



FINAL REPORT

DOUGLAS NCP AMENDMENT WATER SERVICING STRATEGY

Prepared on Behalf of:

**Cressey Development Corporation
& Equitas Development Corporation**

For Review by:

City of Surrey



February 6, 2007

Our File: 25194

City of Surrey
Engineering Department
14245 – 56 Avenue
Surrey, BC V3X 3A2

Attention: Mr. K. K. Li, PEng

Dear Sirs:

Re: Douglas Neighbourhood Concept Plan Amendment Water Servicing Strategy

We appreciate this opportunity to provide detailed water servicing solutions for the Douglas Neighbourhood Concept Plan (NCP) Amendment area. We are in agreement that based on the rapid development within Surrey since the 1999 Douglas NCP, the servicing solutions originally established are no longer applicable. We have undertaken a comprehensive analysis of the water supply and distribution infrastructure and devised a detailed servicing strategy to guide the development of the Douglas Amendment area.

In preparing this strategy, we have utilized the City's calibrated WaterCAD model for South Surrey. We modified the consumer demands in the Douglas NCP Amendment area to account for an ultimate population of 1.5-times the 1999 NCP estimates. Further, as we are aware that the Sunnyside Reservoir does not have capacity to accommodate further growth, we have provided for a new supply to be constructed from the Grandview Reservoir.

The servicing strategy for the Douglas NCP Amendment area includes the addition of \$2,473,950 of new growth-related water infrastructure and approval of \$584,350 in upsizing funding from the City into to the City 10 Year Plan. As part of this strategy we propose to construct a 500 mm diameter supply main south along 164 Street, from 24 Avenue to 14 Avenue, and upsize/upgrade many of the existing mains within the Amendment area. This approach will revert the entire 80 m Douglas pressure zone from the existing Sunnyside supply to the Grandview Reservoir, and will provide a well-looped distribution system that provides flows at pressures consistent with the City Design Criteria. However, this Strategy results in a net deficit of \$1,566,711, necessitating a levy of approximately \$27,325/hectare.

PROJECT MANAGEMENT ■ ENGINEERING ■ PLANNING ■ SURVEYING

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It is noted that the proposed emergency feed from Douglas has not been proposed as part of this NCP as its approval and construction is beyond the ability of individual developers to achieve. Further, the construction of the 24 Avenue low-pressure feed funded under the North Grandview Heights NCP has not been included in this analysis. Developers will need to install a PRV from the high-pressure mains on 24 Avenue at their cost until development in North Grandview Heights has progressed to a point that the funds for the low-pressure main are available.

Yours truly,

APLIN & MARTIN CONSULTANTS LTD.



James Kay, PEng
Design Engineer

JBK

Enclosure

cc: Mr. Rob Wilson, City of Surrey
Mr. John Wilson, City of Surrey
Mr. Lorne Robinson, City of Surrey
Mr. Chris Turcotte, Cressey Development Corporation
Mr. Bob Ambardar, Cressey Development Corporation
Mr. James Evans, Equitas Development Corporation

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1.0 DOUGLAS NEIGHBOURHOOD CONCEPT PLAN AMENDMENT

On behalf of Cressey Development Corporation, Equitas Development Corporation, and the City of Surrey, Aplin & Martin Consultants Ltd. has prepared this report to outline a water servicing strategy for the Douglas Neighbourhood Concept Plan (NCP) Amendment area. The Douglas NCP Amendment area covers a developable area of approximately 61 hectares/150 acres bound by Highway 99 to the west, Washington State to the south, 4 Avenue to the north, and industrial lands adjacent 176 Street to the east. The lands presently are serviced by municipal water mains; however, the NCP prepared in July 1999 identified deficiencies in the existing system that would require upgrading to accommodate increases in population. This proposed NCP Amendment will further densify these lands and, as a result, require additional upgrades to the water supply and distribution infrastructure servicing to accommodate growth.

1.1 DOUGLAS NCP – JULY 1999

The current Douglas NCP was adopted by Council in July 1999. It estimated the population in Douglas at the time to be approximately 900 people within 270 housing units. It proposed 954 new housing units and an ultimate population of approximately 2,900 people. This new development was to be predominantly single-family housing. See Figure 1.

Since 1999 there has been limited development activity within the NCP area. However, recent development interest for single-family as well as other types of housing in this area has prompted the review of the original servicing strategies. This NCP Amendment will propose revised servicing strategies where necessary to accommodate additional growth, reflect revisions to City servicing standards, and take into consideration the status and capacity of the adjacent infrastructure.

1.2 DOUGLAS NCP AMENDMENT – 2006

At this time there are several development applications under review by the City of Surrey for development within the Douglas NCP area. However, these applications are still working documents, and as such, their actual development form and populations are not finalized. Assumptions have been made to account for the ultimate build-out of the Douglas NCP area.

1.2.1 Proposed Land Uses & Population Densities

The Douglas Amendment anticipates the same land uses as originally proposed in the 1999 NCP; however, the single-family areas will be developed at higher densities. For example, whereas the original NCP anticipated Urban single-family development at 6 upa, it is more likely that 10 upa will be achieved. Whereas Small Lot single-family was anticipated at 10 upa, the plan now anticipates 15 upa. Ultimately it is anticipated that the Douglas NCP area will accommodate 4200 people and approximately 1400 units.

2.0 WATER SUPPLY AND DISTRIBUTION INFRASTRUCTURE

Extensive discussions between the consulting team and City staff have been held in order to ascertain the implications of more dense development on the City water supply and distribution infrastructure. Due to growth throughout Surrey in the years since the 1999 Douglas NCP, the original servicing strategy is no longer valid. This necessitated an extensive investigation of the infrastructure and a revised water servicing strategy.

