

REPORT OF FINDINGS

FORT SMITH PUBLIC SCHOOLS

PEAK INNOVATION CENTER
Envista Matter No: MAT-160449-G7V3
REPORT DATE: March 14, 2024



03/14/2024

Prepared For:
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BACKGROUND

On October 11, 2023, January 25, 2024, and February 9, 2024, George Feathers of Envista Forensics (Envista) inspected the PEAK Innovation Center, property of Fort Smith Public Schools (FSPS) located at 5900 Painter Lane in Fort Smith, Arkansas (the building). The building consisted of a steel-framed, two-story structure on a concrete foundation. The exterior walls of the building were clad with metal panels, stone veneer accent walls, and integral colored, split-face CMU in select areas, and the low-slope gable-type roof was covered with thermoplastic polyolefin (TPO) membrane roofing. The interior walls were covered with gypsum board (drywall), and the ceilings were covered with gypsum board (drywall) or suspended acoustical ceiling tiles. According to FSPS the building was repurposed from a warehouse/distribution center to an educational center, and construction of the building was completed in 2021. For the purposes of discussion within this report, the front of the building was considered to face south (**Figure 1 – Figure 3**).



Figure 1: Aerial view of the building. (CONNECTExplorer)



Figure 2: Overview of the front (south) elevation of the building, west portion.



Figure 3: Overview of the front (south) elevation of the building, east portion

Reportedly, originating on or about June 7, 2022, the East Wing of the building has experienced water intrusion on multiple occasions at the south side exterior wall from the administrative spaces to the intersecting West Wing. Additionally, the building has experienced overflowing gutters and downspouts on the north side of the East Wing.

George Feathers of Envista Forensics (Envista) inspected the building envelope and roof drain systems on the following dates:

- October 11, 2023 (site & interiors inspection),
- January 25, 2024 (West Wing roof drain inspection), and
- February 9, 2024 (East Wing roof drain inspection)

Provided documents and information reviewed indicated that construction of the subject building occurred between 2020 and 2021. Project documents indicate the building was designed and constructed per the 2012 International Building Code (IBC). Based on the Documents Reviewed, it was understood that the following entities, at a minimum, were involved with the design and/or construction of the Project. The entities shown are not all of the engineers, consultants, and contractors involved with the building; they are the entities known at this point in time to be relevant to the roof drain systems.

<u>Relevant Entity</u>	<u>Company/Name</u>	<u>Reference Within This Report</u>
Owner:	Fort Smith Public Schools	FSPS
Owner’s Representative:	HPM Leadership	HPM
Architect of Record:	Corgan Childers Architect	Corgan CA
Mechanical/Plumbing Engineer:	Burrows & Associates Engineering Consultants, Ltd	B&A
Civil Engineer:	Morrison Shipley	MS
General Contractor:	Turn Key Constructions Management, Inc.	TKC
Roofing Contractors:	Coryell Dale Crampton Company	Coryell DCC
Plumbing Contractor:	Action, Inc.	Action
Utilities Contractor:	Silco Construction	SC

PURPOSE

Fort Smith Public Schools retained Envista to investigate the building and determine the cause(s) of the water intrusion and the gutter and downspout overflow.

CONCLUSIONS

1. Evaluation of the roof drainage system for the north side of the East Wing revealed the following:
 - a. The architectural drawings, plumbing drawings, and civil drawings were not coordinated, which caused discontinuity of the rainwater drainage system from the point of entry into the gutter system to the underground drainage piping.

- b. The plumbing drawings did not include roof drain piping from the building perimeter to the site drainage connections.
 - c. The civil drawings indicated the underground roof drain piping, but they did not identify the required pipe sizes.
 - d. Documents were not available in the files Envista received to identify the missing information on the Construction Documents.
 - e. The gutter was smaller than the minimum size required by a minimum of 7% and a maximum of 63%.
 - f. The gutter did not have expansion joints as required by SMACNA, which caused thermal expansion/contraction stresses to deform the gutter system and potentially compromise the gutter anchor system.
 - g. The downspouts were smaller than the minimum size required by a minimum of 9% and a maximum of 58%.
 - h. The underground single wall, corrugated roof drainage piping was at least 40% smaller than the minimum size required.
2. Evaluation of the roof drainage system for the south facet of the East Wing revealed the following:
- a. The roof drain piping for the East Wing, south side indicated on the civil drawings was not coordinated with the roof drain piping indicated to exit the building on the plumbing drawings because one 12-inch diameter pipe was omitted, and the main roof drain connection was incorrectly located.
 - b. Documents were not available in the files Envista received to identify the missing information on the Construction Documents.
 - c. The roof drains' installation on the East Wing main roof did not comply with the IBC minimum requirements because the TPO membrane reduced the size of the roof drain inlet and was terminated without a watertight connection.
 - d. The roof drainage for the south facet of the East Wing was sized in compliance with the requirements of the NSPC.
 - e. The south facet of the East Wing roof was enclosed by a parapet wall and was missing a secondary (emergency) roof drain system, so that roof drain system was noncompliant with the IPC.
 - f. The East Wing, south side underground roof drain piping installed at the four canopy roof drains was noncompliant with the IPC because the plastic corrugated piping did not have drainage-type fittings. Furthermore, the absence of drainage-type fittings created an unsealed drainage system at these locations, which increased the potential for erosion of the underlying soil and also water intrusion into the building.
 - g. The East Wing, south side site utility roof drains were undersized from the point of the main roof drain inlets at the perimeter of the building to the point of outlet at the parking lot Curb Inlet.
3. Evaluation of the roof drainage system for the east facet of the West Wing revealed the following:
- a. The roof drain piping for the east facet of the West Wing indicated on the plumbing drawings and the civil drawings was not coordinated with the indicated roof drain piping since there was an absence of roof drain piping indicated on drawings below the roof plans.
 - b. Documents were not available in the files Envista received to identify the missing information on the Construction Documents.
 - c. The roof drains' installation on the West Wing, east facet roof did not comply with the IBC minimum requirements because the TPO membrane reduced the size of the roof drain inlet and was terminated without a watertight connection.

