Appendix G

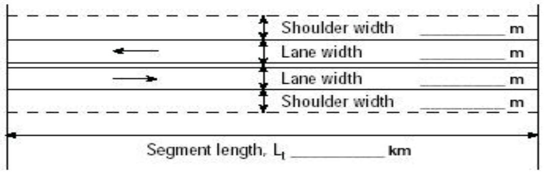
2031 Mainline Worksheets

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Dundas to Sixteen Mile*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*AM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*2815* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*3366*
v_p * highest directional split proportion[2] (pc/h)	*2356*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width[3], f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*11.1*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*3366*
v_p * highest directional split proportion[2] (pc/h)	*2356*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*94.8*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*99.0*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*F*
Volume to capacity ratio, v/c=V_p/ 3,200	*1.05*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*306*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*1126*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*27.5*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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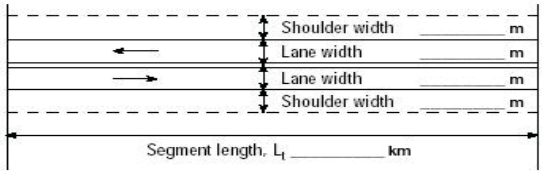
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Sixteen Mile to North Park*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*AM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*2586* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*3092*
v_p * highest directional split proportion^2 (pc/h)	*2164*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	km/h	Base free-flow speed, $BFFS_{FM}$	*70.0* km/h
Observed volume, V_f	veh/h	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0* km/h
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	km/h	Adj. for access points, f_A (Exhibit 20-6)	*2.0* km/h
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0* km/h

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*14.5*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*3092*
v_p * highest directional split proportion^2 (pc/h)	*2164*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*93.4*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*97.6*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*F*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.97*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*211*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*776*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*14.5*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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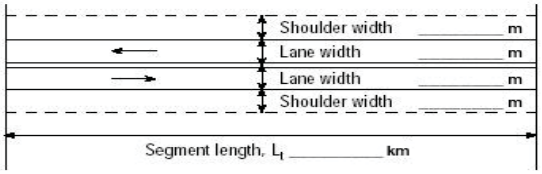
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*North Park to Future St C*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*AM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*2329* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2785*
v_p * highest directional split proportion^2 (pc/h)	*1950*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*18.4*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2785*
v_p * highest directional split proportion^2 (pc/h)	*1950*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*91.4*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*95.6*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*F*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.87*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*316*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*1165*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*17.2*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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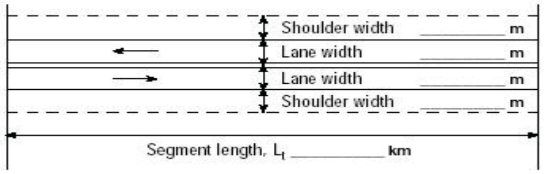
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Future St C to Future St D*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*AM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*2202* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))$	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2633*
v_p * highest directional split proportion[2] (pc/h)	*1843*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width[3], f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS $FFS=S_{FM}+0.00776(V_f/ f_{HV})$	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) $ATS=FFS-0.00776v_p-f_{np}$	*20.3*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))$	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2633*
v_p * highest directional split proportion[2] (pc/h)	*1843*
Base percent time-spent-following, $BPTSF(\%)=100(1-e^{-0.000879v_p})$	*90.1*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, $PTSF(\%)=BPTSF+f_{d/np}$	*94.3*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*F*
Volume to capacity ratio, $v/c=V_p/ 3,200$	*0.82*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= $0.25L_t(V/PHF)$	*299*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=$V*L_t$	*1101*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*14.7*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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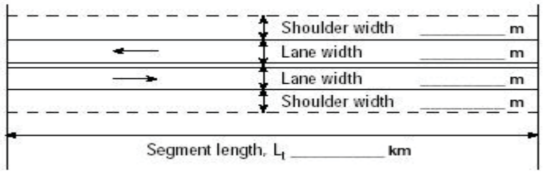
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Future St D to Burnhamthorpe*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*AM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*1915* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))$	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2290*
v_p * highest directional split proportion[2] (pc/h)	*1603*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width[3], f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS $FFS=S_{FM}+0.00776(V_f/ f_{HV})$	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) $ATS=FFS-0.00776v_p-f_{np}$	*24.6*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))$	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2290*
v_p * highest directional split proportion[2] (pc/h)	*1603*
Base percent time-spent-following, $BPTSF(\%)=100(1-e^{-0.000879v_p})$	*86.6*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, $PTSF(\%)=BPTSF+f_{d/np}$	*90.8*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*E*
Volume to capacity ratio, $v/c=V_p/ 3,200$	*0.72*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= $0.25L_t$(V/PHF)	*260*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=$V*L_t$	*958*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*10.6*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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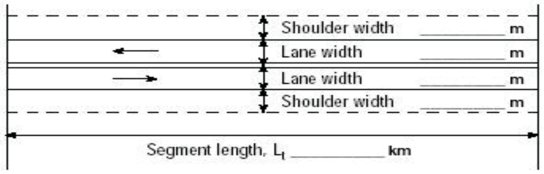
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Burnhamthorpe to NNOC*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*AM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*1779* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2127*
v_p * highest directional split proportion^2 (pc/h)	*1489*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*26.6*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2127*
v_p * highest directional split proportion^2 (pc/h)	*1489*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*84.6*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*88.8*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*E*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.66*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*242*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*890*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*9.1*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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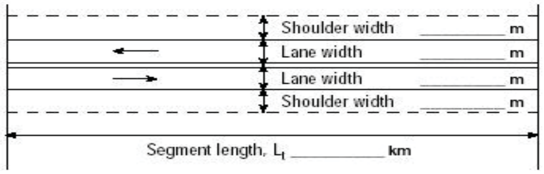
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*NNOC to Hwy 407*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*AM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*1536* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*1837*
v_p * highest directional split proportion^2 (pc/h)	*1286*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*30.2*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*1837*
v_p * highest directional split proportion^2 (pc/h)	*1286*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*80.1*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*5.3*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*85.4*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*E*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.57*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*250*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*922*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*8.3*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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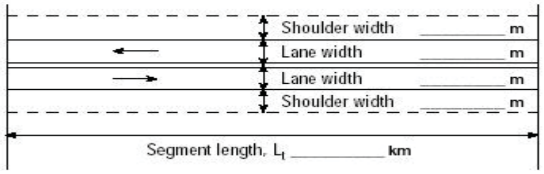
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Dundas to Sixteen Mile*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*PM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*3185* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*3808*
v_p * highest directional split proportion^2 (pc/h)	*2666*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*5.6*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*3808*
v_p * highest directional split proportion^2 (pc/h)	*2666*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*96.5*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*100.7*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*F*
Volume to capacity ratio, v/c=V_p/ 3,200	*1.19*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*346*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*1274*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*61.8*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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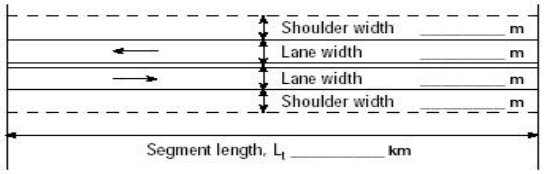
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Sixteen Mile to North Park*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*PM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*2795* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*3342*
v_p * highest directional split proportion^2 (pc/h)	*2339*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*11.4*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*3342*
v_p * highest directional split proportion^2 (pc/h)	*2339*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*94.7*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+$f_{d/np}$	*98.9*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*F*
Volume to capacity ratio, v/c=V_p/ 3,200	*1.04*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*228*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*839*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*20.0*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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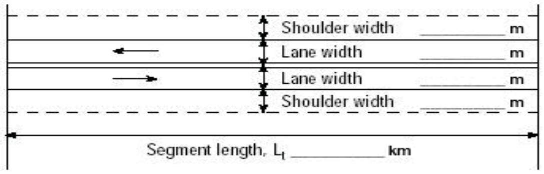
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*North Park to Future St C*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*PM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*2274* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2719*
v_p * highest directional split proportion^2 (pc/h)	*1903*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	km/h	Base free-flow speed, $BFFS_{FM}$	*70.0* km/h
Observed volume, V_f	veh/h	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0* km/h
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	km/h	Adj. for access points, f_A (Exhibit 20-6)	*2.0* km/h
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0* km/h

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*19.2*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2719*
v_p * highest directional split proportion^2 (pc/h)	*1903*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*90.8*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*95.0*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*F*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.85*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*309*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*1137*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*16.1*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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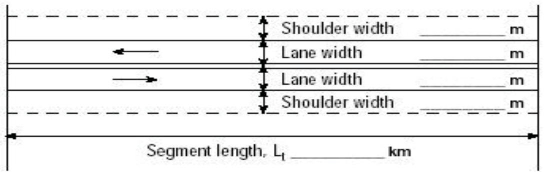
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Future St C to Future St D*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*PM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*2118* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2532*
v_p * highest directional split proportion^2 (pc/h)	*1772*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*21.5*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2532*
v_p * highest directional split proportion^2 (pc/h)	*1772*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*89.2*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*93.4*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*F*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.79*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*288*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*1059*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*13.4*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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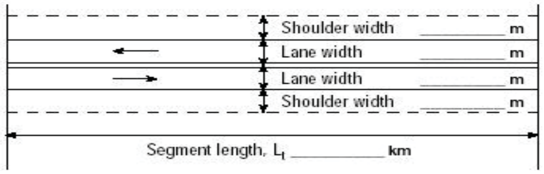
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Future St D to Burnhamthorpe*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*PM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*1844* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2205*
v_p * highest directional split proportion[2] (pc/h)	*1544*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Field Measured speed, S_{FM}	*km/h*	Adj. for lane width and shoulder width[3], f_{LS} (Exhibit 20-5)	*10.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*25.6*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*2205*
v_p * highest directional split proportion[2] (pc/h)	*1544*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*85.6*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.2*
Percent time-spent-following, PTSF(%)=BPTSF+$f_{d/np}$	*89.8*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*E*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.69*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*251*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*922*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*9.8*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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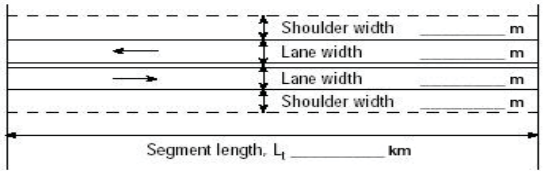
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*Burnhamthorpe to NNOC*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*PM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*1626* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*1944*
v_p * highest directional split proportion[2] (pc/h)	*1361*

Free-Flow Speed from Field Measurement	
Field Measured speed, S_{FM}	km/h
Observed volume, V_f	veh/h
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	km/h

Estimated Free-Flow Speed	
Base free-flow speed, $BFFS_{FM}$	*70.0* km/h
Adj. for lane width and shoulder width[3], f_{LS} (Exhibit 20-5)	*10.0* km/h
Adj. for access points, f_A (Exhibit 20-6)	*2.0* km/h
Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0* km/h

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*28.9*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.909*
Two-way flow rate[1], v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*1944*
v_p * highest directional split proportion[2] (pc/h)	*1361*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*81.9*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*4.6*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*86.5*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*E*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.61*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*221*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*813*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*7.6*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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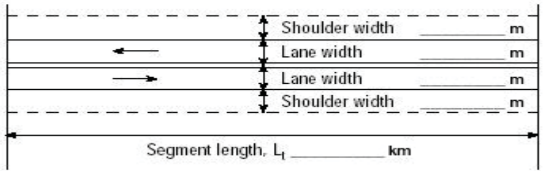
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*MKV*	Highway	*Sixth Line*
Agency or Company	*MHL*	From/To	*NNOC to Hwy 407*
Date Performed	*07/15/12*	Jurisdiction	*Oakville*
Analysis Time Period	*PM Peak Hour*	Analysis Year	*2031 Do Nothing*

Project Description: *Sixth Line EA*

Input Data



☑ Class I highway ☐ Class II highway

Terrain ☑ Level ☐ Rolling

Two-way hourly volume	*1356* veh/h
Directional split	*70 / 30*
Peak-hour factor, PHF	*0.92*
No-passing zone	*100*
% Trucks and Buses , P_T	*10* %
% Recreational vehicles, P_R	*4%*
Access points/ *km*	*10*

Average Travel Speed

Grade adjustment factor, f_G (Exhibit 20-7)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*1621*
v_p * highest directional split proportion^2 (pc/h)	*1135*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field Measured speed, S_{FM}	*km/h*	Base free-flow speed, $BFFS_{FM}$	*70.0 km/h*
Observed volume, V_f	*veh/h*	Adj. for lane width and shoulder width^3, f_{LS} (Exhibit 20-5)	*10.0 km/h*
Free-flow speed, FFS FFS=S_{FM}+0.00776(V_f/ f_{HV})	*km/h*	Adj. for access points, f_A (Exhibit 20-6)	*2.0 km/h*
		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*58.0 km/h*

Adj. for no-passing zones, f_{np} (*km/h*) (Exhibit 20-11)	*4.8*
Average travel speed, ATS (*km/h*) ATS=FFS-0.00776v_p-f_{np}	*32.9*

Percent Time-Spent-Following

Grade Adjustment factor, f_G (Exhibit 20-8)	*1.00*
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.909*
Two-way flow rate^1, v_p (pc/h)=V/ (PHF * f_G * f_{HV})	*1621*
v_p * highest directional split proportion^2 (pc/h)	*1135*
Base percent time-spent-following, BPTSF(%)=100(1-$e^{-0.000879v_p}$)	*75.9*
Adj. for directional distribution and no-passing zone, $f_{d/hp}$(%)(Exh. 20-12)	*6.8*
Percent time-spent-following, PTSF(%)=BPTSF+f $_{d/np}$	*82.7*

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	*E*
Volume to capacity ratio, v/c=V_p/ 3,200	*0.51*
Peak 15-min veh-miles of travel, VMT_{15} (veh- *km*)= 0.25L_t(V/PHF)	*221*
Peak-hour vehicle-miles of travel, VMT_{60}(veh- *km*)=V*L_t	*814*
Peak 15-min total travel time, TT_{15}(veh-h)= VMT_{15}/ATS	*6.7*

Notes

1. If Vp >= 3,200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split Vp>= 1,700 pc/h, terminated anlysis-the LOS is F.

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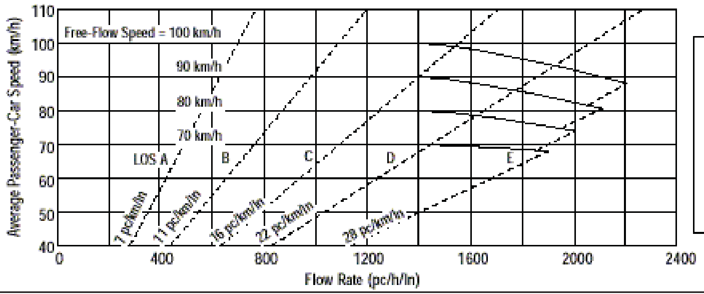
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Dundas to Sixteen Mile
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1206	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	693
Speed, S (km/h)	70.7
D (pc/km/ln)	9.8
LOS	B

Design

Design (N)

Required Number of Lanes, N
Flow Rate, v_p (pc/h)
Max Service Flow Rate (pc/h/ln)
Design LOS

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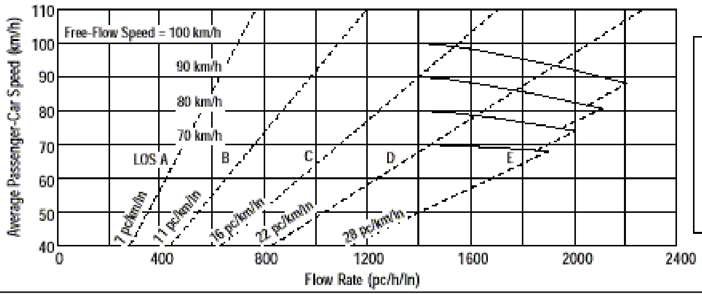
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Dundas to Sixteen Mile
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1609	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	925
Speed, S (km/h)	70.7
D (pc/km/ln)	13.1
LOS	C

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

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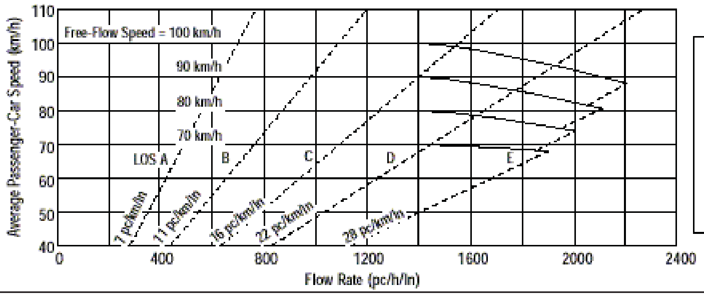
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Sixteen Mile to North Park
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1223	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	703
Speed, S (km/h)	70.7
D (pc/km/ln)	9.9
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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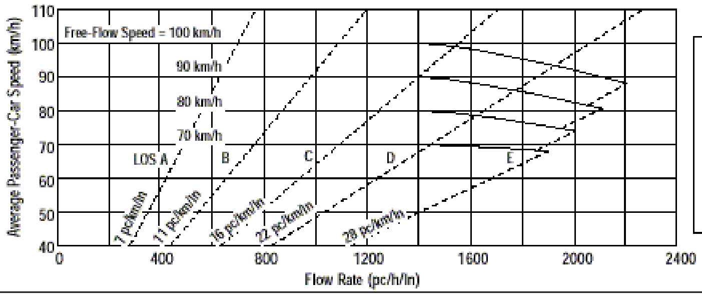
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Sixteen Mile to North Park
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1363	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	783
Speed, S (km/h)	70.7
D (pc/km/ln)	11.1
LOS	C

Design

Design (N)

Required Number of Lanes, N
Flow Rate, v_p (pc/h)
Max Service Flow Rate (pc/h/ln)
Design LOS

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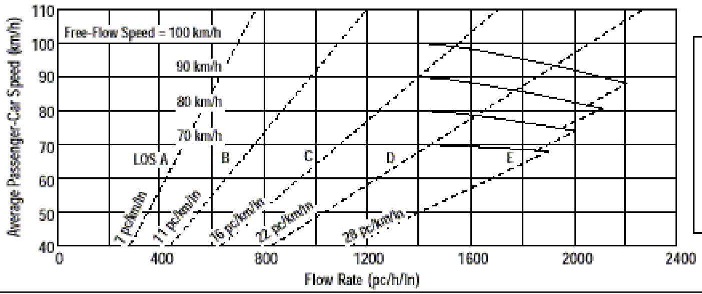
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	North Park to Future St C
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1208	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	694
Speed, S (km/h)	70.7
D (pc/km/ln)	9.8
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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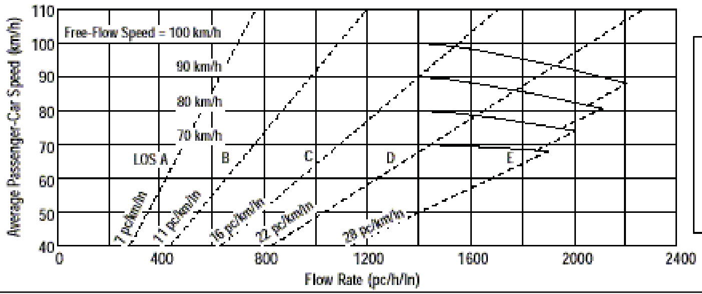
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	North Park to Future St C
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1121	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	644
Speed, S (km/h)	70.7
D (pc/km/ln)	9.1
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

HCS+™ Version 5.2

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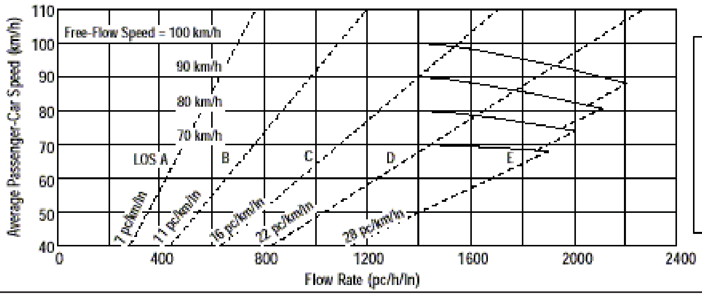
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Future St C to Future St D
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1216	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	699
Speed, S (km/h)	70.7
D (pc/km/ln)	9.9
LOS	B

Design

Design (N)

Required Number of Lanes, N
Flow Rate, v_p (pc/h)
Max Service Flow Rate (pc/h/ln)
Design LOS

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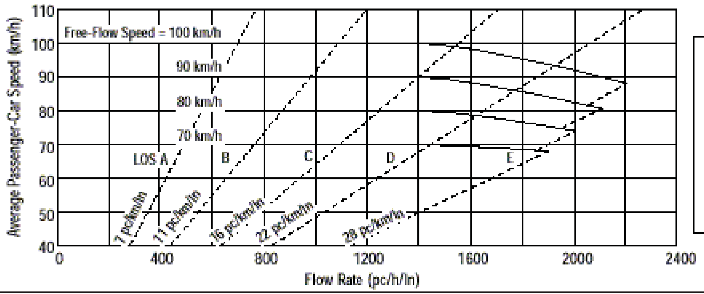
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Future St C to Future St D
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	986	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	566
Speed, S (km/h)	70.7
D (pc/km/ln)	8.0
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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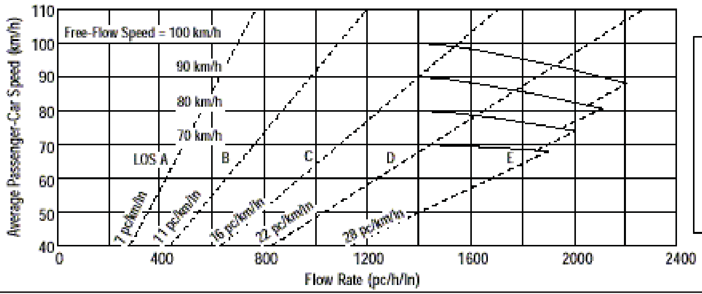
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Future St D to Burnhamthorpe
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1264	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	726
Speed, S (km/h)	70.7
D (pc/km/ln)	10.3
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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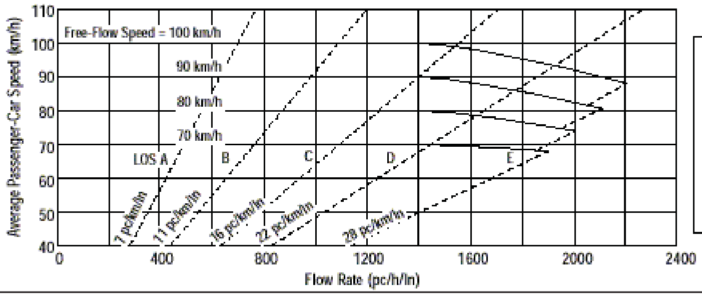
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Future St D to Burnhamthorpe
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	651	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	374
Speed, S (km/h)	70.7
D (pc/km/ln)	5.3
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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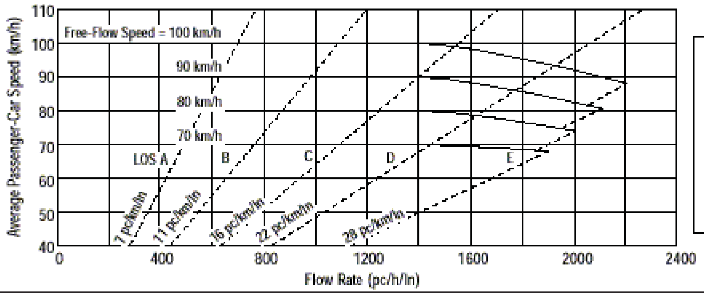
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Burnhamthorpe to NNOC
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1045	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	600
Speed, S (km/h)	70.7
D (pc/km/ln)	8.5
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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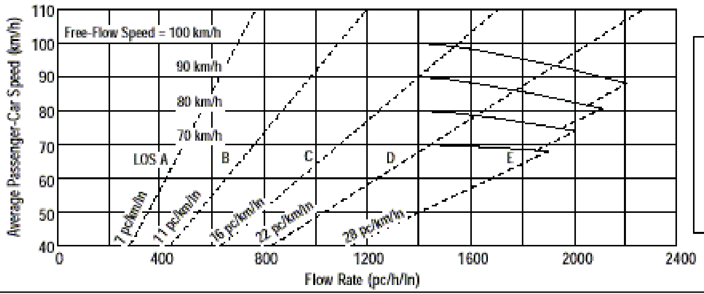
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Burnhamthorpe to NNOC
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	734	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	422
Speed, S (km/h)	70.7
D (pc/km/ln)	6.0
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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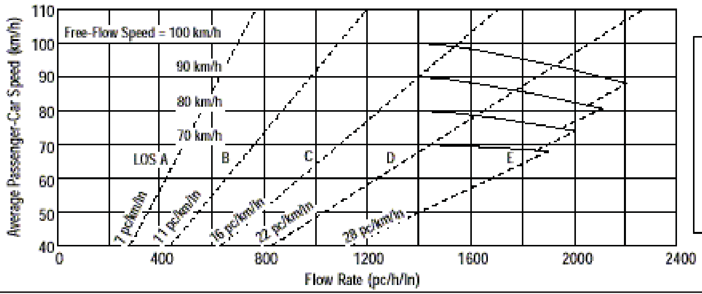
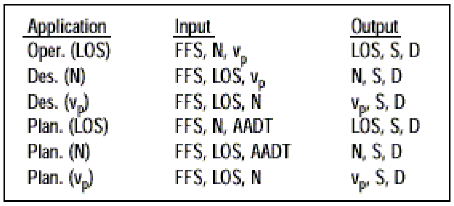
MULTILANE HIGHWAYS WORKSHEET(Direction 1)





Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	NNOC to Hwy 407
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	870	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	500
Speed, S (km/h)	70.7
D (pc/km/ln)	7.1
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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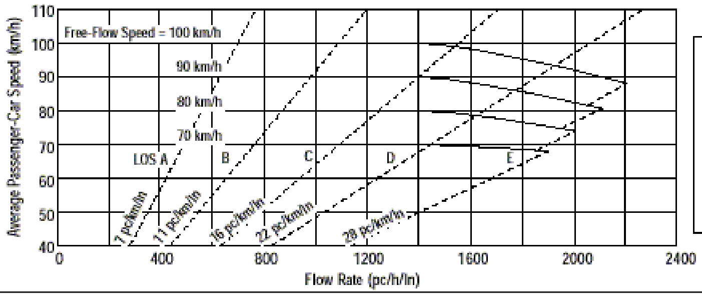
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	AM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	NNOC to Hwy 407
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	666	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	382
Speed, S (km/h)	70.7
D (pc/km/ln)	5.4
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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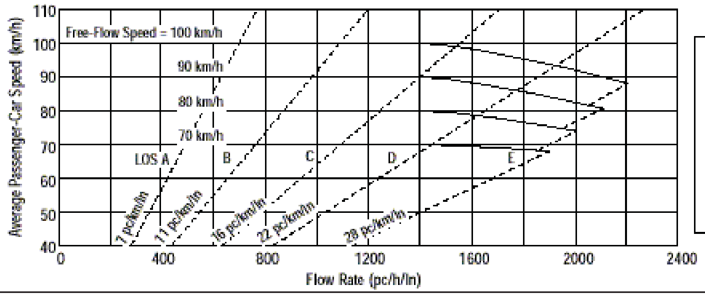
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Dundas to Sixteen Mile
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1808	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	1039
Speed, S (km/h)	70.7
D (pc/km/ln)	14.7
LOS	C

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

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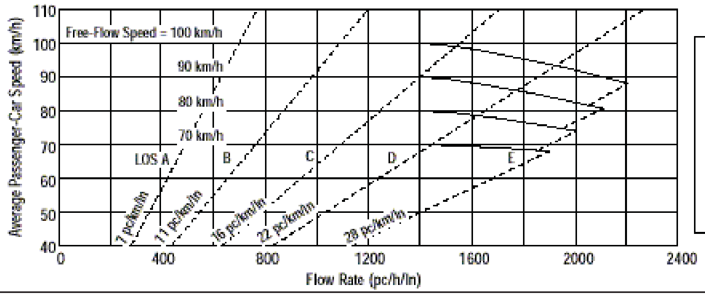
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Dundas to Sixteen Mile
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1377	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	791
Speed, S (km/h)	70.7
D (pc/km/ln)	11.2
LOS	C

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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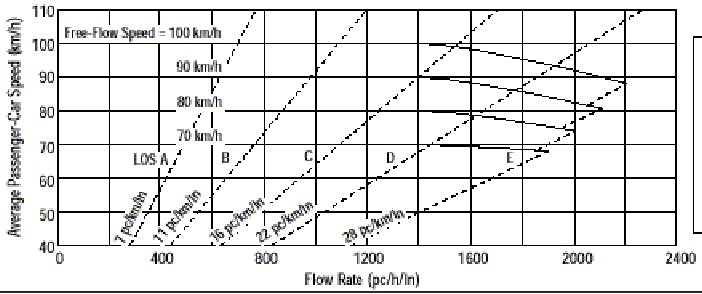
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Sixteen Mile to North Park
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1537	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	883
Speed, S (km/h)	70.7
D (pc/km/ln)	12.5
LOS	C

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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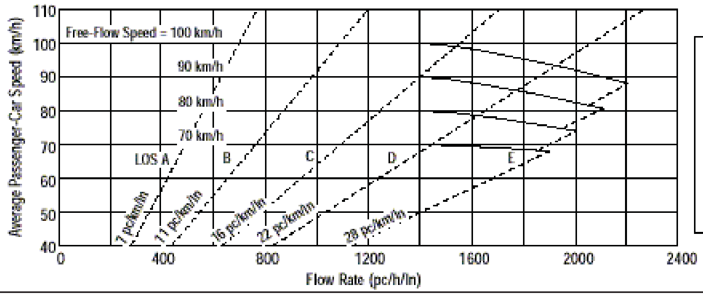
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Sixteen Mile to North Park
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1258	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	723
Speed, S (km/h)	70.7
D (pc/km/ln)	10.2
LOS	B

Design

Design (N)

Required Number of Lanes, N
Flow Rate, v_p (pc/h)
Max Service Flow Rate (pc/h/ln)
Design LOS

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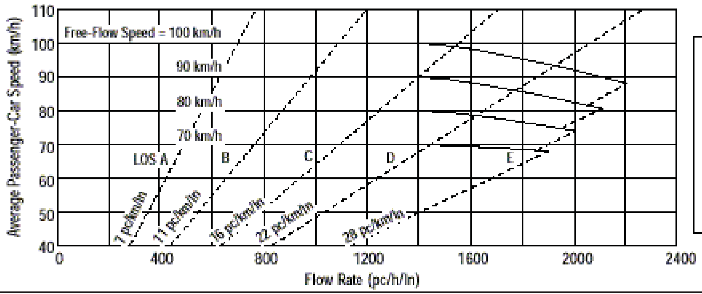
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	North Park to Future St C
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1229	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	706
Speed, S (km/h)	70.7
D (pc/km/ln)	10.0
LOS	B

Design

Design (N)

Required Number of Lanes, N
Flow Rate, v_p (pc/h)
Max Service Flow Rate (pc/h/ln)
Design LOS

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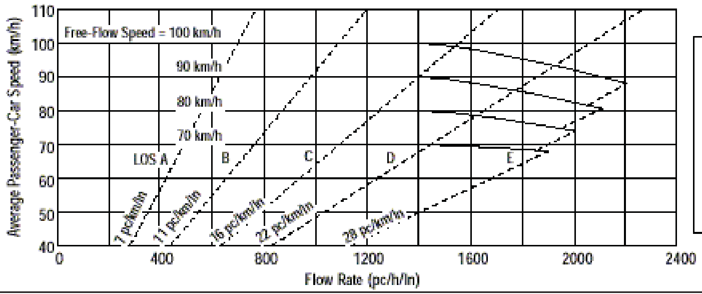
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	North Park to Future St C
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1045	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	600
Speed, S (km/h)	70.7
D (pc/km/ln)	8.5
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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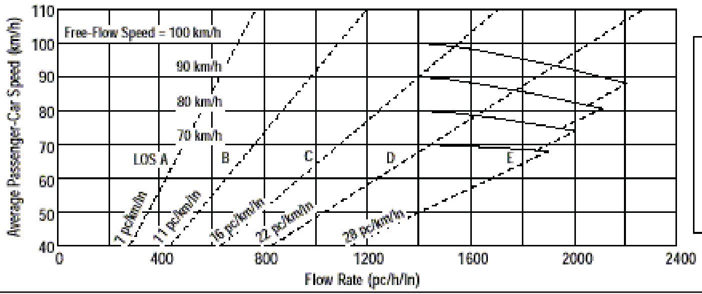
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Future St C to Future St D
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1103	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	634
Speed, S (km/h)	70.7
D (pc/km/ln)	9.0
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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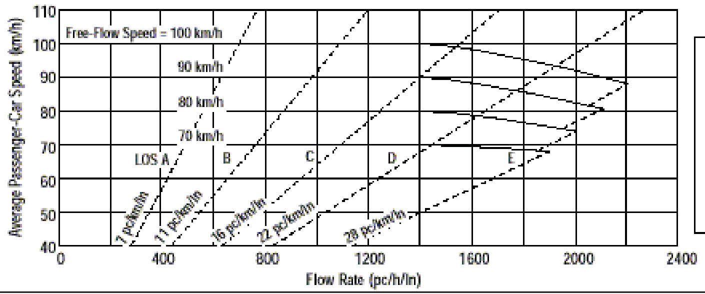
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Future St C to Future St D
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1015	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	583
Speed, S (km/h)	70.7
D (pc/km/ln)	8.2
LOS	B

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

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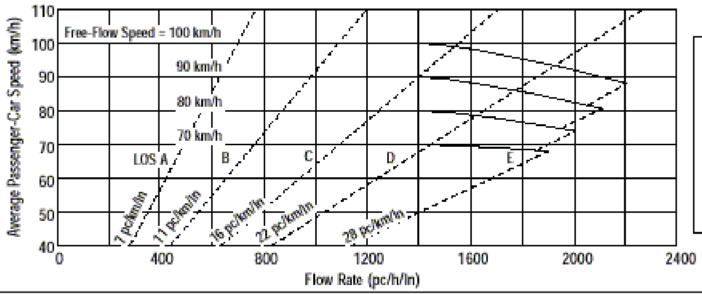
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Future St D to Burnhamthorpe
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	835	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	480
Speed, S (km/h)	70.7
D (pc/km/ln)	6.8
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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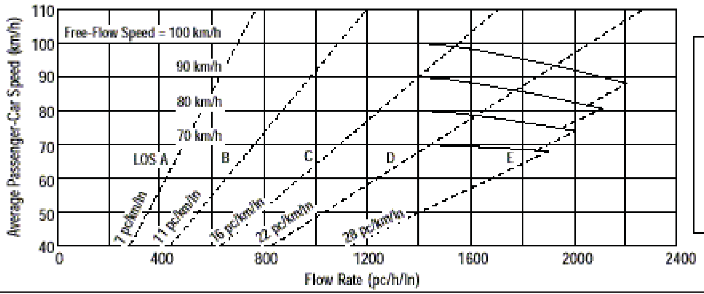
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Future St D to Burnhamthorpe
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1009	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	580
Speed, S (km/h)	70.7
D (pc/km/ln)	8.2
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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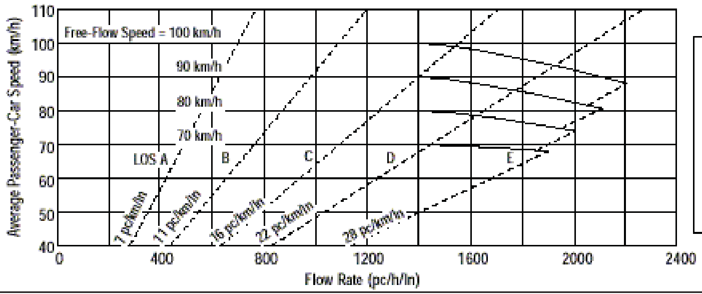
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Burnhamthorpe to NNOC
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	843	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	484
Speed, S (km/h)	70.7
D (pc/km/ln)	6.8
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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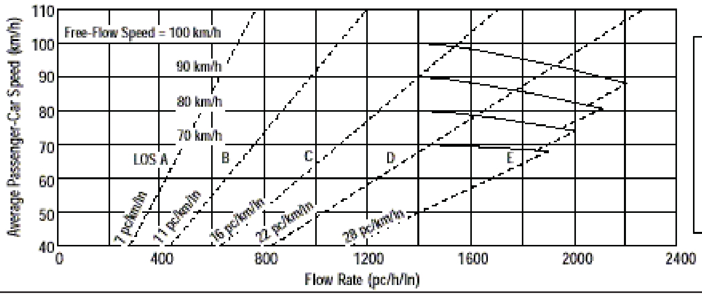
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	Burnhamthorpe to NNOC
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	783	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	450
Speed, S (km/h)	70.7
D (pc/km/ln)	6.4
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

HCS+™ Version 5.2

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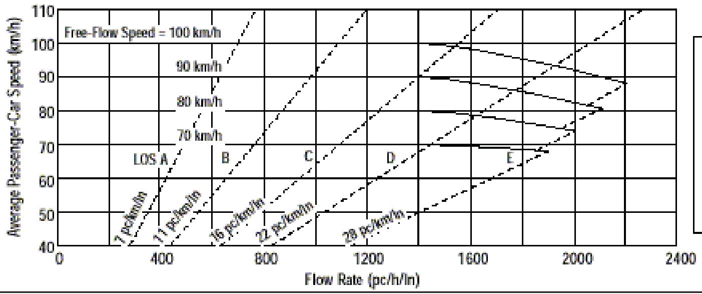
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	NNOC to Hwy 407
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	725	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	416
Speed, S (km/h)	70.7
D (pc/km/ln)	5.9
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

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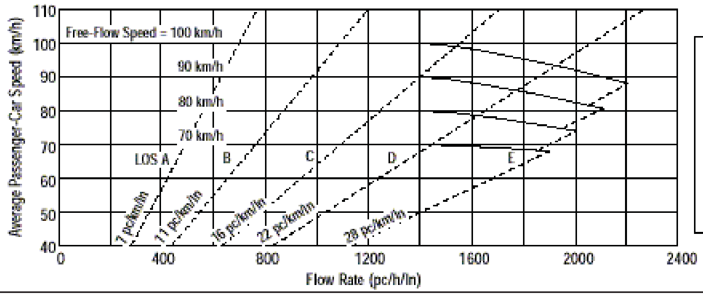
MULTILANE HIGHWAYS WORKSHEET(Direction 2)



Application	Input	Output
Oper. (LOS)	FFS, N, v_p	LOS, S, D
Des. (N)	FFS, LOS, v_p	N, S, D
Des. (v_p)	FFS, LOS, N	v_p, S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	MKV
Agency or Company	MH
Date Performed	7/16/12
Analysis Time Period	PM Peak Hour

Site Information

Highway/Direction to Travel	Sixth Line
From/To	NNOC to Hwy 407
Jurisdiction	Town of Oakville
Analysis Year	2031

Project Description Sixth Line EA

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	631	Peak-Hour Factor, PHF	0.92
AADT(veh/h)		%Trucks and Buses, P_T	10
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (km)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.945

Speed Inputs

Lane Width, LW (m)	3.6
Total Lateral Clearance, LC (m)	3.6
Access Points, A (A/km)	10
Median Type, M	Undivided
FFS (measured)	
Base Free-Flow Speed, BFFS	80.0

Calc Speed Adj and FFS

f_{LW} (km/h)	0.0
f_{LC} (km/h)	0.0
f_A (km/h)	6.7
f_M (km/h)	2.6
FFS (km/h)	70.7

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	362
Speed, S (km/h)	70.7
D (pc/km/ln)	5.1
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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Appendix H

2031 Intersection Worksheets

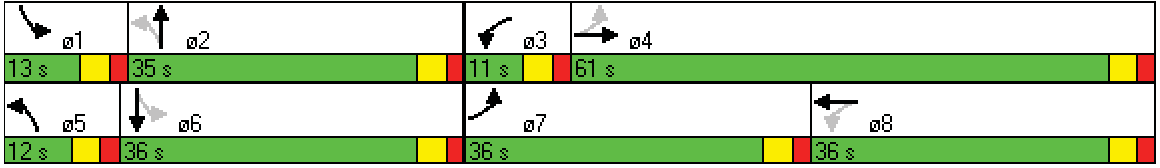
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	0.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.981			0.970			0.956			0.970	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3511	0	1706	3485	0	1825	3431	0	1789	3328	0
Flt Permitted	0.286			0.125			0.308			0.125		
Satd. Flow (perm)	533	3511	0	224	3485	0	592	3431	0	235	3328	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		18			25			51			25	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			80			80	
Link Distance (m)		584.6			658.3			612.3			725.4	
Travel Time (s)		26.3			29.6			27.6			32.6	
Volume (vph)	427	1464	216	157	377	94	157	627	261	167	400	100
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	436	1494	220	160	385	96	160	640	266	170	408	102
Lane Group Flow (vph)	436	1714	0	160	481	0	160	906	0	170	510	0
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Detector Phases	7	4		3	8		5	2		1	6	
Minimum Initial (s)	5.0	20.0		5.0	20.0		5.0	10.0		5.0	10.0	
Minimum Split (s)	10.0	52.0		10.0	31.5		10.0	33.0		10.0	33.0	
Total Split (s)	36.0	61.0	0.0	11.0	36.0	0.0	12.0	35.0	0.0	13.0	36.0	0.0
Total Split (%)	30.0%	50.8%	0.0%	9.2%	30.0%	0.0%	10.0%	29.2%	0.0%	10.8%	30.0%	0.0%
Maximum Green (s)	31.0	56.0		6.0	31.0		7.0	30.0		8.0	31.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	None		None	None	
Walk Time (s)		15.0			15.0			15.0			15.0	
Flash Dont Walk (s)		10.0			10.0			10.0			10.0	
Pedestrian Calls (#/hr)		0			0			0			0	
Act Effct Green (s)	68.0	57.0		47.2	40.2		39.0	31.0		41.0	32.0	
Actuated g/C Ratio	0.57	0.48		0.39	0.34		0.32	0.26		0.34	0.27	
v/c Ratio	0.80	1.02		0.92	0.41		0.58	0.98		0.86	0.56	
Control Delay	27.3	59.0		77.0	31.4		36.9	67.2		66.2	38.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	27.3	59.0		77.0	31.4		36.9	67.2		66.2	38.8	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	E		E	C		D	E		E	D	
Approach Delay		52.6			42.8			62.7			45.7	
Approach LOS		D			D			E			D	
Queue Length 50th (m)	56.2	~224.6		18.5	43.0		25.9	106.7		27.8	52.0	
Queue Length 95th (m)	83.2	#267.6		#67.6	64.5		42.2	#149.4		#62.8	69.5	
Internal Link Dist (m)		560.6			634.3			588.3			701.4	
Turn Bay Length (m)							75.0					
Base Capacity (vph)	593	1677		174	1183		275	924		197	906	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.74	1.02		0.92	0.41		0.58	0.98		0.86	0.56	

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 120
Natural Cycle: 115
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.02
Intersection Signal Delay: 52.6 Intersection LOS: D
Intersection Capacity Utilization 104.3% ICU Level of Service G
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 9: North Oakville Corridor & 6 Line



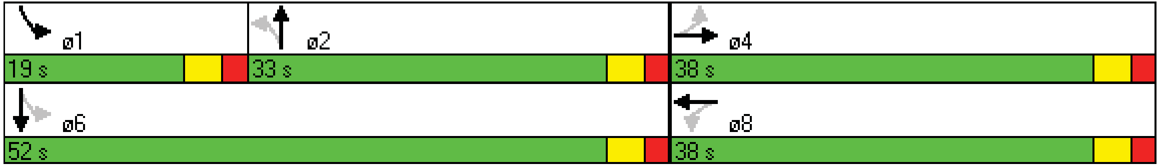
	↰	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	75.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.967			0.954			0.934			0.983	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1821	0	1706	1808	0	1825	3357	0	1789	3378	0
Flt Permitted	0.539			0.358			0.465			0.121		
Satd. Flow (perm)	1005	1821	0	643	1808	0	893	3357	0	228	3378	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		18			28			233			23	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			80	
Link Distance (m)		567.6			690.8			451.7			612.3	
Travel Time (s)		34.1			41.4			20.3			27.6	
Volume (vph)	159	293	83	142	157	69	36	523	411	235	443	56
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	162	299	85	145	160	70	37	534	419	240	452	57
Lane Group Flow (vph)	162	384	0	145	230	0	37	953	0	240	509	0
Turn Type	Perm			Perm			Perm			pm+pt		
Protected Phases		4			8			2		1	6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		1	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		5.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		10.0	30.0	
Total Split (s)	38.0	38.0	0.0	38.0	38.0	0.0	33.0	33.0	0.0	19.0	52.0	0.0
Total Split (%)	42.2%	42.2%	0.0%	42.2%	42.2%	0.0%	36.7%	36.7%	0.0%	21.1%	57.8%	0.0%
Maximum Green (s)	33.0	33.0		33.0	33.0		28.0	28.0		14.0	47.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag							Lag	Lag		Lead		
Lead-Lag Optimize?							Yes	Yes		Yes		
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Min	Min		None	Min	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0			15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0			10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0			0	
Act Effct Green (s)	21.5	21.5		21.5	21.5		25.2	25.2		40.8	40.8	
Actuated g/C Ratio	0.30	0.30		0.30	0.30		0.36	0.36		0.58	0.58	
v/c Ratio	0.53	0.68		0.74	0.40		0.12	0.71		0.63	0.26	
Control Delay	27.8	27.2		46.3	19.4		20.7	19.5		21.3	8.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	27.8	27.2		46.3	19.4		20.7	19.5		21.3	8.6	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	C		D	B		C	B		C	A	
Approach Delay		27.4			29.8			19.6			12.7	
Approach LOS		C			C			B			B	
Queue Length 50th (m)	16.8	40.2		16.3	19.8		3.2	41.1		14.5	14.7	
Queue Length 95th (m)	38.0	75.8		#41.3	41.6		11.6	82.5		46.0	32.1	
Internal Link Dist (m)		543.6			666.8			427.7			588.3	
Turn Bay Length (m)	75.0			75.0			75.0			75.0		
Base Capacity (vph)	418	768		267	768		355	1474		448	2103	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.39	0.50		0.54	0.30		0.10	0.65		0.54	0.24	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 70.7
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 20.7 Intersection LOS: C
Intersection Capacity Utilization 82.8% ICU Level of Service E
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Burnhamthorpe Rd W & 6 Line



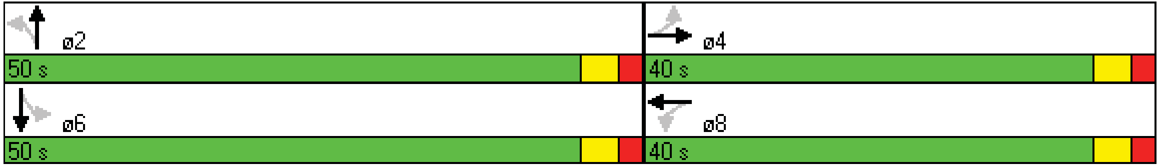
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.859			0.874			0.995			0.991	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1618	0	1789	1646	0	1789	3561	0	1789	3420	0
Flt Permitted	0.711			0.499			0.352			0.147		
Satd. Flow (perm)	1339	1618	0	940	1646	0	663	3561	0	277	3420	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		232			59			6			11	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			60	
Link Distance (m)		575.3			674.3			490.2			451.7	
Travel Time (s)		34.5			40.5			22.1			27.1	
Volume (vph)	113	16	252	126	11	58	83	1093	40	19	594	38
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	115	16	257	129	11	59	85	1115	41	19	606	39
Lane Group Flow (vph)	115	273	0	129	70	0	85	1156	0	19	645	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	40.0	40.0	0.0	40.0	40.0	0.0	50.0	50.0	0.0	50.0	50.0	0.0
Total Split (%)	44.4%	44.4%	0.0%	44.4%	44.4%	0.0%	55.6%	55.6%	0.0%	55.6%	55.6%	0.0%
Maximum Green (s)	35.0	35.0		35.0	35.0		45.0	45.0		45.0	45.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	16.3	16.3		16.3	16.3		46.2	46.2		46.2	46.2	
Actuated g/C Ratio	0.23	0.23		0.23	0.23		0.65	0.65		0.65	0.65	
v/c Ratio	0.37	0.49		0.59	0.16		0.20	0.50		0.10	0.29	
Control Delay	25.8	8.3		35.6	8.5		7.7	7.9		8.1	6.2	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	25.8	8.3		35.6	8.5		7.7	7.9		8.1	6.2	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	A		D	A		A	A		A	A	
Approach Delay		13.5			26.1			7.9			6.2	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	12.7	4.3		15.2	1.1		3.6	33.3		0.8	15.2	
Queue Length 95th (m)	25.4	20.5		30.9	9.4		12.8	67.0		4.4	32.4	
Internal Link Dist (m)		551.3			650.3			466.2			427.7	
Turn Bay Length (m)							75.0			75.0		
Base Capacity (vph)	536	786		376	694		434	2335		181	2244	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.21	0.35		0.34	0.10		0.20	0.50		0.10	0.29	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 70.6
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.59
Intersection Signal Delay: 9.8 Intersection LOS: A
Intersection Capacity Utilization 86.2% ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 12: Future Street D & 6 Line



	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.870			0.864			0.995				
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1639	0	1789	1627	0	1789	3561	0	1789	3444	0
Flt Permitted	0.715			0.742			0.207			0.132		
Satd. Flow (perm)	1347	1639	0	1398	1627	0	390	3561	0	249	3444	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		20			53			6				
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		48			48			80			60	
Link Distance (m)		560.3			693.3			502.8			490.2	
Travel Time (s)		42.0			52.0			22.6			29.4	
Volume (vph)	1	3	20	126	6	58	10	1158	40	19	967	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	1	3	20	129	6	59	10	1182	41	19	987	1
Lane Group Flow (vph)	1	23	0	129	65	0	10	1223	0	19	988	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	39.0	39.0	0.0	39.0	39.0	0.0	51.0	51.0	0.0	51.0	51.0	0.0
Total Split (%)	43.3%	43.3%	0.0%	43.3%	43.3%	0.0%	56.7%	56.7%	0.0%	56.7%	56.7%	0.0%
Maximum Green (s)	34.0	34.0		34.0	34.0		46.0	46.0		46.0	46.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	14.2	14.2		14.2	14.2		56.5	56.5		56.5	56.5	
Actuated g/C Ratio	0.18	0.18		0.18	0.18		0.75	0.75		0.75	0.75	
v/c Ratio	0.00	0.07		0.51	0.19		0.03	0.46		0.10	0.38	
Control Delay	21.0	11.7		31.8	10.3		4.7	5.5		6.1	5.0	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	21.0	11.7		31.8	10.3		4.7	5.5		6.1	5.0	

21: Future Street C & 6 Line
Signalized Intersection

AM Peak - Future Conditions (2031)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		C	B		A	A		A	A	
Approach Delay		12.1			24.6			5.5			5.0	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	0.1	0.3		14.7	1.3		0.3	29.6		0.6	22.2	
Queue Length 95th (m)	1.3	5.3		29.1	9.8		2.0	55.3		3.5	42.1	
Internal Link Dist (m)		536.3			669.3			478.8			466.2	
Turn Bay Length (m)							75.0			75.0		
Base Capacity (vph)	486	604		504	620		291	2656		186	2567	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.00	0.04		0.26	0.10		0.03	0.46		0.10	0.38	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 75.8

Natural Cycle: 60

Control Type: Semi Act-Uncoord

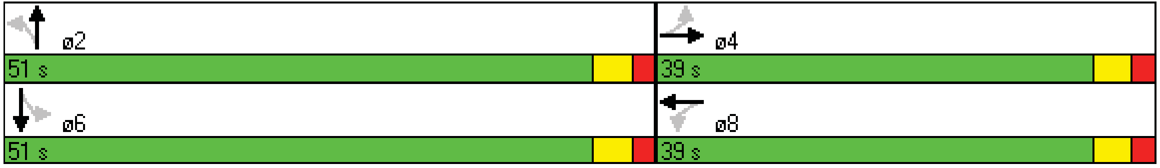
Maximum v/c Ratio: 0.51

Intersection Signal Delay: 6.9 Intersection LOS: A

Intersection Capacity Utilization 53.6% ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 21: Future Street C & 6 Line



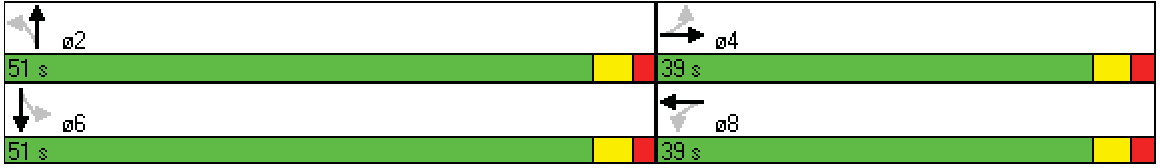
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	35.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.860			0.870			0.994			0.997	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1620	0	1789	1639	0	1789	3557	0	1789	3436	0
Flt Permitted	0.704			0.667			0.169			0.138		
Satd. Flow (perm)	1326	1620	0	1256	1639	0	318	3557	0	260	3436	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		69			57			7			3	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		48			48			80			60	
Link Distance (m)		549.9			702.6			299.7			502.8	
Travel Time (s)		41.2			52.7			13.5			30.2	
Volume (vph)	42	9	120	155	11	70	45	1129	49	42	1058	21
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	43	9	122	158	11	71	46	1152	50	43	1080	21
Lane Group Flow (vph)	43	131	0	158	82	0	46	1202	0	43	1101	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	39.0	39.0	0.0	39.0	39.0	0.0	51.0	51.0	0.0	51.0	51.0	0.0
Total Split (%)	43.3%	43.3%	0.0%	43.3%	43.3%	0.0%	56.7%	56.7%	0.0%	56.7%	56.7%	0.0%
Maximum Green (s)	34.0	34.0		34.0	34.0		46.0	46.0		46.0	46.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	15.7	15.7		15.7	15.7		50.2	50.2		50.2	50.2	
Actuated g/C Ratio	0.21	0.21		0.21	0.21		0.68	0.68		0.68	0.68	
v/c Ratio	0.15	0.33		0.59	0.21		0.21	0.50		0.24	0.47	
Control Delay	22.9	13.9		34.1	10.9		8.9	7.2		10.4	7.0	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	22.9	13.9		34.1	10.9		8.9	7.2		10.4	7.0	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		C	B		A	A		B	A	
Approach Delay		16.1			26.2			7.3			7.2	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	4.6	6.7		18.7	2.6		1.9	33.9		1.9	30.3	
Queue Length 95th (m)	11.8	18.9		35.4	12.1		8.7	64.4		9.1	58.1	
Internal Link Dist (m)		525.9			678.6			275.7			478.8	
Turn Bay Length (m)							35.0			75.0		
Base Capacity (vph)	500	653		473	653		216	2417		177	2334	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.09	0.20		0.33	0.13		0.21	0.50		0.24	0.47	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 73.9
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.59
Intersection Signal Delay: 9.4 Intersection LOS: A
Intersection Capacity Utilization 64.3% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 18: North Park Drive & 6 Line



15: Sixteen Mile Drive & 6 Line
Signalized Intersection

AM Peak - Future Conditions (2031)

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.860			0.870			0.994			0.998	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1620	0	1789	1639	0	1789	3557	0	1789	3439	0
Flt Permitted	0.704			0.662			0.113			0.156		
Satd. Flow (perm)	1326	1620	0	1247	1639	0	213	3557	0	294	3439	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		44			71			8			3	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			60	
Link Distance (m)		540.7			706.6			398.8			299.7	
Travel Time (s)		32.4			42.4			17.9			18.0	
Volume (vph)	41	9	120	155	11	70	45	1112	49	42	1301	20
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	42	9	122	158	11	71	46	1135	50	43	1328	20
Lane Group Flow (vph)	42	131	0	158	82	0	46	1185	0	43	1348	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	36.0	36.0	0.0	36.0	36.0	0.0	54.0	54.0	0.0	54.0	54.0	0.0
Total Split (%)	40.0%	40.0%	0.0%	40.0%	40.0%	0.0%	60.0%	60.0%	0.0%	60.0%	60.0%	0.0%
Maximum Green (s)	31.0	31.0		31.0	31.0		49.0	49.0		49.0	49.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	16.1	16.1		16.1	16.1		52.8	52.8		52.8	52.8	
Actuated g/C Ratio	0.21	0.21		0.21	0.21		0.69	0.69		0.69	0.69	
v/c Ratio	0.15	0.35		0.61	0.21		0.32	0.48		0.21	0.57	
Control Delay	24.1	18.8		36.3	8.9		13.8	7.1		9.1	8.1	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	24.1	18.8		36.3	8.9		13.8	7.1		9.1	8.1	

15: Sixteen Mile Drive & 6 Line

Signalized Intersection

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		D	A		B	A		A	A	
Approach Delay		20.1			26.9			7.3			8.2	
Approach LOS		C			C			A			A	
Queue Length 50th (m)	4.8	10.1		19.9	1.2		2.2	34.1		1.9	42.8	
Queue Length 95th (m)	12.1	23.2		37.2	10.7		11.6	64.4		8.5	80.8	
Internal Link Dist (m)		516.7			682.6			374.8			275.7	
Turn Bay Length (m)				75.0			75.0			75.0		
Base Capacity (vph)	458	589		431	614		146	2445		202	2362	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.09	0.22		0.37	0.13		0.32	0.48		0.21	0.57	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 76.9

Natural Cycle: 60

Control Type: Semi Act-Uncoord

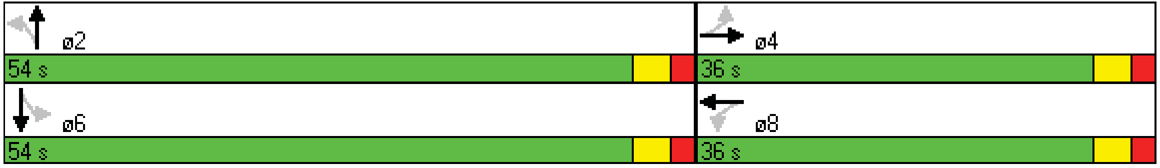
Maximum v/c Ratio: 0.61

Intersection Signal Delay: 10.0 Intersection LOS: A

Intersection Capacity Utilization 64.3% ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 15: Sixteen Mile Drive & 6 Line



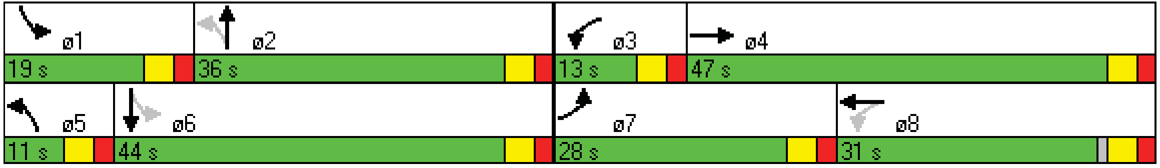
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↑↱		↰	↑↑↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	130.0		115.0	155.0		0.0	125.0		0.0	75.0		0.0
Storage Lanes	2		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	0.97	0.91	0.91	1.00	0.91	0.91	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.983			0.956			0.949			0.931	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3437	4926	0	1674	4544	0	1674	3441	0	1722	3362	0
Flt Permitted	0.950			0.143			0.125			0.174		
Satd. Flow (perm)	3437	4926	0	252	4544	0	220	3441	0	315	3362	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		22			88			77			203	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			60			60	
Link Distance (m)		533.1			698.8			321.3			398.8	
Travel Time (s)		24.0			31.4			19.3			23.9	
Volume (vph)	615	1735	178	172	438	147	141	444	226	247	739	623
Peak Hour Factor	1.00	1.00	0.80	1.00	1.00	0.80	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	3%	5%	2%	9%	13%	4%	9%	1%	0%	6%	2%	0%
Adj. Flow (vph)	615	1735	222	172	438	184	141	444	226	247	739	623
Lane Group Flow (vph)	615	1957	0	172	622	0	141	670	0	247	1362	0
Turn Type	Prot			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases				8			2			6		
Detector Phases	7	4		3	8		5	2		1	6	
Minimum Initial (s)	5.0	20.0		5.0	20.0		5.0	10.0		5.0	10.0	
Minimum Split (s)	10.0	31.0		10.0	31.0		10.0	30.0		10.0	33.0	
Total Split (s)	28.0	47.0	0.0	13.0	31.0	0.0	11.0	36.0	0.0	19.0	44.0	0.0
Total Split (%)	24.3%	40.9%	0.0%	11.3%	27.0%	0.0%	9.6%	31.3%	0.0%	16.5%	38.3%	0.0%
Maximum Green (s)	23.0	42.0		8.0	26.0		6.0	31.0		14.0	39.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	Min		None	Min	
Walk Time (s)		15.0			15.0			15.0			15.0	
Flash Dont Walk (s)		10.0			10.0			10.0			10.0	
Pedestrian Calls (#/hr)		0			0			0			0	
Act Effct Green (s)	23.5	43.0		37.5	28.5		39.5	32.5		51.0	40.0	
Actuated g/C Ratio	0.20	0.37		0.33	0.25		0.34	0.28		0.44	0.35	
v/c Ratio	0.88	1.05		0.89	0.52		0.86	0.65		0.78	1.05	
Control Delay	59.1	72.0		69.9	33.7		66.5	35.5		39.4	69.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	59.1	72.0		69.9	33.7		66.5	35.5		39.4	69.6	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	E	E		E	C		E	D		D	E	
Approach Delay		68.9			41.6			40.9			65.0	
Approach LOS		E			D			D			E	
Queue Length 50th (m)	69.3	~175.8		23.7	38.3		18.9	62.4		35.3	~158.8	
Queue Length 95th (m)	#96.7	#205.7		#64.4	50.6		#52.9	82.3		#66.1	#201.5	
Internal Link Dist (m)		509.1			674.8			297.3			374.8	
Turn Bay Length (m)	130.0			155.0			125.0			75.0		
Base Capacity (vph)	714	1856		193	1193		164	1028		322	1302	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.86	1.05		0.89	0.52		0.86	0.65		0.77	1.05	

Intersection Summary

Area Type: Other
Cycle Length: 115
Actuated Cycle Length: 115
Natural Cycle: 115
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.05
Intersection Signal Delay: 60.1 Intersection LOS: E
Intersection Capacity Utilization 108.6% ICU Level of Service G
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Dundas St W & 6 Line



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	0.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.970			0.970			0.956			0.970	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3471	0	1706	3485	0	1825	3431	0	1789	3328	0
Flt Permitted	0.148			0.129			0.476			0.151		
Satd. Flow (perm)	276	3471	0	232	3485	0	914	3431	0	284	3328	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		33			35			67			38	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			80			80	
Link Distance (m)		584.6			658.3			612.3			725.4	
Travel Time (s)		26.3			29.6			27.6			32.6	
Volume (vph)	316	758	190	387	928	232	126	506	211	158	379	95
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	322	773	194	395	947	237	129	516	215	161	387	97
Lane Group Flow (vph)	322	967	0	395	1184	0	129	731	0	161	484	0
Turn Type	pm+pt			pm+pt			Perm			pm+pt		
Protected Phases	7	4		3	8			2		1	6	
Permitted Phases	4			8			2			6		
Detector Phases	7	4		3	8		2	2		1	6	
Minimum Initial (s)	5.0	20.0		5.0	20.0		7.0	7.0		5.0	10.0	
Minimum Split (s)	10.0	31.0		10.0	31.0		31.0	31.0		10.0	31.0	
Total Split (s)	19.0	31.0	0.0	23.0	35.0	0.0	31.0	31.0	0.0	10.0	41.0	0.0
Total Split (%)	20.0%	32.6%	0.0%	24.2%	36.8%	0.0%	32.6%	32.6%	0.0%	10.5%	43.2%	0.0%
Maximum Green (s)	14.0	26.0		18.0	30.0		26.0	26.0		5.0	36.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lag	Lag		Lead		
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes		
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	None		None	None	
Walk Time (s)		15.0			15.0		15.0	15.0			15.0	
Flash Dont Walk (s)		10.0			10.0		10.0	10.0			10.0	
Pedestrian Calls (#/hr)		0			0		0	0			0	
Act Effct Green (s)	41.6	27.0		49.7	31.1		23.5	23.5		33.5	33.5	
Actuated g/C Ratio	0.46	0.30		0.54	0.34		0.26	0.26		0.37	0.37	
v/c Ratio	0.88	0.92		0.92	0.98		0.55	0.78		0.79	0.39	
Control Delay	49.2	45.7		52.6	51.7		38.9	35.1		49.7	20.4	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	49.2	45.7		52.6	51.7		38.9	35.1		49.7	20.4	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	D	D		D	D		D	D		D	C	
Approach Delay		46.6			51.9			35.7			27.7	
Approach LOS		D			D			D			C	
Queue Length 50th (m)	40.6	86.0		54.1	108.0		19.7	57.6		19.4	29.8	
Queue Length 95th (m)	#90.7	#129.4		#111.7	#160.0		37.9	77.8		#41.7	42.3	
Internal Link Dist (m)		560.6			634.3			588.3			701.4	
Turn Bay Length (m)							75.0					
Base Capacity (vph)	372	1053		432	1211		261	1027		204	1324	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.87	0.92		0.91	0.98		0.49	0.71		0.79	0.37	

Intersection Summary

Area Type: Other

Cycle Length: 95

Actuated Cycle Length: 91.2

Natural Cycle: 85

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.98

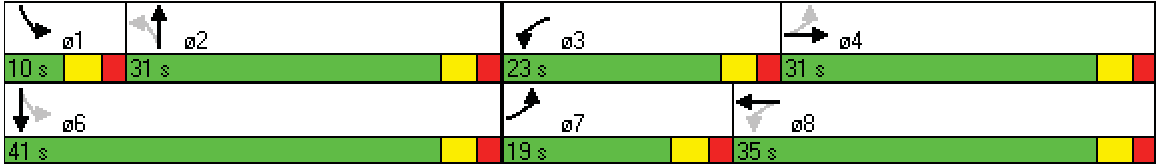
Intersection Signal Delay: 43.6 Intersection LOS: D

Intersection Capacity Utilization 93.4% ICU Level of Service F

Analysis Period (min) 15

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 9: North Oakville Corridor & 6 Line



	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	75.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.944			0.962			0.952			0.983	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1778	0	1706	1821	0	1825	3417	0	1789	3378	0
Flt Permitted	0.290			0.576			0.254			0.344		
Satd. Flow (perm)	541	1778	0	1034	1821	0	488	3417	0	648	3378	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		52			30			96			18	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			80	
Link Distance (m)		567.6			690.8			451.7			612.3	
Travel Time (s)		34.1			41.4			20.3			27.6	
Volume (vph)	98	151	89	323	440	148	72	377	175	85	617	80
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	100	154	91	330	449	151	73	385	179	87	630	82
Lane Group Flow (vph)	100	245	0	330	600	0	73	564	0	87	712	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	53.0	53.0	0.0	53.0	53.0	0.0	37.0	37.0	0.0	37.0	37.0	0.0
Total Split (%)	58.9%	58.9%	0.0%	58.9%	58.9%	0.0%	41.1%	41.1%	0.0%	41.1%	41.1%	0.0%
Maximum Green (s)	48.0	48.0		48.0	48.0		32.0	32.0		32.0	32.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Min	Min		Min	Min	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	26.3	26.3		26.3	26.3		24.3	24.3		24.3	24.3	
Actuated g/C Ratio	0.44	0.44		0.44	0.44		0.41	0.41		0.41	0.41	
v/c Ratio	0.41	0.30		0.72	0.73		0.36	0.39		0.33	0.51	
Control Delay	16.6	8.5		22.6	17.8		23.4	13.0		20.7	16.5	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	16.6	8.5		22.6	17.8		23.4	13.0		20.7	16.5	

3: Burnhamthorpe Rd W & 6 Line
Signalized Intersection

PM Peak - Future Conditions (2031)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	B	A		C	B		C	B		C	B	
Approach Delay		10.8			19.5			14.2			17.0	
Approach LOS		B			B			B			B	
Queue Length 50th (m)	6.0	10.6		23.5	40.8		4.9	16.1		5.7	25.9	
Queue Length 95th (m)	20.7	28.6		63.0	94.2		22.5	44.8		24.1	67.1	
Internal Link Dist (m)		543.6			666.8			427.7			588.3	
Turn Bay Length (m)	75.0			75.0			75.0			75.0		
Base Capacity (vph)	330	1104		631	1122		242	1744		321	1686	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.30	0.22		0.52	0.53		0.30	0.32		0.27	0.42	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 59.2

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

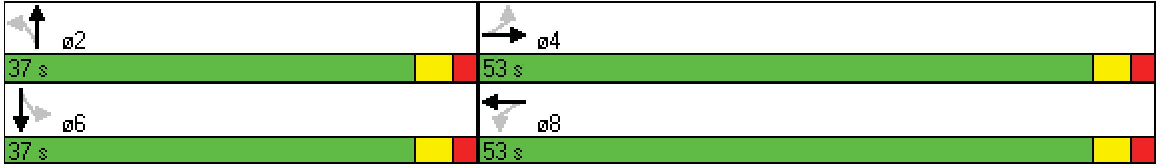
Maximum v/c Ratio: 0.73

Intersection Signal Delay: 16.4 Intersection LOS: B

Intersection Capacity Utilization 90.1% ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 3: Burnhamthorpe Rd W & 6 Line



12: Future Street D & 6 Line
Signalized Intersection

PM Peak - Future Conditions (2031)

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.863			0.897			0.975			0.974	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1625	0	1789	1689	0	1789	3489	0	1789	3376	0
Flt Permitted	0.720			0.593			0.243			0.280		
Satd. Flow (perm)	1356	1625	0	1117	1689	0	458	3489	0	527	3376	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		153			39			48			49	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			60	
Link Distance (m)		575.3			674.3			490.2			451.7	
Travel Time (s)		34.5			40.5			22.1			27.1	
Volume (vph)	94	15	150	83	18	38	257	703	143	64	782	163
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	96	15	153	85	18	39	262	717	146	65	798	166
Lane Group Flow (vph)	96	168	0	85	57	0	262	863	0	65	964	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	31.5	31.5		31.5	31.5		31.5	31.5		31.5	31.5	
Total Split (s)	31.5	31.5	0.0	31.5	31.5	0.0	58.5	58.5	0.0	58.5	58.5	0.0
Total Split (%)	35.0%	35.0%	0.0%	35.0%	35.0%	0.0%	65.0%	65.0%	0.0%	65.0%	65.0%	0.0%
Maximum Green (s)	26.0	26.0		26.0	26.0		53.0	53.0		53.0	53.0	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	13.7	13.7		13.7	13.7		56.8	56.8		56.8	56.8	
Actuated g/C Ratio	0.17	0.17		0.17	0.17		0.72	0.72		0.72	0.72	
v/c Ratio	0.41	0.41		0.44	0.17		0.79	0.34		0.17	0.39	
Control Delay	32.9	9.3		35.0	14.0		29.7	4.4		5.4	4.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	32.9	9.3		35.0	14.0		29.7	4.4		5.4	4.8	

12: Future Street D & 6 Line
PM Peak - Future Conditions (2031)
Signalized Intersection

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	A		D	B		C	A		A	A	
Approach Delay		17.9			26.6			10.3			4.8	
Approach LOS		B			C			B			A	
Queue Length 50th (m)	12.4	1.8		11.0	2.2		18.6	17.1		2.3	20.1	
Queue Length 95th (m)	25.4	16.3		23.4	10.9		#78.6	32.8		8.1	38.6	
Internal Link Dist (m)		551.3			650.3			466.2			427.7	
Turn Bay Length (m)							75.0			75.0		
Base Capacity (vph)	405	593		333	532		331	2536		381	2454	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.24	0.28		0.26	0.11		0.79	0.34		0.17	0.39	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 78.5
Natural Cycle: 90
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 9.8 Intersection LOS: A
Intersection Capacity Utilization 75.2% ICU Level of Service D
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 12: Future Street D & 6 Line

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.905			0.867			0.982				
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1705	0	1789	1633	0	1789	3514	0	1789	3444	0
Flt Permitted	0.729			0.745			0.229			0.147		
Satd. Flow (perm)	1373	1705	0	1403	1633	0	431	3514	0	277	3444	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		12			38			27				
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		48			48			80			60	
Link Distance (m)		560.3			693.3			502.8			490.2	
Travel Time (s)		42.0			52.0			22.6			29.4	
Volume (vph)	1	7	12	83	5	37	20	1066	143	65	950	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	1	7	12	85	5	38	20	1088	146	66	969	1
Lane Group Flow (vph)	1	19	0	85	43	0	20	1234	0	66	970	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	35.0	35.0	0.0	35.0	35.0	0.0	55.0	55.0	0.0	55.0	55.0	0.0
Total Split (%)	38.9%	38.9%	0.0%	38.9%	38.9%	0.0%	61.1%	61.1%	0.0%	61.1%	61.1%	0.0%
Maximum Green (s)	30.0	30.0		30.0	30.0		50.0	50.0		50.0	50.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Min	Min		Min	Min	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	13.7	13.7		13.7	13.7		44.1	44.1		44.1	44.1	
Actuated g/C Ratio	0.20	0.20		0.20	0.20		0.68	0.68		0.68	0.68	
v/c Ratio	0.00	0.05		0.30	0.12		0.07	0.51		0.35	0.41	
Control Delay	17.0	11.8		18.7	8.6		4.9	6.0		11.5	5.3	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	17.0	11.8		18.7	8.6		4.9	6.0		11.5	5.3	

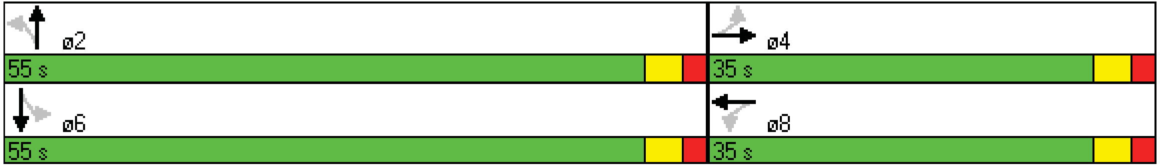
21: Future Street C & 6 Line
Signalized Intersection

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	B	B		B	A		A	A		B	A	
Approach Delay		12.1			15.3			6.0			5.7	
Approach LOS		B			B			A			A	
Queue Length 50th (m)	0.1	0.4		4.5	0.3		0.6	26.6		2.4	19.5	
Queue Length 95th (m)	1.1	5.1		18.8	7.2		2.7	44.4		10.7	32.8	
Internal Link Dist (m)		536.3			669.3			478.8			466.2	
Turn Bay Length (m)							75.0			75.0		
Base Capacity (vph)	547	686		559	673		335	2740		216	2679	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.00	0.03		0.15	0.06		0.06	0.45		0.31	0.36	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 64.6
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.51
Intersection Signal Delay: 6.4 Intersection LOS: A
Intersection Capacity Utilization 71.9% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 21: Future Street C & 6 Line



18: North Park Drive & 6 Line
Signalized Intersection

PM Peak - Future Conditions (2031)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	35.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.870			0.883			0.975			0.992	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1639	0	1789	1663	0	1789	3489	0	1789	3422	0
Flt Permitted	0.719			0.693			0.208			0.102		
Satd. Flow (perm)	1354	1639	0	1305	1663	0	392	3489	0	192	3422	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		86			46			46			10	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		48			48			80			60	
Link Distance (m)		549.9			702.6			299.7			502.8	
Travel Time (s)		41.2			52.7			13.5			30.2	
Volume (vph)	36	13	84	99	13	45	114	1184	239	13	980	52
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	37	13	86	101	13	46	116	1208	244	13	1000	53
Lane Group Flow (vph)	37	99	0	101	59	0	116	1452	0	13	1053	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	31.0	31.0		31.0	31.0		31.0	31.0		31.0	31.0	
Total Split (s)	33.0	33.0	0.0	33.0	33.0	0.0	57.0	57.0	0.0	57.0	57.0	0.0
Total Split (%)	36.7%	36.7%	0.0%	36.7%	36.7%	0.0%	63.3%	63.3%	0.0%	63.3%	63.3%	0.0%
Maximum Green (s)	28.0	28.0		28.0	28.0		52.0	52.0		52.0	52.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	13.7	13.7		13.7	13.7		62.2	62.2		62.2	62.2	
Actuated g/C Ratio	0.16	0.16		0.16	0.16		0.77	0.77		0.77	0.77	
v/c Ratio	0.17	0.29		0.47	0.19		0.38	0.54		0.09	0.40	
Control Delay	27.4	10.2		34.9	12.3		9.4	5.6		5.6	4.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	27.4	10.2		34.9	12.3		9.4	5.6		5.6	4.6	

18: North Park Drive & 6 Line
Signalized Intersection

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		C	B		A	A		A	A	
Approach Delay		14.9			26.6			5.8			4.6	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	4.4	1.5		12.7	1.5		4.9	36.8		0.4	23.2	
Queue Length 95th (m)	11.9	12.8		26.2	10.4		19.0	68.2		2.6	43.4	
Internal Link Dist (m)		525.9			678.6			275.7			478.8	
Turn Bay Length (m)							35.0			75.0		
Base Capacity (vph)	405	551		391	530		302	2694		148	2634	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.09	0.18		0.26	0.11		0.38	0.54		0.09	0.40	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 80.9

Natural Cycle: 65

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.54

Intersection Signal Delay: 6.9 Intersection LOS: A

Intersection Capacity Utilization 79.2% ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 18: North Park Drive & 6 Line

15: Sixteen Mile Drive & 6 Line
Signalized Intersection

PM Peak - Future Conditions (2031)

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.870			0.883			0.979			0.994	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1639	0	1789	1663	0	1789	3503	0	1789	3428	0
Flt Permitted	0.719			0.692			0.156			0.071		
Satd. Flow (perm)	1354	1639	0	1303	1663	0	294	3503	0	134	3428	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		81			44			39			9	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			60	
Link Distance (m)		540.7			706.6			398.8			299.7	
Travel Time (s)		32.4			42.4			17.9			18.0	
Volume (vph)	38	13	85	99	13	45	115	1454	239	13	1193	52
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	39	13	87	101	13	46	117	1484	244	13	1217	53
Lane Group Flow (vph)	39	100	0	101	59	0	117	1728	0	13	1270	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	30.0	30.0	0.0	30.0	30.0	0.0	60.0	60.0	0.0	60.0	60.0	0.0
Total Split (%)	33.3%	33.3%	0.0%	33.3%	33.3%	0.0%	66.7%	66.7%	0.0%	66.7%	66.7%	0.0%
Maximum Green (s)	25.0	25.0		25.0	25.0		55.0	55.0		55.0	55.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	13.8	13.8		13.8	13.8		65.1	65.1		65.1	65.1	
Actuated g/C Ratio	0.16	0.16		0.16	0.16		0.78	0.78		0.78	0.78	
v/c Ratio	0.18	0.30		0.49	0.20		0.51	0.63		0.12	0.48	
Control Delay	29.0	11.7		37.0	13.3		16.2	6.7		7.4	5.1	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	29.0	11.7		37.0	13.3		16.2	6.7		7.4	5.1	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		D	B		B	A		A	A	
Approach Delay		16.5			28.3			7.3			5.1	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	4.9	2.4		13.4	1.9		5.8	51.8		0.4	31.3	
Queue Length 95th (m)	12.7	14.0		27.3	11.0		#36.6	95.8		3.1	57.7	
Internal Link Dist (m)		516.7			682.6			374.8			275.7	
Turn Bay Length (m)				75.0			75.0			75.0		
Base Capacity (vph)	364	500		350	480		228	2728		104	2663	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.11	0.20		0.29	0.12		0.51	0.63		0.13	0.48	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 83.8
Natural Cycle: 80
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.63
Intersection Signal Delay: 7.8 Intersection LOS: A
Intersection Capacity Utilization 86.6% ICU Level of Service E
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 15: Sixteen Mile Drive & 6 Line

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↱		↰	↑↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	130.0		0.0	155.0		0.0	125.0		0.0	75.0		0.0
Storage Lanes	2		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	0.97	0.91	0.91	1.00	0.91	0.91	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.967			0.959			0.968			0.927	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3437	4860	0	1674	4549	0	1674	3506	0	1722	3349	0
Flt Permitted	0.125			0.160			0.108			0.105		
Satd. Flow (perm)	452	4860	0	282	4549	0	190	3506	0	190	3349	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		54			80			28			197	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			60			60	
Link Distance (m)		533.1			698.8			321.3			398.8	
Travel Time (s)		24.0			31.4			19.3			23.9	
Volume (vph)	734	640	143	316	1192	354	181	721	195	173	619	585
Peak Hour Factor	1.00	1.00	0.80	1.00	1.00	0.80	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	3%	5%	2%	9%	13%	4%	9%	1%	0%	6%	2%	0%
Adj. Flow (vph)	734	640	179	316	1192	442	181	721	195	173	619	585
Lane Group Flow (vph)	734	819	0	316	1634	0	181	916	0	173	1204	0
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Detector Phases	7	4		3	8		5	2		1	6	
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	10.0		5.0	10.0	
Minimum Split (s)	10.0	30.0		10.0	30.0		10.0	30.0		10.0	30.0	
Total Split (s)	25.0	36.0	0.0	34.0	45.0	0.0	13.0	41.0	0.0	14.0	42.0	0.0
Total Split (%)	20.0%	28.8%	0.0%	27.2%	36.0%	0.0%	10.4%	32.8%	0.0%	11.2%	33.6%	0.0%
Maximum Green (s)	20.0	31.0		29.0	40.0		8.0	36.0		9.0	37.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	Min		None	Min	
Walk Time (s)		15.0			15.0			15.0			15.0	
Flash Dont Walk (s)		10.0			10.0			10.0			10.0	
Pedestrian Calls (#/hr)		0			0			0			0	
Act Effct Green (s)	59.9	39.5		62.3	41.0		46.0	37.0		48.0	38.0	
Actuated g/C Ratio	0.48	0.32		0.50	0.33		0.37	0.30		0.38	0.30	
v/c Ratio	1.02	0.52		0.81	1.06		1.02	0.87		0.88	1.04	
Control Delay	73.7	35.0		40.0	78.3		104.5	50.3		69.0	73.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	73.7	35.0		40.0	78.3		104.5	50.3		69.0	73.8	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	E	C		D	E		F	D		E	E	
Approach Delay		53.3			72.1			59.2			73.2	
Approach LOS		D			E			E			E	
Queue Length 50th (m)	~79.5	56.5		48.9	~156.3		~32.4	109.2		27.6	~149.6	
Queue Length 95th (m)	#124.5	76.1		78.6	#186.3		#78.8	#137.0		#68.2	#192.0	
Internal Link Dist (m)		509.1			674.8			297.3			374.8	
Turn Bay Length (m)	130.0			155.0			125.0			75.0		
Base Capacity (vph)	718	1571		457	1546		177	1057		196	1155	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	1.02	0.52		0.69	1.06		1.02	0.87		0.88	1.04	

Intersection Summary

Area Type: Other

Cycle Length: 125

Actuated Cycle Length: 125

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.06

Intersection Signal Delay: 65.1 Intersection LOS: E

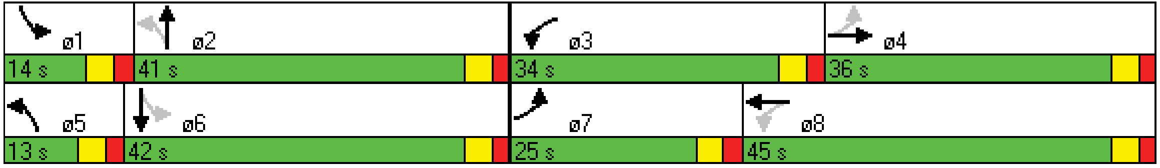
Intersection Capacity Utilization 111.1% ICU Level of Service H

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Dundas St W & 6 Line



Appendix B.2 – Existing (2012) AM and PM Peak Hours - HCM Report

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	109	200	50	31	104	13	7	306	203	153	195	39
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	118	217	54	34	113	14	8	333	221	166	212	42

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	390	161	561	421
Volume Left (vph)	118	34	8	166
Volume Right (vph)	54	14	221	42
Hadj (s)	0.02	0.04	-0.21	0.10
Departure Headway (s)	7.9	9.0	7.4	7.8
Degree Utilization, x	0.85	0.40	1.16	0.91
Capacity (veh/h)	447	363	486	449
Control Delay (s)	42.0	17.9	118.5	50.4
Approach Delay (s)	42.0	17.9	118.5	50.4
Approach LOS	E	C	F	F

Intersection Summary			
Delay	69.8		
HCM Level of Service	F		
Intersection Capacity Utilization	86.2%	ICU Level of Service	E
Analysis Period (min)	15		

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↱		↰	↑	↱	↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	160.0		115.0	155.0		0.0	125.0		0.0	75.0		65.0
Storage Lanes	1		1	1		0	1		1	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1	6.1	30.5	
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	0.95	1.00	1.00	1.00	1.00	0.95	0.95
Frt			0.850		0.995				0.850		0.952	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3476	1601	1674	3223	0	1674	1902	1633	1722	3428	0
Flt Permitted	0.379			0.080			0.589			0.496		
Satd. Flow (perm)	707	3476	1601	141	3223	0	1038	1902	1633	899	3428	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			130		8				115		75	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			60			60	
Link Distance (m)		533.1			698.8			321.3			77.1	
Travel Time (s)		24.0			31.4			19.3			4.6	
Volume (vph)	307	1734	120	85	635	24	78	207	116	82	147	69
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	5%	2%	9%	13%	4%	9%	1%	0%	6%	2%	0%
Adj. Flow (vph)	334	1885	130	92	690	26	85	225	126	89	160	75
Lane Group Flow (vph)	334	1885	130	92	716	0	85	225	126	89	235	0
Turn Type	Perm		Perm	pm+pt			Perm		Perm	Perm		
Protected Phases		4		3	8			2			6	
Permitted Phases	4		4	8			2		2	6		
Detector Phases	4	4	4	3	8		2	2	2	6	6	
Minimum Initial (s)	20.0	20.0	20.0	5.0	20.0		10.0	10.0	10.0	10.0	10.0	
Minimum Split (s)	30.0	30.0	30.0	10.0	30.0		30.0	30.0	30.0	30.0	30.0	
Total Split (s)	50.0	50.0	50.0	10.0	60.0	0.0	30.0	30.0	30.0	30.0	30.0	0.0
Total Split (%)	55.6%	55.6%	55.6%	11.1%	66.7%	0.0%	33.3%	33.3%	33.3%	33.3%	33.3%	0.0%
Maximum Green (s)	45.0	45.0	45.0	5.0	55.0		25.0	25.0	25.0	25.0	25.0	
Yellow Time (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Lead/Lag	Lag	Lag	Lag	Lead								
Lead-Lag Optimize?	Yes	Yes	Yes	Yes								
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	None	None	None	None	None		Min	Min	Min	Min	Min	
Walk Time (s)	15.0	15.0	15.0		15.0		15.0	15.0	15.0	15.0	15.0	
Flash Dont Walk (s)	10.0	10.0	10.0		10.0		10.0	10.0	10.0	10.0	10.0	
Pedestrian Calls (#/hr)	0	0	0		0		0	0	0	0	0	
Act Effct Green (s)	46.4	46.4	46.4	54.0	54.1		16.2	16.2	16.2	16.2	16.2	
Actuated g/C Ratio	0.59	0.59	0.59	0.67	0.69		0.21	0.21	0.21	0.21	0.21	
v/c Ratio	0.80	0.92	0.13	0.44	0.32		0.40	0.57	0.29	0.48	0.31	
Control Delay	32.7	25.2	2.4	13.8	5.7		33.2	34.5	8.5	37.2	18.8	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	32.7	25.2	2.4	13.8	5.7		33.2	34.5	8.5	37.2	18.8	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	C	A	B	A		C	C	A	D	B	
Approach Delay		25.0			6.6			26.7			23.8	
Approach LOS		C			A			C			C	
Queue Length 50th (m)	36.8	126.0	0.0	3.6	17.6		11.4	31.2	1.4	12.1	10.8	
Queue Length 95th (m)	#101.9	#222.3	7.6	14.4	35.0		23.9	51.6	13.8	25.5	19.7	
Internal Link Dist (m)		509.1			674.8			297.3			53.1	
Turn Bay Length (m)	160.0		115.0	155.0			125.0			75.0		
Base Capacity (vph)	419	2059	1001	209	2253		307	563	565	266	1068	
Starvation Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Reduced v/c Ratio	0.80	0.92	0.13	0.44	0.32		0.28	0.40	0.22	0.33	0.22	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 78.4

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.92

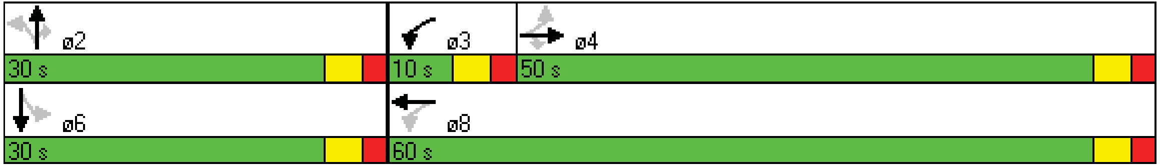
Intersection Signal Delay: 21.3 Intersection LOS: C

Intersection Capacity Utilization 85.2% ICU Level of Service E

Analysis Period (min) 15

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Dundas St W & 6 Line



3: Burnhamthorpe Rd W & 6 Line
Unsignalized Intersection

PM Peak - Existing Conditions (2012)

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	67	100	34	132	301	83	34	223	36	23	186	55
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	73	109	37	143	327	90	37	242	39	25	202	60

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	218	561	318	287
Volume Left (vph)	73	143	37	25
Volume Right (vph)	37	90	39	60
Hadj (s)	0.00	0.00	-0.02	0.00
Departure Headway (s)	7.7	6.9	7.4	7.5
Degree Utilization, x	0.47	1.07	0.66	0.60
Capacity (veh/h)	425	513	465	449
Control Delay (s)	17.3	86.1	23.5	21.2
Approach Delay (s)	17.3	86.1	23.5	21.2
Approach LOS	C	F	C	C

Intersection Summary			
Delay	47.4		
HCM Level of Service	E		
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		

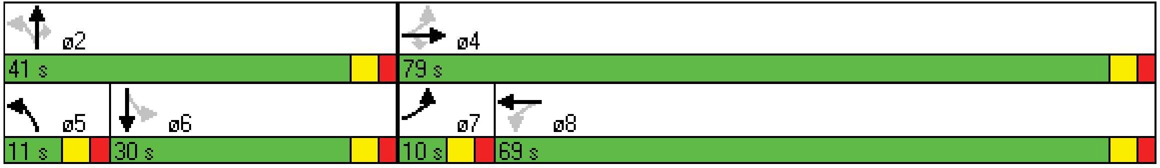
	↰	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↱		↰	↑	↱	↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	160.0		115.0	155.0		0.0	125.0		0.0	75.0		65.0
Storage Lanes	1		1	1		0	1		1	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5		6.1	30.5	6.1	6.1	30.5	
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	0.95	1.00	1.00	1.00	1.00	0.95	0.95
Frt			0.850		0.993				0.850		0.928	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3476	1601	1674	3220	0	1674	1902	1633	1722	3352	0
Flt Permitted	0.058			0.217			0.295			0.657		
Satd. Flow (perm)	108	3476	1601	382	3220	0	520	1902	1633	1191	3352	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			88		6				97		112	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			60			60	
Link Distance (m)		533.1			698.8			321.3			77.1	
Travel Time (s)		24.0			31.4			19.3			4.6	
Volume (vph)	96	1048	81	172	1566	78	115	144	92	42	196	179
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	5%	2%	9%	13%	4%	9%	1%	0%	6%	2%	0%
Adj. Flow (vph)	104	1139	88	187	1702	85	125	157	100	46	213	195
Lane Group Flow (vph)	104	1139	88	187	1787	0	125	157	100	46	408	0
Turn Type	pm+pt		Perm	Perm			pm+pt		Perm	Perm		
Protected Phases	7	4			8		5	2			6	
Permitted Phases	4		4	8			2		2	6		
Detector Phases	7	4	4	8	8		5	2	2	6	6	
Minimum Initial (s)	5.0	20.0	20.0	20.0	20.0		5.0	10.0	10.0	10.0	10.0	
Minimum Split (s)	10.0	30.0	30.0	30.0	30.0		10.0	30.0	30.0	30.0	30.0	
Total Split (s)	10.0	79.0	79.0	69.0	69.0	0.0	11.0	41.0	41.0	30.0	30.0	0.0
Total Split (%)	8.3%	65.8%	65.8%	57.5%	57.5%	0.0%	9.2%	34.2%	34.2%	25.0%	25.0%	0.0%
Maximum Green (s)	5.0	74.0	74.0	64.0	64.0		6.0	36.0	36.0	25.0	25.0	
Yellow Time (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Lead/Lag	Lead			Lag	Lag		Lead			Lag	Lag	
Lead-Lag Optimize?	Yes			Yes	Yes		Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	None	None	None	None	None		None	Min	Min	Min	Min	
Walk Time (s)		15.0	15.0	15.0	15.0			15.0	15.0	15.0	15.0	
Flash Dont Walk (s)		10.0	10.0	10.0	10.0			10.0	10.0	10.0	10.0	
Pedestrian Calls (#/hr)		0	0	0	0			0	0	0	0	
Act Effct Green (s)	75.1	75.1	75.1	65.1	65.1		27.6	27.6	27.6	16.6	16.6	
Actuated g/C Ratio	0.68	0.68	0.68	0.59	0.59		0.25	0.25	0.25	0.15	0.15	
v/c Ratio	0.64	0.48	0.08	0.83	0.94		0.62	0.33	0.21	0.26	0.68	
Control Delay	33.2	9.8	1.8	52.4	33.3		47.7	35.8	7.9	44.7	38.0	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	33.2	9.8	1.8	52.4	33.3		47.7	35.8	7.9	44.7	38.0	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	A	A	D	C		D	D	A	D	D	
Approach Delay		11.1			35.1			32.4			38.7	
Approach LOS		B			D			C			D	
Queue Length 50th (m)	6.8	55.2	0.0	30.4	174.7		22.0	27.8	0.5	8.9	32.1	
Queue Length 95th (m)	#31.9	82.8	5.5	#83.2	#265.8		37.8	45.5	12.8	19.6	48.1	
Internal Link Dist (m)		509.1			674.8			297.3			53.1	
Turn Bay Length (m)	160.0		115.0	155.0			125.0			75.0		
Base Capacity (vph)	163	2358	1114	225	1895		203	586	571	258	814	
Starvation Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Reduced v/c Ratio	0.64	0.48	0.08	0.83	0.94		0.62	0.27	0.18	0.18	0.50	

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 110.7
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.94
Intersection Signal Delay: 27.5 Intersection LOS: C
Intersection Capacity Utilization 82.0% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Dundas St W & 6 Line



Appendix B.3 – Traffic Signals Justification - Future (2021)

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	March 4, 2013	
Analysis Period	2021	**East-West Street**	New North Oakville Corridor	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	2	Minor Street
Additional Comments				

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	**Main Road Approaches**							**Minor Road Approaches**							**Pedestrian Crossing Major Road**	**Pedestrian Crossing Minor Road**
	Northbound			**Southbound**			**Total**	**Eastbound**			**Westbound**			**Total**		
	LT	**TH**	**RT**	**LT**	**TH**	**RT**		**LT**	**TH**	**RT**	**LT**	**TH**	**RT**			
AM Peak Hour	114	457	190	133	319	80	**1293**	360	863	216	88	212	53	**1792**	0	0
PM Peak Hour	94	375	156	121	290	73	**1109**	216	518	129	218	522	131	**1734**	0	0
Total	**208**	**832**	**346**	**254**	**609**	**153**	**2402**	**576**	**1381**	**345**	**306**	**734**	**184**	**3526**	**0**	**0**

Parameter	**AM**	**PM**	**Average Hourly Volume (AHV)**
Vehicle volume, all approaches	3085	2843	1482
Vehicle volume, along minor street	1792	1734	882
Vehicle volume, along major street	1293	1109	601
Combined vehicle and pedestrian volume crossing from minor streets	1311	956	567

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	**PM**
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	448	434
b. The heaviest through volume from the minor street	863	522
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	0
1. the left turn volume > 120	Yes	Yes
2. the left turn volume + opposing volume > 720	No	No
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	March 4, 2013	
Analysis Period	2021	**East-West Street**	New North Oakville Corridor	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	2	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					3085	**2843**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**100%**	**100%**	**100%**	**100%**
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
B. Vehicle volume, along minor streets					**1792**	**1734**	**100%**	**100%**		
				170	340	340				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									

		AM Peak Hour	**PM Peak Hour**
Justification 1:	Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :	Yes	Yes
	Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :	Yes	Yes

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1293	**1109**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**48%**	**41%**	**48%**	**41%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				48%	41%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**1311**	**956**	**100%**	**100%**		
				170	340	340				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									

		AM Peak Hour	**PM Peak Hour**
Justification 2:	Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :	No	No
	Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :	No	No

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**Yes**	**Yes**	**Yes**	**Yes**	No
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are not met.

Therefore traffic control signal is not justified at this intersection for the horizon year 2021

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	Burnhamthorpe Road	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban) ▼	**Major Street**	North-South ▼	
'T' Intersection	No ▼	**Approach lanes per direction**	2 ▼	Major Street
Existing Intersection	Yes ▼	**Approach lanes per direction**	1 ▼	Minor Street
Additional Comments				

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	Main Road Approaches							Minor Road Approaches							Pedestrian Crossing Major Road	Pedestrian Crossing Minor Road
	Northbound			Southbound			Total	Eastbound			Westbound			Total		
	LT	TH	RT	LT	TH	RT		LT	TH	RT	LT	TH	RT			
AM Peak Hour	35	443	314	189	330	46	**1357**	130	240	70	91	127	41	**699**	0	0
PM Peak Hour	63	319	116	54	440	66	**1058**	80	122	80	244	361	113	**1000**	0	0
Total	**98**	**762**	**430**	**243**	**770**	**112**	**2415**	**210**	**362**	**150**	**335**	**488**	**154**	**1699**	**0**	**0**

Parameter	AM	PM	Average Hourly Volume (AHV)
Vehicle volume, all approaches	2056	2058	1029
Vehicle volume, along minor street	699	1000	425
Vehicle volume, along major street	1357	1058	604
Combined vehicle and pedestrian volume crossing from minor streets	461	685	287

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	PM
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	221	324
b. The heaviest through volume from the minor street	240	361
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	0
1. the left turn volume > 120	Yes	No
2. the left turn volume + opposing volume > 720	No	No
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	Burnhamthorpe Road	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	Yes	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire^1**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2056	**2058**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**80%**	**80%**	**80%**	**80%**
	100% Compliance									
	80% Compliance				80%	80%				
	Actual % if below 80%									
B. Vehicle volume, along minor streets					**699**	**1000**	**100%**	**100%**		
				170	170	170				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		**Yes**		**Yes**	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire^1**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1357	**1058**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**63%**	**49%**	**63%**	**49%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				63%	49%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**461**	**685**	**100%**	**100%**		
				170	170	170				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**No**	**No**	**Yes**	**Yes**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are not met.
Therefore traffic control signal is not justified at this intersection for the horizon year 2021

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	Future Street D	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street

Additional Comments

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	**Main Road Approaches**							**Minor Road Approaches**							**Pedestrian Crossing Major Road**	**Pedestrian Crossing Minor Road**
	Northbound			**Southbound**			**Total**	**Eastbound**			**Westbound**			**Total**		
	LT	**TH**	**RT**	**LT**	**TH**	**RT**		**LT**	**TH**	**RT**	**LT**	**TH**	**RT**			
AM Peak Hour	42	853	20	10	453	19	**1397**	57	8	126	63	6	29	**289**	0	0
PM Peak Hour	129	538	72	32	631	82	**1484**	47	8	75	42	9	19	**200**	0	0
Total	**171**	**1391**	**92**	**42**	**1084**	**101**	**2881**	**104**	**16**	**201**	**105**	**15**	**48**	**489**	**0**	**0**

Parameter	**AM**	**PM**	**Average Hourly Volume (AHV)**
Vehicle volume, all approaches	1686	1684	843
Vehicle volume, along minor street	289	200	122
Vehicle volume, along major street	1397	1484	720
Combined vehicle and pedestrian volume crossing from minor streets	128	98	57

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	**PM**
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	120	89
b. The heaviest through volume from the minor street	8	9
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	65
1. the left turn volume > 120	No	Yes
2. the left turn volume + opposing volume > 720	No	Yes
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	Future Street D	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1686	**1684**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**62%**	**62%**	**62%**	**62%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				62%	62%				
B. Vehicle volume, along minor streets					**289**	**200**	**100%**	**78%**		
				170	170	170				
	100% Compliance				100%					
	80% Compliance									
	Actual % if below 80%					78%				
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1397	**1484**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**52%**	**55%**	**50%**	**38%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				52%	55%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**128**	**98**	**50%**	**38%**		
				170	170	170				
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				50%	38%				
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**No**	**No**	**No**	**No**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are not met.
Therefore traffic control signal is not justified at this intersection for the horizon year 2021

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	Future Street C	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street

Additional Comments

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	Main Road Approaches							Minor Road Approaches							Pedestrian Crossing Major Road	Pedestrian Crossing Minor Road
	Northbound			Southbound			Total	Eastbound			Westbound			Total		
	LT	TH	RT	LT	TH	RT		LT	TH	RT	LT	TH	RT			
AM Peak Hour	10	885	20	10	639	0	**1564**	0	2	20	63	3	29	**117**	0	0
PM Peak Hour	20	719	72	33	715	0	**1559**	0	4	12	42	3	19	**80**	0	0
Total	**30**	**1604**	**92**	**43**	**1354**	**0**	**3123**	**0**	**6**	**32**	**105**	**6**	**48**	**197**	**0**	**0**

Parameter	AM	PM	Average Hourly Volume (AHV)
Vehicle volume, all approaches	1681	1639	830
Vehicle volume, along minor street	117	80	49
Vehicle volume, along major street	1564	1559	781
Combined vehicle and pedestrian volume crossing from minor streets	66	46	28

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	PM
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	63	42
b. The heaviest through volume from the minor street	3	4
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	0
1. the left turn volume > 120	No	No
2. the left turn volume + opposing volume > 720	Yes	Yes
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	Future Street C	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1681	**1639**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**62%**	**61%**	**46%**	**31%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				62%	61%				
B. Vehicle volume, along minor streets					**117**	**80**	**46%**	**31%**		
				170	170	170				
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				46%	31%				
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1564	**1559**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**58%**	**58%**	**26%**	**18%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				58%	58%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**66**	**46**	**26%**	**18%**		
				170	170	170				
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				26%	18%				
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**No**	**No**	**No**	**No**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are **<u>not met.</u>**
Therefore traffic control signal is not justified at this intersection for the horizon year 2021

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	North Park Drive	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street

Additional Comments

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	Main Road Approaches							Minor Road Approaches							Pedestrian Crossing Major Road	Pedestrian Crossing Minor Road
	Northbound			Southbound			Total	Eastbound			Westbound			Total		
	LT	TH	RT	LT	TH	RT		LT	TH	RT	LT	TH	RT			
AM Peak Hour	45	865	25	21	684	21	**1661**	42	8	120	78	7	35	**290**	0	0
PM Peak Hour	114	782	120	7	710	52	**1785**	36	9	84	50	10	23	**212**	0	0
Total	**159**	**1647**	**145**	**28**	**1394**	**73**	**3446**	**78**	**17**	**204**	**128**	**17**	**58**	**502**	**0**	**0**

Parameter	AM	PM	Average Hourly Volume (AHV)
Vehicle volume, all approaches	1951	1997	987
Vehicle volume, along minor street	290	212	126
Vehicle volume, along major street	1661	1785	862
Combined vehicle and pedestrian volume crossing from minor streets	128	96	56

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	PM
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	120	86
b. The heaviest through volume from the minor street	8	10
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	0
1. the left turn volume > 120	No	No
2. the left turn volume + opposing volume > 720	Yes	Yes
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	North Park Drive	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1951	**1997**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**72%**	**74%**	**72%**	**74%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				72%	74%				
B. Vehicle volume, along minor streets					**290**	**212**	**100%**	**80%**		
				170	170	170				
	100% Compliance				100%					
	80% Compliance					80%				
	Actual % if below 80%									
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1661	**1785**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**62%**	**66%**	**50%**	**38%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				62%	66%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**128**	**96**	**50%**	**38%**		
				170	170	170				
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				50%	38%				
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**No**	**No**	**No**	**No**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are not met.
Therefore traffic control signal is not justified at this intersection for the horizon year 2021

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	Sixteen Mile Drive	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street

Additional Comments

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	Main Road Approaches							Minor Road Approaches							Pedestrian Crossing Major Road	Pedestrian Crossing Minor Road
	Northbound			Southbound			Total	Eastbound			Westbound			Total		
	LT	TH	RT	LT	TH	RT		LT	TH	RT	LT	TH	RT			
AM Peak Hour	45	859	25	21	866	20	**1836**	41	8	120	78	7	35	**289**	0	0
PM Peak Hour	115	955	120	7	863	52	**2112**	38	9	85	50	10	23	**215**	0	0
Total	**160**	**1814**	**145**	**28**	**1729**	**72**	**3948**	**79**	**17**	**205**	**128**	**17**	**58**	**504**	**0**	**0**

Parameter	AM	PM	Average Hourly Volume (AHV)
Vehicle volume, all approaches	2125	2327	1113
Vehicle volume, along minor street	289	215	126
Vehicle volume, along major street	1836	2112	987
Combined vehicle and pedestrian volume crossing from minor streets	127	98	56

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	PM
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	119	88
b. The heaviest through volume from the minor street	8	10
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	0
1. the left turn volume > 120	No	No
2. the left turn volume + opposing volume > 720	Yes	Yes
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2021	**East-West Street**	Sixteen Mile Drive	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2125	**2327**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**79%**	**80%**	**79%**	**80%**
	100% Compliance									
	80% Compliance					80%				
	Actual % if below 80%				79%					
B. Vehicle volume, along minor streets					**289**	**215**	**100%**	**80%**		
				170	170	170				
	100% Compliance				100%					
	80% Compliance					80%				
	Actual % if below 80%									
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**Yes**	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1836	**2112**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**68%**	**78%**	**50%**	**38%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				68%	78%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**127**	**98**	**50%**	**38%**		
				170	170	170				
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				50%	38%				
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**No**	**No**	**No**	**Yes**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are **not met.**

Therefore traffic control signal is not justified at this intersection for the horizon year 2021

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

Appendix B.4 – Future (2021) AM and PM Peak Hours - HCM Report

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	0.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.970			0.970			0.956			0.970	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3471	0	1706	3485	0	1825	3431	0	1789	3328	0
Flt Permitted	0.585			0.164			0.465			0.302		
Satd. Flow (perm)	1091	3471	0	294	3485	0	893	3431	0	569	3328	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		50			50			85			41	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			80			80	
Link Distance (m)		584.6			658.3			612.3			725.4	
Travel Time (s)		26.3			29.6			27.6			32.6	
Volume (vph)	360	863	216	88	212	53	114	457	190	133	319	80
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	367	881	220	90	216	54	116	466	194	136	326	82
Lane Group Flow (vph)	367	1101	0	90	270	0	116	660	0	136	408	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	20.0	20.0		20.0	20.0		10.0	10.0		10.0	10.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	50.0	50.0	0.0	50.0	50.0	0.0	40.0	40.0	0.0	40.0	40.0	0.0
Total Split (%)	55.6%	55.6%	0.0%	55.6%	55.6%	0.0%	44.4%	44.4%	0.0%	44.4%	44.4%	0.0%
Maximum Green (s)	45.0	45.0		45.0	45.0		35.0	35.0		35.0	35.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	None		None	None	
Walk Time (s)	7.0	7.0		7.0	7.0		7.0	7.0		7.0	7.0	
Flash Dont Walk (s)	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	32.3	32.3		32.3	32.3		21.0	21.0		21.0	21.0	
Actuated g/C Ratio	0.52	0.52		0.52	0.52		0.34	0.34		0.34	0.34	
v/c Ratio	0.65	0.60		0.59	0.15		0.39	0.54		0.71	0.36	
Control Delay	19.3	12.6		33.2	7.6		21.6	16.6		41.9	15.3	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	19.3	12.6		33.2	7.6		21.6	16.6		41.9	15.3	

9: North Oakville Corridor & 6 Line
Signalized Intersection

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	B	B		C	A		C	B		D	B	
Approach Delay		14.2			14.0			17.4			21.9	
Approach LOS		B			B			B			C	
Queue Length 50th (m)	25.1	36.2		5.9	5.6		8.8	24.1		11.8	14.3	
Queue Length 95th (m)	76.6	83.9		#34.5	16.3		27.0	52.0		#40.4	32.6	
Internal Link Dist (m)		560.6			634.3			588.3			701.4	
Turn Bay Length (m)							75.0					
Base Capacity (vph)	673	2159		181	2167		430	1695		274	1623	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.55	0.51		0.50	0.12		0.27	0.39		0.50	0.25	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 62.3

Natural Cycle: 65

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.71

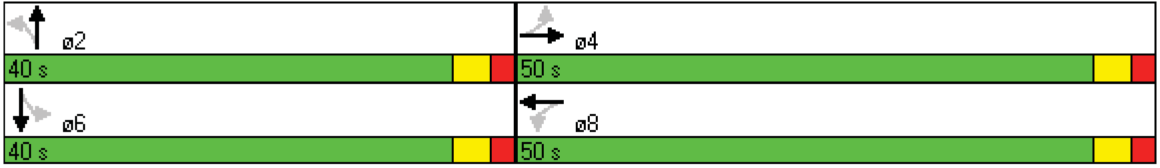
Intersection Signal Delay: 16.3 Intersection LOS: B

Intersection Capacity Utilization 87.8% ICU Level of Service E

Analysis Period (min) 15

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 9: North Oakville Corridor & 6 Line



	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	75.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.966			0.963			0.938			0.982	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1819	0	1706	1822	0	1825	3370	0	1789	3374	0
Flt Permitted	0.598			0.402			0.516			0.310		
Satd. Flow (perm)	1115	1819	0	722	1822	0	991	3370	0	584	3374	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		17			19			320			29	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			80	
Link Distance (m)		567.6			690.8			451.7			612.3	
Travel Time (s)		34.1			41.4			20.3			27.6	
Volume (vph)	130	240	70	91	127	41	35	443	314	189	330	46
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	133	245	71	93	130	42	36	452	320	193	337	47
Lane Group Flow (vph)	133	316	0	93	172	0	36	772	0	193	384	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	31.0	31.0		31.0	31.0		31.0	31.0		31.0	31.0	
Total Split (s)	34.0	34.0	0.0	34.0	34.0	0.0	56.0	56.0	0.0	56.0	56.0	0.0
Total Split (%)	37.8%	37.8%	0.0%	37.8%	37.8%	0.0%	62.2%	62.2%	0.0%	62.2%	62.2%	0.0%
Maximum Green (s)	29.0	29.0		29.0	29.0		51.0	51.0		51.0	51.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Min	Min		Min	Min	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	16.0	16.0		16.0	16.0		28.6	28.6		28.6	28.6	
Actuated g/C Ratio	0.30	0.30		0.30	0.30		0.54	0.54		0.54	0.54	
v/c Ratio	0.40	0.57		0.43	0.31		0.07	0.40		0.62	0.21	
Control Delay	21.3	20.9		24.8	16.3		7.2	4.8		19.8	6.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	21.3	20.9		24.8	16.3		7.2	4.8		19.8	6.6	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	C		C	B		A	A		B	A	
Approach Delay		21.0			19.3			4.9			11.0	
Approach LOS		C			B			A			B	
Queue Length 50th (m)	7.4	17.4		5.2	8.1		1.2	8.6		9.1	6.5	
Queue Length 95th (m)	32.9	65.9		26.3	34.7		6.3	27.0		40.9	19.8	
Internal Link Dist (m)		543.6			666.8			427.7			588.3	
Turn Bay Length (m)	75.0			75.0			75.0			75.0		
Base Capacity (vph)	512	845		332	848		680	2413		401	2324	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.26	0.37		0.28	0.20		0.05	0.32		0.48	0.17	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 53.4

Natural Cycle: 65

Control Type: Actuated-Uncoordinated

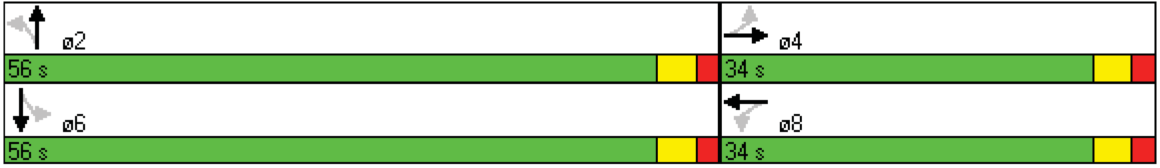
Maximum v/c Ratio: 0.62

Intersection Signal Delay: 11.8 Intersection LOS: B

Intersection Capacity Utilization 77.5% ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 3: Burnhamthorpe Rd W & 6 Line



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	57	8	126	63	6	29	42	853	20	10	453	19
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	58	8	129	64	6	30	43	870	20	10	462	19
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	1046	1469	241	1351	1468	445	482			891		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1046	1469	241	1351	1468	445	482			891		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	64	93	83	22	95	95	96			99		
cM capacity (veh/h)	160	120	760	82	120	560	1077			757		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	58	137	64	36	43	580	311	10	308	173
Volume Left	58	0	64	0	43	0	0	10	0	0
Volume Right	0	129	0	30	0	0	20	0	0	19
cSH	160	576	82	344	1077	1700	1700	757	1700	1700
Volume to Capacity	0.36	0.24	0.78	0.10	0.04	0.34	0.18	0.01	0.18	0.10
Queue Length 95th (m)	11.7	7.0	29.7	2.6	0.9	0.0	0.0	0.3	0.0	0.0
Control Delay (s)	39.9	13.2	132.8	16.7	8.5	0.0	0.0	9.8	0.0	0.0
Lane LOS	E	B	F	C	A			A		
Approach Delay (s)	21.2		91.3		0.4			0.2		
Approach LOS	C		F							

Intersection Summary			
Average Delay	8.0		
Intersection Capacity Utilization	52.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	1	2	20	63	3	29	10	885	20	10	639	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	1	2	20	64	3	30	10	903	20	10	652	1
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	1176	1617	327	1302	1607	462	653			923		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1176	1617	327	1302	1607	462	653			923		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	98	97	42	97	95	99			99		
cM capacity (veh/h)	133	100	669	111	101	547	930			735		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	1	22	64	33	10	602	321	10	435	218
Volume Left	1	0	64	0	10	0	0	10	0	0
Volume Right	0	20	0	30	0	0	20	0	0	1
cSH	133	441	111	387	930	1700	1700	735	1700	1700
Volume to Capacity	0.01	0.05	0.58	0.08	0.01	0.35	0.19	0.01	0.26	0.13
Queue Length 95th (m)	0.2	1.2	21.3	2.1	0.3	0.0	0.0	0.3	0.0	0.0
Control Delay (s)	32.3	13.6	74.9	15.1	8.9	0.0	0.0	10.0	0.0	0.0
Lane LOS	D	B	F	C	A			A		
Approach Delay (s)	14.4		54.8		0.1			0.2		
Approach LOS	B		F							

