Risk Mitigation Plan

Coldstream Park Stream Corridor Restoration and Preservation Consent Decree SEP

Prepared for
Lexington-Fayette Urban County Government
Division of Water Quality
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Risk Management Plan

Background Information:

The information in this Risk Mitigation Plan is associated with the Coldstream Park Stream Corridor Restoration and Preservation Consent Decree Supplemental Environmental Project (SEP). This project involves the restoration of 4,415 l.f. of Cane Run. The stream is located within Coldstream Park, which is approximately south of I-75 and west of Newtown Pike in Lexington, KY. This area is located within the Inner Bluegrass karst region, which is one of four major karst regions in Kentucky and is underlain by Lexington Limestone. Karst is a landscape with sinkholes, sinking streams, caves, and springs. Karst areas develop because they are underlain with limestone or dolomite. In Kentucky 55% of the state is underlain by rocks (e.g. limestone dolostones) that could develop karst features given enough time. Karst features form in natural cracks within the limestone as the limestone is slowly dissolved away by weak acids found naturally in rain and created by decomposition of organic material in soils.

Several types of karst features are located within and near the project area including swallow holes, sinkholes, and sinking springs. Swallow holes are points along a stream where surface flow is lost to underground conduits. A sinkhole is any depression in the surface of the ground from which rainfall is drained underground. Karst sinkholes form when a fracture in the limestone bedrock becomes enlarged (i.e. has had enough exposure to rainfall to develop). Sinking streams are surface-flowing streams that disappear under-ground. Downstream of the project area in Scott County, during normal- and low-flow conditions, Cane Run sinks into an underground conduit system referred to as the Royal Spring groundwater basin. During significant rainfall events when surface runoff exceeds the intake capacity of the karst aquifer, Cane Run flows its entire course and discharges into Elkhorn Creek. It is estimated that this high-flow condition exists for less than 30 days throughout the year.

The Royal Spring groundwater basin is a shallow conduit-flow aquifer that is directly connected to and fed by karst features throughout the Cane Run watershed. It is formed in two major karst-forming units within the Lexington Limestone, the Tanglewood and Grier members, which are relatively soluble with well-developed secondary porosity along bedding planes and joints. The exact location of the conduit is not known within the project area but it is 60 feet below existing surface elevations at the Kentucky Horse Park monitoring station. The highest discharge Kentucky Geological Survey has measured to date in the conduit below the project area is 1.7 cubic meters per second (~70 cfs).

Potential Risks Associated with Project:

- <u>Risk 1 Change in Flow</u>
  - Potential for a complete diversion of surface flow and/or drainage of gravel/epikarst flow system into underground conduits.
    - High probability.
    - Neutral detriment as this is the present condition during periods of low flow. The worst case scenario associated with this risk would be the duration of the completely dry channel increases.

- The hydroperiod of the stream will be modified for low flow, base flow, and flood flow regimes creating the possibility that base flow conditions will be reduced by relocating the channel.
    - Low probability.
    - The water budget will not be changed with the completion of the project. There is only a certain amount of flow the conduit can hold before surface water flow is evident. Additionally, there is existing evidence (trees growing in the middle of the channel) that the lower section of the stream dries during low flow periods. In Scott County it is documented that the stream dries each summer by going underground (ie. sinking).
- Potential significant long-term change in flow to Royal Springs.
    - Low probability.
    - If during low-flow conditions the surface water was maintained for a longer period, it would still sink into the conduit because of existing swallow holes downstream of the project area. High flow conditions will continue to be the same because the water budget will not change.
- Mitigation Measures: The design will take into consideration the interrelationships of surface and karst flow regimes. It will not be the intent to either develop or close off access to the karst conduits. Further, the design goal will also be to expand the floodplain area or extent, by designing a more stable and healthy stream condition that restores appropriate slopes and bank heights allowing access to the floodplain. Groundwater dams located upstream of known swallow hole can help maintain stream flow on the surface, especially post event.

