ARTIBUS DESIGN
ENGINEERING AND PLANNING

Structural evaluation report

of exposed walls, columns, beams, and slabs affected by concrete spalling.

**Structural Complex housing Port Operations,
Waterfront Brewery, Retail, and other uses.
201 William St, Key West, FL 33040**

Prepared for

City of Key West Port and Marine Services

July 19, 2019

**By:
Artibus Design LLC,
3706 N Roosevelt Blvd, Suite i-208**

Digitally signed by Serge Mashtakov P.E. 71480 State of Florida
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Date

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Figure 1. Site Map

Introduction

Existing complex of structures consisting of one and two-story spaces housing multiple tenants including Seaport Operations offices, the Waterfront Brewery restaurant, retail spaces and other uses. According to Monroe County Property Appraiser website, the gross building area of the complex is approximately 33,200 ft^2. and the finished building area is approximately 46,300 ft^2. One building in this complex was first built in 1970s with the remaining three buildings in this complex in 1992. There were major improvements performed during the periods 1996-2000 and 2012-2015. The approximate site location is shown as a red circle in Figure 1.

The building structure consists of CMU (concrete masonry unit) walls, concrete tie columns, concrete beams and precast concrete roof and floor decks. Similarly, to other buildings from that era, this building is also experiencing significant effects of concrete spalling and cracking at various locations.

The City of Key West has requested a professional opinion of the current condition of the building, the extent of repairs required (if any) and the corresponding cost estimate for the repairs.

This report is based on the information gathered during the site inspection by Serge Mashtakov P.E. on March 21th, 2019, March 25th, 2019 and July 5th, 2019

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Inspection Procedure

Structure was visually inspected from inside and outside. Only exposed elements were inspected, subgrade conditions and any covered elements were not inspected. Site measurements were taken during the site visit. The as-built drawing provided by the City of Key West was reviewed and is included as a reference in this report.

Background and Findings

The building is an irregularly shaped building. Its longest dimension is 186 ft long by 107ft wide. The building structure is a frame structure consisting of cast-in-place concrete columns with prestressed T-beams supporting concrete roof. The exterior perimeter of the building is load bearing unreinforced CMU infill walls topped by a cast-in-place tie-beam at its mid-height and at the top. The height of the wall is approximately 26 ft (varies).

The as-built drawing provided by the City of Key West printed on a 11”x17” paper sheet and is provided as a supplement to help navigate this report. The attached drawing of the building shows markers with numbers next to each of them which depict the locations of damage in the building. Damaged beams are shown as lines without any numbers assigned to them. The pictures provided in the report **shall be looked at concurrently with the location numbers on the attached building drawing (Appendix B)** to get a better understanding of the report.

Figure 2. Front Elevation near roundabout. Location 1: Diagonal crack in the corner of CMU Wall and the corner column.

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Figure 3. Front Elevation near roundabout. Location 2: Diagonal crack in the CMU Wall and vertical cracks in column developing at its top. Some spalling of concrete in column visible as well.

