December 16, 2014

Mr. Paul Holzen, P.E., LEED AP
Director of Engineering
City of Franklin
109 3rd Avenue South
Franklin, TN 37064
Delivered via email: paul.holzen@franklintn.gov

Dear Mr. Holzen:

Subject: Feasibility Study for Jordan Branch/Spencer Creek in The Meadow subdivision off Sliders Knob & Bakers Bridge Avenue
City of Franklin, Williamson County, Tennessee
CEC Project 140-624

Civil & Environmental Consultants, Inc. (CEC) understands that the City of Franklin has had complaints for several years regarding erosion of Jordan Branch/Spencer Creek which flows behind several houses before flowing under Cliffe Run in The Meadow subdivision located off of Bakers Bridge Avenue. The stream originates near the corporate boundary between Brentwood and Franklin at the edge of The Meadow subdivision adjacent to a golf course. Google Maps lists the stream as Jordan Branch, but the Tennessee Department of Environment and Conservation (TDEC) GIS lists it as Spencer Creek and impaired for siltation. Below is a photograph of the stream taken on February 13, 2014:

As the photograph shows, the channel is severely entrenched with eroding and undercut banks. The trees are in danger of falling and many could possibly fall on or very near houses. Relatively large portions of backyards are likely going to be "uprooted" when the trees fall. Stormwater channels designed to convey flow from the subdivision to the stream are "head-cutting" which is also contributing to the loss of backyards in the form of eroding channels between lots.

1.0 PURPOSE

The purpose of this project is to prepare a feasibility study to determine potential ways to mitigate the eroding stream channel before investing in field survey and detailed, engineering design. Several stakeholders will need to be involved in the process of determining a solution including, but not limited to: the City of Franklin, The Meadow subdivision Home Owner's Association, the stream's adjacent property owners, the upstream golf course located in Brentwood, the City of Brentwood potentially, TDEC, and the Corps of Engineers.

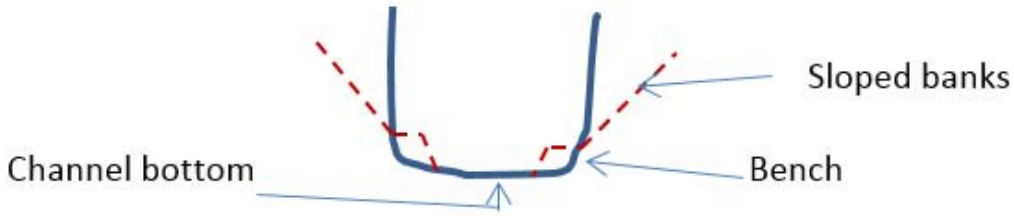
CEC organized a site visit with TDEC, the Corps of Engineers, and City staff on November 12, 2014 to review the condition of the channel and discuss various options for addressing the erosion and associated concerns. Based on this site visit by TDEC (Jimmy Smith), USACE (Josh Frost), City of Franklin (Jeff Willoughby, Doug Noonan, Tom Ingram, Jason Hewitt), and CEC (Steve Casey, Jeff Duke, Deedee Kathman), the following options were discussed as possible solutions to prevent Jordan Branch from continuing to erode downward and widen. Currently, the banks are vertical (and in some places undercut) throughout the length of the stream from Cliffe Run to its beginning at the golf course (Nashville Golf and Athletic Club located inside Brentwood corporate limits) and are characterized by sloughing banks, tree roots dangling in air, and trees that have already fallen or are beginning to fall into the channel. The photos at the end of this document were taken during the site visit on November 12, 2014 and are typical examples of the stream throughout the reach. The following potential solutions are being presented below for consideration to stabilize the banks, prevent more erosion and downcutting, and lessen possible damage from falling trees and eroding banks.

