4th Street Parking Garage

Structural Condition Assessment Report

City of Bloomington

Bloomington, Indiana

Project ID: 17-165

May 25, 2018

CITY OF BLOOMINGTON

CE Solutions
structural engineers

Applied
Engineering Services

TABLE OF CONTENTS

PROJECT OVERVIEW 1

APPROACH 2

OBSERVATIONS 2

RECOMMENDATIONS 5

PRIORITY LEVEL DEFINITION 11

OPINION OF PROBABLE CONSTRUCTION COST 13

CLOSING REMARKS 13

APPENDIX:

A: OPINION OF PROBABLE CONSTRUCTION COST

B: PHOTOGRAPHS

C: DRAINAGE ASSESSMENT AND OPINION OF PROBABLE DRAINAGE CONSTRUCTION COST BY APPLIED ENGINEERING SERVICES

TABLES:

Table 1 4th Street Parking Garage - General information 2
Table 2 4th Street Parking Garage – Observations by structural element 3
Table 3 4th Street Parking Garage – Recommended repairs 5
Table 4 4th Street Parking Garage – Priority level definitions 13

FIGURES:

Figure 1 4th Street Parking Garage – Typical Plan Views 1
Figure 2 4th Street Parking Garage - 3D View 1

PROJECT OVERVIEW

We have completed our structural condition assessment of the 4th Street Parking Garage. This assessment involved a comprehensive field investigation, further described in the following sections of this report, to evaluate the current condition of the parking garage. All findings from this assessment are summarized within this report for the purpose of planning and budgeting for future repair and restoration projects in the upcoming years by the City of Bloomington.

Typical plans views, a 3D view, and general information for the 4th Street parking Garage are provided below.

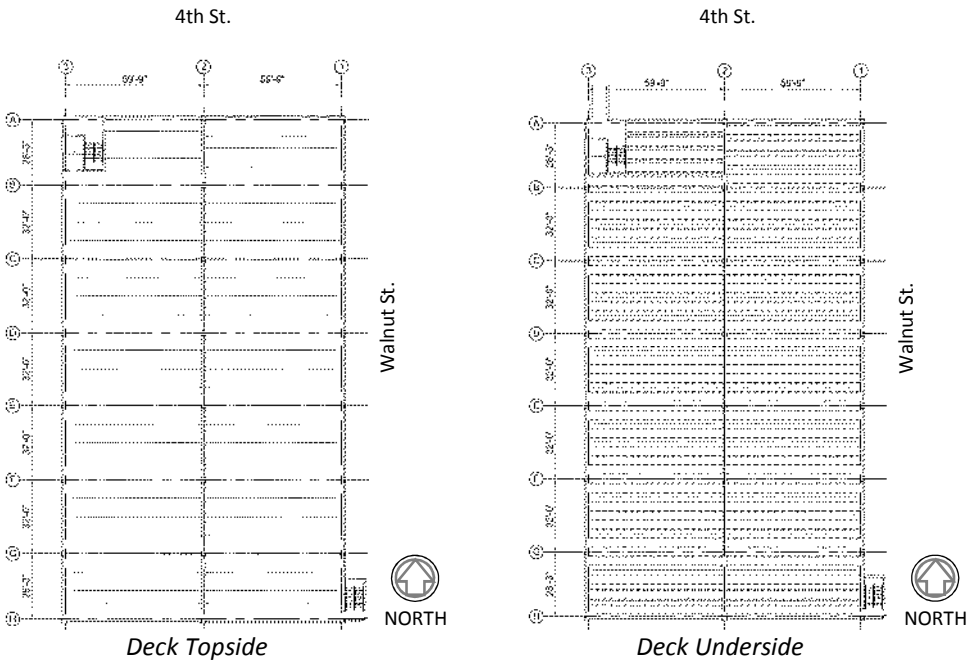


Figure 1: 4th Street Parking Garage – Typical Plan Views

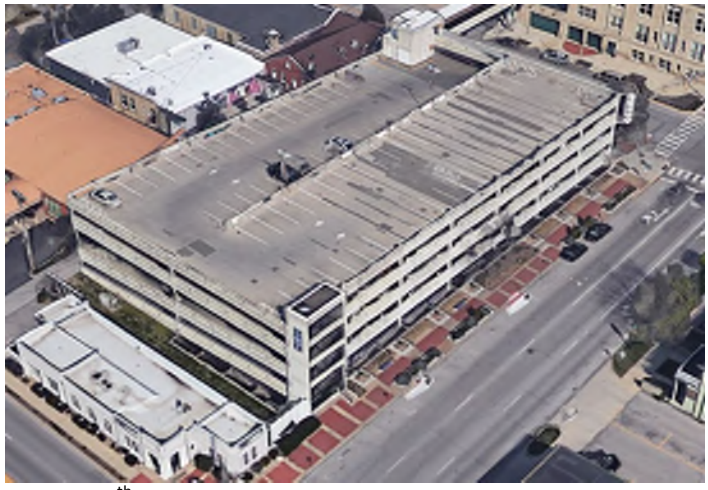


Figure 2: 4th Street Parking Garage – 3D View (*looking northwest*)

Table 1: 4th Street Parking Garage – General information

Year Built:	1985	Est. parking stalls	± 400
Size:	220' L x 123' W x 45' H	Vehicular Accessible from:	4th Street
General Construction:	Basement + 4 Tiers (tier 4 partial) – Basement deck is S.O.G and below grade with concrete retaining walls, all other tiers above are precast double tees with topping slab; double tees are supported by ledger beams and precast columns. Two full stair towers and additional stair from basement to 1st level (Ground Level) – Precast wall panels with cast in place landings and steel staircases.		

APPROACH

Our evaluation was limited to the structural elements (beams, columns, walls, slabs, and stair towers) and the water drainage system. Our evaluation did not include items such as the elevator located within the Northwest stair tower, lighting systems, or other similar items not associated with the structural or water drainage systems.

Prior to our assessment, existing drawings of the parking garage were provided to us by Charles C. Brandt Construction Co., the construction firm involved in the original parking garage construction. These drawings included the original architectural and structural contract drawings dated 1985. The original precast concrete shop drawings were not available.

DRAINAGE SYSTEM:

The drainage assessment of the parking garage was performed on April 12, 2018 by Lucas Burley, EI, of Applied Engineering. Observations and recommendations pertaining to the drainage system can be found in Appendix C of this report.

STRUCTURAL SYSTEM:

The structural assessment of the parking garage was performed between March 23rd and April 13th, 2018 by Carrie L. Walden, PE, Jessica A. Barrios, Nathan D. Boltz, EI, Mike M. Kelly, EI, and Riley M. Sears of our office. Our assessment was completed during the day while the garage was occupied by vehicles. Each day of our assessment, a different section of the parking garage was closed to parking to aid in our assessment of the parking decks.

During our assessment of the parking garage structural deficiencies, deteriorations were identified through visual examination, hammer sounding, and chain dragging. No destructive investigation, structural instrumentation, monitoring, or testing was performed. Selective photographs taken during the assessment are included in Appendix B. A summary of our findings and recommendations is provided in the following sections.

OBSERVATIONS

During our assessment of 4th Street Garage we encountered a number of deterioration types in the structural components of the garage. Below is a tabulated summary of our observations:

Table 2: Observations by structural element

STRUCTURAL ELEMENT:	ELEMENT DESCRIPTION:	GENERAL CONDITION:	OBSERVED PREVIOUS REPAIRS:	ASSESSMENT NOTES:	RELATED REPAIRS:
Elevated Parking Deck - Topside	● 3" Cast-in-place topping slab over double tee beams ○ Reinforced with 6x6 WWF ● Polyurethane crack control joints at 8' O.C. at double tee transitions ● Several drain openings throughout the garage	● Small delaminations detected – lower decks ● Large delaminations detected – top decks ● Cracks ○ Missing control joint at transition beams at several locations ○ Missing and mis-aligned control joints at double tee transitions at several locations ○ Randomly distributed cracks ● Joint sealants severely weathered on top decks, moderately weathered on lower decks ● Handicap parking stall paint slightly worn and chipped on level 1 (ramp)	● Partial Depth Patches – predominantly on top decks ○ Several patches were made without appropriate joints at double tee transitions ○ A few patches appear to be localized topping slab replacement ● Routed and Sealed cracks ● Replaced Joint Sealants (cove joints and deck joints) ● A few Traffic Coating patches throughout the garage	● Slight accessibility restriction due to a few cars parked in stalls	**9B** **9C** **10E-1** **10E-2** **15A** **15B** **21** **22**
Elevated Parking Deck – Double Tee (Underside)	● 4'-9" to 8'-0" wide double tee beams ● Precast ● Bearing on exterior and interior ledger beam, and precast stair tower walls ● Typical span = 59'-9" ● Shear plates along joints (3 typ per span) ● Several drain openings throughout the garage	● Evidence of leaking along joints mostly on top levels ● Several shear plates are corroded, only few are fractured ● Small-medium delaminations detected – typically near flange edges, flange center (top decks), or drain pipes ● Exposed corroded steel from spalling concrete on double tee flanges and webs ● Narrow longitudinal and diagonal cracks in flanges – cracks often show signs of leakage ● Localized narrow vertical cracks on webs due to overload or damage ● Localized narrow horizontal cracks on bottom side of webs	● Partial/Full Depth Patches – typically near flange edges, flange center (top decks), or drain pipes ○ Several previous patches did not re-establish appropriate joints at transitions ● Minimal crack Epoxy Injection ● Localized Additional Bearing Supports	● Visual assessment only of underside of level 2 (ramp bay) and level 1(flat bay) due to high floor height at portion of these bays	**3C** **5B** **7B-1** **7B-2** **8** **10C** **11B** **12B** **13** **14** **26** **27**
Exterior Ledger Beams	● 8" wide x 5'-9" deep ● Beams are pocketed to support double tee joists webs ○ 14" wide x 10¾" deep ledger ● Precast ● Typical span = 38'-0" ● Bearing on exterior column pockets	● Diagonal (Shear) cracks extending from the beam bearing – visible from the underside and the topside. ● Several locations of exposed reinforcing steel on the bottom and sides ● Few delaminations at special bearing condition on south east stair tower wall ● Small delaminations on top of the pockets and on top of the beam ● Few steel plate and bolt connections at columns show signs of corrosion ○ Few connections with slotted holes appeared to be field modified with insufficient material beyond the enlarged hole ● Precast lifting inserts are exposed and corroded.	● Partial Depth Patches – predominantly on top face ● Steel plate and bolt connections Cleaned and Painted ○ Some bolts have been replaced ○ Some connections have been reinforced with additional steel plates ● Crack Epoxy Injection – cracks accessible from the upper portion of the beam ● Thin concrete Patches at precast lifting points (debonded)	● Visual assessment only of underside of level 2 (ramp bay) and level 1(flat bay) due to high floor height at portion of these bays	**1** **2A** **3A** **3B** **5A** **7A** **9A** **9B** **10A** **10B** **11A** **23**
Interior Ledger Beams	● 8" wide x 5'-9" deep ● Beams are pocketed to support double tee joists webs ○ 14" wide x 10¾" deep ledger ● Precast ● Typical span = 38'-0" ● Bearing on corbels on interior columns	● Exposed reinforcing steel on the bottom and sides ○ Often, stirrups exposed on bottom side of transition beams ● Small delaminations and shear cracks at bearing ○ One bearing needs to be rebuilt ● Small delaminations on top of the pockets and on top of the beam ● Few steel plate and bolt connections at columns show signs of corrosion	● Connection steel plates and bolts Cleaned and Painted	● Visual assessment only of underside of level 2 (ramp bay) and level 1(flat bay) due to high floor height at portion of these bays	**1** **2A** **3A** **3B** **5A** **7A** **9A** **9B** **10A** **10B** **11A** **23**