2.1 EXISTING INFRASTRUCTURE

Within the Douglas NCP area there exists a network of water mains ranging in diameter from 150 mm to 400 mm. These mains, operating within the 80m Douglas pressure zone, are supplied via 400 mm and 450 mm diameter City supply mains from a series of PRV's at approximately 14 Avenue, which step-down pressure from the 120 m Semiahmoo zone. The Semiahmoo zone is supplied from the Sunnyside Reservoir at 146 Street and 22 Avenue, which is supplied from the GVRD supply mains to South Surrey from both Newton and Cloverdale. Development over the last few years has exhausted available capacity within the Sunnyside Reservoir.

To address this issue, the Grandview Reservoir, completed in 1998 by the GVRD, was constructed to provide balancing storage for the Grandview areas and supplant the Sunnyside supply to several lower pressure zones. Located at the high point of the 142 metre Grandview Zone on 24 Avenue, this Reservoir is a critical component of all future South Surrey development.

2.2 PREVIOUS ANALYSES

As outlined in the Douglas 1999 NCP, the existing water distribution infrastructure within the Douglas NCP area is not adequately sized to provide the required fire flows and peak domestic demands to service the 1999 Land Use Plan. Consequently, the following existing 150 mm diameter mains require upgrading to 300 mm diameter grid mains:

- Peace Park Drive between 0 Avenue and 2A Avenue;
- 1 Avenue between the off-set segments of Peace Park Drive;
- 0 Avenue between Peace Park Drive and 172 Street;
- 172 Street between 0 Avenue and 2 Avenue; and
- 2 Avenue from 172 Street to 175A Street.

As the Douglas area is supplied via a single-feed, the original report also recommended the construction of a new cross-border connection to the City of Blaine Waterworks. It is believed that an agreement to extend approximately 100 m of 300 mm diameter water main along the alignment of 176 Street, with a meter chamber on the U.S. side of the border and PRV on the Canadian side to tie-in to the 300 mm main on 1 Avenue was reached. Beyond the ability of developers, should this feed be desired, it would need to be pursued by Surrey staff.

As outlined in the Grandview Pump Station Pre-Design Report dated January 2005, the Grandview Reservoir is intended to supply gravity-based low-pressure feeds to the 110 m Kensington, 80 m Morgan Creek, and 80 m Douglas zones. Further, the Grandview Pump Station currently under construction will service the 142 m Grandview pressure zone. These mains are part of the City's ultimate servicing plan for this area, but have not yet been constructed. Until a new supply from the Grandview Reservoir is constructed, there is no additional capacity to service this development.

The North Grandview Heights NCP Amendment dated September 2005 identified both an interim and ultimate water servicing solution to accommodate growth in the lands in the lower pressure zones. Ultimately a new 750 mm diameter low pressure water main will be constructed west from the Grandview Reservoir to 160 Street. In the interim, developers may install a pressure reducing valve, (PRV), from the existing high-pressure mains on 24 Avenue until the low-pressure mains are available. As interim works, the cost of these works is not reimbursable.

2.3 WATERCAD MODELING

The assessment of the existing, and design of proposed water distribution infrastructure has been modeled using WaterCAD software by Bentley Systems. This software conducts steady-state and extended-duration analysis of water supply and distribution infrastructure. The City of Surrey kindly provided their calibrated model of South Surrey for use in this analysis.

2.3.1 South Surrey Calibrated Model – 2004

In 2004 the City of Surrey commissioned the creation of a calibrated model of their South Surrey water infrastructure. It has been instrumental in the identification of undersized infrastructure as well as in the design of new waterworks. Although the model is based on demand rates different than the City Design Criteria, it is believed to be an accurate reflection of the current state of the system. The populations loaded into the model are based on full build-out of land uses approved in the City's Official Community Plan.

2.3.2 Methodology

The modeling of the Douglas NCP Amendment area was essentially performed in two parts: design of the new water supply from the Grandview Reservoir; and analysis of the existing mains within the Douglas NCP area. All additional demands are modeled using the current City design criteria: 1,000 l/d/capita for Max Day Demand, (MDD) and 2000 l/d/capita for Peak Hour Demand (PHD). Limiting conditions are based on the greater of MDD plus Fire Flow, (60 l/s single-family, 90 l/s/ha commercial, 120 l/s/ha school), and PHD.

The WaterCAD model presently estimates demands of 15.7 l/s of MDD to the Douglas NCP area, which based on the above criteria, would represent 1,356 people. This NCP Amendment is expected to accommodate 4,200 people, which is approximately three times the current modeled demand. Since development applications are at a preliminary stage, it is impossible to accurately assign these demands to specific nodes within the model. Instead, modeling has been conducted by multiplying all consumer demands currently within the Amendment area by a factor of four, which provides a factor of safety in the analysis of over 30%.

2.3.3 Proposed Upgrades

As above, the upgrades required to support development within the Douglas Amendment area are in two parts: a new supply main, and new distribution mains within Douglas. In order to supply Douglas with water from the Grandview Reservoir, a new 750 mm diameter water main west to 160 Street, will be required. This new main will service the Kensington, Morgan Creek, and Douglas zones, as well as portions of the Semiahmoo zone east of Highway 99. As a result, the funding of this main should be distributed between all benefiting areas and paid for through a combination of DCC Frontended and City-funded programs.

In addition, a new 350 mm diameter supply main will be required south from 24 Avenue to support any further development within Douglas. This main would adequately service the full build-out of the Amendment's 4,200 people. However, with the construction of this main is the opportunity to also service other existing developments within the Douglas pressure zone northwest of the Amendment area, currently supplied from the Sunnyside Reservoir. Servicing of these additional populations would require the upsizing of the 350 mm main to a 500 mm diameter main. It is recommended that the 350mm diameter main be frontended by developers but ultimately funded through a DCC Frontender Agreement. Further, it is recommended that the City provide a contribution for the upsizing of this main to the 500mm-diameter ultimate size.

