DOWNTOWN DRAINAGE STUDY
JOHNSON CITY, TENNESSEE

Prepared for:
City of Johnson City
Tennessee

Under Work Order #1 of
MSA dated 7 February 2008

Submitted by:
AMEC Earth & Environmental, Inc.
Knoxville, Tennessee

August 20, 2008

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1.0 PURPOSE AND BACKGROUND

The downtown drainage improvement project was performed to determine whether a relatively minor capital improvement project could help to alleviate some of the flooding problems that have plagued the downtown area since the late 1800s. Flooding occurs downtown due to the development of structures in the floodplain. The existing culverts and their ages are shown in Figure 1 below.

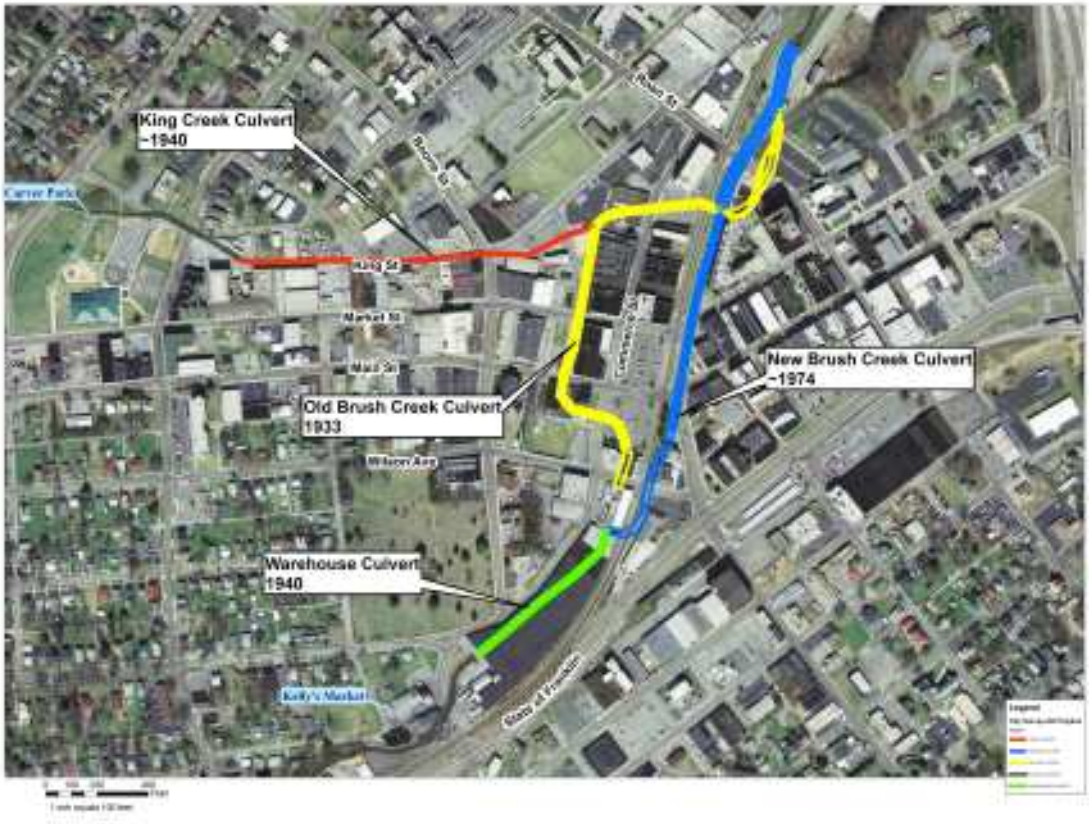

Figure 1: Existing Drainage Infrastructure

Flooding downtown is caused by overflow from Brush Creek and King Creek. Flow from these creeks enters the downtown area when the Brush Creek and King Creek culverts are overtopped. The King Creek culvert is overtopped at its inlet. Overland flow from King Creek flows down King Street and enters the downtown area via Montgomery, Boone and McClure Streets.

The Brush Creek culvert is overtopped at its inlet near the old tobacco warehouse. Brush Creek also overtops the Watauga Street culvert. After overtopping, the overland

flow travels down State of Franklin Road/Water Street and the railroad right of way. This flow finally enters downtown by crossing over the railroad tracks at Market and Main Streets.

Flow from Brush and King Creeks combine in the downtown area and pond until the Brush Creek culvert can dewater the downtown. The flowpaths described above can be seen in Figure 2 below.

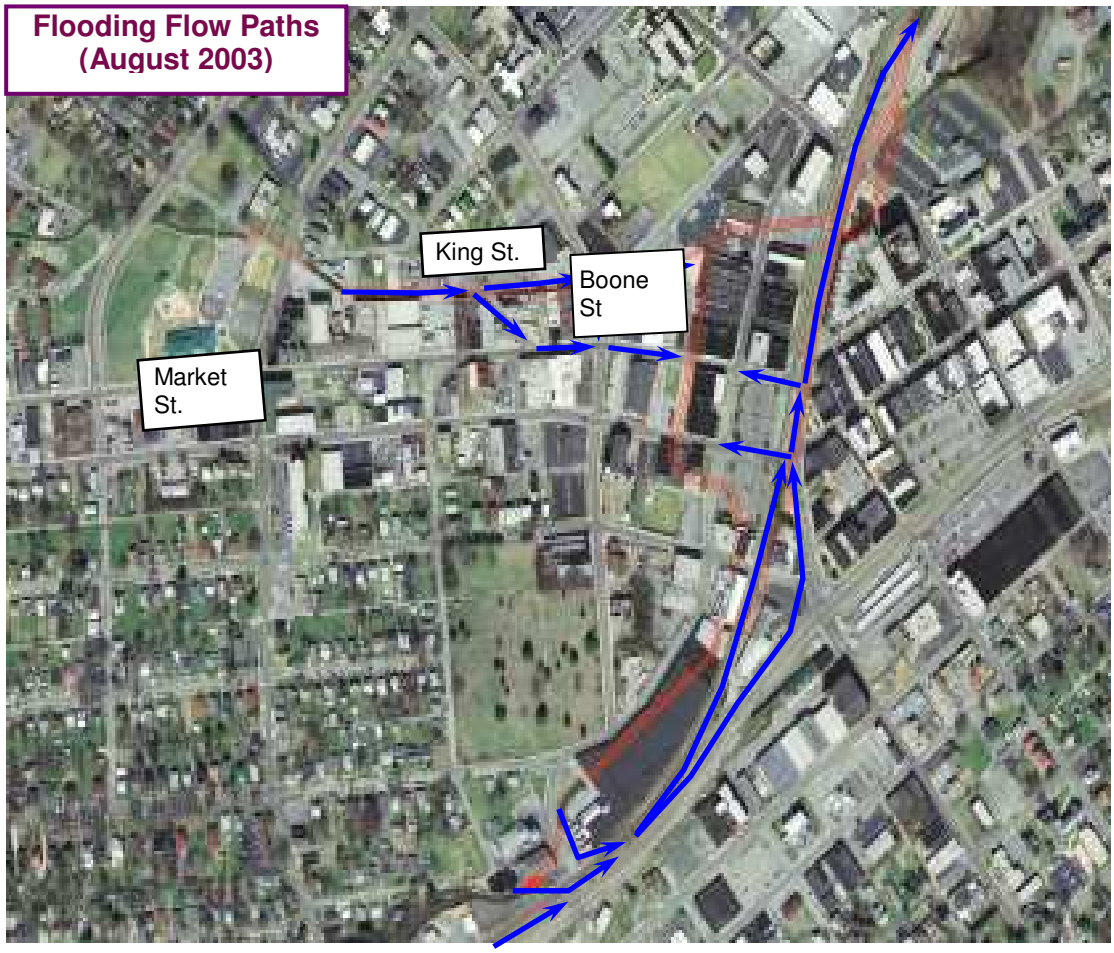

Figure 2: Flooding Flow Paths

A previous study (CDM, 2003) showed that a major project would be necessary to provide flood relief for the downtown during large storms. AMEC was tasked by Johnson City (the City) to determine whether the Public Works Concept (Figure 3) of a small local collection system in the Market and Boone Street area could help alleviate flooding for small storms. The Public Works Concept would take advantage of the currently unused Old Brush Creek Culvert to drain the downtown. Should this concept fail, AMEC was tasked to work with the City to choose and evaluate additional alternatives for alleviating flooding for small storms.

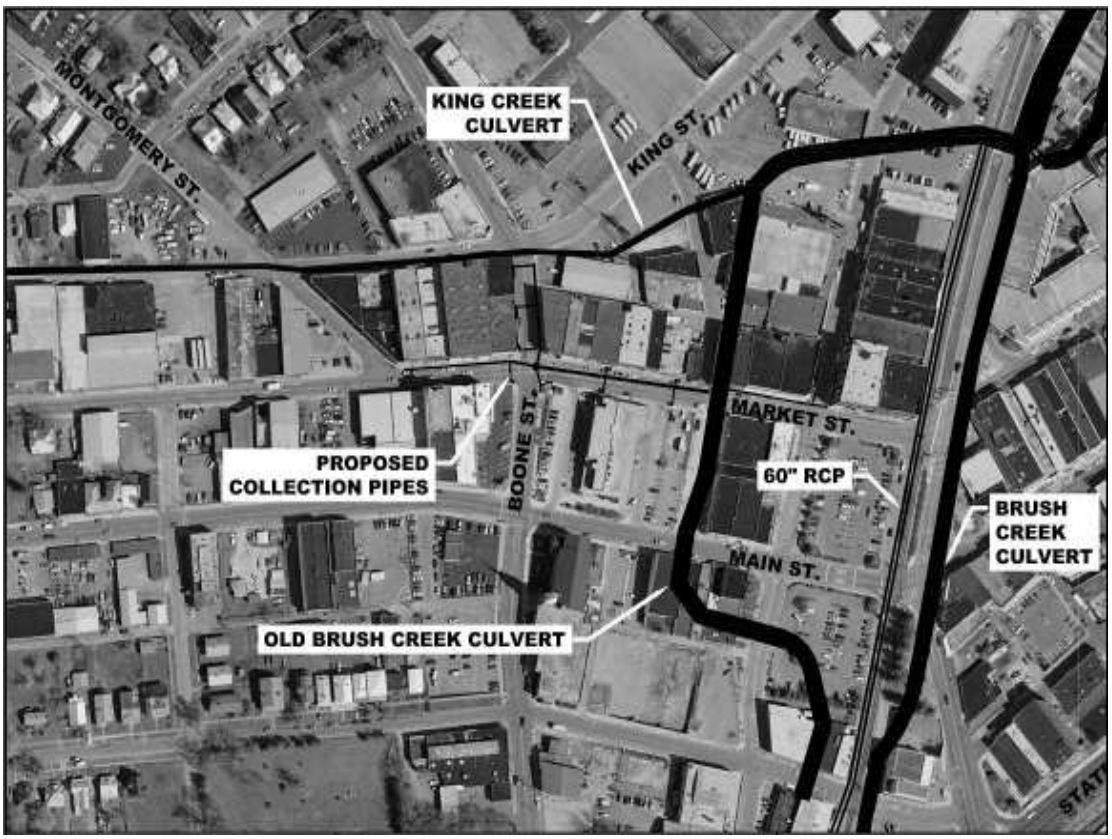

Figure 3: Public Works Concept

In order for the Public Works Concept to be successful, the Old Brush Creek Culvert that drains the new system would have to be:

- structurally sound
- able to dewater downtown fast enough to prevent flooding

AMEC's first task was to determine whether both conditions could be met; the results of these analyses follow.

2.0 Preliminary Structural Evaluation of the Old Brush Creek Culvert

AMEC's subcontractor, Hodge Engineering, performed an evaluation of the Old Brush Creek Culvert over several days in March 2008. The investigating engineers found that the oldest part of the Old Brush Creek culvert is failing severely, especially at the junction of the Old Brush and King Creek culverts. Severe undercutting at this location has caused one of the culvert walls to begin toppling. The effect of this can be seen underground and at the surface in Figure 4 below.

Figure 4: King Street/Brush Creek Culvert Junction Photos

Undercutting, footer failure, top slab failure, poor concrete condition and poor reinforcing steel condition were found in several places along the culvert. Culvert structural problems were also detected under several of the buildings on top of the Old Brush Creek culvert. We recommend that Johnson City work to remedy these problems. The Public Works Concept is not feasible due to the poor condition of the Old Brush Creek Culvert. The full structural evaluation report can be found in Appendix A.

3.0 Modelling Method

3.1 Model Updating

AMEC analyzed the downtown flooding problems from a hydraulic perspective concurrently with the structural evaluation. The first task was to update the existing hydrologic and hydraulic model of the watershed to the newest version (5.0.013) of the Storm Water Management Model (SWMM). The existing model was created by CDM and found to be suitable for this study. Please refer to the CDM report for information on the watershed and hydrologic modelling of the watershed. AMEC made no

substantial changes to the hydrologic components of the model or any of the hydraulic components outside the project area.

