# ASSESSMENT OF COMMERCIAL CUSTOMER WATER IMPACTS

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Most utilities have defined and codified the usage of water per single family unit for the purposes of estimating water demand and assessing impact fees. These values are generally based on historical usage of single family units and system peaks. Furthermore, these values are normally not contested and are straightforward in their application and understanding. But how much water will that new office park use? If the water demand for the office park is estimated too low, then they will not have paid their fair share for plant capacity, transmission, distribution, and financing of the water system infrastructure. The courts (City of Punta Gorda v. Burnt Store Hotel, Inc., 2nd District, Case No. 93-03575) have mandated that a utility may not reassess impact fees to existing customers without substantial change. For example, in the above referenced case, the utility sought to collect additional impact fees from a restaurant that had added increased its seating capacity. Therefore, it is imperative that utilities make an accurate assessment because a second chance is unlikely. Also, courts have ruled (City of Tarpon Springs v. Tarpon Springs Arcade Limited, District Court of Appeal, 2nd District, No. 90-01731) that impact fees must not be arbitrary and capricious. In other words, there must be a rational nexus between the fee being charged and impact upon the system. Therefore, the methods and standards must be established logically. Furthermore, such methods and standards should be properly codified such that the utility remains an administrator of laws and codes rather than becoming a lawmaker for each development.

The two primary methods of assessing commercial developments' water demands are the meter equivalency method and the fixture value method. These methods estimate the water usage and gauge the estimated water demand in terms of equivalent residential connections (ERCs). Both of these methods have their disadvantages, but as this article will discuss, the fixture value method is the better method for estimating commercial water demands provided that the correct number of fixture values per ERC is established. This article will discuss these two methods and compare actual fixture value counts with water usage of a large commercial development located in the city of Miramar. In addition, we will also discuss the general impacts that proper assessment impact fees have on the capital structure of the utility and the effect on existing customers.

The city of Miramar is located in Broward County and is experiencing rapid growth. The city has recently completed construction of a 4.5 million gallons per day (mgd) (expandable to 12 mgd) membrane softening facility to augment its 6.0 mgd lime softening facility. Capacity was sold out at the membrane plant prior to construction and the city is now adding an additional 3.0 mgd at the membrane plant and refurbishing its lime softening plant to keep pace with growth. With the acute demand for and the high cost of water capacity, the city staff became concerned whether commercial developments were paying their fair share for the new facilities through assessments and impact fees. The city's primary concern was that if commercial development demands were estimated incorrectly, then there may be insufficient capacity at the water plant and a shortfall in capital revenues which all rate payers would have to bear. Additionally, if there were to be insufficient capacity, then the city would be forced to finance the needed capacity. Similarly, the city would be placed in an undesirable position as the cost burden of the additional capacity would then fall on the customers.

Therefore, we see that an activity as routine as assessing developments can have a negative effect on the existing utility customers in the future. Such effects can be measured on the

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utility's balance sheet. The balance sheet simply presents the historical cost of assets and the source of funding for those assets. Generally, assets are funded through a combination of debt and equity. Debts are liabilities and usually consist of rebate agreements, interfund loans, short-term loans and revenue bonds. Sources of equity include retained earnings from operations and contributed capital. So if a utility does not collect impact fees commensurate with capacity utilized, it will be forced to finance the capacity expansion itself. If this additional liability has a debt service requirement which involves a coverage covenant, then the utility may need additional revenue to support the added debt. Additional revenue requirements may require a rate increase unless funds can be reallocated from another use. In addition to rate implications, a higher debt ratio may result in a lower credit worthiness rating for the debt issue with a subsequently higher interest rate. Figure 1 illustrates the flow of funds and revenue and their effect on the capital structure of the utility.

The city had historically used the meter equivalent method for assessing the water demand impacts in terms of Equivalent Residential Connections (ERCs) of commercial development. Table 1 shows the ERCs that were assessed for each meter size. In practice, the development engineer determined the meter size and, in some cases, one meter would serve multiple buildings or establishments.

TABLE 1

| Meter Size (inches) | ERCs Assessed |
|---|---|
| 1 | 3.5 |
| 1 ½ | 5 |
| 2 | 12 |

Typically, the developer's professional engineer or attorney would fill out the required forms and present their request for a certain meter size for a project. Based upon the meter size assigned to the service, the appropriate impact fee or assessment would be paid.

The city suspected that recently constructed commercial developments were using more water than they had been assessed. They decided to conduct a study to determine the impact that commercial development has on the water system in terms of ERCs and to determine whether it should revise the ERC values based on meter size or change to the fixture value method. If the fixture value method would be utilized, it would be necessary to determine the number of fixture values that equates to the usage of an ERC.