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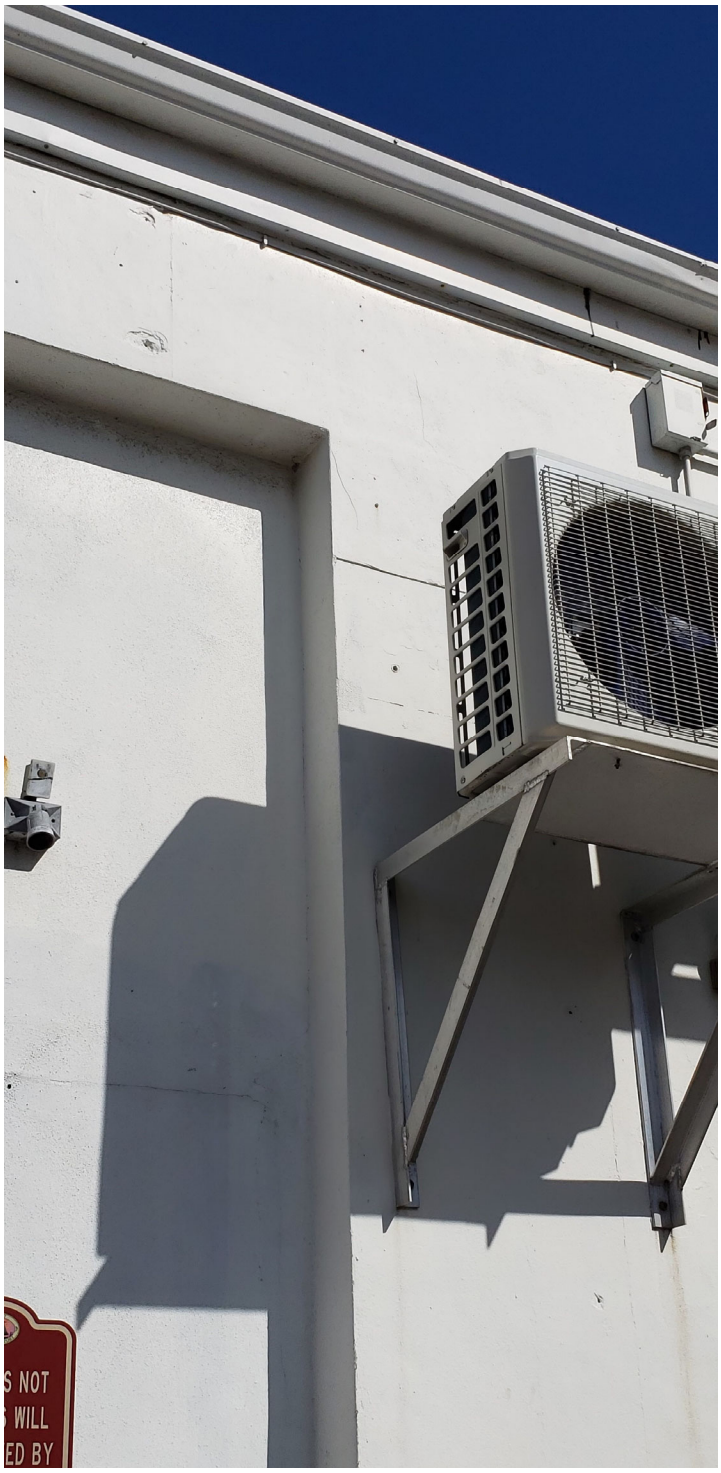

Figure 4. Front Elevation near roundabout. Location 3: Cracking developed in the CMU wall. Light Cracks and spalling observed in the column.

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Figure 5. Front Elevation near roundabout. Location 4: Horizontal tie-beam cracks seen near the AC units. Vertical cracks at the top of the CMU wall also develop above the horizontal cracks in the tie-beam.

Figure 6. Interior of the Building. Location 4: The interior portion of the column is heavily cracked. Large diagonal cracks along with concrete spalling is observed. Existing electrical conduit is supported to a pipe sitting in the damaged portion.

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Figure 7. Location 5: Horizontal CMU wall cracks have formed.

Figure 8. Location 6: Diagonal step ladder cracking on the CMU wall formed as seen next to the concrete frame perpendicular to the wall.

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Figure 9. Location 7: Diagonal cracks in the wall developing

Figure 10. Location 8: Diagonal cracks in the wall developing here as well.

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Figure 11. Location 9: Spalling cracks in the wall (corner tie-column).

Figure 12. Location 9-12. Wall shown between location 9 and location 12. The wall panels have extensive cracking in the tie-beam at the mid-height of the wall. The 4 columns at location 9, 10,11 and 12 have heavy spalling and cracking of concrete.

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Cracks in the walls have been repaired with sealant in the past repair works. All this can be observed in figures 12-16.

Figure 13. Tie-beam cracks in wall panels (mid-height of the wall).

Figure 14. Location 10: Cracking in the column consistent with progressive spalling.

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Figure 15. Location 11: Heavy cracking and spalling in the column. Please note that some of the cracks are not as obvious since they are covered by elastomeric paint and sometimes sealant.

Figure 16. Location 12: Heavy cracking and spalling in the corner column

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Figure 17. Location 12: Corner column heavy cracking

Figure 18. Front Elevation facing Caroline St.

