

I-75 Engineering Report M-102 to South of 12 Mile Rd

CS 63174 – JN 45700 and 100948

Appendix G Tunnel Option Feasibility Memorandum

Submitted to:



Michigan Department of Transportation

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Michigan Department of Transportation
I-75 Engineering Report
From M-102 to South of 12 Mile Road

Draft Drainage Study: Tunnel Option Feasibility
Revision 0
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1. INTRODUCTION

1.1 Project Description

Stormwater along this section of I-75 is currently collected by an enclosed storm sewer system under the freeway lanes that outlets via seven existing pump stations along southbound (SB) I-75 to the Twelve Towns Drain. This I-75 sewer is located under the SB I-75 Service Drive.

The Twelve Towns Drain is a combined sewer system that flows to the Twelve Towns Retention Treatment Facility (RTF) located north of 12 Mile Road. During low flow conditions, the combined flow can be accommodated and treated by the Detroit Wastewater Treatment Plant via the Dequindre Interceptor. During high flow conditions, the Twelve Towns Drain overflows to the Red Run Drain.

As part of this project, it is proposed to separate the I-75 stormwater from the Twelve Towns Drain sewer system to reduce the flows to the Twelve Towns RTF and ultimately improve the quality of discharge to the Red Run Drain. This will be accomplished by constructing a new storm sewer trunkline, starting at 8 Mile Road that will flow north toward 12 Mile Road before heading east, paralleling the RTF to the outlet at the Red Run Drain east of Dequindre Road. Coordination of the storm sewer trunkline outlet design at the Red Run Drain will be required with the project team for the I-75, 12 Mile to M-59 Engineering Report.

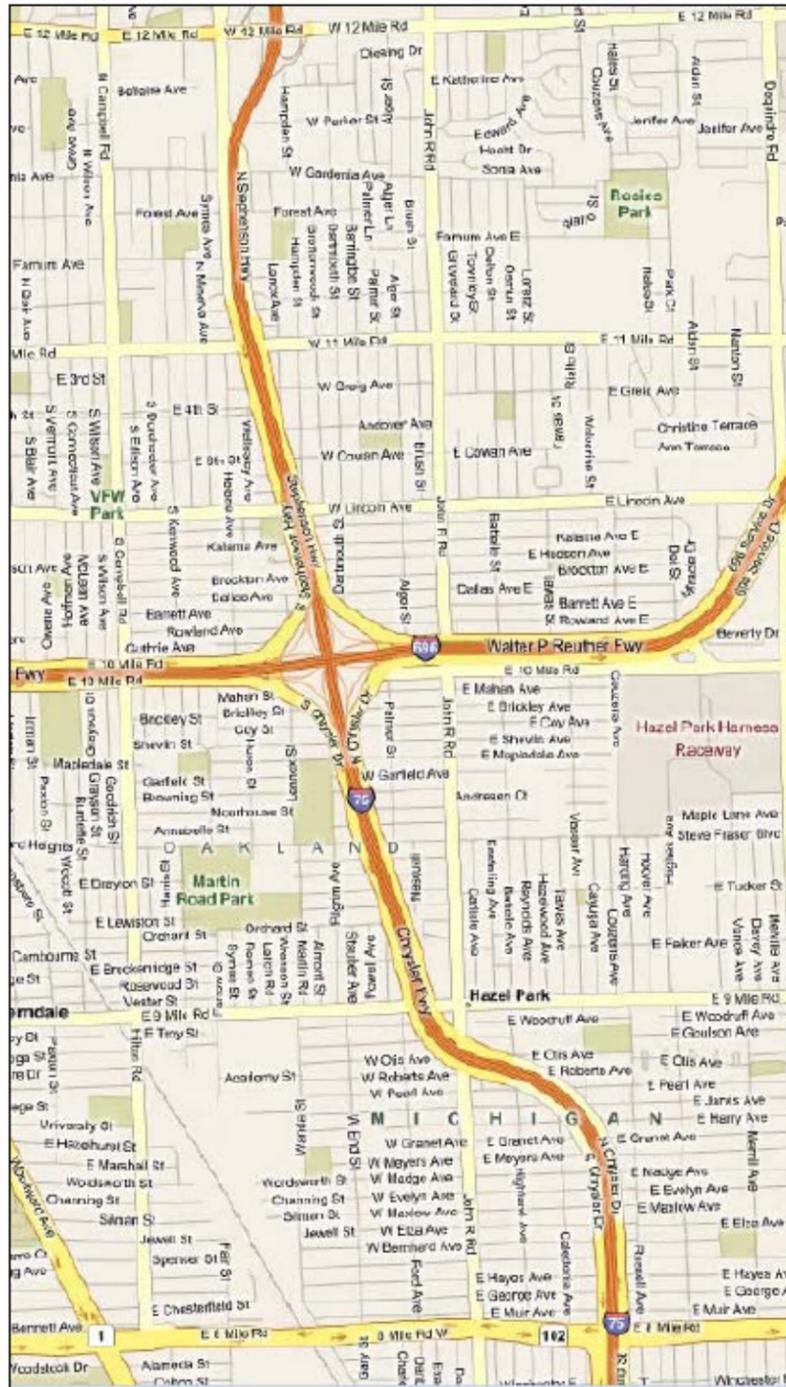
Since the large Twelve Towns Drain is located under the SB I-75 Service Drive, the proposed I-75 storm sewer trunkline would be located under the NB I-75 Service Drive. As outlined in the I-75, 8 to 12 Mile Road Draft Drainage Study Report, this will require new pump stations or, for the tunnel option, drop shafts, to be constructed along NB I-75 to replace the seven existing pump stations along SB I-75. The proposed pump stations or drop shafts will collect flow from the depressed freeway and pump it up to the proposed NB I-75 storm sewer trunkline from the new pump station at the intersection with Greig Street.