First, the city closely evaluated the advantages and disadvantages of the meter equivalency method. The meter equivalency method is straightforward and simple, so if the ERC equivalents could be changed such that commercial development could be reasonably assessed, then it would make sense to do so. The primary disadvantage of the meter equivalency method is that water demand and subsequent assessment are highly generalized into a few average groups and due to the peaking capacity of the equipment, the amount of ERCs can be greatly underestimated. Figure 1 is an example of meter sizing determination from AWWA publication M-22 (Sizing Water Service Lines and Meters). This figure illustrates that it is possible to serve a 160 unit apartment complex through a single 1-1/2 inch meter. If this were an actual case, the developer would pay an impact fee based on five ERCs (Table 1) while the apartments have an actual demand of approximately 80 ERCs.

Metered flows from a recently constructed apartment complex were evaluated and compared to its assessment based on the meter equivalency method. It was determined that the apartment complex was using approximately 164 ERCs of water capacity but had been assessed for only 136 ERCs. It was also determined that many of the meters that serve the buildings within the apartment complex had been oversized. Therefore, the developer had paid for more ERCs than he actually needed to, based on required meter size. Oversized meters can result in unregistered water in the low flow periods. It became clear that using meter size to estimate water demand and assess capacity charges was not a reliable method because even relatively small meters are capable of passing considerable flows. For instance the 1-1/2 inch meter in the case above is capable of passing up to 100 gallons per minute (gpm).

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Figure 1 - Flow of Funds and Capital Structure

