Oxford Falls Retirement Resort

Lots 1110, 1111, 1113 & 1336 in DP752038,
Lot 20 in DP842523 & Lot 80 in DP846099
Oxford Falls Rd, Frenchs Forest

Stormwater Concept Plan
Major Project – 05-0113
Seniors Living Resort, Oxford Falls
Proposed Concept Plan

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For
Tiffany Developments

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1.0 Introduction

This firm has been engaged by Tiffany Developments to develop a stormwater drainage concept plan for the proposed Seniors Living Resort, Oxford Falls located on the subject properties with respect to impacts on stormwater drainage regimes in the locality. The proposed development concept is detailed on plans which have been prepared by others and reproduced here as Figure 1. This report has been prepared based on a review of the proposed development plans and previous stormwater concept plans prepared by this firm with respect to this site. This report considers the management of minor and major stormwater flows through the site only and has been prepared to complement the Water Quality Management Concept report prepared by SEEC.

The proposed development plans detail a proposed retirement resort to be developed on the subject site. The proposed development concept is for the erection of a number of tower blocks joined by podium concourses set at various levels to reflect the existing slope of the site. Access to the site will be provided via an internal road system connecting to Oxford Falls Rd in the vicinity of the current tennis academy administration building and on the unformed section of Barnes Rd. It is proposed that an alternative access point will be provided to the existing formation in Barnes Rd to the west of the site.

The impacts of the current proposal depicted in the proposed development plans have been assessed as being similar to that resulting from previous proposals on the site. The development of the site has been found to not result in any increase in flood flows in the stormwater systems in the area and so the proposal is considered to be consistent with the Director General's requirements for MP05_0113 with respect to Drainage and Flooding.

2.0 Description of the Site

The site, which is currently known as Lots 1110, 1111, 1113 & 1336 in DP752038, Lot 20 in DP842523 & Lot 80 in DP846099 Oxford Falls Rd, Frenchs Forest is located in a valley in the Shire of Warringah bounded by Warringah Rd in the south, the Wakehurst Parkway in the west and Brooker Ave in the east. The valley collects the stormwater runoff from approximately 110 hectares of catchment. While the western portion of this catchment is generally in a natural state, the eastern and southern areas of the catchment have been developed for residential and industrial uses, which in the whole have tended to be uncontrolled with respect to stormwater drainage. That is, the development has been allowed to proceed without the consideration of the increase in stormwater flows and velocities which will occur as a result of that development. The result of this has been that the site now receives substantially more stormwater in a given storm event than would have naturally been discharged from the undeveloped upstream catchments.

The site is traversed by a watercourse which has been substantially altered from natural conditions over the past 50 years. This watercourse which parallels Oxford Falls Road has been denoted as the "the Middle Creek Tributary" for the purposes of this study. Warringa Council have prepared a policy document titled "Warringah

Creek Management Study 2004" (WCMS) which nominates this main creek as being significant with associated riparian and no development zones. The Middle Creek Tributary originates in a gully draining the intersection of Oxford Falls Road with Iris Street located to the south of the site.

The WCMS also nominates two minor tributaries of the main creek within the site as being of significance. One of these tributaries located immediately south of the tennis courts in the Tennis Academy (hereinafter referred to as Tributary T1) and the second is located immediately to the south of the section of Barnes Rd intersecting with Oxfords Falls Road (hereinafter referred to as Tributary T2). The property immediately south of the intersection of Barnes Rd and Oxford Falls Rd is not part of the site. As such, no works are proposed at this time in the Middle Creek Tributary parallel to Oxford Falls Rd south of Barnes Rd.

Tributary T1 in its current form is little more than an engineered drain. The original alignment of this creek can not be ascertained due to the construction of the tennis courts on the site. The upper reaches of this creek have been destroyed by the construction of a water quality structure which is currently under the care and control of Warringah Council (Lot 21 in DP842523 & Lot 29 in DP829321). The lower reach of Tributary T1 has been formed into a grassed trapezoidal channel protected by a 6m wide easement to drain water.

Tributary T2 has also been substantially altered over time in an attempt to minimise the flooding impacts which have resulted from uncontrolled development on the escarpment above the valley. The current form of the drainage line does not have sufficient capacity to convey the design 100 year flood. It is therefore proposed to enlarge the cross-section of Tributary T2 to control runoff through the site.

3.0 Current Flood Flows

The site collects significant flows off the surrounding catchments as depicted in the enclosed catchment plans (Drg No 10040E1). The catchments depicted on the catchment plans have been determined off digital contours and aerial photography and confirmed by site inspection. To establish the effect of past developments in the upstream catchments, an analysis of the catchment in its "natural state" prior to the development has been undertaken. The assumed "natural" Catchments are depicted in Drg No. 10040E1 sheet 1 of 4.

Peak flows off the natural state catchments have been determined using the Rational method as recommended in Australian Rainfall & Runoff. The calculations for these flows are provided in Appendix A. In summary, the peak flow of stormwater off the upstream catchments in the pre-developed state would have been as follows:-

5 year ARI natural catchment flow	= 13.44 cumecs
100 year ARI natural catchment flow	= 33.52 cumecs

The effect of the urban and industrial/commercial development of the catchments above the site has been to increase the velocity and volume of stormwater runoff which is received by the site. The stormwater flows off the developed catchments

(refer Appendix B for calculations and Drg No. 10040E1 sheet 2 of 4 for catchment plan depicting rational method catchments) has been determined as follows:-

5 Year ARI developed catchment flow	= 30.64cumecs
100 Year ARI developed catchment flow	= 56.54 cumecs

Based on the above figures, the development of the upper catchments has resulted in a 228% increase in flows in the 5 year ARI event and 169% increase in the 100 year ARI event. These increases are significant and have been the cause for concern on the part of the owners of the site for some time.

In order to effectively control the runoff from the upper catchments, an analysis of the existing flow paths has been undertaken. The form of the existing roads is such that the flows off catchments 1, 2 & 4 are directed to Iris Street and then into Myra St. Myra St does not have sufficient capacity (refer Appendix C) to convey the full 100 year flow and a portion of the flow overflows to the gully to the east of Myra St as indicated on the catchment plans. When Myra St flows reach Barnes Rd, it is unclear how the flows will spread and it has been assumed that the flow is divided 50/50 down each arm of Barnes Road.

Flows from the southern arm of Barnes Rd will continue to be directed to the gully to the south of Barnes Rd from where they are directed to the site vis the existing topography.

Flows from the northern arm of Barnes Rd are directed into a drainage structure, which has been constructed at the end of a driveway leading the northern end of Barnes Rd. For the purposes of this study, the impact of this basin on the flows has been ignored other than for the purpose of acting as a gross pollutant trap.

Catchment 15 is a wholly natural catchment and the runoff from this catchment is currently directed by the natural topography away from the site.

4.0 Modelling of Design Stormwater Flows

The flows off the catchments upstream of the site have also been modelled using the XP-Rafts computer model in order to confirm the rational flows described above. This computer based hydrological model was jointly developed by SMEC and Willing and Partners and continues to be developed by Willing and Partners. The program is considered to be industry standard and has a user friendly interface capable of simulating rainfall runoff by explicitly taking into account the sub-catchment size, the slope, percentage of impervious area, soil type (loss rates), detention basins, etc.

The catchments adopted for the XP-Rafts model were simplified and have been depicted in the enclosed plan Ref 10040E1 sheet 3 of 4 for undeveloped site and Sheet 4 of 4 for the developed site. An assessment of the % impervious was carried out for each catchment with 1.5mm and 0mm being adopted as initial and continuing (respectively) losses for impervious surfaces. For the residential areas upstream of the site the % impervious was assessed at 60%. 15mm and 2.5mm were the adopted initial and continuing loss rates for pervious surfaces within the catchment. XP-Rafts

provides an option to model older catchments as “old urban”. Selection of this option increases the storage in a catchment to account for delays in flows which results from the lack of formal over-land flow paths. An inspection of the catchments upstream of the site revealed that no significant flow paths had been provided for flow in excess of the road system capacity and so the “old urban” option was selected for catchments with significant percentages of residential development. The catchments located on the valley floor have not been developed and a % impervious of 10% was adopted for these catchments. Catchments located on the sides of the escarpment were observed to be generally in a natural state and a % impervious of 0% was used where no or insignificant levels of development had occurred.