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Figure 19. Location 13. Near the front entrance.

Figure 20. Location 13: Cracking in the wall and some spalling of concrete observed.

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Figure 21. Front Entrance. Location14: Crack formation in the side of the opening.

Figure 22. Front Entrance. Location 15: Cracks in the wall forming above the entrance door. (likely spalling of the tie-beam or header).

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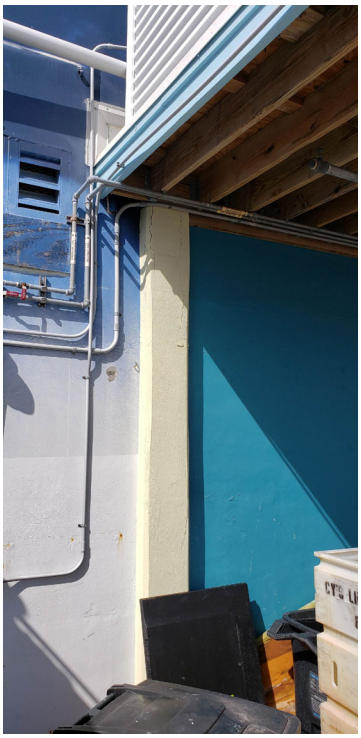

Figure 23. Location 16: Cracking in concrete column at close to mid-height seen. Please note that bottom of these columns were likely to be repaired previously and re-occurring spalling is consistent with the limited area repair approach.

Figure 24. Location 17: Well developed cracks in the column center.

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Figure 25. Location 18: Developed spalling cracks in the bottom of column.

Figure 26: Location 18: Heavy cracking in the column closer to its top observed.

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Figure 27. Between Location 18 and 19: Heavy cracking at the bottom the tie-beam.

Figure 28. Location 19: Heavy cracking in the column at its mid-height approximately.

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Location 20: Damage is similar column 29.

Figure 29. Between Location 20 and 22: The tie-beam has extensive cracking the top.

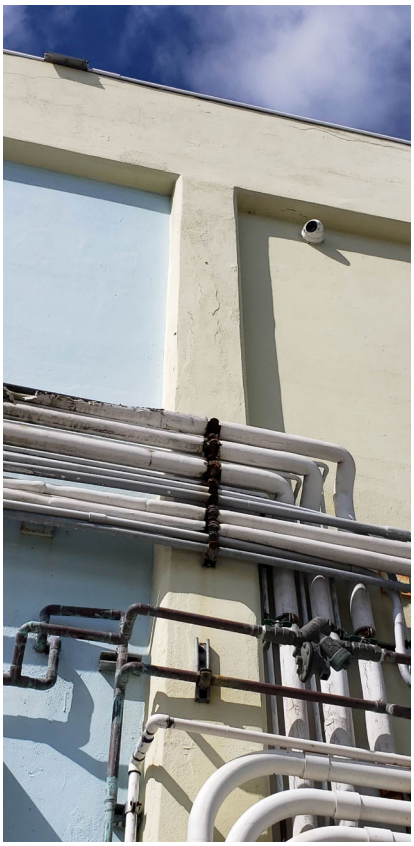

Figure 30. Location 21: Heavy spalling of column around electrical service and conduits. Typical condition due to multiple penetrations, electromagnetic currents and difficulty of proper paint and maintenance of the area.

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Figure 31. Location 22&23: Same as location 21. Heavy damage of the concrete corner and wall.

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Figure 32. Location 24. Column is witnessing light cracking and spalling of concrete at second floor.

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Figure 33. Location 25: Cracks in the wall (likely horizontal tie-beam spalling).

Column at location 26 has developed cracks, some concrete spalling and wear and tear.

Figure 34. Between location 25 and 26. Above the staircase, the concrete tie-beam at the top has significant cracking in it. Heavy spalling and delamination of the concrete

At location 27, the concrete in the column is spalling and lighter cracking.