Within the Amendment area, the upgrading of the existing 150 mm diameter watermains to 200 mm would facilitate adequate fire flow delivery and provide a well-looped system having no dead-end trunk mains. However, as long as the system is supplied via a single-feed, it is recommended that the grid of 300 mm diameter feeder mains be constructed to ensure adequate flows even in the event of breakage or maintenance on any of the existing mains in the Area. This means that the upgrades included in the 1999 report are still relevant. 300mm mains are required on:

- Peace Park Drive between 0 Avenue and 1 Avenue;
- 1 Avenue between the off-set segments of Peace Park Drive;
- 0 Avenue between Peace Park Drive and 172 Street;
- 172 Street between 0 Avenue and 2 Avenue; and
- 2 Avenue from 172 Street to 175A Street.

These mains should be constructed by the first developments fronting the required upgrade.

3.0 DEVELOPMENT PHASING

Generally, development within the Douglas NCP Amendment area will advance on a site-specific basis as applications are received. As a result, there are not rigid boundaries restricting development to future phases. Ultimately all development is contingent on the new supply from the Grandview Reservoir, and so this work will be front-ended immediately and considered to be Phase One. It is recommended that the construction of the remaining grid mains be triggered by development fronting the required mains. Consequently, the mains on 172 Street and 2 Avenue will most likely also be built as Phase One. The remaining mains will be considered as Phase Two.

4.0 INFRASTRUCTURE FINANCING AND FUNDING

The City of Surrey's 10 Year Capital Plan includes engineering works which are required for both the existing and future needs of the community. Typically the existing needs are funded from general revenue or utility monies or grants and infrastructure required for growth is principally (90%) funded by Developers through Development Cost Charges (DCCs). The City will only fund works which are included in the 10-year plan.

The City of Surrey has taken the following approach to infrastructure funding in NCP's:

- The City of Surrey has endorsed the use of DCC Frontender Agreements as a method of reimbursing developers for frontending the cost of major engineering infrastructure that is in the 10 Year Capital Servicing Plan.
- The long term DCC revenues and expenditures for major water improvements within an NCP area must balance or show a positive cash flow at build-out. A Development Works Agreement, (DWA) can be considered to cover the cost of major infrastructure items that are not covered by DCCs.
- The City will not fund interim works.

4.1 DCC ELEMENTS

Table 1 – DCC Eligible Infrastructure

Item Location	Cost (\$)	Current, Removal or Addition	ID # Current 10 Year Plan	Amount in Current Program	Additions to Program	Notes
164 Street: 24 Avenue to 14 Avenue	\$1,732,900 (350 Ø)	Addition	-	-	\$1,732,900	2015m @ \$860/m
164 Street: 24 Avenue to 14 Avenue	\$584,350 (500 Ø)	Addition	-	-	\$584,350*	Upsize – DCW 2015m @ \$290/m
Peace Park Drive between 0 Avenue and 1 Avenue	\$156,200 (300 Ø)	Current	4987	\$156,200	-	220m of 300mm
1 Avenue between the offset segments of Peace Park Drive	\$99,400 (300 Ø)	Current	4963	\$99,400	-	140m
0 Avenue between Peace Park Drive and 172 Street	\$454,400 (300 Ø)	Current	5283	\$454,400	-	Upsize - DCW 400m
172 Street between 0 Avenue and 2 Avenue	\$284,000 (300 Ø)	Current	4961	\$284,000	-	Upsize - DCW 400m
2 Avenue from 172 Street to 175A Street	\$465,050 (300 Ø)	Addition	-	-	\$465,050	655m @ \$710/m
24 Avenue: Grandview Reservoir to 164 St	\$1,584,000 (600/750 Ø)	Current	5379	\$1,308,000	\$276,000**	North Grandview 460m / 1200m
176 St: South to Border	\$253,000	Current	7697	\$253,000	-	Emergency Supply

* Based on upsizing to 500mm (\$1,150/m) over 350mm (\$860/m) (Paid by City of Surrey)

** Addition based on upsizing to 750mm (\$1320/m) over 600mm (\$1090/m)

Only those DCC elements in the current 10 Year Plan (DCC elements) will receive DCC reimbursements as per the current City policy. The proposed works in the NCP will be eligible if they are added to the 10 Year Plan (DCC elements).

Of the infrastructure identified above, not all is fairly attributed to the Douglas NCP Amendment. Consequently, the upsizing of the 164 Street water main and the 176 Street emergency feed will not be calculated in the revenue/expenditure balance. Similarly, the 24 Avenue watermain is being funded by the North Grandview Heights area and hence has not been double-counted in this analysis. The NCP would see the addition of \$2,473,950 in DCC eligible water infrastructure and require \$584,350 in upsizing funding from the City.

4.2 DCC REVENUES AND EXPENDITURES

The Douglas area is anticipated to have a build-out of 1400 units which represents a population of 4200 people. However, for cost-recovery purposes, only 1176 units are anticipated to develop. Further complicating the financial analysis is the City's recent DCC increase, and the applicability of the one year "grace" period wherein in-stream applications would be eligible to develop under the existing DCC rates. All single-family applications that receive subdivision and all multi-family applications that receive building permit by June 26, 2007 will pay the previous 2005 rates. The most appropriate analysis of the NCP revenues reveals:

Table 2 – Projected DCC Revenues: Proposed DCC Rates

	Townhouse \$0.54/\$1.06/ft. ²		Small Lot S.F. \$865/\$1,701		Urban S.F. \$951/\$1,871		Suburban \$951/\$1,871		Commercial/School \$567/1000ft. ²		Total Units	Total Revenue
	Units	Revenue ⁽¹⁾	Units	Revenue	Units	Revenue	Units	Revenue	Units	Revenue ⁽²⁾		
2005	0	\$ 0	187	\$161,755	222	\$211,122	8	\$7,608			417	\$ 380,485
2006	344	\$455,800	147	\$250,047	253	\$473,363	15	\$28,065		\$37,479	759	\$1,244,754
Total at Buildout											1176	\$1,625,239

(1) Based on 1,250 Ft.²/Unit

(2) Based on 37,600 Ft.² Commercial, 75,000 Ft.² School at \$567/1000ft² plus 30 units at \$1.07/ Ft.²

Table 3 – DCC Balance Sheet

	No. of Units	DCC Revenues	DCC Expenditures	Difference
Phase 1	417	\$380,485	\$2,481,950	-\$2,101,465
Phase 2	759	\$1,244,754	\$710,000	\$534,754
Total	1176	\$1,625,239	\$3,191,950	-\$1,566,711

Provided that the items listed above are included in the City's 10-year plan, the water DCC revenues and expenditures result in a net shortfall of \$1,566,711. Throughout the Douglas NCP area, with 57.34-hectares of re-developable land, this represents a shortfall of \$27,325/hectare.