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	41.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	41	8	120	78	7	35	45	859	25	21	866	20
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	42	8	122	80	7	36	46	877	26	21	884	20
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)								399				
pX, platoon unblocked												
vC, conflicting volume	1506	1931	452	1592	1928	451	904			902		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1506	1931	452	1592	1928	451	904			902		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	37	86	78	0	88	94	94			97		
cM capacity (veh/h)	66	60	555	47	60	556	748			749		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	42	131	80	43	46	584	318	21	589	315
Volume Left	42	0	80	0	46	0	0	21	0	0
Volume Right	0	122	0	36	0	0	26	0	0	20
cSH	66	365	47	234	748	1700	1700	749	1700	1700
Volume to Capacity	0.63	0.36	1.70	0.18	0.06	0.34	0.19	0.03	0.35	0.19
Queue Length 95th (m)	20.7	12.0	59.9	5.0	1.5	0.0	0.0	0.7	0.0	0.0
Control Delay (s)	126.0	20.2	528.7	23.8	10.1	0.0	0.0	9.9	0.0	0.0
Lane LOS	F	C	F	C	B			A		
Approach Delay (s)	45.9		352.0		0.5			0.2		
Approach LOS	E		F							

Intersection Summary			
Average Delay	23.8		
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

18: North Park Drive & 6 Line
Unsignalized Intersection

AM Peak - Future Conditions (2021)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	42	8	120	78	7	35	45	865	25	21	684	21
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	43	8	122	80	7	36	46	883	26	21	698	21
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	1324	1752	360	1506	1749	454	719			908		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1324	1752	360	1506	1749	454	719			908		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	54	90	81	0	91	94	95			97		
cM capacity (veh/h)	93	78	637	58	78	553	878			745		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	43	131	80	43	46	588	320	21	465	254
Volume Left	43	0	80	0	46	0	0	21	0	0
Volume Right	0	122	0	36	0	0	26	0	0	21
cSH	93	440	58	275	878	1700	1700	745	1700	1700
Volume to Capacity	0.46	0.30	1.37	0.16	0.05	0.35	0.19	0.03	0.27	0.15
Queue Length 95th (m)	14.8	9.3	52.9	4.1	1.3	0.0	0.0	0.7	0.0	0.0
Control Delay (s)	73.0	16.6	360.5	20.5	9.3	0.0	0.0	10.0	0.0	0.0
Lane LOS	F	C	F	C	A			A		
Approach Delay (s)	30.5		241.5		0.4			0.3		
Approach LOS	D		F							

Intersection Summary			
Average Delay	17.8		
Intersection Capacity Utilization	53.5%	ICU Level of Service	A
Analysis Period (min)	15		

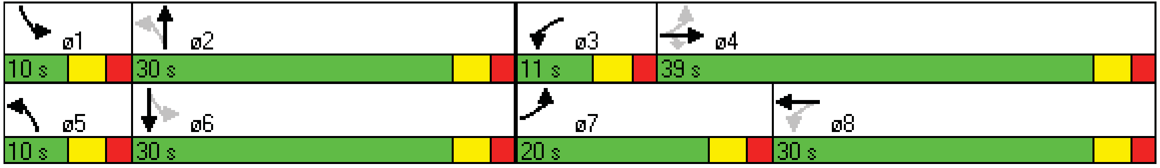
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	130.0		115.0	155.0		0.0	125.0		0.0	75.0		0.0
Storage Lanes	1		1	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Frt			0.850		0.941			0.944			0.933	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3476	1601	1674	3138	0	1674	3424	0	1722	3368	0
Flt Permitted	0.427			0.154			0.154			0.316		
Satd. Flow (perm)	796	3476	1601	271	3138	0	271	3424	0	573	3368	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			150		130			137			228	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			60			60	
Link Distance (m)		533.1			698.8			321.3			398.8	
Travel Time (s)		24.0			31.4			19.3			23.9	
Volume (vph)	473	1065	147	150	196	127	121	328	196	180	498	402
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	5%	2%	9%	13%	4%	9%	1%	0%	6%	2%	0%
Adj. Flow (vph)	483	1087	150	153	200	130	123	335	200	184	508	410
Lane Group Flow (vph)	483	1087	150	153	330	0	123	535	0	184	918	0
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		
Detector Phases	7	4	4	3	8		5	2		1	6	
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0		5.0	10.0		5.0	10.0	
Minimum Split (s)	10.0	30.0	30.0	10.0	30.0		10.0	30.0		10.0	30.0	
Total Split (s)	20.0	39.0	39.0	11.0	30.0	0.0	10.0	30.0	0.0	10.0	30.0	0.0
Total Split (%)	22.2%	43.3%	43.3%	12.2%	33.3%	0.0%	11.1%	33.3%	0.0%	11.1%	33.3%	0.0%
Maximum Green (s)	15.0	34.0	34.0	6.0	25.0		5.0	25.0		5.0	25.0	
Yellow Time (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None	None	None	None		None	Min		None	Min	
Walk Time (s)		15.0	15.0		15.0			15.0			15.0	
Flash Dont Walk (s)		10.0	10.0		10.0			10.0			10.0	
Pedestrian Calls (#/hr)		0	0		0			0			0	
Act Effct Green (s)	44.1	33.0	33.0	31.4	24.3		28.2	22.1		29.1	24.5	
Actuated g/C Ratio	0.52	0.39	0.39	0.37	0.29		0.33	0.26		0.34	0.29	
v/c Ratio	0.81	0.80	0.21	0.70	0.33		0.66	0.54		0.66	0.81	
Control Delay	27.3	28.8	4.1	35.5	15.7		37.0	21.5		32.4	27.7	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	27.3	28.8	4.1	35.5	15.7		37.0	21.5		32.4	27.7	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	C	A	D	B		D	C		C	C	
Approach Delay		26.2			21.9			24.4			28.5	
Approach LOS		C			C			C			C	
Queue Length 50th (m)	53.4	86.1	0.0	13.5	13.7		13.4	29.3		20.9	59.1	
Queue Length 95th (m)	#96.2	111.3	10.9	#38.8	24.5		#28.4	44.2		#38.4	82.5	
Internal Link Dist (m)		509.1			674.8			297.3			374.8	
Turn Bay Length (m)	130.0		115.0	155.0			125.0			75.0		
Base Capacity (vph)	600	1414	740	218	1043		186	1110		280	1184	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.81	0.77	0.20	0.70	0.32		0.66	0.48		0.66	0.78	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 84.4
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.81
Intersection Signal Delay: 26.0 Intersection LOS: C
Intersection Capacity Utilization 89.6% ICU Level of Service E
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Dundas St W & 6 Line



	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	0.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.970			0.970			0.956			0.970	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3471	0	1706	3485	0	1825	3431	0	1789	3328	0
Flt Permitted	0.353			0.356			0.481			0.353		
Satd. Flow (perm)	658	3471	0	639	3485	0	924	3431	0	665	3328	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		55			56			78			38	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			80			80	
Link Distance (m)		584.6			658.3			612.3			725.4	
Travel Time (s)		26.3			29.6			27.6			32.6	
Volume (vph)	216	518	129	218	522	131	94	375	156	121	290	73
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	220	529	132	222	533	134	96	383	159	123	296	74
Lane Group Flow (vph)	220	661	0	222	667	0	96	542	0	123	370	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	20.0	20.0		20.0	20.0		10.0	10.0		10.0	10.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	54.0	54.0	0.0	54.0	54.0	0.0	36.0	36.0	0.0	36.0	36.0	0.0
Total Split (%)	60.0%	60.0%	0.0%	60.0%	60.0%	0.0%	40.0%	40.0%	0.0%	40.0%	40.0%	0.0%
Maximum Green (s)	49.0	49.0		49.0	49.0		31.0	31.0		31.0	31.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	None		None	None	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	29.8	29.8		29.8	29.8		17.6	17.6		17.6	17.6	
Actuated g/C Ratio	0.53	0.53		0.53	0.53		0.31	0.31		0.31	0.31	
v/c Ratio	0.63	0.35		0.66	0.36		0.33	0.48		0.59	0.35	
Control Delay	20.6	8.0		22.2	8.0		20.6	15.5		31.8	15.1	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	20.6	8.0		22.2	8.0		20.6	15.5		31.8	15.1	

9: North Oakville Corridor & 6 Line

PM Peak - Future Conditions (2021)

Signalized Intersection

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	A		C	A		C	B		C	B	
Approach Delay		11.2			11.5			16.3			19.3	
Approach LOS		B			B			B			B	
Queue Length 50th (m)	11.3	13.2		11.7	13.4		5.5	14.4		7.7	9.8	
Queue Length 95th (m)	49.6	38.3		51.9	38.6		24.2	45.0		34.7	32.1	
Internal Link Dist (m)		560.6			634.3			588.3			701.4	
Turn Bay Length (m)							75.0					
Base Capacity (vph)	437	2322		424	2332		433	1647		311	1578	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.50	0.28		0.52	0.29		0.22	0.33		0.40	0.23	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 56.2

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.66

Intersection Signal Delay: 13.8 Intersection LOS: B

Intersection Capacity Utilization 72.3% ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 9: North Oakville Corridor & 6 Line

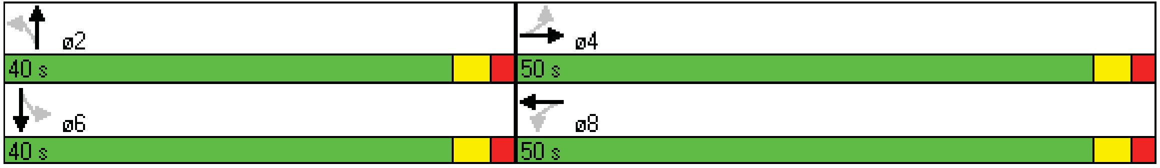
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	75.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.940			0.964			0.960			0.981	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1770	0	1706	1824	0	1825	3444	0	1789	3370	0
Flt Permitted	0.359			0.606			0.390			0.439		
Satd. Flow (perm)	670	1770	0	1088	1824	0	749	3444	0	827	3370	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		54			26			68			22	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			80	
Link Distance (m)		567.6			690.8			451.7			612.3	
Travel Time (s)		34.1			41.4			20.3			27.6	
Volume (vph)	80	122	80	244	361	113	63	319	116	54	440	66
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	82	124	82	249	368	115	64	326	118	55	449	67
Lane Group Flow (vph)	82	206	0	249	483	0	64	444	0	55	516	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	50.0	50.0	0.0	50.0	50.0	0.0	40.0	40.0	0.0	40.0	40.0	0.0
Total Split (%)	55.6%	55.6%	0.0%	55.6%	55.6%	0.0%	44.4%	44.4%	0.0%	44.4%	44.4%	0.0%
Maximum Green (s)	45.0	45.0		45.0	45.0		35.0	35.0		35.0	35.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Min	Min		Min	Min	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	19.5	19.5		19.5	19.5		21.4	21.4		21.4	21.4	
Actuated g/C Ratio	0.40	0.40		0.40	0.40		0.44	0.44		0.44	0.44	
v/c Ratio	0.31	0.28		0.58	0.65		0.20	0.29		0.15	0.35	
Control Delay	12.7	7.8		16.8	15.4		13.3	9.5		12.6	11.1	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	12.7	7.8		16.8	15.4		13.3	9.5		12.6	11.1	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	B	A		B	B		B	A		B	B	
Approach Delay		9.2			15.8			10.0			11.3	
Approach LOS		A			B			B			B	
Queue Length 50th (m)	4.6	8.1		15.7	29.8		3.2	10.1		2.7	13.8	
Queue Length 95th (m)	11.7	17.4		31.5	51.3		12.8	24.7		11.0	31.9	
Internal Link Dist (m)		543.6			666.8			427.7			588.3	
Turn Bay Length (m)	75.0			75.0			75.0			75.0		
Base Capacity (vph)	411	1106		667	1129		426	1988		470	1926	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.20	0.19		0.37	0.43		0.15	0.22		0.12	0.27	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 49
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.65
Intersection Signal Delay: 12.3 Intersection LOS: B
Intersection Capacity Utilization 80.9% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 3: Burnhamthorpe Rd W & 6 Line



	↰	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	47	8	75	42	9	19	129	538	72	32	631	82
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	48	8	77	43	9	19	132	549	73	33	644	84
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	1313	1637	364	1317	1642	311	728			622		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1313	1637	364	1317	1642	311	728			622		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	46	90	88	47	89	97	85			97		
cM capacity (veh/h)	89	82	633	81	81	685	872			954		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	48	85	43	29	132	366	256	33	429	298
Volume Left	48	0	43	0	132	0	0	33	0	0
Volume Right	0	77	0	19	0	0	73	0	0	84
cSH	89	384	81	202	872	1700	1700	954	1700	1700
Volume to Capacity	0.54	0.22	0.53	0.14	0.15	0.22	0.15	0.03	0.25	0.18
Queue Length 95th (m)	18.2	6.3	17.4	3.7	4.0	0.0	0.0	0.8	0.0	0.0
Control Delay (s)	85.0	17.0	91.4	25.7	9.9	0.0	0.0	8.9	0.0	0.0
Lane LOS	F	C	F	D	A			A		
Approach Delay (s)	41.6		65.1		1.7			0.4		
Approach LOS	E		F							

Intersection Summary			
Average Delay	6.8		
Intersection Capacity Utilization	46.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	1	4	12	42	3	19	20	719	72	33	715	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	1	4	12	43	3	19	20	734	73	34	730	1
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	1226	1645	365	1258	1609	404	731			807		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1226	1645	365	1258	1609	404	731			807		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	96	98	63	97	97	98			96		
cM capacity (veh/h)	121	92	632	115	97	596	869			814		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	1	16	43	22	20	489	318	34	486	244
Volume Left	1	0	43	0	20	0	0	34	0	0
Volume Right	0	12	0	19	0	0	73	0	0	1
cSH	121	256	115	351	869	1700	1700	814	1700	1700
Volume to Capacity	0.01	0.06	0.37	0.06	0.02	0.29	0.19	0.04	0.29	0.14
Queue Length 95th (m)	0.2	1.5	11.6	1.6	0.5	0.0	0.0	1.0	0.0	0.0
Control Delay (s)	35.0	20.0	53.8	16.0	9.2	0.0	0.0	9.6	0.0	0.0
Lane LOS	E	C	F	C	A			A		
Approach Delay (s)	20.9		40.8		0.2			0.4		
Approach LOS	C		E							

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	43.1%	ICU Level of Service	A
Analysis Period (min)	15		

15: Sixteen Mile Drive & 6 Line
Unsignalized Intersection

PM Peak - Future Conditions (2021)

	⤴	→	⤵	⤶	←	↖	↰	↑	↱	↳	↓	↲
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	38	9	85	50	10	23	115	995	120	7	863	52
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	39	9	87	51	10	23	117	1015	122	7	881	53
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)								399				
pX, platoon unblocked	0.94	0.94		0.94	0.94	0.94				0.94		
vC, conflicting volume	1692	2294	467	1857	2259	569	934			1138		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1674	2311	467	1849	2274	484	934			1087		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	69	84	0	67	95	84			99		
cM capacity (veh/h)	37	29	543	24	31	499	729			602		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	39	96	51	34	117	677	461	7	587	347
Volume Left	39	0	51	0	117	0	0	7	0	0
Volume Right	0	87	0	23	0	0	122	0	0	53
cSH	37	203	24	90	729	1700	1700	602	1700	1700
Volume to Capacity	1.06	0.47	2.10	0.38	0.16	0.40	0.27	0.01	0.35	0.20
Queue Length 95th (m)	30.0	17.4	48.3	11.3	4.3	0.0	0.0	0.3	0.0	0.0
Control Delay (s)	333.2	37.7	852.0	67.6	10.9	0.0	0.0	11.1	0.0	0.0
Lane LOS	F	E	F	F	B			B		
Approach Delay (s)	122.7		540.1		1.0			0.1		
Approach LOS	F		F							

Intersection Summary			
Average Delay	26.3		
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		

18: North Park Drive & 6 Line
Unsignalized Intersection

PM Peak - Future Conditions (2021)

	⤴	→	⤵	⤶	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	36	9	84	50	10	23	114	782	120	7	710	52
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	37	9	86	51	10	23	116	798	122	7	724	53
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	1426	1918	389	1559	1884	460	778			920		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1426	1918	389	1559	1884	460	778			920		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	48	84	86	0	83	96	86			99		
cM capacity (veh/h)	71	57	610	51	60	548	835			737		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	37	95	51	34	116	532	388	7	483	295
Volume Left	37	0	51	0	116	0	0	7	0	0
Volume Right	0	86	0	23	0	0	122	0	0	53
cSH	71	314	51	158	835	1700	1700	737	1700	1700
Volume to Capacity	0.52	0.30	1.00	0.21	0.14	0.31	0.23	0.01	0.28	0.17
Queue Length 95th (m)	16.3	9.4	33.3	5.9	3.7	0.0	0.0	0.2	0.0	0.0
Control Delay (s)	101.1	21.4	254.0	34.0	10.0	0.0	0.0	9.9	0.0	0.0
Lane LOS	F	C	F	D	B			A		
Approach Delay (s)	43.6		166.5		1.1			0.1		
Approach LOS	E		F							

Intersection Summary			
Average Delay	10.3		
Intersection Capacity Utilization	48.2%	ICU Level of Service	A
Analysis Period (min)	15		

6: Dundas St W & 6 Line
Signalized Intersection

PM Peak - Future Conditions (2021)

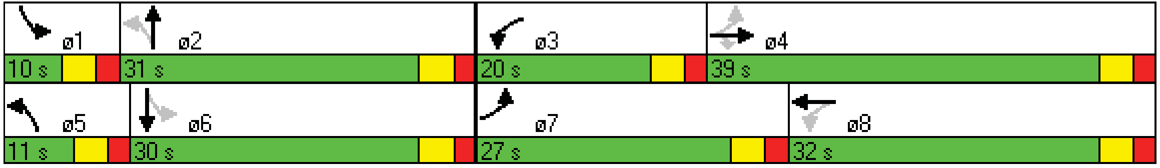
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	130.0		115.0	155.0		0.0	125.0		0.0	75.0		0.0
Storage Lanes	1		1	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5	6.1	6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Frt			0.850		0.953			0.958			0.928	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3476	1601	1674	3157	0	1674	3472	0	1722	3353	0
Flt Permitted	0.125			0.501			0.148			0.234		
Satd. Flow (perm)	233	3476	1601	883	3157	0	261	3472	0	424	3353	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			124		74			55			227	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			60			60	
Link Distance (m)		533.1			698.8			321.3			398.8	
Travel Time (s)		24.0			31.4			19.3			23.9	
Volume (vph)	468	422	122	271	613	280	151	442	171	135	446	416
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	5%	2%	9%	13%	4%	9%	1%	0%	6%	2%	0%
Adj. Flow (vph)	478	431	124	277	626	286	154	451	174	138	455	424
Lane Group Flow (vph)	478	431	124	277	912	0	154	625	0	138	879	0
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8			2			6		
Detector Phases	7	4	4	3	8		5	2		1	6	
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0		5.0	10.0		5.0	10.0	
Minimum Split (s)	10.0	30.0	30.0	10.0	32.0		10.0	30.0		10.0	30.0	
Total Split (s)	27.0	39.0	39.0	20.0	32.0	0.0	11.0	31.0	0.0	10.0	30.0	0.0
Total Split (%)	27.0%	39.0%	39.0%	20.0%	32.0%	0.0%	11.0%	31.0%	0.0%	10.0%	30.0%	0.0%
Maximum Green (s)	22.0	34.0	34.0	15.0	27.0		6.0	26.0		5.0	25.0	
Yellow Time (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None	None	None	None		None	Min		None	Min	
Walk Time (s)		15.0	15.0		15.0			15.0			15.0	
Flash Dont Walk (s)		10.0	10.0		10.0			10.0			10.0	
Pedestrian Calls (#/hr)		0	0		0			0			0	
Act Effct Green (s)	55.0	36.9	36.9	42.2	28.0		32.8	25.8		30.8	24.8	
Actuated g/C Ratio	0.56	0.37	0.37	0.43	0.28		0.33	0.26		0.31	0.25	
v/c Ratio	0.98	0.33	0.18	0.57	0.96		0.82	0.66		0.65	0.87	
Control Delay	64.0	23.8	4.9	18.0	54.6		58.2	33.4		39.2	36.6	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	64.0	23.8	4.9	18.0	54.6		58.2	33.4		39.2	36.6	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	E	C	A	B	D		E	C		D	D	
Approach Delay		40.2			46.0			38.3			37.0	
Approach LOS		D			D			D			D	
Queue Length 50th (m)	76.6	32.0	0.0	27.3	85.7		20.4	51.3		18.0	64.7	
Queue Length 95th (m)	#141.2	44.8	11.5	42.9	#127.1		#47.4	69.7		#35.2	#91.6	
Internal Link Dist (m)		509.1			674.8			297.3			374.8	
Turn Bay Length (m)	130.0		115.0	155.0			125.0			75.0		
Base Capacity (vph)	488	1298	676	512	948		187	978		211	1040	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.98	0.33	0.18	0.54	0.96		0.82	0.64		0.65	0.85	

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 98.8
Natural Cycle: 95
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.98
Intersection Signal Delay: 40.7 Intersection LOS: D
Intersection Capacity Utilization 99.2% ICU Level of Service F
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Dundas St W & 6 Line



Appendix B.5 – Traffic Signals Justification - Future (2031)

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	March 4, 2013	
Analysis Period	2031	**East-West Street**	New North Oakville Corridor	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban) ▼	**Major Street**	North-South ▼	
'T' Intersection	No ▼	**Approach lanes per direction**	2 ▼	Major Street
Existing Intersection	No ▼	**Approach lanes per direction**	2 ▼	Minor Street
Additional Comments				

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	Main Road Approaches							Minor Road Approaches							Pedestrian Crossing Major Road	Pedestrian Crossing Minor Road
	Northbound			Southbound			Total	Eastbound			Westbound			Total		
	LT	TH	RT	LT	TH	RT		LT	TH	RT	LT	TH	RT			
AM Peak Hour	157	627	261	167	400	100	**1712**	427	1464	216	157	377	94	**2735**	0	0
PM Peak Hour	126	506	211	158	379	95	**1475**	316	758	190	387	928	232	**2811**	0	0
Total	**283**	**1133**	**472**	**325**	**779**	**195**	**3187**	**743**	**2222**	**406**	**544**	**1305**	**326**	**5546**	**0**	**0**

Parameter	AM	PM	Average Hourly Volume (AHV)
Vehicle volume, all approaches	4447	4286	2183
Vehicle volume, along minor street	2735	2811	1387
Vehicle volume, along major street	1712	1475	797
Combined vehicle and pedestrian volume crossing from minor streets	2048	1631	920

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	PM
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	584	703
b. The heaviest through volume from the minor street	1464	928
c. 50% of the heavier left turn movement from the major street when both of the following are met:	84	0
1. the left turn volume > 120	Yes	Yes
2. the left turn volume + opposing volume > 720	Yes	No
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	March 4, 2013	
Analysis Period	2031	**East-West Street**	New North Oakville Corridor	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	2	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					4447	**4286**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**100%**	**100%**	**100%**	**100%**
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
B. Vehicle volume, along minor streets					**2735**	**2811**	**100%**	**100%**		
				170	340	340				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									

		AM Peak Hour	**PM Peak Hour**
Justification 1:	Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :	**Yes**	**Yes**
	Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :	**Yes**	**Yes**

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1712	**1475**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**63%**	**55%**	**63%**	**55%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				63%	55%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**2048**	**1631**	**100%**	**100%**		
				170	340	340				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									

		AM Peak Hour	**PM Peak Hour**
Justification 2:	Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :	**No**	**No**
	Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :	**No**	**No**

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**Yes**	**Yes**	**Yes**	**Yes**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are <u>**not met.**</u>
Therefore traffic control signal is not justified at this intersection for the horizon year 2031

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	Burnhamthorpe Road	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	Yes	**Approach lanes per direction**	1	Minor Street
Additional Comments				

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	Main Road Approaches							Minor Road Approaches							Pedestrian Crossing Major Road	Pedestrian Crossing Minor Road
	Northbound			Southbound			Total	Eastbound			Westbound			Total		
	LT	TH	RT	LT	TH	RT		LT	TH	RT	LT	TH	RT			
AM Peak Hour	36	523	411	235	443	56	**1704**	159	293	83	142	157	69	**903**	0	0
PM Peak Hour	72	377	175	85	617	80	**1406**	98	151	89	323	440	148	**1249**	0	0
Total	**108**	**900**	**586**	**320**	**1060**	**136**	**3110**	**257**	**444**	**172**	**465**	**597**	**217**	**2152**	**0**	**0**

Parameter	AM	PM	Average Hourly Volume (AHV)
Vehicle volume, all approaches	2607	2655	1316
Vehicle volume, along minor street	903	1249	538
Vehicle volume, along major street	1704	1406	778
Combined vehicle and pedestrian volume crossing from minor streets	594	861	364

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	PM
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	301	421
b. The heaviest through volume from the minor street	293	440
c. 50% of the heavier left turn movement from the major street when both of the following are met:	118	0
1. the left turn volume > 120	Yes	No
2. the left turn volume + opposing volume > 720	Yes	No
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	Burnhamthorpe Road	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	Yes	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2609	**2655**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**100%**	**100%**	**100%**	**100%**
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
B. Vehicle volume, along minor streets					**903**	**1249**	**100%**	**100%**		
				170	170	170				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		**Yes**		**Yes**	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		**Yes**		**Yes**	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1706	**1406**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**79%**	**65%**	**79%**	**65%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				79%	65%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**594**	**861**	**100%**	**100%**		
				170	170	170				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**Yes**	**Yes**	**Yes**	**Yes**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are <u>not met.</u>
Therefore traffic control signal is not justified at this intersection for the horizon year 2031

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	Future Street D	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	**Main Road Approaches**							**Minor Road Approaches**							**Pedestrian Crossing Major Road**	**Pedestrian Crossing Minor Road**
	Northbound			**Southbound**			**Total**	**Eastbound**			**Westbound**			**Total**		
	LT	**TH**	**RT**	**LT**	**TH**	**RT**		**LT**	**TH**	**RT**	**LT**	**TH**	**RT**			
AM Peak Hour	83	1093	40	19	594	38	**1867**	113	16	252	126	11	58	**576**	0	0
PM Peak Hour	257	703	143	64	782	163	**2112**	94	15	150	83	18	38	**398**	0	0
Total	**340**	**1796**	**183**	**83**	**1376**	**201**	**3979**	**207**	**31**	**402**	**209**	**29**	**96**	**974**	**0**	**0**

Parameter	**AM**	**PM**	**Average Hourly Volume (AHV)**
Vehicle volume, all approaches	2443	2510	1238
Vehicle volume, along minor street	576	398	244
Vehicle volume, along major street	1867	2112	995
Combined vehicle and pedestrian volume crossing from minor streets	255	195	113

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	**PM**
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	239	177
b. The heaviest through volume from the minor street	16	18
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	129
1. the left turn volume > 120	No	Yes
2. the left turn volume + opposing volume > 720	No	Yes
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	Future Street D	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2443	**2510**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**80%**	**80%**	**80%**	**80%**
	100% Compliance									
	80% Compliance				80%	80%				
	Actual % if below 80%									
B. Vehicle volume, along minor streets					**576**	**398**	**100%**	**100%**		
				170	170	170				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									

		AM Peak Hour	**PM Peak Hour**
Justification 1:	Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :	**No**	**No**
	Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :	**Yes**	**Yes**

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					1867	**2112**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**69%**	**78%**	**69%**	**76%**
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				69%	78%				
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**255**	**195**	**80%**	**76%**		
				170	170	170				
	100% Compliance									
	80% Compliance				80%					
	Actual % if below 80%					76%				

		AM Peak Hour	**PM Peak Hour**
Justification 2:	Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :	**No**	**No**
	Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :	**No**	**No**

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**No**	**No**	**Yes**	**Yes**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are not met.
Therefore traffic control signal is not justified at this intersection for the horizon year 2031

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	Future Street C	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	**Main Road Approaches**							**Minor Road Approaches**							**Pedestrian Crossing Major Road**	**Pedestrian Crossing Minor Road**
	Northbound			**Southbound**			**Total**	**Eastbound**			**Westbound**			**Total**		
	LT	**TH**	**RT**	**LT**	**TH**	**RT**		**LT**	**TH**	**RT**	**LT**	**TH**	**RT**			
AM Peak Hour	10	1158	40	19	967	0	**2194**	0	3	20	126	6	58	**213**	0	0
PM Peak Hour	20	1066	143	65	950	0	**2244**	0	7	12	83	5	37	**144**	0	0
Total	**30**	**2224**	**183**	**84**	**1917**	**0**	**4438**	**0**	**10**	**32**	**209**	**11**	**95**	**357**	**0**	**0**

Parameter	**AM**	**PM**	**Average Hourly Volume (AHV)**
Vehicle volume, all approaches	2407	2388	1199
Vehicle volume, along minor street	213	144	89
Vehicle volume, along major street	2194	2244	1110
Combined vehicle and pedestrian volume crossing from minor streets	132	90	56

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	**PM**
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	126	83
b. The heaviest through volume from the minor street	6	7
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	0
1. the left turn volume > 120	No	No
2. the left turn volume + opposing volume > 720	Yes	Yes
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	Future Street C	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2407	**2388**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**80%**	**80%**	**80%**	**56%**
	100% Compliance									
	80% Compliance				80%	80%				
	Actual % if below 80%									
B. Vehicle volume, along minor streets					**213**	**144**	**80%**	**56%**		
				170	170	170				
	100% Compliance									
	80% Compliance				80%					
	Actual % if below 80%					56%				
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		**Yes**		**No**	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2194	**2244**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**80%**	**80%**	**52%**	**35%**
	100% Compliance									
	80% Compliance				80%	80%				
	Actual % if below 80%									
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**132**	**90**	**52%**	**35%**		
				170	170	170				
	100% Compliance									
	80% Compliance									
	Actual % if below 80%				52%	35%				
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		**No**		**No**	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		**No**		**No**	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**No**	**No**	**Yes**	**No**	**No**
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**No**	**No**	

CONCLUSION

The results of the calculations show that justifications are **not met.**
Therefore traffic control signal is not justified at this intersection for the horizon year 2031

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	North Park Drive	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban) ▼	**Major Street**	North-South ▼	
'T' Intersection	No ▼	**Approach lanes per direction**	2 ▼	Major Street
Existing Intersection	No ▼	**Approach lanes per direction**	1 ▼	Minor Street
Additional Comments				

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	**Main Road Approaches**							**Minor Road Approaches**							**Pedestrian Crossing Major Road**	**Pedestrian Crossing Minor Road**
	Northbound			**Southbound**			**Total**	**Eastbound**			**Westbound**			**Total**		
	LT	**TH**	**RT**	**LT**	**TH**	**RT**		**LT**	**TH**	**RT**	**LT**	**TH**	**RT**			
AM Peak Hour	45	1129	49	42	1058	21	**2344**	42	9	120	155	11	70	**407**	0	0
PM Peak Hour	114	1184	239	13	980	52	**2582**	36	13	84	99	13	45	**290**	0	0
Total	**159**	**2313**	**288**	**55**	**2038**	**73**	**4926**	**78**	**22**	**204**	**254**	**24**	**115**	**697**	**0**	**0**

Parameter	**AM**	**PM**	**Average Hourly Volume (AHV)**
Vehicle volume, all approaches	2751	2872	1406
Vehicle volume, along minor street	407	290	174
Vehicle volume, along major street	2344	2582	1232
Combined vehicle and pedestrian volume crossing from minor streets	208	148	89

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	**PM**
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	197	135
b. The heaviest through volume from the minor street	11	13
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	0
1. the left turn volume > 120	No	No
2. the left turn volume + opposing volume > 720	Yes	Yes
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	North Park Drive	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2751	**2872**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**100%**	**100%**	**100%**	**100%**
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
B. Vehicle volume, along minor streets					**407**	**290**	**100%**	**100%**		
				170	170	170				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		Yes		Yes	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		Yes		Yes	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2344	**2582**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**80%**	**80%**	**80%**	**58%**
	100% Compliance									
	80% Compliance				80%	80%				
	Actual % if below 80%									
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**208**	**148**	**80%**	**58%**		
				170	170	170				
	100% Compliance									
	80% Compliance				80%					
	Actual % if below 80%					58%				
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		No		No	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		Yes		No	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**Yes**	**Yes**	**Yes**	**Yes**	Yes
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**Yes**	**No**	

CONCLUSION

The results of the calculations show that justifications are met.
Therefore traffic control signal is justified at this intersection for the horizon year 2031

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	Sixteen Mile Drive	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban) ▼	**Major Street**	North-South ▼	
'T' Intersection	No ▼	**Approach lanes per direction**	2 ▼	Major Street
Existing Intersection	No ▼	**Approach lanes per direction**	1 ▼	Minor Street
Additional Comments				

TRAFFIC & PEDESTRIAN VOLUMES

Hour Ending	Main Road Approaches							Minor Road Approaches							Pedestrian Crossing Major Road	Pedestrian Crossing Minor Road
	Northbound			Southbound			Total	Eastbound			Westbound			Total		
	LT	TH	RT	LT	TH	RT		LT	TH	RT	LT	TH	RT			
AM Peak Hour	45	1112	49	42	1301	20	**2569**	41	9	120	155	11	70	**406**	0	0
PM Peak Hour	115	1454	239	13	1193	52	**3066**	38	13	85	99	13	45	**293**	0	0
Total	**160**	**2566**	**288**	**55**	**2494**	**72**	**5635**	**79**	**22**	**205**	**254**	**24**	**115**	**699**	**0**	**0**

Parameter	AM	PM	Average Hourly Volume (AHV)
Vehicle volume, all approaches	2975	3359	1584
Vehicle volume, along minor street	406	293	175
Vehicle volume, along major street	2569	3066	1409
Combined vehicle and pedestrian volume crossing from minor streets	207	150	89

NOTES

1. The traffic control signal justification was done as per criteria defined in Ontario Traffic Manual, Book: 12 (November 2007) Justification 7 - Projected Volumes.

	AM	PM
2. Traffic crossing MAJOR street defined as:		
a. Left turns from both minor street approaches	196	137
b. The heaviest through volume from the minor street	11	13
c. 50% of the heavier left turn movement from the major street when both of the following are met:	0	0
1. the left turn volume > 120	No	No
2. the left turn volume + opposing volume > 720	Yes	Yes
d. Pedestrians crossing the major street	0	0

3. Justifications 1 and 2 are required to be met to 120% in the case of an existing intersection and 150% in the case of a new intersection

4. For 'T' intersection, the threshold values for warrant 1B needs to be increased by 50%

TRAFFIC SIGNAL WARRANTS

GENERAL INFORMATION **FUTURE WEEKDAY PEAK HOUR**

Analyst	Sara Fadaee	**Jurisdiction**	Town of Oakville	
Agency or Company	Morrison Hershfield Ltd.	**Date**	July 30, 2012	
Analysis Period	2031	**East-West Street**	Sixteen Mile Drive	
		North-South Street	Sixth Line	
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South	
'T' Intersection	No	**Approach lanes per direction**	2	Major Street
Existing Intersection	No	**Approach lanes per direction**	1	Minor Street
Additional Comments				

Justification 1: Minimum Vehicle Volumes

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2975	**3359**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, all approaches				900	1800	1800	**100%**	**100%**	**100%**	**100%**
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
B. Vehicle volume, along minor streets					**406**	**293**	**100%**	**100%**		
				170	170	170				
	100% Compliance				100%	100%				
	80% Compliance									
	Actual % if below 80%									
							AM Peak Hour		**PM Peak Hour**	
Justification 1:					Both 1A and 1B 100% fulfilled in each peak hour (Yes / No) :		Yes		Yes	
					Lesser of 1A and 1B at least 80% fulfilled in each peak hour (Yes / No) :		Yes		Yes	

Justification 2: Delay To Cross Traffic

Justification	**Guidance Approach Lanes**				**Percentage Warrant**		**Section Percent**		**Entire[1]**	
	1 Lanes		**2 or More Lanes**							
Flow Conditions	**Free Flow**	**Restrict. Flow**	**Free Flow**	**Restrict. Flow**	**AM Peak Hour**	**PM Peak Hour**				
					2569	**3066**	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
A. Vehicle volume, major street				900	1800	1800	**80%**	**100%**	**80%**	**59%**
	100% Compliance					100%				
	80% Compliance				80%					
	Actual % if below 80%									
B. Combined vehicle and pedestrian volume crossing artery from minor streets					**207**	**150**	**80%**	**59%**		
				170	170	170				
	100% Compliance									
	80% Compliance				80%					
	Actual % if below 80%					59%				
							AM Peak Hour		**PM Peak Hour**	
Justification 2:					Both 2A and 2B 100% fulfilled in each peak hour (Yes / No) :		No		No	
					Lesser of 2A and 2B at least 80% fulfilled in each peak hour (Yes / No) :		Yes		No	

Justification 3: Combination
Combination of Justification 1 and 2

		100% fullfilled		**80% fullfilled**		**Two Justifications Satisfied 80% or More (Yes / No)**
		AM Peak Hour	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**	
Justification 1	Minimum Vehicle Volume (Yes / No) :	**Yes**	**Yes**	**Yes**	**Yes**	Yes
Justification 2	Delay Cross Traffic (Yes / No) :	**No**	**No**	**Yes**	**No**	

CONCLUSION

The results of the calculations show that justifications are met.
Therefore traffic control signal is justified at this intersection for the horizon year 2031

Note: [1] - The lowest Sectional percentage governs the Entire Warrant.

Appendix B.6 – Future (2031) AM and PM Peak Hours - HCM Report

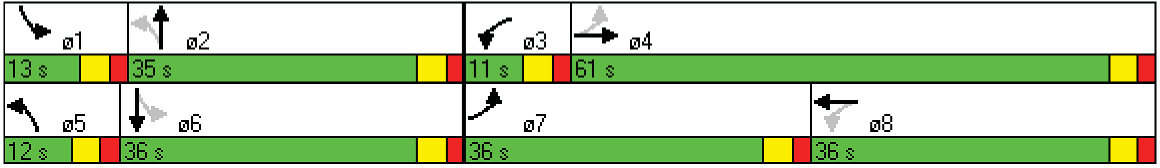
	⤴	→	⤵	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	0.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.981			0.970			0.956			0.970	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3511	0	1706	3485	0	1825	3431	0	1789	3328	0
Flt Permitted	0.286			0.125			0.308			0.125		
Satd. Flow (perm)	533	3511	0	224	3485	0	592	3431	0	235	3328	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		18			25			51			25	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			80			80	
Link Distance (m)		584.6			658.3			612.3			725.4	
Travel Time (s)		26.3			29.6			27.6			32.6	
Volume (vph)	427	1464	216	157	377	94	157	627	261	167	400	100
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	436	1494	220	160	385	96	160	640	266	170	408	102
Lane Group Flow (vph)	436	1714	0	160	481	0	160	906	0	170	510	0
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Detector Phases	7	4		3	8		5	2		1	6	
Minimum Initial (s)	5.0	20.0		5.0	20.0		5.0	10.0		5.0	10.0	
Minimum Split (s)	10.0	52.0		10.0	31.5		10.0	33.0		10.0	33.0	
Total Split (s)	36.0	61.0	0.0	11.0	36.0	0.0	12.0	35.0	0.0	13.0	36.0	0.0
Total Split (%)	30.0%	50.8%	0.0%	9.2%	30.0%	0.0%	10.0%	29.2%	0.0%	10.8%	30.0%	0.0%
Maximum Green (s)	31.0	56.0		6.0	31.0		7.0	30.0		8.0	31.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	None		None	None	
Walk Time (s)		15.0			15.0			15.0			15.0	
Flash Dont Walk (s)		10.0			10.0			10.0			10.0	
Pedestrian Calls (#/hr)		0			0			0			0	
Act Effct Green (s)	68.0	57.0		47.2	40.2		39.0	31.0		41.0	32.0	
Actuated g/C Ratio	0.57	0.48		0.39	0.34		0.32	0.26		0.34	0.27	
v/c Ratio	0.80	1.02		0.92	0.41		0.58	0.98		0.86	0.56	
Control Delay	27.3	59.0		77.0	31.4		36.9	67.2		66.2	38.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	27.3	59.0		77.0	31.4		36.9	67.2		66.2	38.8	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	E		E	C		D	E		E	D	
Approach Delay		52.6			42.8			62.7			45.7	
Approach LOS		D			D			E			D	
Queue Length 50th (m)	56.2	~224.6		18.5	43.0		25.9	106.7		27.8	52.0	
Queue Length 95th (m)	83.2	#267.6		#67.6	64.5		42.2	#149.4		#62.8	69.5	
Internal Link Dist (m)		560.6			634.3			588.3			701.4	
Turn Bay Length (m)							75.0					
Base Capacity (vph)	593	1677		174	1183		275	924		197	906	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.74	1.02		0.92	0.41		0.58	0.98		0.86	0.56	

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 120
Natural Cycle: 115
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.02
Intersection Signal Delay: 52.6 Intersection LOS: D
Intersection Capacity Utilization 104.3% ICU Level of Service G
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 9: North Oakville Corridor & 6 Line



3: Burnhamthorpe Rd W & 6 Line
Signalized Intersection

AM Peak - Future Conditions (2031)

	↱	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	75.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.967			0.954			0.934			0.983	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1821	0	1706	1808	0	1825	3357	0	1789	3378	0
Flt Permitted	0.539			0.358			0.465			0.121		
Satd. Flow (perm)	1005	1821	0	643	1808	0	893	3357	0	228	3378	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		18			28			233			23	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			80	
Link Distance (m)		567.6			690.8			451.7			612.3	
Travel Time (s)		34.1			41.4			20.3			27.6	
Volume (vph)	159	293	83	142	157	69	36	523	411	235	443	56
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	162	299	85	145	160	70	37	534	419	240	452	57
Lane Group Flow (vph)	162	384	0	145	230	0	37	953	0	240	509	0
Turn Type	Perm			Perm			Perm			pm+pt		
Protected Phases		4			8			2		1	6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		1	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		5.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		10.0	30.0	
Total Split (s)	38.0	38.0	0.0	38.0	38.0	0.0	33.0	33.0	0.0	19.0	52.0	0.0
Total Split (%)	42.2%	42.2%	0.0%	42.2%	42.2%	0.0%	36.7%	36.7%	0.0%	21.1%	57.8%	0.0%
Maximum Green (s)	33.0	33.0		33.0	33.0		28.0	28.0		14.0	47.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag							Lag	Lag		Lead		
Lead-Lag Optimize?							Yes	Yes		Yes		
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Min	Min		None	Min	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0			15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0			10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0			0	
Act Effct Green (s)	21.5	21.5		21.5	21.5		25.2	25.2		40.8	40.8	
Actuated g/C Ratio	0.30	0.30		0.30	0.30		0.36	0.36		0.58	0.58	
v/c Ratio	0.53	0.68		0.74	0.40		0.12	0.71		0.63	0.26	
Control Delay	27.8	27.2		46.3	19.4		20.7	19.5		21.3	8.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	27.8	27.2		46.3	19.4		20.7	19.5		21.3	8.6	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	C		D	B		C	B		C	A	
Approach Delay		27.4			29.8			19.6			12.7	
Approach LOS		C			C			B			B	
Queue Length 50th (m)	16.8	40.2		16.3	19.8		3.2	41.1		14.5	14.7	
Queue Length 95th (m)	38.0	75.8		#41.3	41.6		11.6	82.5		46.0	32.1	
Internal Link Dist (m)		543.6			666.8			427.7			588.3	
Turn Bay Length (m)	75.0			75.0			75.0			75.0		
Base Capacity (vph)	418	768		267	768		355	1474		448	2103	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.39	0.50		0.54	0.30		0.10	0.65		0.54	0.24	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 70.7

Natural Cycle: 70

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.74

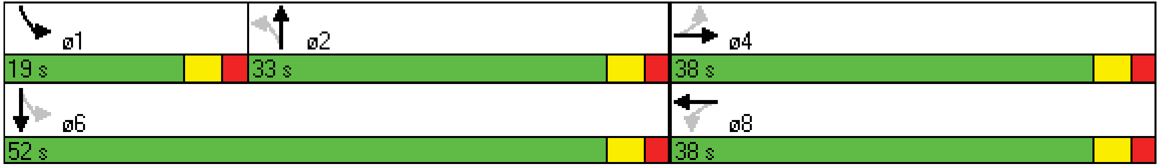
Intersection Signal Delay: 20.7 Intersection LOS: C

Intersection Capacity Utilization 82.8% ICU Level of Service E

Analysis Period (min) 15

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Burnhamthorpe Rd W & 6 Line



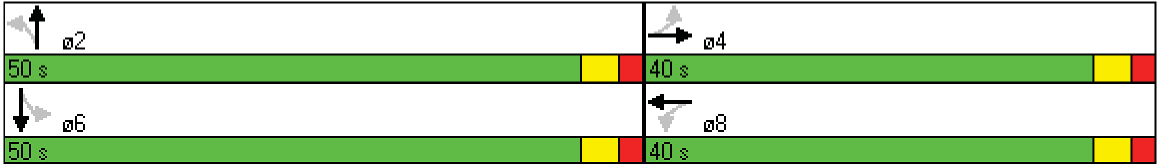
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.859			0.874			0.995			0.991	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1618	0	1789	1646	0	1789	3561	0	1789	3420	0
Flt Permitted	0.711			0.499			0.352			0.147		
Satd. Flow (perm)	1339	1618	0	940	1646	0	663	3561	0	277	3420	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		232			59			6			11	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			60	
Link Distance (m)		575.3			674.3			490.2			451.7	
Travel Time (s)		34.5			40.5			22.1			27.1	
Volume (vph)	113	16	252	126	11	58	83	1093	40	19	594	38
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	115	16	257	129	11	59	85	1115	41	19	606	39
Lane Group Flow (vph)	115	273	0	129	70	0	85	1156	0	19	645	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	40.0	40.0	0.0	40.0	40.0	0.0	50.0	50.0	0.0	50.0	50.0	0.0
Total Split (%)	44.4%	44.4%	0.0%	44.4%	44.4%	0.0%	55.6%	55.6%	0.0%	55.6%	55.6%	0.0%
Maximum Green (s)	35.0	35.0		35.0	35.0		45.0	45.0		45.0	45.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	16.3	16.3		16.3	16.3		46.2	46.2		46.2	46.2	
Actuated g/C Ratio	0.23	0.23		0.23	0.23		0.65	0.65		0.65	0.65	
v/c Ratio	0.37	0.49		0.59	0.16		0.20	0.50		0.10	0.29	
Control Delay	25.8	8.3		35.6	8.5		7.7	7.9		8.1	6.2	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	25.8	8.3		35.6	8.5		7.7	7.9		8.1	6.2	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	A		D	A		A	A		A	A	
Approach Delay		13.5			26.1			7.9			6.2	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	12.7	4.3		15.2	1.1		3.6	33.3		0.8	15.2	
Queue Length 95th (m)	25.4	20.5		30.9	9.4		12.8	67.0		4.4	32.4	
Internal Link Dist (m)		551.3			650.3			466.2			427.7	
Turn Bay Length (m)							75.0			75.0		
Base Capacity (vph)	536	786		376	694		434	2335		181	2244	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.21	0.35		0.34	0.10		0.20	0.50		0.10	0.29	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 70.6
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.59
Intersection Signal Delay: 9.8 Intersection LOS: A
Intersection Capacity Utilization 86.2% ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 12: Future Street D & 6 Line



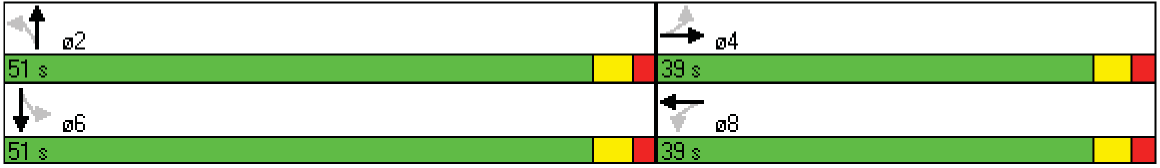
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.870			0.864			0.995				
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1639	0	1789	1627	0	1789	3561	0	1789	3444	0
Flt Permitted	0.715			0.742			0.207			0.132		
Satd. Flow (perm)	1347	1639	0	1398	1627	0	390	3561	0	249	3444	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		20			53			6				
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		48			48			80			60	
Link Distance (m)		560.3			693.3			502.8			490.2	
Travel Time (s)		42.0			52.0			22.6			29.4	
Volume (vph)	1	3	20	126	6	58	10	1158	40	19	967	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	1	3	20	129	6	59	10	1182	41	19	987	1
Lane Group Flow (vph)	1	23	0	129	65	0	10	1223	0	19	988	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	39.0	39.0	0.0	39.0	39.0	0.0	51.0	51.0	0.0	51.0	51.0	0.0
Total Split (%)	43.3%	43.3%	0.0%	43.3%	43.3%	0.0%	56.7%	56.7%	0.0%	56.7%	56.7%	0.0%
Maximum Green (s)	34.0	34.0		34.0	34.0		46.0	46.0		46.0	46.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	14.2	14.2		14.2	14.2		56.5	56.5		56.5	56.5	
Actuated g/C Ratio	0.18	0.18		0.18	0.18		0.75	0.75		0.75	0.75	
v/c Ratio	0.00	0.07		0.51	0.19		0.03	0.46		0.10	0.38	
Control Delay	21.0	11.7		31.8	10.3		4.7	5.5		6.1	5.0	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	21.0	11.7		31.8	10.3		4.7	5.5		6.1	5.0	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		C	B		A	A		A	A	
Approach Delay		12.1			24.6			5.5			5.0	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	0.1	0.3		14.7	1.3		0.3	29.6		0.6	22.2	
Queue Length 95th (m)	1.3	5.3		29.1	9.8		2.0	55.3		3.5	42.1	
Internal Link Dist (m)		536.3			669.3			478.8			466.2	
Turn Bay Length (m)							75.0			75.0		
Base Capacity (vph)	486	604		504	620		291	2656		186	2567	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.00	0.04		0.26	0.10		0.03	0.46		0.10	0.38	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 75.8
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.51
Intersection Signal Delay: 6.9 Intersection LOS: A
Intersection Capacity Utilization 53.6% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 21: Future Street C & 6 Line



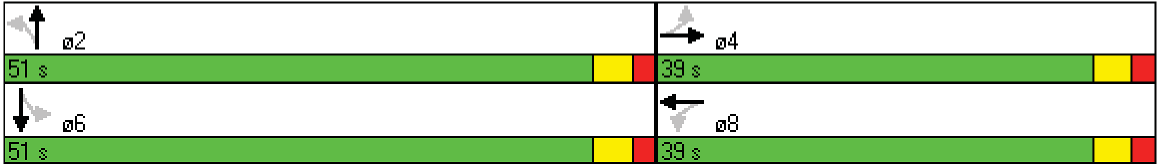
	↰	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	35.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.860			0.870			0.994			0.997	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1620	0	1789	1639	0	1789	3557	0	1789	3436	0
Flt Permitted	0.704			0.667			0.169			0.138		
Satd. Flow (perm)	1326	1620	0	1256	1639	0	318	3557	0	260	3436	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		69			57			7			3	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		48			48			80			60	
Link Distance (m)		549.9			702.6			299.7			502.8	
Travel Time (s)		41.2			52.7			13.5			30.2	
Volume (vph)	42	9	120	155	11	70	45	1129	49	42	1058	21
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	43	9	122	158	11	71	46	1152	50	43	1080	21
Lane Group Flow (vph)	43	131	0	158	82	0	46	1202	0	43	1101	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	39.0	39.0	0.0	39.0	39.0	0.0	51.0	51.0	0.0	51.0	51.0	0.0
Total Split (%)	43.3%	43.3%	0.0%	43.3%	43.3%	0.0%	56.7%	56.7%	0.0%	56.7%	56.7%	0.0%
Maximum Green (s)	34.0	34.0		34.0	34.0		46.0	46.0		46.0	46.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	15.7	15.7		15.7	15.7		50.2	50.2		50.2	50.2	
Actuated g/C Ratio	0.21	0.21		0.21	0.21		0.68	0.68		0.68	0.68	
v/c Ratio	0.15	0.33		0.59	0.21		0.21	0.50		0.24	0.47	
Control Delay	22.9	13.9		34.1	10.9		8.9	7.2		10.4	7.0	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	22.9	13.9		34.1	10.9		8.9	7.2		10.4	7.0	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		C	B		A	A		B	A	
Approach Delay		16.1			26.2			7.3			7.2	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	4.6	6.7		18.7	2.6		1.9	33.9		1.9	30.3	
Queue Length 95th (m)	11.8	18.9		35.4	12.1		8.7	64.4		9.1	58.1	
Internal Link Dist (m)		525.9			678.6			275.7			478.8	
Turn Bay Length (m)							35.0			75.0		
Base Capacity (vph)	500	653		473	653		216	2417		177	2334	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.09	0.20		0.33	0.13		0.21	0.50		0.24	0.47	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 73.9
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.59
Intersection Signal Delay: 9.4 Intersection LOS: A
Intersection Capacity Utilization 64.3% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 18: North Park Drive & 6 Line



	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.860			0.870			0.994			0.998	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1620	0	1789	1639	0	1789	3557	0	1789	3439	0
Flt Permitted	0.704			0.662			0.113			0.156		
Satd. Flow (perm)	1326	1620	0	1247	1639	0	213	3557	0	294	3439	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		44			71			8			3	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			60	
Link Distance (m)		540.7			706.6			398.8			299.7	
Travel Time (s)		32.4			42.4			17.9			18.0	
Volume (vph)	41	9	120	155	11	70	45	1112	49	42	1301	20
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	42	9	122	158	11	71	46	1135	50	43	1328	20
Lane Group Flow (vph)	42	131	0	158	82	0	46	1185	0	43	1348	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	36.0	36.0	0.0	36.0	36.0	0.0	54.0	54.0	0.0	54.0	54.0	0.0
Total Split (%)	40.0%	40.0%	0.0%	40.0%	40.0%	0.0%	60.0%	60.0%	0.0%	60.0%	60.0%	0.0%
Maximum Green (s)	31.0	31.0		31.0	31.0		49.0	49.0		49.0	49.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	16.1	16.1		16.1	16.1		52.8	52.8		52.8	52.8	
Actuated g/C Ratio	0.21	0.21		0.21	0.21		0.69	0.69		0.69	0.69	
v/c Ratio	0.15	0.35		0.61	0.21		0.32	0.48		0.21	0.57	
Control Delay	24.1	18.8		36.3	8.9		13.8	7.1		9.1	8.1	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	24.1	18.8		36.3	8.9		13.8	7.1		9.1	8.1	

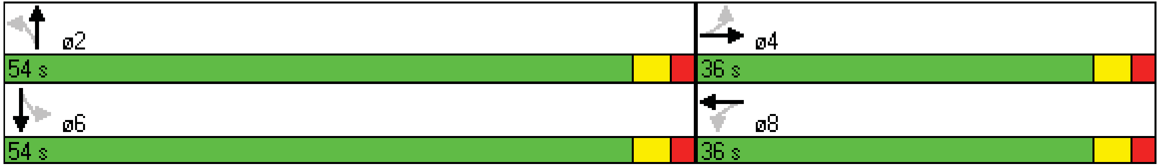
15: Sixteen Mile Drive & 6 Line
AM Peak - Future Conditions (2031)
Signalized Intersection

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		D	A		B	A		A	A	
Approach Delay		20.1			26.9			7.3			8.2	
Approach LOS		C			C			A			A	
Queue Length 50th (m)	4.8	10.1		19.9	1.2		2.2	34.1		1.9	42.8	
Queue Length 95th (m)	12.1	23.2		37.2	10.7		11.6	64.4		8.5	80.8	
Internal Link Dist (m)		516.7			682.6			374.8			275.7	
Turn Bay Length (m)				75.0			75.0			75.0		
Base Capacity (vph)	458	589		431	614		146	2445		202	2362	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.09	0.22		0.37	0.13		0.32	0.48		0.21	0.57	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 76.9
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.61
Intersection Signal Delay: 10.0 Intersection LOS: A
Intersection Capacity Utilization 64.3% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 15: Sixteen Mile Drive & 6 Line



6: Dundas St W & 6 Line
Signalized Intersection

AM Peak - Future Conditions (2031)

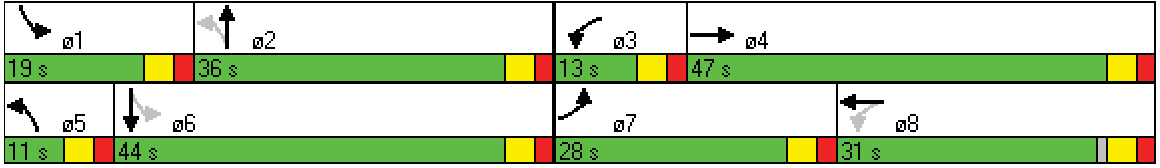
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↱		↰	↑↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	130.0		115.0	155.0		0.0	125.0		0.0	75.0		0.0
Storage Lanes	2		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	0.97	0.91	0.91	1.00	0.91	0.91	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.983			0.956			0.949			0.931	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3437	4926	0	1674	4544	0	1674	3441	0	1722	3362	0
Flt Permitted	0.950			0.143			0.125			0.174		
Satd. Flow (perm)	3437	4926	0	252	4544	0	220	3441	0	315	3362	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		22			88			77			203	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			60			60	
Link Distance (m)		533.1			698.8			321.3			398.8	
Travel Time (s)		24.0			31.4			19.3			23.9	
Volume (vph)	615	1735	178	172	438	147	141	444	226	247	739	623
Peak Hour Factor	1.00	1.00	0.80	1.00	1.00	0.80	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	3%	5%	2%	9%	13%	4%	9%	1%	0%	6%	2%	0%
Adj. Flow (vph)	615	1735	222	172	438	184	141	444	226	247	739	623
Lane Group Flow (vph)	615	1957	0	172	622	0	141	670	0	247	1362	0
Turn Type	Prot			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases				8			2			6		
Detector Phases	7	4		3	8		5	2		1	6	
Minimum Initial (s)	5.0	20.0		5.0	20.0		5.0	10.0		5.0	10.0	
Minimum Split (s)	10.0	31.0		10.0	31.0		10.0	30.0		10.0	33.0	
Total Split (s)	28.0	47.0	0.0	13.0	31.0	0.0	11.0	36.0	0.0	19.0	44.0	0.0
Total Split (%)	24.3%	40.9%	0.0%	11.3%	27.0%	0.0%	9.6%	31.3%	0.0%	16.5%	38.3%	0.0%
Maximum Green (s)	23.0	42.0		8.0	26.0		6.0	31.0		14.0	39.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	Min		None	Min	
Walk Time (s)		15.0			15.0			15.0			15.0	
Flash Dont Walk (s)		10.0			10.0			10.0			10.0	
Pedestrian Calls (#/hr)		0			0			0			0	
Act Effct Green (s)	23.5	43.0		37.5	28.5		39.5	32.5		51.0	40.0	
Actuated g/C Ratio	0.20	0.37		0.33	0.25		0.34	0.28		0.44	0.35	
v/c Ratio	0.88	1.05		0.89	0.52		0.86	0.65		0.78	1.05	
Control Delay	59.1	72.0		69.9	33.7		66.5	35.5		39.4	69.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	59.1	72.0		69.9	33.7		66.5	35.5		39.4	69.6	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	E	E		E	C		E	D		D	E	
Approach Delay		68.9			41.6			40.9			65.0	
Approach LOS		E			D			D			E	
Queue Length 50th (m)	69.3	~175.8		23.7	38.3		18.9	62.4		35.3	~158.8	
Queue Length 95th (m)	#96.7	#205.7		#64.4	50.6		#52.9	82.3		#66.1	#201.5	
Internal Link Dist (m)		509.1			674.8			297.3			374.8	
Turn Bay Length (m)	130.0			155.0			125.0			75.0		
Base Capacity (vph)	714	1856		193	1193		164	1028		322	1302	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.86	1.05		0.89	0.52		0.86	0.65		0.77	1.05	

Intersection Summary

Area Type: Other
Cycle Length: 115
Actuated Cycle Length: 115
Natural Cycle: 115
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.05
Intersection Signal Delay: 60.1 Intersection LOS: E
Intersection Capacity Utilization 108.6% ICU Level of Service G
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Dundas St W & 6 Line



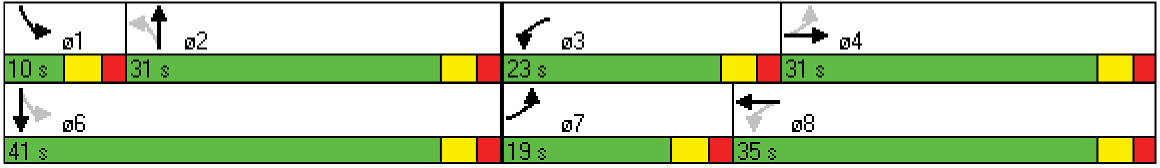
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	0.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.970			0.970			0.956			0.970	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	3471	0	1706	3485	0	1825	3431	0	1789	3328	0
Flt Permitted	0.148			0.129			0.476			0.151		
Satd. Flow (perm)	276	3471	0	232	3485	0	914	3431	0	284	3328	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		33			35			67			38	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			80			80	
Link Distance (m)		584.6			658.3			612.3			725.4	
Travel Time (s)		26.3			29.6			27.6			32.6	
Volume (vph)	316	758	190	387	928	232	126	506	211	158	379	95
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	322	773	194	395	947	237	129	516	215	161	387	97
Lane Group Flow (vph)	322	967	0	395	1184	0	129	731	0	161	484	0
Turn Type	pm+pt			pm+pt			Perm			pm+pt		
Protected Phases	7	4		3	8			2		1	6	
Permitted Phases	4			8			2			6		
Detector Phases	7	4		3	8		2	2		1	6	
Minimum Initial (s)	5.0	20.0		5.0	20.0		7.0	7.0		5.0	10.0	
Minimum Split (s)	10.0	31.0		10.0	31.0		31.0	31.0		10.0	31.0	
Total Split (s)	19.0	31.0	0.0	23.0	35.0	0.0	31.0	31.0	0.0	10.0	41.0	0.0
Total Split (%)	20.0%	32.6%	0.0%	24.2%	36.8%	0.0%	32.6%	32.6%	0.0%	10.5%	43.2%	0.0%
Maximum Green (s)	14.0	26.0		18.0	30.0		26.0	26.0		5.0	36.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lag	Lag		Lead		
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes		
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	None		None	None	
Walk Time (s)		15.0			15.0		15.0	15.0			15.0	
Flash Dont Walk (s)		10.0			10.0		10.0	10.0			10.0	
Pedestrian Calls (#/hr)		0			0		0	0			0	
Act Effct Green (s)	41.6	27.0		49.7	31.1		23.5	23.5		33.5	33.5	
Actuated g/C Ratio	0.46	0.30		0.54	0.34		0.26	0.26		0.37	0.37	
v/c Ratio	0.88	0.92		0.92	0.98		0.55	0.78		0.79	0.39	
Control Delay	49.2	45.7		52.6	51.7		38.9	35.1		49.7	20.4	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	49.2	45.7		52.6	51.7		38.9	35.1		49.7	20.4	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	D	D		D	D		D	D		D	C	
Approach Delay		46.6			51.9			35.7			27.7	
Approach LOS		D			D			D			C	
Queue Length 50th (m)	40.6	86.0		54.1	108.0		19.7	57.6		19.4	29.8	
Queue Length 95th (m)	#90.7	#129.4		#111.7	#160.0		37.9	77.8		#41.7	42.3	
Internal Link Dist (m)		560.6			634.3			588.3			701.4	
Turn Bay Length (m)							75.0					
Base Capacity (vph)	372	1053		432	1211		261	1027		204	1324	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.87	0.92		0.91	0.98		0.49	0.71		0.79	0.37	

Intersection Summary

Area Type: Other
Cycle Length: 95
Actuated Cycle Length: 91.2
Natural Cycle: 85
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.98
Intersection Signal Delay: 43.6 Intersection LOS: D
Intersection Capacity Utilization 93.4% ICU Level of Service F
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 9: North Oakville Corridor & 6 Line



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	75.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.944			0.962			0.952			0.983	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1772	1778	0	1706	1821	0	1825	3417	0	1789	3378	0
Flt Permitted	0.290			0.576			0.254			0.344		
Satd. Flow (perm)	541	1778	0	1034	1821	0	488	3417	0	648	3378	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		52			30			96			18	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			80	
Link Distance (m)		567.6			690.8			451.7			612.3	
Travel Time (s)		34.1			41.4			20.3			27.6	
Volume (vph)	98	151	89	323	440	148	72	377	175	85	617	80
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	3%	2%	2%	7%	2%	0%	0%	2%	1%	2%	6%	8%
Adj. Flow (vph)	100	154	91	330	449	151	73	385	179	87	630	82
Lane Group Flow (vph)	100	245	0	330	600	0	73	564	0	87	712	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	53.0	53.0	0.0	53.0	53.0	0.0	37.0	37.0	0.0	37.0	37.0	0.0
Total Split (%)	58.9%	58.9%	0.0%	58.9%	58.9%	0.0%	41.1%	41.1%	0.0%	41.1%	41.1%	0.0%
Maximum Green (s)	48.0	48.0		48.0	48.0		32.0	32.0		32.0	32.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Min	Min		Min	Min	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	26.3	26.3		26.3	26.3		24.3	24.3		24.3	24.3	
Actuated g/C Ratio	0.44	0.44		0.44	0.44		0.41	0.41		0.41	0.41	
v/c Ratio	0.41	0.30		0.72	0.73		0.36	0.39		0.33	0.51	
Control Delay	16.6	8.5		22.6	17.8		23.4	13.0		20.7	16.5	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	16.6	8.5		22.6	17.8		23.4	13.0		20.7	16.5	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	B	A		C	B		C	B		C	B	
Approach Delay		10.8			19.5			14.2			17.0	
Approach LOS		B			B			B			B	
Queue Length 50th (m)	6.0	10.6		23.5	40.8		4.9	16.1		5.7	25.9	
Queue Length 95th (m)	20.7	28.6		63.0	94.2		22.5	44.8		24.1	67.1	
Internal Link Dist (m)		543.6			666.8			427.7			588.3	
Turn Bay Length (m)	75.0			75.0			75.0			75.0		
Base Capacity (vph)	330	1104		631	1122		242	1744		321	1686	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.30	0.22		0.52	0.53		0.30	0.32		0.27	0.42	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 59.2

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

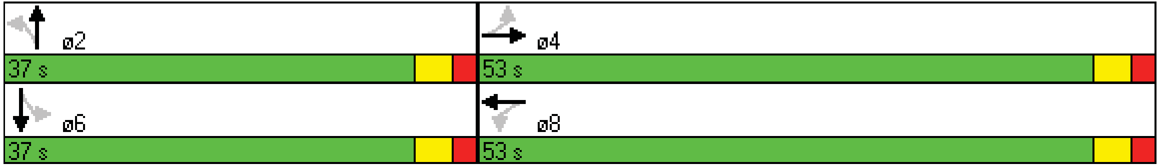
Maximum v/c Ratio: 0.73

Intersection Signal Delay: 16.4 Intersection LOS: B

Intersection Capacity Utilization 90.1% ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 3: Burnhamthorpe Rd W & 6 Line



	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.863			0.897			0.975			0.974	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1625	0	1789	1689	0	1789	3489	0	1789	3376	0
Flt Permitted	0.720			0.593			0.243			0.280		
Satd. Flow (perm)	1356	1625	0	1117	1689	0	458	3489	0	527	3376	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		153			39			48			49	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			60	
Link Distance (m)		575.3			674.3			490.2			451.7	
Travel Time (s)		34.5			40.5			22.1			27.1	
Volume (vph)	94	15	150	83	18	38	257	703	143	64	782	163
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	96	15	153	85	18	39	262	717	146	65	798	166
Lane Group Flow (vph)	96	168	0	85	57	0	262	863	0	65	964	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	31.5	31.5		31.5	31.5		31.5	31.5		31.5	31.5	
Total Split (s)	31.5	31.5	0.0	31.5	31.5	0.0	58.5	58.5	0.0	58.5	58.5	0.0
Total Split (%)	35.0%	35.0%	0.0%	35.0%	35.0%	0.0%	65.0%	65.0%	0.0%	65.0%	65.0%	0.0%
Maximum Green (s)	26.0	26.0		26.0	26.0		53.0	53.0		53.0	53.0	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	13.7	13.7		13.7	13.7		56.8	56.8		56.8	56.8	
Actuated g/C Ratio	0.17	0.17		0.17	0.17		0.72	0.72		0.72	0.72	
v/c Ratio	0.41	0.41		0.44	0.17		0.79	0.34		0.17	0.39	
Control Delay	32.9	9.3		35.0	14.0		29.7	4.4		5.4	4.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	32.9	9.3		35.0	14.0		29.7	4.4		5.4	4.8	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	A		D	B		C	A		A	A	
Approach Delay		17.9			26.6			10.3			4.8	
Approach LOS		B			C			B			A	
Queue Length 50th (m)	12.4	1.8		11.0	2.2		18.6	17.1		2.3	20.1	
Queue Length 95th (m)	25.4	16.3		23.4	10.9		#78.6	32.8		8.1	38.6	
Internal Link Dist (m)		551.3			650.3			466.2			427.7	
Turn Bay Length (m)							75.0			75.0		
Base Capacity (vph)	405	593		333	532		331	2536		381	2454	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.24	0.28		0.26	0.11		0.79	0.34		0.17	0.39	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 78.5

Natural Cycle: 90

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.79

Intersection Signal Delay: 9.8 Intersection LOS: A

Intersection Capacity Utilization 75.2% ICU Level of Service D

Analysis Period (min) 15

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 12: Future Street D & 6 Line

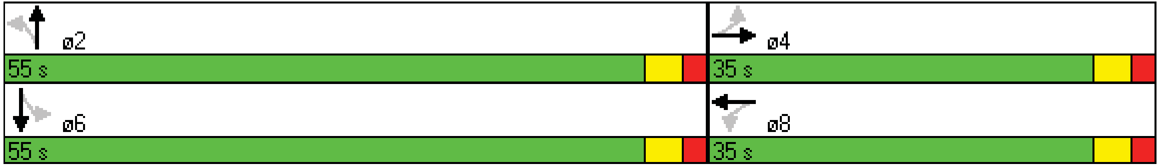
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.905			0.867			0.982				
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1705	0	1789	1633	0	1789	3514	0	1789	3444	0
Flt Permitted	0.729			0.745			0.229			0.147		
Satd. Flow (perm)	1373	1705	0	1403	1633	0	431	3514	0	277	3444	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		12			38			27				
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		48			48			80			60	
Link Distance (m)		560.3			693.3			502.8			490.2	
Travel Time (s)		42.0			52.0			22.6			29.4	
Volume (vph)	1	7	12	83	5	37	20	1066	143	65	950	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	1	7	12	85	5	38	20	1088	146	66	969	1
Lane Group Flow (vph)	1	19	0	85	43	0	20	1234	0	66	970	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	35.0	35.0	0.0	35.0	35.0	0.0	55.0	55.0	0.0	55.0	55.0	0.0
Total Split (%)	38.9%	38.9%	0.0%	38.9%	38.9%	0.0%	61.1%	61.1%	0.0%	61.1%	61.1%	0.0%
Maximum Green (s)	30.0	30.0		30.0	30.0		50.0	50.0		50.0	50.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Min	Min		Min	Min	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	13.7	13.7		13.7	13.7		44.1	44.1		44.1	44.1	
Actuated g/C Ratio	0.20	0.20		0.20	0.20		0.68	0.68		0.68	0.68	
v/c Ratio	0.00	0.05		0.30	0.12		0.07	0.51		0.35	0.41	
Control Delay	17.0	11.8		18.7	8.6		4.9	6.0		11.5	5.3	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	17.0	11.8		18.7	8.6		4.9	6.0		11.5	5.3	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	B	B		B	A		A	A		B	A	
Approach Delay		12.1			15.3			6.0			5.7	
Approach LOS		B			B			A			A	
Queue Length 50th (m)	0.1	0.4		4.5	0.3		0.6	26.6		2.4	19.5	
Queue Length 95th (m)	1.1	5.1		18.8	7.2		2.7	44.4		10.7	32.8	
Internal Link Dist (m)		536.3			669.3			478.8			466.2	
Turn Bay Length (m)							75.0			75.0		
Base Capacity (vph)	547	686		559	673		335	2740		216	2679	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.00	0.03		0.15	0.06		0.06	0.45		0.31	0.36	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 64.6
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.51
Intersection Signal Delay: 6.4 Intersection LOS: A
Intersection Capacity Utilization 71.9% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 21: Future Street C & 6 Line



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	0.0		0.0	35.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.870			0.883			0.975			0.992	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1639	0	1789	1663	0	1789	3489	0	1789	3422	0
Flt Permitted	0.719			0.693			0.208			0.102		
Satd. Flow (perm)	1354	1639	0	1305	1663	0	392	3489	0	192	3422	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		86			46			46			10	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		48			48			80			60	
Link Distance (m)		549.9			702.6			299.7			502.8	
Travel Time (s)		41.2			52.7			13.5			30.2	
Volume (vph)	36	13	84	99	13	45	114	1184	239	13	980	52
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	37	13	86	101	13	46	116	1208	244	13	1000	53
Lane Group Flow (vph)	37	99	0	101	59	0	116	1452	0	13	1053	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	31.0	31.0		31.0	31.0		31.0	31.0		31.0	31.0	
Total Split (s)	33.0	33.0	0.0	33.0	33.0	0.0	57.0	57.0	0.0	57.0	57.0	0.0
Total Split (%)	36.7%	36.7%	0.0%	36.7%	36.7%	0.0%	63.3%	63.3%	0.0%	63.3%	63.3%	0.0%
Maximum Green (s)	28.0	28.0		28.0	28.0		52.0	52.0		52.0	52.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	13.7	13.7		13.7	13.7		62.2	62.2		62.2	62.2	
Actuated g/C Ratio	0.16	0.16		0.16	0.16		0.77	0.77		0.77	0.77	
v/c Ratio	0.17	0.29		0.47	0.19		0.38	0.54		0.09	0.40	
Control Delay	27.4	10.2		34.9	12.3		9.4	5.6		5.6	4.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	27.4	10.2		34.9	12.3		9.4	5.6		5.6	4.6	

18: North Park Drive & 6 Line
Signalized Intersection

PM Peak - Future Conditions (2031)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		C	B		A	A		A	A	
Approach Delay		14.9			26.6			5.8			4.6	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	4.4	1.5		12.7	1.5		4.9	36.8		0.4	23.2	
Queue Length 95th (m)	11.9	12.8		26.2	10.4		19.0	68.2		2.6	43.4	
Internal Link Dist (m)		525.9			678.6			275.7			478.8	
Turn Bay Length (m)							35.0			75.0		
Base Capacity (vph)	405	551		391	530		302	2694		148	2634	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.09	0.18		0.26	0.11		0.38	0.54		0.09	0.40	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 80.9
Natural Cycle: 65
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.54
Intersection Signal Delay: 6.9 Intersection LOS: A
Intersection Capacity Utilization 79.2% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 18: North Park Drive & 6 Line

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	75.0		0.0	75.0		0.0	75.0		0.0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.870			0.883			0.979			0.994	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1789	1639	0	1789	1663	0	1789	3503	0	1789	3428	0
Flt Permitted	0.719			0.692			0.156			0.071		
Satd. Flow (perm)	1354	1639	0	1303	1663	0	294	3503	0	134	3428	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		81			44			39			9	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		60			60			80			60	
Link Distance (m)		540.7			706.6			398.8			299.7	
Travel Time (s)		32.4			42.4			17.9			18.0	
Volume (vph)	38	13	85	99	13	45	115	1454	239	13	1193	52
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	6%	2%
Adj. Flow (vph)	39	13	87	101	13	46	117	1484	244	13	1217	53
Lane Group Flow (vph)	39	100	0	101	59	0	117	1728	0	13	1270	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	10.0	10.0		10.0	10.0		20.0	20.0		20.0	20.0	
Minimum Split (s)	30.0	30.0		30.0	30.0		30.0	30.0		30.0	30.0	
Total Split (s)	30.0	30.0	0.0	30.0	30.0	0.0	60.0	60.0	0.0	60.0	60.0	0.0
Total Split (%)	33.3%	33.3%	0.0%	33.3%	33.3%	0.0%	66.7%	66.7%	0.0%	66.7%	66.7%	0.0%
Maximum Green (s)	25.0	25.0		25.0	25.0		55.0	55.0		55.0	55.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Flash Dont Walk (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)	13.8	13.8		13.8	13.8		65.1	65.1		65.1	65.1	
Actuated g/C Ratio	0.16	0.16		0.16	0.16		0.78	0.78		0.78	0.78	
v/c Ratio	0.18	0.30		0.49	0.20		0.51	0.63		0.12	0.48	
Control Delay	29.0	11.7		37.0	13.3		16.2	6.7		7.4	5.1	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	29.0	11.7		37.0	13.3		16.2	6.7		7.4	5.1	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	B		D	B		B	A		A	A	
Approach Delay		16.5			28.3			7.3			5.1	
Approach LOS		B			C			A			A	
Queue Length 50th (m)	4.9	2.4		13.4	1.9		5.8	51.8		0.4	31.3	
Queue Length 95th (m)	12.7	14.0		27.3	11.0		#36.6	95.8		3.1	57.7	
Internal Link Dist (m)		516.7			682.6			374.8			275.7	
Turn Bay Length (m)				75.0			75.0			75.0		
Base Capacity (vph)	364	500		350	480		228	2728		104	2663	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.11	0.20		0.29	0.12		0.51	0.63		0.13	0.48	

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 83.8

Natural Cycle: 80

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.63

Intersection Signal Delay: 7.8 Intersection LOS: A

Intersection Capacity Utilization 86.6% ICU Level of Service E

Analysis Period (min) 15

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 15: Sixteen Mile Drive & 6 Line

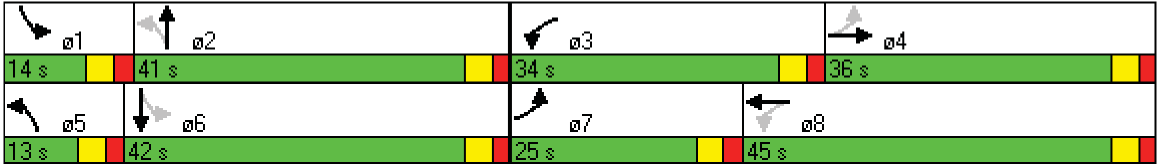
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑↱		↰	↑↑↱		↰	↑↱		↰	↑↱	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	130.0		0.0	155.0		0.0	125.0		0.0	75.0		0.0
Storage Lanes	2		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	6.1	30.5		6.1	30.5		6.1	30.5		6.1	30.5	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	24		14	24		14	24		14	24		14
Lane Util. Factor	0.97	0.91	0.91	1.00	0.91	0.91	1.00	0.95	0.95	1.00	0.95	0.95
Frt		0.967			0.959			0.968			0.927	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3437	4860	0	1674	4549	0	1674	3506	0	1722	3349	0
Flt Permitted	0.125			0.160			0.108			0.105		
Satd. Flow (perm)	452	4860	0	282	4549	0	190	3506	0	190	3349	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		54			80			28			197	
Headway Factor	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Link Speed (k/h)		80			80			60			60	
Link Distance (m)		533.1			698.8			321.3			398.8	
Travel Time (s)		24.0			31.4			19.3			23.9	
Volume (vph)	734	640	143	316	1192	354	181	721	195	173	619	585
Peak Hour Factor	1.00	1.00	0.80	1.00	1.00	0.80	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	3%	5%	2%	9%	13%	4%	9%	1%	0%	6%	2%	0%
Adj. Flow (vph)	734	640	179	316	1192	442	181	721	195	173	619	585
Lane Group Flow (vph)	734	819	0	316	1634	0	181	916	0	173	1204	0
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Detector Phases	7	4		3	8		5	2		1	6	
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	10.0		5.0	10.0	
Minimum Split (s)	10.0	30.0		10.0	30.0		10.0	30.0		10.0	30.0	
Total Split (s)	25.0	36.0	0.0	34.0	45.0	0.0	13.0	41.0	0.0	14.0	42.0	0.0
Total Split (%)	20.0%	28.8%	0.0%	27.2%	36.0%	0.0%	10.4%	32.8%	0.0%	11.2%	33.6%	0.0%
Maximum Green (s)	20.0	31.0		29.0	40.0		8.0	36.0		9.0	37.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lead	Lag		Lead	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	Min		None	Min	
Walk Time (s)		15.0			15.0			15.0			15.0	
Flash Dont Walk (s)		10.0			10.0			10.0			10.0	
Pedestrian Calls (#/hr)		0			0			0			0	
Act Effct Green (s)	59.9	39.5		62.3	41.0		46.0	37.0		48.0	38.0	
Actuated g/C Ratio	0.48	0.32		0.50	0.33		0.37	0.30		0.38	0.30	
v/c Ratio	1.02	0.52		0.81	1.06		1.02	0.87		0.88	1.04	
Control Delay	73.7	35.0		40.0	78.3		104.5	50.3		69.0	73.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	73.7	35.0		40.0	78.3		104.5	50.3		69.0	73.8	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	E	C		D	E		F	D		E	E	
Approach Delay		53.3			72.1			59.2			73.2	
Approach LOS		D			E			E			E	
Queue Length 50th (m)	~79.5	56.5		48.9	~156.3		~32.4	109.2		27.6	~149.6	
Queue Length 95th (m)	#124.5	76.1		78.6	#186.3		#78.8	#137.0		#68.2	#192.0	
Internal Link Dist (m)		509.1			674.8			297.3			374.8	
Turn Bay Length (m)	130.0			155.0			125.0			75.0		
Base Capacity (vph)	718	1571		457	1546		177	1057		196	1155	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	1.02	0.52		0.69	1.06		1.02	0.87		0.88	1.04	

Intersection Summary

Area Type: Other
Cycle Length: 125
Actuated Cycle Length: 125
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.06
Intersection Signal Delay: 65.1 Intersection LOS: E
Intersection Capacity Utilization 111.1% ICU Level of Service H
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Dundas St W & 6 Line

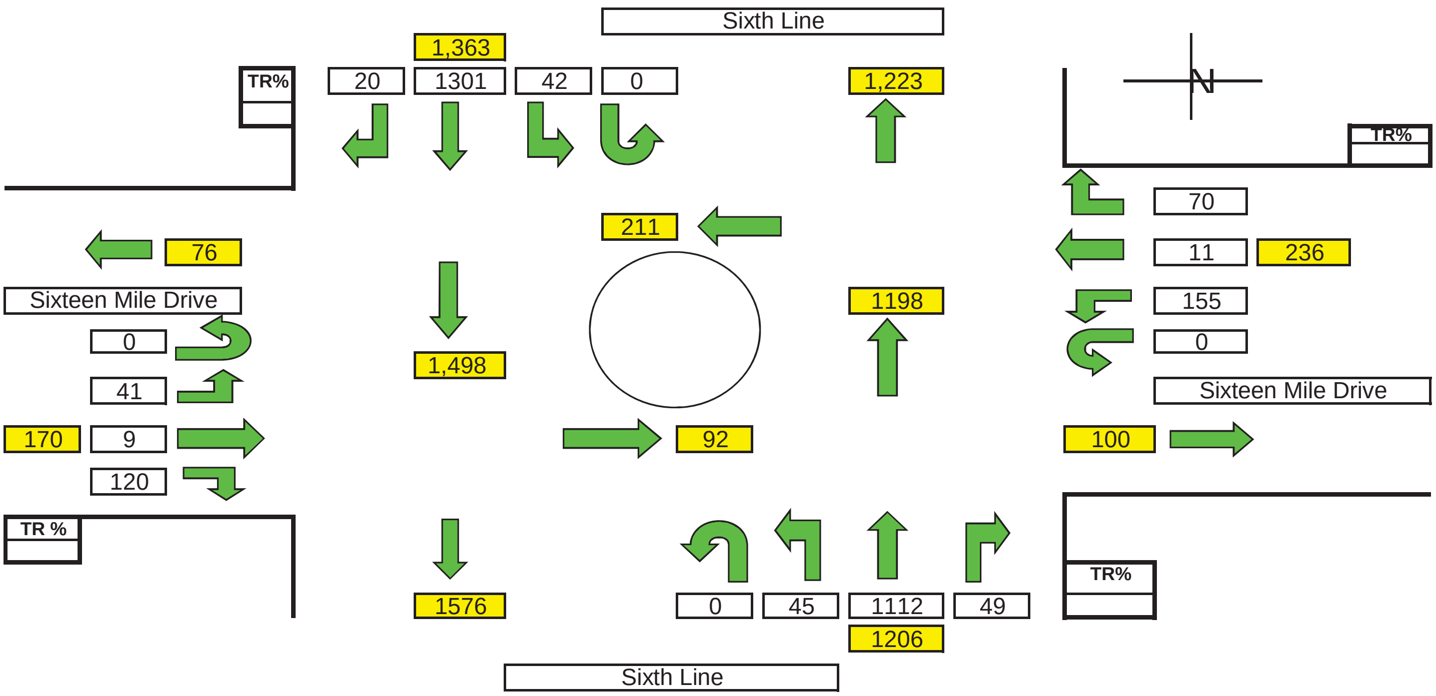


Appendix B.7 – Future (2031) Roundabout Screening Analysis

REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET

VERSION 1.0 AUG 22, 2008

Project: Sixth Line Class EA (Dunda **Drawn By:** DESIGNER
Project No.: #### **Sheet** of
Intersection: Sixteen Mile Drive/Sixth Line
Time Period: AM PEAK (2031)

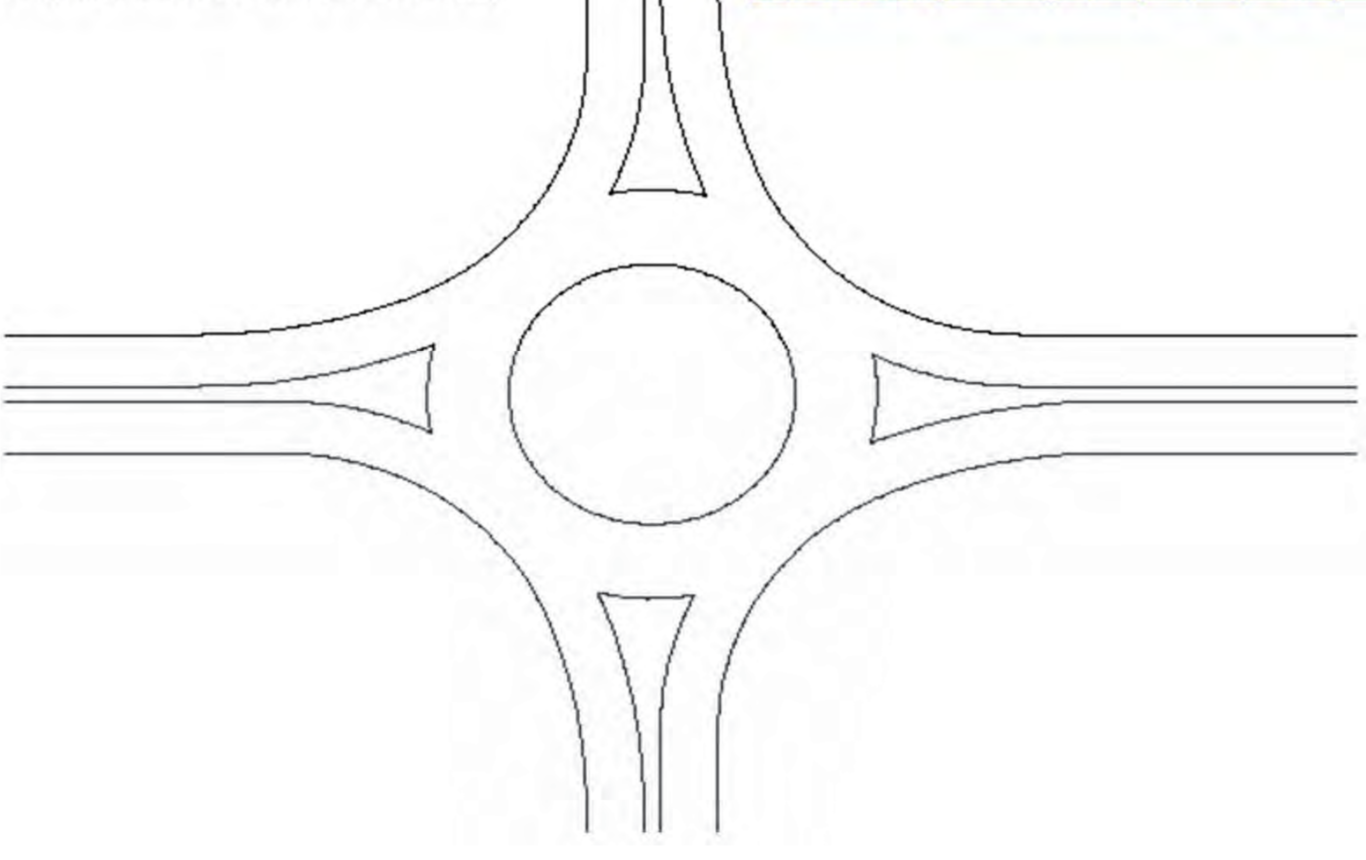


Capacity Guidelines

1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

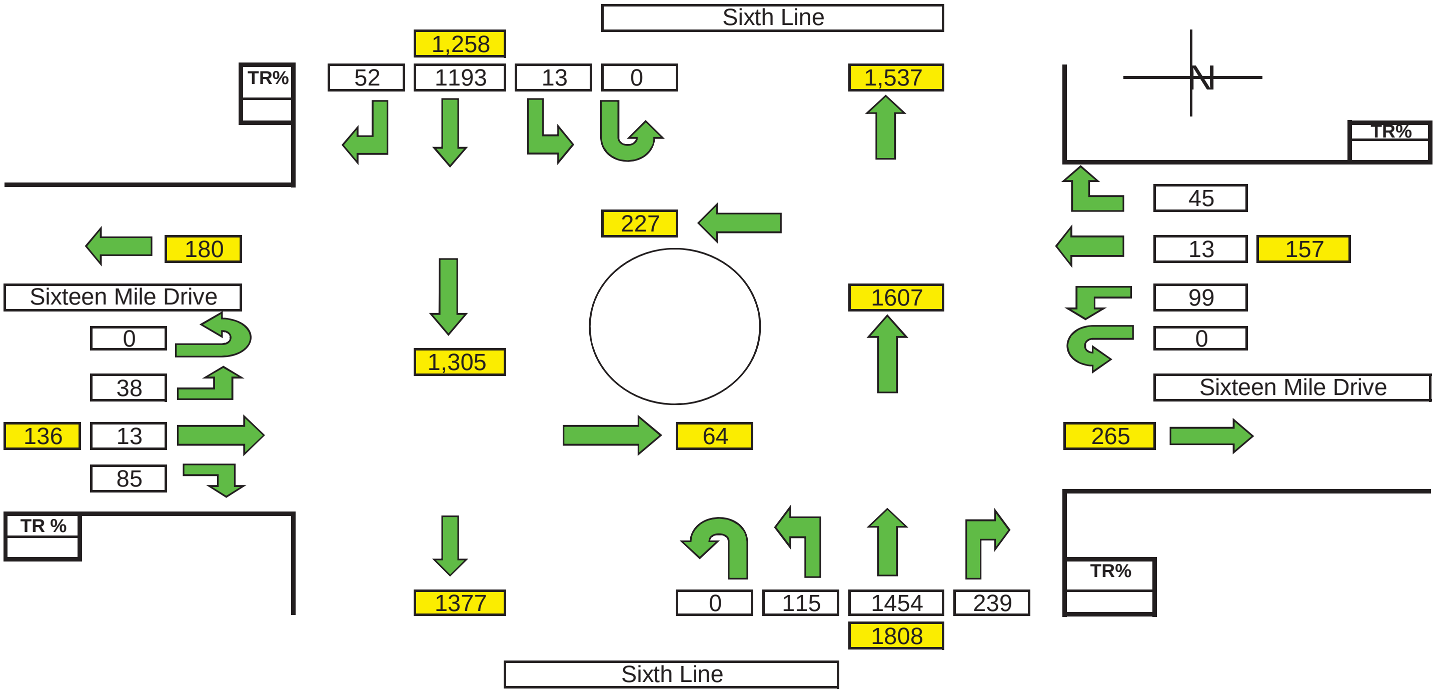
RODEL Inputs

Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	20	1301	42	0
Sixteen Mile Drive	1	120	9	41	0
Sixth Line	1	49	1112	45	0
Sixteen Mile Drive	1	70	11	155	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET
VERSION 1.0 AUG 22, 2008

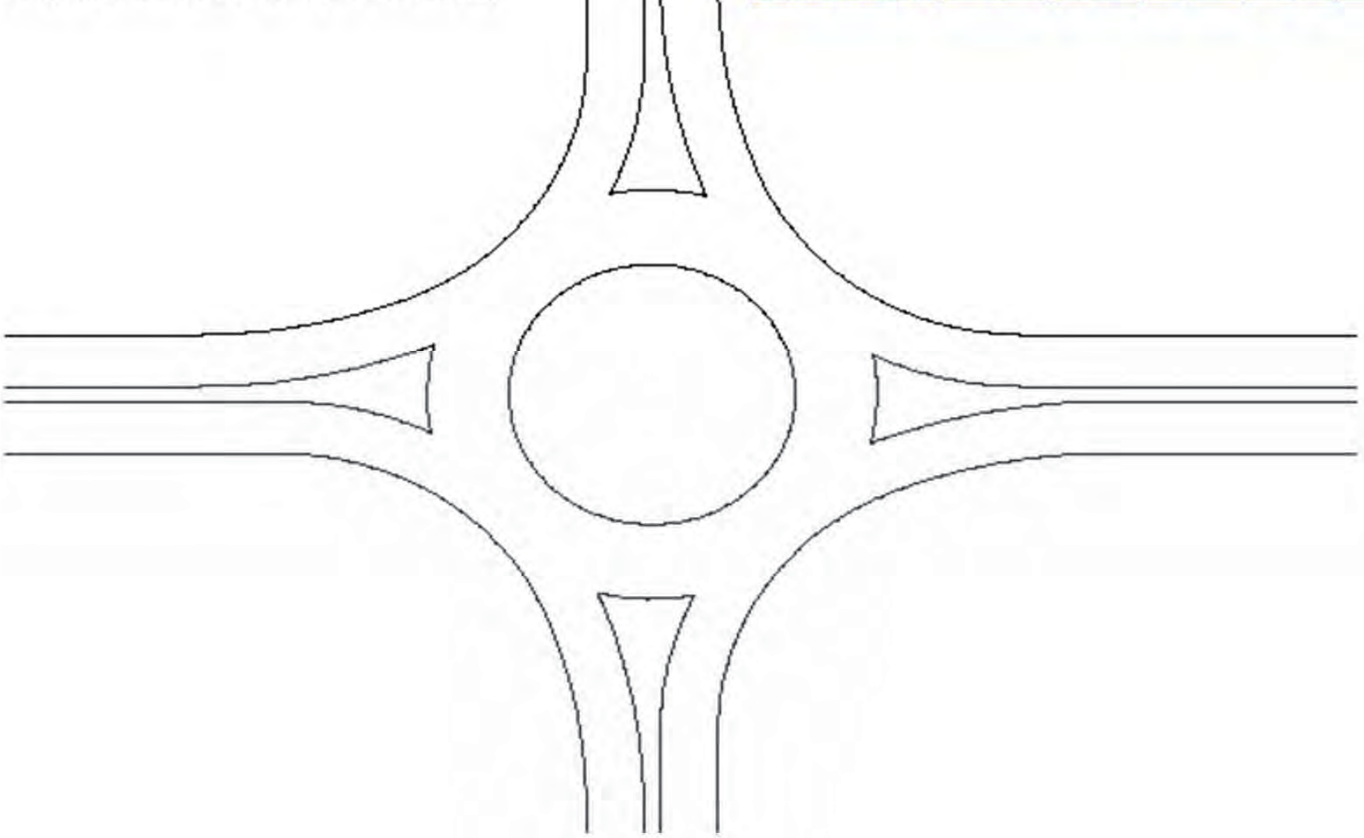
Project: Sixth Line Class EA (Dunda
Drawn By: DESIGNER
Project No.: ####
Sheet of
Intersection: Sixteen Mile Drive/Sixth Line
Time Period: PM PEAK (2031)



Capacity Guidelines
1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

RODEL Inputs

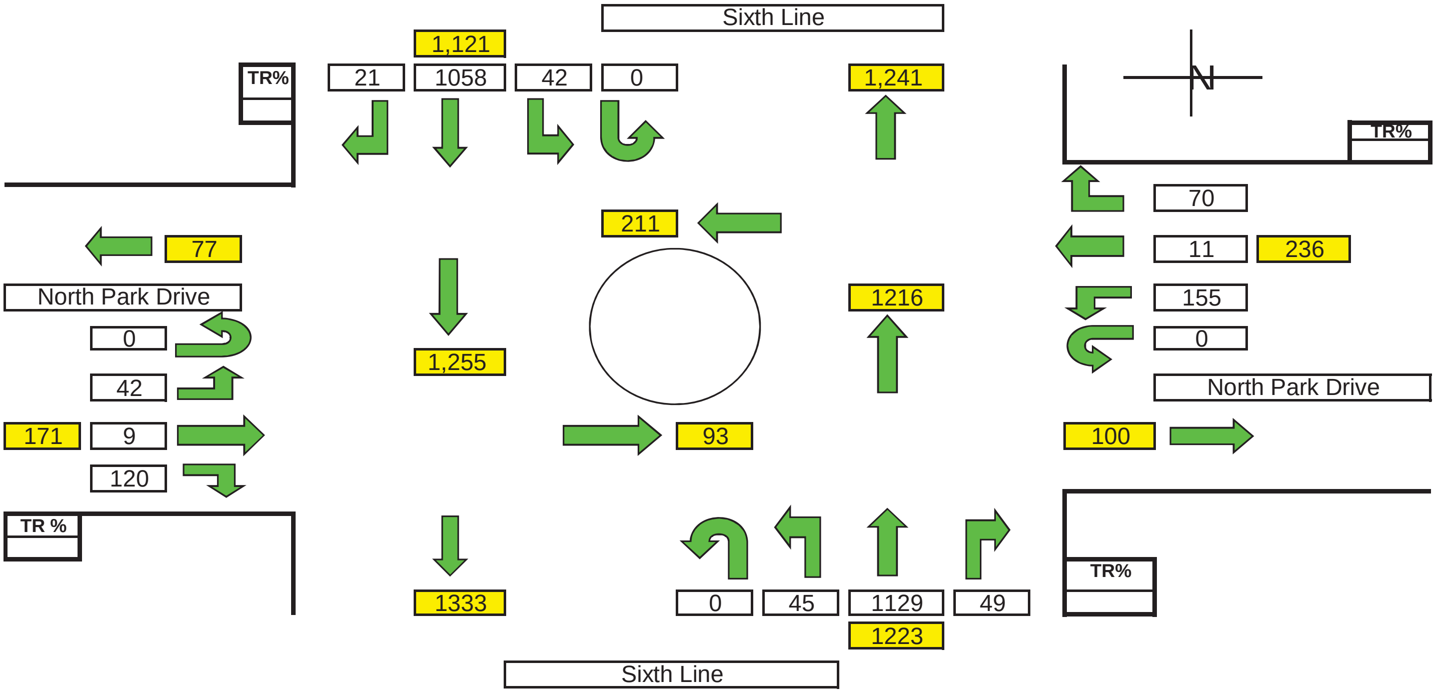
Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	52	1193	13	0
Sixteen Mile Drive	1	85	13	38	0
Sixth Line	1	239	1454	115	0
Sixteen Mile Drive	1	45	13	99	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET

VERSION 1.0 AUG 22, 2008

Project:	**Sixth Line Class EA (Dunda**	**Drawn By:**	DESIGNER
Project No.:	**####**	**Sheet**	**of**
Intersection:	**North Park Drive/Sixth Line**		
Time Period:	**AM PEAK (2031)**		

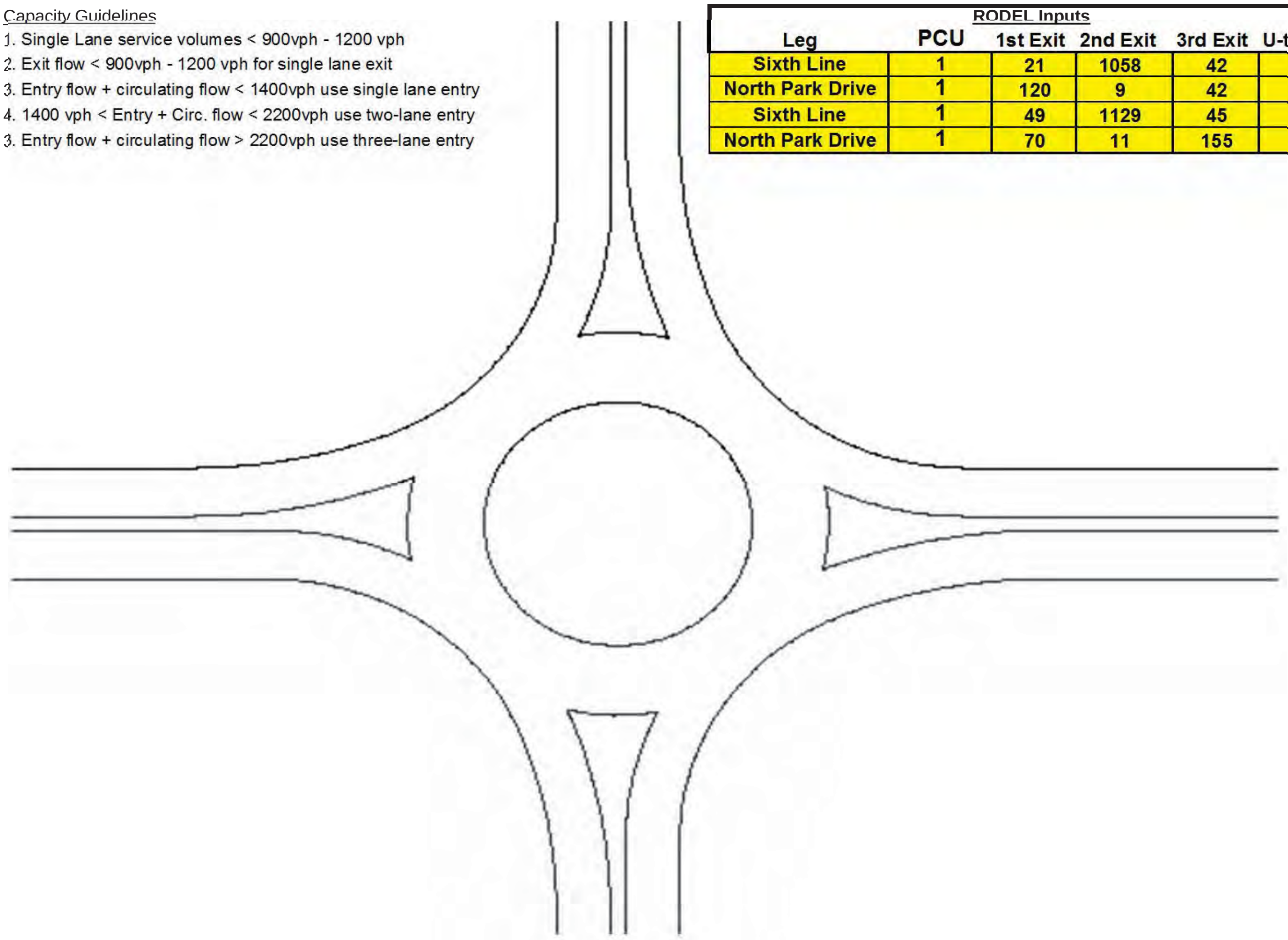


Capacity Guidelines

1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

RODEL Inputs

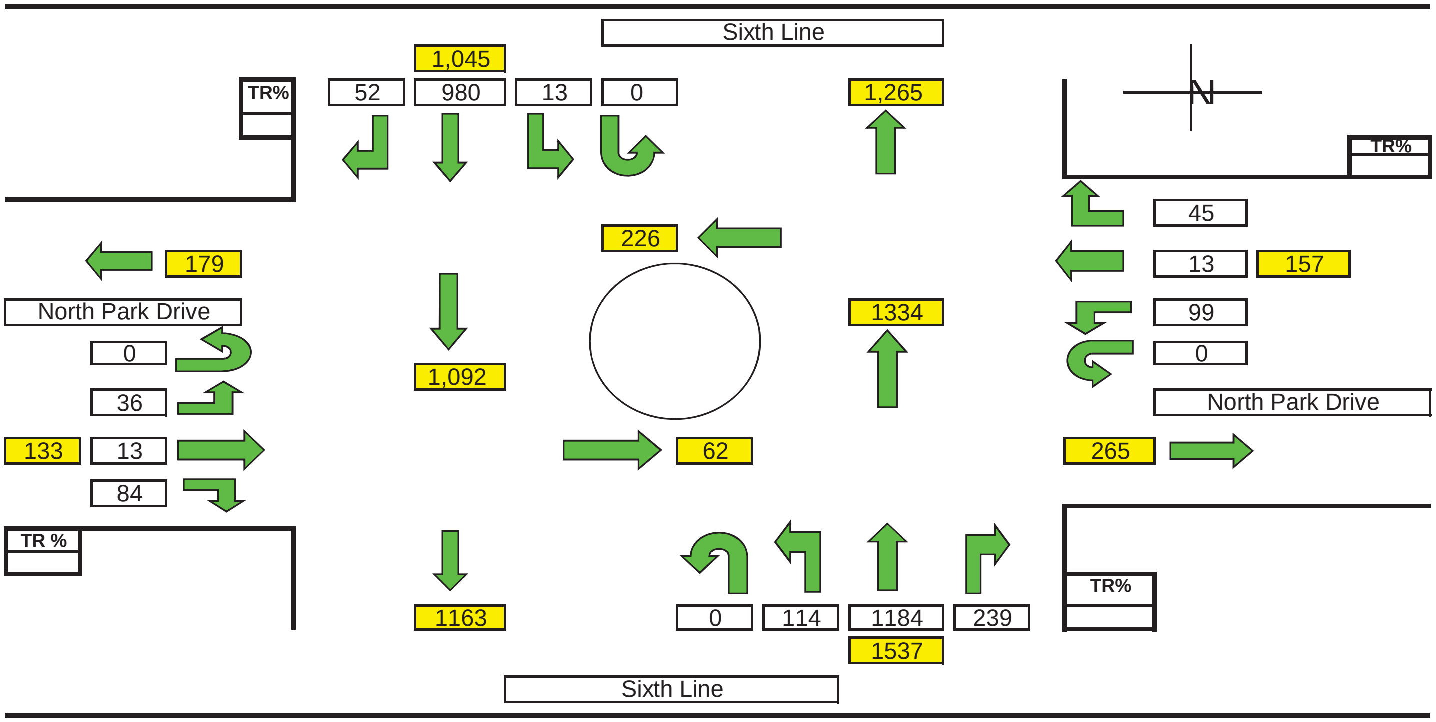
Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	21	1058	42	0
North Park Drive	1	120	9	42	0
Sixth Line	1	49	1129	45	0
North Park Drive	1	70	11	155	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET

VERSION 1.0 AUG 22, 2008

Project: Sixth Line Class EA (Dund
Drawn By: DESIGNER
Project No.: ####
Sheet of
Intersection: North Park Drive/Sixth Line
Time Period: PM PEAK (2031)

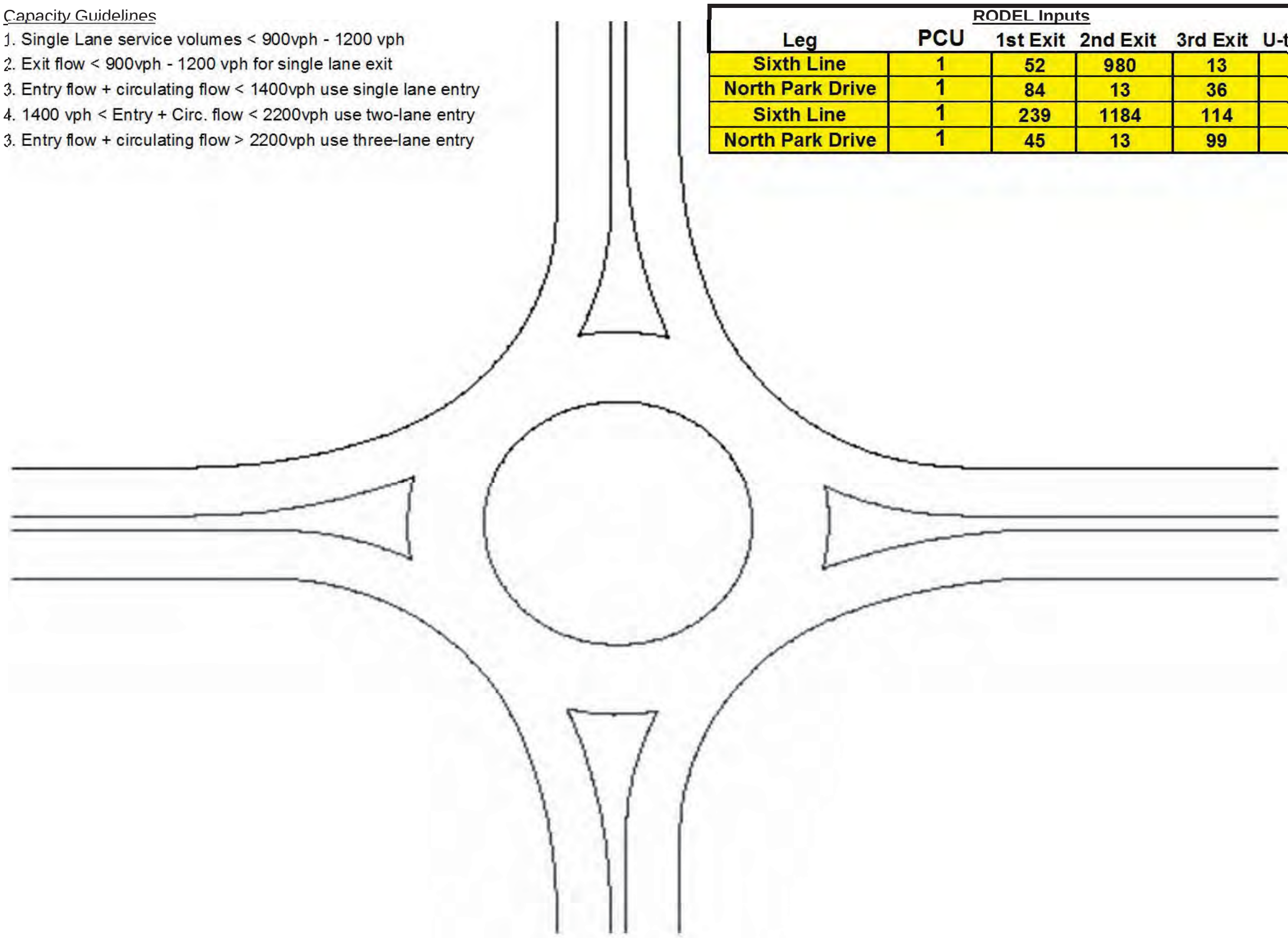


Capacity Guidelines

1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

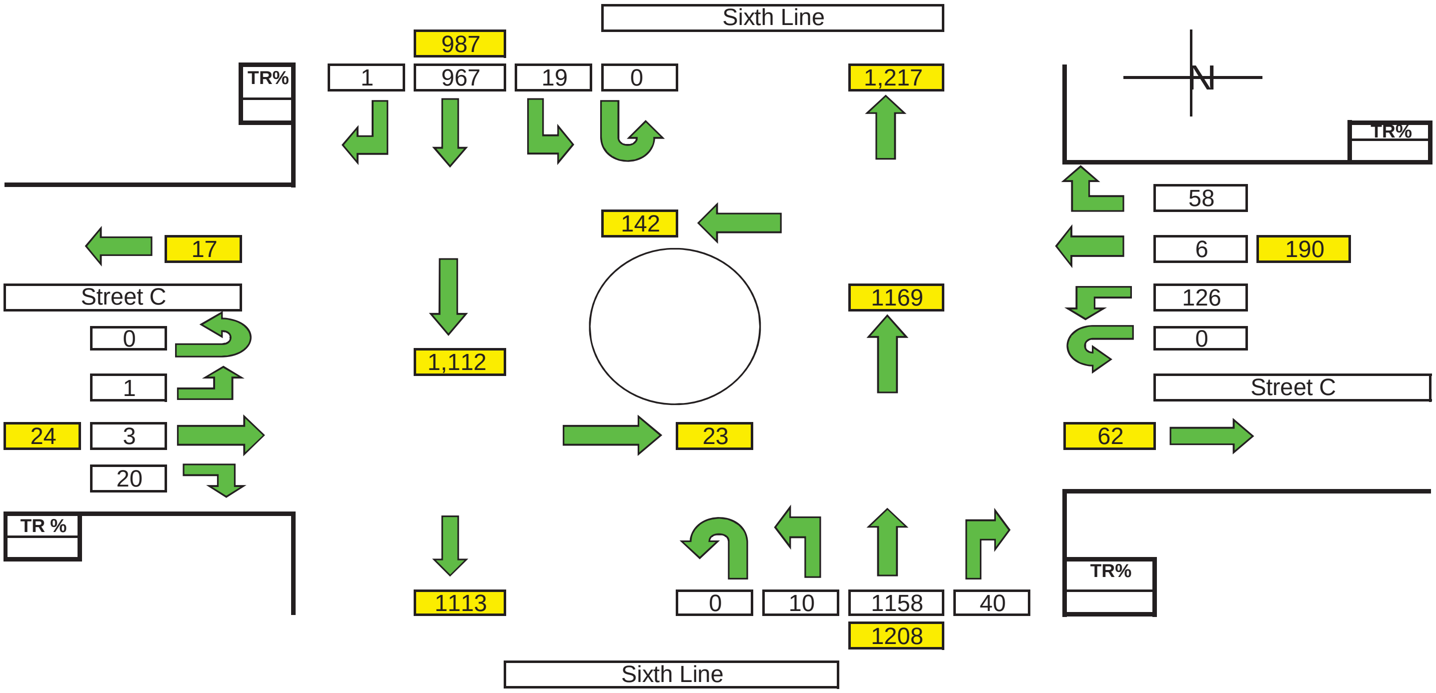
RODEL Inputs

Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	52	980	13	0
North Park Drive	1	84	13	36	0
Sixth Line	1	239	1184	114	0
North Park Drive	1	45	13	99	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET
VERSION 1.0 AUG 22, 2008

