Ayrburn Farm Development Infrastructure Assessment Report

1 EXECUTIVE SUMMARY

Further to Clark Fortune McDonald & Associates correspondence dated 12 February 2015 please find below the assessment of foul sewer reticulation and stormwater disposal for the Ayrburn Farm indicative masterplan.

At this time the estimated density is 150 new residential allotments. The assessment makes some assumptions based on likely development scenarios and relevant development standards.

Ayrburn can be serviced with reticulated foul and stormwater drainage. A summary of the findings is given below.

1.1 FOUL DRAINAGE

Consideration has been given to several options for managing wastewater generated within the Ayrburn development area. It is the view of Clark Fortune McDonald & Associates that the most appropriate method is to gravity reticulate all allotments using an internal pipe network, to discharge to the existing QLDC gravity foul drainage network, and upgrade the existing pump station beside Lake Hayes. It is unlikely that the cost of these works will materially exceed the development contributions that would need to be paid by AFDL as per our original letter, i.e. there should be no capital cost to the QLDC if the development contributions were adjusted for any minor cost increase or if AFDL paid for the required pump station upgrade in lieu of development contributions.

Refer to the wastewater concept plan and the plan of existing waste water pipework contained in Appendices 4 and 5.

1.2 STORMWATER DRAINAGE

Residential development of the Ayrburn Farm area has the potential to increase stormwater runoff and introduce contaminants into the receiving aquatic environment. The preferred stormwater management option is to incorporate traditional big-pipe methods with Low Impact Design (LID) and Sustainable Urban Drainage (SUD) approaches.

Roadway stormwater will be directed to a pipe network through a series of swales and conventional kerb. Stormwater from roofs and hard surfaces within residential allotments will be piped directly.

Stormwater will discharge into detention ponds. Peak flows will be attenuated and clean stormwater will be discharged to Mill Stream at rates not exceeding pre development levels as specified in the QLDC draft land development and subdivision code 2015.

Discharging stormwater from a reticulated system to water or to ground is a restricted discretionary activity pursuant to Section 12.4.2 of the *Regional Plan: Water for Otago* so resource consent will be necessary.

Refer to the pre and post development stormwater catchment plans contained in Appendices 1 and 2, the stormwater concept plan contained in Appendix 3, and the stormwater calculations in appendices 6 and 7.

2 FOUL DRAINAGE

2.1 SEWAGE FLOW

Peak hour sewage flow expected to be generated by the development is approximately 7.8 l/sec, assuming 150 residential dwelling equivalents.

Peak hour flow is based on the following:

- No. of du: 150
- People per dwelling: 3*
- Flow per person: 300 l/day*
- Average dry weather flow: 135 m^3/day
- Diurnal peak factor: 2.5*
- Infiltration factor: 2.0*
- Total peak hour flow: 7.8 l/s.

*Refer QLDC draft Land Development and Subdivision Code 2015.

2.2 DISPOSAL OPTIONS

Options available for wastewater disposal include:

- Onsite treatment on each lot.
- Community onsite treatment.
- Onsite primary treatment before pumping via small bore sewer to Council's sewer network.
- Discharge to Council's sewer network via a foul sewer extension beside Mill Stream.

2.2.1 Option 1 - Onsite Treatment on Each Lot

This option would involve individual allotment owners purchasing and installing a package treatment plant for the home. They would also be responsible for ongoing maintenance and operation which raises the following issues:

- Sizing of allotments to allow waste water to be disposed to land effectively.
- Controls need to be put in place to ensure a minimum level of treatment for each allotment is obtained.

- Land disposal will need to be designed and adequately sized to avoid adverse effects beyond each lot.
- No lot would be permitted to discharge within 50m of any waterway or bore.
- Lot owners would be responsible for ongoing maintenance and operation with loss of control from the Territorial Authority.

The amount of land required to dispose of wastewater onsite is in the vicinity of 200m^2 per residential unit. This option is therefore not considered feasible given the size of the proposed allotments and the amount of land required for on-site disposal.

2.2.2 Option 2 - Community Onsite Treatment

Waste water would be treated at a central community treatment plant. The plant would require 24 hours emergency storage, which would provide a buffer for diurnal variations in flow. Wastewater would then be disposed of via land treatment or discharged to Mill Stream.

The development site contains areas of flat open space which could accommodate hydraulic, biological and nutrient loading.

