BLUE RIVER CHANNEL MODIFICATIONS PROJECT
BRUSH CREEK TO 53RD STREET

REFINED CONCEPTUAL MITIGATION AND ENHANCEMENT PLAN

U.S. Army Corps of Engineers, Kansas City District
and the City of Kansas City, Missouri

DESIGNER OF RECORD APPROVAL

Work Product:

Refined Conceptual Mitigation and Enhancement Plan

Submittal Stage: Pre-Design

Discipline: Civil

Designer of Record: Thomas James Kimes

Signature: Thomas James Kimes

Date: 04-14-08

STATE OF MISSOURI
THOMAS JAMES KIMES
NUMBER
PE-025867
PROFESSIONAL ENGINEER
04-14-08

1.0 INTRODUCTION

As part of the Blue River Channel Modifications Project, Brush Creek to 53rd Street, the U.S. Army Corps of Engineers (USACE) and the City of Kansas City, Missouri (KCMO) have tasked ESI Contracting Corporation (ESI) and HDR Engineering (HDR) with environmental mitigation and enhancement design and construction services as part of the overall flood protection project. The project consists of approximately 3,700 linear feet of channel widening and realignment. Mitigation and enhancement features are proposed throughout the flood protection project reach.

A conceptual mitigation plan was submitted during bidding. This refined conceptual mitigation and enhancement plan describes key elements that will help create functioning and diverse habitats that are compatible with the flood protection project's purpose; uses green solutions; accomplishes sustainable long term water quality benefits; considers future plans for trail development; and helps meet minimum mitigation commitments made by the USACE. This refined conceptual plan is the result of a more detailed review and planning effort to better understand what environmental mitigation and enhancement features are best suited and feasible to use within the constraints of the flood protection channel project and adjacent properties.

2.0 CONCEPTUAL MITIGATION AND ENHANCEMENT PLAN

The refined conceptual mitigation and enhancement plan described below and shown on attached sheets is based on a natural systems approach using both physical and biological design features for in-channel and adjacent habitats. The features are described in this plan starting with in-channel work, then transitioning upwards and outwards away from the river channel into water quality best management practice (BMP) features and terrestrial habitat creation and preservation. Mitigation and enhancement features for this project are defined and understood as follows:

- Mitigation - The USACE's minimum mitigation commitments (per the EIS) for this reach, and other reaches, of the Blue River Channel Modification Project, is seeding and maintenance of native grasses. In addition, 15 acres of tree and shrub plantings were required by the EIS at non-specified locations for the entire Blue River Channel Modification Project. We are assuming some tree and shrub planting for this reach, although no information was available to ascertain whether the full 15 acres has been completed yet.

- Enhancement - Areas 1 & 2, called out in the USACE-provided design bid plans as mitigation areas, are actually contract-required enhancement areas. Enhancement features for this refined conceptual plan include Areas 1 & 2 and other areas as described further in this report and on refined conceptual plan sheets included in Attachment 1 of this document.

2.1 *In-Stream Habitat*

At yet to be determined locations within the designed base flow channel, in-stream structures are proposed as engineered channel stability features that can also function as in-stream aquatic habitat enhancement features. We've observed the stability of other completed flood protection reaches on the Blue River and have identified issues with lower bank stability, particularly on 1:70 slope benches in outer channel bend areas. In the Brush Creek to 53rd Street reach, we've identified opportunities for using in-stream structures to provide improved stability of the lower banks and potentially reducing maintenance. The objectives of channel stability features would be to provide bank and channel bed stabilization through decreasing near-bank shear stress and grade control, while also providing for aquatic habitat diversity and enhancement within the channel of the river. The selection and placement of the structures will be assessed based on such factors as bankfull sheer stress and stability during high flows, constructability, along with the dimension, pattern, and profile of the new channel (Rosgen 2006) (Doll et.al. 2003).

There are five main types of structures being considered for use in the project: bendway weirs, single/j-hook vanes, cross vanes, w-weirs, and Newbury riffles as described below. These structures are being considered based on a wide variety of factors that will be discussed further below. It is the intent of the designers to reuse available materials on-site for the construction of the in-stream structures where practical. The type, locations and size of the structures are subject to further engineering design. Typical design details for each structure can be found in Attachment 1.

- Bendway Weirs – A bendway weir is a low-profile upstream-angled stone sill keyed into the outer bank of a channel bend that is primarily intended to stabilize outer bend channel banks experiencing degradation. Bendway weirs are used to deflect flows away from outer banks and can provide an alternative to rip-rap for bank protection. Bendway weirs help eliminate bank erosion by reducing flow velocities and shear stress on the outer bank of the bend. This occurs by redirecting current flow and a channel's thalweg away from its bend more towards the middle of the channel. Sediment accretion typically occurs downstream of each weir structure, thus helping stabilize the toe of the channel bank. These types of structures are generally used on long reaches of relatively straight or gently curving banks that need protection. Bendway weirs can also provide enhancement benefits by increased habitat diversity and

complexity (Shields et al. 1995). Bendway weirs are being considered for this project primarily as channel stability features, with secondary habitat benefits, and are subject to further analysis.

- Single Vane/J-hook – Single vanes and J-hooks are similar in nature in that they are both upstream facing structures that are located along the outside of stream bends and can be composed of either rock, log, or a combination of both materials. The structure protects the streambank by redirecting the flow away from the streambank and toward the center of the channel. They also improve in-stream habitat by providing oxygen and cover. The vane portion of the structure occupies 1/3 of the bankfull width of the channel, while the "hook" portion of the j-hook vane continues out into the center 1/3 of the channel and creates a scour hole to dissipate energy and provide aquatic habitat. For this project, single and J-hook vanes are being considered as channel stability and habitat enhancement features. The design team is also considering incorporating single/j-hook vane design into riprap gutter design to address erosion problems noted in the field on the ends of several previously constructed gutters.

- Cross Vanes – A cross vane provides grade control, keeps flow directed towards the center of a channel, reduces velocities, and helps protect stream banks from erosion. The structure is constructed by creating two adjacent rock vanes with a center structure perpendicular to the channel. The structure can also increase habitat diversity by creating various riffle, pool, run and glide complexes within the channel. The use of these structures for this project is subject to further review and analysis.

- W-Weirs – A W-weir is the combination of two cross vanes within a stream channel to create a "W" shaped structure when looking downstream. These structures are very similar to cross vanes in that they provide grade control and protect streambanks from erosion. These structures are particularly designed for use in larger river systems. They are often deployed upstream of bridge crossings to aid in the protection against bank scour near bridge piers/abutments and could be used specifically on this project upstream from both the Blue Parkway and proposed Colorado Avenue bridges. These structures also help create habitat diversity within the channel.

- Newbury riffle structures – Newbury-style riffle-pool structures are an alternative to cross-vanes and w-weirs. Their use, placement, and construction is similar to the other cross-stream structures. Their function is also similar in that they direct water toward the center of the channel, aerate water, and serve as a grade-control structure. They differ from cross-vanes in that the legs are closer to perpendicular to the banks. These structures are often used in stream restoration to permit aquatic

species migration across the structure. This structure would be well-suited to medium-sized rivers.

Each structure has been qualitatively ranked against eleven criteria within six general categories (Table 1). The categories and criterion were developed based on overall importance to project goals, needs and concerns. Each structure was ranked with a high, moderate, or low rating for each criterion. The six categories consisted of structural, habitat enhancement, water quality, durability, constructability, and cost. The structural criteria consisted of channel toe stabilization and grade control, which considers the function and/or degree of the in-stream structure to protect the channel banks and to help prevent bed degradation. The habitat enhancement criteria were aquatic and wetland, which considers whether or not, and/or how well, each structure potentially, provides that wetland or aquatic habitat. The water quality criteria considers how well a structure functions to aerate water to provide dissolved oxygen, and how well a structure functions to accrete sediments for the potential development of small wetlands. The durability criterion considers the long term viability of the structure material(s) used. The constructability criterion considers the in-stream structures overall construction degree of difficulty based on comments received from the project construction contractor, ESI. The cost criterion evaluates the relative installation and maintenance costs of each structure based on ease of constructability and general quantities of materials needed, as well as long term structure maintenance costs.

