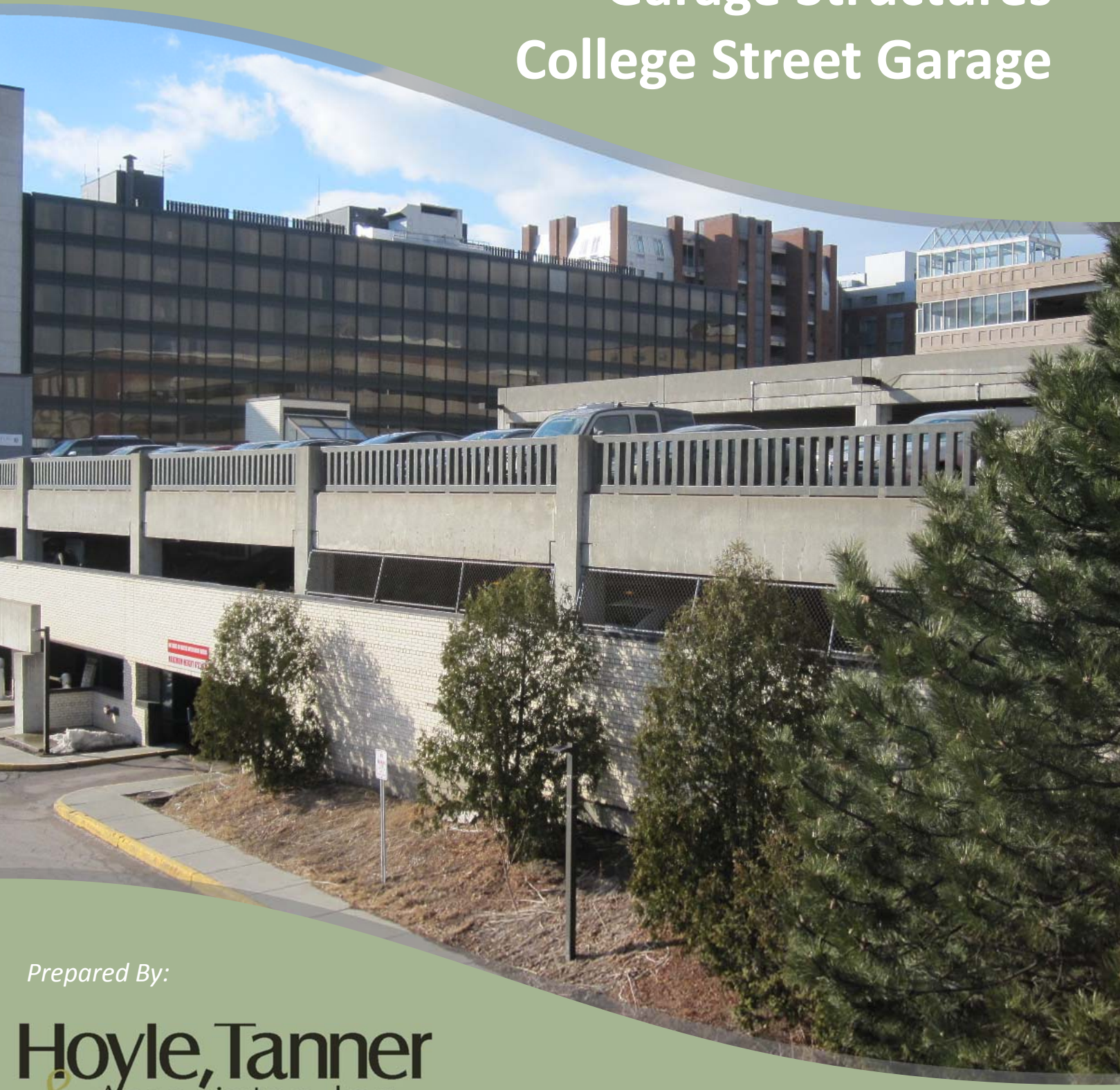
Assessment of City Parking Garage Structures
College Street Garage



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1 EXECUTIVE SUMMARY

The team of Hoyle, Tanner & Associates, Inc. (Hoyle, Tanner), Freeman, French, Freeman (FFF), and Kirick Engineering has been retained by the City of Burlington to perform detailed conditions assessment with repair recommendations and budgetary considerations at the College Street Parking Garage in Burlington, VT. These recommendations include immediate, short term, mid term, and long term needs as well as long term maintenance. This report summarizes our field observations, engineering opinions, and estimated costs.

The College Street (formerly Burlington Square) parking garage is a precast prestressed concrete structure constructed with a Bay Side By Side layout using three rows of "double-tee" beams for the deck that is approximately 174' long by 252' wide. Reference Appendix B for garage floor layout plans. This 4 level structure plus partial roof was opened in 1985 and now serves as the main parking for the Hilton Hotel guests as well as many downtown businesses including Peoples United Bank and Fletcher Allen Health Care. The garage is centrally located within the downtown district midway between Church Street and the Waterfront. There are three vehicular entrances to the garage; the first floor entrance under the Hilton Hotel from Battery Street, the second floor entrance from College Street, and the fourth floor entrance from the Lakeview Parking Garage.

In preparation of this report the following assumptions were made:

- The garage was inspected within the limits of its footprint (generally 252' x 174'). The skywalk to the hotel, walls and ceiling of the tunnel (on Level 1) below the hotel are not owned by the City and are not included in this report.
- The interior of the elevator shaft was inspected for structural and architectural considerations. The elevator and associated equipment are routinely inspected and maintained under a separate contract.

There are many issues in the College Street parking garage that require repair or replacement. Understanding the level of capital investment required for this garage, this report has attempted to categorize repairs that allows for spending to be budgeted and spread over multiple years. All of the recommendations are important to the long term integrity of this garage, if they can be coordinated and completed sooner we recommend doing so. We have also included recommendations for general housekeeping and preventive maintenance schedules. Deferred capital spending will lead to more costly, more structure-critical repairs.

During our inspection we identified the following issues that should be addressed as soon as possible:

1. Remove loose overhead concrete from spalled areas on double tee beams and inverted tee beams. Particularly prevalent on the underside of Level 2 framing this presents a hazard to pedestrians and vehicles below. (DT-8: this nomenclature is used with the report to key identified issues and is further explained in the Conditions Assessment Section of the report)
2. Repair beam bearing condition on Level 2 framing at Grid B/2. (DT-9)

3. Cover and protect exposed wiring connections (ED-1)
4. Repair surface spalls on stair treads. These present a dangerous tripping hazard. (ST-1)
5. Replace concrete pedestrian ramp on Level 4 by the Northeast stair tower. Accelerated concrete failure and voids present pedestrian hazard. (RA-1)

Almost all of the issues in this garage stem from poor drainage pitch and poor drain placement. Sealants, membranes, and concrete integrity break down faster due to ponding, deicing salts carried by vehicular traffic, and freeze/thaw cycles. Because of this it should be anticipated that garage maintenance will be more frequent and will be more costly than for a standard garage of this size and age.

Though there are many repairs and improvements necessary for this garage, much of the structure is still in serviceable condition. If repairs are completed within the recommended timeframe, future issues are quickly addressed, and a strong maintenance plan is adhered to this structure can be serviceable for another 20 to 30 years.

When considering alternatives at this garage location, recent average construction costs are at approximately $25,000 per parking space for new parking garage facilities. So to reconstruct a new garage at this location, matching the existing 460 parking spaces would cost approximately $11,500,000 (including engineering fees and demolitions costs).

2 INTRODUCTION

This report is based on a number of inspections performed by Hoyle, Tanner – structural components, FFF – architectural components, and Kirick Engineering – electrical components. We have reviewed existing plans and historical repairs to better understand the original construction. We have worked closely with Mr. Pat Buteau, Assistant Director of Public Works, and Mr. Brad Cummings, DPW Parking Facilities Manager. They provided a depth of historical knowledge, current needs, stakeholder considerations, and parking facility user challenges.

For the purposes of this study, our inspection was generally completed through representative sampling, with more detailed inspections occurring where visible and historical evidence warranted. Concrete was inspected for spalls utilizing hammer sounding, a laser plumb was used to verify beam and column plumbness, and a light meter was utilized to map light levels within the garage and determine the performance of the overall system and where improvements are needed.

We understand that simultaneous to this study there are three other parking studies being conducted for the City of Burlington:

- Downtown Burlington Parking & Travel Management Plan
- City of Burlington TDM Action Plan
- Parking Study in Residential Areas

We trust the findings of this report in partnership with the above studies will aid in shaping the future of downtown parking in Burlington. Considerations should be made with regards to the mid and long term spending on this garage and the future needs in this area as determined from these studies. The repairs recommended can greatly improve the functionality and user experience of the garage, but there will always be inherent issues associated with the poorly pitched drainage system, and future maintenance costs will remain higher than standard at this facility.

3 CONDITIONS RATING SYSTEM

CI = Conditions Index: The CI rating system used for this assessment was developed specifically for this project to help understand / rate the garage element(s) inspected. There may be select repairs that are prioritized even if an element of the garage is rated favorably. The rating system is intended to score how the element as a whole within the garage (or garage level) is performing with respect to its intended functionality. It is unrelated to public safety concerns, which have been accounted for in the Recommended Repair Timeframe (see section 4 of this report). The rating is from 0 to 10, and is as follows:

0 1	Serious	Element is not performing or is not present. Extensive repairs/replacement required to nearly 100% of element.
2 3 4	Poor	Element is failing or in risk of failing. Multiple locations requiring repair. Repairs extensive in nature.
5 6 7	Moderate	Minor repairs required in select locations
8 9 10	Good	Element in good condition. Maintain preventative maintenance program.

4 REPAIR TIMEFRAME

Each repair recommendation provided in this Report provides a description of the issue along with a repair recommendation and recommended timeframe in which to complete the repair. This conditions assessment was completed with the intent to identify issues, and prioritize them with budgetary costs. Further engineering for the development of bid and construction plans is recommended for all repair projects.

IMMEDIATE	0 – 1 years	Intended for repairs/replacements that represent a public safety hazard, or need to be completed to prevent further damage from occurring within the garage.
Short Term	1 – 2 years	Intended for repairs that need to be completed as soon as possible to prevent further damage within the garage, but are able to go through a proper design-bid-

		build cycle. It is recommended that the design process for these repairs begin shortly after receipt of this report, and be completed within the following construction season (i.e. complete prior to December 2015)
Mid Term	2 – 5 years	Repairs required for the garage that are necessary, but do not present a current hazard to the garage performance
Long Term	5 – 10 years	Aesthetic repairs. Repairs that will improve the long term performance of the garage, but can wait for planning purposes as prioritized needs are met.

5 CONDITIONS ASSESSMENT AND REPAIR RECOMMENDATIONS

For the purposes of this report we have developed an issue identification system so they can be tracked within the description, budget, photos, and prioritization matrix sections of the report. We attempted to utilized nomenclature that matched the garage element it is closely associated with, and numbered multiple issues within that category accordingly. For instance, for Joint Sealant repairs, we used JS, and since there were two different joint sealant conditions to note, they are identified as JS-1 and JS-2.

In order to maintain photograph integrity and size we have separated photos from the report body, but have used the identification system described above and maintained the order as follows in this section. We encourage the reader to utilize the photograph appendix in concert with reviewing the below section.

Estimated quantities of each issue are provided in the cost estimate summary in Appendix A of this report.

Reference to Grid, Column, and Beam Lines are based on the existing drawings which were utilized in developing project base maps as provided in Appendix B.

5.1 Double Tee Flange Joint Sealants

Level 2:	**CI = 1**	Near 100% joint sealant failure
Levels 3 & 4:	**CI = 6**	Spot sealant repair locations

Observations:

Many joint sealant failures were found throughout levels 2, 3, and 4 of the garage. Where joint sealant failures have occurred, water is allowed to penetrate down the sides of beams causing damage to the floor framing below. Levels 3 and 4 appear to have been replaced more recently than level 2 and were generally found in better condition. The majority of sealant at levels 3 and 4 was found in good, elastic condition and well bonded to the concrete surfaces. Failures at these levels were mainly associated with spalled concrete.

The sealant observed at Level 2 has failed, with many tears, debonding, and spalled concrete locations.

JS-1	Issue:	Joint Sealant Failure at Level 2
	Cause:	Service Life Expired
	Effect/Consequence:	Surface water travels between double-tee flanges, increasing the potential for beam damage and joint connection failure.
	Repair Recommendation:	Replace the full length of all joint sealant at this level. Replace spalled concrete to create uniform flange edge (see spalled concrete patching under Precast section of this report). Repair concrete cracks. Clean and prepare bonding surface prior to installation
	Repair Timeframe:	**Short Term**

JS-2	Issue:	Joint Sealant Failure at Level 3 and 4
	Cause:	Mainly due to spalled concrete adjacent to joint locations.
	Effect/Consequence:	See JS-1
	Repair Recommendation:	Replace failed sealant locations. Replace spalled concrete to create uniform flange edge (see spalled concrete patching under Precast section of this report). Repair concrete cracks. Clean and prepare bonding surface prior to installation
	Repair Timeframe:	**Short Term**

Joint Sealant Location	Date of Installation / Replacement	Current Age	Typical Life Expectancy
Level 2 Framing	Original (1985)	29 yrs	8-10 years
Level 3 Framing	2010	4 yrs	8-10 years
Level 4 Framing	2006	8 yrs	8-10 years
Level 5 Framing	Original (1985)	29 yrs	8-10 years

5.2 Miscellaneous Concrete Joints and Sealants

Concrete joints sealants should be replaced at wash areas, and have been accounted for with the wash area replacements. Joint sealants should be replaced at curb and stairwell areas. This small quantity is accounted for in CS-2.

Sealant runs along the perimeter of double-tee beam ends where they meet with spandrel parapets. The Level 4 sealant is concealed beneath the waterproofing membrane and appears to be functioning properly in most locations.

CS-1	Issue:	Floor level perimeter sealant failures (debonding, tears)
	Cause:	Age
	Effect/Consequence:	Water penetration to levels below
	Repair Recommendation:	Replace perimeter sealant at repair locations on level 4 and at all locations on levels 2 and 3, and ramps.
	Repair Timeframe:	**Short Term**

Slabs on-grade are located at Levels 1 and 2. Control joints appear to be functioning well, with some spall repairs needed in a few locations. The sealant in these joints is in need of replacement at all slab joints as it is failing in along the majority of its length.

CS-2	Issue:	Control joint sealant failure at slabs on-grade
	Cause:	Age
	Effect/Consequence:	Water penetration into slab joints. Spalling, concrete degradation
	Repair Recommendation:	Replace joint sealant
	Repair Timeframe:	**Mid Term**

The existing double-tee flange repairs at Levels 3 and 4 have a 4" diameter sealant patch at each bolt location. The majority of these sealants are in good condition. Approximately 10% of patches were worn through or have tears and are in need of replacement. Since these sealant patches were installed in 2006, 8 years old, they are approaching their typical lifespan of approximately 10 years. It should be anticipated to replace all of these patches within the next 5 years.

