NEIL B. HALL & ASSOCIATES, LLC

BUILDING PERFORMANCE · FAILURE ANALYSIS · DAMAGE ASSESSMENT

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BUILDING DAMAGE ASSESSMENT

ANTHONY RESIDENCE
506 RIVERVIEW ROAD
BAY ST. LOUIS, MISSISSIPPI 39520

DATE OF LOSS:

AUGUST 29, 2005
(HURRICANE KATRINA)

PREPARED BY:
NEIL B. HALL, Ph.D.
American Institute of Architects
American Society of Civil Engineers

REPORT NUMBER 90000

DATE OF INSPECTION:
JANUARY 15, 2009

DATE OF REPORT:
JANUARY 15, 2009

Exhibit "M"

INVESTIGATIVE METHODOLOGY

The purpose of this report is to determine the extent of damage caused by wind and flood to the Anthony residence at 506 Riverview Road, Bay St. Louis, Mississippi as a result of Hurricane Katrina. Opinions in this report are based on available evidence including analysis of weather conditions, physical data collected at the site location and the investigator's knowledge, training and experience. Mr. Michael Brandner, the grandson of Mr. and Mrs. Anthony, was interviewed on January 14, 2009. The property lot was visited on January 15, 2009. This report was reviewed for consistency of data and use of a systematic approach desirable and necessary in the analysis of building failure. Satellite images, photographs, maps and other data referenced but not included in this report remain on file in the project folder.

SYNOPSIS OF WEATHER CONDITIONS

Hurricane Katrina made its third landfall at the Louisiana/Mississippi border about 1100 CDT on August 29, 2005 with sustained wind at 125 mph in the eyewall. The central pressure at landfall was 920 mb, ranking 3rd lowest on record for U.S.-landfalling storms behind Camille (909 mb) and the Labor Day hurricane that struck the Florida Keys in 1935 (892 mb).

According to the ARA wind gust map developed for FEMA HAZUS, 3-second wind gusts reached about 128 mph in the Bay St. Louis area. The NOAA wind gust map shows wind gusts in Bay St. Louis at 120 mph (with a 15% margin of error).

According to the FEMA topographic map enclosed with Attachment A, the adjacent grade is about 4' above mean sea level. A 1998 Certificate of Elevation enclosed as Attachment B-1 places the lowest grade at 4.1' above 1929 NGVD and the first elevated floor level at 13.91 feet above mean sea level NGVD. According to the FEMA flood inundation map enclosed with Attachment A, a high water mark about 500 feet from the Anthony residence shows 20.4 feet above mean sea level 1988 NAVD. (The difference between the two datums along the Mississippi coast is negligible for the purpose of this analysis).

A report prepared by Dr. Pat Fitzpatrick specifically for the Anthony residence (Attachment C-1) was reviewed. The report assumes that the adjacent grade level was 13.2 feet above mean sea level and storm surge peaked at 22.5 feet above mean sea level. The Fitzpatrick report assumes wave action less than 1.5 feet superimposed on the surge. Although the actual FEMA high water mark is 2.1 feet lower than the surge height in the ADCIRC model used by Fitzpatrick, the Fitzpatrick assumption of 13.2' floor elevation is generally used in this report. However, where the difference is crucial in the analysis, the differentiation is made clear.

DESCRIPTION OF BUILDING STRUCTURE

The house was constructed in the 1970s with 6' piles and tie-beams attached at grade level between the base of the piles. The front gable-end of the house faced SE towards Riverview Road. After the house was constructed, the exterior cladding (the photos show rigid mineral shingles, possibly with asbestos containing material) was covered with blueboard insulation and vinyl or aluminum siding. (The siding on the remaining timber piles is aluminum siding; this report assumes that aluminum siding was used on the elevated portion of the house, as well).

Exterior walls were constructed under the elevated portion of the house so that the vinyl siding was uniformly applied from the eave to the ground level. The photos appear to show that standing seam metal was applied over an earlier application of three-tab shingles. About 2002, an addition was made to the rear of the house at which time the siding and metal roof were extended towards the waterfront. The addition was a screened-in patio. It is assumed that the three lamp posts were added at this time.

DESCRIPTION OF BUILDING DAMAGE

The site inspection photos (Photos 1-14) were taken after the house was demolished. The value of the site specific information is questionable because of the demolition affect. Of interest, most of the plank boards on the dock (Photos 6-7) survived and were not pulled up by wave action. Trees in the area (Photos 11-14) show the affect of wind gusts that crossed during Katrina.

The post-Katrina damage photos in Attachment B show the metal roof removed; the battens over the shingled roof covering remained. At some locations shingles are missing exposing the building paper; at other locations the roof sheathing is missing.

The siding is removed from most locations; the battens over the original cladding remained. Under the house, the ceiling under the elevated structure and the overhead fans remain intact. This indicates that storm surge rose without any significant wave activity, collapsing the break-away walls and covering the ceiling and overhead fans before wind could attack these components.

The roof over the screen-in patio was removed by wind, exposing the original structure to wind and wind-driven rain. The metal roof over the original structure and portions of the roof deck also were removed by wind allowing wind and wind-driven rain to penetrate the structure.

Based on the Fitzpatrick timeline, 135 mph wind gusts crossed the property lot when only 2.8' of water was above the finished floor. 125 mph wind gusts crossed the property lot before any amount of water reached the finished floor. Referencing the EF Scale (see below), it can be expected that a significant amount of the metal roof covering and sections of the roof deck would have been lost as early as 0630 CDT when wind reached 105 mph, 3 hours before any storm surge reached the elevated portion of the building.

The loss of the roof covering over the addition would have occurred by 0830 CDT, 1 hour before storm surge reached the elevated portion of the building. The amount of damage caused by wind and wind-driven rain penetrating through these openings – even if no further openings were created by wind – would have rendered the elevated portion of the building and its contents a total economic loss before the arrival of storm surge.

EF SCALE (REV 2)
ONE AND TWO STORY RESIDENTIAL STRUCTURES

DOD*	Damage description	Exp**	LB	UB
1	Threshold of visible damage	65	53	80
2	Loss of roof covering material (<20%), gutters and/or awning; loss of vinyl or metal siding	79	63	97
3	Broken glass in doors and windows	96	79	114
4	Uplift of roof deck and loss of significant roof covering material (>20%); collapse of chimney; garage doors collapse inward or outward; failure of porch or carport	97	81	116
5	Entire house shifts off foundation	121	103	141
6	Large sections of roof structure removed; most walls remain standing	122	104	142
7	Exterior walls collapsed	132	113	153
8	Most walls collapsed in bottom floor, except small interior rooms	152	127	178
9	All walls collapsed	170	142	198
10	Destruction of engineered and/or well constructed residence: slab swept clean	200	165	220

* DOD is degree of damage **Wind Speed values are in mph

Surge eventually rose to a height of 9.3 feet above the finished floor of the elevated portion of the building, and it is recognized that absent any affect of wind, flood would have caused substantial damage to the building. Flood more likely than wind collapsed the break-away walls at ground level and damaged the interior at ground level. However, flood would not have removed the roof over the rear addition.

CONCLUSION

Wind damaged the elevated portion of the building (removal of siding, metal roofing, roof deck, damage to the three-tab shingles under the metal roof, removal of the gable end roof over the screen-in addition, water-damage to the interior above the elevated floor level). Wind also removed the siding at the lower level before the rise of storm surge. The building was rendered a total economic loss due to wind load prior to the rise of storm surge to the level of the elevated structure.

Flood damaged the lower portion of the building under the elevated floor level (collapse of break-away walls and water-damage to the lower floor level in advanced of damage caused by wind).

ATTACHMENTS

1) Attachment A provides maps and aerial photographs.
2) Attachment B provides photographs and the Certificate of Elevation
3) Attachment C provides wind and flood data including the Fitzpatrick report.
4) Attachment D provides biographical sketches as recommended by the ASCE Technical Council for Forensic Engineering.

