

Project name:
BR 1-424A on Old Corbit Road

Project ref:
T200507102

From:
Joseph Hofstee

Date:
March 27, 2018

To:
Jason Hastings
State Bridge Engineer
800 S. Bay Road
Dover, DE 19901

CC:
Neil Shemo

Memo

AECOM developed a Benefit Cost Analysis (BCA) for the replacement of Bridge 1-424A on Old Corbit Road. In order to complete this, AECOM used the Federal Emergency Management Agency BCA Toolkit 5.3.0. The Federal Office of Management and Budget (OMB) require federally funded projects to demonstrate cost effectiveness for the use of public funds. As such, FEMA developed the BCA Toolkit to meet this requirement set forth by OMB. The Damage-Frequency (DFA) Mitigation Project Long Form wizard was used to generate a Benefit Cost Ratio (BCR) for analysis. The DFA module is the only module that can be used for non-building projects such as roads, bridges, and utilities. Based on the information that is allowed to be entered into the BCA, a BCR of 0.10 was obtained. A BCR of 1.0 or greater is required for a project to be eligible for funding. This memo will explain what data and information was used in developing the BCA and some of the restrictions associated with the BCA Toolkit.

BR 1-424A and a large portion of Old Corbit Road, as determined by Federal Emergency Management Agency (FEMA), is located within floodplain zone AE not within the LiMWA (Limit of Moderate Wave Action Line), as can be seen in Firmette 100003C030K (attached). ZONE AE is an area where a detail study was completed and the base floodplain is provided. Areas outside the LiMWA have wave heights of less than 1.5 feet. Old Corbit Road has a Base Flood Elevation of 8 feet. Old Corbit Road has the following Stillwater elevations: 6.25 feet for the 10 year, 7.25 feet for the 50 year, and 7.69 feet for the 100 year. The previous mentioned Stillwater elevations are from a completed Flood Insurance Study (FIS) Report conducted along the Appoquinimink River.

Old Corbit Road lies east of Odessa and provides a direct connection between Old Sate Road and Silver Run Road. Old Corbit Road is a local road with an average daily traffic (ADT) of 340 vehicles. The ADT was calculated in 2015 through the use of automated traffic recorder counts along the roadway. There are 16 homes located directly on Old Corbit Road and an additional 10 homes located in a small neighborhood along Old Corbit Road. The overtopping of the roadway results in an additional 0.78 miles of travel for vehicles to detour around the closure from the intersection of Old State Road and Old Corbit Road to the intersection of Silver Run Road and Old Corbit Road. The additional distance associated with the closure results in an additional 45 seconds of travel.

The existing roadway elevation is 2.60 feet above sea level in the area of the bridge. Currently the roadway overtops twice daily in the area of the bridge as a result of the two high tides. The average water elevation event is 3.17 feet above sea level due to the tidal influence. The proposed

bridge would be reconstructed to a proposed elevation of 6.18 feet. Where the proposed bridge approaches would tie in will result in the lowest elevation along Old Corbit Road being 4.25 feet reducing the occurrences of the roadway overtopping.

In order to complete the BCA, we need to determine what would warrant a closure of the roadway and the number of closures that would occur. Studies have found 6 inches of water can result in a driver losing control of a car and 2 feet of water can result in a vehicle being swept away. As a result, for our purposes it was assumed the road would need to be closed if the road was overtopped by 6 inches or more of water. AECOM has examined the National Oceanic and Atmospheric Administration (NOAA) data for Reedy Point from January 1, 2008 to December 31, 2017, which is the closest gauge to the project site and shares the same base flood plain elevation of 8 feet. From that data the average number of hours per year that the water elevation exceeded 3.1 feet and 4.75 feet were determined. The elevation of 3.1 feet was used for determining the number of existing closures; this number was obtained by adding 6 inches to the roadways current lowest elevation of 2.6 feet. The elevation of 4.75 feet was used for determining the number of post mitigation closures; this number was obtained by adding 6 inches to the roadways post mitigation lowest elevation of 4.25 feet. For that ten year period the water elevation exceeded 3.1 feet 4441 hours per year on average. For that ten year period the water elevation exceeded 4.75 feet 2435 hours per year on average.

On March 27, 2017, we met with the Odessa Fire Company to discuss the potential closure of Old Corbit Road. During discussions with emergency responders, they cited having to respond on site several times a year for vehicles that become partially submerged in the area of Bridge 1-424A.

