REBUTTAL TESTIMONY OF GERALD C. HARTMAN, P.E.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

ON BEHALF OF

SOUTHERN STATES UTILITIES, INC.

DOCKET NO. 950495-WS

Q. PLEASE STATE YOUR NAME AND ADDRESS FOR THE RECORD.

A. My name is Gerald C. Hartman. My business address is Hartman & Associates, Inc., 201 E. Pine Street, Suite 1000, Southeast Bank, Orlando, Florida 32801.

Q. ARE YOU THE SAME GERALD C. HARTMAN WHO PREVIOUSLY FILED DIRECT TESTIMONY?

A. Yes, I am.

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

A. The purpose of my testimony is to rebut certain statements made by the following witnesses with regard to used and useful and various other engineering matters: Mr. Ted Biddy, Mr. Hugh Larkin and Ms. Donna DeRonne, Mr. Buddy L. Hansen, Mr. Michael Woelffer, and Mr. Robert F. Dodrill. I will also address some of the comments made by staff witnesses Mr. John Starling, Dr. Janice Beecher, and Mr. Gregory Shafer.

Q. DO ANY OF THESE WITNESSES ADDRESS THE SUBJECT OF ECONOMIES OF SCALE?

A. Yes, a number of them do. Mr. Biddy and Mr. Hansen argue against SSU's requested margin reserve allowances. Mr. Biddy, Mr. Hansen, and Mr. Woelffer argue in favor of the lot-count method for determining the level of water transmission and wastewater collection lines which are used and useful. Mr. Biddy suggests a variety of used and useful adjustments, including adjustments to storage facilities, hydropneumatic tanks, emergency generators, high service pumps, and the like. Mr. Larkin and Ms. DeRonne purport to apply Mr. Biddy's proposed used and useful adjustments to the utility plant balances. These witnesses argue against SSU's requested used and useful percentages and, in so doing, disregard the economies of scale I cited in my direct testimony as supportive of those percentages.

I also note that beginning on line 22, page 16, of his testimony, Mr. Hansen opines that SSU should install a larger ground storage tank at Sugarmill Woods than the one proposed for SSU to take advantage of economies of scale and to provide better service. Staff witness Dr. Beecher makes several comments concerning economies of scale on pages 10 and 20 of her testimony. Staff witness Mr. Starling has compiled certain comparative cost information for different types of water treatment facilities, apparently without considering economies of scale pertinent to the underlying data. Staff witness Shafer discusses several Commission goals which I believe are impacted by economies of scale.

Q. MR. HARTMAN, HAS YOUR FIRM PREPARED AN ECONOMY OF SCALE EVALUATION FOR WATER AND WASTEWATER UTILITY TREATMENT FACILITIES AND COMPONENTS?

A. Yes. An Economy of Scale Evaluation report was completed by my firm in late February of this year and a copy provided to the parties in this case by mail on February 23, 1996, in response to OPC Document Request No. 304. A copy the Economy of Scale Evaluation is attached to my rebuttal testimony and identified as Exhibit _____ (GCH-4).

Q. WAS THIS ECONOMY OF SCALE EVALUATION PREPARED BY YOU OR BY PERSONS UNDER YOUR SUPERVISION AND CONTROL?

A. Yes, it was.

Q. COULD YOU FIRST EXPLAIN WHAT AN ECONOMY OF SCALE IS AND THEN DISCUSS THE CONTENTS OF YOUR ECONOMY OF SCALE EVALUATION?

A. Yes. Generally stated, an economy of scale is the phenomenon of a decreased per unit cost attained through the use of larger units. To illustrate, a 10,000 gallon per day (gpd) wastewater treatment plant may cost $60,000 to build and thus have a per unit cost of $6.00 per gallon per day, whereas a 100,000 gpd plant may cost $250,000 and have a per unit cost of $2.50 per gallon per day. In this example, the per unit cost for building the larger plant is much less than for building the smaller plant and reflects an economy of scale. An economy of scale can likewise be evident for the operation and maintenance costs for running a larger versus a smaller plant.

That the economy of scale phenomenon occurs with water and wastewater facilities and facility components, I believe, is without question. The purpose of the Economy of Scale Evaluation was to identify and measure any economies of scale for the capital costs of water and wastewater treatment facilities and components.

