2133 S. Timberline Road, Suite 110
Fort Collins, CO 80525
ditescoservices.com

DATE: **September 20, 2022**

TO: **Aaron Ehle - Northern Colorado Regional Airport**

FROM: **Jill Burrell, PE – Ditesco**
Kelsey Madsen, PE - Ditesco

RE: **Northern Colorado Regional Airport**
T-Hangar Structural Analysis

Background & Purpose

When Airport ground leases expire at Northern Colorado Regional Airport (Airport or FNL), ownership of the improvements on the land reverts to the Cities of Fort Collins and Loveland, which jointly own the Airport. In 2019, the Airport/Cities gained total ownership of the farthest west three rows of T-hangars. Four hangar buildings occupy this area, with a total of 58 hangar units. The hangars buildings range from approximately 45 to 57 years of age and have varying levels of structural degradation. These hangars are rented out on a month-to-month basis to aircraft owners and operators.

The Airport has been planning to redevelop the area occupied by the aging T-hangars in alignment with the Airport Master Plan. The redevelopment will most likely occur in phases over several years. Potential lease agreements associated with this redevelopment may be structured in ways that anticipate revenue generation from the hangars until they are demolished.

The purpose of this structural assessment is to visually observe the general conditions of the four T-hangar buildings. The assessment will inform FNL of the current conditions of each hangar, including a photo log of observations, and a summary of conclusions.

The four hangars evaluated for this technical memorandum will be referenced as Hangars 4920-A, 4910-B, 4930-C, and 4960-C. Page 1 of Appendix A can be referenced for a map of the hangars.

Summary of Condition

Ditesco performed a structural evaluation of the four hangars on August 18, 2022. Due the high-level approach of this report, only select units were inspected in detail, as shown in Figure 1. The conditions observed in the select units were assumed to be representative of the hangars in their entirety.

FNL does not have any historic record drawings of the buildings. Observations generated within this report are based upon visual inspections and general understanding of the site conditions.

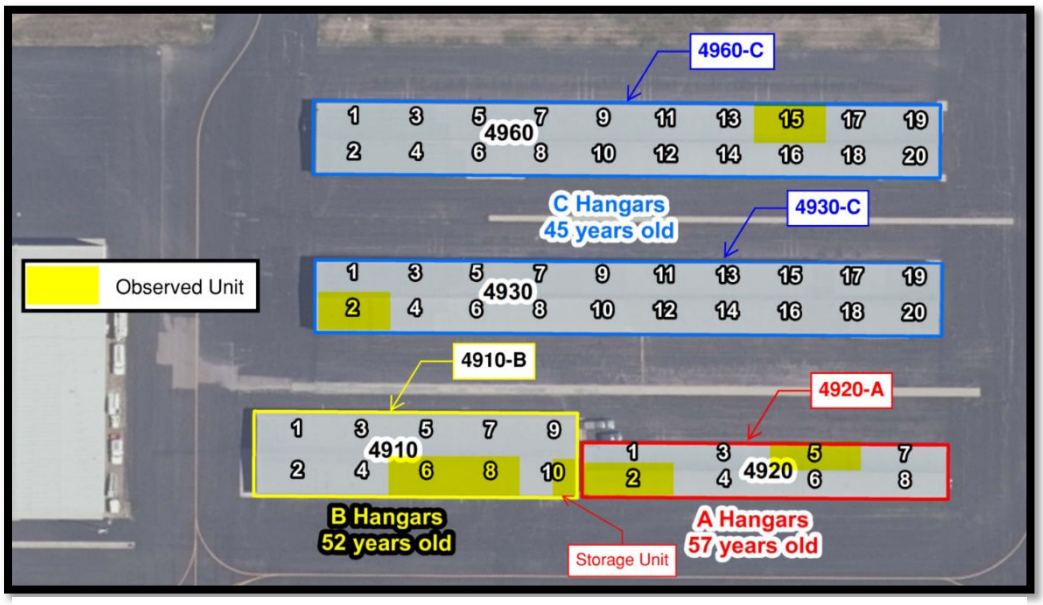


Figure 1

Hangar 4920-A

Hangar 4920-A has been in service at FNL for approximately 57 years and contains eight units. The units are configured in a standard nested "T" and are approximately 980 square feet each. This hangar building is pre-engineered metal with a frame primarily constructed of a steel double howe truss assembly and two four-inch hat channels for the columns. It was communicated that this structure was relocated from its initial location, however the details of the relocation means and methods are unknown.

For the structural evaluation, hangar units 2 and 5 were inspected in detail. The structural steel generally did not show any major signs of corrosion and all fasteners were in place and remained snug. However, several structural members appeared to be deflected and or torqued. Cosmetic damage appeared on some of the exterior metal wall panels due to lack of protection from large equipment and/or vehicles.

Unit 5 had some retrofit structural components incorporated. There were additional members connected to the main roof truss and additional columns constructed out of wooden 2 x 4's. A piece of rebar was also welded to one of the z-shaped wall girts. It is unknown when or why these additions were constructed.

Many of the issues observed with this structure appeared to be a result of subgrade issues. The building is proximate to a site with assumed similar soils, which are known to be expansive, where extensive geotechnical measures were taken to mitigate foundation and structural issues. The combination of expansive soils and an assumed undersized foundation system has caused movement of the structure and settlement of the asphalt floor. This settlement has yielded inconsistent movement of the structure, ultimately compromising the frame. More specifically, this has caused deflection in the upper roller track of the suspended hangar doors resulting in poor operation of the

roller mechanism on the sliding doors and sometimes leading to failure. FNL maintenance staff also reported that the doors have been blown off under windy conditions.

Reference page 2 through 5 for hangar measurements and photo documentation in Appendix A.

Hangar 4910-B

Hangar 4910-B has been in service at FNL for approximately 52 years and contains ten units. The units are configured in a full-nested "T" and are approximately 980 square feet each. This hangar building is pre-engineered metal supported by a tapered web I-beam and W8x10 sections for columns.

For the structural evaluation, the southwestern storage unit and hangar units 6 and 8 were reviewed in detail. Both units indicate that the structure is in poor condition, primarily due to the failed column to foundation connections and compounding effects from this poor connection. The following scenarios were observed, sometimes in combination, during the evaluation:

- The column is not anchored with the intended four anchor bolts to the caisson. Some columns were observed to not be anchored at all to the caisson.
- The nuts on the anchor bolts are not properly tightened and/or missing entirely.
- The column is not bearing its load on the center of the caisson. The minimum edge distance from the bolt to the edge of concrete is not maintained.
- The column is bearing on a shim plate, or other material, and is not properly balanced.
- The holes in the column are significantly larger than the anchor bolt, allowing excess movement.
- The concrete caisson is failing by concrete spalling and pullout, resulting in loose anchors.

Based on the frequency and severity of the items summarized above, the structure is not adequately secured to its foundation. The lack of connectivity poses a significant risk to the stored property and the human lives that access the hangars. This risk is assumed to increase particularly under windy conditions where the structure is subject to additional uplift from the lateral forces. Consequentially, the hangar's structural members have been deflected, torqued, or shifted entirely.

The FNL maintenance staff reported various challenges with the operation of the doors of the hangars. The doors have wheels mounted to the bottom where it bears its weight. The doors are mobilized by a two-rail system cast into a concrete pad. A C-channel (location 1) is mounted to the top of the door where the legs are intended to hold the door in place on the beam (location 2), as shown in Figure 2.