Table 2 (continued): Observations by structural element

STRUCTURAL ELEMENT:	ELEMENT DESCRIPTION:	GENERAL CONDITION:	OBSERVED PREVIOUS REPAIRS:	ASSESSMENT NOTES:	RELATED REPAIRS:
Columns	● 24" x 24" effective area ● Exterior – with haunches (pockets) to support ledger beams ● Interior – with corbels to support ledger beams ● Precast	● Large delaminations – mostly on lower levels ● Very narrow horizontals cracks on interior faces ● Few delaminated corbels ● Several delaminations at embedded steel plates ● Several embedded steel plates show signs of corrosion ● Minimum steel exposed – typically secondary. ● Precast lifting point inserts are exposed and corroded.	● Small Partial Depth Patches ○ Exterior – typically near embedded plates ○ Interior – corbel ● Exposed embedded steel plates Cleaned and Painted ● Thin concrete Patches at precast lifting points (debonded)	● Visual assessment only of underside of level 2 (ramp bay) and level 1(flat bay) due to high floor height at portion of these bays	**3D** **5D** **6** **7D** **9A** **10D** **11D** **12A**
Spandrel Wall Panels	● Two types: ○ Type A: Panels at north and south end for garage - 8" thick x 5'-9" deep - Bearing on columns similar to exterior ledger beams ○ Type B: Panels along west side of the garage - 8" thick x height varies - Extend in-between ledger beams - bearing top of the exterior ledger beams – connected with steel plates and bolts ● Precast	● Type A: ○ Bearing connection to stair tower precast wall at northwest end is severely deteriorated – supplemental framing has been recommended as an urgent repair ○ Several delaminations on the top of the panels ○ Few spalls at artwork decoration connections ● Type B: ○ Few narrow vertical cracks ○ Few steel plate and bolt connections at columns show signs of corrosion ● Precast lifting point inserts are exposed and corroded.	● Small Partial Depth Patches – Type A ● Minimal crack Epoxy Injection – Type B ● Exposed embedded steel plates Cleaned and Painted ● Thin concrete Patches at precast lifting points (debonded)		**3F** **5D** **7E** **9A** **9B** **10F** **11D** **23** **24**
Retaining Walls	● 12" thick ● Cast-in-place ● Painted (aesthetically)	● One vertical crack – paint may be masking sign of leakage.	● None	● 8" thick Cast-in-place retaining walls at wells on the east side of garage were not assessed	**4** **10F**
Stairs Towers	● Southeast tower – staircase ● Northwest tower - staircase + elevator + mechanical/storage rooms + access to pedestrian bridge ● Northeast tower – one flight staircase ● Towers are constructed of precast concrete walls extending the full height of tower, exterior walls have window glazing supported by beam like elements that span between walls ● Intermediate landings and stair flights are constructed with concrete filled composite metal decks; main landing are precast slabs and beams bearing on steel angle anchored to the walls Stairs are steel framed with glass fiber reinforced concrete on treads ● Walls facing the parking garage support double tee and beam bearings	● Deteriorated joint material between wall panels ● Several delaminations of concrete deck and pourstops, door headers and walls ● Few Cracks – mostly on concrete deck ● Moderate-Severe corrosion in multiple locations on steel decks and stair framing - typical near top of stair towers ● Ledger beams at the northwest towers are severely delaminated - shoring has been recommended as an urgent repair ● Exposed embedded steel plates and precast lifting points corroded. ● Handrail post severely corroded ○ Few posts missing caps ○ Few handrail-wall anchor bolt connections deteriorated	● Stair tread replacement ● Thin concrete Patches at precast lifting points (debonded) ● Steel surfaces Cleaned and Painted	● Upon completion of the assessment, Stair Tower restoration work independent from this study began.	**2B** **3G** **4** **5E** **7D** **9A** **10G** **11A** **15C** **16** **17** **18** **19** **20**

Table 2 (continued): Observations by structural element

STRUCTURAL ELEMENT:	ELEMENT DESCRIPTION:	GENERAL CONDITION:	OBSERVED PREVIOUS REPAIRS:	ASSESSMENT NOTES:	RELATED REPAIRS:
Pedestrian Walkway on Fourth Level	● 4" Precast slab spanning 6'-0" between ledger beams ● 3" Cast-in-place topping slab over precast slab ● Ledger beams are: ○ 8" thick x 5'-9" deep ○ spanning 41'-6" ○ bearing on northwest stair tower precast wall and interior ledger beam at level transition.	● Several delaminations on underside of ledger beams and precast slab – relatively large ● Several small delaminations on the topping slab ● Several structural cracks on the underside of the precast slab ○ Pipe penetration patches cracked and weathered ● Minimal exposed steel reinforcement on the underside of the precast slab and on top of ledger beams more often present on the latter ● Beam bearing on the west end (bearing on steel member embedded in the stair wall) severely deteriorated ● Upper portion of beam steel plate and bolt connection to stair tower precast wall is severely deteriorated	● Partial Depth Patches – topping slab ● Pedestrian Traffic Coating on topping slab ● Steel plate and bolt connections Cleaned and Painted ○ Connections have been reinforced with additional steel plates and bolts ● Pipe penetration patch appears different from others at different location of the underside of the garage		**3C** **10E-2** **22**
Exterior	● Limestone concrete finish ● Large "Garage" blade sign on the northeast corner of the garage connected to the garage elements on the second and fourth levels ● Decorative artwork connected to the structural elements on the second, third and fourth level elements on the north side of the garage	● "Garage" blade sign connection appeared inadequate per code – sign recommended to be removed as urgent repair	● None	● Visual assessment of Exterior only, completed at a distance (from ground level) ● Pedestrian bridge spanning 4th Street was not assessed and appears to be independent from the garage	**25**

RECOMMENDATIONS

We recommend the following repairs to address the current structural concerns; please note that: (1) repair ID numbers are for reference only and are not indicative of priority level; (2) "Top of Beam" refers to the area of that element that is visible above the topping slab. Likewise, the area referred to as "Underside of Beam" is the area visible from below the deck topping slab.

Table 3: 4th Street Parking Garage – Recommended repairs

REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
1	Beam underside delamination	5 EA	Partial Depth Patch w/ shoring during repair	Ledger Beams	HIGH	
2A	Beam bearing	5 EA	Partial Depth Patch w/ shoring during repair	Ledger Beams	HIGH	
2B	Beam bearing	4 EA	Partial Depth Patch w/ shoring during repair	Stair Towers	HIGH	

Table 3 (continued): Recommended repairs

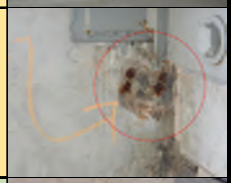
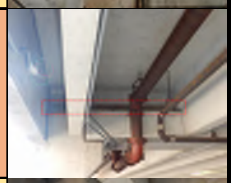
REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
3A	Exposed, corroded steel with spalled concrete on beam underside	218 LF	Clean and Coat	Ledger Beams	HIGH	
3B	Exposed, corroded steel with spalled concrete on beams tops	107 LF	Clean and Coat	Ledger Beams	LOW	
3C	Exposed, corroded steel with deteriorated concrete	205 LF	Clean and Coat	Double Tees Pedestrian Walkway (slab underside)	MED	
3D	Exposed, corroded steel with deteriorated concrete	21 LF	Clean and Coat	Columns	MED	
3E	Exposed, corroded steel with deteriorated concrete	13 LF	Clean and Coat	Wall Panels	LOW	
3F	Exposed, corroded steel with deteriorated concrete	21 LF	Clean and Coat	Stair Towers	MED	
4	Vertical cracks in walls	46 LF	Chemical Grout Injection	Retaining Walls Stair Towers	LOW	
5A	Corroded steel plates and/or bolts	44 EA	Clean and Paint	Ledger Beams	MED	
5B	Corroded steel angles	12 EA	Clean and Paint	Double Tees	HIGH	
5C	Corroded steel plates	10 EA	Clean and Paint	Columns	MED	