Previous inquiries with Council revealed that there are no records of flooding in the vicinity of the site. Given the lack of recorded flow data, it was not possible to calibrate the model results against such records. The results of the modelling were compared to the flow rates estimated using the rational method as described in Australian Rainfall and Runoff and those documented in work-as-executed drawings for Barnes Rd (Drg No 3CY-562.3 prepared by Lovegrove Oxley Associates Pty Ltd dated 12-7-94) obtained from Warringah Council and were found to be comparable. The resultant flow rates are therefore considered to be a reasonable assessment of the design flow rates through the site.

For each recurrence interval, various storm durations were modelled. The 90 minute duration storm found to consistently produce the largest peak flows and so this event was adopted as the design storm event.

The model for the site was then modified to account for the proposed development, The effects of the development on the model included an increase in the percentage impervious for Catchments 1/8, 1/9, 1/10, 5/1 and 5/2 as detailed in Table 4.1 below.

Previous studies by this firm have shown that a two hour storm with an intensity equal to three times the 100 year intensity is a reasonable approximation of the PMF flood event. For the purposes of this analysis, this storm event was applied to the developed scenario XP-Rafts model to estimate the impact of the PMF flood.

The results of the XP-Rafts modelling is summarised in Table 4.2.

The highlighted rows in Table 4.2 detail the before and after flows at the downstream edge of the proposed development in The Middle Creek Tributary. Reference to the table demonstrates that the development of the site actually results in a decrease in the flows in the Tributary. This can be explained by the flows off the development entering the Tributary prior to the peak flows from the upper catchments. In accordance with the terms of Warringah Council On-site Stormwater Detention Technical Specification then, the development is not required to incorporate any storm water detention measures.

Table 4.1 Revisions to Catchments to Account for Proposed Development

Catch. Area	Total Area (ha)	Pre-Exist. Imperv. Area (ha)	Extra Imperv. Area due to Prop. Devel. (ha)	Post-develop. Imperv. Area (ha)	Post-develop. Pervious Area (ha)	Notes
1/8	9.585	0.302	0.538	0.840	8.745	3.02 ha of catchment subject to exist. Development - Area of catchment east of O.F Rd undeveloped
1/9	4.265	0.427	1.423	1.850	2.416	
1/10	3.097	0.310	2.39	2.700	0.397	
5/1	1.5	0.522	0.11	0.632	0.868	Area on top of ridge subject to Residential housing is 0.744 ha - 60% impervious, remainder assumed 10% impervious.
5/2	2.54	0.592	0.16	0.752	1.788	Area on top of ridge subject to Residential housing is 0.677 ha - 60% impervious, remainder assumed 10% impervious.

These flows were then entered into a Hec-Ras model of the site which has been created by interpolation of the site contours to establish the extent of the 100 year flood flows. Drawing 10040E2 sheet 1 of 2 provides a layout of the existing site with the extent of flooding under current conditions indicated by a blue dashed line.

Table 4.2 - Summary of XP-Rafts Modelling flow Results

Link Label	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)	Peak Inflow (m^3/s)
	2yr exist	2yr dev	5yr exist	5yr dev	10yr exist	10yr dev	20yr exist	20yr dev	50yr exist	50yr dev	100yr exist	100yr dev	PMF dev
catch1/1	1.769	1.769	2.467	2.467	2.837	2.837	3.251	3.251	3.597	3.597	4.067	4.067	12.44
catch1/2	4.125	4.125	5.773	5.773	6.606	6.606	7.593	7.593	8.387	8.387	9.517	9.517	28.79
catch1/3	6.141	6.141	8.663	8.663	9.929	9.929	11.405	11.405	12.64	12.64	14.405	14.405	43.96
junctA	5.011	5.011	7.533	7.533	8.799	8.799	10.275	10.275	11.51	11.51	13.275	13.275	42.83
catch2/1	7.735	7.735	11.449	11.449	13.001	13.001	13.683	13.683	14.336	14.336	15.222	15.222	28.03
junctB	5.493	5.493	5.51	5.51	5.49	5.49	5.478	5.478	5.502	5.502	5.604	5.604	5.51
catch5/2	0.3494	0.4049	0.5636	0.6259	0.7202	0.7713	0.9221	0.9934	1.091	1.16	1.279	1.355	4.12
catch1/4	3.179	3.179	4.276	4.276	4.752	4.752	5.233	5.233	5.643	5.643	6.278	6.278	16.44
catch1/5	5.995	5.995	11.115	11.115	13.671	13.671	16.626	16.626	19.205	19.205	22.786	22.786	79.29
catch1/6	6.482	6.482	11.757	11.757	14.807	14.807	18.572	18.572	21.192	21.192	24.491	24.491	84.79
catch1/7	8.473	8.473	14.751	14.751	18.447	18.447	23.135	23.135	26.653	26.653	31.257	31.257	106.46
catch1/8	8.407	8.404	15.132	15.443	19.172	19.337	24.159	24.047	28.379	27.854	33.767	33.421	118.51
catch1/9	9.029	9.279	16.29	17.322	21.049	22.252	26.005	27.411	30.724	32.111	36.53	38.184	134.31
catch2/2	5.882	5.882	5.917	5.917	5.869	5.869	5.916	5.916	5.972	5.972	6.101	6.101	7.16
catch3/1	0.1832	0.1832	0.2858	0.2858	0.324	0.324	0.369	0.369	0.4047	0.4047	0.4582	0.4582	1.33
catch4/1	0.6864	0.6864	1.007	1.007	1.151	1.151	1.32	1.32	1.457	1.457	1.646	1.646	4.81
catch2/3	5.84	5.84	6.43	6.43	6.87	6.87	7.256	7.256	7.598	7.598	8.066	8.066	15.19
catch6/1	1.207	1.207	2.015	2.015	2.533	2.533	3.182	3.182	3.881	3.881	4.589	4.589	19.98
catch5/1	1.619	1.65	1.81	1.853	1.89	1.927	2.073	2.104	2.247	2.271	2.458	2.477	5.37
catch2/4	0.2543	6.078	0.4196	6.823	0.5487	7.296	0.6985	7.868	0.8383	8.366	0.9908	8.963	18.18
catch1/10	15.755	15.099	25.363	24.875	31.881	30.777	39.033	37.643	45.041	43.831	52.194	51.132	175.44
5/2-1/8		8.62		15.948		19.959		24.827		28.993		34.74	122.59

5.0 Description of Proposed Stormwater Management Concepts

The proposed drainage scheme to manage stormwater off and through the proposed development is described in the drawings by JMD Development Consultants Ref 010040E2 issue A dated 9-4-2010.

On the upstream (western) side of the development catch drains will be constructed to train the overland flows off the upstream catchments to The Middle Creek Tributary and Tributary T1.

Stormwater flows off the proposed plaza areas in and around the buildings and internal road systems will be treated as described in the SEEC report and then piped to discharge into the Middle Creek Tributary and Tributary T1 & T2. The number of drainage outlets discharging to the Middle Creek Tributary will be limited to approximately three with proposed outlets being located at the junction of Tributary T2 and the Middle Creek Tributary, the Barnes Road reserve and at the junction of Tributary T1 and The Middle Creek Tributary.

From the previous development proposals, it is understood that the shoulder of Oxford Falls Rd will be required to be constructed to an appropriate standard as a condition of the consent for this development. Such works will require the installation of a piped drainage system along the road shoulder. This piped system would be collected and discharged to the Middle Creek Tributary at the current Barnes Rd intersection and at the existing channel adjacent to the tennis academy building.

The layout and general design of Tributary T1 & T2 has been established during consultation with the appropriate Government Departments. The current drainage line downstream of the Council drainage structure at the head of Tributary T1 is an engineered trapezoidal grassed channel with a small concrete lined invert. It is proposed that this channel be replaced by Tributary T1 which will be constructed as a vegetated trapezoidal drainage swale 10m wide. The vertical alignment of Tributary T1 will be as detailed in Drawing Ref 10040E2 sheet 3 of 3 with a longitudinal grade of approximately 4%. The upper reach of Tributary T1 immediately downstream of the Council drainage structure will be constructed with stacked rock drop structures to reduce the longitudinal grade as elevation decreases from the Council drainage structure to the Middle Creek Tributary. HEC-Ras modelling reveals that the proposed design section for Tributary T1 will be sufficient to contain flood flows up to the PMF event. Drawing Ref 10040E2 sheet 3 of 3 details a typical section for Tributary T1 with indicative depths of flow for 100Year and PMF flood conditions.