During model updating, minor edits were made to ensure compatibility with the new version of the software and to match flood peaks to the elevations reported by CDM as closely as possible. Rainfall distributions were obtained by applying the SCS type II rainfall distribution to the 24-hour rainfall totals provided by the City.

3.2 Survey

Ground survey was performed in the downtown area in order to provide the detailed inputs necessary to accurately model the overland flow and storage of water during storm events. AMEC's subcontractor Michael Brady Inc. (MBI) surveyed flow cross sections, culvert geometries and finished floor elevations for input to the SWMM models and flood damage analysis.

3.3 Model Refinement

Considerable detail was added to the as-is model in order to accurately depict the flow and storage of water in the downtown area. Several portions of King, Market, Main, McClure, Montgomery, Boone, and Commerce Streets act as overland flow channels for flow that has overtopped the King and Brush Creek culverts. These flowpaths were modelled as irregular channels using surveyed cross sections. Vertical channel walls were added at building locations, to ensure that no flow or storage is considered within the existing buildings.

The minor drainage system was modelled as pipes with orifice connections to the overflow system at street level. Where necessary, several adjacent inlets were modelled as a single inlet. An existing 60" RCP line paralleling State of Franklin Road was added to the model, due to its exclusion by the CDM model.

The Brush Creek channel downstream of the downtown was surveyed and modelled in detail in order to provide a more reliable tailwater condition.

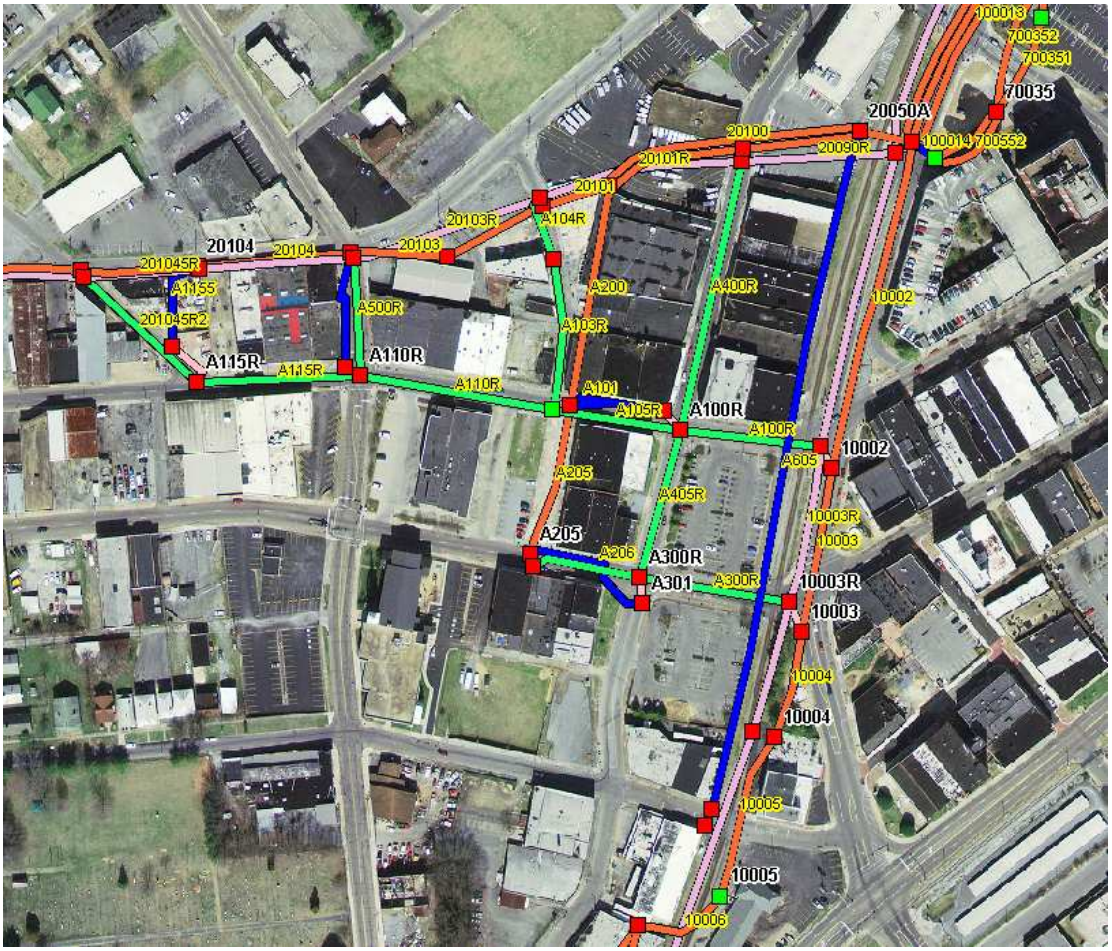

Figure 5: As-Is Model Refinement

Several storage nodes were used in the CDM model to simulate flood storage in the depression of downtown. AMEC's more detailed modelling of the downtown as a series of large channels made these storages unnecessary and they were removed. An example schematic of the model refinements is shown in Figure 5.

The flood elevations produced by the As-Is model, run with the rainfall distribution of the August 2003 storm, were compared with eyewitness accounts of flood elevations and found to be reasonably similar. This correspondence helped to validate the As-Is model and provide a sound basis for continuing on to the flood abatement models.

4.0 Public Works Concept Modelling and Results

The Public Works Concept Model was created from the As-Is model by adding new drainage pipes beneath Market and Boone Streets per the Public Works Concept drawing provided by the City. The new pipes were fed into the Old Brush Creek Culvert. Inlets draining the flooded area of downtown were modelled as orifices. A large number of high capacity inlets were modelled. These inlets would be necessary to efficiently capture the overland flow and transfer it into the new culverts. Please refer back to Figure 3 for the layout of the Public Works Concept.

The Public Works Concept model showed very little benefit to flood levels. This disappointing result was due to the backwater being applied to the Brush Creek culvert from the culverts and open channel downstream of it. The Old Brush Creek culvert has very little remaining flow capacity at storms as small as the 2-year storm due to the backwater filling it up. Installing the number of inlets necessary to capture the overflow from Brush and King Creeks would also be difficult.

A Revised Public Works Concept was also created in an attempt to direct overland flows into the Old Brush Creek Culvert more easily. A pond was modelled at the junction of the Old Brush and King Creek culverts as shown in Figure 6 below. This pond would serve as a sump to more efficiently capture the water flowing into downtown from the overtopping culverts.

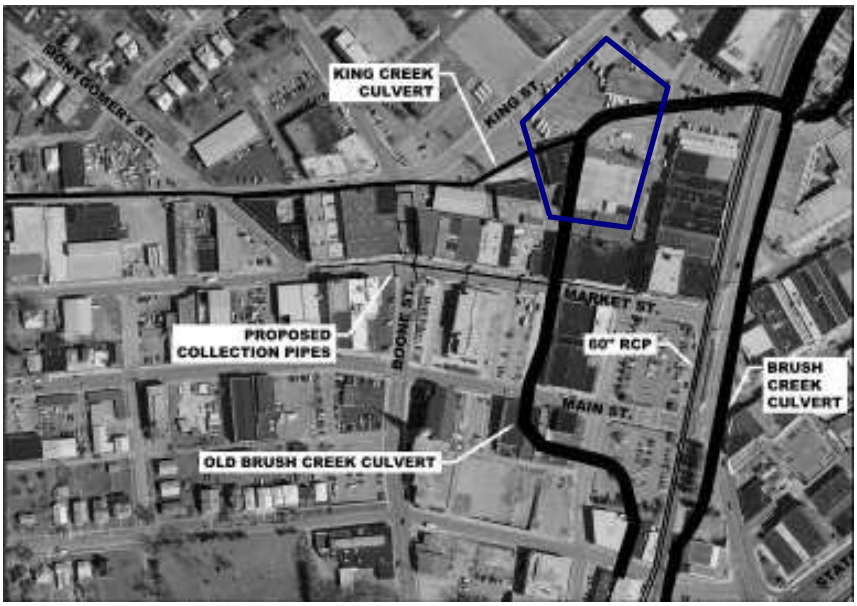

Figure 6: Revised Public Works Concept

The revised Public Works Concept model showed minor improvement in flood levels downtown due to the more efficient capture of overland flows. However, the backwater problem was not resolved and flooding in the downtown still resulted during small storms.

The failure of the Public Works Concepts led the City to request the modelling of several additional concepts, with the hope of finding one that could solve the downtown flooding problems for small storms at a reasonable cost. The additional concepts are shown, one to a page, in the next section.

5.0 Additional Concept Modelling and Results

5.1 Concept 1

The first additional concept modelled was a large (double 16'x6') bypass culvert for King Creek. This concept was selected to remedy the severe undersizing of the existing King Creek Culvert, which is overtopped at even a 2-year storm. The bypass culvert was meant to prevent overtopping of the King Creek Culvert, and to relieve some of the backwater effects being caused by the culvert system downstream of downtown. The concept was modelled by adding a bypass culvert conduit between the King Creek inlet and the outlet downstream of downtown.

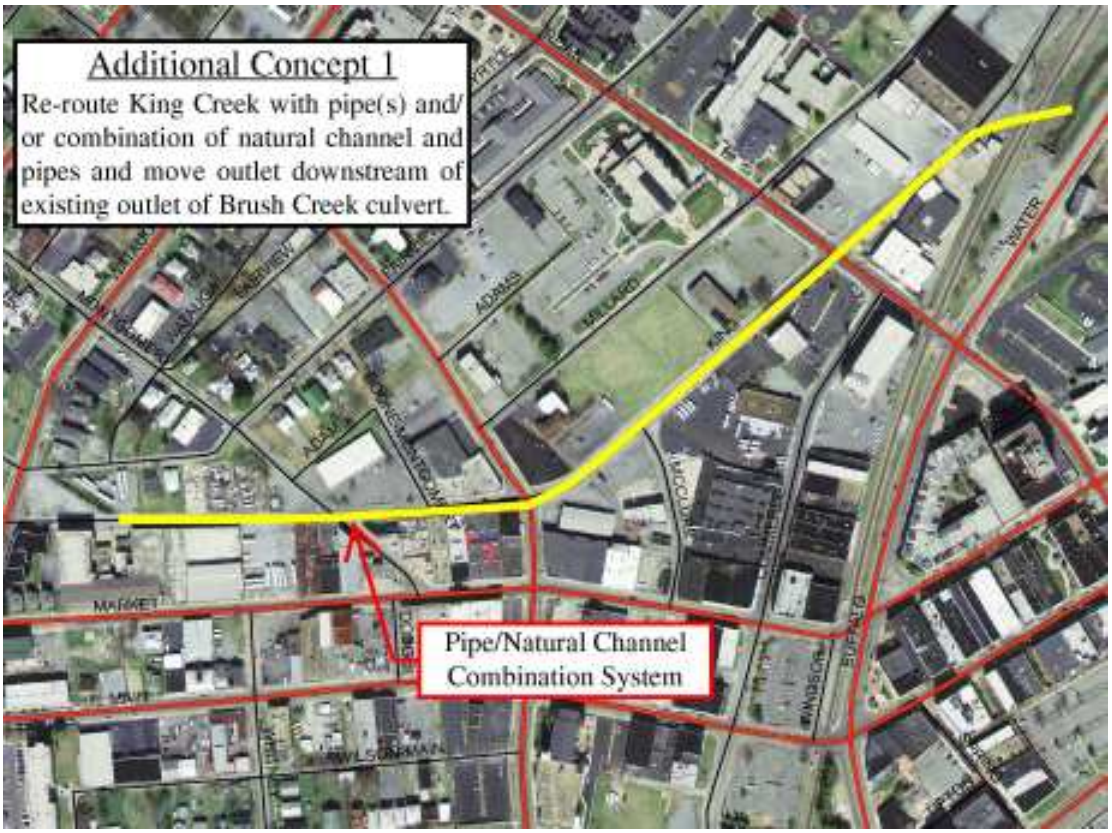

Figure 7: Additional Concept 1

The Concept 1 results showed that the bypass culvert would prevent the downtown from flooding during a 2-year storm by preventing the overflow of the King Creek Culvert. Flooding would still occur at larger storms due to the overflow of Brush Creek into State of Franklin Road and downtown.

5.2 Concept 2

The second additional concept revised the first by using an open channel rather than culvert for the bypass in two places. The sump at the U-Haul facility was also added to better capture overland flow in the downtown area. The sump was modelled as a storage node. Use of the natural channel would necessitate the closing of King Street in the natural channel area. The properties used as a sump would also have to be purchased.