Table 1: In-Stream Structure Evaluation Matrix

IN-STREAM STRUCTURE	STRUCTURAL		HABITAT ENHANCEMENT		WATER QUALITY		DURABILITY	CONSTRUCTABILITY	COST	
	Toe Stabilization	Grade Control	Aquatic	Wetland	Dissolved Oxygen	Sedimentation			Installation	Maintenance
W-Weir	*Moderate*	*High*	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*	*Low*
Single Vane	*Moderate*	*Low*	*High*	*Low*	*Moderate*	*Low*	*Moderate*	*High*	*Low*	*Low*
Bendway Weir	*High*	*Moderate*	*High*	*High*	*Low*	*High*	*High*	*High*	*Moderate*	*Low*
Cross Vane	*Moderate*	*High*	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*	*Low*
J-Hook	*Moderate*	*Low*	*High*	*Low*	*Moderate*	*Low*	*High*	*High*	*Moderate*	*Low*
Newbury Structure	*Moderate*	*High*	*High*	*Low*	*High*	*Low*	*High*	*Moderate*	*High*	*Low*

Note: Highlighted cells visually point out all high ranked criteria.

Table 1 provides some insight into the various pros and cons of each in-stream structure. In terms of similarity trends between in-stream structure types, all structures generally have moderate to high toe stabilization capabilities, high aquatic habitat function, and generally pretty high durability. Note that we

assumed a more moderate durability if recycled logs were used for some or all or vanes. In addition, all structures have low maintenance costs.

Another important criteria consideration is the need to provide for additional channel bed stability. We evaluated the existing and proposed channel bed gradient slopes, and discussed channel bed performance on previously constructed sections of the Blue River Channel Modifications Project with ESI. The information we evaluated provides no indication of appreciable channel bed degradation occurring on previously constructed sections. The necessity of bed stabilization measures such as w-weirs or cross vanes will be further analyzed during engineering design. These structures, if properly constructed, do provide relatively high aquatic habitat and dissolved oxygen benefits, as well as helping direct water into a designed flow path while reducing velocities. ESI has indicated these structures may present some constructability challenges in terms of difficulty in being able to construct across the channel and may potentially have higher material costs. One solution may be to construct cross-channel structures in tangent areas adjacent to temporary low water crossings to gain easier access, or to build these structures by salvaging temporary crossing material during their removal. We will further evaluate this during 35% design.

Bendway weirs were considered a potential solution to help prevent channel bank toe failure and subsequent bank scour. These have been used extensively by the USACE, and other government and non-government groups, as a solution to control and gradually repair extensive river bank scour in larger rivers, including navigable rivers. Bendway weirs are generally relatively easy to construct. We do have some initial concerns about backwater eddying and bank scour on the downstream side of weirs along the bank due largely to the flat nature of weir tops. HDR will further investigate USACE engineering guidance to evaluate these structures during 35% plan development. These may have more utility in other previously constructed reaches of the Blue River Channel Modifications Project where extensive bank erosion is occurring on the 1:70 benches in the low flow channel, particularly in other bends.

The remaining two structures evaluated, the single vane and j-hook, have been used successfully in river and stream restoration for years. These structures can provide many of the desired qualities for bank protection and aquatic habitat, as well as providing some water quality benefits to aerate water, helping to provide dissolved oxygen. These structures tend to more gently direct water away from channel banks, whereas a bendway weir tends to provide a more direct deflection of flow. The arms of vanes and j-hooks are slightly angled in the water from the bank, with a slightly down-sloped pointing projection going upstream. When placed in series, these may reduce erosive outer bend shear stresses and velocities much like bendway weirs, while minimizing current eddying effects and bank scour downstream of bank tie in points. When root wads are placed downstream of vanes or j-hooks near the bank, they can further help reduce or eliminate eddying effects and bank scour, while providing additional aquatic

habitat by providing cover and small collection points for leaves and organic debris necessary for aquatic macro-invertebrate insects. We will continue review of these structures during 35% design, as well as further investigate bendway weirs. The proposed placement, type, and number of structures will be detailed in the 35% submittal.

There are various levels of maintenance and monitoring that should occur during and after construction of in-stream structures. Designer oversight during construction is a best practice to verify that the design is properly constructed. Once construction is complete, the designer should revisit the structures after the first bankfull or similar high-flow event to document performance of each structure. In addition, any early re-vegetation needs on the adjacent banks should be addressed to avoid effects on the in-stream structures.

2.2 Storm Water Best Management Practices

In selected portions of the project area, storm water BMPs are proposed as enhancement features to provide water quality benefits, aesthetic values, and habitat and species diversity. Storm water BMPs proposed are consistent with KCMO's Wet Weather Solutions Program goals and recent comments received from the Blue River Stakeholders Meeting held 7 February 2008 (Attachment 2). The storm water BMP selection process was based on the Manual of Best Management Practices for Storm water Quality (2007) developed by Mid-America Regional Council (MARC) and the American Public Works Association (APWA) and is dependent on such factors as drainage area, slope, and the location of the BMP relative to the right of way boundary and other site constraints.

Note: Use of MARC/APWA BMP Manual for this project is not a contract or regulatory requirement, but rather, a useful tool for BMP planning, selection, and design.

Storm water BMPs are assigned a value rating (VR) based on four criteria: water quality value and reduction of runoff volume, temperature, and oils and floatables. BMPs are evaluated on these criteria to provide a measure of overall water quality protection. A higher VR indicates an increased water quality treatment efficiency and overall water quality improvement. BMPs were selected to provide the highest level of water quality treatment where feasible.

Below is the Storm Water BMP refined concept with descriptions of potential BMPs that may be employed throughout the area based on preliminary planning and engineering subject to further engineering analysis and design.

Storm Water BMP Refined Concept

The following list of storm water BMPs was developed as likely feasible for the proposed project area based on slope, drainage area, and boundaries and site constraints.

- Native Vegetation Swale – These consist of a swale drainage course with gently sloped sides and filled with vegetation, compost, and/or riprap. The water's flow path, wide bottom width and shallow depth are designed to maximize the time water spends in the swale, which aids the trapping and filtering of pollutants and silt. Native vegetation swales are most effective at removing sediment and have a VR of 4.0. These swales can treat runoff from five acre drainage areas or less. The design for native vegetation swales is based on flow rates for the water quality storm, 1% and 10% frequency storms. The velocity for the 50% event should not exceed four feet per second and the depth of water should not surpass four inches for the water quality event. Side slopes should not exceed a 3:1 horizontal to vertical (H:V) ratio and longitudinal slopes should range between 1.0-2.5% without the use of check dams.

- Wetland Swale – These are very similar to native vegetation swales, with one primary exception; the channel bottom is planted with emergent wetland vegetation adapted to wetter conditions. Wetland swales are highly effective at removing sediment, oil and grease, and organics, and have a VR of 6.5. Wetland swales should collect runoff from a drainage area no larger than five acres. Outlet structures should be designed to release the WQv in 40 hours and water depths should not exceed 18 inches for the water quality storm. Longitudinal slopes should be no greater than two percent with side slopes at a 3:1 (H:V) ratio or flatter.

Water quality BMP enhancements are proposed in four primary areas (Attachment 1) and discussed below. A preliminary site visit was conducted at each location to determine the feasibility of different types of BMPs. The proposed enhancements are preliminary in nature and subject to further engineering design.