As above, the first developer in the Douglas Amendment area will be required to front-end the PRV at 164 Street and 24 Avenue, (not DCC reimbursable), the 164 Street supply main, as well as any DCC-eligible watermains along the development site frontage. The proponent will have the option of pursuing a Development Works Agreement, (DWA), in order to establish a levy to recover some of these shortfalls. The levy would be calculated using actual costs of construction, however, in order to establish a DWA, a petition must be signed by a majority of the landowners representing a majority of the land value in the benefiting area. Further, the DWA must be approved by council prior to the developer entering into a servicing agreement to construct these works.

It is important to note that DWA's are traditionally only effective for a period of ten years, so if the area does not build-out within this time frame, the proponent would not recover their costs.

5.0 IMPLEMENTATION PLAN

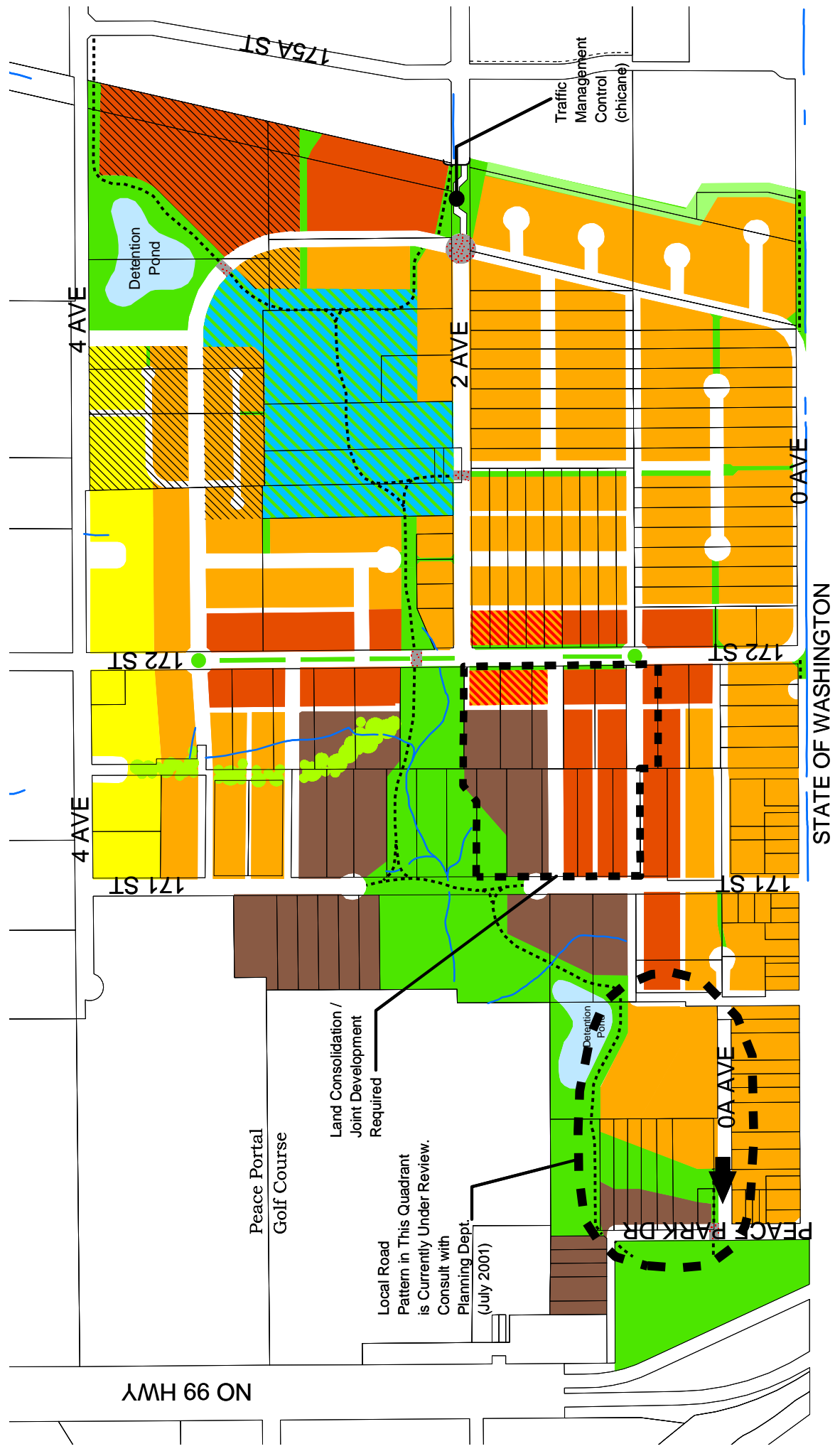
The first requirement for the implementation of this plan is the inclusion of \$2,473,950 of water infrastructure into the City's 10 Year Plan and approval of \$584,350 in upsizing funding from the City.

Second, as all development requires the construction of the new supply from the Grandview Reservoir, it is recommended that the developers initiate the process of garnering support and signatures for the petition required for a Development Works Agreement. This will allow them to recoup the costs of these works.

