# SECTION THREE STORMWATER MANAGEMENT DESIGN

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## OVERVIEW

Since the redevelopment began at LTP in 2008, the drainage system has been designed and upgraded to meet or exceed the current regulations for stormwater treatment and peak attenuation. A Notice of Intent was filed in 2007 for the development of 400 and 200 Shire Way. An Order of Conditions was issued in February 2008.

The drainage system has been updated for the 200 Shire Way project in 2009 and the 300 Shire Way building addition in 2010. Each time the Applicant presented updated calculations and information to the ZBA and to the Conservation Commission.

The Applicant will be filing for an Amendment to the current Order of Conditions for the proposed expansion of the parking areas. The Applicant has recently met with the Conservation Commission to review the project.

The following information demonstrates that the expanded parking remains within the design parameters of the original design including impervious coverage, quality of stormwater discharges, peak flows, and the drainage system hydrology and hydraulics.

## DRAINAGE SYSTEM

The proposed parking expansions will not make any substantial changes to the drainage system. The overall drainage system collects runoff from the portion of the site containing buildings and parking areas for 125 Spring Street, and 200, 300 and 400 Shire Way. This portion of the site is divided into two stormwater collection branches that discharge to one of two forebays on each side of the detention basin. The parking expansion will contribute more runoff to the east forebay from the current conditions, but is within the parameters of the original design.

The water quality of discharges will not be affected by the proposed parking expansions. All catch basins will have deep sumps and hoods. All proposed areas are then tributary to the detention pond and forebays. Additionally, since proposed Lot A will continue to be used for snow storage, all runoff discharging from Lot A will be routed through a water quality unit such as a Stormceptor for added treatment.

## DRAINAGE PIPE DESIGN

The storm drainage system associated with the recent 400, 200 and 300 Shire Way developments are designed using the rational method. The pipe system extending back to the proposed southeastern lot (Lot A) was constructed with a stub for the future reserve parking area, and the pipes design for the additional runoff. The existing pipes through the proposed parking lot south of 125 Spring Street (Lot B) also had additional capacity.

We analyzed the drainage system for the expanded parking lot areas, and all pipes will remain below capacity in the 10-year storm event. Calculation sheets are provided within this Section.

## IMPERVIOUS COVERAGE

The expanded reserve parking areas increase the impervious coverage by 18,784 SF, as compared to the previously designed two 35 space reserve parking lots. This results in a total impervious coverage of 1,086,384 SF, approximately 7,000 SF less than the impervious area in the original system design. The original system was designed with a total impervious coverage of 1,093,301 SF throughout LTP. The total impervious coverage indicated above includes the 400 Shire Way 85 space reserve parking area that has not been constructed.

| Impervious Coverage of Reserve Parking Lots | | | |
|---|---|---|---|
| Lot | Approved Design (SF) | Proposed Design (SF) | Increased Area (SF) |
| A | 13,479 | 27,167 | 13,688 |
| B | 12,564 | 17,660 | 5,096 |
| Total | 26,043 | 44,827 | 18,784 |

## PEAK DISCHARGE SUMMARY

The following Tables summarize the stormwater runoff peak flows from the 7 design points at LTP. The 3 tables show:

- Pre-existing peak flows (prior to 400 Shire Way and the detention pond system),
- Post-development peak flows based on the design approved in 2008,
- Post-development peak flows for the 200 Shire Way re-design,
- Post-development peak flows including the 300 Shire Way building addition, and
- Proposed parking lot expansion for Lots A & B.

In each of the 3 storm events the peak flows for the current design are at or below the pre-existing condition peak flows.

Table 1.1 – 2-Year Peak Discharge Runoff Summary

| | 2 Year Peak Flow (CFS) | | | | |
|---|---|---|---|---|---|
| | Pre-Existing Condition | 2008 Approved Order of Cond. | 200 Shire Way Re-design | 300 Shire Way Addition | Lots A and B Expansions |
| Catchment 1 | 23.47 | 23.47 | 23.47 | 23.47 | 23.47 |
| Catchment 2 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 |
| Catchment 3 | 48.59 | 45.18 | 44.53 | 44.21 | 44.76 |
| Catchment 4 & 8 | 16.64 | 15.85 | 15.82 | 15.85 | 16.03 |
| Catchment 5 | 2.06 | 1.42 | 1.17 | 1.17 | 0.93 |
| Catchment 6 | 2.01 | 2.01 | 2.01 | 2.01 | 2.01 |
| Catchment 7 | 2.68 | 2.36 | 2.11 | 2.11 | 2.11 |