END OF REPORT 90000

Respectfully submitted,

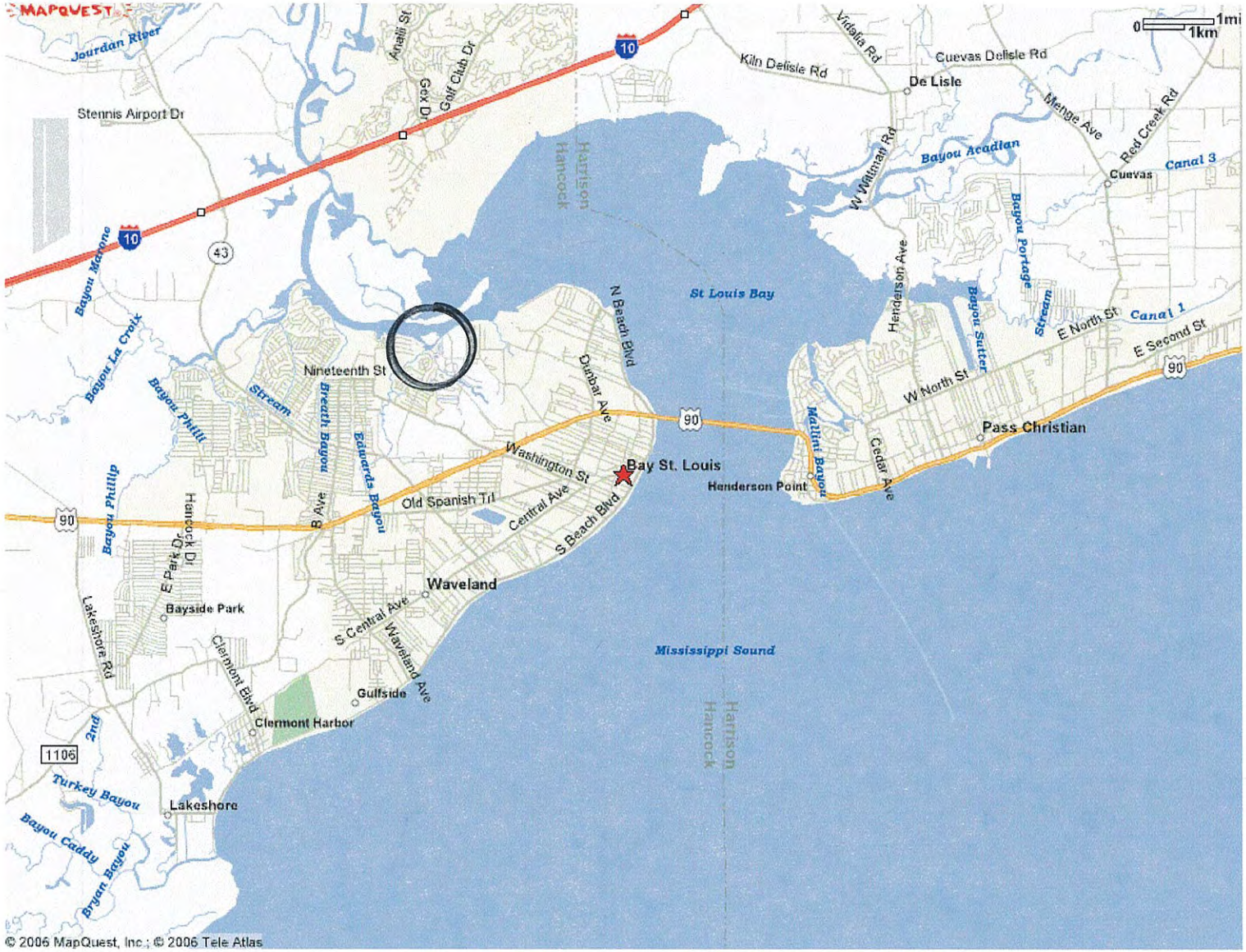
Reviewed by:
Jim H. Moore, P.E.
Mississippi License No. 10709

Neil B. Hall, Ph.D.
American Institute of Architects
American Society of Civil Engineers

ATTACHMENT A

MAPS AND AERIAL PHOTOGRAPHS

NOTE: LOCATION ON MAP MAY BE APPROXIMATE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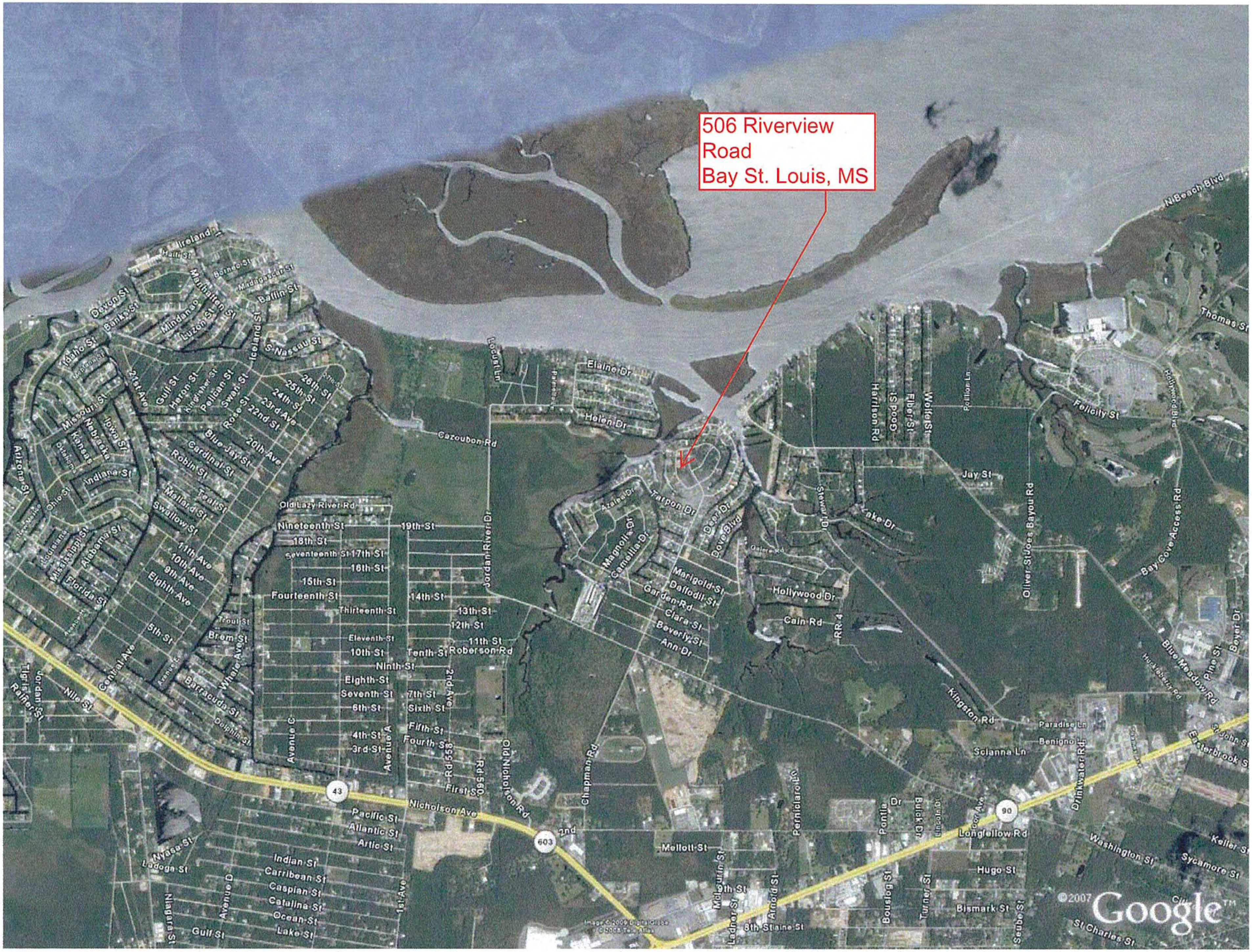
Jourdan River
Stennis Airport Dr
Anatil St
Golf Club Dr
Oak D
10
Kiln Delisle Rd
Vidalia Rd
Cuevas Delisle Rd
De Lisle
Menge Ave
Red Creek Rd
Cuevas
Canal 3
Bayou Acadian
W Wittman Rd
Harrison
Hancock
Bayou Marcine
43
Bayou La Croix
Bayou Phillip
Stream
Nineteenth St
Breach Bayou
Edwards Bayou
St Louis Bay
N Beach Blvd
Dunbar Ave
Henderson Ave
Bayou Portage
Stream
Bayou Sutter
E North St
Canal 1
E Second St
90
W North St
Pass Christian
Washington St
Bay St. Louis
Henderson Point
Malitni Bayou
Cedar Ave
Old Spanish Trl
B Ave
Central Ave
S Beach Blvd
Hancock Dr
E Park Dr
Bayside Park
Waveland
S Central Ave
Waveland Ave
Lakeshore Rd
Clermont Blvd
Gulfside
Clermont Harbor
Mississippi Sound
2nd
1106
Turkey Bayou
Lakeshore
Bayou Caddy
Bryan Bayou
0
1mi
1km
© 2006 MapQuest, Inc.; © 2006 Tele Atlas