- <u>Risk 2 Creation of New Karst Features</u>
    - Opening of a historic or new swallet hole in the reconstructed portion of the stream.
        - High probability.
        - Neutral detriment as this is the present condition. With the current understanding of the connectivity between the surface water and underground conduit, relocating the stream does not create any greater concern that other risks identified. The water budget will not change within the project area and the connectivity between the surface water and ground water systems is not anticipated to be appreciably changed by relocating the stream.
    - Mitigation Measures: Rock excavation will be avoided to the maximum extent practical to minimize the risk of opening new swallet holes. While this occurrence is likely without any stream work at all, it can be exacerbated by not paying attention to this risk during design and during the earthmoving activities.

- <u>Risk 3 Downstream Impacts</u>
    - Potential diversion of valley groundwater or surface flow to underground conduits leading to the quarry.
        - Low probability.
        - Neutral detriment as this is the present condition. Surface water flow currently floods the quarry and direct subsurface conduits already link the quarry to the main conduit that feeds Royal Springs.

- If project results in increased overland flow due to reduced swallow hole intake, it is possible to increase downstream flooding.
  - Low probability.
  - This has a low detriment because the area downstream is rural (agricultural land use) and existing swallow holes downstream will allow the stream access to the conduit.
- Increase in turbidity at Royal Springs during construction.
  - High probability.
  - Introduction of the stream to the newly constructed reaches may entrain loose sediment into the stream flow, which in turn may find its way into the conduit system that feeds Royal Spring. This is anticipated to be a short term, transient effect of low detriment.
- Mitigation Measures: Increased flood flow potential downstream can be minimized through the anticipated design of multiple wetlands in the floodplain area that will capture and reduce flood flow volumes. Within the stream corridor itself, groundwater dams can help establish more pools, reduce peak flows, and extend the duration of the event hydrograph; all of which can dampen the impact of flood flow events. Increased turbidity will be a temporary condition during the construction period and the impacts will be minimized by enhanced erosion prevention and sediment control measures that may include phased construction, open space preservation (limiting mass stripping and grading), multiple layers of perimeter controls (mulch berms followed by silt fences for example).

- <u>Risk 4 Existing Sanitary Sewer Adjacent to Project Area</u>
  - Sanitary sewer line may be undermined.
    - Low probability.
    - This is a high detriment possibility where the coincidental alignment of a sewer-pipe joint and adequate stream flow creates either the washing out of sediment from beneath the sewer-pipe joint or the creation of a new swallow hole resulting in sewer-pipe joint failure.
  - Mitigation Measures: The best measure is to lower the sewer pipe to remove the risk of undermining and this option will be investigated. Stream alignments transitioning to this pipe location will take into consideration the pipe joint locations to avoid having them in the main stream channel location if at all possible. Additional measures that can be evaluated include a concrete approach and exit ramp (essentially a cap), or a cut off trench below with transitional wedges to make a smooth transition (more like a pipe saddle).

Summary:

Risk	Probability	Effect	Mitigation Measures
Complete diversion of surface flow and/or drainage of gravel/epikarst flow system into underground conduits	High probability	This is the present condition during periods of low flow.	Groundwater dams upstream of entry points to the underground conduits.
Base flow conditions may be reduced by relocating the channel	Low probability	The water budget will not change within the project area.	Groundwater investigations will identify base flow potential and the design will attempt to mimic or improve this condition.
Significant long-term change in flow to Royal Springs	Low probability	The surface/groundwater connections will still be in place below the project area allowing any increase in surface flow to access the conduit.	The goal is to neither enhance nor close off connections to the underground conduit. Rock excavation will be limited.
Opening of historic or new swallow holes with the relocation of the stream	High probability	The surface water is currently connected to the groundwater.	Minimize rock excavation and understand the rock profile so that it can be accounted for in design.
Diversion of surface or groundwater flows to the existing quarry downstream	Low probability	The quarry currently has surface water and groundwater connections.	The goal is to neither enhance nor close off connections to the underground conduit. Rock excavation will be limited.
Increased overland flow could result in increased flooding downstream	Low probability	The project area is rural downstream and existing swallow holes downstream of the project area access the conduit.	Wetland storage and infiltration, in-stream structures to create and maintain pools.
Increase in turbidity at Royal Springs during construction	High probability	Short-term effect, possible only during construction.	Enhanced Erosion prevention and sediment control, limit extents of disturbance at any given time.