Table 3 (continued): Recommended repairs

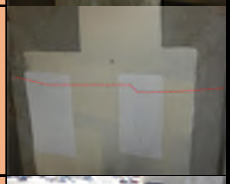
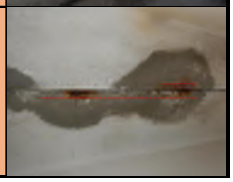
REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
5D	Corroded steel plates and/or bolts	22 EA	Clean and Paint	Wall Panels	HIGH	
5E	Corroded steel plates and angles	44 EA	Clean and Paint	Stair Towers	HIGH	
6	Corbel delamination	2 EA	Partial Depth Patch w/ shoring during repair	Columns	HIGH	
7A	Structural cracks in concrete	330 LF	Epoxy Injection	Ledger Beams	HIGH	
7B-1	Structural cracks in concrete	256 LF	Epoxy Injection	Double Tees	HIGH	
7B-2	Non-structural Leaking Cracks in concrete	467 LF	Epoxy Injection	Double Tees	MED	
7C	Structural cracks in concrete	49 LF	Epoxy Injection	Columns	HIGH	
7D	Structural cracks in concrete	145 LF	Epoxy Injection	Stair Towers	HIGH	
7E	Structural cracks in concrete	34 LF	Epoxy Injection	Wall Panels	HIGH	
8	Exposed steel and concrete spalling on double tee flange edges (at joint)	782 LF	Removal of lose concrete plus Clean and Paint exposed steel	Double Tees	HIGH	

Table 3 (continued): Recommended repairs

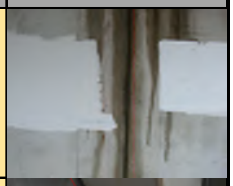
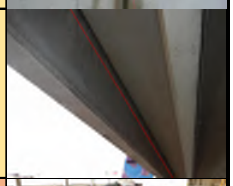
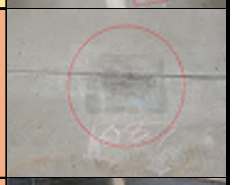
REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
9A	Deteriorated vertical joint material between elements (on top side of deck)	497 LF	Replace vertical joint sealant	Columns Wall Panels Ledger Beams Stair Towers	MED	
9B	Deteriorated perimeter cove joint material (on top side of deck)	4,737 LF	Replace cove joint sealant	Ledger Beams Wall Panels Columns Decks	MED	
9C	Weathered control joints on deck topping slab	11,646 LF	Replace control joint sealant	Decks	HIGH	
10A	Concrete delamination on beam undersides	36 SF	Partial Depth Patch	Ledger Beams	HIGH	
10B	Concrete delamination on beam tops	26 SF	Partial Depth Patch	Ledger Beams	HIGH	
10C	Concrete delamination on double tee webs and flanges	262 SF	Partial Depth Patch	Double Tees	HIGH	
10D	Concrete delamination along columns and corbels	120 SF	Partial Depth Patch	Columns	HIGH	
10E-1	Deck topping slab delamination on lower levels (interior)	336 SF	Partial Depth Patch	Decks	MED	
10E-2	Deck topping slab delamination on upper levels (exterior)	2,091 SF	Partial Depth Patch	Decks Pedestrian Walkway	HIGH	
10F	Concrete delamination on miscellaneous location on wall elements	21 SF	Partial Depth Patch	Retaining Walls Walls Panels	HIGH	

Table 3 (continued): Recommended repairs

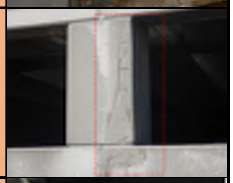
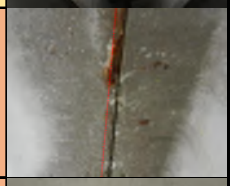
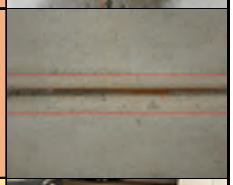
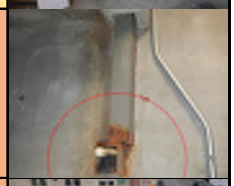
REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
10G	Concrete delamination on stair walls and landings	167 SF	Partial Depth Patch	Stair Towers	HIGH	
11A	Deep concrete delamination on beam undersides and northwest stair tower double tee ledge	60 SF	Deep Patch	Ledger Beams Stair Towers	HIGH	
11B	Deep concrete delamination on double tee	8 SF	Deep Patch	Double Tee	HIGH	
11C	Deep concrete delamination along column	6 SF	Deep Patch	Columns	HIGH	
11D	Deep concrete delamination on wall panels bearings	9 SF	Deep Patch	Wall Panels	HIGH	
12A	Excessive water Leaking through column corbel	3 SF	Apply Silane Sealer	Columns	MED	
12B	Excessive water Leaking through deteriorated double tee flange	315 SF	Apply Silane Sealer	Double Tees	MED	
13	Corroded shear transfer plate and corroded supplemental steel	55 EA	Clean and Coat (concrete demo required to inspect supplemental steel)	Double Tee	HIGH	
14	Broken shear transfer plate	8 EA	Shear Transfer Plate Replacement with "Sandwich Plates"	Double Tee	HIGH	
15A	Deck topping slab cracks on lower levels (interior)	2,339 LF	Rout cracks and Seal with Joint Sealant	Decks	MED	

Table 3 (continued): Recommended repairs

REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
15B	Deck topping slab cracks on upper levels (exterior)	1,437 LF	Rout cracks and Seal with Joint Sealant	Decks	HIGH	
15C	Landing topping slab cracks on stair landings	18 LF	Rout cracks and Seal with Joint Sealant	Stair Towers	HIGH	
16	Missing handrail post cap	3 EA	Replace Handrail Post Cap	Stair Towers	HIGH	
17	Landing topping slab pour stop delamination	3 EA	Replace Landing Pour Stop (re-pour)	Stair Towers	MED	
18	Handrail post section loss	12 EA	Supplemental Handrail Post Steel	Stair Towers	MED	
19	Stair tread nosing section loss	47 EA	Stair Tread Nosing Repair	Stair Towers	HIGH	
20	Stair tread section loss due severe corrosion	30 EA	Tread Strengthening	Stair Towers	HIGH	
21	Deck topping slab deficiency on lower levels (interior)	64,604 SF	Waterproofing <u>Option A:</u> Apply Urethane Traffic Coating System	Decks	MED	See Appendix A
			<u>Option B:</u> Apply PUMA Traffic Coating System		LOW	See Appendix A

Table 3 (continued): Recommended repairs

REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
22	Deck topping slab deficiency on upper levels (exterior)	26,150 SF	Waterproofing Option A: Apply Urethane Traffic Coating System	Decks	HIGH	See Appendix A
			Option B: Apply PUMA Traffic Coating System		MED	See Appendix A
23	Connection plate deficient holes	6 EA	Add plate materal to plates with slotted holes	Ledger Beams Walls Panels	MED	
24	Corroded embedded steel at bearing	4 EA	Provide additional bearing support	Panels	HIGH	
25	Inadequate top garage sign connection	1 EA	Provide additional support	Exterior	HIGH	
26	Concrete flange delamination	15 EA	Rebuild flange	Double Tees	HIGH	
27	Concrete Bearing Delamination	1 EA	Rebuild bearing	Double Tees	HIGH	
28	Severe staircase steel corrosion (stair tower #1)	-	Clean and paint	Stair Towers	HIGH	
29	Severe staircase steel corrosion (stair tower #3)	-	Clean and paint	Stair Towers	MED	

PRIORITY LEVEL DEFINITION

The parking garage, constructed in 1985, is approximately 33 years old. Parking structures of this type and era typically have a life expectancy of up to 50 years with routine maintenance and care. Efforts to waterproof and maintain the 4th Street Parking Garage appear to have been marginal in its early lifetime. Recent efforts included repairs that did not account for movement and did not effectively stop water infiltration into key structural connections. The remaining lifespan of the garage will depend on the level of repair/funding put into the garage.

We have assigned priority levels to the repairs based on how many years the garage will remain in operation in order for the City of Bloomington to perform a cost/benefit analysis to determine the appropriate level of project/funding.

Urgent repairs are being implemented in four locations due to imminent structural integrity concerns. The localized areas of the garage were at risk of structural failure and supplemental strengthening was required immediately. These repairs are not included in the tables above nor in the priority levels below; they are currently underway.

If the garage will be taken out of operation and secure against access in 2019; no additional repairs beyond the “urgent” repairs currently underway are required.

If the garage is to remain in operation 5 years (until 2023) all HIGH priority repairs shall be performed in 2019. An additional repair project may be necessary in 2021 for repair of continuing structural deterioration.

If the garage is to remain in operation 10 years (until 2028) all HIGH + MEDIUM priority repairs shall be performed in 2019. An additional significant repair project will be necessary in 2023 for replacement of joint sealants, traffic coating, and repair of structural deterioration. A repair project may also be necessary in 2026 depending on the rate of structural deterioration.

If the garage is to remain in operation 15 years (until 2033) all HIGH + MEDIUM + LOW priority repairs shall be performed in 2019. Additional significant repair projects will be required every 3-5 years to keep the garage in operation for this extended amount of time due to the current level of deterioration.

All recommendations are based on a repair project in 2019; if the repair project is delayed beyond 2019, additional urgent repairs may need to be implemented and the lifespan of the garage will be decreased.

All repair recommendations provided in the previous section have been assigned priority levels. These priority levels are based upon our professional opinion and are briefly defined and explained in the table below:

Table 4: Priority level definitions

PRIORITY LEVEL:	DEFINITION:
HIGH	● Structural deficiencies within primary structural elements that will adversely impact performance of elements if not addressed ● Needed repairs to waterproofing joints and application of coatings that directly help protect highly susceptible structural elements from water and deicing chemicals exposure ● Structural or non-structural deficiencies that could pose falling debris hazard
MED	● Needed repairs to waterproofing joints and application of coatings that directly help protect structural elements from water and deicing salts exposure ● Early-state structural deficiencies within primary or secondary structural elements that may adversely impact performance of elements if not addressed ● Non-structural deficiencies within non-structural elements that may adversely impact performance of elements if not addressed
LOW	● Needed repairs to waterproofing joints and application of coatings that directly help protect structural elements from water and deicing chemicals exposure

OPINION OF PROBABLE STRUCTURAL CONSTRUCTION COST

Appendix A contains the Opinion of Probable Structural Construction Cost which contains the overall probable drainage construction cost for budgeting purposes. A detailed Opinion of Probable Drainage Construction Cost is provided in appendix C. Dollar amounts are current as of the date of the study (May 2018). If the project is delayed beyond the summer of 2019, additional deterioration may increase the anticipated construction cost.

