

**Roof Hail Distress Evaluation
of Multiple Structures**

PROJECT FILE NO.

18559.0, 18559.01, 18559.02, 18559.03

IDENTIFICATION OF STRUCTURES

CIRSA Wheat Ridge
Multiple Structures
Wheat Ridge, Colorado 80033

PREPARED FOR

Wesley Ellis
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July 19, 2017

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File: CIRSA Wheat Ridge
Multiple Structures
Wheat Ridge, Colorado 80033

Nelson File No.:	18559
EGA File No.:	1000191341
Date of Loss:	5/08/2017

Dear Mr. Ellis:

Nelson Forensics, LLC is pleased to submit this report for the above-referenced file. By signature below, this report was authored by and prepared under the direct supervision of the undersigned professional.

Please contact us if you have any questions regarding this report.

With kindest regards,

NELSON FORENSICS, LLC
Nationwide Experts and Consultants

A handwritten signature in blue ink, appearing to read "A. Harold".

Andrew D. Harold, S.E., P.E.
Regional Manager

A handwritten signature in blue ink, appearing to read "N. Parker".

Nathaniel A. Parker, B.S., E.I.
Senior Associate



7/19/17

Nelson: Report1-18559.doc.

Your questions. Our people. Expert solutions.

REPORT

REPORT

INTRODUCTION

GENERAL INFORMATION

Dates of Investigation:	June 16, June 20, & June 21, 2017
Nelson Staff Present at Investigation:	Andrew D. Harold, S.E., P.E., all dates Nathaniel A. Parker, B.S., E.I., June 20 only
Testing Performed:	Roof condition survey Roof membrane sampling and coring

AUTHORIZATION AND PURPOSE

Nelson Forensics LLC (Nelson) was authorized by Mr. Wesley Ellis with Engle Martin & Associates (client) to evaluate the low-slope roof coverings of four different structures located in Wheat Ridge, Colorado (subject structures), determine the extent of hailstone impact distress from a storm event on the date of loss, and provide associated remedial recommendations.

SCOPE OF INVESTIGATION

Nelson conducted a visual evaluation of the roofs of the subject structures, during which Nelson photographically documented general site conditions and observed distress. Testing performed as part of this evaluation consisted of a roof condition survey and roof membrane coring.

This report was not prepared for use in a real estate transaction. It was prepared for the purpose and for the client as indicated above. Any and all usage or reliance upon this report by parties other than the client is expressly prohibited.

DESCRIPTION OF STRUCTURES

The subject structures were all municipal buildings owned by City of Wheat Ridge, Colorado, aerial views of which are shown in **Figures 1 – 6**. The building names, addresses, approximate locations (latitude, longitude), approximate construction dates, and roof types are outlined in **Table 1**.

Table 1: Summary of structures

Building Name	Address	Location	Date Constructed*	Low-slope Roof Type
City Hall	7500 West 29th Avenue	39°45'26" N, 105°04'49" W	1977	Ethylene propylene diene monomer (EPDM) membrane



Figure 1: Aerial image showing locations of the subject structures (Google, Inc. 2017)



Figure 2: Aerial view of City Hall building (Google, Inc. 2017)

OBSERVATIONS

Photographic documentation and other field-obtained data of the structure are being maintained in Nelson's file. Select photographs are included within the body of this report and may be presented for information only or for a general representation of the condition of the structure. Nelson observed the following:

CITY HALL

- ❑ Measured membrane thickness of 90 mil (0.090") at the lower roof section, and a manufacturer's label indicating a membrane thickness of 60 mil at the upper roof section (**Figures 6 – 7**);
- ❑ Burnish marks measuring up to 1-1/2" in diameter on the south-facing metal roof panels (**Figure 8**);
- ❑ Indentations measuring up to 1-1/2" in diameter on the light-gauge metal vent covers (**Figure 9**);
- ❑ Indentations measuring up to 1" in diameter in the parapet coping and south-facing window sills (**Figure 10**);
- ❑ Burnish marks measuring up to 1-1/2" in diameter on the membrane with coincident softness and/or bruising of the substrate at both the upper and lower roof sections (**Figure 11**).



