BUSINESS OUT OF THE CITY - MOVING FORWARD WITHOUT THE 'PIPE'

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ABSTRACT

Large format retailers (supermarkets, home and garden centres etc.) are aggressively expanding store numbers to increase their coverage before competitors encroach on target markets. Expansion has predominantly occurred in municipal regions, where retailers take over sites within existing reticulated areas, however, they are increasingly looking to expand into rural zones. Likewise, smaller boutique companies, including breweries and butcheries, are targeting rural areas where the zoning is more sympathetic to this land use. But what happens when target markets are to be found in locations beyond the serviced boundaries?

Businesses that traditionally 'connect to the pipe' are increasingly finding themselves reliant on on-site servicing for the three waters – water supply, stormwater, and wastewater. Whilst all three areas have their own development issues, the most difficult of these servicing requirements is typically for wastewater. On-site wastewater, particularly for large commercial establishments, can be a development obstacle for industries unaccustomed to managing this type of constraint. This paper reviews collation of design data and touches on land and environmental constraints of an artisan butchery attempting to establish and a large format supermarket being built in non-reticulated areas.

Keywords: on-site wastewater, large format retail, commercial, rural, flow metering.

INTRODUCTION

There is a continuing trend for large format providers (Progressive, Foodstuffs, Mitre 10, Bunnings, etc.) to increase store numbers during times of economic growth. Expansion is often into existing urban sites, replacing smaller commercial developments, or building on historically subdivided land that has remained undeveloped until local demand is sufficient to support it. Where subdivisions have expanded beyond the rural urban boundary, and municipal reticulation is unavailable, some sites have been developed by large format retailers, whilst others attract boutique industries (e.g. breweries, butcheries, etc.).

New development requires servicing. Generally limited services are provided when creating a subdivision, however, wastewater and water supply are often the responsibility of the party developing the specific site. A lack of some services can complicate site development, particularly if the developer's experience is limited to urban projects where municipal connection for all waters (including trade waste) are already in place. Questions asked by architects and hydraulic engineers include 'where is the site sewer/stormwater/water supply connection that we can supply from/discharge to?' Not simple to answer without engaging a specialist civil engineer. To further complicate matters, engineers are often engaged only once the concept plan has been reviewed and accepted by the client. The plan typically attempts to maximise the development area, often with minimal regard to on-site service land area requirements.

Furthermore, on-site servicing of a development will need to take into consideration a greater number of potential constraints than those of an urban counterpart. If wastewater is to be discharged on-site, the relevant regional council's setback requirements (from watercourses, flooding, neighbours, etc.) will need to be taken into consideration as well as setback from stormwater features (discharge points and treatment devices). Beyond those items, and specific to water supply and wastewater servicing, the design basis (average and peak flows and effluent parameters) will need to be appropriate for the development, and be based on either existing published information or, more likely, gathered from monitoring similar existing activities.

The following details two developments that are being constructed or are proposed for construction in rural, non-reticulated areas that are more typically constructed in urban/reticulated areas with supporting infrastructure and close proximity to consumer base. The first example is a boutique butchery proposed for rural Kaipara, currently in the initial feasibility development stage. The second example is a large format supermarket under construction on Waiheke Island, describes the process from initial information gathering through to consenting and construction.

ON-SITE WASTEWATER FIGURES AND INFORMATION

The majority of flow recommendations published in wastewater texts focus on domestic wastewater or domestic-type wastewater sources such as dwellings, schools, hotels, etc., and are based on units of staff, residents, or visitors.

For a large format supermarket, the reference documentation is either too broad or too narrow to cater for its varied internal activities. In *Metcalfe & Eddy (2003)*, and *Crites and Tchobanoglous (1998)*, the most appropriate facility is most likely a shopping centre, store (resort), or department store. New Zealand design publications, *AS:NZS 1547 (2012)* and *Auckland Council TP58 (2004)* reference rural factories, shopping centres and/or day staff.

