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Low Cost Water Saving by Reducing WC Cistern Volume

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March 1998

Management Summary

The Hippo is a plastic bag which is placed in toilet cisterns, reducing the volume of water used per flush. Field tests of the devices were carried out at Foxhayes First School and Exwick Middle School in Exeter, in order to quantify the potential savings within a real environment. The total water consumption was monitored daily during three phases of the tests: before Hippos were fitted, with Hippos fitted, and after the Hippos had been removed.

The tests revealed a reduction in total water consumption in the order of 10 - 15%. Assuming a 15% reduction in water consumption, with a baseline consumption of 3.5 cubic metres per pupil per annum, potable water consumption could be reduced by 110,410 cubic metres per annum across the SWEEG (South West Energy and Environment Group) region. Implicit in such a saving is a £283,750 financial saving. Annual savings of £270 could be expected for a 200-pupil primary school, and £1350 for a 1000-pupil secondary school. It is therefore recommended that all schools should be urged to fit the devices.

Introduction

The Hippo Water Saver is placed in the cistern to reduce the volume of flush water. The devices were evaluated in two primary schools in Exeter - Foxhayes First School and Exwick Middle School. The aims of the monitoring was to determine whether the fitting of Hippos in the toilet cisterns led to an appreciable reduction in water consumption, how easy they were to fit, and whether the devices led to any reliability problems or reduction in flush efficiency.

Details of the Tests

Daily readings of total water consumption were taken at the two schools every weekday (school holidays excepted) over a period of three months. Data was collected before the devices were fitted to gain an indication of normal levels of consumption (15 readings from Foxhayes and 17 readings from Exwick). The devices were then fitted, and further further data collected (27 readings from Foxhayes and 25 readings from Exwick). The devices were then removed, to check that the consumption returned to pre-fitting levels (21 readings from Foxhayes (including two overnight readings) and 11 readings form Exwick).

Foxhayes school had 20 cisterns (2 staff, 11 girls, 4 boys and 3 nursery) and Exwick had 21 cisterns (3 staff, 12 girls and 6 boys) (excluding urinal cisterns). Urinal cisterns were not equipped with Hippos, as water consumption is governed by filling rate rather than cistern capacity. All cisterns had a nominal capacity of 9 litres flush volume. Foxhayes school had 195 pupils up to Christmas, when a new intake increased this number to 225. Exwick school had 205 pupils.

Collected Data

Some data was rejected as atypical conditions were identified on certain days during the tests.

Date Processing

Before comparing water consumption for the different monitoring periods, data points were removed for any periods during which atypical events were taking place at a school. Data collected during school holidays were also discarded. Table 1 contains a list of the discarded data, and justifies each exclusion.

School	Date(s)	Reasons Discarded
Foxhayes	11/12/97	School closed for use as a polling station
Exwick	17/11/97 - 24/11/97	Police mobile response unit at school as part of murder investigation - creating increased demand
Both	17/12/97	Special Christmas dinner served, creating increased demand
Both	5/1/98 - 8/1/98	Christmas holidays
Foxhayes	17/2/98 - 18/2/98	Half Term Holiday

Table 1. Data Discarded, Together with Justification for Exclusion

After the Hippos were removed from Exwick School, water consumption returned to a similar level as experienced before the units were fitted. However, when the Hippos were removed from Foxhayes First School, average consumption showed a significant increase compared to the before fitting figure. The mean consumption over the period of 14 days before the Hippos were fitted was 3.56 cubic metres (excluding discarded data); after removal of the devices, the mean over 15 days was 3.93 cubic metres - an increase of 10.6%. The figures exclude a very high consumption of 37.4169 cubic metres between 4th and 9th February (no intermediate readings being taken in this period) which was never accounted for. Possible reasons for the anomaly in consumption, when comparing the periods before the Hippos were fitted and after they were removed, are:

1. The school had a new intake in January, increasing the number of pupils by 15% to 225 pupils. However, it is peculiar that this did not manifest itself in the first two weeks after Christmas.
2. A leak may have occurred at around the time that the Hippos were removed. Two overnight readings were taken, the first of which (28th - 29th January) was 0.5964 cubic metres; the following night, the consumption was 0.2242 cubic metres. The second reading shows a similar level of consumption per hour to that during the Christmas holidays, whereas the first reading shows a significantly higher level of consumption. Thus the second does not support the theory of there being a continual leak.
3. Taps may have been left running. One would expect this to be a sporadic occurrence; it may explain the isolated period of extremely high consumption noted above. The consumption at Foxhayes showed considerably more variability than that at Exwick - this could be caused by taps left running by the younger children at Foxhayes. The school has reported some misuse of the wash basins, involving filling the plug hole with paper towels and leaving the tap running. This may have become more frequent at around the time that the Hippos were removed.
4. Operation of one or more ball valves may have been affected by the removal of the Hippos, causing cisterns to overflow. The cisterns were checked, and this was found not to be the case.