Table 1.2 – 10-Year Peak Discharge Runoff Summary

| | 10 Year Peak Flow (CFS) | | | | |
|---|---|---|---|---|---|
| | Pre-Existing Condition | 2008 Approved Order of Cond. | 200 Shire Way Re-design | 300 Shire Way Addition | Lots A and B Expansions |
| Catchment 1 | 43.31 | 43.31 | 43.31 | 43.31 | 43.31 |
| Catchment 2 | 1.56 | 1.56 | 1.56 | 1.56 | 1.56 |
| Catchment 3 | 86.32 | 79.43 | 79.43 | 80.25 | 80.73 |
| Catchment 4 & 8 | 25.14 | 21.55 | 21.47 | 21.44 | 21.57 |
| Catchment 5 | 3.67 | 2.48 | 2.02 | 2.02 | 1.60 |
| Catchment 6 | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 |
| Catchment 7 | 4.34 | 3.68 | 3.25 | 3.25 | 3.25 |

Table 1.3– 100-Year Peak Discharge Runoff Summary

| | 100 Year Peak Flow (CFS) | | | | |
|---|---|---|---|---|---|
| | Pre-Existing Condition | 2008 Approved Order of Cond. | 200 Shire Way Re-design | 300 Shire Way Addition | Lots A and B Expansions |
| Catchment 1 | 76.16 | 76.16 | 76.16 | 76.16 | 76.16 |
| Catchment 2 | 3.01 | 3.01 | 3.01 | 3.01 | 3.01 |
| Catchment 3 | 149.02 | 147.75 | 146.74 | 147.35 | 148.03 |
| Catchment 4 & 8 | 36.57 | 26.01 | 25.94 | 25.89 | 25.96 |
| Catchment 5 | 6.28 | 4.18 | 3.37 | 3.37 | 2.67 |
| Catchment 6 | 6.08 | 6.08 | 6.08 | 6.08 | 6.08 |
| Catchment 7 | 6.92 | 5.69 | 4.98 | 4.98 | 4.98 |

**SYMMES, MAINI & McKEE ASSOCIATES, INC.**
**CLOSED DRAINAGE SYSTEM CALCULATIONS**
**10-YEAR FREQUENCY**

Project: LTP-B200
Proj. #: 15056.00
Date: 9/4/15
By: SEB
Ckd by: JCH

Notes: n= 0.013 for reinforced concrete pipe
n= 0.010 for high density polyethylene pipe (smooth interior)
c= 0.95 (impervious areas)
c= 0.20 (for lawn/planting areas)

| Line | | Length (ft) | | Area Imp. | | Area Perv. | CA | Sum CA | Time of Concen | Rainfall I (in/hr) | Req. Cap. Qd (cfs) | Pipe (in) | Slope (ft/ft) | Flow Full | | Design Vel. Vd (fps) | Rim Elev. (ft) | Inv. Elevations | | Q/Qf | Pipe Cover | Time in Pipe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | To | | (sf) | (acres) | (sf) | (acres) | | | | | | | | Qf (cfs) | Vf (fps) | | | Upper | Lower | | | |
| CB A-1 | DMH A-1 | 73 | 7219 | 0.17 | 4329 | 0.10 | 0.18 | 0.18 | 5.00 | 5.40 | 0.96 | 12 | 0.010 | 4.53 | 5.77 | 3.9 | 260.90 | 256.00 | 255.30 | 0.21 | 3.90 | 0.32 |
| CB A-2 | DMH A-1 | 91 | 5655 | 0.13 | 1642 | 0.04 | 0.13 | 0.13 | 5.00 | 5.40 | 0.71 | 12 | 0.010 | 4.60 | 5.86 | 3.6 | 261.50 | 256.20 | 255.30 | 0.15 | 4.30 | 0.43 |
| CB A-3 | DMH A-1 | 31 | 1264 | 0.03 | 0 | 0.00 | 0.03 | 0.03 | 5.00 | 5.40 | 0.15 | 12 | 0.010 | 4.55 | 5.80 | 2.3 | 260.40 | 255.60 | 255.30 | 0.03 | 3.80 | 0.23 |
| CB A-4 | DMH A-1 | 52 | 3603 | 0.08 | | 0.00 | 0.08 | 0.08 | 5.00 | 5.40 | 0.42 | 12 | 0.010 | 4.54 | 5.78 | 3.0 | 261.00 | 255.80 | 255.30 | 0.09 | 4.20 | |
| DMH A-1 | WQU A-1 | 59 | | 0.00 | | 0.00 | 0.41 | 0.41 | 5.00 | 5.40 | 2.24 | 12 | 0.010 | 4.67 | 5.94 | 5.0 | 260.50 | 255.20 | 254.60 | 0.48 | 4.30 | 0.20 |
| CB A-5 | WQU A-1 | 39 | 7352 | 0.17 | 236 | 0.01 | 0.16 | 0.16 | 5.00 | 5.40 | 0.87 | 12 | 0.010 | 4.69 | 5.97 | 3.8 | 258.10 | 255.00 | 254.60 | 0.19 | 2.10 | |
| WQU A-1 | DMH 7-2 | 12 | | 0.00 | | 0.00 | 0.58 | 0.58 | 5.00 | 5.40 | 3.11 | 12 | 0.010 | 4.63 | 5.90 | 5.5 | 259.20 | 254.50 | 254.38 | 0.67 | 3.70 | |