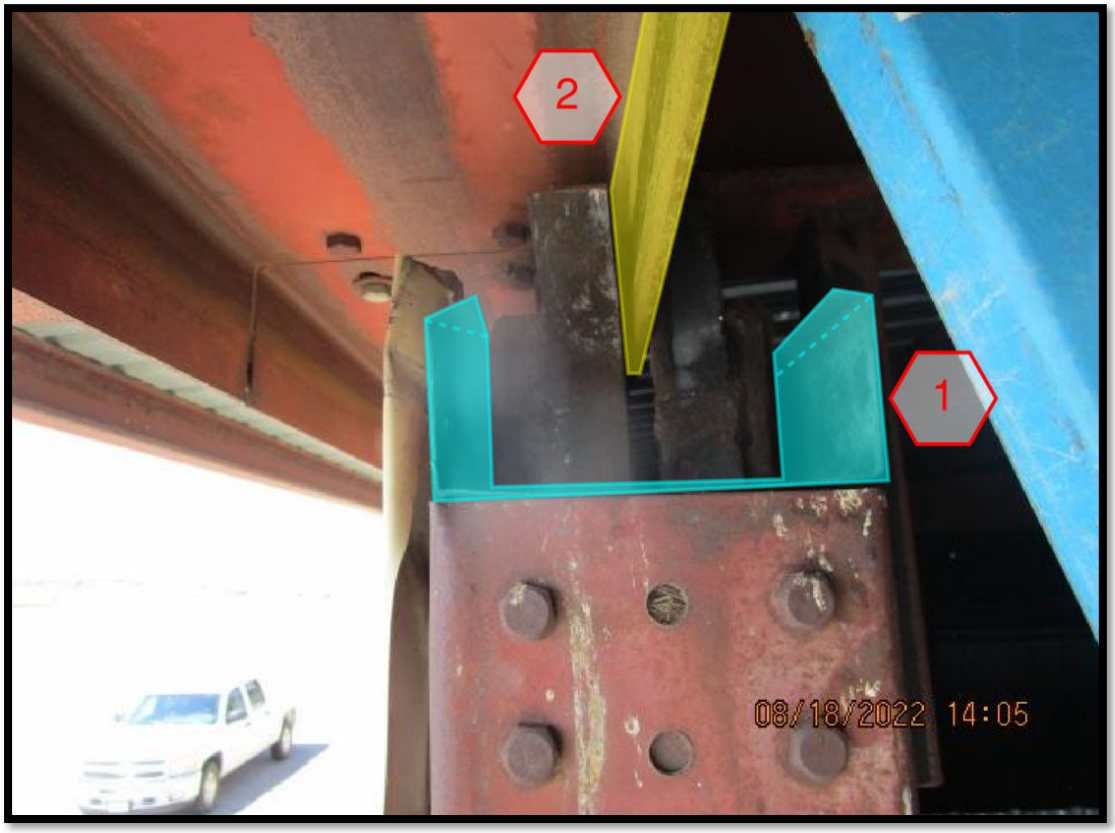


Figure 2

There are on-going issues where the doors are failing as a direct result of the movement and uplift of the structure from its failed foundation connections. The FNL maintenance staff has retrofitted the doors using three methods to mitigate this issue and prevent damage to tenant property housed in the hangars. The three repairs can be referenced in Photo 17, 22, and 28 of Appendix A. While these repairs may be temporarily effective, they do not address the greater issue associated with the hangars and are not recommended as a future repair method.

Additionally, it was observed that the hangar was constructed incorrectly. In Hangar 4910-B (Unit 8) it was observed that the shop-fabricated members were not fully fastened. However, it is unclear if full attachment is necessary based on the original design. Additionally, at the connection between the column and wall girt, there is a welded bracket on the column, as shown in Figure 3. The girt (location 1) has been connected to the underside of the bracket (location 2) and secured with one bolt. Instead, it is assumed that the girt should have been installed on top of the bracket so that the loads would be transferred through the weld and column, rather than relying solely on the bolt. It is also likely that is connection was intended to be fastened with more than one bolt, however without the original plans, this cannot be confirmed. This condition was observed in several instances throughout both units and is assumed to be consistent for the building in its entirety.

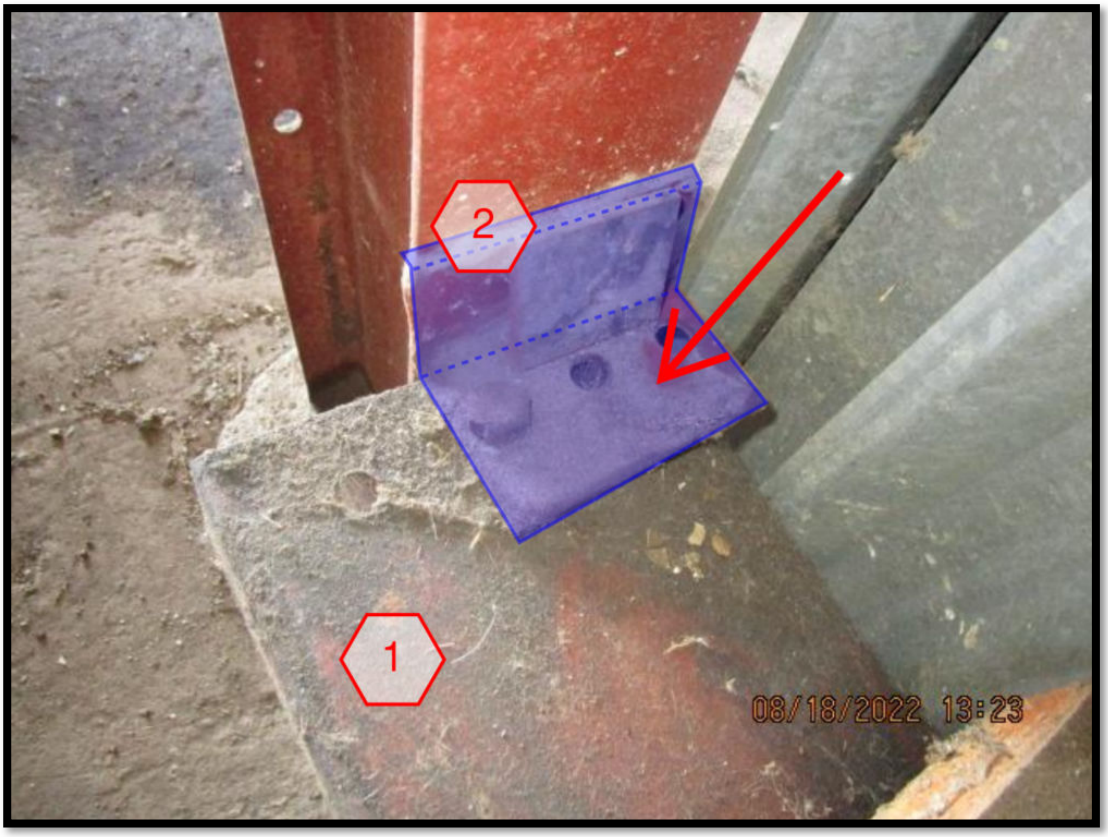


Figure 3

Reference page 6 through 12 for hangar measurements and photo documentation in Appendix A.

Hangars 4930-C and 4960-C

Hangars 4930-C and 4960-C have been in service at FNL for approximately 45 years and contain 20 units per hangar. The units are configured in a standard nested "T" and are approximately 980 square feet each. Both structures are constructed out of a tapered web I-beam and two C-shaped sections for the columns.

For the structural evaluation, unit 2 (4930-C) and unit 15 (4960-C) were evaluated. In general, the steel structure was in poor condition. Degradation of the steel was apparent, resulting in failed structural members and column to foundation connections.

Corrosion was present on the steel columns, anchor bolts, and the hangar door track. In some instances, the corrosion at the column led to pitting of the steel creating an oversized hole at the anchor bolt connection, as shown in Photo 35 of Appendix A. The oversized hole allows excess movement of the structure, or in the most severe cases, provide no connectivity to the foundation. In Hangar 4930-C (Unit 2), the column at Gridline B4 had an anchor bolt completely removed from the foundation. The anchor bolt was severely corroded and assumed to be undersized compared to current industry standards. Additionally, in Hangar 4960-C (Unit 15), the corrosion of the steel resulted in a failed weld at the tension rod connection to the column at Gridline B4.