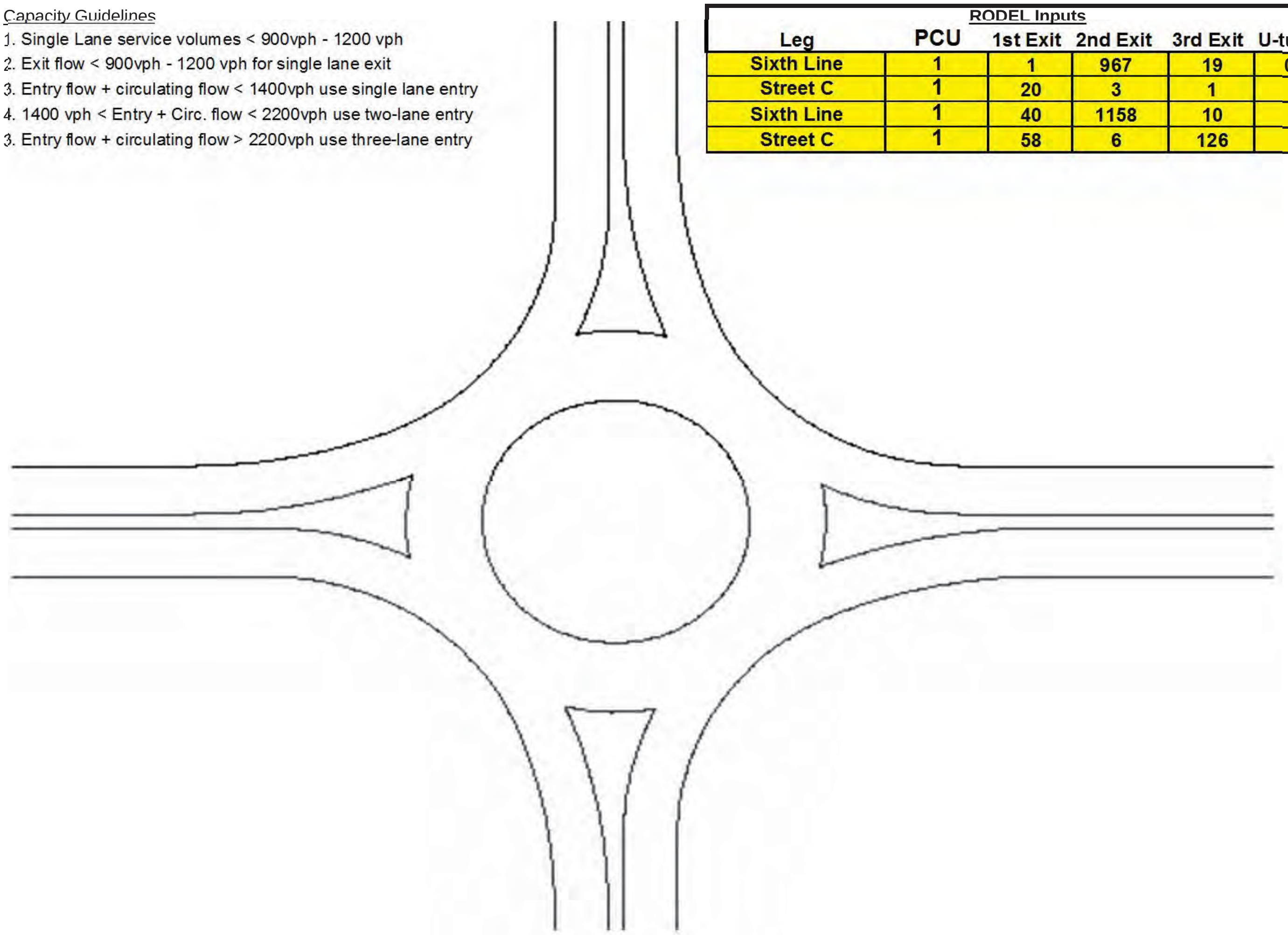
Project: Sixth Line Class EA (Dunda
Drawn By: DESIGNER
Project No.: ####
Sheet of
Intersection: Street C/Sixth Line
Time Period: AM PEAK (2031)



Capacity Guidelines
1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

RODEL Inputs

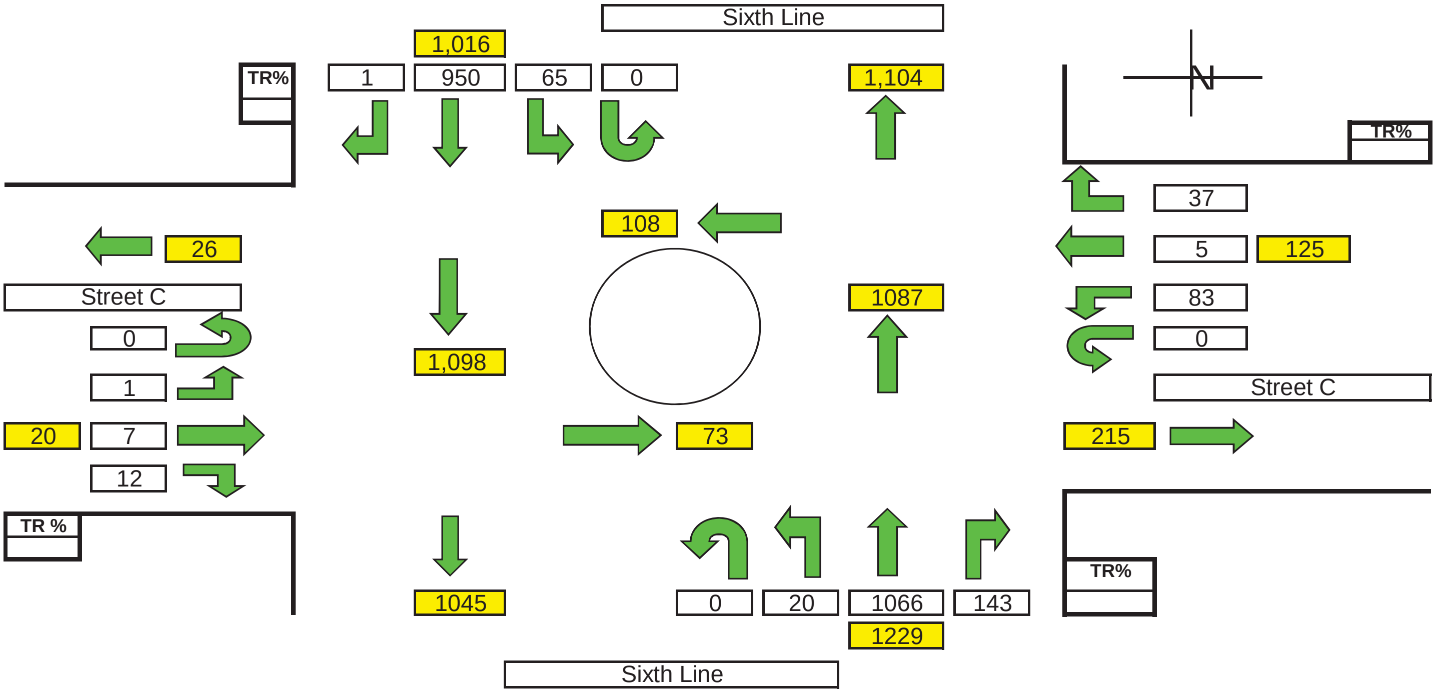
Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	1	967	19	0
Street C	1	20	3	1	0
Sixth Line	1	40	1158	10	0
Street C	1	58	6	126	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET

VERSION 1.0 AUG 22, 2008

Project: Sixth Line Class EA (Dunda **Drawn By:** DESIGNER
Project No.: #### **Sheet** of
Intersection: Street C/Sixth Line
Time Period: PM PEAK (2031)

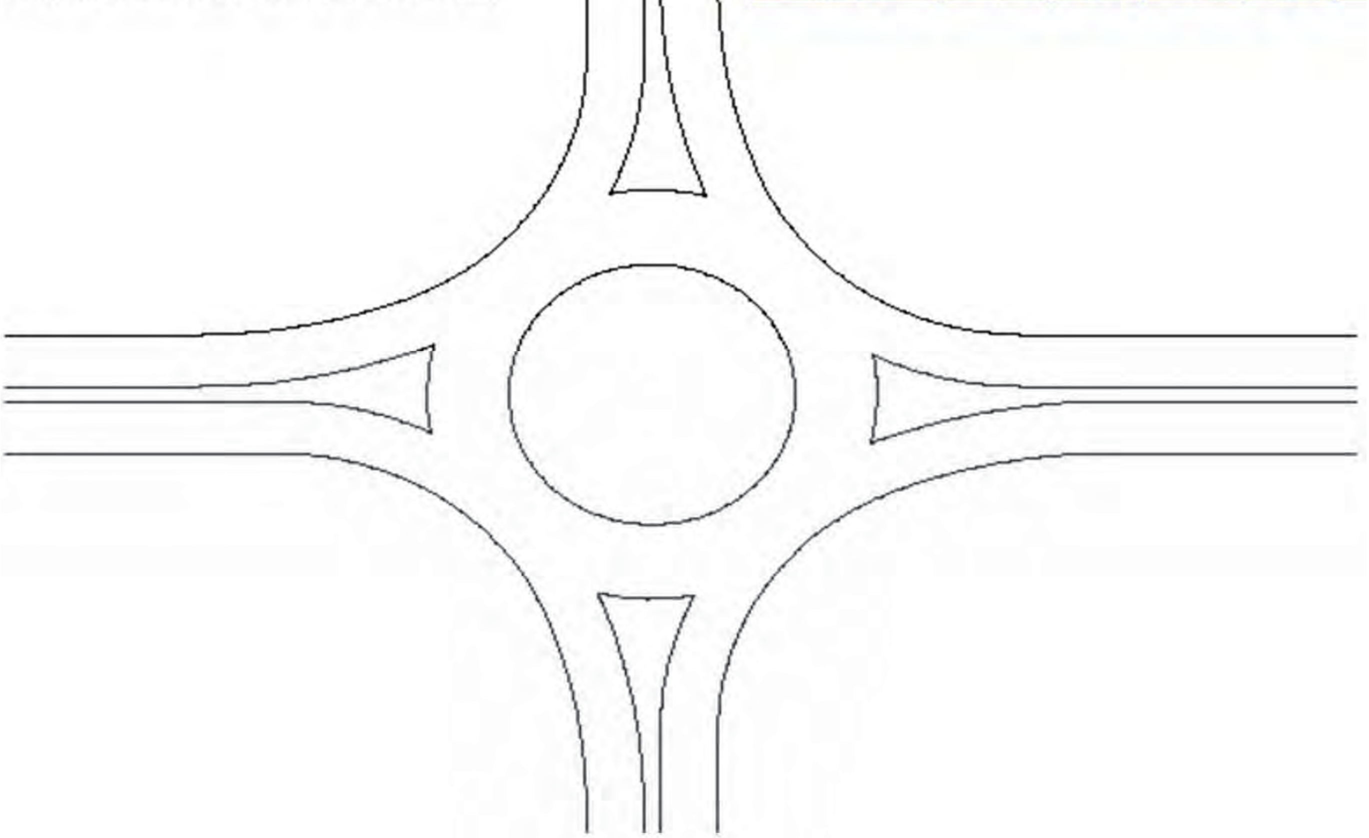


Capacity Guidelines

1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

RODEL Inputs

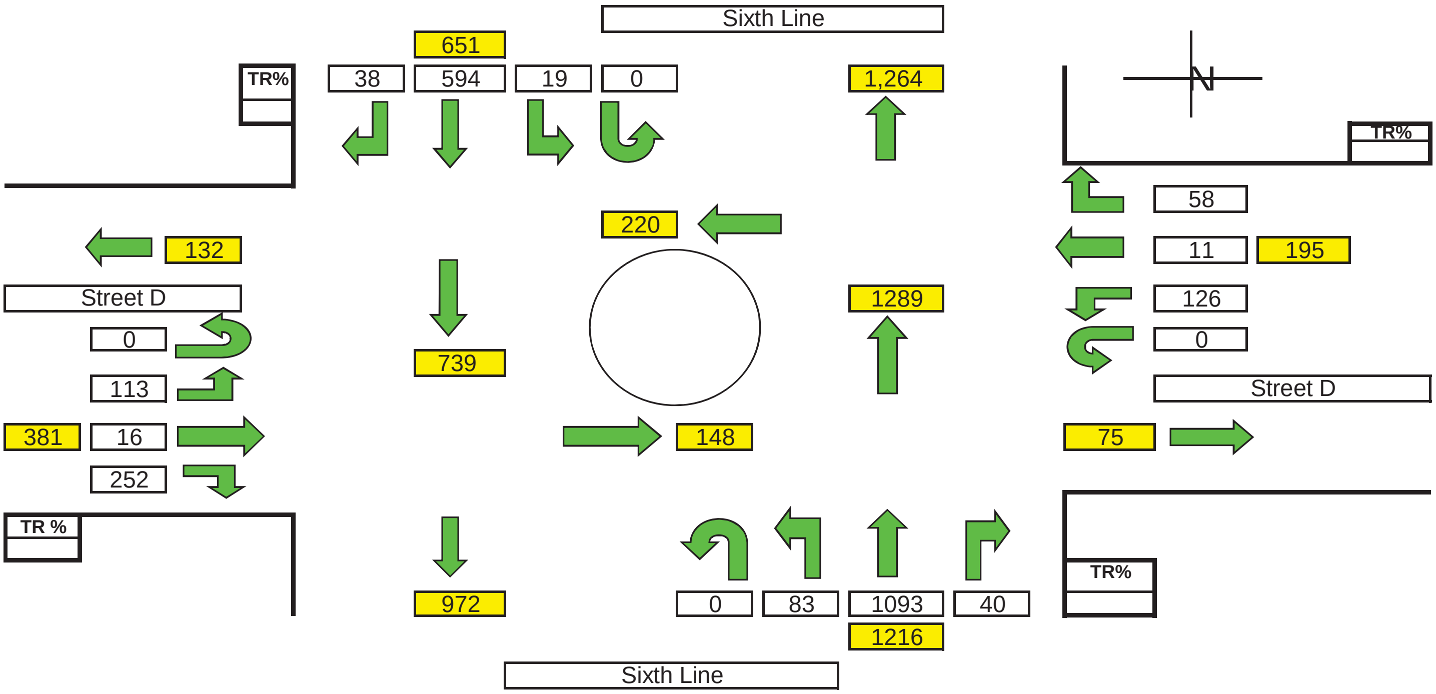
Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	1	950	65	0
Street C	1	12	7	1	0
Sixth Line	1	143	1066	20	0
Street C	1	37	5	83	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET

VERSION 1.0 AUG 22, 2008

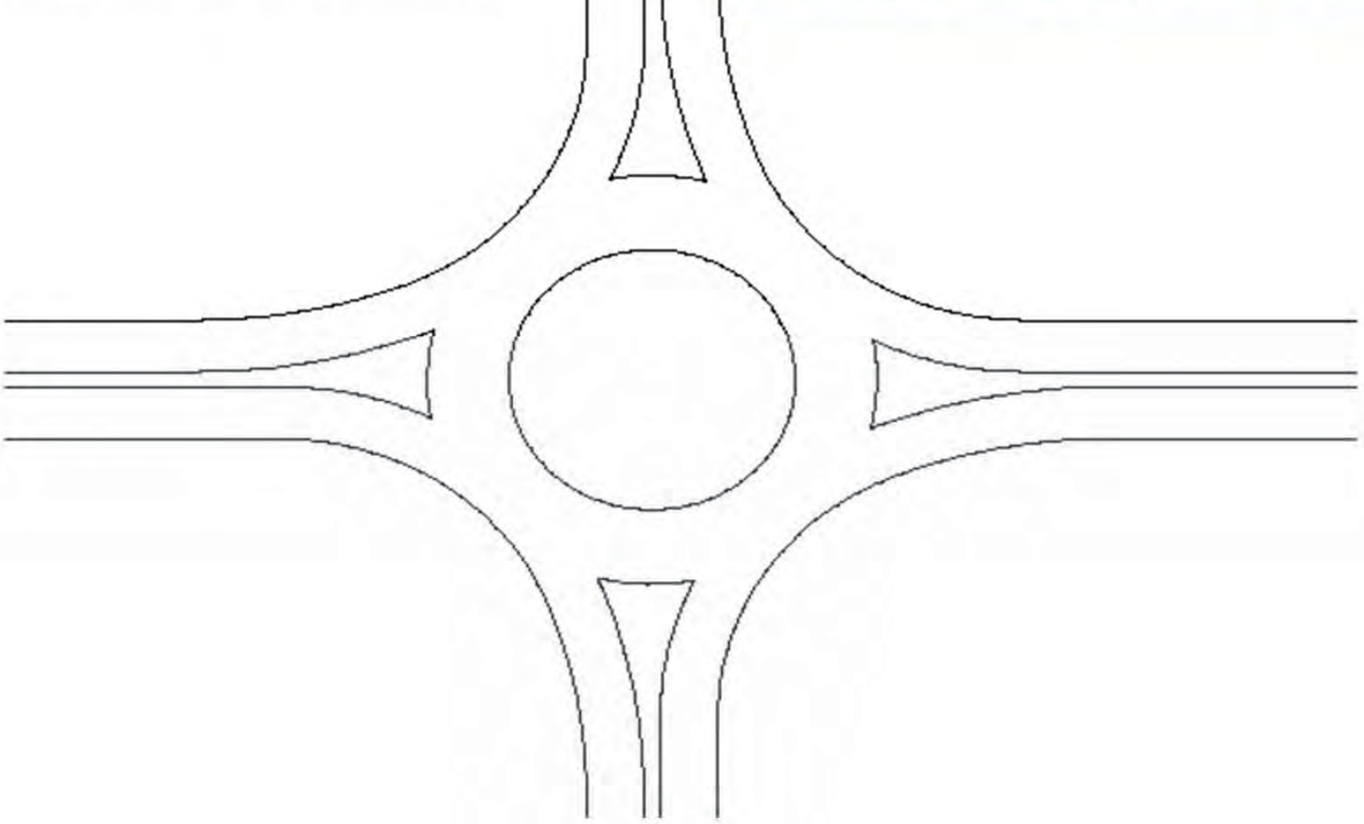
Project: Sixth Line Class EA (Dunda **Drawn By:** DESIGNER
Project No.: #### **Sheet** of
Intersection: Street D/Sixth Line
Time Period: AM PEAK (2031)



Capacity Guidelines
1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

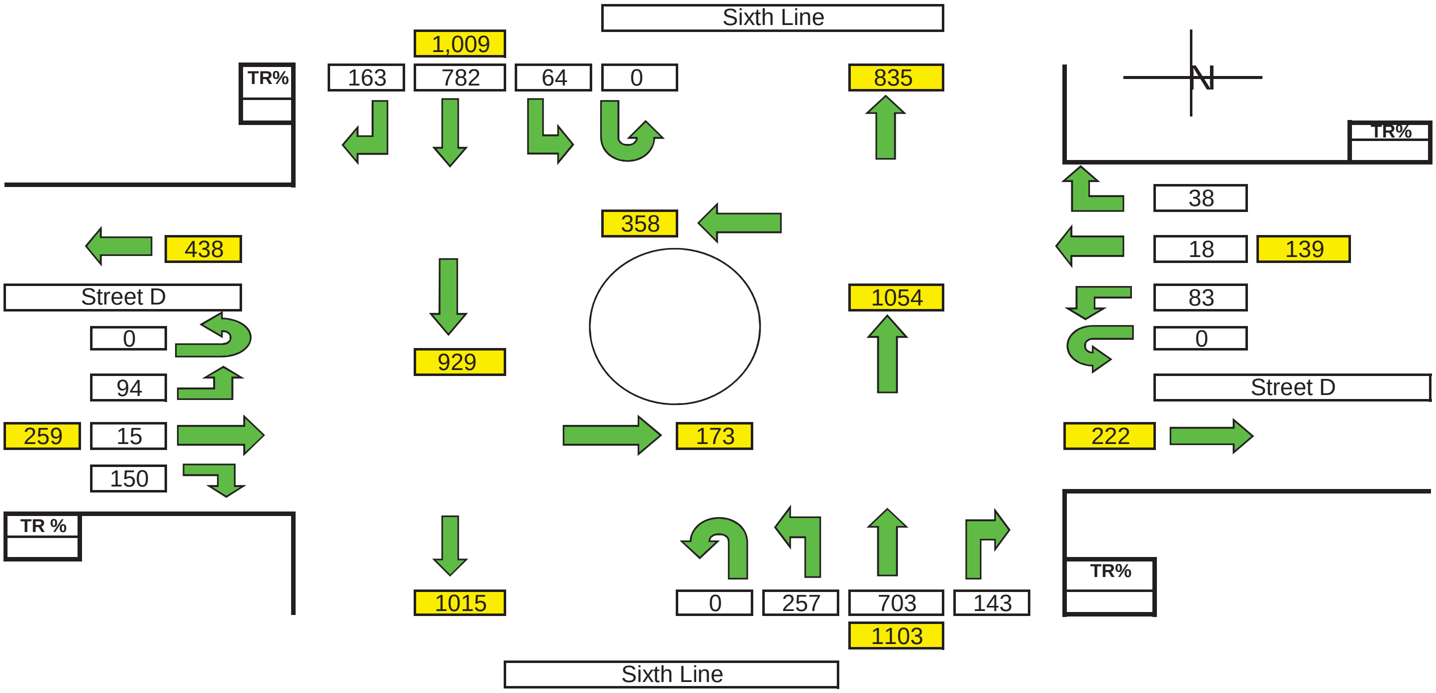
RODEL Inputs

Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	38	594	19	0
Street D	1	252	16	113	0
Sixth Line	1	40	1093	83	0
Street D	1	58	11	126	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET
VERSION 1.0 AUG 22, 2008

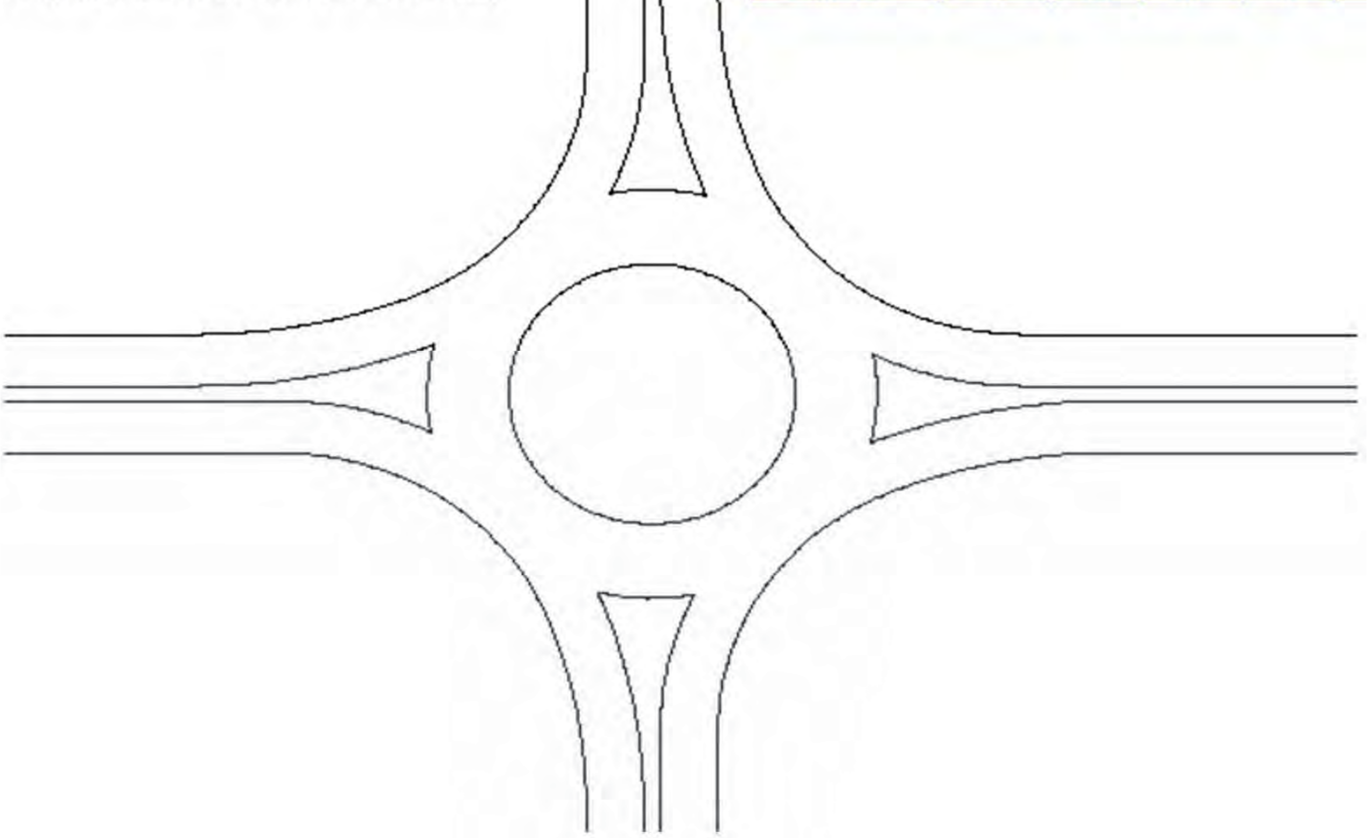
Project: Sixth Line Class EA (Dunda
Drawn By: DESIGNER
Project No.: ####
Sheet of
Intersection: Street D/Sixth Line
Time Period: PM PEAK (2031)



Capacity Guidelines
1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

RODEL Inputs

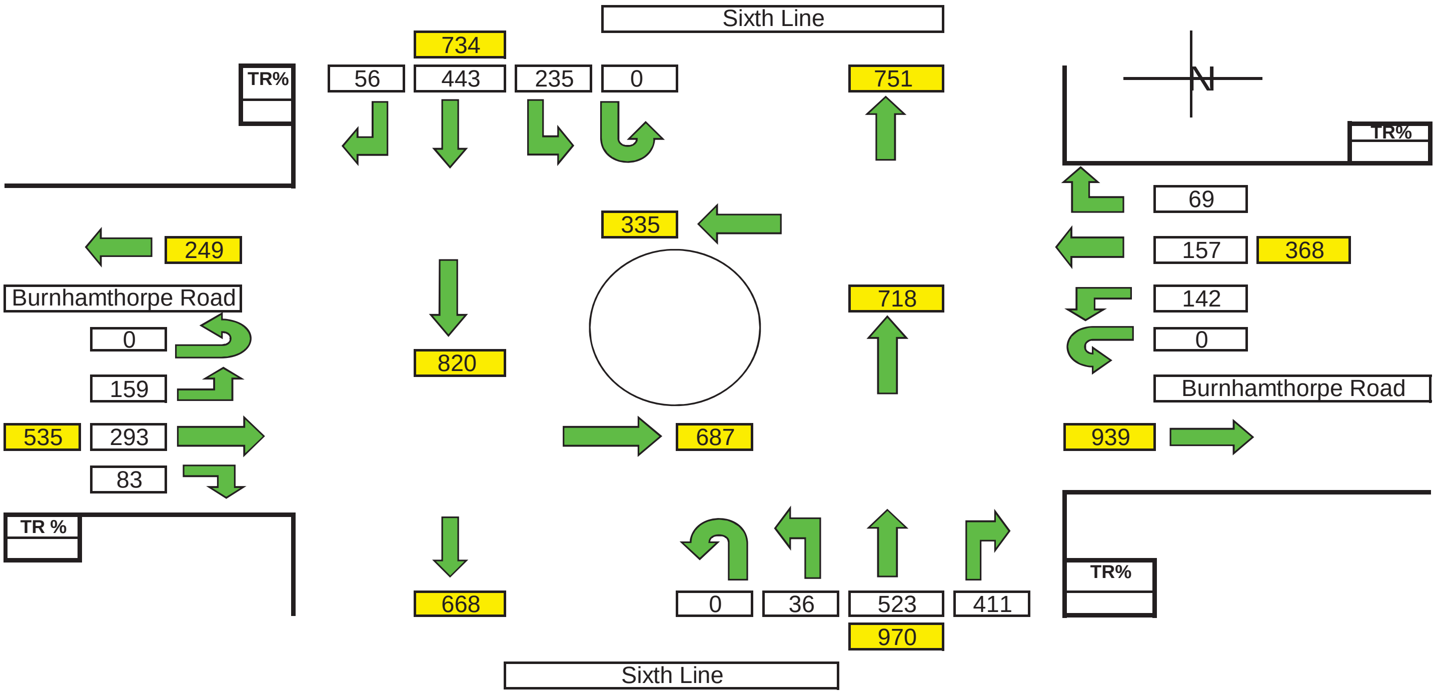
Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	163	782	64	0
Street D	1	150	15	94	0
Sixth Line	1	143	703	257	0
Street D	1	38	18	83	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET

VERSION 1.0 AUG 22, 2008

Project: Sixth Line Class EA (Dunda **Drawn By:** DESIGNER
Project No.: #### **Sheet** of
Intersection: Burnhamthorpe Road/Sixth Line
Time Period: AM PEAK (2031)

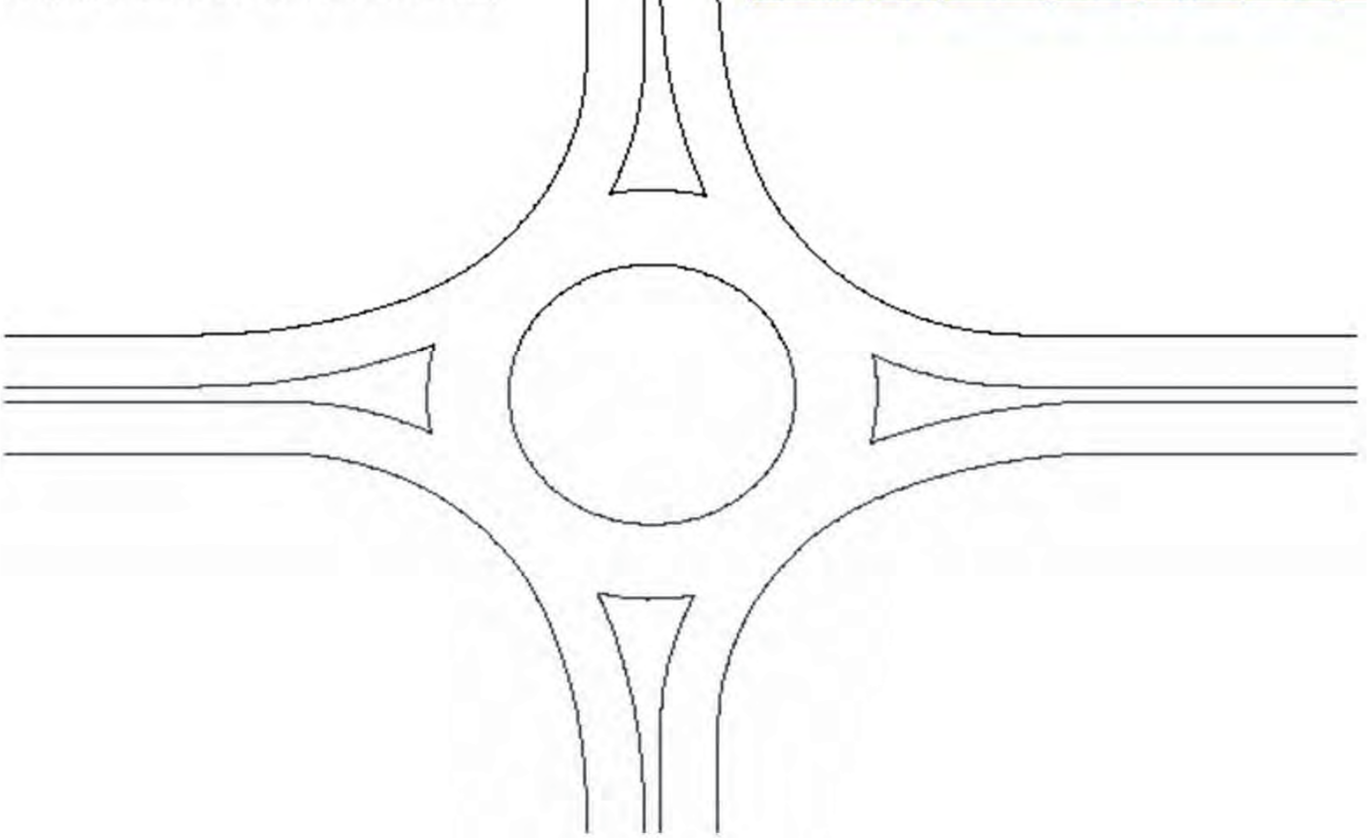


Capacity Guidelines

1. Single Lane service volumes < 900vph - 1200 vph
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

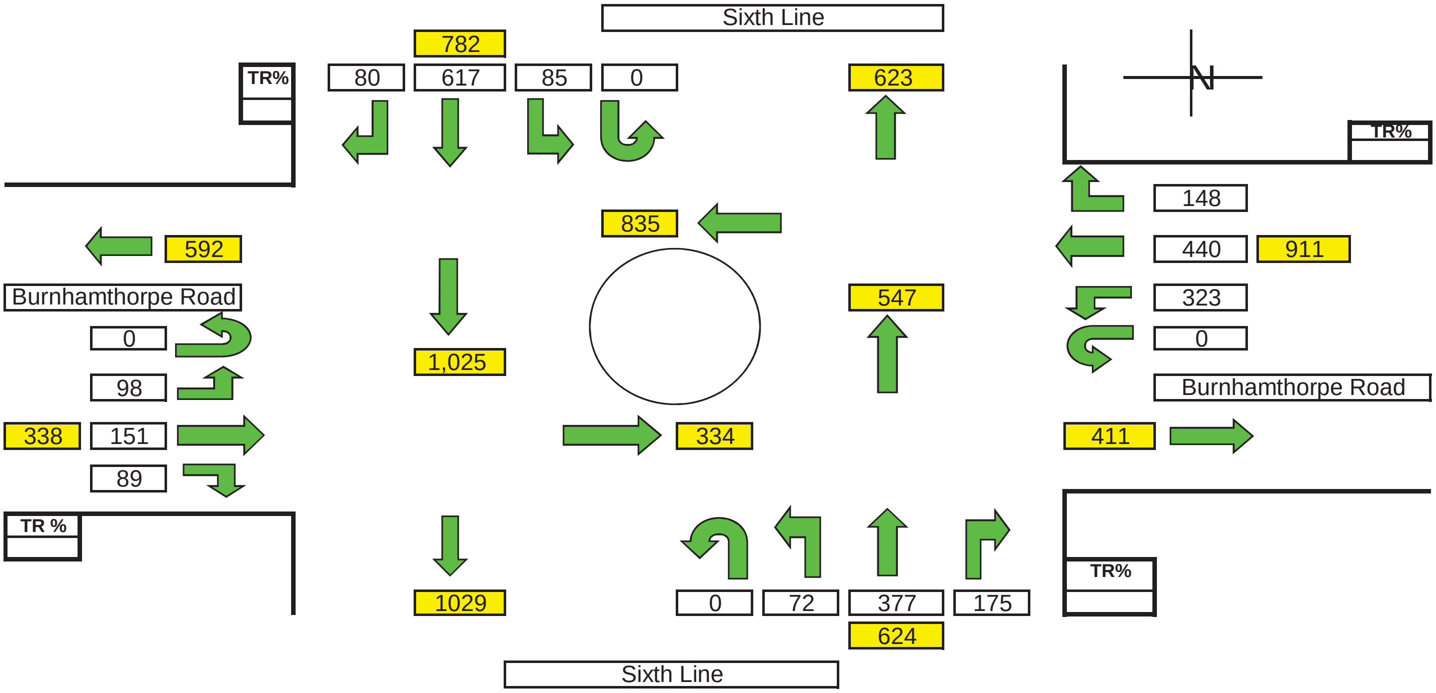
RODEL Inputs

Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	56	443	235	0
urnhamthorpe Roa	1	83	293	159	0
Sixth Line	1	411	523	36	0
urnhamthorpe Roa	1	69	157	142	0



REGION OF WATERLOO
ROUNDABOUT TRAFFIC FLOW SHEET
VERSION 1.0 AUG 22, 2008

Project: Sixth Line Class EA (Dunda **Drawn By:** DESIGNER
Project No.: #### **Sheet** of
Intersection: Burnhamthorpe Road/Sixth Line
Time Period: PM PEAK (2031)



Capacity Guidelines
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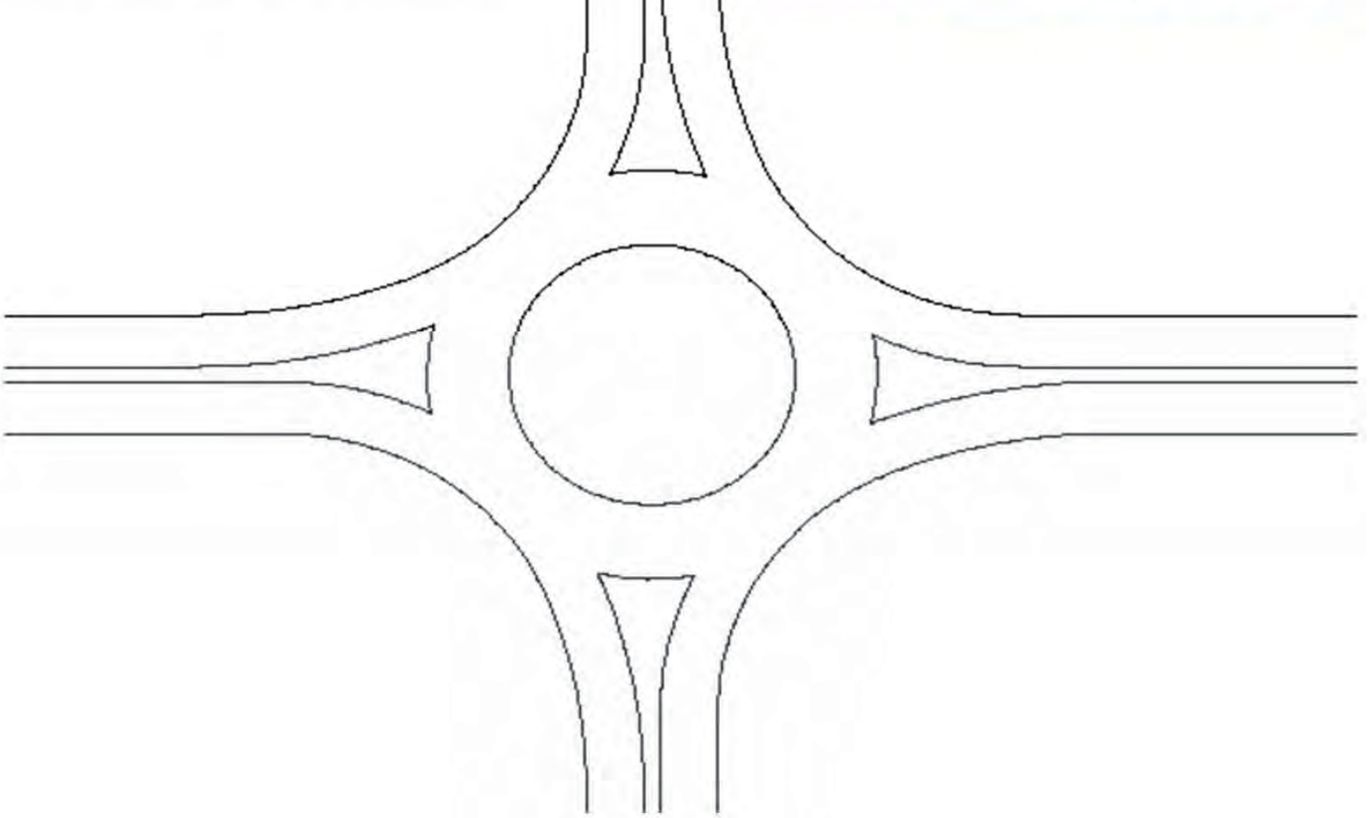
2. Exit flow < 900vph - 1200 vph for single lane exit
3. Entry flow + circulating flow < 1400vph use single lane entry
4. 1400 vph < Entry + Circ. flow < 2200vph use two-lane entry
3. Entry flow + circulating flow > 2200vph use three-lane entry

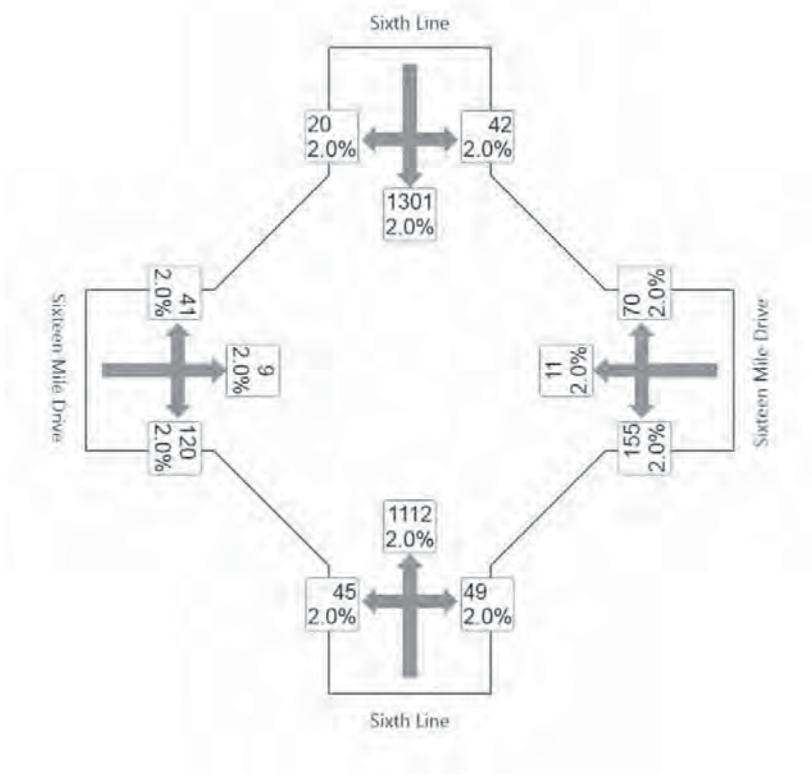
RODEL Inputs

Leg	PCU	1st Exit	2nd Exit	3rd Exit	U-turn
Sixth Line	1	80	617	85	0
urnhamthorpe Roa	1	89	151	98	0
Sixth Line	1	175	377	72	0
urnhamthorpe Roa	1	148	440	323	0

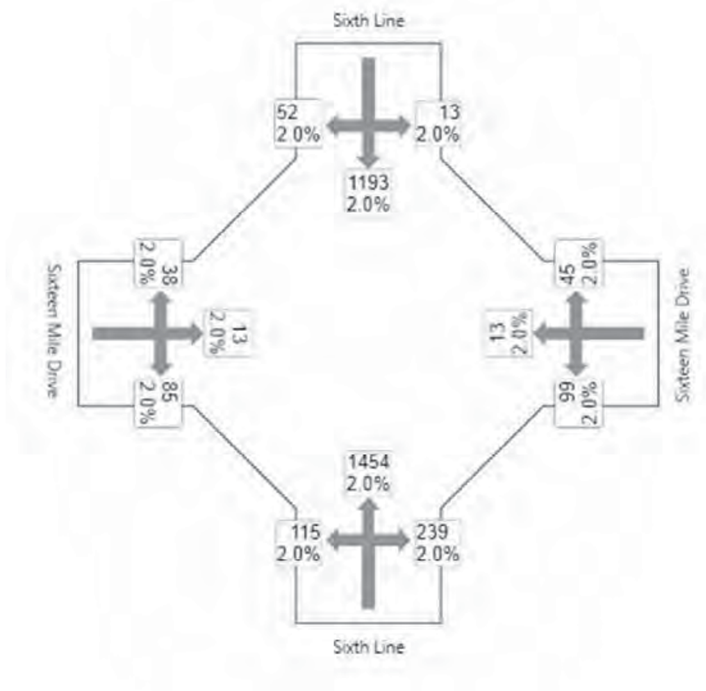


Appendix B.8 – Future (2031) SIDRA Analysis

SIDRA's Input for Future (2031) AM and PM Peak Hours (Sixteen Mile Drive and Sixth Line)



AM Peak Hour Turning Movement Counts



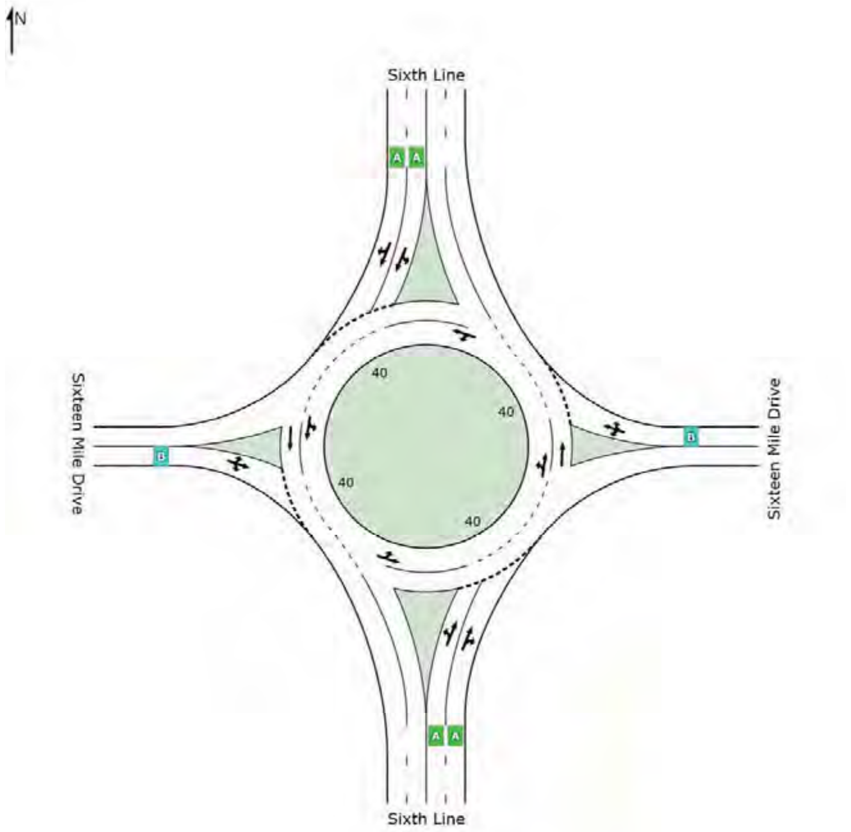
PM Peak Hour Turning Movement Counts

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	45	2.0	0.186	12.8	LOS B	1.2	8.9	0.19	0.87	47.8
4T	T	1112	2.0	0.186	3.6	LOS A	1.2	8.9	0.19	0.32	53.0
4R	R	49	2.0	0.186	5.7	LOS A	1.2	8.9	0.19	0.48	52.5
Approach		1206	2.0	0.186	4.0	LOS A	1.2	8.9	0.19	0.35	52.7
East: Sixteen Mile Drive											
5L	L	155	2.0	0.127	13.9	LOS B	0.8	5.9	0.69	0.75	47.9
2T	T	11	2.0	0.127	7.3	LOS A	0.8	5.9	0.69	0.58	51.6
2R	R	70	2.0	0.127	7.3	LOS A	0.8	5.9	0.69	0.61	51.1
Approach		236	2.0	0.127	11.7	LOS B	0.8	5.9	0.69	0.70	48.9
North: Sixth Line											
3L	L	42	2.0	0.226	12.9	LOS B	1.7	12.4	0.34	0.82	47.8
8T	T	1301	2.0	0.226	3.8	LOS A	1.7	12.4	0.34	0.36	51.7
8R	R	20	2.0	0.226	5.8	LOS A	1.7	12.4	0.34	0.48	51.7
Approach		1363	2.0	0.226	4.1	LOS A	1.7	12.4	0.34	0.37	51.5
West: Sixteen Mile Drive											
1L	L	41	2.0	0.119	15.0	LOS B	0.9	6.2	0.84	0.79	48.6
6T	T	9	2.0	0.119	8.1	LOS A	0.9	6.2	0.84	0.67	50.9
6R	R	120	2.0	0.119	8.5	LOS A	0.9	6.2	0.84	0.70	50.5
Approach		170	2.0	0.119	10.0	LOS B	0.9	6.2	0.84	0.72	50.0
All Vehicles		2975	2.0	0.226	5.0	LOS A	1.7	12.4	0.34	0.41	51.7

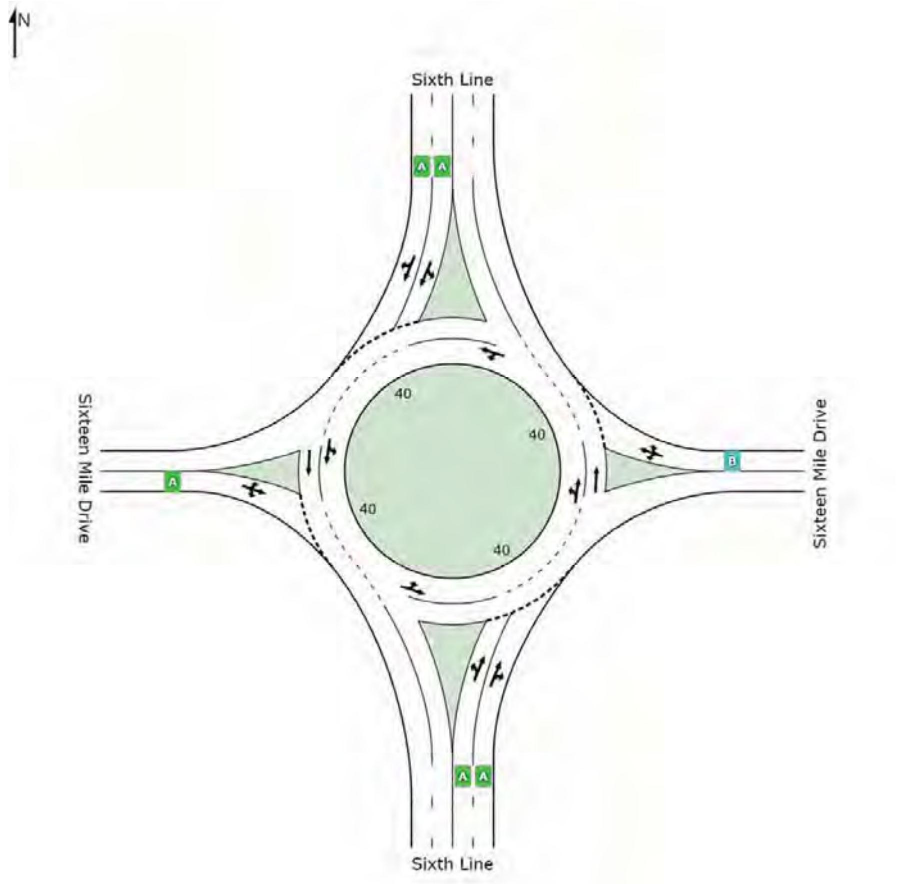
Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.



	South	East	North	West	Intersection
LOS	A	B	A	B	A

Pm peak Hour

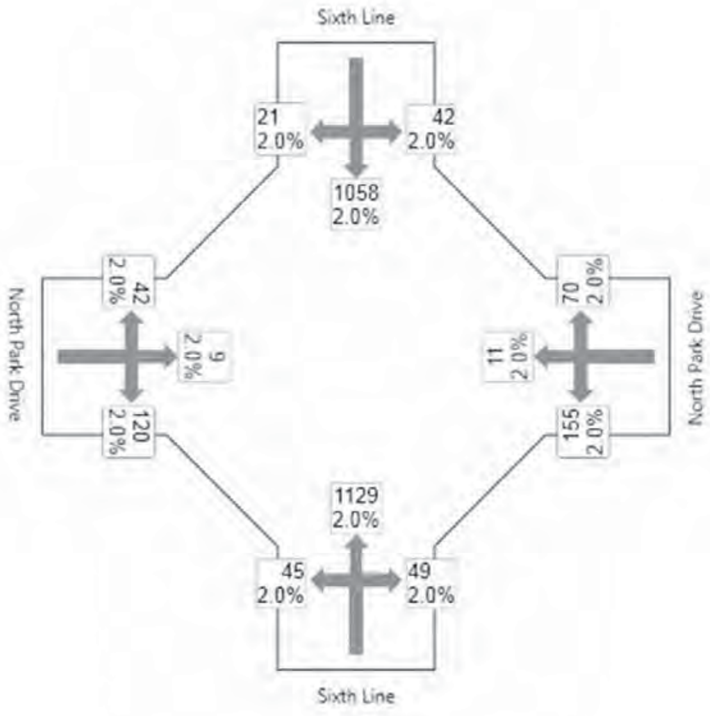
Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	115	2.0	0.275	12.7	LOS B	2.1	14.7	0.17	0.86	47.7
4T	T	1454	2.0	0.275	3.6	LOS A	2.1	14.7	0.17	0.31	53.1
4R	R	239	2.0	0.275	5.7	LOS A	2.1	14.7	0.17	0.47	52.6
Approach		1808	2.0	0.275	4.4	LOS A	2.1	14.7	0.17	0.37	52.6
East: Sixteen Mile Drive											
5L	L	99	2.0	0.112	15.5	LOS B	0.8	5.7	0.83	0.78	47.6
2T	T	13	2.0	0.112	8.9	LOS A	0.8	5.7	0.83	0.71	50.2
2R	R	45	2.0	0.112	8.9	LOS A	0.8	5.7	0.83	0.73	50.0
Approach		157	2.0	0.112	13.1	LOS B	0.8	5.7	0.83	0.76	48.4
North: Sixth Line											
3L	L	13	2.0	0.209	13.0	LOS B	1.5	10.9	0.34	0.83	47.9
8T	T	1193	2.0	0.209	3.8	LOS A	1.5	10.9	0.34	0.36	51.7
8R	R	52	2.0	0.209	5.8	LOS A	1.5	10.9	0.34	0.48	51.7
Approach		1258	2.0	0.209	4.0	LOS A	1.5	10.9	0.34	0.37	51.7
West: Sixteen Mile Drive											
1L	L	38	2.0	0.083	14.2	LOS B	0.6	4.2	0.77	0.76	48.7
6T	T	13	2.0	0.083	7.4	LOS A	0.6	4.2	0.77	0.61	51.5
6R	R	85	2.0	0.083	7.8	LOS A	0.6	4.2	0.77	0.64	51.0
Approach		136	2.0	0.083	9.6	LOS A	0.6	4.2	0.77	0.67	50.4
All Vehicles		3359	2.0	0.275	4.9	LOS A	2.1	14.7	0.29	0.40	51.9



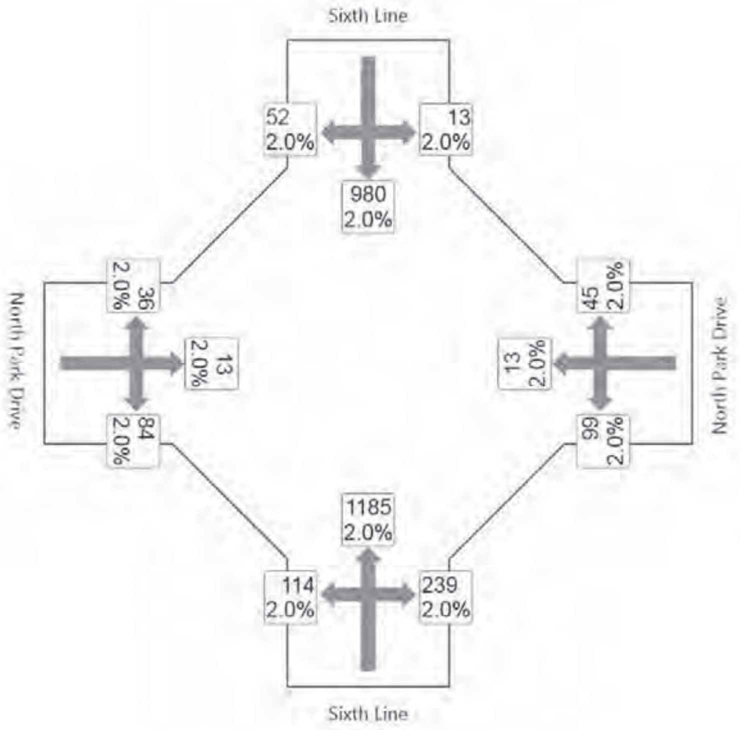
	South	East	North	West	Intersection
LOS	A	B	A	A	A

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

SIDRA's Input for Future (2031) AM and PM Peak Hours (North Park Drive and Sixth Line)



AM Peak Hour Turning Movement Counts



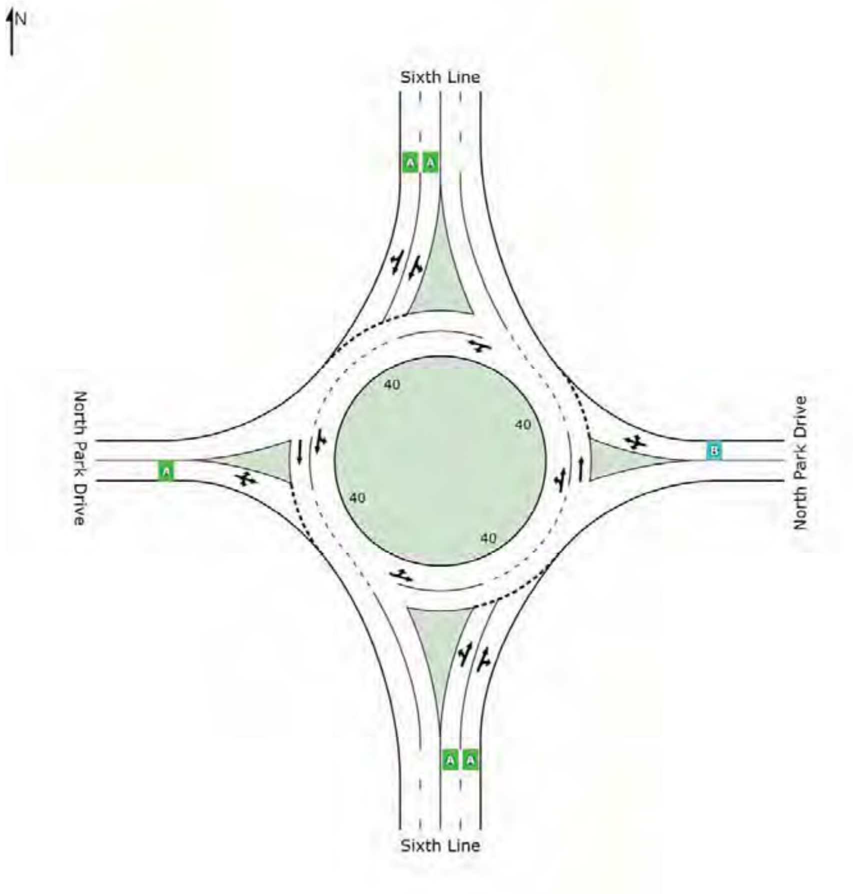
PM Peak Hour Turning Movement Counts

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	45	2.0	0.188	12.8	LOS B	1.2	8.9	0.19	0.87	47.8
4T	T	1129	2.0	0.188	3.6	LOS A	1.2	8.9	0.19	0.32	53.0
4R	R	49	2.0	0.188	5.7	LOS A	1.2	8.9	0.19	0.48	52.5
Approach		1223	2.0	0.188	4.0	LOS A	1.2	8.9	0.19	0.35	52.7
East: North Park Drive											
5L	L	155	2.0	0.128	14.0	LOS B	0.8	6.0	0.70	0.76	47.9
2T	T	11	2.0	0.128	7.3	LOS A	0.8	6.0	0.70	0.58	51.5
2R	R	70	2.0	0.128	7.4	LOS A	0.8	6.0	0.70	0.61	51.1
Approach		236	2.0	0.128	11.7	LOS B	0.8	6.0	0.70	0.71	48.9
North: Sixth Line											
3L	L	42	2.0	0.186	12.9	LOS B	1.4	10.0	0.34	0.81	47.8
8T	T	1058	2.0	0.186	3.8	LOS A	1.4	10.0	0.34	0.35	51.7
8R	R	21	2.0	0.186	5.8	LOS A	1.4	10.0	0.34	0.48	51.7
Approach		1121	2.0	0.186	4.2	LOS A	1.4	10.0	0.34	0.37	51.5
West: North Park Drive											
1L	L	42	2.0	0.102	14.2	LOS B	0.7	5.1	0.76	0.76	48.7
6T	T	9	2.0	0.102	7.4	LOS A	0.7	5.1	0.76	0.60	51.6
6R	R	120	2.0	0.102	7.8	LOS A	0.7	5.1	0.76	0.64	51.1
Approach		171	2.0	0.102	9.3	LOS A	0.7	5.1	0.76	0.67	50.5
All Vehicles		2751	2.0	0.188	5.1	LOS A	1.4	10.0	0.33	0.41	51.7

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

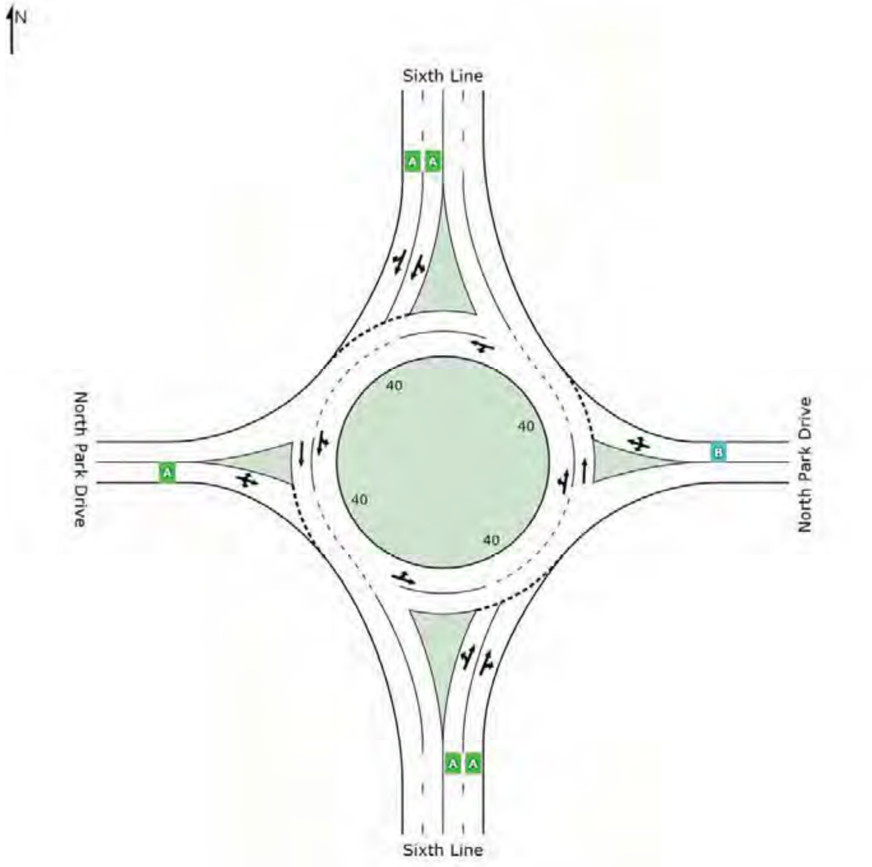


	South	East	North	West	Intersection
LOS	A	B	A	A	A

Pm peak Hour

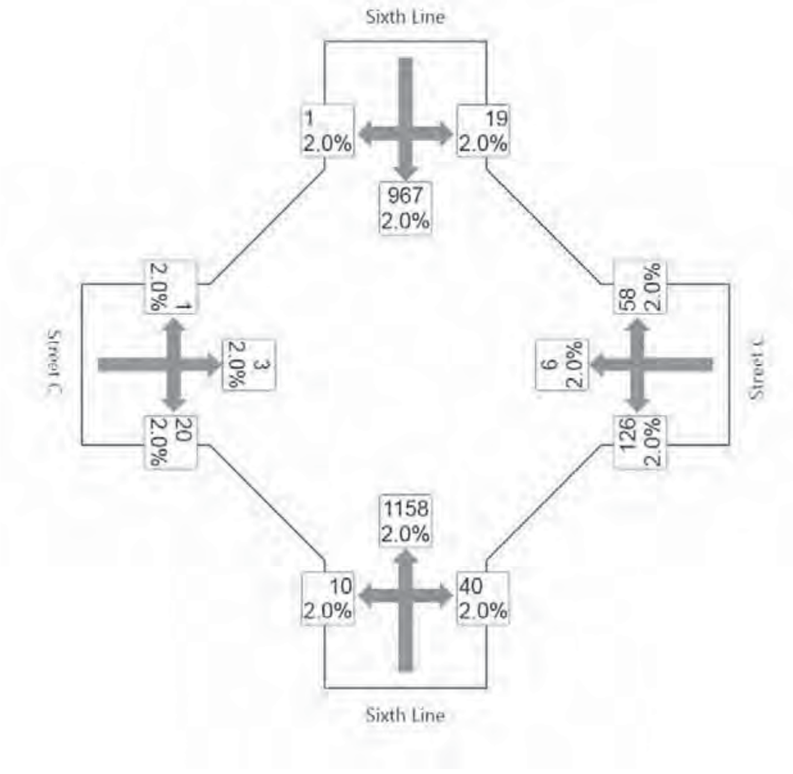
Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	114	2.0	0.233	12.7	LOS B	1.7	11.8	0.16	0.86	47.7
4T	T	1185	2.0	0.233	3.6	LOS A	1.7	11.8	0.16	0.31	53.2
4R	R	239	2.0	0.233	5.7	LOS A	1.7	11.8	0.16	0.47	52.6
Approach		1538	2.0	0.233	4.6	LOS A	1.7	11.8	0.16	0.38	52.6
East: North Park Drive											
5L	L	99	2.0	0.094	14.5	LOS B	0.6	4.6	0.75	0.75	47.9
2T	T	13	2.0	0.094	7.9	LOS A	0.6	4.6	0.75	0.63	51.0
2R	R	45	2.0	0.094	7.9	LOS A	0.6	4.6	0.75	0.66	50.7
Approach		157	2.0	0.094	12.1	LOS B	0.6	4.6	0.75	0.71	48.8
North: Sixth Line											
3L	L	13	2.0	0.174	12.9	LOS B	1.2	8.7	0.33	0.83	47.8
8T	T	980	2.0	0.174	3.8	LOS A	1.2	8.7	0.33	0.36	51.8
8R	R	52	2.0	0.174	5.8	LOS A	1.2	8.7	0.33	0.48	51.7
Approach		1045	2.0	0.174	4.0	LOS A	1.2	8.7	0.33	0.37	51.7
West: North Park Drive											
1L	L	36	2.0	0.071	13.7	LOS B	0.5	3.4	0.69	0.73	48.9
6T	T	13	2.0	0.071	6.9	LOS A	0.5	3.4	0.69	0.56	52.3
6R	R	84	2.0	0.071	7.3	LOS A	0.5	3.4	0.69	0.60	51.7
Approach		133	2.0	0.071	9.0	LOS A	0.5	3.4	0.69	0.63	50.9
All Vehicles		2873	2.0	0.233	5.0	LOS A	1.7	11.8	0.28	0.40	52.0

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

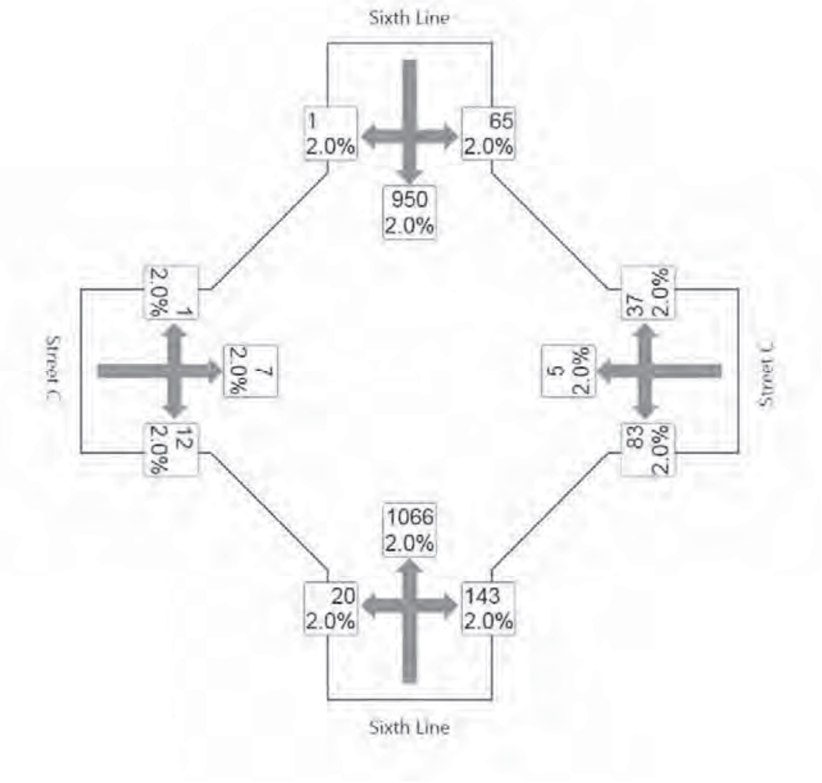


	South	East	North	West	Intersection
LOS	A	B	A	A	A

SIDRA’s Input for Future (2031) AM and PM Peak Hours (Street C and Sixth Line)



AM Peak Hour Turning Movement Counts

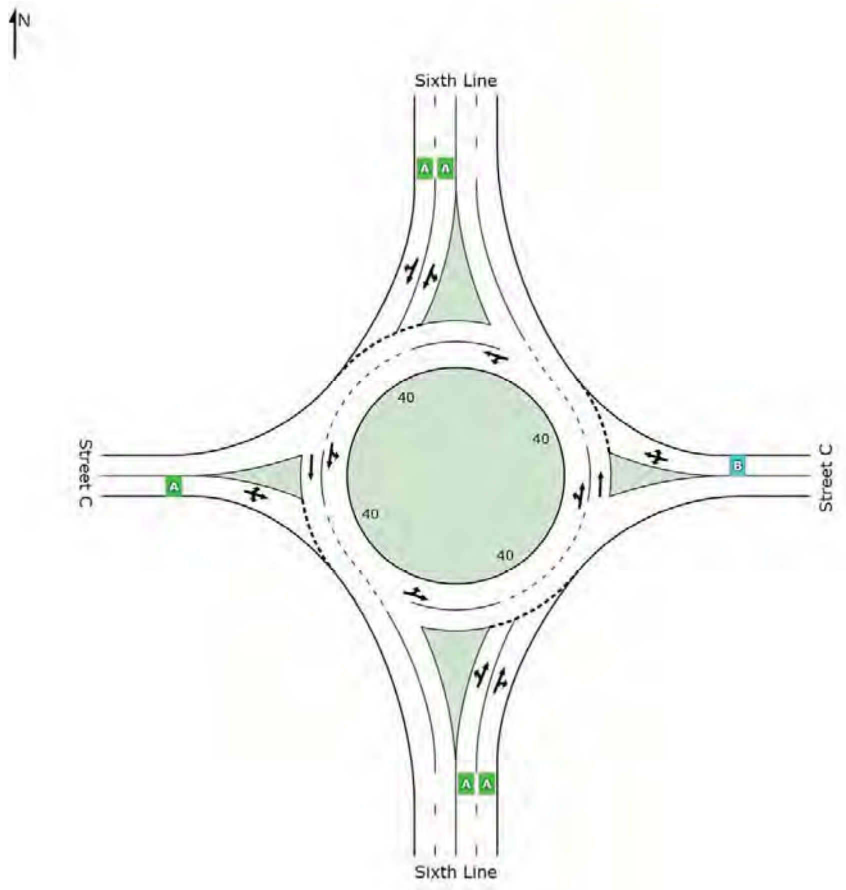


PM Peak Hour Turning Movement Counts

AM Peak Hour

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	10	2.0	0.179	12.7	LOS B	1.0	7.2	0.07	0.96	47.8
4T	T	1158	2.0	0.179	3.5	LOS A	1.0	7.2	0.07	0.32	54.1
4R	R	40	2.0	0.179	5.7	LOS A	1.0	7.2	0.07	0.49	53.2
Approach		1208	2.0	0.179	3.7	LOS A	1.0	7.2	0.07	0.33	54.0
East: Street C											
5L	L	126	2.0	0.096	13.7	LOS B	0.6	4.1	0.64	0.74	48.1
2T	T	6	2.0	0.096	7.1	LOS A	0.6	4.1	0.64	0.56	52.2
2R	R	58	2.0	0.096	7.2	LOS A	0.6	4.1	0.64	0.59	51.6
Approach		190	2.0	0.096	11.5	LOS B	0.6	4.1	0.64	0.69	49.2
North: Sixth Line											
3L	L	19	2.0	0.157	12.8	LOS B	1.1	8.1	0.26	0.85	47.8
8T	T	967	2.0	0.157	3.7	LOS A	1.1	8.1	0.26	0.34	52.4
8R	R	1	2.0	0.157	5.6	LOS A	1.1	8.1	0.26	0.47	52.2
Approach		987	2.0	0.157	3.8	LOS A	1.1	8.1	0.26	0.35	52.3
West: Street C											
1L	L	1	2.0	0.013	13.6	LOS B	0.1	0.6	0.67	0.69	49.5
6T	T	3	2.0	0.013	6.8	LOS A	0.1	0.6	0.67	0.52	52.9
6R	R	20	2.0	0.013	7.2	LOS A	0.1	0.6	0.67	0.55	52.2
Approach		24	2.0	0.013	7.4	LOS A	0.1	0.6	0.67	0.55	52.2
All Vehicles		2409	2.0	0.179	4.4	LOS A	1.1	8.1	0.20	0.37	52.9

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.



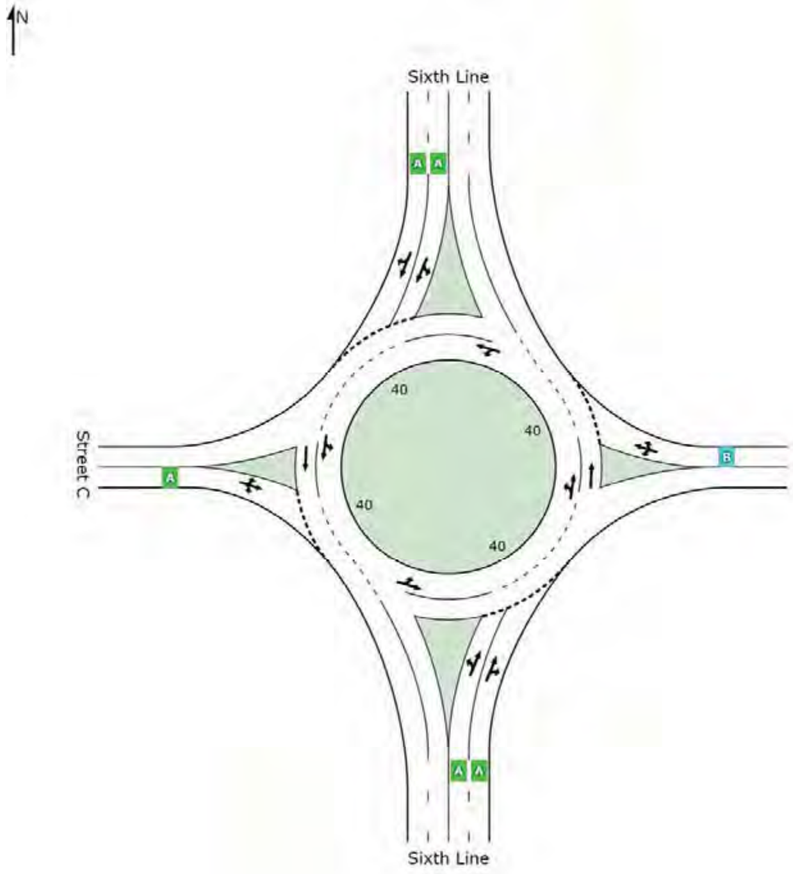
	South	East	North	West	Intersection
LOS	A	B	A	A	A

Pm peak Hour

Movement Performance - Vehicles

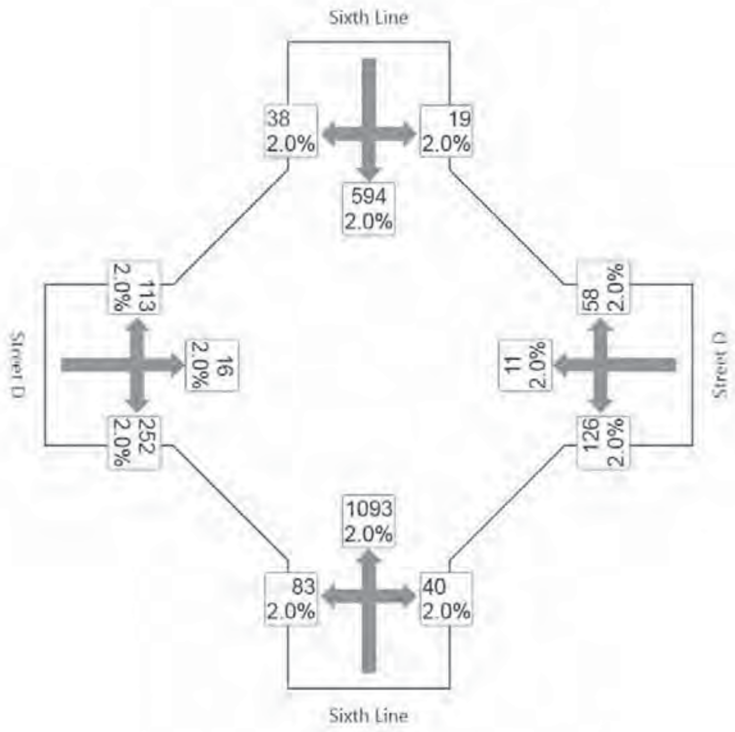
Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	20	2.0	0.186	12.7	LOS B	1.1	7.7	0.15	0.91	47.8
4T	T	1066	2.0	0.186	3.6	LOS A	1.1	7.7	0.15	0.32	53.4
4R	R	143	2.0	0.186	5.7	LOS A	1.1	7.7	0.15	0.48	52.7
Approach		1229	2.0	0.186	4.0	LOS A	1.1	7.7	0.15	0.35	53.2
East: Street C											
5L	L	83	2.0	0.063	13.7	LOS B	0.4	2.8	0.64	0.71	48.1
2T	T	5	2.0	0.063	7.0	LOS A	0.4	2.8	0.64	0.55	52.1
2R	R	37	2.0	0.063	7.1	LOS A	0.4	2.8	0.64	0.59	51.6
Approach		125	2.0	0.063	11.4	LOS B	0.4	2.8	0.64	0.67	49.2
North: Sixth Line											
3L	L	65	2.0	0.158	12.8	LOS B	1.1	7.8	0.22	0.85	47.7
8T	T	950	2.0	0.158	3.6	LOS A	1.1	7.8	0.22	0.33	52.8
8R	R	1	2.0	0.158	5.5	LOS A	1.1	7.8	0.22	0.47	52.5
Approach		1016	2.0	0.158	4.2	LOS A	1.1	7.8	0.22	0.36	52.4
West: Street C											
1L	L	1	2.0	0.010	13.5	LOS B	0.1	0.5	0.64	0.70	49.9
6T	T	7	2.0	0.010	6.7	LOS A	0.1	0.5	0.64	0.51	53.3
6R	R	12	2.0	0.010	7.1	LOS A	0.1	0.5	0.64	0.54	52.6
Approach		20	2.0	0.010	7.3	LOS A	0.1	0.5	0.64	0.54	52.7
All Vehicles		2390	2.0	0.186	4.5	LOS A	1.1	7.8	0.21	0.37	52.6

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

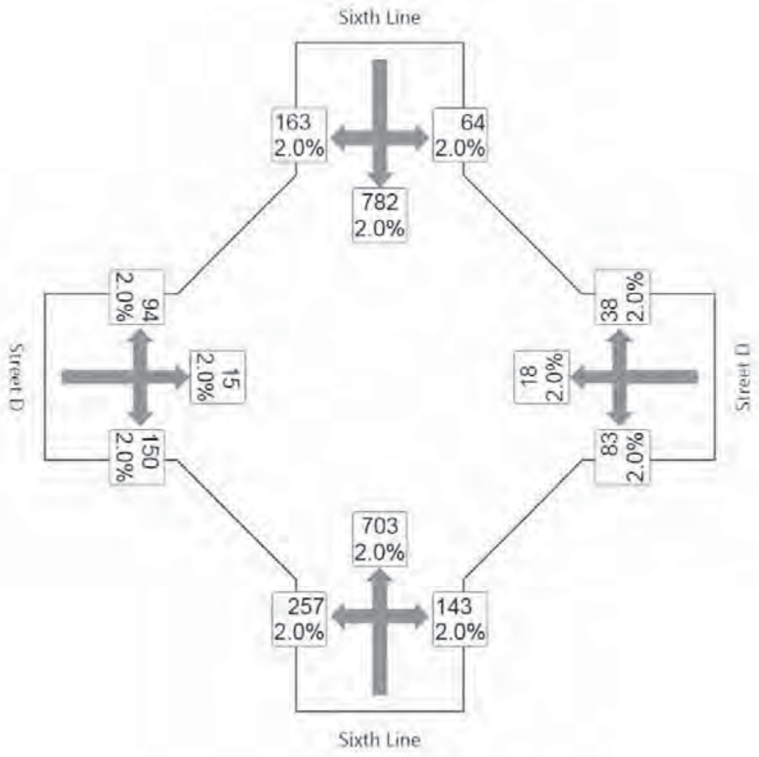


	South	East	North	West	Intersection
LOS	A	B	A	A	A

SIDRA's Input for Future (2031) AM and PM Peak Hours (Street D and Sixth Line)



AM Peak Hour Turning Movement Counts



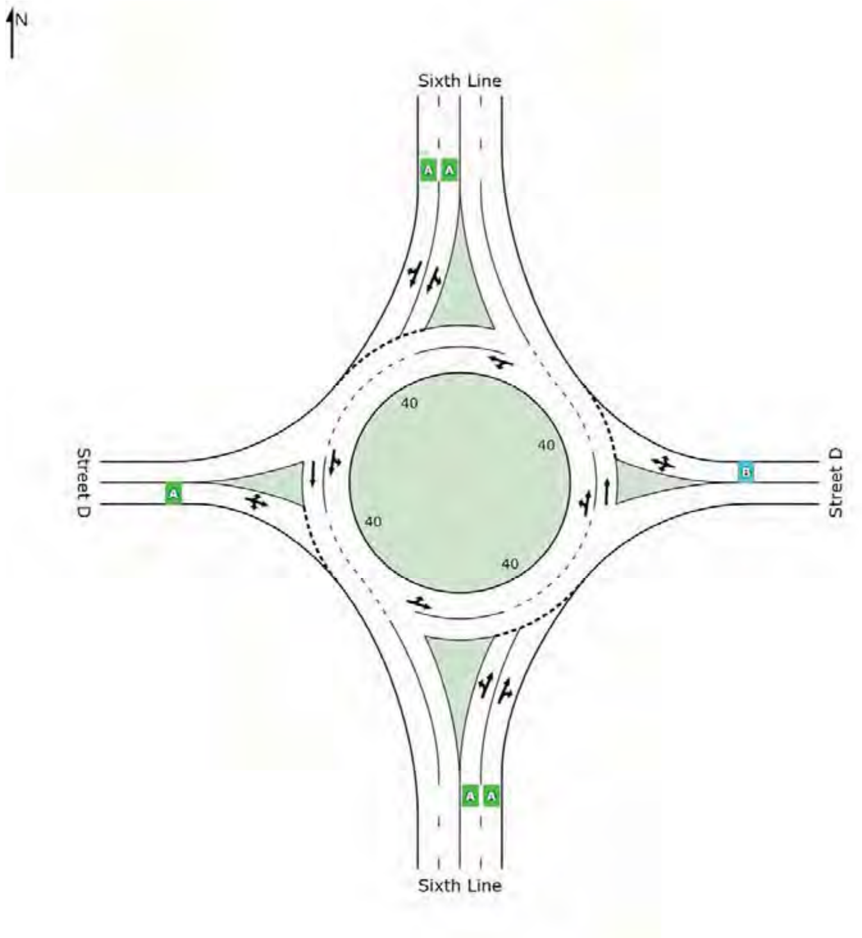
PM Peak Hour Turning Movement Counts

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	83	2.0	0.194	12.8	LOS B	1.4	9.8	0.27	0.82	47.7
4T	T	1093	2.0	0.194	3.7	LOS A	1.4	9.8	0.27	0.34	52.3
4R	R	40	2.0	0.194	5.8	LOS A	1.4	9.8	0.27	0.48	52.0
Approach		1216	2.0	0.194	4.4	LOS A	1.4	9.8	0.27	0.38	51.9
East: Street D											
5L	L	126	2.0	0.115	14.3	LOS B	0.8	5.7	0.75	0.76	47.8
2T	T	11	2.0	0.115	7.6	LOS A	0.8	5.7	0.75	0.61	51.0
2R	R	58	2.0	0.115	7.7	LOS A	0.8	5.7	0.75	0.64	50.7
Approach		195	2.0	0.115	11.9	LOS B	0.8	5.7	0.75	0.71	48.7
North: Sixth Line											
3L	L	19	2.0	0.108	12.9	LOS B	0.8	5.4	0.32	0.82	47.8
8T	T	594	2.0	0.108	3.8	LOS A	0.8	5.4	0.32	0.35	51.8
8R	R	38	2.0	0.108	5.7	LOS A	0.8	5.4	0.32	0.47	51.8
Approach		651	2.0	0.108	4.2	LOS A	0.8	5.4	0.32	0.37	51.7
West: Street D											
1L	L	113	2.0	0.164	13.2	LOS B	1.1	7.8	0.58	0.74	49.0
6T	T	16	2.0	0.164	6.4	LOS A	1.1	7.8	0.58	0.51	53.4
6R	R	252	2.0	0.164	6.7	LOS A	1.1	7.8	0.58	0.55	52.5
Approach		381	2.0	0.164	8.6	LOS A	1.1	7.8	0.58	0.60	51.4
All Vehicles		2443	2.0	0.194	5.6	LOS A	1.4	9.8	0.37	0.44	51.5

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.



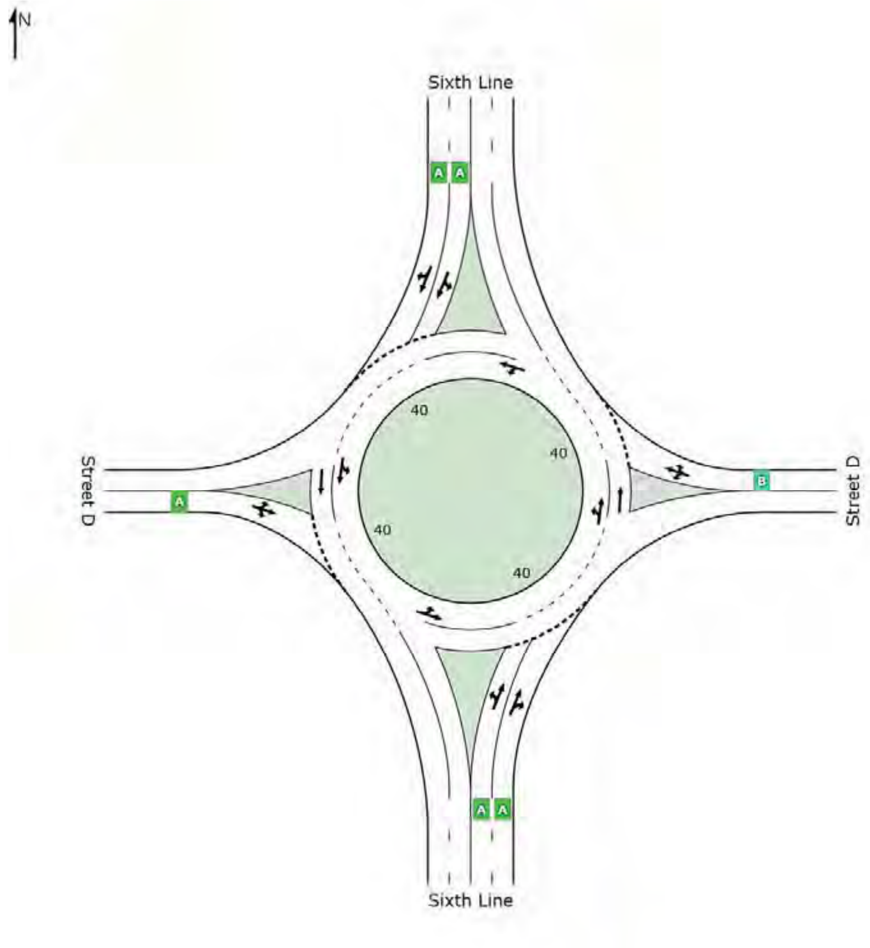
	South	East	North	West	Intersection
LOS	A	B	A	A	A

Pm peak Hour

Movement Performance - Vehicles

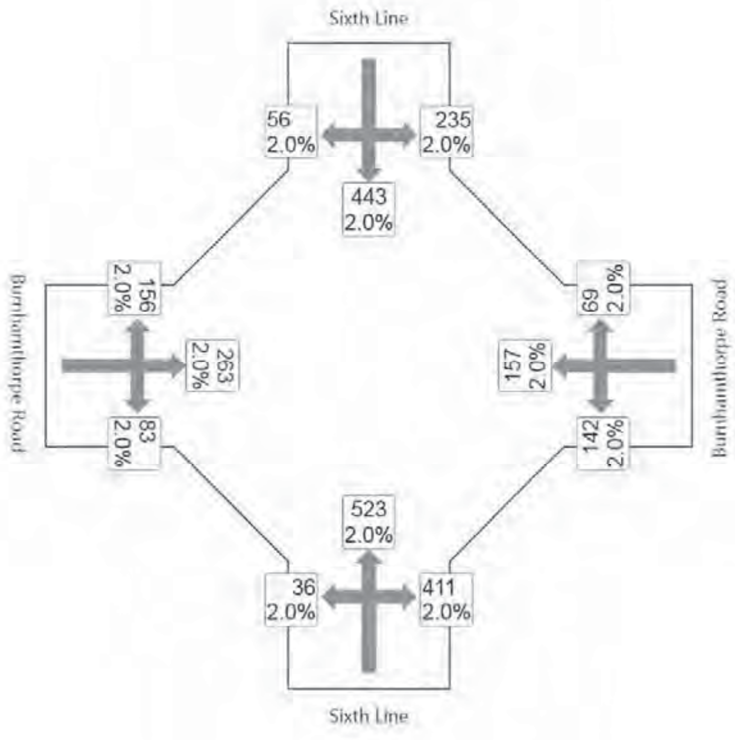
Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	257	2.0	0.178	12.9	LOS B	1.2	8.9	0.28	0.73	47.3
4T	T	703	2.0	0.178	3.7	LOS A	1.2	8.9	0.28	0.34	52.0
4R	R	143	2.0	0.178	5.8	LOS A	1.2	8.9	0.28	0.48	51.9
Approach		1103	2.0	0.178	6.1	LOS A	1.2	8.9	0.28	0.45	50.6
East: Street D											
5L	L	83	2.0	0.072	13.7	LOS B	0.5	3.5	0.68	0.71	48.2
2T	T	18	2.0	0.072	7.1	LOS A	0.5	3.5	0.68	0.57	51.8
2R	R	38	2.0	0.072	7.2	LOS A	0.5	3.5	0.68	0.59	51.4
Approach		139	2.0	0.072	11.1	LOS B	0.5	3.5	0.68	0.66	49.4
North: Sixth Line											
3L	L	64	2.0	0.180	13.2	LOS B	1.3	9.4	0.43	0.79	47.7
8T	T	782	2.0	0.180	4.1	LOS A	1.3	9.4	0.43	0.39	50.8
8R	R	163	2.0	0.180	6.1	LOS A	1.3	9.4	0.43	0.50	51.0
Approach		1009	2.0	0.180	5.0	LOS A	1.3	9.4	0.43	0.43	50.6
West: Street D											
1L	L	94	2.0	0.130	13.6	LOS B	0.9	6.7	0.69	0.73	48.6
6T	T	15	2.0	0.130	6.7	LOS A	0.9	6.7	0.69	0.55	52.2
6R	R	150	2.0	0.130	7.1	LOS A	0.9	6.7	0.69	0.59	51.5
Approach		259	2.0	0.130	9.4	LOS A	0.9	6.7	0.69	0.64	50.4
All Vehicles		2510	2.0	0.180	6.3	LOS A	1.3	9.4	0.41	0.47	50.5

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

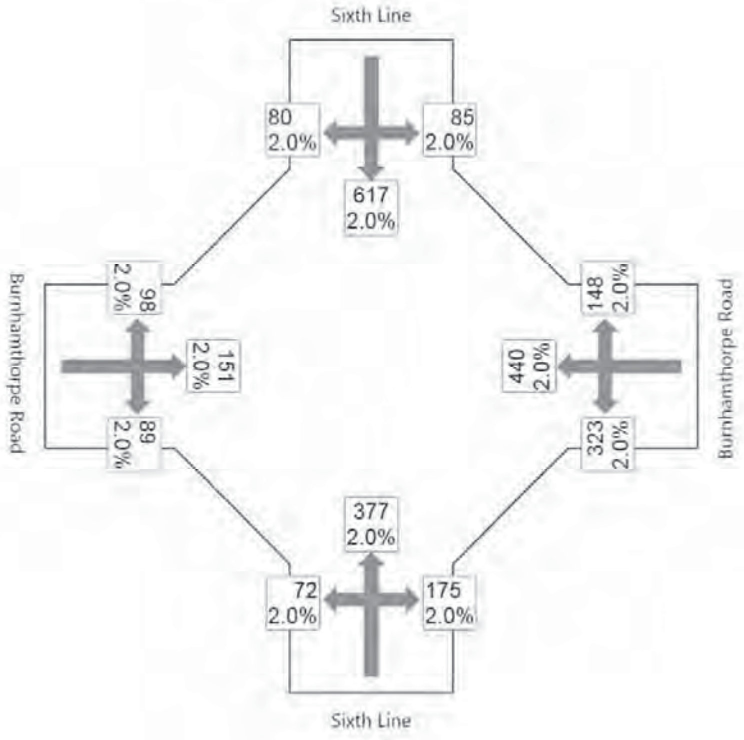


	South	East	North	West	Intersection
LOS	A	B	A	A	A

SIDRA's Input for Future (2031) AM and PM Peak Hours (Burnhamthorpe Road and Sixth Line)



AM Peak Hour Turning Movement Counts



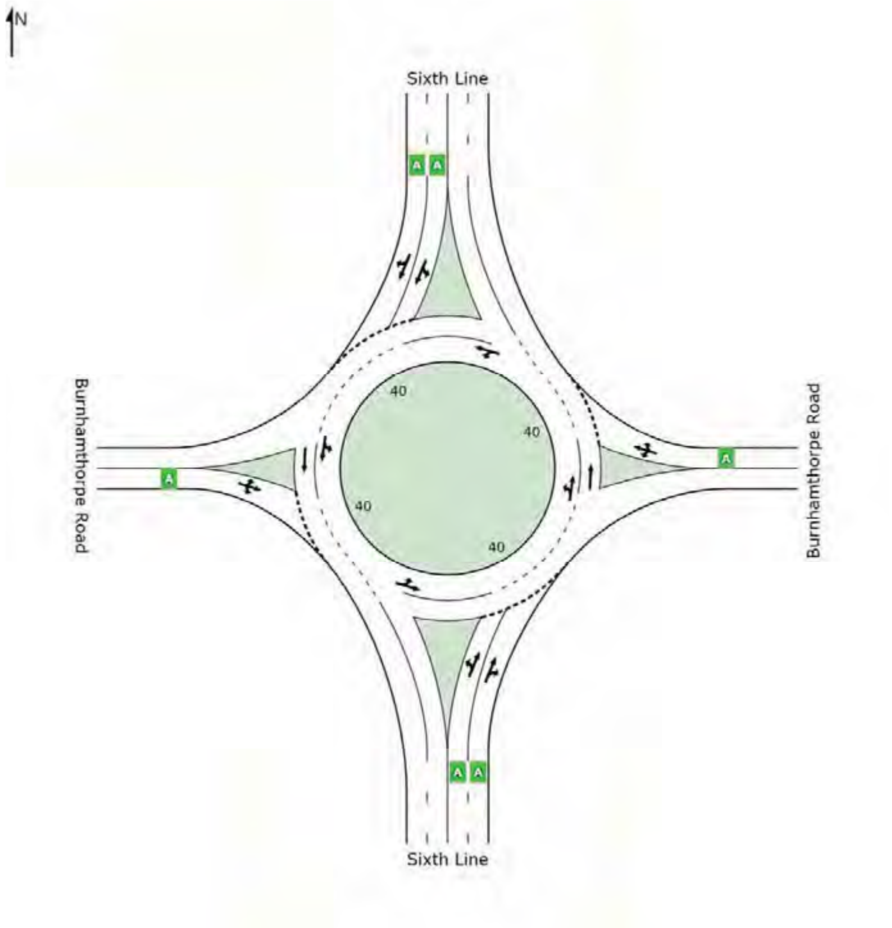
PM Peak Hour Turning Movement Counts

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	36	2.0	0.229	14.4	LOS B	2.3	16.3	0.76	0.72	47.7
4T	T	523	2.0	0.229	5.3	LOS A	2.3	16.3	0.76	0.50	48.1
4R	R	411	2.0	0.229	7.4	LOS A	2.3	16.3	0.76	0.59	48.5
Approach		970	2.0	0.229	6.5	LOS A	2.3	16.3	0.76	0.55	48.3
East: Burnhamthorpe Road											
5L	L	142	2.0	0.176	13.6	LOS B	1.6	11.1	0.72	0.71	49.2
2T	T	157	2.0	0.176	7.0	LOS A	1.6	11.1	0.72	0.56	52.0
2R	R	69	2.0	0.176	7.0	LOS A	1.6	11.1	0.72	0.58	51.6
Approach		368	2.0	0.176	9.5	LOS A	1.6	11.1	0.72	0.62	50.8
North: Sixth Line											
3L	L	235	2.0	0.134	13.2	LOS B	1.1	7.9	0.47	0.66	46.6
8T	T	443	2.0	0.134	4.0	LOS A	1.1	7.9	0.47	0.38	50.3
8R	R	56	2.0	0.134	6.0	LOS A	1.1	7.9	0.47	0.50	50.8
Approach		734	2.0	0.134	7.1	LOS A	1.1	7.9	0.47	0.48	48.9
West: Burnhamthorpe Road											
1L	L	156	2.0	0.234	13.4	LOS B	1.7	12.4	0.66	0.78	49.6
6T	T	263	2.0	0.234	6.6	LOS A	1.7	12.4	0.66	0.53	52.9
6R	R	83	2.0	0.234	7.0	LOS A	1.7	12.4	0.66	0.57	52.3
Approach		502	2.0	0.234	8.8	LOS A	1.7	12.4	0.66	0.61	51.7
All Vehicles		2574	2.0	0.234	7.6	LOS A	2.3	16.3	0.65	0.55	49.5

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

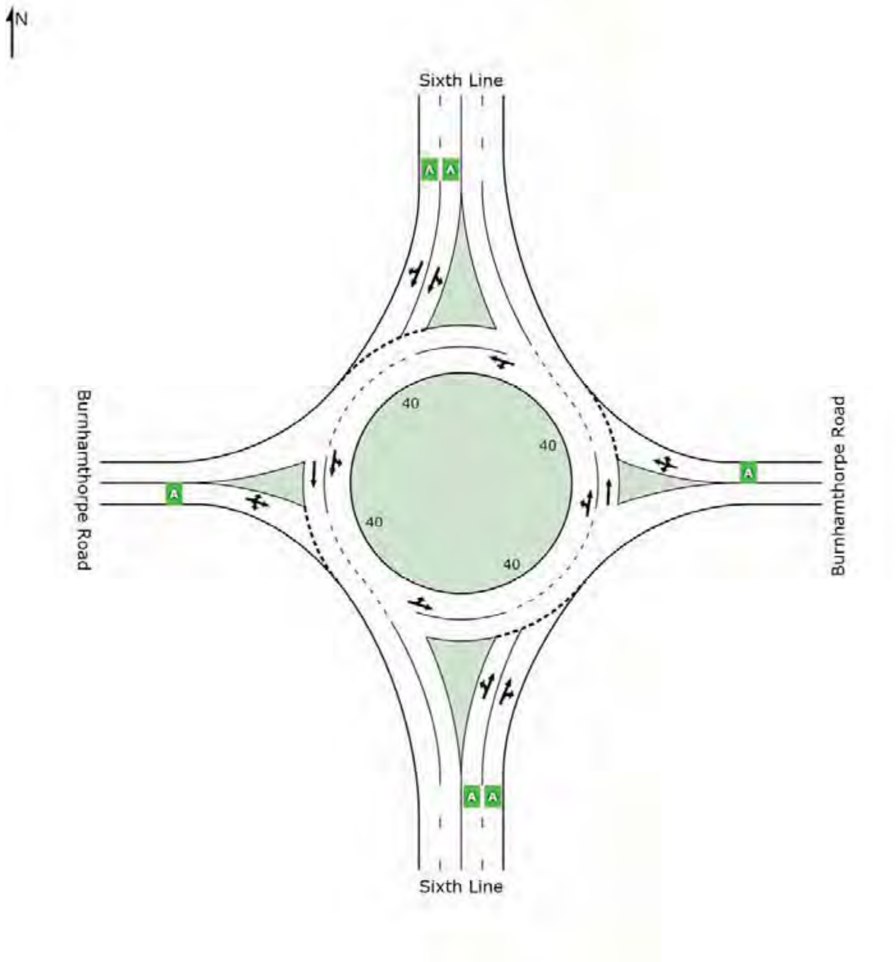


	South	East	North	West	Intersection
LOS	A	A	A	A	A

Pm peak Hour

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Sixth Line											
7L	L	72	2.0	0.114	13.2	LOS B	0.9	6.6	0.46	0.73	47.5
4T	T	377	2.0	0.114	4.0	LOS A	0.9	6.6	0.46	0.38	50.3
4R	R	175	2.0	0.114	6.1	LOS A	0.9	6.6	0.46	0.49	50.5
Approach		624	2.0	0.114	5.7	LOS A	0.9	6.6	0.46	0.45	50.0
East: Burnhamthorpe Road											
5L	L	323	2.0	0.362	13.1	LOS B	2.8	20.0	0.56	0.75	49.6
2T	T	440	2.0	0.362	6.5	LOS A	2.8	20.0	0.56	0.51	53.7
2R	R	148	2.0	0.362	6.5	LOS A	2.8	20.0	0.56	0.54	53.0
Approach		911	2.0	0.362	8.8	LOS A	2.8	20.0	0.56	0.60	52.0
North: Sixth Line											
3L	L	85	2.0	0.234	15.6	LOS B	2.6	18.9	0.94	0.69	46.7
8T	T	617	2.0	0.234	6.5	LOS A	2.6	18.9	0.94	0.62	46.6
8R	R	80	2.0	0.234	8.5	LOS A	2.6	18.9	0.94	0.66	48.0
Approach		782	2.0	0.234	7.7	LOS A	2.6	18.9	0.94	0.64	46.8
West: Burnhamthorpe Road											
1L	L	98	2.0	0.209	14.2	LOS B	1.9	13.4	0.87	0.76	49.2
6T	T	151	2.0	0.209	7.4	LOS A	1.9	13.4	0.87	0.61	50.9
6R	R	89	2.0	0.209	7.8	LOS A	1.9	13.4	0.87	0.63	50.6
Approach		338	2.0	0.209	9.5	LOS A	1.9	13.4	0.87	0.66	50.3
All Vehicles		2655	2.0	0.362	7.8	LOS A	2.8	20.0	0.69	0.58	49.7

Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.



	South	East	North	West	Intersection
LOS	A	A	A	A	A

Appendix C – Environmental Impact Study

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Project Number: 1124037.00

Project Title: **SIXTH LINE BETWEEN DUNDAS STREET AND HIGHWAY 407**

Title:

ENVIRONMENTAL IMPACT STUDY

Client: **Town of Oakville**

Date: **August 2012**

Morrison Hershfield Limited

Erin McLachlan
Terrestrial Ecologist and Environmental Planner

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1.0 Introduction

The Town of Oakville has retained Morrison Hershfield Limited to conduct an Environmental Impact Study (EIS) on 6th Line between Dundas Street and Highway 407 in the Town of Oakville. See Figure 1 for the study area.

The Town of Oakville is completing an Environmental Assessment (EA) study to determine the future road needs and improvements for the 6th Line corridor between Dundas Street and Highway 407. This EIS has been prepared to assess the potential project impacts on the natural heritage system, considering the following:

- Terrestrial natural habitat features and functions including wetlands and wildlife habitat;
- Known watercourses and hydrologic functions and features;
- Significant physical features and landforms;
- Riparian zones or buffer areas and functions;
- Vegetation communities and species of concern; and
- Significant aquatic features and functions.

This EIS Report also provides an assessment of potential impacts based on the proposed site plan and provides an opportunity for the site planning to take into consideration environmental concerns for the site, facilitating an environmentally sensitive design.

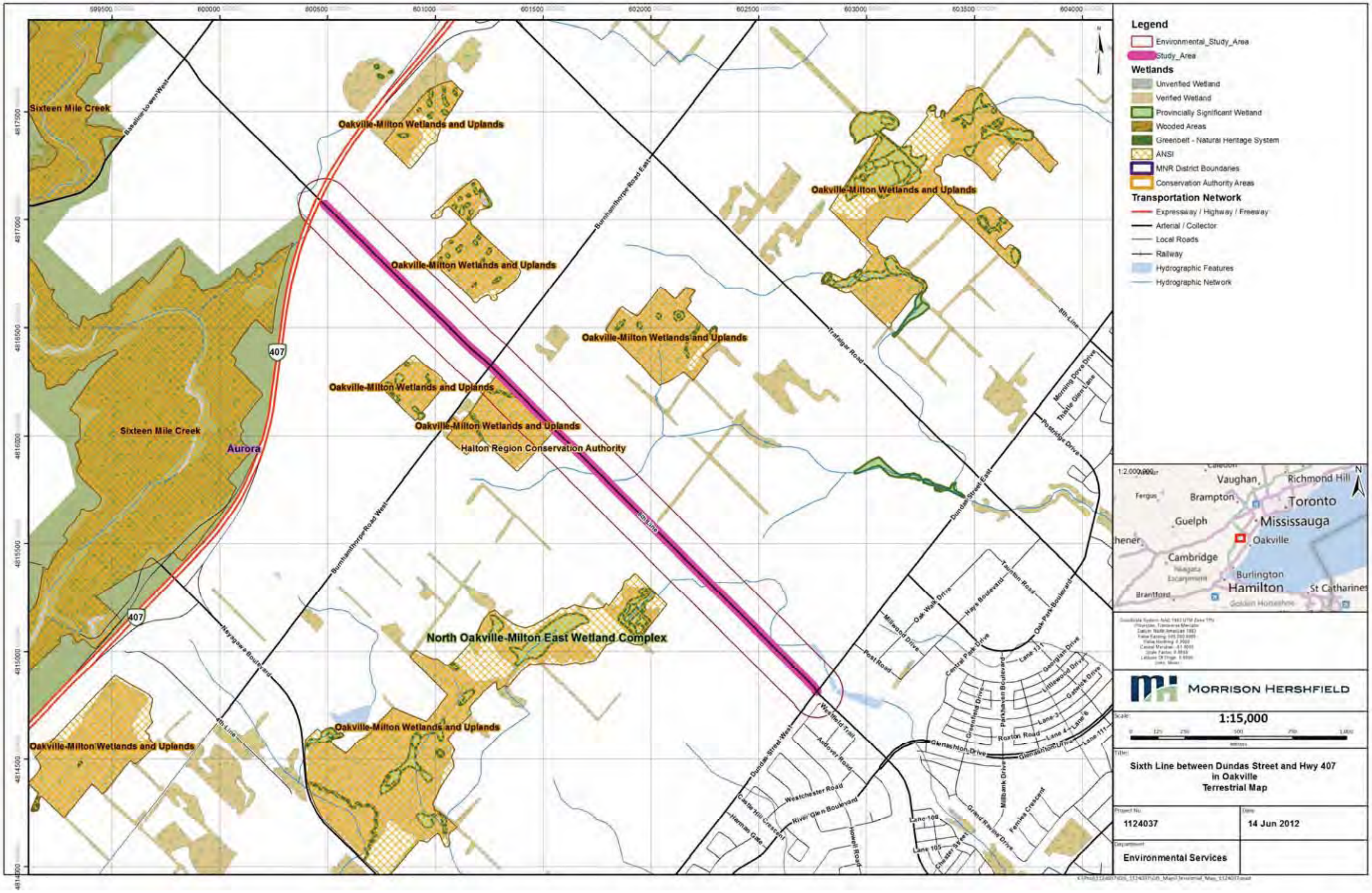

Figure 1. Key Study Area Map

2.0 Existing Conditions

2.1 Methodology

Background information regarding the property was collected and synthesized from the following sources:

- Natural Heritage Information Centre (2008);
- Breeding Bird Atlas (2005);
- Land Information Ontario;
- Ministry of Natural Resources (MNR), Aurora office.

A site visit was conducted on June 1, 2012.

2.2 Aquatic Ecosystems

Within the study area there are two linear aquatic ecosystems that cross 6th Line (see Figure 1) however these are ephemeral watercourses and were dry during the field investigation. Neither crossing provides fish habitat.

Ditches that flow along 6th Line do not provide fish habitat. The ditches are ephemeral and during the investigation, most of the ditch line was dry. There was little to no vegetation and the water source in the ditches was primarily runoff from the surrounding farm fields. See Appendix B.

Two large ponds were identified at the north end of the study area. One of the ponds is within the Highway 407 right-of-way and the other is on a private property on the east side of 6th Line, just south of Highway 407. The riparian habitat at the Highway 407 pond was limited to grasses and low herbaceous plants. The pond on private property was surrounded by mowed grass with some trees. Both waterbodies likely support bait fish. See Appendix B.

2.3 Terrestrial Ecosystems

The vegetation community within the study area consists of cultural meadow (CUM), deciduous forest (FOD), and agricultural crop land. Figures 2 and 3 depict the vegetation communities within the study area. Appendix B provides photos of the communities.

Cultural meadow (CUM) communities are meadow communities that result from, or are maintained by, cultural or anthropogenic-based disturbances. They have less than (or equal to) 25% tree cover and less than (or equal to) 25% shrub cover. These communities often contain a large proportion of non-native plant species. Species observed in the CUM within the study area included: Grass sp. (*Poa sp*.), White Clover (*Trifolium repens*), Dandelion (*Taraxacum officinale*), Ox-eye Daisy (*Chsanthemum leucanthemum*), and Canada Goldenrod (*Solidago canadensis*).

Figure 2. Vegetation Communities North of Dundas Street

Figure 3. Vegetation Communities South of Highway 407

Deciduous forest communities are composed of greater than (or equal to) 75% deciduous tree species and have canopy cover greater than 60%. The forest is a mature stand (40 – 50 years) and contains numerous snags. The tree species present included: White Ash (*Fraxinus americana*), Trembling Aspen (*Populus tremuloides*), Sugar Maple (*Acer saccharum*), Ironwood (*Ostrya virginiana*), Red Oak (*Quercus rubra*), Shagbark Hickory (*Carya ovate*), and Horse Chestnut (*Aesculus hippocastanum).* This forest stand is identified in the Oakville Official Plan Natural Features Mapping as Woodland (Town of Oakville, 2006).

A search on the MNR's Natural Heritage Information Centre (NHIC) database shows that no rare plant species have been recorded in this area. The MNR, Aurora office, does not have record of any vegetation Species at Risk (SAR) as being observed near the study area. No rare vegetation were observed during field investigations.

2.4 Wildlife and Species at Risk

The Breeding Bird Atlas of Canada lists 90 bird species as being recently observed near the study site. Six of these species are listed as SAR: Barn Swallow (*Hirundo rustica*), Bobolink (*Dolichonyx oryzivorus*), Chimney Swift (*Chaetura pelagica*), Common Nighthawk (*Chordeiles* minor), Eastern Meadowlark (*Sturnella magna*) and Whippoorwill (*Caprimulgus vociferous*).

The MNR's NHIC database has a recorded observation of Milksnake (*Lampropeltis triangulum)* and Jefferson x Blue-spotted Salamander (*Ambystoma hybrid*). Historical records on the NHIC database include Northern Bobwhite (*Colinus* virginianus) and Redside Dace (*Clinostomus elongatus*) as being observed in this area.

The MNR, Aurora office, has records of five wildlife SAR as being observed near the study area: Bobolink, Canada Warbler (*Wilsonia canadensis*), Eastern Ribbonsnake (*Thamnophis sauritus*), Milksnake, and Snapping Turtle (*Chelydra serpentina*). See Appendix A.

The following provides a description of the habitat requirements and if there is potential habitat within the study area for each SAR noted from the background research. Table 1 provides a summary of the SAR with the study area.

Barn Swallow

Barn swallow nesting sites include natural features such as caves, holes, crevices, and ledges associated with rocky cliff faces and a variety of artificial structures that provide either a horizontal nesting surface (e.g., a ledge) or a vertical face, often with some sort of overhang that provides shelter. Nests are most commonly located in and around open barns, garages, sheds, boat houses, bridges, road culverts, verandahs and wharfs, and are situated on such things as beams and posts, light fixtures, and ledges over windows and doors. Barn Swallows typically select nesting and foraging sites close to open habitats such as farmlands of various description, wetlands, road rights-of-way, large forest clearings, cottage areas, islands, sand dunes, and subarctic tundra. As Barn Swallow nests are constructed of mud pellets, they require wet sites with a nearby source of mud (Environment Canada, 2011).

While no nests were observed during field investigations, the culverts within the project study area provide suitable habitat for Barn Swallows.

Bobolink

The Bobolink nests primarily in forage crops (e.g., hayfields and pastures), wet prairie, graminoid peatlands and abandoned fields. The Bobolink is sensitive to habitat size and requires large sites of at least 10 hectares (Environment Canada, 2011).

Given these conditions, the project study area is not suitable habitat for Bobolink.

Canada Warbler

The Canada Warbler prefers wet forest types with a well-developed, dense shrub understory. They are also found is dense riparian areas in ravines or on slopes that have dense shrub growth (Environment Canada, 2011).

The deciduous forest within the study area provides potential habitat for the Canada Warbler.

Chimney Swift

The Chimney Swift spends the major part of the day in flight feeding on insects. Flocks can often be seen near bodies of water due to the abundance of insects. The species is mainly associated with urban and rural areas where the birds can find chimneys to use as nesting and resting sites. However, it is likely that a small portion of the population continues to use hollow trees (Environment Canada, 2011).

Given these conditions, the project study area is not suitable habitat for the Chimney Swift.

Common Nighthawk

The Common Nighthawk nests in open, vegetation-free habitat areas such as sand dunes, rocky outcrops, recently burned and logged areas, grasslands, lakeshores and river banks. Mixed and coniferous forests also provide habitat (Environment Canada, 2011).

Given these conditions, the project study area is not suitable habitat for the Common Nighthawk.

Eastern Meadowlark

The Eastern Meadowlark is most common in native grasslands, pastures and savannahs. It also uses a wide variety of other anthropogenic grassland habitats, including hayfields, weedy meadows, young orchards, golf courses, restored surface mines, grassy roadside verges, young oak plantations, grain fields, herbaceous fencerows, and grassy airfields. The minimum area required is estimated at 5 hectares (Environment Canada, 2011).

