

# Task 3

# Baseline Model Development

City of Allen Park

City of Dearborn Heights

City of Ecorse

City of Inkster

City of Lincoln Park

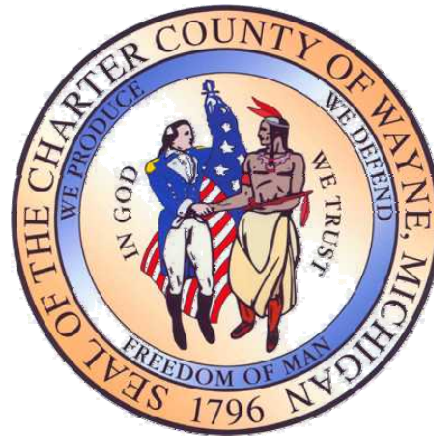
City of Melvindale

City of Taylor

City of Romulus

City of Westland

Prepared by:



Robert A. Ficano  
Wayne County Executive



Kurt L. Heise  
Wayne County Drain Commissioner

Final— July 2007

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## **TASK 3 - BASELINE MODEL DEVELOPMENT**

### **Introduction**

The objective of Task 3 is the development of a baseline conditions model. In Task 2, a hydrologic model and a hydraulic model of the existing conditions of the NBECD and the Reeck Drain, a large tributary to the NBECD in Allen Park and Taylor, were developed. In Task 3, the existing conditions model was updated to develop a baseline conditions model. The differences between the existing conditions model and the baseline conditions model are:

- the baseline model assumes future (build-out) watershed conditions,
- the baseline model assumes that drain crossings are clean (i.e. sediment and debris is removed from drain crossings).

The baseline conditions model will be used as the reference point (or baseline) for developing and evaluating models of flood mitigation alternatives to be considered with this study.

### **Baseline Hydrologic Model Development**

A HEC-HMS hydrologic model for existing conditions and future conditions was developed in Task 2. The future “build-out” conditions hydrologic model presented in Task 2 was used to develop the baseline model. Therefore, the future conditions hydrologic model and the baseline hydrologic model are one and the same. The development of this hydrologic is outlined in detail in Task 2. The following paragraphs provide a brief summary of the development of the baseline hydrologic model.

Future development in NBECD watershed is expected, especially in the upstream portions of the watershed. As future development occurs, an increase in the volume of storm water runoff will occur, as new development will result in an increase of impervious surfaces. The baseline conditions model assumes full development or “build-out” conditions.

The baseline hydrologic model assumes that undeveloped areas within the NBECD watershed will be developed according to the Wayne County Storm Water Management Program (WCSWMP). The WCSWMP requires that new developments provide on-site storm water detention to store the 100-year design storm and discharge storm water at a peak runoff release rate of 0.15 cfs per acre.

The baseline hydrologic model was developed by splitting each of the drainage sub-districts within the watershed into two separate parts: the first representing the existing developed land; and the second representing the currently undeveloped land. The first part was modeled to represent the existing levels of development. The second part, which is currently undeveloped, was modeled as if it were developed in accordance with future land use designations and WCSWMP requirements.

The hydrologic model was run for a range of 24-hour, SCS Type II design storms: the 2-year, 5-year, 10-year and 100-year storms. The hydrographs from these storms were inputted into the HEC-RAS hydraulic model of the NBECD and routed through the NBECD to predict baseline flooding levels and peak flood flow rates.

### **Baseline Hydraulic Model Development**

A HEC-RAS hydrologic model for existing conditions was developed in Task 2. The existing conditions model was updated to develop the baseline conditions model. Three hydraulic model scenarios (model runs) were developed and evaluated in Task 3 including:

- 1) Model Run 10 - existing channel and drain crossing conditions
- 2) Model Run 11A - existing channel conditions and drain crossings downstream of Pelham Road free of sediment/debris
- 3) Model Run 11B - existing channel conditions and all drain crossings free of sediment and debris

Each scenario was modeled for a range of design storm events using hydrographs from the baseline hydrologic model, which considered future land use. This report presents HEC-RAS

model runs for the 10-year and 100-year, 24-hour design storms. Table 3-1 is a matrix that was developed to summarize the HEC-RAS model runs generated in this Task.

**Table 3-1**  
**North Branch of the Ecorse Creek Drain Flood Control Study**  
**Matrix of Unsteady State HEC-RAS Model Runs**

HEC-RAS Plan Name	Design Storm	Land Use Condition	Detroit River Level (feet)	Sexton-Kilfoil Drain Flow Rate (cfs)	NBECDD Stream Channel Condition	Computational Time Step (seconds)	Continuity Error
Run 10 (10 yr)	10-year, 24-hour	Future Build-out	573.4	1,120	Existing	30	-6.4%
Run 11A (10yr)	10-year, 24-hour	Future Build-out	573.4	1,120	Sediment Removed at Crossings d/s Pelham	30	-2.8%
Run 11B (10yr)	10-year, 24-hour	Future Build-out	573.4	1,120	Sediment Removed at All Crossings	30	-2.6%
Run 10 (100yr)	100-year, 24-hour	Future Build-out	573.4	1,760	Existing	30	-3.5%
Run 11A (100yr)	100-year, 24-hour	Future Build-out	573.4	1,760	Sediment Removed at Crossings d/s Pelham	30	-2.8%
Run 11B (100yr)	100-year, 24-hour	Future Build-out	573.4	1,760	Sediment Removed at All Crossings	30	-2.6%
Run 10 Reeck (10 yr)	10-year, 24-hour	Future Build-out	573.4	1,120	Existing	15	8.0%
Run 11B Reeck (10yr)	10-year, 24-hour	Future Build-out	573.4	1,120	Sediment Removed at All Crossings	12	10.5%
Run 10 Reeck (100yr)	100-year, 24-hour	Future Build-out	573.4	1,760	Existing	12	10.6%
Run 11B Reeck (100 yr)	100-year, 24-hour	Future Build-out	573.4	1,760	Sediment Removed at All Crossings	10	7.9%

Model Run 10 was developed by inputting the hydrographs from the baseline HEC-HMS hydrologic model into the calibrated existing conditions HEC-RAS hydraulic model, as developed in Task 2. The existing conditions model is comprised of the existing stream channel geometry and drain crossings.