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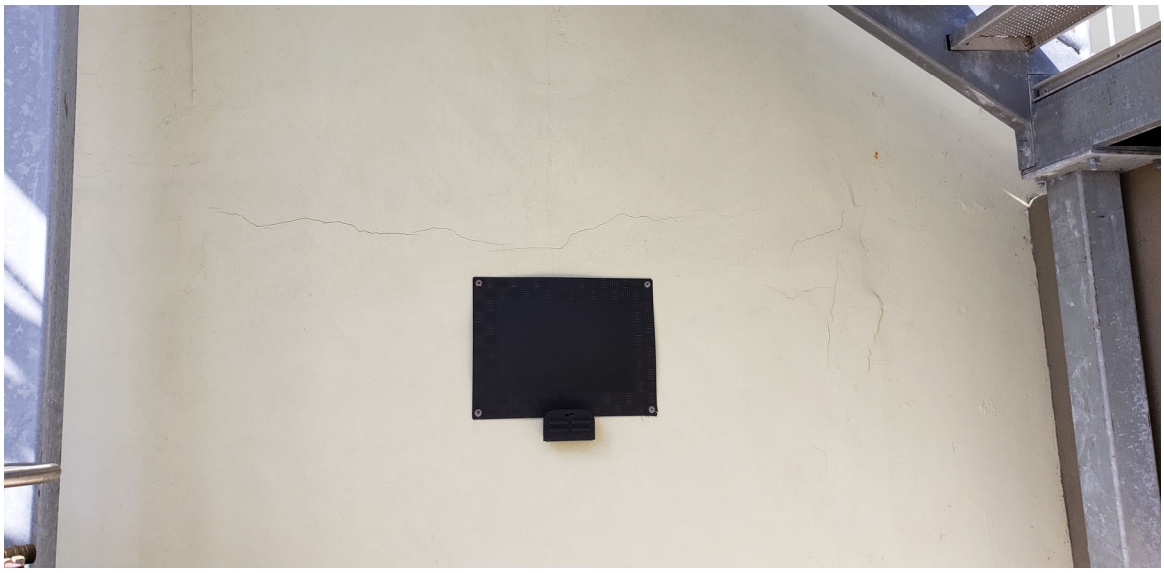

Figure 35. Location 28: Cracks formed in the wall in this area underneath the staircase as well.

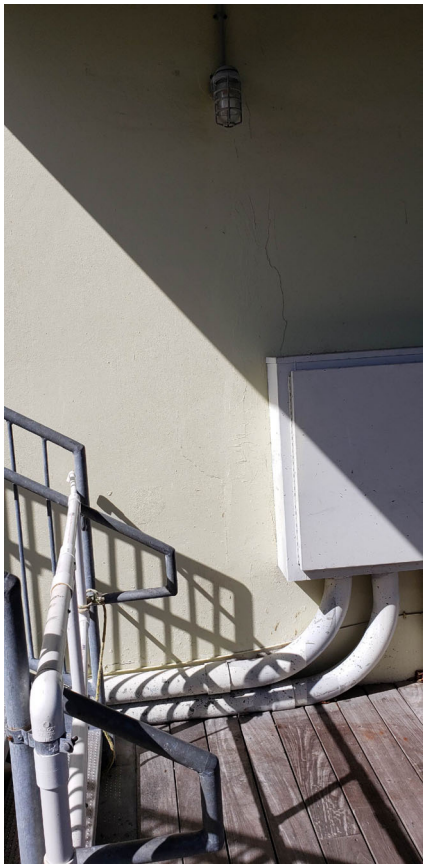

Figure 36. Location 29: Concrete spalling in the column and cracks developing.

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Figure 37. Location 30: Concrete spalling in the wall coupled with several cracks.

Figure 38. Location 31: Corner of the column showing concrete spalling covered with paint and sealant.

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Figure 39. Location 31: Cracks developing at the corner in the wall.

Figure 40. Location 32: Vertical cracks has formed in the column by the door.

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Like the column at location 32 in Figure 39, there are small cracks in the column at location 33.

Figure 41. Location 34. Heavy damage in the column nearly next to entry to waterfront brewery from board walk side.

Figure 42. Location 35. Small vertical cracks in the column have formed at its mid-height and at the bottom.

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Figure 43. Location 36. Vertical cracks in the column starting from the bottom to its mid-height.

Figure 44. Location 36. Horizontal cracks in the wall can be seen developed above the door.