506 Riverview
Road
Bay St. Louis, MS
N Beach Blvd
Thomas St
Felicity St
Hollywood Blvd
Elaine Dr
Helen Dr
Cazoubon Rd
Jordan River Dr
Old Lazy River Rd
Nineteenth St
19th St
18th St
Seventeenth St
17th St
16th St
15th St
Fourteenth St
14th St
Thirteenth St
13th St
12th St
Eleventh St
11th St
10th St
Tenth St
Roberson Rd
Ninth St
Eighth St
Seventh St
7th St
6th St
Sixth St
Fifth St
4th St
Fourth St
3rd St
First St
Avenue C
Avenue A
2nd Ave
Rd 558
Rd 560
Old Nicholson Rd
Tarpon Dr
Magnolia Dr
Camellia Dr
Marigold St
Daffodil St
Garden Rd
Clara St
Beverly St
Ann Dr
Hollywood Dr
Cain Rd
Lake Dr
Jay St
Harrison Rd
Good St
Fiber St
Wolfe St
Oliver St
Joes Bayou Rd
Bay Cove Access Rd
Blue Meadow Rd
Kingston Rd
Paradise Ln
Benigno
Scianna Ln
Chapman Rd
Nicholson Ave
43
603
90
Longfellow Rd
Washington St
Keller St
Sycamore St
Hugo St
Bismark St
St Charles St
Mellott St
Pacific St
Atlantic St
Artic St
Indian St
Carribean St
Caspian St
Catalina St
Ocean St
Lake St
Gulf St
Nyasa St
Ladoga St
Niagara St
Avenue D
1st Ave
Nile St
Jordan St
Tigris St
Rainer St
Central Ave
Barracuda St
Whale Ave
Brem St
5th St
Eighth Ave
9th Ave
10th Ave
11th Ave
Florida St
Alabama St
Mississippi St
Ohio St
Indiana St
Kansas St
Nebraska St
Missouri St
Iowa St
Idaho St
Arizona St
Swallow St
Mallard St
Robin St
Cardinal St
Blue Jay St
20th Ave
21st Ave
22nd St
23rd Ave
24th St
25th St
26th St
Gulf St
Heron St
Pelican St
Swan St
Rose St
Iceland St
S Nassau St
Luzon St
Mindanao St
Manhattan St
Ireland St
Baffin St
Devon St
Banks St
©2007 Google


506 Riverview
Road
Bay St. Louis, MS
Edith Dr
Helen Dr
Riverview Rd
Chapman Rd
Azalea Dr
Tarpon Dr
Larkspur Ln
Skyline Dr
Deer Dr
©2007 Google™

PROVISIONAL TOPOGRAPHIC ELEVATION CONTOUR MAP

FEMA

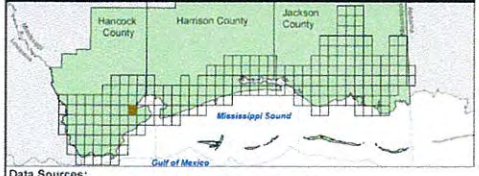
Hancock County, MS

Date of Map: December 15, 2005

Map Number: MS-G9

NOAA

OVERVIEW MAP



0 500 1,000 1,500 2,000

Feet

LEGEND

- State Boundary
- County Boundary
- Topographic Contours[1,2] (Contour Interval = 2 feet)

Data Sources:

Aerial Imagery: *USDA, National Agriculture Imagery Program, 2004*

Topographic Data: *The NOAA Coastal Services Center purchased the Hancock County and Jackson County data from EarthData International for and in coordination with the State of Mississippi. The State of Mississippi purchased the Harrison County data from EarthData International, and permitted these data to be used by FEMA in the Hurricane Katrina recovery mapping effort.*

FOR ADVISORY PURPOSES ONLY

Elevation contours presented on this map are preliminary and do not replace elevations determined by a certified surveyor or engineer.

For more information on advisory flood elevations and available maps, please see www.fema.gov/hazards/floods/recoverydata/katrina_index.shtm

TOPOGRAPHIC DATA PRESENTED IN THESE MAPS ARE PROVISIONAL AND HAVE NOT BEEN VERIFIED

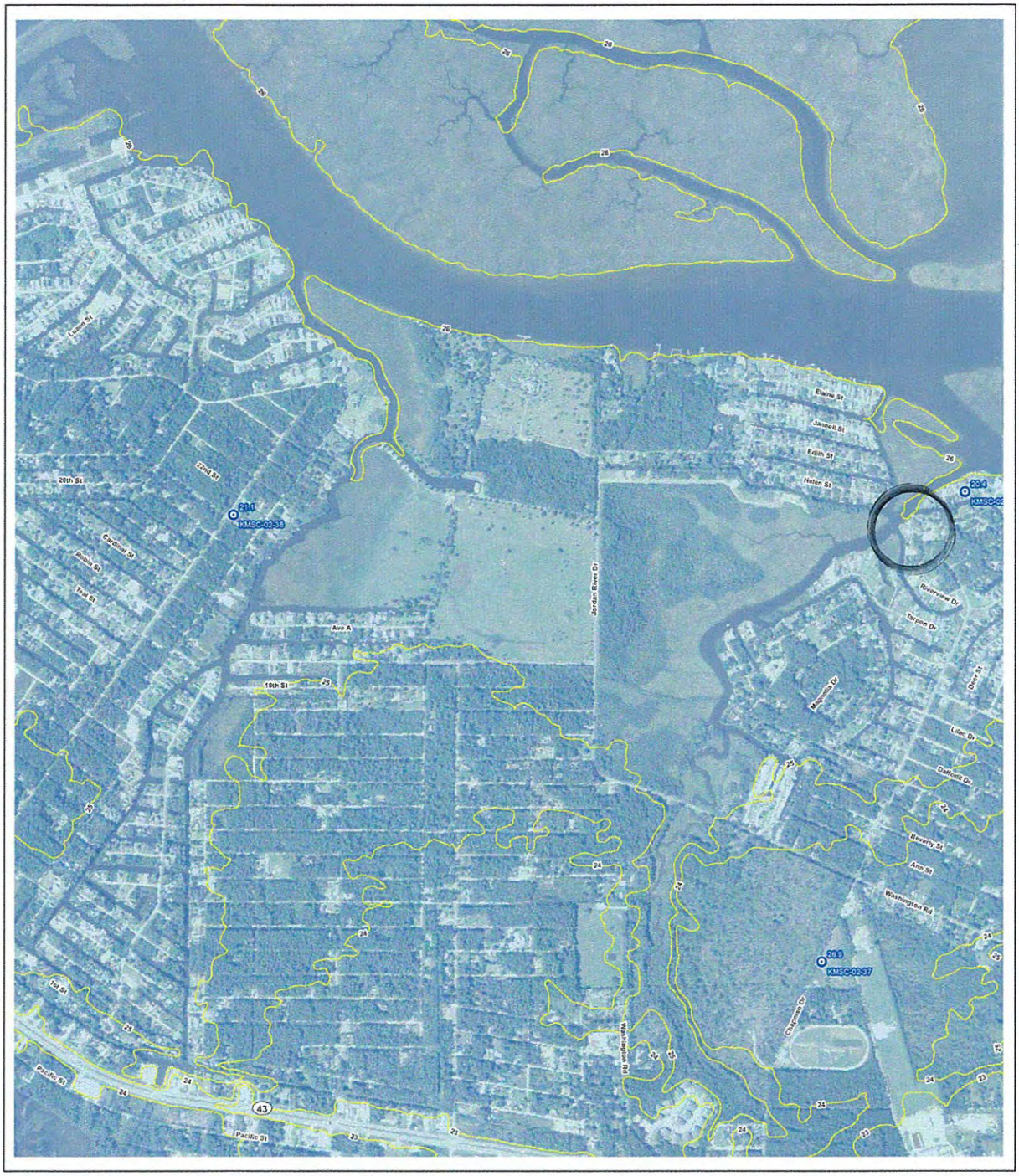
For insurance rating purposes, refer to the currently effective Flood Insurance Rate Map (FIRM), available from your local government or the FEMA Map Service Center (1-800-358-9616/ http://msc.fema.gov)

Notes:

[1] Measured in feet relative to the North American Vertical Datum of 1988.

[2] These data have not been verified and may contain errors. Elevation contours may not represent the true ground surface in some locations. This is due to artifacts of LIDAR data collection, such as trees and buildings, and/or erroneous point data. The final verified data will be available in late December 2005 or January 2006 from the NOAA Coastal Services Center.