The BCA was developed to compare the future benefits of the mitigation work compared to the cost associated with the mitigation work. For this case the mitigation work is the reconstruction of the Bridge 1-424A to raise the bridge to reduce the occurrences of the bridge overtopping during tidal events. As stated previously, the DFA Project Mitigation Long Form was used. The first step is to identify the structure and the mitigation type, the structure was Bridge 1-424A and the mitigation type selected was Elevation.

The next component entered is the project useful life (PUL). The PUL as defined by FEMA is the estimated amount of time (in years) that the mitigation action will be effective; how long it will last on the landscape. The PUL data field is used to calculate annualized benefits. For BR 1-424A the PUL is 50 years. PUL in this case is limited by FEMA acceptable limits for useful life of a bridge. The FEMA PUL table defines this as 35-50 years for bridges with the standard value being 50 years. As a result of the Delaware Department of Transportation defining useful life of a bridge at 100 years for a new bridge structure in the DelDOT Bridge Manual, 50 years is allowed to be used. No backup data will be required to be submitted as part of the BCA formal submission as a result of using the standard value.

For the cost of the portions of the BCA, a Mitigation Project Cost of \$3,750,000 was used which constitutes the bridge replacement cost and engineering design cost. A Base Year of Cost of 2018 was used; the base year of costs for this mitigation project is the year that the cost estimate was developed. An annual maintenance cost of \$10,000 was used. A discounted rate is applied to the future 50 years of maintenance cost. A discount rate of 7% was used; this is the Federal Office of Management and Budget (OMB) mandated discounted rate that must be used for all BCAs. The discounted rate determines the time-value of money. A discount rate is used to calculate a value today (the Net Present Value) of future benefits so that they can be compared to the costs of a mitigation project. This resulted in a present worth of \$138,007 of the annual maintenance cost. The final project mitigation cost for the project is \$3,888,007.

The next component of the BCA is determining the benefits of the projects. This is where the BCA is very limited in what can be entered for a roadway/bridge project; there are only three benefits available: additional trip miles, lost productivity, and mental stress. Mental stress and lost productivity

cannot be applied for this project. To measure the benefits of reducing additional trip miles, the additional trip miles before mitigation need to be compared to the additional trip miles after mitigation which was used to measure the project effectiveness. The project effectiveness is how well the project will reduce future damages. Only structure acquisition and demolition and structure acquisition and relocation projects can assume that a project is completely effective.

The per diem cost of additional trips was determined by entering the following data:

- Estimate Number of One-Way Trips per day – 340
- Additional Time per One-Way Trips – 1 min
- Number of additional miles per trip – 0.8 miles
- Federal Rate mileage rate - \$0.54/mile (this is prepopulated)

The economic loss per day of loss of function is \$336/day.

The historic damages before mitigation was determined by converting the 4441 hours per year that the road is impassable to equivalent day per years which is 185 days. The historic damages after mitigation was determined by converting the 2435 hours per year that the road is impassable to equivalent day per years which is 101 days. This results in an annual damage before mitigation of \$62,229 and an annual damage after mitigation of \$33,974. When converted to present value it results in a before benefit of \$858,807 and after benefit of \$468,867. This results in the project having a net present mitigation value of \$389,940 ($=\$858,807 - \$468,867$). Net Present Value of Future Benefits is the amount of annual benefits that will occur for the life of the project, represented in a present or current dollar value. This brings the values of future benefits in line with the current value of the project cost. Future benefits are discounted by using a discount rate.

The Benefit-Cost Ratio is the Mitigation Benefits divided by the mitigation cost in this scenario the value ended up being 0.10 ($=\$389,940/\$3,888,007$). As a result, the project would not qualify for a FEMA grant using the standard BCA model.

FEMA will allow for the use of alternative Benefit Cost Analysis however this requires FEMA approving the model prior to submitting a grant application. With that in mind, we examined the additional cost that the Odessa Fire Company would experience as a result of the closure. The first item we looked at was the additional mileage cost associated with traveling around Bridge 1-424A when it is impassable. For days closed and distance traveled we used the same information that was used for additional vehicle miles traveled. Based on another module in the BCA toolkit, that is used for determining the BCA for improvements to a fire house, these results in a net mitigation benefit of \$33,011. The other item we looked at was the cost associated with the Odessa Fire Company responding to a vehicle stuck in the water. If we were to assume 6 vehicles stuck in the water a year with the cost of responding assumed to be \$3,000 per incidents, the before mitigation cost per year would be \$12,000. Assuming that 3 vehicles would still need to be rescued in the post mitigation scenario this will result in a cost of \$6,000 per year. As a result, the net benefit is \$3,000 per year. Even when including the cost benefit associated with the Odessa Fire Company, the BCA does not meet the requirements.