The Cultural Meadow communities within the study area provide potential habitat for Eastern Meadowlark.

Eastern Ribbonsnake

The Eastern Ribbonsnake is frequently found along edges of shallow aquatic features bordered with dense vegetation. Areas that can be used for sunning and upland areas for nesting are also an important component of their habitat (Environment Canada, 2011).

The study area does not provide suitable habitat for the Eastern Ribbonsnake.

Jefferson x Blue-spotted Salamander

Jefferson Salamander habitat includes mature Carolinian deciduous forests with permanent or ephemeral wet breeding areas such as sinkhole ponds, kettle ponds or other natural basins (Environment Canada, 2011).

The deciduous forest community provides potential Jefferson Salamander habitat within the study area.

Milksnake

The Milksnake is best known for occurring in rural areas, where it is most frequently reported in and around buildings, especially old structures. However, it is found in a wide variety of habitats, from prairies, pastures, and hayfields, to rocky hillsides and a variety of forest types. Two other important features of good Milksnake habitat are proximity to water, and suitable locations for basking and egg-laying (Environment Canada, 2011).

The deciduous forest community provides potential Milksnake habitat within the study area.

Northern Bobwhite

The Northern Bobwhite prefers open habitats with a mixture of grasslands, croplands, and brush. In Ontario, this species is more commonly found in agricultural croplands than grasslands (Environment Canada, 2011).

The study area does not provide suitable habitat for Northern Bobwhite.

Redside Dace

Redside Dace are found in slow-moving headwaters with riffle-pool morphology where there is abundant overhanging riparian vegetation (COSEWIC, 2007).

Given the watercourse characteristic required for Redside Dace habitat, there is no suitable habitat within the study area.

Snapping Turtle

The preferred habitat of Snapping Turtles is characterized by slow-moving water with a soft mud bottom and dense aquatic vegetation. Snapping Turtles overwinter underwater, buried beneath logs, sticks or overhanging banks in small streams that flow continuously throughout the winter. They can also hibernate buried in deep mud in marshy areas or beneath floating mats of vegetation (Environment Canada, 2011).

There is no potential habitat for the Snapping Turtle in the study area.

Whip-poor-will

Breeding habitat for Whip-poor-will is greatly dependant on the forest structure: semi-open forests with clearings such as barrens or forests that are regenerating. Feeding areas include shrubby pastures and wetlands with perches (Environment Canada, 2011).

The deciduous forest community provides potential habitat for Whip-poor-will.

Table 1. Summary of the Species at Risk with potential habitat within the study area

Common Name	Scientific Name	MNR Species at Risk Status (SARO Status)	COSEWIC Species at Risk Status	Protection*
Barn Swallow	*Hirundo rustica*	Threatened	Threatened	ESA, SARA, MBCA
Canada Warbler	*Wilsonia canadensis*	Threatened	Threatened	ESA, SARA, MBCA
Eastern Meadowlark	*Sturnella magna*	Threatened	Threatened	ESA, SARA MBCA
Jefferson x Blue-spotted Salamander	*Ambystoma hybrid*	Endangered	Threatened	ESA, SARA, FWCA
Milksnake	*Lampropeltis triangulum*	Special Concern	Special Concern	SARA, FWCA
Whip-poor-will	*Caprimulgus vociferous*	Threatened	Threatened	ESA, SARA MBCA

*ESA- Endangered Species Act, SARA- Species at Risk Act, MBCA- Migratory Birds Convention Act, FWCA- Fish and Wildlife Conservation Act

3.0 Impact Assessment

This EIS provides an assessment of potential impacts based on the proposed 6th Line improvements as an “Avenue/Transit Corridor” and provides an opportunity for the site planning to take into consideration environmental concerns for the site, thereby facilitating an environmentally sensitive design.

3.1 Aquatic Ecosystems

No direct impacts to the aquatic system are anticipated to result from the proposed development activities. Providing proper sediment and erosion control measures are implemented, no indirect impacts to the watercourse are expected to result from sediment discharges during construction.

If works are to occur within 30m of the aquatic system, a fisheries assessment is required and authorization from Department of Fisheries and Oceans may be required.

3.2 Terrestrial Ecosystems

The deciduous forest community within the study area is a high quality forest stand that should be protected to the greatest extent possible. The remainder of the study area is primarily cultural meadow community, which is not sensitive to changes or impacts on the local environment. Any areas of disturbed cultural meadow should be replanted within 30 days with native species to reduce the invasion of non-native species.

Recommended mitigation measures to protect terrestrial habitat include:

- Design to avoid the deciduous forest stand to the greatest extent possible;
- Minimize tree removal;
- Fence the deciduous forest stand during construction to prevent entrance by construction equipment. The fence should be installed where possible at least 2 metres from the tree line to protect the root system;
- Utilize standard best management practices;
- Minimize vegetation removals ;
- All vegetation removal should be completed prior to April 1;
- Appropriate lengths of silt fencing along the perimeter of minimized, designated work areas to limit construction impacts;
- Conscientious design, installation and maintenance of sediment traps, silt fencing, and check dams (with preference for alternatives to the traditional straw bale check dams);
- Staged and timely (within 30 days) re-vegetation of exposed soils, both for temporary work areas and final grades with native vegetation species;
- The contractor will be required to specify construction access routes and fuelling areas to avoid watercourse and groundwater contamination and siltation; and
- The contractor will be reminded of the requirement to report contaminant spills (including the discharge of sediment into waterways) as per the *Environmental Protection Act* and the *Fisheries Act*. All toxic chemicals and contaminants must be disposed of off-site in approved disposal sites under appropriate Ministry of the Environment (MOE) regulation.

3.3 Wildlife and Species at Risk

The project study area provides potential habitat for 6 Species at Risk: Barn Swallow, Canada Warbler, Eastern Meadowlark, Jefferson Salamander, Milksnake and Whip-poor-will.

The recommended mitigation measures to protect potential Species at Risk habitat include:

- Minimize the disturbance on the terrestrial environment by minimizing the project footprint, in particular minimize the footprint within the deciduous forest;
- Advise workers not to harm or harass any snakes or other wildlife;
- Advise workers to stop work and inform the Contract Administrator if any snakes, turtles or other potential SAR are encountered;
- All workers should be provided with awareness training (e.g., factsheets) that addresses the existence of SAR on site, identification of those species and proper actions when an individual is encountered and/or needs to be moved out of harm's way;
- Prior to construction the contractor shall inspect the construction area for nests and eggs and advise the Contract Administrator of any locations of nests and eggs immediately;
- Prior to commencing work the work area shall be inspected for individual SAR and any individuals found shall be left to move on their own or moved properly out of harm's way in the direction they were heading;
- The contractor shall not destroy nests and eggs of protected migratory birds during migratory bird nesting season;
- The works should be completed outside of the migratory bird nesting season (April 1 – July 15) and the Barn Swallow nesting season (April 1 – August 31);
- The contractor shall, prior to the removal of any nests, notify the Contract Administrator who shall contact the Environmental Office and the environmental consultant responsible for birds;
- Following the removal of a nest, the structure will be netted to prevent the recurrence of nesting activity;
- The contractor shall monitor the area daily for the recurrence of nesting activity upon removal of nests and notify the Contract Administrator immediately if a nest reappears;
- Report all SAR sightings and encounters to the MNR Parry Sound District office using the appropriate reporting form within **two business days**; and
- If a nesting snake is found the **MNR shall be notified immediately** and a **5 m buffer zone** shall be flagged around the site and that area protected from harm during the nesting season.

4.0 Conclusions

The proposed improvements to 6th Line between Dundas Street and Highway 407 in the Town of Oakville can be completed without significant adverse impacts to the existing natural habitat. Compliance with appropriate mitigation measures will ensure that the natural habitat requiring protection will not be adversely impacted.

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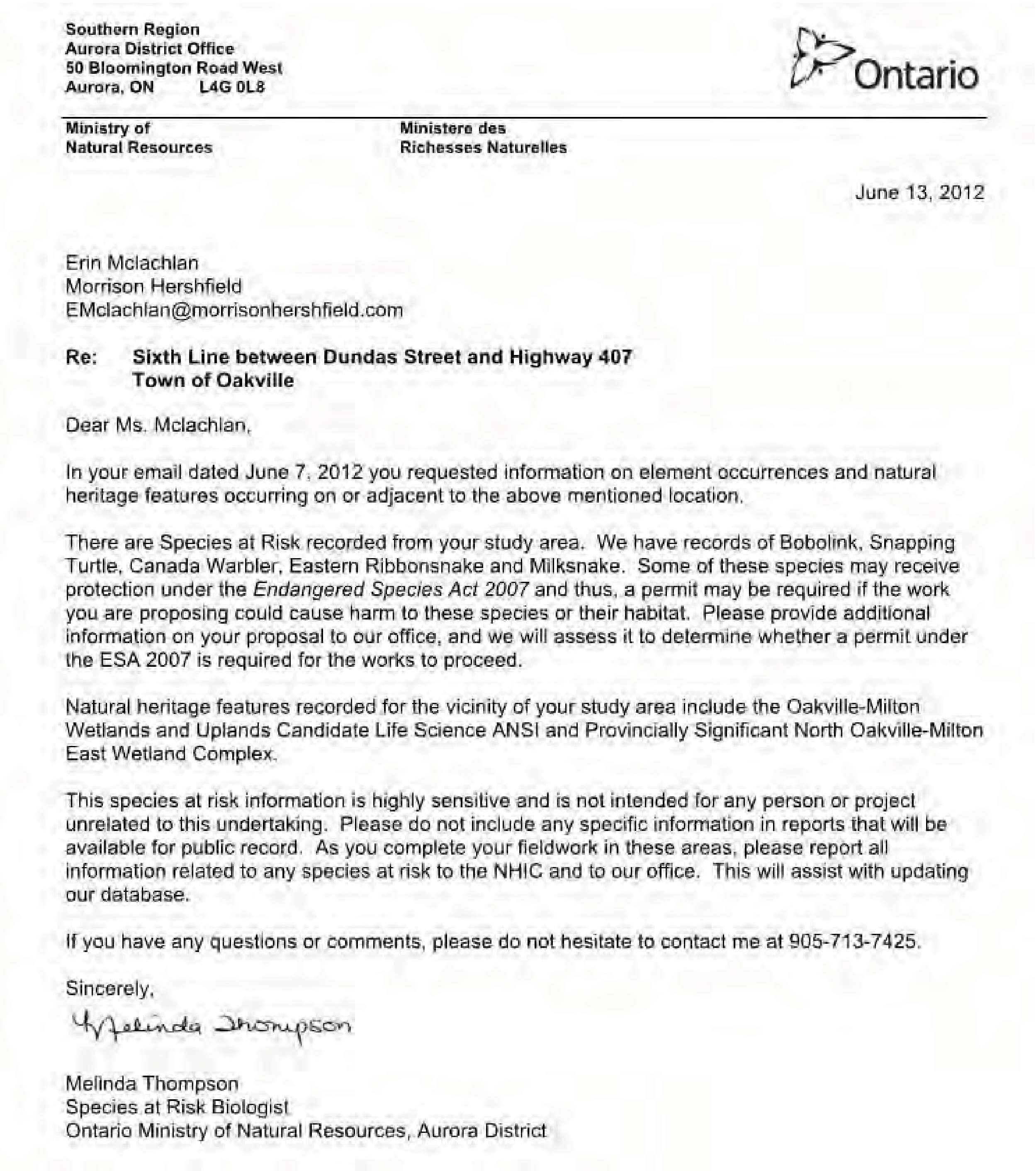
Appendix A
Agency Correspondence



Southern Region
Aurora District Office
50 Bloomington Road West
Aurora, ON L4G 0L8

Ontario

Ministry of
Natural Resources

Ministere des
Richesses Naturelles

June 13, 2012

Erin Mclachlan
Morrison Hershfield
EMclachlan@morrisonhershfield.com

Re: Sixth Line between Dundas Street and Highway 407
Town of Oakville

Dear Ms. Mclachlan,

In your email dated June 7, 2012 you requested information on element occurrences and natural heritage features occurring on or adjacent to the above mentioned location.

There are Species at Risk recorded from your study area. We have records of Bobolink, Snapping Turtle, Canada Warbler, Eastern Ribbonsnake and Milksnake. Some of these species may receive protection under the *Endangered Species Act 2007* and thus, a permit may be required if the work you are proposing could cause harm to these species or their habitat. Please provide additional information on your proposal to our office, and we will assess it to determine whether a permit under the ESA 2007 is required for the works to proceed.

Natural heritage features recorded for the vicinity of your study area include the Oakville-Milton Wetlands and Uplands Candidate Life Science ANSI and Provincially Significant North Oakville-Milton East Wetland Complex.

This species at risk information is highly sensitive and is not intended for any person or project unrelated to this undertaking. Please do not include any specific information in reports that will be available for public record. As you complete your fieldwork in these areas, please report all information related to any species at risk to the NHIC and to our office. This will assist with updating our database.

If you have any questions or comments, please do not hesitate to contact me at 905-713-7425.

Sincerely,

Melinda Thompson

Melinda Thompson
Species at Risk Biologist
Ontario Ministry of Natural Resources, Aurora District

Appendix B
Field Photos

Concrete culvert northwest of Dundas Street and the current housing development on the southwest side of 6th Line. Looking east.

Concrete culvert northwest of Dundas Street and the current housing development on the southwest side of 6th Line. Looking northwest.

Concrete culvert northwest of Dundas Street and the current housing development on the southwest side of 6th Line. Looking southwest.

Cultural Meadow southwest side of 6th Line, looking southwest.

Deciduous Forest community in the southwest corner at the intersection of 6th Line and Burnhamthorpe Road.

Deciduous Forest community in the southwest corner at the intersection of 6th Line and Burnhamthorpe Road.

Pond on private property on the northeast side of 6th Line at the north end of the study area.

Ponds within the Highway 407 right-of-way.

Interior of the Deciduous Forest, southwest of the intersection of 6th Line and Burnhamthorpe Road.

Appendix D – Stage 1 Archaeological Assessment Report

THE STAGE 1 ARCHAEOLOGICAL ASSESSMENT FOR THE CLASS EA-SIXTH LINE FROM DUNDAS STREET TO HIGHWAY 407, TOWN OF OAKVILLE, R. M. HALTON

(ENG PROJECT # EA-067-11)

(Lots15-16, Concession 1 South, 1 & 2 North,
Geographic Township of Trafalgar, Halton County)

Prepared for

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Original Licence Report
Licence P035
P.I.F. # P035-177-2012
12-June-2012

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ACKNOWLEDGEMENTS

Morrison Hershfield Limited provided the project design plans. Ontario Ministry of Tourism, Culture and Sport provided the archaeological sites data. Special thanks to Archaeological Services Inc. and New Directions Archaeology Limited for providing digital copies of the reports referenced in this report.

EXECUTIVE SUMMARY

This report discusses the rationale, methods and results of the Stage 1 archaeological assessment around Sixth Line from Dundas Street to Highway 407. The archaeological assessment is part of a Class EA (Group B) under the *Environmental Assessment Act* for the Spencer Creek bridge replacement and culvert rehabilitation and widening. The purpose of this study is to identify archaeological potential for the location and any Aboriginal and Euro-Canadian archaeological sites that may be impacted by future design needs. The study limits extend 100 metres east and west of the existing Sixth Line right-of-way. The archaeological assessment was conducted for Morrison Hershfield Limited on behalf of the Town of Oakville.

Archaeological recommendations have been made based on the background historic research, property inspection, locations of known or registered archaeological sites, previous archaeological assessments and indicators of archaeological potential. These recommendations include the following:

1. Due to the proximity to water, topography and soils the Sixth Line (Eng. Project #EA-067-11) study area has the potential for archaeological remains but extensive and intensive disturbances have removed any archaeological potential from within the current right-of-way. No further work within right-of-way area is required.
2. The archaeological potential factors indicate approximately 76 percent of lands adjacent to the Sixth Line right-of-way have potential for archaeological remains. Any future design changes to the road that require expansion beyond current right-of-way into these areas mapped this report should be subject to a Stage 2 archaeological assessment by a licensed archaeologist.
3. Prior to any land-disturbing activities in the vicinity of the Munn’s Cemetery, a Stage 3 investigation will be required to confirm the presence or absence of unmarked graves, involving either the monitoring of the area by a licensed archaeologist during construction, or the removal of the topsoil with a Gradall followed by the shovel shining of the exposed surfaces and inspection for grave shafts.

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1.0 PROJECT CONTEXT

1.1 Development Context

This report discusses the rationale, methods and results of the Stage 1 archaeological assessment for the lands of surrounding Sixth Line from Dundas Street to Highway 407, Town of Oakville, R. M. Halton. The archaeological assessment is part of a Class EA (Group B) under the *Environmental Assessment Act* for the Spencer Creek bridge replacement and culvert rehabilitation and widening. The purpose of this study is to identify archaeological potential for the location any Aboriginal and Euro-Canadian archaeological sites that may be impacted. The archaeological assessment was conducted for Morrison Hershfield Limited on behalf of the Town of Oakville.

All archaeological assessment activities were performed according to the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011). All work was done under the archaeological consulting license, P035, issued to Andrew Murray of A. M. Archaeological Associates under the *Ontario Heritage Act*. All records pertaining to this project will be curated at the offices of A. M. Archaeological Associates. All field work was conducted from the public thoroughfare.

The 3.2 linear kilometre study area is located along Sixth Line between Dundas Street and Highway 407 (Lots 15-16, Concessions 1S, 1N and 2N, Geographic Township of Trafalgar, former County of Halton). The study limits include a 100 metre buffer along the east and west sides of the existing roadway. The surrounding lands are rural residential and agricultural.

1.2 Historic Context

Halton County formed part of the Gore District along with Wentworth from 1783 until 1816 when they became separate counties (Walker and Miles 1877). Halton was divided into four separate townships including Trafalgar, Nelson, Nassawageya and Esquesing. Trafalgar Township was opened for settlement by 1810. For the most part the Crown Patents for land in Lots 6 to 22, Concession 2 NDS were issued between 1807-1810 ((Unterman McPhail Associates 2010) 2010). Kings College acquired a few Crown Reserve lots in 1828, and a handful of Crown Patents were issued in the 1840s and late 1850s. Amongst the earliest settlers in the study area were the Biggars, Freemans, Kaittings, Kenneys, Munns, Posts and Sniders.

The Sixth Line runs north to south between Lots 15 and 16 in the Old Survey and was opened from Oakville to Dundas Street by 1830. The Sixth Line and the Seventh Line, built at the same time, met at the corner of Old Mill Road and Trafalgar Road at Oakville (Unterman McPhail Associates 2010). It was extended as far north as Dundas Street, which was the edge of the New Survey, by 1850. Tremaine's map (1858) indicates the road had been extended north into the New Survey by 1858 (Figure 2).

Munn's Corners

Daniel Munn opened a tavern in the southeast corner of Sixth Line and Dundas Street sometime prior to 1814 which became the nucleus for the development of the crossroads hamlet known as Munn's Corners (Unterman McPhail Associates 2010). His widow Millicent (Post) continued to operate the tavern for many years after his death. A schoolhouse for S. S. No. 3 was built on the northeast corner of Dundas Street and Sixth Line on Lot 15 in 1824. A Methodist congregation used the schoolhouse as a place to meet in Munn's Corners in the 1820s. In 1842 Jordan Munn granted property in the southwest corner of Lot 15, 1 NDS to the Trustees of the Wesleyan Methodist Church. The first church building, which was frame, was built in 1844. The church was referred to as the Parsonage Church at the time. Tremaine's map of Halton County from 1858 shows little subdivision of land at Munn's Corners and only three structures. The Trafalgar Township map in the Illustrated Historical Atlas (1877) shows a church and four buildings on the east side of Sixth Line north of Dundas Street (Tremaine 1858;Walker and Miles 1877) (Figures 2 and 3). The present Munn's United Church building was erected on the northwest corner of Sixth Line and Dundas Street in 1898. Munn's United Church was moved back (east and north) on the site in 1977 when Dundas Street was widened. The Munn's Church Cemetery occupies the east corner of the intersection of Dundas Street and the Sixth Line. Although the earliest tombstone is Mary Wilcox who died in 1820, the cemetery does not appear on the 1858 Tremaine map. It does appear on the 1877 Trafalgar Township map.

1.3 Archaeological Context

The existing paved, two-lane Sixth Line roadway has shallow-to-deep ditches and gravel shoulders in some sections. The study corridor passes through open cultivated fields but also past several rural residential properties.

1.3.1 Environmental Setting

There are a number of environmental factors such as water sources, soil types, physiographic features, vegetation and lithic resources that will influence settlement and the archaeological potential of an area. These regional features would have influenced transportation routes, gathering places, food sources, climate (micro-environments), overall vegetation patterns, and soil formation.

1.3.1.1 Physiographic Features and Soils

Land forms and soils can play a role in determining settlement patterns and human behaviour. In particular, elevated areas that are well-drained are preferred areas for settlement.

The property is located in the till plain of the South Slope physiographic region (Chapman and Putnam 1984). The South Slope is described as the southern slope of the interlobate Oak Ridges Moraine and contains a variety of soils (Chapman and Putnam 1984). Through the study area, the South Slope consists of a narrow lobe approximately 6 km wide between the Peel Plain to the north and the Iroquois Plain to the south (Chapman and Putnam 2007). The topography is relatively flat with elevation between 175 metres at the south end at Dundas Street to 185 at the north end at Highway 401.

The soils along the roadway include the well-drained Oneida Clay Loam and the poorly drained Jeddo Clay and Chinguacousy Clay (Gillespie, Wicklund and Miller 1971; Canada Department of Agriculture 1971). There are pre-contact Aboriginal sites located nearby on both loam and clay soils.

1.3.1.2 Water Sources

West Morrison Creek flows along the east side of the roadway near Dundas Street and crosses Sixth Line approximately 700 metres north of Dundas (Figures 1 and 5 - 9). The nineteenth century maps show the creek flowing parallel to the roadway up to 1300 metres further north than the modern mapping (Figures 1, 2 and 3). East Morrison Creek crosses the roadway approximately 1400 metres north of Dundas Street so there may have been so stream alteration or the exact routing of the two branches of the creek were confused in the nineteenth century. There is a small tributary to Sixteen Mile Creek draining westerly just north of Highway 407 at the north end of the study area. There are also many small seasonal swales that cross the roadway.

1.3.1.3 Vegetation

The surrounding area now supports a variety of field crops but it would have supported a rich forest of both deciduous hardwoods and coniferous trees prior to deforestation (Gillespie, Wicklund and Miller 1971).

1.3.1.4 Lithic Sources

There are no known lithic sources on or near the study corridor.

1.3.2 Registered Archaeological Sites

A search of the archaeological sites database at the Ministry of Tourism, Culture and Sport revealed 66 registered sites within one kilometre of the study area. The sites cover the 10,000 year span of human occupation and range from single artifact findspots to pioneer homesteads. Twelve of the sites are within 300 metres of the study area.

Table 1: Summary of registered archaeological sites within one kilometre of study area.

Borden	Name	Culture	Type	Licensed to
AiGw-166	81-403-38	Pre-Contact	Findspot	MIA 1981
AiGw-167	81-403-167	Pre-Contact	Findspot	MIA 1981
AiGw-168	81-403-40	Pre-Contact	Findspot	MIA 1981
AiGw-169	81-403-41	Pre-Contact	Findspot	MIA 1981
AiGw-170	81-403-42	Pre-Contact	Findspot	MIA 1981
AiGw-171	81-403-43	Pre-Contact	Findspot	MIA 1981
AiGw-172	81-403-45	Pre-Contact	Findspot	MIA 1981
AiGw-175	81-TCPL-2	Pre-Contact	Findspot	MIA 1981
AiGw-179	*	Pre-Contact	Findspot	MIA 1984
AiGw-211	Bastille	Pre-Contact	Findspot	ASI 1990
AiGw-212	Robespierre	Pre-Contact	campsite	ASI 1990
AiGw-215	Potemkin	Pre-Contact	campsite	ASI 1990
AiGw-217	Walnut	Archaic, Middle	Findspot	ASI 1990
AiGw-216	Acorn	Archaic, Early	Findspot	ASI 1990

Borden	Name	Culture	Type	Licensed to
AiGw-218	Levar-Reid	Euro-Canadian	homestead	ASI 1990
AiGw-219	Oakdene	Pre-Contact	campsite	ASI 1990
AiGw-227	Abigail Post Homestead	Euro-Canadian; Pre-contact	homestead; Findspot	Mayer Heritage 1992
AiGw-228	Uptown Core Lands 2	Euro-Canadian; Pre-contact	undetermined	Mayer Heritage 1992
AiGw-229	Uptown Core Lands 3	Euro-Canadian	homestead, School, midden	Mayer Heritage 1992
AiGw-230	Daniel Munn Homestead	Euro-Canadian; Pre-contact	homestead; Findspot	Mayer Heritage 1992
AiGw-231	Uptown Core Lands 5	Woodland, early	Findspot	Mayer Heritage 1992
AiGw-307	Shagbark	Iroquoian, late- Daniels	campsite	AMAA 1998; NDA 1998
AiGw-324	*	Woodland, Late- Middleport	Findspot	AMAA 1998
AiGw-325	*	Pre-Contact	Findspot	AMAA 1998
AiGw-326	*	Pre-Contact	Findspot	AMAA 1998
AiGw-414	Fourth Lands	Pre-Contact	campsite	ASI 2007
AiGw-415	*	Woodland, early	Findspot	ASI 2006
AiGw-416	*	Pre-Contact	Findspot	ASI 2006
AiGw-417	*	Pre-Contact	scatter, lithic	ASI 2005
AiGw-418	Pendent	Archaic, Middle	camp	ASI 2005
AiGw-419	*	Archaic, Early	Findspot	ASI 2005
AiGw-420	*	Pre-Contact	scatter, lithic	ASI 2005, 2007
AiGw-421	*	Pre-Contact	scatter, lithic	ASI 2005, 2007
AiGw-427	Landing	Pre-Contact	campsite	Archeoworks 2004
AiGw-428	Thompson	Euro-Canadian	homestead	Archeoworks 2004
AiGw-429	*	Pre-Contact	Findspot	Archeoworks 2004
AiGw-430	*	Pre-Contact	Findspot	Archeoworks 2004
AiGw-431	*	Woodland, middle- Snyders	Findspot	Archeoworks 2004
AiGw-432	*	Archaic, Late- Crawford Knoll	Findspot	Archeoworks 2004
AiGw-433	*	Pre-Contact	Findspot	Archeoworks 2004
AiGw-434	*	Pre-Contact	Findspot	Archeoworks 2004
AiGw-453	*	Archaic, Early	Findspot	ASI 2005
AiGw-454	*	Pre-Contact	scatter, lithic	ASI 2005, 2008
AiGw-455	*	Pre-Contact	Findspot	ASI 2006
AiGw-456	*	Pre-Contact	Findspot	ASI 2006
AiGw-465	Loyalist	Euro-Canadian	domestic	ASI 2007
AiGw-466	Kaitting	Euro-Canadian	domestic	ASI 2007
AiGw-471	Trafalgar	Euro-Canadian	domestic	ASI 2007
AiGw-488	*	Archaic, late, Woodland, early	Findspot	ASI 2007
AiGw-489	Phillips	Euro-Canadian	homestead	ASI 2007, 2008
AiGw-490	*	Euro-Canadian	homestead	ASI 2007, 2008
AiGw-491	*	Euro-Canadian	homestead	ASI 2007, 2008
AiGw-492	H1	Euro-Canadian	undetermined	ASI 2007
AiGw-493	Bourbee (H2)	Euro-Canadian	homestead	ASI 2007
AiGw-494	H3	Euro-Canadian	Findspot	ASI 2007
AiGw-495	H4	Euro-Canadian	undetermined	ASI 2007
AiGw-496	Mosely Farm House (H5)	Euro-Canadian, Mid-19th century - Mid-20th century	midden, historic	ASI 2007
AiGw-497	H6	Euro-Canadian	undetermined	ASI 2007
AiGw-498	H7	Euro Canadian	undetermined	ASI 2007
AiGw-499	H8	Euro-Canadian	undetermined	ASI 2007

Borden	Name	Culture	Type	Licensed to
AiGw-500	H9	Euro-Canadian	undetermined	ASI 2007
AiGw-501	Morrison Creek (P3)	Woodland, Late	undetermined	ASI 2007, 2009
AiGw-504	P1	Pre-Contact	Findspot	ASI 2007
AjGw-462	*	Palaeo-Indian, late; Multi-component	Findspot	Timmins Martelle 2007
AjGw-463	*	Woodland, early (Adena)	Findspot	Timmins Martelle 2007
AjGw-466	*	Woodland, Early, Meadowood	Findspot	Timmins Martelle 2007

Shaded sites are within 300 metres of Sixth Line

1.3.3 Past Projects

The earliest methodical assessment near Sixth Line was conducted in 1981 for the proposed Highway 403 corridor (eventually renamed Highway 407) (Pihl 1982). This initial study was supplemented by assessments in 1983 by Mary Ambrose for the Ministry of Transportation, MTO in 1995 and 1996 and A. M. Archaeological Associates in 1998 (Ambrose 1984; Murray 1998). Although many sites were discovered during these assessments, only four isolated artifact findspots, AiGw-166, AiGw-167, AiGw-168, AiGw-169 and one site known as the Shagbark site, AiGw-307, were identified within 300 metres of the Sixth Line study limits (Pihl 1982; Murray 1998). The Shagbark site was completely mitigated by New Directions Archaeology Limited in 1998 (Woodley 1998). All of the Highway 407 right-of-way near Sixth Line has been subject to Stage 2 assessment.

A wider study of north Oakville was conducted by Archeoworks Inc. in 2008 that included the Sixth Line study area. This study identified 13 historic resources along Sixth Line including:

- Lot 15, Con. 1 - 6 homesteads, 1 church associated with Munn's Corners
- Lot 16, Con. 1 - 2 homesteads and Munn's Corners
- Lot 15, Con. 2 - 2 homesteads
- Lot 16, Con. 2 - 1 homesteads

(Archeoworks Inc. 2008).

A Stage 1 and 2 archeological assessment of lands adjacent to Sixth Line at Dundas Street was conducted by D. R. Poulton Associates in 2007 (Poulton 2008). The 2007 archaeological survey resulted in the discovery of four previously unknown archaeological sites. All were isolated find spots and none of the artifacts is diagnostic. All the finds are of Onondaga chert.

None of these isolated finds were registered with the Ontario Sites Archaeological Database but one bifacial core could potentially be related to the nearby lithic scatter designated AiGw-418. It was recommended that the finds did not constitute significant archaeological resources and no further work was required.

A portion of Lot 15, Concession 1 North approximately one kilometre north of Dundas Street was subject to a Stage 1 and 2 archaeological assessment by Archaeological Services Inc. (ASI) in 2007 (ASI 2008a). The assessment of 29 hectares identified two pre-contact sites, five pre-contact findspots, eight historical sites and one historical findspot. The Morrison Creek Site (AiGw-501), Bourbee Site (AiGw-493) and Mosely Farm House Site (AiGw-496) were considered significant archaeological resources and Stage 3 was recommended. No further work was recommended following the Stage 3 assessment of the Morrison Creek site and the Mosely Farm House site but the Bourbee site was subject to complete Stage 4 excavation (ASI 2008b, 2009). This Stage 4 has been completed and there are no remaining archaeological concerns for this property (ASI personal communication).

Archaeological Services Inc. also completed a Stage 1 archaeological assessment of Dundas Street from Neyagawa Boulevard to Oak Park Boulevard as part of a Class Environmental Assessment in 2006 (ASI 2006a). The concluded with the following recommendations:

1. A Stage 2 archaeological assessment should be conducted of all undeveloped lands in the Dundas Street study area between Neyagawa Boulevard and Oak Park Boulevard (Figure 3), in accordance with the Ministry of Culture's Stage 1-3 Archaeological Assessment Technical Guidelines (1993). This work is required in order to identify any archaeological remains that may be present in advance of any construction.
2. Prior to any land-disturbing activities in the vicinity of the Munn's Cemetery, a Stage 3 investigation will be required to confirm the presence or absence of unmarked graves, involving either the monitoring of the area by a licensed archaeologist during construction, or the removal of the topsoil with a Gradall followed by the shovel shining of the exposed surfaces and inspection for grave shafts.

The Sixth Line water main from the Moore Reservoir Booster Pumping Station to Burnhamthorpe Road West was completed in 2010 but the Ministry of Tourism, Culture and Sport did not provide the title of any reports relating to the project so it is unclear if any assessment was conducted prior to the project.

2.0 METHODOLOGY

2.1 GIS Methods

The existing design plans were supplemented with information from the Ministry of Natural Resources 1:10,000 scale Ontario Base Map (OBM) downloaded from the Geography Network Canada (Figure 5). The Halton archaeological master plan specifies archaeological potential for property within only 200 metres of water while the Standards and Guidelines for Consultant Archaeologists, 2011 specify 300 metres (ASI 1998; MTCR 2011a). Two hundred metre buffers around all streams which had water during the field visit were added to the detailed mapping in addition to three hundred metre buffers around all water sources on the detailed mapping. However, only the two hundred metre buffers are displayed on the detailed mapping since the 300 metre buffer includes all of the study area. Nineteenth century maps for Wentworth were georeferenced and relevant features were digitized (Tremaine 1858; Walker and Miles 1877) (Figures 2 and 3). This archaeological assessment was carried out during the pre-approval stage of the Sixth Line project; therefore detailed design mapping was not available. Combined aerial photographs and parcel mapping from Morrison Hershfield have been used for base mapping instead of a detailed plan.

2.2 Field Methods

A. M. Archaeological Associates conducted a field visit for the Stage 1 archaeological assessment for the study area (Lots 15-16, Concessions 1S, 1N and 2N, Geographic Township of Trafalgar, former County of Halton) consisting of a windshield survey and visual inspection of the study area in order to assess the terrain and archaeological potential factors identified during the background research. The field inspection was undertaken to determine if there were areas extensive and intensive disturbance and steeply sloped and wet areas, which had no or low archaeological potential. It was also intended to determine what survey strategies would be appropriate for a Stage 2 assessment, should it be required. Current conditions for the study area were photographed and the locations were logged by GPS (Figures 5 - 9; Plates 1-23). All property inspection was carried out from the public thoroughfare. The property inspection was carried out on June 9th, 2012 under cloudy skies, occasional light rain and temperatures around 25ºC.

2.3 Property Inspection

The current Sixth Line right-of-way is ditched along both sides of the entire length of the study area except through portions of the Dundas Street and Burnhamthorpe Road West intersections (Figures 5 - 9; Plates 1-23). There is also buried communications cable marked along the west side of the right-of-way and a water main line along the east side. A storm water grate was noted in the grassed median between the Munn's United Church parking lot and the existing roadway. There are several residential properties along the roadway which are partially landscaped but the extent of the landscaping could not be visually determined.

Several of the minor streams or swales just south and just north of Burnhamthorpe Road West which are displayed on supplied detailed mapping that do not appear on 1:10,000 scale base mapping were noted to be dry despite ongoing wet conditions. Most of the lands adjacent to the Sixth Line right-of-way are currently in either active or passive agricultural use. However, there is one forested area that extends southward from Burnhamthorpe Road West 420 metres along Sixth Line. This forested area is sign posted as part of Oakville's Natural Heritage System.

3.0 ANALYSIS AND CONCLUSIONS

3.1 Archaeological Potential

Based on the proximity to water, soils and elevated topography, the Sixth Line study area from Dundas Street to Highway 407 has the potential for archaeological remains but extensive and intensive disturbances from road construction and services have removed any archaeological potential from within the current right-of-way. These disturbances consist of a ditching, road cuts/ fills, a water main and telephone cabling.

The main disturbed areas consisted of the existing Sixth Line road and ditches, Dundas Street and Burnhamthorpe Road West, the area of ongoing residential construction on the west side of the road just north of Dundas Street and the Moore Reservoir approximately 340 metres north of Burnhamthorpe Road West. These disturbed areas beyond right-of-way constitute approximately six percent of adjacent lands. Another 18 percent of the adjacent lands have already been completely assessed. These areas shown in yellow and magenta on the detailed mapping do not require Stage 2 archaeological assessment (Figures 5 - 9).

The remaining lands adjacent to Sixth Line have archaeological potential from a combination of factors and should be subject to Stage 2 assessment prior to any construction activity. All of the adjacent lands are within 100 metres of an historic feature since Sixth Line is an early settlement road. Approximately 12 percent is also within 100 metres of a nineteenth century structure and most of this is clustered around the former community of Munn’s Corners at Dundas Street. It is unclear how extensive impacts from the expansion of Sixth Line in the 1970’s may have been to any remains related to buildings indicated on nineteenth century maps. The Munn’s Church Cemetery occupies the east corner of the intersection of Dundas Street and the Sixth Line. The graves in this historic cemetery extend to the Dundas Street and Sixth Line right-of-ways and the edge of the valley of West Morrison Creek. There is potential for impact to the cemetery by any construction outside of the existing road rights-of-way. It does not appear that a Stage 3 investigation of this area has yet occurred as per the recommendations in the 2006 ASI report.

All of the study area is within 300 metres of a water source and 80 percent is within 200 metres of a source visible during the field visit. The areas of swale around Burnhamthorpe Road West do not represent a source of potable water; however, these areas still have archaeological potential due to their proximity to historic roads.

Approximately 60 percent of the adjacent lands are within 300 metres of a registered archaeological site. The only immediately adjacent sites are the three sites [Morrison Creek Site (AiGw-501), Bourbee Site (AiGw-493) and Mosely Farm House Site (AiGw-496)] discovered and fully assessed by Archaeological Services Inc.

3.2 Conclusions

Based on these findings, the entire corridor originally had archaeological potential, with the exception of the areas noted above as disturbed, and should undergo a Stage 2 archaeological assessment (Figures 5 - 9)

The *Standards and Guidelines for Consultant Archaeologists, 2011* requires that agricultural areas greater than 10 metres along linear survey corridors be subject to pedestrian survey of ploughed and weathered fields at five metre intervals. The preferred seasons for pedestrian survey are in the spring and fall prior to crop seeding or after harvest so any future Stage 2 assessment should be scheduled accordingly.

Other areas including the partially landscaped residential properties and the forested lands that are part of the Natural Heritage System should be subject to Stage 2 test pit survey at five metre intervals in accordance with the *Standards and Guidelines for Consultant Archaeologists* (2011a:30).

A Stage 3 investigation will be required to confirm the presence or absence of unmarked graves at the Munn's Cemetery prior to any land-disturbing activities. This should involve either the monitoring of the area by a licensed archaeologist during construction, or the removal of the topsoil with a Gradall followed by the shovel shining of the exposed surfaces and inspection for grave shafts.

4.0 RECOMMENDATIONS

On the basis of the above information, the following recommendations can be made:

1. Due to the proximity to water, topography and soils the Sixth Line (Eng. Project #EA-067-11) study area has the potential for archaeological remains but extensive and intensive disturbances have removed any archaeological potential from within the current right-of-way. No further work within right-of-way area is required.
2. The archaeological potential factors indicate approximately 76 percent of lands adjacent to the Sixth Line right-of-way have potential for archaeological remains (Figures 5 - 9). Any future design changes to the road that require expansion beyond current right-of-way into these areas mapped this report should be subject to a Stage 2 archaeological assessment by a licensed archaeologist.
3. Prior to any land-disturbing activities in the vicinity of the Munn's Cemetery, a Stage 3 investigation will be required to confirm the presence or absence of unmarked graves, involving either the monitoring of the area by a licensed archaeologist during construction, or the removal of the topsoil with a Gradall followed by the shovel shining of the exposed surfaces and inspection for grave shafts.

5.0 ADVICE ON COMPLIANCE WITH LEGISLATION

1. Advice on compliance with legislation is not part of the archaeological record. However, for the benefit of the proponent and approval authority in the land use planning and development process, the report must include the following standard statements:

a. This report is submitted to the Minister of Culture as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism and Culture, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

b. It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been field in the Ontario Public Register of Archaeological Reports referred to in Section 65.1 of the *Ontario Heritage Act.*

c. Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with sec. 48 (1) of the *Ontario Heritage Act*.

d. The Cemeteries Act, R.S.O. 1990 c. C.4 and the Funeral, Burial and Cremation Services Act, 2002, S.O. 2002, C.33 (when proclaimed in force) requires that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

Contacts: Heritage and Operations Unit, Ministry of Tourism and Culture: (416) 314-7148
Registrar of Cemeteries, Cemeteries Regulation Unit: Michael D’Mello (416) 326-8404 or (416)-326-8393

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7.0 IMAGES

Plate 1: South view across Dundas Street with Munn cemetery on left.

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Plate 3: South view of disturbed ditch and fire hydrant within ROW.

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Plate 10: North view along west side of Sixth Line.

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Plate 12: North view along west side of Sixth Line with berm approximately ## metres west of ROW.

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Plate 22: South view along west side of Sixth Line from Highway 407 bridge.

Plate 23: South view along east side of Sixth Line from Highway 407 bridge.

8.0 MAPS

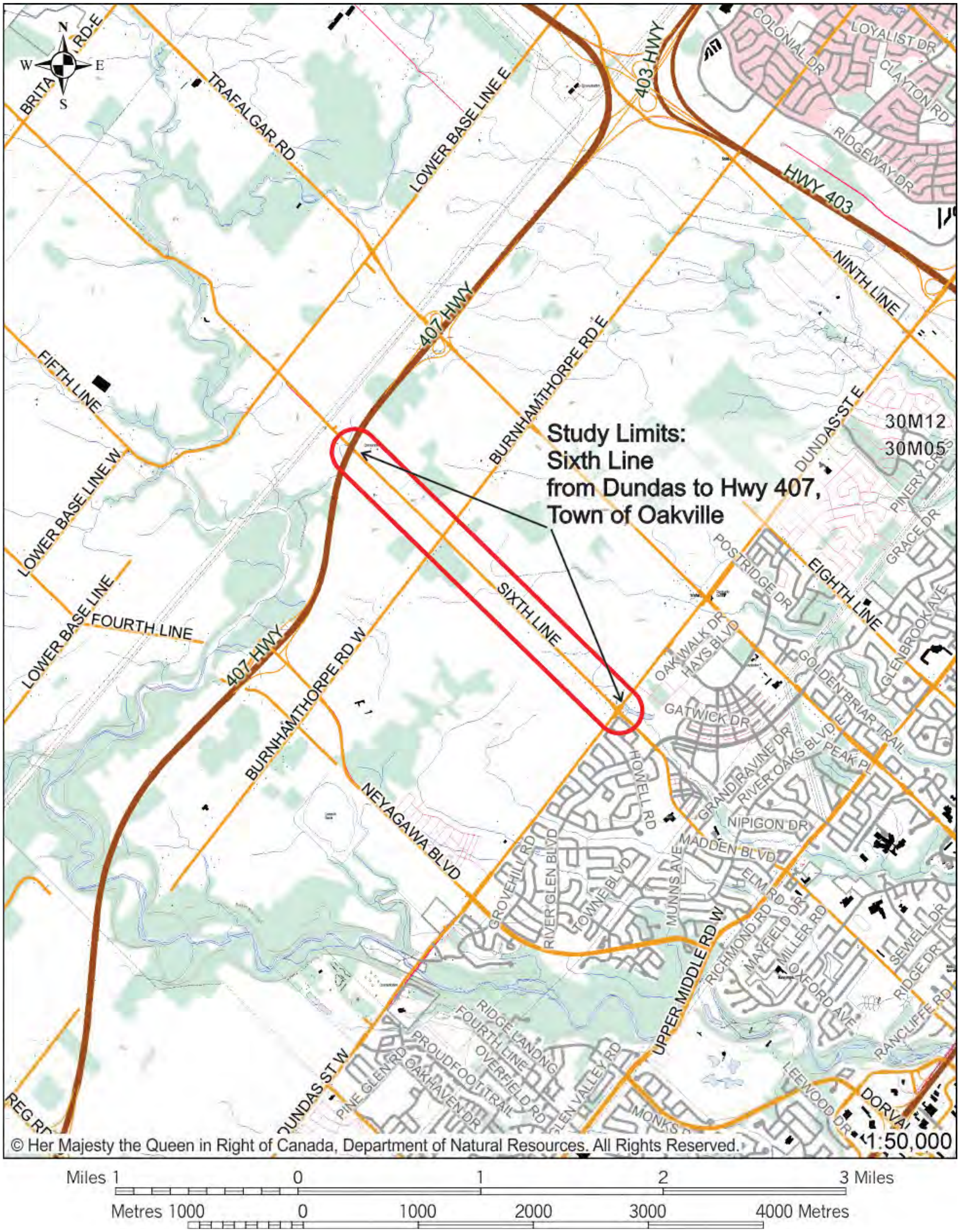

Figure 1: Location of the Sixth Line Dundas to Highway 401 study area (NTS maps 30M05 &30M12) (Natural Resources Canada 2010).

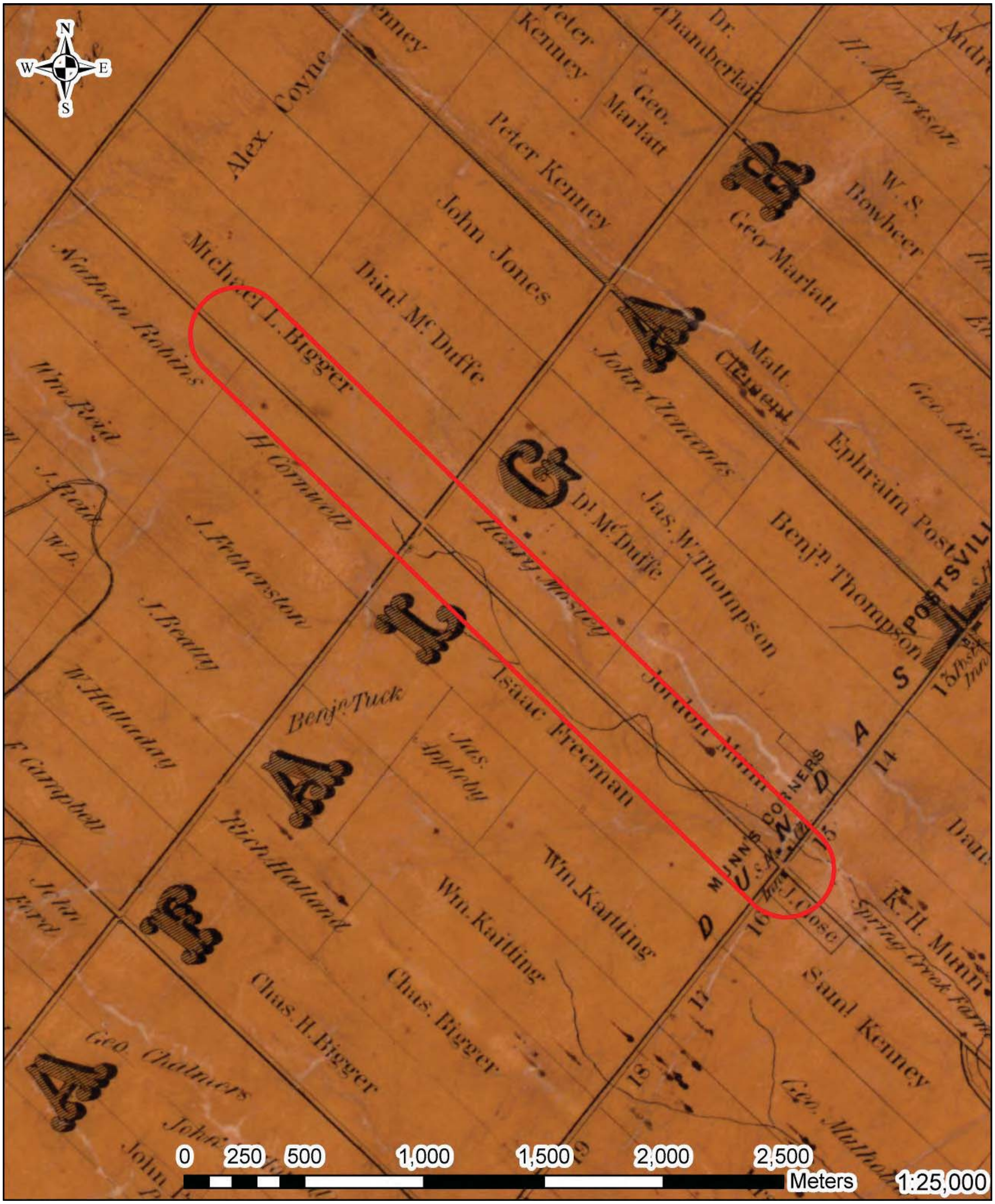

Figure 2: Sixth Line from Dundas Street to Highway 407 study area on 1858 Tremaine map (Tremaine 1858; Reproduced from Library and Archives Canada).

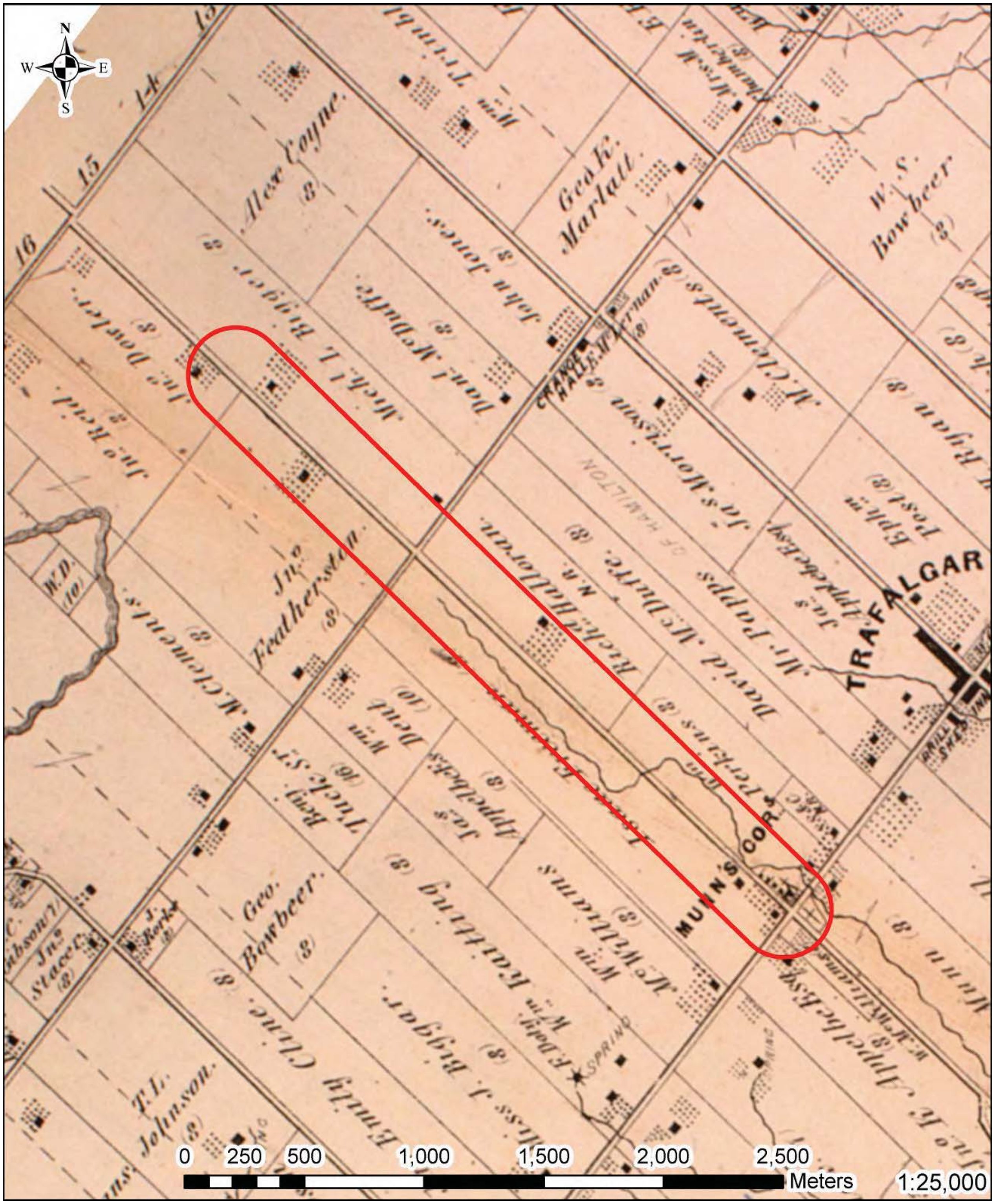

Figure 3: Sixth Line from Dundas Street to Highway 407 study area on 1877 Trafalgar Township map (Walker and Miles 1877) (Reproduced from McGill University).

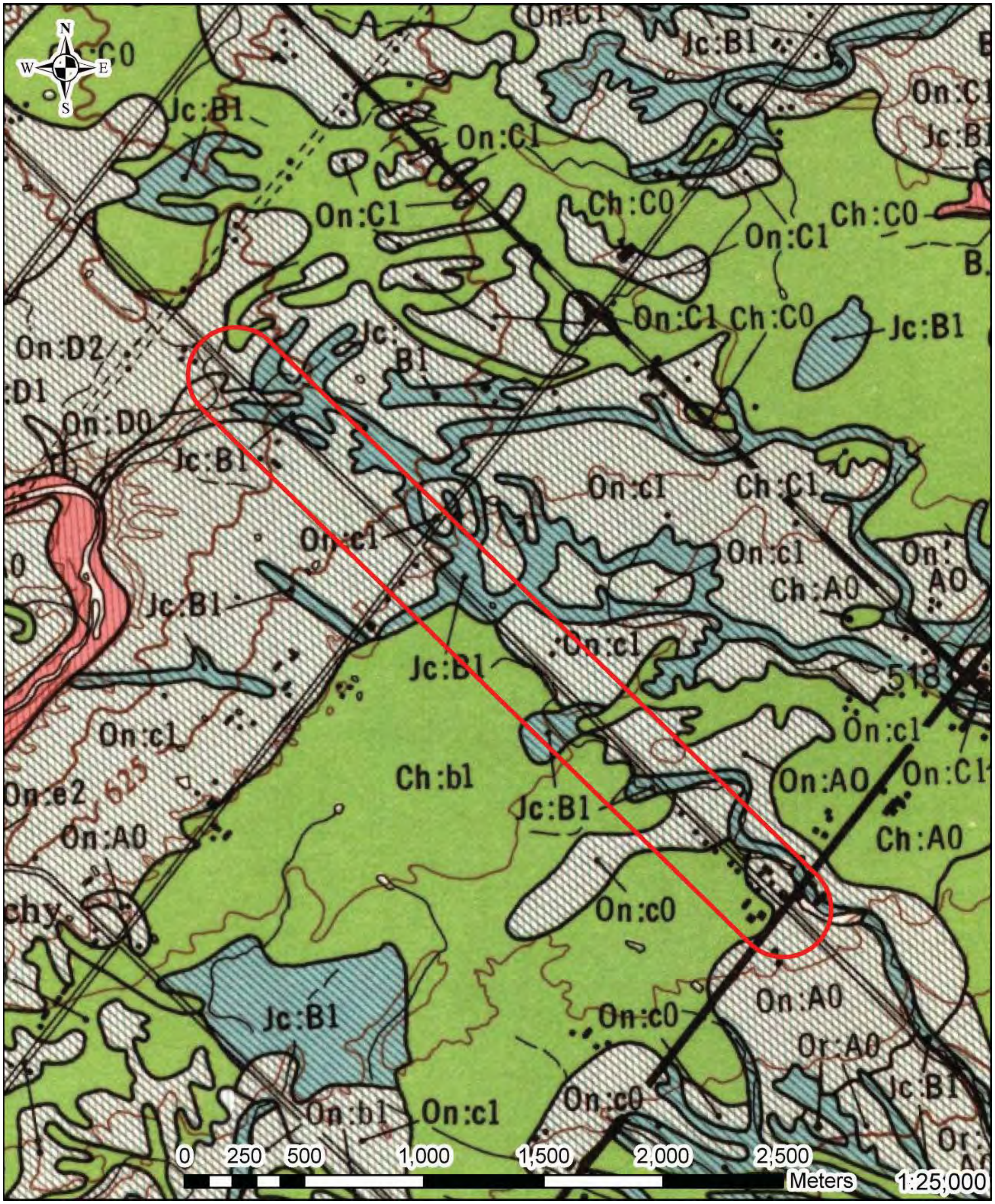

Figure 4: Study area on 1971 Halton County soil map (Gillespie, Wicklund and Miller 1971).

Figure 5: Sixth Line study limits (south end) with zones of archaeological potential and zones with potential removed and photograph locations (mapping provided by Morrison Hershfield).

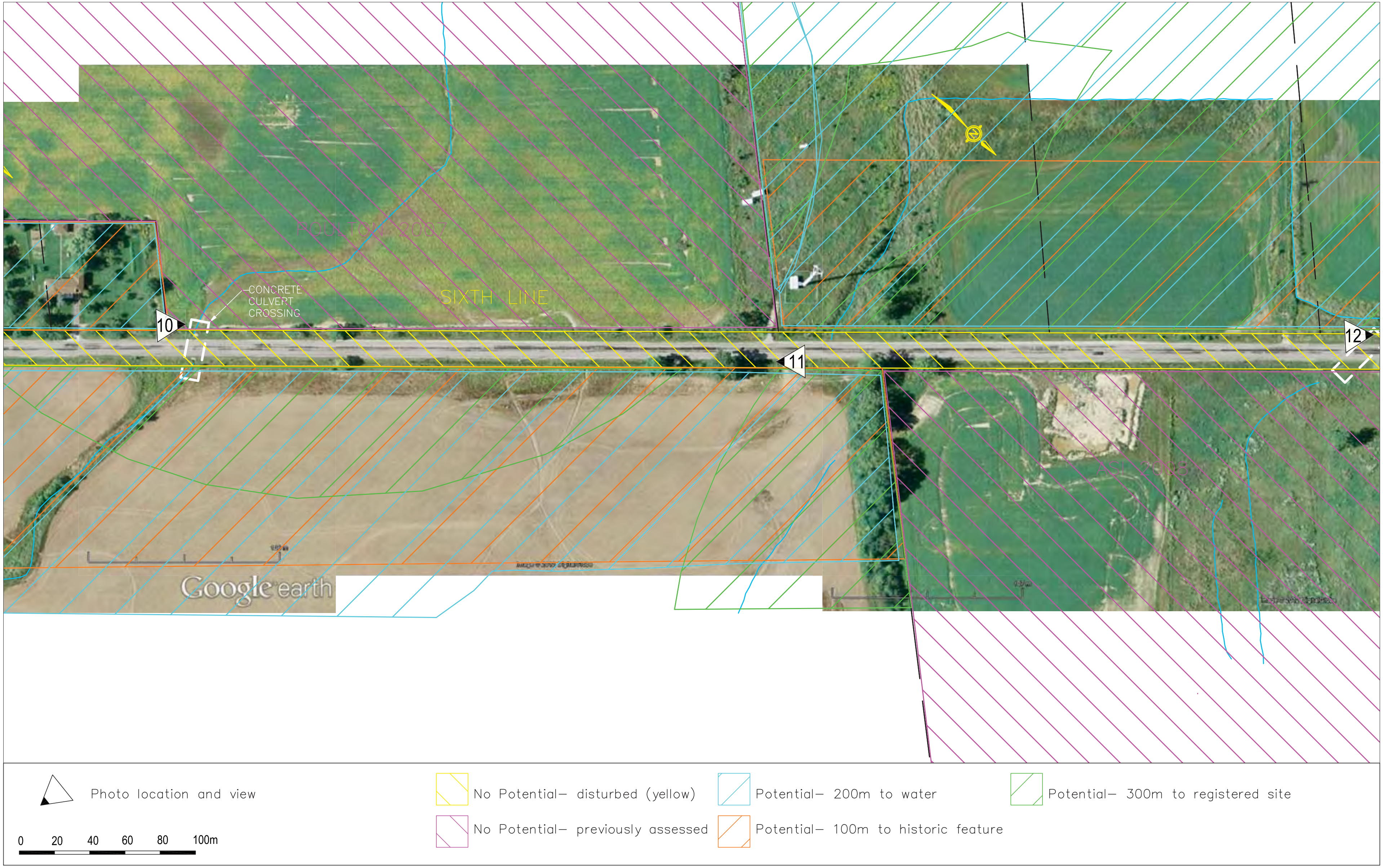

Figure 6: Sixth Line study limits with zones of archaeological potential and zones with potential removed and photograph locations (mapping provided by Morrison Hershfield).

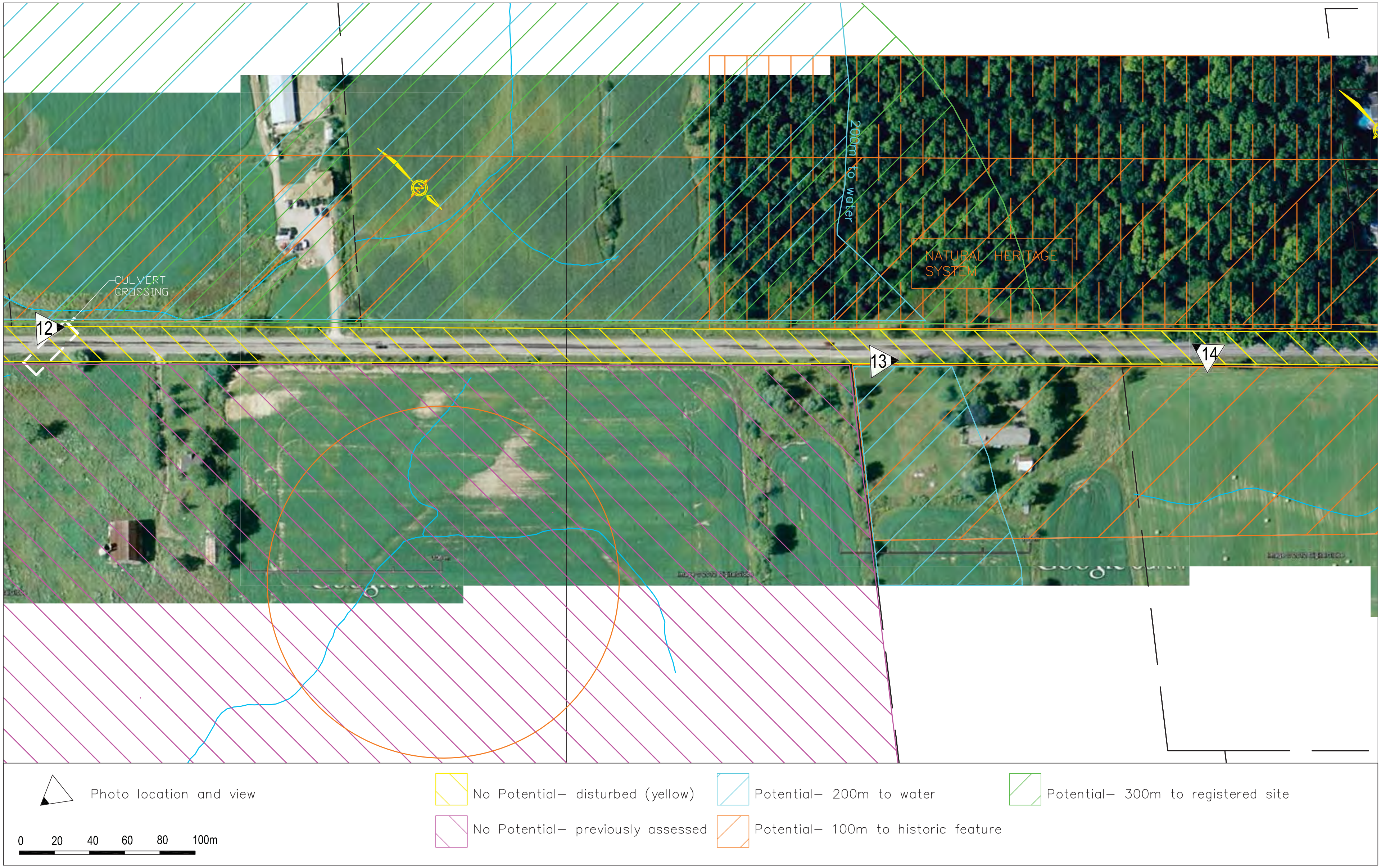

Figure 7: Sixth Line study limits with zones of archaeological potential and zones with potential removed and photograph locations (mapping provided by Morrison Hershfield).

Figure 8: Sixth Line study limits with zones of archaeological potential and zones with potential removed and photograph locations (mapping provided by Morrison Hershfield).

Figure 9: Sixth Line study limits (north end) with zones of archaeological potential and zones with potential removed and photograph locations (mapping provided by Morrison Hershfield).

Appendix E – Cultural Heritage Assessment Report

CULTURAL HERITAGE ASSESSMENT REPORT
BUILT HERITAGE RESOURCES & CULTURAL HERITAGE LANDSCAPES

CLASS ENVIRONMENTAL ASSESSMENT
SIXTH LINE IMPROVEMENTS FROM DUNDAS STREET TO HIGHWAY 407 (ETR)
TOWN OF OAKVILLE, ONTARIO

December 2013

Prepared for:
Morrison Hershfield

Prepared by:

UNTERMAN McPHAIL ASSOCIATES
HERITAGE RESOURCE MANAGEMENT CONSULTANTS

CULTURAL HERITAGE ASSESSMENT REPORT
BUILT HERITAGE RESOURCES &
CULTURAL HERITAGE LANDSCAPES

CLASS ENVIRONMENTAL ASSESSMENT
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December 2013

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1.0 INTRODUCTION

1.1 Purpose of Report

Morrison Hershfield retained Unterman McPhail Associates, Heritage Resource Management Consultants, to undertake a Cultural Heritage Assessment Report (CHAR) for cultural heritage landscapes and built heritage resources, as part of the Class Environmental Assessment for Sixth Line from Dundas Street to Highway 401 in the Town of Oakville ***(Figure 1)***. The approved North Oakville East Secondary Plan identifies Sixth Line from Dundas Street to Highway 407, as a Minor Arterial/Transit Corridor with a right-of-way width of 26 metres. The project is being carried out in accordance with the requirements of a Schedule 'C' project of the Municipal Class Environmental Assessment (October 2000, as amended in 2007 and 2011), which is approved under the Ontario *Environmental Assessment Act* (EAA).

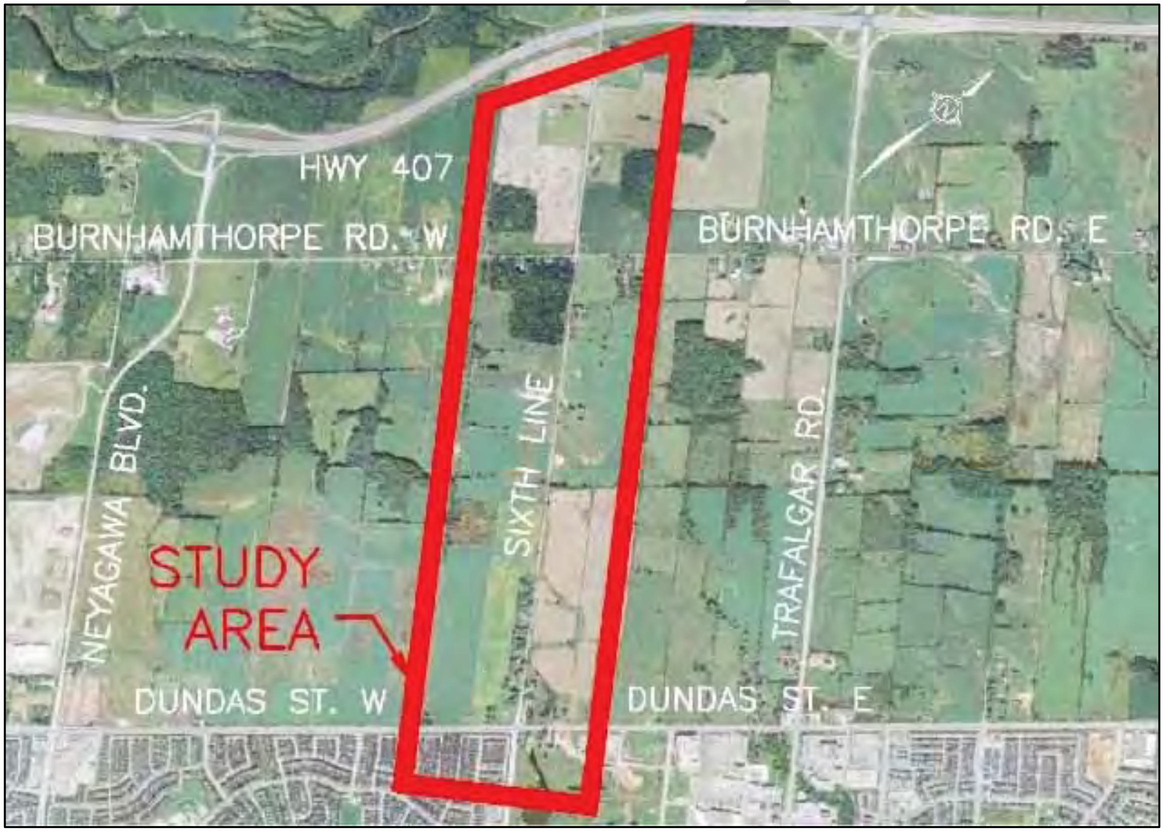


Figure 1. Map of the Sixth Line study corridor from Dundas Street to Highway 407 ETR [Morrison Hershfield, 2013].

This CHAR has been prepared to identify built heritage resources and cultural heritage landscapes of 40 years of age or older within and/or adjacent to the study corridor and potential impacts to the heritage resources.

2.0 ENVIRONMENTAL ASSESSMENT & CULTURAL HERITAGE RESOURCES

The need for the identification, evaluation, management and conservation of Ontario's heritage is acknowledged as an essential component of environmental assessment and municipal planning in Ontario.

For the most part, the analysis of cultural heritage resources in the study area addresses those aboveground, person-made heritage resources of 40 years and older in age. The application of this rolling 40 year principle is an accepted federal and provincial practice for the preliminary identification of cultural heritage resources that may be of heritage value or interest. However, its application does not imply that all built heritage resources or cultural heritage landscapes that are over 40 years and older are worthy of the same levels of protection or preservation as heritage resources.

2.1 Environmental Assessment Act (EAA)

An environmental assessment provides a decision-making process used to promote good environmental planning by assessing the potential effects and benefits of certain activities on the environment. In Ontario, this process is defined and finds its authority in the *Environmental Assessment Act* (EAA*)*. The purpose of the EAA is to provide for the protection, conservation, and wise management of Ontario's environment.

The EAA applies to all public activities. This includes projects originating from Ontario ministries and agencies, municipalities, public utilities, and Conservation Authorities. Projects subject to the Act are typically infrastructure developments and include such things as public roads and highways, transit facilities, waste management facilities, electrical generation and transmission facilities, as well as flood protection works.

Large and complex projects with the potential for significant environmental impacts are subject to an Individual EA process. As a first step, the proponent must prepare terms of reference (ToR), i.e., a plan for completing the EA process. Once the ToR is approved, the proponent’s second step is to conduct the EA. When preparing both the proposed ToR and the EA, the public must be consulted. The Individual EA process requires formal Ministry of the Environment (MOE) review and Ministerial/Cabinet approval. This process may involve the analysis of all transportation alternatives (road, transit, rail and marine) and alternative rote locations.

The analysis throughout the study process addresses that part of the *Environmental Assessment Act,* subsection 1(c), which defines *“environment”* to include:

> *“...cultural conditions that influence the life of humans or a community”;*

as well as,

> *"any building, structure, machine or other device or thing made by humans".*

Infrastructure work and its associated construction activities may potentially affect cultural heritage resources in a number of ways. The effects may include displacement through removal or demolition and/or disruption by the introduction of physical, visual, audible or atmospheric elements that are not in keeping with the character of the cultural heritage resources and, or their setting.

2.1.1 Municipal Class Environmental Assessment (MCEA)

The *Municipal Class Environmental Assessment* (October 2000, as amended 2007 and 2011) outlines a procedure whereby municipalities can comply with the requirements of the *EAA*. It identifies potential positive and negative effects of projects, such as road improvements, facility expansions or to facilitate a new service. The process includes an evaluation of impacts on the natural and social environment including culture. The Municipal Class EA applies to municipal infrastructure projects including roads, water and wastewater projects.

Since projects undertaken by municipalities can vary in their environmental impact, such projects are classified in terms of schedules. Schedule 'A' generally includes normal or emergency operational and maintenance activities whereby the environmental effects of these activities are usually minimal, and therefore these projects are pre-approved. A Schedule 'A+' activity is pre-approved by MOE, and therefore work can proceed upon public notification of the project. Schedule 'B' generally includes improvements and minor expansions to existing facilities where there is the potential for some adverse environmental impacts and therefore, the municipality is required to proceed through a screening process including consultation with those who may be affected. Schedule 'C' generally includes the construction of new facilities and major expansions to existing facilities, and these projects proceed through a five phased environmental assessment planning process.

Part B – Municipal Road Projects, Section B.1.1 (4), refers to the consideration of the cultural environment and cultural heritage in the environment for municipal road projects. The definition of ***cultural heritage resources*** includes built heritage and cultural heritage landscapes. The Ministry of Tourism, Culture and Sport (MTCS) is responsible for the administration of the *Ontario Heritage Act* (OHA) and is responsible for determining policies, priorities and programs for the conservation, protection and preservation of Ontario's heritage, which includes cultural heritage landscapes and built heritage.

As well, Section B.1.1 (4), states significant cultural heritage features should be avoided, where possible. Where they cannot be avoided, then effects should be minimized where possible, and every effort made to mitigate adverse impacts, in accordance with provincial and municipal policies and procedures. Cultural heritage features should be identified early in the process in order to determine significant features and potential impacts.

Section B.1.1 (4), defines built heritage resources and cultural heritage landscapes as follows.

Built heritage resources is defined as one or more significant buildings, structures, monuments, installations or remains associated with architectural, cultural, social, political, economic military history and identified as being important to a community. These resources may be identified through designation or heritage conservation easements under the OHA, or listed by local, provincial or federal jurisdictions.

Cultural heritage landscapes means a defined geographical area of heritage significance, which has been modified by human activities and is valued by a community. It involves grouping(s) of individual heritage features such as structures, spaces, archaeological sites, and natural elements, which together form a significant type of heritage, distinctive from that of its constituent elements of parts. Examples may include, but are not limited to, neighbourhoods, cemeteries, trailways, and industrial complexes of cultural heritage value.

2.2 Ontario Heritage Act (OHA)

The OHA gives MTCS the responsibility for the conservation, protection and preservation of Ontario’s culture heritage resources. Section 2 of the OHA charges the Minister with the responsibility to,

> *“...determine policies, priorities and programs for the conservation, protection and preservation of the heritage of Ontario.”*

The OHA allows municipalities to designate individual properties (Part IV) and districts (Part V), to list individual properties of cultural heritage value or interest (Part IV, Section 27), and to protect a heritage property with an easement (Part IV). The Ontario Heritage Trust (OHT) may protect a heritage property with an easement (Part II) and the Minister of MTCS, after consultation with the Ontario Heritage Trust, may designate a property of provincial significance (Part IV, Section 34.5).

Heritage attributes, in relation to a property, are defined in the OHA as the attributes of the property that cause it to have cultural heritage value or interest. The Provincial Government has established criteria for determining the cultural heritage value or interest of properties through “Ontario Regulation 9/06”. For Crown owned property, MTCS has established criteria for determining the cultural heritage value or interest through “Ontario Regulation 10/6” and prepared the *Standards and Guidelines for the Conservation of Provincial Heritage Properties* (July 1, 2012) under OHA, Part III.1.

Under subsection 27 (1) of the OHA, a municipal clerk is required to keep a current register of properties of cultural heritage value or interest located in their municipality. The municipal register must include all properties designated by the municipality under Part IV of the OHA, all heritage conservation districts under Part V of the OHA, or properties designated by the Minister. In addition, OHA subsection 27 (1.2) allows a property that is not designated, but considered to be of cultural heritage interest or value by the municipal council, to be placed on the register. This is commonly referred to as “listing”. In many cases, listed (non-designated properties) are candidates for protection under section 29 of the OHA.

Municipal designation of heritage resources under Part IV of the OHA publicly recognizes and promotes awareness of heritage properties, provides a process for ensuring that changes to a heritage property are appropriately managed, and that these changes respect the property’s heritage value. This includes protection from demolition. Once a property or district has been designated and notice has been given to the Ontario Heritage Trust, the property is listed on the provincial register of heritage properties.

The alteration process under Section 33 of the OHA helps to ensure the heritage attributes of a designated property, and therefore its heritage value, are conserved. If an owner of a designated property wishes to make alterations to the property that affects the property’s heritage attributes, the owner must obtain written consent from the council. This applies to the alteration of the buildings or structures and to alterations of other aspects of the designated property such as landscape features or natural features that have been identified as heritage attributes.

Although “listing” non-designated properties does not offer any specific protection under the OHA, Section 27 (3) states if a property included in the register, under subsection (1.2), has not been designated under Section 29, the owner of the property shall not demolish or remove a building or structure on the property or permit the demolition or removal of the building or structure, unless the owner gives the council of the municipality at least 60 days notice in writing of the owner’s intention to demolish or remove the building or structure or to permit the demolition or removal of the building.

2.3 Ministry of Tourism, Culture and Sport (MTCS)

MTCS describes heritage buildings and structures, cultural heritage landscapes and archaeological resources as cultural heritage resources. Since cultural heritage resources may be impacted adversely by both public and private land development, it is incumbent upon planning and approval authorities to consider heritage resources when making planning decisions.

MTCS guidelines assist in the assessment of cultural heritage resources as part of an environmental assessment. They include, *Guideline for Preparing the Cultural Heritage Resource Component of Environmental Assessments* (October 1992), and, *Guidelines on the Man-Made Heritage Component of Environmental Assessments* (1980).

The *Guidelines on the Man-Made Heritage Component of Environmental Assessments* state:

> *"When speaking of man-made heritage we are concerned with works of man and the effects of his activities in the environment rather than with moveable human artifacts or those environments that are natural and completely undisturbed by man."*

The guidelines say one may distinguish broadly between two basic ways of visually experiencing cultural heritage resources in the environment, that is, as cultural heritage landscapes and as built heritage. Cultural heritage landscapes are a geographical area perceived as a collection of individual person-made built heritage resources set into a whole, such as historical settlements, farm complexes, waterscapes, roadscapes, railways, etc. They emphasize the interrelationship of people and the natural environment and convey information about the processes and activities that have shaped a community. Cultural heritage landscapes may be organically evolved landscapes as opposed to designed landscapes. Some are 'continuing landscapes', which maintain the historic use and continue to evolve, while others are 'relict landscapes', where the evolutionary process has come to an end but important landscape or built heritage resources from its historic use are still visible. There are also associative landscapes with religious, artistic, or cultural associations of the natural element rather than material cultural evidence, which may be insignificant or even absent. Built heritage comprises individual, person-made or modified, parts of a cultural heritage landscape such as buildings or structures of various types including, but not limited to, cemeteries, planting and landscaping structures, etc.

The MTCS guidelines for environmental assessment also describe the attributes necessary for the identification and evaluation of any discrete aggregation of person-made features or cultural heritage landscapes and the attributes necessary for the identification and evaluation of built heritage resources for environmental assessments.

MTCS provides the *Ontario Heritage Toolkit*, a series of guides that explain different aspects of the *Ontario Heritage Act*, the *Planning Act*, the *Historic Places Initiative*, and related programs. It states to conserve a cultural heritage resource a municipality or approval authority may require a heritage impact assessment and/or a conservation plan to guide the approval, modification, or denial of a proposed development.

As well, MTCS has produced the *Standards and Guidelines for Conservation of Provincial Heritage Properties* (April 28, 2010). The *Standards and Guidelines* state Ministries and prescribed public bodies shall apply the "Criteria for Determining Cultural Heritage Value" set out in the "Ontario Regulation 9/06" under the *Ontario Heritage Act* to determine the cultural heritage value or interest of a property. If the property meets the criteria in "Ontario Regulation 9/06", it is deemed a provincial heritage property. If deemed to be a provincial heritage property the "Criteria for Determining Cultural Heritage Value of Provincial Significance" set out in "Ontario Regulation 10/06" to determine whether or not a property is of provincial significance are to be applied. If the property meets the criteria in “Ontario Regulation 10/06”, it is a provincial heritage property of provincial significance.

3.0 ASSESSMENT METHODOLOGY

3.1 Introduction

Unterman McPhail Associates undertook a cultural heritage resource survey of built heritage resources and cultural heritage landscapes in 2012 on behalf of the Halton Region with regard to improvements on Sixth Line from Dundas Street in the south to Highway 407 in the north in the Town of Oakville. For the purposes of this built heritage resource and cultural heritage landscape assessment Unterman McPhail Associates undertook the following tasks:

- identification of major historical themes and activities of the study corridor through historical research and a review of topographic and historical mapping;
- identification of associated cultural heritage landscapes and built heritage resources within the study corridor through major historical themes and activities and historical mapping;
- survey of lands within and adjacent to the Sixth Line study corridor; and
- identification of sensitivities for change to built heritage resources and cultural heritage landscapes through the review of the historical information, the results of the survey and the proposed changes to Sixth Line.

3.2 Heritage Recognition

The Council has approved the Town of Oakville Heritage Register. The Oakville Heritage Register is an official list of properties that have been identified by the Town as having cultural heritage value or interest. The Town is required to create and maintain the Heritage Register in accordance with the OHA. A Heritage Register includes the following types of heritage properties:

- individually designated properties that fall under Part IV of the OHA;
- properties designated within Heritage Conservation Districts that fall under Part V of the OHA; and
- properties that are not designated but believed to be of cultural heritage value or interest (also known as ‘listed’ properties).

The Town of Oakville Heritage Register (September 1, 2013) includes the following relevant sections:

- Section A: Register of Heritage Properties Individually Designated under Part IV of the OHA;

- Section E: Register of Properties of Cultural Heritage Value or Interest – Not Designated.

Section A: Register of Designated Heritage Properties Under Part IV of the Ontario Heritage Act (September 1, 2013)

Section A contains three (3) municipally designated properties adjacent to the Sixth Line study corridor, namely:

- Munn's Pioneer Cemetery;
- Munn's United Church, No. 5 Dundas Street East; and
- Residence, No. 3369 Sixth Line.

Section E: Register of Properties of Cultural Heritage Value or Interest (NOT Designated (September 1, 2013)

Section E contains two (2) listed properties of heritage value of interest, which are located adjacent to the Sixth Line study corridor, namely:

- 3060 Sixth Line; and
- 4243 Sixth Line.

4.0 HISTORICAL SUMMARY

4.1 Trafalgar Township

Under Upper Canada Treaty No. 14, signed on September 5, 1806, the chiefs of the Mississauga Indians agreed to sell the British government a tract of land consisting of 85,000 acres. The land stretched from the Etobicoke Creek west to Captain Brant`s lands towards the west end of Lake Ontario, with the exceptions of the lands at the mouths of the Credit River and Sixteen and Twelve Mile Creeks. Lands now in the Town of Oakville were part of this acquisition. Deputy Provincial Surveyor Samuel S. Wilmot surveyed the Mississauga Purchase in 1806, dividing it into three new townships. Initially, Township No. 2 was designated as Alexander, but was soon after renamed Trafalgar. Trafalgar Township, which was named after Cape Trafalgar, wherein Admiral Nelson defeated a combined Spanish and French fleet, was established as a municipal unit within the Gore District. In 1851, the Gore District was divided into Wentworth and Halton counties with parts of the Gore District also going to Waterloo and Brant Counties.

The Governor's Road, later known as Dundas Street, was developed in several different time periods and sections. Lieutenant-Governor John Graves Simcoe proposed the route as a military and settlement road between Lake Ontario, Lake Erie, Lake St. Clair and Lake Huron in 1793. By 1794, Dundas Street had cut through the forest to the site of London in southwestern Ontario, with transport between York and Dundas by water. Augustus Jones surveyed the section from York (Toronto) to Lake Simcoe in 1794. By

1796, although barely passable, the road ran from the western end of Lake Ontario east to York. Initially ending at the Humber River, by 1800, Dundas Street was connected with the newly built Yonge Street. Although, Dundas Street had been surveyed as a military road in 1796, it remained incomplete and impassable through the Mississauga Tract until 1806.

Wilmot used Dundas Street as the baseline for the single front survey of 200 acre lots, with a grid system of concessions and sideroads. He laid out four concessions to the south (SDS) of Dundas Street and two concessions to the north (NDS), which became the Old Survey. Trafalgar Township was extended north after the purchase of more land from the Mississaugas in 1818. This area became known as the New Survey. Trafalgar Township west of Sixteen Mile Creek was opened for settlement by 1810. The 'Single Front System' of land survey used in Trafalgar Township imposed a settlement grid system on the land that persists to this day. When split, the original 200 acre township lots are referenced as the south (or front) and north (or rear) half of the lot. Occasionally, the 200 acre lots were split length-wise with the new lots being referenced as the west or east half of the lot.

With the dual purpose of developing the new Township and clearing and maintaining Dundas Street, a military road, the Government's priority was to accelerate continuous settlement along Dundas Street. Therefore, Crown and Clergy Reserve lands along Dundas Street were dispersed throughout Trafalgar Township to encourage settlement, and the lots bordering the Street were the first granted. As well, settlement duties were shortened to eighteen months from the usual two years. The northern area along Dundas Street flourished while development in the southern part of the township was slower due to a high proportion of Crown and Clergy reserve lands. Sixth Line running north to south between Lots 15 and 16 in the Old Survey was opened from Oakville to Dundas Street by 1830, and was extended north of Dundas Street to the edge of the New Survey after 1850. Tremaine's Map (1858) indicates the road had been extended north into the New Survey.

By the mid 1840s, Trafalgar Township was a well-settled township, with numerous well-cleared and cultivated farms, many with good orchards, and a local road network. Early subsistence farming had evolved to growing wheat in the mid 1800s. From the 1850s to the 1890s, there was a consistent increase in the acreage of township land under cultivation. Farmers turned to higher cost cash crops and animal husbandry in the 1870s. The Trafalgar Township map in the *Illustrated Historical Atlas* depicts established farmsteads along Sixth Line to the north of Munn's Corners. By the late nineteenth century, agriculture in the township consisted of mixed crop, livestock and dairy farming. As a result, local farmers consolidated the smaller, earlier farmsteads in the area into larger individual land holdings.

Twentieth century topographical maps indicate an agricultural character in the vicinity of the study corridor, which underwent little change throughout the first three-quarters of the twentieth century. Patterns of agricultural fields with some wood lots characterized

the landscape. Dundas Street became part of King's Highway No. 5 in the early 1920s. During the late 20th century, Dundas Street was widened to four lanes of traffic.
The south side of the intersection of Dundas Street and Sixth Line underwent an urbanization process in the late 20th and early 21st centuries. Highway 407 at the beginning of the 21st century

In 1962, Trafalgar Township was amalgamated with the Town of Oakville. In 1974, the Regional Municipality of Halton was created from the County of Halton, and within the Region the Town of Oakville was created.

4.1.1 Munn's Corners

John Robinson acquired the Crown Patent for all of Lot 15, 1 NDS, Trafalgar Township in 1807. Daniel Munn, who had settled south of Dundas Street on Lot 15, Concession 1 SDS around 1804, and opened a tavern in the southeast corner of Sixth Line and Dundas Street, bought part of Lot 15, 2 NDS in 1816. William Freeman received the Crown Patent for all 200 acres of Lot 16, Concession 1 NDS, Trafalgar Township, in 1808.

Munn's tavern, established sometime prior to 1814 as the first tavern in the township, became the nucleus for the development of the hamlet known as Munn's Corners. Munn was the first township clerk (1813). His widow Millicent (Post) continued to operate the tavern for many years after his death. Schoolhouse S. S. No. 3 was built on the northeast corner of Dundas Street and Sixth Line on Lot 15 in 1824. A Methodist congregation used the schoolhouse as a place to meet in Munn's Corners in the 1820s. In 1842, Jordan Munn granted property in the southwest corner of Lot 15, 1 NDS to the Trustees of the Wesleyan Methodist Church. The first church building, which was frame, was built in 1844.

Tremaine's Map (1858) shows little subdivision of land at Munn's Corners. The *Illustrated Historical Atlas* (1877) depicts a residence on the west side of Sixth Avenue north of Dundas Street, the church and two buildings on the east side of Sixth Line north of Dundas Street. The cemetery is shown on the southeast corner of the intersection. The present Munn's United Church building was erected on the northwest corner of Sixth Line and Dundas Street in 1898. Some earlier twentieth century residential development occurred on Dundas Street West of Sixth Line. The church was moved back on the site in 1977 when Dundas Street was widened in the latter part of the 20th century. The church and cemetery on Dundas Street are the most prominent remains of the 19th century crossroads settlement.

5.0 IDENTIFICATION OF CULTURAL HERITAGE LANDSCAPES AND BUILT HERITAGE RESOURCES

5.1 Introduction

For the purposes of cultural heritage landscape and built heritage resource identification, this section provides a brief description of the existing environment of the study area (i.e., Sixth Line from the Dundas Street to Highway 407 (ETR) and the associated principal cultural heritage landscapes and built heritage resources).

5.2 Description of the Existing Environment

The study corridor is located on Sixth Line, Town of Oakville, in the physiographic region known as the South Slope, The South Slope is the southern slope of the interlobate moraine (Oak Ridges Moraine), which includes the strip south of the Peel Plain and it rises to the line of contact with the moraine at 800 to 1,000 feet above sea level. It extends from the Niagara escarpment to the Trent River and contains a variety of soils, some of which have proved to be excellent through more than a century of agricultural use.

The South Slope was settled largely of British immigrants after the close of the Napoleonic wars. The mixed, subsistence agriculture developed by the early settlers evolved into grain exports from the lake ports and a principal agricultural pursuit by mid 19th century. When wheat growing declined, it was replaced by commercial mixed farming in which beef cattle, hogs and dairy butter were the chief sources of income. Dairy herds replaced beef cattle towards the end of the century and into the 20th century.

A few buildings that once formed part of the historical crossroads settlement known as Munn's Corners remain at the intersection of Dundas Street and Sixth Line. They include, Munn's United Church, and Munn's Pioneer Cemetery and 3060 Sixth Line. Dundas Street is a heavily traveled arterial roads with a signalized intersection at Sixth Line. Sixth Line is a two lane paved local road with a posted speed of 80 km/hr that serves as a north-south route with less traffic volume.

The land on either side of Sixth Line to the north of Dundas Street was once intensively cultivated. Former and active farmland with a few farm complexes is still visible along its length within the study corridor. A Natural Heritage Area lies on the west side of Sixth Line just south of the Burnhamthorpe Road intersection. Highway 407 (ETR) marks the northern boundary of the study area.

5.3 Description of Identified Cultural Heritage Resources

Unterman McPhail Associates undertook a windshield survey of the Sixth Line study corridor in June 2012 to identify cultural heritage resources older than 40 years of age.

Nine (9) built heritage resources and three (3) cultural heritage landscapes of 40 years and older in age and of heritage value or interest were identified within or adjacent to the Sixth Line study corridor from Dundas Street East north to Highway 407.

The intersection of Dundas Street East and Sixth Line was the location of the 19th century historical crossroads settlement of Munn's Corners ***(Site # 1)***. Today, only a few buildings and a cemetery associated with this rural hamlet remain as visible reminders of the former community, such as Munn's Corners ***(Site # 1)***; Munn's Church ***(Site # 2)***; Munn's Cemetery ***(Site # 3)***; and, 3060 Sixth Line ***(Site # 4)***. All four resources are located close to the existing road right-of-way. Sites # 2 and # 3 are designated municipally under the OHA and are included on the Town of Oakville Register *Appendix A: Register of Designated Heritage Properties Under Part IV of the Ontario Heritage Act* (September 1, 2013). Site # 4 at 3060 Sixth Line**,** is included on the Town of Oakville Register *Section E: Register of Properties of Cultural Heritage Value or Interest (Not Designated)* of the Town of Oakville's Heritage Register (September 1, 2013).

Consultation with the Town of Oakville heritage planner (2012 and 2013) indicates the house on No. 3369 Sixth Line ***(Site # 5)***, which is included on the Town of Oakville Register *Appendix A: Register of Designated Heritage Properties Under Part IV of the Ontario Heritage Act* (September 1, 2013), is currently in storage and will be reconstructed on-site. A Heritage Easement for the property and the building reconstruction dated February 28, 2012 was approved. Heritage Permit 19/10-42.205 is approved for the reconstruction. During the 2012 survey, it was noted that the barn and silo still remained on the site; however, these built heritage resources have since been demolished.

There are no known federally or provincially recognized properties or any known cemeteries located within or adjacent to the Sixth Line study corridor.

The identified cultural heritage landscapes (CHL) and built heritage resources (BHR) are listed in the ***Table 1*** and mapped in ***Figure 2***. The following explanatory notes provide background material on the information contained in Table 1.

- Resources are identified by category: Cultural Heritage Landscape (CHL) or Built Heritage Resource (BHR), and by type: roadscape, residential subdivision, cemetery, bridge, residence, church, etc.
- The municipal address, when applicable, locates the identified cultural heritage resources.
- A brief description of the cultural heritage resource, e.g., notable landscape features, structures on the property, construction period(s), building materials, architectural style, is based upon information gained from the public roadway.
- Known heritage value is identified.
- Digital images are supplied for the resources. Unless noted otherwise, Unterman McPhail Associates took all photographs in June 2012.

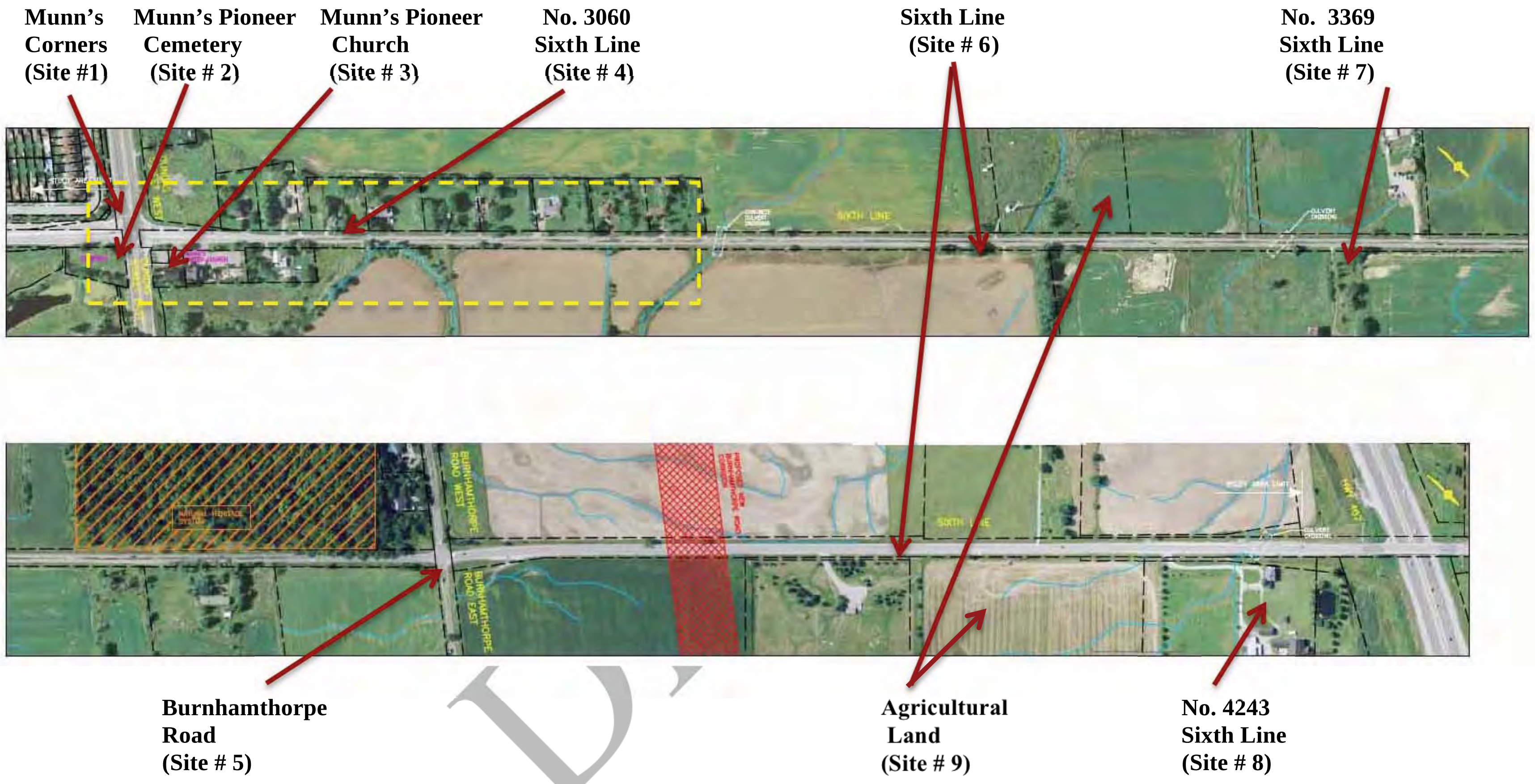


Figure 2. Map of the Identified Cultural Heritage Resource within and adjacent to the Sixth Line Study Corridor [As adapted, Morrison Hershfield].

TABLE 1: IDENTIFIED CULTURAL HERITAGE LANDSCAPES (CHL) AND BUILT HERITAGE RESOURCES (BHR) ADJACENT TO THE PROPOSED ROUTE FOR THE SIXTH LINE IMPROVEMENTS FROM DUNDAS STREET TO HIGHWAY 407 (ETR), TOWN OF OAKVILLE, ONTARIO

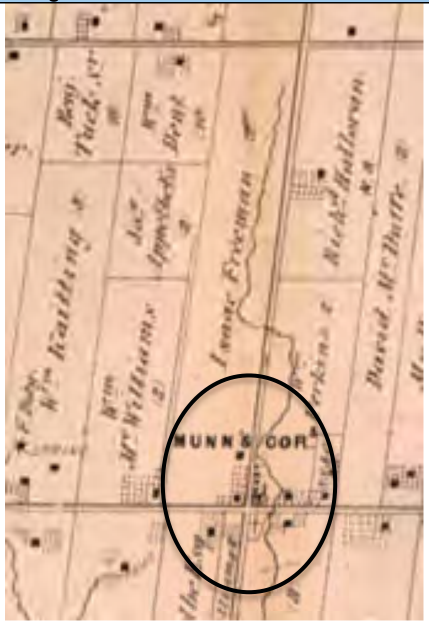
Site #	Resource Category	Resource Type	Location	Description of Resource	Heritage Recognition	Digital Photograph/Aerial or Map Image
1.	CHL	Historical Crossroad Settlement	Munn's Corners (Lots 15 16, Con. 1 NDS and Con. 1 SDS, geographic township of Trafalgar), Town of Oakville	Munn's Corners Former crossroads settlement of Munn's Corners located on the southeast corner of the Sixth Line and Dundas Street East. Local farmer Daniel Munn established Munn's Pioneer Cemetery c1820 and also operated a successful tavern and stage house on the northwest corner of his property. The crossroads hamlet that grew around the intersection became known as Munn's Corners. A small log school, which doubled as a church, was built on Munn's land. The hamlet is now represented by Munn's Church, Mann's Pioneer Cemetery and a few residences on west side of Sixth Line north side of Dundas Street. West.	40 years of age and older, not included on the Town of Oakville *Register.*	 Illustrated Historical Atlas (1877) showing Munn's Corners.

TABLE 1: IDENTIFIED CULTURAL HERITAGE LANDSCAPES (CHL) AND BUILT HERITAGE RESOURCES (BHR) ADJACENT TO THE PROPOSED ROUTE FOR THE SIXTH LINE IMPROVEMENTS FROM DUNDAS STREET TO HIGHWAY 407 (ETR), TOWN OF OAKVILLE, ONTARIO

Site #	Resource Category	Resource Type	Location	Description of Resource	Heritage Recognition	Digital Photograph/Aerial or Map Image
2.	CHL	Funerary	Dundas Street East (Lot 15, Con. 1 SDS, geographic township of Trafalgar), Town of Oakville	Munn's Pioneer Cemetery Located on the southeast corner of the Sixth Line and Dundas Street East, this cemetery was established c1820 by Daniel Munn. It is believed Daniel Munn was the first person to have been interred in the cemetery in 1822.	Included on the Town of Oakville *Section A: Register of Designated Heritage Properties Under Part IV of the Ontario Heritage Act* (September 1, 2013), By-Law 1993-021.	 View south across Dundas Street to Munn's Pioneer Cemetery (2012).
3.	CHL	Religious	No. 5 Dundas Street East (Lot 15, Con. 1 NDS, geographic township of Trafalgar), Town of Oakville	Munn's Church Jordan Munn granted property to the Church Trustees in 1842. Built in 1898, as the second church building on the site, this 2 ½ storey, vernacular Gothic Revival style church has a gable roof, pointed windows with decorated pointed surrounds and drip molds, a Palladian styled window above the main entrance door, brick buttresses located on three facades, and stone window sills. The building was moved on the site in the late 20th century when Dundas Street was widened. The site is associated with the 19th century agricultural development of Trafalgar Township, the historical crossroads settlement of Munn's Corners and Munn's Pioneer Cemetery (Site #1).	Included on the Town of Oakville *Section A: Register of Designated Heritage Properties Under Part IV of the Ontario Heritage Act* (September 1, 2013), By-Law 1989-124.	 Front (south) and west elevation of Munn's United Church (2012).

TABLE 1: IDENTIFIED CULTURAL HERITAGE LANDSCAPES (CHL) AND BUILT HERITAGE RESOURCES (BHR) ADJACENT TO THE PROPOSED ROUTE FOR THE SIXTH LINE IMPROVEMENTS FROM DUNDAS STREET TO HIGHWAY 407 (ETR), TOWN OF OAKVILLE, ONTARIO

Site #	Resource Category	Resource Type	Location	Description of Resource	Heritage Recognition	Digital Photograph/Aerial or Map Image
4.	BHR	Residential	No. 3060 Sixth Line, west side (Lot 16, Con. 1 NDS, geographic township of Trafalgar), Town of Oakville	Residence This mid 19th century, 1 ½ storey building with a side gable roof is much altered. The Trafalgar Township map in the *Illustrated Historical Atlas* (1877) depicts a residence, probably the existing residence at No. 3060 Sixth Line on the west side of Sixth Avenue north of Dundas Street. The residence is associated with the historical settlement of Munn's Corners. The Town considers this property to have cultural heritage value for its vernacular frame construction and its historical associations with Munn's Corners.	Included on the Town of Oakville *Section E: Register of Properties of Cultural Heritage Value or Interest (NOT Designated)* (September 1, 2013).	 View to front (west) elevation of No. 3060 Sixth Line (2012).
5.	CHL	Roadscape	Burnhamthorpe Road (Between Con. 1 and 2 NDS, geographic township of Trafalgar), Town of Oakville	Burnhamthorpe Road This east to west road is narrow and undulating and characterized by tree lines, fencerows, hedgerows and generally grassy ditches with narrow gravel shoulders at the Sixth Line. It is an open road on Tremaine's Map (1859) and the Illustrated Historical Atlas (1877).	40 years and older in age, no known heritage recognition.	 View west on Burnhamthorpe Road from Sixth Line showing rural character of the road [Google 2013, image 2011].

TABLE 1: IDENTIFIED CULTURAL HERITAGE LANDSCAPES (CHL) AND BUILT HERITAGE RESOURCES (BHR) ADJACENT TO THE PROPOSED ROUTE FOR THE SIXTH LINE IMPROVEMENTS FROM DUNDAS STREET TO HIGHWAY 407 (ETR), TOWN OF OAKVILLE, ONTARIO

Site #	Resource Category	Resource Type	Location	Description of Resource	Heritage Recognition	Digital Photograph/Aerial or Map Image
6.	CHL	Roadscape	Sixth Line above Burnhamthorpe Road (Lots 15 and 16, Con. 1 and 2 NDS, geographic township of Trafalgar), Town of Oakville	Sixth Line This two lane, paved rural road has generally grassy ditches, narrow gravel shoulders, tree lines, fencing and hedgerows. It was surveyed as a north to south sideline in the original township survey and was opened in the early 19th century. It is shown an open road on Tremaine's Map (1859) and the Illustrated Historical Atlas (1877).	40 years and older in age, no known heritage recognition.	 View along Sixth Line south from Burnhamthorpe Road showing rural character (2012).
7.	BHR	Residential	No. 3369 Sixth Line (Lot 15, Con. 1 NDS, geographical township of Trafalgar), Town of Oakville	William Bowbeer Residence Built c1853, this brick house has been dismantled and will be reconstructed on site in the future. Driveway with brick gateposts, tree line, barn and silo visible. The barn and silo are now demolished.	Included on the Town of Oakville *Appendi A: Register of Designated Heritage Properties Under Part IV of the Ontario Heritage Act* (September 1, 2013), By-Law 2011-033. A Heritage Easement agreement dated February 28, 2012 is registered on title.	 View east to barn and silo located on 3369 Sixth Line [Google 2013, image 2011].

TABLE 1: IDENTIFIED CULTURAL HERITAGE LANDSCAPES (CHL) AND BUILT HERITAGE RESOURCES (BHR) ADJACENT TO THE PROPOSED ROUTE FOR THE SIXTH LINE IMPROVEMENTS FROM DUNDAS STREET TO HIGHWAY 407 (ETR), TOWN OF OAKVILLE, ONTARIO

Site #	Resource Category	Resource Type	Location	Description of Resource	Heritage Recognition	Digital Photograph/Aerial or Map Image
8.	CHL	Agricultural: Farm Complex	No. 4243 Sixth Line (Lot 15, Con. 2 NDS, geographic township of Trafalgar), Town of Oakville	Farm Complex This property comprises a 2 storey, hip roof, brick farmhouse built in 1898 (date stone), a large gambrel barn, and outbuildings. It is associated with the 19th century agricultural development of Trafalgar Township. Michael J. Bigger is noted as the property owner on Tremaine's Map (1858) and the Illustrated Historical Atlas (1877). The Town considers this property to have potential cultural heritage value for its historic farmstead, including the Victorian brick farmhouse, barn and outbuildings.	Included on the Town of Oakville *Appendix E: Register of Properties of Cultural Heritage Value or Interest (NOT Designated* (September 1, 2013).	 View northeast to farm complex with farmhouse and barn (2012).
9.	CHL	Agricultural	Adjacent to Sixth Line from Dundas Street north to Highway 407 (Lots 15 and 16, Con. 1 NDS and 2 NDS, geographical township of Trafalgar Township) Town of Oakville	Existing and former agricultural land with characteristic rural field patterns, tree lines, hedgerows and fencing.	40 years and older in age, no known heritage recognition	 Aerial view of Sixth Line and surrounding agricultural land [Google 2013].

6.0 POTENTIAL EFFECTS OF UNDERTAKING ON CULTURAL HERITAGE RESOURCES

6.1 Introduction

This section provides a preliminary assessment of the potential adverse effects associated with improvements to Sixth Line from Dundas Street to Highway 407 (ETR), Town of Oakville. The conservation of cultural heritage resources in planning is considered to be a matter of public interest. Generally, changes to a roadway such as widening projects and modifications to interchanges have the potential to adversely affect cultural heritage landscapes and built heritage resources by displacement and/or disruption during and after construction. Cultural heritage landscapes and/or built heritage resources may experience displacement, i.e., removal, if they are located within the rights-of-way of the undertaking. There may also be potential for disruption, or indirect impacts, to cultural heritage resources by the introduction of physical, visual, audible or atmospheric elements that are not in keeping with their character and, or setting.

The key elements of the Preliminary Preferred Design are as follows:

- Sixth Line widened to four lanes from Dundas Street to Highway 407 (ETR);
- a continuous left turn lane provided throughout the corridor;
- the signalization of intersections;
- the provision of sidewalks and on-street bicycle lanes and on street parking layby's in front of Neighbourhood Centre and Park lands;
- the provision of continuous medians to enhance the streetscape and landscaping features; and
- culvert structure replacements.

These improvements will require acquisition of some frontage along the study corridor for the ROW.

6.2 Direct Impacts

There are no identified direct impacts, i.e., removal or relocation, of identified cultural heritage resources with regard to the Preliminary Preferred Design for this project.

6.3 Indirect Impacts

The proposed design for improvements to Sixth Line will introduce new physical, visual, audible and/or atmospheric elements, including urban design elements such median landscaping, sidewalks, curbs, on-street bicycle lanes and on-street parking laybys, that are not in keeping with the existing rural character and, or setting, of the identified cultural heritage resources along the Sixth Line study corridor.

Munn's Corners ***(Site # 1)*** includes Munn's Church ***(Site # 2)*** and Munn's Cemetery ***(Site # 3)***. The Region of Halton will conduct future work at the intersection of Sixth Line and Dundas Street outside of this EA.

There are six (6) identified indirect impacts or disruptions associated with the Preliminary Preferred Design for this project. They include:

- ***Site # 4 - 3060 Sixth Line*** – This property is included on the Town of Oakville Heritage Register, Appendix E. The character and/or setting of this municipally recognized heritage resource will be disrupted, i.e., changes to the entrance drive and property frontage, due to the improvements to Sixth Line. The property acquisition of the existing frontage will result in a reduction of the buffer area between the residence and Sixth Line. This will result in significant change to the character of the existing setting, and potentially change to the residence. There is the possibility that the frontage loss could result in a vacant building or future abandonment, thus resulting in a direct impact, i.e., removal of the resource.

- ***Site # 5 - Burnhamthorpe Road*** – Burnhamthorpe Road at Sixth Line will be improved resulting in a change to the existing roadscape, as a result of the introduction of new physical, visual, audible or atmospheric elements that are not in keeping with their character and, or setting.

- ***Site # 6- Sixth Line*** – The existing rural roadscape of Sixth Line will be transformed into from a two lane roadway to a four lane urban roadway with a landscaped median. This will result in a change to the existing rural roadscape due to the introduction of new physical, visual, audible or atmospheric elements that are not in keeping with their character and, or setting.

- ***Site # 7 – 3369 Sixth Line*** – This property is municipally designated under Part IV of the OHA and is included on the Town of Oakville Heritage Register, Appendix E. There will be some property acquisition at Sixth Line resulting in a change to the existing landscape character of the resource. The residence has been dismantled and the barn and silo located on the property demolished.

- ***Site # 8 –4243 Sixth Line*** – This property is included on the Town of Oakville Heritage Register, Appendix E. There will be some property acquisition at Sixth Line resulting in a minimal change to the existing character of the built resources, which are set back from the road.

- ***Site # 9: Agricultural Land***- The character of the existing rural lands will be disrupted through the removal of existing tree lines, fencing and hedgerows and the introduction of urban road design and pathways/trails as part of the improvements to Sixth Line.

7.0 MITIGATION RECOMMENDATIONS

7.1 Introduction

A proposed undertaking should not adversely affect cultural heritage resources and intervention should be managed in such a way that its impact is sympathetic with the value of the resources. When the nature of the undertaking is such that adverse impacts are unavoidable it may be necessary to implement management or mitigation strategies that alleviate the deleterious effects to cultural heritage resource. Mitigation is the process of causing lessening or negating anticipated adverse impacts to cultural heritage resources and may include, but are not limited to, such actions as avoidance, monitoring, protection, relocation, remedial landscaping, documentation of the cultural heritage landscape and/or built heritage resource if to be demolished or relocated, salvage of building materials.

7.2 Mitigation Recommendations

Mitigation recommendations are provided for the following cultural heritage resources identified in Section 6.3.

- ***Site # 4 - 3060 Sixth Line*** **–** This property is included on the Town of Oakville Heritage Register, Appendix E. It is associated with the historical crossroad settlement of Munn’s Corners. A Cultural Heritage Impact Assessment Report (CHIA) should be completed for this recognized heritage resource with regard to recommendations for heritage designation under the OHA. Reference to the cultural heritage landscape associated with the historical crossroads settlement of Munn’s Corners should it be included in the CHIA.

- ***Site # 6- Sixth Line*** **–** The existing roadscape should be documented with photographs and key plans in a Cultural Heritage Documentation Report.

- ***Site # 8 –4243 Sixth Line*** **–** This property is included on the Town of Oakville Heritage Register, Appendix E. It is associated with the historical crossroad settlement of Munn’s Corners. Halton Region shall complete a Cultural Heritage Impact Assessment Report (CHIA) for this recognized heritage resource with regard to recommendations for heritage designation under the OHA.

- ***Site # 9: Agricultural Land*** **–** Preserve existing tree lines, hedgerows and fencing along Sixth Line were feasible.

SOURCES

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Section E: Register of Properties of Cultural Heritage Value or Interest— Not Designated.

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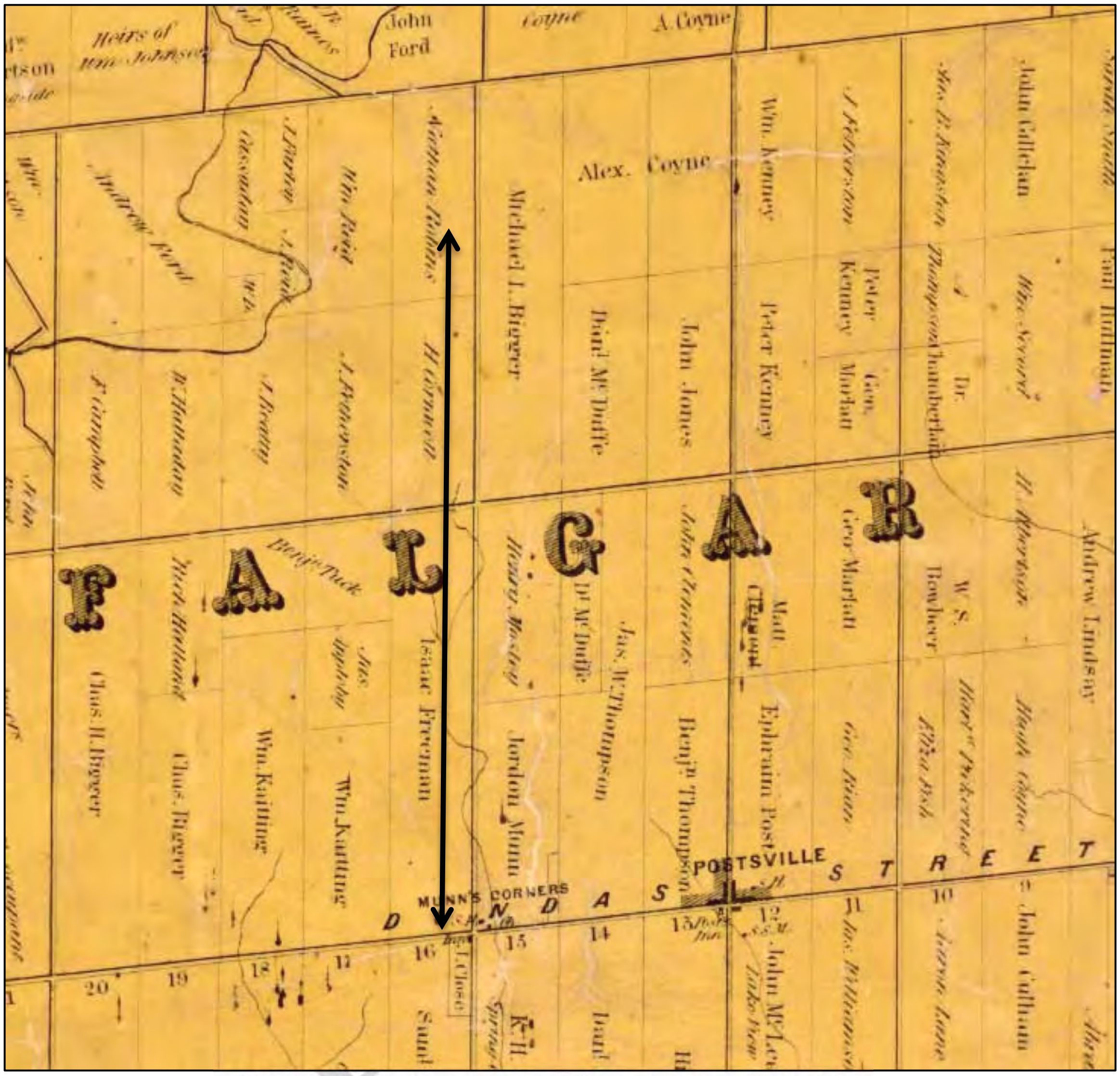
Contact

Carolyn Van Sligtenhorst, CAHP, MCIP, RPP Heritage Planner, District East/Central Planning Services, Town of Oakville, August 2012.

