



Kimley-Horn  
and Associates, Inc.

June 8, 2011

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Suite 600  
333 Fayetteville Street  
Raleigh, North Carolina  
27601

Mr. Joe Lemanski, PE, LEED AP  
Property Manager  
Durham Liberty, LLC.  
101 W. Main Street  
Durham, NC 27701

Re: Property: Liberty Warehouse  
Site Observation of Storm Damage Report  
Location: 611/613 Rigsbee Avenue  
Durham, NC 27701

Dear Mr. Lemanski:

In response to your request on May 16, 2011, Kimley-Horn and Associates, Inc. (KHA) initiated a structural investigation of storm damage throughout the above referenced facility owned by Durham Liberty, LLC "Client". The specific purpose of our investigation was to observe the extent of storm-related damage to structural components resulting from a recent storm event that occurred the afternoon of May 14, 2011. As part of our investigation, Josh Hamby, PE conducted a site visit on May 16, 2011 to review the damaged roof areas. The following report is a summary of our findings.

### **Description**

The Liberty Warehouse is an older located at 611/613 Rigsbee Avenue and was originally constructed in 1938 as a tobacco auction house. Currently, the primary use of the facility is for tenant storage of miscellaneous items. The warehouse structure is a split level facility with one level at grade along Rigsbee Avenue and two elevated levels along Foster Street. The facility occupies the entire block between Rigsbee Avenue and Foster Street.

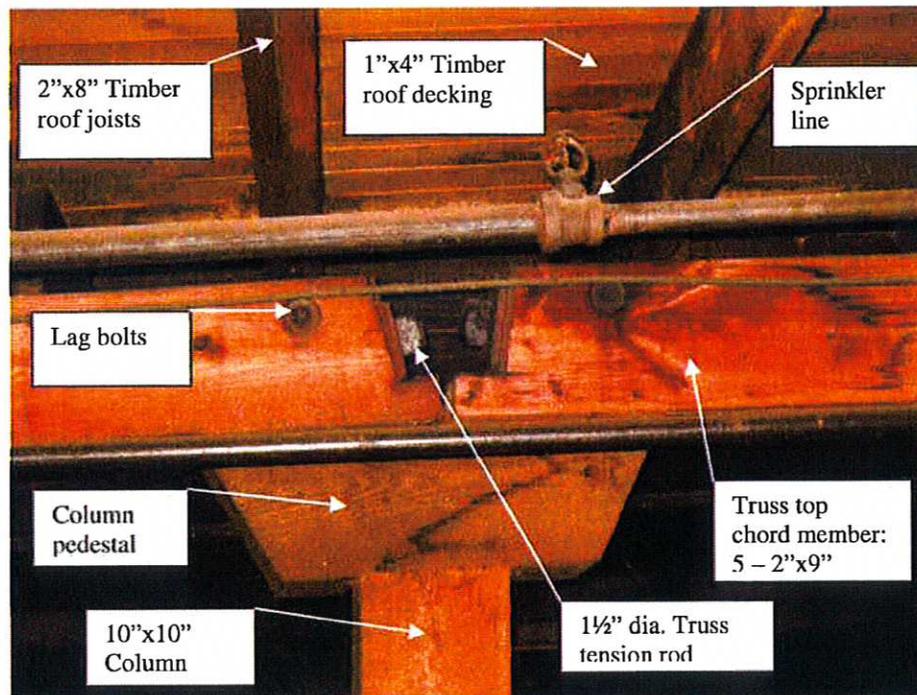
The structural composition of the warehouse roof system consists of 1" x 4" timber decking, overlaid with an older asphaltic roofing membrane and corrugated metal roof deck. The roof decking assembly spans between 2" x 8" timber joists spaced at approximately 2'-0" on-center. The timber joists span approximately 16'-0" between built-up timber trusses configured as king-pin trusses. The top chord of the trusses are comprised of five 2" x 9" timber beams which are oriented side by side and anchored together with staggered lag bolts. The bottom truss tension chord consists of a 1-1/2" diameter steel rod. The truss's steel rod is tensioned to enhance the load carrying capacity and stiffness

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to span approximately 47' between column supports. Square timber columns, approximately 10" x 10" in section, provide support for the trusses at each end and transfer load to the foundation system below grade. Timber bracing (2" x 8") is located at each truss to column connection below the roof system and provides lateral stiffness to the warehouse structure. The primary structural members of roof framing are referenced in the photo shown below.