Another issue was observed as a result of the FNL pavement maintenance. FNL has performed a mill and overlay on the taxilanes adjacent to the hangars. This has resulted in the exterior grade being

higher than the hangar's finish floor elevation, preventing any drainage out of the hangar units. Once water enters the unit through the unsealed roof or perimeter, it has no exit path, leading to a build-up of condensation on the interior of the structure. Excess moisture, in combination with poor ventilation, is assumed to accelerate corrosion of the steel members in the hangar.

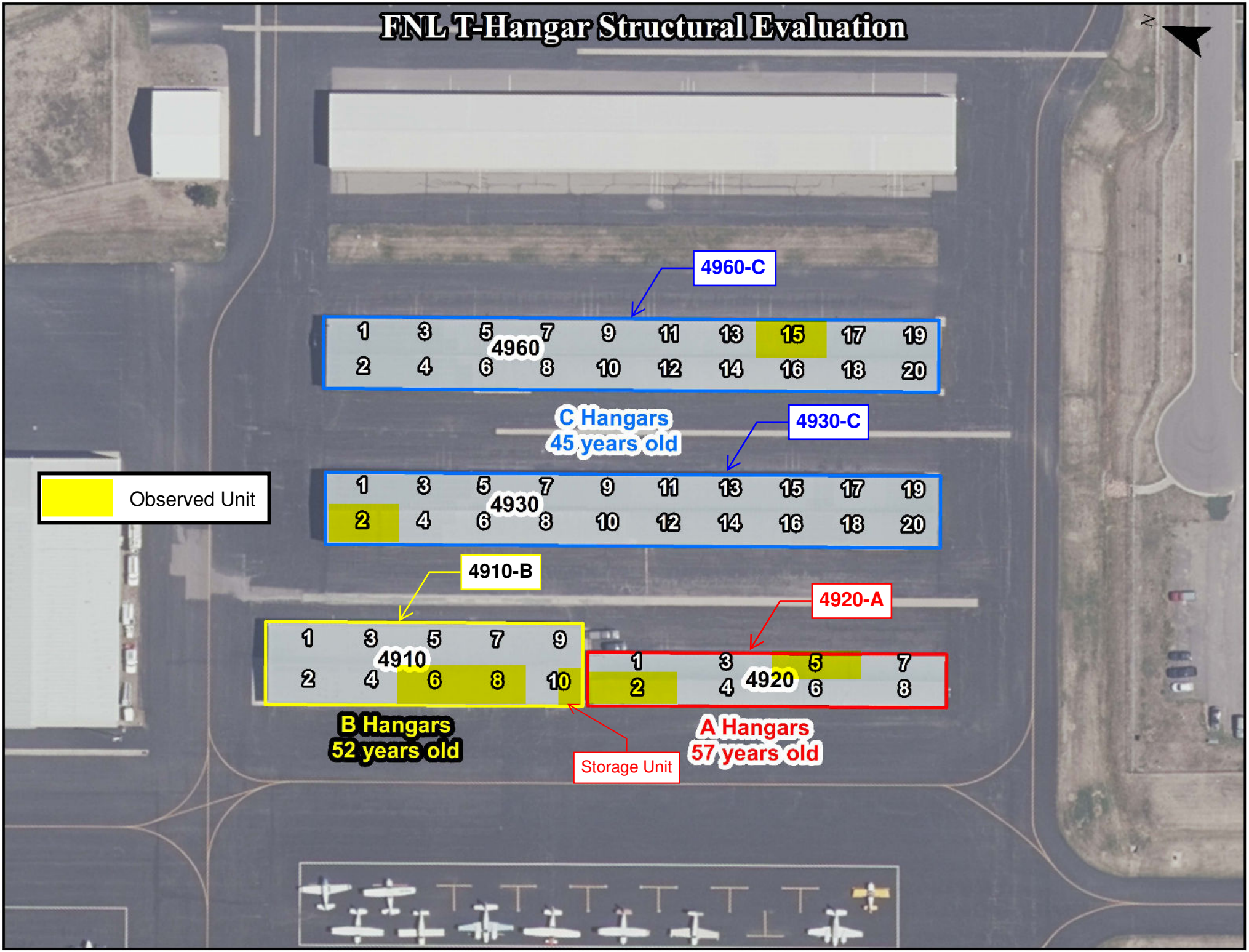
Reference page 13 through 16 for hangar measurements and photo documentation in Appendix A.

Conclusions

All four of the structures were observed to have significant issues with the subgrade, foundation, anchorage, and structural members. The structural framing members are not salvageable due to the on-going damage from wind, snow loading, soil heave, and poor foundational connection and support. The members have been compromised and are torqued, deflected, buckled, and are no longer square. Due to the cumulative effects of the issues observed, there is not an opportunity to implement an isolated repair without addressing the structure in its entirety.

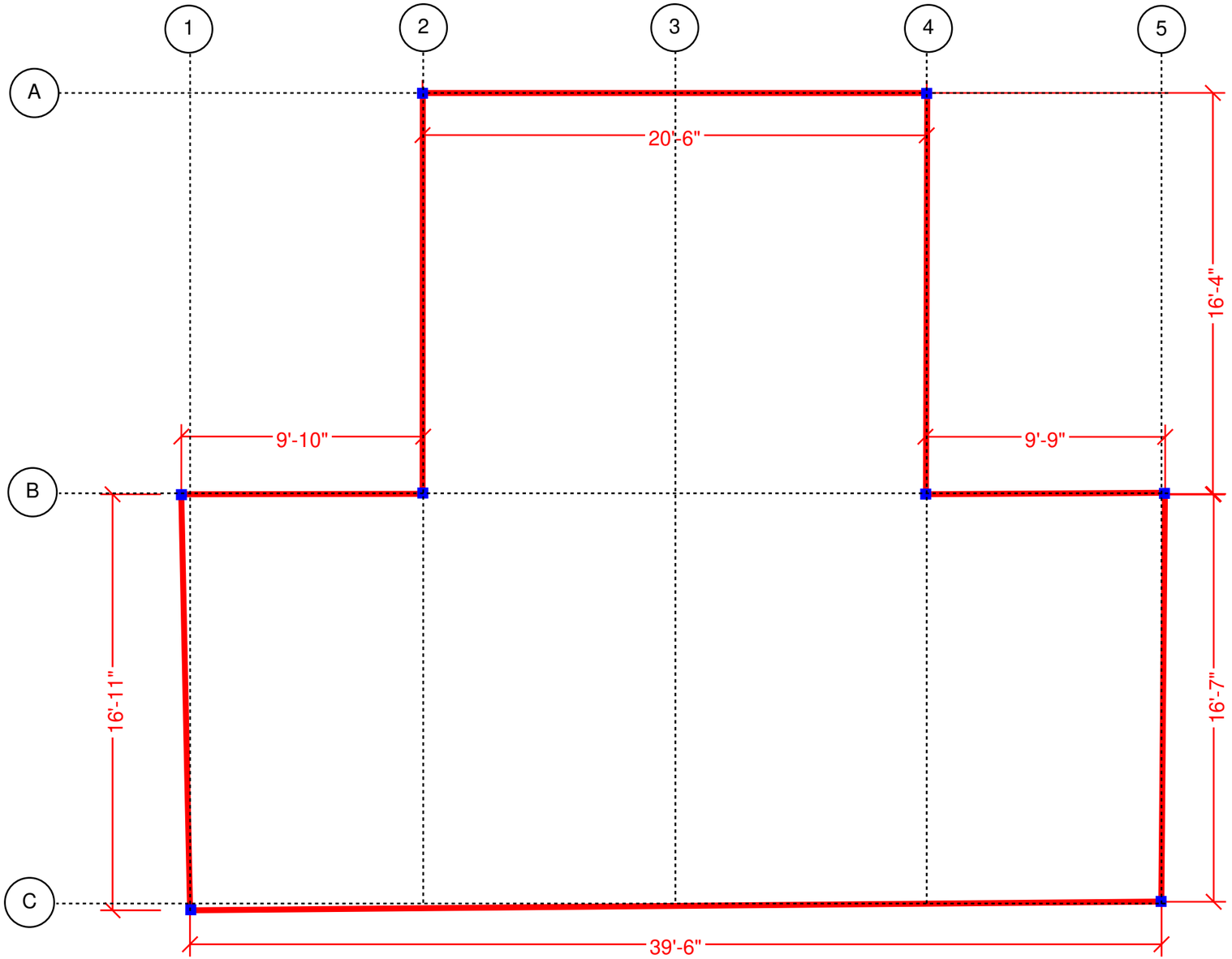
Given the aged structure and observed conditions, it is Ditesco's professional opinion that Hangars A, B, and C have met or exceeded their service life and are not candidates for retrofit to meet current codes. There are no recommendations for remediation to safely extend the lifespan of the hangars.

