

1.0 INTRODUCTION

1.1 BACKGROUND

The Florida Keys stretch 110 miles from south of Miami to Key West, Florida, and represent the only tropical archipelago in the continental United States. **(Figure 1-1)**. The Florida Keys developed after the Second World War by providing a relaxed winter haven for fishing. Land development throughout the state proceeded from the 1940's through the 1970's by the conversion of coastal wetlands into waterfront property suited to provide access for homeowners to the bays and waterways.



Figure 1-1 Florida Keys island chain

Canal development accommodated the popularity and population growth in the Keys **(Figure 1-2)**. Major improvements in infrastructure, such as the water pipeline, resulted in a surge of population growth in the archipelago.

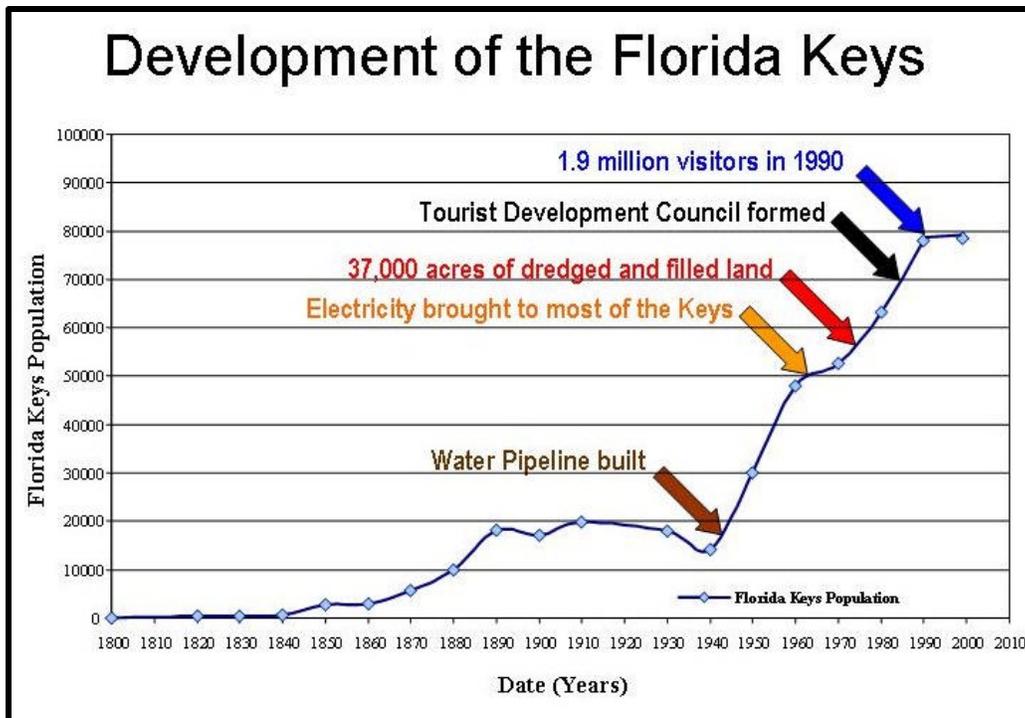


Figure 1-2: Graph of population growth in the Florida Keys since the 19th century

Canal development was initiated and carried out before ecologists and resource managers understood the implications to the local water quality and larger coastal ecosystem. Many canals were dug 10 to 20 feet deep (3 to 6 meters) to maximize production of fill material excavated from the canal, and most canal systems were designed as long, dead-end networks to maximize waterfront property. These long dead-end canal systems exhibit little or no tidal flushing at their upper ends (**Figure 1-3**).

Figure 1-3: Aerial photograph of the construction of finger canals on Sugar Loaf Key (circa 1960's)



Finger canals represented an essential characteristic of Keys life; residents desired homes adjacent to the water and with dock space for boats. The ability to have a boat at one's home was the ultimate attraction to an area known for its marine resources and coastal environment. Today, residential canals are a permanent part of the Florida Keys landscape; there are 481 such canal systems in Monroe County.



Figure 1-4: Photograph of a canal in the Upper Keys

Canal construction has been recognized as impacting water quality and Monroe County is now faced with the management and mitigation efforts for over 111 miles (179 linear kilometers) of canals, representing about 347 miles (555 kilometers) of waterfront. Although information on all canal systems is lacking, there is little doubt that canals can pose a serious water quality and public health threat to the Keys.

Water quality studies of residential canals throughout Florida from 1950 to 1970 determined that canal construction created significant water quality and biological degradation within the canals themselves and in waters adjacent to the canals. Deep, narrow, box-cut canals with dead-end configurations gradually accumulate oxygen-demanding and toxic sediments as well as organic wastes. To the public, the immediate symptoms of water quality degradation in the canals were the darkening color of the water, objectionable odors, floating sludge, and periodic fish kills. All of these symptoms reflected a high biological oxygen demand in the water column from nutrient loading and poor circulation (Baroda and Partington, 1972).