Please check the following link for availability of the final data: http://www.csc.noaa.gov/crs/tcm/missions.html



FEMA

HURRICANE KATRINA SURGE INUNDATION and ADVISORY BASE FLOOD ELEVATION MAP

Hancock County, MS

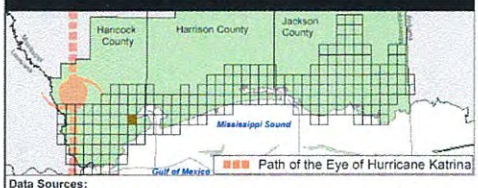
Date of Event: August 29, 2005

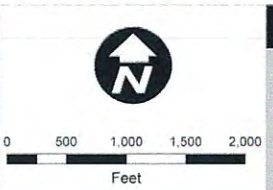
Date of Map: December 30, 2005

Map Number: MS-G9

Estimated Katrina Surge Elevations[1,2]
21-27 ft
Advisory Base Flood Elevations[2,3]
Open Coast: N/A Back Bay: 18-27 ft
Effective Base Flood Elevations[2]
VE Zone: N/A AE Zone: 10-12 ft

OVERVIEW MAP





LEGEND

State Boundary | County Boundary

Hurricane Katrina-Related Data

- Preliminary Indoor High Water Mark[2]
- Preliminary Outdoor High Water Mark[2]
- Preliminary Debris High Water Mark[2]
- Limit of Katrina Surge Inundation

Flood Advisory-Related Data

- ABFE Contours (1-foot intervals)[3]
- ABFE Inland Limit[3]
- Approx. Limit of 1.5-foot Wave Zone[3]
- Approx. Limit of 3-foot Wave Zone[3]
- Open Coast/Back Bay Boundary
- Limit of ABFEs

Data Sources:

Aerial Imagery: *USDA, National Agriculture Imagery Program, 2004*

Flood Zones and Elevations: *FEMA Flood Insurance Rate Maps (Hancock Co., MS, [1983-1992]; Harrison Co., MS [1984-2002]; Jackson Co. [1984-1993]). Elevations converted from NGVD29 to NAVD88.*

High Water Marks: *FEMA (identified and surveyed Sept-Oct, 2005)*

Storm Track: *NOAA National Weather Service*

For more information on these advisory maps, please see www.fema.gov/hazards/floods/recoverydata/katrina_index.shtm

Notes:

[1] Range estimated from surveyed, surge-only HWMs. Local wave effects (wave heights and wave runup) are not included in these elevations.

[2] Measured in feet relative to the North American Vertical Datum of 1988.

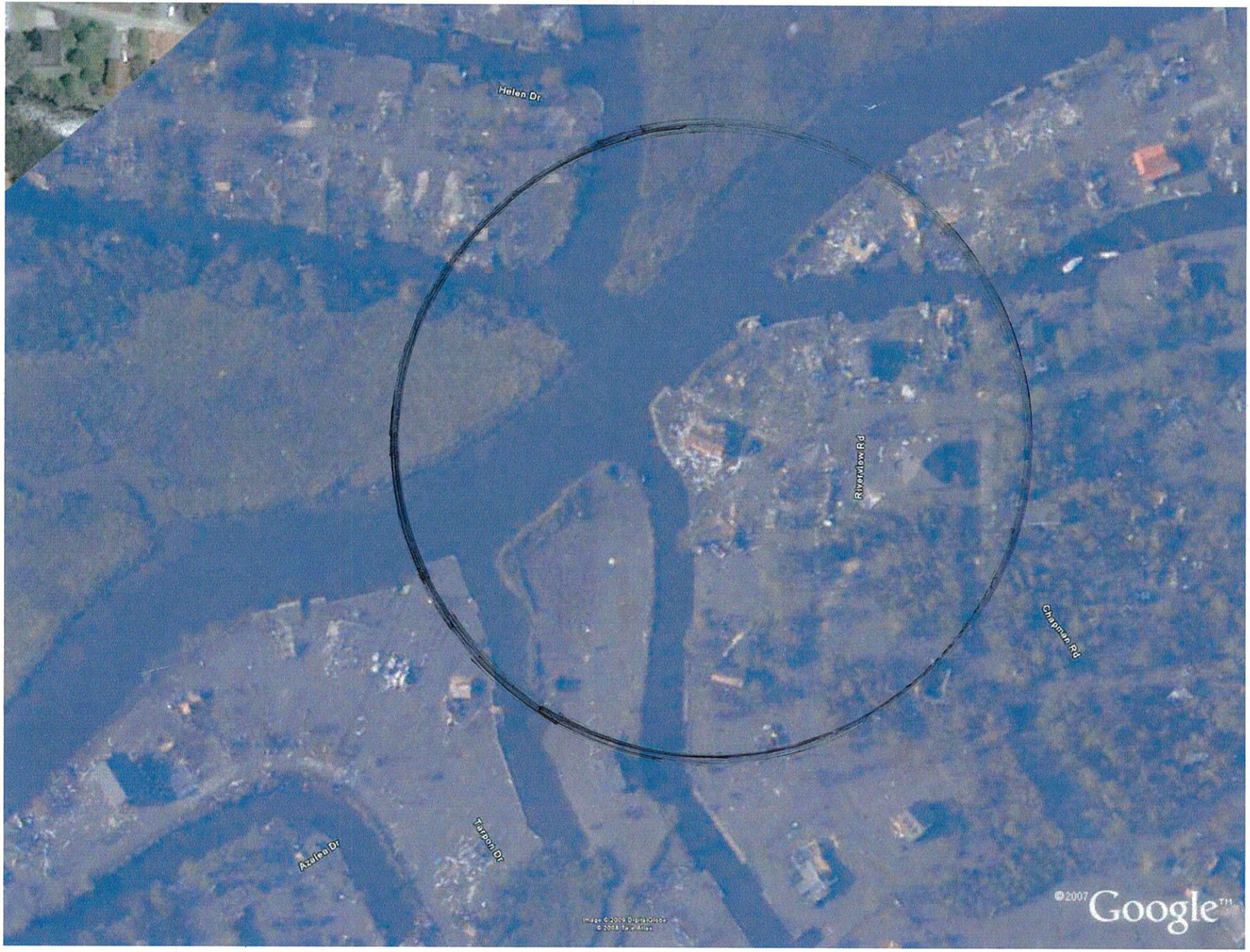
[3] Post-Hurricane Katrina Advisory Base Flood Elevations (ABFEs) are based on updated statistical information to develop the estimated 1%-annual-chance (100-year) stillwater elevations (SWELs) plus estimated wave effects. For Hancock County, MS, the advisory SWEL is 20 ft for the Gulf Coast and 18 ft for back-bay areas. See equation below to calculate the ABFE with wave effects for a given site:

ABFE = Advisory SWEL + Wave Height,

where **Wave Height** = $^{3}/_{7}$ **Stillwater Flooding Depth** (depth measured relative to the ground)

MAPS FOR ADVISORY PURPOSES ONLY - NOT FOR INSURANCE RATING PURPOSES

For insurance rating purposes, refer to the currently effective Flood Insurance Rate Map (FIRM), available from your local government or the FEMA Map Service Center (1-800-358-9616/ http://msc.fema.gov)


Helen Dr
Riverview Rd
Chapman Rd
Tarpon Dr
Azalea Dr
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ATTACHMENT B