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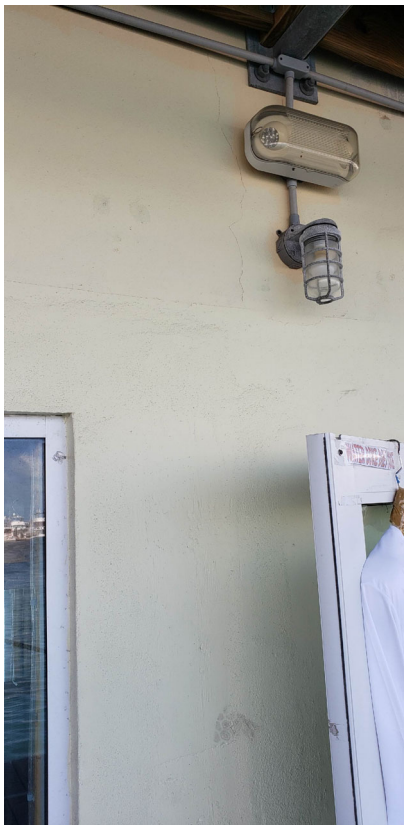

Figure 45. Location 37&38. Horizontal and vertical cracks in the wall propagating spalling of tie beams.

Figure 46. Location 39: Light cracking and spalling of concrete beam above low windows.

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Figure 47. Location 40: Large cracks and heavy spalling of concrete in corner column.

Figure 48. Location 41: Step ladder cracks in the wall starting from roof level propagating downwards. Likely related to incidental settlements of foundations.

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Figure 49. Location 42. Step ladder cracks visible propagating further down

Figure 50. Location 43: Cracks forming in the wall at roof level. Please note that top of roof level tie-beam is concealed with fascia board and gutters. Likely more similar spalling will be observed.

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Figure 51. Between location 43 and 44: Significant cracking along the tie-beam at mid-height of the wall has occurred.

Figure 52. Location 44: Cracking in the tie-beam is continued here from Figure 50 as well. The portion of the wall above the tie-beam is also experiencing vertical cracking (bottom left corner of the top window).

Figure 53. Location 44: The tie-beam above the window on the second floor at location 44 is getting large horizontal cracks.

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Conclusions and Recommendations

Based on my evaluation and analysis of the building condition, my professional opinion is that the concrete elements of the building structural elements experience significant spalling damage (severe in some location) and require repairs within next 2-3 years. Some locations (identified as heavy damage in the report) shall be repaired sooner to safeguard from falling debris hazard for building occupants and general public.

The reasons for damage in columns, beams and walls is due to one or more of several factors such as the age of the building, possible settlement of foundation, weathering of concrete, surrounding chloride environment in the humid air, propagation of damage etc. The extent of repairs required depends on the extent of the damage. Heavily damaged columns require full replacement while the columns with lesser damage, or small cracks would not require full replacement. Instead, smaller areas of columns or beams can be replaced with use of galvanic anodes on the edges of old and new concrete to slowdown the propagation of cracks. Similarly, the tie-beams with heavy damage shall require full replacement while the ones with little damage or no damage and with cracks shall be patched with new concrete. During the repair of any element, proper shoring must be provided to support the structure being repaired wherever necessary.

Column Repair:

The columns that require total replacement are located at Locations **4,9,10,11,12,18,22 and 40.** Temporary shoring and bracing for beams and walls at respective column locations must be provided to provide structural safety to the occupants and the public. The columns, after the supported structure is supported temporarily, shall be demolished till the top of the existing foundation they rest on. The reinforcement cages of the new column would be doweled into the existing foundation. Subsequently, fresh concrete can be then cast once the reinforcement is in place.

The column at location **34** requires new installation of a concrete column as well. Because the location of this column is situated in an area with large public presence throughout the day, we recommend a less-invasive approach. New casting of column would interfere with the businesses and flow of pedestrian traffic along main boardwalk of the port. The replacement of the column would provide much more efficient and lasting An approved galvanic anode must be attached inside the column opening before new concrete is cast in the required patch region. Use of the anode would increase the durability of the repairs done. This approach will not resolve the issue permanently though. It is up to the discretion of the City of Key West whether to repair the column without complete removal or to demolish the column and cast a fully new one at its place.

