We Are Columbia

MEETING DATE:	**August 16, 2016**
DEPARTMENT:	**Utilities and Engineering**
FROM:	***Joey Jaco, Director of Utilities and Engineering***
SUBJECT:	**Council is asked to approve Project WM4348; Columbia Canal Embankment Repair Services, a requested by the Utilities and Engineering Department. Award to Michael Baker International in an amount not to exceed $4,938,139.00. This firm is located in Columbia, SC.**
FINANCIAL IMPACT:	**Staff has negotiated a fee not to exceed amount for services in the amount of $4,938,139.00 Dollars for the specified needs above with Michael Baker International. A ten percent (10%) contingency will be administered by the Special Projects Administrator. Funding for this Agreement will be identified as WM4348-638400 (DR421 Columbia Canal Embankment Repair Services).**
BUSINESS PROGRAM:	**Subcontracting Outreach Program**
CLEAN WATER 2020?:	**No**
FEMA DR-SC4241?:	**Yes**

The Agreement referenced above is to design the repairs to the Columbia Canal embankment due to a historic flooding event that took place in early October, 2015. Rainfall caused historic flooding and unprecedented damages to the City of Columbia. During the October 4, 2015 storm event, high tailwater levels resulted in the flooding of the powerhouse, and high water levels in the canal caused an overtopping failure of part of the canal dike. During the storm the impoundment upstream of the canal headwork's reached elevation 163.5 and a river flow estimated to be between the 10-year and 50-year floods while the water level in the canal exceeded elevation 156 overtopping powerhouse structures and causing a failure of a portion of the canal dike upstream of the powerhouse. As a result of the overtopping, approximately 900 feet of the Canal embankment was damaged including complete breach of approximately 150 feet. A post-flood assessment found that a number of gates at the headgate structure were either jammed in the partially close position or impeded from closing by large trees accumulated beneath the gates. A number of gates that were reported to be "closed" but it was determined that large flows were passing beneath the gates as a result of deteriorated or

missing gate sills. Currently steel bulkheads have been installed on the upstream side of each of the headgates to mitigate the deteriorated condition of the headgates and reduce flow into the canal.

The design remediation for the canal embankment is the evaluation of existing conditions of the entire canal and hydro project; flow analysis of canal flows and flow control structures; geotechnical analysis; structural and stability analysis of embankment and structures; determination of FERC (Federal Energy Regulatory Commission) response requirements and recommendations for entire canal and hydro project; recommendations for embankment repairs meeting minimum FERC and other federal and state agency review requirements; all associated permitting required for recommendations; construction documents for recommendations; construction administration services; construction observations services; and project close-out services.

Staff has negotiated a fee not to exceed amount for services in the amount of Four Million, Nine Hundred Thirty-Eight Thousand, One Hundred Thirty-Nine Dollars and NO/100 ($4,938,139.00) the specified needs above with Michael Baker International, a firm Headquartered in Pittsburgh, PA. A ten percent (10%) contingency will be administered by the Special Projects Administrator. There are 3 stages in the project:

Stage A includes scope of work as currently defined in Project Worksheets specific to repairs of the 2 breaches and the spillway and include Basic Services, Additional Services, and Direct Expenses and totals $2,641,471.00. These fees are anticipated to be reimburseable by FEMA and will be funded from WM4348-638400 (DR421 Columbia Canal Embankment Repair Services).

Stage B are the "Other Additional Services" that may be paid from non-FEMA funds (WM4323 Unforeseen and Miscellaneous Projects). This stage includes Direct Expenses and totals $848,081.00. The Engineer shall not proceed with these services unless authorized in writing by the City.

Stage C includes works for additional flood related damage if found from field inspections of the entire Canal outside the limits of the breaches. If additional flood related damage is found, the City will ask FEMA to version the Project Worksheet to include the damage and the contract will be amended to add the design fees for the repairs. The scope will be finalized after completion of work in Stage A and some tasks in Stage B. The not-to-exceed amount for this stage is currently estimated at $1,448,587.00 and may be funded from WM4348-638400 (DR421 Columbia Canal Embankment Repair Services).

Stage A	Basic Services	$1.95 million
	Additional Services	$592,106.00
	Direct Expenses	$99,365.00
	Subtotal	*$2,641,471.00*

Stage B	Additional Services	$848,081.00
Stage C		$1,448,587.00
	Grand total	*$4,938,139.00*

Original Contract Amount: $4,938,139.00
Sub consulting services:
$655,544.00 (13.3% of the total contract value) awarded to Hazen and Sawyer will provide water supply/H&H modeling; spillway/dike repair design; construction contract administration; environmental science/natural resources.
$419,378.00 (8.5% of the total contract value) awarded to Kleinschmidt Associates will provide FERC coordination locks; gates design; and construction contract administration.
$1,046,089.50 (21.2% of the total contract value) awarded to F&ME Consultants, Inc. will provide geotechnical design services.
$37,564.00 (0.8% of the total contract value) awarded to CASE Consulting, Inc., will provide construction administration support services.
$32,000.00 (0.6% of the total contract value) awarded to Construction Support Services, will provide land surveying services.
$64,817.16 (1.3% of the total contract value) awarded to MA Engineering Consultants, will provide geospatial/GIS/photogrammetry services.
$38,500.00 (0.8% of the total contract value) awarded to ESP Associates, will provide hydrographic survey services.
$17,702.92 (0.4% of the total contract value) awarded to New South Engineering, will provide historic context for National Register research.

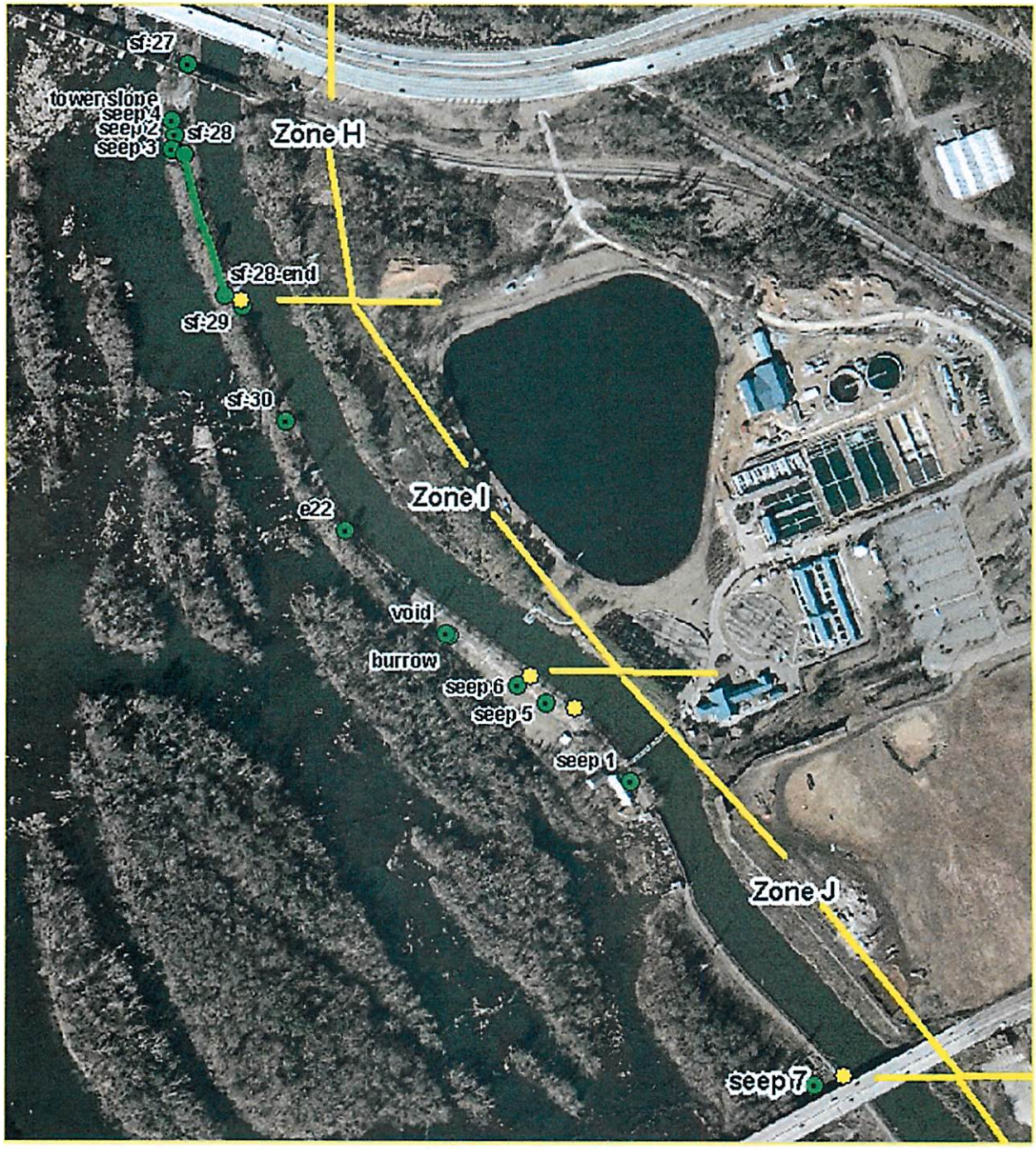
Services to be performed will impact all City Council Districts. The City's Flood Recovery Program Manager, Landmark Consulting Services and the City of Columbia's Legal Department have reviewed the Agreement. The Director of Utilities and Engineering and ACM for Operations recommend its approval.

ATTACHMENTS:

- Columbia Canal Map dated 8.24.2007 (PDF)
- Map (PDF)
- 20160802 Columbia Canal Repair - MBI Integrated Scope Revised Proposal (2) (PDF)
- Exhibit B_1 (PDF)
- Exhibit B_2 (PDF)
- Exhibit C (PDF)
- Exhibit D (PDF)
- Exhibit E (PDF)
- 20160811 Columbia Canal Repair - MBI Integrated Scope Revised Proposal (PDF)

Columbia Canal Map

August 24, 2007



Latitude, longitude and address of any point on Google Maps

Click directly on the map to get an address and its GPS coordinates. The latitude coordinate and the longitude coordinate are displayed on the left column and on the map.

Address Three Rivers Greenway, Columbia, SC 2

Get GPS Coordinates

DD (decimal degrees)*

Latitude 33.99721720000001

Longitude -81.04927599999996

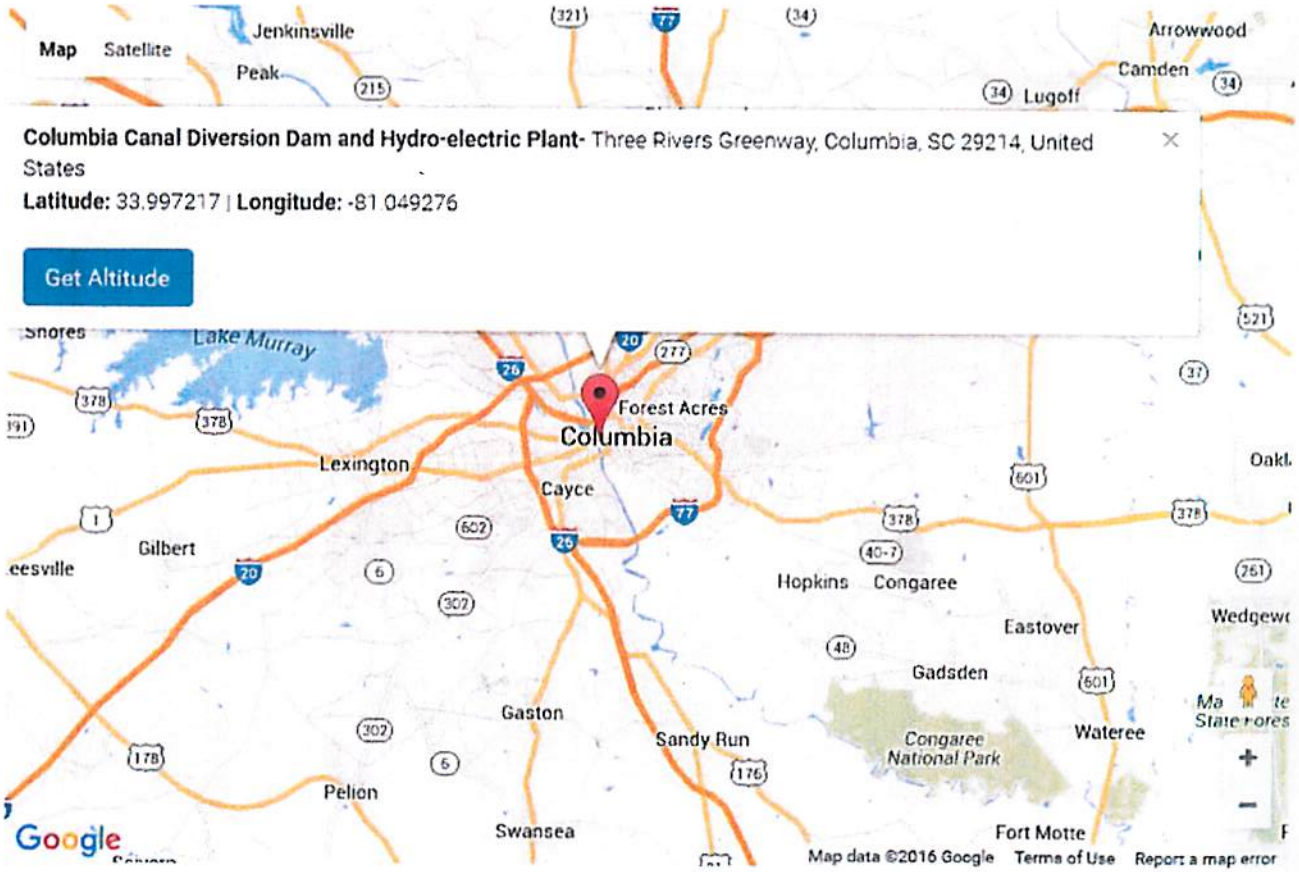
Get Address

DMS (degrees, minutes, secondes)*

Latitude (•) N ( ) S 33 ° 59 ' 49.982 "

Longitude ( ) E (•) W 81 ° 2 ' 57.393 "

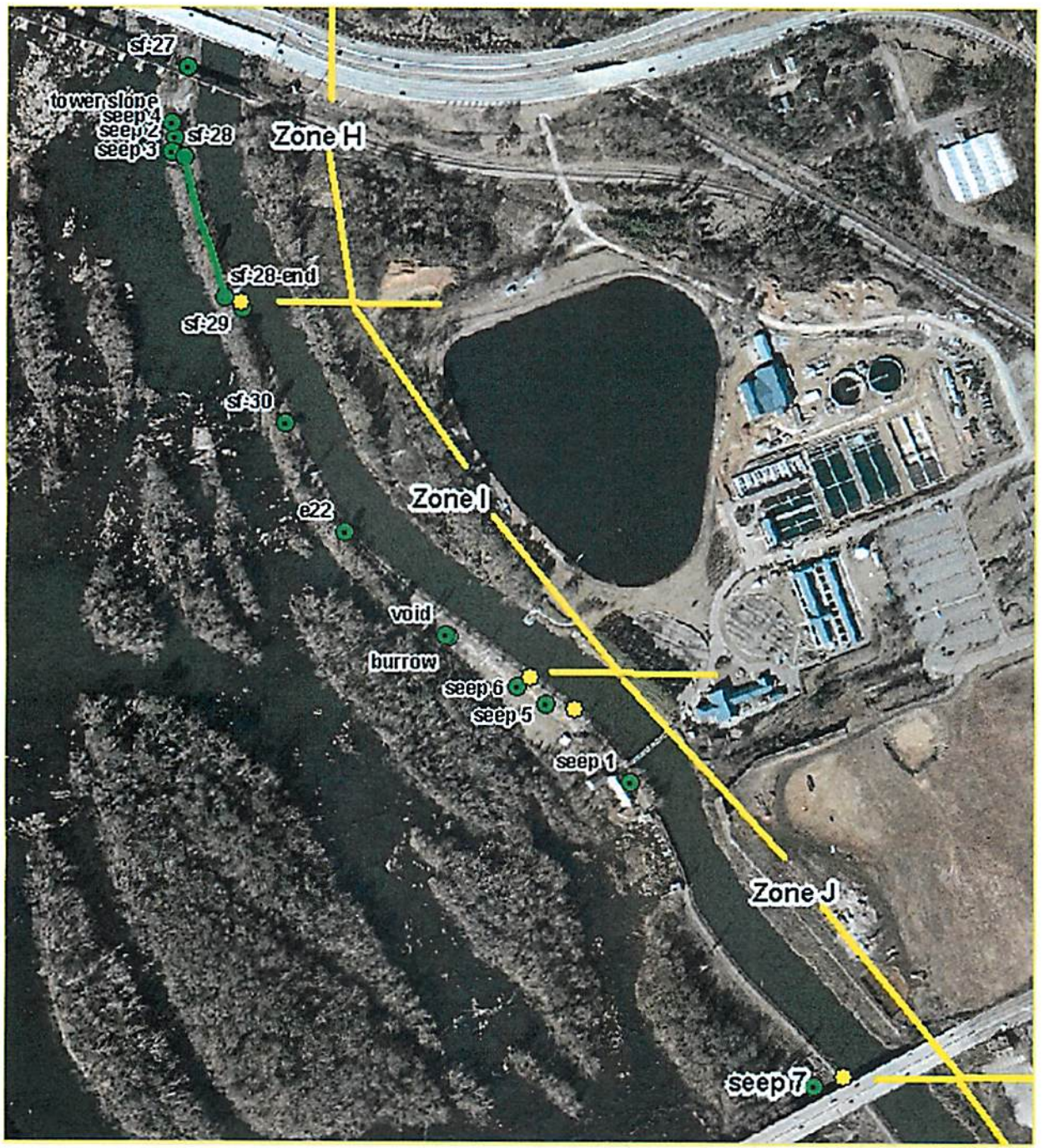
Get Address



* World Geodetic System 84 (WGS 84)

Columbia Canal Map

August 24, 2007



Legend

- Canal_Investigation
- Maintenance_Zones

0 145 290 580 870 1,160 Feet

CITY of COLUMBIA, S.C.
JUSTITIA VIRTUTUM REGINA

Scope of Services –
Phase 1 – Canal Embankment Assessment

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INTRODUCTION

A. Project Overview

At the request of the City of Columbia, Michael Baker International, Inc. (MBI), herein referred to as the **CONSULTANT**, has been requested to provide engineering services for the Columbia Canal Embankment Repair Services (Columbia Canal Restoration) project for the City of Columbia, herein referred to as the **CITY**.

The **CITY** owns and operates the Columbia Canal and the 10 MW Hydroelectric facility in Columbia, SC. The Columbia Hydroelectric Project consists of a power canal that was expanded and its headworks structure and diversion dam constructed circa 1890, with the existing hydroelectric powerhouse constructed in 1896. The Canal extends approximately 3.2 miles in a southward direction from the diversion dam (approximately 0.75 miles upstream of the US 176 Broad River Road Bridge) to the Columbia Hydroelectric Plant located adjacent to the Gervais Street Bridge. The canal source is the Broad River fed by the diversion dam and headworks structure. The canal is used for generation of hydroelectric power, water supply to the **CITY**'s water treatment plant, and recreational purposes. Under normal operating conditions the hydroelectric turbines discharge up to 6,000 cubic feet per second (cfs) of flow; and the water treatment plant withdraws up to 50 MGD.

General canal construction consists of an earthen dike structure with paved pedestrian walking path at the top of the dike with a grassed shoulder east of the dike and rip-rap (1- to 3-foot diameter) extending down the embankment of the dike into the canal. Exact canal dimensions (i.e. depth, crest width, base width) vary along the length of the dike; however, estimated widths and depths range from approximately 100 to 250 feet in width at the base, and approximately 10 to 20 feet in depth, crest to base. Elevation at the dike crest ranges from approximate 153.8 to 169.3 feet (NGVD 29 datum).

In early October 2015, a historic flooding event took place in South Carolina. Parts of Columbia experienced rainfall that exceeded once in a thousand year levels. Almost two feet of rainfall fell in less than 48 hours. Rainfall caused historic flooding and unprecedented damages to the **CITY**. During the October 4, 2015 storm event, high tailwater levels resulted in the flooding of the powerhouse, and high water levels in the canal caused an overtopping failure of part of the canal dike. During the storm the impoundment upstream of the canal headworks reached elevation 163.5 with a river flow estimated to be between the 10-year and 50-year floods while the water level in the canal exceeded elevation 156 overtopping powerhouse structures and causing a failure of a portion of the canal dike upstream of the powerhouse. As a result of the overtopping, approximately 900 feet of the Canal embankment was damaged including a complete breach of approximately 150 feet width. A post-flood assessment found that a number of gates at the headworks structure were either jammed in the partially closed position or impeded from closing by large trees accumulated beneath the gates. A number of gates were reported to be "closed", but it was determined that large flows were passing beneath the gates as a result of deteriorated or missing gate sills. Currently steel bulkheads have been temporarily installed on the upstream side of each of the headgates to mitigate the deteriorated condition of the headgates and reduce flow into the canal.

B. Purpose

The **CONSULTANT** is providing an integrated Scope of Services for engineering services to complete an assessment and design to restore the Columbia Canal to a safe and reliable working order in accordance with the **CITY**' Request for Qualifications ENGRFQ0004-15-16 dated March 4, 2016, and scoping meetings with the **CITY** that were conducted on April 28, May 5, May 24, June 9, June 23, and July 28, 2016.

The **CONSULTANT** understands that Kleinschmidt (also a member of the **CONSULTANT**'s team) and Chao & Associates (Kleinschmidt-Chao) have been engaged by the **CITY** to analyze and design remediation to the headworks structure for the construction of measures that will allow the headgates to be closed to prevent the uncontrolled release of flow into the canal. The **CONSULTANT** understands that Kleinschmidt-Chao will assess and address the stability of the headworks structure; design replacements for the headgates and operators; design trash racks and a trash rake and debris handling system; and design a replacement lock gate.

In support of the **CONSULTANT**'s development of a coordinated restoration plan for the canal and associated structures, **CONSULTANT** will contact and coordinate with Kleinschmidt-Chao to obtain construction cost information for the **CONSULTANT**'s use and inclusion in the Phase 1 Canal Embankment Assessment and Phase 1 Alternatives Analysis (Task 19).

To clarify the division of work responsibility between the **CONSULTANT** and Kleinschmidt-Chao engineering service agreements, the following key points are presented with regard to work that will be completed at and adjacent to the headworks structure.

- Structural repair at the headworks structure (and vehicular bridge that spans overtop) will be completed under the Kleinschmidt-Chao primary engineering services agreement with the **CITY**;
- Test borings drilled at the headworks structure by F&ME, also a member of the **CONSULTANT**'s team, are associated with the work of Kleinschmidt-Chao and are not part of the work of the **CONSULTANT**;
- Embankment dike repair design activity will be completed under the **CONSULTANT** engineering services agreement with the **CITY**. Embankment dikes are defined as the structures that extend along the canal and including the existing embankment dam on the east side of the headworks structure; and
- Assessment of the diversion dam is to be performed by the **CONSULTANT**.

Based on the discussion at the scoping meeting(s), it was mutually agreed to complete the requested engineering services in the following three (3) phases. This Proposal only addresses work of Phase 1 - Canal Embankment Assessment. Work for Phases 2 and 3 will be addressed at a future date based on the outcome of the Phase 1 work. Phase 1 has been subdivided into three (3) stages, two (2) separate design reaches, and multiple Tasks as described in the Scope of Services below. In addition, Phase 1 has been further subdivided into Basic Services and Additional Services, to facilitate tracking of engineering cost to perform the Work. The intent of Phase 1 work is to focus effort on Stage A base flood damage repair that is directly related to structures and facilities that were damaged during the October 2015 flooding (as described below), address supplemental **CITY**-requested services on a reach-by-reach and Task-by-Task basis identified in Stages B and C, and acquire reconnaissance data to make a general delineation and characterization of probable flood-damaged areas within Reach 2. Basic Services and Additional Services are described in the following Scope of Work. Basic Services pertain to a portion of the work completed

in Stage A, as indicated in the following scope of services. All of Stage B and Stage C work is considered Additional Services. In addition, the Scope of Services for Tasks 10 and 11 have been further broken down into two distinct tiers of effort based on simplified design assumptions to deliver base repair services (Tier 1) and more refined assumptions to deliver more in depth repair services that will provide a higher level of flood resiliency confidence (Tier 2). The location and limits of the two design reaches is described below in the Introduction Paragraph C. During the course of the work, the **CONSULTANT** and **CITY** will assess the results of each Task as they are completed to determine when and where any scope adjustments are required; and the **CITY** reserves the right to add, modify or delete any tasks based on available funding sources to implement corrective action to mitigate flood damage and/or make any other preferred enhancements. Any modification to the Scope of Services will be mutually agreed to by both the **CITY** and **CONSULTANT** and documented as the work progresses.

- Phase 1 Canal Embankment Assessment
    - Stage A: Base Flood Damage Repair Services
        - Reach 1
        - Reach 2
    - Stage B: Supplemental **CITY**' Requested Services
        - Reach 1
        - Reach 2
    - Stage C: Supplemental Flood Resiliency Enhancement Services
        - Reach 1
        - Reach 2
- Phase 2 Final Design
- Phase 3 Construction

Base Flood Repair Services for Reach 1 are defined as those services required to support activities captured under existing Project Workbook (PW) agreements that are in place as of June 24, 2016 between the **CITY** and FEMA to repair flood damage and restore the Columbia Canal to pre-flood conditions. The FEMA' PW Scope of Services provides for repair of flood damage that occurred between October 1 and October 23, 2015 due to overtopping of the dike near the downstream end of the approximate 3.1 mile long canal dike, and which generally includes the following.

- Repair of the dike breach, just north of the Broad River Bridge, that was about 100 feet long x 85 feet wide by 50 feet deep, involving approximately 15,740 cubic yards of fill that was lost downstream into the Broad River.
- Repair of a second breach that was about 205 feet long x 65 feet wide x 50 feet deep, involving approximately 24,675 cubic yards of fill that was washed downstream into the canal.
- Repair of mechanical and physical damage to the canal spillway.
- Repair of mechanical and physical damage to the gates at the diversion dam (headworks), to be performed by others under separate contract with the **CITY**.
- Decommission of a Temporary Emergency Dam (cofferdam) that was erected during the flooding event across the canal to stop outflow from the canal and resupply water to water intakes for the **CITY**' water works.
- Hazard mitigation against future flood-borne damage to the Columbia Canal by utilizing approximately 3,952 cubic yards of the Temporary Emergency Dam (riprap and various stone) to

armor select truck-accessible portions of the remaining canal embankment (dike).

At this time, there are no Stage A Base Flood Repair Services planned for Reach 2, other than repair of the canal spillway and headworks gates and possible riprap/stone placement at discreet truck-accessible locations.

To make the Scope of Services clear with regard to the applicable Stage (A, B and/or C), Tier (1 or 2) and Reach (1 and/or 2), footnotes have been added in the Task descriptions presented below, which correspond to the breakdown of estimated Labor Costs and Direct Costs Other Than Payroll that is presented in the separate Price Proposal.

The design intent is to evaluate conceptual alternatives during the Phase 1 Canal Embankment Assessment, and reach consensus on a common vision with vested partners, regulatory agencies and the **CITY** of the extent and level of repair to be performed in order to restore the Columbia Canal to a safe and reliable condition based on a benefit-cost assessment, within the realm of available funding sources. Near the end of the Phase 1 Canal Embankment Assessment, a detailed Scope of Services for Phase 2 Final Design and Phase 3 Construction will be prepared for review and acceptance by the **CITY**, after which a contract amendment will be executed.

Based on the scoping meetings with the **CITY**, it was agreed that the Scope of Services for the Phase 1 Canal Embankment Assessment will embody the following key considerations/objectives and options, from which a preferred alternative will be recommended with supporting documentation and rationale.

Key Considerations/Objectives	Option				
	1	2	3	4	5
Columbia Canal Embankment (Dike) Repair					
- High Hazard Potential	X			X	
- Significant (current) Hazard Potential		X	X		X
Electrical Generation					
- Restore Hydroelectric Power Plant	X	X		X	X
- Decommission Hydroelectric Power Plant			X		
Water Intake Source					
- Canal	X			X	
- Canal with Distribution Backup (raw water supply intake from Broad River or Saluda River; or finished water supply from Lake Murray)		X	X		X
Recreational Opportunities					
- Pedestrian	X	X	X	X	X
- Fishing	X	X	X	X	X
- Parks	X	X	X	X	X
- River Access				X	X
Flood-Fighting Deployment					
- Connectivity		X	X	X	X
- Emergency Access	X	X	X	X	X
- Usage/Parking				X	X

Figure 1-1- Key Considerations/Objectives

C. Project Limits and Delineation

Based on discussion at the Scoping meetings described above, the project limits for the restoration of the Columbia Canal have been established as extending from the upstream side of the diversion dam and headworks structure and the downstream side of the Gervais Street bridge crossing, and along the existing canal and right embankment (dike); all within CITY' property. For discussion purpose in the following Scope of Services, the Project is generally delineated into two (2) contiguous reaches. The two contiguous reaches share a common limit that is located at the downstream exposed edge of the prison hydroelectric plant remains, and which is located approximately 100 feet upstream of the center of the Jarvis Klapman Boulevard Bridge. For discussion purpose, these two contiguous reaches are referred to as the following.

- Reach 1: downstream reach that is captured within the repair reach under the USACE Emergency Permit; and which generally includes the existing Gervais Street Bridge (overhead), existing hydroelectric plant, the existing complete and partial dike breaches, temporary cofferdam, Jarvis Klapman Boulevard Bridge (overhead), aerial fiber optic line crossing (over the canal), steam tunnel (within the Jarvis Klapman Boulevard approach embankment near the left canal bank), and dike between the former prison hydroelectric plant and the existing hydroelectric plant.
- Reach 2: upstream reach, which generally includes the former prison hydroelectric plant remains, former water treatment plant intake, existing canal spillway and access bridge, pedestrian access bridge over the canal, former water pumping plant, drainage tunnel (under the canal), water treatment plant intake, Elmwood Avenue Bridges (I-126 eastbound and westbound bridges) and adjacent railroad bridge (both overhead), Broad River Bridge (overhead), dike between the former prison hydroelectric plant and the canal headworks, diversion dam, canal headworks and former lock structure, and the headworks embankment dam.

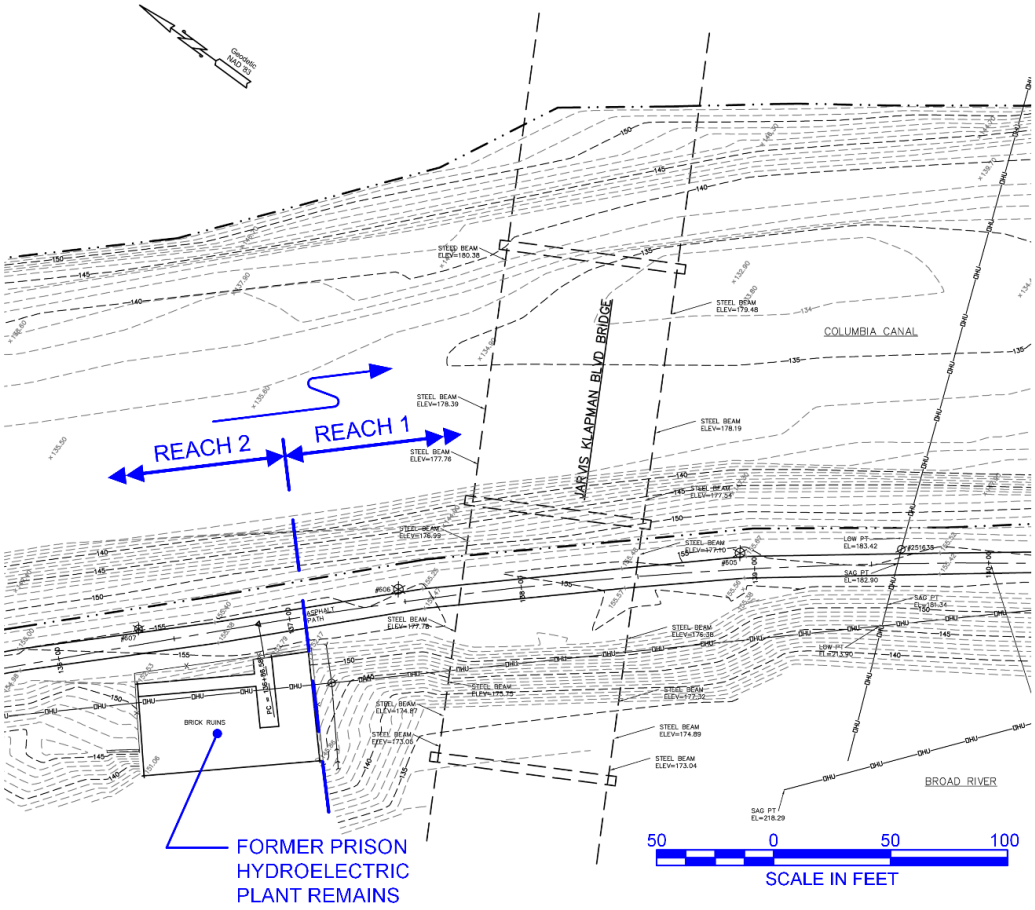

Figure 1-2- Transition Point from Reach 1 to Reach 2

D. Summary of Work

Page No.

E. Clarifications and Assumptions for Proposal Preparation Purpose

*Several clarifications and/or **assumptions** have been made in the following Scope of Services for proposal preparation purposes. In general, these statements are identified in **italic font** to make these statements stand-out in the Scope of Services presented herein.*

F. FEMA/HUD Funding Sensitivity

The **CONSULTANT** is sensitive to the **CITY**'s need to complete the work by capitalizing on available funding sources and grants. These include, but are not limited to, maximizing Federal Emergency Management Agency (FEMA) and Housing and Urban Development (HUD) disaster recovery funding for both the October 2015 flood and possible future events. A decision-tree style metric will be used throughout the Alternatives Assessment development to maintain cognizance of possible funding impacts for conclusions/recommendations/decisions made.

G. Deliverables

All Deliverables will be presented in a form that is suitable for submittal to review agencies.

1. Criteria

All Tasks and deliverables completed, where applicable, will conform to FERC' requirements for a high hazard project; and will provide the basis for subsequent permitting by the United States Army Corps of Engineers (USACE) for work in the waters of the United States. FEMA is a funding agency for the project; and hence all work performed will also be required to satisfy FEMA requirements for design and construction.

2. Data Reports (DRs) and Technical Basis Reports (TBRs)

Completion of Tasks 4 through 11, and Tasks 13 through 18 will culminate in preparation of either a Data Report (DR) or a Technical Basis Report (TBR) as deliverables. In general, DRs will consolidate and present source documents and raw data obtained in a comprehensive organized manner for future reference; and TBRs will present the results of engineering analyses and assessments performed, engineering considerations evaluated, and conclusions/recommendations made to develop dike/spillway/gate repair strategies, enhance hazard mitigation (e.g. select armoring to improve overtopping/scour resiliency), and evaluate Phase 1 alternatives.

3. Preliminary Engineering Report (PER): Phase 1 Alternatives Analysis

At the end of the Phase 1 Alternatives Analysis, the **CONSULTANT** will prepare and submit a Preliminary Engineering Report (PER) to present Task 19 findings, conclusions and recommendations for review and approval by the **CITY**. DR's and TBR's from the Phase 1 Alternatives Analysis will be cross-referenced and appended to the PER to formalize the Phase 1 Alternatives Analysis documentation.

4. Deliverable Submission(s) in Electronic Format

*For proposal preparation purpose, it is understood that all Deliverables (e.g. TBRs) will be made using standardized electronic format; except for delivery of a permanent record in hard-copy format after **CITY**' approval of the final PER for Phase 1 Alternatives Analysis (Task 19).*

Electronic submission of Deliverables will be made on a solid-state portable "stick type" drive. All documents will be submitted in Adobe Portable Document Format (PDF). In general, documents will be saved from the original software application (e.g. MSWord, Excel, AutoCAD), where possible, at a minimum 600 dots per inch (DPI). Image documents (e.g. TIF, JPG, etc.) and letters/documents from outside sources, will be scanned into .PDF format, at a minimum of 600 DPI. Where possible, searchable PDF documents will be furnished; and drawings will be furnished in PDF format at full-size of the original drawing sets, using visual bar scales. The **CONSULTANT** will provide sample electronic deliverables, with standardized file-naming convention, for review and acceptance by the **CITY**.

5. Final Deliverable Submission in Hard-Copy Format

After **CITY**' approval of the final Phase 1 PER for Phase 1 Alternatives Analysis (Task 19), three (3) multi-volume bound hard-copies of the Phase 1 PER will be submitted to the **CITY**. *For proposal preparation purpose, it has been assumed that no other paper copies of Deliverables will be*

required, other than documents required at Public Information Meetings, Focus Group Sessions, and resource agency coordination meetings as indicated in Tasks 2 and 3.

6. Electronic Deliverable for Permanent Record (end of Phase 1 Services)

At completion of Phase 1 services, all supporting documents for the PER for Phase 1 Alternatives Analysis will be delivered to the **CITY** on a portable hard drive for the permanent record, including AutoCAD files for base plans and Plan Overlays that were prepared for the Phase 1 Alternatives Analysis.

H. <u>Schedule</u>

The **CONSULTANT** anticipates performing the Phase 1 Canal Embankment Assessment within eight *(8) months* from the date of Notice to Proceed based on the current understanding of work. The actual duration required is dependent on the extent of Stage C that are required, and the CONSULTANT will work with the CITY to maximize work effectiveness and strive to reduce possible work delays.

ID	Task Name	Start	Finish	Duration
1	NTP – Phase 1 Alterntaives Analysis	8/18/2016	8/18/2016	0w
2	TASK 1 - Emergency Response Documentation Gathering (Stage A)	8/18/2016	8/31/2016	2w
3	TASK 2 - Resource Agency Coordination (Stage A portion)	8/18/2016	1/4/2017	20w
4	TASK 4 - Environmental Documentation (Stage A portion)	8/25/2016	1/4/2017	19w
5	TASK 5 - Project Mapping	8/25/2016	10/12/2016	7w
6	5B. Stakeout / locate survey control points (Stage A)	9/8/2016	9/21/2016	2w
7	5C. LiDAR survey (Stage A)	9/8/2016	9/21/2016	2w
8	5D. Bathymetric Survey (Stage A portion)	9/1/2016	10/12/2016	6w
9	TASK 6 - Historic Data (Stage A portion)	8/25/2016	9/7/2016	2w
10	TASK 7 - Detailed Field Reconnaissance (Stage A portion)	8/25/2016	9/28/2016	5w
11	7A. Infrared Survey (Stage C)	9/1/2016	9/28/2016	4w
12	7B. Geotechnical-Related Field Reconnaissance – 1 (Stage A portion)	8/25/2016	9/14/2016	3w
13	7B. Geotechnical-Related Field Reconnaissance – 2 (Stage A portion)	9/15/2016	9/28/2016	2w
14	TASK 8 - Existing Dike Condition Assessment (Stage A portion)	9/15/2016	10/19/2016	5w
15	TASK 9 - Subsurface Investigation (Stage A portion)	8/25/2016	11/2/2016	10w
16	9A. Subsurface Exploration Plan (Stage A portion)	8/25/2016	9/7/2016	2w
17	9B. Field Investigation (Stage A portion)	9/8/2016	10/26/2016	7w
18	9C. Laboratory Investigation – Part 1 (Stage A portion)	10/6/2016	10/26/2016	3w
19	9C. Laboratory Investigation – Part 2 (Stage A portion)	10/27/2016	11/16/2016	3w
20	9D. TBR: Subsurface Investigation (Stage A portion)	11/17/2016	12/14/2016	4w
21	TASK 10 - Hydrologic and Hydraulic (H&H) Analysis (Stage A portion)	9/1/2016	12/14/2016	15w
22	TASK 11 - Water Supply Alternatives Analysis – Part 1 (Stage B Tier 1)	9/1/2016	11/16/2016	11w
23	TASK 11 - Water Supply Alternatives Analysis – Part 2 (Stage B Tier 1)	11/17/2016	12/14/2016	4w
24	11H. Subsurface Profiles (Stage B Tier 2)	10/20/2016	11/16/2016	4w
25	TASK 13 - Canal Structures Analysis (Stage A portion)	8/25/2016	11/16/2016	12w
26	TASK 14 - Masonry Drainage Tunnel Condition Assessment (Stage C)	9/15/2016	10/12/2016	4w
27	TASK 15 - Embankment (Dike) Geotechnical Analysis (Stage A portion)	10/27/2016	12/7/2016	6w
28	15C. TBR: Embankment (Dike) Geotechnical Analyses (Stg A portion)	12/8/2016	1/11/2017	5w
29	TASK 16 - Embankment (Dike) Repair Assessment – 1 (Stage A portion)	11/17/2016	12/7/2016	3w
30	TASK 16 – Embankment (Dike Repair Assessment – 2 (Stg A portion)	12/8/2016	12/28/2016	3w
31	TASK 17 - Recreational Opportunities Assessment (Stage B)	9/15/2016	12/14/2016	13w
32	TASK 18 - Flood Fighting Access Assessment (Stage B)	11/17/2016	12/21/2016	5w
33	TASK 19 - Phase I Alternatives Assessment – Part 1 (Stage B portion)	12/8/2016	12/28/2016	3w
34	TASK 19 - Phase I Alternatives Assessment – Part 2 (Stage B portion)	12/29/2016	1/25/2017	4w
35	19F. Submit Draft Prelim. Engr. Report – Phase 1 Alt. Analysis (Stg B)	1/26/2017	1/26/2017	0w
36	TASK 21 - Project Management and Administration	8/18/2016	1/25/2017	23w

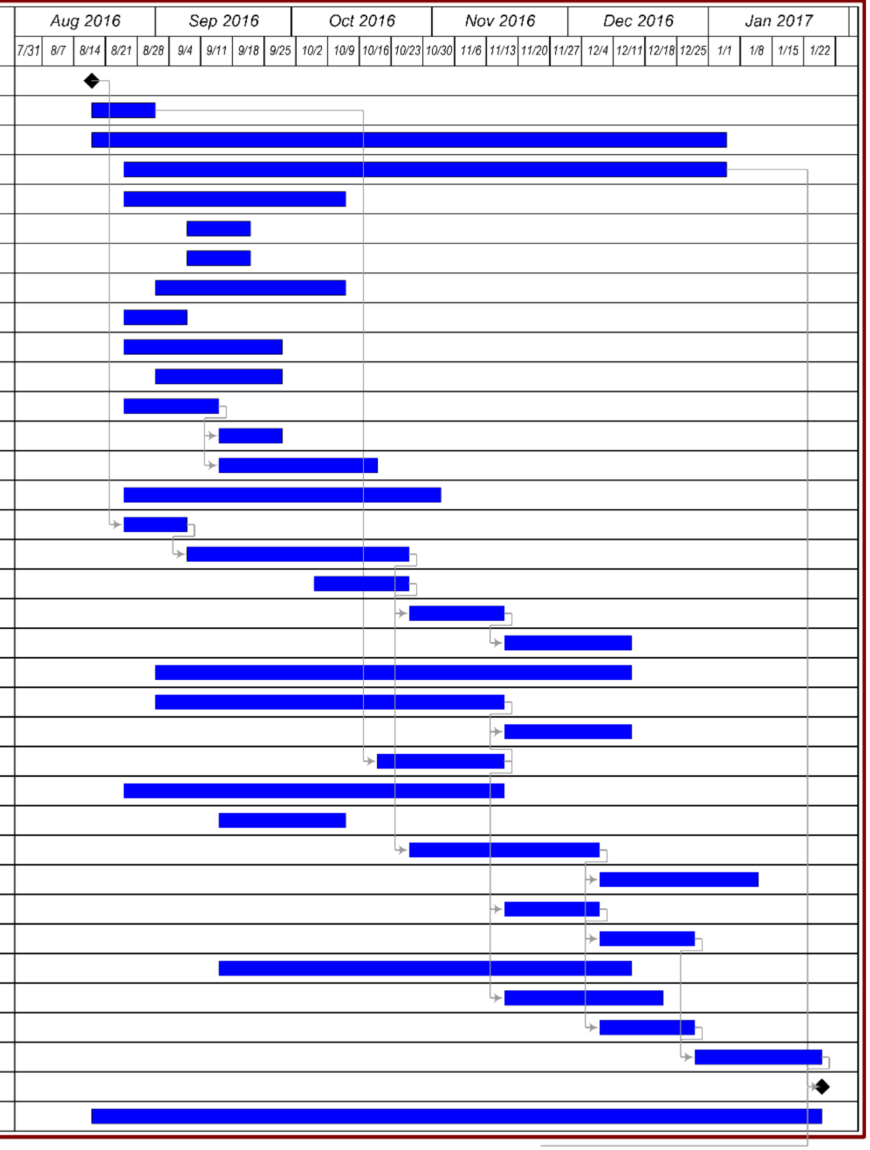

Figure 1-3- Bar Schedule

TASK 1 - EMERGENCY RESPONSE DOCUMENTATION GATHERING (STAGE A BASIC SERVICES)[1]

The **CITY** is taking the lead to gather documentation for the emergency response effort that was completed to-date (October 2015 to present) by others, which was completed on behalf of the **CITY** to implement emergency mitigation measures associated with the flooding event of early-October 2015 (described above). Some limited effort is anticipated to be required to consolidate and organize the documentation gathered; *but it has been assumed that the source entity(ies) anticipate the **CITY**'s request and as such is providing readily-accessible well-organized documentation. For proposal preparation purpose, a total of 80 man-hours has been estimated to process, consolidate, organize, digitize in word-searchable PDF format, index and digitally-file readily-available documentation received; and that all of the effort for Task 1 will be rolled-up and accounted for under the Reach 1 estimate.* The digitally-filed and indexed documentation will be placed on the **CONSULTANT**'s project server for direct access and reference by the project Team, and designated **CITY**' representatives for the complete duration of the project. At the end of Phase 1, digitally-filed and indexed documentation will be delivered to the **CITY** on a portable hard drive for permanent storage.

TASK 2 - RESOURCE AGENCY COORDINATION (STAGE A BASIC SERVICES)[2]

A. <u>Stakeholder Database</u>

A project related database will be created and maintained, to inform stakeholders and to solicit comment and input at key milestones during project implementation. The initial project related database will be created by updating and incorporating the names and contact information from key stakeholder lists compiled from a myriad of sources, which will include Project Steering Committee members, elected officials whose constituents may be impacted, various interest group representatives to include environmental and watershed organizations, the River Keeper, identified community leaders, representatives from Three Rivers Greenway, Chamber of Commerce, key user group representatives of the walkways and river ways, major employers in the area, small business owners, neighborhood/community representatives, SC Department of Commerce, economic development agency representatives, Richland County officials, Lexington County officials, South Carolina Department of Transportation (SCDOT) representatives, college and university representatives, the **CITY** and County Recreation Departments, those who attend project-related public information meetings and others who express an interest in the project.

[1] Stage A: Base Flood Damage Repair Services, Reach 1
[2] Stage A: Base Flood Damage Repair Services, Reach 1

B. Stakeholder Coordination

The **CONSULTANT** will be responsible to establish and facilitate a Stakeholder Advisory Committee to elicit input and keep stakeholders informed about the project. It is anticipated that key stakeholders will include the following.

- FERC
- SCSHPO
- SCDOT
- USACE
- HUD
- FEMA
- SCDNR
- SCANA
- SCDHEC
- City of Columbia
- Lexington County
- Richland County
- U.S. Fish and Wildlife Service

Figure 2-1- Stakeholders

For proposal preparation purpose, it is assumed that the Stakeholder Advisory Committee will meet at the following times to elicit input at key milestones during the Phase 1 Alternatives Analysis.

- *Stakeholder Meeting 1: Kick-off project overview;*
- *Stakeholder Meeting 2: Present initially-defined conceptual alternatives;*
- *Stakeholder Meeting 3: Present "defined" Alternatives;*
- *Stakeholder Meeting 4: Present draft Recommended Alternatives; and*
- *Stakeholder Meeting 5: Present final recommended Preferred Alternatives.*

*For proposal preparation purpose, it has been assumed that the **CITY** will identify and assist in recruiting stakeholder advisory committee members; the stakeholder meetings will be held at MBI's Columbia office with the understanding that there will be maximum of 90 session participants; and the **CONSULTANT** will be responsible to provide meeting agenda(s), printed matter, meeting exhibits, technical presentations and meeting minutes for the stakeholder meetings.*

C. FERC Advisor

The **CONSULTANT**'s Team includes Kleinschmidt's Paul Cyr, P.E., an independent Consultant approved by the Federal Energy Regulatory Commission (FERC) for performing Part 12 Dam Safety Inspections. Mr. Cyr will guide and advise the **CONSULTANT** on FERC and the South Carolina Department of Health and Environmental Control (SCDHEC) dam safety regulations and requirements on the rehabilitation of the canal specifically with regard to stability analyses and required hydraulic capacities of the dam and canal for compliance with the respective agency's regulations. Mr. Cyr will coordinate interactions with FERC and guide development of **CITY**' submittals to FERC.

D. FEMA/HUD Advisor (Omitted)

Refer to Task 20.

