita water use rate. For each service area, a Public Water Supply (PWS) demand and a domestic self-supplied demand were estimated for 1990. A Public Water Supply and domestic self-supplied demand for each service area were also projected for 2010. For 2010, it was assumed that all population growth within each service area will be provided potable water by the PWS utility. Current self-supplied demand within the service areas was assumed to remain constant.

Summary

Using the above-stated methodology, the total population estimates for the LWC Planning Area for 1990 was 512,633. The projected total population for 2010 increased to 976,652. The estimated water demand for urban users was 97 million gallons per day (MGD) in 1990. Water demand was projected to increase 91 percent from 1990 to 2010 to a total water demand of 185 MGD.

Table G-2 shows the per capita water use rate for each service area, the population estimates, and the resulting water demand for 1990. Table G-3 shows the per capita water use rate for each service area, the population projections, and the resulting water demand for 2010. The demands quantify only demands for the water resource, and make no assumptions about its availability or conveyances. Charlotte, Glades, and Monroe counties were not included in the tables because they contain very little urban uses.

TABLE G-2. Population and Water Demand Estimates, 1990.

Service Area Name	Utility Supplied Population	Utility Supplied Use (MGD)	Computed GPCD*	Self-Supplied Population	Self-Supplied Use (MGD)	Service Area Population	Service Area Use (MGD)
Collier County:							
Collier County	44,959	10.22	227	8,324	1.89	53,283	12.11
Everglades City	642	0.10	156	3	0.00	645	0.10
Florida Cities (Golden Gate)	7,700	0.90	117	6,413	0.75	14,113	1.65
Immokalee	15,105	2.47	164	243	0.04	15,349	2.51
Marco Island	10,194	5.27	517	70	0.04	10,264	5.31
Naples	49,833	17.35	348	634	0.22	50,467	17.57
North Naples	525	0.17	324	3	0.00	528	0.17
Orangetree	170	0.19	1116	9	0.01	179	0.20
Collier Planning Area 1	0	0.00	0	7,272	1.65	7,272	1.65
Collier County Total	**129,128**	**36.67**	**284**	**22,971**	**4.60**	**152,099**	**41.27**
Hendry County:							
Clewiston/South Shore/U.S. Sugar	13,139	2.85	217	0	0.00	13,139	2.85
GDU - Port La Belle	1,907	0.20	105	0	0.00	1,907	0.20
La Belle	3,194	0.56	175	0	0.00	3,194	0.56
Hendry Correctional	589	0.3	509	0	0.00	589	0.30
Hendry Planning Area 1	0	0	217	6,621	1.44	6,621	1.44
Hendry County Total	**18,830**	**3.91**	**208**	**6,621**	**1.44**	**25,451**	**4.79**
Lee County:							
Bayshore	408	0.03	73	0	0.00	408	0.03
Bonita Springs	16,250	2.15	132	1,684	0.22	17,934	2.37

TABLE G-2. Population and Water Demand Estimates, 1990 (Continued).

Service Area Name	Utility Served Population	Utility Supplied Use (MGD)	Computed GPCD*	Self-Supplied Population	Self-Supplied Use (MGD)	Service Area Population	Service Area Use (MGD)
Lee County Continued:							
Cape Coral	59,169	10.11	171	17,117	2.92	76,286	13.03
Citrus Park	1,108	0.12	108	0	0.00	1,108	0.12
Florida Cities South	39,804	5.70	143	2,428	0.35	42,232	6.05
Florida Cities Waterway	6,703	0.97	145	265	0.04	6,968	1.01
Fort Myers	43,737	6.24	143	616	0.09	44,353	6.33
Gasparilla	698	0.38	541	27	0.01	724	0.39
Gulf	13,387	1.74	130	3,301	0.43	16,687	2.17
Harbor	644	0.05	78	86	0.01	730	0.06
Island Water Association	5,873	3.18	541	108	0.06	5,981	3.24
Lake Fairway	1,643	0.12	73	0	0.00	1,643	0.12
Lee County	68,541	9.11	133	9,205	1.22	77,746	10.33
Lehigh Acres	13,872	1.28	92	9,081	0.84	22,953	2.12
Orange Harbor	524	0.05	95	0	0.00	524	0.05
Pine Island	7,057	1.22	173	575	0.10	7,632	1.32
Spring Creek	387	0.04	103	0	0.00	387	0.04
USEPPA	6	0.02	3264	0	0.00	6	0.02
Lee Planning Area 1	0	0	135	332	0.04	332	0.04
Lee Planning Area 2	0	0	135	9,843	1.33	9,843	1.33
Lee Planning Area 3	0	0	135	636	0.09	636	0.09
Lee County Total	**279,811**	**42.51**	**152**	**55,302**	**7.73**	**335,113**	**50.24**
Region Total	**427,769**	**83.09**	**194**	**84,893**	**13.77**	**512,663**	**96.86**

*Gallons per capita per day.

Note: Clewiston/Southshore includes population and use for customers in Glades and Palm Beach counties.

TABLE G-3. Population and Water Demand Estimates, 2010.

Service Area Name	Utility Served Population	Utility Supplied Use (MGD)	Projected GPCD*	Self-Supplied Population	Self-Supplied Use (MGD)	Service Area Population	Service Area Use (MGD)
Collier County:							
Collier County	131,476	29.89	227	8,324	1.89	139,800	31.78
Everglades City	1,303	0.20	156	3	0.00	1,306	0.20
Florida Cities (Golden Gate)	9,790	1.14	117	6,413	0.75	16,203	1.89
Immokalee	22,059	3.61	164	243	0.04	22,303	3.65
Marco Island	28,297	14.63	517	70	0.04	28,367	14.66
Naples	59,173	20.60	348	634	0.22	59,807	20.82
North Naples	1,147	0.37	324	3	0.00	1,150	0.37
OrangeTree	774	0.86	1116	9	0.01	783	0.87
Collier Planning Area 1	0		227	23,751	5.40	23,751	5.40
Collier County Total	**254,019**	**71.31**	**281**	**39,450**	**8.35**	**293,469**	**79.66**
Hendry County:							
Clewiston/South Shore/U.S. Sugar	17,855	3.87	217	0	0.00	17,855	3.87
GDU - Port La Belle	2,996	0.31	105	0	0.00	2,996	0.31
La Belle	8,495	1.49	175	0	0.00	8,495	1.49
Hendry Correctional	926	0.47	509	0	0.00	926	0.47
Hendry Planning Area 1	0	0.00	217	10,394	2.26	10,394	2.26
Hendry County Total	**30,272**	**6.15**	**203**	**10,394**	**2.26**	**40,666**	**8.41**
Lee County:							
Bayshore	408	0.03	73	0	0.00	408	0.03
Bonita Springs	41,325	5.47	132	1,684	0.22	43,009	5.69

TABLE G-3. Population and Water Demand Estimates, 2010 (Continued).

Service Area Name	Utility Served Population	Utility Supplied Use (MGD)	Projected GPCD*	Self-Supplied Population	Self-Supplied Use (MGD)	Service Area Population	Service Area Use (MGD)
Lee County Continued:							
Cape Coral	89,664	15.32	171	17,117	2.92	106,781	18.25
Citrus Park	1,108	0.12	108	0	0.00	1,108	0.12
Florida Cities South	88,420	12.66	143	2,428	0.35	90,847	13.01
Florida Cities Waterway	10,935	1.58	145	265	0.04	11,199	1.62
Fort Myers	67,408	9.62	143	616	0.09	68,024	9.71
Gasparilla	671	0.36	541	27	0.01	698	0.38
Greater Pine Island	14,362	2.48	173	575	0.10	14,937	2.58
Gulf	27,548	3.58	130	3,301	0.43	30,849	4.01
Harbor	1,242	0.10	78	86	0.01	1,328	0.10
Island Water Association	17,965	9.73	541	108	0.06	18,073	9.79
Lake Fairway	1,643	0.12	73	0	0.00	1,643	0.12
Lee County	154,392	20.52	133	9,205	1.22	163,596	21.74
Lehigh Acres	51,296	4.73	92	9,081	0.84	60,377	5.57
Orange Harbor	524	0.05	95	0	0.00	524	0.05
Spring Creek	387	0.04	103	0	0.00	387	0.04
USEPPA	6	0.02	3,264	0	0.00	6	0.02
Lee Planning Area 1	0	0.00	135	2,013	0.27	2,013	0.27
Lee Planning Area 2	0	0.00	135	19,053	2.58	19,053	2.58
Lee Planning Area 3	0	0.00	135	5,656	0.77	5,656	0.77
Lee County Total	**569,303**	**86.53**	**152**	**71,213**	**9.84**	**640,516**	**96.38**
Region Total	**853,594**	**163.99**	**192**	**121,057**	**20.88**	**974,651**	**184.45**

*Gallons per capita per day.

Note: Clewiston/Southshore includes population and use for customers in Glades and Palm Beach counties.

COMMERCIAL AND INDUSTRIAL

A prototype method for estimating the impact of the commercial and industrial sector on the gross per capita demand for a county is being tested by the District in conjunction with the USGS. This method involves estimating the number of employees by Standard Industrial Classification (SIC) code that can be attributed to those industries holding District water use permits, subtracting those employees from the total of each employee designation published in the current issue of "County Business Patterns" (U.S. Bureau of the Census, 1988), and then estimating the use by SIC code using the gallons per day per employee figures found in the IWR-MAIN report (Davis *et al.*, 1988). This total demand by employees was applied to the total pumpage in the county for the appropriate year, to derive a percentage of commercial and industrial use, and then to reduce the county's gross per capita by the commercial and industrial use estimate.

The employment by sector was also evaluated regarding the predominant types of employment found in the county, and if these employment types could be expected to grow at the same rate and in the same direction as the population. In the Lower West Coast Planning Area, the majority of the employees are found in the service and retail sales sectors, indicating that water demand by these sectors will generally grow along with the population. Water used for commercial and industrial purposes supplied by utilities are included with other water supply demands. Self-supplied commercial and industrial demands are shown in Table G-4. Appraised industrial self-supplied water demand was based on District permitted allocations for 1985 and 1990. Industrial self-supplied water use was assumed to increase at the same rate as the county population, with 1990 used as the base year.

TABLE G-4. Commercial and Industrial Self-Supplied Demand in Collier and Lee Counties.

County	1985	1990	1995	2000	2005	2010
Collier						
Population		152,099	186,749	221,798	257,634	293,469
Demand (MGD)	7.12	8.28	10.18	12.07	14.03	15.98
Lee						
Population		335,113	414,906	494,699	568,095	640,516
Demand (MGD)	18.7	31.3	38.8	46.2	53.0	59.8

Source: District permit files; U.S. Bureau of the Census,1992; Collier and Lee county comprehensive plans (1989).

There are no significant commercial and industrial self-supplied demands in Hendry County, and none are forecast through 2010.

RECREATION SELF-SUPPLIED

Landscape

Demand projections for this section include irrigated acreage permitted for landscape and recreation, excluding golf courses. Landscaping and recreational water use was assumed to increase at the same rate as the county population, with 1990 used as the base year. Projections for landscaping and recreation self-supplied demand are outlined in Table G-5.

TABLE G-5. Landscape Self-Supplied Demand in Collier and Lee Counties.

County	1985	1990	1995	2000	2005	2010
Collier						
Population		152,099	186,749	221,798	257,634	293,469
Demand (MGD)	2.83	4.02	4.94	5.86	6.81	7.76
Lee						
Population		335,113	414,906	494,699	568,095	640,516
Demand (MGD)	12.7	23.5	29.1	34.7	39.8	44.9

Source: District permit files; U.S. Bureau of the Census, 1992; Collier and Lee county comprehensive plans, 1989.

There are no significant landscape and recreational self-supplied demands in Hendry County, and none are forecast through the projection period.

Golf Course

Golf course irrigation requirement estimates were made by time horizon and month. Historical irrigated golf course acreage data were gathered from *The Official Florida Golf Guide* (Florida Dept. of Commerce, 1990), *Golf Guide to the South* (Florida Golfweek, 1989), *The Golf Course* (Cornish and Whitten, 1988), District water use permits, and personal communication with several of the golf courses listed. Irrigated acreage was projected using trend analysis techniques. Golf course irrigation requirements were calculated using the District's modified Blaney-Criddle permitting model.

Collier County

The golf courses presently in Collier County are described in Table G-6. The method chosen to project Collier County irrigated golf course acreage used a linear projection model of the form shown in Equation (G-1).

$$CUMIRR_t = f(Time, Popt, Dt) \qquad \text{(G-1)}$$

where:
$CUMIRR_t$ = *cumulative irrigated golf course acreage in Collier County in year t.*
Time = a time trend variable which takes the value of 1 in 1953 and increases by one unit each year.
Pop_t = *reported, projected or interpolated population (in thousands) in Collier County for year t.*
D_t = *a dichotomous variable equal to 1 in years 1976 to 1981 inclusive and 0 otherwise.*

TABLE G-6. Golf Courses in Collier County.

Name	Year Opened	Total Acres	Irrigated Acres
Naples Beach Hotel & GC	1953	110	107
Hole-In-The-Wall GC	1957	323	120
CC of Naples	1960	119	115
Royal Palm CC	1960	160	160
Palm River CC	1961	147	75
Moorings CC, The	1963	40	38
Golden Gate CC	1965	163	77
Island CC (Marco Island)	1965	160	85
Hibiscus GC	1968	174	110
Royal Poinciana GC	1969	440	312
Glades CC	1972	100	80
High Point CC	1972	20	20
Riviera GC of Naples	1972	97	85
Quail Run CC	1972	55	55
Imperial GC	1973	310	260
Wilderness CC	1974	220	120
Marco Shores CC	1975	160	80
Lakewood CC	1979	330	53
Wyndemere CC	1980	450	232
Bears Paw CC	1980	245	130
Club at Pelican Bay	1981	227	217
Naples Shores CC	1982	360	160
Eagle Creek CC	1982	125	125
Quail Creek CC	1982	680	680
Hideaway Beach GC (Habitat)	1984	20	19
Windstar G & CC (Whispering Pines)	1984	150	100
Foxfire CC	1985	320	125
Lely Resorts Flamingo	1985	165	165
Bentley Village GC	1987	46	25
Naples Golf Center	1987	45	12
Vineyards of Naples	1987	240	240
Quail Village GC	1987	65	65
Royal Wood G & CC	1988	233	96
Audubon CC	1988	150	115
Countryside	1988	100	65
Golf Club of Marco	1990	178	119
TOTAL		6,926	4,642

Historic and projected population figures were not available for all years. Where actual population figures were not available, a linear interpolation between the two adjacent available population figures was made. This may tend to make population estimates used here more highly correlated with time than they actually are. When Equation (G-1) was estimated using ordinary least squares regression, Equation (G-2) was obtained.

$$CUMIRR_t = -119.99 + \underset{(56.77)}{32.33Popt} - \underset{(-5.27)}{428.85D} \qquad \text{(G-2)}$$

Goodness of Fit Statistics
$R^2 = 0.9899$
$F = 1612.19$
$Pr F > 0 > .999$
$D - W = 2.011$
t - statistics in parentheses

"Goodness of fit statistics" are used throughout Appendix G to evaluate the accuracy of equations in describing time series of historical acreage data. A detailed explanation of goodness of fit statistics can be found in "Ecometric Models, Techniques, and Applications" (Intriligator, 1978).

Equation (G-3) was used to develop the primary projection of irrigated golf course acreage in Collier County. Population projections used to project other urban demands earlier in this appendix were used in projection models. The Collier County primary projection for irrigated golf course acreage is presented in Table G-7.

The irrigation requirements in Table G-8 were calculated by applying the projected irrigated acreage to the supplemental water requirements (as calculated by the Blaney-Criddle permitting model). Input variables used were irrigated acreage of grass from Table G-7, sandy soil with 0.4 inch usable soil water capacity, sprinkler irrigation systems with an irrigation efficiency of 75 percent, with Naples as the rainfall station (Table G-9).

TABLE G-7. Historical and Projected Irrigated Golf Course Acreage in Collier County.

Year	Historical	Primary Projection	Primary -15%	Primary +15%
1960	502			
1965	777			
1970	1,199			
1971	1,199			
1972	1,439			
1973	1,699			
1974	1,819			
1975	1,899			
1976	1,899			
1977	1,899			
1978	1,899			
1979	1,952			
1980	2,314			
1981	2,531			
1982	3,496			
1983	3,496			
1984	3,615			
1985	3,905			
1986	3,905			
1987	4,247			
1988	4,523			
1989	4,523			
1990	4,642			
Projections				
1991		4,867	4,137	5,597
1992		5,093	4,329	5,867
1993		5,318	4,520	6,116
1994		5,543	4,712	6,374
1995		5,769	4,904	6,634
1996		5,994	5,095	6,893
1997		6,219	5,286	7,152
1998		6,445	5,478	7,412
1999		6,670	5,670	7,670
2000		6,895	5,861	7,929
2001		7,127	6,058	8,196
2002		7,359	6,255	8,463
2003		7,591	6,452	8,730
2004		7,822	6,649	8,995
2005		8,054	6,846	9,262
2006		8,286	7,043	9,529
2007		8,517	7,239	9,795
2008		8,749	7,437	10,061
2009		8,981	7,634	10,328
2010		9,213	7,831	10,595

TABLE G-8. Irrigation Requirements in Millions of Gallons for the Primary Irrigated Golf Course Acreage Projection in Collier County.

Average	1985	1990	1995	2000	2005	2010
January	174	207	257	307	359	410
February	202	240	299	357	417	477
March	406	482	599	717	837	957
April	590	701	871	1,041	1,216	1,391
May	673	800	994	1,188	1,388	1,588
June	506	602	748	894	1,044	1,194
July	568	676	840	1,004	1,172	1,341
August	543	645	802	959	1,120	1,281
September	349	415	516	617	720	824
October	430	511	635	759	887	1,014
November	370	440	547	654	764	874
December	242	287	357	427	499	570
TOTAL	5,033	6,007	7,466	8,823	10,422	11,922

2-in-10	1985	1990	1995	2000	2005	2010
January	188	224	278	332	388	444
February	219	261	324	387	452	517
March	424	504	627	749	875	1,001
April	609	724	900	1,076	1,257	1,438
May	711	845	1,051	1,256	1,467	1,678
June	584	694	863	1,031	1,204	1,378
July	648	770	957	1,143	1,336	1,528
August	619	736	915	1,093	1,277	1,461
September	430	511	635	759	887	1,014
October	468	556	691	826	965	1,104
November	382	454	564	674	787	901
December	252	299	372	444	519	594
TOTAL	5,534	6,579	8,0176	9,771	11,414	13,056

TABLE G-9. Supplemental Water Requirements for Grass in Collier County.

Month	Average (in.)	2-in-10 (in.)
January	1.23	1.33
February	1.43	1.55
March	2.87	3.00
April	4.17	4.31
May	4.76	5.03
June	3.58	4.13
July	4.02	4.58
August	3.84	4.38
September	2.47	3.04
October	3.04	3.31
November	2.62	2.70
December	1.71	1.78
Total	**35.74**	**39.14**

Naples rainfall station.
Soil = 0.4 inches.

Lee County

The golf courses presently in Lee County are described in Table G-10. Lee County has experienced rapid growth in irrigated golf course acreage since the early 1960s. There was an over five-fold increase in Lee County irrigated golf course acreage between 1960 and 1970. Between 1970 and 1981 Lee County golf course acreage nearly tripled, and again doubled during the 1980s. As in other counties, the growth in golf course acreage has occurred irregularly on a year-by-year basis.

Several alternative functional forms were used to forecast future Lee County golf course acreage. Because of the rapid increase in recent years, results obtained from simple trend analyses were deemed unreliable. Instead, the statistical technique of double exponential smoothing was used. (See Sullivan and Claycombe, 1977, Chapter 5 for a discussion of exponential smoothing.) In general, the procedure for calculating exponentially smoothed projections is summarized in equations (G-3) and (G-4).

$$S_t = ax_t + a(1-a)x_{t-1} + a(1-a)^2 x_{t-2} + \ldots (1-a)^t S_0^{(1)} \quad \text{(G-3)}$$

$$S_t^{(2)} = aS_t^{(1)} + (1-a)S_{t-1}^{(2)} \quad \text{(G-4)}$$

where:
$S_t^{(1)}$ = *the singly exponentially smoothed statistic for period t.*
a = *the smoothing constant.*
$S_t^{(2)}$ = *the doubly exponentially smoothed statistic.*

In order to use double exponential smoothing, initial values of $S_0^{(1)}$ and $S_0^{(2)}$ must be assumed, as well as the value of "a", the smoothing constant. As exponential smoothing is applied to the data, the initial estimates of $S_0^{(1)}$ is discounted and

TABLE G-10. Golf Courses in Lee County.

Name	Year Opened	Total Acres	Irrigated Acres
Fort Myers CC	1918	135	55
Lehigh Acres North (Lehigh CC)	1960	110	95
Cypress Lake CC	1960	150	100
Cape Coral G & RC	1963	187	187
Lehigh Acres South (Mirror Lakes)	1967	175	160
Cape Coral Executive GC	1968	29	29
El Rio GC	1968	41	35
South Seas Plantation GC	1969	300	75
Palmetto Pine CC	1970	120	95
Mirror Lakes CC	1970	175	160
Seven Lakes CC	1971	264	125
San Carlos G & CC	1972	123	101
Lochmoor CC	1972	143	81
Myerlee CC	1972	15	15
Bay Beach GC	1973	45	29
Estero Woods Village (Fountain Lakes)	1975	7	6
Six Lakes CC	1975	43	43
Landings, The	1975	50	50
Bonita Springs G & CC	1977	257	160
Lake Lawn CC	1978	33	33
Eastwood GC	1978	232	100
Beachview GC	1978	80	70
Spanish Wells CC	1979	631	90
Forest CC, The	1980	650	520
Burnt Store Marina (2 courses)	1981	419	243
Alden Pines GC	1981	72	55
Lake Fairways CC	1981	200	200
Cypress Pines CC	1982	155	89
Riverbend GC (East & West)	1982	212	23
Dunes CC	1983	340	109
Fiddlesticks CC	1983	710	265
Deltura CC	1983	300	79
Spring Creek	1983	94	75
Hideaway CC	1984	137	61
Eagle Ridge G & TC	1984	402	68
Tara Woods	1985	212	4
Cross Creek CC	1985	279	60
Pine Lakes CC	1985	366	80
Deer Run GC	1985	335	77
Terraverde CC	1985	60	12
Wildcat Run	1985	35	35
Whiskey Creek CC	1985	52	52
Bonita Bay Club	1985	151	121
Gasparilla Inn GC	1985	67	30
Vines CC, The	1985	280	72
Golfview CC	1986	40	27
Coral Oaks GC (Cape Coral Municipal)	1986	187	113
River's Edge Y & CC	1986	547	205
Pelican's Nest GC	1986	370	104
Royal Tee CC	1986	458	95
Burnt Store Marina addition	1987	209	122
Kelly Greens G & CC	1987	299	102
Sabal Springs G & RC	1987	371	50
Heritage, The	1987	214	25
Golf Villas/Bonita Springs	1988	2	2
Gateway GC	1988	190	135
Country Creek CC	1988	35	35
Coral Oaks GC	1988	122	103
Old Hickory Club	1989	313	85
Hunters Ridge	1989	270	83
TOTAL		12,616	5,486

becomes a negligible part of $S_t^{(1)}$. The same is true of $S_0^{(2)}$. The choice of an appropriate value of "a" is not so easily dismissed. A large value of "a" places more importance on the most recent data, while a small value of "a" places more nearly equal weights on observations regardless of how recent the data are. Usually "a" is selected between 0.1 and 0.3 (Sullivan and Claycombe, 1977). A search procedure was used, and it was determined that an "a" value of 0.12 was appropriate. Double exponential smoothing results in a forecasting equation of the form in Equation (G-5).

$$Y_{t+T} = a_t + b_t T \qquad \textbf{(G-5)}$$

where:
Y_{t+T} = *the forecast value of variable Y,T periods in the future, where t represents the present time period.*
$a_t = 2S_t^{(1)} - S_t^{(2)}$.
$b_t = (a/(1-a)) * (S_t^{(1)} - S_t^{(2)})$.

Note that to be consistent with notation used elsewhere, golf course acreage in year subscript t in Equation (G-5) is set equal to 0, so that Equation (G-2) is re-written as Equation (G-6).

$$Y_T = a + b * T \qquad \textbf{(G-6)}$$

When double exponential smoothing was applied to the Lee County golf acreage data, using a value of 0.12, Equation (G-7) resulted.

$$Y_T = -1101.58 + 200.71 * T \qquad \textbf{(G-7)}$$

Equation (G-8), adjusted for the amount by which it under projected irrigated acreage in 1992, and was used to develop the primary projection of irrigated golf course acreage in Lee County. This projection is presented in Table G-11.

The irrigation requirements in Table G-12 were calculated by applying projected irrigated acreages to the supplemental water requirements (as calculated by the Blaney-Criddle permitting model). Input variables used were irrigated acreage of grass from Table G-11, sandy soil with 0.8 inch usable soil water capacity, sprinkler irrigation systems with an irrigation efficiency of 75 percent, with Fort Myers as the rainfall station (Table G-13).

TABLE G-11. Historical and Projected Irrigated Golf Course Acreage in Lee County.

Year	Historical	Primary Projection	Primary -15 %	Primary +15 %
1960	250			
1965	437			
1970	831			
1971	956			
1972	1,153			
1973	1,182			
1974	1,182			
1975	1,281			
1976	1,281			
1977	1,441			
1978	1,644			
1979	1,754			
1980	2,254			
1981	2,752			
1982	2,284			
1983	3,392			
1984	3,521			
1985	4,064			
1986	4,608			
1987	4,907			
1988	5,182			
1989	5,350			
1990	5,486			
1991	5,486			
1992	5,486			
Projections				
1993		5,677	4,825	6,529
1994		5,877	4,995	6,759
1995		6,078	5,166	6,990
1996		6,279	5,337	7,221
1997		6,479	5,507	7,451
1998		6,680	5,678	7,682
1999		6,881	5,849	7,913
2000		7,082	6,020	8,144
2001		7,282	6,190	8,374
2002		7,483	6,361	8,605
2003		7,684	6,531	8,837
2004		7,884	6,701	9,067
2005		8,085	6,872	9,298
2006		8,286	7,043	9,529
2007		8,888	7,555	10,221
2008		8,687	7,384	9,990
2009		8,888	7,555	10,221
2010		9,089	7,726	10,452

TABLE G-12. Irrigation Requirements in Millions of Gallons for the Primary Irrigated Golf Course Acreage Projection in Lee County.

Average	1985	1990	1995	2000	2005	2010
January	146	199	222	258	294	331
February	170	230	257	299	342	384
March	374	507	565	658	751	843
April	558	757	845	983	1,122	1,260
May	661	896	1,000	1,164	1,328	1,492
June	403	546	610	710	810	910
July	494	669	747	870	992	1,115
August	491	665	743	865	986	1,108
September	346	469	523	609	695	781
October	426	578	645	751	857	963
November	341	463	517	601	686	771
December	211	286	319	372	424	476
TOTAL	4,621	6,265	6,994	8,140	9,286	10,432

2-in-10	1985	1990	1995	2000	2005	2010
January	164	222	248	289	330	370
February	190	258	288	336	383	430
March	396	536	599	697	795	893
April	586	795	887	1,032	1,178	1,323
May	706	957	1,069	1,244	1,419	1,594
June	500	677	756	880	1,004	1,128
July	587	797	889	1,035	1,181	1,326
August	577	783	874	1,017	1,160	1,303
September	429	582	650	756	863	969
October	466	632	705	821	936	1,052
November	356	483	539	627	715	804
December	226	306	341	397	453	509
TOTAL	5,183	7,028	7,845	9,131	10,416	11,702

TABLE G-13. Supplemental Water Requirements for Grass in Lee County.

Month	Average (inches)	2-in-10 (inches)
January	1.00	1.12
February	1.16	1.30
March	2.55	2.70
April	3.81	4.00
May	4.51	4.82
June	2.75	3.41
July	3.37	4.01
August	3.35	3.94
September	2.36	2.93
October	2.91	3.18
November	2.33	2.43
December	1.44	1.54
TOTAL	31.54	35.38

Ft. Myers rainfall station.
Soil = 0.8 inches.

Hendry County Area

In 1990, there were two golf courses in the Hendry County, and both were in the LWC Plannning Area. These are described in Table G-14. No meaningful trend or explanatory model can be developed due to the small number of golf courses in the county. Therefore, projections must rely upon empirical knowledge of the golf industry in this area. The National Golf Foundation in Jupiter, which tracks the stage of development and location of all golf courses nationally, has no record of any golf course development presently occurring in Hendry County. Therefore, irrigated golf course acreage was projected to remain constant through the year 2010.

TABLE G-14. Golf Courses in Hendry County.

Name	Year Opened	Total Acres	Irrigated Acres
Clewiston GC	1959	146	62
Oxbow GC at Port La Belle	1974	240	190
TOTAL		386	252

The irrigation requirements in Table G-15 were calculated by applying the current irrigated acreage to the Blaney-Criddle permitting model. Input variables used were 252 acres of grass, sandy soil with 0.8 inch usable soil water capacity, sprinkler irrigation systems with an irrigation efficiency of 75 percent, with data from the La Belle rainfall station.

TABLE G-15. Supplemental Water Requirements and Projected Irrigation Requirements for Golf Courses in Hendry County.

Month	Supplemental Water Requirements		Irrigation Requirements	
	Average (in.)	2-in-10 (in.)	Average (mg.)	2-in-10 (mg.)
January	1.08	1.18	10	11
February	1.09	1.24	10	11
March	2.30	2.49	21	23
April	3.50	3.72	32	34
May	4.35	4.67	40	43
June	2.70	3.35	25	31
July	3.42	4.03	31	37
August	3.46	4.02	32	37
September	2.48	3.02	22	28
October	2.82	3.09	26	28
November	2.31	2.40	21	22
December	1.42	1.51	13	14
TOTAL	30.93	34.72	283	317

La Belle rainfall station.
Soil = 0.8 inches.

Glades County Area

Hendry Isles Resort is the only golf course in Glades County, and it is in the LWC Planning Area. This golf course opened in 1978 and covers 72 acres, of which 20 acres are irrigated. No additional golf course development is anticipated through 2010 in Glades County. The existing acreage has average and 2-in-10 irrigation requirements of 24 MGY and 26 MGY respectively.

AGRICULTURAL WATER DEMAND

Acreage Projections

Agricultural demand was projected for all of Lee and Collier counties and the portions of Hendry, Glades and Charlotte counties within the LWC Planning Area (referred to as county areas). There is a portion of Monroe County in the planning area, but it contains no agricultural land. Agricultural irrigation and cattle watering demand estimates were made by month and time horizon (1985, 1990, 1995, 2000, 2005, and 2010). Land availability for the future growth of agriculture was examined. Crop acreage projections relied on various techniques, which are described in this text; irrigation requirements were based on these crop acreage projections and the District's modified Blaney-Criddle permitting model.

The techniques chosen to project crop acreages were those judged to best reflect the specific crop and county scenario. This led to some variation in projection techniques between crop types, and in method between counties. While it would have been ideal if a comprehensive functional form could have been found which produced tangible projections universally, no such functional form was found. The acreage projections developed reflect a combination of methods, each deemed appropriate where used.

Water demand projections were based on the extrapolation of current trends and circumstances, and consequently could not incorporate unforeseeable changes in the variables which determine water use. Projections should therefore be understood as surprise-free, and imply an extension of current production, market, and legal circumstances.

Mathematical models were used to test for the presence of crop acreage trends within individual counties. In some cases, a single mathematical model could be chosen since it accurately explained past trends, and projected a likely future scenario. In other cases, several models accurately explained past trends; and none explicitly provided more likely projections than the others. In these cases, the projections of several statistically valid and empirically sound models were averaged. This approach was justified by research performed at the Bureau of Economic and Business Research (Mahmoud, 1984), which showed that taking the average of a number of different projections reduces the chances of making large errors and leads to more reliable projections.

When no statistically valid trend, or any convincing empirical knowledge on future changes in a crop's acreage could be found, the crop's acreage was projected at its current size ($\pm$15 percent) for future time horizons. Usually these situations arose from relatively insignificant water users (in terms of quantity).

Irrigation Demands

A crop's supplemental water requirement is the amount of water used for evapotranspiration minus effective rainfall, while irrigation requirement includes both the supplemental water requirement and the losses incurred in getting irrigation to the crop's root zone. This relationship is expressed in Equation (G-8). Irrigation efficiency refers to the average percent of total water pumped or delivered for use that is stored in the plant's root zone. The overall irrigation efficiency is also equal to the product of the reservoir storage, water conveyance, and irrigation application efficiencies (Smajstrla *et al.*, 1991).

$$\textit{Irrigation requirement} = \frac{\textit{Supplemental water requirement}}{\textit{Irrigation efficiency}} \qquad \text{G-8}$$

Two values of effective rainfall are considered in calculating the supplemental crop requirements presented in this appendix. The first is a derivative of average rainfall, while the second reflects rainfall in an annual drought which has a probability of occurring two years in every ten ("2-in-10").

Projections of irrigation system type, and the effect of the corresponding estimated irrigation efficiencies, were based on the interpretation of current ratios and trends. The three basic types of irrigation systems currently used in crop production and their corresponding irrigation efficiencies (shown in parentheses) are: seepage (50 percent), overhead sprinkler (75 percent), and micro irrigation (85 percent) systems.

The usable water capacity of a soil directly affects the fraction of total rainfall that is effective. For each crop, assumptions for soil type were made for current acreage and future growth. Soil type, with regard to water use permitting by the District, refers to the soil's usable water holding capacity. The District has classified five types of soil with regard to usable soil water capacity in inches (0.2, 0.4, 0.8, 1.5, and 3.6). The locations of these soil types in the Lower West Coast Planning Area are shown by county in Figure G-1.

Unless otherwise specified, a crop's entire acreage was treated as if all took place on the most common soil type permitted for that crop in the respective county. Likewise, unless otherwise stated, the rainfall station most frequently used to permit allocations for that crop in the respective county was used.

Crop Types

The irrigated commercially grown crops in the counties of the LWC Planning Area are citrus, sugarcane, tropical fruit, vegetables, field crops, sod, and ornamental nursery plants. Pasture is rarely irrigated. However, there are some demands for cattle watering.

Agricultural irrigation and cattle watering demand estimates were made by crop type, time horizon and month. Historical crop acreage data were gathered from the Florida Department of Agriculture and Consumer Services' Florida Agricultural Statistic Service (FASS) and Division of Plant Industry (DPI); Institute of Food and Agricultural Sciences (IFAS); the U.S. Department of Agriculture's Soil Conservation Service (SCS); Southwest Florida Water Management District (SWFWMD); and District records.

Citrus

All categories of citrus (oranges, grapefruit, tangerines, etc.) were grouped together for projection purposes. Historical citrus acreage data were gathered from volumes of the "Commercial Citrus Inventory," which is published biennially by FASS.

The citrus planting rates in the Gulf Coast from 1986 to the present are at historically high levels concurrent with a period of post-freeze shifting of citrus

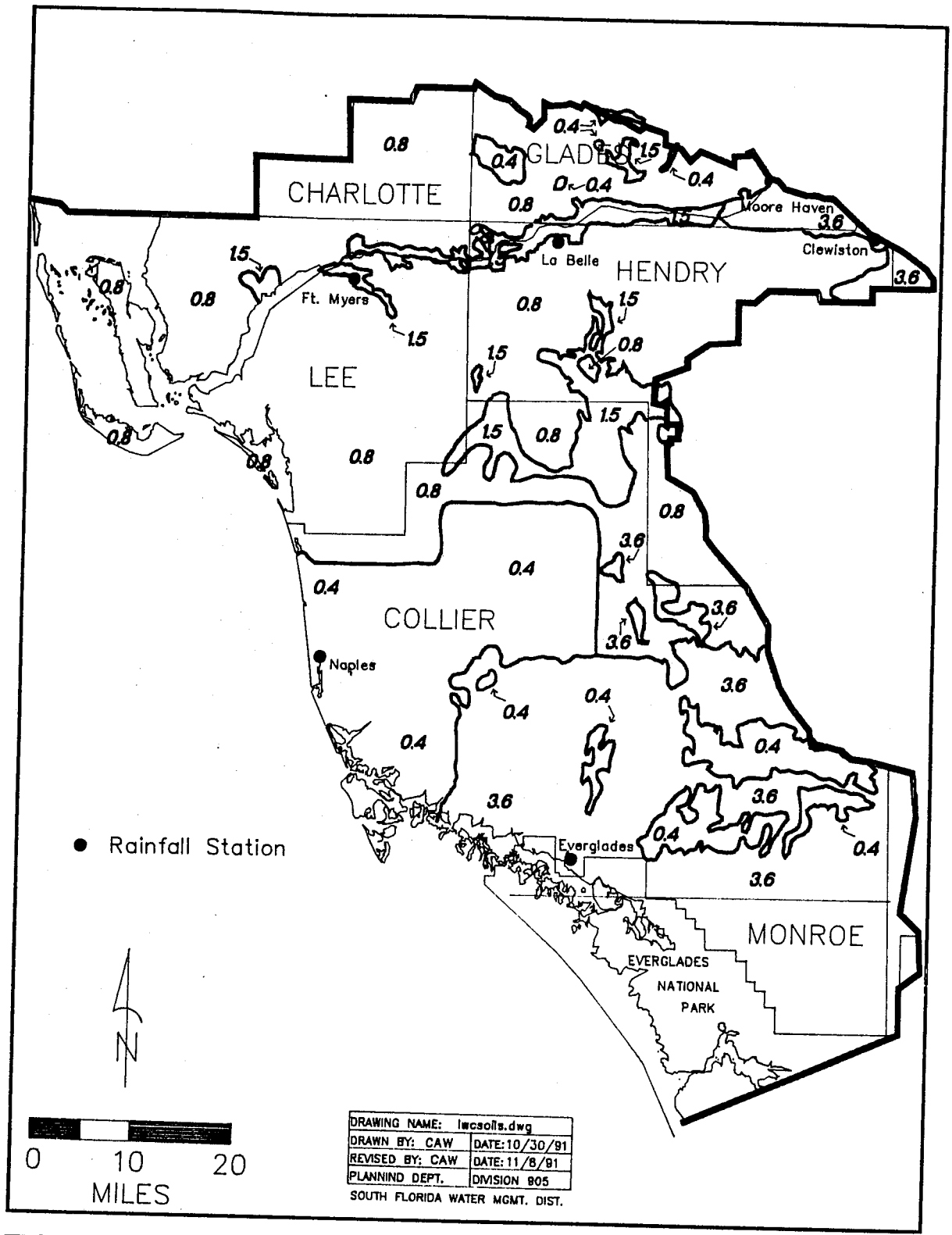


FIGURE G-1. Soil Types (in inches) in the Lower West Coast Planning Area.

acreage from central to Southwest Florida, and until recently, of relatively high market prices. This high rate of growth over a relatively short period adds apprehension to the development of acreage projections, as it is unlikely that this rate of growth will be sustainable throughout the projection period, and it is unclear when the growth rate will return to a more normal level.

In addressing future growth in the Gulf Coast citrus producing region (which includes Collier, Lee, Hendry, Glades, and Charlotte counties), Behr *et al.* (1988) developed three scenarios for future citrus planting rates (high, medium, and low). The medium planting rate is anticipated to reflect rates more consistent with the normal returns to producing citrus. This medium growth rate represents additional growth at half the rate experienced between 1986 and 1988. However, the FASS reports for 1990 indicate that the high rate of growth experienced between 1986 and 1988 (or the high scenario) has continued. Nevertheless, it is expected that there will come a point where growth will slow, but it is not clear when this is likely to occur.

Tables projecting citrus acreages for Collier, Lee, and Hendry counties outline an extrapolation of the medium planting rate scenario for future years to 1990 as outlined by Behr *et al.* (1988). Forecasting equations are presented for Glades and Charlotte counties, where recent growth has not been as extreme. Hendry is the only county in the LWC Planning Area with significant citrus nursery acreage; these irrigation requirements are projected separately.

In order to assess the types of irrigation systems in use, acreage ratios of existing systems permitted by the District were used. In recent years, micro irrigation has been the system of choice on new citrus groves for a variety of reasons. Reasons include the cost advantage that micro irrigation 'systems have over overhead sprinkler systems, and the production advantage (less time to tree maturity) micro irrigation systems have over seepage systems. However, there is still a substantial citrus acreage in the LWC Planning Area with seepage irrigation, and to a lesser extent, overhead sprinkler irrigation. The ratio of the permitted acreage in 1990 for each of the three different types of irrigation systems for citrus in each county was assessed from District permits. This ratio was applied to the acreage for 1990, and the corresponding efficiencies used to calculate irrigation requirements. All citrus planted after 1985 was assumed to have some form of micro irrigation system.

Collier County

Citrus Acreage. Table G-16 shows historical citrus acreage in Collier County and presents an extrapolation of the medium planting rate scenario for years future to 1990, as outlined by Behr *et al.* (1988). Citrus growth was capped at 52,950 acres during the land projection exercise described later in the text.

Citrus Irrigation Requirements. In 1990 permitted citrus acreage in Collier County had permitted irrigation systems in the ratio shown in Table G-17. The average and 2-in-10 supplemental water requirements for citrus at the Clewiston rainfall station, which is the most common rainfall station used to permit citrus in Collier County on 0.8 inch soil, are shown in Table G-18.

The supplemental water requirements shown in Table G-18 were divided by irrigation efficiency to yield the irrigation requirements. For example, average irrigation requirement for citrus in July 1990 is as calculated below.

TABLE G-16. Historical and Projected Citrus Acreage in Collier County.

Year	Historical	Primary projection	Primary -15 %	Primary+15 %
1966	2,605			
1968	3,933			
1970	5,052			
1972	5,228			
1974	5,474			
1976	5,396			
1978	5,975			
1980	6,706			
1982	7,931			
1984	8,425			
1986	10,063			
1988	17,309			
1990	23,565			
Projections				
1991		25,377	21,570	29,183
1992		27,188	23,110	31,266
1993		29,000	24,650	33,349
1994		30,811	26,189	35,433
1995		32,623	27,729	37,516
1996		34,434	29,269	39,599
1997		36,246	30,809	41,682
1998		38,057	32,348	43,766
1999		39,869	33,888	45,849
2000		41,680	35,428	47,932
2001		43,492	36,968	50,015
2002		45,303	38,508	52,098
2003		47,115	40,047	54,182
2004		48,926	41,587	56,265
2005		50,738	43,127	58,348
2006		52,549	44,667	60,431
2007		52,950	45,008	60,893
2008		52,950	45,008	60,893
2009		52,950	45,008	60,893
2010		52,950	45,008	60,893

Source: Historical acreage from Commercial Citrus Inventory 1966-1990, Florida Agricultural Statistics Service.

TABLE G-17. 1990 Ratio of Permitted Irrigation System Type on Citrus in Collier County.

Type of System	% of Permitted Citrus	Estimated Irrigation Efficiency
Micro-irrigation	72 percent	0.85
Overhead Sprinkler	4 percent	0.75
Seepage	24 percent	0.50

Source: SFWMD Water Supply Planning Permit Database.

TABLE G-18. Supplemental Water Requirements for Citrus at the Clewiston Rainfall Station.

Month	Average (in.)	2-in-10 (in.)
January	1.69	1.80
February	1.61	1.76
March	2.52	2.68
April	2.82	3.05
May	2.93	3.31
June	2.40	2.93
July	2.79	3.31
August	2.54	3.07
September	1.45	2.04
October	2.37	2.66
November	2.54	2.62
December	1.64	1.77
TOTAL	27.30	31.00

Soil type = 0.8 inch.

Assumptions:

- Citrus acreage for Collier County in 1990 = 23,565 acres.
- 72 percent under micro-irrigation = 16,967 acres @ 85 percent efficiency.
- 4 percent under sprinkler irrigation = 943 acres @ 75 percent efficiency.
- 24 percent under seepage irrigation = 5,656 acres @ 50 percent efficiency.

Calculation:

The average irrigation requirement for citrus in July of 1990 is:

(((2.79 in./0.85) * 16,967 acres) + ((2.79 in./0.75) * 943 acres)) +
((2.79 in./0.50) * 5,656 acres)) / 12 inches)= 7,563 ac.ft.
(7,563 ac.ft. * 325,872 gal/ac.ft.)/1,000,000 = 2,465 MG.

Average and 2-in-10 irrigation requirements were calculated for the primary projection, and are shown in Table G-19.

TABLE G-19. Irrigation Requirements in Millions of Gallons for the Primary Citrus Acreage Projection in Collier County.

Average	1985	1990	1995	2000	2005	2010
January	720	1,493	1,982	2,471	2,960	3,097
February	686	1,422	1,888	2,354	2,820	2,934
March	1,073	2,226	2,955	3,685	4,414	4,592
April	1,201	2,491	3,307	4,123	4,939	5,139
May	1,248	2,588	3,436	4,284	5,132	5,339
June	1,022	2,120	2,815	3,509	4,204	4,373
July	1,188	2,465	3,272	4,079	4,887	5,084
August	1,082	2,244	2,979	3,714	4,449	4,628
September	617	1,281	1,700	2,120	2,540	2,642
October	1,009	2,094	2,779	3,465	4,151	4,319
November	1,082	2,244	2,979	3,714	4,449	4,628
December	698	1,449	1,923	2,398	2,872	2,988
TOTAL	11,625	24,116	32,016	39,916	47,816	49,745
2-in-10	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**
January	767	1,590	2,111	2,632	3,153	3,280
February	749	1,555	2,064	2,573	3,083	3,207
March	1,141	2,367	3,143	3,918	4,694	4,883
April	1,299	2,694	3,577	4,459	5,342	5,558
May	1,410	2,924	3,882	4,840	5,797	6,031
June	1,248	2,588	3,436	4,284	5,132	5,339
July	1,410	2,924	3,882	4,840	5,797	6,031
August	1,307	2,712	3,600	4,489	5,377	5,594
September	869	1,802	2,392	2,983	3,573	3,717
October	1,133	2,350	3,120	3,889	4,659	4,847
November	1,116	2,314	3,073	3,831	4,589	4,774
December	754	1,564	2,076	2,588	3,100	3,225
TOTAL	13,201	27,384	36,355	45,325	54,296	56,487

Lee County

Citrus Acreage. Table G-20 shows historical citrus acreage in Lee County and presents an extrapolation of the medium planting rate scenario for years future to 1990 as outlined by Behr *et al.* (1988).

TABLE G-20. Historical and Projected Citrus Acreage in Lee County.

Year	Historical	Primary Projection	Primary-15 %	Primary+15 %
1966	195			
1968	743			
1970	5,427			
1972	7,290			
1974	7,397			
1976	6,243			
1978	5,384			
1980	5,139			
1982	4,787			
1984	6,575			
1986	7,313			
1988	8,247			
1990	9,692			
Projections				
1991		9,926	8,437	11,414
1992		10,159	8,635	11,683
1993		10,393	8,834	11,951
1994		10,626	9,032	12,220
1995		10,860	9,231	12,488
1996		11,093	9,429	12,757
1997		11,327	9,628	13,025
1998		11,560	9,826	13,294
1999		11,794	10,024	13,563
2000		12,027	10,223	13,831
2001		12,261	10,421	14,100
2002		12,494	10,620	14,368
2003		12,728	10,818	14,637
2004		12,961	11,017	14,905
2005		13,195	11,215	15,174
2006		13,428	11,414	15,442
2007		13,662	11,612	15,711
2008		13,895	11,811	15,979
2009		14,129	12,009	16,248
2010		14,362	12,208	16,516

Source: Historical acreage from Commercial Citrus Inventory 1966-1990, Florida Agricultural Statistics Service.

Citrus Irrigation Requirements. In August 1990, citrus acreage in Lee County had permitted irrigation systems in the ratio shown in Table G-21. The average and 2-in-10 supplemental water requirements for citrus at the rainfall station in Fort Myers on 0.8 inch soil are shown in Table G-22.

TABLE G-21. Ratio of Permitted Irrigation System Type on Citrus in Lee County.

Type of System	Percent of Permitted Citrus	Estimated Irrigation Efficiency
Micro-irrigation	50 percent	0.85
Overhead Sprinkler	0 percent	0.75
Seepage	50 percent	0.50

Source: District Water Supply Planning Permit Database.

TABLE G-22. Supplemental Water Requirements for Citrus in Lee County.

Month	Average (in.)	2-in-10 (in.)
January	1.51	1.63
February	1.48	1.62
March	2.31	2.47
April	2.98	3.15
May	3.26	3.55
June	1.47	2.07
July	2.00	2.58
August	2.05	2.60
September	1.38	1.91
October	2.30	2.57
November	2.33	2.43
December	1.78	1.88
TOTAL	24.85	28.46

Rainfall station = Fort Myers.
Soil type = 0.8 inch.

The supplemental water requirements shown in Table G-35 were divided by irrigation efficiency to yield irrigation requirements. Average and 2-in-10 irrigation requirements were calculated for the primary projection, and are shown in Table G-23.

TABLE G-23. Irrigation Requirements in Millions of Gallons for the Primary Citrus Acreage Projection in Lee County.

Average	1985	1990	1995	2000	2005	2010
January	499	631	688	744	800	856
February	489	619	674	729	784	839
March	763	966	1,052	1,138	1,224	1,310
April	984	1,246	1,357	1,468	1,579	1,690
May	1,077	1,363	1,484	1,606	1,728	1,849
June	485	614	669	724	779	834
July	660	836	911	985	1,060	1,134
August	677	857	933	1,010	1,086	1,163
September	456	577	628	680	731	783
October	760	961	1,047	1,133	1,219	1,305
November	769	974	1,061	1,148	1,235	1,322
December	588	744	810	877	943	1,010
TOTAL	8,206	10,388	11,315	12,242	13,169	14,095

2-in-10	1985	1990	1995	2000	2005	*2010*
January	538	681	742	803	864	925
February	535	677	738	798	858	919
March	816	1,033	1,125	1,217	1,309	1,401
April	1,040	1,317	1,434	1,552	1,669	1,787
May	1,172	1,484	1,616	1,749	1,881	2,014
June	684	865	943	1,020	1,097	1,174
July	852	1,078	1,175	1,271	1,367	1,463
August	859	1,087	1,184	1,281	1,378	1,475
September	631	798	870	941	1,012	1,083
October	849	1,074	1,170	1,266	1,362	1,458
November	802	1,016	1,106	1,197	1,288	1,378
December	621	786	856	926	996	1,066
TOTAL	9,398	11,897	12,959	14,020	15,082	16,143

Hendry County Area

Citrus Acreage. Table G-24 shows the historical citrus acreage in Hendry County and presents an extrapolation of the medium planting scenario for years future to 1990 as outlined by Behr *et al.* (1988).

TABLE G-24. Historical and Projected Citrus Acreage in Hendry County.

Year	Historical	Primary Projection	Primary-15 %	Primary+15 %
1966	16,152			
1968	19,988			
1970	22,447			
1972	22,684			
1974	24,225			
1976	25,944			
1978	28,903			
1980	30,086			
1982	32,944			
1984	36,807			
1986	40,269			
1988	54,957			
1990	73,754			
Projections				
1991		77,426	65,812	89,040
1992		81,098	68,933	93,263
1993		84,770	72,055	97,485
1994		88,442	75,176	101,708
1995		92,114	78,297	105,931
1996		95,786	81,418	110,154
1997		99,458	84,539	114,377
1998		103,130	87,661	118,599
1999		106,802	90,782	122,822
2000		110,474	93,903	127,045
2001		114,146	97,024	131,268
2002		117,818	100,145	135,491
2003		121,490	103,267	139,714
2004		125,162	106,388	143,936
2005		128,834	109,509	148,159
2006		132,506	112,630	152,382
2007		136,178	115,751	156,605
2008		139,850	118,873	160,828
2009		143,522	121,994	165,050
2010		147,194	125,115	169,273

Source: Historical acreage from Commercial Citrus Inventory 1966-1990, Florida Agricultural Statistics Service.

Citrus Irrigation Requirements. In October 1990 citrus acreage in Hendry County had permitted irrigation systems in the ratio shown in Table G-25. The average and 2-in-10 supplemental water requirements for citrus at the rainfall station in La Belle on 0.8 inch soil are shown in Table G-26. These water requirements were divided by irrigation efficiency to yield the irrigation requirements in Table G-27. In 1990, 75 percent of the citrus irrigation permitted by the District in Hendry County was in the LWC Planning Area. This is projected to change to 73 percent by 2010. Land use projections are described in detail later in the text.

TABLE G-25. Ratio of Permitted Irrigation System Type on Citrus in Hendry County.

Type of System	Percent of Permitted Citrus	Estimated Irrigation Efficiency
Micro irrigation	60 percent	0.85
Sprinkler	4 percent	0.75
Seepage	36 percent	0.50

Source: District Water Supply Planning Permit Database.

TABLE G-26. Supplemental Water Requirements for Citrus in Hendry County.

Month	Average (in.)	2-in-10 (in.)
January	1.58	1.69
February	1.41	1.56
March	2.07	2.26
April	2.68	2.89
May	3.12	3.41
June	1.43	2.03
July	2.05	2.61
August	2.16	2.68
September	1.50	2.00
October	2.23	2.49
November	2.31	2.40
December	1.75	1.84
TOTAL	24.29	27.86

Rainfall station = La Belle.
Soil type = 0.8 inch.

TABLE G-27. Irrigation Requirements in Millions of Gallons for the Primary Citrus Acreage Projection in the Hendry County Area.

Average	1985	1990	1995	2000	2005	2010
January	2,178	3,511	4,178	4,836	5,484	6,123
February	1,943	3,133	3,728	4,315	4,894	5,464
March	2,853	4,600	5,473	6,335	7,185	8,022
April	3,694	5,955	7,086	8,202	9,302	10,386
May	4,300	6,933	8,250	9,549	10,829	12,092
June	1,971	3,177	3,781	4,377	4,963	5,542
July	2,825	4,555	5,421	6,274	7,115	7,945
August	2,977	4,800	5,711	6,611	7,497	8,371
September	2,067	3,333	3,966	4,591	5,206	5,813
October	3,073	4,955	5,897	6,825	7,740	8,642
November	3,184	5,133	6,108	7,070	8,018	8,952
December	2,412	3,889	4,627	5,356	6,074	6,782
TOTAL	33,476	53,972	64,227	74,339	84,309	94,137

2-in-10	1985	1990	1995	2000	2005	2010
January	2,329	3,755	4,469	5,172	5,866	6,550
February	2,150	3,466	4,125	4,774	5,415	6,046
March	3,115	5,022	5,976	6,917	7,844	8,759
April	3,983	6,422	7,642	8,845	10,031	11,200
May	4,700	7,577	9,017	10,436	11,836	13,216
June	2,798	4,511	5,368	6,213	7,046	7,867
July	3,597	5,799	6,901	7,988	9,059	10,115
August	3,694	5,955	7,086	8,202	9,302	10,386
September	2,756	4,444	5,288	6,121	6,942	7,751
October	3,432	5,533	6,584	7,621	8,643	9,650
November	3,308	5,333	6,346	7,345	8,330	9,301
December	2,536	4,088	4,865	5,631	6,387	7,131
TOTAL	38,396	61,905	73,667	85,265	96,701	107,972

Irrigated Acreage	1985	1990	1995	2000	2005	2010
County	38,538	73,754	92,114	110,474	128,834	147,194
County Area	28,904	55,316	68,625	81,751	94,693	107,452
% in LWC	75%	75%	74.5%	74%	73.5%	73%

Citrus Nursery Acreage. Hendry is the only county in the LWC Planning Area with a significant citrus nursery acreage. Robust regression analysis was used to project citrus nursery acreage in Hendry County, as a function of Hendry County citrus acreage, a trend variable, and a dichotomous variable to reflect the abnormally high levels of citrus nursery acreage in the early years of the period under study. The model estimated took the general form of Equation (G-9). This equation is based on the awareness that the output from citrus nurseries is used as an input into citrus production.

$$HECNA_t = f(HED_t, HETOT_t, Year) \qquad \textbf{(G-9)}$$

where:
$HECNA_t$ = *citrus nursery acreage in Hendry County in year t.*
HED_t = *0 for the years 1972 and 1973 and 1 thereafter.*
$HETOT_t$ = *total citrus acreage in Hendry County in year t; (note that since citrus acreage is only measured every two years, the citrus acreage variable has the same value for two years in a row).*
Year = the year for which the estimate is being made.

The functional form represented in Equation (G-9) was estimated using robust regression analysis, resulting in Equation (G-10).

$$HECNA_t = -5445.611 - \underset{(-2.98)}{22.8029} * HED_t + \underset{(6.91)}{.003245} * HETOT_t + \underset{(2.50)}{.2.73054} * Year \qquad \textbf{(G-10)}$$

Goodness of fit statistics
$R^2 = .9703$
$F = 141.46$
$Pr\,F > 0 > .9999$
$D\text{-}W = 1.624$
t - statistics in parentheses

Equation (G-10), adjusted for the amount by which the model over-projected citrus nursery acreage in 1990 (27 acres), was used to develop the acreage projections shown in Table G-28.

TABLE G-28. Historical and Projected Citrus Nursery Acreage in Hendry County.

Year	Historical	Primary Projection	Primary-15 %	Primary+15 %
1972	13			
1973	15			
1974	15			
1975	7			
1976	14			
1977	14			
1978	Unavailable			
1979	26			
1980	33			
1981	31			
1982	28			
1983	48			
1984	53			
1985	74			
1986	91			
1987	151			
1988	147			
1989	167			
1990	178	205		
Projections				
1991		193	164	222
1992		207	176	238
1993		222	189	255
1994		237	201	273
1995		251	213	289
1996		266	226	306
1997		281	239	323
1998		295	251	339
1999		310	264	357
2000		324	275	373
2001		339	288	390
2002		354	301	407
2003		368	313	423
2004		383	326	440
2005		398	338	458
2006		412	350	474
2007		427	363	491
2008		442	376	508
2009		456	388	524
2010		471	400	542

Source: Historical acreage from Bureau of Plant Inspection Annual Report, Division of Plant Industry 1972-1990, Florida Dept. of Agr. and Consumer Services.

Citrus Nursery Irrigation Requirements. Supplemental water requirements for citrus nurseries are considered to be the same as that for citrus by the District, and are outlined for Hendry County in Table G-26. These water requirements were applied to the citrus nursery acreage projections (shown in Table G-28) to calculate the irrigation requirements (shown in Table G-29). The same distribution that was used for citrus was applied to the citrus nursery acreage.

TABLE G-29. Irrigation Requirements in Millions of Gallons for the Primary Citrus Nursery Acreage Projection in the Hendry County Area.

Average	1985	1990	1995	2000	2005	2010
January	5	11	10	13	16	18
February	4	10	9	11	14	16
March	6	15	13	17	21	24
April	8	19	17	22	27	31
May	9	23	20	25	31	36
June	4	10	9	12	14	17
July	6	15	13	17	20	24
August	7	16	14	18	21	25
September	5	11	10	12	15	18
October	7	16	14	18	22	26
November	7	17	15	19	23	27
December	5	13	11	14	17	20
Total	73	176	154	198	241	283
2-in-10	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**
January	5	12	11	14	17	20
February	5	11	10	13	15	18
March	7	16	14	18	22	26
April	9	21	18	24	29	34
May	10	25	22	28	34	40
June	6	15	13	17	20	24
July	8	19	17	21	26	30
August	8	19	17	22	27	31
September	6	15	13	16	20	23
October	8	18	16	20	25	29
November	7	17	15	20	24	28
December	6	13	12	15	18	21
Total	84	202	177	227	277	325

The majority of citrus nurseries in Hendry County use overhead sprinkler systems for irrigation. Normally, overhead sprinkler irrigation systems are estimated by the District to have an irrigation system efficiency of 75 percent. However, an indeterminable number of nurseries containerize their plants, and this reduces the efficiency to approximately 20 percent. To account for this range of irrigation efficiencies, an efficiency of 50 percent was assumed for time horizons prior to 1993. After January 1993, all container nurseries will be allocated based on an 85 percent efficiency. Because citrus nurseries include both types of nursery, an average efficiency of 80 percent was used for time horizons after 1993.

Glades County Area

Citrus Acreage. Forecasting models were developed to project citrus acreage in Glades County. A variety of variables and functional forms were tested, and models of the general form of Equation (G-11) were found to best explain past trends in citrus acreage in Glades County.

$$GLCIT_t = f(time, D, RP_p, RP_w, RP_o) \quad \text{(G-11)}$$

where:
$GLCIT_t$ = *citrus acreage in Glades County in year t.*
Time = a time trend variable which takes the value of 1 in 1966 and increases by one unit each year.
RP_p, RP_w, *and* RP_o = *the real prices of Interior Region pink and white grapefruit and oranges respectively.*
D = a dichotomous variable equal to 0 before 1980 and 1 in the period 1980 and after.

The dichotomous variable corresponds closely to the onset of the series of severe winters, so the D variable picks up a portion of the interregional shift in citrus production within Florida associated with these recent severe winters. Statistical models were run which weighted all observations equally and with the weight assigned to a particular observation declining geometrically with time, with the lowest weight being assigned to the earliest observation. Weighted Glades County citrus acreage is denoted as $WGLCIT_t$. Eight specific sub-models were estimated as shown in equations (G-12) through (G-19).

$$GLCIT_t = f(time, RP_p, RP_w, RP_o, D) \quad \text{(G-12)}$$

$$WGLCIT_t = f(time, RP_p, RP_w, RP_o, D) \quad \text{(G-13)}$$

$$GLCIT_t = f(time, D) \quad \text{(G-14)}$$

$$WGLCIT_t = f(time, D) \quad \text{(G-15)}$$

$$GLCIT_t = f(time, RP_p, RP_o, RP_w) \quad \text{(G-16)}$$

$$WGLCIT_t = f(time, RP_p, RP_w, RP_o) \quad \text{(G-17)}$$

$$GLCIT_t = f(time) \quad \text{(G-18)}$$

$$WGLCIT_f = f(time) \quad \text{(G-19)}$$

Functional forms (G-12) through (G-19) were estimated using ordinary least squares regression. The results are shown in equations (G-20) through (G-27).

$$GLCIT_t = -1547.241 + \underset{(5.06)}{237.488} * time + \underset{(3.00)}{1757.5} * D + \underset{(1.71)}{520.552} * RP_w$$
$$\underset{(-1.51)}{-284.2936} * RP_o + \underset{(0.15)}{51.859} * RP_p \qquad \text{(G-20)}$$

Goodness of fit statistics
$R^2 = .9655$
$F = 39.14$
$Pr\,F > 0 > .999$
t - statistics in parentheses

$$WGLCIT_t = -3246.637 + \underset{(4.53)}{254.9774} * time + \underset{(2.79)}{1962.661} * D - \underset{(-1.17)}{263.3348} * RP_o$$
$$+ \underset{(0.98)}{357.813} * RP_w + \underset{(0.66)}{267.3135} * RP_p \qquad \text{(G-21)}$$

Goodness of fit statistics
$R^2 = .9605$
$F = 34.03$
$Pr\,F > 0 > .999$
t - statistics in parentheses

$$GLCIT_t = 661.7312 + \underset{(3.85)}{153.5731} * time + \underset{(3.40)}{2203.411} * D \qquad \text{(G-22)}$$

Goodness of fit statistics
$R^2 = .9299$
$F = 66.34$
$Pr\,F > 0 > .999$
t - statistics in parentheses

$$WGLCIT_t = -735.7443 + \underset{(4.09)}{179.6155} * time + \underset{(3.31)}{2351.752} * D \qquad \text{(G-23)}$$

Goodness of fit statistics
$R^2 = .9325$
$F = 69.11$
$Pr\,F > 0 > .999$
t - statistics in parentheses

$$GLCIT_t = -3051.487 + \underset{(8.08)}{345.2226} * time - \underset{(-0.04)}{275.7016} * RP_o + \underset{(1.68)}{705.7448} * RP_w$$
$$\underset{(-0.04)}{-16.84349} * RP_p \qquad \text{(G-24)}$$

Goodness of fit statistics
$R^2 = .9211$
$F = 23.36$
$Pr\, F > 0 > .999$
t - statistics in parentheses

$$WGLCIT_t = -4926.481 + \underset{(7.62)}{375.2878 * time} - \underset{(-0.83)}{253.7398 * RP_o} + \underset{(1.16)}{564.6245 * RP_w} + \underset{(0.35)}{190.5909 * RP_p} \quad \text{(G-25)}$$

Goodness of fit statistics
$R^2 = .9164$
$F = 21.93$
$Pr\, F > 0 > .999$
t - statistics in parentheses

$$GLCIT_t = -76.7747 + \underset{(7.86)}{262.533 * time} \quad \text{(G-26)}$$

Goodness of fit statistics
$R^2 = .8487$
$F = 61.70$
$Pr\, F > 0 > .999$
t - statistics in parentheses

$$WGLCIT_t = -1523.97 + \underset{(8.18)}{295.911 * time} \quad \text{(G-27)}$$

Goodness of fit statistics
$R^2 = .8588$
$F = 66.92$
$Pr\, F > 0 > .999$
t - statistics in parentheses

When equations (G-20) through (G-27) were used for projection purposes, the results shown as columns (G-20) through (G-27) in Table G-30 were obtained.

On the basis of recent historic growth in citrus acreage, it was observed that all models underestimated 1990 acreage. To overcome this deficiency, the projection by Equation (G-25) was selected, and future projections were adjusted by the amount by which 1990 acreage is underestimated (650 acres). This is equivalent to inserting a dichotomous intercept-shift variable into the model for the period 1990 and after. When this adjustment is made the primary projection shown in Table G-31 was obtained.

TABLE G-30. Alternative Projections for Citrus Acreage in Glades County.

Year	Historical	Column (E-20)	Column (E-21)	Column (E-22)	Column (E-23)	Column (E-24)	Column (E-25)	Column (E-26)	Column (E-27)
1966	1,413								
1968	1,461								
1970	1,572								
1972	1,639								
1974	1,661								
1976	1,615								
1978	1.613								
1980	3,395								
1982	4,026								
1984	5,141								
1986	6,076								
1988	6,235								
1990	7,523								
Projections									
1991		7,191	6,730	6,858	6,286	7,218	6,760	6,749	6,170
1992		7,429	6,985	7,012	6,466	7,563	7,135	7,012	6,466
1993		7,666	7,240	7,165	6,645	7,909	7,510	7,274	6,762
1994		7,904	7,495	7,319	6,825	8,254	7,886	7,537	7,057
1995		8,141	7,750	7,472	7,004	8,599	8,261	7,799	7,353
1996		8,379	8,005	7,626	7,184	8,944	8,636	8,062	7,649
1997		8,616	8,260	7,779	7,364	9,290	9,012	8,324	7,945
1998		8,854	8,515	7,933	7,543	9,635	9,387	8,587	8,241
1999		9,091	8,770	8,087	7,723	9,980	9,762	8,849	8,537
2000		9,329	9,025	8,240	7,903	10,325	10,138	9,112	8,833
2001		9,566	9,280	8,394	8,082	10,670	10,513	9,374	9,129
2002		9,804	9,535	8,547	8,262	11,016	10,888	9,637	9,425
2003		10,041	9,790	8,701	8,441	11,361	11,263	9,899	9,721
2004		10,279	10,045	8,854	8,621	11,706	11,639	10,162	10,017
2005		10,516	10,300	9,008	8,801	12,051	12,014	10,425	10,312
2006		10,754	10,555	9,162	8,980	12,397	12,389	10,687	10,608
2007		10,991	10,810	9,315	9,160	12,742	12,765	10,950	10,904
2008		11,229	11,065	9,469	9,339	13,087	13,140	11,212	11,200
2009		11,466	11,319	9,622	9,519	13,432	13,515	11,475	11,496
2010		11,704	11,574	9,776	9,699	13,777	13,890	11,737	11,792

Source: Historical acreage from Commercial Citrus Inventory 1966-1990, Florida Agricultural Statistics Service.

TABLE G-31. Historical and Projected Citrus Acreage in Glades County.

Year	Historical	Primary projection	Primary -15 %	Primary + 15 %
1966	1,413			
1968	1,461			
1970	1,572			
1972	1,639			
1974	1,661			
1976	1,615			
1978	1,613			
1980	3,395			
1982	4,026			
1984	5,141			
1986	6,076			
1988	6,235			
1990	7,523			
Projections				
1991		7,868	6,688	9,048
1992		8,213	6,981	9,445
1993		8,559	7,275	9,843
1994		8,904	7,568	10,240
1995		9,249	7,862	10,636
1996		9,594	8,155	11,033
1997		9,940	8,449	11,431
1998		10,285	8,742	11,828
1999		10,630	9,036	12,224
2000		10,975	9,329	12,621
2001		11,320	9,622	13,018
2002		11,666	9,916	13,416
2003		12,011	10,209	13,813
2004		12,356	10,503	14,209
2005		12,701	10,796	14,606
2006		13,047	11,090	15,004
2007		13,392	11,383	15,401
2008		13,737	11,676	15,798
2009		14,082	11,970	16,194
2010		14,427	12,263	16,591

Source: Historical acreage from Commercial Citrus Inventory 1966-1990, Florida Agricultural Statistics Service.

Citrus Irrigation Requirements. In October 1989, permitted citrus acreage in Glades County had irrigation systems in the ratio shown in Table G-32. The average and 2-in-10 supplemental water requirements for citrus at the rainfall station in Moore Haven on 0.8 inch soil are shown in Table G-33.

TABLE G-32. Ratio of Permitted Irrigation System Type on Citrus in Glades County.

Type of System	Percent of Permitted Citrus	Estimated Irrigation Efficiency
Micro-irrigation	77 percent	0.85
Overhead sprinkler	3 percent	0.75
Seepage	20 percent	0.50

Source: District Water Supply Planning Permit Database.

TABLE G-33. Supplemental Water Requirements for Citrus in Glades County.

Month	Average (in.)	2-in-10 (in.)
January	1.58	1.70
February	1.52	1.66
March	2.16	2.33
April	2.64	2.86
May	2.79	3.14
June	1.76	2.34
July	2.24	2.80
August	2.42	2.93
September	1.52	2.05
October	2.12	2.38
December	2.27	1.92
TOTAL	24.86	28.53

Rainfall station = Moore Haven.
Soil type = 0.8 inch.

The supplemental water requirements in Table G-33 were divided by irrigation efficiency to yield irrigation requirements. Average and 2-in-10 irrigation requirements for the primary projection are shown in Table G-34.

TABLE G-34. Irrigation Requirements in Millions of Gallons for the Primary Citrus Acreage Projection in the Glades County Area.

Average	1985	1990	1995	2000	2005	2010
January	208	256	316	368	419	471
February	200	247	304	354	403	453
March	284	350	433	503	573	643
April	348	428	529	615	701	786
May	367	453	559	650	740	831
June	232	286	353	410	467	524
July	295	363	449	522	594	667
August	319	393	485	563	642	721
September	200	247	304	354	403	453
October	279	344	425	494	563	632
299	299	368	455	529	602	676
December	241	297	367	426	486	545
TOTAL	3,272	4,031	4,977	5,786	6,594	7,403
2-in-10	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**
January	224	276	341	396	451	506
February	219	269	332	386	441	495
March	307	378	467	542	618	694
April	377	464	573	666	759	852
May	413	509	629	731	833	935
June	308	380	469	545	621	697
July	369	454	561	652	743	834
August	386	475	587	682	778	873
September	270	333	411	477	544	611
October	319	393	485	563	642	721
November	313	386	477	554	632	709
December	253	311	385	447	509	572
TOTAL	3,757	4,628	5,714	6,643	7,571	8,499
Irrigated Acreage	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**
County	5,609	7,523	9,249	10,975	12,701	14,427
County Area	3,309	4,439	5,457	6,475	7,494	8,512
% in LWC	59%	59%	59%	59%	59%	59%

Charlotte County Area

Citrus Acreage. A variety of variables and functional forms were tested, and models of the general form of Equation (G-28) were found to best explain past trends in citrus acreage in Charlotte County, as was the case in Glades County.

$$CHCIT_t = f(time, D, RP_p, RP_w, RP_o) \quad \textbf{(G-28)}$$

where:
$CHCIT_t$ = *citrus acreage in Charlotte County in year t.*
RP_p, RP_w, *and* RP_o = *the real prices of Interior Region pink and white grapefruit and oranges respectively.*
D = *a dichotomous variable equal to 0 before 1984 and 1 in the period 1984 and after.*

The dichotomous variable corresponds closely to the onset of the series of severe winters in recent years, similar to Glades County, the D variable picks up a portion of the interregional shift in citrus production within Florida. Models were run which weighted all observations equally and with the weight assigned to a particular observation declining geometrically with time, with the lowest weight being assigned to the earliest observation. Weighted Charlotte citrus acreage is denoted as $WCHCIT_t$. Eight specific sub-models were estimated as shown in equations (G-29) through (G-36).

$$CHCIT_t = f(time, RP_p, RP_w, RP_o, D) \quad \text{(G-29)}$$

$$WCHCIT_t = f(time, RP_p, RP_w, RP_o, D) \quad \text{(G-30)}$$

$$CHCIT_t = f(time, D) \quad \text{(G-31)}$$

$$WCHCIT_t = f(time, D) \quad \text{(G-32)}$$

$$CHCIT_t = f(time, RP_p, RP_o, RP_w) \quad \text{(G-33)}$$

$$WCHCIT_t = f(time, RP_p, RP_w, RP_o) \quad \text{(G-34)}$$

$$CHCIT_t = f(time) \quad \text{(G-35)}$$

$$WCHCIT_t = f(time) \quad \text{(G-36)}$$

Functional forms (G-29) through (G-36) were estimated using ordinary least squares regression, resulting in equations (G-37) through (G-44).

$$CHCIT_t = \underset{}{3798.387} + \underset{(1.80)}{54.70814} * time - \underset{(-1.18)}{859.3431} * RP_w - \underset{(-2.33)}{280.8888} * RP_o + \underset{(1.69)}{1450.652} * RP_p + \underset{(4.98)}{2185.069} * D \quad \text{(G-37)}$$

Goodness of fit statistics
$R^2 = .9475$
$F = 21.67$
$Pr\,F>0>.999$
$D\text{-}W = 2.708$
t - statistics in parentheses

$$WCHCIT_t = \underset{}{764.5834} + \underset{(5.17)}{328.3388} * time + \underset{(1.29)}{1973.772} * RP_w - \underset{(-2.10)}{528.362} * RP_o - \underset{(-0.80)}{1423.541} * RP_p + \underset{(1.64)}{1506.609} * D \quad \text{(G-38)}$$

Goodness of fit statistics
$R^2 = .9507$
$F = 23.14$
$Pr\,F>0>.999$
$D\text{-}W = 2.441$
t - statistics in parentheses

$$CHCIT_t = 5897.75 + 33.25 * time + 2178.667 * D \quad \text{(G-39)}$$
$$(1.02) \qquad (4.19)$$

Goodness of fit statistics
$R^2 = .8651$
$F = 28.85$
$Pr\ F>0>.999$
$D\text{-}W = 0.9491$
t - statistics in parentheses

$$WCHCIT_t = -215.7632 + 296.627 * time + 1234.235 * D \quad \text{(G-40)}$$
$$(4.89) \qquad (1.28)$$

Goodness of fit statistics
$R^2 = .8997$
$F = 40.35$
$Pr\ F>0>.999$
$D\text{-}W = 2.267$
t - statistics in parentheses

$$CHCIT_t = 565.0319 + 168.7962 * time - 1634.997 * FP_w - 136.627 * RP_o + 2443.092 * RP_p \quad \text{(G-41)}$$
$$(4.01) \qquad (1.09) \qquad (-0.56) \qquad (1.40)$$

Goodness of fit statistics
$R^2 = .7303$
$F = 4.74$
$Pr\ F>0=.964$
$D\text{-}W=1.441$
t - statistics in parentheses

$$WCHCIT_t = 1464.821 + 407.00027 * time + 1438.957 * RP_w - 428.8932 * RP_o - 739.2515 * Rp_p \quad \text{(G-42)}$$
$$(8.72) \qquad (0.86) \qquad (-1.58) \qquad (-0.38)$$

Goodness of fit statistics
$R^2 = .9285$
$F = 22.71$
$Pr\ F>O>.999$
$D\text{-}W = 1.532$
t - statistics in parentheses

$$CHCIT_t = 5208.347 + 136.0089 * time \quad \text{(G-43)}$$
$$(3.89)$$

Goodness of fit statistics
$R^2 = .6020$
$F = 15.12$
$Pr\ F>O = .997$
$D\text{-}W = .8554$
t - statistics in parentheses

$$WCHCIT_t = 606.3165 + 354.8663 * time \quad (8.62) \qquad \text{(G-44)}$$

Goodness of fit statistics
$R^2 = .8815$
$F = 74.37$
$Pr\,F>O>.999$
$D\text{-}W = 1.498$
t - statistics in parentheses

When equations (G-37) through (G-44) were used to project Charlotte County citrus acreage, the results shown in columns (G-37) through (G-44) in Table G-35 were obtained.

On the basis of the recent growth in citrus acreage, it was observed that all models underestimated 1990 citrus acreage. To overcome this deficiency, the projection by Equation (G-42) was selected, and future projections were adjusted by the amount by which 1990 acreage was underestimated (2,751 acres). This is equivalent to inserting a dichotomous intercept-shift variable into the model for the period 1990 and after. When this adjustment was made, the primary projection shown in Table G-36 was obtained. Table G-36 shows the historical and projected citrus acreage in Charlotte County as a whole. To generate estimates of citrus acreage in the Charlotte County Area it was assumed that changes is citrus acreage will be proportional to the current acreages within the two districts.

It was estimated from SFWMD and SWFWMD permit data that approximately 15 percent of the citrus acreage in Charlotte County currently lies within the SFWMD. Citrus acreage projections for the Charlotte County Area were based on this ratio. The estimated citrus acreages for Charlotte County and the Charlotte County Area for the six time horizons are shown in Table G-37.

Citrus Irrigation Requirements. All citrus permitted by the District in August 1990 in the Charlotte County Area was permitted for micro irrigation, and all future citrus is anticipated to be irrigated with similar systems. The average and 2-in-10 supplemental water requirements for citrus at the rainfall station in La Belle on 0.8 inch soil are shown in Table G-38.

Table G-38 shows the supplemental water requirement by month for citrus in the Charlotte County Area. Average and 2-in-10 irrigation requirements were calculated for the primary proje ction, and are shown in Table G-39.

TABLE G-35. Alternative Model Projections for Citrus Acreage in Charlotte County.

Year	Historical	Column (E-37)	Column (E-38)	Column (E-39)	Column (E-40)	Column (E-41)	Column (E-42)	Column (E-43)	Column (E-44)
1966	5,048								
1968	6,052								
1970	6,734								
1972	6,640								
1974	6,549								
1976	6,408								
1978	6,100								
1980	6,122								
1982	6,120								
1984	8,220								
1886	8,759								
1988	9,345								
Projections									
1989		8,873	9,690	8,874	8,138	6,189	8,560	8,474	7,911
1990		8,928	10,018	8,908	8,434	6,358	8,967	8,611	8,266
1991		8,983	10,347	8,941	8,731	6,527	9,374	8,747	8,621
1992		9,037	10,675	8,974	9,027	6,695	9,781	8,883	8,976
1993		9,092	11,003	9,007	9,324	6,864	10,188	9,019	9,330
1994		9,147	11,332	9,041	9,621	7,033	10,595	9,155	9,685
1995		9,201	11,660	9,074	9,917	7,202	11,002	9,291	10,040
1996		9,256	11,988	9,107	10,214	7,371	11,409	9,427	10,395
1997		9,311	12,317	9,140	10,511	7,539	11,816	9,563	10,750
1998		9,366	12,645	9,174	10,807	7,708	12,223	9,699	11,105
1999		9,420	12,973	9,207	11,104	7,877	12,630	9835	11,460
2000		9,475	13,302	9,240	11,400	8,046	13,037	9,971	11,815
2001		9,530	13,630	9,273	11,697	8,215	13,444	10,108	12,170
2002		9,584	13,958	9,307	11,994	8,383	13,851	10,244	12,524
2003		9,639	14,287	9,340	12,290	8,552	14,258	10,380	12,879
2004		9,694	14,615	9,373	12,587	8,721	14,665	10,516	13,234
2005		9,749	14,943	9,406	12,884	8,890	15,072	10,652	13,589
2006		9,803	15,272	9,440	13,180	9,058	15,479	10,788	13,944
2007		9,858	15,600	9,473	13,477	9,227	15,886	10,924	14,299
2008		9,913	15,928	9,506	13,773	9,396	16,293	11,060	14,654
2009		9,967	16,257	9,539	14,070	9,565	16,700	11,196	15,009
2010		10,022	16,585	9,573	14,367	9,734	17,107	11,332	15,364

Source: Historical acreage from Commercial Citrus Inventory 1966-1990, Florida Agricultural Statistics Service.

TABLE G-36. Historical and Projected Citrus Acreage in Charlotte County.

Year	Historical	Primary Projection	Primary-15 %	Primary+15 %
1966	5,048			
1968	6,052			
1970	6,734			
1972	6,640			
1974	6,549			
1976	6,408			
1978	6,100			
1980	6,122			
1982	6,120			
1984	8,220			
1986	8,759			
1988	9,345			
1990	11,718			
Projections				
1991		12,125	10,306	13,944
1992		12,532	10,652	14,412
1993		12,939	10,998	14,880
1994		13,346	11,344	15,348
1995		13,753	11,690	15,816
1996		14,160	12,036	16,284
1997		14,567	12,382	16,752
1998		14,974	12,728	17,220
1999		15,381	13,074	17,688
2000		15,788	13,420	18,156
2001		16,195	13,766	18,624
2002		16,602	14,112	19,092
2003		17,009	14,458	19,560
2004		17,416	14,804	20,028
2005		17,823	15,150	20,496
2006		18,230	15,496	20,965
2007		18,637	15,841	21,433
2008		19,044	16,187	21,901
2009		19,451	16,533	22,369
2010		19,858	16,879	22,837

Source: Historical acreage from Commercial Citrus Inventory 1966-1990, Florida Agricultural Statistics Service.

TABLE G-37. Historical and Projected Citrus Acreage in the Charlotte County Area.

	1985	1990	1995	2000	2005	2010
Charlotte County	8,490	11,718	13,753	15,788	17,823	19,858
Charlotte County Area	1,274	1,758	2,063	2,368	2,673	2,979

TABLE G-38. Supplemental Water Requirements for Citrus in the Charlotte County Area.

Month	Average (in.)	2-in-10 (in.)
January	1.58	1.69
February	1.41	1.56
March	2.07	2.26
April	2.68	2.89
May	3.12	3.41
June	1.43	2.03
July	2.05	2.61
August	2.16	2.68
September	1.50	2.00
October	2.23	2.49
November	2.31	2.40
December	1.75	1.84
TOTAL	24.29	27.86

Rainfall Station = La Belle.
Soil Type = 0.8 inch.

TABLE G-39. Irrigation Requirements in Millions of Gallons for the Primary Citrus Acreage Projection in the Charlotte County Area.