Risk	Probability	Effect	Mitigation Measures
Existing sanitary sewer line may be undermined.	Low probability	Sewer-pipe failure due to stream flow creating instability under sanitary sewer pipe or new karst feature.	Lower sanitary sewer line. Avoid transitioning stream into pipe joint locations. Create smooth transition along with more structurally sound protection (concrete cap or cut-off saddle)

Sources:

Currens, J.C., 2002. Kentucky is karst kountry! What you should know about sinkholes and springs. Kentucky Geological Survey.

Zhu, J., Currens, J.C., and Dinger, J.S., 2011. Challenges of using electrical resistivity method to locate karst conduits – A field case study in the Inner Bluegrass Region, Kentucky. Journal of Applied Geophysics 75 (2011) 523-530.

Technical Memorandum

Coldstream Park Stream Corridor Restoration and Preservation Consent Decree SEP

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Executive Summary

The Coldstream Park Stream Corridor Restoration and Preservation Consent Decree Supplemental Environmental (SEP) Project is located in Lexington, KY. Field work has been completed for the project and project monitoring to establish baseline data for the project area has been established. Geotechnical results from the field work were discussed to determine feasible alternatives for the project and ultimately the preferred alternative to move forward into the next design phase. The alternatives are summarized below in Table 1.

Table 1: Alternatives Comparison

	Alternative 1 Excavate a new floodplain	Alternative 2 Raise the channel	Alternative 3 Bank stabilization	Alternative 4 No Change
Purpose of the SEP*:				
Reduce Flooding	Yes	No	No Change	No Change
Reduce pollutant loadings entering Cane Run	Yes	Yes	Yes	No Change
Enhance Recreation and Education Opportunities	Yes	Yes	Yes	No
Project components and requirements*:				
Channel stabilization through use of appropriate natural design parameters	Yes	Yes	No	NA
Enhance amphibian habitat	Yes	Yes	No	NA
Floodplain design – habitat, pollutant uptake, groundwater recharge, and restoration of base flows	Yes	Yes	Yes	NA
Habitat restoration throughout the greenway	Yes	Yes	Yes	Partial
Pros:	Increases habitat, reduces erosion, reduces flooding, and provides stormwater treatment in floodplain.	Increases habitat and reduces erosion.	Limited habitat improvement, less excavation.	Does not meet the purpose of the project.
Cons:	Requires more excavation and exposes more of the soil/rock interface	Increases flooding, construction and maintenance of a grade control structure to tie into downstream channel.	Armored channel, increased maintenance, limited stormwater treatment, and concern for long-term stability of the system.	Does not meet the purpose of the project.

*From Appendix J-1 of Consent Decree for LFUCG

Alternative 1 is the preferred alternative that best meets the purpose of the SEP and has the project components and requirements also described in the SEP. This alternative provides long-term stability for the project that can be met in a feasible manner.

Introduction

The Coldstream Park Stream Corridor Restoration and Preservation Consent Decree Supplemental Environmental Project (SEP) will be funded by Lexington Fayette Urban County Government (LFUCG) to resolve alleged violations of the Clean Water Act as agreed upon by LFUCG and U.S. Environmental Protection Agency (EPA). The project area is located west of Newtown Pike and south of I-75. The project will provide stream bank stabilization, habitat restoration, and greenway creation in Coldstream Park with the restoration of a 4,415 l.f. of Cane Run.

This section of Cane Run has been degraded due to straightening, stream bank erosion, and downcutting of the stream channel resulting in disconnection from the floodplain. The stream banks of Cane Run are severely denuded due to past free grazing of cattle during the park's history as a University of Kentucky agricultural research facility. The drainage area includes commercial, industrial and residential land uses. Runoff from this stream ultimately recharges the Royal Springs Aquifer, which is a raw water supply for the City of Georgetown municipal water system.

