Case Studies of basement excavation in relation to programme and vehicle movements

Prepared for RBKC

January 2014

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Contents

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1.Introduction

RBKC have requested a study to establish if there is a link between the basement size, construction duration and vehicle movements.

Initially an appraisal was made of a large number of Planning Applications and the associated Construction Management Plans to identify a range of basement sizes and depths. However it was recognised that the programme durations in the CMP's were not reliable and were likely to under-estimate the duration.

This study is therefore based on schemes where detailed plans and sections of basements were available together with a reasonably detailed programme, so that an accurate assessment could be made.

2.Brief

The purpose of the study is to provide evidence on the numbers of lorry movements involved in the case studies already undertaken by Alan Baxter and Associates on the construction duration. This will involve estimating the cubic capacity of soil that would be excavated and how many lorry movements it would take to remove the soil. Given the width of residential roads in the Borough a suitable lorry size should be reflected. Commentary should include the constrained character of many of the streets in the Borough which would preclude the use of large lorries thereby generating a large number of trips.

The brief evolved to also consider basement excavation periods and overall construction periods in relation to the basement volume and also the rates of excavation (m^3/week) which were achieved.

It makes use of some of the information in previous case studies used in the RBKC Residential Basement Study Report dated March 2013 and other projects where the relevant information was available. Some of the projects are confidential.

3.Approach

This study is based on detailed drawings (plans and sections) and the pre construction stage programmes from 12 case studies.

In many of the projects the basement is likely to be constructed in parallel with an extensive refurbishment of the house. This has not been considered in any detail in the assessment of vehicle movements. The relevant details of the reference projects used are listed in Table 1. The following is a brief summary of each project:

Ref No. Description

1. Single storey basement extension under rear garden and reconfiguration of the existing basement. Some underpinning required. Five storey terraced house. Access is via two way road with street parking either side. Site office adjacent to pavement, but no impact on pedestrian flow. Parking spaces used for loading etc.

2. New single storey basement under building footprint (already has lower ground floor). Three storey terrace house. Basement constructed by underpinning the existing building. Access is via the single carriageway around a square with one-way traffic. There is street parking either side. Due to access constraints, site storage is remote from site so that a small vehicle can run between the storage facility and site rather than larger vehicles going to site.

3. New single storey basement mainly under existing building footprint. Basement extends beyond front face up to property boundary. Underpinning assumed. Access is along a two-way road with some cars parked. Site is not overly constrained. Two storey building in a terrace. 22 weeks quoted for groundworks. Time for excavation is not specifically stated

4. New single storey basement extension under footprint of existing basement. Two storey building in a terrace. Basement formed by underpinning. Access down very narrow road off of a larger road. Site is also small and constrained.

5. New single storey basement under building footprint. Existing lower ground floor extends into rear garden. 3 storey terraced house. Construction method assumed to by underpinning. Access via two-way road with on street parking either side. Bus stop temporarily closed for duration of works for deliveries etc.

6. Single storey basement extension. Relatively large semi-detached house. Good site access.

7. Swimming pool basement extension to rear of property under garden constructed using contiguous piled wall. Single room basement extension to front of property – construction method unclear, underpinning of boundary wall assumed. 3 storey terrace house. Access to rear via gated entrance between adjacent properties. Access to property via large 4 lane road. Unloading and off-loading from high level gantry. No vehicle holding area. Works contained within site.

8. New two storey basement within building footprint. 3 storey terrace house. Basement constructed by underpinning external and party walls. Restricted access due to narrow and low arched entrance to mews. Mews has parked cars. Roads leading to the mews are also relatively narrow – one way with on street parking either side. Excavation time is much longer than normal as underpinning and excavation were carried out sequentially together. (Top down construction).

9. Two storey basement under the existing building footprint. First storey constructed by underpinning the external and party walls. Second storey constructed through a secant piled wall. Large 4 storey terrace house. Access from rear of site down very narrow single track dead end road. Part of rear wall of building removed to gain access to site. Full time traffic marshall required. One vehicle down access road at a time, therefore strict vehicle timetable required. Site office in a high level gantry over front pavement. Parking bays at front of property suspended (3No.).

10. New sub-basement, including swimming pool, to rear of property. Constructed with secant piled wall. Large volume relative to area due to dig from ground level with large depth of soil replaced. Large detached house. Good access to the site.

11. New sub-basement to rear of property (within garden). Formed by combination of secant piled wall and (assumed) open excavation. Small extension to existing basement. Large detached house. Good access to the site.

12. New basement and sub-basement to rear of two combined properties. Alterations and additions to existing basement. Large detached house. Majority of works within relatively large rear garden with very good access. All site offices and storage also contained within front garden which was able to accommodate relatively large vehicles.

4. Lorry Movements

The vehicle movements have been assessed on the following basis:

Single storey basements where the basement volume does not exceed 350m^3

- Spoil removed by conveyors to a skip either in the front or rear garden and then removed by a skip lorry or grab lorry. It has been assumed that 4m^3 of spoil excluding bulking, will be removed by each load.

Note
Soil when excavated and deposited in a skip or lorry takes up a larger volume than the volume excavated – this is known as bulking. The increase in volume relates to the type of soil. Bulking can increase the soil volume by 30-40% typically.