Average	1985	1990	1995	2000	2005	2010
January	64	89	104	120	135	150
February	57	79	93	107	120	134
March	84	116	136	157	177	197
April	109	150	177	203	229	255
May	127	175	206	236	266	297
June	58	80	94	108	122	136
July	83	115	135	155	175	195
August	88	121	142	163	184	206
September	61	84	99	113	128	143
October	91	125	147	169	190	212
November	94	130	152	175	197	220
December	71	98	115	132	149	167
TOTAL	988	1,364	1,601	1,838	2,075	2,312
2-in-10	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**
January	69	95	111	128	144	161
February	63	88	103	118	133	148
March	92	127	149	171	193	215
April	118	162	190	219	247	275
May	139	191	225	258	291	325
June	83	114	134	154	173	193
July	106	147	172	197	223	248
August	109	150	177	203	229	255
September	81	112	132	151	171	190
October	101	140	164	188	213	237
November	98	135	158	182	205	228
December	75	103	121	139	157	175
TOTAL	1,134	1,564	1,836	2,108	2,380	2,651

Sugarcane

Sugarcane is grown commercially in Hendry and Glades counties. Projections of sugarcane acreage in both these counties were developed using trend analysis.

Sugarcane is initially propagated vegetatively by planting stalk cuttings. The first harvest takes place approximately 13 months after planting. Roots are left in the ground (ratooned) and yield additional crops of sugarcane which take about 12 months to reach maturity. Sugar production per acre declines gradually and progressively with each additional ratoon, and there comes a point where the increased yields associated with replanting outweigh the cost of replanting. In Florida, this point comes on average after four years (1 planting and 3 ratoons).

After the final ratoon in the cycle is harvested on a parcel of land (from November through March), and before replanting takes place (from September through January), there is no sugarcane on that parcel. The land is invariably fallowed during this period. This means that there is on average 20 percent of land associated with sugarcane production that will be in fallow and not reported as production by FASS. This 20 percent of land will not require irrigation and is not included in the demand projections presented here.

Historical sugarcane acreage data were gathered from annual volumes of the Field Crops Summary (Florida Department of Agricultural and Consumer Services, 1975-1990). A variety of variables and functional forms were tested. Two models which performed well, based on ability to explain past trends in sugarcane acreage, are shown in equations (G-45) and (G-46).

$$A_{jt} = a + b_1 * t + b_2 * D \qquad \text{(G-45)}$$

$$A_{jt} = a + b_1 * P_{re} + b_2 * t + b_3 * t * D \qquad \text{(G-46)}$$

where:
A_{jt} = *sugarcane acreage in area j in time t.*
t = *a linear trend variable.*
P_{re} = *the real price of sugarcane received by farmers.*
D = *a 0-1 variable; 0 prior to 1985; 1 after 1985.*

Hendry County Area

Sugarcane Acreage. The projections obtained using functional forms (G-45) and (G-46) are shown in columns (G-48) and (G-49) in Table G-40. Column (G-48) shows sugarcane acreage projections for Hendry County estimated as a linear function of time with the inclusion of a 0-1 dichotomous variable. This dichotomous variable took the value of 0 prior to 1985 and a value of 1 in 1985 and after. For projection purposes, the dichotomous variable was set equal to 1. Equation (G-45) estimated by ordinary least squares is shown as Equation (G-47).

$$A_{sht} = 44423.24 + \underset{(7.96)}{2882.953 * t} - \underset{(-6.00)}{20711.17 * D} \qquad \text{(G-47)}$$

where:
A_{sht} = *estimated sugarcane acreage in Hendry County in year t.*
t = *a trend variable taking on a value of 1 in 1975 and increasing by one unit per year.*
D = *a dichotomous variable taking on a value of 0 prior to 1985 and a value of 1 after 1985.*

Goodness of fit statistics
$R^2 = .8331$
$F = 32.44$
$Pr F > 0 > .999$
$D - W = 2.663$
t - statistics are in parentheses

For projection purposes, D was set equal to 1, so the reduced form equation used for projection purposes is given by Equation (G-48).

$$A_{sht} = 23712.07 + 2882.953 * t \qquad \text{(G-48)}$$

The estimated equation of functional form (G-46) is given by Equation (G-49), from which column (G-49) was derived. In Equation (G-49) sugarcane acreage was estimated as a function of the real price of sugarcane, a trend variable, and an interaction term between the trend variable and the dichotomous variable.

$$A_{sht} = \underset{}{49641.03} - \underset{(-0.82)}{496.191 * P_{re}} + \underset{(6.31)}{2905.534 * t} - \underset{(-5.04)}{1595.181 * t * D} \qquad \text{(G-49)}$$

where:
P_{re} = *the average annual price of sugar received by farmers, deflated by the consumer price index.*
All other variables are as previously defined.

Goodness of fit statistics
$R^2 = .7981$
$F = 15.82$
$Pr F > 0 > .999$
$D-W = 3.616$
t - statistics are in parentheses

For the projections, the value of D was set equal to 1, and P_{re} was held at its 1989 level.

Equation (G-49), adjusted for the difference between estimated and actual acreage for 1990, was selected to project sugarcane acreage in Hendry County since it performed well in explaining past observed sugarcane acreage, and was believed to produce likely values for future acreages. On the advise of the local IFAS extension office, projected acreage was capped at 85,000 acres to reflect the limitation of transportation costs combined with the appeal of alternative crops. The primary projection ($\pm$ 15%) is shown in Table G-40.

Sugarcane Irrigation Requirements. There are two basic soil types on which sugarcane is grown in Hendry County, i.e., muck and sand. Presently there are approximately 35,000 acres of sugarcane produced annually on muck in Hendry

TABLE G-40. Historical and Projected Sugarcane Acreage in Hendry County.

Year	Historical	Column (G-48)	Column (G-49)	Primary Projection	Primary -15 %	Primary +15 %
1975	50,637					
1976	52,545					
1977	51,579					
1978	53,314					
1979	57,217					
1980	58,173					
1981	62,476					
1982	72,750					
1983	69,281					
1984	74,923					
1985	56,571					
1986	58,257					
1987	61,720					
1988	62,525					
1989	60,252					
1990	76,467	69,839	66,505			
Projectionss						
1991		72,722	67,816	77,778	66,111	89,445
1992		75,605	69,126	79,088	67,225	90,951
1993		78,488	70,436	80,398	68,338	92,458
1994		81,371	71,747	81,709	69,453	93,965
1995		84,254	73,057	83,019	70,566	95,472
1996		87,137	74,367	84,329	71,680	96,978
1997		90,020	75,678	85,000	72,250	97,750
1998		92,903	76,988	85,000	72,250	97,750
1999		95,786	78,298	85,000	72,250	97,750
2000		98,669	79,609	85,000	72,250	97,750
2001		101,552	80,919	85,000	72,250	97,750
2002		104,435	82,229	85,000	72,250	97,750
2003		107,318	83,540	85,000	72,250	97,750
2004		110,201	84,850	85,000	72,250	97,750
2005		113,084	86,160	85,000	72,250	97,750
2006		115,967	87,471	85,000	72,250	97,750
2007		118,850	88,781	85,000	72,250	97,750
2008		121,733	90,092	85,000	72,250	97,750
2009		124,615	91,402	85,000	72,250	97,750
2010		127,498	92,712	85,000	72,250	97,750

Source: Historical acreage from Field Crops Summary 1975-1990, Florida Agricultural Statistics Service.

County. This area is almost entirely within the LEC portion of Hendry County; therefore irrigation requirements for the LWC portion of the county were calculated for sandy soil. The area of sugarcane production on muck is anticipated to remain constant over the projection period, and all expansion in sugarcane acreage is expected to take place on sand. The average and 2-in-10 supplemental water requirements for sugarcane at the rainfall station in La Belle for sandy soil are shown in Table G-41.

TABLE G-41. Supplemental Water Requirements for Sugarcane in Hendry County.

Soil Type	Sand 0.8 (in.) Average (in.)	Sand 0.8 (in.) 2-in-10 (in.)
January	0.72	0.82
February	0.14	0.27
March	1.38	1.56
April	2.19	2.39
May	3.05	3.35
June	1.92	2.54
July	2.57	3.15
August	3.01	3.55
September	1.67	2.18
October	3.30	3.58
November	2.52	2.61
December	1.93	2.02
Total	**24.40**	**28.02**

Rainfall station = La Belle.

Historical and projected acreage of sugarcane in the Hendry County Area was taken as 61 percent of the whole county's acreage presented in Table G-42. This ratio was assessed using GIS analysis and is described later in the text. It remains constant over the projection period. Sugarcane is assumed to use seepage irrigation, with an irrigation efficiency of 50 percent. Irrigation requirements were calculated using Equation (G-8).

Average and 2-in-10 irrigation requirements were calculated for the primary projection, and are shown in Table G-42.

TABLE G-42. Irrigation Requirements in Millions of Gallons for the Primary Sugarcane Acreage Projection in the Hendry County Area.

Average	1985	1990	1995	2000	2005	2010
January	1,349	1,824	1,980	2,028	2,028	2,018
February	262	355	385	394	394	394
March	2,586	3,496	3,795	3,886	3,886	3,886
April	4,105	5,548	6,023	6,167	6,167	6,167
May	5,716	7,727	8,388	8,589	8,589	8,589
June	3,598	4,864	5,281	5,407	5,407	5,407
July	4,817	6,511	7,068	7,237	7,237	7,237
August	5,641	7,625	8,278	8,476	8,476	8,476
September	3,130	4,231	4,593	4,703	4,703	4,703
October	6,185	8,360	9,076	9,293	9,293	9,293
November	4,723	6,384	6,931	7,097	7,097	7,097
December	3,617	4,889	5,308	5,435	5,435	5,435
TOTAL	45,731	61,814	67,107	68,712	68,712	68,712

2-in-10	1985	1990	1995	2000	2005	2010
January	1,537	2,077	2,255	2,309	2,309	2,309
February	506	684	743	760	760	760
March	2,924	3,952	4,290	4,393	4,393	4,393
April	4,479	6,055	6,573	6,730	6,730	6,730
May	6,279	8,487	9,213	9,434	9,434	9,434
June	4,761	6,435	6,986	7,153	7,153	7,153
July	5,904	7,980	8,663	8,871	8,871	8,871
August	6,653	8,993	9,763	9,997	9,997	9,997
September	4,086	5,523	5,996	6,139	6,139	6,139
October	6,710	9,069	9,846	10,082	10,082	10,082
November	4,892	6,612	7,178	7,350	7,350	7,350
December	3,786	5,117	5,556	5,688	5,688	5,688
TOTAL	52,516	70,985	77,063	78,906	78,906	78,906

Irrigated Acreage	1985	1990	1995	2000	2005	2010
County	56,571	76,467	83,014	85,000	85,000	85,000
County Area	34,508	34,508	50,639	51,850	51,850	51,850
% in LWC	61%	61%	63%	61%	61%	61%

Glades County Area

Sugarcane Acreage. The projections obtained using functional forms (G-45) and (G-46) are shown in equations and columns (G-51) and (G-52). Column (G-51) in Table G-43 shows sugarcane acreage projections for Glades County estimated as a linear function of time with the inclusion of a 0-1 dichotomous variable. This dichotomous variable took the value of 0 prior to 1985 and a value of 1 in 1985 and after. For projection purposes, the dichotomous variable was set equal to 1. The functional form (G-45) estimated by ordinary least squares is shown as Equation (G-50).

$$A_{sgt} = 15215.53 + 971.423 * t - 9520.366 * D \quad \textbf{(G-50)}$$
$$(8.54) \qquad (-8.79)$$

where:
A_{sgt} = *estimated sugarcane acreage in Glades County in year t.*
t = *a trend variable taking on a value of 1 in 1975 and increasing by one unit per year.*
D = *a dichotomous variable taking on a value of 0 prior to 1985 and a value of 1 after 1985.*

Goodness of fit statistics
$R^2 = .8628$
$F = 40.87$
$Pr\, F > 0 > .999$
t - statistics are in parentheses

For projection purposes, D was set equal to 1, so the reduced form equation used for projection purposes is given by Equation (G-51).

$$A_{sgt} = 5695.16 + 971.423 * t \quad \textbf{(G-51)}$$

The estimated equation of functional form (G-46) is given by Equation (G-52), from which column (G-52) was derived. In Equation (G-52) sugarcane acreage was estimated as a function of the real price of sugarcane, a trend variable, and an interaction term between the trend variable and the dichotomous variable.

$$A_{sgt} = 16530.28 - 147.801 * P_{re} + 1020.495 * t - 747.184 * t * D \quad \textbf{(G-52)}$$
$$(0.77) \qquad (7.01) \qquad (-7.47)$$

where:
P_{re} = *the average annual price of sugar received by farmers, deflated by the consumer price index.*
All other variables are as previously defined.

Goodness of fit statistics
$R^2 = .8319$
$F = 19.80$
$Pr\, F > 0 > .999$
t - statistics are in parentheses

For the projections, the value of D was set equal to 1, and P_{re} was held at its 1989 level. Projections resulting from equations (G-51) and (G-52) were averaged and adjusted to reflect the difference between the average and the actual acreage for 1990. This amounted to subtracting 826 acres from the average for years after 1990, to yield the primary projection for sugarcane acreage in Glades County. The primary projection ($\pm$15%) is shown in Table G-43.

Sugarcane Irrigation Requirements. All of the sugarcane grown in Glades County is in the LWC Planning Area. Sugarcane is grown on both muck and sand in the Glades County Area. Presently, there are about 13,000 acres of sugarcane produced annually on muck. This area of sugarcane production on muck is expected to remain constant over the projection period, and all change in sugarcane acreage is expected to take place on sand. The average and 2-in-10 supplemental water requirements for sugarcane on the two soil types at the rainfall station in Moore Haven is shown in Table G-44.

Historical and projected acreage of sugarcane in Glades County was taken from Table G-43. Sugarcane is assumed to use seepage irrigation, with an irrigation efficiency of 50 percent. Irrigation requirements were calculated using Equation (G-8). Average and 2-in-10 irrigation requirements were calculated for the primary projection, and are shown in Table G-45.

TABLE G-43. Historical and Projected Sugar Cane Acreage in Glades County.

Year	Historical	Column (G-51)	Column (G-52)	Average	Primary Projection	Primary -15 %	Primary +15 %
1975	16,636						
1976	18,545						
1977	16,842						
1978	18,294						
1979	19,494						
1980	20,096						
1981	22,908						
1982	23,904						
1983	22,924						
1984	26,015						
1985	15,559						
1986	17,165						
1987	20,020						
1988	20,321						
1989	20,119						
1990	19,633	21,237	19,680	20,459	19,633		
Projections							
1991		22,208	19,953	21,081	20,255	17,217	23,293
1992		23,178	20,226	21,702	20,877	17,745	24,008
1993		24,149	20,498	22,324	21,498	18,273	24,723
1994		25,120	20,771	22,946	22,120	18,802	25,438
1995		26,091	21,044	23,568	22,742	19,331	26,153
1996		27,062	21,316	24,189	23,364	19,859	26,868
1997		28,033	21,589	24,811	23,986	20,388	27,583
1998		29,004	21,862	25,433	24,608	20,916	28,299
1999		29,975	22,134	26,055	25,229	21,445	20,013
2000		30,946	22,407	26,677	25,851	21,973	29,729
2001		31,917	22,680	27,299	26,473	22,502	30,444
2002		32,888	22,952	27,920	27,095	23,030	31,159
2003		33,858	23,225	28,542	27,716	23,559	31,873
2004		34,829	23,498	29,164	28,338	24,087	32,589
2005		35,800	23,770	29,785	28,960	24,616	33,303
2006		36,771	24,043	30,407	29,582	25,144	34,019
2007		37,742	24,316	31,029	30,204	25,673	34,734
2008		38,713	24,588	31,651	30,825	26,201	35,449
2009		39,684	24,861	32,273	31,447	26,730	36,164
2010		40,655	25,134	32,895	32,069	27,259	36,879

Source: Historical acreage from Field Crops Summary 1975-1990, Florida Agricultural Statistics Service.

TABLE G-44. Supplemental Water Requirements for Sugarcane in Glades County.

Soil Type	Sand 0.8 (in.) Average (in.)	Sand 0.8 (in.) 2-in-10 (in.)	Muck 3.6 (in.) Average (in.)	Muck 3.6(in.) 2-in-10 (in.)
January	0.73	0.84	0.45	0.60
February	0.26	0.39	0.00	0.10
March	1.47	1.64	1.02	1.26
April	2.16	2.37	1.60	1.90
May	2.73	3.08	1.80	2.29
June	2.25	2.86	0.67	1.50
July	2.77	3.35	1.24	2.05
August	3.28	3.82	1.85	2.60
September	1.69	2.23	0.27	1.02
October	3.20	3.52	2.33	2.79
November	2.49	2.60	2.20	2.35
December	2.01	2.10	1.77	1.90
TOTAL	25.04	28.79	15.20	20.36

Rainfall station = Moore Haven.

TABLE G-45. Irrigation Requirements in Millions of Gallons for the Primary Sugarcane Acreage Projection in the Glades County Area.

Average	1985	1990	1995	2000	2005	2010
January	421	581	704	827	951	1,074
February	37	94	138	181	225	269
March	928	1,250	1,498	1,746	1,994	2,243
April	1,435	1,908	2,273	2,637	3,002	3,367
May	1,656	2,254	2,715	3,176	3,637	4,098
June	791	1,284	1,664	2,043	2,423	2,803
July	1,267	1,873	2,341	2,809	3,277	3,744
August	1,769	2,488	3,042	3,596	4,149	4,703
September	429	799	1,085	1,370	1,656	1,941
October	2,097	2,798	3,338	3,879	4,419	4,959
November	1,905	2,450	2,871	3,291	3,712	4,132
December	1,533	1,974	2,313	2,653	2,992	3,331
TOTAL	14,267	19,753	23,981	28,209	32,437	36,665

2-in-10	1985	1990	1995	2000	2005	2010
January	542	726	868	1,010	1,152	1,294
February	126	211	277	343	409	475
March	1,121	1,480	1,757	2,034	2,311	2,588
April	1,676	2,195	2,595	2,996	3,396	3,796
May	2,052	2,726	3,247	3,767	4,287	4,807
June	1,463	2,089	2,572	3,055	3,538	4,021
July	1,920	2,654	3,220	3,786	4,351	4,917
August	2,375	3,212	3,857	4,502	5,147	5,792
September	1,035	1,524	1,900	2,277	2,653	3,030
October	2,467	3,238	3,832	4,427	5,021	5,615
November	2,026	2,596	3,035	3,474	3,913	4,352
December	1,638	2,098	2,453	2,807	3,162	3,516
TOTAL	18,441	24,751	29,614	34,477	39,340	44,203

Tropical Fruit

With the exception of citrus, all categories of tropical fruit (avocados, mangoes, etc.) were grouped together for projection purposes. Lee is the only county in the LWC Planning Area with significant tropical fruit acreage.

Lee County

Tropical Fruit Acreage. In 1989 there were 1,630 acres of tropical fruit in Lee County (IFAS, University of Florida, 1989). There was not sufficient historical data to establish a statistically valid trend. However, the local IFAS extension office estimated that presently there typically is an increase in tropical fruit acreage of about 50 acres a year. This leads to estimates of tropical fruit acreage to be 1,430 acres in 1985, 1,680 acres in 1990, 1,930 acres in 1995, 2,180 acres in 2000, 2,430 acres in 2005, and 2,680 acres in 2010.

Tropical Fruit Irrigation Requirements. The District's Blaney-Criddle permitting model has no category for tropical fruit as a grouping, and the crop category of avocado was used to calculate irrigation requirements for all tropical fruit (avocados in 1990 made up over 80 percent of the permitted non-citrus tropical fruit acreage in Lee County).

In Lee County, 90 percent of the 1990 permitted tropical fruit acreage was permitted for seepage irrigation. This 90 percent represents one large permittee which produces the bulk of avocado in Lee County. Although the current acreage is mostly seepage irrigated, it is believed by the local IFAS extension office that future expansion will use micro irrigation.

All tropical fruit production was assumed to take place on soil with a usable soil water capacity of 0.8 inch. The average and 2-in-10 supplemental water requirements for avocado on 0.8 inch soil at the rainfall station in Fort Myers are shown in Table G-46.

TABLE G-46. Supplemental Water Requirements for Avocado in Lee County.

Month	Average (in.)	2-in-10 (in.)
January	0.19	0.31
February	0.62	0.76
March	1.84	1.99
April	2.98	3.15
May	3.73	4.02
June	2.09	2.72
July	2.40	2.99
August	2.05	2.60
September	0.97	1.49
October	1.53	1.78
November	1.29	1.38
December	0.49	0.59
TOTAL	20.18	23.78

Rainfall station = Fort Myers.
Soil type = 0.8 inch.

The irrigation requirement for 1985 was estimated by subtracting the 1985 acreage from the 1990 total, and assuming that all the tropical fruit irrigated using micro-irrigation in Lee County was planted between 1985 and 1990. Irrigation requirements for years future to 1990 were projected with the assumption that micro-irrigation will be used on all additional acreage. Average and 2-in-10 irrigation requirements for the primary tropical fruit acreage projections for Lee County are presented in Table G-47.

TABLE G-47. Irrigation Requirements in Millions of Gallons for the Primary Tropical Fruit Acreage Projection in Lee County.

Average	1985	1990	1995	2000	2005	2010
January	14	17	18	20	21	23
February	47	54	59	64	69	74
March	140	161	176	190	205	220
April	227	261	285	308	332	356
May	284	326	356	386	416	445
June	159	183	200	216	233	250
July	183	210	229	248	267	287
August	156	179	196	212	228	245
September	74	85	93	100	108	116
October	117	134	146	158	171	183
November	98	113	123	133	144	154
December	37	43	47	51	55	59
TOTAL	1,538	1,765	1,927	2,088	2,249	2,410

2-in-10	1985	1990	1995	2000	2005	2010
January	24	27	30	32	35	37
February	58	66	73	79	85	91
March	152	174	190	206	222	238
April	240	276	301	326	351	376
May	306	352	384	416	448	480
June	207	238	260	281	303	325
July	228	262	285	309	333	357
August	198	227	248	269	290	311
September	114	130	142	154	166	178
October	136	156	170	184	198	213
November	105	121	132	143	154	165
December	45	52	56	61	66	70
TOTAL	1,812	2,080	2,270	2,460	2,650	2,840

Vegetables

Vegetable crops were grouped together for projection purposes. This was validated by the lack of significant difference in the irrigation requirements of different types of vegetables cultivated in the LWC Planning Area, and the production practices used on vegetable farms (different types of vegetables are often grown interchangeably). Much of the vegetable land is double cropped, and as many of the acreage data sources report harvested production, these data had to be adjusted to reflect acres of land in production. This adjustment is described for each county, depending on the prevailing vegetable crops and production practices, to yield a row acreage subtotal, after which the following adjustments were made to yield the total land acreage used for vegetable production:

- Fifteen percent of the subtotal row was added to account for non-harvested acreage. An examination of historical planted versus harvested acreage for vegetable crops within south Florida showed that an average of 15 percent of the acreage cultivated is not harvested. As FASS presently only reports harvested acreage, this 15 percent needed to be added to reflect the non-harvested vegetable row acreage.

- Vegetable acreage data reported in the FASS Vegetable Summaries and by IFAS represent the estimated area of land in the production rows. The District's model for estimating irrigation requirements is based on total land acreage, which includes the land necessary for vegetable production, but not in rows (i.e., spaces between rows, irrigation furrows, etc.). Land in rows represents approximately 60 percent of this total land (personal communication 1991 with D. Pitts, Southwest Florida Research and Education Center, Immokalee, FL.), so the row acreage was divided by 0.6 to yield the total (land) acreage column.

There are a variety of vegetable crops grown in the LWC Planning Area. Vegetable fields are usually planted and harvested sequentially; therefore, some portion of the land acreage used for vegetable production is commonly vacant. This temporal area of vegetable land vacancy effects total irrigation requirement, but it is difficult to quantify. This is because many eventualities occur which change production timing. For instance, freezes may necessitate replanting, which would delay the spring growing season; or growers may enter into a contract to harvest vegetables in a particular time window, which would in turn determine their growing season. Also, as seepage irrigation is the predominant type of irrigation system used for vegetable production, some of these vacant fields are unavoidably irrigated, either in part or in whole. With these constraints in mind, generalized cultivation schedules were developed with the assistance of the local IFAS extension offices.

Vegetables are planted throughout the year, and crop ET values depend on planting dates. Average ET values were developed based on an average of Blaney-Criddle values with planting dates at the beginning of each month.

Collier County

Vegetable Acreage. Table G-48 shows historical vegetable acreage in Collier County. These data were assembled in the following manner:

- Acreage data for cucumbers, peppers, squash, tomatoes, and watermelons were gathered from FASS Vegetable Summaries. A default value for potatoes was estimated by the local IFAS vegetable extension agent.

- With the exception of watermelons and potatoes these acreages were divided by two (to reflect the two growing seasons), and summed to yield the subtotal (row), as shown in Table G-48. FASS reports acreage as acres of production (i.e., 10 acres of land cultivated twice a year is reported as 20 acres).

- To yield the total (row), fifteen percent was added to account for non-harvest acreage, and this number was divided by 0.6 to account for the land between rows.

TABLE G-48. Historical Vegetable Acreage in Collier County.

Year	Cucumbers	Peppers	Squash	Tomatoes	Double cropped /2 (row)	Water-melons	Potatoes*	Subtotal (row)	Total (row)	Total (land)
1989-90	1,300	5,200	700	13,750	10,475	4,700	1,600	16,775	19,291	32,152
1988-89	1,350	5,100	1,000	15,250	11,350	4,600	1,600	17,550	20,183	33,638
1987-88	1,350	4,800	1,100	14,560	10,905	4,000	1,600	16,505	18,981	31,635
1986-87	1,700	3,800	1,500	12,000	9,500	3,400	1,600	14,500	16,675	27,792
1985-86	2,100	3,100	1,700	9,400	8,150	3,500	1,600	13,250	15,237	25,396
1984-85	1,600	2,800	2,000	8,800	7,600	3,500	1,600	12,700	14,605	24,342
1983-84	1,900	3,000	1,900	8,650	7,725	3,100	1,600	12,425	14,289	23,815
1982-83	2,100	3,400	1,800	7,950	7,625	2,700	1,600	11,925	13,714	22,856
1981-82	2,500	3,800	1,550	7,510	7,680	2,500	1,600	11,780	13,547	22,578
1980-81	2,450	4,000	1,700	9,130	8,640	2,400	1,600	12,640	14,536	24,227
1979-80	2,350	4,050	1,550	7,235	7,593	2,150	1,600	11,343	13,044	21,740
1978-79	2,600	4,750	1,500	6,800	7,825	1,850	1,600	11,275	12,966	21,610
1977-78	3,050	6,250	1,550	6,630	8,740	1,350	1,600	11,690	13,443	22,406
1976-77	3,070	5,850	1,900	5,110	7,965	1,400	1,600	10,965	12,610	21,016
1975-76	3,700	5,050	1,050	4,380	7,090	1,200	1,600	9,890	11,374	18,956
1974-75	3,400	3,890	1,000	3,775	6,033	1,450	1,600	9,083	10,445	17,408
1973-74	2,450	3,500	520	3,230	4,850	1,700	1,600	8,150	9,373	15,621
1972-73	2,700	3,650	460	3,520	5,165	1,600	1,600	8,365	9,620	16,033
1971-72	2,850	2,930	460	3,400	4,820	2,590	1,600	9,010	10,362	17,269
1970-71	2,900	2,950	420	2,885	4,578	2,900	1,600	9,078	10,439	17,399
1969-70	2,750	2,430	520	3,240	4,470	2,300	1,600	8,370	9,626	16,043
1968-69	4,070	3,530	340	1,940	4,940	3,000	1,600	9,540	10,971	18,285
1967-68	3,600	2,630	450	2,000	4,340	2,700	1,600	8,640	9,936	16,560
1966-67	3,250	3,180	760	2,060	4,625	2,900	1,600	9,125	10,494	17,490

*Default value from local IFAS extension office.
Source: Historical acreage from Vegetable Summaries 1966-1967, Florida Agricultural Statistics Service.

No statistically valid trend was found which produced tangible projections over the planning horizon. Vegetable researchers at the local IFAS research station in Immokalee believe that vegetable production in Collier County has stabilized, and probably will remain steady in the future (personal communication 1991 with C. Vavrina, Southwest Florida Research and Education Center, Immokalee, FL.). The primary projection for vegetable acreage in Collier County was based on this empirical knowledge, and was projected to remain at its 1990 level of 32,152 acres. The primary range is from 27,329 acres to 36,975 acres.

Vegetable Irrigation Requirements. The generalized cultivation schedule shown in Table G-49 was developed for 1988 with the assistance of the local IFAS extension office.

For the calculation of irrigation requirements, data from the Naples rainfall station on 0.4 inch soil were used. Table G-50 shows the supplemental water requirements, the estimated percentage of vegetable land in production in any given month (from Table G-49) and the irrigation requirements for vegetables in Collier County.

Example

Average irrigation requirements for vegetables in December 1995.

Assumptions:

- Primary projected area used for vegetable production for Collier County in 1995 = 32,152 acres.
- 40% of vegetable land in use in December (Table G-49).
- Irrigation efficiency = 50%.

Calculation:

The average irrigation requirement for vegetables in December is:

(((2.12 in./0.50) * 32,152 ac.) * 0.4) / 12 inches = 4,544 ac.ft.
(4,544 ac.ft. x 325,872 gal/ac.ft.) / 1,000,000 = 1,481 mg.

TABLE G-49. Generalized Cultivation Schedule for Vegetable Crops in Collier County.

Crop	Acres pro-duced	Crops per year	Acres of land	Jan *	% tot land **	Feb *	% tot land **	Mar *	% tot land **	Apr *	% tot land **	May *	% tot land **
Tomatoes	14,560	2	7,280	50	22	100	44	100	44	100	44	50	22
Cucumbers	1,350	2	675	50	2	100	4	100	4	100	4	50	2
Squash	1,100	2	550	50	2	100	3	100	3	100	3	50	2
Peppers	4,800	2	2,400	50	7	100	15	100	15	100	15	50	7
Potatoes	1,600	1	1,600	100	10	100	10	66	6	33	3	0	0
Watermelons	4,000	1	4,000	50	12	100	24	100	24	100	24	50	12
TOTAL	27,410		16,505		55 ***		100 ***		97 ***		94 ***		45 ***

TABLE G-49. (Continued).

Crop	Jun *	% tot land **	Jul *	% tot land **	Aug *	% tot land **	Sep *	% tot land **	Oct *	% tot land **	Nov *	% tot land	Dec *	% tot land **
Tomatoes	0	0	0	0	50	22	100	44	100	44	100	44	50	22
Cucumbers	0	0	0	0	50	2	100	4	100	4	100	4	50	2
Squash	0	0	0	0	50	2	100	3	100	3	100	3	50	2
Peppers	0	0	0	0	50	7	100	15	100	15	100	15	50	7
Potatoes	0	0	0	0	0	0	0	0	100	10	100	10	100	10
Watermelons	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0 ***		0 ***		33 ***		66 ***		76 ***		76 ***		43.

* Percentage of land dedicated to relevant crop which is actually in the ground in that total particular month.

** Land dedicated to relevant crop to vegetable production (percentage).

*** Weighted average percent of vegetable land acreage which is actually in production during the relevant month.

TABLE G-50. Supplemental Water Requirements and Irrigation Requirements for Vegetable Crops in Collier County.

Month	Supplemental Water Requirements		Approx % in ground	1985 Irrigation Requirements Acreage=24,342		1990 to 2010 Irrigation Requirements Acreage=32,152	
	Avg.2-in-10 (in.)	Avg.2-in-10 (in.)		Avg. 2-in-10 (mg)	Avg.2-in-10 (mg)	Avg. 2-in-10 (mg)	Avg.2- in-10 (mg)
January	1.89	1.97	60	1,499	1,565	1,980	2,067
February	1.75	1.87	100	2,310	2,466	3,052	3,257
March	2.50	2.62	100	3,299	3,467	4,357	4,580
April	3.03	3.17	90	3,608	3,772	4,766	4,982
May	3.12	3.37	50	2,062	2,224	2,724	2,938
June	1.86	2.34	0	0	0	0	0
July	2.19	2.68	0	0	0	0	0
August	2.11	2.59	30	838	1,028	1,107	1,358
September	1.20	1.72	70	1,106	1,587	1,461	2,096
October	2.27	2.53	80	2,401	2,673	3,171	3,531
November	2.54	2.63	80	2,689	2,782	3,552	3,674
December	2.12	2.20	40	1,121	1,162	1,481	1,535
TOTAL	26.57	29.68		20,934	22,726	27,650	30,017

Rainfall Station = Naples.
Soil type = 0.4 in./ft.

Lee County

Vegetable Acreage. Table G-51 shows the historical vegetable acreage in Lee County by type. These data were assembled in the following manner:

- Historical acreage data for cucumbers, peppers, tomatoes, and watermelons were gathered from FASS Vegetable Summaries (FASS, Florida Dept. of Agriculture and Consumer Services, 1973-1974 to 1989-1990).

- Historical squash and potato acreage was assessed as a constant percentage of production in the "South" region of Florida (as reported by FASS), based on production data provided by the local IFAS extension office for the 1988-1989 growing season (University of Florida, 1989).

- A default value of 1,000 acres of latin vegetables was based on production reported by the local IFAS extension office for the 1988-89 growing season (University of Florida, 1989).

- A default value of 500 acres was entered for watermelon for the 6 year period period between 1977 and 1982. During this period FASS incorporated Lee County's watermelon acreage with several other counties and reported a total for the "South" region.

- With the exception of watermelon, potato, and latin vegetables, these acreages were divided by two (to reflect the two growing seasons), and summed to yield

the subtotal. FASS and IFAS report acreage as acres of production, i.e., 10 acres of row cultivated twice a year is reported as 20 acres.

- To yield the total land, fifteen percent was added to account for non-harvested acreage, and this number was divided by 0.6 to account for the land between rows.

TABLE G-51. Historical Vegetable Acreage in Lee County.

Year	Cucum-bers (D)	Peppers (D)	Squash* (D)	Tomatoes (D)	Double crop-ped/2 (row)	Potatoes** (S)	Latin Veg.*** (S)	Water-melon**** (S)	Sub-Total (row)	Total (row)	Total (land)
1989-90	1,650	1,600	900	1,350	2,750	455	1,000	900	5,105	5,871	9,785
1988-89	1,450	1,800	900	1,540	2,845	359	1,000	1,100	5,304	6,100	10,166
1987-88	1,650	1,700	977	1,480	2,903	287	1,000	800	4,991	5,739	9,565
1986-87	1,800	1,500	1,093	1,700	3,047	287	1,000	700	5,034	5,789	9,648
1985-86	2,000	1,350	1,279	1,670	3,150	287	1,000	800	5,237	6,022	10,037
1984-85	2,000	1,600	1,581	1,030	3,106	305	1,000	1,000	5,411	6,222	10,371
1983-84	1,600	1,650	1,488	650	2,694	269	1,000	600	4,563	5,248	8,747
1982-83	1,450	1,750	1,442	920	2,781	188	1,000	500	4,469	5,140	8,566
1981-82	1,450	1,900	1,395	1,210	2,978	278	1,000	500	4,756	5,469	9,115
1980-81	1,400	1,800	1,209	1,040	2,725	260	1,000	500	4,485	5,158	8,596
1979-80	1,350	1,950	1,163	1,790	3,126	215	1,000	500	4,842	5,568	9,280
1978-79	1,500	2,280	1,130	1,595	3,253	233	1,000	500	4,986	5,734	9,556
1977-78	1,500	2,230	1,079	1,145	2,977	215	1,000	500	4,692	5,396	8,994
1976-77	1,380	1,950	1,209	650	2,595	215	1,000	500	4,310	4,957	8,261
1975-76	1,550	1,850	953	485	2,419	215	1,000	450	4,085	4,697	7,829
1974-75	1,500	1,830	907	640	2,438	251	1,000	450	4,140	4,761	7,935
1973-74	1,580	1,650	674	600	2,252	278	1,000	600	4,130	4,750	7,917

(D) = Double cropped.
(S) = Single cropped.
* 1989 ratio (as reported by IFAS) applied to the FASS vegetable acreage total for the Southwest region for years before 1989 (47%).
** 1989 ratio (as reported by FASS) applied to the FASS vegetable acreage total for the Southwest region for all other years (350/2000).
*** Default value from IFAS.
**** Default value of 500 acres of watermelon for years 1977 through 1982.

Since acreage estimates for all vegetable crops were aggregated for projection purposes, there is no single price measure which accurately reflects the economic returns to vegetable production. Consequently time-trends and a dichotomous variable, designed to capture shifts in vegetable acreage were included in the projection model. The general formulation of the model is expressed in Equation (G-53).

$$A_t = f(t, D) \qquad \textbf{(G-53)}$$

where:
A_t = *acreage used for vegetable production in Lee County in year t.*
t = *a time-trend variable equal to 1 in 1974 and increasing by one unit each subsequent year.*

D = a 0-1 dichotomous variable equal to 0 before 1985 and equal to 1 in 1985 and after.

When Equation (G-53) was estimated using robust regression analysis, the results shown in Equation (G-54) were obtained.

$$A_t = \underset{(2.92)}{7958.171} + \underset{(2.15)}{85.220 * t} + 666.656 * D \qquad \text{(G-54)}$$

Goodness of fit statistics
$R^2 = .8387$
$F = 36.39$
$Pr F > 0 > .999$
$D - W = 1.149$
t - statistics in parentheses

The value of the Durbin-Watson (D-W) statistic is in the indeterminate region, which indicates a potential problem of serially correlated error terms. An evaluation of the model residuals shows that there was a tendency for the model to over-predict in the early years of the data set, 1974-1977. Alternative functional forms which reduced the problem of serially correlated error terms were examined; however, these alternative functional forms created new problems, so the decision was made to use Equation (G-54) as the primary projection model.

When Equation (G-54) was used to project Lee County vegetable acreage, and adjusted to reflect the difference between estimated and actual acreage for 1990, the results shown in Table G-52 were obtained. The primary projection is therefore column (G-55) minus 289 acres..

Vegetable Irrigation Requirements. The generalized cultivation schedule shown in Table G-53 was developed with the assistance of the local IFAS extension office.

For the calculation of irrigation requirements, data from the Fort Myers rainfall station on 0.8 inch soil were used. Table G-54 shows the supplemental water requirements and the estimated percentage of vegetable land in production in any given month (from Table G-53).

Historical and projected acreage of land used for vegetable production were taken from Table G-52. Vegetables are assumed to use seepage irrigation systems with an irrigation efficiency of 50 percent. Average and 2-in-10 irrigation requirements for the primary vegetable acreage projection for Lee County are presented in Table G-55.

TABLE G-52. Historical and Projected Acreage Used for Vegetable Production in Lee County.

Year	Historical	Column (G-54)	Primary projection	Primary -15%	Primary + 15%
1974	7,917				
1975	7,935				
1976	7,829				
1977	8,261				
1978	8,994				
1979	9,556				
1980	9,280				
1981	8,596				
1982	9,115				
1983	8,566				
1984	8,747				
1985	10,371				
1986	10,037				
1987	9,648				
1988	9,565				
1989	10,166				
1990	9,785	10,074			
Projections					
1991		10,159	9,870	8,390	11,351
1992		10,244	9,955	8,462	11,448
1993		10,329	10,040	8,534	11,546
1994		10,414	10,125	8,606	11,644
1995		10,500	10,211	8,679	11,743
1996		10,585	10,296	8,752	11,840
1997		10,670	10,381	8,824	11,938
1998		10,755	10,466	8,896	12,036
1999		10,841	10,552	8,969	12,135
2000		10,926	10,637	9,041	12,233
2001		11,011	10,722	9,114	12,330
2002		11,096	10,807	9,186	12,428
2003		11,181	10,892	9,258	12,526
2004		11,267	10,978	9,331	12,625
2005		11,352	11,063	9,404	12,722
2006		11,437	11,148	9,476	12,820
2007		11,522	11,233	9,548	12,918
2008		11,608	11,319	9,621	13,017
2009		11,693	11,404	9,693	13,115
2010		11,778	11,489	9,766	13,212

TABLE G-53. Generalized Cultivation Schedule for Vegetable Crops in Lee County.

Crop	Acres produced	Crops per year	Acres of land	Jan *	% tot land **	Feb *	% tot land **	Mar *	% tot land **	Apr *	% tot land **	May *	% tot land **
Tomatoes	2,000	2	1,000	50	9	100	17	100	17	100	17	50	9
Latin	1,000	1	1,000	100	17	100	17	100	17	100	17	100	17
Squash	2,000	2	1,000	50	9	100	17	100	17	100	17	50	9
Cucumbers	1,800	1	900	50	8	100	15	100	15	100	15	50	8
Potatoes	350	1	350	100	6	100	6	66	4	33	2	0	0
Watermelons	1,100	1	1,100	50	9	100	19	100	19	100	19	50	9
Peppers	1,000	2	900	50	4	100	9	100	9	100	9	50	4
TOTAL	9,250		5,850		62 ***	700	100 ***	666	98 ***	633	96 ***	350	56 ***

TABLE G-53. (Continued).

Crop	Jun *	% tot land **	Jul *	% tot land **	Aug *	% tot land **	Sep *	% tot land **	Oct *	% tot land **	Nov *	% tot land	Dec *	% tot land **
Tomatoes	0	0	0	0	50	9	100	17	100	17	100	17	50	9
Latin	100	17	100	17	100	17	100	17	100	17	100	17	100	17
Squash	0	0	0	0	50	9	100	17	100	17	100	17	50	9
Cucumbers	0	0	0	0	50	8	100	15	100	15	100	15	50	8
Potatoes	0	0	0	0	0	0	0	0	100	6	100	6	100	6
Watermelons	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peppers	0	0	0	0	50	4	100	9	100	9	100	9	50	4
TOTAL	100	17 ***	100	17 ***	300	46 ***	500	75 ***	600	81 ***	600	81 ***	400	52 ***

* Percentage of land dedicated to relevant crop which is actually in the ground in that total particular month.

** Land dedicated to relevant crop to vegetable production (percentage).

*** Weighted average percent of vegetable land acreage which is actually in production during the relevant month.

TABLE G-54. Supplemental Water Requirements for Vegetable Crops in Lee County.

Month	Average (in.)	2-in-10 (in.)	% in Ground
January	1.59	1.72	60
February	1.46	1.60	100
March	2.19	2.34	100
April	2.72	2.89	100
May	2.89	3.17	60
June	1.12	1.71	20
July	1.62	2.18	20
August	1.68	2.21	50
September	1.11	1.63	80
October	2.16	2.42	80
November	2.27	2.36	80
December	1.84	1.94	50
TOTAL	22.65	26.17	

Rainfall Station = Ft. Myers.
Soil Type = 0.8 inch.

TABLE G-55. Irrigation Requirements in Millions of Gallons for the Primary Vegetable Acreage Projection in Lee County.

Average	1985	1990	1995	2000	2005	2010
January	520	507	544	566	588	610
February	796	776	833	866	900	934
March	1,194	1,164	1,249	1,300	1,350	1,401
April	1,483	1,446	1,551	1,614	1,677	1,740
May	945	922	989	1,029	1,069	1,109
June	122	119	128	133	138	143
July	177	172	185	192	200	207
August	458	446	479	498	518	537
September	484	472	506	527	547	568
October	942	918	985	1,025	1,065	1,105
November	990	965	1,036	1,078	1,120	1,162
December	502	489	525	546	567	589
TOTAL	8,612	8,396	9,009	9,375	9,740	10,106

2-in-10	1985	1990	2005	2000	2005	2010
January	563	548	589	612	636	660
February	872	850	912	949	986	1,023
March	1,276	1,244	1,334	1,389	1,443	1,497
April	1,575	1,536	1,648	1,715	1,782	1,849
May	1,037	1,011	1,085	1,129	1,173	1,217
June	186	182	195	203	211	219
July	238	232	249	259	269	279
August	602	587	630	656	681	707
September	711	693	744	774	804	854
October	1,055	1,029	1,104	1,149	1,194	1,238
November	1,029	1,003	1,077	1,120	1,164	1,208
December	529	515	553	576	598	620
TOTAL	9,673	9,430	10,120	10,530	10,941	11,351

Hendry County Area

Vegetable Acreage. Table G-56 shows historical acreages used for vegetable production. These data were assembled in the following manner:

- Acreage data for cucumbers, peppers, tomatoes, and watermelons were gathered from FASS Vegetable Summaries (1966-67 and 1989-90). A default value for squash and eggplant was estimated by the local IFAS extension office.
- With the exception of watermelon, these acreages were divided by two (to reflect the two growing seasons), and summed to yield the subtotal. FASS reports acreage as acres of production (i.e., 10 acres of land cultivated twice a year is reported as 20 acres).
- To yield the total, fifteen percent was added to account for non-harvested acreage, and this number was divided by 0.6 to account for the land between rows.

TABLE G-56. Historical Vegetable Acreage in Hendry County.

Year	Cucumbers	Peppers	Tomatoes	Squash & Eggplant	Double crop/2 (row)	Water-melon	Subtotal (row)	Total (row)	Total (land)
1989-90	1,650	2,500	2,550	600	3,650	2,200	5,850	6,727	11,212
1988-89	1,600	3,000	3,270	600	4,235	2,500	6,735	7,745	12,909
1987-88	1,450	1,800	2,360	600	3,105	2,500	5,605	6,446	10,743
1986-87	1,800	1,700	1,700	600	2,900	2,500	5,400	6,210	10,350
1985-86	1,600	1,300	1,580	600	2,540	2,600	5,140	5,911	9,852
1984-85	1,200	1,200	1,370	600	2,185	2,800	4,985	5,733	9,555
1983-84	1,500	1,300	1,085	600	2,243	3,000	5,243	6,029	10,048
1982-83	1,600	1,600	1,530	600	2,665	3,100	5,765	6,630	11,050
1981-82	1,700	1,700	2,080	600	3,040	2,600	5,640	6,486	10,810
1980-81	1,650	1,760	2,530	600	3,270	2,500	5,770	6,635	11,059
1979-80	1,600	1,850	2,775	600	3,413	1,950	5,363	6,167	10,278
1978-79	1,750	2,200	2,580	600	3,565	1,500	5,065	5,825	9,708
1977-78	1,750	2,250	2,095	600	3,348	1,550	4,898	5,632	9,387
1976-77	1,850	2,200	1,030	600	2,840	1,900	4,740	5,451	9,085
1975-76	1,700	2,100	2,305	600	3,353	1,650	5,003	5,753	9,588
1974-75	1,500	1,670	2,255	600	3,013	2,050	5,063	5,822	9,703
1973-74	900	1,500	2,720	600	2,860	2,200	5,060	5,819	9,698
1972-73	900	1,580	4,110	600	3,595	2,450	6,045	6,952	11,586
1971-72	1,060	1,780	3,710	600	3,575	3,880	7,455	8,573	14,289
1970-71	1,240	1,930	4,420	600	4,095	3,600	7,695	8,849	14,749
1969-70	1,200	1,920	4,975	600	4,348	3,100	7,448	8,565	14,274
1968-69	1,290	1,200	4,720	600	3,905	3,500	7,405	8,516	14,193
1967-68	1,225	950	5,680	600	4,228	4,200	8,428	9,692	16,153
1966-67	950	800	5,810	600	4,080	3,800	7,880	9,062	15,103

Since acreage estimates for all vegetable crops were aggregated for projection purposes, there is no single price measure which accurately reflects the economic returns to vegetable production. Consequently time-trends and a dichotomous variable, designed to capture shifts in vegetable acreage were included in the projection model. The general formulation of the model is expressed in Equation (G-55).

$$LogA_t = f(t, D, logtime) \qquad \textbf{(G-55)}$$

where:
$LogA_t$ = *the common logarithm of vegetable acreage in Hendry County in year t.*
t = *a trend variable equal to 1 in 1966-67 and increasing by 1 each year.*
D = *a dichotomous variable equal to 0 prior to 1973-74 and 1 in 1973-74 and thereafter.*
logtime = the common logarithm of t.

Equation (G-56) represents the model estimated using ordinary least squares for total vegetable acreage.

$$LogA_t = 4.199 + .0090 * t - .1540 * logtime - .1515 * D \qquad \textbf{(G-56)}$$
$$(3.54) \qquad (-2.70) \qquad (-5.60)$$

Goodness of fit statistics
$R^2 = .8443$
$F = 36.15$
$Pr\, F > 0 > .999$
t - statistics in parentheses
$D\text{-}W = 1.683$

Projections derived from Equation (G-56) are shown in column (G-56) in Table G-57. These projections were adjusted by the amount by which vegetable acreage was over projected in 1990, and amounted to subtracting 84 acres from column (G-56) to yield the primary projection.

Vegetable Irrigation Requirements. The generalized cultivation schedule shown in Table G-58 was developed with the assistance of the local IFAS extension office.

Table G-59 represents the supplemental water requirements and the estimated percent of vegetable land in production in any given month (from Table G-58). Soil with a usable water capacity of 0.8 inch was chosen as representative of land most used for vegetable production in Hendry County.

The primary acreage projection was used to calculate the irrigation requirements shown in Table G-60.

TABLE G-57. Historical and Projected Acreage Used for Vegetable Production in Hendry County.

Year	Historical	Column (G-56)	Primary Projection	Primary -15%	Primary +15%
1967	15,103				
1968	16,153				
1969	14,193				
1970	14,274				
1971	14,749				
1972	14,289				
1973	11,586				
1974	9,698				
1975	9,703				
1976	9,588				
1977	9,085				
1978	9,387				
1979	9,708				
1980	10,278				
1981	11,059				
1982	10,810				
1983	11,050				
1984	10,048				
1985	9,555				
1986	9,852				
1987	10,350				
1988	10,743				
1989	12,909				
1990	11,212	11,296			
Projections					
1991		11,461	11,377	9,671	13,084
1992		11,632	11,548	9,816	13,281
1993		11,808	11,724	9,966	13,483
1994		11,990	11,906	10,121	13,692
1995		12,176	12,092	10,279	13,906
1996		12,368	12,284	10,442	14,127
1997		12,564	12,480	10,608	14,353
1998		12,766	12,682	10,780	14,585
1999		12,974	12,890	10,957	14,824
2000		13,186	13,102	11,137	15,068
2001		13,404	13,320	11,322	15,319
2002		13,627	13,543	11,512	15,575
2003		13,855	13,771	11,706	15,837
2004		14,089	14,005	11,905	16,106
2005		14,328	14,244	12,108	16,381
2006		14,572	14,488	12,315	16,662
2007		14,823	14,739	12,529	16,950
2008		15,079	14,995	12,746	17,245
2009		15,341	15,257	12,969	17,546
2010		15,608	15,524	13,196	17,853

TABLE G-58. Generalized Cultivation Schedule for Vegetable Crops in Hendry County.

Crop	Acres produced	Crops per year	Acres of land	Jan *	% tot land **	Feb *	% tot land **	Mar *	% tot land **	Apr *	% tot land **	May *	% tot land **
Tomatoes	2,360	2	1,180	50	11	100	21	100	21	100	21	50	11
Cucumbers	1,450	2	725	50	6	100	13	100	13	100	13	50	6
Squash	600	2	300	50	3	100	5	100	5	100	5	50	3
Peppers	1,800	2	900	50	8	100	16	100	16	100	16	50	8
Watermelons	2,500	1	2,500	50	22	100	45	100	45	100	45	50	22
TOTAL	8,710		5,605		50 ***		100 ***		100 ***		100 ***		50 ***

TABLE G-58. (Continued).

Crop	Jun *	% tot land **	Jul *	% tot land **	Aug *	% tot land **	Sep *	% tot land **	Oct *	% tot land **	Nov *	% tot land	Dec *	% tot land **
Tomatoes	0	0	0	0	50	11	100	21	100	21	100	21	50	11
Cucumbers	0	0	0	0	50	6	100	13	100	13	100	13	50	6
Squash	0	0	0	0	50	3	100	5	100	5	100	5	50	3
Peppers	0	0	0	0	50	8	100	16	100	16	100	16	50	8
Watermelons	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0 ***		0 ***		28 ***		55 ***		55 ***		55 ***		28.

* Percentage of land dedicated to relevant crop which is actually in the ground in that total particular month.

** Land dedicated to relevant crop to vegetable production (percentage).

*** Weighted average percent of vegetable land acreage which is actually in production during the relevant month.

TABLE G-59. Supplemental Water Requirements for Vegetable Crops in Hendry County.

Month	Average (in.)	2-in-10 (in.)	Approx. % in ground
January	1.67	1.78	50
February	1.39	1.54	100
March	1.95	2.14	100
April	2.43	2.64	100
May	2.75	3.04	50
June	1.09	1.67	0
July	1.67	2.22	0
August	1.80	2.30	30
September	1.23	1.72	60
October	2.09	2.35	60
November	2.24	2.33	60
December	1.80	1.89	30
TOTAL	22.11	25.61	

Rainfall station = La Belle.
Soil type = 0.8 inch.

TABLE G-60. Irrigation Requirements in Millions of Gallons for the Primary Vegetable Acreage Projections in the Hendry County Area.

Average	1985	1990	1995	2000	2005	2010
January	191	224	219	212	203	191
February	317	372	365	353	338	318
March	446	523	513	496	475	447
April	555	652	639	618	592	557
May	314	369	362	350	335	315
June	0	0	0	0	0	0
July	0	0	0	0	0	0
August	123	144	142	137	131	123
September	169	198	194	188	179	169
October	286	336	329	318	305	287
November	307	361	354	342	327	308
December	123	144	142	137	131	123
TOTAL	2,831	3,322	3,260	3,153	3,015	2,838

2-in-10	1985	1990	1995	2000	2005	2010
January	203	238	234	226	216	203
February	351	412	404	391	374	352
March	488	573	562	543	520	489
April	602	707	693	671	641	604
May	347	408	400	387	370	348
June	0	0	0	0	0	0
July	0	0	0	0	0	0
August	157	185	181	175	168	158
September	236	277	272	263	251	237
October	322	377	370	358	343	322
November	320	375	368	356	340	320
December	130	152	149	144	138	130
TOTAL	3,156	3,703	3,633	3,514	3,361	3,163

Irrigated Acreage	1985	1990	1995	2000	2005	2010
County	9,555	11,212	12,176	13,186	14,328	15,608
County Area	4,204	4,933	4,840	4,681	4,478	4,214
% in LWC	44%	44%	39.75%	35.5%	31.25%	27%

Glades County Area

Vegetable Acreage. Glades County vegetable production is included in the "West Central" area as defined by the FASS Vegetable Summaries, and acreage data for Glades County individually is not available from FASS. The only vegetable acreage data available was that supplied by the local IFAS extension agent, and only for 1989. Due to the lack of historical data, future vegetable acreage was projected at its current level (±15 percent). Present vegetable production is very modest in Glades County (approximately 100 acres), and is projected to remain constant by the local extension office.

Vegetable Irrigation Requirement. All vegetable production in Glades County takes places in the LWC Planning Area. Vegetable crops grown in the Glades County Area are usually cultivated twice a year between August and May with the planting and harvesting schedule shown in Table G-61.

TABLE G-61. Average Planting and Harvesting Schedule for Vegetables in the Glades County Area.

Fall			
August	September	November	December
1/2 planted	1/2 planted	1/2 harvested	1/2 harvested
Winter			
January	February	April	May
1/2 planted	1/2 planted	1/2 harvested	1/2 harvested

Source: IFAS Extension Office, Moore Haven, Florida.

Table G-62 represents the supplemental water requirements for vegetable crops using the planting dates outlined in Table G-61. In Glades County, vegetable production takes place on muck soil with an estimated usable water capacity of 3.6 inches.

The primary acreage projection was used to calculate the irrigation requirements shown in Table G-63.

TABLE G-62. Supplemental Water Requirements for Vegetable Crops in Glades County.

Month	January Planting		February Planting		August Planting		September Planting	
	Avg. (in.)	2-in-10 (in.)	Avg. (in.)	2-in-10 (in.)	Avg. (in.)	2-in-10 (in)	Avg. (in.)	2-in-10 (in)
January	0.76	0.91						
February	1.52	1.72	0.54	0.72				
March	2.26	2.51	2.07	2.32				
April	1.37	1.66	2.63	2.94				
May			1.01	1.47				
June								
July								
August					0.00	0.29		
September					0.46	1.22	0.00	0.00
October					1.96	2.41	1.75	2.19
November					1.55	1.70	2.57	2.72
December							1.32	1.44
TOTAL	5.91	6.80	6.25	7.45	3.97	5.62	5.64	6.35

Rainfall Station = Moore Haven.
Soil type = 3.6 inches.

TABLE G-63. Irrigation Requirements for the Primary Vegetable Acreage Projection in the Glades County Area.

Month	Average (MG)	2-in-10 (MG)
January	2	2
February	6	7
March	12	13
April	11	12
May	3	4
June	0	0
July	0	0
August	0	1
September	1	3
October	10	12
November	11	12
December	4	4
TOTAL	60	70

Charlotte County Area

Vegetable Acreage. Charlotte County's historical vegetable acreage is combined with other counties' data when published in the FASS Vegetable Summaries. Because of this consolidation, data from the Vegetable Summaries were not suitable to establish crop acreages or production trends.

An agricultural commodity report developed by the local Soil Conservation Office at the request of the District (Table G-64) reported the land used for vegetable production in the Charlotte County Area for the most recent year of production (1991).

TABLE G-64. Vegetable Production in Charlotte County Area, 1991.

Crop	Acres of Production	Spring Acreage	Fall Acreage
Tomatoes	1,814	1,014	800
Potatoes	150	150	0
Snap Beans	100	100	0
Peppers	1,600	800	800
Watermelon	242	242	0
TOTAL	3,906	2,306	1,600

Source: Steve Pirie, Soil Conservation Service, 4/9/92.

No meaningful trend or explanatory mathematical model could be developed due to the lack of historical vegetable acreage data in the Charlotte County Area. Therefore, irrigated vegetable acreage was projected to remain constant ($\pm$15 percent). The projection of a constant vegetable acreage in the Charlotte County Area is consistent with empirical input from the local Soil Conservation Service office, and the vegetable acreage projections developed for neighboring Hendry and Lee counties, where there were enough data to establish trends.

Vegetable Irrigation Requirements. Table G-65 was applied to the supplemental water requirements for vegetables in the area to calculate irrigation requirements. Supplemental water requirements and irrigation requirements for vegetables in the Charlotte County Area are presented in Table G-66.

TABLE G-65. Generalized Cultivation Schedule for Vegetable Crops in Charlotte County.

Crop	Acres produced	Crops per year	Acres of land	Jan *	% tot land **	Feb *	% tot land **	Mar *	% tot land **	Apr *	% tot land **	May *	% tot land **
Tomatoes	1,814	2	1,014	50	22	100	44	100	44	100	44	50	22
Snap Beans	100	1	100	50	2	100	4	100	4	100	4	50	2
Peppers	1,600	2	800	50	17	100	35	100	35	100	35	50	17
Potatoes	150	1	150	100	7	100	7	66	4	33	2	0	0
Watermelons	242	1	242	50	5	100	10	100	10	100	10	50	5
Total	3,906		2,306		53 ***		100 ***		98 ***		47 ***		0 ***

TABLE G-65. (Continued).

Crop	Jun *	% tot land **	Jul *	% tot land **	Aug *	% tot land **	Sep *	% tot land **	Oct *	% tot land **	Nov *	% tot land	Dec *	% tot land **
Tomatoes	0	0	0	800	50	17	100	35	100	35	100	35	50	17
Snap Beans	0	0	0	0	50	0	100	0	100	0	100	0	50	0
Peppers	0	0	0	800	50	17	100	35	100	35	100	35	50	17
Potatoes	0	0	0	0	0	0	0	0	100	0	100	0	100	0
Watermelons	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		0 ***		1,600 ***		35 ***		69 ***		69 ***		69 ***		35

* Percentage of land dedicated to relevant crop which is actually in the ground in that total particular month.

** Land dedicated to relevant crop/ total land dedicated to vegetable crop production (percentage).

*** Weighted average percent of vegetable land acreage which is actually in production during the relevant month.

TABLE G-66. Supplemental Water Requirements and Irrigation Requirements for Vegetable Crops in the Charlotte County Area.

Month	Supplemental Water Requirements		Approx % in ground	Irrigation Requirements	
	Average (in.)	2-in-10 (in)		Average (MG)	2-in-10 (MG)
January	1.67	1.78	50	105	111
February	1.39	1.54	100	174	193
March	1.95	2.14	100	245	268
April	2.43	2.64	100	305	330
May	2.75	3.04	50	172	191
June	1.09	1.67	0	0	0
July	1.67	2.22	0	0	0
August	1.80	2.30	40	90	115
September	1.23	1.72	70	108	151
October	2.09	2.35	70	183	206
November	2.24	2.33	70	197	204
December	1.80	1.89	40	90	95
TOTAL	22.11	25.61		1,668	1,864

Rainfall station = La Belle.
Soil type = 0.8 inch.

Field Crops

Field crop production in the LWC Planning Area is limited to the Charlotte County Area. This acreage varies from year to year based on the demand for seed corn, which in turn is primarily dependent on production in other parts of the country. This variation in production of more of a fluctuation than a trend.

An agricultural commodity report developed by the local Soil Conservation Service office at the request of the District (Table G-67) reported the land used for filed crop production in the Charlotte County Area for the most recent years of production (1991).

TABLE G-67. Field Crop Production in the Charlotte County Area, 1991.

Crop	Acres of Production	Spring Acreage	Fall Acreage
Seed Corn	2,123	1,423	700
Soybeans	1,000	1,000	0
TOTAL	3,123	2,423	700

Source: Steve Pirie, Soil Conservation Service, April 9, 1992.

While fluctuations are anticipated, the magnitude of the acreages presented are typical for the Charlotte County Area. Irrigation requirements were calculated based on these acreages with the cultivation schedule Table G-68, data from the La Belle rainfall station, and seepage systems with an estimated irrigation efficiency of 50 percent. Irrigation requirements are presented in Table G-68.

TABLE G-68. Irrigation Requirements for Field Crops in the Charlotte County Area.

Month	Seed Corn			Soybean			Total	
	Avg. (in.)	2-in-10 (in.)	Approx. Acreage in Ground	Avg. (in.)	2-in-10 (in.)	Approx. Acreage in Ground	Avg. (MG)	2-in-10 (MG)
January	3.10	3.22	700	0.00	0.00	0	118	122
February	2.49	2.65	1,062	0.00	0.13	500	144	156
March	1.22	1.40	1,423	0.63	0.80	1,000	129	152
April	2.37	2.58	1,423	1.88	2.08	1,000	285	312
May	4.43	4.75	1,423	3.87	4.18	1,000	553	594
June	3.56	4.26	1,423	3.21	3.89	1,000	449	541
July	4.26	4.92	712	2.92	3.51	500	244	285
August	3.82	4.39	0	0.00	0.00	0	0	0
September	0.31	0.77	350	0.00	0.00	0	6	15
October	2.03	2.29	700	0.00	0.00	0	77	87
Novemeber	3.34	3.44	700	0.00	0.00	0	127	131
Decemeber	3.29	3.39	700	0.00	0.00	0	125	129
TOTAL	34.22	38.06		12.51	14.59		2,256	2,524

Rainfall station = La Belle.
Soil type = 0.8 inch.

Sod

There is some variation in the production practices of sod in the LWC Planning Area. Some harvested sod is irrigated, and some is not, serving largely as pasture until the sod is sold. Since the objective here is to project irrigation requirement, only irrigated sod is addressed.

Lee County

Sod Acreage. There were 650 acres of irrigated sod in Lee County in 1989 (IFAS, University of Florida, 1989). No meaningful trend or explanatory mathematical model could be developed due to the lack of historical sod acreage data in Lee County. Similarly, no convincing empirical knowledge of future changes in sod acreage was available from the local IFAS extension office. Therefore, irrigated sod acreage was projected to remain relatively constant through the year 2010 ($\pm$15 percent) at 650 acres, and the primary range is from 553 to 748 acres.

Sod Irrigation Requirement. The irrigation requirements in Table G-69 were calculated by applying the current irrigated acreage to the District's modified

Blaney-Criddle permitting model. Input variables used were 650 acres of grass, sandy soil with 0.8 inch usable soil water capacity, seepage systems with an irrigation efficiency of 50 percent, with Fort Myers as the rainfall station.

TABLE G-69. Supplemental Water Requirements and Projected Irrigation Requirements for Sod in Lee County.

Month	Supplemental Water Requirements		Irrigation Requirements	
	Average (in.)	2-in-10 (in.)	Average (MG)	2-in-10 (MG)
January	1.00	1.12	35	40
February	1.16	1.30	41	46
March	2.55	2.70	90	95
April	3.81	4.00	135	141
May	4.51	4.82	159	170
June	2.75	3.41	97	120
July	3.37	4.01	119	42
August	3.35	3.94	118	139
September	2.36	2.93	83	103
October	2.91	3.18	103	112
November	2.33	2.43	82	86
December	1.44	1.54	51	54
TOTAL	31.54	35.38	1,113	1,249

Rainfall Station = Ft. Myers.
Soil Type = 0.8 inch.

Hendry County Area

Sod Acreage. Currently, there are two companies producing irrigated sod in Hendry County. According to District water use permits, these two companies use a total of 2,945 acres. No meaningful trend or explanatory mathematical model could be developed due to the lack of historical sod acreage data in Hendry County. Therefore, irrigated sod acreage was projected to remain constant through the year 2010 (±15 percent). The primary projection for the six time horizons is 2,945 acres, and the primary range is from 2,503 to 3,387 acres.

Sod Irrigation Requirement. All commercial sod production in Hendry County is in the LWC Planning Area. Input variables used to calculate the irrigation requirements of sod in the Hendry County Area were 2,945 acres of grass, sandy soil with 0.8 inch usable soil water capacity, seepage irrigation systems with an irrigation efficiency of 50 percent, with La Belle as the rainfall station. These irrigation requirements are shown in Table G-70.

TABLE G-70. Supplemental Water Requirements and Projected Irrigation Requirements for Sod in the Hendry County Area.

Month	Supplemental Water Requirements		Irrigation Requirements	
	Average (in.)	2-in-10 (in.)	Average (MG)	2-in-10 (MG)
January	1.08	1.18	173	189
February	1.09	1.24	174	198
March	2.30	2.49	368	398
April	3.50	3.72	560	595
May	4.35	4.67	696	747
June	2.70	3.35	432	536
July	3.42	4.03	547	645
August	3.46	4.02	553	643
September	2.48	3.02	397	483
October	2.82	3.09	451	494
November	2.31	2.40	369	384
December	1.42	1.51	227	242
TOTAL	30.93	34.72	4,947	5,553

Rainfall Station = La Belle.
Soil Type = 0.8 inch.

Glades County Area

Sod Acreage. There is only one company presently producing irrigated sod in Glades County, using 673 acres. No meaningful trend or explanatory mathematical model could be developed due to the lack of historical sod acreage data in Glades County. Therefore, irrigated sod acreage was projected to remain constant through the year 2010 (±15 percent). The primary projection for the six time horizons is 673 acres, and the primary range is from 572 to 774 acres.

Sod Irrigation Requirements. All commercial sod production in Glades County is in the LWC Planning Area. The irrigation requirements in Table G-71 were calculated by applying the current irrigated acreage to the Blaney-Criddle permitting model. Input variables used were 673 acres of grass, sandy soil with 0.8 inch usable soil water capacity, seepage irrigation systems with an irrigation efficiency of 50 percent, with Moore Haven as the rainfall station.

TABLE G-71. Supplemental Water Requirements and Projected Irrigation Requirements for Sod in the Glades County Area.

Month	Supplemental Water Requirements		Irrigation Requirements	
	Average (in.)	2-in-10 (in.)	Average (MG)	2-in-10 (MG)
January	1.09	1.20	40	44
February	1.21	1.34	44	49
March	2.39	2.57	87	94
April	3.45	3.67	126	134
May	3.98	4.35	145	159
June	3.05	3.68	111	135
July	3.62	4.24	132	155
August	3.73	4.29	136	157
September	2.50	3.06	91	112
October	2.71	3.03	99	111
November	2.27	2.38	83	87
December	1.50	1.59	55	58
TOTAL	31.5	35.4	1,149	1,295

Rainfall Station = Moore Haven.
Soil type = 0.8 inch.

Ornamental Nursery

The majority of ornamental nurseries in the LWC Planning Area use overhead sprinkler systems for irrigation. Normally overhead sprinkler irrigation systems are estimated by the District to have an irrigation efficiency of 75 percent. However, an indeterminable number of nurseries containerize their plants, and this reduces the system efficiency to approximately 20 percent. To account for this range of efficiencies, an average efficiency of 50 percent was assumed. Micro irrigation systems will be required on all new container nursery projects, raising the estimated efficiency of these projects to 85 percent, and the future overall average efficiency to 80 percent. This often means that, even with increased acreage, the overall ornamental nursery irrigation demands are reduced (SFWMD, 1985, rev. 1993). Currently the District's Blaney-Criddle permitting model has no category for ornamental nursery, and the value for grass is used for permitting purposes.

Collier County

Ornamental Nursery Acreage. Collier County ornamental nursery acreage is expanding. However, due to the inconsistent nature of historical acreage data, no meaningful trend or explanatory mathematical model could be developed. The local IFAS extension office estimates that a reasonable projected growth rate for the next five years is 30 acres per year.

If this rate is applied throughout the projection period, it leads to estimates of 1,532 acres in 1995, 1,682 acres in 2000, 1,832 acres in 2005, and 1,982 acres in 2010. Historical ornamental nursery acreage is shown in Table G-72.

TABLE G-72. Historical Ornamental Nursery Acreage in Collier County.

Year	Historical	Year	Historical
1972	416	1982	328
1973	600	1983	328
1974	336	1984	260
1975	1,035	1985	227
1976	360	1986	226
1977	496	1987	528
1978	unavailable	1988	578
1979	329	1989	946
1980	286	1990	1,382
1981	291		

Source: Bureau of Plant Inspection, Annual Reports 1972-1990, Division of Plant Industry, Florida Dept. of Agr. and Consumer Services.

Ornamental Nursery Irrigation Requirements. Supplemental water requirements for grass at the Naples rainfall station on 0.4 inch soil are shown in Table G-73. These water requirements were applied to the ornamental nursery acreage projections to calculate the irrigation requirements shown in Table G-74.

TABLE G-73. Supplemental Water Requirements for Grass in Collier County.

Month	Average (in.)	2-in-10 (in.)
January	1.23	1.33
February	1.43	1.55
March	2.87	3.00
April	4.17	4.31
May	4.76	5.03
June	3.58	4.13
July	4.02	4.58
August	3.84	4.38
September	2.47	3.04
October	3.04	3.31
November	2.62	2.70
December	1.71	1.78
TOTAL	35.74	39.14

Rainfall Station = Naples.
Soil type = 0.4 inch.

TABLE G-74. Irrigation Requirements in Millions of Gallons for the Primary Ornamental Nursery Acreage Projections in Collier County.

Average	1985	1990	1995	2000	2005	2010
January	15	92	64	70	76	83
February	18	107	74	82	89	96
March	35	215	149	164	178	193
April	51	313	217	238	259	281
May	59	357	248	272	296	320
June	44	269	186	204	223	241
July	50	302	209	230	250	270
August	47	288	200	219	239	258
September	30	185	128	141	154	166
October	37	228	158	174	189	205
November	32	197	136	150	163	176
December	21	128	89	98	106	115
TOTAL	441	2,683	1,859	2,041	2,223	2,405
2-in-10	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**
January	16	100	69	76	83	89
February	19	116	81	88	96	104
March	37	225	156	171	187	202
April	53	324	224	246	268	290
May	62	378	262	287	313	338
June	51	310	215	236	257	278
July	56	344	238	261	285	308
August	54	329	228	250	272	295
September	37	228	158	174	189	205
October	41	248	172	189	206	223
November	33	203	140	154	168	182
December	22	134	93	102	111	120
TOTAL	483	2,938	2,035	2,235	2,434	2,633

Lee County

Ornamental Nursery Acreage. In order to project Lee County ornamental nursery acreage, a model of the form shown in Equation (G-57) was estimated.

$$LEEORN_t = f(Year, D) \quad \text{(G-57)}$$

where:
$LEEORN_t$ = *Lee County ornamental nursery acreage in year t.*
Year = the numeric value of the year for which ornamental nursery acreage is being projected (e. g., the value of Year for 1988 is 1988).
D = 1 in 1987, 0 otherwise.

The D variable was included to take into account a large one-time increase in acreage from 398 in 1986 to 625 in 1987. It is hypothesized that this one-time increase in ornamental nursery acreage may have been associated with replacement of plants damaged by the freezes in the mid-1980s. When Equation (G-57) was estimated using ordinary least squares, the results obtained in Equation (G-58) were obtained.

$$LEEORN_t = -37534.03 + \underset{(9.18)}{19.133} * Year + \underset{(2.79)}{141.944} * D \quad \text{(G-58)}$$

Goodness of fit statistics
$R^2 = .8621$
$F = 56.12$
$Pr F > 0 > .999$
$D - W = 2.398$
t-statistics in parentheses

Equation (G-58), adjusted for the amount by which it under projected 1990 acreage (66 acres), was used to generate the primary projection for Lee County ornamental nursery acreage. The resulting projections are shown in Table G-75.

Ornamental Nursery Irrigation Requirements. Supplemental water requirements for grass on 0.8 inch soil in Lee County are shown in Table G-69. These water requirements were applied to the ornamental nursery acreage projections (shown in Table G-75) to calculate the irrigation requirements (shown in Table G-76).

TABLE G-75. Historical and Projected Ornamental Nursery Acreage in Lee County.

Year	Historical	Primary Projection	Primary -15 %	Primary +15 %
1972	251			
1973	264			
1974	158			
1975	285			
1976	232			
1977	267			
1978	unavailable			
1979	251			
1980	370			
1981	406			
1982	437			
1983	413			
1984	430			
1985	441			
1986	398			
1987	625			
1988	486			
1989	508			
1990	606	540		
Projections				
1991		625	531	719
1992		644	547	741
1993		663	564	762
1994		683	581	785
1995		702	597	807
1996		721	613	829
1997		740	629	851
1998		759	645	873
1999		778	661	895
2000		797	677	917
2001		816	694	938
2002		836	711	961
2003		855	727	983
2004		874	743	1,005
2005		893	759	1,027
2006		912	75	1,049
2007		931	791	1,071
2008		950	808	1,093
2009		970	825	1,116
2010		989	841	1,137

Source: Historical acreage from Bureau of Plant Inspection Annual Reports, 1972-1990, Division of Plant Industry, Florida Dept. of Agr. and Consumer Services.

TABLE G-76. Irrigation Requirements in Millions of Gallons for the Primary Ornamental Nursery Acreage Projections in Lee County.

Average	1985	1990	1995	2000	2005	2010
January	24	33	24	27	30	34
February	28	38	28	31	35	39
March	61	84	61	69	77	86
April	91	125	91	103	115	128
May	108	148	107	122	137	151
June	66	91	66	74	83	92
July	81	111	80	91	102	113
August	80	110	80	91	102	112
September	57	78	56	64	72	79
October	70	96	69	79	88	98
November	56	77	56	63	71	78
December	34	47	34	39	44	48
TOTAL	755	1,038	752	853	956	1,059

2-in-10	1985	1990	1995	2000	2005	2010
January	27	37	27	30	34	38
February	31	43	31	35	39	44
March	65	89	64	73	82	91
April	96	132	95	108	121	134
May	115	159	115	130	146	162
June	82	112	81	92	103	114
July	96	132	96	108	122	135
August	94	130	94	107	119	132
September	70	96	70	79	89	98
October	76	105	76	86	96	107
November	58	80	58	66	74	82
December	37	51	37	42	47	52
TOTAL	847	1,164	843	957	1,072	1,188

Hendry County Area

Ornamental Nursery Acreage. An equation of the form (G-59) was used to project ornamental nursery acreage for Hendry County.

$$HENORN_i = f(t, D_t) \quad \textbf{(G-59)}$$

where:
$HENORN_i$ = *ornamental nursery acreage in Hendry County in year i.*
t = *a trend variable which takes on a value of 5 in 1976 and increased by one unit per year throughout the estimation period (1976-1990).*
D_t = *a dichotomous variable which takes on a value of 0 prior to 1990 and a value of 1 in 1990. For projection purposes the value of D_t is held at 1 throughout the period to be projected.*

When model (G-59) was estimated using ordinary least squares, Equation (G-60) resulted:

$$HENORN_i = -20.239 + 23.550 * t + 596.978 * D_t \quad \textbf{(G-60)}$$
$$(4.60) \qquad (7.07)$$

Goodness of fit statistics
$R^2 = .9175$
$F = 61.17$
$Pr\ F > 0 > .999$
t - statistics in parentheses
$D\text{-}W = 2.006$

The negative coefficient on the intercept term may be interpreted as the predicted value of $HENORN_i$ when t and D_t are 0. Since acreage by definition is non-negative, this suggests that there may be some non-linearity in the trend. It should be noted that the t-statistic on the intercept is -0.45, which is not statistically significant at the 10 percent level of significance. However, when non-linear models were tested, the projections tended to grow to what were considered to be improbable levels within the projection period. In addition, several linear and non-linear models which omitted the 1990 dichotomous variable tended to severely underestimate 1990 acreage. In interpreting projections made with Equation (G-60), it should be noted that the future course of ornamental nursery acreage in Hendry County depends upon the nature of the change which occurred between 1989 and 1990. As additional data for 1991 and future years become available, the appropriate formulation of the model should become clearer.

Ornamental Nursery Irrigation Requirements. Supplemental water requirements for grass on 0.8 inch soil in Hendry County are shown in Table G-70. These water requirements were applied to the ornamental nursery acreage projections (shown in Table G-77) to calculate the irrigation requirements (shown in Table G-78). All the ornamental nursery acreage in Hendry County is in the LWC Planning Area.

TABLE G-77. Historical and Projected Ornamental Nursery Acreage in Hendry County.

Year	Historical	Primary Projection	Primary -15 %	Primary+15 %
1976	49			
1977	59			
1978	unavailable			
1979	67			
1980	77			
1981	126			
1982	150			
1998	110			
1984	164			
1985	124			
1986	200			
1987	245			
1988	487			
1989	281			
1990	930			
Projections				
1991		954	811	1,097
1992		977	830	1,124
1993		1,001	851	1,151
1994		1,024	870	1,178
1995		1,048	891	1,205
1996		1,071	910	1,232
1997		1,095	931	1,259
1998		1,118	950	1,286
1999		1,142	971	1,313
2000		1,166	991	1,341
2001		1,189	1,011	1,367
2002		1,213	1,031	1,395
2003		1,236	1,051	1,421
2004		1,260	1,071	1,449
2005		1,283	1,091	1,475
2006		1,307	1,111	1,503
2007		1,330	1,131	1,529
2008		1,354	1,151	1,557
2009		1,377	1,170	1,584
2010		1,401	1,191	1,611

Source: Historical acreage from Bureau of Plant Inspection Annual Reports, 1976-1990, Division of Plant Industry, Florida Dept. of Agr. and Consumer Services.

TABLE G-78. Irrigation Requirements in Millions of Gallons for the Primary Ornamental Nursery Acreage Projection in the Hendry County Area.

Average	1985	1990	1995	2000	2005	2010
January	7	55	59	63	67	72
February	7	55	59	64	68	72
March	15	116	125	135	144	153
April	24	177	191	205	219	233
May	29	220	237	255	272	289
June	18	136	147	158	169	180
July	23	173	186	200	214	227
August	23	175	189	202	216	230
September	17	125	135	145	155	165
October	19	142	154	165	176	188
November	16	117	126	135	144	154
December	10	72	77	83	89	94
TOTAL	208	1,562	1,686	1,810	1,933	2,057

2-in-10	1985	1990	1995	2000	2005	2010
January	8	60	64	69	74	78
February	8	63	68	73	77	82
March	17	126	136	146	156	166
April	25	188	203	218	232	247
May	31	236	255	273	292	311
June	23	169	183	196	209	223
July	27	204	220	236	252	268
August	27	203	219	235	251	267
September	20	153	165	177	189	201
October	21	156	168	181	193	205
November	16	121	131	140	150	160
December	10	76	82	88	94	100
TOTAL	234	1,754	1,893	2,032	2,170	2,309

Glades County Area

Ornamental Nursery Acreage. In order to forecast ornamental nursery acreage for Glades County, a model was developed using data for the period 1976-1990. The functional form of this model is outlined in Equation (G-61).

$$GLAORN_i = f(t, D_i) \qquad \text{(G-61)}$$

where:
$GLAORN_i$ = *acreage of Glades ornamental nursery in year i.*
t = *a trend variable which takes on a value of 5 in 1976 and increases by 1 unit each year.*
D_i = *a dichotomous variable where* $D_i = 0$ *prior to 1986 and 1 in 1986 and following years.*

The model was estimated using robust regression and is shown in Equation (G-62), which was used to generate the primary projection for Glades County ornamental nursery acreage. A minute adjustment was made for the amount by which the model over projected acreage for 1990 (one acre was subtracted from projections), and the resulting projections are shown in Table G-79).

$$Glncn_i = -15.67821 + 9.030 * t + 469.479 * D_i \qquad \text{(G-62)}$$
$$(10.90) \qquad (68.39)$$

Goodness of fit statistics
$R^2 = .9997$
$F = 10616$
$Pr\,F > 0 > .9999$
t - statistics in parentheses
$D\text{-}W = 2.348$

TABLE G-79. Historical and Projected Ornamental Nursery Acreage in Glades County.

Year	Historical	Primary Projection	Primary -15 %	Primary +15 %
1976	21			
1977	42			
1978	unavailable			
1979	4			
1980	68			
1981	83			
1982	83			
1983	68			
1984	103			
1985	109			
1986	164			
1987	528			
1988	607			
1989	409			
1990	502	503		
Projections				
1991		511	434	588
1992		521	443	599
1993		530	451	610
1994		539	458	620
1995		548	466	630
1996		558	474	642
1997		567	482	652
1998		576	490	662
1999		586	498	674
2000		595	506	684
2001		604	513	695
2002		614	522	706
2003		623	530	716
2004		632	537	727
2005		641	545	737
2006		651	553	749
2007		660	561	759
2008		669	569	769
2009		679	577	781
2010		688	585	791

Source: Historical acreage from Bureau of Plant Inspection Annual Reports, 1976-1990, Division of Plant Industry, Florida Dept. of Agr. and Consumer Services.

Ornamental Nursery Irrigation Requirements. Supplemental water requirements for grass on 0.8 inch soil in Glades County are shown in Table G-71. These water requirements were applied to the ornamental nursery acreage projections (shown in Table G-79) to calculate the irrigation requirements (shown in Table G-80). All the ornamental nursery acreage is in the LWC Planning Area.

TABLE G-80. Irrigation Requirements in Millions of Gallons for the Primary Ornamental Nursery Acreage Projection in the Glades County Area.