**SYMMES, MAINI & McKEE ASSOCIATES, INC.**
**CLOSED DRAINAGE SYSTEM CALCULATIONS**
**10-YEAR FREQUENCY**

Project: LTP-B200 - Reserve Parking Expansion
Proj. #: 15056
Date: 8-28-15
By: SEB
Ckd by: JCH

Notes: n= 0.013 for reinforced concrete pipe
n= 0.010 for high density polyethylene pipe (smooth interior)
c= 0.95 (impervious areas)
c= 0.20 (for lawn/planting areas)

| Line | | Length | | Area Imp. | | Area Perv. | CA | Sum CA | Time of | Rainfall I | Req. Cap. | Pipe (in) | | Flow Full | | Design Vel | | Inv. Elevations | | Q/Qf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | To | (ft) | (sf) | (acres) | (sf) | (acres) | | | Concen | (in/hr) | Qd (cfs) | | Slope (ft/ft) | Qf (cfs) | Vf (fps) | Vd (fps) | Rim Elev (ft) | Upper | Lower | |
| Lot A | WQU A-1 | | | 0.58 | | 0.15 | 0.58 | 0.58 | | | | | | | | | | | | |
| WQU A-1 | DMH 7-2 | 12 | | | | | | 0.58 | 5.00 | 5.40 | 3.13 | 12 | 0.010 | 4.63 | 5.90 | 5.5 | | | | 0.68 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 7-3 | DMH 7-2 | 32 | 4350 | 0.10 | 5763 | 0.13 | 0.12 | 0.12 | 5.00 | 5.30 | 0.64 | 12 | 0.020 | 6.55 | 8.34 | 4.5 | 259.20 | 255.20 | 254.56 | 0.10 |
| CB 7-4 | DMH 7-2 | 31 | 4615 | 0.11 | 0 | 0.00 | 0.10 | 0.10 | 5.00 | 5.30 | 0.53 | 12 | 0.020 | 6.55 | 8.34 | 4.2 | 258.80 | 254.80 | 254.18 | 0.08 |
| | | | | | | | | | | | | | | | | | | | | |
| DMH 7-2 | DMH 7-3 | 114 | 0 | 0.00 | 0 | 0.00 | 0.00 | 0.80 | 5.00 | 5.30 | 4.25 | 12 | 0.010 | 4.63 | 5.90 | 6.0 | 258.50 | 248.22 | 247.08 | 0.92 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 7-6 | DMH 7-3 | 19 | 2235 | 0.05 | 1686 | 0.04 | 0.06 | 0.06 | 5.00 | 5.30 | 0.30 | 12 | 0.020 | 6.55 | 8.34 | 3.6 | 255.60 | 251.60 | 251.22 | 0.05 |
| CB 7-7 | DMH 7-4 | 28 | 1988 | 0.05 | 0 | 0.00 | 0.04 | 0.04 | 5.09 | 5.30 | 0.23 | 12 | 0.020 | 6.55 | 8.34 | 3.3 | 255.75 | 251.75 | 251.19 | 0.04 |
| DMH 7-3 | DMH 7-4 | 37 | 0 | 0.00 | 0 | 0.00 | 0.00 | 0.86 | 5.23 | 5.30 | 4.55 | 12 | 0.010 | 4.63 | 5.90 | 6.1 | 255.20 | 246.98 | 246.61 | 0.98 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 7-8 | DMH 7-5 | 10 | 3743 | 0.09 | 0 | 0.00 | 0.08 | 0.08 | 5.00 | 5.30 | 0.43 | 12 | 0.020 | 6.55 | 8.34 | 4.0 | 254.50 | 250.50 | 250.30 | 0.07 |
| DMH 7-4 | DMH 7-5 | 91 | 0 | 0.00 | 0 | 0.00 | 0.00 | 0.90 | 5.00 | 5.30 | 4.78 | 15 | 0.010 | 8.40 | 6.85 | 6.1 | 254.60 | 246.51 | 245.60 | 0.57 |
| | | | | | | | | | | | | | | | | | | | | |
| DMH 7-5 | DMH 5-7 | 145 | 0 | 0.00 | 0 | 0.00 | 0.00 | 0.98 | 5.00 | 5.30 | 5.21 | 15 | 0.010 | 8.40 | 6.85 | 6.2 | 251.10 | 245.50 | 244.05 | 0.62 |
| | | | | | | | | | | | | | | | | | | | | |