TASK 3 - PUBLIC RELATIONS (STAGE C[3] ADDITIONAL SERVICES)

Based on Scoping discussion with the **CITY**, it is the **CONSULTANT**'s understanding that:

- In-depth Public Involvement will be engaged after the Phase 1 Alternatives Analysis process is completed,
- The **CITY** will address public involvement needs with in-house staff during the Phase 1 Alternatives Analysis, and

[3] Stage C: Supplemental Flood Resiliency Enhancement Services

- Focus Group and Public Information meeting scheduling/implementation, and Public Update Notice preparation/distribution, City' Website Postings and Press Release(s) will all be deferred to Phase 2 final design.

A. Public Participation / Communication Plan (Omitted, outside the Scope of this Proposal)

B. Public Identity Graphic (Omitted, outside the Scope of this Proposal)

C. Focus Group Session (deferred to Phase 2, outside the Scope of this Proposal)

During Phase 2, the **CONSULTANT** will implement focus group sessions in order to ascertain stakeholder opinions regarding the Columbia Canal Restoration project's alternative solutions and recommendations from a small group of key stakeholders that may have a unique perspective regarding identifying certain pre-existing conditions, historic issues and / or various design alternatives, which will be taken into account to identify and consider options moving forward. *For proposal preparation purpose, it has been assumed that the **CITY** will identify and assist in recruiting focus group participants; focus group session(s) will be held at MBI's Columbia office with the understanding that there will be maximum of 90 session participants; and the **CONSULTANT** will be responsible to provide printed matter, exhibits and technical presentations for Focus Group Session(s). The **CONSULTANT** understands that Focus Group Sessions will not be conducted during the Phase 1 Canal Embankment Assessment.*

D. Public Information Meeting (deferred to Phase 2, outside the Scope of this Proposal)

During Phase 2, the **CONSULTANT** will facilitate and implement logistics for a series of Public Information Meetings, to be held for the general public*. For proposal preparation purpose, the **CONSULTANT** understands that Public Information Meetings will not be conducted during the Phase 1 Canal Embankment Assessment.*

During Phase 2, the **CONSULTANT** will be responsible for overall logistics coordination and management of the Public Information Meeting process. *For proposal preparation purpose, it has been assumed that Public Information Meeting(s) will be held at MBI's Columbia office with the understanding that there is a maximum of 90 meeting participants; the **CITY**' Public Relations (PR) office will be responsible to distribute meeting notices to appropriate media outlets; and the **CONSULTANT** will be responsible to provide design exhibits, visuals, handouts or other technical information to the meeting attendees.*

E. Project Update Notices (deferred to Phase 2, outside the Scope of this Proposal)

During Phase 2, Project Updates will be prepared and distributed in conjunction with key milestone deliverables. The **CONSULTANT** will prepare project update bulletins, and submit the bulletins to the **CITY** for distribution. *For proposal preparation purpose, the **CONSULTANT** understands that Project Update Notice(s) will not be prepared/distributed during the Phase 1 Canal Embankment Assessment.*

F. CITY Website Postings (deferred to Phase 2, outside the Scope of this Proposal)

The **CONSULTANT** will forward project materials, exhibits, updates, and press notices to the **CITY'** PR Staff for posting on the **CITY**'s website at each key project milestone. *For proposal preparation purpose, a total of one (1) website posting will be prepared and submitted to the **CITY** for posting.*

G. Press Release(s) (deferred to Phase 2, outside the Scope of this Proposal)

The **CONSULTANT** will prepare press releases that are consistent with key project milestones and will submit the press releases to the **CITY** PR staff for distribution to local broadcast and print media outlets. *For proposal preparation purpose, a total of one (1) press release will be prepared and submitted to the **CITY** for distribution.*

TASK 4 - ENVIRONMENTAL DOCUMENTATION (STAGE A ADDITIONAL SERVICES AND STAGE C ADDITIONAL SERVICES)

USACE, FERC, FEMA and HUD guidance will be used to develop and maintain required environmental documentation as described below.

A. Jurisdictional Waters Delineation

The **CONSULTANT** will use current USACE guidance to delineate the limit of the "waters of the United States" (canal and river) that are "jurisdictional" and subject to regulatory requirements under the Clean Water Act (CWA). In general, jurisdictional waters are anticipated to include those waters that are located in whole or in part within the 100-year floodplain within the project limits. Approval of the delineation will be obtained from the USACE and incorporated into the TBR and design files for the purpose of avoidance, minimization, permitting, Canal Embankment Assessment, and eventual design of the preferred alternative in Phase 2.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, it is assumed that Stage A[4] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[5] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. Evaluation of Environmental Impact (based on secondary sources)

Because the study area of the project is confined predominantly to the canal and dike, some of the typical National Environmental Policy Act (NEPA) categories that are studied in an Environmental Assessment (EA) do not apply and will not be evaluated. These include farmlands, environmental justice, and displacements. Impact categories that will be applicable to this project, and therefore evaluated, include:

- Land use,
- Cultural resources,
- Section 4(f)/6(f),
- Social and economic,
- Noise (construction),
- Air quality (construction),
- Hazardous materials,
- Federally protected species,
- Floodplains; and indirect and cumulative impacts.

[4] Stage A: Base Flood Damage Repair Services, Reach 1

[5] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

Data on existing conditions for each of these impact categories will be gathered to serve as a baseline for evaluating potential impacts, based on the footprint of each alternative developed. At this time it is not clear who the lead federal agency (ies) will be; and determination of the lead agency(ies) will depend on which alternative is selected as the preferred alternative. Each federal agency interprets NEPA differently, therefore the content and format of the EA could be driven by the key components of the preferred alternative. For example, if the power generating component is dropped as an alternative, it is likely that the USACE will be the lead agency since a Section 404 permit will be required for any repairs or alterations to the dike, whereas if the current use of the canal is maintained, FERC and FEMA will most likely be the lead agencies.

It is anticipated that a wide range of alternative uses for the canal and dike will be developed and evaluated. Because of the recreational value afforded by the canal area, public involvement will be an important component to this project. Public information meetings and workshops with stakeholders will be conducted (under Task 3), per the requirements of NEPA. Input from the public could play a major role in the development and selection of project alternatives and foster public support for the preferred alternative.

After the lead agency(ies) is(are) identified, the **CONSULTANT** will meet with the lead agency(ies) to determine the level of environmental documentation required; however such level of environmental documentation is not known until the lead agency(ies) is(are) identified and agreed upon by the key stakeholders involved. *Hence for proposal preparation purpose, it has been assumed that environmental-related documentation in format and detail as dictated by the USACE and entail an EA (e.g. no Environmental Impact Statement) and will culminate in a Finding of No Significant Impact (FONSI). In gathering data under this task, it is assumed that no cultural resources field work or aquatic species surveys will be conducted. In addition, it is assumed that buried or submerged historic or prehistoric archaeological remains are not discovered during the process of gathering subsurface data, other than the known structure remains that are described elsewhere in this Scope of Services. If buried or submerged remains of historical or archaeological interest to the South Carolina State Historic Preservation Office (SCSHPO) are discovered, the **CONSULTANT** will notify the **CITY** immediately to determine appropriate steps moving forward, since such discovery most likely will have a significant impact on the level of effort to complete the Phase 1 Canal Embankment Assessment (e.g. change in scope).*

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[6] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[7] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

C. <u>Plan Overlays</u>

Relevant environmental constraints (socioeconomic and environmental) and existing baseline engineering constraints inventoried (within the project limits) will be identified on separate Plan Overlays that are worked with the base plans and other plan overlays to identify avoidance areas and

[6] Stage A: Base Flood Damage Repair Services, Reach 1

[7] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

maximize beneficial use of the project site. The Plan Overlay(s) will be an essential resource for future reference and completion of the Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[8] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[9] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

D. <u>TBR: Environmental Documentation</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 4 environmental documentation. Once an alternative has been selected, data collected and used to compile the TBR will be utilized in the EA as the Existing Conditions section of the document.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[10] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[11] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

E. <u>Draft Environmental Assessment</u>

A draft EA will be prepared that evaluates the range of alternatives and upon approval of the lead federal agency(ies), the document will be made available to the public and other resource and regulatory agencies for review and comment and a public hearing will be conducted. The draft EA will include the Plan Overlays (described above in Task 4.C). As mentioned above, the baseline data contained in the TBR will be incorporated into the EA. Comments received during this process will be addressed either individually or in the Final EA. The Final EA will also include a Record of Decision (ROD) from the lead federal agency(ies).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[12] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[13] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

[8] Stage A: Base Flood Damage Repair Services, Reach 1

[9] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[10] Stage A: Base Flood Damage Repair Services, Reach 1

[11] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[12] Stage A: Base Flood Damage Repair Services, Reach 1

[13] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

TASK 5 - PROJECT MAPPING (STAGE A ADDITIONAL SERVICES AND STAGE C ADDITIONAL SERVICES)

A. Pre-Dike Breach Event Base Mapping

The **CONSULTANT** is aware of bathymetric and topographic survey mapping (circa January 2009, 1"=30' scale with 1-foot contour interval) of the Columbia Canal that is available, which extends the entire length of the embankment (dike) from the headgates to the hydroelectric plant intake gates (approximate 15,000 feet in length). *For proposal preparation purpose, it has been assumed that the survey drawings can be provided to the **CONSULTANT** in AutoCAD, or other suitable format, and permission will be granted to the **CITY** and the **CONSULTANT** to use this bathymetric and topographic survey mapping. The **CITY** is currently engaged in making contacts to obtain this permission from the owner of the 2009 mapping.*

For proposal preparation purpose, assume that all of the effort for the Pre-Dike Breach Event Base Mapping will be rolled-up and accounted for under Stage A[14] for the entire dike length.

B. Stakeout / Locate Survey Control Points

The **CONSULTANT** will perform a closed second-order survey level loop that is tied into the nearest USGS survey benchmark to:

- Establish temporary survey benchmarks on approximate 1,000 foot intervals over the entire length of the dike,
- Establish 6 to 8 additional survey benchmarks on the city-side of the canal to establish aerial triangulation control for infrared aerial photogrammetry (Task 7A).
- Establish permanent survey benchmarks in the top of the concrete headworks structure, canal spillway and existing hydroelectric plant (if none exists now);
- Field spot-check the 2009 mapping,
- Establish elevation control for mobile LiDAR, bathymetric and drainage tunnel surveys (Tasks 5C, 5D and 5F, respectively), and
- Provide reference for detailed field reconnaissance (Task 7), subsurface investigation (Task 9), hydrologic and hydraulic analysis (Task 10), and canal structures analysis (Task 13).

The **CONSULTANT** will perform ground control surveys to establish 3rd order coordinates (X, Y, Z) for at least 6 of the survey benchmarks, which are based on the SC State Plane coordinate system.

For proposal preparation purpose, assume that all of the effort for the stakeout/locations of survey control points will be rolled-up and accounted for under Stage A[15] for the entire dike length.

C. LiDAR Survey

To document the Post-Dike Breach Event conditions, the **CONSULTANT** will perform a mobile LiDAR survey to document features that can be located by direct line-of-site between the mobile LiDAR vehicle and the point/feature of interest. The mobile LiDAR will conduct multiple sweeps from truck-accessible locations for a maximum of two (2) consecutive 8-hour days at the project site. Post-

[14] Stage A: Base Flood Damage Repair Services

[15] Stage A: Base Flood Damage Repair Services

processing of LiDAR data will be completed on select portions of the data collected, to support priority mapping needs to complete the Phase 1 Canal Embankment Assessment. All raw LiDAR data collected will be stored and made readily available for post-processing over the complete duration of the project.

The LiDAR survey will be used to:

- Discern features that were disturbed/damaged/moved since the 2009 base mapping survey;
- Locate visible drainage structure outfalls that are in a direct line of sight from the mobile LiDAR unit;
- Postulate probable flood damage, when used in combination with the base mapping (circa 2009) and actual conditions observed during the detailed field reconnaissance (Task 7); and
- Expand topographic survey coverage beyond that currently captured in the 2009 topographic survey, particularly:
  - at staging areas under considered on the east side of the left canal bank (Figure 18-2), and
  - where the temporary earthen cofferdam was constructed across the canal during the October 2015 emergency response.

For proposal preparation purpose, assume that all of the effort for the LiDAR survey will be rolled-up and accounted for under Stage A[16] for the entire dike length.

D. <u>Bathymetric Survey</u>

Since accelerated canal flow in October 2015 occurred as a result of the dike breach, the **CONSULTANT** will perform a dual frequency bathymetric survey within the Columbia canal to:

- Identify possible scour damage, including accessible portions of the pedestrian bridge substructures (pier and abutments) and SCDOT bridge substructures,
- Assess possible short-term sediment aggradation/degradation, and
- Determine and map the top of soft fluid sediment and firm bottom within Columbia Canal at the project site,
- Investigate three (3) potential raw water withdrawal locations to identify depth of channel bottom for suitability of the potential withdrawal location, and
- Identify anomalous conditions that are detected, such as scour holes that may or may not have been filled-in, sunken vessels that may have been abandoned in-place and abandoned objects (e.g. civil war era munitions that may possibly exist, like those encountered by others elsewhere along the Broad River, which could pose a danger to drill rig operators during the subsurface investigation, Task 9)

Near-full bottom bathymetric mapping will be collected with a main-survey vessel that is equipped with an Edgetech 6205 Interferometric Swath Sonar (or equal). Hydrographic survey coverage will be dependent on the side slope of the dike forming the west bank of the canal, the more natural slope on the east bank and the depth of water at/near vessel approach to these banks. In general, the interferometer gives wider bottom coverage the deeper the water is. In addition, an Odom Echotrac

[16] Stage A: Base Flood Damage Repair Services

CV 200 dual frequency single-beam sonar (or equal) will be utilized to collect top and bottom elevations of sediment deposits at approximate 1000-foot interval transects across the canal.

Due to the unknown depth of the canal (after the dike breach) and the required depth needed for the main-survey vessel to operate safely and efficiently, the bathymetric survey will consist of a two-phase approach.

Bathymetric survey at accessible bridge and canal substructures will be conducted and mapping

1. Phase 1 Bathymetric Survey

Phase 1 will include launching a shallow-draft flat-bottom john boat (reconnaissance vessel) that is equipped with a survey-grade Hydrolite echo sounder to collect reconnaissance depth data along the center of the canal. This reconnaissance mission will also collect the clearance available under the pedestrian bridge. If sufficient depth exists to utilize the main-survey vessel for near-full bottom bathymetric coverage, the reconnaissance vessel will be extracted from the canal and launched to collect data at the 3 proposed intake study areas. If sufficient depths do not exist to utilize the main-survey vessel, then the reconnaissance vessel will become the primary data collection vessel for the entire project.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, it is assumed that Stage A[17] will only include Phase 1 Bathymetric Survey that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[18] will include Phase 1 Bathymetric Survey that is required over the remaining length of dike up to the headworks within Reach 2.

2. Phase 2 Bathymetric Survey

Phase 2 will be implemented, if water depth is sufficient to safely operate the main-survey vessel. The main-survey vessel will be utilized to collect near-full bottom coverage, conditions permitting.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that all of the in-depth Phase 2 bathymetric survey will be completed in Stage A[19].

3. Data Collection Area Limitations

Single Beam Hydrolite System – minimum water depth 2 feet

Edgetech 6205 – minimum water depth 6 feet (under sonar)

[17] Stage A Basic Services: Base Flood Damage Repair Services, Reach 1

[18] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[19] Stage A Additional Services: Supplemental Flood Resiliency Enhancement Services, Reach 2

4. Main-Survey Vessel Characteristic Features

- Vessel type: Scully 20' (25' overall length), all aluminum hydrographic survey vessel.
- Maximum loaded weight 6000 pounds
- Length Overall: 25 feet
- Beam of Vessel: 8 feet
- Beam with sonars deployed: 9.5 feet
- Minimum Water Draft: 2.5 feet
- Safe Operational Draft: 4.5 feet
- Air Draft: 10 feet (water surface to top of radar dome)
- Engines: (2) 90 HP Honda 4 stroke
- Bottom Paint: Food/Potable Water Grade Epoxy Paint
- Sonars: (1) Odom Echotrac CV dual frequency Sonar, and
  (1) Edgetech 6205 Interferometric Dual Frequency Swath Bathymetry/Side Scan
- Navigational and 3D Inertial Sensing Equipment: Survey Grade Applanix POS MV 320 Positioning System with GAMS and Inertial Measurement Unit
- Computers: (1) Industrial Grade Rack-Mount Computer System running Windows 7 OS
- Software (for data reduction): HyPack and HySweep
- Communication : Cellular Modem and Cellular Amplifier; Marine Grade VHF Radio(s)

For proposal preparation purpose, the following assumptions have been made with regard to the bathymetric survey.

- *An adequate boat ramp does not exist to launch and retrieve the main-survey vessel. Hence, a crane with 50-foot horizontal reach with minimum rated 6,000 pound safe working load is used to pick-up, launch and retrieve the main-survey vessel. A total of four (4) crane lifts are required due to possible clearance restrictions under the pedestrian bridge (twice-in and twice out).*
- *VRS or RTK GPS correction data is used to support the bathymetric survey over 3-mile canal length.*
- *The reconnaissance vessel is operated along a navigation route (to and from intake study areas) at safe locations.*
- *Horizontal and vertical survey control points are used to operate RTK base operations, if VRS correction data cannot be received onsite.*

E. <u>SC811 Utility Notification and Annotated Plan Overlay of Known Utilities</u>

The **CONSULTANT** will perform an SC811 utility notification.

Base plans will be submitted to utility respondents, to engage utilities to return annotated plan sheets with the approximate location of known utilities (both overhead and underground) for future reference. The Plan Overlay will be worked with the base plans and other plan overlays to:

- Identify locations where measurable ground surface change has occurred,
- Identify avoidance areas, and
- Maximize beneficial use of the project site.

This Plan Overlay will be an essential resource for future reference and to complete the hydrologic and hydraulic analyses (Task 10), complete the canal spillway capacity analysis (Task 10F), assess the condition of masonry drainage tunnel under the canal (Task 14), consider dike repair strategies (Task 16) and complete the Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[20] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[21] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

F. Drainage Tunnel Survey

The **CONSULTANT** will perform a location and alignment survey of the drainage tunnel that extends beneath the canal from the water treatment plant to the abandoned water pumping plant, and the cross-sectional geometry of the tunnel will be measured and located wherever visible changes occur. The tunnels' location will be shown on the Plan Overlay; and a typical tunnel cross section will be prepared.

For proposal preparation purpose and consideration, assume that Stage C[22] will include the drainage tunnel survey within Reach 2.

G. Plan Overlay(s)

Plan annotations, which are returned to the **CONSULTANT** by the impacted utility company(ies), will be scanned and transcribed onto a Plan Overlay in AutoCAD.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[23] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[24] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

H. DR: Project Mapping

A stand-alone DR will be prepared to summarize and present work product for the Task 5 project mapping. The DR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies) of electronic file structure, layer naming convention, and symbol library; a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The DR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), and used as basis to address various remediation options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[25] will only include work that is required to repair the dike

[20] Stage A: Base Flood Damage Repair Services, Reach 1

[21] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[22] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[23] Stage A: Base Flood Damage Repair Services, Reach 1

[24] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[25] Stage A: Base Flood Damage Repair Services, Reach 1

to preexisting conditions within Reach 1; and that Stage C[26] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 6 - HISTORIC DATA (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. <u>Data Gathering</u>

To fill-in gaps that may not have been gathered previously by others during the Emergency Response (Task 1, circa last quarter 2015 through 1st quarter 2016), the **CONSULTANT** will make reasonable effort, as described in the following, to contact and gather readily-available historic data that is relevant to the Columbia Canal Restoration project, from the following sources.

- SCE&G. Make contact with SCE&G Dam Safety and request historical data for the Columbia Canal inclusive of: any drawings of all structures associated with the canal and Diversion Dam, bathometric and topographic drawings of the canal and impoundment, and documents relative to compliance with FERC dam safety requirements.
- **CITY**. Provide the **CITY'** Project Manager a list of information to be obtained from the **CITY** file archives.
- SCDOT. Obtain readily-available bridge plans for structures that cross over the Columbia Canal within the project limits.
- SCDNR. The **CONSULTANT** will contact the South Carolina Department of Natural Resources (SCDNR), which is operating under a Cooperating Technical Partners (CTP) flood study mapping agreement with FEMA, to obtain the current preliminary HEC-RAS model for the river system, FEMA flood insurance study (FIS) and breach data reports.
- Lockhart Power Company

*For proposal preparation purpose, it has been assumed that the readily-available data that is acquired will include bridge plans and inspection reports for the canal pedestrian bridge, and canal spillway vehicular access bridge. The **CONSULTANT** understands that Kleinschmidt-Chao will be responsible to assess the vehicular access bridge over the canal headworks. Furthermore it is assumed that these bridge plans will include details about existing structural members, section properties, material strengths, design standards and as-built foundation information; and that the inspection reports will include detailed information documenting historic deficiencies, member/reinforcing section losses and any applied repairs.*

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[27] will only include work that is required to repair the dike

[26] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[27] Stage A: Base Flood Damage Repair Services, Reach 1

to preexisting conditions within Reach 1; and that Stage C[28] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. DR: Historic Data

A stand-alone DR will be prepared to summarize and present work product for the Task 6 historical data. The DR will be a multi-volume document, to facilitate progressive delivery of readily-available historic data as it becomes available. The TBR will include a tabular summary to document the source historic data acquired, along with a general description of the data content. Data obtained will be indexed where possible, to maintain consistent cross-referencing throughout the project documentation. The DR of historic data will be referenced in other TBRs and the Preliminary Engineering Report (PER), to minimize duplicate reproduction of historic data used. The DR of historic data will be referenced as applicable in the Canal Embankment Assessment (Task 16) and Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[29] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[30] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 7 - DETAILED FIELD RECONNAISSANCE (STAGE A BASIC SERVICES IN REACH 1, STAGE A ADDITIONAL SERVICES IN REACH 2, AND SUPPLEMENTAL RECONNAISSANCE IN STAGE C ADDITIONAL SERVICES)

Field reconnaissance activity will be performed in general accordance with FERC Regulations, Safety of Water Power Projects and Project Works. In addition, an infrared survey of the dike will be conducted to further identify water movement within the dike.

A. Infrared Survey

Aerial Infrared and Photographic Surveys will be performed to identify leaks, saturation, anomalies and/or potential areas of water movement within the dike structures. These surveys will be performed along the full length of the dike. The information from these surveys will be utilized to refine the field reconnaissance approach and focus effort on critical regions of the dike that are of most concern with regard to dike stability and flood-fighting resiliency.

Aerial infrared photogrammetry will be obtained at a 3-inch pixel resolution, or better. Using photogrammetric techniques, the **CONSULTANT** will collect 4-band (B, G, R and CIR) ortho-quality digital elevation model (DEM) data and use the DEM to generate ortho imagery. After the ortho imagery has been created, image processing will be performed to create the Normalized Difference Vegetation Index (NDVI) to identify water seepage areas.

[28] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[29] Stage A: Base Flood Damage Repair Services, Reach 1

[30] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose and consideration that Stage A is intended to repair damaged sections of dike in Reach 1 to preexisting conditions, assume that the Infrared Survey will be completed under Stage A[31] as Additional Services over the entire length of dike within the project limits.

B. <u>Geotechnical-Related Field Reconnaissance</u>

A geotechnical-related desktop literature review will be completed based on readily-available information in the office, to develop an understanding of the overall subsurface setting and regional geology, and to develop a punch-list of items that are anticipated to be of interest during the subsequent field reconnaissance. Using the results from the desktop literature review, a geotechnical-related field reconnaissance will be performed that generally entails visual evaluation, observation and documentation of the following aspects relative to the following areas: embankment dike; east bank of the canal; and areas germane to the alternatives shown in Figure 18A and 18B shown herein. Key observations will be documented in field observation reports, field sketches based on hand-taped measurements and a hand-held GPS unit, and digital photographs. Observations regarding damage caused by the flood will be segregated where possible from typical observations.

- Evidence of displacement, cracks, sinkholes, heave, springs, wet spots, and sand boils,
- Cracking, desiccation and deterioration,
- Abnormal vegetation growth, surface erosion, animal borrows, and trees,
- Embankment depressions, crimped and bulged areas, slumps, and evidence of slope instability,
- Surface erosion, scour damage, inadequate slope protection, concentrated surface runoff,
- Evidence of dispersion, suspended solids, suffusion/suffosion, and surface stains,
- Surface erosion, erosion gullies, internal erosion, backward erosion piping, sand boils, concentrated leak erosion and ponded areas,
- Dike penetration(s) and utility crossing(s),
- Through-seepage, under-seepage and leakage, and
- Indicators of internal stress and excess pore pressure.

In addition to the items listed above, existing structures at/near the embankment (dike) will be observed, including but not limited to existing SCDOT bridge substructures, overhead transmission tower foundations and remains of abandoned structures. Among other things, consideration will be given to field procedures recommended to estimate the headcut erodibility index by the Natural Resources Conservation Service (NRCS) in the National Engineering Handbook (NEH) Part 628 Chapter 52.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[33]Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; Stage A Additional Services will include a coarse-level field reconnaissance that is sufficient to delineate probable flood-damaged areas within

[31] Stage A: Base Flood Damage Repair Services, Reach 1

[33] Stage A: Base Flood Damage Repair Services, Reach 1

Reach 2; and that Stage C[34] will include supplemental work that is required to complete a more refined field reconnaissance within Reach 2.

C. Existing Visible Drainage Outfalls

The **CONSULTANT** will conduct a field review of the Canal to confirm the location of visible Drainage Outfalls from the **CITY** drainage system including natural features along with piped and channelized systems. This work will include a review of the **CITY** storm water inventory information prior to the field review. A condition assessment of the masonry drainage tunnel that extends beneath the canal will be conducted in Task 14.

The **CONSULTANT** will conduct a qualitative inspection of the canal spillway to supplement the LiDAR survey (Task 5C) with hand-taped measurements as needed to support Tasks 10F and 13B. Readily-available spillway documentation (from Task 6) will be reviewed. The existing canal spillway will be field viewed to visually observe and photograph the general condition of the canal spillway, where safely accessible from the ground surface or john boat. Particular attention will be placed on identification of possible flood damage, such as visual evidence of recent scour activity and/or possible member damage from floating debris. A Technical Memorandum with field notes, field sketches and representative photographs will be prepared to document inspection findings. *For proposal preparation purpose, it has been assumed that existing structural members, section properties, material strengths, and section losses are all contained in the most recent inspection report and this data will be utilized by the **CONSULTANT** for the Phase 1 Canal Embankment Assessment; and that no detailed inspection, section loss determination, or detailed measurements will have to be obtained to complete the Phase 1 Canal Embankment Assessment.*

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[35] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[36] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

D. Existing Pedestrian and Vehicular Access Bridges

The **CONSULTANT** will conduct a qualitative bridge inspection of the following access bridges:

- Two-span truss canal pedestrian bridge; and
- Canal spillway timber vehicular access bridge.

The **CONSULTANT** understands that the condition of the canal headwork's vehicular access bridge will be assessed by Kleinschmidt-Chao under separate contract to the **CITY**.

Readily-available bridge documentation (from Task 6) will be reviewed. The canal pedestrian and canal spillway bridges will be visually inspected to observe and photograph the general condition of the exposed members of the existing bridge substructure and superstructure, both from above and

[34] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[35] Stage A: Base Flood Damage Repair Services, Reach 1

[36] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

below, where safely accessible from the ground surface or john boat. Particular attention will be placed on identification of possible flood damage, such as evidence of recent scour activity based on visual observation and soundings and/or possible member damage from floating debris; and the exposed condition of the deteriorated substructures at the 2-span canal pedestrian bridge. A Technical Memorandum with field notes, field sketches and representative photographs will be prepared to document inspection findings. The work of assessing the canal spillway bridge will be conducted as part of Task 7D. *For proposal preparation purpose, it has been assumed that existing structural members, section properties, material strengths, detailed measurements, and section losses are all contained in the most recent bridge plans and inspection reports and this data will be utilized by the **CONSULTANT** for the Phase 1 Canal Embankment Assessment; and that no detailed inspection, section loss determination, or measurements will have to be obtained to complete the Phase 1 Canal Embankment Assessment.*

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[37] will only include a qualitative bridge inspection of the canal spillway timber vehicular access bridge that is sufficient to repair the access bridge to preexisting conditions within Reach 1; and that Stage C[38] will include a qualitative bridge inspection of the two-span truss canal pedestrian bridge within Reach 2.

E. <u>Plan Overlay of Significant Reconnaissance Features and Historic Boring Locations</u>

Relevant geotechnical-related data from the desktop literature review and field reconnaissance will be presented on a Plan Overlay that is worked with the base plans and other plan overlays to identify avoidance areas and maximize beneficial use of the project site. This Plan Overlay will be an essential resource for future reference and to develop and execute the subsurface investigation (Task 9), complete the dike seepage and stability analysis (Task 15), consider dike repair strategies (Task 16), evaluate subsurface conditions at alternate flood-fighting access bridge locations (Task 18) and complete the Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[39] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[40] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

F. <u>Plan Overlay of Drainage Outfalls and Relevant Drainage Features</u>

Relevant hydrologic- and hydraulic-related data from the desktop literature review and field reconnaissance will be presented on a Plan Overlay that is worked with the base plans and other plan overlays to identify avoidance areas and maximize beneficial use of the project site. This Plan Overlay will be an essential resource for future reference and to complete the hydrologic and hydraulic

[37] Stage A: Base Flood Damage Repair Services, Reach 1

[38] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[39] Stage A: Base Flood Damage Repair Services, Reach 1

[40] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

analyses (Task 10), assess the condition of masonry drainage tunnel under the canal (Task 14), consider dike repair strategies (Task 16) and complete the Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[41] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[42] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

G. DR: Detailed Field Reconnaissance

A stand-alone DR will be prepared to summarize and present work product for the Task 7 detailed field reconnaissance. The DR will be a multi-volume document; and findings for each major reconnaissance item (Tasks 7A through 7F) will be presented in a separate volume, to facilitate progressive delivery of findings on a topic-by-topic basis. The DR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The DR will be referenced as applicable in the Alternatives Assessment Report (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[43] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[44] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 8 - EXISTING DIKE CONDITION ASSESSMENT (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. Plan Overlay of Flood Damage, Scour, Seepage, Bank Instability and Restricted Access Features

Key flood-damage, scour, seepage, bank instability and restricted access from the field reconnaissance (Task 7) will be featured on a Plan Overlay that is worked with the base plans and other plan overlays to identify avoidance areas and maximize beneficial use of the project site. This Plan Overlay will be an essential resource for future reference and to complete the subsurface investigation (Task 9) dike seepage and stability analysis (Task 15) and dike repair strategies (Task 16), and Phase 1 Alternatives Analysis (Task 19).

[41] Stage A: Base Flood Damage Repair Services, Reach 1

[42] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[43] Stage A: Base Flood Damage Repair Services, Reach 1

[44] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[45] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[46] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. TBR: Existing Dike Condition Assessment

A stand-alone TBR will be prepared to summarize and present work product for the Task 8 existing dike conditions assessment. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The TBR will be referenced as applicable in the Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[47] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[48] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 9 - SUBSURFACE INVESTIGATION (STAGE A ADDITIONAL SERVICES AND STAGE C ADDITIONAL SERVICES)

A. Subsurface Exploration Plan

The subsurface investigation will be performed in accordance with the FERC' Engineering Guidelines for the Evaluation of Hydropower Projects, Chapters 4 and 5. Because this is a canal embankment assessment, the investigation will be in general accordance with Section 5-7.2 – Initial Design Investigation. It is anticipated that standard USACE drilling and sampling techniques and rotosonic drilling techniques will be utilized during the subsurface investigation.

A boring location plan will be developed and submitted to the **CITY** for review and approval. Historic data (Tasks 1 and 6) and field reconnaissance (Task 7) will be utilized to refine the proposed borings location plan, in combination with available bathymetric survey data (Task 5D). The boring location plan will include proposed borings locations and estimated boring depths.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[49] will only include work that is required to repair the dike

[45] Stage A: Base Flood Damage Repair Services, Reach 1

[46] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[47] Stage A: Base Flood Damage Repair Services, Reach 1

[48] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[49] Stage A: Base Flood Damage Repair Services, Reach 1

to preexisting conditions within Reach 1; and that Stage C[50] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. Field Investigation – Stage A Reach 1[51]

1. Dike Breach Investigation

The cross section of the dike exposed by the breach will be investigated by a Geologist. Soil stratification within the dike cross section at the breach will be documented and bulk samples will be taken for laboratory testing. In addition, hand auger drilling will be performed at select locations identified in the field by the Geologist.

One (1) bulk sample of the dry sediment in the bottom of the canal south of the cofferdam will be obtained. A broad spectrum screening of the bulk sample will be performed to identify potential hazardous contamination that may have an impact on disposal and handling of dredged material (including construction handling).

The following assumptions apply to the above described land based drilling:

- *Pedestrian control will be provided by the City. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included with regard to unearthing historical artifacts.*

2. Dike Borings

One (1) boring will be drilled on either side of the breach for a total of two (2) dike borings to support characterization of the existing embankment dike in Reach 1. Water levels at time of drilling completion and 24 hour water levels will be measured.

Due to expected variation in embankment thickness, depth of soil overburden and changes in bedrock elevation, boring depths are anticipated to range from about fifty (50) to eighty (80) feet in depth (not including rock coring). Rock coring will be performed after auger refusal is encountered, at designated borings. Rock coring will be performed to a depth of five (5) feet below the point at which auger refusal was achieved.

The following assumptions apply to the above described land-based drilling:

- *Equipment that utilizes standard petroleum products will be utilized.*
- *The **CITY** will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the **CITY**.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*

[50] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[51] Stage A: Base Flood Damage Repair Services, Reach 1

- *Pedestrian control will be provided by the **CITY**. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *Drill rig will be mobilized to the dike via access across the canal head works. No cranes or barges will be required.*
- *The **CITY** will provide conformation that the Headworks Structure is structurally adequate to support all loadings from the drilling equipment and drilling operations.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*

3. Dike Borings – Stage C Reach 2[52]

One (1) boring will be drilled at each of four (4) subsurface section locations for a total of four (4) dike borings to support characterization of the existing embankment dike. Water levels at time of drilling completion and 24 hour water levels will be measured.

Due to expected variation in embankment thickness, depth of soil overburden and changes in bedrock elevation, boring depths are anticipated to range from about fifty (50) to eighty (80) feet in depth (not including rock coring). Rock coring will be performed after auger refusal is encountered, at designated borings. Rock coring will be performed to a depth of five (5) feet below the point at which auger refusal was achieved.

The following assumptions apply to the above described land-based drilling:

- *Equipment that utilizes standard petroleum products will be utilized.*
- *The **CITY** will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the **CITY**.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*
- *Pedestrian control will be provided by the **CITY**. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *Drill rig will be mobilized to the dike via access across the canal head works. No cranes or barges will be required.*
- *The **CITY** will provide conformation that the Headworks Structure is structurally adequate to support all loadings from the drilling equipment and drilling operations.*

[5252] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*

4. Canal Subsurface Section Borings

At four (4) locations, borings will be performed on an alignment perpendicular to the dike such that a subsurface section can be developed. Each subsurface section is anticipated to include at least two (2) borings.

At three of the four (4) subsurface section locations, one (1) sample of soft sediment in the bottom of the canal will be obtained. A broad spectrum screen of these samples will be performed to identify potential hazardous contamination that may have an impact on disposal and handling of dredged material (including construction handling).

Due to the depth of soil overburden and changes in bedrock elevation, boring depths are anticipated to range from about thirty (30) to fifty (50) feet in depth (not including rock coring). Rock coring will be performed after auger refusal is encountered, at designated borings. Rock coring will be performed to a depth of five (5) feet below the point at which auger refusal was achieved.

The following assumptions apply to the above described water based drilling:

- *The depth of water in the canal will be sufficient for the barge platform to float and be maneuvered upstream and downstream. The only obstructions that are anticipated are the pedestrian bridge at the Canal Water Plant and the cofferdam constructed when the breach occurred.*
- *Equipment that utilizes standard petroleum products will be utilized.*
- *The **CITY** will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the **CITY**.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*
- *Pedestrian control will be provided by the **CITY**. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*

5. Columbia Canal Spillway Borings

One (1) boring will be performed within the footprint of the Columbia Canal Spillway. This boring will penetrate through the existing structure and past the spillway/bedrock interface to a depth of 35 feet into sound bedrock. These borings will include core recovery along the full length of the boring.

Efforts will be made to collect representative samples of the masonry cored that make up the structure of the Canal Spillway. Up to 3 core samples of the masonry that form the structure will be obtained. These core samples will be utilized to determine the compressive strength and unit weight of the masonry.

The following assumptions apply to the above described land-based drilling:

- *Equipment that utilizes standard petroleum products will be utilized.*
- *City will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the City.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*
- *Pedestrian control will be provided by the City. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *Drill rig will be mobilized to the spillway via access across the canal head works. No crane or barges will be required.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*

6. Dike Borings East of the Headgates

One (1) boring will be performed between the east end of the headgate structure and the railroad right-of-way. Boring depths are anticipated to be approximately eighty (80) feet in depth (not including rock coring). Rock coring will be performed after auger refusal is encountered, at designated borings. Rock coring will be performed to a depth of five (5) feet below the point at which auger refusal was achieved.

The following assumptions apply to the above described land based drilling:

- *Equipment that utilized standard petroleum products will be utilized.*
- *The **CITY** will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the City.*
- *No intrusive activity nor access on railroad property will be required; and no provision has been made to obtain railroad protective liability insurance.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*
- *Pedestrian control will be provided by the **CITY**. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*

- *Drill rig will be mobilized to the dike via access across the canal head works. No crane or barges will be required.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*
- *No addition insurance and fees associated with working within the railroad right of way have been included.*

7. Shear Wave Velocity

Downhole seismic suspension logging survey will be performed at one (1) location along the dike in a boring that extends to a depth of one hundred (100) below the ground surface.

For proposal preparation purpose and consideration that seismic loading will not be considered under Stage A, assume that Stage A will not include a downhole seismic suspension logging survey; and that Stage C[53] only will include a downhole seismic suspension logging survey.

8. Logistics for Subsurface Investigation

For the subsurface investigation details herein, there will be numerous access conditions that require various levels of manpower, skill and equipment. *For proposal preparation purpose, it is anticipated that the following will be required to respond to the logistics associated with the subsurface investigation:*

- *Non-ATV mounted drill rig*
- *ATV mounted drill rig*
- *Mechanized clearing equipment*
- *Water based drilling platform*
- *Crew boat*
- *Crane*
- *Hand clearing*
- *Private utility locates*
- *Rotosonic drill rig*
- *Drill rig support equipment*
- *Masonry coring equipment*

C. <u>Laboratory Investigation</u>

All laboratory testing will be performed in accordance with the appropriate ASTM Standards in F&ME's AASHTO Accredited USACE Certified laboratory. A laboratory testing program will be implemented to obtain engineering properties of soil and rock for geotechnical-related analyses. A review of the samples obtained during the subsurface investigation will be performed. Representative samples will be selected and prepared for laboratory testing. Laboratory testing on representative samples will be performed to generally identify the following:

[53] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

- Physical soil properties:
  - Grain size distribution (mechanical sieve and hydrometer)
  - Plasticity characteristics (Atterberg limits)
  - In-place density (undisturbed sample)
  - In-situ moisture content
  - Soil compaction characteristics (Proctor densities)
- Mechanical soil properties (undisturbed and remolded samples):
  - Soil shear strength (triaxle shear and direct shear)
- Hydraulic conductivity
  - Constant head - undisturbed samples
  - Constant head - remolded samples
- Internal erosion susceptibility
  - Pinhole dispersion test
- Electrochemical properties
  - Soil
  - Water
- A review of the rock cores will be performed. Representative core samples will be selected and tested in the laboratory to identify:
  - Rock quality designation
  - Compressive strength

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[54] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[55] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

D. <u>DR: Subsurface Investigation</u>

A stand-alone DR will be prepared to summarize and present the work product for the Task 9 subsurface investigation, which will serve as a "Data Report" to document subsurface conditions encountered. The DR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. In addition, this DR will contain an introduction, project description, and the purpose and scope of the subsurface investigation performed. The narrative portion of this will be relatively short, with the Appendices of the report being large. The Appendices will contain project and testing location plans, field exploration (boring logs), and the results of all laboratory and field testing. Each field exploration record will contain the location of the testing and corresponding testing location plan. The laboratory testing results will indicate the location and depth of each sample clearly on the test result. The DR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

[54] Stage A: Base Flood Damage Repair Services, Reach 1

[55] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[56] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[57] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 10 - HYDROLOGIC AND HYDRAULIC (H&H) ANALYSIS (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. <u>Design Criteria Memorandum: Hydrologic and Hydraulic Analysis</u>

A Design Criteria Memorandum (DCM) will be developed to identify the analyses and investigations to be performed in order to evaluate the Canal Dike and critical structures. The DCM will describe the means, methods, and assumptions to be used in the analyses.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[58] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[59] will include supplemental work that is required to support planned analyses and assessments.

B. <u>Site-Specific Dam Breach Analysis</u>

The **CONSULTANT** will develop a Site Specific Dam Break Analysis for both the Diversion Dam and Canal Dike. The analysis will be based on the current preliminary HEC-RAS model for the river system (from Task 6), without existing conditions update, as reviewed in the River Flood Evaluation (Task 10D). The HEC-RAS model will be reviewed to insure compliance with the current FEMA recommended modeling procedures. Due to the length of the Canal Dike, we anticipate modeling a breach at two separate locations. The resulting breach waves from the Diversion Dam and Canal Dike will be depicted on the project GIS mapping so that potential hazards can be identified. Breach parameters will be based on FERC Guidelines and current standard of practice. The following items will be included in this Task:

1. Data Gathering

- Obtain available Existing Breach Reports
- Develop GIS and Survey Base Mapping
- Perform Downstream Reach Field Walk

2. Diversion Dam Breach Model

- Breach Parameter Development
- Develop GIS Inundation Mapping
- Incremental Hazard Evaluation

[56] Stage A: Base Flood Damage Repair Services, Reach 1

[57] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[58] Stage A: Base Flood Damage Repair Services, Reach 1

[59] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

3. Canal Breach Model (Two Locations)

- Breach Parameter Development
- Breach Location Selection
- Develop GIS Inundation Mapping
- Incremental Hazard Evaluation

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[60] will not include a dam breach analysis; and only Stage C[61] will include a site-specific dam breach analysis.

C. River Hydrologic Modeling

Detailed FERC compliant hydrologic modeling will be deferred to Phase 2 Final Design.

For the Phase 1 Alternatives Analysis, the **CONSULTANT** will develop a hydrologic model of the drainage basin that drains to the Diversion Dam/Headworks Structure and Canal Spillway. The analysis will be developed in accordance with the current standard of practice using the best available existing models and GIS based data. Available hydrologic models will be reviewed and used as a basis of comparison for the model along with the FEMA Flood Insurance Study flows and existing gage and rainfall data. Peak flow rates and hydrographs for multiple storms and the Inflow Design Flood will be approximated. This information will be used for several other tasks including the Site Specific Breach (Task 10B) and River Flooding Evaluation (Task 10D). The following items will be included in this Task:

1. Data Gathering

- Obtain Existing Hydrologic Models for the Canal Structures
- Obtain USGS Gage and Rainfall Data
- Obtain Historical Rain Records, Historical Flood Records, Base Flow Information, etc.
- Obtain Drainage Basin GIS Data Layers for Land Use, Soils, Topography, etc.

2. Review Existing Hydrologic Models

- Compare Existing Hydrologic Model Flows to Historic and Published Flows
- Analyze USGS Gages within the River System

3. Develop River System Hydrologic Model

- Determine Watershed Characteristics based on best available GIS data including – Soil Classifications, Land Use Values, Imperviousness, Time of Concentration, Antecedent Moisture Conditions, etc.
- Unit Hydrograph Selection and Development
- Storm Event Rainfall Value Selection
- Probable Maximum Precipitation Determination
- Probable Maximum Flood Evaluation

[60] Stage A: Base Flood Damage Repair Services, Reach 1

[61] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[62] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[63] will include supplemental work that is required to support planned analyses and assessments.

D. River Flooding Evaluation

Any changes to the existing model will be deferred to Phase 2 Final Design.

For the Phase 1 Alternatives Analysis, the **CONSULTANT** will analyze the flooding condition along the Broad River and Congaree River in order to evaluate potential project alternatives. The analysis will be based on the current preliminary HEC-RAS model for the river system (from Task 6). The existing models will be reviewed and updated to reflect the potential project alternative in order to determine impacts and/or increases to the current flood plain and floodway. The following items will be included in this Task:

1. Data Gathering

- Develop GIS and Survey Base Mapping
- Perform Field Walk to verify conditions

2. Existing HEC-RAS Model Review

- River and Cross Section Geometry
- Flows and Boundary Conditions
- Flow Regime
- Hydraulic Model Gaps
- Bridge and Structure Modeling

3. Existing Conditions Evaluation

- Dike Overtopping
- Structure Deficiencies
- Localized Flooding
- Bridge Impacts
- Develop GIS Mapping of the Existing Conditions for various Storm Events

4. Alternative Analysis

- Post-Project Conditions Model(s) and GIS Mapping
- CLOMR/LOMR Evaluation
- FEMA Coordination

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[64] will only include work that is required to repair the canal

[62] Stage A: Base Flood Damage Repair Services, Reach 1

[63] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[64] Stage A: Base Flood Damage Repair Services, Reach 1

spillway and Reach 1 dike to preexisting conditions; and that Stage C[65] will include supplemental work that is required to support planned analyses and assessments.

E. CITY Runoff Evaluation

A detailed basin-by-basin analysis will be deferred to Phase 2 Final Design.

For the Phase 1 Alternatives Analysis, the **CONSULTANT** will develop a hydrologic model for the portion of the **CITY** that drains directly to the Canal. This model will be developed in order to evaluate the potential for Canal Dike overtopping resulting from **CITY** storm water runoff directly entering the Canal. The natural and constructed drainage systems which flow into the Canal contribute significantly to the total flow within the Canal. There are historical indications that flow from these contributing systems has directly resulted in overtopping the Canal. As such, modeling of contributing areas is proposed to quantify the impact of such systems to Canal Spillway performance. The models will also be used to evaluate the proposed project alternatives. The storm event of October 4, 2015 will be used to assess and evaluate overland and river inflow into the canal that resulted in the overtopping of the Canal Dike. The following items will be included in this task:

1. **Data Gathering**
   - Obtain Existing Hydrologic & Hydraulic Models for the Canal's City-side Drainage Basin
   - Obtain available GIS data including topography, drainage system inventory, utilities, roads, soils, structures, land usage, impervious surfaces, parcels, etc.

2. **Existing Condition Analysis**
   - Delineate the Canal's City-side Drainage Areas using five composite drainage basins, Assign Land Cover Coefficients, Calculate Time of Concentrations based on GIS and Survey Data
   - Develop Hydrologic Model to determine flows at each of the five composite discharge points into the canal using standard software such as SWMM, Autodesk Storm and Sanitary Analysis, HEC-HMS, etc.
   - Validate Model Results Based on Historical and Anecdotal Data

3. **Evaluate Existing Condition**
   - Establish Allowable Maximum Flows to minimize Canal Embankment Overtopping
   - Develop GIS Mapping of the Existing Storm Elevations within the Canal associated with the city-side Drainage.

4. **Develop Alternates**
   - Identify Potential Flow Reduction Alternatives to Reduce Peak Flows into Canal from **CITY** Drainage Systems

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[66] will only include work that is required to repair the canal

[65] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[66] Stage A: Base Flood Damage Repair Services, Reach 1

spillway and Reach 1 dike to preexisting conditions; and that Stage C[67] will include supplemental work that is required to support planned analyses and assessments.

F. Canal Spillway Capacity Analysis

The **CONSULTANT** will determine the hydraulic capacity of the Canal Spillway's Tainter Gates and Stop log Bays. The analysis will be based on the existing structure information augmented with field measurements (Task 7D). This information will be used for several Tasks including the Site Specific Breach Analysis (Task 10B), River Flooding (Task 10D) and **CITY** Storm Water Runoff Evaluation (Task 10E) to evaluate the overall hydraulic capacity of the Canal and potential for overtopping Inflow Design Flood (IDF) Evaluation.

The **CONSULTANT** will assess the hazard potential resulting from a failure of the Canal during flood flows in order to determine the adequacy of the Canal Spillway. The analysis will be developed in accordance with FERC Guidelines and the current standard of practice. The analysis will include storm events ranging from the 100-year to the Probable Maximum Precipitation (PMP).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[68] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[69] will include supplemental work that is required to support planned analyses and assessments.

G. Overtopping Evaluation

A detailed overtopping evaluation will be deferred to Phase 2 Final Design. For the Phase 1 Canal Embankment Assessment, the **CONSULTANT** will evaluate the potential for an overtopping failure along the Canal Dike and at several critical structures including the headworks and powerhouse. This Task includes a preliminary evaluation of the Canal Dike embankment's estimated scour and armoring requirements.

The **CONSULTANT** will develop the following plan overlays to depict the results of the analysis and assess the project alternatives:

1. Site Specific Dam Breach Analysis
    a. The resulting breach waves from the Diversion Dam and Canal Dike will be depicted on a Plan Overlay, so that potential hazards can be identified.
2. River Flooding Evaluation
    a. The modeled River Flooding events will be depicted on a Plan Overlay.
3. **CITY** Storm Water Runoff Evaluation

[67] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[68] Stage A: Base Flood Damage Repair Services, Reach 1

[69] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

a. The limits of flooding associated with the urban storm water runoff within the Canal will be depicted on a Plan Overlay along with the major sources of the flows entering the Canal from the **CITY**.
b. The location of potential flow reduction alternatives will be shown on a Plan Overlay.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[70] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[71] will include supplemental work that is required to support planned analyses and assessments.