Average	1985	1990	1995	2000	2005	2010
January	6	30	31	33	35	37
February	7	33	35	37	39	41
March	14	65	69	73	76	80
April	20	94	99	105	110	116
May	24	109	115	121	127	134
June	18	83	88	93	98	102
July	21	99	104	110	116	122
August	22	102	108	113	119	125
September	15	68	72	76	80	84
October	16	74	78	82	87	91
November	13	62	65	69	73	76
December	9	41	43	46	48	50
TOTAL	186	859	908	958	1,007	1,058

2-in-10	1985	1990	1995	2000	2005	2010
January	7	33	33	37	38	40
February	8	37	39	41	43	45
March	15	70	74	78	82	86
April	22	100	106	112	117	123
May	26	119	125	132	139	146
June	22	100	106	112	118	124
July	25	116	122	129	136	142
August	25	117	124	131	137	144
September	18	83	88	93	98	103
October	18	83	87	92	97	102
November	14	65	69	72	76	80
December	9	43	46	48	51	53
TOTAL	210	965	1,020	1,077	1,132	1,189

Improved Pasture/Cattle Watering

Improved pasture has, by District definition, the facilities in place to carry out irrigation. However, these facilities were typically designed and installed for drainage, and are rarely used for irrigation. This is because the returns associated with cattle production no longer justify the expense associated with pasture irrigation. In fact the required pumps and other equipment necessary for irrigation are usually not operable. When irrigation is carried out, it is usually in a period of extreme drought and is done to prevent grass from dying.

The assumption was made that improved pasture will not be irrigated throughout the projection period. Although this assumption may not be the case in some rare instances, it is much closer to actual production practices than the values given by any irrigation requirement model.

Total pasture acreage (improved and unimproved) does affect the water required for cattle watering by limiting cattle population. Total pasture was projected by subtracting land expansion for other purposes from the current acreage of pasture. Note that pasture acreage includes wetlands which will not be converted to other agricultural uses. Unless otherwise stated, the 1990 pasture acreage estimate was obtained from the local IFAS extension office. Historical and primary projected changes in acreage for other uses were applied to that figure.

Water required for cattle watering was calculated as a function of the number of number and type of cattle (beef or dairy), which in turn was appraised as a function of the acreage used for pasture. Demand projections for cattle watering are based on the District allocation of 12 gal/day/cow for beef cattle and 185 gal/cow/day for dairy cattle (35 gal/cow/day for drinking and 150 gal/cow/day for barn washing).

Collier County

In 1990, Collier County had approximately 15,000 head of beef cattle and no dairy cattle (Florida Cattlemen's Association, 1990). These cattle account for 330,000 acres of improved and unimproved pasture. The association between cattle and acreage is 22 acres per head of cattle.

Lee County

In 1990, Lee County had 15,000 head of beef cattle and no dairy cattle (Florida Cattlemen's Association, 1990) accounting for 118,000 acres of improved and unimproved pasture. The association between cattle and acreage is approximately 7.9 acres per head of cattle.

Hendry County Area

In 1990, Hendry County had 117,000 head of beef cattle, and no dairy cattle (Florida Cattlemen's Association, 1990), accounting for 596,000 acres of improved and unimproved pasture. The association between cattle and acreage is 5.1 acres per head of cattle.

Glades County Area

In 1990, Glades County had 61,000 head of beef cattle and 4,000 head of dairy cattle (Florida Cattlemen's Association, 1990). The association between cattle and

acreage is about 5.1 acres per head of cattle. In 1989/1990 Glades County had approximately 4,000 head of dairy cattle. The dairy cattle population in Glades County is anticipated to remain relatively constant over the projection period.

Charlotte County Area

The 1986-1988 pasture acreage estimate (the most recent available) was obtained from District land use maps (SFWMD, 1987). There are no dairies in the Charlotte County Area, and the beef cattle approximation was based on the ratio estimated by the local IFAS extension office of 8 acres per head of beef cattle.

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TOTAL AVERAGE ANNUAL WATER DEMAND

Estimated and projected demands for the counties in the LWC Planning Area are shown in Table G-81. Demands are presented by use classification, with agricultural use broken down to its components. Neither the Charlotte, Glades, or Monroe county areas have significant urban demands. The Monroe County Area, in addition, lies entirely within Everglades National Park, and has no significant agricultural demands.

TABLE G-81. Annual Water Demand by Use Classification.

Use Classification	Average Annual Water Demand (MG)		
	1990	2000	2010
Collier County			
Public Water Supplied	13,385	19,706	26,028
Domestic Self Supplied	1,679	2,363	3,048
Comm. & Ind. Self Supplied	3,022	4,406	5,833
Landscape & Rec. Self Supplied	1,467	2,139	2,832
Golf Course	6,007	8,823	11,922
Agriculture	54,515	69,669	79,858
Citrus	24,116	39,916	49,745
Vegetables	27,650	27,650	27,650
Ornamental Nursery	2,683	2,041	2,405
Cattle Watering	66	62	58
TOTAL	80,075	107,106	129,521
Lee County			
Public Water Supplied	15,516	23,550	31,583
Domestic Self Supplied	2,821	3,207	3,592
Comm. & Ind. Self Supplied	11,425	16,863	21,827
Landscape & Rec. Self Supplied	8,578	12,666	16,389
Golf Course	6,265	8,140	10,432
Agriculture	22,766	25,733	28,845
Citrus	10,388	12,242	14,095
Tropical Fruit	1,765	2,088	2,410
Vegetables	8,396	9,375	10,106
Sod	1,113	1,113	1,113
Ornamental Nursery	1,038	853	1,059
Cattle Watering	66	62	62
TOTAL	67,371	90,159	112,688
Hendry County Area			
Public Water Supplied	1,427	1,836	2,245
Domestic Self Supplied	526	675	825
Golf Course	283	283	283

TABLE G-81. (Continued).

Use Classification	Average Annual Water Demand (MG)		
	1990	2000	2010
Hendry County Area (cont.)			
Agriculture	125,995	153,351	173,155
Citrus	53,972	74,339	94,137
Citrus Nursery	176	198	283
Sugarcane	61,814	68,712	68,712
Vegetables	3,322	3,153	2,838
Sod	4,947	4,947	4,947
Ornamental Nursery	1,562	1,810	2,057
Cattle Watering	202	192	181
TOTAL	128,231	156,145	176,508
Glades County Area			
Golf Course	24	24	24
Agriculture	26,033	36,343	46,515
Citrus	4,031	5,786	7,403
Sugarcane	19,753	28,209	36,665
Vegetables	60	60	60
Sod	1,149	1,149	1,149
Ornamental Nursery	859	958	1,058
Cattle Watering	181	181	180
TOTAL	26,057	36,367	46,539
Charlotte County Area			
Agriculture	5,327	5,797	6,271
Citrus	1,364	1,838	2,312
Vegetables	1,668	1,668	1,668
Field Crops	2,256	2,256	2,256
Cattle Watering	39	35	35
TOTAL	5,327	5,797	6,721
GRAND TOTAL	**307,061**	**395,574**	**471,507**

LWC Planning Area Total by Use (MGY)	Estimated 1990	Projected 2010	Percent of Total	
			1990	2010
Public Water Supplied	30,328	59,856	10%	13%
Domestic Self Supplied	5,026	7,465	2%	2%
Comm. & Ind. Self Supplied	14,447	27,660	5%	6%
Recreation Self Supplied	22,624	41,882	7%	9%
Agriculture	234,636	334,644	76%	71%

PROJECTED AGRICULTURAL LAND USE

Agricultural Land Use Projection Methodology

For modeling purposes the 1990 land use assessment reflects the permitted 1990 irrigated acreage and water withdrawals. In order to model forecast 2010 withdrawals and land use, the numerical acreage projections described previously in this appendix were allocated to suitable locations. Projections for land use changes in Collier, Lee, and Hendry counties were developed for citrus, sugarcane, and vegetables. Crops which were projected to remain at their 1990 level, or not to surpass their 1990 permitted level, were assigned to the 1990 permitted locations. The crop with the most change projected is citrus, with continued growth forecast through 2010, although at a significantly lower average growth rate than recently experienced. Some growth is also projected for sugarcane, vegetables, and ornamental nursery, while sod is anticipated to stay at about the 1990 level.

Citrus

The criteria considered in evaluating the suitability of areas in the LWC Planning Area for the expansion of citrus were land ownership and soil type. Available blocks of land which are 40 acres or larger were considered. A summary of the evaluations of these criteria are presented below. Justification of these methodologies and a description of the techniques used to determine ownership and soil suitability are described by Mazzotti *et al.*, 1992. Urban areas, land permitted for irrigated agricultural crops other than citrus, and protected wetlands were ruled out as potential sites for citrus expansion.

Land Ownership. Land ownership was rated with respect to ownership history of citrus production, with L1 as the highest rating and L3 the lowest.

L1. Land owned by an agricultural company or individual that is known to already own existing citrus groves within the IFAS study boundary area (Hendry, Collier, Glades, Lee, and Charlotte counties).

L2. Privately owned land in large tracts (>100 acres), owned by companies or individuals not known to own any existing citrus groves within the IFAS study boundary area.

L3. Land broken up into small tracts, residential areas, towns, subdivisions, or planned communities. Land owned by city, county, state, or federal government. Land owned by the Audubon Society.

Soil Feasibility. The feasibility for a given soil series to support a viable citrus grove was based on the Soil Conservation Service soil survey. Soils were identified with respect to ease of drainage, since this is the chief concern of the long-term survivability of citrus groves within the study area. Soils were grouped into three feasibility categories, with highest feasibility equal to S1 and lowest feasibility equal to S3.

S1- Flatwoods. In their natural state these soils occupy upland positions. Hammocks may be considered in a similar position for this rating system, although the soils within them may be quite different. Soils within the flatwoods grouping have a high potential to support citrus development because flooding is unlikely if a standard flatwoods grove drainage system is installed.

S2 - Sloughs. In their natural state these soils occupy transitional areas between flatwoods and depressions. These soils are more likely to flood under chronic high rainfall conditions than the soils classified as S1. Sloughs have the potential to support citrus development with a standard drainage system if it is sized properly and is well maintained.

S3 - Depressions. In their natural state these soils remain under ponded water for six months or more per year. In normal to deficient rainfall years, sandy soils within this grouping could support citrus development with a standard drainage system. However, intermittent flooding may occur during above normal rainfall years, which would be detrimental to the long-term health of citrus. It is doubtful that the muck soils within this grouping could support long-term viable citrus groves.

The two evaluations (land ownership and soil suitability) were evaluated in combination. For example, L1S1 refers to land classified as most appropriate for citrus both in terms of land ownership and soil suitability. Soils considered undevelopable wetlands were masked out (i.e., not considered as potential sites for citrus). The National Wetlands Inventory (NWI) classifies nontidal wetlands as follows:

H - Permanently flooded. Water covers the substrate throughout the year in all years. Ecotype: estuarine bay, harbor.

Z - Intermittently exposed. Surface water is present throughout the year except in years of extreme drought. Ecotype: seagrass bed.

F - Semipermanently flooded. Surface water persists throughout the rainy season (May through October) and much of the dry season (November through April) in most years. When surface water is absent, the water table is at or very near the land surface. Ecotype: maple swamp, willow head, Thalia marsh, deep marsh.

C - Seasonally flooded. Surface water is present throughout the rainy season, but is absent soon after the rainy season in most years. When surface water is absent, the water table is often near the land surface. Ecotype: Cypress dome, prairie pond, sawgrass marsh, mixed hardwood swamp.

B - Saturated. The substrate is saturated to the surface throughout the rainy season or for extended periods through the rainy season in most years. Surface water is seldom present. Ecotype: bayhead, seep, hydric hammock.

A - Temporarily flooded. Surface water is present for brief periods during the rainy season, but the water table usually lies well below the soil surface for most of the year. Plants that grow in both uplands and wetlands are characteristic of this water regime.

W - Intermittently flooded. The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal without detectable seasonal periodicity. Weeks, months, or years may intervene between periods of inundation. (Used rarely, if at all, in Florida. Ecotype: no known examples in the District.

K - Artificially flooded. The amount and duration of flooding is controlled by means of pumps or siphons in combination with dikes and dams. The vegetation growing in these areas cannot be considered a reliable indicator of water regime. Ecotype: conservation area, mitigation wetland.

From a regional perspective the Class A wetlands have the potential to be permitted for irrigated agriculture. However, the District's Regulation Department staff makes wetlands determinations based on vegetation on a case by case basis. In this analysis Class A wetlands were not excluded (masked) from potential citrus development sites.

The following steps were taken using Geographic Information System (GIS) software to geographically allocate the numerical citrus acreage projections described previously in this appendix:

1. Establish the locations permitted for citrus production for 1990.

2. Add the locations permitted for citrus production between 1990 and 1993.

3. Identify potential acreage growth within permit boundaries.
   a. Develop a GIS mask for wetland areas within citrus permit boundaries.
   b. Identify and allocate numerical acreage projections to areas outside the mask with the S1 soil type within citrus permit boundaries.
   c. Identify and allocate numerical acreage projections to areas outside the mask with the S2 soil type within citrus permit boundaries.

4. Identify potential acreage growth outside permit boundaries.
   a. Develop a GIS mask for areas outside citrus permit boundaries. This mask includes the 1993 permitted citrus locations, areas identified for irrigated crops other than citrus for the 2010 projection, wetlands, and urban areas.
   b. Identify and allocate the numerical acreage projections to areas outside the mask with the L1S1 ownership/soil type outside the 1993 citrus permit boundaries.
   c. Identify and allocate numerical acreage projections to areas outside the mask w ith the L1S2 ownership/soil type outside the 1993 citrus permit boundaries.

5. Create the output for the models by overlaying the grid with projected citrus growth areas.

Sugarcane

Sugarcane is produced commercially in the portions of Glades and Hendry counties within the LWC Planning Area. The local IFAS extension office identified areas of projected sugarcane expansion in the Hendry County Area. Some growth was also forecast within Hendry County's 1993 permit boundaries. These land use projections were consistent with the numerical acreage projections made earlier in this appendix.

Vegetables

In the model area, vegetable acreage is projected to stay at about its current level through 2010 in Collier County, and to grow moderately in Lee and Hendry counties. Vegetable acreage was assigned to the existing permitted irrigated locations, and if necessary, to additional areas with suitable soil within the current vegetable permit boundaries.

Other Crops

An increase in irrigated acreage for crops other than citrus, vegetables, or sugarcane was either insignificant or their total irrigation demands were small. Land use projections for Collier, Lee, and Hendry counties were made for citrus, sugarcane, vegetables, and sod. Citrus nursery acreage was included with citrus acreage. Ornamental nurseries are individually small, and make up a relatively insignificant portion of agricultural demands. No land use projection was made for ornamental nurseries: however, the existing permitted locations were included.

Results

Collier County. Agricultural land use projections were made for citrus and vegetables using the described methodologies. Citrus acreage was capped at 52,950 acres as shown in Table G-16. This represents the limit of growers with a history of citrus production in Collier County using suitable land for citrus production. Vegetable production was projected to remain at its current level.

Lee County. The increase in projected irrigated acreage in Lee County is modest in comparison to other counties in the LWC Planning Area. This acreage is accommodated within the current permitted boundaries.

Land use projections were made for citrus, tropical fruit, vegetables, and sod. The citrus land analysis by Mazzotti *et al.* 1992 did not include Lee County. However, an analysis titled "Lee County Soil Potential for Citrus" (Lee County Soil and Water Conservation District, 1992) contained soil suitability analyses. Soils were assigned a soil potential index (SPI). Those soils with highest SPI within existing permit boundaries were used to assign the relatively modest forecast growth in Lee County.

Hendry County. Agricultural land use projections were made for citrus, vegetables, sugarcane, and sod. The local IFAS extension office identified areas of projected sugarcane expansion. Some growth was also forecast within 1993 permit boundaries. These land use projections were consistent with the numerical acreage projections made earlier in this appendix.

Citrus locations were projected using the soil suitability and land ownership analysis previously described. There is enough suitable land within the current citrus permit boundaries in Hendry County to accommodate the numerical projections made earlier in the appendix.

APPENDIX H

Factors Affecting Water Supply

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AMBIENT GROUND WATER QUALITY

Ambient ground water quality of the Lower West Coast Planning Area was assessed with the use of the Ambient Ground Water Quality Monitoring Network (AGWQMN). The AGWQMN is a statewide network of Monitor wells (and associated database) which is maintained by a cooperative agreement between the Florida Department of Environmental Regulation and the water management districts. The purpose of the AGWQMN is to typify regional ambient water quality. It is not intended to include wells which monitor zones of discharge of landfills, contamination sites, or any other anthropogenic pollution sources, nor is it intended to delineate specific saltwater intrusion impacts. The aquifer classifications used by the AGWQMN in the LWC Planning Area are the Surficial, Intermediate, and Floridan aquifer systems. For the Lower West Coast Water Supply Plan (LWCWSP), the wells were further segregated by specific aquifer (water table, lower Tamiami, Sandstone, mid-Hawthorn, lower Hawthorn) for a more detailed picture of water quality. Refer to Chapter III for a review of the hydrogeology and aquifer systems.

Information derived from the first four years of AGWQMN sampling (1984 through 1987) within the SFWMD was summarized and published in Technical Publication 89-1, "South Florida Water Management District Ambient Ground Water Quality," (Herr and Shaw, 1989). For the LWCWSP, district staff utilized all available data from the wells which were located within the LWC Planning Area, encompassing a time span from 1984 through 1990. Average data values of all sampling events for each well were obtained with the use of the GWIS database.

The following is a brief summary of the selected water quality parameters obtained from the AGWQMN data search for the LWC Planning Area. The water quality parameters reviewed are those which can affect the treatability of a potential drinking water source. These include chloride, sodium, total dissolved solids (TDS), iron, total organic carbon (TOC), total alkalinity, nitrate nitrogen, hardness, and color. Tables V-1 and V-2 in the Water Supply Issues and Constraints Section are suggested references for the potable drinking water standards which apply to several of these parameters. All units are stated in milligrams per liter (mg/L), except color (stated as color units). The water quality contour maps of the ambient water quality data alone do not depict the extent of saltwater intrusion along the coast, due to the deficiency of AGWQMN wells in the affected coastal areas. This topic is included in the saltwater intrusion discussion later in this appendix.

Tables H-1 through H-4 (beginning on page H-10) contain the ambient water quality data retrieved from the AGWQMN database for the water table, lower Tamiami, Sandstone, mid-Hawthorn and lower Hawthorn aquifers. Well construction information (casing and total depths) and well locations in Florida state planar coordinates are included. Figures H-1 through H-5 (beginning on page H-5) are location maps depicting the wells within each aquifer. Figures H-6 through H-46 (beginning on page H-17) contain the water quality contour maps for the selected water quality parameters. The contour plots were generated with "Surfer," a Golden Software product, using the Kriging algorithm method. Additional figures illustrating estimated chloride concentrations of the upper and lower portions of the Floridan Aquifer System (FAS), as indicated by the U.S. Geological Survey, are included as figures H-47and F-48 (beginning on page H-58).

Water Table Aquifer

Among the water table aquifer ambient wells only, chloride concentrations are within potable water standards, ranging from 5 to 158 mg/L. However, saltwater intrusion in coastal areas has caused contamination of the surficial aquifer in various localities. Connate water which remains in many places also contributes to locally elevated levels of chlorides and other dissolved minerals. Additional chloride data from the saltwater intrusion monitoring program and other sources is presented in the saltwater intrusion discussion and accompanying materials presented later in this appendix. In addition to saltwater intrusion, inter-aquifer cross contamination from the more saline FAS is a problem stemming from past irrigation practices, and from flowing FAS irrigation wells or oil test wells which were improperly constructed or abandoned. Chloride levels in the water table aquifer near La Belle are as high as 1,800 mg/L due to this problem (Smith and Adams, 1988). This problem is not restricted to the water table aquifer.

Sodium and total dissolved solids generally follow the same patterns as chlorides, and are highest in the areas of saltwater intrusion, flowing Floridan wells, and in areas of localized pockets of connate water. Sodium concentrations in the ambient wells are within potable drinking water standards, ranging from 2 to 110 mg/L. Total dissolved solids range from 31 to 981 mg/L, exceeding potable water standards in approximately 25 percent of the ambient wells.

Additional AGWQMN data indicates that the water is moderately hard to very hard (144 to 444 mg/L as $CaCO_3$), with the exception of some anomalously low levels in Glades County. It is relatively high in color and total organic carbon (TOC), due to the rich, organic nature of the overlying soils in much of the LWC. Iron levels vary from 0.190 to 5.815 mg/L, exceeding the potable standard in nearly all wells. Alkalinity normally ranges from approximately 130 to 385 mg/L (as HCO_3), again with the exception of some very low values in Glades County. Nitrate nitrogen concentrations are far below potable standards in all wells.

Lower Tamiami Aquifer

Due to the relatively small number of ambient wells in the lower Tamiami aquifer, the water quality analysis is roughly limited to west-central Collier County. Generally speaking, in the aquifers of the LWC Planning Area, ground water quality degrades with increasing depth, with respect to chloride, TDS, and sodium. Nevertheless, in the lower Tamiami ambient wells, unimpacted by saltwater intrusion, the ranges of chlorides (12 to 155 mg/L) and sodium (9 to 87 mg/L) remain well within potable water standards. Total dissolved solids range from 204 to 647 mg/L, often in excess of potable standards. Naturally, in areas affected by saltwater intrusion or cross contamination from deeper, more mineralized aquifers, these parameters may be present in far greater concentrations. Connate water also accounts for localized pockets of highly mineralized water. Additional information on chloride levels in areas of saltwater intrusion is the Saltwater Intrusion section of this appendix.

Ranges of other parameters in the ambient wells are as follows (all in mg/L except color): iron: 0.050 to 2.220; TOC: 6 to 54; alkalinity 174 to 340; nitrate nitrogen: 004 (detection level) to 0.009; color: 20 and 39 (only two data points); and hardness: 179 to 467 (hard to very hard).

In Collier County, lower Tamiami water quality with respect to dissolved solids appears to degrade toward the south, although TOC levels increase inland, toward the northeast.

Sandstone Aquifer

Moving deeper, within the Sandstone Aquifer, the overall averages for chloride, TDS, sodium and hardness continue to increase with depth, above the levels found in the overlying aquifer. Conversely, levels of iron, TOC, and color are lower in the Sandstone than in the overlying aquifer, while alkalinity and nitrate levels remain relatively constant. Average well data ranges are as follows (all in mg/L except color): chloride: 30 to 1010; TDS: 374 to 2139; sodium: 38 to 593; iron: 0.045 to 1.593; TOC: 1 to 44; alkalinity: 122 to 433; nitrate nitrogen: 0.004 (detection level) to 0.017; color: 6 to 25; and hardness: 86 to 715 (moderately hard to very hard).

In Collier County, water quality in the Sandstone Aquifer generally deteriorates in a southwest direction. There is a pocket of poor water quality in the area of northeast Lee and northwest Hendry counties, suggesting the presence of connate water or contamination by short-cased FAS wells as described previously.

Mid-Hawthorn Aquifer

In the mid-Hawthorn aquifer, chlorides, TDS, sodium and hardness continue the trend of increasing with overall depth, resulting in a marked deterioration in water quality from the shallower aquifers. These constituents also share a common overall trend of increasing in the southwesterly direction. Chloride ranges from 28 to 844 mg/L, in excess of potable standards in six of the ten ambient wells. Total dissolved solids range from 263 to 1,591 mg/L, and sodium from 43 to 480 mg/L; both exceed potable standards in all but two of the ten wells.

Concentrations of all other parameters investigated are distinctly lower in the mid-Hawthorn than in the overlying aquifers, as observed in the average ranges (mg/L): iron: 0.050 to 0.463; TOC: 0.7 to 16.5; alkalinity: 144 to 286; nitrate nitrogen: 0.004 (detection level) to 0.006; and color: 3 to 13 units (four wells only).

Lower Hawthorn Aquifer/Floridan Aquifer System

In the LWC Planning Area, AGWQMN wells in the Floridan Aquifer System are limited to lower Hawthorn aquifer wells located in Lee and northern Collier counties. For this reason, water quality contour lines were omitted in the areas where no data existed. Additional data were obtained from other sources to supplement the chloride contour plot, although information on the FAS in Southwest Florida is sparse.

Water quality in the FAS is generally poor, with high levels of chloride, sodium, and TDS, all of which increase with depth and distance from the primary recharge area. Chloride in the lower Hawthorn, the uppermost aquifer of the FAS, ranges from approximately 360 to 1,900 mg/L . Sodium ranges from 221 to 920 mg/L; TDS from 923 to 2,556 mg/L. Water from most of the lower Hawthorn wells is below detection levels for iron and nitrate, and is also very low in color. Hardness ranges from 225 to 691 mg/L (hard to very hard). Alkalinity averages 158 mg/L, ranging from 90 to 200 mg/L.

There are no AGWQMN wells in the LWC Planning Area which penetrate the deeper aquifers of the FAS. In the Cape Coral area, however, the following chloride

ranges have been documented: lower Hawthorn: 320 to 3,200 mg/L; upper Suwannee: 480 to 5,600, lower Suwannee: 660 to 13,500 mg/L; Ocala: 1,900 to 20,000; Avon Park: 11,000 to 16,000 mg/L (Missimer & Associates, 1991). Recent information from a lower Hawthorn reverse osmosis well under construction for Marco Island reported chloride concentrations to be 3100 to 4800 mg/L, where levels of 1,500 to 3,000 mg/L had been predicted.

In its Regional Aquifer System Analysis (RASA) Program, the U.S. Geological Survey has further defined the geochemistry of the Floridan Aquifer System in a series of reports (Sprinkle, 1989; Meyer, 1989; Bush and Johnson, 1988; Miller, 1986). Figures F-52 and F-53 illustrate the ranges of chloride concentrations in the upper and lower portions of the FAS throughout the SFWMD (after Sprinkle, 1989). The USGS indicates that in Southwest Florida the lower part of the Tampa Limestone (the lower Hawthorn aquifer) is included as part of the upper portion of the FAS (Meyer, 1989). Also, as indicated in Table D-1, the SFWMD defines the top of the upper portion of the FAS as including the lower Hawthorn aquifer. This definition reflects the fact that, within the LWC Planning Area, the lower Hawthorn often reflects and responds to hydrologic conditions in the Suwannee aquifer, which is part of the FAS, but responds only slightly to hydrologic conditions in the Intermediate Aquifer System.

Information found in the USGS report by Sprinkle (1989) indicates that in the upper portion of the FAS, concentrations of dissolved solids are greater than 1,000 mg/L in most of the LWC Planning Area, increasing in concentration toward the coast. Exceptions are north-central Glades County (Fisheating Creek Area) where it ranges from 501 to 1,000 mg/L, in wells drilled into the upper portion of the FAS. Fully penetrating wells near the coast would likely yield dissolved solids concentrations which would approach seawater concentrations (about 36,000 mg/L). The report indicates that dissolved solids concentrations in water from the lower portion of the FAS in this region are far greater than 10,000 mg/L, except in northeast Glades County where they range from 1,000 to 10,000 mg/L.

It should be noted that this information on water quality in the FAS is based on extrapolation of data from wells which are, with little exception, not located within the LWC Planning Area. Precise determination of water quality from the FAS in this region will require the installation of test wells at sites under consideration for development of the FAS as a water source.

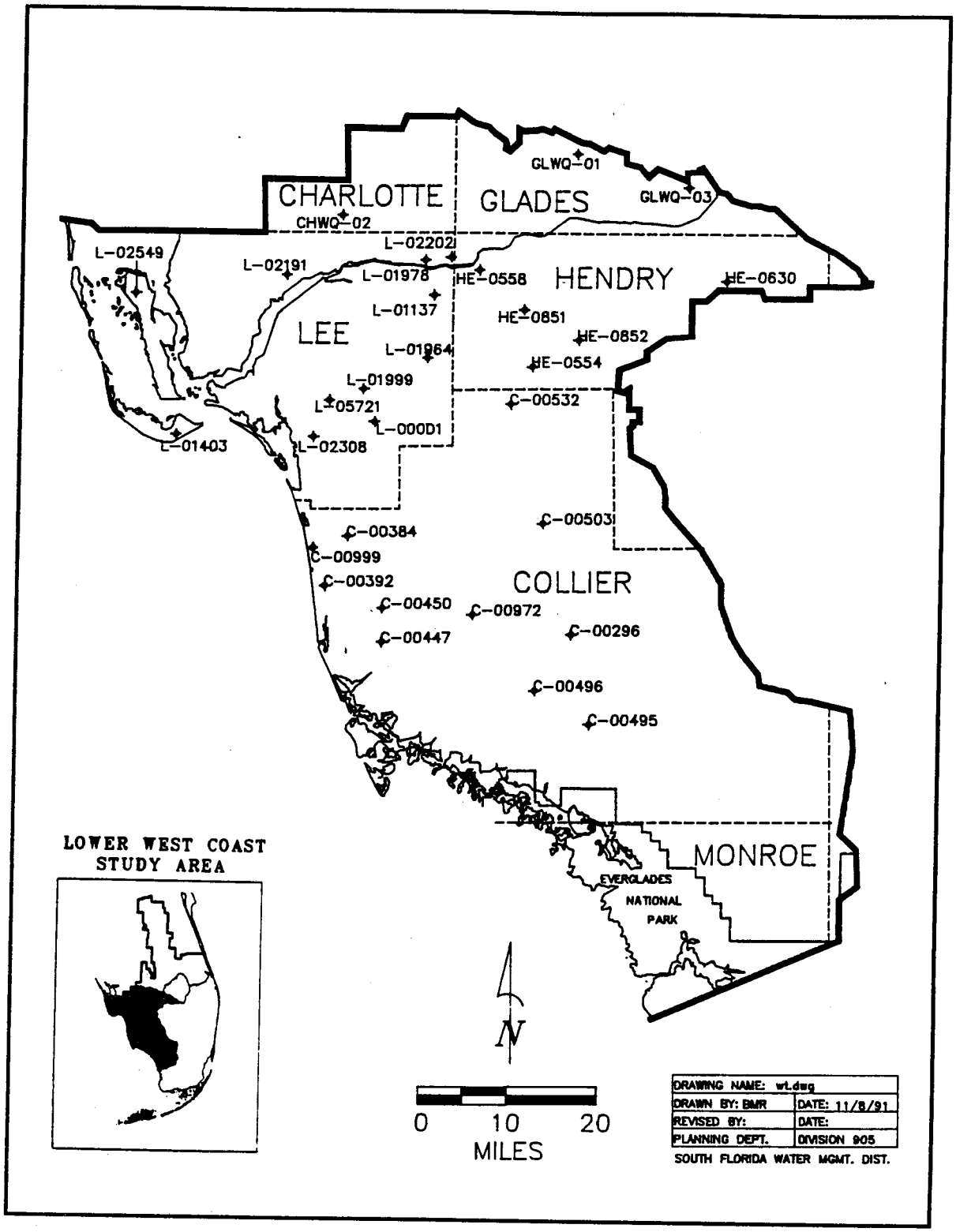


FIGURE H-1. Water Table Aquifer Ambient Ground Water Quality Monitor Wells.

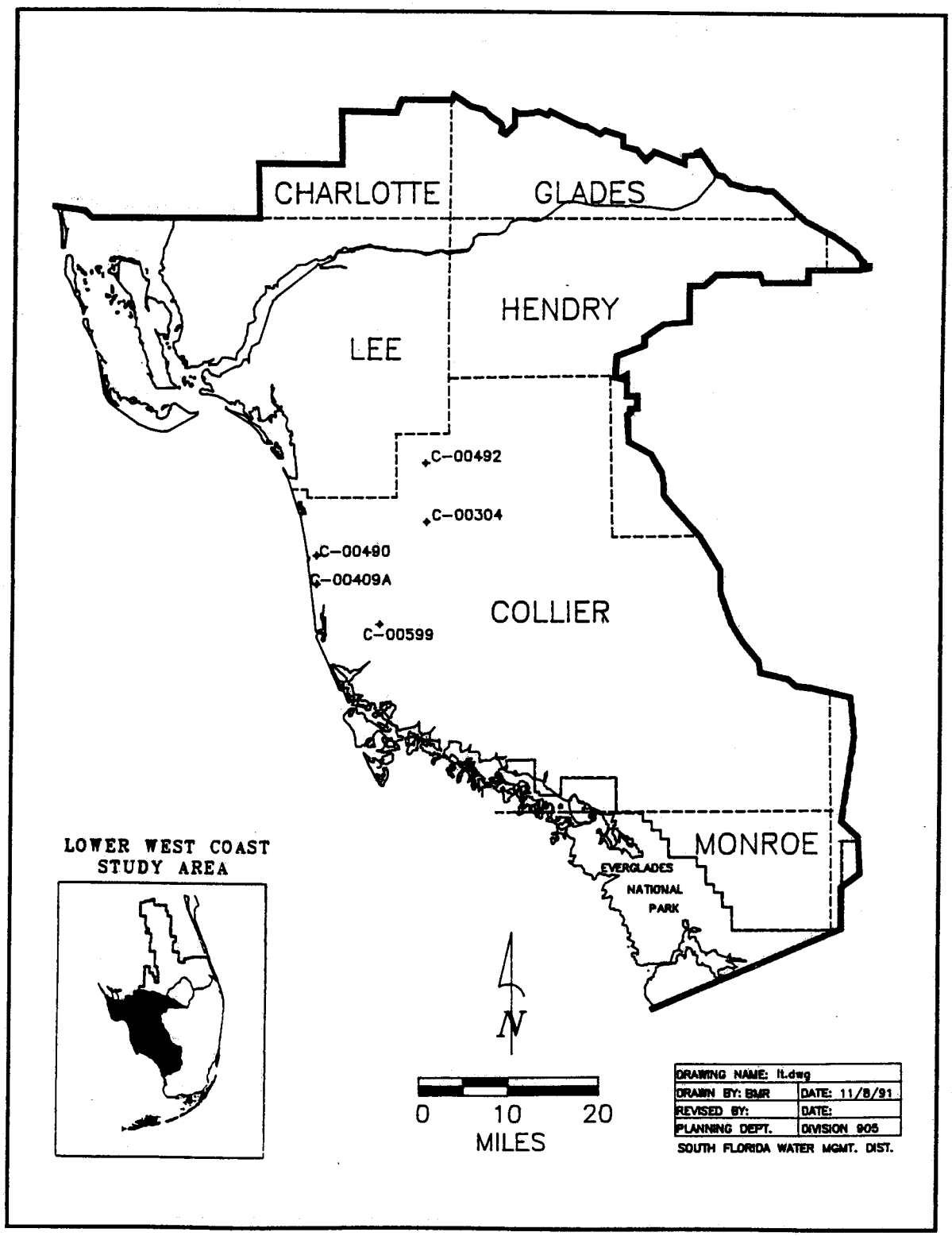


FIGURE H-2. Lower Tamiami Aquifer Ambient Ground Water Quality Monitor Wells.

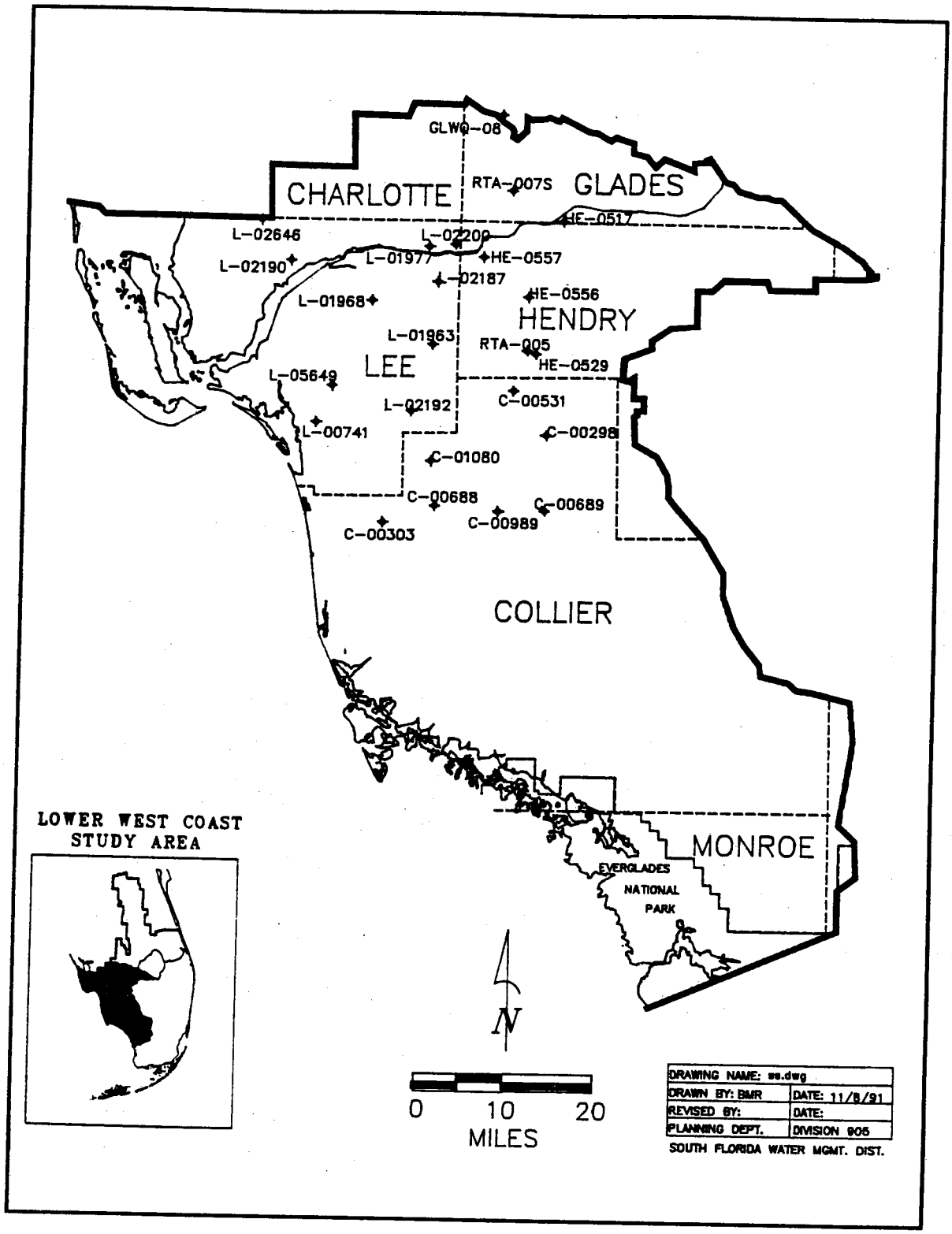


FIGURE H-3. Sandstone Aquifer Ambient Ground Water Quality Monitor Wells.

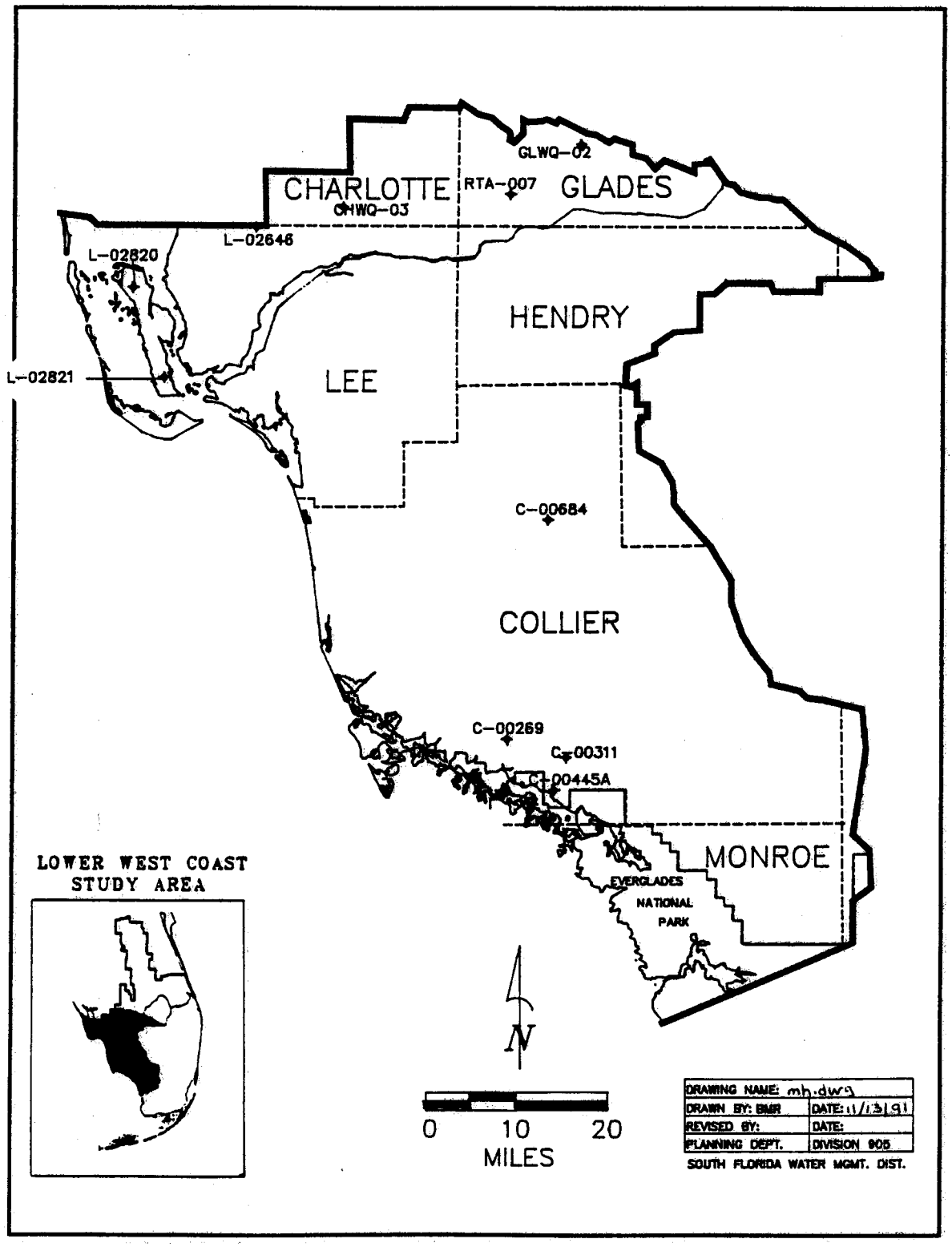


FIGURE H-4. Mid-Hawthorn Aquifer Ambient Ground Water Quality Monitor Wells.

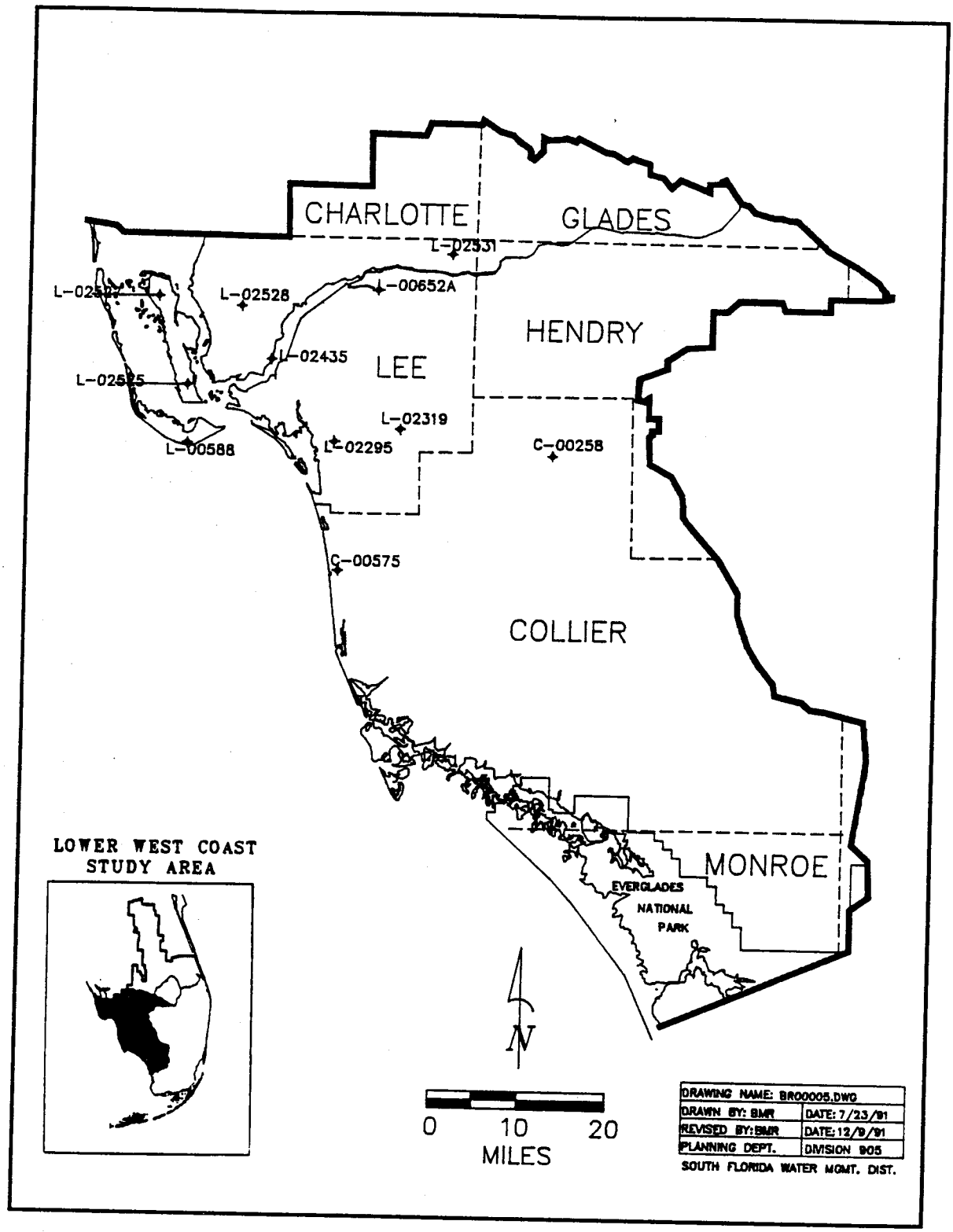


FIGURE H-5. Lower Hawthorn Aquifer Ambient Ground Water Quality Monitor Wells.

TABLE H-1. Water Table Aquifer Ambient Ground Water Quality Monitor Wells.

WELL CONSTRUCTION DATA					AVERAGE VALUES OF AVAILABLE DATA								
WELL #	EASTING	NORTHING	CASING DEPTH	TOTAL DEPTH	Chloride mg/L	TDS mg/L	Sodium mg/L	Iron mg/L	TOC mg/L	Alkalin mg/L	Nitrate N mg/L	Color units	Hardness mg/L
CHWQ-02	249724	896582	18	28	35	385	26	2.997	16	228	0.004	--	257
C-00054	538081	668072*	7	8	23	337	15	1.643	35	270	0.006	--	282
C-00296	386697	646196	8	45	--	601	--	0.842	8	279	0.013	--	406
C-00384	253768	705317	10	10	23	340	11	0.670	7	282	--	24	330
C-00392	240386	675510	23	30	46	344	27	1.415	25	316	0.005	--	315
C-00447	274369	641594	8	26	73	483	45	2.468	18	317	0.011	125	432
C-00450	274659	662088	8	30	40	261	69	0.345	17	315	0.005	88	432
C-00495	397509	592964	8	70	24	222	13	0.455	7	204	0.025	--	211
C-00496	365081	613044	8	60	44	284	22	0.553	18	251	0.006	--	267
C-00503	369492	712981	8	23	44	369	21	3.687	32	244	0.005	64	262
C-00532	350178	784426	3	10	25	319	15	0.653	76	190	0.010	265	216
C-00972	328042	658205	25	44	9	349	9	0.195	13	268	0.014	--	299
C-00999	233332	698170	13	23	16	276	9	1.678	44	216	0.008	--	250
GLWQ-01	388737	933334	39	49	8	48	9	0.458	49	6	0.011	--	5
GLWQ-03	454712	912914	34	44	64	704	44	1.762	54	371	0.014	--	444
GLWQ-06	499095	979529*	31	41	--	981	--	0.358	15	385	0.019	--	438
GLWQ-07	337398	954452*	35	45	155	612	74	5.815	16	206	0.005	--	326
GLWQ-09	388318	979075*	18	28	14	85	11	3.405	49	18	0.014	--	20
HE-0554	362972	806797	5	15	36	259	26	2.065	60	134	0.004	--	144
HE-0558	330785	863963	3	14	--	--	--	3.880	24	180	0.006	--	--
HE-0630	477507	857364	70	75	158	634	48	0.443	9	288	0.006	--	288
HE-0851	357820	840638	5	13	36	522	26	0.130	38	398	0.005	--	394
HE-0852	390528	822669	9	14	36	471	29	--	74	249	0.015	--	258

Water quality data represents average values from multiple sampling events for time period 1984-1990.
*Well located outside of LWC Planning Area; used for background data.

TABLE H-1. (Continued).

WELL CONSTRUCTION DATA					AVERAGE VALUES OF AVAILABLE DATA								
WELL #	EASTING	NORTHING	CASING DEPTH	TOTAL DEPTH	Chloride mg/L	TDS mg/L	Sodium mg/L	Iron mg/L	TOC mg/L	Alkalin mg/L	Nitrate N mg/L	Color units	Hardness mg/L
HE-0854	492737	819194*	3	14	18	371	16	2.397	63	231	0.013	--	286
HE-0856	458673	797002*	4	11	5	218	3	0.558	49	182	0.019	--	181
HE-0862	534583	712188*	7	11	19	311	20	2.800	44	259	0.011	--	245
L-00001	269436	773685	0	35	64	346	17	2.920	10	230	0.004	--	255
L-01137	304234	849034	15	20	15	342	29	3.875	33	238	0.010	142	213
L-01403	151756	765609	2	11		756	--	0.340	12	294	0.012	--	350
L-01964	300519	811995	14	24	27	375	18	2.120	40	275	0.017	203	273
L-01978	298800	869759	7	17	41	329	16	1.700	38	201	0.014	--	224
L-01999	262912	793310	16	26	19	403	21	1.995	44	308	0.013	59	314
L-02191	216948	861046	15	20	25	518	12	2.863	20	253	0.006	--	329
L-02202	314041	871505	7	19	58	464	25	4.037	65	290	0.004	--	320
L-02308	233386	764508	12	13	23	314	11	3.340	48	245	0.010	123	251
L-02549	127505	849935	58	80	102	535	36	0.190	50	307	0.016	22	365
L-05721	242522	786766	0	30	42	384	20	2.615	34	230	0.004	117	272

Water quality data represents average values from multiple sampling events for time period 1984-1990.
*Well located outside of LWC Planning Area; used for background data.

TABLE H-2. Lower Tamiami Aquifer Ambient Ground Water Quality Monitor Wells.

WELL CONSTRUCTION DATA					AVERAGE VALUES OF AVAILABLE DATA								
WELL #	EASTING	NORTHING	CASING DEPTH	TOTAL DEPTH	Chloride mg/L	TDS mg/L	Sodium mg/L	Iron mg/L	TOC mg/L	Alkalin mg/L	Nitrate N mg/L	Color units	Hardness mg/L
C-00304	237526	669570	63	73	25	222	12	0.210	7	205	0.008	--	224
C-00409A	301731	741716	60	64	55	432	28	2.220	46	263	0.004	--	307
C-00490	274481	645632	40	50	155	647	87	0.050	14	340	0.005	--	467
C-00492	302204	706578	125	130	41	376	42	0.150	12	251	0.004	20	260
C-00599	237539	686533	70	71	12	204	9	0.370	6	174	0.008	39	179
HE-0855	458673	797002*	70	90	98	526	65	0.208	54	316	0.009	--	311

Water quality data represents average values from multiple sampling events for time period 1984-1990.
*Well located outside of LWC Planning Area; used for background data.

TABLE H-3. Sandstone Aquifer Ambient Ground Water Quality Monitor Wells.

WELL CONSTRUCTION DATA					AVERAGE VALUES OF AVAILABLE DATA								
WELL #	EASTING	NORTHING	CASING DEPTH	TOTAL DEPTH	Chloride mg/L	TDS mg/L	Sodium mg/L	Iron mg/L	TOC mg/L	Alkalin mg/L	Nitrate N mg/L	Color units	Hardness mg/L
C-00298	369813	758009	254	303	63	308	69	0.365	4	220	0.005	6	140
C-00303	273977	705204	232	300	676	1533	369	0.310	5	227	0.004	20	455
C-00531	350178	784426	210	237	47	423	60	0.107	21	293	0.004	--	230
C-00689	369492	712880	230	265	81	430	62	0.107	12	275	0.004	18	238
C-00989	342095	712266	240	270	205	797	208	0.060	26	252	0.004	--	173
C-01080	301812	742221	238	309	26	258	65	0.050	1	178	0.005	--	86
C-00688	304520	715351	220	405	45	416	74	0.068	14	267	0.005	18	216
GLWQ-04	463481	996105*	60	70	130	796	96	0.260	39	419	0.017	--	443
GLWQ-08	340725	949243	70	80	111	955	114	0.348	34	433	0.014	--	522
HE-0517	377733	885708	128	138	30	368	17	--	18	295	0.005	--	283
HE-0529	362972	806797	135	155	45	416	39	0.288	28	288	0.005	--	273
HE-0556	357820	840638	135	175	207	689	138	0.160	24	249	0.005	21	284
HE-0557	330784	863962	80	100	--	--	593	0.087	23	122	0.004	22	715
HE-0861	534583	712188*	37	44	69	507	59	0.280	44	363	0.021	--	318
RTA-005	357712	808834	165	200	61	448	44	0.100	21	296	0.004	--	303
RTA-007S	347436	903781	60	80	111	514	114	0.123	21	184	0.009	--	165
L-00741	233386	764508	102	119	162	478	39	1.593	37	144	0.005	7	274
L-01963	301881	811989	65	74	185	678	105	0.355	12	287	0.004	25	353
L-01968	265433	838026	70	165	75	469	46	0.150	20	282	0.004	20	300
L-01977	298800	869759	65	185	1010	2139	514	0.157	17	126	0.004	--	705
L-02187	304234	849034	136	154	350	1016	190	0.138	27	223	0.004	15	424

Water quality data represents average values from multiple sampling events for time period 1984-1990.
*Well located outside of LWC Planning Area; used for background data.

TABLE H-3. (Continued).

WELL CONSTRUCTION DATA					AVERAGE VALUES OF AVAILABLE DATA								
WELL #	EASTING	NORTHING	CASING DEPTH	TOTAL DEPTH	Chloride mg/L	TDS mg/L	Sodium mg/L	Iron mg/L	TOC mg/L	Alkalin mg/L	Nitrate N mg/L	Color units	Hardness mg/L
L-02190	216948	861046	71	109	249	708	100	0.245	12	230	0.004	--	407
L-02192	289875	771761	155	180	78	503	90	0.442	11	286	0.006	21	215
L-02200	314041	871505	122	163	867	1880	413	0.045	23	127	0.004	--	655
L-02646	199160	884598	170	220	81	374	38	0.066	22	193	0.004	--	226
L-05649	242522	786766	118	135	--	730	74	0.240	33	196	0.006	22	376

Water quality data represents average values from multiple sampling events for time period 1984-1990.

TABLE H-4. Mid-Hawthorn Aquifer Ambient Ground Water Quality Monitor Wells.

WELL CONSTRUCTION DATA					AVERAGE VALUES OF AVAILABLE DATA								
WELL #	EASTING	NORTHING	CASING DEPTH	TOTAL DEPTH	Chloride mg/L	TDS mg/L	Sodium mg/L	Iron mg/L	TOC mg/L	Alkalin mg/L	Nitrate N mg/L	Color units	Hardness mg/L
CHWQ-03	249724	896582	175	240	462	977	189	0.050	4.7	167	0.006	--	446
C-00311	380022	573222	430	450	441	1015	447	0.160	0.8	286	0.004	5	205
C-00445A	373117	554060	346	467	701	1235	480	0.463	2.5	231	0.004	--	448
C-00684	369492	712880	440	490	166	--	373	0.237	16.5	190	0.003	11	--
C-00269	345546	584235	300	392	547	1071	351	0.130	0.7	237	0.004	--	358
GLWQ-02	388737	933334	360	460	28	263	43	0.038	0.7	193	0.004	--	146
L-02646	199160	884598	170	220	81	374	38	0.066	21.5	193	0.004	--	226
L-02820	127505	849935	192	250	844	1591	374	0.038	9.8	144	0.005	13	552
L-02821	145296	797370	290	340	591	1402	314	0.103	9.9	162	0.004	3	508
RTA-007	347436	903781	395	410	109	511	119	0.095	3.0	183	0.005	--	161

Water quality data represents average values from multiple sampling events for time period 1984-1990.

TABLE H-5. Lower Hawthorn Aquifer Ambient Ground Water Quality Monitor Wells.

WELL CONSTRUCTION DATA					AVERAGE VALUES OF AVAILABLE DATA								
WELL #	EASTING	NORTHING	CASING DEPTH	TOTAL DEPTH	Chloride mg/L	TDS mg/L	Sodium mg/L	Iron mg/L	TOC mg/L	Alkalin mg/L	Nitrate N mg/L	Color units	Hardness mg/L
C-00575	237087	687040	345	640	1015	2556	657	.05	--	195	0.004	--	--
L-00588	145911	762527	403	557	976	2153	560	--	--	155	0.004	--	--
L-02295	233386	764508	300	610	497	924	350	.05	--	195	0.004	3	--
L-02525	145296	797370	405	645	444	1127	221	.05	--	150	0.004	3	--
L-02527	127505	849935	360	605	1937	3568	830	.05	--	130	0.004	7	--
L-02528	176732	844779	420	625	927	1945	456	.05	--	145	0.004	6	--
L-02531	301557	877419	345	605	789	1849	421	.07	--	90	0.004	--	--

Water quality data represents average values from multiple sampling events for time period 1984-1990.

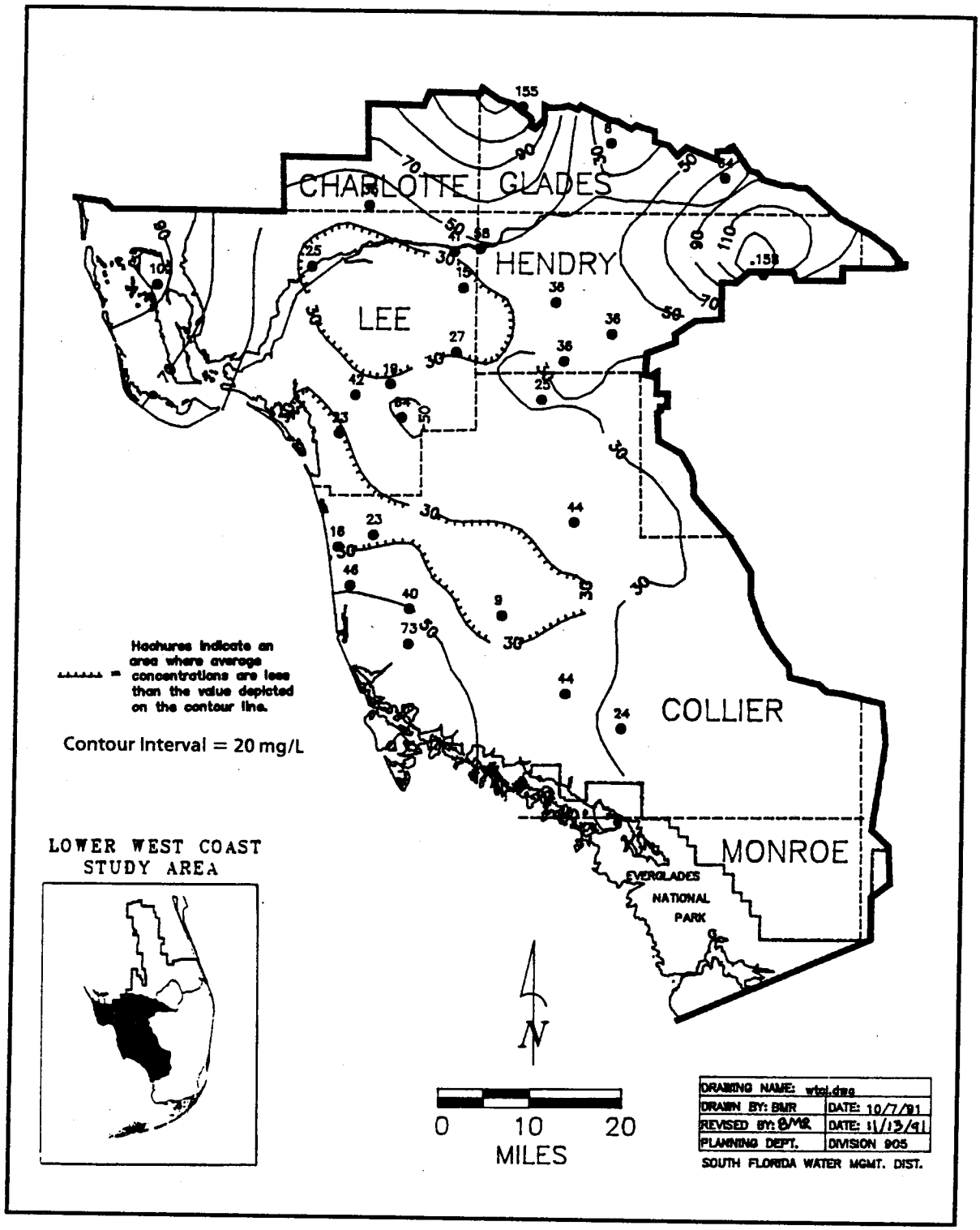


FIGURE H-6. Average Chloride Concentrations (mg/L) of the Water Table Aquifer (1984 - 1990).

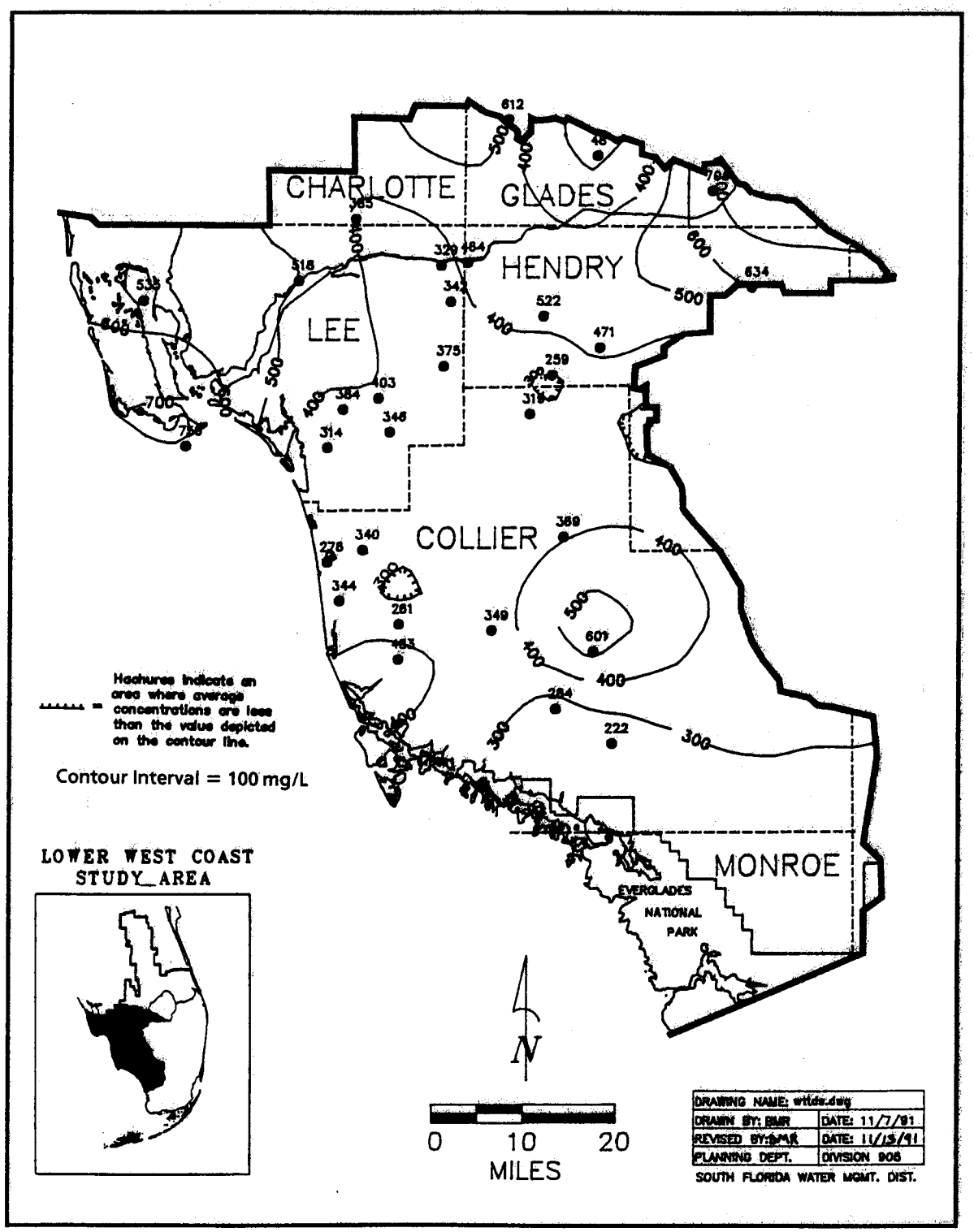


FIGURE H-7. Average Total Dissolved Solids (mg/L) of the Water Table Aquifer (1984 to 1990).

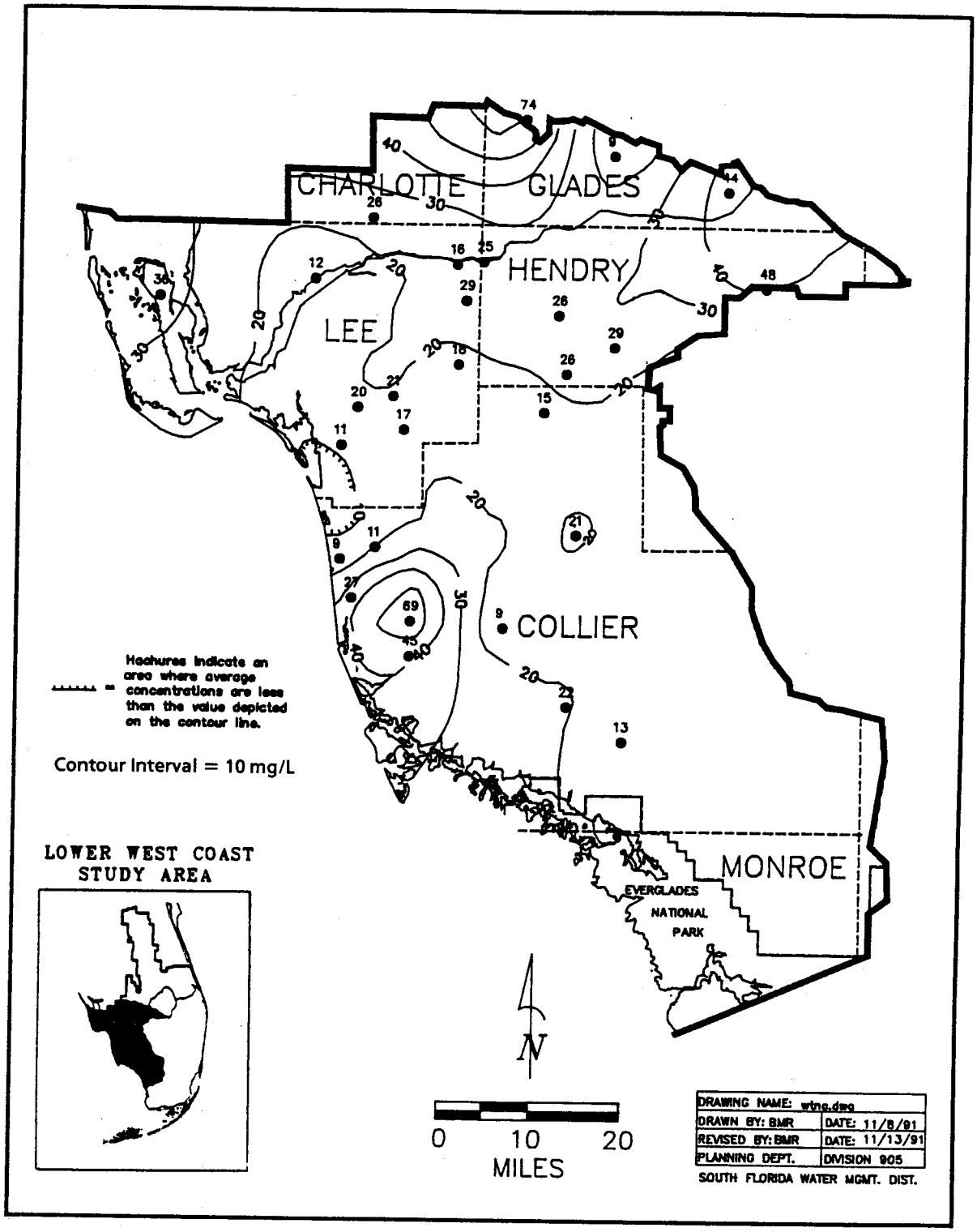


FIGURE H-8. Average Sodium Concentrations (mg/L) of the Water Table Aquifer (1984 to 1990).

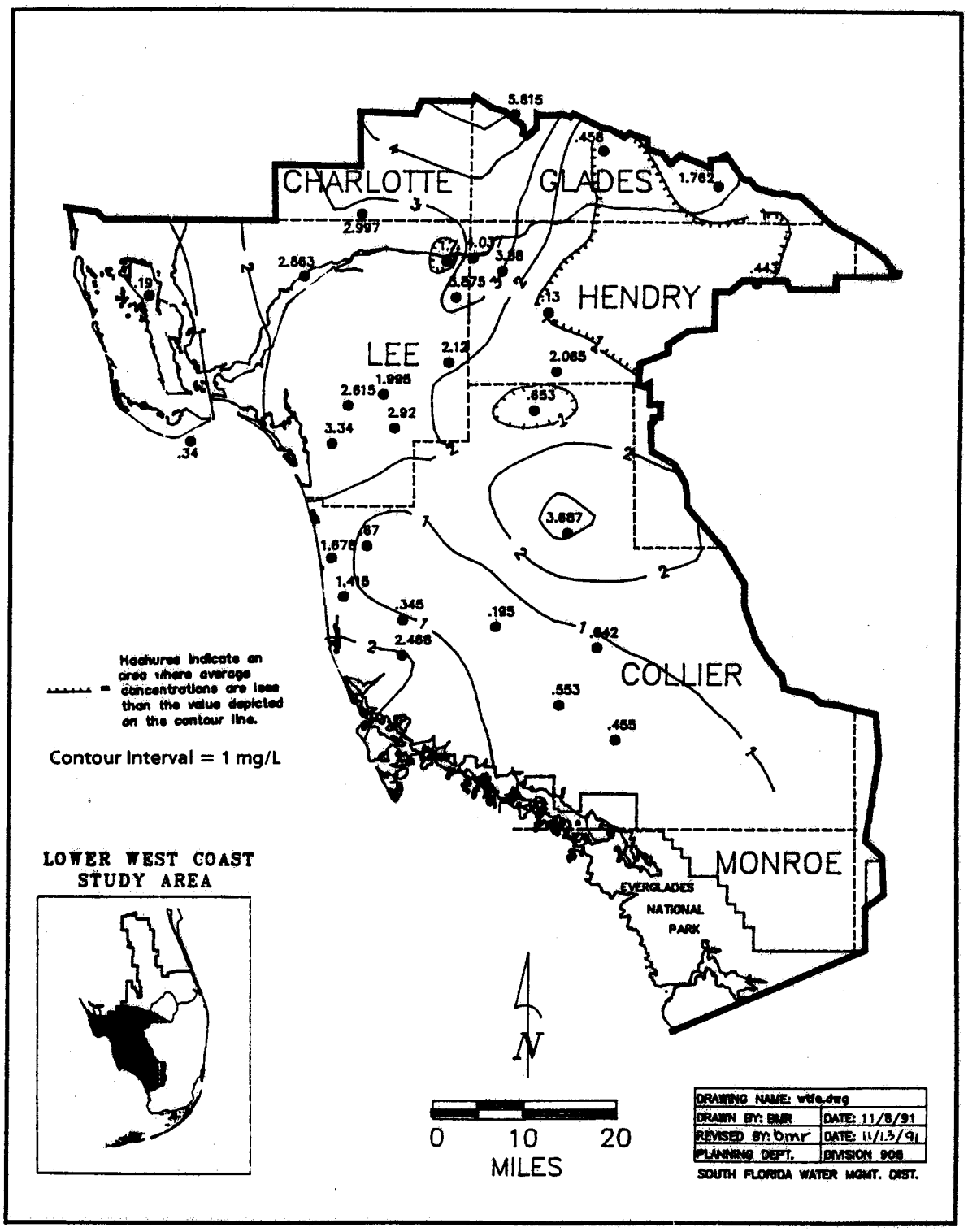


FIGURE H-9. Average Iron Concentrations (mg/L) of the Water Table Aquifer (1984 to 1990).

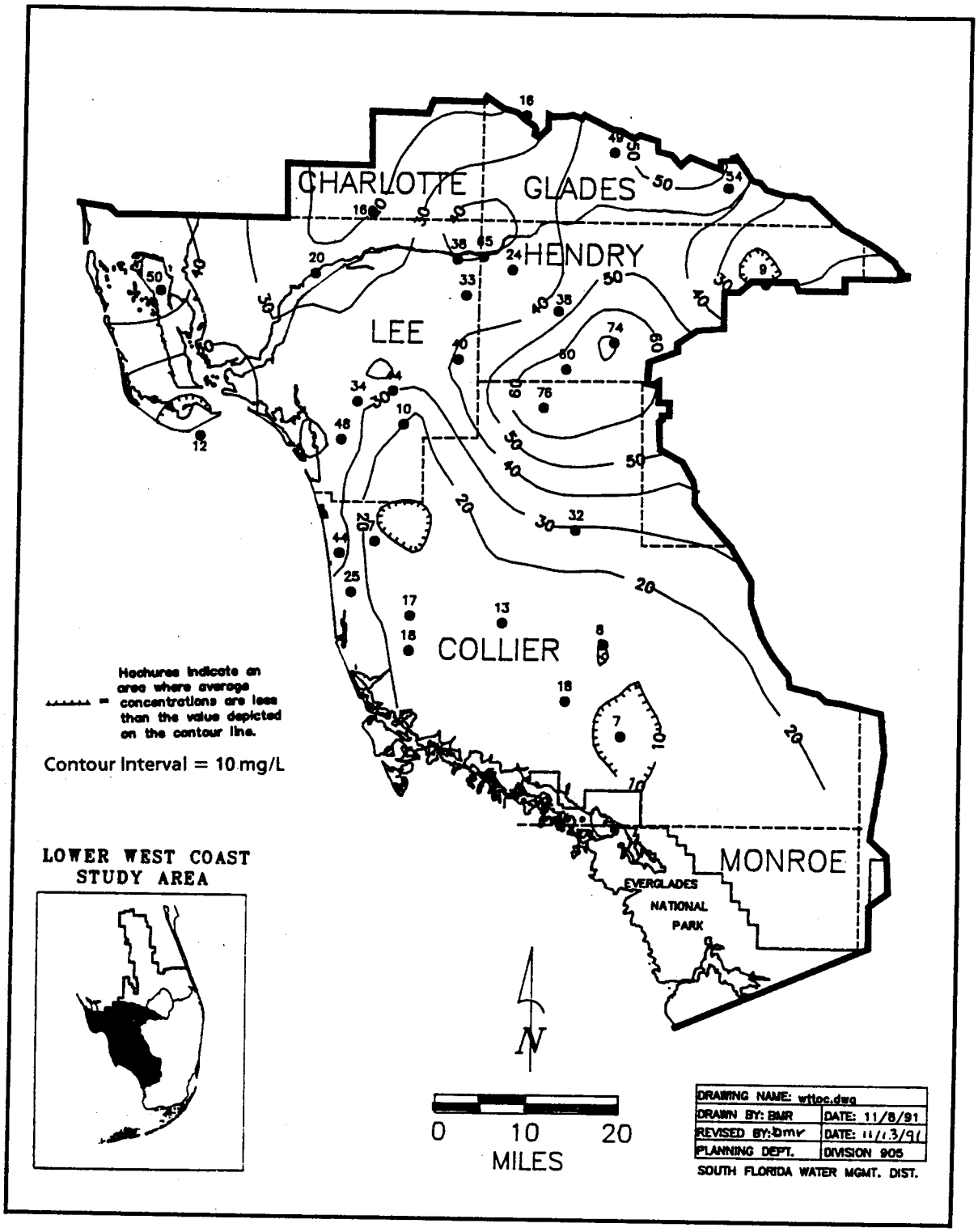


FIGURE H-10. Average Total Organic Carbon (mg/L) of the Water Table Aquifer (1984 to 1990).

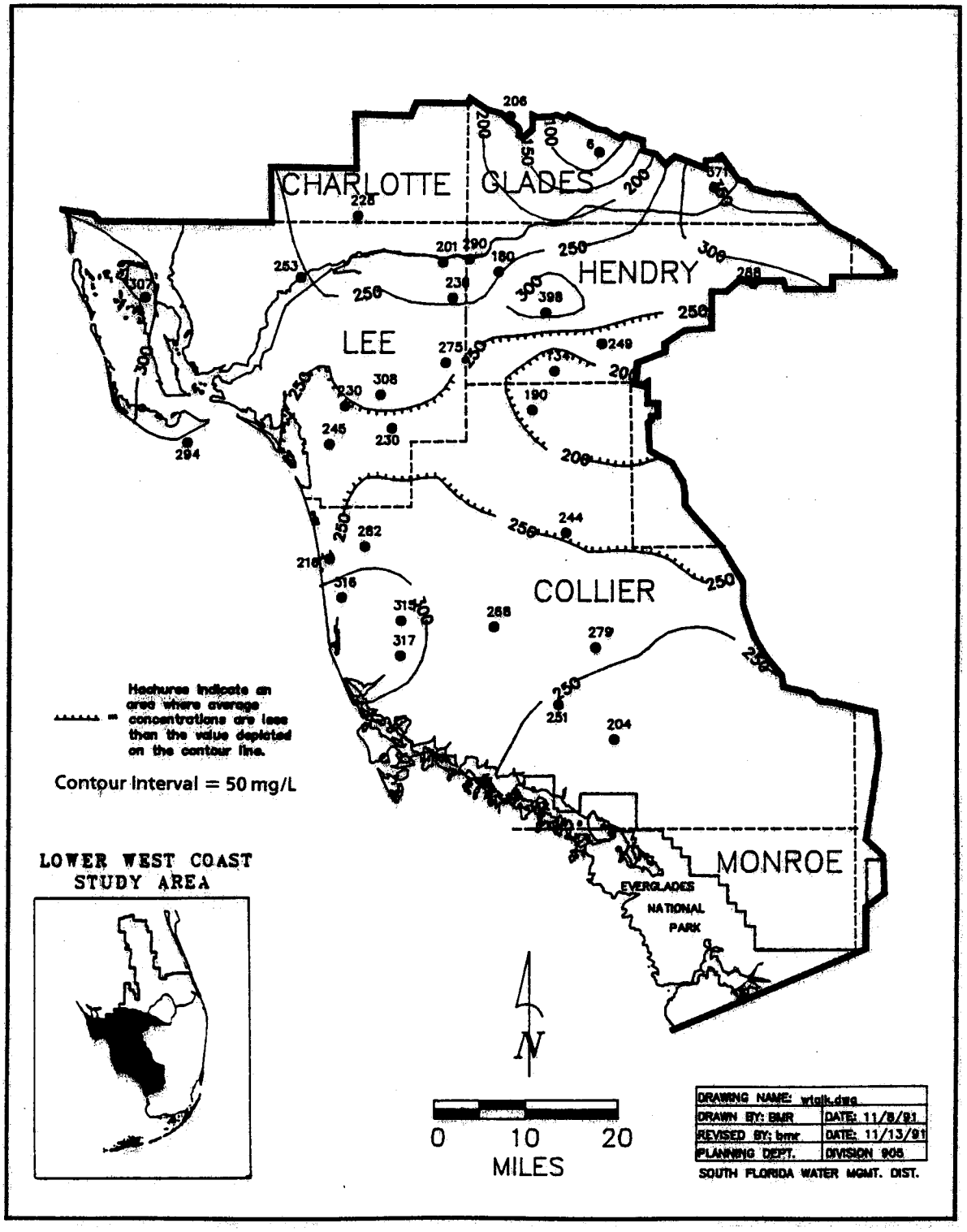


FIGURE H-11. Average Alkalinity (as mg/L of HCO_3) of the Water Table Aquifer (1984 to 1990).

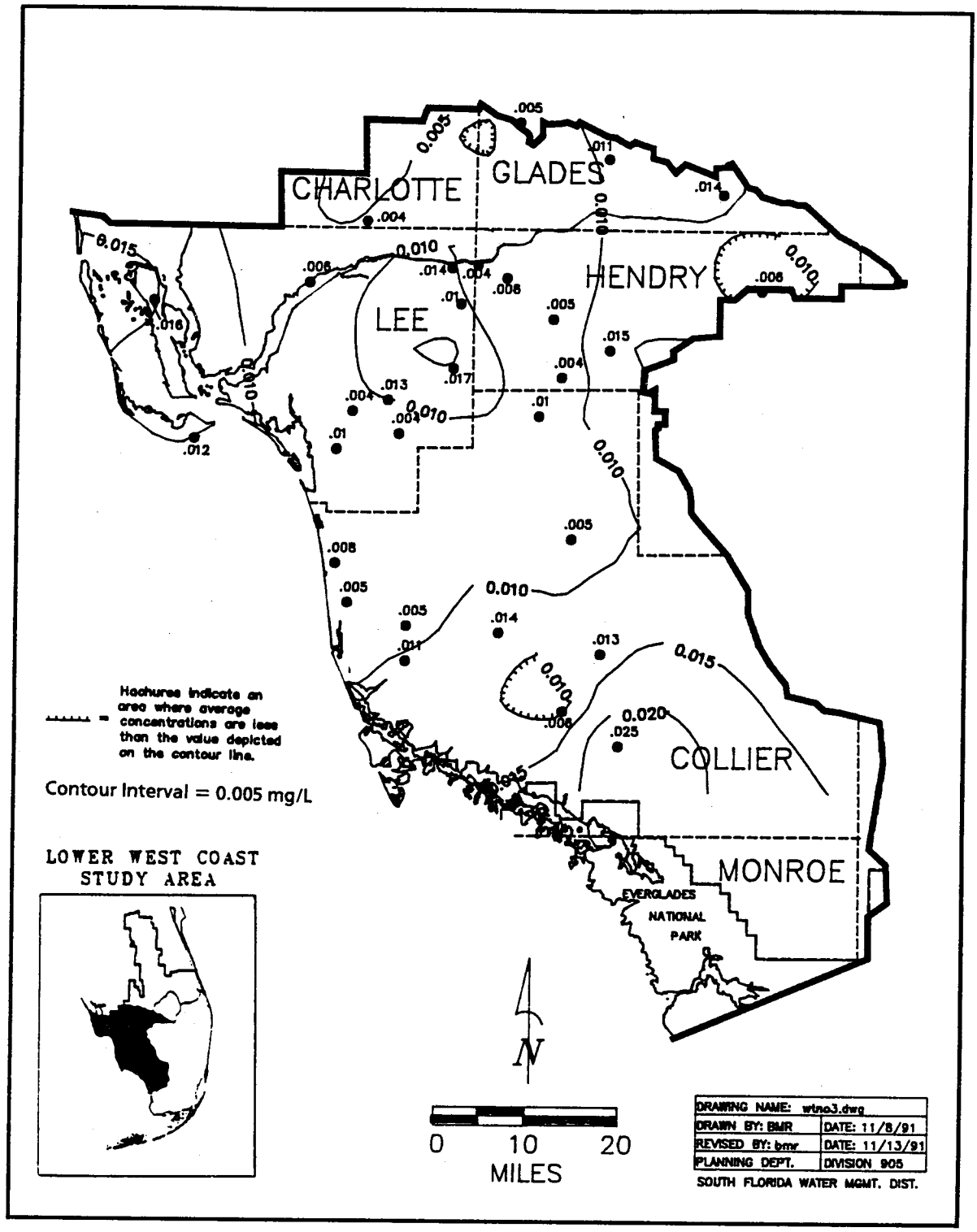


FIGURE H-12. Average Nitrate Nitrogen Concentrations (mg/L) of the Water Table Aquifer (1984 - 1990).