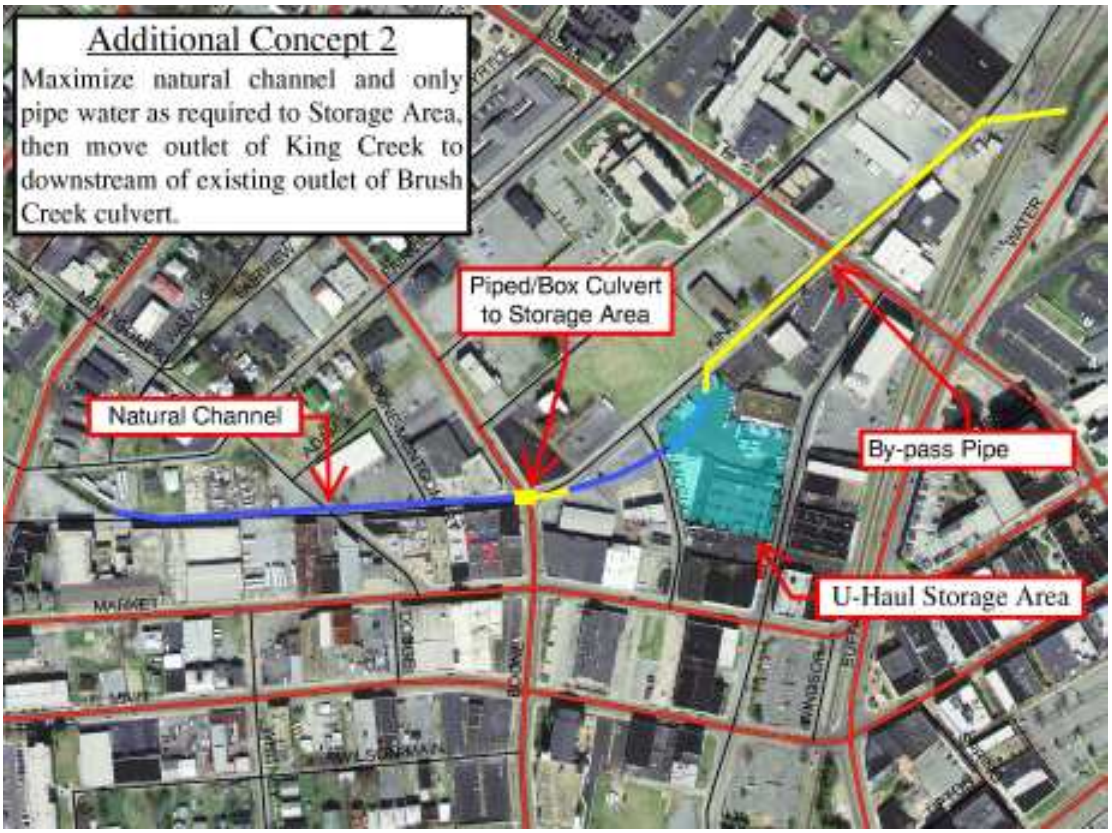

Figure 8: Additional Concept 2

The Concept 2 results showed an increase of flood protection to approximately the 5-year storm due to the increased storage and better capture of overland flow.

5.3 Concept 3

The third additional concept revised the second by addition of three storage areas upstream of the King Creek Culvert. The elevation-area relationships for the storage areas were generated through conceptual excavation plans for each storage area. Each storage area was created by converting a junction node to a storage node in the model. No dams were used in the concept, so that water levels would not be increased and therefore flood properties adjacent to the storage areas.

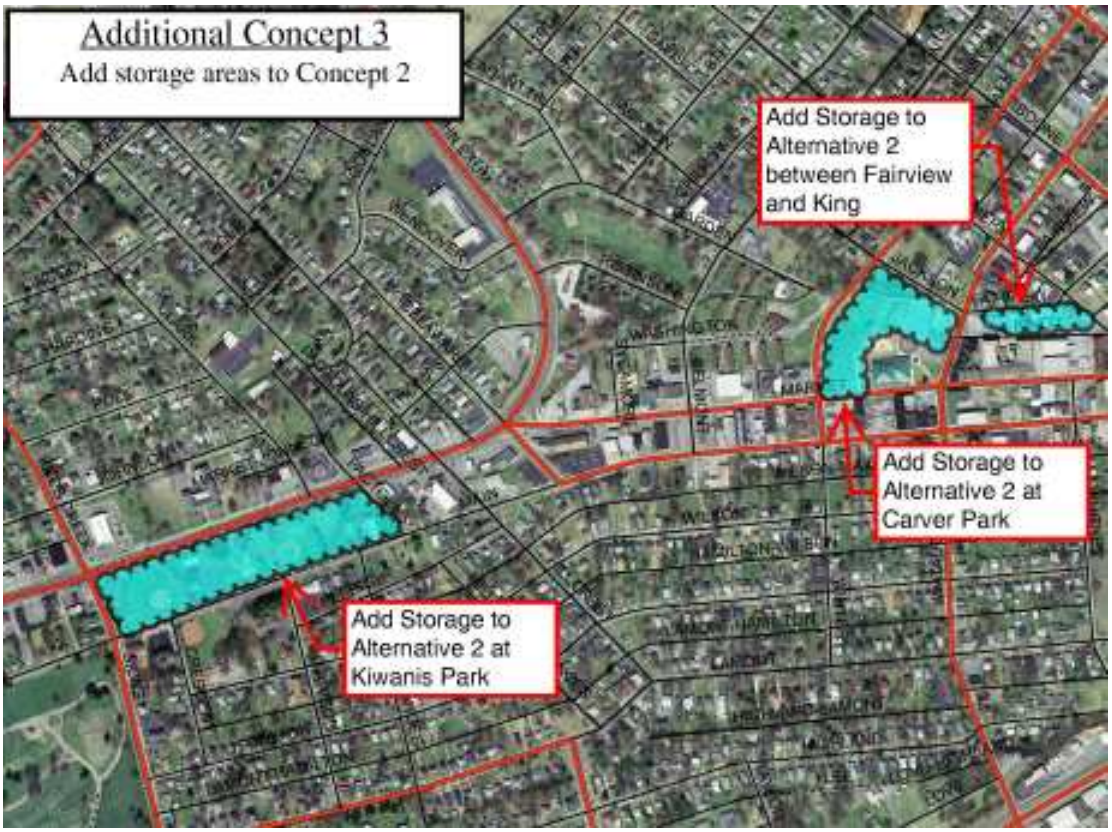

Figure 9: Additional Concept 3

The Concept 3 results showed negligible increase in flood protection due to the small size of the storage areas and lack of suitable topography at the selected locations.

5.4 Concept 4

The fourth additional concept maintained the use of the sump and lower portion of the King Creek bypass. Rather than adding a bypass or natural channel in the upper portion of King Street, however, Concept 4 modelled a new berm between King Street and Downtown. The berm would serve to keep flow in King Street from entering the downtown area, prior to its emptying into the sump. The berm was modelled by raising the street channel offsets at the junctions of King Street and the side streets that join it.

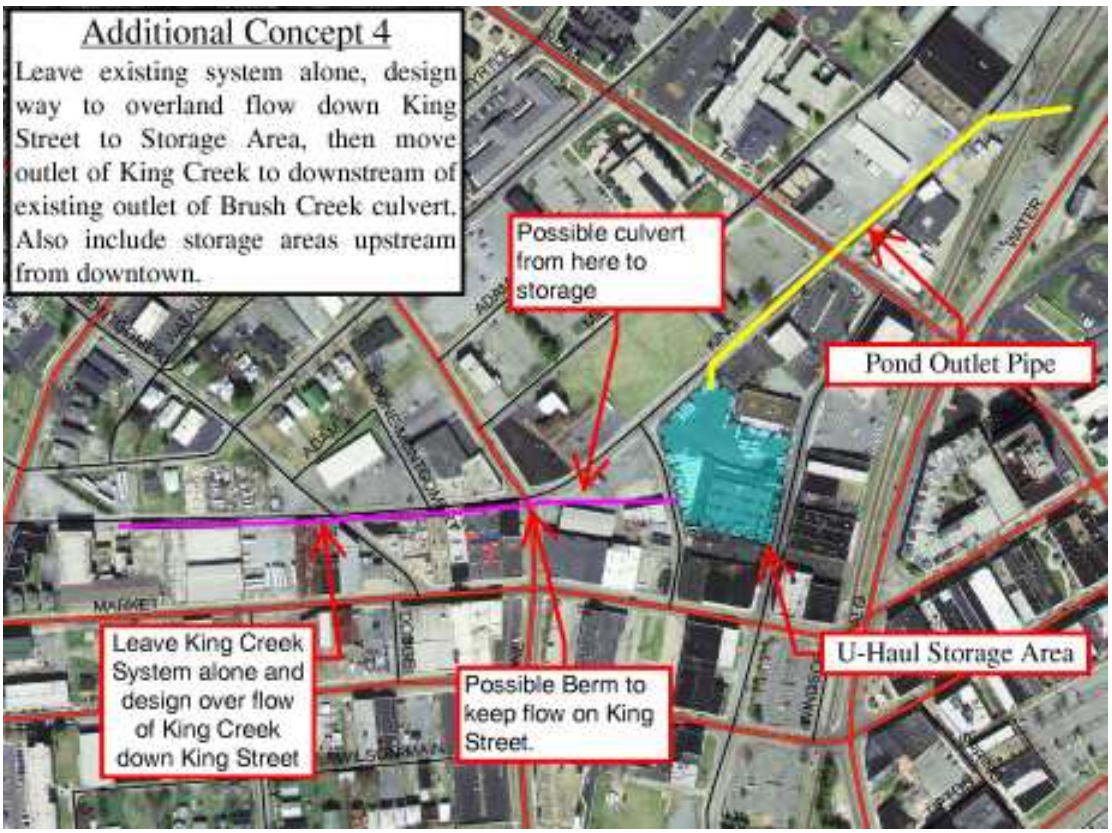

Figure 10: Additional Concept 4

The Concept 4 results showed benefits similar to Concept 2 in the lower downtown area. However, flow depths in King Street were increased significantly. Concept 4 is not advisable due to the dangers of flooding a street, and the possibility of stormwater and sewer backflow due to the high head that would be created between water in King Street and adjacent sewer and stormwater connections.

5.5 Concept 5

The fifth additional concept modelled separation of the three culvert barrels downstream of downtown to isolate the King and Brush Creek flows. This scenario was modelled by adding a new SWMM junction at the confluence of the culverts and separating the King Creek barrel to travel through it without connecting to the Brush Creek barrels.

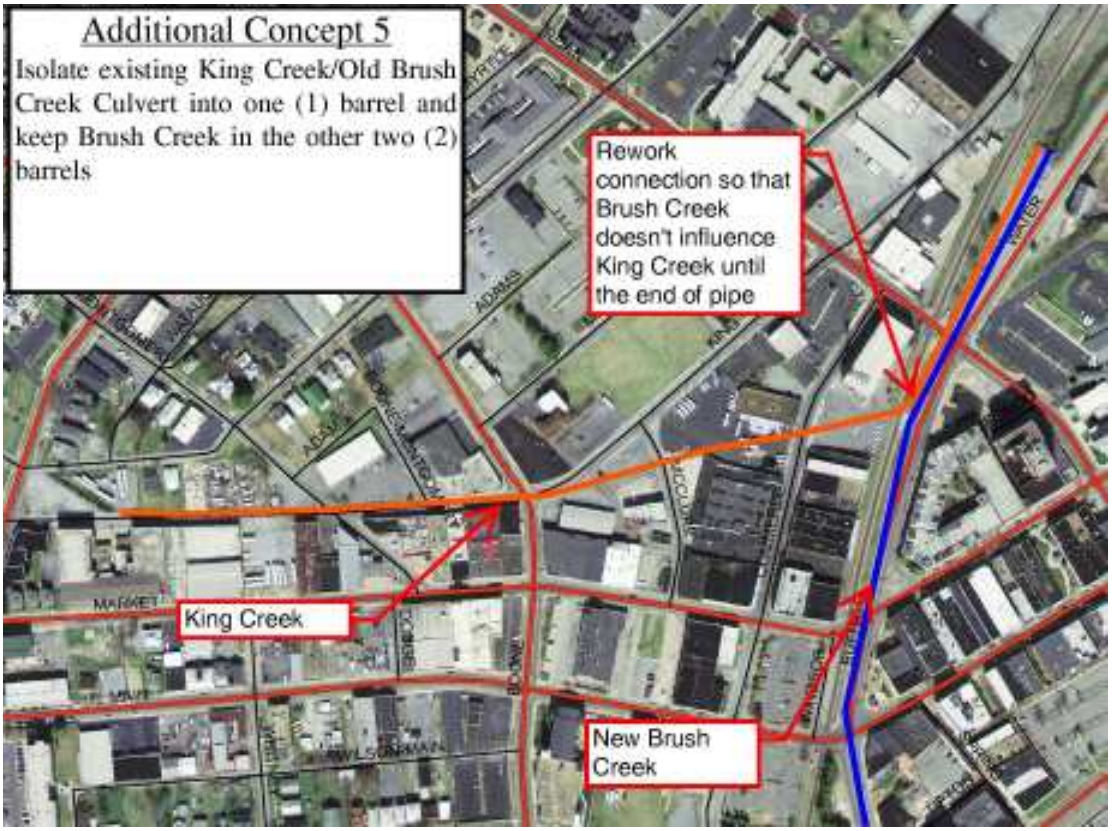

Figure 11: Additional Concept 5

The Concept 5 results showed no appreciable benefit to flooding conditions over the As-Is model.