Per LFUCG's Consent Decree this SEP will serve multiple purposes including the reduction of flooding by removing artificial restrictions within the floodway, reduce pollutant loadings entering Cane Run through the use of green infrastructure concepts that minimize erosion and maximize infiltration, and enhance the recreational and educational opportunities within the Urban Service Area by enhancing passive land use within the park system and habitat restoration. Additional purposes stated in the RFP for this project per LFUCG include stabilize the channel, restore habitat, reduce peak flows, and create a permanent greenway. Project components and requirements (LFUCG Consent Decree) include the following:

- Natural channel design parameters appropriate to the Inner Bluegrass. The elevation of the baseflow will be adjusted for maximum habitat improvements and floodplain hydrology restoration;
- Backwater areas and vernal pools to enhance floodplain habitat;
- Infiltration basins built into the floodplain to provide additional terrestrial habitat and to enhance pollutant uptake, groundwater recharge, and restoration of healthy baseflows; and
- Habitat restoration in bordering areas throughout the greenway.

1. Site Description

1.1 Hydrology

The hydrology of the project area has been reviewed utilizing several available resources. A Log Pearson III analysis was completed on 12 years of peak flow data available at the USGS gage station located downstream of the project (USGS 03288200 Cane Run at Berea Road near Donerail, KY). The drainage area at this gage station was 19.9 mi^2. Two cross sections from available Flood Insurance Studies (FIS) for the project area were reviewed. The first cross section is located at the upstream side of the I-75 Bridge and the second cross section is located 4,000 ft upstream of the I-75 Bridge. Flows were generated from the USGS Kentucky StreamStats website and compared with the equations in *Estimating the Magnitude of Peak Flows for Streams in Kentucky for Selected Recurrence Intervals* (Hodgkins, G.A. and Martin, G.R., 2003). Finally, in 1998 the University of Kentucky contracted PEH Engineers to complete a study of the Cane Run watershed to assess site stormwater detention requirements for the proposed development of the Coldstream Research Campus.

The Log Pearson III analysis had similar flow values to the PEH study at Donerail for the 2 and 10 year events. The variability in the 50 and 100 year events can be attributed to the limited gage data available at Donerail. The flow results from the FIS study within the proximity of the study area are generally higher than the PEH study, the regression equations estimating peak flows, and the USGS KentuckyStreamStat website. Flows from FIS will be utilized in designing the new floodplain widths with appropriate shear stresses. To assess the stability of the stream, flows from several of the sources identified will be utilized to compare shear stresses. Flow values are summarized in Table 2.

Table 2 Summary of Available Project Area Flow Data

Method or Source	Q_2	Q_{10}	Q_{50}	Q_{100}
Log Pearson III – USGS Site Donerail	1000	3595	8354	11386
PEH Study at Donerail Existing	1510	3104	5049	6111
PEH Study at Donerail Proposed	1716	3356	5341	6524
HEC2 – FIS (I-75 Bridge)	NA	2836	4082	4715
HEC2 – FIS (4000 feet u/s of I-75)	NA	2758	3959	4570
PEH Study at I-75 Existing	1146	2274	2668	3105
PEH Study at I-75 Proposed	1187	2260	2697	3127
Regression Equations (Hodkins, 2003)	565	1104	1652	1898
KentuckyStreamStats website	565	1104	1652	1898

1.2 Karst Topography/Groundwater

The project area is located within the Inner Bluegrass karst region, which is one of four major karst regions in Kentucky and is underlain by Lexington Limestone. Review of the “Fayette County Karst Areas” map categorizes the project area as “intense karst”. Additionally, Kentucky Geologic Survey (KGS) have identified several known swallets within the project area.