CS-3	Issue:	4" diameter sealant patch failures
	Cause:	Age, vehicular wear
	Effect/Consequence:	Water penetration into bolt locations. Potential corrosion of bolts and steel angle at double-tee flange connectors
	Repair Recommendation:	Replace sealant patches
	Repair Timeframe:	**Mid Term**

5.3 Expansion Joints

There are no formal expansion joints in this garage.

5.4 Waterproofing Membrane

Level 3 & 4: CI = 4 Membranes are failing in many locations.

Observations:

Epoxy based waterproofing membranes were installed with the 2005 garage repairs at locations on levels 3 and 4 of the garage. The locations included the roof perimeter (Grids A, D, 1, and 11), Grid 10, and extended areas around the elevator and above the Managers

Office (located on Level 2). Where membranes were installed, and are away from heavy traffic, they do appear to be performing their purpose, which is to not allow water to penetrate, however the surface water has found other paths adjacent to the membrane locations, and the membrane at Grid 10 does not withstand the frequent vehicular traffic and winter plowing operations.

The membranes installed have met their intended life expectancy and should be replaced at all currently installed locations, with the exception of Grid 10 on the roof level. Though this location has significant surface water issues they should be remedied with additional drain locations and joint sealant maintenance. Due to the poor drainage pitch of this garage it should be budgeted under long-term maintenance to replace membranes at Level's 3 and 4 within their recommended lifespan.

MB-1	Issue:	Membrane Failure
	Cause:	Age, Water penetration, Vehicular Traffic and Plowing Operations
	Effect/Consequence:	Age, Water penetration, Vehicular Wear and Plowing Operations
	Repair Recommendation:	Clean concrete surface and apply new liquid membrane.
	Repair Timeframe:	**Mid Term**

5.5 Precast Members and Connections

Level 2 – Double Tee Flange connections:	**CI = 1**	Near 100% shear tab failure
Levels 2 – Double Tee Beams:	**CI = 5**	Repairs needed, but beam integrity in good condition
Levels 3, 4, 5 – Double Tee Beams & Connections:	**CI = 6**	Repairs needed, but beam integrity in good condition
Spandrel Beams Grids A & D	**CI = 4**	Repairs needed at several beams
Support Beams Grids B & C	**CI = 4**	Repairs needed at several beams

5.5.1 Precast Double-Tee Beam

In general the Precast Double-Tee Beams were in found to be in good condition. The majority of issues were associated with poorly drained areas where surface water carrying salts and contaminants caused cracking and spalling generally at flange edges and beam ends.

In 2006, repairs were completed on the Double-Tee Beam flange connections at Levels 3 and 4, including Ramp 2-3. The repair consisted of the installation of an angle bolted to the

beam flanges across joints. Through bolts were installed recessed into the beam flanges with 4" diameter sealant patches covering the bolt heads and sealing from water penetration. The spacing of these bolted angles matches the original shear tab spacing. This repair was not completed at level 2 floor framing. The flange connection repairs appear to be in good condition. In order to maintain the integrity of flange connections, periodic replacement/repair of joint sealant and bolt sealant patches will be required.

DT-1	Issue:	Grout patch failure at Shear Tabs
	Cause:	Age, Water penetration, Improper Installation
	Effect/Consequence:	Further damage to Double-Tee Beam flanges.
	Repair Recommendation:	Replace failed grout patches. When patches are removed, chip out unsound portions of beam flanges. Clean exposed steel and protect from corrosion while exposed during repair. Install quality non-shrink grout patch per manufacturers' instructions. Clean existing surface, and apply scrub coat for improved patch bonding. Aggregate may be required in the grout mix for larger patch locations. Patches need to be installed flush with the beam flange edges and surface level. Coordinate patch repair with joint sealant replacement.
	Repair Timeframe:	**Short Term**

DT-2	Issue:	Double-Tee Beam flange cracks - Hairline
	Cause:	Majority of cracks found on Level 4 – potentially from sun exposure on beams. Cracks could have also developed due to warping stresses during installation
	Effect/Consequence:	Water can penetrate into beam cause potential flange reinforcement corrosion, and eventual extensive beam damage
	Repair Recommendation:	Cracks should be repaired with a self-penetrating crack healer/sealer
	Repair Timeframe:	**Mid Term**

DT-3	Issue:	Surface Spalls
	Cause:	Typically associated with rebar corrosion / expansion
	Effect/Consequence:	Water can penetrate into beam cause potential flange reinforcement corrosion, and eventual extensive beam damage
	Repair Recommendation:	Surface grout patch. Similar installation requirements to PC-1
	Repair Timeframe:	**Short Term**

DT-4	Issue:	Shear Tab Failure (Level 2 Beams)
	Cause:	Joint sealant failure, corrosion of shear tabs
	Effect/Consequence:	Large differential deflection between Double-Tee beams caused impacts to each beam as vehicles move on the floor level, and prevents sealants from maintaining bond as they cannot support that level of movement. Shear tabs also provide structural qualities for the transfer of lateral loads during a wind or seismic event.
	Repair Recommendation:	Install bolted angle repair as previously installed at levels 3 and 4.
	Repair Timeframe:	**Short Term**
DT-5	Issue:	Cored Holes on Level 2 Beam 1.1. Proximity of holes is close and removes majority of interior beam flange.
	Cause:	Installation of piping post construction completion
	Effect/Consequence:	Beam appears in good condition. Cores left flange reinforcing exposed. Reinforcing could rust, causing concrete spalls and further beam damage.
	Repair Recommendation:	Wire brush exposed reinforcing and apply spray coat epoxy. Fill or Cover (with pipe boot) annular space.
	Repair Timeframe:	**Minor repair. At DPW convenience.**

DT-6	Issue:	Beam End Spalls and Flange Spalls
	Cause:	Water draining down ends of Double-Tee beams. Related to wash area concrete failures.
	Effect/Consequence:	Continued beam damage.
	Repair Recommendation:	Chip out spalled, un-sound concrete. Clean exposed steel free of rust. Depending on extent of damage, splicing repair steel bars may be required. Apply grout patch, form vertical edges (reference PC-1 for installation instructions). Coordinate repair with Wash Area repair above.
	Repair Timeframe:	**Short Term**

DT-7	Issue:	Double-Tee Beam Bearing Pads – Frayed, Heavily Compressed
	Cause:	Age, water damage, improper design load
	Effect/Consequence:	Potential restriction of beam expansion/contraction and rotation resulting in beam cracking or damage to beam support member.
	Repair Recommendation:	Replace bearing pads. Note: Each beam end will need to be jacked to remove and install new bearing pad.
	Repair Timeframe:	**Long Term**

DT-8	Issue:	Double Tee Beam Overhead Flange Spalls
	Cause:	Spalls at shear tabs at Level 2. Overhead patch failure at Levels 3 and 4.
	Effect/Consequence:	Public Safety Risk
	Repair Recommendation:	Remove all loose overhead concrete.
	Repair Timeframe:	**IMMEDIATE**

DT-9	Issue:	Double-Tee Beam Bearing Issue (Level 2 – Beam 2.1 at Grid B)
	Cause:	Water damage, spalled concrete on beam and on top of wall at bearing location
	Effect/Consequence:	Beam has dropped and bearing is now taken through its flange on the wall.
	Repair Recommendation:	Repair bearing location and end of beam. Top of wall: chip out concrete to expose longitudinal bar, chip flat shelf for patch, install grout patch (wrapping around exposed reinforcing bar). End of beam: confirm limits of beam damage, verify adequate bearing area can be provided, protect exposed reinforcing and prestressing strands. Engineering calculations and repair development is required.
	Repair Timeframe:	**IMMEDIATE**

5.5.2 Precast Spandrel Beams

Observations:

Precast spandrel beams surround the perimeter of floors 3, 4, and 5 framing where the structure is above grade. Spandrels along the North and South grid lines were cast with a shelf that provides bearing support for the double-tee beams. Spandrels along the East (only on level 5) and West grid lines are not load bearing, but provide the function of vehicular barrier. Generally the spandrel beams and their connections were found in good condition. Some repairs to the double-tee support shelves, and their column supports are necessary as described below.

PC-1	Issue:	Spandrel Beam Support Shelf Cracks / Spalls
	Cause:	Water down ends of Double-Tee beams causing rebar corrosion and cracks and spalling of concrete.
	Effect/Consequence:	Beam support damage.
	Repair Recommendation:	Remove spalled concrete, clean reinforcing steel, patch with approved grout (PC-1a). At locations where shelf supports have cracks less than ¼" in width and the concrete has not spalled, the recommended repair is epoxy injection (PC-1b).
	Repair Timeframe:	**Short Term**

PC-2	Issue:	Spandrel Beam Web Shear Crack
	Cause:	Notched beam bearing. Original design did not provide sufficient crack control reinforcing to account for the reduction in beam web depth
	Effect/Consequence:	Currently cracks are relatively small, measured at 1/64". If cracks are left exposed water can penetrate, damaging reinforcing and concrete beam integrity
	Repair Recommendation:	Epoxy Inject crack
	Repair Timeframe:	**Mid Term**

PC-3	Issue:	Spandrel Beam – Column Corbel Damage
	Cause:	Water penetration causing reinforcing steel corrosion and concrete cracking. It appears that the corbels were repaired with an epoxy injection repair method, which has since become brittle due to age and exposure.
	Effect/Consequence:	Spandrel Beam support issues – large structural consequences
	Repair Recommendation:	Completely chip out and remove existing damaged corbels. Install galvanized steel shelf similar to the repair completed at Floor 4 framing, Column D/2 (adjacent to Southwest Stair Tower). Note: for corbels with single small width cracks, epoxy injection repair methods may be considered. Repair required temporarily supporting beam weight during construction.
	Repair Timeframe:	**Short Term**

PC-4	Issue:	Spandrel Beam – Map Pattern Cracking (Level 5, Grid 9)
	Cause:	Potentially due to thermal cambering of beam. East face of beam receives sun exposure, heating it, while the west face of beam remains cooler underneath Level 5 – thus inducing a camber effect and pattern cracking of concrete. This effect is called "sun cambering"
	Effect/Consequence:	Potential long term beam damage.
	Repair Recommendation:	Routine application of penetrating sealer. Coordinated with remainder of garage
	Repair Timeframe:	**See Maintenance Section of this Report**

5.5.3 Inverted-Tee Beams

Observations:

Inverted-Tee Beams support the double-tee beams at interior bearing grids B and C. These beams were cast with shelves on both sides forming an inverted-tee shape. The majority of these beams have significant structural issues consisting of spalled bottom cover concrete and substantial reinforcing bar corrosion and section loss.

PC-5	Issue:	Interior Inverted-Tee Beam – Steel Lateral Restraints at Bearing - Floor 4 framing Column B/10
	Cause:	Water damage from ponding issues above
	Effect/Consequence:	Later restraint compromised for Inverted-Tee Beam – large structural consequences in lateral event (wind or seismic).
	Repair Recommendation:	Coordinate with surface drainage repair at level 4. Clean existing steel and verify remaining section of steel angle and weld connection is suitable for continued use (evaluate reduced section structural capacity). Clean and Paint.
	Repair Timeframe:	**Short Term**

PC-6	Issue:	Interior Inverted-Tee Beam – Section Loss
	Cause:	Water damage from ponding issues and Wash Area spalls above
	Effect/Consequence:	Significant beam damage to a primary structural framing member.
	Repair Recommendation:	Damaged beams require additional investigation and engineering analysis to determine if reduced reinforcing bar sections can continue to support design loads. Repair alternatives can be developed based on this analysis. Alternatives to include the removal of damaged concrete, casting of new concrete to the undersides of beams, splicing of reinforcement where necessary, and may include a structural fabric wrap or cast-in ductile connectors to provide a composite connection between new and existing concrete. Double-tee beams will likely need to be supported during repair. Repair should be coordinated with wash area repairs above.
	Repair Timeframe:	**Short Term**

5.5.4 Precast Columns

Generally precast columns were found in good condition. Issues were found at column bases and vertical faces where drainage issues exist. Several columns along Grid D at levels 1, 2, and 3 have full width spalls on the face of the column. Spalls appear to have occurred from rebar corrosion and expansion. Drainage issues along this grid line at levels 3 and 4 have cause significant damage to all levels below.

PC-7	Issue:	Column corner spall
	Cause:	Water damage causing reinforcement corrosion and spalling
	Effect/Consequence:	Continued damage to columns
	Repair Recommendation:	Remove unsound concrete. Form and cast column corner.
	Repair Timeframe:	**Short Term**

PC-8	Issue:	Column vertical patch
	Cause:	Water damage causing reinforcement corrosion and spalling
	Effect/Consequence:	Continued damage to columns
	Repair Recommendation:	Remove unsound concrete. Apply vertical patch material, trowel applied.
	Repair Timeframe:	**Short Term**

5.6 Cast-In-Place Concrete

Floor Slabs On-grade: CI = 8 Majority of slab surface in good condition

Wash Areas: CI = 3 Large percentage of wash areas in serious condition

Foundation Walls: CI = 6 Spall repairs needs for significant area of wall

Observations:

The main Cast-In-Place (CIP) Concrete exposed and inspected by our team was at slabs-on-grade, wash areas, and foundation walls. The majority of slabs-on-grade were found to be in good condition with occasional minor spall repairs needed at control joints.

A large percentage of wash areas observed were in serious condition, with concrete disintegration having occurred through 100% of the CIP concrete depth. Concrete disintegration is as it name implies, it is the complete breakdown of concrete occurring from chemical reactions and freeze / thaw cycles. The wash areas play a critical role in directing the stormwater flow away from the vulnerable ends of double-tee beams.

Foundation walls appear to be in good condition with the exception of locations where drainage issues existing such as along grids A and D on levels 1 and 2. At these location there are large areas of spalling and scaling.

CIP-1	Issue:	Wash Area concrete failure
	Cause:	Road salt from vehicular traffic, ponding, and freeze/thaw cycles
	Effect/Consequence:	Water damage to structural members below.
	Repair Recommendation:	Remove existing wash areas full depth (to top of precast beams) at damaged locations. Install reinforcing to match existing sizes, and cast new wash with durable concrete mix. Cover wash areas with new membrane extending 6" beyond the wash both on the precast surface and up the wall.
	Repair Timeframe:	**Short Term**

CIP-2 (no picture provided)	Issue:	Foundation wall spalls
	Cause:	Water damage
	Effect/Consequence:	Continued wall damage and section loss
	Repair Recommendation:	Remove unsound concrete. Install vertical patch
	Repair Timeframe:	**Short Term**

5.7 Miscellaneous Steel

Observations:

The majority of this garage is constructed of precast and cast-in-place concrete. There are metal railings at the roof level that bolt to spandrel beams. These railings and their connections appear in good condition. Routine cleaning and painting should be maintained, this is accounted for in the maintenance section of this report.