Resource consent from the Otago Regional Council would be required to discharge treated effluent to land or water. It is unlikely that consent would be granted, given the availability of other cheaper options which are more favourable to the QLDC.

2.2.3 Option 3 - Small Bore Sewers to Council Sewer

This option would involve individual allotment owners purchasing and installing a package grinder pump for the home. They would also be responsible for ongoing maintenance and operation.

This option is considered appropriate for small clusters of housing which are reasonably close to a Council main, but which are not able to discharge by gravity. It is not likely to be feasible in this instance.

2.2.4 Option 4 - Discharge to Council's sewer network via a foul sewer extension beside Mill Stream

This proposal is shown on the wastewater concept plan contained in appendix 4. The proposed connection point is suitably placed for this development, and it would be practical to construct a gravity connection to the Council trunk main.

This option is reliant upon execution of a satisfactory agreement in relation to obtaining an easement through land beside Mill Stream between the development and Speargrass Flat Road.

Based on inspection of the QLDC GIS we can confirm that the existing wastewater pipework has sufficient capacity to receive flow from the development, however the gradients of some sections of pipework will need to be verified by survey.

We anticipate that some work will be necessary to upgrade the existing pump station beside Lake Hayes. It is unlikely that the cost of these works will materially exceed the development contributions that would need to be paid by AFDL as per our original letter, i.e. there should be no capital cost to the QLDC if the development contributions were adjusted for any minor cost increase or if AFDL paid for the required pump station upgrade in lieu of development contributions.

2.3 PREFERRED OPTION

After consultation of the above options, Option 4 - Discharge to Council's sewer network is preferred, as it is likely to:

- Have the lowest capital cost,
- Require the least amount of land,
- Have the lowest ongoing cost to the QLDC;
- Provide the most systematic, area wide solution for Wastewater disposal.

The wastewater concept plan, and the plan of existing QLDC pipework are shown in appendices 4 and 5.

3 STORMWATER DISPOSAL

3.1 DEVELOPMENT CODE

Stormwater disposal has been considered in terms of the QLDC draft land development and subdivision code 2015. The code specifies that:

- discharge to a waterway shall require consent/permission from the Otago Regional Council; and
- discharge to a watercourse from a primary system shall be at a rate no greater than would have occurred for the undeveloped catchment during a 60 minute 5 year storm.

3.2 HYDROLOGICAL ANALYSIS

Runoff has been considered based on the Baxter Design Group draft concept plan dated 01 May 2015, and calculated using the Rational Method. The development area is 11.26 ha and presently consists mainly of pasture and some trees. The soil drainage is medium and the development area is quite flat, so a slope correction of -0.05 has been applied to the runoff coefficient for each surface type. Runoff coefficients have been obtained from Approved Document for New Zealand Building Code, Surface Water, Clause E1. Rainfall intensity has been determined from NIWA HIRDS V3 (http://hirds.niwa.co.nz/).

As specified in the development code pre-development runoff shall not exceed that which would have occurred for the undeveloped catchment during a 60 minute 5 year storm. Refer to the following calculations:

<u>Pre development runoff</u>

Annual recurrence interval:	5 years
∑CA:	2.91ha
Tc:	60 min
i:	12.7 mm / hr
Q:	103 l / s

A runoff coefficient for the residential area of 0.65 has been used in the post development calculations. This is specified in the Approved Document for New Zealand Building Code, Surface Water, Clause E1, as being appropriate for shopping areas and townhouse developments.

Storage capacity has been provided for the 100 year ARI storm. The critical storm duration, as it relates to the storage required in the detention ponds, was determined by analysing storms of varying length: from 15 minutes through to 72 hours.

It was found that the 2 hour storm was critical for storage as follows:

Post development runoff

Annual recurrence interval:	100 years
$\sum CA$:	6.3ha
Tc:	120 min
i:	17.7 mm / hr
Q:	310 l / s
$-Q_{5yr}$:	-103 l / s
Q_{net}:	207 l / s
Storage (total):	1490 m^3
Pond Area (total):	3000 m^2
Max depth:	0.50 m

Outlet control for the detention ponds will be provided by two small diameter pipes (300mm) laid at 2.62%.

The remainder of the calculations are included in appendices 6 and 7.

3.3 RUNOFF QUALITY

Stormwater can contain a number of contaminants which may adversely affect the receiving environment. Studies in New Zealand and abroad have identified urban development as a major contributor to the declining quality of aquatic environments. It is estimated that upwards of 40% of the contaminant content of this runoff can be attributed to run-off from roads.