2.0 POTENTIAL SOLUTIONS

<u>Option #1:</u>

This option involves keeping the channel where it is, but narrowing the channel bottom, constructing floodplain benches, and excavating the banks back on a 2:1 slope from the top of the floodplain bench on each side. Excavated soil from sloping the banks back would be used to construct the floodplain benches. This would allow the groundwater to continue to seep from the soil and flow down the channel. Stone toe protection would be installed at channel bends to help

stabilize the newly constructed soil benches. Most of the trees would have to be removed, with smaller ones (ball and burlap) replacing them. Although these smaller trees wouldn't be as large, nor provide much shade or privacy initially, the existing trees, mostly hackberry interspersed with privet, would be removed, and the land would be more manageable and stable. Replacement trees would be more valuable for habitat and visually appealing than the existing trees.

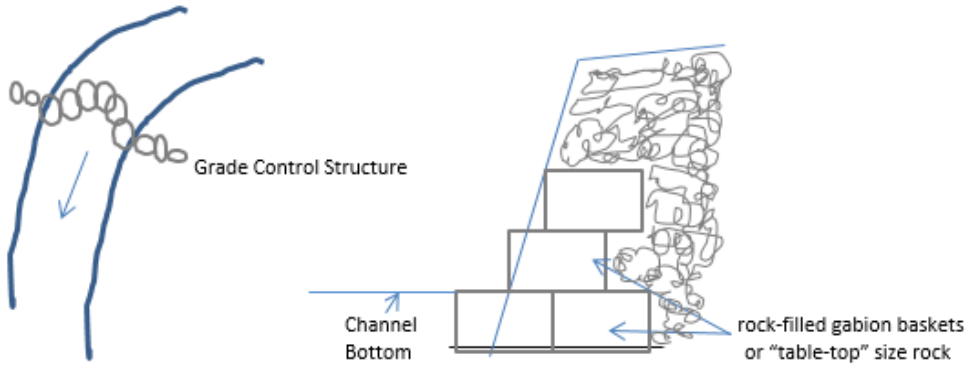


Option #2:

This option would involve raising the entire bed of the channel by using the soil from sloping back the banks to fill in the channel, and make benches on each side. The design would allow for a balance of soil quantities, i.e., the amount of soil put in the bottom of the channel would equal that removed from the sides to create the benches. The existing trees would have to be removed, and replanted, as in Option #1, with smaller ones. There may be a loss of a groundwater source for the newly-created stream channel bottom; this would have to be investigated to determine if some flow would be lost and if mitigation would be required. Likely, this option would be more difficult to permit than Option #1 because of the risk of losing connectivity to groundwater and not maintaining any of the existing channel bottom.

Option #3:

This option involves leaving the channel as is, but installing hard toe protection at the base of banks (e.g., rocks, gabion baskets, articulated concrete blocks) and cross-channel grade controls (e.g., cross vanes, J-hook vanes, log vanes). Many of the existing trees could be left in place except where the toe protection and cross-channel grade controls would be installed, although those nearest the top of bank would have to be removed. Mitigation (at a reduced rate) may be needed for bank alteration.



Option #4:

Detaining stormwater that enters the stream at the uppermost point (at the golf course) in a detention basin to slow the flow rate characterizes this option. This option could also be combined with other options presented herein. Implemented alone, this option would involve leaving the channel as is. Slowing the rate at which stormwater flows into the upper portion of the stream would tend to reduce the erosion potential of the water (i.e. reduced shear stress and velocity).

Option #4a: As an added benefit, detention of stormwater that enters the stream channel from the left descending bank (LDB) could be accomplished by excavating an existing area that is located within common land to create a dry detention basin. This dry detention basin could also function as a floodplain relief area for higher storm events flowing in the stream to spill over into as floodplain storage. The area could be excavated, a separation berm between the stream and basin left in place, and landscaped with rain garden type plants. The entry and exit points for stream flow would need to be reinforced and the basin stabilized adequately to withstand the erosion potential of stream flow spilling into the area as well as storm sewer discharges from the street drainage. Existing headcutting associated with the street drainage entering the stream in this area would be repaired as part of this option. Headcutting at the other outfall locations into the stream could also be considered as part of this option, although there is much less area in which to construct along the right descending bank.