In 1972, during the peak of finger-fill canal construction in the Keys, the Florida Department of Pollution Control (FDPC) issued a dredge and fill moratorium halting all canal construction in the Keys until completion of a study to assess the effects of canal development on marine habitats. At this time, a study of ten canal systems in the Keys was carried out by the State to assess water quality (FDPC, 1973). The results of the study determined that canals demonstrated strong water column stratification and depressed dissolved oxygen levels, less than 4.0 milligrams per liter (mg/l), the State standard, and often less than 1.0 mg/L. Prolonged low oxygen conditions promote anaerobic bacteria that produce hydrogen sulfide. Trapped hydrogen sulfide at the bottom limits biological diversity and primary production. Numerous other studies cite water quality degradation in the Keys canals (USEPA, 1999). The FDPC study and its recommendations effectively stopped construction of additional finger-fill residential canal systems in the Keys. In addition, because of the stringent regulatory requirements, several constructed canal systems were plugged or were not opened to adjacent waters after construction. The opening of these plugged canals remains a source of controversy today.

Subsequent water quality studies in Monroe County (see **Table 2-1** of this report) have documented the extent of water quality degradation due to nitrification from on-site wastewater disposal and storm water run-off from adjacent developments. The physical orientation of some canals has contributed to the accumulation of organic debris, including floating seagrass and algae; this sea-based loading has further contributed to canal water quality problems. Water quality degradation not only presents aesthetic and ecological problems, but public health threats as well (Paul et al., 1995). Degraded canal water results in deterioration of the environmental quality of receiving waters which may result in dysfunction of adjacent communities (Lapointe and Clark 1992; Lapointe et al. 1994; Lapointe and Matzie, 1992). The cooperative relationship between the County, the State of Florida and the National Marine Sanctuary (NMS) program has produced a strategic plan for water quality improvement and protection of Outstanding Florida Waters. This cooperation, and the designation of the Florida Keys as an Outstanding Florida Waters, are evidence of the importance of environmental quality and protection to the economic future, as well as quality of life, in the Florida Keys.

1.2 PURPOSE AND ORGANIZATION OF THIS REPORT

The purpose of the work presented in this report is to assist in efforts to improve the water quality in residential canals in the Florida Keys. The scope of work was derived from an initial January 2001 Request for Proposal (RFP) from Monroe County and subsequent mutually agreed modifications. The purpose for the RFP was to fulfill Objectives 202.14 and 202.15 of Monroe County's Comprehensive Plan and Strategy W.10 of the Water Quality Protection Program Document for the Florida Keys National Marine Sanctuary (EPA, 1996). These objectives required the county to conduct a comprehensive inventory of residential canals and evaluate existing water quality information. The assessment was to include a basic characterization of residential canals, and recommendations of treatment technologies appropriate to improve water quality by reducing nutrient loading and increasing circulation. The overall project required the

delivery of several technical products that are not contained in the body of this report, but are included as attachments. This final report presents a summary of the spatial data compilation and analysis to give the reader an overview of the ecology of the canals as well as site-specific treatment technologies.

The report acknowledges that large scale landscape solutions to nearshore water quality problems in the Florida Keys, such as advanced waste water treatment facilities, are critical to the overall reduction of nutrient loadings to the canals. Costing of these technologies is beyond the scope of this report, however, and is being undertaken by the County and several other municipalities. This final report addresses smaller scale, canal-specific treatments, including community stewardship of canal systems as a critical link to the improvement of water quality in the Keys canals.

1.3 OVERVIEW OF SCOPE OF WORK

Enclosed, man-made waterways were thought to pose an inherent pollution threat by the accumulation of organic matter, nutrients and pathogens. Early in the development of canals, residents expressed concern over the quality and safety of the water. By the mid-1970's, individuals and neighborhood associations were conducting their own water quality monitoring of canals to address aesthetic symptoms of water quality degradation such as fish kills, algal mats, and bad odors. Residents were independently contracting engineering and consulting firms to do canal by canal water quality testing for some neighborhoods in an effort to improve water quality by adding culverts or aeration. With the designation of the Florida Keys National Marine Sanctuary (FKNMS) in 1992, and the release of a FKNMS special study report on salt-water-borne pathogens potentially contaminating enclosed waters (Griffin et al., 1997), the County wanted to respond to this concern in a broader effort by a comprehensive study of residential canal water quality.

The specific tasks accomplished in this residential canal assessment and inventory study included:

- Compilation of existing data related to water quality in the Keys and preparation of a bibliography.
- Review of available canal water quality data, determination of quality, and summation of all available electronic data sets.
- Development of a GIS database of physical attributes that could potentially impact water quality in the canals.
- Development of a canal classification that relates physical attributes to potential for water quality degradation.
- Development of a tool that assists in evaluating the effectiveness of various treatment approaches and technologies for improving the canal's water quality.
- Performance of a sampling program in a recently unplugged canal system in Sunset Acres to determine the water quality changes since unplugging.
- Identification of recommendation for future work efforts relating to improving the water quality in the canal systems in the Florida Keys.

Sections 2.0 through 6.0 of this report provide details of each of the major tasks performed as part of this study. Section 7.0 presents recommendations. A hard copy of each task deliverable that has been completed is included in the appendices of this report. Additionally, electronic copies of all products and compiled datasets are provided on the attached CD ROM.