A Draft Drainage Study Report was prepared for MDOT in May 2009 which evaluates a trunk line sewer constructed by open-cut methods. This would require deep excavations; crossing local roads and side streets, and existing utilities; ROW impacts; lane closures which affect residents and business owners; and several pump stations.

The purpose of this study is to investigate tunneling as an alternative to the open-cut construction method to reduce the surface impacts.

Refer to Figure 1-1 on the following page for a project location map.

Figure 1-1 Project Location Map



(SOURCE: MICROSOFT VIRTUAL EARTH)

1.2 Terms of Reference

A preliminary tunnel feasibility option analysis has been undertaken as an alternative to the proposed near surface pipeline and pump stations. The near surface pipeline will be replaced with a deeper tunnel option to reduce the number of pump stations and significantly decrease disruptions to local roads and utilities.

The feasibility study will include preparation of a preliminary alignment and identification of structures required to provide a replacement sewer system.

As part of the tunnel option feasibility a high level cost estimate at feasibility level has been prepared.

It is recommended for the next stage that:

1. The hydraulic design is rechecked for system capacity and surge.
2. A preliminary design is developed.
3. Further site investigation is undertaken.
4. A more detailed cost estimate is prepared which will allow the development of a contract schedule.
5. Utility and structure clearances are checked.
6. Estimates of tunnel settlement and impact of settlement on structures should be undertaken.
7. Working areas and construction space assessment are undertaken to check availability of MDOT land.

1.3 Available Information

The following Documents have been reviewed for the Tunnel Option Feasibility Study:

- Draft Drainage Study, I-75, M-102 to South of 12 Mile Road Engineering Report, May 2009
- Somat Geotechnical Investigation of 2003
- Selected Historic Bridge Soil Borings for the following Bridges
 - P02 – Bernhard St.
 - S22 – Meyer Ave.
 - S24 – John R. Ave.
 - S27 – 9 Mile Road
 - S28 – Woodward Heights Ave.
 - S04 – Shevlin Ave.
 - S07 – Dallas Ave.
 - S30 – Lincoln Ave.
 - S31 – 11 Mile Road
 - S01 – Gardenia Ave.