- Area 1 – This area is located on the west bank of Blue River, between Blue Parkway Bridge and the proposed Colorado Avenue Bridge and is located entirely within Kansas City property. A native vegetation swale or wetland swale could be used in this location for water quality treatment. A forebay area would be used to intercept water from an inlet structure collecting flow from the contributing drainage area. The forebay area would reduce velocities and allow for sedimentation and collection of trash and debris. Runoff would be conveyed though the swale in a southwesterly direction and

discharge into a stormwater riprap gutter located near Station (Sta.) 107+00. The fill area previously proposed by HNTB in Area 1 would need to be modified slightly to allow for proper drainage within the swale.

- Area 2 – This area is located south of Blue Parkway Bridge on the east bank of the Blue River, and is located entirely within the City of Kansas City ownership. Area 2 consists of a low lying bench with a nice stand of mature trees that may become inundated periodically (Figure 1). HNTB's initial proposal called for this area to be filled and the trees removed. It is recommended that land disturbance be minimized in this area, preserving as much forested area as possible. Enhancement activities in this area could include removal of debris and planting of native grasses. Some small fill areas required in Area 2 will be re-vegetated with forest vegetation. This will result in slight adjustments to the side slopes of the proposed realigned tributary (confluence with the Blue River is at Sta. 101+70). Taliaferro and Brown, Inc aligned a preliminary trail to run through Area 2. As we are proposing to preserve this area if possible, rather than fill it, the design of the access roads will stop near Sta. 108+50 and 105+00 due to variation in elevations (Attachment 3). ESI had originally proposed to use Area 2 as a fill site, but will support the idea of preserving the area if only small fill quantities can be reasonably placed in Area 2. Topographic verification will be necessary before making a final recommendation to preserve Area 2.

Figure 1: Enhancement Area 2, general site photo.

- Area 3 – This area is located on the west bank of the Blue River between Sta. 87+00 and 100+00. Usable land in Area 3 for enhancements is restricted due to location of the permanent right of way, top of bank, and elevation limitations. Native vegetation swales are proposed in this location as water quality enhancement features. Vance Brothers, Inc operates an asphalt plant, which would drain into the proposed enhancement features. Vegetated swales could offer some water quality improvements as well as sediment removal prior to discharge into the Blue River. Discharge from these areas could outlet into the storm water riprap gutter near Sta. 93+00. Fill areas proposed by HNTB will need to be slightly modified to allow for proper swale drainage in these locations. Area 3 is also near the Burns properties, an area of several small tracts that KCMO has identified as a potential additional property acquisition if enhanced BMPs could be installed. While it is believed that acquiring these properties is generally beneficial, it is not necessary for functioning of the vegetated swale BMP shown in Attachment 1. The current surface elevations and drainage patterns of these tracts do not drain well towards the proposed vegetated swale and proposed river channel between stations 97+50 to 99+00. The benefit in acquiring these tracts would be to develop them for more green space and water quality purposes for the Blue River. This would be accomplished by removing impervious surface and planting with native grasses, forbs, shrubs, and trees. It is recommended that this area be further investigated during detailed design before making a final recommendation to the USACE and KCMO.

- Area 4 – This area is located on the east bank of Blue River between Sta. 95+00 and 99+00. It is recommended that cut areas be sculpted into a native vegetation swale for gradual conveyance into the side tributary. The proposed confluence of the side tributary with the Blue River is located approximately at Sta. 101+70. Fill areas near Area 4 are to be planted with forest vegetation.

The effectiveness and overall success of any BMP is dependent on regular maintenance and inspection, as provided in the Interim Operations and Maintenance Manual for the Blue River (2004). Proper long term maintenance will also improve aesthetics and increase the life of the facility. Maintenance for the proposed BMPs could include the following:

- Inspection of the BMPs

- Control vegetation by mowing or grubbing techniques (not by chemicals)
- Selective control of non-native or invasive species as appropriate

2.3 Vegetated Areas

The use of native vegetation throughout the project area will be used for the creation of terrestrial habitat. This would be accomplished through three main planting types within the site boundaries; grassland, forested/grassland, and BMP plantings. Planted species could include trees, grasses, rushes, sedges, and forbs adapted to regional conditions and selected from a local source when available. Along with re-vegetation of the project area, preservation areas have been identified at locations where impacts to existing riparian habitat can be avoided. The use of riprap would be minimized to the extent practical in vegetated areas.

Grassland Creation
To meet mitigation requirements and maintain the flow regime of the original design intent, native grasslands are proposed as the primary vegetation on the slopes and benches of the channel and over bank areas. These areas would created by planting various native grasses and forbs in the designated areas. The plantings would include warm- and cool-season grasses along with annual and perennial forbs. ESI is recommending that the lower 1:70 bench of the flood protection channel be excluded from seeding (or planting) based on past siltation accumulation problems on this bench from previous Blue River projects. The seed that was sown was smothered with silt deposition, thus not allowing germination. Furthermore, ESI has indicated that on past Blue River projects, they did not seed 1:70 benches in the channel at the direction of the USACE because of the sedimentation issue. The upper benches and slopes of previous constructed reaches don't appear to be accumulating silt, thus should not have problems with plantings or seed germination. Attachment 1 depicts a typical cross-section of the designed flood protection channel showing the planting areas of the flood protection channel. An example of grass and forb species that would be used for grassland creation plantings is provided in Table 2.

Table 2: Example Grassland Creation Native Grass and Forb Species List

Common Name	Scientific Name
Grasses	
Big bluestem	*Andropogon gerardii*
Canada wildrye	*Elymus canadensis*
Eastern gammagrass	*Tripsacum dactyloides*
Indian grass	*Sorghastrum nutans*
Little bluestem	*Schizachyrium scoparium*
Prairie dropseed	*Sporobolus heterolepis*

Side oats grama	*Bouteloua curtipendula*
Switchgrass	*Panicum virgatum*
Western wheatgrass	*Pascopyron smithii*
Forbs	
Black-eyed susan	*Rudbeckia hirta*
Blue sage	*Salvia azure*
Gray-headed coneflower	*Ratibida pinnata*
Purple coneflower	*Echinacea purpurea*
Wild bergamot	*Monarda fistulosa*
Hydrophytes	
Lurid sedge	*Carex lurida*
Rough-clustered sedge	*Carex sparganioidex v. cephaloidea*
Bulrush	*Scirpus spp*
Tussock sedge	*Carex stricta*
Rush	*Juncus spp*
Smartweed	*Polygonum spp.*

Forested/Grassland Creation

The development of a diverse forested riparian corridor along the channel bank and overbank areas would be beneficial in returning some of the area to its previous vegetated habitat and to help address comments received during the Blue River Stakeholder Meeting (Attachment 2). However, trees are not desirable on channel banks for hydraulic purposes of long term flood protection based on the Interim Operations & Maintenance Manual for the Blue River (2004). If the USACE or KCMO desire tree plantings on channel banks and benches, please advise ESI and HDR. One overbank area that is being proposed for a forested/grassland tree buffer strip is located along the west outer perimeter of Area 1 adjacent to and in conjunction with the storm water BMP area. Remnant concrete foundations would be removed with additional grading work to create the buffer strip and BMP. Seeding along this strip would generally include a similar seed mix as the grassland along with planting saplings of mast and non-mast producing tree species that are native to the area. Other overbank areas would be evaluated for tree plantings in concert with the hydrologic and hydraulic analysis. Table 3 provides example tree species that may be planted in these areas. Over time, natural ecological succession processes may transition this habitat type into more of a forested riparian habitat similar to that which exists in some undeveloped areas along the Blue River today.