PHOTOGRAPHS

Site Inspection Photos

Photo 1: Looking NW towards rear of building footprint

Photo 2: Looking NW towards rear of building footprint

Photo 3: Looking SE towards street

Photo 4: Looking SE towards street

Photo 5: Snapped lightpole

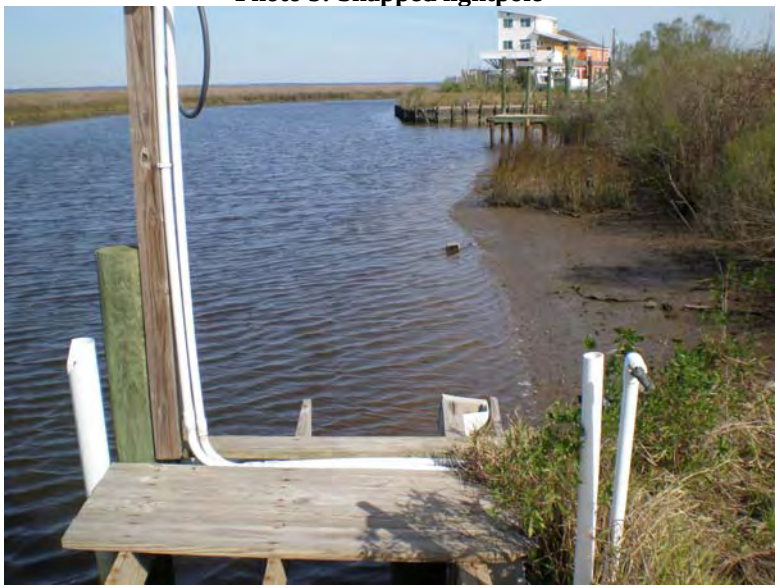


Photo 6: Looking downstream (NE) towards Jourdan River

Photo 7: Looking upstream (SW); boat canal at left

Photo 8: Surviving lightpole and four timber piles

Photo 9: Looking towards rear of building footprint

Photo 10: Remaining slabs NE of Anthony residence

Photo 11: Snapped tree trunks on Chapman Road

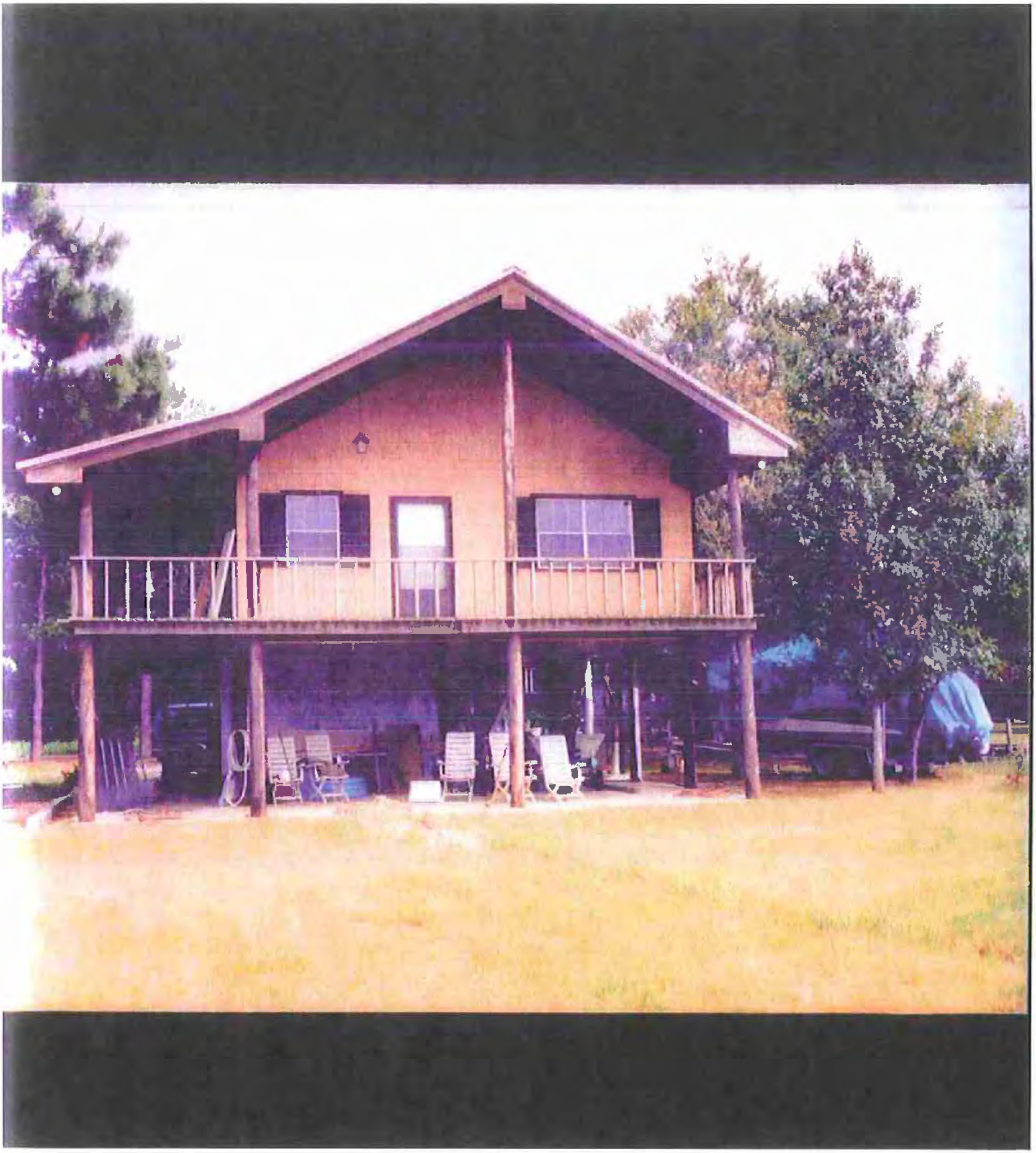
Photo 12: Denuded tree trunks on Chapman Road

Photo 13: Denuded tree trunks on Chapman Road

Photo 14: Uprooted trees on Riverview Road

Pre-Katrina Photos

24-z180-557 (HO)
Anthony 100255



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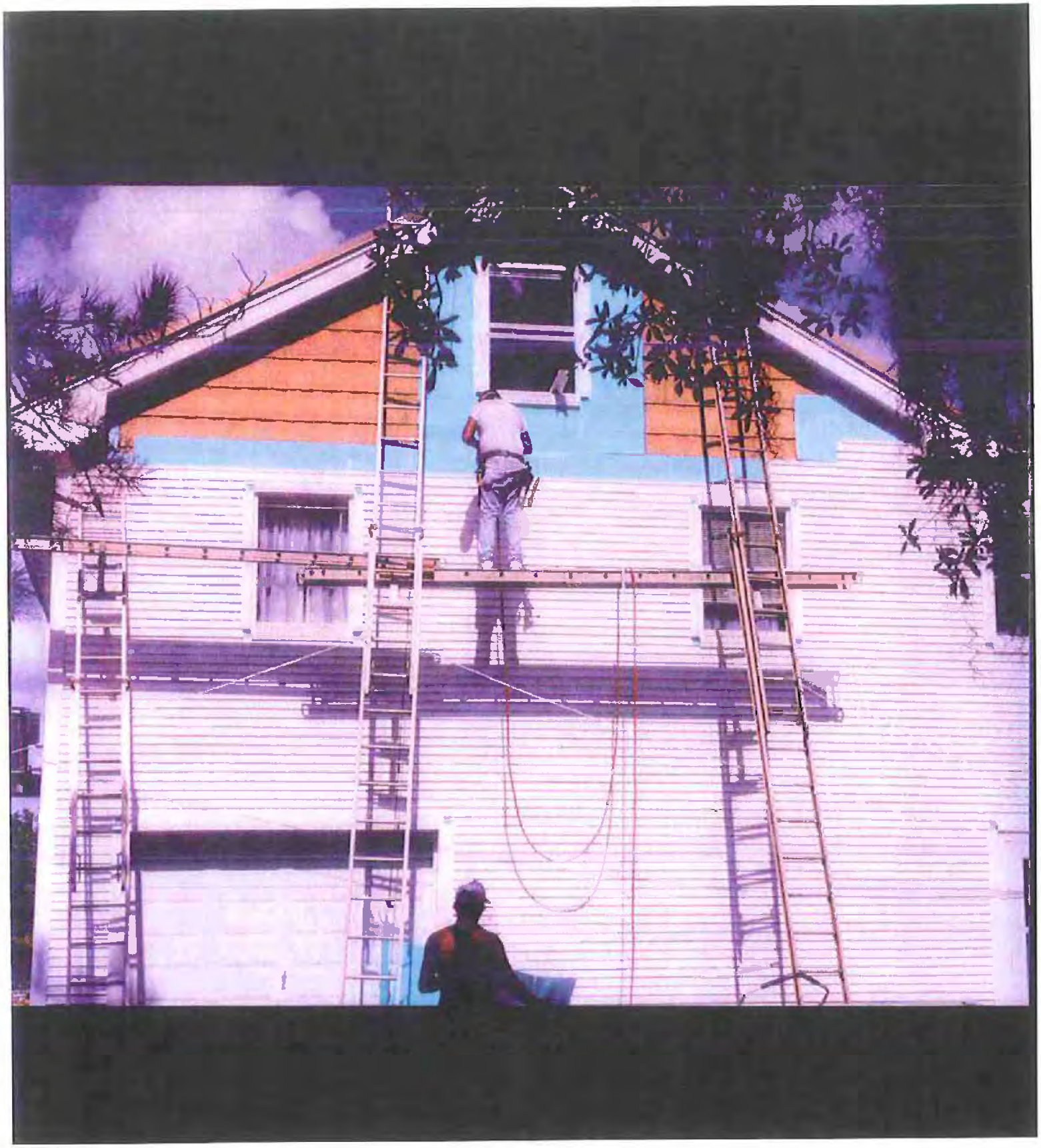