Results

The mean and standard deviation in daily consumption were calculated over each stage of the test, for each school (Table 2).

Comparison of consumption before fitting, and after removal of, the devices at Foxhayes School shows a considerable difference in consumption (Table 2). In view of this anomaly, two calculations were performed to quantify the effectiveness of the Hippos:

1. Consumption with Hippos compared to consumption before fitting and after removal (making best use of the data collected at Exwick), and
2. Consumption with Hippos compared to consumption before Hippos were fitted, thus ensuring that at Foxhayes consumption data arising from the same number of pupils are being compared.
- 3.

	Foxhayes	Exwick
Mean Consumption before Hippos Fitted (standard deviation)	3.56 cubic metres (0.69 cubic metres)	2.77 cubic metres (0.29 cubic metres)
Mean Consumption with Hippos Fitted (standard deviation)	3.02 cubic metres (0.36 cubic metres)	2.46 cubic metres (0.43 cubic metres)
Mean Consumption after Hippos Removed (standard deviation)	3.93 cubic metres (0.54 cubic metres)	2.77 cubic metres (0.44 cubic metres)
% Reduction with Hippos vs. Before Hippos Fitted	15.2%	11.1%
% Reduction With Hippos vs. After Hippos Removed	23.3%	11.0%
% Reduction with Hippos vs. Without Hippos	19.6%	11.1%
% Increase After Hippos Removed vs. Before Hippos Fitted	10.6%	-0.04%

Table 2. Mean and Standard Deviation in Daily Water Consumption During the Three Stages of the Tests, and Percentage Changes in Mean Consumption

The reduction in total metered water consumption was found to be significant - in the order of 10% - 15%. Water and sewerage charges are currently £2.57 per cubic metre. Assuming an average school water consumption is in the order of 3.5 cubic metres per pupil per annum, the following annual financial saving could be achieved by a 15% reduction in water consumption: at a secondary school with 1000 pupils, £1,350; for a 200-pupil primary school, £270.

It was noted that the water filling levels in the WC cisterns at both schools were frequently set lower than the design level, especially at Foxhayes school. At Foxhayes, the actual level was on average 2cm lower than the design level; at Exwick the difference was 1.5cm on average. A 1.5cm lowering in the filling level corresponds to a 0.9 litre reduction in flush water volume, or 10% of the total design capacity. This measure would reduce water consumption in itself (consumption at the two schools without Hippos was below the 3.5 cubic metre per pupil per annum assumed above, Table 3), and Hippos may well bring about a greater reduction in consumption where cistern water levels are higher. Hippos provide a more effective way of reducing flush water volume than lowering the water level, as the head of water is not reduced.

	Foxhayes*	Exwick
Before Fitting	3.47 cubic metres	2.57 cubic metres
With Hippos	2.94 cubic metres	2.28 cubic metres
After Removal	3.31 cubic metres	2.57 cubic metres

Notes: Calculations based on 190 school days in a year. *Foxhayes figures based on 195 pupils before fitting and with Hippos, and 225 after removal. Use during school holidays and weekends has been assumed negligible.

Table 3. Estimated Annual Water Consumption Per Pupil During the Three Stages of the Tests, at Each School

Estimation of Achievable Savings

There are about 210,300 school children in the SWEEG region, if a 15% reduction in an assumed baseline consumption of 3.5 cubic metres per pupil per year were achieved, this would amount to a financial saving of £283,750 per annum. Implicit in these figures is a 110,410 cubic metre per annum reduction in potable water consumption.

Problems Experienced

The technique of Hippo installation is easily mastered, and no problems were noted during their installation or use. The Hippo may restrict the downward movement of the ball valve arm; this simply leads to the cistern re-filling more slowly, reducing water consumption further (less water siphons through the cistern during flush).

The reduction in flush water may reduce the efficiency of a flush. We received no complaints from the caretakers about the toilets becoming significantly dirtier with the Hippos fitted. The significant decrease in water consumption with the Hippos fitted shows that a reduction in flush water volume did not reduce the flush efficiency such that multiple flushes were required.

Conclusions

Field tests of the Hippo Water Saver in two primary schools have shown a reduction in water use in the order of 10 - 15%. Savings in the order of £275 could be expected for a 200-pupil primary school, and £1350 for a 1000-pupil secondary school. Across the SWEEG region, this implies a saving of around £283,750 per annum. This represents a reduction in demand for potable water of 110,410 cubic metres. All schools should be encouraged to fit the devices, from an environmental, educational and financial point of view. Water saving strategies could be used to impart similar ideals to the pupils, as they are made aware of the simple measures that can contribute to water conservation.