



HURRICANE LOSS REDUCTION FOR HOUSING IN FLORIDA

**A Research Project of the International Hurricane Center
at Florida International University
Funded by the Florida Department of Community Affairs
Under Contract 02-RC-11-13-00-05-001**

FINAL REPORT

VOLUME 1

DELIVERABLE No. 5

DUE JUNE 30, 2002

**PREPARED BY
THE INTERNATIONAL HURRICANE CENTER
FLORIDA INTERNATIONAL UNIVERSITY
Miami, FL 33199**



June 28, 2002

Mr. Ted Court
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100

RE: Contract # 02-RC-11-13-00-05-001

Dear Mr. Court:

I am pleased to attach one printed and one digital copy of the Final Report for the research project *Hurricane Loss Reduction for Housing in Florida* completed by the IHC Research Team for the Hurricane Loss Mitigation Program under the contract of the reference.

This Final Report describes work completed from through June 30, 2002 as required by the contract of the reference executed on August 6, 2001. This report consists of two volumes and it is supported by pictorial information contained in web pages referred to in the text of the report itself. This Final report complements the quarterly reports and other deliverables we have submitted to you throughout the year in compliance with contractual requirements.

On behalf of the thirty-five individuals from three academic institutions who were part of the research team led by the IHC and on my own behalf, as principal investigator for this project, I want to thank you and others at DCA for your continued support and pertinent commentary as we worked on the required research topics. We look forward to the opportunity of continuing to be of service to DCA and through you to the residents of our state.

Please do not hesitate to call me should you have any comments or questions regarding this Final Report.

Sincerely

Ricardo A. Alvarez
Deputy Director

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FOREWORD

The International Hurricane Center (IHC) at Florida International University (FIU) is proud to be part of the Hurricane Loss Mitigation Program coordinated by the Florida Department of Community Affairs (DCA). The research work we contribute under this program goes to the core of our mission as Florida's Type 1 center for hurricane research.

We at the IHC believe the Hurricane Loss Mitigation Program provides a critical venue to link scientific research with practical applications to reduce the potential for damage to housing from recurring hurricanes, for the benefit of many in our vulnerable state. Certainly this practical approach also has use in other hurricane vulnerable areas throughout the country.

The IHC Research Team has important findings as a result of the work our team of 35 researchers, research assistants and support staff from three academic institutions. These findings are summarized in the Executive Summary section of this Final Report (Volume 1) and they are also discussed in detail in Volume 2 of this report. We believe a number of these findings already address practical issues that are relevant to our work toward hurricane loss reduction.

This year's work was made more effective as a result of invaluable input from the Hurricane Loss Mitigation Advisory Council both collectively and from individual members, as well as from commentary provided by DCA Secretary Mr. Steve Seibert, by Division of Housing and Community Development Director Ms. Shirley Collins, and by other DCA staff. We are thankful for these contributions and look forward to continuing to benefit from such interaction in the future.

In closing we would like to stress the importance of keeping the larger issue of housing in perspective even as we tackle new research challenges in our quest for hurricane loss reduction. When addressing issues that affect manufactured housing we must look beyond the installation, manufacturing or other technical issues, to the more than two million Floridians who reside in these affordable dwellings.

On behalf of the IHC, FIU and our research team, thank you for the opportunity of serving our state.

July 28, 2002

EXECUTIVE SUMMARY

SECTION 215.559 FLORIDA STATUTES

This section summarizes the research activities undertaken by a team lead by the International Hurricane Center (IHC) at Florida International University (FIU), as required under Section 215.559 of the Florida Statutes – Hurricane Loss Mitigation Program, during the period from July 1, 2001 through June 30, 2002.

Before addressing the summary of research activities it is important to note that the statute earmarking funds for the same, the “Bill Williams Residential Safety and Preparedness Act”, was amended by the State Legislature in 2001. One significant amendment was the extension of the repeal date for the Hurricane Loss Mitigation Program from June 30, 2002 to June 30, 2006. The IHC and its research team believe this extension of the repeal date will provide needed continuity to the research effort allowing work to be built upon prior findings, which should result in a more effective contribution for the benefit of the residents of the State of Florida.

SUBGRANT AGREEMENT

A Subgrant agreement between the State of Florida Department of Community Affairs (DCA) and Florida International University (FIU) was executed on August 6, 2001. Said agreement is identified by Contract Number 02-RC-11-13-00-05-001. The agreement provided a Subgrant in the amount of \$700,000 for the IHC and its research team to carry out specific research activities as approved by statute. Of the Subgrant amount \$33,333 covered indirect cost incurred by FIU with the balance of \$666,667 going for actual research work.

SCOPE OF WORK

The scope of work required by the statute included three specific research topics as listed below:

- (a) Eliminating state and local barriers to upgrading existing mobile homes and communities;

- (b) Research and develop a program for the recycling of existing older mobile homes;
- (c) Programs of research and development relating to hurricane loss reduction devices and techniques for site-built residences.

In addition to conducting research under these three topics the IHC was also charged with assisting DCA in the preparation of a full report and accounting of activities under Section 215.559 of the Florida Statutes, the Hurricane Loss Mitigation program, to be submitted by DCA to the Speaker of the State House of Representatives, the President of the State Senate and the Majority and Minority Leaders of the House of representatives and the Senate by January 1, 2002. The IHC complied with this requirement by submitting Deliverable No. 3 – ANNUAL REPORT FOR 2001 – to DCA on November 30, 2001.

THE RESEARCH TEAM

In order to carry out the required research agenda, and to meet the other requirements under the grant, the IHC organized a team consisting of thirty-five individuals from three academic institutions. The expertise of team members ranged from the social sciences and urban planning, to computer science, architecture, structural engineering, wind engineering and construction management. In addition to faculty researchers the team also included research assistants and support staff. Team members were drawn from Florida International University, the University of South Florida and Clemson University.

WORK PLAN

The statute also required the IHC to develop a work plan for carrying out research on the above three topics to be submitted for approval to the Hurricane Loss Mitigation Advisory Council. This Work Plan, including a list of milestones, was submitted by the IHC to DCA in September 7, 2001 as required under the Schedule of Deliverables in the Subgrant.

FINAL REPORT

Under the terms of the Subgrant Agreement the IHC is required to submit this Final Report to DCA covering all research activities and findings during the period funded under this grant. This Final Report consists of two volumes. Volume One, which includes this Executive Summary, covers a summary of key activities and findings as well as other supporting information to help provide a comprehensive picture of the work conducted by the IHC and its research team and its relevancy relative to the objectives of the State of Florida. Volume Two includes detailed reports on the research activities conducted during the year under each of the three required research topics.

SUPPORTING INFORMATION

Volume two of this Final Report includes detailed information of research activities conducted under each of the three research topics required by statute. This Final Report is further supported by mostly pictorial information that resides in the IHC web page (www.fiu.edu/ihc) and also in the FIU web page (<http://hpdr.ccs.fiu.edu/terrafly/IHC>).