Tributary T2 will also be constructed as a vegetated trapezoidal drainage swale. The width of Tributary T2 will be 20m wide to provide for the larger flows discharging for the upstream catchments. The existing dam at the upstream end of Tributary T2 will be retained but reconstructed to be clear of the proposed building footprint for the development with flows discharging via an appropriately design spillway to Tributary T2. The vertical alignment of Tributary T2 will be as detailed in Drawing Ref 10040E2 sheet 3 of 3 with a longitudinal grade of approximately 2.5%. HEC-Ras modelling reveals that the proposed design section for Tributary T2 will be sufficient to contain flood flows up to the PMF event. Drawing Ref 10040E2 sheet 3 of 3 details a typical section for Tributary T2 with indicative depths of flow for 100Year and PMF flood conditions. The construction of Tributary T2 will improve the current flood conditions experience by the triangular

shaped property on the corner of Barnes Road and Oxford Falls Road known as Lot 1125. Under existing conditions flood flows from the dam at the head of Tributary T2 enter Lot 1125 from the west and south. The construction of Tributary T2 will divert these flows away from the western side of Lot 1125 and restrict flows through Lot 1125 to the Middle Creek Tributary.

Prior to discharge to Tributary T1 and T2, it is proposed that low flows off the existing catchments will be processed through appropriately sized gross pollutant traps (GPT). The existing Council drainage structure at the head of Tributary T1 drains an estimated catchment area of 16.37ha (7.39ha pervious and 8.98ha impervious). The existing outlet from the council drainage structure will be directed to the proposed GPT via a surcharge pit which will divert low flows to the GPT and excess flows in larger storm events to the Tributary T1 channel.

The existing dam at the head of Tributary T2 drains an estimated catchment of 38.8ha (16.02ha pervious and 22.78ha impervious). The dam is to be reconstructed to suit the proposed development. The outlet weir for the dam will be designed such that a low-flow pipe will direct low flows from the dam to an appropriately designed GPT with flows in major storm events bypassing the GPT and discharging directly to Tributary T2.

The Current construction standard of Barnes Road adjacent to the development footprint is informal at best. The section of Barnes Road required to provide access to and around the proposed development will be constructed to a more formal standard such as that indicated in the proposed typical section detailed on Drawing Ref 10040E2 sheet 3 of 3. The capacity of this section to convey surface flows is estimated at approximately 3 cumecs. The section of Barnes Rd adjacent to the proposed development footprint is required to convey the flows from Catchment 5/2. Reference to Table 4.2 reveals that the estimated design flows from this catchment are 1.36cumecs in the 100 year event and 4.24cumecs in the PMF event. The combined capacity of the proposed piped drainage and surface flow path of Barnes Road as reconstructed will be sufficient to convey the design flows to the Middle Creek Tributary.

It is proposed that the overland flows collected by the northern portion of the western access road will be diverted down the access road denoted as “Middle Road Flow Path” on Drawing Ref 10040E2 sheet 2 of 3. This Middle Road flow path has a combined width of 12.5m (6m wide carpark and 6.5m wide road pavement). The typical section for this Middle Road is detailed on Drawing Ref 10040E2 sheet 3 of 3 and has an estimated overland flow capacity of 6.28cumecs which is sufficient to convey the expected flows off Catchment 5/1 in all storm events up to and including the PMF event.

Stormwater falling directly onto the roof areas of the proposed development buildings will be captured and directed to underground storage tanks distributed around the site as indicated in the attached drawings. Water from these storages will be reticulated through the development for non-potable water uses.

Generally, plaza areas between the buildings will be graded to fall gently towards the Middle Creek Tributary. Stormwater flows from the plaza areas will be directed as surface flows or in piped drainage systems to rain garden structures which will filter the flows prior to discharge to the Middle Creek Tributary.

Circulation roads through the site will be graded generally as indicated in the development plans. Stormwater flows off the roads will be treated prior to discharge to the tributaries by the installation of Stormfilter cartridge filter pits at appropriate intervals.

With respect to the Middle Creek Tributary, the extent of stormwater flows in the design 100 Year event under current conditions has been assessed by the use of a hydraulic model using the HEC-RAS program. The flows as described in Table 4.2 were entered into a HEC-RAS model of the site derived from the available site survey and the resulting flood extents are depicted by blue dashed line indicated on Drawing Ref 10040E2 sheet 1 of 3.

This model was then adjusted to reflect the developed conditions (changes to the discharge points from Tributary T1 & T2 and adjustment to creek cross section ch140 to 240 to reflect batter to proposed access road adjacent to building footprint) and the flood levels under developed conditions established for the 100 year and PMF flood events. For the purposes of this exercise, the two access roads across the Middle Creek Tributary providing access to the site from Oxford Falls Road do not impact on the flood levels as the creek crossings will be constructed as bridges with the level of the deck above flood level.

Copies of electronic files (XP-Rafts & HEC-RAS) used in this assessment are contained on the enclosed CD. The HEC-RAS flood results for the Middle Creek Tributary are detailed in Appendix D and the resultant flood levels summarised in Drawing Ref 10040E2 sheet 2 of 3. The HEC-RAS model demonstrates that all flood flows up to and including the PMF will be contained in the Middle Creek Tributary and that the all ground floor levels satisfy Warringah Council flood requirement of 0.5m freeboard to the 100 year flood level.

6.0 Conclusion

This report has considered the impacts of the proposed Seniors Living Resort development on the storm water flows traversing the subject site. The proposed development layout is similar to previous layouts considered on this site in that it will not adversely impact on the stormwater flows in the area.

The proposed development will incorporate significant stormwater treatment and re-use systems which will ensure that water quality issues for flows off the proposed development satisfy or exceed the water quality control targets specified by DECC and Council. Further, stormwater flows off the existing developed upstream catchments will be treated via gross pollutant traps to provide additional treatment and enhance existing water quality of flows down the Middle Creek Tributary discharging ultimately to the Narrabeen Lagoon.

The storm water assessments conducted on this site have determined that the peak flows for the design 1% AEP flood will be contained within the existing form of the Middle Creek Tributary with only minor creek training works required to divert the flows around the proposed development. Various works as described in the attached plans Ref 10040E2 will be required to control stormwater flows through the site. The storm water investigations on this site have demonstrated that the proposed development layout described in the Proposed Development plans will in fact result in a small decrease in flows from the Middle Creek Tributary thereby improving the grossly distorted hydrological regime in the area which has resulted from uncontrolled (with respect to stormwater) development of the upstream catchments. The proposed development is therefore

considered to be consistent with the outcomes required by the Director General's Requirements outlined for this project with respect to stormwater quantity measures.

This assessment has confirmed that the proposed development layout can be designed to safely convey all flood events up to and including the PMF event through and/or around the site and will provide for all habitable floor levels in the proposed development to achieve at least 0.5m freeboard to the design 100 year flood levels through the site.

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Appendix A
Calculation of Natural Catchment Peak Flows

Assuming natural catchment prior to development.