6.0 Evaluation of Public Works and Additional Concepts

Review of the Public Works and Additional Concepts results made it clear that a small local drainage improvement project would not provide flood protection for even the 2-year storm. A larger bypass culvert or channel would be necessary to keep King Creek from overflowing and to relieve the high backwater at the bottom of downtown. Additionally, a sump at the lowest point of downtown would be necessary to capture overland flows and transfer them to the bypass if a culvert was chosen rather than an open channel.

The models also showed that while a King Creek bypass could be beneficial for the 2-year to 5-year storms, it would not serve for the 10-year and greater storms. Larger storms cause the Brush Creek and Watauga Avenue culverts to overtop and send flow down State of Franklin Road and into downtown. A flooding solution for storms greater than the 5-year would require the Brush Creek overflow to be addressed as well as the King Creek overflow.

The cost of constructing the King Creek bypass and downtown sump would be greater than the benefits to existing structures if only the 2-year and 5-year storms are addressed and the Brush Creek overflows ignored. Due to this prohibitive cost, the City requested AMEC to fashion a concept that would involve the total solution of the downtown drainage problem. This solution would need to have benefits other than flooding abatement in order to be financially desirable. The following section details the final concept that was created to solve the downtown flooding problem.

7.0 Redevelopment Concept

Any expensive drainage improvement project in the downtown would be financially undesirable because many of the buildings to be protected in the downtown are deteriorating and underused. This problem is difficult to solve because of the following circular cause-effect-cause relationship:

- Flooding occurs downtown
- Little investment and maintenance occurs downtown because the buildings flood frequently
- Flooding abatement projects are not done because project costs are greater than the benefits accrued to the deteriorated properties in the downtown
- Flooding occurs downtown…

The downtown area is unlikely to become a vital part of the community if something is not done to break this cycle. As shown in the previous sections, there is no inexpensive way to solve the flooding problem downtown. The only way to break the cycle is to simultaneously solve the flooding problem and encourage significant investment in the properties downtown, many of which are historic. Vibrant downtowns can serve as catalysts for economic growth in medium-sized cities such as Johnson City.

AMEC decided to feature newly restored creeks and a pond in a redevelopment concept that would solve the flooding problem and attract private investment to the downtown area. A large format plot of the redevelopment concept can be found in Appendix B. The stormwater conveyances would be open channels wherever possible. Several of the structures that lie directly over the Old Brush Creek Culvert would be removed. These structures currently have some of the worst flooding and structural issues in the area. All historically significant structures would be preserved. A schematic of the Redevelopment Concept stormwater system is shown in Figure 12.

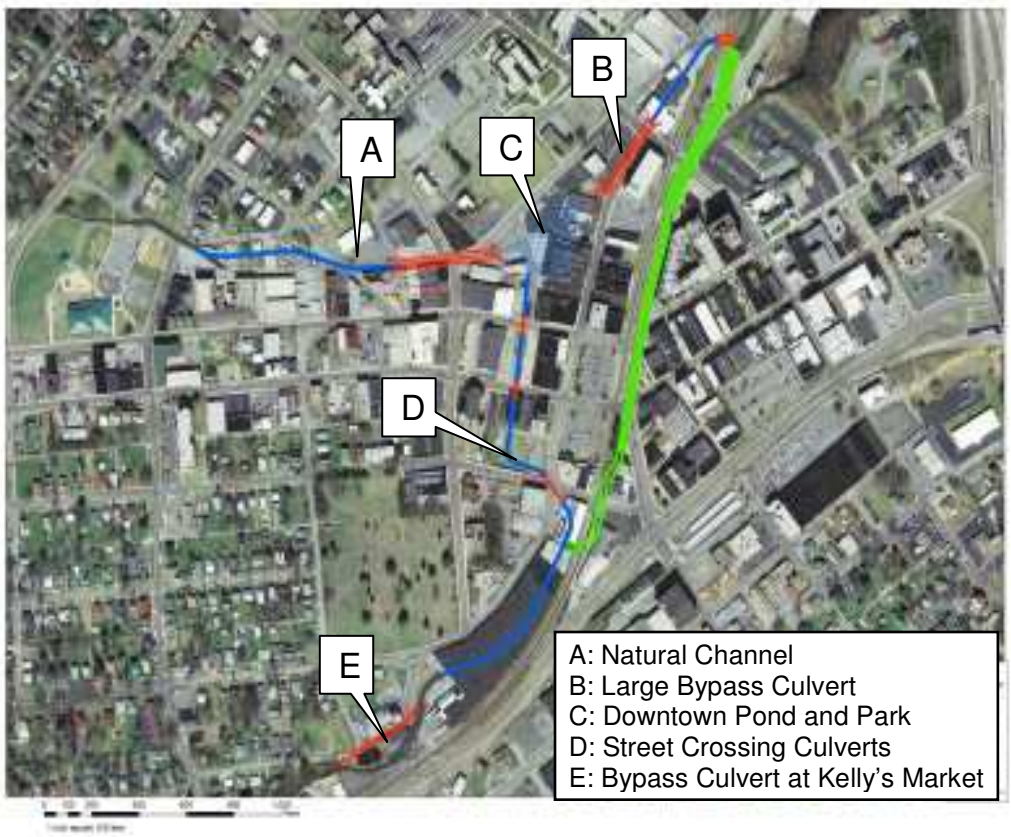

Figure 12: Redevelopment Concept Stormwater Conveyance

The redevelopment would create several unique spaces such as the outdoor environmental classroom, located where the old tobacco warehouse currently sits. There would be greenways along the restored stream channels and a park surrounding the pond. The park would be situated close to the beautiful new library, and could serve as a festival location. Please see Appendix C for additional graphics depicting how the redevelopment could look and what kind of activities could occur in the downtown after the redevelopment.

8.0 Downtown Redevelopment Concept Modelling

The Downtown Redevelopment Concept was broken into three phases so that the City could coordinate incremental investments in downtown infrastructure with corresponding property redevelopment by downtown landowners. The three phases are as follows:

- Phase I: King Street bypass and U-Haul pond
- Phase II: Restoration of Brush Creek to a natural channel and culvert capacity upgrades at Watauga Ave. and Kelly's Market
- Phase III: Installation of Brush Creek regional detention ponds

Phase I: The Downtown Redevelopment Concept model was created by altering the As-Is model through the addition of the King Creek bypass and U-Haul sump, similar to the previously described Concept 2. Open channel was utilized in the model as much as possible, while culverts were employed where loss of usable space and buildings would be unacceptable.

Phase II: Additional culvert capacity was modelled in the Brush Creek floodplain at Watauga Avenue and at Kelly's Market. This additional culvert capacity serves to keep Brush Creek from overtopping the culverts and entering State of Franklin Road during small storms. Brush Creek was modelled as a restored open channel from Sevier Street to the U-Haul pond. Box culverts were modelled where downtown streets crossed Brush Creek.

Phase III: Three large regional detention ponds were modelled in the Brush Creek watershed to reduce flows for the 50- and 100-year storms. This flow reduction ensures that Brush Creek does not overtop culverts and enter State of Franklin Road in the downtown area. All three ponds will remain dry under baseflow and small storm conditions. The regional detention pond locations are displayed in Figure 13.

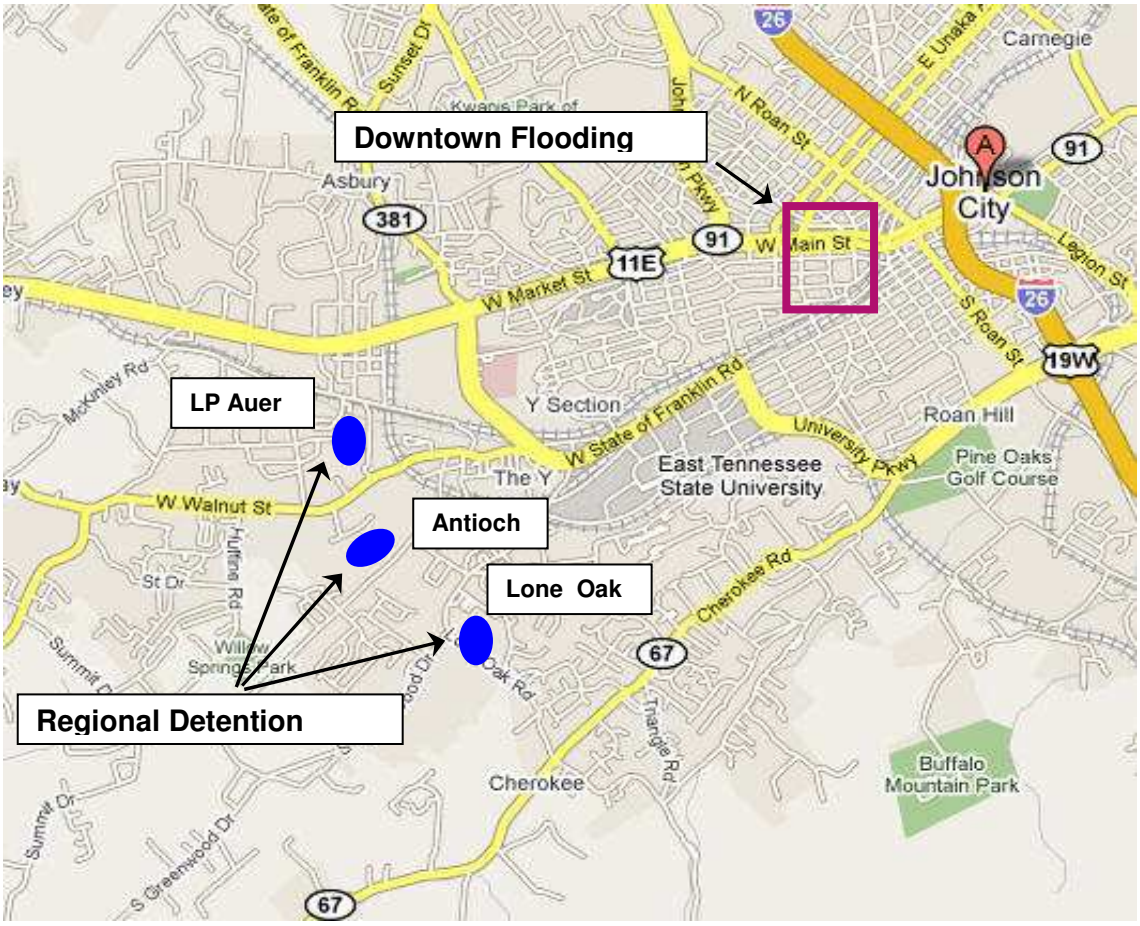

Figure 13: Regional Detention Pond Locations

9.0 Downtown Redevelopment Concept Results

The Phase I, Phase II and Phase III models were run for the 2, 5, 10, 25, 50 and 100 year storms. The model results showed increasing flooding protection with each phase of the downtown redevelopment project. The results can be summarized as follows:

- Phase I: protection to approximately the 5-year storm
- Phase II: protection to approximately the 25-year storm
- Phase III: protection to approximately the 50- to 100-year storm

A structure flooding analysis was then performed using results from the stormwater models. The flooding depth for each structure was found by subtracting the finished floor elevation for each structure from the peak stormwater depth at the most applicable (usually nearest) junction in the stormwater model. Finished floor elevations for the downtown area were taken from surveys done by AMEC's subcontractor, Michael Brady, Inc. Finished floor elevations for the structures East of State of Franklin Road were estimated based on City topographical maps. Buildings with multiple tenants had finished floor elevations surveyed for each tenant.

The structure flooding analysis was performed for each structure, at each storm, for each phase of the project. Structure removal during the project was accounted for. Flooding of parking lots, parks, empty parcels and other open areas was not considered. Figure 14 and Figure 15 demonstrate the results of the structure flooding analysis for the 50-year storm; parcels with flooded structures are shown red, while parcels without flooded structures are shown blue. The structure flooding calculations are included in an Excel spreadsheet on the accompanying compact disc.

Figure 14: As-Is Structures Flooded for 50-year storm

Figure 15: Redevelopment Concept Phase III Structures Flooded for 50-year storm

10.0 Downtown Redevelopment Concept Costs and Benefits

Conceptual cost estimates were prepared for each phase of the Redevelopment Concept using RS Means 2008 cost data. The costs included property acquisition, demolition, design, surveying, permitting, geotechnical consulting, construction, and a contingency. The overall costs are summarized below:

- Phase I: $11 million
- Phase II: $10 million
- Phase III: $5 million

The conceptual cost estimates can be found in Appendix D.

Flood abatement is the main benefit of the Downtown Redevelopment Project. The financial benefit of flood abatement was calculated using the FEMA limited data methodology. Flood depths for each structure were used to determine flood damages as a percentage of structure values using depth-damage functions. This process was performed for each structure, at each storm, for each phase of the Redevelopment Project. The Corps of Engineers depth-damage functions for commercial buildings were chosen over the FEMA function due to the commercial nature of the downtown (US Army Corps, 2006). The selected functions are shown in Figure 16 and Figure 17 below.