Modern supermarkets are generally constructed to a similar design, adapted for the specific site. The departments within these supermarkets are more often than not similar in size so comparison between supermarkets should provide similar results. It is also increasingly common for supermarkets to have butchery, fish, and delicatessen goods prepared off-site and delivered to the store for local storage and placement on shelves without further preparation. With regard to wastewater generation, this greatly decreases the expected wastewater produced from these departments, and also potentially its strength, as wastes such as blood, trimmed fat, etc. are not produced on-site. In modern supermarkets, waste streams typically consist of wash-down from departments or cabinet and shelf cleaning.

Given that a supermarket has staff facilities, and may have grocery, butchery, bakery, and delicatessen departments, the applicability of their recommendation and broad range makes them a good comparison, but not a potential design basis. Furthermore, in both instances the recommendations are based on staff or patron numbers. The developer of a business may have forecasts on sales, but expected patron numbers may be harder to pin down for use as a design basis. Alternatively, a design basis of patron numbers may not even be applicable (e.g. a butchery business with no on-site sales).

With regard to effluent constituents, because of the variety of potential activities, the treatment plant will need to be specifically designed based on testing from similar businesses if available, or a conservative estimate made based on engineer and supplier knowledge.

On-site wastewater – boutique butchery

With the proliferation of boutique wineries and breweries, it is unsurprising that industries set up boutique establishments in rural settings. RILEY has recently been involved with the initial stages of the establishment of a boutique butchery in rural Kaipara. The person seeking to establish this business has had dealings with similar sites overseas.

When first presented to us, the design called for all processing plant wastewater to be collected within a central tank with a discharge to the rest of the site, and showed a pipe extending into the site.

Given the rules governing discharges in the Auckland area we raised questions for a better basis upon which to design a suitable treatment and discharge plant. This information was considered important as this type of waste can be high in biological oxygen demand (BOD), total nitrogen, and fats and greases, which could affect the treatment process or the final receiving environment. The questions included:

- What will be the likely discharge flow from the process, plus any seasonal variation?
- What typical pre-treatment processing can be put in place to reduce biological/fats and grease load?
- What wastewater quality can be expected?

We are currently in the process of working with the project team to collate sufficient information to proceed with the design.

On-site wastewater – large format supermarket

As with any wastewater design for a development where published data is unavailable or incomplete, the next best source is data from an existing, closely matching, activity. Fortunately the developer operates an existing supermarket on Waiheke Island that has a consented discharge system with conditions requiring daily flows to be metered. This facility is, however, significantly older and smaller than the proposed new development, therefore interpretation and scaling of the data was required to model design flows that may be produced by the new supermarket.

A variety of wastewater and water supply information was sought to support a wastewater design and consent for the site. These included the existing Waiheke Island supermarket; existing supermarkets owned/operated by the client, both urban and rural; and other rural supermarkets or convenience stores.

From our review it was ascertained that there is limited information about of supermarket water usage in New Zealand due to the following practices:

- Urban – There is no requirement to monitor flows, and no incentive as there is an associated cost. In some urban areas, monthly water consumption is monitored (i.e. by Watercare for water/wastewater charging purposes), however, this monitoring is monthly, and does not offer an insight into daily or weekly trends.
- Small towns – Water supply/wastewater is either unmetered or there is a fixed charge (metering not required), therefore no information is available.

- Rural – On-site wastewater systems are often utilised, and are supplied by roof tank water or bore water, neither of which are usually metered.
- Perceived Competition – Companies are generally reluctant to provide information on any aspect of their business.

In this instance the information obtainable was limited to the existing Waiheke Island supermarket and similar supermarkets operated by our client.

EXISTING WAIHEKE SUPERMARKET

It was considered that the existing supermarket would provide the best indication of the proposed supermarket expected flows for the following reasons:

- It is representative of the community that the supermarket is to support, including the expected usage trends and peaks.
- It is to have identical facilities to the existing supermarket (e.g. bakery, off-site meat preparation, etc.)
- As both sites are reliant on on-site water supply and wastewater management, theoretically they have/will have similar practices in place to limit water consumption/wastewater production.