Downstream of the project area, during normal and low-flow conditions, Cane Run sinks into an underground conduit system referred to as the Royal Spring groundwater basin. During significant rainfall events when surface runoff exceeds the intake capacity of the karst aquifer, Cane Run flows its entire course and discharges into Elkhorn Creek. Kentucky Geological Survey estimated that this high-flow condition exists for less than 30 days throughout the year. Within the project area the project team observed that by March of 2012, the stream completely infiltrated into the ground at a point approximately 300 ft north of the Citation Boulevard Bridge. A significant portion of the flow upstream and under the Citation Boulevard Bridge comes from a small tributary that joins Cane Run just south of Citation Boulevard. The source of the water for the small tributary is a spring located within 200 ft of the Cane Run confluence.

1.3 Sediment Transport

In the upper section of the stream many riffle areas contain bed material where the intermediate axis measured approximately 100 to 150 mm. During March and April of 2012, this bed material was covered with algae, indicating that the large material was not recently mobilized. Most of the coarse bed material is dominated by small gravel and fines that appeared to be mobilized and transported on a frequent basis and are likely to compose the bulk of the bed material load. The primary sediment source to the project area is believed to be bank erosion.

During field reconnaissance in April 2012 a bed material sample was obtained and sieve analysis completed. The classification of the bed material sample was well graded gravel with a D_{50} of 4.22 mm. A riffle pebble count was collected using the Wolman methodology. Analysis of the riffle pebble count resulted in a D_{50} of 10.02 mm. The bed material sample and riffle pebble count results are shown in Table 3.

Table 3 Riffle and Preliminary Bedload Particle Sizes

Particle Size (mm)	Riffle (400 count)	Particle Size (mm)	Bed Material (mm)
D_{16}	3.02	D_{15}	0.47
D_{35}	6.79	D_{30}	1.94
D_{50}	10.02	D_{50}	4.22
D_{84}	21.67	D_{60}	5.76
D_{95}	37.73	D_{85}	12.47
D_{100}	179.98	D_{100}	38.1

1.4 Watershed Pollutants

Within the Cane Run watershed bacteria, nutrients, and sediment are the primary pollutants of concern. E.Coli concentrations routinely exceed primary and secondary contact standards. The in-stream fecal coliform target for primary recreational contact is a 30-day geometric mean of 200 colonies/100 ml, and an instantaneous maximum of 400 colonies/100 ml that must not be exceeded more than 20% of the time for the summer recreational period (i.e. May through October). For secondary contact recreation, the in-stream fecal coliform target is a geometric mean of 1000 colonies/100 ml, and an instantaneous maximum of less than or equal to 2000 colonies/100 ml 80% of the time, and this applies year round. Phosphorus is considered to be the limiting nutrient for eutrophication in the Cane Run Watershed. The in-stream total phosphorus target for warm water aquatic habitat (WWAH) is 0.3 mg/L. Current pollutant concentrations and pollutant loads entering the project area are shown in Table 4 below. The Simple Method was used for this estimation of pollutant load with data from the Cane Run Watershed Plan being utilized in part of the calculation.

Table 4 Existing Concentrations and Estimated Pollutant Loads

	Fecal (CFU/100mL)	P (mg/L)	N (mg/L)	TSS (mg/L)
Existing Concentrations*	4342.38	0.34	0.16	12.79
	Fecal (colonies)	P (lbs)	N (lbs)	TSS (lbs)
Existing pollutant loads*	1.3×10^{12}	225,405	106,073	8,479,203

* Water quality samples collected at Citation Boulevard Bridge (drainage area 5.6 mi^2)

1.5 Engineering considerations/site constraints

There are several constraints within the project area.