During the survey phases of this study (see Task 1 and Task 2), many drain crossings were identified with sediment accumulation reducing the effective waterway area of the crossings. Model Run 10 includes the sediment accumulations at the drain crossings.

Table 3-2 presents the existing waterway area of the drain crossing (with sediment) and the potential waterway area if the sediment was removed. Not all of the drain crossings have sediment accumulations. The drain crossings with sediment accumulations are shaded in Table 3-2.

**Table 3-2  
Summary of Sediment Accumulations for Drain Crossings  
Along the North Branch of the Ecorse Creek Drain**

Crossing Name	River Station (mile)	Existing Conditions		Sediment Removed at All Crossings	
		Invert Elevation	Waterway Area (ft <sup>2</sup> )	Invert Elevation	Waterway Area (ft <sup>2</sup> )
Ecorse Rd.	16.91	648.0	21.2	648.0	21.2
Private Drive	16.75	646.3	19.6	646.3	19.6
Private Drive	16.71	645.7	19.6	645.7	19.6
Private Drive	16.70	645.4	19.6	645.4	19.6
Private Drive	16.65	645.8	30.3	645.5	30.5
Private Footbridge	16.63	645.4	51.8	645.4	51.8
Private Drive	16.62	646.1	18.8	645.1	21.7
Private Footbridge	16.55	644.6	39.6	643.9	39.9
Private Drive	16.54	643.9	23.0	643.9	23.0
Sargent Rd.	16.45	644.3	9.7	643.8	10.6
Henry Ruff Rd.	16.41	644.9	9.1	642.9	15.9
Venoy Rd.	15.91	637.6	38.4	637.6	38.4
Merriman Rd.	15.30	629.9	30.2	629.9	30.2
Smith Rd.	14.34	623.5	27.9	623.0	29.0
Private Drive	13.84	622.5	21.5	621.6	23.8
Middlebelt Rd.	13.78	621.5	64.0	621.5	72.6
Ecorse Rd.	13.10	619.1	65.8	619.1	65.8
Private Drive	12.77	618.6	26.0	618.6	26.0
Beverly Rd.	12.46	616.5	81.1	616.5	97.1
Van Born Rd.	11.75	612.3	119.2	612.3	119.2
Inkster Rd.	11.57	613.3	81.2	613.3	81.2
Bayham St.	10.84	610.9	32.5	609.9	35.8
Private Footbridge	10.80	609.1	182.3	609.1	182.3
Old Driveway	10.74	608.3	47.2	608.3	47.2
Beech Daly Rd.	10.46	605.9	177.9	605.9	217.8
Gulley St.	10.20	604.9	132.4	604.9	151.8
Banner Ave.	9.57	603.1	182.2	603.1	182.2

**Table 3-2 (continued)**  
**Summary of Sediment Accumulations for Drain Crossings**  
**Along the North Branch of the Ecorse Creek Drain**

Crossing Name	River Station (mile)	Existing Conditions		Sediment Removed at Crossings	
		Invert Elevation	Waterway Area (ft <sup>2</sup> )	Invert Elevation	Waterway Area (ft <sup>2</sup> )
Telegraph Rd. South	9.43	602.3	195.2	602.3	195.2
Telegraph Rd. North	9.41	602.4	208.5	602.4	208.5
Madison Ave.	9.10	601.0	189.2	601.0	209.8
Parker Ave.	8.81	600.4	214.8	600.4	214.8
Pardee Ave.	8.51	599.4	143.2	599.4	143.5
Monroe St.	8.16	596.7	172.8	596.7	239.6
Williams St.	7.97	596.0	58.1	596.0	58.1
Hanover St.	7.84	595.1	118.6	595.1	214.3
Campbell St.	7.83	596.0	79.5	596.0	146.7
Gertrude Ave.	7.75	595.5	187.7	595.5	187.7
Harding Ave.	7.70	595.7	185.1	595.7	185.1
Hanover St.	7.65	595.1	114.9	595.1	190.0
Polk St.	7.55	594.6	58.1	594.6	58.1
Hipp St.	7.48	594.7	58.1	594.7	58.1
Hanover St.	7.42	594.1	104.5	594.1	121.5
Jackson St.	7.22	592.5	118.3	592.5	138.1
Pelham St.	7.12	592.0	74.0	592.0	86.3
Kingston St.	6.89	590.8	78.8	590.8	166.1
Edgewood St.	6.82	592.4	84.5	592.4	118.6
Bedford St.	6.70	591.1	180.2	591.1	180.2
Southfield Rd. (M-39)	6.37	591.1	194.1	588.1	245.2
Euclid Ave.	6.31	588.2	51.9	588.2	51.9
Watson Ave.	6.24	587.9	51.9	587.9	51.9
Russell Ave.	6.16	588.4	51.9	588.4	51.9
Larme Ave./Keppen Ave.	6.07	587.0	51.9	587.0	51.9
Shenandoah Ave.	5.92	587.2	167.4	587.2	167.4
W. I-94	5.47	586.5	90.5	585.1	108.0
E. I-94	5.43	586.5	87.8	584.9	108.0
Baker College	5.35	583.7	137.4	583.7	165.4
Railroad Tracks	5.07	583.2	139.1	583.2	190.4
Railroad Tracks	4.97	582.8	130.9	582.8	149.8
Railroad Tracks	4.92	582.5	218.8	582.5	235.0
Footbridge	4.83	582.4	365.9	582.4	365.9
Allen Rd.	4.61	579.9	147.6	579.9	188.7
Stanley Ave.	4.20	580.3	89.5	580.3	89.5
Frank Ave.	3.92	577.6	151.5	577.6	182.6
Footbridge	3.84	577.8	141.5	577.8	141.5
Dix Hwy.	3.74	578.3	132.3	578.3	132.3
Porter Ave.	3.54	576.0	186.8	576.0	203.9
Private Drive	3.43	575.7	174.8	575.7	174.8
Railroad Tracks	3.41	576.6	179.5	576.6	179.5
John a Papalas Dr.	3.30	576.1	377.1	576.1	377.1
Fisher Fwy. (I-75)	3.20	575.0	313.3	575.0	313.3