Option #5:

Piping the entire stream (from Cliffe Run to the golf course) in a box culvert that matches the dimensions of the culvert at Cliffe Run is the most expensive and challenging option from a permitting perspective. This would require a large amount of earth movement and many trees being removed. Because Jordan Branch is on the TDEC 303(d) list for impaired streams,

mitigation would have to be found within the 12-digit HUC (basically in the same watershed). In other words, the City could not just pay the mitigation rate of $240 per foot but would need to find a stream in the same 12-digit HUC that could be restored to offset the lost stream footage encapsulated by the new box culvert.

Option #6:

Doing nothing is the final option considered in this report. The site would be left as is. If nothing is done, it is likely that more trees will fall causing private property damage. Head-cutting of stormwater outfalls into the stream would continue, meaning that the ditches between private lots where the outfalls are located would likely deepen. The banks would likely continue to slough carrying sediment downstream and further destabilizing the banks and trees along the channel.

NOTE: Options 1 – 3 could all include construction of a detention basin on the edge of the golf course, where Jordan Branch begins. This could be designed to collect the stormwater from the watershed draining to the stream's beginning and slowly release it to the channel. It would provide ecological lift for the stream, since much of the existing downstream section of the stream is usually dry, and the slow release of water would likely provide wet conditions conducive to aquatic life. It could also be used with Option 6, in which the only work would be the detention basin construction.

Headwater Detention Basin					
Storm Event	Inflow (cfs)	Outflow (cfs)	Max Depth (feet)	Storage (cubic-feet)	% Reduction
2-yr, 24-hr	66.94	30.05	4.95	45,504	55.1
5-yr, 24-hr	97.66	68.88	5.50	62,911	29.5
10-yr, 24-hr	124.32	99.71	5.73	71,435	19.8
25-yr, 24-hr	161.73	140.26	6.00	82,494	13.3
50-yr, 24-hr	193.12	171.55	6.18	91,025	11.2
100-yr, 24-hr	226.32	203.99	6.36	99,797	9.9
500-yr, 24-hr	308.56	282.94	6.76	120,960	8.3

Three choices were discussed during the November 12, 2014 site visit as a possible stepwise progression to address the problems associated with Jordan Branch, as follows:

1) Build the detention basin at the head of Jordan Branch and monitor the stream for two or three years to see how the basin affects the stream;
2) Build the basin and do one of Option numbers 1 – 3;
3) Build the basin and fix the worst head cut from the stormwater channel entering Jordan Branch perpendicularly on the LDB.

3.0 RECOMMENDATIONS

Recommendation #1:

The first step should be to perform a Hydrologic Determination on the upchannel portion below the golf course (Nashville Golf and Athletic Club). Work done in the channel may require mitigation, so determining the jurisdictional nature of the channel is paramount (i.e. stream or wet weather conveyance). If it is a stream, and mitigation is required, the mitigation will have to occur in the 12-digit HUC (Hydrologic Unit Code), since Jordan Branch is a tributary of Spencer Creek, and Spencer Creek is on the 303(d) list for impaired streams. According to the 2012 antidegradation rules, if a waterbody is listed as being impaired, any mitigation must be accomplished within the 12-digit Hydrologic Unit Code (TDEC 2012), unless social and economic justification can document the need for the impact and there is no opportunity to perform mitigation in the 12-digit HUC.

Recommendation #2:

The City of Franklin could contact the golf course to assess the possibility of using a portion of land on the course as a detention basin. This detention basin could be designed to maintain a permanent pool as a "water hazard" on the golf course. If this option was possible, it would be advisable to build the detention basin and monitor the stream's response. Bank erosion indicators could be installed and a few representative cross-sections could be surveyed for future comparison to quantify the response.

Should the City desire more precise construction cost estimates for an option that involves in-stream construction, a field survey would need to be performed. Currently, the construction cost estimates involving earthwork for in-stream work are based on an estimated, typical channel cross-section. No field survey work was performed as part of this initial feasibility study.

Access for construction will be challenging for all options involving in-stream construction. Restoring adjacent properties to pre-construction condition will be costly and is not included with the cost estimates because of the unknowns about how construction will be accomplished. Communication among all affected property owners will be imperative. Obtaining temporary construction easements from all property owners adjacent to the stream is also likely.

