Benefit-Cost Analysis Methods Summary

2021 FEMA BRIC Grant Application

Town of Siler City, Blood Run Pump Station Relocation and Sewer Line Replacement

Introduction

A benefit cost analysis (BCA) has been performed by McGill Associates as part of the FEMA Building Resilient Infrastructure and Communities (BRIC) Grant Application for the Town of Siler City. The purpose of the application is to obtain federal funds which will support the relocation of the Blood Run pump station and sewer line replacement. (The Project).

The Project features the relocation of the Blood Run pump station at coordinates (in decimal degrees): 35.721908, -79.498242. The Project also includes linear outfall replacement generally parallel to Blood Run Stream between the coordinates 35.729712, -79.496110 (north end) to the Blood Run Pump Station. The Project will construct linear force main replacement that generally runs parallel to Elder Rd., Airport Rd., W 3rd St. and W 2nd St. between the coordinates 35.721908, -79.498242 (west end) and 35.722753, -79.466377 (east end). The Project will construct linear interceptor replacement generally parallel to Loves Creek between the coordinates 35.726048, -79.467600 (northwest end) and 35.724871, -79.445883 (southeast end). Streambank enhancement is proposed to be a part of the project along the 30" interceptor. This includes repairing degraded and undercut streambanks to a more stable channel cross section via the use of natural channel design and the armoring where required. This will reduce the sediment load, restore floodplain connectivity and enhancing the riparian community. The Project will provide protection to all of these components of infrastructure in Siler City, NC. The pump station and collection lines serve a large portion (72.2%) of Siler City's sewer customers. The BCA analysis was completed with Blood Run pump station representing the total project. The 15", 18" and 24" sewer interceptors were constructed in 1963 and the material is VCP with mostly brick manholes. A majority of the sewer lines are located in the 100-year floodplain with portions being in the floodway. In 1963, the construction of sewer lines was not designed to operate in submerged conditions. VCP has an expected useful life of approximately 50 years and has short pipe lengths with numerous joints. The VCP is brittle and will fail under pressure especially when submerged and the joints allow for water to infiltrate more than modern pressure rated EPDM gasketed joints. The pump station was constructed in 1977 and the outfall is believed to have been constructed at the same time. The same issues mentioned above apply to these components. In this project the 12" Blood Run truss outfall will be replaced with 24" PVC, the 8" DIP force main will be replaced with 18" PVC, the 15" and 18" VCP interceptors will be replaced with 30" PVC and the 24" VCP interceptor will be replaced with 36" PVC.

The project is estimated to cost $7,144,857 (2021 $'s) for construction.

The FEMA BCA toolkit ver. 6.0 was used to estimate the present value stream of expected annual benefits and costs of The Project.

Benefits considered in the analysis include avoided loss of service, avoided repair and reconstruction costs, and ecosystem services.

The steps inputs to develop the BCA model are outlined below and are followed by a discussion of the findings.

Methodology

The following sections document the primary assumptions related to the level of protection, professional expected damages as a basis for the analysis, and key inputs into the analysis.

Project Useful Life

The proposed project will be designed to have a 50-year useful life in accordance with Appendix D of the FEMA BCA reference guide, Major Infrastructure (minor localized flood reduction projects), standard value 50.

Level of Protection

EXISTING

The Blood Run pump station floods currently at the 100-year event as indicated in Major Infrastructure (minor localized flood reduction projects), standard value 50. Portions of the outfall will flood at the 100-year event. Portions of the existing 15”, 18”, and 24” interceptors are located in the 500-year, 100-year and the floodway and will flood in their respective storm events. The Blood Run pump station is critical to the operation of the sewers and it’s elevation was utilized as a key level to estimate the impacts of flood events.

PROPOSED

The project is proposed to provide protection to the pump station past the 100-yr event with future conditions through the relocation. The project is also proposed to relocate the outfall outside of the 100-yr event boundary with future conditions where feasible. Where infeasible, floodproofing measures will be installed such as watertight locking manhole lids with elevated vent piping. All measures are proposed a minimum of 2 feet above the current mapped 100 year base flood elevation.