**Table 3-2 (continued)**  
**Summary of Sediment Accumulations for Drain Crossings**  
**Along the North Branch of the Ecorse Creek Drain**

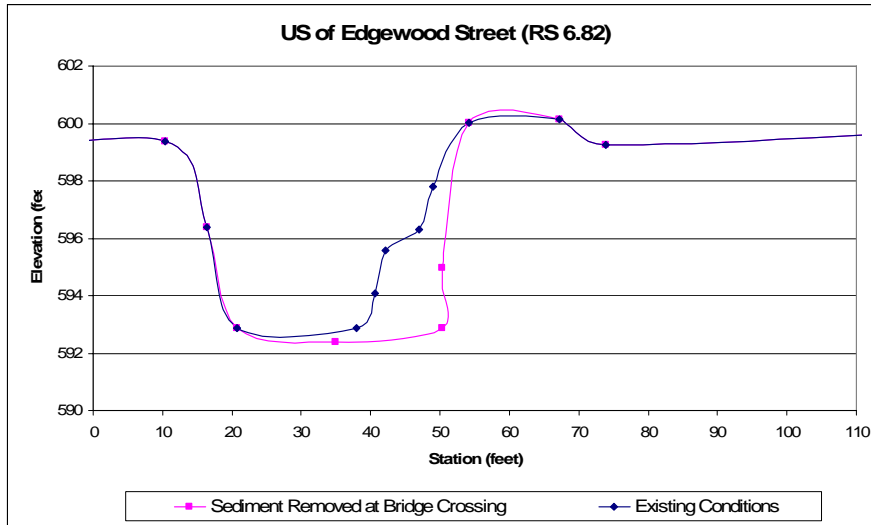
Crossing Name	River Station (mile)	Existing Conditions		Sediment Removed at Crossings	
		Invert Elevation	Waterway Area (ft <sup>2</sup> )	Invert Elevation	Waterway Area (ft <sup>2</sup> )
Lafayette Blvd.	3.12	574.9	160.9	574.9	189.2
Fort St. (M-85)	2.85	573.1	204.4	573.1	280.9
Fort St. (M-85)	2.83	572.7	166.9	572.7	284.9
Victoria Ave.	2.74	571.0	175.9	571.0	194.8
Austin Ave.	2.44	573.0	303.6	573.0	354.5
Southfield Rd.	1.40	570.5	363.4	570.5	433.0
Railroad Tracks	0.26	566.4	593.4	566.4	593.4
Railroad Tracks	0.24	565.8	747.1	565.8	747.1
Railroad Tracks	0.23	565.2	1025.7	565.2	1025.7
Railroad Tracks	0.22	565.2	893.8	565.2	893.8
W. Jefferson Ave.	0.09	564.1	1056.6	564.1	1056.6

 Indicates sediment at crossing removed in HEC RAS baseline model

It is expected that sediment removal at the drain crossings will be a component of any flood mitigation alternative, either as part of a comprehensive flood control project or as drain maintenance pursuant to the Michigan Drain Code. Based on this, sediment removal from the drain crossings has been established as a baseline condition for the NBECD flood control study.

To develop a baseline model consistent with this assumption, the existing conditions model was updated to develop the baseline conditions model by removing sediment at the drain crossings that are highlighted in Table 3-2. At the drain crossings that are bridges with sediment accumulation, the upstream and downstream cross-sections were changed in the HEC-RAS model to simulate sediment removed conditions. At the drain crossings that are culverts with sediment accumulation, the HEC-RAS model culvert data editor was revised to simulate sediment removed culvert conditions. An example of a cross section changed in HEC-RAS to simulate the removal of sediment at the bridge crossings is shown in Figure 3-1. All of the cross sections that were changed for the baseline hydraulic model are shown in Appendix A.

**Figure 3-1  
 North Branch of the Ecorse Creek Drain  
 HEC-RAS Model Cross-Section Comparison  
 Existing Conditions vs. Sediment Removed at Crossings (Baseline Conditions)**



Model Run 11A was developed by removing sediment from drain crossings located downstream of Pelham Road. This model run was developed to identify the level of flood reduction that would occur if sediment removal at the indicated drain crossings was completed expeditiously.

Model Run 11B was developed by removing sediment drain crossings along the entire length of the NBECD. Run 11B will be used as the “baseline conditions model” for comparison with future models of flood mitigation alternatives. Model Run 11B also incorporates the Reeck Drain into the HEC-RAS hydraulic model of the NBECD.