INITIAL CONCLUSIONS

Before addressing the specific activities undertaken under each of the three research topics and relevant findings it is important to convey the following important conclusions reached by the IHC Research Team on the basis of work conducted this 2001/2002 period. These conclusions are:

- (1) The three research topics tackled this year truly benefited from work conducted during the 2000/2001 period.
- (2) There exists a strong relationship between the three research topics required this 2001/2002 period. In fact the issue of hurricane loss reduction is a common thread that runs across these three research topics.
- (3) The removal of barriers to the upgrading of existing mobile homes and communities, research topic 1, goes to the issue that a form of upgrading may be the replacement (*recycling*) of mobile homes with units that meet the post-1994 HUD standards. This creates a direct link between topics 1 and 2 while both also address the issue of hurricane loss mitigation.

- (4) Topic 3, which focuses on loss reduction methods and techniques, may provide knowledge about upgrading site-built housing that could also be applicable to manufactured housing. Also work under Topic 3 could also lead to state or local barriers that may stand in the way of implementing some of the proposed loss mitigation methods and techniques. As a result it can be concluded that Topic 3 is also linked with Topics 1 and 2.

ELIMINATING STATE AND LOCAL BARRIERS TO UPGRADING EXISTING MOBILE HOME AND COMMUNITIES

Area of Study:

Using work Pinellas, Hillsborough, Miami-Dade and Broward counties during the 2000/2001 research period as a foundation the IHC Research Team continued to focus of the issue of barriers to the upgrading of existing mobile homes and communities.

Particular emphasis was placed on Polk County by recommendation of the Hurricane Loss Mitigation Program Advisory Council, due to the fact that the county is home to more than 500 mobile home parks with a total of 45,810 mobile home spaces. An additional 15,000 to 23,000 mobile homes may be installed in individual lots throughout the county (although there was at least one source of information that placed the total number of mobile homes in Polk County at 84,000 units). Based on these data it could be estimated that between 25% and 30% of the population of Polk County actually resides in mobile homes.

Methodology:

The effort of the IHC Research Team in Hillsborough, Pinellas and Polk counties involved analyses of zoning codes, comprehensive development plans, floodplain management plans, storm water management and other relevant land use regulation from the 18 municipalities and the unincorporated area of Polk County. The IHC Research Team also conducted interviews with manufactured home park residents, park managers, manufacturers and agent/brokers. Meetings were also

held with local building and planning offices as well as with mobile home park owners.

To gain additional knowledge relevant to the research effort the IHC Research Team visited three mobile home parks in each of the three counties – Hillsborough, Pinellas and Polk. These parks were chosen through a combination of random selection, accessibility and willingness of residents and managers to participate in this process. In addition, specific case studies were developed for three other parks located in Polk County.

Continuing with the data collection methodology used during the 2000/2001 period GIS based maps were developed this year. These maps compare mobile home locations, natural hazard zones, land use districts and other parameters that may be useful in determining patterns of vulnerability in the mobile home stock in these counties.

The effort of the IHC Research Team in Broward and Miami-Dade counties concentrated on the usage of municipal codes to allow or prevent the installation of mobile homes, and also on the dissemination of information to the general public by municipal and county agencies with respect to mobile home issues.

Objectives:

The main objectives of the IHC Research Team in pursuing this work under this specific required research topic were:

- (1) To determine if/how and to what extent the existing regulatory environment, including state, county and local regulations, may be contributing to limiting or even preventing the upgrading of existing mobile homes and communities;
- (2) To learn if mobile home parks within the counties mentioned are prone to being located in areas that are more vulnerable to natural hazards in higher proportion than site-built housing;
- (3) To assess if/how the dissemination of information by public agencies with respect to matters of mobile home installation or upgrading may be contributing to an environment that makes it difficult for residents to undertake such activities;

- (4) To identify potential solutions that may help alleviate some of the existing problems with the installation or upgrading of mobile homes.

Findings:

With respect to above objectives the IHC Research Team identified several issues of concern as well as areas where additional study is needed. These findings include the following:

- (1) A combination of personal visits, phone calls and faxed requests for information to numerous municipal building and zoning departments in Miami-Dade and Broward counties showed it is quite difficult for individual residents to obtain clear, brief and specific guidelines regarding the requirements for installation of mobile homes within the jurisdiction. During personal visits members of the IHC Research Team were often sent from one office to another and from one individual to another within given offices. Most offices visited did not have any printed information to give out. It appears some public officials are not informed or really sure about mobile home requirements. Examples of responses received by members of the IHC Research Team, listed below, illustrate this problem:
 - (a) Just check the South Florida Building Code;
 - (b) All you need for installing a mobile home is a licensed general contractor;
 - (c) The mobile home park manager has the necessary requirements;
 - (d) DCA is responsible for installation standards.
- (2) The most troubling aspect of this finding is not so much the difficulty faced by the general public in obtaining needed information, but that it is a reflection of large knowledge gaps that exist among public servants in the two counties studied with respect to matters involving manufactured housing. Such knowledge gaps act a real, although not insurmountable, barriers to the installation or upgrading of mobile homes within those jurisdictions. In addition such knowledge gaps also go to the issue of oversight over matters

involving mobile homes and a lack of clarity as to what statute or agency may be responsible for important life and safety issues.

- (3) Another important finding in Miami-Dade County was that 17 of 30 municipalities have local statutes that may prohibit the installation of mobile homes within their jurisdictions. There are an additional five municipalities in this county that only allow mobile homes to be installed within mobile home parks, but not on private lots.
- (4) In Broward County the initial finding is that only one municipality appears to preclude mobile home installation outright, but none allow these units in private lots except that 12 municipalities would allow such installation in existing mobile home parks or mobile home subdivisions.
- (5) An intuitive conclusion, not based on documented fact, that could be derived from this research effort or at least a perception that was shared by the individual researchers who participated in this specific effort, is that both these counties (Miami-Dade and Broward) present a somewhat adversarial behavior toward matters of mobile homes.
- (6) In contrast, the IHC Research Team can only intuitively conclude that Polk County is “mobile home friendly”. This is certainly reflected in the large number of mobile homes installed there and the large percentage of the total population in the county that resides in these units.
- (7) Despite such perceived mobile home friendly atmosphere in Polk County the IHC Research Team found areas of concern when it comes to duplication of information in zoning codes and building codes regarding installation requirements for mobile homes. In other cases the relevant information regarding tie downs, foundations or additions is in the zoning code, but not in the building code. It appears that in some cases requirements that really belong in building codes were added to zoning codes because of the simpler process that this represented in some municipalities. This specific finding led the IHC Research Team to the following conclusions:
 - (a) Given the fact that zoning officials in general lack the proper training or expertise to enforce what really amount to building code requirements, mobile homes in some municipalities may as a result be at higher risk of potential loss from hurricane impact;

- (b) There exists a lack of clarity with respect to which statute, building or zoning, really addresses important health and safety issues. As a result some mobile homes may be at higher risk of potential loss.
- (8) Visits by the IHC Research team to mobile home parks in Hillsborough, Pinellas and Polk County disclosed a significant number of site-built attachments to mobile homes in those parks. While zoning codes have authority over the location of residential structures it appears the statutes are either unclear or not enforced with regards to mobile homes within parks. Such site-built additions must be considered as added contributors to potential damage in the event of a hazard impact (i.e. a hurricane).
- (9) No Polk County zoning codes address the issue of mobile home maintenance although the County itself requires inspection for those units that are moved from one location to another. Site visits by the IHC Research Team in Hillsborough, Pinellas and Polk County and articles in local media show there are important numbers of poorly maintained mobile homes, which goes to the issue of potential for hurricane loss.
- (10) A significant finding in Polk County has to do with the fact that several mobile home parks are now located within incompatible land use districts as a result of zoning changes that post-date the original construction of the park. This places these parks in a situation of non-conformity with allowable land use. As a result said parks are faced with statutes prohibiting the redesign, expansion in area or the accommodation of additional units. Often such non-conforming parks can not even replace existing mobile homes. This constitutes an actual regulatory barrier to the upgrading of existing mobile homes and mobile home communities.
- (11) The IHC Research Team has identified re-platting of existing mobile home parks as a solution for the upgrading of units installed there. Re-platting would actually allow for upgrading existing mobile home while also solving such issues as vehicle circulation right of way, setback rules, size of lots etc. Unfortunately the combination of various regulatory requirements, including that discussed in the prior numeral (#10) make re-platting virtually impossible under current regulations.