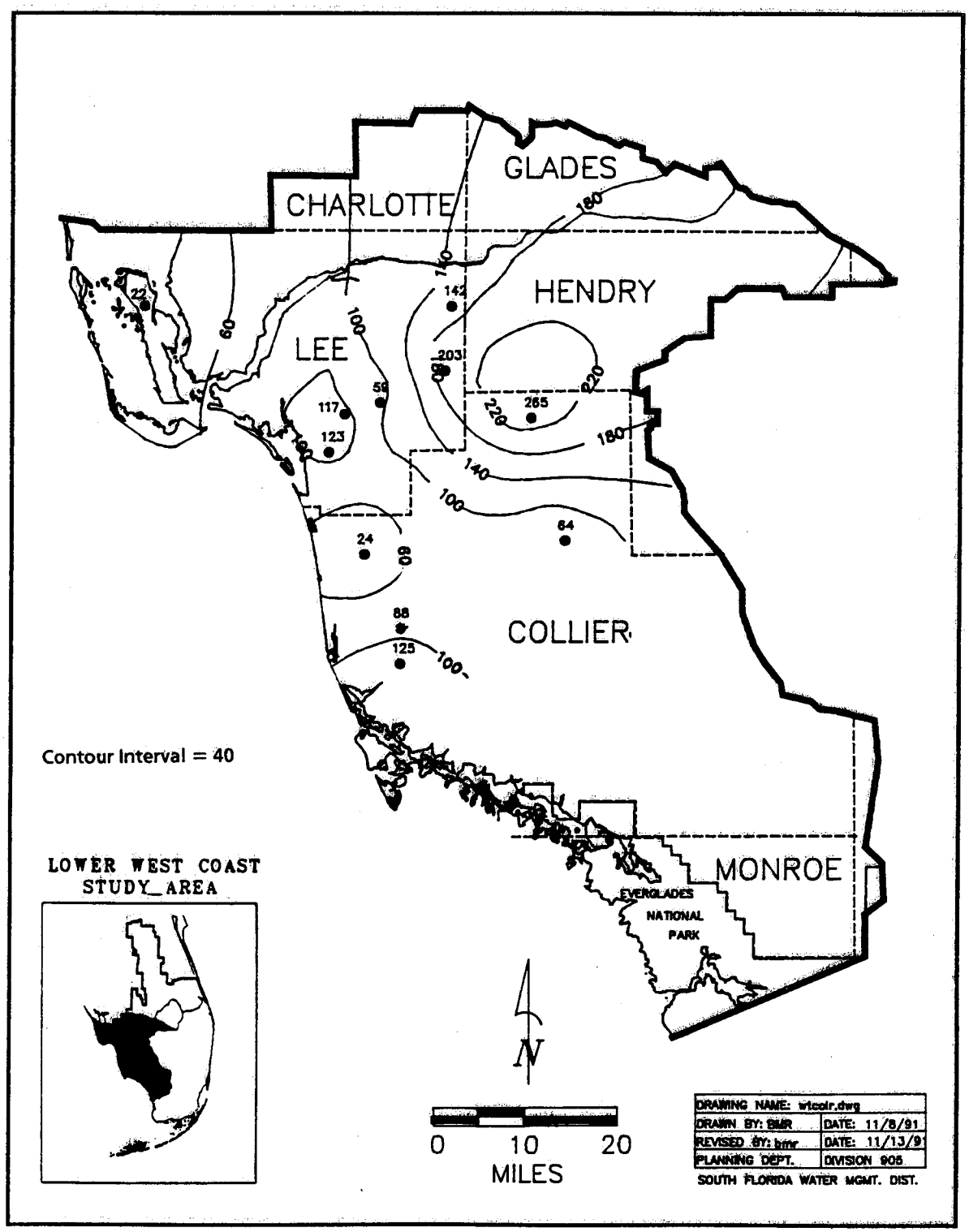


FIGURE H-13. Average Color (units) of the Water Table Aquifer (1984 to 1990).

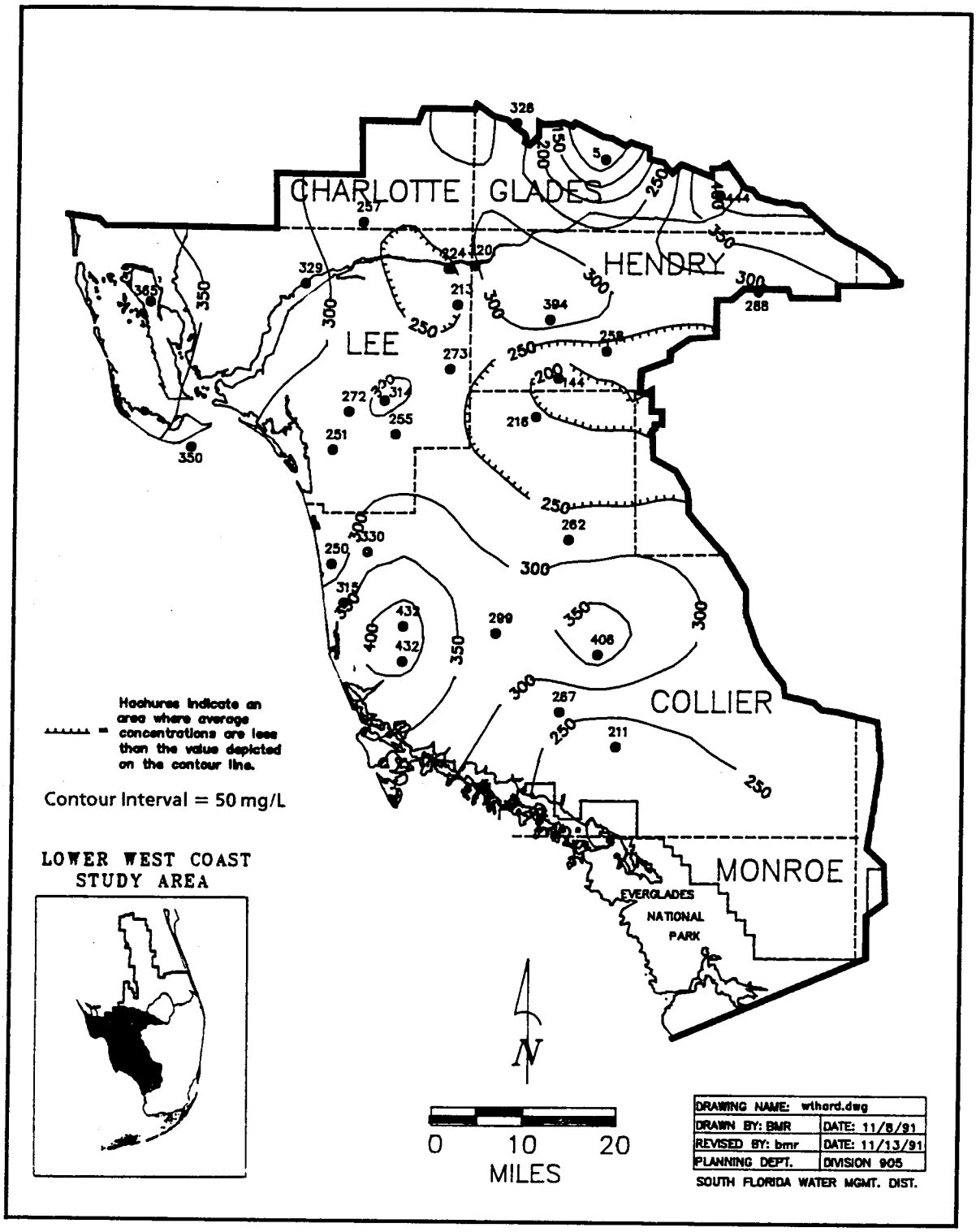


FIGURE H-14. Average Hardness (as mg/L of $CaCO_3$) of the Water Table Aquifer (1984 to 1990).

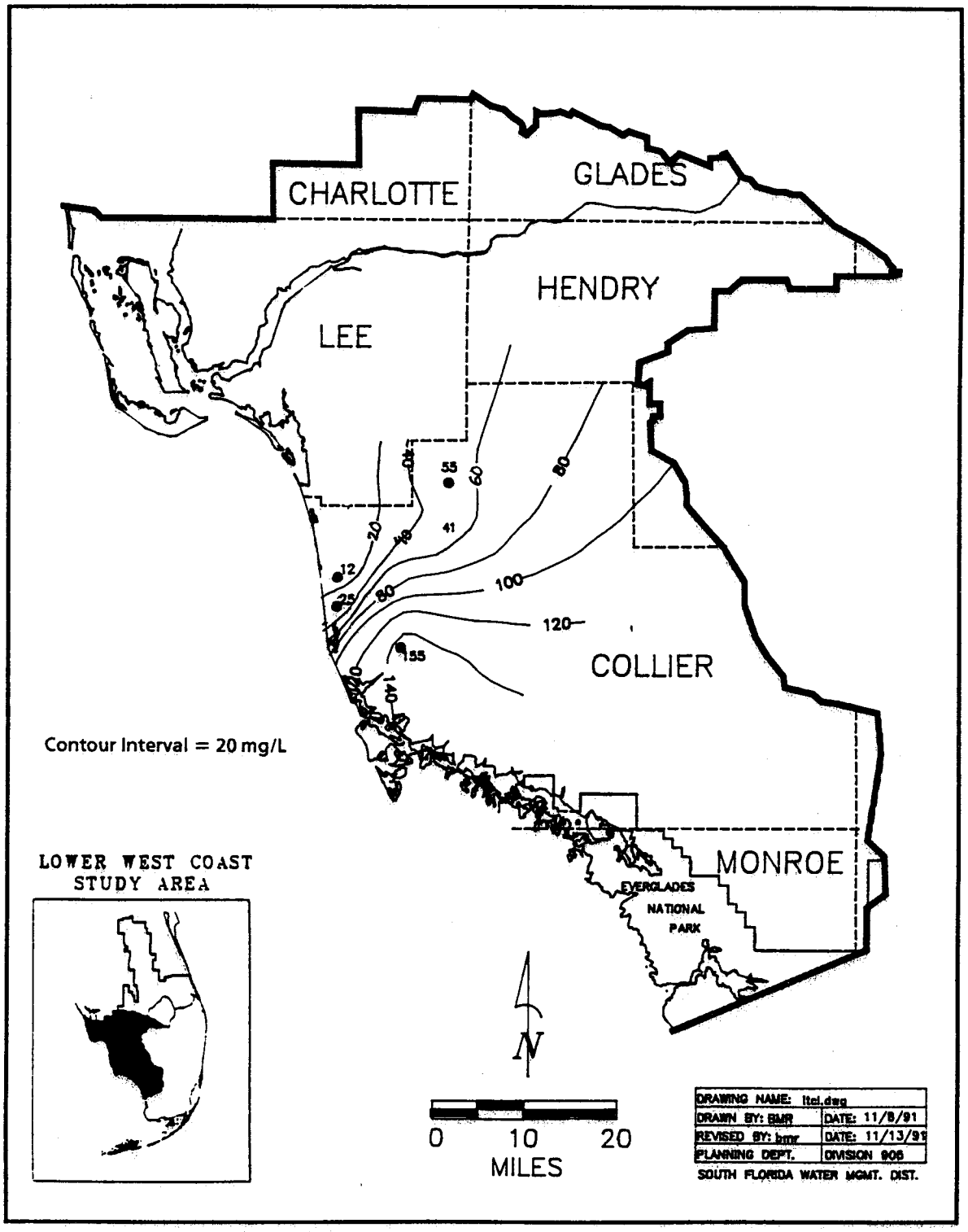


FIGURE H-15. Average Chloride Concentrations (mg/L) of the Lower Tamiami Aquifer (1984 to 1990).

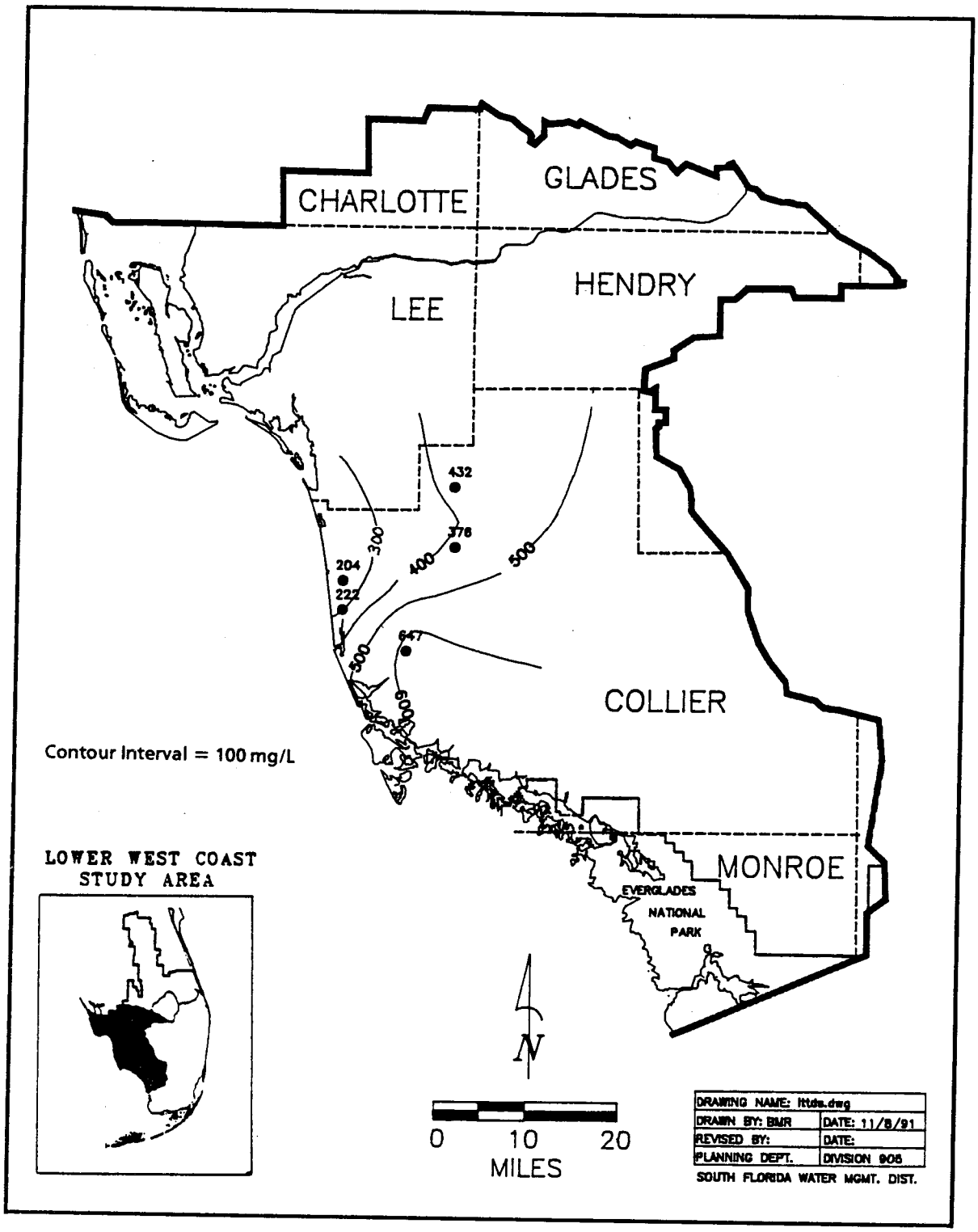


FIGURE H-16. Average Total Dissolved Solids (mg/L) of the Lower Tamiami Aquifer (1984 to 1990).

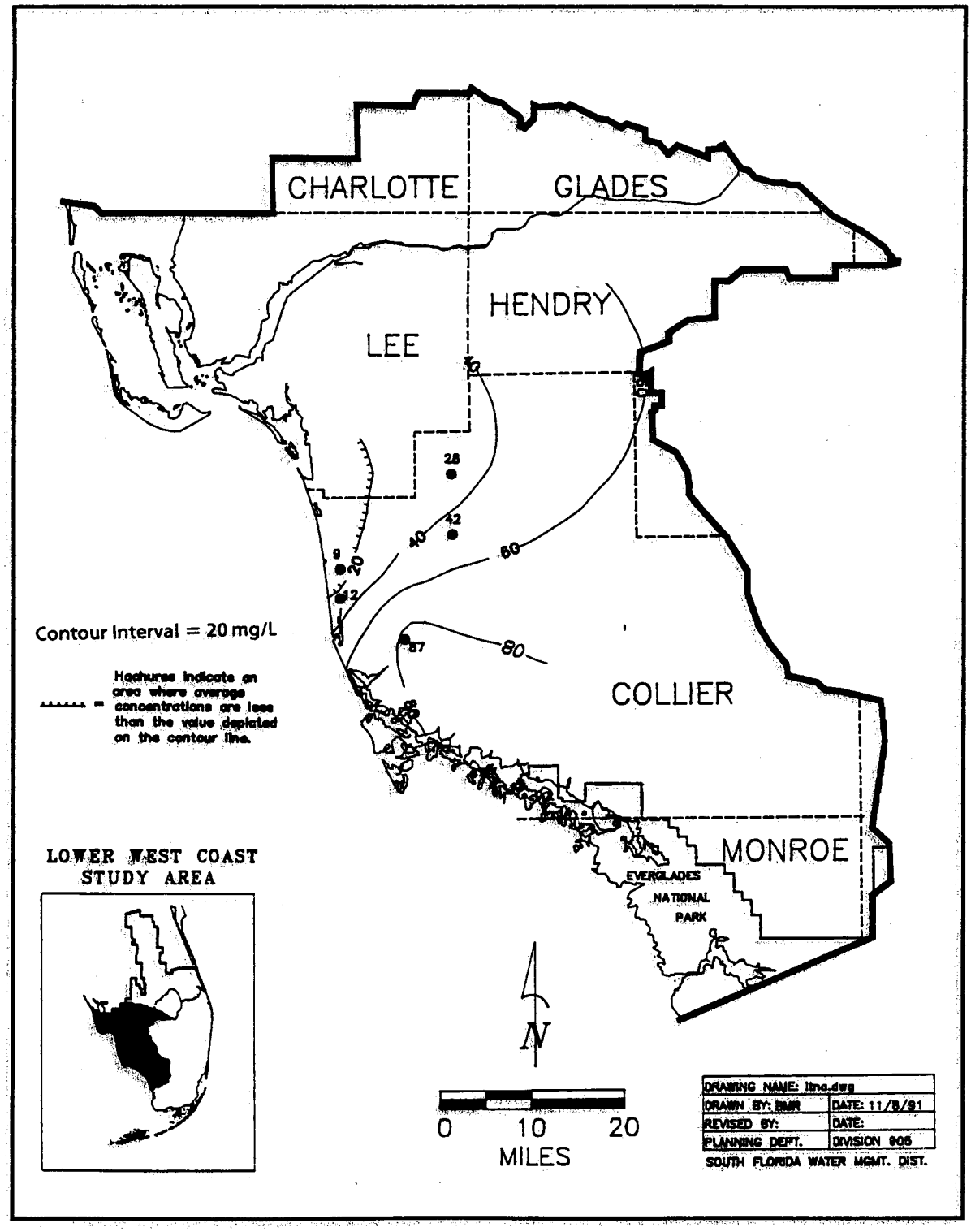


FIGURE H-17. Average Sodium Concentrations (mg/L) of the Lower Tamiami Aquifer (1984 to 1990).

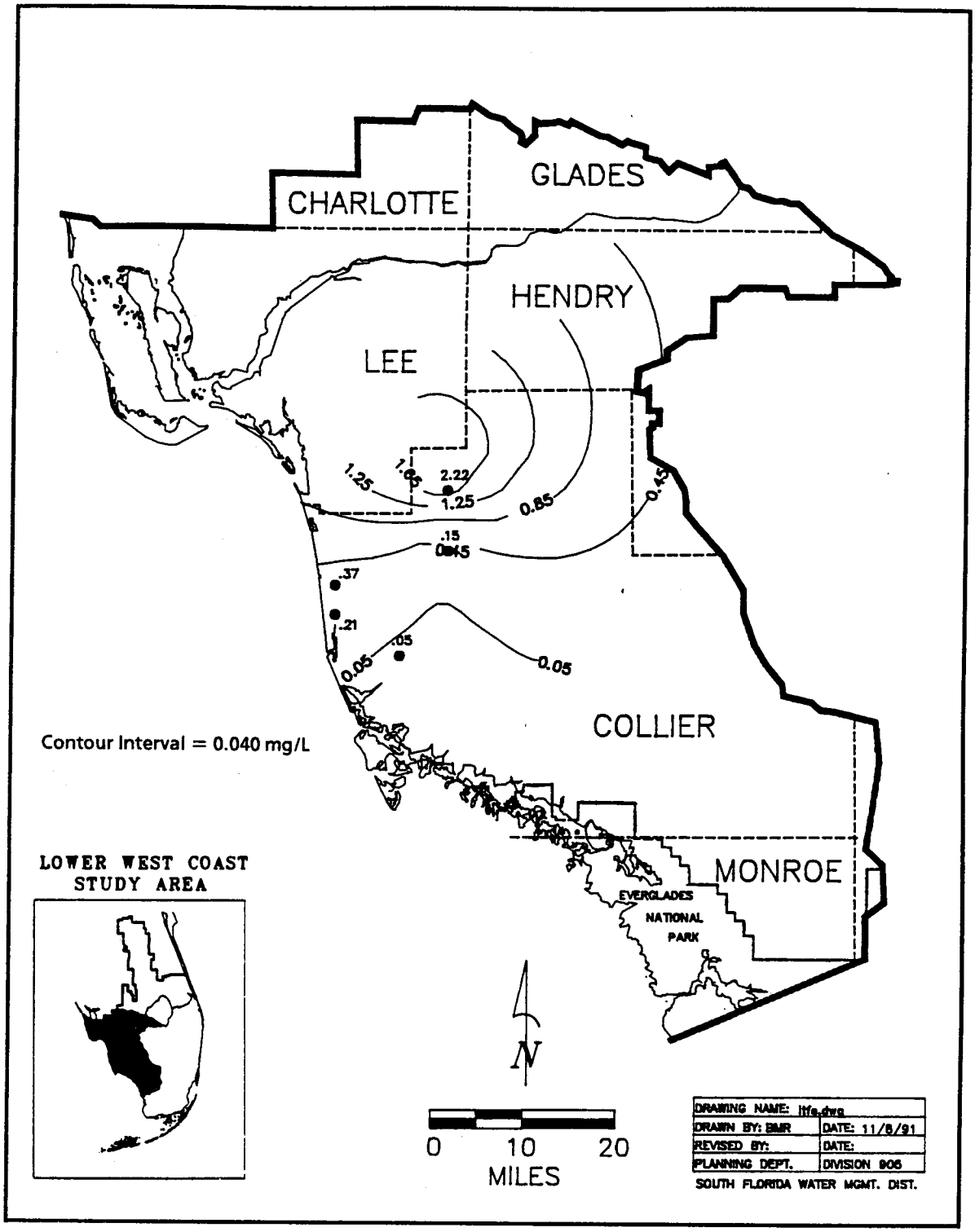


FIGURE H-18. Average Iron Concentrations (mg/L) of the Lower Tamiami Aquifer (1984 to 1990).

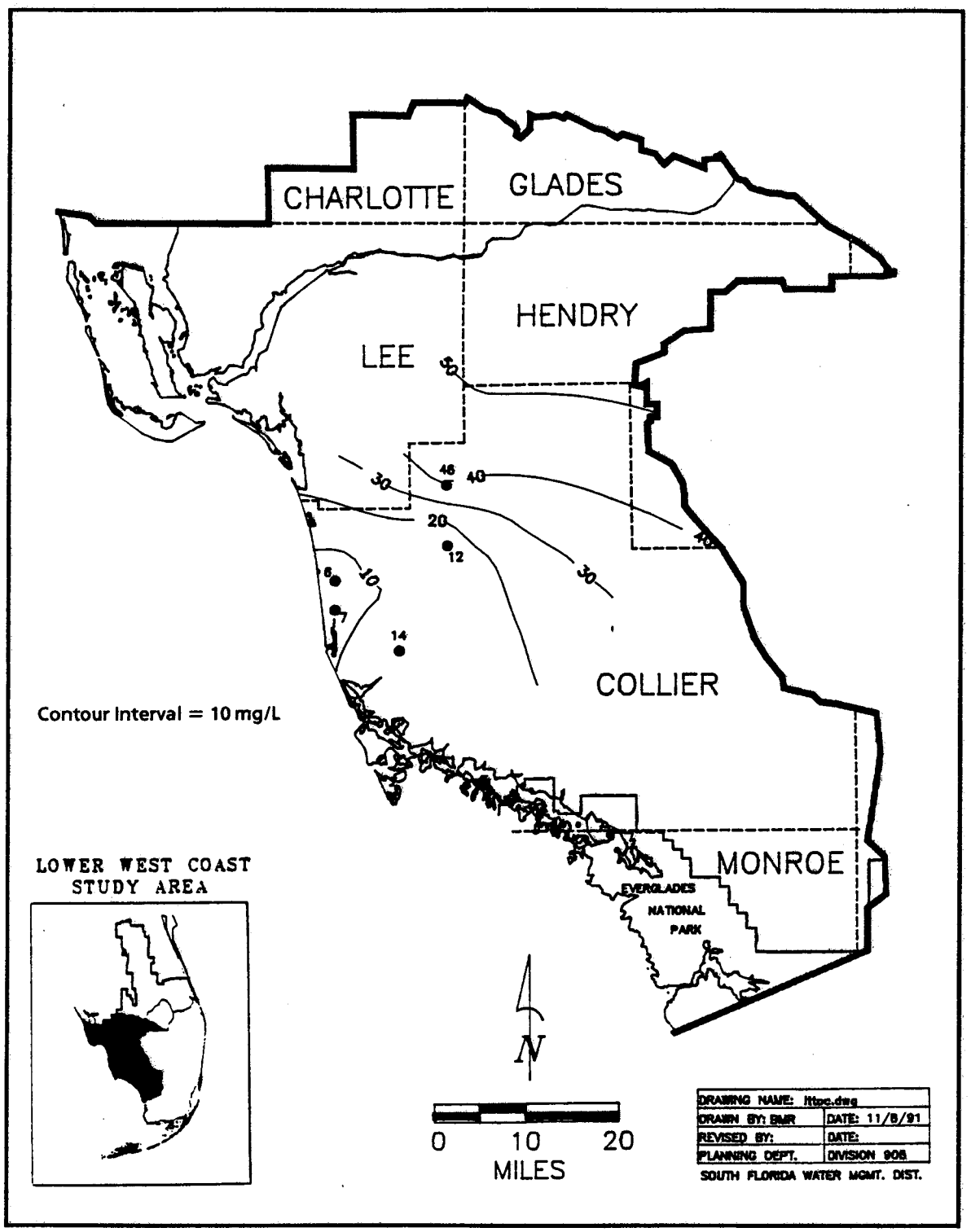


FIGURE H-19. Average Total Organic Carbon (mg/L) of the Lower Tamiami Aquifer (1984 to 1990).

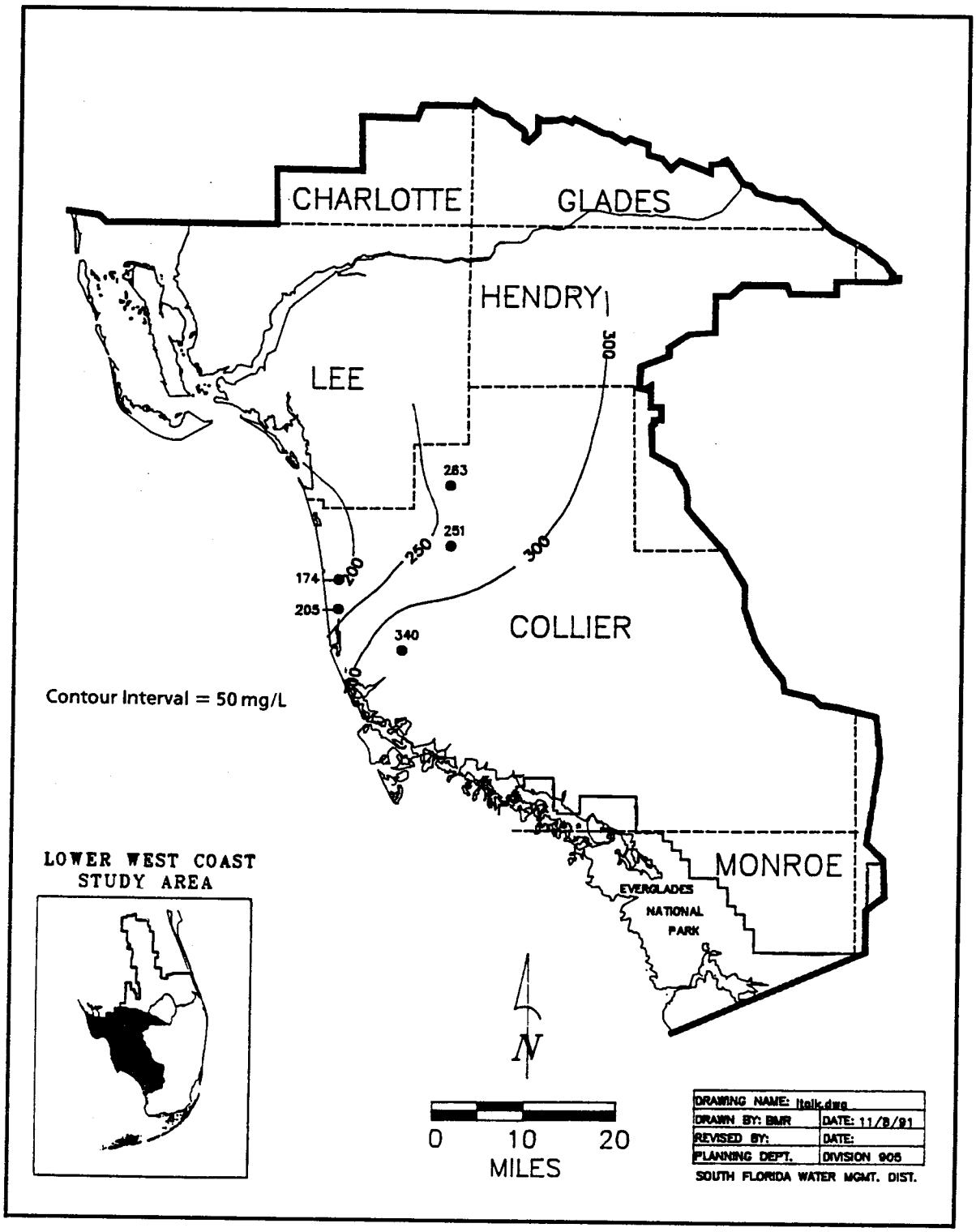


FIGURE H-20. Average Alkalinity (as mg/L of HCO_3) of the Lower Tamiami Aquifer (1984 to 1990).

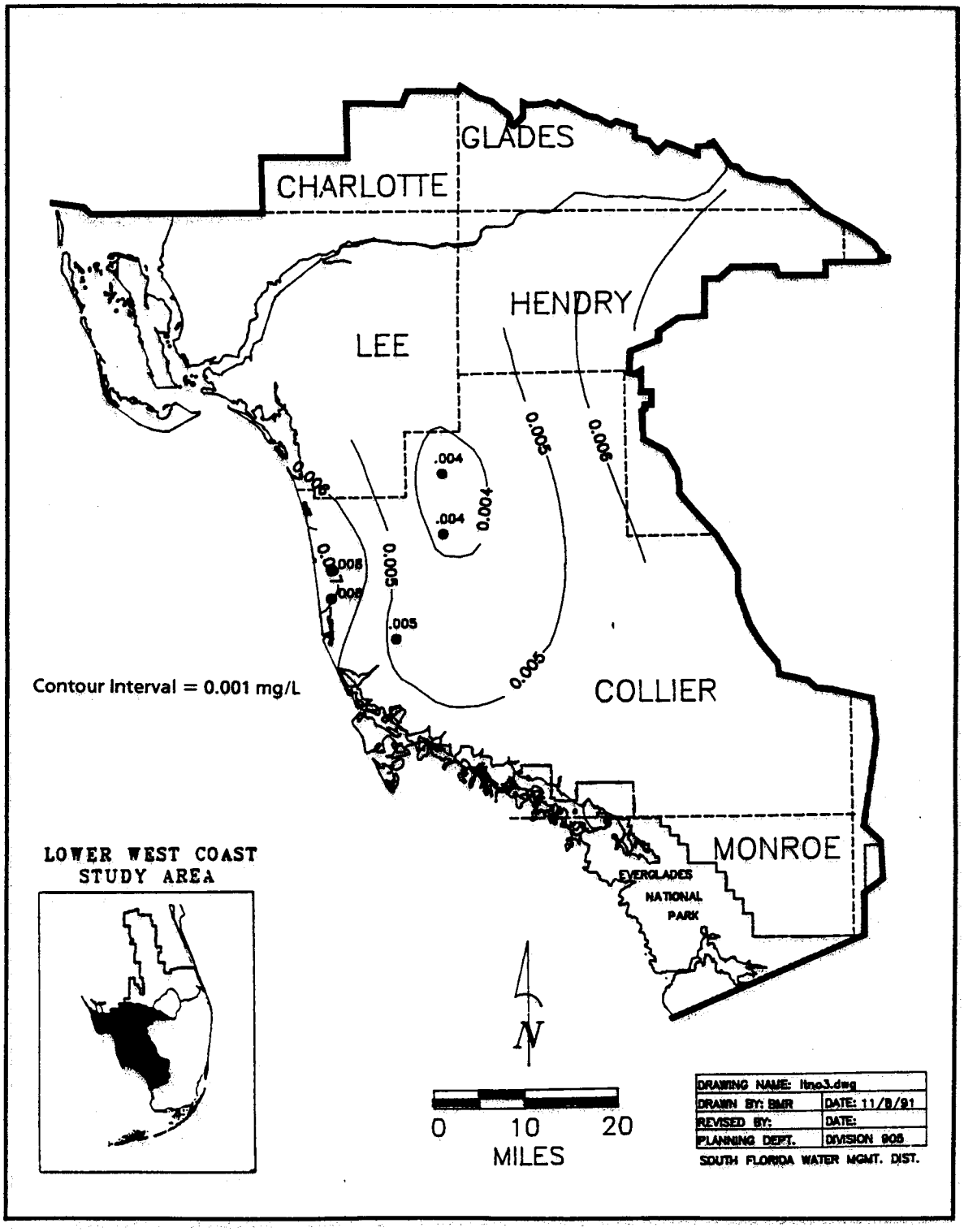


FIGURE H-21. Average Nitrate Nitrogen Concentrations (mg/L) of the Lower Tamiami Aquifer (1984 to 1990).

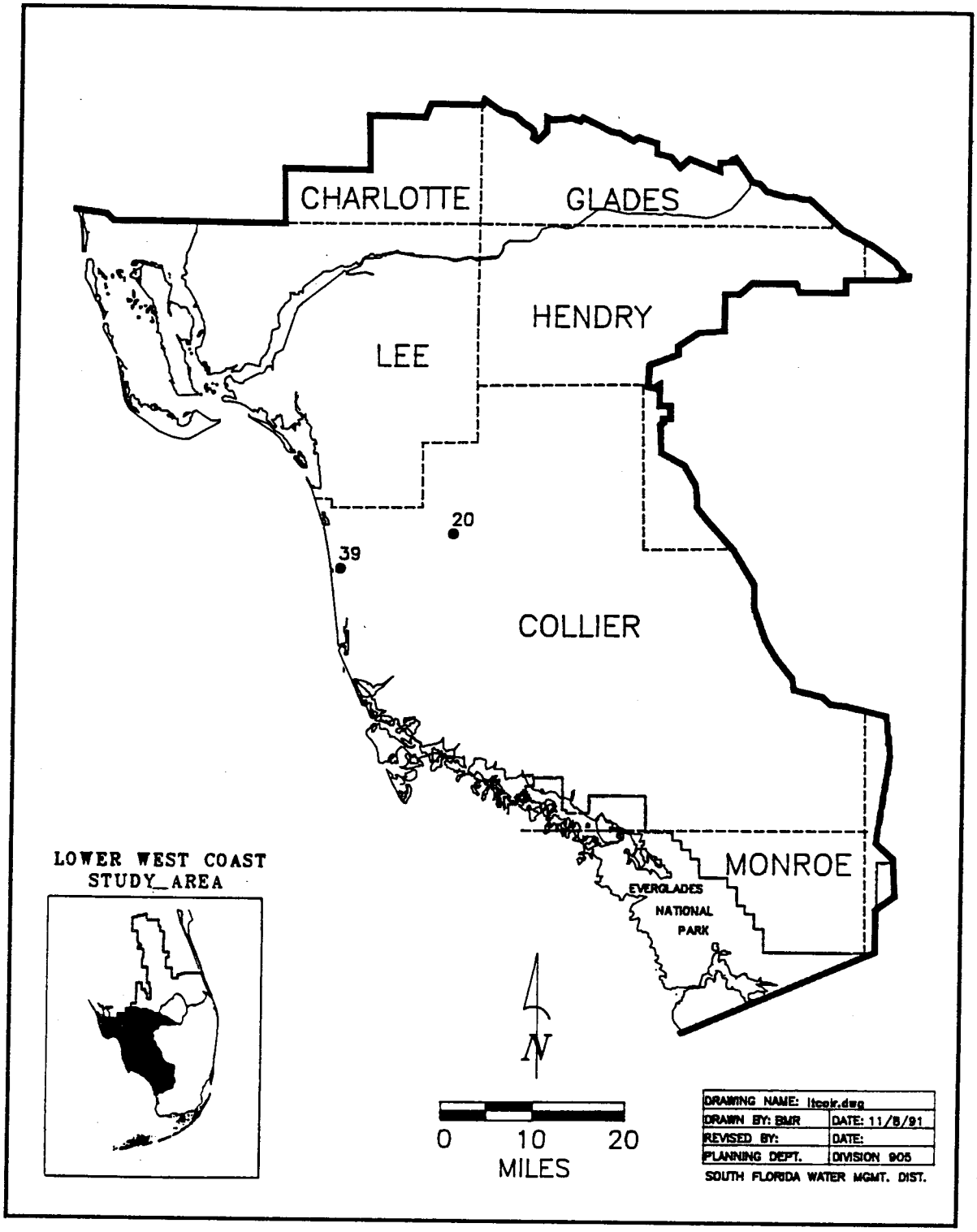


FIGURE H-22. Average Color (units) of the Lower Tamiami Aquifer (1984 to 1990).

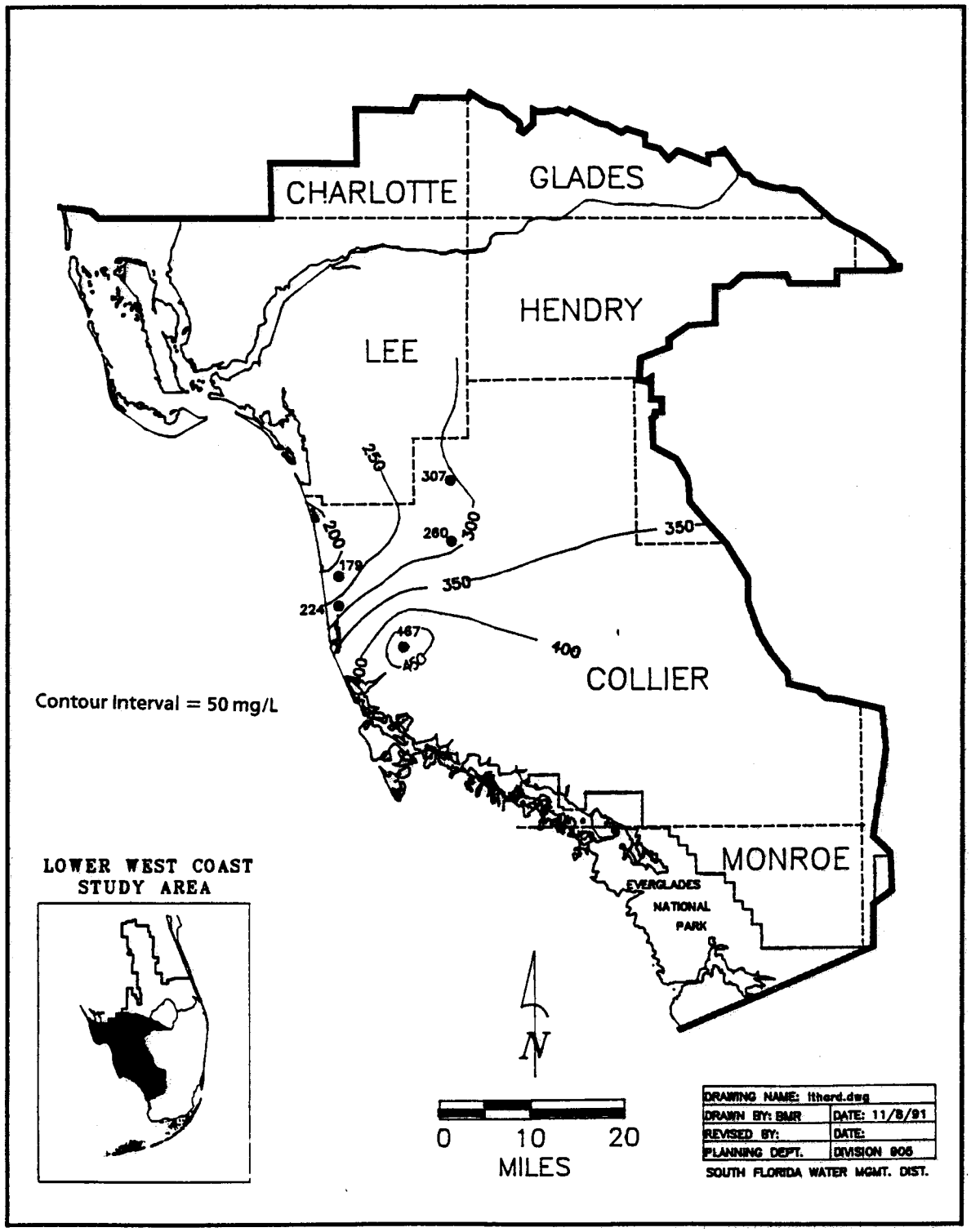


FIGURE H-23. Average Hardness (as mg/L of $CaCO_3$) of the Lower Tamiami Aquifer (1984 to 1990).

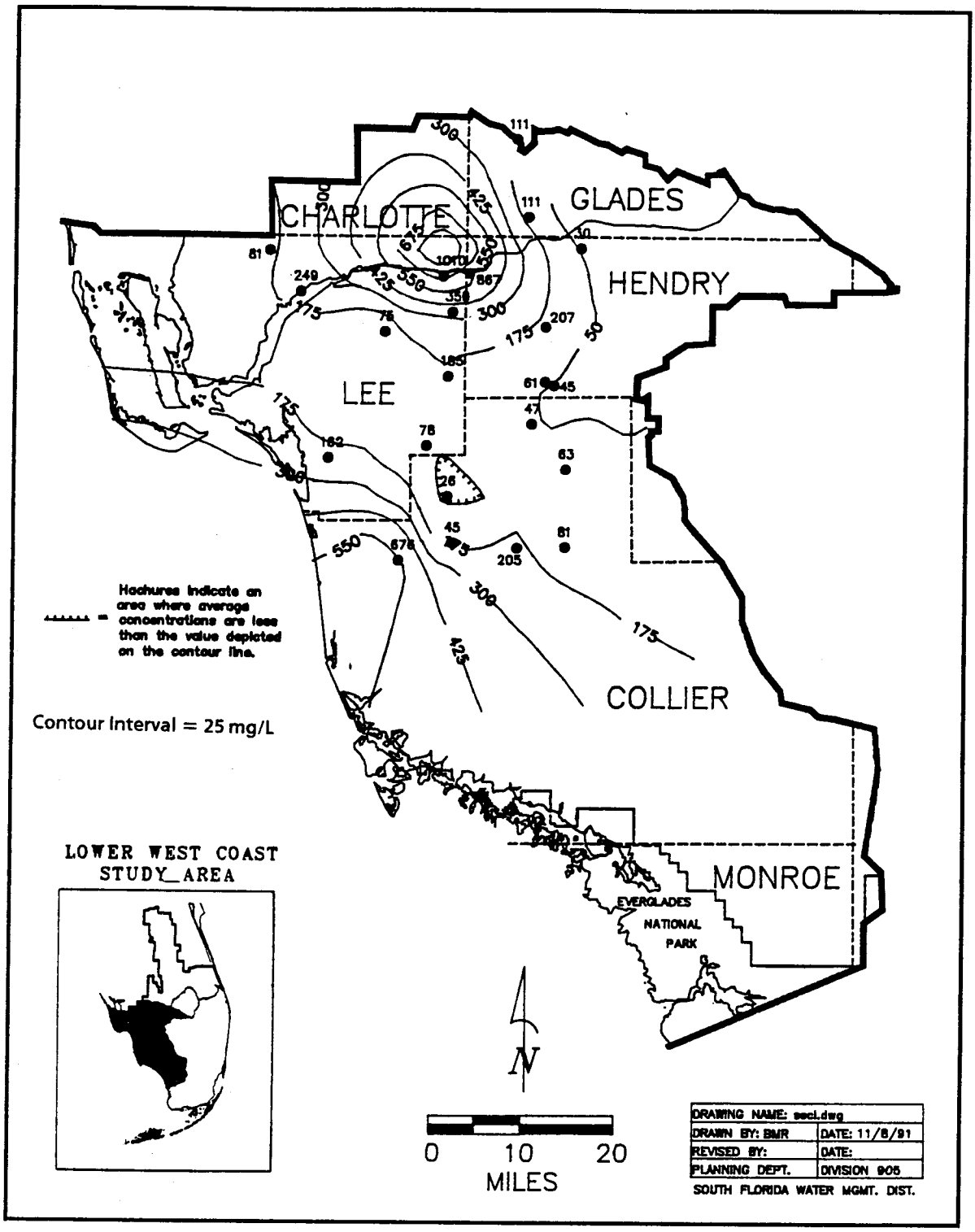


FIGURE H-24. Average Chloride Concentrations (mg/L) of the Sandstone Aquifer (1984 to 1990).

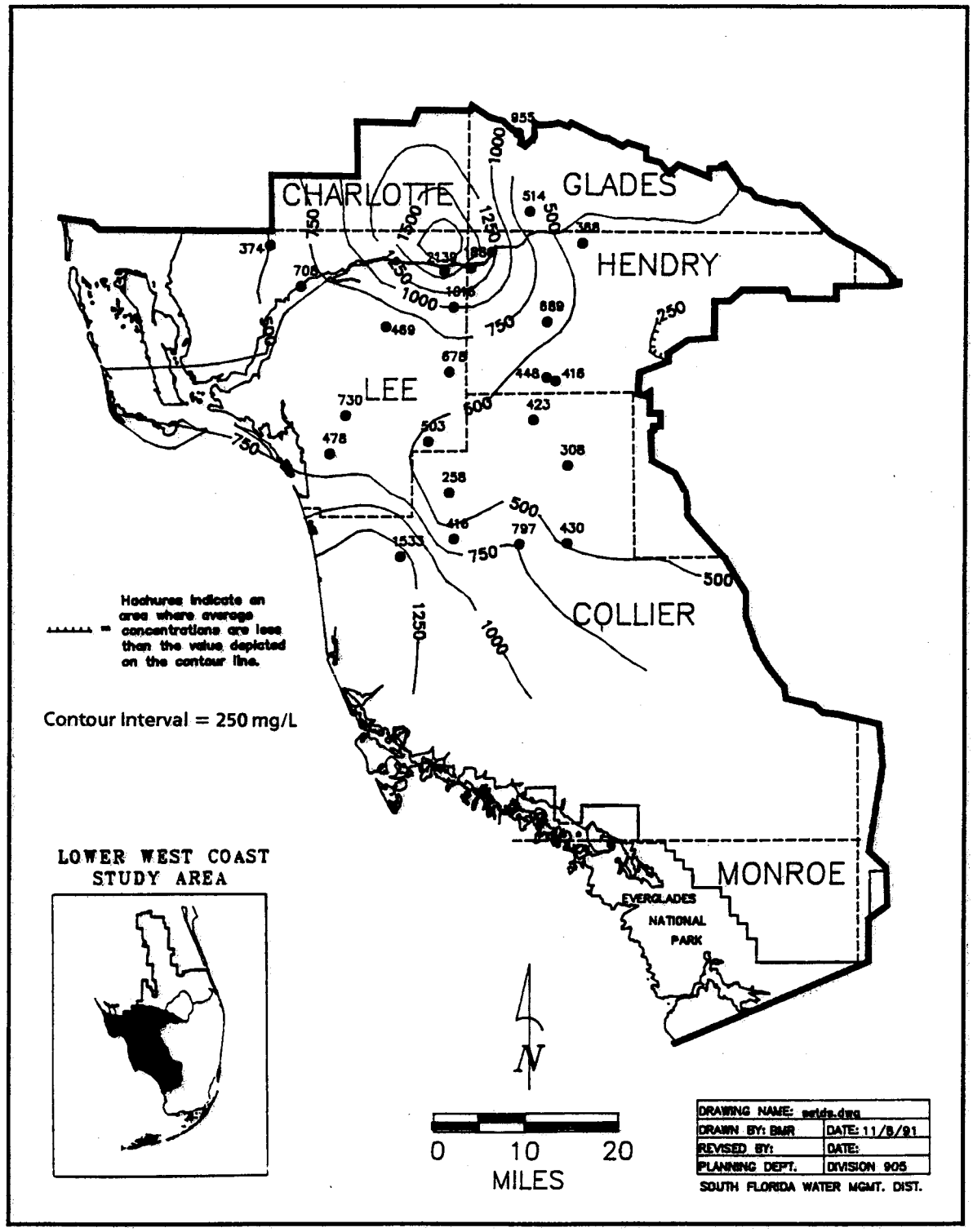


FIGURE H-25. Average Total Dissolved Solids (mg/L) of the Sandstone Aquifer (1984 to 1990).

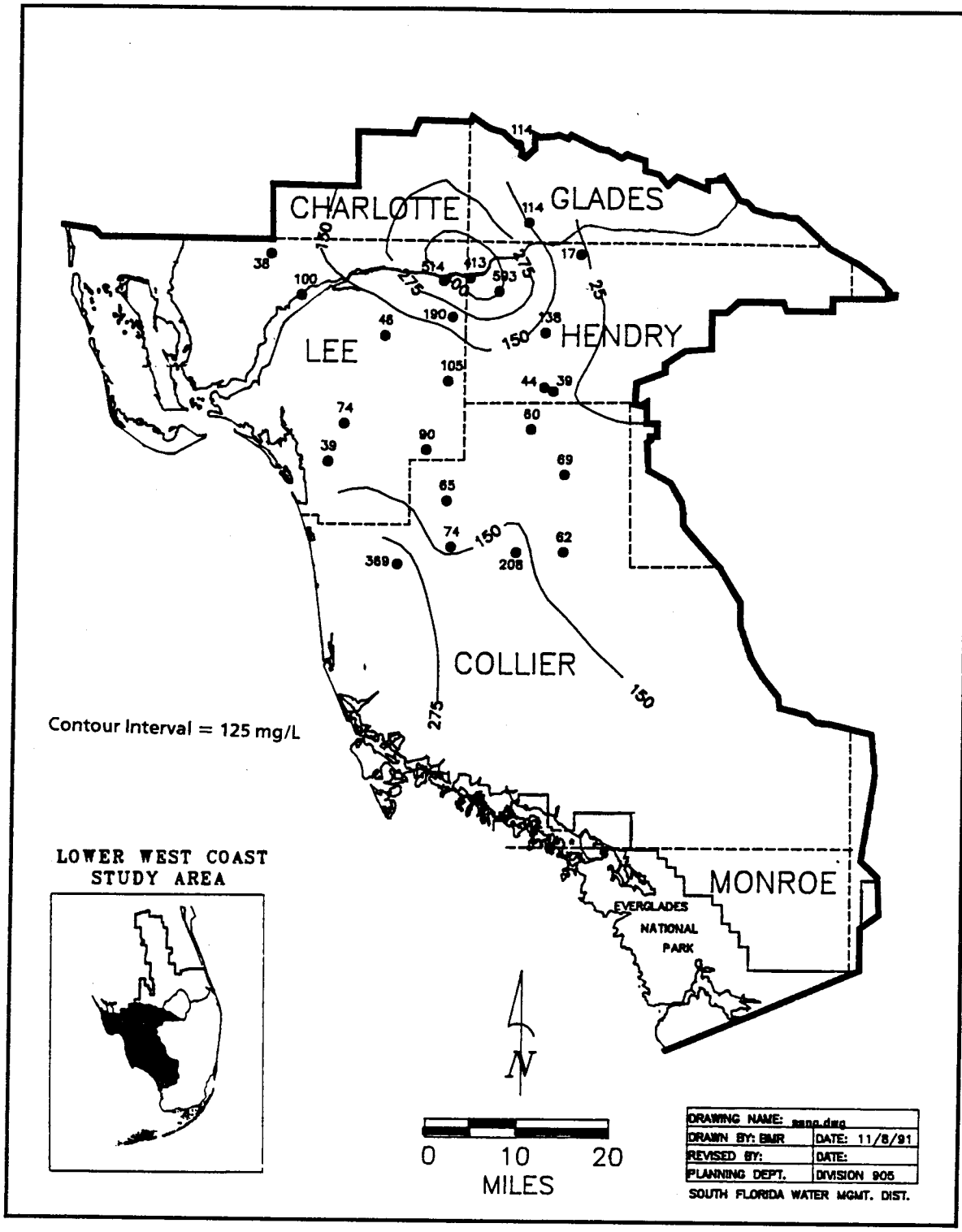


FIGURE H-26. Average Sodium Concentrations (mg/L) of the Sandstone Aquifer (1984 to 1990).

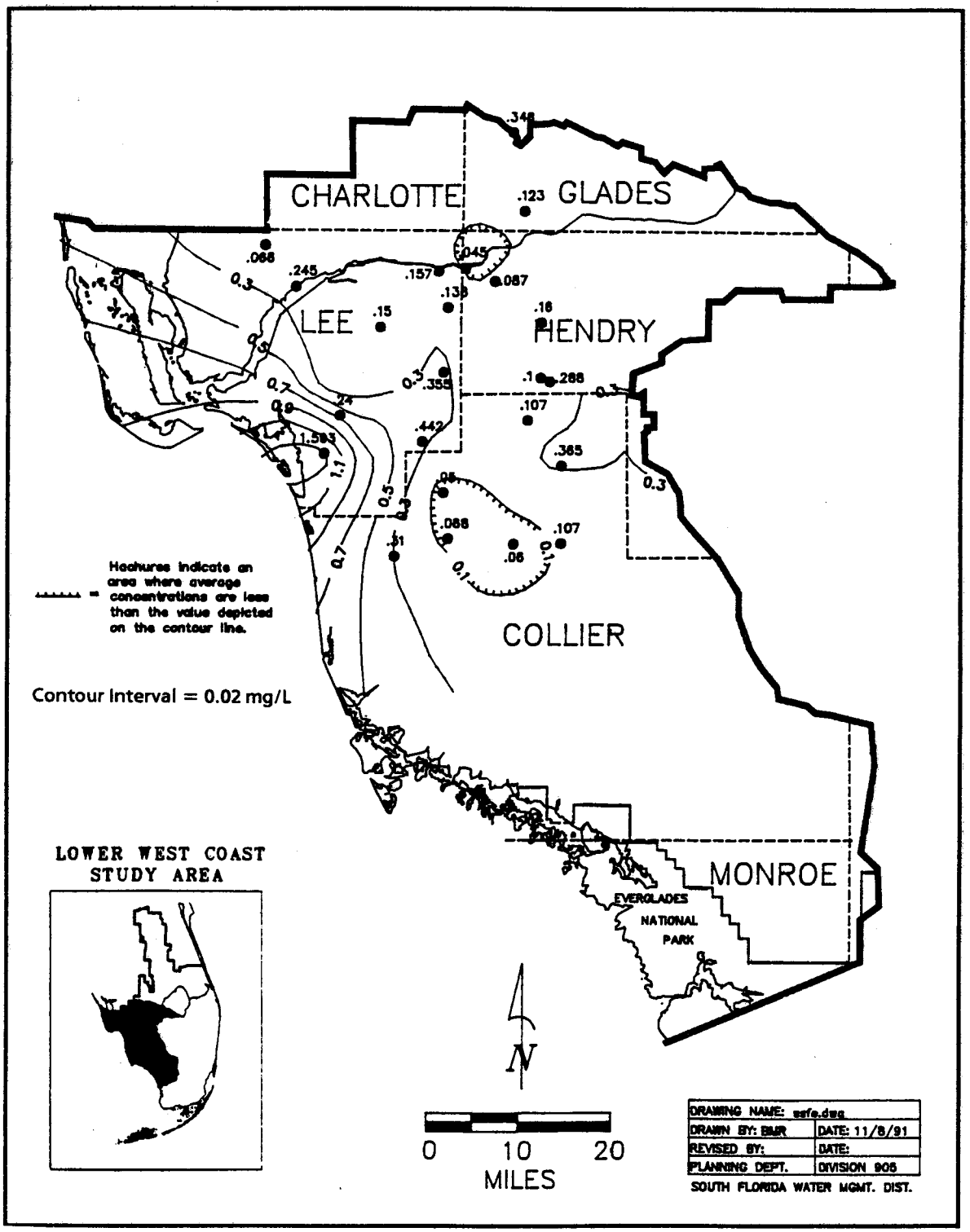


FIGURE H-27. Average Iron Concentrations (mg/L) of the Sandstone Aquifer (1984 to 1990).

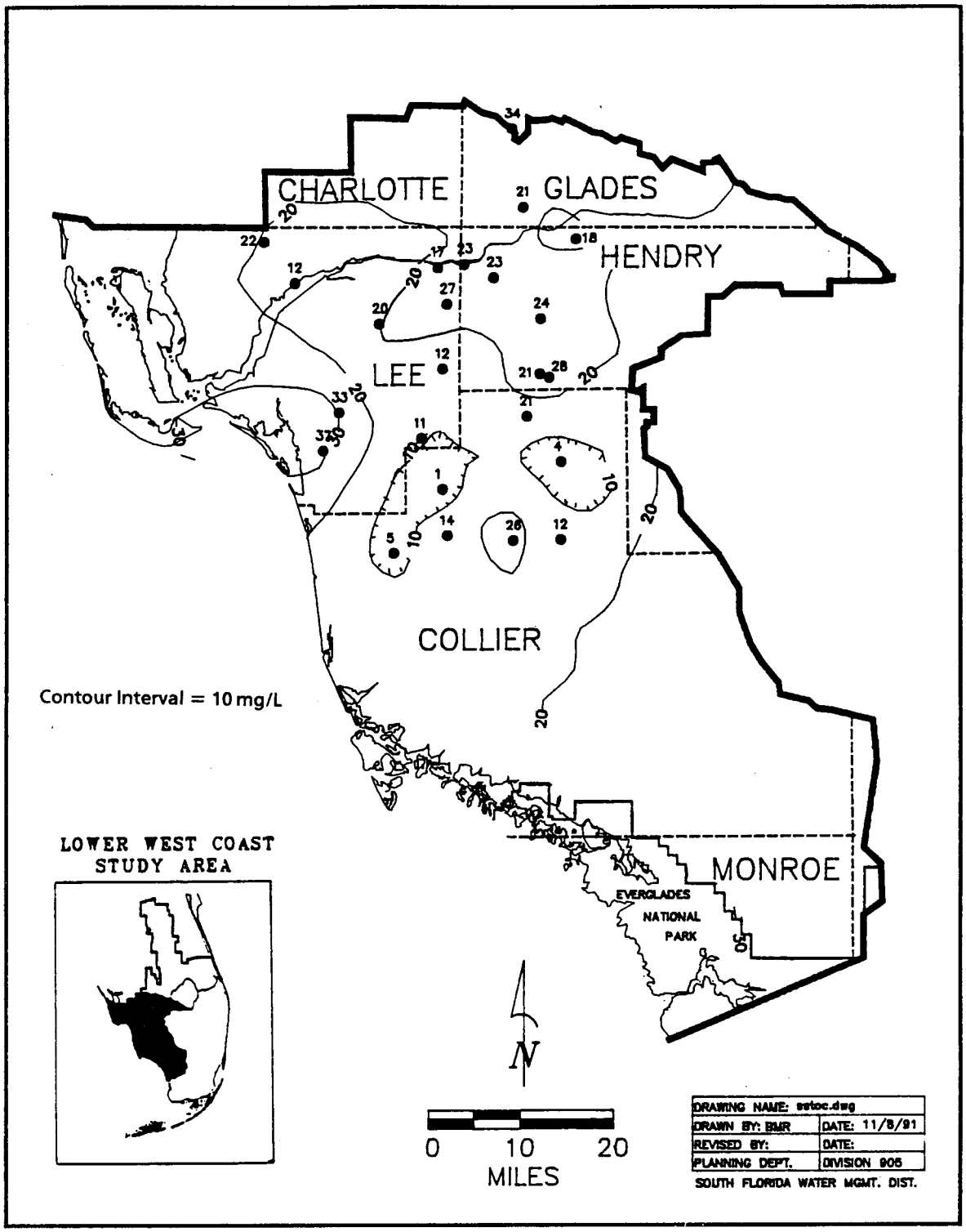


FIGURE H-28. Average Total Organic Carbon Concentrations (mg/L) of the Sandstone Aquifer (1984 to 1990).

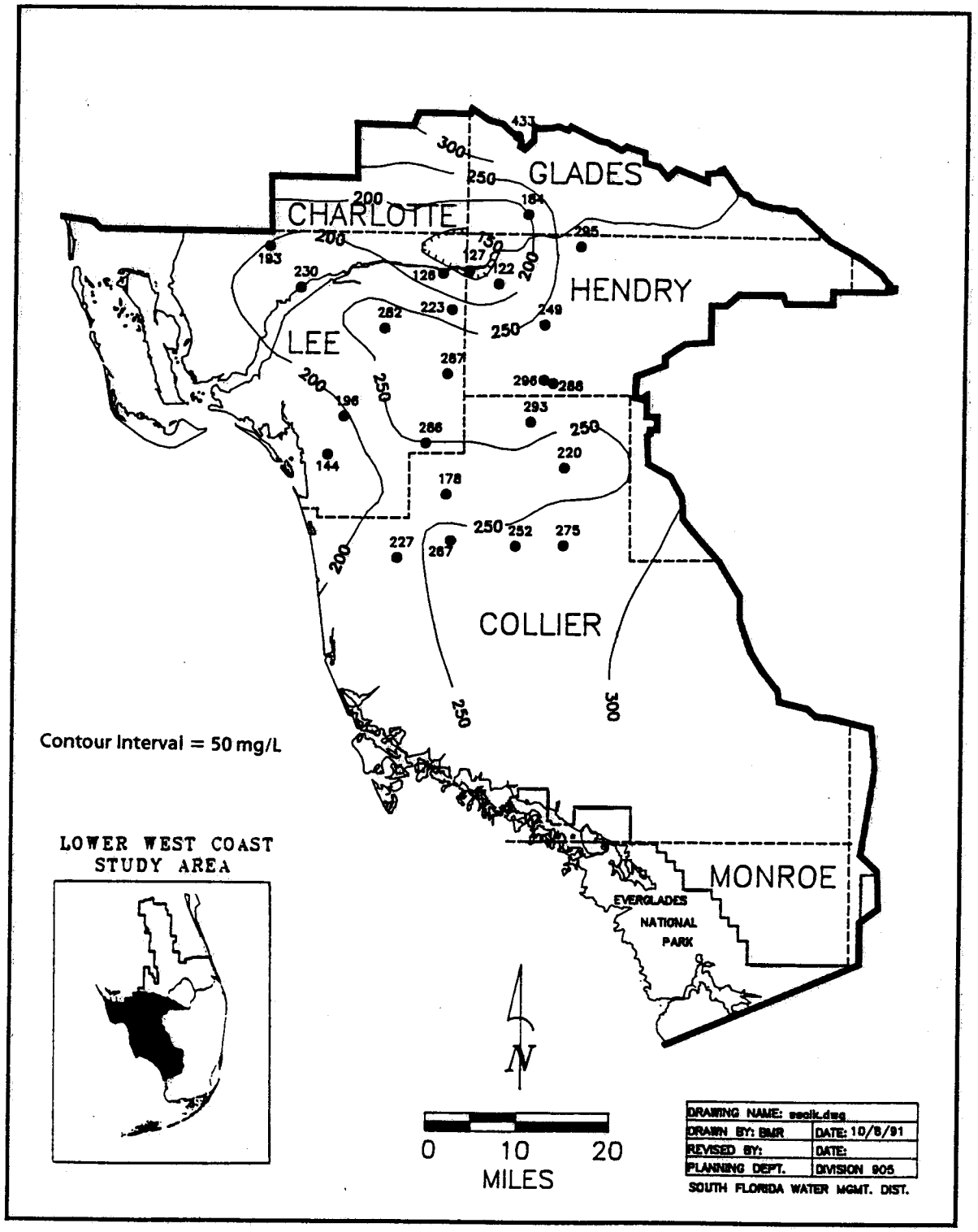


FIGURE H-29. Average Alkalinity (as mg/L of HCO_3) of the Sandstone Aquifer (1984 to 1990).

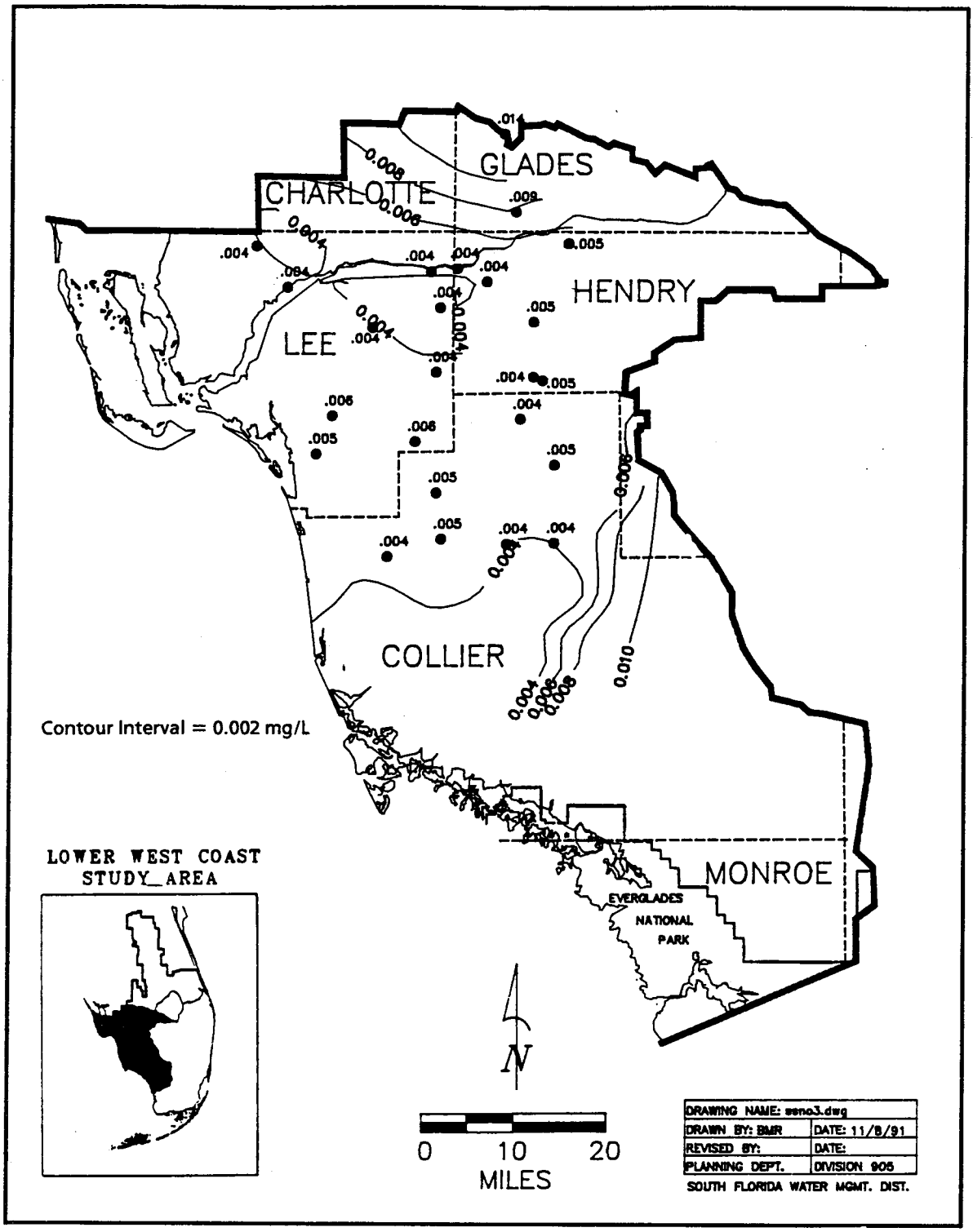


FIGURE H-30. Average Nitrate Nitrogen Concentrations (mg/L) of the Sandstone Aquifer (1984 to 1990).

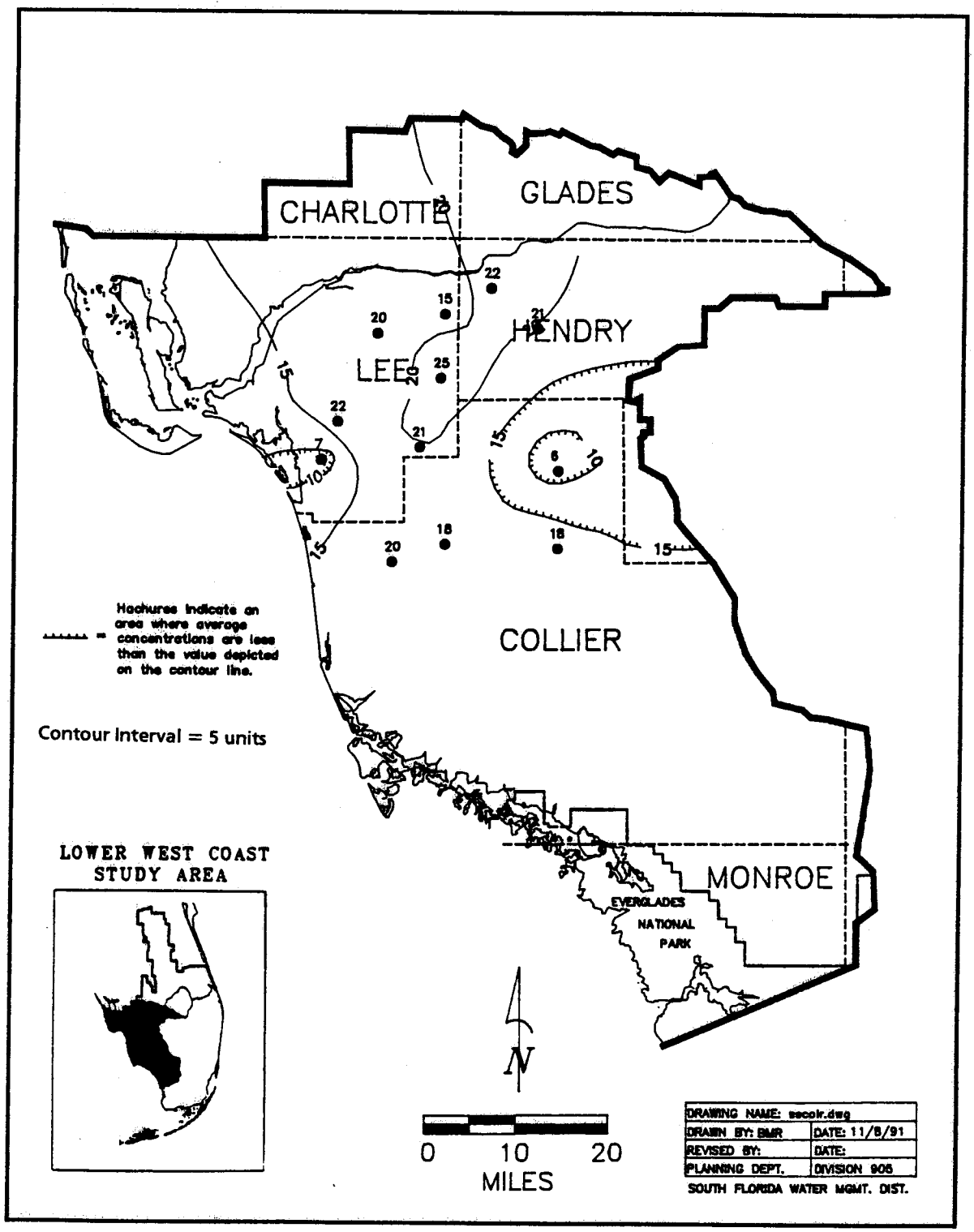


FIGURE H-31. Average Color (units) of the Sandstone Aquifer (1984 to 1990).

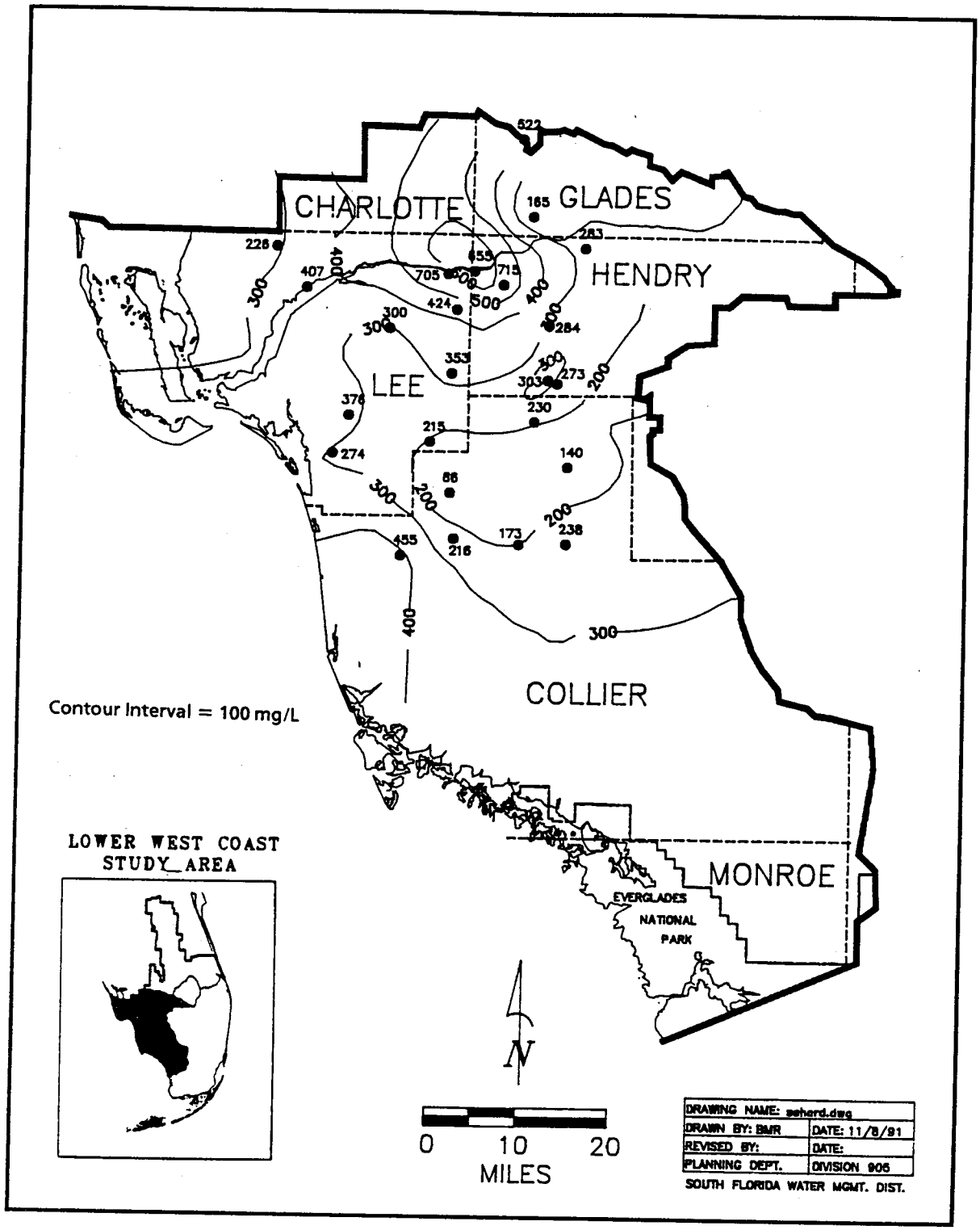


FIGURE H-32. Average Hardness (as mg/L of $CaCO_3$) of the Sandstone Aquifer (1984 to 1990).

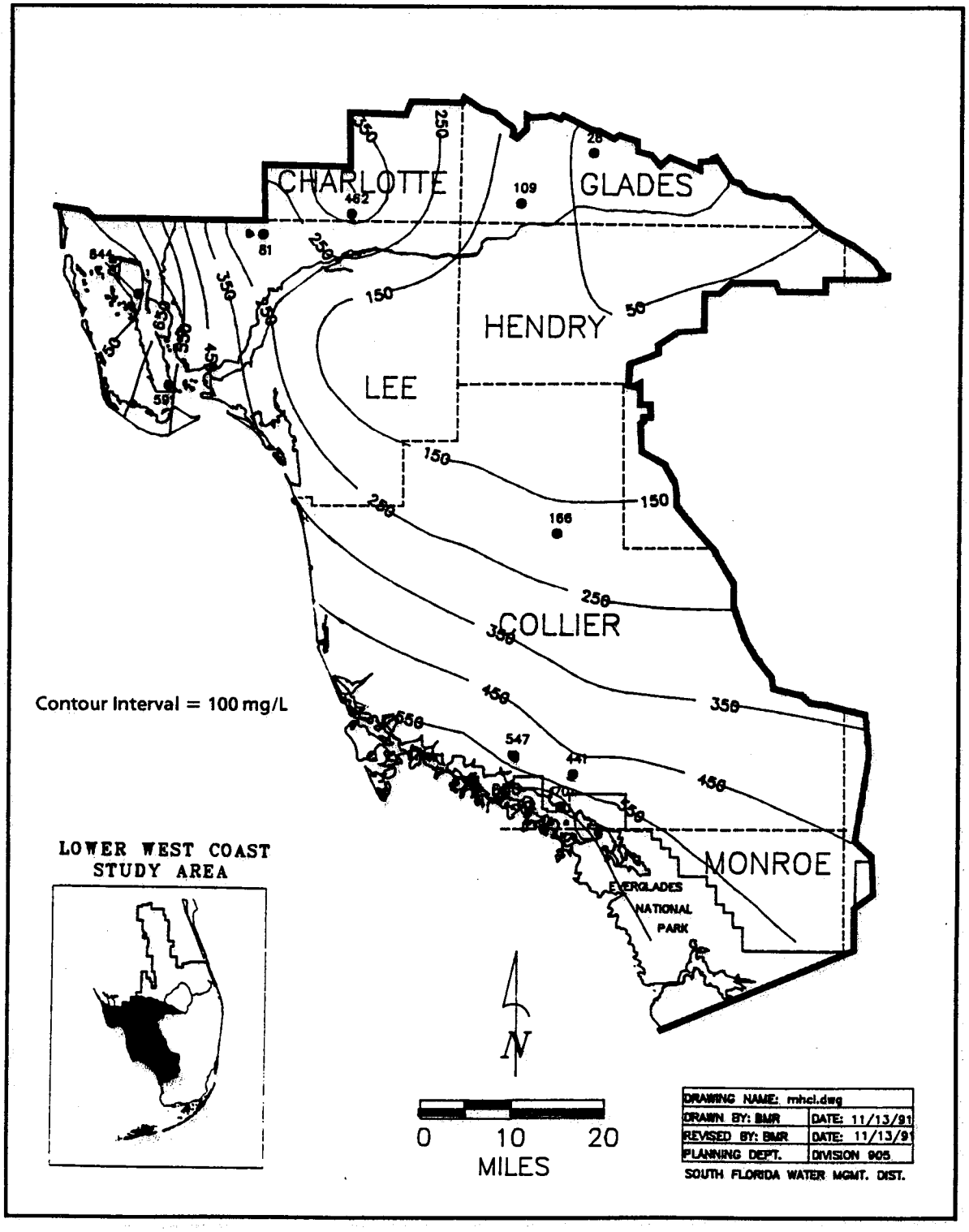


FIGURE H-33. Average Chloride Concentrations (mg/L) of the Mid-Hawthorn Aquifer (1984 to 1990).