- d. The roof drainage for the east facet of the West Wing was sized in general accordance with the requirements of the NSPC.
- e. The east facet of the West Wing roof was enclosed by a parapet wall and was missing a secondary (emergency) roof drain system, so that roof drain system was noncompliant with the IPC.
- f. The West Wing, east side underground roof drain piping from the north portion roof drains installation did not comply with the IPC because the downstream pipe size was reduced.

DOCUMENTS REVIEWED

The following documents and materials were reviewed and/or referenced as part of Envista's investigation, and/or contain information pertinent to the discussion and conclusions presented herein:

1. *2012 Arkansas State Fire Prevention Code* (International Code Council (ICC), International Building Code (IBC), 2012 Edition with Arkansas Amendments.
2. *2018 Arkansas Plumbing Code* (International Code Council (ICC), International Plumbing Code (IPC), 2018 Edition with Arkansas Amendments adopted by the City of Fort Smith, Arkansas.
3. *2018 National Standard Plumbing Code*, International Association of Plumbing and Mechanical Officials, 2018.
4. CONNECTExplorer aerial imagery, URL: <https://explorer.pictometry.com/login.php>.
5. Project Record Documents provided by FSPS, including drawings, project manual, and closeout documents. Exterior and interior packages with multiple revisions and dates throughout the documents.
6. *The NRCA Roofing and Waterproofing Manual*, Volume 2, Architectural Sheet Metal and Metal Roofing, Fifth Edition, 2006.
7. *NRCA Guidelines for Single-Ply Membrane Roof Systems*, National Roofing Contractors Association, 2015.
8. *The NRCA Roofing Manual, Membrane Roof Systems*, 2015 (Includes January 2016 and February 2016 Updates).
9. *Architectural Sheet Metal Manual*, Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), Sixth Edition, September 2003.
10. *Drainage Handbook*, Plastic Pipe Institute (PPI), Chapter 5, Hydrology, 2019.

PROVIDED INFORMATION

Present during Envista's inspection was Mr. Craig Tecmire (FSPS), Mr. Eric Schaeffer (FSPS), and Mr. Joe Velasquez (FSPS) who reported the following information:

- The building was constructed in 2020 – 2021.
- There was flooding during heavy thunderstorms in 2022 at the southeast corner parking lot area caused by the Earthen Channel overflowing, which caused water intrusion at the southeast entrance doors. Plywood formwork inside a concrete junction box at the west end of the drainageway was found and removed. Flooding has not been experienced at this location after the plywood was removed.
- There was water intrusion experienced at the administrative offices west of the main entrance, and the water was discolored from soil deposits. Excavation to expose the West Wing underground roof drain in that area revealed a breach in the top of the roof drain. A sump pump with an independent piping outlet was installed in the excavation and water intrusion at the administrative offices has not been observed after the sump pump was installed.

- When excavating the West Wing underground roof drain line, it was discovered that the 12-inch PVC roof drain pipe exiting the building was connected to an 8-inch site roof drain pipe.
- Additionally, excavations at the underground roof drains for the canopy connected to a site roof drain line did not have connector fittings causing open gaps in the drain line.
- During moderate and heavier rainfall, the north side gutter system overflows the gutter in the center portion of the gutter, and water emerging from the downspout-to-underground roof drain transition fittings at all 15 downspouts was observed.
- FSPS does not have confirmatory information regarding the underground roof drain pipes on the north side of the building.

FSPS provided Envista photographs of various construction work that were taken during the progress of the project.

DISCUSSION

Gutters and Downspouts – North Side

Envista's Observations

Envista inspected the gutters and downspouts on the north side of the East Wing. There were two, 5-inch by 4-inch sheet metal downspouts connected to an approximately 24-foot-long by 7-inch-wide by 5-inch-deep sheet metal gutter for the north end of West Wing. These downspouts turned out with an elbow above-grade and splash blocks were not present on the ground. One downspout was located adjacent to the West Wing northeast corner, and the other downspout was located at approximately the mid-point of the gutter.