Table 1: Level of Protection and Project Useful Life

Input/Assumption	Value	Source
Project useful life	50 years	FEMA BCA reference guide Appendix D
Existing level of protection	<100-yr recurrence interval	As noted in the Scope of Work section, the Blood Run pump station and a majority of the sewer lines are within the 100-year floodplain.
Proposed level of protection for Blood Run pump station (post mitigation)	100-yr recurrence interval	As noted in Scope of Work section, the selected project alternative will design for the 100-year recurrence interval.
Proposed level of protection for Blood Run 24" outfall (post mitigation)	100-yr recurrence interval (where feasible)	As noted in Scope of Work section, the selected project alternative will design for the 100-year recurrence interval.
Proposed level of protection for 30" interceptor (post mitigation)	500-yr/100-yr recurrence interval (where feasible)	As noted in Scope of Work section, the selected project alternative will design for the 500-year/100-year recurrence interval.
Proposed level of protection for 36" interceptor (post mitigation)	500-yr/100-yr recurrence interval (where feasible)	As noted in Scope of Work section, the selected project alternative will design for the 500-year/100-year recurrence interval.

Damages Estimates

The FEMA BCA toolkit ver. 6.0 was setup to estimate damages using Professional Expected Damages as historical information was not available. The BCA analysis was conducted using detailed information collected for the Project. Key inputs in the analysis are shown below in the following sections.

Tables 2 and 3 provide a breakdown of general impacts to the Blood Run pump station and interceptors. The FEMA standard value for loss of wastewater collection service was used in the analysis as well as damages for each storm event. Additionally, the Asset Inventory and Assessment document provided the population served by the most downstream point of the proposed project.

Table 2: Blood Run Pump Station Impact Assumptions

Input/Assumption	Value	Source
Loss of Wastewater Service	$58	FEMA BCA toolkit 6.0, standard value
Number of Customers Served	5,938	As noted in Scope of Work section, the selected project alternative serves 5,938 people.
25-yr damages	$10,000	These damages include minor electrical repairs
50-yr damages	$75,000	These damages include electrical control panel and motor starter replacement
100-yr damages	$125,000	These damages include electrical control panel, motor starter and sewage pump replacement and standby generator repairs
500-yr damages	$125,000	These damages include electrical control panel, motor starter and sewage pump replacement and standby generator repairs

Table 3: Interceptor Impact Assumptions

Input/Assumption	Value	Source
100-yr damages	$200,000	Sewer main and manhole replacements damaged by flood waters

Durations for loss of service were estimated for existing conditions and for future conditions, 100-, and 500-yr recurrence intervals (Table 4). Engineering estimates of flood events translated inundation depth into event duration days. Drainage duration was then estimated for each flood event based on previous sanitary sewer overflow (SSO) information. Professional judgement was used to estimate repair time based on an occurrence of 2-year and 5-year storm events. Estimated drainage duration were included based on previous storm events in 2016, 2018, and 2019. No events recorded were greater than a 5- year storm, therefore the 25-, 50-, 100-, and 500-year storms were estimated using professional judgement.

The flood benefits in the BCA toolkit submitted with the grant application were estimated using future conditions.

Table 4: Estimated Loss of Service Due to Flood Inundation

Existing conditions				
Recurrence Interval	**Blood Run pump station inundation depth, ft.**	**Drainage duration, days**	**Repair duration, days**	**Total loss of service time, days**
2-yr	Not Mapped	0.25	0	0.25
5-yr	Not Mapped	0.5	0	0.5
25-yr	0	2	5	7
50-yr	0.6	5	25	30
100-yr	1.2	10	50	60
500-yr	2.8	25	125	150
Future conditions after mitigation				
Recurrence Interval	**Blood Run pump station inundation depth, ft.**	**Drainage duration, days**	**Repair duration, days**	**Total loss of service time, days**
500-yr	0.2	10	20	30

Assumptions:

1. Inundation depths are just for Blood Run pump station, with approx. elevation of 572.3 ft.
2. Event durations based on local flooding observed during Hurricane Michael (2-year) and Hurricane Matthew (5-year)
3. Inundation value of the 500-yr storm is calculated by taking the difference of the 500-year flood elevation minus the new pump station elevation.

Finally, environmental benefits were also included in the BCA framework. Table 5 below shows, key inputs for the ecosystem services benefits estimates in the toolkit.

Table 5: Ecosystem Service Inputs

Input/Assumption	Value	Source
Project Area (Acres)	16.7	Estimated from project conceptual designs based on limits of construction
Riparian Area (%)	12.4	Value calculated by dividing length of stream rehabilitation by total length of sewer line replacement