Table 3: Example Forested/Grassland Creation Tree Species list

Common Name	Scientific Name
Silver maple	*Acer saccharinum*
Ohio buckeye	*Aesculus glabra*
Downy serviceberry	*Amelanchier arborea*
Pawpaw	*Asimina triloba*

River birch	*Betula nigra*
Pecan	*Carya illinoensis*
Shagbark hickory	*Carya ovata*
Persimmon	*Diospyros virginiana*
Green ash	*Fraxinum pennsylvanicus*
Honey locust	*Gleditsia triacanthos*
Sweetgum	*Liquidambar styraciflua*
Black cherry	*Platanus occidentalis*
White oak	*Quercus alba*
Bur oak	*Quercus macrocarpa*
Slippery elm	*Ulmus rubra*
Viburnum	*Viburnum spp.*

BMP Areas

Plantings required for BMPs are dependent on the functional goals of each individual BMP. The size, grading elevation, hydrologic conditions, and any maintenance program that is developed for the BMPs will play a crucial role in the selection of species to be used in each location. Table 4 contains example herbaceous species that could be used in the proposed BMPs.

Table 4: Example BMP Species list	
Common Name	**Scientific Name**
Wetland Swale	
Pointed broom sedge	*Carex scoparia*
Switchgrass	*Panicum virgatum*
Fowl manna grass	*Glyceria striata*
River bulrush	*Scirpus fluvialtilis*
Native Vegetation Swale	
Big bluestem	*Andropogon gerardii*
Little bluestem	*Schizachyrium scoparium*
Prairie cordgrass	*Spartina pectinata*
Virginia wildrye	*Elymus virginicus*

Preservation Areas

Two areas of existing forested riparian habitat within the project boundary on KCMO property have been identified as preservation areas as shown in Attachment 1. One area is located southeast of the future Colorado Avenue Bridge over the Blue River, while the second is associated with BMP Area 3 previously described. Both are located along the future trail alignment (Attachment 3) along the Blue River. Two additional forested riparian areas were initially identified for permanent preservation, but later discounted because they were determined to be on private property which KCMO has no control over land use activities. Therefore, we are not considering these as preservation areas, but rather would be avoided during construction.

Preservation areas would be protected from clearing, grubbing and construction activities. If desired, additional enhancement for these preservation areas would be the removal of undesirable species and seeding or planting of desirable ones. Undesirable species may include species that are invasive or exotic. Undesirable species are rapid colonizers that may limit the growth of other desirable native species. Some undesirable species known to occur in the area of the project that could be removed include honeysuckle (*Lonicera* sp.), osage orange (*Maclura pomifera*), buckbrush (*Symphoricarpos orbiculatus*) bristly greenbrier (*Smilax tamnoides*), and garlic mustard (*Alliaria petiolata*). Removal could consist of select tree and shrub clearing, or chemical removal of shrubs and forbs, and grinding up stumps and cleared trees into wood chips. Woods chips could be used for temporary erosion control berms or for low impact trail development.

The long term success of all vegetated areas will be dependent in part, upon following the Interim Operations & Maintenance Manual for the Blue River. General maintenance and management measures would vary from year to year and could include mowing or prescribed burning (only as deemed safe by KCMO and local laws), and the application of EPA approved herbicides.

3.0 REFERENCES

Doll, B.A., G.L. Grabow, K.R. Hall, J. Halley, W.A. Harman, G.D. Jennings and D.E. Wise, 2003. *Stream Restoration: A Natural Channel Design Handbook*. NC Stream Restoration Institute, NC State University.

Mid-America Regional Council/American Public Works Association. 2007. *Draft Manual of Best Management Practices for Stormwater Quality*.

Rosgen David L., P.H., Ph. D.. 2006. *Cross Vane, W-weir, and J-hook Vane Structures – Description, Design and Application for Stream Stabilization and River Restoration*. Wildland Hydrology Inc. Fort Collins, CO.

Shields, Jr. F.D., Knight, S.S., and Cooper, C.M. 1995. Streambank Protection and Habitat Restoration. Volume 1 of the ASCE conference, The First International Conference on Water Resources Engineering, San Antonio, TX. p. 721-725.

US Army Corps of Engineers. 2004. Interim Operations & Maintenance Manual for the Blue River.

Attachment 1
Brush Creek to 53rd Street Refined Conceptual Mitigation and Enhancement Plans

PLAN

SCALE: 1" = 50'-0"

US Army Corps of Engineers
Kansas City District

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Description	Initials	Date
1	INTERIM ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN		

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

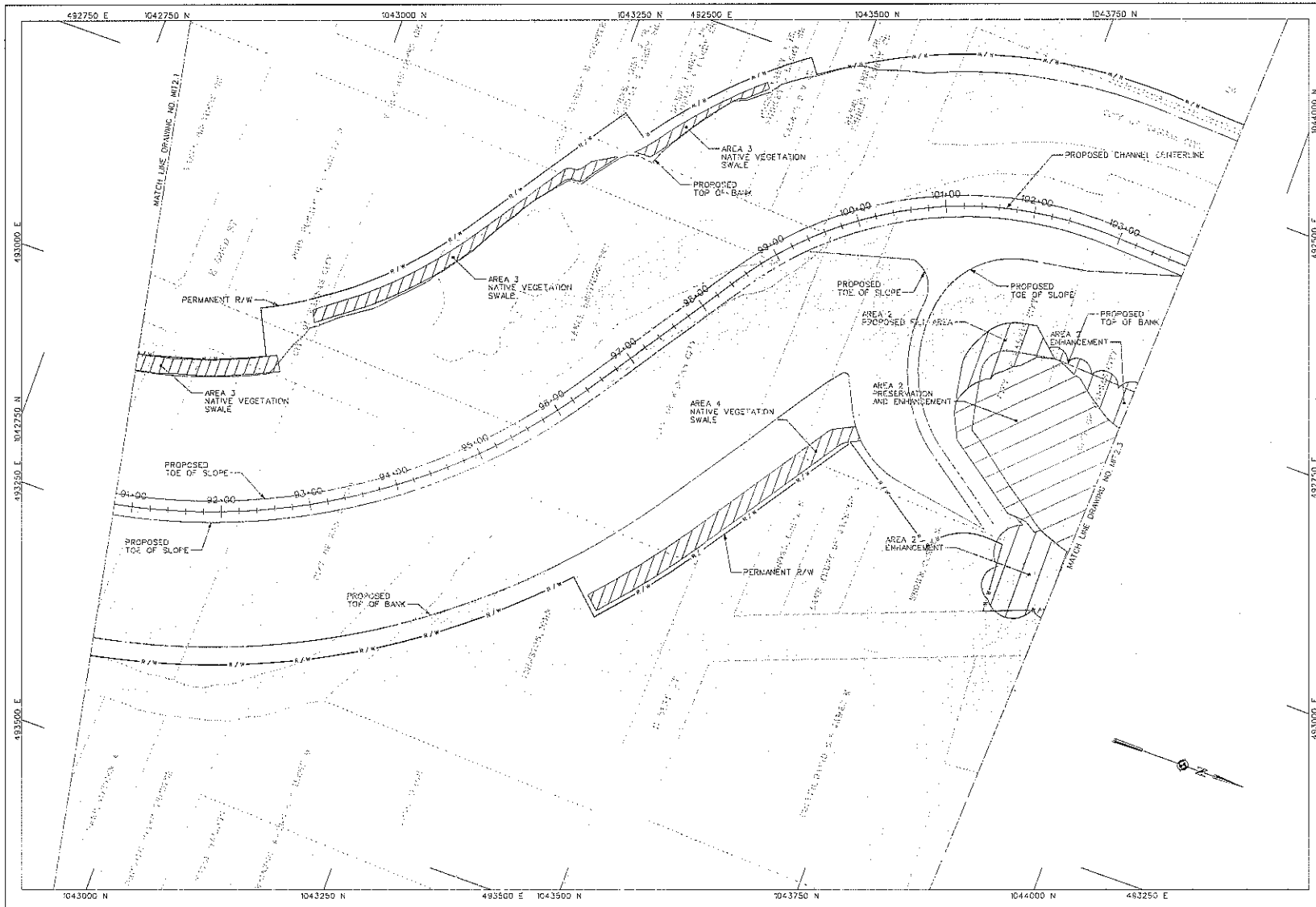
HDR Engineering, Inc.