There were 15, 5-inch by 4-inch sheet metal downspouts connected to an approximately 336-foot-long by 7-inch-wide by 5-inch-deep sheet metal gutter for the north side of the East Wing. The downspouts terminated above-grade at a plastic transition fitting that was connected to a 6" single-wall plastic corrugated drainage pipe that was routed below grade. The spacing of the downspouts along the length of the gutter varied from approximately 20-feet to 57-feet. The gutter along the roof eave consisted of approximately 10-foot sections with lapped joints, and there was an absence of expansion joints over the full length of the gutter. The existing gutter exhibited a curved, wavy-type appearance over its length and the gutter lap joints' sealant exhibited gaps and cracks.

Reference Attachment A, Photographs 3-9

Constructions Documents' Review

The construction documents reviewed were from the building renovation and improvements used for construction to repurpose the building to an educational center. Envista reviewed the Construction Documents to identify the requirements for the gutters and downspouts, including the plumbing and site roof drain pipe requirements. Review of the architect drawings A02-03B, *Enlarged Roof Plan – Segment B (Shell)* and A02-03D, *Enlarged Roof Plan – Segment D* revealed the existing gutter was to remain. Based on the drawings and Envista's observations, the overall size of the roof's tributary area is 45,000 square feet with a 7-inch by 5-inch gutter on the 336-foot side of the eave that drained through 15, 4-inch by 5-inch downspouts.

Review of the plumbing drawings P01-01B, *Level 01 Plumbing Plan – Area B*, P01-01D, *Level 01 Plumbing Plan – Area D*, and P01-02, *Level 02 Plumbing Plan* revealed an absence of piping or notations for downspouts and their associated connection to underground drain piping.

Civil drawing C3.01, *Overall Grading and Drainage Plan* revealed an underground roof drain piping routed along the north side of the building and continued along the east side of the building and to terminate at an Earthen Channel at the southeast corner of the building. That underground roof drain had 15 lateral connections that terminated at the building's north perimeter wall with an annotation "Roof Drains (See Plumbing Plans for Size)."

Envista reviewed the documents provided, which revealed an absence of Architect's Supplemental Instructions, Requests for Information, Change Orders, or other documentation requesting clarifications and/or missing information be provided from the Architect, engineers, or Contractor.

Building Code and Industry Standards Review

Envista completed an evaluation of the gutter and downspouts to compare the installed size to the minimum required size based on the IPC and SMACNA. There are some differences between the two methodologies so the most restrictive was engaged due to the extent of the overflow conditions observed by the FSPS. The SMACNA Downspout & Gutter Sizing Calculator App generated a sizing report using the Rainfall Intensity Wizard and the Roof Rainfall Design Area Wizard. SMACNA Rectangular Gutter Design requires gutter expansion joints to occur no more than 50-feet apart with at least one downspout for each gutter section. The existing gutter was 7-inches by 5-inches (W x D) and was 336-feet long without expansion joints. Downspouts had varied spacing, which varied from approximately 12.5-feet to 39-feet, serving 1,688 square feet and 5,198 square feet of roof surface, respectively. Envista used the most common roof surface (20-foot downspout spacing, 2,700 square feet) and the largest roof surface serving a downspout for calculating the minimum size of the gutter and downspouts. Envista's research revealed the most common roof surface requires a minimum 8-inch by 6-inch gutter with a minimum 23 square inch downspout per 20-foot section, which confirmed the existing gutter and downspouts at this condition were approximately 7% and 9% smaller than the minimum size required respectively. At the largest roof surface, Envista's research revealed a minimum 8.5-inch by 11-inch gutter with a minimum 48 square inch downspout per 39-foot section, which confirmed the existing gutter and downspouts at this condition were approximately 63% and 58% smaller than the minimum size required, respectively.

Envista's observations for the underground drainage piping revealed a 12-inch single wall, corrugated pipe terminated at the earthen channel, so with the absence of verifying information, that 12-inch pipe was used to compare with minimum piping size requirements. Based on the roof tributary area of 45,300 square feet and the type of pipe installation observed, the minimum underground pipe size required is 20-inches, which confirmed the piping was undersized by approximately 40%.

Therefore, Envista concluded that *the evaluation of the roof drainage system for the north side of the East Wing revealed the following:*

- a. *The architectural drawings, plumbing drawings, and civil drawings were not coordinated, which caused discontinuity of the rainwater drainage system from the point of entry into the gutter system to the underground drainage piping.*
- b. *The plumbing drawings did not include roof drain piping from the building perimeter to the site drainage connections.*
- c. *The civil drawings indicated the underground roof drain piping, but they did not identify the required pipe sizes.*

- d. Documents were not available in the files Envista received to identify the missing information on the Construction Documents.
- e. The gutter was smaller than the minimum size required by a minimum of 7% and a maximum of 63%.
- f. The gutter did not have expansion joints as required by SMACNA, which caused thermal expansion/contraction stresses to deform the gutter system and potentially compromise the gutter anchor system.
- g. The downspouts were smaller than the minimum size required by a minimum of 9% and a maximum of 58%.
- h. The underground single wall, corrugated roof drainage piping was at least 40% smaller than the minimum size required.

