HSA ENGINEERING

Peak Innovation Center – Roof Drainage Systems Assessment for Fort Smith, Arkansas

Date: 05/11/2023

Reported by: M. Scott Archer, P.E.

Building: Peak Innovation Center
5900 Painter Lane
Fort Smith, Arkansas

Introduction

Please find below HSA Engineering's Assessment report for the Fort Smith School District Peak Innovation Center located at 5900 Painter Lane, Fort Smith, AR. This assessment was conducted by HSA Engineering through onsite inspections on March 29, April 4, and April 7, 2023, as well as through review of the design documents provided to our office by the district. It is based on a physical/visual examination along with calculations to verify the sizing of the roof drainage piping. Visual verification was conducted of the above grade systems where they are exposed and accessible, as well as inspection of the sub-slab/sub-surface drainage, where accessible, using a piping inspection camera system. Use of the camera system was partially constrained in that portions of the piping system were not accessible due to physical limitations. The location of these limitations will be described below, and in our opinion were not a factor in providing an adequate assessment.

HSA used existing plans for the subject property provided by the Fort Smith School District for reference purposes. These plans were the record plans provided to the district by the design team and contractors during and after the design and construction of the facility. The record was mostly complete but required a bit of interpretation and interpolation.

Based on initial visual inspection, on March 24, 2023, water intrusion event appeared to originate along the south wall of the office area between column lines 2 and 4. Most of the intrusion appeared to happen between column grids 2 and 3 at the interface of the slab and grade beam carrying columns along the "L" gridline. Evidence indicated a very substantial and sustained flow from this interface (See Photo 1). In addition to water, a significant amount of silt infiltrated the building as apparent in Photo 1. Based on this initial evidence, our suspicion was that a below slab roof drainpipe had failed allowing water to escape below slab. Based on this we decided that visual inspection of the below slab roof drain piping using a camera inspection system was warranted.

Assessment

Roof Drain Piping

We began the assessment by verifying adequacy of the existing roof drainage system design; both original existing drainage system left in place and those newly designed as part of the Peak Innovation Center design. In the original released plans, new roof drainage systems were designed for the east two thirds of the south half of the east wing of the building. Later design revisions (ASI 04 EXT) addressed the remainder of the south half of the east wing, as well as the east half of the west wing of the building. Our calculations indicate that the newly designed roof drainage systems for these areas were appropriately sized per the Arkansas Plumbing Code based on a 4 inch per hour rain.

The roof drainage for the south half of the east wings was installed per the final design mentioned above and is adequate to five (5) feet outside the building for the area served. This portion of the roof drain system is served by two (2) vertical 12-inch drain leaders that convey storm water to five (5) feet outside the building where it enters the site storm water drainage system. The site sub surface system is discussed later in this report.

It appears that at some point (Approximately August 25, 2021 – Refer to EMAIL correspondence in Appendix "A") during the construction of the building it was decided to leave the original roof drainage piping in place for the northern 2/3 of the east half of the west wing of the building. This portion of the roof is approximately 31,000 sq. ft. Based on table 1106.3 of the 2009 Arkansas Plumbing Code and entering the table for a 4 inch per hour rain this amount of roof area would require a 12-inch horizontal pipe. The original roof drainage piping that was left in place appears to be an 8-inch pipe all the way to the ditch on the south border of the site and does not appear to be adequately sized for the area served. The remaining 9,400 sq. ft. portion of that piece of roof is served by a 12-inch pipe and is oversized for the area served. This 12-inch pipe could almost handle the entire east half of the west wing of the building, which is roughly 40,000 sq. ft.

On April 4 and April 7, the below slab, as well as the site sub surface drainage piping associated with the roof drainage system was inspected using a piping inspection camera system. Photo snips from the videos are provided in Appendix "B" and a Site Plan keying the photos to the locations and direction taken is provided in appendix "C".