Briefly stated, the Evaluation examined the average cost and per unit cost of the following facilities/components: extended aeration package wastewater treatment plants; contact stabilization wastewater treatment plants; blowers, filters, and chlorination units for wastewater plants; standby generators for water and wastewater plants; prestressed concrete ground storage tanks, steel ground storage tanks; water plant disinfection (chlorination) equipment; high service pumps; hydropneumatic tanks; lime softening water treatment plants; reverse osmosis water treatment plants; gravity sewer lines; sewage pump stations; sewer force mains; and water mains. Unit cost curves, showing the cost per unit of capacity on one axis of a graph and capacity on the other, were created for all facilities/components examined. These unit cost curves clearly demonstrate the economy of scale associated with each facility/component. Furthermore, the unit cost curves in the evaluation also serve to illustrate the threshold minimum size which selected facilities/components must be before the rate of change in the per unit cost begins to decline. Exhibit ________ (GCH-5) is a one page summary illustration of water plant component unit cost curves.

Q. COULD YOU EXPLAIN HOW THE ECONOMIES OF SCALE REVEALED IN THE EVALUATION SPECIFICALLY RELATE TO THE TESTIMONY OF THE WITNESSES YOU HAVE MENTIONED?

A. Yes. Let us take as an example the issue of margin reserve specifically as it relates to the sort of concerns Mr. Hansen mentioned and ground storage tanks.

The economy of scale associated with various sized steel ground storage tanks is illustrated in the series of graphs, charts and tables contained in Exhibit __________ (GCH-6). Since a written explanation or summary and conclusion sheet appears before each of the various graphs, charts and tables presented in the Exhibit, I will not repeat the content of those sheets here. However, I would like to point out a few items in order to better focus the issue. The first graph included in the Exhibit shows the cost curve and unit cost curve for steel ground storage tanks. The unit cost curve, simply stated, illustrates the economy of scale. The "inflection point" of the unit cost curve refers to that point at which the relative maximum economy of scale is achieved and beyond which the unit price remains nearly constant. In the case of the steel ground storage tanks, the inflection point is at the 100,000 gallon tank. Therefore, to take advantage of the optimal economy of scale, a 100,000 gallon tank would be the threshold size necessary. This is not to say, however, that a tank of that size is appropriate in all cases -- only that it is the threshold size required to achieve the optimal economy of scale.

The remaining graphs, charts and tables in the Exhibit serve to illustrate the cost-effectiveness of installing different size tanks over time under various growth and economic conditions and considering the Commission's present form of used and useful determinations. The graphs immediately following the cost curves provide a clear picture of the following events and conditions for the tank example over time: demand, tank phasing, total tank capacity, total investment, investment used and useful comparison, and used and useful percentage. The next set of graphs depict: (1) the investment savings associated with sizing tanks in larger sizes and (2) the margin reserve period necessary to promote larger sizing and, hence, achieve that savings, 15 years in these examples. The tables appearing next in the Exhibit show the costs savings per ERC over time under various tank sizing scenarios. These tables portray the long-term cost savings to the customer with a larger tank as compared to a smaller tank. Present value charts appear last in the Exhibit. These charts show the present value for installing a tank or tanks assuming the scenarios described. These charts are significant in that they invoke the illogical economic signal the Commission sends utilities by measuring used and useful as it has in recent years. All things being equal, the most cost effective choice for the utility engineer is the choice with the lowest present value (both to the utility and the customer), but the Commission's used and useful practices act as a disincentive to economies of scale and corrupt the decision-making process. In other words, the Commission's used and useful practices encourage a utility to install the smallest tank necessary so the utility may recover the greatest portion of its total investment in the tank, but the present value tables in this Exhibit reveal that the smallest tank necessary is not the most cost-effective choice. It is my testimony that one of the ways the Commission can correct this illogical economic signal and encourage economies of scale is through an appropriate allowance for the margin reserve.

It should be noted that based on the information and analyses in the Economy of Scale Evaluation, the storage tank example is representative of the economy of scale for all of the components/facilities examined.

Mr. Hansen's testimony illustrates the irony of used and useful in recent years. Mr. Hansen opposes a margin reserve, suspects that SSU's goal is to operate at or near capacity, yet he asks that SSU install a ground storage tank larger than the minimum currently needed. He embraces the service benefits and long-term cost effectiveness of the margin reserve and the economy of scale, but he fails to grasp the economic penalty he proposes.