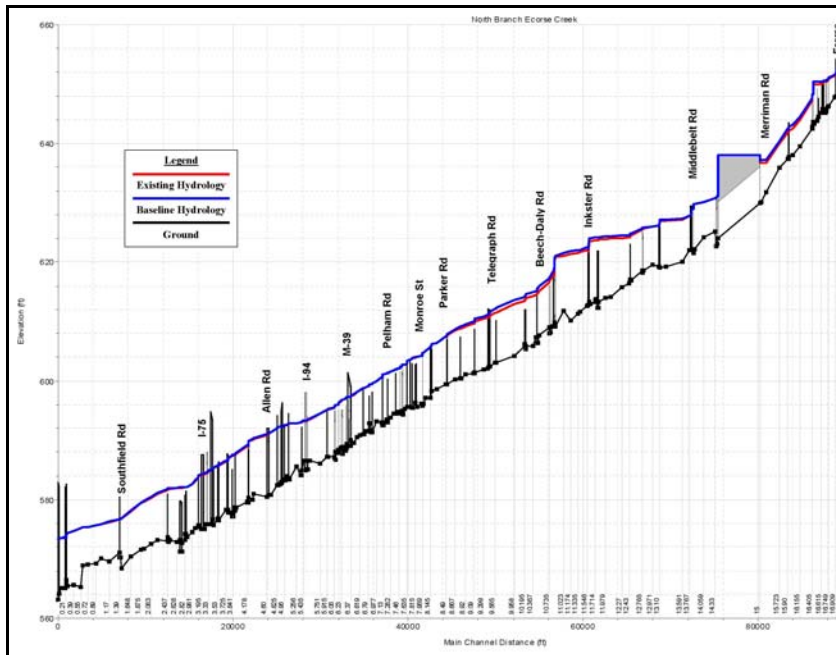
Table 3-2 and the cross sections in Appendix A show the drain crossings that sediment was removed from in the model. Other than the removal of sediment from the drain crossings, model runs 11A and 11B have the same channel geometry and hydraulic model parameters as the existing conditions model developed in Task 2 of this study.

## Model Results

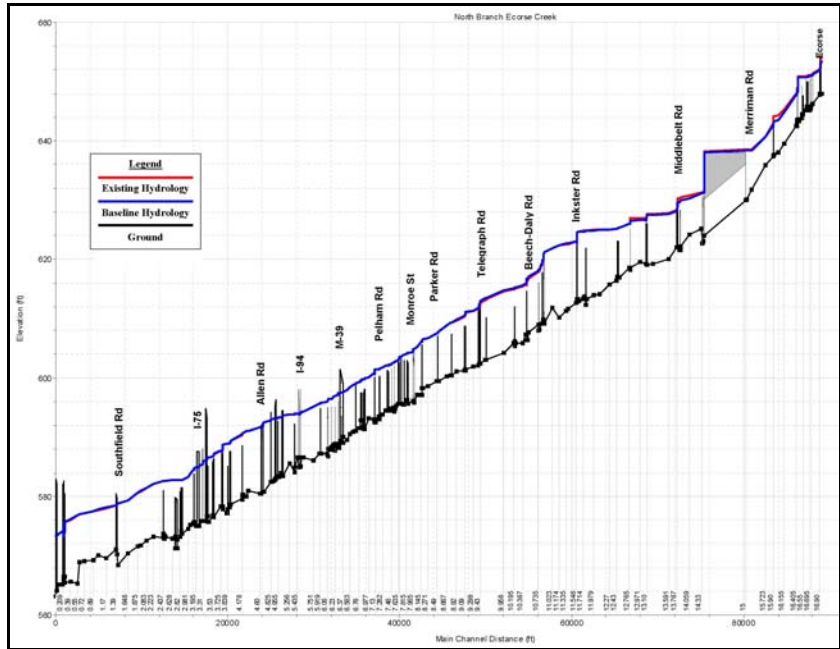
### *Existing Land Use and Future Land Use*

A comparison of the hydraulic grade lines along the NBECD for the existing conditions hydrology and the baseline hydrology routed through the existing stream channel geometry for the 10-year and 100-year design storms are presented in Figure 3-2 and 3-3, respectively.

**Figure 3-2**  
**NBECD Existing Conditions Hydraulic Model**  
**Comparison of Hydraulic Grades**  
**Routing Existing Hydrology versus Baseline Hydrology**  
**For the 10-year Design Storm**



**Figure 3-3**  
**NBECD Existing Conditions Hydraulic Model**  
**Comparison of Hydraulic Grades**  
**Routing Existing Hydrology versus Baseline Hydrology**  
**for the 100-year Design Storm**



In general, the predicted grade lines and flood levels generated by the existing conditions hydrology and the baseline hydrology are very similar for both design storms.

Table 3-3 compares peak flood flow rates for existing hydrology and baseline hydrology at several road crossings along the NBECD for the 10-year and 100-year design storms.

**Table 3-3  
Flood Flow Rates from NBECD Existing Conditions Hydraulic Model  
Comparing Existing Conditions Hydrology and Baseline Hydrology**

Drain Crossing	River Station	Peak Flow Rates (cfs)			
		10-Year Storm		100-Year Storm	
		Existing Hydrology	Future Build-Out Hydrology	Existing Hydrology	Future Build-Out Hydrology
<b>NBECD</b>					
Ecorse Rd.	16.91	86.3	86.3	127.4	127.4
Middlebelt Rd.	13.78	318.2	324.1	373.0	376.7
Inkster Rd.	11.57	590.3	590.7	761.6	773.2
Beech Daly Rd.	10.46	813.7	811.2	1184.7	1182.6
Telegraph Rd. North	9.41	785.6	786.5	1067.7	1063.3
Parker Ave.	8.81	794.8	795.2	1084.5	1039.3
Monroe St.	8.16	496.7	515.3	611.7	827.9
Pelham St.	7.12	377.9	377.2	435.7	543.6
Southfield Rd. (M-39)	6.37	384.3	385.4	449.0	543.1
Allen Rd.	4.61	542.5	563.1	719.6	764.3
Fisher Fwy. (I-75)	3.20	665.9	686.7	916.3	953.2
Southfield Rd.	1.40	726.1	742.0	1051.7	1065.8
<b>Reeck</b>					
I-94	180+24	19.3	19.3	33.2	33.2
Monroe St.	167+83	83.7	83.1	112.8	107.9
Merrick Rd.	139+04	35.4	35.3	35.2	35.2
I-94	97+24	30.6	31.0	31.4	31.4
Southfield Rd.	69+67	38.2	41.4	39.6	42.1
Enterprise Dr.	35+21	138.3	136.7	220.5	220.8

The results show that the predicted flood levels and flood flows for the existing channel conditions are very similar when comparing existing conditions hydrology and baseline conditions hydrology. This is attributed to the WCSWMP, as the WCSWMP requires that new developments provide on-site storm water detention basins and regulate discharge rates. The on-site detention basins are required to store the 100-year design storm and discharge at a runoff rate of 0.15 cfs per acre.