Observations of the East Wing Roof Drainage – South Facet

Envista's Observations

Envista inspected the underground roof drain piping at the south side of the East Wing where four areas were excavated and exposed the piping at fittings connected to an underground roof drain main piping. The main piping consisted of a 12-inch single-wall corrugated plastic pipe that was reportedly connected to the two 12-inch PVC main roof drains and subsequently routed underground to a parking lot Curb Inlet.

The four excavated areas occurred where the canopy roof's 4-inch PVC roof drain pipes were connected to the main piping. The fittings consisted of a flexible rubber transition connector from the 4-inch PVC pipe to a 4-inch single wall plastic corrugated pipe. The 4-inch corrugated pipe was inserted through a hole cut into the side of the 12-inch main piping leaving open gaps around the cut-in-place hole for water to escape. The invert elevation of the 4-inch corrugated pipe at the main piping connection appeared to be higher than the invert elevation of the 4-inch PVC roof drain pipe. A fitting was not used at the connection to the main piping, which caused open gaps around the connection. (Figure 4)



Figure 4: Example of a PVC roof drain connection at the underground main roof drain piping (occurs in four places).

Envista observed the roofing for the East Wing, which revealed a fully adhered Thermoplastic Polyolefin (TPO) single-ply membrane. There were 14 roof drains for the south facet spaced at 24-foot centers and located adjacent to a parapet wall. Each roof drain appeared to be a 6-inch diameter outlet and the roofing membrane was turned down inside the pipe. There was not an apparent connection between the membrane and the roof drain except for

potentially the membrane adhesive. Each roof drain had a strainer that was attached to the roofing membrane with three tabs of roofing membrane material heat-welded to the primary roof membrane. There was not a secondary roof drain system present, nor were there secondary scuppers in the parapet wall adjacent to the drains. There were areas of ponded water on the high side of the roof drains, which indicated a discontinuity of positive roof drainage to the roof drains. The edge of the ponded water was approximately 24-inches from the roof drain inlet at each location. (Figure 5)



Figure 5: Example of a roof drain at the south facet of the East Wing roof.

Envista's observations at the south canopy roofing revealed a TPO single-ply membrane like the main roof. There were four roof drains that were equally spaced on the longitudinal direction of the roof. The roof drains appeared to be 4-inch diameter outlets and the membrane was fixed to the drains with a clamp ring and a strainer was placed over each roof drain. There was a scupper in the parapet wall adjacent to each roof drain.

Reference Attachment A, Photographs 10-15

Constructions Documents' Review

Envista reviewed the Construction Documents to identify the requirements for the roof drain system, including the plumbing and site drain pipe requirements. Review of the architect drawings A02-03A, *Enlarged Roof Plan – Segment A (Shell)* and A02-03C, *Enlarged Roof Plan – Segment C* revealed a continuous integral gutter and concealed downspouts. Based on the drawings and Envista's observations, the overall size of the main roof's tributary area is approximately 45,700 square feet and had 14 roof drains adjacent to a south side parapet wall. There was also a canopy roof toward the west end of the main roof which was approximately 8'-9" below the main roof and had four roof drains.

According to plumbing drawing P01-03, *Roof Plumbing Plan* revealed 14 primary roof drains at the main roof and four primary roof drains at the canopy roof with roof drain piping sizes indicated. The main roof drainage was divided into two portions at gridline '7' with eight roof drains for the east roof portion and six roof drains for the west roof portion. There were two 12-inch diameter roof drain lines, one for each roof area indicated, turned down at grid 'L/7', which subsequently exited the building perimeter. Each of the four canopy roof drains were indicated to have an independent 4-inch diameter roof drain that were indicated to be turned down at grids 'L/2', 'L/3', 'L/4', and 'L/5', which subsequently exited the building perimeter at each grid location.

Civil drawing C3.02, *Enlarged Grading and Drainage Plan* revealed an underground roof drain piping routed along the south side of the building, which had a lateral roof drain line indicated near gridline '4' that subsequently connected to a Curb Inlet in the parking lot. That underground roof drain had five additional lateral connections that terminated at the building's south perimeter wall at gridlines 'L/2', 'L/3', 'L/4', 'L/5', and 'L/9'. The lateral roof drain line from the building perimeter main line to the Curb Inlet was indicated to be 12-inch. The five lateral lines terminating at the building perimeter as well as the main

roof drain piping did not have sizes indicated. Additionally, the east lateral piping for connecting to the main roof drain pipes was at gridline '9' in lieu of gridline '7' indicated on the plumbing drawings, and the civil drawing had one roof drain line connection in lieu of the two, 12-inch roof drains indicated on the plumbing drawings that exited the building.