The existing supermarket has a gross floor area of 1,900m^2 (including all facilities, storage, shelves, etc.). The proposed supermarket has a gross floor area of 3,325m^2. The existing site wastewater flows are recorded on a weekly basis. The weekly meter readings during the period October 2010 to January 2011 are presented below.

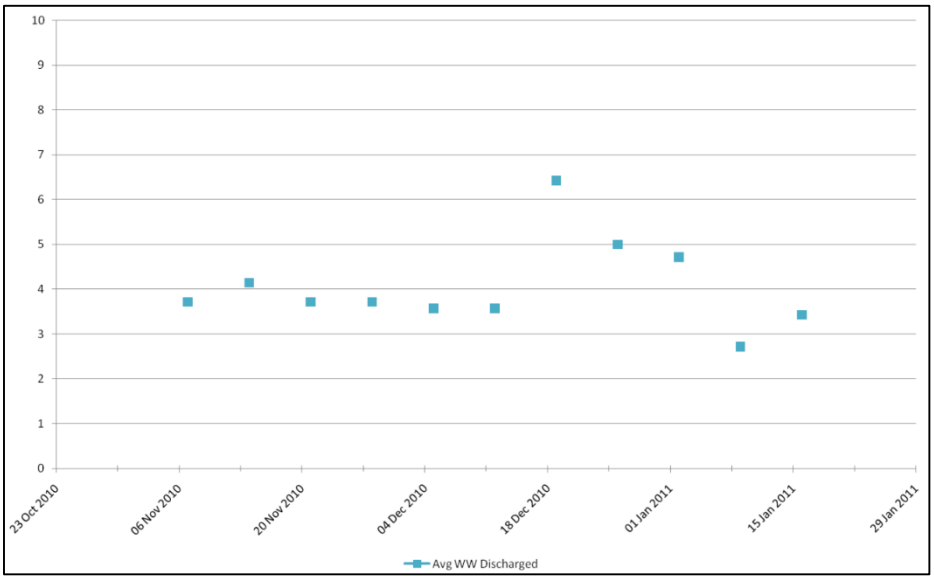

Fig. 1. Existing supermarket wastewater discharge (October 2010 – January 2011)

Further monitoring undertaken in late January 2011 included water supply volumes, which highlighted that the existing system is prone to infiltration. It is likely that the data point for the week ending 19 December was affected by infiltration (refer Fig. 2., which shows wastewater discharge volume higher than water supply readings for the week). However, even when all data is included, an average volume of 4m^3/day still appears appropriate. The average flow figure of 4m^3/day is, therefore, considered the design average wastewater flow for the existing supermarket.

For the existing site, wastewater discharge volumes were compared to the water supply volumes, which are recorded daily, (refer Fig. 2.). From this data it was seen that, excluding a few outliers (most likely due to external water usage or meter misreads), the supply volume is fairly consistent.