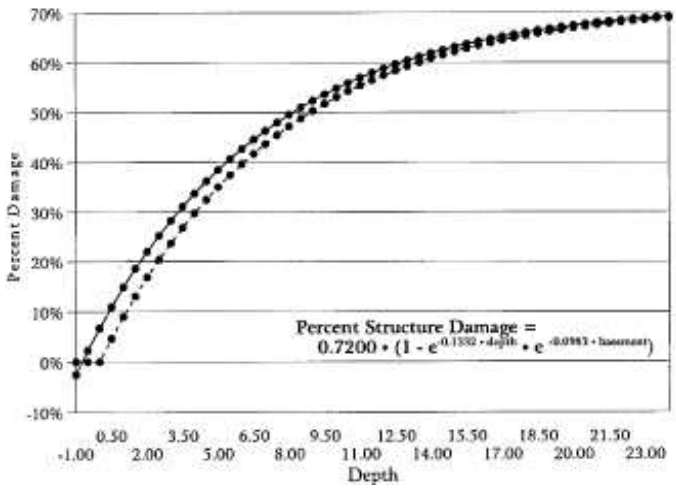

Figure 16: Structure Depth-Damage Function

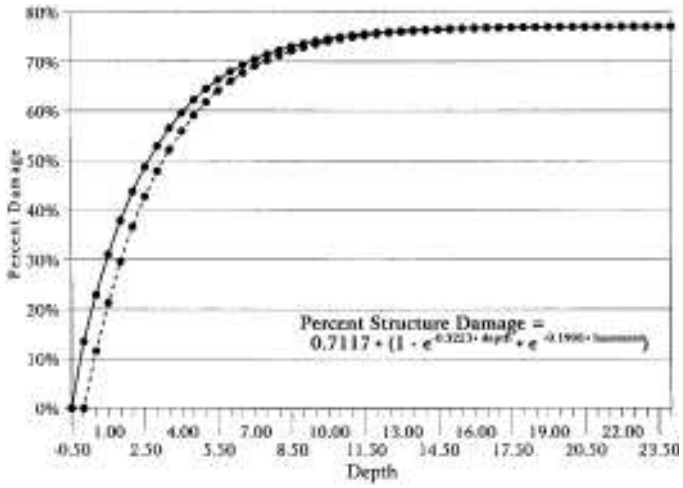

Figure 17: Contents Depth-Damage Function

The resulting damage percentages were then multiplied by the structure values to arrive at damage costs. Structure values were taken from appraised values provided by the City. Structure values for future phases were computed by adjusting property values to $75/SF for areas that were assumed to redevelop at each phase. Damage costs can be found in the structure flooding spreadsheet on the accompanying compact disc.

The overall flood mitigation benefits and project costs were then used in a FEMA limited data cost-benefit analysis for each phase (FEMA, 2005). Each phase used the damage results from the previous phase as its initial condition. The analysis showed the Phase I benefits to roughly balance costs. Phases II and III showed less benefit than cost. Phase I has much more effect on the cost-benefit analysis because it is the portion of the project that relieves flooding for the smaller storms that occur more often. A flood damage cost that occurs once every five years has much more impact that one that occurs once every one hundred years. The results of the cost-benefit analysis can be found in Appendix E.

Finally, the impact of redevelopment on City tax revenues was analyzed using the assumed increase in property values. Tax revenues were found to increase from $110,000 to $785,000 per year for the downtown area. This increased tax revenue could be used to pay for a portion of the Redevelopment Project using tax increment financing. However, a significant portion of the funding will have to come from elsewhere. The tax base analysis can also be found in the structure flooding spreadsheet on the accompanying compact disc.

11.0 Conclusions and Future Actions

The downtown drainage study found that the longstanding flooding problems in the downtown area are caused by backwater effects from constriction below the downtown and overtopping of the undersized King Creek and Brush Creek culverts. The structural condition of the Old Brush Creek culvert is very poor and it should be repaired or demolished. Solution of the flooding problem will require the addition of a large bypass, restoration of natural channels and creation of regional detention ponds. No small scale and inexpensive solution to flooding is possible due to the backwater effects and volume of flow overtopping the existing culverts.

The City must decide whether to invest a significant sum of money to solve the downtown drainage problems and redevelop the downtown into a place that the citizens will be proud to use. The redevelopment concept presented in this report is one alternative for the City to consider. Another alternative would be for the City to simply let the downtown flood and continue to deteriorate; this option may carry liability for the buildings that lie over the deteriorating culverts. A third option would be for the

City to simply purchase all of the structures that flood downtown and turn the area into a park and natural floodplain.

The choice of alternatives will be affected by the public will to fund the redevelopment project and the willingness of landowners to invest money in restoring their historic structures. As of this writing, the City has engaged a consulting firm to evaluate the redevelopment potential of the downtown. The results of this analysis will help the City to make an informed decision on how to proceed with solving the downtown flooding problem. The conceptual models created during this study can serve as the starting point for the design of any detailed design for flood abatement; they are found on the accompanying compact disc.

12.0 References

Camp, Dresser & McKee. Downtown Drainage Study: City of Johnson City, Tennessee. 2003.

Federal Emergency Management Agency. Benefit-Cost Analysis of Hazard Mitigation Projects: Volume 2 Riverine. 2005.

US Army Corps of Engineers. Analysis of Nonresidential Content Value and Depth-Damage Data for Flood Damage Reduction Studies. 1996.

Appendix A: Preliminary Structural Evaluation Report

PRELIMINARY STRUCTURAL OPINION

OLD BRUSH CREEK CULVERT

City of Johnson City

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PRELIMINARY STRUCTURAL OPINION

OLD BRUSH CREEK CULVERT

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Appendix A – Drawing & Notes

Appendix B – Photographs

1. PURPOSE OF REPORT

The purpose of this report is to determine if a full structural evaluation of the Old Brush Creek Culvert is warranted.

This report has been prepared for AMEC as part of their contract with the City of Johnson City for the Downtown Drainage Improvement Project.

2. METHOD

A preliminary walkdown of the Old Brush Creek Culvert was performed on March 13 and 17, 2008. The physical condition of the interior of the culvert was observed and documented with photographs. The majority of the time was spent inside the culvert with limited observation of the exterior. Access was made thru the new Brush Creek Culvert and thru a failed roof section located between W. Market Street and W. Main Street. The investigation team also observed the failed section of the King Street Culvert.

3. FINDINGS

Major elements of the Culvert investigation include:

1. Two distinct sections of the culvert noted as ‘Old Section’ and ‘New Section’.
2. No bottom slab in the culvert.
3. Many post construction invasions for utility lines, street drainage, and roof drains.
4. Several buildings have been constructed over the culvert.
5. King Street Culvert failure.

1. The ‘Old Section’ appears to have been constructed as two gravity retaining walls at the edge of Brush Creek to provide channelization. The center wall and roof slab was added at a later date to provide floors for buildings. Different designs were used for the roof section at various locations. The street crossings

were also built as separate design sections from the culvert although they may have been installed at the same time.

There has been one slab failure between W. Main Street and W. Market Street. The remainder of this slab will continue to fail if live loads and/or dead loads are imposed on it. The slab is thin and was built as a building floor slab. The underside of the slab has exposed reinforcing steel. The structural beams located at 14 foot centers are in very poor condition. The bottom steel is exposed, some beams are bowed, and one has completely failed.

A second failure has occurred under the building face fronting Lamont Street. This area has a failed center wall, failed footers and one outside wall failure. The settlement is severe enough that water is flowing in the reverse direction in the west barrel. A sewer line in the culvert has deflected and is leaking. There appears to be minimal storm water influent in this section of the culvert and continuing failure should be slow.

The 'New Section' appears to have been built at one time as a double barreled culvert. The railroad section is a separate structure. The west barrel has one foot of accumulated silt and debris. The walls are very thick, one measurement was 24 inches. Concrete cover over reinforcing steel is generally good. There are two areas of structural compromise; the intersection of the King Street Culvert and the wall abutting the railroad culvert.

2. The entire culvert was probably built to span the existing Brush Creek. The bottom of the culvert is the creek bed in most locations, although some channelization may have occurred in the original construction. There are several exposed rock outcroppings. The entire length shows intrusion of ground water flows into the culvert. The installation of footers at the edge of the stream flow without a bottom slab has allowed for undercutting of the footers throughout the length of the culvert. In most cases this is a minor structural problem.

3. Over the many years that this culvert has been in place many utility lines have been installed thru the culvert. Water lines, sewer lines, cable conduit, and abandoned small diameter lines of unknown use are present. Several storm drain pipes have been added and some roof drains have been cut into the top slab or walls. There was a wide variety of methods used to cut thru the concrete with several instances of minor to significant damage caused by the intrusions. Where sewer lines are near the culvert invert there has been water scour induced as the flow goes over the pipe.

4. The 'Old Section' of the culvert has buildings using the outside walls as structural footers for the building walls and as support for flooring. The 'New Section' appears to have buildings spanning over the culvert but not incorporating the culvert structurally.

5. The King Street Culvert has completely failed at the intersection with the Brush Creek Culvert. The North wall is under cut up to 4 feet and has overturned. The south wall is also undercut. Turbulence caused by the intersecting flows of the two culverts is probably the major cause, however, a sewer line just upstream of the failure is acting as a weir dam in the King Street Culvert and induces continuous water scour.

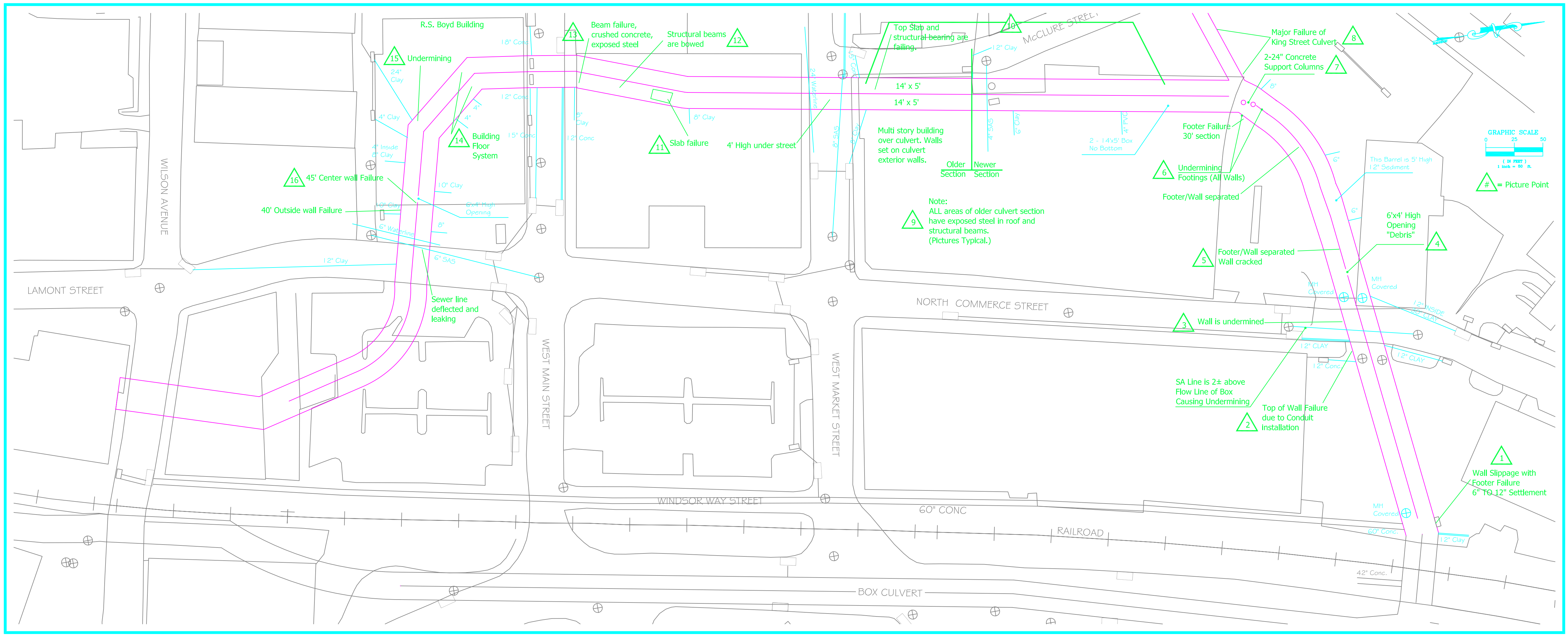
4. OPINIONS

The opinions of the author are two fold as related to the 'Old Section' and 'New Section'. The 'Old Section' of the culvert has started to fail and no amount of rehabilitation will correct its flaws and damage. The City should be made aware of the failure under the existing building and monitor the situation to minimize the possibility of injury to people.

The 'New Section' is sound enough to warrant further analysis and measurement for rehabilitation efforts. The most extensive work will be in the area of the King Street Culvert intersection.