The final additional item that could be included is historical damages to the cars. This would require obtaining the insurance claims for the vehicles that were damaged. This was beyond the scope of the study and likely there would not be enough records available to significantly alter the previous outcomes, it is not recommended to pursue obtaining the insurance claims.

Attachments:

Memo
BR 1-424A on Old Corbit Road

- BCA report for Bridge 1-424A
- NOAA values for Reedy Point
- FEMA Firmettes
- PUL with FEMA Standards
- Travel Times around BR 1-424A

Memo
BR 1-424A on Old Corbit Road

BCA Report for BR 1-424A on Old Corbit Road

27 Mar 2018

Project: **BR 1-424A on N24 Old Corbit Road**

Pg 1 of 5

Total Benefits: **\$389,940**

Total Costs: **\$3,888,007**

BCR: **0.10**

Project Number: T200507102Disaster #:

Program: FMA

Agency: **AECOM**

State: **Delaware**

Point of Contact: Joe Hofstee

Analyst: Joseph Hofstee

Project Summary:

Project Number: T200507102

Disaster #:

Program: FMA

Agency: AECOM

Analyst: Joseph Hofstee

Discount Rate: 0.070

Point of Contact: Joe Hofstee

Phone Number: 302-468-5880

Address: 1013 Centre Road, Wilmington, Delaware, 19805

Email: [REDACTED]

Comments:

Structure Summary For:

BR 1-424A, Middletown, Delaware, 19709, New Castle

Structure Type: Other

Historic Building: No

Contact: Joseph Hofstee

Benefits: \$389,940

Costs: \$3,888,007

BCR: 0.10

Mitigation	Hazard	BCR	Benefits	Costs
Elevation	Damage-Frequency Assessment	0.10	\$389,940	\$3,888,007

Fire House, Delaware, , New Castle

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$0

Costs: \$0

BCR: 0.00

27 Mar 2018

Project: **BR 1-424A on N24 Old Corbit Road**

Pg 2 of 5

Total Benefits: **\$389,940**

Total Costs: **\$3,888,007**

BCR: **0.10**

Project Number: T200507102Disaster #:

Program: FMA

Agency: **AECOM**

State: **Delaware**

Point of Contact: Joe Hofstee

Analyst: Joseph Hofstee

Structure and Mitigation Details For: BR 1-424A, Middletown, Delaware, 19709, New Castle

Benefits: \$389,940

Costs: \$3,888,007

BCR: .10

Hazard: **Damage-Frequency Assessment - Flood**

Mitigation Option: Elevation

Latitude:

Longitude:

Project Useful Life: 50

Mitigation Information

Basis of Damages: Historical Damages

Number of Estimated Damage Events: 4328

Number of Events with Know Recurrence

Intervals: 4328

27 Mar 2018

Project: **BR 1-424A on N24 Old Corbit Road**

Pg 3 of 5

Total Benefits: **\$389,940**

Total Costs: **\$3,888,007**

BCR: **0.10**

Project Number: T200507102Disaster #:

Program: FMA

Agency: **AECOM**

State: **Delaware**

Point of Contact: Joe Hofstee

Analyst: Joseph Hofstee

Roads And Bridges

Estimated Number of One-Way
Traffic Trips Per Day: 340

Additional Time per One-Way Trip: 0:1

Number of Additional Miles: 0.8

Federal Rate: 0.540

Economic Loss Per Day of
Loss of Function: \$336

Facility Description:

Old Corbit Road/BR 1-424A

Historic Damages Before and After Mitigation

Analysis Year: 2018

Analysis Duration: 54

Utilities (\$/day):

Year Built: 1965

User Input Analysis Duration: 10

Buildings (\$/day):

Roads/Bridges (\$/day): \$336.37

Damages Before Mitigation

Damage Year:

RI: 1.00

Are Damages In Current Dollars? Yes

Buildings (Days):