More research is obviously needed to determine how prevalent such regulatory barriers are especially in those counties in regions 4, 5 and 7 where more than 75% of the mobile home stock in Florida is located.

RESEARCH AND DEVELOP A PROGRAM FOR THE RECYCLING OF EXISTING OLDER MOBILE HOMES

Important progress was made during the year regarding the issue of replacing existing mobile homes through a yet to be developed program for the recycling of existing “older” mobile homes.

Three key findings during the period were:

- (1) The main objective of the intended program should be characterized as the “replacement” of existing manufactured houses rather than the “recycling” of such housing units. As will be illustrated below there is minimal recycling value to be obtained from the demolition and disposal of exiting older mobile homes.
- (2) There are five key issues that would be critical for any replacement program, which must be fully addressed before any type of a program can be implemented. Each of these five issues provides a distinct perspective for the analysis of parameters and criteria to assess the feasibility of any eventual replacement program. These five key issues are:
 - (a) Technical
 - (b) Regulatory
 - (c) Financial
 - (d) Social
 - (e) Programmatic
- (3) There are two distinct sectors of manufactured houses that could derive benefits from the proposed replacement program. The two sectors are:
 - (a) Existing “older” mobile homes meaning those manufactured before 1994 when the now current HUD standards for manufacturing were implemented, but mainly those that pre-date 1976 in their year of

manufacture before any mandatory industry-wide manufacturing standards existed. This pre-1976 stock includes approximately 338,000 mobile homes. This so called “older” mobile home sector has been the focus of this initial effort.

- (b) The other sector, one that began to emerge in the research period covered by this report, includes manufactured homes that may be at risk of “being displaced” not because of age, but due to a combination of mostly regulatory factors. In reality this “new” sector is one that could emerge as a considerably large one to the degree we find and adopt ways of removing barriers to the upgrading of existing mobile homes and communities.

The Five Key Issues:

As stated above, the IHC Research Team had identified five key issues that are critical to the development and implementation of an eventual “Mobile Home Replacement Program”.

Following is a discussion summarizing the relevant aspects of each of these five key issues:

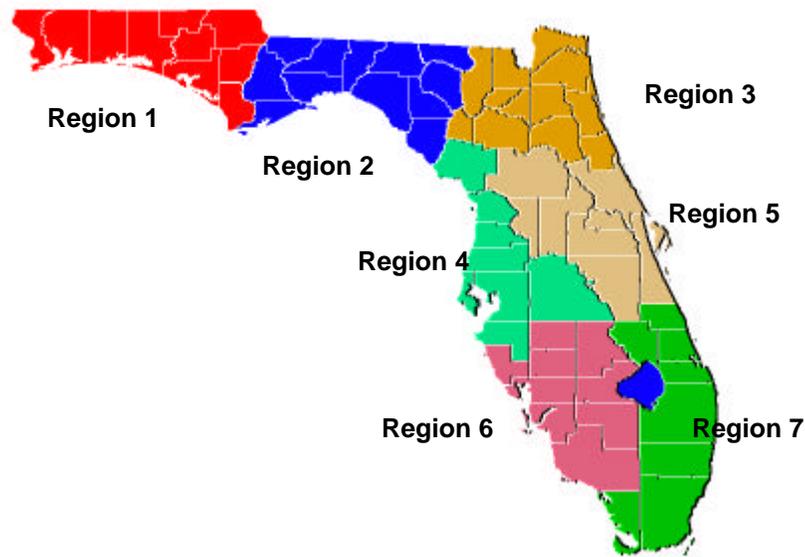
(1) TECHNICAL ISSUE

*At the core of this issue is the question *Is a Mobile Home Replacement Program Technically Feasible?* Or said in a different manner *Do we have the Technical Ability and Capability to Develop and Implement a Mobile Home Replacement Program in Florida?**

One way to answer this critical question is to identify the technical components of the program in order to determine not only if such know-how exist in Florida, but if it exists with enough capacity to tackle the volume of replacement that said program could generate.

Another important factor to consider is the availability of technical know-how and capability with respect to the distribution of the mobile home stock that would be the main target for replacement.

To assess the issue of adequacy of availability of technical know-how versus that of distribution of mobile home stock the IHC Research Team has chosen to use the seven regions identified by the State Division of Emergency Management illustrated by the map below:



AREA/REGION	REGION NAME	COUNTIES IN REGION
1	West	Escambia, Santa Rosa, Okaloosa, Walton, Holmes, Washington, Bay, Jackson, Calhoun, Gulf
2	Big Bend	Gadsden, Liberty, Franklin, Leon, Wakulla, Jefferson, Madison, Taylor, Hamilton, Suwannee, Lafayette, Dixie
3	Northeast	Columbia, Gilchrist, Baker, Union, Bradford, Alachua, Nassau, Duval, Clay, Putnam, St. John, Flagler
4	West Center	Levy, Citrus, Hernando, Pasco, Pinellas, Hillsborough, Manatee, Polk
5	Central	Marion, Sumter, Lake, Volusia, Seminole, Orange, Osceola, Brevard
6	Southwest	Sarasota, Hardee, DeSoto, Charlotte, Lee, Highlands, Glades, Hendry, Collier
7	Southeast	Okeechobee, Indian River, St. Lucie, Martin, Palm Beach, Broward, Monroe, Miami-Dade

The largest stock of mobile homes, 37.9% of the total or nearly 432,000 units, in the state is located in Region 4 known as West-Center as identified in the map above. Followed by Region 5 with 223,521 units or 19.6% of the total and region 7 – South-East with 208,903 units of 18.3% of the state’s total.

Required technical components fall within three categories:

- (a) Demolition or disassembly of the mobile home;
- (b) Transportation of the mobile home to a demolition/disassembly site;
- (c) Final disposal and/or salvage of demolished/disassembled unit.

1.1 Technical Requirements for Demolition/Disassembly of Units:

With respect to demolition of existing units the IHC Research Team has concluded, on the basis of interviews throughout the state, that save two exceptions the preferred mode of demolition is away from the mobile home park. Such mode of demolition is defined as “offsite” demolition.