The cause-and-effect relationship at work with used and useful and economies of scale is simple. The Commission's used and useful practices of recent years, combined with no margin reserve, an insufficient margin reserve, or a margin reserve with CIAC imputed thereon -- the various proposals of the intervenors in this case -- provide utilities no incentive to take advantage of economies of scale and instead cause economic harm to those utilities who do. No utility company can be asked to make investment of shareholder money when the recovery of and a return on a substantial portion of that money is virtually totally at risk. This is particularly true here as the rate of return to the shareholders is set by regulators and does not increase to the extent which would be necessary to compensate for that risk. Thus, the economic message from the Commission in recent years, and the economic message the intervenors would have the Commission send in this case, is to build plant in small increments, ignore economies of scale, and bear inordinate risk for even threshold sizing.

In consideration of the results of the Economy of Scale Evaluation, I believe that for the utility and the customers to experience the benefits of sizing all facilities/components to take advantage of economies of scale, the minimum margin reserve period for all facilities/components should be seven years. The intervenor's suggestion that there be no margin reserve at all will only serve to harm the customers over time. A five-year margin reserve period as SSU has suggested is an initial step to more cost-effective rate setting.

Q. **MR. HARTMAN, DOESN'T YOUR ECONOMY OF SCALE EVALUATION IN FACT SUPPORT USED AND USEFUL PERCENTAGES HIGHER THAN THOSE REQUESTED BY SSU IN ITS MFR'S?**

A. Yes, it does. SSU's position in this proceeding, however, is that the Economy of Scale Evaluation supports the used and useful percentages SSU requested in its filing as a minimum. SSU's requested used and useful percentages should therefore not be reduced unless SSU accepts an error in calculations.

In this case, SSU followed the basic formula approach to used and useful which the Commission accepted in SSU's last case. Generally, this approach may capture economies of scale in the margin reserve.

Q. **YOU MENTIONED THAT STAFF WITNESS MR. SHAFER REFERENCES ECONOMIES OF SCALE OR MATTERS WHICH ECONOMIES OF SCALE INFLUENCE. WHAT COMMENTS DO YOU HAVE REGARDING HIS TESTIMONY?**

A. Mr. Shafer recites several Commission goals which I believe should be influenced by economies of scale, specifically the following: providing safe, efficient service at an affordable price; resource protection; and a financially healthy and independent utility. As I stated in my direct testimony, I do not believe the Commission can promote resource protection and reliable service unless used and useful considerations parallel design and regulatory requirements. Efficient service, moreover, must be considered on a long-term basis. The economy of scale to be realized in utility facilities, as well as in the operations and administration functions, provides for long-term, efficient, and cost-effective service. Thus, if, as Mr. Shafer says, the Commission is to make decisions which will give utilities an incentive to be more efficient, economies of scale must be given greater weight in used and useful considerations than it has in recent years.

I note that applying the used and useful formulae I have referred to has not always been the Commission practice. Several years ago, the Commission considered economies of scale in evaluating used and useful because it was recognized that economies of scale promoted safe and efficient service and minimized long term capital investment. Attached hereto as Exhibit _____ (GCH-7) are copies of Commission staff memoranda which served as a guide to used and useful and wherein economies of scale are emphasized criteria. In recent years, with only occasional exceptions, the Commission came to ignore ignoring economies of scale in favor of a rigid formula approach to used and useful. This was also about the time capital investment requirements for water and wastewater utilities were heightened due to increased regulatory requirements such as those imposed by the Clean Water Act. In my view, periods of increased capital investment requirements are precisely the wrong time to forsake economies of scale, especially where growth is present to support the economies.

Q. DO YOU HAVE ANY OTHER COMMENTS REGARDING THE ECONOMY OF SCALE AS IT RELATES TO USED AND USEFUL?

A. Yes, but I will make those comments as I address specific areas of the intervenor's rebuttal. Also, later on in my testimony, I will briefly address economies of scale insofar as they relate to Mr. Starling's cost comparisons and Dr. Beecher's testimony on single-tariff pricing.