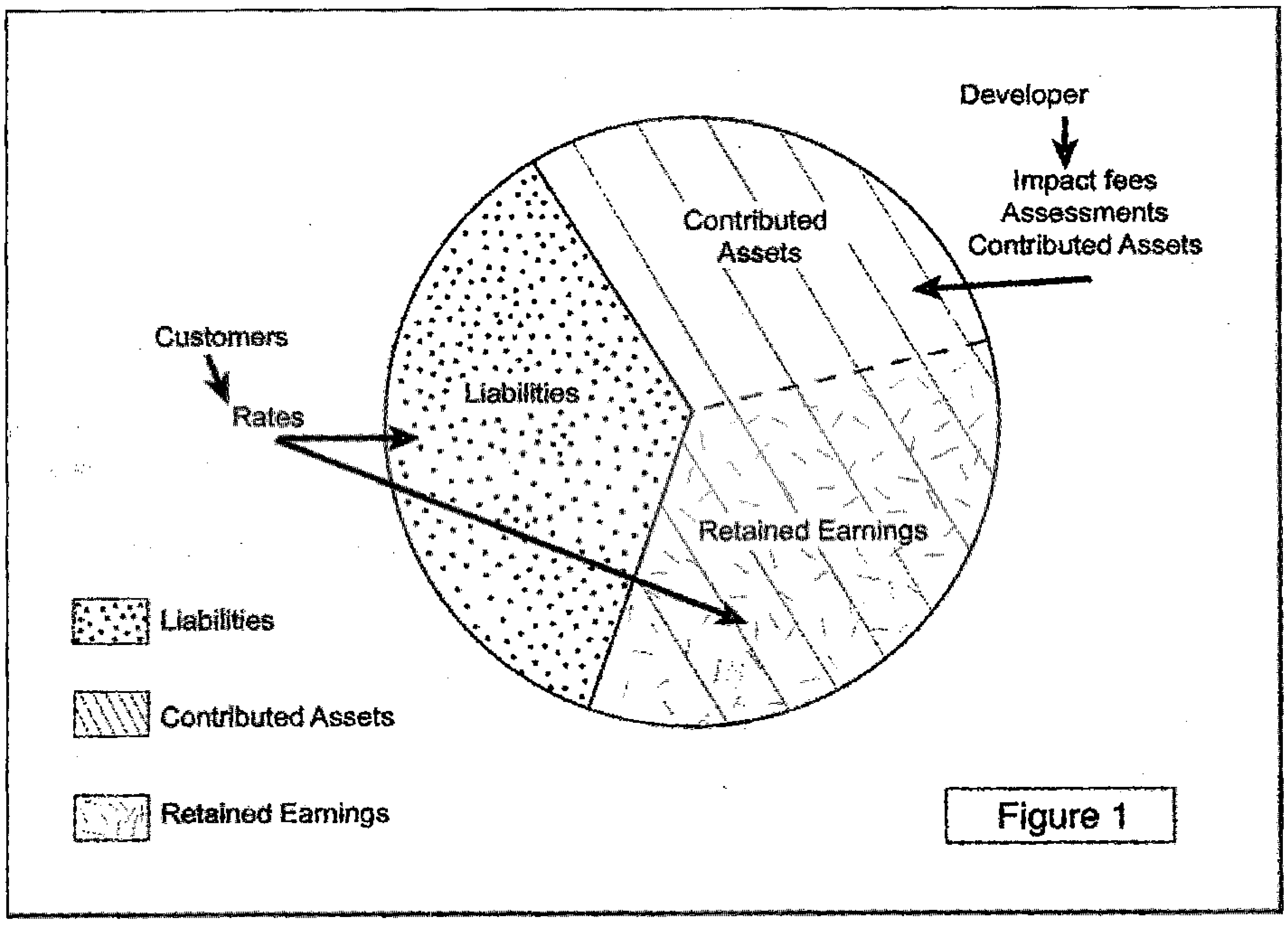
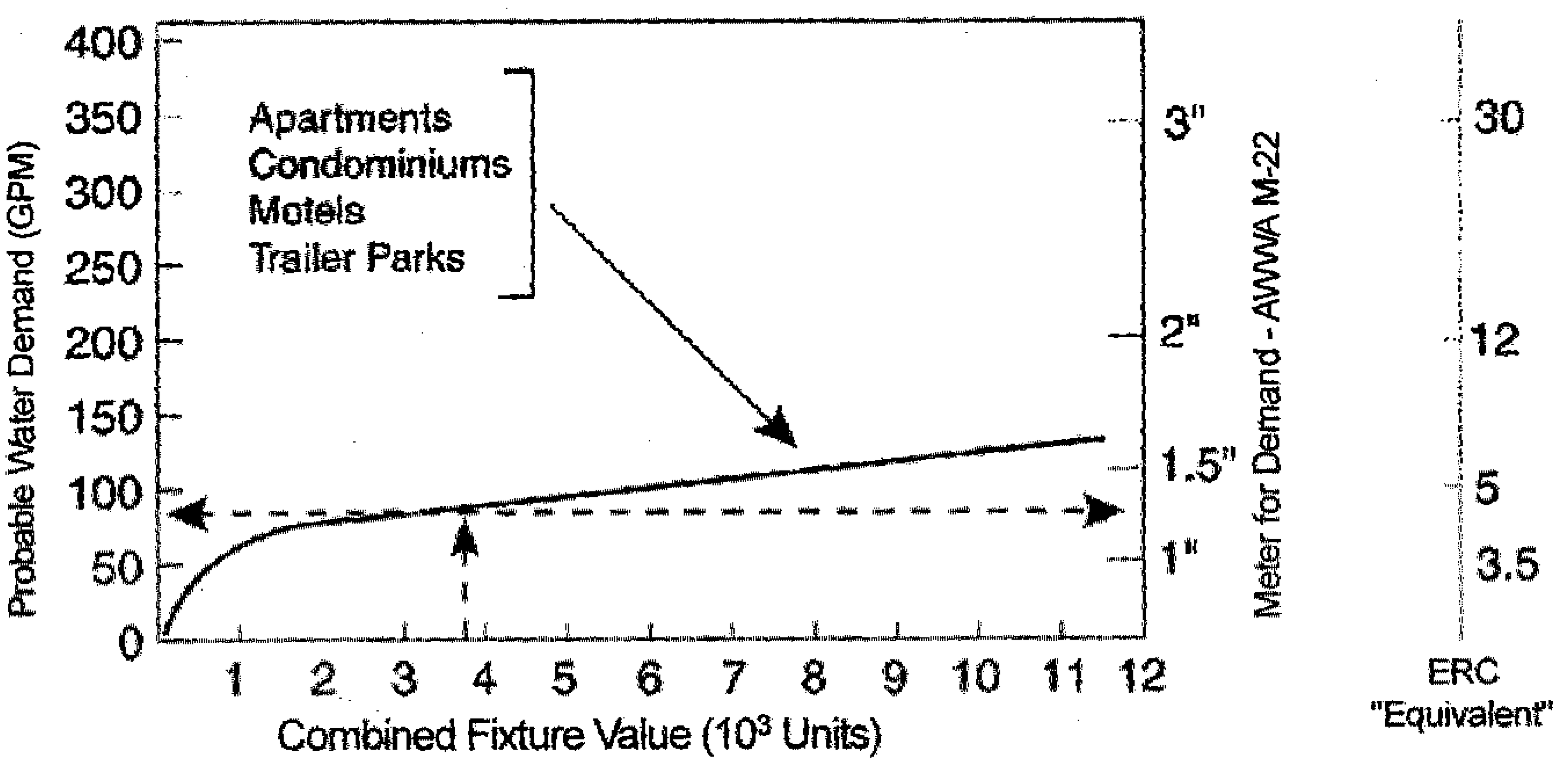



Figure 2 – Peak Flow Demand of Typical Utility Customers



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Our attention turned to the fixture value method. First, it is important to understand the fixture value method and why it was developed. The method was originally developed to size water lines within buildings without the need to perform complex headloss calculations. Values were assigned various fixtures and thus it was known that certain line sizes could support a given fixture value. Generally, a fixture value is a quantity in terms of the demand producing effects on the plumbing system of different kinds of plumbing fixtures. AWWA M-22 utilizes the fixture value method for estimating peak demands that are then used for meter size selection. So the fixture value method is really a way of estimating a customer's water peak demand based on plumbing fixtures. Peak demand is estimated based on fixture values as shown in Figure 2. The relationship between peak demand and number of fixture values is nearly directly related up to approximately 1,000 fixture values. As fixture values increase beyond 1,000, peak demand increases only slightly. This is because the probability of all fixture values operating simultaneously diminishes as the number of fixture values increases. This dampening effect is intuitive and was verified by several studies conducted by the United States Department of Housing and Urban Development in the 1970s.