CLOSING REMARKS

In closing, please note that our structural condition assessment of the 4th Street Parking Garage was limited strictly to those items identified in this report and to the extent noted. Should unforeseen deficiencies exist (structural or non-structural), they are beyond the scope of this structural condition assessment. Should you have any questions or wish to discuss this matter further, please do not hesitate to contact CE Solutions.

Carrie L. Walden, PE
Senior Project Manager

APPENDIX A – OPINION OF PROBABLE STRUCTURAL CONSTRUCTION COST

CE Solutions
structural engineers
10 Shoshone Drive
Carmel, IN 46032
317.818.1912
cesolutionsinc.com

4TH ST PARKING GARAGE STUDY
CES Project No: 17-165
Date: 05.25.18

OPINION OF PROBABLE STRUCTURAL CONSTRUCTION COST

	WORK ITEM	PRIORITY	QUANTITY	UNIT	UNIT COST	TOTAL
	Cost opinion assumes garage remains operational during repair, with closures by level and as needed to facilitate the work.					
	STRUCTURAL REPAIRS					
1.	Ledger beam delamination **Partial depth beam patch, with shoring during repair**	HIGH	5	EA	$1,250.00	$6,250
2.	Ledger beam bearing delamination – ledger beams and stair towers **Partial depth patch at beam bearing, with shoring during repair**	HIGH	9	EA	$2,500.00	$22,500
3.	Exposed, corroded steel with spalled concrete – ledger beam undersides **Clean and coat**	HIGH	218	LF	$25.00	$5,450
4.	Corroded steel plates, angles and bolts – double tees, wall panels, and stair towers **Clean and paint**	HIGH	78	EA	$100.00	$7,800
5.	Column corbel delamination **Partial depth corbel patch, with shoring during repair**	HIGH	2	EA	$1,500.00	$3,000
6.	Structural cracks in concrete – all elements **Epoxy injection**	HIGH	814	LF	$125.00	$101,750
7.	Exposed steel and concrete spalling on double tee flange edges **Removal of loose concrete, clean and paint exposed steel**	HIGH	782	LF	$75.00	$58,650
8.	Weathered control joints on deck topping slab **Replace control joint sealant**	HIGH	11,646	LF	$4.00	$46,584
9.	Concrete delamination – ledger beam undersides, and double tees **Overhead partial depth patch**	HIGH	298	SF	$200.00	$59,600
10.	Concrete delamination – ledger beam tops, columns, retaining walls, and wall panels **Vertical and horizontal partial depth patch**	HIGH	167	SF	$150.00	$25,050
11.	Deck topping slab delamination – upper levels: 3 (west) and 4 **Horizontal partial depth patch**	HIGH	2,091	SF	$75.00	$156,825
12.	Landing Concrete delamination – stair tower **Miscellaneous partial depth patch**	HIGH	167	SF	$100.00	$16,700
13.	Concrete delamination – ledger beam undersides, double tee, column, panels **Overhead/vertical deep patch, with shoring during repair**	HIGH	83	SF	$450.00	$37,350
14.	Corroded shear transfer plate and corroded supplemental steel – double tees **Clean and coat, minor demo required for embedded steel inspection**	HIGH	55	EA	$250.00	$13,750.00
15.	Broken shear transfer plate – double tees **Shear transfer plate replacement with "sandwich plates"**	HIGH	8	EA	$500.00	$4,000.00
16.	Deck topping slab cracks – upper levels: 3 (west) and 4 **Rout cracks and seal with joint sealant**	HIGH	1,437	LF	$5.00	$7,185.00
17.	Landing topping slab cracks – stair towers **Rout cracks and seal with joint sealant**	HIGH	18	LF	$5.00	$90.00
18.	Missing handrail post cap at landing – stair tower **Replace handrail post cap**	HIGH	3	EA	$75.00	$225.00
19.	Corroded stair tread nosing – stair tower **Stair tread nosing repair**	HIGH	47	EA	$200.00	$9,400.00
20.	Deck topping slab deterioration – upper levels: 3 (west) and 4 **Apply traffic coating system – waterproofing** **Urethane system**	HIGH	26,150	SF	$5.00	$130,750.00
21.	Corroded Embedded steel at bearing – wall panels and stair towers **Provide additional bearing support**	HIGH	4	EA	$2,000.00	$8,000.00
22.	Inadequate Top Garage Sign connection **Provide additional support**	HIGH	1	EA	$4,500.00	$4,500.00
23.	Concrete Flange Delamination **Rebuild double tee flange**	HIGH	15	SF	$500.00	$7,500.00
24.	Double Tee concrete Bearing Delamination **Rebuild double tee bearing**	HIGH	1	EA	$1,100.00	$1,100.00
25.	Severe staircase steel corrosion – stair tower #1 **Clean and paint staircase steel**	HIGH	1	LS	$8,000.00	$8,000.00
26.	**Drainage Assessment – Repairs: P1 through P6** [3]	HIGH	1	LS	$56,650.00	$56,650.00
27.	Exposed, corroded steel with spalled concrete – double tees, pedestrian walkway, columns, and stair towers **Clean and coat**	MED	466	LF	$25.00	$11,638
28.	Corroded steel plates and bolts – ledger beams and columns **Clean and paint**	MED	54	EA	$100.00	$5,400
29.	Non-structural cracks in concrete – double tees **Epoxy injection**	MED	467	LF	$125.00	$58,375

	WORK ITEM	PRIORITY	QUANTITY	UNIT	UNIT COST	TOTAL
30.	Deteriorated vertical joint material – all elements **Replace vertical joints sealant**	MED	497	LF	$10.00	$4,970
31.	Deteriorated cove joint material – all elements **Replace cove joints sealant**	MED	4,737	LF	$5.00	$23,685
32.	Deck topping slab delamination – lower levels: 1 thru 3 (east) **Horizontal partial depth patch**	MED	336	SF	$75.00	$25,200
33.	Excessive water Leaking through deteriorated concrete – double tees and columns corbel **Silane Sealer**	MED	318	SF	$5.00	$1,590.00
34.	Deck topping slab cracks – lower levels: 1 thru 3 (east) **Rout cracks and seal with joint sealant**	MED	2,339	LF	$5.00	$11,695.00
35.	Landing topping slab pour stop delamination – stair towers **Replace landing pour stop (repour)**	MED	3	EA	$300.00	$900.00
36.	Landing handrail post section loss – stair towers **Supplemental handrail post steel**	MED	12	EA	$400.00	$4,800.00
37.	Stair tread section loss due severe corrosion – stair tower **Stair tread strengthening**	MED	30	EA	$400.00	$12,000.00
38.	Deck topping slab deterioration **Apply traffic coating system – waterproofing** **Upper levels: 3 (west) and 4: PUMA system (cost adjusted)** **Lower levels: 1 thru 3 (east): Urethane system**	MED	26,150 64,604	SF	$10.00 $5.00	$261,500.00 $323,020.00
39.	Connection plate deficient holes **Enlarge slotted plate holes**	MED	6	EA	$350.00	$2,100.00
40.	Severe staircase steel corrosion – stair tower #3 **Clean and paint staircase steel**	MED	1	LS	$5,000.00	$5,000.00
41.	Exposed, corroded steel with spalled concrete – ledger beam tops, and wall panels **Clean and coat**	LOW	120	LF	$25.00	$2,988
42.	Vertical cracks in retaining walls in the basement and stair towers **Chemical grout injection**	LOW	46	LF	$100.00	$4,550
43.	Deck topping slab deterioration **Apply traffic coating system – waterproofing** **Upper levels: 3 (west) and 4: PUMA system (included in medium repairs)** **Lower levels: 1 thru 3 (east): PUMA system (cost adjusted)**	LOW	64,604	SF	$10.00	$646,040.00
	High Priority Subtotal				**$798,659**	
	General Conditions	20	%		$159,732	
	Mobilization and Demobilization	10	%		$79,865.90	
	Contingency	10	%		$79,865.90	
	GRAND TOTAL - 2019 PROJECT COST FOR 5 YEAR LIFESPAN FOR GARAGE				**$1,118,123**	
	High Priority Subtotal				**$798,659**	
	Medium Priority Subtotal				**$751,873**	
	General Conditions	20	%		$310,106	
	Mobilization and Demobilization	10	%		$155,053	
	Contingency	10	%		$155,053	
	GRAND TOTAL - 2019 PROJECT COST FOR 10 YEAR LIFESPAN FOR GARAGE				**$2,170,744**	
	High Priority Subtotal				**$798,659**	
	Medium Priority Subtotal				**$751,873**	
	Low Priority Subtotal				**$653,578**	
	General Conditions	20	%		$440,822	
	Mobilization and Demobilization	10	%		$220,411	
	Contingency	10	%		$220,411	
	GRAND TOTAL - 2019 PROJECT COST FOR 15 YEAR LIFESPAN FOR GARAGE				**$3,085,753**	

Notes:

1. All costs are current as of the time of the report submission (May 2018)

2. Subtotals are exclusive of contractor GC, OH&P and contingency

3. See Appendix C for Drainage study repair recommendation summary

4. See report for priority level descriptions and garage lifespan information; 2019 project costs are NOT total lifespan costs