There are several concrete filled metal pipe bollards located throughout the garage. Some bollards serve to protect vertical drain pipes, and several are located in front of the elevator vestibule on Level 4. At multiple locations bollards span and are connected to both sided of precast double tee joints. This is not a good detail as it exposes the bollard connection to forces from the precast beam movements. Additionally, the typical drainage path is at these joints. Where possible removal of these bollards should be considered, and their connections and voids infilled with a non-shrink grout. Bollards that remain should be cleaned and painted. The steel bollard at the Level 2 entry island should be removed and reset to the concrete sidewalk; additionally, this bollard should be infilled with concrete, it is currently hollow. The steel bollard on Level 2 at Grid D/5 should be removed. Significant damage has occurred in the beam flange below and needs repair; it is not recommended to replace a bollard at this location.

There are 4 metal frames at Level 4 Grids B/9, C/9, B/3, and C/3. These frame have significant corrosion. They serve no structural purpose. They should either be replaced with new painted steel frames or removed, and grout connection locations.

The steel railing along Grids A and D is in good condition. Minor cleaning and painting is required.

5.8 Foundation Performance

We performed inspection of columns and walls considering potential for foundation issues. Our inspection utilized laser levels to verify the columns and building are in plumb condition. Based on our inspection, we did not find indications of foundation related issues such as settlement or wall movement.

5.9 Electrical and Lighting Systems

This garage was built in 1985 and it appears that very little additional electrical infrastructure was added or replaced since this initial construction (however, the main parking area lighting appears to have been replaced in kind with newer fixtures and a new fire alarm system panel has been installed recently). Water infiltration appears to have been a constant problem at this structure and as a result much of the electrical system in the lower levels has extreme rusting corrosion problems. A complete assessment of the electrical infrastructure for this garage has been conducted on the above dates. The following conditions were field checked:

5.9.1 Service Equipment

CI = 1 Lack of Panel and Transfer Switch for Emergency Power

Observations:

The main service feeder size is 400 amps, 277/480 volt, three phase, and terminates at a wireway which has 4 individual, service rated, fused disconnects tapped from this single feed. This is a bit of an odd arrangement but falls legally under the maximum 6 service disconnect rule. One of these disconnects feeds a main lighting panel, which appears to have been designed for time clock control, a second disconnect feeds a panel designated as “emergency”; however, there is no emergency power source connected to this system, so the label is a bit deceptive. The reason for this panel seems to be to feed about 10% of the lights independent of time clock control and then to provide a step-down transformer for a 120/208 volt panel and its subsequent power for tool booths, fire alarm power and other miscellaneous lower voltage and critical to basic operational needs. Even though there is no current emergency or alternate power source, a generator could easily be added to this system to provide true back-up emergency power. It is also feasible to install wiring to the Lakeview garage and utilize the existing emergency generator in place for this garage.

Generally, this equipment is in fairly good condition, since the electric room has been spared the brunt of the water seepage problems, except for the lower 6 inches of the room, which has similar corrosion conduit and wireway problems as the general space (see distribution system concerns below). Overall these panels, disconnects, and associated transformer are still in reasonable condition and are manufactured by Square D, a company that is still a leader in electrical equipment; and therefore are able to accommodate on-going equipment parts and service support in the maintenance of this gear.

ES-1	Issue:	Lack of main distribution panel and automatic transfer switch for emergency power
	Cause:	Original design omission
	Effect/Consequence:	Lack of true emergency power to facility.
	Repair Recommendation:	Consider the replacement of the tapped service feeder and individual disconnects with a single distribution panel and installation of a transfer switch so that emergency generator can be added to system.
	Repair Timeframe:	**Short Term**

5.9.2 Distribution Equipment

CI = 1 Highly Corroded

Observations:

As mentioned above for service equipment, there are three sub-panels in the main electric room that serve the entire parking structure. These are in reasonably good condition; however, the distributed branch circuit wiring, once it leaves this room, is in generally poor condition (high levels of rust), with the condition exceedingly worse the lower in the structure one goes. In many places the rusting is so severe that coverplates have fallen completely off the junction boxes they were once attached to, leaving the conductors within now exposed and open to any and all passers-by. This exposed condition is a code violation and a safety concern.

The rusting has so deteriorated the conduit system that the boxes will not be able to support new coverplates and the conduits themselves are likely not able to even support new boxes being attached to them. In places, even the conduits have been corroded completely through. Replacement of the entire conduit and wiring system is the only remedy at this point. These conduits are EMT type and if replaced in kind will start to decay again, unless effective means are undertaken to remediate the water infiltration problem for the structure. PVC conduit would be an acceptable alternate to a steel based conduit, if added resistance to moisture is desired.

The present location of the disconnects for the large fan units on Levels 1 and 2 would probably not pass inspection due to their lack of clearance of front of them. These units are non-operational, but should they be replaced additional electrical equipment modifications may be necessary.

ED-1	Issue:	Missing Junction Boxes & Wiring Safety Concerns
	Cause:	Water infiltration to facility.
	Effect/Consequence:	Exposed live wiring connections. Public Safety Hazard
	Repair Recommendation:	Cover & Seal wiring connections to protect from public access and from water penetration. Potential repair is to fasten a plastic cover to the concrete beam and seal perimeter. This is a short term fix to improve safety until long term replacement can be conducted.
	Repair Timeframe:	**IMMEDIATE**

ED-2	Issue:	Highly corroded conduit and wiring.
	Cause:	Water infiltration to facility.
	Effect/Consequence:	Eventual circuit failures. Danger to occupants.
	Repair Recommendation:	Replace conduit and wiring for all active branch circuits on all floors.
	Repair Timeframe:	**Short Term**

5.9.3 General Lighting

CI = 6

Observations**:**

The original lighting systems were a combination of high pressure sodium (HPS) based High Intensity Discharge (HID) fixtures for the general parking areas, and linear fluorescent fixtures for smaller rooms and stairwells. None of these HID lighting systems would be used in a new parking garage design, due to vastly improved and much more energy efficient systems available today; however, they were the design standard of the day when first installed. These are still in operation, but it is difficult to tell if they have been replaced at one time since initial install. The HID general area lights look to be in relative good condition, but the stairwell lights are very dirty and/or damaged, some with lenses even missing from them.

Generally, the National Parking Association (NPA) in association with the Illumination Engineering Society of North America (IESNA) recommend 2.0 footcandles (FC) average for general parking areas, with 20 FC in stairwells and at stair entrances, and 6 FC at ramps and a minimum of 1 FC maintained at floor throughout. Higher FC levels at entrance areas are also recommended for daytime use when exterior daylight could be quite bright and entering a (relatively) dark parking garage needs to have a transitional zone so that eyes have a chance to adjust to the lower internal levels. Egress pathways are required by code to have a minimum of 1 FC average for path and 10 FC minimum for egress stairs. For this facility the following field lighting levels were measured:

- 3-20 FC at College Street entrance/exit
- 3-8 FC down center of drive path (as high as 30 FC near individual fixtures)
- 3-16 FC in stair towers (but some don't meet the minimum 10 FC required for egress lighting)

- 3-20 FC Throughout general indoor parking areas. Lower levels had higher measured light readings than upper floors.
- 0.1- 35 FC at rooftop level with mostly below 0.5 FC. Wide ranging light levels due to design that has lights installed only around the center ramp structure and no fixtures installed at the perimeter of the parking deck.

Generally, the lighting was fully operational and the light levels were adequate for the spaces within the structure with the exception of low light levels in some stairwell areas. However, the open upper deck area had lighting so low in places that even readings of 0.1 FC could not be measured, especially around the exterior perimeter line of parking spaces. Contrasting the perimeter areas the parking spaces near the ramp mounted pole fixtures was very bright at readings of 35 FC. This upper deck area had the most extreme variation in light levels and was uncomfortably low in places, especially compared to adjacent People's Bank walkway, which had a much more even and appealing lighting scheme that only ranged from 0.5 – 8 FC. Please note that while the lighting FC levels for most of the interior areas seems adequate, the color rendering of the HPS is not good and better systems are available now that give better energy efficiency while also having better color rendering qualities.

EL-1	Issue:	Poor lighting.
	Cause:	Aging fixtures and lighting design deficiencies.
	Effect/Consequence:	Reduced security and comfort of patrons, higher energy bills than what newer lighting systems yield
	Repair Recommendation:	Replace all lighting throughout with a fully integrated lighting scheme, using high-efficiency lighting systems such LED or induction based. The upper deck area needs the replacement most, due to the ineffective lighting levels with the system installed there now. The replacement of the HPS system is recommended for both increased energy efficiency as well as increased security due to the better color quality of a recommended LED based system. LED lighting should also have increased maintenance savings since LED lamp or driver modules are expected to have three to four times the life expectancy as a typical HPS lamp.
	Repair Timeframe:	**Short Term**

5.9.4 Required Life Safety Systems

CI = 5

Observations:

Life-safety systems consist of two elements: the emergency egress lighting system, and the fire alarm system. Both of these systems have deficiencies and operational problems. Details of each of the critical elements are described below -

Egress Lighting – Emergency egress lighting consists of two components, exit signage marking and auxiliary power backed-up pathway illumination. Exit signage must be either internally or externally illuminated and be placed along egress routes so that at no location along the egress path is the distance greater than 100'. Also, generally building inspectors like to have two different exit signs visible from any given location so that if one pathway is blocked by a hazardous condition during an emergency the viewer can opt to take the alternate path to safety.

In general, at the College Street structure most places have inadequate placement and quantities of exit signage. Some of the few exit signs observed were of the non-electric type, which are supposed to have self-illuminating elements for night use visibility. These fixtures well observed to not have any visible self-illumination at night and should be replaced with newer, effective units. These should also be supplemented with additional fixtures where lacking.

As for emergency lighting operations, the existing system as designed is not functioning as a true emergency system. Although some lights are provided with power from the panel labeled as "emergency", as mentioned earlier, this panel does not have an emergency power source associated with it. It appears that only a few exit signs have self-contained battery packs for emergency lighting.

Fire Alarm- For parking structures over 100,000 square feet (SF) in size, a manual or automatic fire alarm system is required (unless sprinkler protected). The College Street garage is larger than 100,000 SF, but does have a sprinkler system installed, and a sprinkler monitoring type fire alarm panel was initially installed for this structure. In addition, this structure has an elevator, which also has requirements for automatic smoke and heat detection for its associated spaces. In this elevator tower, manual pull stations were added to the system, but only at the elevator tower access doors. Notification appliances (strobe/horns) do not appear to have been part of the system design.

Recently the original fire alarm system was replaced with a new Mircom FX-2000 addressable fire alarm panel system. No observed improvements were done to the existing system design at the time of replacement.

The garage does have a manual fire alarm system installed with pull stations at the southwest stair tower. This does not meet the standards for a manual fire alarm system (which would require pull stations at each stair tower), but it is not required per code and we understand an allowance was given for as the system is above code requirements.

Generator System: There is no generator or alternate power supply system for this facility. Emergency circuits for a limited number of exit signs based upon supplemental battery packs is all that is installed here now.

ELS-1	Issue:	Lack of emergency power system.
	Cause:	Initial building design deficiencies.
	Effect/Consequence:	No emergency egress and exit signage lighting as required by code.
	Repair Recommendation:	A generator based emergency power system is recommended for the facility, especially if the service gear is upgraded and an automatic transfer switch can be incorporated into the replacement gear design. The unit would not have to be very big, maybe in the 20 kW size range and should be able to be situated so as to have easy access for maintenance and where noise during regular test running will not be bothersome.
	Repair Timeframe:	**Short Term**

ELS-2	Issue:	Exit signage deficiencies.
	Cause:	Initial building design deficiencies.
	Effect/Consequence:	Reduced security and comfort of patrons.
	Repair Recommendation:	Add exit signage as required.
	Repair Timeframe:	**Short Term**

5.9.5 Communications Systems

Telephone: **CI = 8**
Telephone service is basic and appears adequate for the use of the facility.

Computer/Data: **CI = 8**
There is a local network for a minimal number of workstations associated with the office and adjoining toll booths. CAT5e cabling is fairly new and in good condition. System is adequate for its function.

Communications/PA: **N/A**
The building does not have any public address or other mass notification systems in place.

Security: **CI = 8**
Several security monitoring cameras have been recently installed at the main toll exit ramp. This is an IP based system (not a recorder based system) which is connected to Burlington DPW for remote monitoring of facility as needed. The cameras are mostly utilized for reading license plates as they exit the facility.

5.10 Openings (Windows, Doors and Storefronts)

CI = 4 Multiple deficiencies in code compliance, operating condition, and public safety.

CI = 1 Door missing and Storefront failure at elevator vestibule (top level).

Observations:

Doors and hardware are in generally poor condition; extensive rust, broken and inoperable hardware, non-ADA compliant thresholds were observed in each stairwell at most levels. Of particular note is the storefront system at the top level elevator vestibule. The door has been removed and the base frame has failed, facilitating water and debris to enter the vestibule and elevator shaft.

OP-1	Issue:	Doors and hardware are in generally poor condition
	Likely Cause:	Insufficient weatherization / waterproofing; misuse or abuse.
	Effect/Consequence:	Usefulness of the doors will become increasingly compromised.
	Repair Recommendation:	Repair (or replace) all doors and hardware. (approx. 17)
	Repair Timeframe:	**Mid Term**

OP-2	Issue:	Door missing and Storefront failure at elevator vestibule
	Likely Cause:	Improper drainage, misuse or abuse, sealant failure
	Effect/Consequence:	Causing multiple moisture issues in the elevator shaft. Direct interaction with weather leading to continued degradation of exposed systems
	Repair Recommendation:	Patch/repair sloped concrete approach. Replace door. Repair or replace a portion or all of the storefront system.
	Repair Timeframe:	**Short Term**

5.11 Stair Towers

Stair Towers: CI = 6 Some Repairs necessary

Observations:

Stair towers were constructed of a combination of concrete masonry units and precast wall panels. Wall panels are clipped at each floor with welded metal tabs. Precast stairs and landings are connected to the walls at each landing. Stairwells exhibit a humid environment with poor ventilation and tracked-in water (by foot traffic) causing rusting of railings and stair reinforcement. Some spall patches are required on stair treads, as well as a penetrating crack healer/sealer for cracks less than 1/16 of an inch.

Roof areas appeared in good conditions with no noted leaking. Some slab cracks existing on the underside of the roof slab. These cracks appear old, are present in each stairwell roof, and do not present a structural concern so long as the membrane is maintained in good condition.

Stairs and railings are generally in moderate condition, with 2012 NFPA 101 Life Safety Code compliance deficiencies throughout. Tread nosing inserts are worn but not loose; railings show some rust but are not loose or broken; stair rise/run as well as railing height and gaps

do not meet current life safety code standards. If substantial work is to be completed at stairs and/or railings they will be required to be brought up to current code standards (this would be a significant undertaking).