1.4 Approach

PB's approach to the Tunnel Option Feasibility Study was as follows:

- PB collected the available site investigation information from the following and selected relevant investigation information.
 - Somat investigation
 - Historic MDOT bridge investigation information
- A preliminary alignment was prepared to assess the tunnel structures required. This was based on the available site investigation. In all cases, no investigation holes were drilled to rock. The alignment envelope was; therefore, constrained to at least 10 feet above the bottom of the deepest holes to reduce the risk of encountering artesian pressure and gas in the rock during tunneling.
- Structures were selected based on tunneling access requirements.
- A preliminary feasibility analysis of the proposed tunnel was undertaken which included a high level estimate.

2. LIMITATIONS OF FEASIBILITY STUDY

The tunnel feasibility study has been based on available soils investigation which has been developed for design of a surface pipeline and surface structures such as bridges and retaining walls.

If it is decided to proceed with the tunnel option, a more detailed geotechnical investigation will be required to develop a more accurate geotechnical profile and assessment of ground conditions including soil type, soil state, soil strength, permeability, extent of boulders and depth to rock together with an assessment of the methane and hydrogen sulfide gas in the soils.

Clearance to underground structures has not been checked such as bridge foundations and piles and utilities crossing the alignment.

It is assumed that all work space required for construction lies within MDOT ROW.

The cost estimate has been prepared at a very high level and a number of contingencies have been applied which reflect the current "known unknowns" and known risks. The cost estimate allows for some element of "unknowns" but it is likely that not all risks can be mitigated within the estimated costs.

3. ALIGNMENT

3.1 Vertical and Horizontal Alignment

The vertical alignment for the tunnel option was set with regards to the inflow elevation required at the 8 Mile Road drop shaft of 600.00; and the inflow elevations at the other drop shafts locations, and the I-696 trunkline sewer. The vertical alignment proceeds north, following the NB Service Drive, at a slope of 0.1% to the proposed pump station at Greig Street. At this location flows will need to be pumped up to an elevation suitable for connection with the sewer system from north of 12 Mile Road and discharge at the Red Run Drain.

North of the Greig Street Pump Station flows will be pumped up into the 77" x 121" elliptical pipe as analyzed in the Draft Drainage Study Report. Due to shallower cover at this elevation, the pipe heading north from the pump station may be installed by the open-cut method, except where the sewer crosses 11 Mile and 12 Mile Roads, which will require jack-and-bore methods to avoid impact to traffic.

The horizontal alignment will generally follow the left curb line of the NB Service Drive. As listed below, drop shaft structures (which will also serve as tunnel construction access) are assumed to be at the same location as the pump stations in the Draft Drainage Study Report. This will allow for easier tie-in with freeway drainage and will provide greater clearance to buildings along the east side of the Service Drive. Because of the depth of the tunnel, the alignment under the I-696 interchange will be under the east approach pavement of the S05 Bridge. From the as-built drawings, the east abutment of the S05 Bridge was constructed on a spread footing with a bottom of footing elevation of 651.5. The tunnel invert in this location is approximately 580.

3.2 Impact to Building Structures

Several retail stores, churches, and residential structures are located along the NB Service Drive. The tunnel has been located under the left curb line of the service drive to increase the distance to the building structures on the east side and decrease potential surface settlements inherent with soft ground tunneling. In the next stage of design a preliminary assessment of settlements will be undertaken and the horizontal alignment adjusted and the need for additional analysis identified. In order to mitigate settlement impacts on buildings and structures, an Earth Pressure Balance (closed face) tunnel boring machine (TBM) is proposed for the tunnel section of the project. The final lining is proposed to be a one-pass precast concrete segmental lining constructed immediately behind the TBM.

3.3 Tunnel Overview

A single tunnel internal diameter of 12 feet is proposed to allow for the full length of tunneling from a tunnel driving shaft at 8 Mile Road (M-102) to the proposed pump station at Greig Street. This tunnel driving shaft will be used as a drop shaft in the final configuration.