Single/double basement where the basement volume is between 350m^3 and 1000m^3

- It is assumed that the spoil will be removed in 6m^3 lorries excluding bulking.

Basements larger than 1000m^3

- It is assumed that the spoil will be removed in 10m^3 lorries excluding bulking

Each lorry load is counted as two vehicle movements.

Dimensions and details of the typical lorries are included in Appendix B.

Note: It is recognised that the vehicle size adopted may not necessarily relate to the volume of the material to be excavated as there are a large variety of other factors including the location of the site, width of the roads, availability of waiting areas both on or off site. Each site location has been reviewed. If there are access constraints, then the assumed vehicle size has been adjusted to take account of this.

This report has been prepared to give a general overview of the vehicle movements related to the excavations of spoil to form basements. It makes no allowances for other vehicle movements, for example, concrete wagons, formwork, reinforcement, temporary works materials etc .

5. Results from Study

The information obtained has been assembled and is presented in tabular and graphical format as follows:

Table 1: This provides general details on the basement area/volume, the construction period for the basement box and the period allowed to excavate the basement.

Figure 1: Basement excavation time v basement volume for single storey basements

Figure 2: Basement excavation time v basement volume for all basements

Figure 3: Basement construction time v basement volume for single storey basement

Figure 4: Basement construction time v basement volume for all basements

Figure 5: Rate of excavation v basement volume for one storey basement

Figure 6: Rate of excavation v basement volume for all basements

Figure 7: Volume of Excavation v total number of lorry movements for single level basements

Figure 8: Volume of Excavation v total number of lorry movements for all basements.

The figures show an average trend line which may be useful for general guidance. These figures can be refined as more data becomes available.

6. Conclusions

6.1 Basement Excavation Time and Basement Volume
Figs 1 and 2

The conclusion of the study suggests that there is no clear correlation between the time taken to excavate the basement and the overall size or volume of the basement. However and not unsurprisingly, the excavation times relate to the site constraints and the methods used to construct the basement. Basements under existing buildings formed by underpinning with poor access to the site take much longer to excavate than larger basements in gardens within piled walls and good site access. In part this relates to the sequential nature of underpinning and excavation followed by more underpinning.

6.2 Basement Construction Time v Basement Volume
Figs 3 and 4

This looks at the total construction period which includes forming the basement structure and fitting it out. As noted above there is little correlation between the excavation times but, for single level basements there is a slight trend that larger basements take slightly longer to build which appears to mostly relate to the additional time required to fit out a larger basement. This trend appears to be more obvious when both single and double basements are considered.

6.3 Rate of Excavation v Basement Volume
Figs 5 and 6

As expected, larger basements in general have a greater rate of excavation (m3/week) than smaller ones. The rate of excavation for single basements varies quite a bit which appears to relate to the location of the basement and the access restrictions to the site. Again, there is more correlation when the larger double basements are considered. This is because the double basements are within front and rear gardens where a piled wall is used and access is good which allows greater rates of excavation.

6.4 Volume of Excavation v Total Number of Lorry Movements
Figs 7 and 8

As would be expected, there is good correlation between the volume of excavation and the total number of lorry movements. The variation relates to the size of vehicles which can be used. The data used makes a variety of assumptions which relate to the volume of material to be excavated. These have then been assessed against the specific constraints on access for each site and the assumptions varied to suit

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REF NO.	NO. OF BASEMENT LEVELS	DESCRIPTION	BASEMENT AREA (m^2)	BASEMENT VOLUME EXCAVATED (m^3)	BASEMENT CONSTRUCTION PERIOD EXCLUDING FITTING OUT (weeks)	PERIOD TO EXCAVATE THE BASEMENT (weeks)	LORRY LOADS	LORRY MOVEMENTS	LORRY MOVEMENTS PER WEEK	RATE OF EXCAVATION (m^3/week)
1	1	Basement lowered	67	235	40	18	59	118	7	13.1
2	1	Basement and refurb	79	332	32	16	83	166	10	20.8
3	1	New building with basement and retained façade	70	225	27	22	56	113	5	10.2
4	1	New basement and rebuild of existing floors	65	200	26	8	50	100	13	25.0
5	1	New basement and refurb	56	168	30	8	42	84	11	21.0
6	1	New basment	43.5	130	17	9	33	65	7	14.4
7	1	Basement under lightwells	107	311	22	4	78	156	39	77.8
8	2	New basement and reconstruction of existing floors	72	418	27	19	105	209	11	22.0
9	2	New basement	235	630	52	21	158	315	15	30.0
10	2 (1 constructed)	Small sub-basement added to existing basement	230	1150	25	4	115	230	58	287.5
11	2 (1 constructed)	2No. Sections of sub-basement added to existing basement. Existing basement extended	261	1610	68	13	161	322	25	123.8
12	2	Basement extensions and pool sub-basement	629	3510	70	14	351	702	50	250.7

Notes:

1. Times quoted relate to programmes provided by RBKC and are subject to a number of assumptions made when analysing them.