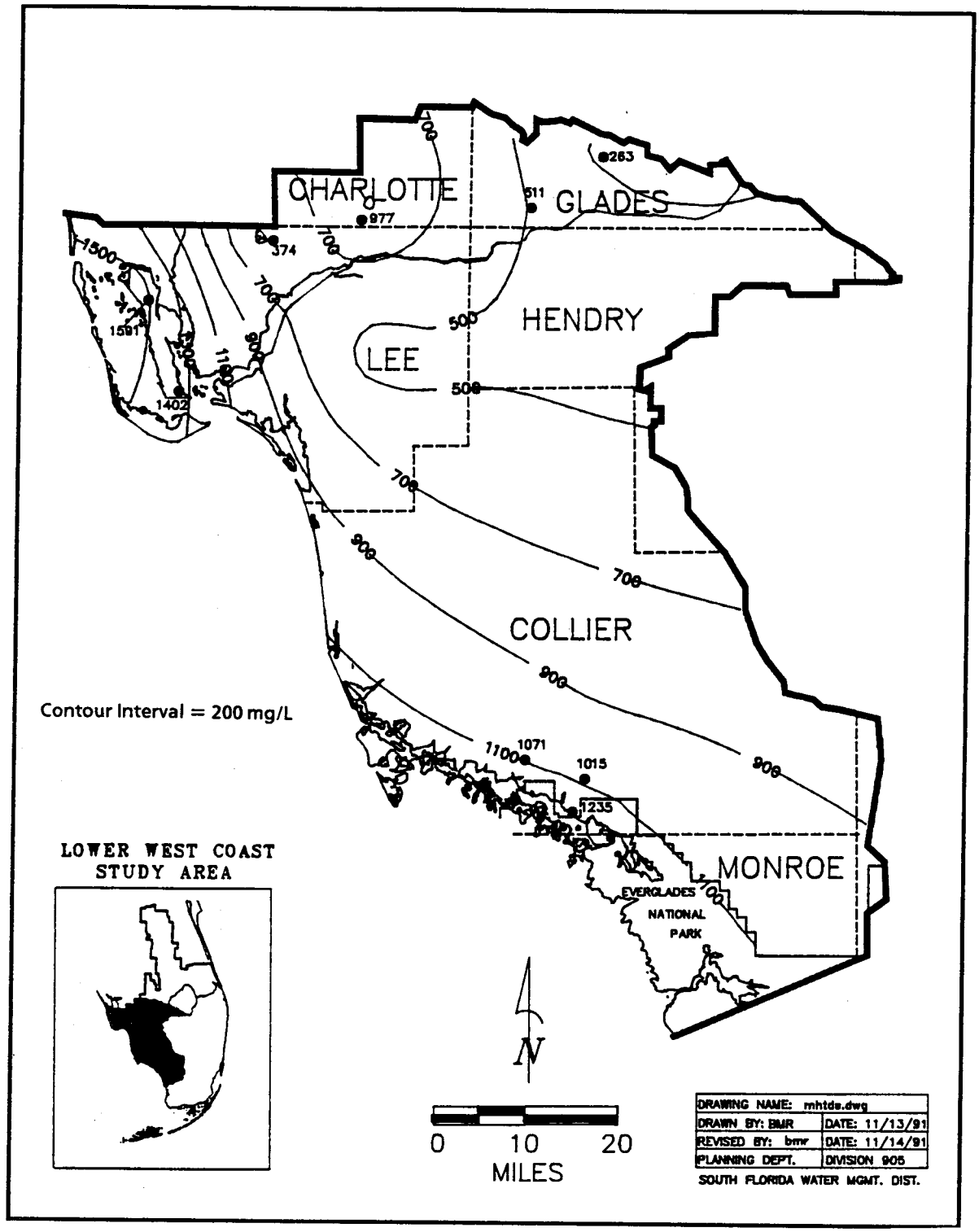


FIGURE H-34. Average Total Dissolved Solids (mg/L) of the Mid-Hawthorn Aquifer (1984 to 1990).

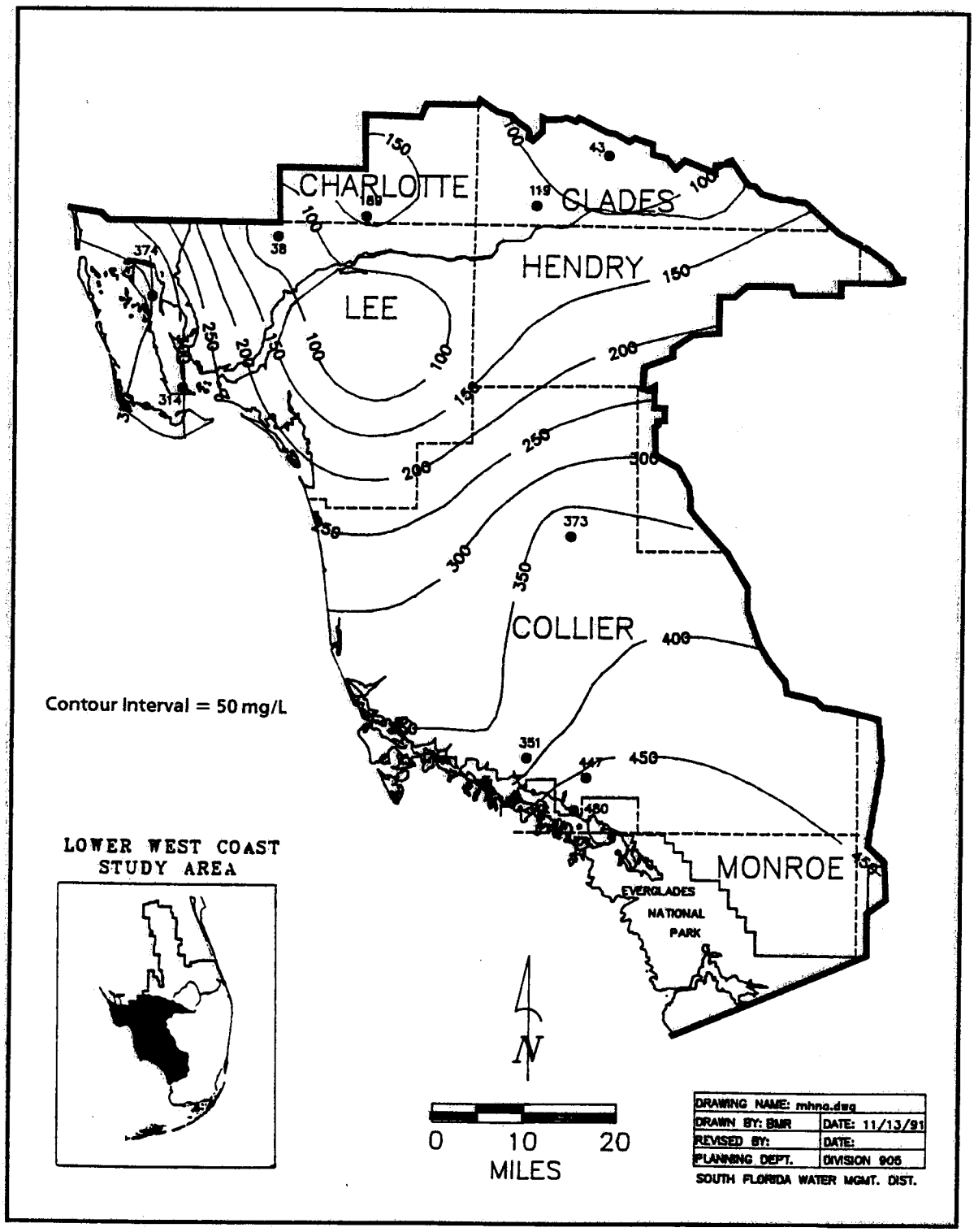


FIGURE H-35. Average Sodium Concentrations (mg/L) of the Mid-Hawthorn Aquifer (1984 to 1990).

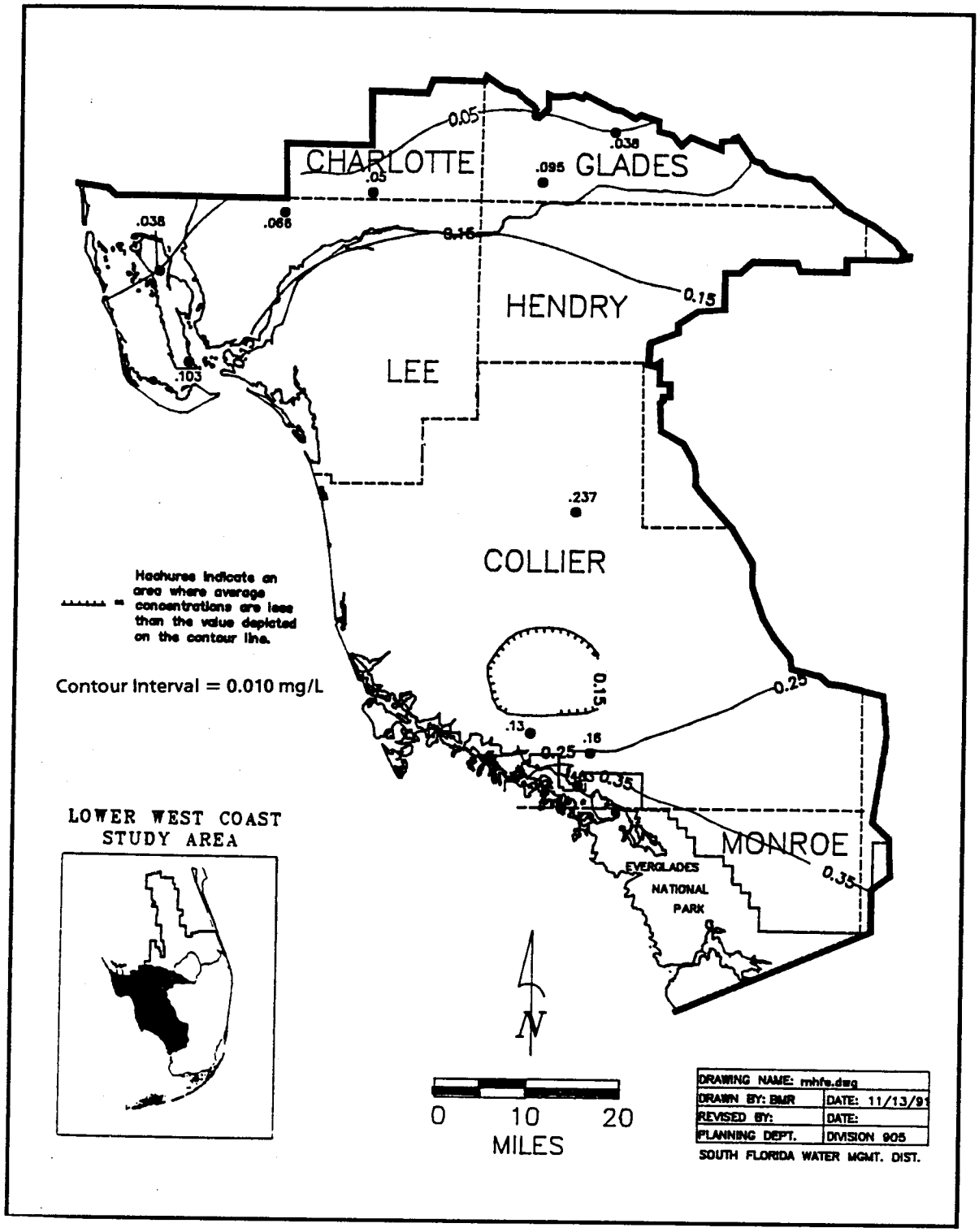


FIGURE H-36. Average Iron Concentrations (mg/L) of the Mid-Hawthorn Aquifer (1984 to 1990).

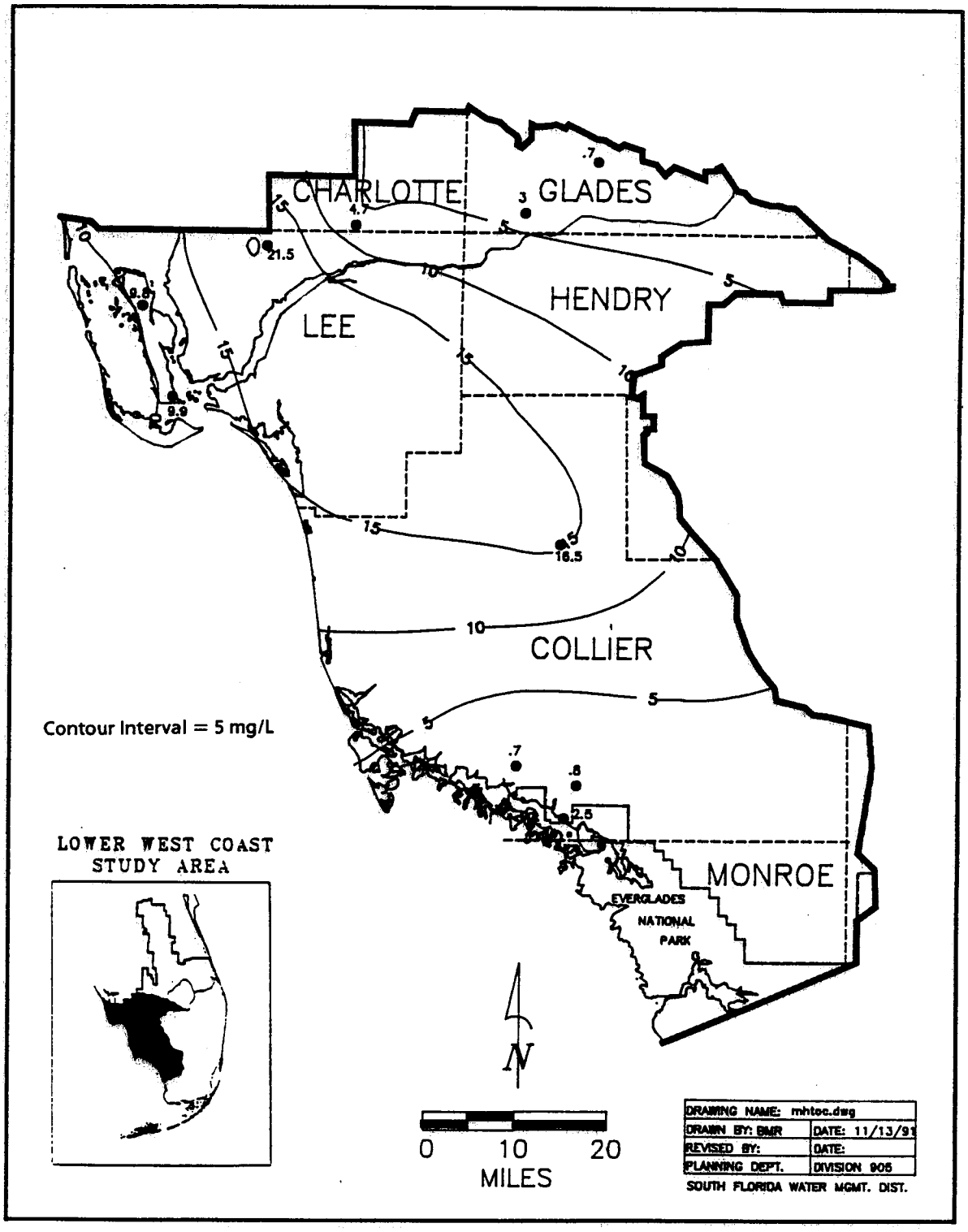


FIGURE H-37. Average Total Organic Carbon Concentrations (mg/L) of the Mid-Hawthorn Aquifer (1984 to 1990).

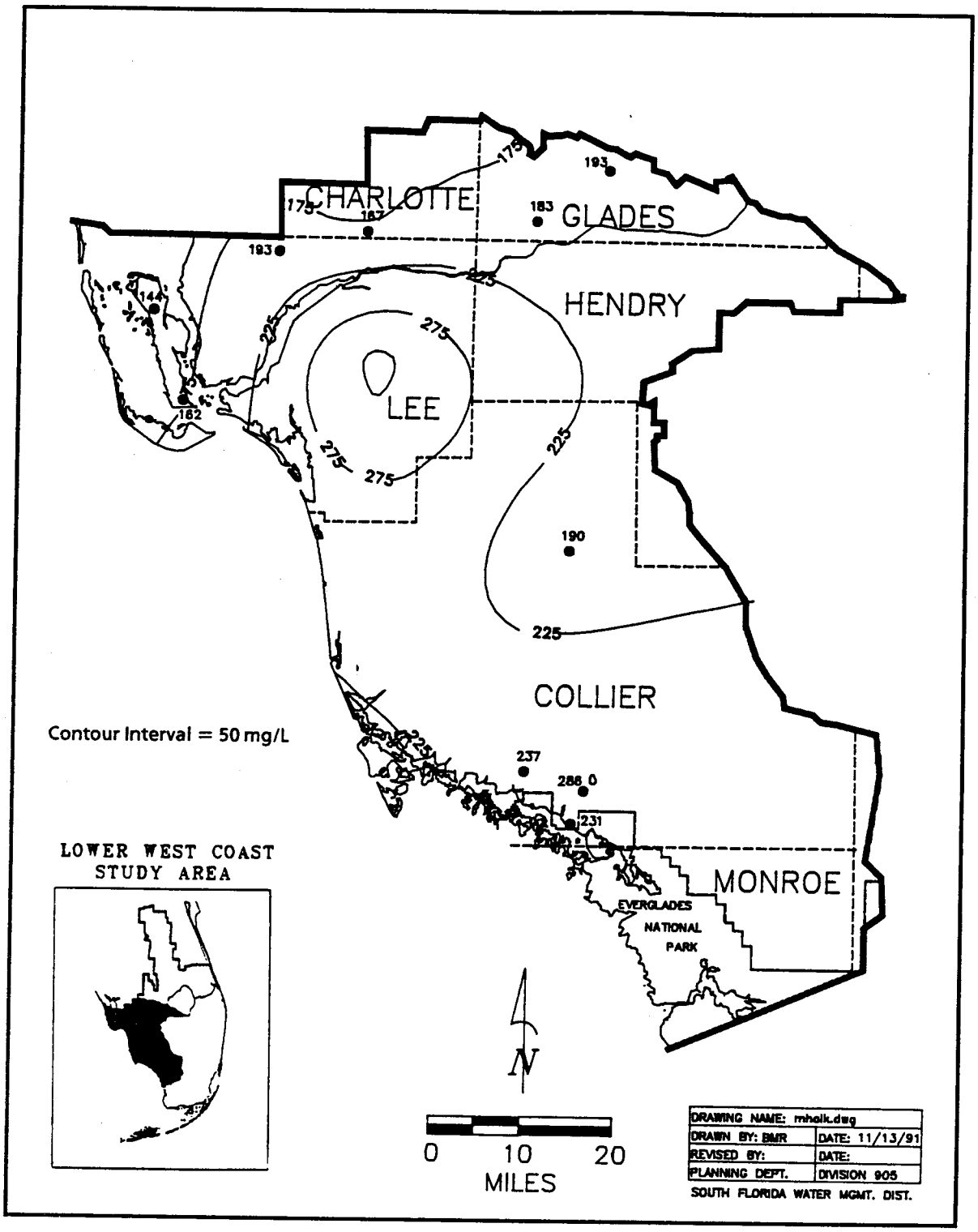


FIGURE H-38. Average Alkalinity (as mg/L of HCO_3) of the Mid-Hawthorn Aquifer (1984 to 1990).

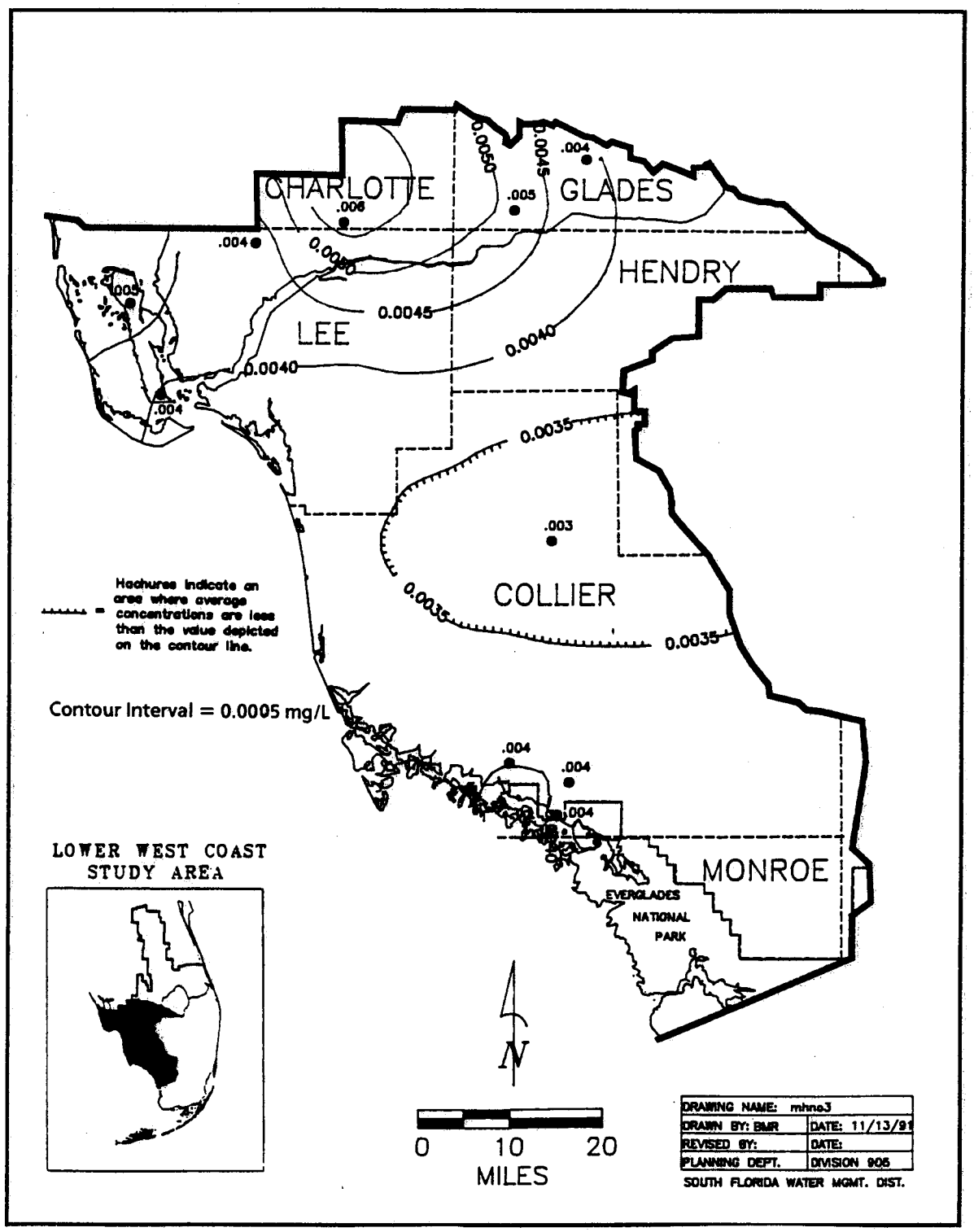


FIGURE H-39. Average Nitrate Nitrogen Concentrations (mg/L) of the Mid-Hawthorn Aquifer (1984 to 1990).

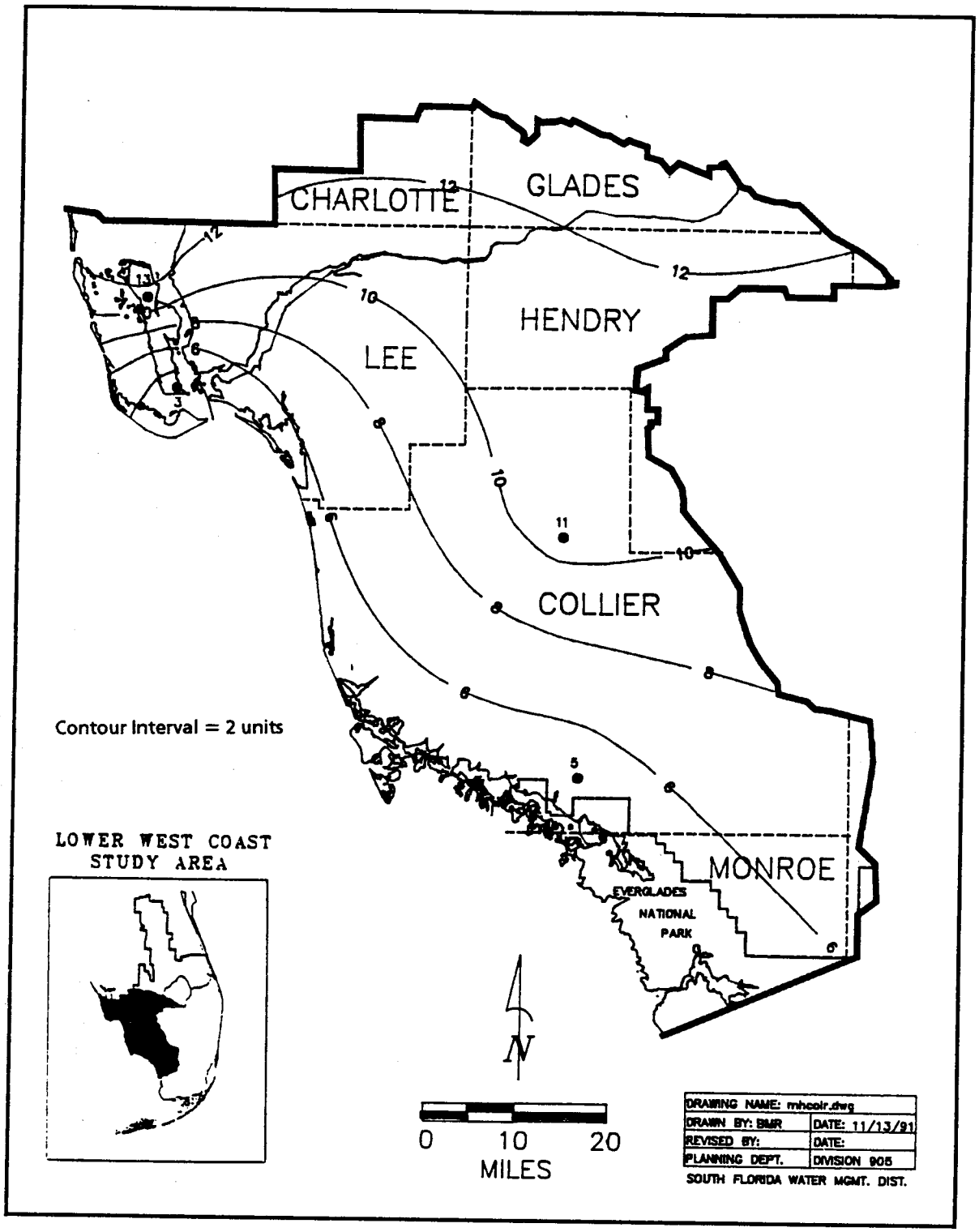


FIGURE H-40. Average Color (units) of the Mid-Hawthorn Aquifer (1984 to 1990).

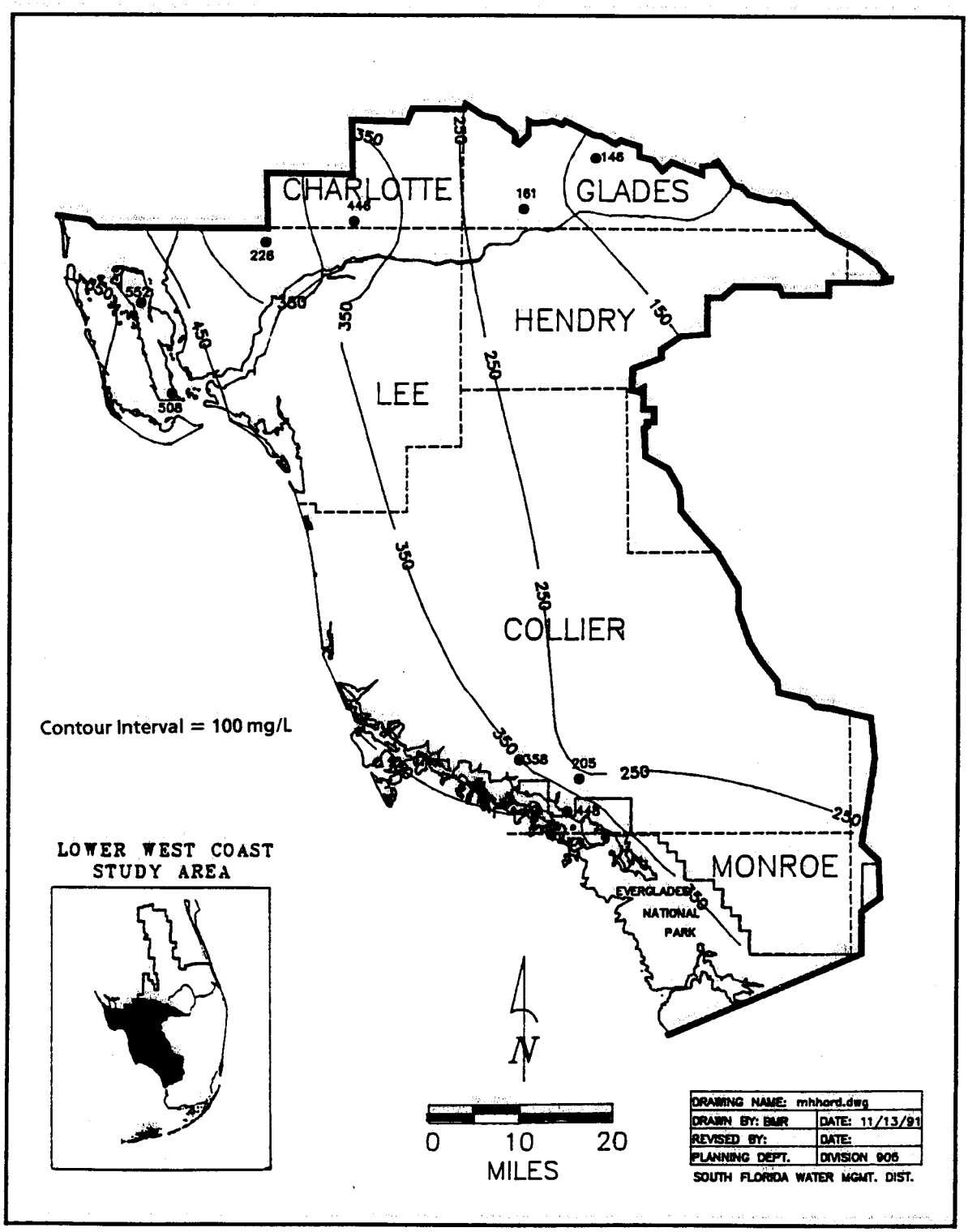


FIGURE H-41. Average Hardness (as mg/L of $CaCO_3$) of the Mid-Hawthorn Aquifer (1984 to 1990).

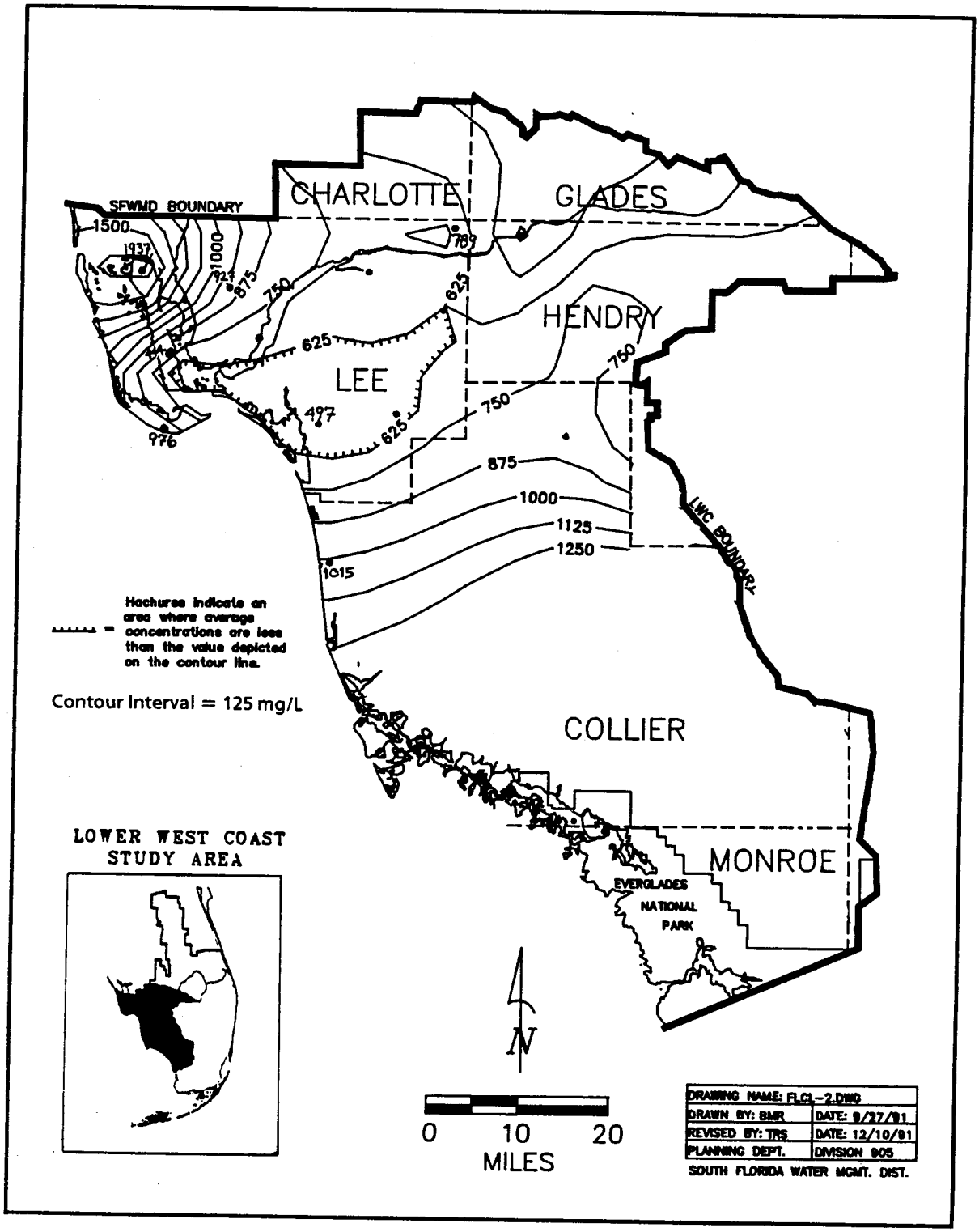


FIGURE H-42. Average Chloride Concentrations (mg/L) of the Lower Hawthorn Aquifer (1984 to 1990).

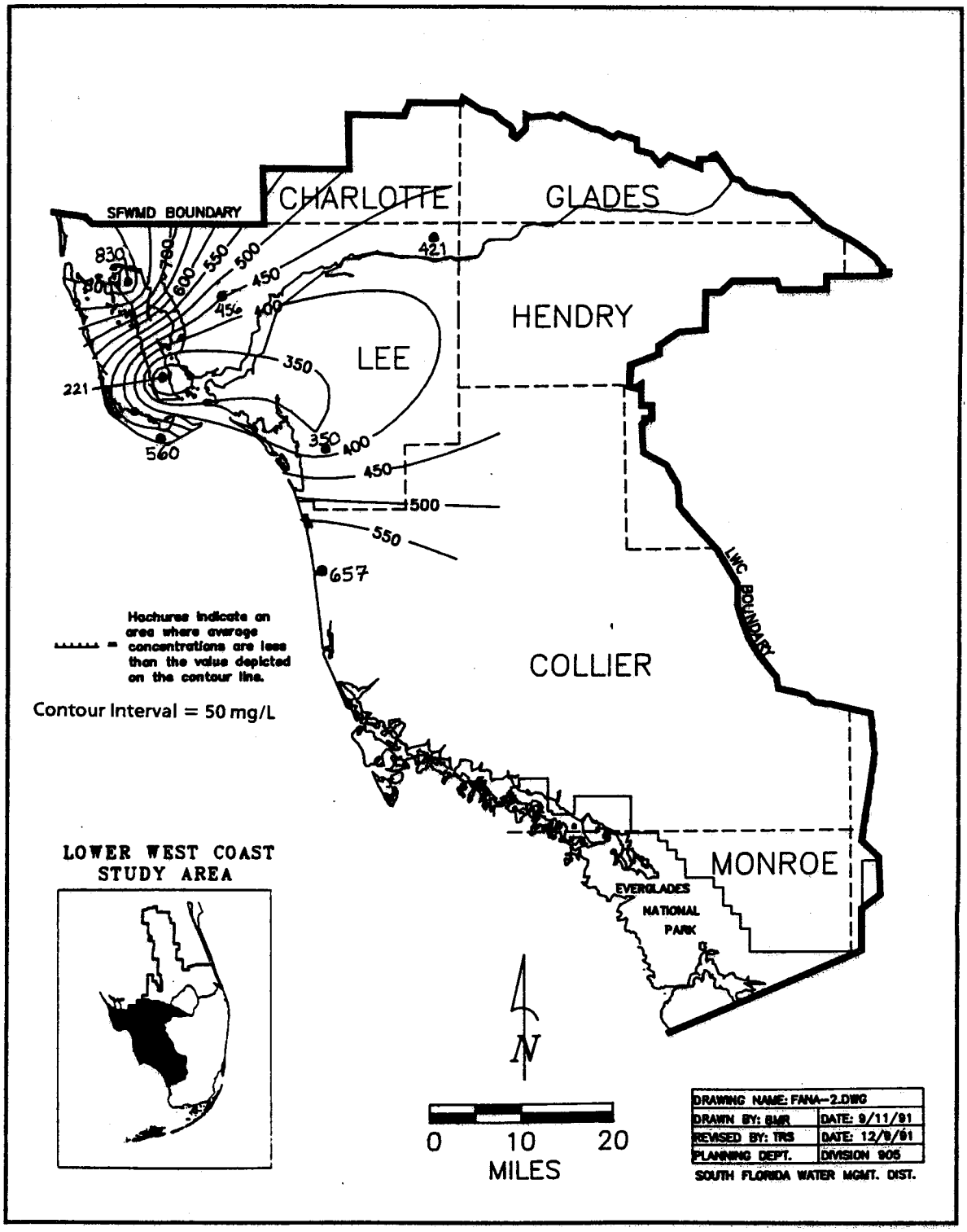


FIGURE H-43. Average Sodium Concentrations (mg/L) of the Lower Hawthorn Aquifer (1984 to 1990).

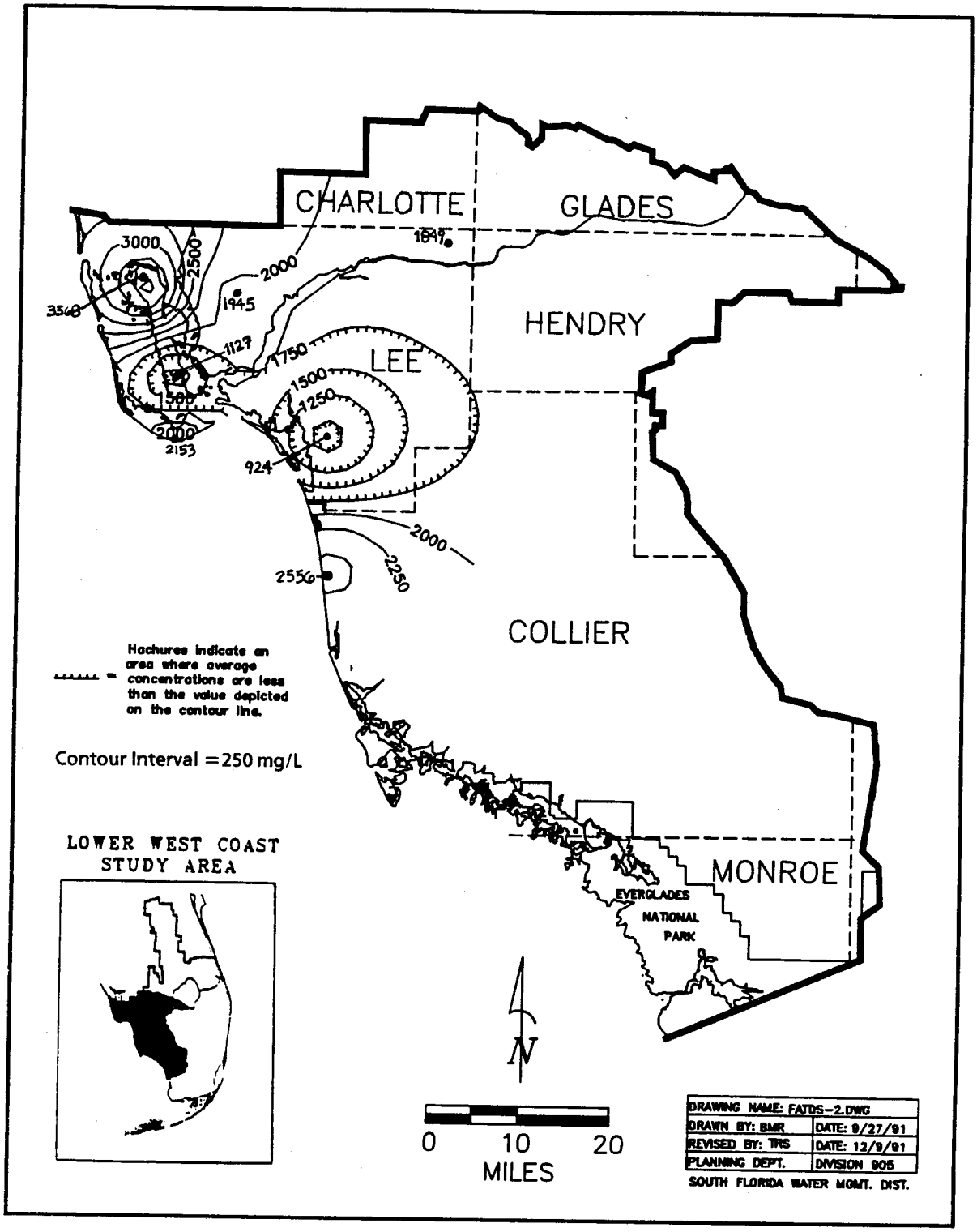


FIGURE H-44. Average Total Dissolved Solids (mg/L) of the Lower Hawthorn Aquifer (1984 to 1990).

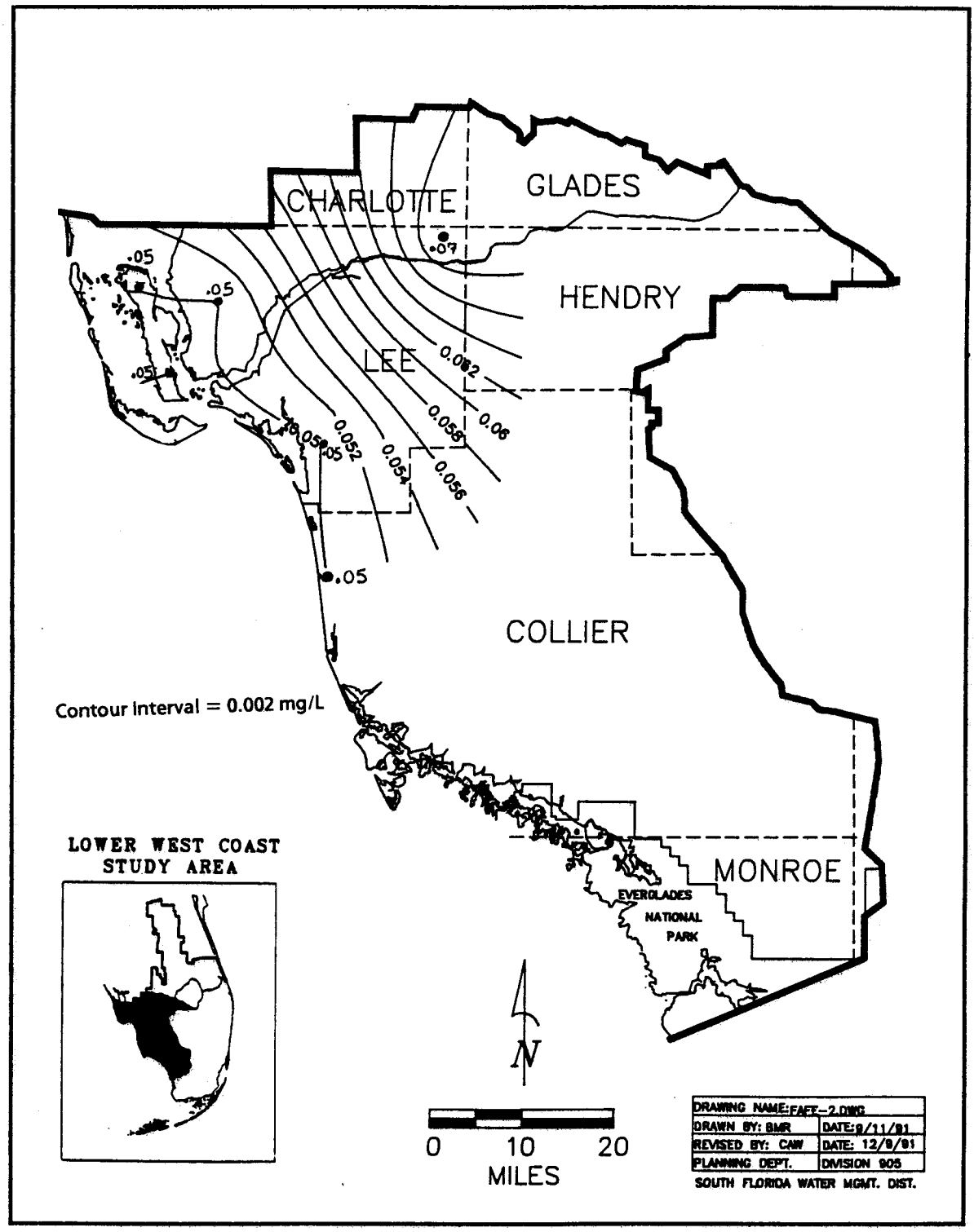


FIGURE H-45. Average Iron Concentrations (mg/L) of the Lower Hawthorn Aquifer (1984 to 1990).

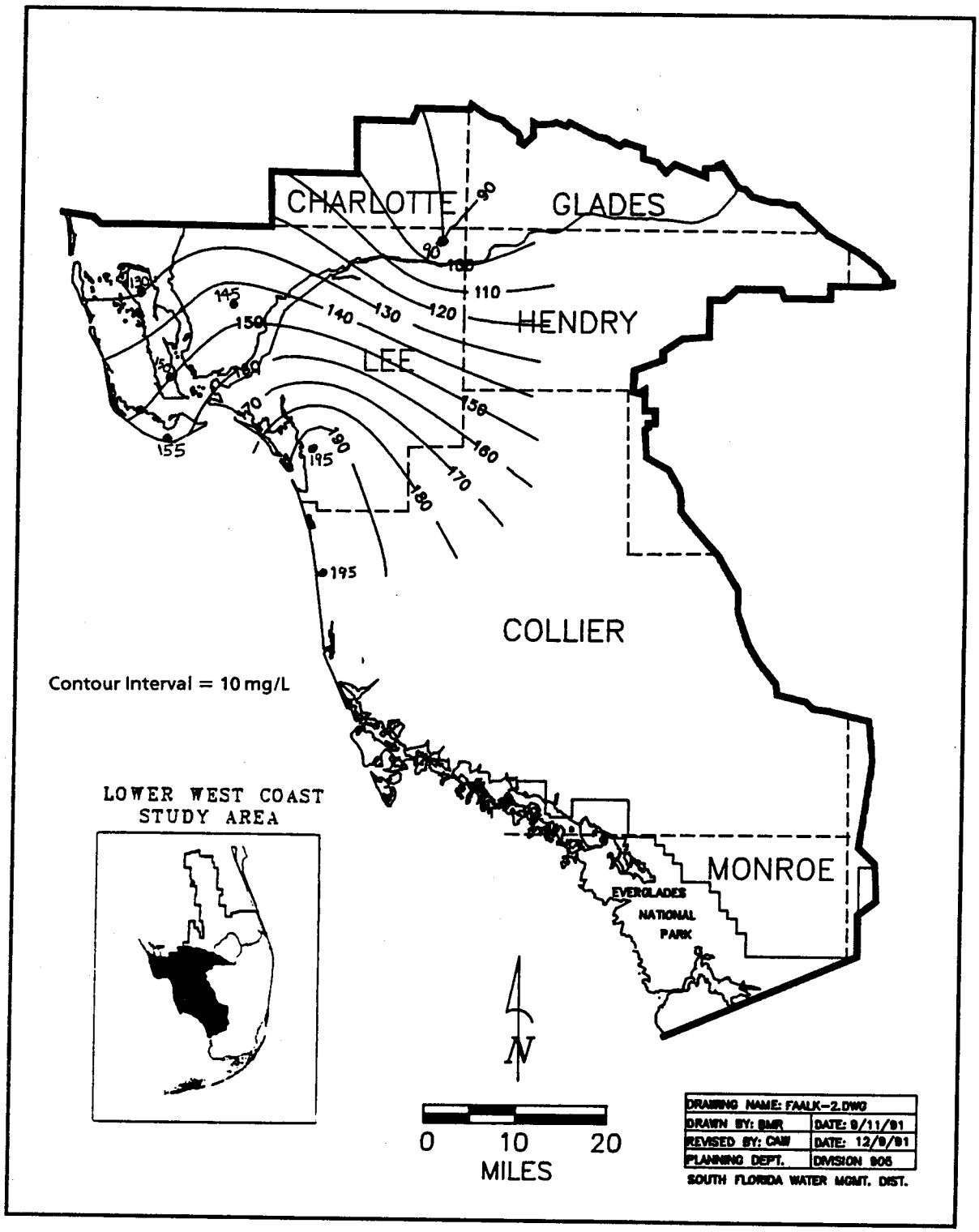


FIGURE H-46. Average Alkalinity (as mg/L of HCO3)of the Lower Hawthorn Aquifer (1984 to 1990).

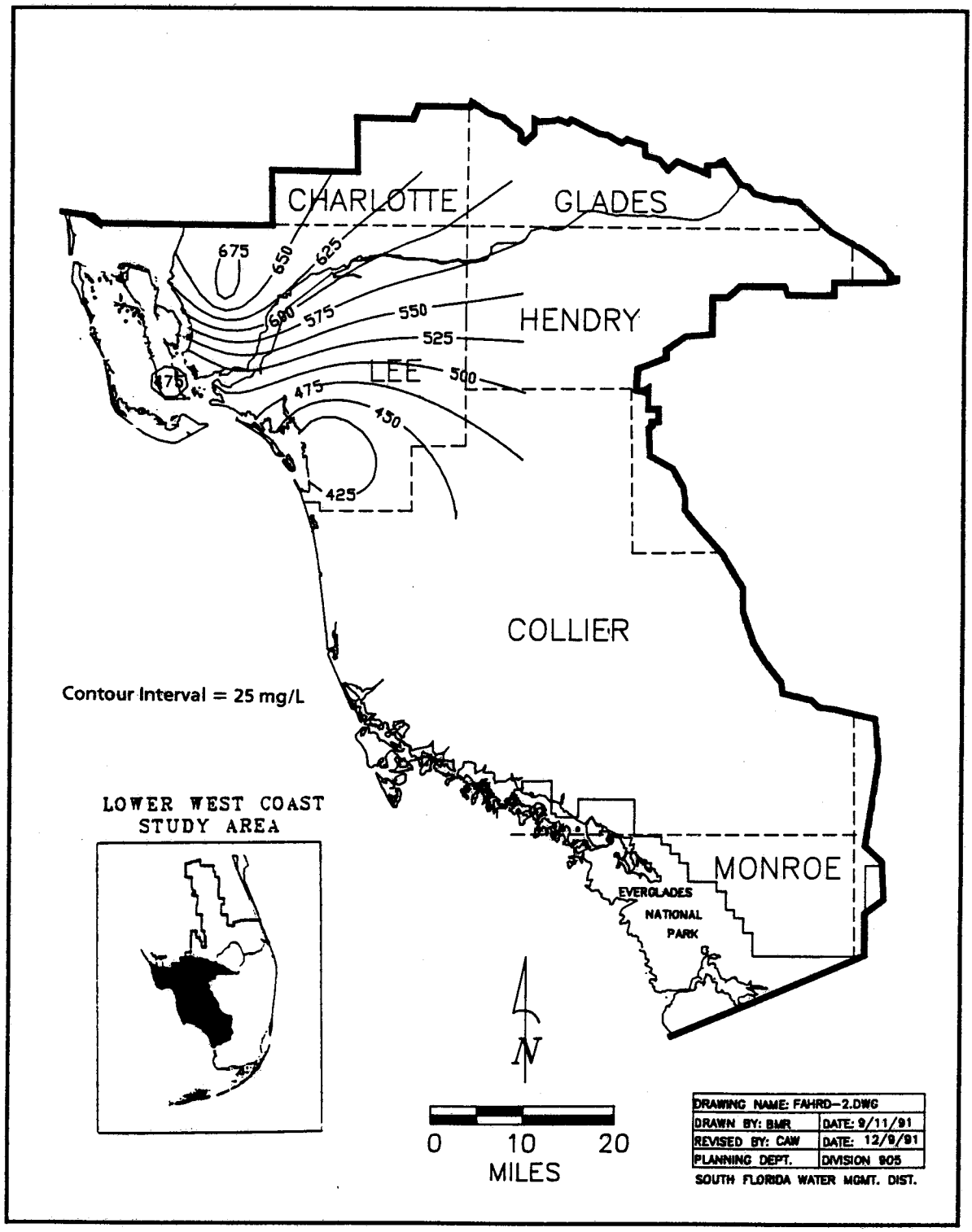


FIGURE H-47. Average Hardness (as mg/L of CaCO3) of the Lower Hawthorn Aquifer (1984 to 1990).

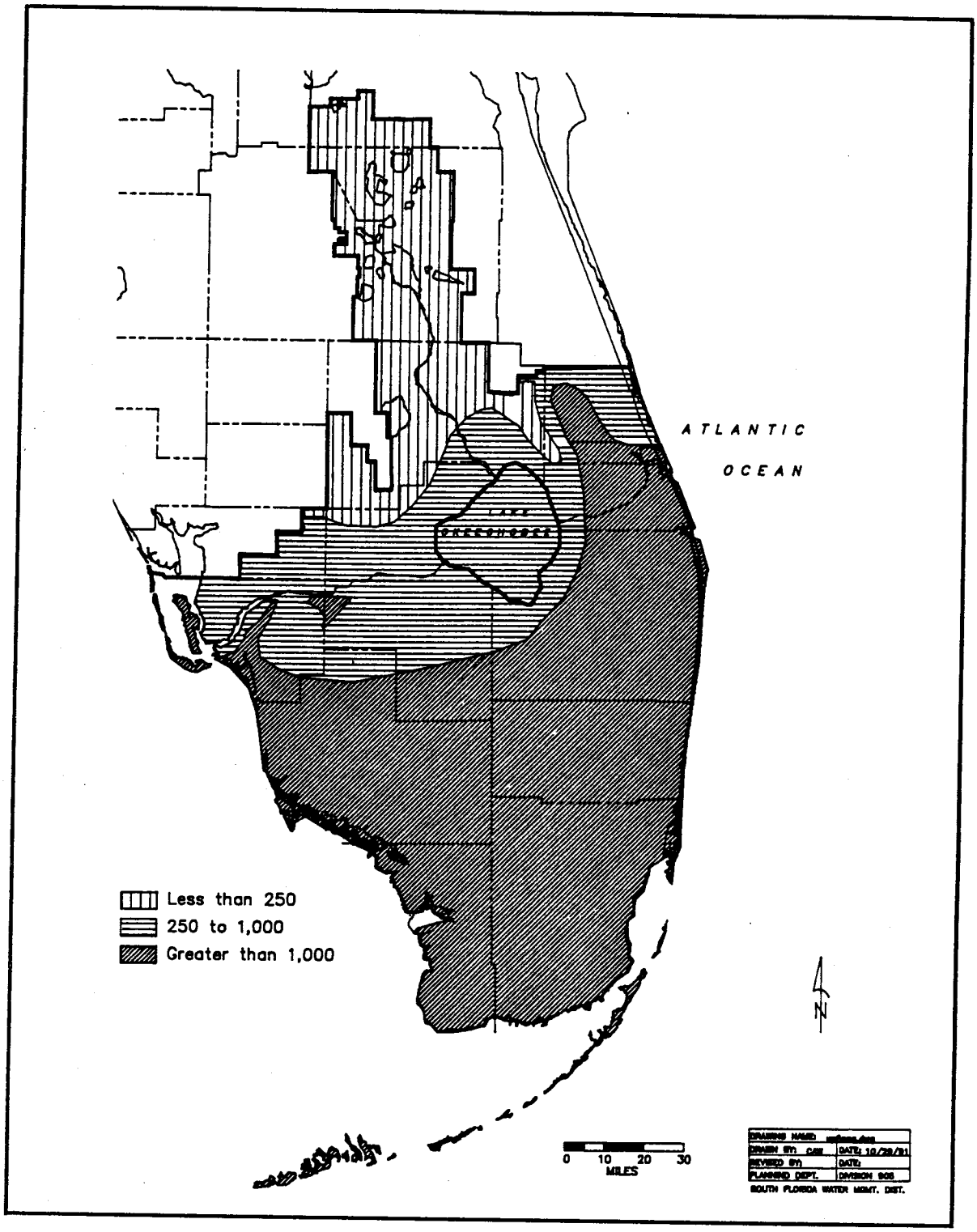


FIGURE H-48. Chloride Concentrations in the Upper 200 Feet of the Floridan Aquifer System (From Sprinkle, 1989).

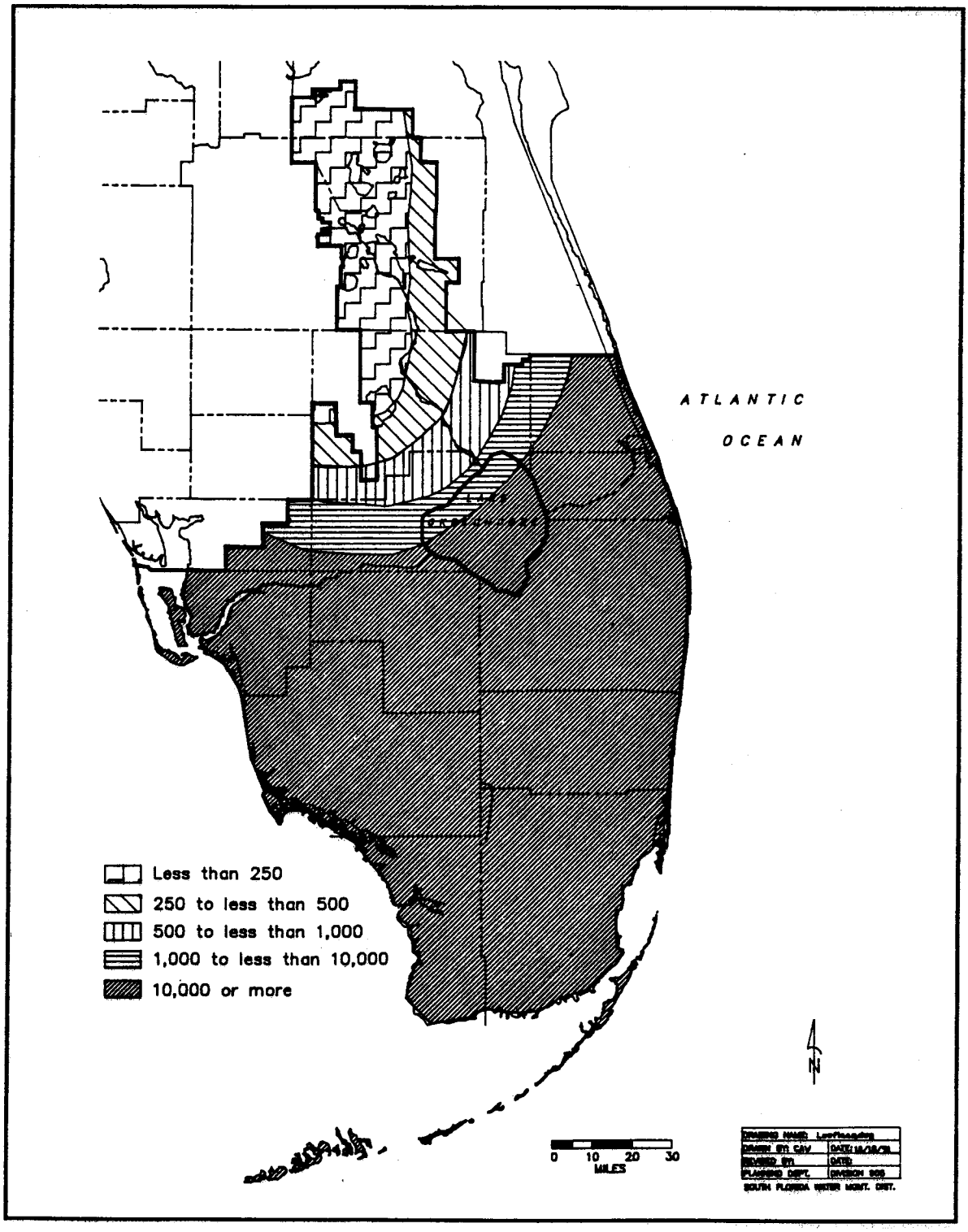


FIGURE H-49. Chloride Concentrations in the Lower Floridan Aquifer System (From Sprinkle, 1989).

CONTAMINATION SITES

Figures and other supporting documentation are provided for selected contamination sites in the LWC Planning Area is presented in this section. The contamination sites include landfills, Superfund sites, and FDER hazardous waste sites.

Landfills

Landfills are identified by the Florida Department of Environmental Regulation (FDER) as Class I, Class II or Class III facilities. Class I landfills are defined as those which receive an average of 20 tons or more of solid waste per day. Class II landfills are those that receive an average of less than 20 tons or 50 cubic yards of solid waste per day. Class III landfills are those that receive only trash or yard trash. The FDER has required all Class I and Class II landfills to have liners and leachate collection systems installed since 1985 (Chapter 17-701, F.A.C.).

In a sanitary landfill operation, a layer of compacted trash is covered with a layer of earth at least once a day. When the site is full, a thick layer of earth is placed on top to cap the landfill, and the land can be used for other purposes. This method of disposal carries with it an inherent potential for the pollution of ground water resources by the leachate created by landfill operations. Leachate is formed as liquids infiltrate through the solid waste and extract dissolved or suspended materials. If soil above and below a landfill is permeable, leachate can escape to contaminate proximal surface or ground water sources. This is especially a problem with older landfills that were constructed without impermeable liner systems.

There are 23 Class I and II landfills, as well as other unknown disposal sites, in the LWC Planning Area. These facilities, classified as either active, closed, or proposed, were compiled from several sources listed in Table H-6. The accompanying landfill location map is included as Figure H-50. Many of these sites had been used for years with little or no control over what materials were disposed of in them. Although most have not been active for some time, they may still represent a potential threat to the ground water resource.

A review of the ground water quality data from the active and closed landfills within the planning area indicates that immediately adjacent to and down gradient from the unlined fill areas, water quality is likely to be nutrient-rich, with elevated levels of ammonium and ammonia nitrogen, organic nitrogen, and total nitrogen. BOD, COD, sulfate, and total organic carbon were found to be elevated at most sites. Total dissolved solids commonly exceeds the 500 mg/L drinking water standard. Chloride, which is routinely used as an indicator parameter in tracking of leachate plumes, is usually elevated above normal background levels.

Several trace metals of significant concern were detected and include lead, detected at two landfill sites, and chromium, detected at three sites. Also elevated at nearly all the sites were iron and sodium. Iron levels may be very high, often present in concentrations which are many times the drinking water standard of 0.3 mg/L, although the regional ground water also contains natural levels of iron which frequently exceed this standard. Sodium, was elevated above background levels at many sites, and exceeded the drinking water standard of 160 mg/L in some cases.

Volatile organic compounds, synthetic organic compounds and pesticides were sampled for at several of the sites., and the following compounds have been detected,

although in concentrations below FDER standards: 1,1,1 Trichloroethane was detected on one occasion. At another site, chlorobenzene and 1,2-dichlorobenzene were detected several times.

Not all landfills in the planning area exhibited poor ground water quality. Data from some sites appeared to reflect normal background ground water quality. Size and age of the landfill, types of wastes produced in the area, local hydrogeology and landfilling techniques are factors which can dictate the extent and character of the resulting impacts on ground water quality. In addition, an effective ground water monitoring program is crucial for accurate determination of ground water degradation. Improperly located Monitor wells can result in the oversight of a contaminant plume.

TABLE H-6. Class I and II Landfill Facilities in Lower West Coast Planning Area.

Map Number	Facility Name	Class	Status	Source
Collier County				
1	Goodlette Road	--	Closed	6
2	Immokalee #1	I	Closed	1,3,4,6
3	Immokalee #2	I	Active	1,3,4,5,6
4	Naples	I	Active	1,3,4,5,6
5	Naples Airport	I	Closed	3,4,5,6
6	Temple Drive	--	Closed	6
Glades County				
7	Glades County #2	I	Active	4
Hendry County				
8	Airglades	I	Closed	1,6
9	County Landfill (Pioneer)	I	Active	1,4,5,6
10	Labelle	I	Closed	6
11	Lee/Hendry	I	Proposed	5
Lee County				
12	Alva School Dump	--	Closed	6
13	Alva-Spanish River Dump	--	Closed	6
14	Billy's Creek Dump	--	Closed	6
15	Buckingham	I	Closed	2,4,5,6
16	Corkscrew Road	II	Closed	4
17	Detar Lane	II	Closed	4
18	Fort Myers, City	--	Closed	2,6
19	Gulf Coast	I	Active	1,2,4,5,6
20	Harlem Heights (Kelly Road)	II	Closed	2,4,5,6
21	Lake Kennedy	II	Closed	4
22	Old Lehigh Dump	I	Closed	6
23	Pine Island Dump	--	Closed	6

Source Codes:

1- Miller *et al.* (1987).
2- Phone conversation January 3, 1991 with Mr. Van Horn, Lee County Solid Waste, Fort Myers, FL.
3- Letter dated December 31, 1990 from Robert Fahey, Solid Waste Management Director, Collier County Government, Naples, FL.
4- Letter dated January 17, 1991 from Philip Edwards, FDER South District Deputy Assistant Secretary, Fort Myers, FL.
5- South Florida Water Management District. 1989. Solid Waste Disposal Site Surface Water Management System Inventory. SFWMD, West Palm Beach, FL.
6- Shaw, J.E. 1985. Water Quality Assurance Act Program Progress Report December 1983 to March 1985. SFWMD, West Palm Beach, FL.

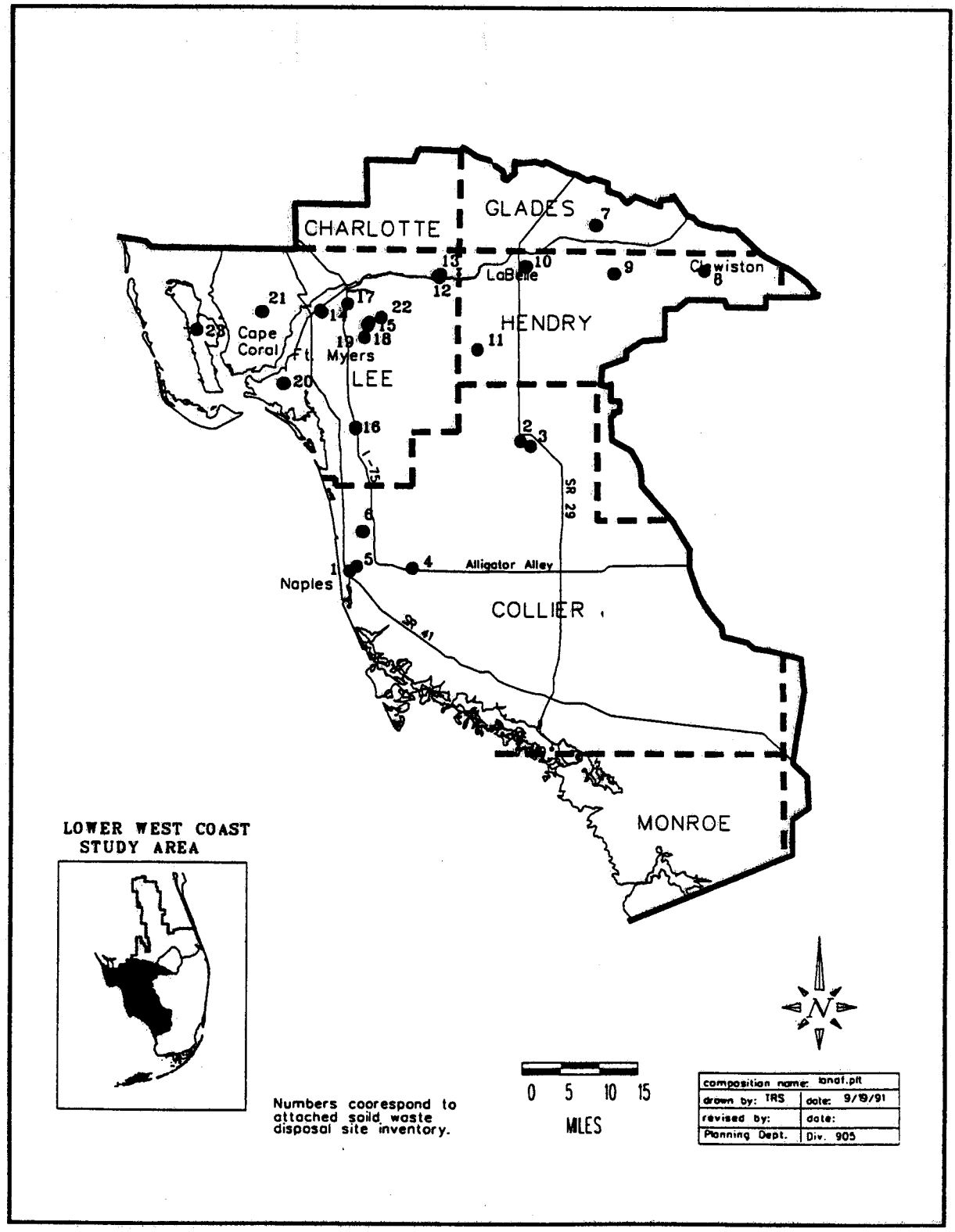


FIGURE H-50. Location of Landfills in the Lower West Coast Planning Area.

Superfund Program Sites

Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), commonly known as the Superfund, requires the U.S. Environmental Protection Agency (U.S. EPA) to maintain a national hazardous waste site inventory, also known as the Superfund inventory or CERCLIS (U.S. EPA,1990). The inventory consists of sites that are either actual or potential threats of hazardous waste substance releases to the environment. Sites considered to have a high health and environmental risk are included in EPA's National Priorities List (NPL). There are more than 32,000 sites in the Superfund inventory of which 1,236 sites are on the NPL. Once a site is listed in the Superfund inventory, the site will remain on the list for record keeping purposes even after the site has been cleaned up and no further action is needed.

The Superfund inventory contains 27 sites located in the LWC Planning Area (U.S. EPA, 1990). The location of these sites are identified in Figure H-51. Florida has 54 sites on the NPL of which none exist in the LWC Planning Area (FDER, 1990).

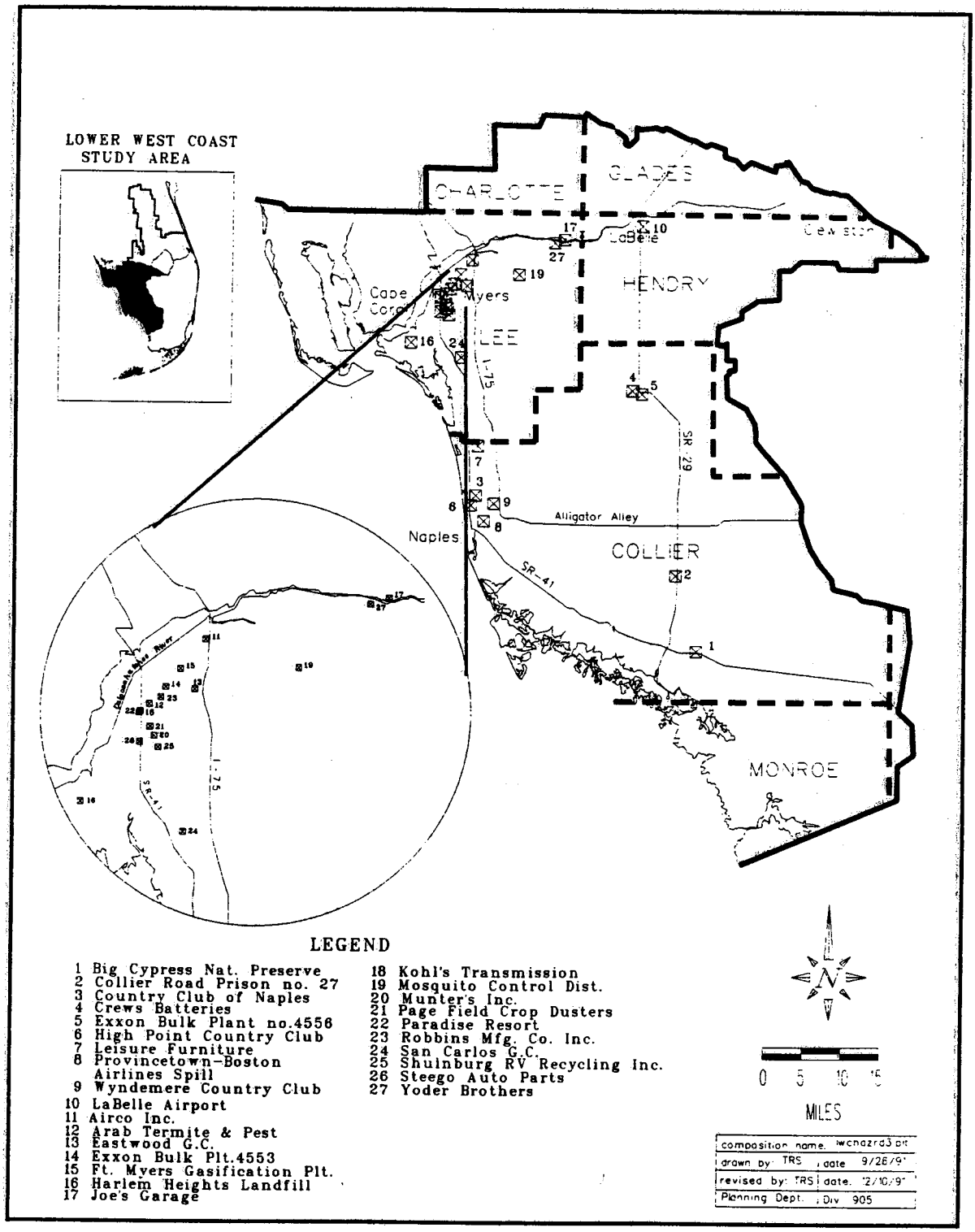


FIGURE H-51. Location of EPA Superfund Sites in the Lower West Coast Planning Area.

FDER Hazardous Waste Sites

The Resource Conservation and Recovery Act (RCRA) was enacted by Congress in 1976. Regulations developed by the U.S. EPA to implement the Act, are intended to provide cradle-to-grave management of hazardous waste. There are 18 FDER hazardous waste program sites identified in the LWC Planning Area (Letter dated January 17, 1991 from P.R. Edwards, Deputy Assistant Secretary, FDER South District, Fort Myers, FL). The locations of these sites are shown in Figure H-52.

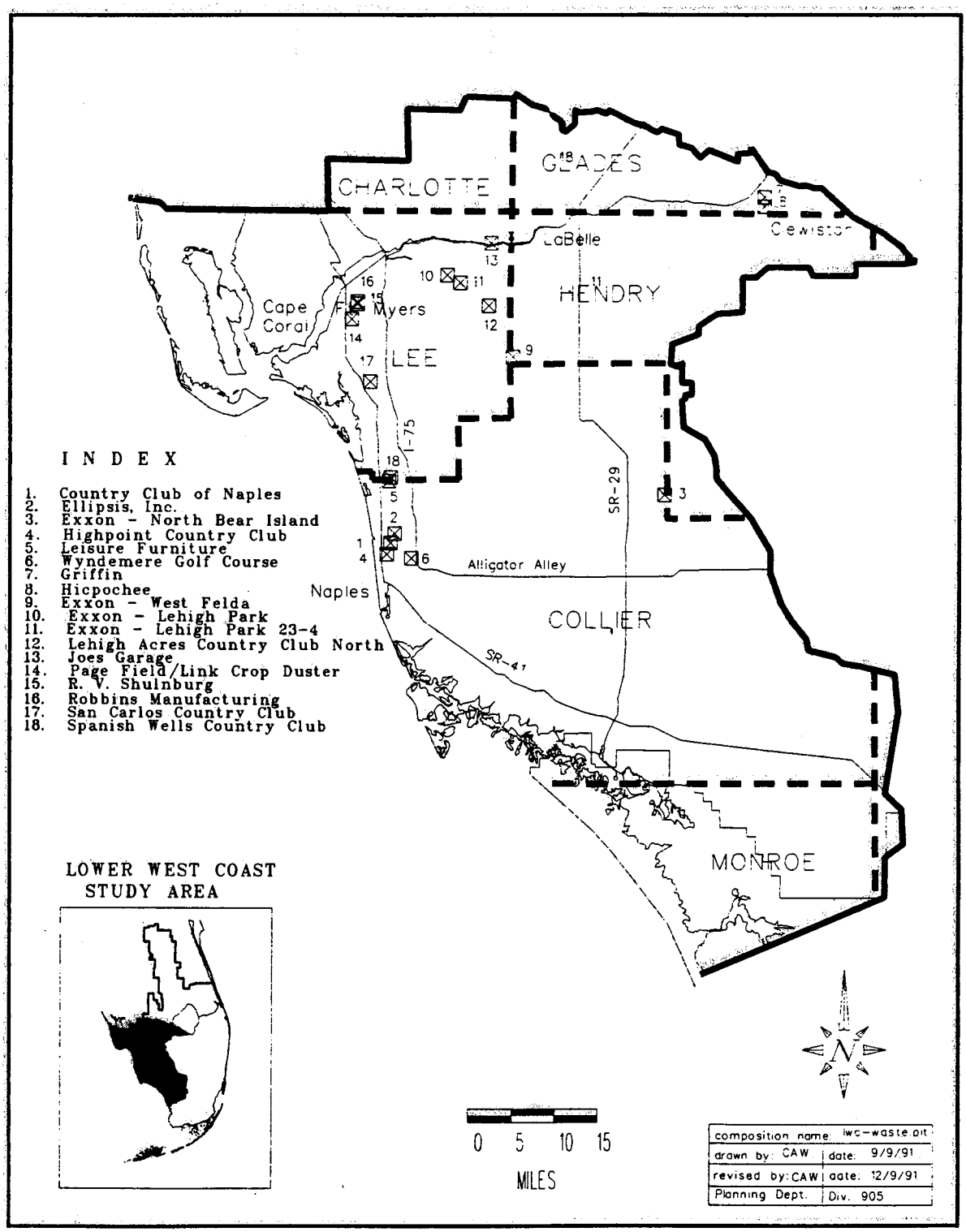


FIGURE H-52. FDER Hazardous Waste Program Sites in the Lower West Coast Planning Area.

WELLFIELD PROTECTION ORDINANCES

It is far more cost effective to utilize an unpolluted raw water source than one which will require add-on treatment processes or a higher level and more costly overall treatment method. The ability of local government to effectively regulate and control existing and potential ground water contamination is critical to protecting and optimizing the fresh ground water resource.

Wellfield protection ordinances are locally adopted ordinances that are intended to provide long-term protection of the ground water resources in areas surrounding potable water supply wells. Contamination of supply wells is prevented through managing land uses, regulating well construction and abandonment, and controlling the storage, handling, use and production of hazardous or toxic materials. Wellfield protection ordinances consist of several wellfield protection zones, which are delineated by determining ground water travel times within the area of the wellfield. The innermost zone, which has the shortest travel time, is afforded the most protection from potential pollution.

Lee and Collier counties are the only counties with wellfield protection ordinances in effect in the LWC Planning Area. Lee County adopted an ordinance in August 1989, and Collier County adopted its ordinance in October 1991. These wellfield protection zones are presented in figures H-53 and H-54.

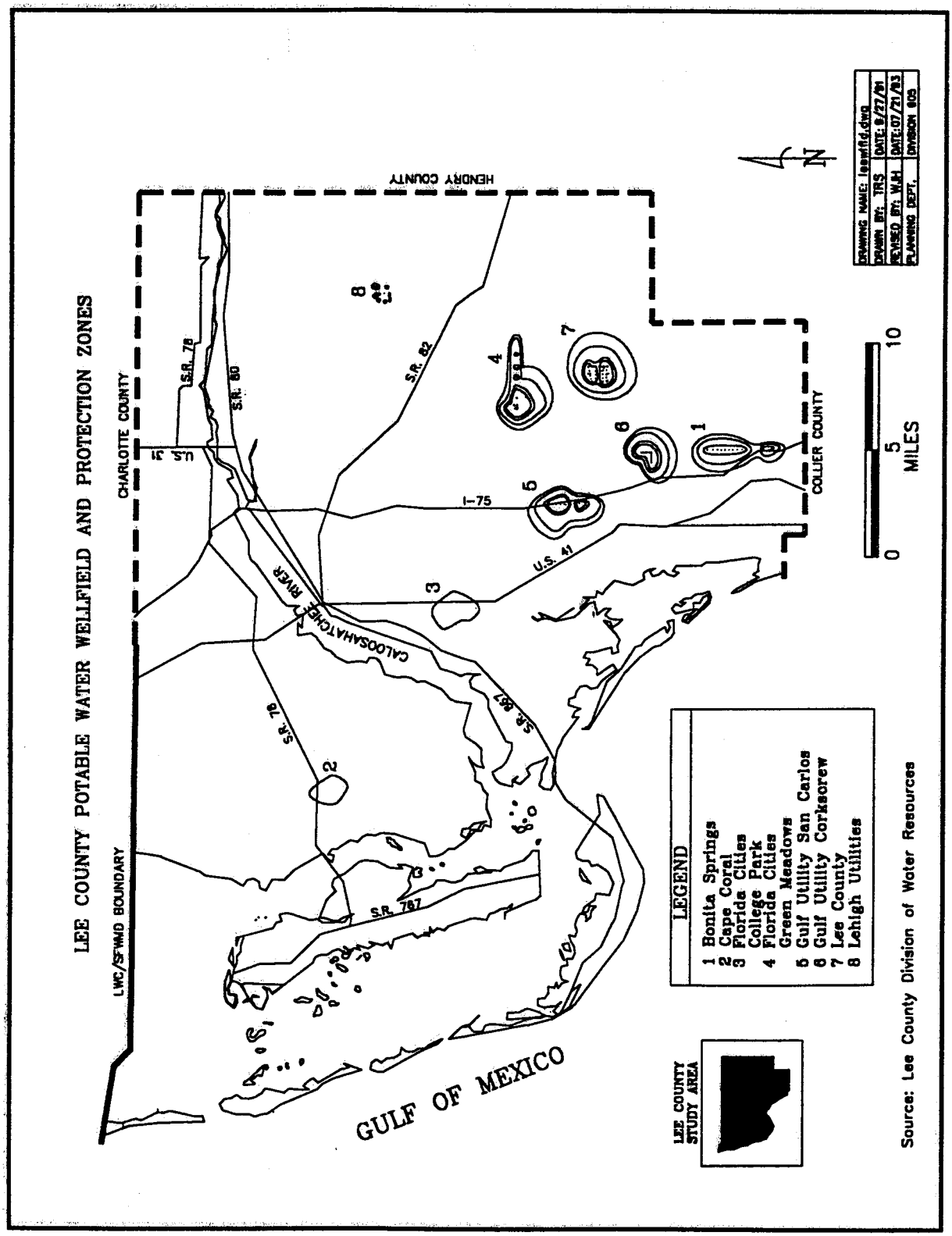


FIGURE H-53. Lee County Potable Water Wellfield and Protection Zones.