Appendix A
T-Hangar Observation Report Log


FNL T-Hangar Structural Evaluation
N
4960-C
1 3 5 7 9 11 13 15 17 19
4960
2 4 6 8 10 12 14 16 18 20
C Hangars
45 years old
4930-C
1 3 5 7 9 11 13 15 17 19
4930
2 4 6 8 10 12 14 16 18 20
Observed Unit
4910-B
1 3 5 7 9
4910
2 4 6 8 10
B Hangars
52 years old
4920-A
1 3 5 7
2 4 4920 6 8
A Hangars
57 years old
Storage Unit

HANGAR 4920-A
UNIT 5

SITE LAYOUT



NORTHERN COLORADO
REGIONAL AIRPORT

ditesco
Project & Construction Services

HANGAR 4920-A
UNIT 5

PHOTO LOG

PHOTO 1

Gridline C

Unsuitable, expansive soils are causing the pavement to heave.

PHOTO 2

Gridline A

After market remediation repairs completed. Rebar has been welded to wall girt along its length.

PHOTO 3

Gridline C

The door roller mechanism is in poor condition with misaligned track.

PHOTO 4

Entire Structure

Roof is not properly sealed allowing water infiltration.

PHOTO 5

Gridline B2

20-inch diameter caissons with two anchors connected to the column. Depth of foundation is unknown.

PHOTO 6

Gridline A

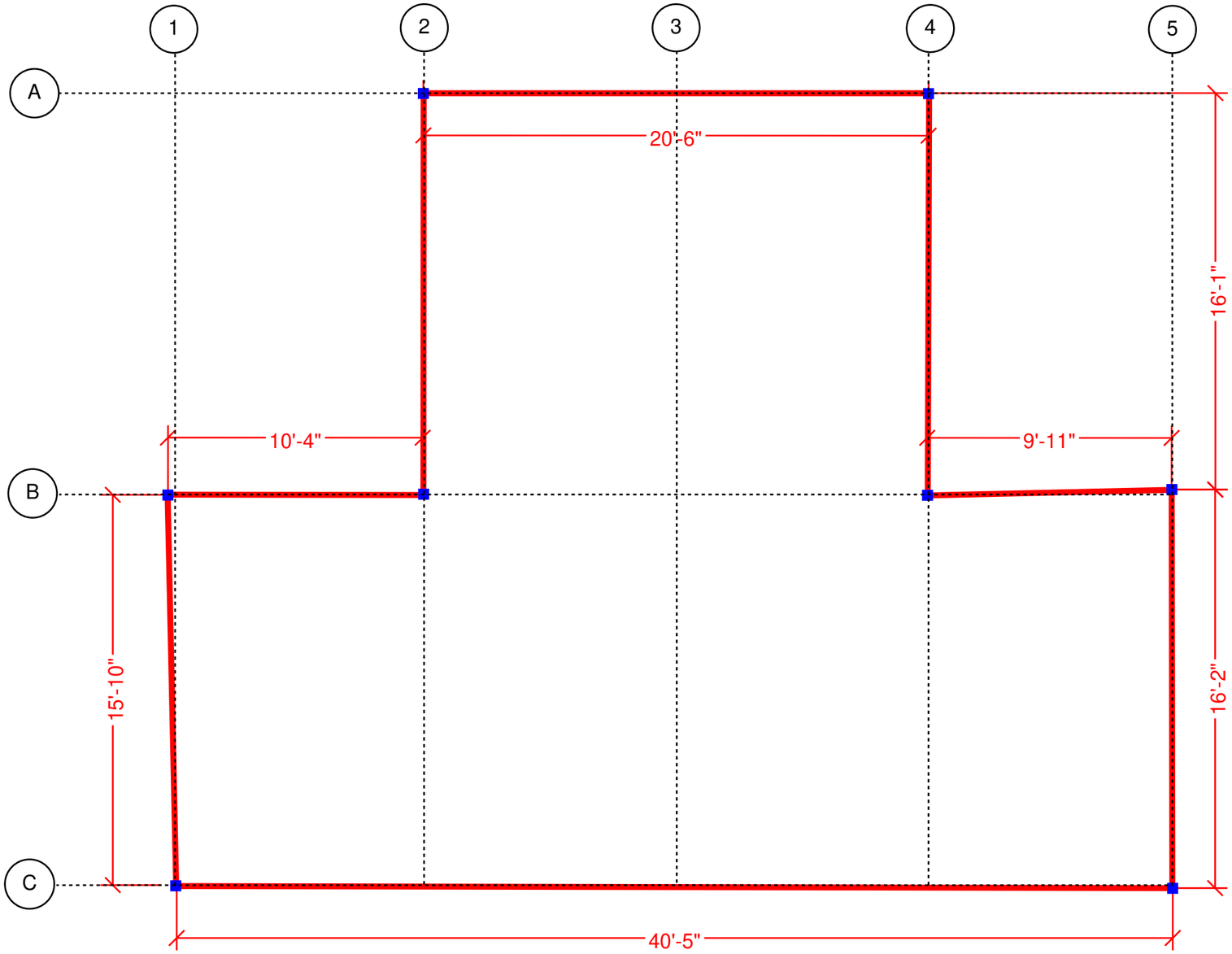
Damage to exterior metal panels.

NORTHERN COLORADO REGIONAL AIRPORT

ditesco Project & Construction Services

HANGAR 4920-A
UNIT 2

SITE LAYOUT



NORTHERN COLORADO
REGIONAL AIRPORT

ditesco
Project & Construction Services

HANGAR 4920-A
UNIT 2

PHOTO LOG

PHOTO 7

Gridline A2

Damage to structural member. Column observed to be torqued in the upper third.

PHOTO 8

Gridline A

20-inch diameter caissons with two anchors connected to the column. Depth of foundation is unknown.

PHOTO 9

Gridline B4 to C4

After market remediation repairs completed. Additional truss members have been added to the double howe truss.