The yellow highlighted area on the site keying plan in Appendix "C" indicates the area we were most concerned with at the beginning of our assessment. Our original concern was that the piping in this area had failed somewhere in the intrusion area and was allowing water to escape below the slab. Our investigation eliminated this possibility, as this below slab piping appeared fully intact based on our inspection. However, it appears to be undersized based on our roof drainage sizing investigation as discussed above. This portion of the original existing piping continues out the south side of the east wing terminating in the drainage ditch to the south of the facility. There was a failure in this portion of the original drainage piping external to the building causing a sink hole to form in the green highlighted area of the site keying plan. We inspected that repair to ensure that was still intact. The repair interface can be seen in Photo 2. We inspected this same pipe from the terminus end at the drainage ditch and found a piping connection that had appeared to fail at approximately location 1 on the site keying plan. This can be seen in Photo 3. This break is far enough outside the building that it does not cause concern.

However, we were unable to get the camera past the break, so the portion of the piping highlighted in blue was not able to be inspected.

An internal gutter drain was employed in the original design of the east wing where the west wing of the building joins the east wing of the building. The gutter drain is a flat pan style drain that runs the length of the interface between the buildings (see Photo 5B for a section detail of this gutter) with roof drains that feed into the piping system described in the previous paragraph. Evidence indicates that this gutter drain is not draining sufficiently to alleviate the amount of water that was experienced during the March 24 event. Evidence of this can be seen in Photo 4 and Photo 5 as water was witnessed sheet flowing down the wall between the two buildings, as well as wetting the underside of the roof in several areas.

Next, we inspected the site below grade drainage piping south of the east wing of the building. This area is highlighted in pink on the site keying plan. During this inspection we noted several items, as follows.

The piping in locations 4 & 5 were holding water, indicating there was a belly in the piping. Since the pipe was full of water we were unable to get a view of the PVC to corrugated connection.

All connections made by fittings in this area of the piping system are made using bull head tees or pipes stubbed directly into another pipe without a fitting. No directional fittings were employed. Directional fittings help direct water flow in the desired direction of flow. This can be seen in Photo 6 at location 3, Photo 7 at location 7 and Photo 8 at location 10. At location 10 & location 11, these two 12in x 12in x 12in bullhead tees are delivering the drainage from approximately 43,000 SF of roof area into a single 12-inch corrugated drainpipe. This is a significant amount of drainage being delivered to this main drainpipe and would have benefited from directional fittings at this location. In addition, the 12-inch main drainpipe appears to be undersized based on the flow. In our opinion, this pipe should probably be at least a 15-inch drainpipe. Our review of the drawings indicates that this main drainpipe was appropriately sized at 12 inches prior to the addition of the roof drain piping added in ASI 04 EXT. It appears that the roof drain design changes contained in the referenced ASI were never communicated to or coordinated with the civil design team.

Where the 4-inch canopy roof drains tie into the 12-inch main corrugated below grade pipe, no fittings were used. The 4-inch corrugated pipe from the canopy roof drain is simply shoved through a hole cut into the side of the 12- inch corrugated pipe. This can be seen in Photo 9 taken at location 8. We were not able to inspect the connection from the outside of the pipe to determine if the connection had been sealed in some fashion.

The 4-inch canopy drains are PVC pipe until they get below grade. At some point below grade, they connect to 4-inch corrugated piping. During our inspection we found a poor connection at one of these PVC/corrugated interfaces. Based on our inspection it appears that the 4-inch PVC has been inserted into the 4-inch corrugated and has not been sealed. You can see the poor connection that we found during our inspection in Photo 10 in the appendix.

In reviewing the original permit site plan drawings (dated 08.04.2020) for the renovation, we noticed an existing sewer pump on the north side of the building that was noted to be abandoned. The final disposition of this sewer sump is unclear. If the piping from the sump to the building has not been

adequately plugged, it may provide a possible avenue for water to enter if the pipe happens to be open below the slab.