APPENDIX B – PHOTOGRAPHS

REPAIR ID - 01

REPAIR ID - 02A

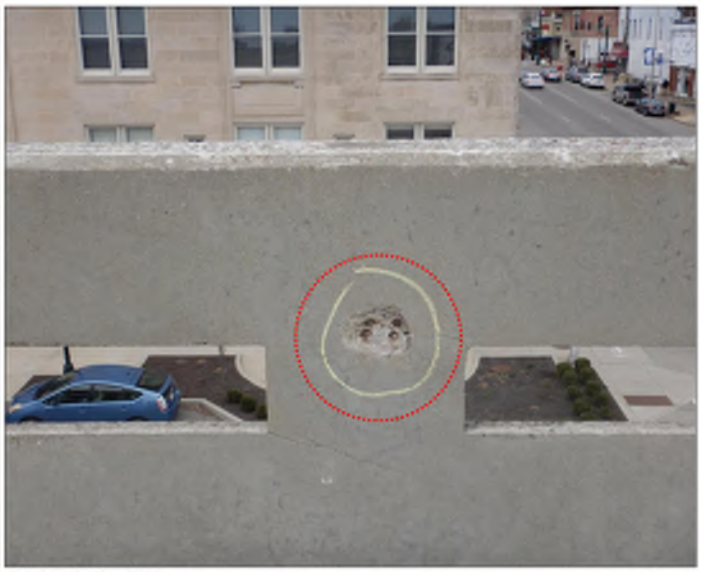
REPAIR ID - 02B

REPAIR ID - 03A

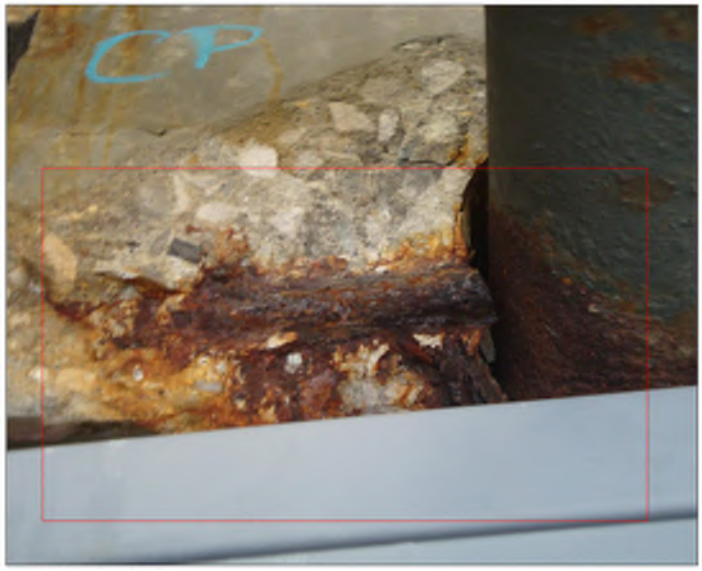
REPAIR ID - 03B

REPAIR ID - 03C

REPAIR ID - 03D



REPAIR ID - 03E



REPAIR ID - 03F

REPAIR ID - 04

REPAIR ID - 05A

REPAIR ID - 05B

REPAIR ID - 05C

REPAIR ID - 05D

REPAIR ID - 05E

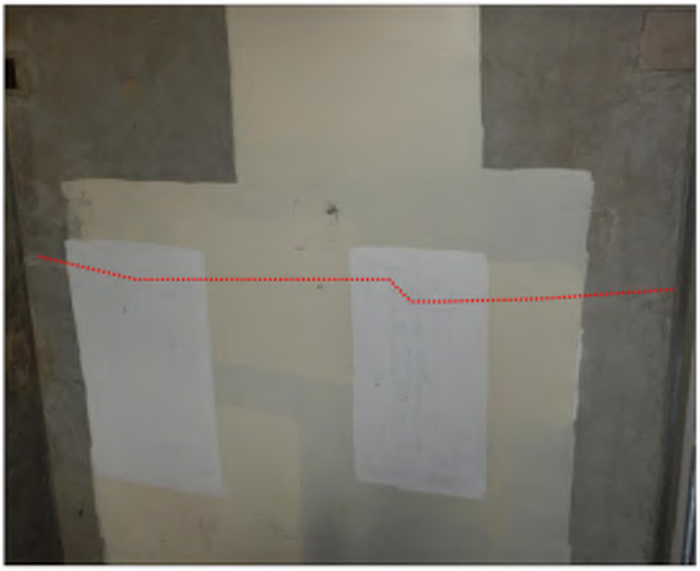
REPAIR ID - 06

REPAIR ID - 07A

REPAIR ID - 07B-1

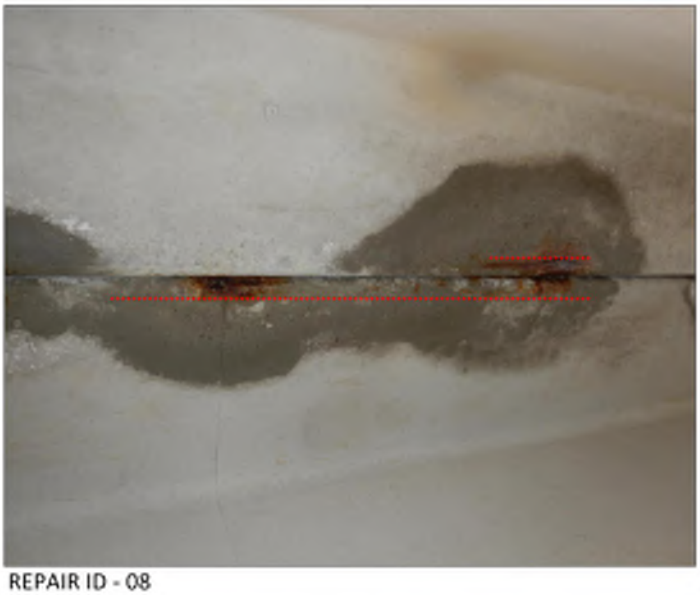
REPAIR ID - 07B-2

REPAIR ID - 07C



REPAIR ID - 07D

REPAIR ID - 07E



REPAIR ID - 08

REPAIR ID - 09A

REPAIR ID - 09B

REPAIR ID - 10A

REPAIR ID - 10B

REPAIR ID - 10C

REPAIR ID - 10D

REPAIR ID - 10E-1

REPAIR ID - 10E-2

REPAIR ID - 10F

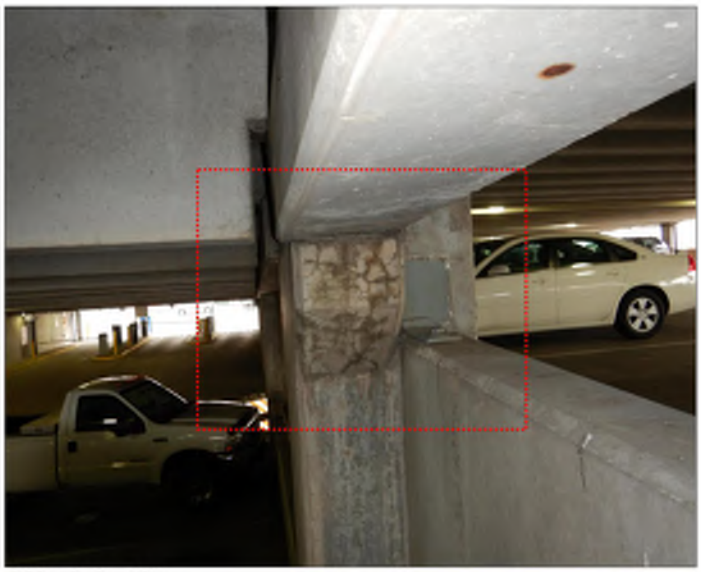
REPAIR ID - 10G

REPAIR ID - 11A

REPAIR ID - 11B

REPAIR ID - 11C

REPAIR ID - 11D



REPAIR ID - 12A

REPAIR ID - 12B

REPAIR ID - 13

REPAIR ID - 14

REPAIR ID - 15A

REPAIR ID - 15B

REPAIR ID - 15C

REPAIR ID - 16

REPAIR ID - 17

REPAIR ID - 18

REPAIR ID - 19

REPAIR ID - 20

REPAIR ID - 23

REPAIR ID - 24

REPAIR ID - 25

REPAIR ID - 26

REPAIR ID - 27

REPAIR ID - 28

REPAIR ID - 29

REPAIR ID - 9C

GENERAL - 01

GENERAL - 02

GENERAL - 03

GENERAL - 04

APPENDIX C – DRAINAGE ASSESSMENT AND OPINION OF PROBABLE DRAINAGE CONSTRUCTION COST BY APPLIED ENGINEERING SERVICES

5975 Castle Creek Pkwy N Dr, Suite 300, Indianapolis, IN 46250 P: 317.810.4141 applied-e-s.com

20 YEARS STRONG

City of Bloomington

4th Street Parking Garage Drainage Piping Study
Final Study
5-25-2018

Applied
Engineering Services

Fourth Street Garage Drainage Piping Study

Visual Walk-Thru

Design team performed a visual walk-thru of the Fourth Street Parking Garage on April 12th, 2018. Design Team noted and photographed problems from the initial walk-thru. Type of Repair, Location, Photograph No., Cost of Repair, Priority and Comments are given on the attached spread sheet. Photographs illustrating the problem are included.