Figure 1 (attached) shows the watershed and associated stormwater runoff flows of the stream and includes the watershed to the detention basin constructed below Cliffe Run within the

stream. This situation involving a dry detention basin constructed within a stream is not currently permitted; however, the plat for this subdivision obtained from the City shows that this was done in or around 1995. Also shown is the conceptual layout for the detention basin discussed in Option #4 and the floodplain detention in Option #4a among other information.

Attached are construction cost estimates for each option presented above with a corresponding channel cross-section, where applicable. The costs presented are intended for planning purposes and to provide an idea about the magnitude of construction costs for comparison among the options. The lists of estimated quantities are not comprehensive but instead capture the "big ticket" items. A more accurate construction cost estimate could be developed after a detailed design for one of the options is performed.

4.0 REPRESENTATIVE PHOTOS

5.0 CLOSING

CEC appreciates the opportunity to assist the City with determining a course of action to address the concerns surrounding the erosion of this stream. We would be happy to assist you in presenting this information to the BOMA or other committee, as appropriate.

Sincerely,

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.

Steven E. Casey, PE, CPESC
Senior Project Manager

Jeff Duke, PWS, CPESC
Vice President

Enclosures

Point of Interest #1

Total Drainage Area to Outlet Structure = 123.4 Acres
Composite Curve Number = 75

TDEC Name: Spencer Creek
TDEC ID: TN05130204016_0200
City of Franklin Name: Jordan Branch

Existing Stormwater Outfalls

Point of Interest #2

Detention Storage Area

Floodplain Storage Area

Berm with 24" RCP and 40' wier

Sanitary Sewer Location Per Plat

Parcel ID: 054H D 00100 00008054H
Owner: Single-Family Subassociation of Cool Springs
Area: 1.61 Acres

Parcel ID: 054I D 00100 00008054I
Owner: Cool Springs Real Estate Assoc LP
Area: 1.17 Acres

Parcel ID: 054I A 00100 00008054I
Owner: Cool Springs Real Estate Assoc LP
Area: 0.72 Acres

REVISION RECORD		
NO	DATE	DESCRIPTION

SUBMITTAL RECORD		
NO	DATE	DESCRIPTION

NRCS Method Flows (cfs)

Return Interval	Point of Interest #1	Point of Interest #2
2 Year 24-hour	162	29
5Year 24-hour	239	42
10 Year 24-hour	305	53
25 Year 24-hour	399	69
50 Year 24-hour	479	82
100 Year 24-hour	563	96
500 Year 24-hour	770	131

Regression Equation Flows for Point of Interest #1 (cfs)

Return Interval	Minimum Value	Mid-range Value	Maximum Value
2 Year 24-hour	54	76	105
5Year 24-hour	90	126	176
10 Year 24-hour	116	162	227
25 Year 24-hour	149	210	296
50 Year 24-hour	173	246	351
100 Year 24-hour	196	282	406
500 Year 24-hour	247	366	543

NOTE: The watershed to Point of Interest #2 was too small for using the regression equations to estimate flows

LEGEND

- Points of Interest
- Spencer Creek
- Watershed to Outlet Structure
- Stormwater Outfalls
- Detention Berm
- Detention Area
- Brentwood City Limit
- Parcels
- 5 ft contours

REFERENCE

ESRI WORLD IMAGERY / ARCGIS MAP SERVICE:
HTTP://GOTO.ARCGISONLINE.COM/MAPS/WORLD_IMAGERY,
ACCESSED 12/16/2014, IMAGERY DATE: 2011.