Catchment R1

Area	= 68.88 ha.	
t'c	= 0.76A^0.38	
	= 39.6 minutes say 40 minutes	
I(5yr)	= 67.7mm/hr	
I(100yr)	= 117.6mm/hr	
C10	= 0.7	(AR&R Vol 2)
FF(5yr)	= 0.88	(AR&R Vol 1 book 4)
FF(100yr)	=1.26	(AR&R Vol 1 book 4)

Q =FFY.C10.I.A/360

Q(5yr) = 0.88x0.7x67.7x68.88/360
= 7.98 cumecs

Q(100yr) = 1.26x0.7x117.6x68.88/360
= 19.85 cumecs

Catchment R2

Area	= 17.8 ha.	
t'c	= 0.76A^0.38	
	= 23.7 minutes say 24 minutes	
I(5yr)	= 87.5mm/hr	
I(100yr)	= 149.5mm/hr	
C10	= 0.7	(AR&R Vol 2)
FF(5yr)	= 0.88	(AR&R Vol 1 book 4)
FF(100yr)	=1.26	(AR&R Vol 1 book 4)

Q =FFY.C10.I.A/360

Q(5yr) = 0.88x0.7x87.5x17.8/360
= 2.67 cumecs

Q(100yr) = 1.26x0.7x149.5x17.8/360
= 6.85 cumecs

Catchment R3

Area	= 18.61 ha.	
t'c	= 0.76A^0.38	
	= 24 minutes	
I(5yr)	= 87.5mm/hr	
I(100yr)	= 149.5mm/hr	
C10	= 0.7	(AR&R Vol 2)
FF(5yr)	= 0.88	(AR&R Vol 1 book 4)

FF(100yr) =1.26 (AR&R Vol 1 book 4)

Q =FFY.C10.I.A/360

Q(5yr) = 0.88x0.7x87.5x18.61/360
= 2.79 cumecs

Q(100yr) = 1.26x0.7x149.5x18.61/360
= 6.82 cumecs

Thus total flows to creek in natural state was as follows:-

5 year ARI	7.98+2.67+2.79	= 13.44 cumecs
100 year ARI	19.85+6.85+6.82	= 33.52 cumecs

Appendix B

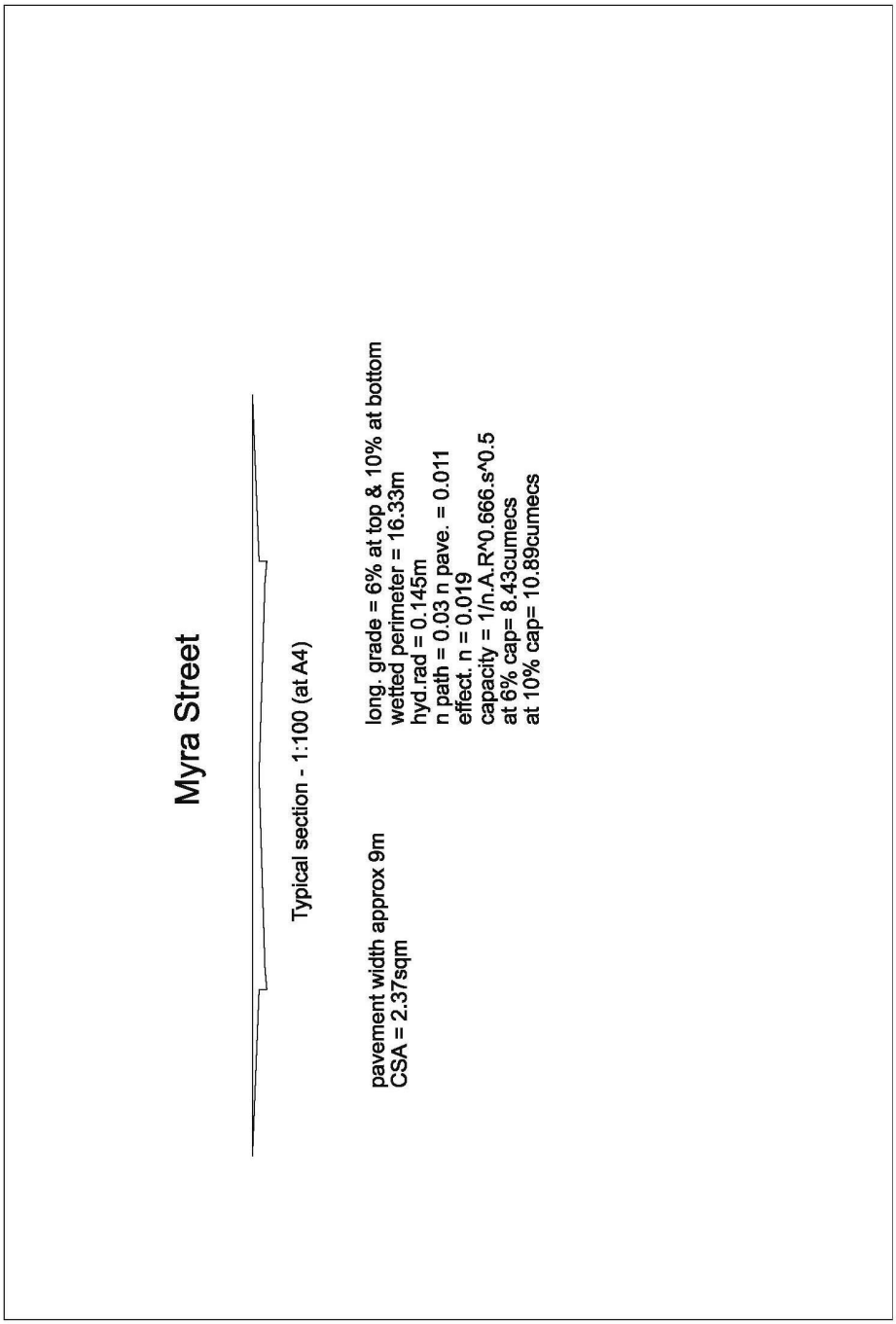
Calculation of Developed Catchment Peak Flows – Refer Drawing Ref 10040E1 sheet 2 of 4 for Rational Method

Catchments

Oxford Falls Retirement Resort - Developed Flows

					c10(AR&R)=		0.7	C5 Adopted for Natural =			0.616				
					FF100 =		1.26	C5 Adopted for Developed =			0.9				
					FF5 =		0.88	C5 Adopted for Fully Sealed =			1			Totals	
Catch	Area	t'c rural	Length of overland flow	Slope	n*	t'c adopt	I(100 ARI)	C(100yr)	Q(100yr)	I (5yrARI)	C(5yr)	Q(5yrARI)		Q(5yrARI)	Q(100yr)
1	8.123	17.6	300	3	0.011	6	252.5	1	5.697	154.5	1	3.486			
2	8.18	17.6	280	4	0.08	12	198.5	0.9	4.059	119	0.9	2.434			
3	9.76	18.8	380	10	0.08	12	198.5	0.9	4.843	119	0.9	2.904	sum 1,2+4	8.258	13.608
4	6.044	15.7	230	4	0.08	8	229.4	1	3.851	139.3	1	2.339	sum 1-4	11.162	18.451
5	4.56	14.1	150	6	0.08	8	229.4	0.9	2.615	139.3	0.9	1.588			
6	1.72	9.7	140	7	0.08	8	229.4	0.9	0.986	139.3	0.9	0.599			
7	1.767	9.8	140	7	0.08	8	229.4	0.9	1.013	139.3	0.9	0.615			
8A	0.3479	5.3	90	12	0.08	6	252.5	0.9	0.220	154.5	0.9	0.134			
8B	1.091	8.2	150	20	0.08	6	252.5	0.9	0.689	154.5	0.9	0.421			
8C	8.308	17.7				15	182.1	0.882	3.707	108.3	0.616	1.540			
9	6.126	15.8	160	11	0.08	6	252.5	0.9	3.867	154.5	0.9	2.366			
10	16.767	23.1				23	152.3	0.882	6.256	89.3	0.616	2.562			
11	2.425	11.1	170	6	0.08	8	229.4	0.9	1.391	139.3	0.9	0.845			
12	0.665	6.8	100	6	0.08	6	252.5	0.9	0.420	154.5	0.9	0.257			
13	2.85	11.8	120	25	0.15	6	252.5	0.9	1.799	154.5	0.9	1.101	sum 11-13	2.202	3.610
14A	1.324	8.8	200	24	0.15	8	229.4	0.882	0.744	139.3	0.616	0.316			
14B	2.018	10.3	115	24	0.15	8	229.4	0.9	1.157	139.3	0.9	0.703			
15	2.715	11.6	200	18	0.15	8	229.4	0.882	1.526	139.3	0.616	0.647			
16A	0.667	6.8	70	16	0.1	6	252.5	0.9	0.421	154.5	0.9	0.258			
16B	0.202	4.3	70	16	0.1	6	252.5	0.9	0.128	154.5	0.9	0.078	sum 16A,16B&8A	0.470	0.768
16C	1.121	8.3	85	5	0.08	6	252.5	0.9	0.708	154.5	0.9	0.433			
16D	0.2	4.3	21	10	0.15	6	252.5	0.882	0.124	154.5	0.616	0.053	sum 16C+16D	0.486	0.831
16E	0.651	6.7	32	10	0.15	6	252.5	0.882	0.403	154.5	0.616	0.172			
17	3.235	12.4	165	6	0.1	8	229.4	0.882	1.818	139.3	0.77616	0.972			
18	1.896	10.1				10	212.2	0.882	0.986	128	0.616	0.415			
19	4.644	14.2				14	187.1	0.882	2.129	111.6	0.77616	1.117			
20	13.385	21.2				21	158.5	0.882	5.198	93.2	0.616	2.135			
21	2.28	10.8	150	6	0.08	8	229.4	0.9	1.308	139.3	0.9	0.794			
suma(-15)	110.3569							sumQ(-15)	56.536		sumQ(-15)	30.635			