Q. DO YOU HAVE ANY OTHER COMMENTS ON THE INTERVENOR'S TESTIMONY ON MARGIN RESERVE NOTWITHSTANDING ECONOMY OF SCALE?

A. Yes. I believe I have already adequately addressed Mr. Hansen's margin reserve comments. On page 3 of Mr. Biddy's testimony, he characterizes Rule 62-600.405 as establishing the intervals for submitting a capacity analysis report ("CAR") and not a 5 year reserve capacity requirement. I disagree with Mr. Biddy's interpretation for the reasons stated in my direct testimony and as explained further by SSU witness Harvey in rebuttal. The rule is applied by DEP to assure that at least a 5 year margin reserve of capacity exists or that the expansion process is underway. To interpret the rule as Mr. Biddy suggests is to separate the words of the rule, which on the surface address reporting requirements, from the rule's meaning, which focuses on performing the acts one must report. Further, a shorter margin reserve period would place utilities in a position where the expansion activities for one interval and the next interval overlap, which makes no economic or regulatory sense whatsoever.

Q. **DO YOU AGREE WITH MR. BIDDY'S COMMENT ON PAGE 4 REGARDING THE WATER PLANT MARGIN RESERVE PERIOD?**

A. I agree that DEP does not presently have in place a rule for water facilities similar to Rule 62.600-405. Yet, on recent submittals I have made to the DEP, adequate capacity has been an issue in the permit application process. Those reviewing these applications have with increased regularity asked if 5 years of water plant capacity is available or planned.

My direct testimony lists the multitude of activities necessary for an expansion project. It is simply wrong to restrict the water treatment plant margin reserve to less than 3 years on the basis of Mr. Biddy's paltry claim, "**Sometimes** it does not take a long time to increase capacity for water treatment, such as adding a new well and filters." Further, as stated in DEP's letter of June 29, 1995, attached to the testimony of SSU witness Harvey, "[DEP] strongly recommend[s] that the Commission recognize at least a five-year reserve capacity when calculating the "used and useful" percentage of water and wastewater treatment facilities."

Q. MR. BIDDY SUGGESTS A MARGIN RESERVE IS NOT NECESSARY. DO YOU DISAGREE WITH HIM?

A. Yes. Of course a margin reserve is necessary. There are three basic reasons which support margin reserve: (1) economic benefit to the customers and the utility, (2) public health and environmental protection, and (3) reduced regulatory costs. First, a margin reserve permits the utility an opportunity to achieve at least some portion of the economy of scale benefit I have already described. Second, if no margin reserve is permitted, utilities will be forced into a situation where they would constantly be butting up against the capacity limitations of their facilities. The dangers to the public health and the environment which result from this are obvious: insufficient water pressure, connection moratoria, insufficient chlorine contact time, lack of sufficient disposal facilities, improper discharge of wastewater, and insufficient wastewater treatment to name a few. And all of these problems can occur due simply to the variability of demand if a margin reserve is not present. Third, if utilities cannot earn a return on economically sized plant, forcing the utilities to constantly operate facilities on the edge of their capacity limitations, all of the activities associated with needed improvements and expansions will likewise be in constant motion. A perpetual permit and construction apparatus on the part of utilities requires the perpetual attention of the regulatory authorities' engineers, inspectors, analysts, etc. -- all at an increased cost to the utility, the customers and the state. Each of these adverse consequences result from the intervenors' no margin reserve position and should be scrupulously avoided.

Q. IS MARGIN RESERVE "SOLELY FOR NEW CUSTOMERS" AS MR. BIDDY STATES?

A. No. In fact, OPC witness Ms. Kim Dismukes suggests that the current customers will consume more water in the future. Therefore, OPC's witnesses are inconsistent on this point. The Commission should recognize that different OPC witnesses have made directly conflicting assertions to support the results OPC desires on different issues. Of course, OPC cannot have it both ways -- customers cannot consume more water to suit Ms. Dismukes' proposed consumption adjustment while at the same time not consume such additional quantities to support Mr. Biddy's assertion that the margin reserve is exclusively for future customers. I would also note that it is not absolutely certain what effect SSU's conservation efforts would have on peak demands, as opposed to total consumption. SSU's plants must meet the peak demands of the existing customers and many components are designed to meet that level of demand.

The existing customers benefit from the capacity to serve their needs, to attenuate the impacts of growth in connections, and from the long-term economies of scale.

The variability of demand over the useful life of an asset (30-50 years) can be great, and only the existing customers create this variability. Smaller facilities demonstrate higher variability in demand than do larger facilities. SSU is comprised mostly of small facilities; therefore, all of the small SSU facilities require a margin of reserve due to this factor alone.