SCALE IN FEET
0 150 300 450 600

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www.cecinc.com

CITY OF FRANKLIN
SPENCER CREEK
FEASIBILITY STUDY
WILLIAMSON CO., TN

* Hand signature on file

DRAWN BY:	JMB/JBS	CHECKED BY:	SEC	APPROVED BY:	SEC*
DATE:	12/16/2014	SCALE:	1 " = 150 '	PROJECT NO:	140-624

FEASIBILITY STUDY HYDROLOGIC & HYDRAULIC ANALYSIS

FIGURE NO: 1

SHEET 1 OF 1

\\SVR-NASH\ P:\2014\140-624\Draft Documents\JBS_GIS\Maps\140624_Spencer_Creek_20141215.mxd (12/16/2014 12:31:26 PM)

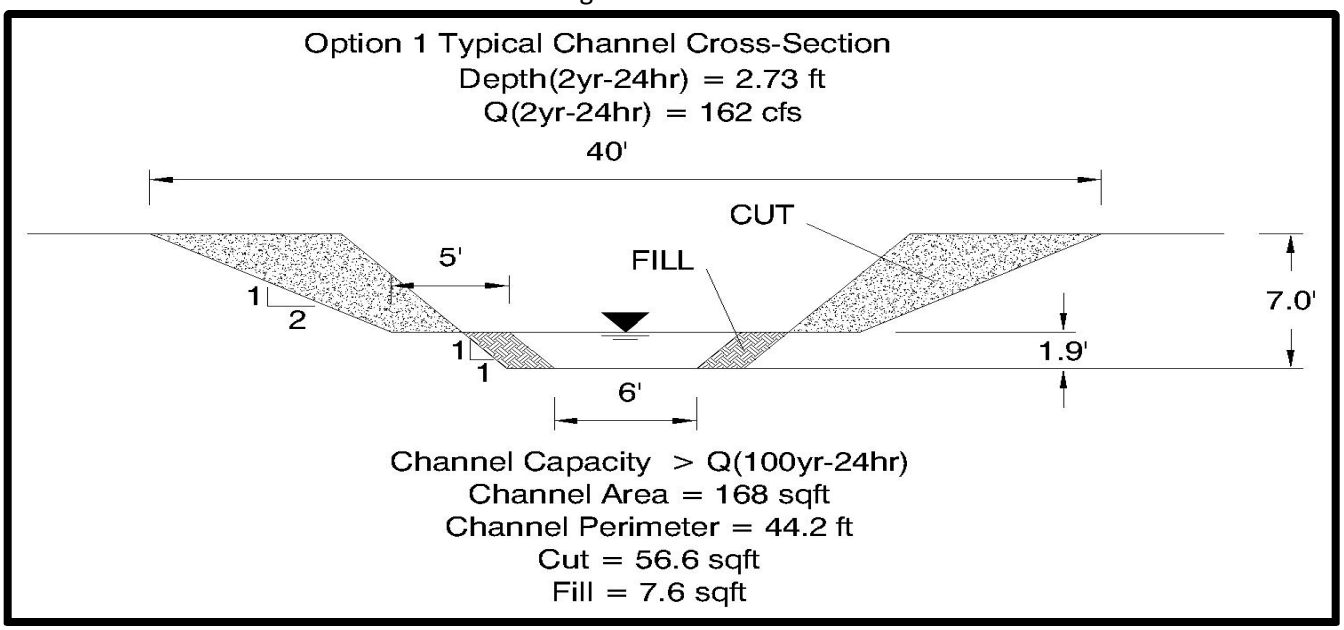
Estimate of "Big Ticket" Items

Option 1 - Reduce Channel Width, Excavate Benches, Hard Toe Protection, and Install Grade Control Structures

ITEM	Description	UNIT	QTY	UNIT COST		Total Cost
203-01	Road & Drainage Excavation (Unclassified)	CY	2,600	$20.00		$52,000
	Fill Material Placement	CY	340	$20.00		$6,800
	Grade Control Structures	EA	12	$2,000.00		$24,000
209-03.57	Stone Toe Protection	LF	800	$100.00		$80,000
209-65.04	Temporary In Stream Diversion	LF	1,200	$19.03		$22,836
209-09.24	Jute Mesh Fabric	SY	5,100	$3.25		$16,575
801-01	Seeding (With Mulch)	UNIT	155	$22.07		$3,421
801-01.07	Temporary Seeding (With Mulch)	UNIT	155	$15.75		$2,441
	Landscaping	LS	1	$50,000.00		$50,000
				TOTAL ESTIMATE		$258,073

This estimate of probable cost is based on reducing the channel width to 6-ft and excavating 5-ft wide floodplain benches on each side of the channel. A 2H:1V slope would then connect the floodplain bench to the existing ground. Tree removal would be required. Stream monitoring after construction will be required. However, compensatory offsite mitigation will likely not be required. The cost of the following items are not included in the estimate of probable cost, but will be additional cost if this alternative is selected.