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**10-YEAR FREQUENCY**

Project: LTP-B200 - Reserve Parking Expansion
Proj. #: 15056
Date: 8-28-15
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c= 0.20 (for lawn/planting areas)

| Line | | Length | | Area Imp. | | Area Perv. | CA | Sum CA | Time of | Rainfall I | Req. Cap. | Pipe (in) | | Flow Full | | Design Vel. | Rim Elev. | Inv. Elevations | | Q/Qf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | To | (ft) | (sf) | (acres) | (sf) | (acres) | | | Concen | (in/hr) | Qd (cfs) | | Slope (ft/ft) | Qf (cfs) | Vf (fps) | Vd (fps) | (ft) | Upper | Lower | |
| CB B-1 | Ex DMH B-2 | 48 | | 0.148 | | 0.503 | 0.24 | 0.24 | 5.00 | 5.30 | 1.28 | 12 | 0.008 | 4.23 | 5.38 | 4.0 | 261.75 | 256.50 | 256.1 | 0.30 |
| CB B-2 | DMH B-1 | 19 | | 0.22 | | 0.67 | 0.34 | 0.34 | 5.00 | 5.30 | 1.82 | 12 | 0.011 | 4.75 | 6.05 | 4.8 | 264.80 | 259.10 | 258.90 | 0.38 |
| B125 | EX CB | 43 | | 2.51 | | 1.53 | 2.69 | 2.69 | 5.00 | 5.30 | 14.26 | 12 | 0.095 | 14.27 | 18.17 | 19.0 | 259.10 | 254.10 | 250.02 | 1.00 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 5-2 | DMH 1-11 | 98 | 0 | 0.00 | 16853 | 0.39 | 0.08 | 0.08 | 5.00 | 5.30 | 0.41 | 12 | 0.005 | 3.27 | 4.17 | 2.4 | 251.70 | 247.70 | 247.21 | 0.13 |
| CB 5-3 | DMH 1-11 | 15 | 0 | 0.00 | 21047 | 0.48 | 0.10 | 0.17 | 5.00 | 5.30 | 0.92 | 12 | 0.020 | 6.55 | 8.34 | 4.9 | 252.50 | 248.50 | 248.20 | 0.14 |
| EX CB | DMH 1-11 | 150 | 0 | 0.00 | 0 | 0.00 | 0.00 | 3.28 | 5.68 | 5.30 | 17.36 | 24 | 0.060 | 72.14 | 22.96 | 15.9 | 251.70 | 256.00 | 247.01 | 0.24 |
| CB 5-4 | DMH 1-11 | 68 | 0 | 0.00 | 14857 | 0.34 | 0.07 | 0.07 | 5.00 | 5.30 | 0.36 | 12 | 0.005 | 3.27 | 4.17 | 2.3 | 251.70 | 247.70 | 247.36 | 0.11 |
| DMH 1-11 | DMH 5-2 | 170 | 0 | 0.00 | 0 | 0.00 | 0.00 | 3.60 | 5.49 | 5.30 | 19.05 | 24 | 0.010 | 29.47 | 9.38 | 8.7 | 252.50 | 247.01 | 245.31 | 0.65 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 5-5 | DMH 5-2 | 64 | 0 | 0.00 | 13447 | 0.31 | 0.06 | 0.06 | 5.00 | 5.30 | 0.33 | 12 | 0.029 | 7.94 | 10.10 | 4.2 | 252.50 | 248.50 | 246.62 | 0.04 |
| DMH 5-2 | DMH 5-3 | 160 | 0 | 0.00 | 0 | 0.00 | 0.00 | 3.66 | 5.25 | 5.30 | 19.38 | 24 | 0.010 | 29.47 | 9.38 | 8.7 | 257.30 | 245.21 | 243.61 | 0.66 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 5-6 | DMH 5-3 | 100 | 3532 | 0.08 | 7564 | 0.17 | 0.11 | 0.11 | 5.00 | 5.30 | 0.59 | 12 | 0.020 | 6.55 | 8.34 | 4.3 | 253.30 | 249.30 | 247.30 | 0.09 |