Therefore, Envista concluded that *the roof drain piping for the East Wing, south side indicated on the civil drawings was not coordinated with the roof drain piping indicated to exit the building on the plumbing drawings since one 12-inch diameter pipe was omitted, and the main roof drain connection was incorrectly located.*

Envista reviewed the documents provided, which revealed an absence of Architect's Supplemental Instructions, Requests for Information, Change Orders, or other documentation requesting clarifications and/or missing information be provided from the Architect, engineers, or Contractor. Therefore, Envista concluded that *documents were not available in the files Envista received to identify the missing information on the Construction Documents.*

Building Code Review

Envista reviewed the IBC, Chapter 15 – Roof Assemblies and Rooftop Structures for the minimum required roof drain requirements, which revealed the following:

1503.4 Roof Drainage. Design and installation of roof drainage systems shall comply with Section 1503 of this code and Sections 1106 and 1108, as applicable, of and the *International Plumbing Code*.

1503.4.1 Secondary (emergency overflow) drains or scuppers. Where roof drains are required, secondary (emergency overflow) roof drains or scuppers shall be provided where the roof perimeter construction ends above the roof in such a manner that water will be entrapped if the primary drains allow buildup for any reason. The installation and sizing of secondary emergency overflow drains, leaders and conductors shall comply with Sections 1106 and 1108, as applicable, of the *International Plumbing Code*.

Envista reviewed the IPC, Chapter 11 – Storm Drainage for the minimum required roof drain requirements, which revealed the following:

1105.1 General.

Roof drains shall be installed in accordance with the manufacturer's instructions. The inside opening for the roof drain shall not be obstructed by the roof membrane material."

1105.3 Roof drain flashings.

The connection between roofs and roof drains which pass through the roof and to the interior of the building shall be made water tight by the use of approved flashing material.

As noted in Envista's observations above, the roof membrane was turned in to the roof drains and there was an absence of visual evidence to verify a watertight connection was provided. Therefore, Envista concluded that *the roof drains' installation on the East Wing main roof did not comply with the IBC minimum requirements because the TPO membrane reduced the size of the roof drain inlet and was terminated without a watertight connection.*

Envista evaluated the roof drain system with the minimum requirements in the NSPC, Appendix A, Sizing Storm Drain Systems as follows:

Table A.1 Rainfall Rates for Cities

Fort Smith, Arkansas, Primary Storm Drainage 60-Min. Duration 100-Yr Return: 3.9 IN/HR, 0.041 GPM/SF.

Envista's evaluation of the 14 roof drains on the main roof, the four roof drains on the canopy, and their vertical conductors and horizontal branches were sized as required for the roof area covered and the flow rates required for each roof drain. Therefore, Envista concluded that *the roof drainage for the south facet of the East Wing was sized in general accordance with the requirements of the NSPC.*

Envista reviewed the secondary roof drain requirements in the IPC, Section 1108, Secondary (Emergency) Roof Drains, which revealed the following:

1108.1 Secondary (emergency overflow) drains or scuppers.

Where roof drains are required, secondary (emergency) roof drains or scuppers shall be provided where the roof perimeter construction extends above the roof in such a manner that water will be entrapped if the primary drains allow buildup for any reason. Where primary and secondary roof drains are manufactured as a single assembly, the inlet and outlet for each drain shall be independent.

1108.2 Separate systems required.

Secondary roof drains systems shall have the end point of discharge separate from the primary system. Discharge shall be above grade, in a location which would normally be observed by the building occupants or maintenance personnel.

1108.3 Sizing of secondary drains.

Secondary (emergency) roof drain systems shall be sized in accordance with Section 1106 based on the rainfall rate for which the primary system is sized in Tables 1106.2, 1106.3 and 1106.6. Scuppers shall be sized to prevent the depth of ponding water from exceeding that for which the roof was designed as determined by Section 1101.7. Scuppers shall not have an opening dimension of less than 4 inches (102 mm). The flow through the primary system shall not be considered when sizing the secondary roof drain system.

Envista's observations of the East Wing south facet revealed an absence of secondary (emergency) roof drains or scuppers, and there was only a primary roof drain system present. The south canopy roof for the East Wing had a functional scupper for each roof drain present. Therefore, Envista concluded that *the south facet of the East Wing roof was enclosed by a parapet wall and was missing a secondary (emergency) roof drain system, so that roof drain system was noncompliant with the IPC.*

Envista reviewed the requirements for the storm drainage system as required by the IPC Chapter 11, Storm Drainage, Section 1101, General, which revealed the following:

1101.5 Change in size.

The size of a drainage pipe shall not be reduced in the direction of flow.

1101.6 Fittings and connections.

All connections and changes in direction of the storm drainage system shall be made with approved drainage-type fittings in accordance with Table 706.3. The fittings shall not obstruct or retard flow in the system.

Envista's observations of the roof drains' underground installation for the south side of the East Wing revealed plastic corrugated piping for the main roof drain and for the four lateral lines connected to the canopy roof drain pipes. The main roof drain was a 12-inch pipe, and the four lateral pipes were 4-inch pipes. The four, 4-inch corrugated plastic pipes were connected to the 4-inch PVC pipes with a transition connector fitting. The subsequent connection of the 4-inch corrugated plastic pipes to the 12-inch corrugated pipe did not have a fitting, and they were inserted into cut-in-place openings into the 12-inch pipe.