- The karst topography is a concern for the design and construction of the project area. Field work has been completed and available data gathered to understand the risks associated with construction in this area.
- The land for the project area is currently used as a "passive" park and is managed by Fayette County Division of Parks and Recreation. Parks and Recreation have identified future improvements in the park that include the addition of a bathroom facility at the Trailhead parking lot and expansion of the existing parking lot facility.
- Existing infrastructure within the project area identified as site constraints include Legacy Trail, which was constructed in 2010 and a sanitary sewer main that approximately parallels Legacy Trail.
- Existing infrastructure downstream of the project area include the Cane Run sanitary sewer pump station. A sanitary sewer pipe crosses Cane Run downstream of the project area. This sanitary sewer crossing controls channel grade and causes backwater into the downstream end of the proposed project area. The sewer line crossing has a direct impact on the stream profile for approximately 1,000 ft upstream.
- Two Bur Oaks that estimated to be more than 250 years old are located within the project area in close proximity to one another. To protect the trees additional consideration will be required during design to provide adequate floodplain access to the stream and minimize shear stresses.

2. Summary of Field Work

Field work for the project was completed in April 2012. From Citation Boulevard to the north boundary of the project area, cross sections were spaced at 200' intervals with Geoprobe points taken every 20' across each section. The results showed that the bedrock surface varied significantly throughout the project area. Test pits were dug throughout the project area, which were generally located at the Geoprobe cross sections. The soils were predominately dark brown clays on top and became sandier at the deeper depths. CSI Kentucky, the project team geotechnical consultant, determined that the soil in the test pits was a residual soil, which means it is weathered from bedrock and has remained at the place of formation. The clays went from lean to fat in the soil profile, indicating the less permeable clays were located towards the bottom. Within this geographic area the distinction between lean and fat clays is very minimal because they are so similar. No groundwater was found in any of the test pits.

Pit traps were installed at the upstream limits of the project area. The pit traps will be utilized to sample bed material load entering the project area. Additionally, three water level loggers were installed. The first water level logger was installed adjacent to the pit traps and will measure flow stage during flow events that mobilize and transport bed material. The other water level loggers were installed in two different pools within the project reach to provide additional verification of the existing hydroperiod.

3. Alternatives Descriptions

The project area for the SEP is oriented in a north-south direction and is divided by the Legacy Trail, which is a multi-use pedestrian trail. Cane Run is located west of the Legacy Trail and flows in a northerly direction. McGrathiana Parkway is an existing road located east of Legacy Trail and is the east boundary of the SEP for part of the project. McGrathiana Parkway has five (5) storm sewer structures that direct stormwater runoff through grassed swales to five (5) storm sewer structures located under Legacy Trail. The project area west of Legacy Trail focuses on the restoration of Cane Run and the project area east of Legacy Trail focuses on stormwater quality improvements by utilizing green infrastructure concepts. However, design elements that improve water quality and increased aquatic habitat are utilized throughout all areas of the SEP.

Described below are the four (4) design alternatives considered for this project. These alternatives coincide with the natural channel design approaches I, II, and III shown in Figure 1. Development of these alternatives occurred after the field data was collected and reviewed. From the field data collected the following points were observed:

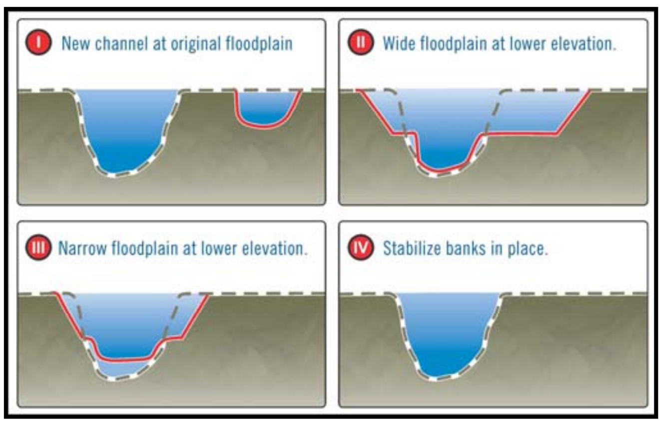

Figure 1 Types of Natural Channel Design

- There was no clear evidence of a historic channel in the valley bottom soil profile;
- No clear indication of alluvial sediment was found in the test pits;
- Woody debris and other coarse organic matter was not present in the valley soils;
- Some alluvial fill material appears to be present on the valley bottom adjacent to the existing stream; and
- Existing stream appears to have downcut due to alterations of the stream channel and urbanization of the upstream watershed.