As we have seen, Figure 2 shows the general relationship between peak demand and residential (multi-family) units. Figure 3 shows that the probable demand is higher for commercial establishments based on fixture value count. Let's consider why commercial demands generally are higher than residential demands when the fixture value counts are the same. First, there are probably multiple users of the same fixture units. An example of this would be a sink and toilet located in an office. Compare the usage of the sink and toilet in a home that may have only two users to that located in an office with many workers. Along the same line of reasoning are the uses of commercial laundry and food preparation facilities. Secondly, some commercial activities use higher volumes of water because water is an integral part of their processes or is used for cleaning. If more plumbing fixtures are being installed in a building than are required by the plumbing code, then that customer may be a high water user.

Based on the previous discussion, it is apparent that the fixture unit approach must be adapted such that a methodology is used for estimating peak flows to estimate average daily or maximum day impacts. Some could argue that since meter size is a function of the number of fixture values, then why not just adjust the number of ERCs per respective meter size as shown in Table 1? That simplification may not be valid because high peak demands, as indicated by a large meter, may not correlate with high average daily usage. Also, as we have seen in Figure 2, a 1-1/2 inch meter is capable of supporting a large number of fixture values and to adequately cover that range, a relatively high ERC value would need to be assigned. Fortunately, a large office/industrial park had opened in Miramar several years ago thus enabling the city to quantify fixtures and correlate them with water usage. Tenants within the complex consisted of services, light manufacturing and warehouses.

The city was able to enter each establishment within the industrial park and conducted a fixture value count. Also, the annual average metered flow was obtained from billing records for each establishment. The results of this analysis are presented in Table 2. Table 3 presents typical fixture values.

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TABLE 1

FLOW OF FUNDS AND CAPITAL STRUCTURE

Source: Author's Construct

Insert Figure 2 – Peak Flow Demand of Typical Utility Customers]

**Customer: 160 Unit Apartment**

| **Fixtures:** | | **Factor** | | **Fixture Value** |
|---|---|---|---|---|
| 205 Tank Water Closets | x | 3 | = | 615 |
| 259 Lavatories: 3/8-inch | x | 2 | = | 518 |
| 138 Dishwashers: ½-inch | x | 4 | = | 552 |
| 10 Washing Machines: ½-inch | x | 5 | = | 50 |
| 165 Kitchen Sinks: ½-inch | x | 3 | = | 495 |
| 162 Bathtubs | x | 8 | = | 1,296 |
| | | | **Total** | **3,526** |

Source: American Water Works Association
Sizing Water Service Lines and Meters (AWWA M-22)

TABLE 2

RECORDED FIXTURES
**VALUES AND METERED FLOW**

| Meter Size | Fixture Values | Annual Average Metered Flow (gpd) |
|---|---|---|
| 1 | 39.5 | 164 |
| 1.5 | 71.5 | 497 |
| 1.5 | 80.5 | 332 |
| 1.5 | 42 | 249 |
| 1.5 | 47.5 | 323 |
| 1 | 41.5 | 672 |
| 1 | 46.5 | 153 |
| 2 | 90.5 | 4,222 |
| 2 | 116 | 1,126 |
| 1.5 | 139 | 7,741 |
| 1 | 61.5 | 76 |
| 2 | 113 | 8,092 |
| 1.5 | 61.5 | 467 |
| 1.5 | 83 | 2,290 |
| 1.5 | 248.5 | 2,009 |
| 1.5 | 181 | 990 |
| 2 | 62 | 493 |
| 1.5 | 208 | 1,525 |
| 2 | 248 | 1,767 |

Source: Miramar Fixture Value Study, Hartman & Associates, Inc.

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Figure 3 – Demand versus Fixture Valve

TABLE 3

TYPICAL AWWA FIXTURE VALUES

| Fixture Value | Fixture Type Based On 35 ps at Meter Outlet |
|---|---|
| Bathtub | 8 |
| Bedpan washers | 10 |
| Combination sink and tray | 3 |
| Dental unit | 1 |
| Dental lavatory | 2 |
| Drinking fountain (cooler) | 1 |
| Drinking fountain (public) | 2 |
| Kitchen sink: ½-inch connection | 3 |
| ¾-inch connection | 7 |
| Lavatory: 3/8-inch connection | 2 |
| ½-inch connection | 4 |
| Laundry tray: ½-inch connection | 3 |
| ¾-inch connection | 7 |
| Shower head (shower only) | 4 |
| Service sink: ½-inch connection | 3 |
| ¾-inch connection | 7 |
| Urinal: Pedestal flush valve | 35 |
| Wall or stall | 12 |
| Trough (2-ft unit) | 2 |
| Wash sink (each set of faucets) | 4 |
| Water closet: Flush valve | 35 |
| Tank type | 3 |
| Dishwasher: ½-inch connection | 4 |
| ¾-inch connection | 10 |
| Washing machine: ½-inch connection | 5 |
| ¾-inch connection | 12 |
| 1-inch connection | 25 |
| Hose connections (wash down): ½-inch | 6 |
| ¾-inch | 10 |
| Hose (50-ft length-wash down): ½-inch | 6 |
| 5/8 inch | 9 |
| 3/4 inch | 12 |

Source: American Water Works Association
Sizing Water Service Lines and Meters (AWWA M22), Table 4.3

Figure 4 – Fixture Values versus Average Daily Flow for Miramar Industrial Park

Source: City of Miramar Fixture Value Study, Hartman & Associates, Inc.

