amec foster wheeler

PHILLIPPI CREEK OPEN CHANNEL ASSESSMENT
OPERATION, MAINTENANCE AND LONG-TERM MANAGEMENT GUIDANCE

PROJECT BACKGROUND AND OBJECTIVES

The Phillippi Creek watershed has an extensively modified drainage network, largely consisting of canals constructed along the former wetland strands and sloughs that occurred prior to development. The canal system has improved drainage in support of residential and commercial land use, but has had some unintended environmental consequences concerning downstream water quality impacts, excessive sedimentation, and extensive natural aquatic and wetland habitat losses. Most of the canals are trapezoidal in cross-section and lack woody vegetation on their banks. These unnatural conditions lack an energy-dissipating floodplain, which when coupled with banks held together by low-strength grasses instead of plants with stronger roots masses, makes the channels more susceptible to erosion than a natural stream. This erosion is associated with a significant amount of Sarasota County's open channel maintenance budget.

The primary purpose of this project is to provide procedures most likely to reduce the long-term operation and maintenance costs of the canals. In other words, to enable the channel systems to become more self-sustaining. Investments that reduce the perennial maintenance and operation costs and that will concurrently improve downstream water quality, reduce sedimentation, improve fish habitat, and create recreational/aesthetic conditions for public benefit will be conceived and described. In essence, the design philosophy is to migrate canal corridor conditions closer to those of natural riparian corridors[1] without compromising the primary flood protection mission of the drainage network. Some treatments may improve flood protection, but this scope does not include the modeling to confirm a particular level-of-service.

These high-functioning alternatives will typically require investments associated with reconfiguring canal shape, dimension, control structures, and shoreline vegetation. A matrix of cost, co-funding potential, risks, and benefits will vary not only in terms of the functional gains sought, but will depend on the intrinsic and extrinsic characteristics of each canal segment related to channel condition and location. This level of complexity suggests value in developing a prioritization matrix derived from a conceptual model with good geographic portability around the watershed and similar areas across the County. This means the main deliverable is not going to merely be a static checklist of ranked canal segments, but a management system (MS) that can be applied in a more flexible manner as conditions and understanding change over time. The MS will be developed to account for and compare channel factors including:

[1] Florida riparian corridors often naturally include in-line wetlands, strands and sloughs as well as open stream channels. These patterns will be considered.

- Existing channel type and current conditions (canal type),
- Landscape setting and corridor condition (fragmented versus contiguous with high-functioning areas, upstream and downstream eco-linkages, watershed condition)[2],
- Improvability (sedimentation, nutrient water quality, aesthetics, fishery habitat, fish passage, drainage, wildlife corridor)
- Routine management costs of the channel ($)
- Erosional status and susceptibility (risks to external infrastructure – roads, buildings; risks to canal stability and hydraulic capacity; sedimentation risks to nature and downstream navigability),
- Maintenance and management logistics (accessibility, remoteness, equipment needed, crew safety),
- Costs of improvements ($),
- Co-funding potential ($).

The 'existing channel type and current conditions' should serve as a channel classification framework that will influence much of the rest of the MS. It is likely that the MS will be hierarchical in structure, with improvability, cost, and co-funding options differing among certain high-level categories such as canal type and landscape setting. The upper hierarchies of the classification are likely to include watershed soil drainage conditions and valley characteristics. The practical application of this can be seen as follows; sub-basins with high water tables cannot support techniques relying on good soil drainage, and canal segments with confined valleys (e.g. very narrow easements) cannot accommodate treatments requiring a meandering channel. First knowing the watershed and valley setting in the upper tier of a canal classification will thus aid in honing in on the available and best solutions for each canal segment. Conversely, some of the factors related to risk, key linkages, and logistics might vary independently of the classification (like how accessible the reach is from a public road, or the location of a barrier to fish passage) and such variables may best be conceived as index adjusters acting outside of the classification structure, thus enabling their use on an 'as applicable and as needed' basis. The MS will be accompanied by a guidance manual describing:

- The various kinds of existing open channel types and corridor settings,
- A map of channel segment types in the Phillippi Creek watershed,
- A review of the existing maintenance program, its costs, and suggested near-term improvements to reduce costs (if any),
- Management and design concepts to reduce long-term maintenance activities while achieving various functional improvements and their unit costs; by improvement category as applicable for each channel type and setting,
- An overall investment cost model comparing existing program costs versus those necessary to achieve self-maintaining systems (with a breakeven analysis),
- DSS flow chart and scoring criteria,
- A prioritization of 5 'bang-for-the-buck' projects to serve as a working example of applying the MS, provide case studies in break-even analysis, facilitate co-funding applications, initiate reduced maintenance costs, and provide a jump-start toward high-level benefits.