The 12 ft diameter is the current minimum size of precast lining available from local precast concrete suppliers. Below this 12 ft size, it is common to use a two-pass lining system. The first pass is a tunnel lining constructed of ribs and laggings followed by a second pass of a carrier pipe pulled into the tunnel then grouted in place. However, the ribs and lagging method is permeable and lowering of the ground water table will occur during tunneling leading to increased long term settlement.

For the current opinion of cost it has been assumed that the remaining alignment from the pump station at Greig Street, to the connection with the system from north of 12 Mile Road will be open-cut with elliptical pipe and this is proposed from the pump station to the connection with the Red Run Drain.

The tunnel length will be approximately 17,000 ft.

It may be possible in later design development to:

- a. extend the length of tunnel and relocate the pumping station to further reduce surface impact and/or,
- b. reduce the internal tunnel lining diameter in discussion with local precast concrete suppliers.

The drop shafts can be constructed as small diameter drilled shafts from the surface and the final tunnel connection will be made from the bored tunnel to the drilled shaft. Lateral connections can be connected by pipe jacking directly into the drilled shaft if ground cover above the connection is significant.

3.4 Drop Shafts And Pump Stations

The tunnel invert elevation has been set below the flowline elevations for the freeway drainage at the tunnel connection location. Tie-ins will be either into the side of the tunnel or into a drainage structure manhole located over the centerline of the tunnel. When connecting to a manhole, the I-75 pipe will be approximately 5-ft above the tunnel crown.

The drop shafts locations are as follows.

- Eight Mile Road Drop Shaft – This shaft will initially serve as the tunnel mining shaft during construction. The tunnel boring machine will be launched from this location and will provide access for labor, equipment, materials and spoils removal. Once the sewer system is in service, the shaft will be the connection between the existing and proposed drainage. The invert elevation is approximately 594.00, which coincides with the inflow invert elevation.
- Meyers Drop Shaft – Located south of the I-75 and Meyers Avenue Bridge. The invert elevation is approximately 604.00.
- John R. Drop Shaft - Located west of the I-75 and John R. Avenue Bridge. The invert elevation is approximately 600.00.
- Woodward Heights Drop Shaft - - Located south of the I-75 and Woodward Heights Bridge. The invert elevation is approximately 597.00.
- I-696 Drop Shaft - - Located south of the I-696 over I-75 Bridge (S05) and north of the I-75 NB ramps to I-696 EB/WB. At the approximate mid-point of the tunnel drive, this location would likely serve as a tunnel access shaft, similar to the Eight Mile Road shaft. This would allow the tunnel contractor to perform any maintenance on the TBM before tunneling under the I-696 interchange. The invert elevation is approximately 594.00.

The pump station locations are as follows. The pump station locations will be reviewed further in this area to determine if two of the following pump stations may be eliminated. If possible, one pump station would be located north of 11 Mile Road, thereby extending tunneling as well.

- Greig Street Pump Station – As described in the Draft Drainage Study Report, this pump station is located at the intersection of Greig St. and the NB Service Drive. At this location flows from the tunnel would be pumped up to a 77" x 121" elliptical pipe. This is necessary to align the sewer invert for tie-in at the Twelve Towns RTF. Because this is the end of the tunnel drive, this site will also serve as the receiving shaft where the TBM will be disassembled and removed.
- 11 Mile Road Pump Station – Located north of the I-75 and 11 Mile Road Bridge. The invert elevation is approximately 621.00.
- Gardenia Pump Station – Located north of the I-75 and Gardenia Avenue Bridge. The invert elevation is approximately 619.00.

4. SUMMARY & APPROXIMATE OPINION OF COST

A sewer system constructed by tunneling is a feasible alternative to the open-cut method. However, as outlined above, there are additional analyses required in the next stages of design, as summarized below, to further develop this option.

- Additional soils investigation in order to define the underground conditions and specify the appropriate tunneling methods.
- Verify the hydraulic design for system capacity and surge
- Coordination regarding the storm sewer trunkline outlet at the Red Run Drain will be required with the project team for the I-75, 12 Mile to M-59 Engineering Report
- Utility and structure clearances are checked
- Estimates of tunnel settlement and impact of settlement on structures should be undertaken.
- A more detailed cost estimate is prepared which will allow the development of a contract schedule.
- Working areas and construction space assessment are undertaken to check availability of MDOT ROW.