Therefore, Envista concluded that *the East Wing, south side underground roof drain piping installed at the four canopy roof drains was noncompliant with the IPC because the plastic corrugated piping did not have drainage-type fittings. Furthermore, the absence of drainage-type fittings created an unsealed drainage system at these locations, which increased the potential for erosion of the underlying soil and also water intrusion into the building.*

Envista performed an evaluation of the roof drain system from the roof surface to the site parking lot Curb Inlet box where the roof drains tie-in was located using known information and assumptions. The roof drain component sizes indicated on the design drawings and/or observed during Envista's observations were the basis for the evaluation. Envista utilized the requirements and methodology outlined in the APC as adopted by the City of Fort Smith, Arkansas, as well as the 2018 *National Standard Plumbing Code* (NSPC). Pipe sizing was based on the 60-minute, 100-year rainfall rate of 3.9-inches/hour per the NSCP, Appendix A. An assumed slope of 0.125-inches per 12-inches was used for the horizontal leaders and the drain lines. Envista used PPI's *Drainage Handbook*, Manning's Roughness Coefficient values in Table 5.4 of 0.010 for the PVC pipes and 0.0215 for the corrugated plastic pipes. Envista assumed corrugated wall pipes based on site observations and a submittal for the utility piping not being available.

Evaluation of the designed system, along with site observations, for the PVC pipe roof drains within the building from the roof drain inlets to the outlets at the building perimeter revealed compliance with the approved plumbing codes.

Evaluation of the designed system, along with site observations, for the corrugated plastic roof drains on the site from the inlet at the PVC pipe connections to the Curb Inlet revealed the 12-inch main roof drain pipe was undersized and was noncompliant with the approved plumbing codes. Envista's evaluation revealed the corrugated plastic pipe used for the main roof drain would require a minimum 20-inch diameter corrugated plastic pipe to positively drain the rainwater from the building to the outlet point at the Curb Inlet. For reference purposes only, a 14-inch PVC pipe would be an acceptable means to positively drain the rainwater if that was used in lieu of the corrugated plastic pipe.

Reference Attachment B, Analysis of Roof Drain System Sizing

Therefore, Envista concluded that *the East Wing, south side site utility roof drains were undersized from the point of the main roof drain inlets at the perimeter of the building to the point of outlet at the parking lot Curb Inlet.*

Observations of the West Wing Roof Drains – East Facet

Envista's Observations

Envista inspected the underground roof drain piping at the east side of the West Wing (south of the East Wing) where an area was excavated adjacent to the East Wing to expose the piping and fittings connected to underground roof drain main piping. The West Wing roof drain pipe outlet emerged from the building beneath the East Wing and was a 12-inch black PVC pipe that reportedly connected six roof

drains for the east side of the roof where the West Wing abutted the East Wing. There was an approximately 3- to 4-inch square hole in the top of the 12-inch roof drain that was reportedly found in the pipe during the excavation. Approximately 5-feet south of the East Wing foundation wall, the 12-inch roof drain outlet was connected to an 8-inch green PVC site roof drain pipe with a reducer fitting. The reducer fitting was fixed to each of the pipes with band clamps, which did not appear to be snug/tight against the fitting. The 8-inch site roof drain pipe reportedly was routed south to an Area Inlet near the southeast corner of the West Wing. A temporary sump pit was installed by the FSPS as an alternate drain due to the excavated area filling with rainwater from the hole in the roof drain pipe. (Figure 6)



Figure 6: Excavation where the West Wing roof drain pipe emerged from below the East Wing.

Envista observed the roofing for the West Wing, which revealed the roofing to likely be a fully adhered Thermoplastic Polyolefin (TPO) single-ply membrane. There were 10 roof drains for the east facet: the six drains previously noted and four additional roof drains where the West Wing projected south beyond the East Wing spaced at 55-foot centers and 26-foot centers respectively. Each roof drain appeared to be a 6-inch diameter outlet and the roofing membrane was turned down inside the pipe. There was not an apparent connection between the membrane and the roof drain except for potentially the membrane adhesive. Each roof drain had a strainer that was attached to the roofing membrane with three tabs of roofing membrane material heat-welded to the primary roof membrane. There was not a secondary roof drain present, nor were there secondary scuppers in the parapet wall adjacent to the drains. There were areas of environmental deposits on the high side of the roof drains. (Figure 7)



Figure 7: Example of a roof drain on the east facet of the West Wing.

Reference Attachment A, Photographs 16-25

Construction Documents' Review

Envista reviewed the Construction Documents to identify the requirements for the roof drain system, including the plumbing and site drain pipe requirements. Review of the architect drawings A02-03E, *Roof Plan – Segment E (Shell)* and A02-03F, *Roof Plan – Segment F* revealed an integral gutter and concealed

downspouts at the south portion of the roof and primary roof drains without secondary roof drains at the north portion of the roof. Based on the drawings and Envista's observations, the overall size of the main roof's tributary area is 37,500 square feet and had 7 roof drains and the integral gutter system adjacent to the east side parapet wall. It was not clear how the concealed downspouts for the integral gutter system were routed nor where they exited the building.