The two exceptions when “onsite” demolition would be preferable are:

- (I) In the event a mobile home park has been abandoned or closed down, and
- (II) In the event of a major disaster i.e.: a hurricane that has severely damaged or destroyed a large number of the units in the park.

The main technical resource needed for this phase of the replacement process is a supply of demolition contractors. This means demolition and wrecking or salvaging licensed contractors who may be currently involved or could potentially become involved in the demolition of mobile homes.

The IHC Research team has identified 345 such contractors in Florida of which 106 or 30.7% are based in Region 7, a total of 67 or 19.4% are based in Region 5 and 57 or 16.5% are based on Region 4, the one with the largest stock of mobile homes. These data show that 66.7% of currently available demolition contractors are based on regions that account for 75.8% of the total mobile home stock in Florida. On the basis of these findings the IHC Research team concluded that the availability and capability of this specific technical factor is adequate both with respect to the location and the quantity of contractors.

It is important to note that several contractors, who were interviewed with respect to their availability and capability to demolish mobile homes, expressed a willingness to mobilize their resources on the basis of demand. This is an important point in view of the relatively modest supply of demolition contractors in Region 4 when compared to the large stock of mobile homes present there.

1.2 Technical Requirements for Transporting Units to Staging Sites:

With offsite demolition identified as the preferred method this phase of the process requires a supply of duly licensed transportation contractors that have equipment with towing capacities above 20,000 pounds, plus the necessary expertise to transport wide loads. These contractors would be used to transport to-be-demolished units to staging sites operated by demolition contractors.

With assistance from the Florida Manufactured Housing Association (FMHA) the IHC Research Team has identified 244 transportation contractors that meet these criteria. In fact all of these are contractors who specialize in the transportation of mobile homes.

It would appear the availability of transportation contractors could be one limiting factor in the implementation of a replacement program, especially one that goes beyond the stock of pre-1976 mobile homes.

Another factor to consider is the inadequacy of the supply of transportation capability with respect to the distribution of the stock of mobile homes. More than 53% of the total availability is based in regions 1 and 3, the extreme northwestern and northeastern corners of the state. While this probably reflects such factors as the location of manufacturing facilities and the ultimate destination of the manufactured houses, it also represents an inadequacy with respect to those regions where the largest numbers of to-be-demolished units are located. For example Region 4 only accounts for 11.9% of available transportation contractors, but it represents 37.9% of the total mobile home stock. This discrepancy of potential supply versus demand is further illustrated by the fact that 31.9% of the transportation contractors are based in regions 4, 5 and 7 while these same regions represent 75.8% of the potential demand.

With respect to this requirement the IHC Research Team has concluded that further study is needed to assess how market forces, driven by an active replacement program, might provide incentives that will increase the availability of transportation contractors while also improving their distribution to better reflect the potential demand for services. Additional research could also focus on the location of sites for ultimate disposal or salvage of units, and on how this plays into the location of stock-availability of transport equation.

1.3 Technical Requirements for Disposal/Salvage of Units:

The last technical factor to be considered results from the question *What happens once the mobile home has been transported to a demolition contractor's site and has been demolished/disassembled?*

The simplest answer to this question is that once the mobile home has been demolished or disassembled it needs to be disposed of in a managed and environmentally sound manner. In other words, throw away the remains as permitted by current regulations.

In reality the true answer to the question is somewhat more complex and it would involve policy-making with respect to any eventual replacement program.

Absent such policy the IHC Research Team has initially concluded that the most effective replacement program would involve a two-step process in the final disposal/salvage of the units. These two steps are:

- (I) Separation of recyclable/salvageable materials from the units;
- (II) Ultimate disposal of non-usable debris.

The separation of recycling and salvaging materials can be done at the demolition site itself or at special material recovery and recycling facilities. These facilities are licensed under regulations of the state through the Department of Environmental Protection and include three basic types of operation: (i) Construction and Demolition Debris facilities, (ii) Scrap Metal facilities, and (iii) White Goods Facilities. A combined total of 537 such facilities currently exist in Florida. It would appear existing recycling and salvaging capacity may be adequate for the

potential demand that would be generated by the replacement program that is the subject of this study.

The ultimate disposal of non-reusable debris would fall under existing allowable waste management operations in the state. As such this last phase would involve two types of existing and duly regulated facilities:

- (a) Landfills, of which there are three classes per the Florida Administrative Code, and
- (b) Construction and Demolition Debris Disposal facilities. There is a total of 96 landfills and a combined 158 C&D debris disposal and land-clearing debris facilities in Florida.

Preliminary analysis completed by the IHC Research Team appears to show that the impact of a mobile home replacement program targeting the pre-1976 units would have minimal impact on the current landfill operations statewide.

(2) REGULATORY ISSUE:

The IHC Research team has identified two types of regulatory issues that most be taken into account in the implementation of any mobile home replacement program. These are:

- (a) Various permits licenses required for the demolition, transportation and ultimate disposal of mobile home units. These include licenses required for the operation of landfills and disposal sites. The IHC Research Team has concluded that such required permits and licenses are clearly identified by state and local statutes, and appear, in general, to present no obstacle to the development and implementation of the replacement program subject of this study.
- (b) A second type of regulatory issue identified by the IHC Research Team may be cause for higher concern. This results from the presence of hazardous materials, such as asbestos or lead based paint, in the units to be demolished. This would trigger a required pre-demolition process of environmental assessment and abatement, which would add factors of time and cost to the overall process.

At this point the IHC Research Team has not determined the extent of the impact this last issue would have on an eventual mobile home replacement program. More research would be needed to determine the degree to which said additional regulatory requirements would be needed.

(3) FINANCIAL ISSUE:

How much would it cost?

Technical factors are the main contributors to the direct cost of an eventual replacement program.

The IHC Research Team has identified numerous cost components that would help estimate a unit-cost for the replacement of mobile homes based on transportation, actual demolition and disposal, including all pertinent permits and licenses. Such cost components range from permits for the disconnection of utilities (plumbing and electricity) and the actual demolition, to inspection services (for asbestos and lead-based paint), to cost of insurance, equipment, labor and waste management. The average dollar amount for each cost component was derived from interviews of several contractors and from other sources of data.

Based on such average costs and assuming some economies of scale due to the absolute number of units to be replaced over time the following replacement cost components may be used to estimate the total financial impact of a replacement program:

(a) Average cost of offsite demolition per unit:	\$1,200
(b) Average cost of transportation to staging site per unit:	\$ 800
(c) Average cost of hazardous materials inspections per unit:	\$ 900
(d) Average cost of hazmat abatement/disposal per unit:	\$3,000

TOTAL REPLACEMENT COST PER UNIT: \$5,900

A separate finding of the IHC Research Team indicates there may be up to \$450 of recycling revenue per single-wide unit at current market prices. However the IHC Research Team also found that any recycling revenue does

not to offset the cost of demolition/disposal, but rather it is considered as an additional source of revenue for the demolition contractor.

On the basis of these findings and without accounting for the time-value of money for a program that may last ten years, the IHC Research Team estimates that a mobile home replacement program focusing exclusively on the pre-1976 stock of 338,000 units would have a total cost of roughly \$2.0 billion.