Designed by: KL
Drawn by: D
Checked by: TP, TK
Submitted by: TK
Date: APRIL 2008
Drawing scale: 1"=50'
Plot scale:
CADD File Name: BRIDGEATBRLA.DGN

FLOOD PROTECTION PROJECT
BLUE RIVER CHANNEL
KANSAS CITY, MISSOURI
BRUSH CREEK TO 63RD STREET

MITIGATION
STA. 86+00 TO STA. 90+80

Sheet Reference Number:
MIT2.1



PLAN

SCALE: 1" = 50'-0"

US Army Corps of Engineers
Kansas City District

PRELIMINARY - NOT FOR IMPLEMENTATION

Symbol	Description	Date	Approved
	PREPARED ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN		

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

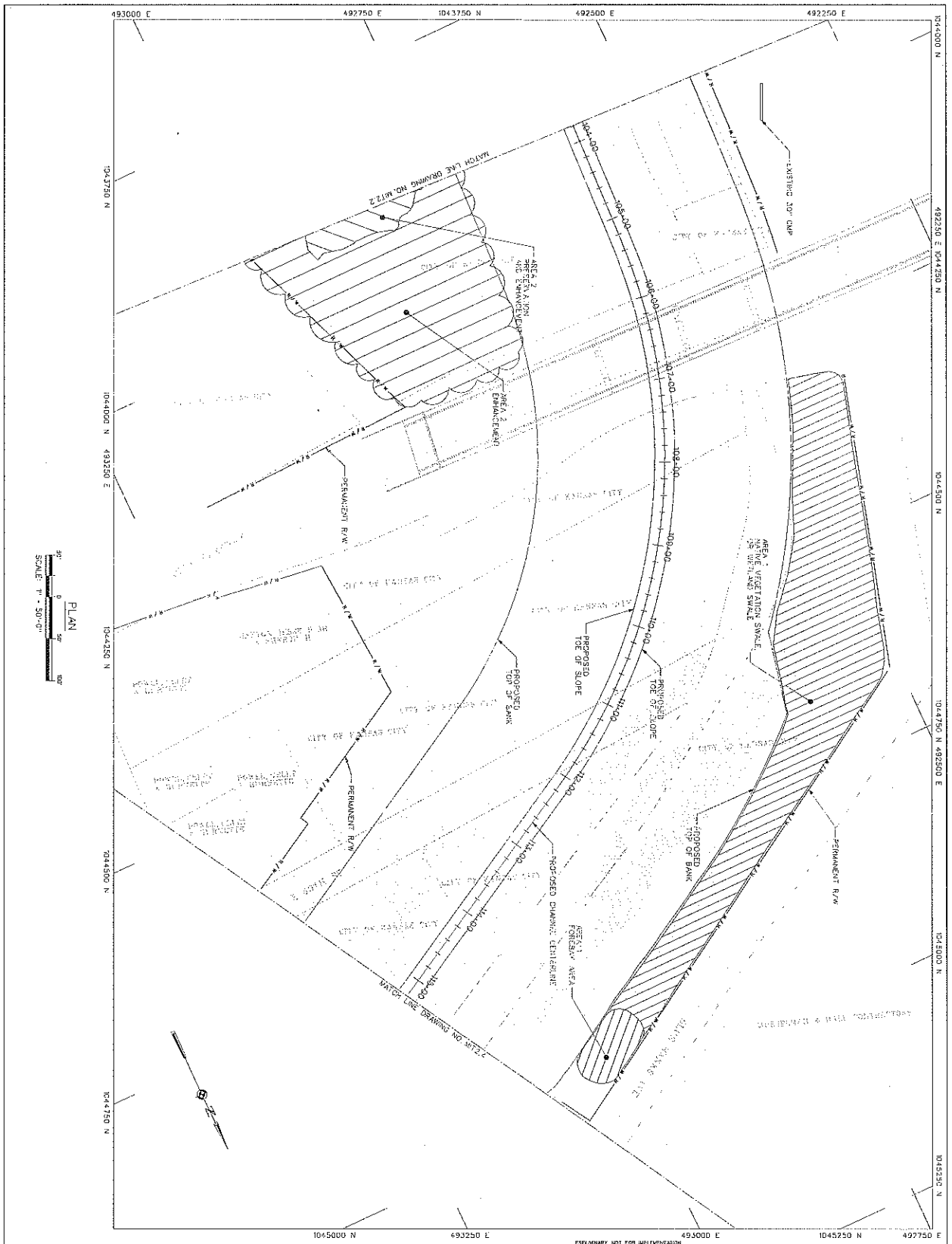
HDR
HDR Engineering, Inc

Designed by: KK
Drawn by: KK
Checked by: TP, TK
Submitted by: TK
Date: April 2005
Drawing scale: 1" = 50'
Plot scale: 1:1
CAD File Name: BRUSHCREEK-MIT2.2

FLOOD PROTECTION PROJECT
FEL-PORTE DES MORTS
FEL, MISSOURI
BRUSH CREEK TO 33RD STREET

MITIGATION
STA. 90+80 TO STA. 103+80

Sheet Reference Number:
MIT2.2



Sheet Reference Number: MIT2.3

FLOOD PROTECTION PROJECT
BLUE RIVER CHANNEL
KANSAS CITY, MISSOURI
BRUSH CREEK TO 53RD STREET

MITIGATION
STA. 103+80 TO STA. 115+20

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

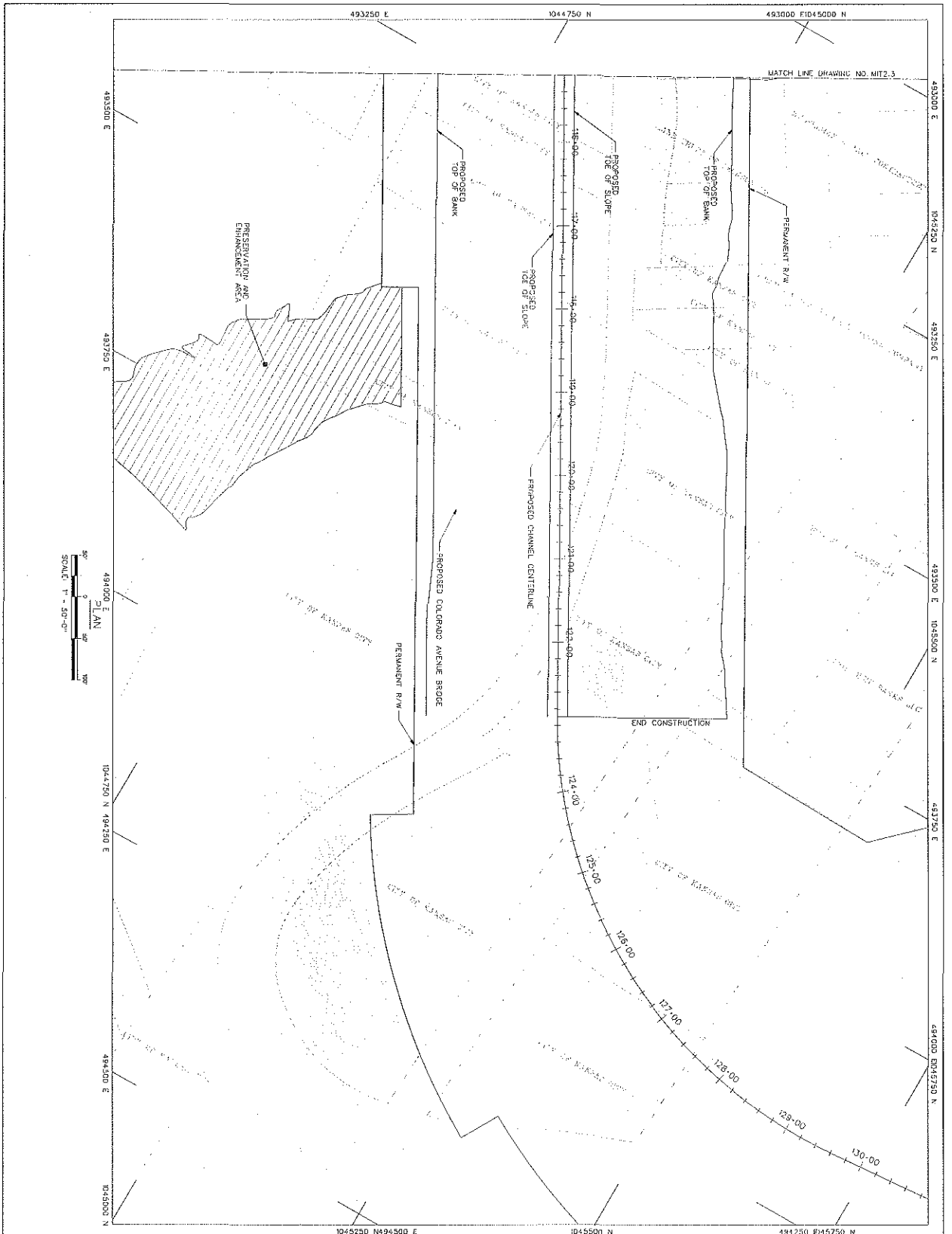
HDR
HDR Engineering, Inc.