Review of the plumbing drawing P01-03, *Roof Plumbing Plan* revealed 10 primary roof drains at the main roof. The main roof drainage was divided into two portions at gridline 'L' with six roof drains for the north roof portion and three roof drains for the south roof portion. Envista reviewed plumbing drawings P01-01C, *Level 01 Plumbing Plan – Area C*; P01-01E, *Level 01 Plumbing Plan – Area E*; and P01-01F, *Level 01 Plumbing Plan – Area F*. Subsequent routing of the roof drain piping in the building to the observed roof drain outlet was not found on the plumbing drawings.

Civil drawing C3.02, *Enlarged Grading and Drainage Plan* revealed underground roof drain piping routed from the southeast corner of the West Wing to an Area Inlet near the southwest corner of the building. The size of that underground roof drain was not indicated. There were no other underground roof drain lines indicated for the east facet of the West Wing on the civil drawings.

Therefore, Envista concluded that *the roof drain piping for the east facet of the West Wing indicated on the plumbing drawings and the civil drawings was not coordinated with the indicated roof drain piping since there was an absence of roof drain piping indicated on drawings below the roof plans.*

Envista reviewed the documents provided, which revealed an absence of Architect's Supplemental Instructions, Requests for Information, Change Orders, or other documentation requesting clarifications and/or missing information be provided from the Architect, engineers, or Contractor. Therefore, Envista concluded that *documents were not available in the files Envista received to identify the missing information on the Construction Documents.*

Building Code Review

As included previously in this report, Envista reviewed the IBC, Chapter 15 – Roof Assemblies and Rooftop Structures for the minimum required roof drain requirements.

As included previously in this report, Envista reviewed the IPC, Chapter 11 – Storm Drainage for the minimum required roof drain requirements.

As noted in Envista's observations above, the roof membrane was turned into roof drains and there was an absence of visual evidence to verify a watertight connection was provided. Therefore, Envista concluded that *the roof drains' installation on the West Wing, east facet roof did not comply with the IBC minimum requirements because the TPO membrane reduced the size of the roof drain inlet and was terminated without a watertight connection.*

Envista evaluated the roof drain system with the minimum requirements in the NSPC, Appendix A, Sizing Storm Drain Systems as follows:

Table A.1 Rainfall Rates for Cities

Fort Smith, Arkansas, Primary Storm Drainage 60-Min. Duration 100-Yr Return: 3.9 IN/HR, 0.041 GPM/SF.

Envista's evaluation of the 10 roof drains on the roof, and their vertical conductors and horizontal branches per observations and reported conditions were sized as required for the roof area covered and

the flow rates required for each roof drain. Therefore, Envista concluded that *the roof drainage for the east facet of the West Wing was sized in general accordance with the requirements of the NSPC.*

As noted previously in this report, Envista reviewed the secondary roof drain requirements in the IPC, Section 1108, Secondary (Emergency) Roof Drains.

Envista's observations of the east facet of the West Wing revealed an absence of secondary (emergency) roof drains or scuppers, and there was only a primary roof drain system present. Therefore, Envista concluded that *the east facet of the West Wing roof was enclosed by a parapet wall and was missing a secondary (emergency) roof drain system, so that roof drain system was noncompliant with the IPC.*

As noted previously in this report, Envista reviewed the requirements for the storm drainage system as required by the IPC Chapter 11, Storm Drainage, Section 1101, General.

Envista's observations of the roof drains' underground installation at the east side of the West Wing revealed the site underground roof drain connection inlet to the building roof drain outlet reduced the pipe size from 12-inches to 8-inches.

Therefore, Envista concluded that *the West Wing, east side underground roof drain piping from the north portion roof drains installation did not comply with the IPC because the downstream pipe size was reduced.*

Attachment A, Photographs contains photographs relevant to this discussion.

CLOSURE

This report is for the exclusive use of Envista's client and is not intended for any other purpose. All opinions expressed by the undersigned within this report are formulated to a reasonable degree of engineering certainty. This report is based on information made available to Envista at this time. Should additional information become available, Envista reserves the right to determine the impact, if any, of the new information on the opinions and conclusions herein and to revise the opinions and conclusions if necessary and warranted by the discovery of additional information.

Envista Forensics



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Technical Review by:
Justin DeAngelis, P.E.
Regional Technical Leader

Attachment A, Photographs
Attachment B, Analysis of Roof Drain System Sizing

ATTACHMENT A

Photographs

Photographs taken during our inspection, which have not been included in this report, have been retained in our files and will be made available to you upon your request. Note that the brightness and/or contrast of some photographs may have been enhanced for purposes of clarity. Some photographs may be cropped from their original sizes in order to emphasize a specific item or feature. No significant changes to any photographs were made that would alter factual representations.

Photograph #1



Overview of the south side of the East Wing, west portion.

Photograph #2



Overview of the south side of the East Wing, east portion.

Photograph #3



Overview of the north side of the East Wing, east portion.

Photograph #4



Continued view of the north side of the East Wing, central portion.



Insured: Fort Smith Public Schools
Location: 5900 Painter Lane, Fort Smith, AR

Envista Matter No: MAT-160449-G7V3
Client Claim/File: PEAK Innovation Center

Photograph #5



Overview of the north side of the East Wing, west portion looking east.