[2] Proximity and loadings to intact tidal creeks will be a significant, but by no means the sole, consideration.

SCOPE OF WORK

Amec Foster Wheeler Environment and Infrastructure, Inc. (the Consultant) will provide the following services:

Task 1 - Compile Relevant Information

Consultant will assemble the following GIS layers into a working MXD (with source in parenthesis):

- Canal I.D. Maps (Sarasota County)
- LiDAR (Sarasota County)
- Easements (Sarasota County)
- Land Use (Sarasota County)
- Vegetative Cover (Sarasota County)
- Impervious Cover (Sarasota County)
- Aerials (1995-present) (Sarasota County)
- Utilities with Valve Size (Sarasota County)
- Soils (SSURGO)
- TMDL WBIDs (FDEP)
- NPDES MS4 and Point Source Discharges (Sarasota County, FDEP?)
- Flood-prone areas or level-of-service deficiencies (Sarasota County)
- Areas of recurring maintenance activities (Sarasota County)

Consultant will accept and review the following information to be received from Sarasota County: relevant rainfall data (ARMS) and canal stage time series, the Phillippi Creek watershed ICPR Model (executable), the Phillippi Creek Water Quality Basin study, sediment sump design reports and plans (Sarasota County), channel cross-sections (Sarasota County), and Canal O&M Activities/Protocols and associated tracking data of labor, materials, equipment (via Maximo) and other available and related expenses (Sarasota County).

<u>Deliverables</u>:

- Inventory list of digital files with the
- ESRI ArcGIS Geodatabase

Task 2 - Characterize Maintenance Activities and Costs

Consultant will review published O&M procedures and related financially-relevant tracking data. Consultant will conduct Sarasota County maintenance staff interviews to solicit comments regarding their experience related to canal performance and the required O&M. The opinions of the front-line field supervisor will be sought regarding existing practices and conditions and how they could be improved. Consultant will provide a memo summarizing existing protocols and costs. Recommendations for improvement will be made. For the purposes of **Task 2**, recommendations for improvement will focus on maintenance activities that can be implemented in the near-term, with limited need for significant capital investment. Major shifts in practice requiring significant investments, especially those related to re-patterning the canals, are addressed in **Tasks 4** through **7**.

Deliverables:

- Practice Improvement and Cost Summary Memo

Task 3 - Develop a Channel System Classification

Consultant will derive a classification system and summarize its development and content in a technical memo, considering the following information in its synthesis:

Channel

- Channel shape, dimension
- Valley slope
- Erosion (absent, grade control loss, bank loss – and type of failure)
- Instream habitat
- Palustrine habitat and buffers
- Easement Width/Meander Belt Width[3]

Watershed

- Drainage Area
- NRCS HSG
- Urban hydromodification
- TMDL WBID
- NPDES (MS4 and PS)
- Land Use
- Protected Forest Cover

The system will be developed predominantly from desktop information, but will necessarily be informed by field conditions. Thus the Consultant's fluvial geomorphologist will conduct a 3-day reconnaissance of the canal systems. Consultant will attempt to coordinate the dates of the recon to allow the voluntary participation of County staff, to the extent that such coordination allows for the project deadlines to be met.

Data from the classification system will be used to provide a tabular inventory of the Phillippi Creek basin channel segments including their Legacy ID, GIS Identifier, Classification, and Ranking. The Legacy ID is the existing County nomenclature for each channel and the GIS Identifier will be supplied by the Consultant based on physical or biological change points within each Legacy segment, as applicable. For example, a segment (Legacy ID) may be divided into two reaches (GIS ID) at a tributary junction or at a point between two differently sloped areas within the segment. The reaches will be ranked based on a workability index considering bank slope, accessibility issues, vegetation condition, and flow magnitude. This table will subsequently be updated under Task 4 to add the kinds of categorical improvements indicated for each reach.

[3] Meander Belt Width (MBW) is the valley width necessary to accommodate a meandering stream. If the easement width is less than the MBW, then a naturally meandering stream channel cannot be accommodated without causing problems.