Recommendation Comments:

Although our investigation did not uncover a definitive failure that we believe could have caused the significant water intrusion event, we do believe there are issues with the roof drainage system that should be addressed to improve roof drain performance. The following are our recommendations for improvements.

1. Abandon the existing below slab drainpipe and reroute the drains serving the internal gutter drain between the east and west wings of the building from the existing below slab drainpipe to the south end of the building and terminate them into the existing south drainage ditch. The size of this new drain could be minimized by routing a portion of the redesigned drainage system into the existing roof drain system at the southeast portion of the west wing. As part of this work, we recommend a full analysis be conducted to determine if the number of roof drains located in the internal gutter drain are adequate to drain the gutter drain during a minimum 4 inch per hour rain event to help ensure that the gutter does not overflow and allow water into the building as shown in photos 4 and 5.

2. Rework the below grade roof drain piping on the south side of the east wing to allow adequate relief of the drainage from the south half of the east wing of the building. There are several options for accomplishing this while minimizing the required disturbance of the existing concrete in the area.

3. The abandoned sewer lift station sump on the north side of the building should be further investigated to ensure that the piping serving that sump has been adequately capped to prevent water from entering below the slab from that sump in the event storm water is infiltrating the sewer sump.

END OF REPORT

APPENDIX “A”

From: Kenny Brown <kbrown@action-mechanical.com> on behalf of Kenny Brown
Sent: Wednesday, April 5, 2023 12:16 PM
To: Scott Archer
Subject: FW: PEAK - ROOF DRAIN REVISION - SKETCH

From: William Stroo <wstroo@action-mechanical.com>
Sent: Wednesday, March 29, 2023 10:42 AM
To: Kenny Brown <kbrown@action-mechanical.com>
Subject: FW: PEAK - ROOF DRAIN REVISION - SKETCH

Will Stroo

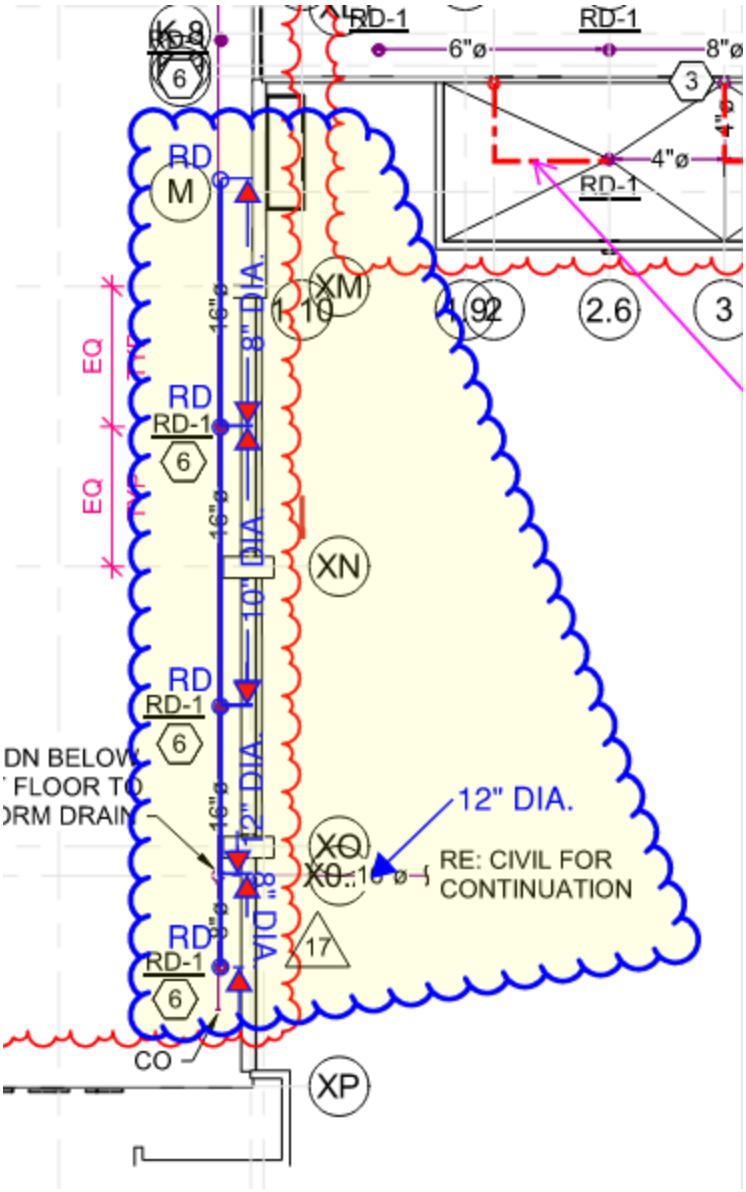
From: Michael Martin <michael@tkcmgt.com>
Sent: Wednesday, August 25, 2021 6:38 AM
To: William Stroo <wstroo@action-mechanical.com>; Angelica Connelly <aconnelly@tkcmgt.com>; Danny Haynal <dhaynal@tkcmgt.com>
Subject: Fwd: PEAK - ROOF DRAIN REVISION - SKETCH