Further research is needed to determine how and if programmatic factors as well as market forces would have an impact on the ultimate cost structure per replaced unit. This additional research should also look into other financial issues including the economic impact of such a program on the involved industries, the added tax revenue that may be generated, and also the benefit-cost analysis of such a program based on its effectiveness in reducing potential hurricane losses from future impacts.

(4) SOCIAL ISSUE:

A significant key finding of the IHC Research Team during this year's work is that the potential social impact of a replacement program would be enormous. In fact, the social issues may pose the most important barriers for the implementation of such a program.

A good part of the social issues result from the demographics of the mobile home residents as well as from their economic status. Three issues in particular may be the most difficult to overcome in implementing a replacement program for pre-1976 units:

- (a) More than 93% of those owning pre-1976 units located in mobile home parks DO NOT have a mortgage; they own the unit outright (free and clear);
- (b) The mean age of this group is 69 years and, as is typical with this age group in general, they are not interested in moving;
- (c) In general there is no clear perception among members of this group that they are at higher risk from potential hurricane impacts, thus they

do not see the benefit of moving into a unit built to higher standards of wind resistance and installation.

To explore the roots of this social issue the IHC Research Team designed hypothetical replacement programs based on a variety of incentives to make them attractive to residents of pre-1976 units. To measure the degree of interest among this group the IHC Research team conducted focus groups. The results of these focus groups only reinforced what was inferred from initial surveys that focused on demographics and socio-economic issues.

Although 72.1% of those surveyed cited mobile homes as their preferred type of housing a total of 74.4% of those indicated they are not interested in a program that would offer them a \$5,000 rebate toward a new mobile home built to post-1994 standards.

A total of 95.3% indicate no interest at all in a program that would offer the same \$5,000 incentive to move into a site-built house.

While it is possible that the descriptions of these hypothetical programs left many details out thus triggering the overwhelming negative response, the response to a third hypothetical option really indicates there is a lot more than simple economics involved here. The third option was represented as a program where the pre-1976 resident would incur no cost whatsoever in moving to a new post-1994 unit. A total of 79.1% indicated they would have no interest in such a program.

From these results it already appears that the social aspects of any replacement program might constitute the most difficult barriers to overcome, even when it is shown that such a program might be feasible from a technical and financial standpoint while also making an important contribution to the larger issue of hurricane loss reduction.

(5) PROGRAMMATIC ISSUE:

Findings with respect to the four issues discussed above already provide important criteria for proposing alternatives for the design of a replacement program. However more research would be needed if the ultimate objective of

this specific work is to provide a menu of policy alternatives that could be offered to legislators considering a decision with respect to such a program.

Before any such policy alternatives are arrived at more work is needed to design program alternatives that take into consideration the full extent of these five issues. Toward this objective findings from this year's work will make an important contribution.

PROGRAMS OF RESEARCH AND DEVELOPMENT RELATING TO HURRICANE LOSS REDUCTION DEVICES AND TECHNIQUES FOR SITE-BUILT RESIDENCES

The IHC Research Team used a dual approach to research work under this required topic during 2001/2002. On one side work was done focusing on technical aspects involving structural design criteria and standards, materials and methods of construction, and performance under simulated hurricane conditions. This technical work was complemented by qualitative analytical work focusing on the development of "best practices" for the planning, siting, design and maintenance of single-family residential communities in hurricane vulnerable areas.

Structural Testing and Performance

Research under this topic involved the development of new and unique testing facilities that were used to conduct a series of test as described below. Important findings resulted from this research that contributed to insight into design procedures, but which also raised several new issues.

Research Objectives:

Specific objectives of this work included:

1. Review and evaluation of test methods for assessing the performance of asphalt shingle roof-covering systems.
2. Assessment of uplift resistance of roof sheathing attachments and the design procedures used to establish fastener schedules.
3. Assessment of capacities and development of guidelines for design of high wind connections in light-frame wood structures subjected to combined loads.

Why These Objectives?

Above objectives were driven by knowledge that five of the most common failures experienced by housing under hurricane impacts include the following:

1. Damage to and loss of roof coverings.
2. Loss of roof sheathing, including failure of sheathing at gable roof overhangs.
3. Breaching of components of the building envelope, such as windows and doors.
4. Water penetration of the building envelope.
5. Collapse and/or loss of entire roofs, including coverings, sheathing, and roof structure.

Tests Conducted:

Three types of tests were conducted during the research period, they were:

1. Roof Shingle Testing and Performance Evaluation;
2. Roof Sheathing Attachment to Structural Members;
3. Anchorage of Roof Structure to Wall Structural System.

1. ROOF SHINGLE TESTING AND PERFORMANCE EVALUATION

A key objective of this test was to replicate the PA 107 test protocol, one of two required by the *2001 Florida Building Code* for roof shingle products. This specific test protocol requires specimens to be subjected to a uniform flow of 110 mph wind for a period of two hours to determine their resistance to wind induced blow-up or blow-off.

The IHC Research Team attempted to replicate the PA 107 test protocol with the addition of detailed pressure measurements. This research also evaluated

the usefulness of airboat to generate the required wind field to study the performance of shingle roofing along the gable roof edge.

The test specimen consisted of a full-scale gable roof mockup measuring 12 feet by 22 feet with a roof pitch of 2.5 inches in 12 inches. Supporting trusses spanned the 22-foot direction. The wall height for the mockup was determined by the total height of the airboat propellers.

The construction on one side of this test specimen complied with the requirements of the 2001 *Florida Building Code* for shingle roof installation in the High velocity Hurricane Zone areas. Shingles on the opposite side of the gable roof were installed without an asphalt 8-inch wide adhesive layer to replicate installations that are more typical in most other areas of the State of Florida. Pressure sensors (taps) were installed at strategic locations along the edge of the roof.

These initial tests produced mixed results. While peak negative pressures consistent with code design values for the produced wind speeds, of 110 to 120 mph at a height of 9 to 12 inches above the roof surface, such pressure peaks were very localized and had little correlation over distances as small as 4 inches. It would appear the test configuration itself might require adjustments for future tests.

An early conclusion from these findings is that the airboat arrangement as used for these tests did not produce pressure distributions that are consistent with those produced by a natural wind event. This conclusion was supported by visualization of the artificial wind-flow, using smoke, and comparing it to that produced by natural winds at the site.

More tests will be needed, but the IHC Research Team believes this work may be useful in creating a relationship between performance in these tests and the subsequent expected performance in actual field applications under natural conditions.

2. ROOF SHEATHING ATTACHMENT TO STRUCTURAL MEMBERS

This research tested 5/8-inch thick plywood roofing panels for uplift capacity under simulated hurricane winds. Nailing schedules used were consistent with *Florida Building Code* requirements. Two sets of actual tests were conducted. One set compared variations in uplift capacity resulting from different types of fasteners (nails) being used. Other tests measured the

reduction in uplift capacity resulting from missing fasteners along the edge of the roof panel.

Tests were conducted using a mobile apparatus constructed for this research project. A total of 120 roof panels were tested.