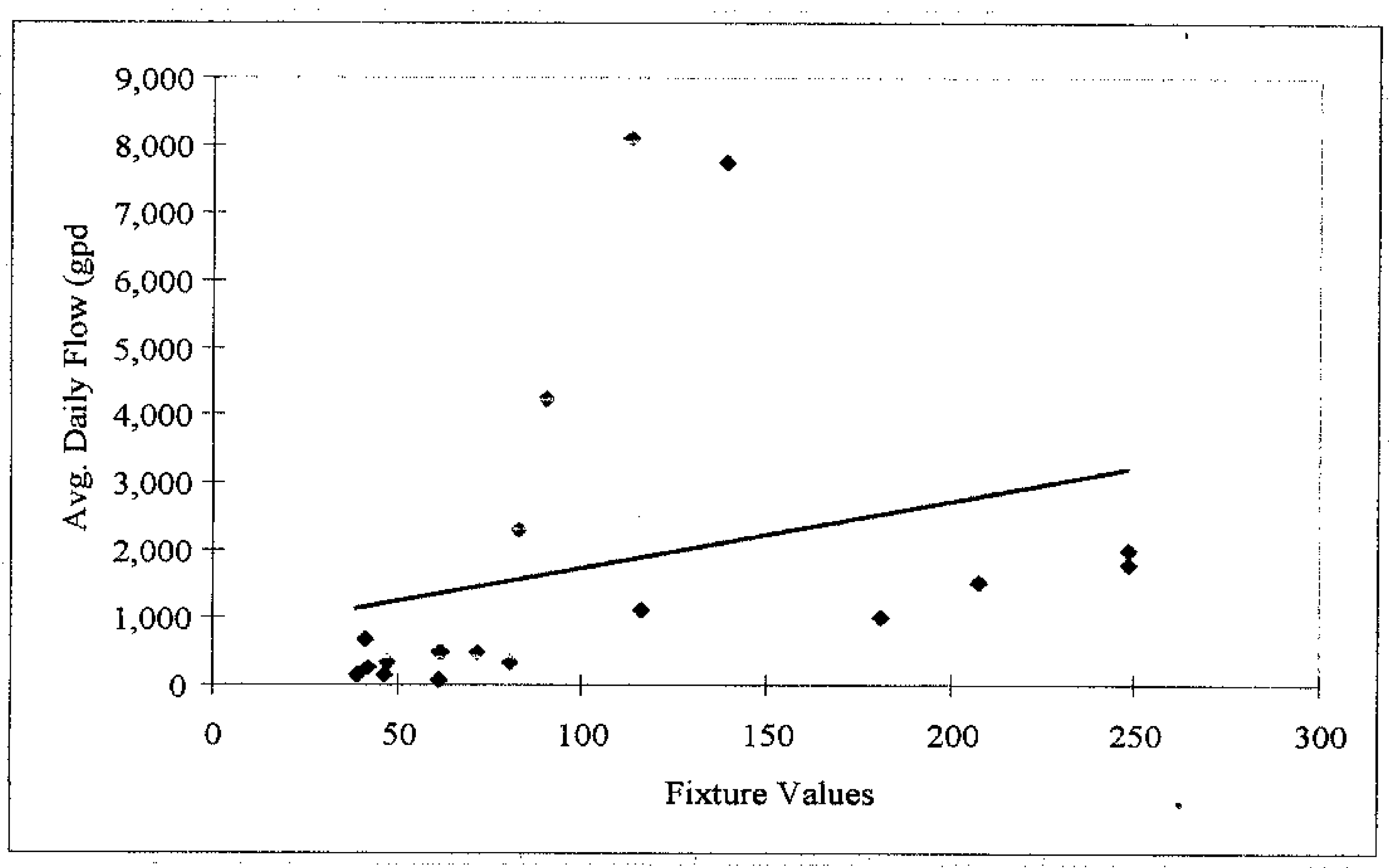


**Figure 4 – Fixture Values versus Average Daily Flow for Miramar Industrial Park**

Figure 4 is a scatterplot with a least squares regression line of fixture values versus average daily demand. We can see that as the number of the fixture values increases, the daily demand also increases. However, there are three outliers (high water users) with fixture values ranging from 75 to 150.

Figure 5 illustrates the relationship between fixture values and meter size. This figure shows that most of the variation in fixture values occurs with 1-1/2 inch meters and that meters are generally being oversized. Remember that according to AWWA M-22, a 1-1/2 inch meter can handle up to approximately 100 gpm and approximately 500 fixture values. We see in Figure 4 that we have most of the 1-1/2 inch meters supporting only 40 to 75 fixture values. Now this would be entirely correct if these fixture values were being used in some industrial or process capacity and the meters were sized based on expected flow. Perhaps the meters were selected based on high peak demands. However, this seems unlikely because most of these establishments were offices and warehouses.