ST-1	Issue:	Stair Tread Spalls
	Cause:	Water damage
	Effect/Consequence:	Potential tripping hazard
	Repair Recommendation:	Remove unsound concrete – patch spalls
	Repair Timeframe:	**IMMEDIATE**

ST-2	Issue:	Stair Tread and Landing cracks
	Cause:	Water damage
	Effect/Consequence:	Continued damage
	Repair Recommendation:	Epoxy injection for cracks less than ¼". At spall locations remove spalled concrete and repair with formed non-shrink grout product (repair design to consider ductile connection)
	Repair Timeframe:	**Mid Term**

ST-3	Issue:	Rust and peeling paint at Stairwells
	Likely Cause:	Envelope and roof drain failure allowing water to enter stairwells
	Effect/Consequence:	Rails – peeling paint and rust; concrete walls and stairs – peeling paint and erosion
	Repair Recommendation:	Refinish (scrape, sand, prime and paint) stair interiors and stair components. (Replace roof membrane, flashing, drain assemblies: see related roof membrane item)
	Repair Timeframe:	**Mid Term**

ST-4	Issue:	Railing and stair code deficiencies
	Cause:	Handrails in all stair towers are below 32" as measured from stair nosing.
	Effect/Consequence:	Code deficiency
	Repair Recommendation:	Replace rails with code compliant handrail/guardrail combination at interior stair runs.
	Repair Timeframe:	**Short Term**

5.12 Elevator Shafts

We found the interior of the elevator shaft at Grid 1 (Elevator #2) to be in generally good condition. Some water is leaking in from the roof drain and at level 4, but the walls and wall connections appeared in generally sound condition. The drainage pipe and roof drain should be repaired with **Short Term** drainage system repairs. Level 4 stormwater should be captured outside of the elevator vestibule, coordinate with sealant and surface drainage

repairs. Per discussions with elevator maintenance contractor, and our observations, water entering the shaft causes issues to the elevator equipment and function. Elevator #2 is a TK 3500 with 6'9 x 5'8" inside dimensions. Pit Light not operating. A ½"+ lip is present at 2nd floor threshold. Door at top landing missing and storefront and associated sealant has failed. Roof drain sealant has failed. (See Openings and Roof Membrane items)

5.13 Roofing Membranes

CI = 4 Exceeds expected life span of roof system 15-20 years (this roof system is assumed to be about 30 years old)

Observations:

Total area of roof membrane(s) = 603 SF
Three corner towers (Stairs #1, 3, 4) approximately 8'x14' =(112 SF);
One (NE) corner tower (Stair 2 elevator #1) 8'x 18' (S2) + 8'6"x 7'4" (E1) = (206 SF)
One Elevator (E2) tower 8'6" x 7'2" = (61 SF)
All roofing is assumed to be the original 1984 ballasted membrane(s) on precast plank with parapet of metal coping on wood blocking.

3" roof drains typical at all membranes, penetrate stair enclosure through 4" sleeve and daylight, terminating 6" above garage deck (Finished Floor).

RM-1	Issue:	Exceeds expected life span of roof system. Some staining indicative of leaking observed.
	Likely Cause:	Age
	Effect/Consequence:	Expected building maintenance item
	Repair Recommendation:	Replace roofing membranes on a maintenance schedule. Following repair of more critical enclosure issues.
	Repair Timeframe:	**Mid Term**

RM-2	Issue:	Elevator #2 roof Drain sealant has failed
	Likely Cause:	Age
	Effect/Consequence:	Compromises elevator shaft
	Repair Recommendation:	Replace elevator roof drain; or reseal and schedule maintenance replacement.
	Repair Timeframe:	**Short Term**

Roof Membrane Location	Date of Installation / Replacement	Date of Repairs / Patching	Age
SE Stair Tower	Original (1985)	-	29 yrs
NE Stair Tower	Original (1985)	-	29 yrs
NW Stair Tower	Original (1985)	-	29 yrs
SW Stair Tower	Original (1985)	-	29 yrs
Level 5 (cover over Ramp 3-4)	2010	-	4 yrs
Elevator Shaft	Original (1985)	-	29 yrs

5.14 Mechanical / Utility Rooms

There is a fan room on Level 2 and Level 1 of the garage. Both rooms have fan units (which have not been used during City ownership). It was noted during the site visit that air flow is poor at these levels and moist floor/wall areas take a very long time to dry. This has a deleterious effect on structural, mechanical, and electrical garage components, as well as contributing to poor air quality. It appears to have been the design intent for these units to circulate air at these levels, and it is recommended to replace these units (it is anticipated that existing units are no longer operable, and efficiency technology improvements warrant mechanical replacement). Assessing whether improved ventilation is required by code or needed based on air quality readings was not part of the scope of this report. Further code review (including the 2012 International Mechanical Code) and air quality readings is recommended for the 1st and 2nd levels of this garage.

Utility Rooms (Elevator & Fire Alarm, Electrical, Sprinkler) on the first floor were relatively dry and in good condition. Protection for equipment should be considered at locations below floor joints above.

ME-1	Issue:	Poor Air Flow/Fans Not Operating at Levels 1 and 2
	Cause:	Majority of both levels are underground – limited fresh air exposure
	Effect/Consequence:	Poor air quality, moisture related issues on structural, mechanical, and electrical components
	Repair Recommendation:	Install new fan units
	Repair Timeframe:	**Long Term**

ME-2	Issue:	CMU Wall damage
	Cause:	Drainage issues and roadway salt tracked in from vehicles causing disintegration of the base of wall
	Effect/Consequence:	Stability and integrity of CMU wall compromised
	Repair Recommendation:	Remove unsound masonry. Patch with non-shrink grout
	Repair Timeframe:	**Mid Term**

5.15 Occupied Spaces

Generally the occupied spaces within the College Street Garage are in adequate condition. The maintenance office on the second floor has no known issues. The Parking Facilities Manager's office in the Southwest corner of the second floor has a history of leaking, but is currently has no issues as the membrane above is preventing joint leakage. The ponding above is associated with drainage repair SD-1 as described later in this report.

If the fan units are to be replaced in the utility rooms on levels 1 and 2 (see ME-1), there may be a need for an alternate enclosed storage space. Stored materials should be kept on covered elevated pallets.

5.16 Sidewalks, Curbs and Ramps

A concrete curb bumpout was installed adjacent to each stairwell. These bumpouts appear to serve in preventing parking at stairwell entrance/exit locations. However, the bumpouts also block drainage flows. Several solutions exist including removing a portion of the bumpouts (essentially making an island) so water can flow around them, or adding additional drains within these drainage-blocked areas. For the purposes of this report, installing additional drains has been accounted for with the drainage summary.

Multiple spalls exist on curbs within the garage; these spalls should be cleaned and patched. This small quantity has been accounted for with vertical wall patching in the cast-in-place concrete summary.

RA-1	Issue:	4th floor at Northeast stair tower – Concrete Ramp degradation
	Cause:	Water and deicing chemical damage
	Effect/Consequence:	Potential tripping hazard
	Repair Recommendation:	Remove all cast-in-place ramp concrete down to top of precast beams. Construct a new ADA accessible concrete ramp with appropriate detectable warning surface.
	Repair Timeframe:	**IMMEDIATE**

5.17 Building Façade

CI = 5- repair or replace to avoid degradation to CI-4.

Observations:

The brick type used is vulnerable to freeze/thaw spalling and cosmetic damage. It appears to be the same brick on the adjacent Peoples United building, which is painted. Many locations have a poor appearance because the brick has degraded and spalled and mortar joints are cracking. These locations could have extensive brick replacements, or potentially selective patching and general painting of the façade. Ongoing maintenance requirements associated with pain should be considered during the repair alternatives review. Sealant needs replacement at vertical joints, flashing should be repaired/replaced to protect tops of walls, and some repointing is necessary.

FA-1	Issue:	Facade damage at Grid D/7
	Cause:	Impact damage from vehicle (note: photo in appendix is shown on the exterior face of this location and does not reflect deduced vehicular impact as does the opposite face at this location).
	Effect/Consequence:	Brick ties exposed, potential for section of façade to fall off (Note: area below is not accessed by the public)
	Repair Recommendation:	Remove area of brick and reset new bricks and brick ties to match.
	Repair Timeframe:	**Mid Term**

FA-2	Issue:	General Façade repairs
	Cause:	Age, weather
	Effect/Consequence:	Aesthetic. Long term - façade damage could become severe and present public hazard
	Repair Recommendation:	Replace sealant (coordinate sealant replacement and complete sooner with other sealant work), patch, repoint, paint
	Repair Timeframe:	**Long Term**

5.18 Striping and Deck Markings

CI = 4 Multiple locations with poor to no striping visibility

Observations:

The striping of stalls was barely visible to not present on levels 1 and 2. Markings such as turn arrows were not visible and are needed. Level 4 markings were in the best condition. All levels should be restriped, including arrows, parking stalls, and curbs. This has been accounted for with general maintenance recommendations, and should be coordinated following short term repairs.

5.19 Surface (Floor) Drainage

CI = 1 Many ponding locations. Garage is poorly pitched for drainage.

Observations:

The College Street Garage was constructed with very poor drainage pitch. Many locations see ponding to depths over 1"; joint sealant failure, concrete spalling, and beam issues below are commonly associated with these areas. Many drains were not located at the floor level low points, and beam camber as well as raised wash areas hold water in locations where no drains are present. Additionally many floor drains were found plugged, the severe amount of debris that is present in the College Street Garage is causing many drains to become completely plugged. Multiple drains at levels 2 and 3 have failed, allowing water to onto the beams below.

SD-1	Issue:	Water is not reaching storm drainage system.
	Cause:	Poor drainage pitch and floor drain placement
	Effect/Consequence:	Pooled water undergoes freeze/thaw cycles, causing damage to sealant, membranes, and structural framing. The majority of issues in this garage stem from water penetration.
	Repair Recommendation:	Install additional floor drains and associated piping at ponding water locations. All levels, approximately 30 new floor drains total.
	Repair Timeframe:	**Short Term**

SD-2	Issue:	Plugged Drains
	Cause:	Debris build up.
	Effect/Consequence:	Similar to SD-1
	Repair Recommendation:	Clean out floor drains, including Level 5, and stair tower and elevator shaft roofs. Clean debris out of garage. Pressure was garage thoroughly. Flush drainage system at each drain location.
	Repair Timeframe:	**Short Term**

SD-3	Issue:	Failed Drain locations
	Cause:	Drain deterioration (cast iron corrosion – rust), cracking, and surrounding concrete failures.
	Effect/Consequence:	Similar to SD-1
	Repair Recommendation:	Replace failed floor drains and repair surrounding concrete at all levels. Approximately 15 floor drains total.
	Repair Timeframe:	**Short Term**

SD-4	Issue:	Failed Trench Drains
	Cause:	Heavy corrosion
	Effect/Consequence:	Drain collapse causing travelway issues at College St entrance/exits.
	Repair Recommendation:	Replace failed trench drains and support framing at level 2 and repair surrounding concrete. Approximately 5 trench drains total.
	Repair Timeframe:	**Short Term**

Consider removing trench drains at the bottom of Level 3-4 ramp. These drains are located across a double-tee flange joint and are located towards the center span between grids B and C. Stormwater is directed to the Grids B and C as it flows down the ramp. Drains are needed at these corners as noted on the plans.

5.20 Drainage System

CI = 3 Repairs required at each level. Extensive repairs are required at Level 2.

Observations:

The entire storm drainage piping for the elevated section of level 2 (double-tee framing over level 1) has failed and is either completely missing or has significant cracks. Lengths of storm drainage piping for levels 3, 4, and 5 show signs of failure, either having cracked, or showing severe section loss due to corrosion of the cast iron pipe.

Based on observations of the existing building plans and our inspection, the system is comprised mainly of 5" diameter cast iron piping. The drainage system outlets to a sand interceptor (one located between Grids A and B on level 2, and one located between Grids C and D on level 1). A 10" diameter pipe outlets from the south side of the pit and ties into the City stormwater collection system. No issues were noted with the interceptors, however a more thorough evaluation of that system type and its required maintenance should be conducted.

DS-1	Issue:	Piping has failed – cracked or rusted through.
	Cause:	Cracked pipes appear to have failed from the freezing of water trapped inside the pipe. This could have occurred as a result of a plug within the pipe, having noted the debris issues within the garage and the expanded pipe section at the crack. Pipes that have significant section loss due to corrosion appear to have occurred at locations where water is causing damage to the outside of pipes (i.e. below a leaking joint, below a concrete wash area failure)
	Effect/Consequence:	Water escapes the drainage system and causes structural issues to areas of the garage not intended for stormwater exposure
	Repair Recommendation:	Replace lengths of failed stormwater piping to match existing size and type (consider non-ferrous piping alternatives with replacement – coordinate with code requirements for material selection). Where possible improve pipe pitch during replacement.
	Repair Timeframe:	**Short Term**

5.21 Mechanical and Fire Suppression Systems

Trunk lines of the fire suppression system were replaced in approximately 2005 with galvanized piping. Distribution lines remained as original; these lines have experienced minor corrosion and section loss, and are generally protected as they run between beam webs. Through representative sampling no significant areas of pipe section loss were found. The system is pressure tested annually to ensure piping distribution system is leak free, and system is operated to confirm sprinkler heads are functioning properly. Repairs to the system are made at the time of the inspection as necessary.

5.22 Americans with Disabilities Act (ADA) Review

CI = 2 Garage does not meet 2010 ADA standards

Observations:

Access/ entry to the garage does not meet the 2010 ADA standards. From College Street, sidewalks are in poor condition; curb cuts are provided, but with a greater than 1" high step up. From Battery Street, adequate lanes for wheelchair travel are not provided. From Pine Street, a sloped walkway is provided; concrete is eroded to the point where aggregate is exposed, creating a rough and uneven surface. A hole in the sloped walkway has opened to the garage below.

Inside the garage, seven accessible parking spaces were observed (appropriate for 201-300 spaces). The garage has 460 spaces (per p.6 http://www.ccrpcvt.org/library/studies/Downtown_Burlington_Parking_Study_200303.pdf).

Per ADA Table 208.2 this number of spaces requires 9 ADA accessible spaces, for every 6 or fraction of 6 ADA spaces at least one shall be accessible Van Parking. Therefore the required number of spaces to meet ADA requirements is (7 Accessible parking spaces + 2 Van Spaces = 9 spaces). Note: the 2006 Pavement Markings Plan indicates 9 Handicap spaces. In general, Accessible parking spaces themselves are of adequate width but do not include adjacent clear space for wheelchair loading and unloading. Signage and/or painting depicting the universal symbol of accessibility is provided, but striping is not visible.

At stairwells, access is poor in places due to damaged, cracked, and loose concrete at door approaches. Guards are not provided at the lowest stair levels, allowing clear height below 6'8". Door hardware is in poor repair, requiring considerable effort to operate doors. Most door thresholds are not ADA compliant.

ADA-1	Issue:	Accessibility and Accessible Parking Spaces
	Likely Cause:	Deterioration over time or compliance deficiency
	Effect/Consequence:	Limits Accessibility
	Repair Recommendation:	Comply with 2010 ADA sections 208 & Ch. 5
	Repair Timeframe:	**Short Term**

5.23 General Recommended Improvements

In addition to the necessary repairs and preventative maintenance proposed in this report there are several features that could be added which would greatly benefit the overall function and appearance of the garage. They are as follows:

- **Additional Security Cameras:** Security at Parking Facilities could benefit from additional cameras in stair towers, general floor level locations, and operational cameras in elevators.