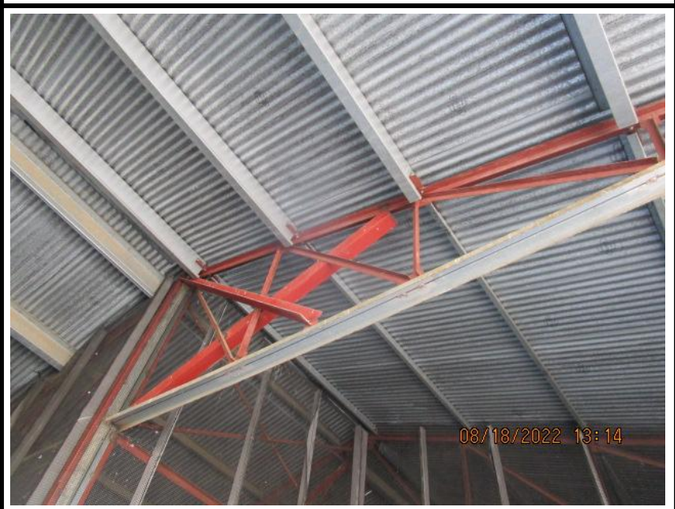


PHOTO 10

Gridline B4 to B5 and B5 to C5

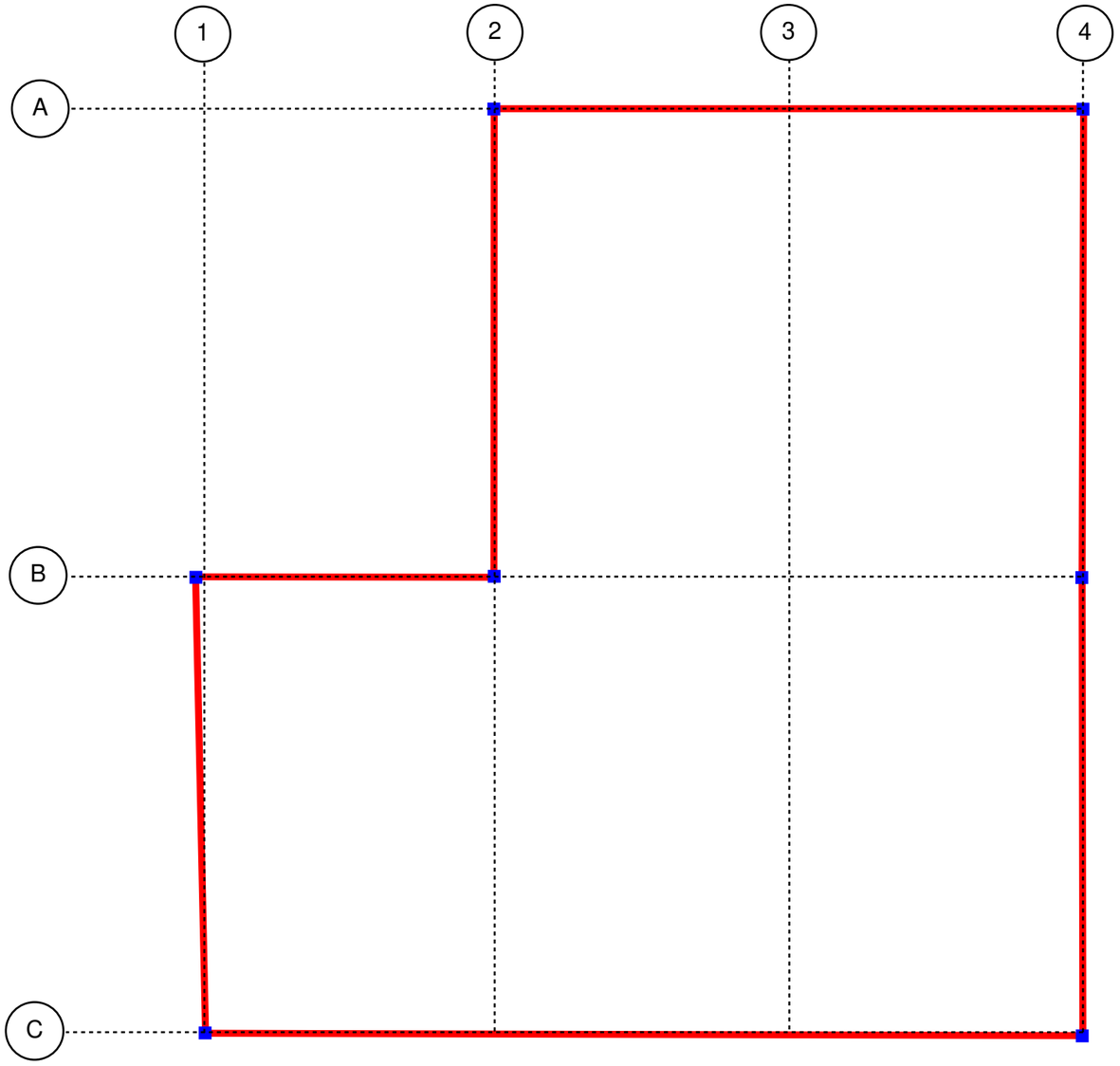
After market remediation repairs completed. Additional 2 x 4's installed as stiffeners for the columns.

NORTHERN COLORADO REGIONAL AIRPORT

ditesco Project & Construction Services

HANGAR 4910-B
STORAGE UNIT

SITE LAYOUT



NOTES:
1. Dimensions of the storage unit were not documented at the time of observation.

NORTHERN COLORADO REGIONAL AIRPORT

ditesco
Project & Construction Services

HANGAR 4910-B STORAGE UNIT

PHOTO LOG

PHOTO 11

Gridline C4

Deterioration of foundation and missing anchors.

PHOTO 12

Gridline B2

16-inch caisson at column connection. Missing anchors and incorrectly bearing on shim.

PHOTO 13

Gridline B2

Incorrect installation of structural members. Wall girt should be bearing on welded bracket.

PHOTO 14

Gridline A2

16-inch caisson at column connection. Anchors are missing the nut and washer. Hole in column is oversized for anchor allowing additional movement. Column is incorrectly bearing on the shim.

PHOTO 15

Gridline A4

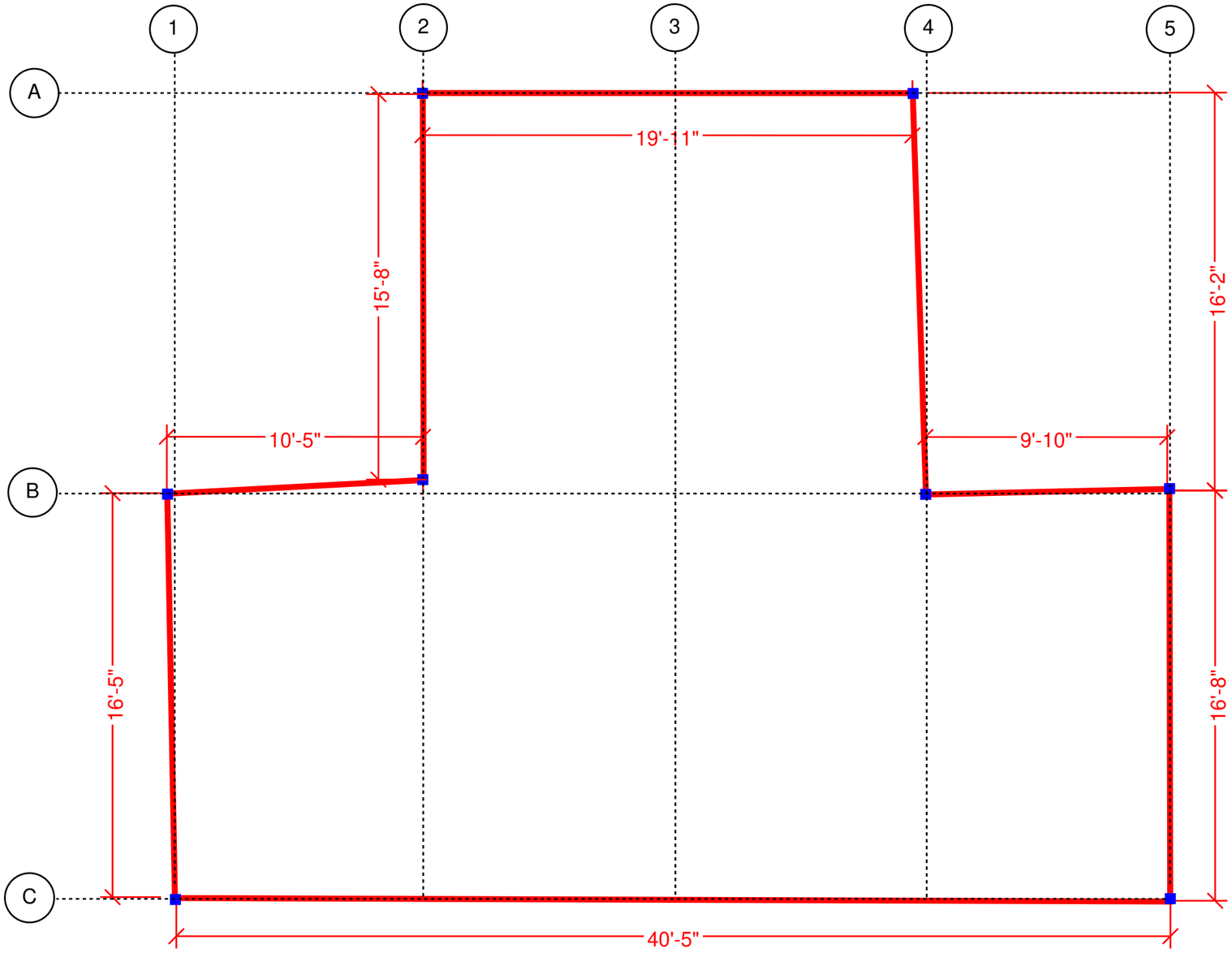
Concrete failure of foundation at anchor location. Anchor is missing nut and washer. Hole in column is oversized for anchor allowing additional movement.