Figure 6 shows the relationship between meter size and average daily demand. It can be seen that one-inch meters had the lowest average daily demand. But larger meters are not indicative of increased average daily demand as we see approximately half of the 1-1/2 inch meters with essentially the same demands as one inch meters and most of the 2 inch meters with similar demands placed on 1-inch meters. Once again, perhaps some of these meters were sized to accommodate very high peak demands.

While the data and graphs are of interest and demonstrate that there was a high likelihood that meters were being oversized, they did not answer the question of how many fixture values equate to the demand of an ERC. First, the city of Miramar defines an ERC on a maximum daily flow basis of 325 gallons per day (gpd). Data obtained from the billing records represent the cumulative monthly use of each customer. This cumulative monthly use was divided by the appropriate days per month to obtain the annual average daily usage. The average daily usage was then multiplied by the system maximum day and unaccounted for water factor of 1.76, to obtain the usage in terms of maximum day demand. The maximum day demand was then divided by 325 to obtain water usage in terms of ERCs. The total fixture values were then divided by total ERCs. Thus it was determined that approximately 11 fixture values equal one ERC (325 gpd). However, this determination was based on a skewed sample set. Remember that we had three outliers (our high users) in our data and when these were eliminated it was determined that approximately 23 fixture values equal one ERC. It is important to note that the 23 value is based on office and

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warehouse facilities. It was determined that the high users were tenants that were using water for various processes. The city decided to adopt 23 fixture values per ERC for commercial, but reserved the right under ordinance to review on a case-by-case basis those customers that use water for processes or washdown. The adoption of this ordinance and ERC value results in the most equitable assessment of water impact fees to the public and also protects the city.

Figure 7 presents the relationship of ERCs versus fixture values. This is the original data without the outliers and adjusted on an ERC basis as described above. Thus we get a high degree of correlation between demand in terms of ERCs and fixture values.

In summary, the city determined that a single fixture value per ERC could not be equitably established for all commercial developments and decided to differentiate between commercial developments that use water for purely sanitary purposes and those that do not. It was then determined for the commercial tenants that use water for primarily sanitary purposes, 23 fixture values equal one ERC. Also, it should be noted that meters should be used for their intended purpose and that is to meter water used, and not as an indicator of potential demand.

The result of the ordinance revision is the collection of additional millions of dollars in capacity funds. Consequently, growth will pay its way without the burden of funding falling on the customers through higher commodity charges. In fact, this has been the result; commodity rates have been stable and reflect only inflationary pressures.

The water industry is a rising cost industry and there is already much pressure on utilities to control costs. Thus, a utility and its customers don't need the additional burden of financing assets that should have been funded by development through fees, assessments and/or contributions. ■