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*Photo showing structural roof members (note braces not shown).*

### Observations

During our site visit, accessible portions of the warehouse facilities interior and exterior were observed to document the extent of storm-related damage. Photos documenting our site visit observations can be found as an appendix to this report. The most significant findings are summarized below.

- An area of the warehouse roof structure of approximately 50' x 150' has collapsed onto an elevated walkway and central loading ramp. The failed structure was observed to be located above and partially covering tenant spaces number 14, 15, 16, and 17 in the 611 Rigsbee Avenue building. (Photos #1 - #4)
- The fallen roof structure is bearing on the elevated walkway handrail and interior wooden partition framing, which is used to separate tenant storage



- spaces. (*Photos #5 – #6*)
- Significant wood deterioration was not observed in the failed structural members directly impacted by the storm event.
  - The long-span timber roof trusses have rotated off of their supporting column pedestals at multiple locations above the elevated walkway adjacent to the central loading ramp. (*Photo #8*)
  - In one location the top chord member of the timber roof truss (five – 2” x 9”) appears to have failed at the beam / brace joint. (*Photo #9*)
  - In some instances the roof truss 2” x 8” timber braces have buckled under high compression loading as a result of the roof collapse. (*Photos #10 – #11*)
  - Fire suppression sprinkler lines were observed to be severed due to the roof collapse. (*Photo #12*)
  - A portion of the gutter and associated 10” PVC drainage lines have been severed in the collapse. (*Photos #13 – #15*)
  - The metal roof decking has separated from the timber roof decking, revealing the original asphaltic roofing system. (*Photo #16*)
  - Concrete slab-on-grade located at the Foster Street loading ramp was observed to have isolated areas of concrete failure and subgrade scour from stormwater damage. (*Photos #17 – #18*)
  - The foundation system consists of built-up masonry pedestals supported by concrete footings. There was no significant storm related damage observed to the foundation system below the roof collapse area. (*Photo #19*)
  - Temporary shoring, consisting of 4” x 4” timber posts, was observed at several locations supporting timber trusses located directly below the existing roof gutter. Based on information gathered at the time of the site visit, the shoring was installed in the adjacent bays immediately after the roof collapse. (*Photo #20*)

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## Conclusions

The roof structure of the Liberty Warehouse has suffered considerable damage as a result of the storm related events of May 14<sup>th</sup>, 2011. The collapsed portion of the roof is completely destroyed and should be considered non-salvageable. The structural members previously connected to the collapsed region should be carefully removed and replaced. Based on our observations while on site investigating the damaged warehouse and our relevant experience, we submit the following conclusions for your consideration.

### Roof Drainage System / Ponding Water

During our site visit on May 16<sup>th</sup>, 2011 we observed the extents of the damaged roof structure as well as adjacent roof areas that did not collapse during the storm. Based on our observations, we believe the primary cause of the structural roof collapse is due to insufficient roof drainage during a highly intensive rain event.



The two warehouse facilities, 611 and 613 Rigsbee Ave., are joined together by a central drainage gutter that is approximately 1'-6" in width and runs the full length of the warehouse. The underside of the gutter can be seen in Photo #7 in the photo sheet attachment. The central roof gutter is responsible for conveying rainwater from a roof area of approximately 95-ft x 370-ft (~35,150-SF). PVC roof piping, consisting of two 5-in diameter vertical risers and two 10-in diameter horizontal drainage pipes, collect the roof stormwater and distribute it to a basement level stormwater piping system. Refer to Photo #7 for the 5-in vertical PVC riser and Photo #14 for the 10-in horizontal PVC drain. It is our opinion that the quantity and size of the drainage piping originally in-use may have been insufficiently designed to support a surface area flow of this magnitude while also operating at an acceptable flow capacity.