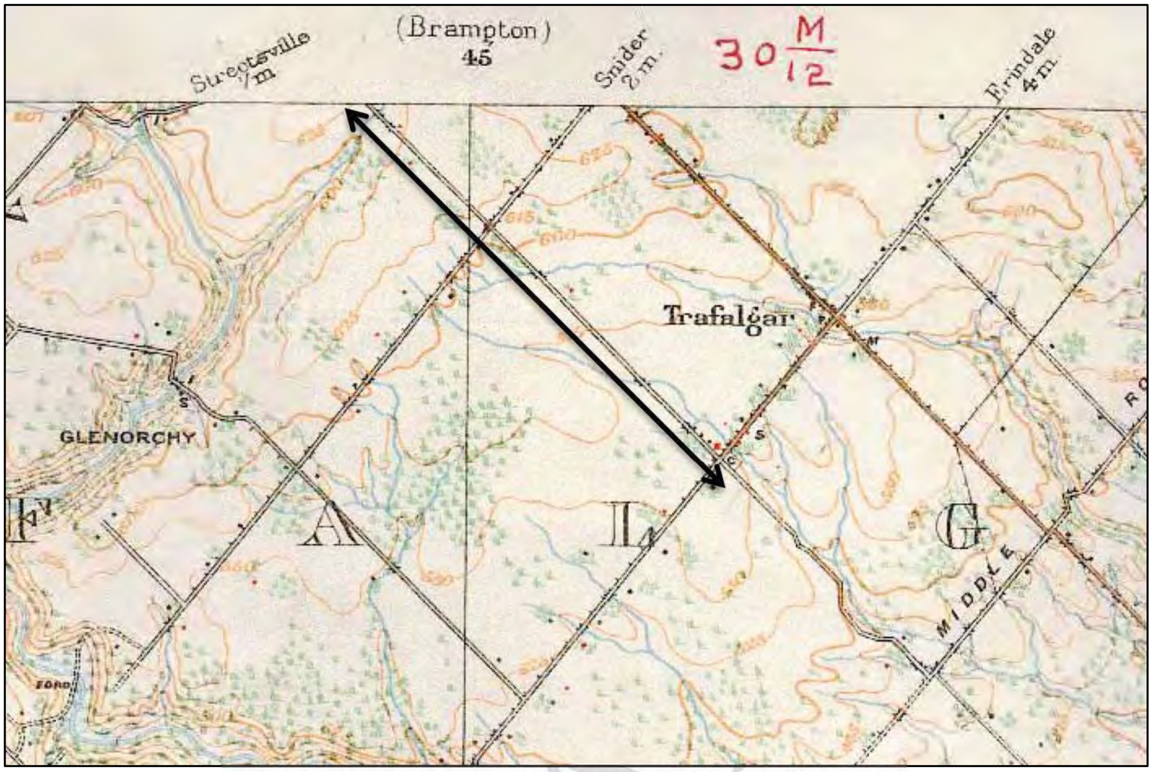
Scott Hannah, MCIP, RPP, Senior Manager, Current Planning and Heritage Planning Services, Town of Oakville, December 2013.

APPENDIX:
HISTORICAL MAPS



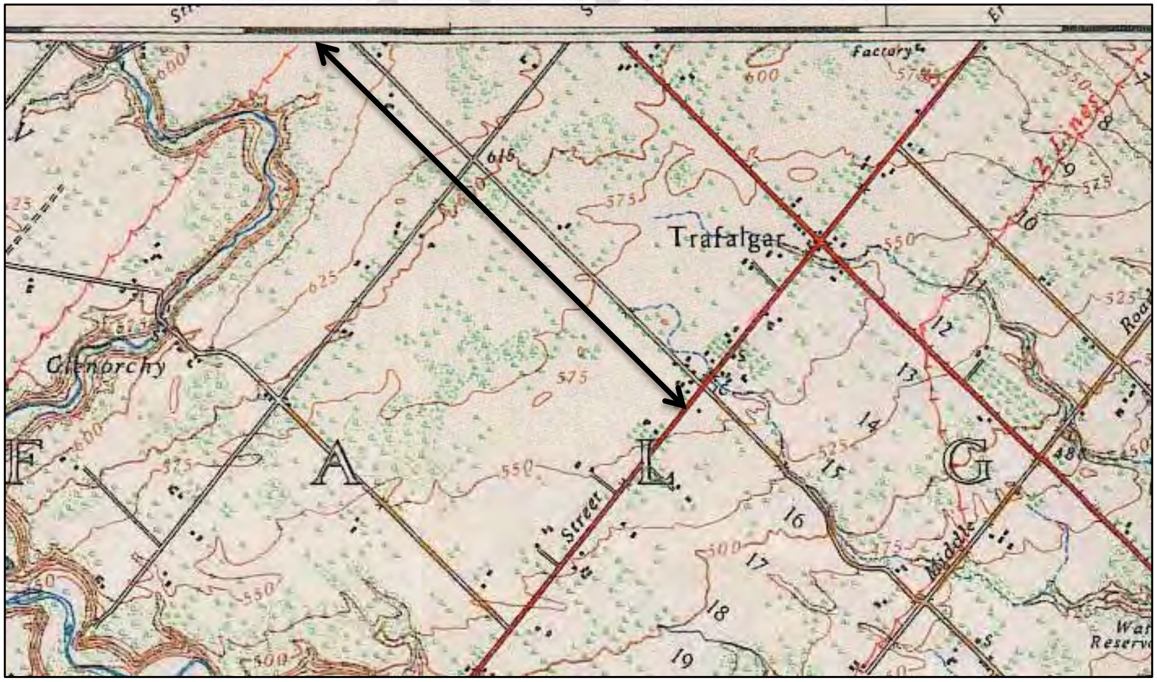
Approximate length of Sixth Line study corridor as shown on Tremaine's Map of the County of Halton [Tremaine Map, George C. Tremaine, 1858].

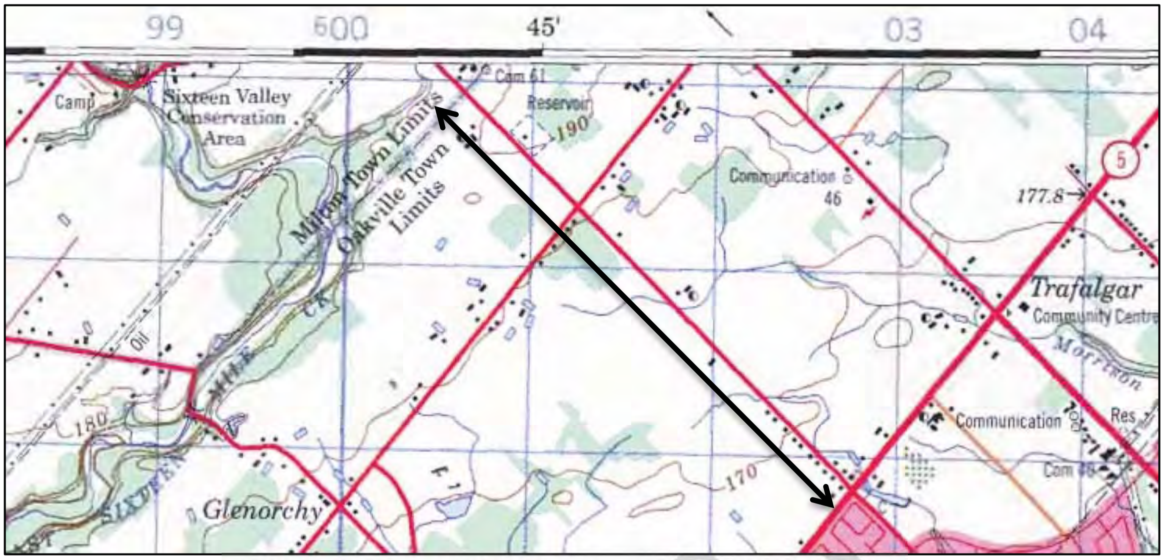
Sixth Line in the late 1870s showing Munn's Corners and the agricultural character of the land [*Map of Trafalgar Township. Illustrated Historical Atlas of the County of Halton*, Ontario. Walker & Miles, Toronto. 1877].



Sixth Line study corridor as shown on National Topographic Series. Hamilton 30 M/5, 1923.

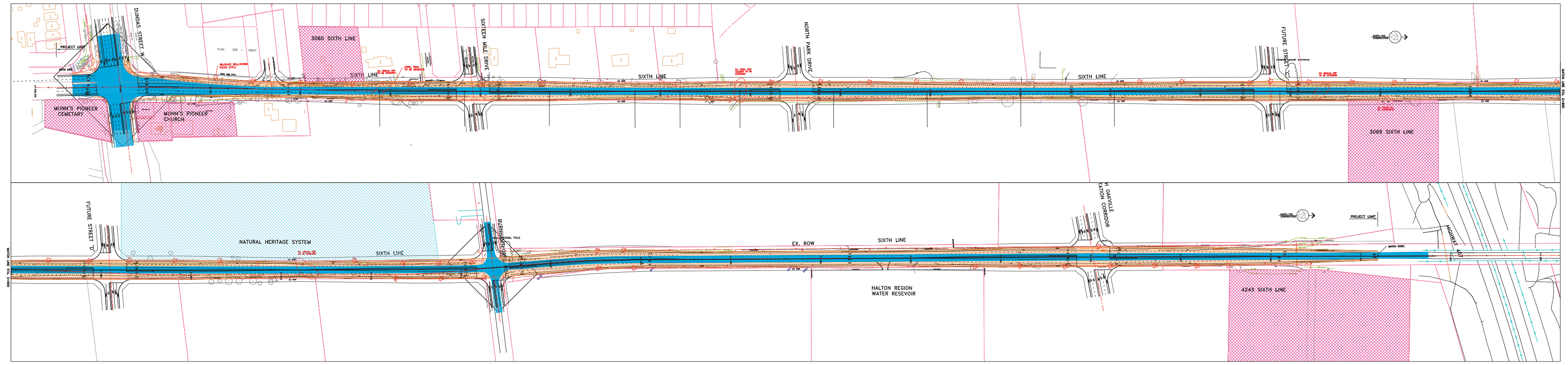
Sixth Line study corridor as shown on National Topographic Series. Hamilton 30 M/5, 1938.





Sixth Line study corridor as shown on National Topographic Series. Hamilton 30 M/5, 1999.

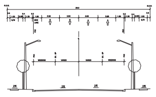
Appendix F – Alternative Design Drawings



LEGEND

- EXISTING R.O.W.
- WATER CROSSING
- PROPOSED ALIGNMENT
- PROPOSED R.O.W.

- EXISTING PAVEMENT AREA
- WIDENING AREA
- CULTURAL HERITAGE RESOURCE
- NATURAL HERITAGE SYSTEM



TYPICAL SECTION
AS PER STD 7-26

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SHEET 1 OF 1

SIXTH LINE EA STUDY ALTERNATIVE 1 – WIDENING BOTH SIDES ALONG EXISTING CENTRE LINE

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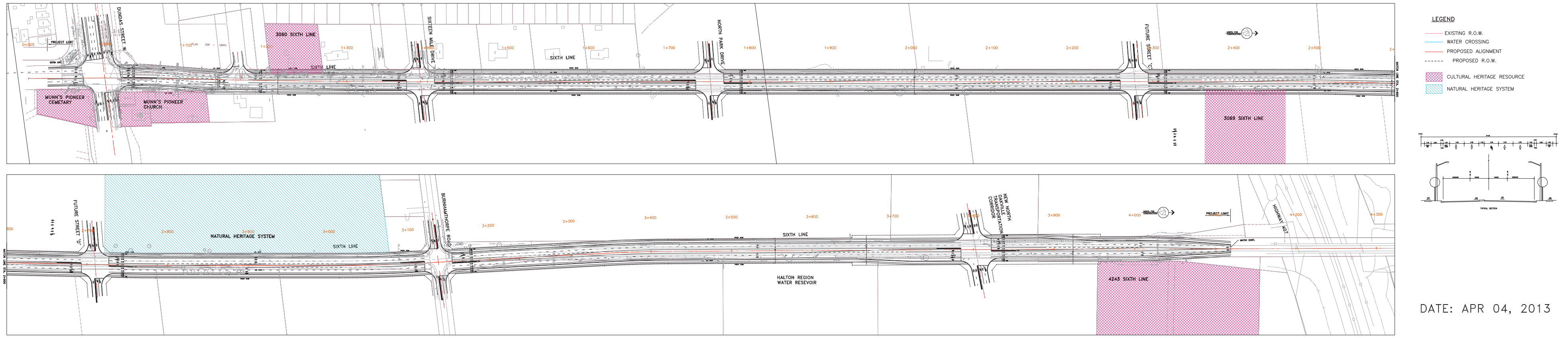
DATE: Mar. 4, 13



DATE: APR 04, 2013

PLOT DATE Apr. 22, 14 11:47 AM
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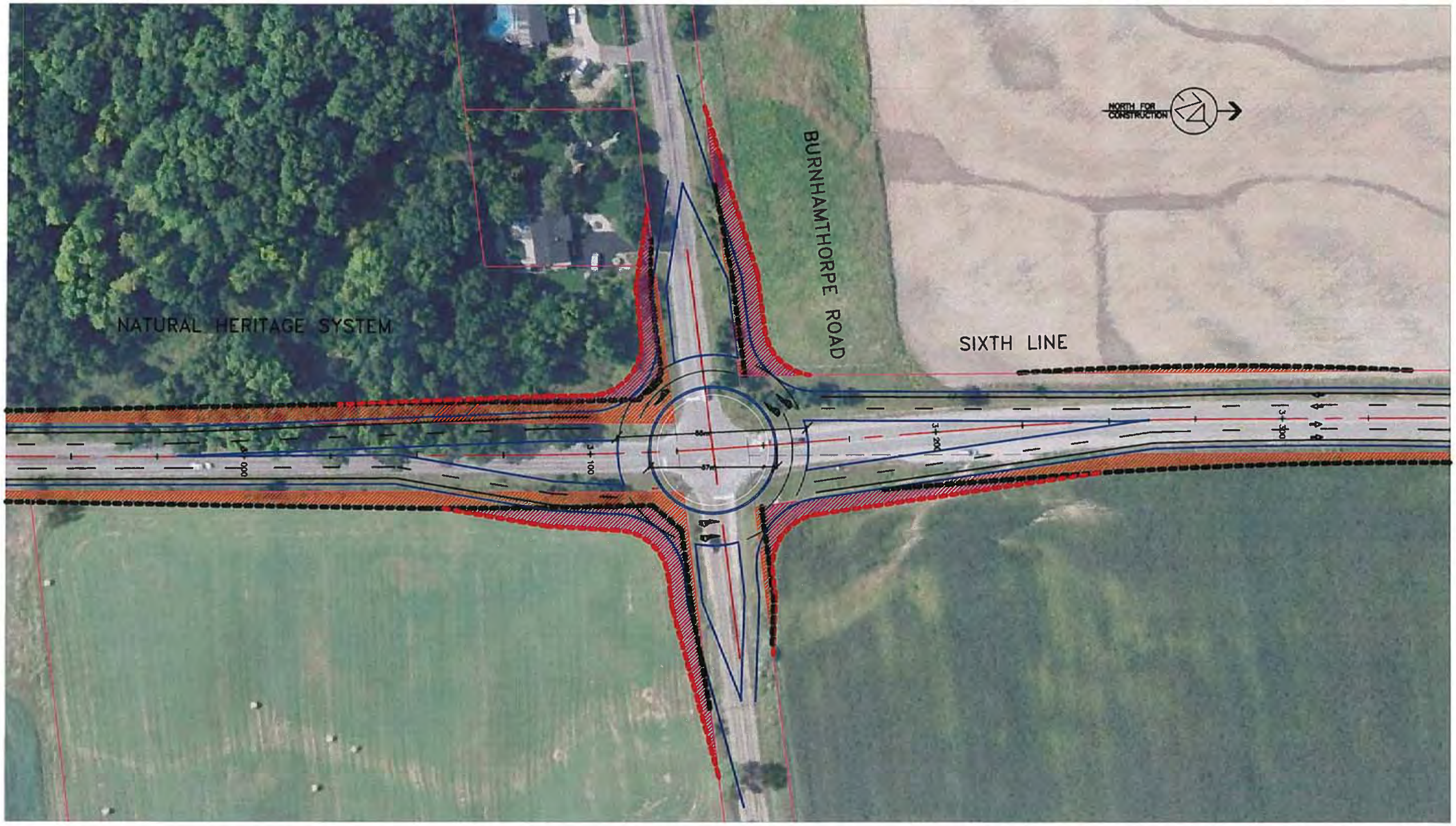
SIXTH LINE EA STUDY ALTERNATIVE 2 – WIDENING BOTH SIDES ALONG EXISTING CENTRE LINE AND TO THE EAST ALONG THE NATURAL HERITAGE SYSTEM



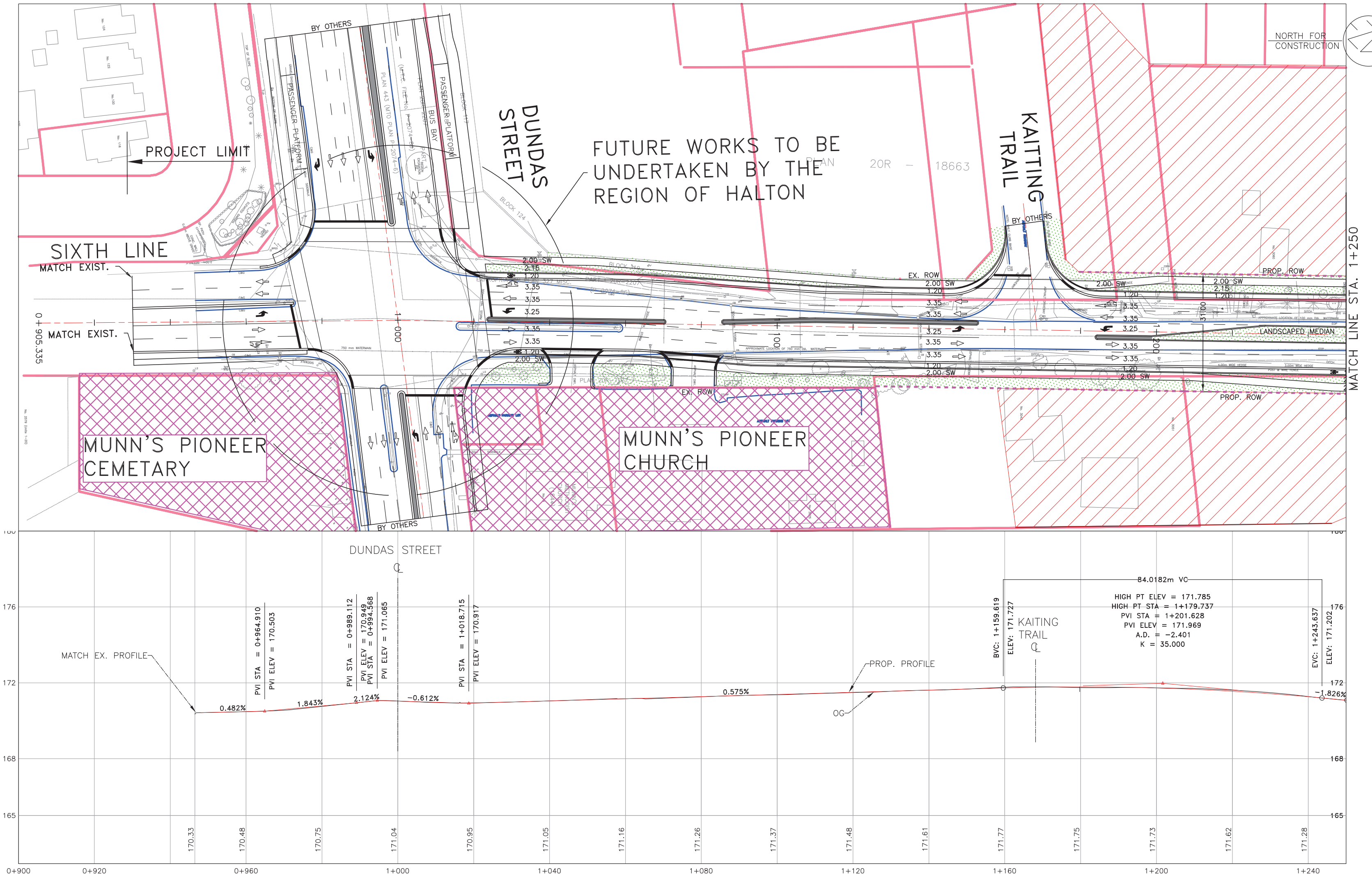
LEGEND

━	EXISTING R.O.W
━	WATERCROSSING
●●●●	PROPOSED TRAFFIC SIGNALS R.O.W
●●●●	PROPOSED ROUNDABOUT R.O.W

▨	SIGNALIZED INTERSECTION PROPERTY REQUIREMENTS (ESTIMATED QUANTITY: 2835 m2)
▨	ROUNDABOUT INTERSECTION ADDITIONAL PROPERTY REQUIREMENTS (ESTIMATED QUANTITY: 1785m2)
	TOTAL ROUNDABOUT INTERSECTION PROPERTY REQUIREMENTS: 4620 m2

SIXTH LINE EA STUDY | BURNHAMTHORPE INTERSECTION – ROUNDABOUT ALTERNATIVE | MARCH 4 2013

Appendix G – Preliminary Preferred Design Drawings



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▬	EXISTING R.O.W.
▪▪▪▪	PROPOSED R.O.W.
— – —	PROPOSED ALIGNMENT
▨	LANDSCAPED AREAS
▨	NEIGHBOURHOOD CENTRE AREA
▨	CULTURAL HERITAGE RESOURCE
▨	NATURAL HERITAGE SYSTEM
▨	PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 0+905 TO STA. 1+250

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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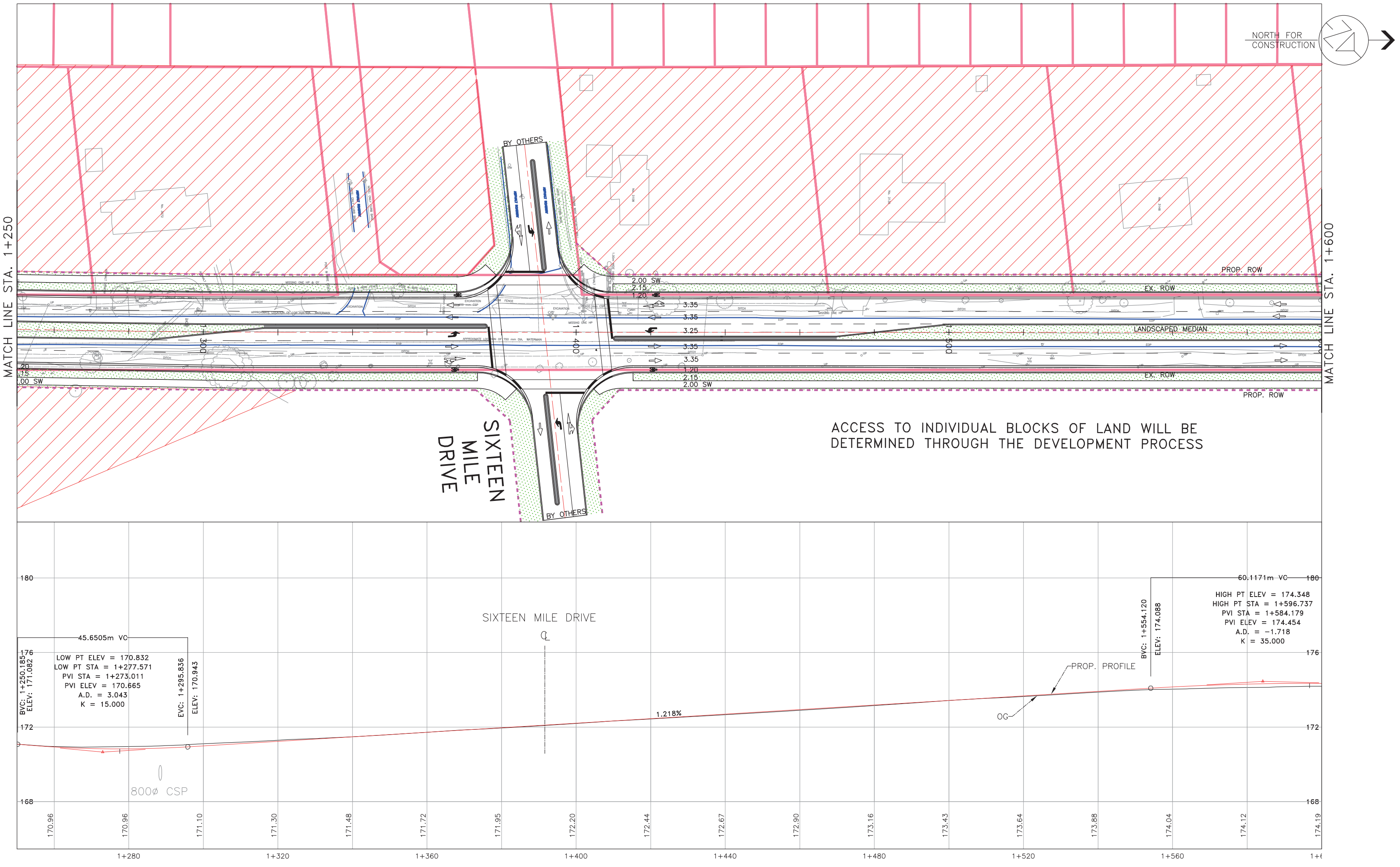

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LEGEND

- EXISTING EDGE OF PAVEMENT
- EXISTING R.O.W.
- PROPOSED R.O.W.
- PROPOSED ALIGNMENT
- LANDSCAPED AREAS
- ▨ NEIGHBOURHOOD CENTRE AREA
- ▨ CULTURAL HERITAGE RESOURCE
- ▨ NATURAL HERITAGE SYSTEM
- 🟩 PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 1+250 TO STA. 1+600

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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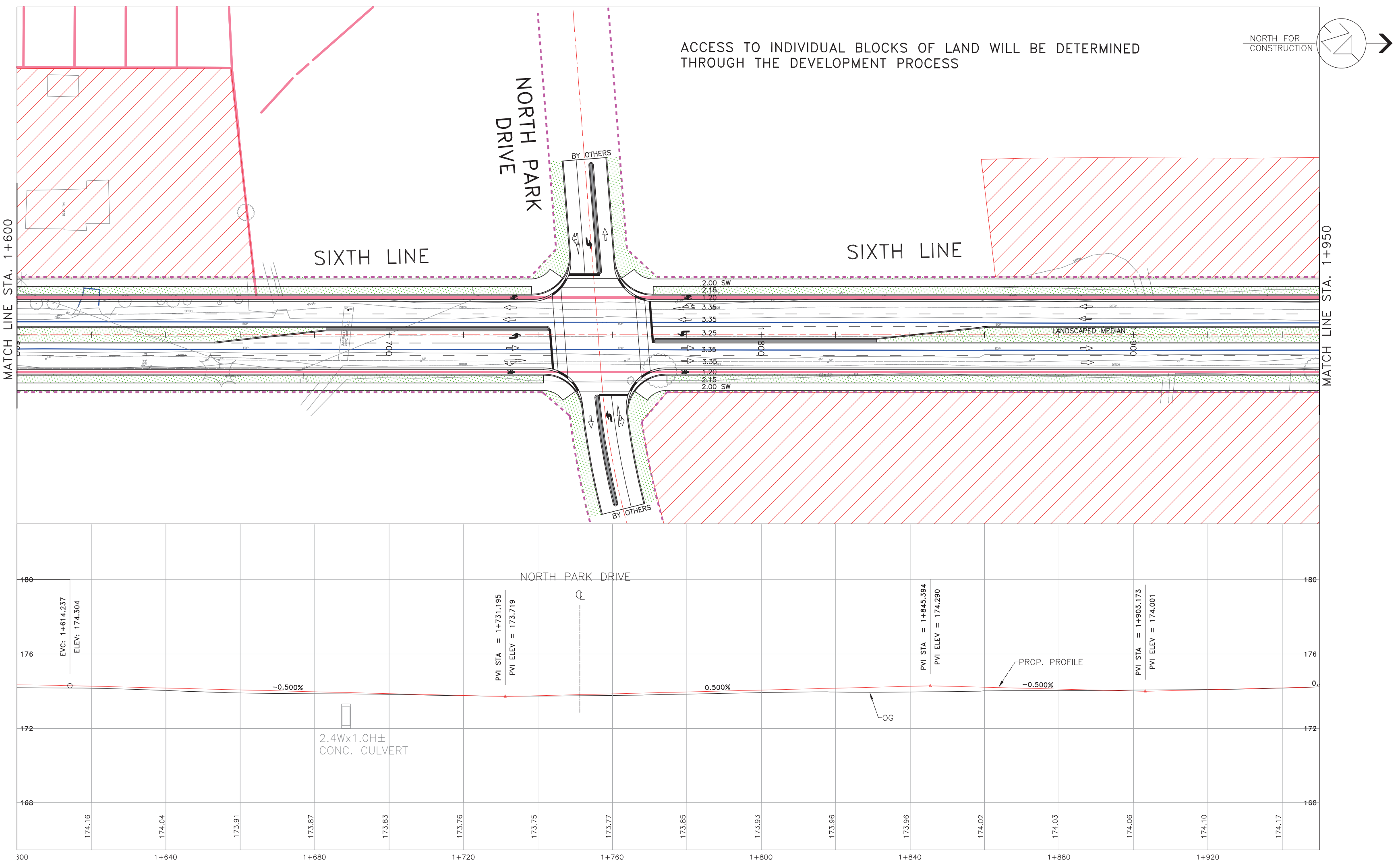

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LEGEND

━	EXISTING EDGE OF PAVEMENT
━	EXISTING R.O.W.
▪▪▪▪	PROPOSED R.O.W.
— —	PROPOSED ALIGNMENT
▨	LANDSCAPED AREAS
▨	NEIGHBOURHOOD CENTRE AREA
▨	CULTURAL HERITAGE RESOURCE
▨	NATURAL HERITAGE SYSTEM
🟩	PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 1+600 TO STA. 1+950

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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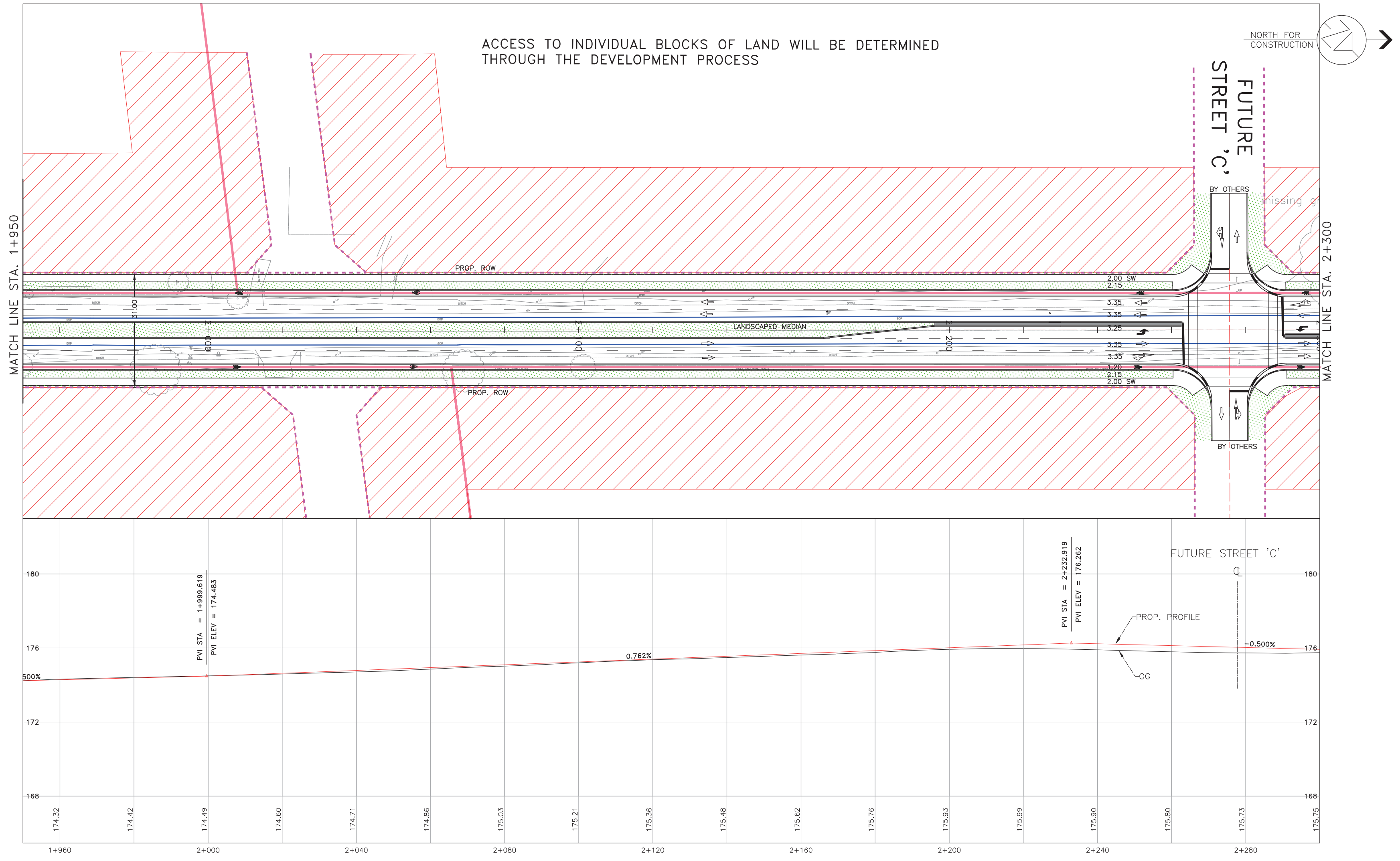

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LEGEND

- EXISTING EDGE OF PAVEMENT
- EXISTING R.O.W.
- PROPOSED R.O.W.
- PROPOSED ALIGNMENT
- LANDSCAPED AREAS
- NEIGHBOURHOOD CENTRE AREA
- CULTURAL HERITAGE RESOURCE
- NATURAL HERITAGE SYSTEM
- PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 1+950 TO STA. 2+300

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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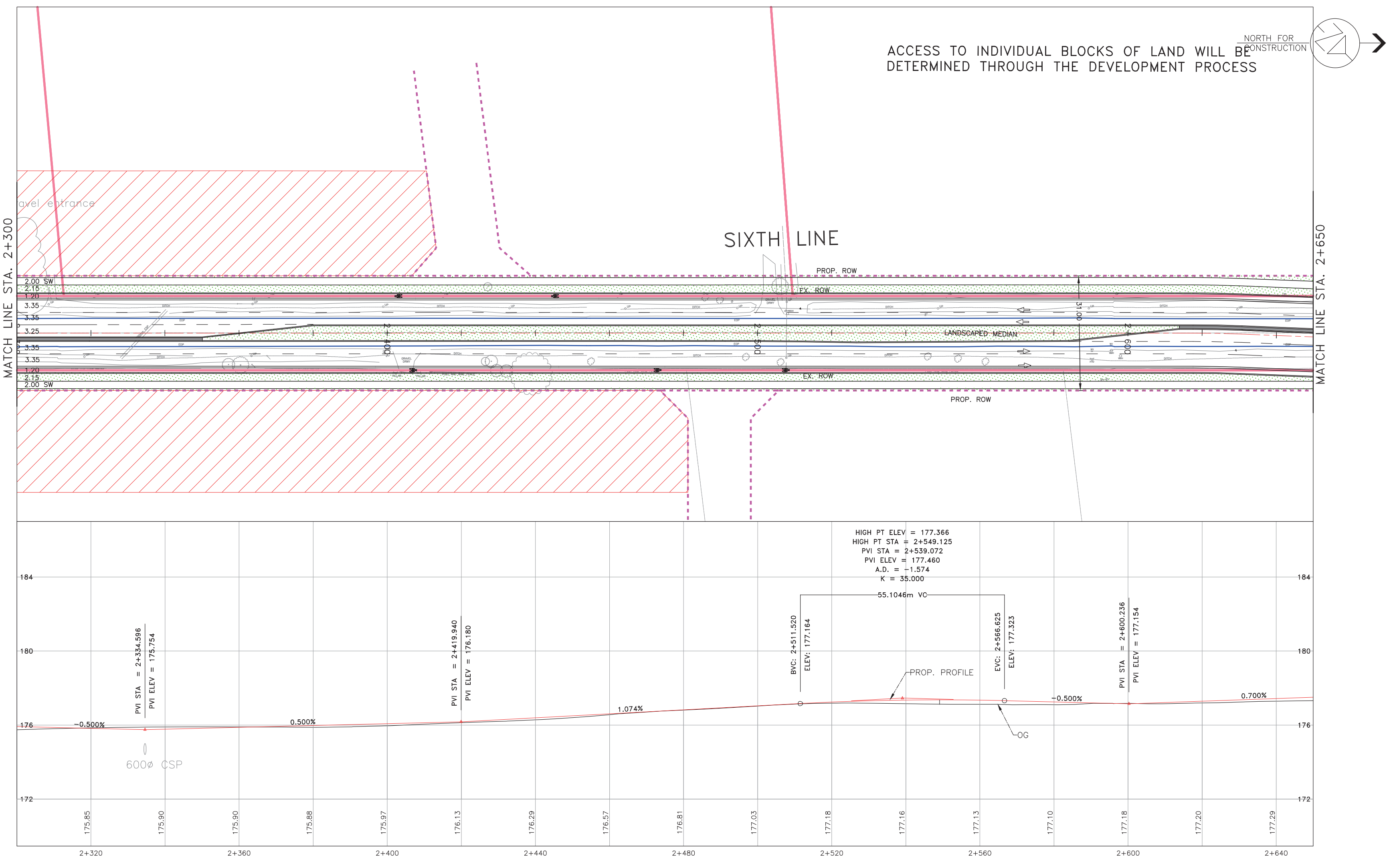

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LEGEND

- EXISTING EDGE OF PAVEMENT
- EXISTING R.O.W.
- PROPOSED R.O.W.
- PROPOSED ALIGNMENT
- LANDSCAPED AREAS
- NEIGHBOURHOOD CENTRE AREA
- CULTURAL HERITAGE RESOURCE
- NATURAL HERITAGE SYSTEM
- PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 2+300 TO STA. 2+650

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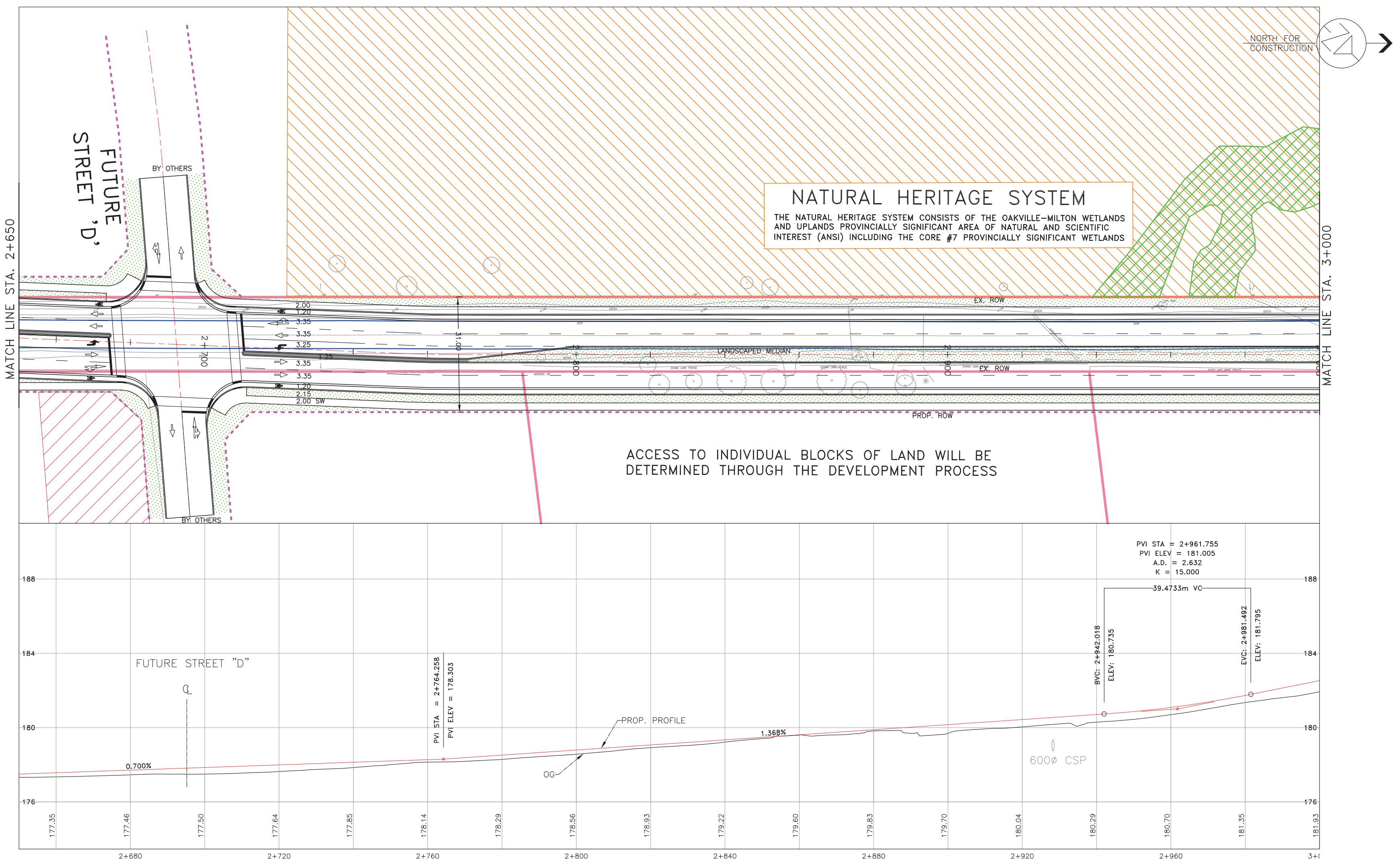

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LEGEND

━	EXISTING EDGE OF PAVEMENT
━	EXISTING R.O.W.
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— —	PROPOSED ALIGNMENT
░	LANDSCAPED AREAS
▨	NEIGHBOURHOOD CENTRE AREA
▩	CULTURAL HERITAGE RESOURCE
▨	NATURAL HERITAGE SYSTEM
▩	PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 2+650 TO STA. 3+000

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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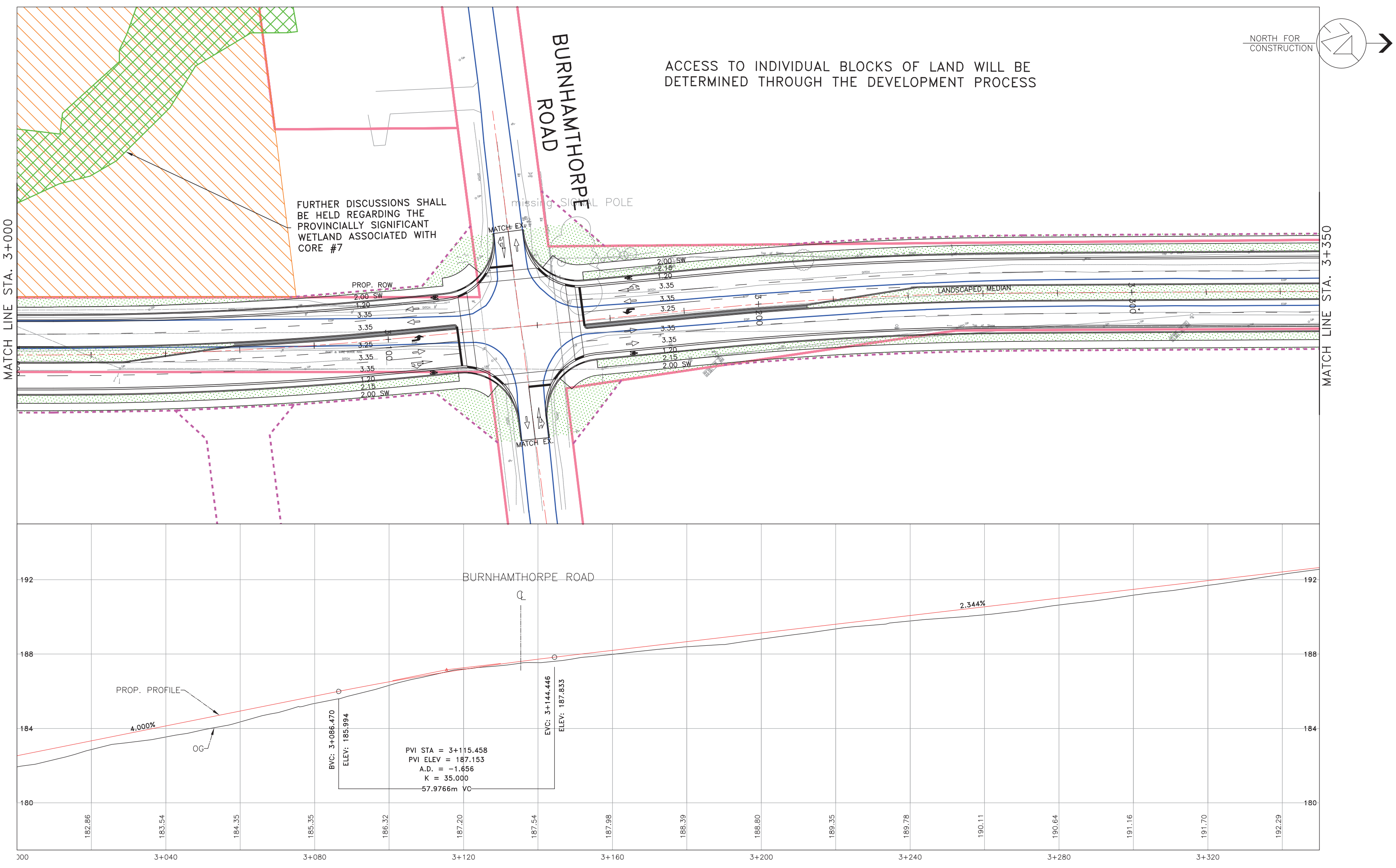

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LEGEND
- EXISTING EDGE OF PAVEMENT
- EXISTING R.O.W.
- PROPOSED R.O.W.
- PROPOSED ALIGNMENT
- LANDSCAPED AREAS
- NEIGHBOURHOOD CENTRE AREA
- CULTURAL HERITAGE RESOURCE
- NATURAL HERITAGE SYSTEM
- PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 3+000 TO STA. 3+350

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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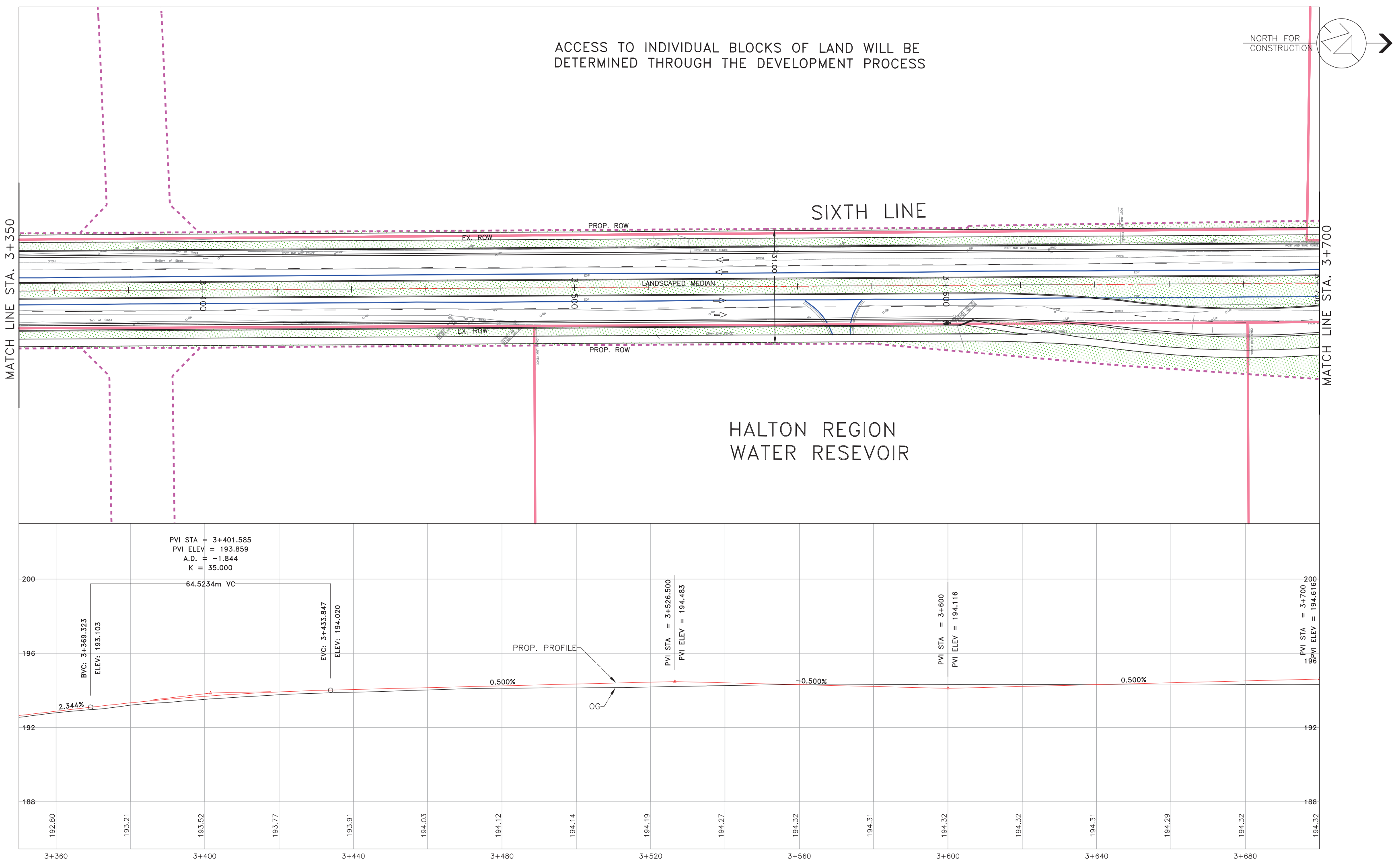

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LEGEND

—	EXISTING EDGE OF PAVEMENT
—	EXISTING R.O.W.
▪▪▪	PROPOSED R.O.W.
— —	PROPOSED ALIGNMENT
░	LANDSCAPED AREAS
▨	NEIGHBOURHOOD CENTRE AREA
▨	CULTURAL HERITAGE RESOURCE
▨	NATURAL HERITAGE SYSTEM
▨	PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 3+350 TO STA. 3+700

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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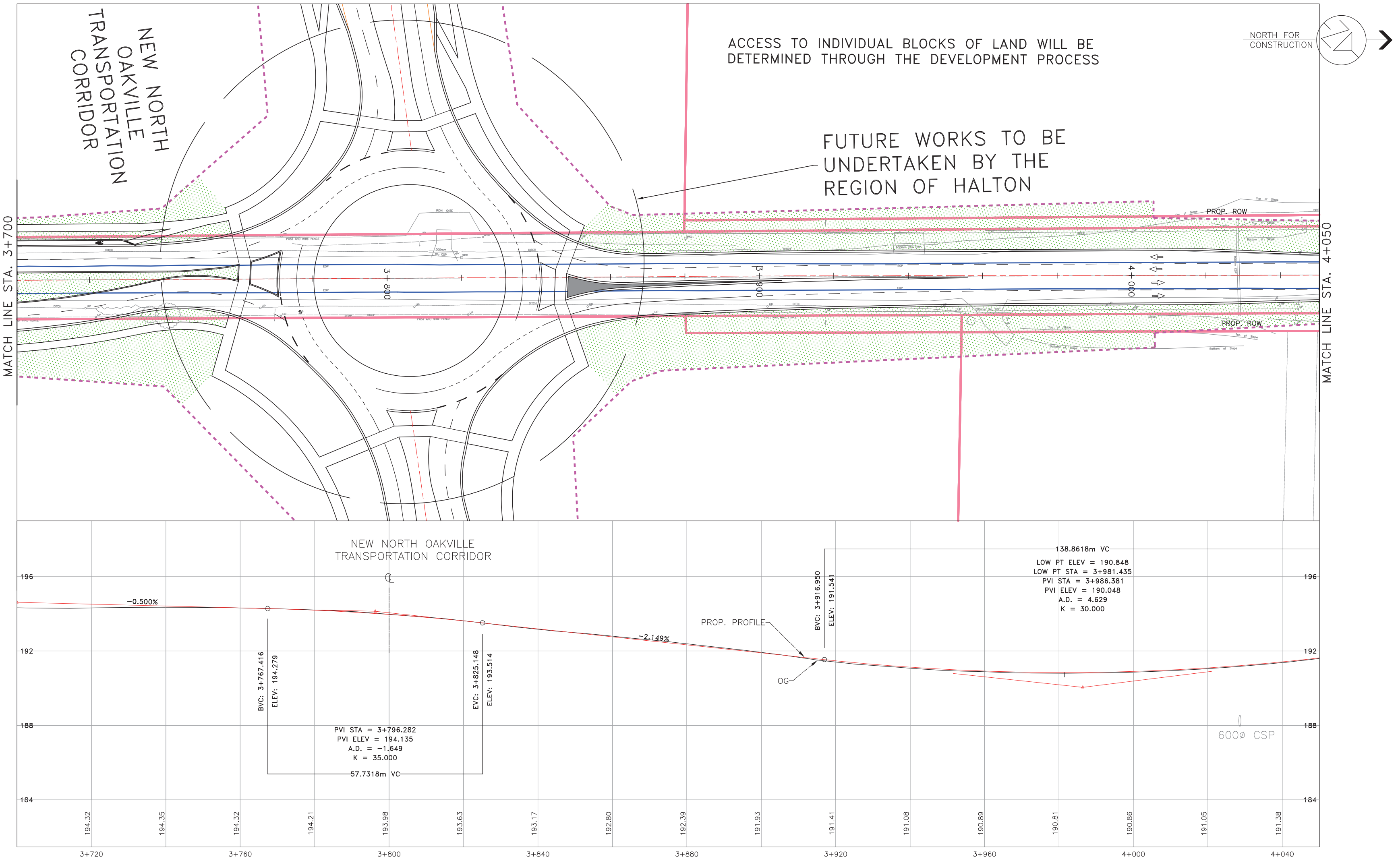

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LEGEND

- EXISTING EDGE OF PAVEMENT
- EXISTING R.O.W.
- PROPOSED R.O.W.
- PROPOSED ALIGNMENT
- ▨ LANDSCAPED AREAS
- ▨ NEIGHBOURHOOD CENTRE AREA
- ▨ CULTURAL HERITAGE RESOURCE
- ▨ NATURAL HERITAGE SYSTEM
- 🟩 PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 3+700 TO STA. 4+050

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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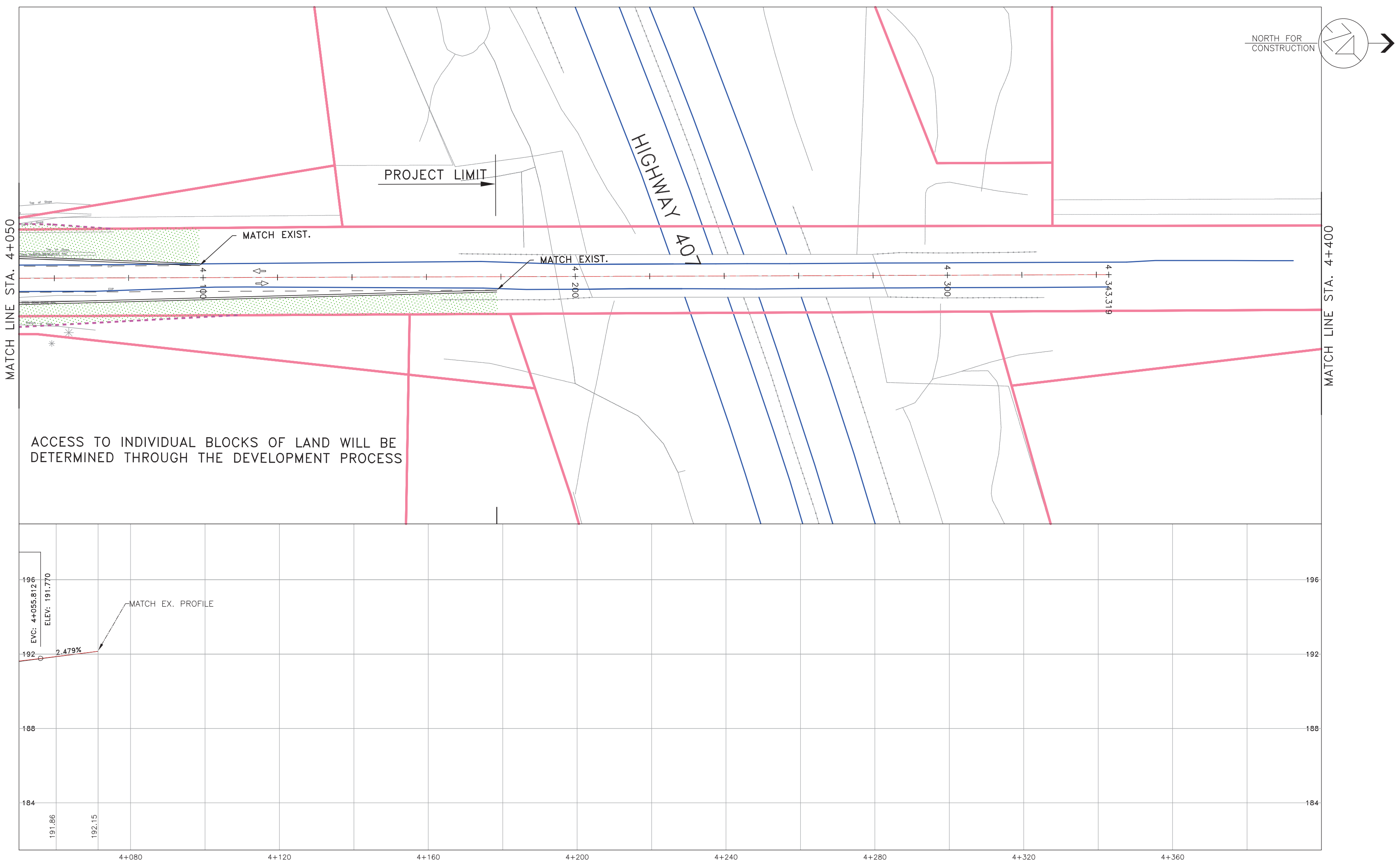

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LEGEND

- — EXISTING EDGE OF PAVEMENT
- — EXISTING R.O.W.
- ▪▪▪▪ PROPOSED R.O.W.
- — — PROPOSED ALIGNMENT
- ░ LANDSCAPED AREAS
- ▨ NEIGHBOURHOOD CENTRE AREA
- ▨ CULTURAL HERITAGE RESOURCE
- ▨ NATURAL HERITAGE SYSTEM
- 🟩 PROVINCIALLY SIGNIFICANT WETLANDS

MORRISON HERSHFIELD

OAKVILLE

SIXTH LINE CLASS ENVIRONMENTAL ASSESSMENT
PRELIMINARY PREFERRED DESIGN

STA. 4+050 TO STA. 4+400

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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Appendix H – Drainage Conditions Report

Draft Drainage Conditions Report

Sixth Line from Dundas to Highway 407

Presented to:

The Town of Oakville

Project Number: 1124037 April 30, 2014

K:\PROJ\1124037\DRAINAGE\DRAINAGE CONDITIONS REPORT APRIL 2014\REPORT PARTS\EXISTING DRAINAGE CONDITIONS.DOCX

EXECUTIVE SUMMARY

This report is presented to the Town of Oakville as part of a Municipal Class EA for Sixth Line between Dundas and Highway 407. The purpose of this report is to characterize the existing drainage conditions in the study area, establish targets for future stormwater management (SWM) design, outline strategies and alternatives, provide an analysis and discussion of alternatives, and development recommendations for future SWM design.

Water resources targets have been established in the North Oakville Creeks Subwatershed Study (NOCSS). Targets are included for stream systems, topographic depressions/ hydrologic feature A and B, infiltration, water quality, and water quantity. In addition, Town of Oakville Development Engineering Procedures and Guidelines has set out standards for design flow for culverts and overland flow.

Under existing conditions, Sixth Line is a straight two lane rural road with limited development on either side. Under proposed conditions, Sixth Line will be widened and the adjacent properties will be developed on either side. There are five culverts crossing Sixth Line in the study area which range in size from a 600 mm CSP to a 2160 mm x 900 mm concrete box.

Four subwatersheds overlap the Sixth Line study area including Munn's Creek, East Sixteen Mile Creek, East Morrison Creek and West Morrison Creek. There are three hydrologic features located adjacent to the roadway, all three of which are wetlands. One of these wetlands is considered a Provincially Significant Wetland (PSW). It is recommended that the existing hydrologic function of these wetlands be maintained by restricting widening of ROW into these areas. The boundaries of the wetlands should be field proofed in the detailed design phase.

The recommended design for conveyance of the minor system is the installation of a trunk storm sewer on Sixth Line. With the urbanization of surrounding property, roadside ditches will no longer be a viable option for conveyance. A number of alternatives have been considered to meet NOCSS targets. These alternatives include the following: Sixth Line stormwater management ponds, low impact development (LID) stormwater management controls, underground pipe storage along with oil-grit separators, and collaboration with adjacent developers on stormwater management design.

The preferred alternative for providing quality and quantity treatment is collaboration with adjacent developers on stormwater pond design. Underground pipe storage and oil grit are recommended only when the preferred alternative is not feasible. The use of a LID strategy should be considered in the detailed design stage if there is available space within the right of way.

Pre development flow targets for Sixth Line have been calculated based on the unit flow rates established in NOCSS. Post development flow rates have been calculated using hydrologic modeling software. In addition, the volume required to attenuate post development flow to pre development levels has been determined.

Under post development conditions, only two culvert crossings will remain on Sixth Line. One of the proposed culverts is an 825 mm CSP (or one of equivalent or greater hydraulic capacity) just south of Burnhamthorpe Road West. The size of this culvert should be verified in the detailed design phase because drainage area exchanges have been proposed by adjacent land developers. The other proposed culvert is a 2160 x 900 mm concrete box culvert (or one of equivalent or greater hydraulic capacity) that will be at the crossing of Sixth Line and West Morrison Creek. It is recommended to install an open bottom culvert at this crossing. The size of the West Morrison Creek crossing should be verified by fluvial geomorphologic assessment during the detailed design phase.

Phasing of Sixth Line improvements will likely take place in two phases. Phase 1 will consist of the area between Dundas Street West and Burnhamthorpe Road. Phase 2 will consist of the area between Burnhamthorpe Road to Highway 407. Sixth Line’s proposed drainage strategy relies on the proposed development of adjacent residential lands. If the widening of Sixth Line precedes adjacent land developments, a temporary strategy will be required. This strategy should the two culverts and spill areas. The temporary drainage strategy is to be developed during the detailed design phase if required.

TABLE OF CONTENTS

1. INTRODUCTION

Morrison Hershfield has been retained by the Town of Oakville to conduct a Class EA for Sixth Line between Dundas and Highway 407. The study area is show in Figure 1. This report addresses the existing and the future drainage conditions of the study area.

The purpose of this report is to characterize the existing conditions in the study area, establish targets for future stormwater management (SWM) design, outline strategies and alternatives, provide an analysis and discussion of alternatives, and development recommendations for future SWM design.

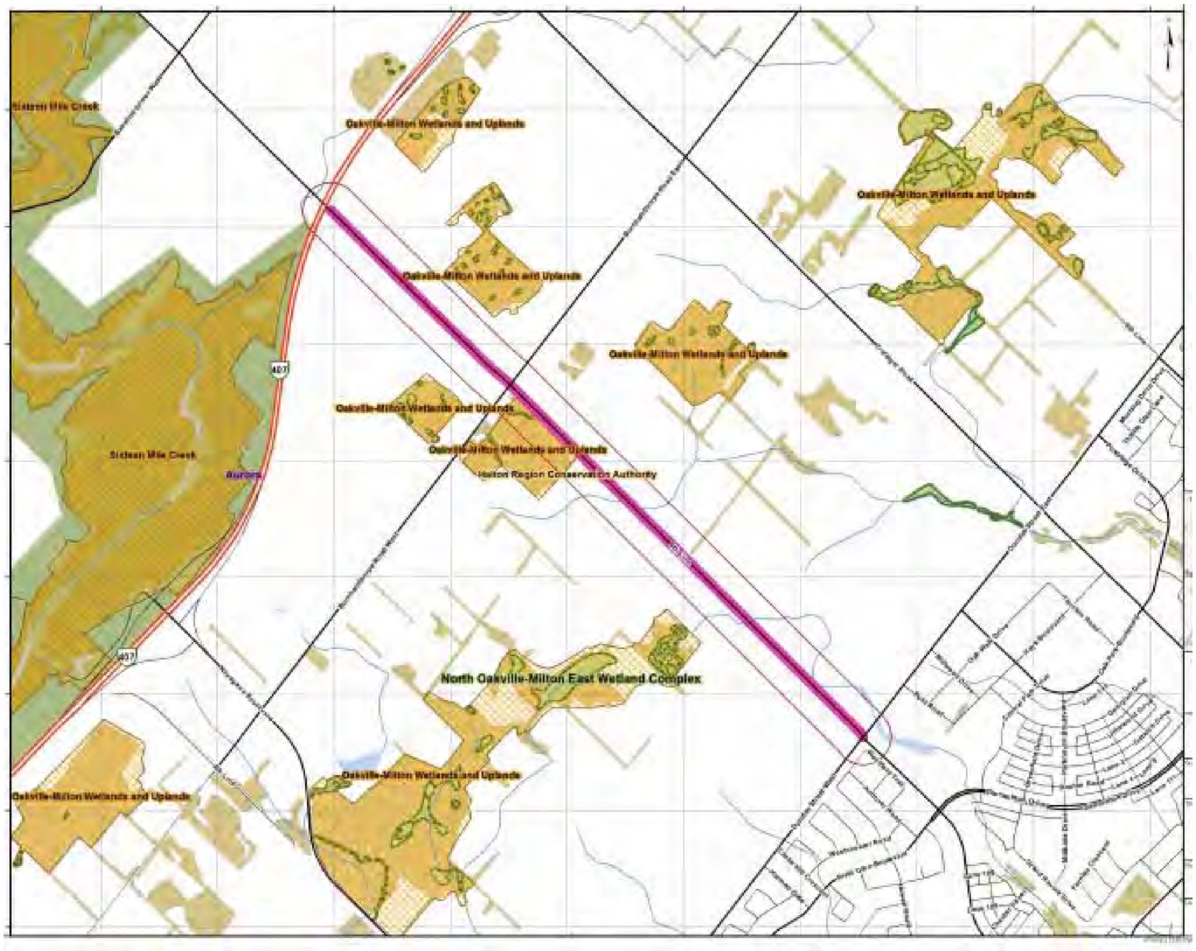


Figure 1 Sixth Line study area

2. TARGETS

Stormwater management and water resources targets are established in the North Oakville Subwatershed Study (NOCSS). All relevant goals are shown in Table 6.2.1 of NOCSS which has been included in Appendix A of this report.

Targets that are relevant to this study area are discussed in the following sub sections.

2.1 Stream Systems

The NOCSS goal for stream systems is to restore, protect and enhance water quality and associated aquatic resources and water supplies for watercourses, including their associated hydrologic functions, within the sub watershed areas. Relevant targets include:

- Protecting stream morphological and fluvial character;
- Restore, where appropriate and feasible, sinuosity;
- Maintain physical habitat attributes (e.g. pools and riffles), diversity and fluvial processes (e.g. bedload transport and energy reduction through sinuosity) and prevent increase in erosion and deposition, through maintenance of hydrological regime.

2.2 Topographic Depressions/ Hydrologic Features A and B Targets

NOCSS identifies a number of wetland and pond features that are in the subwatershed. An analysis of wetlands and ponds was conducted to determine if the wetland or pond was located online on a medium or high constraint stream, and/ or located within the stream corridor of a medium or high constraint stream. If the wetland or pond satisfies one or both of these criteria it is considered a Hydrologic Feature “A.” All others were identified as Hydrologic Features “B.”

The NOCSS recommendation for Hydrologic Features “A” is they must be carefully considered through detailed hydrological, hydrogeological and ecological assessment as part of the Environmental Implementation Report and Functional Servicing Study (EIR & FSS). If relocating these features, the form and function must be maintained.

The NOCSS recommendation for Hydrologic Features “B” is that during the EIR stage, these features must be identified and maintained. These features may be relocated and consolidated with other features, provided the hydrologic function of the feature is maintained.

Other NOCSS recommendations related to wetlands include:

- Minimizing fragmentation of wetlands;
- Maintaining the function of all wetlands associated with watercourses;
- Maintaining the function and structure of wetlands within woodlands;
- Establishing appropriate feature-specific buffers for protection of natural habitats.

2.3 Infiltration

Infiltration goals are related to managing groundwater resources and maintaining the hydrologic cycle. The targets related to infiltration include:

- No detrimental change in existing groundwater quality;
- Maintaining groundwater supplies for existing residents while development and servicing proceed;
- Maintaining the groundwater contribution to stream health (ground water quantity and quality) where it currently exists.

2.4 Water Quality

The NOCSS recommendations for water quality control aim to offer controls that will prevent further nutrient enrichment of streams, protect fisheries, and preserve overall water quality through management of phosphorus, suspended solids, chloride, dissolved oxygen, and temperature. Stormwater management systems must be designed to meet NOCSS Section 6.0 criteria, specifically Table 6.2.1. The NOCSS recommendations with respect to the water quality parameters outlined are as follows:

- Achieve MOE ‘enhanced’ level of SWM protection (80% TSS removal);

- Control to current nutrient levels in the streams to mitigate to potential increase in:
    - nutrients and associated impacts on the algae growth;
    - the potential increase in suspended solids associated with urban pollutants;

- the level of chloride and potential increase;
- and the need to manage stream temperature for fisheries protection.

2.5 Water Quantity

The recommendations for water quantity control in NOCSS Table 6.2.1 state that SWM systems be designed to maintain existing peak discharge rates for all design events, particularly high flows.

The flow targets to be used in calculations are the unit area peak flow rates that have been established in NOCSS. The target unit area flow rates for the subwatersheds in the study area are summarized in Table 1. The subwatersheds will be described in more detail in the following sections.

Table 1 NOCSS Target unit Area Peak Flow Rates

	2 Year	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**	**Regional Storm**
Subwatershed	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$
West Morrison Creek	0.006	0.009	0.011	0.015	0.017	0.019	0.048
East Morrison Creek	0.005	0.008	0.01	0.013	0.015	0.016	0.044
Munn's Creek	0.007	0.011	0.013	0.017	0.019	0.022	0.054
East Sixteen Mile Creek	0.004	0.007	0.009	0.012	0.014	0.016	0.044

2.6 Culverts

According to the Town of Oakville Development Engineering Procedures and Guidelines, road crossings of watercourses shall be designed per flood frequencies. It is assumed that Sixth Line between Dundas Street West and Highway 407 is considered a Minor Arterial-Transit Corridor. Therefore, roadway crossings of watercourses shall be designed per flood frequencies. The minimum capacity provided shall be the 1:100 Year to Regional with allowance for overtopping of roads.

If overtopping of the roadway occurs, the Town of Oakville standards for overland flow dictate that the product of depth of water (m) at the gutter times the velocity of flow (m/s) shall not exceed 0.65 m^2/s.

3. CHARACTERIZATION

3.1 Sixth Line

The section of Sixth Line in the study area is about 3.1 km in length. Within the study area, Sixth Line runs from north to south. The study area is bound by Highway 407 at the north end and Dundas Street at the south end.

3.1.1 Existing Conditions

Under existing conditions Sixth Line is a straight two lane rural road with limited development on either side. Drainage is conveyed via vegetated ditches on the east and west side of the roadway. The existing Right of Way is 20.0 m, and approximately 52.5% of the existing cross section is made up of impermeable surface material (lanes, shoulders). The remaining 47.5% is permeable material (ditches, grass cover).

3.1.2 Proposed Conditions

Under proposed conditions, Sixth Line will be widened and the adjacent properties will include subdivisions on both sides. The road cross section will be updated to a more urbanized, four lane cross section. Storm sewers are proposed in place of roadside ditches. The proposed Right of Way is 31.0 m. Approximately 83.4% of the proposed cross section is made up of impermeable surface material (lanes, shoulders). The remaining 16.6% is permeable material (green landscaping).

3.2 Culverts

There are five culvert crossings in the study area. The location of the culverts is shown on Figure 2 and information about each is provided in Table 2.

Legend

🟥 Existing Culvert

MORRISON HERSHFIELD

Title: Location of Sixth Line Existing Culverts

Project No.: 1124037

Figure 2

Department: Water Resources

Date: May 2013

Table 2 Existing culverts on Sixth Line

Culvert No.	Location	Size	Material
1	300m North of Dundas St. E	800mm	CSP
2	700m North of Dundas St. E	2160mm x 900mm	CONC. BOX CULV.
3	1.3km North of Dundas St. E	600mm	CSP
4	1.9km North of Dundas St. E	600mm	CSP
5	3km North of Dundas St. E	600mm	CSP

3.3 Stream Systems

According to NOCSS, there are four subwatersheds that overlap the Sixth Line study area. These subwatersheds include Munn’s Creek, East Sixteen Mile Creek, East Morrison Creek and West Morrison Creek. Figure 3 shows the location of these subwatersheds and Figure 4 shows reach delineation. Both Figure 3 and Figure 4 were extracted from NOCSS.

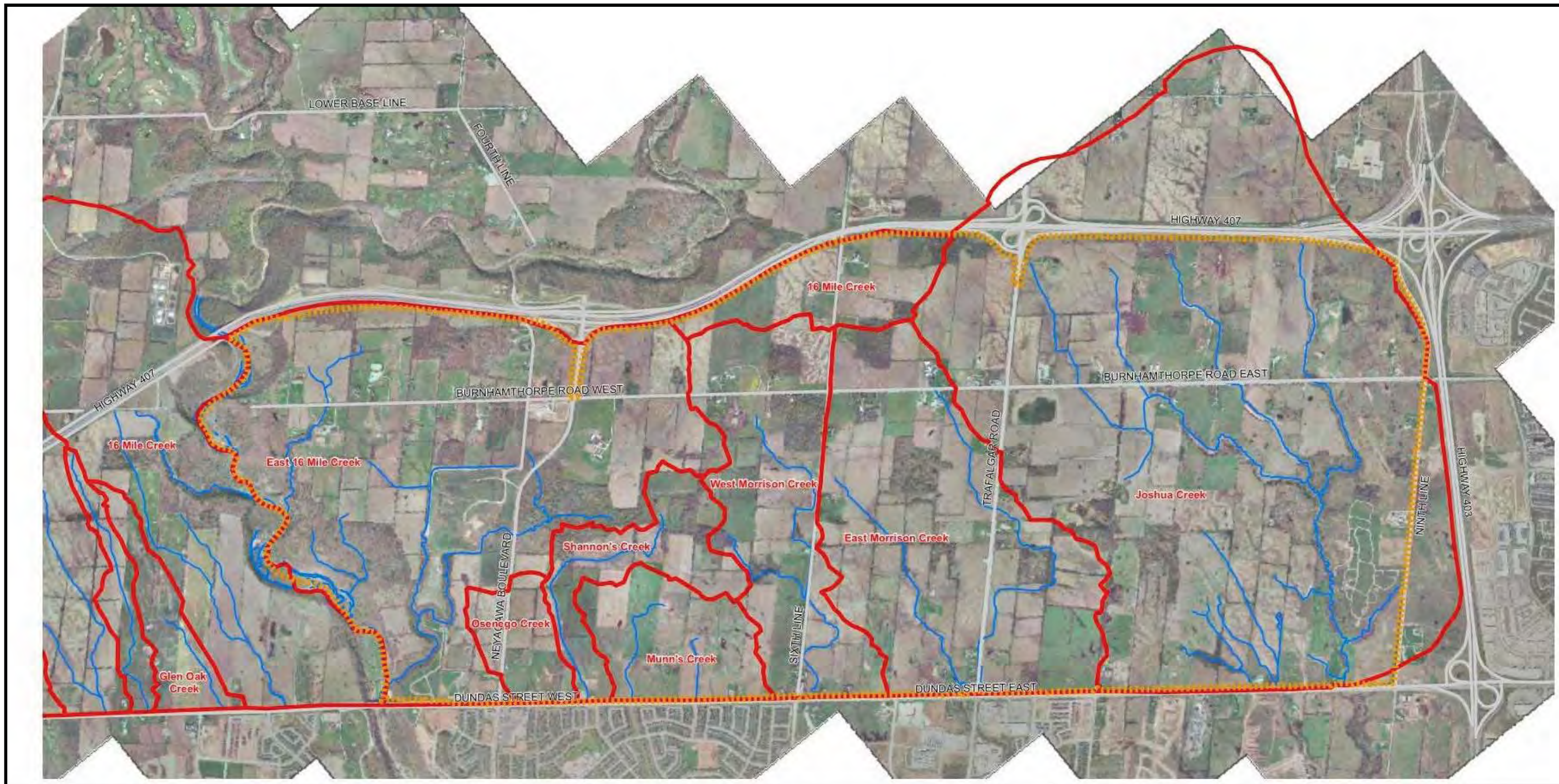
3.3.1 Munn’s Creek

Within the NOCSS study area, Munn’s Creek flows from north to south. Munn’s Creek originates from a poorly defined swale running through agricultural land. There are two tributaries of Munn’s Creek in the study area. Both of the tributaries originate in cattail marshes to the immediate north of Dundas Street. In total, 3 reaches of this creek were surveyed in NOCSS.

A small portion of Sixth Line north of Dundas Street drains into the Munn’s Creek system. This includes approximately 155 m of Sixth Line at the south end of the study area. There is an existing high point on Sixth Line at Kaitting Trail. This is the divide between the Munn’s Creek subwatershed and the West Morrison Creek subwatershed.

3.3.2 East Sixteen Mile Creek

East Sixteen Mile Creek generally flows from east to west within the NOCSS study area. In the portion of the East Sixteen Mile Creek subwatershed that overlaps the study area, no reaches were surveyed. There is one culvert crossing of Sixth Line within this subwatershed.



NORTH OAKVILLE CREEKS SUBWATERSHED STUDY

August 2006

East Study Area

Watershed Boundaries

Figure 4E.1.1

HERSHFIELD

Watershed Boundaries

Figure 3

NORTH OAKVILLE CREEKS SUBWATERSHED STUDY

August 2006

Legend
- East Study Area
- Road
- Watercourse
- Reach Break
- Detailed Field Sites

East Study Area

Reach Delineation and Field Sites

Figure 4E.8.1

NOCSS Reach Delineation

Figure 4

July 2013

3.3.3 East Morrison Creek

East Morrison Creek flows generally from north-west to south-east. East Morrison Creek is made up of two tributaries that join just north of Dundas Street. The western tributary is ploughed through with crops. There is no riparian vegetation or canopy cover in this reach. The eastern tributary of East Morrison Creek originates just south of Burnhamthorpe Road where it flows south through ploughed fields.

East Morrison Creek, north of Dundas Street, includes reaches MOC-5, MOC-5A and MOC-4. MOC-5 is considered a low constraint stream corridor, MOC-5A is considered a medium constraint stream corridor and MOC-4 is considered a high constraint stream corridor.

East Morrison Creek does not cross Sixth Line and therefore, any potential realignment or modifications to the three reaches described above will not be described in this report.

3.3.4 West Morrison Creek

West Morrison Creek flows generally from north-west to south-east. West Morrison Creek crosses Sixth Line and then runs south parallel to it as shown in Figure 3. In NOCSS, this creek was divided into four surveyed reaches. This section of stream is ploughed through with crops. Tilling has eliminated most riparian cover for the creek. To the north, west Morrison Creek originates from swales in agricultural fields before flowing into the Sixth Line roadside ditch. At the downstream end, there is more tree canopy cover of the creek. Just north of Dundas, there is a small cattail marsh.

West Morrison Creek, north of Dundas Street, includes reaches MOC-W5, MOC-W3, MOC-W2 and MOC-W1. All four of these reaches are considered medium constraint stream corridors.

Reach MOC-W3 currently runs parallel to Sixth Line. It flows partially within the ditch on the west side of Sixth Line as can be seen in Figure 4. During major storm events, it is likely that even more flow would spill into the Sixth Line ditch system.

As identified in the Timsin/Arrassa EIR & FSS, realignment of reach MOC-W3 is discussed. The turns found in the channel are not representative of natural planform adjustments; therefore they are considered to be artificial.

Reach MOC-W1 encounters the ditch on the west side of Sixth Line approximately 330 m north of Dundas Street West. During major storm events, it is likely that even more flow would spill into the Sixth Line ditch system.

The Lower West Morrison Creek (reach MOC-W1) has been identified for realignment in the Sixth Line Corporation's EIR & FSS. In both cases, the objectives of realigning the channel are to safely convey the 100-year and Regional flood flows, promote fish and amphibian habitat, to maintain or increase floodplain storage, and to maintain the low flow length of the channel.

In relation to the Sixth Line widening, the only place the realignment of the West Morrison Creek impacts Sixth Line is at Culvert MW-S2 (Culvert 2). The outlet of Culvert MW-S2 is at MOC-W1.

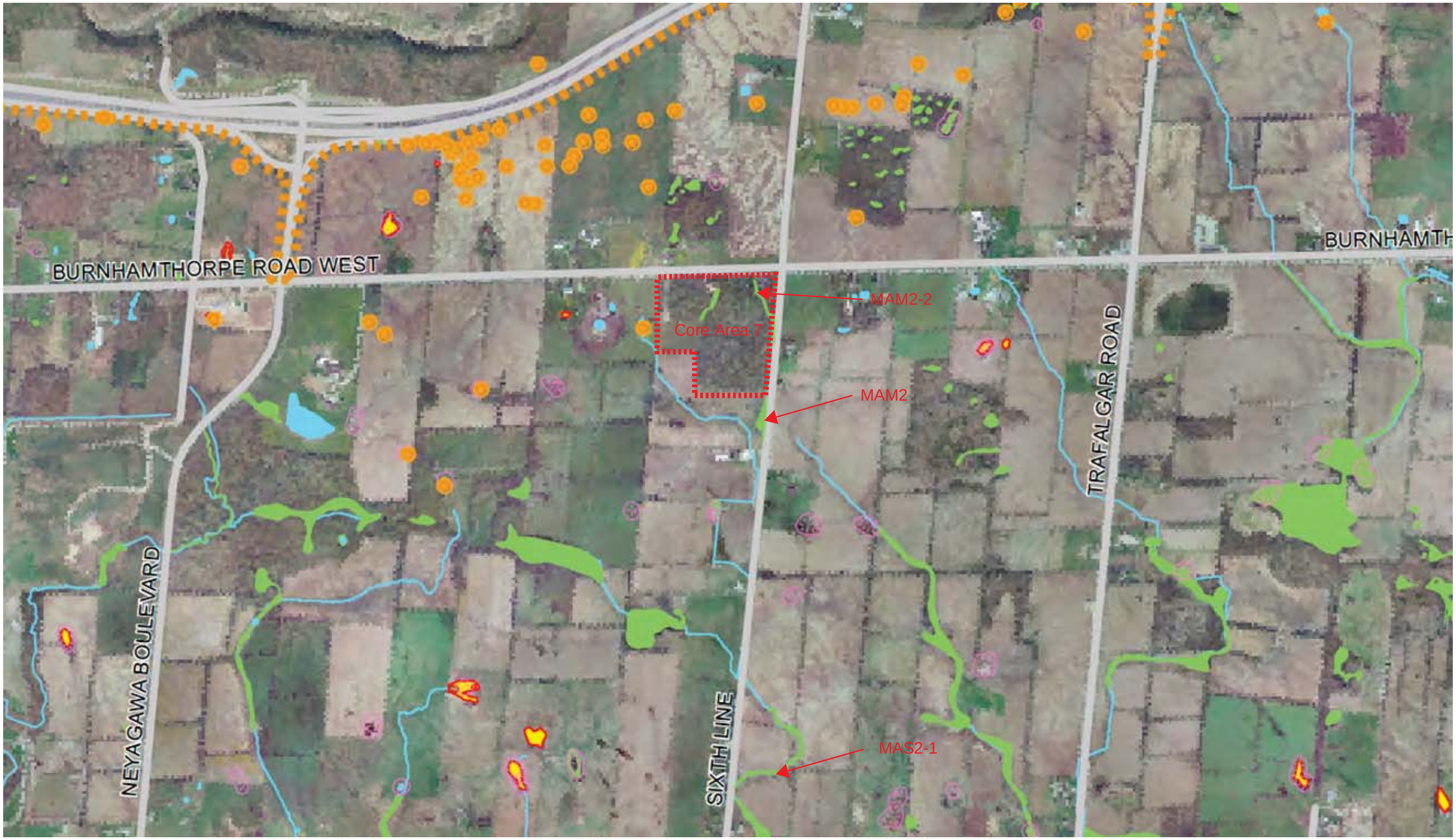
A fluvial geomorphologic analysis and channel design was carried out by Geomorphic Solutions for MOC-W1. Based on this analysis, the recommended channel design is a riffle-pool channel that will naturally adjust to the annual range of flows conveyed. Conceptual channel design drawings were prepared as part of the EIR/FSS. These drawings show that the design intent is to maintain the existing culvert alignment. The culvert will be extended due Sixth Line widening. The outlet of the culvert will be approximately 21 m east of the existing outlet. At this point, the realigned MOC-W1 will begin.

3.4 Topographic Depressions/ Hydrologic Features A and B

There are three hydrologic features located adjacent to the study area. Two of these features are wetlands located on the west side of Sixth Line within the West Morrison Creek subcatchment. The third is a wetland located on the east side of Sixth Line within the West Morrison Creek subcatchment. The locations of the wetlands are shown on Figure 5.

Wetland MAM2-2 is approximately 0.25 ha in size and called Reed-canary Grass Mineral Meadow Marsh. This wetland is considered a Provincially Significant Wetland (PSW). Wetland MAM2 is approximately 0.24 ha in size and is not named. Wetland MAS2-1 is approximately 0.19 ha is size and is called Cattail Mineral Shallow Marsh.

Neither wetlands MAM2-2 or MAM2 are located online or in the West Morrison Creek watercourse. Wetland MAM2 is considered a hydrologic feature B. The hydrologic function of this wetland should be maintained. This can be achieved by restricting development of the Sixth Line right-of-way (ROW) into this area.



NOCSS Wetlands and Core Area 7

Figure 5

July 2013

Wetland MAS2-1 is located on a medium constraint stream and is therefore considered a hydraulic feature A. The NOCSS recommendation for Hydrologic Features “A” is they must be carefully considered through detailed hydrological, hydrogeological and ecological assessment as part of the EIR. If relocating these features, the form and function must be maintained.

Wetland MAM2-2 is a PSW and therefore as per Ontario Regulation 162/06, no impacts to the hydrologic function should be proposed. This wetland is located within NOCSS Core #7 and therefore is given special consideration. NOCSS has established a “Core Area” approach where by natural features area treated as a cluster of habitats. Core #7 will be described in more detail in Section 3.5.

3.5 Infiltration

The overall goal for groundwater in NOCSS is to maintain infiltration as close to current levels as possible. Wetlands, woodlots and stream corridors are important areas for groundwater recharge.

Core #7 is located immediately adjacent to the Sixth Line ROW on the east side of Sixth Line, just south of Burnhamthorpe Road. Core #7 includes some small forest interior habitat (<1 ha). It includes wetland MAM2-2, a PSW. The existing woodlot and wetland in Core #7 has been recommended for retention in NOCSS. The hydrologic function of this Core Area should be maintained. This can be achieved by restricting development of the ROW into this area.

4. SWM STRATEGY AND ALTERNATIVES

The proposed widening of Sixth Line will require and updated stormwater management strategy that addresses the targets established in NOCSS and incorporates the additional drainage from the increased impervious area.

The recommended design for conveyance of the minor system is installation of a trunk storm sewer on Sixth Line. With the urbanization of surrounding property, roadside ditches will no longer be a viable option for conveyance.

A number of alternatives have been considered to meet NOCSS targets. These alternatives are discussed in detail below.

Alternative 1 Sixth Line SWM pond(s): Stormwater management ponds designed for treatment of drainage from Sixth Line alone.

Alternative 2 Low Impact development (LID) SWM on Sixth Line: Using a LID techniques within the Sixth Line ROW as part of the overall SWM strategy.

Alternative 3 Underground pipe storage and oil grit separators: Using oversized storm sewer pipes and orifice plates to meet quantity control targets and oil grit separators to meet quality control targets.

Alternative 4 Collaborate with adjacent developers on SWM design: Considering Sixth Line drainage in tandem with drainage from proposed, adjacent residential developments. Designing a SWM strategy that encompasses drainage from both developments.

The advantages and disadvantages of these alternatives are discussed in Table 3.

Table 3 Stormwater management alternatives for Sixth Line

No.	Description	Advantages	Disadvantages	Recommendation
1	Sixth Line SWM pond(s)	NA	Implementing SWM ponds solely for the purpose of treating Sixth Line drainage is not feasible due to limited space constraints in the ROW.	Not recommended
2	LID SWM on Sixth Line	LIDs can be integrated into landscaped and parking areas. Can provide some quality and quantity control. Facilitates evapotranspiration and infiltration. Some of the drainage can managed within the Sixth Line ROW.	Space within Sixth Line ROW. is limited and implementing LID may not be possible.	Consider the use of LIDs in the detailed design stage.
3	Underground pipe storage and oil grit separators	Can attenuate peak post development flows to existing levels. Water quality targets addressed through the use of oil grit separators. Drainage can be managed within the Sixth Line ROW.	Would not allow any infiltration for evapotranspiration to occur. Expensive in comparison to other SWM alternatives.	Recommended only when other alternatives are not feasible
4	Collaborate with adjacent developers on SWM pond design	An economical management strategy when drainage from Sixth Line and adjacent developments is considered in tandem. SWM ponds would also allow for potential evapotranspiration and infiltration.	Proposed development of Sixth Line stormwater management strategy depends on timing of adjacent developments moving forward	Recommended alternative

The preferred alternative for providing quality and quantity treatment is Alternative 4; collaborate with adjacent developers on stormwater pond design. Alternative 3, underground pipe storage and oil grit separators, is recommended only when Alternative 4 is not feasible. Alternative 2, the use of a LID strategy, should be considered in the detailed design stage if there is available space within the ROW.

5. STORMWATER MANAGEMENT ANALYSIS AND DISCUSSION

In this section, the specific requirements of the proposed stormwater management plan are discussed. A hydrologic analysis has been conducted to determine the pre development, target flows and the post development, uncontrolled flows from Sixth Line. In addition, the volume required to attenuate post development flow to pre development, target flow has been found.

The purpose of this section is to provide a preliminary indication of volume and space requirements for stormwater strategy for the proposed development. These calculations are based on the information available at the time of writing and should be refined during the detailed design stage.

Available information has been reviewed to determine possible drainage design strategies for the future, urbanized Sixth Line. Existing and future SWM facilities in the area of Sixth Line have been considered.

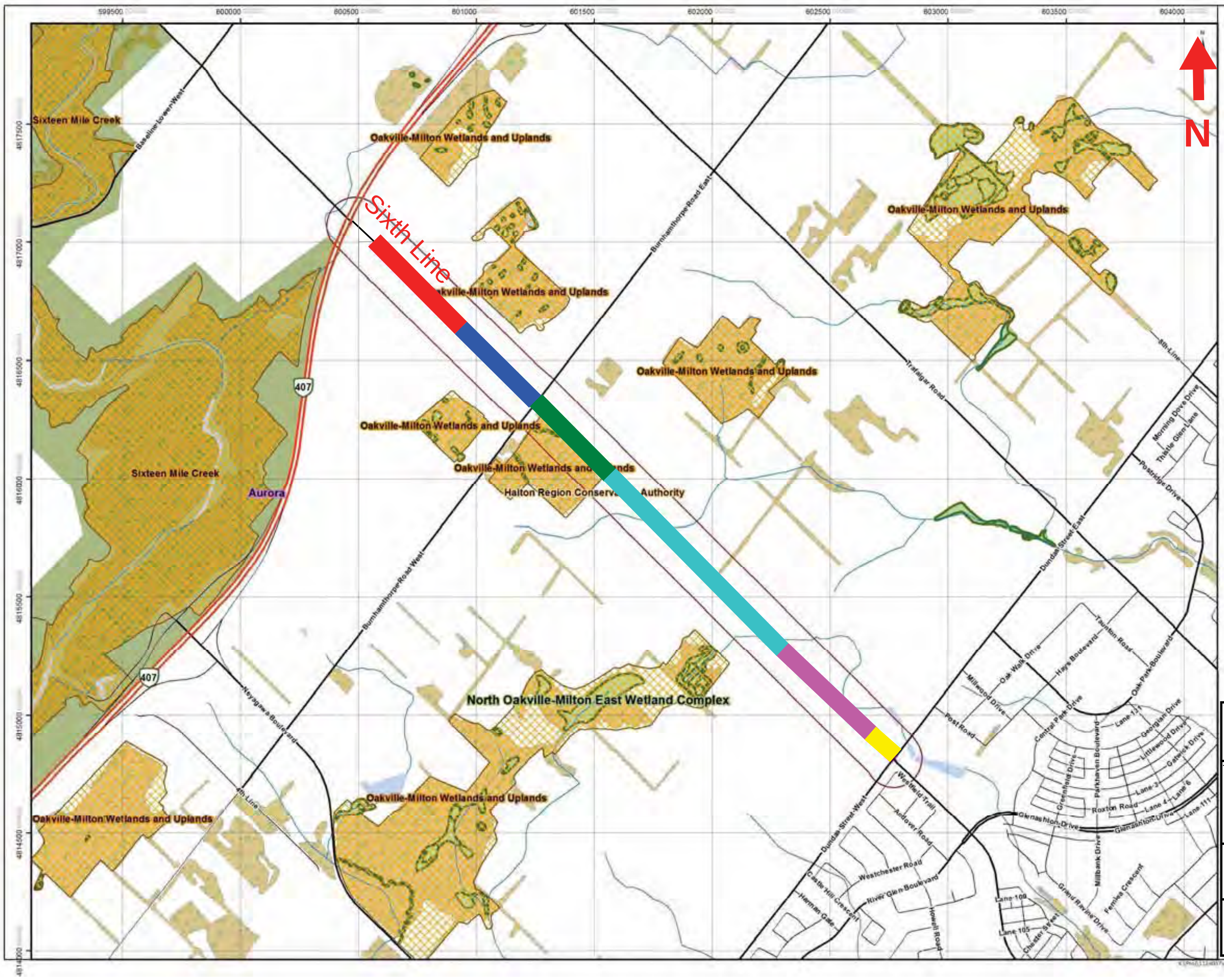
This section has been broken down into seven parts. In section 5.1, the general procedure for the hydrologic analysis is discussed. In the following five sections 5.2 to 5.7, specific areas of Sixth Line are considered. Sixth Line has been divided into six drainage areas because of differing SWM requirements. The results and discussion for each of the drainage areas will be discussed separately for this reason.

5.1 Hydrologic Analysis

A hydrologic analysis has been conducted to determine future drainage requirements for Sixth Line.

Sixth Line between Highway 407 and Dundas Street East has been divided into six drainage areas. Drainage areas were selected based on the existing road profile and future drainage boundaries. Future drainage boundaries are based on proposed SWM pond locations, culvert crossings, future intersections and sub watershed boundaries. Drainage is divided between four sub watersheds including Munn’s Creek, East Sixteen Mile Creek, West Morrison Creek and East Morrison Creek.

Drainage areas are described in Table 4 and shown in Figure 6.



Legend

🟥 D1 (520 m)

🟦 D2 (470 m)

🟩 D3 (425 m)

🟦 D4 (1025 m)

🟪 D5 (525 m)

🟨 D6 (150 m)

MORRISON HERSHFIELD

Title:
Existing Sixth Line Drainage Catchments

Project No.:
1124037

Figure 6

Department:
Water Resources

Date:
May 2013

Table 4 Summary of Sixth Line ROW Drainage Areas

Drainage Area No.	Drainage Area Existing (ha)	Drainage Area Proposed (ha)	Direction of Existing Surface Flow
D1	1.20	1.65	North
D2	1.19	1.42	South
D3	0.84	1.19	South
D4	2.05	3.00	South
D5	1.09	1.53	South
D6	0.40	0.41	South

As established by NOCSS, the flow rates to be used for the existing condition are based on unit area flows for each subwatershed. Flow rates are summarized in Table 5.

Table 5 NOCSS Target unit Area Peak Flow Rates

	2 Year	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**	**Regional Storm**
Subwatershed	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$	$m^3/s/ha$
West Morrison Creek	0.006	0.009	0.011	0.015	0.017	0.019	0.048
East Morrison Creek	0.005	0.008	0.01	0.013	0.015	0.016	0.044
Munn's Creek	0.007	0.011	0.013	0.017	0.019	0.022	0.054
East Sixteen Mile Creek	0.004	0.007	0.009	0.012	0.014	0.016	0.044

The hydrologic modeling program SWMHYMO was used to determine the effect on the stormwater flow from the proposed development of the Sixth Line ROW. The parameters use in the analysis are described in detail below. The modeling results can be found in Appendix B.

IDF Values: As per the Town of Oakville Development Engineering Procedures and Guidelines, the rainfall data used in hydrologic models shall be from the Toronto Bloor Street station. IDF values are summarized in Table 6 .

Table 6 IDF Values

Return Period	A	B	C
2 year	725	4.8	0.808
5 year	1170	5.8	0.843
10 year	1400	5.8	0.848
25 year	1680	5.6	0.851
50 year	1960	5.8	0.861
100 year	2150	5.7	0.861

Slope of Catchment: The slope of the catchment was determined based on the existing road profile.

Depression Storage: Depression storage for pervious areas is assumed to be 5.0 mm and depression storage for impervious areas is assumed to be 2.0 mm.

Percent Impervious: The proposed Right of Way is 31.0 m. Approximately 83.4% of the proposed cross section is made up of impermeable surface material (lanes, shoulders). The remaining 16.6% is permeable material (green landscaping). The future percent imperviousness value is based on a 31.0 m ROW with 5.0 m landscaped median (sod and trees). This value should be refined during the detailed design.

5.2 D1: Highway 407 to 470m north of Burnhamthorpe Road

This section of Sixth Line is approximately 520 m in length and drains north towards Highway 407. Under existing conditions, at the low point in the road profile there is a 600 mm CSP culvert crossing Sixth Line. At this point, drainage from D1 travels west across an open field to two SWM ponds on the south side of Highway 407.

The results from the hydrologic analysis for existing and proposed flow from D1 are shown in Table 7.

Table 7 Pre and post development flow from D1

Storm	NOCSS Existing Flow (m^3/s)	Post Flow (m^3/s)
2 year	0.0066	0.26
5 year	0.0116	0.39
10 year	0.0149	0.46
25 year	0.0198	0.57
50 year	0.0231	0.65
100 year	0.0264	0.74
Regional	0.0726	0.32

It is expected that in the future, undeveloped land to the east of this catchment will be replaced by residential subdivision. 68.83 ha east of Sixth Line is owned by Star Oaks Development Limited. This development will require stormwater management measures to control post to pre development flows. These measures will likely consist of one or more of the following: SWM ponds, underground storage tanks, bioretention areas and rain water harvesting. It is recommended that the Town collaborate with developers on stormwater management design. It is recommended that these ponds be sized to meet targets as outlined in NOCSS and in this report.

The 100 year design flow from D1 is 0.74 m^3/s. Based on the hydrologic model included in Appendix B, 971 m^3 of storage is required to control the 100 year post development flow to NOCSS pre development levels.

5.3 D2: 470m north of Burnhamthorpe Road to Burnhamthorpe Road

This section of Sixth Line is approximately 470 m in length and drains south towards Burnhamthorpe Road. Flow crosses Burnhamthorpe Road via an existing 600 mm CSP culvert. Drainage in D2 is part of the Upper West Morrison Creek subcatchment.

The results from the hydrologic analysis for existing and proposed flow from D2 are shown in Table 8.

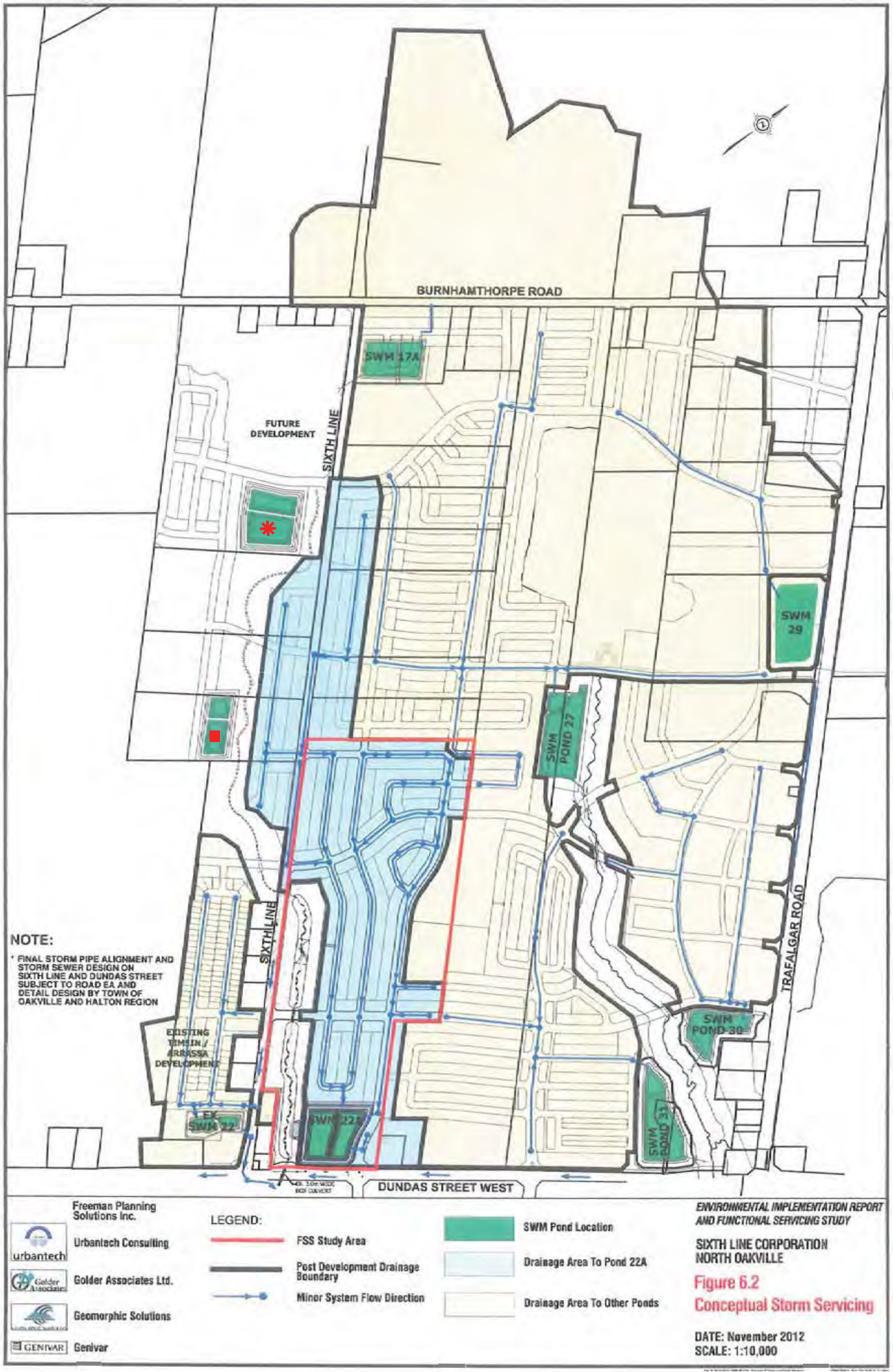
Table 8 Pre and post development flow from D2

Storm	NOCSS Existing Flow (m^3/s)	Post Flow (m^3/s)
2 year	0.0085	0.20
5 year	0.0128	0.30
10 year	0.0156	0.36
25 year	0.0213	0.45
50 year	0.0241	0.51
100 year	0.0270	0.57
Regional	0.0680	0.27

Catch basins and storm sewers will replace roadside ditches on Sixth Line under future conditions. The road profile slopes from north to south throughout catchment D2 which will be maintained in the future. Therefore, end of pipe facilities for D2 will be south of the catchment.

The EIR & FSS (2012) completed for the Sixth Line Corporation shows a number of future ponds south of catchment D2 off of Sixth Line. Figure 7 shows the location of these ponds. There are three ponds that should be investigated including SWM 17A, unnamed pond #1 (indicated with a star), and unnamed pond #2 (indicated with a square). At this time, no information has been provided for any of the three ponds. It is recommended that the Town collaborate with the developers on design of the above mentioned ponds. The Town should work together with developers to ensure that ponds meet quality and quantity control targets as outlined in NOCSS and this report.

The 100 year design flow from D2 is 0.57 m^3/s. To control this flow from post development to NOCSS pre-development levels 822 m^3 of storage would be required.



NOTE:

* FINAL STORM PIPE ALIGNMENT AND STORM SEWER DESIGN ON SIXTH LINE AND DUNDAS STREET SUBJECT TO ROAD EA AND DETAIL DESIGN BY TOWN OF OAKVILLE AND HALTON REGION

ENVIRONMENTAL IMPLEMENTATION REPORT AND FUNCTIONAL SERVICING STUDY

SIXTH LINE CORPORATION
NORTH OAKVILLE

Figure 6.2
Conceptual Storm Servicing

DATE: November 2012
SCALE: 1:10,000

Legend

✱ Future unnamed SWM Pond #1
🟥 Future unnamed SWM Pond #2

HERSHFIELD

Figure 7

5.4 D3: Burnhamthorpe Road to 425m South of Burnhamthorpe Road

This section of Sixth Line is approximately 425m in length and drains to roadside ditches on Sixth Line towards the south. Drainage crosses Sixth Line at an existing 600 mm CSP culvert crossing and continues south-east. Drainage in D3 is part of the Upper West Morrison Creek subcatchment.

The results from the hydrologic analysis for existing and proposed flow from D3 are shown in Table 9.

Table 9 Pre and post development flow from D3

Storm	NOCSS Existing Flow (m^3/s)	Post Flow (m^3/s)
2 year	0.0071	0.19
5 year	0.0107	0.27
10 year	0.0131	0.33
25 year	0.0179	0.41
50 year	0.0202	0.47
100 year	0.0226	0.52
Regional	0.0571	0.23

Catch basins and storm sewers will replace roadside ditches on Sixth Line under future conditions. The road profile slopes from north to south throughout catchment D3 which will be maintained in the future. Therefore, end of pipe facilities for D3 will be south of the catchment.

The EIR & FSS completed for the Sixth Line Corporation shows two future ponds downstream from D3 that should be investigated. These ponds are shown on Table 7 and include unnamed pond #1 (indicated with a star) and unnamed pond #2 (indicated with a square). At this time, no information has been provided for these two ponds. It is recommended that the Town collaborate with the developers on design of the above mentioned ponds. The Town should collaborate with developers to ensure that ponds meet quality and quantity control targets as descried in NOCSS and in this report.

The 100 year design flow from D3 is 0.52 m^3/s. To control this flow from post development to NOCSS pre-development levels 682 m^3 of storage would be required.

5.5 D4: 425m South of Burnhamthorpe Road to 675m North of Dundas Street

This section of Sixth Line is approximately 1025 m in length and drains towards the south via road side ditches. Flow from the west ditch crosses Sixth Line at the existing 2160 mm x 900 mm concrete box culvert and continues south-east. Drainage in D4 is part of the Lower West Morrison Creek subcatchment.

The results from the hydrologic analysis for existing and proposed flow from D4 are shown in Table 10.

Table 10 Pre and post development flow from D4

Storm	NOCSS Existing Flow (m^3/s)	Post Flow (m^3/s)
2 year	0.0180	0.26
5 year	0.0270	0.40
10 year	0.0330	0.50
25 year	0.0450	0.64
50 year	0.0510	0.73
100 year	0.0570	0.84
Regional	0.1440	0.53

Catchment D4 has been considered by the EIR & FSS completed for the Sixth Line Corporation. SWM pond 22A will include drainage from this portion of Sixth Line as show on Figure 7. In the preliminary modeling results for 22A (included in an appendix of the EIR & FSS), the entire catchment flowing into 22A has been considered as just one area. These modeling results are included in this report in Appendix C. It is assumed that during the detailed design of 22A, the impact of drainage from the future Sixth Line will be considered thoroughly.

It is recommended that storm sewers and catch basins be installed on Sixth Line to collect drainage and divert it to Pond 22A. It is recommended that the Town collaborate with Sixth Line Corporation and Argo Development Corporation to design this storm sewer. As shown on Figure 7, Sixth Line Corporation is investigating three connection points to a future storm sewer on Sixth Line. The connections shown are at future streets “C” and “D.” The third connection point is at future street “AS” as described in the Phase I Environmental Site Assessment for the Proposed Housing Development prepared for Argo Development

Corporation (June 2005). The storm sewer system will outlet to SWM 22A, located at the south end of the development

The 100 year design flow from D4 is 0.84 m^3/s. Approximately 1880 m^3 of storage will be required to control the post development 100 year flow to NOCSS predevelopment levels.

5.6 D5: 675m North of Dundas Street to 150m north of Dundas Street

This section of Sixth Line is approximately 525 m in length and drains towards the south via Sixth Line road side ditches. Flow crosses Sixth Line at the existing 800 mm CSP culvert crossing and continues south-east. Drainage in D5 is part of the Lower West Morrison Creek subcatchment.

The results from the hydrologic analysis for existing and proposed flow from D5 are shown in Table 11.

Table 11 Pre and post development flow from D5

Storm	NOCSS Existing Flow (m3/s)	Post Flow (m^3/s)
2 year	0.0092	0.22
5 year	0.0138	0.32
10 year	0.0168	0.40
25 year	0.0230	0.49
50 year	0.0260	0.55
100 year	0.0291	0.62
Regional	0.0734	0.29

Catchment D5 has not been incorporated in the future SWM 22A by the Sixth Line Corporation. This is due to the channel on the east side of Sixth Line that separates Sixth Line from this future development. Crossing the channel is not a viable option.

The residential development on the west side of catchment D5 is owned by Timsin/ Arrassa. SWM pond 22 is planned for south end of this development. Drainage from catchment D5 has not been considered in the design of SWM 22. Therefore, it is not recommended for treatment of Sixth Line drainage.

There are two options for treatment of drainage from D5. In option 1, an adjacent pond can be designed to over control to account for this section of Sixth Line. In option 2, underground pipe storage for quantity control and an oil grit separator for quality control can be used.

The 100 year post development flow from D5 is 0.62 m^3/s. Based on modeling results, 874 m^3 of storage is required to attenuate post development flow to NOCSS pre development levels.

In option 1, the 874 m^3 of storage can be accounted for in future SWM pond 22A. This pond can be designed to over control for D5.

In option 2, the 874 m^3 of storage can be accounted for in oversized underground pipes. Orifice plates can be used to restrict post development flows to pre development levels. Preliminary orifice calculations and pipe storage sizing have been completed for this catchment. There is an existing low point in the Sixth Line profile near the existing 800 mm CSP culvert. This would be an ideal location to outlet future storm sewers. The outlet could be directed towards to the future realigned channel on the east side of Sixth Line. It is recommended to use a 97 mm orifice plate. The approximate diameter required for pipe storage is 1650 mm. Calculations are included in Appendix D.

In option 2, for quality control, it is recommended to use oil grit separators designed for enhanced level protection at the outlet point.

The preferred option by Conservation Halton and the Town of Oakville is over control in an adjacent SWM pond, therefore option 1 is recommended.

5.7 D6: 150m north of Dundas Street to Dundas Street

This section of Sixth Line is approximately 150 m in length and drains towards the south. Catchment D6’s northern boundary is at Kaitting Trail where there is an existing high point on Sixth Line. This high point is the dividing line between Munn’s Creek subwatershed and West Morrison Creek subwatershed.

Concrete curb and gutter begins 150 m north of Dundas Street. From this point, catch basins on the east and west side of Sixth Line collect drainage and convey it into an existing 450 mm concrete storm sewer. This storm sewer runs south under Sixth Line until it reaches the west quadrant of Dundas Street/ Sixth Line intersection. From this point, the sewer connects to a 700 mm CSP that outlets to an existing ditch.

The results from the hydrologic analysis for existing and proposed flow from D6 are shown in Table 12.

Table 12 Pre and post development flow from D6

Storm	NOCSS Existing Flow (m3/s)	Post Flow (m^3/s)
2 year	0.0029	0.056
5 year	0.0045	0.083
10 year	0.0053	0.100
25 year	0.0070	0.120
50 year	0.0078	0.14
100 year	0.0090	0.16
Regional	0.0221	0.08

Catchment D6 is located at the south end of the study area. As such, it is the lowest section of Sixth Line based on the existing road profile. Therefore, drainage from this section cannot be directed to any of the future ponds mentioned in the previous sections.

A very minimal amount of roadway work is proposed as part of the Sixth Line widening in catchment D6. As such, no additional water quantity control measures are proposed.

There is an existing 450 mm concrete storm sewer in this catchment running south towards Dundas Street. The 450 mm sewer connects to a 700 mm storm sewer near the intersection of Dundas Street and Sixth Line. The 700 mm storm sewer outlets to a ditch at the intersection of Dundas and Sixth Line. Drainage into this sewer includes Catchment 6 and the church property east of Catchment 6.

The capacity of this storm sewer was checked to verify if it can handle increased drainage from Sixth Line. See Appendix E for calculations. The calculations show that the sewer is undersized at one length of pipe. It is recommended to maintain the existing connection and upsize the length of pipe that is under capacity from a 450 mm to a 525 mm.

For water quality control, it is proposed to use oil grit separators designed for enhanced level protection at the outlet.