3.1 Alternative 1

Alternative 1 The existing stream elevation would be maintained or raised slightly and a new floodplain would be excavated. Grade control would be placed across the entire floodplain to maintain vertical control. The floodplain would be designed for an acceptable range of shear stresses, generally 1.5 psf or less, which allows for some increase in sinuosity of the channel planform. Wetlands would be created throughout the floodplain to provide water quality treatment and habitat. This alternative would reconnect the floodplain to the stream, increase habitat, treat the "first flush", reduce shear stress on the bank and reduce erosion, reduce the flooding frequency of Legacy Trail, reduce the potential for floods overtopping the sewer line, increase the frequency of stormwater treatment. This alternative would require more excavation and would create more exposure of the existing soil/rock interface than the other listed alternatives.

3.2 Alternative 2

Alternative 2 The channel would be raised such that the top of the bankfull channel would match the existing floodplain elevation. Grade control would be utilized to maintain vertical stability. Wetlands would be created throughout the floodplain to provide water quality treatment and habitat. This alternative would reconnect the stream to the floodplain, increase habitat, and reduce bank erosion. However, this alternative would increase the flooding frequency and duration of Legacy Trail, increase the frequency and duration of no flow in the channel, and will require a construction and maintenance of a massive grade control structure at the end of the project to transition flood flow from the high floodplain and elevated channel to the existing downstream incised channel.

3.3 Alternative 3

Alternative 3 Existing banks and channel would be stabilized in the current alignment and a narrow floodplain bench would be created at a lower elevation. This alternative is more "typical" of current restoration practices than other alternatives and would generally require less excavation than other alternatives. Disadvantages associated with this alternative include no hydraulic connectivity between the stream and the floodplain, no shear stress reduction in the channel which will require armoring most of the channel, increased maintenance issues related to the high shear stress channel, no stormwater treatment, no long-term reduction in sediment erosion, and any wetlands constructed will be perched on the existing floodplain and not hydraulically connected to the stream channel.

3.4 Alternative 4

Alternative 4 is to project the project area with a conservation easement and plant additional plants or let the area secede naturally with no construction proposed. This alternative will cost less but does not meet the requirements of the Consent Decree.

3.5 Green Infrastructure Concepts

Stormwater runoff from the Coldstream Research Park will be directed through a series of wetlands before flowing through existing storm sewer infrastructure under Legacy Trail. The wetlands will provide a treatment train approach that will improve water quality, treat the first flush, provide additional storage, and create habitat. Wetland construction techniques will vary depending on the purpose of each wetland. Vernal pools will be created in some of the wetlands to provide habitat, while some of the wetlands will be designed function more as infiltration basins. A fishing pond is being proposed that will have wetland habitat around the fringes but will be deep enough to support native fish species for recreational fishing. Additionally, existing storm sewer runoff from McGrathiana Parkway will be directed into the fishing pond after being treated through a series of wetland step-pools.

4. Alternatives Comparison

Review of field work completed and available data for the project area has allowed the design team to get a better understanding of the geomorphology and hydrology of this stream system. This understanding was used to develop and compare alternatives. Alternatives 1 and 2 both re-establish the hydrologic connection between the stream and floodplain during periods of flows. Alternatives 1 and 2 are anticipated to be the most similar to what was there previously. Alternative 3 does not apply the best available natural channel design techniques to this project and does not represent the type of channel that is believed most suitable for the project area. Alternative 4 makes no changes to the existing system.

Floodplain habitat would be established to varying degrees with Alternatives 1, 2, and 3. The floodplain for Alternatives 1 and 2 would be designed to include habitat features such as woody debris, backwater areas, and vernal pools. Vertical grade control would be established throughout the length of the project that would extend across the floodplain to maximize the potential for surface water hydrology and floodplain restoration. Alternative 3 would not establish a hydrologic connection between the stream and floodplain. Any wetlands or habitat features (i.e. vernal pools) created in the floodplain for Alternative 3 would be perched. The creation of backwater areas would be limited with this design approach. Alternative 4 makes no changes to the existing system.