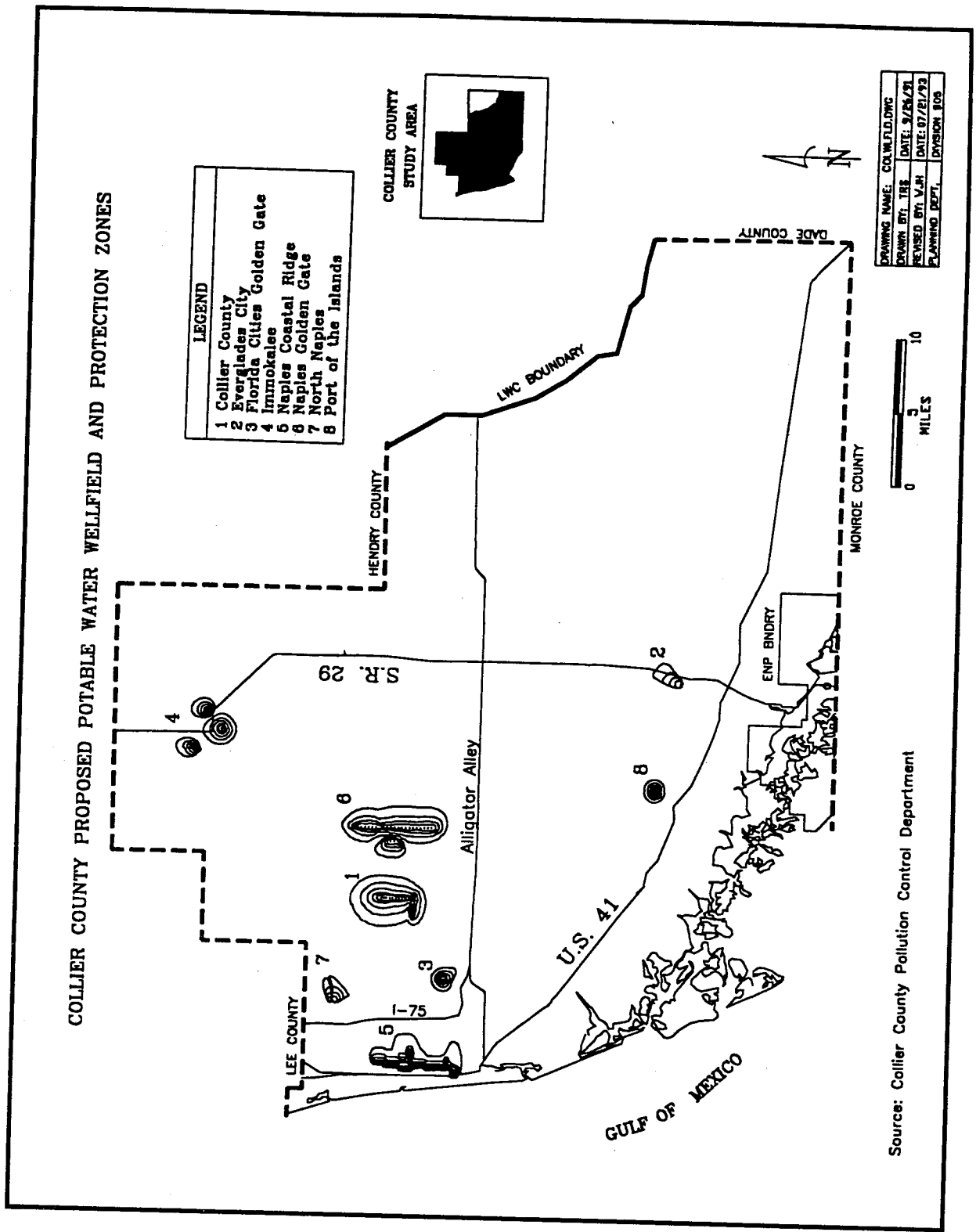


FIGURE H-54. Collier County Proposed Potable Water Wellfield and Protection Zones.

SALTWATER INTRUSION

Saltwater intrusion along the coast of the LWC Planning Area has been advanced by canal excavation and aquifer development for public water supplies and agriculture. In some channels, salinity control structures have been installed to limit saltwater encroachment by maintaining freshwater heads on the inland side. The greatest threat from saltwater intrusion lies where ground water and surface water gradients are lowest. Saltwater intrusion has been most evident in the lower Tamiami aquifer in the Naples Coastal Ridge and Bonita Springs/North Naples areas, and also in the water table aquifer in the area of Marco Island's public water supply withdrawals.

The SFWMD maintains a saltwater intrusion database called SALT that collects information on chloride, specific conductance, and water levels from the District's monitoring network. The monitoring network consists of data supplied by the public water supply utilities and USGS monitoring wells. Selected data acquired from this network, the USGS, and the District's DB-Hydro database were used to construct maps of average chloride concentrations in monitor wells in the water table, lower Tamiami, and mid-Hawthorn aquifers. Isochlor contour maps were generated by performing an inverse distance weighted (IDW) interpolation on the point data set using ARC/INFO GRID. The isochlor maps are intended to serve as an aid in visualizing the distribution of known values, rather than as an absolute indicator of saltwater intrusion. Figures H-55 through H-67 are maps containing well locations, average chloride concentrations and isochlors. A graph showing long-term increases in chloride concentrations in a lower Tamiami well, L-738 in the Bonita Springs area, is included as Figure H-68.

In addition to saltwater intrusion from coastal waters, overdevelopment of aquifers which overlie more saline aquifers increases the possibility of upconing and contamination from the poorer quality layers. This potential exists throughout the planning area. Although upconing of saline water is not considered to be true seawater intrusion, it is a significant threat because of its potential to degrade potable water supplies. Figure H-69 illustrates a long-term chloride increase in lower Hawthorn well L-2435, where chloride concentrations rose from 1,500 mg/L in late water year 1978 to a high of approximately 3,900 mg/L in early water year 1988. Recharge in this case, comes largely from the underlying Suwannee Aquifer, raising chloride and total dissolved solids concentrations in the lower Hawthorn. This example also illustrates the necessity of long term observations in evaluating aquifer impacts.

Cross contamination of shallow aquifers has also occurred from many of the Floridan aquifer wells in the planning area. Numerous artesian wells were drilled into the highly mineralized Floridan Aquifer System from the 1930s through the 1950s for agricultural water supply and oil exploration. Many of these wells were short-cased, meaning the casings extended to less than about 200 feet below land surface, which exposed the shallower zones to invasion by the more saline Floridan water. Additionally, steel casings may have corroded, allowing inter-aquifer exchange through the casings. Often, if a well was abandoned, it was either plugged improperly, or simply left open, free-flowing on the land surface, and recharging the surficial aquifer with saline water. The result is the existence of localized sites throughout the shallow aquifers containing anomalously high concentrations of dissolved minerals. This is evident in the water quality data and associated isochlor maps. The actual lateral influence of such impacts, however, is localized and may be exaggerated by the contour lines surrounding these areas.

In 1981 the Florida Legislature passed the Water Quality Assurance Act which required the water management districts to plug abandoned FAS wells. Under this program, many known wells in the LWC Planning Area were plugged. The federal government is currently offering a well abandonment program through the Soil Conservation Service for wells on specific agricultural lands.

Another source of localized pockets of mineralized water is connate water, theorized to be ancient seawater remaining from periods of inundation, entrapped within the aquifer, and relatively unexposed to freshwater flushing.

The effects of seawater intrusion, upconing, aquifer cross contamination, and connate water can create a complex and somewhat unpredictable scenario of local ground water quality. Monitor wells provide a great deal of information where they exist, but there are limits as to how many wells can be installed and monitored. Where more detailed information is required, additional methods may be needed to monitor the saltwater interface. The District recently participated in a cooperative study in Broward County which utilized a surface geophysical method for delineating saltwater intrusion. Geophysical surveys can provide extremely useful information about the extent of saltwater intrusion at relatively low cost (Benson and Yuhr, 1993).

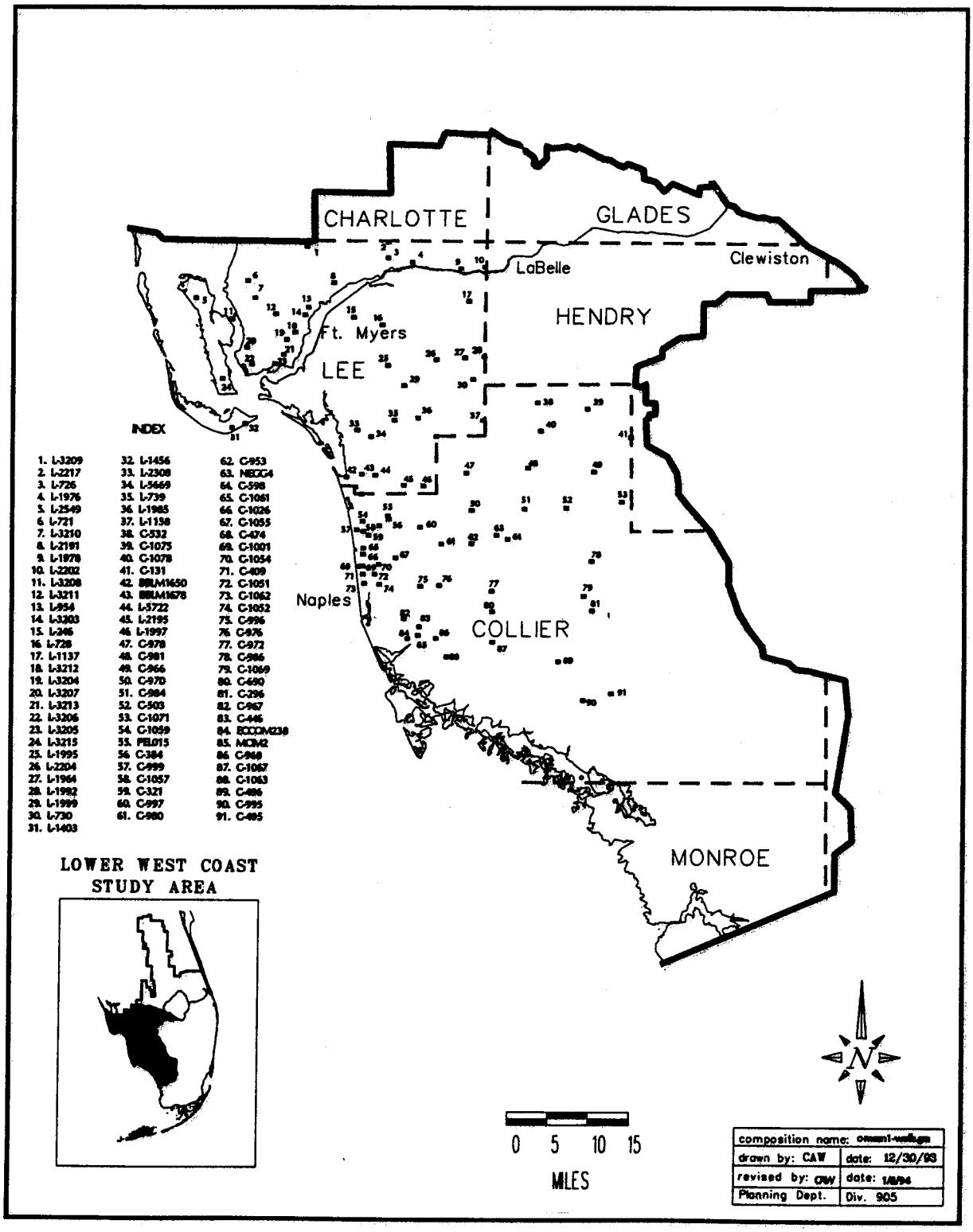


FIGURE H-55. Selected Monitor Wells for the Water Table Aquifer.

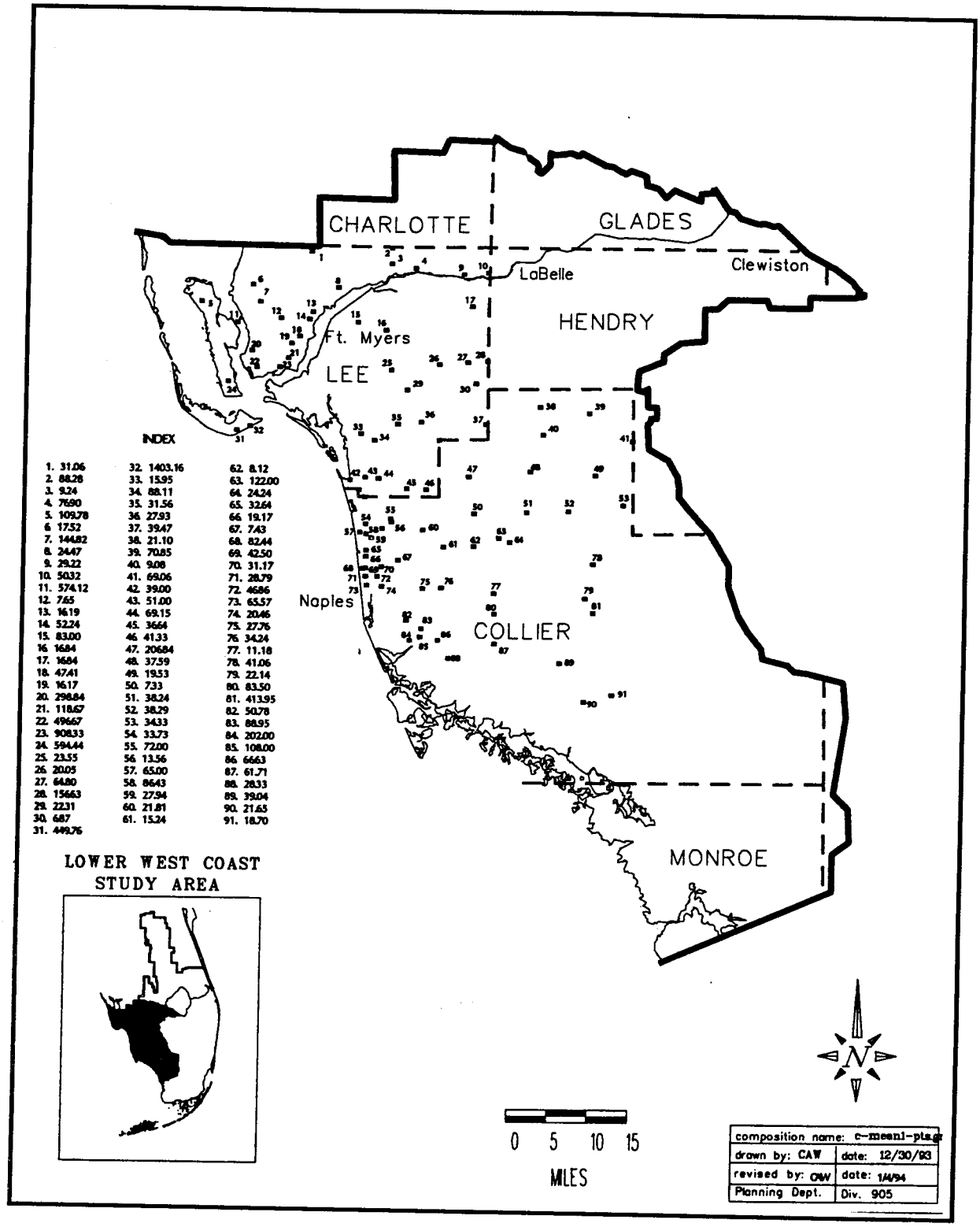


FIGURE H-56. Average Chloide Values for Selected Monitor Wells for the Water Table Aquifer (mg/L).

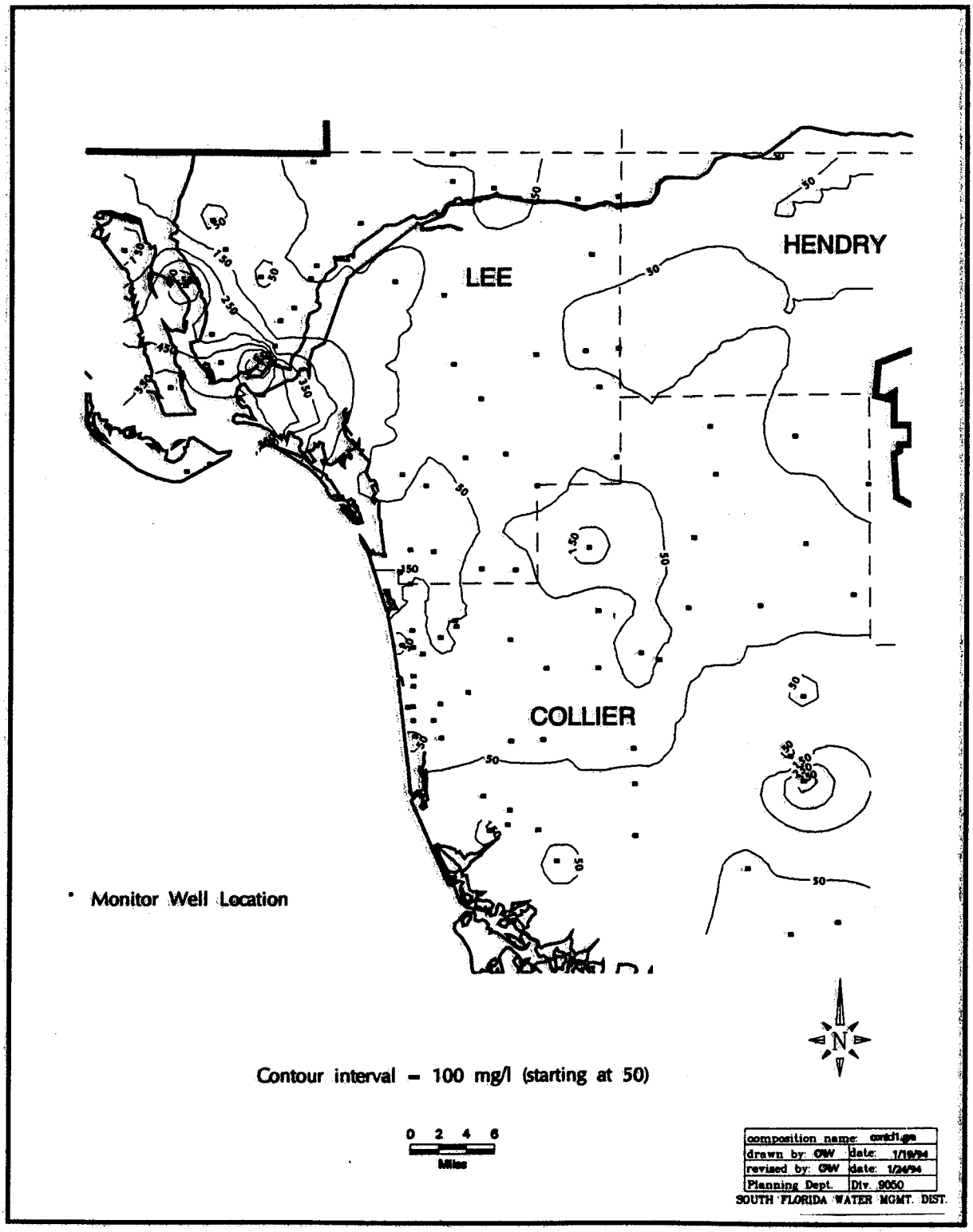


FIGURE H-57. Isochlor Map of the Water Table Aquifer (mg/L).

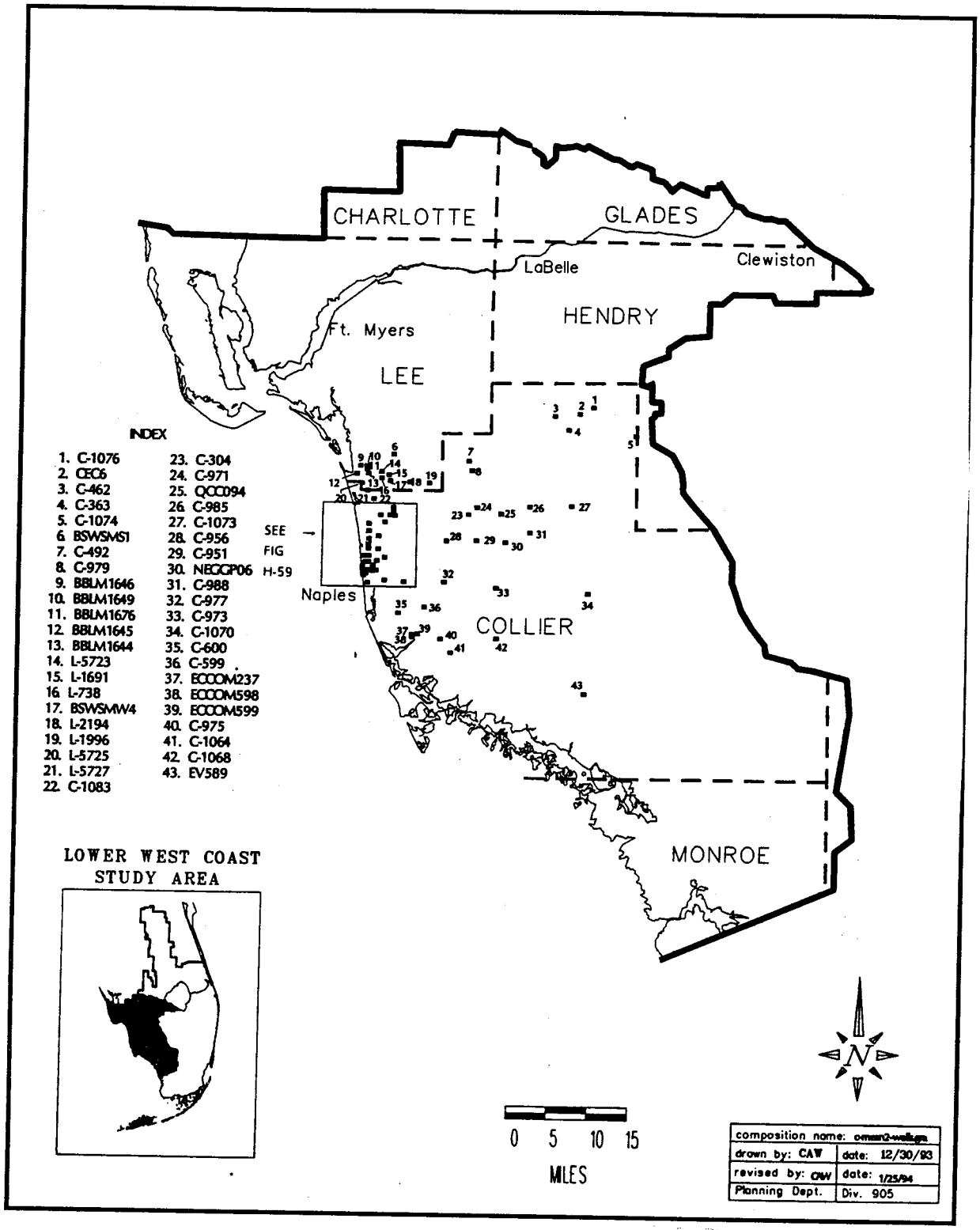


FIGURE H-58. Selected Monitor Wells for the Lower Tamiami Aquifer.

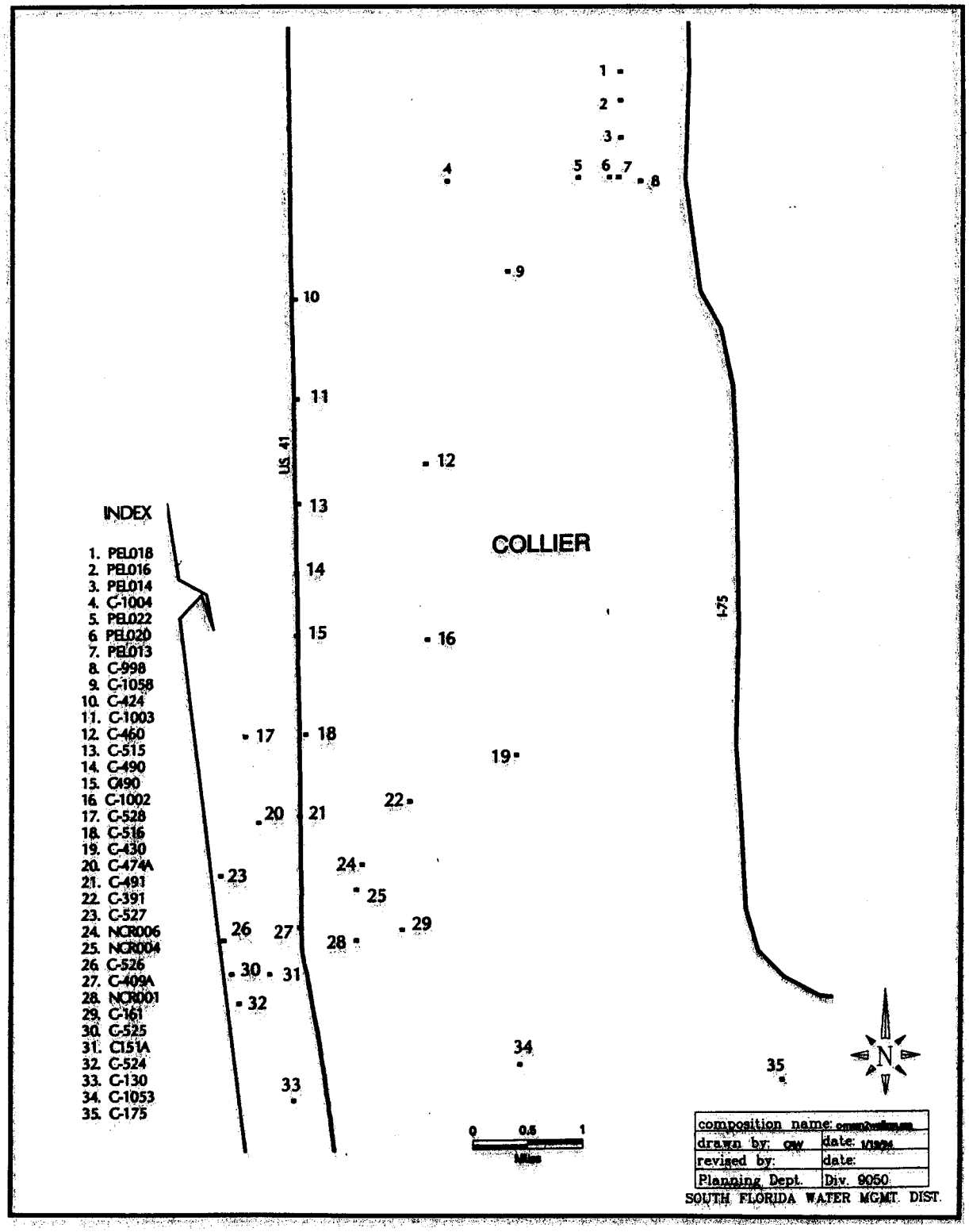


FIGURE H-59. Selected Monitor Wells for the Lower Tamiami Aquifer in the Naples Coastal Ridge Area.

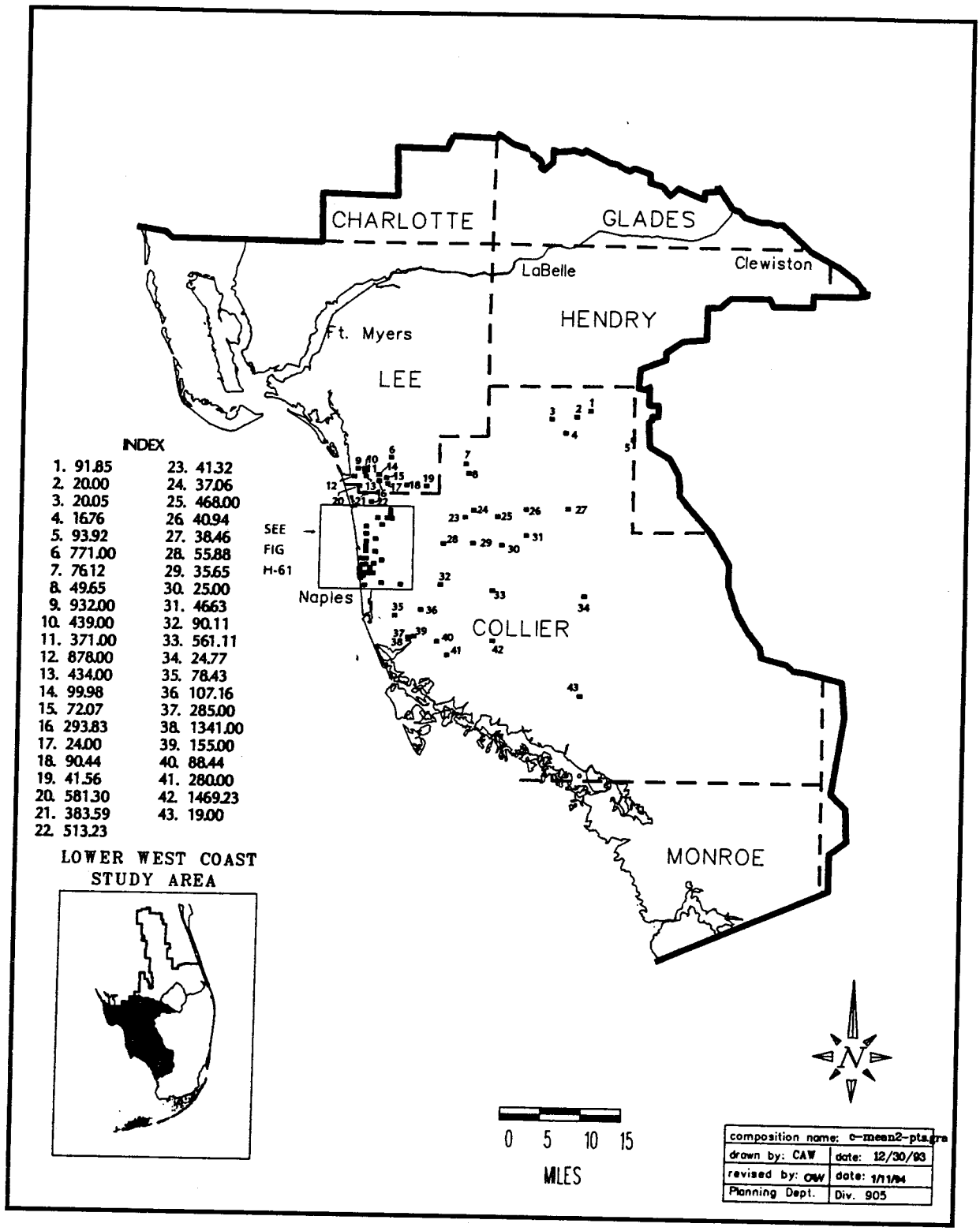


FIGURE H-60. Average Chloride Values for Selected Monitor Wells for the Lower Tamiami Aquifer (mg/L).

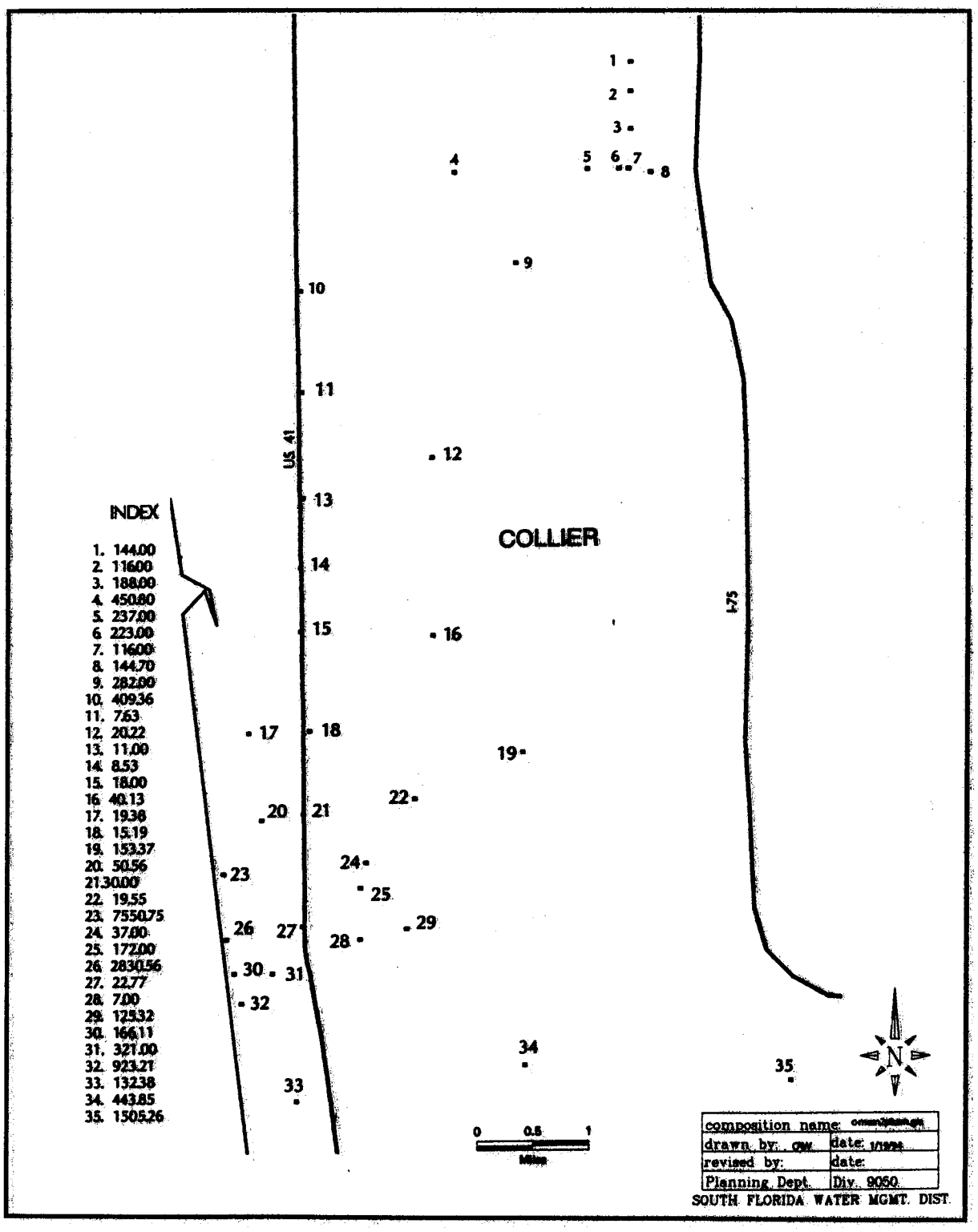


FIGURE H-61. Average Chloride Values for Selected Monitor Wells for the Lower Tamiami Aquifer in the Naples Coastal Ridge Area (mg/L).

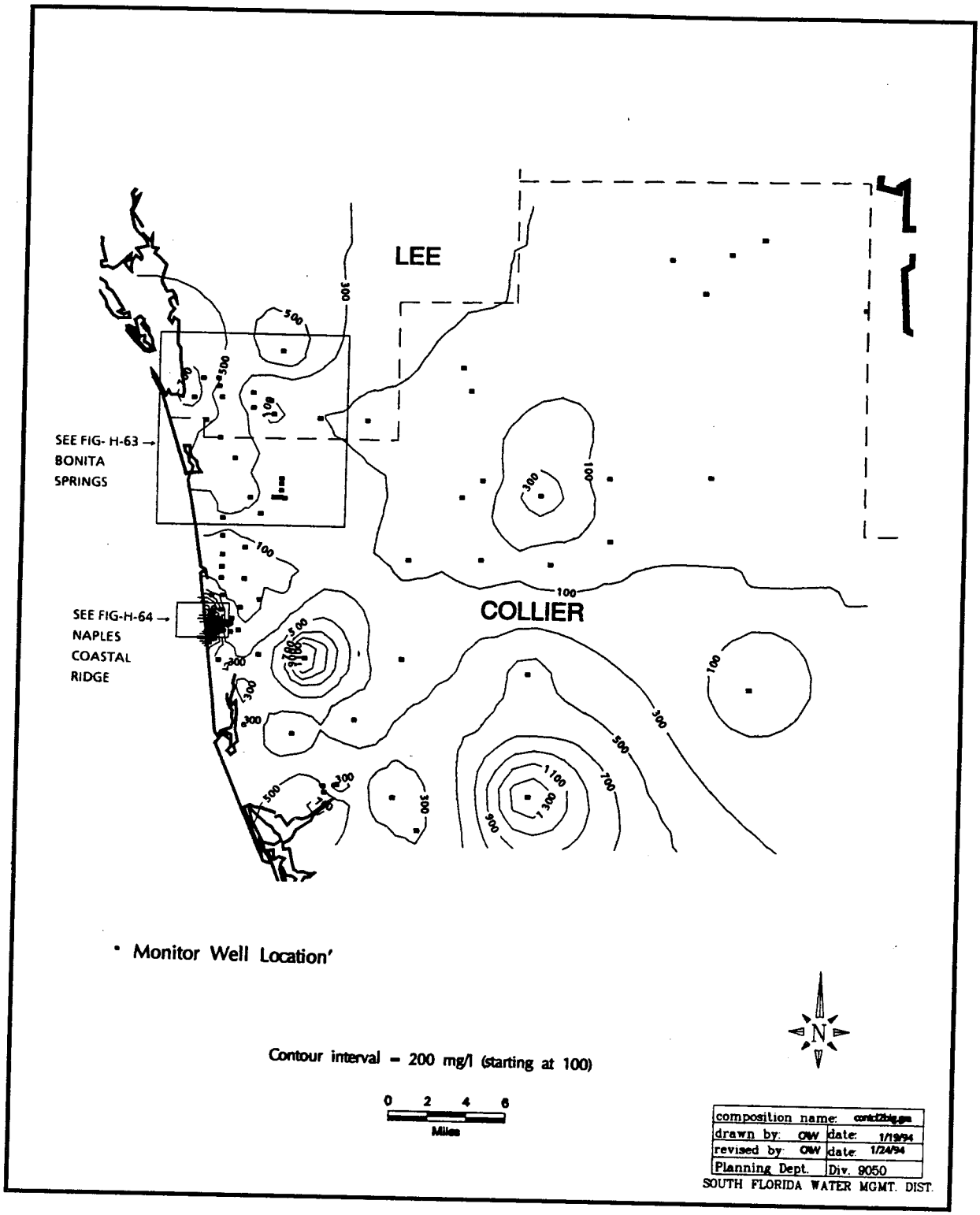


FIGURE H-62. Isochlor map of the Lower Tamiami Aquifer (mg/L).

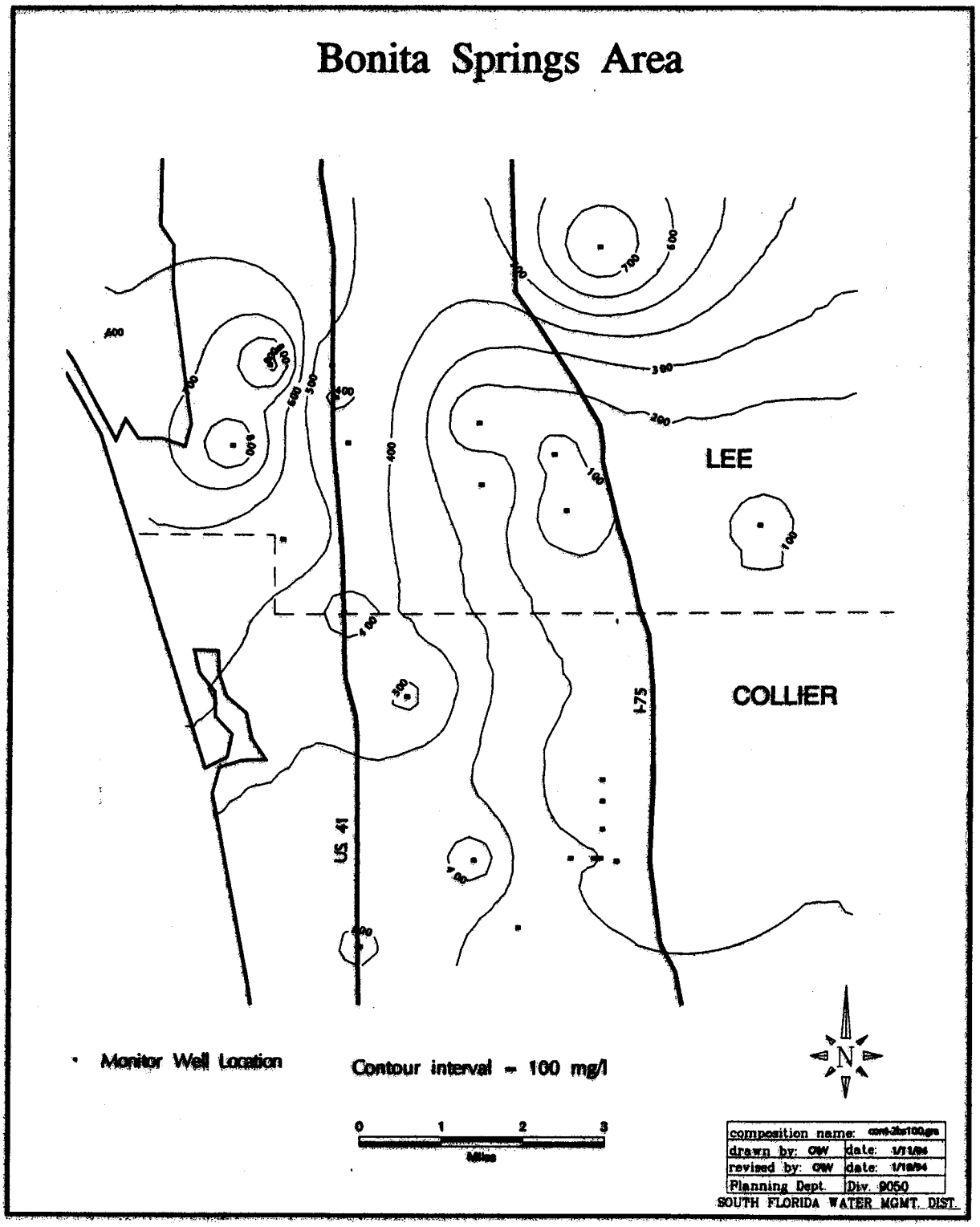


FIGURE H-63. Isochlor map of the Lower Tamiami Aquifer for the Bonita Springs/North Naples Area (mg/L).

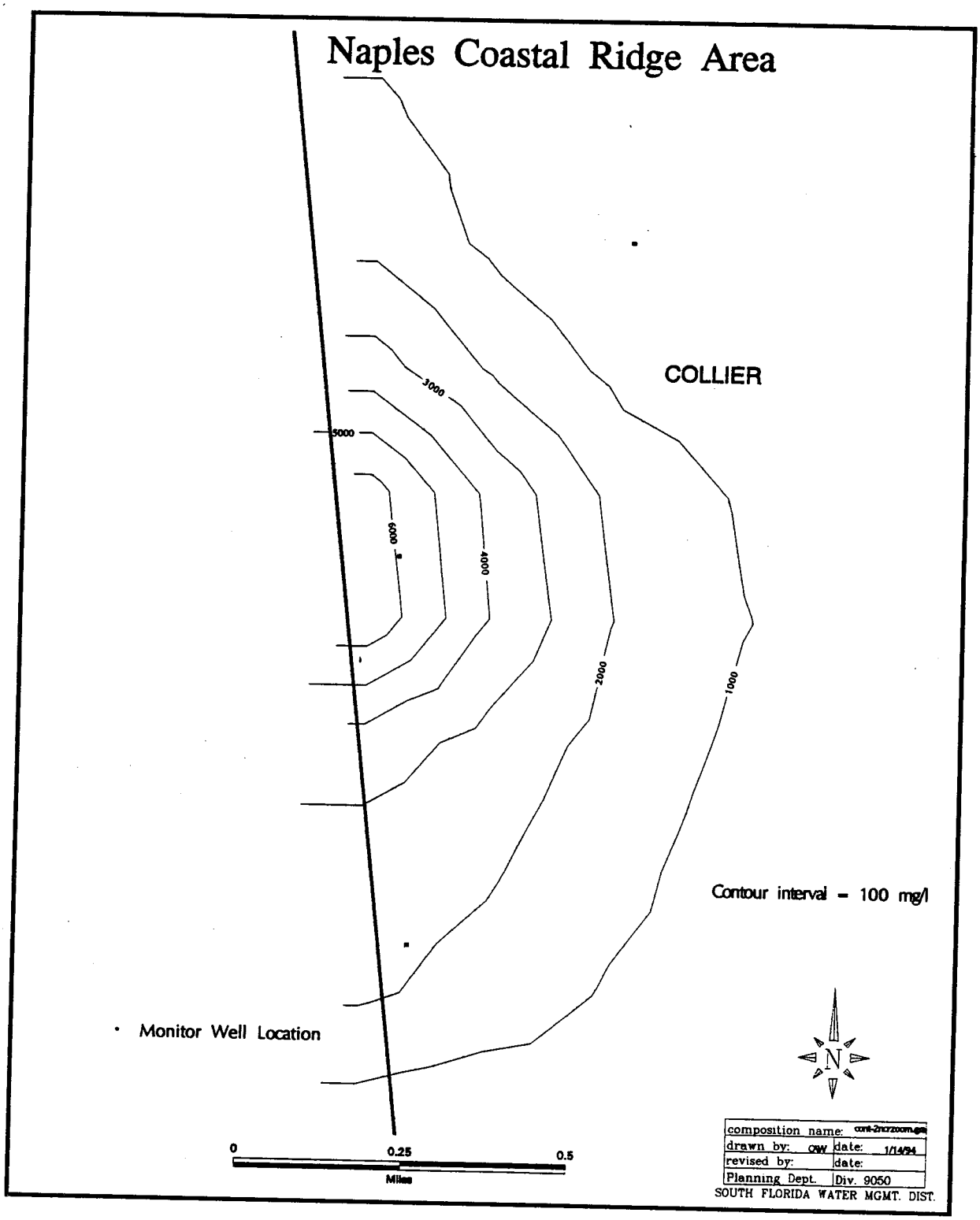


FIGURE H-64. Isochlor map of the Lower Tamiami Aquifer for the Naples Coastal Ridge Area (mg/L).

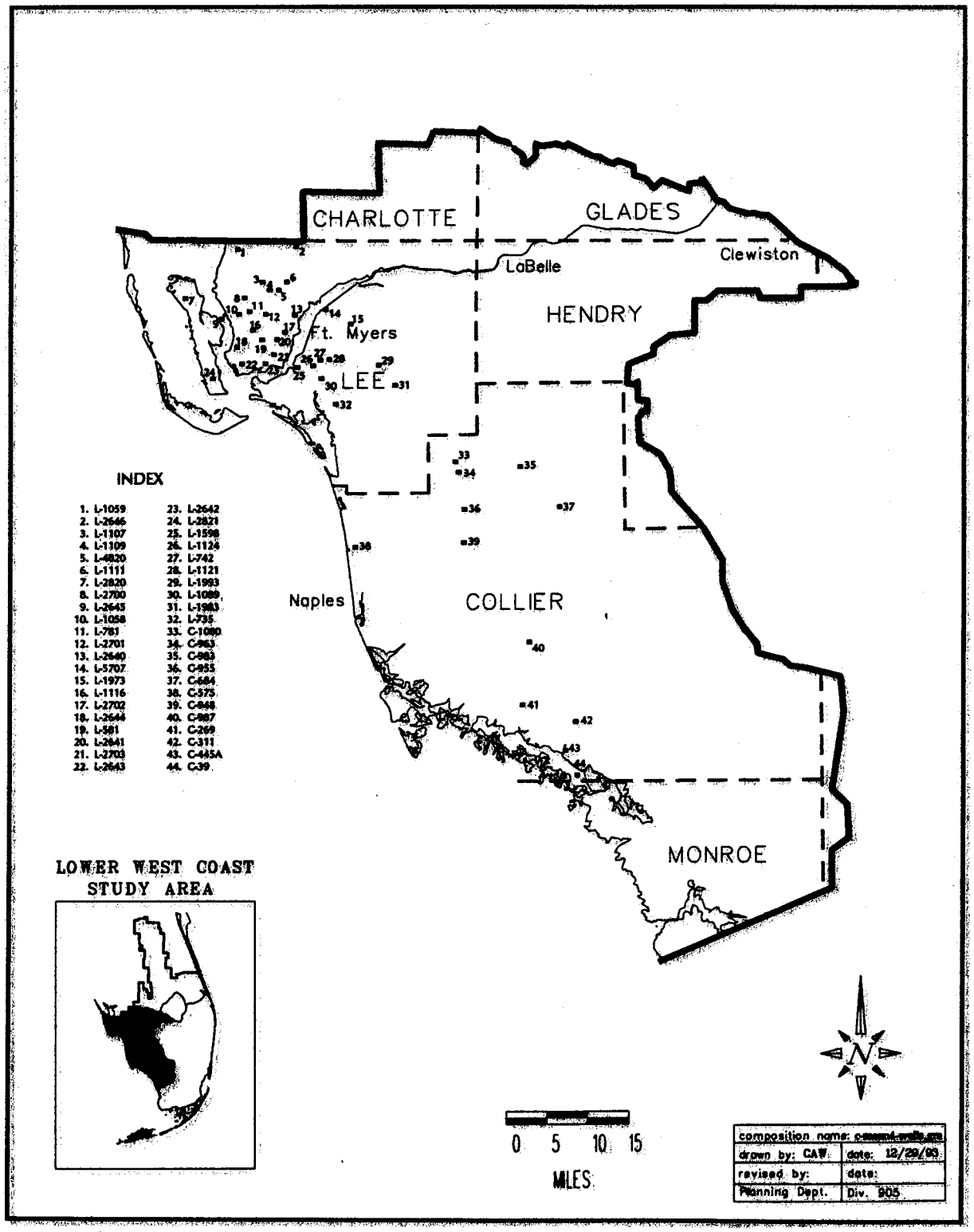


FIGURE H-65. Selected Monitor Wells for the Mid-Hawthorn Aquifer.

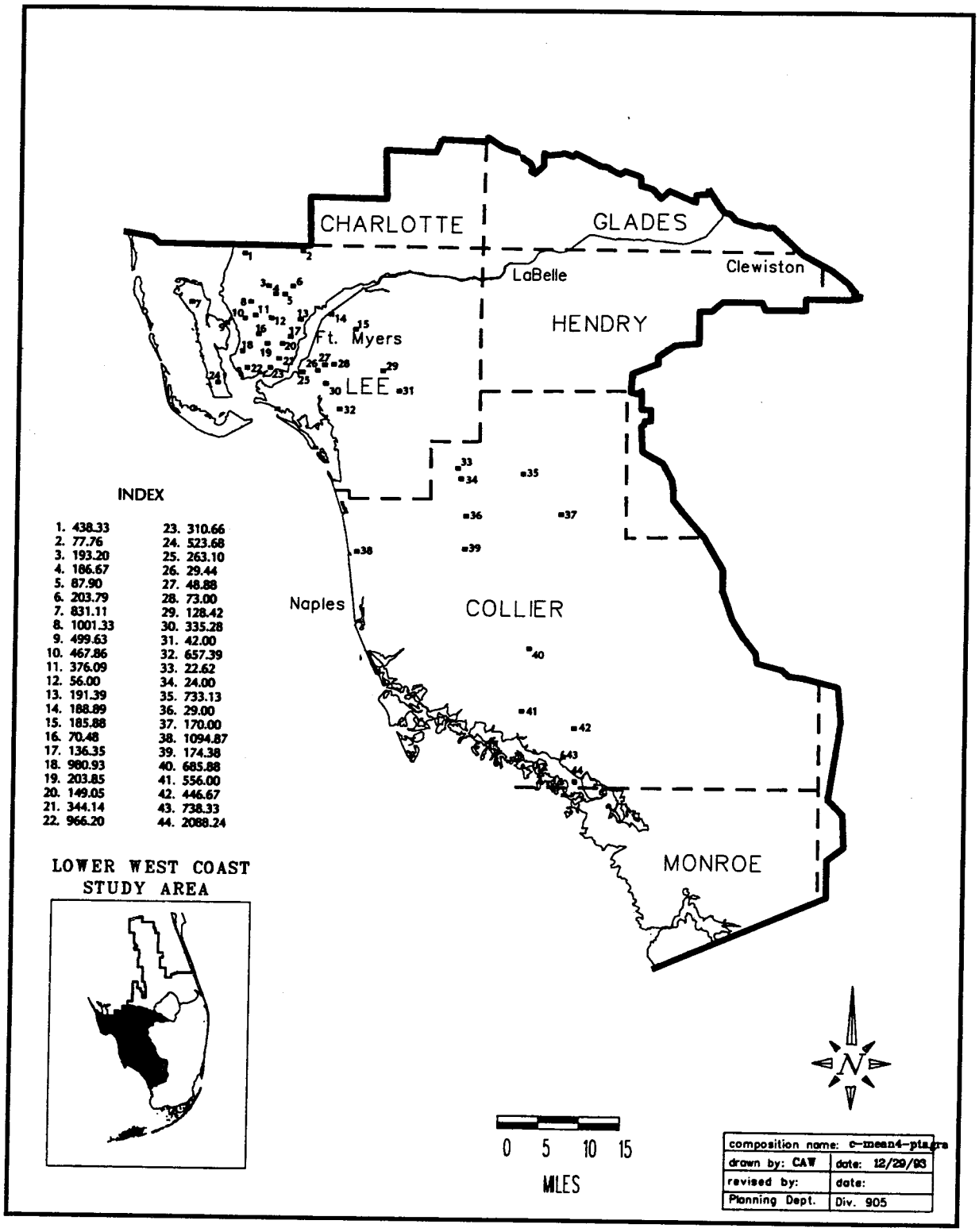


FIGURE H-66. Average Chloride Values for Selected Monitor Wells for the Mid-Hawthorn Aquifer (mg/L).

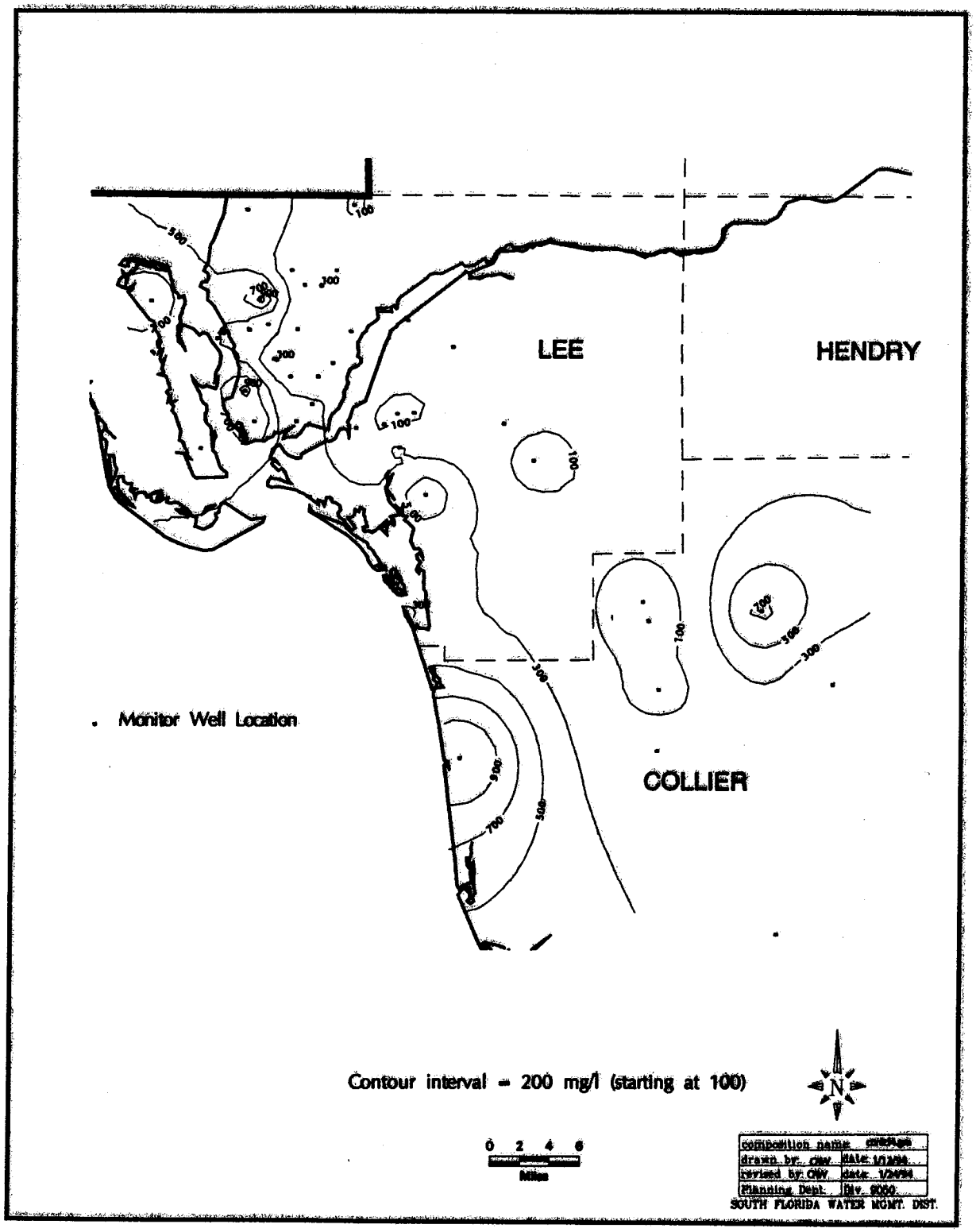


FIGURE H-67. Isochlor Map of the Mid-Hawthorn Aquifer (mg/L).

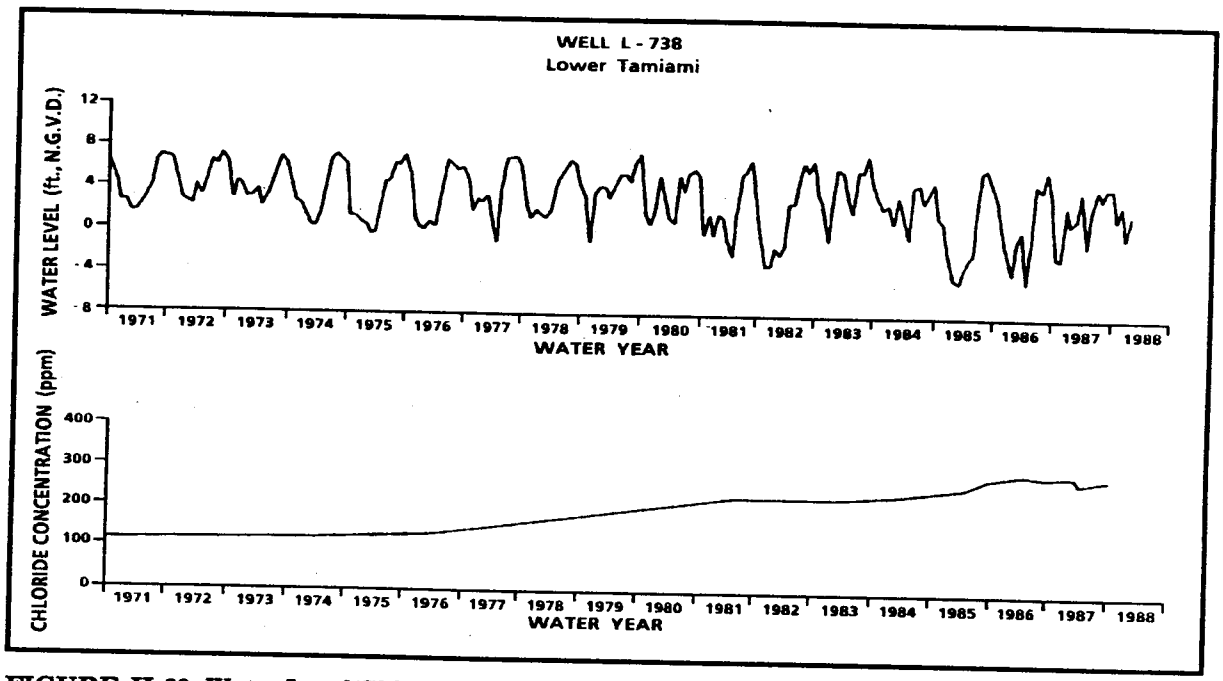


FIGURE H-69. Water Level/Chloride Concentration Comparison in Lower Tamiami Well L-738 (Bonita Springs). From: USGS. In: JMM, 1988.

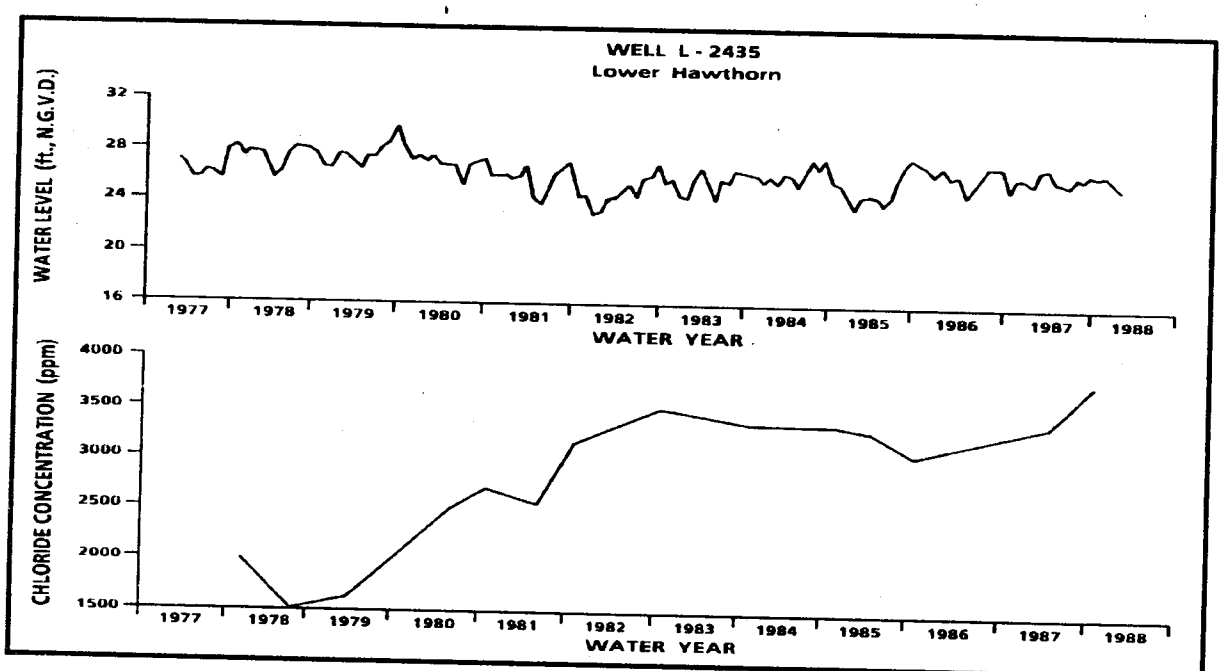


FIGURE H-70. Water Level/Chloride Concentration Comparison in Lower Hawthorn Well L-2435 (North Fort Myers). From: USGS. In: JMM, 1988.

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APPENDIX I

Water Conservation and Supply Measures

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COST EFFECTIVENESS OF WATER CONSERVATION MEASURES

This portion of Appendix I discusses the costs, cost savings, and water use reductions that determine the economic effectiveness of the conservation measures discussed in Chapter V of the LWC Background Document. A key measure used in this discussion is cost effectiveness. Cost effectiveness is a comparative measure reflecting both the dollar costs (and dollar savings) of actions taken to achieve conservation goals and the water use reductions that result. The cost effectiveness of a measure can be defined as the net change in the costs that result from its implementation divided by the reduction in water use achieved while maintaining the same level of satisfaction.

The primary goal of water conservation is the reduction of water use. Water use is of concern to water managers both as a withdrawal and as a consumptive use. Consumptive use takes into account not only the withdrawal of water from the source (aquifer or surface water body) but the extent to which control of its future use is lost as it enters some other stage of the hydrologic cycle or system. Water that is applied for irrigation and adds to evapotranspiration is consumptive use. For all practical purposes, water discharged to tide is also consumptive use. Withdrawals, on the other hand, are the total water taken from the source. Withdrawals include both those parts lost and those which return to the original source or another reasonably usable source. The effectiveness measure most often considered for the conservation measures discussed in this appendix is water withdrawal. Determining the extent to which the withdrawals result in recharge or consumptive use requires detailed site-specific hydrologic testing and modeling, which is not feasible for this analysis. It is still important, however, in some cases to pay attention to whether the withdrawals generally result in consumptive use. For instance, irrigation withdrawals from the lower Tamiami aquifer in the Bonita Springs area are more significant when recharge rates from the water table aquifer are relatively low.

No conservation measure is equally cost effective in all applications. In fact, cost effectiveness is expected to vary greatly. Key factors affecting the cost effectiveness include the frugality of water use without the measures, the costs of the devices selected, their performance and reliability in providing desired services with reduced water use, and the costs of supplying water if the conservation measure had not been undertaken. A major focus of this section is to summarize the major conditions and cost factors which influence the cost effectiveness of conservation measures in particular applications.

Many of the conservation measures offer the possibility that, over time and for selected applications, the cumulative savings will exceed the costs. These conservation applications offer economic advantages over others that may entail additional costs, while still being less costly than available supply augmentation measures. For this reason a special term "cost saving" is used to describe the importance of these conservation measures.

Mandatory Water Conservation Measures

Water Utilities

Adoption of an Irrigation Hours Ordinance. The water use impacts of restricting allowable irrigation hours will depend on the changes in scheduling that users undertake. Users who merely switch the hours of operation of their irrigation

systems and do not change the amount of time the systems are run will in effect be applying a little more water to the landscape. This will most likely increase the average soil moisture thereby increasing local recharge during minor rainfall events and runoff during major rainfall events. It may also increase the evapotranspiration (ET) off the landscape if the area is presently under irrigated. Users who reduce the time the systems are on or the number of days they are operated will be reducing withdrawals from the source. It has been estimated that switching the hours might increase the efficiency of application by 10 percent (conversation 1990 with Alan Smajstrla, Agricultural Engineering Department, University of Florida, Gainesville, FL). The use of manually controlled irrigation systems may be reduced because of the inconvenience of non-daylight operation.

Small costs are expected to result from the imposition of these requirements. Those with irrigation system timers may need to adjust the time of operation. Some effort will be required of those without timers and without in-ground sprinkler systems as they will most likely perform those jobs during the limited morning or evening daylight hours. In South Florida, the early morning is the best time to irrigate because disease problems are avoided and the vegetation is better prepared for daylight.

Adoption of a Xeriscape Landscape Ordinance. Water use savings from implementing Xeriscape landscape codes will result from reductions in irrigation water applied. The main factors influencing the cost effectiveness of Xeriscape landscape codes include the initial landscaping costs, irrigation costs, and maintenance requirements.

Landscaping Costs. The primary direct cost relating to a Xeriscape code is that for the initial landscaping, especially when it is installed by a professional landscape contractor. When a Xeriscape code is in effect, very drought-tolerant plants, such as ground covers or drought-tolerant grasses, may substitute in a portion (about 30 percent) of the landscape for the grass presently used (mostly standard St. Augustine varieties). An estimate of the installed cost of sod is $.17 per square foot. Ground covers generally cost more to install. Estimates of installed cost range from $.55 to $1.00 per square foot; however costs may be reduced by increased spacing between plants. Bahia costs about the same as conventional St. Augustine grass. Costs for the FX-10 drought-tolerant St. Augustine variety of turfgrass are higher than those for the other grasses. The difference in the installation costs of ground covers versus turf could amount to between $570 and $1,245 for a single-family residence with 5,000 square feet of total landscaped area when an additional 30 percent of the area is landscaped in ground cover instead of turf. It is important to note that very limited or no installation costs would be associated with preserved natural areas and that the area where the groundcover is installed may not require an irrigation system.

Irrigation Costs and Maintenance Requirements. In most areas, the costs for obtaining additional water for irrigation are low, so that for example, when $1.50 per 1000 gallons is charged by the utility to the customer, the expected reduction in watering costs will do little to equalize the costs between the turf and the drought-tolerant ground cover installations. Since the operating costs of individual wells and surface water intakes is smaller ($0.10 to $0.15 per thousand gallons), users of well water will save less by reducing water use than users of utility water.

Maintenance requirements for the different types of grasses are expected to be about the same as long as they are maintained to standards acceptable for urban landscapes. Maintenance efforts and costs for the ground cover are expected to be

somewhat lower because they require periodic weeding and pruning about 4 times a year instead of mowing about 36 times a year. Some analyses indicate that large savings in maintenance costs will be achieved as a result of Xeriscaping. These analyses are often those that show large overall cost savings from Xeriscape.

The extent to which Xeriscape will reduce the costs of building new facilities to supply irrigated water will depend on the extent to which peak period water demands are reduced. Where utility supplied water is used for irrigation, peak utility demands typically occur in periods of high irrigation water use. By reducing water use in peak demand periods, utility plant expansions to meet these peak demands can be delayed. The effectiveness of Xeriscape in reducing these peaks, in turn, depends on the ability of the selected plants to tolerate reduced irrigation during droughts. Preserved on-site natural areas will have no need for irrigation and suffer little or no damage during extended periods of no rainfall. Where utility water is used for irrigation, the "no irrigation" areas will reduce the peak demands on the utility. For those self-supplied users with "no irrigation" areas, withdrawals would still remain low during periods when the Surficial Aquifer System is experiencing the least recharge and greatest potential for drawdown.

Adoption of an Ultra-Low Volume Fixture Ordinance. District estimates show that changing to the ULV fixtures from low-volume fixtures will save approximately 15 gallons per capita per day for residents of new housing structures. Almost all the savings would mean reductions in utility wellfield withdrawals.

The costs incurred will include the difference in the purchase and installation costs of the ULV fixtures versus the low-volume fixtures. However, these costs are offset by the savings in water and sewer costs. The savings in shower and faucet use have the additional benefit of saving water heating costs.

The key to the cost effectiveness of this alternative is that there not be a significant differential in the costs, operational life, and performance of the ultra-low volume versus the low-volume devices. Available data indicate that for devices with similar construction and use patterns, the ULV devices provide significant operating cost savings, and have payback periods of less than seven years for toilets, and even less for devices which save water heating costs.

Installation of ULV faucets and showerheads is generally cost saving. The cost effectiveness depends upon: (a) the cost of heating water; (b) the cost of water and sewer; (c) the utility discount rate; and (d) the number of persons per household, which is related to the intensity of use.

The most important factors influencing the cost effectiveness of ultra-low volume toilets are: (a) the relative cost of ULV and conventional toilets; (b) the cost of water and sewer; and (c) the intensity of toilet use, which is determined by the interaction of the number of people per household, the number of flushes per person per day, and the number of toilets per household. In part because of the relatively high cost of toilets, the degree to which the ULV toilets will be cost saving is less clear than in the case of faucets. Public restrooms, where the number of flushes per toilet per day is larger than in the typical home, offer one setting where ULV toilets can be effectively utilized. The payback period for ULV toilets is almost always longer than the payback period for ultra-low flow faucets.

Adoption of a Conservation Rate Structure. Successful implementation of a water conservation rate structure is reflected in reduced withdrawals at the utility

wellfield. The responsiveness of the customers to the conservation rate structure depends on the existing price structure, the water conservation incentives of the new price structure, and the customer base and their water uses. Implementation of other water conservation measures such as Xeriscape, in conjunction with the conservation rate structure increases the effectiveness of this measure since users would be provided with a vehicle to achieve reductions in water use.

A model developed by Brown and Caldwell Consulting Engineers for the District estimated that a $1.00 increase in price per thousand gallons is expected to result in an 8 percent decline in indoor single-family residential (SFR) water use, and a 31 percent decline in SFR outdoor water use. This model shows the demand for water in the aggregate being relatively inelastic, which implies that relatively large increases in price may be necessary to achieve targeted levels of demand reduction. This relatively inelastic demand is consistent with values reported in the literature (Maddaus, 1987).

All utilities have the ability to use rate structures to guide customers in selecting water consumption levels and practices. A water conservation rate structure also allows each customer the freedom to select the most appropriate measures for their needs. Adoption of rate structures should consider the long-term costs differentiated by the conditions of service (e.g., time, location, volume) as they affect costs. That is, rates should reflect both utility operating costs and the costs of capacity expansion needed to meet anticipated future demands over the planning horizon. Properly designed conservation rates should assure that the desired level of cost recovery is achieved based on the anticipated demand patterns associated with the conservation rates. In implementing this concept, it is important that a long-run perspective be adopted, since in the short run, operating costs typically decline as water use increases, particularly if no value is assigned to the raw water.

Adoption of a Utility Leak Detection and Repair Program. Factors affecting the cost effectiveness of leak detection and repair programs include the costs of auditing water use and locating leaks, the size and location of leaks, and the costs of obtaining and treating the water that leaks, and the costs of the repair itself. Water savings from utility leak detection and repair will depend on the extent of implementation. The water resource impacts of the leaks, and the benefits of their repair depend on the size of the leak relative to the location of the source. That is, greater water resource impacts occur when the leak is large and close to the source aquifer.

Leaks are part of each utility's base and peak demands, and they require the utility to have capacity at all times to meet the burdens imposed by this loss of water. The financial costs of ignoring the leak include both the capital and the operating costs to supply water for the leaks. Water audit and leak detection are carried out on a periodic basis by most utilities and on a continuing basis by larger utilities. These audits help quantify the unmetered uses, identify the locations of unauthorized hookups, and determine how large the leakage problems are, and where they are located in the system. The inventory of losses and their locations then is the basis for the scheduling of leak repairs.

Adoption of a Rain Sensor Device Ordinance. The cost of a rainfall sensor switch has been estimated at $25 to $30 if the homeowner installs the system, or approximately $60 if the homeowner has the device professionally installed. Tensiometers and other soil moisture sensors cost several times as much, but allow for better control of irrigation scheduling and greater water savings. Rain sensor

devices, when used as a part of a systematic irrigation program, can be quite cost-effective.

Implementation of a Water Conservation Public Education Program. The costs of public information programs are the outlays by public or private agencies to develop and implement these programs. The impacts on water use and the benefits to the water resource will depend on the actual use changes that result from the public information campaign and the sources of water for those uses. It is difficult to estimate the water savings from this alternative. It tends to act in synergy with other alternatives and is particularly important in supporting retrofit and audit programs as well as encouraging behavioral changes.

Literature on water conservation indicates that public information programs can be expected to achieve approximately four to five percent water savings. Public information may play an important role in encouraging water conservation for short-term drought management purposes. However, the impact of public information programs tends to decline the longer the public is asked to conserve water.

Analysis of Reclaimed Water Feasibility. An analysis of the economic, environmental and technical feasibility of making reclaimed water available is a required component of each utility water conservation plan. The wastewater utility capsules presented in Appendix E indicate that, with a few exceptions, the existing disposal plans of wastewater utilities in the LWC Planning Area include reuse of a large portion of available water. The required feasibility study should determine if additional reuse is economically feasible. Additional reuse may include transmission to areas where there are unmet demands that reclaimed water could meet; the use of percolation ponds, especially in locations where wellfields may benefit from the ground water recharge; and additional residential reuse. Studies of the costs of achieving high percentages of reuse show that the costs of adding to existing systems may vary from around $1.15 to $1.60 per thousand gallons. Implementing reclaimed water systems also saves the wastewater utility the cost of disposing of the water by other means and saves the user the cost of supplying water by alternative means. Also, the use of reclaimed water that offsets the use of potable water could forestall the need for costly water treatment plant expansion. An advantage to the user of reclaimed water is that its use is not restricted during declared water shortages. These advantages and cost savings have contributed to the widespread implementation of reuse by wastewater utilities and water users in the LWC Planning Area.

Commercial/Industrial Users

District regulations are formulated so that only those water conservation measures which the applicant finds to be cost-effective are required. Although it is difficult to generalize about the cost effectiveness of mandatory commercial/industrial conservation measures due to the wide variety of uses covered, a study by Ploeser *et al.* (1992) shows major types of commercial/industrial facilities which have significant potential for cost-effective conservation. These facilities and their range of observed percentage reductions include:

(a) Hospitals (13% to 42%);
(b) Schools (21%);
(c) Hotels (13% to 30%);
(d) Commercial - office buildings (16% to 45%);
(e) Beverage processors) (11% to 21%);

(f) Metal finishers - pc board manufacturers (15%);
(g) Commercial laundry (29% to 39%); and
(h) Food processors (15% to 30%).

"Businesses, industries, institutions and other large nonresidential water users often have the potential for meaningful water conservation. In recognition of this finding, a number of water utilities have instituted programs to promote water conservation by customers who use large volumes of water. In many cases, the customers themselves have recognized that water conservation is cost-effective and that implementing conservation actions is an investment in efficient plant operations. . . . As the cost of water increases . . . it is likely that more conservation actions will become cost-effective and therefore implementable." Furthermore, "water conservation by industry can result in reduced consumption and cost savings in other resources as well, including wastewater treatment, energy, and chemicals" (Ploeser *et al.*, 1992).

Landscape and Golf Course Users

Landscape and golf course permittees are required to use Xeriscape landscaping principles for new projects and modifications when they find this to be of significant benefit as a conservation measure relative to its cost. They are also required to install rain sensor devices or switches and to abide by the prohibition of irrigation between the hours of 10:00 A.M. and 4:00 P.M.

Many of the effects of provisions related to Xeriscape requirements on individual landscape and golf course permittees are similar to the effects of the Xeriscape ordinance on water utilities. Few adverse effects are expected because of the provision that Xeriscape landscaping provisions are only required when they are found to be to be of significant benefit as a conservation measure relative to their cost. Because of the large amounts of water used by landscape and golf course users, potential water savings are significant. Major factors affecting the cost effectiveness of landscape and golf course conservation measures include: (1) present sources of irrigation water and availability of alternative water sources, including reuse water; and (2) efficiency of existing irrigation systems and management practices. The flexibility of the Xeriscape requirement allows it to be imposed without resulting in significant adverse economic impacts on the regulated community.

The cost effectiveness of adopting rainfall sensor and irrigation hours ordinances by landscape and golf course users is similar to the cost effectiveness of adopting these measures by water utilities. These measures were previously discussed under the mandatory water conservation measures for water utilities.

Agricultural Users

Most new citrus acreage in the LWC Planning Area planted in the recent past has used micro irrigation, even in the absence of the mandatory conservation requirement. Nursery water users, however will face higher costs in complying with the new standard. University of Florida personnel who work with the nursery industry indicate that "trickle irrigation is currently limited in nursery situations to field-grown stock and large container stock, i.e., 5-gallon and larger" (Knox, 1989). Another factor increasing the costs of compliance with the nursery standard is that freeze protection requirements are not met by nursery low-volume systems. In many cases an overhead irrigation system will need to be constructed to provide supplemental freeze protection. Container nurseries utilize land intensively;

therefore potential losses associated with freezes pose a high risk, which many growers will not be willing to accept. These same intensity factors mean that potential losses from inadequate availability of water during drought are high.

The initial system costs for newly installed micro irrigation systems have been estimated at $5,500 for woody container nurseries, $6,500 per acre for potted foliage nurseries, and $40,000 per acre for bedding plants (SFWMD, 1993). Due to the need for supplemental freeze protection, container nurseries must often add the cost of an overhead or other high-volume system to their irrigation system costs.

Supplementary Water Conservation Measures

Residential and Commercial Users

Indoor Audit and Retrofit Measures. The residential audit will ultimately reduce the demands on the source supplying water to the users. In most cases, this source will be a utility, although the water may also be self supplied. Since the reductions in indoor use and leaks will provide constant reductions in demand, the peak as well as the base demands will both be reduced. Savings apart from those generated through device installations will result from leak repair and behavioral changes.

Preliminary analyses indicate that retrofit programs for significant portions of the population in existing housing would be cost saving. These programs would reduce water heating and wastewater treatment costs by an amount greater than the costs of the retrofit programs and devices. A high degree of cost savings can be obtained by targeting customers of utilities facing the need to expand capacity; customers having the older higher water use devices; and users with two or more persons using the retrofitted devices. Partial retrofit of the most heavily used facilities can increase the cost effectiveness of an audit and retrofit program.

The costs of implementation will depend on the devices chosen for retrofit and the methods of installation. Retrofit efforts which choose quality devices and professional installation are the most expensive, but may be offset by greater customer participation, water savings, and life of use reductions. The cost savings will depend on the reduction in economic resources needed to supply and heat the water, and treat the wastewater. Life-cycle spreadsheet analyses of the professional installation of ULV devices show that as long as there are two or more people using the retrofit device, there will be a savings until the end of the its useful life. Due to the volumes involved, a well-organized retrofit program should be able to offer lower costs in the purchase and installation of the devices.

The magnitude of savings from using low-flow showerheads and devices depends on (a) the cost of heating water; (b) the cost of water and sewer; (c) the utility discount rate; and (d) the number of persons per household, which is related to the intensity of use. The timing of the retrofit (i.e., useful life remaining in the device to be replaced) is an important factor in determining the cost effectiveness of low volume devices.

The primary factors which influence the cost effectiveness of retrofit toilets are relative cost of ULV and conventional toilets, cost of water and sewer, and the intensity of toilet use. Because of the higher capital costs associated with toilets, the timing of the retrofit program is important in determining the ability of the retrofit program to be cost saving. In general, retrofit is most cost effective when most of the

useful life of the existing toilet has been exhausted. Toilets are more sensitive in this respect than are faucets and showerheads because of the higher capital cost and the longer useful life of the devices.

Savings per capita per day for each person using ULV devices, including toilets, instead of low-volume devices will be the same as for the ordinance alternative, about 15 gallons per capita day (GPCD). Savings when high-volume (pre-1980) toilets are replaced with ULV models would increase to about 20 GPCD. Because of the rapid growth in the LWC Planning Area, pre-1980 toilets make up a relatively small share of the toilets. Since domestic indoor uses are continuing at a constant rate, retrofits will affect demands during peak and off-peak demand periods.

Landscape Audit and Retrofit Measures. Factors affecting the cost effectiveness of landscape audit and retrofit measures include irrigation scheduling, audit costs, water costs, and the costs of purchasing, installing, and maintaining retrofit devices.