6. CULVERT ANALYSIS AND DISCUSSION

The purpose of this section is to provide an analysis and discussion regarding the hydraulics of the five culverts in the study area. This section will include an analysis of existing culvert flow and hydraulics as well as a discussion of future conditions.

6.1 Existing Conditions

There are five culvert crossings in the study area. The location of the culverts is shown on Figure 2 and information about each is provided in Table 13.

Table 13 Existing culverts on Sixth Line

Culvert No.	Location	Size	Material
1	300m North of Dundas St. E	800mm	CSP
2	700m North of Dundas St. E	2160mm x 900mm	CONC. BOX CULV.
3	1.3km North of Dundas St. E	600mm	CSP
4	1.9km North of Dundas St. E	600mm	CSP
5	3km North of Dundas St. E	600mm	CSP

The existing drainage area for each of the culverts is shown in Drawing 1 and further information is provided in Table 14 below.

Table 14 Drainage area to existing culverts on Sixth Line

Culvert Number	Catchment Number(s)	Drainage Area (ha)	Subwatershed
1	C1	16.9	West Morrison Creek
2	C2	121.3	West Morrison Creek
3	C3, C4, C6	50.5	West Morrison Creek
4	C6	28.6	West Morrison Creek
5	C5	42.9	East 16 Mile Creek

As per NOCSS, the established unit area flows will be used for the existing condition flow targets. The existing condition target flow rates have been calculated for each of the culverts and are shown in Table 15 below.

Table 15 NOCSS Target existing flow rates

Culvert Number	Drainage Area (ha)	Q_5 (m^3/s)	Q_{25} (m^3/s)	Q_{50} (m^3/s)	Q_{100} (m^3/s)	$Q_{Regional}$ (m^3/s)
1	16.9	0.15	0.25	0.29	0.32	0.81
2	121.3	1.09	1.82	2.06	2.30	5.82
3	50.5	0.45	0.76	0.86	0.96	2.42
4	28.6	0.26	0.43	0.49	0.54	1.37
5	42.9	0.30	0.51	0.60	0.69	1.89

As discussed in Section 2.6, roadway crossings of watercourses shall be designed per flood frequencies. The minimum capacity provided shall be the 1:100 Year to Regional with allowance for overtopping of roads. If overtopping of the roadway occurs, the Town of Oakville standards for overland flow dictate that the product of depth of water (m) at the gutter times the velocity of flow (m/s) shall not exceed 0.65 m^2/s.

A hydraulic analysis has been conducted to determine effect of the 100 year and Regional existing flow on head water levels. The hydraulic model CulvertMaster by Bentley was used to assess the capacity of the existing culverts. The results are shown in Table 16 and Table 17 and the models can be found in Appendix F.

Table 16 Hydraulic results for Existing Culverts (100 Year Existing Flow)

Culvert Number	Culvert Size (mm)	Q_{100} (m^3/s)	Existing Road Sag Elevation (m)	Headwater Elevation (m)
1	800	0.32	170.93	overtopping road
2	2160 x 900	2.30	173.76	173.04
3	600	0.96	175.72	overtopping road
4	600	0.54	177.22	overtopping road
5	600	0.69	190.80	190.39

Table 17 Hydraulic results for Existing Culverts (Existing Regional Flow)

Culvert Number	Culvert Size (mm)	$Q_{Regional}$ (m^3/s)	Existing Road Sag Elevation (m)	Headwater Elevation (m)
1	800	0.81	170.93	overtopping road
2	2160 x 900	5.82	173.76	overtopping road
3	600	2.42	175.72	overtopping road
4	600	1.37	177.22	overtopping road
5	600	1.89	190.80	overtopping road

Existing culverts 1, 3, and 4 are not able to discharge the 100 year existing flow without overtopping during this event. All five culverts are not able to discharge the existing Regional flow without overtopping the roadway. Relief would occur at roadway low point for Culvert 5. At Culverts 3 and 4, it is expected that drainage that is backed up at the culvert inlet would bypass the culvert and continue south via existing ditches.

6.2 Future Conditions

Under proposed conditions, only two culverts will be crossing Sixth Line between Dundas and Burnhamthorpe. The crossings are at Culvert 2 and Culvert 4. New culverts are proposed in place of existing.

A hydraulic analysis has been completed for these two culverts to determine the feasibility of replacement alternatives.

Residential developments are proposed for the east and west sides of Sixth Line. The catchments of the two proposed will be affected by these developments.

The details of the stormwater management plan for the adjacent developments will be discussed in their corresponding EIR & FSS reports. For the purpose of this discussion, it is assumed that flow rates into the culverts will be controlled to the existing condition flow targets discussed in Section 6.1.

During the detailed design phase, it is necessary to refine the existing flow targets for the two culvert crossings. Significant drainage area exchanges have been proposed by adjacent developers that will affect the catchment area upstream the two culverts. At the time of writing, not all of these exchanges have been finalized and therefore are not considered in this analysis. Any future drainage area exchanges must be taken into account during the detailed design phase.

6.2.1 Culvert 2

As discussed in Section 3.3.4, West Morrison Creek will be realigned as part of the developments of the adjacent lands. Culvert 2 is affected by this channel realignment.

A fluvial geomorphology assessment is required for the section of West Morrison Creek that will be realigned, including Culvert 2. At this time, allocation has not yet been finalized for Culvert 2 works. Culvert 2 replacement and lowering should be left to when development works proceed. The party that proceeds first with development, be it adjacent land owners with residential development or the Town with Sixth Line widening, will be responsible for a full fluvial geomorphologic assessment.

A the time of writing, Rand Engineering has conducted a review of Culvert 2 as part of an EIR & FSS Study for Upper West Morrison Creek for Star Oaks. Based on their hydraulic and geomorphic assessment of this culvert, they concluded that this culvert is undersized and does not meet NOCSS requirements with respect to wildlife and fish passage. They have recommended that Culvert 2 be replaced with a 7.32 m x 1.75 m CONSPAN open bottom culvert. According to Rand, the installation of the new culvert will result in a grade lowering of the existing grade by about 0.85 m at the upstream invert. A letter detailing the results of Rand Engineering’s analysis is included in Appendix G.

A hydraulic analysis of the culvert proposed by Rand Engineering has been conducted to verify its hydraulic adequacy. Assumptions in the analysis are based on what has been proposed by Rand.

Future Culvert 2 will be extended in length to fit in with the proposed road widening. The outlet of Culvert 2 will be at the realigned reach MOC-W1.

The inlet of this culvert has been estimated based on the existing channel elevations and the proposed grade lower of 0.85 m. The approximate length required for this culvert is 47

m. Although the existing alignment of the culvert can be maintained, the vertical profile will change with the proposed works. The proposed 7.32 m x 1.75 m culvert was analyzed using CulvertMaster software to determine if it meets hydraulic requirements. The results of the analysis are show in Table 18 and the model can be found in Appendix H.

Table 18 CulvertMaster results for Culvert 2 alternative

	Culvert Size (mm)	Q (m3/s)	Proposed Road Sag Elevation (m)	H/W Elevation (m)	% Full at Inlet
100 Year	7320 x 1750	2.30	173.72	172.31	23
Regional	7320 x 1750	5.82	173.72	172.64	42

As shown in Table 18, the 7.32 m x 1.75 m replacement alternative for Culvert 2 is able to discharge the 100 year design flow and the Regional flow without overtopping the roadway. It is expected that there will be no increase to upstream flood levels due the large increase in culvert span under proposed conditions. It is recommended that the existing culvert be replaced with the 7.32 m x 1.75 m culvert as proposed by Rand Engineering or an alternative open bottom culvert with equivalent hydraulic capacity.

6.2.1 Culvert 4

Future culvert 4 will be extended in length to fit in with the proposed road widening. The existing inlet of this culvert is at the ditch east of Sixth Line that runs perpendicular to the roadway (See Figure 8). In the future, the inlet of this culvert will be at the outlet of SWM pond “17A.” Because of this, horizontal alignment of this culvert will also change. The approximate culvert length required is 36.4 m. The inlet and outlet elevations were estimated based on survey information of the existing ditches.

Figure 8 Looking east from Sixth Line at the ditch that inlets to culvert #4

The road sag elevation reported is much higher under proposed conditions. This because under existing conditions, drainage is able to continue south via roadside ditches until it reached the lowest point in the road profile, where overtopping would occur. This point was considered the road sag elevation in the existing analysis.

Under proposed conditions, there are no road side ditches. Developed area surrounds Sixth Line. There is a local low point over top of the culvert where overtopping would be expected to occur. The results of the hydraulic analysis are show in Table 19.

Table 19 HY-8 results for Culvert 4 alternative

	Culvert Size (mm)	Q (m3/s)	Proposed Road Sag Elevation (m)	H/W Elevation (m)	% Full at Inlet
100 Year	825	0.54	180.54	179.90	91
Regional	825	1.37	180.54	overtopping	100
Max Flow before overtopping of roadway = 1.13 m3/s					

Based on the modeling results, the minimum size of culvert that meets Town of Oakville standards is an 825 mm CSP. For the 100 year flow, there is no overtopping of the roadway.

The maximum flow that an 825 mm CSP can discharge before overtopping occurs is 1.13 m^3/s. Therefore, the peak flow that will overtop the roadway during the Regional storm event is 0.24 m^3/s.

Calculations were completed to determine if the proposed 825 mm CSP meets Town of Oakville standards for overland flow. The calculations included in Appendix I show that an 825 mm culvert at this location does meet overland flow standards. Therefore, it is recommended that the minimum size of the replacement culvert at crossing 4 is 825 mm.

Since the recommendation for the replacement culvert 4 is larger than existing and the proposed road profile at this location is similar to existing, therefore no increase in flood levels is expected.

7. EROSION AND SEDIMENT CONTROL

The widening of Sixth Line will require clearing of vegetation, topsoil stripping and earth grading. A detailed erosion and sedimentation control (ESC) plan is required to ensure the adjacent natural heritage system is not negatively impacted by construction activities.

The following ESC measures should be considered for application during the construction phase (non-limited list):

- Sediment traps, dewatering traps;
- Sediment control fencing;
- Check dams;
- Inceptor swales and ditches;
- Temporary stabilization measures of exposed soils (e.g., erosion control matting, seeding, hydro seeding, and mulches);
- Construction mud matts; and
- Protecting surface inlets with filter cloth.

During the detailed design phase, an ESC plan should be developed and tailored to meet the needs of the Sixth Line widening site. Prior to construction this plan must be submitted to the Town of Oakville and the Conservation Authority for approval.

Monitoring and inspection of ESC measures is required to ensure the success of the plan. All ESC measures must be monitored regularly by the contractor, ensuring they are in proper working order, until the site has become fully stabilized. The ESC plan must include details of the monitoring and inspection procedures.

8. PHASING

Development of Sixth Line between Dundas Street West and Highway 407 will take place in two phases. Phase 1 will consist of the area between Dundas Street West and Burnhamthrope Road. Phase 2 will consist of the area between Burnhamthorpe Road to Highway 407.

8.1 Adjacent Stormwater Management Facilities

The stormwater management strategy for Sixth Line relies on the implementation of SWM facilities by adjacent developers. It has been recommended that all drainage from north of the West Morrison Channel Crossing (Culvert 2) be considered by adjacent developers in their pond design. Therefore, management of drainage from the widened Sixth Line depends on developers moving forward with pond construction.

In terms of SWM, the ideal timing of Sixth Line widening is after adjacent pond development. If development of Sixth Line precedes adjacent pond construction, it is recommended that a temporary drainage strategy be implemented.

8.2 Culvert 2

As discussed in Section 6.2.1, a fluvial geomorphology assessment is required for the section of West Morrison Creek that will be realigned, including Culvert 2. At this time, allocation has not yet been finalized for Culvert 2 works. Culvert 2 replacement and lowering should be left to when development works proceed. The party that proceeds first with development, be it adjacent land owners with residential development or the Town with Sixth Line, will be responsible for a full fluvial geomorphologic assessment.

If development of Sixth Line precedes the West Morrison Creek channel realignment, a fluvial geomorphologic assessment must complete for this crossing as part of Sixth Line widening works. A temporary culvert will be required at this crossing until adjacent channel works are completed.

The preference is to wait to do widening works north of the channel (ie. north of North Park Drive) until EIR & FSS reports are finalized.

8.3 Culvert 4

The outlet of SWM Pond 17A will be at the inlet of Culvert 4. It is recommended that the construction of this culvert go in tandem with the construction of SWM 17A. If widening of Sixth Line precedes construction of SWM Pond 17A, a temporary culvert crossing will be required.

8.4 Spill Areas

8.4.1 Reach MOC-W3

As noted in section 3.3.4, the existing reach MOC-W3 on West Morrison Creek flows partially within the ditch on the west side of Sixth Line. During major storm events, there is a possibility that even more flow would spill into the Sixth Line ditch system. Under post development conditions, this reach will be realigned as previously described.

If widening of Sixth Line precedes the realignment of reach MOC-W3 on West Morrison Creek, an interim drainage strategy will be required. This strategy should involve a temporary ditch on the west side of Sixth Line. The ditch should extend from south of Core Area #7 to the West Morrison Creek culvert crossing (Culvert 2). During the detailed design, the location and extent of the spill areas should be verified so that any temporary ditches that may be required can be designed accordingly.

8.4.1 Reach MOC-W1

As noted in section 3.3.4, reach MOC-W1 encounters the ditch on the west side of Sixth Line approximately 330 m north of Dundas Street West. During major storm events, it is likely that even more flow would spill into the Sixth Line ditch system. Under post development conditions, this reach will be realigned as previously described.

If widening of Sixth Line precedes the realignment of reach MOC-W1 on West Morrison Creek, an interim drainage strategy will be required. This strategy should involve a temporary ditch on the east side of Sixth Line. During the detailed design, the location and extent of the spill areas should be verified so that any temporary ditches that may be required can be designed accordingly.

9. CONCLUSION AND RECOMMENDATIONS

Morrison Hershfield has been retained by the Town of Oakville to conduct a Class EA for Sixth Line between Dundas and Highway 407. This report addresses the existing the future drainage conditions of the study area.

In the future, Sixth Line will be widened from a 20.0 m rural cross section to a 31.0 m urban cross section. Drainage from the study area will increase under proposed conditions and a SWM strategy is required.

The major water quality target is MOE ‘enhanced’ level of SWM protection (80% TSS removal). The major water quantity target is controlling post development flow to predevelopment levels.

Recommendations:

Stream Systems:

- Maintain existing subwatershed boundaries by maintaining existing high points in road profile.

Topographic Depressions/ Hydrologic Features A and B:

- Maintain the existing hydrologic function of wetlands adjacent to study area by restricting widening of ROW into this area;

- The boundaries of the wetlands should be field proofed in the detailed design phase.

Infiltration:

- Maintain the existing hydrologic function of Core Area #7, which includes a Provincially Significant Wetland (PSW), adjacent to study area by restricting widening of ROW into this area;

- The boundaries of the PSW should be field proofed in the detailed design phase.

Water Quality:

- Future SWM facilities should be designed to meet Enhanced Level Protection for (80% TSS removal) Morrison Creek subwatersheds;

- 80% TSS removal should be achieved through the use of SWM ponds wherever possible. This is proposed for catchments D1, D2, D3 and D4;

- 80% TSS removal should be achieved through the use of oil-grit separators when it is not possible to utilize SWM ponds. Oil-grit seperators are proposed for catchments D5 and D6. Alternative best management practices such as tree pits may also be considered for quality and quantity control.

Water Quantity:

- The preferred SWM strategy for water quantity control is through the use of SWM ponds;

- Drainage from Sixth Line should be incorporated in to future SWM ponds in adjacent developments for Catchments D1, D2, D3 and D4. The Town should collaborate with developers on pond design. Storage requirements for Sixth Line catchments shown below:

Catchment	Storage Volume Required (m^3)
D1	971
D2	822
D3	682
D4	1880

- Drainage from Catchment D5 should be controlled through the use of underground pipe storage and an orifice place. Storage requirements for D5 are shown below:

Catchment	Storage Volume Required (m3)
D5	874

- Drainage from Catchment 6 should be directed to the existing 450 mm storm sewer running south towards Dundas Street. Roadway improvement work in this section of Sixth Line is minimal and therefore no water quantity controls are proposed.

Culverts:

- It is recommended that the existing 2160 x 900 mm concrete box culvert (Culvert 2) be replaced with a 7320 x 1750 mm open bottom concrete box culvert (or one with equivalent hydraulic adequacy). This size culvert meets Town of Oakville standards for hydraulics and overland flow;

- It is recommended to replace the existing 600 mm CSP (Culvert # 4) with an 825 mm CSP or larger. This size culvert meets Town of Oakville standards for hydraulics and overland flow.

Conveyance:

- It is recommended that storm sewers replace road side ditches in Catchments D1, D2, D3, D4 and D5;

- It is recommended that the existing connection to the 450 mm storm sewer be maintained in catchment D6. The one length of sewer that is under capacity should be removed and replaced with a 525 mm pipe.

Phasing:

- Sixth Line's proposed drainage strategy relies on the proposed development of adjacent residential lands. If Sixth Line widening precedes adjacent land developments, a temporary strategy will be required. This strategy should include Culvert 2, Culvert 4 and spill areas. The temporary drainage strategy is to be developed during the detailed design phase if required.

At this time, all assumptions and calculations are based on preliminary design information. It is recommended that calculations be refined and verified during the detailed design phase.

APPENDIX A: NOCSS Table 6.2.1

Table 6.2.1
NORTH OAKVILLE SUBWATERSHED STUDY
Meeting the Subwatershed Goals & Objectives
Target Setting

Goals	Objectives	Associated Issues from Characterization & Analysis Management Needs	Targets
1. To minimize the threat of life and the destruction of property and natural resources from flooding, and preserve (or re-establish, where possible) natural floodplain hydrologic functions.	1.1 To ensure that runoff from developing and urbanizing areas is controlled such that it does not increase the frequency and intensity of flooding at the risk of threatening life and property.	▪ Flooding has been experienced throughout the lower subwatersheds in some areas. Flood control measures have been applied in the form of storage, diversions and channelization. ▪ Excess capacity in downstream receiving watercourses does not exist ▪ Controls must be applied to ensure that flood potential is not increased. ▪ The natural flood attenuation within the existing watercourses in the subwatersheds provides protection to downstream reaches. ▪ Some limited flood potential exists at specific locations in the watershed.	▪ Maintain existing peak discharge rates for all design events, particularly high flows. ▪ Target discharge rates required for each catchment (unit area). ▪ Stream reach floodplain storage targets to protect existing floodplain storage. ▪ Remove flood potential at identified locations within the study area. ▪ Delineate floodplains to provide development limits. ▪ Restrict development in the floodplains as per Provincial and CA policies.
	1.2 To adopt appropriate land use controls and development standards to prevent development in natural flood hazard and erosion hazard areas.	▪ Development is not to be permitted in natural floodplain areas to preserve flood storage and protect against flooding. ▪ Erosion hazard exists primarily through natural stream migration. ▪ Some valley wall hazards exist (related to erosion and valley wall stability).	▪ Delineate floodplains to provide development limits. ▪ Restrict development in the floodplains as per Provincial and CA policies. ▪ Delineate meander belt and erosion setback to be applied on all streams designated to be left as open watercourse (providing erosion protection). ▪ Apply valley wall setback standard (slope plus top of valley setback). ▪ Develop stormwater management plan to replicate flow-frequency-duration from existing conditions. ▪ Meet threshold tractive force targets. ▪ Use Distributed Runoff Control (DRC) approach
	1.3 To ensure that new development incorporates the most appropriate development form and mitigation measures necessary to optimize compatibility with natural features and their associated functions.	▪ The natural features (terrestrial and aquatic) are sensitive to both current land use (agricultural and urban), and potential urban land uses. Buffers are required to mitigate impacts. ▪ Terrestrial protection based on maintaining current species and habitat diversity. ▪ Four levels of aquatic habitats exist: - Critical - Important - Marginal - No fish habitat	▪ Aquatic protection based upon resident fish community and existing aquatic habitat conditions. • Achieve MOE 'enhanced' level of SWM protection (80% TSS Removal) for all reaches of streams supporting resident redside dace populations (14 Mile and Morrison Creeks). • For all other stream reaches, achieve 'normal' level of SWM protection (70% TSS removal) to adequately protect aquatic habitat and resident fish. Note that 'enhanced' protection of these streams will be required for reasons not directly related to aquatic habitat and resident fish. (see Section 2.2 regarding Phosphorus loadings).

Table 6.2.1
NORTH OAKVILLE SUBWATERSHED STUDY
Meeting the Subwatershed Goals & Objectives
Target Setting

Goals	Objectives	Associated Issues from Characterization & Analysis Management Needs	Targets
2. To restore, protect, and enhance water quality and associated aquatic resources and water supplies for watercourses, including their associated hydrologic and hydrogeologic functions, within the subwatershed areas.	2.1 Protect stream morphological and fluvial character; restore, where appropriate and feasible, sinuosity; maintain physical habitat attributes (e.g., pools and riffles), diversity and fluvial processes (e.g., bedload transport and energy reduction through sinuosity); and prevent increase in erosion and deposition, through maintenance of hydrological regime.	▪ Erosion varies across the subwatersheds, but is present. ▪ Erosion potential will increase with future development, unless flow regime is controlled. ▪ Geomorphic classification identified three categories of streams according to their relative sensitivity, rehabilitation potential and geomorphic form and function: 1. streams that displayed a high sensitivity to change and have a well-developed geomorphic form and function 2. streams that exhibited some sensitivity to change and geomorphic function with a moderate degree of form 3. streams that lacked geomorphic form but still performed function in the form of sediment, flow conveyance, and connectivity to other features.	▪ Streams that displayed a high sensitivity to change and have a well-developed geomorphic form and function; ▪ Streams that exhibited some sensitivity to change and geomorphic function with a moderate degree of form; and ▪ Streams that lacked a defined form but still had a geomorphic function such as sediment transport, flow conveyance, and connectivity to other features.
	2.2 To prevent the accelerated enrichment of streams and contamination of waterways from runoff containing nutrients, pathogenic organisms, organic substances, and heavy metals and toxic substances.	▪ Current water quality conditions indicate elevated: - Phosphorous - Chlorides - Nitrates - Bacteria (E.Coli) - Some Metals ▪ Potential impact concerns include increases in: - Phosphorous impacts on local streams and on the Oakville Lake Ontario shoreline - Suspended Solids - Associated urban pollutants - Chlorides from road salt - Associated urban pollutants such as metals and industrial organic chemicals	▪ Control to current nutrient levels in the streams to mitigate the potential increases in nutrients and associated impacts on algae growth; ▪ The potential increase in suspended solids and associated urban pollutants; ▪ The level of chloride and potential increase; and ▪ The need to manage stream temperature for fisheries protection.
	2.3 To maintain or restore a natural vegetative canopy along streams where required to ensure that mid-summer stream temperatures do not exceed tolerance limits of desirable aquatic organisms.	▪ Potential temperature increases have not been identified as a significant issue. ▪ Streams are all warmwater fisheries. ▪ Redside Dace in 14 Mile and Morrison ▪ To maintain or enhance the level of Biodiversity in aquatic communities ▪ 14 Mile, Morrison and Joshua's Creeks show reasonable biodiversity in the fish communities present	▪ Maintain existing riparian vegetation associated with watercourses where feasible. ▪ Active restoration of riparian zones with native plantings, in cases where watercourse modifications/alterations require permitting/authorization.
	2.4 To minimize the disturbance of the streambed and prevent streambank erosion and, where practical, to restore eroding streambanks to a natural or stable condition.	▪ Stream erosion exists at some locations to a varying degree. ▪ Protection required to ensure that erosion rates do not increase with changes in landuse.	▪ Targets as outlined in Objectives 2.1 and 2.2.
	2.5 To restore, rehabilitate, or enhance water quality and associated resources through the implementation of appropriate Best Management Practices on the land.	▪ (See 2.2)	▪ Targets for surface water as outlined in Objective 2.2. ▪ For groundwater, target of no detrimental change in existing groundwater quality.

Table 6.2.1
NORTH OAKVILLE SUBWATERSHED STUDY
Meeting the Subwatershed Goals & Objectives
Target Setting

Goals	Objectives	Associated Issues from Characterization & Analysis Management Needs	Targets
	2.6 To ensure that hydrogeologic functions are preserved and maintained and take full advantage of stream and groundwater discharge/baseflow enhancement opportunities.	▪ Current groundwater recharge rates are relatively low as a result of soil permeability conditions (low permeability) ▪ Some potential for groundwater discharge to local streams. ▪ Groundwater contribution to stream flow is primarily provided through local recharge/discharge along stream system.	▪ Maintaining groundwater supplies for existing residents while development and servicing proceed. ▪ Keeping changes in the depth to the local water table to within the seasonal fluctuations normally experienced. ▪ Maintaining the groundwater contribution to stream health (groundwater quantity and quality), where it currently exists.
	2.7 To maintain and enhance the aquatic habitat.	▪ Fisheries conditions/benthic conditions have been identified and primarily include warmwater, warmwater baitfish and degraded habitats. ▪ In degraded areas, opportunities for enhancement exist. ▪ 14 Mile and Morrison Creeks are redside dace streams and require special consideration.	▪ The targets relating to biodiversity for Fourteen Mile, Morrison, and Joshua's Creeks should be that the biodiversity of the fish community be, at a minimum, maintained at existing levels and increased if possible. ▪ Identify stream corridors for protection. ▪ Fluvial geomorphology/erosion control targets under Objective 2.1. ▪ Water quality targets under Objective 2.2. ▪ Designate reaches which support redside dace populations as "no touch" areas where stream sections cannot be relocated. ▪ Enhanced level of stormwater quality control for Fourteen Mile and Morrison Creeks. ▪ Retain wetlands associated with streams if possible and incorporate into drainage system.
	2.8 To minimize disturbance of wetlands, preserving and/or enhancing the habitat and functions they provide.	▪ Wetland characteristics have been identified through the analysis carried out. ▪ The important characteristics to be managed have been identified. ▪ Wetlands in the area consist of three general types: 1. Wetlands with no permanent inflow or outflow of water (isolated wetlands). 2. Wetlands with a direct outflow (palustrine wetlands). Associated with a watercourse or other wetland feature and may play an important hydrological role in addition to their ecological role. 3. Wetlands associated with the channels of watercourses. In some locations offline wetlands are found in close proximity to channels (in some cases direct connections are only found for short periods of time, in others show more defined outflows).	▪ Minimize the fragmentation of wetlands. ▪ Maintain the function of all wetlands associated with watercourses. ▪ Maintain the function and structure of wetlands within woodlands.
	2.9 Provide appropriate buffers to wetlands, watercourses, and valley lands to maintain or enhance their biological health and meet objectives of long-term sustainability of these features.	▪ The natural features (terrestrial and aquatic) are sensitive to both current land use (agricultural and urban), and potential urban land uses. Buffers are required to mitigate any impact. ▪ Terrestrial protection based on maintaining current species and habitat diversity. ▪ Aquatic protection based upon current fisheries. Four levels exist: Critical Important	▪ Establish appropriate feature-specific buffers for protection of natural habitats.

Table 6.2.1
NORTH OAKVILLE SUBWATERSHED STUDY
Meeting the Subwatershed Goals & Objectives
Target Setting

Goals	Objectives	Associated Issues from Characterization & Analysis Management Needs	Targets
		Marginal No fish habitat	
3. To restore, protect, develop and enhance the Natural Heritage, historic cultural, recreational, and visual amenities of rural and urban stream corridors.	3.1 To ensure that environmental resource constraints are fully considered in establishing land use patterns in the subwatershed.	▪ Focuses on the protection of important naturally vegetated features in terms of both structure as well as function. ▪ Specific detailed discussion relative to wetlands is included under Objective 2.8 ▪ Woodlands, other vegetation communities, and wildlife are considered. ▪ Current natural features, particularly terrestrial vary in size and characteristics. ▪ As a whole, the most significant exhibit high diversity of species and habitats. ▪ Functional connectivity between a number of the features exist. ▪ There are a number of rare species of conservation concern.	▪ Minimize the fragmentation of woodlands; ▪ Maintain the function of all woodlands that are >200m in width (*i.e.,* provide potential interior conditions); ▪ Maintain the function of woodlands associated with watercourses.
	3.2 To ensure that existing wildlife linkages are preserved and that opportunities for improving these linkages are considered/implemented as part of any future development.	▪ Field analysis has identified that functional connectivity exits between some of the environmental features. ▪ General linkage types are identified as follows: 1. Wide, wooded linkages required to link stands with forest interior conditions. 2. Linkages associated with watercourse corridors in which a multiple of ecological and hydrological functions are considered. These features are likely to be narrower as they are seen to link other habitat types. ▪ Connectivity between habitat patches can occur simply as a result of proximity (without a direct physical connection)	▪ Minimize the discontinuities in linkages (especially >20 m). ▪ Linkages to be 100 m wide. ▪ Allow for linkages to habitats or other linkages located outside the study area (for example Sixteen Mile Creek valley and Bronte Creek).
	3.3 To retain, preserve or maintain Natural Heritage Features (i.e., open space and visual amenities) in urban and rural areas by establishing and maintaining greenbelts along stream corridors and adjacent natural areas and maintaining linkages between these areas.	▪ See discussions under Objectives 2.8, 3.1 and 3.2.	▪ See discussions under Objectives 2.8, 3.1 and 3.2.
	3.4 To ensure that development in the stream corridor is consistent with the historical and cultural character of the surroundings and reflects the need to protect visual amenities.	▪ Historical characteristics and visual amenities are being addressed in the Secondary Planning Process. Integration with the Subwatershed Plans is occurring.	▪ Presence of visual and historic amenities through the subwatershed and Secondary Planning Processes.
	3.5 To ensure that the recreational and fisheries potential of a steam corridor are developed to the fullest extent practicable.	▪ The fisheries assessment has considered the existing fisheries conditions and potential for enhancement. Some streams are currently degraded by past land use activities and could be enhanced by stream rehabilitation. ▪ The stream corridors and terrestrial features provide potential for recreational use with trails or parkland adjacent to the	▪ See discussion under Objectives 1.3, 2.3 and 2.7.

Table 6.2.1
NORTH OAKVILLE SUBWATERSHED STUDY
Meeting the Subwatershed Goals & Objectives
Target Setting

Goals	Objectives	Associated Issues from Characterization & Analysis Management Needs	Targets
		features.	

APPENDIX B: Post Development SWMHYMO Model

```
==================================================================================

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO       999   999   =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O    9   9 9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O ## 9   9 9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O     9999  9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO         9     9   =========
                                                      9   9 9   9   # 3573794
        StormWater Management HYdrologic Model         999   999    =========

 ********************************************************************************
 ****************************** SWMHYMO Ver/4.05  ******************************
 *********  A single event and continuous hydrologic simulation model  *********
 *********     based on the principles of HYMO and its successors      *********
 *********                OTTHYMO-83 and OTTHYMO-89.                   *********
 ********************************************************************************
 ********* Distributed by:  J.F. Sabourin and Associates Inc.           *********
 *********                  Ottawa,  Ontario: (613) 836-3884           *********
 *********                  Gatineau, Quebec: (819) 243-6858           *********
 *********                  E-Mail: swmhymo@jfsa.Com                   *********
 ********************************************************************************

 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: Morrison Hershfield Ltd                      +++++++++
 +++++++++                in any City          SERIAL#:3573794         +++++++++
 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ********************************************************************************
 *********             ++++++ PROGRAM ARRAY DIMENSIONS ++++++          *********
 *********             Maximum value for ID numbers  :     10          *********
 *********             Max. number of rainfall points: 105408          *********
 *********             Max. number of flow points    : 105408          *********
 ********************************************************************************


 **********************   D E T A I L E D   O U T P U T   **********************
 ********************************************************************************
 *         DATE: 2014-04-11     TIME: 14:13:21     RUN COUNTER: 000352          *
 ********************************************************************************
 * Input   filename: K:\PROJ\1124037\Drainage\SWMHYMO\post.dat                  *
 * Output  filename: K:\PROJ\1124037\Drainage\SWMHYMO\post.out                  *
 * Summary filename: K:\PROJ\1124037\Drainage\SWMHYMO\post.sum                  *
 * User comments:                                                               *
 * 1:___________________________________________________________________________*
 * 2:___________________________________________________________________________*
 * 3:___________________________________________________________________________*
 ********************************************************************************

------------------------------------------------------------------------------------
-
001:0001----------------------------------------------------------------------------
-
*#******************************************************************************
*#  Project Name: [ Sixth Line   ]    Project Number: [  1124037   ]
*#  Date        : 09-26-2012
*#  Modeller    : [   RS     ]
*#  Company     : Morrison Hershfield Ltd
*#  License #   :  3573794
*#******************************************************************************
--------------------
| START            |  Project  dir.: K:\PROJ\1124037\Drainage\SWMHYMO\

--------------------  Rainfall dir.: K:\PROJ\1124037\Drainage\SWMHYMO\
```

```
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   0
------------------------------------------------------------------------------------
-
001:0002----------------------------------------------------------------------------
-
***FLOW FROM HURRICANE HAZEL***
--------------------
| READ STORM        |    Filename: 48 hour Hurricane Hazel
| Ptotal= 285.00 mm|    Comments: 48 hour Hurricane Hazel
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              1.00  73.000 |   5.00  13.000 |   9.00  13.000 |  13.00  13.000
              2.00   6.000 |   6.00  17.000 |  10.00  13.000 |
              3.00   4.000 |   7.00  13.000 |  11.00  53.000 |
              4.00   6.000 |   8.00  23.000 |  12.00  38.000 |

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001:0003----------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.65
| 01: 1     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.38          .27
     Dep. Storage     (mm)=        .00          .00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=     380.00       380.00
     Mannings n          =       .013         .025

     Max.eff.Inten.(mm/hr)=      73.00        60.65
                over (min)        5.00        14.00
     Storage Coeff.  (min)=       5.24 (ii)   13.60 (ii)
     Unit Hyd. Tpeak (min)=       5.00        14.00
     Unit Hyd. peak  (cms)=        .22          .08
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .28          .04           .320 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.03          1.000
     RUNOFF VOLUME    (mm)=     285.00       246.24        278.571
     TOTAL RAINFALL   (mm)=     285.00       285.00        285.000
     RUNOFF COEFFICIENT   =       1.00          .86           .977

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0004----------------------------------------------------------------------------
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| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:( 1    )   |
| OUT<02:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
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                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .026  .4000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: ( 1    )       1.65      .320     1.000    278.571
     OUTFLOW<02: (STORAG)       1.65      .026    13.133    278.550

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    8.186
                   TIME SHIFT OF PEAK FLOW         (min)=   728.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3966E+00

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001:0005----------------------------------------------------------------------------
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----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.42
| 03: 2     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        1.18          .24
     Dep. Storage     (mm)=         .00          .00
     Average Slope     (%)=        1.30         1.30
     Length            (m)=      480.00       480.00
     Mannings n          =         .013         .025

     Max.eff.Inten.(mm/hr)=       73.00        60.02
                over (min)         7.00        18.00
     Storage Coeff.  (min)=        6.86 (ii)   17.85 (ii)
     Unit Hyd. Tpeak (min)=        7.00        18.00
     Unit Hyd. peak  (cms)=         .16          .06
                                                               *TOTALS*
     PEAK FLOW       (cms)=         .24          .03              .272 (iii)
     TIME TO PEAK    (hrs)=        1.00         1.07             1.000
     RUNOFF VOLUME    (mm)=      284.96       246.23           278.571
     TOTAL RAINFALL   (mm)=      285.00       285.00           285.000
     RUNOFF COEFFICIENT   =        1.00          .86              .977

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0006----------------------------------------------------------------------------
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---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>03:( 2    )   |
| OUT<04:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .027  .3900E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >03: ( 2    )       1.42      .272     1.000    278.571
     OUTFLOW<04: (STORAG)       1.42      .023    13.183    278.547

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    8.622
```

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                   TIME SHIFT OF PEAK FLOW        (min)=   731.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3386E+00

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-
001:0007----------------------------------------------------------------------------
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----------------------
| CALIB STANDHYD      |   Area    (ha)=    1.19
| 05: 3     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .99          .20
     Dep. Storage     (mm)=        .00          .00
     Average Slope     (%)=       2.20         2.20
     Length            (m)=     420.00       420.00
     Mannings n          =       .013         .025

     Max.eff.Inten.(mm/hr)=      73.00        60.65
                over (min)        5.00        14.00
     Storage Coeff.  (min)=       5.41 (ii)   14.04 (ii)
     Unit Hyd. Tpeak (min)=       5.00        14.00
     Unit Hyd. peak  (cms)=        .21          .08
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .20          .03           .230 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.03          1.000
     RUNOFF VOLUME    (mm)=     284.98       246.23        278.571
     TOTAL RAINFALL   (mm)=     285.00       285.00        285.000
     RUNOFF COEFFICIENT   =       1.00          .86           .977

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0008----------------------------------------------------------------------------
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---------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>05:( 3    )    |
| OUT<06:(STORAG)    |    =========  OUTLFOW STORAGE TABLE  =========
---------------------     OUTFLOW    STORAGE  |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                             .000  .0000E+00   |      .023  .2900E+00

     ROUTING RESULTS             AREA     QPEAK     TPEAK        R.V.
     --------------------        (ha)     (cms)     (hrs)        (mm)
     INFLOW >05: ( 3    )        1.19      .230     1.000     278.571
     OUTFLOW<06: (STORAG)        1.19      .022    13.117     278.558

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    9.434
                   TIME SHIFT OF PEAK FLOW        (min)=   727.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2789E+00

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001:0009----------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK    TPEAK   R.V.    DWF
```

```
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:STORAGE        1.42     .023   13.18 278.55    .000

                    +ID2 06:STORAGE        1.19     .022   13.12 278.56    .000

                     ============================================================
                     SUM 10:ADD            2.61     .045   13.15 278.55    .000


   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0010----------------------------------------------------------------------------
-
----------------------
| CALIB STANDHYD     |   Area    (ha)=    3.00
| 07: 4     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        2.50          .50
     Dep. Storage     (mm)=         .00          .00
     Average Slope     (%)=         .40          .40
     Length            (m)=     1000.00      1000.00
     Mannings n          =         .013         .025

     Max.eff.Inten.(mm/hr)=       73.00        55.00
                over (min)        15.00        40.00
     Storage Coeff.  (min)=       15.18 (ii)   40.36 (ii)
     Unit Hyd. Tpeak (min)=       15.00        40.00
     Unit Hyd. peak  (cms)=         .07          .03
                                                          *TOTALS*
     PEAK FLOW       (cms)=         .49          .06           .525 (iii)
     TIME TO PEAK    (hrs)=        1.00        11.50          1.017
     RUNOFF VOLUME    (mm)=      284.94       246.17        278.571
     TOTAL RAINFALL   (mm)=      285.00       285.00        285.000
     RUNOFF COEFFICIENT   =        1.00          .86           .977

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0011----------------------------------------------------------------------------
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---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>07:( 4    )   |
| OUT<08:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .029  .7610E+00

     ROUTING RESULTS           AREA     QPEAK     TPEAK        R.V.
     --------------------      (ha)     (cms)     (hrs)        (mm)
     INFLOW >07: ( 4    )      3.00      .525     1.017     278.571
     OUTFLOW<08: (STORAG)      3.00      .029    13.667     278.529

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.535
                   TIME SHIFT OF PEAK FLOW         (min)=   759.00
```

```
                  MAXIMUM  STORAGE   USED       (ha.m.)=.7603E+00

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-
001:0012------------------------------------------------------------------------
-
------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK    TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)    (hrs)   (mm)   (cms)
                    ID1 10:ADD             2.61     .045    13.15 278.55    .000

                   +ID2 08:STORAGE         3.00     .029    13.67 278.53    .000

                    ==============================================================
                    SUM 10:ADD             5.61     .074    13.28 278.53    .000


   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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-
001:0013------------------------------------------------------------------------
-
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.53
| 09: 5     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.28          .25
     Dep. Storage     (mm)=        .00          .00
     Average Slope     (%)=        .75          .75
     Length            (m)=     360.00       360.00
     Mannings n          =        .013         .025

     Max.eff.Inten.(mm/hr)=      73.00        60.02
                over (min)        7.00        18.00
     Storage Coeff.  (min)=       6.81 (ii)   17.72 (ii)
     Unit Hyd. Tpeak (min)=       7.00        18.00
     Unit Hyd. peak  (cms)=        .16          .06
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .26          .04            .293 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.07           1.000
     RUNOFF VOLUME    (mm)=     284.98       246.22         278.571
     TOTAL RAINFALL   (mm)=     285.00       285.00         285.000
     RUNOFF COEFFICIENT   =       1.00          .86            .977

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0014------------------------------------------------------------------------
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---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>09:( 5    )   |
| OUT<01:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   | OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |   (cms)    (ha.m.)
                            .000  .0000E+00   |     .029  .3600E+00
```

```
     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >09: ( 5    )       1.53      .293     1.000    278.571
     OUTFLOW<01: (STORAG)       1.53      .029    13.150    278.552

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=    9.824
                  TIME SHIFT OF PEAK FLOW         (min)=   729.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.3561E+00

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001:0015------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 10:ADD             5.61     .074   13.28 278.53    .000

                   +ID2 01:STORAGE         1.53     .029   13.15 278.55    .000

                    ===========================================================
                    SUM 10:ADD             7.14     .103   13.23 278.54    .000


   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0016------------------------------------------------------------------------
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----------------------
| CALIB STANDHYD     |   Area    (ha)=     .41
| 02: 6     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=         .34          .07
     Dep. Storage     (mm)=         .00          .00
     Average Slope     (%)=         .20          .20
     Length            (m)=      225.00       225.00
     Mannings n          =        .013         .025

     Max.eff.Inten.(mm/hr)=       73.00        59.69
                over (min)         8.00        20.00
     Storage Coeff.  (min)=        7.64 (ii)   19.90 (ii)
     Unit Hyd. Tpeak (min)=        8.00        20.00
     Unit Hyd. peak  (cms)=         .15          .06
                                                          *TOTALS*
     PEAK FLOW       (cms)=         .07          .01          .078 (iii)
     TIME TO PEAK    (hrs)=        1.00        11.08         1.000
     RUNOFF VOLUME    (mm)=      284.97       246.24       278.571
     TOTAL RAINFALL   (mm)=      285.00       285.00       285.000
     RUNOFF COEFFICIENT   =        1.00          .86          .977

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  85.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0017------------------------------------------------------------------------
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| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>02:( 6     )   |
| OUT<03:(STORAG)    |    =========  OUTLFOW STORAGE TABLE  =========
---------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                             .000  .0000E+00   |     .009  .9220E-01

     ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
     --------------------        (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: ( 6    )         .41      .078     1.000    278.571
     OUTFLOW<03: (STORAG)         .41      .009    13.150    278.556

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   11.532
                   TIME SHIFT OF PEAK FLOW        (min)=   729.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.9216E-01

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001:0018--------------------------------------------------------------------------
-
------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                 (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 09: 5            1.53      .293    1.00 278.57    .000

                    +ID2 02: 6             .41      .078    1.00 278.57    .000

                     ============================================================
                     SUM 04:ADD           1.94      .371    1.00 278.57    .000


   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0019--------------------------------------------------------------------------
-
---------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>04:(ADD    )   |
| OUT<05:(STORAG)    |    =========  OUTLFOW STORAGE TABLE  =========
---------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                             .000  .0000E+00   |     .402  .4200E-01

     ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
     --------------------        (ha)     (cms)     (hrs)       (mm)
     INFLOW >04: (ADD   )        1.94      .371     1.000    278.571
     OUTFLOW<05: (STORAG)        1.94      .341     1.050    278.571

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   91.823
                   TIME SHIFT OF PEAK FLOW        (min)=     3.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3562E-01

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001:0020--------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                 (ha)     (cms)   (hrs)   (mm)   (cms)
```

```
             ID1 10:ADD             7.14     .103   13.23 278.54    .000

            +ID2 03:STORAGE          .41     .009   13.15 278.56    .000

             ============================================================
             SUM 10:ADD             7.55     .112   13.22 278.54    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0021------------------------------------------------------------------------
-
***FLOW FROM 100 YEAR CHICAGO STORM***
--------------------
| CHICAGO STORM    |     IDF curve parameters: A=2150.000
| Ptotal= 98.13 mm |                           B=   5.700
--------------------                           C=    .861
                         used in:   INTENSITY =  A / (t + B)^C

                         Duration of storm  = 24.00 hrs
                         Storm time step    = 10.00 min
                         Time to peak ratio =   .33

              TIME     RAIN |   TIME     RAIN |   TIME     RAIN |   TIME     RAIN
               hrs    mm/hr |    hrs    mm/hr |    hrs    mm/hr |    hrs    mm/hr
               .17     .590 |   6.17    2.221 |  12.17    1.956 |  18.17     .872
               .33     .601 |   6.33    2.434 |  12.33    1.887 |  18.33     .860
               .50     .613 |   6.50    2.696 |  12.50    1.822 |  18.50     .847
               .67     .625 |   6.67    3.027 |  12.67    1.762 |  18.67     .836
               .83     .638 |   6.83    3.458 |  12.83    1.706 |  18.83     .824
              1.00     .652 |   7.00    4.043 |  13.00    1.654 |  19.00     .813
              1.17     .666 |   7.17    4.887 |  13.17    1.605 |  19.17     .802
              1.33     .681 |   7.33    6.211 |  13.33    1.559 |  19.33     .792
              1.50     .696 |   7.50    8.589 |  13.50    1.516 |  19.50     .782
              1.67     .712 |   7.67   14.090 |  13.67    1.475 |  19.67     .772
              1.83     .729 |   7.83   39.571 |  13.83    1.437 |  19.83     .762
              2.00     .747 |   8.00  200.802 |  14.00    1.401 |  20.00     .753
              2.17     .766 |   8.17   54.105 |  14.17    1.366 |  20.17     .744
              2.33     .787 |   8.33   25.640 |  14.33    1.334 |  20.33     .735
              2.50     .808 |   8.50   16.478 |  14.50    1.303 |  20.50     .726
              2.67     .830 |   8.67   12.086 |  14.67    1.273 |  20.67     .718
              2.83     .854 |   8.83    9.539 |  14.83    1.245 |  20.83     .709
              3.00     .880 |   9.00    7.885 |  15.00    1.218 |  21.00     .701
              3.17     .907 |   9.17    6.727 |  15.17    1.193 |  21.17     .693
              3.33     .936 |   9.33    5.873 |  15.33    1.168 |  21.33     .686
              3.50     .967 |   9.50    5.217 |  15.50    1.145 |  21.50     .678
              3.67    1.001 |   9.67    4.697 |  15.67    1.122 |  21.67     .671
              3.83    1.037 |   9.83    4.275 |  15.83    1.101 |  21.83     .664
              4.00    1.076 |  10.00    3.926 |  16.00    1.080 |  22.00     .657
              4.17    1.119 |  10.17    3.632 |  16.17    1.061 |  22.17     .650
              4.33    1.165 |  10.33    3.381 |  16.33    1.042 |  22.33     .643
              4.50    1.215 |  10.50    3.164 |  16.50    1.023 |  22.50     .637
              4.67    1.271 |  10.67    2.975 |  16.67    1.006 |  22.67     .630
              4.83    1.332 |  10.83    2.808 |  16.83     .989 |  22.83     .624
              5.00    1.400 |  11.00    2.660 |  17.00     .972 |  23.00     .618
              5.17    1.476 |  11.17    2.527 |  17.17     .956 |  23.17     .612
              5.33    1.561 |  11.33    2.408 |  17.33     .941 |  23.33     .606
              5.50    1.657 |  11.50    2.301 |  17.50     .926 |  23.50     .600
              5.67    1.768 |  11.67    2.203 |  17.67     .912 |  23.67     .595
              5.83    1.895 |  11.83    2.114 |  17.83     .898 |  23.83     .589
              6.00    2.044 |  12.00    2.032 |  18.00     .885 |  24.00     .584
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001:0022---------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.65
| 01: 1     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.38          .27
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=     380.00       380.00
     Mannings n          =        .013         .025

     Max.eff.Inten.(mm/hr)=     200.80        76.24
                over (min)        3.00        11.00
     Storage Coeff.  (min)=       3.50 (ii)   11.13 (ii)
     Unit Hyd. Tpeak (min)=       3.00        11.00
     Unit Hyd. peak  (cms)=        .34          .10
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .72          .04           .736 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.15          8.000
     RUNOFF VOLUME    (mm)=      96.13        42.93         87.305
     TOTAL RAINFALL   (mm)=      98.13        98.13         98.134
     RUNOFF COEFFICIENT   =        .98          .44           .890

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0023---------------------------------------------------------------------------
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| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:( 1    )   |
| OUT<02:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE    |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)    |    (cms)    (ha.m.)
                            .000  .0000E+00    |     .026  .9800E-01

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: ( 1    )       1.65      .736     8.000     87.305
     OUTFLOW<02: (STORAG)       1.65      .026     9.333     87.303

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    3.551
                   TIME SHIFT OF PEAK FLOW         (min)=    80.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.9709E-01

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001:0024---------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.42
| 03: 2     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
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                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=         1.18          .24
     Dep. Storage     (mm)=         2.00         5.00
     Average Slope     (%)=         1.30         1.30
     Length            (m)=       480.00       480.00
     Mannings n           =         .013         .025

     Max.eff.Inten.(mm/hr)=       200.80        63.77
                over (min)          5.00        15.00
     Storage Coeff.  (min)=         4.58 (ii)   15.31 (ii)
     Unit Hyd. Tpeak (min)=         5.00        15.00
     Unit Hyd. peak  (cms)=          .24          .07
                                                           *TOTALS*
     PEAK FLOW       (cms)=          .56          .03           .574 (iii)
     TIME TO PEAK    (hrs)=         8.02         8.22          8.017
     RUNOFF VOLUME    (mm)=        96.12        42.93         87.305
     TOTAL RAINFALL   (mm)=        98.13        98.13         98.134
     RUNOFF COEFFICIENT   =          .98          .44           .890

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0025----------------------------------------------------------------------------
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---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>03:( 2    )   |
| OUT<04:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .027  .9000E-01

     ROUTING RESULTS             AREA     QPEAK      TPEAK        R.V.
     --------------------        (ha)     (cms)      (hrs)        (mm)
     INFLOW >03: ( 2    )        1.42      .574      8.017      87.305
     OUTFLOW<04: (STORAG)        1.42      .025      9.283      87.303

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    4.295
                   TIME SHIFT OF PEAK FLOW         (min)=    76.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.8223E-01

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001:0026----------------------------------------------------------------------------
-
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| CALIB STANDHYD     |   Area    (ha)=    1.19
| 05: 3     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=          .99          .20
     Dep. Storage     (mm)=         2.00         5.00
     Average Slope     (%)=         2.20         2.20
     Length            (m)=       420.00       420.00
     Mannings n           =         .013         .025

     Max.eff.Inten.(mm/hr)=       200.80        72.31
                over (min)          4.00        12.00
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     Storage Coeff.  (min)=       3.61 (ii)   11.65 (ii)
     Unit Hyd. Tpeak (min)=       4.00        12.00
     Unit Hyd. peak  (cms)=        .30          .10
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .51          .02          .519 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.17         8.000
     RUNOFF VOLUME    (mm)=      96.13        42.93        87.305
     TOTAL RAINFALL   (mm)=      98.13        98.13        98.134
     RUNOFF COEFFICIENT   =        .98          .44          .890

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0027------------------------------------------------------------------------
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| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:( 3    )   |
| OUT<06:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .023  .6900E-01

     ROUTING RESULTS            AREA     QPEAK     TPEAK        R.V.
     --------------------       (ha)     (cms)     (hrs)        (mm)
     INFLOW >05: ( 3    )       1.19      .519     8.000      87.305
     OUTFLOW<06: (STORAG)       1.19      .022     9.150      87.303

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    4.304
                   TIME SHIFT OF PEAK FLOW        (min)=    69.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.6815E-01

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001:0028------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:STORAGE        1.42      .025    9.28  87.30    .000

                    +ID2 06:STORAGE        1.19      .022    9.15  87.30    .000

                     ============================================================
                     SUM 10:ADD            2.61      .047    9.22  87.30    .000


   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0029------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    3.00
| 07: 4     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
```

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     Surface Area     (ha)=       2.50          .50
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .40          .40
     Length            (m)=    1000.00      1000.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     200.80        33.42
                over (min)      10.00        41.00
     Storage Coeff.  (min)=      10.13 (ii)   40.86 (ii)
     Unit Hyd. Tpeak (min)=      10.00        41.00
     Unit Hyd. peak  (cms)=        .11          .03
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .83          .03           .841 (iii)
     TIME TO PEAK    (hrs)=       8.10         8.67          8.100
     RUNOFF VOLUME    (mm)=      96.11        42.91         87.305
     TOTAL RAINFALL   (mm)=      98.13        98.13         98.134
     RUNOFF COEFFICIENT   =        .98          .44           .890

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0030--------------------------------------------------------------------------
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| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>07:( 4    )   |
| OUT<08:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |      .029  .1900E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK        R.V.
     --------------------       (ha)     (cms)     (hrs)        (mm)
     INFLOW >07: ( 4    )       3.00      .841     8.100      87.305
     OUTFLOW<08: (STORAG)       3.00      .029    10.600      87.302

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    3.429
                   TIME SHIFT OF PEAK FLOW         (min)=   150.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1883E+00

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001:0031--------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 10:ADD            2.61      .047    9.22  87.30    .000

                    +ID2 08:STORAGE        3.00      .029   10.60  87.30    .000

                     ==========================================================
                     SUM 10:ADD            5.61      .075    9.60  87.30    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0032---------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.53
| 09: 5     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                          IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.28          .25
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .75          .75
     Length            (m)=     360.00       360.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     200.80        63.77
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       4.54 (ii)   15.19 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .24          .07
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .61          .03            .620 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.22           8.017
     RUNOFF VOLUME    (mm)=      96.12        42.93          87.305
     TOTAL RAINFALL   (mm)=      98.13        98.13          98.134
     RUNOFF COEFFICIENT   =        .98          .44            .890

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0033---------------------------------------------------------------------------
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| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>09:( 5    )   |
| OUT<01:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .029  .8800E-01

     ROUTING RESULTS               AREA     QPEAK     TPEAK       R.V.
     --------------------          (ha)     (cms)     (hrs)       (mm)
     INFLOW >09: ( 5    )          1.53      .620     8.017     87.305
     OUTFLOW<01: (STORAG)          1.53      .029     9.200     87.304

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    4.659
                   TIME SHIFT OF PEAK FLOW         (min)=    71.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.8738E-01

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001:0034---------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA      QPEAK    TPEAK   R.V.    DWF
------------------------                  (ha)      (cms)    (hrs)   (mm)   (cms)
                     ID1 10:ADD            5.61      .075     9.60  87.30    .000

                    +ID2 01:STORAGE        1.53      .029     9.20  87.30    .000
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                    ============================================================
                    SUM 10:ADD           7.14     .104    9.47  87.30    .000


  NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0035--------------------------------------------------------------------------
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----------------------
| CALIB STANDHYD     |   Area    (ha)=     .41
| 02: 6     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .34          .07
     Dep. Storage     (mm)=      2.00         5.00
     Average Slope     (%)=       .20          .20
     Length            (m)=    225.00       225.00
     Mannings n          =       .013         .025

     Max.eff.Inten.(mm/hr)=    200.80        59.83
                over (min)       5.00        17.00
     Storage Coeff.  (min)=      5.10 (ii)   17.34 (ii)
     Unit Hyd. Tpeak (min)=      5.00        17.00
     Unit Hyd. peak  (cms)=       .22          .07
                                                             *TOTALS*
     PEAK FLOW       (cms)=       .16          .01             .161 (iii)
     TIME TO PEAK    (hrs)=      8.02         8.25            8.017
     RUNOFF VOLUME    (mm)=     96.12        42.93           87.305
     TOTAL RAINFALL   (mm)=     98.13        98.13           98.134
     RUNOFF COEFFICIENT   =       .98          .44             .890

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0036--------------------------------------------------------------------------
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---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>02:( 6    )   |
| OUT<03:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .009  .2300E-01

     ROUTING RESULTS            AREA     QPEAK      TPEAK        R.V.
     --------------------       (ha)     (cms)      (hrs)        (mm)
     INFLOW >02: ( 6    )        .41      .161      8.017      87.305
     OUTFLOW<03: (STORAG)        .41      .009      9.083      87.304

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.558
                   TIME SHIFT OF PEAK FLOW         (min)=    64.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2280E-01

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001:0037---------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                 (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 09: 5            1.53      .620    8.02  87.30    .000

                    +ID2 02: 6             .41      .161    8.02  87.30    .000

                     ==========================================================
                     SUM 04:ADD           1.94      .781    8.02  87.30    .000


   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0038---------------------------------------------------------------------------
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---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(ADD   )   |
| OUT<05:(STORAG)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |      .402  .4200E-01

     ROUTING RESULTS           AREA     QPEAK      TPEAK        R.V.
     --------------------      (ha)     (cms)      (hrs)        (mm)
     INFLOW >04: (ADD   )      1.94      .781      8.017      87.305
     OUTFLOW<05: (STORAG)      1.94      .398      8.167      87.305

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   50.943
                   TIME SHIFT OF PEAK FLOW        (min)=     9.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.4158E-01

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001:0039---------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                 (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 10:ADD           7.14      .104    9.47  87.30    .000

                    +ID2 03:STORAGE        .41      .009    9.08  87.30    .000

                     ==========================================================
                     SUM 10:ADD           7.55      .113    9.42  87.30    .000


   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0040---------------------------------------------------------------------------
-
***FLOW FROM 50 YEAR CHICAGO STORM***
--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1960.000
| Ptotal= 89.46 mm |                          B=   5.800
--------------------                          C=    .861
                        used in:   INTENSITY =  A / (t + B)^C
```

```
                        Duration of storm  = 24.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17    .538 |   6.17   2.028 |  12.17   1.786 |  18.17    .795
               .33    .548 |   6.33   2.222 |  12.33   1.722 |  18.33    .784
               .50    .559 |   6.50   2.462 |  12.50   1.663 |  18.50    .773
               .67    .570 |   6.67   2.764 |  12.67   1.608 |  18.67    .762
               .83    .582 |   6.83   3.159 |  12.83   1.557 |  18.83    .752
              1.00    .594 |   7.00   3.695 |  13.00   1.509 |  19.00    .742
              1.17    .607 |   7.17   4.467 |  13.17   1.465 |  19.17    .732
              1.33    .621 |   7.33   5.680 |  13.33   1.423 |  19.33    .722
              1.50    .635 |   7.50   7.859 |  13.50   1.383 |  19.50    .713
              1.67    .650 |   7.67  12.902 |  13.67   1.346 |  19.67    .704
              1.83    .665 |   7.83  36.223 |  13.83   1.311 |  19.83    .695
              2.00    .682 |   8.00 182.059 |  14.00   1.278 |  20.00    .687
              2.17    .699 |   8.17  49.510 |  14.17   1.247 |  20.17    .678
              2.33    .717 |   8.33  23.487 |  14.33   1.217 |  20.33    .670
              2.50    .737 |   8.50  15.092 |  14.50   1.188 |  20.50    .662
              2.67    .757 |   8.67  11.064 |  14.67   1.162 |  20.67    .654
              2.83    .779 |   8.83   8.729 |  14.83   1.136 |  20.83    .647
              3.00    .803 |   9.00   7.213 |  15.00   1.111 |  21.00    .640
              3.17    .827 |   9.17   6.152 |  15.17   1.088 |  21.17    .632
              3.33    .854 |   9.33   5.370 |  15.33   1.066 |  21.33    .625
              3.50    .882 |   9.50   4.769 |  15.50   1.044 |  21.50    .619
              3.67    .913 |   9.67   4.293 |  15.67   1.024 |  21.67    .612
              3.83    .946 |   9.83   3.907 |  15.83   1.004 |  21.83    .605
              4.00    .982 |  10.00   3.587 |  16.00    .986 |  22.00    .599
              4.17   1.020 |  10.17   3.318 |  16.17    .967 |  22.17    .593
              4.33   1.063 |  10.33   3.088 |  16.33    .950 |  22.33    .587
              4.50   1.109 |  10.50   2.890 |  16.50    .933 |  22.50    .581
              4.67   1.159 |  10.67   2.717 |  16.67    .917 |  22.67    .575
              4.83   1.215 |  10.83   2.564 |  16.83    .902 |  22.83    .569
              5.00   1.277 |  11.00   2.429 |  17.00    .887 |  23.00    .564
              5.17   1.346 |  11.17   2.308 |  17.17    .872 |  23.17    .558
              5.33   1.424 |  11.33   2.199 |  17.33    .858 |  23.33    .553
              5.50   1.513 |  11.50   2.100 |  17.50    .845 |  23.50    .548
              5.67   1.613 |  11.67   2.011 |  17.67    .832 |  23.67    .542
              5.83   1.730 |  11.83   1.929 |  17.83    .819 |  23.83    .537
              6.00   1.866 |  12.00   1.854 |  18.00    .807 |  24.00    .532

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001:0041----------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.65
| 01: 1     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.38          .27
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=     380.00       380.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     182.06        61.04
                over (min)        4.00        12.00
     Storage Coeff.  (min)=       3.64 (ii)   11.98 (ii)
     Unit Hyd. Tpeak (min)=       4.00        12.00
```

```
     Unit Hyd. peak  (cms)=        .30          .09
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .64          .03           .650 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.17          8.000
     RUNOFF VOLUME    (mm)=      87.45        36.89         79.064
     TOTAL RAINFALL   (mm)=      89.46        89.46         89.457
     RUNOFF COEFFICIENT   =        .98          .41           .884

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0042----------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.42
| 02: 2     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.18          .24
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.30         1.30
     Length            (m)=     480.00       480.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     182.06        52.20
                over (min)        5.00        16.00
     Storage Coeff.  (min)=       4.76 (ii)   16.38 (ii)
     Unit Hyd. Tpeak (min)=       5.00        16.00
     Unit Hyd. peak  (cms)=        .23          .07
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .51          .02           .514 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.23          8.017
     RUNOFF VOLUME    (mm)=      87.44        36.89         79.064
     TOTAL RAINFALL   (mm)=      89.46        89.46         89.457
     RUNOFF COEFFICIENT   =        .98          .41           .884

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0043----------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.19
| 03: 3     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .99          .20
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.20         2.20
     Length            (m)=     420.00       420.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     182.06        61.04
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           over (min)        4.00        12.00
Storage Coeff.  (min)=       3.75 (ii)   12.36 (ii)
Unit Hyd. Tpeak (min)=       4.00        12.00
Unit Hyd. peak  (cms)=        .29          .09
                                                     *TOTALS*
PEAK FLOW       (cms)=        .46          .02          .465 (iii)
TIME TO PEAK    (hrs)=       8.00         8.17         8.000
RUNOFF VOLUME    (mm)=      87.45        36.89        79.064
TOTAL RAINFALL   (mm)=      89.46        89.46        89.457
RUNOFF COEFFICIENT   =        .98          .41          .884

  (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
      CN* =  70.0    Ia = Dep. Storage  (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
      THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0044--------------------------------------------------------------------
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----------------------
| CALIB STANDHYD     |   Area    (ha)=    3.00
| 04: 4     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.50          .50
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .40          .40
     Length            (m)=    1000.00      1000.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     170.01        27.04
                over (min)       11.00        44.00
     Storage Coeff.  (min)=      10.83 (ii)   44.27 (ii)
     Unit Hyd. Tpeak (min)=      11.00        44.00
     Unit Hyd. peak  (cms)=        .10          .03
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .73          .02          .733 (iii)
     TIME TO PEAK    (hrs)=       8.12         8.72         8.117
     RUNOFF VOLUME    (mm)=      87.43        36.86        79.064
     TOTAL RAINFALL   (mm)=      89.46        89.46        89.457
     RUNOFF COEFFICIENT   =        .98          .41          .884

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0045--------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.53
| 05: 5     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.28          .25
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .75          .75
     Length            (m)=     360.00       360.00
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     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     182.06        52.20
                over (min)        5.00        16.00
     Storage Coeff.  (min)=       4.73 (ii)   16.26 (ii)
     Unit Hyd. Tpeak (min)=       5.00        16.00
     Unit Hyd. peak  (cms)=        .23          .07
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .55          .02            .555 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.23           8.017
     RUNOFF VOLUME    (mm)=      87.45        36.89          79.064
     TOTAL RAINFALL   (mm)=      89.46        89.46          89.457
     RUNOFF COEFFICIENT   =        .98          .41            .884

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0046----------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=     .41
| 06: 6     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .34          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .20          .20
     Length            (m)=     225.00       225.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     182.06        48.15
                over (min)        5.00        19.00
     Storage Coeff.  (min)=       5.30 (ii)   18.66 (ii)
     Unit Hyd. Tpeak (min)=       5.00        19.00
     Unit Hyd. peak  (cms)=        .22          .06
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .14          .01            .143 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.28           8.017
     RUNOFF VOLUME    (mm)=      87.44        36.89          79.064
     TOTAL RAINFALL   (mm)=      89.46        89.46          89.457
     RUNOFF COEFFICIENT   =        .98          .41            .884

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0047----------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK    TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)    (hrs)   (mm)   (cms)
                     ID1 02: 2             1.42     .514     8.02  79.06    .000

                    +ID2 03: 3             1.19     .465     8.00  79.06    .000
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                  +ID3 04: 4              3.00     .733    8.12  79.06    .000

                  +ID4 05: 5              1.53     .555    8.02  79.06    .000

                  +ID5 06: 6               .41     .143    8.02  79.06    .000

                   ============================================================
                   SUM 08:ADD             7.55    2.264    8.03  79.06    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0048------------------------------------------------------------------------
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***FLOW FROM 25 YEAR CHICAGO STORM***
--------------------
| CHICAGO STORM    |     IDF curve parameters: A=1680.000
| Ptotal= 82.47 mm |                           B=   5.600
--------------------                           C=    .851
                         used in:   INTENSITY =  A / (t + B)^C

                         Duration of storm  = 24.00 hrs
                         Storm time step    = 10.00 min
                         Time to peak ratio =   .33

              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17    .530 |   6.17   1.955 |  12.17   1.725 |  18.17    .779
               .33    .540 |   6.33   2.138 |  12.33   1.665 |  18.33    .768
               .50    .551 |   6.50   2.364 |  12.50   1.609 |  18.50    .758
               .67    .562 |   6.67   2.647 |  12.67   1.557 |  18.67    .747
               .83    .573 |   6.83   3.016 |  12.83   1.509 |  18.83    .737
              1.00    .585 |   7.00   3.515 |  13.00   1.463 |  19.00    .727
              1.17    .597 |   7.17   4.231 |  13.17   1.421 |  19.17    .718
              1.33    .610 |   7.33   5.346 |  13.33   1.381 |  19.33    .709
              1.50    .624 |   7.50   7.335 |  13.50   1.343 |  19.50    .700
              1.67    .638 |   7.67  11.884 |  13.67   1.308 |  19.67    .691
              1.83    .654 |   7.83  32.571 |  13.83   1.274 |  19.83    .682
              2.00    .669 |   8.00 162.166 |  14.00   1.242 |  20.00    .674
              2.17    .686 |   8.17  44.309 |  14.17   1.212 |  20.17    .666
              2.33    .704 |   8.33  21.322 |  14.33   1.184 |  20.33    .658
              2.50    .723 |   8.50  13.848 |  14.50   1.157 |  20.50    .651
              2.67    .743 |   8.67  10.235 |  14.67   1.131 |  20.67    .643
              2.83    .764 |   8.83   8.126 |  14.83   1.107 |  20.83    .636
              3.00    .786 |   9.00   6.748 |  15.00   1.083 |  21.00    .629
              3.17    .810 |   9.17   5.780 |  15.17   1.061 |  21.17    .622
              3.33    .836 |   9.33   5.062 |  15.33   1.039 |  21.33    .615
              3.50    .863 |   9.50   4.509 |  15.50   1.019 |  21.50    .608
              3.67    .893 |   9.67   4.070 |  15.67    .999 |  21.67    .602
              3.83    .924 |   9.83   3.712 |  15.83    .980 |  21.83    .596
              4.00    .959 |  10.00   3.415 |  16.00    .962 |  22.00    .589
              4.17    .996 |  10.17   3.165 |  16.17    .945 |  22.17    .583
              4.33   1.036 |  10.33   2.950 |  16.33    .928 |  22.33    .577
              4.50   1.081 |  10.50   2.765 |  16.50    .912 |  22.50    .572
              4.67   1.129 |  10.67   2.603 |  16.67    .897 |  22.67    .566
              4.83   1.182 |  10.83   2.460 |  16.83    .882 |  22.83    .561
              5.00   1.242 |  11.00   2.332 |  17.00    .867 |  23.00    .555
              5.17   1.308 |  11.17   2.219 |  17.17    .854 |  23.17    .550
              5.33   1.382 |  11.33   2.116 |  17.33    .840 |  23.33    .545
              5.50   1.466 |  11.50   2.023 |  17.50    .827 |  23.50    .540
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              5.67   1.562 |  11.67   1.939 |  17.67    .815 |  23.67    .534
              5.83   1.673 |  11.83   1.862 |  17.83    .803 |  23.83    .530
              6.00   1.802 |  12.00   1.791 |  18.00    .791 |  24.00    .525

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001:0049------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.65
| 01: 1     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.38          .27
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=     380.00       380.00
     Mannings n          =       .013         .025

     Max.eff.Inten.(mm/hr)=     162.17        48.47
                over (min)        4.00        13.00
     Storage Coeff.  (min)=       3.81 (ii)   12.95 (ii)
     Unit Hyd. Tpeak (min)=       4.00        13.00
     Unit Hyd. peak  (cms)=        .29          .09
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .56          .02           .571 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.18          8.000
     RUNOFF VOLUME    (mm)=      80.46        32.20         72.463
     TOTAL RAINFALL   (mm)=      82.47        82.47         82.474
     RUNOFF COEFFICIENT   =        .98          .39           .879

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0050------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.42
| 02: 2     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.18          .24
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.30         1.30
     Length            (m)=     480.00       480.00
     Mannings n          =       .013         .025

     Max.eff.Inten.(mm/hr)=     162.17        41.10
                over (min)        5.00        18.00
     Storage Coeff.  (min)=       4.99 (ii)   17.77 (ii)
     Unit Hyd. Tpeak (min)=       5.00        18.00
     Unit Hyd. peak  (cms)=        .23          .06
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .44          .02           .451 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.27          8.017
     RUNOFF VOLUME    (mm)=      80.46        32.20         72.463
     TOTAL RAINFALL   (mm)=      82.47        82.47         82.474
     RUNOFF COEFFICIENT   =        .98          .39           .879
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0051-------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.19
| 03: 3     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .99          .20
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.20         2.20
     Length            (m)=     420.00       420.00
     Mannings n          =        .013         .025

     Max.eff.Inten.(mm/hr)=     162.17        48.47
                over (min)        4.00        13.00
     Storage Coeff.  (min)=       3.93 (ii)   13.37 (ii)
     Unit Hyd. Tpeak (min)=       4.00        13.00
     Unit Hyd. peak  (cms)=        .29          .09
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .40          .02            .409 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.18           8.000
     RUNOFF VOLUME    (mm)=      80.47        32.20          72.463
     TOTAL RAINFALL   (mm)=      82.47        82.47          82.474
     RUNOFF COEFFICIENT   =        .98          .39            .879

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0052-------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    3.00
| 04: 4     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.50          .50
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .40          .40
     Length            (m)=    1000.00      1000.00
     Mannings n          =        .013         .025

     Max.eff.Inten.(mm/hr)=     151.45        21.26
                over (min)       11.00        48.00
     Storage Coeff.  (min)=      11.34 (ii)   48.16 (ii)
     Unit Hyd. Tpeak (min)=      11.00        48.00
     Unit Hyd. peak  (cms)=        .10          .02
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .64          .02            .640 (iii)
     TIME TO PEAK    (hrs)=       8.12         8.78           8.117
```

```
     RUNOFF VOLUME    (mm)=      80.45         32.17          72.463
     TOTAL RAINFALL   (mm)=      82.47         82.47          82.474
     RUNOFF COEFFICIENT   =        .98           .39            .879

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0053------------------------------------------------------------------------
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----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.53
| 05: 5     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.28           .25
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=        .75           .75
     Length            (m)=     360.00        360.00
     Mannings n           =       .013          .025

     Max.eff.Inten.(mm/hr)=     162.17         41.10
                over (min)        5.00         18.00
     Storage Coeff.  (min)=       4.95 (ii)    17.64 (ii)
     Unit Hyd. Tpeak (min)=       5.00         18.00
     Unit Hyd. peak  (cms)=        .23           .06
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .48           .02            .487 (iii)
     TIME TO PEAK    (hrs)=       8.02          8.27           8.017
     RUNOFF VOLUME    (mm)=      80.46         32.20          72.463
     TOTAL RAINFALL   (mm)=      82.47         82.47          82.474
     RUNOFF COEFFICIENT   =        .98           .39            .879

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0054------------------------------------------------------------------------
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----------------------
| CALIB STANDHYD     |   Area    (ha)=     .41
| 06: 6     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .34           .07
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=        .20           .20
     Length            (m)=     225.00        225.00
     Mannings n           =       .013          .025

     Max.eff.Inten.(mm/hr)=     162.17         39.26
                over (min)        6.00         20.00
     Storage Coeff.  (min)=       5.55 (ii)    20.04 (ii)
     Unit Hyd. Tpeak (min)=       6.00         20.00
     Unit Hyd. peak  (cms)=        .20           .06
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                                                           *TOTALS*
     PEAK FLOW       (cms)=        .12          .00          .124 (iii)
     TIME TO PEAK    (hrs)=       8.03         8.30         8.033
     RUNOFF VOLUME    (mm)=      80.46        32.20        72.463
     TOTAL RAINFALL   (mm)=      82.47        82.47        82.474
     RUNOFF COEFFICIENT   =        .98          .39          .879

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0055----------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 02: 2             1.42     .451    8.02  72.46    .000

                    +ID2 03: 3             1.19     .409    8.00  72.46    .000

                    +ID3 04: 4             3.00     .640    8.12  72.46    .000

                    +ID4 05: 5             1.53     .487    8.02  72.46    .000

                    +ID5 06: 6              .41     .124    8.03  72.46    .000

                     ============================================================
                     SUM 08:ADD            7.55    1.984    8.03  72.46    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0056----------------------------------------------------------------------------
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***FLOW FROM 10 YEAR CHICAGO STORM***
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| CHICAGO STORM    |    IDF curve parameters: A=1400.000
| Ptotal= 70.24 mm |                          B=   5.800
--------------------                          C=    .848
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  = 24.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

               TIME     RAIN |    TIME     RAIN |    TIME     RAIN |    TIME     RAIN
                hrs    mm/hr |     hrs    mm/hr |     hrs    mm/hr |     hrs    mm/hr
                .17     .461 |    6.17    1.692 |   12.17    1.494 |   18.17     .676
                .33     .469 |    6.33    1.850 |   12.33    1.442 |   18.33     .667
                .50     .478 |    6.50    2.045 |   12.50    1.393 |   18.50     .658
                .67     .488 |    6.67    2.289 |   12.67    1.348 |   18.67     .649
                .83     .498 |    6.83    2.607 |   12.83    1.307 |   18.83     .640
               1.00     .508 |    7.00    3.037 |   13.00    1.267 |   19.00     .631
               1.17     .519 |    7.17    3.653 |   13.17    1.231 |   19.17     .623
               1.33     .530 |    7.33    4.614 |   13.33    1.196 |   19.33     .615
               1.50     .542 |    7.50    6.324 |   13.50    1.164 |   19.50     .607
               1.67     .554 |    7.67   10.226 |   13.67    1.133 |   19.67     .600
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              1.83    .568 |   7.83  27.818 |  13.83   1.104 |  19.83    .593
              2.00    .581 |   8.00 134.793 |  14.00   1.077 |  20.00    .585
              2.17    .596 |   8.17  37.759 |  14.17   1.051 |  20.17    .578
              2.33    .611 |   8.33  18.292 |  14.33   1.026 |  20.33    .572
              2.50    .627 |   8.50  11.910 |  14.50   1.003 |  20.50    .565
              2.67    .645 |   8.67   8.814 |  14.67    .981 |  20.67    .558
              2.83    .663 |   8.83   7.003 |  14.83    .959 |  20.83    .552
              3.00    .682 |   9.00   5.820 |  15.00    .939 |  21.00    .546
              3.17    .703 |   9.17   4.987 |  15.17    .920 |  21.17    .540
              3.33    .725 |   9.33   4.370 |  15.33    .901 |  21.33    .534
              3.50    .749 |   9.50   3.893 |  15.50    .884 |  21.50    .528
              3.67    .774 |   9.67   3.515 |  15.67    .867 |  21.67    .523
              3.83    .802 |   9.83   3.207 |  15.83    .850 |  21.83    .517
              4.00    .832 |  10.00   2.951 |  16.00    .835 |  22.00    .512
              4.17    .864 |  10.17   2.735 |  16.17    .820 |  22.17    .507
              4.33    .899 |  10.33   2.550 |  16.33    .805 |  22.33    .502
              4.50    .937 |  10.50   2.391 |  16.50    .791 |  22.50    .497
              4.67    .979 |  10.67   2.251 |  16.67    .778 |  22.67    .492
              4.83   1.025 |  10.83   2.127 |  16.83    .765 |  22.83    .487
              5.00   1.076 |  11.00   2.018 |  17.00    .753 |  23.00    .482
              5.17   1.133 |  11.17   1.919 |  17.17    .741 |  23.17    .478
              5.33   1.197 |  11.33   1.831 |  17.33    .729 |  23.33    .473
              5.50   1.270 |  11.50   1.751 |  17.50    .718 |  23.50    .469
              5.67   1.353 |  11.67   1.678 |  17.67    .707 |  23.67    .464
              5.83   1.448 |  11.83   1.611 |  17.83    .696 |  23.83    .460
              6.00   1.560 |  12.00   1.550 |  18.00    .686 |  24.00    .456

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001:0057----------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.65
| 01: 1    DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.38          .27
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=     380.00       380.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     134.79        32.55
                over (min)        4.00        15.00
     Storage Coeff.  (min)=       4.10 (ii)   14.82 (ii)
     Unit Hyd. Tpeak (min)=       4.00        15.00
     Unit Hyd. peak  (cms)=        .28          .08
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .46          .02          .464 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.22         8.000
     RUNOFF VOLUME    (mm)=      68.23        24.44        60.968
     TOTAL RAINFALL   (mm)=      70.24        70.24        70.237
     RUNOFF COEFFICIENT   =        .97          .35          .868

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0058----------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.42
| 02: 2     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.18          .24
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.30         1.30
     Length            (m)=     480.00       480.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     134.79        28.66
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       5.37 (ii)   20.14 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=        .22          .06
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .36          .01            .366 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.30           8.017
     RUNOFF VOLUME    (mm)=      68.23        24.44          60.968
     TOTAL RAINFALL   (mm)=      70.24        70.24          70.237
     RUNOFF COEFFICIENT   =        .97          .35            .868

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0059----------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.19
| 03: 3     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .99          .20
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.20         2.20
     Length            (m)=     420.00       420.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     134.79        32.55
                over (min)        4.00        15.00
     Storage Coeff.  (min)=       4.23 (ii)   15.30 (ii)
     Unit Hyd. Tpeak (min)=       4.00        15.00
     Unit Hyd. peak  (cms)=        .27          .07
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .33          .01            .332 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.22           8.000
     RUNOFF VOLUME    (mm)=      68.23        24.44          60.968
     TOTAL RAINFALL   (mm)=      70.24        70.24          70.237
     RUNOFF COEFFICIENT   =        .97          .35            .868

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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001:0060--------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    3.00
| 04: 4     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.50          .50
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .40          .40
     Length            (m)=    1000.00      1000.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     112.40        14.06
                over (min)       13.00        56.00
     Storage Coeff.  (min)=      12.78 (ii)   56.22 (ii)
     Unit Hyd. Tpeak (min)=      13.00        56.00
     Unit Hyd. peak  (cms)=        .09          .02
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .49          .01            .497 (iii)
     TIME TO PEAK    (hrs)=       8.15         8.92           8.150
     RUNOFF VOLUME    (mm)=      68.22        24.41          60.968
     TOTAL RAINFALL   (mm)=      70.24        70.24          70.237
     RUNOFF COEFFICIENT   =        .97          .35            .868

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0061--------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.53
| 05: 5     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.28          .25
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .75          .75
     Length            (m)=     360.00       360.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=     134.79        28.66
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       5.33 (ii)   19.99 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=        .22          .06
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .39          .01            .395 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.30           8.017
     RUNOFF VOLUME    (mm)=      68.23        24.43          60.968
     TOTAL RAINFALL   (mm)=      70.24        70.24          70.237
     RUNOFF COEFFICIENT   =        .97          .35            .868

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
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```
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0062----------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=     .41
| 06: 6     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .34          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .20          .20
     Length            (m)=     225.00       225.00
     Mannings n          =       .013         .025

     Max.eff.Inten.(mm/hr)=     134.79        26.03
                over (min)        6.00        23.00
     Storage Coeff.  (min)=       5.98 (ii)   23.06 (ii)
     Unit Hyd. Tpeak (min)=       6.00        23.00
     Unit Hyd. peak  (cms)=        .19          .05
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .10          .00           .100 (iii)
     TIME TO PEAK    (hrs)=       8.03         8.35          8.033
     RUNOFF VOLUME    (mm)=      68.23        24.43         60.968
     TOTAL RAINFALL   (mm)=      70.24        70.24         70.237
     RUNOFF COEFFICIENT   =        .97          .35           .868

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0063----------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 02: 2             1.42     .366    8.02  60.97    .000

                    +ID2 03: 3             1.19     .332    8.00  60.97    .000

                    +ID3 04: 4             3.00     .497    8.15  60.97    .000

                    +ID4 05: 5             1.53     .395    8.02  60.97    .000

                    +ID5 06: 6              .41     .100    8.03  60.97    .000

                     ============================================================
                     SUM 08:ADD            7.55    1.546    8.03  60.97    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0064----------------------------------------------------------------------------
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***FLOW FROM 5 YEAR CHICAGO STORM***
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| CHICAGO STORM    |    IDF curve parameters: A=1170.000
| Ptotal= 60.87 mm |                          B=   5.800
--------------------                          C=    .843
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  = 24.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17    .412 |   6.17   1.498 |  12.17   1.324 |  18.17    .603
               .33    .420 |   6.33   1.637 |  12.33   1.279 |  18.33    .595
               .50    .428 |   6.50   1.808 |  12.50   1.236 |  18.50    .587
               .67    .436 |   6.67   2.022 |  12.67   1.197 |  18.67    .579
               .83    .445 |   6.83   2.300 |  12.83   1.160 |  18.83    .571
              1.00    .454 |   7.00   2.675 |  13.00   1.125 |  19.00    .564
              1.17    .464 |   7.17   3.212 |  13.17   1.093 |  19.17    .556
              1.33    .474 |   7.33   4.047 |  13.33   1.062 |  19.33    .549
              1.50    .484 |   7.50   5.528 |  13.50   1.034 |  19.50    .542
              1.67    .495 |   7.67   8.889 |  13.67   1.007 |  19.67    .536
              1.83    .507 |   7.83  23.900 |  13.83    .981 |  19.83    .529
              2.00    .519 |   8.00 114.214 |  14.00    .957 |  20.00    .523
              2.17    .532 |   8.17  32.355 |  14.17    .934 |  20.17    .516
              2.33    .546 |   8.33  15.797 |  14.33    .913 |  20.33    .510
              2.50    .560 |   8.50  10.336 |  14.50    .892 |  20.50    .505
              2.67    .575 |   8.67   7.676 |  14.67    .872 |  20.67    .499
              2.83    .591 |   8.83   6.115 |  14.83    .854 |  20.83    .493
              3.00    .609 |   9.00   5.092 |  15.00    .836 |  21.00    .488
              3.17    .627 |   9.17   4.371 |  15.17    .819 |  21.17    .482
              3.33    .647 |   9.33   3.835 |  15.33    .802 |  21.33    .477
              3.50    .668 |   9.50   3.421 |  15.50    .787 |  21.50    .472
              3.67    .690 |   9.67   3.092 |  15.67    .772 |  21.67    .467
              3.83    .714 |   9.83   2.824 |  15.83    .757 |  21.83    .462
              4.00    .741 |  10.00   2.600 |  16.00    .743 |  22.00    .458
              4.17    .769 |  10.17   2.412 |  16.17    .730 |  22.17    .453
              4.33    .800 |  10.33   2.251 |  16.33    .717 |  22.33    .448
              4.50    .834 |  10.50   2.111 |  16.50    .705 |  22.50    .444
              4.67    .871 |  10.67   1.988 |  16.67    .693 |  22.67    .440
              4.83    .911 |  10.83   1.880 |  16.83    .682 |  22.83    .435
              5.00    .957 |  11.00   1.784 |  17.00    .671 |  23.00    .431
              5.17   1.007 |  11.17   1.698 |  17.17    .660 |  23.17    .427
              5.33   1.064 |  11.33   1.621 |  17.33    .650 |  23.33    .423
              5.50   1.127 |  11.50   1.550 |  17.50    .640 |  23.50    .419
              5.67   1.200 |  11.67   1.486 |  17.67    .630 |  23.67    .415
              5.83   1.284 |  11.83   1.428 |  17.83    .621 |  23.83    .412
              6.00   1.382 |  12.00   1.374 |  18.00    .612 |  24.00    .408

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001:0065------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.65
| 01: 1     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        1.38          .27
     Dep. Storage     (mm)=        2.00         5.00
     Average Slope     (%)=        2.00         2.00
     Length            (m)=      380.00       380.00
```

```
     Mannings n           =       .013          .025

     Max.eff.Inten.(mm/hr)=     114.21         22.78
                over (min)        4.00         17.00
     Storage Coeff.  (min)=       4.38 (ii)    16.75 (ii)
     Unit Hyd. Tpeak (min)=       4.00         17.00
     Unit Hyd. peak  (cms)=        .27           .07
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .38           .01          .386 (iii)
     TIME TO PEAK    (hrs)=       8.00          8.25         8.000
     RUNOFF VOLUME    (mm)=      58.87         18.95        52.246
     TOTAL RAINFALL   (mm)=      60.87         60.87        60.873
     RUNOFF COEFFICIENT   =        .97           .31          .858

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0066------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.42
| 02: 2     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.18           .24
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=       1.30          1.30
     Length            (m)=     480.00        480.00
     Mannings n           =       .013          .025

     Max.eff.Inten.(mm/hr)=     114.21         19.41
                over (min)        6.00         23.00
     Storage Coeff.  (min)=       5.74 (ii)    23.00 (ii)
     Unit Hyd. Tpeak (min)=       6.00         23.00
     Unit Hyd. peak  (cms)=        .19           .05
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .30           .01          .298 (iii)
     TIME TO PEAK    (hrs)=       8.03          8.37         8.033
     RUNOFF VOLUME    (mm)=      58.86         18.94        52.246
     TOTAL RAINFALL   (mm)=      60.87         60.87        60.873
     RUNOFF COEFFICIENT   =        .97           .31          .858

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0067------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=    1.19
| 03: 3     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .99           .20
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```
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=       2.20          2.20
     Length            (m)=     420.00        420.00
     Mannings n           =       .013          .025

     Max.eff.Inten.(mm/hr)=     114.21         22.78
                over (min)        5.00         17.00
     Storage Coeff.  (min)=       4.52 (ii)    17.29 (ii)
     Unit Hyd. Tpeak (min)=       5.00         17.00
     Unit Hyd. peak  (cms)=        .24           .07
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .27           .01            .273 (iii)
     TIME TO PEAK    (hrs)=       8.02          8.25           8.017
     RUNOFF VOLUME    (mm)=      58.87         18.94          52.246
     TOTAL RAINFALL   (mm)=      60.87         60.87          60.873
     RUNOFF COEFFICIENT   =        .97           .31            .858

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0068------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    3.00
| 04: 4     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.50           .50
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=        .40           .40
     Length            (m)=    1000.00       1000.00
     Mannings n           =       .013          .025

     Max.eff.Inten.(mm/hr)=      90.83          9.50
                over (min)       14.00         65.00
     Storage Coeff.  (min)=      13.91 (ii)    64.73 (ii)
     Unit Hyd. Tpeak (min)=      14.00         65.00
     Unit Hyd. peak  (cms)=        .08           .02
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .40           .01            .403 (iii)
     TIME TO PEAK    (hrs)=       8.17          9.10           8.167
     RUNOFF VOLUME    (mm)=      58.85         18.93          52.246
     TOTAL RAINFALL   (mm)=      60.87         60.87          60.873
     RUNOFF COEFFICIENT   =        .97           .31            .858

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0069------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.53
| 05: 5     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
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                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.28          .25
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .75          .75
     Length            (m)=     360.00       360.00
     Mannings n          =       .013         .025

     Max.eff.Inten.(mm/hr)=     114.21        19.41
                over (min)        6.00        23.00
     Storage Coeff.  (min)=       5.70 (ii)   22.83 (ii)
     Unit Hyd. Tpeak (min)=       6.00        23.00
     Unit Hyd. peak  (cms)=        .20          .05
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .32          .01            .322 (iii)
     TIME TO PEAK    (hrs)=       8.03         8.37           8.033
     RUNOFF VOLUME    (mm)=      58.87        18.94          52.246
     TOTAL RAINFALL   (mm)=      60.87        60.87          60.873
     RUNOFF COEFFICIENT   =        .97          .31            .858

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0070------------------------------------------------------------------------
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| CALIB STANDHYD      |   Area    (ha)=     .41
| 06: 6     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
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                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .34          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .20          .20
     Length            (m)=     225.00       225.00
     Mannings n          =       .013         .025

     Max.eff.Inten.(mm/hr)=     114.21        17.94
                over (min)        6.00        26.00
     Storage Coeff.  (min)=       6.39 (ii)   26.21 (ii)
     Unit Hyd. Tpeak (min)=       6.00        26.00
     Unit Hyd. peak  (cms)=        .18          .04
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .08          .00            .083 (iii)
     TIME TO PEAK    (hrs)=       8.03         8.42           8.033
     RUNOFF VOLUME    (mm)=      58.87        18.94          52.246
     TOTAL RAINFALL   (mm)=      60.87        60.87          60.873
     RUNOFF COEFFICIENT   =        .97          .31            .858

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0071------------------------------------------------------------------------
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------------------------
| ADD HYD (ADD       ) | ID: NHYD          AREA     QPEAK    TPEAK    R.V.    DWF
------------------------                    (ha)     (cms)    (hrs)    (mm)   (cms)
                     ID1 02: 2              1.42      .298     8.03   52.25    .000

                    +ID2 03: 3              1.19      .273     8.02   52.25    .000

                    +ID3 04: 4              3.00      .403     8.17   52.25    .000

                    +ID4 05: 5              1.53      .322     8.03   52.25    .000

                    +ID5 06: 6               .41      .083     8.03   52.25    .000

                     ============================================================
                     SUM 08:ADD             7.55     1.257     8.05   52.25    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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001:0072------------------------------------------------------------------------
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***FLOW FROM 2 YEAR CHICAGO STORM***
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| CHICAGO STORM    |    IDF curve parameters: A= 725.000
| Ptotal= 48.69 mm |                          B=   4.800
--------------------                          C=    .808
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  = 24.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17    .400 |   6.17   1.353 |  12.17   1.206 |  18.17    .574
               .33    .407 |   6.33   1.470 |  12.33   1.167 |  18.33    .567
               .50    .414 |   6.50   1.612 |  12.50   1.130 |  18.50    .559
               .67    .422 |   6.67   1.789 |  12.67   1.096 |  18.67    .552
               .83    .430 |   6.83   2.016 |  12.83   1.064 |  18.83    .545
              1.00    .438 |   7.00   2.319 |  13.00   1.035 |  19.00    .538
              1.17    .447 |   7.17   2.745 |  13.17   1.007 |  19.17    .532
              1.33    .456 |   7.33   3.393 |  13.33    .980 |  19.33    .525
              1.50    .466 |   7.50   4.511 |  13.50    .955 |  19.50    .519
              1.67    .476 |   7.67   6.953 |  13.67    .932 |  19.67    .513
              1.83    .487 |   7.83  17.302 |  13.83    .910 |  19.83    .507
              2.00    .498 |   8.00  82.180 |  14.00    .889 |  20.00    .501
              2.17    .510 |   8.17  23.060 |  14.17    .869 |  20.17    .496
              2.33    .522 |   8.33  11.785 |  14.33    .849 |  20.33    .490
              2.50    .535 |   8.50   7.986 |  14.50    .831 |  20.50    .485
              2.67    .549 |   8.67   6.087 |  14.67    .814 |  20.67    .479
              2.83    .564 |   8.83   4.948 |  14.83    .798 |  20.83    .474
              3.00    .579 |   9.00   4.187 |  15.00    .782 |  21.00    .469
              3.17    .596 |   9.17   3.641 |  15.17    .767 |  21.17    .464
              3.33    .613 |   9.33   3.230 |  15.33    .752 |  21.33    .460
              3.50    .632 |   9.50   2.909 |  15.50    .738 |  21.50    .455
              3.67    .652 |   9.67   2.650 |  15.67    .725 |  21.67    .451
              3.83    .674 |   9.83   2.437 |  15.83    .712 |  21.83    .446
              4.00    .697 |  10.00   2.259 |  16.00    .700 |  22.00    .442
              4.17    .723 |  10.17   2.107 |  16.17    .688 |  22.17    .437
              4.33    .750 |  10.33   1.976 |  16.33    .677 |  22.33    .433
              4.50    .780 |  10.50   1.862 |  16.50    .666 |  22.50    .429
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            4.67    .813 |  10.67   1.762 |  16.67    .655 |  22.67    .425
            4.83    .848 |  10.83   1.673 |  16.83    .645 |  22.83    .421
            5.00    .888 |  11.00   1.593 |  17.00    .635 |  23.00    .417
            5.17    .932 |  11.17   1.521 |  17.17    .626 |  23.17    .414
            5.33    .981 |  11.33   1.456 |  17.33    .616 |  23.33    .410
            5.50   1.037 |  11.50   1.397 |  17.50    .607 |  23.50    .406
            5.67   1.099 |  11.67   1.343 |  17.67    .599 |  23.67    .403
            5.83   1.172 |  11.83   1.294 |  17.83    .590 |  23.83    .399
            6.00   1.255 |  12.00   1.248 |  18.00    .582 |  24.00    .396

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001:0073---------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.65
| 01: 1    DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.38          .27
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=     380.00       380.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=      82.18        11.59
                over (min)        5.00        21.00
     Storage Coeff.  (min)=       5.00 (ii)   21.21 (ii)
     Unit Hyd. Tpeak (min)=       5.00        21.00
     Unit Hyd. peak  (cms)=        .23          .05
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .26          .01              .264 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.33             8.017
     RUNOFF VOLUME    (mm)=      46.68        12.51            41.015
     TOTAL RAINFALL   (mm)=      48.69        48.69            48.688
     RUNOFF COEFFICIENT   =        .96          .26              .842

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0074---------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.42
| 02: 2    DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.18          .24
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.30         1.30
     Length            (m)=     480.00       480.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=      82.18         9.31
                over (min)        7.00        30.00
     Storage Coeff.  (min)=       6.55 (ii)   29.70 (ii)
     Unit Hyd. Tpeak (min)=       7.00        30.00
     Unit Hyd. peak  (cms)=        .17          .04
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                                                                 *TOTALS*
     PEAK FLOW       (cms)=        .20          .00          .201 (iii)
     TIME TO PEAK    (hrs)=       8.05         8.48         8.050
     RUNOFF VOLUME    (mm)=      46.68        12.50        41.015
     TOTAL RAINFALL   (mm)=      48.69        48.69        48.688
     RUNOFF COEFFICIENT   =        .96          .26          .842

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0075------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.19
| 03: 3     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .99          .20
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.20         2.20
     Length            (m)=     420.00       420.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=      82.18        11.24
                over (min)        5.00        22.00
     Storage Coeff.  (min)=       5.16 (ii)   22.09 (ii)
     Unit Hyd. Tpeak (min)=       5.00        22.00
     Unit Hyd. peak  (cms)=        .22          .05
                                                                 *TOTALS*
     PEAK FLOW       (cms)=        .19          .00          .188 (iii)
     TIME TO PEAK    (hrs)=       8.02         8.35         8.017
     RUNOFF VOLUME    (mm)=      46.68        12.51        41.015
     TOTAL RAINFALL   (mm)=      48.69        48.69        48.688
     RUNOFF COEFFICIENT   =        .96          .26          .842

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0076------------------------------------------------------------------------
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----------------------
| CALIB STANDHYD     |   Area    (ha)=    3.00
| 04: 4     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.50          .50
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .40          .40
     Length            (m)=    1000.00      1000.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=      57.84         4.56
                over (min)       17.00        85.00
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     Storage Coeff.  (min)=      16.67 (ii)   84.85 (ii)
     Unit Hyd. Tpeak (min)=      17.00        85.00
     Unit Hyd. peak  (cms)=        .07          .01
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .26          .00           .260 (iii)
     TIME TO PEAK    (hrs)=       8.22         9.48          8.217
     RUNOFF VOLUME    (mm)=      46.67        12.49         41.015
     TOTAL RAINFALL   (mm)=      48.69        48.69         48.688
     RUNOFF COEFFICIENT   =        .96          .26           .842

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0077-----------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=    1.53
| 05: 5     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.28          .25
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .75          .75
     Length            (m)=     360.00       360.00
     Mannings n           =       .013         .025

     Max.eff.Inten.(mm/hr)=      82.18         9.49
                over (min)        6.00        29.00
     Storage Coeff.  (min)=       6.50 (ii)   29.30 (ii)
     Unit Hyd. Tpeak (min)=       6.00        29.00
     Unit Hyd. peak  (cms)=        .18          .04
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .22          .00           .221 (iii)
     TIME TO PEAK    (hrs)=       8.03         8.47          8.033
     RUNOFF VOLUME    (mm)=      46.68        12.50         41.015
     TOTAL RAINFALL   (mm)=      48.69        48.69         48.688
     RUNOFF COEFFICIENT   =        .96          .26           .842

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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001:0078-----------------------------------------------------------------------------
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| CALIB STANDHYD     |   Area    (ha)=     .41
| 06: 6     DT= 1.00 |   Total Imp(%)=   83.40   Dir. Conn.(%)=   83.40
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .34          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .20          .20
     Length            (m)=     225.00       225.00
     Mannings n           =       .013         .025
```

```
     Max.eff.Inten.(mm/hr)=      82.18         8.55
                over (min)        7.00        34.00
     Storage Coeff.  (min)=       7.29 (ii)   33.95 (ii)
     Unit Hyd. Tpeak (min)=       7.00        34.00
     Unit Hyd. peak  (cms)=        .16          .03
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .06          .00           .056 (iii)
     TIME TO PEAK    (hrs)=       8.05         8.55          8.050
     RUNOFF VOLUME    (mm)=      46.68        12.51         41.015
     TOTAL RAINFALL   (mm)=      48.69        48.69         48.688
     RUNOFF COEFFICIENT   =        .96          .26           .842

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  70.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
-
001:0079------------------------------------------------------------------------
-
------------------------
| ADD HYD (ADD       ) | ID: NHYD          AREA     QPEAK    TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)    (hrs)   (mm)   (cms)
                    ID1 02: 2               1.42      .201     8.05  41.02    .000

                   +ID2 03: 3               1.19      .188     8.02  41.02    .000

                   +ID3 04: 4               3.00      .260     8.22  41.02    .000

                   +ID4 05: 5               1.53      .221     8.03  41.02    .000

                   +ID5 06: 6                .41      .056     8.05  41.02    .000

                    ============================================================
                    SUM 08:ADD              7.55      .828     8.05  41.02    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
-
001:0080------------------------------------------------------------------------
-
      FINISH
--------------------------------------------------------------------------------
-
********************************************************************************
*
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2014-04-11     at 14:13:23
================================================================================
=
```