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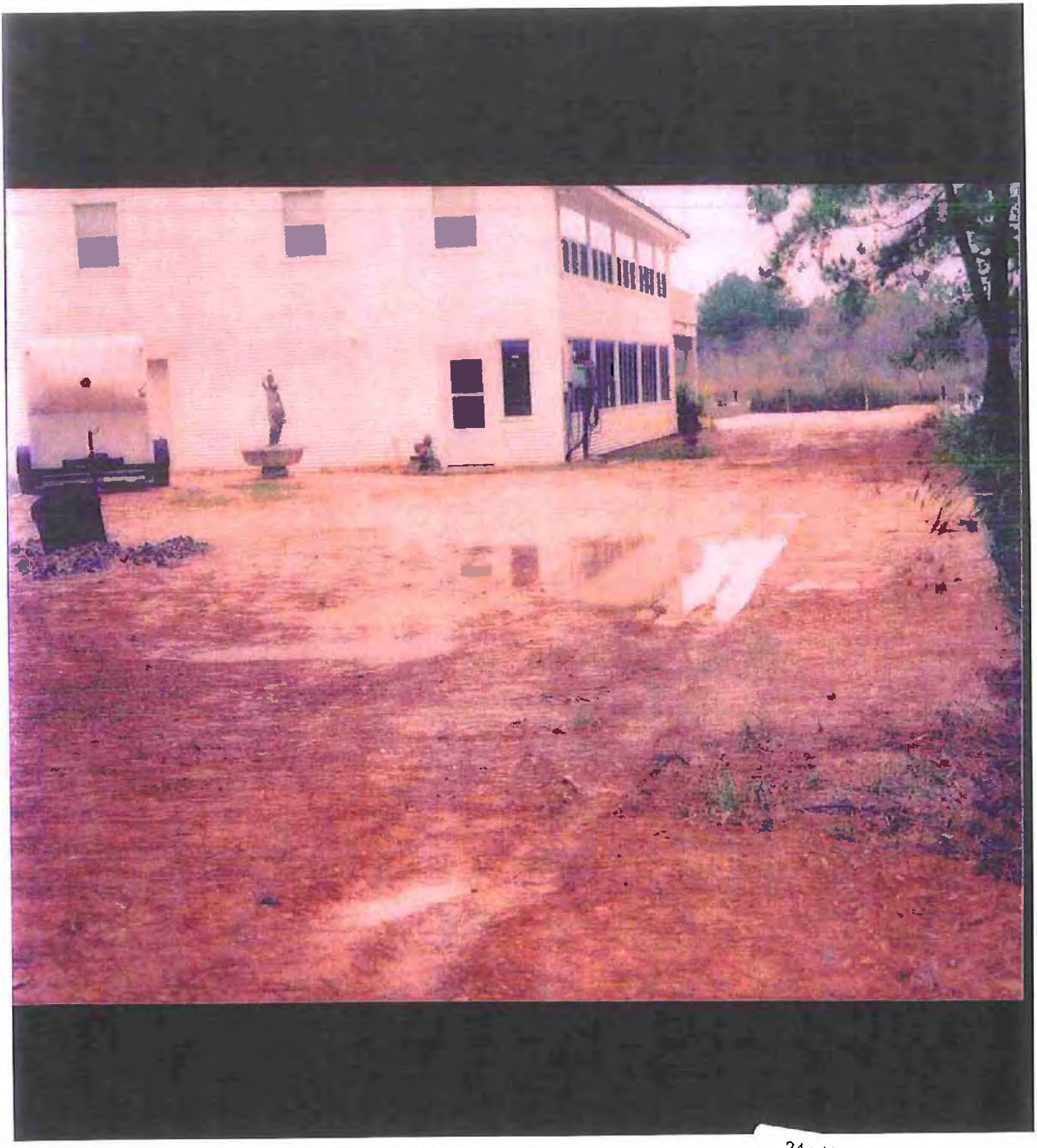

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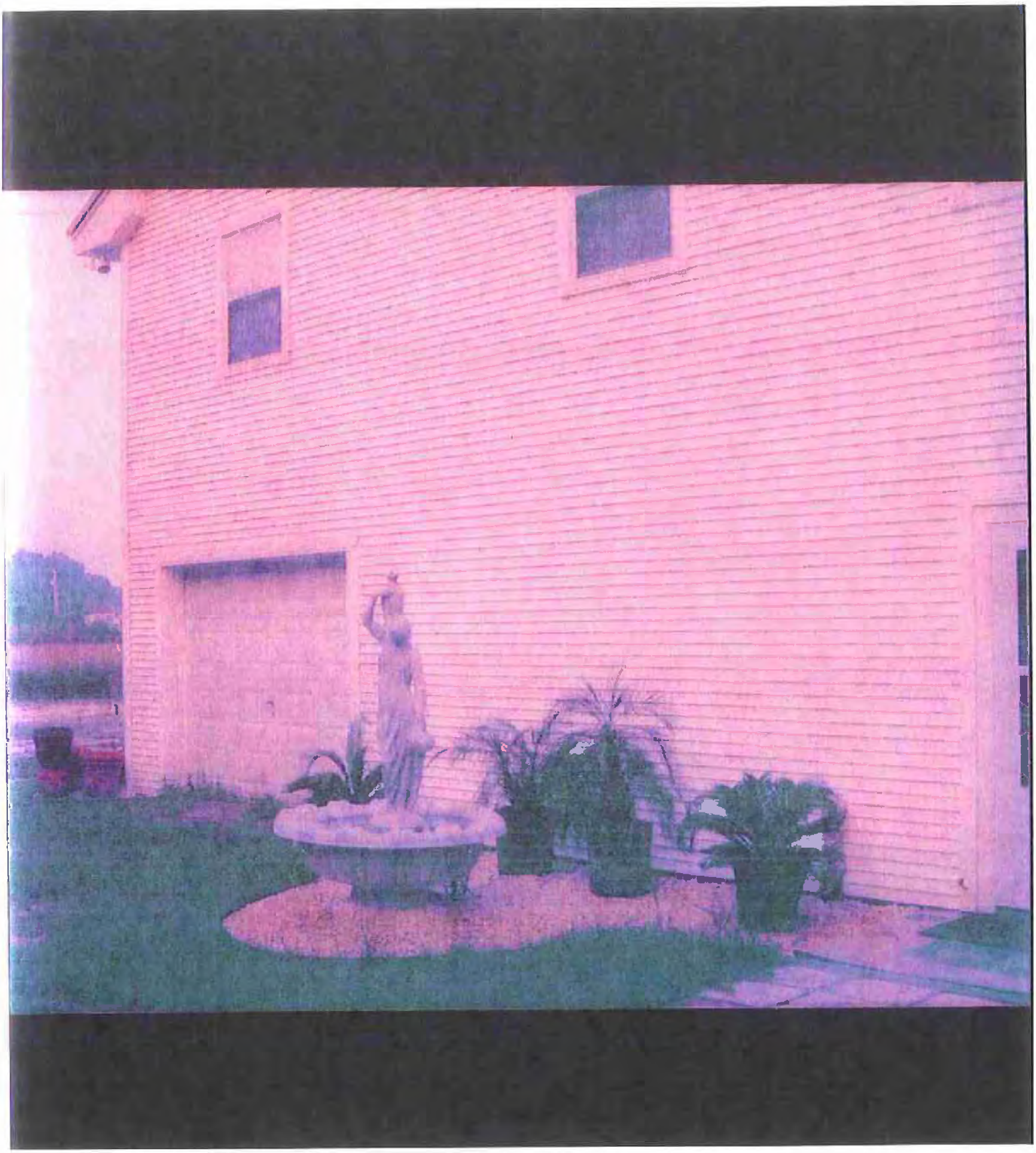

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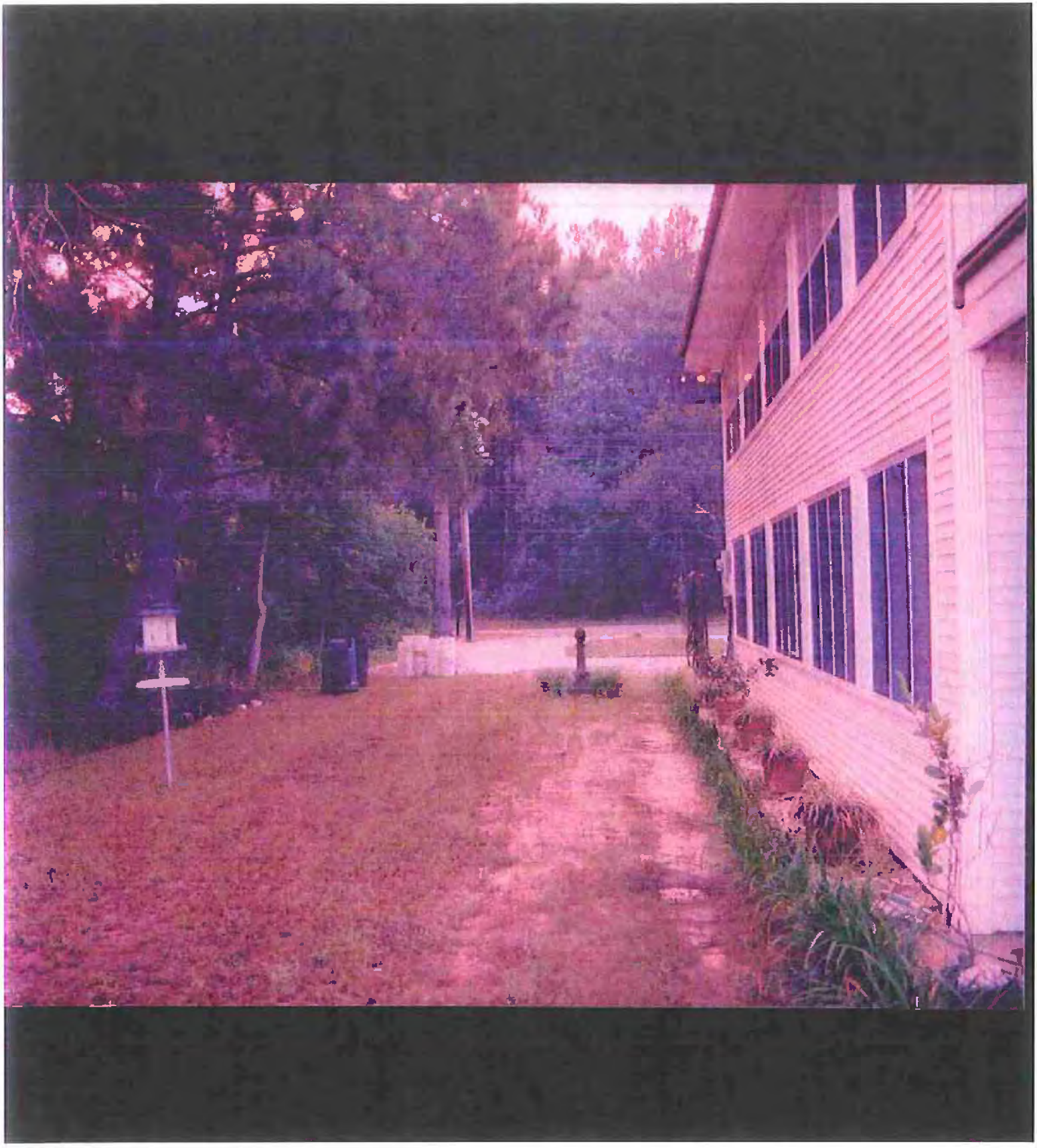