At this site stormwater will be generated by run-off from the following:

- Roofs of residential buildings;
- Urban roadways;
- Footpaths; and
- Other hard-standing areas.

Based on available information it is expected that stormwater from the above named developed surfaces could contain the following contaminants:

- Suspended solids;
- Oxygen demanding substances;
- Pathogens; and
- Dissolved contaminants.

The dissolved stormwater contaminants of concern at this site can cause an aquatic risk to the ecology of the receiving environment. The parameters of concern are as follows:

(1) Hydrocarbons and Oils

These are associated with vehicle use, although there is potential for spillages of hydrocarbon products to occur. They may be in solution or absorbed into sediments. Routine stormwater discharges are likely to have low concentrations ranging between 1 and 5g/m^3 total hydrocarbons over each storm event.

(2) Toxic Metals

A variety of persistent trace-metal compounds are carried in stormwater in both solid and dissolved forms. The most commonly measured metals of concern are zinc, copper, and chromium (mostly associated with vehicles and roads).

(3) Nutrients

Fertiliser application and animal waste associated with the current agricultural use of the site have the potential to generate high levels of nutrients such as phosphorus and nitrogen within stormwater runoff. High nutrient levels are not anticipated within the post-development stormwater runoff as, agricultural activities, such as grazing in particular, will cease.

3.3.1 Expected Contaminant Levels

Ranges of contaminant levels area provided by both the Auckland Regional Council (TP 10 and 53) and NIWA (Williamson 1993). This data can be used to predict the likely contaminant loading levels associated with changes in land use.

Contaminant levels anticipated for this development have been estimated from TP10 and are included in Table 3 below.

Table 3 – Estimated Contaminant Loading Ranges for Land Use Types (kg/ha/year)

Land Use	Total Susp. Solids	Total Phosph.	Total Nitrogen	BOD	Lead (median)	Zinc	Copper
Road	281-723	0.59-1.5	1.3-1.5	20-33	0.49-1.10	0.18-0.45	0.03-0.09
Residential	60-340	0.46-0.64	3.4-4.7	12-20	0.03-0.09	0.07-0.20	0.09-0.27

Pasture	103-583	0.01-0.25	1.2-7.1	NA	0.004-0.015	0.02-0.17	0.02-0.04
Grass	80-588	0.01-0.25	1.2-7.1	NA	0.03-0.10	0.02-0.17	0.02-0.04

3.3.2 Construction-Stage Stormwater

Construction stage stormwater has the greatest potential to cause discharge of sediment laden runoff to the receiving environment. We would suggest that the applicant provide details of the proposed stormwater management plan as part of the engineering design phase of the project.

The detention ponds will be designed generally in accordance with Auckland Regional Council TP10. Each pond will have a fore-bay and will be suitably vegetated. The detention ponds will provide stormwater treatment before it is discharged into Mill Stream. The primary contaminant removal mechanism of all pond systems is settling or sedimentation.

3.4 Stormwater Management Objectives

The following draft overall objectives should be recognised while assessing stormwater management options for the development area:

- Primary protection for 25 year ARI storms;
- Secondary protection (overland flowpaths) for 100 year ARI storms;
- Regulatory Compliance;
- Avoidance of increases in downstream peak flows resulting from the increase in developed surface areas;
- Sustainable management of the effects of the proposed development;
- Minimisation of pollution of receiving waterways through the reduction of stormwater contaminants from roadways;
- Erosion protection in the stormwater discharge zone;
- Construction and maintenance costs.

3.5 Stormwater Management Approaches

This Section of the report introduces options available for Ayrburn stormwater management, in particular traditional design (big pipe), Low Impact Design (LID) or Sustainable Urban Drainage (SUD) approaches.

3.5.1 Traditional Approaches (Big Pipe)

The traditional approach to stormwater management has been to direct all runoff from residential allotments and roadways to a pipe network which discharges to the nearest receiving water body, with minimal effort made to replicate the pre-development hydrological regime.

The big pipe approach has one advantage over LID and SUD approaches: lower construction and maintenance costs.

3.5.2 LID / SUD Approaches

Some LID options are presented below. These have been sourced from the *Low Impact Design Manual* for the Auckland Region TP124 (Shaver et al. 2000), the *On-Site Stormwater Management Guideline* (NZWERF, 2004) and *Waterways, Wetlands and Drainage Guide* (CCC, 2003).