Utilities (Days):

Roads (Days): 185.0

Total	\$62,229
Total Inflated	\$62,229

Damages After Mitigation

RI: 1.00

Are Damages In Current Dollars? Yes

Buildings (Days):

Utilities (Days):

Roads (Days): 101.0

Total	\$33,974

Volunteers Cost

Number of Volunteers Required:

Cost of Volunteers Time (\$/Hour/Person):

Per-Person Cost of Lodging for a Volunteer:

Number of Hours Volunteered/Person:

Number of Days Lodging/Volunteer:

Cost of Volunteers:

27 Mar 2018

Project: **BR 1-424A on N24 Old Corbit Road**

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Total Benefits: **\$389,940**

Total Costs: **\$3,888,007**

BCR: **0.10**

Project Number: T200507102Disaster #:

Program: FMA

Agency: **AECOM**

State: **Delaware**

Point of Contact: Joe Hofstee

Analyst: Joseph Hofstee

Social Benefits

Mental Stress and Anxiety

Number of Person: 0

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$0.00

Lost Productivity

Number of Worker: 0

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$0.00

BCR Calculation Results

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual: \$62,229
Present Value: \$858,807

Annual: \$33,974
Present Value: \$468,867

Annual: \$28,255
Present Value: \$389,940

Mitigation Benefits: \$389,940

Mitigation Costs: \$3,888,007

Benefits Minus Costs: (\$3,498,067)

Benefit-Cost Ratio: 0.10

Cost Estimate

Project Useful Life (years): 50

Construction Type:

Mitigation Project Cost: \$3,750,000

Detailed Scope of Work: Yes

Annual Project Maintenance Cost: \$10,000

Detailed Estimate for Entire Project: Yes

Final Mitigation Project Cost: \$3,888,007

Years of Maintenance: 50

Cost Basis Year:

Present Worth of Annual Maintenance Costs: \$138,007

Construction Start Year:

Estimate Reflects Current Prices: Yes

Construction End Year:

Project Escalation:

27 Mar 2018

Project: **BR 1-424A on N24 Old Corbit Road**

Pg 5 of 5

Total Benefits: **\$389,940**

Total Costs: **\$3,888,007**

BCR: **0.10**

Project Number: T200507102Disaster #:

Program: FMA

Agency: **AECOM**

State: **Delaware**

Point of Contact: Joe Hofstee

Analyst: Joseph Hofstee

Justification/Attachments

Field	Description	Attachments
Facility Description	Was calculated in 2015 using automated traffic recorder counts.	RE Old Corbitt Road.msg
Mitigation Project Cost	Based on previous cost estimate completed by DelDOT an increased for inflation.	
Number of Additional Miles	Travel times were conducted in 2015 by the Delaware Department of Transportation.	Travel Time.pdf
Project useful life	PUL is based on the standard FEMA useful life for bridges.	PUL with FEMA standards.pdf
Roads/Bridges	Without the project the roadway over tops as result of tidal events as result the road is impassable.	

Memo
BR 1-424A on Old Corbit Road

NOAA Data Values for Reedy Point

NOAA Data from Reedy Point, Delaware

	Average water elevation	Hours exceeding 3.1 feet	Days exceeding 3.1 feet	Hours exceeding 4.75 feet	Days exceeding 4.75 feet
2008	3.04	4248	177	2252	93.83333333
2009	3.22	4525	188.5416667	2488	103.6666667
2010	3.22	4504	187.6666667	2487	103.625
2011	3.31	4568	190.3333333	2642	110.0833333
2012	3.19	4493	187.2083333	2500	104.1666667
2013	3.09	4343	180.9583333	2327	96.95833333
2014	3.13	4399	183.2916667	2406	100.25
2015	3.06	4328	180.3333333	2281	95.04166667
2016	3.18	4476	186.5	2451	102.125
2017	3.25	4529	188.7083333	2518	104.9166667
10 year average	3.169	4441.3	185.0541667	2435.2	101.4666667

Memo
BR 1-424A on Old Corbit Road

FEMA Firmettes

National Flood Hazard Layer FIRMette



39°27'11.49"N



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Feet 1:6,000

75°38'20.86"W

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS

- Without Base Flood Elevation (BFE)
Zone A, V, A99
- With BFE or Depth
- Regulatory Floodway *Zone AE, AO, AH, VE, AR*

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*

- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee, See Notes, *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS OF FLOOD HAZARD

- NO SCREEN
- Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

OTHER AREAS

- Channel, Culvert, or Storm Sewer Levee, Dike, or Floodwall

GENERAL STRUCTURES

- 20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
- 17.5 Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

OTHER FEATURES

- Digital Data Available
- No Digital Data Available
- Unmapped

MAP PANELS

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The base map shown complies with FEMA's base map accuracy standards.