The columns at locations **1,2,3,16,17,19,20,21,24,26,27,29,31,32,33,35,36** and **38** show lesser cracking and damage than the rest of the columns. Thus, the columns only require smaller and less invasive repairs of concrete in the region of cracking. In parts where concrete is removed all corroded reinforcement must be cleaned by mechanical means (recommended use of needle scalers), sistered with new

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reinforcement if significant loss of section is observed > 10%, primer and galvanic anodes installed prior new concrete placement.

Tie-Beam Repair:

The cast-in-place concrete tie-beam between locations **9 and 12, 18 and 19** and **43 and 44** needs to be removed completely and be replaced with new tie-beams that shall be cast with new concrete and new rebar. The tie-beams between location **9 and 12, and 43 and 44** are approximately located at the mid-height of their walls. The one between location **18 and 19** is located at the top of the wall. Once the temporary supports are provided to the structure supported by the tie-beams, the beams can be demolished in a set of segments. Each set would be demolished, new rebar will be placed, and casting of fresh concrete shall follow. Remaining sets of segments of the beams would be cast one at time to ensure structural integrity of the building. Proper lapping of reinforcement between segments would need to be provided by the means of doweling into existing segments.

The beams at location **4,** between location **25 and 26** shall be repaired in a similar way to the less-invasive method recommended for the column at location **34.** The repair of these beams would require the galvanized anodes between the old concrete and new concrete unless whole sections of the beam are replaced entirely without any existing reinforcement embedded into new cast.

The walls around the perimeter of its building have also experienced cracking and spalling of concrete at discrete locations on the walls. As shown by the pictures, different types of cracking such as step ladder cracking, diagonal cracking, vertical cracking, and horizontal cracking have taken place in the walls. These cracks would need to be repaired with an engineer approved sealants and elastomeric paint. The masonry is likely not to have any vertical cell reinforcement and any mortar bed wire reinforcement is likely to be completely corroded away. In my professional opinion CMU cracks observed are mostly cosmetic and could be related to the secondary effects of concrete spalling of columns and beams, some incidental settlement of foundations and structurally non-critical.

Since large number of areas needing concrete repairs is identified – the building will require complete repainting of exteriors. Locations where murals are present on the wall restoration of the mural by the original artist will be necessary.

Electrical distribution system would need to be suspended, when required, at locations where the repair work is taking place after which it would need to be re-installed. Which will require coordination with building tenants and licensed electrical subcontractor.

Sincerely,
Artibus Design LLC
Serge Mashtakov, P.E.
President

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Appendix A

ARTIBUS DESIGN
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201 William St - Preliminary Concrete Spalling Evaluation Report
Opinion of Probable Cost

Item No	Work Description	Estimated Unit Cost	Quantity +/-	Unit	Total
1	Mobilization & Demobilization	$40,000.00	1	EA	$40,000.00
2	Light Shoring/reshoring of the existing structure and walls	$40,000.00	1	L.S.	$40,000.00
3	Concrete Spalling Repair as Replacement of entire tie beam and headers	$400.00	102	CU.FT.	$40,888.89
4	Concrete Spalling Repair/Repair of smaller areas in beams	$500.00	180	CU.FT.	$90,000.00
5	Concrete Spalling Repair as Replacement of entire columns	$350.00	312	CU.FT.	$109,200.00
6	Concrete Spalling Repair/Repair of smaller areas in columns	$500.00	118	CU.FT.	$58,833.33
7	Wall crack repairs with sealant	$25,000.00	1	L.S.	$25,000.00
8	Stucco of new concrete and misc stucco repairs	$30,000.00	1	L.S.	$30,000.00
9	Mural Artwork (estimated)	$25,000.00	1	EA	$25,000.00
10	Priming and painting building (two coats latex paint)	$90,000.00	1	L.S.	$90,000.00
11	Misc electrical work - maintaining all existing fixtures, panel and service (rough estimate)	$20,000.00	1	EA	$20,000.00
					$568,922.22
	Contingensy and unforceen items			15%	$85,338.33
	Engineering and Project administration			5%	$28,446.11
		TOTAL ESTIMATE			**$682,706.67**