- Clustering and alternative allotment configuration. Fewer, smaller allotments, with more open space. This approach is less economic for the Developer and is also at odds with some of the principals of modern urban design.
- Reduction in setbacks. Reduction in the front setback reduces the length of driveway required. Correspondingly, the total amount of impervious area within the development is reduced. This approach presents some compliance issues with QLDC District Plan rules.
- Reduction in developed surfaces. This approach applies mainly to transport related aspects of residential developments such as reduced carriageway widths, use of grassed swales as opposed to kerb & channel, and alternative turning head design.
- Vegetated filter strips and swales. Stormwater from roadways is directed through a densely vegetated strip, and then into a road-side swale. Swales are generally used for conveyance of stormwater however they do have contaminant removal properties such as sediment removal efficiency of 20 – 40% (Waterways, Wetlands and Drainage Guide, CCC 2003). Stormwater velocity is reduced so this approach is beneficial in reducing peak flows.
- Infiltration Trench. Infiltration trenches can be constructed in place of swales if natural soils are sufficiently free draining. This is applicable to sites with limited available open space. Infiltration trenches also have the ability to store stormwater. Infiltration trenches can reduce peak flows however they present maintenance issues.
- Infiltration Basin. The suitability of this option is reliant upon free draining natural soils, adequate depth to groundwater, and sufficient open space to construct.
- Soakage chambers. These allow direct discharge of stormwater to groundwater or free drainage soils. Soakage chambers require clean, pre-treated stormwater.
- Permeable paving. This option allows stormwater to permeate directly into pavement layers, and is applicable for low traffic areas with low ground water levels and free draining non-cohesive soils. Construction and maintenance costs for this option are high.
- Detention Ponds. These are used to reduce peak discharges to pre-development levels. They allow for settlement of suspended solids by vegetation. They require sufficient open space to construct.

3.6 Management Options

Many options are available to avoid, remedy or mitigate the adverse effects associated with residential development on receiving environments.

For the Ayrburn project the recommended stormwater management strategy is to provide an integrated treatment train approach to water management, which is premised on providing control at the catchment wide level, the allotment level, and the extent feasible in conveyance followed by end of pipe controls. This combination of controls provides a satisfactory means of meeting the criteria for water quality, volume of discharge, erosion and flood control (if required).

Table 4 – Recommendations

	Recommendations	Remarks
Collection	Combinations of LID/SUD measures, kerb & channel, swales, open channels and pipes.	(1) Where allotment density allows direct roadway runoff to grass swales (primary treatment) – also for secondary overland flow during flood events. (2) Where natural soils allow incorporate infiltration measures. (3) Kerb & channel & pipework to provide primary protection.
Treatment	Combinations of swales, detention ponds and end of pipe structures (gross pollution traps and filters).	(1) Pipework to discharge to detention / infiltration ponds. (2) End of pipe structures and fore bay bunds to provide pre-treatment of stormwater before infiltration to ground water / discharge to Mill Stream.
Disposal	Use attenuation prior to discharging to watercourses.	(1) Sufficient space is available to construct detention ponds. (2) Where natural soils allow incorporate infiltration ponds. (3) Post development discharge not to exceed pre-development levels.

3.7 STORMWATER CONCEPT DESIGN

Runoff from undeveloped areas shall be directed around the developed areas via grass swales, and then discharged into Mill Stream. This will replicate the pre development runoff scenario for the undeveloped areas. The developed areas will be serviced using a hybrid LID/SUD/Big Pipe design. This will incorporate a combination of grass swales, kerbs, pipework and detention areas.

The development area effectively consists of two separate catchments: one on each bank of Mill Stream. Two separate pipe networks are proposed - one for each catchment. Each network will discharge to its own detention pond near the southern boundary of the site. The ponds will then discharge into the stream.

The stormwater concept plan is shown in appendix 3.