H. TBR: Hydrologic and Hydraulic (H&H) Analysis

A stand-alone TBR will be prepared to summarize and present work product for the Task 10 Hydrologic and Hydraulic Analysis performed. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The TBR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[72] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[73] will include supplemental work that is required to support planned analyses and assessments.

TASK 11 - WATER SUPPLY ALTERNATIVES ASSESSMENT (STAGE B[74] ADDITIONAL SERVICES)

During the October 2015 flood, the Canal WTP was severely impacted and the **CITY** had an extremely difficult time producing drinking water. This is the single most important resource to the **CITY'** customers and citizens. Therefore, consideration needs to be given to the reliable operations of the Canal WTP when considering repairs done on the canal. Normal operation levels and volumes need to be maintained in the canal in such a manner that the plant is still able to withdraw water during and after the repair work. Alternative supply measures may also need to be addressed to bolster raw water supply capabilities both for the short- and long-term needs.

The Task 11 items below are defined to provide a review of raw water and finished water source alternatives to mitigate the risk of water supply loss to the City in the event of additional Canal breaches and failures. It is assumed that all items in this task are Tier 1 items except where specifically noted to be

[70] Stage A: Base Flood Damage Repair Services, Reach 1

[71] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[72] Stage A: Base Flood Damage Repair Services, Reach 1

[73] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[74] Stage B Tiers 1 and 2: Supplemental **CITY**' Requested Services

Tier 2. The Tier 2 items can be omitted and coarse assumptions made. The Tier 2 items are specifically addressed as follows:

- Subtask H – Subsurface Profiles: it will be assumed that entire route on land will be out of rock and any water body crossings will be in rock. Any tunneling will be assumed deep enough to remain in a rock strata.
- Subtask J – Finished Water Supply to the Canal WTP: This task can specifically be eliminated if it is the goal of the City to only focus on raw water supply options.
- Subtask M - TBR: Water Supply Alternatives Assessment – Intake alternatives: Only one intake concept will be used as a basis of comparing source alternatives.

A. <u>Evaluation Criteria Memorandum: Water Intake Source Alternatives</u>

The **CONSULTANT** will develop an evaluation criteria memorandum that will layout the goal and objectives for safe and reliable water supply alternatives for the Columbia Canal WTP. The memorandum will identify the following basis for evaluations:

- Define the planning horizon for which supply needs will be based
- Establish water supply levels of service for the Columbia Canal for the planning period
- Define finished water quality goals
- Identify regulatory limitations and requirements
- Establish the criteria for supply redundancy and resiliency relative to flow and water quality.
- Develop a summary of non-cost factors to be considered in the evaluation of each alternative, including relative weighting factors to be used in a decision matrix (e.g., source accessibility, reliability, etc.)

Facilitate a workshop with the **CITY** to review the goals and objectives for safe and reliable water supply alternatives for the Columbia Canal WTP. The anticipated attendees for this workshop will include:

- City of Columbia
- Water Plant Representative(s)
- Engineering
- Utility Management

The **CONSULTANT** will:

- Prior to the workshop, provide an agenda along with a list of meeting objectives.
- Conduct the workshop, including discussion on water quality, reliability, resiliency, and future supply needs and the potential criteria to be used to evaluate supply alternatives.
- Prepare and issue workshop meeting minutes for the **CITY** to review and comment.

Following the workshop, the **CONSULTANT** will:

- Prepare a draft technical memorandum documenting the water supply objectives and the evaluation criteria.
- Submit an electronic PDF of the draft technical memorandum to the **CITY** for review.

- Receive comments, address, and submit the final technical memorandum to the **CITY**.

For proposal preparation purpose, assume that Stage B Tier 1[75] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[76] effort will include supplemental work that is required to support planned analyses and assessments.

B. <u>Information Review</u>

The **CONSULTANT** will collect and review readily-available relevant information, which is anticipated to include the following.

- Previous raw water supply studies and alternatives analyses
- Previous water distribution planning studies
- River flow studies (7Q10) and available historical flow data for the following water bodies from gauging stations in the closest proximity of the of the Canal WTP:
  - Saluda River
  - Broad River
  - Congaree River
- Historical water quality data (Saluda River, Congaree River , Broad River, and from the canal) available from the **CITY**, West Columbia WTP monthly raw water monitoring reports and at other gauging stations in the closest proximity to the Canal WTP
- Water release operations for Lake Murray and Parr Reservoir
- **CITY** Canal WTP and Lake Murray operations, water quality records (monthly reports) and chemical feed record for water treatment
- WTP site plans and hydraulic profiles (if available), including any recent upgrades to the plant.

Perform review of source water quality for the following alternatives using available historical raw water quality data:

- Existing canal intake
- Canal upstream of its confluence with the Broad River
- Saluda River
- Congaree River downstream of its confluence with Saluda River and Broad River

For proposal preparation purpose, assume that Stage B Tier 1[77] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[78] effort will include supplemental work that is required to support planned analyses and assessments.

[75] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[76] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

[77] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[78] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

C. Available Reliable Capacity

Prepare an estimate of available reliable capacity from each water source alternative based on the information review, meetings with regulators and key stakeholders in the process along with the previous low flow frequency studies. The water sources to be considered in this task are:

- Existing canal intake
- Canal upstream of its confluence with the Broad River
- Saluda River
- Congaree River downstream of its confluence with Saluda River and Broad River

It is anticipated the meeting will be required with the following:

- City of Columbia
- South Carolina Department of Health and Environmental Control
- South Carolina Electric and Gas
- FERC
- USACE

For proposal preparation purpose, assume that Stage B Tier 1[79] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[80] effort will include supplemental work that is required to support planned analyses and assessments.

D. Sampling Plan (Deferred to Phase 2, outside the Scope of this proposal)

A Sampling Plan, if needed, will be developed during Phase 2 Final Design. *For proposal preparation purpose, it has been agreed that a Sampling Plan will not be prepared during Phase 1.*

If needed, Phase 2 Final Design will include development of a sampling plan for the **CITY** to collect additional raw water quality data on an on-going basis. The **CONSULTANT** will provide a written plan detailing water quality parameters to monitor, frequency of monitoring, and sampling analysis recommendations and references.

E. Bench Scale Testing (Deferred to Phase 2, outside the Scope of this proposal)

Bench Scale Testing, if needed, will be performed during Phase 2 Final Design. *For proposal preparation purpose, it has been agreed that Bench Scale Testing will not be performed during Phase 1.*

If needed, Phase 2 Final Design will include a bench-scale testing program using alternative water sources compared to the existing source water. Bench-scale testing will simulate the full-scale WTP's rapid mix, flocculation, and sedimentation processes based on design criteria. Treatment chemicals currently used at the WTP will be dosed and optimized during bench-scale testing to simulate the full-scale WTP. Glass fiber filters will be used to estimate filtered water quality from the bench-scale settled water samples. Chemical doses will be optimized on the various water sources for removal of turbidity, color, UV254 (as a surrogate for TOC), iron, and manganese. Upon determining optimal

[79] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[80] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

chemical dosages for each raw water source, disinfection byproduct formation (TTHM and HAA5 formation potential tests) will be tested based on current chlorination strategies. Testing will be completed once during cold-water conditions and once during warm-water conditions. Unless directed by the **CITY**, this phase of bench-scale testing will not include evaluation of alternative coagulants, oxidants, or disinfectants for optimization of performance. Hazen's mobile water supply lab will be located at the plant site for completion of testing. The **CITY** will be responsible for providing necessary electrical, water supply, and drainage to the mobile lab based on the requirements provided by Hazen.

The **CONSULTANT** will prepare a draft bench-scale testing protocol, including anticipated water quality analysis requirements and water samples to be provided by the **CITY**. The protocol will be delivered to the **CITY** for review and approval prior to the initiation of testing.

F. Existing Treatment Process (Deferred to Phase 2, outside the Scope of this proposal)

A review of the existing treatment process, if needed, will be performed during Phase 2 Final Design. *For proposal preparation purpose, it has been agreed that a review of the existing treatment process will not be performed during Phase 1.*

If needed, Phase 2 Final Design will include a review of the existing treatment processes at the Canal WTP to determine potential upgrades needed to adequately treat the alternative water sources. This will also include reviewing the capacity of existing bulk storage and chemical feed pumps for lime and coagulant) and reviewing the capacity of the existing residuals handling systems.

G. Estimated Treatment Cost

The Consultant will make a relative order-of-magnitude estimate of the change in treatment costs for the various sources, including chemical demand, as compared to the existing process. The **CITY** will provide current operations costs and unit chemical costs to the **CONSULTANT** for use in the evaluation. If available, the CONSULTANT will review current chemical consumption per volume of treated water from the City of West Columbia for a basis of comparison for the Saluda River Source.

For proposal preparation purpose, assume that Stage B Tier 1[81] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[82] effort will include supplemental work that is required to support planned analyses and assessments.

H. Subsurface Profiles (Stage B Tier 2)

The **CONSULTANT** will develop a subsurface profile utilizing available historic subsurface data as well as subsurface data obtained during Phase 1 that identifies the anticipated depth to top of rock. Information regarding the type and strength of rock will also be included, if available. The subsurface profile will be developed to assess the impact of the depth to top of rock relative to the following raw water supply alternatives.

- Canal upstream of its confluence with the Broad River
- Saluda River

[81] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[82] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

- Congaree River downstream of its confluence with Saluda River and Broad River

For proposal preparation purpose, assume that Stage B Tier 1[83] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[84] effort will include supplemental work that is required to support planned analyses and assessments.

I. Supply Conveyance Options

The **CONSULTANT** will evaluate supply conveyance options, including identifying a preliminary potential location for an intake on the alternative supply, developing preliminary routes to convey water to the Canal WTP, and sizing the conveyance system using either pipe or tunnel methodologies.

For proposal preparation purpose, assume that Stage B Tier 1[85] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[86] effort will include supplemental work that is required to support planned analyses and assessments.

J. Finished Water Supply to the Canal WTP (Stage B Tier 2)

The **CONSULTANT** will perform hydraulic simulations to determine the feasibility of supplying the Canal Water Treatment Plant with finished water from the Lake Murray Treatment Plant via the distribution system for emergency backup and also an alternate to the current Canal raw water supply. The existing system hydraulic model will be used to perform this analysis. The original hydraulic model was completed and calibrated by Woolpert in 2002 and updated by Brown and Caldwell and Hazen using the Bentley's WaterGEMS software. The model has not been calibrated since the original model development. However, system functionality and operation was confirmed with Columbia personnel. It is not anticipated that the model will be recalibrated for these preliminary analysis.

The following items will be performed to analyze the feasibility of a finished water supply alternative:

- Develop analysis criteria for the model simulations.
- Perform the hydraulic simulations to determine the piping size required and the ability of the pipe to be connected to supply the Canal WTP.
- Evaluate two (2) potential pipe line routes for the purpose of developing an alternative cost.
- Develop a construction cost for the proposed routes to compare with the other alternatives.

For proposal preparation purpose, assume that Stage B Tier 1[87] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier

[83] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[84] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

[85] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[86] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

[87] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

2[88] effort will include supplemental work that is required to support planned analyses and assessments.

K. 50-Year Present Worth Analysis

A 50-year present worth analysis for each raw water supply alternative will be performed, including:

- Maintain existing canal water supply
- Broad River raw water supply
- Saluda River raw water supply
- Congaree River raw water supply
- Lake Murray via finished water supply

L. Workshop

The **CONSULTANT** will facilitate a workshop with project stakeholders to review scoring of each alternative and reach consensus on recommendations. The anticipated attendees for this workshop will include:

- City of Columbia
- South Carolina Department of Health and Environmental Control
- South Carolina Electric and Gas
- FERC

The **CONSULTANT** will:

- Prior to meeting, provide agenda along with associated information related to the options evaluated.
- Conduct meeting – discuss results and receive comments; preview next steps.
- Prepare and issue meeting notes for the **CITY** to review and comment.

For proposal preparation purpose, assume that Stage B Tier 1[89] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[90] effort will include supplemental work that is required to support planned analyses and assessments.

M. TBR: Water Supply Alternatives Assessment

A stand-alone TBR will be prepared to summarize and present work product for the Task 11 water intake source Alternatives Assessment. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary.

[88] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

[89] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[90] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

In addition, the following will be documented in the TBR for the Water Supply Alternatives Assessment.

- Estimated reliable safe yield from each water source option;
- Estimated treatment costs for each water supply, and recommendations as to the validity of treating each water supply alternative;
- Evaluation of alternative raw water supply to the Canal Water Plant including:
    - Intake concepts to access the raw water source (Tier 2 effort)
    - Route and sizing alternatives for raw water conveyance. Two delivery concepts will be considered for each alternative source with the exception of the existing canal source.
    - Planning-level construction cost estimates for the proposed routes
- Evaluation of supplemental finished water supply to the Canal Water Plant including (Tier 2 effort):
    - Route and sizing alternatives for two (2) routes
    - Construction cost estimates for the proposed routes
- Calculation of the 50-year present worth analysis for each raw water supply alternative in electronic PDF format.

The TBR will be referenced as applicable in the Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose, assume that Stage B Tier 1[91] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[92] effort will include supplemental work that is required to support planned analyses and assessments.

TASK 12 - SECTION OMITTED

OMITTED SECTION

TASK 13 - CANAL STRUCTURES ANALYSIS (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

The **CONSULTANT** will assess the stability of the canal spillway, generate a conceptual design for replacement of current fixed stoplogs with removable stoplogs, generate a conceptual design replacement of the spillway bridge with a structure capable of allowing the removal of the stoplogs and with sufficient structural capacity to allow limited emergency and construction equipment to cross the bridge, and assess the overall condition of the canal structure. Work to assess the canal dike will be

[91] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[92] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

addressed in Task 16. Work to address the condition of the canal headworks will be performed by others as identified by Task 13E under separate contract with the **CITY**.

A. <u>Design Criteria Memorandum: Canal Structures Analysis</u>

A Design Criteria Memorandum (DCM) will be developed to identify the analysis and investigations to be performed to assess the canal structures/elements described below under Task 13. The DCM will describe the means, methods and assumptions to be used in the analysis.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[93] Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[94] Additional Services will include supplemental work that is required to support planned analyses and assessments.

B. <u>Canal Spillway Assessment & Modifications</u>

1. Assessment of Structure Stability

A stability analyses of the canal structure will be performed in compliance with FERC's Engineering Guidelines for Evaluation of Hydropower Projects (Guidelines). Two sections will be analyzed, one of a Tainter gate bay, and a one-foot strip of the stoplog regulated spillway. The structure will be analyzed using two dimensional limited equilibrium analyses (gravity method). The analyses will be performed for five load cases:

- Case 1 - Normal Operating Level (El. 150.5 feet),
- Case 2 - Top of Stoplogs (High Normal Operating Level, El. 153.8 feet),
- Case 3 - Flood Condition (canal water level at the top of dike with stoplogs removed),
- Case 4 - Extreme Flood Condition (canal water level at the top of dike with stoplogs in place, representative of the October 2015 flood condition), and
- Case 5 - Seismic.

Tailwater levels for Cases 1, 2, and 5 will be at normal levels, and tailwater levels used in Cases 3 and 4 will be determined based on historical information or the dam break analysis performed to assess the hazard classification of the canal (Task 10B). Foundation parameters will be based on subsurface investigations and stability analyses of the October 2015 flood.

The canal spillway is constructed of stone masonry, therefore stability analyses for seismic loading will be performed using the pseudo-static method based on peak ground accelerations published by The United States Geological Society for the project area.

If the stability analyses indicate that the structure's factors of safety do not meet the requirements of the Guidelines (Chapter 3, Table 13-1 (table follows)), then additional analyses will be performed to determine the magnitude of post-tensioned anchors needed to bring the structure into compliance. The analyses performed will be sufficient in detail so that they do not have to be extensively redone to support the final design of the post-tensioned anchors and design of the means to transfer the anchor loads into the masonry structure.

[93] Stage A: Base Flood Damage Repair Services, Reach 1

[94] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

Alternate Recommended Minimum Factors of Safety
for Use in Conjunction with a No Cohesion Assumption

Loading Condition	Factor or Safety
Worst Case (see Note 5, below)	1.5
Flood if Flood is PMF (see Note 6, below)	1.3
Post-Earthquake	1.3

Notes:

5 The worst static case is defined as the static load case with the lowest factor of safety. It shall be up to the analyst to determine the worst static case and to demonstrate that it truly is the worst static case.

6 Because the PMF is by definition the flood that will not be exceeded, a lower factor of safety may be tolerated. Therefore if the worst static case is the PMF, a factor of safety of 1.3 is acceptable. If the IDF is not the PMF, then the safety factor for the worst case shall control.

Figure 13-1- Alternate Recommended Minimum Factors of Safety for Use in Conjunction with a No Cohesion Assumption

The use of post-tensioned anchors, over the addition of mass concrete to improve the structure's stability, allows the structure to appear visually unchanged thereby addressing any concerns that SCSHPO may have with the proposed modifications. A conceptual design (10% design level) of the anchors and the concrete elements needed to transfer the anchor loads into the masonry structure will be in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the design and installation of the post-tensioned anchors and concrete elements will be performed during Phase 2 final design.

In order to obtain the dimensional information needed to perform the stability analyses, *assuming that there are no drawings available of the structure,* a field survey will be performed to measure the structure. Two borings will also be drilled through the spillway (Task 9B) to validate how the structure was constructed, determine allowable and ultimate bearing capacities for the masonry, determine an average unit weight of the masonry, and establish a sliding friction factor along the stone masonry – rock foundation contact interface. The borings are anticipated to extend about 35 feet into bedrock (about the tip of any anchors if needed) to assess the type of foundation rock, the rock's quality, and the unit weight for use in designing the rock anchors.

For proposal preparation purpose, assume that Stage A[95] Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[96] Additional Services will include supplemental work that is required to support planned analyses and assessments.

[95] Stage A: Base Flood Damage Repair Services, Reach 1

[96] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

2. Removable Stop Logs

Analyses will be performed and a conceptual design generated for the fabrication and installation of removable stoplogs in the canal spillway. The conceptual design (10% design level) will be in sufficient detail to develop an opinion of probable construction costs to facilitate the Phase 1 Alternatives Analysis. *In order to minimize a significant change in appearance to the spillway and to provide stoplogs of a manageable weight for handling, the **CONSULTANT** assumed that the stoplogs will be similar in dimensions of the non-removable stoplogs (twelve, 5.5' high x 11.17 feet wide panels) shown on the project's FERC License Exhibits.* Drawings and specifications detailing the fabrication of the stoplogs will be performed during Phase 2 final design.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence consideration of removable stop logs will be completed under Stage C[97].

3. Bridge Replacement

A qualitative bridge inspection of the bridge over the spillway will be conducted as part of Task 7E. Particular attention will be placed on identification of possible flood damage, such as evidence of recent scour activity based on visual observation and soundings and/or possible member damage from floating debris.

Analyses will be performed and a conceptual design (10% design level) generated for a replacement bridge over the canal spillway that is in sufficient detail to develop an opinion of the order-of-magnitude probable construction cost to facilitate the Phase 1 Alternatives Analysis. In order to minimize a significant change in appearance to the spillway the bridge will be similar in dimensions and geometry as the existing bridge. The replacement bridge is anticipated to be constructed of low maintenance materials and with a structural capacity and other modifications needed to support and accommodate emergency and construction equipment of limited weight. The bridge will be configured to include small removable deck sections in strips to allow access to and removal of the spillway stoplogs using a boom truck or small crane that does not require the use of outriggers to lift the panels. Drawings and specifications detailing the construction of the replacement bridge will be developed during Phase 2 final design.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence consideration of removable stop logs will be completed under Stage C[98] *Additional Services.*

4. Masonry Structure and Abutment Walls

A qualitative inspection of the canal spillway structure will be conducted as part of Task 7D. The physical condition of the masonry structure will be assessed to determine if there are repairs needed to replace or secure missing, loose or damaged stone masonry; repairs to replace missing masonry will be done using reinforced concrete. Particular attention will be placed on identification of possible flood damage, such as visual evidence of recent scour activity and/or

[97] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[98] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

possible member damage from floating debris. Leakage from the spillway structure will also be assessed, with a specific focus on the leakage that occurs along the structure's wing walls. The assessment of leakage will be done based on discussions with operating personal with a long knowledge of the structure's condition; the canal's water level is currently 3 to 5 feet below normal and maximum operating levels and therefore direct observation of leakage under those conditions cannot be observed. Repairs needed will be described in sufficient detail (10% design level) to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the implementation of the repairs will be developed during Phase 2 final design.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence consideration of removable stop logs will be completed under Stage C[99] Additional Services.

C. Existing Hydroelectric Plant

An assessment of the existing hydroelectric plant will be performed to determine what repairs or modifications are needed to return the plant to operation. An evaluation will also be made to determine what means are needed to decommission the powerhouse and either remove, abandon, or repurpose the structure.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence the following restart and decommissioning considerations about the existing hydroelectric plant will only be completed under Stage C[100] Additional Services.

1. Restart (maintain FERC License)

a. Powerhouse Stability

A stability analysis of the powerhouse will be performed in compliance with FERC's Engineering Guidelines for Evaluation of Hydropower Projects (Guidelines) because no such analysis currently exists. One section will be analyzed, typical of a bay associated with one turbine-generator unit. The structure will be analyzed using two dimensional limited equilibrium analyses (gravity method). The analyses will be performed for five load cases:

- Case 1 - Normal Operating Level (El. 150.5 feet),
- Case 2 – High Normal operating Level (El. 153.8 feet),
- Case 3 – Normal Operation with Unit Dewatered,
- Case 4 - Extreme Flood Condition (point where powerhouse will be flooded, canal water level at the top of dike with elevated tailwater level representative of the October 2015 flood condition), and
- Case 5 - Seismic.

[99] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[100] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

Tailwater levels for Cases 1, 2, and 5 will be at normal levels, and tailwater levels used for Case 4 will be based on historical levels when the powerhouse is flooded. Foundation parameters will be based on the subsurface investigation results (Task 9) and stability analysis of the October 2015 flood.

The powerhouse structure is constructed of stone masonry, therefore stability analyses for seismic loading will be performed using the pseudo-static method based on peak ground accelerations published by The United States Geological Society for the project area.

If the stability analyses indicate that the structure's factors of safety do not meet the requirements of the Guidelines (Chapter 3, Table 13-2 (table follows)), then additional analyses will be performed to determine the type and magnitude of modifications needed to bring the structure into compliance. The additional analyses performed will be sufficient in detail so that they do not have to be extensively redone to support Phase 2 final design of the modifications.

Alternate Recommended Minimum Factors of Safety
for Use in Conjunction with a No Cohesion Assumption

Loading Condition	Factor or Safety
Worst Case (see Note 5, below)	1.5
Flood if Flood is PMF (see Note 6, below)	1.3
Post-Earthquake	1.3

Notes:

5 The worst static case is defined as the static load case with the lowest factor of safety. It shall be up to the analyst to determine the worst static case and to demonstrate that it truly is the worst static case.

6 Because the PMF is by definition the flood that will not be exceeded, a lower factor of safety may be tolerated. Therefore if the worst static case is the PMF, a factor of safety of 1.3 is acceptable. If the IDF is not the PMF, then the safety factor for the worst case shall control.

Figure 13-2- Alternate Recommended Minimum Factors of Safety for Use in conjunction with a No Cohesion Assumption

Modifications proposed will be done bearing in mind the historical significance of the powerhouse to the community and the need to obtain approval from the SCSHPO to construct any improvements needed. Repairs or modifications needed will be described in sufficient detail (10% design level) to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the implementation of the repairs will be developed during Phase 2 final design.

In order to obtain the dimensional information needed to perform the stability analyses, assuming that there are no drawings available of the structure, a field survey will be performed to measure the structure. Based on current knowledge of the powerhouse regarding its construction, no borings or subsurface investigations of the powerhouse are proposed at this time.

b. Equipment Rehabilitation

The hydroelectric generators, switchgear and controls and other electrical systems/equipment were damaged during the October 2015 flood when the powerhouse was intentionally flooded to prevent a structural collapse of any the walls as a result of unbalanced hydrostatic loads that were acting on them. The **CONSULTANT** understands that the generators must be cleaned and dried out before they can be restarted, the switchgear and controls must be replaced, and other electrical systems/equipment repaired or replaced. In discussion with plant operating personnel, the **CONSULTANT** understands that it is probable that the switchgear and controls will be relocated from inside of the plant to an area atop the dike adjacent to the plant. It is also understood that the repairs will be made using money from an insurance policy which was carried that covered damage or loss of the plant's generator equipment including the damaged electrical equipment/systems.

The work to be performed in support of the Phase 1 Alternatives Analysis (Task 19) is to identify what equipment needs to be repaired or replaced, what equipment is to be relocated to reduce the potential for future flooding, ascertain if the insurance funds are sufficient to perform the work needed, and identify what additional funds may be needed to performed the required work. It is currently understood that the work to rehabilitate and return the hydroelectric plant to operation is the responsibility of the **CITY**'s plant operator, Lockhart Power Company.

2. Decommissioning

Decommissioning is not a simple matter of removing an electrical breaker, locking the doors, and walking away. Decommissioning could involve demolishing and removal of the hydroelectric plant in its entirety, securing the plant to allow abandonment of the structure, or securing and modifying the plant for use for other purposes. Decommissioning of the hydroelectric plant will not have any impact on the work needed to address the condition or requirements for the canal's dike, spillway, or headworks structure or the water treatment plant's intake. No subsurface investigations are proposed at this time.

a. Surrendering of License

Any decommissioning of the hydroelectric plant whether removed, abandoned, or repurposed will require the surrender of the FERC License. The surrender of the License is not only for the hydroelectric plant but includes removing the whole of the canal and the diversion dam from FERC's jurisdiction.

To surrender a license for any hydroelectric project whether operational or not requires the development of a mini-Environmental Assessment (mEA) using existing information and a Decommissioning Plan (DP). *The **CONSULTANT** has assumed that there will be sufficient information available to address a mEA without the need to conduct supplemental studies or analyses. For proposal preparation purpose and in consideration of the timing and flow of the work, it has been assumed that the mEA described in Task 13 will use the results from Task 4 to pursue an independent track to meet the needs described in Task 13.C.*

The mEA will address: aquatic resources such as what is to happen with the existing upstream and downstream fish passage facilities; impacts to aquatic or terrestrial species in the canal;

impacts to water quality; how will release of flows at the diversion dam and canal be maintained and controlled; impacts to recreational use; impacts to cultural resources; structural condition and stability of water retaining structures and will they comply with SCDNR's dam safety requirements; and how the **CITY**'s water supply will be maintained or impacted.

The DP will address in detail what modifications or work is to be performed to shutdown, decommission, remove, secure, or otherwise modify water retaining structures to serve in a new role.

Phase I work will involve contacting FERC and applicable natural resources and environmental agencies to determine what information or studies will be required to surrender the FERC Licensee, what mitigation actions the natural resources and environmental agencies anticipate that they will require in support of the license surrender, and to obtain and review available information that could be used to develop the mEA; and Phase I work is considered to be a scoping exercise. The mEA and DP will be developed only if the FERC License is to be surrendered (part of work of Phase 2 final design), but the cost for developing the mEA and DP will be identified in the TBR.

Because of the **CITY**'s sensitivity with decommissioning the hydroelectric plant and the prospects of surrendering the FERC Licensing and associated response by the general public and special interest groups / non-governmental organizations, contacts with agency personnel during Phase I work will be by phone or private meetings rather than holding a large meeting of all agency personnel which then may draw in the interest of the general public or special interest groups / non-governmental organizations.

b. Demolish and Remove

An opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis will be generated for the complete demolition and removal of the hydroelectric plant and all associated equipment. Conceptual design (10% design level) drawings will be developed in sufficient detail to descript the closure concept and develop the cost opinion.

Because the powerhouse serves as the closure for the downstream end of the canal, another means to close the canal will be needed to replace the demolished powerhouse. The location and means to close the canal will have an aesthetics impact on the EdVenture Museum and the esplanade on the city-side of the canal as well as having to interface with the work to restore the canal dike downstream of the Klapman Street Bridge. The assessment of the multitude of options possible for the closure structure is beyond the intended scope of the Phase I work.

*For the Phase I work performed in support of the Alternatives Assessment, the **CONSULTANT** has assumed for simplicity that the structure used to close off the canal will be an earthen dike, like that used to repair the breaches in the canal; and the closure dike will extend from the west end of the esplanade to end at the downstream end of the dike used to repair the breach in the canal.* Closing the end of the canal will provide water along the esplanade.

The closure structure should also include a crest type bottom hinged gate to allow release of flow from the canal for water quality purposes, allow flushing of debris that accumulates at the downstream end of the canal, and include a low level outlet gate to allow draining of the canal. The discharge from the crest gate could also be used for recreational purposes. A conceptual design (10% design level) arrangement drawing will be generated to describe the closure and in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis.

There are a number of ways to close off the end of the canal, and all will have a visual impact on, and affect the use of EdVenture Museum and the esplanade. The exact means to be used to close off the canal will be addressed in Phase 2 final design wherein drawings and specifications will ultimately be developed detailing the demolition of the hydroelectric plant and construction of the canal closure.

c. Abandonment

An opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis will be generated for the in-place abandonment of the hydroelectric plant and all associated equipment.

Abandonment of the plant will require permanently plugging the penstocks to the seven turbines and possibly the downstream fish passage structure; de-energizing and removing the existing step-up transformer and associated substation; and removal of all oil and grease. External trash racking equipment, trash racks and support structure and other features should be removed as they will ultimately deteriorate and collapse into the canal. Stability analyses of the hydroelectric plant will have to be performed to document that the plant is stable and safe to remain in-place in compliance with SCDNR's regulations, and if it is not safe then remedial modifications will be needed before it is abandoned; stability analyses performed for Task 13.C.1.a will be adequate to address the stability of the powerhouse if abandoned. Existing features currently in place to prevent the flooding of the powerhouse through windows or other openings will have to be opened to allow the powerhouse to flood automatically to prevent a structural collapse of its walls under unbalanced hydrostatic load.

Abandonment also results in the loss of means to release flow and debris at the downstream end of the canal. Abandonment should also include the construction of a crest type, bottom hinged gate to allow release of flow from the canal for water quality purpose, allow flushing of debris that accumulates at the downstream end of the canal, and include a low level outlet gate to allow draining of the canal; similar to that described in Task 13.C.2.b. The discharge from the gate could also be used for recreational purposes. A conceptual design (10% design level) arrangement drawing will be generated to describe the closure and in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the work to be performed to allow abandonment of the hydroelectric plant will be developed during the Phase 2 final design.

d. Repurposing

An opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis will be generated for the repurposing of the hydroelectric plant and associated equipment for educational purposes.

Repurposing will require permanently plugging the penstocks to the seven turbines and the downstream fish passage structure; de-energizing and removing the existing step-up transformer and associated substation; and removal of all oils and greases. External trash racking equipment, trash racks and support structure and other features should be removed as they ultimately deteriorate and collapse into the canal. Stability analyses of the hydroelectric plant will have to be performed to document that the plant is stable and safe to remain in place in compliance with SCDNR regulations, and if it is not safe then remedial modifications will be needed before it is abandoned; stability analyses will be performed as described in Task 13.C.1.a. Existing features currently in-place to flood the plant to prevent a structural collapse of its walls under unbalance hydrostatic load will need to continue being operated and may have to be modified; in addition a means to dewater the plant after it has been flooded will need to be added.

Repurposing also results in the loss of means to release flow and debris at the downstream end of the canal. Repurposing should include the construction crest type, bottom hinged gate to allow release of flow from the canal for water quality purposes, allow flushing of debris that accumulates at the downstream end of the canal, and include a low level outlet gate to allow draining of the canal; similar to that described in Task 13c.2.b. The discharge from the gate could also be used for recreational purposes.

Repurposing for educational purposes will require cleaning and painting of the plant and equipment, improve lighting and ventilation systems, modifications to bring the plant into compliance with ADA accessible requirements, modifications to restrict visitors and to prevent injury to those touring the plant, and informational signage that describes the function and purpose of what is being viewed.

A conceptual design (10% design level) arrangement drawing will be generated in conjunction with a closure description in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the work to be performed to allow repurposing and use of the hydroelectric plant will be developed during Phase 2 final design.

D. Diversion Dam (deferred to Phase 2, outside the scope of this proposal)

During Phase 2, the **CONSULTANT** will perform a stability analysis of the Diversion Dam in compliance with FERC's Engineering Guidelines for Evaluation of Hydropower Projects (Guidelines) because no such analysis currently exists. Due to the dam's varying geometries and foundation conditions, five sections will be analyzed (see locations identified as Sections B through F on Figure 13-4). The structure will be analyzed as one foot strips or bays, as applicable, using two dimensional limited equilibrium analyses (gravity method). The analyses will be performed for five load cases:

- Case 1 - Normal Operating Level (El. 153.5 feet),

- Case 2 – Flood Condition (representative of the October 2015 flood condition with impoundment at El. 163.5 feet ±),
- Case 3 – Inflow Design Flood (approximately the 100-year flood Elevation 172 feet ±), and
- Case 4 - Seismic.

Tailwater levels for Cases 1 and 4 will be at normal levels, and tailwater levels used Cases 2 and 3 will be determined based on historical information or the dam break analyses performed to assess the hazard classification of the dam (Task 10B). Foundation parameters will be based on the stability analyses of the Normal Pond and October 2015 flood.

The Diversion Dam is a very short structure, initially constructed as a rock-filled timber crib structure and subsequently capped with concrete and buttressed with concrete piers. Due to the nature of the dam's construction, stability analyses for seismic loading will be performed using the pseudo-static method based on peak ground accelerations published by The United States Geological Society for the project area.

If the stability analyses indicate that the structure's factors of safety do not meet the requirements of the Guidelines (Chapter 3, (Table 13-3 table follows)), then additional analyses will be performed to determine the magnitude of modifications needed to bring the structure into compliance. If the optimum modification involves post-tensioned anchors, the analyses performed will be sufficient in detail so that they do not have to be extensively redone to support Phase 2 final design of the post-tensioned anchors and design of the means to transfer the anchor loads into the structure.

Alternate Recommended Minimum Factors of Safety
for Use in Conjunction with a No Cohesion Assumption

Loading Condition	Factor or Safety
Worst Case (see Note 5, below)	1.5
Flood if Flood is PMF (see Note 6, below)	1.3
Post-Earthquake	1.3

Notes:

5 The worst static case is defined as the static load case with the lowest factor of safety. It shall be up to the analyst to determine the worst static case and to demonstrate that it truly is the worst static case.

6 Because the PMF is by definition the flood that will not be exceeded, a lower factor of safety may be tolerated. Therefore if the worst static case is the PMF, a factor of safety of 1.3 is acceptable. If the IDF is not the PMF, then the safety factor for the worst case shall control.

Figure 13-3- Alternate Recommended Minimum Factors of Safety for Use in Conjunction with a No Cohesion Assumption

The use of post-tensioned anchors, over the addition of mass concrete to improve the structure's stability, allows the structure to appear visually unchanged thereby addressing any concerns the SCSHPO may have with the proposed modifications. A conceptual design (10% design level) of the anchors and the concrete elements needed to transfer the anchor loads into the structure will be in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1

Alternatives Analysis. Drawings and specifications detailing the design and installation of the post-tensioned anchors and concrete elements will be performed during Phase 2 final design.

In order to obtain the dimensional information needed to perform the stability analyses, *assuming that there are no drawings available of the structure,* a field survey will be performed to measure the structure at the locations where the sections are to be analyzed. No borings or other geotechnical investigations are proposed at this time.

E. <u>Canal Headworks</u>

The **CONSULTANT** understands that Kleinschmidt (also a member of the **CONSULTANT**'s team) and Chao & Associates (Kleinschmidt-Chao) have been engaged by the **CITY** to analyze and design remediation to the headworks structure (Figure 13E) for the construction of measures that will allow the headgates gates to be closed to prevent the uncontrolled release of flow into the canal. The **CONSULTANT** understands that Kleinschmidt-Chao will assess and address the stability of the headworks structure; design replacements for the headgates and operators; design trash racks and a trash rake and debris handling system; and design a replacement lock gate. Any geotechnical investigations of the headworks structure will be the responsibility of Kleinschmidt-Chao even if they use the services of F&ME who is also a member of the **CONSULTANT**'s team. The assessment of the earthen embankment dam on the east side of the headworks structure will be performed by the **CONSULTANT** as part of Task 15. The **CONSULTANT** also understand that Kleinschmidt-Chao are to work with the **CITY** in the tendering of bids to construct the rehabilitation measures and monitor is construction.

In support of the **CONSULTANT**'s development of a coordinated restoration plan for the canal and associated structures, **CONSULTANT** will contact and coordinate with Kleinschmidt-Chao to obtain construction cost information for **CONSULTANT**'s use and inclusion in the Canal Embankment Assessment Report.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence the work described in the preceding discussion about the canal headworks will only be completed under Stage C[101] Additional Services.

F. <u>TBR: Canal Structures Analysis</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 13 canal structures analysis. The TBR will be a multi-volume document; and findings for each structure analyzed will be presented in a separate volume to facilitate progressive delivery of findings on a structure-by-structure basis. The TBR will identify the means, methods, and assumptions used to perform the work; describe in concept the modifications needed for the structure or structure's element(s) to meet design requirements of the governing agency; include a plan and figures as needed to describe the modifications; include a tabular summary of benefits and disadvantages for alternatives considered; include an order-of-magnitude opinion about probable construction cost for comparison of alternatives; and include an executive summary. The TBR will be referenced as

[101] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analyses of the options.

For proposal preparation purpose, assume that Stage A[102] Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[103] Additional Services will include supplemental work that is required to support planned analyses and assessments.

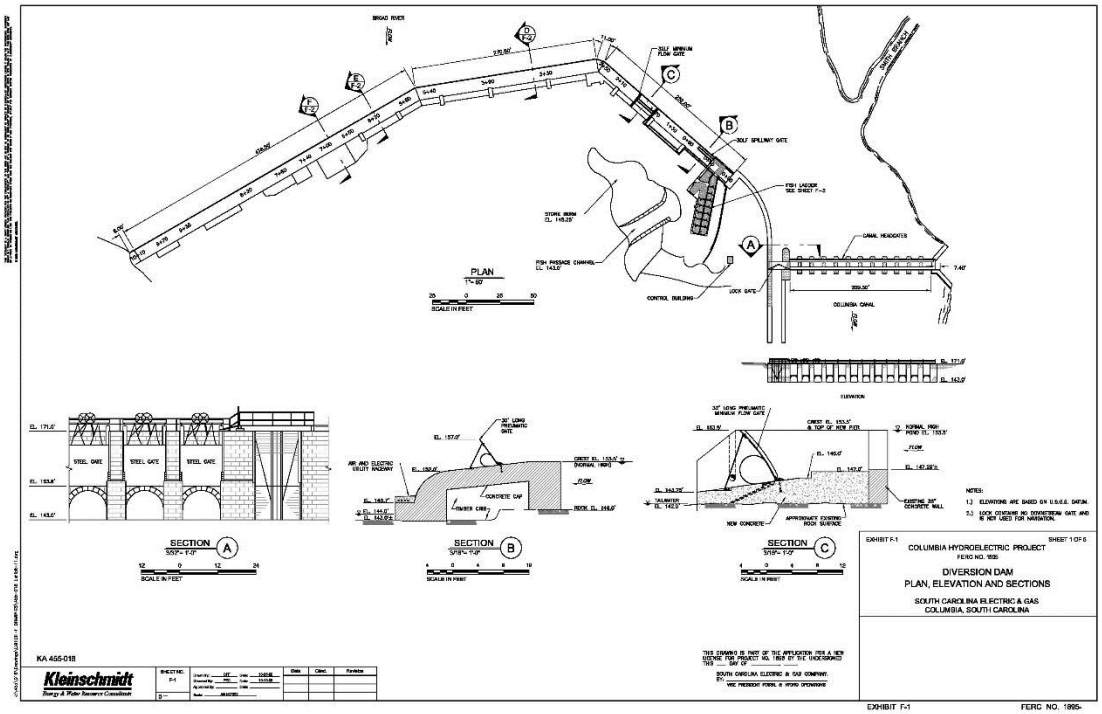

Figure 13-4- Diversion Dam

[102] Stage A: Base Flood Damage Repair Services, Reach 1

[103] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

TASK 14 - MASONRY DRAINAGE TUNNEL CONDITION ASSESSMENT (STAGE C ADDITIONAL SERVICES)[104]

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence the masonry drainage tunnel condition assessment will be completed under Stage C[105] Additional Services.

A. Survey and Structure Information

A survey will be performed to map the location of the masonry drainage tunnel that extends beneath the canal from the water treatment plant to the abandoned water pumping plant (Task 5F), and a review of available document will be performed to obtain any information on the design, construction, or condition of the tunnel (Task 6).

B. Assess Condition and Need for Repair

The **CONSULTANT** will conduct a qualitative inspection of the drainage tunnel to supplement the LiDAR survey (Task 5A) with hand-taped measurements (see Task 14 for additional detail). Readily-available documentation (from Task 6) will be reviewed. The tunnel will be field viewed to visually observe and photograph the general condition. Particular attention will be placed on identification of possible flood damage, such as visual evidence of recent scour activity and/or possible member damage from floating debris. An evaluation of the physical condition of the stone masonry tunnel will be made to determine if there is any need for repair or improvements to its structural integrity or capacity, and to determine if there is a need to address seepage / leakage into the tunnel. The canal's water level is currently 3 to 5 feet below normal and maximum operating levels therefore seepage/leakage may be reduced, or not occurring in locations where it normally occurs**.** A Technical Memorandum with field notes, field sketches and representative photographs will be prepared to document inspection findings.

In consultation with the **CITY**'s Jon Sherer, we understand that the tunnel normally has very little depth of water within. Although the **CITY** is currently discharging flow into the tunnel that results in a water depth of 6-inches deep in the tunnel, the current discharge is supposed to terminate about mid-June 2016. *Hence, for proposal preparation purpose, it has been assumed that the tunnel is accessible over the complete length of tunnel using 1) confined-space entry protocol to perform a visual condition assessment for structural integrity and 2) without the use of underwater equipment.* Upon completion of the condition assessment a determination will be made as to the need for coring of the masonry to assist in assessing its condition or structural capacity.

Repairs needed will be noted on a survey drawing and described in sufficient detail (10% design level) to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the implementation of the repairs will be developed during Phase 2 final design.

[104] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[105] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

C. TBR: Masonry Drainage Tunnel Condition Assessment

A stand-alone TBR will be prepared to summarize and present work product for the Task 14 masonry drainage tunnel (under canal) condition assessment. The TBR will identify the means, methods, and assumptions used to perform the work; describe in concept the repairs or modifications needed for the structure to meet design requirements of the governing agency; include a plan and figures as needed to describe the modifications; include a tabular summary of benefits and disadvantages for alternatives considered; include an order-of-magnitude opinion about probable construction cost for comparison of alternatives; and include an executive summary. The TBR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analyses of the options.

TASK 15 - EMBANKMENT (DIKE) GEOTECHNICAL ANALYSES (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. Design Criteria Memorandum: Dike Seepage and Stability

As indicated in the Scope of Services Introduction Section E.1, dike seepage and stability analyses (10% design level) will be completed in accordance with FERC requirements for a high hazard project. A Design Criteria Memorandum (DCM) will be developed to identify the analyses to be performed. The DCM will describe the criteria, critical failure modes, analytical methods, foundation and embankment material properties and shear strength parameters, assumptions, loading conditions and factors of safety that will be considered for analysis.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[106] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[107] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. Geotechnical Analyses

A stability and seepage analysis (10% design level) will be performed in accordance with FERC Engineering Guidelines for the Evaluation of Hydropower Projects for static and seismic conditions. These analyses will be performed utilizing the data obtained during the subsurface investigation (Task 9) as well as bathometric and topographic survey data (Task 5). These analyses will be performed at four (4) discrete locations along the dike and at the proposed reconstructed portion of the dike at the breach.

Embankment stability will be analyzed for the following loading conditions, based on the prevailing seepage condition(s).

- Sudden drawdown from maximum pool (upstream slope)
- Sudden drawdown from spillway crest or top of gates (upstream slope)
- Steady state seepage with maximum storage pool (upstream and downstream slopes)

[106] Stage A: Base Flood Damage Repair Services, Reach 1

[107] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

- Stead state seepage with surcharge pool (downstream slope)
- Earthquake (for steady stage seepage condition with seismic loading using a pseudo-static lateral force coefficient, upstream and downstream slope)

An assessment of potentially liquefiable soil, potential piping, internal erosion, interior drainage systems, and available toe protection will be performed.

Embankment erodibility will be evaluated. The presence of existing trees and root penetrations will be considered with regard to risk of probable failure modes.

A qualitative assessment will be made regarding the potential and magnitude of future loss of freeboard as a result of dike settlement, in particular where the dike breach is reconstructed.

A deterministic seismic hazard evaluation will be performed to arrive at earthquake ground motion parameters for analysis of seismic loading conditions.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[108] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1 (no seismic and no liquefaction analyses in Stage A); and that Stage C[109] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

C. <u>TBR: Embankment (Dike) Geotechnical Analyses</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 15 embankment (dike) geotechnical analyses. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The TBR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[110] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[111] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

[108] Stage A: Base Flood Damage Repair Services, Reach 1

[109] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[110] Stage A: Base Flood Damage Repair Services, Reach 1

[111] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

TASK 16 - EMBANKMENT (DIKE) REPAIR ASSESSMENT (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. Dike Reconstruction / Repair

A qualitative assessment (10% design level) will be performed to evaluate viable alternatives, with comparative benefits, challenges and disadvantages, as well as an opinion rendered about the order-of-magnitude probable construction cost to facilitate the Phase 1 Alternatives Analysis (Task 19). To do this, results from the project mapping (Task 5), Historical Data (Task 6), detailed field reconnaissance (Task 7), dike conditions assessment (Task 8), subsurface investigation (Task 9) and dike seepage and stability analysis (Task 15) will be used to sub-divide the dike into distinct reaches and segments for analysis. Factors/situations considered will generally include the following.

1. Hydroelectric Plant to Canal Spillway

a. Temporary cofferdam removal
- Seepage cutoff/control
- Dike embankment repair

b. Former water pumping plant
- Seepage cutoff/control
- Dike penetration treatment
- Possible penstock breach assessment

c. Existing hydroelectric plant
- Permanent repairs to areas that were overtopped
- Dike damage repair on upstream side of existing structure(s)

d. Remains of hydroelectric plant to textile mill (by breach)
- Option where former hydroelectric plant remains are removed from within the rebuild foot print
- Option (if any) where former hydroelectric plant remains to the textile mill are left exposed and not located within the rebuild foot print

e. New concrete spillway in proximity to dike breach

f. Remains of upstream hydroelectric (former prison hydroelectric plant)
- Disposition of plugging at abandoned penstocks
- Seepage cutoff/control

g. Rebuilding of breached section of dike
- Seepage cutoff/control
- Dike penetration treatment
- Dike embankment section with seepage berm

2. **Canal spillway to canal headworks**
    a. Scour-damaged/over-steepened dike side-slope
    b. Existing embankment dam at the east end of the headworks with cutoff

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[112] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[113] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. Overtopping Protection

A qualitative assessment (10% design level) will be completed with regard to overtopping protection. This assessment will initially concentrate on identifying and categorizing characteristic features at the following general dike reaches.

- Breached dike (near the hydroelectric plant) that failed during the flood of October 2015,
- Saddle depression at the Broad River Bridge crossing,
- Overtopped dike reaches where flood water rose above the pre-flood dike crest elevation during the flood of October 2015, and
- Dike reaches that are purported to have been overtopped during former flood events of record (based on readily-available historic data and flood studies).
- Dike reaches that depict visual evidence of overtopping damage that are cross-referenced against headcut erodibility index values that are obtained during the detailed field reconnaissance (Task 7), and
- Dike reaches with in-place overtopping protection.

Overtopping assessment methodology will generally follow FEMA guidance about Analysis and Mapping Procedures for Non-Accredited Levee Systems.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[114] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[115] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

C. SCDOT Bridge Substructure Impact

The **CONSULTANT** will assess the impact of existing SCDOT substructures at/near the embankment (dike) and identify feasible alternatives to mitigate apparent deficiencies.

[112] Stage A: Base Flood Damage Repair Services, Reach 1

[113] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[114] Stage A: Base Flood Damage Repair Services, Reach 1

[115] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and hence the SCDOT Bridge Substructure Impact assessment will only be completed in Stage C[116] Additional Services.

D. <u>Utility Pole Foundations on Dike</u>

The **CONSULTANT** understands that the eight small steel lattice work electrical towers atop the canal dike between the Klapman Street Bridge and just upstream of the water plant intake were removed in December 2015 in conjunction with the work to remediate the dike breach. The **CONSULTANT** further understands that FERC agreed with the **CITY** and Kleinschmidt that the concrete piers that supported the towers, all located on the downstream side of the dike, did not have to be removed because removal could result in conditions that are worst with respect to seepage and sloughing of the dike's downstream slope.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and hence assessment of utility pole foundations on the dike will only be completed in Stage C[117] Additional Services.