Additionally, the steel straps used to hold the 10-in horizontal PVC piping may have been insufficient in supporting a fully loaded pipe. Additional hydraulic choke forces may have been impressed upon the pipe system as it reached maximum flow capacity during the storm event. The damaged 10-in PVC piping and broken support straps can be seen in Photo #15 of the attached photo sheets. As the piping system reached its max flow capacity, any additional water would have then began to backup in the drainage system and caused ponding on the roof structure. The area of roof collapse is located adjacent to and directly below the central gutter and the 10-in horizontal PVC roof drain piping.

As with typical roof failures involving water ponding; as the water weight supported by the roof structure continues to grow, significant structure deflections occur. As the roof structure begins to deflect under the increased water weight, additional water begins to flow to the depressed region in the roof. As the roof deflections further increase so does the additional water weight supported by the roof structure. This process continues until the structural roof members reach their elastic load carrying limit. Shortly following the elastic limit, as water weight continues to increase, permanent deflections can occur which lead to a progressive structural collapse.

The following represents a potential sequence of events which we believe may have unfolded during the storm event on May 14<sup>th</sup>, 2011 ultimately leading to the warehouse partial roof failure:

1. A high intensity storm event occurred which loaded the gutter and drainage piping to their maximum stormwater flow capacity. Based on local reports, it is believed that this rain event exceeded 1-inch in less than one hour for a period of at least 30 minutes.
2. As the drainage piping filled with stormwater, the water began to backup on the roof where the ponding cycle began.
3. The weight of the water in the fully loaded 10-in horizontal PVC pipe, in combination with any hydraulic flow forces, may have caused the



- structural support brackets to fail (Refer to Photo #15).
4. Failure of these brackets would likely have caused the drainage pipe to sag and to further restrict the ability of the pipe to gravity drain the stormwater. This event would have exacerbated the rate of water backing up on top of the roof and ponding on the roof structure.
  5. As the weight of ponding water exceeded the maximum limit of the roof structure capacity, failure of the roof structure occurred.

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It is our opinion that the rooftop stormwater ponding ultimately led to the failure of the warehouse roof section. The ponding water may have been the direct result of the roof drainage system's inability to adequately drain the rain water during the storm event. Under-designed roof drainage in combination with a highly intense storm event contributed in the sequence of events that destroyed a section of the warehouse roof.

#### Closure

This report has been prepared in accordance with the applicable professional standard of care. No other warranties or guarantees, express or implied, are made or intended. This report has been prepared solely for Durham Liberty, LLC for the purpose stated herein and should not be relied upon by any other party or for any other purpose. The conclusions in this report are based on the limited investigation described above. Any reliance on this report by any party other than Durham Liberty, LLC shall be without liability to Kimley-Horn and Associates, Inc. or its employees.

Please call us at (919) 677-2119 if you have any questions regarding this report.

Very truly yours,

KIMLEY-HORN AND ASSOCIATES, INC.  
(KHA License Number F-0102)