1. Mobilization
2. Tree Removal (~$1,000 per tree based on 2012 stream project in Franklin)
3. Clearing and grubbing
4. Erosion prevention and sediment control
5. Stormwater outfall protection to stop existing head-cutting
6. Post construction stream monitoring



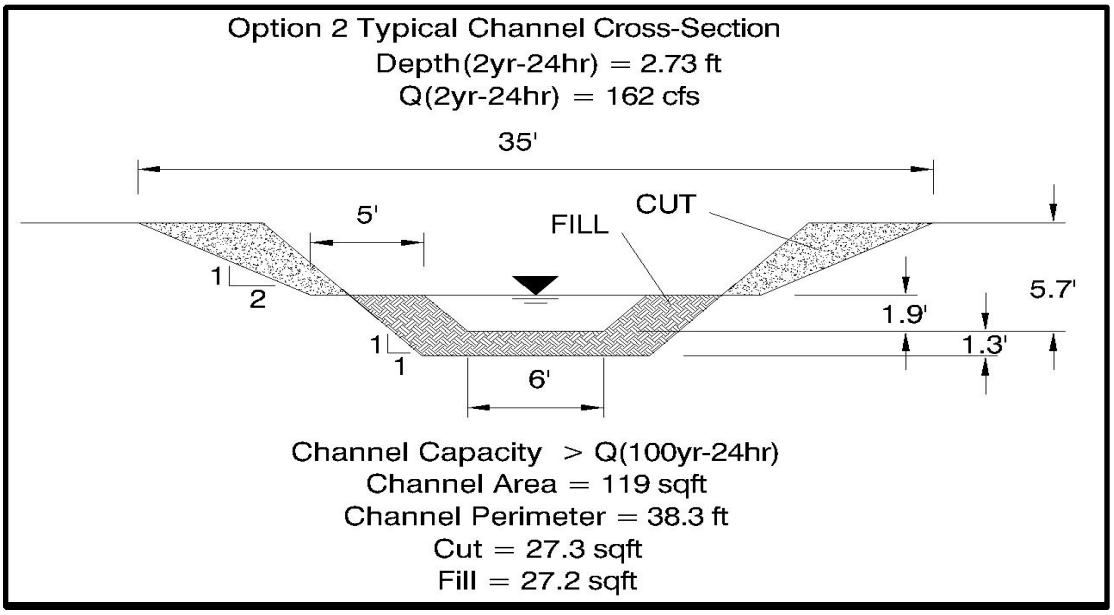
Estimate of "Big Ticket" Items

Option 2 - Raise Channel Bed, Reduce Channel Width, and Excavate Benches, and Install Grade Control Structures

ITEM	Description	UNIT	QTY	UNIT COST		Total Cost
203-01	Road & Drainage Excavation (Unclassified)	CY	1,300	$20.00		$26,000
	Fill Material Placement	CY	1,300	$20.00		$26,000
	Grade Control Structures	EA	24	$2,000.00		$48,000
209-65.04	Temporary In Stream Diversion	LF	1,200	$19.03		$22,836
209-09.24	Jute Mesh Fabric	SY	4,400	$3.25		$14,300
801-01	Seeding (With Mulch)	UNIT	155	$22.07		$3,421
801-01.07	Temporary Seeding (With Mulch)	UNIT	155	$15.75		$2,441
	Landscaping	LS	1	$50,000.00		$50,000
	Stream Mitigation In-Lieu Fee	LF	1,200	$240.00		$288,000
				TOTAL ESTIMATE		$480,998

This estimate of probable cost is based on raising the channel bottom and reducing the channel width to 6-ft and excavating 5-ft wide floodplain benches on each side of the channel. A 2H:1V slope would then connect the floodplain bench to the existing ground. Tree removal would be required. Stream mitigation may be required. Stream monitoring after construction will be required. The cost of the following items are not included in the estimate of probable cost, but will be additional cost if this alternative is selected.