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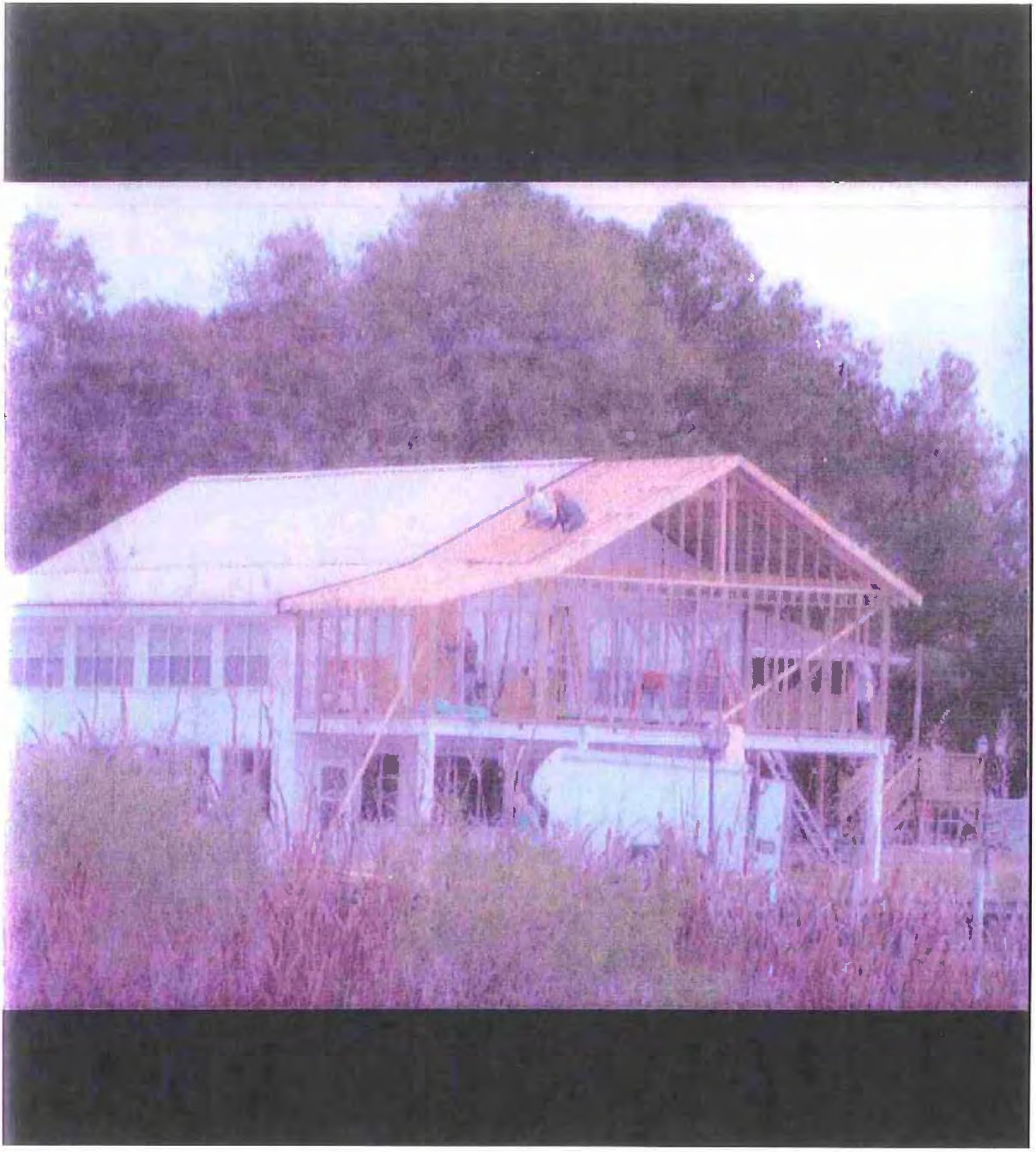

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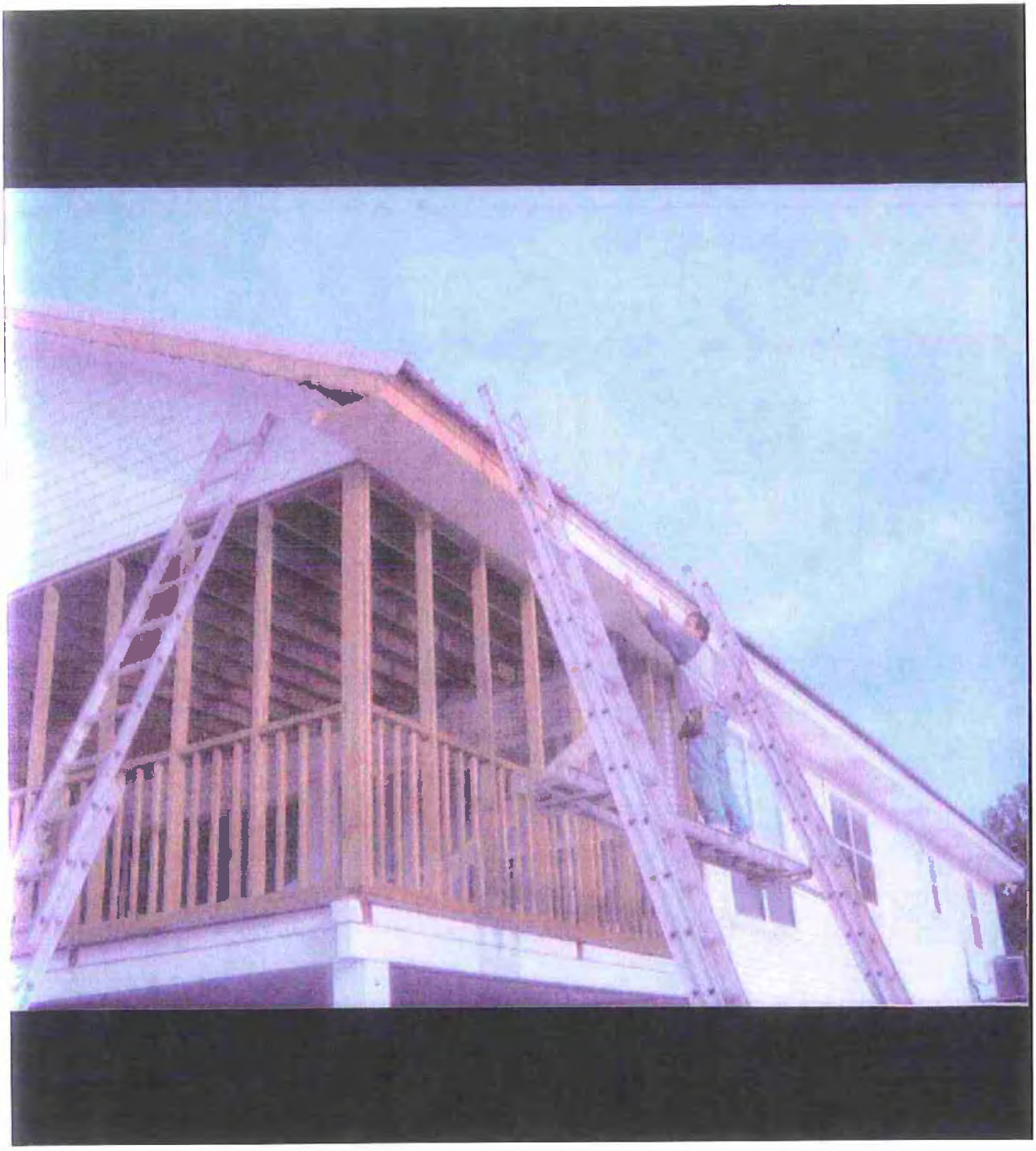