- **Public Address System:** Public Address (PA) systems provide an opportunity for mass notification throughout the facility in the event of an emergency.

- **LED Signage throughout garage:** Hotel, exit, traffic directional, and stair signage could all be upgraded to LED signage which would improve sign visibility and user experience.

- **Protect Entrance from Lakeview with Overhead Protection**: Lakeview Garage clearance is higher than College Street Garage. An overhead barrier placed at the drive between garages would help vehicular awareness of this reduced clearance helping to protect the garage structure.

- **Electric Vehicle (EV) Charging Stations**: Level 3 (fast charging) Chargepoint charging systems have been installed at the Marketplace and Lakeview Garages. This is a charge card based system allowing for charging activation based upon a swiped credit or debit card. KEA does not know the details of the business model used for this new convenience, or if plans are underway to also provide such a charging station at this facility. We recommend that charging stations be planned for when doing any electrical system upgrades at this facility. This added customer convenience could be set up as a free service as a loss leader for incentivizing vehicles to the downtown area, or as a charged service for revenue enhancement.

- **Solar PV Panel Installation**: The parking garage has an opportunity to leverage the recent reduction in photovoltaic system (PV) installation costs to reduce its carbon footprint while offering better protection from the elements for cars parked on the upper decks of this structure. Arrays can be designed for installation on the unused Level 5 roof (over the Ramp 3-4). The PV system would be net-metered, and if done in conjunction with other garages could be group metered as well. This power generation could be significant, easily up to 300 kW for this garage alone if a significant portion of the rooftop area is used. This site has a clear uninhibited skyview and is oriented to take maximum advantage of the south and west facing parts of the sky for maximum production. System costs could be in the $3/watt installed range for the PV system itself, plus mounting structure cost of elevating the system above the car deck. A glare study would need to be conducted for impacts to adjacent properties if a PV panel system were to be proposed.

- **WiFi or WiMax**: With the already installed data network, the parking garage already has internet access capabilities to deploy a Wifi or WiMax internet access point(s) for the facility. Again, this could be used as a customer draw to the downtown area. Arrangements could be made with several downtown merchants to creatively deliver special sales or coupon offers via this service platform to further entice users to the garage(s). Similar to the EV charging stations, this system could be used as a free amenity to patrons or possibly used as a revenue stream with area merchants who return a negotiated fee for every customer that makes store purchases as a result of using this parking garage service.

- **Replace Elevator**: According to DPW staff and elevator subcontractor the elevator in this facility should be replaced within the next 5 to 10 years. Though not part of

this study we have accounted for elevator costs (see EV-1 below and maintenance budget estimate).

EV-1	Issue:	Elevator Replacement
	Cause:	Age
	Effect/Consequence:	Elevator Function
	Repair Recommendation:	Replace Elevator
	Repair Timeframe:	**Long Term**

- **Replace Attendant Booths:** Per DPW staff, attendant booths have poor heating and ventilation as well as wiring and general condition issues and are in need of replacement.

BO-1	Issue:	Attendant Booth Replacement
	Cause:	Age
	Effect/Consequence:	Poor quality for attendant staff
	Repair Recommendation:	Replace Attendant Booths
	Repair Timeframe:	**Mid Term**

- **Infill Unused Northeast Elevator Shaft:** The existing NE elevator shaft is not used and not accessible. Each floor level could be infilled and additional storage space / utility rooms / covered bike parking could be provided with no loss to facility parking spaces.

NE-1	Issue:	Unused elevator shaft
	Cause:	Original construction
	Effect/Consequence:	This space is unutilized
	Repair Recommendation:	Infill NE elevator shaft at each floor level
	Repair Timeframe:	**Long Term**

5.24 Maintenance

Parking garages require more housekeeping and preventative maintenance than most structures. Owners can see significant long term savings by following best practices for routine garage upkeep. The Precast Concrete Institute (PCI) provides a detailed Maintenance Manual for Precast Parking Structures that includes recommendations for daily, weekly, monthly, quarterly, semi-annually, annually, and as required housekeeping, preventative maintenance, and inspection schedules. Reference Appendix D for excerpts from this manual: Table A – Housekeeping Schedule, and Table B – Preventative Maintenance Schedule. Capital planning efforts should account for these routine activities.

Due to the amount of debris currently in the College Street garage (mainly spalled, disintegrated concrete) we have included several maintenance activities in the Short Term repairs. These items are beyond standard housekeeping costs and should be coordinated with repair projects.

MA-1	Issue:	Debris on floors and framing bearing locations
	Cause:	Deterioration, accumulation
	Effect/Consequence:	Debris needs to be cleared for repair projects to be completed
	Repair Recommendation:	Coordinate with short term repairs. Complete overhead spall removal prior to debris removal. Due to level of debris this will likely require enclosure of the areas to be cleaned. Vacuum excavation of floor surface (particularly failed wash areas), including upper areas such as wall and beam support shelves. Once majority of debris has been collected floor surfaces can be swept with a power sweeper.
	Repair Timeframe:	**Short Term**

MA-2	Issue:	Chemical buildup on structural members
	Cause:	Vehicles tracking roadway salts into garage
	Effect/Consequence:	Structural Damage
	Repair Recommendation:	Once MA-1 operations have been completed each floor level needs to be power washed both on surface levels and undersides of framing. Electrical power may need to be turned off during power washing operations.
	Repair Timeframe:	**Short Term**

Preventative Maintenance: Many Components of the garage require frequent cleaning, repair, and replacement. Elements such as paint, joint sealants, waterproofing membranes, roofing membranes, and concrete sealer degrade over time and have a dependable life expectancy as supplied by the manufacturer and industry standards. We have calculated for a garage of this size and type the City should appropriate an annual **Preventative Maintenance and Housekeeping Budget of $145,000 to $150,000**. This accounts for work to be completed each year as well as routine repair/replacement items. A breakdown of this estimate has been provided in Appendix A of this report.

6 SUMMARY

The current overall condition of this garage is poor. Many structural repairs need to be made in the near future, as they represent a public safety or structural integrity hazard. In order to assist with completing the most pressing projects and developing funding for future projects we have summarized the above described issues into the following prioritization matrix (in order of highest priority to lowest):

Report Designation	Description	Cost	Recommended Timeframe
DT-8	Double Tee Beam Overhead Flange Spalls	$7,890	IMMEDIATE
DT-9	Double-Tee Beam Bearing Issue (Level 2 – Beam 2.1 at Grid B)	$8,250	
ST-1	Stair Tread Spalls	$27,890	
RA-1	4th floor at Northeast stair tower – Concrete Ramp Repair	$10,560	
ED-1	Cover and Protect Exposed Wiring	$24,750	
SD-2	Flush Existing Drainage System (Unplug)	$8,250	Short Term
MA-1	Debris Cleaning on all Levels	$132,830	
MA-2	Powerwash all Levels	$265,650	
PC-3	Spandrel Beam Bearing Issue - Column Corbel Damage	$66,000	
PC-6	Inverted-Tee Beam - Extensive Beam Damage Repair	$297,000	
PC-1a	Spandrel Beam Support Shelf Spall Repair	$34,490	
PC-1b	Spandrel Beam Support Shelf Crack Repair	$130,980	
DT-4	Double-Tee Beam Flange Connection Repair - Level 2	$270,270	
DT-6	Double-Tee Beam End Spall Repair	$78,590	
PC-5	Inverted-Tee Beam - Steel Restraint Repair	$14,850	
CIP-1	Wash Area Repair	$316,800	
RM-2	Replace Elevator Roof Drain	$4,950	
OP-2	Install Door and Patch Storefront at Elevator Vestibule	$74,290	
SD-1	Additional Floor Drains	$74,250	
SD-3	Replace Failed Storm Drains	$37,130	
SD-4	Replace Failed Trench Drains	$32,590	
DS-1	Piping Replacement and Piping Installation for New Drains	$204,320	
ST-4	Replace Stair Tower Handrails	$47,030	
JS-1	Joint Sealant Replacement at Level 2	$29,700	

Report Designation	Description	Cost	Recommended Timeframe
JS-2	Joint Sealant Repairs at Levels 3 and 4	$41,580	
ED-2	Replace Electrical Distribution System	$330,000	
EL-1	Replace Lighting Fixtures	$247,500	
CS-1	Floor Level Perimeter Sealant Repairs	$57,330	
DT-1	Double-Tee Beam Flange Grout Patch Repair	$23,760	
DT-3	Double-Tee Beam Surface Spall Repair	$1,320	
PC-7	Column Corner Spall Repair	$5,940	
PC-8	Column Face Spall Repair - Vertical Patch	$40,100	
CIP-2	Foundation Wall Spalls - Vertical Patch	$66,300	
ES-1	Electrical Service Panel	$33,000	
ELS-1	Install Emergency Power System	$39,600	
ELS-3	Add Exit Signage	$24,750	
ST-2	Stair Tread and Landing Cracks	$39,600	Mid Term
ME-2	CMU Wall Grout Patch Repair	$8,910	
MB-1	Membrane Replacement	$135,960	
PC-2	Spandrel Beam Web Shear Crack Repair	$24,750	
FA-1	Facade Repair at Level 4, Grid D/7	$1,980	
DT-2	Double-Tee Beam Flange Crack Repair	$21,450	
BO-1	Replace Attendant Booths	$66,000	
OP-1	Repair/Replace Doors and Hardware	$66,000	
CS-3	4" Diameter Sealant Patch Replacement	$29,110	
ST-3	Repaint Stairwell Towers	$89,100	
RM-1	Replace Roofing Membranes	$59,400	
CS-2	Slab-on-Grade Joint Sealant Replacement	$53,170	
ME-1	New Fan Units at Levels 1 and 2	$165,000	Long Term
ST-3	Stairwell Ventilation Improvements	$8,250	
DT-7	Replace Double-Tee Beam Bearing Pads	$70,620	
ST-4	Repaint Stair Walls	$16,500	
FA-2	General Façade Repairs	$33,000	
NE-1	Infill floor levels at NE elevator shaft	$49,500	
EV-1	Elevator Replacement	$288,750	

- Note: Individual costs shown above account for Project Management and Engineering Fees

Completing repairs in this garage is a logistical challenge. The garage serves the Hilton hotel, which experiences high guest turnover on Saturdays and Sundays, causing increased garage traffic. Additionally the hotel receives guest complaints if night operations in the garage cause noise issues in hotel rooms. During weekday working hours there is heavy traffic flow from the businesses who lease spaces in this garage. Further discussion is necessary with DPW and invested stakeholders to determine the optimum construction operation hours for repair work and long term routine maintenance work at this garage.

Due to the extent of repairs required, and the challenge of coordinating proper dust control while maintaining garage access, we recommend the complete shutdown of the garage to complete short term repairs. A strict schedule for start and completion dates can be developed for construction in the 2015 season with high liquidated damages to ensure work is completed in a timely manner. Completing repairs during a garage shut down will greatly improve the cost and schedule, resulting in less overall impact to garage stakeholders than would a drawn out level by level staged construction effort. If this path is chosen, we recommend obtaining engineering services as soon as possible to begin the development of construction plans. This will allow the project to be bid during winter months leaving the spring to complete administrative submissions, secure lead-time materials, and coordinate construction efforts.

The budget estimates for repair work have assumed staged efforts to maintain garage access. Each unit price includes an additional 20% to account for Traffic Control and added Mobilization costs.

Engineering, Resident Engineering, and Project Management fees have been estimated for each group of repairs based on a percentage of the total construction costs. These fees are for budgetary purposes and may be higher or lower depending on the grouping of repairs to be completed.

As stated earlier in this report, housekeeping and preventative maintenance need to occur at their recommended schedule (reference Appendix D), coordinated but independent of repair schedules. It is likely that there are structural issues which haven't presented yet. Routine inspections should be completed by parking garage staff, with bi-annual structural inspections by a professional engineer.

APPENDIX A

Budgetary Estimates

Hoyle, Tanner & Associates, Inc.	Calc. By:	JAO	Date:	6/24/2014
	Chck. By:		Date:	
	Chck. By:		Date:	
	Chck. By:		Date:	

College Street Parking Garage Assessment
Budgetary Estimate of Probable Repair/Replacement Costs
Hoyle, Tanner Project No. 909041

		Quantity		Cost	
		Unit	Amount	Unit Price	Total
IMMEDIATE Recommendations					
DT-8	Double-Tee Beam - Removal of Loose Overhead Concrete	EA	191	$25.00	$ 4,777.50
DT-9	Double-Tee Beam Bearing Repair (Level 2 - Beam 2.1)	EA	1	$5,000.00	$ 5,000.00
ED-1	Complete Emergency Repairs to Distribution Wiring	LS	1	$15,000.00	$ 15,000.00
ST-1	Stair Tread Spalls and Threshold Repairs	SF	169	$100.00	$ 16,900.00
RA-1	Concrete Ramp Repair at Level 4	SF	160	$40.00	$ 6,400.00

CONSTRUCTION SUBTOTAL	**$48,077.50**
20% CONSTRUCTION CONTINGENCY	**$9,615.50**
ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$9,615.50**
RESIDENT ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$9,615.50**
PROJECT MANAGEMENT COSTS (5% OF CONSTRUCTION, INTERNAL TO CITY)	**$2,403.88**
TOTAL COST =	**$79,400**

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as Hoyle, Tanner's experience with similar projects and understanding of current industry trends. It should be noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.