Josh B. Hamby, P.E., LEED AP  
Associate

Attachments: Photographs



Liberty Warehouse  
**Photograph Sheet**

KHA Job No.: 012937006

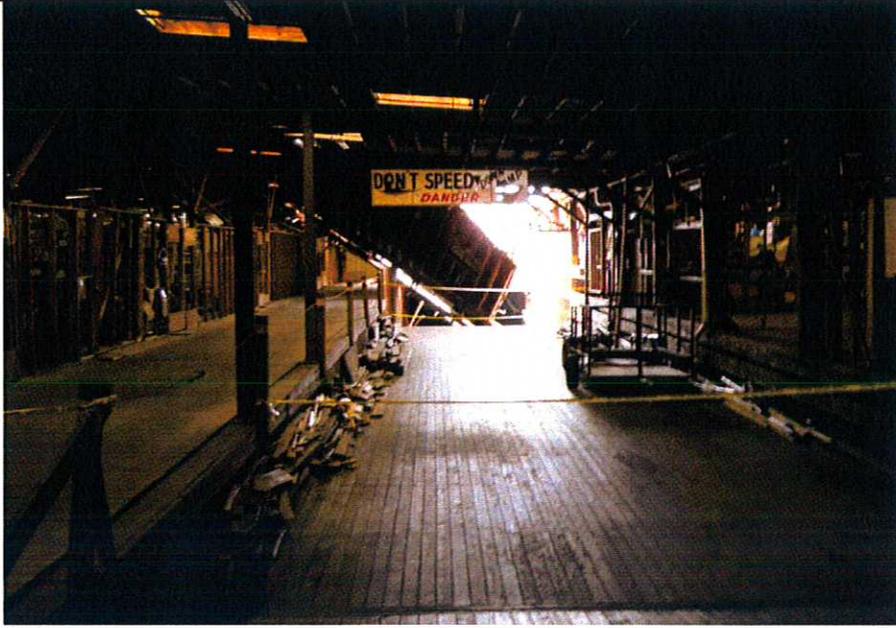
KHA Rep.: J. Hamby

Date: June 8, 2011

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Claim # N/A

Photo No. 1



Remarks: Overall photo of warehouse collapse showing extent of roof damage.

Location: 611 Rigsbee Ave.

Elevation: Interior

Photo No. 2



Remarks: Overall photo of warehouse collapse showing extent of roof damage.

Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
**Photograph Sheet**

KHA Job No.: 012937006

KHA Rep.: J. Hamby

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Claim # N/A

Photo No. 3

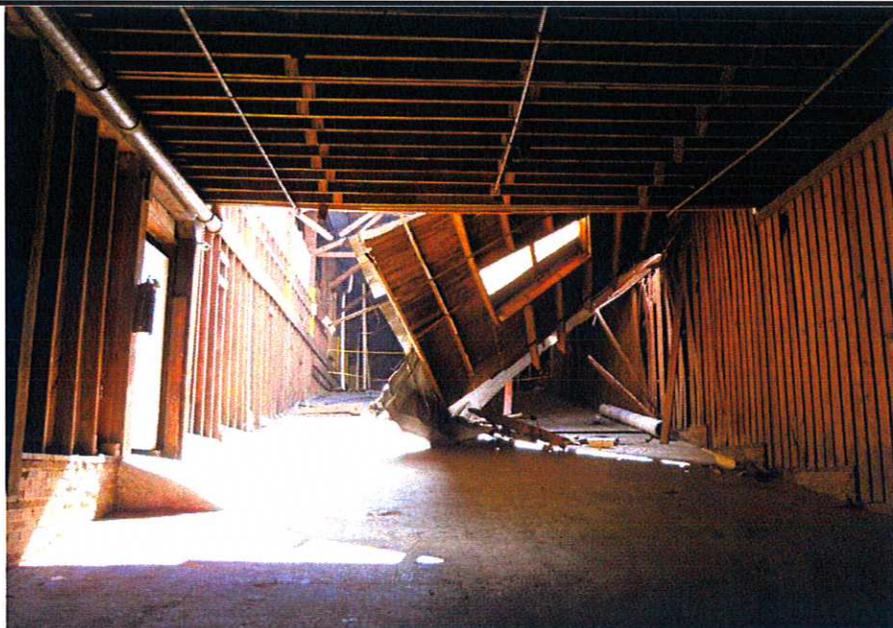


Remarks: Overall photo of warehouse collapse showing extent of roof damage.

Location: 611 Rigsbee Ave.

Elevation: Interior

Photo No. 4



Remarks: Overall photo of warehouse collapse showing extent of roof damage.

Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
**Photograph Sheet**

Claim # N/A

Photo No. 5



Remarks: Collapsed roof structure bearing on walkway handrail & partition framing.