Figure 6: 90 mil membrane thickness at lower roof section



Figure 7: Label indicating 60 mil membrane thickness at upper roof section



Figure 8: 1-1/2" burnish mark on south facing metal roof panels



Figure 9: 1-1/2" diameter indentation in metal vent cover



Figure 10: 1" diameter indentation in metal parapet coping

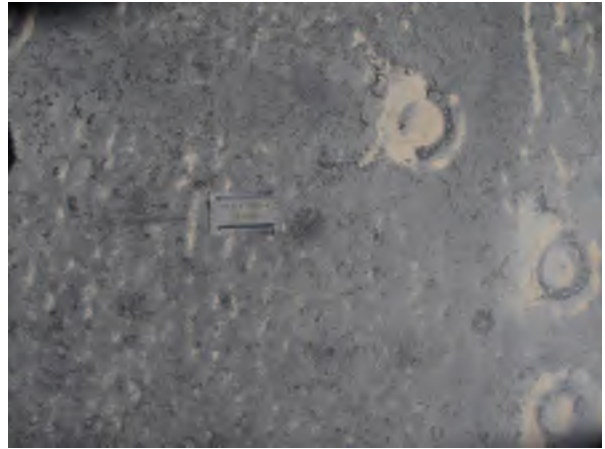


Figure 11: 1-1/2" diameter burnish mark on membrane at lower roof section

TESTING PERFORMED

ROOF CONDITION SURVEY

Nelson performed a condition survey to quantify the extent of hail impact, if any, to the EPDM (not ballasted only) and thermoplastic roofing. Nelson selected and evaluated seven (7) representative 2'x2' sample areas at the roofs of the subject structures. The sample areas were selected away from parapet walls or mechanical units which could have potentially shielded the roof surface from hail impact. The approximate locations of the sample areas are indicated on **Figures 30 – 32**. The sample areas were chosen to represent the general condition of the roof membranes.

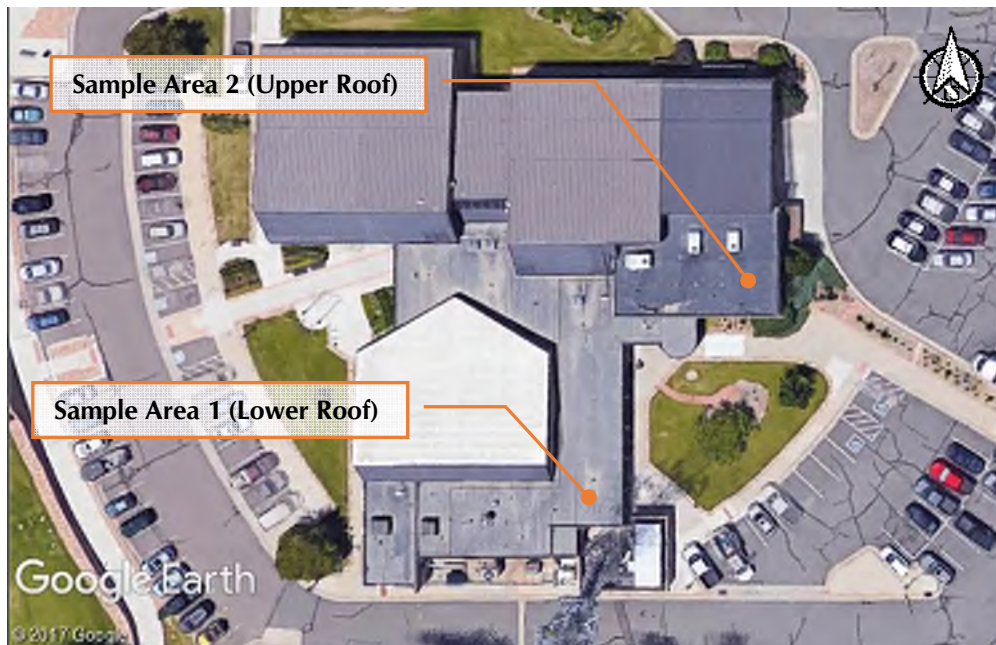


Figure 30: Approximate locations of sample areas at City Hall (Google, Inc. 2017)

Within each 2'x2' sample area, the roof was evaluated for indentations or depressions in the membrane substrate coincident with burnish marks on the membrane. The purpose of the evaluation was to identify locations on the membrane which were struck by hailstones, to quantify the density of potential distress to the substrate, and to visually evaluate the adhesion of the membrane to the substrate at the sample locations. Representative photographs of the sample areas are shown in **Figures 33 – 39**. **Table 2**, below, lists the representative 2'x2' sample areas and summarizes the observed indentations/depressions which were potentially consistent with hailstone impact.