Designed by: ML	Date: APRIL 2006
Drawn by: ML	Drawing code:
Checked by: TF, TK	Field scale:
Submitted by: TK	CADD File Name: BROKEN1T20SPLAN.DWG

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Description	Date	Appr.
1	REVISED ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN		

U.S. Army Corps of Engineers Kansas City District



Sheet Reference Number: MIT2.4

FLOOD PROTECTION PROJECT
BLUE RIVER CHANNEL
KANSAS CITY, MISSOURI
BRUSH CREEK TO 53RD STREET

MITIGATION
STA. 115+20 TO STA. 122+89.16 (BK)

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

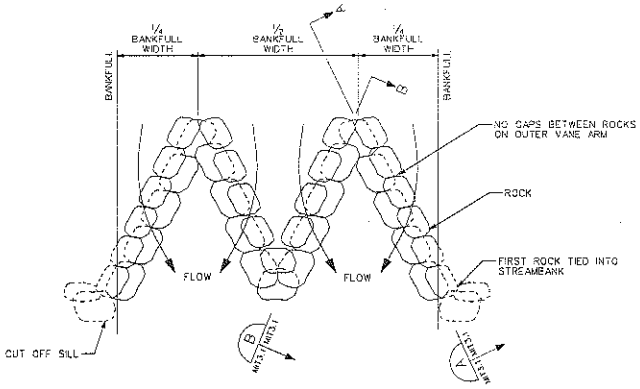
HDR
HDR Engineering, Inc.

Designed by: MS	Date: APRIL 2006
Drawn by: ML	Drawing Loc:
Checked by: TF, TK	Plot scale:
Submitted by: TK	CADD File Name: BNCREMIT3D4PE.DWG,SHT

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Description	Date	Appr.
1	REFINED ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN	11/14/06	

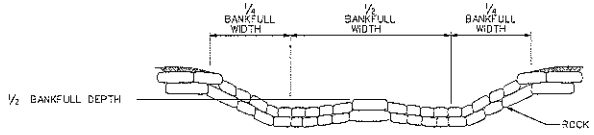
US Army Corps of Engineers Kansas City District



C MIT3.1 | MIT3.1

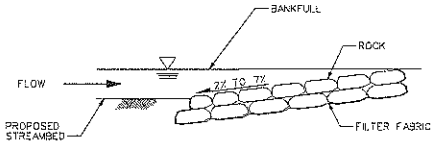
PLAN VIEW

SCALE: NTS



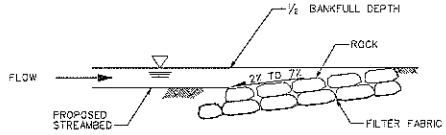
C MIT3.1 | MIT3.1 ELEVATION LOOKING UPSTREAM

SCALE: NTS



A MIT3.1 | MIT3.1 SECTION THROUGH OUTER VANE ARM

SCALE: NTS



B MIT3.1 | MIT3.1 SECTION THROUGH INNER VANE ARM

SCALE: NTS

US Army Corps of Engineers
Kansas City District

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Description	Date	Approved
	BEFORE ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN		

Designed by: TC, TA
Drawn by: RS, ML
Checked by: TC, TA
Submitted by: TA
Date: April 2008
Drawing scale: FULL SCALE
CADD File name: E:\FOR-MIT3.1\MIT3.1.dwg

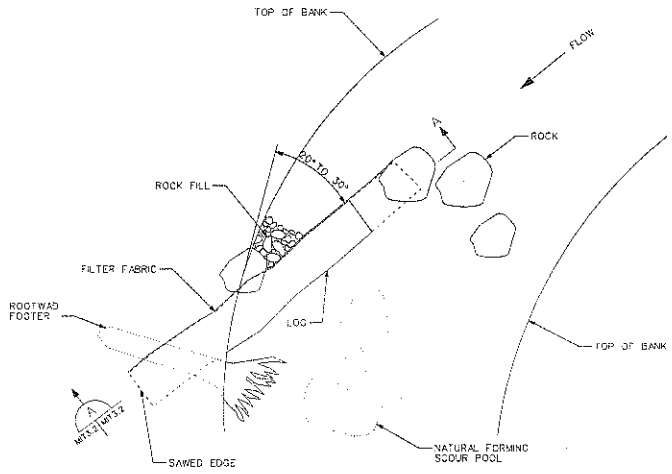
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

HDR
HDR Engineering, Inc.

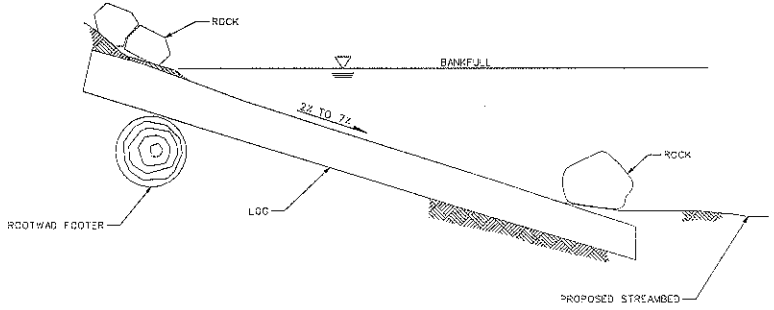
FLOOD PROTECTION PROJECT
MAGNOLIA, IOWA
KANSAS CITY, MISSOURI
BRUSH CREEK TO 53RD STREET

TYPICAL W-WEIR DETAILS

Sheet Reference Number:
MIT3.1



PLAN VIEW
SCALE: NTS



A SECTION THROUGH LOG VANE
MIT3.2 MIT3.2 SCALE: NTS

U.S. Army Corps of Engineers
Kansas City District

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Description	Initials	Date
	REVISED ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN		

U.S. ARMY ENGINEER DISTRICT
KANSAS CITY, MISSOURI
FORMERLY (MISSOURI)

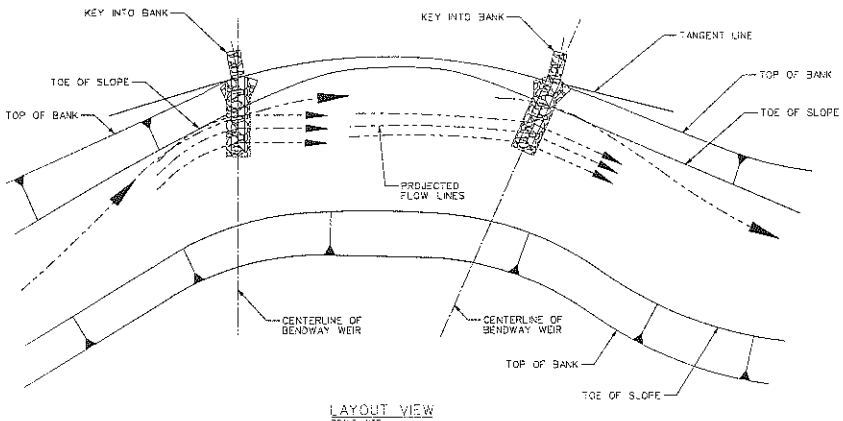
HDR
HDR Engineering, Inc.