Location: 611 Rigsbee Ave.

Elevation: Interior

Photo No. 6



Remarks: Collapsed roof structure bearing on walkway handrail & partition framing.

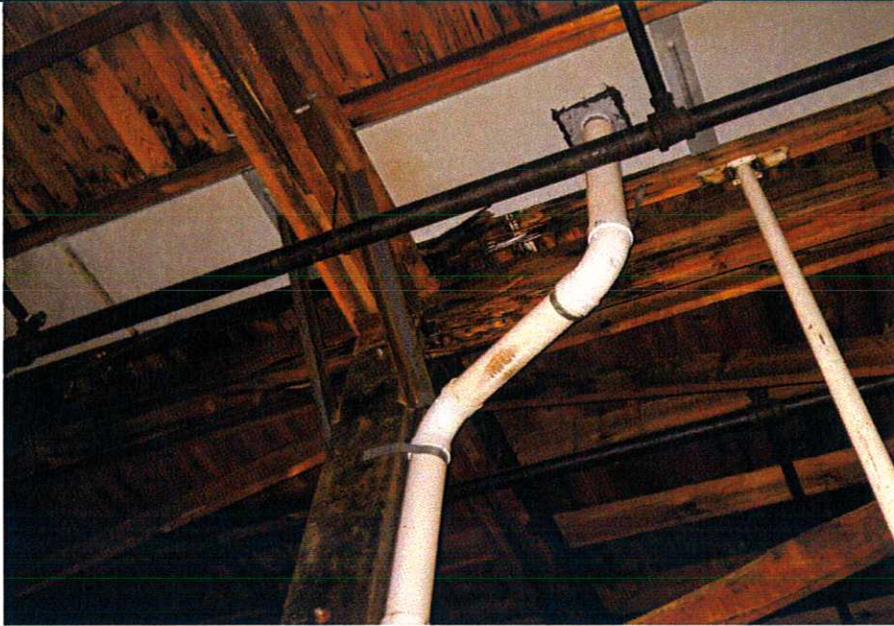
Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
**Photograph Sheet**

Claim # N/A

Photo No. 7



Remarks: Roof gutter / drain adjacent to collapsed area.

Location: 611 Rigsbee Ave.

Elevation: Interior

Photo No. 8



Remarks: Roof truss top chord shown rotated off of column pedestal.

Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
**Photograph Sheet**

Claim # N/A

Photo No. 9

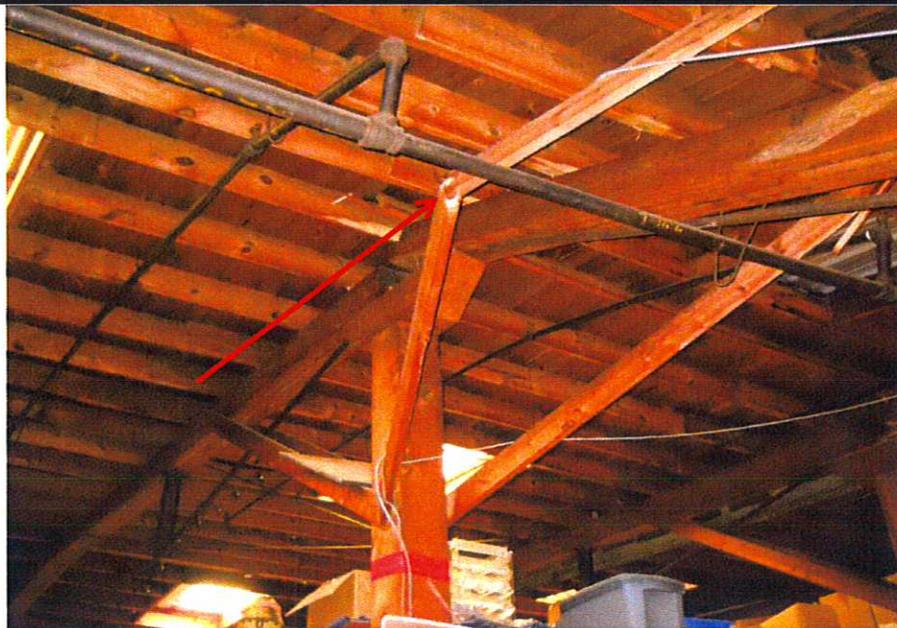


Remarks: Failed roof truss top chord shown damaged at brace connection.