E. <u>TBR: Embankment (Dike) Repair Assessment</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 16 embankment (dike) repair assessment. The TBR will identify the means, methods, and assumptions used to perform the work; describe in concept the modifications needed for the embankment (dike) to meet design requirements of the governing agency; include a plan and figures as needed to describe the modifications; include a tabular summary of benefits and disadvantages for alternatives considered; include an order-of-magnitude opinion about probable construction cost for comparison of alternatives; and include an executive summary. The TBR will be referenced as applicable in the Alternatives Assessment (Task 19), which will address the various remediation options identified via a matrix analyses of the options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[118] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[119] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

[116] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[117] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[118] Stage A: Base Flood Damage Repair Services, Reach 1

[119] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

TASK 17 - RECREATIONAL OPPORTUNITIES ASSESSMENT (STAGE B ADDITIONAL SERVICES)[120]

A. Recreational Opportunities Exploration and Visioning

The objective of the recreational opportunities exploration and visioning for Columbia's Canal Park will be to create an informed community understanding and direction for future improvements to the Canal Park area. The vision plan will focus on enhancing public access and usage along the riverfront by harnessing stakeholder and public input to create a resilient space that is unique to Columbia and reflects the community's priorities and values.

B. Canal Park Inventory and Analysis

Working in conjunction with the overall team, data for the Canal Park Area inventory and analysis will be gathered. This information will include the natural, socioeconomic and historic resources compiled as part of [Task 4] Environmental Documentation as well as [Task 5] Project Mapping, [Task 6] Historical Data, [Task 7] Detailed Field Reconnaissance including photography and video; cultural resources; vehicular and bicycle/pedestrian data. The inventory and analysis will consist of mapping and diagramming that highlights existing recreational opportunities as well as the potential for the development of new opportunities, connections and resources. Recreational items to be addressed in the analysis will include, but not be limited to:

- Pedestrian circulation
- Fishing facilities and opportunities (on land and on water)
- Parks – facilities and programming (active and passive)
- River access (pedestrian and boat access)
- River usage
- Former water pumping plant interaction/protection needs
- Existing hydroelectric plant interaction/protection needs

C. Community Engagement

Baker's Urban Design Studio has an extensive, time tested toolkit of strategies and methods that provide inclusive and engaging ways for stakeholders and the public to identify community needs and collaborate on consensus-built solutions. Suggested community engagement tools for the Canal Park Visioning include:

1. Stakeholder Meetings/Interviews

The **CONSULTANT**'s Urban Design Studio will facilitate two (2), **CITY** approved, meetings/interviews with key stakeholders (property owners, organized groups, special interests, etc.). Initial meetings will focus on understanding the audiences' concerns associated with the Canal Park Area, provide focused information, and build consensus. Documentation of these meetings will lead to developing an issues/opportunities list that will be reviewed with the design team in conjunction with input from the Community Workshops. Later, these meetings and/or interviews will allow for conceptual project alternatives to be explored.

[120] Stage B: Supplemental **CITY**' Requested Services

2. Walking Tour Workshop

The **CONSULTANT**'s Urban Design Studio will host an interactive and engaging walking workshop of the Canal Park site to ground Columbia residents and stakeholders in specific opportunities and constraints in the project design (i.e. park facilities, connections to the park, non-park structures, and flood control). The workshop will facilitate community understanding of the current design of the project site as well imagine opportunities for the future.

3. Visual Preferencing - Townscan™:

The **CONSULTANT** will prepare a presentation utilizing visual storytelling, sketches, photographs and storyboards. The presentation will include real time voting by the audience and discussion of project elements. We find that this is one of the most powerful ways for communities to understand their needs, and the differing viewpoints of community members. After images are voted on, **CONSULTANT**'s facilitators guide conversations to assess commonalities and sticking points that need to be worked through. At Canal Park, we will work with stakeholders and the public to identify how the recreation opportunities can be used to develop an enhanced experience for public users. The community input is vital to ensuring that the park alternatives reflect the priorities and values of Columbia's residents and business owners.

4. Charrette

After a Visual Preferencing presentation, it is useful to literally "bring the community to the table" in a Charrette format for a hands-on opportunity to write, note or draw concepts on plans of the Canal Park area in conjunction with **CONSULTANT**'s landscape architects and designers. The Charrette allows participants to apply what they just learned from visual preferencing and observed in the Canal Park into designs.

5. Summary

The **CONSULTANT** Urban Design Studio will assemble a document that includes a narrative, photos and drawings from all community events as a record of activities and community preferences. The summary will be provided as a record of the public's participation in the design process.

6. Alternatives Development:

Building on the preferences for visual character and preliminary goals for the riverfront, a series of 5 alternatives will be developed (10% design level) by the **CONSULTANT**'s landscape architects and planners. The alternatives will explore distinctly different ways of improving the Canal Park Area by identifying opportunities for resilient new amenities; connections between the existing **CITY** and the riverfront; storm water infiltration; and important canal and river access points. The alternatives will address the following topics:

a. Pedestrian/Trail locations and connections

- Dike Crest
- Walking trail along Broad River (downstream side of dike)
- Downstream side of powerhouse over the tailrace
- Existing (abandoned) steam tunnel usage
- Existing pedestrian bridge usage

b. Fishing – locations, platforms and piers

- Below the Gervais Street Bridge
- Downstream side of powerhouse at canal's end (also serves as pedestrian bypass around powerhouse)

c. Park activities, spaces, programming

d. River Access (pedestrian and boat access)

e. Former water pumping plant modifications and potential public interaction

f. Existing hydroelectric plant modifications and potential public interaction

g. Maintenance – vehicle connections

Creating a resilient riverfront will be a theme throughout the concept development of a coordinated restoration plan. Considerations for resiliency could include elements such as durable materials, location of amenities and storm water infiltration. Opportunities for art, cultural interpretation and education could also be integrated into plans for recreational opportunities.

A high-level opinion-of-cost will be included with each of the 5 alternatives to aid in the evaluation of the alternatives.

7. Alternative Analysis:

The Canal Embankment Assessment (10% design level) will consist of two main components: a presentation/assimilation of feedback from stakeholders and the public; and an evaluation by the **CONSULTANT**.

a. Public Workshop

The alternatives will be presented to the public and feedback gathered either by notations, interviews and/or web based survey. Feedback will be summarized and utilized in the evaluation of the alternatives by the Baker Team.

b. SWOT Analysis

The **CONSULTANT** will create an analysis of strengths, weaknesses, opportunities and constraints with stakeholder and public preferences of each of the alternatives. This analysis will include Team recommendations and suggested path forward for future steps in the Canal Park improvement process.

c. Vision

The Alternative Analysis will result in the development of a preferred concept and an overall Vision for the waterfront – enabling visitors to forge deeper connections with the river through a variety of recreation opportunities created with resiliency in mind. The preferred concept will be a true product of public participation, and as such reflect Columbia's culture, priorities and values. The final product of this phase of design will be a vision Poster which will highlight the unique aspects of the preferred alternative, and will guide future design endeavors for Canal Park.

D. <u>TBR: Recreational Opportunities Assessment</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 17 recreational opportunities assessment. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The TBR will be referenced as applicable in the Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

Figure 17-1- Headgates (looking Easterly)

TASK 18 - FLOOD FIGHTING ACCESS ASSESSMENT (STAGE B ADDITIONAL SERVICES)[121]

A. <u>Design Criteria Memorandum: Flood Fighting Access Structures</u>

A Design Criteria Memorandum (DCM) will be developed to identify the analyses and investigations to be performed to assess flood fighting access described herein. The DCM will describe the means, methods and assumptions to be used in the analyses. Conceptual design, to assess alternate structure types and locations for Phase 1 Alternatives Analysis, will generally follow the Load Resistance Factor Design (LRFD) Guide Specifications for the Design of Pedestrian Bridges and the 2014 AASHTO LRFD Bridge Design Specifications, 7th Edition.

[121] Stage B: Supplemental **CITY'** Requested Services

B. Connectivity

1. Pedestrian

a. Condition assessment of existing pedestrian bridges

A qualitative assessment will be completed for the 2-span truss canal pedestrian bridge; and attention will be paid to qualitatively assess the feasibility of rehabilitating or replacing deteriorated substructures at the 2-span truss bridge (Figure 18-1). Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost. Proposed work is addressed in Task 7G.

b. Existing steam tunnel

A qualitative assessment will be completed for the existing steam tunnel (Figure 18-1) to evaluate possible measures to retrofit the steam tunnel for pedestrian access. Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost.

c. Powerhouse Pedestrian Bridge

A qualitative assessment will be completed to construct a pedestrian bridge on the downstream side of the powerhouse (Figure 18-1) thereby completing pedestrian conductivity from the canal spillway to the existing riverside board walk on the extending beneath Gervais Street Bridge. The bridge could also serve as a fishing platform over the powerhouse tailrace. Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost.

2. Emergency Vehicles

a. Vehicular access bridge replacement over canal spillway

A qualitative assessment will be completed to replace the vehicular access bridge over the canal spillway (Figure 18-1) based on the analyses completed in Task 13.B.3. Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost.

b. Limited vehicular access bridge across the canal upstream of powerhouse

An assessment will be conducted to provide a vehicular access bridge across the canal upstream of the existing powerhouse to facilitate flood-fighting readiness and deployment. A total of four (4) bridge alignments will be considered for the Phase 1 Alternatives Analysis generally at the locations indicated in Figures 18-1 and 18-2 below, namely 2 alternate locations in the lower canal reach (Figure 18-1) and the remaining 2 alternate locations in the upper canal reach (Figure 18-2). Based on discussion at the scoping meetings, the bridge types considered will be single lane structures that have sufficient capacity to support HS20 live load. Bridge span lengths on the order of 150 to 200 feet are anticipated to be assessed. Consideration will be given to the following factors:

- Elevating the bottom chord of the access bridges, giving due consideration of the limited freeboard and elevation of the high water mark;
- Measures that can be taken to minimize impact on the floodway by bridge approaches;
- Utilization of existing bridge piers along the new Broad River Bridge (e.g. Alternate Vehicle Access Bridge Location 5B in Figure 18-2 below);
- Holding the bottom chord of the access bridge high enough to permit kayak/canoe access under the bridge at high-normal canal-pool level (e.g. Elevation 153.5, equal to the crest elevation of the Diversion Dam); and
- Multi-bridge use to maximize benefit-cost, including restricted access for maintenance vehicles servicing dike/park facilities, canal spillway and other **CITY** assets that are situated along the dike embankment, all during non-critical flood events.

Analyses will be performed (10% design level) and a conceptual design completed with sufficient detail to identify benefits and disadvantages of vehicular access bridge alternatives considered. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost. Based on the information available, it appears that either a 1-span steel girder structure or a 2-span structure of either steel girders or P/S concrete beams will be feasible. A matrix will be developed indicating the pros and cons and each bridge type. Based on the matrix, the **CONSULTANT** will recommend a preferred bridge type. Design sketches (8 ½" x 11") will be developed for the recommended structure type. No full size CADD bridge drawings will be prepared under the Phase 1 Alternatives Analysis.

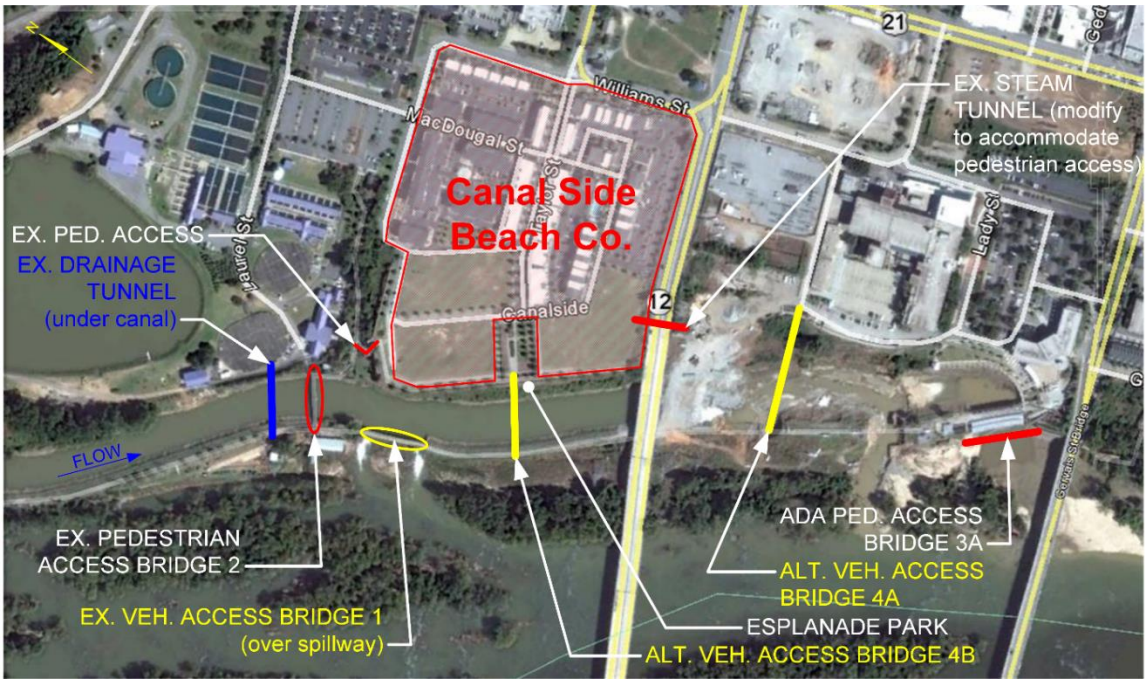

Figure 18-1- Alternate Access Bridge Locations - Reach 1 (downstream reach)

Figure 18-2- Alternate Access Bridge Locations - Reach 2 (upstream reach)

C. Staging Area(s)

A qualitative assessment (10% design level) will be completed to provide staging areas for flood-fighting readiness and deployment. Three (3) alternate staging areas will be considered during the Phase 1 Alternatives Analysis; namely 1 location at the downstream Reach 1 in proximity to the temporary causeway that is depicted in Figure 18-1, and the remaining 2 locations at the upstream Reach 2 generally within the limits depicted in Figure 18-2. Consideration will be given to multi-use of staging area(s) to maximize benefit-cost, including possible use for public parking during non-critical flood events. Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost.

D. TBR: Flood Fighting Access Assessment

A stand-alone TBR will be prepared to summarize and present work product for the Task 18 flood fighting access assessment. The TBR will identify the means, methods, and assumptions used in performing the work; describe in concept measures required to meet design requirements of the governing agency; include a plan and figures, as needed to describe alternatives considered; a tabular summary of benefits and disadvantages for alternatives considered; include an order-of-magnitude opinion about the probable construction cost estimate for comparison of alternatives; and include an executive summary. The TBR will be referenced in the Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analyses of the options considered.

TASK 19 - PHASE I ALTERNATIVES ANALYSIS (STAGE B ADDITIONAL SERVICES)[122]

A. Evaluation of Alternatives

The **CONSULTANT** will conduct a qualitative assessment of alternatives, which is focused on the key considerations/objectives and options that are tabulated in the Introduction Purpose section of the Scope of Services above. Priority and weighting factors will be used to evaluate alternatives, based on the **CONSULTANT**'s professional experience and consultation with the **CITY** and key stakeholders.

Results from the preceding tasks (1 through 18) will be used to process a Project Formulation, which will serve to document flood damage, identify items and scopes of work that are believed to be eligible for mitigation funding under grant(s) from stakeholders.

B. Constructability Review

The **CONSULTANT** will perform two (2) constructability reviews at approximate 35% and 70% completion of the Phase 1 Alternatives Analysis, to ensure optimum results by verifying that the assessment meets project objectives. These reviews will be performed to identify potential construction problem areas, to capitalize on possible cost savings, and to reduce exposure to potential future construction claims. The reviews will be performed to ensure that practical and cost effective construction approaches are developed and adhered to throughout the Phase 1 Alternatives Analysis. Major design issues with significant impact on project cost and time of construction will be

[122] Stage B: Supplemental **CITY**' Requested Services

considered. A technical memorandum will be prepared to document the constructability review findings.

C. Comparison Matrix Analysis

Tabular summaries of benefits and disadvantages for alternatives considered, including order-of-magnitude construction cost estimates, will be carried forward and rolled-up for the following tasks to compare alternatives:

- Task 11 – Water Supply Alternatives Assessment
- Task 13 – Canal Structures Analysis
- Task 14 – Masonry Drainage Tunnel Condition Assessment
- Task 16 – Embankment (Dike) Geotechnical Analyses
- Task 17 – Recreational Opportunities Assessment
- Task 18 – Flood Fighting Access Assessment

The **CONSULTANT** will prepare tabular matrix comparisons to evaluate various remediation options.

D. Recommended Preferred Alternative

Based on the data obtained and analyses performed, The **CONSULTANT** will recommend a preferred alternative after consulting with the **CITY**.

E. Recommended Phase 2 Scope of Services

After the **CITY** and the key stakeholders have reached consensus with common vision, the **CONSULTANT** will develop and submit to the **CITY** a recommended Phase 2 Scope of Services.

F. Preliminary Engineering Report (PER): Phase 1 Alternatives Analysis

The PER for the Phase 1 Alternatives Analysis will be based on emergency response documentation gathered (Task 1), resource agency coordination (Task 2), public relations (Task 3) and a series of DR and TBR deliverables (Tasks 4 through 18), which will be prepared at the end of each respective task. The following DRs and TBRs will be prepared and submitted as described above in the Scope of Services.

- Task 4 – TBR: Environmental Documentation
- Task 5 – DR: Project Mapping
- Task 6 – DR: Historic Data
- Task 7 – DR: Detailed Field Reconnaissance
- Task 8 – TBR: Existing Dike Condition Assessment
- Task 9 – DR: Subsurface Investigation
- Task 10 – TBR: Hydrologic and Hydraulic (H&H) Analysis
- Task 11 – TBR: Water Supply Alternatives Assessment
- Task 13 – TBR: Canal Structures Analysis
- Task 14 – TBR: Masonry Drainage Tunnel Condition Assessment
- Task 15 – TBR: Embankment (Dike) Geotechnical Analyses
- Task 16 – TBR: Embankment (Dike) Repair Assessment
- Task 17 – TBR: Recreational Opportunities Assessment
- Task 18 – TBR: Flood Fighting Access Assessment

The **CONSULTANT** will use the items listed above to prepare and submit the PER for the Phase 1 Alternatives Analysis. This PER will present Task 19 findings, conclusions and recommendations. TBR's from the Phase 1 Alternatives Analysis will be cross-referenced and appended to the PER for the Phase 1 Alternatives Analysis.

The **CONSULTANT** will prepare and submit a draft PER for review and comment; address review comments; and then prepare and submit a final PER for approval by the **CITY**.

Draft deliverable submission(s) of the PER will be in electronic format; and after the final PER is approved by the **CITY**, a final deliverable submission of the PER will be made to the **CITY** in bound-hard-copy format. All supporting documents for the PER for the Phase 1 Alternatives Analysis will be delivered to the **CITY** on a portable hard drive for permanent storage, including AutoCAD files for base plans and Plan Overlays that were prepared for Phase 1.

Further discussion about deliverables is presented in the Scope of Services, Introduction Section G.

TASK 20 - ALTERNATE FUNDING SOURCE SUPPORT (OMITTED)

The **CITY** has retained an independent consultant under separate contract to provide grant application support services to the **CITY** in support of the Canal Embankment renovation project.

*Based on the Scoping Meetings, the **CITY** and **CONSULTANT** have mutually agreed that the **CONSULTANT** will not be engaged to compile documentation to support preparation of FEMA Project Workbooks (PWs) and benefit-cost analyses for grant application(s), other than to make available the DR, TBR and PER work products that are described in this Scope of Services.*

TASK 21 - PROJECT MANAGEMENT AND ADMINISTRATION (STAGES A, B & C)

The **CONSULTANT**'s Project Manager will plan, schedule, organize and control Baker's resources to achieve specific objectives within the established schedule, budget and quality standards of the tasks Baker is responsible.

Based on the Scoping Meetings, Task 21 man-hours and direct costs have been integrated with the preceding tasks (1 through 20) where applicable.

A. <u>Quality Assurance and Quality Control</u>

The **CONSULTANT** will follow Quality Assurance/Quality Control procedures outlined in **CONSULTANT**'s Quality Management Plan for Project Development. A project specific quality assurance plan will be developed as part of this task. This will include proper checking procedures, QA/QC reviews, peer reviews and if applicable, cross-discipline reviews. The **CONSULTANT** will utilize personnel for reviews that are knowledgeable and qualified in their respective fields.

B. <u>Meetings</u>

The **CONSULTANT**'s Project Manager will attend bi-weekly status meetings with the project team and the **CITY** for the duration of the project as well as any other meetings that may arise requiring representatives knowledgeable in the issues to be discussed. The **CONSULTANT** will prepare and

distribute minutes of meetings to all attendees. It is anticipated that there will be eight (8) meetings for this task.

C. Project Procedures and Implementation

The **CONSULTANT** has prepared for and participated in Scoping Meetings (Introduction Section B) with the **CITY** to develop the detailed Scope of Services presented herein.

D. Administrative

This task includes all clerical work to maintain internal project files, preparing project correspondence, and distributing correspondence to appropriate project personnel, both internal and external.

TASK 22 - PHASE 2 FINAL DESIGN SCOPING (STAGE A BASIC SERVICES)

Based on the results of the Phase 1 Canal Embankment Assessment (and alternatives analysis), the **CONSULTANT** will develop a detailed Phase 2 and Phase 3 Scope of Services.

Without further notice, the **CITY** and **CONSULTANT** anticipates that the Phase 2 Final Design will entail base flood repair services for Reach 1 as defined under existing Project Workbook (PW) agreements that are in place as of June 24, 2016 between the **CITY** and FEMA to repair flood damage and restore the Columbia Canal to pre-flood conditions. The FEMA' PW Scope of services provides for repair of flood damage that occurred between October 1 and October 23, 2015 due to overtopping of the dike near the downstream end of the approximate 3.1 mile long canal dike, and which generally includes the following.

- Repair of the dike breach, just north of the Broad River Bridge, that was about 100 feet long x 85 feet wide by 50 feet deep, involving approximately 15,740 cubic yards of fill that was lost downstream into the Broad River.
- Repair of a second breach that was about 205 feet long x 65 feet wide x 50 feet deep, involving approximately 24,675 cubic yards of fill that was washed downstream into the canal.
- Repair of mechanical and physical damage to the canal spillway.
- Repair of mechanical and physical damage to the gates at the diversion dam (headworks), to be performed by others under separate contract with the **CITY**.
- Decommission of a Temporary Emergency Dam (cofferdam) that was erected during the flooding event across the canal to resupply water to water intakes for the **CITY**' water works.
- Hazard mitigation against future flood-borne damage to the Columbia Canal by utilizing approximately 3,952 cubic yards of the Temporary Emergency Dam (riprap and various stone) to armor select truck-accessible portions of the remaining canal embankment (dike).

Exhibit B, Fee Proposal Summary – *DR4241 Columbia Canal Embankment Repair Services*

- Not-to-exceed amounts should be rolled up to the Stage level and not the task level. This will give flexibility in the event they need to move money from one task to another.

- Even though the scope of work for Stage C is unknown at this time as it depends of further field investigation, MBI requested that we include an estimate for the not-to-exceed cost in Stage C to avoid delays by having to go again to council. Gregory is in agreement with this.

  Here is a brief description of the 3 stages in the project. These stages are described in detail in the attached scoping document from Michael Baker International.

  Stage A: Scope of work for this stage is as currently defined in the PW (repairs of the 2 breaches and the spillway). These fees are reimbursable by FEMA

  Stage B: These are the "Other Additional Services" that will be paid from non-FEMA funds. MBI will only proceed if they are given written notification by the City.

  Stage C: MBI will perform a field inspection of the entire Canal outside the limits of the breaches. If they find additional flood related damage, we will ask FEMA to version the PW to include the damage and MBI contract will be amended to add the design fees for the repairs. The scope will be finalized after completion of work in Stage A and some tasks in Stage B.

The Engineer's contract shall be a fixed price, not-to-exceed contract in the amount of Four Million, Nine Hundred Thirty-Eight Thousand, One Hundred Thirty-Nine Dollars and No/100 ($4,938,139.00). The manhour rates for this project are shown in Exhibit B.

Refer to Scope of Services in Exhibit A for description of work that will be performed in each Stage.

STAGE A: The not-to-exceed amount for basic services for the scope of work described in Stage A shall be determined using Figure 3 – Engineering and Design Services of Above Average Complexity in the FEMA PA 322 Guide, 2007 (refer to Exhibit E).

Below are the estimated milestones:

Assessment	40%
Final Design and Construction Documents	40%
Construction Administration	20%

For Billing purposes, the initial not-to-exceed amount for Basic Services shall be $1.95 million (based on a preliminary construction estimate of $27.8 million). The Final not-to-exceed amount for Basic Services shall be determined using Figure 3 in FEMA PA Guide 322, 2007. The net construction cost used in the computation of the not-to-exceed amount for Basic Services shall be the lower of the Engineer's Final Estimate and the Low Bid.

The following Additional Services will be performed for Stage A. The not-to-exceed amount for these services is $592,106.00

- Field Reconnaissance (Reach 2)
- Environmental Assessment
- Project Mapping and Surveying
- Geotechnical Investigation
- Condition Evaluation of Hydroplant

Direct Expenses for Travel, Reproduction and Equipment Rental will be reimbursed at cost. The not-to-exceed amount for Stage A Direct Expenses is $99,365.00

STAGE B: The following is a list of Additional Services described in the Scope of Services for Stage B. The Engineer shall not proceed with these services unless authorized in writing by the City. The not-to-exceed amount for these services is $848,081.00. This amount includes Direct Expenses.

- Environmental Assessment
- Project Mapping and Surveying
- Hydrology and Hydraulics
- Water Supply Assessment
- Canal Structures Assessment
- Recreational Opportunities Assessment
- Alternatives Assessment

- Scoping for Stage C

STAGE C: The scope of work for Stage C will be finalized after the Engineer has completed the Field Investigation described in Stage A. The Engineer shall not proceed with these services unless authorized in writing by the City.

The not-to-exceed amount for this stage is currently estimated at $1,448,587.00

SUBCONSULTANT FIRM INFORMATION RECORDS

The Engineer shall list all firms, including minority and female owned firms, providing subconsulting services under this Agreement. The list shall be submitted in the format provided below. Any proposed changes must be submitted in writing to the City, including the reason(s) for the proposed changes, prior to initiation of any action by the Engineer. Any invoices submitted for payment under this Agreement must include the dollar amount to be paid to each firm listed below for the invoice period.

SUBCONTRACTOR SUMMARY

PROJECT NAME:	City of Columbia - Canal Repair Project
CITY OF COLUMBIA CIP #	
DATE:	
PAY APPLICATION NO.:	
REPORTING PERIOD:	
CONTRACT AMOUNT:	$3,519,989.53

FIRM NAME, ADDRESS, CONTACT NAME AND TELEPHONE #	DOLLAR VALUE OF SERVICES*	GROUP / CLASSIFICATION (MBE, WBE, SBE, NON MBE/WBE/SBE)	SERVICES TO BE PROVIDED	PREVIOUS CUMULATIVE EARNINGS	EARNINGS FOR THIS REPORTING PERIOD	CUMULATIVE EARNINGS TO DATE
HAZEN AND SAWYER Bill Orne (803-779-0001)	$655,544.00	Non MBE/WBE/SBE	Water Supply/H&H Modeling		$0.00	$0.00
KLEINSCHMIDT ASSOCIATES Bill Reminger, PE (803-462-5620)	$419,378.00	Non MBE/WBE/SBE	FERC Coordination, Locks/Gates Design		$0.00	$0.00
F&ME CONSULTANTS, INC. Shawn Epps, PE (803-254-4540)	$1,046,089.50	Non MBE/WBE/SBE	Geotechnical Design		$0.00	$0.00
CASE CONSULTING, INC. Calvin Wise (803-926-1600)	$37,564.80	SBE	Contract Administration Services		$0.00	$0.00
CONSTRUCTION SUPPORT SERVICES Jay Joshi, PLS (803-776-9909)	$32,000.00	MBE	Land Surveying Services		$0.00	$0.00
MA ENGINEERING CONSULTANTS, INC. Matt Elious (877-623-2123)	$27,252.36	DBE	Geospatial/GIS/ Photogrammetry		$0.00	$0.00
ESP ASSOCIATES, PA Jesse J. Price (813-295-9024)	$38,500.00	Non MBE/WBE/SBE	Bathymetric Survey		$0.00	$0.00
NEW SOUTH ENGINEERING Mary Beth Reed (803-771-7083)	$17,702.92	DBE	Historic Context Study		$0.00	$0.00
TOTAL:	$2,274,031.58			$0.00	$0.00	$0.00

***Estimated fee; fee may vary based on actual services provided.**
Please clearly note the Protege Firm in the "Group" Column.
Add additional rows as needed.

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
OR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage A-Base Services
CITY OF COLUMBIA

PHASE 1 - Alternatives Analysis Stage A - Base Services	$	608,168.68
PHASE 2 - Final Design (TBD at end of Phase 1)	$	-
PHASE 3 - Construction Consultation (TBD at end of Phase 1)	$	-
	$	608,168.68

Proposed Method of Payment : PHASE I - COST PLUS NET FEE

Length of Agreement: PHASE 1 [8] months

Total Estimated Manhours: PHASE 1 [695] Hrs.

Engineer: Michael Baker International, Inc.

Federal ID No 25-1228638

Contact Person: Donald R. Green, P.E., Project Manager or locally, Angie Logan, Project Financial Coordinator
(412) 269 6091 (803)-231-4054

Proposal Prepared By: John Walsh, PE - Principal In Charge

SUMMARY OF COSTS - PHASE 1 ALTERNATIVES ANALYSIS STAGE A BASE SERVICES

MBI loaded Labor Cost (Direct Paytroll + Indirect Payroll + Net Fee)	=		$100,387.62
MBI Direct Costs Other Than Payroll	+	$	23,540.00
Subconsultant Loaded Labor Cost (Direct Paytroll + Indirect Payroll + Net Fee)	=		$431,462.06
Subconsultant Direct Costs Other Than Payroll	+	$	52,779.00
ESTIMATED ENGINEERING COST - PHASE 1	=	$	608,168.68

MBI LOADED LABOR RATE MULTIPLIER
PHASE I - ALTERNATIVES ANALYSIS

Loaded Labor Rate Multiplier	=	3.000

We anticipate starting this part of the project on: [17 Aug 16]
and completing it by: [16 Apr 17]

MBI DIRECT COSTS OTHER THAN PAYROLL
PHASE 1 - ALTERNATIVES ANALYSIS

(a) Travel - Airfare	$4,800.00 (8 flights @ $600/per flight)
Vehicle Rental	$1,080.00 (20 rental days @ $54/per day)
Mileage	$2,000.00 (1000 mileage miles@.54/mile
Lodging	$7,200.00 (20 nights @ $160/per night)
(b) Reproduction	$3,960.00 (8.5"X 11" b/w $3,300.& 11"X 17" b/w $660)
(c) Public Meeting Related Costs:	$0.00
(d) Misc.	$4,500.00
(e) Crane Rental	$0.00

TOTAL MBI DIRECT COSTS OTHER THAN PAYROLL - PHASE 1	=	**$23,540.00**

SUBCONSULTANT COSTS (SERVICES BY OTHERS)
PHASE 1 - ALTERNATIVES ANALYSIS

Kleinschmidt Labor:		$43,219.00	
Hazen & Sawyer Labor:		$291,964.00	
CASE Consulting:		$25,544.06	
CSS		$12,000.00	
MA Engineering Consultants:		$0.00	DBE/SBE Total
FSP Associates:		$0.00	$37,544.06
New South:		$0.00	6.17%
F&ME Labor:		$58,735.00	
Subconsultant Loaded Labor Cost - Phase 1	=	**$431,462.06**	
Kleinschmidt		$2,947.00	
Hazen & Sawyer:		$8,300.00	
MA Engineering Consultants		$0.00	
New South Engineering:		$1,966.00	
F&ME Consultants:		$39,566.00	
Subconsultant Direct Costs Other Than Payroll - Phase 1	=	**$52,779.00**	

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/3/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment Stage A-Base Services
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee	CSS & ESP	Sub Total Tasks
	Sr. Civil	20	$3,565.80																				
	GIS Tech.	60	$6,906.60																				
TASK 3 - Emergency Response Documentation Gathering		80	$10,472.40		0	$0.00																	$10,472.40
	Proj. Mgr	0		$0.00 Prin.Cons.	12	$2,220.00				Sr. Assoc	40	$6,480.00											
	Sr. Env Spec	36		$6,572.88 Sr. Engr. Cons	2	$396.00																	
	Enviro Sp.	32		$4,040.64 Adm.	3	$222.00																	
	Enviro As.	32		$3,256.32																			
TASK 2 - Resource Agency Coordination		200	$13,869.84		17	$2,778.00					40	$6,480.00											$25,127.84
	Const Rev	0	$0.00																				
	Sr. Civil	0	$0.00																				
TASK 3 - Public Relations		0	$0.00		0	$0.00					0	$0.00											$0.00
TASK 4 - Environmental Documentation		0	$0.00		0	$0.00														0	$0.00	$0.00	$0.00
TASK 5 - Project Meeting		0	$0.00		0	$0.00																	$0.00
	Sr. Struc.	8		$1,407.12 Prin.Cons.	24	$4,440.00	Sr. Princ	10	$2,320.00	Sr. Proj.Eng	10	$1,360.00											
	Struc.Eng.	15		$1,783.35 Sr. Engr. Cons.	2	$396.00	Sr Geo.Eng.	24	$3,840.00														
	GIS Tech.	30		$3,453.30 Adm.	1	$74.00	Proj. Princ	31	$10,320.00														
							Proj.Mgr.	31	$7,920.00														
TASK 6 - Historic Data		93	$6,643.77		27	$4,850.00		98	$24,180.00		10	$2,550.00											$37,223.77
	Env. Ass.	8		$814.08 Prin.Cons.	35	$6,475.00	Sr. Princ.	6	$1,350.00	Sr. Assoc.	31	$6,572.00	G. Mgr	0	$0.00								
	GIS Tech.	12		$1,381.32 Sr. Engr. Cons.	4	$672.00	Geologist	4	$360.00	Associate	63	$10,773.00	Survey Mgr.	0	$0.00								
	Proj. Mgr.	20		$3,615.00 Adm.	1	$74.00	Assoc.Geol.	9	$585.00	Sr.Proj.Eng	16	$2,480.00	Sr. Stereo Comp	0	$0.00								
				Proj.Eng	15	$1,905.00	Proj.Princ.	6	$1,260.00	Proj.Eng.	24	$3,000.00											
							Proj.Mgr.	26	$4,160.00														
							Sr.Geo.Tech	22	$1,650.00														
							CADD	8	$560.00														
							Clerical	3	$165.00														
TASK 7 - Detailed Field Reconnaissance-Reach 1		40	$5,810.40		55	$9,126.00		84	$10,100.00		134	$22,825.00		0	$0.00								$47,861.40
	Env. Ass.	8		$814.08 Prin.Cons.	23	$2,220.00	Sr. Princ.	3	$690.00	Sr. Assoc.	12	$2,544.00											
	GIS Tech	6		$690.66 Sr. Engr. Cons	2	$336.00	Proj.Princ	1	$210.00	Associate	12	$2,052.00											
							Proj.Mgr.	8	$1,280.00	Sr. Proj.Eng	6	$930.00											
							CADD	2	$140.00	Proj.Eng.	1	$250.00											
										Des.GIS	8	$568.00											
TASK 8 - Existing Dike Condition Assessment		14	$1,304.74		14	$2,556.00		14	$2,320.00		40	$6,344.00											$12,724.74
TASK 9 - Subsurface Investigation					0	$0.00	0		$0.00														$0.00
				Prin.Cons.	0	$0.00				Vice Pres	4	$1,016.00											
										Sr. Assoc.	72	$15,264.00											
										Associate	152	$32,832.00											
										Sr.Proj.Eng	394	$61,070.00											
										Proj.Eng	812	$101,500.00											
TASK 10 - Hydrologic and Hydraulic (H&H) Analysis		0	$0.00		0	$0.00					1,474	$211,682.00											$211,682.00
TASK 11 - Water Supply Alternatives Assessment - Tier 1					0	$0.00	0		$0.00		0	$0.00											$0.00
TASK 12 - Water Supply Alternatives Assessment - Tier 2					0	$0.00	0		$0.00		0	$0.00											$0.00
TASK 11 - Water Supply Alternatives ASSESSMENT - Tier 1 and Tier 2					0	$0.00	0		$0.00		0	$0.00											$0.00
TASK 12 - SECTION OMITTED					0	$0.00					0	$0.00											$0.00
	Struc.Eng	10	$1,288.90							Sr. Assoc.	4	$848.00											
										Sr.Proj.Eng	12	$1,860.00											
TASK 13A - Canal Structures Analysis - Criteria Memorandum		10	$1,288.90		0	$0.00					16	$2,708.00											$3,996.90
	Sr Hyd. Eng.	20	$3,685.40																				
	Hyd Engineer	9	$1,101.87																				
TASK 13B - Canal Structures Analysis - Canal Spillway		29	$4,791.27		0	$0.00	0		$0.00		0	$0.00											$4,791.27
TASK 13C - Canal Structures Analysis - Existing Hydro Plant					0	$0.00	0		$0.00		0	$0.00											$0.00
TASK 13D - Canal Structures Analysis - Diversion Dam							0		$0.00		0	$0.00											$0.00
TASK 13E - Canal Structures Analysis - Canal Headworks					0	$0.00	0		$0.00		0	$0.00											$0.00

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
094241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage A-Base Services
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	M&S Title	M&S Hrs.	M&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee	
				Prin.Cons.	6	$1,110.00				Sr. Assoc.	2	$424.00										
				Sr Engr Cons	2	$336.00																
				Admin	0	$0.00																
				Sr Engr.	4	$552.00																
				Proj Engr	0	$0.00																
				Engineer	0	$0.00																
				Sr Des.	0	$0.00																
				Sr Mgr Lic	0	$0.00																
				Team Ld	0	$0.00																
				Proj Scientc	0	$0.00																
				Sr Mgr.	0	$0.00																
TASK 13F - Canal Structures Analysis - TBR					12	$1,992.00		0	$0.00		2	$424.00										$2,422.00
TASK 14 - Masonry Drainage Tunnel Condition Assessment		0	$0.00		0	$0.00		0	$0.00		0	$0.00										$0.00
	Proj Mgr.	40	$7,292.00				Sr. Princ.	19	$4,370.00	Sr. Assoc.	8	$1,696.00										
	QA Mgr.	25	$4,633.50				Sr Geo Eng	11	$4,340.00	Sr Proj Eng.	20	$3,100.00										
	QA Rev	5	$1,047.60				Geo Train.	28	$2,100.00													
	Sr. Hyd. Eng.	5	$922.35				Geologist	2	$170.00													
	Sr. Civil	14	$2,496.06				Proj.Princ.	6	$1,260.00													
							Proj Mgr.	23	$3,160.00													
							CADD	10	$700.00													
TASK 15 - Embankment (Dike) Geotechnical Analyses		89	$16,139.51		0	$0.00		117	$16,300.00		28	$4,796.00										$37,425.51
	Sr. Hyd. Eng.	12	$2,213.64	Prin.Cons.	11	$2,035.00	Sr. Princ.	1	$230.00	Sr Assoc	4	$848.00										
	Proj.Mgr	13	$2,349.75	Sr Engr Cons	0	$0.00	Sr.Geo.Eng.	2	$280.00	Sr Proj Eng	1	$155.00										
	QA Mgr	5	$926.70				Proj Princ	1	$220.00													
	QA Rev.	1	$209.52				Proj Mgr	1	$160.00													
TASK 16 - Embankment (Dike) Repair Assessment		51	$9,698.61		11	$2,035.00		5	$680.00		5	$1,008.00										$9,617.61
TASK 17 - Recreational Opportunities Assessment		0	$0.00		0	$0.00																$0.00
TASK 18 - Flood Fighting Access Assessment		0	$0.00		0	$0.00																$0.00
TASK 19 - Phase I Alternatives Assessment		0	$0.00		0	$0.00		0	$0.00		0	$0.00										$0.00
TASK 20 - Alternate Funding Source Support					0	$0.00																$0.00
	Princ.Mgr.	9	$2,767.50	Prin.Cons.	92	$17,020.00	Proj.Princ.	8	$1,680.00	Sr. Assoc.	146	$30,952.00				Administrator	233	$25,544.06				
	Proj.Mgr.	0	$0.00	Sr Engr.Cons.	17	$2,836.00	Proj Mgr	18	$2,560.00	Admin	16	$1,209.00										
	Asst.Proj Mgr	72	$12,515.88				Clerical	13	$715.00													
	QA Mgr.	0	$0.00																			
	QA Rev.	0	$0.00																			
	Sr. Hyd.	0	$0.00																			
	Hyd.Eng.	0	$0.00																			
	Sr. Civil.	0	$0.00																			
	Enviro Assoc.	0	$0.00																			
	Scoping	0	$0.00																			
	Off.Serv.Mgr.	159	$18,793.80																			
TASK 21 - Project Management and Administration		240	$34,077.18		109	$19,876.00		37	$4,955.00		162	$32,152.00		0	$0.00		233	$25,544.06			$12,000.00	$128,604.24
	Enviro Assoc																					
	Scoping																					
	Off.Serv.Mgr.																					
TASK 22 - Phase 2 - Final Design Scoping		0	$0.00		0	$0.00		0	$0.00		0	$0.00		0	$0.00		0	$0.00		0	$0.00	$0.00
TOTALS		685	$100,387.62		233	$43,219.00		355	$58,735.00		1,893	$291,964.00		0	$0.00		233	$25,544.06		0	$0.00	$12,000.00	$531,849.68

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage A- Additional Services
CITY OF COLUMBIA

PHASE 1 - Alternatives Analysis-Stage A Additional Services	$	615,152.44
PHASE 2 - Final Design (TBD at end of Phase 1)	$	-
PHASE 3 - Construction Consultation (TBD at end of Phase 1)	$	-
	$	615,152.44

Proposed Method of Payment: PHASE 1 - COST PLUS NET FEE

Length of Agreement: PHASE 1 [8] months

Total Estimated Manhours: PHASE 1 [2326] Hrs.

Engineer: Michael Baker International, Inc.

Federal ID No. 25-1228638

Contact Person: Donald R. Green, P.E., Project Manager or locally, Angie Logan, Project Financial Coordinator
(412) 269-6091 (803)-231-4054

Proposal Prepared By: John Walsh, PE - Principal In Charge

SUMMARY OF COSTS - PHASE 1 ALTERNATIVES ANALYSIS STAGE A ADDITIONAL SERVICES

MBI Loaded Labor Cost (Direct Payroll + Indirect Payroll + Net Fee)	=		$320,324.03
MBI Direct Costs Other Than Payroll	=	$	7,729.40
Subconsultant Loaded Labor Cost (Direct Payroll + Indirect Payroll + Net Fee)	=		$271,781.52
Subconsultant Direct Costs Other Than Payroll	=	$	15,317.50
ESTIMATED ENGINEERING COST - PHASE 1	=	$	615,152.44

MBI LOADED LABOR RATE MULTIPLIER
PHASE I - ALTERNATIVES ANALYSIS

Loaded Labor Rate Multiplier	=	**3.000**

We anticipate starting this part of the project on: [17-Aug-16]
and completing it by: [16-Apr-17]

MBI DIRECT COSTS OTHER THAN PAYROLL
PHASE 1 - ALTERNATIVES ANALYSIS

(a) Travel Airfare	$0.00	
Vehicle Rental	$0.00	
Mileage	$540.00	(1000 mileage miles @ .54/mile)
Lodging	$0.00	
(b) Reproduction	$0.00	
(c) Public Meeting Related Costs:	$0.00	
(d) Misc.	$0.00	
(e) Crane Rental	$7,189.40	

TOTAL MBI DIRECT COSTS OTHER THAN PAYROLL - PHASE 1		**$7,729.40**

SUBCONSULTANT COSTS (SERVICES BY OTHERS)
PHASE 1 - ALTERNATIVES ANALYSIS

Kleinschmidt Labor:		$52,053.00	
Hazen & Sawyer Labor:		$48,386.00	
CASE Consulting		$12,020.74	
CSS		$20,000.00	
MA Engineering Consultants:		$11,934.86	DBE/SBE Total
LSP Associates:		$38,500.00	$59,692.52
New South:		$15,736.92	9.70%
F&ME Labor:		$73,150.00	
Subconsultant Loaded Labor Cost - Phase 1	=	**$271,781.52**	

Kleinschmidt	$0.00	
Hazen & Sawyer:	$0.00	
MA Engineering Consultants:	$15,317.50	
New South Engineering:	$0.00	
F&ME Consultants:	$0.00	
Subconsultant Direct Costs Other Than Payroll - Phase 1	=	**$15,317.50**

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment- Stage A
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	ES Title	ES Hrs.	ES Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee	CSS & ESP	Sub Total Tasks
TASK 1 - Emergency Response Documentation Gathering		0	$0.00		0	$0.00																	$0.00
TASK 2 - Resource Agency Coordination		0	$0.00		0	$0.00					0	$0.00											$0.00
TASK 3 - Public Relations		0	$0.00		0	$0.00					0	$0.00											$0.00
	Principal	8	$2,460.00																				
	Proj. Mgr.	73	$13,194.75																				
	Asst. Proj.Mgr.	71	$12,491.27																				
	QA Mgr.	23	$4,262.82																				
	QA Rev.	12	$2,514.24																				
	Sr. Civil	25	$4,457.25																				
	Sr. Envrn.	74	$13,419.63																Proj. Mgr	4	$460.96		
	Envrn.Sp	256	$32,299.55																Historian	234	$12,427.74		
	Envrn.As	354	$36,060.60																Graphics	42	$2,213.72		
	GIS Tech.	30	$3,453.30																Editor	10	$616.50		
	Adm.Ast	57	$3,137.85																				
	Office Mgr.	36	$4,296.10																				
	Scoping	97	$13,867.13																				
TASK 4 - Environmental Documentation		1,115	$145,748.58		0	$0.00														290	$15,736.92		$161,485.50
	Principal	8	$2,460.00																				
	Proj. Mgr.	103	$18,617.25																				
	Asst. Proj.Mgr.	71	$12,491.27																				
	QA Mgr.	52	$9,697.68																				
	QA Rev.	16	$3,352.32																				
	Sr. Civil	60	$10,697.40																				
	Sr. Hyd.Eng.	22	$4,058.34																				
	Hyd. Eng.	9	$1,101.87																				
	Env. Ass.	32	$3,256.32																				
	Pub. Coor	75	$6,738.75																				
	LIDAR PM	15	$2,586.60																				
	LIDAR An	47	$4,779.90																				
	LIDAR Data	62	$5,057.34																				
	LIDAR Proc	34	$2,754.20																				
	GIS Tech.	168	$19,338.48																				
	Office Mgr.	35	$4,197.00																				
	Scoping	98	$13,585.58																				
TASK 5 - Project Meeting		907	$124,089.80		0	$0.00																	$124,089.80
TASK 6 - Historic Data		0	$0.00		0	$0.00		0	$0.00		0	$0.00											$0.00
	Env. Ass.	0	$0.00	Prin.Cons.	38	$7,030.00	Sr. Princ.	29	$6,670.00	Sr. Assoc	31	$6,572.00	G. Mgr	16	$2,764.48								
	GIS Tech	0	$0.00	Sr. Engr. Cons	4	$672.00	Geologist	18	$1,530.00	Associate	63	$10,773.00	Survey Mgr	10	$1,424.62								
	Proj. Mgr.	60	$10,845.00	Adm.	1	$74.00	Assoc.Geol	42	$2,665.00	Sr Proj.Eng	16	$2,480.00	Sr. Stereo Comp	72	$7,745.76								
				Proj.Eng	15	$1,905.00	Proj.Princ	26	$5,460.00	Proj.Eng	24	$3,000.00											
							Proj.Mgr	119	$19,040.00														
							Sr Geo Tech	101	$7,575.00														
							CADD	36	$2,520.00														
							Derical	14	$770.00														
TASK 7 - Detailed Field Reconnaissance- Reach 3		60	$10,845.00		56	$9,681.00		230	$46,230.00		134	$22,825.00		58	$11,954.86								$101,535.86
TASK 8 - Existing Dike Condition Assessment		0	$0.00		0	$0.00		0	$0.00		0	$0.00											$0.00
				Prin.Cons.	30	$5,550.00	Sr. Princ.	2	$460.00														
				Sr. Engr. Cons	4	$672.00	Sr Geo.Eng	15	$2,100.00														
							Geo.Eng	35	$3,850.00														
							Geo.Tram.	3	$225.00														
							Geologist	38	$2,805.00														
							Assoc.Geol.	24	$1,560.00														
							Proj.Princ.	5	$1,050.00														
							Proj Mgr.	25	$4,000.00														
							Sr Geo Tech	3	$225.00														
							AugerTeam	24	$3,120.00														
							Env Scientist	2	$330.00														
							CADD	3	$540.00														
TASK 9 - Subsurface Investigation					34	$6,222.00		180	$20,285.00														$26,507.00
TASK 10 - Hydrologic and Hydraulic (H&H) Analysis		0	$0.00		0	$0.00					0	$0.00											$0.00

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage A
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee	
TASK 12 - Water Supply Alternatives Assessment - Tier 1					0	$0.00		0	$0.00		0	$0.00										$0.00
TASK 11 - Water Supply Alternatives Assessment - Tier 2					0	$0.00		0	$0.00		0	$0.00										$0.00
TASK 11 - Water Supply Alternatives ASSESSMENT - Tier 1 and Tier 2					0	$0.00		0	$0.00		0	$0.00										$0.00
TASK 12 - SECTION OMITTED					0	$0.00					0	$0.00										$0.00
	Struc.Eng.	10	$1,188.90							Sr. Assoc.	8	$1,696.00										
										Sr Proj Eng	24	$3,720.00										
TASK 13A - Canal Structures Analysis - Criteria Memorandum		10	$1,188.90		0	$0.00					32	$5,416.00										$6,604.90
TASK 13B - Canal Structures Analysis - Canal Stability		0	$0.00		0	$0.00		0	$0.00		0	$0.00										$0.00
				Prin Cons.	15	$2,775.00																
				Sr Engr Cons.	7	$534.00																
				Admin.	0	$0.00																
				Sr Engr.	44	$6,072.00																
				Proj Engr	17	$2,159.00																
				Engineer	0	$0.00																
				Sr.Des	9	$990.00																
				Sr.Mgr.Lic.	0	$0.00																
				Team Ld	0	$0.00																
				Proj.Scient.	0	$0.00																
				Sr.Mgr.	13	$2,340.00																
TASK 13C - Canal Structures Analysis - Existing Hydro Plant					101	$14,840.00		0	$0.00		0	$0.00										$14,840.00
TASK 13D - Canal Structures Analysis - Diversion Dam								0	$0.00		0	$0.00										$0.00
				Prin Cons.	2	$370.00																
TASK 13E - Canal Structures Analysis - Canal Headworks					2	$370.00		0	$0.00		0	$0.00										$370.00
				Prin Cons.	6	$1,110.00				Sr. Assoc.	2	$424.00										
				Sr Engr Cons	3	$534.00																
				Admin	1	$74.00																
				Sr.Engr	5	$690.00																
				Proj Engr	1	$127.00																
				Engineer	0	$0.00																
				Sr.Des	1	$110.00																
				Sr.Mgr.Lic.	0	$0.00																
				Team Ld	0	$0.00																
				Proj.Scient.	0	$0.00																
				Sr Mgr	1	$185.00																
TASK 13F - Canal Structures Analysis - TBD					18	$2,791.00		0	$0.00		2	$424.00										$3,219.00

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
D84201 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage A
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	M&S Title	M&S Hrs.	M&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee	
TASK 14 - Masonry Drainage Tunnel Condition Assessment		0	$0.00		0	$0.00		0	$0.00		0	$0.00										$0.00
TASK 15 - Embankment (Dike) Geotechnical Analyses		0	$0.00		0	$0.00		0	$0.00		0	$0.00										$0.00
	Sr. Hyd. Eng.	45	$8,801.25	Prin.Cons.	45	$8,325.00	Sr. Princ.	2	$460.00	Sr.Assoc.	18	$3,816.00										
	Proj.Mgr.	52	$9,899.00	Sr.Engr.Cons.	1	$168.00	Sr Geo Eng.	8	$560.00	Sr Proj Eng	3	$465.00										
	QA Mgr.	20	$3,706.50				Proj Princ.	2	$420.00													
	QA Rev.	4	$838.68				Proj Mgr	5	$800.00													
TASK 16 - Embankment (Dike) Repair Assessment		121	$22,243.93		46	$8,493.00		13	$2,340.00		21	$4,281.00										$37,259.93
	Const.Rev	0	$0.00																			
	Sr.Land.Arch.	0	$0.00																			
	Land.Arch	0	$0.00																			
	Cost Est.	0	$0.00																			
TASK 17 - Recreational Opportunities Assessment		0	$0.00		0	$0.00																$0.00
	Sr.Trans.Eng.	0	$0.00																			
	Struc.Eng.	0	$0.00																			
TASK 18 - Flood Fighting Access Assessment		0	$0.00		0	$0.00																$0.00
	Sr.Civil Eng	0	$0.00																			
	Sr Land Arch	0	$0.00																			
	Enviro.Assoc.	0	$0.00																			
	GIS Tech.	0	$0.00																			
TASK 19 - Phase I Alternatives Assessment		0	$0.00		0	$0.00	0		$0.00		0	$0.00										$0.00
TASK 20 - Alternate Funding Source Support					0	$0.00																$0.00
	Princ.Mgr	4	$1,250.00	Prin.Cons.	44	$8,140.00	Proj Princ.	19	$2,730.00	Sr. Assoc	70	$14,840.00				Administrator	111	$12,020.74				
	Proj.Mgr.	0	$0.00	Sr Engr.Cons.	9	$1,512.00	Proj.Mgr.	8	$1,280.00	Asstnt	8	$600.00										
	Asst.Proj.Mgr	34	$5,993.52				Consul	7	$385.00													
	QA Mgr.	0	$0.00																			
	QA Rev	0	$0.00																			
	Sr. Hyd.	0	$0.00																			
	Hyd.Eng	0	$0.00																			
	Sr. Civil.	0	$0.00																			
	Enviro.Assoc	0	$0.00																			
	Scoping	0	$0.00																			
	Off.Serv.Mgr.	76	$8,983.20																			
TASK 21 - Project Management and Administration		114	$16,206.72		53	$9,652.00		28	$4,395.00		78	$15,440.00		0	$0.00		111	$12,020.74			$58,500.00	$116,214.46
	Enviro.Assoc.																					
	Scoping																					
	Off.Serv.Mgr.																					
TASK 23 - Phase 2 - Final Design Scoping		0	$0.00		0	$0.00	0		$0.00		0	$0.00		0	$0.00		0	$0.00		0	$0.00	$0.00
TOTALS		2,326	$320,324.03		191	$52,053.00		605	$73,150.00		233	$48,386.00		98	$11,934.85		111	$12,020.74		290	$15,736.92	$58,500.00	$592,105.55

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/3/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage B
CITY OF COLUMBIA

PHASE 1 - Alternatives Analysis- Stage B Services	$	848,080.95
PHASE 2 - Final Design (TBD at end of Phase 1)	$	-
PHASE 3 - Construction Consultation (TBD at end of Phase 1)	$	-
	$	848,080.95

Proposed Method of Payment : PHASE I - COST PLUS NET FEE

Length of Agreement: PHASE 1 8 months

Total Estimated Manhours: PHASE 1 3236 Hrs.