Designed by: [illegible]
Drawn by: [illegible]
Reviewed by: [illegible]
Checked by: [illegible]
Submitted by: [illegible]
Date: 2005
Drawing scale: Plot scale:
CADD File name: DISCUSSION1.dwg

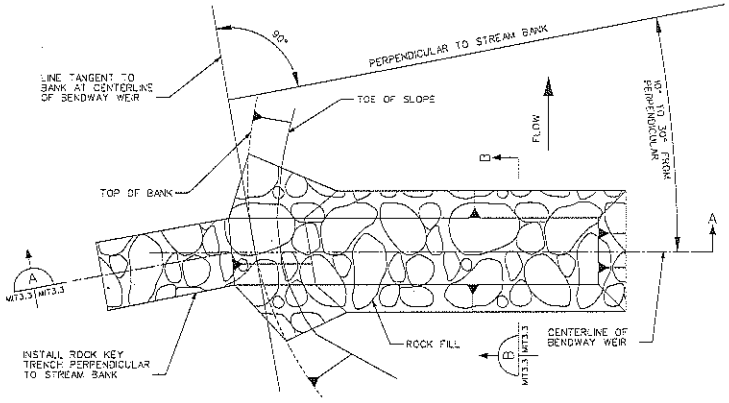
FLOOD PROTECTION PROJECT
ELEVEN POINTS CANYON
KANSAS CITY, MISSOURI
BRUSH CREEK TO 59RD STREET

TYPICAL J-HOOK LOG VANE DETAILS

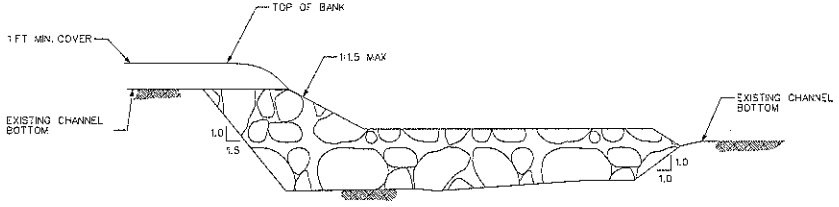
Sheet Reference Number:
MIT3.2



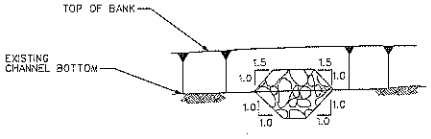
LAYOUT VIEW
SCALE: NTS



PLAN VIEW
SCALE: NTS



A SECTION CUTS
MIT3.3 MIT3.3 SCALE: NTS



B END VIEW
MIT3.3 MIT3.3 SCALE: NTS

US Army Corps of Engineers
Kansas City District

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Description	Date	Approved
	REVISED ENVIRONMENTAL ENHANCEMENTS, KENCITY, IA		

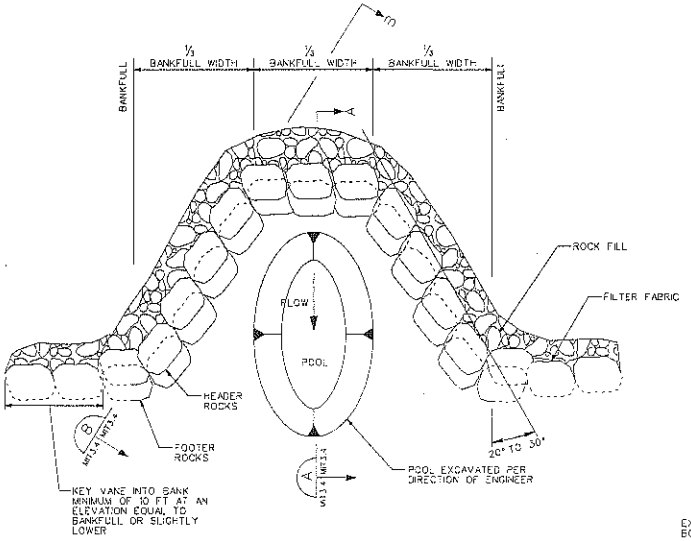
Designed by: BLM
Drawn by: RLM
Checked by: TT, TN
Submitted by: JK
Date: APRIL 2006
Drawing name: Plot name
CADD file name: SPECIAL3-3SLCL1.DWG

U.S. ARMY ENGINEER DISTRICT
KANSAS CITY, MISSOURI
HDR Engineering, Inc.

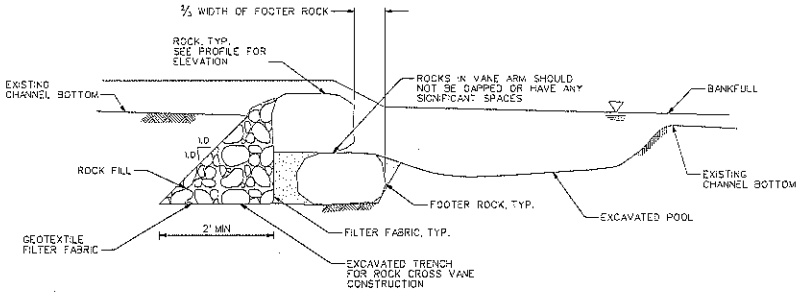
FLOOD MITIGATION PROJECT
BLUE RIVER CHANNEL
KANSAS CITY, MISSOURI
BRUSH CREEK TO 53RD STREET

TYPICAL BENDWAY WEIR DETAILS

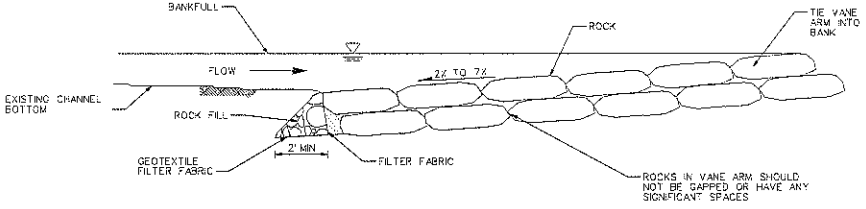
Sheet Reference Number:
MIT3.3



PLAN VIEW
SCALE: NTS



A SECTION THROUGH THALWEG
MIT3.4 | MIT3.4 SCALE: NTS



B SECTION THROUGH VANE
MIT3.4 | MIT3.4 SCALE: NTS

US Army Corps of Engineers
Kansas City District

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Description	Date
	BYPASS ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN	07/14/08

Drawn by: AMB
Date: APR. 2008
Designed by: HDR, Inc.
Drawing number
Plot scale:
Checked by: TC, RK
Revised by: TC
Filename: 0408 Fish Habitat UMDC-Mit-Sheet-01.Dwg