Drainage Narrative

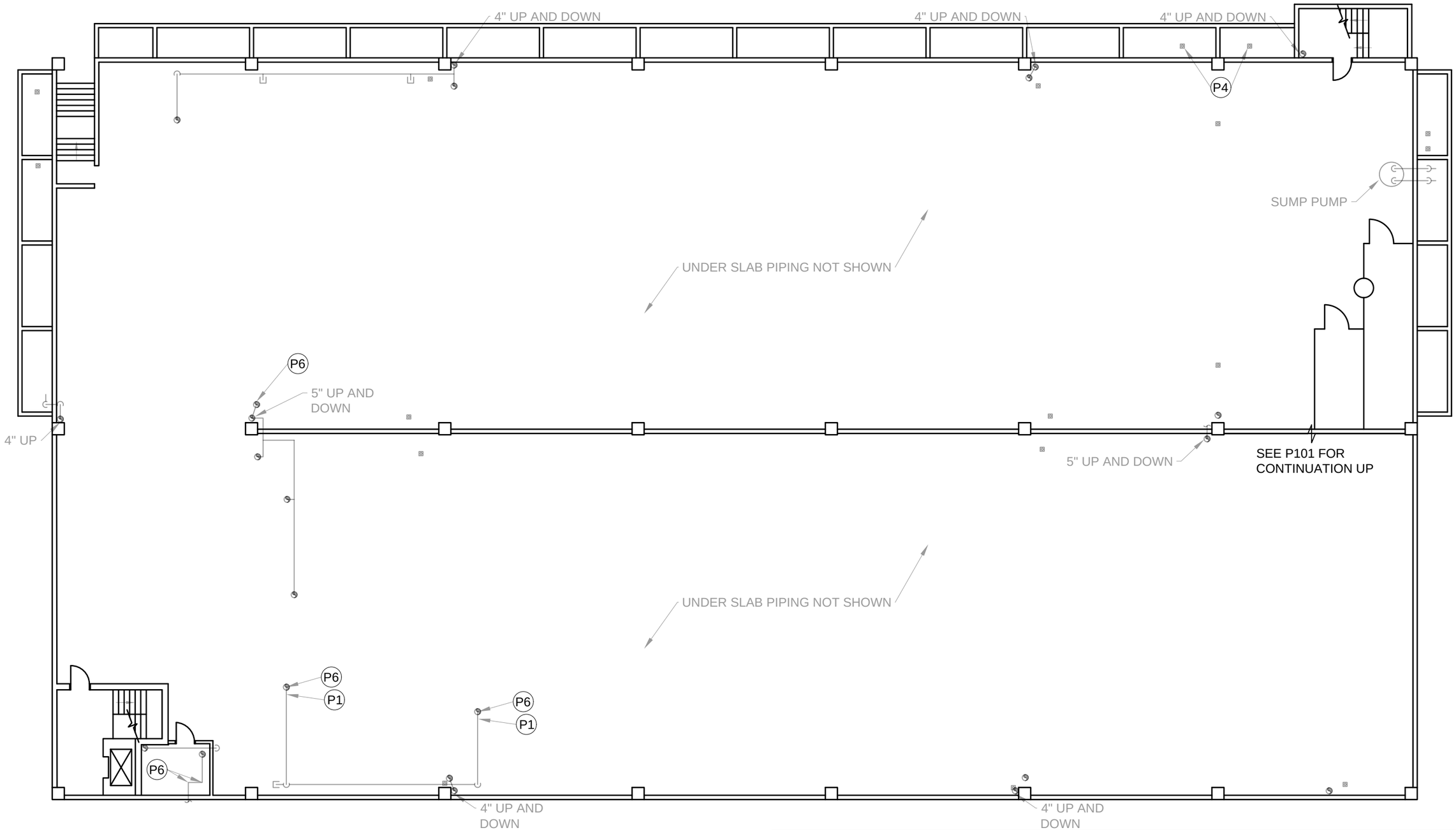
The storm drain system for the parking garage is comprised of primarily hubless cast iron pipe and fittings with some PVC pipe and fittings. In general, the hubless cast iron piping and fittings are deteriorating. This report calls out the fittings needing the most attention and recommends that all the laterals be replaced because various hubless couplings are failing and leaking. It is further recommended that either new hubless fittings be installed, or new PVC piping and fittings. The attached inspection summary and drawings show locals with particularly notable damage, and apparent issues based on the walk through are attached. The repair items called out all fit into the "High" priority level matching the structural assessment. These repair items appear to either be currently leaking, or if not addressed will likely fail and cause additional leaks. Due to the nature of pipe deterioration, it is difficult to identify needed repairs for the lower priority levels. It is likely additional significant repairs will be needed every 3-5 years to keep the drainage system in operation for an extended period, based on the overall condition of the existing hubless drain pipes.

Various floor drains appeared to be clogged with debris. The parking deck, drains, and lateral piping should be cleaned out and inspected to ensure there are no further blockages.

4th Street Parking Garage Summary of Visual Inspection
Applied No. 18-048 CES No. 17-165

Date: May 25, 2018

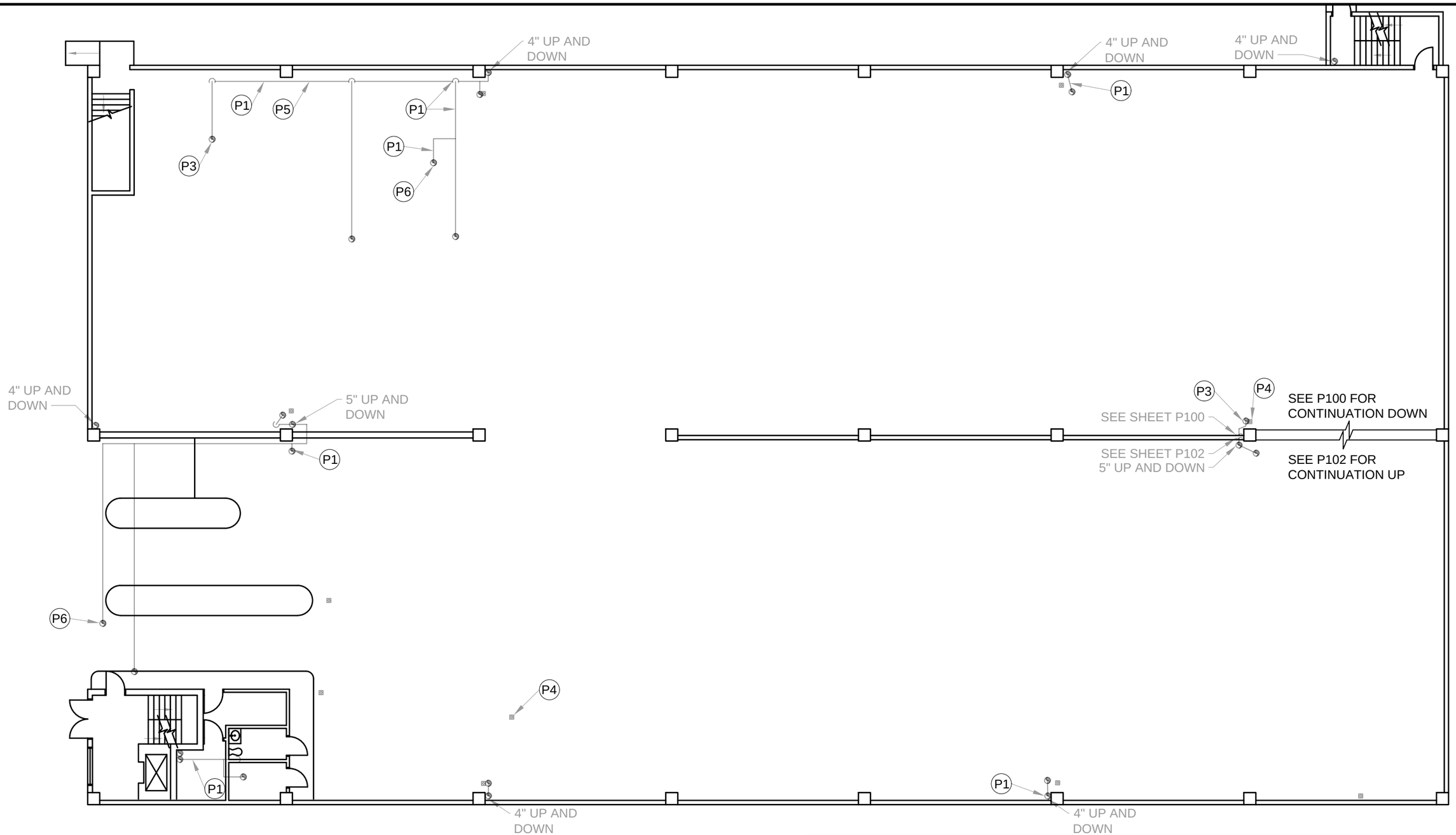
	Type of Repair	Location	Photo No.	Cost for Repair	Priority	Comments	No. of High Priority	Total
	Plumbing							
P1	Replace CI pipe rusted through, cracked	Various, see attached drawings	898, 951, 964, 996, 1011, 1021, 1027, 1035, 1106, 1113, 1148, 1165, 1262, 1271, 1273, 1275, 1290, 1293, 1314, 1317, 1351, 1366, 1380	$750	High	COST EACH, 10' section of hubless CI pipe, 2 couplings	25	$18,750
P2	Replace leaking/missing hubless coupling	Various, see attached drawings	1035, 1086	$100	High	COST EACH	10	$1,000
P3	Replace floor drain, repair to be coordinated with structural work.	Various, see attached drawings	764, 827, 898, 993, 1011, 1026, 1070, 1077, 1247	$2,000	High	COST EACH	14	$28,000
P4	Clear clogged drain, inspect lateral.	Various, see attached drawings	802, 983, 1119, 1246, 1342	$2,500	High	APPROX MOBILIZATION AND TOTAL FOR LOCATIONS SHOWN	9	$2,500
P5	Resupport sagging PVC pipe at coupling to CI.	First Floor, NE Corner	1282	$150	High		1	$150
P6	Replace rusted / leaking CI elbow, 2 couplings	Various, see attached drawings	898, 964, 969, 988, 992, 996, 998, 1009, 1010, 1011,1027, 1035, 1053, 1070, 1077, 1106, 1148, 1165, 1186, 1274, 1325, 1398, 1407	$250	High	COST EACH	25	$6,250
	Total							$56,650



Applied Engineering Services
5675 Castle Creek Parkway N Drive, Suite 300 • Indianapolis, Indiana 46250
Tel: 317.810.4141 • Fax: 317.810.4140 • www.applied-e-s.com

City of Bloomington 4th Street Garage Bloomingtown, IN				SHEET REF.
DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	PROJECT NO. 18-048	P100