2. Lorry movements are based on the following assumptions:

a) 1 storey basements up to a maximum excavated volume of $350m^3$ use lorries which carry $4m^3$ of spoil - assumes soil loaded into skip and removed by either a skip or grab lorry
b) 1/2 storey basements with an excavated volume of $350\text{-}1000m^3$ use lorries which carry $6m^3$ of spoil
c) 1/2 storey basements with an excavated volume in excess of $1000m^3$ use lorries which carry $10m^3$ of spoil
d) Each load removed equates to two lorry movements
e) Volumes of spoil noted do not include bulking factors.

3. Following the assumptions in note 2, the individual sites were assessed according to the access constraints. The lorry sizes were then adjusted accordingly. The changes made were to:
a) No. 8 and No. 9 to use a skip.

Table 1.
This provides general details on the basement area/volume, the construction period for the basement box and the period to excavate the basement.

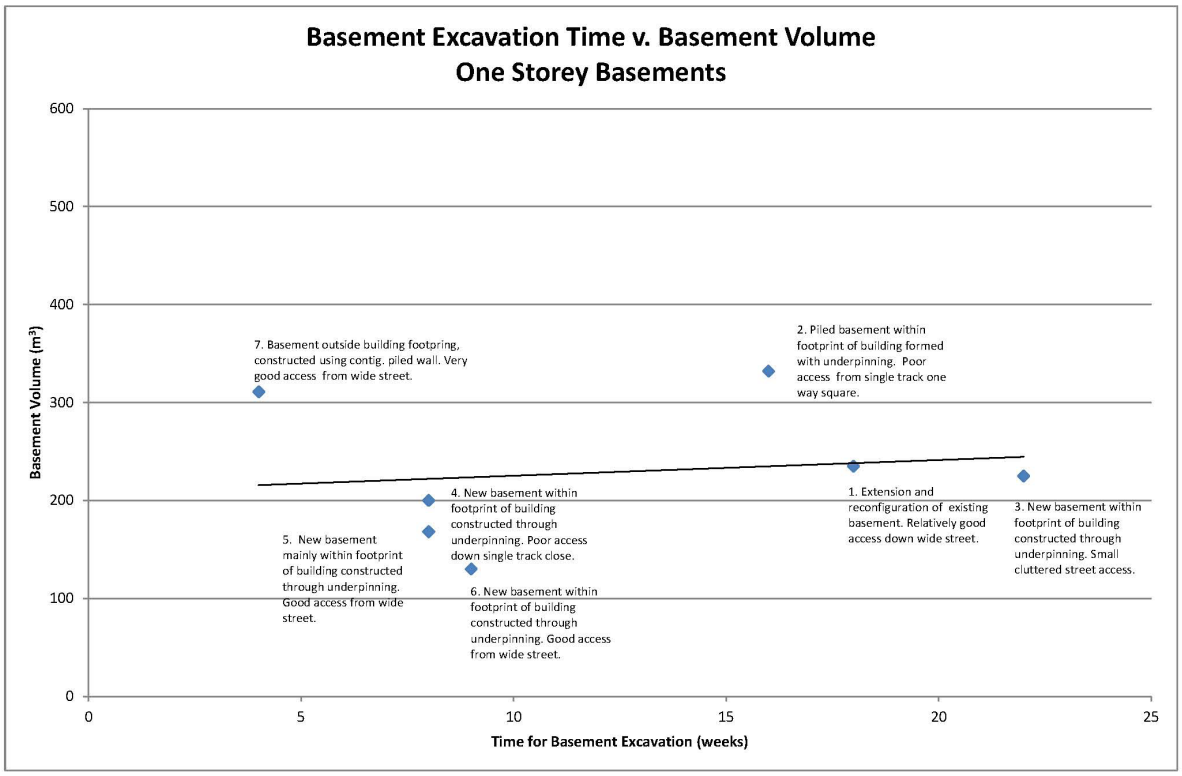


Figure 1
Basement excavation time v basement volume for a one storey basement

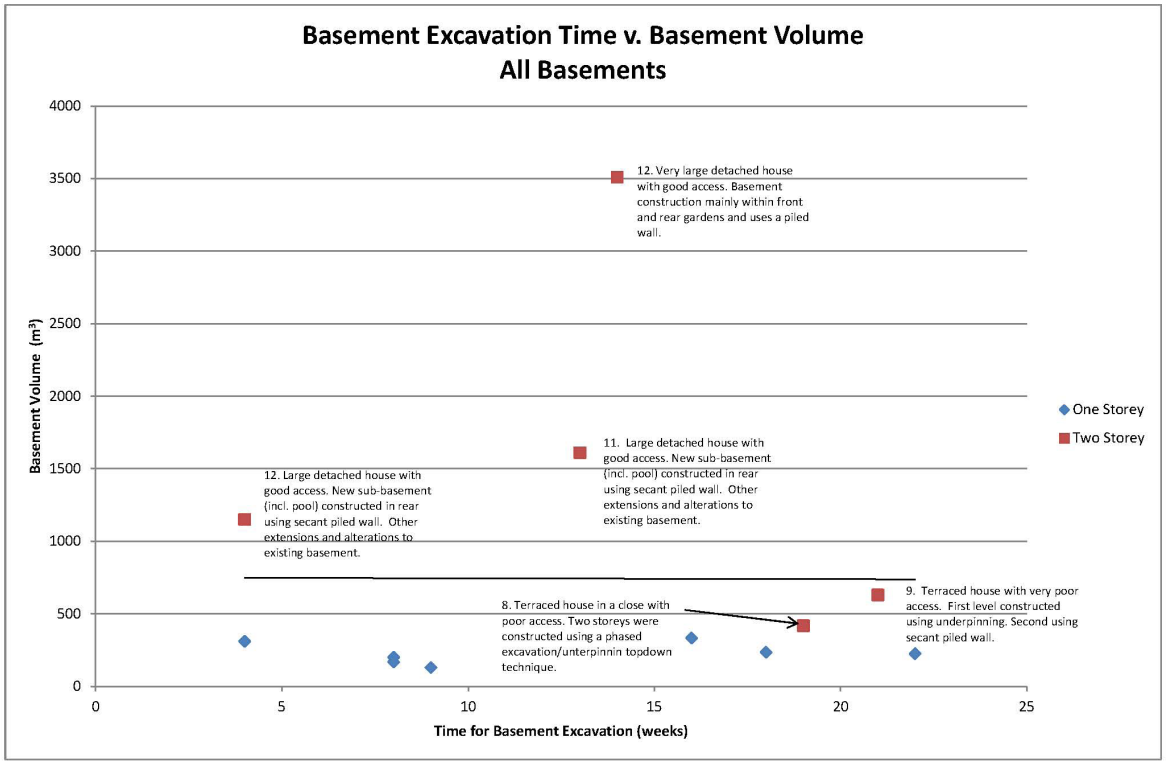


Figure 2