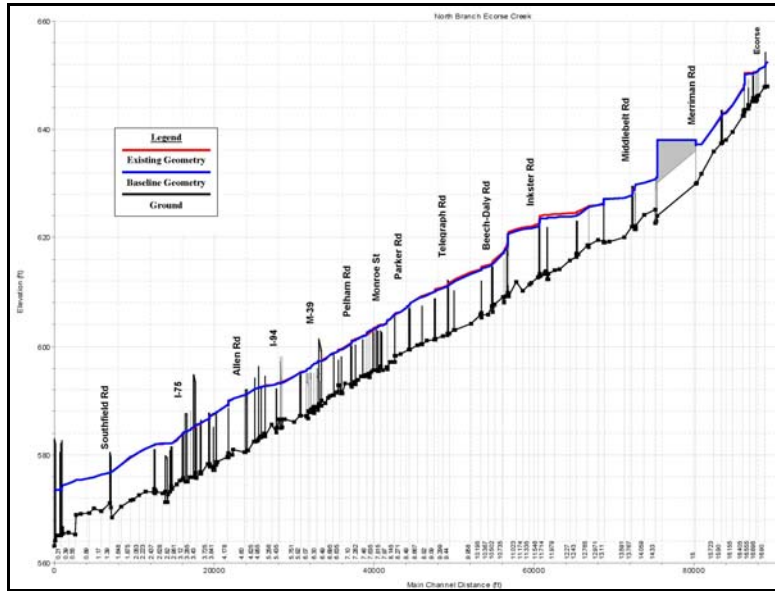
### *Baseline Channel Hydraulics*

Three channel geometry scenarios were developed in the HEC-RAS model for baseline modeling as shown on Table 3-1. Initially, the Model Run 10 was compared to Run 11A. Run 11A included the removal of sediment from the drain crossings downstream of Pelham Road. The objective of Model Run 11A was to identify if the sediment removal from these drain crossing provided significant flood relief. Comparison of Model Runs 10 and 11A showed virtually no change or reduction in flood levels. Therefore, only comparisons of the Model Runs 10 and 11B will be discussed in detail throughout the remainder of this report.

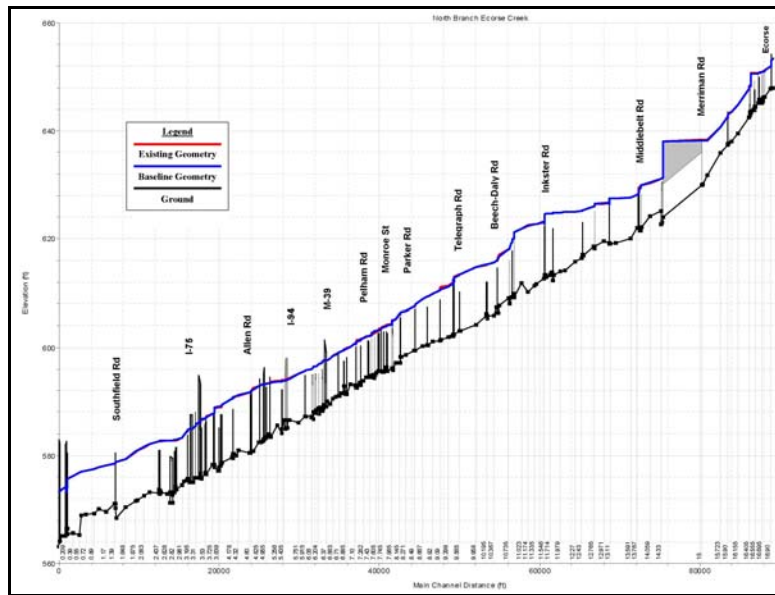
A comparison of predicted flood levels along the NBECD for both the existing channel conditions (Run 10) and baseline channel conditions (Run 11B) for the 10-year and 100-year, 24-hour design storms are presented on Figures 3-4 and 3-5, respectively.

As shown on Figures 3-4 and 3-5, the removal of the sediment from the crossings did not significantly change the hydraulic grade line or lower flood levels. Small reductions in flood levels were predict in isolated areas. Table 3-4 compares flood levels for existing channel geometry and baseline channel geometry at several road crossings along the NBECD and Reeck Drain.

**Figure 3-4**  
**Comparison of Hydraulic Grades along the NBECD**  
**Existing Channel versus Baseline Channel**  
**using Baseline Hydrology for 10-year Design Storm**



**Figure 3-5**  
**Comparison of Hydraulic Grades along the NBECD**  
**Existing Channel versus Baseline Channel**  
**using Baseline Hydrology for 100-year Design Storm**