1. Mobilization
2. Tree Removal (~$1,000 per tree based on 2012 stream project in Franklin)
3. Clearing and grubbing
4. Erosion prevention and sediment control
5. Stormwater outfall protection to stop existing headcutting
6. Post construction stream monitoring



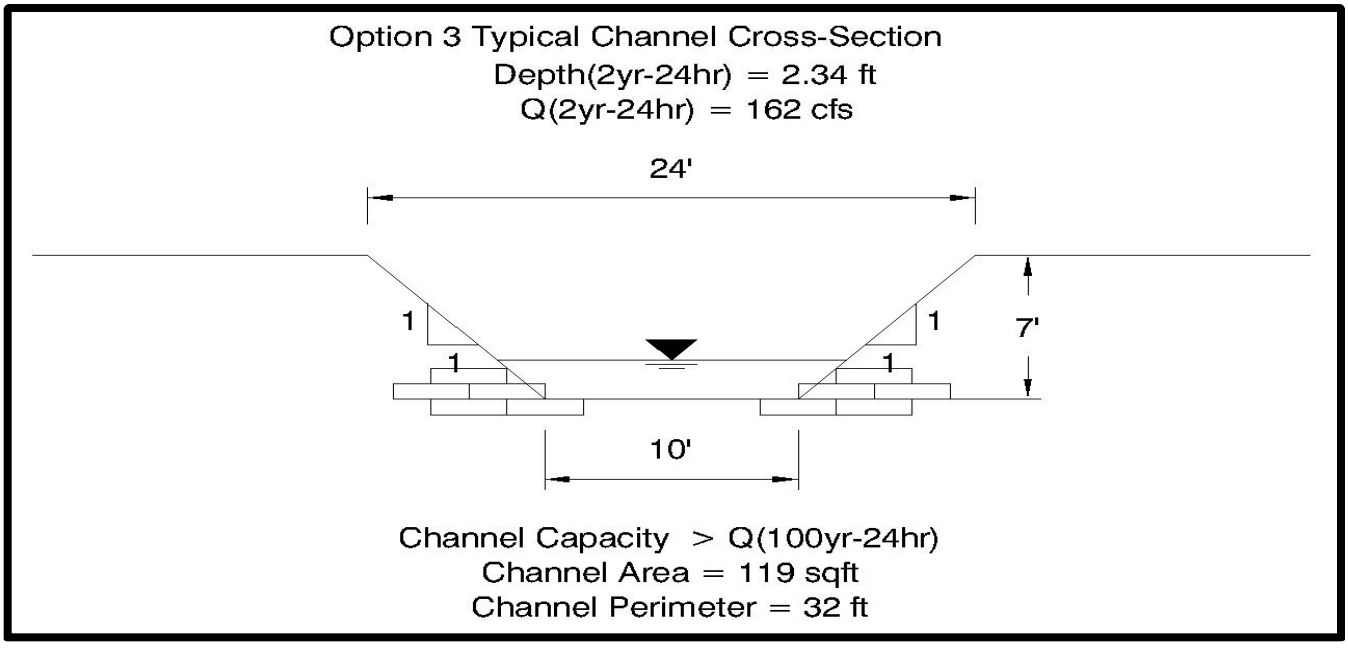
Estimate of "Big Ticket" Items

Option 3 - Install Hard Toe Protection and Grade Control Structures

ITEM	Description	UNIT	QTY	UNIT COST		Total Cost
209-03.57	Stone Toe Protection	LF	2,400	$100.00		$240,000
	Grade Control Structures	EA	12	$2,000.00		$24,000
209-65.04	Temporary In Stream Diversion	LF	1,200	$19.03		$22,836
209-09.24	Jute Mesh Fabric	SY	2,150	$3.25		$6,988
801-01	Seeding (With Mulch)	UNIT	155	$22.07		$3,421
801-01.07	Temporary Seeding (With Mulch)	UNIT	155	$15.75		$2,441
	Landscaping	LS	1	$50,000.00		$50,000
	Stream Mitigation In-Lieu Fee	LF	900	$240.00		$216,000
				TOTAL ESTIMATE		$565,686

This estimate of probable cost is based on Installing stone toe protection on both sides of hte existing channel. Grade control sturctures would also be installed. Tree removal adjacent to the stream would be required to install the stone toe protection. Stream mitigation may be required at a rate of 0.75 based on current TDEC guidance. Stream monitoring after construction will be required. The cost of the following items are not included in the estimate of probable cost, but will be additional cost if this alternative is selected.