Third, the 164 Street supply main and PRV at 24 Avenue is required prior to any development within the Douglas Amendment Area. The decision to upsize the main and contribute the appropriate funds will be at the City's discretion. The upsizing of the remaining mains will be undertaken as development fronting these mains proceeds.

Finally, at some point in the foreseeable future, the construction of the low pressure main from the Grandview Reservoir to 164 Street as identified in the North Grandview Heights NCP will be required. The identification of trigger points is already underway and developers in the Amendment area will need to abide by these decisions.

FIGURES



NO 99 HWY

Peace Portal
Golf Course

Land Consolidation/
Joint Development
Required

Local Road
Pattern in This Quadrant
is Currently Under Review.
Consult with
Planning Dept.
(July 2001)

Detention
Pond

PEACE PARK DR

0A AVE

171 ST

172 ST

STATE OF WASHINGTON

0 AVE

2 AVE

4 AVE

175A ST

Detention
Pond

Traffic
Management
Control
(chicane)



- Creeks & Rivers
- Special Paving Areas
- Strata lots
- Main Pedestrian Corridors
- Buffer to Industrial Area
- Townhouse (15 u.p.a.)
- Small Lot Single Family (10 u.p.a.)
- Urban Single Family (6 u.p.a.)
- Suburban 1/2 Acre (2 u.p.a.)
- Commercial / Residential
- Open Space
- School / Park Site
- Traffic Circles & Landscaped Median
- Significant Vegetation Corridor

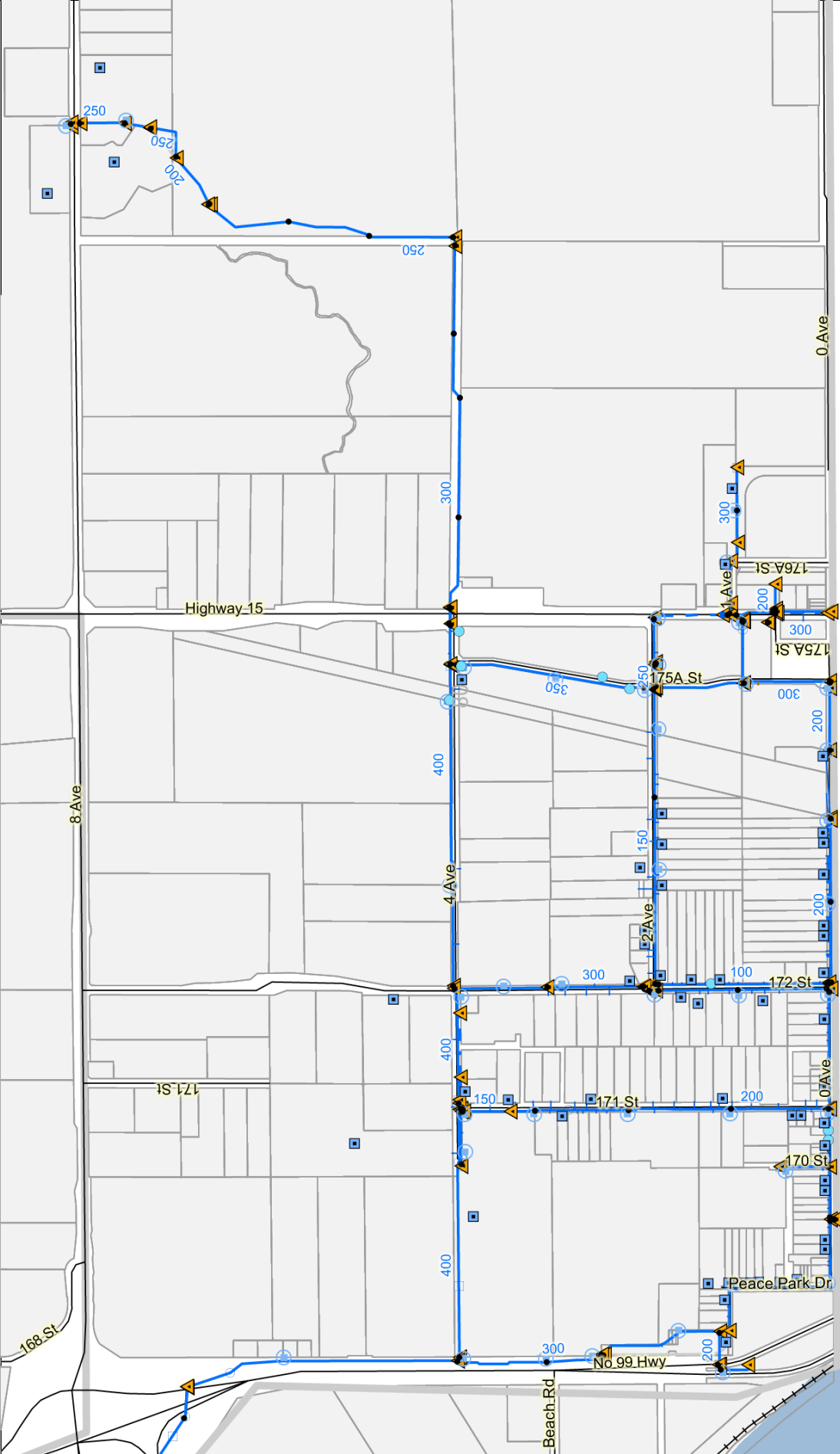
DOUGLAS LAND USE PLAN

Approved by Council: April 15, 1999

This map is provided as general reference only. The City of Surrey makes no warranties, express or implied, as to the fitness of the information for any purpose, or to the results obtained by individuals using the information and is not responsible for any action taken in reliance on the information contained herein.



Existing Water Infrastructure



The data provided is compiled from various sources and IS NOT warranted as to its accuracy or sufficiency by the City of Surrey. This information is provided for information and convenience purposes only. Lot sizes, legal descriptions and encumbrances must be confirmed at the Land Title Office. Use and distribution of this map is subject to all copyright and disclaimer notices at cosmos.surrey.ca.