PROJECTED COSTS (ESTIMATED INFLATION AT 3%)	2015	2016	2017	2018
	$79,400	$81,790	$84,250	$86,780

Hoyle, Tanner & Associates, Inc.	Calc. By:	JAO	Date:	6/24/2014
	Chck. By:		Date:	
	Chck. By:		Date:	
	Chck. By:		Date:	

College Street Parking Garage Assessment
Budgetary Estimate of Probable Repair/Replacement Costs
Hoyle, Tanner Project No. 909041

		Quantity		Cost	
		Unit	Amount	Unit Price	Total
Short-Term Recommendations					
JS-1	Joint Sealant Replacement at Level 2	LF	1,500	$12.00	$ 18,000.00
JS-2	Joint Sealant Repairs at Levels 3 and 4	LF	1,800	$14.00	$ 25,200.00
CS-1	Floor Level Perimeter Sealant Repairs	LF	2,895	$12.00	$ 34,740.00
DT-1	Double-Tee Beam Flange Grout Patch Repair	SF	240	$60.00	$ 14,400.00
DT-3	Double-Tee Beam Surface Spall Repair	SF	20	$40.00	$ 800.00
DT-4	Double-Tee Beam Flange Connection Repair - Level 2	EA	252	$650.00	$ 163,800.00
DT-6	Double-Tee Beam End Spall Repair	SF	340	$140.00	$ 47,628.00
PC-1a	Spandrel Beam Support Shelf Spall Repair	SF	110	$190.00	$ 20,900.00
PC-1b	Spandrel Beam Support Shelf Crack Repair	LF	397	$200.00	$ 79,380.00
PC-3	Spandrel Beam Bearing Issue - Column Corbel Damage	EA	4	$10,000.00	$ 40,000.00
PC-5	Inverted-Tee Beam - Steel Restraint Repair	EA	18	$500.00	$ 9,000.00
PC-6	Inverted-Tee Beam - Extensive Beam Damage Repair	EA	9	$20,000.00	$ 180,000.00
PC-7	Column Corner Spall Repair	EA	18	$200.00	$ 3,600.00
PC-8	Column Face Spall Repair - Vertical Patch	SF	270	$90.00	$ 24,300.00
CIP-1	Wash Area Repair	LF	2,400	$80.00	$ 192,000.00
CIP-2	Foundation Wall Spalls - Vertical Patch	SF	446	$90.00	$ 40,176.00
ES-1	Electrical Service Panel	LS	1	$20,000.00	$ 20,000.00
ED-2	Replace Distribution Conduit and Wiring	LS	1	$200,000.00	$ 200,000.00
EL-1	Replace Lighting Fixtures	LS	1	$150,000.00	$ 150,000.00
ELS-1	Install Emergency Power System	LS	1	$24,000.00	$ 24,000.00
ELS-2	Add Exit Signage	LS	1	$15,000.00	$ 15,000.00
OP-2	Replace Door and Storefront System	LS	1	$45,020.00	$ 45,020.00
ST-4	Replace Stair Tower Handrails	LS	1	$28,500.00	$ 28,500.00
RM-2	Replace Elevator Roof Drain and Repair Membrane	EA	1	$3,000.00	$ 3,000.00
SD-1	Additional Floor Drains	EA	30	$1,500.00	$ 45,000.00
SD-2	Flush Existing Drainage System (Unplug)	LS	1	$5,000.00	$ 5,000.00
SD-3	Replace Failed Storm Drains	EA	15	$1,500.00	$ 22,500.00
SD-4	Replace Failed Trench Drains	EA	5	$3,950.00	$ 19,750.00
DS-1	Piping Replacement and Piping Installation for New Drains	LF	1,769	$70.00	$ 123,830.00
ADA-1	Install ADA Accessible Parking Spaces	EA	9	$340.00	$ 3,060.00
MA-1	Debris Cleaning on all Levels	LS	1	$80,500.00	$ 80,500.00
MA-2	Powerwash all Levels	LS	1	$161,000.00	$ 161,000.00

CONSTRUCTION SUBTOTAL	**$1,840,084.00**
20% CONSTRUCTION CONTINGENCY	**$368,016.80**
ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$368,016.80**
RESIDENT ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$368,016.80**
PROJECT MANAGEMENT COSTS (5% OF CONSTRUCTION, INTERNAL TO CITY)	**$92,004.20**
TOTAL COST =	**$3,036,200**

PROJECTED COSTS (ESTIMATED INFLATION AT 3%)	2015	2016	2017	2018
	$3,036,200	$3,127,290	$3,221,110	$3,317,750

Hoyle, Tanner & Associates, Inc.	Calc. By:	JAO	Date:	6/24/2014
	Chck. By:		Date:	
	Chck. By:		Date:	
	Chck. By:		Date:	

College Street Parking Garage Assessment
Budgetary Estimate of Probable Repair/Replacement Costs
Hoyle, Tanner Project No. 909041

		Quantity		Cost	
		Unit	Amount	Unit Price	Total
Mid-Term Recommendations					
CS-2	Slab-on-Grade Joint Sealant Replacement	LF	4,028	$8.00	$ 32,224.00
CS-3	4" Diameter Sealant Patch Replacement	EA	1,764	$10.00	$ 17,640.00
MB-1	Membrane Replacement	SF	16,480	$5.00	$ 82,400.00
DT-2	Double-Tee Beam Flange Crack Repair	LF	260	$50.00	$ 13,000.00
PC-2	Spandrel Beam Web Shear Crack Repair	LF	75	$200.00	$ 15,000.00
OP-1	Repair/Replace Doors and Hardware	LS	1	$40,000.00	$ 40,000.00
ST-2	Stair Tread and Landing Cracks	LF	120	$200.00	$ 24,000.00
ST-3	Repaint Stairwell Towers	SF	10,800	$5.00	$ 54,000.00
RM-1	Replace Roofing Membranes	SF	600	$60.00	$ 36,000.00
ME-2	CMU Wall Grout Patch Repair	SF	60	$90.00	$ 5,400.00
FA-1	Facade Repair at Level 4, Grid D/7	SF	24	$50.00	$ 1,200.00
BO-1	Attendant Booth Replacement	EA	2	$20,000.00	$ 40,000.00

CONSTRUCTION SUBTOTAL	**$360,864.00**
20% CONSTRUCTION CONTINGENCY	**$72,172.80**
ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$72,172.80**
RESIDENT ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$72,172.80**
PROJECT MANAGEMENT COSTS (5% OF CONSTRUCTION, INTERNAL TO CITY)	**$18,043.20**
TOTAL COST =	**$595,500**

PROJECTED COSTS (ESTIMATED INFLATION AT 3%)	2015	2016	2017	2018
	$595,500	$613,370	$631,780	$650,740

Hoyle, Tanner & Associates, Inc.

Calc. By:	JAO	Date:	6/24/2014
Chck. By:		Date:	
Chck. By:		Date:	
Chck. By:		Date:	

College Street Parking Garage Assessment
Budgetary Estimate of Probable Repair/Replacement Costs
Hoyle, Tanner Project No. 909041

		Quantity		Cost	
		Unit	Amount	Unit Price	Total
Long-Term Recommendations					
DT-7	Replace Double-Tee Bearing Pads	EA	107	$400.00	$ 42,800.00
ST-3	Stairwell Ventilation Improvements	LS	1	$5,000.00	$ 5,000.00
ST-4	Repaint Stair Walls	LS	1	$10,000.00	$ 10,000.00
ME-1	New Fan Units at Levels 1 and 2	EA	2	$50,000.00	$ 100,000.00
FA-2	General Façade Repairs	LS	1	$20,000.00	$ 20,000.00
EV-1	Elevator Replacement	EA	1	$175,000.00	$ 175,000.00
NE-1	Infill Floor Levels at Northeast Elevator Shaft	EA	3	$10,000.00	$ 30,000.00

CONSTRUCTION SUBTOTAL	**$382,800.00**
20% CONSTRUCTION CONTINGENCY	**$76,560.00**
ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$76,560.00**
RESIDENT ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$76,560.00**
PROJECT MANAGEMENT COSTS (5% OF CONSTRUCTION, INTERNAL TO CITY)	**$19,140.00**
TOTAL COST =	**$631,700**

PROJECTED COSTS (ESTIMATED INFLATION AT 3%)	2015	2016	2017	2018
	$631,700	$650,660	$670,180	$690,290

Hoyle, Tanner & Associates, Inc.

Calc. By:	JAO	Date:	7/8/2014
Chck. By:		Date:	
Chck. By:		Date:	
Chck. By:		Date:	

College Street Parking Garage Assessment
Budgetary Estimate of Preventative Maintenance Costs
Hoyle, Tanner Project No. 909041

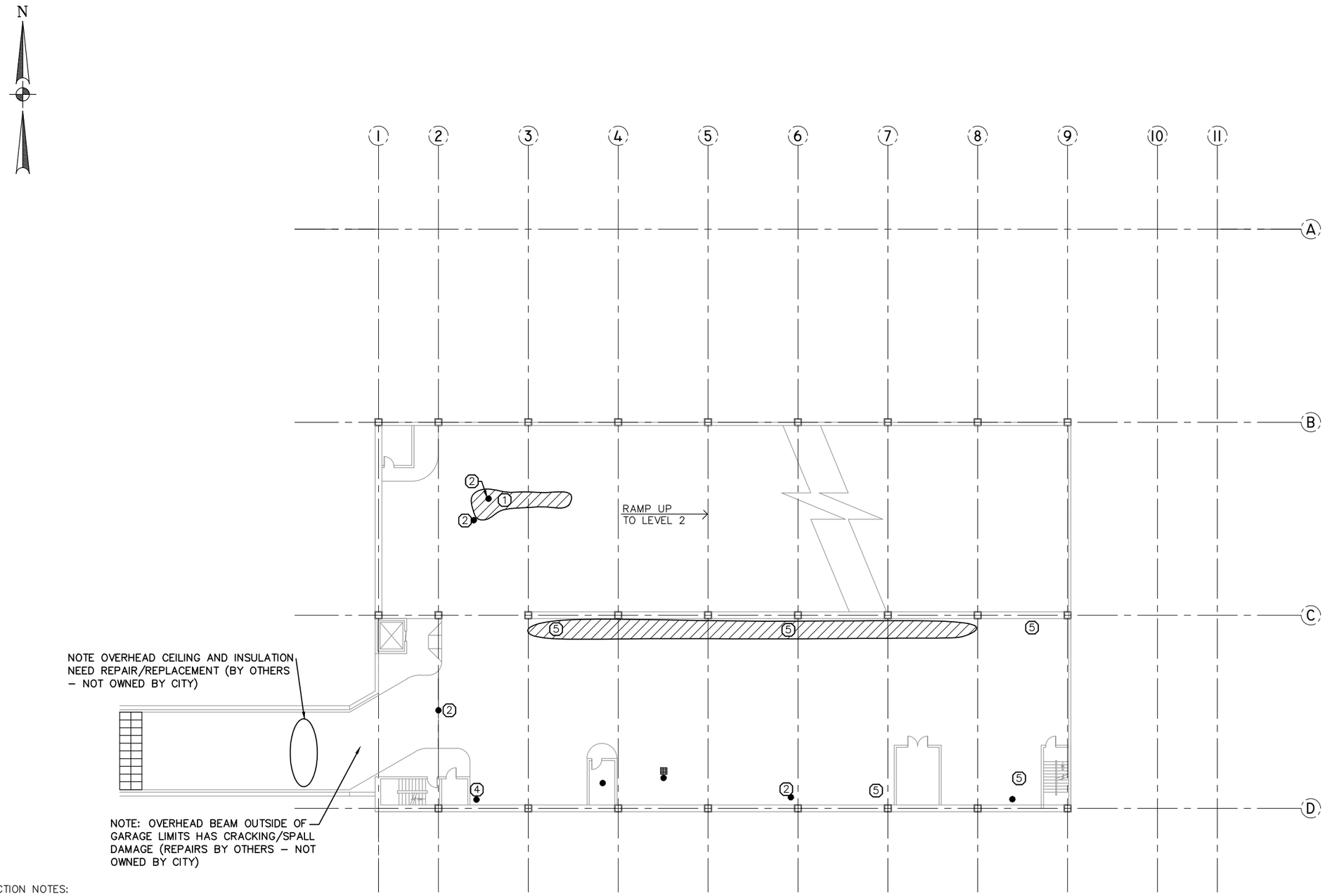
	Cost	Estimated Frequency	Adjusted Annual Frequency	Adjusted Annual Cost
Maintenance Cost				
Floor Washdowns	$10,000.00	twice/yr	2.00	$ 20,000.00
Silane Concrete Sealer	$129,000.00	every 5 yrs	0.20	$ 25,800.00
Paint Misc Steel	$5,000.00	every 5 yrs	0.20	$ 1,000.00
Striping & Markings	$23,000.00	every 2 yrs	0.50	$ 11,500.00
Joint Sealant - Full Replacement	$125,000.00	every 7 yrs	0.14	$ 17,857.14
Joint Sealant Repairs	$5,000.00	annual	1.00	$ 5,000.00
General Concrete Sealant Replacement	$38,000.00	every 10 yrs	0.10	$ 3,800.00
Expansion Joint Replacement	n/a			
Epoxy Floor Membranes	$66,000.00	every 5 yrs	0.20	$ 13,200.00
Roofing Membranes	$31,000.00	every 20 yrs	0.05	$ 1,550.00
HVAC Equipment Maintenance	n/a			
Annual Sprinkler System Maintenance Contract Costs	$5,000.00	annual	1.00	$ 5,000.00
Annual Elevator Maintenance Contract Costs	$4,400.00	annual	1.00	$ 4,400.00
Elevator Repair Costs	$30,000.00	every 7 yrs	0.20	$ 6,000.00
Misc. Repairs	$5,000.00	annual	1.00	$ 5,000.00

CONSTRUCTION SUBTOTAL	**$120,107.14**
10% INFLATION COSTS	**$24,021.43**
TOTAL COST =	**$145,000**

Note: Budgeted Costs shown do not include standard operating costs which acount for staff salaries, utility costs, basic routine housekeeping, and general garage software systems and licenses. Nor do items shown above reflect all housekeeping and preventative maintenance efforts. The intent of this is to assit with budget planning and should be updated as routine maintenance costs are standardized for this garage.

APPENDIX B

Garage Plans and Inspection Notes



LEVEL 1 PLAN

INSPECTION NOTES:

1. STANDING WATER (OBSERVED DURING INSPECTION ON 5/23/14)
2. PLUGGED STORM DRAIN
3. CONCRETE SPALL IN BEAM
4. STORM DRAIN NOT LOCATED DUE TO DEBRIS COVER
5. POTENTIAL STORM DRAIN LOCATIONS (FURTHER DESIGN REQUIRED FOR OPTIMUM LOCATION)

ENGINEER

REV.	DESCRIPTION	DRW BY	CHKD BY	DATE

MAY 2014

DESIGN BY: JAO
DRAWN BY: AAS
CHKD. BY: JAO
SCALE: AS SHOWN

Hoyle, Tanner & Associates, Inc.
125 College St, Burlington VT 05401
Tel (802) 860-1331 · Fax (802) 860-6499
Webpage: www.hoyletanner.com