Among the important findings from these tests we have the following:

- (a) Head pull through, a problem usually caused by overdriven nails where the roofing panel pulls away from the nail under wind uplift leaving the nail attached to the supporting truss, was not a problem when 5/8-inch thick plywood is used for the sheathing. These tests validated the requirements of the *Florida Building Code* for a nominal 5/8-inch minimum thickness for roof sheathing.
- (b) Use of 8d ring shank nails nearly doubled the uplift capacity of the 5/8-inch roof sheathing as compared to the same roof panels when attached with 8d common bright or 8d galvanized nails. This is a significant finding that goes to the core issue of hurricane loss reduction devices and techniques for site-built housing. Data obtained from these tests are not only credible, but also practical. This will allow studies of benefit-cost to support eventual recommendations for cost-effective improvements in construction practices. These findings are summarized in the table below:

Table 1. Summary of Roof Panel Uplift Test Results

Panel Series #	Type of Nail	No. of Panels Tested	Mean Failure Pressure (psf)	Standard Deviation of Fail. Press. (psf)	# of Nail Pullout Tests	Mean Nail Pullout (lbs)	Standard Deviation of Nail Pullout (lbs)
1	8D Common Bright	7	127	23.8	125	175	47
2	8D Galvanized	7	116	24.8	118	225	95
3	10D Coated Galvanized	7	108	14.4	101	167	40
4	10D Sinkers 2 7/8"	6	125	20.6	96	178	81
5	10D Coated Galvanized	3	132	33.7			
6	8D Ring Shank	7	231	38.2	87	373	82
13	10D Coated Galvanized	3	108	13.6	57	120	50
23	10D Coated Galvanized	3	89	16.5	57	126	56

- (c) These tests were also instrumental in demonstrating the role missing fasteners play in reducing the uplift capacity of roofing panels. A single missing nail along the edge of the panel, which could also be a nail that missed the top chord on the supporting truss, resulted in no discernable reduction in uplift capacity. In contrast two missing nails along the edge of the panel reduced its uplift capacity by an average of 18%. This is an important finding as it goes to the issue of quality control in construction.

3. ANCHORAGE OF ROOF STRUCTURE TO WALL STRUCTURAL SYSTEM

Actual tests combined with extensive literature review on design procedures, guidelines and wind loading information related to combined wind loads on low-rise buildings, were conducted as part of this project.

The main issue behind these specific tests is the requirement that connections between roof structures (trusses, rafters) must transmit complex sets of loads from the roof structural system into the walls, which then transmit them to the foundations. To complicate the issue the load path from roof through wall to foundation may become quite eccentric as a result of the roof structural system considerably deforming under hurricane wind loads. This issue has resulted in questions concerning the definition of the loads to be applied to the design of these connections.

Research by the IHC Research Team involved:

- (a) Wind tunnel tests using scale models to investigate appropriate load combinations and possible load combination reductions for use in the design of these connections.
- (b) Assessment of performance of roof-to-wall connections under combined loads, using an especially constructed test apparatus that allowed loads to be applied individually or in combination to the roof and walls.

Key findings from this specific area include the following:

- (a) The wind tunnel tests indicated that for the most critical wind directions, the directions where the combined loads are that largest (wind directions within 15 degrees of perpendicular to the gable end), the reduction in loads for the combined loads is only 90 percent of the sum of the

maximum component and cladding loads for the appropriate tributary areas in each of the individual directions. The wind loads on the individual faces were generally consistent with the ASCE 7-98 component and cladding coefficients for the corresponding tributary area except for the windward wall where the positive pressures were about 20 percent higher than the ASCE 7-98 values.

- (b) The ultimate capacities found for single direction loading in any of the three loading directions were very close to the ultimate capacities published by the connector manufacturer. The walls and roof structures were built following the 2001 Florida Building Code requirements for wood frame walls and roofs constructed in High Velocity Hurricane Zones. The tests demonstrated that the ultimate capacity of the walls was frequently exceeded before the ultimate capacity of the connectors was exceeded. This was remedied by decreasing the spacing of 8d nails in the upper piece of wall sheathing to 3 inches. For these tests, the anchorage of the wall studs to the base also proved to be a critical connection, particularly for high shear loads. The design of these connections needs to be assessed using typical installations during the next year of the project.

Qualitative Research Work:

The IHC Research Team looked into a “best practices” approach as a way for architects, planners and others to contribute to hurricane loss mitigation for housing. The team found the following areas of concern for architects and other housing design professionals:

- (a) Planning and site design. Initial research indicates that a well-planned and designed community will greatly enhance the success of mitigation efforts, evacuation procedures, post-disaster relief and recovery effort. The document provides guidelines for selecting the most appropriate sites for residences in terms of hazard mitigation, land use compatibility and other issues.
- (b) Landscaping. While our initial studies indicate that several codes include landscape requirements in their zoning codes, the purposes of the requirements are not for wind mitigation, but for aesthetics. Initial studies indicate that thoughtful landscape plans can obstruct, filter deflect, and guide significant winds.
- (c) Building form. While codes address multiple prescriptive concerns about construction assemblies, these guidelines also include some principles

regarding overall building geometry, roof shape, and additions and attachments.

(d) Building technology. The guidelines summarize pertinent principles for construction materials and methods.

(e) Maintenance. State and local building codes are relatively silent on continuing maintenance standards. Poorly maintained houses are the most hazardous in hurricane events (internally and externally).

The IHC Research Team also identified several areas of concern that would require future study. These are listed in the body of the report for this research topic in Volume 2 of this Final Report.

CHAPTER 1 – THE BILL WILLIAMS ACT

The 2001 Florida Statutes

Title XIV
Taxation And Finance Chapter 215
Financial Matters: General Provisions View Entire Chapter

215.559 Hurricane Loss Mitigation Program.--

(1) There is created a Hurricane Loss Mitigation Program. The Legislature shall annually appropriate \$10 million of the moneys authorized for appropriation under s. 215.555(7)(c) from the Florida Hurricane Catastrophe Fund to the Department of Community Affairs for the purposes set forth in this section.

(2)(a) Seven million dollars in funds provided in subsection (1) shall be used for programs to improve the wind resistance of residences and mobile homes, including loans, subsidies, grants, demonstration projects, and direct assistance; cooperative programs with local governments and the Federal Government; and other efforts to prevent or reduce losses or reduce the cost of rebuilding after a disaster.

(b) Three million dollars in funds provided in subsection (1) shall be used to retrofit existing facilities used as public hurricane shelters. The department must prioritize the use of these funds for projects included in the September 1, 2000, version of the Shelter Retrofit Report prepared in accordance with s. 252.385(3), and each annual report thereafter. The department must give funding priority to projects in regional planning council regions that have shelter deficits and to projects that maximize use of state funds.

(3) Forty percent of the total appropriation in paragraph (2)(a) shall be used to inspect and improve tie-downs for mobile homes. Within 30 days after the effective date of that appropriation, the department shall contract with a public higher educational institution in this state which has previous experience in administering the programs set forth in this subsection to serve as the administrative entity and fiscal agent pursuant to s. 216.346 for the purpose of administering the programs set forth in this subsection in accordance with established policy and procedures. The

administrative entity working with the advisory council set up under subsection (5) shall develop a list of mobile home parks and counties that may be eligible to participate in the tie-down program.