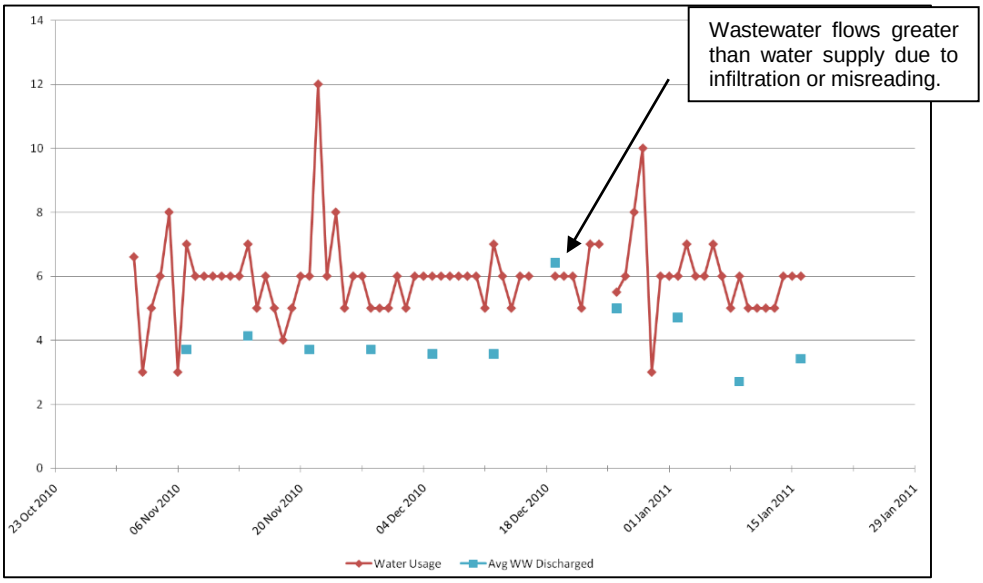

Fig. 2. Wastewater and water supply meter readings (October 2010 – January 2011)

Fig. 2. shows the wastewater discharge is typically 60% to 70% of the water supplied (water supply average of 5.9m^3/day and wastewater discharge of 4m^3/day – all data included).

NATIONAL SUPERMARKET FLOW INFORMATION

As a comparison, a snapshot of water usage data, including a month's water meter readings (taken from municipal reticulation charges), was collected. Data was filtered to show only supermarkets with facilities and floor areas (2,500m² to 3,500m^2) similar to the proposed supermarket.

Table 1. National supermarket flow figures

Store	Gross Area (m^2)	Water Usage (m^3)	Ratio (m^3/m^2)
Bethlehem	3352	9.68	0.0029
Cambridge	2953	5.50	0.0019
Glenfield	3285	4.48	0.0014
Grey Lynn	2865	6.08	0.0021
Highland Park	3145	8.70	0.0028
Kensington	2884	6.98	0.0024
Meadowlands	3390	4.88	0.0014
Pakuranga	3005	7.41	0.0025
Te Atatu South	2652	5.00	0.0019
Wanganui	3361	4.70	0.0014
Average	**3089**	**6.34**	**0.0021**

Due to its age and limited timeframe, this data in isolation could only be used to indicate the range in which the proposed supermarket discharge volume should lie. Based on the same analysis, the existing Waiheke supermarket has a potable water usage ($5.9m^3$/day) to floor area ($1,900m^2$) ratio of $0.0031m^3/m^2$, i.e. proportionately (to its floor area) the existing supermarket has a greater water consumption than the average of the urban sites. However, given the age of the existing supermarket and the variation in activities, department sizes, etc. this is not unexpected.

SUPERMARKET DESIGN FLOWS

The proposed supermarket has a total area of $3,325m^2$. This relates to an increase in size over the existing supermarket of 175%. The proposed supermarket is expected to have larger patronage due to increased size and modern facilities, but the majority of the increased size is likely to be in the form of shelving areas and storage, which will not directly increase patronage and wastewater production. Other areas, including butchery, delicatessen, bakery, and produce, will receive pre-prepared stock for sale and, will therefore, only increase wastewater through additional cleaning. Overall there is expected to be an economy of scale that is unlikely to see an increase in wastewater proportional to the increase in total floor area (i.e. a straight percentage increase calculation is considered conservative).

Other facilities, such as staff toilets, are likely to see a linear increase in wastewater due to an increase in floor and checkout staff numbers, although there are also expected to be economies of scale as the number of administrative staff is unlikely to increase to the same extent.

Based on the national average water usage to floor area ratio ($0.0021m^3/m^2$), an expected average water usage of $7m^3$/day can be determined for the proposed supermarket ($3325m^2$ x $0.021m^3/m^2$). The existing supermarket has a water usage to wastewater discharge ratio of 70% (conservative estimate) and, therefore, the expected average wastewater based on this method would be approximately $5m^3$/day.