Photograph #6



Overview of the East Wing gutter on the north side looking east. Note the curved/wavy appearance of the gutter and roof edge.

Insured: Fort Smith Public Schools
Location: 5900 Painter Lane, Fort Smith, AR

Envista Matter No: MAT-160449-G7V3
Client Claim/File: PEAK Innovation Center

Photograph #7



Overview of the East Wing gutter on the north side looking west. Note the curved/wavy appearance of the gutter and roof edge.

Photograph #8



Example of a gutter lap joint on the north side of the East Wing. Note the open gap in the lap sealant.

Photograph #9



Example of a gutter to corrugated plastic pipe transition on the north side of the East Wing.

Photograph #10



Overview of the roof drains on the south side of the East Wing looking east.

Photograph #11



View of the roof drains on the south side of the East Wing. Note the gap between the pooled water and the roof drains.

Photograph #12



Overview of the canopy roof at the East Wing with the roof drains and the adjacent scuppers.

Photograph #13



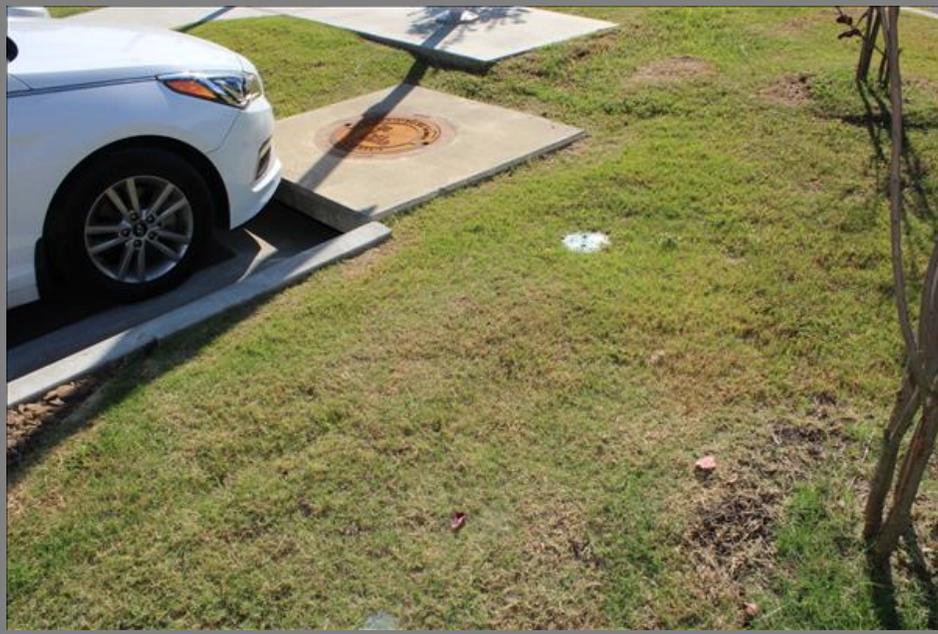
View of excavations at the connection of the building roof drain lines and the site utility roof drain lines covered by plywood.

Photograph #14



View of a connection between a canopy roof drain and site roof drain.
Note a fitting was not used at the raised pipe invert.

Photograph #15



View of the Curb Inlet in the parking lot at the site roof drain line tie-in location.

Photograph #16



Overview of the east roof facet of the West Wing looking south.

Photograph #17



Overview of the east roof facet of the West Wing looking north.

Photograph #18



View of a roof drain at the east facet of the West Wing adjacent to the East Wing exterior wall.

Photograph #19



View of the interior roof drain piping at the south end of the West Wing.

Photograph #20



View of the interior 12-inch roof drain piping where it turned down prior to exiting the building to the site drainage.

Photograph #21



Overview of the junction between the East Wing and the West Wing.

Photograph #22



View of the excavation at the West Wing roof drain outlet from below the East Wing.

Photograph #23



View of the West Wing roof drain transition to site roof drain. Note the breach in the roof drain and downstream reducer fitting.

Photograph #24



View of the site Area Inlet near the southeast corner of the West Wing.

Photograph #25



View of the Area Inlet shown in the previous photograph looking south.

ATTACHMENT B

Analysis of Roof Drain System Sizing

Gutter & Downspout Sizing Requirements

Source: SMACNA Architectural Sheet Metal Manual
Green arrows indicate downspouts that were equal to or larger than the size required by the downspout sizing calculator.
Red arrows indicate downspouts that were smaller than the size required by the downspout sizing calculator.
Red lines indicate gutter that was smaller than the size required by the gutter sizing calculator.

These two gutter sections are the largest and used to size the gutter.

WEST WING West Facet
(Drainage from this roof was not reviewed)

WEST WING East Facet

EAST WING North Facet

EAST WING South Facet

Roof Drain Sizing Requirements

Source: National Standard Plumbing Code, Appendix A
Green arrows indicate roof drains and interior piping that were equal to or larger than the size required.
Red arrows indicate roof drains and interior piping that were smaller than the size required.

SOURCE:
Drawing A02-03
05/18/2021