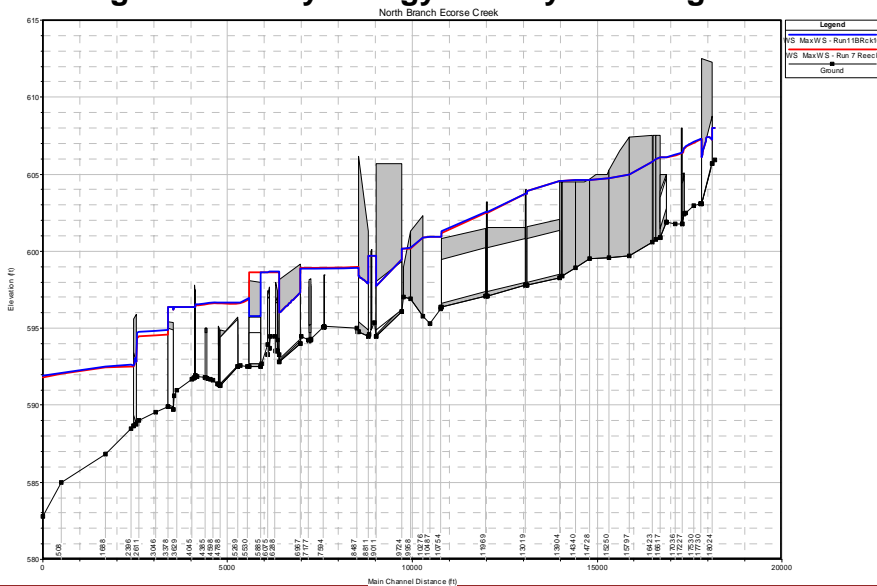


**Table 3-4**  
**Comparison of Flood Levels along the NBECD**  
**Existing Conditions versus Baseline Conditions**  
**Using Baseline Hydrology**

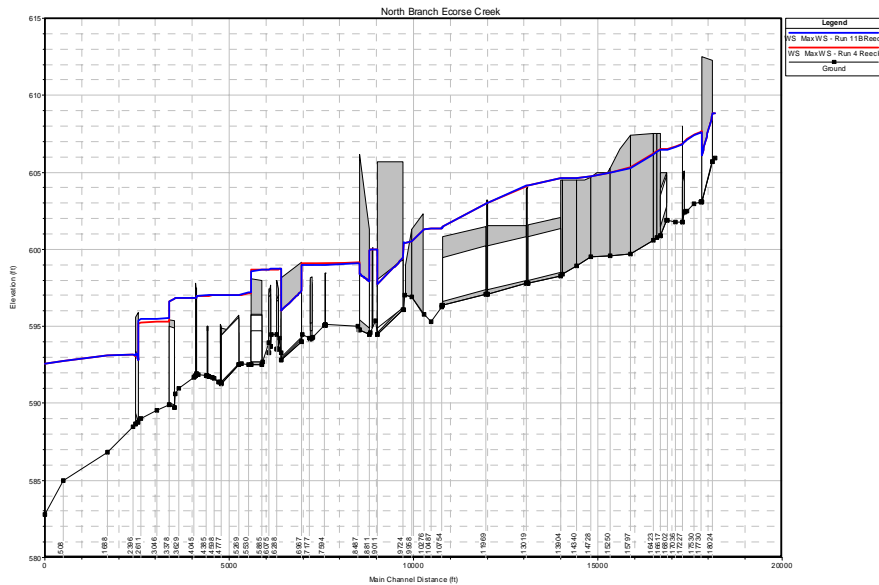
Crossing Name	River Station (mile)	Maximum Flood Level (feet)			
		10-Year Storm		100-Year Storm	
		Existing Conditions Model	Baseline Model	Existing Conditions Model	Baseline Model
Ecorse Rd.	16.91	652.1	652.1	653.1	653.1
Middlebelt Rd.	13.78	628.7	628.5	629.4	629.1
Inkster Rd.	11.57	624.0	624.0	624.6	624.6
Beech Daly Rd.	10.46	615.7	615.4	616.8	616.4
Telegraph Rd. North	9.41	611.3	611.3	612.5	612.3
Parker Ave.	8.81	609.1	609.1	609.4	609.4
Monroe St.	8.16	606.0	605.9	606.3	606.3
Pelham St.	7.12	601.1	600.9	601.3	601.1
Southfield Rd. (M-39)	6.37	597.4	597.4	597.7	597.6
Allen Rd.	4.61	591.2	591.2	592.4	592.1
Fisher Fwy. (I-75)	3.20	584.3	584.3	585.0	585.0
Southfield Rd.	1.40	576.8	576.8	578.7	578.7

Figures 3-6 and 3-7 show the predicted baseline conditions 10-year and 100-year flood levels along the Reeck Drain. Also, the results of Model Run 11B are shown on flood maps located in Appendix B.

**Figure 3-6**  
**Comparison of Hydraulic Grades along the Reeck Drain**  
**Existing Channel versus Baseline Channel**  
**using Baseline Hydrology for 10-year Design Storm**



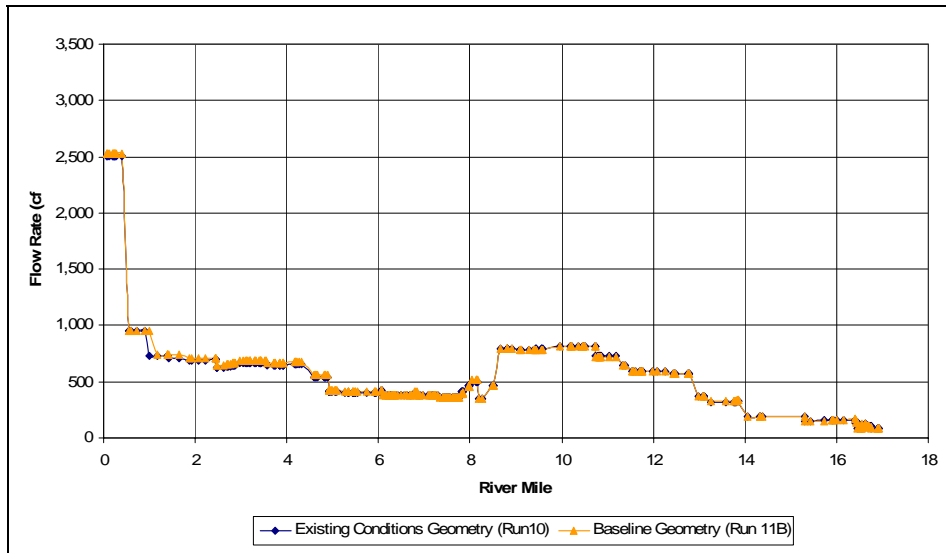
**Figure 3-7  
Comparison of Hydraulic Grades along the Reeck Drain  
Existing Channel versus Baseline Channel  
Using Baseline Hydrology for 100-year Design Storm**