Engineer: Michael Baker International, Inc.

Federal ID No: 25 1226638

Contact Person: Donald R. Green, P.E., Project Manager or locally, Angie Logan, Project Financial Coordinator
(412) 269 6091 (803)-231 4054

Proposal Prepared By: John Walsh, PE - Principal In Charge

SUMMARY OF COSTS - PHASE 1 ALTERNATIVES ANALYSIS

MBI Loaded Labor Cost (Direct Paytroll + Indirect Payroll + Net Fee)	=		$476,146.96
MBI Direct Costs Other Than Payroll	=	$	36,180.00
Subconsultant Loaded Labor Cost (Direct Paytroll + Indirect Payroll + Net Fee)	=		$328,354.00
Subconsultant Direct Costs Other Than Payroll	=	$	7,400.00
ESTIMATED ENGINEERING COST - PHASE 1	=	$	848,080.95

MBI LOADED LABOR RATE MULTIPLIER
PHASE I - ALTERNATIVES ANALYSIS

Loaded Labor Rate Multiplier	=	3.000

We anticipate starting this part of the project on: 01-Aug-16
and completing it by: 31 Mar 17

MBI DIRECT COSTS OTHER THAN PAYROLL
PHASE 1 - ALTERNATIVES ANALYSIS

(a) Travel - Airfare	$4,800.00
Vehicle Rental	$1,080.00
Mileage	$2,000.00
Lodging	$7,200.00
(b) Reproduction	$7,600.00
(c) Public Meeting Related Costs:	$0.00
(d) Misc.	$13,500.00

TOTAL MBI DIRECT COSTS OTHER THAN PAYROLL - PHASE 1	=	$36,180.00

SUBCONSULTANT COSTS (SERVICES BY OTHERS)
PHASE 1 - ALTERNATIVES ANALYSIS

Kleinschmidt Labor:		$0.00	
Hazen & Sawyer Labor:		$287,994.00	
CASE Consulting:		$0.00	
CSS		$0.00	
MA Engineering Consultants:		$0.00	DBE/SBE Total
ESP Associates:		$0.00	$0.00
New South:		$0.00	0.00%
F&ME Labor:		$40,360.00	
Subconsultant Loaded Labor Cost - Phase 1	=	$328,354.00	

Kleinschmidt		$0.00
Hazen & Sawyer:		$7,400.00
MA Engineering Consultants:		$0.00
New South Engineering:		$0.00
F&ME Consultants:		$0.00
Subconsultant Direct Costs Other Than Payroll - Phase 1	=	$7,400.00

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage B
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee
	Sr. Civil	0	$0.00																		
	GIS Tech.	0	$0.00																		
TASK 1 - Emergency Response Documentation Gathering		0	$0.00																		
	Proj.Mgr.	0	$0.00																		
	Sr. Env.Spec.	0	$0.00																		
	Enviro Sp.	0	$0.00																		
	Enviro As.	0	$0.00																		
TASK 2 - Resource Agency Coordination		0	$0.00								0	$0.00									
	Const.Rev.	0	$0.00																		
	Sr. Civil	0	$0.00																		
TASK 3 - Public Relations		0	$0.00								0	$0.00									
	Proj.Mgr.	97	$17,332.75																		
	Asst. Proj.Mgr.	50	$8,814.00																		
	QA Mgr.	50	$9,000.00																		
	QA Rev.	15	$3,107.25																		
	Sr. Hyd.Eng.																				
	Hyd. Eng.																				
	Sr. Civil Eng.	17	$3,030.93																		
	Sr. Enviro.	0	$0.00																		
	Enviro Sp	0	$0.00																		
	Enviro As	36	$3,614 52																		
	Office Serv. Mgr	30	$3,546.00																		
	Scoping	250	$35,677.50																		
TASK 4 - Environmental Documentation		545	$84,322.95																	0	$0.00
	Proj.Mgr.	96	$17,352.00																		
	Asst. Proj.Mgr.	50	$8,814.00																		
	QA Mgr.	50	$9,000.00																		
	QA Rev.	15	$3,107.25																		
	Sr. Hyd.Eng.	22	$4,058.34																		
	Hyd. Eng.	8	$979.44																		
	Sr. Civil	18	$3,209 22																		
	Office Serv. Mgr	34	$4,018.80																		
	Scoping	250	$35,677.50																		
TASK 5 - Project Mapping		549	$85,216.55																		
	Sr. Struc.	0	$0.00																		
	Struc.Eng	0	$0.00																		
	GIS Tech.	0	$0.00																		
TASK 6 - Historic Data		0	$0.00					0	$0.00		0	$0.00									
	Env. Ass.	0	$0.00																		
	GIS Tech.	0	$0.00																		
TASK 7 - Detailed Field Reconnaissance		0	$0.00					0	$0.00		0	$0.00		0	$0.00						
	Env. Ass.	0	$0.00																		
	GIS Tech.	0	$0.00																		
TASK 8 - Existing Dike Condition Assessment		0	$0.00					0	$0.00		0	$0.00									

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage B
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee
TASK 9 - Subsurface Investigation								0	$0.00												
TASK 10 - Hydrologic and Hydraulic (H&H) Analysis		0	$0.00					0	$0.00		0	$0.00									
										VicePres	40	$10,160.00									
										Sr. Assoc	304	$64,448.00									
										Associate	518	$88,578.00									
										Sr.Proj.Eng.	0	$0.00									
										Proj.Eng	470	$58,750.00									
										Proj.Des.	8	$976.00									
										Des.GIS	84	$5,964.00									
										Admin	26	$1,950.00									
TASK 11 - Water Supply Alternatives Assessment - Tier 1								0	$0.00		1,450	$230,826.00									
							Sr. Princ	4	$920.00	VicePres	0	$0.00									
										Sr. Assoc.	0	$0.00									
							Sr.Geo Eng.	16	$2,240.00	Associate	0	$0.00									
							Geologist	80	$6,800.00	Sr.Proj.Eng.	0	$0.00									
							Assoc.Geol.	32	$2,080.00	Proj.Eng.	0	$0.00									
							Proj.Mgr.	16	$2,560.00	Proj.Des.	0	$0.00									
							CADD	72	$5,040.00	Des.GIS	0	$0.00									
										Admin	0	$0.00									
TASK 11 - Water Supply Alternatives Assessment - Tier 2								220	$19,640.00		0	$0.00									
TASK 11 - Water Supply Alternatives ASSESSMENT - Tier 1 and Tier 2								220	$19,640.00		1,450	$230,826.00									
TASK 12 - SECTION OMITTED											0	$0.00									
TASK 13A - Canal Structures Analysis - Criteria Memorandum		0	$0.00	0	$0.00						0	$0.00									
	Principal	15	$4,612.50																		
	Proj. Mgr.	11	$1,988.25																		
	Asst. Proj. Mgr.	27	$4,808.92																		
	QA Mgr.	11	$1,980.00																		
	Sr. Hyd. Eng.	22	$4,058.34																		
	Hyd. Eng.	8	$979.44																		
	Scoping	50	$7,135.50																		
TASK 13B - Canal Structures Analysis - Canal Spillway		144	$25,562.95	0	$0.00		0	0	$0.00		0	$0.00									

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
D04241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage B
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee
TASK 13C - Canal Structures Analysis - Existing Hydro Plant					0	$0.00		0	$0.00		0	$0.00									
TASK 13D - Canal Structures Analysis - Diversion Dam					0	$0.00		0	$0.00		0	$0.00									
TASK 13E - Canal Structures Analysis - Canal Headworks					0	$0.00		0	$0.00		0	$0.00									
TASK 13F - Canal Structures Analysis - TBR					0	$0.00		0	$0.00		0	$0.00									
TASK 13A thru 13F - Canal Structures Analysis					0	$0.00		0	$0.00		0	$0.00									
TASK 14 - Masonry Drainage Tunnel Condition Assessment		0	$0.00		0	$0.00		0	$0.00		0	$0.00									
	Sr. Hyd. Eng.	20	$3,689.40																		
	Scoping	50	$7,135.50																		
TASK 15 - Embankment (Dike) Geotechnical Analyses		70	$10,824.90					0	$0.00		0	$0.00									

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage B
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee
	Struc.Eng.	80	$9,511.20																		
	Sr. Hyd. Eng.	27	$4,980.69																		
	Env. Assoc.	32	$3,256.32																		
	Scoping	74	$10,560.54																		
TASK 16 - Embankment (Dike) Repair Assessment		213	$28,308.75					0	$0.00		0	$0.00									
	Const Rev.	108	$19,362.24																		
	Sr.Land.Arch.	196	$25,519.20																		
	Land.Arch.	204	$18,623.16																		
	Cost Est.	40	$6,000.00																		
TASK 17 - Recreational Opportunities Assessment		548	$69,504.60																		
	Sr.Trans.Eng.	280	$50,794.80																		
	Struc.Eng.	292	$34,715.88																		
TASK 18 - Flood Fighting Access Assessment		572	$85,510.68																		
	Sr.Civil Eng.	16	$2,852.64				Sr. Princ.	16	$3,680.00	Sr. Assoc.	120	$25,440.00									
	Sr.Land.Arch.	64	$8,332.80				Sr Geo Eng.	40	$5,600.00												
	Enviro.Assoc.	64	$6,512.64				Proj.Princ.	24	$5,040.00												
	GIS Tech.	24	$2,762.64				Proj.Mgr.	40	$6,400.00												
TASK 19 - Phase I Alternatives Assessment		168	$20,460.72					120	$20,720.00		120	$25,440.00									
TASK 20 - Alternate Funding Source Support																					
	Princ.Mgr.	11	$3,527.03							Sr. Assoc.	144	$30,528.00									
	Proj.Mgr.	0	$0.00							Admin	16	$1,200.00									
	Asst.Proj Mgr.	95	$16,827.69																		
	QA Mgr.	0	$0.00																		
	QA Rev.	0	$0.00																		
	Sr. Hyd.	0	$0.00																		
	Hyd.Eng.	0	$0.00																		
	Sr. Civil.	0	$0.00																		
	Enviro Assoc.	0	$0.00																		
	Scoping	0	$0.00																		
	Off.Serv.Mgr.	212	$25,015.85																		
TASK 21 - Project Management and Administration		319	$45,370.56					0	$0.00		160	$31,728.00		0	$0.00		0	$0.00			
	Principal	12	$3,690.00																		
	Proj.Mgr.	30	$5,422.50																		
	Asst.Proj.Mgr.	40	$7,051.20																		
	Off.Serv.Mgr.	33	$3,500.60																		
TASK 22 - Phase 2 - Final Design Scoping		115	$20,064.30	0		$0.00		0	$0.00		0	$0.00		0	$0.00		0	$0.00		0	$0.00
TOTALS		3,236	$476,146.96	0		$0.00		340	$40,360.00		280	$287,994.00		0	$0.00		0	$0.00		0	$0.00

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
8/2/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage C
CITY OF COLUMBIA

PHASE 1 - Alternatives Analysis - Stage C	$ 1,448,587.46
PHASE 2 - Final Design (TBD at end of Phase 1)	$ -
PHASE 3 - Construction Consultation (TBD at end of Phase 1)	$ -
	$ 1,448,587.46

Proposed Method of Payment: PHASE I - COST PLUS NET FEE

Length of Agreement: PHASE 1 [8] months

Total Estimated Manhours: PHASE 1 [1578] Hrs.

Engineer: Michael Baker International, Inc.

Federal ID No: 25-1228638

Contact Person: Donald R. Green, P.E., Project Manager or locally, Angie Logan, Project Financial Coordinator
(412) 269-6091 (803) 233-4054

Proposal Prepared By: John Walsh, PE - Principal In Charge

SUMMARY OF COSTS - PHASE 1 ALTERNATIVES ANALYSIS

MBI Loaded Labor Cost (Direct Paytroll + Indirect Payroll + Net Fee)	=	$230,020.57
MBI Direct Costs Other Than Payroll	=	$ 51,629.40
Subconsultant Loaded Labor Cost (Direct Paytroll + Indirect Payroll + Net Fee)	=	$768,535.00
Subconsultant Direct Costs Other Than Payroll	=	$ 398,402.50
ESTIMATED ENGINEERING COST - PHASE 1	=	$ 1,448,587.46

MBI LOADED LABOR RATE MULTIPLIER
PHASE I - ALTERNATIVES ANALYSIS

Loaded Labor Rate Multiplier	=	3.000

We anticipate starting this part of the project on: [1 Aug 16]
and completing it by [15 Apr 17]

MBI DIRECT COSTS OTHER THAN PAYROLL
PHASE 1 - ALTERNATIVES ANALYSIS

(a) Travel Airfare	$2,400.00
Vehicle Rental	$540.00
Mileage	$1,000.00
Lodging	$3,600.00
(b) Reproduction	$11,400.00
(c) Public Meeting Related Costs:	$12,000.00
(d) Miss.	$13,500.00
(e) Crane Rental	$7,189.40

TOTAL MBI DIRECT COSTS OTHER THAN PAYROLL - PHASE 1	=	$51,629.40

SUBCONSULTANT COSTS (SERVICES BY OTHERS)
PHASE 1 - ALTERNATIVES ANALYSIS

Kleinschmidt Labor:		$311,360.00	
Hazen & Sawyer Labor:		$11,500.00	
CASE Consulting:		$0.00	
CSS		$0.00	
MA Engineering Consultants:		$0.00	DBE/SBE Total
ESP Associates:		$0.00	$0.00
New South:		$0.00	0.00%
F&ME Labor:		$445,675.00	
Subconsultant loaded Labor Cost - Phase 1	=	$768,535.00	
Kleinschmidt		$9,799.00	
Hazen & Sawyer:		$0.00	
MA Engineering Consultants:		$0.00	
New South Engineering:		$0.00	
F&ME Consultants:		$388,603.50	
Subconsultant Direct Costs Other Than Payroll - Phase 1	=	$398,402.50	

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
7/8/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage C
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee
	Sr. Civil	0	$0.00																		
	GIS Tech.	0	$0.00																		
TASK 1 - Emergency Response Documentation Gathering		0	$0.00		0	$0.00															-
	Proj.Mgr.	0	$0.00	Prin.Cons.	90	$16,650.00															
	Sr. Env.Spec.	0	$0.00	Sr. Engr. Cons.	5	$840.00															
	Enviro Sp.	0	$0.00	Adm.	9	$666.00															
	Enviro As.	0	$0.00																		
TASK 2 - Resource Agency Coordination		0	$0.00		104	$18,156.00					0	$0.00									
	Const.Rev.	102	$18,286.56							Sr. Assoc.	8	$1,696.00									
	Sr. Civil	32	$5,705.28																		
TASK 3 - Public Relations		134	$23,991.84		0	$0.00					8	$1,696.00									
	Principal	3	$922.50																		
	Proj.Mgr.	55	$9,941.25																		
	Asst.Proj.Mgr.	38	$6,670.44																		
	QA Mgr.	20	$3,600.00																		
	QA Rev.	9	$1,864.35																		
	Sr. Civil	6	$1,069.74																		
	Sr. Enviro.	25	$4,473.21																		
	Enviro.Sp	160	$20,234.77																		
	Enviro.As	126	$12,833.97																		
	GIS Tech.	10	$1,151.10																		
	Office Serv. Mgr	10	$1,182.00																		
	Scoping	50	$7,135.50																		
	Adm.Ast.	19	$1,045.95																		
TASK 4 - Environmental Documentation		531	$72,124.77		0	$0.00														0	$0.00
	Principal	3	$922.50																		
	Proj.Mgr.	55	$9,941.25																		
	Asst.Proj.Mgr.	37.84	$6,670.44																		
	QA Mgr.	20	$3,600.00																		
	QA Rev.	9	$ 1,864.35																		
	Sr. Civil	14	$2,496.06																		
	Env. Ass.	0	$0.00																		
	Util. Coor.	0	$0.00																		
	LiDAR PM	0	$0.00																		
	LiDAR An.	0	$0.00																		
	LiDAR Data	0	$0.00																		
	LiDAR Proc	0	$0.00																		
	GIS Tech.	0	$0.00																		
	Office Serv. Mgr	10	$1,182.00																		
	Scoping	50	$7,135.50																		
TASK 5 - Project Mapping		199	$33,812.10		0	$0.00															
	Sr. Struc.	8	$1,407.12				Sr. Princ.	8	$1,380.00												
	Struc.Eng.	15	$1,783.35				Sr.Geo Eng.	14	$1,960.00												
	GIS Tech.	30	$3,453.30				Proj Princ.	17	$10,320.00												
							Proj.Mgr.	17	$7,920.00												
TASK 6 - Historic Data		53	$6,643.77		0	$0.00		54	$21,580.00		0	$0.00									
	Env. Ass.	15	$1,526.40	Prin.Cons.	6	$1,110.00	Sr. Princ.	35	$8,050.00												
	GIS Tech.	22	$2,532.42	Sr. Engr. Cons.	0	$0.00	Geologist	22	$1,870.00												
				Adm.	0	$0.00	Assoc.Geol.	49	$3,185.00												
				Proj.Eng.	0	$0.00	Proj.Princ.	30	$6,300.00												
							Proj.Mgr.	144	$23,040.00												
							Sr Geo.Tech	119	$9,925.00												
							CADD	44	$3,080.00												
							Clerical	18	$990.00												
TASK 7 - Detailed Field Reconnaissance		37	$4,058.82		8	$1,110.00		461	$55,440.00		0	$0.00		0	$0.00						

MICHAEL BAKER INTERNATIONAL, INC.
TASK/HOURS/FEE BY TITLE
7/8/2016
DR4241 Columbia Canal Embankment Repair Services
Phase I Alternatives Assessment-Stage C
CITY OF COLUMBIA

	MBI Title	MBI Hrs.	MBI Fee	KS Title	KS Hrs.	KS Fee	F&ME Title	F&ME Hrs.	F&ME Fee	H&S Title	H&S Hrs.	H&S Fee	MA Title	MA Hrs.	MA Fee	CASE Title	CASE Hrs.	CASE FEE	New South Title	New South Hrs.	New South Fee
	Env. Ass.	24	$2,442.24	Prin.Cons.	9	$1,665.00	Sr. Princ.	13	$2,990.00	Sr. Assoc.	4	$848.00									
	GIS Tech.	18	$2,071.98	Sr. Engr. Cons.	0	$0.00	Proj Princ.	7	$1,470.00	Associate	4	$684.00									
							Proj.Mgr.	40	$6,400.00	Sr. Proj.Eng.	6	$930.00									
							CADD	13	$910.00	Proj.Eng.	2	$250.00									
										Des.GIS	8	$568.00									
TASK 8 - Existing Dike Condition Assessment		42	$4,514.22		9	$1,665.00		73	$11,770.00		24	$3,250.00									
				Prin.Cons.	41	$7,585.00	Sr. Princ.	26	$5,960.00												
				Sr. Engr. Cons.	0	$0.00	Sr Geo Eng.	152	$21,280.00												
							Geo.Eng.	165	$18,150.00												
							Geo.Train.	13	$975.00												
							Geologist	83	$7,055.00												
							Assoc.Geol.	0	$0.00												
							Proj. Princ.	27	$5,670.00												
							Proj.Mgr.	133	$21,200.00												
							Sr Geo Tech	27	$2,025.00												
							Auger Team	30	$3,900.00												
							Env.Science	29	$3,190.00												
							CADD	54	$3,780.00												
TASK 9 - Subsurface Investigation					41	$7,585.00		739	$93,205.00												
				Prin.Cons.	27	$4,995.00															
TASK 10 - Hydrologic and Hydraulic (H&H) Analysis		0	$0.00		27	$4,995.00					0	$0.00									
TASK 11 - Water Supply Alternatives Assessment - Tier 1					0	$0.00		0	$0.00		0	$0.00									
TASK 11 - Water Supply Alternatives Assessment - Tier 2					0	$0.00		0	$0.00		0	$0.00									
TASK 11 - Water Supply Alternatives ASSESSMENT - Tier 1 and Tier 2					0	$0.00		0	$0.00		0	$0.00									
TASK 12 - SECTION OMITTED					0	$0.00		0	$0.00		0	$0.00									
	Struc.Eng.	112	$13,315.68	Prin.Cons.	18	$3,330.00															
				Sr.Engr.Cons.	5	$840.00															
				Admin	1	$74.00															
TASK 13A - Canal Structures Analysis - Criteria Memorandum		112	$13,315.68		24	$4,244.00					0	$0.00									
	Principal	3	$922.50	Prin.Cons.	57	$10,545.00															
	Proj. Mgr.	5	$903.75	Sr.Engr.Cons.	36	$6,048.00															
	Sr. Hyd.Eng.	28	$5,165.16	Admin	0	$0.00															
	Hyd. Eng.	10	$1,224.30	Sr.Engr.	8	$1,104.00															
	Office Ser.Mgr.	10	$1,182.00	Proj Engr.	180	$22,860.00															
	Scoping	4	$610.80	Engineer	0	$0.00															
				Sr.Des.	40	$4,400.00															
TASK 13B - Canal Structures Analysis - Canal Spillway		60	$10,008.51		321	$44,957.00		0	$0.00		0	$0.00									

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DR4241 Columbia Canal Embankment Repair Services
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CITY OF COLUMBIA

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				Prin.Cons.	84	$15,540.00															
				Sr.Engr.Cons.	141	$23,688.00															
				Admin.	6	$444.00															
				Sr.Engr.	72	$9,936.00															
				Proj.Engr.	234	$27,178.00															
				Engineer	24	$2,736.00															
				Sr.Des.	72	$7,920.00															
				Sr.Mgr.Lic.	29	$5,220.00															
				Team Ld.	48	$7,488.00															
				Proj.Scientc.	52	$6,136.00															
				Sr.Mgr.	0	$0.00															
TASK 13C - Canal Structures Analysis - Existing Hydro Plant		0	$0.00		742	$106,286.00		0	$0.00		0	$0.00									
TASK 13D - Canal Structures Analysis - Diversion Dam								0	$0.00		0	$0.00									
				Prin.Cons.	8	$1,480.00															
TASK 13E - Canal Structures Analysis - Canal Headworks					8	$1,480.00		0	$0.00		0	$0.00									
				Prin.Cons.	51	$9,435.00															
				Sr.Engr.Cons.	70	$11,760.00															
				Admin.	6	$444.00															
				Sr.Engr.	0	$0.00															
				Proj.Engr.	20	$2,540.00															
				Engineer	0	$0.00															
				Sr.Des.	0	$0.00															
				Sr.Mgr.Lic.	0	$0.00															
				Team Ld.	2	$312.00															
				Proj.Scientc.	4	$472.00															
				Sr.Mgr.	0	$0.00															
TASK 13F - Canal Structures Analysis - TBR					153	$24,963.00		0	$0.00		0	$0.00									
TASK 13A thru 13F - Canal Structures Analysis					1,248	$181,930.00		0	$0.00		0	$0.00									
				Prin.Cons.	31	$5,735.00															
				Sr.Engr.Cons.	20	$3,360.00															
				Admin.	1	$74.00															
				Sr.Engr.	0	$0.00															
				Proj.Engr.	32	$4,064.00															
				Engineer	0	$0.00															
				Sr.Des.	16	$1,760.00															
TASK 14 - Masonry Drainage Tunnel Condition Assessment		0	$0.00		100	$14,993.00		0	$0.00		0	$0.00									
	Proj.Mgr.	41	$7,410.75	Prin.Cons.	46	$8,510.00	Sr. Princ.	121	$41,630.00												
	QA Mgr.	26	$4,680.00				Sr.Geo.Eng.	313	$43,820.00												
	Office Services A	4	$472.80				Geo.Train	284	$21,300.00												
							Geologist	14	$1,190.00												
							Proj.Princ.	58	$12,180.00												
							Proj.Mgr.	203	$32,480.00												
							CADD	102	$7,140.00												
TASK 15 - Embankment (Dike) Geotechnical Analyses		71	$12,563.55		46	$8,510.00		1,155	$159,740.00		0	$0.00									

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	Struc.Eng.	80	$9,511.20	Prin.Cons.	46	$8,510.00	Sr. Princ.	37	$8,510.00	Sr.Assoc.	22	$4,664.00									
	Env. Assoc.	0	$0.00				Sr.Geo.Eng.	74	$10,360.00	Sr.Proj.Eng.	12	$1,860.00									
	Proj.Mgr.	40	$7,230.00				Proj Princ.	29	$6,090.00												
	Hyd. Mgr.	26	$4,796.22				Proj.Mgr.	74	$11,840.00												
	Office Services A	4	$472.80																		
TASK 16 - Embankment (Dike) Repair Assessment		150	$22,010.22		46	$8,510.00		214	$36,800.00		34	$6,524.00									
	Const.Rev.	0	$0.00																		
	Sr.Land.Arch.	0	$0.00																		
	Land.Arch.	0	$0.00																		
	Cost Est.	0	$0.00																		
TASK 17 - Recreational Opportunities Assessment		0	$0.00		0	$0.00															
	Sr.Trans.Eng.	0	$0.00																		
	Struc.Eng.	0	$0.00																		
TASK 18 - Flood Fighting Access Assessment		0	$0.00		0	$0.00															
	Sr.Civil Eng.	0	$0.00	Prin.Cons.	46	$8,510.00															
	Sr.Land.Arch.	0	$0.00	Sr.Engr.Cons.	22	$3,696.00															
	Enviro.Assoc	0	$0.00																		
	GIS Tech.	0	$0.00																		
TASK 19 - Phase I Alternatives Assessment		0	$0.00		68	$12,206.00		0	$0.00		0	$0.00									
TASK 20 - Alternate Funding Source Support					0	$0.00															
	Princ.Mgr.	7	$2,097.15	Prin.Cons.	144	$26,640.00	Proj.Princ.	108	$22,680.00												
	Proj.Mgr.	0	$0.00	Sr.Engr.Cons	36	$6,048.00	Proj.Mgr.	216	$34,560.00												
	Asst.Proj.Mgr.	57	$10,005.65	Admin.	6	$444.00	Clerical	180	$9,900.00												
	QA Mgr.	0	$0.00																		
	QA Rev.	0	$0.00																		
	Sr. Hyd.	0	$0.00																		
	Hyd.Eng.	0	$0.00																		
	Sr. Civil.	0	$0.00																		
	Enviro.Assoc.	0	$0.00																		
	Scoping	0	$0.00																		
	Off.Serv.Mgr.	126	$14,874.29																		
TASK 21 - Project Management and Administration		189	$26,977.09		186	$33,132.00		504	$67,140.00		0	$0.00		0	$0.00		0	$0.00			
				Prin.Cons.	66	$12,580.00															
	Enviro.Assoc.			Sr.Engr Cons.	33	$5,544.00															
	Scoping			Admin.	6	$444.00															
	Off.Serv.Mgr.																				
TASK 22 - Phase 2 - Final Design Scoping		0	$0.00		107	$18,568.00		0	$0.00		0	$0.00		0	$0.00		0	$0.00		0	$0.00
TOTALS		1,578	$230,020.57		1,988	$312,360.00		3,200	$445,675.00		66	$11,500.00		0	$0.00		0	$0.00		0	$0.00

Michael Baker International, Inc. (MBI)
8/2/2016

ESTIMATED COSTS

The estimated costs included herein are based on the Scope of Services.

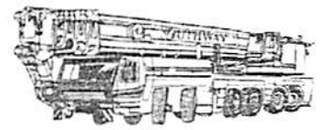
BURDENED LABOR COSTS (Direct + Indirect Payroll + Net Fee)

List of Anticipated MBI Project Employees:

	Labor Classification	Average Burdened Wage Rate	Wage Rate Multiplier	Average Direct Hourly Rate
1	Principal	$ 307.50	3.000	$ 102.50
2	Project Manager	$ 180.75	3.000	$ 60.25
3	Assistant Project Manager	$ 176.28	3.000	$ 58.76
4	QA Manager	$ 185.34	3.000	$ 61.78
5	QA Reviewer	$ 209.52	3.000	$ 69.84
6	Constructability Reviewer	$ 179.28	3.000	59.76
7	Funding Agency Advisor	$ 156.90	3.000	$ 52.30
8	Sr. Transporation Engineer	$ 181.41	3.000	$ 60.47
11	Sr. Structural Engineer	$ 175.89	3.000	$ 58.63
12	Structural Engineer	$ 118.89	3.000	$ 39.63
14	Sr. Hydraulics Engineer	$ 184.47	3.000	$ 61.49
15	Hydraulic Engineer	$ 122.43	3.000	$ 40.81
16	Hydraulics Associate	$ 76.71	3.000	$ 25.57
17	Sr. Civil Engineer	$ 178.29	3.000	$ 59.43
18	Sr. Landscape Architect	$ 130.20	3.000	$ 43.40
19	Landscape Associate	$ 91.29	3.000	$ 30.43
20	Sr. Environmental Specialist	$ 182.58	3.000	$ 60.86
21	Environmental Specialist	$ 126.27	3.000	$ 42.09
22	Environmental Associate	$ 101.76	3.000	$ 33.92
23	Utility Coordinator	$ 84.51	3.000	$ 28.17
28	LiDAR Manager	$ 172.44	3.000	$ 57.48
29	LiDAR Project Manager	$ 150.00	3.000	$ 50.00
30	LiDAR Analyst	$ 101.70	3.000	$ 33.90
31	LiDAR Data Processing Analyst	$ 81.57	3.000	$ 27.19
32	LiDar Processing Technician	$ 66.30	3.000	$ 22.10
32	GIS Technician	$ 115.11	3.000	$ 38.37
33	Office Services Manager	$ 118.20	3.000	$ 39.40
34	Administrative Assistant	$ 55.05	3.000	$ 18.35
35	Sr. Geotechnical Engineer	$ 147.69	3.000	$ 49.23
36	Cost Estimator	$ 150.00	3.000	$ 50.00
36	Scoping	$ 142.71	3.000	$ 47.57

SOUTHWAY CRANE & RIGGING

P O Box 2109
Lexington, S.C. 29071
Phone (803) 957-3222
Fax (803) 957-3211



225 Twin Hills Rd
N.Augusta, SC 29860
Phone (803) 279-5252
Fax (803) 279-0993

June 6, 2016

Michael Baker International
700 Huger St.
Columbia, SC 29201

Attn: Mr. Michael Baker

E-mail: mleath@mbakerintl.com

"Ask About Our 75 Ton"
TRILIFTER

Ref: *REVISED* Set boat in canal, Columbia, SC; Contact: Phil Busby (803) 318-8275

Dear Mr. Baker,

We at Southway Crane & Rigging are pleased to offer the following quote for your consideration:

75 Ton Hydraulic Truck Crane

Hourly Rate (6 hour minimum per day)		$ 195.00 per hour
Operator Overtime	+	$ 35.00 per hour
Operator Overtime (Sundays & Holidays)	+	$ 45.00 per hour
Travel: Port to Port		
Fuel Surcharge		3% of Total Invoice

Note: at 80' Radius crane is good for 8,000 lbs.

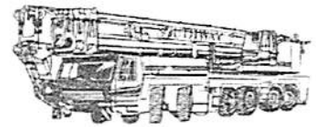
90 Ton Hydraulic Truck Crane

Hourly Rate (8 hour minimum per day)		$ 235.00 per hour
Crew Overtime	+	$ 70.00 per hour
Premium Crew Overtime (Sundays & Holidays)	+	$ 90.00 per hour
Counterweight Freight in		$ 450.00
Counterweight Freight out		$ 450.00
Fuel Surcharge		3% of Total Invoice

Note: at 96' Radius crane is good for 8,200 lbs.

SOUTHWAY CRANE & RIGGING

P O Box 2109
Lexington, S.C. 29071
Phone (803) 957-3222
Fax (803) 957-3211



225 Twin Hills Rd
N.Augusta, SC 29860
Phone (803) 279-5252
Fax (803) 279-0993

110 Ton Hydraulic Truck Crane

Quoted price based on (2) 10 hour days.

Hourly Rate (2/ 10 hour days) at $290.00 per hour	$ 5,800.00
Crew Overtime (2 hours each day) at $ 70.00 per hour	$ 280.00
Counterweight Freight in	$ 450.00
Counterweight Freight out	$ 450.00
Fuel Surcharge (3% of Total Invoice)	$ 209.40
Estimated Quote Total	$ 7,189.40

Note: at 111' Radius crane is good for 7,500 lbs. The boat weighs 6,000 lbs. per customer.

Quote based on availability

Mr. Baker, we appreciate this opportunity and look forward to working with you soon. If you have any questions, please call me.

Best regards,
Larry Chubbuck
Larry@southwaycrane.com
Cell: 803-605-5132

Exhibit C, Sub consultant/Subcontractor Business Information

EXHIBIT C – SUBCONSULTANT/SUBCONTRACTOR BUSINESS INFORMATION

Project: DR 4241 Columbia Canal Embankment Repair Services

The Bidder shall list all subcontractors and vendors, who will be providing subcontracting services, furnishings materials, etc. for this project. The list shall be submitted in the format provided below. Any proposed changes from the list shall be submitted in writing to the Owner prior to initiation of any action, with the reason for the proposed changes.

L= Labor D= Directs

Business Name/ Address	Contact Name Telephone	Services/Materials to be Provided	Cost of Service/Mat ($ Value)
Hazen and Sawyer 1122 Lady Street Suite 1230 Columbia, SC 29201 DUNS: 064966138 CAGE: 1CRV1	Bill Orne, Jr., P.E. (803) 779-0001	Water Supply/H&H Modeling; Spillway/Dike Repair Design; Construction Contract Administration; Environmental Science/Natural Resources	L $639,844.00 D $15,700.00
Kleinschmidt Associates 204 Caughman Farm Lane Suite 301 Lexington, SC 29072 DUNS: 067051037 CAGE: 3CHW0	Bill Remington, P.E. (803) 462-5620, Ext. 505	FERC Coordination; Locks/Gates Design; Construction Contract Administration	L $406,632.00 D $12,746.00
F&ME Consultants, Inc. 3112 Devine Street, #B Columbia, SC 29205 DUNS: 043692631 CAGE: 7EXW6	Shawn Epps, P.E. (803) 254-4540	Geotechnical Design	L $617,920.00 D $428,169.50
CASE Consulting Inc. (MBE Firm) 840 Shull Street Suite 210 West Columbia, SC 29169 DUNS: 167788608 CAGE: 4HDC8	Calvin Wise (803) 926-1600	Construction Administration Support Services	L $37,564.80
Construction Support Services (MBE Firm) 1318 R L Coward Road Hopkins, SC 29061 DUNS: 146508721 CAGE: 5ELB4	Jay Joshi, P.L.S. (803) 776-9909	Land Surveying Services	L $32,000.00

MA Engineering Consultants, Inc. (DBE) 598 E. Chatham Street Suite 137 Cary, NC 27511 DUNS: 825377575 CAGE: 1WVN4	Matt Elious (877) 623-2123	Geospatial/GIS/ Photogrammetry	L $11,934.86 D $15,317.50
ESP Associates, P.A. (DBE) 5455 W. Waters Avenue Tampa, FL 33634 DUNS: 362258592 CAGE: 1TYE0	Jesse J. Price (813) 295-9024	Bathymetric Survey	L $38,500.00
New South Engineering (DBE) 722-A South Blanding Street Columbia, SC 29201 DUNS:197533573 CAGE: 0K629	Mary Beth Reed (803) 771-7083	Historic Context Study	L $15,736.92 D $ 1,966.00

TOTAL: $ 2,274,031.58

Michael Baker International, Inc.
Consultant DUNS: 079900161 CAGE: 7EZ77

08/08/2016
Date

By _____
John V. Walsh, P.E., Vice President
I certify this information is true and correct.

Rev Purchasing Div_08 08 13

Exhibit D, Small Minority, Women-Owned Business Objectives –

(Including Labor Surplus Utilization Plan)

DR4241 Columbia Canal Embankment Repair Services

EXHIBIT D

SMALL, MINORITY, WOMEN-OWNED BUSINESS OBJECTIVES

INCLUDING LABOR SURPLUS UTILIZATION PLAN

INSTRUCTIONS: This form must be submitted with any bid, proposal, or proposed negotiated contract or within a reasonable time thereafter, but prior to contract award. This Utilization Plan must contain a detailed description of the supplies and/or services to be provided by each certified Small, Minority and Women-owned Business Enterprise (SMWBE) under the contract. This form includes federally required Labor Surplus Utilization efforts. Attach additional sheets if necessary.

If you are a SBE, MBE WBE, or other type of disadvantaged business enterprise, please check one of the following boxes:

SBE ☐ MBE ☐ WBE ☐ Other _____

1. In the spaces below, report the anticipated dollars that you intend to subcontract to each business type if a contract or agreement is awarded to your firm. (If you do not intend to subcontract any work to others, even if you are a S/M/WBE, put zeros in the spaces below).

   Total **SBE Participation Percentage** to be subcontracted ___2_____%

   Total **MBE Participation Percentage** to be subcontracted ___0_____%

   Total **WBE Participation Percentage** to be subcontracted ___1_____%

   Total **Other DBE Participation Percentage** to be subcontracted__0____%

2. If you are not a SBE, MBE, or WBE and you do not plan to utilize such firms in this agreement, please state your reasons and use an additional page if needed:

_____

_____

_____

_____

LABOR SURPLUS UTILIZATION PLAN

In accordance with federal requirements, the City also encourages the use of firms located in labor Surplus areas. A Labor Surplus area is an area designated by the Secretary of Labor as having concentrated unemployment or underemployment in comparison with other areas. Used as one of the criteria for designating economically disadvantaged vendors/suppliers. **If your business is located in a labor surplus area, please check here:** ☐

Define the LSA here_____

The City anticipates that this effort will be continued to the maximum extent practicable throughout the life of the contract or agreement. Any changes or modification to the contract/ agreement will include, at a minimum the same proposed goals included in the negotiated agreement/contract.

The goals provided by the Successful Offeror shall be incorporated into the final contractual agreement between the parties or as amended through final contract negotiations.

By submitting this Exhibit, the respondent certifies he/she is an authorized representative of the company, understands and will comply with all requirements herein in any awarded action.

John V. Walsh

_____ 8/2/2016

Signature **Date**

John V. Walsh, P.E. Vice President Michael Baker International, Inc.

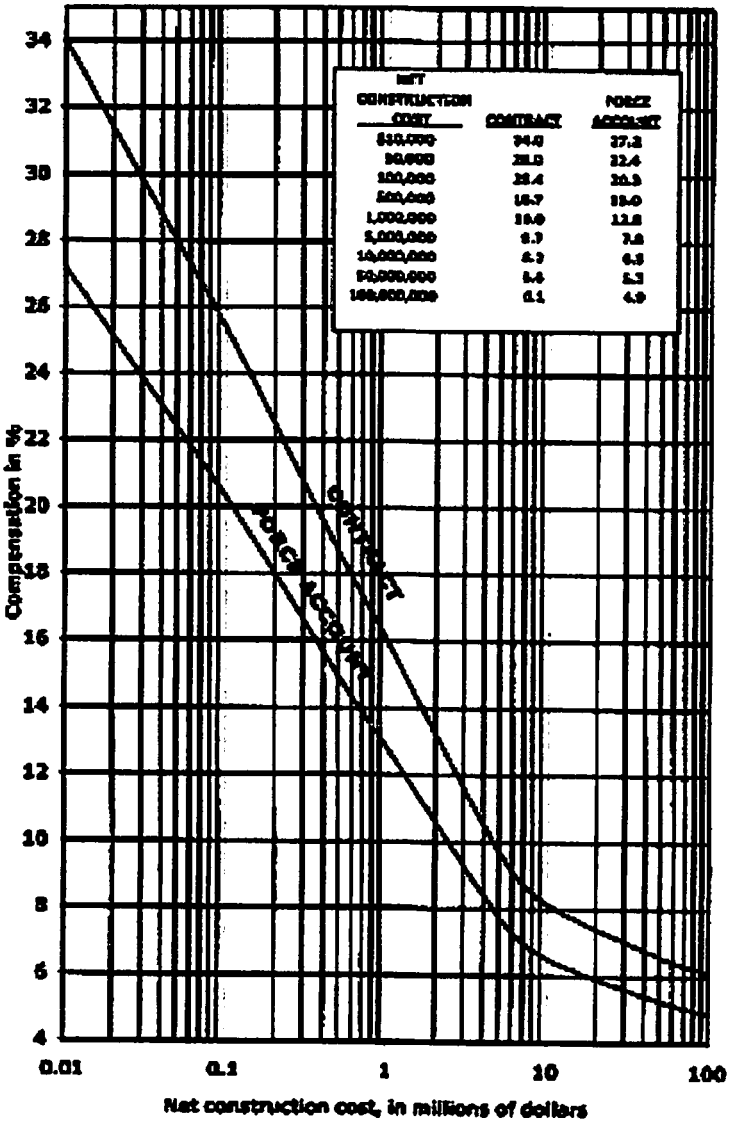
(Print Name) **Business Name**

Exhibit E, Engineering and Design Services of Above Average Complexity (FEMA CURVE)

DR4241 Columbia Canal Embankment Repair Services

Exhibit E
Engineering and Design Services of Above-Average Complexity

CURVE A. COMPENSATION FOR BASIC SERVICES EXPRESSED AS A PERCENTAGE OF CONSTRUCTION COST FOR PROJECTS OF ABOVE-AVERAGE COMPLEXITY AND NON-STANDARD DESIGN



NOTE: "Contract" and "Force Account" above mean engineering and design services performed by contract or by an applicant's own employees, respectively.

Scope of Services –
Phase 1 – Canal Embankment Assessment

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INTRODUCTION

A. Project Overview

At the request of the City of Columbia, Michael Baker International, Inc. (MBI), herein referred to as the **CONSULTANT**, has been requested to provide engineering services for the Columbia Canal Embankment Repair Services (Columbia Canal Restoration) project for the City of Columbia, herein referred to as the **CITY**.

The **CITY** owns and operates the Columbia Canal and the 10 MW Hydroelectric facility in Columbia, SC. The Columbia Hydroelectric Project consists of a power canal that was expanded and its headworks structure and diversion dam constructed circa 1890, with the existing hydroelectric powerhouse constructed in 1896. The Canal extends approximately 3.2 miles in a southward direction from the diversion dam (approximately 0.75 miles upstream of the US 176 Broad River Road Bridge) to the Columbia Hydroelectric Plant located adjacent to the Gervais Street Bridge. The canal source is the Broad River fed by the diversion dam and headworks structure. The canal is used for generation of hydroelectric power, water supply to the **CITY**'s water treatment plant, and recreational purposes. Under normal operating conditions the hydroelectric turbines discharge up to 6,000 cubic feet per second (cfs) of flow; and the water treatment plant withdraws up to 50 MGD.

General canal construction consists of an earthen dike structure with paved pedestrian walking path at the top of the dike with a grassed shoulder east of the dike and rip-rap (1- to 3-foot diameter) extending down the embankment of the dike into the canal. Exact canal dimensions (i.e. depth, crest width, base width) vary along the length of the dike; however, estimated widths and depths range from approximately 100 to 250 feet in width at the base, and approximately 10 to 20 feet in depth, crest to base. Elevation at the dike crest ranges from approximate 153.8 to 169.3 feet (NGVD 29 datum).