(4) Of moneys provided to the Department of Community Affairs in paragraph (2)(a), 10 percent shall be allocated to a Type I Center within the State University System dedicated to hurricane research. The Type I Center shall develop a preliminary work plan approved by the advisory council set forth in subsection (5) to eliminate the state and local barriers to upgrading existing mobile homes and communities, research and develop a program for the recycling of existing older mobile homes, and support programs of research and development relating to hurricane loss reduction devices and techniques for site-built residences. The State University System also shall consult with the Department of Community Affairs and assist the department with the report required under subsection (7).

(5) Except for the program set forth in subsection (3), the Department of Community Affairs shall develop the programs set forth in this section in consultation with an advisory council consisting of a representative designated by the Department of Insurance, a representative designated by the Florida Home Builders Association, a representative designated by the Florida Insurance Council, a representative designated by the Federation of Manufactured Home Owners, a representative designated by the Florida Association of Counties, and a representative designated by the Florida Manufactured Housing Association.

(6) Moneys provided to the Department of Community Affairs under this section are intended to supplement other funding sources of the Department of Community Affairs and may not supplant other funding sources of the Department of Community Affairs.

(7) On January 1st of each year, the Department of Community Affairs shall provide a full report and accounting of activities under this section and an evaluation of such activities to the Speaker of the House of Representatives, the President of the Senate, and the Majority and Minority Leaders of the House of Representatives and the Senate.

(8) This section is repealed June 30, 2006.

History.--s. 2, ch. 99-305; s. 1, ch. 2000-140; s. 1, ch. 2001-227.

CHAPTER 2 – THE RESEARCH TEAM

In order to carry out the year 2001-2002 research agenda approved by DCA and the RCMP Advisory Council the IHC organized a team comprised of thirty-five individuals from three academic institutions.

The IHC research team included the following individuals”

Principal Investigator: Ricardo A. Alvarez IHC/FIU

Project Coordinator: Nicole Dash IHC/FIU

Researchers:

Marshall Allen	FIU	HCET
Amaury Caballero	FIU	Construction Management
M. Ali Ebadian	FIU	HECT
George Epolito	USF	Architecture
T. Trent Green	USF	Architecture
Martha Gutierrez	FIU	HPDRC
Jose Mitrani	FIU	Construction Management
Timothy Reinhold	CLEMSON	Civil Engineering
Naphtali Rishe	FIU	HPDRC
Stephen Schreiber	USF	Architecture
Gary Thye-Shue	FIU	HPDRC
Cindy Zhang-Torres	FIU	HCET

Research Assistants [includes both Graduate and Undergraduate students]:

Luis Arencibia	FIU	Construction Management
Deepangkar Bhattacharjee	USF	Architecture
Brian Dick	CLEMSON	Civil Engineering
Elpidio Dominguez	FIU	Construction Management
Michael Dailey	USF	Architecture
Kurt Dyer	FIU	Construction Management
Cos Gardner	CLEMSON	Civil Engineering
John Lamb	CLEMSON	Civil Engineering
Janaina Monteiro	FIU	Architecture
Kevin Nickorick	USF	Architecture
Mary Phillips	CLEMSON	Civil Engineering
Jorge Remedios	FIU	Construction Management
Scott Robinett	CLEMSON	Civil Engineering

Swapnali Salunkhe	USF	Architecture
Roger Williams	FIU	Environmental Engineering

Support Staff:

Anthony Ayala	FIU	Space Management
Kyle Campbell	USF	Florida Center Comm. Design
Maria Cano	FIU	IHC
Scott Caput	FIU	IHC
Regnier Jurado	FIU	IHC
Jennifer Sandford	USF	Architecture

CHAPTER 3 – THE WORK PLAN AND TIMELINES

Included below is the text of a document submitted by the IHC to DCA containing the work plan and timelines that was eventually approved by the Hurricane Loss Mitigation Advisory Council. This Work Plan guided all research work during the 2001/2002 year covered under this Final Report.

RE: PROPOSED WORK PLAN
DCA AGREEMENT # 02-RC-11-13-00-05-001

PROJECT: HURRICANE LOSS REDUCTION FOR RESIDENCES AND MOBILE HOMES IN FLORIDA

BACKGROUND

During its 1999 session the Florida State Legislature enacted a Hurricane Loss Mitigation Program (s. 215.559) also known as the “Bill Williams Residential Safety and Preparedness Act” (the Act). This program is to be funded by an annual appropriation from the Florida Hurricane Catastrophe Fund (s. 215.555) and it is to be managed by the department of Community Affairs (DCA)

The Act allocates ten percent of the annual allocation to the International Hurricane Center (IHC) at Florida International University (FIU) for the purpose of:

..supporting programs of research and development relating to hurricane loss reduction devices and techniques for residences and mobile homes and relating to the development of credible data on potential loss reduction.

During its 2000 session the Florida State Legislature in authorizing the annual allocation under the Act approved the research topics listed below to be included in the work to be conducted by the IHC/FIU during the fiscal year that ends June 30, 2002:

- (a) Eliminating state and local barriers to upgrading mobile homes and communities;
- (b) Research and develop a program for the recycling of existing older mobile homes;

- (c) Programs of research and development relating to hurricane loss reduction devices and techniques for site-built residences.

In addition to working on these specific research topics the IHC/FIU has also been tasked with assisting DCA in preparing a full report and accounting of activities under Section 215.559, Florida Statutes, and an evaluation of such activities. Such report is to be submitted to the Speaker of the House of Representatives, the President of the senate, and the Majority and Minority Leaders of the House of Representatives and the Senate by January 1, 2002.

GUIDING CRITERIA AND OBJECTIVES

Work to be conducted by the IHC/FIU will abide by the following guiding criteria:

- (a) The IHC/FIU will emphasize assessing the scope of the issue by identifying those factors, ranging from the physical and structural to the social and regulatory, that may contribute to or influence the incidence of hurricane damage to site-built residences and manufactured housing in Florida.
- (b) The IHC/FIU will build upon the findings and recommendations that resulted from work completed for this project during the fiscal year that ended June 30, 2001.
- (c) The IHC/FIU will continue to work on specific areas initiated during the first year of this project that are critical to enhancing our assessment of the scope of the issue as it related to the three specific research tracks approved by the State Legislature.

The main objectives of the work proposed by the IHC/FIU are:

1. To meet the requirements established by the Act related to the development of hurricane loss reduction devices and techniques and credible data on potential loss reduction;
2. To understand the issues, and the factors that may influence the same, that may act as barriers or incentives to hurricane loss mitigation;
3. To identify specific issues arising from work under this project that are relevant to the mission and objectives of DCA and other interested

parties, including homeowners and regulators having jurisdiction over housing-related matters;

4. To identify potential policy alternatives that may be considered by state policy-makers that address issues of hurricane loss reduction for the housing stock in Florida.