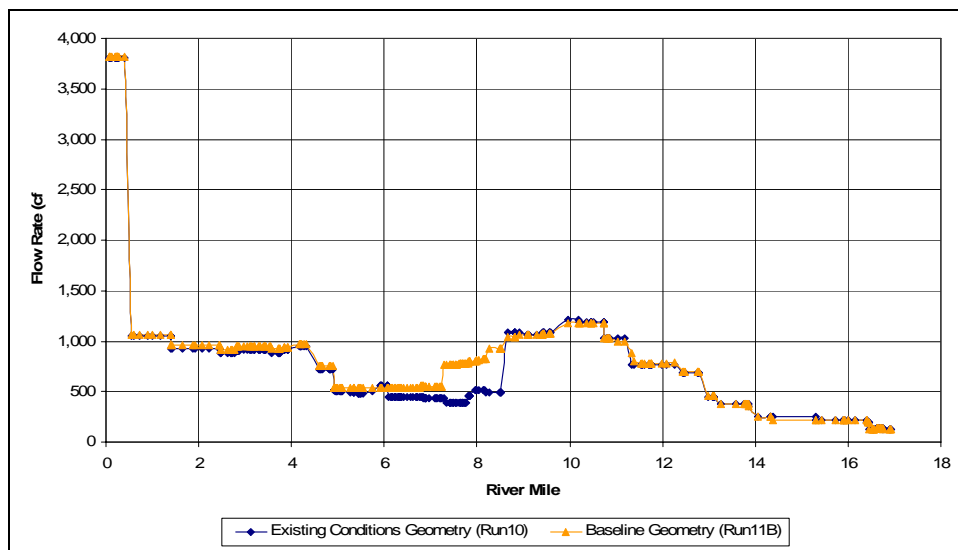
The small reduction in flood levels predicted for the baseline channel for both design storm events can be attributed to an increase in channel conveyance capacity due to the removal of sediment from previously obstructed drain crossings.

The predicted peak flood flow rates for baseline channel geometry were compared to the peak flood flow rates for existing channel geometry for the 10-year and 100-year storms. Both model runs predicted similar flow rates along the NBECD. A comparison of peak flood flow rates by river mile for the 10-year and 100-year, 24-hour design storms are shown on page 14 on Figures 3-8 and 3-9, respectively.

**Figure 3-8**  
**Comparison of Flood Flow Rates Along the NBECD**  
**for Existing Channel and Baseline Channel**  
**10-year Design Storm**



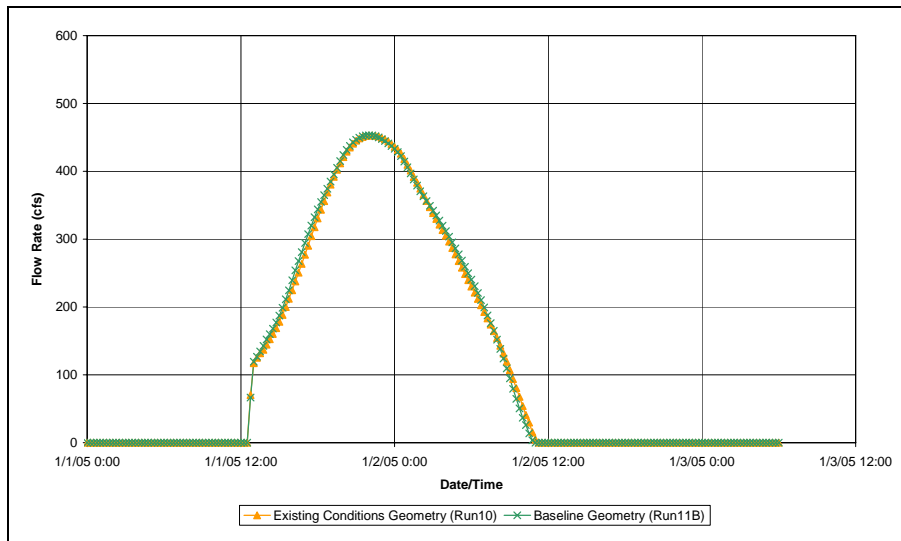
**Figure 3-9**  
**Comparison of Flood Flow Rates Along the NBECD**  
**for Existing Channel and Baseline Channel**  
**100-year Design Storm**



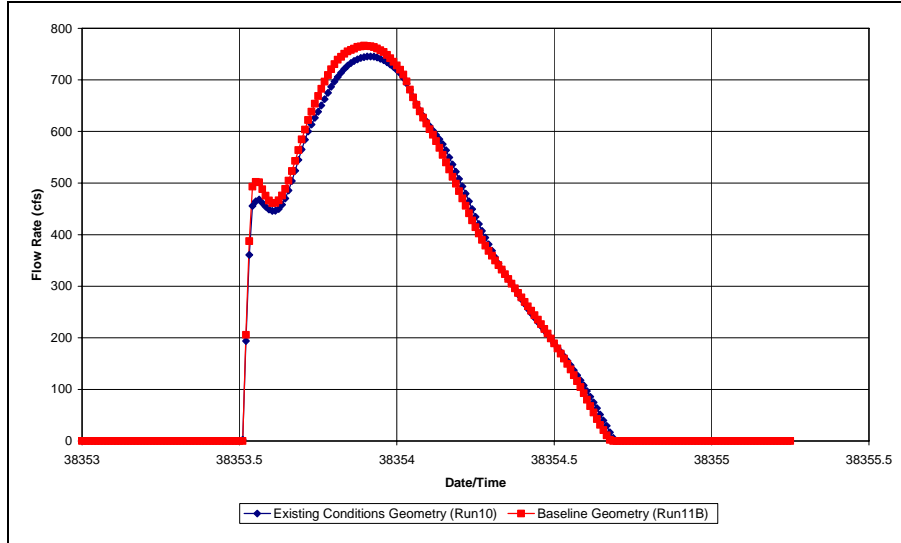
The maximum increase in flood flow rates from existing channel geometry to baseline channel geometry was 435 cfs between Pardee Avenue (RS 8.51) and Pelham Street (RS 7.12). This increase is attributed to the removal of sediment from drain crossings in this reach of the drain. No significant change in the flood levels was predicted due to the increased flood flow rates since the peak flow rates do not occur at the same time as peak flood levels.