Appendix C
Calculation of Myra St Flow Capacity



Appendix D
HEC-RAS Output Summary
Existing Conditions – 100 year flows

Notes:
"Tennis" denotes existing flow path downstream of Council structure
"South" denotes flow path downstream of existing dam
"Main" denotes Middle Creek Tributary

HEC-RAS Plan: Plan 06 Profile: PF 1

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top	Width
	Froude # Chl			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
TENNIS	203	160	PF 1	8.07	84.56	84.73	85.03	92.34	5.002701	12.22	0.66	7.88	
	13.48												
TENNIS	203	140	PF 1	8.07	82.58	82.90	83.02	83.29	0.113913	2.76	2.92	18.95	2.25
TENNIS	203	120	PF 1	8.07	80.26	80.77	80.88	81.13	0.101850	2.67	3.03	18.93	2.13
TENNIS	203	100	PF 1	8.07	78.57	79.67	79.77	80.05	0.033315	2.75	2.94	7.15	1.37
TENNIS	203	60	PF 1	8.07	76.61	79.11	77.41	79.11	0.000017	0.10	78.16	94.78	0.04
TENNIS	203	40	PF 1	8.07	76.71	79.11		79.11	0.000023	0.11	74.08	104.82	0.04
TENNIS	203	20	PF 1	8.07	77.72	79.11		79.11	0.000075	0.15	53.56	112.15	0.07
TENNIS	203	00	PF 1	8.07	76.77	79.11		79.11	0.000002	0.06	138.31	65.58	0.01
SOUTH	202	145.687	PF 1	24.49	87.81	88.29	88.87	105.69	5.006480	18.48	1.33	8.25	
	14.72												
SOUTH	202	120	PF 1	24.49	86.48	87.22	87.92	89.73	0.154748	7.02	3.49	6.41	3.04
SOUTH	202	100	PF 1	24.49	86.13	87.03	87.13	87.32	0.055822	2.40	10.21	47.45	1.65
SOUTH	202	80	PF 1	24.49	85.76	86.51	86.52	86.66	0.019606	1.70	14.41	51.54	1.03
SOUTH	202	60	PF 1	24.49	85.18	85.44	85.56	85.85	0.113931	2.83	8.65	54.37	2.26
SOUTH	202	40	PF 1	24.49	84.23	85.05	85.05	85.19	0.018598	1.67	14.68	52.06	1.00
SOUTH	202	20	PF 1	24.49	80.95	81.79	82.40	84.15	0.153902	6.80	3.60	6.95	3.02
SOUTH	202	00	PF 1	24.49	80.72	81.94	82.00	82.19	0.036658	2.21	11.06	41.97	1.38
MAIN	201-3	696.1	PF 1	31.26	85.15	85.77	86.75	117.96	5.009112	25.14	1.24	4.45	
	15.19												
MAIN	201-3	680	PF 1	31.26	84.53	85.44	86.02	90.09	0.536353	9.56	3.27	10.22	5.39
MAIN	201-3	660	PF 1	31.26	84.25	85.27	85.46	85.86	0.069683	3.41	9.16	29.77	1.96
MAIN	201-3	640	PF 1	31.26	83.60	85.21	85.14	85.36	0.010811	1.67	18.77	44.42	0.82
MAIN	201-3	620	PF 1	31.26	83.15	84.85	84.80	85.11	0.012415	2.26	13.81	22.43	0.92
MAIN	201-3	600	PF 1	31.26	82.53	84.53	84.53	84.83	0.015809	2.42	12.93	22.11	1.01
MAIN	201-2	579.701	PF 1	33.77	81.87	83.31	83.77	84.72	0.068152	5.25	6.43	9.83	2.07
MAIN	201-2	540	PF 1	33.77	81.23	82.63	82.79	83.17	0.062433	3.27	10.34	32.66	1.85
MAIN	201-2	520	PF 1	33.77	80.92	82.80	82.17	82.82	0.000724	0.67	50.43	61.29	0.24
MAIN	201-2	500	PF 1	33.77	80.64	82.79		82.81	0.000428	0.61	55.68	52.48	0.19
MAIN	201-2	480	PF 1	33.77	80.66	82.77		82.80	0.000438	0.71	47.39	36.01	0.20
MAIN	201-2	460	PF 1	33.77	81.44	82.61		82.77	0.006735	1.73	19.55	30.74	0.69
MAIN	201-2	440	PF 1	33.77	80.59	82.33	82.33	82.55	0.017162	2.10	16.11	37.54	1.02
MAIN	201-2	420	PF 1	33.77	80.25	81.84	81.90	82.13	0.025731	2.41	14.01	36.31	1.24
MAIN	201-2	400	PF 1	33.77	79.21	80.94	81.11	81.63	0.020751	3.69	9.15	10.07	1.24
MAIN	201-2	380	PF 1	33.77	78.50	79.95	80.27	80.93	0.064054	4.38	7.70	15.27	1.97

MAIN	**201-2**	**360**	**PF 1**	**33.77**	**78.25**	**79.69**	**79.47**	**79.85**	**0.006131**	**1.78**	**19.02**	**26.00**	**0.66**
MAIN	**201-2**	**340**	**PF 1**	**33.77**	**77.98**	**79.55**		**79.73**	**0.005291**	**1.88**	**18.00**	**19.72**	**0.63**
MAIN	**201-2**	**320**	**PF 1**	**33.77**	**77.78**	**79.42**		**79.62**	**0.006358**	**1.97**	**17.17**	**20.35**	**0.68**
MAIN	**201-2**	**300**	**PF 1**	**33.77**	**77.82**	**79.42**		**79.50**	**0.002833**	**1.23**	**27.53**	**37.26**	**0.46**
MAIN	**201-2**	**280**	**PF 1**	**33.77**	**77.71**	**79.05**	**79.05**	**79.36**	**0.014852**	**2.50**	**13.52**	**21.91**	**1.01**
MAIN	**201-2**	**260**	**PF 1**	**33.77**	**77.54**	**79.05**	**78.48**	**79.11**	**0.001684**	**1.12**	**30.05**	**31.81**	**0.37**
MAIN	**201-1**	**253.709**	**PF 1**	**36.53**	**77.20**	**79.07**		**79.11**	**0.000854**	**0.88**	**41.28**	**37.51**	**0.27**
MAIN	**201-1**	**240**	**PF 1**	**36.53**	**77.12**	**79.07**		**79.09**	**0.000617**	**0.69**	**53.20**	**55.53**	**0.22**
MAIN	**201-1**	**220**	**PF 1**	**52.19**	**76.77**	**79.00**		**79.06**	**0.002571**	**1.08**	**48.45**	**74.64**	**0.43**
MAIN	**201-1**	**200**	**PF 1**	**52.19**	**76.70**	**78.74**		**78.97**	**0.005845**	**2.15**	**24.26**	**24.26**	**0.69**
MAIN	**201-1**	**180**	**PF 1**	**52.19**	**76.64**	**78.56**		**78.83**	**0.007557**	**2.32**	**22.48**	**24.38**	**0.77**
MAIN	**201-1**	**160**	**PF 1**	**52.19**	**76.58**	**78.36**	**78.31**	**78.64**	**0.012001**	**2.38**	**21.93**	**32.55**	**0.93**
MAIN	**201-1**	**152.89**	**PF 1**	**52.19**	**76.55**	**78.20**	**78.20**	**78.54**	**0.014396**	**2.61**	**20.01**	**29.75**	**1.01**
MAIN	**201-1**	**145.214**	**PF 1**	**52.19**	**76.53**	**78.19**	**77.94**	**78.39**	**0.006341**	**1.94**	**26.94**	**33.95**	**0.69**
MAIN	**201-1**	**140**	**PF 1**	**52.19**	**76.51**	**78.22**		**78.34**	**0.003968**	**1.56**	**33.37**	**40.92**	**0.55**
MAIN	**201-1**	**120**	**PF 1**	**52.19**	**76.43**	**78.15**		**78.25**	**0.004649**	**1.40**	**37.24**	**60.87**	**0.57**
MAIN	**201-1**	**100**	**PF 1**	**52.19**	**76.36**	**77.98**		**78.13**	**0.006183**	**1.74**	**29.98**	**43.80**	**0.67**
MAIN	**201-1**	**80**	**PF 1**	**52.19**	**76.29**	**77.83**		**78.00**	**0.007028**	**1.84**	**28.39**	**42.06**	**0.71**
MAIN	**201-1**	**60**	**PF 1**	**52.19**	**76.22**	**77.69**		**77.86**	**0.007094**	**1.81**	**28.80**	**43.94**	**0.71**
MAIN	**201-1**	**40**	**PF 1**	**52.19**	**76.15**	**77.55**		**77.72**	**0.006955**	**1.80**	**29.02**	**44.15**	**0.71**
MAIN	**201-1**	**20**	**PF 1**	**52.19**	**76.07**	**77.28**	**77.23**	**77.53**	**0.011804**	**2.22**	**23.51**	**38.79**	**0.91**
MAIN	**201-1**	**00**	**PF 1**	**52.19**	**76.00**	**77.01**	**77.01**	**77.26**	**0.015039**	**2.25**	**23.18**	**44.96**	**1.00**