APPENDIX A

DRAWINGS & NOTES


R.S. Boyd Building
Undermining
Beam failure, crushed concrete, exposed steel
Structural beams are bowed
Top Slab and structural bearing are failing.
McCLURE STREET
Major Failure of King Street Culvert
2-24" Concrete Support Columns
14' x 5'
14' x 5'
Building Floor System
Slab failure
4' High under street
Multi story building over culvert. Walls set on culvert exterior walls.
Older Section
Newer Section
2 - 14'x5' Box No Bottom
Footer Failure 30' section
Undermining Footings (All Walls)
Footer/Wall separated
GRAPHIC SCALE
0 25 50
(IN FEET)
1 inch = 50 ft.
= Picture Point
45' Center wall Failure
40' Outside wall Failure
Note:
ALL areas of older culvert section have exposed steel in roof and structural beams.
(Pictures Typical.)
This Barrel is 5' High
12" Sediment
6'x4' High Opening "Debris"
Footer/Wall separated
Wall cracked
WILSON AVENUE
LAMONT STREET
Sewer line deflected and leaking
NORTH COMMERCE STREET
Wall is undermined
MH Covered
SA Line is 2± above Flow Line of Box Causing Undermining
Top of Wall Failure due to Conduit Installation
WEST MAIN STREET
WEST MARKET STREET
WINDSOR WAY STREET
60" CONC
RAILROAD
Wall Slippage with Footer Failure 6" TO 12" Settlement
BOX CULVERT
42" Conc.

APPENDIX B

PHOTOGRAPHS

Johnson City Drainage - Picture Point 1

Cam 1-016.jpg

Cam 1-017.jpg

Cam 1-018.jpg

Cam 1-019.jpg

Cam 1-020.jpg

Cam 1-021.jpg

Johnson City Drainage - Picture Point 1

Cam 1-022.jpg

Johnson City Drainage - Picture Point 2

Cam 4-019.jpg

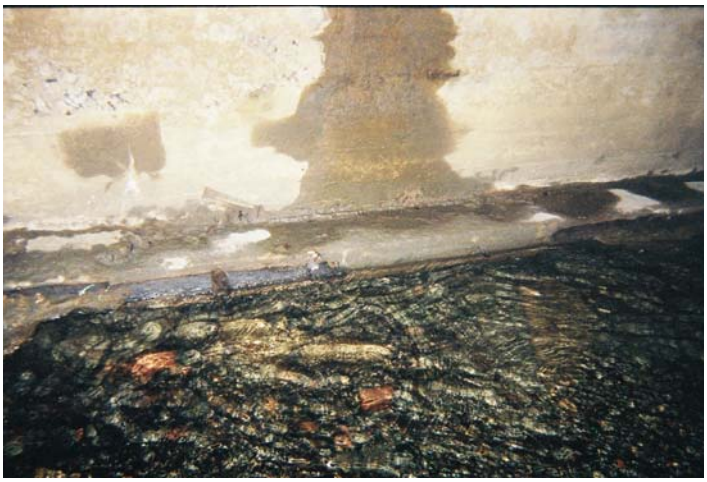
Cam 4-020.jpg

Cam 4-021.jpg

Cam 4-022.jpg

Johnson City Drainage - Picture Point 3

Cam 4-015.jpg



Johnson City Drainage - Picture Point 4

Cam 1-023.jpg

Cam 1-024.jpg

Cam 1-025.jpg

Cam 1-026.jpg

Johnson City Drainage - Picture Point 5

Cam 1-012.jpg

Cam 1-013.jpg

Cam 1-014.jpg

Johnson City Drainage - Picture Point 6

Cam 4-010.jpg

Cam 4-011.jpg

Cam 4-012.jpg

Cam 4-013.jpg

Cam 4-014.jpg

Cam 4-016.jpg

Johnson City Drainage - Picture Point 6

Cam 4-017.jpg

Johnson City Drainage - Picture Point 7

Cam 1-003.jpg

Cam 1-009.jpg

Cam 1-010.jpg

Cam 1-011.jpg

Johnson City Drainage - Picture Point 8

Cam 1-004.jpg

Cam 1-005.jpg

Cam 1-006.jpg

Cam 1-007.jpg

Cam 1-008.jpg

Cam 4-006.jpg

Johnson City Drainage - Picture Point 8

Cam 4-007.jpg

IMG_1719.JPG

IMG_1720.JPG

IMG_1722.JPG

IMG_1724.JPG

Johnson City Drainage - Picture Point 9

Cam 2-007.jpg

Cam 2-008.jpg

Cam 2-009.jpg

Cam 2-011.jpg

Cam 2-012.jpg

Cam 3-022.jpg

Johnson City Drainage - Picture Point 9

Cam 3-023.jpg

Cam 3-024.jpg

Cam 3-025.jpg

Cam 3-026.jpg

Cam 3-027.jpg

Cam 4-024.jpg

Johnson City Drainage - Picture Point 9

Cam 4-026.jpg

Cam 4-027.jpg

Johnson City Drainage - Picture Point 10

Cam 2-006.jpg

Cam 2-013.jpg

Cam 2-014.jpg

Cam 2-015.jpg

Cam 2-016.jpg

Cam 2-017.jpg

Johnson City Drainage - Picture Point 10

Cam 2-018.jpg

Cam 2-019.jpg

Cam 2-020.jpg

Cam 2-021.jpg

Johnson City Drainage - Picture Point 11

Johnson City Drainage - Picture Point 12

Cam 2-004.jpg

Cam 2-005.jpg

Johnson City Drainage - Picture Point 13

Cam 2-001.jpg

Cam 2-002.jpg

Cam 2-003.jpg

Johnson City Drainage - Picture Point 14

Cam 2-022.jpg

Cam 2-023.jpg

Cam 2-024.jpg

Cam 2-025.jpg

Cam 2-026.jpg

Cam 2-027.jpg

Johnson City Drainage - Picture Point 14

Cam 3-001.jpg

Cam 3-002.jpg

Cam 3-015.jpg

Cam 3-016.jpg

Cam 3-017.jpg

Cam 3-018.jpg

Johnson City Drainage - Picture Point 14

Cam 3-019.jpg

Cam 3-020.jpg

Cam 3-021.jpg

Johnson City Drainage - Picture Point 15

Cam 3-003.jpg

Cam 3-004.jpg

Johnson City Drainage - Picture Point 16

Cam 3-010.jpg

Cam 3-011.jpg

Cam 3-012.jpg

Cam 3-013.jpg

Cam 3-014.jpg

Appendix B: Redevelopment Concept

JOHNSON CITY DOWNTOWN REDEVELOPMENT PLAN

Johnson City, Tennessee

July 2008

Appendix C: Redevelopment Concept Graphics

Conceptual Downtown Redevelopment Plan

Johnson Architecture

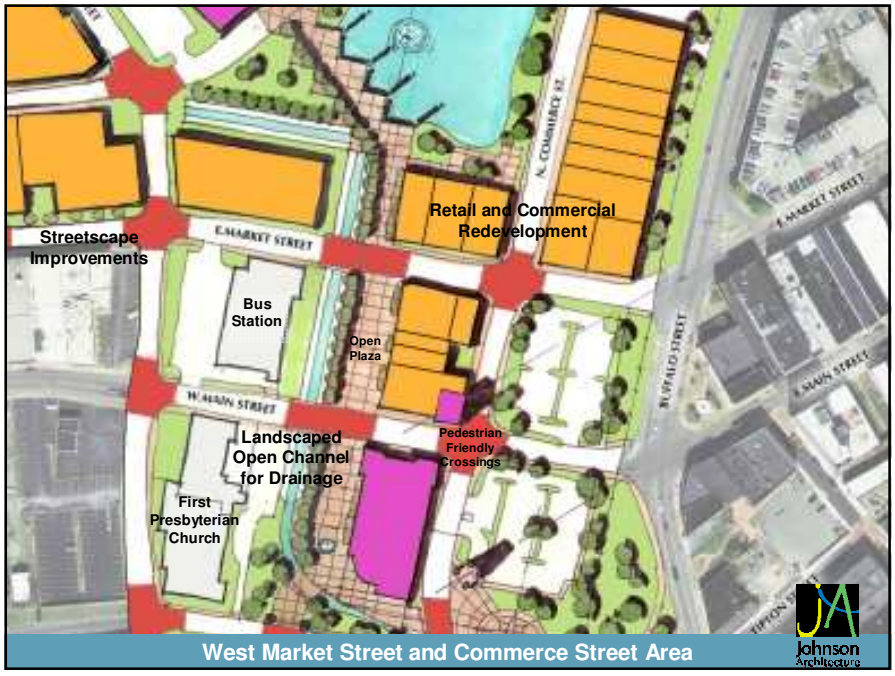
Goals of Redevelopment:

- Re-establish the downtown district as the city center
- Acknowledge the intrinsic value of a historic downtown
- Highlight “unique spaces”
- Provide range of uses and activities
- Combine new retail and residential opportunities
- Incorporate storm drainage systems into plan

King Street Area Plan
Johnson Architecture
Public Library
Open Lawn
Playground
Public Plaza
Embarq
Future Development
Pond

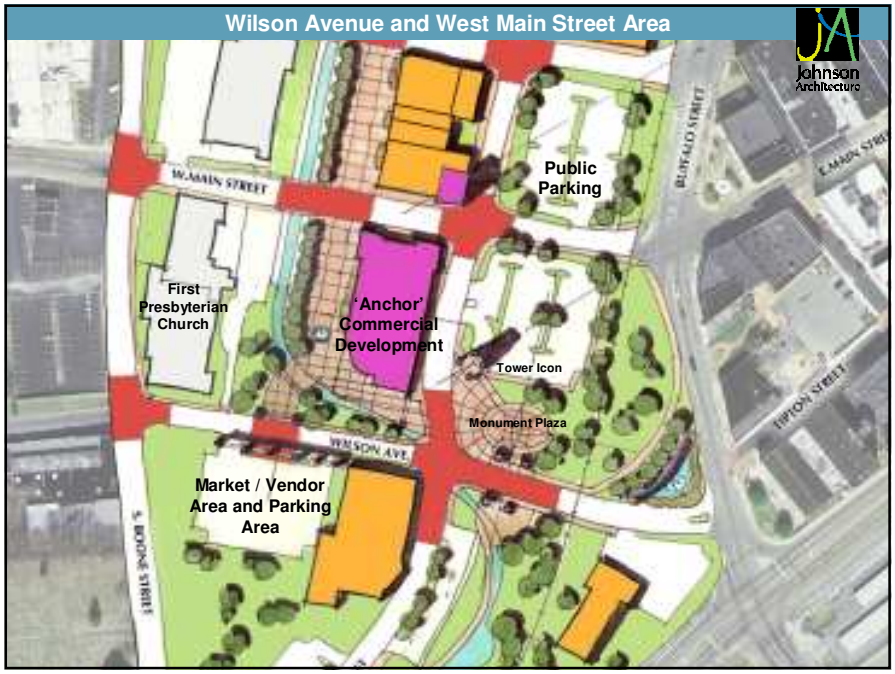
Chattanooga, Tennessee
Houston, Texas
Knoxville, Tennessee

Conceptual View – King Street Area
Johnson
Architecture


Streetscape Improvements
E MARKET STREET
Retail and Commercial Redevelopment
N. COMMERCE ST
Bus Station
Open Plaza
W MAIN STREET
Landscaped Open Channel for Drainage
Pedestrian Friendly Crossings
First Presbyterian Church
BUFFALO STREET
E MARKET STREET
E MAIN STREET
West Market Street and Commerce Street Area
Johnson
Architecture

Philadelphia, Pennsylvania
Bethesda, Maryland
Harvard Square
W. MAIN STREET
N. COMMERCE ST.
N. PAUL STREET
E. MAIN STREET
WILSON AVE

Conceptual View - West Market Street and Commerce Street Area
Johnson Architecture
46


Wilson Avenue and West Main Street Area
Johnson Architecture
W. MAIN STREET
Public Parking
BUFFALO STREET
E. MAIN STREET
First Presbyterian Church
'Anchor' Commercial Development
Tower Icon
Monument Plaza
TIPTON STREET
WILSON AVE.
Market / Vendor Area and Parking Area
S. BOONE STREET

Bethesda, Maryland
Charleston, South Carolina
Quincy Market
Boston, Massachusetts
E. MAIN STREET
TIPTON STREET
WILSON AVE.
S. BOONE STREET

Conceptual View – Wilson Avenue and West Main Street Area

South Commerce Street Area

Maryville-Alcoa Greenway,
Maryville, Tennessee

Johnson
Architecture
Proposed Redevelopment Plan
amec

Appendix D: Cost Estimates

Phase I: U-Haul Pond

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
13333	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$41,900
521500	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$130,400
45400	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$212,500
5215	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$234,700
1200	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$2,000
1000	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$12,500
1300	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$20,600
4	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$800
28100		Earthwork			$ 6.00	$168,600
28100	023154900330	Hauling, 1 mi trip, 12 CY truck	CY	$ 3.91	$ 5.00	$140,500
1		Riser Structure	Ea.		$ 20,000.00	$20,000
45	022405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$33,800
8889	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$11,500
1000	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$900
600	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$9,800
5	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$1,200
2	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$2,400
600	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$4,000
600	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$1,600
4	026304001120	Storm Drainage Manholes, Frames, and Covers, concrete, precast, 4' I.D., 6' deep, excludes base, excavation, backfill, frame and cover	Ea.	$ 1,202.75	$ 1,202.75	$4,800
80	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$25,500
					Construction	**$1,080,000**