NORTHERN COLORADO REGIONAL AIRPORT

ditesco Project & Construction Services

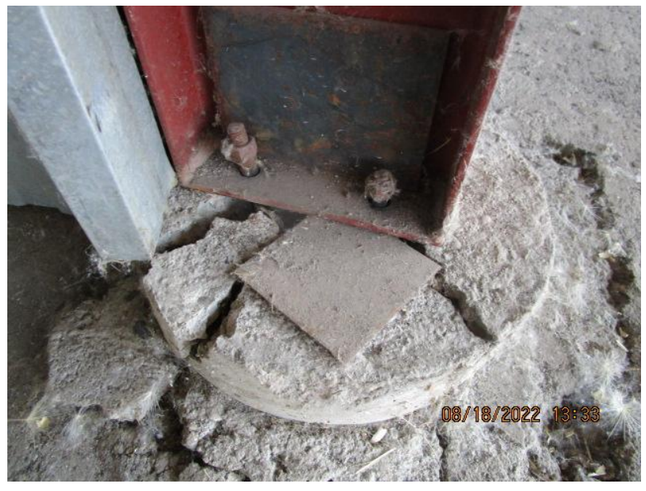
HANGAR 4910-B
UNIT 6

SITE LAYOUT



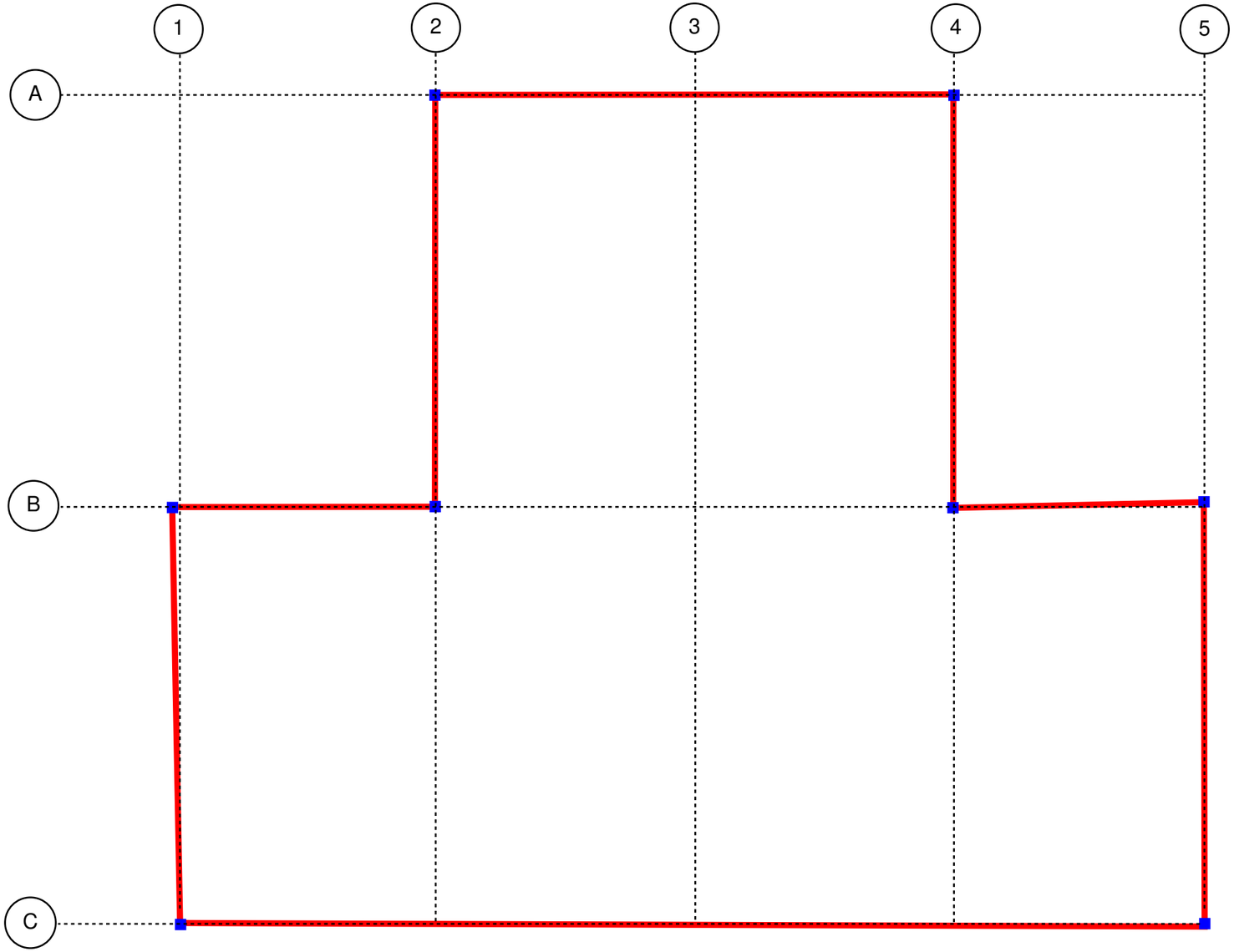
NORTHERN COLORADO
REGIONAL AIRPORT

ditesco
Project & Construction Services

PHOTO 16		PHOTO 19		HANGAR 4910-B UNIT 6 PHOTO LOG
Gridline C Poorly maintained wheel roller mechanism.		Gridline C Poorly maintained rail system for door operation. Concrete degradation adjacent to rails.		
PHOTO 17				
Gridline C4 After market remediation repairs. Cable installed from floor to beam to prevent doors from falling into hangar.				
PHOTO 18				
Gridline B4 Concrete failure of 16-inch caisson at column connection. Anchor embedment is compromised. Anchors are missing washer and nut. Column is incorrectly bearing on the shim plate.				

NORTHERN COLORADO REGIONAL AIRPORT

ditesco Project & Construction Services



HANGAR 4910-B
UNIT 8

SITE LAYOUT

NOTES:
1. Dimensions of the storage unit were not documented at the time of observation.

NORTHERN COLORADO REGIONAL AIRPORT

ditesco
Project & Construction Services

HANGAR 4910-B
UNIT 8

PHOTO LOG

PHOTO 20

Gridline C

Poorly maintained rail system for door operation. Concrete degradation adjacent to rails.

PHOTO 21

Gridline C

Shop-fabricated members are not fully fastened. Unclear if full attachment is necessary based on original design.

PHOTO 22

Gridline C

After market repairs to prevent door failure. Additional steel plates were welded on either side of door frame to prevent door from caving in or falling outward.

PHOTO 23

Gridline B1

Column is not centered on foundation, preventing proper load transfer. A single anchor bolt is cast in the concrete and the minimum edge distance is not maintained.

PHOTO 24

Gridline B2

Failed concrete causing imbalanced heaving of column. Anchor bolts are corroded and entirely removed from column connection.