Developed Conditions – 100 year flows

HEC-RAS Plan: Plan 06 Profile: PF 1

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top	Width
	Froude # Chl												
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
TRIB T2	T2-1	140	PF 1	24.49	88.00	88.38	89.35	110.27	4.006370	23.02	1.27	4.90	
	12.04												
TRIB T2	T2-1	130.*	PF 1	24.49	87.75	88.36	89.10	93.59	0.548350	11.78	2.63	6.77	4.83
TRIB T2	T2-1	120.*	PF 1	24.49	87.50	88.35	88.84	90.18	0.133087	7.23	4.46	8.66	2.51
TRIB T2	T2-1	110.*	PF 1	24.49	87.25	88.33	88.59	89.15	0.045725	4.98	6.66	10.50	1.53
TRIB T2	T2-1	100.*	PF 1	24.49	86.99	88.26	88.34	88.74	0.022271	3.86	8.74	11.98	1.10
TRIB T2	T2-1	90.*	PF 1	24.49	86.74	87.98	88.09	88.50	0.024898	4.02	8.38	11.74	1.16
TRIB T2	T2-1	80.*	PF 1	24.49	86.49	87.73	87.84	88.25	0.024952	4.02	8.37	11.73	1.16
TRIB T2	T2-1	70.*	PF 1	24.49	86.24	87.48	87.59	87.99	0.024780	4.01	8.40	11.75	1.16
TRIB T2	T2-1	60.*	PF 1	24.49	85.99	87.23	87.34	87.74	0.024897	4.02	8.38	11.74	1.16
TRIB T2	T2-1	50.*	PF 1	24.49	85.74	86.97	87.08	87.49	0.024935	4.02	8.38	11.73	1.16
TRIB T2	T2-1	40.*	PF 1	24.49	85.49	86.72	86.83	87.24	0.024755	4.01	8.40	11.75	1.15
TRIB T2	T2-1	30.*	PF 1	24.49	85.23	86.47	86.58	86.99	0.024979	4.02	8.37	11.73	1.16
TRIB T2	T2-1	20.*	PF 1	24.49	84.98	86.22	86.33	86.74	0.024754	4.01	8.40	11.75	1.15
TRIB T2	T2-1	10.*	PF 1	24.49	84.73	85.97	86.08	86.49	0.024990	4.02	8.37	11.73	1.16
TRIB T2	T2-1	00	PF 1	24.49	84.48	85.98	85.83	86.24	0.010058	2.91	11.80	13.88	0.76
TRIB T1	T1-1	205.7	PF 1	8.07	86.83	87.05	87.63	98.09	4.002955	15.69	0.58	3.60	
	10.94												

TRIB T1	T1-1	197.8*	PF 1	8.07	86.37	86.77	87.17	88.81	0.349647	7.06	1.38	5.07	3.59
TRIB T1	T1-1	189.9*	PF 1	8.07	85.91	86.48	86.71	87.21	0.085305	4.39	2.30	6.37	1.88
TRIB T1	T1-1	182	PF 1	8.07	85.45	86.08	86.25	86.62	0.055659	3.79	2.70	6.85	1.54
TRIB T1	T1-1	180	PF 1	8.07	84.85	85.36	85.65	86.40	0.137556	5.16	1.93	5.88	2.34
TRIB T1	T1-1	173	PF 1	8.07	84.57	85.22	85.37	85.70	0.047755	3.60	2.86	7.03	1.44
TRIB T1	T1-1	171	PF 1	8.07	83.97	84.48	84.77	85.50	0.132595	5.10	1.96	5.92	2.30
TRIB T1	T1-1	162.*	PF 1	8.07	83.60	84.27	84.40	84.71	0.041442	3.43	3.01	7.20	1.35
TRIB T1	T1-1	153.*	PF 1	8.07	83.24	83.91	84.03	84.34	0.040713	3.41	3.03	7.22	1.34
TRIB T1	T1-1	144.*	PF 1	8.07	82.87	83.54	83.67	83.97	0.040714	3.41	3.03	7.22	1.34
TRIB T1	T1-1	135.*	PF 1	8.07	82.50	83.18	83.30	83.60	0.040568	3.40	3.03	7.23	1.33
TRIB T1	T1-1	126.*	PF 1	8.07	82.14	82.81	82.93	83.24	0.040493	3.40	3.04	7.23	1.33
TRIB T1	T1-1	117.*	PF 1	8.07	81.77	82.44	82.57	82.87	0.040943	3.42	3.02	7.22	1.34
TRIB T1	T1-1	108.*	PF 1	8.07	81.40	82.08	82.20	82.50	0.040806	3.41	3.03	7.22	1.34
TRIB T1	T1-1	99.*	PF 1	8.07	81.04	81.71	81.83	82.14	0.040808	3.41	3.03	7.22	1.34
TRIB T1	T1-1	90	PF 1	8.96	80.67	81.41	81.51	81.80	0.033117	3.28	3.54	7.76	1.22
TRIB T1	T1-1	80.1111*	PF 1	8.96	80.23	80.92	81.07	81.41	0.044814	3.64	3.16	7.37	1.41
TRIB T1	T1-1	70.2222*	PF 1	8.96	79.79	80.48	80.63	80.96	0.043955	3.62	3.18	7.39	1.40
TRIB T1	T1-1	60.3333*	PF 1	8.96	79.35	80.04	80.19	80.52	0.043955	3.62	3.18	7.39	1.40
TRIB T1	T1-1	50.4444*	PF 1	8.96	78.91	79.60	79.74	80.08	0.044147	3.62	3.18	7.39	1.40
TRIB T1	T1-1	40.5555*	PF 1	8.96	78.46	79.16	79.30	79.64	0.044257	3.62	3.18	7.38	1.40
TRIB T1	T1-1	30.6666*	PF 1	8.96	78.02	78.72	78.86	79.20	0.044312	3.63	3.17	7.38	1.40
TRIB T1	T1-1	20.7777*	PF 1	8.96	77.58	78.27	78.42	78.76	0.044327	3.63	3.17	7.38	1.40
TRIB T1	T1-1	10.8888*	PF 1	8.96	77.14	78.34	77.98	78.42	0.003614	1.50	7.84	10.00	0.44
TRIB T1	T1-1	1	PF 1	8.96	76.70	78.36		78.39	0.000897	0.93	12.42	10.00	0.23
MAIN	201-3 13.73	696.1	PF 1	6.26	85.15	85.51	86.08	100.07	5.002877	16.90	0.37	2.40	
MAIN	201-3	681	PF 1	6.26	84.53	86.28	85.46	86.29	0.000149	0.23	27.75	52.89	0.10
MAIN	201-2	680	PF 1	31.26	84.53	86.02	86.02	86.23	0.017129	2.01	15.59	39.26	1.02
MAIN	201-2	660	PF 1	31.26	84.25	85.34	85.45	85.72	0.038183	2.73	11.46	33.22	1.48
MAIN	201-2	640	PF 1	31.26	83.60	85.21	85.14	85.36	0.010801	1.67	18.77	44.43	0.82
MAIN	201-2	620	PF 1	31.26	83.15	84.85	84.80	85.11	0.012434	2.27	13.80	22.42	0.92
MAIN	201-2	600	PF 1	31.26	82.53	84.53	84.53	84.83	0.015784	2.42	12.94	22.13	1.01
MAIN	201-2	579.701	PF 1	31.26	81.87	83.42	83.72	84.27	0.044066	4.09	7.64	12.51	1.67
MAIN	201-2	540	PF 1	31.26	81.23	82.61	82.77	83.15	0.063746	3.25	9.62	31.08	1.87
MAIN	201-2	520	PF 1	31.26	80.92	82.78	82.15	82.80	0.000653	0.63	49.56	60.98	0.22
MAIN	201-2	500	PF 1	31.26	80.64	82.78		82.79	0.000381	0.57	54.98	52.30	0.18
MAIN	201-2	480	PF 1	31.26	80.66	82.76		82.79	0.000385	0.67	46.99	35.88	0.19
MAIN	201-2	460	PF 1	31.26	81.44	82.64		82.76	0.005256	1.55	20.22	31.17	0.61
MAIN	201-2	440	PF 1	34.74	80.59	82.34	82.34	82.57	0.017070	2.11	16.47	37.90	1.02
MAIN	201-2	420	PF 1	34.74	80.25	81.85	81.92	82.14	0.025660	2.42	14.36	36.88	1.24
MAIN	201-2	400	PF 1	34.74	79.21	80.97	81.14	81.66	0.020208	3.66	9.48	10.38	1.22
MAIN	201-2	380	PF 1	34.74	78.50	79.96	80.28	80.96	0.064908	4.43	7.85	15.50	1.98
MAIN	201-2	360	PF 1	34.74	78.25	79.74	79.48	79.89	0.005503	1.72	20.24	26.83	0.63