Probably the largest immediate water use savings from the landscape audit would be derived from improved scheduling of irrigations. The amount of potential improvement will depend on the schedule previously followed. For instance, watering on a daily or bi-daily basis could result in annual applications of 90 to 100 inches. This depth of water is applied over the area of the irrigated landscape, so that the larger the area to which the landscape audit and retrofit measures are applied, the larger will be the savings measured in gallons. If the landscape irrigator agrees to operate the irrigation system manually based on observation of the need for irrigation, then the irrigation could be reduced to 20 to 30 inches per year. Relying on a schedule that approximates evapotranspiration replacement would not require any observation of lawn conditions and would result in applications of about 60 inches. Achieving a reduction from a high schedule (90 inches) to the more efficient schedule (60 inches) is in accord with the experience of a study in Hillsborough County (West Coast Regional Water Supply Authority, 1987) which showed reductions averaging 27 percent between residences with and without calibrated and properly scheduled irrigation systems.

As an individually oriented information measure, there are usually significant costs to carrying out the visits and audits themselves. The District estimates that it would cost about $45 to $55 per household for a landscape audit program that includes testing the water source for pressure and output rate, testing sprinkler heads for precipitation rate and coefficient of uniformity, setting irrigation zones for proper times and frequencies, and developing an irrigation schedule.

The most cost effective areas will be areas in which the cost of water is high, such as saltwater intrusion areas where irrigation with potable water is common. The landscape audit and retrofit measure is also an important method to get irrigators to adopt good scheduling practices and, if they are willing, to adopt a practice of irrigating based on observed need.

The costs of this measure depend on the devices chosen for retrofit and the methods of installation. Choosing quality devices and professional installation are the most expensive implementation technique, but this may be offset by greater participation by the user, increased water savings, and longer lives of use reductions. At the present time, a rainfall sensor and switch costs about $25 to $30 retail. Professional installation costs about the same, bringing the total to about $60. Installation can be combined with a check of the irrigation clock to see that it is

properly functioning and reasonably scheduled. The reduced irrigation saves on irrigation pumping costs or water costs if utility water is used.

Most of the irrigation water saved comes from individual wells and surface intakes. The estimated cost of applying water in this way is $0.10 to $0.15 per thousand gallons. Utility water cost savings, if potable water were the source, would be about $0.50 to $1.00 per thousand gallons. Using a conservative reduction in water application of 6 to 8 inches per year, the water cost saving would be about $0.56 to $0.75 per thousand square feet per year for individually supplied water and $1.87 to $4.99 per thousand square feet per year for utility supplied water. Since rainfall will be reasonably consistent over the area covered by a single irrigation system clock, only one rainfall sensor/switch should be needed per system. The effectiveness of the device, then, depends on the area covered by the switch. Using a 20 percent capital cost recovery factor for the rainfall sensor switch, the device could be cost saving for systems controlling more than about 18,000 square feet when self-supplied water is used and about 3,500 square feet when utility water is used. This indicates that these devices are cost effective for most existing landscapes of a size that are professionally managed and for homeowner sized areas using utility water.

Water Utilities

Utility Filter Backwash Recycling. This measure involves returning filter backwash to the water treatment facility for retreatment versus disposing of it in a pond. Recycling backwash water decreases raw water withdrawals. Disposing of this water in a pond may provide aquifer recharge, depending on the geology. Savings are achieved in that less raw water has to be pumped. Additional costs may be incurred for equipment to route the backwash to the head of the treatment plant.

This alternative is appropriate for evaluation of its cost effectiveness by water utilities in the LWC Planning Area when they prepare their conservation plans.

Utility Pressure Control. Utility pressure control affects the rate of withdrawal from the utility's water sources. Pressure differences will be greatest during periods of high demand in systems incapable of balancing pressures. The potential water savings from this measure will be highly specific to the utility involved. A 1984 U.S. Department of Housing and Urban Development report summarized the experience of previous evaluations of this measure. The summaries showed that a three to six percent reduction in water use was associated with a reduction of 30 to 40 psi in water pressure to selected areas in which residential water use was closely monitored. Irrigation is believed to have been a small part of residential use in those areas.

The costs incurred to implement this water conservation measure include the costs of data collection and engineering studies to determine the appropriate system adjustments, and the costs of the improvements including pipelines and valves. The savings would be the reduction in the capital and operating costs of the utility systems. Again, the costs will depend heavily on the specific configuration of each utility's system and the extent to which the utility has already taken advantage of the most cost-effective options.

This alternative is appropriate for evaluation with regard to cost effectiveness when utilities in the LWC Planning Area prepare their conservation plans. The focus of their analysis should be on pressure relief in areas experiencing abnormally high pressures.

Wastewater Utility Infiltration Detection and Repair. Infiltration depends on the outside water pressure relative to that inside the sewage collection pipes. Since ground water levels are highest during wet conditions, the infiltration rates also tend to be highest during wet periods. Thus, infiltration contributes most heavily to peak demands and will require that the utility have capacity to meet those burdens. Wastewater utilities have the greatest incentive to detect and stop infiltration when they are reaching the capacity of their treatment and disposal systems.

This alternative needs further evaluation to more accurately determine its potential and the cost effectiveness of efforts to reduce such inflows.

Agricultural Users

Irrigation Audit and Improved Scheduling. Irrigation audits and improved scheduling are ways to increase the efficiency of an irrigation system without making major modifications to the system's physical layout. Improved scheduling can be done with existing equipment through soil moisture budgets or by using soil moisture sensors. Improved scheduling alters the amount of water applied to better reflect the water content of the soil and the water requirements of the crop.

Because irrigation scheduling practices are site specific and dependent on rainfall patterns, it is difficult to estimate potential water savings from improved irrigation scheduling. For pumped irrigation systems, such as are common in the LWC Planning Area, the energy cost associated with pumping water is a significant consideration in selecting cost-effective irrigation systems and management practices. As water becomes increasingly scarce and energy costs rise, the importance of proper irrigation scheduling is likely to increase.

Irrigation audits are encouraged for all agricultural irrigation systems. Based on data assembled by the District, irrigation audits, and the implementation of the irrigation schedule recommendations, have been shown to significantly reduce water use.

Micro Irrigation Systems. The system efficiency of micro irrigation systems is estimated to be about 85 percent, while the system efficiency of seepage irrigation is about 50 percent. However, the realized efficiency of seepage is highly variable depending on a variety of site-specific factors. In the field, micro irrigation would use about 58 percent of the water that seepage irrigation uses, all other factors remaining the same. At present, use of high efficiency systems is mandatory only for new citrus and container irrigation system installations. This section discusses the water savings potential and the costs for retrofitting existing farms with micro irrigation systems. The discussion below summarizes water savings attainable for Collier, Hendry, and Lee counties.

Collier County. Agricultural water use accounts for 68 percent of the water demand in Collier County, and this percentage is projected to decrease slightly to 63 percent by the year 2010. There has been significant incorporation of micro irrigation systems, which have a potentially high application efficiency, into citrus production. However, use of high efficiency systems is limited for vegetable production in Collier County.

Hendry County Area. Agricultural water use accounts for 98 percent of the water demand in the Hendry County Area. In 1990, irrigation requirements for citrus

made up 43 percent of the total agricultural demand, and this is projected to increase to 54 percent by 2010. Micro irrigation systems, which have a potentially high application efficiency, have been incorporated into new citrus production. The magnitude of water demand for citrus irrigation is such that even small percentages saved will result in significant decreases in demand. Use of high-efficiency systems is limited for the other crops grown in Hendry County.

Lee County. Agricultural water use accounts for 34 percent of the water demand in Lee County, and this percentage is forecast to decline to 26 percent by the year 2010. Although agriculture uses less water than urban areas in Lee County, there is still a significant amount of water to be saved in agriculture. As in Collier and Hendry counties, major potential savings beyond the irrigation audit and the mandatory adoption of low-volume irrigation systems is the promotion of semi-closed irrigation systems for vegetable production.

Whether or not a switch to micro irrigation systems will prove financially attractive to farmers depends on the net effect on profits of adopting production systems that incorporate efficient irrigation systems. To date, most citrus growers have adopted production systems based on efficient irrigation. On the other hand, vegetable growers and container nurseries have been slow to adopt these efficient systems, which indicate problems with the costs and/or revenues.

REGULATIONS AND SUPPLEMENTAL INFORMATION FOR WATER SUPPLY ALTERNATIVES

The state's environmental regulation agency, the Florida Department of Environmental Protection (FDEP), regulates the two water supply alternatives discussed in this section, wastewater reuse and aquifer storage and recovery. The FDEP was formerly the Florida Department of Environmental Resources (FDER). In July 1993, the FDER was merged with the Florida Department of Natural Resources (FDNR) to form the Florida Department of Environmental Protection (FDEP). This appendix refers to the FDEP even when the data was collected prior to the merger.

Wastewater Reuse

Reuse is the deliberate application of reclaimed water for a beneficial purpose in compliance with the FDEP and Water Management Districts rules. Reclaimed water is wastewater that has received at least secondary treatment and is reused after flowing out of a wastewater treatment plant (Chapter 17-610, F.A.C.). Reuse includes:

- Landscape irrigation (such as irrigation of golf courses, cemeteries, highway medians, parks, playgrounds, school yards, retail nurseries and residential properties).
- Agricultural irrigation (such as irrigation of food, fiber, fodder and seed crops, wholesale nurseries, sod farms, and pastures)
- Aesthetic uses (such as decorative ponds and fountains)
- Ground water recharge (such as slow rate and rapid rate land application systems)
- Industrial uses (such as cooling water, process water and wash waters)
- Environmental enhancement (such as wetlands restoration)
- Fire protection

The FDEP 1992 Reuse Inventory identified 308 wastewater treatment facilities ($\geq$ .10 MGD) that are reusing approximately 290 MGD of reclaimed water in Florida. These facilities have a permitted design capacity for reuse of 601 MGD. This is a substantial increase from the 1990 Reuse Inventory, which identified 199 wastewater treatment facilities that were reusing approximately 266 MGD of reclaimed water (FDEP, 1990). Among the many reasons for the increased utilization of reuse are: (1) it is an environmentally acceptable means of disposal; (2) state regulations have been adopted; (3) there is an increased public acceptance; and (4) the frequency of drought and water restrictions have increased. Treated wastewater, when properly treated to acceptable standards for the reuse, is no longer a waste but a valuable nonpotable water resource which will enhance the regional water inventory. Reclaimed water is and will continue to have a substantial role in water supply in Florida.

Reuse in the Planning Area

Sixteen of the regional wastewater facilities in the LWC Planning Area utilized reuse for reclaimed water disposal in 1990. The methods of reuse employed by these facilities included ground water recharge via percolation ponds, public access spray irrigation of golf courses, residential lots and other green space, and restricted public access spray irrigation of hay fields. The facilities utilizing reuse for all or part of their disposal needs are listed in Table I-1.

TABLE I-1. Lower West Coast Planning Area 1990 Reuse Facilities.

Facility	Public Access Spray Irrigation			Percolation Ponds	Spray Fields
	Golf Course	Residential Lots	Green Space		
Collier County					
Collier County North	X			X	
Collier County South	X			X	
FL Cities Golden Gate				X	
Immokalee					X
Marco Island	X			X	
Naples	X		X		
Pelican Bay	X	X	X		
Hendry County					
Clewiston					X
Lee County					
Bonita Springs	X	X	X		
FL Cities Fiesta Villages	X				
Forest Utilities	X				
Fort Myers Beach	X		X	X	
Gateway				X	
Lehigh Utilities				X	
North Fort Myers	X				
Sanibel Island	X			X	

Many of the treatment facilities utilized reclaimed water for plant process water and for irrigation of the plant site, which also could be considered reuse. Reuse of 19.08 MGD of reclaimed water in 1990, accounted for 46 percent of the total wastewater processed in 1990 in the LWC Planning Area. The remaining 22.68 MGD was disposed of by deep well injection or discharge to surface water and lost from the water supply inventory. This water, that was disposed of by deep well injection and discharge to surface water, could have been made available with the addition of regulatory mandated equipment including filtration and the associated chemical feed system, disinfection facilities and reclaimed water monitoring equipment. A required facility reliability of Class I, or an equivalent may exist via their existing method of disposal. In some cases, the existing method of disposal may also be utilized as an alternate means of disposal during periods of low demand or when the required reclaimed water quality is not met, which may negate the need for regulatory mandated storage.

Many of the facilities listed in Table I-1 will continue to increase their amount of reuse when additional reclaimed water becomes available and/or when demand is created. In addition to these facilities, the City of Cape Coral completed and initiated operation of their Water Independence for Cape Coral (WICC) program in early 1992. This program provides reclaimed water, supplemented with canal water, for public access spray irrigation on residential lawns and other green space. Approximately 10,000 properties have been connected to the system. Also, a 2.00 MGD reuse facility

at the Fort Myers Central Facility is under design. Initial use includes 1.00 MGD for cooling water at the resource recovery facility, and irrigation of the city nursery, the Fort Myers cemetery, ball fields, and others. Utility-specific information is provided in Appendix E.

Florida's Comprehensive Reuse Program

The State and District objectives include promoting and encouraging water conservation and reuse of reclaimed water. To achieve these objectives, several requirements and regulations have been implemented as part of a comprehensive reuse program. These are: (1) Chapter 17-40, F.A.C., (2) Section 403.064, F.S., (3) the FDEP's Antidegradation Policy, (4) guidelines for preparation of reuse feasibility studies, (5) SFWMD Basis of Review, and (6) State reuse regulations.

Chapter 17-40, F.A.C. This chapter, also referred to as the State Water Policy, requires the water management districts to designate areas that have water supply problems which have become critical or are anticipated to become critical within the next 20 years. This chapter further states that a reasonable amount of reuse shall be required within these areas. The SFWMD adopted the designated critical water supply problem areas by rule (Chapter 40E-23, F.A.C.) in October of 1991. The Lower West Coast Planning Area is incorporated in this designation.

Section 403.064, Florida Statutes. This section of the statutes requires all applicants for domestic wastewater permits from the FDEP for facilities located in a critical water supply problem area to evaluate the feasibility of reuse of reclaimed water as part of their application for the permit.

FDEP Antidegradation Policy. This policy is contained in Chapter 17-4, F.A.C., "Permits," and Chapter 17-302, F.A.C., "Surface Water Quality Standards." Compliance with the state's antidegradation policy must be justified prior to issuance of a permit by FDEP for any new or expanded surface water discharge. The antidegradation policy requires a utility proposing to construct a new discharge or expansion of an existing discharge, to demonstrate that an alternative disposal method such as reuse of domestic reclaimed water is not feasible in lieu of a discharge to surface water, and that such a discharge is clearly in the public interest. This requirement is discussed further in Appendix E.

Reuse Feasibility Studies. There are several rules, statutes, or laws that require preparation of reuse feasibility studies. The FDEP, with assistance from the water management districts and the public service commission, have developed guidelines for preparation of reuse feasibility studies for applicants having responsibility for wastewater management to aid in coordination, consistency and completeness of these studies.

SFWMD Basis of Review. Revisions to the District's Basis of Review, adopted by the Governing Board in October 1992 and which became effective January 4, 1993, require feasibility evaluations of reuse. For all potable public water supply utilities who control, directly or indirectly, a wastewater treatment facility, an analysis of the economic, environmental and technical feasibility of making reclaimed water available shall be incorporated into their water conservation plan at the time of permit application.

Applicants for permits for commercial/industrial uses and agricultural, landscape, and golf course irrigation uses which are located in a critical water supply

problem area are required to use reclaimed water in place of higher quality water sources, unless it is demonstrated that its use is either not environmentally, economically or technically feasible. Reclaimed water also has to be readily available for facilities located outside a designated critical water supply problem area.

State Reuse Regulations. The state adopted Chapter 17-610, F.A.C., "Reuse of Reclaimed Water and Land Application," in April of 1989. This Chapter contains the specific reuse and land application requirements of the FDEP and the Local Pollution Control programs where such authority has been delegated to those programs. The chapter is discussed in detail later in this section.

Reuse Benefits

Several benefits result from the use of reclaimed water for nonpotable water needs. When reclaimed water is utilized to replace a potable supply for nonpotable needs, the benefits include:

- Postponement or elimination of future water treatment plant expansions
- Postponement or elimination of construction of additional water supply wells
- Reduction in the size of the potable water distribution lines
- Reduction in monthly water bills

Additional benefits to the above and with respect to other ground water users are:

- Guaranteed source of water
- Reduced demand on the ground- or surface-water resource
- Exempt from water shortage/restriction requirements
- Reduced application of commercial fertilizers since reclaimed water contains nutrients
- More water available and reduced demands during water shortages for the regional water supplier
- Ground water recharge
- Satisfaction of antidegradation requirement for expansion of a surface water disposal facility
- Exempt from SFWMD permitting

Public Health

Health risks with reclaimed water are relative to the degree of human contact and adequacy/reliability of the treatment processes that produce the reclaimed water. The FDEP has developed reuse regulations that require extensive treatment and disinfection to assure that continuous and reliable supplies of high quality reclaimed water are produced to ensure that public health and environmental quality are protected. Each type of reuse is afforded an appropriate level of treatment and disinfection. In addition to extensive treatment requirements, several application site standards must be adhered to which also minimize potential health risks. The Florida Department of Health and Rehabilitative Services has concluded that a reuse facility designed, constructed, and operated to meet the requirements of the state's reuse rules poses no threat to public health (FDEP, 1990).

Regulatory Agencies and Requirements

Reclaimed water treatment, quality and use is regulated by the FDEP. The primary document utilized for regulation of reclaimed water and reuse is Chapter 17-610, F.A.C., "Reuse of Reclaimed Water and Land Application," which was promulgated on April 5, 1989. This chapter contains specific reuse and land application requirements of the FDEP and the Local Pollution Control Authority delegated programs providing design, operation and maintenance requirements for land application systems. Chapter 17-610 provides the requirements for reuse via (1) Slow-Rate Land Application Systems; Public Access Areas, Residential Irrigation, and Edible Crops; (2) Slow-Rate Land Application Systems; Restricted Public Access, and; (3) Rapid Rate Land Application Systems and Other Land Application Systems. The document specifies the level of treatment required for specific uses of the reclaimed water, the required reclaimed water monitoring equipment, the reliability of the treatment facility, the criteria for the land application system (i.e., golf course, percolation pond, etc.) and system operation. The specific requirements for slow-rate land application systems; public access areas; residential irrigation; and edible crops are located in Table I-2.

In addition to Chapter 17-610, F.A.C., the state has adopted the Wetlands Application Rule, Chapter 17-611, F.A.C., which establishes the foundation and criteria for wetlands receiving reclaimed water.

Reclaimed Water Distribution

Reclaimed water, that has received the required treatment, is delivered to individual users by a dual water system. A dual water system consists of two transmission systems/pipes: One delivers potable water for activities such as cooking, drinking and bathing. The other delivers reclaimed water for activities that do not require potable water, such as irrigation, car washing and industrial uses. Although the reclaimed water transmission system could be designed in several ways and configurations, it is generally one of three basic designs: (1) a low pressure transmission system, (2) a medium pressure transmission system with booster pumps, and (3) a high pressure transmission system. Storage requirements of the system would have to be developed on a case-by-case basis, depending on the design of the reclaimed water transmission system and the user's reclaimed water usage schedule. To prevent cross connection, reclaimed water pipes must be color coded or marked to differentiate reclaimed water from domestic or other water.

The low pressure transmission system consists of an open system which delivers reclaimed water at a low pressure 24 hours a day to the user's on-site storage facility (storage tank, pond, etc.). The reclaimed water is repumped by the user when needed. The reclaimed low pressure water transmission system is designed to meet the peak daily flow because the user's storage facility is filling continuously throughout the day. The operating pressure must be sufficient to deliver water to the user's storage facility for repumping. This system is best suited for large users such as a golf course or industrial facility with ponds or holding tanks to store the reclaimed water until it is needed.

The medium pressure transmission system, with booster pumps, is a closed system that delivers reclaimed water at a pressure which may be below the minimum pressure requirements of some of the users; the pressure is boosted to meet those user's needs on site. The reclaimed water transmission system is designed to meet peak hourly flows because reclaimed water should be available on demand. Pressure

TABLE I-2. Chapter 17-610, F.A.C. specific requirements for reuse of reclaimed water and land application for public access areas and edible crops.

Criteria	Requirements
Minimum System Size	- 0.10 MGD FDEP rated capacity for slow-rate application in public access areas - 0.50 MGD FDEP rated capacity for slow-rate land application on residential properties or edible crops; except for citrus, where the minimum system size can be reduced to 0.10 MGD if the reclaimed water does not contact the fruit, the fruit is processed before human consumption, and public access is restricted
Waste Treatment and Disinfection	Advanced Secondary Treatment - Carbonaceous Biochemical Oxygen Demand (CBOD) $\leq$ 20 mg/L - Total Suspended Solids (TSS) $\leq$ 5 mg/L - Filtration and chemical feed facilities required High Level Disinfection - No detectable fecal coliform 75 percent of the time with no one sample exceeding 25 colonies per 100 ml
Reliability	- Class I or an equivalent
Monitoring	- Continuous on-line monitoring for turbidity and disinfectant
Storage Requirements	- No storage required if another disposal system is incorporated into system design System Storage - Storage that would be required for a ten year recurrence interval and at a minimum, a volume equal to three times the design average daily flow of the reuse system. Golf course ponds are appropriate for reclaimed water system storage and storm water management provided all Department and District rules are met. - System storage ponds do not have to be lined. Off-Line (Reject) Storage - Minimum volume equal to one day at the average daily design flow
Setback Distances Application Site	- 75 feet from edge of wetted area to potable water supply wells - No setback distances to nonpotable water supply wells, surface waters, developed areas, private swimming pools, hot tubs, spas, saunas, picnic tables or barbecue pits
Hydraulic Loading Rates	- A maximum annual average loading rate of two inches per week is recommended
Monitoring of Ground Water	- A ground water monitoring program will have to be established for the system

range for the system is between 40-60 pounds per square inch (psi). This is sufficient pressure to operate most irrigation systems; however, this pressure would have to be boosted to meet the pressure needs of a golf course irrigation system.

The high pressure reclaimed water transmission system is a closed system which is directly connected to, and delivers reclaimed water to the user, at a necessary pressure, to operate the user's distribution (irrigation) system. The reclaimed water transmission system is designed to meet the peak hourly flow since reclaimed water should be available on demand. The system pressure would be approximately 80 psi or higher. Golf course irrigation systems require a pressure of at least 80 psi while residential and other irrigation systems require no greater than 40 psi. This system could include a multi-application reuse system for residential, golf course, park and any other green space irrigation that lacks sufficient space to construct on-site storage facilities.

Potential Uses

Florida's water policy states that water management programs shall seek to "encourage the use of water of the lowest acceptable quality for the purpose intended ... where economically and environmentally feasible." The District and State support reclaimed water as an appropriate alternate source for irrigation when reasonable and available. There are many uses of reclaimed water as identified previously. A discussion of each follows.

Golf Courses. One of the predominate methods of reuse in Florida is for large-scale irrigation, particularly irrigation of golf courses. Currently, there are approximately 141 golf courses in Florida utilizing reclaimed water for irrigation. In the LWC Planning Area, there are a total of 96 golf courses with a total irrigated acreage of 10,138 acres. The estimated average supplemental (irrigation) water requirements of the existing golf course acreage is 33.59 MGD. Thirty-eight of these courses utilize reclaimed water for all or a portion of their irrigation. The irrigated golf course acreage in the LWC Planning Area is projected to increase to 19,578 acres by the year 2010. The 2010 projected acreage will require an average supplemental irrigation of 65.15 MGD (see Appendix G for a detailed discussion of demand projections). The golf courses and wastewater treatment facilities in the LWC Planning Area are indicated in figures I-1 through I-3. The City of Naples and the Loxahatchee Environmental Control District (ENCON) are examples of golf course reuse systems.

The City of Naples wastewater treatment facility is an 8.50 MGD facility which provides reclaimed water for irrigation to nine golf courses as well as three sites for green space irrigation. In 1990, the irrigation sites utilized an average of 3.14 MGD of reclaimed water. Besides providing irrigation water, reuse provides Naples with an environmentally acceptable alternate disposal method to the existing surface water discharge pursuant to a FDEP no-discharge requirement. The reuse system significantly reduces the demand for ground water, which is one of the city's major sources of potable water (Marcello and Chaffee, 1988).

ENCON is a 6.54 MGD wastewater treatment facility located in Jupiter, Florida. They provide reclaimed water to nine golf courses in the Jupiter/Tequesta area via a 25 mile distribution network. Many golf courses in the area had drastic reductions in ground water allocations, and the treatment facility was seeking an environmentally accepted means of effluent disposal and a method to enhance the regional water inventory. The first golf course started receiving reclaimed water in 1984 and since

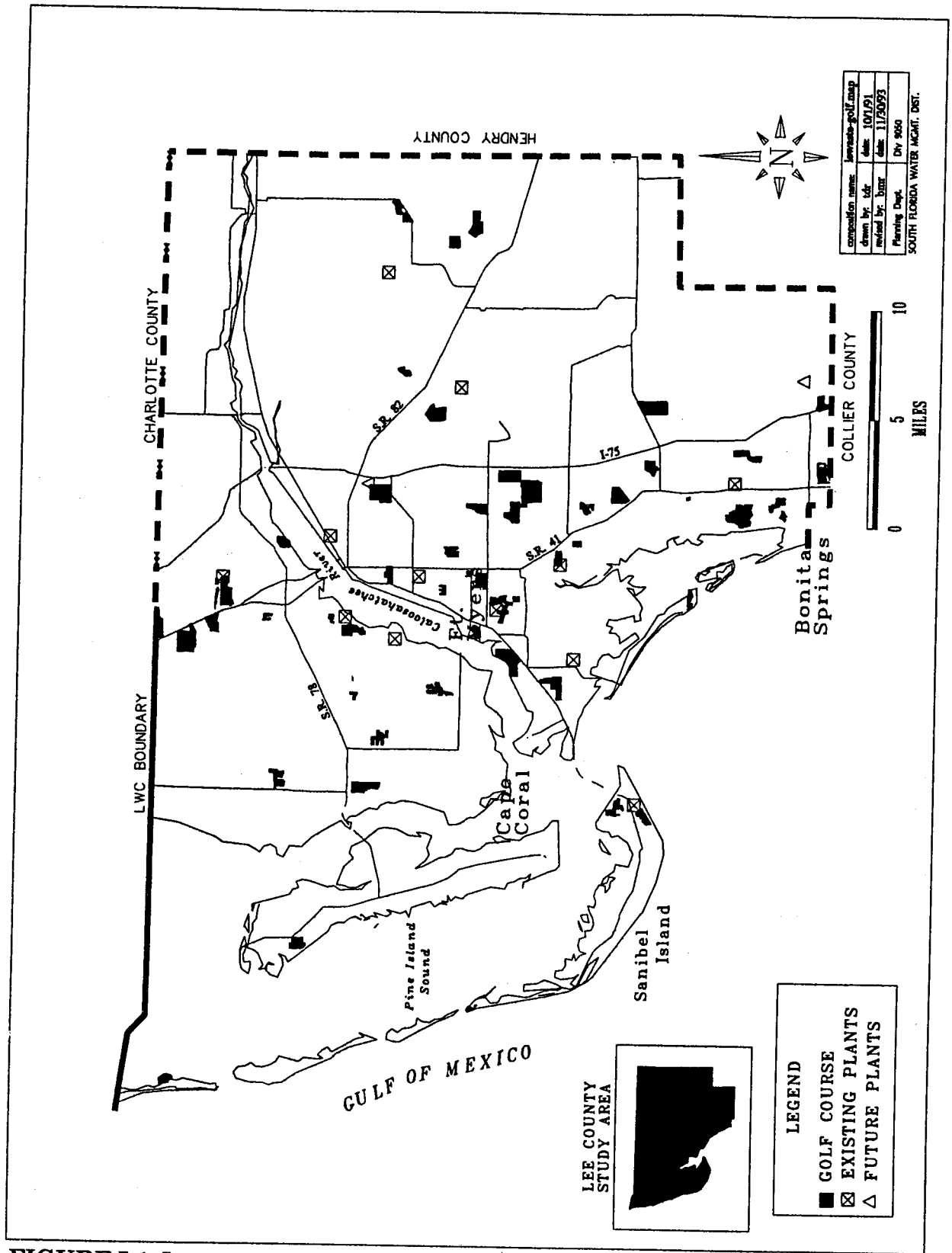


FIGURE I-1. Lee County Wastewater Treatment Plants and Golf Courses.

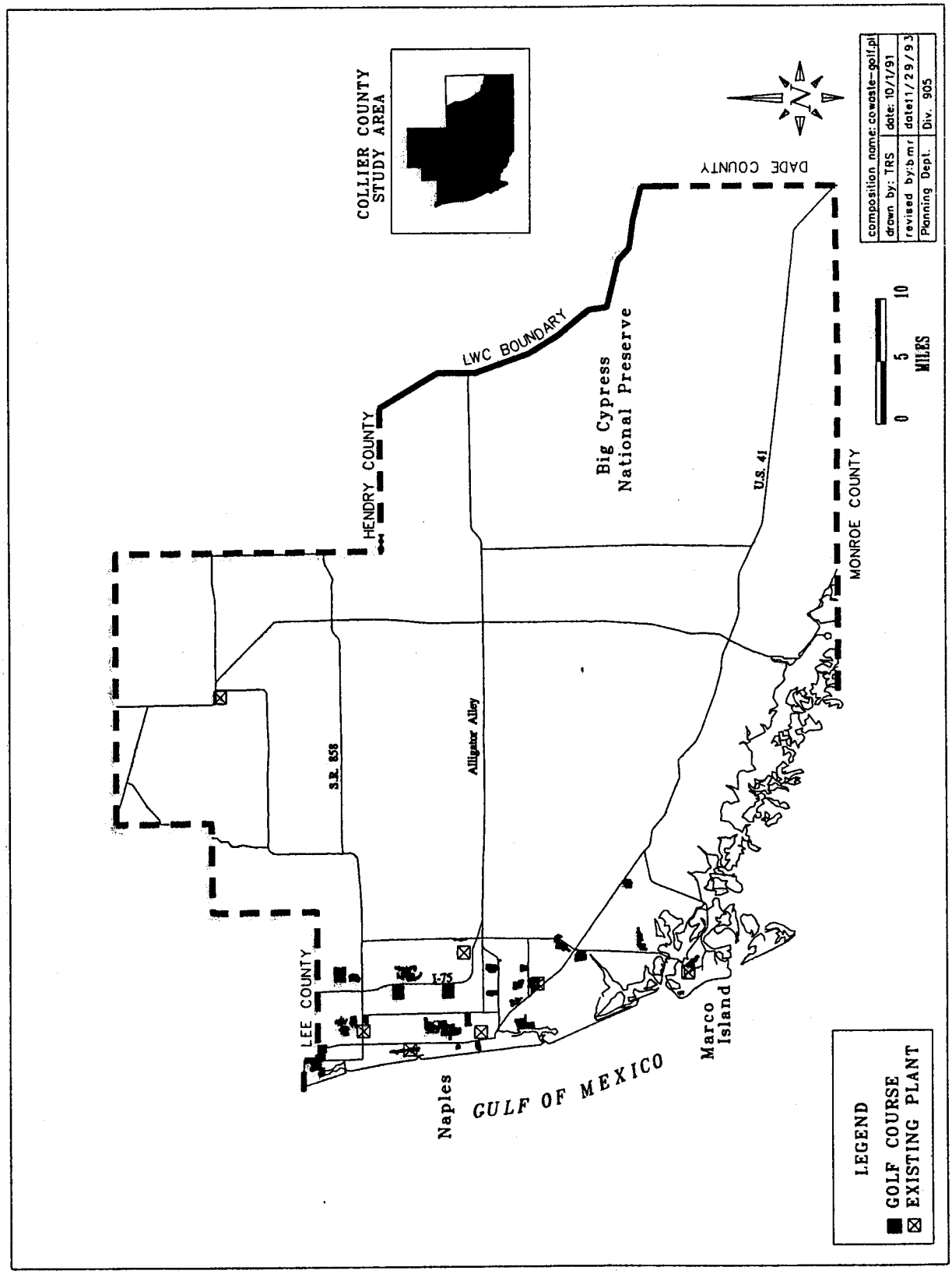


FIGURE I-2. Collier County Wastewater Treatment Plants and Golf Courses.

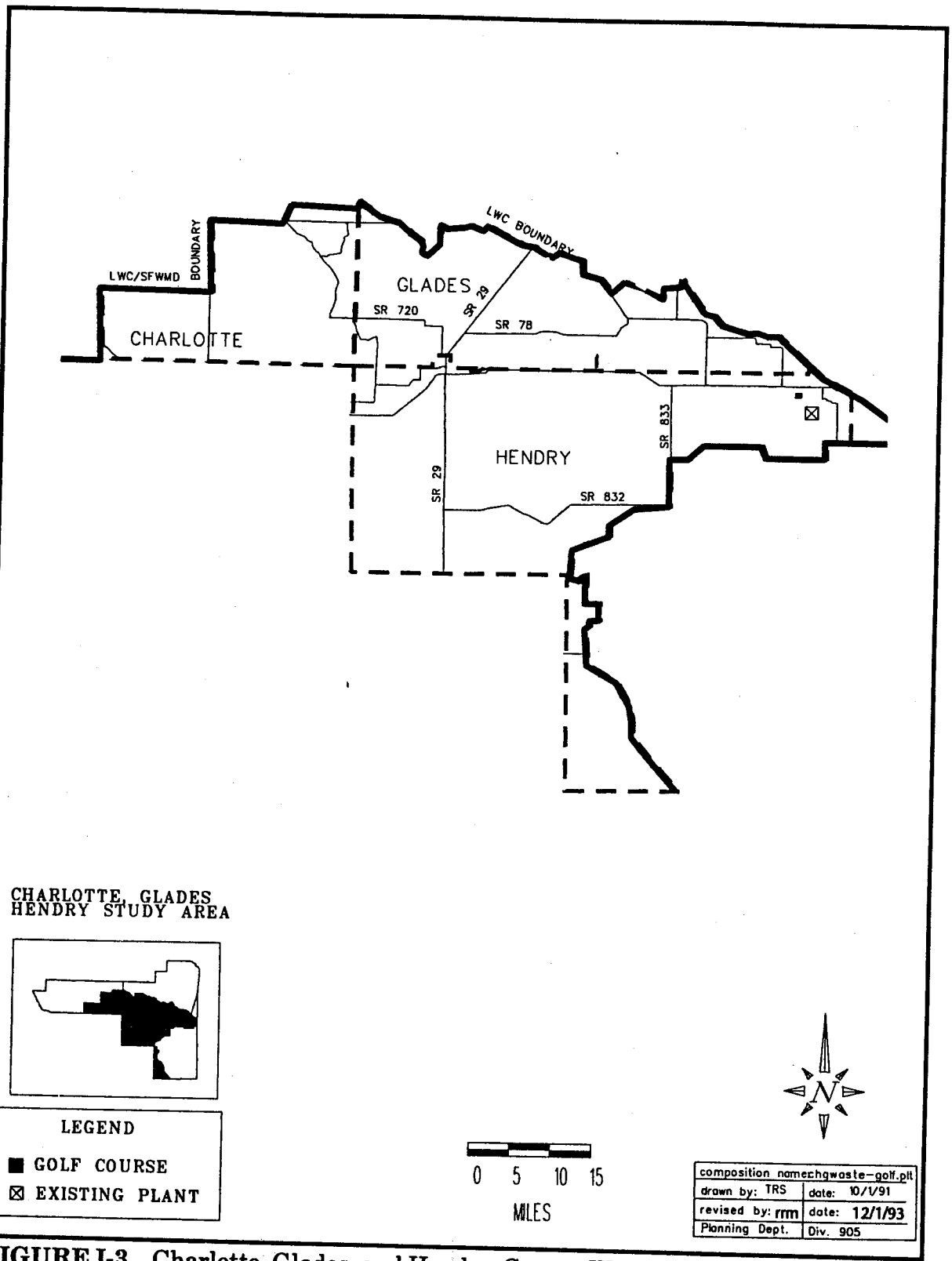


FIGURE I-3. Charlotte, Glades, and Hendry County Wastewater Treatment Plants and Golf Courses.

then, the response has been overwhelming to the concept (Dent and Davis, 1987). The facility is delivering approximately 4 MGD of reclaimed water to the reuse system.

Outdoor Residential. It is estimated that approximately 50 percent of the potable water delivered to single family homes is utilized for outside uses. This can amount to a considerable volume of water treated to potable standards. A substantial savings in potable water, and in turn ground water, could be realized by utilizing reclaimed water for these outdoor nonpotable water uses. These savings may eliminate the need for expansion of existing water treatment facilities, drilling of new wells, or reduce the need for new facilities. The benefit to the consumer in utilizing reclaimed water are lower monthly water bills, reduced need for fertilizer, and exclusion from water shortage restrictions. Several municipalities, including the cities of Naples and Fort Myers, have adopted ordinances that require new developments over 10 acres to install dual water distribution systems with the anticipation of reclaimed water becoming available in the future. Some Florida communities which have implemented, or which are proposing to implement, residential reclaimed water systems are Cape Coral, St. Petersburg, and Boca Raton.

The City of Cape Coral initiated operation of a system in early 1992 to provide reclaimed water for public access irrigation on residential lawns and other green space via a secondary water line as part of the Water Independence for Cape Coral (WICC) program. As part of WICC, reclaimed water and canal water is used are used as supply sources for the secondary system, which will be distributed throughout the city for residential lawn and other green space irrigation. Approximately 10,000 properties are connected to the system. The city will continue to connect additional users to the secondary system. A secondary water system demand of 36.80 MGD is projected in 1993 and 116 MGD at build-out.

St. Petersburg has one of the largest urban reuse irrigation systems in the nation. The program was initiated in the mid-to-late 1970s when the city recognized the need to reduce future potable water imports from adjoining counties. In addition, they were faced with required wastewater treatment facility upgrades because of more stringent water quality standards established for Tampa Bay. St. Petersburg was also declared a water short area (Eingold and Johnson, n.d.). Today, the reuse program consists of four treatment facilities with a total rated capacity of 68.4 MGD with approximately 240 miles of reclaimed water transmission main. Deep well injection systems serve as an alternate means of disposal for the reuse system. The reuse system currently serves 6,570 residential customers among other users. The average daily reclaimed water usage is approximately 21 MGD. It has been estimated that the reuse program in St. Petersburg has extended the capacity of their potable water treatment and supply system by 15 years (phone conversation March 26, 1991 with Joe Towery, Reuse Coordinator, City of St. Petersburg, FL.).

The City of Boca Raton is in the process of initiating "Project IRIS" or "In-city Reclamation Irrigation System." Project IRIS will be an extensive dual reclaimed water system throughout the eastern two-thirds of the city's service area. It is in this area that reuse will have the greatest impact on potable water consumption and reduction of saltwater intrusion. Boca Raton's 1989 potable water per capita consumption was well over 400 GPD. It was determined 70 percent (280 GPD) of consumption was for outdoor use. There are also several golf courses and other large users with wells for irrigation in this area. Elimination of these wells would also reduce the potential for saltwater intrusion of the freshwater aquifer. It is projected that the wastewater flow in the year 2000 will be 15 MGD, which will be sufficient to

supply reclaimed water to the proposed service area. This daily reclaimed water demand will annually conserve three billion gallons of treated potable water and one billion gallons of untreated irrigation water presently withdrawn from the surficial aquifer. With timely implementation, the proposed reuse project will eliminate the need for a 10 MGD expansion of the water treatment plant and related water supply wells, thereby avoiding a capital expenditure of between $7.7 million and $8.7 million. Funding for the project is recommended to come from accumulated water conservation rate funds (Camp, Dresser & McKee, 1990).

Other Green Space. This category includes all other green space that requires supplemental irrigation where use of reclaimed water is desirable. This would include irrigation of parks, activity fields, schools, median strips, cemeteries, commercial landscapes, common areas, and retail nurseries. The development of Pelican Bay utilizes reclaimed water to supply their master irrigation system, which supplies irrigation water for residential lawns, median strips, common areas and other green space. In addition, Lee County's Fort Myers Beach facility provides reclaimed water to five developments for their green space irrigation needs.

Agriculture. Agricultural irrigation includes irrigation of food, fiber, fodder and seed crops, wholesale nurseries, sod farms, and pastures. State regulations prohibit direct contact of reclaimed water with edible crops that will not be peeled, skinned, cooked, or thermally processed before human consumption. However, if an indirect reclaimed water-application irrigation method is used (such as ridge and furrow, drip, or subsurface), precluding direct contact of the reclaimed water with the crop, irrigation is allowed. There are several agricultural operations that utilize reclaimed water for irrigation throughout the state, including sites in Tallahassee, Orlando, and Okeechobee and Manatee counties. Citrus, gladiolus, sod, ridge and furrow crops, ferns, hay, corn, soybeans, rye, oats and wholesale nursery plants are some of the crops presently being irrigated with reclaimed water. In 1990, the LWC Planning Area contained approximately 224,549 acres of irrigated agricultural lands. This is projected to increase to 341,047 acres by 2010.

The Conserv II water reclamation facility, located in Orange County, is jointly owned and utilized for reclaimed water disposal by both the City of Orlando and Orange County. Conserv II currently provides reclaimed water for irrigation of 7,000 acres of citrus and 10 acres of ferns plus ground water recharge via 2,000 acres of rapid infiltration basins. This site receives reclaimed water from the City of Orlando Sand Lake Road and Orange County McLeod Road wastewater treatment facilities with rated capacities of 21 MGD and 23 MGD, respectively. Conserv II has a capacity to irrigate 15,000 acres and dispose of 50 MGD (Metcalf & Eddy, n.d.).

Industrial. Potential industrial uses of reclaimed water include cooling, process and wash waters. Potential users include power plants, manufacturers such as metal fabricators and plating, cement makers, commercial and institutional facilities. Facilities in Hillsborough and Broward counties, Tampa and Largo use reclaimed water for industrial uses. In certain situations, reclaimed water is not fully consumed in some industrial processes. Proper disposal of this reclaimed water must be satisfactorily addressed. Two examples of industrial facilities that utilize reclaimed water are the North Broward resource recovery facility and the Curtis Stanton Energy Center.

The North Broward County resource recovery facility recently placed into operation utilizes approximately 2 MGD of reclaimed water from the Broward County North District wastewater treatment facility as cooling water. The used

cooling water is returned for treatment when the quality decreases below the power plants specifications.

The coal fired Curtis Stanton Energy Center power plant in Orange County utilizes approximately 3.5 MGD of reclaimed water from the Orange County Eastern Service Area wastewater treatment facility for boiler cooling water.

Environmental Enhancement. Reclaimed water could be utilized for environmental enhancement in the restoration of hydrologically altered wetlands. There are several wetlands projects utilizing reclaimed water in Florida, two of which are the City of Orlando Iron Bridge and the Orange County Eastern Service Area wastewater treatment facilities.

The Orlando Iron Bridge Regional Water Pollution Control wastewater treatment facility utilizes a man-made wetlands system for reclaimed water disposal. The 1,200 acre created wetlands consist of a deep marsh, mixed marsh, and hardwood swamp. The current flow into the wetlands is limited to 13 MGD, but ultimately the wetland will receive up to 20 MGD of reclaimed water that has received advanced wastewater treatment. From the created wetlands, the reclaimed water flows through the 660 acre Seminole Ranch wetlands prior to discharge to the St. John's River. This system was placed into operation in 1987 (Schnelle and Ferraro, 1991).

The Orange County Eastern Service Area wastewater treatment facility utilizes an overland flow and wetlands system to currently dispose of 3.5 MGD of reclaimed water that has received advanced wastewater treatment. The wetlands system consists of 150 acres of natural wetlands and 150 acres of pine flatwood converted to wetlands which discharges to the Econlockhatchee River. The system will have an ultimate capacity of 6.2 MGD. This system was placed into operation in 1988.

Rapid Rate Land Application. Rapid rate land application involves discharging reclaimed water to a series of percolation ponds or subsurface absorption systems (drainfields). The FDEP requires, at a minimum, that reclaimed water receive secondary treatment and basic level disinfection prior to discharge to a rapid rate land application system. In addition, reclaimed water discharged to subsurface application systems must not contain total suspended solids greater than 10 mg/L. The application rate is limited to 5.6 gallons per day per square foot, unless greater loading rates are justified. There are many rapid rate land application systems in operation in the LWC Planning Area, mostly associated with reclaimed water disposal from small wastewater treatment plants. However, several large plants utilize rapid rate land application for their primary method of reclaimed water disposal or as a backup to another reuse system.

Hydrodynamic Saltwater Intrusion Barriers. Reclaimed water could be used for ground water recharge in areas of saltwater intrusion. This would be accomplished via rapid rate land application systems or by shallow injection wells. Rapid rate land application such as ponds or drainfields would be strategically placed to deter further migration of the saltwater front. This could be accomplished by constructing long trenches, percolation ponds or subsurface disposal systems parallel to the saltwater front. Injection of reclaimed water by shallow wells has been investigated on Florida's southeast coast. This method of reuse would consist of construction of several injection wells along the saltwater front, which when in operation, would create a positive freshwater head and impede further migration of the saltwater front inland. Injection of reclaimed water is heavily regulated by state and federal agencies. These agencies' regulations prohibit injection of fluids that do

not meet applicable water quality standards. Florida Statutes prohibit the direct pumping of reclaimed water into any geologic formation of the Biscayne Aquifer containing less than 500 mg/L total dissolved solids (TDS). Depending on the local geology/geologic profile and the TDS of the formation fluid, various regulations and criteria apply (FDEP, 1990).

Aquifer Storage and Recovery

Regulatory Criteria

Current regulating criteria for ASR are divided into three categories: (1) untreated surface water permitting, (2) treated water permitting, and (3) aquifer-to-aquifer permitting. Proper clearance of an untreated surface water ASR project, as seen in Table I-3, includes up to six state and federal permits. Proper clearance of a treated water ASR project as seen in Table I-4 generally requires two permits from the SFWMD and FDEP. For a project that involves injecting untreated ground water from one aquifer into another aquifer, the permits identified in Table I-5 are required.

TABLE I-3. Permits Required for Untreated Surface Water ASR Projects.

Permit Type	Description	Issuing Agency
Well Construction Permit	Untreated surface water ASR must be in accordance with Class I well standards (state permit)	Florida Department of Environmental Protection
Dredge and Fill Permit	Permit needed if intake occurs from a surface water body (state and federal permits)	Florida Department of Environmental Protection and United States Army Corps of Engineers
Consumptive Water Use Permit	Permit needed for operation of untreated surface water ASR project (state permit)	South Florida Water Management District
National Pollution Disposal Elimination System (NPDES)	Permit needed if untreated surface water ASR project discharges to a surface water body (federal permit)	United States Environmental Protection Agency
Water Quality Criteria Exemption	Exemption needed if untreated surface water ASR project discharges to a surface water body (state permit)	Florida Department of Environmental Protection
Aquifer Exemption	Exemption needed if injected waters are nonpotable and the aquifer is classified as an underground source of drinking water (federal permit)	United States Environmental Protection Agency

Permitting for untreated surface water has only been done once in the southeastern United States, for the South Florida Water Management District's Lake Okeechobee Pilot Project. Permitting is extremely stringent due to the regulatory criteria that must be met and may cause projects such as these to be cost prohibitive.

As seen in Table I-4, minimal permitting is required for treated water ASR projects. This type of ASR project is becoming more prevalent in Florida. Utilities

TABLE I-4. Permits Required for Treated Water ASR Projects.

Permit Type	Description	Issuing Agency
Well Construction Permit	Treated water ASR must be in accordance with Class V well standards (state Permit)	Florida Department of Environmental Protection
Consumptive Water Use Permit	Permit needed for operation of system, which states quantity of water available for use (state permit)	South Florida Water Management District

TABLE I-5. Permits Required for Untreated Ground Water from one Aquifer to be Injected into Another Aquifer for ASR.

Permit Type	Description	Issuing Agency
Well Construction Permit	Untreated aquifer water for ASR must be in accordance with Class I well standards (state permit)	Florida Department of Environmental Regulation
Water Quality Criteria Exemption	Exemption needed if untreated aquifer water for ASR does not meet primary drinking water standards (state permit)	Florida Department of Environmental Protection
Aquifer Exemption	Exemption needed if injected waters are nonpotable and the aquifer is classified as an underground source of drinking water (federal permit)	United States Environmental Protection Agency
Consumptive Water Use Permit	Permit needed when pumping water from one aquifer to another (state permit)	South Florida Water Management District

may find this alternative useful for meeting seasonal and daily peak demands and future water needs as the population increases.

In 1975, a permit was issued for an aquifer-to-aquifer untreated water ASR pilot project at the Miami Dade Water and Sewer Authority Hialeah Water Treatment Plant. Permitting requirements have become more stringent since the Hialeah project was conducted. An aquifer exemption is now required for aquifer-to-aquifer untreated water ASR projects. Currently this exemption is difficult to obtain since regulating authorities categorize aquifer-to-aquifer ASR as a nonpotable source of water being injected into an underground source of drinking water. The costs of construction and operation of aquifer-to-aquifer ASR facilities designed to meet the more stringent regulatory criteria may be prohibitive.

Existing ASR Facilities

Manatee County. In 1978, Manatee County began treated water ASR investigations in cooperation with the Southwest Florida Water Management District (SWFWMD) and CH2M Hill Engineers. This program start up was a direct result of a 1976 CH2M Hill project for Naples, Florida which included two shallow connector wells that recharged the local production zone by gravity from the overlying water table.

The Manatee County Utilities Department has a surface water treatment plant that operates at 54 MGD adjacent to Lake Manatee, which is an impoundment on the Manatee River. An investigation of an artesian limestone aquifer beneath Lake Manatee was conducted which evaluated aquifer hydraulic characteristics such as transmissivity, storativity and leakance. After a series of injection and recovery tests were conducted to determine water quality and percent of water recovered, it was concluded that Manatee County could meet peak water demands as high as 70 MGD without expanding their water treatment plant. The ASR facility is currently in operation, with a rated storage capacity of 316 million gallons. At the end of 1993, 294 million gallons were in storage in the aquifer (phone conversation January 6, 1994 with Bruce McCloud, Manatee County Utilities, Bradenton, FL.).

Peace River. A 12 MGD surface water treatment plant built by General Development Utilities, Inc. (GDU) supplies water to Port Charlotte. Port Charlotte's source of raw water is the Peace River (now owned and operated by the Peace River/Manasota Regional Water Supply Authority). Due to variations in both water flow and water quality of the river, including occasional movement of saltwater upstream of the plant intake, a 1,920 acre-foot capacity offstream reservoir was constructed for raw water storage. In 1984, GDU was faced with the need to expand their water storage capacity, and as a result, treated water ASR was examined as a potentially less expensive storage option. Two potential production zones were tested to determine if treated water ASR was feasible. Six ASR wells were installed which provide a treated water expansion of 4.9 MGD. Three additional wells are planned for feasibility testing in 1994 (phone conversation January 6, 1994 with Grady Sorah, Peace River/Manasota Regional Water Supply Authority, Port Charlotte, FL.). Over the next 30 years, ASR is expected to reduce capital investment for water supply and treatment facilities for the Peace River by over 50 percent.

Cocoa. The Floridan Aquifer System (FAS) is the source of well water for the Cocoa service area. The wells are located inland as far as 50 miles from some locations in the service area. This great distance is due to saltwater intrusion which is occurring along the coast. The Claude H. Dyal water treatment plant has a capacity of 40 MGD. In 1987 demand had reached 37 MGD, which prompted the City of Cocoa to investigate the potential for treated water ASR as an alternative to water treatment plant expansion.

The success of this test program allowed Cocoa to proceed with treated water ASR and defer a water treatment plant expansion. The system was permitted in 1991 and presently operates at a maximum permitted recovery rate of 8 MGD, utilizing 6 ASR wells (phone conversation January 6, 1994 with Glenn Loeffler, Claude Dyal Water Treatment Plant, Cocoa, FL). Present indications are that plant expansion can be deferred until maximum day demand reaches 50 MGD, but an expansion of raw water supply will be necessary to sustain increases in average withdrawals.

Port Malabar. In 1987, the Palm Bay Utility Corporation at Port Malabar began treated water ASR investigations. The Port Malabar development is within the city limits of Palm Bay on the east coast of Florida and obtains its water supply from an intermediate aquifer. At the time the ASR investigation began, water demands were approaching the water treatment plant capacity of 6 MGD and were, at times, equal to wellfield supply capacity. If the treated water ASR project investigation proved successful, it would help Port Malabar meet its upcoming seasonal and daily peak demands and defer water treatment plant expansion.

A test facility was constructed within the Port Malabar distribution system. This location enabled the recovered water to be put directly into a nearby transmission main. The treated water ASR facility was tested and the recovered water met all drinking water standards and required no retreatment other than disinfection. Today, the Port Malabar ASR facility is fully operational and provides an additional 1 MGD of treated water supply during peak demand months.

Boynton Beach. In late 1992, the city of Boynton Beach began testing of its ASR facility. During the wet season, treated ground water from the Surficial Aquifer System is pumped into the upper portion of the Floridan Aquifer System for storage. Upon recovery, the water is filtered and rechlorinated, then used to augment the public water supply during dry periods and during peak demands. This serves to alleviate stress on the Surficial Aquifer System which is susceptible to saltwater intrusion.

During a dry spell in May 1993, about 17 million gallons of water were recovered from the ASR system. The single ASR well can provide 2,000 GPM of recovered water, although the city is still gathering information. As of early 1994, five injection/storage/recovery cycles had been completed (phone conversation January 6, 1994 with Peter Mazzotti, City of Boynton Beach Utilities, Boynton Beach, FL.).

APPENDIX J

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APPENDIX K

Seawater Intrusion and General Aquifer Protection Criteria Levels Used in Modeling

List of Figures

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Figure K-2. Seawater Intrusion Trigger Points in the Lower Tamiami Aquifer K-2

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Figure K-4. General Aquifer Protection Water Levels for the Sandstone Aquifer in Collier County K-4

Figure K-5. General Aquifer Protection Water Levels for the mid-Hawthorn Aquifer in Collier County K-5

Figure K-6. General Aquifer Protection Water Levels for the Sandstone Aquifer in Lee County K-6

Figure K-7 General Aquifer Protection Water Levels for the mid-Hawthorn Aquifer in Lee County K-7

Figure K-8. General Aquifer Protection Water Levels for the Lower Tamiami Aquifer in Hendry County K-8

Figure K-9. General Aquifer Protection Water Levels for the Sandstone Aquifer in Hendry County K-9

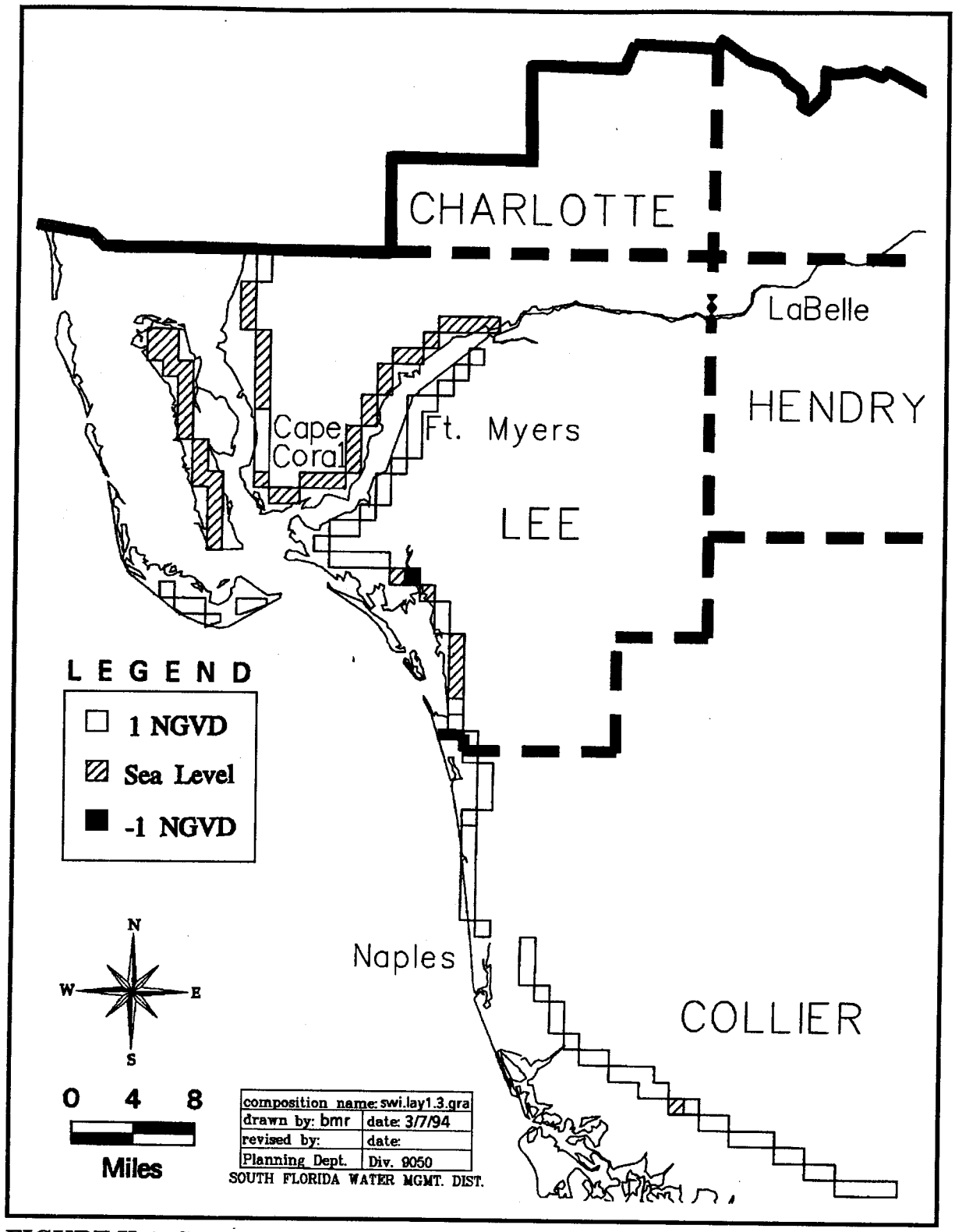


FIGURE K-1. Seawater Intrusion Trigger Points in the Water Table Aquifer.

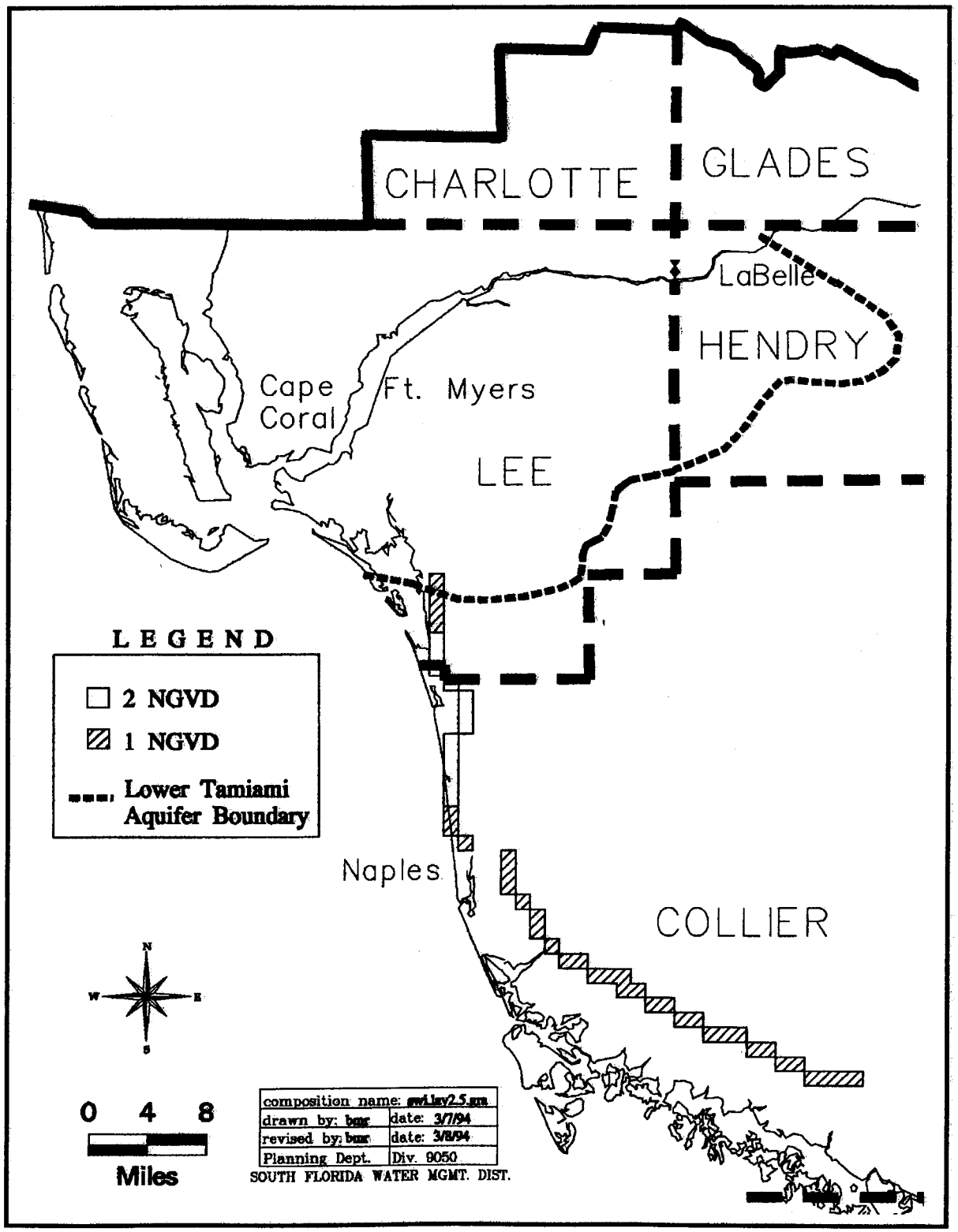


FIGURE K-2. Seawater Intrusion Trigger Points in the Lower Tamiami Aquifer.

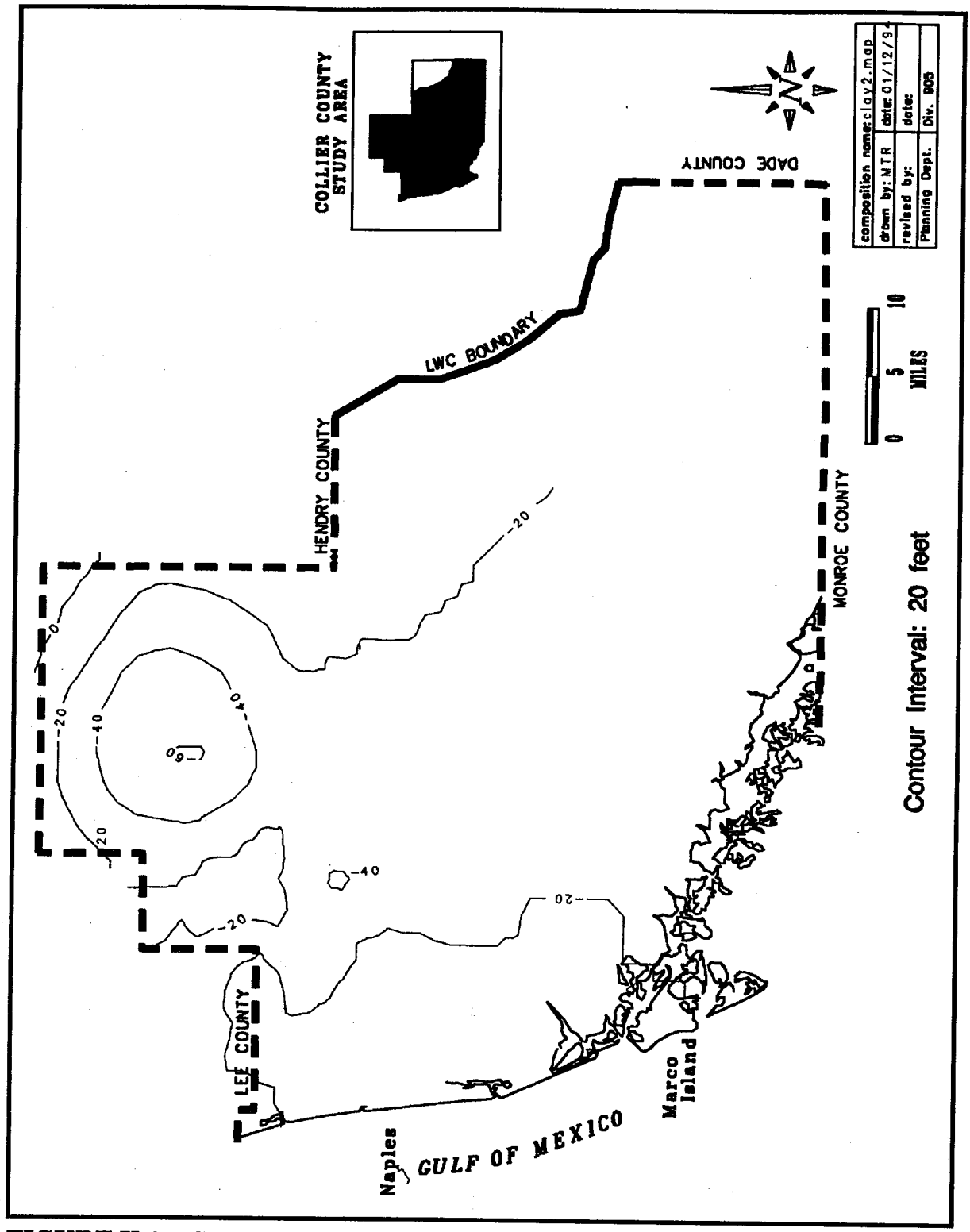


FIGURE K-3. General Aquifer Protection Water Levels for the Lower Tamiami Aquifer in Collier County.

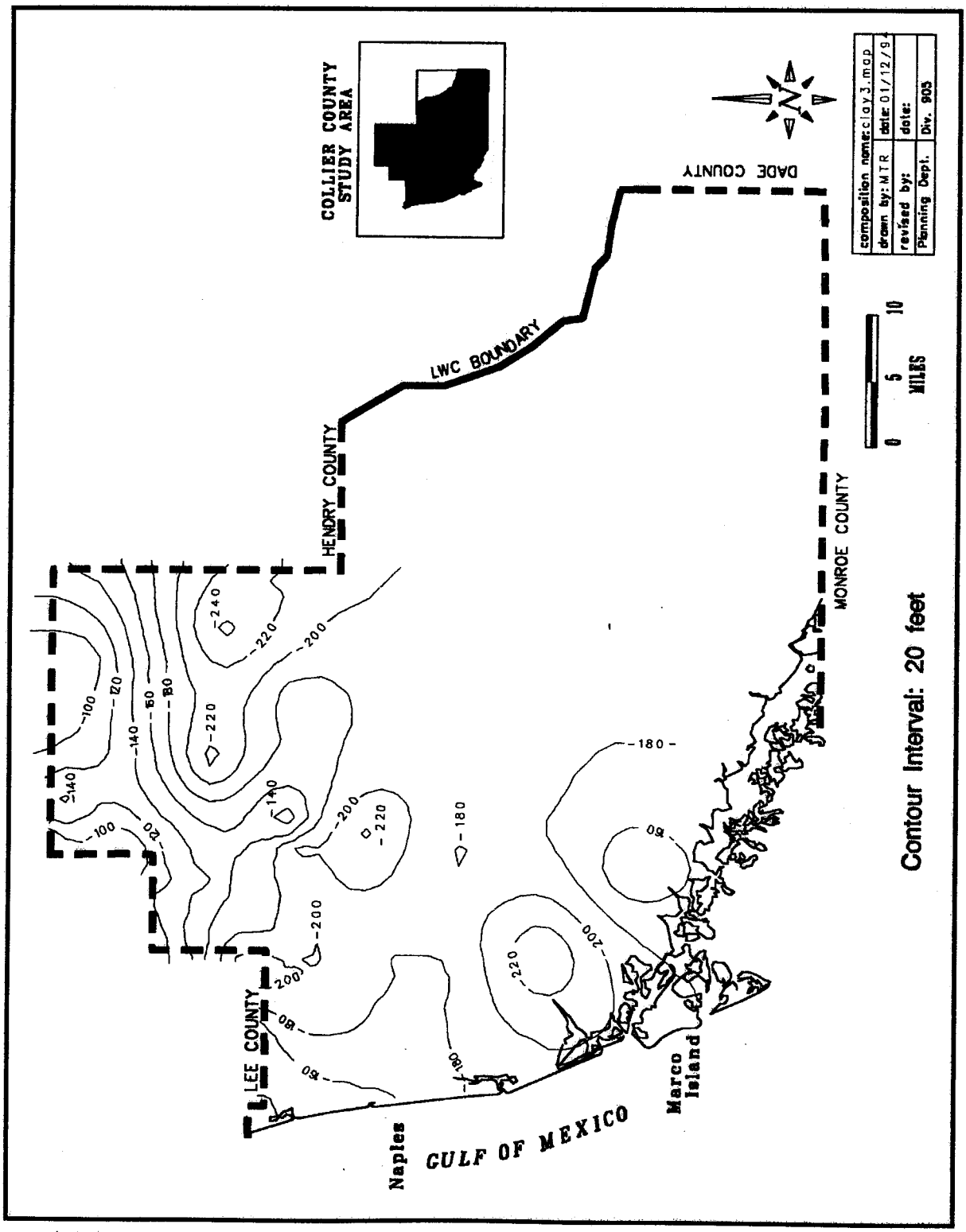


FIGURE K-4. General Aquifer Protection Water Levels for the Sandstone Aquifer in Collier County.

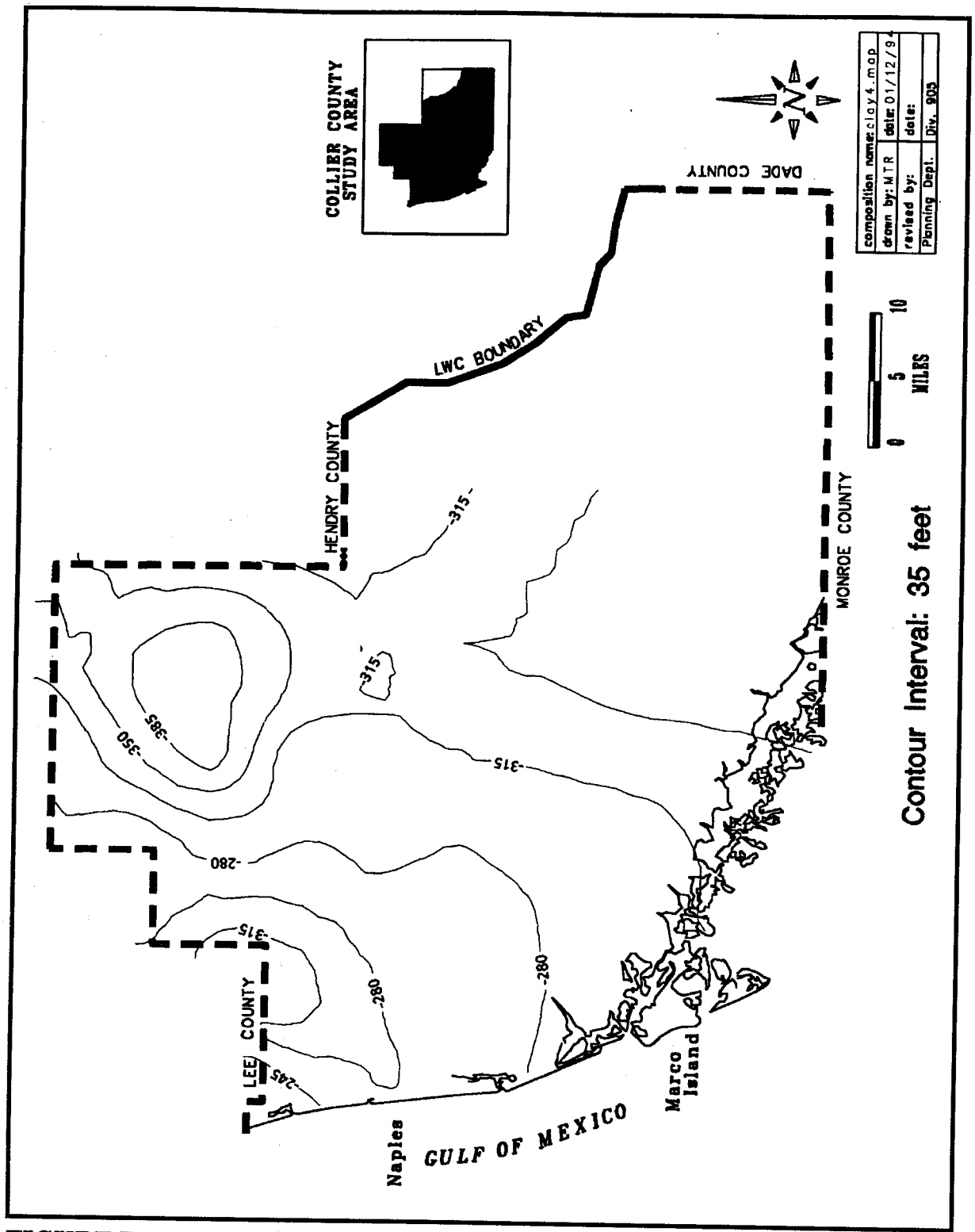


FIGURE K-5. General Aquifer Protection Water Levels for the mid-Hawthorn Aquifer in Collier County.

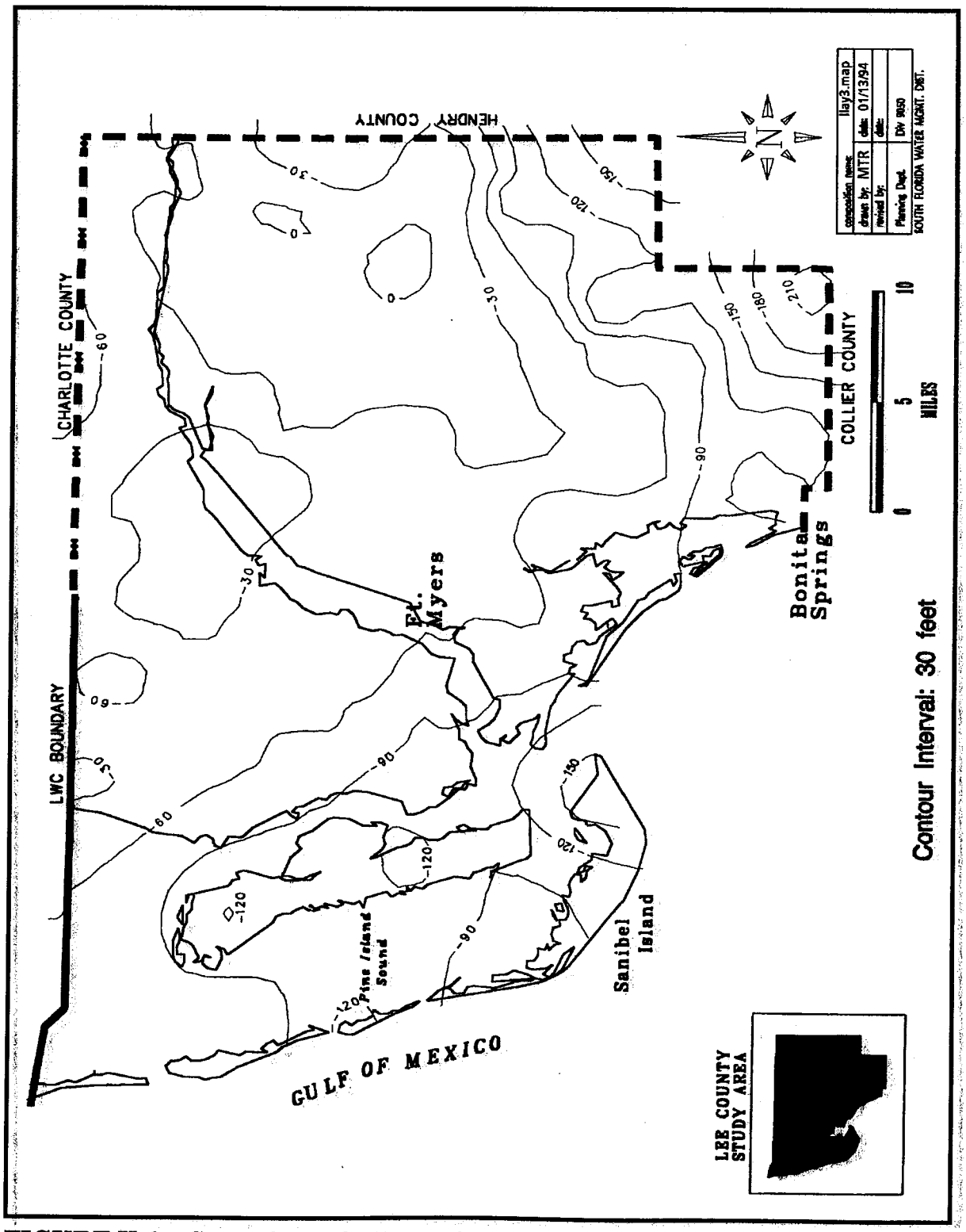


FIGURE K-6. General Aquifer Protection Water Levels for the Sandstone Aquifer in Lee County.

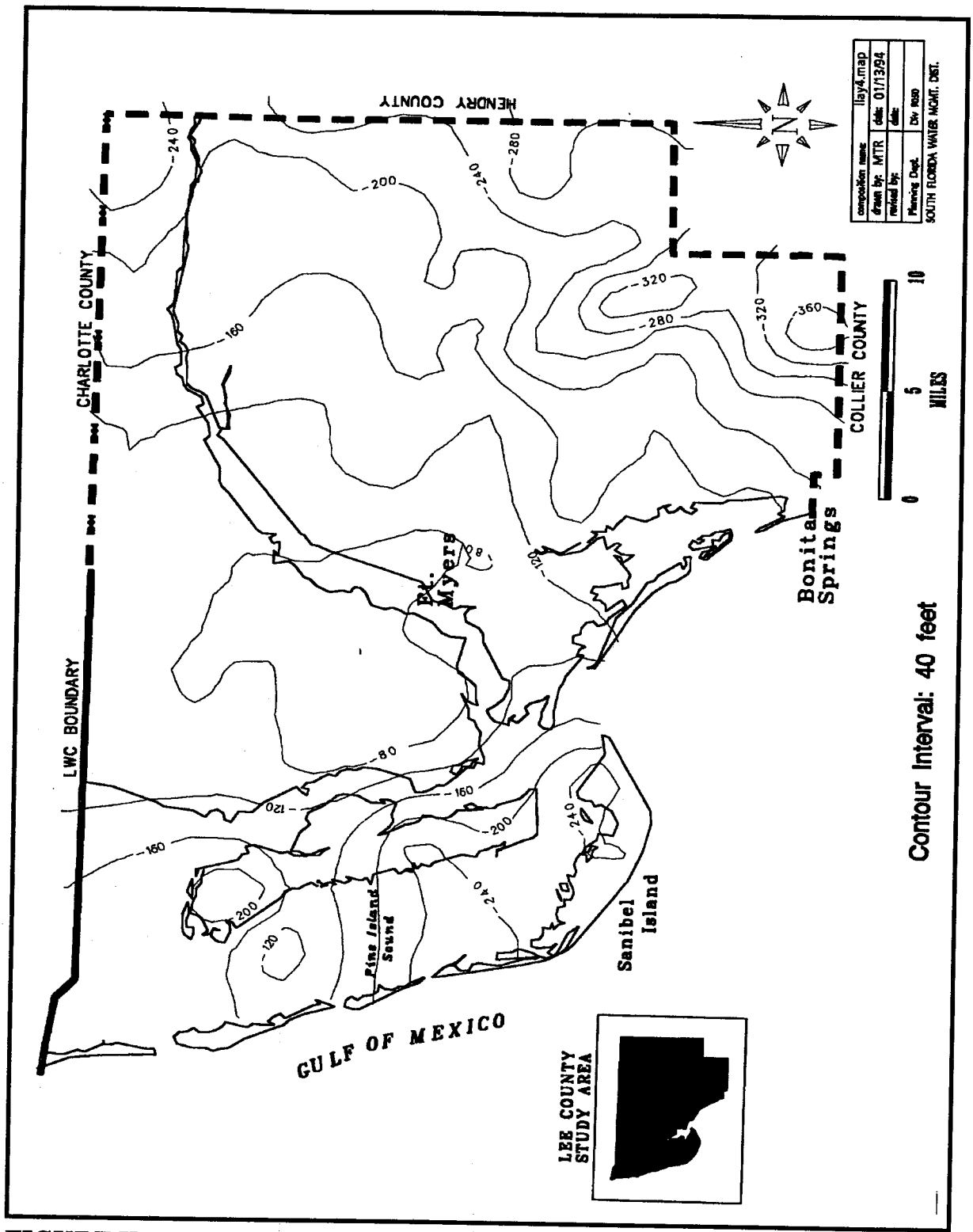


FIGURE K-7. General Aquifer Protection Water Levels for the mid-Hawthorn Aquifer in Lee County.