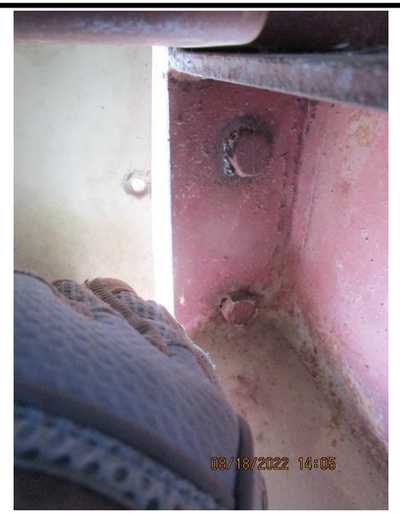
PHOTO 25

Gridline B2

Failed concrete causing imbalanced heaving of column. Anchor bolts are corroded and entirely removed from column/concrete connection.

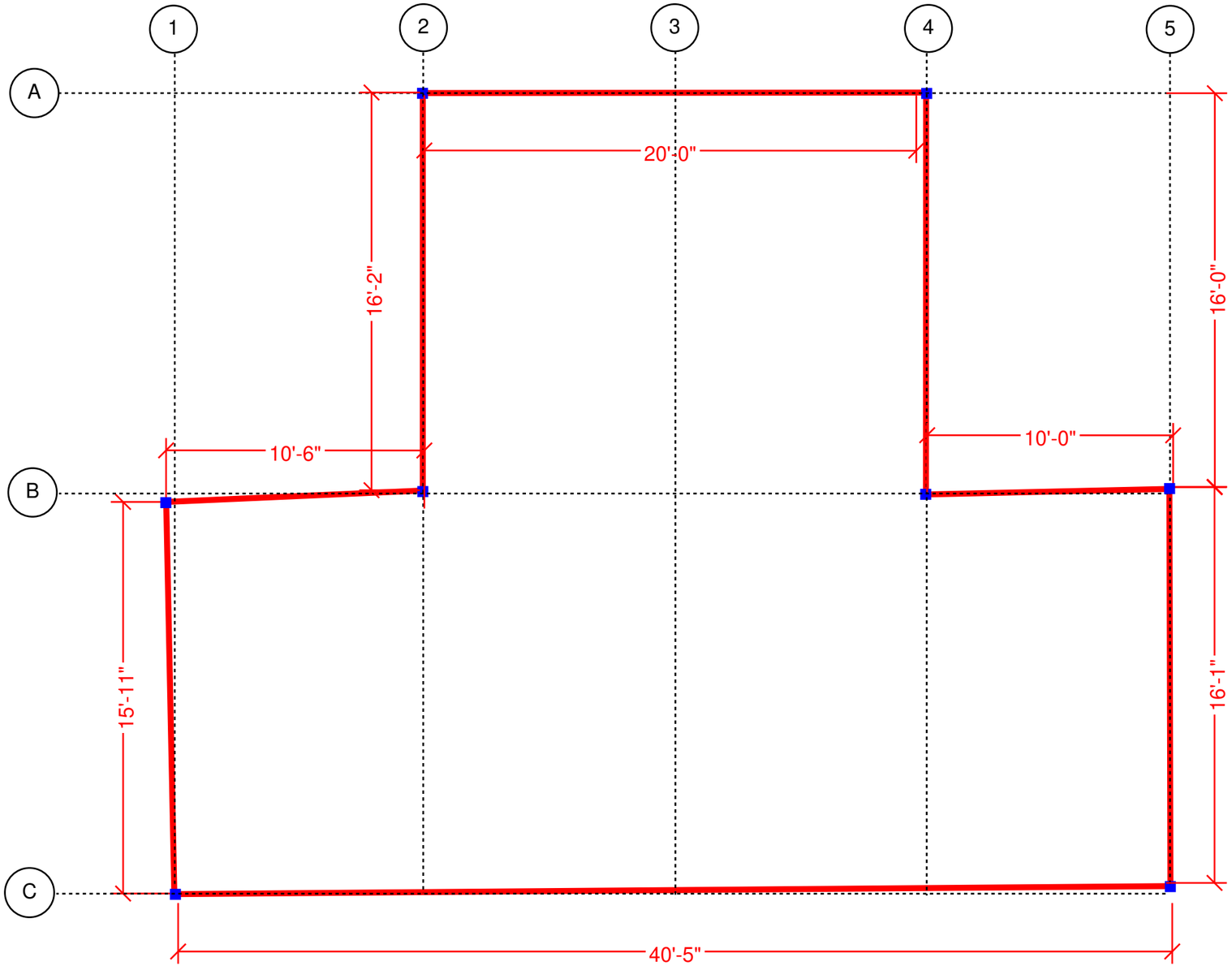
NORTHERN COLORADO REGIONAL AIRPORT

ditesco Project & Construction Services

PHOTO 26 Gridline B4 Failed concrete causing imbalanced heaving of column. Anchor bolts are corroded and entirely removed from column/concrete connection.		PHOTO 29 Gridline C2 Corrosion of structural members.		HANGAR 4910-B UNIT 8 PHOTO LOG
PHOTO 27 Gridline B4 Failed concrete causing imbalanced heaving of column. Anchor bolts are corroded and entirely removed from column/concrete connection.				
PHOTO 28 Gridline A After market repairs to prevent door failure. Additional HSS tubes were welded on either side of door frame to prevent door from caving in or falling outward.				NORTHERN COLORADO REGIONAL AIRPORT ditesco Project & Construction Services

HANGAR 4930-C
UNIT 2

SITE LAYOUT



NORTHERN COLORADO
REGIONAL AIRPORT

ditesco
Project & Construction Services

HANGAR 4930-C
UNIT 2

PHOTO LOG

PHOTO 30

Gridline C

Mill and overlay maintenance has resulted in taxilane grade higher than hangar finish floor, resulting in poor drainage.

PHOTO 31

Gridline C1

Corrosion of steel. Column loads bear poorly on foundation.

PHOTO 32

Gridline A

Corrosion of steel.

After market remediation repairs to maintain functionality of the doors.

PHOTO 33

Gridline B4

Anchor completely removed from connection. Anchor is corroded and likely undersized.