Basement excavation time v basement volume for all basements

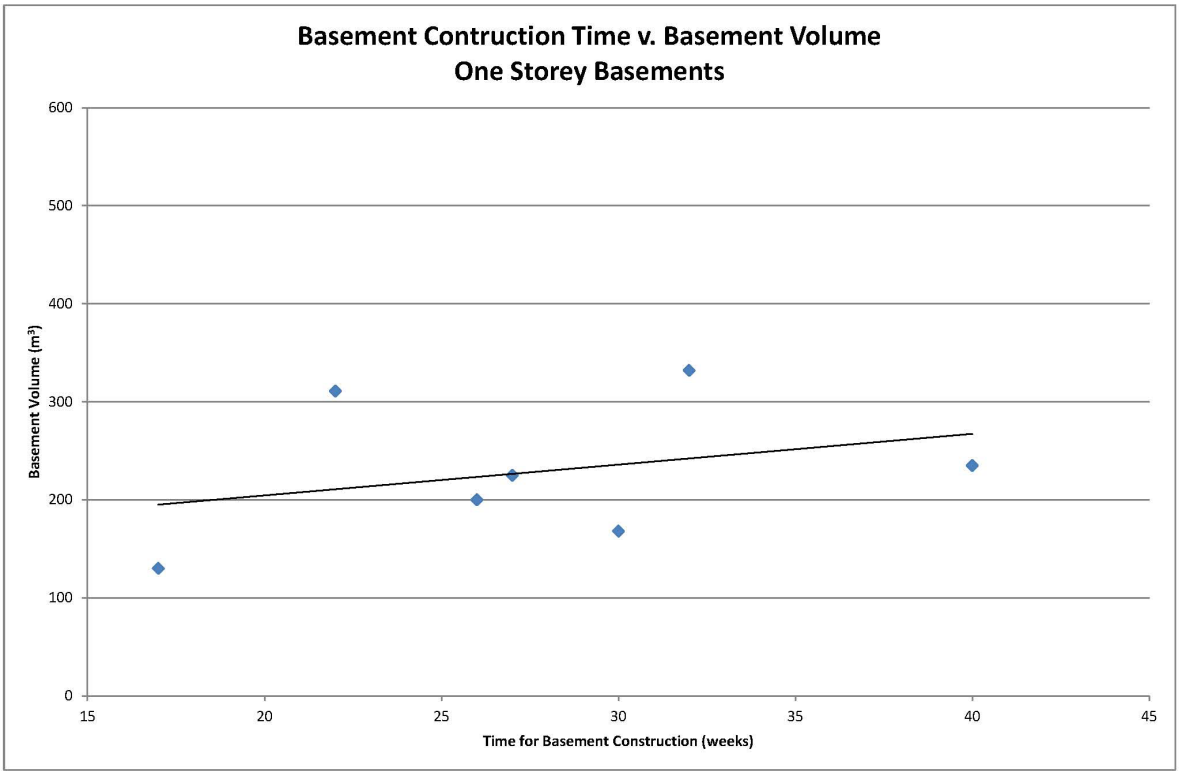


Figure 3
Basement construction time v basement volume for a one storey basement

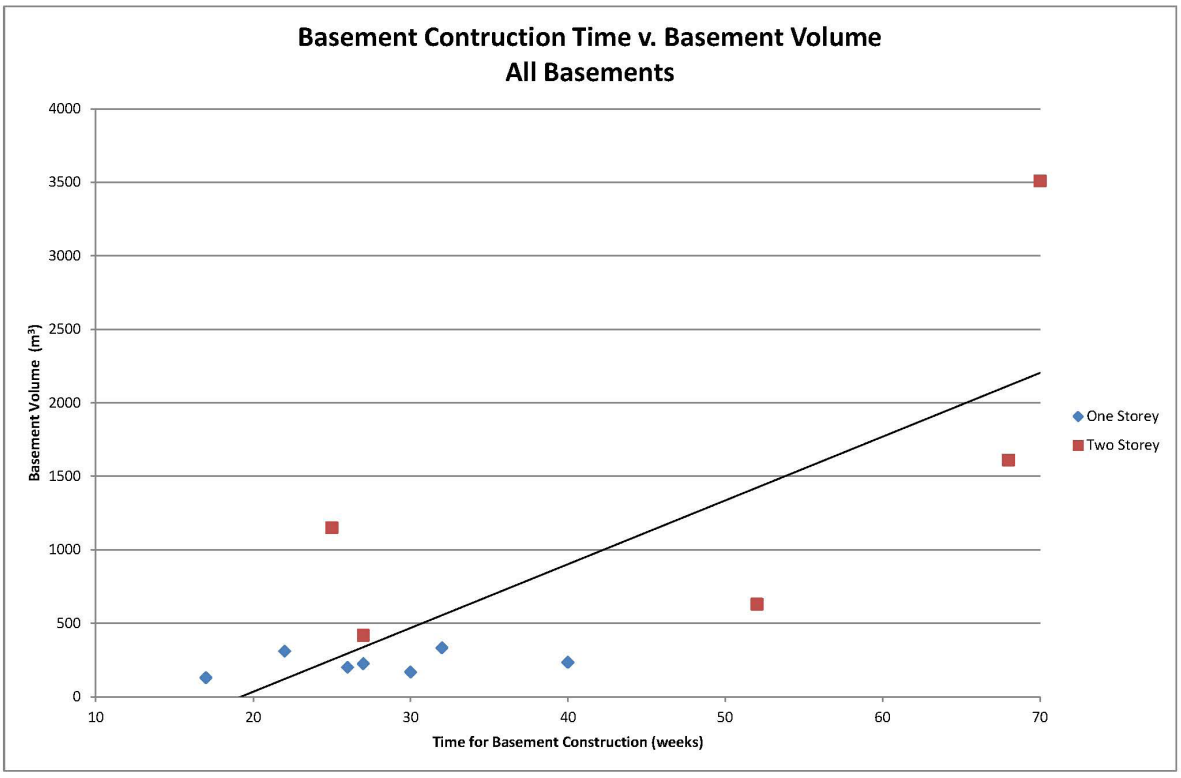


Figure 4
Basement construction time v basement volume for all basements

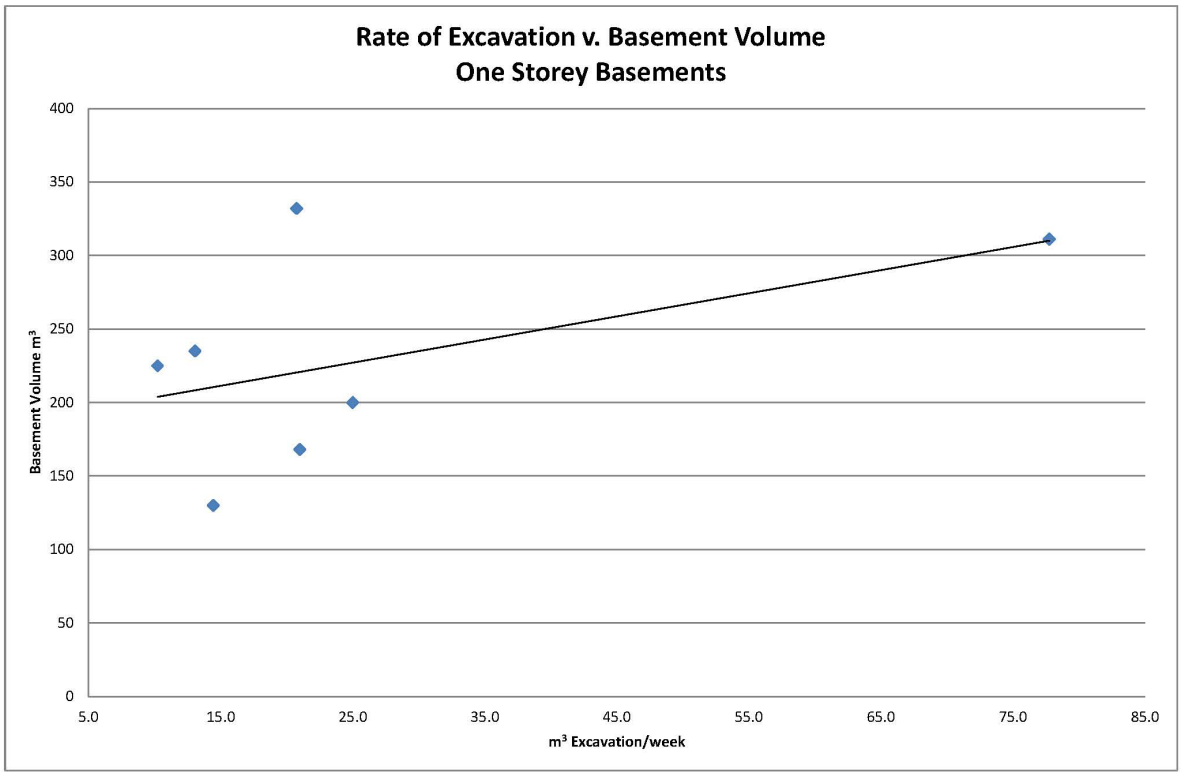


Figure 5
Rate of excavation v basement volume for a one storey basement