1. Mobilization
2. Tree Removal (~$1,000 per tree based on 2012 stream project in Franklin)
3. Clearing and grubbing.
4. Erosion prevention and sediment control
5. Stormwater outfall protection to stop existing headcutting
6. Post construction stream monitoring



Estimate Cost of "Big Ticket" Items

Option 4 - Detention

ITEM	Description	UNIT	QTY	UNIT COST		Total Cost
203-01	Road & Drainage Excavation (Unclassified)	CY	225	$20.00		$4,500
	Clay Backfill Material for Cutoff Trench	CY	225	$20.00		$4,500
203-03	Borrow Fill Material and Placement	CY	1,300	$20.00		$26,000
607-05.02	24" Concrete Pipe Culvert	LF	50	$60.00		$3,000
801-01	Seeding (With Mulch)	UNIT	27	$22.07		$596
801-01.07	Temporary Seeding (With Mulch)	UNIT	27	$15.75		$425
	Landscaping	LS	1	$15,000.00		$15,000
				TOTAL ESTIMATE		$54,021

This estimate of probable cost is based on placing a berm to detain the stormwater generated on the golf course prior to it flowing into Jordan Branch. Some tree removal may be required. No work in the stream is anticipated. The cost of the following items are not included in the estimate of probable cost, but will be additional cost if this alternative is selected.

1. Golf Course Property Easements
2. Mobilization
3. Tree Removal (~$1,000 per tree based on 2012 stream project in Franklin)
4. Clearing and grubbing
5. Erosion prevention and sediment control
6. Stormwater outfall protection to stop existing headcutting
7. Option 4a - Floodplain storage area

Estimate of "Big Ticket" Items

Option 5 - Encapsulate Jordan Branch in 1,200 feet of 8ft x 4ft Reinforced Concrete Box Culvert

ITEM	Description	UNIT	QTY	UNIT COST		Total Cost
203-01	Road & Drainage Excavation (Unclassified)	CY	487	$20.00		$9,740
203-07	Furnishing & Spreading Topsoil	CY	788	$20.00		$15,760
209-65.04	Temporary In Stream Diversion	LF	1,200	$19.03		$22,836
303-01.01	Granular Backfill (Roadway)	TON	5,996	$6.45		$38,674
604-02.01	Class A Concrete (Box Bridges)	CY	934	$352.59		$329,319
604-02.02	Steel Bar Reinforcement (Box Bridges)	LB	237,543	$0.81		$192,410
801-01	Seeding (With Mulch)	UNIT	155	$22.07		$3,421
801-01.07	Temporary Seeding (With Mulch)	UNIT	155	$15.75		$2,441
	Landscaping	LS	1	$50,000.00		$50,000
	Stream Mitigation In System	LF	1,200	$240.00		$288,000
				TOTAL ESTIMATE		$952,601

This estimate of probable cost is based on encapsulating 1,250 feet of Jordan Branch in an 8ft x 4ft reinforced concrete box culvert. Tree removal will be required. In system stream mitigation will be required. The cost of the following items are not included in the estimate of probable cost, but will be additional cost if this alternative is selected.

1. Stream mitigation cost greater than $240 per linear foot. In system stream mitigation may include property accusitions, additional design, construction cost, and post construction monitoring based on selected site.
2. Mobilization
3. Tree Removal (~$1,000 per tree based on 2012 stream project in Franklin)
4. Clearing and grubbing
5. Erosion prevention and sediment control
6. Drainage system to convey stormwater from adjacent properties
7. Connecting proposed culvert to existing culvert under Cliffe Run