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Right-of-Way Improvements and Pipeline Lowering Project

Pre- and Post-development Flow Calculations for Two-year Flood Events for Culvert Installation

The purpose for this letter-report is to evaluate the flow for pre- and post-installations of concrete culverts along the natural streams or channels. The installation of the culverts is to allow maintenance, emergency, and inspection vehicles to access the El Paso's Right-of-Way.

BACKGROUND:

There are nine natural streams or wetlands that Tennessee Gas' personnel need to cross to allow maintenance, and possibly emergency vehicles, across the existing pipelines. All nine crossings would use a Geoweb® articulate mat, while three crossings would require the installation of concrete culverts to cross the natural stream.

Most natural streams carry the two-year flood events before spilling out into the floodplain. The two-year rain events are the main cause of channel erosion. Even though the two-year rain events have a lower peak flow, the duration is extended over a longer period of time. Flow events that exceed the capacity of the natural stream channel spill out into the adjacent floodplains and are sometimes called "overbank." Unless these "overbank" floods damage adjacent property or up and downstream structures, these overbanks flood are desirable to spread nutrients and moisture to a wider surface area.

SCOPE:

The scope of this report is to analyze and evaluate the flows of three of the natural streams (culvert crossing). The stream pre- and post-development (installation of culverts) flow conditions are also compared. Calculations were not performed on the other six streams or wetlands due to the fact that they have a very low profile and the installation of the Geoweb® articulate mat would require only minor adjustments to the existing profile. Eight inches of the existing top soil would be replaced with the eight-inch thick Geoweb®. The proposed Geoweb®'s surface would have vegetation similar to the pre-installation vegetation.

DATA:

To compare the capacity of the three natural streams with the post-installation of the culverts the following parameters were used:

- Existing wetted perimeter. Measured directly from site survey data. The wetted permitted was measured by inspecting the upper limits of the "rutting" of the natural stream which represents the eroding effects of the 2-year flood events (see above).
- Up and downstream elevations. Measured directly from site survey data.
- Manning's coefficients used for existing ground = 0.03 and concrete liner = 0.013. These coefficients are engineering accepted coefficients.

- Length 20 feet.
- Software used to calculate open channel hydraulics, 1990 Haestad Methods Inc., Flowmaster 1, Version 2.01.

CALCUALTIONS:

1. Site 2
   The existing flow for this crossing is 54.7 cfs (See Exhibit 1). The proposed flow after the installation of one 24-inch culverts is 39.7 cfs (See Exhibit 2); for two culverts is 79.4 cfs. The proposed culverts are adequate to handle the 2-year flows.

2. Site 5
   The existing flow for this crossing is 10.1 cfs (See Exhibit 3). The proposed flow after the installation of one 24-inch culverts is 6.5 cfs (See Exhibit 4); for two culverts it is 13.0 cfs. The proposed culverts are adequate to convey the 2-year flows.

3. Site 8
   The existing flow for this crossing is 4.8 cfs (See Exhibit 5). The proposed flow after the installation of one 24-inch culverts is 4.7 cfs (See Exhibit 6). The proposed culverts are adequate to handle the 2-year flows.

CONCLUSIONS:

The hydrologic calculations show that the installation of the culvert at the three sites (Sites 2, 5, and 8) would not affect the post-development flows after the installation of the concrete culverts. As noted above, the culverts convey the pre-development flows.

The velocities for Sites 5 and 8 are under 5 fps which is the accepted limiting velocities that triggers energy dissipaters. The velocities at Site 2 are 8.9 fps for pre-development flow (see Exhibit 1) and 15.7 fps for post-development flows I(See Exhibit 2).

RECOMMENDATIONS:

To provide access along the El Paso's Right-of-Way, it is recommended that at Site 2, two 24-inch diameter culverts be installed with an energy dissipater at the downstream side of the culverts; two 24-inch culverts be installed at Site 5, and one 24-inch culvert be installed at Site 8 to adequately convey the 2-year flows.

As noted above, the remaining (6) six sites were not analyzed since the natural ground would be modified slightly to install the Geoweb® (without culverts). The surface of the Geoweb® articulate mats shall have a herbaceous surface similar to the existing natural vegetation. Thus, by comparison, the new Geoweb® crossing would not affect the hydrology of the streams or wetlands.

EXHIBIT 1

SANDY CREEK- SITE 2 EXISTING

Circular Channel Analysis & Design
Solved with Manning's Equation
Open Channel - Uniform flow

Worksheet Name: Sandy Creek Existing Flow Conditions

DATA:

Manning's = 0.03 per Engineering Fluid Mechanics,
By Reuben M. Olson, University of Minnesota, Pg. 291
Channel wetted perimeter 7.23 ft
Depth of channel approximately 1.5 ft
Slope per survey = 0.037

Solve For Actual Discharge

Given Input Data:

Diameter.......... 7.23 ft
Slope............ 0.0370 ft/ft
Manning's n....... 0.030
Depth............ 1.50 ft

Computed Results:

Discharge......... 54.74 cfs
Velocity.......... 8.89 fps
Flow Area......... 6.16 sf
Critical Depth.... 1.86 ft
Percent Full...... 20.75 %
Full Capacity..... 580.43 cfs
QMAX @.94D........ 624.37 cfs
Froude Number..... 1.53 (flow is Supercritical)