Deliverables:

- Technical Memo
- Field Recon Photos and Field Notes
- Canal segment inventory and ranking table

Task 4 - Develop Categorical Improvements

The desired channel stability, water quality, aesthetics, and fish habitat improvements can be achieved in a variety of ways, falling into two broad categories – gray and green. Gray infrastructure is classic civil engineering emphasizing the use of hard synthetic materials (typically concrete, steel and plastics) and often also pumps, to resist erosion and divert water from areas where it is unwanted to those where it is. These materials degrade over time, requiring preventative maintenance to extend their life cycles. They eventually need to be replaced in kind. Green infrastructure emphasizes the use of natural materials, organized in ways to facilitate self-maintenance. In essence, green approaches migrate channel form and functions to be closer to that of natural streams using soil bioengineering and natural channel design techniques. Although they incorporate soil, native stone, and native plant materials extensively, they also selectively use gray technology as needed. Green infrastructure often requires similar capital improvement costs to gray, but requires less maintenance and provides a greater life cycle. Green infrastructure contributes to the triple bottom line better (social, ecological, financial) because it provides biological and aesthetic benefits gray infrastructure alone typically cannot. Therefore, the design approach will emphasize green infrastructure.

The Consultant will identify ways to improve the open channel systems to achieve these benefits in a largely self-sustaining manner after construction. These means will be organized into a treatment matrix, whereby each treatment will be described and its benefits for water quality, channel stability, fish habitat, wildlife habitat, and aesthetics noted. The applicability of each treatment to each channel type described in **Task 3** will be noted.

Nutrient reduction and erosion treatment benefits will be quantified in an approximate manner, based on literature values and best professional judgement. Nutrient benefits will be expressed as potential load reductions (e.g. lbs/year/linear foot of treated channel). Stabilization benefits will be quantified similarly based on sediment load reductions (lbs/year/LF). However, Consultant will also review historic and recent cross-section data, aerial photos, and maintenance records for evidence useful to estimate the yields that could be arrested. If the data is available and appropriate, the sediment treatment will be quantified using it, else literature values[4] and best professional judgment will be applied. This scope does not include numerical modeling or other intensive erosion and sedimentation calculations.

Fish and wildlife habitat benefits will be split into open water, wetland (marsh versus swamp), and terrestrial unit areas (acres/LF). The open water habitat heterogeneity will be further characterized on a unit length basis into simple-flashy, complex flashy, simple steady, and complex steady categories. These categories are related to straight trapezoidal canals with little geomorphic variability, canals with in-line grade control and energy dissipating structures creating steps and pools, two-stage trapezoidal canals, and two-stage canals fit with either a meandering lower channel or a lower channel with step-pool structures. These categories are important because

[4] Such as, but not limited to, information used by UCF to develop their BMPTrains Model and found in the State of Florida Erosion and Sediment Control Manual (2013).

they tie to treatments along a gradient of construction costs and biological and physical functions. Consultant will coordinate with Mote Marine and Sarasota County to determine if a basis for attributing treatments with snook benefits is available and, if so, will incorporate such benefits in the treatment descriptions.

Deliverables:

- Report describing the treatments
- Tabular matrix of benefits of treatments, by channel type
- Canal segment inventory table update with categorical improvements

Task 5 - Estimate Unit Costs

Consultant will assign unit construction and O&M costs to each treatment described in **Task 4**. Costs will necessarily be approximate, useful for comparative purposes. Unit cost information sources include FDOT, NRCS (Environmental Quality Improvement Program), USACE, Engineering News Record, and other resources deemed applicable by the Consultant. They will not be developed at a level of detail and accuracy akin to a professional estimator's opinion of project-specific costs. Consultant will develop analogous cost estimates for competing gray and green infrastructure approaches, as applicable.

Deliverables:

- Cost table with supporting calculation memo
- Backup documents
- Comparison to Existing O&M costs

Task 6 - Develop a Total Life-Cycle Cost Model

Consultant will assign a life-cycle period to each treatment described under **Task 5** and conduct an economic evaluation of each, taking into account the timing of expenditures and the time value of money. Because the period of service may be long, and associated costs therefore misleadingly high, the deliverables will be clear on the length of the cycle and on the annual timing of expenditures. The description will distinguish initial capital investment from the longer-term O&M costs. The cost model will be described in a sequential fashion, starting with a comparison of life-cycle costs of the evaluated treatments to those of the existing canal systems, determining the break-even point. In other words, the treatment costs will be compared to the existing O&M costs. The County will provide the internal rate of return (IRR) it uses for investment decisions, if available. Otherwise, Consultant will select the IRR.