The Opinion of Probable Construction Cost, Table 4-1, is based on tunneling from the Eight Mile Road shaft to a pump station at Greig St., approximately 17,000 feet; 4,000 feet of elliptical pipe installed by open-cut methods; and three pump stations (Greig St., 11 Mile Road, and Gardenia Ave.). No cost savings have been included for eliminating the reconstruction of the NB Service Drive and extensive utility relocations, and traffic control for the open-cut method.

Table 4-1 Approximate Opinion of Cost

Michigan Department of Transportation I-75, from M-102 to south of 12 Mile Road, Drainage Study Tunnel Option					
OPINION OF PROBABLE CONSTRUCTION COSTS					
Item No.	Description	Quantity	Unit	Unit Cost	Amount
1	EPB TBM - New	1	Ea	\$ 6,000,000.00	\$ 6,000,000.00
2	144" ID Mined Tunnel	17,000	Ft	\$ 2,500.00	\$ 42,500,000.00
3	Sewer, CL IV, 77" x 121"	3,940	Ft	\$ 1,400.00	\$ 5,516,000.00
4	Drainage Structure, 60"	60	Ea	\$ 2,500.00	\$ 150,000.00
5	Drainage Structure, 120"	2	Ea	\$ 9,000.00	\$ 18,000.00
6	Drainage Structure Cover	30,000	Lb	\$ 1.25	\$ 37,500.00
7	8-Mile Shaft (20-ft diameter)	1	LS	\$ 750,000.00	\$ 750,000.00
8	Meyer Shaft (6-ft diameter)	1	LS	\$ 250,000.00	\$ 250,000.00
9	John R Shaft (6-ft diameter)	1	LS	\$ 250,000.00	\$ 250,000.00
10	Woodward Heights Shaft (6-ft diameter)	1	LS	\$ 250,000.00	\$ 250,000.00
11	I-696 Shaft (6-ft diameter)	1	LS	\$ 250,000.00	\$ 250,000.00
12	*11 Mile Road Pump Station	1	LS	\$ 1,441,000.00	\$ 1,441,000.00
13	*Gardenia Pump Station	1	LS	\$ 1,343,000.00	\$ 1,343,000.00
14	*Greig St. Trunkline Pump Station	1	LS	\$ 2,500,000.00	\$ 2,500,000.00
Subtotal, Construction Costs					\$ 61,255,500.00
MOBILIZATION (5%)					\$ 3,062,775.00
CONTINGENCY (30%)					\$ 18,376,650.00
TOTAL ESTIMATED SUBCONTRACT VALUE					\$ 82,694,925.00
ASSUMPTIONS					
1. All Costs in 2009 Dollars					
*2. Assumed CI IV sewer pipe based on depth of bury					
3. No roadway or restoration items have been included. Note: Complete Service Dr reconstruction is eliminated with the tunnel option.					
4. Drainage Structure size is based on drilled shaft diameter					
5. 60" Diameter precast concrete drainage structures are included for drop shaft manholes					
*6. No stormwater bypass pumping due to construction phasing schemes was included.					
7. The manhole for the Eight Mile Road shaft is included in the Drainage Structure, 120" item					
8. No utility relocation costs have been included - only required at shaft locations					
*9. Pump station wet well structures are assumed to be cast-in-place concrete with a wall thickness of 18 inches.					
*10. No cost for providing electrical service to the pump station has been included.					
*11. All controls for the pump station are assumed to be housed within the pump station structure. No costs for additional control buildings has been included.					
*12. Pumps are assumed to be submersible mixed flow with draft tubes.					
*13. Due to limited geotechnical information, only a standard foundation was considered for the pump station. Excavation assumed to be 3' below bottom of slab. Bottom slab assumed to be 5' thick.					
14. Resale value of the TBM has been included					
15. Cost of geotechnical site investigation not included					

* From Draft Drainage Study Report