In early October 2015, a historic flooding event took place in South Carolina. Parts of Columbia experienced rainfall that exceeded once in a thousand year levels. Almost two feet of rainfall fell in less than 48 hours. Rainfall caused historic flooding and unprecedented damages to the **CITY**. During the October 4, 2015 storm event, high tailwater levels resulted in the flooding of the powerhouse, and high water levels in the canal caused an overtopping failure of part of the canal dike. During the storm the impoundment upstream of the canal headworks reached elevation 163.5 with a river flow estimated to be between the 10-year and 50-year floods while the water level in the canal exceeded elevation 156 overtopping powerhouse structures and causing a failure of a portion of the canal dike upstream of the powerhouse. As a result of the overtopping, approximately 900 feet of the Canal embankment was damaged including a complete breach of approximately 150 feet width. A post-flood assessment found that a number of gates at the headworks structure were either jammed in the partially closed position or impeded from closing by large trees accumulated beneath the gates. A number of gates were reported to be "closed", but it was determined that large flows were passing beneath the gates as a result of deteriorated or missing gate sills. Currently steel bulkheads have been temporarily installed on the upstream side of each of the headgates to mitigate the deteriorated condition of the headgates and reduce flow into the canal.

B. Purpose

The **CONSULTANT** is providing an integrated Scope of Services for engineering services to complete an assessment and design to restore the Columbia Canal to a safe and reliable working order in accordance with the **CITY'** Request for Qualifications ENGRFQ0004-15-16 dated March 4, 2016, and scoping meetings with the **CITY** that were conducted on April 28, May 5, May 24, June 9, June 23, and July 28, 2016.

The **CONSULTANT** understands that Kleinschmidt (also a member of the **CONSULTANT**'s team) and Chao & Associates (Kleinschmidt-Chao) have been engaged by the **CITY** to analyze and design remediation to the headworks structure for the construction of measures that will allow the headgates to be closed to prevent the uncontrolled release of flow into the canal. The **CONSULTANT** understands that Kleinschmidt-Chao will assess and address the stability of the headworks structure; design replacements for the headgates and operators; design trash racks and a trash rake and debris handling system; and design a replacement lock gate.

In support of the **CONSULTANT**'s development of a coordinated restoration plan for the canal and associated structures, **CONSULTANT** will contact and coordinate with Kleinschmidt-Chao to obtain construction cost information for the **CONSULTANT**'s use and inclusion in the Phase 1 Canal Embankment Assessment and Phase 1 Alternatives Analysis (Task 19).

To clarify the division of work responsibility between the **CONSULTANT** and Kleinschmidt-Chao engineering service agreements, the following key points are presented with regard to work that will be completed at and adjacent to the headworks structure.

- Structural repair at the headworks structure (and vehicular bridge that spans overtop) will be completed under the Kleinschmidt-Chao primary engineering services agreement with the **CITY**;
- Test borings drilled at the headworks structure by F&ME, also a member of the **CONSULTANT**'s team, are associated with the work of Kleinschmidt-Chao and are not part of the work of the **CONSULTANT**;
- Embankment dike repair design activity will be completed under the **CONSULTANT** engineering services agreement with the **CITY**. Embankment dikes are defined as the structures that extend along the canal and including the existing embankment dam on the east side of the headworks structure; and
- Assessment of the diversion dam is to be performed by the **CONSULTANT**.

Based on the discussion at the scoping meeting(s), it was mutually agreed to complete the requested engineering services in the following three (3) phases. This Proposal only addresses work of Phase 1 - Canal Embankment Assessment. Work for Phases 2 and 3 will be addressed at a future date based on the outcome of the Phase 1 work. Phase 1 has been subdivided into three (3) stages, two (2) separate design reaches, and multiple Tasks as described in the Scope of Services below. In addition, Phase 1 has been further subdivided into Basic Services and Additional Services, to facilitate tracking of engineering cost to perform the Work. The intent of Phase 1 work is to focus effort on Stage A base flood damage repair that is directly related to structures and facilities that were damaged during the October 2015 flooding (as described below), address supplemental **CITY**-requested services on a reach-by-reach and Task-by-Task basis identified in Stages B and C, and acquire reconnaissance data to make a general delineation and characterization of probable flood-damaged areas within Reach 2. Basic Services and Additional Services are described in the following Scope of Work. Basic Services pertain to a portion of the work completed

in Stage A, as indicated in the following scope of services. All of Stage B and Stage C work is considered Additional Services. In addition, the Scope of Services for Tasks 10 and 11 have been further broken down into two distinct tiers of effort based on simplified design assumptions to deliver base repair services (Tier 1) and more refined assumptions to deliver more in depth repair services that will provide a higher level of flood resiliency confidence (Tier 2). The location and limits of the two design reaches is described below in the Introduction Paragraph C. During the course of the work, the **CONSULTANT** and **CITY** will assess the results of each Task as they are completed to determine when and where any scope adjustments are required; and the **CITY** reserves the right to add, modify or delete any tasks based on available funding sources to implement corrective action to mitigate flood damage and/or make any other preferred enhancements. Any modification to the Scope of Services will be mutually agreed to by both the **CITY** and **CONSULTANT** and documented as the work progresses.

- Phase 1 Canal Embankment Assessment
    - Stage A: Base Flood Damage Repair Services
        - Reach 1
        - Reach 2
    - Stage B: Supplemental **CITY**' Requested Services
        - Reach 1
        - Reach 2
    - Stage C: Supplemental Flood Resiliency Enhancement Services
        - Reach 1
        - Reach 2
- Phase 2 Final Design
- Phase 3 Construction

Base Flood Repair Services for Reach 1 are defined as those services required to support activities captured under existing Project Workbook (PW) agreements that are in place as of June 24, 2016 between the **CITY** and FEMA to repair flood damage and restore the Columbia Canal to pre-flood conditions. The FEMA' PW Scope of Services provides for repair of flood damage that occurred between October 1 and October 23, 2015 due to overtopping of the dike near the downstream end of the approximate 3.1 mile long canal dike, and which generally includes the following.

- Repair of the dike breach, just north of the Broad River Bridge, that was about 100 feet long x 85 feet wide by 50 feet deep, involving approximately 15,740 cubic yards of fill that was lost downstream into the Broad River.
- Repair of a second breach that was about 205 feet long x 65 feet wide x 50 feet deep, involving approximately 24,675 cubic yards of fill that was washed downstream into the canal.
- Repair of mechanical and physical damage to the canal spillway.
- Repair of mechanical and physical damage to the gates at the diversion dam (headworks), to be performed by others under separate contract with the **CITY**.
- Decommission of a Temporary Emergency Dam (cofferdam) that was erected during the flooding event across the canal to stop outflow from the canal and resupply water to water intakes for the **CITY**' water works.
- Hazard mitigation against future flood-borne damage to the Columbia Canal by utilizing approximately 3,952 cubic yards of the Temporary Emergency Dam (riprap and various stone) to

armor select truck-accessible portions of the remaining canal embankment (dike).

At this time, there are no Stage A Base Flood Repair Services planned for Reach 2, other than repair of the canal spillway and headworks gates and possible riprap/stone placement at discreet truck-accessible locations.

To make the Scope of Services clear with regard to the applicable Stage (A, B and/or C), Tier (1 or 2) and Reach (1 and/or 2), footnotes have been added in the Task descriptions presented below, which correspond to the breakdown of estimated Labor Costs and Direct Costs Other Than Payroll that is presented in the separate Price Proposal.

The design intent is to evaluate conceptual alternatives during the Phase 1 Canal Embankment Assessment, and reach consensus on a common vision with vested partners, regulatory agencies and the **CITY** of the extent and level of repair to be performed in order to restore the Columbia Canal to a safe and reliable condition based on a benefit-cost assessment, within the realm of available funding sources. Near the end of the Phase 1 Canal Embankment Assessment, a detailed Scope of Services for Phase 2 Final Design and Phase 3 Construction will be prepared for review and acceptance by the **CITY**, after which a contract amendment will be executed.

Based on the scoping meetings with the **CITY**, it was agreed that the Scope of Services for the Phase 1 Canal Embankment Assessment will embody the following key considerations/objectives and options, from which a preferred alternative will be recommended with supporting documentation and rationale.

Key Considerations/Objectives	Option				
	1	2	3	4	5
Columbia Canal Embankment (Dike) Repair					
- High Hazard Potential	X			X	
- Significant (current) Hazard Potential		X	X		X
Electrical Generation					
- Restore Hydroelectric Power Plant	X	X		X	X
- Decommission Hydroelectric Power Plant			X		
Water Intake Source					
- Canal	X			X	
- Canal with Distribution Backup (raw water supply intake from Broad River or Saluda River; or finished water supply from Lake Murray)		X	X		X
Recreational Opportunities					
- Pedestrian	X	X	X	X	X
- Fishing	X	X	X	X	X
- Parks	X	X	X	X	X
- River Access				X	X
Flood-Fighting Deployment					
- Connectivity		X	X	X	X
- Emergency Access	X	X	X	X	X
- Usage/Parking				X	X

Figure 1-1- Key Considerations/Objectives

C. Project Limits and Delineation

Based on discussion at the Scoping meetings described above, the project limits for the restoration of the Columbia Canal have been established as extending from the upstream side of the diversion dam and headworks structure and the downstream side of the Gervais Street bridge crossing, and along the existing canal and right embankment (dike); all within CITY' property. For discussion purpose in the following Scope of Services, the Project is generally delineated into two (2) contiguous reaches. The two contiguous reaches share a common limit that is located at the downstream exposed edge of the prison hydroelectric plant remains, and which is located approximately 100 feet upstream of the center of the Jarvis Klapman Boulevard Bridge. For discussion purpose, these two contiguous reaches are referred to as the following.

- Reach 1: downstream reach that is captured within the repair reach under the USACE Emergency Permit; and which generally includes the existing Gervais Street Bridge (overhead), existing hydroelectric plant, the existing complete and partial dike breaches, temporary cofferdam, Jarvis Klapman Boulevard Bridge (overhead), aerial fiber optic line crossing (over the canal), steam tunnel (within the Jarvis Klapman Boulevard approach embankment near the left canal bank), and dike between the former prison hydroelectric plant and the existing hydroelectric plant.
- Reach 2: upstream reach, which generally includes the former prison hydroelectric plant remains, former water treatment plant intake, existing canal spillway and access bridge, pedestrian access bridge over the canal, former water pumping plant, drainage tunnel (under the canal), water treatment plant intake, Elmwood Avenue Bridges (I-126 eastbound and westbound bridges) and adjacent railroad bridge (both overhead), Broad River Bridge (overhead), dike between the former prison hydroelectric plant and the canal headworks, diversion dam, canal headworks and former lock structure, and the headworks embankment dam.

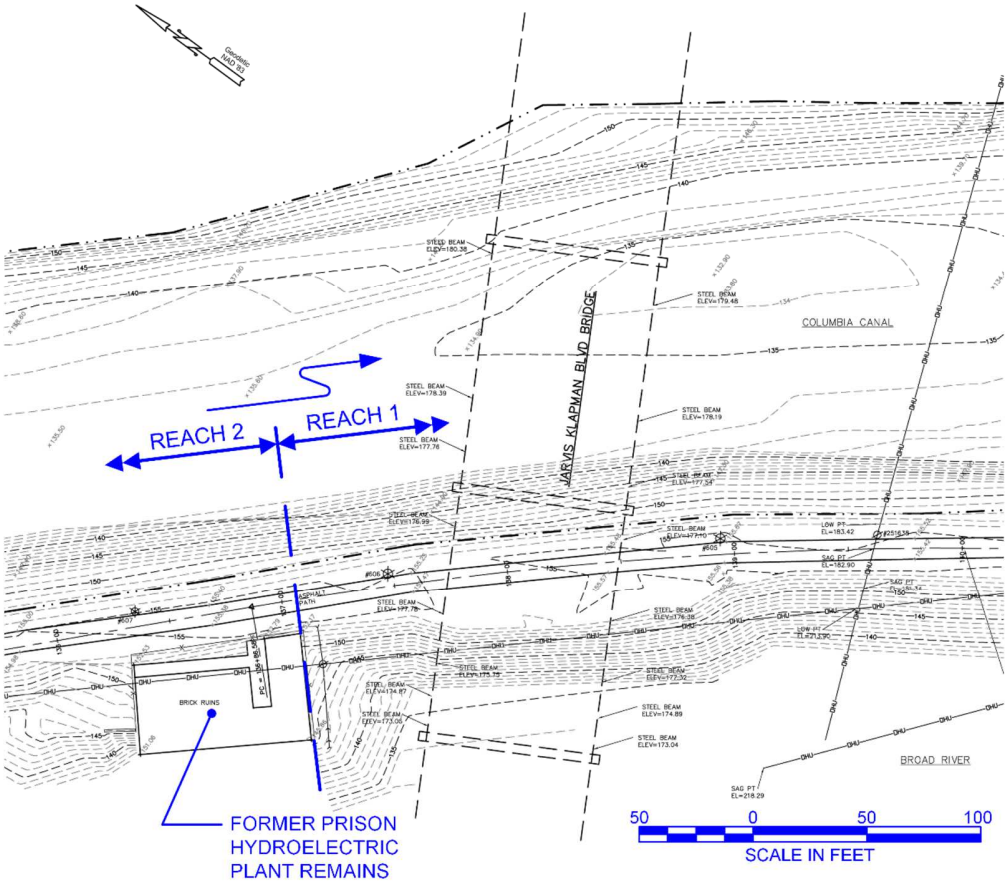

Figure 1-2- Transition Point from Reach 1 to Reach 2

D. Summary of Work

Page No.

E. Clarifications and Assumptions for Proposal Preparation Purpose

*Several clarifications and/or **assumptions** have been made in the following Scope of Services for proposal preparation purposes. In general, these statements are identified in **italic font** to make these statements stand-out in the Scope of Services presented herein.*

F. FEMA/HUD Funding Sensitivity

The **CONSULTANT** is sensitive to the **CITY**'s need to complete the work by capitalizing on available funding sources and grants. These include, but are not limited to, maximizing Federal Emergency Management Agency (FEMA) and Housing and Urban Development (HUD) disaster recovery funding for both the October 2015 flood and possible future events. A decision-tree style metric will be used throughout the Alternatives Assessment development to maintain cognizance of possible funding impacts for conclusions/recommendations/decisions made.

G. Deliverables

All Deliverables will be presented in a form that is suitable for submittal to review agencies.

1. Criteria

All Tasks and deliverables completed, where applicable, will conform to FERC' requirements for a high hazard project; and will provide the basis for subsequent permitting by the United States Army Corps of Engineers (USACE) for work in the waters of the United States. FEMA is a funding agency for the project; and hence all work performed will also be required to satisfy FEMA requirements for design and construction.

2. Data Reports (DRs) and Technical Basis Reports (TBRs)

Completion of Tasks 4 through 11, and Tasks 13 through 18 will culminate in preparation of either a Data Report (DR) or a Technical Basis Report (TBR) as deliverables. In general, DRs will consolidate and present source documents and raw data obtained in a comprehensive organized manner for future reference; and TBRs will present the results of engineering analyses and assessments performed, engineering considerations evaluated, and conclusions/recommendations made to develop dike/spillway/gate repair strategies, enhance hazard mitigation (e.g. select armoring to improve overtopping/scour resiliency), and evaluate Phase 1 alternatives.

3. Preliminary Engineering Report (PER): Phase 1 Alternatives Analysis

At the end of the Phase 1 Alternatives Analysis, the **CONSULTANT** will prepare and submit a Preliminary Engineering Report (PER) to present Task 19 findings, conclusions and recommendations for review and approval by the **CITY**. DR's and TBR's from the Phase 1 Alternatives Analysis will be cross-referenced and appended to the PER to formalize the Phase 1 Alternatives Analysis documentation.

4. Deliverable Submission(s) in Electronic Format

*For proposal preparation purpose, it is understood that all Deliverables (e.g. TBRs) will be made using standardized electronic format; except for delivery of a permanent record in hard-copy format after **CITY**' approval of the final PER for Phase 1 Alternatives Analysis (Task 19).*

Electronic submission of Deliverables will be made on a solid-state portable "stick type" drive. All documents will be submitted in Adobe Portable Document Format (PDF). In general, documents will be saved from the original software application (e.g. MSWord, Excel, AutoCAD), where possible, at a minimum 600 dots per inch (DPI). Image documents (e.g. TIF, JPG, etc.) and letters/documents from outside sources, will be scanned into .PDF format, at a minimum of 600 DPI. Where possible, searchable PDF documents will be furnished; and drawings will be furnished in PDF format at full-size of the original drawing sets, using visual bar scales. The **CONSULTANT** will provide sample electronic deliverables, with standardized file-naming convention, for review and acceptance by the **CITY**.

5. Final Deliverable Submission in Hard-Copy Format

After **CITY**' approval of the final Phase 1 PER for Phase 1 Alternatives Analysis (Task 19), three (3) multi-volume bound hard-copies of the Phase 1 PER will be submitted to the **CITY**. *For proposal preparation purpose, it has been assumed that no other paper copies of Deliverables will be*

required, other than documents required at Public Information Meetings, Focus Group Sessions, and resource agency coordination meetings as indicated in Tasks 2 and 3.

6. Electronic Deliverable for Permanent Record (end of Phase 1 Services)

At completion of Phase 1 services, all supporting documents for the PER for Phase 1 Alternatives Analysis will be delivered to the **CITY** on a portable hard drive for the permanent record, including AutoCAD files for base plans and Plan Overlays that were prepared for the Phase 1 Alternatives Analysis.

H. <u>Schedule</u>

The **CONSULTANT** anticipates performing the Phase 1 Canal Embankment Assessment within eight *(8) months* from the date of Notice to Proceed based on the current understanding of work. The actual duration required is dependent on the extent of Stage C that are required, and the CONSULTANT will work with the CITY to maximize work effectiveness and strive to reduce possible work delays.

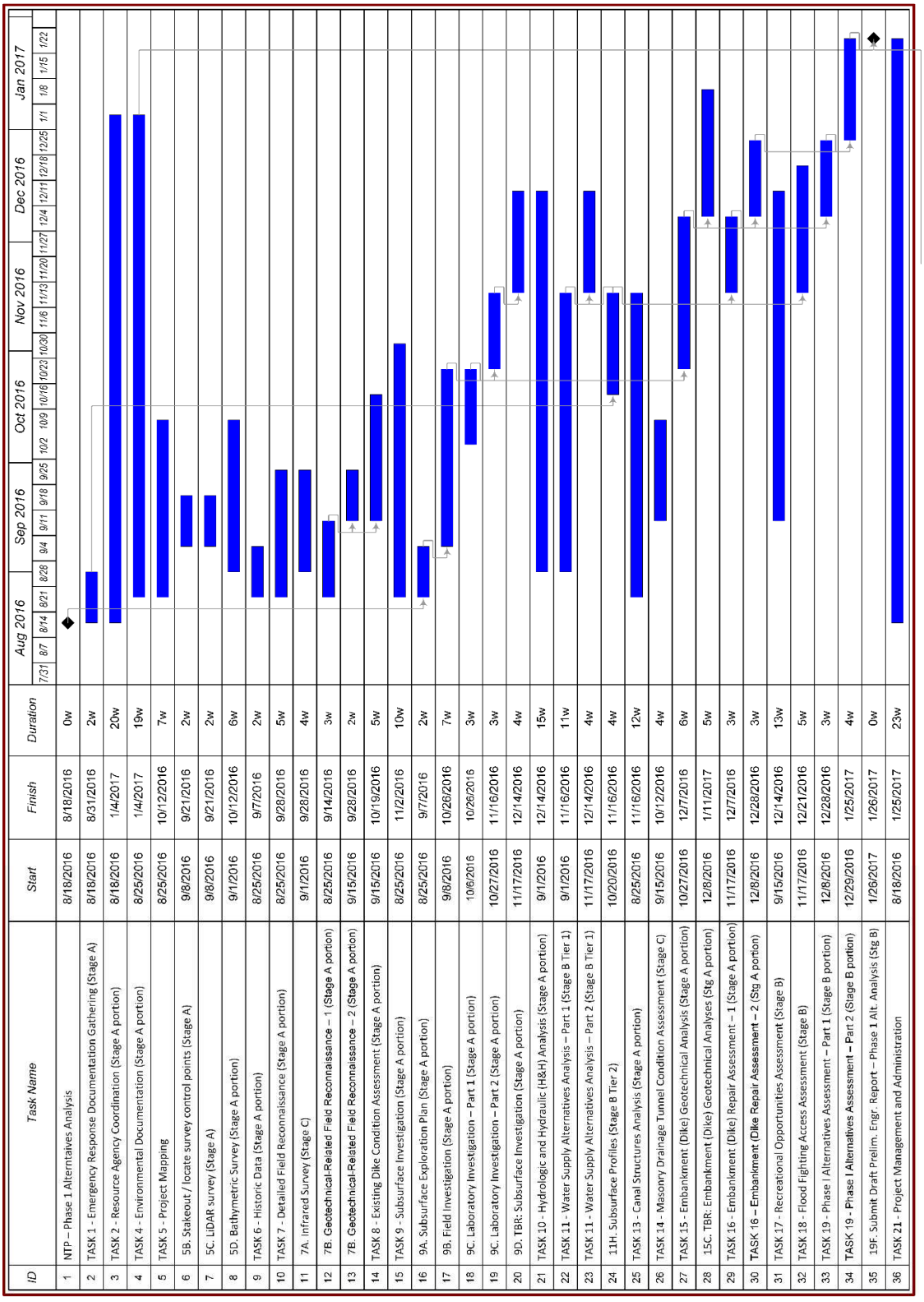

Figure 1-3- Bar Schedule

TASK 1 - EMERGENCY RESPONSE DOCUMENTATION GATHERING (STAGE A BASIC SERVICES)[1]

The **CITY** is taking the lead to gather documentation for the emergency response effort that was completed to-date (October 2015 to present) by others, which was completed on behalf of the **CITY** to implement emergency mitigation measures associated with the flooding event of early-October 2015 (described above). Some limited effort is anticipated to be required to consolidate and organize the documentation gathered; *but it has been assumed that the source entity(ies) anticipate the **CITY**'s request and as such is providing readily-accessible well-organized documentation. For proposal preparation purpose, a total of 80 man-hours has been estimated to process, consolidate, organize, digitize in word-searchable PDF format, index and digitally-file readily-available documentation received; and that all of the effort for Task 1 will be rolled-up and accounted for under the Reach 1 estimate.* The digitally-filed and indexed documentation will be placed on the **CONSULTANT**'s project server for direct access and reference by the project Team, and designated **CITY**' representatives for the complete duration of the project. At the end of Phase 1, digitally-filed and indexed documentation will be delivered to the **CITY** on a portable hard drive for permanent storage.

TASK 2 - RESOURCE AGENCY COORDINATION (STAGE A BASIC SERVICES)[2]

A. <u>Stakeholder Database</u>

A project related database will be created and maintained, to inform stakeholders and to solicit comment and input at key milestones during project implementation. The initial project related database will be created by updating and incorporating the names and contact information from key stakeholder lists compiled from a myriad of sources, which will include Project Steering Committee members, elected officials whose constituents may be impacted, various interest group representatives to include environmental and watershed organizations, the River Keeper, identified community leaders, representatives from Three Rivers Greenway, Chamber of Commerce, key user group representatives of the walkways and river ways, major employers in the area, small business owners, neighborhood/community representatives, SC Department of Commerce, economic development agency representatives, Richland County officials, Lexington County officials, South Carolina Department of Transportation (SCDOT) representatives, college and university representatives, the **CITY** and County Recreation Departments, those who attend project-related public information meetings and others who express an interest in the project.

[1] Stage A: Base Flood Damage Repair Services, Reach 1
[2] Stage A: Base Flood Damage Repair Services, Reach 1

B. Stakeholder Coordination

The **CONSULTANT** will be responsible to establish and facilitate a Stakeholder Advisory Committee to elicit input and keep stakeholders informed about the project. It is anticipated that key stakeholders will include the following.

- FERC
- SCSHPO
- SCDOT
- USACE
- HUD
- FEMA
- SCDNR
- SCANA
- SCDHEC
- City of Columbia
- Lexington County
- Richland County
- U.S. Fish and Wildlife Service

Figure 2-1- Stakeholders

For proposal preparation purpose, it is assumed that the Stakeholder Advisory Committee will meet at the following times to elicit input at key milestones during the Phase 1 Alternatives Analysis.

- *Stakeholder Meeting 1: Kick-off project overview;*
- *Stakeholder Meeting 2: Present initially-defined conceptual alternatives;*
- *Stakeholder Meeting 3: Present "defined" Alternatives;*
- *Stakeholder Meeting 4: Present draft Recommended Alternatives; and*
- *Stakeholder Meeting 5: Present final recommended Preferred Alternatives.*

*For proposal preparation purpose, it has been assumed that the **CITY** will identify and assist in recruiting stakeholder advisory committee members; the stakeholder meetings will be held at MBI's Columbia office with the understanding that there will be maximum of 90 session participants; and the **CONSULTANT** will be responsible to provide meeting agenda(s), printed matter, meeting exhibits, technical presentations and meeting minutes for the stakeholder meetings.*

C. FERC Advisor

The **CONSULTANT**'s Team includes Kleinschmidt's Paul Cyr, P.E., an independent Consultant approved by the Federal Energy Regulatory Commission (FERC) for performing Part 12 Dam Safety Inspections. Mr. Cyr will guide and advise the **CONSULTANT** on FERC and the South Carolina Department of Health and Environmental Control (SCDHEC) dam safety regulations and requirements on the rehabilitation of the canal specifically with regard to stability analyses and required hydraulic capacities of the dam and canal for compliance with the respective agency's regulations. Mr. Cyr will coordinate interactions with FERC and guide development of **CITY'** submittals to FERC.

D. FEMA/HUD Advisor (Omitted)

Refer to Task 20.

TASK 3 - PUBLIC RELATIONS (STAGE C[3] ADDITIONAL SERVICES)

Based on Scoping discussion with the **CITY**, it is the **CONSULTANT**'s understanding that:

- In-depth Public Involvement will be engaged after the Phase 1 Alternatives Analysis process is completed,
- The **CITY** will address public involvement needs with in-house staff during the Phase 1 Alternatives Analysis, and

[3] Stage C: Supplemental Flood Resiliency Enhancement Services

- Focus Group and Public Information meeting scheduling/implementation, and Public Update Notice preparation/distribution, City' Website Postings and Press Release(s) will all be deferred to Phase 2 final design.

A. <u>Public Participation / Communication Plan (Omitted, outside the Scope of this Proposal)</u>

B. <u>Public Identity Graphic (Omitted, outside the Scope of this Proposal)</u>

C. <u>Focus Group Session (deferred to Phase 2, outside the Scope of this Proposal)</u>

During Phase 2, the **CONSULTANT** will implement focus group sessions in order to ascertain stakeholder opinions regarding the Columbia Canal Restoration project's alternative solutions and recommendations from a small group of key stakeholders that may have a unique perspective regarding identifying certain pre-existing conditions, historic issues and / or various design alternatives, which will be taken into account to identify and consider options moving forward. *For proposal preparation purpose, it has been assumed that the **CITY** will identify and assist in recruiting focus group participants; focus group session(s) will be held at MBI's Columbia office with the understanding that there will be maximum of 90 session participants; and the **CONSULTANT** will be responsible to provide printed matter, exhibits and technical presentations for Focus Group Session(s). The **CONSULTANT** understands that Focus Group Sessions <u>will not</u> be conducted during the Phase 1 Canal Embankment Assessment.*

D. <u>Public Information Meeting (deferred to Phase 2, outside the Scope of this Proposal)</u>

During Phase 2, the **CONSULTANT** will facilitate and implement logistics for a series of Public Information Meetings, to be held for the general public*. For proposal preparation purpose, the **CONSULTANT** understands that Public Information Meetings <u>will not</u> be conducted during the Phase 1 Canal Embankment Assessment.*

During Phase 2, the **CONSULTANT** will be responsible for overall logistics coordination and management of the Public Information Meeting process. *For proposal preparation purpose, it has been assumed that Public Information Meeting(s) will be held at MBI's Columbia office with the understanding that there is a maximum of 90 meeting participants; the **CITY**' Public Relations (PR) office will be responsible to distribute meeting notices to appropriate media outlets; and the **CONSULTANT** will be responsible to provide design exhibits, visuals, handouts or other technical information to the meeting attendees.*

E. <u>Project Update Notices (deferred to Phase 2, outside the Scope of this Proposal)</u>

During Phase 2, Project Updates will be prepared and distributed in conjunction with key milestone deliverables. The **CONSULTANT** will prepare project update bulletins, and submit the bulletins to the **CITY** for distribution. *For proposal preparation purpose, the **CONSULTANT** understands that Project Update Notice(s) <u>will not</u> be prepared/distributed during the Phase 1 Canal Embankment Assessment.*

F. <u>CITY Website Postings (deferred to Phase 2, outside the Scope of this Proposal)</u>

The **CONSULTANT** will forward project materials, exhibits, updates, and press notices to the **CITY'** PR Staff for posting on the **CITY**'s website at each key project milestone. *For proposal preparation purpose, a total of one (1) website posting will be prepared and submitted to the **CITY** for posting.*

G. Press Release(s) (deferred to Phase 2, outside the Scope of this Proposal)

The **CONSULTANT** will prepare press releases that are consistent with key project milestones and will submit the press releases to the **CITY** PR staff for distribution to local broadcast and print media outlets. *For proposal preparation purpose, a total of one (1) press release will be prepared and submitted to the **CITY** for distribution.*

TASK 4 - ENVIRONMENTAL DOCUMENTATION (STAGE A ADDITIONAL SERVICES AND STAGE C ADDITIONAL SERVICES)

USACE, FERC, FEMA and HUD guidance will be used to develop and maintain required environmental documentation as described below.

A. Jurisdictional Waters Delineation

The **CONSULTANT** will use current USACE guidance to delineate the limit of the "waters of the United States" (canal and river) that are "jurisdictional" and subject to regulatory requirements under the Clean Water Act (CWA). In general, jurisdictional waters are anticipated to include those waters that are located in whole or in part within the 100-year floodplain within the project limits. Approval of the delineation will be obtained from the USACE and incorporated into the TBR and design files for the purpose of avoidance, minimization, permitting, Canal Embankment Assessment, and eventual design of the preferred alternative in Phase 2.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, it is assumed that Stage A[4] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[5] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. Evaluation of Environmental Impact (based on secondary sources)

Because the study area of the project is confined predominantly to the canal and dike, some of the typical National Environmental Policy Act (NEPA) categories that are studied in an Environmental Assessment (EA) do not apply and will not be evaluated. These include farmlands, environmental justice, and displacements. Impact categories that will be applicable to this project, and therefore evaluated, include:

- Land use,
- Cultural resources,
- Section 4(f)/6(f),
- Social and economic,
- Noise (construction),
- Air quality (construction),
- Hazardous materials,
- Federally protected species,
- Floodplains; and indirect and cumulative impacts.

[4] Stage A: Base Flood Damage Repair Services, Reach 1

[5] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

Data on existing conditions for each of these impact categories will be gathered to serve as a baseline for evaluating potential impacts, based on the footprint of each alternative developed. At this time it is not clear who the lead federal agency (ies) will be; and determination of the lead agency(ies) will depend on which alternative is selected as the preferred alternative. Each federal agency interprets NEPA differently, therefore the content and format of the EA could be driven by the key components of the preferred alternative. For example, if the power generating component is dropped as an alternative, it is likely that the USACE will be the lead agency since a Section 404 permit will be required for any repairs or alterations to the dike, whereas if the current use of the canal is maintained, FERC and FEMA will most likely be the lead agencies.

It is anticipated that a wide range of alternative uses for the canal and dike will be developed and evaluated. Because of the recreational value afforded by the canal area, public involvement will be an important component to this project. Public information meetings and workshops with stakeholders will be conducted (under Task 3), per the requirements of NEPA. Input from the public could play a major role in the development and selection of project alternatives and foster public support for the preferred alternative.

After the lead agency(ies) is(are) identified, the **CONSULTANT** will meet with the lead agency(ies) to determine the level of environmental documentation required; however such level of environmental documentation is not known until the lead agency(ies) is(are) identified and agreed upon by the key stakeholders involved. *Hence for proposal preparation purpose, it has been assumed that environmental-related documentation in format and detail as dictated by the USACE and entail an EA (e.g. no Environmental Impact Statement) and will culminate in a Finding of No Significant Impact (FONSI). In gathering data under this task, it is assumed that no cultural resources field work or aquatic species surveys will be conducted. In addition, it is assumed that buried or submerged historic or prehistoric archaeological remains are not discovered during the process of gathering subsurface data, other than the known structure remains that are described elsewhere in this Scope of Services. If buried or submerged remains of historical or archaeological interest to the South Carolina State Historic Preservation Office (SCSHPO) are discovered, the **CONSULTANT** will notify the **CITY** immediately to determine appropriate steps moving forward, since such discovery most likely will have a significant impact on the level of effort to complete the Phase 1 Canal Embankment Assessment (e.g. change in scope).*

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[6] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[7] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

C. <u>Plan Overlays</u>

Relevant environmental constraints (socioeconomic and environmental) and existing baseline engineering constraints inventoried (within the project limits) will be identified on separate Plan Overlays that are worked with the base plans and other plan overlays to identify avoidance areas and

[6] Stage A: Base Flood Damage Repair Services, Reach 1

[7] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

maximize beneficial use of the project site. The Plan Overlay(s) will be an essential resource for future reference and completion of the Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[8] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[9] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

D. TBR: Environmental Documentation

A stand-alone TBR will be prepared to summarize and present work product for the Task 4 environmental documentation. Once an alternative has been selected, data collected and used to compile the TBR will be utilized in the EA as the Existing Conditions section of the document.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[10] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[11] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

E. Draft Environmental Assessment

A draft EA will be prepared that evaluates the range of alternatives and upon approval of the lead federal agency(ies), the document will be made available to the public and other resource and regulatory agencies for review and comment and a public hearing will be conducted. The draft EA will include the Plan Overlays (described above in Task 4.C). As mentioned above, the baseline data contained in the TBR will be incorporated into the EA. Comments received during this process will be addressed either individually or in the Final EA. The Final EA will also include a Record of Decision (ROD) from the lead federal agency(ies).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[12] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[13] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

[8] Stage A: Base Flood Damage Repair Services, Reach 1

[9] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[10] Stage A: Base Flood Damage Repair Services, Reach 1

[11] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[12] Stage A: Base Flood Damage Repair Services, Reach 1

[13] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

TASK 5 - PROJECT MAPPING (STAGE A ADDITIONAL SERVICES AND STAGE C ADDITIONAL SERVICES)

A. <u>Pre-Dike Breach Event Base Mapping</u>

The **CONSULTANT** is aware of bathymetric and topographic survey mapping (circa January 2009, 1"=30' scale with 1-foot contour interval) of the Columbia Canal that is available, which extends the entire length of the embankment (dike) from the headgates to the hydroelectric plant intake gates (approximate 15,000 feet in length). *For proposal preparation purpose, it has been assumed that the survey drawings can be provided to the **CONSULTANT** in AutoCAD, or other suitable format, and permission will be granted to the **CITY** and the **CONSULTANT** to use this bathymetric and topographic survey mapping. The **CITY** is currently engaged in making contacts to obtain this permission from the owner of the 2009 mapping.*

For proposal preparation purpose, assume that all of the effort for the Pre-Dike Breach Event Base Mapping will be rolled-up and accounted for under Stage A[14] for the entire dike length.

B. <u>Stakeout / Locate Survey Control Points</u>

The **CONSULTANT** will perform a closed second-order survey level loop that is tied into the nearest USGS survey benchmark to:

- Establish temporary survey benchmarks on approximate 1,000 foot intervals over the entire length of the dike,
- Establish 6 to 8 additional survey benchmarks on the city-side of the canal to establish aerial triangulation control for infrared aerial photogrammetry (Task 7A).
- Establish permanent survey benchmarks in the top of the concrete headworks structure, canal spillway and existing hydroelectric plant (if none exists now);
- Field spot-check the 2009 mapping,
- Establish elevation control for mobile LiDAR, bathymetric and drainage tunnel surveys (Tasks 5C, 5D and 5F, respectively), and
- Provide reference for detailed field reconnaissance (Task 7), subsurface investigation (Task 9), hydrologic and hydraulic analysis (Task 10), and canal structures analysis (Task 13).

The **CONSULTANT** will perform ground control surveys to establish 3rd order coordinates (X, Y, Z) for at least 6 of the survey benchmarks, which are based on the SC State Plane coordinate system.

For proposal preparation purpose, assume that all of the effort for the stakeout/locations of survey control points will be rolled-up and accounted for under Stage A[15] for the entire dike length.

C. <u>LiDAR Survey</u>

To document the Post-Dike Breach Event conditions, the **CONSULTANT** will perform a mobile LiDAR survey to document features that can be located by direct line-of-site between the mobile LiDAR vehicle and the point/feature of interest. The mobile LiDAR will conduct multiple sweeps from truck-accessible locations for a maximum of two (2) consecutive 8-hour days at the project site. Post-

[14] Stage A: Base Flood Damage Repair Services

[15] Stage A: Base Flood Damage Repair Services

processing of LiDAR data will be completed on select portions of the data collected, to support priority mapping needs to complete the Phase 1 Canal Embankment Assessment. All raw LiDAR data collected will be stored and made readily available for post-processing over the complete duration of the project.

The LiDAR survey will be used to:

- Discern features that were disturbed/damaged/moved since the 2009 base mapping survey;
- Locate visible drainage structure outfalls that are in a direct line of sight from the mobile LiDAR unit;
- Postulate probable flood damage, when used in combination with the base mapping (circa 2009) and actual conditions observed during the detailed field reconnaissance (Task 7); and
- Expand topographic survey coverage beyond that currently captured in the 2009 topographic survey, particularly:
  - at staging areas under considered on the east side of the left canal bank (Figure 18-2), and
  - where the temporary earthen cofferdam was constructed across the canal during the October 2015 emergency response.

For proposal preparation purpose, assume that all of the effort for the LiDAR survey will be rolled-up and accounted for under Stage A[16] for the entire dike length.

D. <u>Bathymetric Survey</u>

Since accelerated canal flow in October 2015 occurred as a result of the dike breach, the **CONSULTANT** will perform a dual frequency bathymetric survey within the Columbia canal to:

- Identify possible scour damage, including accessible portions of the pedestrian bridge substructures (pier and abutments) and SCDOT bridge substructures,
- Assess possible short-term sediment aggradation/degradation, and
- Determine and map the top of soft fluid sediment and firm bottom within Columbia Canal at the project site,
- Investigate three (3) potential raw water withdrawal locations to identify depth of channel bottom for suitability of the potential withdrawal location, and
- Identify anomalous conditions that are detected, such as scour holes that may or may not have been filled-in, sunken vessels that may have been abandoned in-place and abandoned objects (e.g. civil war era munitions that may possibly exist, like those encountered by others elsewhere along the Broad River, which could pose a danger to drill rig operators during the subsurface investigation, Task 9)

Near-full bottom bathymetric mapping will be collected with a main-survey vessel that is equipped with an Edgetech 6205 Interferometric Swath Sonar (or equal). Hydrographic survey coverage will be dependent on the side slope of the dike forming the west bank of the canal, the more natural slope on the east bank and the depth of water at/near vessel approach to these banks. In general, the interferometer gives wider bottom coverage the deeper the water is. In addition, an Odom Echotrac

[16] Stage A: Base Flood Damage Repair Services

CV 200 dual frequency single-beam sonar (or equal) will be utilized to collect top and bottom elevations of sediment deposits at approximate 1000-foot interval transects across the canal.

Due to the unknown depth of the canal (after the dike breach) and the required depth needed for the main-survey vessel to operate safely and efficiently, the bathymetric survey will consist of a two-phase approach.

Bathymetric survey at accessible bridge and canal substructures will be conducted and mapping

1. **Phase 1 Bathymetric Survey**

Phase 1 will include launching a shallow-draft flat-bottom john boat (reconnaissance vessel) that is equipped with a survey-grade Hydrolite echo sounder to collect reconnaissance depth data along the center of the canal. This reconnaissance mission will also collect the clearance available under the pedestrian bridge. If sufficient depth exists to utilize the main-survey vessel for near-full bottom bathymetric coverage, the reconnaissance vessel will be extracted from the canal and launched to collect data at the 3 proposed intake study areas. If sufficient depths do not exist to utilize the main-survey vessel, then the reconnaissance vessel will become the primary data collection vessel for the entire project.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, it is assumed that Stage A[17] will only include Phase 1 Bathymetric Survey that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[18] will include Phase 1 Bathymetric Survey that is required over the remaining length of dike up to the headworks within Reach 2.

2. **Phase 2 Bathymetric Survey**

Phase 2 will be implemented, if water depth is sufficient to safely operate the main-survey vessel. The main-survey vessel will be utilized to collect near-full bottom coverage, conditions permitting.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that all of the in-depth Phase 2 bathymetric survey will be completed in Stage A[19].

3. **Data Collection Area Limitations**

Single Beam Hydrolite System – minimum water depth 2 feet

Edgetech 6205 – minimum water depth 6 feet (under sonar)

[17] Stage A Basic Services: Base Flood Damage Repair Services, Reach 1

[18] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[19] Stage A Additional Services: Supplemental Flood Resiliency Enhancement Services, Reach 2

4. Main-Survey Vessel Characteristic Features

- Vessel type: Scully 20' (25' overall length), all aluminum hydrographic survey vessel.
- Maximum loaded weight 6000 pounds
- Length Overall: 25 feet
- Beam of Vessel: 8 feet
- Beam with sonars deployed: 9.5 feet
- Minimum Water Draft: 2.5 feet
- Safe Operational Draft: 4.5 feet
- Air Draft: 10 feet (water surface to top of radar dome)
- Engines: (2) 90 HP Honda 4 stroke
- Bottom Paint: Food/Potable Water Grade Epoxy Paint
- Sonars: (1) Odom Echotrac CV dual frequency Sonar, and
  (1) Edgetech 6205 Interferometric Dual Frequency Swath Bathymetry/Side Scan
- Navigational and 3D Inertial Sensing Equipment: Survey Grade Applanix POS MV 320 Positioning System with GAMS and Inertial Measurement Unit
- Computers: (1) Industrial Grade Rack-Mount Computer System running Windows 7 OS
- Software (for data reduction): HyPack and HySweep
- Communication : Cellular Modem and Cellular Amplifier; Marine Grade VHF Radio(s)

For proposal preparation purpose, the following assumptions have been made with regard to the bathymetric survey.

- *An adequate boat ramp does not exist to launch and retrieve the main-survey vessel. Hence, a crane with 50-foot horizontal reach with minimum rated 6,000 pound safe working load is used to pick-up, launch and retrieve the main-survey vessel. A total of four (4) crane lifts are required due to possible clearance restrictions under the pedestrian bridge (twice-in and twice out).*
- *VRS or RTK GPS correction data is used to support the bathymetric survey over 3-mile canal length.*
- *The reconnaissance vessel is operated along a navigation route (to and from intake study areas) at safe locations.*
- *Horizontal and vertical survey control points are used to operate RTK base operations, if VRS correction data cannot be received onsite.*

E. <u>SC811 Utility Notification and Annotated Plan Overlay of Known Utilities</u>

The **CONSULTANT** will perform an SC811 utility notification.

Base plans will be submitted to utility respondents, to engage utilities to return annotated plan sheets with the approximate location of known utilities (both overhead and underground) for future reference. The Plan Overlay will be worked with the base plans and other plan overlays to:

- Identify locations where measurable ground surface change has occurred,
- Identify avoidance areas, and
- Maximize beneficial use of the project site.

This Plan Overlay will be an essential resource for future reference and to complete the hydrologic and hydraulic analyses (Task 10), complete the canal spillway capacity analysis (Task 10F), assess the condition of masonry drainage tunnel under the canal (Task 14), consider dike repair strategies (Task 16) and complete the Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[20] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[21] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

F. Drainage Tunnel Survey

The **CONSULTANT** will perform a location and alignment survey of the drainage tunnel that extends beneath the canal from the water treatment plant to the abandoned water pumping plant, and the cross-sectional geometry of the tunnel will be measured and located wherever visible changes occur. The tunnels' location will be shown on the Plan Overlay; and a typical tunnel cross section will be prepared.

For proposal preparation purpose and consideration, assume that Stage C[22] will include the drainage tunnel survey within Reach 2.

G. Plan Overlay(s)

Plan annotations, which are returned to the **CONSULTANT** by the impacted utility company(ies), will be scanned and transcribed onto a Plan Overlay in AutoCAD.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[23] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[24] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

H. DR: Project Mapping

A stand-alone DR will be prepared to summarize and present work product for the Task 5 project mapping. The DR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies) of electronic file structure, layer naming convention, and symbol library; a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The DR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), and used as basis to address various remediation options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[25] will only include work that is required to repair the dike

[20] Stage A: Base Flood Damage Repair Services, Reach 1

[21] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[22] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[23] Stage A: Base Flood Damage Repair Services, Reach 1

[24] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[25] Stage A: Base Flood Damage Repair Services, Reach 1

to preexisting conditions within Reach 1; and that Stage C[26] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 6 - HISTORIC DATA (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. <u>Data Gathering</u>

To fill-in gaps that may not have been gathered previously by others during the Emergency Response (Task 1, circa last quarter 2015 through 1st quarter 2016), the **CONSULTANT** will make reasonable effort, as described in the following, to contact and gather readily-available historic data that is relevant to the Columbia Canal Restoration project, from the following sources.

- SCE&G. Make contact with SCE&G Dam Safety and request historical data for the Columbia Canal inclusive of: any drawings of all structures associated with the canal and Diversion Dam, bathometric and topographic drawings of the canal and impoundment, and documents relative to compliance with FERC dam safety requirements.
- **CITY**. Provide the **CITY'** Project Manager a list of information to be obtained from the **CITY** file archives.
- SCDOT. Obtain readily-available bridge plans for structures that cross over the Columbia Canal within the project limits.
- SCDNR. The **CONSULTANT** will contact the South Carolina Department of Natural Resources (SCDNR), which is operating under a Cooperating Technical Partners (CTP) flood study mapping agreement with FEMA, to obtain the current preliminary HEC-RAS model for the river system, FEMA flood insurance study (FIS) and breach data reports.
- Lockhart Power Company

*For proposal preparation purpose, it has been assumed that the readily-available data that is acquired will include bridge plans and inspection reports for the canal pedestrian bridge, and canal spillway vehicular access bridge. The **CONSULTANT** understands that Kleinschmidt-Chao will be responsible to assess the vehicular access bridge over the canal headworks. Furthermore it is assumed that these bridge plans will include details about existing structural members, section properties, material strengths, design standards and as-built foundation information; and that the inspection reports will include detailed information documenting historic deficiencies, member/reinforcing section losses and any applied repairs.*

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[27] will only include work that is required to repair the dike

[26] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[27] Stage A: Base Flood Damage Repair Services, Reach 1

to preexisting conditions within Reach 1; and that Stage C[28] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. <u>DR: Historic Data</u>

A stand-alone DR will be prepared to summarize and present work product for the Task 6 historical data. The DR will be a multi-volume document, to facilitate progressive delivery of readily-available historic data as it becomes available. The TBR will include a tabular summary to document the source historic data acquired, along with a general description of the data content. Data obtained will be indexed where possible, to maintain consistent cross-referencing throughout the project documentation. The DR of historic data will be referenced in other TBRs and the Preliminary Engineering Report (PER), to minimize duplicate reproduction of historic data used. The DR of historic data will be referenced as applicable in the Canal Embankment Assessment (Task 16) and Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[29] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[30] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 7 - DETAILED FIELD RECONNAISSANCE (STAGE A BASIC SERVICES IN REACH 1, STAGE A ADDITIONAL SERVICES IN REACH 2, AND SUPPLEMENTAL RECONNAISSANCE IN STAGE C ADDITIONAL SERVICES)

Field reconnaissance activity will be performed in general accordance with FERC Regulations, Safety of Water Power Projects and Project Works. In addition, an infrared survey of the dike will be conducted to further identify water movement within the dike.

A. <u>Infrared Survey</u>

Aerial Infrared and Photographic Surveys will be performed to identify leaks, saturation, anomalies and/or potential areas of water movement within the dike structures. These surveys will be performed along the full length of the dike. The information from these surveys will be utilized to refine the field reconnaissance approach and focus effort on critical regions of the dike that are of most concern with regard to dike stability and flood-fighting resiliency.

Aerial infrared photogrammetry will be obtained at a 3-inch pixel resolution, or better. Using photogrammetric techniques, the **CONSULTANT** will collect 4-band (B, G, R and CIR) ortho-quality digital elevation model (DEM) data and use the DEM to generate ortho imagery. After the ortho imagery has been created, image processing will be performed to create the Normalized Difference Vegetation Index (NDVI) to identify water seepage areas.

[28] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[29] Stage A: Base Flood Damage Repair Services, Reach 1

[30] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose and consideration that Stage A is intended to repair damaged sections of dike in Reach 1 to preexisting conditions, assume that the Infrared Survey will be completed under Stage A[31] as Additional Services over the entire length of dike within the project limits.

B. <u>Geotechnical-Related Field Reconnaissance</u>

A geotechnical-related desktop literature review will be completed based on readily-available information in the office, to develop an understanding of the overall subsurface setting and regional geology, and to develop a punch-list of items that are anticipated to be of interest during the subsequent field reconnaissance. Using the results from the desktop literature review, a geotechnical-related field reconnaissance will be performed that generally entails visual evaluation, observation and documentation of the following aspects relative to the following areas: embankment dike; east bank of the canal; and areas germane to the alternatives shown in Figure 18A and 18B shown herein. Key observations will be documented in field observation reports, field sketches based on hand-taped measurements and a hand-held GPS unit, and digital photographs. Observations regarding damage caused by the flood will be segregated where possible from typical observations.