If the floor area percentage size increase method is applied, an expected average flow of $7m^3$/day can be determined ($4m^3$/day x 175%). This is equivalent to the water usage to floor area ratio of $0.0031m^3/m^2$. A design flow of $7m^3$/day was considered appropriate and reasonable for this site and is conservative based on data available.

A consent was granted on this design basis. The conditions required thorough monitoring of the water usage and wastewater discharge from the site, which included seasonal limits on the land application rate (mainly due to poor soils in the receiving environment). The monitoring also extended to metering the water usage of individual major departments within the supermarket (e.g. delicatessen and bakery) to allow for a full assessment of the water usage within sections of the complete store. These conditions reflected Council's wariness of the design being based on modelled not published data.

Existing urban supermarket monitoring

During the site's detailed design phase the client and their architect regularly challenged the size of the discharge area recommended and consented. In urban environments most of the entire site can be occupied by the proposed building, however, on this site, approximately half of the total area was dedicated to wastewater and other to on-site services. To reassure the client, a further investigation was undertaken to confirm the design basis, and ensure it was sound and not overly conservative. It was decided that continuous monitoring of the water supply to and wastewater flows from a newly constructed modern supermarket would enable confirmation of the design flow basis for this site. A recently constructed Auckland site was selected.

Options considered were metering of individual departments potable water supply; installation of a weir on the terminal sewer manhole; installation of an in-line mag flow meter; or continuous monitoring of potable water.

It was determined that the most economic and least disruptive option would involve the installation of a pulse logger for the site's existing water meter supply, and a weir structure on the terminal manhole exiting the site. Monitoring was undertaken for an initial three month period and the results are recorded in Fig. 3.

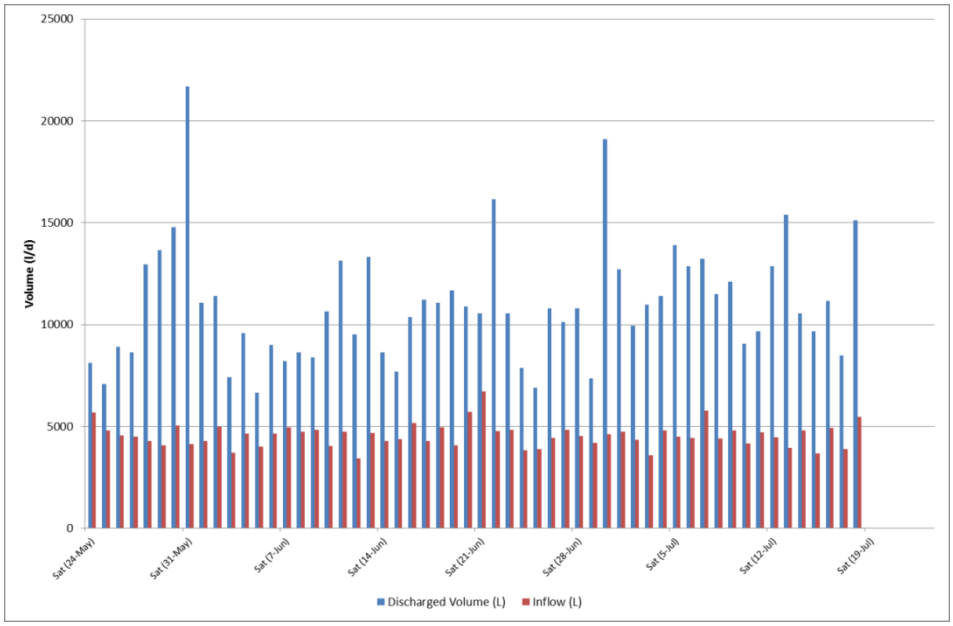

Fig. 3. New supermarket – wastewater and water supply meter readings (May – July 2014)

As with the existing supermarket there were discrepancies between the water supply and the wastewater discharge (varied between 1.4x and 5.3x the inflow) with little correlation to the water supply. Based on this, the wastewater flow information was excluded from analysis.

The outflow was most likely due to groundwater infiltration in the new sewer network prior to the monitoring point.