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/22/2018 at 7:41:24 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: base map imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Memo
BR 1-424A on Old Corbit Road

PUL with FEMA Standards

Table 1: Acquisition/Relocation

Project Type	Useful Life (Years): Standard Value	Useful Life (Years): Acceptable Limits (documentation required)	Comment
All Structures	100	100	

Table 2: Elevation

Project Type	Useful Life (Years): Standard Value	Useful Life (Years): Acceptable Limits (documentation required)	Comment
Residential building	30	30-50	
Non-Residential Building	25	25-50	
Public Building	50	50-100	
Historic Buildings	50	50-100	

Table 3: Structural/Non-Structural Building Project

Project Type	Useful Life (Years): Standard Value	Useful Life (Years): Acceptable Limits (documentation required)	Comment
Residential Building Retrofit	30	30	
Non-Residential Building Retrofit	25	25-50	
Public Building Retrofit	50	50-100	
Historic Building Retrofit	50	50-100	
Roof Diaphragm Retrofit	50	50-100	Roof hardening and roof clips
Tornado Safe Room - Residential	30	30	
Tornado Safe Room -	30	30-50	Retrofit or Small Community safe room ≤ 16 people (30 yr),

Community			New (50 yr)
Non-Structural Building Elements	30	30	Ceilings, electrical cabinets, generators, parapet walls, or chimneys
Non-Structural Major Equipment	15	15-30	Elevators, HVAC, sprinklers
Non-Structural Minor Equipment	5	5-20	Generic contents, racks, shelves

Table 4: Infrastructure Projects

Project Type	Useful Life (Years): Standard Value	Useful Life (Years): Acceptable Limits (documentation required)	Comment
Major Infrastructure (dams, levees)	50	35-100	
Concrete infrastructure, flood walls, roads, bridges, major drainage system	50	35-50	
Culverts (concrete, PVC, CMP, HDPE, etc.) with end treatment (i.e., wing walls, end sections, head walls, etc.)	30	25-50	
Culverts (concrete, PVC, CMP, HDPE, etc.) without end treatment (i.e., wing walls, end sections, head walls, etc.)	10	5-20	
Pump stations, substations, wastewater systems, or equipment such as generators - Structures	50	50	
Pump stations, substations, wastewater systems, or equipment such as generators - Equipment	5	5-30	
Hurricane Storm Shutters	15	15-30	Depends on the type of storm shutter
Major Utility Mitigation Projects (power lines, cable, hardening gas, water, sewer lines, etc.)	50	50-100	
	5	5-30	

Minor Utility Mitigation Projects (backflow valves, downspout disconnect, etc.)			
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Table 5: Miscellaneous Equipment Projects