4 APPENDICES

APPENDIX 1

PRE DEVELOPMENT CATCHMENT

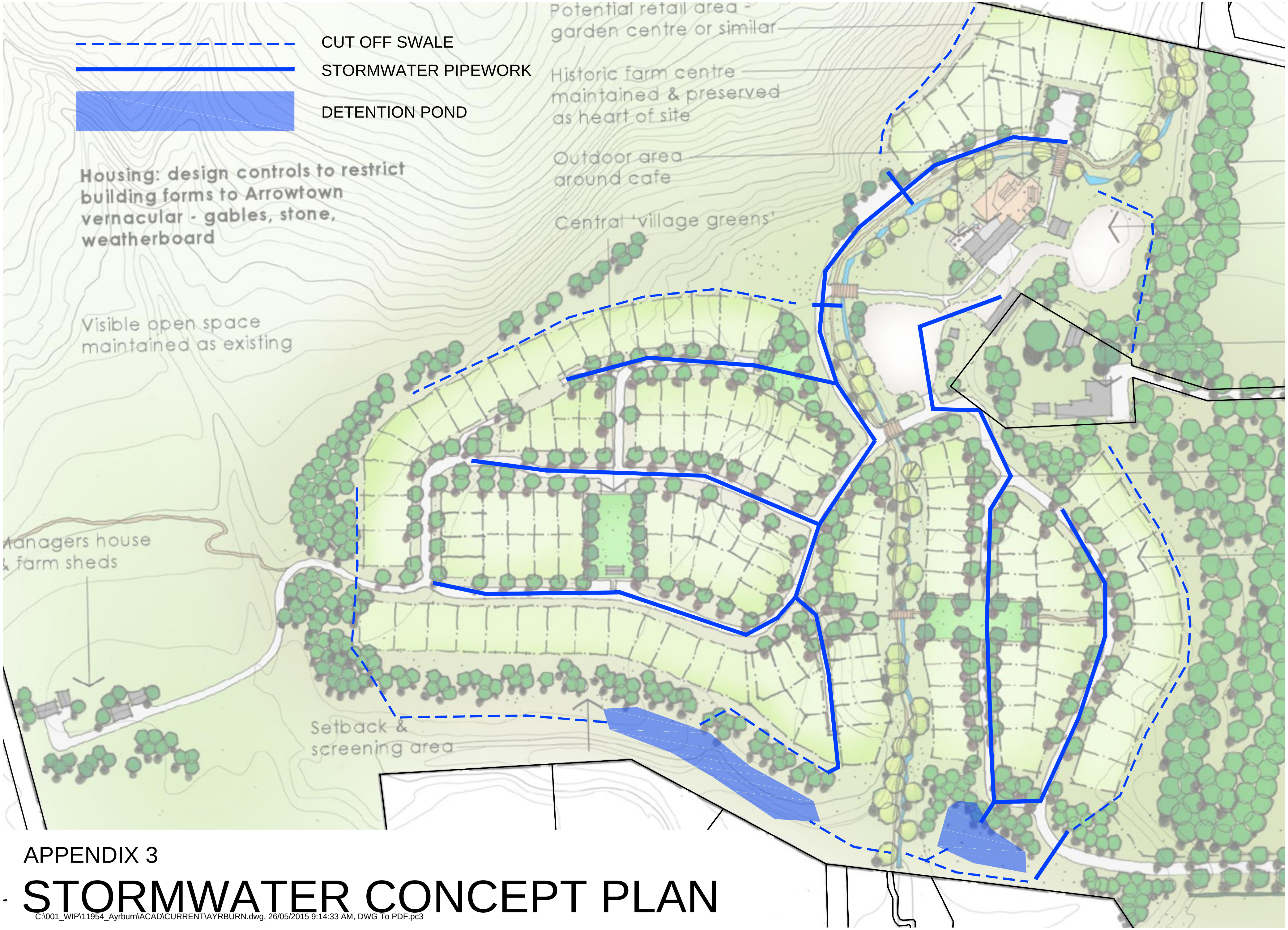
C:\001_WIP\11954_Ayrburn\ACAD\CURRENT\AYRBURN.dwg, 26/05/2015 9:14:31 AM, DWG To PDF.pc3

BUILDINGS
GRAVEL DRIVES
HIGH DENSITY RESIDENTIAL
PASTURE / GRASS
SEALED ROADS
TREES

APPENDIX 2

POST DEVELOPMENT CATCHMENT

C:\001_WIP\11954_Ayrburn\ACAD\CURRENT\AYRBURN.dwg, 26/05/2015 9:14:32 AM, DWG To PDF.pc3