Location: 611 Rigsbee Ave.

Elevation: Interior

Photo No. 10



Remarks: Failed timber truss braces shown damaged.

Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
**Photograph Sheet**

KHA Job No.: 012937006

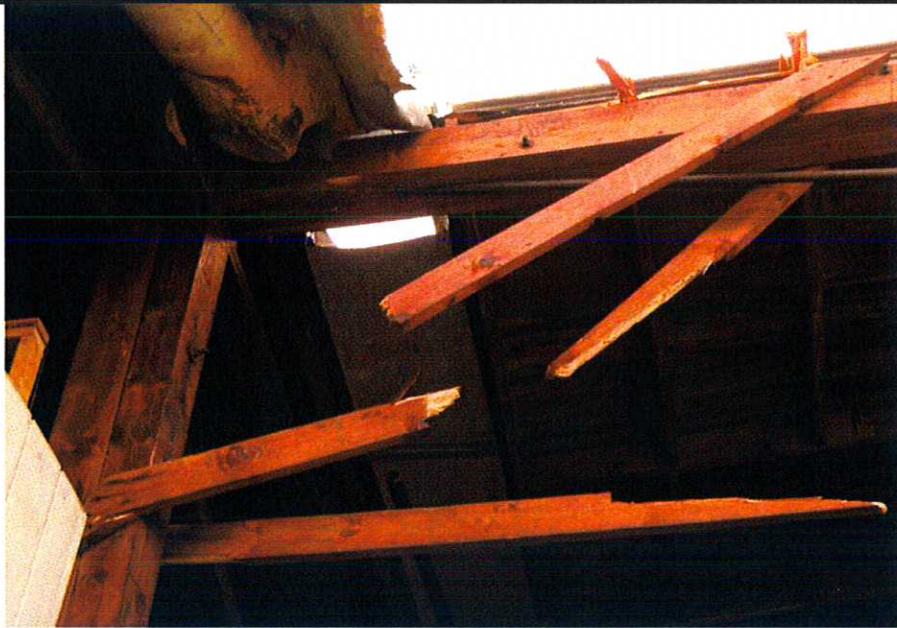
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Claim # N/A