Potable water monitored was continued beyond the initial monitoring period until June 2015 (approximately 12 months).

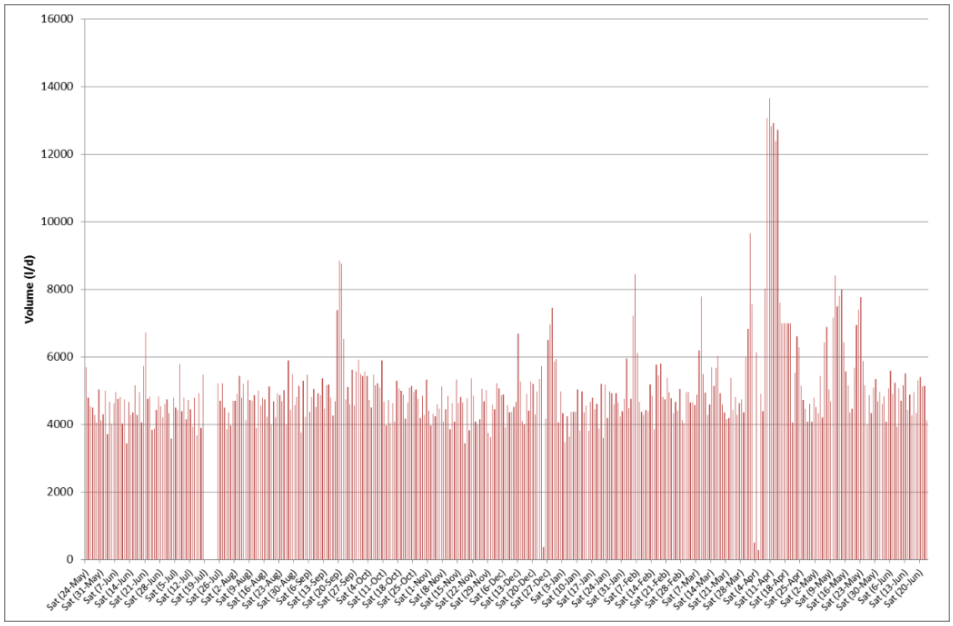

Fig. 4. New supermarket – water supply meter readings (May 2014 – June 2015)

This data shows a relatively consistent water usage pattern throughout the year, with only a few instances of variability caused by issues within the supermarket (e.g. leaking cabinets). Given the modern facilities it was considered appropriate to assume wastewater discharged was equivalent to water supplied, rather than apply the factor determined from the older supermarket. Also, the supermarket at which the data was recorded, will be unaffected by the same seasonal loads as the Waiheke sites.

RESULTS AND DISCUSSION

For an on-site wastewater system to be successful its design basis needs to be sound. Published data will often provide this basis for smaller, more typical, on-site wastewater-dependant developments, however, for larger or unusual developments published data is often unavailable.

Data has been sourced from existing supermarkets, both rural and urban, to provide a suitable design basis for the new supermarket. This process has shown that collation of this type of data is not straightforward, it needs to be carefully considered and reviewed before being applied to a development in differing surrounds and circumstances.

A similar approach could be undertaken for the boutique butchery, but collecting the required information is a time consuming and potential expensive task if similar local industries are not supportive.

Given this approach, and with extensive monitoring in place, the consent for the site was granted. This will hopefully ensure that, in the future, more complete and reliable data will be available for similar designs. Once established, results will be presented in future papers.

CONCLUSIONS

Establishing a large format supermarket or other business in a rural, non-reticulated area where the developers and their technical project team are unfamiliar with the constraints of the development can lead to design pressure on the specialist civil engineer. The specialist civil engineer has to ensure the requirements on-site systems for the development, based on non-published and limited design data, can be catered for to ensure a sustainable outcome for the development. Furthermore, this information needs to be sufficiently substantive to support discharge consents requirement from the regional council.

This process also highlights the importance of monitoring existing systems to provide range and depth of suitable data for application to similar and not-so-similar future designs.

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