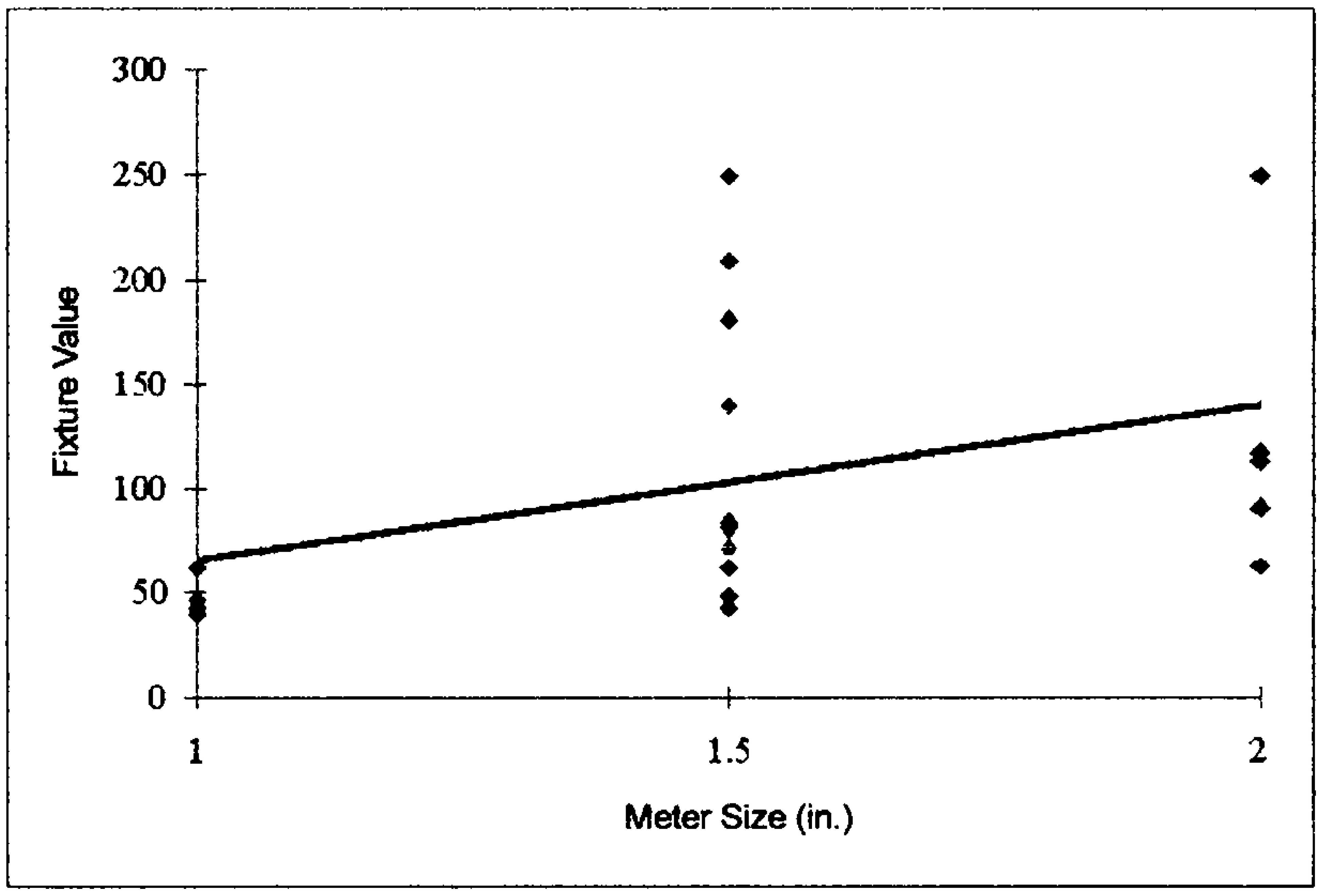


**Figure 5 – Meter Size versus Fixture Values for Miramar Industrial Park**

Source: City of Miramar Fixture Value Study, Hartman & Associates, Inc.