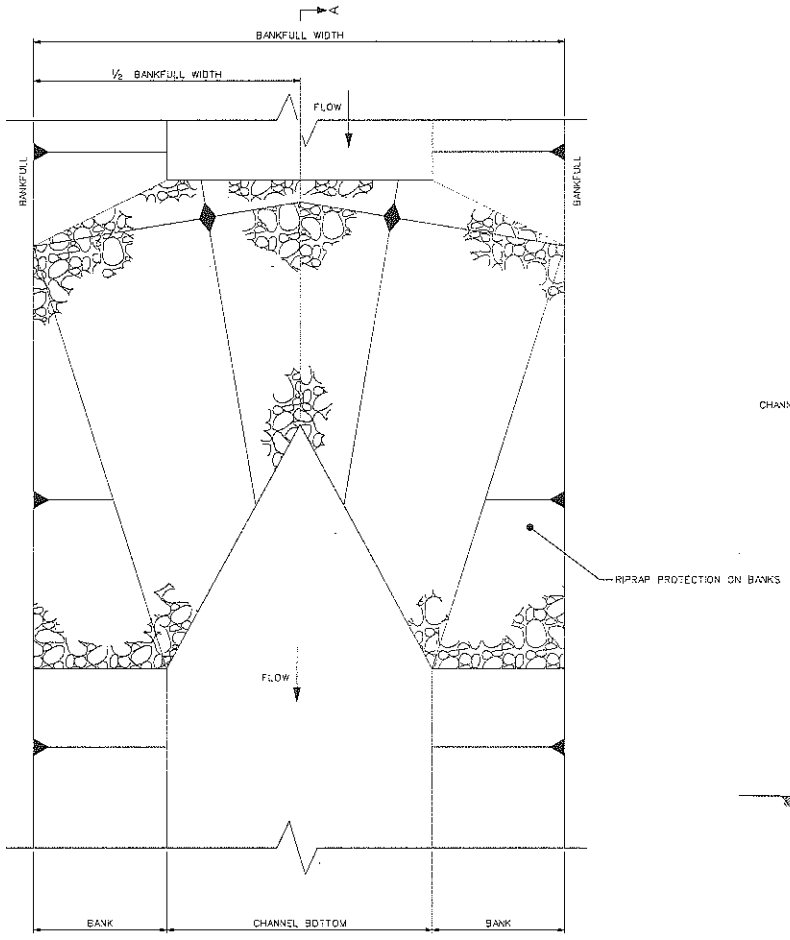
U.S. ARMY ENGINEER DISTRICT
MISSOURI RIVER PROJECTS
KANSAS CITY, MISSOURI

HDR
HDR Engineering, Inc.

FLOOD PROTECTION PROJECT
BLUE RIVER CHANNEL
KANSAS CITY, MISSOURI
BRUSH CREEK TO 55TH STREET

TYPICAL ROCK CROSS-VANE DETAILS

Sheet Reference Number:
MIT3.4

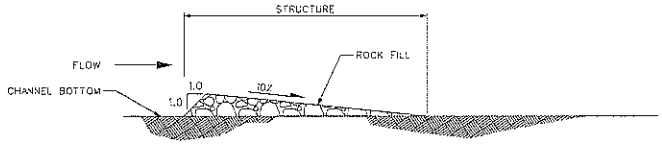


A MIT3.5 | MIT3.5

B MIT3.5 | MIT3.5

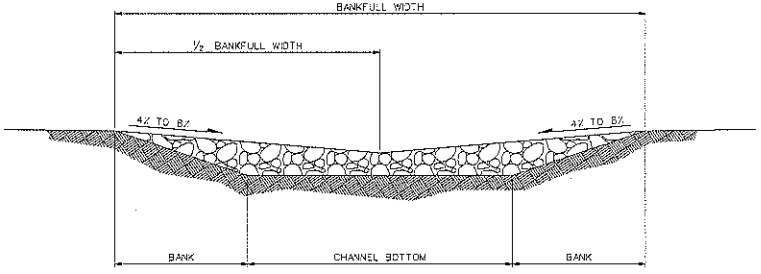
PLAN VIEW

SCALE: NTS



A MIT3.5 | MIT3.5 SECTION THROUGH THALWEG

SCALE: NTS



B MIT3.5 | MIT3.5 ELEVATION LOOKING UPSTREAM

SCALE: NTS

U.S. Army Corps of Engineers
Kansas City District

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Description	Date	Appr.
	REVISED ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN		

Designed by: TK
Drawn by: TK
Checked by: TJ
Submitted by: TK

Date: APRIL 2005
Drawing Scale: 1"=20'
Plot Scale: 1:240
CAD File Name: BATCHPLOT\MIT3.5.DWG

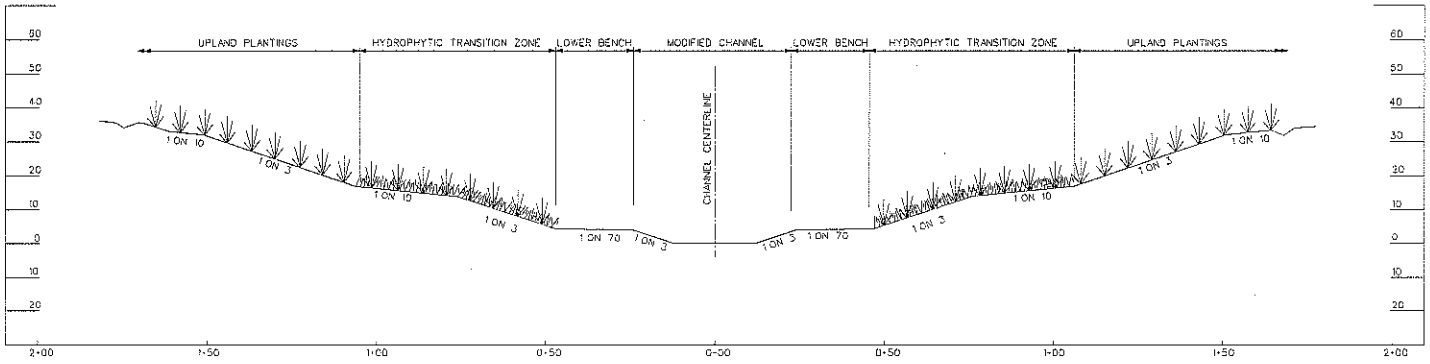
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

HDR
HDR Engineering, Inc.

FLOOD MITIGATION PROJECT
NEWBURY, MISSOURI
KANSAS CITY, MISSOURI
BRUSH CREEK TO 53RD STREET

TYPICAL NEWBURY
STRUCTURE DETAIL

Sheet Reference Number:
MIT3.5



NOTES

1. PLANTING PLANS WILL BE ADJUSTED TO ACCOMMODATE CHANNEL ARMORING AS CHANNEL DESIGN PROGRESSES.

U.S. Army Corps of Engineers
Kansas City District

PRELIMINARY NOT FOR IMPLEMENTATION

Symbol	Revision	Date	Approved
1	INITIAL ENVIRONMENTAL ENHANCEMENT CONCEPT PLAN		

U.S. ARMY ENGINEER DISTRICT
KANSAS CITY, MISSOURI

HDR
HDR Engineering, Inc.

Designed by: RG, MA
Drawn by: RG, WL
Checked by: TT, TK
Submitted by: TK
Date: KPM, 2006
Drawing date:
Plot scale:
CADD File Name: BRUSHCLAT3B&EC.DGN

FLOOD PROTECTION PROJECT
BRUSH CREEK CHANNEL
KANSAS CITY, MISSOURI
BRUSH CREEK TO 53RD STREET

TYPICAL PLANTING ZONE SECTION

Sheet Reference Number:
MIT3.6

Attachment 2
Blue River Stakeholder's Meeting Notes, February 7, 2008