APPENDIX C: Future SWM Pond 22A Modeling Results

```
============================================================
=======================================================

   V   V  I   SSSSS U  U   A   L
   V   V  I   SS     U  U  A A  L
    V V   I    SS    U  U AAAAA L
    V V   I     SS  U  U A   A L
     VV   I   SSSSS UUUUU A   A LLLLL

   OOO  TTTTT TTTTT H   H Y  Y M   M  OOO    TM
   O   O   T      T   H   H  Y Y  MM MM  O   O
   O   O   T      T   H   H   Y   M   M  O   O
    OOO    T      T   H   H   Y   M   M   OOO

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          ***** D E T A I L E D   O U T P U T *****

 Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.2.4\voin.dat

 Output  filename: p:\Projects\11-350\Design\SWM\Conceptual Pond Design\VO2 Mode for
Storage Calculations\VO2 Model For EIR FSS Report\Pond
 Summary filename: p:\Projects\11-350\Design\SWM\Conceptual Pond Design\VO2 Mode for
Storage Calculations\VO2 Model For EIR FSS Report\Pond

DATE: 06/11/2012                TIME: 12:31:55 PM

USER:

COMMENTS: ____________________________________________________

---------------------------------------------------------------------------
 ***************************
 ** SIMULATION NUMBER:   1 **
```

```
 ***************************

--------------------
|   READ STORM    |   Filename: P:\Design Tools\SWM\Hydrologic Design - VO2\
|                 |    Storm Files\Brampton\HAZEL.STM
| Ptotal=212.00 mm |   Comments: Hurricane Hazel for the last 12 hrs of t
--------------------
          TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
           hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
          1.00    6.00 |  4.00   13.00 |  7.00   23.00 | 10.00   53.00
          2.00    4.00 |  5.00   17.00 |  8.00   13.00 | 11.00   38.00
          3.00    6.00 |  6.00   13.00 |  9.00   13.00 | 12.00   13.00

--------------------------------------------------------------------------

--------------------
| CALIB            |
| STANDHYD  (0001) |   Area    (ha)=  45.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  40.00
--------------------
                       IMPERVIOUS   PERVIOUS (i)
    Surface Area    (ha)=     29.35      15.80
    Dep. Storage    (mm)=      2.00       6.35
    Average Slope    (%)=      1.00        .20
    Length           (m)=    548.60      40.00
    Mannings n          =      .013       .250

     NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.

                 ---- TRANSFORMED HYETOGRAPH ----
          TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
           hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
          .083    6.00 | 3.083   13.00 | 6.083   23.00 |  9.08   53.00
          .167    6.00 | 3.167   13.00 | 6.167   23.00 |  9.17   53.00
          .250    6.00 | 3.250   13.00 | 6.250   23.00 |  9.25   53.00
          .333    6.00 | 3.333   13.00 | 6.333   23.00 |  9.33   53.00
          .417    6.00 | 3.417   13.00 | 6.417   23.00 |  9.42   53.00
          .500    6.00 | 3.500   13.00 | 6.500   23.00 |  9.50   53.00
          .583    6.00 | 3.583   13.00 | 6.583   23.00 |  9.58   53.00
          .667    6.00 | 3.667   13.00 | 6.667   23.00 |  9.67   53.00
```

```
     .750    6.00 | 3.750   13.00 | 6.750   23.00 |  9.75   53.00
     .833    6.00 | 3.833   13.00 | 6.833   23.00 |  9.83   53.00
     .917    6.00 | 3.917   13.00 | 6.917   23.00 |  9.92   53.00
    1.000    6.00 | 4.000   13.00 | 7.000   23.00 | 10.00   53.00
    1.083    4.00 | 4.083   17.00 | 7.083   13.00 | 10.08   38.00
    1.167    4.00 | 4.167   17.00 | 7.167   13.00 | 10.17   38.00
    1.250    4.00 | 4.250   17.00 | 7.250   13.00 | 10.25   38.00
    1.333    4.00 | 4.333   17.00 | 7.333   13.00 | 10.33   38.00
    1.417    4.00 | 4.417   17.00 | 7.417   13.00 | 10.42   38.00
    1.500    4.00 | 4.500   17.00 | 7.500   13.00 | 10.50   38.00
    1.583    4.00 | 4.583   17.00 | 7.583   13.00 | 10.58   38.00
    1.667    4.00 | 4.667   17.00 | 7.667   13.00 | 10.67   38.00
    1.750    4.00 | 4.750   17.00 | 7.750   13.00 | 10.75   38.00
    1.833    4.00 | 4.833   17.00 | 7.833   13.00 | 10.83   38.00
    1.917    4.00 | 4.917   17.00 | 7.917   13.00 | 10.92   38.00
    2.000    4.00 | 5.000   17.00 | 8.000   13.00 | 11.00   38.00
    2.083    6.00 | 5.083   13.00 | 8.083   13.00 | 11.08   13.00
    2.167    6.00 | 5.167   13.00 | 8.167   13.00 | 11.17   13.00
    2.250    6.00 | 5.250   13.00 | 8.250   13.00 | 11.25   13.00
    2.333    6.00 | 5.333   13.00 | 8.333   13.00 | 11.33   13.00
    2.417    6.00 | 5.417   13.00 | 8.417   13.00 | 11.42   13.00
    2.500    6.00 | 5.500   13.00 | 8.500   13.00 | 11.50   13.00
    2.583    6.00 | 5.583   13.00 | 8.583   13.00 | 11.58   13.00
    2.667    6.00 | 5.667   13.00 | 8.667   13.00 | 11.67   13.00
    2.750    6.00 | 5.750   13.00 | 8.750   13.00 | 11.75   13.00
    2.833    6.00 | 5.833   13.00 | 8.833   13.00 | 11.83   13.00
    2.917    6.00 | 5.917   13.00 | 8.917   13.00 | 11.92   13.00
    3.000    6.00 | 6.000   13.00 | 9.000   13.00 | 12.00   13.00

Max.Eff.Inten.(mm/hr)=     53.00       87.31
         over (min)       10.00       25.00
Storage Coeff.  (min)=     9.14 (ii)  24.01 (ii)
Unit Hyd. Tpeak (min)=    10.00       25.00
Unit Hyd. peak  (cms)=      .12         .05
                                     *TOTALS*
PEAK FLOW      (cms)=      2.65        3.46        6.054 (iii)
TIME TO PEAK   (hrs)=       .00       10.17       10.00
RUNOFF VOLUME   (mm)=    210.00      176.85      190.11
TOTAL RAINFALL  (mm)=    212.00      212.00      212.00
RUNOFF COEFFICIENT  =       .99         .83         .90
```

```
   (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
        CN* =  80.0    Ia = Dep. Storage  (Above)
  (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
        THAN THE STORAGE COEFFICIENT.
 (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------
--------------------
| RESERVOIR (0002) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |    OUTFLOW    STORAGE  | OUTFLOW    STORAGE
--------------------     (cms)     (ha.m.)  |  (cms)     (ha.m.)
                         .0000      .0000   |  .5190     1.9200
                         .0280      .6100   |  .5880     2.1500
                         .2070      .9800   |  .6570     2.4000
                         .3110     1.3300   | 1.6600     6.0500
                         .3800     1.6000   |  .0000      .0000

                             AREA     QPEAK     TPEAK     R.V.
                             (ha)     (cms)     (hrs)     (mm)
    INFLOW : ID= 2 (0001)    45.15     6.05     10.00    190.11
    OUTFLOW: ID= 1 (0002)    45.15     1.66     12.08    188.34

              PEAK  FLOW   REDUCTION [Qout/Qin](%)= 27.38
              TIME SHIFT OF PEAK FLOW        (min)=125.00
              MAXIMUM  STORAGE  USED       (ha.m.)= 6.0408

---------------------------------------------------------------------------
 ****************************
 ** SIMULATION NUMBER:  2 **
 ****************************

--------------------
| CHICAGO STORM     |   IDF curve parameters: A=2150.000
| Ptotal= 98.13 mm |                          B=   5.700
--------------------                          C=    .861
                    used in:   INTENSITY =  A / (t + B)^C

                    Duration of storm  = 24.00 hrs
                    Storm time step    = 10.00 min
                    Time to peak ratio =   .33
```

```
TIME   RAIN | TIME   RAIN | TIME   RAIN | TIME   RAIN
 hrs  mm/hr |  hrs  mm/hr |  hrs  mm/hr |  hrs  mm/hr
  .17    .59 |  6.17   2.24 | 12.17   1.95 | 18.17    .87
  .33    .61 |  6.33   2.45 | 12.33   1.88 | 18.33    .86
  .50    .62 |  6.50   2.72 | 12.50   1.81 | 18.50    .84
  .67    .63 |  6.67   3.05 | 12.67   1.75 | 18.67    .83
  .83    .64 |  6.83   3.49 | 12.83   1.70 | 18.83    .82
 1.00    .66 |  7.00   4.08 | 13.00   1.65 | 19.00    .81
 1.17    .67 |  7.17   4.93 | 13.17   1.60 | 19.17    .80
 1.33    .69 |  7.33   6.26 | 13.33   1.55 | 19.33    .79
 1.50    .70 |  7.50   8.66 | 13.50   1.51 | 19.50    .78
 1.67    .72 |  7.67  14.21 | 13.67   1.47 | 19.67    .77
 1.83    .74 |  7.83  39.75 | 13.83   1.43 | 19.83    .76
 2.00    .75 |  8.00 200.80 | 14.00   1.39 | 20.00    .75
 2.17    .77 |  8.17  54.01 | 14.17   1.36 | 20.17    .74
 2.33    .79 |  8.33  25.55 | 14.33   1.33 | 20.33    .73
 2.50    .81 |  8.50  16.41 | 14.50   1.30 | 20.50    .72
 2.67    .84 |  8.67  12.04 | 14.67   1.27 | 20.67    .71
 2.83    .86 |  8.83   9.50 | 14.83   1.24 | 20.83    .71
 3.00    .89 |  9.00   7.85 | 15.00   1.21 | 21.00    .70
 3.17    .91 |  9.17   6.70 | 15.17   1.19 | 21.17    .69
 3.33    .94 |  9.33   5.85 | 15.33   1.16 | 21.33    .68
 3.50    .98 |  9.50   5.19 | 15.50   1.14 | 21.50    .68
 3.67   1.01 |  9.67   4.68 | 15.67   1.12 | 21.67    .67
 3.83   1.05 |  9.83   4.26 | 15.83   1.10 | 21.83    .66
 4.00   1.08 | 10.00   3.91 | 16.00   1.08 | 22.00    .65
 4.17   1.13 | 10.17   3.62 | 16.17   1.06 | 22.17    .65
 4.33   1.17 | 10.33   3.37 | 16.33   1.04 | 22.33    .64
 4.50   1.23 | 10.50   3.15 | 16.50   1.02 | 22.50    .63
 4.67   1.28 | 10.67   2.96 | 16.67   1.00 | 22.67    .63
 4.83   1.34 | 10.83   2.80 | 16.83    .98 | 22.83    .62
 5.00   1.41 | 11.00   2.65 | 17.00    .97 | 23.00    .62
 5.17   1.49 | 11.17   2.52 | 17.17    .95 | 23.17    .61
 5.33   1.57 | 11.33   2.40 | 17.33    .94 | 23.33    .60
 5.50   1.67 | 11.50   2.29 | 17.50    .92 | 23.50    .60
 5.67   1.78 | 11.67   2.19 | 17.67    .91 | 23.67    .59
 5.83   1.91 | 11.83   2.10 | 17.83    .89 | 23.83    .59
 6.00   2.06 | 12.00   2.02 | 18.00    .88 | 24.00    .58

--------------------------------------------------------------------------------
--------------------
```

```
| CALIB              |
| STANDHYD  (0001) |   Area    (ha)=  45.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  40.00
--------------------
                          IMPERVIOUS    PERVIOUS (i)
    Surface Area     (ha)=      29.35        15.80
    Dep. Storage     (mm)=       2.00         6.35
    Average Slope     (%)=       1.00          .20
    Length            (m)=     548.60        40.00
    Mannings n          =        .013         .250

    NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                     ---- TRANSFORMED HYETOGRAPH ----
       TIME    RAIN | TIME    RAIN | TIME    RAIN | TIME   RAIN
        hrs   mm/hr |  hrs   mm/hr |  hrs   mm/hr |  hrs  mm/hr
       .083     .59 | 6.083    2.24 |12.083   1.95 | 18.08    .87
       .167     .59 | 6.167    2.24 |12.167   1.95 | 18.17    .87
       .250     .61 | 6.250    2.45 |12.250   1.88 | 18.25    .86
       .333     .61 | 6.333    2.45 |12.333   1.88 | 18.33    .86
       .417     .62 | 6.417    2.72 |12.417   1.81 | 18.42    .84
       .500     .62 | 6.500    2.72 |12.500   1.81 | 18.50    .84
       .583     .63 | 6.583    3.05 |12.583   1.75 | 18.58    .83
       .667     .63 | 6.667    3.05 |12.667   1.75 | 18.67    .83
       .750     .64 | 6.750    3.49 |12.750   1.70 | 18.75    .82
       .833     .64 | 6.833    3.49 |12.833   1.70 | 18.83    .82
       .917     .66 | 6.917    4.08 |12.917   1.65 | 18.92    .81
      1.000     .66 | 7.000    4.08 |13.000   1.65 | 19.00    .81
      1.083     .67 | 7.083    4.93 |13.083   1.60 | 19.08    .80
      1.167     .67 | 7.167    4.93 |13.167   1.60 | 19.17    .80
      1.250     .69 | 7.250    6.26 |13.250   1.55 | 19.25    .79
      1.333     .69 | 7.333    6.26 |13.333   1.55 | 19.33    .79
      1.417     .70 | 7.417    8.66 |13.417   1.51 | 19.42    .78
      1.500     .70 | 7.500    8.66 |13.500   1.51 | 19.50    .78
      1.583     .72 | 7.583   14.21 |13.583   1.47 | 19.58    .77
      1.667     .72 | 7.667   14.21 |13.667   1.47 | 19.67    .77
      1.750     .74 | 7.750   39.75 |13.750   1.43 | 19.75    .76
      1.833     .74 | 7.833   39.76 |13.833   1.43 | 19.83    .76
      1.917     .75 | 7.917  200.80 |13.917   1.39 | 19.92    .75
      2.000     .75 | 8.000  200.79 |14.000   1.39 | 20.00    .75
      2.083     .77 | 8.083   54.01 |14.083   1.36 | 20.08    .74
```

```
2.167   .77 | 8.167  54.01 |14.167   1.36 | 20.17   .74
2.250   .79 | 8.250  25.55 |14.250   1.33 | 20.25   .73
2.333   .79 | 8.333  25.55 |14.333   1.33 | 20.33   .73
2.417   .81 | 8.417  16.41 |14.417   1.30 | 20.42   .72
2.500   .81 | 8.500  16.41 |14.500   1.30 | 20.50   .72
2.583   .84 | 8.583  12.04 |14.583   1.27 | 20.58   .71
2.667   .84 | 8.667  12.04 |14.667   1.27 | 20.67   .71
2.750   .86 | 8.750   9.50 |14.750   1.24 | 20.75   .71
2.833   .86 | 8.833   9.50 |14.833   1.24 | 20.83   .71
2.917   .89 | 8.917   7.85 |14.917   1.21 | 20.92   .70
3.000   .89 | 9.000   7.85 |15.000   1.21 | 21.00   .70
3.083   .91 | 9.083   6.70 |15.083   1.19 | 21.08   .69
3.167   .91 | 9.167   6.70 |15.167   1.19 | 21.17   .69
3.250   .94 | 9.250   5.85 |15.250   1.16 | 21.25   .68
3.333   .94 | 9.333   5.85 |15.333   1.16 | 21.33   .68
3.417   .98 | 9.417   5.19 |15.417   1.14 | 21.42   .68
3.500   .98 | 9.500   5.19 |15.500   1.14 | 21.50   .68
3.583  1.01 | 9.583   4.68 |15.583   1.12 | 21.58   .67
3.667  1.01 | 9.667   4.68 |15.667   1.12 | 21.67   .67
3.750  1.05 | 9.750   4.26 |15.750   1.10 | 21.75   .66
3.833  1.05 | 9.833   4.26 |15.833   1.10 | 21.83   .66
3.917  1.08 | 9.917   3.91 |15.917   1.08 | 21.92   .65
4.000  1.08 |10.000   3.91 |16.000   1.08 | 22.00   .65
4.083  1.13 |10.083   3.62 |16.083   1.06 | 22.08   .65
4.167  1.13 |10.167   3.62 |16.167   1.06 | 22.17   .65
4.250  1.17 |10.250   3.37 |16.250   1.04 | 22.25   .64
4.333  1.17 |10.333   3.37 |16.333   1.04 | 22.33   .64
4.417  1.23 |10.417   3.15 |16.417   1.02 | 22.42   .63
4.500  1.23 |10.500   3.15 |16.500   1.02 | 22.50   .63
4.583  1.28 |10.583   2.96 |16.583   1.00 | 22.58   .63
4.667  1.28 |10.667   2.96 |16.667   1.00 | 22.67   .63
4.750  1.34 |10.750   2.80 |16.750    .98 | 22.75   .62
4.833  1.34 |10.833   2.80 |16.833    .98 | 22.83   .62
4.917  1.41 |10.917   2.65 |16.917    .97 | 22.92   .62
5.000  1.41 |11.000   2.65 |17.000    .97 | 23.00   .62
5.083  1.49 |11.083   2.52 |17.083    .95 | 23.08   .61
5.167  1.49 |11.167   2.52 |17.167    .95 | 23.17   .61
5.250  1.57 |11.250   2.40 |17.250    .94 | 23.25   .60
5.333  1.57 |11.333   2.40 |17.333    .94 | 23.33   .60
5.417  1.67 |11.417   2.29 |17.417    .92 | 23.42   .60
5.500  1.67 |11.500   2.29 |17.500    .92 | 23.50   .60
5.583  1.78 |11.583   2.19 |17.583    .91 | 23.58   .59
```

```
  5.667   1.78 |11.667   2.19 |17.667    .91 | 23.67   .59
  5.750   1.91 |11.750   2.10 |17.750    .89 | 23.75   .59
  5.833   1.91 |11.833   2.10 |17.833    .89 | 23.83   .59
  5.917   2.06 |11.917   2.02 |17.917    .88 | 23.92   .58
  6.000   2.06 |12.000   2.02 |18.000    .88 | 24.00   .58

 Max.Eff.Inten.(mm/hr)=    200.80      246.62
         over (min)         5.00       20.00
 Storage Coeff. (min)=      5.37 (ii)  15.18 (ii)
 Unit Hyd. Tpeak (min)=     5.00       20.00
 Unit Hyd. peak  (cms)=      .21         .07
                                     *TOTALS*
 PEAK FLOW      (cms)=      8.79        4.96      10.974 (iii)
 TIME TO PEAK   (hrs)=       .00        8.25       8.00
 RUNOFF VOLUME   (mm)=     96.13       67.82      79.15
 TOTAL RAINFALL  (mm)=     98.13       98.13      98.13
 RUNOFF COEFFICIENT  =       .98         .69        .81

  (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
      CN* =  80.0    Ia = Dep. Storage  (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
      THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (0002) |
| IN= 2---> OUT= 1 |
| DT= 5.0 min      |    OUTFLOW    STORAGE  | OUTFLOW    STORAGE
--------------------     (cms)     (ha.m.)  |  (cms)     (ha.m.)
                         .0000      .0000   |  .5190     1.9200
                         .0280      .6100   |  .5880     2.1500
                         .2070      .9800   |  .6570     2.4000
                         .3110     1.3300   | 1.6600     6.0500
                         .3800     1.6000   |  .0000      .0000

                          AREA     QPEAK     TPEAK      R.V.
                          (ha)     (cms)     (hrs)      (mm)
 INFLOW : ID= 2 (0001)    45.15    10.97      8.00     79.15
 OUTFLOW: ID= 1 (0002)    45.15      .65      9.67     77.57
```

```
PEAK  FLOW  REDUCTION [Qout/Qin](%)=  5.95
TIME SHIFT OF PEAK FLOW        (min)=100.00
MAXIMUM  STORAGE  USED       (ha.m.)=  2.3838

-----------------------------------------------------------------------------
 ****************************
 ** SIMULATION NUMBER:   3 **
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| CHICAGO STORM     |    IDF curve parameters: A=1960.000
| Ptotal= 89.46 mm |                         B=   5.800
--------------------                        C=    .861
          used in:   INTENSITY =  A / (t + B)^C

          Duration of storm  = 24.00 hrs
          Storm time step    = 10.00 min
          Time to peak ratio =   .33

   TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
    hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
    .17     .54 |  6.17    2.04 | 12.17    1.78 | 18.17     .79
    .33     .55 |  6.33    2.24 | 12.33    1.71 | 18.33     .78
    .50     .56 |  6.50    2.48 | 12.50    1.66 | 18.50     .77
    .67     .57 |  6.67    2.79 | 12.67    1.60 | 18.67     .76
    .83     .59 |  6.83    3.19 | 12.83    1.55 | 18.83     .75
   1.00     .60 |  7.00    3.73 | 13.00    1.50 | 19.00     .74
   1.17     .61 |  7.17    4.51 | 13.17    1.46 | 19.17     .73
   1.33     .63 |  7.33    5.73 | 13.33    1.42 | 19.33     .72
   1.50     .64 |  7.50    7.93 | 13.50    1.38 | 19.50     .71
   1.67     .65 |  7.67   13.01 | 13.67    1.34 | 19.67     .70
   1.83     .67 |  7.83   36.39 | 13.83    1.31 | 19.83     .69
   2.00     .69 |  8.00  182.06 | 14.00    1.27 | 20.00     .68
   2.17     .70 |  8.17   49.43 | 14.17    1.24 | 20.17     .68
   2.33     .72 |  8.33   23.41 | 14.33    1.21 | 20.33     .67
   2.50     .74 |  8.50   15.03 | 14.50    1.18 | 20.50     .66
   2.67     .76 |  8.67   11.02 | 14.67    1.16 | 20.67     .65
   2.83     .79 |  8.83    8.69 | 14.83    1.13 | 20.83     .64
   3.00     .81 |  9.00    7.18 | 15.00    1.11 | 21.00     .64
   3.17     .83 |  9.17    6.13 | 15.17    1.08 | 21.17     .63
   3.33     .86 |  9.33    5.35 | 15.33    1.06 | 21.33     .62
   3.50     .89 |  9.50    4.75 | 15.50    1.04 | 21.50     .62
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   3.67     .92 |  9.67    4.27 | 15.67    1.02 | 21.67     .61
   3.83     .95 |  9.83    3.89 | 15.83    1.00 | 21.83     .60
   4.00     .99 | 10.00    3.57 | 16.00     .98 | 22.00     .60
   4.17    1.03 | 10.17    3.30 | 16.17     .96 | 22.17     .59
   4.33    1.07 | 10.33    3.08 | 16.33     .95 | 22.33     .58
   4.50    1.12 | 10.50    2.88 | 16.50     .93 | 22.50     .58
   4.67    1.17 | 10.67    2.71 | 16.67     .91 | 22.67     .57
   4.83    1.23 | 10.83    2.55 | 16.83     .90 | 22.83     .57
   5.00    1.29 | 11.00    2.42 | 17.00     .88 | 23.00     .56
   5.17    1.36 | 11.17    2.30 | 17.17     .87 | 23.17     .56
   5.33    1.44 | 11.33    2.19 | 17.33     .86 | 23.33     .55
   5.50    1.52 | 11.50    2.09 | 17.50     .84 | 23.50     .55
   5.67    1.63 | 11.67    2.00 | 17.67     .83 | 23.67     .54
   5.83    1.74 | 11.83    1.92 | 17.83     .82 | 23.83     .54
   6.00    1.88 | 12.00    1.85 | 18.00     .80 | 24.00     .53

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| CALIB             |
| STANDHYD  (0001) |   Area    (ha)=  45.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  40.00
--------------------
                     IMPERVIOUS   PERVIOUS (i)
    Surface Area    (ha)=     29.35        15.80
    Dep. Storage    (mm)=      2.00         6.35
    Average Slope    (%)=      1.00          .20
    Length           (m)=    548.60        40.00
    Mannings n         =       .013         .250

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.

                     ---- TRANSFORMED HYETOGRAPH ----
   TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
    hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
   .083     .54 | 6.083    2.04 |12.083    1.78 | 18.08     .79
   .167     .54 | 6.167    2.04 |12.167    1.78 | 18.17     .79
   .250     .55 | 6.250    2.24 |12.250    1.71 | 18.25     .78
   .333     .55 | 6.333    2.24 |12.333    1.71 | 18.33     .78
   .417     .56 | 6.417    2.48 |12.417    1.66 | 18.42     .77
   .500     .56 | 6.500    2.48 |12.500    1.66 | 18.50     .77
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 .583   .57 | 6.583   2.79 |12.583   1.60 | 18.58   .76
 .667   .57 | 6.667   2.79 |12.667   1.60 | 18.67   .76
 .750   .59 | 6.750   3.19 |12.750   1.55 | 18.75   .75
 .833   .59 | 6.833   3.19 |12.833   1.55 | 18.83   .75
 .917   .60 | 6.917   3.73 |12.917   1.50 | 18.92   .74
1.000   .60 | 7.000   3.73 |13.000   1.50 | 19.00   .74
1.083   .61 | 7.083   4.51 |13.083   1.46 | 19.08   .73
1.167   .61 | 7.167   4.51 |13.167   1.46 | 19.17   .73
1.250   .63 | 7.250   5.73 |13.250   1.42 | 19.25   .72
1.333   .63 | 7.333   5.73 |13.333   1.42 | 19.33   .72
1.417   .64 | 7.417   7.93 |13.417   1.38 | 19.42   .71
1.500   .64 | 7.500   7.93 |13.500   1.38 | 19.50   .71
1.583   .65 | 7.583  13.01 |13.583   1.34 | 19.58   .70
1.667   .65 | 7.667  13.01 |13.667   1.34 | 19.67   .70
1.750   .67 | 7.750  36.39 |13.750   1.31 | 19.75   .69
1.833   .67 | 7.833  36.40 |13.833   1.31 | 19.83   .69
1.917   .69 | 7.917 182.06 |13.917   1.27 | 19.92   .68
2.000   .69 | 8.000 182.05 |14.000   1.27 | 20.00   .68
2.083   .70 | 8.083  49.43 |14.083   1.24 | 20.08   .68
2.167   .70 | 8.167  49.43 |14.167   1.24 | 20.17   .68
2.250   .72 | 8.250  23.41 |14.250   1.21 | 20.25   .67
2.333   .72 | 8.333  23.41 |14.333   1.21 | 20.33   .67
2.417   .74 | 8.417  15.03 |14.417   1.18 | 20.42   .66
2.500   .74 | 8.500  15.03 |14.500   1.18 | 20.50   .66
2.583   .76 | 8.583  11.02 |14.583   1.16 | 20.58   .65
2.667   .76 | 8.667  11.02 |14.667   1.16 | 20.67   .65
2.750   .79 | 8.750   8.69 |14.750   1.13 | 20.75   .64
2.833   .79 | 8.833   8.69 |14.833   1.13 | 20.83   .64
2.917   .81 | 8.917   7.18 |14.917   1.11 | 20.92   .64
3.000   .81 | 9.000   7.18 |15.000   1.11 | 21.00   .64
3.083   .83 | 9.083   6.13 |15.083   1.08 | 21.08   .63
3.167   .83 | 9.167   6.13 |15.167   1.08 | 21.17   .63
3.250   .86 | 9.250   5.35 |15.250   1.06 | 21.25   .62
3.333   .86 | 9.333   5.35 |15.333   1.06 | 21.33   .62
3.417   .89 | 9.417   4.75 |15.417   1.04 | 21.42   .62
3.500   .89 | 9.500   4.75 |15.500   1.04 | 21.50   .62
3.583   .92 | 9.583   4.27 |15.583   1.02 | 21.58   .61
3.667   .92 | 9.667   4.27 |15.667   1.02 | 21.67   .61
3.750   .95 | 9.750   3.89 |15.750   1.00 | 21.75   .60
3.833   .95 | 9.833   3.89 |15.833   1.00 | 21.83   .60
3.917   .99 | 9.917   3.57 |15.917    .98 | 21.92   .60
4.000   .99 |10.000   3.57 |16.000    .98 | 22.00   .60
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     4.083   1.03 |10.083   3.30 |16.083    .96 | 22.08    .59
     4.167   1.03 |10.167   3.30 |16.167    .96 | 22.17    .59
     4.250   1.07 |10.250   3.08 |16.250    .95 | 22.25    .58
     4.333   1.07 |10.333   3.08 |16.333    .95 | 22.33    .58
     4.417   1.12 |10.417   2.88 |16.417    .93 | 22.42    .58
     4.500   1.12 |10.500   2.88 |16.500    .93 | 22.50    .58
     4.583   1.17 |10.583   2.71 |16.583    .91 | 22.58    .57
     4.667   1.17 |10.667   2.71 |16.667    .91 | 22.67    .57
     4.750   1.23 |10.750   2.55 |16.750    .90 | 22.75    .57
     4.833   1.23 |10.833   2.55 |16.833    .90 | 22.83    .57
     4.917   1.29 |10.917   2.42 |16.917    .88 | 22.92    .56
     5.000   1.29 |11.000   2.42 |17.000    .88 | 23.00    .56
     5.083   1.36 |11.083   2.30 |17.083    .87 | 23.08    .56
     5.167   1.36 |11.167   2.30 |17.167    .87 | 23.17    .56
     5.250   1.44 |11.250   2.19 |17.250    .86 | 23.25    .55
     5.333   1.44 |11.333   2.19 |17.333    .86 | 23.33    .55
     5.417   1.52 |11.417   2.09 |17.417    .84 | 23.42    .55
     5.500   1.52 |11.500   2.09 |17.500    .84 | 23.50    .55
     5.583   1.63 |11.583   2.00 |17.583    .83 | 23.58    .54
     5.667   1.63 |11.667   2.00 |17.667    .83 | 23.67    .54
     5.750   1.74 |11.750   1.92 |17.750    .82 | 23.75    .54
     5.833   1.74 |11.833   1.92 |17.833    .82 | 23.83    .54
     5.917   1.88 |11.917   1.85 |17.917    .80 | 23.92    .53
     6.000   1.88 |12.000   1.85 |18.000    .80 | 24.00    .53

Max.Eff.Inten.(mm/hr)=    182.06      166.29
        over (min)        5.00       20.00
Storage Coeff.  (min)=      5.58 (ii)  17.07 (ii)
Unit Hyd. Tpeak (min)=      5.00       20.00
Unit Hyd. peak  (cms)=       .20         .06
                                       *TOTALS*
PEAK FLOW      (cms)=       7.88        4.11        9.648 (iii)
TIME TO PEAK    (hrs)=       .00        8.25        8.00
RUNOFF VOLUME    (mm)=     87.46       59.88         70.91
TOTAL RAINFALL   (mm)=     89.46       89.46         89.46
RUNOFF COEFFICIENT   =       .98         .67           .79


 (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
     CN* =  80.0    Ia = Dep. Storage  (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
     THAN THE STORAGE COEFFICIENT.
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(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| RESERVOIR (0002) |
| IN= 2---> OUT= 1 |
| DT= 5.0 min    |   OUTFLOW    STORAGE   | OUTFLOW    STORAGE
--------------------    (cms)     (ha.m.)   |  (cms)     (ha.m.)
                        .0000      .0000   |  .5190     1.9200
                        .0280      .6100   |  .5880     2.1500
                        .2070      .9800   |  .6570     2.4000
                        .3110     1.3300   | 1.6600     6.0500
                        .3800     1.6000   |  .0000      .0000

                         AREA    QPEAK    TPEAK      R.V.
                         (ha)    (cms)    (hrs)      (mm)
  INFLOW : ID= 2 (0001)   45.15     9.65     8.00     70.91
  OUTFLOW: ID= 1 (0002)   45.15      .58     9.75     69.36

           PEAK   FLOW   REDUCTION [Qout/Qin](%)=  6.04
           TIME SHIFT OF PEAK FLOW        (min)=105.00
           MAXIMUM  STORAGE   USED       (ha.m.)=  2.1319

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 *****************************
 ** SIMULATION NUMBER:   4 **
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| CHICAGO STORM    |    IDF curve parameters: A=1680.000
| Ptotal= 82.47 mm |                          B=   5.600
--------------------                          C=    .851
                  used in:   INTENSITY =  A / (t + B)^C

                  Duration of storm   = 24.00 hrs
                  Storm time step     = 10.00 min
                  Time to peak ratio  =   .33

              TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
               .17     .53 |  6.17    1.97 | 12.17    1.72 | 18.17     .78
               .33     .54 |  6.33    2.16 | 12.33    1.66 | 18.33     .77
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               .50     .55 |  6.50    2.38 | 12.50    1.60 | 18.50     .75
               .67     .57 |  6.67    2.67 | 12.67    1.55 | 18.67     .74
               .83     .58 |  6.83    3.04 | 12.83    1.50 | 18.83     .73
              1.00     .59 |  7.00    3.54 | 13.00    1.46 | 19.00     .72
              1.17     .60 |  7.17    4.27 | 13.17    1.41 | 19.17     .72
              1.33     .62 |  7.33    5.39 | 13.33    1.38 | 19.33     .71
              1.50     .63 |  7.50    7.40 | 13.50    1.34 | 19.50     .70
              1.67     .64 |  7.67   11.98 | 13.67    1.30 | 19.67     .69
              1.83     .66 |  7.83   32.72 | 13.83    1.27 | 19.83     .68
              2.00     .67 |  8.00  162.17 | 14.00    1.24 | 20.00     .67
              2.17     .69 |  8.17   44.24 | 14.17    1.21 | 20.17     .66
              2.33     .71 |  8.33   21.25 | 14.33    1.18 | 20.33     .66
              2.50     .73 |  8.50   13.79 | 14.50    1.15 | 20.50     .65
              2.67     .75 |  8.67   10.19 | 14.67    1.13 | 20.67     .64
              2.83     .77 |  8.83    8.09 | 14.83    1.10 | 20.83     .63
              3.00     .79 |  9.00    6.72 | 15.00    1.08 | 21.00     .63
              3.17     .82 |  9.17    5.76 | 15.17    1.06 | 21.17     .62
              3.33     .84 |  9.33    5.04 | 15.33    1.04 | 21.33     .61
              3.50     .87 |  9.50    4.49 | 15.50    1.01 | 21.50     .61
              3.67     .90 |  9.67    4.05 | 15.67    1.00 | 21.67     .60
              3.83     .93 |  9.83    3.70 | 15.83     .98 | 21.83     .59
              4.00     .97 | 10.00    3.40 | 16.00     .96 | 22.00     .59
              4.17    1.00 | 10.17    3.15 | 16.17     .94 | 22.17     .58
              4.33    1.04 | 10.33    2.94 | 16.33     .92 | 22.33     .58
              4.50    1.09 | 10.50    2.75 | 16.50     .91 | 22.50     .57
              4.67    1.14 | 10.67    2.59 | 16.67     .89 | 22.67     .56
              4.83    1.19 | 10.83    2.45 | 16.83     .88 | 22.83     .56
              5.00    1.25 | 11.00    2.32 | 17.00     .86 | 23.00     .55
              5.17    1.32 | 11.17    2.21 | 17.17     .85 | 23.17     .55
              5.33    1.39 | 11.33    2.11 | 17.33     .84 | 23.33     .54
              5.50    1.48 | 11.50    2.02 | 17.50     .82 | 23.50     .54
              5.67    1.57 | 11.67    1.93 | 17.67     .81 | 23.67     .53
              5.83    1.69 | 11.83    1.85 | 17.83     .80 | 23.83     .53
              6.00    1.82 | 12.00    1.78 | 18.00     .79 | 24.00     .52

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| CALIB            |
| STANDHYD  (0001) |   Area    (ha)=  45.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  40.00
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                    IMPERVIOUS   PERVIOUS (i)
Surface Area    (ha)=    29.35       15.80
Dep. Storage    (mm)=     2.00        6.35
Average Slope    (%)=     1.00         .20
Length          (m)=    548.60       40.00
Mannings n        =       .013        .250

   NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


             ---- TRANSFORMED HYETOGRAPH ----
      TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME   RAIN
       hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs  mm/hr
      .083     .53 | 6.083    1.97 |12.083    1.72 | 18.08    .78
      .167     .53 | 6.167    1.97 |12.167    1.72 | 18.17    .78
      .250     .54 | 6.250    2.16 |12.250    1.66 | 18.25    .77
      .333     .54 | 6.333    2.16 |12.333    1.66 | 18.33    .77
      .417     .55 | 6.417    2.38 |12.417    1.60 | 18.42    .75
      .500     .55 | 6.500    2.38 |12.500    1.60 | 18.50    .75
      .583     .57 | 6.583    2.67 |12.583    1.55 | 18.58    .74
      .667     .57 | 6.667    2.67 |12.667    1.55 | 18.67    .74
      .750     .58 | 6.750    3.04 |12.750    1.50 | 18.75    .73
      .833     .58 | 6.833    3.04 |12.833    1.50 | 18.83    .73
      .917     .59 | 6.917    3.54 |12.917    1.46 | 18.92    .72
     1.000     .59 | 7.000    3.54 |13.000    1.46 | 19.00    .72
     1.083     .60 | 7.083    4.27 |13.083    1.42 | 19.08    .72
     1.167     .60 | 7.167    4.27 |13.167    1.41 | 19.17    .72
     1.250     .62 | 7.250    5.39 |13.250    1.38 | 19.25    .71
     1.333     .62 | 7.333    5.39 |13.333    1.38 | 19.33    .71
     1.417     .63 | 7.417    7.40 |13.417    1.34 | 19.42    .70
     1.500     .63 | 7.500    7.40 |13.500    1.34 | 19.50    .70
     1.583     .64 | 7.583   11.98 |13.583    1.30 | 19.58    .69
     1.667     .64 | 7.667   11.98 |13.667    1.30 | 19.67    .69
     1.750     .66 | 7.750   32.72 |13.750    1.27 | 19.75    .68
     1.833     .66 | 7.833   32.73 |13.833    1.27 | 19.83    .68
     1.917     .67 | 7.917  162.17 |13.917    1.24 | 19.92    .67
     2.000     .67 | 8.000  162.16 |14.000    1.24 | 20.00    .67
     2.083     .69 | 8.083   44.24 |14.083    1.21 | 20.08    .66
     2.167     .69 | 8.167   44.23 |14.167    1.21 | 20.17    .66
     2.250     .71 | 8.250   21.25 |14.250    1.18 | 20.25    .66
     2.333     .71 | 8.333   21.25 |14.333    1.18 | 20.33    .66
     2.417     .73 | 8.417   13.79 |14.417    1.15 | 20.42    .65
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     2.500     .73 | 8.500   13.79 |14.500    1.15 | 20.50    .65
     2.583     .75 | 8.583   10.19 |14.583    1.13 | 20.58    .64
     2.667     .75 | 8.667   10.19 |14.667    1.13 | 20.67    .64
     2.750     .77 | 8.750    8.09 |14.750    1.10 | 20.75    .63
     2.833     .77 | 8.833    8.09 |14.833    1.10 | 20.83    .63
     2.917     .79 | 8.917    6.72 |14.917    1.08 | 20.92    .63
     3.000     .79 | 9.000    6.72 |15.000    1.08 | 21.00    .63
     3.083     .82 | 9.083    5.76 |15.083    1.06 | 21.08    .62
     3.167     .82 | 9.167    5.76 |15.167    1.06 | 21.17    .62
     3.250     .84 | 9.250    5.04 |15.250    1.04 | 21.25    .61
     3.333     .84 | 9.333    5.04 |15.333    1.04 | 21.33    .61
     3.417     .87 | 9.417    4.49 |15.417    1.01 | 21.42    .61
     3.500     .87 | 9.500    4.49 |15.500    1.01 | 21.50    .61
     3.583     .90 | 9.583    4.05 |15.583    1.00 | 21.58    .60
     3.667     .90 | 9.667    4.05 |15.667    1.00 | 21.67    .60
     3.750     .93 | 9.750    3.70 |15.750     .98 | 21.75    .59
     3.833     .93 | 9.833    3.70 |15.833     .98 | 21.83    .59
     3.917     .97 | 9.917    3.40 |15.917     .96 | 21.92    .59
     4.000     .97 |10.000    3.40 |16.000     .96 | 22.00    .59
     4.083    1.00 |10.083    3.15 |16.083     .94 | 22.08    .58
     4.167    1.00 |10.167    3.15 |16.167     .94 | 22.17    .58
     4.250    1.04 |10.250    2.94 |16.250     .92 | 22.25    .58
     4.333    1.04 |10.333    2.94 |16.333     .92 | 22.33    .58
     4.417    1.09 |10.417    2.75 |16.417     .91 | 22.42    .57
     4.500    1.09 |10.500    2.75 |16.500     .91 | 22.50    .57
     4.583    1.14 |10.583    2.59 |16.583     .89 | 22.58    .56
     4.667    1.14 |10.667    2.59 |16.667     .89 | 22.67    .56
     4.750    1.19 |10.750    2.45 |16.750     .88 | 22.75    .56
     4.833    1.19 |10.833    2.45 |16.833     .88 | 22.83    .56
     4.917    1.25 |10.917    2.32 |16.917     .86 | 22.92    .55
     5.000    1.25 |11.000    2.32 |17.000     .86 | 23.00    .55
     5.083    1.32 |11.083    2.21 |17.083     .85 | 23.08    .55
     5.167    1.32 |11.167    2.21 |17.167     .85 | 23.17    .55
     5.250    1.39 |11.250    2.11 |17.250     .84 | 23.25    .54
     5.333    1.39 |11.333    2.11 |17.333     .84 | 23.33    .54
     5.417    1.48 |11.417    2.02 |17.417     .82 | 23.42    .54
     5.500    1.48 |11.500    2.02 |17.500     .82 | 23.50    .54
     5.583    1.57 |11.583    1.93 |17.583     .81 | 23.58    .53
     5.667    1.57 |11.667    1.93 |17.667     .81 | 23.67    .53
     5.750    1.69 |11.750    1.85 |17.750     .80 | 23.75    .53
     5.833    1.69 |11.833    1.85 |17.833     .80 | 23.83    .53
     5.917    1.82 |11.917    1.78 |17.917     .79 | 23.92    .52
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       6.000    1.82 |12.000    1.78 |18.000     .79 | 24.00     .52

 Max.Eff.Inten.(mm/hr)=     162.17        142.89
          over (min)          5.00         20.00
 Storage Coeff.  (min)=       5.85 (ii)   18.06 (ii)
 Unit Hyd. Tpeak (min)=       5.00         20.00
 Unit Hyd. peak  (cms)=        .20           .06
                                        *TOTALS*
 PEAK FLOW       (cms)=       6.93         3.45        8.394 (iii)
 TIME TO PEAK    (hrs)=        .00         8.25         8.00
 RUNOFF VOLUME    (mm)=      80.47        53.58        64.33
 TOTAL RAINFALL   (mm)=      82.47        82.47        82.47
 RUNOFF COEFFICIENT   =        .98          .65          .78

  (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
       CN* =  80.0    Ia = Dep. Storage  (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
       THAN THE STORAGE COEFFICIENT.
 (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR (0002) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   | OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |  (cms)     (ha.m.)
                          .0000      .0000    |  .5190     1.9200
                          .0280      .6100    |  .5880     2.1500
                          .2070      .9800    |  .6570     2.4000
                          .3110     1.3300    | 1.6600     6.0500
                          .3800     1.6000    |  .0000      .0000

                            AREA     QPEAK     TPEAK       R.V.
                            (ha)     (cms)     (hrs)       (mm)
 INFLOW : ID= 2 (0001)     45.15      8.39      8.00      64.33
 OUTFLOW: ID= 1 (0002)     45.15       .51      9.83      62.80

           PEAK  FLOW   REDUCTION [Qout/Qin](%)=  6.12
           TIME SHIFT OF PEAK FLOW        (min)=110.00
           MAXIMUM  STORAGE   USED       (ha.m.)=  1.9090
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 ****************************
 ** SIMULATION NUMBER:   5 **
 ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1400.000
| Ptotal= 70.24 mm |                          B=   5.800
--------------------                        C=    .848
                used in:   INTENSITY =  A / (t + B)^C

                Duration of storm   = 24.00 hrs
                Storm time step     = 10.00 min
                Time to peak ratio =   .33

          TIME    RAIN | TIME    RAIN | TIME    RAIN | TIME    RAIN
           hrs   mm/hr |  hrs   mm/hr |  hrs   mm/hr |  hrs   mm/hr
           .17     .46 |  6.17   1.71 | 12.17   1.49 | 18.17    .67
           .33     .47 |  6.33   1.87 | 12.33   1.44 | 18.33    .66
           .50     .48 |  6.50   2.06 | 12.50   1.39 | 18.50    .66
           .67     .49 |  6.67   2.31 | 12.67   1.34 | 18.67    .65
           .83     .50 |  6.83   2.63 | 12.83   1.30 | 18.83    .64
          1.00     .51 |  7.00   3.06 | 13.00   1.26 | 19.00    .63
          1.17     .52 |  7.17   3.68 | 13.17   1.23 | 19.17    .62
          1.33     .53 |  7.33   4.65 | 13.33   1.19 | 19.33    .61
          1.50     .55 |  7.50   6.38 | 13.50   1.16 | 19.50    .61
          1.67     .56 |  7.67  10.31 | 13.67   1.13 | 19.67    .60
          1.83     .57 |  7.83  27.94 | 13.83   1.10 | 19.83    .59
          2.00     .59 |  8.00 134.79 | 14.00   1.07 | 20.00    .58
          2.17     .60 |  8.17  37.70 | 14.17   1.05 | 20.17    .58
          2.33     .62 |  8.33  18.23 | 14.33   1.02 | 20.33    .57
          2.50     .63 |  8.50  11.86 | 14.50   1.00 | 20.50    .56
          2.67     .65 |  8.67   8.78 | 14.67    .98 | 20.67    .56
          2.83     .67 |  8.83   6.97 | 14.83    .96 | 20.83    .55
          3.00     .69 |  9.00   5.80 | 15.00    .94 | 21.00    .54
          3.17     .71 |  9.17   4.97 | 15.17    .92 | 21.17    .54
          3.33     .73 |  9.33   4.35 | 15.33    .90 | 21.33    .53
          3.50     .75 |  9.50   3.88 | 15.50    .88 | 21.50    .53
          3.67     .78 |  9.67   3.50 | 15.67    .86 | 21.67    .52
          3.83     .81 |  9.83   3.19 | 15.83    .85 | 21.83    .52
          4.00     .84 | 10.00   2.94 | 16.00    .83 | 22.00    .51
          4.17     .87 | 10.17   2.72 | 16.17    .82 | 22.17    .50
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  4.33    .91 | 10.33   2.54 | 16.33    .80 | 22.33    .50
  4.50    .94 | 10.50   2.38 | 16.50    .79 | 22.50    .49
  4.67    .99 | 10.67   2.24 | 16.67    .77 | 22.67    .49
  4.83   1.03 | 10.83   2.12 | 16.83    .76 | 22.83    .49
  5.00   1.08 | 11.00   2.01 | 17.00    .75 | 23.00    .48
  5.17   1.14 | 11.17   1.91 | 17.17    .74 | 23.17    .48
  5.33   1.21 | 11.33   1.82 | 17.33    .73 | 23.33    .47
  5.50   1.28 | 11.50   1.74 | 17.50    .71 | 23.50    .47
  5.67   1.36 | 11.67   1.67 | 17.67    .70 | 23.67    .46
  5.83   1.46 | 11.83   1.60 | 17.83    .69 | 23.83    .46
  6.00   1.57 | 12.00   1.54 | 18.00    .68 | 24.00    .45

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| CALIB            |
| STANDHYD  (0001) |   Area    (ha)=  45.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  40.00
-------------------
                         IMPERVIOUS   PERVIOUS (i)
    Surface Area     (ha)=    29.35        15.80
    Dep. Storage     (mm)=     2.00         6.35
    Average Slope     (%)=     1.00          .20
    Length            (m)=   548.60        40.00
    Mannings n          =      .013         .250

     NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                     ---- TRANSFORMED HYETOGRAPH ----
          TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
           hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
          .083     .46 | 6.083    1.71 |12.083    1.49 | 18.08     .67
          .167     .46 | 6.167    1.71 |12.167    1.49 | 18.17     .67
          .250     .47 | 6.250    1.87 |12.250    1.44 | 18.25     .66
          .333     .47 | 6.333    1.87 |12.333    1.44 | 18.33     .66
          .417     .48 | 6.417    2.06 |12.417    1.39 | 18.42     .66
          .500     .48 | 6.500    2.06 |12.500    1.39 | 18.50     .66
          .583     .49 | 6.583    2.31 |12.583    1.34 | 18.58     .65
          .667     .49 | 6.667    2.31 |12.667    1.34 | 18.67     .65
          .750     .50 | 6.750    2.63 |12.750    1.30 | 18.75     .64
          .833     .50 | 6.833    2.63 |12.833    1.30 | 18.83     .64
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          .917     .51 | 6.917    3.06 |12.917    1.26 | 18.92     .63
         1.000     .51 | 7.000    3.06 |13.000    1.26 | 19.00     .63
         1.083     .52 | 7.083    3.68 |13.083    1.23 | 19.08     .62
         1.167     .52 | 7.167    3.68 |13.167    1.23 | 19.17     .62
         1.250     .53 | 7.250    4.65 |13.250    1.19 | 19.25     .61
         1.333     .53 | 7.333    4.65 |13.333    1.19 | 19.33     .61
         1.417     .55 | 7.417    6.38 |13.417    1.16 | 19.42     .61
         1.500     .55 | 7.500    6.38 |13.500    1.16 | 19.50     .61
         1.583     .56 | 7.583   10.31 |13.583    1.13 | 19.58     .60
         1.667     .56 | 7.667   10.31 |13.667    1.13 | 19.67     .60
         1.750     .57 | 7.750   27.94 |13.750    1.10 | 19.75     .59
         1.833     .57 | 7.833   27.95 |13.833    1.10 | 19.83     .59
         1.917     .59 | 7.917  134.79 |13.917    1.07 | 19.92     .58
         2.000     .59 | 8.000  134.79 |14.000    1.07 | 20.00     .58
         2.083     .60 | 8.083   37.70 |14.083    1.05 | 20.08     .58
         2.167     .60 | 8.167   37.70 |14.167    1.05 | 20.17     .58
         2.250     .62 | 8.250   18.23 |14.250    1.02 | 20.25     .57
         2.333     .62 | 8.333   18.23 |14.333    1.02 | 20.33     .57
         2.417     .63 | 8.417   11.86 |14.417    1.00 | 20.42     .56
         2.500     .63 | 8.500   11.86 |14.500    1.00 | 20.50     .56
         2.583     .65 | 8.583    8.78 |14.583     .98 | 20.58     .56
         2.667     .65 | 8.667    8.78 |14.667     .98 | 20.67     .56
         2.750     .67 | 8.750    6.97 |14.750     .96 | 20.75     .55
         2.833     .67 | 8.833    6.97 |14.833     .96 | 20.83     .55
         2.917     .69 | 8.917    5.80 |14.917     .94 | 20.92     .54
         3.000     .69 | 9.000    5.80 |15.000     .94 | 21.00     .54
         3.083     .71 | 9.083    4.97 |15.083     .92 | 21.08     .54
         3.167     .71 | 9.167    4.97 |15.167     .92 | 21.17     .54
         3.250     .73 | 9.250    4.35 |15.250     .90 | 21.25     .53
         3.333     .73 | 9.333    4.35 |15.333     .90 | 21.33     .53
         3.417     .75 | 9.417    3.88 |15.417     .88 | 21.42     .53
         3.500     .75 | 9.500    3.88 |15.500     .88 | 21.50     .53
         3.583     .78 | 9.583    3.50 |15.583     .86 | 21.58     .52
         3.667     .78 | 9.667    3.50 |15.667     .86 | 21.67     .52
         3.750     .81 | 9.750    3.19 |15.750     .85 | 21.75     .52
         3.833     .81 | 9.833    3.19 |15.833     .85 | 21.83     .52
         3.917     .84 | 9.917    2.94 |15.917     .83 | 21.92     .51
         4.000     .84 |10.000    2.94 |16.000     .83 | 22.00     .51
         4.083     .87 |10.083    2.72 |16.083     .82 | 22.08     .50
         4.167     .87 |10.167    2.72 |16.167     .82 | 22.17     .50
         4.250     .91 |10.250    2.54 |16.250     .80 | 22.25     .50
         4.333     .91 |10.333    2.54 |16.333     .80 | 22.33     .50
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     4.417     .94 |10.417   2.38 |16.417    .79 | 22.42    .49
     4.500     .94 |10.500   2.38 |16.500    .79 | 22.50    .49
     4.583     .99 |10.583   2.24 |16.583    .77 | 22.58    .49
     4.667     .99 |10.667   2.24 |16.667    .77 | 22.67    .49
     4.750    1.03 |10.750   2.12 |16.750    .76 | 22.75    .49
     4.833    1.03 |10.833   2.12 |16.833    .76 | 22.83    .49
     4.917    1.08 |10.917   2.01 |16.917    .75 | 22.92    .48
     5.000    1.08 |11.000   2.01 |17.000    .75 | 23.00    .48
     5.083    1.14 |11.083   1.91 |17.083    .74 | 23.08    .48
     5.167    1.14 |11.167   1.91 |17.167    .74 | 23.17    .48
     5.250    1.21 |11.250   1.82 |17.250    .73 | 23.25    .47
     5.333    1.21 |11.333   1.82 |17.333    .73 | 23.33    .47
     5.417    1.28 |11.417   1.74 |17.417    .71 | 23.42    .47
     5.500    1.28 |11.500   1.74 |17.500    .71 | 23.50    .47
     5.583    1.36 |11.583   1.67 |17.583    .70 | 23.58    .46
     5.667    1.36 |11.667   1.67 |17.667    .70 | 23.67    .46
     5.750    1.46 |11.750   1.60 |17.750    .69 | 23.75    .46
     5.833    1.46 |11.833   1.60 |17.833    .69 | 23.83    .46
     5.917    1.57 |11.917   1.54 |17.917    .68 | 23.92    .45
     6.000    1.57 |12.000   1.54 |18.000    .68 | 24.00    .45

Max.Eff.Inten.(mm/hr)=    134.79      110.13
         over (min)        5.00        20.00
Storage Coeff.  (min)=     6.30 (ii)   19.84 (ii)
Unit Hyd. Tpeak (min)=     5.00        20.00
Unit Hyd. peak  (cms)=      .19          .06
                                     *TOTALS*
PEAK FLOW       (cms)=     5.63        2.53        6.677 (iii)
TIME TO PEAK    (hrs)=      .00        8.25        8.00
RUNOFF VOLUME    (mm)=    68.24       42.74       52.94
TOTAL RAINFALL   (mm)=    70.24       70.24       70.24
RUNOFF COEFFICIENT   =      .97         .61         .75

  (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
      CN* =  80.0    Ia = Dep. Storage  (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
      THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| RESERVOIR (0002) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |    OUTFLOW    STORAGE  |  OUTFLOW    STORAGE
--------------------     (cms)     (ha.m.)  |   (cms)     (ha.m.)
                         .0000      .0000   |    .5190     1.9200
                         .0280      .6100   |    .5880     2.1500
                         .2070      .9800   |    .6570     2.4000
                         .3110     1.3300   |   1.6600     6.0500
                         .3800     1.6000   |    .0000      .0000

                           AREA    QPEAK    TPEAK      R.V.
                           (ha)    (cms)    (hrs)      (mm)
   INFLOW : ID= 2 (0001)   45.15    6.68     8.00     52.94
   OUTFLOW: ID= 1 (0002)   45.15     .37    10.08     51.45

             PEAK  FLOW   REDUCTION [Qout/Qin](%)=  5.60
             TIME SHIFT OF PEAK FLOW        (min)=125.00
             MAXIMUM  STORAGE  USED        (ha.m.)=  1.5767

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 ****************************
 ** SIMULATION NUMBER:   6 **
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--------------------
| CHICAGO STORM     |   IDF curve parameters: A=1170.000
| Ptotal= 60.87 mm  |                         B=   5.800
--------------------                          C=    .843
                     used in:   INTENSITY =  A / (t + B)^C

                     Duration of storm   = 24.00 hrs
                     Storm time step     = 10.00 min
                     Time to peak ratio  =   .33

            TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
             hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
             .17     .42 |  6.17    1.51 | 12.17    1.32 | 18.17     .60
             .33     .42 |  6.33    1.65 | 12.33    1.27 | 18.33     .59
             .50     .43 |  6.50    1.82 | 12.50    1.23 | 18.50     .58
             .67     .44 |  6.67    2.04 | 12.67    1.19 | 18.67     .58
             .83     .45 |  6.83    2.32 | 12.83    1.16 | 18.83     .57
            1.00     .46 |  7.00    2.70 | 13.00    1.12 | 19.00     .56
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  2.833     .60 | 8.833   6.09 |14.833    .85 | 20.83   .49
  2.917     .61 | 8.917   5.07 |14.917    .83 | 20.92   .49
  3.000     .61 | 9.000   5.07 |15.000    .83 | 21.00   .49
  3.083     .63 | 9.083   4.35 |15.083    .82 | 21.08   .48
  3.167     .63 | 9.167   4.35 |15.167    .82 | 21.17   .48
  3.250     .65 | 9.250   3.82 |15.250    .80 | 21.25   .48
  3.333     .65 | 9.333   3.82 |15.333    .80 | 21.33   .48
  3.417     .67 | 9.417   3.41 |15.417    .78 | 21.42   .47
  3.500     .67 | 9.500   3.41 |15.500    .78 | 21.50   .47
  3.583     .70 | 9.583   3.08 |15.583    .77 | 21.58   .47
  3.667     .70 | 9.667   3.08 |15.667    .77 | 21.67   .47
  3.750     .72 | 9.750   2.81 |15.750    .75 | 21.75   .46
  3.833     .72 | 9.833   2.81 |15.833    .75 | 21.83   .46
  3.917     .75 | 9.917   2.59 |15.917    .74 | 21.92   .46
  4.000     .75 |10.000   2.59 |16.000    .74 | 22.00   .46
  4.083     .78 |10.083   2.40 |16.083    .73 | 22.08   .45
  4.167     .78 |10.167   2.40 |16.167    .73 | 22.17   .45
  4.250     .81 |10.250   2.24 |16.250    .71 | 22.25   .45
  4.333     .81 |10.333   2.24 |16.333    .71 | 22.33   .45
  4.417     .84 |10.417   2.10 |16.417    .70 | 22.42   .44
  4.500     .84 |10.500   2.10 |16.500    .70 | 22.50   .44
  4.583     .88 |10.583   1.98 |16.583    .69 | 22.58   .44
  4.667     .88 |10.667   1.98 |16.667    .69 | 22.67   .44
  4.750     .92 |10.750   1.87 |16.750    .68 | 22.75   .43
  4.833     .92 |10.833   1.87 |16.833    .68 | 22.83   .43
  4.917     .96 |10.917   1.78 |16.917    .67 | 22.92   .43
  5.000     .96 |11.000   1.78 |17.000    .67 | 23.00   .43
  5.083    1.01 |11.083   1.69 |17.083    .66 | 23.08   .43
  5.167    1.01 |11.167   1.69 |17.167    .66 | 23.17   .43
  5.250    1.07 |11.250   1.61 |17.250    .65 | 23.25   .42
  5.333    1.07 |11.333   1.61 |17.333    .65 | 23.33   .42
  5.417    1.14 |11.417   1.54 |17.417    .64 | 23.42   .42
  5.500    1.14 |11.500   1.54 |17.500    .64 | 23.50   .42
  5.583    1.21 |11.583   1.48 |17.583    .63 | 23.58   .41
  5.667    1.21 |11.667   1.48 |17.667    .63 | 23.67   .41
  5.750    1.29 |11.750   1.42 |17.750    .62 | 23.75   .41
  5.833    1.29 |11.833   1.42 |17.833    .62 | 23.83   .41
  5.917    1.39 |11.917   1.37 |17.917    .61 | 23.92   .41
  6.000    1.39 |12.000   1.37 |18.000    .61 | 24.00   .41

Max.Eff.Inten.(mm/hr)=    114.21       86.21
       over (min)          5.00        25.00
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    Storage Coeff.  (min)=      6.73 (ii)  21.67 (ii)
    Unit Hyd. Tpeak (min)=      5.00       25.00
    Unit Hyd. peak  (cms)=       .18         .05
                                          *TOTALS*
    PEAK FLOW      (cms)=       4.67       1.84        5.254 (iii)
    TIME TO PEAK   (hrs)=        .00       8.33        8.00
    RUNOFF VOLUME   (mm)=      58.87      34.69       44.36
    TOTAL RAINFALL  (mm)=      60.87      60.87       60.87
    RUNOFF COEFFICIENT  =        .97        .57         .73

     (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
         CN* =  80.0   Ia = Dep. Storage  (Above)
    (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
         THAN THE STORAGE COEFFICIENT.
   (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR (0002) |
| IN= 2---> OUT= 1 |
| DT= 5.0 min     |   OUTFLOW    STORAGE  | OUTFLOW    STORAGE
--------------------    (cms)     (ha.m.)  |  (cms)     (ha.m.)
                        .0000      .0000   |  .5190     1.9200
                        .0280      .6100   |  .5880     2.1500
                        .2070      .9800   |  .6570     2.4000
                        .3110     1.3300   | 1.6600     6.0500
                        .3800     1.6000   |  .0000      .0000

                          AREA     QPEAK     TPEAK      R.V.
                          (ha)     (cms)     (hrs)      (mm)
    INFLOW : ID= 2 (0001)  45.15     5.25      8.00     44.36
    OUTFLOW: ID= 1 (0002)  45.15      .31     10.25     42.91

           PEAK  FLOW   REDUCTION [Qout/Qin](%)=  5.83
           TIME SHIFT OF PEAK FLOW        (min)=135.00
           MAXIMUM  STORAGE   USED       (ha.m.)=  1.3137

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 ****************************
 ** SIMULATION NUMBER:   7 **
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--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 725.000
| Ptotal= 48.69 mm |                          B=   4.800
--------------------                         C=    .808
            used in:   INTENSITY =  A / (t + B)^C

            Duration of storm  = 24.00 hrs
            Storm time step    = 10.00 min
            Time to peak ratio =   .33

     TIME    RAIN | TIME    RAIN | TIME    RAIN | TIME    RAIN
      hrs   mm/hr |  hrs   mm/hr |  hrs   mm/hr |  hrs   mm/hr
      .17     .40 |  6.17   1.36 | 12.17   1.20 | 18.17    .57
      .33     .41 |  6.33   1.48 | 12.33   1.16 | 18.33    .56
      .50     .42 |  6.50   1.62 | 12.50   1.13 | 18.50    .56
      .67     .43 |  6.67   1.80 | 12.67   1.09 | 18.67    .55
      .83     .43 |  6.83   2.03 | 12.83   1.06 | 18.83    .54
     1.00     .44 |  7.00   2.34 | 13.00   1.03 | 19.00    .54
     1.17     .45 |  7.17   2.77 | 13.17   1.00 | 19.17    .53
     1.33     .46 |  7.33   3.42 | 13.33    .98 | 19.33    .52
     1.50     .47 |  7.50   4.54 | 13.50    .95 | 19.50    .52
     1.67     .48 |  7.67   7.00 | 13.67    .93 | 19.67    .51
     1.83     .49 |  7.83  17.37 | 13.83    .91 | 19.83    .51
     2.00     .50 |  8.00  82.18 | 14.00    .89 | 20.00    .50
     2.17     .51 |  8.17  23.02 | 14.17    .87 | 20.17    .49
     2.33     .53 |  8.33  11.75 | 14.33    .85 | 20.33    .49
     2.50     .54 |  8.50   7.96 | 14.50    .83 | 20.50    .48
     2.67     .55 |  8.67   6.07 | 14.67    .81 | 20.67    .48
     2.83     .57 |  8.83   4.93 | 14.83    .79 | 20.83    .47
     3.00     .58 |  9.00   4.17 | 15.00    .78 | 21.00    .47
     3.17     .60 |  9.17   3.63 | 15.17    .76 | 21.17    .46
     3.33     .62 |  9.33   3.22 | 15.33    .75 | 21.33    .46
     3.50     .64 |  9.50   2.90 | 15.50    .74 | 21.50    .45
     3.67     .66 |  9.67   2.64 | 15.67    .72 | 21.67    .45
     3.83     .68 |  9.83   2.43 | 15.83    .71 | 21.83    .44
     4.00     .70 | 10.00   2.25 | 16.00    .70 | 22.00    .44
     4.17     .73 | 10.17   2.10 | 16.17    .69 | 22.17    .44
     4.33     .76 | 10.33   1.97 | 16.33    .67 | 22.33    .43
     4.50     .79 | 10.50   1.86 | 16.50    .66 | 22.50    .43
     4.67     .82 | 10.67   1.76 | 16.67    .65 | 22.67    .42
     4.83     .85 | 10.83   1.67 | 16.83    .64 | 22.83    .42
```

```
     5.00     .89 | 11.00   1.59 | 17.00    .63 | 23.00    .42
     5.17     .94 | 11.17   1.52 | 17.17    .62 | 23.17    .41
     5.33     .99 | 11.33   1.45 | 17.33    .61 | 23.33    .41
     5.50    1.04 | 11.50   1.39 | 17.50    .61 | 23.50    .40
     5.67    1.11 | 11.67   1.34 | 17.67    .60 | 23.67    .40
     5.83    1.18 | 11.83   1.29 | 17.83    .59 | 23.83    .40
     6.00    1.26 | 12.00   1.24 | 18.00    .58 | 24.00    .39

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--------------------
| CALIB             |
| STANDHYD (0001) |   Area    (ha)=  45.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  40.00
--------------------
                      IMPERVIOUS    PERVIOUS (i)
    Surface Area    (ha)=     29.35       15.80
    Dep. Storage    (mm)=      2.00        6.35
    Average Slope    (%)=      1.00         .20
    Length           (m)=    548.60       40.00
    Mannings n         =       .013        .250

      NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                       ---- TRANSFORMED HYETOGRAPH ----
       TIME    RAIN | TIME    RAIN | TIME    RAIN | TIME    RAIN
        hrs   mm/hr |  hrs   mm/hr |  hrs   mm/hr |  hrs   mm/hr
       .083     .40 | 6.083   1.36 |12.083   1.20 | 18.08    .57
       .167     .40 | 6.167   1.36 |12.167   1.20 | 18.17    .57
       .250     .41 | 6.250   1.48 |12.250   1.16 | 18.25    .56
       .333     .41 | 6.333   1.48 |12.333   1.16 | 18.33    .56
       .417     .42 | 6.417   1.62 |12.417   1.13 | 18.42    .56
       .500     .42 | 6.500   1.62 |12.500   1.13 | 18.50    .56
       .583     .43 | 6.583   1.80 |12.583   1.09 | 18.58    .55
       .667     .43 | 6.667   1.80 |12.667   1.09 | 18.67    .55
       .750     .43 | 6.750   2.03 |12.750   1.06 | 18.75    .54
       .833     .43 | 6.833   2.03 |12.833   1.06 | 18.83    .54
       .917     .44 | 6.917   2.34 |12.917   1.03 | 18.92    .54
      1.000     .44 | 7.000   2.34 |13.000   1.03 | 19.00    .54
      1.083     .45 | 7.083   2.77 |13.083   1.00 | 19.08    .53
      1.167     .45 | 7.167   2.77 |13.167   1.00 | 19.17    .53
```

```
 1.250    .46 | 7.250   3.42 |13.250    .98 | 19.25    .52
 1.333    .46 | 7.333   3.42 |13.333    .98 | 19.33    .52
 1.417    .47 | 7.417   4.54 |13.417    .95 | 19.42    .52
 1.500    .47 | 7.500   4.54 |13.500    .95 | 19.50    .52
 1.583    .48 | 7.583   7.00 |13.583    .93 | 19.58    .51
 1.667    .48 | 7.667   7.00 |13.667    .93 | 19.67    .51
 1.750    .49 | 7.750  17.37 |13.750    .91 | 19.75    .51
 1.833    .49 | 7.833  17.38 |13.833    .91 | 19.83    .51
 1.917    .50 | 7.917  82.18 |13.917    .89 | 19.92    .50
 2.000    .50 | 8.000  82.18 |14.000    .89 | 20.00    .50
 2.083    .51 | 8.083  23.02 |14.083    .87 | 20.08    .49
 2.167    .51 | 8.167  23.02 |14.167    .87 | 20.17    .49
 2.250    .53 | 8.250  11.75 |14.250    .85 | 20.25    .49
 2.333    .53 | 8.333  11.75 |14.333    .85 | 20.33    .49
 2.417    .54 | 8.417   7.96 |14.417    .83 | 20.42    .48
 2.500    .54 | 8.500   7.96 |14.500    .83 | 20.50    .48
 2.583    .55 | 8.583   6.07 |14.583    .81 | 20.58    .48
 2.667    .55 | 8.667   6.07 |14.667    .81 | 20.67    .48
 2.750    .57 | 8.750   4.93 |14.750    .79 | 20.75    .47
 2.833    .57 | 8.833   4.93 |14.833    .79 | 20.83    .47
 2.917    .58 | 8.917   4.17 |14.917    .78 | 20.92    .47
 3.000    .58 | 9.000   4.17 |15.000    .78 | 21.00    .47
 3.083    .60 | 9.083   3.63 |15.083    .76 | 21.08    .46
 3.167    .60 | 9.167   3.63 |15.167    .76 | 21.17    .46
 3.250    .62 | 9.250   3.22 |15.250    .75 | 21.25    .46
 3.333    .62 | 9.333   3.22 |15.333    .75 | 21.33    .46
 3.417    .64 | 9.417   2.90 |15.417    .74 | 21.42    .45
 3.500    .64 | 9.500   2.90 |15.500    .74 | 21.50    .45
 3.583    .66 | 9.583   2.64 |15.583    .72 | 21.58    .45
 3.667    .66 | 9.667   2.64 |15.667    .72 | 21.67    .45
 3.750    .68 | 9.750   2.43 |15.750    .71 | 21.75    .44
 3.833    .68 | 9.833   2.43 |15.833    .71 | 21.83    .44
 3.917    .70 | 9.917   2.25 |15.917    .70 | 21.92    .44
 4.000    .70 |10.000   2.25 |16.000    .70 | 22.00    .44
 4.083    .73 |10.083   2.10 |16.083    .69 | 22.08    .44
 4.167    .73 |10.167   2.10 |16.167    .69 | 22.17    .44
 4.250    .76 |10.250   1.97 |16.250    .67 | 22.25    .43
 4.333    .76 |10.333   1.97 |16.333    .67 | 22.33    .43
 4.417    .79 |10.417   1.86 |16.417    .66 | 22.42    .43
 4.500    .79 |10.500   1.86 |16.500    .66 | 22.50    .43
 4.583    .82 |10.583   1.76 |16.583    .65 | 22.58    .42
 4.667    .82 |10.667   1.76 |16.667    .65 | 22.67    .42
```

```
 4.750    .85 |10.750   1.67 |16.750    .64 | 22.75    .42
 4.833    .85 |10.833   1.67 |16.833    .64 | 22.83    .42
 4.917    .89 |10.917   1.59 |16.917    .63 | 22.92    .42
 5.000    .89 |11.000   1.59 |17.000    .63 | 23.00    .42
 5.083    .94 |11.083   1.52 |17.083    .62 | 23.08    .41
 5.167    .94 |11.167   1.52 |17.167    .62 | 23.17    .41
 5.250    .99 |11.250   1.45 |17.250    .61 | 23.25    .41
 5.333    .99 |11.333   1.45 |17.333    .61 | 23.33    .41
 5.417   1.04 |11.417   1.39 |17.417    .61 | 23.42    .40
 5.500   1.04 |11.500   1.39 |17.500    .61 | 23.50    .40
 5.583   1.11 |11.583   1.34 |17.583    .60 | 23.58    .40
 5.667   1.11 |11.667   1.34 |17.667    .60 | 23.67    .40
 5.750   1.18 |11.750   1.29 |17.750    .59 | 23.75    .40
 5.833   1.18 |11.833   1.29 |17.833    .59 | 23.83    .40
 5.917   1.26 |11.917   1.24 |17.917    .58 | 23.92    .39
 6.000   1.26 |12.000   1.24 |18.000    .58 | 24.00    .39

     Max.Eff.Inten.(mm/hr)=     82.18        46.12
                over (min)        10.00        30.00
     Storage Coeff.  (min)=       7.67 (ii)   26.86 (ii)
     Unit Hyd. Tpeak (min)=      10.00        30.00
     Unit Hyd. peak  (cms)=        .13          .04
                                                      *TOTALS*
     PEAK FLOW       (cms)=       2.80          .99         3.213 (iii)
     TIME TO PEAK    (hrs)=        .00         8.42          8.08
     RUNOFF VOLUME    (mm)=      46.69        24.67         33.48
     TOTAL RAINFALL   (mm)=      48.69        48.69         48.69
     RUNOFF COEFFICIENT   =        .96          .51           .69

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN* =  80.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
--------------------
| RESERVOIR (0002) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |   OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------    (cms)     (ha.m.)   |   (cms)     (ha.m.)
```

```
         .0000      .0000  |  .5190    1.9200
         .0280      .6100  |  .5880    2.1500
         .2070      .9800  |  .6570    2.4000
         .3110     1.3300  | 1.6600    6.0500
         .3800     1.6000  |  .0000     .0000

                     AREA    QPEAK    TPEAK     R.V.
                     (ha)    (cms)    (hrs)     (mm)
INFLOW : ID= 2 (0001)    45.15     3.21     8.08    33.48
OUTFLOW: ID= 1 (0002)    45.15      .20    10.92    32.06

         PEAK  FLOW  REDUCTION [Qout/Qin](%)= 6.28
         TIME SHIFT OF PEAK FLOW        (min)=170.00
         MAXIMUM  STORAGE  USED       (ha.m.)= .9690

--------------------------------------------------------------------------------
 ****************************
 ** SIMULATION NUMBER:  8 **
 ****************************


 --------------------
 |  READ STORM    |   Filename: P:\Design Tools\SWM\Hydrologic Design - VO2\
 |                |             Storm Files\25MM4HRC_10min Edited 2012.stm
 | Ptotal= 25.00 mm |   Comments: 25 mm, 4 hr. chicago dist'n. - water qua
 --------------------
           TIME   RAIN |  TIME   RAIN |  TIME   RAIN |  TIME   RAIN
            hrs  mm/hr |   hrs  mm/hr |   hrs  mm/hr |   hrs  mm/hr
            .17   2.07 |  1.17   5.70 |  2.17   5.19 |  3.17   2.80
            .33   2.27 |  1.33  10.78 |  2.33   4.47 |  3.33   2.62
            .50   2.52 |  1.50  50.21 |  2.50   3.95 |  3.50   2.48
            .67   2.88 |  1.67  13.37 |  2.67   3.56 |  3.67   2.35
            .83   3.38 |  1.83   8.29 |  2.83   3.25 |  3.83   2.23
           1.00   4.18 |  2.00   6.30 |  3.00   3.01 |  4.00   2.14

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 --------------------
 | CALIB            |
 | STANDHYD  (0001) |   Area    (ha)=  45.15
 |ID= 1 DT= 5.0 min |   Total Imp(%)=  65.00   Dir. Conn.(%)=  40.00
 --------------------
```

```
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area    (ha)=      29.35        15.80
     Dep. Storage    (mm)=       2.00         6.35
     Average Slope    (%)=       1.00          .20
     Length           (m)=     548.60        40.00
     Mannings n          =       .013         .250

     NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                     ---- TRANSFORMED HYETOGRAPH ----
           TIME   RAIN |  TIME   RAIN |  TIME   RAIN |  TIME   RAIN
            hrs  mm/hr |   hrs  mm/hr |   hrs  mm/hr |   hrs  mm/hr
           .083   2.07 | 1.083   5.70 | 2.083   5.19 |  3.08   2.80
           .167   2.07 | 1.167   5.70 | 2.167   5.19 |  3.17   2.80
           .250   2.27 | 1.250  10.78 | 2.250   4.47 |  3.25   2.62
           .333   2.27 | 1.333  10.78 | 2.333   4.47 |  3.33   2.62
           .417   2.52 | 1.417  50.21 | 2.417   3.95 |  3.42   2.48
           .500   2.52 | 1.500  50.21 | 2.500   3.95 |  3.50   2.48
           .583   2.88 | 1.583  13.37 | 2.583   3.56 |  3.58   2.35
           .667   2.88 | 1.667  13.37 | 2.667   3.56 |  3.67   2.35
           .750   3.38 | 1.750   8.29 | 2.750   3.25 |  3.75   2.23
           .833   3.38 | 1.833   8.29 | 2.833   3.25 |  3.83   2.23
           .917   4.17 | 1.917   6.30 | 2.917   3.01 |  3.92   2.14
          1.000   4.18 | 2.000   6.29 | 3.000   3.01 |  4.00   2.14

     Max.Eff.Inten.(mm/hr)=      50.21        11.60
               over (min)        10.00        45.00
     Storage Coeff.  (min)=       9.34 (ii)   42.67 (ii)
     Unit Hyd. Tpeak (min)=      10.00        45.00
     Unit Hyd. peak  (cms)=        .12          .03
                                                      *TOTALS*
     PEAK FLOW       (cms)=       1.61          .25      1.656 (iii)
     TIME TO PEAK    (hrs)=        .00         2.33       1.58
     RUNOFF VOLUME    (mm)=      23.00         7.77      13.86
     TOTAL RAINFALL   (mm)=      25.00        25.00      25.00
     RUNOFF COEFFICIENT   =        .92          .31        .55

     (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN* =  80.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
```

```
      THAN THE STORAGE COEFFICIENT.
   (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (0002) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |    OUTFLOW    STORAGE  | OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)  |  (cms)     (ha.m.)
                          .0000      .0000   |  .5190     1.9200
                          .0280      .6100   |  .5880     2.1500
                          .2070      .9800   |  .6570     2.4000
                          .3110     1.3300   | 1.6600     6.0500
                          .3800     1.6000   |  .0000      .0000

                            AREA    QPEAK    TPEAK     R.V.
                            (ha)    (cms)    (hrs)     (mm)
   INFLOW : ID= 2 (0001)   45.15     1.66     1.58    13.86
   OUTFLOW: ID= 1 (0002)   45.15      .03     5.50    12.94

             PEAK  FLOW   REDUCTION [Qout/Qin](%)=  1.63
             TIME SHIFT OF PEAK FLOW        (min)=235.00
             MAXIMUM  STORAGE   USED       (ha.m.)=  .5883

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FINISH
=========================================================================
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```

APPENDIX D: Orifice Calculations

Orifice Calculations- Catchment 5

Preliminary Assumptions:

-Proposed storm sewer will outlet to the realigned channel east of Sixth Line

-Outlet from Sixth Line storm sewer will be at/ near the existing low point in Catchment 5

-Sixth Line Corp proposed elevation of realigned channel adjacent to Sixth Line low point = 168.50 m

-Control manhole top of grate elevation = 171.00 m

-Invert of orifice is at elevation 168.80 m

$$H = 2.15 \text{ m}$$

$$D = 0.096 \text{ m}$$

$$A = \frac{\pi * d^2}{4}$$

$$A = \frac{\pi * (0.096)^2}{4}$$

$$A = 0.0074 \text{m}^2$$

$$Q = C * A * \sqrt{2 * g * h}$$

$$Q = 0.61 * 0.0074 * \sqrt{2 * 9.81 * 2.15}$$

$$Q = 0.029 \frac{m^3}{s}$$

Diameter of Storm Sewer Required in Catchment 5

Preliminary Assumptions:

-From SWMHYMO model, 874 m^3 of storage is required

-Total length of storm sewer is approximately 480 m in length, based on the length of Catchment 5

$$A = \frac{V}{L}$$

$$A = \frac{874}{480}$$

$$A = 1.82 m^2$$

$$A = \frac{\pi * d^2}{4}$$

$$1.82 = \frac{\pi * d^2}{4}$$

$$d = 1.52 \, m$$

Therefore, the approximate diameter of storm sewer required in catchment 5 is 1650 mm

APPENDIX E: Storm Sewer Capacity Check

Town of Oakville
Storm Sewer Capacity Check
Existing Storm Sewer on Sixth Line North of Dundas Street

Rainfall Intensity:
IDF Parameters - Bloor Street - (5 years)
a=1170.0 b=5.8 c=0.843

Existing Storm Sewer

Drainage Area & Runoff Data										Outlet Pipe Data								
From	To	Area	Runoff Coefficient		Cummulative	Time of Concentration	Intensity	Flow	Flow Controlled	Total Flow	Type	Size	Length	Roughness Coefficient	Slope	Design Flow	Velocity	Time	% FULL
MH	MH	A	C	AC	AC	Tc	I	Q=CIA/360	Q	Q			L	n	S	Q	V	t	
		(Ha)				(min)	(mm/hr)	(l/s)	(l/s)	(l/s)		(mm)	(m)		(%)	(l/s)	(m/s)	(min)	(%)
CB1	CB2	0.06	0.90	0.05	0.05	10.0	114	73	0.0	73	CONC	450	49.4	0.013	0.40%	180	1.1	0.73	40%
CB2	NODE1	0.29	0.90	0.26	0.31	10.7	110	80		153	CONC	450	21.3	0.013	0.42%	185	1.2	0.31	83%
NODE1	DCB1	0.20	0.90	0.18	0.49	11.0	108	54		207	CONC	450	44.9	0.013	0.42%	185	1.2	0.64	112%
DCB1	OUTLET	0.33	0.90	0.30	0.79	11.0	108	89		242	CONC	700	18.0	0.013	0.40%	586	1.5	0.20	41%

*Slope of DCB1 to Outlet is not known and therefore estimated to be 0.4%, to be verified during detailed design

Proposed Storm Sewer

Drainage Area & Runoff Data											Outlet Pipe Data								
From	To	Area	Runoff Coefficient		Cummulative	Time of Concentration	Intensity	Flow	Flow Controlled	Total Flow	Type	Size	Length	Roughness Coefficient	Slope	Design Flow	Velocity	Time	% FULL
MH	MH	A	C	AC	AC	Tc	I	Q=CIA/360	Q	Q			L	n	S	Q	V	t	
		(Ha)				(min)	(mm/hr)	(l/s)	(l/s)	(l/s)		(mm)	(m)		(%)	(l/s)	(m/s)	(min)	(%)
CB1	CB2	0.06	0.90	0.05	0.05	10.0	114	73	0.0	73	CONC	450	49.4	0.013	0.40%	180	1.1	0.73	40%
CB2	NODE1	0.29	0.90	0.26	0.31	10.7	110	80		153	CONC	525	21.3	0.013	0.42%	279	1.3	0.28	55%
NODE1	DCB1	0.20	0.90	0.18	0.49	11.0	108	54		207	CONC	525	44.9	0.013	0.42%	279	1.3	0.58	74%
DCB1	OUTLET	0.33	0.90	0.30	0.79	11.0	108	89		242	CONC	700	18.0	0.013	0.40%	586	1.5	0.20	41%

*Slope of DCB1 to Outlet is not known and therefore estimated to be 0.4%, to be verified during detailed design

APPENDIX F: Existing Culvert Hydraulic Results (CulvertMaster)

Culvert Designer/Analyzer Report
Culvert 1

Peak Discharge Method: User-Specified

Design Discharge	0.3200	m³/s	Check Discharge	0.8100	m³/s

Grades Model: Inverts

Invert Upstream	169.60	m	Invert Downstream	169.06	m
Length	21.60	m	Slope	0.025000	m/m
Drop	0.54	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-800 mm Circular	0.3200 m³/s	178.63 m	4.39 m/s

Culvert Designer/Analyzer Report
Culvert 1

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	178.63	m	Discharge	0.3200	m³/s
Headwater Depth/Height	29.64		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	173.25	m	Control Type	Outlet Control	
Outlet Control HW Elev.	178.63	m			

Grades

Upstream Invert	169.60	m	Downstream Invert	169.06	m
Length	21.60	m	Constructed Slope	0.025000	m/m

Hydraulic Profile

Profile	CompositeM2PressureProfile		Depth, Downstream	0.30	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.30	m
Velocity Downstream	4.39	m/s	Critical Slope	0.325662	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.30	m
Section Size	800 mm		Rise	0.30	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	178.63	m	Upstream Velocity Head	0.98	m
Ke	0.90		Entrance Loss	0.88	m

Inlet Control Properties

Inlet Control HW Elev.	173.25	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.1	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 1

Peak Discharge Method: User-Specified

Design Discharge	0.3200 m³/s	Check Discharge	0.8100 m³/s

Grades Model: Inverts

Invert Upstream	169.60 m	Invert Downstream	169.06 m
Length	21.60 m	Slope	0.025000 m/m
Drop	0.54 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-800 mm Circular	0.8100 m³/s	228.76 m	11.10 m/s

Culvert Designer/Analyzer Report
Culvert 1

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	228.76	m	Discharge	0.8100	m³/s
Headwater Depth/Height	194.11		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	192.12	m	Control Type	Outlet Control	
Outlet Control HW Elev.	228.76	m			

Grades					
Upstream Invert	169.60	m	Downstream Invert	169.06	m
Length	21.60	m	Constructed Slope	0.025000	m/m

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	0.30	m
Slope Type	N/A		Normal Depth	N/A	m
Flow Regime	N/A		Critical Depth	0.30	m
Velocity Downstream	11.10	m/s	Critical Slope	2.197249	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.30	m
Section Size	800 mm		Rise	0.30	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	228.76	m	Upstream Velocity Head	6.28	m
Ke	0.90		Entrance Loss	5.65	m

Inlet Control Properties					
Inlet Control HW Elev.	192.12	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.1	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 2

Peak Discharge Method: User-Specified

Design Discharge	2.3000 m³/s	Check Discharge	5.8200 m³/s

Grades Model: Inverts

Invert Upstream	172.15 m	Invert Downstream	172.19 m
Length	14.40 m	Slope	-0.002778 m/m
Drop	-0.04 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2160 mm x 900 mm Box	2.3000 m³/s	173.04 m	2.19 m/s

Culvert Designer/Analyzer Report
Culvert 2

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	173.04	m	Discharge	2.3000	m³/s
Headwater Depth/Height	0.99		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	173.02	m	Control Type	Outlet Control	
Outlet Control HW Elev.	173.04	m			

Grades					
Upstream Invert	172.15	m	Downstream Invert	172.19	m