APPENDIX 3

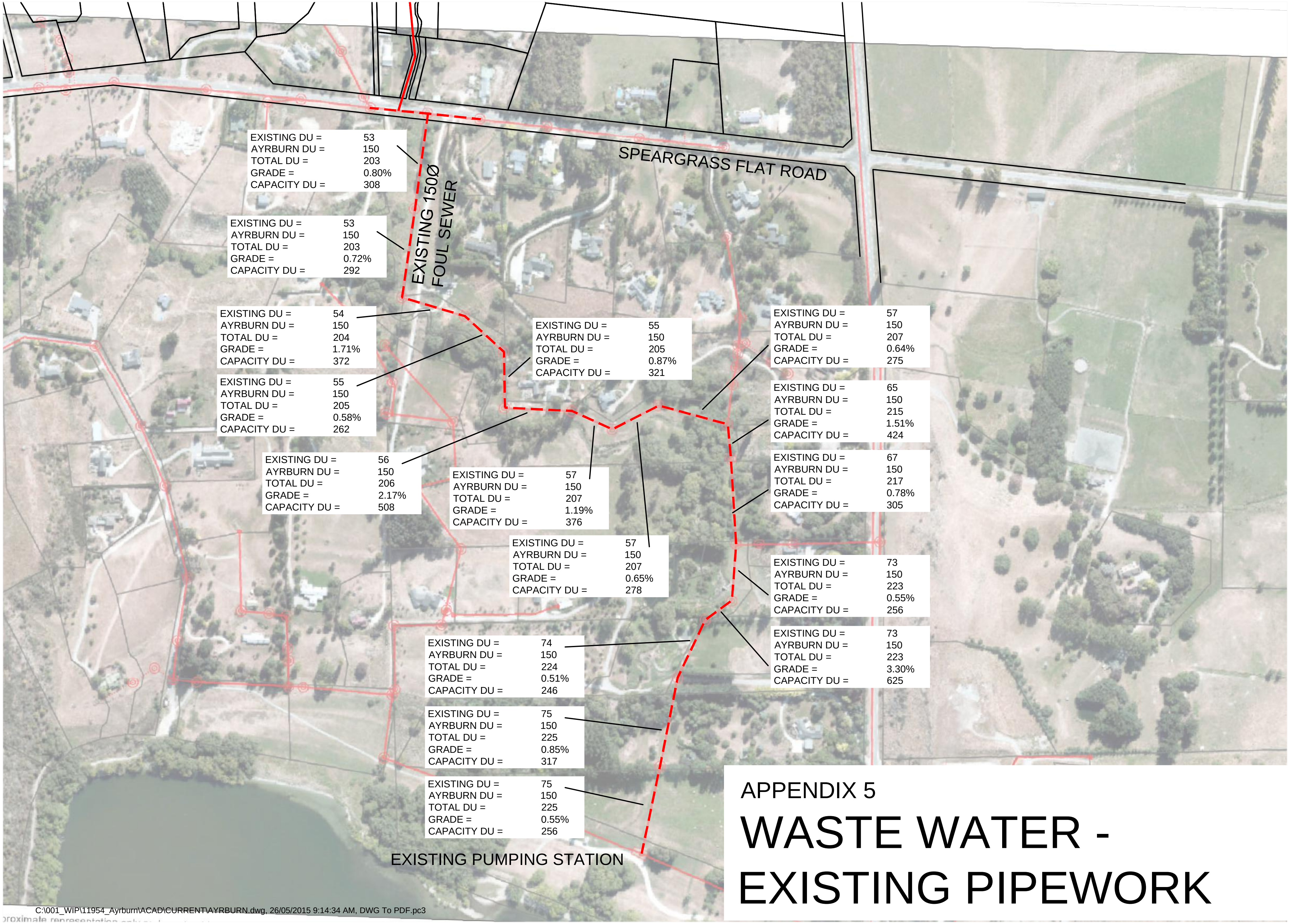
STORMWATER CONCEPT PLAN

C:\001_WIP\11954_Ayrburn\ACAD\CURRENT\AYRBURN.dwg, 26/05/2015 9:14:33 AM, DWG To PDF.pc3

APPENDIX 4

WASTE WATER CONCEPT PLAN

C:\001_WIP\11954_Ayrburn\ACAD\CURRENT\AYRBURN.dwg, 26/05/2015 9:14:33 AM, DWG To PDF.pc3



APPENDIX 5

WASTE WATER - EXISTING PIPEWORK

APPENDIX 6

Catchment runoff coefficients - pre and post development

Pre development

Surface type	Area (ha)	C	Slope correction	CA
Buildings	0.18	0.9	-0.05	0.15
Gravel drives	0.46	0.5	-0.05	0.21
Pasture / lawn	8.48	0.3	-0.05	2.12
Trees	2.14	0.25	-0.05	0.43
				2.91