PHOTO 34

Gridline B4

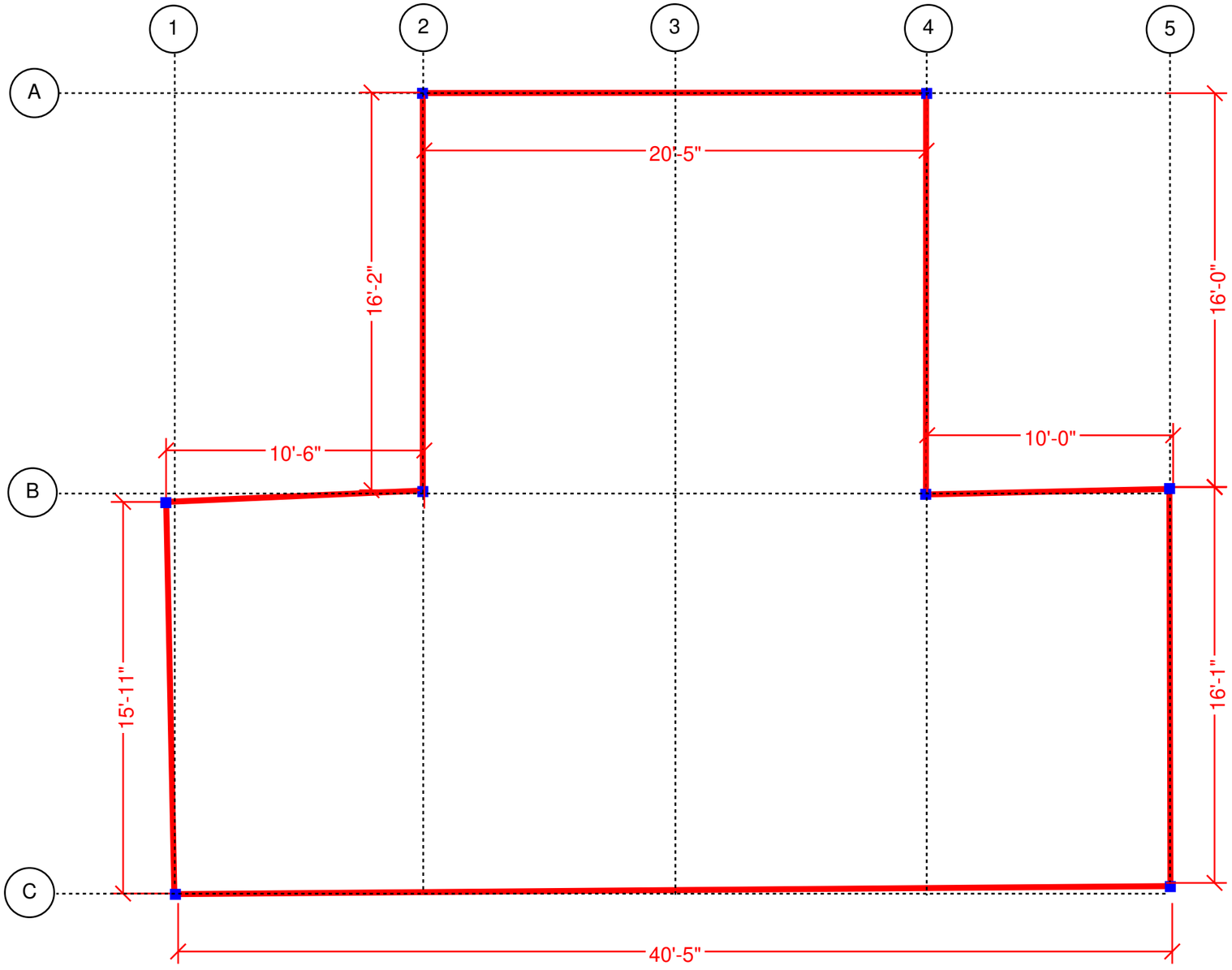
Corrosion of steel at column to foundation connection.

NORTHERN COLORADO REGIONAL AIRPORT

ditesco Project & Construction Services

HANGAR 4960-C
UNIT 15

SITE LAYOUT



NORTHERN COLORADO
REGIONAL AIRPORT

ditesco
Project & Construction Services

HANGAR 4960-C
UNIT 15

PHOTO LOG

PHOTO 35

Gridline C1

Corrosion of steel column resulting in oversized hole at anchor bolt location. Column is not anchored to concrete at this location.

PHOTO 36

Gridline B4

Corrosion of tension rod and column.

PHOTO 37

Gridline B4

Side view of failed weld at tension rod connection to column.

PHOTO 38

Gridline B4

Top view of failed weld at tension rod connection to column.

PHOTO 39

Gridline C5

Corrosion of tension rod.

PHOTO 40

Gridline C5

Corrosion of column and anchor bolt. Column load bears poorly on foundation.

NORTHERN COLORADO REGIONAL AIRPORT

ditesco Project & Construction Services

ditesco
Project & Construction Services

2133 S Timberline Road, Suite 110
Fort Collins, CO 80525
ditescoservices.com

Delivery by email
Aaron.ehle@cityofloveland.org

February 5, 2023

Mr. Aaron Ehle
City of Loveland
Northern Colorado Regional Airport
4900 Earhart Road
Loveland, CO 80538

RE: FNL T-Hangar Structural Evaluation
Additional Engineering Inspection

Dear Aaron:

This letter follows Ditesco's site investigation of the T-Hangars at FNL Airport in August 2023 and subsequent Technical Memorandum dated September 20, 2022. As identified in the referenced Technical Memorandum, the T-Hangars have significant structural issues including:

- Concrete structural foundation failure
- Column to foundation anchorage failure
- Untreated subgrade
- Missing or damaged hardware
- Misplaced structural column load bearing
- Deformed structural members
- Failed tension rod connections
- After-market structural additions such as additional angle and stiffeners
- Additional issues, as identified in the Technical Memorandum

Following this memorandum, FNL staff has been requested to procure additional engineering investigation to complete a more comprehensive structural condition sampling within the T-Hangars. Engineered metal buildings, such as the T-Hangars, are designed with engineered loads distributed across the entire structure. With the structural conditions witnessed during the initial field inspection, it is highly anticipated that similar conditions exist throughout the remaining structure.

It is our professional opinion that regardless of condition in the remaining T-Hangars, the condition witnessed in the inspected units is not salvageable and the structure is not a candidate for retrofit. Based upon the observed condition of the T-Hangars, it is our professional opinion that the T-Hangars have met or exceeded their useful design life and additional analysis of the T-Hangars will yield the same result.

Sincerely,

Jill Burrell

Jill Burrell, PE

Cc: Kelsey Madsen, PE

ditesco
Project & Construction Services

2133 S Timberline Road, Suite 110
Fort Collins, CO 80525
ditescoservices.com

Delivery via email to:
Jason Licon Jason.Licon@cityofloveland.org

March 7, 2023

Mr. Jason Licon
Airport Director
Northern Colorado Regional Airport (FNL)
4900 Earhart Road
Loveland, CO 80538

RE: FNL T-Hangar Structural Evaluation - follow up

Dear Jason:

This letter follows on our March 7, 2023 conversation regarding the FNL T-Hangar structural condition assessment. Your request for further clarification regarding the results of our September 20, 2022 report and February 5, 2023 letter are provided below.

1. Ditesco's scope of services was to perform a limited structural inspection to gain a high-level understanding of the existing condition of the metal hangar buildings. Our work was not meant to be, nor was it, a comprehensive structural evaluation of the existing, individual, hangars. Our scope of work contained two primary tasks:

    a. Complete a visual inspection of a sample of the hangars.
    b. Prepare a technical memorandum summarizing our inspection and develop potential costs to retrofit the existing structures to extend their useful life 2 to 10 years.

2. As you know, Ditesco staff inspected 6 hangars (10% of the total number). Upon our inspection, we discovered buildings that were of a deteriorated condition containing failed, or failing, structural elements including foundational parts of the buildings. We further noticed modifications to various building structural supports.

3. From this inspection, we discussed findings with FNL staff noting that developing retrofit alternatives for the current hangar condition would be very difficult. Building code requires that if a retrofit is contemplated, the building (or those parts modified) would need to be improved to meet current building code standards.

4. Modifying building foundation elements, stiffening the structural frame and possibly replacing the exterior skin elements would be likely improvements needed to meet current building codes through a retrofit. Considering these building modifications, a simple conclusion was derived that the buildings have served their useful life, and that any retrofit would not provide a reasonable return on a repair investment (through additional years of service). The retrofit necessary may be more expensive than a replacement alternative. Due to this, we did not prepare retrofit cost estimates.

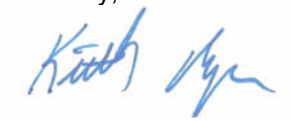
5. Thus, our overarching conclusion based on our abbreviated, limited, inspection and factors outlined above, remains that the buildings could not be reasonably retrofitted to extend their service life meeting current building code standards.

Since the release of our report and subsequent meetings with FNL staff, we now understand FNL has taken action to cancel hangar leases over the next several months to remove the risk of building failure. Please note our analysis and report was done to understand existing building condition and develop retrofit alternatives. While we noted occupancy risk in our report, we were not contracted, nor did we perform failure analysis of the structures.

Throughout this process our staff have been asked if the hangars are “safe”. As practicing professional engineers, our greatest obligation is to hold paramount the safety, health, and welfare of the public.

Here, again, we feel continued use of the hangars presents risk to the occupants and FNL. However, further evaluation of the structures could certainly be completed to verify the high-level conclusions in our report and to analyze failure scenarios. It is only through this level of effort that a complete understanding could be gained to deem the structures code compliant (or not) and “safe”. This effort is outside of our contracted scope of work.

Sincerely,



Keith Meyer, PE

Cc: Kelsey Madsen, PE
Jill Burrell, PE
file