| CB 5-7 | DMH 5-3 | 35 | 6885 | 0.16 | 2355 | 0.05 | 0.16 | 0.27 | 5.00 | 5.30 | 1.45 | 12 | 0.020 | 6.55 | 8.34 | 5.6 | 253.00 | 249.00 | 248.30 | 0.22 |
| CB 5-8 | DMH 5-3 | 23 | 10499 | 0.24 | 21590 | 0.50 | 0.33 | 0.60 | 5.00 | 5.30 | 3.18 | 12 | 0.020 | 6.55 | 8.34 | 7.1 | 251.70 | 247.70 | 247.24 | 0.49 |
| DMH 5-3 | DMH 5-4 | 48 | 0 | 0.00 | 0 | 0.00 | 0.00 | 4.64 | 5.38 | 5.30 | 24.60 | 30 | 0.010 | 54.02 | 11.00 | 9.2 | 252.50 | 243.51 | 243.02 | 0.46 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 5-9 | DMH 5-4 | 22 | 8921 | 0.20 | 0 | 0.00 | 0.19 | 0.19 | 5.00 | 5.30 | 1.03 | 12 | 0.020 | 6.55 | 8.34 | 5.1 | 252.10 | 248.10 | 247.66 | 0.16 |
| DMH 5-4 | DMH 5-5 | 60 | 2400 | 0.06 | 0 | 0.00 | 0.05 | 4.89 | 5.07 | 5.30 | 25.91 | 30 | 0.010 | 53.47 | 10.89 | 9.2 | 252.50 | 242.92 | 242.32 | 0.48 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 5-10 | DMH 5-5 | 56 | 4614 | 0.11 | 1405 | 0.03 | 0.11 | 0.11 | 5.00 | 5.30 | 0.57 | 12 | 0.020 | 6.55 | 8.34 | 4.3 | 251.70 | 247.70 | 246.58 | 0.09 |
| CB 5-11 | DMH 5-5 | 30 | 14129 | 0.32 | 3758 | 0.09 | 0.33 | 0.43 | 5.00 | 5.30 | 2.29 | 12 | 0.020 | 6.55 | 8.34 | 6.4 | 252.50 | 248.50 | 247.90 | 0.35 |
| DMH 5-5 | DMH 5-6 | 73 | 0 | 0.00 | 0 | 0.00 | 0.00 | 5.43 | 5.22 | 5.30 | 28.77 | 30 | 0.010 | 53.47 | 10.89 | 9.5 | 251.80 | 242.22 | 241.49 | 0.54 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 5-12 | DMH 5-6 | 48 | 4727 | 0.11 | 0 | 0.00 | 0.10 | 0.10 | 5.00 | 5.30 | 0.55 | 12 | 0.020 | 6.55 | 8.34 | 4.2 | 251.50 | 247.50 | 246.54 | 0.08 |
| DMH 5-6 | DMH 5-7 | 105 | 0 | 0.00 | 0 | 0.00 | 0.00 | 5.53 | 5.19 | 5.30 | 29.32 | 30 | 0.010 | 53.47 | 10.89 | 9.6 | 252.20 | 241.39 | 240.34 | 0.55 |
| DMH 5-7 | DMH 5-8 | 72 | 0 | 0.00 | 0 | 0.00 | 0.00 | 6.52 | 5.37 | 5.30 | 34.53 | 30 | 0.008 | 47.57 | 9.69 | 9.2 | 249.10 | 240.24 | 239.67 | 0.73 |
| | | | | | | | | | | | | | | | | | | | | |
| CB 5-13 | DMH 5-8 | 24 | 5918 | 0.14 | 1299 | 0.03 | 0.14 | 0.14 | 5.00 | 5.30 | 0.72 | 12 | 0.020 | 6.55 | 8.34 | 4.6 | 246.60 | 242.60 | 242.12 | 0.11 |
| CB 5-14 | DMH 5-8 | 10 | 8486 | 0.19 | 427 | 0.01 | 0.19 | 0.32 | 5.00 | 5.30 | 1.71 | 12 | 0.020 | 6.55 | 8.34 | 5.9 | 244.50 | 240.50 | 240.30 | 0.26 |
| DMH 5-8 | DMH 1-15 | 123 | 0 | 0.00 | 0 | 0.00 | 0.00 | 7.37 | 5.09 | 5.30 | 39.08 | 30 | 0.008 | 47.72 | 9.72 | 9.6 | 247.00 | 239.57 | 238.59 | 0.82 |