Lo = 300m @ 3%	To = 25 min
	Tc = 25 min

Post development

Surface type	Area (ha)	C	Slope correction	CA
Buildings	0.22	0.9	-0.05	0.19
Gravel drives	0.67	0.5	-0.05	0.30
High density residential	8.52	0.65	-0.05	5.11
Pasture / lawn	1.13	0.3	-0.05	0.28
Seale roads	0.42	0.9	-0.05	0.36
Trees	0.3	0.25	-0.05	0.06
				6.30

Lo = 50m	To = 13 min
Pipe = 250m @ 2 %	Tp = 2 min
	Tc = 15 min

APPENDIX 7

Ayrburn stormwater routing calculations

Development areas

25 year ARI pre development | 25 year ARI post development

CA	Tc		Tc	i	Qpeak	Runoff	Runoff		CA	Tc		Tc	i	Qpeak	Runoff	Runoff		Outlet	Net	Storage	Storage	Storage	Depth
ha			min	mm/hr	l/s	l	m3		ha			min	mm/hr	l/s	l	m3		l/s	l/s	l	m3	m2	m
2.91	25	min	25	26.7	216	323996	324		6.3	15	min	15	33.3	583	524895	525		103	480	432195	432	3000	0.14
2.91	1	hr	60	18.7	151	544605	545		6.3	1	hr	60	18.7	328	1179042	1179		103	225	808242	808	3000	0.27
2.91	2	hr	120	13	105	757205	757		6.3	2	hr	120	13	228	1639310	1639		103	125	897710	898	3000	0.30
2.91	6	hr	360	7.3	59	1275600	1276		6.3	6	hr	360	7.3	128	2761608	2762		103	25	536808	537	3000	0.18
2.91	12	hr	720	5	40	1747397	1747		6.3	12	hr	720	5	88	3783024	3783		103	-15	-666576	-667	3000	-0.22
2.91	24	hr	1440	3.5	28	2446356	2446		6.3	24	hr	1440	3.5	61	5296234	5296		103	-42	-3602966	-3603	3000	-1.20
2.91	48	hr	2880	2.1	17	2935627	2936		6.3	48	hr	2880	2.1	37	6355480	6355		103	-66	-11442920	-11443	3000	-3.81
2.91	72	hr	4320	1.5	12	3145314	3145		6.3	72	hr	4320	1.5	26	6809443	6809		103	-77	-19888157	-19888	3000	-6.63

5 year ARI pre development

2.91	60	min	60	12.7	103	369866	370		2 No. 300 dia pipes at 2.62%

100 year ARI pre development | 100 year ARI post development

CA	Tc		Tc	i	Qpeak	Runoff	Runoff		CA	Tc		Tc	i	Qpeak	Runoff	Runoff		Outlet	Net	Storage	Storage	Storage	Depth
ha			min	mm/hr	l/s	l	m3		ha			min	mm/hr	l/s	l	m3		l/s	l/s	l	m3	m2	m
2.91	25	min	25	37	299	448984	449		6.3	15	min	15	46.1	807	726656	727		103	704	633956	634	3000	0.21
2.91	1	hr	60	26	210	757205	757		6.3	1	hr	60	26	455	1639310	1639		103	352	1268510	1269	3000	0.42
2.91	2	hr	120	17.7	143	1030964	1031		6.3	2	hr	120	17.7	310	2231984	2232		103	207	1490384	1490	3000	0.50
2.91	6	hr	360	9.6	78	1677501	1678		6.3	6	hr	360	9.6	168	3631703	3632		103	65	1406903	1407	3000	0.47
2.91	12	hr	720	6.5	53	2271616	2272		6.3	12	hr	720	6.5	114	4917931	4918		103	11	468331	468	3000	0.16
2.91	24	hr	1440	4.5	36	3145314	3145		6.3	24	hr	1440	4.5	79	6809443	6809		103	-24	-2089757	-2090	3000	-0.70
2.91	48	hr	2880	2.7	22	3774377	3774		6.3	48	hr	2880	2.7	47	8171332	8171		103	-56	-9627068	-9627	3000	-3.21
2.91	72	hr	4320	2	16	4193752	4194		6.3	72	hr	4320	2	35	9079258	9079		103	-68	-17618342	-17618	3000	-5.87