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Appendix B

Location Map/ Building Drawing (not to scale)

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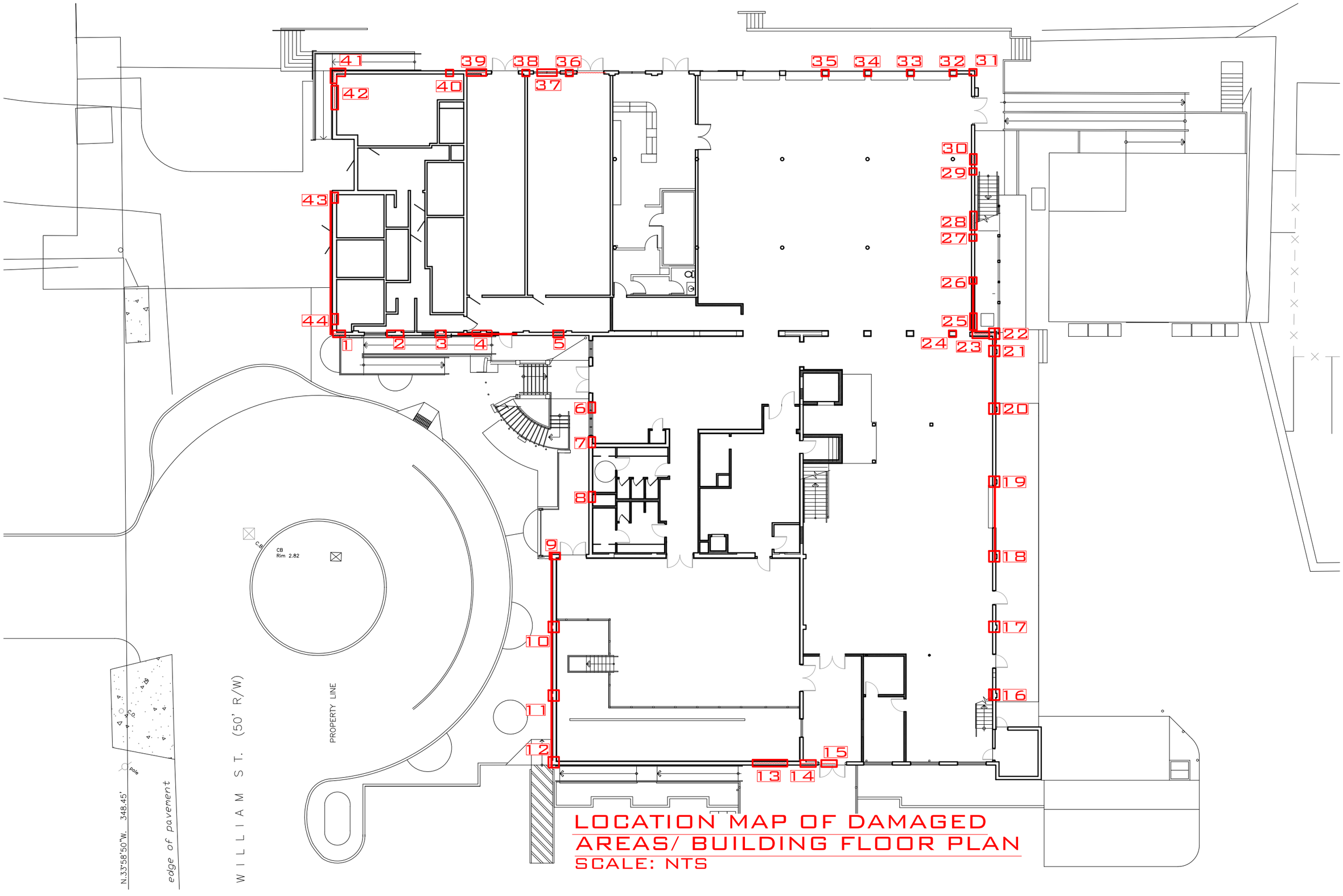

LOCATION MAP OF DAMAGED AREAS/ BUILDING FLOOR PLAN

SCALE: NTS