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Anthony 100263

24-z180-557 (HO)
Anthony 100279

Post-Katrina Photos


24-z180-557 (HO)
Anthony 100244

24-z180-557 (HO)
Anthony 100245


24-z180-557 (HO)
Anthony 100224


24-z180-557 (HO)
Anthony 100225


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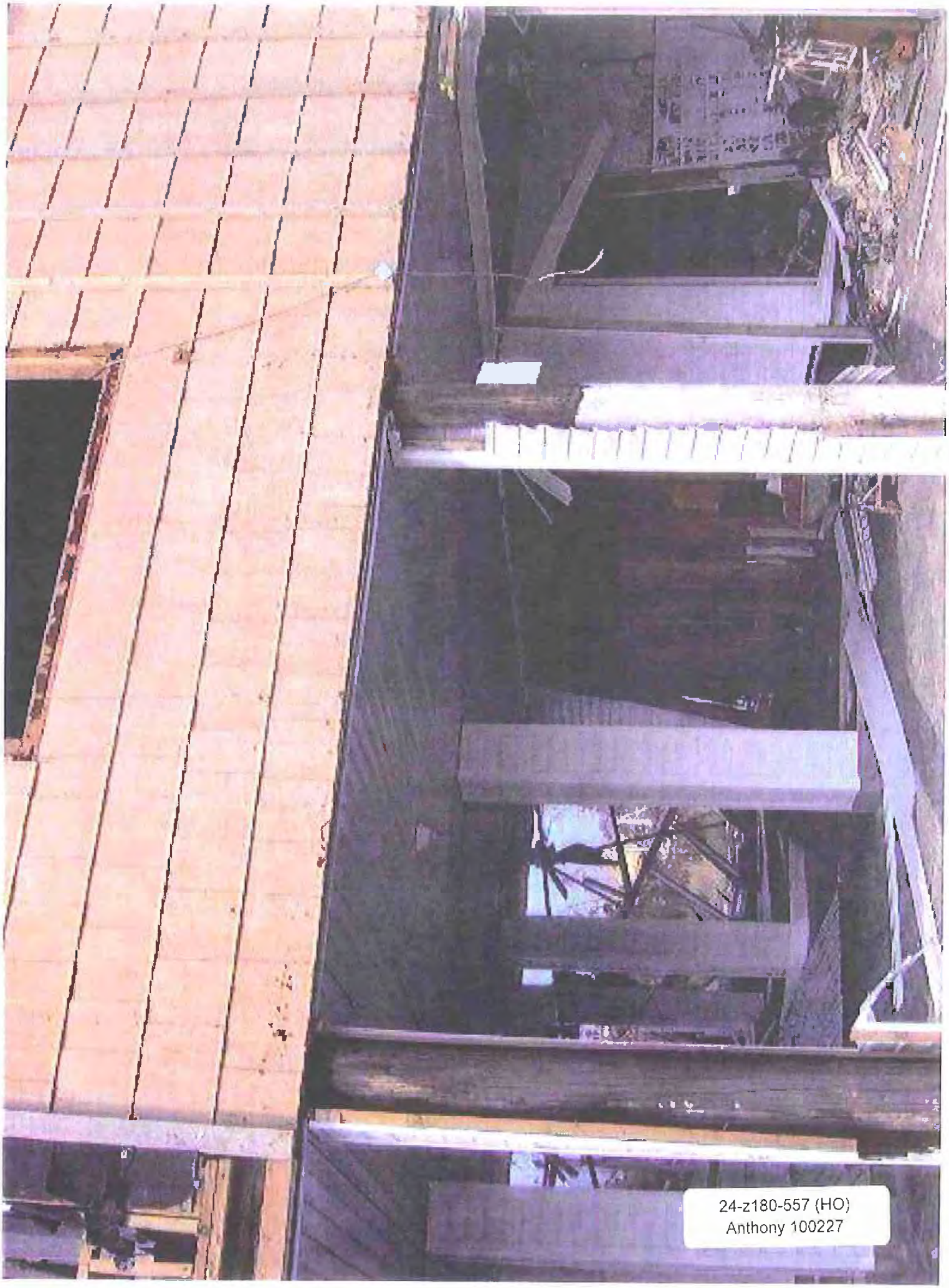
Anthony 100226



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Anthony 100227


24-z180-557 (HO)
Anthony 100228

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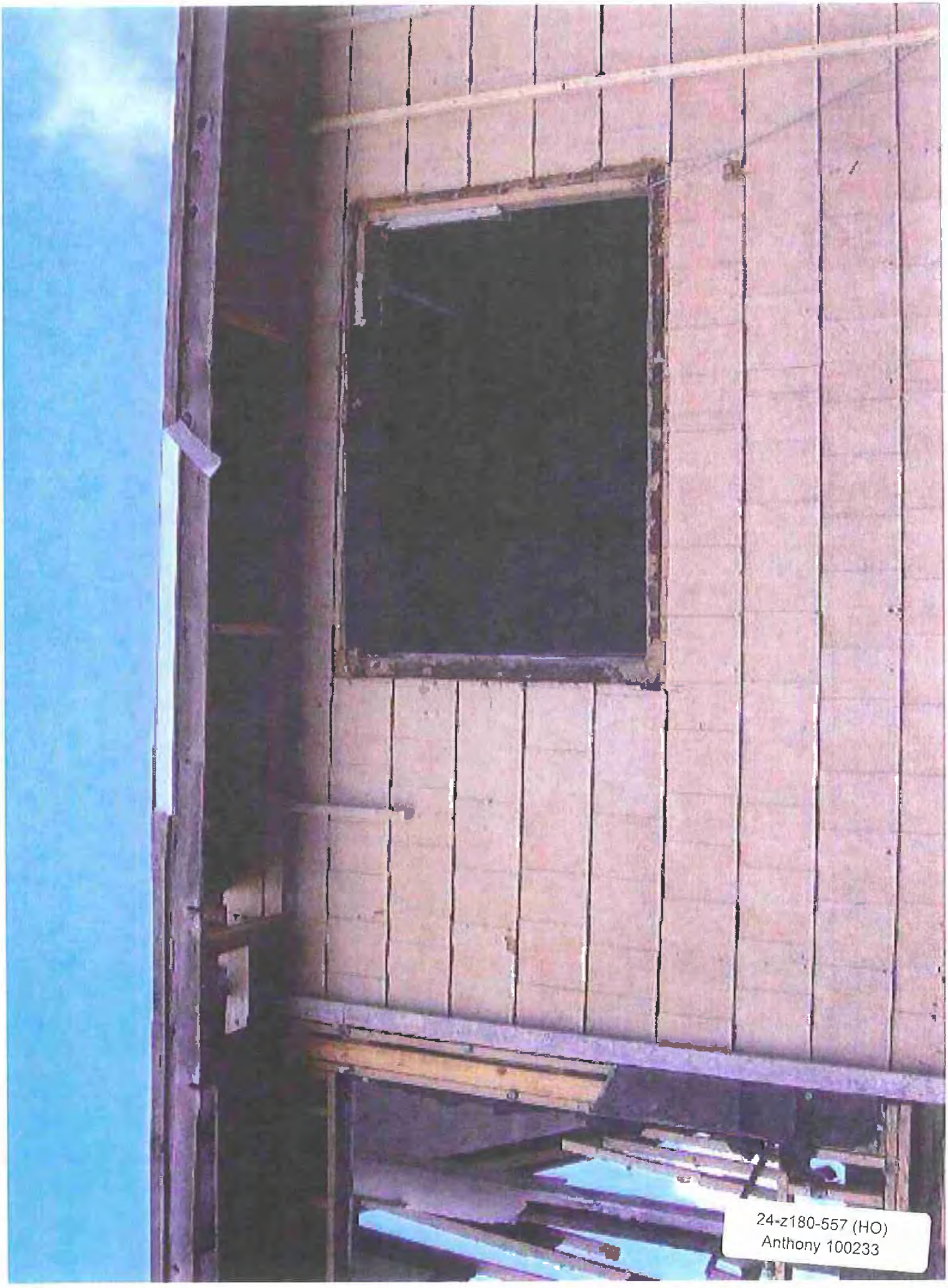
Anthony 100229


24-z180-557 (HO)
Anthony 100232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Anthony 100233


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Anthony 100234