WORK ELEMENTS

The IHC/FIU proposes to complete the following specific elements of work:

1. Eliminating state and local barriers to upgrading existing mobile homes and communities:
2. Research and develop a program of recycling of existing older mobile homes:
3. Programs of research and development relating to hurricane loss reduction devices and techniques for site-built residences:
4. Project progress reports:
5. Assisting DCA in drafting annual report:

WORK PLAN

The work plan will include the following tasks and activities:

1. Eliminating state and local barriers to upgrading existing mobile homes and communities:
 - (a) The IHC research team will conduct research to identify issues in (i) land use regulations, (ii) community design guidelines, and (iii) building/zoning codes, that may be contributing to knowledge gaps or regulatory obstacles that act as barriers to the upgrading of existing mobile homes and mobile home communities. The main objective of this specific area of research is to make recommendations on ways by which the most serious of these barriers could be eliminated. It is

proposed that this work will focus on the west central and the panhandle region of Florida. Key areas of research include:

- Issues of platting to address the problem faced by newer or larger mobile homes that do not meet existing older plats.
- Building code and zoning issues where requirements under one code may not be supported by the other, or where enforcing officials may lack the expertise or training to uphold specific requirements
- Hurricane hazard zones and issues of wind damage.

(b) The IHC team will also research other types of barriers that may involve technical issues. The main goal here is to identify specific contributors to hurricane losses and alternatives to reduce such damage, but also to collect credible data relative to the effectiveness of such devices in reducing potential hurricane damage. This could be achieved through research that draws on the expertise and information of the manufactured housing industry coupled with actual testing on a cross section of first and second generation mobile homes.

2. Research and develop a program of recycling of existing older mobile homes:

The IHC proposes a research and development program that includes four phases, as follows:

Phase I

Research will be conducted to identify and assess the following issues:

- a. Technical details and costs relating to the logistics for removal, disassembly, transportation, recycling and dumping of manufactured housing units;
- b. Costs-benefits associated with the above technical issues;
- c. Regulatory issues pertinent to promoting the recycling of manufactured housing units;

- d. Support and incentives from the various sectors that may benefit from a recycling program. This will be a key step in developing a prototype program for Florida. Without support from key sectors, it will be impossible to implement a program;
- e. Sources of funding to implement an eventual program in Florida. This is a key step in the development of a program. Without support from the industry, the state and HUD any program will fail to address the needs of the poorest, most vulnerable households.

This phase will build on work completed during Year 1 of this project. Support from various sectors will be key to moving forward with the development of a recycling program that addresses both the technical and social dimensions of the issue. Without this support, a recycling program will not be able to address these social issues, and as a result, will leave the most vulnerable units and people still in harm's way.

Phase II

Based on the findings from Phase I of this research, a prototype recycling program will be designed to address both the technical and social dimensions of the issue. Once such a prototype is developed, various methodologies such as focus groups, telephone interviews and mail surveys will be employed to get feedback from stakeholders including but not limited to homeowners, industry representatives and government agencies. Based on this feedback, the program will be fine tuned and finalized.

Phase III

Once Phase II is completed and a final program developed, *pilot projects* will be used to test the sensitivity of the program, analyze the logistics involved, and develop accurate operating budget figures. These pilot projects may include acquiring pre-1976 manufactured housing units, and following them through the recycling process from removal, transportation, disassembly and recycling.

Phase IV

Based on the findings from Phases I, II, and III, a proposal will be developed as a base for policy consideration by state legislators. Such a proposal will include timelines and budgetary estimates for implementation of a state-wide recycling program that would phase-out most of the pre-1976 generation of mobile homes by a given date.

3. Programs of research and development relating to hurricane loss reduction devices and techniques for site-built residences:

The IHC team proposes a two-tier approach to this specific research topic. They are as follows:

- (a) The first is based on technical aspects involving materials and methods of construction and specific performance under hurricane conditions that may lead to given types of damage. This work will be based on the proposition that the development of devices for loss reduction and of credible data regarding their effectiveness in reducing potential damage can be best achieved through a program of actual physical field-testing supported by laboratory tests and theoretical qualitative work through computer simulation and modeling. Some specific areas to be subjected to such testing may include:
 - Roof coverings, such as asphalt or fiberglass shingles, regarding their resistance to uplift or their performance depending on specific locations such as along the edges of a gable roof. This work is expected to lead to recommendation on how to improve the performance of these materials under hurricane conditions.
 - Roof sheathing connections with regard to how and why such connections may fail under hurricane conditions. Work is proposed to test individual fasteners used in these connections and also full roof panels. It is expected that this work could lead to the development and design of appropriate retrofit methods to improve the effectiveness of these devices on site-built housing.

- Roof to wall connections with regard to how the structural assembly supporting a roof is required to work to transmit complex loads, experienced under hurricane conditions, through the walls to the foundation.

(b) The second tier of work will look into qualitative issues that may contribute to the relative vulnerability of individual site-built houses or whole communities. Some of these qualitative factors may include:

- Site selection with regard to the hazard mitigation “value” that may be effective in reducing potential damage.
- Landscaping and community design under the theory that well planned landscaping and community design may play a role in reducing the potential for damage, under hurricane impact, to individual site-built houses.
- Additions to existing houses done in-situ and post initial construction and the role these may play in exacerbating the relative vulnerability of this and neighboring houses under hurricane conditions.
- Architectural design including layout, materials and construction technology as well as location, in order to identify those designs that may improve the performance of the house and contribute to hurricane loss reduction. The IHC team is looking into the possibility of building some scale models of these effective design that could, where possible, be tested under wind tunnel conditions.

The ultimate goal of work conducted under this tier is to arrive at the development of a ‘best practice’ guidelines for planning, siting and the design of housing units and the residential communities in which they are located.

4. Project progress reports.

5. Assisting DCA in drafting annual report.

TIMELINES

Main timelines for this project are:

1. By September 7, 2001: submit detailed work plan and milestones chart to DCA.
2. By September 15, 2001: initiate research work related to “elimination of barriers to upgrading existing mobile homes and communities” in Polk, Pinellas and Hillsborough counties.
3. By September 21, 2001 complete organizational/contractual phase including:
(a) subcontracting with researchers/consultants outside FIU, (b) hiring/retaining graduate students, affiliated FIU faculty.
4. By October 1, 2001: define with DCA the methodology for gathering information from the different participants in the RCMP project for purposes of assisting DCA in preparing the annual report to the Legislature’s leadership. Obtain from DCA complete listing and contact information of all participants in the RCMP project whose activities will need to be reported on and included in the annual report.
5. By October 5, 2001 complete ordering/purchases of major equipment and materials required for project.
6. By October 15, 2001: submit quarterly progress report to DCA.
7. By November 15, 2001 complete assembly/set-up of testing apparatus.
8. By November 19, 2001: initiate testing on roof covering.
9. By November 30, 2001: submit draft of annual report to DCA.
10. By January 7, 2002: hold working meeting of research team.

11. By January 15, 2002: submit quarterly progress report to DCA.
12. By January 22, 2002: initiate testing on roof sheathing connections.
13. By February 1, 2002: initiate work on hurricane loss reduction devices and techniques for site-built housing based on the “best practices” approach to planning, siting, and design of residential communities, with a focus on Polk, Pinellas and Hillsborough counties.
14. By March 1, 2002: initiate testing on roof to wall connections.
15. By April 7, 2002: hold working meeting of research team.
16. By April 15, 2002: submit quarterly progress report to DCA.
17. By May 1, 2002: complete focus-group assessment of identified alternatives for a mobile home recycling program.
18. By June 1, 2001: complete draft of final report and distribute for review and discussion to all members of IHC/FIU research team.
19. By June 29, 2002: submit final report including key findings and recommendations to DCA.