MAIN	201-2	340	PF 1	34.74	77.98	79.62		79.78	0.004730	1.81	19.22	20.48	0.60
MAIN	201-2	320	PF 1	34.74	77.78	79.52		79.68	0.005109	1.80	19.25	22.08	0.62
MAIN	201-2	300	PF 1	38.18	77.82	79.50		79.58	0.002981	1.24	30.77	42.61	0.47
MAIN	201-2	280	PF 1	38.18	77.71	79.11	79.11	79.44	0.014240	2.56	14.94	22.65	1.00
MAIN	201-2	260	PF 1	38.18	77.54	78.78	78.55	78.93	0.005523	1.75	21.76	28.80	0.64
MAIN	201-2	253.709	PF 1	38.18	77.20	78.75		78.90	0.003592	1.70	22.42	22.00	0.54
MAIN	201-2	240	PF 1	38.18	77.12	78.76		78.85	0.002146	1.35	28.28	26.94	0.42
MAIN	201-2	220	PF 1	38.18	76.77	78.73		78.80	0.001829	1.23	31.15	30.10	0.38
MAIN	201-2	200	PF 1	38.18	76.70	78.55		78.74	0.005096	1.90	20.05	21.70	0.63
MAIN	201-2	180	PF 1	38.18	76.64	78.43		78.63	0.005932	1.97	19.37	22.38	0.68
MAIN	201-2	160	PF 1	38.18	76.58	78.30		78.48	0.008079	1.90	20.11	31.12	0.75
MAIN	201-2	152.89	PF 1	38.18	76.55	78.28		78.42	0.005769	1.70	22.41	31.77	0.65
MAIN	201-1	145.214	PF 1	51.13	76.53	78.19		78.37	0.006273	1.92	26.63	33.72	0.69
MAIN	201-1	140	PF 1	51.13	76.51	78.21		78.33	0.003933	1.55	32.96	40.65	0.55
MAIN	201-1	120	PF 1	51.13	76.43	78.14		78.23	0.004719	1.40	36.55	60.58	0.57
MAIN	201-1	100	PF 1	51.13	76.36	77.97		78.12	0.006172	1.73	29.50	43.32	0.67
MAIN	201-1	80	PF 1	51.13	76.29	77.82		77.99	0.007018	1.83	27.95	41.69	0.71
MAIN	201-1	60	PF 1	51.13	76.22	77.68		77.85	0.007092	1.80	28.34	43.52	0.71
MAIN	201-1	40	PF 1	51.13	76.15	77.54		77.70	0.006975	1.79	28.55	43.79	0.71
MAIN	201-1	20	PF 1	51.13	76.07	77.27	77.22	77.52	0.011687	2.20	23.24	38.56	0.90
MAIN	201-1	00	PF 1	51.13	76.00	77.00	77.00	77.25	0.015077	2.24	22.81	44.59	1.00

Developed Conditions – PMF flows

HEC-RAS Plan: Plan 06 Profile: PF 1

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top	Width
	Froude # Chl												
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
TRIB T2	T2-1	140	PF 1	84.79	88.00	88.69	90.35	132.14	4.003432	34.42	3.16	7.37	
	13.31												
TRIB T2	T2-1	130.*	PF 1	84.79	87.75	88.68	90.10	105.20	1.093249	21.96	5.14	9.27	7.31
TRIB T2	T2-1	120.*	PF 1	84.79	87.50	88.66	89.85	96.36	0.397854	15.40	7.52	11.14	4.58
TRIB T2	T2-1	110.*	PF 1	84.79	87.25	88.64	89.60	92.76	0.174908	11.51	10.26	12.95	3.13
TRIB T2	T2-1	100.*	PF 1	84.79	86.99	88.60	89.34	91.05	0.088332	9.03	13.28	14.70	2.28
TRIB T2	T2-1	90.*	PF 1	84.79	86.74	88.56	89.09	90.14	0.049952	7.36	16.48	16.35	1.75
TRIB T2	T2-1	80.*	PF 1	84.79	86.49	88.48	88.84	89.61	0.032167	6.28	19.46	17.75	1.43
TRIB T2	T2-1	70.*	PF 1	84.79	86.24	88.33	88.59	89.27	0.025091	5.74	21.38	18.60	1.27
TRIB T2	T2-1	60.*	PF 1	84.79	85.99	88.08	88.34	89.02	0.025107	5.74	21.38	18.59	1.27
TRIB T2	T2-1	50.*	PF 1	84.79	85.74	87.83	88.09	88.76	0.025045	5.74	21.40	18.60	1.27
TRIB T2	T2-1	40.*	PF 1	84.79	85.49	87.58	87.84	88.51	0.025023	5.74	21.40	18.61	1.27
TRIB T2	T2-1	30.*	PF 1	84.79	85.23	87.33	87.59	88.26	0.024940	5.73	21.43	18.62	1.27
TRIB T2	T2-1	20.*	PF 1	84.79	84.98	87.08	87.34	88.01	0.024865	5.72	21.46	18.63	1.26
TRIB T2	T2-1	10.*	PF 1	84.79	84.73	86.83	87.08	87.75	0.024923	5.73	21.44	18.62	1.27
TRIB T2	T2-1	00	PF 1	84.79	84.48	86.58	86.83	87.50	0.024812	5.72	21.47	18.63	1.26
TRIB T1	T1-1	205.7	PF 1	15.19	86.83	87.13	87.92	103.58	4.004727	19.57	0.90	4.26	
	11.56												