Table 2: Summary of Roof Membrane Condition Survey

2'x2' Sample Area	Building	Area Surveyed	Areas of Identified Distress
SA #1	City Hall	4 ft. ²	15
SA #2	City Hall	4 ft. ²	14



Figure 33: Overall view of 2'x2' sample area 1 on lower roof section of City Hall



Figure 34: Overall view of 2'x2' sample area 2 on upper roof section of City Hall

ROOF MEMBRANE SAMPLING AND CORING

Roof membrane sampling and coring were performed at seven (7) locations at the roofs of the subject structures. The 2'x2' membrane samples areas were cut on three sides and visually evaluated for the extent of adhesion between the membrane and substrate. The membrane and substrate were visually evaluated for evidence of discrete impact distress. The roof assembly at each sample location was determined by coring to the structural deck. Roof coring was performed by a representative of Independent Roofing Specialists and observed and documented by Nelson.

The roof assembly and observed conditions at the sample locations are summarized in **Table 3** below. Representative photographs of the sample extraction process follow in **Figures 40 – 57**.

Table 3: Roof assembly and observations at sample locations

Roof Sample (Core)	Building	Low-Slope Roof Assembly	Observations
1	City Hall (Lower Roof)	90 mil (0.090") EPDM membrane, 1/4" gypsum board, 2-1/2" polyisocyanurate (polyiso) insulation, metal deck	Fully adhered system; no visible shrinkage of membrane from cut edges; membrane had to be peeled from substrate; remnants of gypsum board facer throughout underside of membrane; gypsum board crushing coincident with burnish marks.
2	City Hall (Upper Roof)	60 mil (0.060") EPDM membrane, 1/4" gypsum board, 3-3/4" polyiso, metal deck	Fully adhered system; no visible shrinkage of membrane from cut edges; membrane had to be peeled from substrate; gypsum board crushing coincident with burnish marks.

ANALYSIS

In Nelson's opinion, hail up to 2.25" in diameter was experienced at the subject structures on the date of loss. Analysis provided by CompuWeather indicated hail between 1.75" and 2.25" in diameter for this storm event was experienced at or near all four of the subject structures. Observed distress at roofing and roof appurtenances, along with indicators such as burnish marks and indentations, are generally consistent with hail of this size.

CITY HALL

In Nelson's opinion, the weatherproofing function of the EPDM membrane roof sections has not been damaged by hail impact; however, hail impact has damaged the gypsum board substrate such that it is no longer suitable for attachment of this fully-adhered EPDM roof system. The gypsum board was indented and crushed below the locations of burnish marks and the facer material was fractured and/or separated, indicating that they are the result of hail impact. The indentations and separated facer material have decreased the perpendicular tensile strength, and therefore have decreased the wind uplift resistance of the roof assembly. Given the size and density of the burnish marks, Nelson estimates up to a 10% reduction in the adherence to the substrate, with a corresponding reduction in wind uplift capacity, and therefore the EPDM roof sections should be replaced.

CONCLUSIONS

Based on observed conditions, testing performed, weather data, and analysis; Nelson concludes the following regarding the hail storm event on the date of loss:

- Hail up to 2.25" in diameter was experienced at the subject structures on the date of loss;
- The weatherproofing function of the EPDM membrane roof sections at **City Hall** has not been damaged by hail impact; however, hail impact has damaged the gypsum board substrate such that it is no longer suitable for attachment of this fully-adhered EPDM roof system and therefore it should be replaced;

RECOMMENDATIONS

Nelson recommends the following repairs to restore the noted items of hail-related distress to a "pre-loss" condition:

CITY HALL

- Remove and Replace the fully-adhered EPDM roof systems down to the roof deck, to include parapet coping (which will likely be damaged during removal of the existing roof systems).