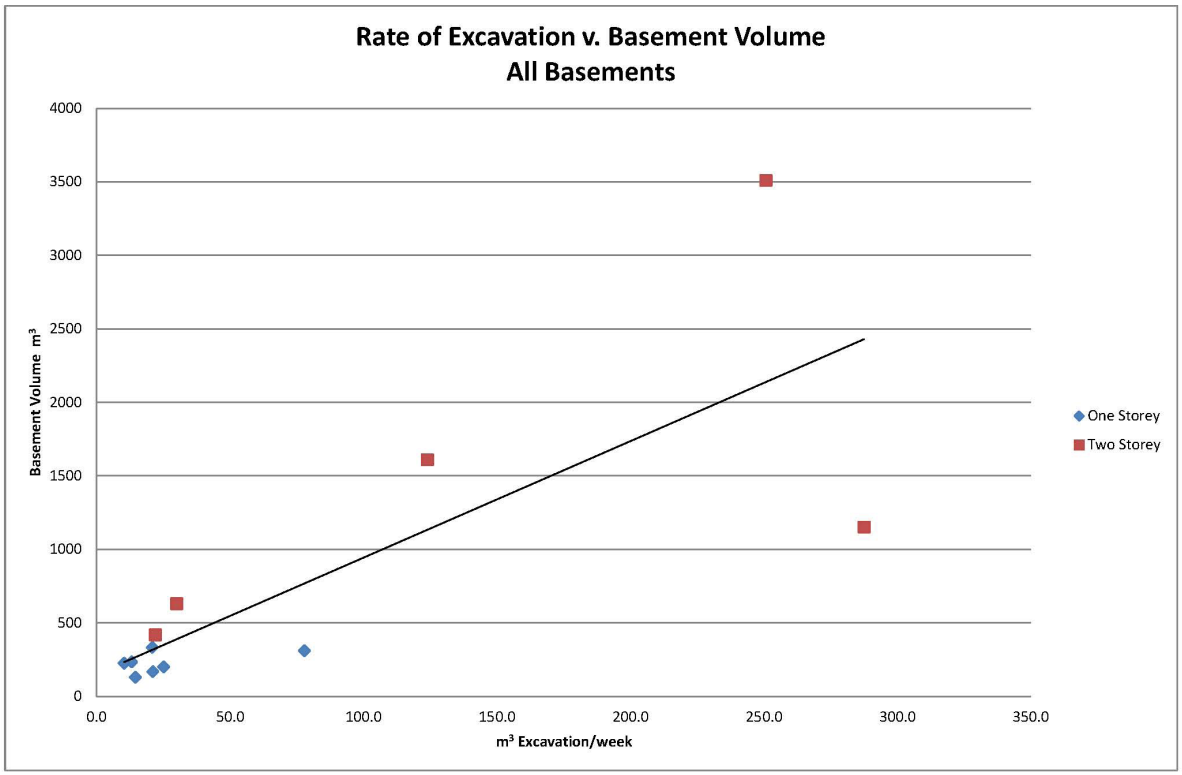


Figure 6
Rate of excavation v basement volume for all basements

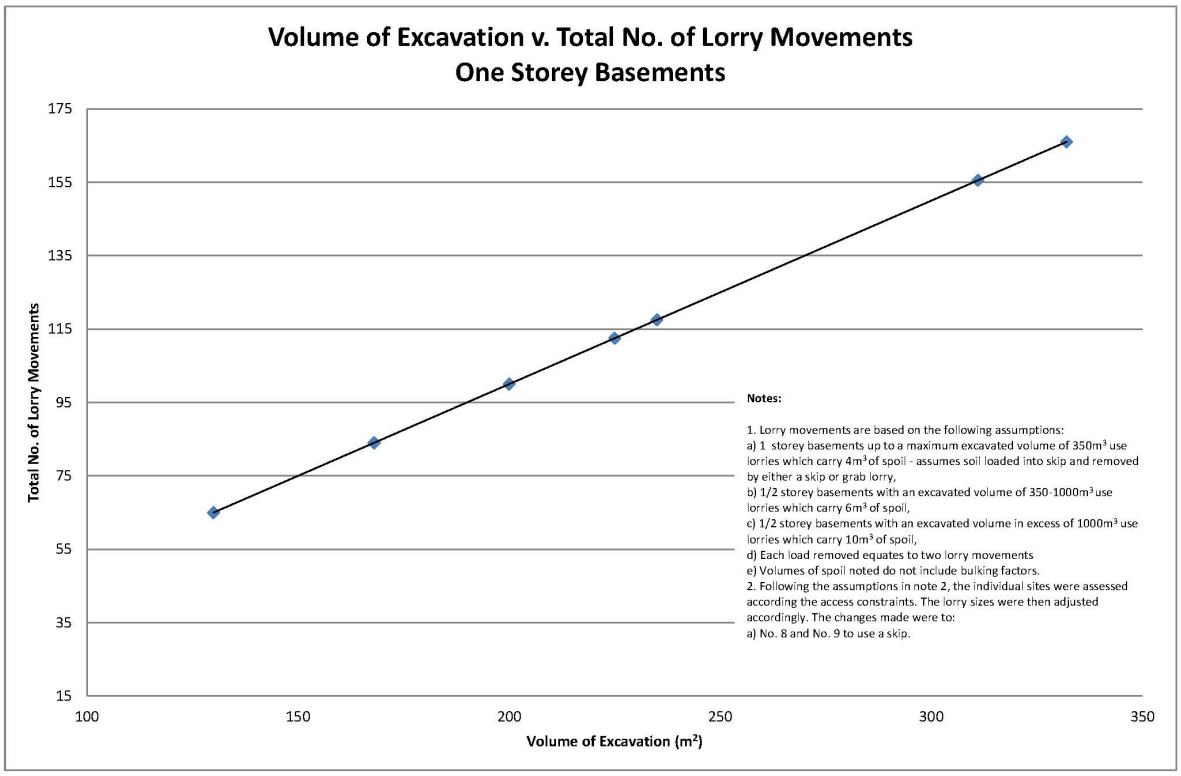


Figure 7
Volume of excavation v total No. of lorry movements for a one storey basement

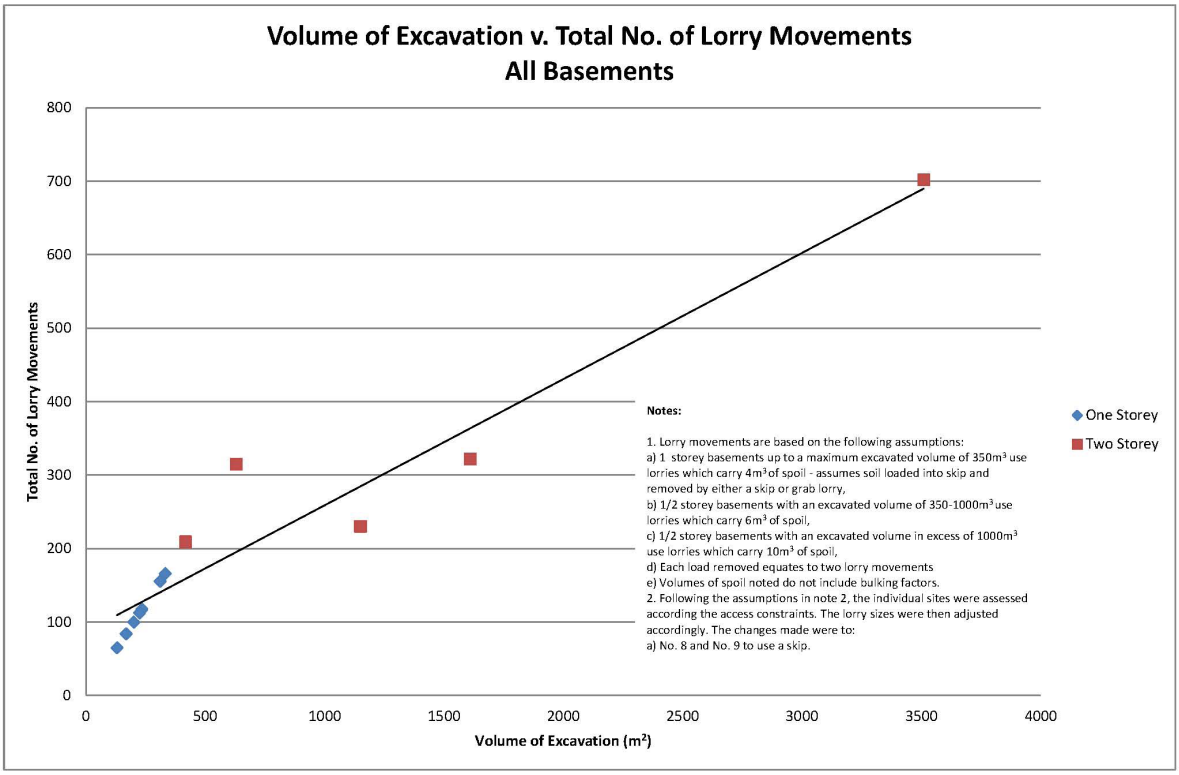
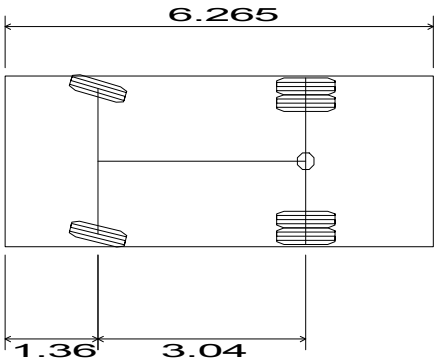
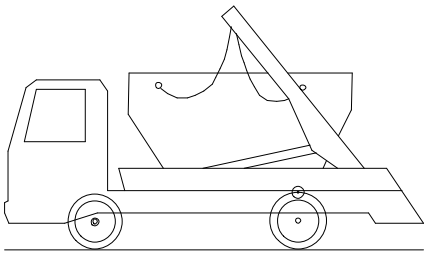