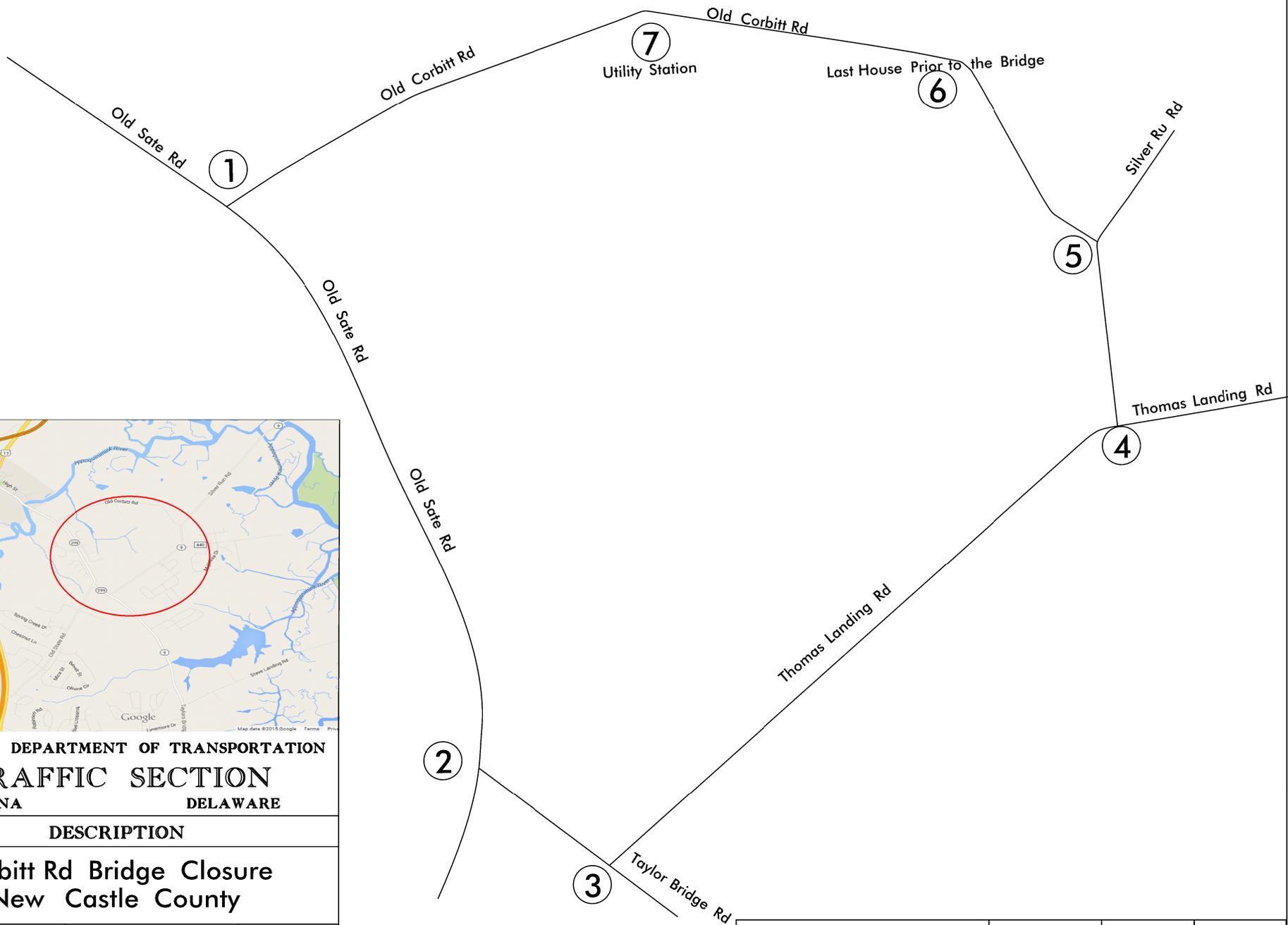
Project Type	Useful Life (Years): Standard Value	Useful Life (Years): Acceptable Limits (documentation required)	Comment
Equipment purchases: Small, portable equipment (e.g., computer)	2	2-10	
Equipment purchases: Heavy equipment	5	5-30	

Table 6: Wildfire Mitigation Projects

Project Type	Useful Life (Years): Standard Value	Useful Life (Years): Acceptable Limits (documentation required)	Comment
Defensible Space/Hazardous Fuels Reduction <ul style="list-style-type: none"> Vegetation Management: Brush 	4	2-4	Depends on drought conditions
Defensible Space/Hazardous Fuels Reduction <ul style="list-style-type: none"> Vegetation Management: Grass 	1	1	Depends on geographic location and precipitation
Defensible Space/Hazardous Fuels Reduction <ul style="list-style-type: none"> Vegetation Management: Forest Canopy 	20	3-20	Must be maintained every 3 years
Ignition Resistant Construction	10	10-30	Depends on type of construction and materials used.

Memo
BR 1-424A on Old Corbit Road

Travel Times around BR 1-424A Closure



**DELAWARE DEPARTMENT OF TRANSPORTATION
TRAFFIC SECTION
SMYRNA DELAWARE**

DESCRIPTION

**Corbitt Rd Bridge Closure
New Castle County**

DRAWN BY: **Ahmed** DATE: **August 12, 2015**

Investigation for: **Travel Time**

Travel Time/Location	From 1 to 5	From 1 to 6	From 1 to 7
Existing Travel Time (Minutes)	2.5	1.25	1
Projected Travel Time (Minutes)	3.25	4	4.5