CITY OF BURLINGTON
BURLINGTON, VERMONT

COLLEGE STREET PARKING GARAGE

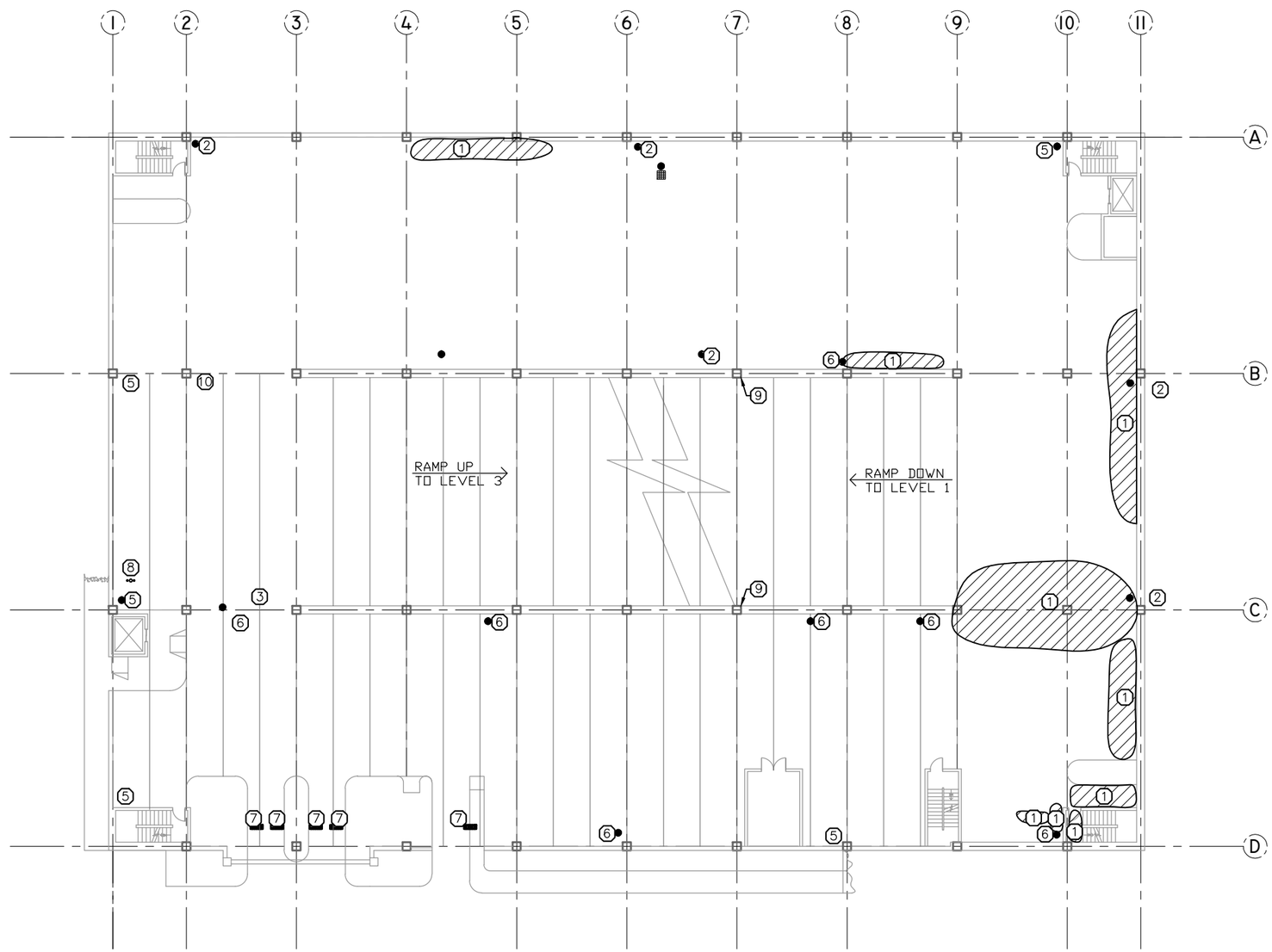
LEVEL 1 PLAN
INSPECTION NOTES

PROJECT NO.: 909041
FILE NAME: INSPECTION PLANS

SHEET NO.

I-1

SHEET 1 OF 4



LEVEL 2 PLAN

INSPECTION NOTES:

1. STANDING WATER (OBSERVED DURING INSPECTION ON 5/23/14)
2. PLUGGED STORM DRAIN
3. CONCRETE SPALL IN BEAM
4. STORM DRAIN NOT LOCATED DUE TO DEBRIS COVER
5. POTENTIAL STORM DRAIN LOCATIONS (FURTHER DESIGN REQUIRED FOR OPTIMUM LOCATION)
6. DAMAGED STORM DRAIN TO BE REPLACED
7. DAMAGED/DETERIORATED TRENCH DRAIN
8. HOLES CORED IN PRECAST BEAM (REPAIR 'PC-5')
9. GAPS AT COLUMN WALLS
10. DOUBLE-TEE BEAM WITH BEARING ISSUE (REPAIR 'PC-9')

ENGINEER

REV.	DESCRIPTION	DRW BY	CHKD BY	DATE

MAY 2014

DESIGN BY: JAO
DRAWN BY: AAS
CHKD. BY: JAO
SCALE: AS SHOWN

Hoyle, Tanner & Associates, Inc.
125 College St, Burlington VT 05401
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CITY OF BURLINGTON
BURLINGTON, VERMONT

COLLEGE STREET PARKING GARAGE

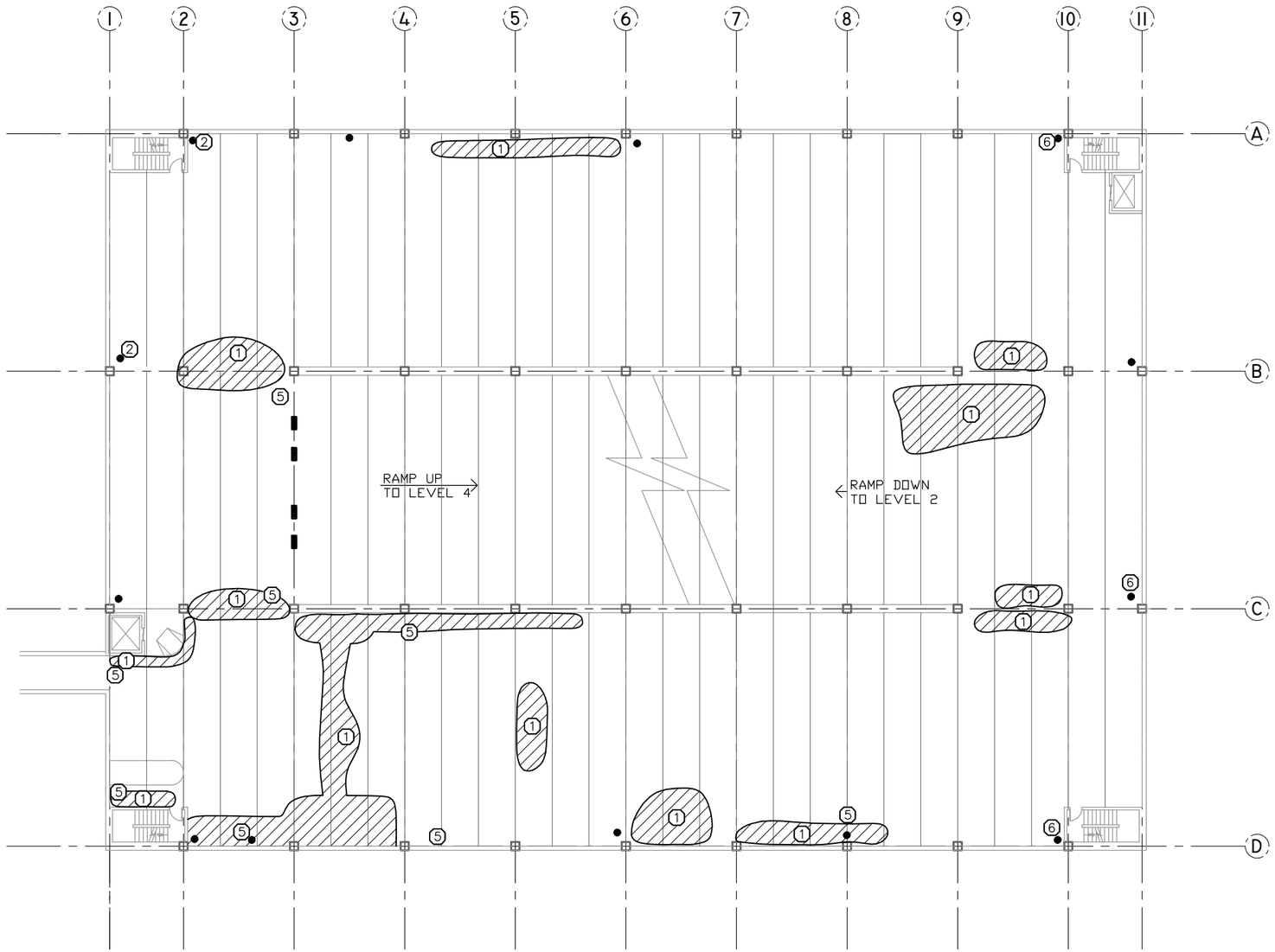
LEVEL 2 PLAN
INSPECTION NOTES

PROJECT NO.: 909041
FILE NAME: INSPECTION PLANS

SHEET NO.

I-2

SHEET 2 OF 4



LEVEL 3 PLAN

INSPECTION NOTES:

1. STANDING WATER (OBSERVED DURING INSPECTION ON 5/23/14)
2. PLUGGED STORM DRAIN
3. CONCRETE SPALL IN BEAM
4. STORM DRAIN NOT LOCATED DUE TO DEBRIS COVER
5. POTENTIAL STORM DRAIN LOCATIONS (FURTHER DESIGN REQUIRED FOR OPTIMUM LOCATION)
6. DAMAGED STORM DRAIN TO BE REPLACED
7. DAMAGED/DETERIORATED TRENCH DRAIN
8. HOLES CORED IN PRECAST BEAM (REPAIR 'PC-5')
9. GAPS AT COLUMN WALLS
10. DOUBLE-TEE BEAM WITH BEARING ISSUE (REPAIR 'PC-9')

ENGINEER

REV.	DESCRIPTION	DRW BY	CHKD BY	DATE

MAY 2014

DESIGN BY: JAO
DRAWN BY: AAS
CHKD. BY: JAO
SCALE: AS SHOWN

Hoyle, Tanner & Associates, Inc.
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CITY OF BURLINGTON
BURLINGTON, VERMONT

COLLEGE STREET PARKING GARAGE

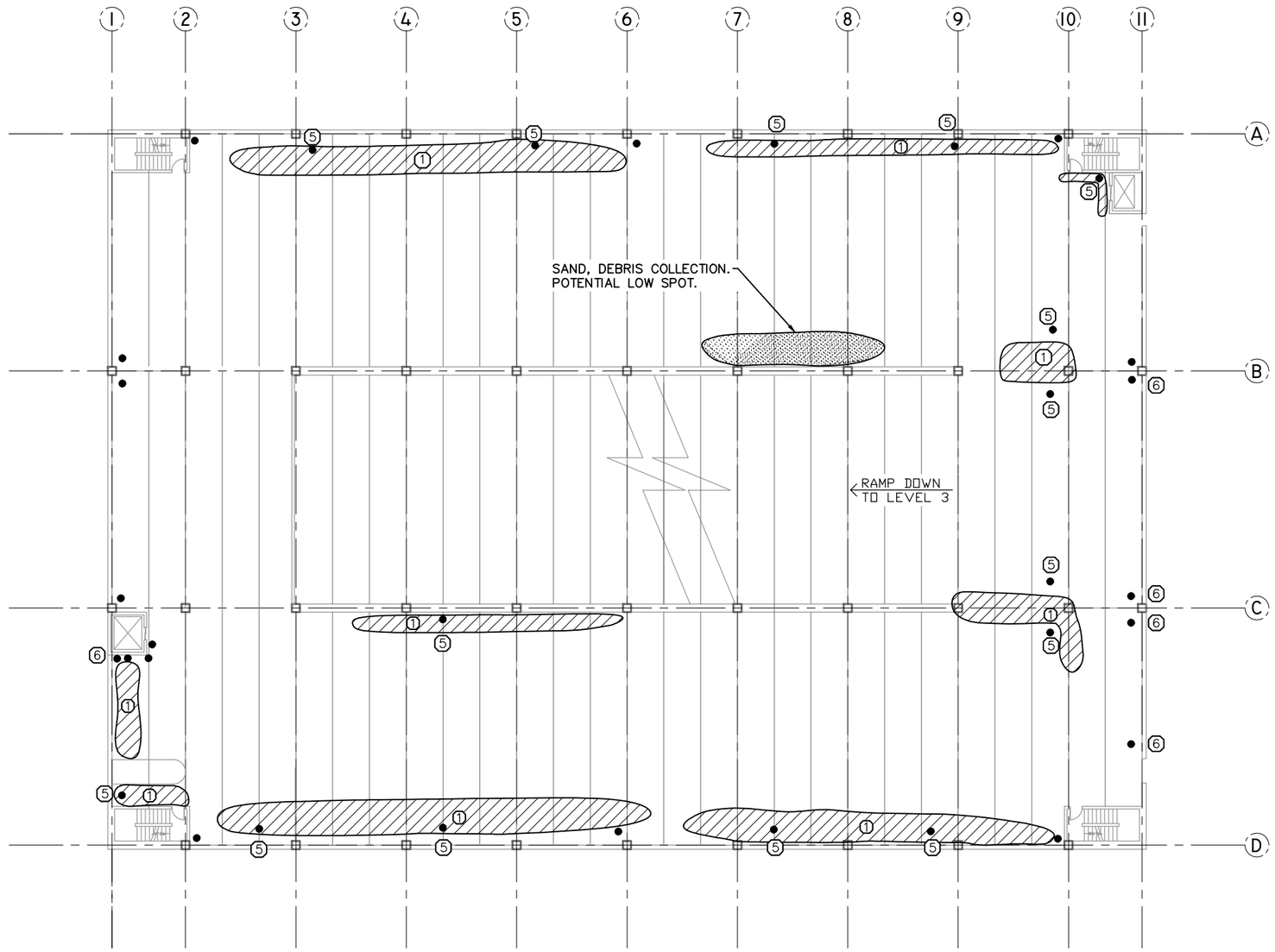
LEVEL 3 PLAN
INSPECTION NOTES

PROJECT NO.: 909041
FILE NAME: INSPECTION PLANS

SHEET NO.

I-3

SHEET 3 OF 4



LEVEL 4 PLAN

INSPECTION NOTES:

1. STANDING WATER (OBSERVED DURING INSPECTION ON 5/23/14)
2. PLUGGED STORM DRAIN
3. CONCRETE SPALL IN BEAM
4. STORM DRAIN NOT LOCATED DUE TO DEBRIS COVER
5. POTENTIAL STORM DRAIN LOCATIONS (FURTHER DESIGN REQUIRED FOR OPTIMUM LOCATION)
6. DAMAGED STORM DRAIN TO BE REPLACED
7. DAMAGED/DETERIORATED TRENCH DRAIN
8. HOLES CORED IN PRECAST BEAM (REPAIR 'PC-5')
9. GAPS AT COLUMN WALLS
10. DOUBLE-TEE BEAM WITH BEARING ISSUE (REPAIR 'PC-9')

ENGINEER

REV.	DESCRIPTION	DRW BY	CHKD BY	DATE

MAY 2014

DESIGN BY: JAO
DRAWN BY: AAS
CHKD. BY: JAO
SCALE: AS SHOWN

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CITY OF BURLINGTON
BURLINGTON, VERMONT

COLLEGE STREET PARKING GARAGE

LEVEL 4 PLAN
INSPECTION NOTES

PROJECT NO.: 909041
FILE NAME: INSPECTION PLANS

SHEET NO.