Length	14.40	m	Constructed Slope	-0.002778	m/m

Hydraulic Profile					
Profile	A2		Depth, Downstream	0.49	m
Slope Type	Adverse		Normal Depth	0.00	m
Flow Regime	Subcritical		Critical Depth	0.49	m
Velocity Downstream	2.19	m/s	Critical Slope	0.003460	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.16	m
Section Size	2160 mm x 900 mm		Rise	0.90	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	173.04	m	Upstream Velocity Head	0.13	m
Ke	0.70		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	173.02	m	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	1.9	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert 2

Peak Discharge Method: User-Specified

Design Discharge	2.3000	m^3/s	Check Discharge	5.8200	m^3/s

Grades Model: Inverts

Invert Upstream	172.15	m	Invert Downstream	172.19	m
Length	14.40	m	Slope	-0.002778	m/m
Drop	-0.04	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2160 mm x 900 mm Box	5.8200 m^3/s	174.17 m	2.99 m/s

Culvert Designer/Analyzer Report
Culvert 2

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	174.17	m	Discharge	5.8200	m³/s
Headwater Depth/Height	2.25		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	174.17	m	Control Type	Inlet Control	
Outlet Control HW Elev.	173.97	m			

Grades

Upstream Invert	172.15	m	Downstream Invert	172.19	m
Length	14.40	m	Constructed Slope	-0.002778	m/m

Hydraulic Profile

Profile	PressureProfile		Depth, Downstream	0.90	m
Slope Type	N/A		Normal Depth	N/A	m
Flow Regime	N/A		Critical Depth	0.90	m
Velocity Downstream	2.99	m/s	Critical Slope	0.006989	m/m

Section

Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.16	m
Section Size	2160 mm x 900 mm		Rise	0.90	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	173.97	m	Upstream Velocity Head	0.46	m
Ke	0.70		Entrance Loss	0.32	m

Inlet Control Properties

Inlet Control HW Elev.	174.17	m	Flow Control	Submerged	
Inlet Type	0° wingwall flares		Area Full	1.9	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert 3

Peak Discharge Method: User-Specified					
Design Discharge	0.9600	m³/s	Check Discharge	2.4200	m³/s

Grades Model: Inverts					
Invert Upstream	174.40	m	Invert Downstream	174.41	m
Length	17.90	m	Slope	-0.000555	m/m
Drop	-0.01	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	174.41	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.9600 m³/s	177.43 m	3.34 m/s

Culvert Designer/Analyzer Report
Culvert 3

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	177.43	m	Discharge	0.9600	m³/s
Headwater Depth/Height	4.97		Tailwater Elevation	174.41	m
Inlet Control HW Elev.	176.70	m	Control Type	Outlet Control	
Outlet Control HW Elev.	177.43	m			

Grades

Upstream Invert	174.40	m	Downstream Invert	174.41	m
Length	17.90	m	Constructed Slope	-0.000559	m/m

Hydraulic Profile

Profile	CompositeA2PressureProfile		Depth, Downstream	0.58	m
Slope Type	Adverse		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.58	m
Velocity Downstream	3.34	m/s	Critical Slope	0.066472	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	177.43	m	Upstream Velocity Head	0.55	m
Ke	0.90		Entrance Loss	0.50	m

Inlet Control Properties

Inlet Control HW Elev.	176.70	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 3

Peak Discharge Method: User-Specified

Design Discharge	0.9600	m³/s	Check Discharge	2.4200	m³/s

Grades Model: Inverts

Invert Upstream	174.40	m	Invert Downstream	174.41	m
Length	17.90	m	Slope	-0.000559	m/m
Drop	-0.01	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	174.41	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	2.4200 m³/s	190.39 m	8.29 m/s

Culvert Designer/Analyzer Report
Culvert 3

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	190.39	m	Discharge	2.4200	m³/s
Headwater Depth/Height	26.23		Tailwater Elevation	174.41	m
Inlet Control HW Elev.	187.21	m	Control Type	Outlet Control	
Outlet Control HW Elev.	190.39	m			

Grades

Upstream Invert	174.40	m	Downstream Invert	174.41	m
Length	17.90	m	Constructed Slope	-0.000559	m/m

Hydraulic Profile

Profile	CompositeA2PressureProfile		Depth, Downstream	0.61	m
Slope Type	Adverse		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.61	m
Velocity Downstream	8.29	m/s	Critical Slope	0.472510	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	190.39	m	Upstream Velocity Head	3.51	m
Ke	0.90		Entrance Loss	3.15	m

Inlet Control Properties

Inlet Control HW Elev.	187.21	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 4

Peak Discharge Method: User-Specified

Design Discharge	0.5400	m³/s	Check Discharge	1.3700	m³/s

Grades Model: Inverts

Invert Upstream	179.09	m	Invert Downstream	178.73	m
Length	17.30	m	Slope	0.020809	m/m
Drop	0.36	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.5400 m³/s	180.03 m	2.20 m/s

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	180.03	m	Discharge	0.5400	m³/s
Headwater Depth/Height	1.55		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	180.03	m	Control Type	Inlet Control	
Outlet Control HW Elev.	180.01	m			

Grades

Upstream Invert	179.09	m	Downstream Invert	178.73	m
Length	17.30	m	Constructed Slope	0.020809	m/m

Hydraulic Profile

Profile	M2		Depth, Downstream	0.48	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.48	m
Velocity Downstream	2.20	m/s	Critical Slope	0.026300	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	180.01	m	Upstream Velocity Head	0.19	m
Ke	0.90		Entrance Loss	0.17	m

Inlet Control Properties

Inlet Control HW Elev.	180.03	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 4

Peak Discharge Method: User-Specified

Design Discharge	0.5400	m³/s	Check Discharge	1.3700	m³/s

Grades Model: Inverts

Invert Upstream	179.09	m	Invert Downstream	178.73	m
Length	17.30	m	Slope	0.020809	m/m
Drop	0.36	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	1.3700 m³/s	184.17 m	4.70 m/s

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	184.17	m	Discharge	1.3700	m³/s
Headwater Depth/Height	8.33		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	183.41	m	Control Type	Outlet Control	
Outlet Control HW Elev.	184.17	m			

Grades

Upstream Invert	179.09	m	Downstream Invert	178.73	m
Length	17.30	m	Constructed Slope	0.020809	m/m

Hydraulic Profile

Profile	CompositeM2PressureProfile		Depth, Downstream	0.60	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.60	m
Velocity Downstream	4.70	m/s	Critical Slope	0.142915	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	184.17	m	Upstream Velocity Head	1.12	m
Ke	0.90		Entrance Loss	1.01	m

Inlet Control Properties

Inlet Control HW Elev.	183.41	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 5

Peak Discharge Method: User-Specified

Design Discharge	0.6900	m³/s	Check Discharge	1.8900	m³/s

Grades Model: Inverts

Invert Upstream	187.52	m	Invert Downstream	188.25	m
Length	25.93	m	Slope	-0.028153	m/m
Drop	-0.73	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.6900 m³/s	190.39 m	2.55 m/s

Culvert Designer/Analyzer Report
Culvert 5

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	190.39	m	Discharge	0.6900	m³/s
Headwater Depth/Height	4.72		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	189.60	m	Control Type	Outlet Control	
Outlet Control HW Elev.	190.39	m			

Grades

Upstream Invert	187.52	m	Downstream Invert	188.25	m
Length	25.93	m	Constructed Slope	-0.028153	m/m

Hydraulic Profile

Profile	CompositeA2PressureProfile		Depth, Downstream	0.53	m
Slope Type	Adverse		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.53	m
Velocity Downstream	2.55	m/s	Critical Slope	0.035937	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	190.39	m	Upstream Velocity Head	0.28	m
Ke	0.90		Entrance Loss	0.26	m

Inlet Control Properties

Inlet Control HW Elev.	189.60	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 5

Peak Discharge Method: User-Specified

Design Discharge	0.6900 m³/s	Check Discharge	1.8900 m³/s

Grades Model: Inverts

Invert Upstream	187.52 m	Invert Downstream	188.25 m
Length	25.93 m	Slope	-0.028153 m/m
Drop	-0.73 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	1.8900 m³/s	200.62 m	6.48 m/s

Culvert Designer/Analyzer Report
Culvert 5

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	200.62	m	Discharge	1.8900	m³/s
Headwater Depth/Height	21.48		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	196.20	m	Control Type	Outlet Control	
Outlet Control HW Elev.	200.62	m			

Grades

Upstream Invert	187.52	m	Downstream Invert	188.25	m
Length	25.93	m	Constructed Slope	-0.028153	m/m

Hydraulic Profile

Profile	CompositeA2PressureProfile		Depth, Downstream	0.61	m
Slope Type	Adverse		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.61	m
Velocity Downstream	6.48	m/s	Critical Slope	0.282949	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	200.62	m	Upstream Velocity Head	2.14	m
Ke	0.90		Entrance Loss	1.92	m

Inlet Control Properties

Inlet Control HW Elev.	196.20	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

APPENDIX G: Letter from Rand Engineering (Culvert #2)

RAND™
ENGINEERING

May 1, 2013 Project: 08877

Town of Oakville
P.O. Box 310,
1225 Trafalgar Road
Oakville, Ontario
L6J 5A6

ATTENTION: **MR. GABE CHARLES**
MANAGER, PLANNING SERVICES DEPARTMENT

Dear Mr. Charles,

RE: **UPPER WEST MORRISON CREEK**
ENVIRONMENTAL IMPLEMENTATION REPORT AND
FUNCTIONAL SERVICING STUDY
NORTH OAKVILLE EAST
TOWN OF OAKVILLE

On behalf of the consulting team working on the Upper West Morrison Creek Environmental Implementation Report / Functional Servicing Study (EIR/FSS) we are writing to inform you that we are in the final stages of the study completion and we intend to make a formal submission to the Town of Oakville in May. The study lands include the portion of the exiting West Morrison Creek drainage subcatchment located upstream of Sixth Line.

In accordance with the 2006 North Oakville Creeks Subwatershed Study (NOCSS) recommendations the proposed development plan within the study limits includes a relocation and channelization of West Morrison Creek. This plan is being coordinated with the proposed creek channelization works between Sixth Line and Dundas Street as recommended in the November 2012 Sixth Line Corporation North Oakville EIR/FSS prepared by Urbantech et al.

Please be advised that we have also communicated our study findings and development impact with Morrison Hersfield Limited, presently involved in a Class Environment Assessment (EA) for improvements to Sixth Line.

As part of our EIR/FSS, we have investigated the watercourse crossing requirements for roads both internal and external to the study limits. In accordance with the 2006 NOCSS recommendations, the crossings should be sized to accommodate predicted flows and allow for wildlife passage and low flow channels. The EIR/FSS for Upper West Morrison Creek includes the recommendations for two (2) proposed channel crossings and review of the existing Sixth Line 2.16 m x 0.9 m concrete box culvert conditions.

The hydraulic and geomorphic assessment of the exiting Sixth Line culvert concluded that this crossing is undersized and does not meet the 2006 NOCSS requirements with respect to the wildlife and fish passage.

Based on our study team findings, it is recommended that the existing Sixth Line culvert should be replaced with a 7.32 m x 1.75 m CONSPAN culvert in conjunction with the proposed road improvements. The installation of the new culvert would result with lowering of the existing grade by approximately 0.85 m at the upstream side of the culvert.

We have further investigated the proposed crossing in relation to the design of the future West Morrison Creek channel upstream of Sixth Line and grading and storm servicing plans for the developments within the study limits. It has been concluded that the additional lowering of the existing grade by approximately 0.8 m at the upstream side of the Sixth Line culvert would allow optimizing earthworks cut-fill balance.

Please note that we have reviewed the proposed channel design information between Sixth Line and Dundas Street provided in the November 2012 Sixth Line Corporation North Oakville EIR/FSS and determined that the proposed channel design accounted for a potential creek lowering at Sixth Line. We would like to confirm now that the anticipated creek lowering is indeed required and should be incorporated in the final Urbantech EIR/FSS.

Based on the above information we recommend that the type and grade of the proposed West Morrison Creek culvert crossing of Sixth Line should be taken into consideration in the future improvement plans for the road.

Should you have any questions or require additional information please contact the undersigned.

Yours truly,

RAND Engineering Corporation

Piotr Szponar, P.Eng.

cc: Dale Lipnicky – Town of Oakville
Nasser Saad - Morrison Hersfield Limited
Michael Telawski – Trinison
David Faye – Star Oak Developments
Rick McConnell – Matson, McConnell Ltd.
David Leighton – Urbantech
Paul Villard – GHD Inc.

APPENDIX H: Proposed Culvert Hydraulics (CulvertMaster)

Culvert Designer/Analyzer Report
Culvert 2

Peak Discharge Method: User-Specified

Design Discharge	2.3000 m^3/s	Check Discharge	5.8200 m^3/s

Grades Model: Inverts

Invert Upstream	171.91 m	Invert Downstream	171.89 m
Length	47.00 m	Slope	0.000426 m/m
Drop	0.02 m		

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A m

Name	Description	Discharge	HW Elev.	Velocity
x Trial-5	1-7320 x 1750 mm CONSPAN Box	2.3000 m^3/s	172.31 m	1.46 m/s

Culvert Designer/Analyzer Report
Culvert 2

Design:Trial-5

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	172.31	m	Discharge	2.3000	m³/s
Headwater Depth/Height	0.23		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	172.27	m	Control Type	Outlet Control	
Outlet Control HW Elev.	172.31	m			

Grades

Upstream Invert	171.91	m	Downstream Invert	171.89	m
Length	47.00	m	Constructed Slope	0.000426	m/m

Hydraulic Profile

Profile	M2		Depth, Downstream	0.22	m
Slope Type	Mild		Normal Depth	0.39	m
Flow Regime	Subcritical		Critical Depth	0.22	m
Velocity Downstream	1.46	m/s	Critical Slope	0.002982	m/m

Section

Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.32	m
Section Siz	7320 x 1750 mm CONSPAN		Rise	1.75	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	172.31	m	Upstream Velocity Head	0.05	m
Ke	0.70		Entrance Loss	0.04	m

Inlet Control Properties

Inlet Control HW Elev.	172.27	m	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	12.8	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert 2

Peak Discharge Method: User-Specified

Design Discharge	2.3000	m³/s	Check Discharge	5.8200	m³/s

Grades Model: Inverts

Invert Upstream	171.91	m	Invert Downstream	171.89	m
Length	47.00	m	Slope	0.000426	m/m
Drop	0.02	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-5	1-7320 x 1750 mm CONSPAN Box	5.8200 m³/s	172.64 m	1.98 m/s

Culvert Designer/Analyzer Report
Culvert 2

Design:Trial-5

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	172.64	m	Discharge	5.8200	m³/s
Headwater Depth/Height	0.42		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	172.59	m	Control Type	Outlet Control	
Outlet Control HW Elev.	172.64	m			

Grades

Upstream Invert	171.91	m	Downstream Invert	171.89	m
Length	47.00	m	Constructed Slope	0.000426	m/m

Hydraulic Profile

Profile	M2		Depth, Downstream	0.40	m
Slope Type	Mild		Normal Depth	0.71	m
Flow Regime	Subcritical		Critical Depth	0.40	m
Velocity Downstream	1.98	m/s	Critical Slope	0.002582	m/m

Section

Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.32	m
Section Size	7320 x 1750 mm CONSPAN		Rise	1.75	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	172.64	m	Upstream Velocity Head	0.11	m
Ke	0.70		Entrance Loss	0.08	m

Inlet Control Properties

Inlet Control HW Elev.	172.59	m	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	12.8	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert 4

Peak Discharge Method: User-Specified

Design Discharge	0.5400	m^3/s	Check Discharge	1.3700	m^3/s

Grades Model: Inverts

Invert Upstream	179.15	m	Invert Downstream	178.70	m
Length	36.40	m	Slope	0.012363	m/m
Drop	0.45	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1520 x 910 mm Box	1.3700 m^3/s	179.85 m	3.00 m/s
	Trial-2	1-1200 mm Circular	1.3700 m^3/s	180.25 m	2.23 m/s
	Trial-3	1-825 mm Circular	0.5400 m^3/s	179.90 m	1.85 m/s
	Trial-4	1-600 mm Circular	1.3700 m^3/s	187.12 m	4.70 m/s

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	179.85	m	Discharge	1.3700	m³/s
Headwater Depth/Height	0.76		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	179.84	m	Control Type	Entrance Control	
Outlet Control HW Elev.	179.85	m			

Grades

Upstream Invert	179.15	m	Downstream Invert	178.70	m
Length	36.40	m	Constructed Slope	0.012363	m/m

Hydraulic Profile

Profile	S2		Depth, Downstream	0.30	m
Slope Type	Steep		Normal Depth	0.29	m
Flow Regime	Supercritical		Critical Depth	0.44	m
Velocity Downstream	3.00	m/s	Critical Slope	0.003994	m/m

Section

Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.52	m
Section Size	1520 x 910 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	179.85	m	Upstream Velocity Head	0.22	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties

Inlet Control HW Elev.	179.84	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	1.4	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	180.25	m	Discharge	1.3700	m³/s
Headwater Depth/Height	0.90		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	180.14	m	Control Type	Outlet Control	
Outlet Control HW Elev.	180.25	m			

Grades

Upstream Invert	179.15	m	Downstream Invert	178.70	m
Length	36.40	m	Constructed Slope	0.012363	m/m

Hydraulic Profile

Profile	M2		Depth, Downstream	0.64	m
Slope Type	Mild		Normal Depth	0.65	m
Flow Regime	Subcritical		Critical Depth	0.64	m
Velocity Downstream	2.23	m/s	Critical Slope	0.013439	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	180.25	m	Upstream Velocity Head	0.24	m
Ke	0.90		Entrance Loss	0.21	m

Inlet Control Properties

Inlet Control HW Elev.	180.14	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-3

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	179.90	m	Discharge	0.5400	m³/s
Headwater Depth/Height	0.89		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	179.83	m	Control Type	Outlet Control	
Outlet Control HW Elev.	179.90	m			

Grades

Upstream Invert	179.15	m	Downstream Invert	178.70	m
Length	36.40	m	Constructed Slope	0.012363	m/m

Hydraulic Profile

Profile	M2		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	0.47	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	1.85	m/s	Critical Slope	0.015250	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	179.90	m	Upstream Velocity Head	0.15	m
Ke	0.90		Entrance Loss	0.13	m

Inlet Control Properties

Inlet Control HW Elev.	179.83	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-4

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	187.12	m	Discharge	1.3700	m³/s
Headwater Depth/Height	13.07		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	183.47	m	Control Type	Outlet Control	
Outlet Control HW Elev.	187.12	m			

Grades					
Upstream Invert	179.15	m	Downstream Invert	178.70	m
Length	36.40	m	Constructed Slope	0.012363	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.60	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.60	m
Velocity Downstream	4.70	m/s	Critical Slope	0.142915	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	187.12	m	Upstream Velocity Head	1.12	m
Ke	0.90		Entrance Loss	1.01	m

Inlet Control Properties					
Inlet Control HW Elev.	183.47	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 4

Peak Discharge Method: User-Specified

Design Discharge	0.5400	m^3/s	Check Discharge	1.3700	m^3/s

Grades Model: Inverts

Invert Upstream	179.15	m	Invert Downstream	178.70	m
Length	36.40	m	Slope	0.012363	m/m
Drop	0.45	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater

Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1520 x 910 mm Box	1.3700 m^3/s	179.85 m	3.00 m/s
	Trial-2	1-1200 mm Circular	1.3700 m^3/s	180.25 m	2.23 m/s
	Trial-3	1-825 mm Circular	1.3700 m^3/s	181.10 m	2.78 m/s
	Trial-4	1-600 mm Circular	1.3700 m^3/s	187.12 m	4.70 m/s

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	179.85	m	Discharge	1.3700	m³/s
Headwater Depth/Height	0.76		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	179.84	m	Control Type	Entrance Control	
Outlet Control HW Elev.	179.85	m			

Grades

Upstream Invert	179.15	m	Downstream Invert	178.70	m
Length	36.40	m	Constructed Slope	0.012363	m/m

Hydraulic Profile

Profile	S2		Depth, Downstream	0.30	m
Slope Type	Steep		Normal Depth	0.29	m
Flow Regime	Supercritical		Critical Depth	0.44	m
Velocity Downstream	3.00	m/s	Critical Slope	0.003994	m/m

Section

Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.52	m
Section Size	1520 x 910 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	179.85	m	Upstream Velocity Head	0.22	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties

Inlet Control HW Elev.	179.84	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	1.4	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	180.25	m	Discharge	1.3700	m³/s
Headwater Depth/Height	0.90		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	180.14	m	Control Type	Outlet Control	
Outlet Control HW Elev.	180.25	m			

Grades

Upstream Invert	179.15	m	Downstream Invert	178.70	m
Length	36.40	m	Constructed Slope	0.012363	m/m

Hydraulic Profile

Profile	M2		Depth, Downstream	0.64	m
Slope Type	Mild		Normal Depth	0.65	m
Flow Regime	Subcritical		Critical Depth	0.64	m
Velocity Downstream	2.23	m/s	Critical Slope	0.013439	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	180.25	m	Upstream Velocity Head	0.24	m
Ke	0.90		Entrance Loss	0.21	m

Inlet Control Properties

Inlet Control HW Elev.	180.14	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-3

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	181.10	m	Discharge	1.3700	m³/s
Headwater Depth/Height	2.33		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	180.72	m	Control Type	Outlet Control	
Outlet Control HW Elev.	181.10	m			

Grades

Upstream Invert	179.15	m	Downstream Invert	178.70	m
Length	36.40	m	Constructed Slope	0.012363	m/m

Hydraulic Profile

Profile	CompositeM2PressureProfile		Depth, Downstream	0.70	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.70	m
Velocity Downstream	2.78	m/s	Critical Slope	0.027640	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	181.10	m	Upstream Velocity Head	0.31	m
Ke	0.90		Entrance Loss	0.28	m

Inlet Control Properties

Inlet Control HW Elev.	180.72	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 4

Design:Trial-4

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	187.12	m	Discharge	1.3700	m³/s
Headwater Depth/Height	13.07		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	183.47	m	Control Type	Outlet Control	
Outlet Control HW Elev.	187.12	m			

Grades

Upstream Invert	179.15	m	Downstream Invert	178.70	m
Length	36.40	m	Constructed Slope	0.012363	m/m

Hydraulic Profile

Profile	CompositeM2PressureProfile		Depth, Downstream	0.60	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.60	m
Velocity Downstream	4.70	m/s	Critical Slope	0.142915	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	187.12	m	Upstream Velocity Head	1.12	m
Ke	0.90		Entrance Loss	1.01	m

Inlet Control Properties

Inlet Control HW Elev.	183.47	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

APPENDIX I: Overland Flow Calculations

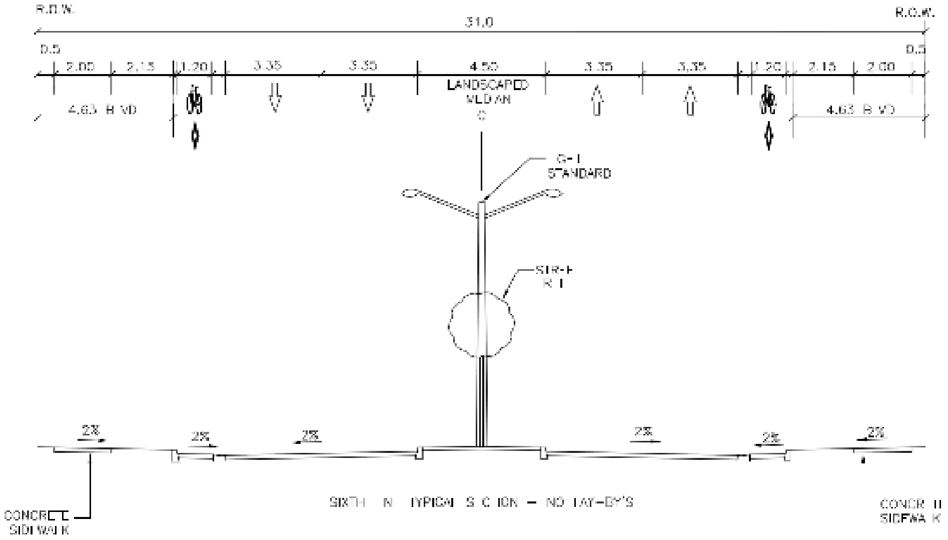
Overland Flow Calculations at Culvert 4

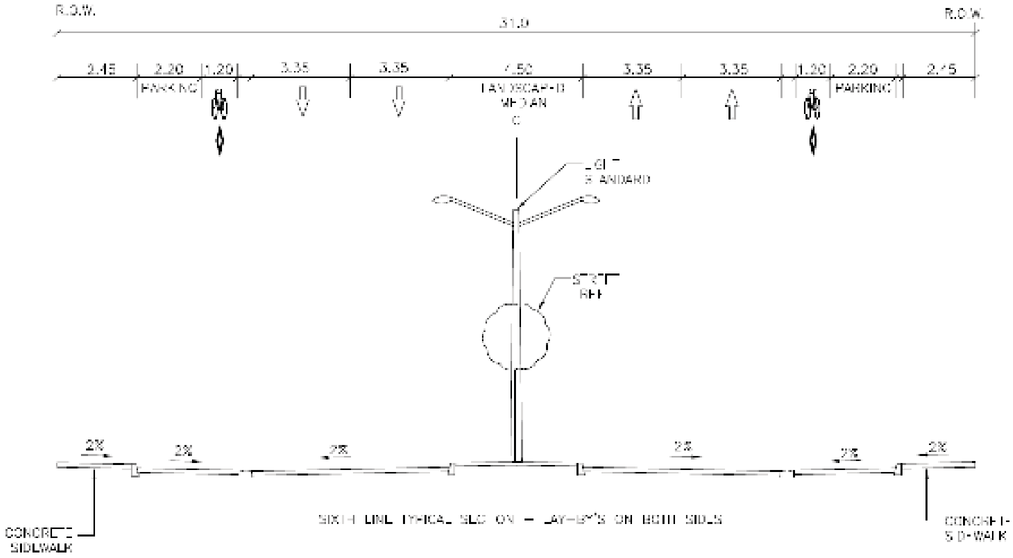
Town of Oakville Standards for Overland Flow Routes:

- For all classes of roads, the product of depth of water (m) at the gutter times the velocity of flow (ms$_{-1}$) shall not exceed 0.65 m^{2}/s
- For arterial roads, the depth of water at the crown shall not exceed 0.15 m.

Assumptions:

- Flow depth to top of gutter
- Assumed cross section:





SIXTH LINE TYPICAL SECTION – LAY-BY'S ON BOTH SIDES

Velocity Calculations:

$$v = \frac{1}{n}(R^{\frac{2}{3}})(S^{\frac{1}{2}})$$

$$R = A/P$$

No Lay-by's:

A = 0.98m^2 (half the road cross section), P = 8.60m (half the road cross section), n = 0.013, S = 1.37%

$$v = \frac{1}{0.013}(0.11^{\frac{2}{3}})(0.0137^{\frac{1}{2}})$$

$$v = 2.07/s$$

Lay-by's:

A = 1.75m^2 (half the road cross section), P = 10.84m (half the road cross section), n = 0.013, S = 1.37%

$$v = \frac{1}{0.013}(0.16^{\frac{2}{3}})(0.0137^{\frac{1}{2}})$$

$$v = 2.65/s$$

Velocity x Depth Calculations:

No Lay-by's:

$$(v)(d) = (2.07)(0.15)$$

$$(v)(d) = 0.31\frac{m^2}{s}$$

Lay-by's:

$$(v)(d) = (2.65)(0.15)$$

$$(v)(d) = 0.40\frac{m^2}{s}$$

Therefore, if flow is up to the top of gutter, the Town of Oakville standards for velocity times depth (<0.65 m^2/s) is met.

Flow Calculations:

No Lay-by's:

$$Q = Av$$

$$Q = (0.98)(2.07)$$

$$Q = 2.03\frac{m^3}{s}$$

Lay-by's:

$$Q = Av$$

$$Q = (1.75)(2.65)$$

$$Q = 4.64\frac{m^3}{s}$$

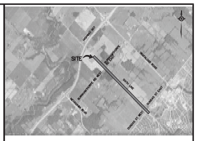
Therefore, for the proposed cross section without lay-by's, flow up to the top of gutter for half of the road cross section is 2.03 m^3/s, for the whole road cross section flow is 4.06m^3/s. For the proposed cross section with lay-bys, flow up to the top of gutter for half of the road cross section is 4.64 m^3/s, for the whole road cross section flow is 9.28 m^3/s.

Culvert 4:

0.24m^3/s is overtopping the roadway during Regional storm conditions at proposed culvert 4 (825 mm CSP). Since this is less than all flows calculated above, it is assumed that the Town of Oakville standards for velocity times depth (<0.65 m^2/s) is met.

LEGEND

C6 1.2ha	CATCHMENT NAME CATCHMENT AREA
– – –	CULVERT CATCHMENT BOUNDARY
⇨	DIRECTION OF OVERLAND FLOW



KEY PLAN – NOT TO SCALE

CONSULTANT:

MORRISON HERSHFIELD
Suite 600 – 235 Yorkland Blvd.
Toronto, ON M2J 1T1
Tel: (416) 499–3110 Fax: (416) 499–9658

PROJECT:

REV	DESCRIPTION	DATE	BY
-	-	YYYY/MM/DD	-

SHEET TITLE:

SIXTH LINE CULVERT
DRAINAGE AREAS

DRAWN BY: M.S.	DATE: 2013/06/25
DESIGNED BY: R.S.	CHECKED BY:
SCALE: 1:5000	DWG FILE:
Project No: 1124037	Drawing No: 1

Appendix I – Geotechnical Investigation Report

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GEOTECHNICAL INVESTIGATION
CLASS ENVIRONMENTAL ASSESSMENT STUDY
6TH LINE FROM DUNDAS STREET
TO BURNHAMTHORPE ROAD WEST
OAKVILLE, ONTARIO

Ref. No. 6223-13-1

May 2013

Prepared for:

Morrison Hershfield Group
1005 Skyview Drive, Suite 175
Burlington, Ontario
L7P 5B1

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CONTENTS

APPENDICES

ENCLOSURES

1.0 INTRODUCTION

V.A. Wood Associates Limited was retained by Morrison Hershfield Group to carry out the geotechnical investigation for the Class Environmental Assessment Study of Improvement of 6TH Line in Oakville, Ontario. The road section investigated is 3.2± km long and stretches from just south Dundas Street in the south to beyond Burnhamthorpe Road West (just before Highway 407) in the north.

It is understood that the improvements will involve the widening of the existing road to 4 lanes and the construction of left turn lanes and culverts. The purpose of the investigation was to determine the existing sub-surface conditions and to provide geotechnical recommendations for the preliminary design of the pavements, road improvements, culverts, foundations and embankments.

*2.0 **SUBSURFACE INVESTIGATION***

The field work was carried out between March 14 and May 6, 2013 and consisted of thirty boreholes at the approximate locations shown on Enclosures 1A to 1H. The boreholes were generally 2.5 to 3.5 m deep, and were advanced to the sampling depths by means of a power-auger machine equipped for soil sampling. Standard Penetration tests were carried out at frequent intervals of depth and the results are shown on the Borehole Logs as N-values.

The boreholes were drilled on the existing pavement on the west side of the road, and generally about 0.5 m from the curb. The field work was supervised by a soils technician and the soil samples were logged by a soils engineer. All samples were transported to our soils laboratory for further examination, classification and testing. The ground elevation at each borehole location was interpolated from the elevations shown on the road plan and profile drawing provided by the Client.

*3.0 **SUBSURFACE CONDITIONS***

Full details of the soils encountered in each borehole are given on the Borehole Logs, Enclosures 2 to 31 inclusive, and the following notes are intended to summarize this data.

3.1 Pavement

The composition of the pavement and immediate subgrade soil at the borehole locations is summarized as follows:

BH No.	*Approx. Station*	*Asphalt Thickness*	*Gran. Base Thickness*	*Subgrade Soil*
1	*0+850*	*175 mm*	*300 mm*	*dense gravelly sand FILL*
2	*0+700*	*175 mm*	*250 mm*	*hard clayey silt TILL*
3	*1+150*	*150 mm*	*150 mm*	*dense gravelly sand FILL*
4	*1+200*	*100 mm*	*300 mm*	*very stiff clayey silt TILL*
5	*1+335*	*125 mm*	*375 mm*	*compact organic stained clayey to sandy silt FILL*
6	*1+470*	*125 mm*	*250 mm*	*dense gravelly sand FILL*
7	*1+595*	*125 mm*	*250 mm*	*very stiff clayey silt TILL*
8	*1+680*	*100 mm*	*250 mm*	*compact silty clay FILL, organic stained*
9	*1+775*	*100 mm*	*250 mm*	*compact silty clay FILL, organic stained*
10	*1+890*	*100 mm*	*250 mm*	*compact silty clay FILL, organic stained*
11	*2+000*	*125 mm*	*275 mm*	*compact gravelly sand FILL*
12	*2+115*	*125 mm*	*300 mm*	*compact gravelly sand FILL*
13	*2+215*	*75 mm*	*250 mm*	*compact gravelly sand FILL*

14	*2+325*	*125 mm*	*275 mm*	*loose silty clay FILL, trace organics*
15	*2+435*	*125 mm*	*300 mm*	*loose organic silty clay FILL*
16	*2+550*	*100 mm*	*275 mm*	*stiff clayey silt TILL*
17	*2+665*	*125 mm*	*250 mm*	*compact silty clay FILL, organic stained*
18	*2+775*	*125 mm*	*250 mm*	*compact silty clay FILL, organic stained, some wood fragments*
19	*2+925*	*125 mm*	*250 mm*	*compact mixed topsoil and organic stained silty clay FILL*
20	*3+050*	*150 mm*	*250 mm*	*very stiff clayey silt TILL*
21	*3+165*	*100 mm*	*250 mm*	*loose organic silty clay FILL*
22	*3+275*	*150 mm*	*325 mm*	*very stiff clayey silt TILL*
23	*3+375*	*150 mm*	*225 mm*	*very stiff clayey silt TILL*
24	*3+475*	*150 mm*	*200 mm*	*very stiff clayey silt TILL*
25	*3+575*	*150 mm*	*250 mm*	*very stiff clayey silt TILL*
26	*3+675*	*125 mm*	*200 mm*	*very stiff clayey silt TILL*
27	*3+775*	*150 mm*	*175 mm*	*very stiff clayey silt TILL*
28	*3+875*	*125 mm*	*400 mm*	*compact sandy silt FILL*
29	*3+975*	*125 mm*	*400 mm*	*compact sandy silt FILL, organic stained*
30	*4+075*	*125 mm*	*450 mm*	*very dense gravelly sand FILL*

Based on the findings, the thickness of the existing asphalt surfacing varies from 75 mm to 175 mm (generally 100 to 150 mm), and the granular base varies from 150 mm to 450 mm thick (generally 250 to 300 mm). Grain size analyses were carried out on representative samples of the granular base, and the test results are shown on Enclosures 32 to 36. The grain size envelopes for Granular A and Granular B have been overlain on the graphs, which show that the grading of the samples are generally just outside (fine side) the *grading envelope for Granular A, but are well within the envelope for Granular B. It is possible that the granular base is comprised of an upper Granular A base and a lower Granular B sub-base. However, due to the sampling method (by auger), the sample obtained is an aggregate mixture of the entire granular base.*

3.2 Fill

The pavement was underlain by fill in most of the boreholes over the southern 2/3 of the alignment and north of the New North Oakville Transportation Corridor . The fill extended to a depth of between 0.6 and 1.3 m, and varied in composition from loose to compact silty to compact gravelly sand. The silty clay fill is generally organic stained and contained traces of gravel, topsoil and organics in places. Wood fragments and decayed organics were encountered within the fill in Boreholes 18 and 21. The gravelly sand fill contained some asphalt fragments in some of the boreholes. Stone (20mm) and a fragment of PVC pipe was encountered at the bottom of Borehole 3.

3.3 Clayey Silt Till

The fill was underlain by native clayey sit till. Where there is no backfill, the pavement was immediately underlain by native clayey silt till (except in Boreholes 13, 18, 19, 28, 29 and 30). This glacial deposit extended to a depth of between 0.9 and 2.4 m below grade, and is comprised of a clayey silt matrix which contained some fine to medium gravel. Based on the Standard Penetration Test results and a visual and tactile examination of the *samples, the clayey silt till is considered to have a very stiff to hard consistency.*

3.4 *Sandy Silt Till*

The pavement in Boreholes 13, 18, 19, 28, 29 and 30, and the clayey silt till in the remaining boreholes (except Boreholes 5, 6, 8, 9 and 10) were underlain by a deposit of sandy silt till, which extended to a depth of between 2.8 and more than 3.5 m below grade (maximum depth investigated). This glacial deposit is comprised of a sandy silt matrix which contained some fine to medium gravel. Based on the Standard Penetration Test results, the sandy silt till is considered to have a compact to very dense relative density.

3.5 *Weathered Shale*

The clayey silt till in Boreholes 5, 6, 8, 9 and 10 and the sandy silt till in Boreholes 11, 12 and 13 were underlain by weathered shale, which extended to a depth of more than 3.5 m below grade (maximum depth investigated). The shale is highly weathered and is generally damp and brick red in colour.

4.0 GROUNDWATER CONDITIONS

No free water was encountered in the boreholes, which were all open and dry to the full depth upon completion of the fieldwork. It is noted that the water level measurements were carried out immediately after completion of drilling of each borehole, and it is likely that the ground water had not yet stabilized in the boreholes.

An examination of the soil samples revealed that the native soil samples were generally moist, and had a brown to reddish brown to brick red colour for the full depth of the boreholes.

Based on the foregoing, the permanent groundwater table is considered to be located below the depths investigated (i.e., at least 2.5 to 3.5 m below grade) along most of the alignment. However, perched water conditions may occur within the fill and on top of the relatively impervious native till and weathered shale.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

The boreholes encountered a pavement consisting of 75 to 175 mm thick asphalt on a 150 to 450 mm thick granular base, followed by 0 to 1.5± m of fill, then generally competent deposits of clayey silt till and sandy silt till. Highly weathered shale was encountered in some of the boreholes. The groundwater table is located at least 2.5 to 3.5 m below grade along most of the alignment, although perched water conditions are may occur within the fill and on top of the native till and weathered shale.

The improvements will involve the widening of the road to 4 lanes and the construction of left turn lanes, concrete curbs and sidewalks, bus shelters and bus pads, light standards and traffic light posts. A sewer pipe will be installed on the south side of the alignment. Preliminary geotechnical recommendations are required.

5.2 Cut and Fill

The topography along the road alignment is generally flat to slightly sloping, and minimal changes in grade is required. It is anticipated that very little cut and fill works will be required.

5.3 Pavement Design

All topsoil, organics, wet or loose fill and other deleterious materials should be removed from all areas to be paved. The subgrade should be inspected and proof-rolled prior to construction of the pavement. Any soft or wet areas identified should be removed and replaced with approved compacted fill. Backfill should be placed in not more than 200 mm thick horizontal loose lifts and compacted to at least 98% of its Standard Proctor maximum dry density.

Considering the traffic requirements and subgrade conditions, the following pavement design is recommended:

HL3 Asphaltic Concrete	*50 mm*
HL8 Asphaltic Concrete	*100 mm*
Granular 'A' or 20 mm crusher run limestone	*150 mm*
Granular 'B' or 50 mm crusher run limestone	*450 mm*

The base and sub-base granular materials should be compacted to at least 98% Standard Proctor maximum dry density and the asphaltic concrete to 96% Marshall density. The thicknesses shown above are compacted thicknesses. The top course asphalt should not be placed until the base course asphalt has been in place for one winter season.

If the Town of Oakville or Halton Region have stricter specifications than those recommended, then the requirements of the Town or Region should be followed.

Frequent inspection by qualified geotechnical personnel should be carried out during construction to verify the compaction of the subgrade, base courses and asphaltic concrete by in-situ density testing using nuclear gauges.

5.4 Sub-Drains

Where the subgrade is comprised of granular soil of medium to high permeability, sub-drains are considered not necessary. Where the subgrade is composed of silty clay fill or native clayey silt till to sandy silt till, which have a generally low permeability, then sub-drains are recommended.

5.5 Culverts

A rectangular concrete culvert is proposed at approx. Sta.1+690, and CSP culverts at approx. Sta. 2+335 and Sta. 4+030. The boreholes located in the vicinity of these culverts indicate that the invert subgrade will likely be comprised of very stiff to hard clayey silt till or very dense sandy silt till.

For planning purposes, the very stiff till may be assumed to have an allowable bearing capacity (and SLS capacity) of at least 150 kPa (150 kPa in ULS). The hard and very dense till may be assumed to have an allowable bearing capacity (and SLS capacity) of up to 300 kPa (450 kPa in ULS).

The foundation of the culverts should extend below the maximum scour level plus the frost cover requirement, and onto competent subgrade. Site-specific investigation is recommended for the detailed design.

5.6 Services

It is understood that a storm sewer will be built between Sta. 1+290 and Sta. 1+570, and between Sta. 1+620 and Sta. 1+690. Based on the borehole data, the subgrade of the pipes will likely be comprised of weathered shale or very dense sandy silt till, which will generally provide adequate support for the pipes and allow the use of normal Class 'B' bedding using Granular 'A' material.

Clear crushed stone should not be used as bedding, otherwise the fines from the surrounding subsoils may migrate into the voids of the stone and cause undesirable settlements. If loose or soft soil is encountered, this should be sub-excavated and replaced with compacted granular fill or the bedding thickness may have to be increased.

5.7 Foundations

The native sub-soils are generally competent, and are considered capable of supporting normal footings designed to bearing pressures in SLS of between 150 and 300 kPa (225 to 450 kPa in ULS), depending on the type of subgrade. Site-specific geotechnical investigations should be carried out for detailed design of significant structures.

5.8 Excavation and Groundwater Control

Excavations for the culverts will require effective diversion of the existing flow. In this case, no major construction problems, due to water, are anticipated with excavations extending less than 2.5 to 3.5 m below the existing road grade. Provision should be made for the control of surface run-off or sub-surface seepage from perched water, which will likely be controlled by pumping from local sumps as and where required.

Excavations of more than 1.2 metres deep should be cut back to a side slope of 1:1. Alternatively, the excavation should be supported using adequately braced sheeting.

It is expected that the excavated granular fill and native sandy silt till soils will generally be suitable as backfill (except in trenches) as long as their moisture content is within 3% of the optimum value . Backfill should be placed in not more than 150 to 200 mm thick lifts and compacted to at least 98% of its Standard Proctor maximum dry density.

The existing granular base may be re-used as Granular B sub-base or as engineered fill. The asphalt may be re-used also as Granular B sub-base by grinding and sieving.

6.0 ***STATEMENT OF LIMITATIONS***

The Statement of Limitations presented on Appendix 'A' is an integral part of this report.

V.A. WOOD ASSOCIATES LIMITED

Prepared by:

Rene Quiambao, P. Eng.

Reviewed by:

V. WOOD

V. Wood, M.Eng., P.Eng.,

RQ/VW

APPENDIX.

STATEMENT OF LIMITATIONS

The conclusions and recommendations in this report are based on information determined at the borehole locations and on geological data of a general nature which may be available for the area investigated. Soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the borehole locations and conditions may become apparent during construction which would not be detected or anticipated at the time of the soil investigation.

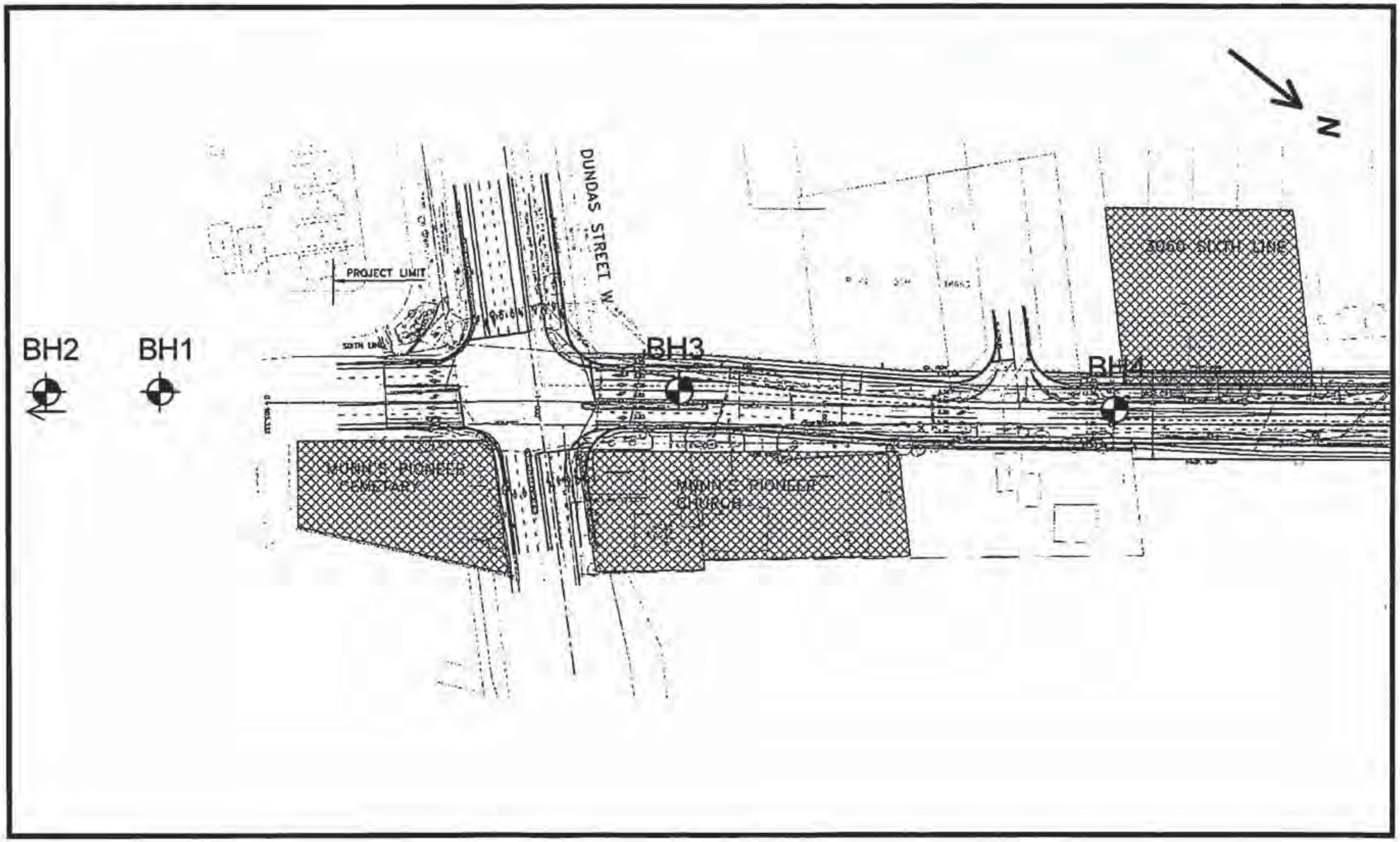
We recommend that we be retained to ensure that all necessary stripping, subgrade preparation and compaction requirements are met, and to confirm that the soil conditions do not deviate materially from those encountered in the boreholes. In cases where this recommendation is not followed, the company's responsibility is limited to interpreting accurately the information encountered at the borehole locations.

This report is applicable only to the project described in the introduction, constructed substantially in accordance with details of alignment and elevations quoted in the text.

ENCLOSURES

Ref. No. 6223-13-1

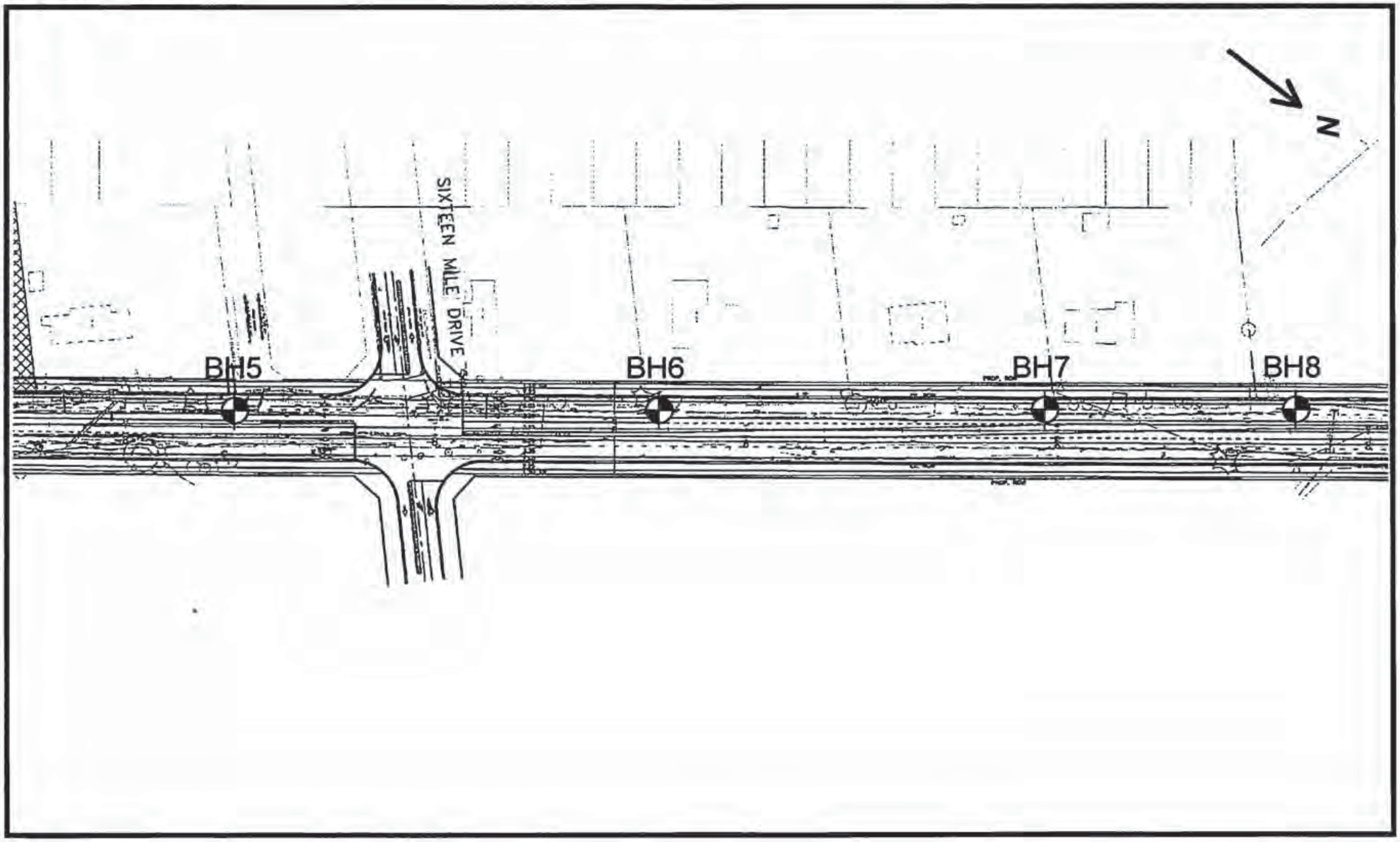
Enclosure 1A



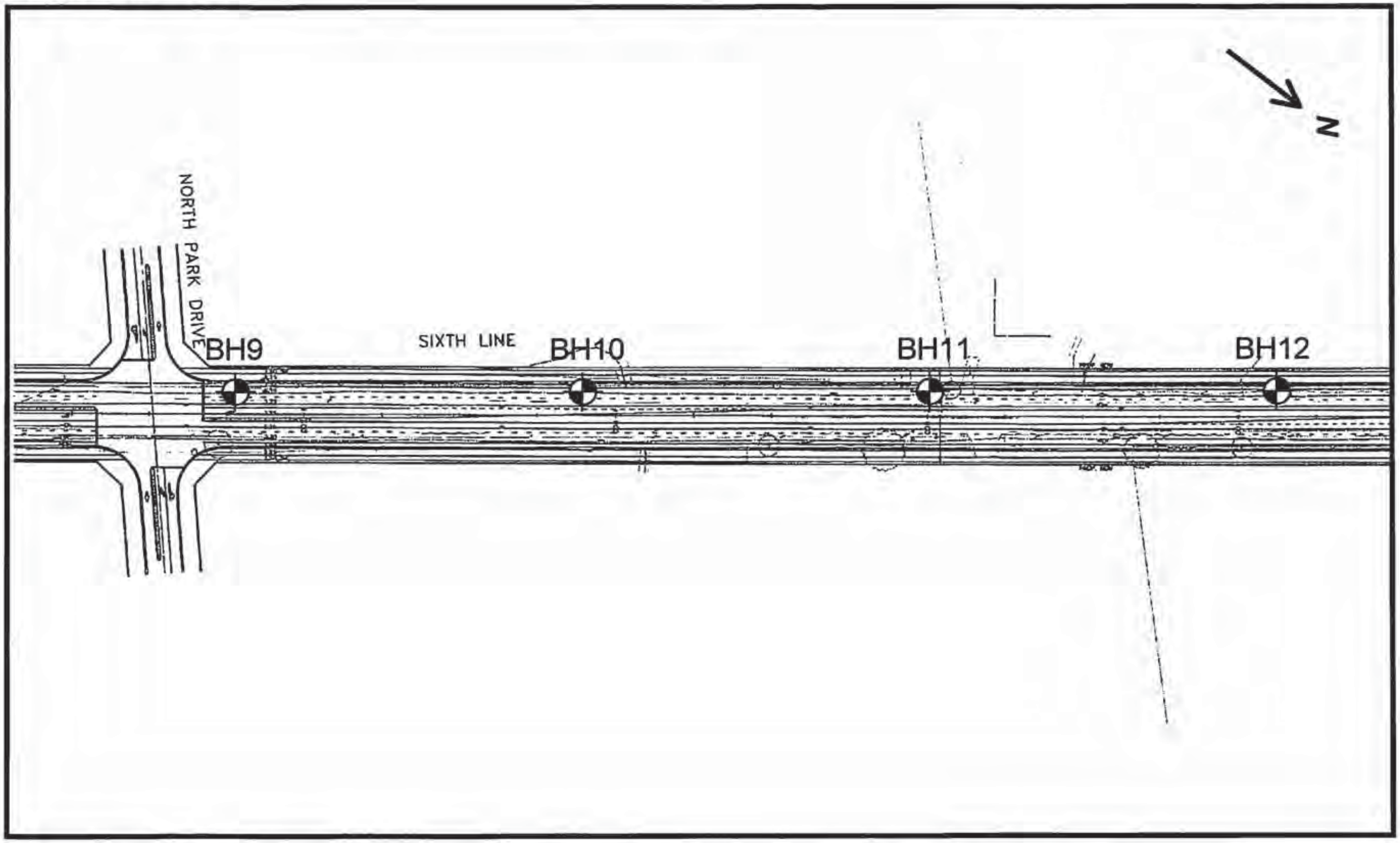
BOREHOLE LOCATION PLAN

Ref. No. 6223-13-1

Enclosure 1B



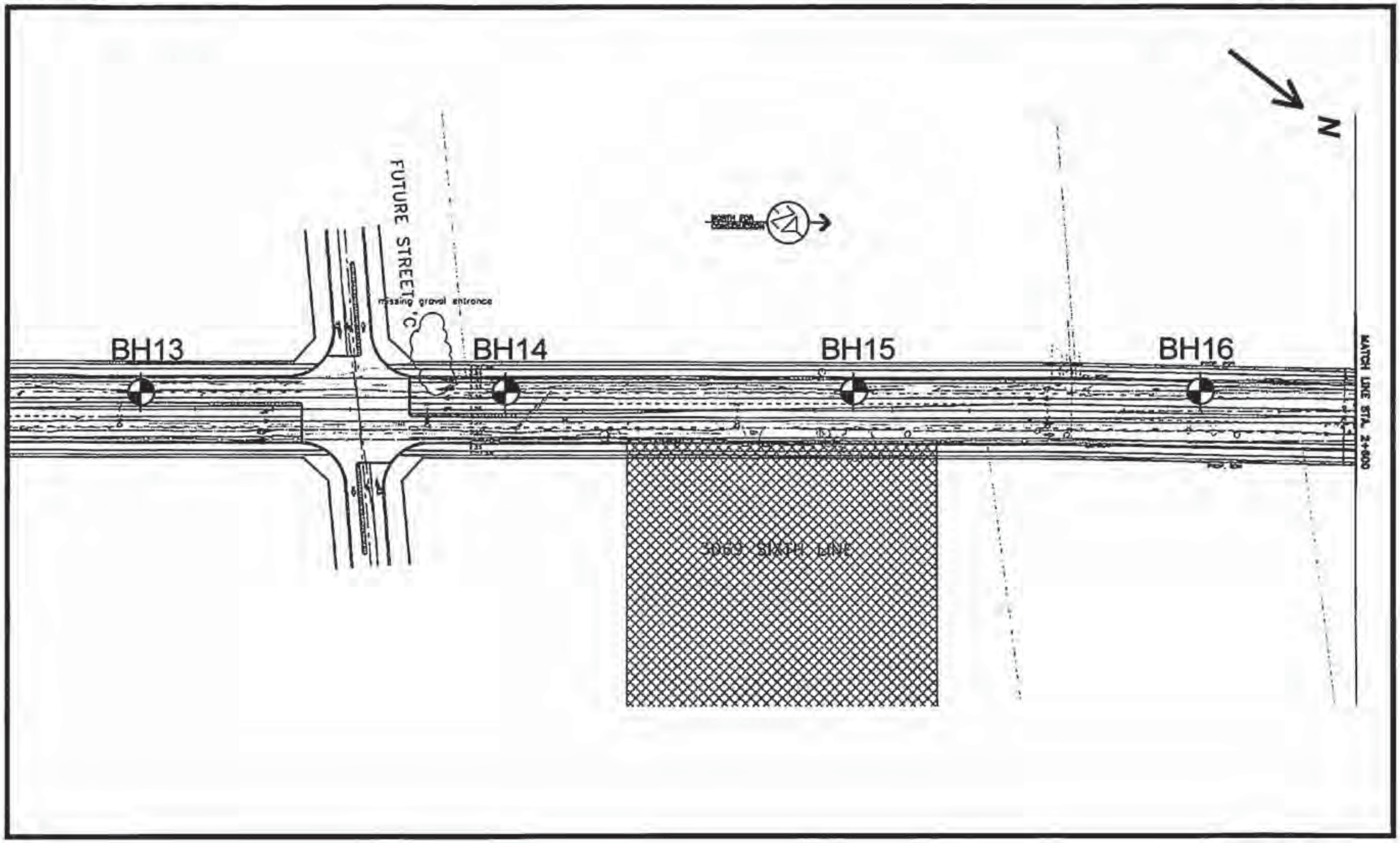
BOREHOLE LOCATION PLAN



BOREHOLE LOCATION PLAN

Ref. No. 6223-13-1

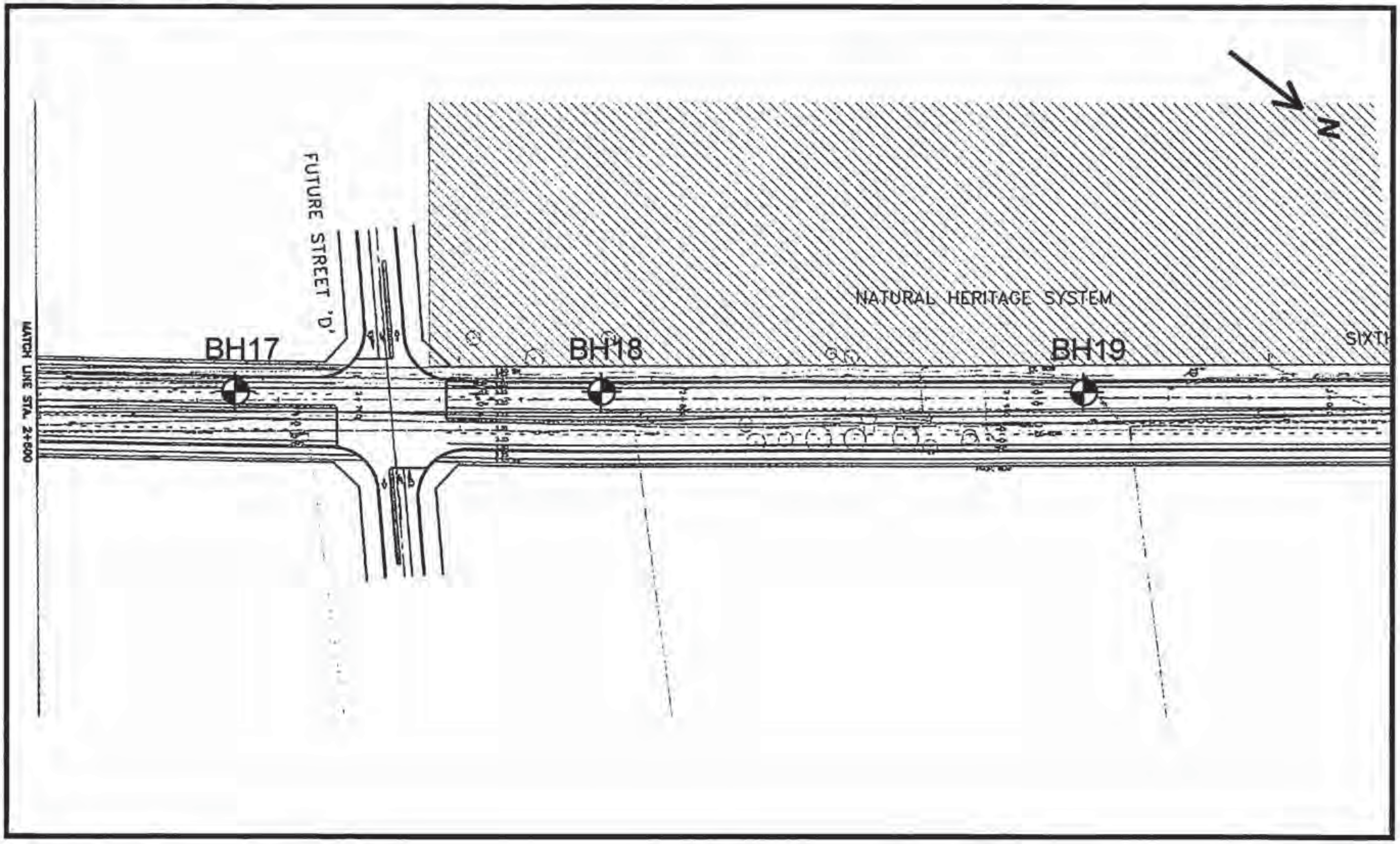
Enclosure 1D



BOREHOLE LOCATION PLAN

Ref. No. 6223-13-1

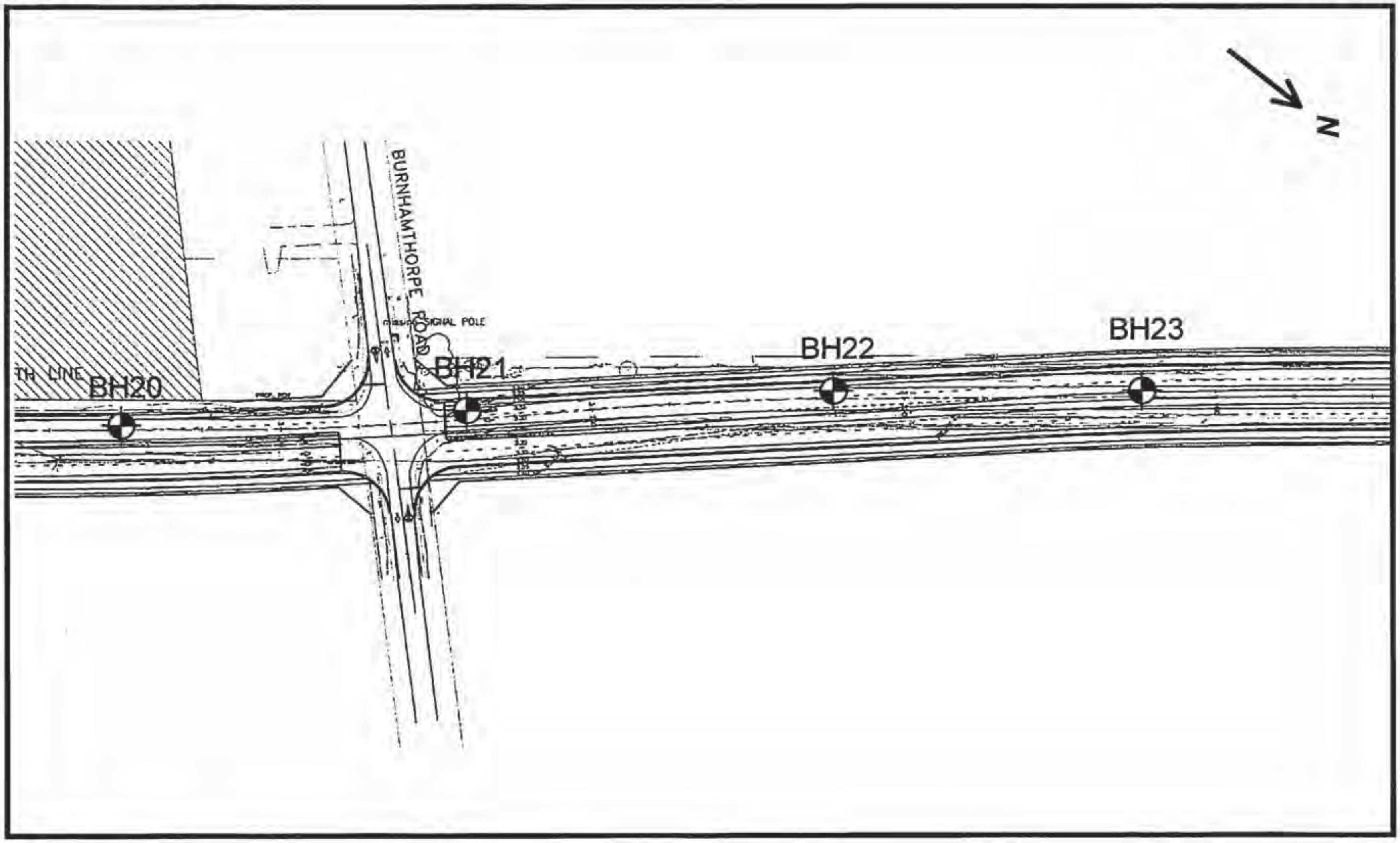
Enclosure 1E



BOREHOLE LOCATION PLAN

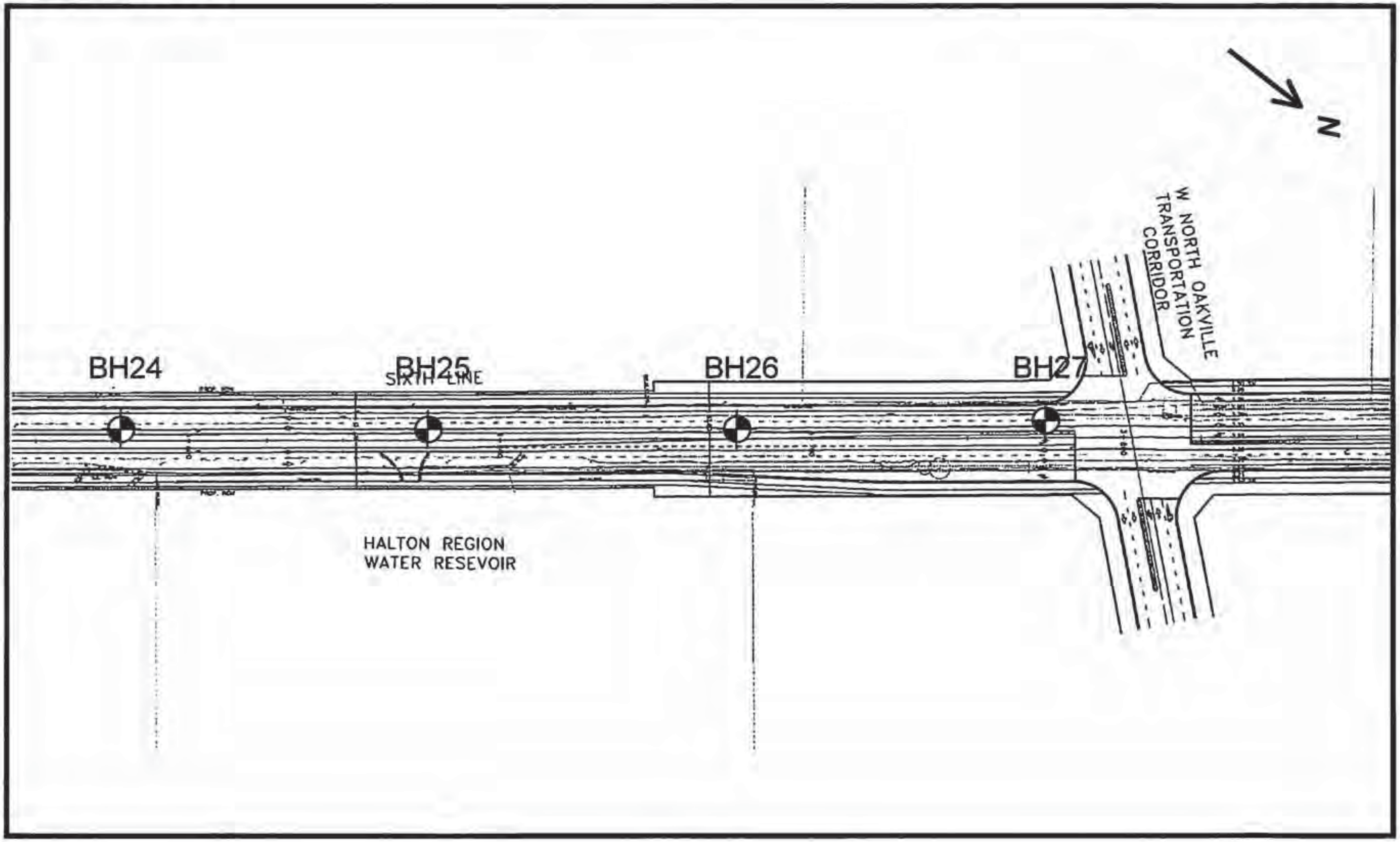
Ref. No. 6223-13-1

Enclosure 1F



BOREHOLE LOCATION PLAN

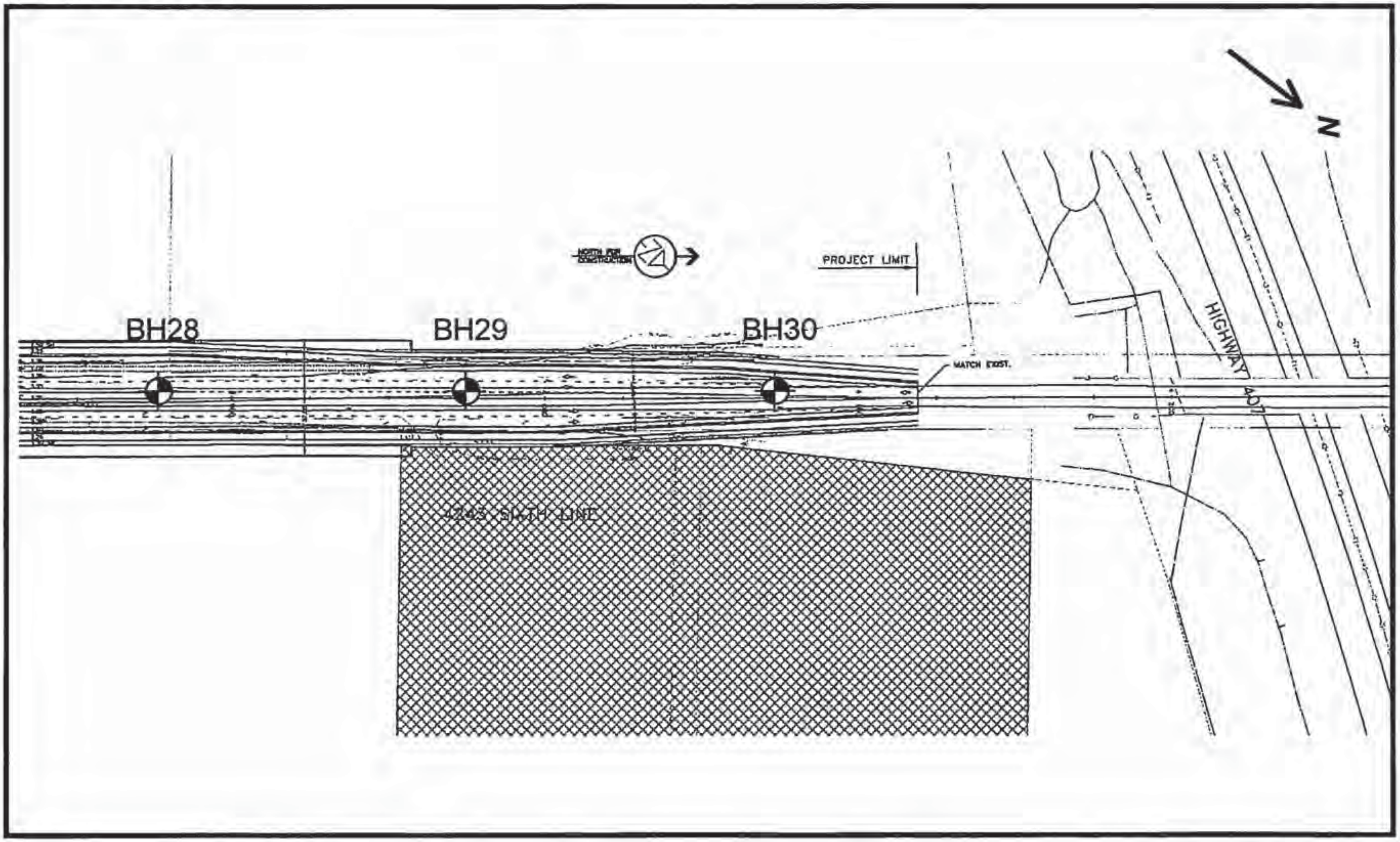
Enclosure 1G



BOREHOLE LOCATION PLAN

Ref. No. 6223-13-1

Enclosure 1H



BOREHOLE LOCATION PLAN

Reference No : 6223-13-1

Borehole No : 1

Enclosure No : 2

Client : Morrison Hershfield

Project : Class EA Sixth Line

Location : Dundas St to Burnhamthorpe Rd, Oakville

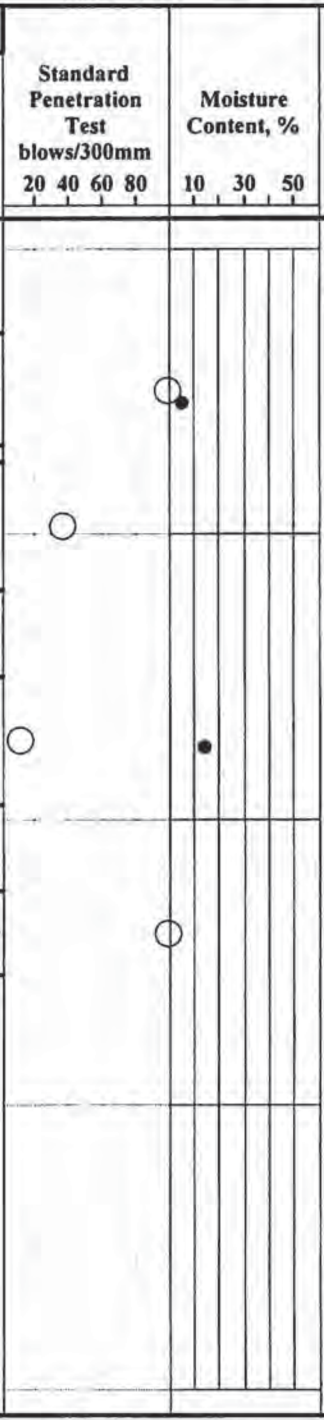
Datum Elevation : Geodetic

Method : Auger

Diameter : 110 mm

Date : March 14, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
170.2	0	Ground Surface								
169.72		*PAVEMENT* Asphalt 175mm Granular Base 300mm		DRY						Borehole open and dry on completion
168.9	1	*FILL* Gravelly sand, trace silt and asphalt fragments, damp, dense to very dense			1 2	SS SS	100+ 36			
167.65	2	*CLAYEY SILT TILL* Hard, some fine to medium gravel, reddish brown, moist			3 4	SS SS	11 100+			
	3 4	End of Borehole								



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Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 2

Enclosure No : 3

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

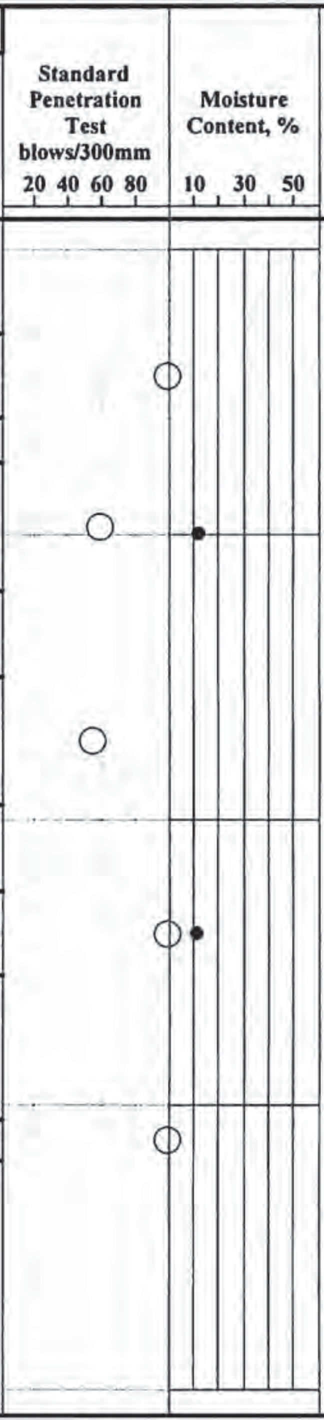
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : March 14, 2013

SUBSURFACE PROFILE					SAMPLE			
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Remarks
170.1	0	Ground Surface						
		PAVEMENT Asphalt 175mm Granular Base 250mm						Borehole open and dry on completion
169.68		***CLAYEY SILT TILL*** Hard, some fine to medium gravel, reddish brown, moist		D R Y	1	SS	100+	
	1				2	SS	59	
					3	SS	54	
168	2	***SANDY SILT TILL*** Very dense, some fine to medium gravel, brown, moist			4	SS	100+	
	3				5	SS	100+	
166.9		End of Borehole						
	4							



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 3

Enclosure No : 4

Client : Morrison Hershfield

Project : Class EA Sixth Line

Location : Dundas St to Burnhamthorpe Rd, Oakville

Datum Elevation : Geodetic

Method : Auger

Diameter : 110 mm

Date : March 28, 2013

SUBSURFACE PROFILE					SAMPLE			Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value			
171.1	0	Ground Surface								
170.8		*PAVEMENT* Asphalt 150mm Granular Base 150mm								
	1	*FILL* Gravelly sand, trace silt , damp, dense then compact	▨	DRY	1 2	SS SS	44 17	○ ○		
169.6		*STONE* 20mm stone, trace sand, a fragment of blue PVC pipe encountered			3	SS	8	○		
169.15	2	End of Borehole								
	3									
	4									

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 4

Enclosure No : 5

Client : Morrison Hershfield

Project : Class EA Sixth Line

Location : Dundas St to Burnhamthorpe Rd, Oakville

Datum Elevation : Geodetic

Method : Auger

Diameter : 110 mm

Date : April 4, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
171.7	0	Ground Surface								
171.3		***PAVEMENT*** Asphalt 100mm Granular Base 300mm								Borehole open and dry on completion
		CLAYEY SILT TILL Stiff to very stiff, trace fine gravel, greenish to reddish brown, moist		D R Y	1	SS	39	○		
	1				2	SS	15	○		
169.6	2				3	SS	13	○		
		SANDY SILT TILL Very dense, some fine to medium gravel, reddish brown then brick red, moist			4	SS	100+	○		
168.5	3				5	SS	100+	○		
	4	End of Borehole								

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 5

Enclosure No : 6

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : March 28, 2013

SUBSURFACE PROFILE					SAMPLE			Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value			
171.5		Ground Surface								
171	0	***PAVEMENT*** Asphalt 125mm Granular Base 375mm			1	SS	100+			Borehole open and dry on completion
170.2	1	***FILL*** Organic stained clayey to sandy silt, some decayed organic matter, trace gravel, organic odour, dark grey, moist, compact		DRY	2	SS	25			
169.7		***CLAYEY SILT TILL*** Hard, some fine to medium gravel, reddish brown, moist			3	SS	100+			
168.3	2 3	***WEATHERED SHALE*** Highly weathered, brick red, damp			4 5	SS SS	100+ 100+			
	4	End of Borehole								

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 6

Enclosure No : 7

Client : Morrison Hershfield

Project : Class EA Sixth Line

Location : Dundas St to Burnhamthorpe Rd, Oakville

Datum Elevation : Geodetic

Method : Auger

Diameter : 110 mm

Date : March 28, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
173	0	Ground Surface								
172.62		**PAVEMENT** Asphalt 125mm Granular Base 250mm								Borehole open and dry on completion
172.3		**FILL** Gravelly sand, trace asphalt fragments, dense, damp			1	SS	38	○		slight petrohydrocarbon odour
171.7	1	**CLAYEY SILT TILL** Hard, some fine to medium gravel, reddish brown, moist			2	SS	45	○		
169.8	2 3	**WEATHERED SHALE** Highly weathered, brick red, damp		DRY	3 4 5	SS SS SS	100+ 100+ 100+	○ ○ ○		
	4	End of Borehole								

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 7

Enclosure No : 8

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : March 28, 2013

SUBSURFACE PROFILE					SAMPLE			Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value			
174.2	0	Ground Surface								Borehole open and dry on completion
173.82		***PAVEMENT*** Asphalt 125mm Granular Base 250mm								
					1	SS	14			
	1	***CLAYEY SILT TILL*** Very stiff, then hard, some fine to medium gravel, greenish to reddish brown, moist		DRY	2	SS	40			
					3	SS	83			
172.1	2									
		SANDY SILT TILL Very dense, some clay and fine to medium gravel, reddish brown, moist			4	SS	100+			
171	3				5	SS	100+			
		End of Borehole								
	4									

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Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 8

Enclosure No : 9

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

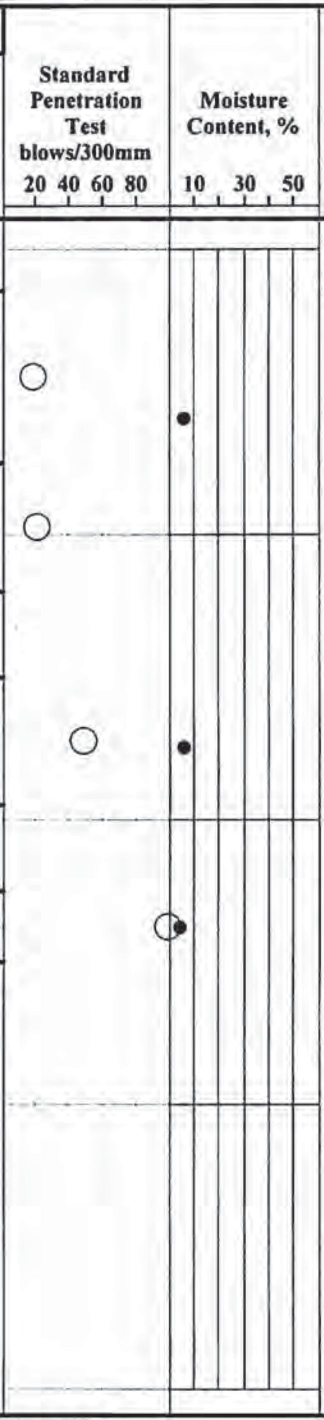
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : April 9, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
173.8	0	Ground Surface								Borehole open and dry on completion
173.45		*PAVEMENT* Asphalt 100mm Granular Base 250mm								
172.5	1	*FILL* Organic stained silty clay, some topsoil and gravel, grey, moist, compact		DRY	1 2	SS SS	19 21			
171.7	2	*CLAYEY SILT TILL* Hard, trace fine to medium gravel, reddish brown, moist			3	SS	49			
171.3		*WEATHERED SHALE* Highly weathered, brick red, damp			4	SS	100+			
	3 4	End of Borehole								



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 9

Enclosure No : 10

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : April 9, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
173.7	0	Ground Surface								
173.35		*PAVEMENT* Asphalt 100mm Granular Base 250mm								Borehole open and dry on completion
172.95		*FILL* Organic stained silty clay, trace gravel and organics, grey, moist, compact			1	SS	12			
171.9	1	*CLAYEY SILT TILL* Hard, trace fine to medium gravel, reddish brown, moist		D R Y	2 3	SS SS	39 100+			
171.75		*WEATHERED SHALE* Highly weathered, brick red, damp								
	2	End of Borehole								
	3									
	4									

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 10

Enclosure No : 11

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

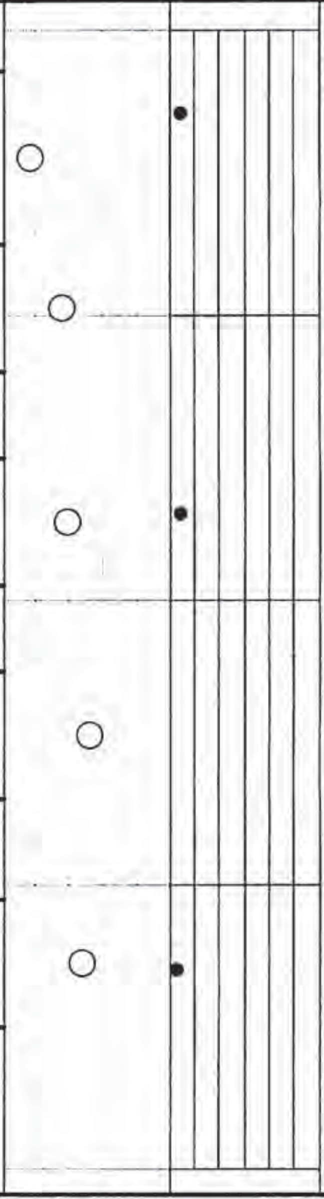
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : April 9, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
173.9	0	Ground Surface								
173.55		*PAVEMENT* Asphalt 100mm Granular Base 250mm								Borehole open and dry on completion
173.15		*FILL* Organic stained silty clay, some topsoil and gravel, grey, moist, compact			1	SS	16			
171.8	1 2	*CLAYEY SILT TILL* Hard, trace fine to medium gravel, reddish brown, moist		DRY	2 3	SS SS	35 39			
170.4	3	*WEATHERED SHALE* Highly weathered, brick red, damp			4 5	SS SS	52 48			
	4	End of Borehole								



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 11

Enclosure No : 12

Client : Morrison Hershfield

Project : Class EA Sixth Line

Location : Dundas St to Burnhamthorpe Rd, Oakville

Datum Elevation : Geodetic

Method : Auger

Diameter : 110 mm

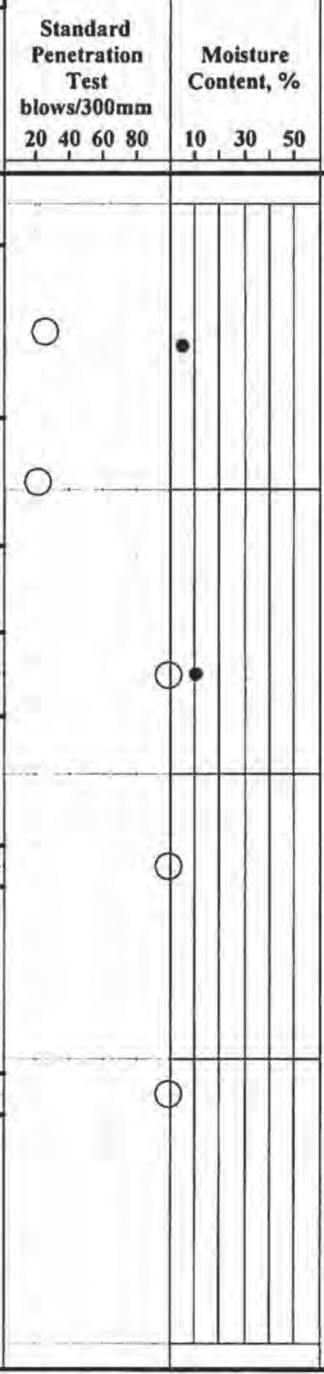
Date : April 4, 2013

SUBSURFACE PROFILE

Elevation m	Depth m	Description	Water
174.4	0	Ground Surface	
174		*PAVEMENT* Asphalt 125mm Granular Base 275mm	
173.8		*FILL* Gravelly sand, compact	
173.1	1	*CLAYEY SILT TILL* Very stiff, weathered, trace fine gravel, reddish brown, moist	
171.6	2	*SANDY SILT TILL* Very dense, some gravel, reddish brown to brick red, moist	D R Y
171.2	3	*WEATHERED SHALE* Highly weathered, brick red, wet	
	4	End of Borehole	

SAMPLE

Number	Type	N-value
1	SS	25
2	SS	21
3	SS	100+
4	SS	100+
5	SS	100+



Remarks

Borehole open and dry on completion

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 12

Enclosure No : 13

Client : Morrison Hershfield

Project : Class EA Sixth Line

Location : Dundas St to Burnhamthorpe Rd, Oakville

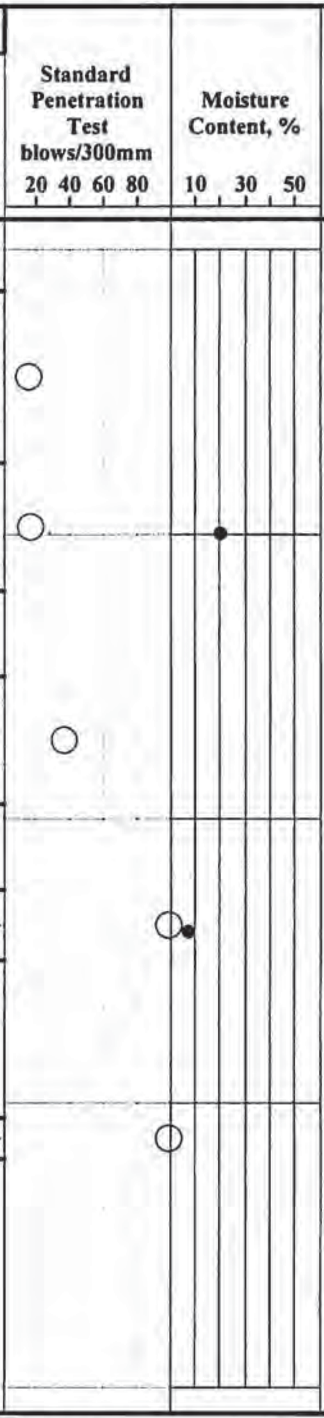
Datum Elevation : Geodetic

Method : Auger

Diameter : 110 mm

Date : April 4, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
175.1	0	Ground Surface								Borehole open and dry on completion
174.67		***PAVEMENT*** Asphalt 125mm Granular Base 300mm								
174.5		***FILL*** Gravelly sand, compact			1	SS	15			
173.8	1	***CLAYEY SILT TILL*** Stiff, weathered, trace fine gravel, brown, moist			2	SS	16			
172.3	2	***SANDY SILT TILL*** Dense to very dense, some gravel, greenish to reddish brown to brick red, moist		D R Y	3 4	SS SS	37 100+			
171.9	3	***WEATHERED SHALE*** Highly weathered, brick red, damp			5	SS	100+			
	4	**End of Borehole**								



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 13

Enclosure No : 14

Client : Morrison Hershfield

Project : Class EA Sixth Line

Location : Dundas St to Burnhamthorpe Rd, Oakville

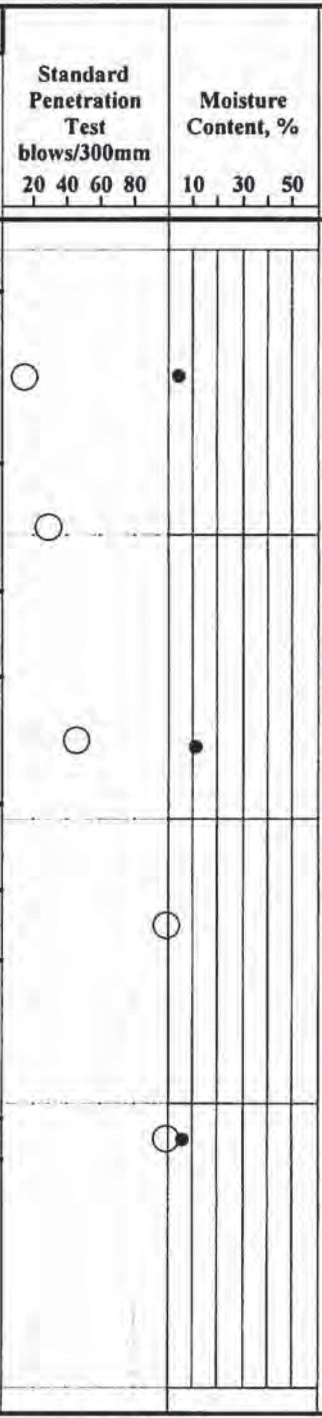
Datum Elevation : Geodetic

Method : Auger

Diameter : 110 mm

Date : April 4, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
175.9	0	Ground Surface								Borehole open and dry on completion
175.57		**PAVEMENT** Asphalt 75mm Granular Base 250mm								
175.3		**FILL** Gravelly sand, compact			1	SS	14			
	1			DRY	2	SS	29			
		SANDY SILT TILL Compact, then dense to very dense, some gravel, greenish to reddish brown, moist			3	SS	46			
173.1	2				4	SS	100+			
172.7	3	**WEATHERED SHALE** Highly weathered, brick red, damp			5	SS	100+			
	4	End of Borehole								



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 14

Enclosure No : 15

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

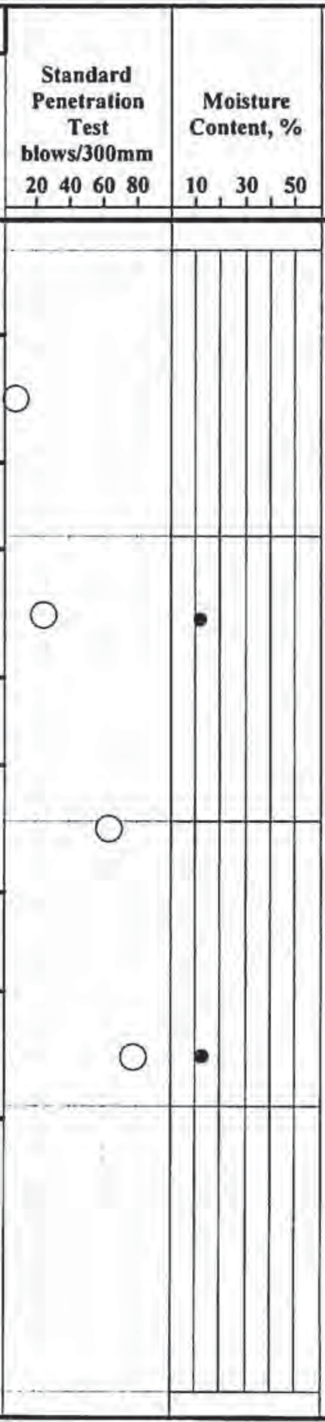
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
175.7	0	Ground Surface								
175.3		***PAVEMENT*** Asphalt 125mm Granular Base 275mm								Borehole open and dry on completion
174.8		***FILL*** Organic silty clay, trace gravel and organics, dark grey, moist, loose			1	SS	7	○		
174.1	1	***CLAYEY SILT TILL*** Very stiff, trace fine gravel, brown, moist		DRY	2	SS	24	○	●	
172.65	2	***SANDY SILT TILL*** Very dense, some fine to medium gravel, brown, moist			3 4	SS SS	63 78	○ ○	 ●	
	3	End of Borehole								
	4									



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 15

Enclosure No : 16

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
176.1	0	Ground Surface								
175.68		*PAVEMENT* Asphalt 125mm Granular Base 300mm								Borehole open and dry on completion
175.2		*FILL* Organic silty clay, trace gravel and topsoil, dark grey, moist, loose			1	SS	9			
174.5	1	*CLAYEY SILT TILL* Hard, trace fine gravel, brown, moist		DRY	2	SS	38			
173.05	2 3	*SANDY SILT TILL* Very dense, some fine to medium gravel, brown, moist			3 4	SS SS	70 82			
	4	End of Borehole								

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 16

Enclosure No : 17

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

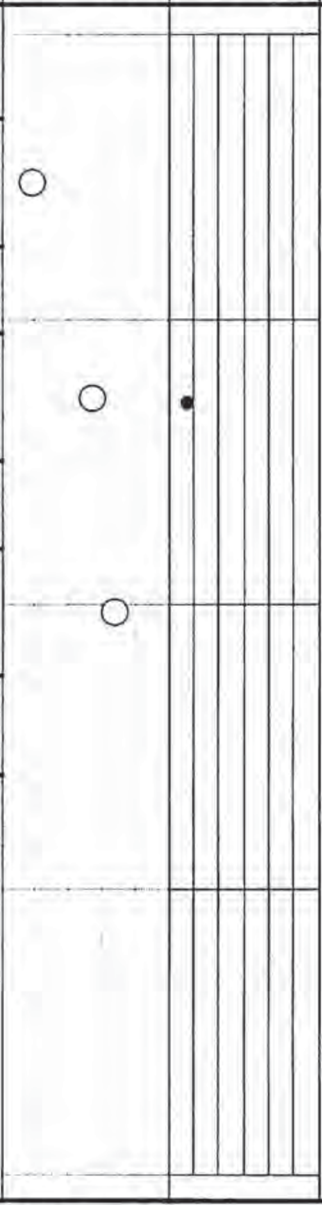
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
177	0	Ground Surface								
176.62		***PAVEMENT*** Asphalt 100mm Granular Base 275mm								Borehole open and dry on completion
176.1		***CLAYEY SILT TILL*** Stiff to very stiff, trace fine gravel, reddish brown, moist			1	SS	19	○		
174.4	1	***SANDY SILT TILL*** Very dense, some fine to medium gravel, brown, moist		DRY	2	SS	54	○	●	
	2				3	SS	68	○		
		auger refusal at 2.6m								
		End of Borehole								
	3									
	4									



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 17

Enclosure No : 18

Client : Morrison Hershfield

Project : Class EA Sixth Line

Location : Dundas St to Burnhamthorpe Rd, Oakville

Datum Elevation : Geodetic

Method : Auger

Diameter : 110 mm

Date : April 9, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
177.4	0	Ground Surface								Borehole open and dry on completion
177.02		***PAVEMENT*** Asphalt 125mm Granular Base 250mm								
176.6		***FILL*** Topsoil and organic stained silty clay, trace asphalt fragments, grey, moist, compact			1	SS	10	○		
175.3	1	***CLAYEY SILT TILL*** Very stiff, trace fine gravel, reddish brown, moist		DRY	2	SS	18	○		
					3	SS	17	○		
174.2	2	***SANDY SILT TILL*** Very dense, some fine to medium gravel, reddish brown, moist			4	SS	87	○		
	3				5	SS	100+	○		
		End of Borehole								
	4									

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 18

Enclosure No : 19

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : April 9, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
178.3	0	Ground Surface								
177.93		*PAVEMENT* Asphalt 125mm Granular Base 250mm								Borehole open and dry on completion
177.5		*FILL* Organic stained silty clay, some wood fragments and decayed organics, grey, moist, compact			1	SS	10	○		
	1	*SANDY SILT TILL* Compact to very dense, some clay and fine to medium gravel, reddish brown, moist		DRY	2	SS	21	○		
					3	SS	43	○		
	2				4	SS	58	○		
175.1	3				5	SS	100+	○		
	4	End of Borehole								

V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 19

Enclosure No : 20

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : April 9, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
180.3		Ground Surface								
	0	*PAVEMENT* Asphalt 125mm Granular Base 250mm								Borehole open and dry on completion
179.93		*FILL* Topsoil and organic stained silty clay, grey, moist, compact			1	SS	13	○		
	1				2	SS	23	○		
179		*SANDY SILT TILL* Dense to very dense, some fine to medium gravel, reddish brown, moist		DRY	3	SS	32	○		
	2				4	SS	51	○		
	3				5	SS	68	○		
176.8		End of Borehole								
	4									

V.A. WOOD ASSOCIATES LIMITED

Disk :

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Reference No : 6223-13-1

Borehole No : 20

Enclosure No : 21

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : April 9, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
184.4	0	Ground Surface								
184		***PAVEMENT*** Asphalt 150mm Granular Base 250mm								Borehole open and dry on completion
183.6		***CLAYEY SILT TILL*** Very stiff, trace fine gravel, brown, moist			1	SS	16			
180.9	1 2 3	***SANDY SILT TILL*** Dense to very dense, some fine to medium gravel, reddish brown, moist		D R Y	2 3 4 5	SS SS SS SS	39 49 71 45			
	4	End of Borehole								

V.A. WOOD ASSOCIATES LIMITED

Disk :

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Reference No : 6223-13-1

Borehole No : 21

Enclosure No : 22

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

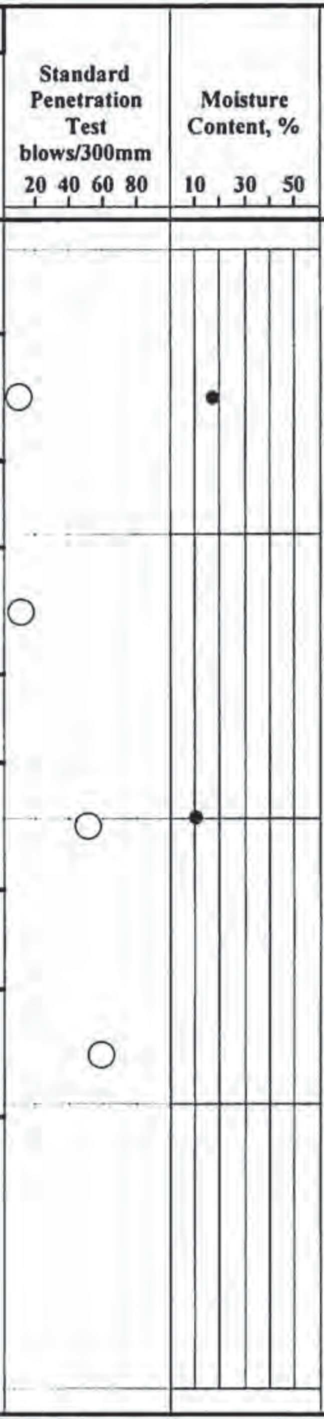
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm	Moisture Content, %	Remarks
188.1	0	Ground Surface								
187.75		***PAVEMENT*** Asphalt 100mm Granular Base 250mm								Borehole open and dry on completion
187.2		***FILL*** Organic silty clay, trace gravel and decayed plant matter, grey, moist, loose			1	SS	9			
186.5	1	***CLAYEY SILT TILL*** Firm to stiff, trace fine gravel, reddish brown, moist		DRY	2	SS	11			
185.05	2	***SANDY SILT TILL*** Very dense, some fine to medium gravel, brown, moist			3 4	SS SS	51 59			
	3	End of Borehole								
	4									



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Reference No : 6223-13-1

Borehole No : 22

Enclosure No : 23

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

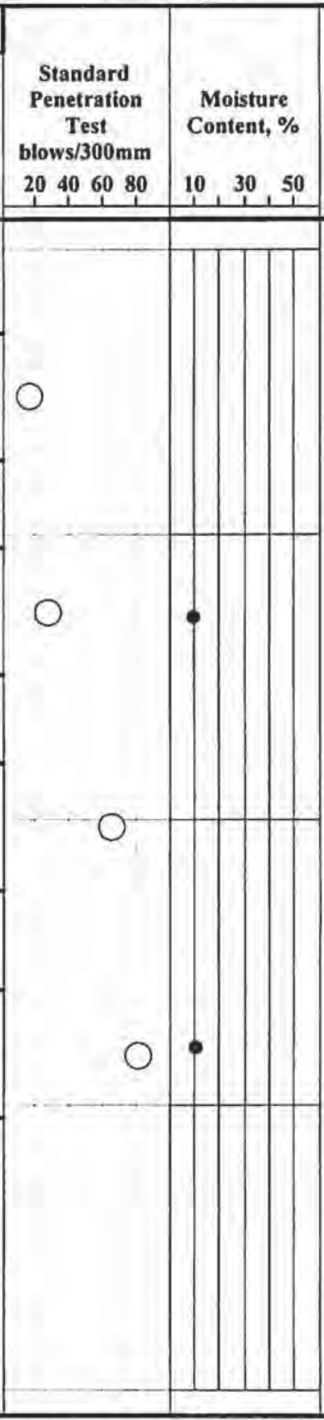
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
190.6	0	Ground Surface								
190.12		***PAVEMENT*** Asphalt 150mm Granular Base 325mm								Borehole open and dry on completion
189	1	***CLAYEY SILT TILL*** Very stiff, trace fine gravel, brown, moist		DRY	1 2	SS SS	16 28			
187.55	2 3	***SANDY SILT TILL*** Very dense, some fine to medium gravel, brown, moist			3 4	SS SS	66 81			
	4	End of Borehole								



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Reference No : 6223-13-1

Borehole No : 23

Enclosure No : 24

Client : Morrison Hershfield

Project : Class EA Sixth Line

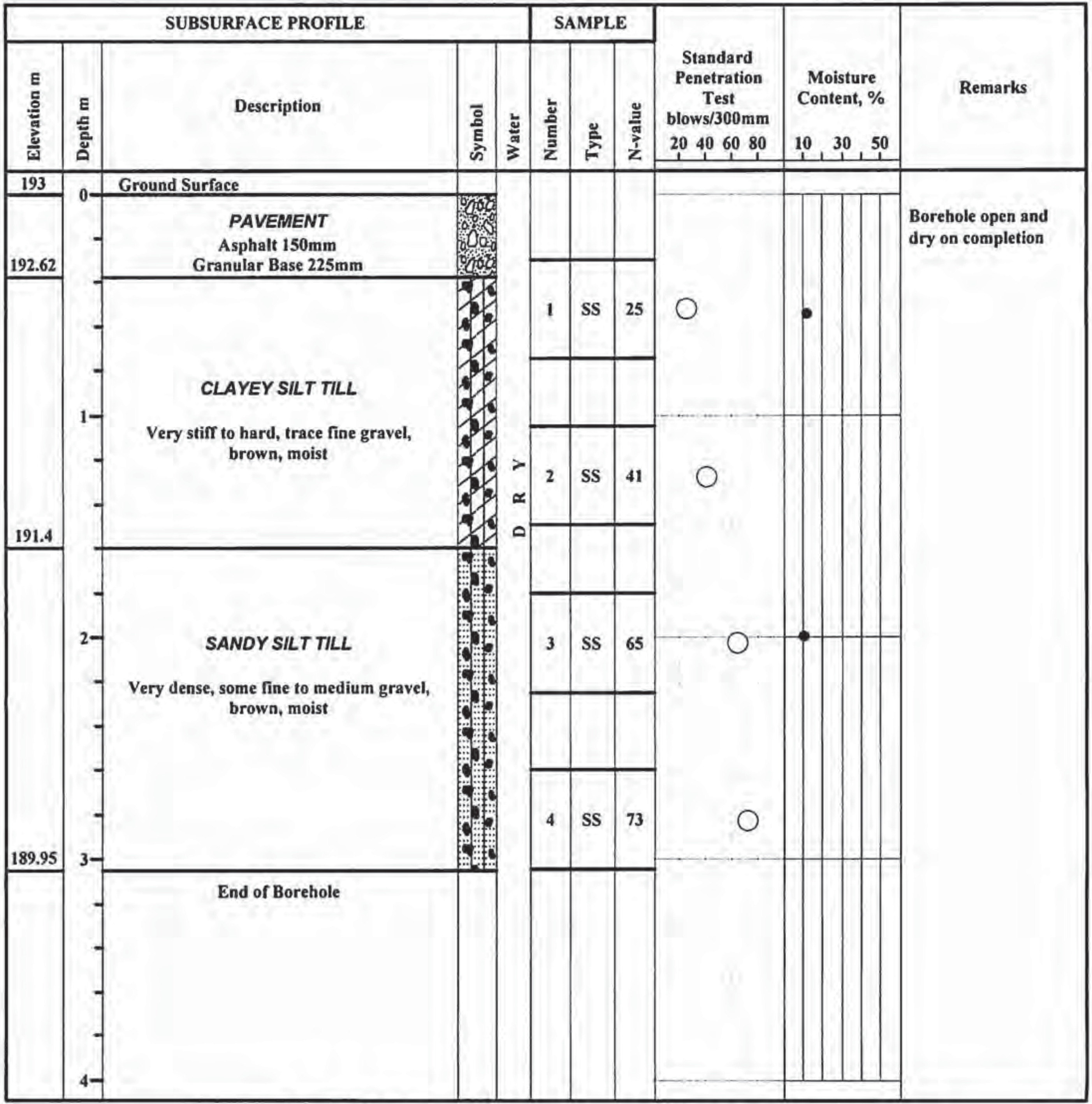
Method : Auger

Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013



SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
193	0	Ground Surface								
192.62		*PAVEMENT* Asphalt 150mm Granular Base 225mm								Borehole open and dry on completion
191.4	1	*CLAYEY SILT TILL* Very stiff to hard, trace fine gravel, brown, moist		DRY	1 2	SS SS	25 41	○ ○	●	
189.95	2 3	*SANDY SILT TILL* Very dense, some fine to medium gravel, brown, moist			3 4	SS SS	65 73	○ ○	●	
	4	End of Borehole								

V.A. WOOD ASSOCIATES LIMITED

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Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 24

Enclosure No : 25

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

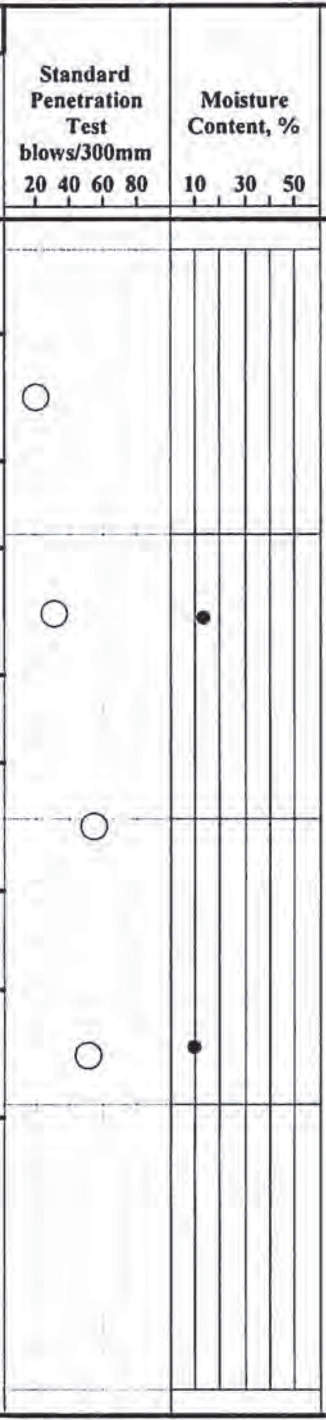
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE			
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Remarks
194		Ground Surface						
193.65	0	***PAVEMENT*** Asphalt 150mm Granular Base 200mm						Borehole open and dry on completion
		CLAYEY SILT TILL Very stiff to hard, trace fine gravel, brown, moist		DRY	1	SS	20	
192.4	1				2	SS	31	
	2	***SANDY SILT TILL*** Very dense, some fine to medium gravel, brown, moist			3	SS	54	
190.95	3				4	SS	51	
	4	End of Borehole						



V.A. WOOD ASSOCIATES LIMITED

Disk :

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Reference No : 6223-13-1

Borehole No : 25

Enclosure No : 26

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

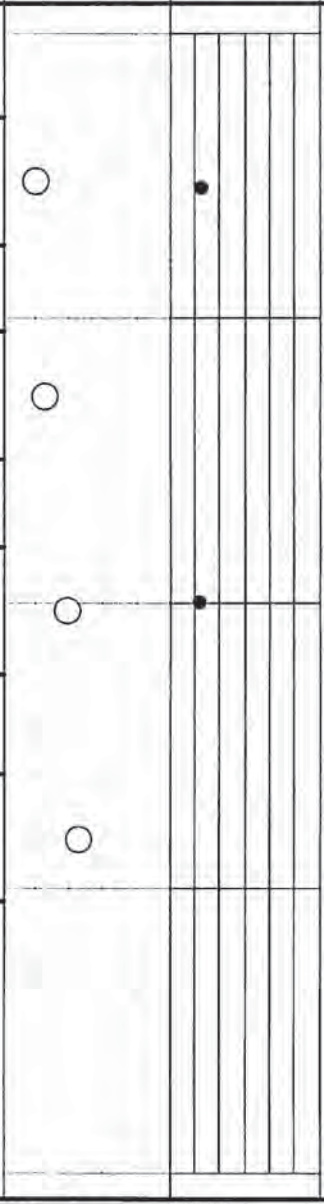
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
194.2	0	Ground Surface								
193.8		*PAVEMENT* Asphalt 150mm Granular Base 250mm								Borehole open and dry on completion
		CLAYEY SILT TILL Very stiff to hard, trace fine gravel, brown, moist		DRY	1	SS	20			
	1				2	SS	25			
	2				3	SS	39			
191.8		*SANDY SILT TILL* Dense, some fine to medium gravel, brown, moist			4	SS	45			
191.15	3	End of Borehole								
	4									



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 26

Enclosure No : 27

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

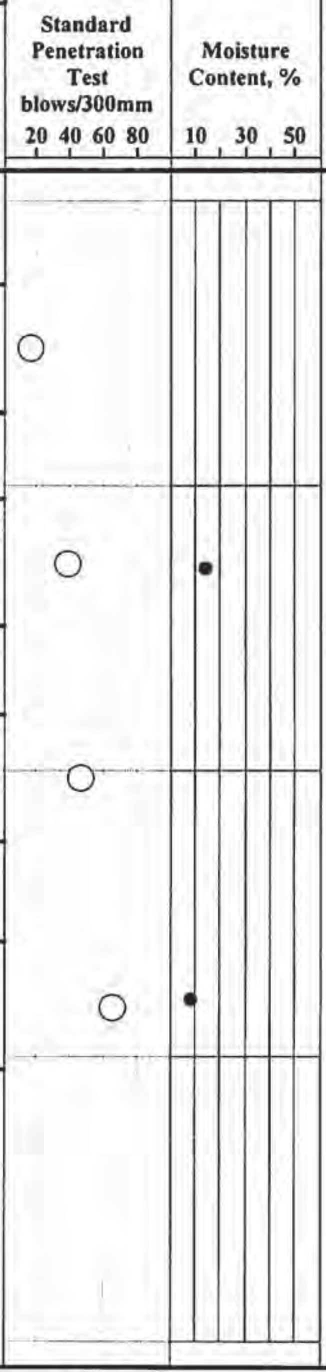
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE				
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Remarks	
194.2	0	**Ground Surface**							
193.88		***PAVEMENT*** Asphalt 125mm Granular Base 200mm						**Borehole open and dry on completion**	
					1	SS	16		
	1	***CLAYEY SILT TILL*** Very stiff to hard, trace fine gravel, brown, moist		D R Y	2	SS	39		
192.6									
	2	***SANDY SILT TILL*** Dense to very dense, some fine to medium gravel, brown, moist			3	SS	47		
					4	SS	66		
191.15	3								
		End of Borehole							
	4								



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Disk :

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Reference No : 6223-13-1

Borehole No : 27

Enclosure No : 28

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

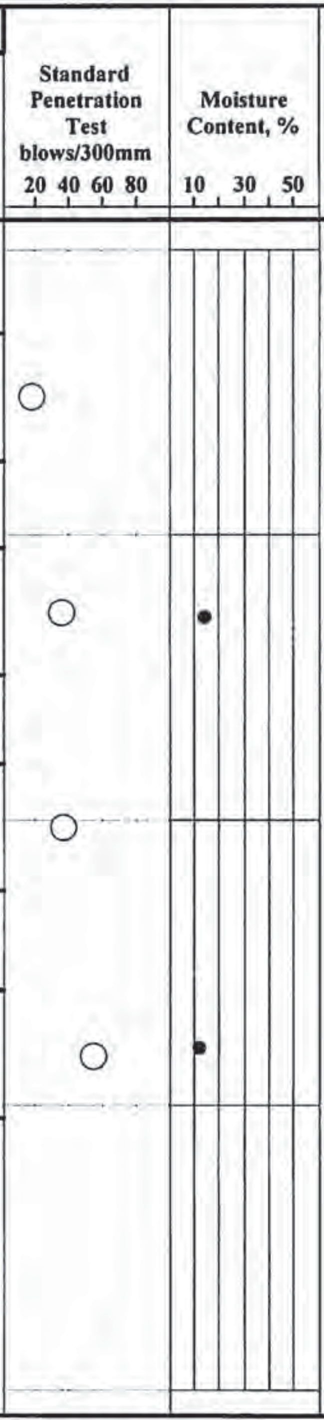
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : May 6, 2013

SUBSURFACE PROFILE					SAMPLE				
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm / Moisture Content, %	Remarks
194.1	0	Ground Surface							
		PAVEMENT Asphalt 150mm Granular Base 175mm							Borehole open and dry on completion
193.78		*CLAYEY SILT TILL* Very stiff to hard, trace fine gravel, brown, moist		DRY	1	SS	17		
	1				2	SS	35		
	2				3	SS	36		
191.7		*SANDY SILT TILL* Very dense, some fine to medium gravel, brown, moist			4	SS	55		
191.05	3	End of Borehole							
	4								



V.A. WOOD ASSOCIATES LIMITED

Disk :

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Reference No : 6223-13-1

Borehole No : 28

Enclosure No : 29

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

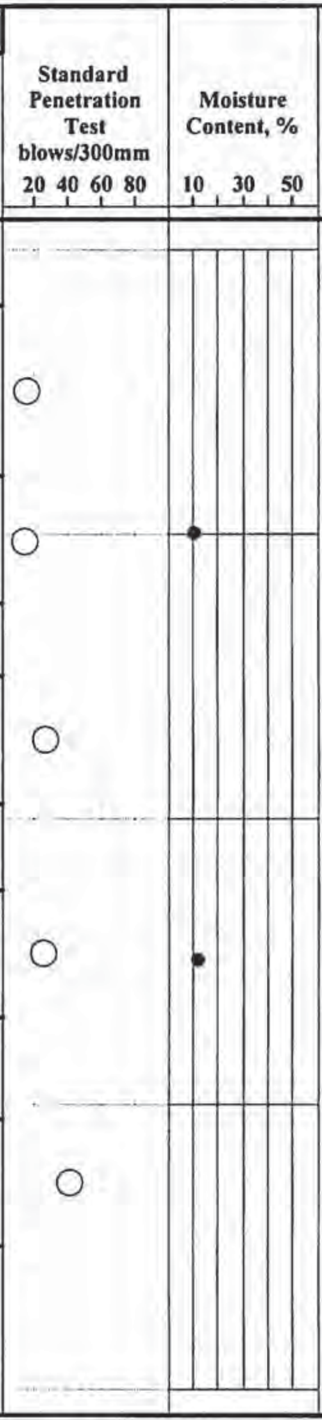
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation :

Date : April 19, 2013

SUBSURFACE PROFILE					SAMPLE					
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm 20 40 60 80	Moisture Content, % 10 30 50	Remarks
192.4		Ground Surface								
	0	***PAVEMENT*** Asphalt 125mm Granular Base 400mm								Borehole open and dry on completion
					1	SS	15			
191.87		***FILL*** Sandy silt, trace gravel, occasional organic stains, moist, compact								
191.6										
	1	***SANDY SILT TILL*** Compact to dense, some fine to medium gravel, reddish brown, moist		DRY	2	SS	14			
					3	SS	26			
	2				4	SS	25			
	3				5	SS	41			
188.9		End of Borehole								
	4									



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Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 29

Enclosure No : 30

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

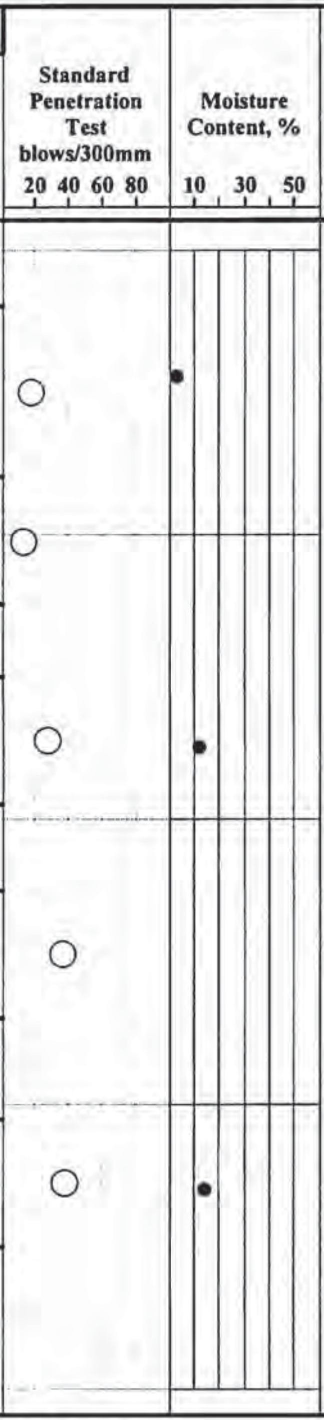
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : April 19, 2013

SUBSURFACE PROFILE					SAMPLE			Remarks
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	
190.7	0	Ground Surface						
190.17		***PAVEMENT*** Asphalt 125mm Granular Base 400mm			1	SS	17	Borehole open and dry on completion
189.4	1	***FILL*** Organic stained sandy silt, trace topsoil and organics, compact		DRY	2	SS	13	
187.2	2 3	***SANDY SILT TILL*** Compact to dense, some fine to medium gravel, reddish brown, moist			3 4 5	SS SS SS	28 36 38	
	4	End of Borehole						



V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

Reference No : 6223-13-1

Borehole No : 30

Enclosure No : 31

Client : Morrison Hershfield

Project : Class EA Sixth Line

Method : Auger

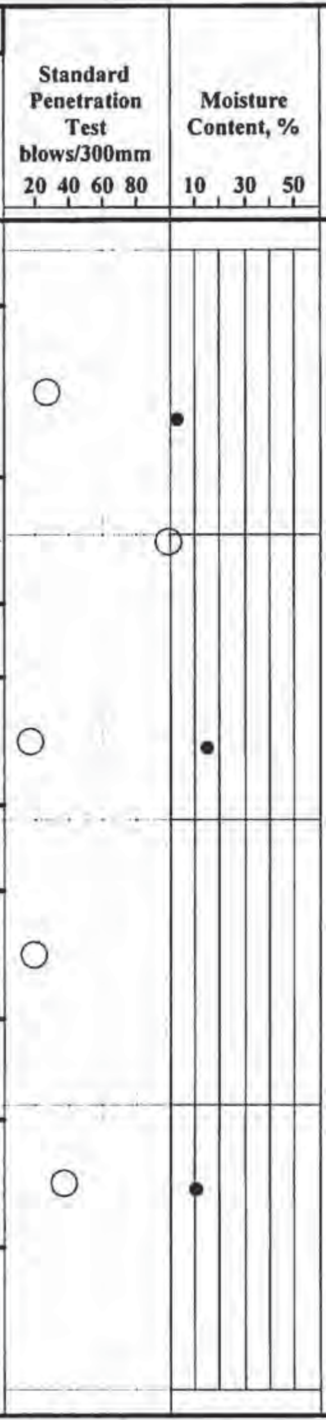
Location : Dundas St to Burnhamthorpe Rd, Oakville

Diameter : 110 mm

Datum Elevation : Geodetic

Date : April 19, 2013

SUBSURFACE PROFILE					SAMPLE			
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Remarks
192	0	Ground Surface						
191.43		*PAVEMENT* Asphalt 125mm Granular Base 450mm			1	SS	26	Borehole open and dry on completion
190.7	1	*FILL* Gravelly sand with limestone fragments, very dense		DRY	2	SS	100+	
189.9	2	*FILL* Organic stained clayey silt, trace topsoil and organics, compact			3	SS	16	
188.5	3	*SANDY SILT TILL* Compact to dense, some fine to medium gravel, reddish brown, moist			4 5	SS SS	18 36	
	4	End of Borehole						



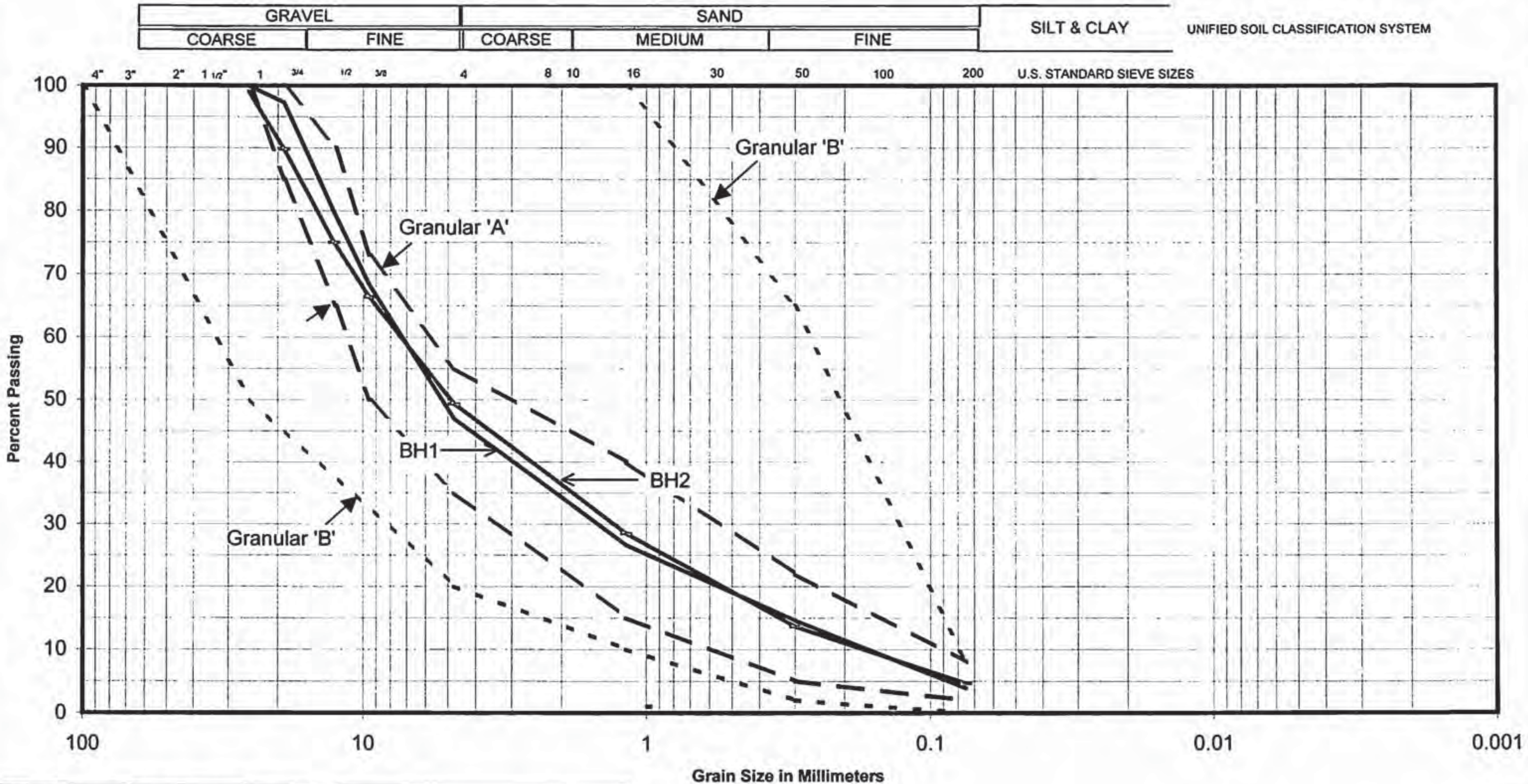
V.A. WOOD ASSOCIATES LIMITED

Disk :

Sheet : 1 of 1

GRAIN SIZE DISTRIBUTION

OUR REFERENCE No.: 6223-13-1



PROJECT: Class EA for Sixth Line, Town of Oakville

LOCATION: From Dundas St. E to Burnhamthorpe Rd. W, Oakville, ON

BOREHOLE NO.: BH1 and BH2

SAMPLE NO.: Granular Base

DEPTH:

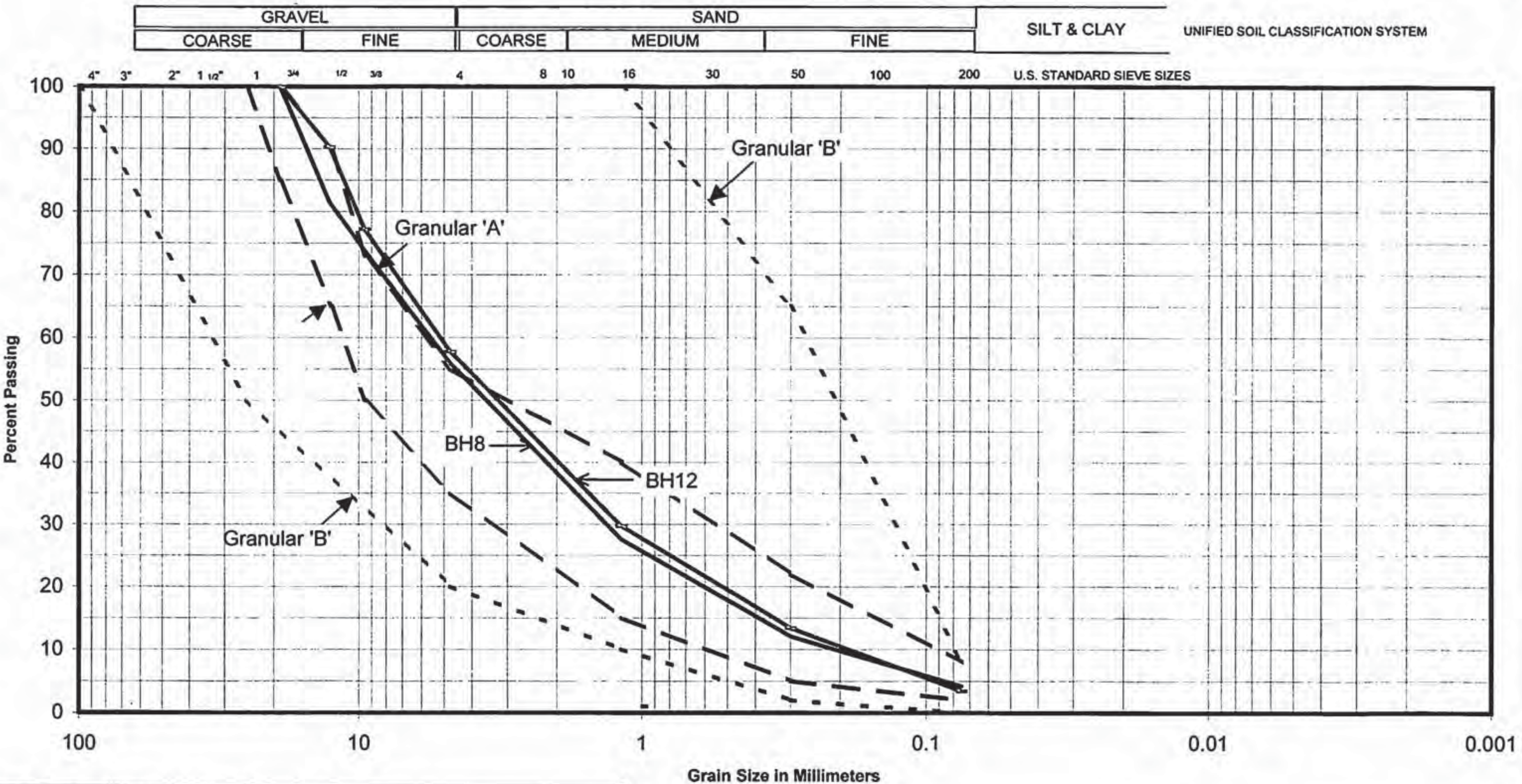
DATE: May 2013

ENCLOSURE No.: 32

EXISTING GRANULAR BASE

GRAIN SIZE DISTRIBUTION

OUR REFERENCE No.: 6223-13-1



PROJECT: Class EA for Sixth Line, Town of Oakville

LOCATION: From Dundas St. E to Burnhamthorpe Rd. W, Oakville, ON

BOREHOLE NO.: BH8 and BH12

SAMPLE NO.: Granular Base

DEPTH:

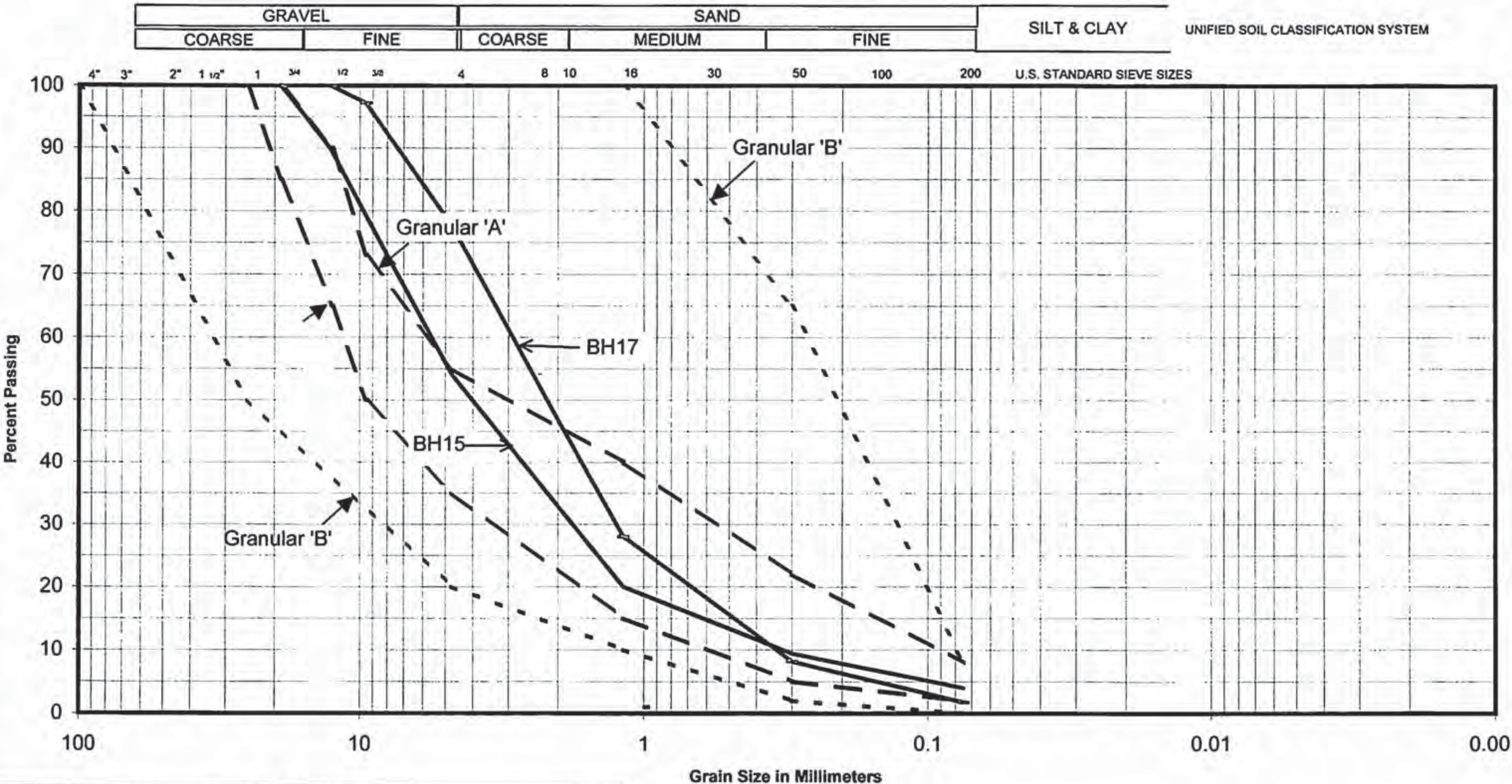
DATE: May 2013

EXISTING GRANULAR BASE

ENCLOSURE No.: 33

GRAIN SIZE DISTRIBUTION

OUR REFERENCE No.: 6223-13-1



PROJECT: Class EA for Sixth Line, Town of Oakville

LOCATION: From Dundas St. E to Burnhamthorpe Rd. W, Oakville, ON

BOREHOLE NO.: BH15 and BH17

SAMPLE NO.: Granular Base

DEPTH:

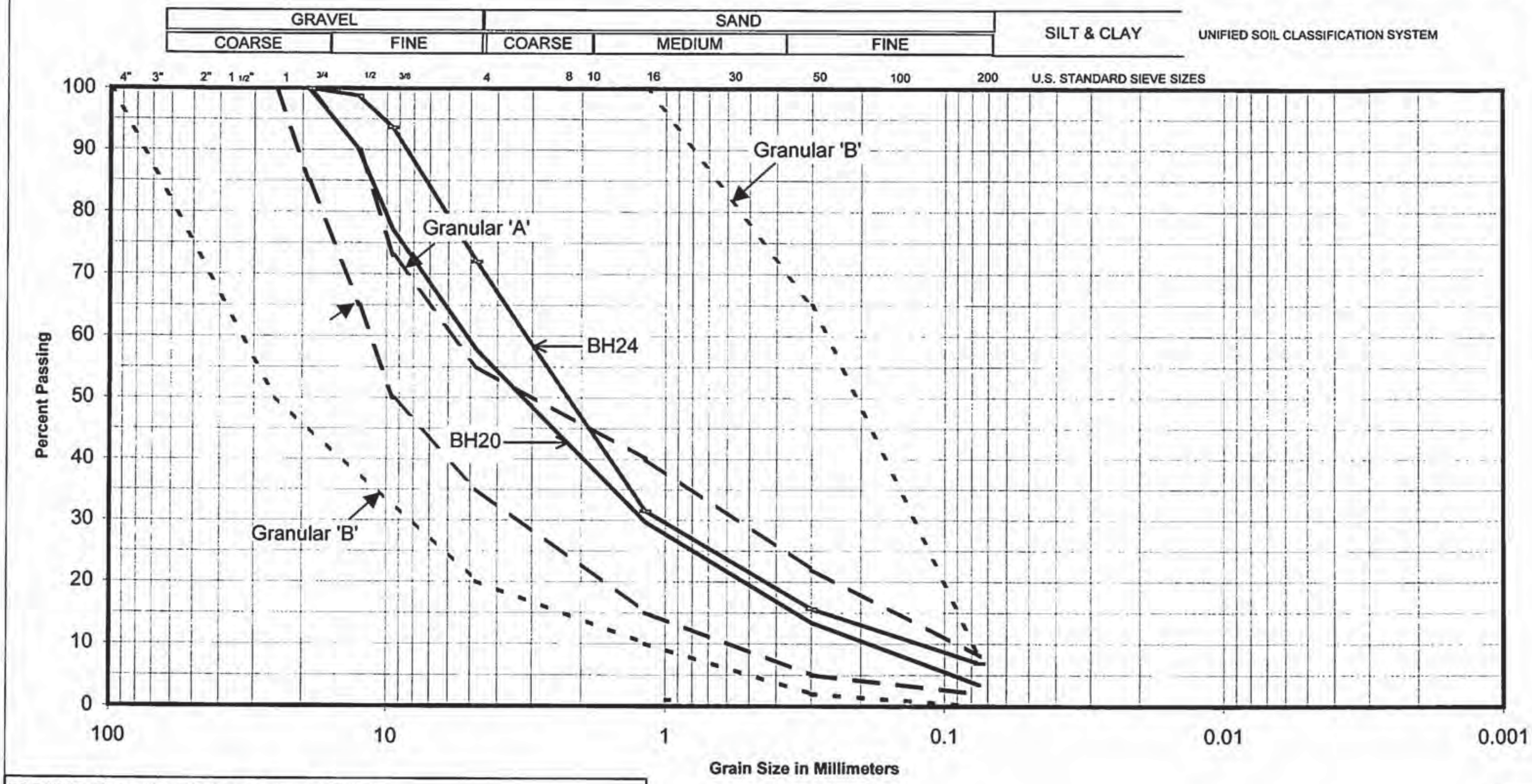
DATE: May 2013

ENCLOSURE No.: 34

EXISTING GRANULAR BASE

GRAIN SIZE DISTRIBUTION

OUR REFERENCE No.: 6223-13-1



PROJECT: Class EA for Sixth Line, Town of Oakville

LOCATION: From Dundas St. E to Burnhamthorpe Rd. W, Oakville, ON

BOREHOLE NO.: BH20 and BH24

SAMPLE NO.: Granular Base

DEPTH:

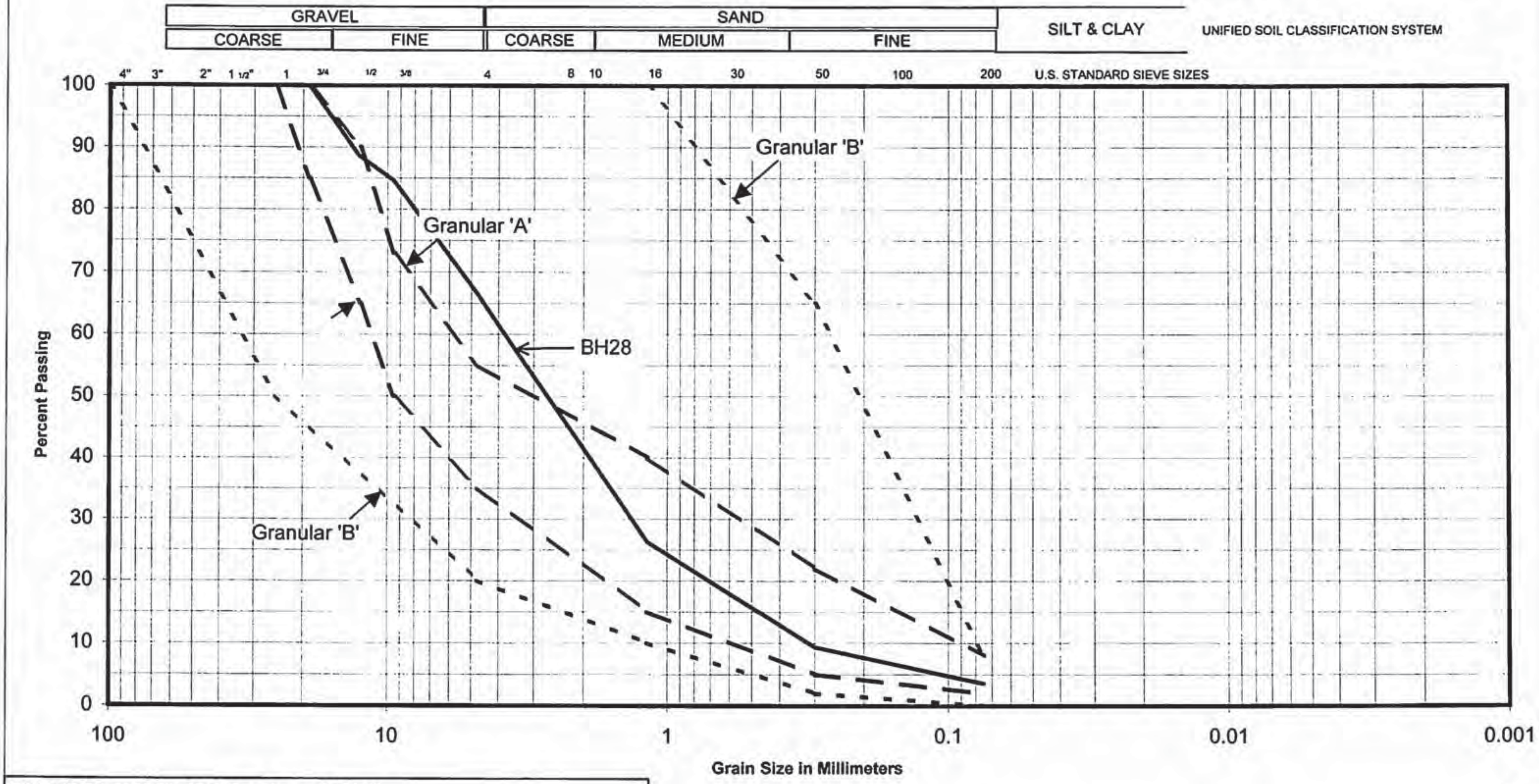
DATE: May 2013

EXISTING GRANULAR BASE

ENCLOSURE No.: 35

GRAIN SIZE DISTRIBUTION

OUR REFERENCE No.: 6223-13-1



PROJECT: Class EA for Sixth Line, Town of Oakville

LOCATION: From Dundas St. E to Burnhamthorpe Rd. W, Oakville, ON

BOREHOLE NO.: BH28

SAMPLE NO.: Granular Base

DEPTH:

DATE: May 2013

EXISTING GRANULAR BASE

ENCLOSURE No.: 36

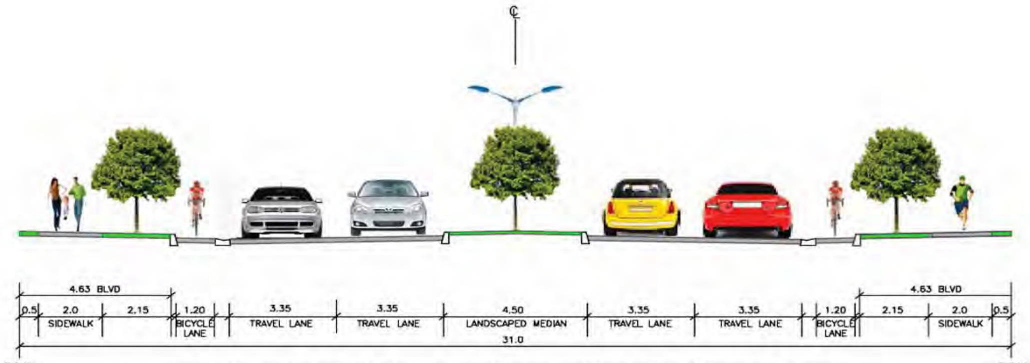
Appendix J – Design Criteria

TOWN OF OAKVILLE
ROADWAY DESIGN CRITERIA
SIXTH LINE
DUNDAS STREET TO HIGHWAY 407 (ETR)

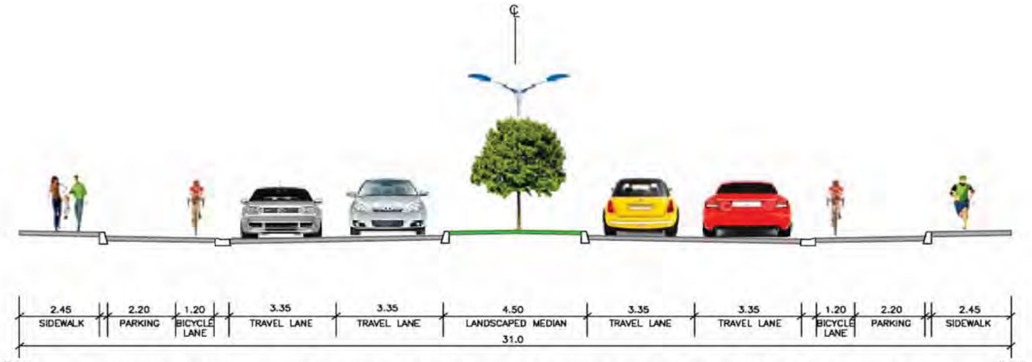
CRITERIA	TAC DESIGN STANDARD	TOWN OF OAKVILLE DESIGN STANDARD	PROPOSED ESR STANDARD
CLASSIFICATION			
ROAD CLASSIFICATIONS	UAU 70	Arterial	UAU 70
DESIGN SPEED (km/h)	70	70	70
POSTED SPEED (km/h)	60	60	60
HORIZONTAL ALIGNMENTS			
NC NORMAL CROWN (-0.02m/m) **R**min. (m)	1680	250	1680
CURVE RADIUS WITH SUPERELEV. RATE e=0.06 **R**min (m)	190	130	190
RC REVERSE CROWN (+0.02m/m) **R**min (m), for e=0.06	330	N/A	330
CURVE RADIUS WITH SUPERELEV. RATE e=0.04 **R**min (m)	200	N/A	200
RC REVERSE CROWN (+0.02m/m) **R**min (m), for e=0.04	290	N/A	290
MINIMUM TANGENT BETWEEN CURVES (m)	N/A	75	75
MINIMUM TANGENT AT INTERSECTIONS (m)	N/A	60	60
TRANSITION BETWEEN 4-LANE AND 2-LANE :			
PARALLEL LANE (m)	120-195	N/A	120-195
MERGING TAPER (m)	115	N/A	115
DIVERGING TAPER (m)	60	N/A	60
RIGHT TURN TAPER (m)	60-70	N/A	60-70
RIGHT TURN PARALLEL (m)	50-110	N/A	50-110
LEFT TURN TAPER (m)	50-140	N/A	50-140
LEFT TURN PARALLEL (m)	95-110	N/A	95-110
VERTICAL ALIGNMENTS			
MAXIMUM GRADE (%)	5	6	6
MINIMUM GRADE (%)	0.5	0.5	0.5
SAG VERTICAL CURVE, **K**min.	10-12	N/A	12
CREST VERTICAL CURVE, **K**min.	16-23	N/A	23
LENGTH OF CURVE (m) (min)	70	N/A	70
MINIMUM STOPPING SIGHT DISTANCE (m)	100-115	85-140	115
CROSS SECTIONS			
THROUGH LANE WIDTH (m) (See Note 1)	3.5-3.7	3.35	3.35
LEFT TURN LANE WIDTH (m)	3.3-3.5	3.25	3.25
RIGHT TURN LANE WIDTH (m)	3.3-3.5	3.25	3.25
CURB LANE WIDTH (m)	3.3-3.5	3.35	3.35
TANGENT SECTION CROSS FALL (%)	2%	2%	2%
SIDEWALK WIDTH (m) (min)	1.50	1.50	1.50
SIDEWALK CROSSFALL (%)	2-5%	2%	2%
LAYOUT			
RADIUS OF CURBS AT INTERSECTION			
ARTERIAL TO LOCAL (m)	N/A	10.5	10.5
ARTERIAL TO COLLECTOR (m)	N/A	10.5	10.5
ARTERIAL TO ARTERIAL (m)	N/A	15	15
RIGHT-OF-WAY			
ROW WIDTH (m) (min)		31	31

1 - Directed by Town of Oakville

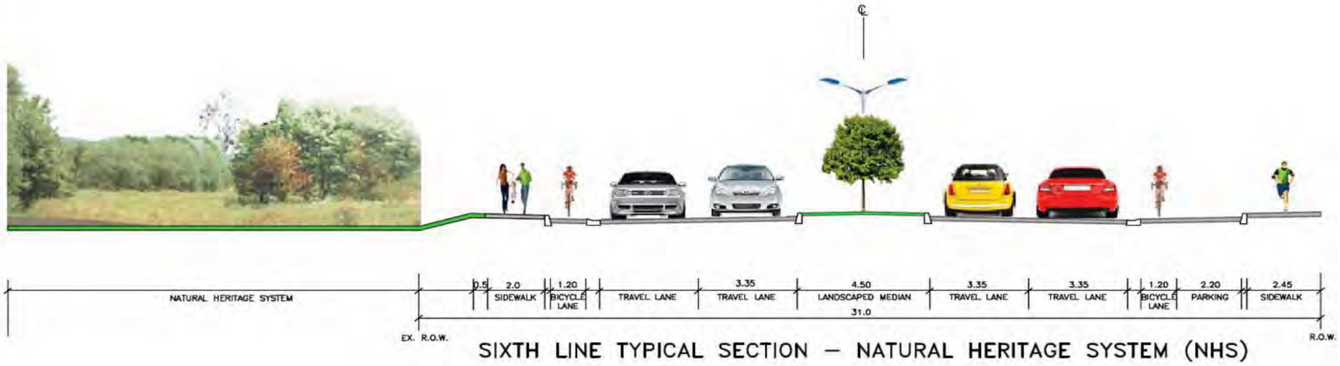
TOWN OF OAKVILLE
TYPICAL SECTIONS
SIXTH LINE
DUNDAS STREET TO HIGHWAY 407 (ETR)



SIXTH LINE TYPICAL SECTION – NO PARKING LAYBY'S



SIXTH LINE TYPICAL SECTION – PARKING LAYBY'S ON BOTH SIDES



SIXTH LINE TYPICAL SECTION – NATURAL HERITAGE SYSTEM (NHS)

Appendix K – Preliminary Cost Estimate

Preliminary Cost Estimate

SUMMARY		
Phase 1	Dundas Street to North Park Drive	$5,819,469.50
Phase 2	North Park Drive to Burnhamthorpe Road	$7,776,366.00
Phase 3	Burnhamthorpe Road to Highway 407 ETR	$4,247,925.50
	TOTAL	$17,843,761.00

Preliminary Cost Estimate
Phase 1 - Dundas Street to North Park Drive

Item	Description	Est. Qty.	Unit	Unit Price	Total Price
1	Traffic Management, Site Office and Bonds	1	L.S.	$100,000	$100,000
2	Clearing, Grubbing & Tree Removal	1	L.S.	$20,000	$20,000
3	Stripping	2690	m^3	$15	$40,350
4	Full Depth Asphalt Pavement Removal	10405	m^2	$6	$62,430
5	Miscellaneous Removals	1	L.S.	$100,000	$100,000
6	Earth Excavation and Grading	8830	m^3	$15	$132,450
7	Roadway Granular 'A' Base Course (150mm)	8805	tonne	$20	$176,100
8	Roadway Granular 'B' Base Course (450mm)	20385	tonne	$15	$305,775
9	HL3 Asphalt Pavement (50mm)	2370	tonne	$90	$213,300
10	HL8 Asphalt Pavement (100mm)	4625	tonne	$75	$346,875
11	Tack Coat	37585	m	$1	$37,585
12	Concrete Median	320	m^2	$50	$16,000
13	Concrete Curb and Gutter	4925	m	$50	$246,250
14	150mm Dia. Subdrain	1855	m	$20	$37,100
15	Concrete Sidewalk	3195	m^2	$50	$159,750
16	Silt Fencing	1700	m	$22	$37,400
17	Topsoil and Sod	6015	m^2	$10	$60,150
18	Street Tree Plantings	60	each	$500	$30,000
19	7.32 m x 1.75 m CONSPAN culvert	1	L.S.	$420,000	$420,000
20	Storm Sewer Pipes	1	L.S.	$300,000	$300,000
21	Maintenance Holes, Catchbasins and Catchbasin Leads	1	L.S.	$135,000	$135,000
22	Pavement Markings and Symbols and Signs	1	L.S.	$25,000	$25,000
23	Utility Relocation	1	L.S.	$800,000	$800,000
24	Illumination	1	L.S.	$150,000	$150,000
25	Traffic Signals	3	each	$175,000	$525,000
				Sub-total - Construction Cost	**$4,476,515**
				Engineering (10%)	**$447,652**
				Contingency (20%)	**$895,303**
				Total Construction Cost	**$5,819,470**

Preliminary Cost Estimate
Phase 2 - North Park Drive to Burnhamthorpe Road

Item	Description	Est. Qty.	Unit	Unit Price	Total Price
1	Traffic Management, Site Office and Bonds	1	L.S.	$150,000	$150,000
2	Clearing, Grubbing & Tree Removal	1	L.S.	$30,000	$30,000
3	Stripping	4855	m^3	$15	$72,825
4	Full Depth Asphalt Pavement Removal	10780	m^2	$6	$64,680
5	Miscellaneous Removals	1	L.S.	$150,000	$150,000
6	Earth Excavation and Grading	12280	m^3	$15	$184,200
7	Roadway Granular 'A' Base Course (150mm)	12750	tonne	$20	$255,000
8	Roadway Granular 'B' Base Course (450mm)	28600	tonne	$15	$429,000
9	HL3 Asphalt Pavement (50mm)	3240	tonne	$90	$291,600
10	HL8 Asphalt Pavement (100mm)	6325	tonne	$75	$474,375
11	Tack Coat	51390	m	$1	$51,390
12	Concrete Median	280	m^2	$50	$14,000
13	Concrete Curb and Gutter	8355	m	$50	$417,750
14	150mm Dia. Subdrain	2960	m	$20	$59,200
15	Concrete Sidewalk	5540	m^2	$50	$277,000
16	Silt Fencing	2700	m	$22	$59,400
17	Topsoil and Sod	11640	m^2	$10	$116,400
18	Street Tree Plantings	100	each	$500	$50,000
19	825mm Culvert	1	L.S.	$20,000	$20,000
20	Storm Sewer Pipes	1	L.S.	$400,000	$400,000
21	Maintenance Holes, Catchbasins and Catchbasin Leads	1	L.S.	$220,000	$220,000
22	Pavement Markings and Symbols and Signs	1	L.S.	$40,000	$40,000
23	Utility Relocation	1	L.S.	$1,400,000	$1,400,000
24	Illumination	1	L.S.	$230,000	$230,000
25	Traffic Signals	3	each	$175,000	$525,000
				Sub-total - Construction Cost	**$5,981,820**
				Engineering (10%)	**$598,182**
				Contingency (20%)	**$1,196,364**
				Total Construction Cost	**$7,776,366**

Preliminary Cost Estimate
Phase 3 - Burnhamthorpe Road to Highway 407 ETR

Item	Description	Est. Qty.	Unit	Unit Price	Total Price
1	Traffic Management, Site Office and Bonds	1	L.S.	$100,000	$100,000
2	Clearing, Grubbing & Tree Removal	1	L.S.	$20,000	$20,000
3	Stripping	3085	m^3	$15	$46,275
4	Full Depth Asphalt Pavement Removal	6730	m^2	$6	$40,380
5	Miscellaneous Removals	1	L.S.	$100,000	$100,000
6	Earth Excavation and Grading	10100	m^3	$15	$151,500
7	Roadway Granular 'A' Base Course (150mm)	6590	tonne	$20	$131,800
8	Roadway Granular 'B' Base Course (450mm)	15155	tonne	$15	$227,325
9	HL3 Asphalt Pavement (50mm)	1725	tonne	$90	$155,250
10	HL8 Asphalt Pavement (100mm)	3370	tonne	$75	$252,750
11	Tack Coat	27385	m	$1	$27,385
12	Concrete Median	105	m^2	$50	$5,250
13	Concrete Curb and Gutter	4265	m	$50	$213,250
14	150mm Dia. Subdrain	1785	m	$22	$39,270
15	Concrete Sidewalk	2475	m^2	$50	$123,750
16	Silt Fencing	1800	m	$22	$39,600
17	Topsoil and Sod	12885	m^2	$10	$128,850
18	Street Tree Plantings	70	each	$500	$35,000
19	Storm Sewer Pipes	1	L.S.	$300,000	$300,000
20	Maintenance Holes, Catchbasins and Catchbasin Leads	1	L.S.	$150,000	$150,000
21	Pavement Markings and Symbols and Signs	1	L.S.	$30,000	$30,000
22	Utility Relocation	1	L.S.	$800,000	$800,000
23	Illumination	1	L.S.	$150,000	$150,000
				Sub-total - Construction Cost	**$3,267,635**
				Engineering (10%)	**$326,764**
				Contingency (20%)	**$653,527**
				Total Construction Cost	**$4,247,926**