Open Channel Flow Module, Version 2.01 (c) 1990
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EXHIBIT 2

SANDY CREEK- SITE 2 PROPOSED

Circular Channel Analysis & Design
Solved with Manning's Equation
Open Channel - Uniform flow

Worksheet Name: Sandy Creek Proposed Flow Conditons with (2) 24" culverts

DATA:

Manning's = 0.03 per Engineering Fluid Mechanics,
By Reuben M. Olson, University of Minnesota, Pg. 291
Depth of channel approximately 1.5 ft
Slope per survey = 0.037

Given Input Data:

Diameter.......... 2.00 ft
Slope............. 0.0370 ft/ft
Manning's n....... 0.013
Depth............. 1.50 ft

Computed Results:

Discharge......... 39.68 cfs
Velocity.......... 15.70 fps
Flow Area......... 2.53 sf
Critical Depth.... 1.95 ft
Percent Full...... 75.00 %
Full Capacity..... 43.52 cfs
QMAX @.94D........ 46.81 cfs
Froude Number..... 2.29 (flow is Supercritical)

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EXHIBIT 3

SANDY CREEK- SITE 5 EXISTING

Circular Channel Analysis & Design
Solved with Manning's Equation
Open Channel - Uniform flow

Worksheet Name: Sandy Creek Existing Flow Conditions

DATA:

Manning’s = 0.03 per Engineering Fluid Mechanics,
By Reuben M. Olson, University of Minnesota, Pg. 291
Channel wetted perimeter 8.75 ft
Depth of channel approximately 1.5 ft
Slope per survey = 0.001

Solve For Actual Discharge

Given Input Data:

Diameter.......... 8.75 ft
Slope............. 0.0010 ft/ft
Manning's n....... 0.030
Depth............. 1.50 ft

Computed Results:

Discharge......... 10.15 cfs
Velocity.......... 1.48 fps
Flow Area......... 6.86 sf
Critical Depth.... 0.75 ft
Percent Full...... 17.14 %
Full Capacity..... 158.72 cfs
QMAX @.94D........ 170.74 cfs
Froude Number..... 0.26 (flow is Subcritical)

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EXHIBIT 4

SANDY CREEK- SITE 5 PROPOSED

Circular Channel Analysis & Design
Solved with Manning's Equation
Open Channel - Uniform flow

Worksheet Name: Sandy Creek Proposed Flow Conditions with (2) 24" culverts

DATA:

Manning’s = 0.03 per Engineering Fluid Mechanics,
By Reuben M. Olson, University of Minnesota, Pg. 291
Depth of channel approximately 1.5 ft
Slope per survey = 0.001

Solve For Actual Discharge

Given Input Data:

Diameter.......... 2.00 ft
Slope............. 0.0010 ft/ft
Manning's n....... 0.013
Depth............. 1.50 ft

Computed Results:

Discharge......... 6.52 cfs
Velocity.......... 2.58 fps
Flow Area......... 2.53 sf
Critical Depth.... 0.91 ft
Percent Full...... 75.00 %
Full Capacity..... 7.15 cfs
QMAX @.94D........ 7.70 cfs
Froude Number..... 0.38 (flow is Subcritical)

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EXHIBIT 5

SANDY CREEK- SITE 8 EXISTING

Circular Channel Analysis & Design
Solved with Manning's Equation
Open Channel - Uniform flow

Worksheet Name: Sandy Creek Existing Conditions

DATA:

Manning's = 0.03 per Engineering Fluid Mechanics,
By Reuben M. Olson, University of Minnesota, Pg. 291
Channel wetted perimeter 5.60 ft
Depth of channel approximately 1.5 ft
Slope per survey = 0.001

Solve For Actual Discharge

Given Input Data:

Diameter.......... 5.60 ft
Slope............ 0.0010 ft/ft
Manning's n....... 0.030
Depth............ 1.19 ft

Computed Results:
Discharge......... 4.78 cfs
Velocity.......... 1.25 fps
Flow Area......... 3.82 sf
Critical Depth.... 0.58 ft
Percent Full...... 21.25 %
Full Capacity..... 48.28 cfs
QMAX @.94D........ 51.94 cfs
Froude Number..... 0.24 (flow is Subcritical)

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EXHIBIT 6

SANDY CREEK- SITE 8 PROPOSED

Circular Channel Analysis & Design
Solved with Manning's Equation
Open Channel - Uniform flow

Worksheet Name: Sandy Creek Proposed Flow Conditions with (1) 24" culvert

DATA:

Manning's = 0.03 per Engineering Fluid Mechanics,
By Reuben M. Olson, University of Minnesota, Pg. 291
Depth of channel approximately 1.5 ft
Slope per survey = 0.001

Solve For Actual Discharge

Given Input Data:

Diameter.......... 2.00 ft
Slope............. 0.0010 ft/ft
Manning's n....... 0.013
Depth............. 1.19 ft

Computed Results:

Discharge......... 4.74 cfs
Velocity.......... 2.44 fps
Flow Area......... 1.95 sf
Critical Depth.... 0.77 ft
Percent Full...... 59.50 %
Full Capacity..... 7.15 cfs
QMAX @.94D........ 7.70 cfs
Froude Number..... 0.43 (flow is Subcritical)

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