Figure 8
Volume of excavation v total No. of lorry movements for all basements

Appendix A Typical Vehicle Sizes

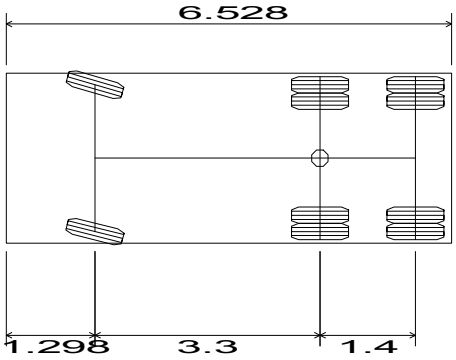
Vehicle Name:	**Small Skip Lorry**
Type:	Rigid vehicle
Category	Savoy
Classification	Savoy
Source:	Leyland DAF / Telehoist
Description:	Typical small skip lorry based upon a Leyland DAF 17.18 Freighter chassis with a Telehoist CH503A Load Lugger body.
Notes:	
Unit 1 Name:	Small Skip Lorry

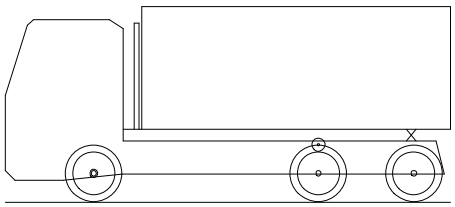




Small Skip Lorry	
Overall Length	6.265m
Overall Width	2.500m
Overall Body Height	3.650m
Min Body Ground Clearance	0.396m
Max Track Width	2.435m
Lock to Lock Time	6.00s
Kerb to Kerb Turning Radius	6.340m

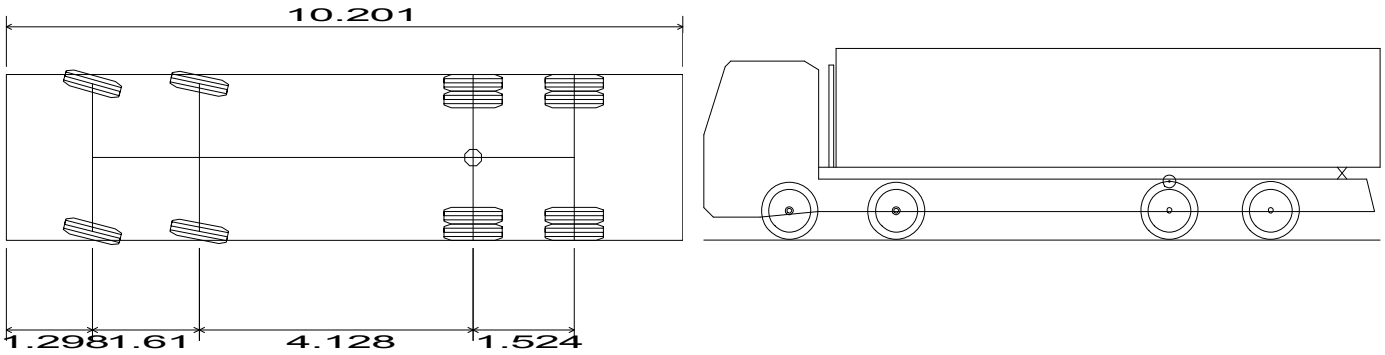
Vehicle Name:	**Small Tipper**
Type:	Tipper
Category	Savoy
Classification	Savoy
Source:	ERF / Thompson
Description:	Typical tipper based upon an ERF E6.18 4 x 2 chassis with a Thompson Tipper body.
Notes:	
Unit 1 Name:	Small Tipper





Small Tipper	
Overall Length	6.528m
Overall Width	2.495m
Overall Body Height	2.877m
Min Body Ground Clearance	0.327m
Track Width	2.393m
Lock to Lock Time	6.00s
Kerb to Kerb Turning Radius	7.850m

Vehicle Name:	**Large Tipper**
Type:	Tipper
Category	Savoy
Classification	Savoy
Source:	ERF / Thompson
Description:	Typical large tipper based upon an ERF E8.27 8 x 4 chassis with a Thompson Tipper body.
Notes:	
Unit 1 Name:	Large Tipper



Large Tipper	
Overall Length	10.201m
Overall Width	2.500m
Overall Body Height	2.893m
Min Body Ground Clearance	0.343m
Max Track Width	2.500m
Lock to Lock Time	6.00s
Kerb to Kerb Turning Radius	11.550m

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