For Alternatives 1, 3, and 3 water quality best management practices (BMPs) would be utilized between Legacy Trail and McGrathiana Parkway to treat stormwater runoff entering the floodplain before it reaches Cane Run. Wetland cells would be designed to provide terrestrial habitat and provide pollutant uptake and filtering. In areas that do not have suitable soils to create wetlands through compaction, the wetland would be designed to infiltrate water with a smaller liner placed in the bottom 2/3 of the wetland to hold a small pool of water in order to increase habitat. The wetlands would naturally filter water and with the selection of appropriate vegetation, pollutant uptake would increase. Due to the karst nature of the project area and proximity to the underground conduit, groundwater recharge occurs continuously. None of the alternatives are anticipated to appreciably alter groundwater recharge within the project area. Preliminary monitoring of the project area and review of available data has indicated that the baseflow is highly variable. The proposed BMPs are anticipated to hold water on the surface for longer periods of time. Alteration of the stream base flow is not anticipated with Alternatives 1, 2, or 3 and is a result of the surface/groundwater connectivity in the area. Alternative 4 makes no changes to the existing system.

Alternatives 1, 2, and 3 involve the construction of numerous wetland cells and vernal pools throughout the greenway. The design and construction of each wetland cell would vary depending on the purpose of that wetland (i.e. water quality, habitat). All the Alternatives would provide habitat restoration throughout the greenway with the planting of appropriate native tree, shrub, herbaceous, and wild flower species. The alternatives are summarized in Table 5.

Table 5 Alternative Comparison

Project Components	Alternative 1 Excavate a new floodplain	Alternative 2 Raise the channel	Alternative 3 Bank stabilization	Alternative 4 No Change
Use of Natural Channel Design Parameters	Yes	Yes	No	NA
Adjust baseflow to maximize habitat improvement and floodplain hydrology improvements	Yes	Yes	No	NA
Backwater areas and vernal pools to enhance floodplain habitat	Yes	Yes	No	NA
Infiltration basins built into the floodplain (terrestrial habitat, pollutant uptake, groundwater recharge, restoration of health base flows)	Yes	Yes	Yes	NA
Habitat restoration in bordering areas throughout the greenway	Yes	Yes	Yes	Partial

5. Preferred Alternative

Based upon the goals of the project, Alternative 1 is recommended for design and is anticipated to be the most suitable alternative for the project area. Plan sheets for the 30% Design Submittal have been submitted concurrently with this Technical Memorandum and illustrate the preliminary design concepts associated with Alternative 1. Topographic information was utilized to determine a minimum floodplain width of 100 ft. for Alternative 1 and still maintain a low shear stress system. This minimum width was drawn in and expanded in areas that were conducive to wider floodplain widths. In the next design phase the critical design decision to be made includes removal of the downstream sanitary sewer crossing and placement of grade control structures to provide long-term security of the project. After determination of those design decisions additional items for completion include the upstream and downstream transition areas, establishment of floodplain slopes, verification of channel shear stresses, and placement of floodplain grade control structures. Additionally, on-site resources will be further reviewed to determine the best utilization of available construction material. It is believed that clay is available on-site that meets the compaction requirements needed during construction of several project related items. Rock is potentially available within cut areas of the project and can be excavated downstream at the pump station where two underground storage tanks are to be constructed. Excavated soils can be wasted at approved locations adjacent to the project area on land owned by the University of Kentucky.

6. Schedule Update

This Technical Memorandum summarizes the 30% design submittal and the alternatives analyzed to date. With approval of the next Task Order the design team will move into 75% design, which is currently due August 31. Per LFUCG's approval, the 75% submittal date will be changed to September 28. The 95% design submittal is scheduled for October 31 of this year and the Consent Decree deadline is January 2, 2013.