Map center: 519115, 5428496

Scale: 1:12,500

APPENDICES

Analysis Results

Scenario: Douglas MDD & Fire

Fire Flow Analysis

Title: South Surrey Water Model 2004 w. Douglas Revisions
 Project Engineer: James B. Kay, P.Eng
 Project Date: 15/05/06
 Comments: Based on Mike Homenuke's Surrey Model with Grandview Pump Station Added and Grandview Reservoir modelled as a tank with fixed volume.
 Addition of 750mm LP main along 24 Avenue to 164 Street, and 500mm LP main along 164 Street to 14 Avenue.

Scenario Summary

Scenario	Douglas MDD & Fire
Active Topology	2004 Pumped
Alternative	Supply
Physical Alternative	Douglas 2006
Demand Alternative	2004 MDD
Initial Settings Alternative	2004 Base - pumped BD v2
Operational Alternative	Operational - no controls
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Douglas Fire Flow
Capital Cost Alternative	Base-Capital Cost
Energy Cost Alternative	Base-Energy Cost
User Data Alternative	Base-User Data

Liquid Characteristics

Liquid	Water at 20C(68F)	Specific Gravity	1.00
Kinematic Viscosity	1.0037e-6 m ² /s		

Network Inventory

Pressure Pipes	4034	Number of Tanks	1
Number of Reservoirs	4	- Constant Area:	0
Number of Pressure Junctions	3468	- Variable Area:	1
Number of Pumps	8	Number of Valves	69
- Constant Power:	0	- FCV's:	1
- One Point (Design Point):	0	- PBV's:	0
- Standard (3 Point):	6	- PRV's:	68
- Standard Extended:	0	- PSV's:	0
- Custom Extended:	0	- TCV's:	0
- Multiple Point:	2	- GPV's:	0
Number of Spot Elevations	0		

Analysis Results

Scenario: Douglas MDD & Fire

Fire Flow Analysis

Pressure Pipes Inventory

25.0 mm	630.63 m	321.0 mm	8.84 m
50.0 mm	3,309.82 m	321.1 mm	33,519.16 m
75.0 mm	35.66 m	337.0 mm	3.40 m
87.9 mm	156.06 m	350.0 mm	2.13 m
100.0 mm	1,719.16 m	374.4 mm	7,252.11 m
101.6 mm	5,491.58 m	378.4 mm	3.05 m
102.3 mm	119.18 m	387.4 mm	44.50 m
105.0 mm	3,813.35 m	387.4 mm	12.50 m
108.0 mm	4,007.82 m	400.0 mm	4.30 m
109.2 mm	11,106.91 m	426.7 mm	9,278.72 m
150.0 mm	80.47 m	438.2 mm	224.94 m
152.4 mm	34,707.88 m	440.3 mm	352.96 m
154.1 mm	64.31 m	479.6 mm	4,425.73 m
154.5 mm	2,229.61 m	479.8 mm	2,195.47 m
155.0 mm	28,374.44 m	508.0 mm	2018.35 m
162.6 mm	68,582.74 m	590.0 mm	3.35 m
200.0 mm	424.28 m	590.6 mm	85.04 m
202.7 mm	335.89 m	591.0 mm	271.88 m
203.2 mm	16,268.70 m	610.0 mm	1,998.57 m
204.3 mm	54,647.29 m	638.6 mm	754.38 m
217.2 mm	23,519.89 m	660.4 mm	5,338.57 m
250.0 mm	16,665.41 m	685.8 mm	987.86 m
254.0 mm	1,678.23 m	743.0 mm	7,137.20 m
254.5 mm	21.03 m	750.0 mm	588.57 m
268.7 mm	10,177.58 m	756.0 mm	4,306.82 m
297.0 mm	24,385.83 m	762.0 mm	808.02 m
300.0 mm	3.35 m	838.2 mm	3,113.23 m
304.8 mm	5,946.04 m	895.4 mm	407.52 m
Total Length	403,650.3 m		

Pressure Pipes @ 0.00 hr

Label	Control Status	Discharge (l/s)	Velocity (m/s)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Calculated Friction Headloss (m)	Calculated Minor Headloss (m)	Pressure Headloss (m)	Headloss Gradient (m/km)
115220	Open	0.0000	0.00	77.86	77.86	0.00	0.00	0.00	0.00
115256	Open	1.8497	0.02	77.85	77.85	0.00	0.00	0.00	0.00
115306	Open	1.5556	0.02	77.85	77.85	0.00	0.00	0.00	0.00
115307	Open	-	0.00	77.84	77.84	0.00	0.00	0.00	0.00
115308	Open	0.1296	-	77.84	77.84	0.00	0.00	0.00	0.02
115309	Open	2.4624	0.05	77.84	77.84	0.00	0.00	0.00	0.00
115310	Open	0.0000	0.00	77.84	77.84	0.00	0.00	0.00	0.00
115311	Open	2.4624	0.05	77.84	77.84	0.00	0.00	0.00	0.02
115312	Open	2.4624	0.05	77.85	77.84	0.01	0.00	0.01	0.02
115312	Open	2.4624	0.04	77.86	77.85	0.01	0.00	0.01	0.01