I-4

SHEET 4 OF 4

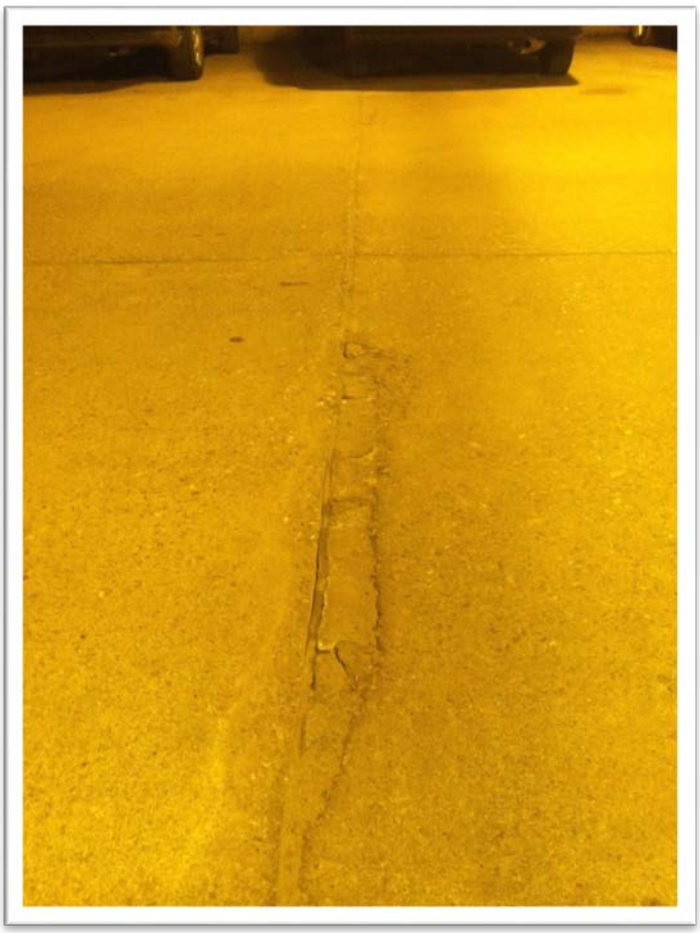
APPENDIX C

Photograph Log

JS-1 Joint Sealant Failure at Level 2

JS-2: Joint Sealant Failure at Level 4

CS-1: Floor Level Perimeter Sealant (Level 4, Grid D)



CS-2: Control Joint Sealant at slab on-grade

CS-3: 4” Diameter Sealant Patch at 4th floor beam (bolt head showing)

MB-1: Membrane Failure at Level 4, Grid A (localized concrete wash area disintegration)

DT-1: Double-Tee Beam Grout Patch Failure (Level 2)

DT-2: Double-Tee Beam Flange Crack (Level 4)

DT-3: Double-Tee Beam Surface Spall (Level 4)

DT-4a: Double-Tee Beam Flange Shear Tab Connection Failure (Level 2)

DT-4b: Double-Tee Beam Flange Connection Repair – Constructed 2006 (Level 3)

DT-5: Double-Tee Beam - Existing Cored Holes on Beam 1.1 (Level 2)

DT-6: Double-Tee Beam End – Flange Spalls and Reinforcing Corrosion

DT-7: Double-Tee Beam Bearing Pad Damage (frayed)

DT-8: Double-Tee Beam –Debris from Fallen Overhead Spalled Concrete

DT-9: Double-Tee Beam Bearing Issue at Beam 2.1 (Level 2)

PC-1: Spandrel Beam Support Shelf Damage (Inverted-Tee Beam Shelf Shown – Similar)

PC-2: Spandrel Beam Web Shear Crack (Level 4, Grid D)

PC-3: Spandrel Beam Bearing at Damaged Column Corbel (Level 4 Framing, Grid A)

PC-3b: Spandrel Beam Bearing – Existing Column Corbel Repair (Level 4 Framing, Grid D)

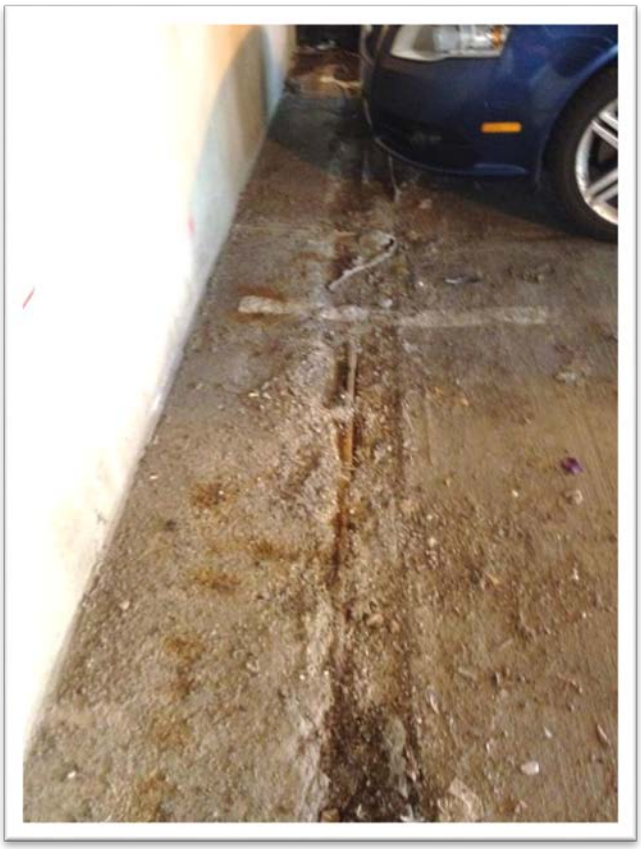
PC-4: Spandrel Beam Map Cracking (Level 5)

PC-5: Inverted-Tee Beam – Steel Lateral Restraint Damage

PC-6: Inverted-Tee Beam – Extensive Beam Damage

PC-7: Column Corner Spall

PC-8: Column Face Spall

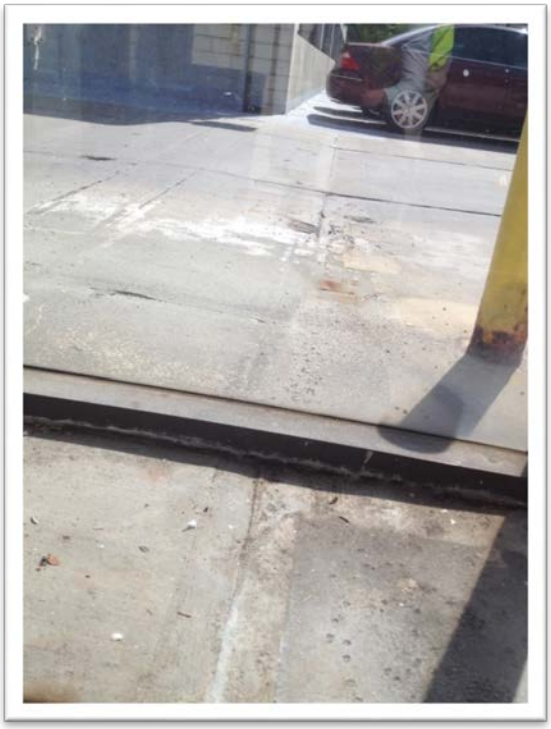


CIP-1: Wash Area Concrete Disintegration (exposed rebar corrosion)

ED-1: Electrical System Distribution Wiring (Missing Junction Box)

EL-1: Existing Lighting

OP-1: Doors and Hardware are in Generally Poor Condition



OP-2: Door Missing and Storefront Failure at Elevator Vestibule

ST-1: Stair Tread Spall

ST-1: Stair 2 (Northeast), Level 2 – Trip Hazard

ST-1: Trip Hazard/Accessibility Deficiency at Stairwell Approaches

ST-2: Stair Crack

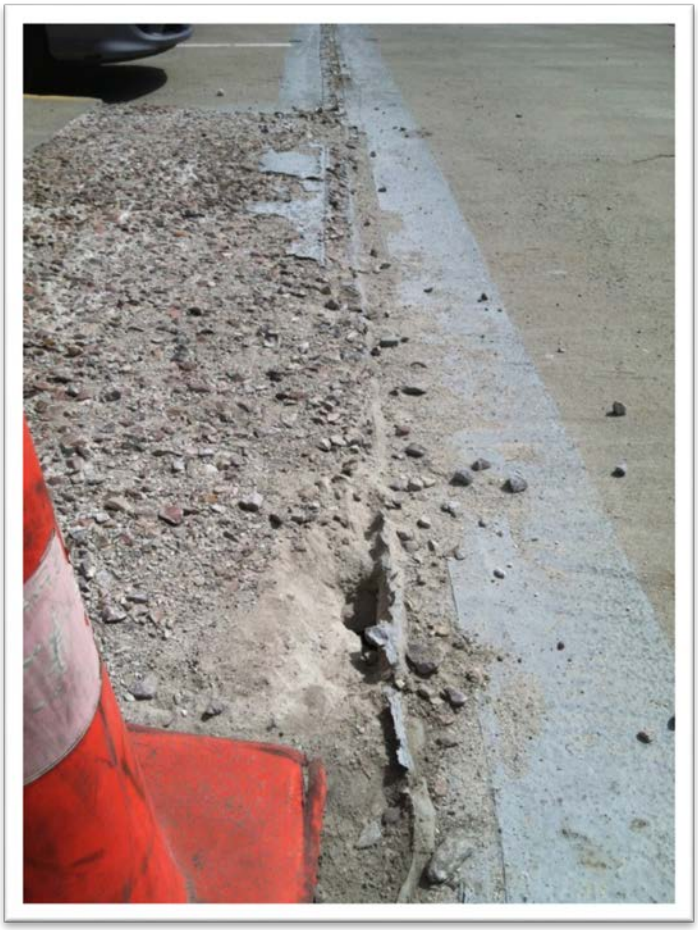
ST-3**:** Rust and Peeling Paint at Stairwells

ST: Railing and Stair Code Deficiencies

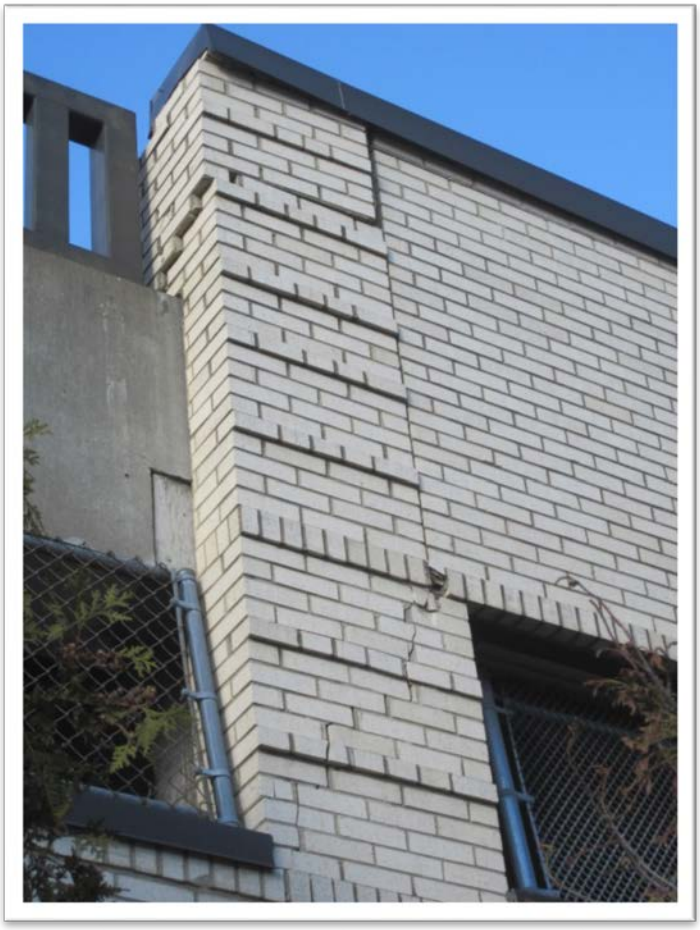
RM-1: Stair Tower Roof from Above

RM-2: Elevator #2 Roof Drain Leaking at Failed Sealant.

ME-2: Mechanical Room CMU wall patch (Level 2 shown)



RA-1: Level 4 Concrete Ramp Degradation



FA-1: Façade Damage at Level 4, Grid D/7

FA-2: General Façade Damage

SD-1: Ponding Issues where Additional Floor Drain is Necessary (Level 4, Grid 10)

SD-3: Failed Storm Drain (Level 2, missing piping)

SD-4: Failed Trench Drain (Level 2)

ADA-1: Accessibility and Accessible Parking Spaces

APPENDIX D

Excerpts from PCI Parking Garage Maintenance Manual

TABLE A Housekeeping Schedule	Daily		Weekly		Monthly		Quarterly		Semi Annually		Annually		As Required		Other
Sweeping															
Localized	*														
Overall			*												
Trash Pickup	*														
Control Joint Cleaning									*						
Expansion Joint Cleaning			*												
Elevator Cleaning	*														
Elevator Maintenance											*				
Window Cleaning									*						
Stain Cleaning			*												
Parking Space Restriping					O								*		
Remove Oil Stains	O												*		
Relamping	O		*												
Check Light Fixtures and Exposed Conduit and Repair					O								*		
Light Fixture Cleaning											*				
Floor Drain Cleaning			O						*						
Lavatory, Office, Waiting Room, Janitorial Service, Cashier Booths	*														
Graffiti Removal			*												
Graphics Cleaning											*				
Graphics Repair & Maintenance															
Non-Illuminated							O						*		
Illuminated	O												*		
Parking Equipment Maintenance	O												*		
Security System Check	*														
Landscaping			*												
Doors & Hardware	*														
Ventilation	O														
Snow Removal	*												*		
Ice Removal	O												*		
Safety checks	O												*		
Carbon Monoxide Monitor	O												*		(3)
Exit Lights	O												*		
Emergency Lights	O												*		
Tripping Hazards	O												*		
Handrails & Guardrails			O										*		
Control Joint Cleaning									*						

O = Inspect
* = Perform Operation

EXCERPT FROM PCI MAINTENANCE MANUAL FOR PRECAST PARKING STRUCTURES

TABLE B Preventive Maintenance Schedule Inspect and Repair as Necessary	Daily		Weekly		Monthly		Quarterly		Semi Annually		Annually		As Required		Other
Floor Washdowns									*						(1)
Floor Potholes & Cracking			O						*						
Scaling			O						*						
Expansion Joints									*						
Joint Sealants											*				
Bearing Pads											O		*		
Rust (Exposed Steel)							O				*				
Repaint					O								*		
Drain Water Systems for Winter											O				
Floor Surface Sealer															(2)
Stair Repair	O												*		
Plumbing			O								*				
HVAC Equipment					O								*		(3)
Fire Protection Systems					O								*		
Floor Drains			O						*						
Check Sanitary Facilities Operation	*														
Roofing & Flashing					O						*				
Floor Membranes					O								*		
Check for Water Leakage			O												
Check for Rusting Concrete Reinforcement			O												
Inspect Mortar Joints and Repair											O		*		
Inspect and Repair Concrete Cracks									O				*		

O = Inspect
* = Perform Operation

Notes:
(1) Minimum twice, per year (spring and fall) in snow or coastal regions, otherwise minimum once per year.
(2) Surface sealer (three to five years), Penetrating sealer (seven to ten years more often in abrasive areas).
(3) Daily enclosed garage (warning to management office recommended).
(4) For additional notes, see text.
(5) Tables utilize information in part from the National Parking Association Consultants Council "Parking Garage Maintenance Manual."

EXCERPT FROM PCI MAINTENANCE MANUAL FOR PRECAST PARKING STRUCTURES

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