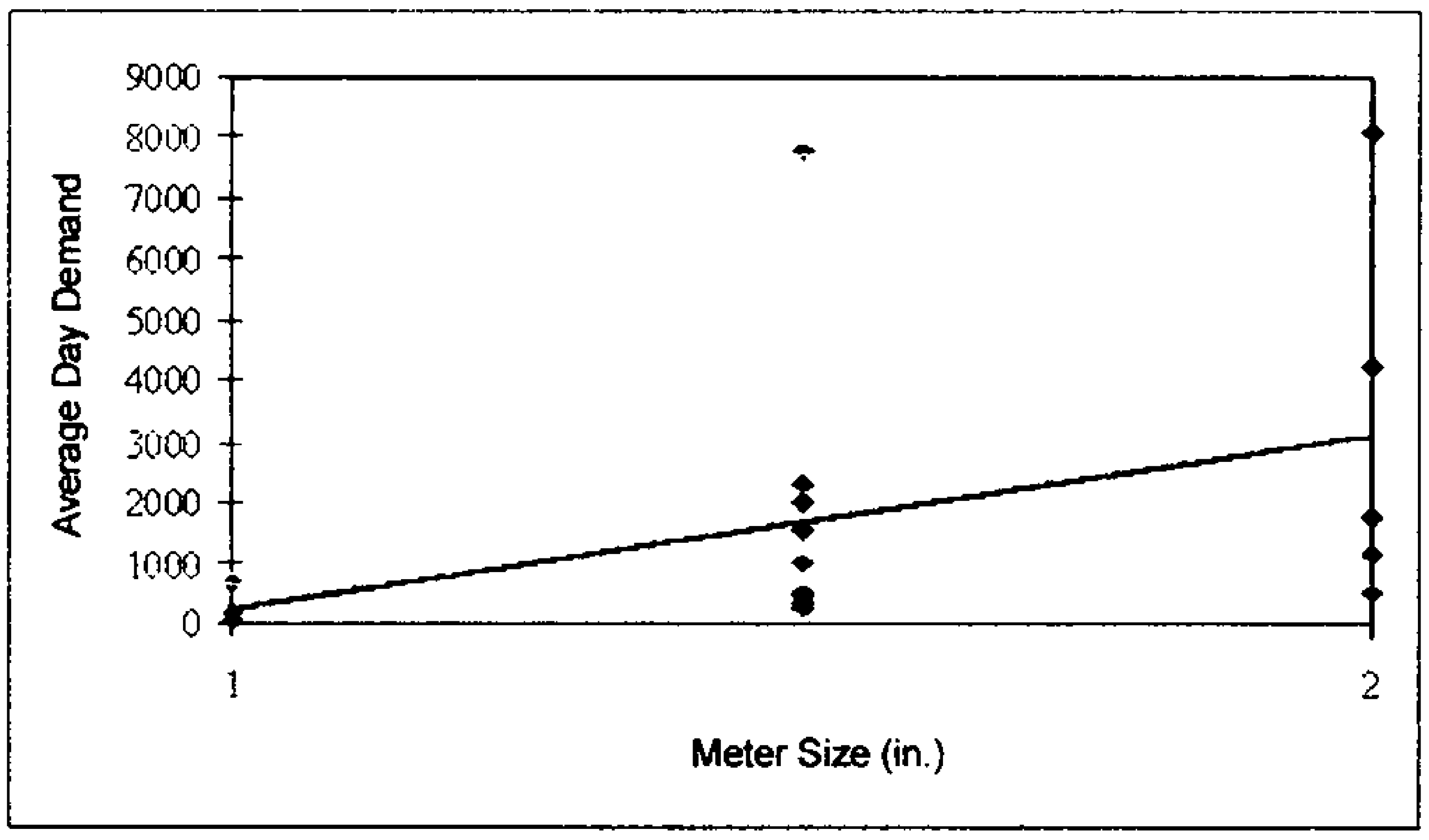


**Figure 6 - Meter Size versus Annual Average Daily Demand for Miramar Industrial Park**

Source: City of Miramar Fixture Value Study, Hartman & Associates, Inc.

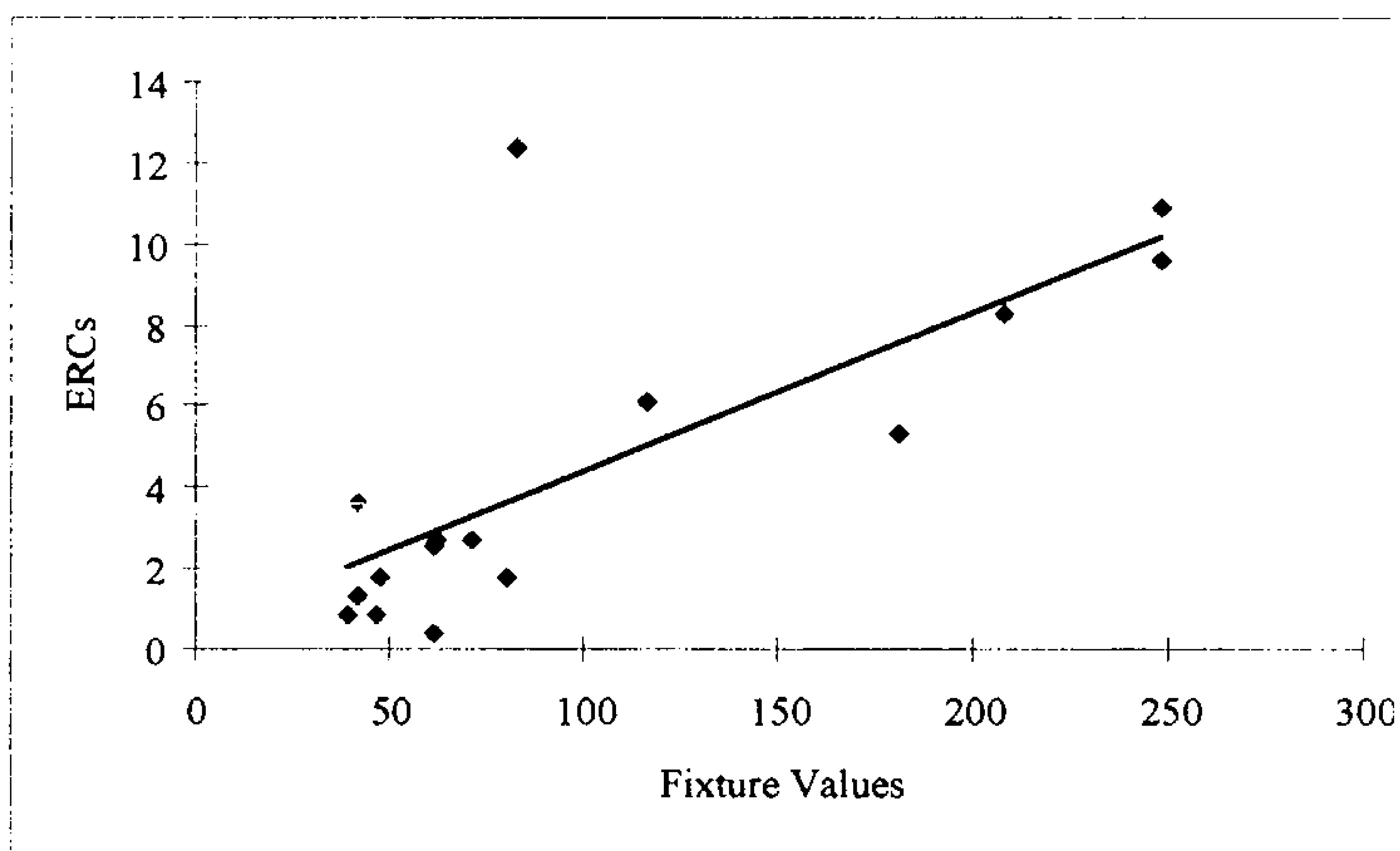


**Figure 7 – Fixture Values versus ERCs for Miramar Industrial Park**