Because the treatments are conceived to provide multiple benefits the existing canals do not provide, Consultant will also compare the time-value of costs necessary to achieve similar benefits using alternate approaches. For example, nutrient loads could be reduced via canal re-configurations or by advanced wastewater treatment, wet-detention and other curb and gutter treatments for stormwater, etc. Such comparisons can be summarized as $/lb treated during project life-cycle, as well as by incorporating the related capital and O&M estimates over time and determining the break-even point in the overall model. To the extent practical, Consultant will include alternative costs for non-canal water quality treatment, gray-infrastructure erosion control (e.g. hard-armoring canals with rip-rap, gabions, buried pipes, or concrete flumes), and wetland and stream mitigation bank fees. The latter two items are a means of providing some valuation of

the habitat created. Because no stream mitigation banks exist in Florida, fees commanded in other southeastern coastal plain states will be used. Wetland fees will be based on actual banks that work in the Phillippi basin could use. A broad view of County costs will be adopted and discussed with County staff. The model will account for the fact that some activities externalize costs to prevent their value from being over-inflated. For example, a potentially buried costs like future downstream dredging will be quantified because some activities will allow more sedimentation to occur than others.

If the County has the relevant information available, Consultant will add one or more layers to the cost model representing selected intangible benefits. For example, some of the treatments could facilitate activities known to have economic value such as snook fishing or bird-watching, while others may increase property values. Even if such benefits cannot adequately be represented in the cost model, Consultant will provide mention of them in the report. This includes values related to the current canal O&M practices.

The final layer in the cost model will account for co-funding opportunities. These will be added as applicable for each treatment. Because these are often awarded on a competitive basis, lending a degree of uncertainty, a probability adjustment factor will be added.

Deliverables:

- Report describing the cost model and results
- Backup documents
- Cost Model (MS Excel Spreadsheets)

Task 7 - Develop a Management System (MS)

Consultant will develop a flow chart and report describing a process for selecting from among treatment alternatives for any given canal segment. The flow chart will incorporate a benefit, cost, risk matrix. The MS will be portable to areas with similar conditions to those of the Philippi basin.

Deliverables:

- MS Flow Chart
- Report

Task 8 - Open Channel System GIS Map

Consultant will develop an index to assign comparative scores for the in-stream habitat and erosivity of the canals, by type and will provide a GIS map depicting:

- Map of in-stream habitat index scores
- Map of erosivity index scores
- Maps of native channel buffers and habitat continuity
- Maps showing locations of barriers to fish passage and the extent of their upstream cutoffs

The barriers to fish passage locations will be provided by Mote Marine/Sarasota County.

Each GIS layer will include fields that when updated will change the image colors or hatching to reflect different threshold categories of benefits and will enable the new total length or total area

distribution of channel corridor condition to be re-calculated. Directions for how to update the map will be included. This enables a visual and quantitative tool for exploring the benefits of potential treatment scenarios and sequences that can assist with prioritizing work and explaining decisions to the public.

Deliverables:

- GIS files
- Technical memo describing the habitat and erosivity indices and map update procedures[5]

Task 9 - Write a Guidance Manual

Consultant will provide a guidance manual describing the most-viable treatment options for each canal type, their benefits and economic evaluations, and how to apply the MS. In many respects, this document will provide a synthesis of what was gleaned from the previous Tasks. It will also include a case-study ranking of 5 canal segments selected by the County to determine the first project(s) to be implemented. Consultant will demonstrate the MS to County staff.

Deliverables:

- PowerPoint presentation and live demonstration
- Guidance Manual

Task 10 - Coordination with County Staff and Shareholders[6] Meetings

Consultant will participate in 10 client coordination/milestone updates, 8 by teleconference and up to 2 in person at County facilities. Consultant will participate in 2 shareholders meetings to be scheduled and coordinated by the County.

Deliverables:

- Client meeting minutes
- PowerPoint presentations for in-person and shareholders meetings

SCHEDULE

The schedule cumulatively provides 6 months of time for Consultant to complete the deliverables and 3 months of review time by the County, for a total of nine months from the notice-to-proceed (NTP). Consultant will complete the tasks in accordance with **Table 1**.

[5] Procedure descriptions will assume good working knowledge of ESRI ArcGIS.

[6] Sarasota Bay Estuary Program, City of Sarasota, Mote Marine, and Southwest Florida Water Management District