Will,
See attached drawing of the proposed gutter drains for Area E. Please price as drawn to 5' to exterior of building. Contact me if you have any questions.
Thank you.
Get Outlook for iOS

From: Graham Sharum, AIA - LEED AP - NCARB <GSharum@childersarchitect.com>
Sent: Wednesday, August 25, 2021 1:06:45 AM
To: Larry Marley <lmarley@tkcmgt.com>; Michael Martin <michael@tkcmgt.com>; Danny Haynal <dhaynal@tkcmgt.com>; Angelica Connelly <aconnelly@tkcmgt.com>
Cc: Scott Ditto <sditto@hpmleadership.com>; Phil Walters <pwalters@hpmleadership.com>; Angie Stutsman <Angie.Stutsman@corgan.com>
Subject: PEAK - ROOF DRAIN REVISION - SKETCH

Michael,

Here is a sketch for the revised roof drain leaders (Blue markups) along grid X6. Let me know if you have any questions.



Thank you,

Graham Sharum, AIA, LEED AP, NCARB
Project Manager

CHILDERS ARCHITECT

PHONE 479-783-2480
MOBILE 479-522-7840
gsharum@childersarchitect.com

45 South 4th Street, Fort Smith, AR 72901

www.childersarchitect.com
To send large files, please use

APPENDIX “B”