Analysis Results

Scenario: Douglas MDD & Fire

Fire Flow Analysis

Pressure Pipes @ 0.00 hr

Label	Control Status	Discharge (l/s)	Velocity (m/s)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Calculated Friction Headloss (m)	Calculated Minor Headloss (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)
115313	Open	0.3240	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115314	Open	2.4624	0.05	77.85	77.85	0.00	0.00	0.00	0.02
115315	Open	0.0000	0.00	77.86	77.86	0.00	0.00	0.00	0.00
115316	Open	2.6459	0.04	77.86	77.86	0.00	0.00	0.00	0.01
115317	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115318	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115319	Open	-	0.00	77.84	77.84	0.00	0.00	0.00	0.00
		0.1296							
115320	Open	-	0.00	77.84	77.84	0.00	0.00	0.00	0.00
		0.1296							
115388	Open	2.9030	0.08	77.85	77.85	0.00	0.00	0.00	0.05
115389	Open	2.9030	0.08	77.85	77.85	0.00	0.00	0.00	0.05
115390	Open	-	0.09	77.85	77.85	0.00	0.00	0.00	0.08
		1.8397							
115391	Open	-	0.16	77.70	77.85	0.15	0.00	0.15	0.24
		3.2358							
115392	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115393	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115394	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115395	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115396	Open	-	0.33	77.43	78.09	0.67	0.00	0.67	0.88
		6.2498							
115397	Open	-	0.00	77.85	77.85	0.00	0.00	0.00	0.00
		0.0000							
115398	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115399	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115400	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115401	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115402	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115403	Open	17.7056	0.26	77.88	77.83	0.05	0.00	0.05	0.25
115404	Open	14.7928	0.45	77.78	77.76	0.02	0.00	0.02	1.13
115405	Open	50.0513	0.35	78.11	77.93	0.18	0.00	0.18	0.34
115406	Open	7.3248	0.07	77.86	77.85	0.01	0.00	0.01	0.02
115407	Open	35.4934	0.25	77.92	77.88	0.04	0.00	0.04	0.18
115408	Open	12.7590	0.09	77.88	77.86	0.02	0.00	0.02	0.03
115409	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115410	Open	2.9030	0.14	77.85	77.85	0.00	0.00	0.00	0.19
115411	Open	2.5821	0.03	77.85	77.85	0.00	0.00	0.00	0.01
115412	Open	2.5821	0.02	77.85	77.85	0.00	0.00	0.00	0.00
115413	Open	16.8686	0.21	77.88	77.88	0.00	0.00	0.00	0.18

Analysis Results

Scenario: Douglas MDD & Fire

Fire Flow Analysis

Pressure Pipes @ 0.00 hr

Label	Control Status	Discharge (l/s)	Velocity (m/s)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Calculated Friction Headloss (m)	Calculated Minor Headloss (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)
115414	Open	13.9159	0.38	77.93	77.92	0.01	0.00	0.01	0.86
115415	Open	7.2139	0.22	77.38	77.59	0.20	0.00	0.20	0.30
115416	Open	0.0000	0.00	77.34	77.34	0.00	0.00	0.00	0.00
115417	Open	1.2755	0.07	77.34	77.34	0.00	0.00	0.00	0.11
115418	Open	4.3524	0.13	77.34	77.29	0.04	0.00	0.04	0.12
115419	Open	6.9828	0.21	77.34	77.34	0.00	0.00	0.00	0.28
115420	Open	1.6568	0.09	77.38	77.34	0.04	0.00	0.04	0.17
115421	Open	6.9641	0.34	77.70	77.34	0.37	0.00	0.37	0.98
115422	Open	1.1544	0.04	77.29	77.29	0.00	0.00	0.00	0.01
115423	Open	35.4934	0.51	77.93	77.92	0.01	0.00	0.01	0.92
115424	Open	35.4934	0.25	77.93	77.93	0.00	0.00	0.00	0.18
115425	Open	2.6459	0.04	77.86	77.86	0.00	0.00	0.00	0.01
115426	Open	2.6483	0.04	77.86	77.86	0.00	0.00	0.00	0.01
115427	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115428	Open	1.8497	0.02	77.85	77.85	0.00	0.00	0.00	0.00
115429	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115430	Open	0.0000	0.00	77.43	77.43	0.00	0.00	0.00	0.00
115431	Open	2.5973	0.14	77.38	77.43	0.04	0.00	0.04	0.40
115432	Open	1.4405	0.18	77.34	77.70	0.36	0.00	0.36	0.96
115433	Open	0.1389	0.01	77.38	77.38	0.00	0.00	0.00	0.00
115434	Open	1.4900	0.07	77.38	77.38	0.01	0.00	0.01	0.06
115435	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115436	Open	4.7955	0.23	77.70	77.70	0.01	0.00	0.01	0.49
115437	Open	16.1820	0.23	77.78	77.83	0.04	0.00	0.04	0.22
115438	Open	0.0000	0.00	77.78	77.78	0.00	0.00	0.00	0.00
115439	Open	14.2648	0.69	77.70	77.76	0.05	0.00	0.05	3.71
115440	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115441	Open	0.0000	0.00	77.85	77.85	0.00	0.00	0.00	0.00
115442	Open	4.9667	0.06	77.86	77.86	0.00	0.00	0.00	0.02
115443	Open	13.3987	0.65	77.59	77.92	0.33	0.00	0.33	3.30
115444	Open	2.4823	0.13	77.38	77.38	0.00	0.00	0.00	0.16

Analysis Results

Scenario: Douglas MDD & Fire

Fire Flow Analysis

Pressure Pipes @ 0.00 hr

Label	Control Status	Discharge (l/s)	Velocity (m/s)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Calculated Friction Headloss (m)	Calculated Minor Headloss (m)	Pressure Headloss (m)	Headloss Gradient (m/km)
115445	Open	- 0.5172	0.02	77.92	77.92	0.00	0.00	0.00	0.01
115446	Open	0.5172	0.02	77.92	77.92	0.00	0.00	0.00	0.01
115447	Open	0.0000	0.00	77.92	77.92	0.00	0.00	0.00	0.00
115448	Open	- 0.5172	0.02	77.92	77.92	0.00	0.00	0.00	0.01
115636	Open	- 7.0738	0.09	78.11	78.12	0.01	0.00	0.01	0.04
115637	Open	50.051 3	0.35	78.12	78.11	0.00	0.00	0.00	0.34
115638	Open	57.125 1	0.40	78.38	78.12	0.26	0.00	0.26	0.44
115639	Open	7.0738	0.34	78.11	78.09	0.01	0.00	0.01	1.01
115640	Open	0.0000	0.00	78.38	78.38	0.00	0.00	0.00	0.00
118506	Open	5.4851	0.06	77.85	77.85	0.00	0.00	0.00	0.03