126 W. Market (1/2)	$113,000
111 McClure	$28,400
119 McClure	$53,900
125 W. King	$23,200
128 Commerce	$104,500
114 W. King	$235,200
110 Commerce	$117,300
116 McClure	$15,500
Property Acquisition	**$691,000**
Design/Surveying/CM/Permitting/Geotechnical	**$110,000**
Contingency	**$160,000**
Amenities	**$2,250,000**
Overall Total	**$4,290,000**

Phase I: Bypass Entrance

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total
1167	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$3,700
700	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$1,200
500	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$6,300
900	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$14,200
45000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$11,300
3000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$14,000
2484.722	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$111,800
4	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$800
9333	023156100610	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering	B.C.Y.	$ 2.54	$ 2.54	$23,700
9333	023154900330	Hauling, 1 mi trip, 12 CY truck	CY		$ 3.91	$36,500
45	022405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$33,800
900		Stream treatment	LF		$ 200.00	$180,000
2000	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$2,600
2700	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$2,400
825	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$13,500
10	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$2,400
2	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$2,400
825	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$5,600
825	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$2,200
2200	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick	S.F.	$ 3.25	$ 3.25	$7,200
43	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$13,700

Construction $490,000

319 Watauga	$18,000
317 West Fairview	$6,500
315 West Fairview	$14,100
313 West Fairview	$51,500
311 West Fairview	$46,200
246 West King Street	$86,200
Property Acquisition	**$222,500**

Design/Surveying/CM/Permitting/Geotechnical $50,000

Contingency $70,000

Overall Total $830,000

Phase I: King Street Bypass Culverts

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
4000	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$12,600
450000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$112,500
30000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$140,400
6220.833333	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$279,900
2400	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$4,000
1280	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$16,000
750	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$11,900
5000	022602001400	between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$98,700
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
2	023052502000	Mobilization or demobilization, crane, truck-mounted, up to 75 ton, includes both mobilization/demobilization	Ea.	$ 99.76	$ 99.76	$200
1666.666667	023101000011	Fine grading, finish grading granular subbase for highway paving, +/- 1"	S.Y.	$ 0.48	$ 0.48	$800
4481.481481	023151101900	Backfill, trench, up to 300' haul, dozer backfilling, excludes compaction	L.C.Y.	$ 1.68	$ 1.68	$7,500
4481.481481	023153107020	Compaction, around structures and trenches, 3 passes, 18" wide, 6" lifts, walk behind, vibrating plate	E.C.Y.	$ 1.65	$ 1.65	$7,400
4481.481481	023153109000	Compaction, water for, 3000 gallon truck, 3 mile haul	E.C.Y.	$ 1.49	$ 1.49	$6,700
14263.74074	023156100610	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering	B.C.Y.	$ 2.54	$ 2.54	$36,200
9782	023154900330	Hauling, 1 mi trip, 12 CY truck	CY		$ 3.91	$38,200
3888.888889	027202000100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	S.Y.	$ 10.11	$ 10.11	$39,300
2222.222222	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$2,900
6600	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$5,800
1500	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$24,500
20	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$4,800
6	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$7,100
1	025303002500	Packaged Utility Lift Ststions, packaged sewage lift station, 200,000 GPD, excludes fencing or external piping	Ea.	$202,722.70	$ 202,722.70	$202,700
1500	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$10,100
1500	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$4,000
3	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 25,000.00	$75,000
8	026304001120	Storm Drainage Manholes, Frames, and Covers, concrete, precast, 4' I.D., 6' deep, excludes base, excavation, backfill, frame and cover	Ea.	$ 1,202.75	$ 1,202.75	$9,600
2000	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$2,400,000
180	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$135,000
1	026305300500	Public Storm Utility Drainage Piping, precast concrete, box culvert, set up charge at plant, excludes excavation or backfill, add	Job	$ 5,541.58	$ 5,541.58	$5,500
1		Tunnel under railroad	Ea.		$ 300,000.00	$300,000
1833.333333	027202000100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	S.Y.	$ 10.11	$ 10.11	$18,500
1666.666667	027403100160	Plant-mix asphalt paving, for highways and large paved areas, binder course, 3" thick	S.Y.	$ 9.71	$ 9.71	$16,200
1666.666667	027403100300	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 1" thick	S.Y.	$ 3.42	$ 3.42	$5,700
1000	027703000416	Cast-in place concrete curbs & gutters, concrete, machine formed, radius, 6" x 18" radius	L.F.	$ 6.93	$ 6.93	$6,900
6000	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	S.F.	$ 3.25	$ 3.25	$19,500
90	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$28,700

Construction	**$4,100,000**
Bank Lot and Repave	$200,000
Property Acquisition	**$200,000**
Design/Surveying/CM/Permitting/Geotechnical	**$410,000**
Contingency	**$620,000**
Overall Total	**$5,130,000**

Phase I: Downstream Open Channel

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
333	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$1,000
450	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$800
500	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$6,300
550	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$8,700
375000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$93,800
25000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$117,000
4990.278	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$224,600
4	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$800
8148	023156100610	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering	B.C.Y.	$ 2.54	$ 2.54	$20,700
8148	023154900330	Hauling, 1 mi trip, 12 CY truck	CY		$ 3.91	$31,900
45	022405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$33,800
450		Stream treatment	LF		$ 200.00	$90,000
1000	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$1,300
1350	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$1,200
675	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$11,000
10	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$2,400
2	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$2,400
675	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$4,500
675	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$1,800
1800	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick	S.F.	$ 3.25	$ 3.25	$5,900
56	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$17,900

Construction	**$680,000**
Good Samaritan	$100,000
Property Acquisition	**$100,000**
Design/Surveying/CM/Permitting/Geotechnical	**$70,000**
Contingency	**$100,000**
Overall Total	**$950,000**

Phase II: Downtown Park and Stream

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
4629.62963	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$14,500
2955000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$738,800
197000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$922,000
41550	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$1,869,800
4000	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$6,700
1280	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$16,000
4000	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$63,300
6000	022602001400	Cofferdams, soldier beams & lagging, H piles with wood sheeting horizontal between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$118,400
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
5000	023101000011	Fine grading, finish grading granular subbase for highway paving, +/- 1"	S.Y.	$ 0.48	$ 0.48	$2,400
30000	023156100610	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering	B.C.Y.	$ 2.54	$ 2.54	$76,200
30000	023154900330	Hauling, 1 mi trip, 12 CY truck	CY		$ 3.91	$117,300
2000		Channel Stabilization	L.F.		$ 200.00	$400,000
13333.33333	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$17,200
6000	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$5,300
3000	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$48,900
10	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$2,400
6	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$7,100
1	025303002500	Packaged Utility Lift Ststions, packaged sewage lift station, 200,000 GPD, excludes fencing or external piping	Ea.	$ 202,722.70	$ 202,722.70	$202,700
3000	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$20,200
3000	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$7,900
6	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 15,000.00	$90,000
180	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$216,000
2	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 15,000.00	$30,000
500	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$600,000
2	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 15,000.00	$30,000
60	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$72,000
1		Earthwork, demo and repave for Wautauga and Kelly's Market			$ 125,000.00	$125,000
120	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$90,000
1	026305300500	Public Storm Utility Drainage Piping, precast concrete, box culvert, set up charge at plant, excludes excavation or backfill, add	Job	$ 5,541.58	$ 5,541.58	$5,500
500	027202000100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	S.Y.	$ 10.11	$ 10.11	$5,100
500	027403100160	Plant-mix asphalt paving, for highways and large paved areas, binder course, 3" thick	S.Y.	$ 9.71	$ 9.71	$4,900
500	027403100300	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 1" thick	S.Y.	$ 3.42	$ 3.42	$1,700
300	027703000416	Cast-in place concrete curbs & gutters, concrete, machine formed, radius, 6" x 18" radius	L.F.	$ 6.93	$ 6.93	$2,100
8000	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	S.F.	$ 3.25	$ 3.25	$26,000
1		Landscaping and amenities	Ea.		$ 400,000.00	$400,000
285	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$90,800

Construction	**$6,450,000**
133 West Main	$138,700
127 West Main	$34,300
125 West Main	$42,100
123 West Main	$19,400
119 West Main	$47,100
102 Commerce	$18,400
104 Commerce	$52,600
8 Wilson	$203,000
105 Wilson (Red Cross)	$0
103 Wilson	$104,900
Lamont	$56,500
Lamont	$88,300
125 Lamont	$823,600
Property Acquisition	**$1,630,000**
Design/Surveying/CM/Permitting/Geotechnical	**$650,000**
Contingency	**$970,000**
Overall Total	**$9,700,000**

Phase III: LP Auer Dam

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
2600	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$8,200
750000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$187,500
50000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$234,000
7500	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$337,500
1800	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$3,000
256	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$3,200
75	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$1,200
1000	022602001400	Cofferdams, soldier beams & lagging, H piles with wood sheeting horizontal between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$19,700
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
27000	023101000011	Fine grading, finish grading granular subbase for highway paving, +/- 1"	S.Y.	$ 0.48	$ 0.48	$13,000
40000		Excavate, haul, place and compact dam	B.C.Y.	$ 5.00	$ 10.00	$400,000
1500		Channel Stabilization	L.F.		$ 100.00	$150,000
16666.66667	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$21,500
4500	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$4,000
1350	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$22,000
5	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$1,200
3	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$3,500
1350	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$9,100
1350	025504641000	distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$3,600
4	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 10,000.00	$40,000
100	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$120,000
200	026305302090	60" diameter RCP, no backfill or compaction	L.F.		$ 233.07	$46,600
90	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$67,500
1	026305300500	Public Storm Utility Drainage Piping, precast concrete, box culvert, set up charge at plant, excludes excavation or backfill, add	Job	$ 5,541.58	$ 5,541.58	$5,500
3120	027202000100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	S.Y.	$ 10.11	$ 10.11	$31,500
2600	027403100160	Plant-mix asphalt paving, for highways and large paved areas, binder course, 3" thick	S.Y.	$ 9.71	$ 9.71	$25,200
2600	027403100300	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 1" thick	S.Y.	$ 3.42	$ 3.42	$8,900
1800	027703000416	Cast-in place concrete curbs & gutters, concrete, machine formed, radius, 6" x 18" radius	L.F.	$ 6.93	$ 6.93	$12,500
900	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	S.F.	$ 3.25	$ 3.25	$2,900
1		Landscaping and amenities	Ea.		$ 30,000.00	$30,000
75	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$23,900

Construction	**$1,840,000**
102 LP Auer	$381,600
108 LP Auer	$158,300
McKinley Road Trailer Park (1/4)	$20,500
Property Acquisition	**$560,000**
Design/Surveying/CM/Permitting/Geotechnical	**$180,000**
Contingency	**$280,000**
Overall Total	**$2,860,000**

Phase III: Lone Oak Dam

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
75	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$1,200
1000	022602001400	Cofferdams, soldier beams & lagging, H piles with wood sheeting horizontal between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$19,700
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
15000		Excavate, haul, place and compact dam	B.C.Y.	$ 5.00	$ 10.00	$150,000
1000		Channel Stabilization	L.F.		$ 100.00	$100,000
11111.11111	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$14,300
3000	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$2,600
1000	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$6,700
1000	025504641000	distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$2,600
4	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 10,000.00	$40,000
200	026305302090	60" diameter RCP, no backfill or compaction	L.F.		$ 233.07	$46,600
474.0740741		Excavate trench, place culvert, backfill and compact	C.Y.		$ 20.00	$9,500
90	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$67,500
1		Landscaping and amenities	Ea.		$ 10,000.00	$10,000
50	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$15,900

Construction	**$490,000**
Obtain deed restrictions	$100,000
Property Acquisition	**$100,000**
Design/Surveying/CM/Permitting/Geotechnical	**$50,000**
Contingency	**$70,000**
Overall Total	**$710,000**

Phase III: Antioch Dam

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
75	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$1,200
1000	022602001400	Cofferdams, soldier beams & lagging, H piles with wood sheeting horizontal between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$19,700
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
30000		Excavate, haul, place and compact dam	B.C.Y.	$ 5.00	$ 10.00	$300,000
2000		Channel Stabilization	L.F.		$ 100.00	$200,000
22222.22222	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$28,700
6000	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$5,300
2000	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$13,500
2000	025504641000	distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$5,300
4	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 10,000.00	$40,000
275	026305302090	60" diameter RCP, no backfill or compaction	L.F.		$ 233.07	$64,100
651.8518519		Excavate trench, place culvert, backfill and compact	C.Y.		$ 20.00	$13,000
90	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$67,500
1		Landscaping and amenities	Ea.		$ 10,000.00	$10,000
100	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$31,900

Construction	**$800,000**
Obtain deed restrictions	$250,000
Property Acquisition	**$250,000**
Design/Surveying/CM/Permitting/Geotechnical	**$80,000**
Contingency	**$120,000**
Overall Total	**$1,250,000**

Appendix E: Cost-Benefit Analysis

FEMA

Benefit-Cost Analysis of Hazard Mitigation Projects

LIMITED DATA MODULE

Version 5.2.3
May 2, 2006

Report of Benefit-Cost Analysis

Project	**Downtown Drainage - I**
Address	**209 Water Street**
City, State, Zip	**Johnson City**
County	**City of Johnson City**
Applicant	**City of Johnson City**
Contact Person	**Andrew Best, PE**
Analysis Date	**7/3/2008**
Analyst	**Curt Jawdy**
Scenario Run ID	
File Save As Name	**I.xls**
Disaster Number	
DSR Number	

FEMA Disclaimer:
The results produced by this analysis are neither conclusive evidence that the proposed project is cost-effective, nor a guarantee that a project is eligible for any government grant for whatever purpose.

LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

PROJECT INFORMATION

Disaster Number		Project	Downtown Drainage - I
DSR Number		Address	209 Water Street
DSR Category		City, State, Zip	Johnson City
DSR Subject		County	Washington
Inspection Date		Applicant	City of Johnson City
Application Date		Contact Person	Andrew Best, PE
Analysis Date	7/3/2008	Scenario Run ID	
Analyst	Curt Jawdy	File Save As Name	I.xls

PROJECT DATA

Phase I of Downtown Drainage Project. Includes open channel, pond three large culverts, and local collection along Market St. Discount rate per CWSRF.

Project Useful Life (Years)	75
Base Year of Costs	2008
Historic Preservation Issues (Yes or No)?	Yes
Environmental Issues (Yes or No)?	?

Economic Factors: Discount Rate (%) 3.00 Present Value Coefficient 29.70

Net Mitigation Project Cost:	$11,000,000

Notes: Conceptual cost only. Includes property acquisition.

Additional Annual Maintenance Cost ($/year) for Mitigation Project	$10,000
Present Value of Additional Annual Maintenance Cost ($)	$297,018
TOTAL MITIGATION PROJECT COST	$11,297,018

TYPE OF FACILITY (for Loss of Function): BUILDINGS

FACILITY DESCRIPTION: Downtown Buildings

Loss of Function for Buildings

Annual Budget of Public/Nonprofit Agencies	$1,000,000
Cost of Providing Services from this Building ($/day)	$2,740
Post-Disaster Continuity Premium ($/day)	$2,000
Total Value of Lost Services ($/day)	$4,740

FLOOD HISTORY

Estimated Frequency of Declared Flood Event (Years)	2

Data Sources and Documentation

SWMM flood models were used for flood elevations with various designs and storm sizes.
Finished floor elevations for each building were surveyed.
Flood elevations for each structure at each phase for each storm were taken from the nearest SWMM node.
Demolished buildings had flood depths set to zero. New buildings assumed to cover 60% of lot area.
$75/SF used for redeveloped building valuation, $50/SF in fringe areas. Appraised value used for As-Is case.
Flood depths were calculated for each structure. Corps DDF functions applied for damages.
Damages for each phase/storm/building were calculated from DDF results and summed for input below.

LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

DAMAGES BEFORE MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$537,060				$0	$537,060
5	$1,186,995				$0	$1,186,995
10	$1,684,025				$0	$1,684,025
25	$2,021,402				$0	$2,021,402
50	$2,229,840				$0	$2,229,840
100	$2,521,545				$0	$2,521,545
250					$0	$2,521,545
500					$0	$2,521,545
					Total Annualized Damages	$566,375

Data Sources and Documentation

Damages Before Mitigation are for the As-Is condition.

DAMAGES AFTER MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$48,709				$0	$48,709
5	$371,390				$0	$371,390
10	$738,864				$0	$738,864
25	$838,030				$0	$838,030
50	$1,459,261				$0	$1,459,261
100	$2,060,605				$0	$2,060,605
250					$0	$2,060,605
500					$0	$2,060,605
					Total Annualized Damages	$205,472

Data Sources and Documentation

Damages After Mitigation are for the Phase I condition.

SUMMARY OF BENEFITS AND COSTS

	Expected Annual	Present Value
Expected Annual Damages Before Mitigation	$566,375	$16,822,360
Expected Annual Damages After Mitigation	$205,472	$6,102,887
Expected Avoided Damages After Mitigation (BENEFITS)	$360,903	$10,719,472
PROJECT COSTS	$11,297,018	
PROJECT BENEFITS	$10,719,472	
BENEFITS MINUS COSTS	($577,546)	
BENEFIT-COST RATIO	0.95	

Data Sources and Documentation

FEMA Disclaimer: The results produced by this analysis are neither conclusive evidence that a proposed project is cost-effective, nor a guarantee that a project is eligible for any government grant for whatever purpose.

FEMA

Benefit-Cost Analysis of Hazard Mitigation Projects

LIMITED DATA MODULE

Version 5.2.3
May 2, 2006

Report of Benefit-Cost Analysis

Project	**Downtown Drainage - II**
Address	**209 Water Street**
City, State, Zip	**Johnson City**
County	**City of Johnson City**
Applicant	**City of Johnson City**
Contact Person	**Andrew Best, PE**
Analysis Date	**7/3/2008**
Analyst	**Curt Jawdy**
Scenario Run ID	
File Save As Name	**II.xls**
Disaster Number	
DSR Number	

FEMA Disclaimer:
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LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

PROJECT INFORMATION

Disaster Number		Project	Downtown Drainage - II
DSR Number		Address	209 Water Street
DSR Category		City, State, Zip	Johnson City
DSR Subject		County	Washington
Inspection Date		Applicant	City of Johnson City
Application Date		Contact Person	Andrew Best, PE
Analysis Date	7/3/2008	Scenario Run ID	
Analyst	Curt Jawdy	File Save As Name	II.xls

PROJECT DATA

Phase II of Downtown Drainage Project. Includes open channel, downtown culverts, Kelly's Market bypass, Wautauga culvert upgrade and warehouse natural channel. Discount rate per CWSRF.

Project Useful Life (Years)	75
Base Year of Costs	2008
Historic Preservation Issues (Yes or No)?	Yes
Environmental Issues (Yes or No)?	?

Economic Factors: Discount Rate (%) 3.00 Present Value Coefficient 29.70

Net Mitigation Project Cost:	$10,000,000

Notes: Conceptual cost only. Includes property acquisition.

Additional Annual Maintenance Cost ($/year) for Mitigation Project	$10,000
Present Value of Additional Annual Maintenance Cost ($)	$297,018
TOTAL MITIGATION PROJECT COST	$10,297,018

TYPE OF FACILITY (for Loss of Function): BUILDINGS

FACILITY DESCRIPTION: Downtown Buildings

Loss of Function for Buildings

Annual Budget of Public/Nonprofit Agencies	$500,000
Cost of Providing Services from this Building ($/day)	$1,370
Post-Disaster Continuity Premium ($/day)	$500
Total Value of Lost Services ($/day)	$1,870

FLOOD HISTORY

Estimated Frequency of Declared Flood Event (Years)	2

Data Sources and Documentation

SWMM flood models were used for flood elevations with various designs and storm sizes.
Finished floor elevations for each building were surveyed.
Flood elevations for each structure at each phase for each storm were taken from the nearest SWMM node.
Demolished buildings had flood depths set to zero. New buildings assumed to cover 60% of lot area.
$75/SF used for redeveloped building valuation, $50/SF in fringe areas. Appraised value used for As-Is case.
Flood depths were calculated for each structure. Corps DDF functions applied for damages.
Damages for each phase/storm/building were calculated from DDF results and summed for input below.

LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

DAMAGES BEFORE MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$48,709				$0	$48,709
5	$371,390				$0	$371,390
10	$738,864				$0	$738,864
25	$838,030				$0	$838,030
50	$1,459,261				$0	$1,459,261
100	$2,060,605				$0	$2,060,605
250					$0	$2,060,605
500					$0	$2,060,605
					Total Annualized Damages	$205,472

Data Sources and Documentation

Damages Before Mitigation are for the Phase I condition.

DAMAGES AFTER MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$1,574				$0	$1,574
5	$29,463				$0	$29,463
10	$66,759				$0	$66,759
25	$292,495				$0	$292,495
50	$479,005				$0	$479,005
100	$743,830				$0	$743,830
250					$0	$743,830
500					$0	$743,830
					Total Annualized Damages	$37,107

Data Sources and Documentation

Damages After Mitigation are for the Phase II condition.

SUMMARY OF BENEFITS AND COSTS

	Expected Annual	Present Value
Expected Annual Damages Before Mitigation	$205,472	$6,102,887
Expected Annual Damages After Mitigation	$37,107	$1,102,149
Expected Avoided Damages After Mitigation (BENEFITS)	$168,365	$5,000,738
PROJECT COSTS	$10,297,018	
PROJECT BENEFITS	$5,000,738	
BENEFITS MINUS COSTS	($5,296,280)	
BENEFIT-COST RATIO	0.49	

Data Sources and Documentation

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FEMA

Benefit-Cost Analysis of Hazard Mitigation Projects

LIMITED DATA MODULE

Version 5.2.3
May 2, 2006

Report of Benefit-Cost Analysis

Project	**Downtown Drainage - III**
Address	**209 Water Street**
City, State, Zip	**Johnson City**
County	**City of Johnson City**
Applicant	**City of Johnson City**
Contact Person	**Andrew Best, PE**
Analysis Date	**7/3/2008**
Analyst	**Curt Jawdy**
Scenario Run ID	
File Save As Name	**III.xls**
Disaster Number	
DSR Number	

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LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

PROJECT INFORMATION

Disaster Number		Project	Downtown Drainage - III
DSR Number		Address	209 Water Street
DSR Category		City, State, Zip	Johnson City
DSR Subject		County	Washington
Inspection Date		Applicant	City of Johnson City
Application Date		Contact Person	Andrew Best, PE
Analysis Date	7/3/2008	Scenario Run ID	
Analyst	Curt Jawdy	File Save As Name	III.xls

PROJECT DATA

Phase III of Downtown Drainage Project. Includes detention ponds in Brush Creek basin.
Discount rate per CWSRF.

Project Useful Life (Years)	75
Base Year of Costs	2008
Historic Preservation Issues (Yes or No)?	Yes
Environmental Issues (Yes or No)?	?

Economic Factors: Discount Rate (%) 3.00 Present Value Coefficient 29.70

Net Mitigation Project Cost:	$5,000,000

Notes: Conceptual cost only. Includes property acquisition.

Additional Annual Maintenance Cost ($/year) for Mitigation Project	$10,000
Present Value of Additional Annual Maintenance Cost ($)	$297,018
TOTAL MITIGATION PROJECT COST	$5,297,018

TYPE OF FACILITY (for Loss of Function): BUILDINGS

FACILITY DESCRIPTION: Downtown Buildings

Loss of Function for Buildings

Annual Budget of Public/Nonprofit Agencies	$500,000
Cost of Providing Services from this Building ($/day)	$1,370
Post-Disaster Continuity Premium ($/day)	$500
Total Value of Lost Services ($/day)	$1,870

FLOOD HISTORY

Estimated Frequency of Declared Flood Event (Years)	2

Data Sources and Documentation

SWMM flood models were used for flood elevations with various designs and storm sizes.
Finished floor elevations for each building were surveyed.
Flood elevations for each structure at each phase for each storm were taken from the nearest SWMM node.
Demolished buildings had flood depths set to zero. New buildings assumed to cover 60% of lot area.
$75/SF used for redeveloped building valuation, $50/SF in fringe areas. Appraised value used for As-Is case.
Flood depths were calculated for each structure. Corps DDF functions applied for damages.
Damages for each phase/storm/building were calculated from DDF results and summed for input below.

LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

DAMAGES BEFORE MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$1,574				$0	$1,574
5	$29,463				$0	$29,463
10	$66,759				$0	$66,759
25	$292,495				$0	$292,495
50	$479,005				$0	$479,005
100	$743,830				$0	$743,830
250					$0	$743,830
500					$0	$743,830
					Total Annualized Damages	$37,107

Data Sources and Documentation

Damages Before Mitigation are for the Phase II condition.

DAMAGES AFTER MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$0				$0	$0
5	$65,005				$0	$65,005
10	$116,383				$0	$116,383
25	$141,567				$0	$141,567
50	$193,747				$0	$193,747
100	$210,896				$0	$210,896
250					$0	$210,896
500					$0	$210,896
					Total Annualized Damages	$23,346

Data Sources and Documentation

Damages After Mitigation are for the Phase III condition.

SUMMARY OF BENEFITS AND COSTS

	Expected Annual	Present Value
Expected Annual Damages Before Mitigation	$37,107	$1,102,149
Expected Annual Damages After Mitigation	$23,346	$693,429
Expected Avoided Damages After Mitigation (BENEFITS)	$13,761	$408,720
PROJECT COSTS	$5,297,018	
PROJECT BENEFITS	$408,720	
BENEFITS MINUS COSTS	($4,888,298)	
BENEFIT-COST RATIO	0.08	

Data Sources and Documentation

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Appendix F: Compact Disc Containing Project Files