Photo 1: Infiltration Along Grade Beam and Slab

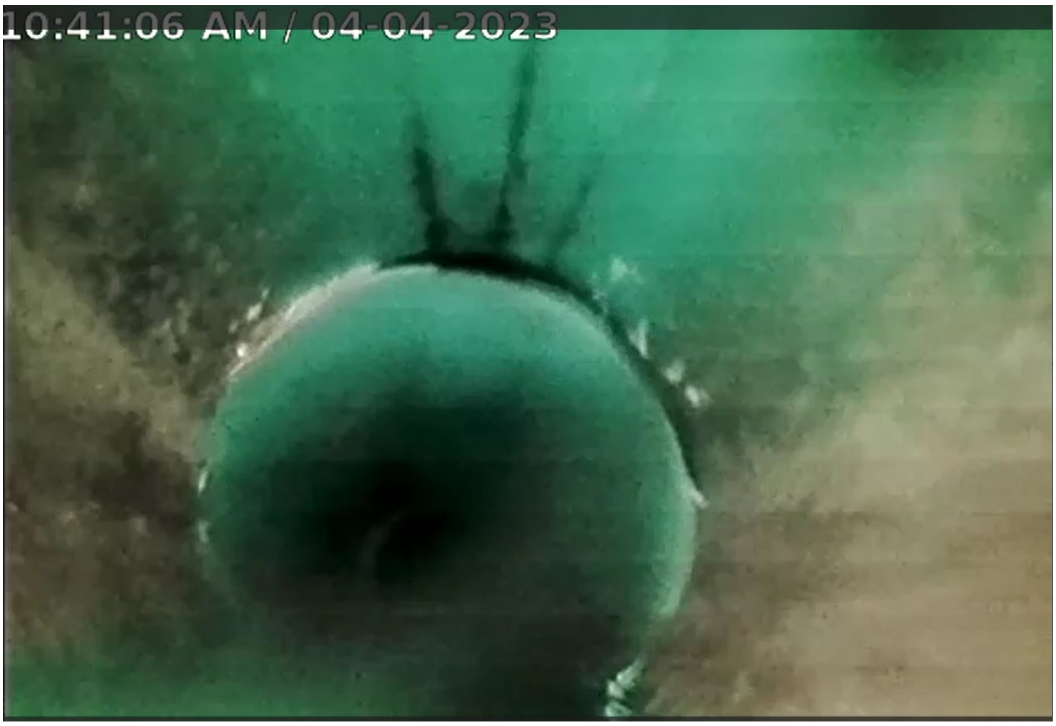


Photo 2: Drainage Repair Interface at Location 2

Photo 3: Piping Connection a Location 1.

Photo 4: Sheet flow on wall between east and west wings of the building.

Photo 5: Water on west side of wall between the east and west wing, and indication of water on the underside of the roof in the west wing of the building.

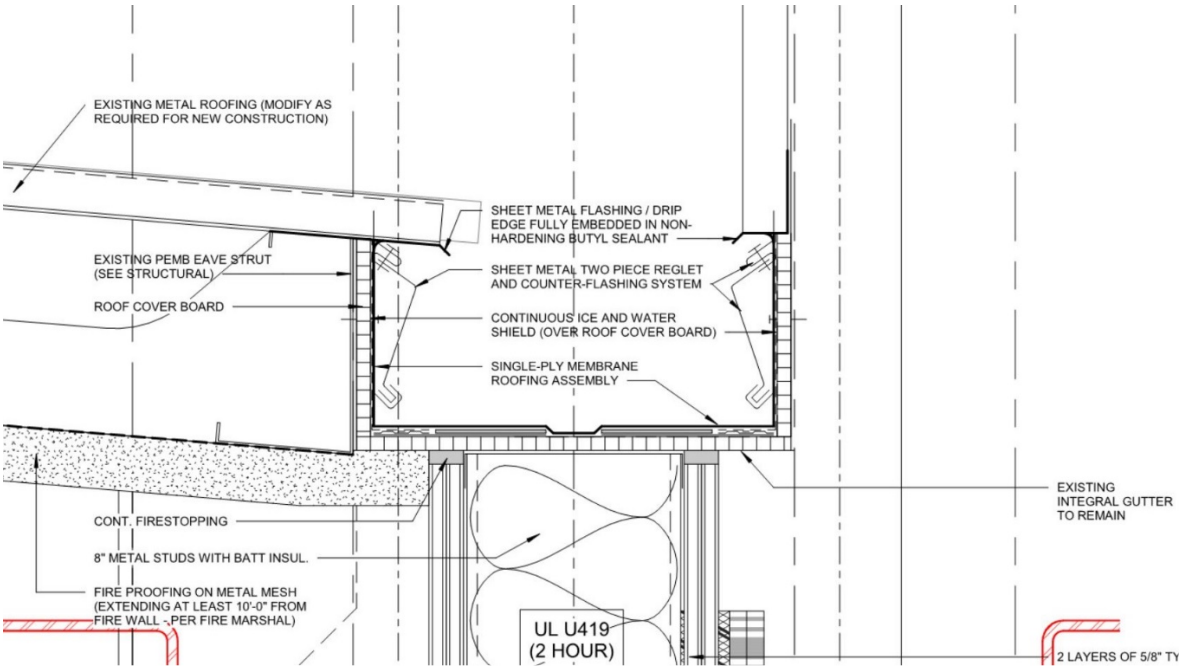


Photo 5B: Detail of Internal Gutter Drain at interface of east and west wing. From Sheet A06-23

Photo 6: Bull Head Tee at Location 3

Photo 7: Bull Head Tee at Location 7

Photo 8: Bull Head Tee at Location 10

Photo 9: 4-inch corrugated penetrating through the wall of the 12 Inch corrugated pipe at Location 8.