- Evidence of displacement, cracks, sinkholes, heave, springs, wet spots, and sand boils,
- Cracking, desiccation and deterioration,
- Abnormal vegetation growth, surface erosion, animal borrows, and trees,
- Embankment depressions, crimped and bulged areas, slumps, and evidence of slope instability,
- Surface erosion, scour damage, inadequate slope protection, concentrated surface runoff,
- Evidence of dispersion, suspended solids, suffusion/suffosion, and surface stains,
- Surface erosion, erosion gullies, internal erosion, backward erosion piping, sand boils, concentrated leak erosion and ponded areas,
- Dike penetration(s) and utility crossing(s),
- Through-seepage, under-seepage and leakage, and
- Indicators of internal stress and excess pore pressure.

In addition to the items listed above, existing structures at/near the embankment (dike) will be observed, including but not limited to existing SCDOT bridge substructures, overhead transmission tower foundations and remains of abandoned structures. Among other things, consideration will be given to field procedures recommended to estimate the headcut erodibility index by the Natural Resources Conservation Service (NRCS) in the National Engineering Handbook (NEH) Part 628 Chapter 52.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[32]Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; Stage A Additional Services will include a coarse-level field reconnaissance that is sufficient to delineate probable flood-damaged areas within

[31] Stage A: Base Flood Damage Repair Services, Reach 1

[32] Stage A: Base Flood Damage Repair Services, Reach 1

Reach 2; and that Stage C[33] will include supplemental work that is required to complete a more refined field reconnaissance within Reach 2.

C. Existing Visible Drainage Outfalls

The **CONSULTANT** will conduct a field review of the Canal to confirm the location of visible Drainage Outfalls from the **CITY** drainage system including natural features along with piped and channelized systems. This work will include a review of the **CITY** storm water inventory information prior to the field review. A condition assessment of the masonry drainage tunnel that extends beneath the canal will be conducted in Task 14.

The **CONSULTANT** will conduct a qualitative inspection of the canal spillway to supplement the LiDAR survey (Task 5C) with hand-taped measurements as needed to support Tasks 10F and 13B. Readily-available spillway documentation (from Task 6) will be reviewed. The existing canal spillway will be field viewed to visually observe and photograph the general condition of the canal spillway, where safely accessible from the ground surface or john boat. Particular attention will be placed on identification of possible flood damage, such as visual evidence of recent scour activity and/or possible member damage from floating debris. A Technical Memorandum with field notes, field sketches and representative photographs will be prepared to document inspection findings. *For proposal preparation purpose, it has been assumed that existing structural members, section properties, material strengths, and section losses are all contained in the most recent inspection report and this data will be utilized by the **CONSULTANT** for the Phase 1 Canal Embankment Assessment; and that no detailed inspection, section loss determination, or detailed measurements will have to be obtained to complete the Phase 1 Canal Embankment Assessment.*

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[34] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[35] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

D. Existing Pedestrian and Vehicular Access Bridges

The **CONSULTANT** will conduct a qualitative bridge inspection of the following access bridges:

- Two-span truss canal pedestrian bridge; and
- Canal spillway timber vehicular access bridge.

The **CONSULTANT** understands that the condition of the canal headwork's vehicular access bridge will be assessed by Kleinschmidt-Chao under separate contract to the **CITY**.

Readily-available bridge documentation (from Task 6) will be reviewed. The canal pedestrian and canal spillway bridges will be visually inspected to observe and photograph the general condition of the exposed members of the existing bridge substructure and superstructure, both from above and

[33] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[34] Stage A: Base Flood Damage Repair Services, Reach 1

[35] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

below, where safely accessible from the ground surface or john boat. Particular attention will be placed on identification of possible flood damage, such as evidence of recent scour activity based on visual observation and soundings and/or possible member damage from floating debris; and the exposed condition of the deteriorated substructures at the 2-span canal pedestrian bridge. A Technical Memorandum with field notes, field sketches and representative photographs will be prepared to document inspection findings. The work of assessing the canal spillway bridge will be conducted as part of Task 7D. *For proposal preparation purpose, it has been assumed that existing structural members, section properties, material strengths, detailed measurements, and section losses are all contained in the most recent bridge plans and inspection reports and this data will be utilized by the **CONSULTANT** for the Phase 1 Canal Embankment Assessment; and that no detailed inspection, section loss determination, or measurements will have to be obtained to complete the Phase 1 Canal Embankment Assessment.*

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[36] will only include a qualitative bridge inspection of the canal spillway timber vehicular access bridge that is sufficient to repair the access bridge to preexisting conditions within Reach 1; and that Stage C[37] will include a qualitative bridge inspection of the two-span truss canal pedestrian bridge within Reach 2.

E. <u>Plan Overlay of Significant Reconnaissance Features and Historic Boring Locations</u>

Relevant geotechnical-related data from the desktop literature review and field reconnaissance will be presented on a Plan Overlay that is worked with the base plans and other plan overlays to identify avoidance areas and maximize beneficial use of the project site. This Plan Overlay will be an essential resource for future reference and to develop and execute the subsurface investigation (Task 9), complete the dike seepage and stability analysis (Task 15), consider dike repair strategies (Task 16), evaluate subsurface conditions at alternate flood-fighting access bridge locations (Task 18) and complete the Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[38] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[39] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

F. <u>Plan Overlay of Drainage Outfalls and Relevant Drainage Features</u>

Relevant hydrologic- and hydraulic-related data from the desktop literature review and field reconnaissance will be presented on a Plan Overlay that is worked with the base plans and other plan overlays to identify avoidance areas and maximize beneficial use of the project site. This Plan Overlay will be an essential resource for future reference and to complete the hydrologic and hydraulic

[36] Stage A: Base Flood Damage Repair Services, Reach 1

[37] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[38] Stage A: Base Flood Damage Repair Services, Reach 1

[39] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

analyses (Task 10), assess the condition of masonry drainage tunnel under the canal (Task 14), consider dike repair strategies (Task 16) and complete the Phase 1 Alternatives Analysis (Task 19).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[40] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[41] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

G. DR: Detailed Field Reconnaissance

A stand-alone DR will be prepared to summarize and present work product for the Task 7 detailed field reconnaissance. The DR will be a multi-volume document; and findings for each major reconnaissance item (Tasks 7A through 7F) will be presented in a separate volume, to facilitate progressive delivery of findings on a topic-by-topic basis. The DR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The DR will be referenced as applicable in the Alternatives Assessment Report (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[42] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[43] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 8 - EXISTING DIKE CONDITION ASSESSMENT (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. Plan Overlay of Flood Damage, Scour, Seepage, Bank Instability and Restricted Access Features

Key flood-damage, scour, seepage, bank instability and restricted access from the field reconnaissance (Task 7) will be featured on a Plan Overlay that is worked with the base plans and other plan overlays to identify avoidance areas and maximize beneficial use of the project site. This Plan Overlay will be an essential resource for future reference and to complete the subsurface investigation (Task 9) dike seepage and stability analysis (Task 15) and dike repair strategies (Task 16), and Phase 1 Alternatives Analysis (Task 19).

[40] Stage A: Base Flood Damage Repair Services, Reach 1

[41] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[42] Stage A: Base Flood Damage Repair Services, Reach 1

[43] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[44] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[45] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. <u>TBR: Existing Dike Condition Assessment</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 8 existing dike conditions assessment. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The TBR will be referenced as applicable in the Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[46] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[47] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 9 - SUBSURFACE INVESTIGATION (STAGE A ADDITIONAL SERVICES AND STAGE C ADDITIONAL SERVICES)

A. <u>Subsurface Exploration Plan</u>

The subsurface investigation will be performed in accordance with the FERC' Engineering Guidelines for the Evaluation of Hydropower Projects, Chapters 4 and 5. Because this is a canal embankment assessment, the investigation will be in general accordance with Section 5-7.2 – Initial Design Investigation. It is anticipated that standard USACE drilling and sampling techniques and rotosonic drilling techniques will be utilized during the subsurface investigation.

A boring location plan will be developed and submitted to the **CITY** for review and approval. Historic data (Tasks 1 and 6) and field reconnaissance (Task 7) will be utilized to refine the proposed borings location plan, in combination with available bathymetric survey data (Task 5D). The boring location plan will include proposed borings locations and estimated boring depths.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[48] will only include work that is required to repair the dike

[44] Stage A: Base Flood Damage Repair Services, Reach 1

[45] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[46] Stage A: Base Flood Damage Repair Services, Reach 1

[47] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[48] Stage A: Base Flood Damage Repair Services, Reach 1

to preexisting conditions within Reach 1; and that Stage C[49] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. <u>Field Investigation – Stage A Reach 1[50]</u>

1. Dike Breach Investigation

The cross section of the dike exposed by the breach will be investigated by a Geologist. Soil stratification within the dike cross section at the breach will be documented and bulk samples will be taken for laboratory testing. In addition, hand auger drilling will be performed at select locations identified in the field by the Geologist.

One (1) bulk sample of the dry sediment in the bottom of the canal south of the cofferdam will be obtained. A broad spectrum screening of the bulk sample will be performed to identify potential hazardous contamination that may have an impact on disposal and handling of dredged material (including construction handling).

The following assumptions apply to the above described land based drilling:

- *Pedestrian control will be provided by the City. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included with regard to unearthing historical artifacts.*

2. Dike Borings

One (1) boring will be drilled on either side of the breach for a total of two (2) dike borings to support characterization of the existing embankment dike in Reach 1. Water levels at time of drilling completion and 24 hour water levels will be measured.

Due to expected variation in embankment thickness, depth of soil overburden and changes in bedrock elevation, boring depths are anticipated to range from about fifty (50) to eighty (80) feet in depth (not including rock coring). Rock coring will be performed after auger refusal is encountered, at designated borings. Rock coring will be performed to a depth of five (5) feet below the point at which auger refusal was achieved.

The following assumptions apply to the above described land-based drilling:

- *Equipment that utilizes standard petroleum products will be utilized.*
- *The **CITY** will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the **CITY**.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*

[49] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[50] Stage A: Base Flood Damage Repair Services, Reach 1

- *Pedestrian control will be provided by the **CITY**. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *Drill rig will be mobilized to the dike via access across the canal head works. No cranes or barges will be required.*
- *The **CITY** will provide conformation that the Headworks Structure is structurally adequate to support all loadings from the drilling equipment and drilling operations.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*

3. Dike Borings – Stage C Reach 2[51]

One (1) boring will be drilled at each of four (4) subsurface section locations for a total of four (4) dike borings to support characterization of the existing embankment dike. Water levels at time of drilling completion and 24 hour water levels will be measured.

Due to expected variation in embankment thickness, depth of soil overburden and changes in bedrock elevation, boring depths are anticipated to range from about fifty (50) to eighty (80) feet in depth (not including rock coring). Rock coring will be performed after auger refusal is encountered, at designated borings. Rock coring will be performed to a depth of five (5) feet below the point at which auger refusal was achieved.

The following assumptions apply to the above described land-based drilling:

- *Equipment that utilizes standard petroleum products will be utilized.*
- *The **CITY** will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the **CITY**.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*
- *Pedestrian control will be provided by the **CITY**. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *Drill rig will be mobilized to the dike via access across the canal head works. No cranes or barges will be required.*
- *The **CITY** will provide conformation that the Headworks Structure is structurally adequate to support all loadings from the drilling equipment and drilling operations.*

[5151] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*

4. Canal Subsurface Section Borings

At four (4) locations, borings will be performed on an alignment perpendicular to the dike such that a subsurface section can be developed. Each subsurface section is anticipated to include at least two (2) borings.

At three of the four (4) subsurface section locations, one (1) sample of soft sediment in the bottom of the canal will be obtained. A broad spectrum screen of these samples will be performed to identify potential hazardous contamination that may have an impact on disposal and handling of dredged material (including construction handling).

Due to the depth of soil overburden and changes in bedrock elevation, boring depths are anticipated to range from about thirty (30) to fifty (50) feet in depth (not including rock coring). Rock coring will be performed after auger refusal is encountered, at designated borings. Rock coring will be performed to a depth of five (5) feet below the point at which auger refusal was achieved.

The following assumptions apply to the above described water based drilling:

- *The depth of water in the canal will be sufficient for the barge platform to float and be maneuvered upstream and downstream. The only obstructions that are anticipated are the pedestrian bridge at the Canal Water Plant and the cofferdam constructed when the breach occurred.*
- *Equipment that utilizes standard petroleum products will be utilized.*
- *The **CITY** will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the **CITY**.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*
- *Pedestrian control will be provided by the **CITY**. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*

5. Columbia Canal Spillway Borings

One (1) boring will be performed within the footprint of the Columbia Canal Spillway. This boring will penetrate through the existing structure and past the spillway/bedrock interface to a depth of 35 feet into sound bedrock. These borings will include core recovery along the full length of the boring.

Efforts will be made to collect representative samples of the masonry cored that make up the structure of the Canal Spillway. Up to 3 core samples of the masonry that form the structure will be obtained. These core samples will be utilized to determine the compressive strength and unit weight of the masonry.

The following assumptions apply to the above described land-based drilling:

- *Equipment that utilizes standard petroleum products will be utilized.*
- *City will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the City.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*
- *Pedestrian control will be provided by the City. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*
- *Drill rig will be mobilized to the spillway via access across the canal head works. No crane or barges will be required.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*

6. Dike Borings East of the Headgates

One (1) boring will be performed between the east end of the headgate structure and the railroad right-of-way. Boring depths are anticipated to be approximately eighty (80) feet in depth (not including rock coring). Rock coring will be performed after auger refusal is encountered, at designated borings. Rock coring will be performed to a depth of five (5) feet below the point at which auger refusal was achieved.

The following assumptions apply to the above described land based drilling:

- *Equipment that utilized standard petroleum products will be utilized.*
- *The **CITY** will obtain and provide in writing permission from property owners in locations were work is not performed on property not owned by the City.*
- *No intrusive activity nor access on railroad property will be required; and no provision has been made to obtain railroad protective liability insurance.*
- *No lane closures or traffic control will be required to mobilize or demobilize equipment.*
- *Pedestrian control will be provided by the **CITY**. No devices or man power have been anticipated to keep pedestrians segregated from the work area.*
- *No provisions have been included to screen for or handle unexploded ordnance.*

- *Drill rig will be mobilized to the dike via access across the canal head works. No crane or barges will be required.*
- *No provisions have been included to identify historical artifacts that may be unearthed as a result of the work described herein. No coordination or delay time has been included associated with unearthing of historical artifacts.*
- *No addition insurance and fees associated with working within the railroad right of way have been included.*

7. Shear Wave Velocity

Downhole seismic suspension logging survey will be performed at one (1) location along the dike in a boring that extends to a depth of one hundred (100) below the ground surface.

For proposal preparation purpose and consideration that seismic loading will not be considered under Stage A, assume that Stage A will not include a downhole seismic suspension logging survey; and that Stage C[52] only will include a downhole seismic suspension logging survey.

8. Logistics for Subsurface Investigation

For the subsurface investigation details herein, there will be numerous access conditions that require various levels of manpower, skill and equipment. *For proposal preparation purpose, it is anticipated that the following will be required to respond to the logistics associated with the subsurface investigation:*

- *Non-ATV mounted drill rig*
- *ATV mounted drill rig*
- *Mechanized clearing equipment*
- *Water based drilling platform*
- *Crew boat*
- *Crane*
- *Hand clearing*
- *Private utility locates*
- *Rotosonic drill rig*
- *Drill rig support equipment*
- *Masonry coring equipment*

C. <u>Laboratory Investigation</u>

All laboratory testing will be performed in accordance with the appropriate ASTM Standards in F&ME's AASHTO Accredited USACE Certified laboratory. A laboratory testing program will be implemented to obtain engineering properties of soil and rock for geotechnical-related analyses. A review of the samples obtained during the subsurface investigation will be performed. Representative samples will be selected and prepared for laboratory testing. Laboratory testing on representative samples will be performed to generally identify the following:

[52] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

- Physical soil properties:
  - Grain size distribution (mechanical sieve and hydrometer)
  - Plasticity characteristics (Atterberg limits)
  - In-place density (undisturbed sample)
  - In-situ moisture content
  - Soil compaction characteristics (Proctor densities)
- Mechanical soil properties (undisturbed and remolded samples):
  - Soil shear strength (triaxle shear and direct shear)
- Hydraulic conductivity
  - Constant head - undisturbed samples
  - Constant head - remolded samples
- Internal erosion susceptibility
  - Pinhole dispersion test
- Electrochemical properties
  - Soil
  - Water
- A review of the rock cores will be performed. Representative core samples will be selected and tested in the laboratory to identify:
  - Rock quality designation
  - Compressive strength

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[53] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[54] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

D. <u>DR: Subsurface Investigation</u>

A stand-alone DR will be prepared to summarize and present the work product for the Task 9 subsurface investigation, which will serve as a "Data Report" to document subsurface conditions encountered. The DR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. In addition, this DR will contain an introduction, project description, and the purpose and scope of the subsurface investigation performed. The narrative portion of this will be relatively short, with the Appendices of the report being large. The Appendices will contain project and testing location plans, field exploration (boring logs), and the results of all laboratory and field testing. Each field exploration record will contain the location of the testing and corresponding testing location plan. The laboratory testing results will indicate the location and depth of each sample clearly on the test result. The DR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

[53] Stage A: Base Flood Damage Repair Services, Reach 1

[54] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[55] will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[56] will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

TASK 10 - HYDROLOGIC AND HYDRAULIC (H&H) ANALYSIS (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. <u>Design Criteria Memorandum: Hydrologic and Hydraulic Analysis</u>

A Design Criteria Memorandum (DCM) will be developed to identify the analyses and investigations to be performed in order to evaluate the Canal Dike and critical structures. The DCM will describe the means, methods, and assumptions to be used in the analyses.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[57] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[58] will include supplemental work that is required to support planned analyses and assessments.

B. <u>Site-Specific Dam Breach Analysis</u>

The **CONSULTANT** will develop a Site Specific Dam Break Analysis for both the Diversion Dam and Canal Dike. The analysis will be based on the current preliminary HEC-RAS model for the river system (from Task 6), without existing conditions update, as reviewed in the River Flood Evaluation (Task 10D). The HEC-RAS model will be reviewed to insure compliance with the current FEMA recommended modeling procedures. Due to the length of the Canal Dike, we anticipate modeling a breach at two separate locations. The resulting breach waves from the Diversion Dam and Canal Dike will be depicted on the project GIS mapping so that potential hazards can be identified. Breach parameters will be based on FERC Guidelines and current standard of practice. The following items will be included in this Task:

1. Data Gathering

- Obtain available Existing Breach Reports
- Develop GIS and Survey Base Mapping
- Perform Downstream Reach Field Walk

2. Diversion Dam Breach Model

- Breach Parameter Development
- Develop GIS Inundation Mapping
- Incremental Hazard Evaluation

[55] Stage A: Base Flood Damage Repair Services, Reach 1

[56] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[57] Stage A: Base Flood Damage Repair Services, Reach 1

[58] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

3. Canal Breach Model (Two Locations)

- Breach Parameter Development
- Breach Location Selection
- Develop GIS Inundation Mapping
- Incremental Hazard Evaluation

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[59] will not include a dam breach analysis; and only Stage C[60] will include a site-specific dam breach analysis.

C. River Hydrologic Modeling

Detailed FERC compliant hydrologic modeling will be deferred to Phase 2 Final Design.

For the Phase 1 Alternatives Analysis, the **CONSULTANT** will develop a hydrologic model of the drainage basin that drains to the Diversion Dam/Headworks Structure and Canal Spillway. The analysis will be developed in accordance with the current standard of practice using the best available existing models and GIS based data. Available hydrologic models will be reviewed and used as a basis of comparison for the model along with the FEMA Flood Insurance Study flows and existing gage and rainfall data. Peak flow rates and hydrographs for multiple storms and the Inflow Design Flood will be approximated. This information will be used for several other tasks including the Site Specific Breach (Task 10B) and River Flooding Evaluation (Task 10D). The following items will be included in this Task:

1. Data Gathering

- Obtain Existing Hydrologic Models for the Canal Structures
- Obtain USGS Gage and Rainfall Data
- Obtain Historical Rain Records, Historical Flood Records, Base Flow Information, etc.
- Obtain Drainage Basin GIS Data Layers for Land Use, Soils, Topography, etc.

2. Review Existing Hydrologic Models

- Compare Existing Hydrologic Model Flows to Historic and Published Flows
- Analyze USGS Gages within the River System

3. Develop River System Hydrologic Model

- Determine Watershed Characteristics based on best available GIS data including – Soil Classifications, Land Use Values, Imperviousness, Time of Concentration, Antecedent Moisture Conditions, etc.
- Unit Hydrograph Selection and Development
- Storm Event Rainfall Value Selection
- Probable Maximum Precipitation Determination
- Probable Maximum Flood Evaluation

[59] Stage A: Base Flood Damage Repair Services, Reach 1

[60] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[61] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[62] will include supplemental work that is required to support planned analyses and assessments.

D. River Flooding Evaluation

Any changes to the existing model will be deferred to Phase 2 Final Design.

For the Phase 1 Alternatives Analysis, the **CONSULTANT** will analyze the flooding condition along the Broad River and Congaree River in order to evaluate potential project alternatives. The analysis will be based on the current preliminary HEC-RAS model for the river system (from Task 6). The existing models will be reviewed and updated to reflect the potential project alternative in order to determine impacts and/or increases to the current flood plain and floodway. The following items will be included in this Task:

1. Data Gathering

- Develop GIS and Survey Base Mapping
- Perform Field Walk to verify conditions

2. Existing HEC-RAS Model Review

- River and Cross Section Geometry
- Flows and Boundary Conditions
- Flow Regime
- Hydraulic Model Gaps
- Bridge and Structure Modeling

3. Existing Conditions Evaluation

- Dike Overtopping
- Structure Deficiencies
- Localized Flooding
- Bridge Impacts
- Develop GIS Mapping of the Existing Conditions for various Storm Events

4. Alternative Analysis

- Post-Project Conditions Model(s) and GIS Mapping
- CLOMR/LOMR Evaluation
- FEMA Coordination

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[63] will only include work that is required to repair the canal

[61] Stage A: Base Flood Damage Repair Services, Reach 1

[62] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[63] Stage A: Base Flood Damage Repair Services, Reach 1

spillway and Reach 1 dike to preexisting conditions; and that Stage C[64] will include supplemental work that is required to support planned analyses and assessments.

E. <u>CITY Runoff Evaluation</u>

A detailed basin-by-basin analysis will be deferred to Phase 2 Final Design.

For the Phase 1 Alternatives Analysis, the **CONSULTANT** will develop a hydrologic model for the portion of the **CITY** that drains directly to the Canal. This model will be developed in order to evaluate the potential for Canal Dike overtopping resulting from **CITY** storm water runoff directly entering the Canal. The natural and constructed drainage systems which flow into the Canal contribute significantly to the total flow within the Canal. There are historical indications that flow from these contributing systems has directly resulted in overtopping the Canal. As such, modeling of contributing areas is proposed to quantify the impact of such systems to Canal Spillway performance. The models will also be used to evaluate the proposed project alternatives. The storm event of October 4, 2015 will be used to assess and evaluate overland and river inflow into the canal that resulted in the overtopping of the Canal Dike. The following items will be included in this task:

1. Data Gathering

- Obtain Existing Hydrologic & Hydraulic Models for the Canal's City-side Drainage Basin
- Obtain available GIS data including topography, drainage system inventory, utilities, roads, soils, structures, land usage, impervious surfaces, parcels, etc.

2. Existing Condition Analysis

- Delineate the Canal's City-side Drainage Areas using five composite drainage basins, Assign Land Cover Coefficients, Calculate Time of Concentrations based on GIS and Survey Data
- Develop Hydrologic Model to determine flows at each of the five composite discharge points into the canal using standard software such as SWMM, Autodesk Storm and Sanitary Analysis, HEC-HMS, etc.
- Validate Model Results Based on Historical and Anecdotal Data

3. Evaluate Existing Condition

- Establish Allowable Maximum Flows to minimize Canal Embankment Overtopping
- Develop GIS Mapping of the Existing Storm Elevations within the Canal associated with the city-side Drainage.

4. Develop Alternates

- Identify Potential Flow Reduction Alternatives to Reduce Peak Flows into Canal from **CITY** Drainage Systems

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[65] will only include work that is required to repair the canal

[64] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[65] Stage A: Base Flood Damage Repair Services, Reach 1

spillway and Reach 1 dike to preexisting conditions; and that Stage C[66] will include supplemental work that is required to support planned analyses and assessments.

F. Canal Spillway Capacity Analysis

The **CONSULTANT** will determine the hydraulic capacity of the Canal Spillway's Tainter Gates and Stop log Bays. The analysis will be based on the existing structure information augmented with field measurements (Task 7D). This information will be used for several Tasks including the Site Specific Breach Analysis (Task 10B), River Flooding (Task 10D) and **CITY** Storm Water Runoff Evaluation (Task 10E) to evaluate the overall hydraulic capacity of the Canal and potential for overtopping Inflow Design Flood (IDF) Evaluation.

The **CONSULTANT** will assess the hazard potential resulting from a failure of the Canal during flood flows in order to determine the adequacy of the Canal Spillway. The analysis will be developed in accordance with FERC Guidelines and the current standard of practice. The analysis will include storm events ranging from the 100-year to the Probable Maximum Precipitation (PMP).

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[67] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[68] will include supplemental work that is required to support planned analyses and assessments.

G. Overtopping Evaluation

A detailed overtopping evaluation will be deferred to Phase 2 Final Design. For the Phase 1 Canal Embankment Assessment, the **CONSULTANT** will evaluate the potential for an overtopping failure along the Canal Dike and at several critical structures including the headworks and powerhouse. This Task includes a preliminary evaluation of the Canal Dike embankment's estimated scour and armoring requirements.

The **CONSULTANT** will develop the following plan overlays to depict the results of the analysis and assess the project alternatives:

1. Site Specific Dam Breach Analysis
    a. The resulting breach waves from the Diversion Dam and Canal Dike will be depicted on a Plan Overlay, so that potential hazards can be identified.
2. River Flooding Evaluation
    a. The modeled River Flooding events will be depicted on a Plan Overlay.
3. **CITY** Storm Water Runoff Evaluation

[66] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[67] Stage A: Base Flood Damage Repair Services, Reach 1

[68] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

a. The limits of flooding associated with the urban storm water runoff within the Canal will be depicted on a Plan Overlay along with the major sources of the flows entering the Canal from the **CITY**.
b. The location of potential flow reduction alternatives will be shown on a Plan Overlay.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[69] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[70] will include supplemental work that is required to support planned analyses and assessments.

H. <u>TBR: Hydrologic and Hydraulic (H&H) Analysis</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 10 Hydrologic and Hydraulic Analysis performed. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The TBR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[71] will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[72] will include supplemental work that is required to support planned analyses and assessments.

TASK 11 - WATER SUPPLY ALTERNATIVES ASSESSMENT (STAGE B[73] ADDITIONAL SERVICES)

During the October 2015 flood, the Canal WTP was severely impacted and the **CITY** had an extremely difficult time producing drinking water. This is the single most important resource to the **CITY'** customers and citizens. Therefore, consideration needs to be given to the reliable operations of the Canal WTP when considering repairs done on the canal. Normal operation levels and volumes need to be maintained in the canal in such a manner that the plant is still able to withdraw water during and after the repair work. Alternative supply measures may also need to be addressed to bolster raw water supply capabilities both for the short- and long-term needs.

The Task 11 items below are defined to provide a review of raw water and finished water source alternatives to mitigate the risk of water supply loss to the City in the event of additional Canal breaches and failures. It is assumed that all items in this task are Tier 1 items except where specifically noted to be

[69] Stage A: Base Flood Damage Repair Services, Reach 1

[70] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[71] Stage A: Base Flood Damage Repair Services, Reach 1

[72] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[73] Stage B Tiers 1 and 2: Supplemental **CITY**' Requested Services

Tier 2. The Tier 2 items can be omitted and coarse assumptions made. The Tier 2 items are specifically addressed as follows:

- Subtask H – Subsurface Profiles: it will be assumed that entire route on land will be out of rock and any water body crossings will be in rock. Any tunneling will be assumed deep enough to remain in a rock strata.
- Subtask J – Finished Water Supply to the Canal WTP: This task can specifically be eliminated if it is the goal of the City to only focus on raw water supply options.
- Subtask M - TBR: Water Supply Alternatives Assessment – Intake alternatives: Only one intake concept will be used as a basis of comparing source alternatives.

A. <u>Evaluation Criteria Memorandum: Water Intake Source Alternatives</u>

The **CONSULTANT** will develop an evaluation criteria memorandum that will layout the goal and objectives for safe and reliable water supply alternatives for the Columbia Canal WTP. The memorandum will identify the following basis for evaluations:

- Define the planning horizon for which supply needs will be based
- Establish water supply levels of service for the Columbia Canal for the planning period
- Define finished water quality goals
- Identify regulatory limitations and requirements
- Establish the criteria for supply redundancy and resiliency relative to flow and water quality.
- Develop a summary of non-cost factors to be considered in the evaluation of each alternative, including relative weighting factors to be used in a decision matrix (e.g., source accessibility, reliability, etc.)

Facilitate a workshop with the **CITY** to review the goals and objectives for safe and reliable water supply alternatives for the Columbia Canal WTP. The anticipated attendees for this workshop will include:

- City of Columbia
- Water Plant Representative(s)
- Engineering
- Utility Management

The **CONSULTANT** will:

- Prior to the workshop, provide an agenda along with a list of meeting objectives.
- Conduct the workshop, including discussion on water quality, reliability, resiliency, and future supply needs and the potential criteria to be used to evaluate supply alternatives.
- Prepare and issue workshop meeting minutes for the **CITY** to review and comment.

Following the workshop, the **CONSULTANT** will:

- Prepare a draft technical memorandum documenting the water supply objectives and the evaluation criteria.
- Submit an electronic PDF of the draft technical memorandum to the **CITY** for review.

- Receive comments, address, and submit the final technical memorandum to the **CITY**.

For proposal preparation purpose, assume that Stage B Tier 1[74] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[75] effort will include supplemental work that is required to support planned analyses and assessments.

B. <u>Information Review</u>

The **CONSULTANT** will collect and review readily-available relevant information, which is anticipated to include the following.

- Previous raw water supply studies and alternatives analyses
- Previous water distribution planning studies
- River flow studies (7Q10) and available historical flow data for the following water bodies from gauging stations in the closest proximity of the of the Canal WTP:
  - Saluda River
  - Broad River
  - Congaree River
- Historical water quality data (Saluda River, Congaree River , Broad River, and from the canal) available from the **CITY**, West Columbia WTP monthly raw water monitoring reports and at other gauging stations in the closest proximity to the Canal WTP
- Water release operations for Lake Murray and Parr Reservoir
- **CITY** Canal WTP and Lake Murray operations, water quality records (monthly reports) and chemical feed record for water treatment
- WTP site plans and hydraulic profiles (if available), including any recent upgrades to the plant.

Perform review of source water quality for the following alternatives using available historical raw water quality data:

- Existing canal intake
- Canal upstream of its confluence with the Broad River
- Saluda River
- Congaree River downstream of its confluence with Saluda River and Broad River

For proposal preparation purpose, assume that Stage B Tier 1[76] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[77] effort will include supplemental work that is required to support planned analyses and assessments.

[74] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[75] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

[76] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[77] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

C. Available Reliable Capacity

Prepare an estimate of available reliable capacity from each water source alternative based on the information review, meetings with regulators and key stakeholders in the process along with the previous low flow frequency studies. The water sources to be considered in this task are:

- Existing canal intake
- Canal upstream of its confluence with the Broad River
- Saluda River
- Congaree River downstream of its confluence with Saluda River and Broad River

It is anticipated the meeting will be required with the following:

- City of Columbia
- South Carolina Department of Health and Environmental Control
- South Carolina Electric and Gas
- FERC
- USACE

For proposal preparation purpose, assume that Stage B Tier 1[78] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[79] effort will include supplemental work that is required to support planned analyses and assessments.

D. Sampling Plan (Deferred to Phase 2, outside the Scope of this proposal)

A Sampling Plan, if needed, will be developed during Phase 2 Final Design. *For proposal preparation purpose, it has been agreed that a Sampling Plan will not be prepared during Phase 1.*

If needed, Phase 2 Final Design will include development of a sampling plan for the **CITY** to collect additional raw water quality data on an on-going basis. The **CONSULTANT** will provide a written plan detailing water quality parameters to monitor, frequency of monitoring, and sampling analysis recommendations and references.

E. Bench Scale Testing (Deferred to Phase 2, outside the Scope of this proposal)

Bench Scale Testing, if needed, will be performed during Phase 2 Final Design. *For proposal preparation purpose, it has been agreed that Bench Scale Testing will not be performed during Phase 1.*

If needed, Phase 2 Final Design will include a bench-scale testing program using alternative water sources compared to the existing source water. Bench-scale testing will simulate the full-scale WTP's rapid mix, flocculation, and sedimentation processes based on design criteria. Treatment chemicals currently used at the WTP will be dosed and optimized during bench-scale testing to simulate the full-scale WTP. Glass fiber filters will be used to estimate filtered water quality from the bench-scale settled water samples. Chemical doses will be optimized on the various water sources for removal of turbidity, color, UV254 (as a surrogate for TOC), iron, and manganese. Upon determining optimal

[78] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[79] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

chemical dosages for each raw water source, disinfection byproduct formation (TTHM and HAA5 formation potential tests) will be tested based on current chlorination strategies. Testing will be completed once during cold-water conditions and once during warm-water conditions. Unless directed by the **CITY**, this phase of bench-scale testing will not include evaluation of alternative coagulants, oxidants, or disinfectants for optimization of performance. Hazen's mobile water supply lab will be located at the plant site for completion of testing. The **CITY** will be responsible for providing necessary electrical, water supply, and drainage to the mobile lab based on the requirements provided by Hazen.

The **CONSULTANT** will prepare a draft bench-scale testing protocol, including anticipated water quality analysis requirements and water samples to be provided by the **CITY**. The protocol will be delivered to the **CITY** for review and approval prior to the initiation of testing.

F. <u>Existing Treatment Process (Deferred to Phase 2, outside the Scope of this proposal)</u>

A review of the existing treatment process, if needed, will be performed during Phase 2 Final Design. *For proposal preparation purpose, it has been agreed that a review of the existing treatment process will not be performed during Phase 1.*

If needed, Phase 2 Final Design will include a review of the existing treatment processes at the Canal WTP to determine potential upgrades needed to adequately treat the alternative water sources. This will also include reviewing the capacity of existing bulk storage and chemical feed pumps for lime and coagulant) and reviewing the capacity of the existing residuals handling systems.

G. <u>Estimated Treatment Cost</u>

The Consultant will make a relative order-of-magnitude estimate of the change in treatment costs for the various sources, including chemical demand, as compared to the existing process. The **CITY** will provide current operations costs and unit chemical costs to the **CONSULTANT** for use in the evaluation. If available, the CONSULTANT will review current chemical consumption per volume of treated water from the City of West Columbia for a basis of comparison for the Saluda River Source.

For proposal preparation purpose, assume that Stage B Tier 1[80] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[81] effort will include supplemental work that is required to support planned analyses and assessments.

H. <u>Subsurface Profiles (Stage B Tier 2)</u>

The **CONSULTANT** will develop a subsurface profile utilizing available historic subsurface data as well as subsurface data obtained during Phase 1 that identifies the anticipated depth to top of rock. Information regarding the type and strength of rock will also be included, if available. The subsurface profile will be developed to assess the impact of the depth to top of rock relative to the following raw water supply alternatives.

- Canal upstream of its confluence with the Broad River
- Saluda River

[80] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[81] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

- Congaree River downstream of its confluence with Saluda River and Broad River

For proposal preparation purpose, assume that Stage B Tier 1[82] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[83] effort will include supplemental work that is required to support planned analyses and assessments.

I. Supply Conveyance Options

The **CONSULTANT** will evaluate supply conveyance options, including identifying a preliminary potential location for an intake on the alternative supply, developing preliminary routes to convey water to the Canal WTP, and sizing the conveyance system using either pipe or tunnel methodologies.

For proposal preparation purpose, assume that Stage B Tier 1[84] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[85] effort will include supplemental work that is required to support planned analyses and assessments.

J. Finished Water Supply to the Canal WTP (Stage B Tier 2)

The **CONSULTANT** will perform hydraulic simulations to determine the feasibility of supplying the Canal Water Treatment Plant with finished water from the Lake Murray Treatment Plant via the distribution system for emergency backup and also an alternate to the current Canal raw water supply. The existing system hydraulic model will be used to perform this analysis. The original hydraulic model was completed and calibrated by Woolpert in 2002 and updated by Brown and Caldwell and Hazen using the Bentley's WaterGEMS software. The model has not been calibrated since the original model development. However, system functionality and operation was confirmed with Columbia personnel. It is not anticipated that the model will be recalibrated for these preliminary analysis.

The following items will be performed to analyze the feasibility of a finished water supply alternative:

- Develop analysis criteria for the model simulations.
- Perform the hydraulic simulations to determine the piping size required and the ability of the pipe to be connected to supply the Canal WTP.
- Evaluate two (2) potential pipe line routes for the purpose of developing an alternative cost.
- Develop a construction cost for the proposed routes to compare with the other alternatives.

For proposal preparation purpose, assume that Stage B Tier 1[86] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier

[82] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[83] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

[84] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[85] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

[86] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

2[87] effort will include supplemental work that is required to support planned analyses and assessments.

K. <u>50-Year Present Worth Analysis</u>

A 50-year present worth analysis for each raw water supply alternative will be performed, including:

- Maintain existing canal water supply
- Broad River raw water supply
- Saluda River raw water supply
- Congaree River raw water supply
- Lake Murray via finished water supply

L. <u>Workshop</u>

The **CONSULTANT** will facilitate a workshop with project stakeholders to review scoring of each alternative and reach consensus on recommendations. The anticipated attendees for this workshop will include:

- City of Columbia
- South Carolina Department of Health and Environmental Control
- South Carolina Electric and Gas
- FERC

The **CONSULTANT** will:

- Prior to meeting, provide agenda along with associated information related to the options evaluated.
- Conduct meeting – discuss results and receive comments; preview next steps.
- Prepare and issue meeting notes for the **CITY** to review and comment.

For proposal preparation purpose, assume that Stage B Tier 1[88] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[89] effort will include supplemental work that is required to support planned analyses and assessments.

M. <u>TBR: Water Supply Alternatives Assessment</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 11 water intake source Alternatives Assessment. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary.

[87] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

[88] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[89] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

In addition, the following will be documented in the TBR for the Water Supply Alternatives Assessment.

- Estimated reliable safe yield from each water source option;
- Estimated treatment costs for each water supply, and recommendations as to the validity of treating each water supply alternative;
- Evaluation of alternative raw water supply to the Canal Water Plant including:
    - Intake concepts to access the raw water source (Tier 2 effort)
    - Route and sizing alternatives for raw water conveyance. Two delivery concepts will be considered for each alternative source with the exception of the existing canal source.
    - Planning-level construction cost estimates for the proposed routes
- Evaluation of supplemental finished water supply to the Canal Water Plant including (Tier 2 effort):
    - Route and sizing alternatives for two (2) routes
    - Construction cost estimates for the proposed routes
- Calculation of the 50-year present worth analysis for each raw water supply alternative in electronic PDF format.

The TBR will be referenced as applicable in the Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose, assume that Stage B Tier 1[90] work will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage B Tier 2[91] effort will include supplemental work that is required to support planned analyses and assessments.

TASK 12 - SECTION OMITTED

OMITTED SECTION

TASK 13 - CANAL STRUCTURES ANALYSIS (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

The **CONSULTANT** will assess the stability of the canal spillway, generate a conceptual design for replacement of current fixed stoplogs with removable stoplogs, generate a conceptual design replacement of the spillway bridge with a structure capable of allowing the removal of the stoplogs and with sufficient structural capacity to allow limited emergency and construction equipment to cross the bridge, and assess the overall condition of the canal structure. Work to assess the canal dike will be

[90] Stage B Tier 1: Supplemental **CITY**' Requested Services to deliver base repair services

[91] Stage B Tier 2: Supplemental **CITY**' Requested Services to deliver a higher level of flood resiliency confidence

addressed in Task 16. Work to address the condition of the canal headworks will be performed by others as identified by Task 13E under separate contract with the **CITY**.

A. <u>Design Criteria Memorandum: Canal Structures Analysis</u>

A Design Criteria Memorandum (DCM) will be developed to identify the analysis and investigations to be performed to assess the canal structures/elements described below under Task 13. The DCM will describe the means, methods and assumptions to be used in the analysis.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[92] Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[93] Additional Services will include supplemental work that is required to support planned analyses and assessments.

B. <u>Canal Spillway Assessment & Modifications</u>

1. Assessment of Structure Stability

A stability analyses of the canal structure will be performed in compliance with FERC's Engineering Guidelines for Evaluation of Hydropower Projects (Guidelines). Two sections will be analyzed, one of a Tainter gate bay, and a one-foot strip of the stoplog regulated spillway. The structure will be analyzed using two dimensional limited equilibrium analyses (gravity method). The analyses will be performed for five load cases:

- Case 1 - Normal Operating Level (El. 150.5 feet),
- Case 2 - Top of Stoplogs (High Normal Operating Level, El. 153.8 feet),
- Case 3 - Flood Condition (canal water level at the top of dike with stoplogs removed),
- Case 4 - Extreme Flood Condition (canal water level at the top of dike with stoplogs in place, representative of the October 2015 flood condition), and
- Case 5 - Seismic.

Tailwater levels for Cases 1, 2, and 5 will be at normal levels, and tailwater levels used in Cases 3 and 4 will be determined based on historical information or the dam break analysis performed to assess the hazard classification of the canal (Task 10B). Foundation parameters will be based on subsurface investigations and stability analyses of the October 2015 flood.

The canal spillway is constructed of stone masonry, therefore stability analyses for seismic loading will be performed using the pseudo-static method based on peak ground accelerations published by The United States Geological Society for the project area.

If the stability analyses indicate that the structure's factors of safety do not meet the requirements of the Guidelines (Chapter 3, Table 13-1 (table follows)), then additional analyses will be performed to determine the magnitude of post-tensioned anchors needed to bring the structure into compliance. The analyses performed will be sufficient in detail so that they do not have to be extensively redone to support the final design of the post-tensioned anchors and design of the means to transfer the anchor loads into the masonry structure.

[92] Stage A: Base Flood Damage Repair Services, Reach 1

[93] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

Alternate Recommended Minimum Factors of Safety
for Use in Conjunction with a No Cohesion Assumption

Loading Condition	Factor or Safety
Worst Case (see Note 5, below)	1.5
Flood if Flood is PMF (see Note 6, below)	1.3
Post-Earthquake	1.3

Notes:

5 The worst static case is defined as the static load case with the lowest factor of safety. It shall be up to the analyst to determine the worst static case and to demonstrate that it truly is the worst static case.

6 Because the PMF is by definition the flood that will not be exceeded, a lower factor of safety may be tolerated. Therefore if the worst static case is the PMF, a factor of safety of 1.3 is acceptable. If the IDF is not the PMF, then the safety factor for the worst case shall control.

Figure 13-1- Alternate Recommended Minimum Factors of Safety for Use in Conjunction with a No Cohesion Assumption

The use of post-tensioned anchors, over the addition of mass concrete to improve the structure's stability, allows the structure to appear visually unchanged thereby addressing any concerns that SCSHPO may have with the proposed modifications. A conceptual design (10% design level) of the anchors and the concrete elements needed to transfer the anchor loads into the masonry structure will be in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the design and installation of the post-tensioned anchors and concrete elements will be performed during Phase 2 final design.

In order to obtain the dimensional information needed to perform the stability analyses, *assuming that there are no drawings available of the structure,* a field survey will be performed to measure the structure. Two borings will also be drilled through the spillway (Task 9B) to validate how the structure was constructed, determine allowable and ultimate bearing capacities for the masonry, determine an average unit weight of the masonry, and establish a sliding friction factor along the stone masonry – rock foundation contact interface. The borings are anticipated to extend about 35 feet into bedrock (about the tip of any anchors if needed) to assess the type of foundation rock, the rock's quality, and the unit weight for use in designing the rock anchors.

For proposal preparation purpose, assume that Stage A[94] Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[95] Additional Services will include supplemental work that is required to support planned analyses and assessments.

[94] Stage A: Base Flood Damage Repair Services, Reach 1

[95] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

2. Removable Stop Logs

Analyses will be performed and a conceptual design generated for the fabrication and installation of removable stoplogs in the canal spillway. The conceptual design (10% design level) will be in sufficient detail to develop an opinion of probable construction costs to facilitate the Phase 1 Alternatives Analysis. *In order to minimize a significant change in appearance to the spillway and to provide stoplogs of a manageable weight for handling, the **CONSULTANT** assumed that the stoplogs will be similar in dimensions of the non-removable stoplogs (twelve, 5.5' high x 11.17 feet wide panels) shown on the project's FERC License Exhibits.* Drawings and specifications detailing the fabrication of the stoplogs will be performed during Phase 2 final design.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence consideration of removable stop logs will be completed under Stage C[96].

3. Bridge Replacement

A qualitative bridge inspection of the bridge over the spillway will be conducted as part of Task 7E. Particular attention will be placed on identification of possible flood damage, such as evidence of recent scour activity based on visual observation and soundings and/or possible member damage from floating debris.

Analyses will be performed and a conceptual design (10% design level) generated for a replacement bridge over the canal spillway that is in sufficient detail to develop an opinion of the order-of-magnitude probable construction cost to facilitate the Phase 1 Alternatives Analysis. In order to minimize a significant change in appearance to the spillway the bridge will be similar in dimensions and geometry as the existing bridge. The replacement bridge is anticipated to be constructed of low maintenance materials and with a structural capacity and other modifications needed to support and accommodate emergency and construction equipment of limited weight. The bridge will be configured to include small removable deck sections in strips to allow access to and removal of the spillway stoplogs using a boom truck or small crane that does not require the use of outriggers to lift the panels. Drawings and specifications detailing the construction of the replacement bridge will be developed during Phase 2 final design.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence consideration of removable stop logs will be completed under Stage C[97] Additional Services.

4. Masonry Structure and Abutment Walls

A qualitative inspection of the canal spillway structure will be conducted as part of Task 7D. The physical condition of the masonry structure will be assessed to determine if there are repairs needed to replace or secure missing, loose or damaged stone masonry; repairs to replace missing masonry will be done using reinforced concrete. Particular attention will be placed on identification of possible flood damage, such as visual evidence of recent scour activity and/or

[96] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[97] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

possible member damage from floating debris. Leakage from the spillway structure will also be assessed, with a specific focus on the leakage that occurs along the structure's wing walls. The assessment of leakage will be done based on discussions with operating personal with a long knowledge of the structure's condition; the canal's water level is currently 3 to 5 feet below normal and maximum operating levels and therefore direct observation of leakage under those conditions cannot be observed. Repairs needed will be described in sufficient detail (10% design level) to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the implementation of the repairs will be developed during Phase 2 final design.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence consideration of removable stop logs will be completed under Stage C[98] Additional Services.

C. <u>Existing Hydroelectric Plant</u>

An assessment of the existing hydroelectric plant will be performed to determine what repairs or modifications are needed to return the plant to operation. An evaluation will also be made to determine what means are needed to decommission the powerhouse and either remove, abandon, or repurpose the structure.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence the following restart and decommissioning considerations about the existing hydroelectric plant will only be completed under Stage C[99] Additional Services.

1. Restart (maintain FERC License)

a. <u>Powerhouse Stability</u>

A stability analysis of the powerhouse will be performed in compliance with FERC's Engineering Guidelines for Evaluation of Hydropower Projects (Guidelines) because no such analysis currently exists. One section will be analyzed, typical of a bay associated with one turbine-generator unit. The structure will be analyzed using two dimensional limited equilibrium analyses (gravity method). The analyses will be performed for five load cases:

- Case 1 - Normal Operating Level (El. 150.5 feet),
- Case 2 – High Normal operating Level (El. 153.8 feet),
- Case 3 – Normal Operation with Unit Dewatered,
- Case 4 - Extreme Flood Condition (point where powerhouse will be flooded, canal water level at the top of dike with elevated tailwater level representative of the October 2015 flood condition), and
- Case 5 - Seismic.

[98] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[99] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

Tailwater levels for Cases 1, 2, and 5 will be at normal levels, and tailwater levels used for Case 4 will be based on historical levels when the powerhouse is flooded. Foundation parameters will be based on the subsurface investigation results (Task 9) and stability analysis of the October 2015 flood.

The powerhouse structure is constructed of stone masonry, therefore stability analyses for seismic loading will be performed using the pseudo-static method based on peak ground accelerations published by The United States Geological Society for the project area.

If the stability analyses indicate that the structure's factors of safety do not meet the requirements of the Guidelines (Chapter 3, Table 13-2 (table follows)), then additional analyses will be performed to determine the type and magnitude of modifications needed to bring the structure into compliance. The additional analyses performed will be sufficient in detail so that they do not have to be extensively redone to support Phase 2 final design of the modifications.

Alternate Recommended Minimum Factors of Safety
for Use in Conjunction with a No Cohesion Assumption

Loading Condition	**Factor or Safety**
Worst Case (see Note 5, below)	1.5
Flood if Flood is PMF (see Note 6, below)	1.3
Post-Earthquake	1.3

Notes:

5 The worst static case is defined as the static load case with the lowest factor of safety. It shall be up to the analyst to determine the worst static case and to demonstrate that it truly is the worst static case.