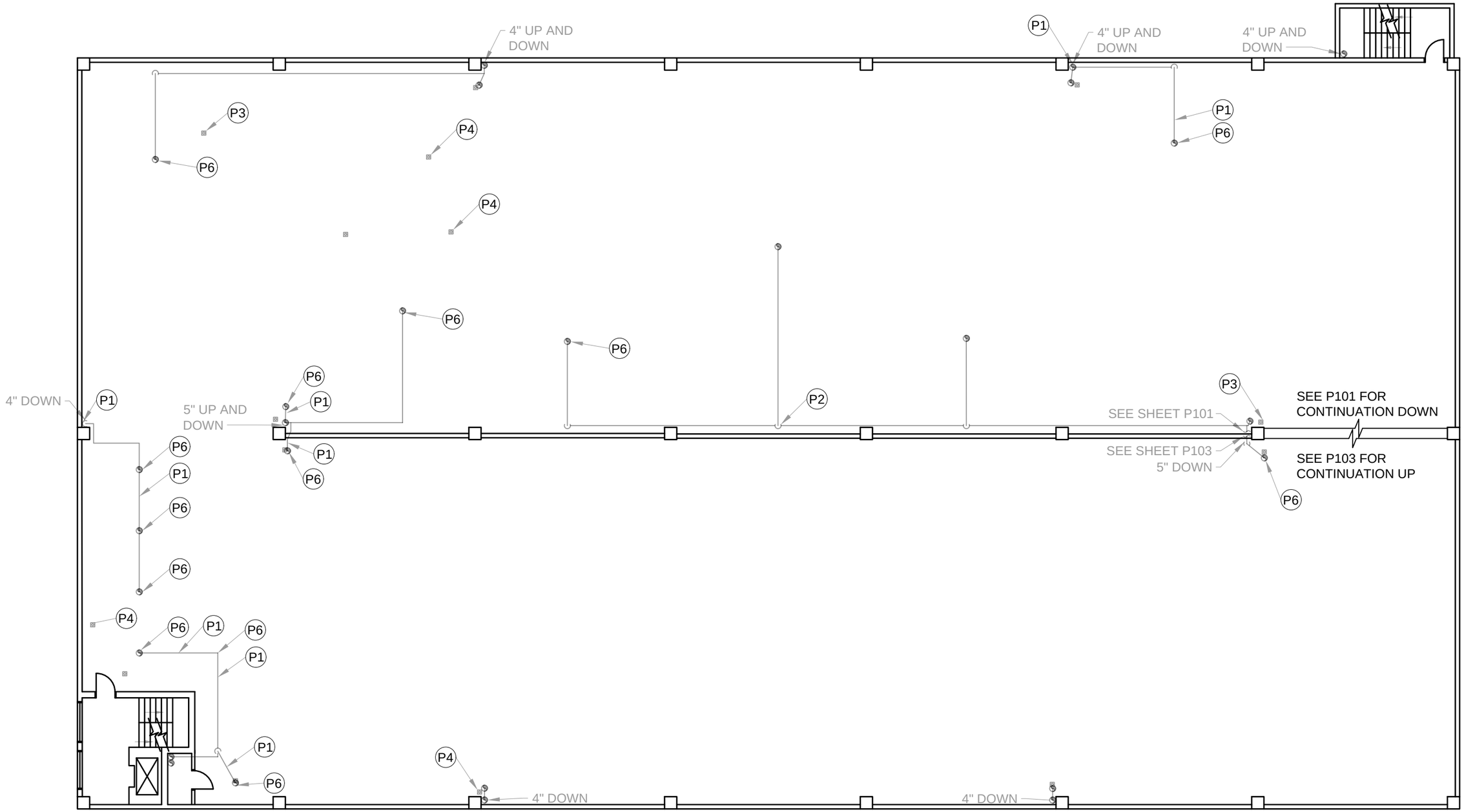
Location:G:\PROJECTS\18-048 CE SOLUTIONS - CITY OF BLOOMINGTON 4TH STREET GARAGE DRAINAGE PIPING STUDY\CADD\P100 | Plot Date:5/23/2018 3:24 PM | By:LBURLEY | Save Date:5/23/2018 3:24 PM | By:LBURLEY | Sheet Size:ANSI FULL BLEED B (17.00 X 11.00



Applied Engineering Services
5675 Castle Creek Parkway N Drive, Suite 300 • Indianapolis, Indiana 46250
Tel: 317.810.4141 • Fax: 317.810.4140 • www.applied-e-s.com

City of Bloomington 4th Street Garage Bloomingtown, IN				SHEET REF.
DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	PROJECT NO. 18-048	P101

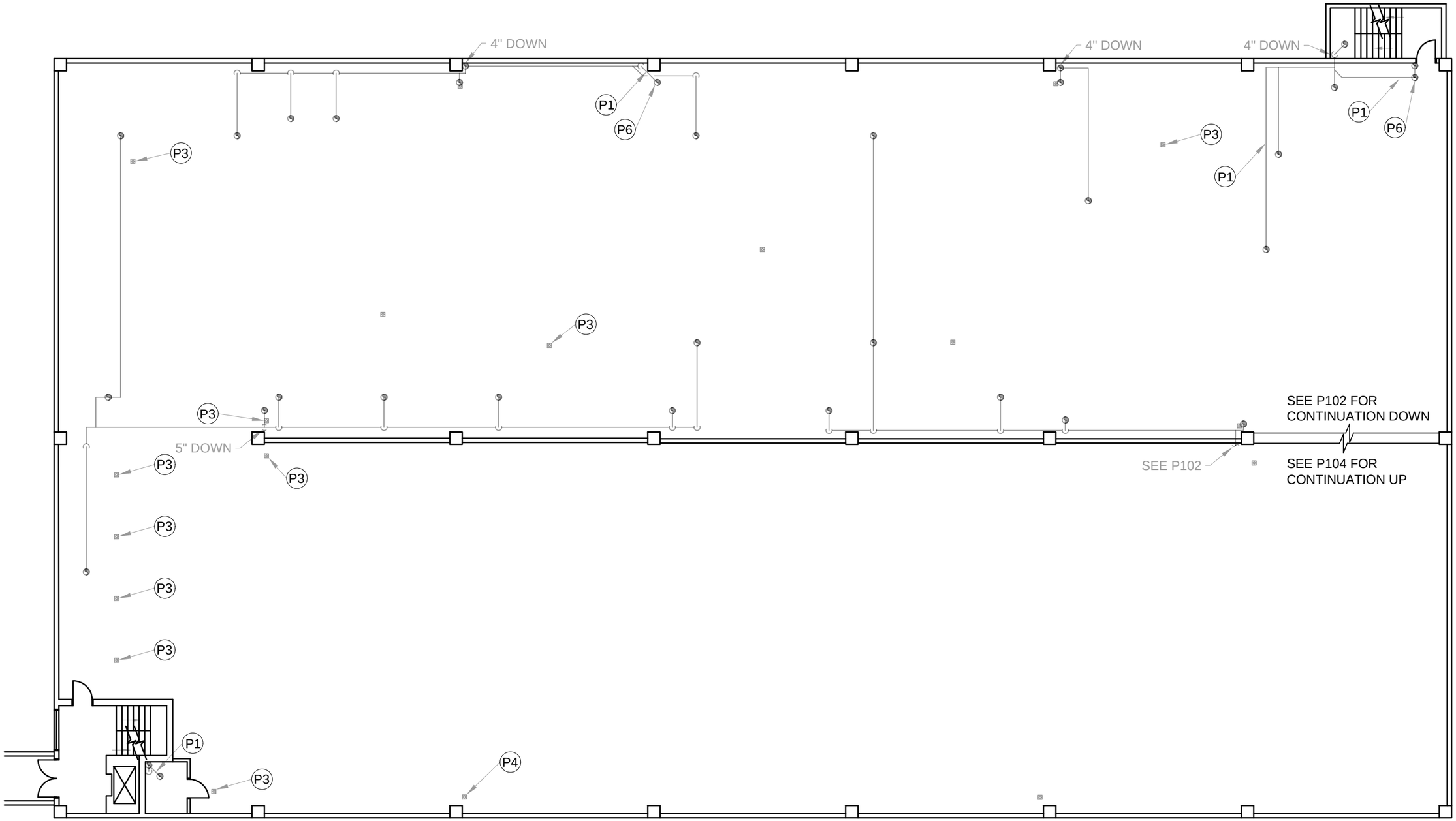
Location:G:\PROJECTS\18-048 CE SOLUTIONS - CITY OF BLOOMINGTON 4TH STREET GARAGE DRAINAGE PIPING STUDY\CADD\P101 | Plot Date:5/23/2018 3:24 PM | By:LBURLEY | Save Date:5/23/2018 3:24 PM | By:LBURLEY | Sheet Size:ANSI FULL BLEED B (17.00 X 11.00



Applied Engineering Services
5975 Castle Creek Parkway N Drive, Suite 300 • Indianapolis, Indiana 46250
Tel: 317.810.4141 • Fax: 317.810.4140 • www.applied-e-s.com

City of Bloomington 4th Street Garage Bloomingtown, IN				SHEET REF.
DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	PROJECT NO. 18-048	P102

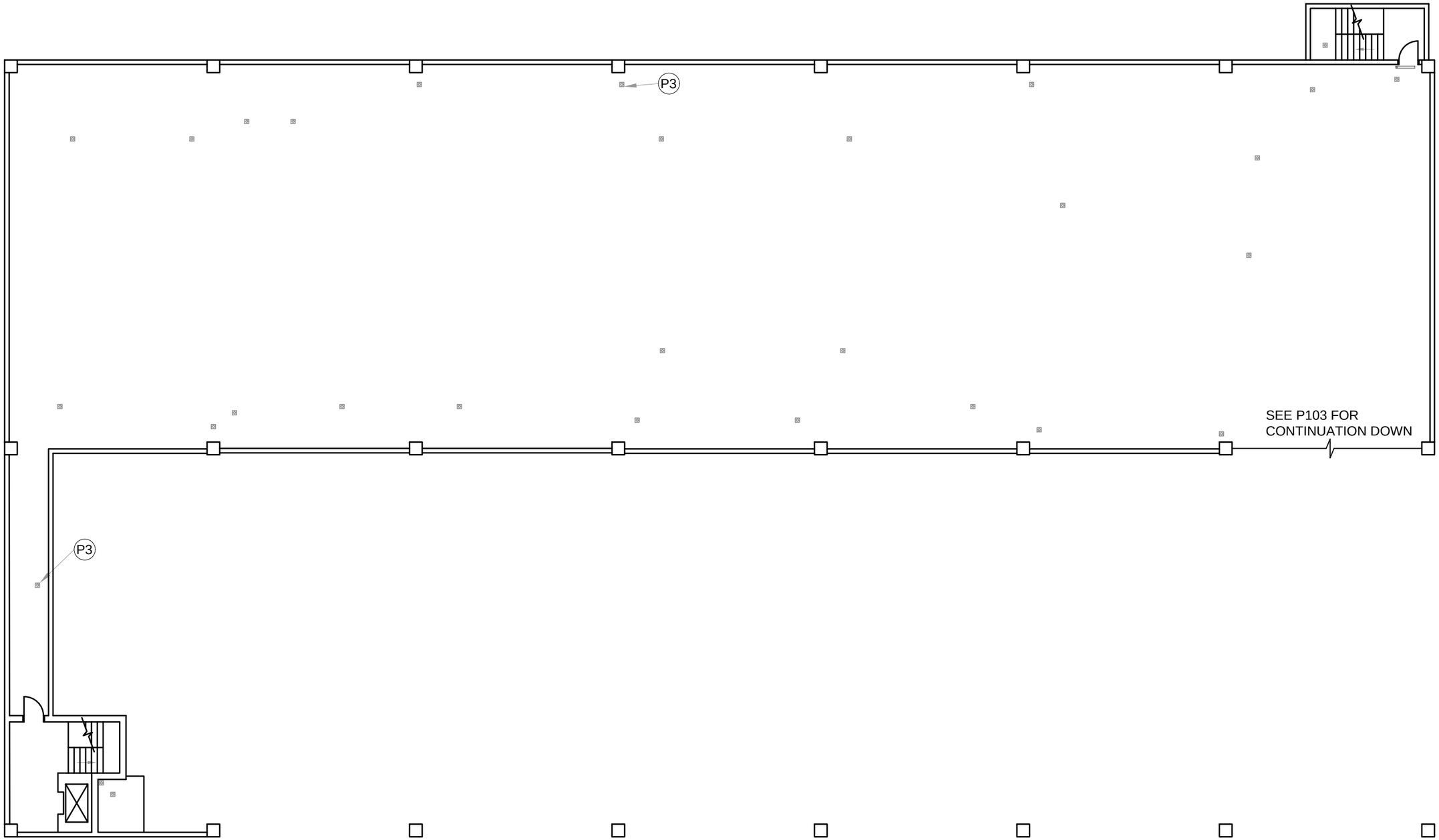
Location:G:\PROJECTS\18-048 CE SOLUTIONS - CITY OF BLOOMINGTON 4TH STREET GARAGE DRAINAGE PIPING STUDY\CADD\P102 | Plot Date:5/23/2018 3:24 PM | By:LBURLEY | Save Date:5/23/2018 3:24 PM | By:LBURLEY | Sheet Size:ANSI FULL BLEED B (17.00 X 11.00