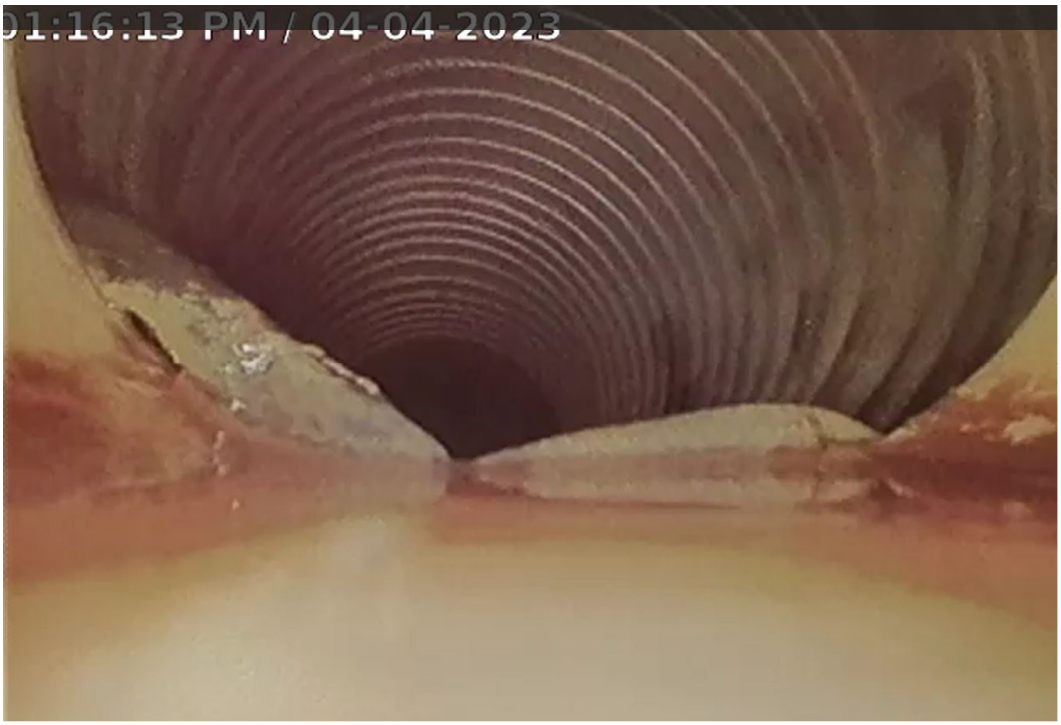


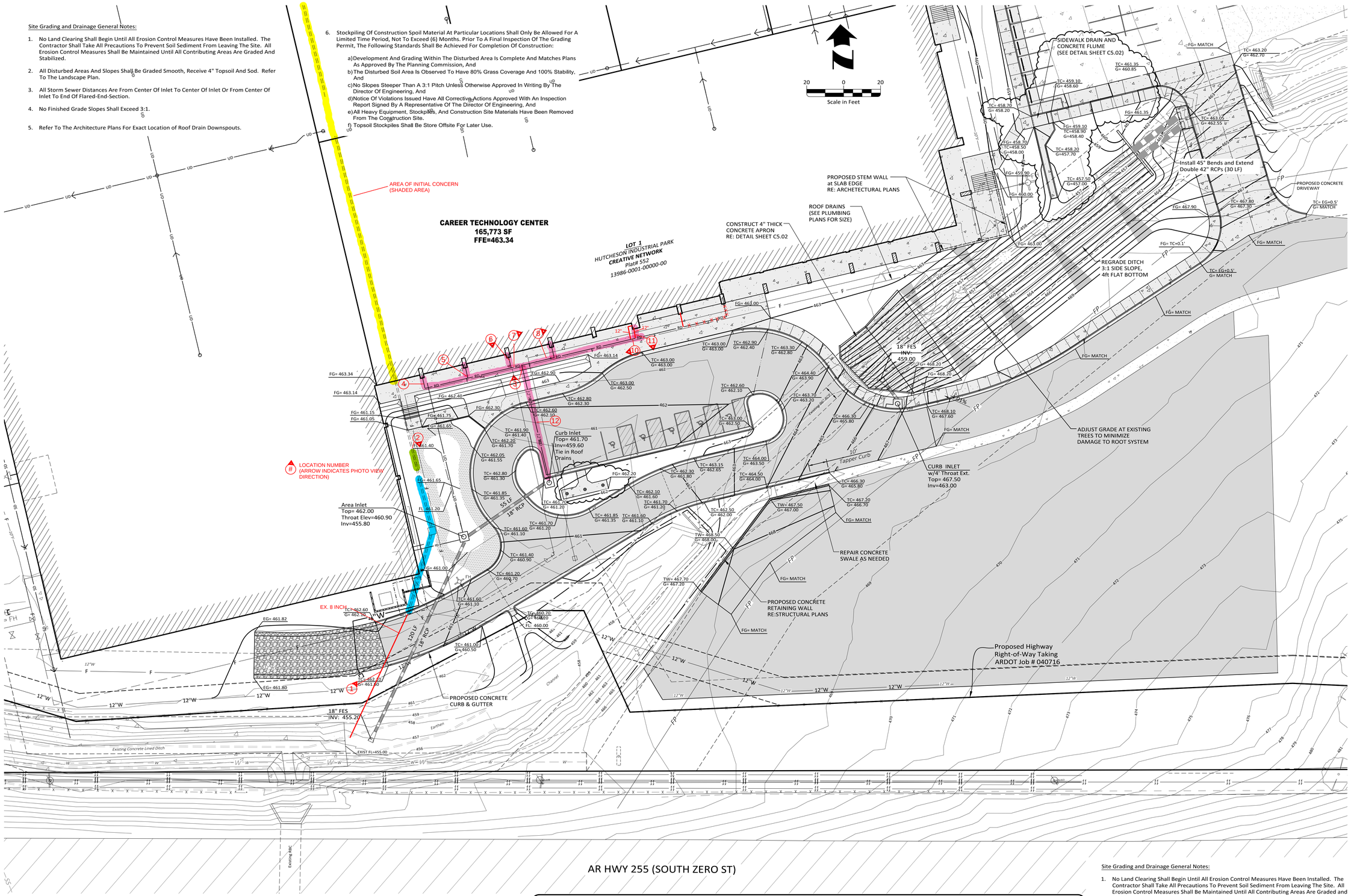
Photo 10: Poor connection of canopy roof 4-inch PVC to 4-inch corrugated piping.

APPENDIX "C"

SITE KEYED PLAN

Site Grading and Drainage General Notes:

1. No Land Clearing Shall Begin Until All Erosion Control Measures Have Been Installed. The Contractor Shall Take All Precautions To Prevent Soil Sediment From Leaving The Site. All Erosion Control Measures Shall Be Maintained Until All Contributing Areas Are Graded And Stabilized.
2. All Disturbed Areas And Slopes Shall Be Graded Smooth, Receive 4" Topsoil And Sod. Refer To The Landscape Plan.
3. All Storm Sewer Distances Are From Center Of Inlet To Center Of Inlet Or From Center Of Inlet To End Of Flared-End-Section.
4. No Finished Grade Slopes Shall Exceed 3:1.
5. Refer To The Architecture Plans For Exact Location of Roof Drain Downspouts.
6. Stockpiling Of Construction Spoil Material At Particular Locations Shall Only Be Allowed For A Limited Time Period, Not To Exceed (6) Months. Prior To A Final Inspection Of The Grading Permit, The Following Standards Shall Be Achieved For Completion Of Construction:
   a) Development And Grading Within The Disturbed Area Is Complete And Matches Plans As Approved By The Planning Commission, And
   b) The Disturbed Soil Area Is Observed To Have 80% Grass Coverage And 100% Stability, And
   c) No Slopes Steeper Than A 3:1 Pitch Unless Otherwise Approved In Writing By The Director Of Engineering, And
   d) Notice Of Violations Issued Have All Corrective Actions Approved With An Inspection Report Signed By A Representative Of The Director Of Engineering, And
   e) All Heavy Equipment, Stockpiles, And Construction Site Materials Have Been Removed From The Construction Site.
   f) Topsoil Stockpiles Shall Be Store Offsite For Later Use.



LEGEND

- Proposed Building
- Standard Duty Asphalt Paving: 1.5" ACHM Surface Course (AHTD Type 3), 1.5" ACHM Surface Course (AHTD Type 2), 6" Crushed Base Course (AHTD Class 7)
- Proposed Concrete Pavement With 6" Conc. Curb
- Standard Duty Concrete Paving: 6" PCCP 4" Crushed Stone Base Course (AHTD Class 7)
- Dumpster Pad Paving 8" PCCP w/ #4@12" E.W. 4" Crushed Stone Base Course (AHTD Class 7)
- Proposed Gravel Pavement
- Proposed Sidewalk
- 1135 Proposed Contour Line
- 2% Finished Grade Slope
- Proposed Curb Inlet
- Proposed Drainage Pipe
- RD Proposed Roof Drain
- TC= 467.80 G= 467.30 Proposed Spot Elevation
- 475 / 474 Existing Contours
- Existing Concrete
- Existing Asphalt
- PR R/W Right-Of-Way (ARDOT Proposed)
- R/W Right-Of-Way (Existing)
- Existing Easement Line
- X X Existing Fence Line
- X Proposed Fence Line
- RD Proposed Roof Drain
- UD Proposed Underdrain
- Existing Rebar
- Existing Nail
- Set Mag Nail w/ PS# 1507 Washer
- Set 1/2" Rebar w/ PS# 1507 Cap
- Existing Water Meter
- Existing Fire Hydrant
- Existing Water Valve
- Existing Sewer Manhole
- CO Existing Sewer Clean Out
- Existing Gas Meter
- Existing Telephone Pedestal
- Existing Electric Pedestal
- UP Existing Utility Pole
- Existing Power Pole
- Existing Power Pole w/ Guy Wire
- Existing Sign
- Existing Tree

Site Grading and Drainage General Notes:

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2. All Disturbed Areas And Slopes Shall Be Graded Smooth, Receive 4" Topsoil And Sod. Refer To The Landscape Plan.
3. All Storm Sewer Distances Are From Center Of Inlet To Center Of Inlet Or From Center Of Inlet To End Of Flared-End-Section.
4. No Finished Grade Slopes Shall Exceed 3:1.
5. Refer To The Architecture Plans For Exact Location of Roof Drain Downspouts.
6. Provide 2" Asphalt Overlay on all Existing Aspalt not removed During the Demolition Phase. Provide Cold-Milling at Pavement Transitions to Insure a Flush Instalation.

MORRISON SHIPLEY
5704 EUPER LANE, SUITE 200 • FORT SMITH, AR 72903 • 479.452.1933 • MORRISONSHIPLEY.COM

CORGAN

CHILDERS ARCHITECT
45 SOUTH 4TH STREET · FORT SMITH, ARKANSAS 72901
479-783-2400 · WWW.CHILDERSARCHITECT.COM

ISSUE FOR EDA REVIEW NO 2

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No.10420
JESSE L. BRISENDINE
The Original Signed and Sealed Document is on File at the Office of Record
10-22-20

PEAK INNOVATION CENTER