6 Because the PMF is by definition the flood that will not be exceeded, a lower factor of safety may be tolerated. Therefore if the worst static case is the PMF, a factor of safety of 1.3 is acceptable. If the IDF is not the PMF, then the safety factor for the worst case shall control.

Figure 13-2- Alternate Recommended Minimum Factors of Safety for Use in conjunction with a No Cohesion Assumption

Modifications proposed will be done bearing in mind the historical significance of the powerhouse to the community and the need to obtain approval from the SCSHPO to construct any improvements needed. Repairs or modifications needed will be described in sufficient detail (10% design level) to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the implementation of the repairs will be developed during Phase 2 final design.

In order to obtain the dimensional information needed to perform the stability analyses, assuming that there are no drawings available of the structure, a field survey will be performed to measure the structure. Based on current knowledge of the powerhouse regarding its construction, no borings or subsurface investigations of the powerhouse are proposed at this time.

b. Equipment Rehabilitation

The hydroelectric generators, switchgear and controls and other electrical systems/equipment were damaged during the October 2015 flood when the powerhouse was intentionally flooded to prevent a structural collapse of any the walls as a result of unbalanced hydrostatic loads that were acting on them. The **CONSULTANT** understands that the generators must be cleaned and dried out before they can be restarted, the switchgear and controls must be replaced, and other electrical systems/equipment repaired or replaced. In discussion with plant operating personnel, the **CONSULTANT** understands that it is probable that the switchgear and controls will be relocated from inside of the plant to an area atop the dike adjacent to the plant. It is also understood that the repairs will be made using money from an insurance policy which was carried that covered damage or loss of the plant's generator equipment including the damaged electrical equipment/systems.

The work to be performed in support of the Phase 1 Alternatives Analysis (Task 19) is to identify what equipment needs to be repaired or replaced, what equipment is to be relocated to reduce the potential for future flooding, ascertain if the insurance funds are sufficient to perform the work needed, and identify what additional funds may be needed to performed the required work. It is currently understood that the work to rehabilitate and return the hydroelectric plant to operation is the responsibility of the **CITY**'s plant operator, Lockhart Power Company.

2. Decommissioning

Decommissioning is not a simple matter of removing an electrical breaker, locking the doors, and walking away. Decommissioning could involve demolishing and removal of the hydroelectric plant in its entirety, securing the plant to allow abandonment of the structure, or securing and modifying the plant for use for other purposes. Decommissioning of the hydroelectric plant will not have any impact on the work needed to address the condition or requirements for the canal's dike, spillway, or headworks structure or the water treatment plant's intake. No subsurface investigations are proposed at this time.

a. Surrendering of License

Any decommissioning of the hydroelectric plant whether removed, abandoned, or repurposed will require the surrender of the FERC License. The surrender of the License is not only for the hydroelectric plant but includes removing the whole of the canal and the diversion dam from FERC's jurisdiction.

To surrender a license for any hydroelectric project whether operational or not requires the development of a mini-Environmental Assessment (mEA) using existing information and a Decommissioning Plan (DP). *The **CONSULTANT** has assumed that there will be sufficient information available to address a mEA without the need to conduct supplemental studies or analyses. For proposal preparation purpose and in consideration of the timing and flow of the work, it has been assumed that the mEA described in Task 13 will use the results from Task 4 to pursue an independent track to meet the needs described in Task 13.C.*

The mEA will address: aquatic resources such as what is to happen with the existing upstream and downstream fish passage facilities; impacts to aquatic or terrestrial species in the canal;

impacts to water quality; how will release of flows at the diversion dam and canal be maintained and controlled; impacts to recreational use; impacts to cultural resources; structural condition and stability of water retaining structures and will they comply with SCDNR's dam safety requirements; and how the **CITY**'s water supply will be maintained or impacted.

The DP will address in detail what modifications or work is to be performed to shutdown, decommission, remove, secure, or otherwise modify water retaining structures to serve in a new role.

Phase I work will involve contacting FERC and applicable natural resources and environmental agencies to determine what information or studies will be required to surrender the FERC Licensee, what mitigation actions the natural resources and environmental agencies anticipate that they will require in support of the license surrender, and to obtain and review available information that could be used to develop the mEA; and Phase I work is considered to be a scoping exercise. The mEA and DP will be developed only if the FERC License is to be surrendered (part of work of Phase 2 final design), but the cost for developing the mEA and DP will be identified in the TBR.

Contact with agency personnel during Phase I work will be by phone or meeting rather than holding a large meeting of all agency personnel.

b. Demolish and Remove

An opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis will be generated for the complete demolition and removal of the hydroelectric plant and all associated equipment. Conceptual design (10% design level) drawings will be developed in sufficient detail to descript the closure concept and develop the cost opinion.

Because the powerhouse serves as the closure for the downstream end of the canal, another means to close the canal will be needed to replace the demolished powerhouse. The location and means to close the canal will have an aesthetics impact on the EdVenture Museum and the esplanade on the city-side of the canal as well as having to interface with the work to restore the canal dike downstream of the Klapman Street Bridge. The assessment of the multitude of options possible for the closure structure is beyond the intended scope of the Phase I work.

*For the Phase I work performed in support of the Alternatives Assessment, the **CONSULTANT** has assumed for simplicity that the structure used to close off the canal will be an earthen dike, like that used to repair the breaches in the canal; and the closure dike will extend from the west end of the esplanade to end at the downstream end of the dike used to repair the breach in the canal.* Closing the end of the canal will provide water along the esplanade.

The closure structure should also include a crest type bottom hinged gate to allow release of flow from the canal for water quality purposes, allow flushing of debris that accumulates at the downstream end of the canal, and include a low level outlet gate to allow draining of the canal. The discharge from the crest gate could also be used for recreational purposes. A conceptual design (10% design level) arrangement drawing will be generated to describe the closure and in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis.

There are a number of ways to close off the end of the canal, and all will have a visual impact on, and affect the use of EdVenture Museum and the esplanade. The exact means to be used to close off the canal will be addressed in Phase 2 final design wherein drawings and specifications will ultimately be developed detailing the demolition of the hydroelectric plant and construction of the canal closure.

c. Abandonment

An opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis will be generated for the in-place abandonment of the hydroelectric plant and all associated equipment.

Abandonment of the plant will require permanently plugging the penstocks to the seven turbines and possibly the downstream fish passage structure; de-energizing and removing the existing step-up transformer and associated substation; and removal of all oil and grease. External trash racking equipment, trash racks and support structure and other features should be removed as they will ultimately deteriorate and collapse into the canal. Stability analyses of the hydroelectric plant will have to be performed to document that the plant is stable and safe to remain in-place in compliance with SCDNR's regulations, and if it is not safe then remedial modifications will be needed before it is abandoned; stability analyses performed for Task 13.C.1.a will be adequate to address the stability of the powerhouse if abandoned. Existing features currently in place to prevent the flooding of the powerhouse through windows or other openings will have to be opened to allow the powerhouse to flood automatically to prevent a structural collapse of its walls under unbalanced hydrostatic load.

Abandonment also results in the loss of means to release flow and debris at the downstream end of the canal. Abandonment should also include the construction of a crest type, bottom hinged gate to allow release of flow from the canal for water quality purpose, allow flushing of debris that accumulates at the downstream end of the canal, and include a low level outlet gate to allow draining of the canal; similar to that described in Task 13.C.2.b. The discharge from the gate could also be used for recreational purposes. A conceptual design (10% design level) arrangement drawing will be generated to describe the closure and in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the work to be performed to allow abandonment of the hydroelectric plant will be developed during the Phase 2 final design.

d. Repurposing

An opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis will be generated for the repurposing of the hydroelectric plant and associated equipment for educational purposes.

Repurposing will require permanently plugging the penstocks to the seven turbines and the downstream fish passage structure; de-energizing and removing the existing step-up transformer and associated substation; and removal of all oils and greases. External trash racking equipment, trash racks and support structure and other features should be removed as they ultimately deteriorate and collapse into the canal. Stability analyses of the hydroelectric plant will have to be performed to document that the plant is stable and safe to remain in place in compliance with SCDNR regulations, and if it is not safe then remedial modifications will be needed before it is abandoned; stability analyses will be performed as described in Task 13.C.1.a. Existing features currently in-place to flood the plant to prevent a structural collapse of its walls under unbalance hydrostatic load will need to continue being operated and may have to be modified; in addition a means to dewater the plant after it has been flooded will need to be added.

Repurposing also results in the loss of means to release flow and debris at the downstream end of the canal. Repurposing should include the construction crest type, bottom hinged gate to allow release of flow from the canal for water quality purposes, allow flushing of debris that accumulates at the downstream end of the canal, and include a low level outlet gate to allow draining of the canal; similar to that described in Task 13c.2.b. The discharge from the gate could also be used for recreational purposes.

Repurposing for educational purposes will require cleaning and painting of the plant and equipment, improve lighting and ventilation systems, modifications to bring the plant into compliance with ADA accessible requirements, modifications to restrict visitors and to prevent injury to those touring the plant, and informational signage that describes the function and purpose of what is being viewed.

A conceptual design (10% design level) arrangement drawing will be generated in conjunction with a closure description in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the work to be performed to allow repurposing and use of the hydroelectric plant will be developed during Phase 2 final design.

D. Diversion Dam (deferred to Phase 2, outside the scope of this proposal)

During Phase 2, the **CONSULTANT** will perform a stability analysis of the Diversion Dam in compliance with FERC's Engineering Guidelines for Evaluation of Hydropower Projects (Guidelines) because no such analysis currently exists. Due to the dam's varying geometries and foundation conditions, five sections will be analyzed (see locations identified as Sections B through F on Figure 13-4). The structure will be analyzed as one foot strips or bays, as applicable, using two dimensional limited equilibrium analyses (gravity method). The analyses will be performed for five load cases:

- Case 1 - Normal Operating Level (El. 153.5 feet),

- Case 2 – Flood Condition (representative of the October 2015 flood condition with impoundment at El. 163.5 feet ±),
- Case 3 – Inflow Design Flood (approximately the 100-year flood Elevation 172 feet ±), and
- Case 4 - Seismic.

Tailwater levels for Cases 1 and 4 will be at normal levels, and tailwater levels used Cases 2 and 3 will be determined based on historical information or the dam break analyses performed to assess the hazard classification of the dam (Task 10B). Foundation parameters will be based on the stability analyses of the Normal Pond and October 2015 flood.

The Diversion Dam is a very short structure, initially constructed as a rock-filled timber crib structure and subsequently capped with concrete and buttressed with concrete piers. Due to the nature of the dam's construction, stability analyses for seismic loading will be performed using the pseudo-static method based on peak ground accelerations published by The United States Geological Society for the project area.

If the stability analyses indicate that the structure's factors of safety do not meet the requirements of the Guidelines (Chapter 3, (Table 13-3 table follows)), then additional analyses will be performed to determine the magnitude of modifications needed to bring the structure into compliance. If the optimum modification involves post-tensioned anchors, the analyses performed will be sufficient in detail so that they do not have to be extensively redone to support Phase 2 final design of the post-tensioned anchors and design of the means to transfer the anchor loads into the structure.

Alternate Recommended Minimum Factors of Safety
for Use in Conjunction with a No Cohesion Assumption

Loading Condition	Factor or Safety
Worst Case (see Note 5, below)	1.5
Flood if Flood is PMF (see Note 6, below)	1.3
Post-Earthquake	1.3

Notes:

5 The worst static case is defined as the static load case with the lowest factor of safety. It shall be up to the analyst to determine the worst static case and to demonstrate that it truly is the worst static case.

6 Because the PMF is by definition the flood that will not be exceeded, a lower factor of safety may be tolerated. Therefore if the worst static case is the PMF, a factor of safety of 1.3 is acceptable. If the IDF is not the PMF, then the safety factor for the worst case shall control.

Figure 13-3- Alternate Recommended Minimum Factors of Safety for Use in Conjunction with a No Cohesion Assumption

The use of post-tensioned anchors, over the addition of mass concrete to improve the structure's stability, allows the structure to appear visually unchanged thereby addressing any concerns the SCSHPO may have with the proposed modifications. A conceptual design (10% design level) of the anchors and the concrete elements needed to transfer the anchor loads into the structure will be in sufficient detail to develop an opinion of probable construction cost to facilitate the Phase 1

Alternatives Analysis. Drawings and specifications detailing the design and installation of the post-tensioned anchors and concrete elements will be performed during Phase 2 final design.

In order to obtain the dimensional information needed to perform the stability analyses, *assuming that there are no drawings available of the structure,* a field survey will be performed to measure the structure at the locations where the sections are to be analyzed. No borings or other geotechnical investigations are proposed at this time.

E. <u>Canal Headworks</u>

The **CONSULTANT** understands that Kleinschmidt (also a member of the **CONSULTANT**'s team) and Chao & Associates (Kleinschmidt-Chao) have been engaged by the **CITY** to analyze and design remediation to the headworks structure (Figure 13E) for the construction of measures that will allow the headgates gates to be closed to prevent the uncontrolled release of flow into the canal. The **CONSULTANT** understands that Kleinschmidt-Chao will assess and address the stability of the headworks structure; design replacements for the headgates and operators; design trash racks and a trash rake and debris handling system; and design a replacement lock gate. Any geotechnical investigations of the headworks structure will be the responsibility of Kleinschmidt-Chao even if they use the services of F&ME who is also a member of the **CONSULTANT**'s team. The assessment of the earthen embankment dam on the east side of the headworks structure will be performed by the **CONSULTANT** as part of Task 15. The **CONSULTANT** also understand that Kleinschmidt-Chao are to work with the **CITY** in the tendering of bids to construct the rehabilitation measures and monitor is construction.

In support of the **CONSULTANT**'s development of a coordinated restoration plan for the canal and associated structures, **CONSULTANT** will contact and coordinate with Kleinschmidt-Chao to obtain construction cost information for **CONSULTANT**'s use and inclusion in the Canal Embankment Assessment Report.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence the work described in the preceding discussion about the canal headworks will only be completed under Stage C[100] Additional Services.

F. <u>TBR: Canal Structures Analysis</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 13 canal structures analysis. The TBR will be a multi-volume document; and findings for each structure analyzed will be presented in a separate volume to facilitate progressive delivery of findings on a structure-by-structure basis. The TBR will identify the means, methods, and assumptions used to perform the work; describe in concept the modifications needed for the structure or structure's element(s) to meet design requirements of the governing agency; include a plan and figures as needed to describe the modifications; include a tabular summary of benefits and disadvantages for alternatives considered; include an order-of-magnitude opinion about probable construction cost for comparison of alternatives; and include an executive summary. The TBR will be referenced as

[100] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analyses of the options.

For proposal preparation purpose, assume that Stage A[101] Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and that Stage C[102] Additional Services will include supplemental work that is required to support planned analyses and assessments.

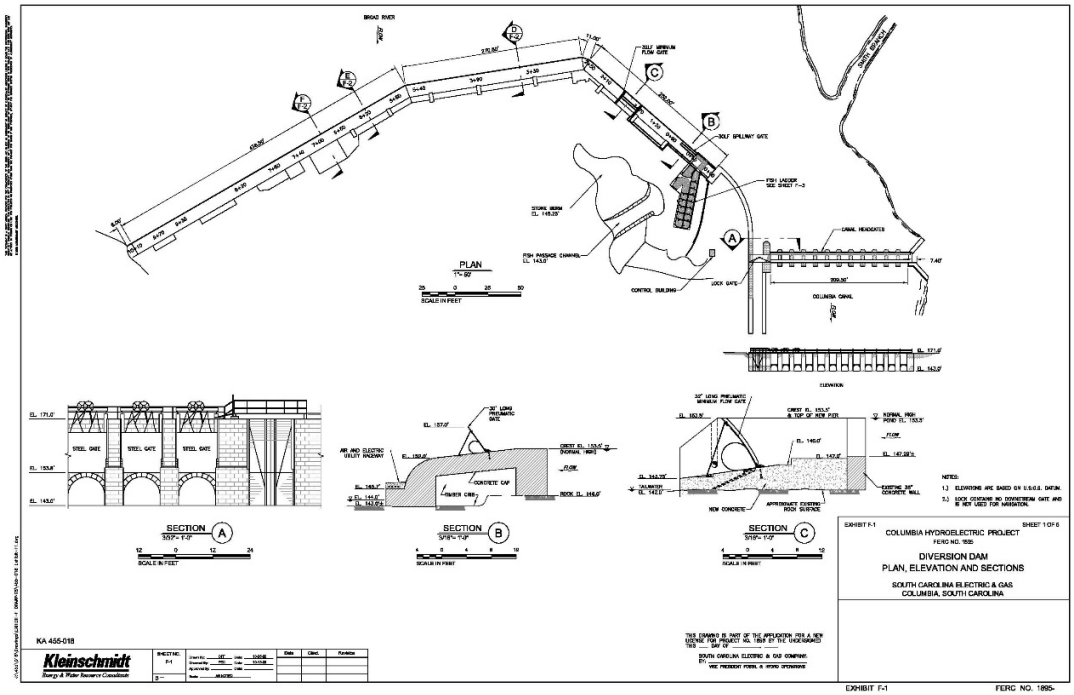

Figure 13-4- Diversion Dam

[101] Stage A: Base Flood Damage Repair Services, Reach 1

[102] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

TASK 14 - MASONRY DRAINAGE TUNNEL CONDITION ASSESSMENT (STAGE C ADDITIONAL SERVICES)[103]

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the canal spillway and Reach 1 dike to preexisting conditions; and hence the masonry drainage tunnel condition assessment will be completed under Stage C[104] Additional Services.

A. Survey and Structure Information

A survey will be performed to map the location of the masonry drainage tunnel that extends beneath the canal from the water treatment plant to the abandoned water pumping plant (Task 5F), and a review of available document will be performed to obtain any information on the design, construction, or condition of the tunnel (Task 6).

B. Assess Condition and Need for Repair

The **CONSULTANT** will conduct a qualitative inspection of the drainage tunnel to supplement the LiDAR survey (Task 5A) with hand-taped measurements (see Task 14 for additional detail). Readily-available documentation (from Task 6) will be reviewed. The tunnel will be field viewed to visually observe and photograph the general condition. Particular attention will be placed on identification of possible flood damage, such as visual evidence of recent scour activity and/or possible member damage from floating debris. An evaluation of the physical condition of the stone masonry tunnel will be made to determine if there is any need for repair or improvements to its structural integrity or capacity, and to determine if there is a need to address seepage / leakage into the tunnel. The canal's water level is currently 3 to 5 feet below normal and maximum operating levels therefore seepage/leakage may be reduced, or not occurring in locations where it normally occurs**.** A Technical Memorandum with field notes, field sketches and representative photographs will be prepared to document inspection findings.

In consultation with the **CITY**'s Jon Sherer, we understand that the tunnel normally has very little depth of water within. Although the **CITY** is currently discharging flow into the tunnel that results in a water depth of 6-inches deep in the tunnel, the current discharge is supposed to terminate about mid-June 2016. *Hence, for proposal preparation purpose, it has been assumed that the tunnel is accessible over the complete length of tunnel using 1) confined-space entry protocol to perform a visual condition assessment for structural integrity and 2) without the use of underwater equipment.* Upon completion of the condition assessment a determination will be made as to the need for coring of the masonry to assist in assessing its condition or structural capacity.

Repairs needed will be noted on a survey drawing and described in sufficient detail (10% design level) to develop an opinion of probable construction cost to facilitate the Phase 1 Alternatives Analysis. Drawings and specifications detailing the implementation of the repairs will be developed during Phase 2 final design.

[103] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[104] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

C. TBR: Masonry Drainage Tunnel Condition Assessment

A stand-alone TBR will be prepared to summarize and present work product for the Task 14 masonry drainage tunnel (under canal) condition assessment. The TBR will identify the means, methods, and assumptions used to perform the work; describe in concept the repairs or modifications needed for the structure to meet design requirements of the governing agency; include a plan and figures as needed to describe the modifications; include a tabular summary of benefits and disadvantages for alternatives considered; include an order-of-magnitude opinion about probable construction cost for comparison of alternatives; and include an executive summary. The TBR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analyses of the options.

TASK 15 - EMBANKMENT (DIKE) GEOTECHNICAL ANALYSES (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. Design Criteria Memorandum: Dike Seepage and Stability

As indicated in the Scope of Services Introduction Section E.1, dike seepage and stability analyses (10% design level) will be completed in accordance with FERC requirements for a high hazard project. A Design Criteria Memorandum (DCM) will be developed to identify the analyses to be performed. The DCM will describe the criteria, critical failure modes, analytical methods, foundation and embankment material properties and shear strength parameters, assumptions, loading conditions and factors of safety that will be considered for analysis.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[105] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[106] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. Geotechnical Analyses

A stability and seepage analysis (10% design level) will be performed in accordance with FERC Engineering Guidelines for the Evaluation of Hydropower Projects for static and seismic conditions. These analyses will be performed utilizing the data obtained during the subsurface investigation (Task 9) as well as bathometric and topographic survey data (Task 5). These analyses will be performed at four (4) discrete locations along the dike and at the proposed reconstructed portion of the dike at the breach.

Embankment stability will be analyzed for the following loading conditions, based on the prevailing seepage condition(s).

- Sudden drawdown from maximum pool (upstream slope)
- Sudden drawdown from spillway crest or top of gates (upstream slope)
- Steady state seepage with maximum storage pool (upstream and downstream slopes)

[105] Stage A: Base Flood Damage Repair Services, Reach 1

[106] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

- Stead state seepage with surcharge pool (downstream slope)
- Earthquake (for steady stage seepage condition with seismic loading using a pseudo-static lateral force coefficient, upstream and downstream slope)

An assessment of potentially liquefiable soil, potential piping, internal erosion, interior drainage systems, and available toe protection will be performed.

Embankment erodibility will be evaluated. The presence of existing trees and root penetrations will be considered with regard to risk of probable failure modes.

A qualitative assessment will be made regarding the potential and magnitude of future loss of freeboard as a result of dike settlement, in particular where the dike breach is reconstructed.

A deterministic seismic hazard evaluation will be performed to arrive at earthquake ground motion parameters for analysis of seismic loading conditions.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[107] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1 (no seismic and no liquefaction analyses in Stage A); and that Stage C[108] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

C. <u>TBR: Embankment (Dike) Geotechnical Analyses</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 15 embankment (dike) geotechnical analyses. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The TBR will be referenced as applicable in the dike repair strategies (Task 16) and Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[109] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[110] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

[107] Stage A: Base Flood Damage Repair Services, Reach 1

[108] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[109] Stage A: Base Flood Damage Repair Services, Reach 1

[110] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

TASK 16 - EMBANKMENT (DIKE) REPAIR ASSESSMENT (STAGE A BASIC SERVICES AND STAGE C ADDITIONAL SERVICES)

A. Dike Reconstruction / Repair

A qualitative assessment (10% design level) will be performed to evaluate viable alternatives, with comparative benefits, challenges and disadvantages, as well as an opinion rendered about the order-of-magnitude probable construction cost to facilitate the Phase 1 Alternatives Analysis (Task 19). To do this, results from the project mapping (Task 5), Historical Data (Task 6), detailed field reconnaissance (Task 7), dike conditions assessment (Task 8), subsurface investigation (Task 9) and dike seepage and stability analysis (Task 15) will be used to sub-divide the dike into distinct reaches and segments for analysis. Factors/situations considered will generally include the following.

1. Hydroelectric Plant to Canal Spillway

a. Temporary cofferdam removal
- Seepage cutoff/control
- Dike embankment repair

b. Former water pumping plant
- Seepage cutoff/control
- Dike penetration treatment
- Possible penstock breach assessment

c. Existing hydroelectric plant
- Permanent repairs to areas that were overtopped
- Dike damage repair on upstream side of existing structure(s)

d. Remains of hydroelectric plant to textile mill (by breach)
- Option where former hydroelectric plant remains are removed from within the rebuild foot print
- Option (if any) where former hydroelectric plant remains to the textile mill are left exposed and not located within the rebuild foot print

e. New concrete spillway in proximity to dike breach

f. Remains of upstream hydroelectric (former prison hydroelectric plant)
- Disposition of plugging at abandoned penstocks
- Seepage cutoff/control

g. Rebuilding of breached section of dike
- Seepage cutoff/control
- Dike penetration treatment
- Dike embankment section with seepage berm

2. **Canal spillway to canal headworks**
    a. Scour-damaged/over-steepened dike side-slope
    b. Existing embankment dam at the east end of the headworks with cutoff

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[111] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[112] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

B. Overtopping Protection

A qualitative assessment (10% design level) will be completed with regard to overtopping protection. This assessment will initially concentrate on identifying and categorizing characteristic features at the following general dike reaches.

- Breached dike (near the hydroelectric plant) that failed during the flood of October 2015,
- Saddle depression at the Broad River Bridge crossing,
- Overtopped dike reaches where flood water rose above the pre-flood dike crest elevation during the flood of October 2015, and
- Dike reaches that are purported to have been overtopped during former flood events of record (based on readily-available historic data and flood studies).
- Dike reaches that depict visual evidence of overtopping damage that are cross-referenced against headcut erodibility index values that are obtained during the detailed field reconnaissance (Task 7), and
- Dike reaches with in-place overtopping protection.

Overtopping assessment methodology will generally follow FEMA guidance about Analysis and Mapping Procedures for Non-Accredited Levee Systems.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[113] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[114] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

C. SCDOT Bridge Substructure Impact

The **CONSULTANT** will assess the impact of existing SCDOT substructures at/near the embankment (dike) and identify feasible alternatives to mitigate apparent deficiencies.

[111] Stage A: Base Flood Damage Repair Services, Reach 1

[112] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[113] Stage A: Base Flood Damage Repair Services, Reach 1

[114] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and hence the SCDOT Bridge Substructure Impact assessment will only be completed in Stage C[115] Additional Services.

D. <u>Utility Pole Foundations on Dike</u>

The **CONSULTANT** understands that the eight small steel lattice work electrical towers atop the canal dike between the Klapman Street Bridge and just upstream of the water plant intake were removed in December 2015 in conjunction with the work to remediate the dike breach. The **CONSULTANT** further understands that FERC agreed with the **CITY** and Kleinschmidt that the concrete piers that supported the towers, all located on the downstream side of the dike, did not have to be removed because removal could result in conditions that are worst with respect to seepage and sloughing of the dike's downstream slope.

For proposal preparation purpose, assume that Stage A Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and hence assessment of utility pole foundations on the dike will only be completed in Stage C[116] Additional Services.

E. <u>TBR: Embankment (Dike) Repair Assessment</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 16 embankment (dike) repair assessment. The TBR will identify the means, methods, and assumptions used to perform the work; describe in concept the modifications needed for the embankment (dike) to meet design requirements of the governing agency; include a plan and figures as needed to describe the modifications; include a tabular summary of benefits and disadvantages for alternatives considered; include an order-of-magnitude opinion about probable construction cost for comparison of alternatives; and include an executive summary. The TBR will be referenced as applicable in the Alternatives Assessment (Task 19), which will address the various remediation options identified via a matrix analyses of the options.

For proposal preparation purpose and consideration that Reach 1 represents approximately 6 percent of the total dike length, assume that Stage A[117] Basic Services will only include work that is required to repair the dike to preexisting conditions within Reach 1; and that Stage C[118] Additional Services will include supplemental work that is required to include the remaining length of dike up to the headworks within Reach 2.

[115] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[116] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

[117] Stage A: Base Flood Damage Repair Services, Reach 1

[118] Stage C: Supplemental Flood Resiliency Enhancement Services, Reach 2

TASK 17 - RECREATIONAL OPPORTUNITIES ASSESSMENT (STAGE B ADDITIONAL SERVICES)[119]

A. Recreational Opportunities Exploration and Visioning

The objective of the recreational opportunities exploration and visioning for Columbia's Canal Park will be to create an informed community understanding and direction for future improvements to the Canal Park area. The vision plan will focus on enhancing public access and usage along the riverfront by harnessing stakeholder and public input to create a resilient space that is unique to Columbia and reflects the community's priorities and values.

B. Canal Park Inventory and Analysis

Working in conjunction with the overall team, data for the Canal Park Area inventory and analysis will be gathered. This information will include the natural, socioeconomic and historic resources compiled as part of [Task 4] Environmental Documentation as well as [Task 5] Project Mapping, [Task 6] Historical Data, [Task 7] Detailed Field Reconnaissance including photography and video; cultural resources; vehicular and bicycle/pedestrian data. The inventory and analysis will consist of mapping and diagramming that highlights existing recreational opportunities as well as the potential for the development of new opportunities, connections and resources. Recreational items to be addressed in the analysis will include, but not be limited to:

- Pedestrian circulation
- Fishing facilities and opportunities (on land and on water)
- Parks – facilities and programming (active and passive)
- River access (pedestrian and boat access)
- River usage
- Former water pumping plant interaction/protection needs
- Existing hydroelectric plant interaction/protection needs

C. Community Engagement

Baker's Urban Design Studio has an extensive, time tested toolkit of strategies and methods that provide inclusive and engaging ways for stakeholders and the public to identify community needs and collaborate on consensus-built solutions. Suggested community engagement tools for the Canal Park Visioning include:

1. Stakeholder Meetings/Interviews

The **CONSULTANT**'s Urban Design Studio will facilitate two (2), **CITY** approved, meetings/interviews with key stakeholders (property owners, organized groups, special interests, etc.). Initial meetings will focus on understanding the audiences' concerns associated with the Canal Park Area, provide focused information, and build consensus. Documentation of these meetings will lead to developing an issues/opportunities list that will be reviewed with the design team in conjunction with input from the Community Workshops. Later, these meetings and/or interviews will allow for conceptual project alternatives to be explored.

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2. Walking Tour Workshop

The **CONSULTANT**'s Urban Design Studio will host an interactive and engaging walking workshop of the Canal Park site to ground Columbia residents and stakeholders in specific opportunities and constraints in the project design (i.e. park facilities, connections to the park, non-park structures, and flood control). The workshop will facilitate community understanding of the current design of the project site as well imagine opportunities for the future.

3. Visual Preferencing - Townscan™:

The **CONSULTANT** will prepare a presentation utilizing visual storytelling, sketches, photographs and storyboards. The presentation will include real time voting by the audience and discussion of project elements. We find that this is one of the most powerful ways for communities to understand their needs, and the differing viewpoints of community members. After images are voted on, **CONSULTANT**'s facilitators guide conversations to assess commonalities and sticking points that need to be worked through. At Canal Park, we will work with stakeholders and the public to identify how the recreation opportunities can be used to develop an enhanced experience for public users. The community input is vital to ensuring that the park alternatives reflect the priorities and values of Columbia's residents and business owners.

4. Charrette

After a Visual Preferencing presentation, it is useful to literally "bring the community to the table" in a Charrette format for a hands-on opportunity to write, note or draw concepts on plans of the Canal Park area in conjunction with **CONSULTANT**'s landscape architects and designers. The Charrette allows participants to apply what they just learned from visual preferencing and observed in the Canal Park into designs.

5. Summary

The **CONSULTANT** Urban Design Studio will assemble a document that includes a narrative, photos and drawings from all community events as a record of activities and community preferences. The summary will be provided as a record of the public's participation in the design process.

6. Alternatives Development:

Building on the preferences for visual character and preliminary goals for the riverfront, a series of 5 alternatives will be developed (10% design level) by the **CONSULTANT**'s landscape architects and planners. The alternatives will explore distinctly different ways of improving the Canal Park Area by identifying opportunities for resilient new amenities; connections between the existing **CITY** and the riverfront; storm water infiltration; and important canal and river access points. The alternatives will address the following topics:

a. Pedestrian/Trail locations and connections

- Dike Crest
- Walking trail along Broad River (downstream side of dike)
- Downstream side of powerhouse over the tailrace
- Existing (abandoned) steam tunnel usage
- Existing pedestrian bridge usage

b. Fishing – locations, platforms and piers
- Below the Gervais Street Bridge
- Downstream side of powerhouse at canal's end (also serves as pedestrian bypass around powerhouse)

c. Park activities, spaces, programming

d. River Access (pedestrian and boat access)

e. Former water pumping plant modifications and potential public interaction

f. Existing hydroelectric plant modifications and potential public interaction

g. Maintenance – vehicle connections

Creating a resilient riverfront will be a theme throughout the concept development of a coordinated restoration plan. Considerations for resiliency could include elements such as durable materials, location of amenities and storm water infiltration. Opportunities for art, cultural interpretation and education could also be integrated into plans for recreational opportunities.

A high-level opinion-of-cost will be included with each of the 5 alternatives to aid in the evaluation of the alternatives.

7. Alternative Analysis:

The Canal Embankment Assessment (10% design level) will consist of two main components: a presentation/assimilation of feedback from stakeholders and the public; and an evaluation by the **CONSULTANT**.

a. Public Workshop

The alternatives will be presented to the public and feedback gathered either by notations, interviews and/or web based survey. Feedback will be summarized and utilized in the evaluation of the alternatives by the Baker Team.

b. SWOT Analysis

The **CONSULTANT** will create an analysis of strengths, weaknesses, opportunities and constraints with stakeholder and public preferences of each of the alternatives. This analysis will include Team recommendations and suggested path forward for future steps in the Canal Park improvement process.

c. Vision

The Alternative Analysis will result in the development of a preferred concept and an overall Vision for the waterfront – enabling visitors to forge deeper connections with the river through a variety of recreation opportunities created with resiliency in mind. The preferred concept will be a true product of public participation, and as such reflect Columbia's culture, priorities and values. The final product of this phase of design will be a vision Poster which will highlight the unique aspects of the preferred alternative, and will guide future design endeavors for Canal Park.

D. <u>TBR: Recreational Opportunities Assessment</u>

A stand-alone TBR will be prepared to summarize and present work product for the Task 17 recreational opportunities assessment. The TBR will: identify the means, methods, and assumptions used to perform the work; data obtained in a concise organized format with tabular summary(ies); a plan and figures as needed to consolidate and present the data obtained; and an executive summary. The TBR will be referenced as applicable in the Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analysis of options.

Figure 17-1- Headgates (looking Easterly)

TASK 18 - FLOOD FIGHTING ACCESS ASSESSMENT (STAGE B ADDITIONAL SERVICES)[120]

A. <u>Design Criteria Memorandum: Flood Fighting Access Structures</u>

A Design Criteria Memorandum (DCM) will be developed to identify the analyses and investigations to be performed to assess flood fighting access described herein. The DCM will describe the means, methods and assumptions to be used in the analyses. Conceptual design, to assess alternate structure types and locations for Phase 1 Alternatives Analysis, will generally follow the Load Resistance Factor Design (LRFD) Guide Specifications for the Design of Pedestrian Bridges and the 2014 AASHTO LRFD Bridge Design Specifications, 7th Edition.

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B. Connectivity

1. Pedestrian

a. Condition assessment of existing pedestrian bridges

A qualitative assessment will be completed for the 2-span truss canal pedestrian bridge; and attention will be paid to qualitatively assess the feasibility of rehabilitating or replacing deteriorated substructures at the 2-span truss bridge (Figure 18-1). Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost. Proposed work is addressed in Task 7G.

b. Existing steam tunnel

A qualitative assessment will be completed for the existing steam tunnel (Figure 18-1) to evaluate possible measures to retrofit the steam tunnel for pedestrian access. Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost.

c. Powerhouse Pedestrian Bridge

A qualitative assessment will be completed to construct a pedestrian bridge on the downstream side of the powerhouse (Figure 18-1) thereby completing pedestrian conductivity from the canal spillway to the existing riverside board walk on the extending beneath Gervais Street Bridge. The bridge could also serve as a fishing platform over the powerhouse tailrace. Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost.

2. Emergency Vehicles

a. Vehicular access bridge replacement over canal spillway

A qualitative assessment will be completed to replace the vehicular access bridge over the canal spillway (Figure 18-1) based on the analyses completed in Task 13.B.3. Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost.

b. Limited vehicular access bridge across the canal upstream of powerhouse

An assessment will be conducted to provide a vehicular access bridge across the canal upstream of the existing powerhouse to facilitate flood-fighting readiness and deployment. A total of four (4) bridge alignments will be considered for the Phase 1 Alternatives Analysis generally at the locations indicated in Figures 18-1 and 18-2 below, namely 2 alternate locations in the lower canal reach (Figure 18-1) and the remaining 2 alternate locations in the upper canal reach (Figure 18-2). Based on discussion at the scoping meetings, the bridge types considered will be single lane structures that have sufficient capacity to support HS20 live load. Bridge span lengths on the order of 150 to 200 feet are anticipated to be assessed. Consideration will be given to the following factors:

- Elevating the bottom chord of the access bridges, giving due consideration of the limited freeboard and elevation of the high water mark;
- Measures that can be taken to minimize impact on the floodway by bridge approaches;
- Utilization of existing bridge piers along the new Broad River Bridge (e.g. Alternate Vehicle Access Bridge Location 5B in Figure 18-2 below);
- Holding the bottom chord of the access bridge high enough to permit kayak/canoe access under the bridge at high-normal canal-pool level (e.g. Elevation 153.5, equal to the crest elevation of the Diversion Dam); and
- Multi-bridge use to maximize benefit-cost, including restricted access for maintenance vehicles servicing dike/park facilities, canal spillway and other **CITY** assets that are situated along the dike embankment, all during non-critical flood events.

Analyses will be performed (10% design level) and a conceptual design completed with sufficient detail to identify benefits and disadvantages of vehicular access bridge alternatives considered. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost. Based on the information available, it appears that either a 1-span steel girder structure or a 2-span structure of either steel girders or P/S concrete beams will be feasible. A matrix will be developed indicating the pros and cons and each bridge type. Based on the matrix, the **CONSULTANT** will recommend a preferred bridge type. Design sketches (8 ½" x 11") will be developed for the recommended structure type. No full size CADD bridge drawings will be prepared under the Phase 1 Alternatives Analysis.

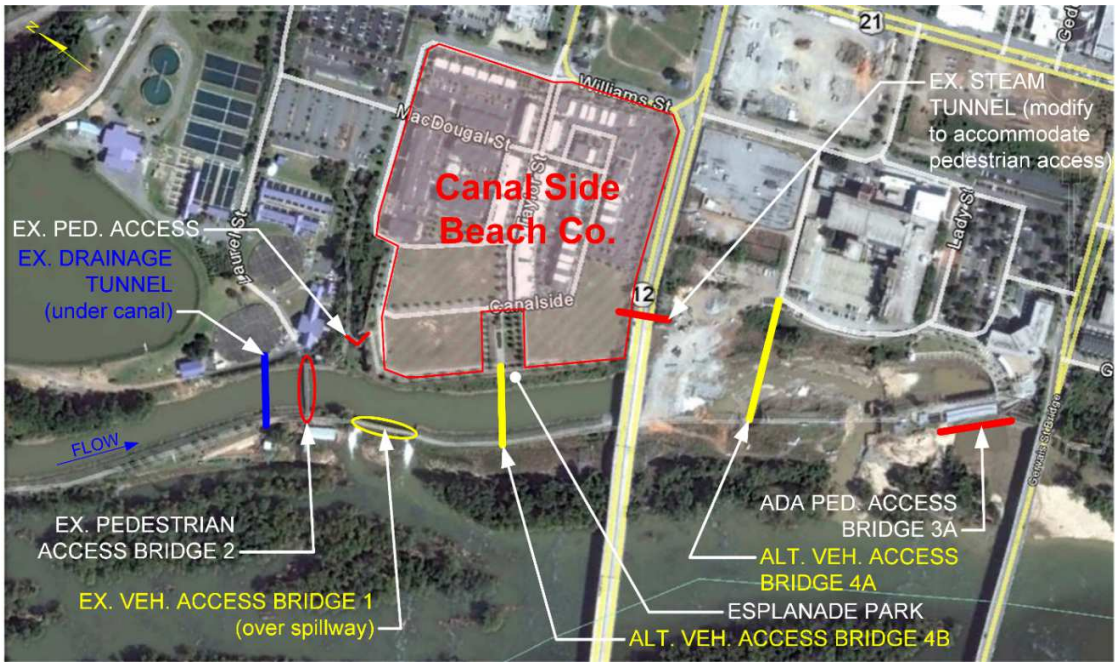

Figure 18-1- Alternate Access Bridge Locations - Reach 1 (downstream reach)

Figure 18-2- Alternate Access Bridge Locations - Reach 2 (upstream reach)

C. Staging Area(s)

A qualitative assessment (10% design level) will be completed to provide staging areas for flood-fighting readiness and deployment. Three (3) alternate staging areas will be considered during the Phase 1 Alternatives Analysis; namely 1 location at the downstream Reach 1 in proximity to the temporary causeway that is depicted in Figure 18-1, and the remaining 2 locations at the upstream Reach 2 generally within the limits depicted in Figure 18-2. Consideration will be given to multi-use of staging area(s) to maximize benefit-cost, including possible use for public parking during non-critical flood events. Benefits and disadvantages for alternatives considered will be documented. A qualitative assessment will be performed in sufficient detail to develop an opinion about the order-of-magnitude probable construction cost.

D. TBR: Flood Fighting Access Assessment

A stand-alone TBR will be prepared to summarize and present work product for the Task 18 flood fighting access assessment. The TBR will identify the means, methods, and assumptions used in performing the work; describe in concept measures required to meet design requirements of the governing agency; include a plan and figures, as needed to describe alternatives considered; a tabular summary of benefits and disadvantages for alternatives considered; include an order-of-magnitude opinion about the probable construction cost estimate for comparison of alternatives; and include an executive summary. The TBR will be referenced in the Phase 1 Alternatives Analysis (Task 19), which will address the various remediation options identified via a matrix analyses of the options considered.

TASK 19 - PHASE I ALTERNATIVES ANALYSIS (STAGE B ADDITIONAL SERVICES)[121]

A. Evaluation of Alternatives

The **CONSULTANT** will conduct a qualitative assessment of alternatives, which is focused on the key considerations/objectives and options that are tabulated in the Introduction Purpose section of the Scope of Services above. Priority and weighting factors will be used to evaluate alternatives, based on the **CONSULTANT**'s professional experience and consultation with the **CITY** and key stakeholders.

Results from the preceding tasks (1 through 18) will be used to process a Project Formulation, which will serve to document flood damage, identify items and scopes of work that are believed to be eligible for mitigation funding under grant(s) from stakeholders.

B. Constructability Review

The **CONSULTANT** will perform two (2) constructability reviews at approximate 35% and 70% completion of the Phase 1 Alternatives Analysis, to ensure optimum results by verifying that the assessment meets project objectives. These reviews will be performed to identify potential construction problem areas, to capitalize on possible cost savings, and to reduce exposure to potential future construction claims. The reviews will be performed to ensure that practical and cost effective construction approaches are developed and adhered to throughout the Phase 1 Alternatives Analysis. Major design issues with significant impact on project cost and time of construction will be

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considered. A technical memorandum will be prepared to document the constructability review findings.

C. Comparison Matrix Analysis

Tabular summaries of benefits and disadvantages for alternatives considered, including order-of-magnitude construction cost estimates, will be carried forward and rolled-up for the following tasks to compare alternatives:

- Task 11 – Water Supply Alternatives Assessment
- Task 13 – Canal Structures Analysis
- Task 14 – Masonry Drainage Tunnel Condition Assessment
- Task 16 – Embankment (Dike) Geotechnical Analyses
- Task 17 – Recreational Opportunities Assessment
- Task 18 – Flood Fighting Access Assessment

The **CONSULTANT** will prepare tabular matrix comparisons to evaluate various remediation options.

D. Recommended Preferred Alternative

Based on the data obtained and analyses performed, The **CONSULTANT** will recommend a preferred alternative after consulting with the **CITY**.

E. Recommended Phase 2 Scope of Services

After the **CITY** and the key stakeholders have reached consensus with common vision, the **CONSULTANT** will develop and submit to the **CITY** a recommended Phase 2 Scope of Services.

F. Preliminary Engineering Report (PER): Phase 1 Alternatives Analysis

The PER for the Phase 1 Alternatives Analysis will be based on emergency response documentation gathered (Task 1), resource agency coordination (Task 2), public relations (Task 3) and a series of DR and TBR deliverables (Tasks 4 through 18), which will be prepared at the end of each respective task. The following DRs and TBRs will be prepared and submitted as described above in the Scope of Services.

- Task 4 – TBR: Environmental Documentation
- Task 5 – DR: Project Mapping
- Task 6 – DR: Historic Data
- Task 7 – DR: Detailed Field Reconnaissance
- Task 8 – TBR: Existing Dike Condition Assessment
- Task 9 – DR: Subsurface Investigation
- Task 10 – TBR: Hydrologic and Hydraulic (H&H) Analysis
- Task 11 – TBR: Water Supply Alternatives Assessment
- Task 13 – TBR: Canal Structures Analysis
- Task 14 – TBR: Masonry Drainage Tunnel Condition Assessment
- Task 15 – TBR: Embankment (Dike) Geotechnical Analyses
- Task 16 – TBR: Embankment (Dike) Repair Assessment
- Task 17 – TBR: Recreational Opportunities Assessment
- Task 18 – TBR: Flood Fighting Access Assessment

The **CONSULTANT** will use the items listed above to prepare and submit the PER for the Phase 1 Alternatives Analysis. This PER will present Task 19 findings, conclusions and recommendations. TBR's from the Phase 1 Alternatives Analysis will be cross-referenced and appended to the PER for the Phase 1 Alternatives Analysis.

The **CONSULTANT** will prepare and submit a draft PER for review and comment; address review comments; and then prepare and submit a final PER for approval by the **CITY**.

Draft deliverable submission(s) of the PER will be in electronic format; and after the final PER is approved by the **CITY**, a final deliverable submission of the PER will be made to the **CITY** in bound-hard-copy format. All supporting documents for the PER for the Phase 1 Alternatives Analysis will be delivered to the **CITY** on a portable hard drive for permanent storage, including AutoCAD files for base plans and Plan Overlays that were prepared for Phase 1.

Further discussion about deliverables is presented in the Scope of Services, Introduction Section G.

TASK 20 - ALTERNATE FUNDING SOURCE SUPPORT (OMITTED)

The **CITY** has retained an independent consultant under separate contract to provide grant application support services to the **CITY** in support of the Canal Embankment renovation project.

*Based on the Scoping Meetings, the **CITY** and **CONSULTANT** have mutually agreed that the **CONSULTANT** will not be engaged to compile documentation to support preparation of FEMA Project Workbooks (PWs) and benefit-cost analyses for grant application(s), other than to make available the DR, TBR and PER work products that are described in this Scope of Services.*

TASK 21 - PROJECT MANAGEMENT AND ADMINISTRATION (STAGES A, B & C)

The **CONSULTANT**'s Project Manager will plan, schedule, organize and control Baker's resources to achieve specific objectives within the established schedule, budget and quality standards of the tasks Baker is responsible.

Based on the Scoping Meetings, Task 21 man-hours and direct costs have been integrated with the preceding tasks (1 through 20) where applicable.

A. <u>Quality Assurance and Quality Control</u>

The **CONSULTANT** will follow Quality Assurance/Quality Control procedures outlined in **CONSULTANT**'s Quality Management Plan for Project Development. A project specific quality assurance plan will be developed as part of this task. This will include proper checking procedures, QA/QC reviews, peer reviews and if applicable, cross-discipline reviews. The **CONSULTANT** will utilize personnel for reviews that are knowledgeable and qualified in their respective fields.

B. <u>Meetings</u>

The **CONSULTANT**'s Project Manager will attend bi-weekly status meetings with the project team and the **CITY** for the duration of the project as well as any other meetings that may arise requiring representatives knowledgeable in the issues to be discussed. The **CONSULTANT** will prepare and

distribute minutes of meetings to all attendees. It is anticipated that there will be eight (8) meetings for this task.

C. Project Procedures and Implementation

The **CONSULTANT** has prepared for and participated in Scoping Meetings (Introduction Section B) with the **CITY** to develop the detailed Scope of Services presented herein.

D. Administrative

This task includes all clerical work to maintain internal project files, preparing project correspondence, and distributing correspondence to appropriate project personnel, both internal and external.

TASK 22 - PHASE 2 FINAL DESIGN SCOPING (STAGE A BASIC SERVICES)

Based on the results of the Phase 1 Canal Embankment Assessment (and alternatives analysis), the **CONSULTANT** will develop a detailed Phase 2 and Phase 3 Scope of Services.

Without further notice, the **CITY** and **CONSULTANT** anticipates that the Phase 2 Final Design will entail base flood repair services for Reach 1 as defined under existing Project Workbook (PW) agreements that are in place as of June 24, 2016 between the **CITY** and FEMA to repair flood damage and restore the Columbia Canal to pre-flood conditions. The FEMA' PW Scope of services provides for repair of flood damage that occurred between October 1 and October 23, 2015 due to overtopping of the dike near the downstream end of the approximate 3.1 mile long canal dike, and which generally includes the following.

- Repair of the dike breach, just north of the Broad River Bridge, that was about 100 feet long x 85 feet wide by 50 feet deep, involving approximately 15,740 cubic yards of fill that was lost downstream into the Broad River.
- Repair of a second breach that was about 205 feet long x 65 feet wide x 50 feet deep, involving approximately 24,675 cubic yards of fill that was washed downstream into the canal.
- Repair of mechanical and physical damage to the canal spillway.
- Repair of mechanical and physical damage to the gates at the diversion dam (headworks), to be performed by others under separate contract with the **CITY**.
- Decommission of a Temporary Emergency Dam (cofferdam) that was erected during the flooding event across the canal to resupply water to water intakes for the **CITY**' water works.
- Hazard mitigation against future flood-borne damage to the Columbia Canal by utilizing approximately 3,952 cubic yards of the Temporary Emergency Dam (riprap and various stone) to armor select truck-accessible portions of the remaining canal embankment (dike).