Photo No. 11

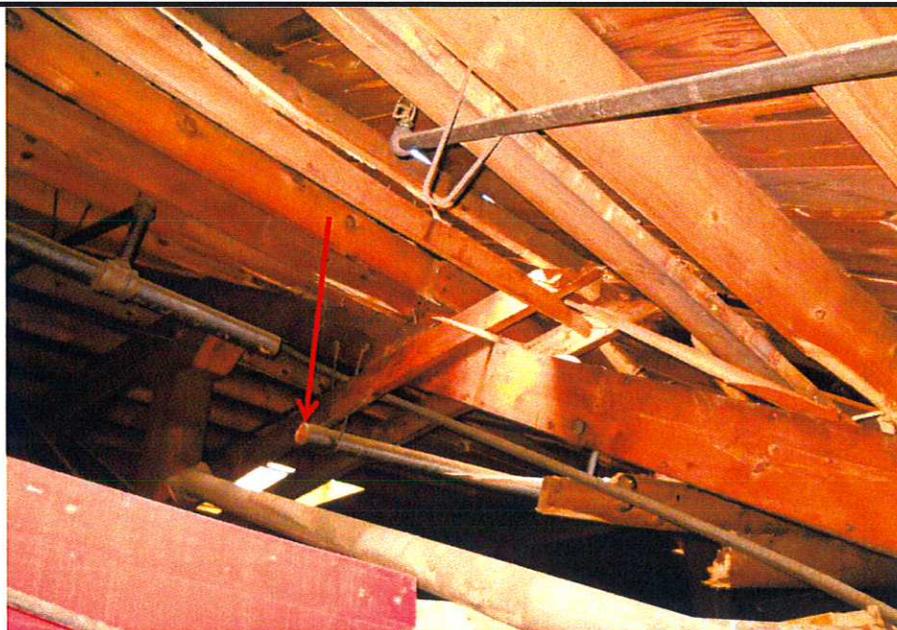


Remarks: Failed timber truss braces shown damaged.

Location: 611 Rigsbee Ave.

Elevation: Interior

Photo No. 12



Remarks: Severed fire suppression sprinkler lines.

Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
Photograph Sheet

KHA Job No.: 012937006

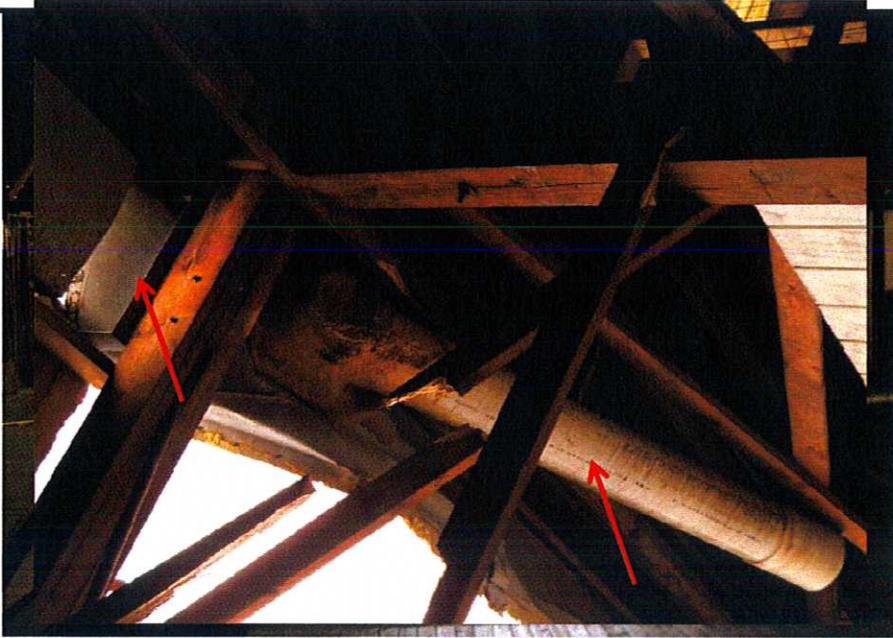
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Claim # N/A

Photo No. 13



Remarks: Severed roof gutter and PVC drainage lines.

Location: 611 Rigsbee Ave.

Elevation: Interior

Photo No. 14



Remarks: Severed roof gutter and PVC drainage lines.

Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
**Photograph Sheet**

Claim # N/A

Photo No. 15



Remarks: Severed roof gutter and PVC drainage lines.

Location: 611 Rigsbee Ave.

Elevation: Interior

Photo No. 16



Remarks: Separated metal roof decking from previous asphaltic roofing material.

Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
**Photograph Sheet**

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Claim # N/A

Photo No. 17



Remarks: Failed concrete slab-on-grade.

Location: 611 Rigsbee Ave.

Elevation: Exterior

Photo No. 18



Remarks: Subgrade scour below failed concrete slab-on-grade.

Location: 611 Rigsbee Ave.

Elevation: Interior

Liberty Warehouse  
**Photograph Sheet**

KHA Job No.: 012937006

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Claim # N/A

Photo No. 19



Remarks: Columns and foundations below area of collapse.

Location: 611 Rigsbee Ave.

Elevation: Exterior

Photo No. 20



Remarks: Temporary shoring installed below timber roof trusses.

Location: 611 Rigsbee Ave.

Elevation: Basement