Flood flow over Dartmouth Road was predicted to occur for existing channel geometry (Run 10) and the baseline channel geometry (Run 11B). The composite predicted overflow hydrographs for flow over Dartmouth Road for the 10-year and 100-year storms are shown on Figures 3-10 and 3-11, respectively.

**Figure 3-10**  
**Flood Flow over Dartmouth Road**  
**for Existing Channel vs. Baseline Channel**  
**10-year Design Storm**

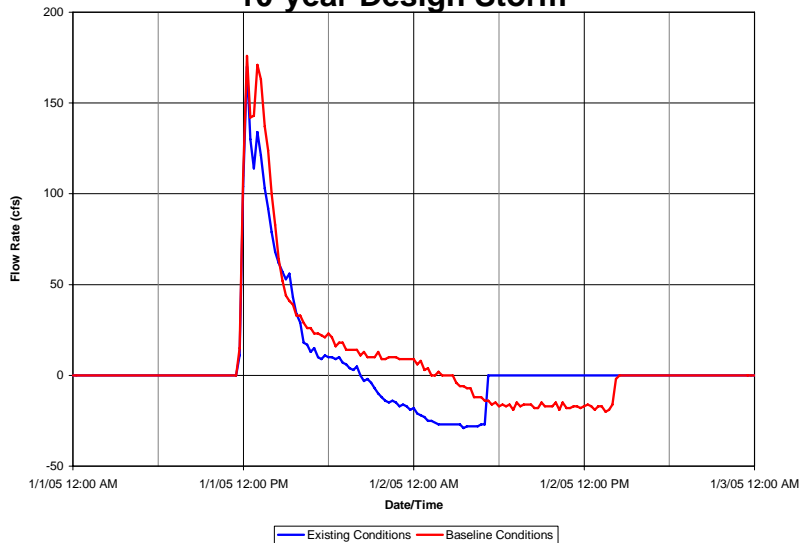


**Figure 3-11**  
**Flood Flow over Dartmouth Road**  
**for Existing Channel vs. Baseline Channel**  
**100 year-Design Storm**

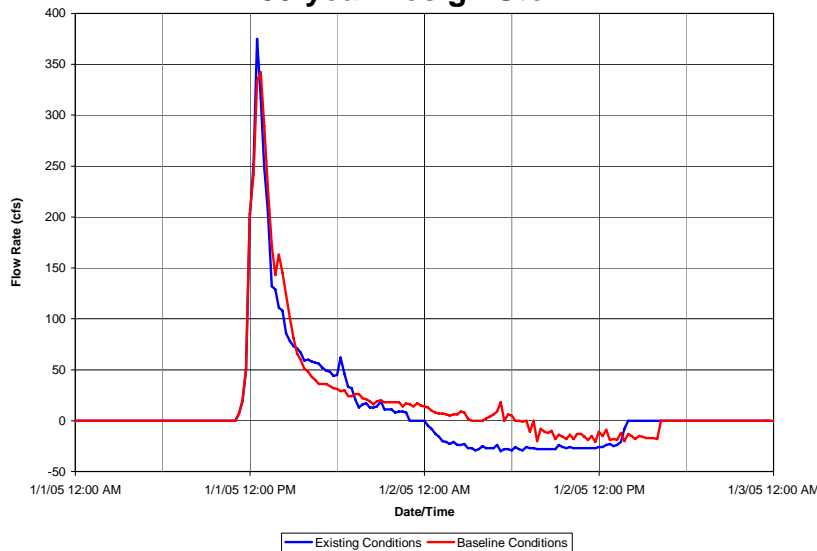


Flood flow over Van Born Road was also predicted to occur for existing channel geometry (Run 10) and the baseline channel geometry (Run 11B). The composite predicted overflow hydrographs for flow over Van Born Road for the 10-year and 100-year storms are shown on Figures 3-12 and 3-13, respectively.

**Figure 3-12**  
**Flood Flow over Van Born Road**  
**for Existing Channel vs. Baseline Channel**  
**10-year Design Storm**



**Figure 3-13**  
**Flood Flow over Van Born Road**  
**for Existing Channel vs. Baseline Channel**  
**100-year Design Storm**



## Conclusions

Based on the model results, the following general conclusions were developed:

- Predicted peak flood flow rates and flood levels for future land use build-out conditions are similar to existing conditions.
- Removal of sediment (maintenance cleaning) from drain crossing downstream of Pelham Road does not mitigate existing flooding problems along the NBECD and Reeck Drain.
- Removal of sediment (maintenance cleanout) from all drain crossings along the NBECD does not significantly mitigate existing flooding problems along the NBECD and Reeck Drain.

Since sediment removal from drain crossings would be a component of any flood mitigation alternative, “cleaned-out” crossings are assumed for baseline conditions (Model Run 11B).

Flood maps for baseline modeling for the 10-year and 100-year design storm events are located in Appendix B. The maps show the extents of flooding along the NBECD and the Reeck Drain that will be used for the baseline comparison with future mitigation alternatives.