Pressure Junctions @ 0.00 hr

Label	Calculated Hydraulic Grade (m)	Pressure (psi)	Pressure Head (m)	Demand (Calculated) (l/s)
167790063 2	78.38	106.7 02	75.17	0.3088
167790063 3	78.38	106.7 02	75.17	0.0000
168070036 0	78.12	88.17 5	62.12	0.0000
168080020 7	78.11	88.15 9	62.11	0.0000
168100034 1	78.11	89.33 4	62.93	0.0000
168130020 3	78.09	87.71 4	61.79	0.8240
169590000 0	77.43	88.61 2	62.43	3.6524
169590000 1	77.43	88.61 2	62.43	0.0000
170140000 0	77.38	88.49 7	62.35	1.4900
170150000 0	77.38	87.90 9	61.93	0.9684
170150033 9	77.92	88.82 7	62.58	0.0000
170740028 7	77.59	88.58 3	62.41	6.1848
170740033 7	77.92	86.47 1	60.92	0.0000

Analysis Results Scenario: Douglas MDD & Fire Fire Flow Analysis

Pressure Junctions @ 0.00 hr				
Label	Calculated Hydraulic Grade (m)	Pressure (psi)	Pressure Head (m)	Demand (Calculated) (l/s)
1707400340	77.92	88.330	62.23	0.0000
1707600342	77.93	89.101	62.77	0.6420
1707700000	77.38	86.859	61.19	4.7316
1707700001	77.38	86.858	61.19	0.9644
1707700340	77.92	88.316	62.22	0.0000
1708200343	77.93	89.324	62.93	0.0000
1708600342	77.92	89.300	62.91	0.0000
1711000340	77.92	88.145	62.10	0.5172
1720300131	77.70	87.174	61.41	2.5052
1720300138	77.76	87.349	61.54	0.5280
1720500000	77.34	85.077	59.94	2.9136
1720500001	77.34	85.771	60.43	2.6304
1720500347	77.88	88.372	62.26	0.9192
1720700246	77.83	87.788	61.85	1.5236
1720800143	77.78	86.277	60.78	0.0000
1720800144	77.78	88.079	62.05	1.3892
1720800347	77.88	85.985	60.58	4.1096
1720900131	77.70	87.364	61.55	6.5908
1721100000	77.34	84.227	59.34	0.1650
1721200000	77.34	84.227	59.34	0.0000
1738600001	77.29	84.504	59.53	3.1980
1738800000	77.29	84.504	59.53	1.1544
1746000038	77.85	86.372	60.85	0.0000
1752600132	77.85	84.952	59.85	1.5069
1752700037	77.85	86.372	60.85	0.0000

Analysis Results

Scenario: Douglas MDD & Fire Fire Flow Analysis

Pressure Junctions @ 0.00 hr				
Label	Calculated Hydraulic Grade (m)	Pressure (psi)	Pressure Head (m)	Demand (Calculated) (l/s)
175270013	77.85	84.95	59.85	0.0000
3		3		
175280013	77.85	84.95	59.85	0.0000
3		3		
175320003	77.85	86.78	61.14	0.0000
7		4		
175320003	77.85	83.53	58.85	0.0000
8		3		
175330003	77.85	86.37	60.85	0.0000
7		2		
175340003	77.85	86.37	60.85	0.0000
7		2		
175520035	77.86	95.14	67.03	0.4675
1		2		
175530035	77.86	95.14	67.03	2.3184
1		2		
175960035	77.86	93.83	66.11	0.0024
1		6		
175970001	77.85	83.53	58.85	0.0000
1		2		
175980003	77.85	86.79	61.15	0.0000
7		7		
175980003	77.85	86.69	61.08	0.7324
8		7		
176000003	77.85	86.79	61.15	0.0000
8		7		
176020013	77.85	87.05	61.33	0.0000
3		3		
176050006	77.85	83.73	58.99	0.0000
9		1		
176050007	77.85	83.54	58.86	0.0000
6		6		
176070000	77.85	85.80	60.45	0.0000
3		3		
176070002	77.85	82.79	58.33	0.0000
2		4		
176080002	77.85	82.73	58.29	0.0000
0		7		
176090000	77.85	85.80	60.45	0.0000
0		3		
176090000	77.85	85.80	60.45	0.0000
3		3		
176120000	77.85	84.24	59.35	0.0000
3		2		
176120035	77.86	96.80	68.20	0.0000
1		2		
176130035	77.86	96.80	68.20	0.1835
1		2		
176130035	77.86	96.80	68.20	0.0000
2		2		

Analysis Results Scenario: Douglas MDD & Fire Fire Flow Analysis

Pressure Junctions @ 0.00 hr				
Label	Calculated Hydraulic Grade (m)	Pressure (psi)	Pressure Head (m)	Demand (Calculated) (l/s)
1761700068	77.85	83.887	59.10	0.2940
1763800003	77.85	84.242	59.35	0.0000
1766300050	77.85	86.285	60.79	1.2316
1768300043	77.85	86.228	60.75	0.3240
1776300044	77.85	85.987	60.58	0.0000
1800000346	77.85	96.936	68.29	0.0000
1800900346	77.85	96.808	68.20	0.0000
1804400608	77.84	103.354	72.81	0.0000
1804400611	77.84	103.354	72.81	0.0000
1812600672	77.84	96.210	67.78	0.0000
1812800757	77.84	97.514	68.70	0.1296
1813200699	77.84	96.123	67.72	2.3328
1813200747	77.84	99.260	69.93	0.0000
1813200757	77.84	97.401	68.62	0.0000
KWL_1077	77.86	93.736	66.04	0.0000
KWL_1095	77.85	85.407	60.17	0.0000
KWL_1096	77.85	85.223	60.04	0.0000