Applied Engineering Services
5975 Castle Creek Parkway N Drive, Suite 300 • Indianapolis, Indiana 46250
Tel: 317.810.4141 • Fax: 317.810.4140 • www.applied-e-s.com

City of Bloomington 4th Street Garage Bloomingtown, IN				SHEET REF.
DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	PROJECT NO. 18-048	P103

Location:G:\PROJECTS\18-048 CE SOLUTIONS - CITY OF BLOOMINGTON 4TH STREET GARAGE DRAINAGE PIPING STUDY\CADD\P103 | Plot Date:5/23/2018 3:24 PM | By:LBURLEY | Save Date:5/23/2018 3:24 PM | By:LBURLEY | Sheet Size:ANSI FULL BLEED B (17.00 X 11.00



Applied Engineering Services
5675 Castle Creek Parkway N Drive, Suite 300 • Indianapolis, Indiana 46250
Tel: 317.810.4141 • Fax: 317.810.4140 • www.applied-e-s.com

City of Bloomington 4th Street Garage Bloomingtown, IN				SHEET REF.
DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	PROJECT NO. 18-048	P104

Location:G:\PROJECTS\18-048 CE SOLUTIONS - CITY OF BLOOMINGTON 4TH STREET GARAGE DRAINAGE PIPING STUDY\CADD\P104 | Plot Date:5/23/2018 3:24 PM | By:LBURLEY | Save Date:5/23/2018 3:24 PM | By:LBURLEY | Sheet Size:ANSI FULL BLEED B (17.00 X 11.00

0764

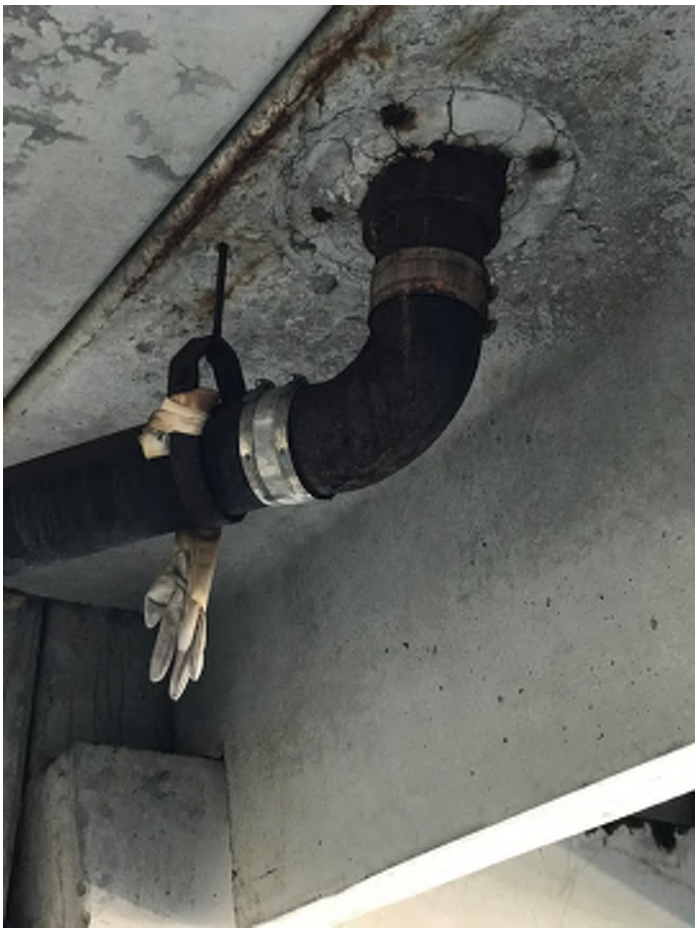
0802

0827

0898

0951

0964



0969

0983

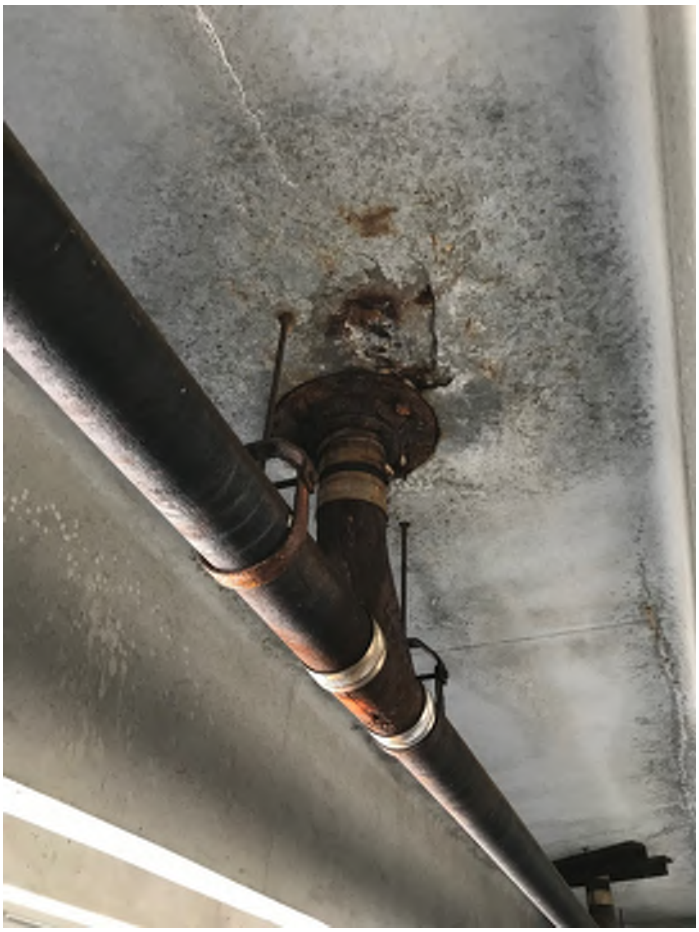
0988

0992

0993

0996

1009



1010

1011

1021

1026

1027

1035

1053

1070

1077

1086

1106

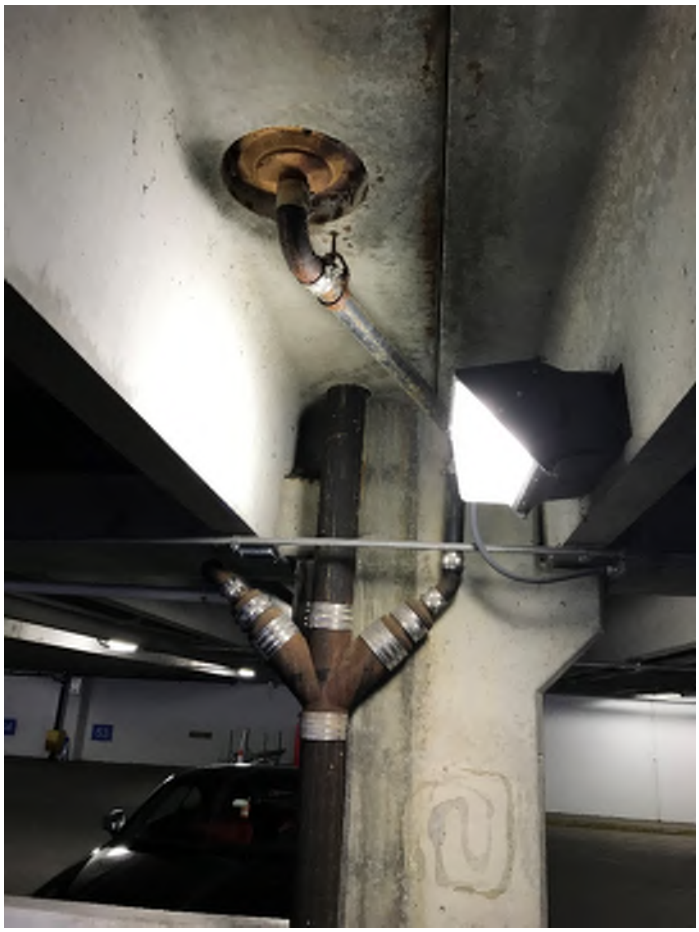
1113

1119

1148

1156

1165



1186

1246

1247

1262

1271

1273

1274

1275

1282

1290

1293

1314

1317

1325

1342

1351

1366

1380

1398

1407