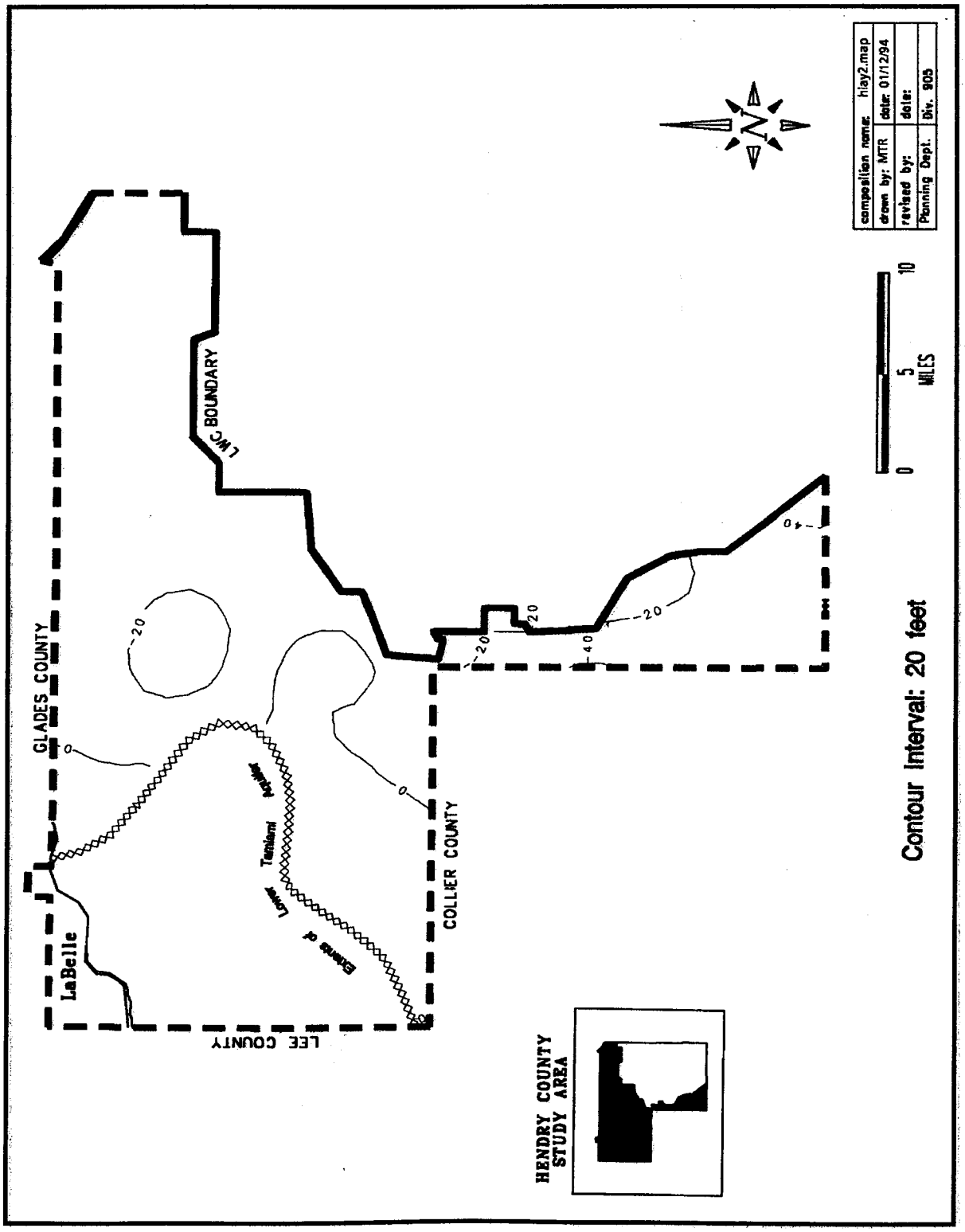


FIGURE K-8. General Aquifer Protection Water Levels for the Lower Tamiami Aquifer in Hendry County.

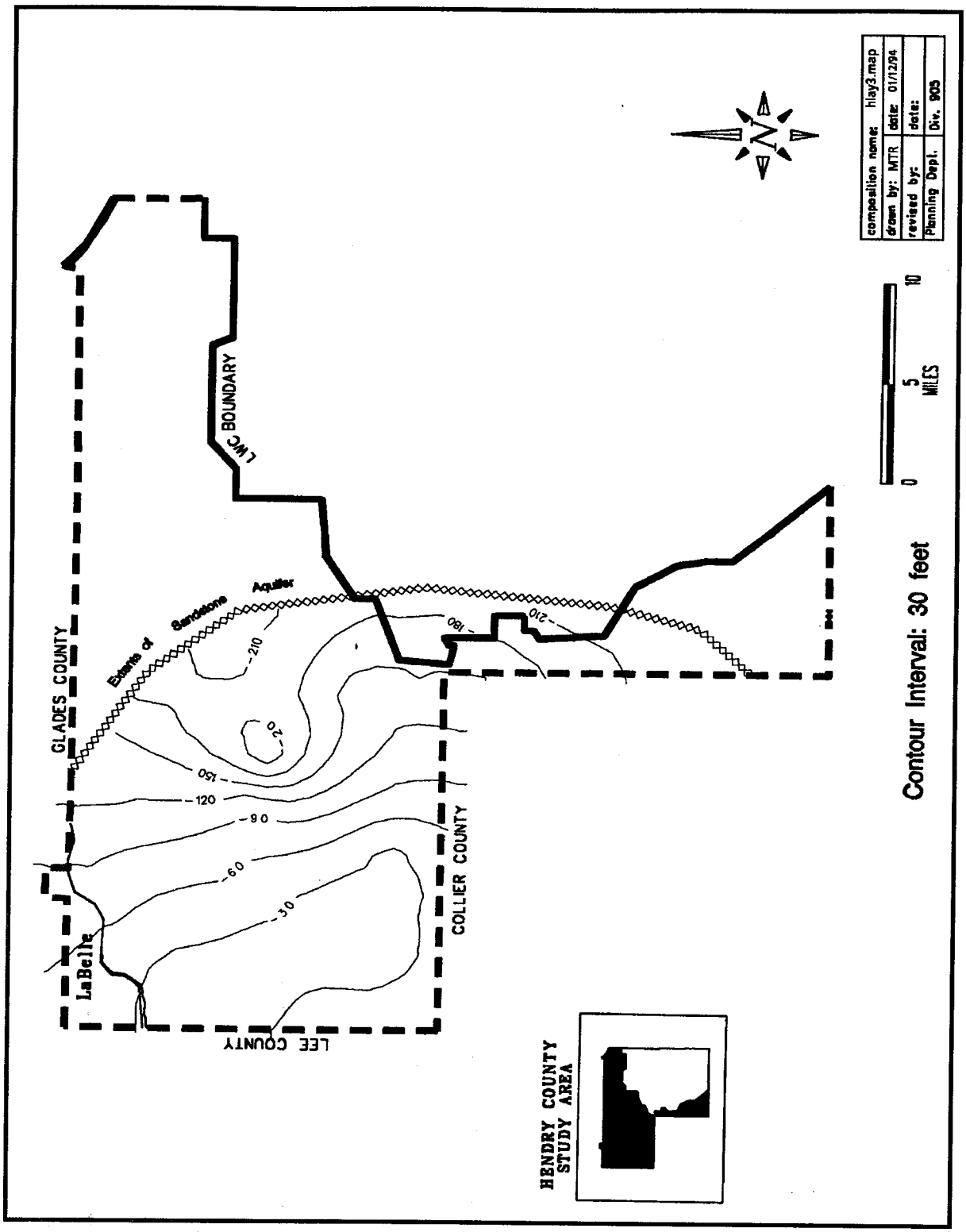


FIGURE K-9. General Aquifer Protection Water Levels for the Sandstone Aquifer in Hendry County.

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APPENDIX L

Public, Local, Government & Agency Comments

COMMENTS RECEIVED ON THE DRAFT LOWER WEST COAST WATER SUPPLY PLAN

	Organization	Signatory Individual
1.	1000 Friends of Florida	James F. Murley, Executive Director
2.	Collier County Government	Fred Bloetscher, Sr. Project Manager
3.	Collier County Government-Utilities Division	Fred Bloetscher, Asst. Utilities Administrator
4.	Collier Enterprises	Ray March, P.E.
5.	Environmental Confederation of Southwest Florida	Becky Ayech, President
6.	Florida Game and Fresh Water Fish Commission	James W. Beever, III, Biological Scientist III
7.	United State Government	Todd Logan, Florida Panther NWR
8.	Gulf Citrus Growers	Ron Hamel, Executive Vice President
9.	Gulf Utility Company	James W. Moore, President
10.	Henderson, Franklin, Starnes & Holt, P.A.	Russell P. Schropp
11.	The Island Water Association, Inc.	Thomas A. Sharp, President
12.	Lee County Board of County Commissioners	Daryl C. Walk, Acting Director
13.	Lee County Regional Water Supply Authority	Paul Van Buskirk, Executive Director
14.	Lee County Regional Water Supply Authority	Paul Van Buskirk, Executive Director
15.	Lee County Regional Water Supply Authority	Paul Van Buskirk, Executive Director
16.	Lee County Regional Water Supply Authority	Paul Van Buskirk, Executive Director
17.	Lee County Regional Water Supply Authority	Paul Van Buskirk, Executive Director
18.	Lykes Bros., Inc.	P.R. Hamilton
19.	National Audubon Society	Michael Duever, Director of Ecosystem Research Unit
20.	United State Department of the Interior	T.E Miller, Hydrologist
21.	ViroGroup, Missimer Division	Akin Owosina

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Earl Starnes
Victoria Tschinkel
Jack Wilson
Carl Feiss, *Emeritus*

FRIENDS 1000 FLORIDA

April 23, 1992

Mr. Tilford C. Creel
Executive Director
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33406

Dear Mr. Creel:

As you may be aware, 1000 Friends of Florida's efforts include monitoring the activities of the five water management districts that relate to growth management. Therefore, it was with interest that we read about your Water Supply Advisory Committees in the minutes of the March Governing Board meeting. We are particularly interested because of the direct linkages between water demand projections and future land uses.

I would like to request consideration of a member of 1000 Friends of Florida for appointment to the Lower East Coast (LEC), Lower West Coast (LWC) and the to-be-created Dade/Florida Keys Water Supply Plan advisory committees. I would also like to formally request to be added to the mailing list for information disseminated to these committee members.

I look forward to hearing from you. Best regards.

Sincerely,

James F. Murley
Executive Director

JFM/jd

cc: Nathaniel Reed, President, 1000 Friends of Florida
Patricia McKay, Planning Director, 1000 Friends of Florida

1000 FRIENDS OF FLORIDA • POST OFFICE BOX 5948 • TALLAHASSEE, FLORIDA • 32314-5948
(904) 222-6277 • FAX (904) 222-1117 • (800) 277-2926
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JAN 7 1994

COLLIER COUNTY GOVERNMENT

PLANNING DEPARTMENT

COUNTY MANAGER'S OFFICE

OFFICE OF CAPITAL PROJECTS MANAGEMENT

3301 E. TAMIAMI TR.
NAPLES, FL 33962
(813) 774-8192
FAX (813) 774-9370

A CERTIFIED BLUE CHIP COMMUNITY

January 5, 1994

Ms. Sharon Trost, Director
Planning Department
South Florida Water Management District
P.O. Box 24680
West Palm Beach, FL 33416-4680

RE: Lower West Coast Water Supply Plan

Dear Ms. Trost:

Per the last meeting of the Lower West Coast Water Supply Committee and my subsequent reading of the draft document, I have several comments regarding the Lower West Coast Water Supply Plan (LWCWSP) as drafted of which need further review. These are as follows:

1. Since its inception, one of the LWCWSP themes has been to push urban users from freshwater sources to saline sources. Long term, this is probably a good idea in order to meet future demands. Collier County recognized the prudence of planning for possible future saline supplies when it designed the new North County Regional Water Treatment Plant, which initially can treat fresh water via membrane softening but can be converted to reverse osmosis in the future, or run in both modes at the same time. Seven years ago, a lime softening plant had been proposed that would need to be discarded if conversion to saline sources occurred. However, most urban users have not had the luxury of Collier County's timing. Many have millions of dollars invested in lime softening facilities and wellfields that are ten to twenty years old and are not near the end of their life expectancy. Forcing these users to abandon freshwater sources would cause their customers to incur drastic increases in user fees. In addition, smaller utilities typically have limitations on borrowing funds or revenue raising, and thus cannot acquire the necessary funds to make these conversions.

2. Over a year ago, the question was raised concerning concentrate disposal from reverse osmosis plants. You will recall a bill in the Florida Legislature in 1990 that would have banned deep injection wells from Tampa to Ft. Myers, including

all of Lee County. FDEP should to be consulted on how disposal can occur if deep wells are banned prior to requiring new urban users to use saline sources. I know of only one utility that does not use deep wells (Venice). They discharge to ponds that leach into an estuary system that goes immediately to the ocean. Utilities that are not on the coast will not be able to economically dispose of millions of gallons of concentrate that will be produced. I also understand that there is some difference of opinion between FDEP representatives and water management district personnel over the use of deep wells, which also needs to be resolved.

3. Reuse is not a panacea to solve all the ills of urban irrigation. It is expensive to install an entire effluent distribution system. There is a drastic disparity between winter flow demands and summer demands, which does not correspond with availability. Collier County has entered into contracts with area golf courses to accept effluent. The contracts specify the daily demand. However, this amount is the average for the year. For example, a typical agreement would be for 500,000 gallons per day. During the wet season, we are lucky to deliver 100,000 gallons per day due to saturation of the course. During the winter, they will take 700,000 gallons or more. The wastewater flows do not fluctuate to this extent. As a result, while Collier County is 100% reuse, only 50 percent goes to golf courses and the rest to percolation ponds. It may be more prudent to contract near the minimum, but the golf courses will obtain SFWMD permits to make up the shortfall during the winter, thereby taxing a resource during its most vulnerable period. For 100 percent reuse to be attainable, a supplemental irrigation source must be developed for the winter months.

4. Aquifer Storage and Recovery (ASR) is a good idea. However, it requires large volumes of water (100 million gallons or more) just to start. This eliminates most smaller utilities because they do not have this kind of avalability. Collier County has a test ASR well on Manatee Road. One hundred ten million gallons have been injected in six cycles over three years. We think we have a successful well and will pursue permitting this winter. However, if the geology is not correct or if transmissivities are too high, ASR may not be feasible even for large utilities.

5. ASR and reuse, as noted in the plan, can be compatible. ASR can supplement reuse systems using surface sources injected during wet periods. However, storage of effluent is not yet attainable under current regulations. This must to be addressed correctly in the plan.

6. Much research needs to be done to more fully understand the needs of the environment and the effect that other land uses may have upon the environment. South Florida's long-term future depends on this balance being met. It is fairly obvious that the balance is not met at present, given apparent long term decreasing rainfall totals, decreasing wildlife populations and lengthening dry seasons. We should all recognize that the natural landscape here had its own balance prior to agriculture or urban users. We also should recognize the economic stimulus that natural areas bring to South Florida, which is often ignored. In 1991, the Everglades/Big Cypress was the number one tourist destination for Europeans. Any economic analysis is likely to significantly underestimate the value of the environment to the south Florida economy.

7. The proposed policy that, in a competing situation, agricultural users always "win" is unacceptable. If there is such a significant problem, who came first? If urban users have had wellfields for years in a certain area, and agriculture moves in (typically by replacing abandoned groves and fields in central Florida), agriculture should be required to re-evaluate their move. Agriculture is a business, and agricultural enterprises must make a business decision on their location based on land costs, labor and water availability. If water is not available, the site simply is not suitable. Urban users must also make these decisions, as most currently do. If a long term plan of an urban user is to draw from a certain area, they usually have existing infrastructure investments, so plans for future resource development should be considered. Agricultural interests should not automatically negate those plans and investments. That could be construed as a "taking."

8. The biggest water "user" in Collier County is the Big Cypress Basin Board that oversees the yearly discharge of 150 billion gallons of water into the Gulf of Mexico. Seven days of that flow supplies the Collier County system for a year, and the City of Naples likewise. The LWCWSP addresses this issue to some extent, but is not specific. We need to determine how this runoff can be reduced or eliminated. Flooding of the south blocks of the Estates is one part of the solution. The flooding may provide additional groundwater recharge for the environment, a positive step, but more thinking needs to go into this approach. While the District has the goal to deal with flooding, it probably needs to become secondary to retaining water. The canals are to alleviate flooding and more water being held back would create additional flooding. The public, however, needs to remember that South Florida is a swamp!! Some balance is needed between environmental needs and agricultural/urban demands.

9. Public education should be an important aspect. Conservation of water is only one portion of the problem. We live in a swamp. We should expect some flooding, high water tables, wildlife, etc. in developed areas. We have degraded the environment with canals because canals effectively drain aquifer levels during the dry season (our studies show the canal levels to match aquifer levels) and prevent full recharge in the wet season. Water that once stood in the Big Cypress Swamp and the Estates now drains off, eliminating the ability of standing water to evaporate and recharge early and late season thunderstorms; hhence, total rainfall decreases. Good public education efforts might build some support for raising weir levels. Higher weir levels may increase surrounding water levels, thereby increasing recharge, but they do not store significantly more water.

10. The plan does not force the urban and agricultural users to see their similarities, thereby breeding competition for water resources. This competition has not traditionally been healthy because the environment suffers, and the true usage is often distorted. Urban users pull water from one area and use it in another, typically in coastal areas subject to saltwater intrusion. In Collier County, most water use goes on lawns or golf courses (in many cases as effluent from wastewater plants). Some is lost via evapo-transpiration. Agricuture users use water in the same vicinity, but they also lose part of it via evapotranspiration. As such, both use water that does not go back into the ground from whence it came. The parties need to work together to see their similarities and each others benefits, and to work toward regional solutions, not separately to meet individual demands. For example, urban use does address coastal saltwater problems, which agriculture does not. The fact that water goes from one spot to aanother is not necessarily bad, unless it causes a negative reaction to that transfer in the environment.

11. As a reality check, the staff and the Board need to keep in mind that the opportunity to make decisions in the best interests of the global spectrum is available because the District Board is not elected. With 5.5 million people in South Florida, and over a million in the LWCWSP area, some of these proposals are going to cost those constituents significant amounts of money, while benefitting the agricultural users. The plan seems oriented to forcing urban users to spend money to find new sources and alternatives so agriculture can use the inexpensive water sources. That balance needs to be

re-examined. Having the environment get the urban water is likley more palatable to the majority of the constituecy than agriculture. Enough exists for all, if only we can retain it, use it, and reuse it wisely.

Overall we have made some progress, but there are remaining issues that must be dealt with prior to creating additional new problems for ourselves, while trying to rectify our current ones.

Should you have any questions, please let me know.

Sincerely,

Fred Bloetscher, PE
Sr. Project Manager

cc: Thomas E. Conrecode, PE, Director OCPM

COLLIER COUNTY GOVERNMENT

UTILITIES DIVISION
WATER AND WASTEWATER SERVICES

3050 NORTH HORSESHOE DRIVE
NAPLES, FL 33942
(813) 434-5050
FAX (813) 434-5039

A CERTIFIED BLUE CHIP COMMUNITY

August 31, 1993

Mr. Dean Powell
Supervising Professional
Upper District Planning Division
Planning Department
South Florida Water Management District
3301 Gun Club Road
P. O. Box 24680
West Palm Beach, FL 33416-4680

Dear Mr. Powell:

Please note the attached package for the O & S information and the Lower West Coast Water Supply Plan Advisory Committee meeting notices were received after the meeting. Mike Slayton advised me that they had occurred and noted that a revised copy of the Lower West Coast Water Supply Plan drought form was provided. I would appreciate it if you would send me any information that I did not receive by not attending the meeting.

Should you have any further questions, please let me know. I appreciate your help and efforts.

Sincerely,

Fred Bloetscher, P.E.
Assistant Utilities Administrator

FB:amk

COLLIER
ENTERPRISES

550 NEW MARKET ROAD, P.O. BOX 738, IMMOKALEE, FL 33934
PHONE 813/657-5133

February 10, 1993

South Florida Water Management District
3301 Gun Club Road
P.O. Box 24680
West Palm Beach, Florida 33406

Attention: Mr. Dean Powell
Supervising Professional
Upper District Planning Division
Planning Department

Subject: Outstanding Natural System Working Group

Dear Dean:

At the Outstanding Natural System Working Group meeting on February 3, 1993, the need for a description of the intended limits of Outstanding Natural System (ONS) boundaries was discussed. Given the proposed large scale of the ONS map, this description is necessary for the map to be appropriately interpreted. It was suggested that members of the working group convey their ideas in this regard to staff prior to the next meeting. Accordingly, my thoughts on this matter are described herein.

The purpose of the ONS map is to identify areas where, because of their ecological value, the District should exercise a higher degree of scrutiny when evaluating the potential impact from water use activities. These potential impacts are anticipated to be predominantly associated with drawdowns beneath wetlands. Upland habitats should be included in the ONS designation where: (1) specific habitat values can be linked to potential drawdown impacts and (2) it can be shown that drawdown limits adequate to protect wetlands will not protect the adjacent uplands (given the gradational nature of well drawdowns). In my opinion, uplands are not significantly threatened by drawdown impacts and, therefore, these criteria will be satisfied very rarely. This is why the Lower West Coast Water Supply Plan is not the appropriate vehicle for upland preservation efforts.

Accordingly, some version of the following statement should appear on the ONS map:

> This map designates the approximate boundaries of natural systems which because of their ecological value should receive a high degree of scrutiny in the evaluation of potential impacts from water use. These boundaries are generally limited to wetlands, due to their sensitivity to hydroperiod changes. Uplands are only intended to be included where specific habitat values can be linked to potential drawdown impacts.

Please call me if you wish to discuss this further. Otherwise, I will see you at the next ONS meeting on February 24, 1993.

Very truly yours,

COLLIER ENTERPRISES

Ray March, P.E.

RM/lg
cc: David Land

ECSWF Environmental Confederation of Southwest Florida

Route 2, Box 341
Sarasota, FL 34234
November 12, 1993

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406-4680

Re:District Water Management PlAN
Dear Sir:

Your mission statement includes four important elements, all of which must be met if the quality of life in South Florida and all of the state is to be enhanced. Conservation of water with every means possible and the improvement of water quality free of pollutants are paramount to the health, safety and welfare of the citizens.

There are two items that still bother me. First, the draw down of one foot for thirty days (of wetlands) during a one in ten-year drought situation is not acceptable. The fragile wetlands should not have to pay for careless overuse by the citizens. There should be no drawdown of wetlands allowed, putting them in peril. Alternate sources must be found.

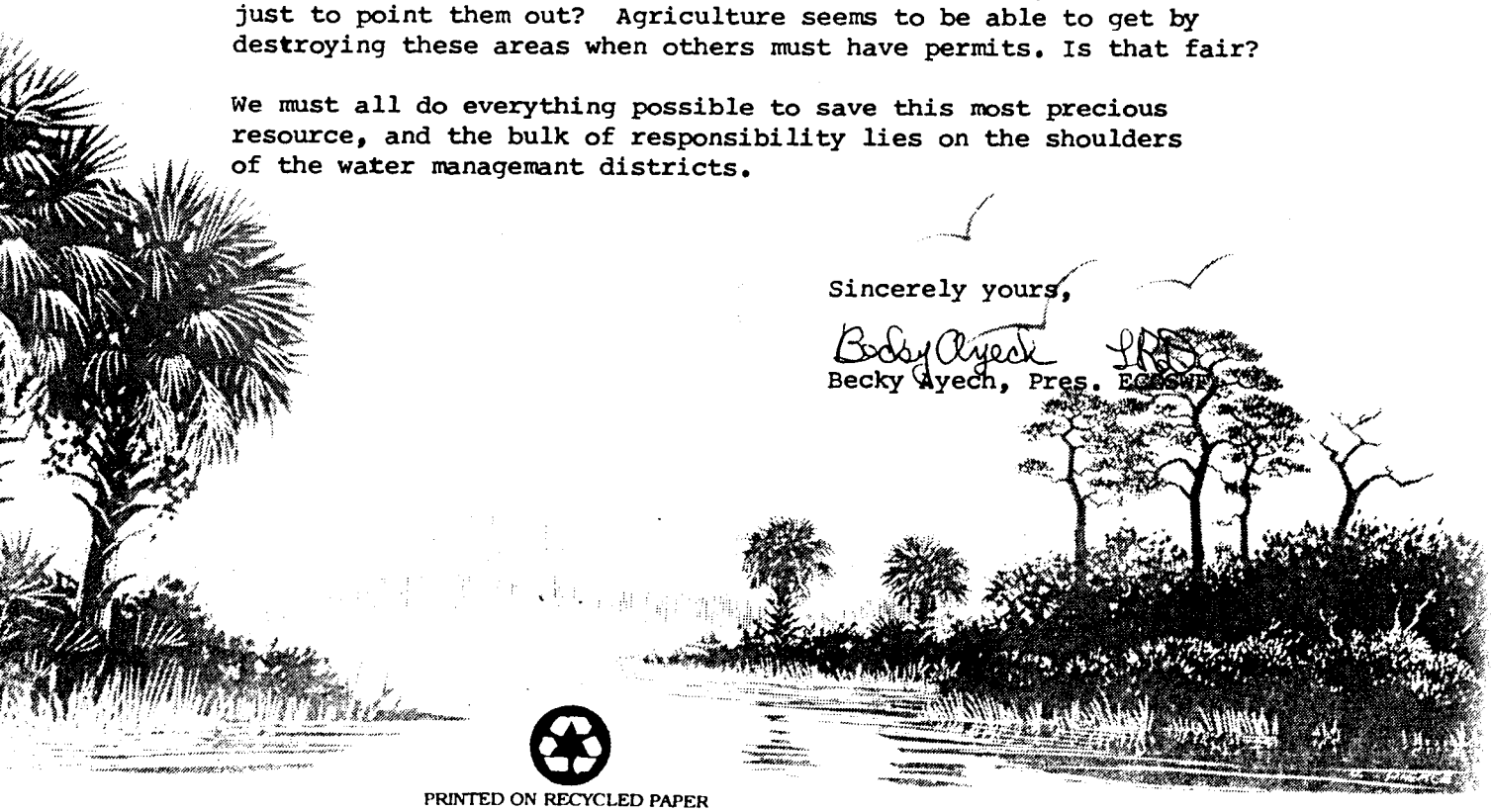
The Outstanding Natural Systems (ONS) map that was prepared took a great deal of time and effort, but the "multiple use" areas need protection, and there must be some enforcement to keep them that way. Nothing was said about enforcement. What good is it just to point them out? Agriculture seems to be able to get by destroying these areas when others must have permits. Is that fair?

We must all do everything possible to save this most precious resource, and the bulk of responsibility lies on the shoulders of the water managemant districts.

Sincerely yours,

Becky Ayech

Becky Ayech, Pres. ECSWF



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BEN ROWE, Gainesville

ROBERT M. BRANTLY, Executive Director
ALLAN L. EGBERT, Ph. D., Assistant Executive Director

Office of Environmental Services
29200 Tuckers Grade
Punta Gorda, Florida 33955

February 8, 1993

Ms. Sharon Frost
South Florida Water Management District
Resource Control Department
3301 Gun Club Road
P.O. Box 24680
West Palm Beach, Florida 33416-4680

RE: ONS Meeting Notice, Intended Use of CREW Purchase Area

Dear Ms. Frost:

I am writing this letter to address two matters. First, I did not receive notice of the January meeting of the ONS committee and I did not receive notice of the February 3, 1993 meeting until the afternoon of the February 3, 1993, meeting of the ONS. In order to be able to attend ONS meetings, I need at least one week notice.

Also, please note that when the CARL committee designated those areas of the CREW that were to be purchased by CARL monies, the intent and purpose of the purchase was explicitly stated. I enclose the CREW listing from the 1992 CARL book. This is material I provided SFWMD staff in previous meetings for distribution to the committee. Thank you for your consideration.

Sincerely,

James W. Beever III

James W. Beever III
Biological Scientist III

JWB3/lav
ENV 2-1-1/5
Enclsoure
onsfrost.sfm

RECEIVED
FEB 11 1993
PLANNING DEPARTMENT

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#52 CORKSCREW REGIONAL ECOSYSTEM WATERSHED		COLLIER/LEE COUNTIES	
Acreage		Value	
Acquired	Remaining	Funds Expended or Encumbered	Remaining Tax Value
-0-*	18,205	-0-*	$23,704,330

* See "Coordination".

LOCATION
In Collier County south of Lake Trafford and the City of Immokalee. On the southern border the project connects with the Florida Panther National Wildlife Refuge.

RESOURCE DESCRIPTION
The project would connect the Florida Panther National Wildlife Refuge and Fakahatchee Strand State Preserve with the National Audubon Society's Corkscrew Swamp Sanctuary, and secure important habitat for the Florida panther, Florida black bear, and wood stork. These large, contiguous expanses of

Highest Ranked FNAI-listed Elements

Name	FNAI Rank
Florida panther	G4T1/S1
Florida black bear	G5T2/S2
Round-tailed muskrat	G3/S3
Swale	G4?/S3
Dome Swamp	G4?/S3?
Slough	G4/S4?
Mesic Flatwoods	G?/S4
Strand Swamp	G4?/S4?
Wet Flatwoods	G?/S4?
Wood stork	G5/S2
14 FNAI elements known from site	

South Florida wetlands are believed to be critical to the continued survival of these critically-imperilled, wide-ranging species. The acquisition project supports populations of at least two species of rare and endangered orchids, and includes an unusual stand of dwarf bald cypress.

No archeological/historical sites within the boundaries of this project are recorded within the Florida Master Site File. When compared to other projects, the potential for significant sites is considered to be moderate.

The project could accommodate hiking, bicycling, camping, and horseback riding as well as provide opportunities for education.

RECOMMENDED PUBLIC PURPOSE
Qualifies for State acquisition under the "Environmentally Endangered Lands (EEL)" category, as defined in Section 18-8.003 of the Florida Administrative Code. Public acquisition would protect lands connecting the Corkscrew Swamp Sanctuary, the Florida Panther National Wildlife Refuge, and the Fakahatchee Strand State Preserve, and create a corridor of uninterrupted protected lands within active Florida panther range. Acquisition would also protect significant populations of Florida black bears, wood storks, and rare orchids.

MANAGER
South Florida Water Management District with Game and Fresh Water Fish Commission, Lee County, National Audubon Society, and Collier County cooperating.

PROPOSED USE
Water Conservation Area, Wildlife Management Area, and County Park.

MANAGEMENT CONCEPTS
The project would be managed by the South Florida Water Management District with Game and Fresh Water Fish Commission, Lee County, National Audubon Society, and Collier County cooperating. It would be managed under multiple use concepts with special attention given to maintaining and enhancing Florida panther populations and hydrological

MANAGEMENT COSTS

Estimated start-up cost for South Florida Water Management District

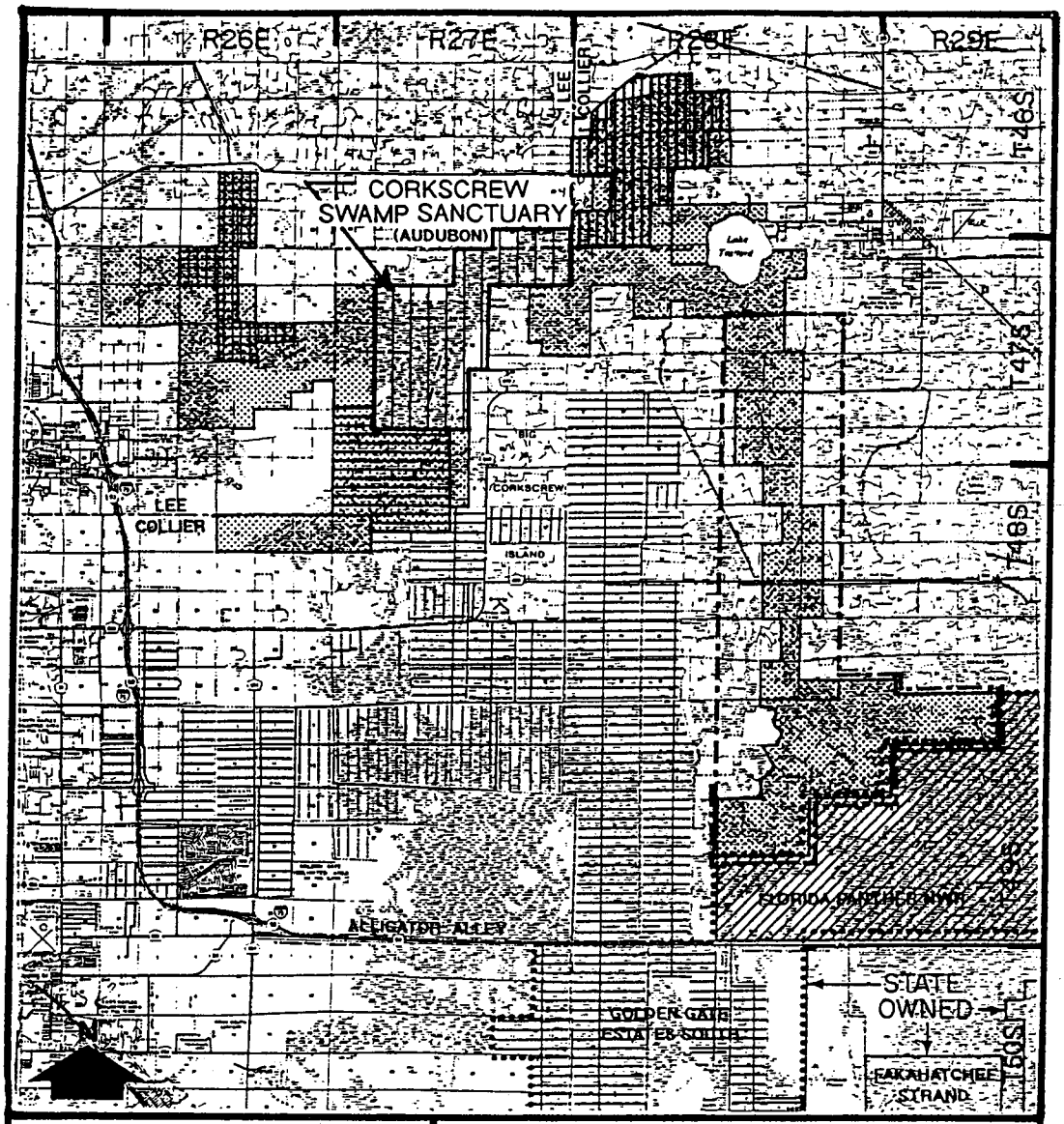
Salary	OPS	Expense	OCO	FCO	Total
$15,000	$2,000	$210,000	$5,000	$10,000	$242,000

Source of Funding: Water Management Lands Trust Fund (Save Our Rivers)

Estimated start-up costs for Lee County

Salary	OPS	Expense	OCO	FCO	Total
$25,765	-0-	$2,000	-0-	-0-	$27,765

Source of Funding: Lee County

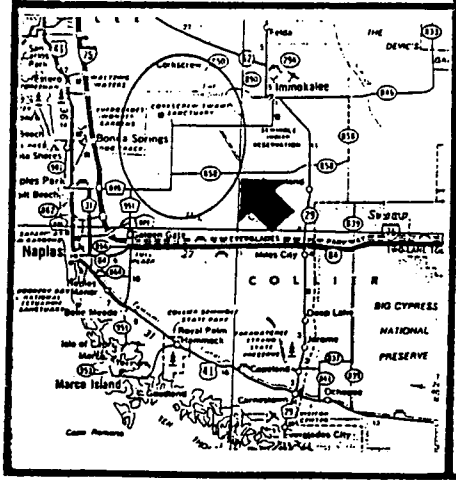


0 1 2
MILES

CORKSCREW REGIONAL ECOSYSTEM WATERSHED

(C.R.E.W.)

COLLIER/LEE COUNTIES



- PROJECT AREA
- CARL TARGETED AREA
- SFWMD PURCHASED
- TPL/LEE CO. PURCHASED OR UNDER OPTION
- TNC/COLLIER CO. PURCHASED OR UNDER OPTION
- CORKSCREW SWAMP SANCTUARY (AUDUBON)
- PANTHER NATIONAL WILDLIFE REFUGE
- SAVE OUR EVERGLADES CARL

resources. Emphasis would also be placed on protection of other rare or sensitive biological resources. The project would be divided into several units for management purposes. One unit will be managed by the Florida Game and Fresh Water Fish Commission as a Wildlife Management Area; another unit will be managed as a park with limited recreational development such as primitive camping and environmental education; and at least one unit will be managed by the South Florida Water Management District as a Water Conservation Area or Preserve.

VULNERABILITY AND ENDANGERMENT

The vast majority of the project consists of wetland swamps and marshes unsuitable for residential development. However, this region is traditionally used for agriculture, and much of it has already been drained, ditched and developed for row crops. Some of the area surrounding the project has been converted to citrus groves.

This is a growth center in Florida, so there is a threat of residential development in the upland areas of the project. The portion of the project in Collier County is identified on the Future Land Use Map of the adopted comprehensive plan as Agricultural/ Residential, with a maximum density of one unit per five acres. The wetland areas of the site are designated Areas of Environmental Concern, and a majority of the site is indicated as lands to be acquired for conservation. The portion in Lee County is designated on the Future Land Use Map as Open Land, with allowable residential densities of one unit per acre, interspersed with Environmentally Critical Areas where densities are not to exceed one unit per 40 acres.

A portion of the project in Collier County is in the Big Cypress Area of Critical State Concern.

ACQUISITION PLANNING

On December 7, 1990, the Land Acquisition Advisory Council (LAAC) approved the project design with the acknowledgement that the CARL program's primary focus would be on acquiring easements and ownerships in the Camp Kelas Strand area connecting the project with the Florida Panther National Wildlife Refuge and Fakahatchee Strand. Special emphasis will be placed on providing suitable upland buffer to complement the existing wetland corridor. If fee-simple acquisition is not negotiable, then conservation easements or other less-than-fee-acquisition techniques will be pursued.

Coordination

The entire project in both Lee and Collier Counties consists of approximately 49,810 acres. South Florida Water Management District has acquired 6,800 acres in Corkscrew Marsh, which connects with Audubon's Corkscrew Swamp Sanctuary. Both Lee and Collier Counties are participating in the purchase of land within the project area. Lee County, in conjunction with the Trust for Public Lands is negotiating purchases and now owns 4,650 acres and has 150 under contract in Flint Pen Strand. The Nature Conservancy has been negotiating approximately 8,000 acres in Collier County, Bird Rookery Swamp. State, federal and local governments will be planning and work together to bring this project under public management.

OWNERSHIP

This project consists of 18,205 acres and 73 owners. The largest owner is the Collier family.

ACQUISITION STATUS

Due to its low ranking and limited CARL funds, negotiations have not been initiated on this project.

RESOLUTIONS

Number	Submitting Agency	Issues or Comments
—	Lee County Commission	Pledging $1.5 Million

Shan Trost

OPTIONAL FORM NO. 10
5010-109

UNITED STATES GOVERNMENT

Memorandum

TO : Valerie Boyd, Chair
LWC Water Supply Plan Advisory Committee

DATE: Sept. 8, 1992

FROM : Todd Logan, Florida Panther NWR

SUBJECT: LWC Water Supply Plan Mailing List

Could you drop me from the LWC Water Supply Plan mailing list? Our agency is interested in the plan, but Peter Plage has been designated as our agency contact/participant. He is also receiving the mailings. Thanks.

Todd Logan

Gulf Citrus Growers Assn. Inc.

cc: Jim G. & David G-H

Ron Hamel
Executive Vice President
and
General Manager

Recd 6/7/93

June 3, 1993

Mr. Terry Clark
SWFMD
P. O. Box 24680
West Palm Beach, FL 33416

Dear Mr. Clark:

Attached, please find the most current projections for citrus development in the "Gulf" citrus production area. This includes Charlotte, Collier, Glades, Hendry and Lee counties.

As you will note, these projections greatly reduce the rate of growth experienced in this area during the past decade. And, this should reduce the pressures on our water resources within the lower west coast area.

If we can be of additional service, please let us know.

Sincerely,

Ron Hamel
Executive Vice President
General Manager

RH/cfh

encl.

cc: Board of Directors
Ed English, Tom Jones, Glenn Simpson

P.O. Box 1319, LaBelle, Florida 33935, 813/675-2180 / Fax 813/675-8087

cc: Jim G. & David G.

STATE OF FLORIDA
DEPARTMENT OF CITRUS

ECONOMIC RESEARCH DEPARTMENT
2129 McCARTY HALL/P.O. BOX 110240
UNIVERSITY OF FLORIDA
GAINESVILLE, FLORIDA 32611-0240

Telephone: 904/392-1874 FAX: 904/392-8634

AGENCY HEAD
FLORIDA CITRUS COMMISSION
HUGH M. ENGLISH, Chairman

INTERIM EXECUTIVE DIRECTOR
MICHAEL W. SPARKS
Phone: (813) 499-2500
FAX: (813) 499-2374

May 13, 1993

Recd 6/7/93

Ron Hamel
Gulf Citrus Growers Association, Inc.
250 Lee Street
P. O. Box 1319
LaBelle FL 33935

Dear Mr. Hamel:

Please find enclosed a report on Gulf citrus acreage and trees, which Bob Behr asked me to do for you. Acreage and tree projections are made for the 1992-93 to 2009-10 seasons.

If you have any questions regarding the projections, I would be glad to try to answer them.

Sincerely,

Mark G. Brown
Research Economist

MGB/dk
Enclosure

Gulf Citrus Acreage and Tree Projections 1992-93 Through 2009-10*

The Gulf citrus region includes five counties—Charlotte, Collier, Glades, Hendry and Lee. According to the Florida Agricultural Statistics Service's (FASS) "Commercial Citrus Inventory 1992," total citrus acreage in the Gulf region in 1992 was 157,239, representing 19.9% of Florida's total citrus acreage of 791,290. The number of citrus trees in the Gulf region in 1992 was 22.2 million, representing 24.2% of Florida's citrus tree population of 92.0 million.

Projections of acres and trees were made by applying assumed loss and planting rates to the 1992 acreage and tree levels reported by FASS. The loss and planting assumptions are based on historic rates implied by changes in the commercial citrus inventory over time. Over the last ten years, loss rates have been declining somewhat in the Gulf region. Comparison of the 1990 and 1992 commercial tree inventories indicates that the tree loss rate was about 1.6%. The 1.6% tree loss rate was assumed over the projection period. Acreage projections were based on the tree projections.

The average annual tree planting level in the Gulf region over 1989 through 1991 was roughly 3.1 million trees. For the projection period, tree planting levels were assumed to be one half the 1989-1991 average for 1992-93 and 1993-94 and one quarter the average thereafter. The assumed decline in plantings follows the same assumed trend for Florida plantings reported in "Florida Citrus Production Trends, 1993-94 Through 2002-03," Florida Department of Citrus, Economic and Market Research Department. The assumed reductions in plantings are based on the expectation that supply will tend to grow faster than demand in the upcoming years, putting downward pressure on prices and providing less incentive to plant.

---

*Prepared by Mark G. Brown, Research Economist, Florida Department of Citrus, May 7, 1993.

Table 1 shows that Gulf citrus acreage could grow to 201.5 thousand acres by 2009-10, 28.2% greater than the 1992 level of 157.2 thousand acres. The Gulf citrus tree population could grow to 30.1 million trees by 2009-10, 35.6% greater than the 1992 level of 22.2 million trees.

Table 1. Gulf region[a] citrus acreage and tree population projections, 1992-93 through 2009-10.

Season	Acres	Trees
	thousands	millions
1991-92	157.2	22.2
1992-93	164.4	23.4
1993-94	171.5	24.6
1994-95	173.6	25.0
1995-96	175.7	25.4
1996-97	177.8	25.7
1997-98	179.8	26.1
1998-99	181.7	26.5
1999-2000	183.7	26.8
2000-01	185.6	27.2
2001-02	187.5	27.5
2002-03	189.4	27.8
2003-04	191.2	28.2
2004-05	193.0	28.5
2005-06	194.7	28.8
2006-07	196.5	29.1
2007-08	198.2	29.5
2008-09	199.9	29.8
2009-10	201.5	30.1

[a] Charlotte, Collier, Glades, Hendry and Lee counties.

Gulf Utility Company
P.O. Box 350
Estero, FL 33928-0350
18513 Bartow Blvd. S.E.
Ft. Myers, FL 33912
813/267-1000

Terry Pls File w/ LCWA corres. I left a message

November 19, 1992

Ms. Sharon M. Trost, Director
Upper District Planning Division
South Florida Water Management
District
P.O. Box 24680
West Palm Beach, FL 33416-4680

Re: Lower West Coast Water Supply Plan - Revised Modeling

Dear Sharon:

The central concern of all water users is planning for adequate supply to meet their projected demands - through 2010 and beyond.

At last week's meeting of the Lee County Regional Water Supply Authority, Missimer & Associates made a presentation which concluded that, based on the modeling parameters proposed by the District, future withdrawals from the water table aquifer would be effectively eliminated. Missimer went on to report that the very limited existing data available indicated that alternative supplies - i.e., the deeper aquifers - were inadequate to either replace current sources of supply or meet future demand in Lee County.

Given these facts, I hope those responsible at the District will see to it that the "revised" model is a practical and usable one. If withdrawals are to be limited in the water table aquifer, which aquifer will future withdrawals come from, and are there adequate quantities in that aquifer to meet future demand?

It will serve no purpose to effectively limit future sources of supply without providing reasonable alternatives - and reasonable prospects of these future sources being permitted for withdrawal.

Thank you for all your hard work in this project to date, and your efforts to address the complex concerns raised by all the constituencies involved in this process.

Sincerely,

James W. Moore
President

cc: Valerie Boyd

JWM/kb

HENDERSON, FRANKLIN, STARNES & HOLT, P.A.

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BRUCE M. STANLEY
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RANDAL H. THOMAS
GUY E. WHITESMAN

1715 MONROE STREET
POST OFFICE BOX 280
FORT MYERS, FLORIDA 33902-0280
(813) 334-4121
FACSIMILE (813) 332-4494

Writer's Direct Dial Number (813) 337-8414

April 3, 1992

Ms. Sharon Trost
South Florida Water Management District
3301 Gun Club Road
Post Office Box 24680
West Palm Beach FL 33416-4680

RE: LOWER WEST COAST WATER SUPPLY PLAN

Dear Sharon:

Thank you for returning my phone call on April 2, 1992. Unfortunately, I was out of the office, and rather than try to catch you by telephone, I thought it would be easier to write this short letter.

It appears that it will not be necessary to take your deposition regarding the Water Supply Plan, as we discussed last week. I do appreciate your taking the time to discuss the Plan with me at the meeting.

Thanks again.

Sincerely,

Russell P. Schropp

/jlf

2/8/93 RES 16-14

Original in Executive Office

c: Terry Clark, Trost, Dempsey

THE ISLAND WATER ASSOCIATION, INC.

February 5, 1993

Mr. Thomas K. MacVicar
Deputy Executive Director
South Florida Water Management District
P.O. Box 24680
West Palm Beach, FL 33416-4680

Dear Mr. MacVicar:

Thank you for your response to my letter of December 19, 1992 regarding inter-district transfer of water. It was reassuring to the Board of Directors of The Island Water Association that Chapter 373 of the Florida Statutes should not prohibit such interchange.

This issue was addressed on our part since it could affect the availability of Sanibel-Captiva water supplies in the future.

Our technical staff is anxious to participate in the preparation of the Lower West Coast Regional Water Supply Plan. Richard Derowitsch, our Engineering Supervisor, will be in touch with your Terry Clark soon.

Sincerely,

THE ISLAND WATER ASSOCIATION, INC.

Thomas A. Sharp

THOMAS A. SHARP, President
Board of Directors

cc: Senator Fred Dudley
Representative Tim Ireland

POST OFFICE BOX 509 • SANIBEL, FLORIDA 33957-0509 • PHONE (813) 472-1502 • FAX (813) 472-1505

COUNTY

BOARD OF COUNTY COMMISSIONERS

P.O. Box 398
Fort Myers, Florida 33902-0398
(813) 335-2111

335-2830

Author's Direct Dial Number

PL-022-92

John E. Manning
District One

Douglas R. St. Cerny
District Two

Ray Judah
District Three

Vicki Lopez-Wolfe
District Four

Donald Slisher
District Five

Robert W. Gray
Acting County Administrator

James G. Yaeger
County Attorney

Robert E. Spitt
County Hearing Examiner

March 26, 1992

3/30/92 RES 16-14

Orig. in EXO

c: Harvey, Trost, Pearson

Tilford Creel, Executive Director
SOUTH FLORIDA WATER MANAGEMENT DISTRIC
3301 Gun Club Road
West Palm Beach, FL 33416-2045

RE: REVIEW OF DRAFT LOWER WEST COAST WATER SUPPLY PLAN

Dear Mr. Creel:

The Department of Lee County Utilities has reviewed the draft report entitled, "Lower West Coast Water Supply Plan," dated January, 1992, as prepared by the South Florida Water Management District Planning Department staff. The intent of this letter is to provide our input and actions regarding the proposed Plan.

The Lower West Coast Water Supply Plan identifies five water supply problems within Lee County, including potential environmental impacts resulting from water level declines in the Corkscrew Wellfield. It is indicated that no drawdown, versus the current one foot drawdown of the water table aquifer, will be allowed beneath wetlands and other sensitive areas. The Plan recommends that future raw water supply from the Corkscrew Wellfield be obtained from the Floridan Aquifer System due to the expected impact on large and small wetland systems from current surficial aquifer pumpage.

Lee County Utilities sincerely supports the conservation of wetlands, as described in the Lower West Coast Water Supply Plan. However, the definition of wetland impact and the relationship to wellfield drawdown, as determined by regional and local groundwater flow modeling, should be better defined. We are concerned that the Plan's recommendations will result in significant economic burdens on Lee County Utilities' customers. The Plan should address assessing environmental impacts and cost/benefit analyses on a site-by-site basis.

In addition, we think that other alternatives, such as wetland monitoring to verify actual ecological impacts and wetland mitigation, which has been accepted in many other areas of Florida as wetland protection, should be considered in the Lower West Coast Water Supply Plan to protect the local environment.

Lee County is ready to work with SFWMD in developing an effective and implementable water supply plan. If you have any questions, please contact me.

Sincerely,

Daryl C. Walk

Daryl C. Walk, P.E.
Acting Director
DEPARTMENT OF LEE COUNTY UTILITIES

DCW/lmm
001302

cc: Commissioner St. Cerny
Commissioner Lopez-Wolfe
Commissioner Judah
Commissioner Manning
Commissioner Slisher
Julio Avael, County Administrator
Karen B. Hawes, Deputy County Administrator

Lee County Regional Water Supply Authority

1617 Hendry Street, #310, Fort Myers, FL 33901

Paul Van Buskirk, P.E., A.I.C.P.
Executive Director

Tel.: (813) 332-5819
Fax.: (813) 332-5819

Rec'd 12/29/93 pc

December 16, 1993

Mr. Terry A. Clark, AICP
Director
Upper District Planning
South Florida Water Management District
Post Office Box 24680
West Palm Beach FL 33416-4680

Dear Terry:

This letter accompanies a copy of the Lee County Regional Water Supply Authority's Draft Water Supply Master Plan 1993-2030, Volumes I - II, and Appendices A, B, & C for your review.

Please call with any questions or comments you and your staff may have. I look forward to hearing from you.

Sincerely,

Paul Van Buskirk, P.E., AICP
Executive Director

LT11093E

Board Members

Robert Hollander, General Manager, Island Water Assoc., Inc.
John E. Albion, Commissioner, Lee County
Joseph M. Mazurkiewicz, Mayor, City of Cape Coral
Bruce Grady, Councilman, City of Fort Myers
Jerrold A. Muench, Councilman, City of Sanibel
Earl F. Hamilton, Councilman, City of Cape Coral
Emmette P. Waite, Jr., Director of Public Works, City of Fort Myers

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Lee County Regional Water Supply Authority

1617 Hendry Street, #310, Fort Myers, FL 33901

Paul Van Buskirk, P.E., A.I.C.P.
Executive Director

Tel.: (813) 332-5819
Fax.: (813) 332-5819

Recd 11/15/93

M E M O R A N D U M

TO: Terry Clark, AICP
Director, Upper District Planning
South Florida Water Management District

FROM: Paul Van Buskirk, P.E., AICP
Executive Director

DATE: November 10, 1993

RE: Draft Lower West Coast Water Supply Plan-Oct. 1993

On page 44, the last sentence reads:

"All recommendations in the RWSA plan must be found consistent with this plan...."

This sounds somewhat dictatorial. We want to cooperate, however, do it our way.

We may come up with better solutions or approaches. I would recommend the following language:

"The RWSA plan was developed using similar modeling methods, resource criteria and guidelines so that it would be consistent with this plan. Appropriate permits shall be obtained prior to plan implementation."

PVB

MM04993E

Board Members

Robert Hollander	John E. Albion	Joseph M. Mazurkiewicz	Bruce Grady	Jerrold A. Muench	Earl F. Hamilton	Emmette P. Waite, Jr.
General Manager	Commissioner	Mayor	Councilman	Councilman	Councilman	Director of Public Works
Island Water Assoc., Inc.	Lee County	City of Cape Coral	City of Fort Myers	City of Sanibel	City of Cape Coral	City of Fort Myers

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Lee County Regional Water Supply Authority

1617 Hendry Street, #310, Fort Myers, FL 33901

Paul Van Buskirk, P.E., A.I.C.P.
Executive Director

Tel.: (813) 332-5819
Fax.: (813) 332-5819

November 3, 1993

RECEIVED
NOV 10 1993
UPPER DISTRICT PLANNING DIV.

Mr. Terry A. Clark, AICP
Director, Upper District Planning
South Florida Water Management District
Post Office Box 24680
West Palm Beach FL 33416-4680

Dear Terry:

Enclosed are two copies of the Lee County Regional Water Supply Authority's Master Plan Briefing Document for your review. This document was presented to the Authority's Board on October 28, 1993.

The plan will be available on November 18. The technical appendices will be available on December 16.

Please call me with your comments. I look forward to hearing from you.

Sincerely,

Paul Van Buskirk, P.E., AICP
Executive Director

Enclosure

LT09293E

Board Members

Robert Hollander	John E. Albion	Joseph M. Mazurkiewicz	Bruce Grady	Jerrold A. Muench	Earl F. Hamilton	Emmette P. Waite, Jr.
General Manager	Commissioner	Mayor	Councilman	Councilman	Councilman	Director of Public Works
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Lee County Regional Water Supply Authority

1617 Handry Street, #310, Fort Myers, FL 33901

Paul Van Buskirk, P.E., A.I.C.P.
Executive Director

Tel.: (813) 332-5819
Fax : (813) 332-5819

June 3, 1993

Mr. Terry Clark, A.I.C.P.
Senior Planner, Planning Department
South Florida Water Management District
Post Office Box 24680
West Palm Beach FL 33416-4680

RE: Lee County Regional Water Supply Authority (LCRWSA)
Water Supply Master Plan
Datasets for Well Withdrawals

Dear Terry:

I am sure it is our mutual desire that the groundwater modeling efforts done for the Lee County portion of SFWMD's lower west coast plan and the LCRWSA 40-year water supply master plan be as similar as possible with respect to the aquifer hydraulic parameters input data, the calibrated base year (1990) solution, and the projected groundwater withdrawals. To that end, I would appreciate it if you would provide the LCRWSA the disaggregated data sets for projected well withdrawals for all users (domestic self-supplied, golf courses, commercial and industrial, utilities, and agricultural). We have projections of water demands by utilities that we plan to use for the model runs.

I understand that your projected water use for agricultural users is being re-evaluated so that it is not currently available. Could you please provide all well withdrawal package datasets which are available at this time, and then send the agricultural withdrawals when they are available. Groundwater model runs, for the future scenarios for the LCRWSA master plan, are scheduled to begin during the week of June 14, so you prompt reply will be appreciated.

Have you completed your evaluation of the calibrated MODFLOW model of the Lee County prepared by ViroGroup, Missimer Division

LT05393E
1/2

Board Members

Robert Hollender
General Manager
Inland Water Assoc., Inc.

John E. Albion
Commissioner
Lee County

Joseph M. Mazurkiewicz
Mayor
City of Cape Coral

Bruce Grady
Councilman
City of Fort Myers

Jerold A. Laurich
Councilman
City of Sanibel

Earl P. Hamilton
Councilman
City of Cape Coral

James T. Williams
Executive Director
Development
City of Fort Myers

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LT05393E
6/3/93
2/2

for the LCRWSA master plan? I forwarded the model diskettes and draft documentation to you (through Chip Morriam) on April 23, 1993. If you or your staff have any questions you would like us to address, please notify me.

Sincerely,

Paul Van Buskirk, P.E., A.I.C.P.
Executive Director

c: C. Merriam, SFWMD
M.J. Shine, SFWMD
S.J. Calise, CDM
R.A. Dickinson, CDM
W.K. Martin, M&A

cc: Sharon T.

Lee County Regional Water Supply Authority

1617 Hendry Street, #310, Fort Myers, FL 33901

Paul Van Buskirk, P.E., A.I.C.P.
Executive Director

Tel.: (813) 332-5819
Fax.: (813) 332-5819

April 14, 1993

Mr. Terry A. Clark, A.I.C.P.
Senior Planner
South Florida Water Management District
Post Office Box 24680
West Palm Beach FL 33416-4680

Dear Terry:

Due to a reorganization within the Lee County Board of County Commissioners, there has been a change in your representative for the Lower West Coast Water Supply Plan. Commissioner John Albion has taken over for Commissioner John Manning regarding this issue. Please forward all correspondence to:

Commissioner John E. Albion
Lee County Board of County Commissioners
Post Office Box 398
Fort Myers FL 33902-0398

You may also note that Commissioner Albion has joined the Authority's Board as a representative for Lee County.

Please call me if I may be of any further assistance. I look forward to seeing you soon.

Sincerely,

Paul Van Buskirk, P.E., A.I.C.P.
Executive Director

LT03493E

Board Members

Robert Hollander	John E. Albion	Joseph M. Mazurkiewicz	Bruce Grady	Jerrold A. Muench	Earl F. Hamilton	James T. Williams
General Manager	Commissioner	Mayor	Councilman	Councilman	Councilman	Executive Director
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						City of Fort Myers

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LYKES BROS. INC.
Agriculture Group
7 LYKES ROAD
LAKE PLACID, FL 33852
TELEPHONE: (813) 465-4127
FAX: (813) 465-7111

LYKES CITRUS MANAGEMENT DIVISION
7 Lykes Road
Lake Placid, FL 33852
Telephone: (813) 465-4127
FAX: (813) 465-7111

LYKES SOUTHERN OPERATING DIVISION
106 S.W. C.R. 721
Okeechobee, FL 34974-8918
Telephone: (813) 763-3041
(813) 763-3545
FAX: (813) 467-4951

RECEIVED
OCT 18 1993
PLANNING DEPARTMENT

October 5, 1993

Ms. Sharon Trost, Planning Director
South Florida Water Management District
P. O. Box 24680
West Palm Beach, FL 33416-4680

Re: ONS Mapping

Dear Ms. Trost:

At a March 11, 1993 meeting between WMD Staff and the Save Our Creek group (held as an adjunct to the LWCWSPAC meeting), Sonny Williamson asked when the ONS map would be ready. David Thatcher (WMD Staff) indicated that the draft map showing possible ONS designations was approximately 2 months from completion. He further indicated that owner representatives would be involved in the process and that an area would not be designated ONS without the consent of the owner.

At this date there is now a draft ONS map being circulated which appears to designate all of Lykes Glades County property within the LWCWSPA as ONS. Contrary to Mr. Thatcher's representation, we have not been consulted nor have we consented to this designation.

In following up on this oversight, one of my staff attended a meeting in Naples 09/14/93. At that meeting, Mr. Terry Clark (WMD Staff) and 3 other staff persons were asked to provide the criteria and methodology by which sites were evaluated for ONS inclusion or exclusion. The indication was that no written documentation for that process existed.

It is impossible for us to even speculate as to what rationale was used to include Lykes property since the mapping covers large areas of the following:

1. Intensive Silviculture - Eucalyptus
2. Intensive Silviculture - Pine
3. Intensively managed improved pastures
4. Intensively farmed row crops
5. Heavily managed semi-improved and rangeland pastures
6. Heavily managed water control programs (Grandfathered)
7. WMD Permitted Surface Water Management Plans

In short there are few if any areas that would qualify as pristine, largely natural or not dominated by man-managed agricultural activities.

We can only speculate, but it would appear that the only real reason for including Lykes' property is that it represents a large block of land in one ownership, or that Lykes' intensively managed agricultural operations have been so beneficial to environmental values that we can expect a resolution of the Governing Board asking us to do more of the same.

On the basis of the foregoing, we would like to indicate to the SFWMD in the strongest possible terms:

1. We have not, do not and will not consent to the inclusion of Lykes properties as ONS in this or any other mapping effort.

2. There is no rational, defensible criteria and methodology for evaluating lands for inclusion in, or exclusion from, any such mapping effort and hence any product of such an effort is fatally flawed.

3. The total absence of credibility of this effort indicates that it should be abandoned since bad data are worse than no data at all.

We would be pleased to hear from you further in this regard.

Sincerely,



P.R. Hamilton

xc: B. Blain
S. Williamson

National Audubon Society

ECOSYSTEM RESEARCH UNIT, BOX 1877, RT. 6, SANCTUARY RD. NAPLES, FLORIDA 33964 (813) 657-2531

3 April 1992

Valerie Boyd
Board Member, SFWMD
1442 Galleon Drive
Naples, FL 33940

Dear Ms. Boyd,

I have been conducting research on the ecology of natural ecosystems in southwest Florida for over 18 years, and as a result have developed something of an expertise on the area. The main focus of my work has been the relationship between hydrology, soils, and plant communities as they operate under natural conditions and how they can be affected by man's activities.

I attended the last meeting of the LWCWSP Advisory Committee in Ft. Myers, because several people felt I might be able to make a useful contribution to discussions of the plan. I realize the size of the advisory committee is already rather large, but if it were possible, I would like to be considered for membership on the advisory committee. I think that some of the information our research group has collected over the years, some of which is not generally available, may be quite helpful in future discussions.

Sincerely,

Michael Duever, Ph.D.
Director

cc. Sharon Trost
Terry Clark

United States Department of the Interior
NATIONAL PARK SERVICE
BIG CYPRESS NATIONAL PRESERVE
S. R. BOX 110
OCHOPEE, FLORIDA 33943

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

David R. Swift
Planning Department
South Florida Water Management District
PO Box 24680, 3301 Gun Club Road
West Palm Beach, Florida 33416-4680
July 2, 1993

RECEIVED
JUL 15 1993
LOWER DISTRICT PLANNING

Dear David,

Enclosed are brief discussions of the some of the issues of greatest concern to Big Cypress National Preserve, as per Sharon Trost's request of May 18.

Our primary interest is in ensuring that Big Cypress National Preserve needs are considered in the water budget of the Lower East Coast Water Supply Plan. As detailed somewhat more in the accompanying document, at least 50% of the total Big Cypress-Everglades flow across the Tamiami Trail originates in Big Cypress National Preserve prior to entering either the marshes of the Everglades, or the estuarine environment of the Ten Thousand Islands. This enormous freshwater influx (>500,000 acre-feet/year) from the Preserve has, far-ranging effects far beyond the Ten Thousand Islands: *its movement down the coast critically influences Florida Bay.*

In South Florida, natural hydrologic catchments do not neatly coincide with agency jurisdictional boundaries. It is important to assure to the Big Cypress Swamp proper allocations of that share of the regional water supply necessary to support the long-term viability both of the Big Cypress National Preserve natural ecosystem, and the distant environments dependent upon it.

Sincerely,

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HYDROLOGIC ENVIRONMENTAL ISSUES at BIG CYPRESS NATIONAL PRESERVE

INTRODUCTION

Big Cypress National Preserve was created to protect and manage its internal resources, as well as the quality and quantity of water flowing to the Ten Thousand Islands area of Everglades National Park. Agency jurisdictional boundaries that do not coincide with natural hydrologic catchments have inhibited proper allocations of that share of the regional water supply necessary to support the long-term viability of the Big Cypress National Preserve natural ecosystem.

Modelling of regional and local hydrologic regimes has been begun by the South Florida Water Management District (SFWMD) both east and west of Big Cypress National Preserve, yet the 716,000 acres of the Preserve have not been included.

This is a significant omission: long-term discharge means [determined from 28-52 years of data] measured by the US Geological Survey demonstrate that at least 50% of the total Big Cypress-Everglades flow across the Tamiami Trail (from the Barron River Canal to WMD Levee 30) has originated in Big Cypress National Preserve prior to entering either the marshes of the Everglades, or the estuarine environment of the Ten Thousand Islands [USGS 1992, pp. 110, 113, 124, 125, 149].

This enormous freshwater influx (>500,000 acre-feet/year) from Big Cypress National Preserve has far-ranging effects far beyond the Ten Thousand Islands: *its movement down the coast is of critical influence to Florida Bay* (Fourqurean et al., 1993; Porter and Meier, 1992; and Smith et al. 1989).

The hydrologic issues of greatest environmental concern to Big Cypress National Preserve, those that can be most influenced by consideration in SFWMD planning, can be grouped in the following:

I. BASELINE HYDROLOGY CHARACTERIZATION: CLIMATE, WATER BUDGET, FLOW ROUTES AND WATER QUALITY

II. GROUNDWATER DISCHARGE and QUALITY, and SUBSURFACE GEOLOGY

III. ANALYSIS OF EXISTING HYDROLOGIC DATA

IV. EXTERNAL FLOWS: CATCHMENT AREAS, AGRICULTURE, WATER QUALITY

V. RESTORATION OF THE FLOW REGIME IN THE EASTERN BIG CYPRESS

VI. OTHER ISSUES: –

1. Precipitation quality
2. Changes in vegetation along roads and canals downstream of discharge structures
3. Changes in salinity gradients
4. Canals as habitat for exotic species
5. A list of mitigation priorities

REFERENCES CITED:

Fourqurean, J.W.; Jones, R.D.; and Zieman, J.C. (1993)
Processes influencing water column nutrient characteristics and phosphorus limitation of biomass in Florida Bay, Florida, USA: Inferences from spatial distributions *Estuarine, Coastal and Shelf Science* **36**:295-314

Porter, J.M. (1992)
Quantification of loss and change in Floridian reef coral populations *American Zoologist* 32:625-640

Smith, T.J. III; Hudson, J.H.; Robblee, M.B.; Powell, G.V.N.; and Isdale, P.J. (1989)
Freshwater flow from the Everglades to Florida Bay: An historical reconstruction based on fluorescent banding in the coral *Solenastra bournoni*. *Bulletin of Marine Science 44:275-282*

ISSUE DISCUSSION

I. BASELINE HYDROLOGY CHARACTERIZATION: CLIMATE, WATER BUDGET, FLOW ROUTES AND WATER QUALITY

The natural surface water hydrology of Big Cypress National Preserve has not been determined: it is poorly understood in terms of total precipitation, evapo-transpiration, and the relation of discharge to these factors.

A. Baseline Hydrologic Data The only long-term weather and climate stations in the area are at Everglades City and Tamiami Trail-Mile 40 [NOAA], which are both outside the Preserve boundaries. Adequate statistical analysis does not appear to been made on either of these stations, and there is at present no system for sharing this data in a real-time framework. No stations with long-term records exist within Big Cypress National Preserve.

Five rain recorders [two provided by SFWMD] and two temperature sensors exist in Big Cypress National Preserve, but all were recently installed, and the small size of the "network" cannot adequately represent conditions for the Preserve because of the localized and highly variable precipitation patterns. In addition, these stations were designed to be operated for the purposes of fire condition prediction, with no provision for data inclusion in a hydrologic program.

Objectives

Existing climate information should be utilized to characterize the regime of the Big Cypress National Preserve area. Data from stations neighboring Big Cypress National Preserve need to be analyzed, and a system developed for sharing them. A data storage and analysis system needs to be created for currently-collected fire weather data.

SFWMD is currently funding a study in Everglades National Park to determine the density of gages necessary to adequately quantify rainfall in that area: such a study should be extended into the area of Big Cypress National Preserve. It would be efficient to site meteorological instrumentation at each surface or groundwater monitoring station in the Preserve.

B. Baseline Water Quality A small water quality monitoring program (with lab analysis funded by SFWMD) has been operated by Preserve personnel for the past two years. However, water collection is made at only nine stations, on a bi-monthly schedule at best, and some parameters (such as metals) are analyzed only twice a year.

The SFWMD Department of Water Resource Evaluation maintains a large, regular monitoring program south of Lake Okeechobee and into Everglades National Park. The program also responds to major hydrologic events such as storms, hurricanes, etc.

Objectives
A Preserve-wide water resource database should be developed. Existing water quality for Water Conservation Area 3A (WCA 3A), L-28 Lateral, the Miccosukee lands and others should be accessed and analyzed.

C. Original Flow Patterns Discharge routes in Big Cypress National Preserve have been altered since the 1920's by the construction of numerous canals, roads, borrow pits, etc. No definitive work exists even now that outlines present flow routes. Quantitative modelling of Big Cypress National Preserve hydrology will be hampered until this problem is addressed; while it may not be possible to make a quantitative determination of original flow patterns, qualitative information may be available from longtime residents in the area.

Objectives
The collection of oral histories from longtime residents, concerning the hydrology of the area (water levels, areas of flooding, etc.), should be initiated. Aerial photographs that date from the 1940's, and the results of a 1954 Soil Conservation Service Soil Survey of the Preserve should be acquired and examined for clues to historic hydrology and changes. Notes also exist from local area surveys of roads, canals, and legal boundaries, that could provide clues for indicators of historic volumes, directions and timing of flow.

II. GROUNDWATER DISCHARGE and QUALITY, and SUBSURFACE GEOLOGY

Knowledge of groundwater in the Preserve is practically non-existent. Major studies have been conducted east and west of Big Cypress National Preserve (e.g. SFWMD, 1986 in western Collier County) but not in the Preserve. These findings cannot be reliably extrapolated into Big Cypress National Preserve, yet it is clear that the Surficial Aquifer groundwater flow and surface waters are intimately linked in the Big Cypress. There is also reason to consider that the karst environment of Big Cypress National Preserve provides some connection to the Lower Tamiami Aquifer, which is less than 50 feet below the surface in much of the Preserve.

Slightly more information exists of the subsurface geology of Big Cypress National Preserve, but this is nearly all derived from cuttings, rather than cores. The information sought in the drilling of these wells was for the purpose of oil and gas extraction--near-surface information was considered peripheral to their purpose, and they tend to be concentrated in the north, over the petrochemical trend. This lack of knowledge of geologic structure and stratigraphy greatly inhibits any understanding of groundwater conditions and movements.

Objectives

Initial steps to remedy the absence of adequate geologic and geohydrologic knowledge in the Preserve must start with the installation of a groundwater monitoring network. This should likely include at least four transects, with 3 well clusters each: north-south along the Turner River Road and the Florida Trail, andeast-west along I-75 and Highway 41. Installation and monitoring would be coordinated between Big Cypress National Preserve, SFWMD and USGS.

The information gained from the wells would also be used to construct fence diagrams of the subsurface geology.

III. ANALYSIS OF EXISTING HYDROLOGIC DATA

Water quality and stage data have been collected in cooperation with SFWMD for several years. Because of initial insufficient training and a shortage of personnel (Big Cypress National Preserve has had a staff hydrologist only since January, 1993), there is a backlog of stage recorder charts that have not been compiled, and no adequate method of sharing data between SFWMD and Big Cypress National Preserve.

The remoteness of most of the Big Cypress National Preserve sites requires visitation by helicopter, creating maintenance problems, and an inability to predict flows in a timely manner. Currently, it is planned to upgrade the stage recorders from charts to data loggers over a two-year period, but the instruments still have to be visited on a regular basis by helicopter.

Given the large area involved, the density of the existing network is also insufficient to adequately characterize flows within and from the Preserve.

Objectives

Realistically, the early, most-complicated backlogged charts will not be possible to do in any prompt time-frame at Big Cypress National Preserve. SFWMD personnel who continually work with A-71 charts and have the necessary software and hardware could likely resolve this issue quickly and easily, and make the collected data usable, to the benefit of both Big Cypress National Preserve and SFWMD.

Big Cypress National Preserve will be able to maintain what is now routine computation and entry of daily stage means until the entire monitoring network is upgraded to a low-maintenance situation more reflective of our personnel realities.

An evaluation of the network adequacy and density should be made under the same criteria governing the placement of these stations elsewhere in the SFWMD and Everglades National Park.

IV. EXTERNAL FLOWS: CATCHMENT AREAS, AGRICULTURE, WATER QUALITY

The hydrology of the original Preserve appeared relatively self-contained, but the enlargement of Big Cypress National Preserve in 1988 with the Addition lands has complicated the overall water discharge and quality status. Firstly, surface flows into and through the Big Cypress National Preserve Addition lands are not well understood, and secondly, because Addition lands now have the effect of making Big Cypress National Preserve an upstream user of a large portion of the flow that ultimately enters Everglades National Park and the Shark valley Slough system.

Most of the flow into the Addition area exits to WCA 3a, but it is not certain whether water once flowed to most or all of the rest of Big Cypress National Preserve from the Addition. Current topographic information is not accurate enough to make such a determination with any certainty. If water does regularly flow from Mullet Slough to the rest of Big Cypress National Preserve, then all of the Preserve could be affected by agricultural and other land use changes north of the Preserve. Lastly, the extent or the occurrence of groundwater flow is unknown.

Activities on lands outside of the Preserve probably affect the volume, timing and quality of water flow into the Preserve. Surface waters definitely flow into the Preserve from lands that are adjacent to Okaloacoochee Slough and Mullet Slough, and from Everglades National Park in Big Cypress National Preserve's southeastern corner.

Agricultural development along the northern Preserve boundary is also increasing. Elsewhere in south Florida it has been found that agriculture can cause a variety of impacts to water resources, e.g. lowering water tables in the wet season, raising water tables in the dry season, and contributing pesticide and nutrient runoff. Effects to the water table can extend 100 to 10,000 feet laterally. If it becomes necessary to obtain more water from Conservation Area 3a or Mullet Slough in order to restore natural flows, however, the quality of these waters needs to be determined before they are delivered to eastern Big Cypress National Preserve.

Objectives

The variety of actions programs needed to assess these questions could include the following:

1. Accurate topographic mapping of Big Cypress National Preserve, in particular the southern margin of Mullet Slough and the eastern boundary of the Preserve. The mapping should extend to adjacent lands to understand surface flow patterns into and out of the Preserve.

2. Determine through observation, mapping, tracers or other means, whether significant water moves from Mullet Slough to the rest of Big Cypress National Preserve.

3. Expand the water quality monitoring program, and archive relevant areal water quality information from SFWMD and Environmental Protection Agency in one place.

4. Examine historic and current land uses north of Big Cypress National Preserve in order to identify trends and the probable nature of impacts. Investigate the impacts of external land uses on the quantity and quality of surface and groundwater flows to the Preserve, e.g. by investigating citrus pumping impacts on Mullet Slough.

V. RESTORATION OF THE FLOW REGIME IN THE EASTERN BIG CYPRESS

A substantial portion of Big Cypress contributes flow to, and receives flow from, the Everglades marsh system. It has therefore also been significantly impacted by the roads, canals, etc. constructed southward from Lake Okeechobee in recent decades, to the detriment of historic discharge timing, durations, and amounts.

Relatively recently, two other major changes have occurred: inflows from the north have likely declined because backpumping of agricultural water into Lake Okeechobee is no longer permitted, and water that formerly flowed overland to southeastern Big Cypress National Preserve has been interrupted by construction of the L-28 and L-29 levee complexes, and impounded in Conservation Area 3A.

Levee 29 (paralleling US 41 east-west) is the major obstruction for flow southward from Lake Okeechobee into Shark Valley Slough (the central portion of Everglades National Park, and eastern area of Big Cypress National Preserve). Pumping, and manipulation of release scheduling using WCA 3A as a reservoir, has attempted to restore original conditions of flow volumes and timing to Shark Valley to ameliorate the effect of L-29.

Westward, this levee merges into Levee 28. L-28 extends 18 miles north from US 41, as the eastern edge of Big Cypress; Conservation Area 3A lies to the east. L-28 was constructed in the 1960's to control floods and to protect the Jetport site, and creates an artificial boundary between the Big Cypress National Preserve and Everglades drainage systems.

Water that would flow west from Conservation Area 3A in Big Cypress National Preserve is held back by the levee, except for periodic releases through the S-343 culverts, and in extreme high water conditions when recently-cut "crossover culverts" become operational. Outflows from the S-343 culverts and from the S-12's are periodic and unplanned: the timing, duration, and volume of water deliveries to southeastern Big Cypress National Preserve have been inappropriate, and in no way recreate natural flow patterns and hydrologic regimes of SE Big Cypress National Preserve.

Flow regime modifications of Everglades National Park discharge cannot be disconnected hydrologically from changes in Big Cypress National Preserve, because they share the same levee system and same water reservoir (WCA 3A). The original, natural hydrologic regime of Shark Valley, and the sloughs to its west (Stairsteps) in Big Cypress National Preserve, were interconnected.

There is a finite amount of water available from Water Conservation Areas 3a and 3b. Releases from WCA 3A have been largely driven by consideration of discharge to the Shark Valley Slough in Everglades National Park, to the detriment of the natural system of Big Cypress National Preserve. The outflow that does occur into Big Cypress National Preserve through the L-28 culverts and Structure

343 (at the southern end) occurs as a by-product of US Army Corps of Engineers (USACOE) releases scheduled to simulate natural flows into Shark Valley Slough, rather than as planned additions to Big Cypress National Preserve flow.

This history of operation of the WCA, is of great concern to the Preserve, *in particular* the possibility that water which had previously been delivered to southeast Big Cypress National Preserve (and maintained Lostmans, Dixons and East Sloughs) might instead be released much further east to rewater East Everglades.

Objectives

1. Realistic, long-term solutions to the problems of water distribution in South Florida require that the major hydrological resources and needs of Big Cypress National Preserve be included in regional planning and operation. Recognition is needed that Big Cypress National Preserve needs must be considered in the water budget of both the Lower East Coast Management Plan **and** the Lower West Coast Management Plan. Within the operation of the Lower East Coast Management Plan, there must be coordination among the SFWMD, Everglades National Park, USACOE and Big Cypress National Preserve.

For example, development and operation of the "Natural Systems Model" should include data from Big Cypress National Preserve; the timing and evaluation of experimental deliveries and permanent changes of operation, and future releases from, or modification of, L-29, L-28, and S-343 A & B, and S-12 should operate as part of a hydrologic program inclusive of both Shark Valley (Everglades National Park) and Stairstep (Big Cypress National Preserve) needs.

2. Quantitative analysis of existing historical flow information can be used to help characterize some of the changes that operation of control structures can effect on flow releases, and evaluate the role of water deliveries from the WCA to Big Cypress National Preserve: e.g. flow-section data for USGS stage-recorders on US 41 and southeastern Big Cypress National Preserve should be evaluated in conjunction with WMD discharge and pumping histories, to quantify the hydrologic interrelation of Shark Valley and the Stairstep area [Lostman's, Gum, and East Sloughs], and to determine how the L-28 Tieback is altering flows into Big Cypress National Preserve and how these impacts can be mitigated.

3. A surface and groundwater hydrologic monitoring system of common instrumentation and density of coverage should be developed among SFWMD, Big Cypress National Preserve, and Everglades National Park. It should include integrated database management, and standardized analyses and would likely be best coordinated by SFWMD assistance to support planning. Water-quality monitoring of all discharges from Area 3A should be included.

4. The need for experimental deliveries should be evaluated immediately, and transitional delivery schedules for S-343 A & B should be developed, implemented and monitored. These should be implemented with concurrent monitoring by SFWMD and US ACOE.
5. Accurate topographic surveys should be extended into Big Cypress National Preserve from Everglades National Park and WCA 3A to aid in hydrologic modelling.

VI. OTHER ISSUES of MUTUAL SFWMD-BCNP INTEREST:

PRECIPITATION QUALITY

The quality of wet and dry deposition, and its impacts to Preserve waters has not been evaluated. The Preserve has a NADP precipitation monitoring station that will provide data, but this one site may be insufficient.

CHANGES IN VEGETATION ALONG ROADS, CANALS, DOWNSTREAM OF STRUCTURES, AND EXTERNAL IMPACTS-

Some obvious vegetation changes have occurred immediately adjacent to roads and canals, but there has been no investigation of possible changes further away from disturbances. Increased agricultural developments north of Big Cypress National Preserve could impact water quality and groundwater, and subsequently, vegetation in the near future.

CHANGES IN SALINITY GRADIENTS

Anecdotal and descriptive information of long-term residents in the Preserve indicates significant changes in the flow regime where waters from Big Cypress National Preserve empty into the mangrove swamps in Everglades National Park. Possible causes are reduced flows from the Big Cypress National Preserve and Everglades National Park watersheds and/or sea level rise. Channels that were once historically open where the major sloughs empty to the bays, have become choked with mangroves.

CANALS AS HABITAT FOR EXOTIC SPECIES

Exotic species such as hyacinth and cichlids are known to have large populations in the canals in the Preserve. These may be providing pathways for spreading infestations through the Preserve.

ESTABLISH A LIST OF MITIGATION PRIORITIES

The Preserve should have a list to identify several wetlands mitigation projects that can be offered to those needing mitigation for wetlands impacts outside the Preserve.

South Florida Water Management District

3301 Gun Club Road • P.O. Box 24680 • West Palm Beach, FL 33416-4680 • (407) 686-8800 • FL WATS 1-800-432-2045

RES 16-14-03

May 18, 1993

Tom Miller, Ph.D.
Hydrologist
Big Cypress National Preserve
HCR 61, Box 110
Ochopee, FL 33943

Dear Dr. Miller:

Last month Mr. David Swift, a member of the District's Planning Department had the opportunity to contact your office with regard to compiling information needed for future water resource planning efforts within the Lower East Coast (LEC) Planning Region of Florida. As you know, the LEC Planning Area includes Lake Okeechobee, the Everglades Agricultural Area, Lower East Coast Urban Areas, the Western Basins, the Water Conservation Areas, Everglades National Park, and a portion of the Big Cypress National Preserve (BCNP). The District would appreciate your agency's help in obtaining the information listed below to assist the District in its long-range planning efforts.

1. Identification of existing hydrologic/environmental issues within the BCNP. The District would be interested in receiving comments from the BCNP staff on all areas of LEC Planning Region; however, your primary responsibility would be defining existing hydrologic/environmental issues within the BCNP and adjacent lands.

2. Identify (list) existing priority areas within lands under jurisdiction of the BCNP which are in need of hydrologic restoration (i.e., list areas that need more or less water, better timing or distribution of water or hydroperiod improvements).

3. If known, identify specific hydrological objectives for maintaining or restoring these priority areas.

4. Identify what operational, structural or other improvements your agency would recommend to implement restoration of the priority areas identified above as well as probable time frames for implementation of these programs.

   The District recognizes that some of this information is yet to be developed for some areas of the Everglades. In these cases, please list the data requirements or additional research that needs to be undertaken to develop a strategy for restoring these areas.

5. Identify and list ongoing environmental restoration programs designed to improve hydrological conditions within the BCNP. If known, identify the time frames associated with the implementation of these programs.

Governing Board:
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July 29, 1993

Planning Department,
South Florida Water Management District
3301, Gun Club Road,
West Palm Beach, FL 33416-4680

ATTENTION JAMES T. GROSS

Dear Mr. Gross:

Please find enclosed a diskette containing the MODFLOW BCF2, STR1, and PCG2 packages.

BCF2 allows re-wetting of dry cells and is documented in USGS Open-File Report 91-536, "A Method of Converting No-Flow Cells to Variable-Head Cells for the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model" by M.G. McDonald, A.W. Harbaugh, B.R. Orr, and D.J. Ackerman.

We have found the PCG2 solver much more efficient and faster than either SOR or SIP on our PC-computers. I am not sure what improvement you will get on the workstations but we had significant improvement in speed, accuracy and convergence. The PCG2 solver is documented in USGS Open-File Report 90-4048, "Preconditioned Conjugate-Gradient 2 (PCG2), a Computer Program for Solving Ground-Water Flow Equations" by M.C. Hill.

STR1 is a simple stream routing package for MODFLOW which I found interesting and think you might like to add to your library. It is documented in USGS Open-File Report 88-729, "Documentation of a Computer Program to Simulate Stream-Aquifer Relations Using a Modular, Finite-Difference, Ground-Water Flow Model" by D.E. Prudic.

You may have some of these reports in your library or need to order them. I could make you a copy of instruction pages from our copies should you have an immediate need.

Sincerely,

Akin Owosina

Akin Owosina