TRIB T1	T1-1	197.8*	PF 1	15.19	86.37	87.46	87.46	87.76	0.016821	3.03	6.69	10.00	0.93
TRIB T1	T1-1	189.9*	PF 1	15.19	85.91	86.75	87.00	87.50	0.055725	4.62	4.32	8.53	1.62
TRIB T1	T1-1	182	PF 1	15.19	85.45	86.28	86.54	87.05	0.057442	4.67	4.27	8.49	1.64
TRIB T1	T1-1	180	PF 1	15.19	84.85	85.56	85.94	86.84	0.114535	5.93	3.30	7.52	2.26
TRIB T1	T1-1	173	PF 1	15.19	84.57	85.41	85.66	86.14	0.053973	4.57	4.37	8.58	1.60
TRIB T1	T1-1	171	PF 1	15.19	83.97	84.68	85.06	85.94	0.111781	5.88	3.33	7.55	2.24
TRIB T1	T1-1	162.*	PF 1	15.19	83.60	84.47	84.69	85.14	0.047605	4.37	4.58	8.78	1.51
TRIB T1	T1-1	153.*	PF 1	15.19	83.24	84.14	84.32	84.72	0.039616	4.10	4.91	9.07	1.39
TRIB T1	T1-1	144.*	PF 1	15.19	82.87	83.77	83.96	84.36	0.040359	4.13	4.88	9.04	1.40
TRIB T1	T1-1	135.*	PF 1	15.19	82.50	83.40	83.59	83.99	0.040508	4.14	4.87	9.03	1.40
TRIB T1	T1-1	126.*	PF 1	15.19	82.14	83.04	83.22	83.63	0.040729	4.14	4.86	9.02	1.40
TRIB T1	T1-1	117.*	PF 1	15.19	81.77	82.67	82.86	83.26	0.040445	4.13	4.87	9.04	1.40
TRIB T1	T1-1	108.*	PF 1	15.19	81.40	82.30	82.49	82.90	0.040879	4.15	4.85	9.02	1.41
TRIB T1	T1-1	99.*	PF 1	15.19	81.04	81.93	82.12	82.53	0.040858	4.15	4.85	9.02	1.41
TRIB T1	T1-1	90	PF 1	18.18	80.67	81.74	81.83	82.21	0.026275	3.74	6.50	10.00	1.16
TRIB T1	T1-1	80.1111*	PF 1	18.18	80.23	81.20	81.39	81.86	0.041811	4.41	5.51	9.58	1.44
TRIB T1	T1-1	70.2222*	PF 1	18.18	79.79	80.75	80.95	81.43	0.043615	4.48	5.42	9.51	1.47
TRIB T1	T1-1	60.3333*	PF 1	18.18	79.35	80.30	80.51	80.99	0.043988	4.49	5.40	9.49	1.47
TRIB T1	T1-1	50.4444*	PF 1	18.18	78.91	79.86	80.07	80.55	0.044122	4.50	5.40	9.49	1.48
TRIB T1	T1-1	40.5555*	PF 1	18.18	78.46	79.42	79.63	80.11	0.044238	4.50	5.39	9.48	1.48
TRIB T1	T1-1	30.6666*	PF 1	18.18	78.02	78.98	79.19	79.67	0.044276	4.50	5.39	9.48	1.48
TRIB T1	T1-1	20.7777*	PF 1	18.18	77.58	79.37	78.74	79.47	0.002720	1.70	13.74	10.00	0.41
TRIB T1	T1-1	10.8888*	PF 1	18.18	77.14	79.39		79.44	0.001161	1.29	18.28	10.00	0.28
TRIB T1	T1-1	1	PF 1	18.18	76.70	79.39		79.43	0.000610	1.06	22.74	10.00	0.21
MAIN	201-3	696.1	PF 1	21.67	85.15	85.70	86.64	112.54	5.008425	22.95	0.94	3.87	
MAIN	14.84 201-3	681	PF 1	21.67	84.53	85.32	85.85	89.80	0.415402	9.38	2.31	5.98	4.82
MAIN	201-2	680	PF 1	106.46	84.53	86.15	86.52	87.46	0.091888	5.08	20.95	46.17	2.41
MAIN	201-2	660	PF 1	106.46	84.25	85.83	85.97	86.35	0.025463	3.20	33.27	56.22	1.33
MAIN	201-2	640	PF 1	106.46	83.60	85.86	85.63	86.05	0.006194	1.95	54.47	66.91	0.69
MAIN	201-2	620	PF 1	106.46	83.15	85.64	85.56	85.89	0.010594	2.22	48.02	72.61	0.87
MAIN	201-2	600	PF 1	106.46	82.53	85.24	85.24	85.63	0.013802	2.76	38.55	50.32	1.01
MAIN	201-2	579.701	PF 1	106.46	81.87	84.19	84.49	85.17	0.031747	4.39	24.28	29.21	1.54
MAIN	201-2	540	PF 1	106.46	81.23	82.93	83.32	84.23	0.072097	5.05	21.07	38.68	2.18
MAIN	201-2	520	PF 1	106.46	80.92	83.61	82.63	83.66	0.000781	1.01	105.64	73.58	0.27
MAIN	201-2	500	PF 1	106.46	80.64	83.59		83.65	0.000724	1.04	102.15	63.51	0.26
MAIN	201-2	480	PF 1	106.46	80.66	83.55		83.62	0.001724	1.23	86.43	81.17	0.38
MAIN	201-2	460	PF 1	106.46	81.44	83.21		83.53	0.008986	2.50	42.58	47.76	0.85
MAIN	201-2	440	PF 1	122.59	80.59	82.92	82.92	83.30	0.013847	2.75	44.65	59.56	1.01
MAIN	201-2	420	PF 1	122.59	80.25	82.25	82.44	82.87	0.033717	3.49	35.16	64.41	1.51
MAIN	201-2	400	PF 1	122.59	79.21	82.10	82.10	82.46	0.013972	2.67	45.95	64.62	1.01
MAIN	201-2	380	PF 1	122.59	78.50	80.67	81.08	81.91	0.045217	4.95	24.78	32.60	1.81
MAIN	201-2	360	PF 1	122.59	78.25	79.93	80.30	81.08	0.035896	4.75	25.80	30.35	1.65

MAIN	201-2	340	PF 1	122.59	77.98	80.54	80.28	80.80	0.006811	2.26	54.18	56.25	0.74
MAIN	201-2	320	PF 1	122.59	77.78	80.30		80.63	0.008775	2.57	47.67	49.40	0.84
MAIN	201-2	300	PF 1	134.31	77.82	80.32		80.48	0.003422	1.78	75.53	67.78	0.54
MAIN	201-2	280	PF 1	134.31	77.71	80.04	79.95	80.36	0.010180	2.48	54.26	67.52	0.88
MAIN	201-2	260	PF 1	134.31	77.54	80.10		80.21	0.002152	1.47	91.22	77.43	0.43
MAIN	201-2	253.709	PF 1	134.31	77.20	79.76		80.16	0.005148	2.83	47.53	28.10	0.69
MAIN	201-2	240	PF 1	134.31	77.12	79.81		80.06	0.003146	2.21	60.75	36.47	0.55
MAIN	201-2	220	PF 1	134.31	76.77	79.78		79.99	0.002826	2.02	66.57	42.08	0.51
MAIN	201-2	200	PF 1	134.31	76.70	79.42		79.88	0.007815	2.99	44.97	34.23	0.83
MAIN	201-2	180	PF 1	134.31	76.64	79.27	79.15	79.70	0.009230	2.88	46.60	42.63	0.88
MAIN	201-2	160	PF 1	134.31	76.58	79.30		79.51	0.004284	2.02	66.45	58.39	0.60
MAIN	201-2	152.89	PF 1	134.31	76.55	79.30		79.47	0.004250	1.81	74.15	76.81	0.59
MAIN	201-1	145.214	PF 1	175.44	76.53	78.84	78.84	79.38	0.011814	3.25	53.92	49.84	1.00
MAIN	201-1	140	PF 1	175.44	76.51	78.45	78.68	79.27	0.022189	4.00	43.84	47.76	1.33
MAIN	201-1	120	PF 1	175.44	76.43	78.92	78.49	79.11	0.003729	1.90	92.23	80.82	0.57
MAIN	201-1	100	PF 1	175.44	76.36	78.78		79.02	0.005078	2.15	81.69	75.19	0.66
MAIN	201-1	80	PF 1	175.44	76.29	78.58		78.89	0.007186	2.45	71.53	69.99	0.77
MAIN	201-1	60	PF 1	175.44	76.22	78.46		78.74	0.006685	2.34	75.00	74.67	0.75
MAIN	201-1	40	PF 1	175.44	76.15	78.32		78.61	0.006836	2.37	74.13	73.74	0.75
MAIN	201-1	20	PF 1	175.44	76.07	77.95	77.95	78.41	0.012590	3.00	58.57	64.73	1.01
MAIN	201-1	00	PF 1	175.44	76.00	77.55	77.65	78.10	0.017257	3.31	53.07	64.12	1.1