Further, margin reserve is an accepted regulatory allowance for growth in the need for service from both existing and new customers. The margin reserve cannot be sequestered for, or dedicated exclusively to, future customers. If one were to apply Mr. Biddy's premise to its logical end, whenever test year customers use any water or produce any wastewater in excess of test year levels, the utility should disconnect those customers because they have used all the capacity they have paid for. Needless to say, disconnections of this sort are impossible as a practical matter, but it illustrates the point that Mr. Biddy expects the customers to receive all the benefits of the margin reserve but with the costs therefor borne exclusively by the utility. If no margin reserve is allowed as Mr. Biddy proposes, the existing customers will not receive any of the service benefits Mr. Biddy must expect them to experience.

Generally, growth for SSU statewide is about 3% per year. In 3 years only 9% to 10% growth on the average would occur. As indicated in the Economies of Scale Evaluation, economical sizing is typically in increments greater than 10%. For most water plants, the variability of the maximum day demand from existing customers can easily be 10% from year to year. Thus, Mr. Biddy fails to recognize the public health, safety and welfare requirements of proper facility sizing which would necessitate a margin reserve without growth and which would necessitate a greater one with growth.

Mr. Biddy's suggestion that the utility could recover its costs through "prepaid fees from future customers" and "in other ways" is without foundation. Prepayments from future customers or developers would be a disincentive to growth and, if imposed, may not ever occur, much less in an orderly and economic fashion. To make the utility entirely dependent on Mr. Biddy's nebulous suggestion is inappropriate.

Q. CONTINUING ON WITH MR. BIDDY'S TESTIMONY, DO YOU BELIEVE FIREFLOW SHOULD BE APPLIED IN USED AND USEFUL CALCULATIONS?

A. Yes, if facilities are designed to and sized to provide fireflow service, fireflow should be included in used and useful. Mr. Biddy excluded fireflow from his used and useful calculations because SSU did not provide fireflow test records with the original filing. It should first be noted that fireflow test results are not a filing requirement -- I would suggest for very practical reasons. SSU has several thousand hydrants, and it is unreasonable and uneconomical to test every last one of them for a used and useful analysis, especially when those tests are not always conclusive. In this and in SSU's previous rate case, the PSC staff and OPC had ample opportunity to inspect all of SSU's facilities if there were any concerns with fireflow. To arbitrarily delete fire flow from the used and useful calculation is wrong when the fireflow service needs to be provided and facilities are sized to provide the service as shown in the MFR's.

Even if the level of fireflow to a few hydrants is unsatisfactory, fire fighting requirements may still be met. Normal water distribution pressures may be in the 40 to 60 psi range. Fireflow requirements are at the 20 psi level. As the pressure decreases, the flow rate from the high service pumps increases and more flow is available at lower pressures. Pumper trucks, commonly used in the rural areas which SSU serves, have the ability to pull water from the system and can readily operate in the lower pressure ranges and even at no pressure at a specific location.

Moreover, the appropriate action in response to conclusive and unsatisfactory test results for one or more hydrants, without any consideration to the nature or extent of the cause, is certainly not to exclude fireflow from used and useful. Such action does not improve the security of the customers and provides no incentive for a utility to correct potential problem situations in service areas where the utility should provide fireflow. After evaluation, an operational change or capital improvement should be designated to correct the condition, a reasonable time allowed therefor, and, if a capital improvement is required, an allowance for the improvement made in rates.

Fire service requirements are shown in the MFR's and reflected in the used and useful analysis appropriately.

Q. IS IT COST EFFECTIVE TO USE SOURCE OF SUPPLY TO MEET INSTANTANEOUS DEMANDS?

A. It depends on the water resource availability. In productive and high yield aquifer areas, yes, it is quite cost effective and common practice in Florida. Mr. Biddy suggests that it is not cost effective, while the majority of small plants in Florida are designed, built, and function in this fashion. Where the water resources are not available, it is not cost effective due to higher treatment, storage and pumping costs.

Q. DO SMALL WATER FACILITIES WITHOUT STORAGE TANKS PROVIDE FIRE PROTECTION?

A. Yes, many do. Again, Mr. Biddy ignores the majority of small facilities in Florida including SSU's. If fire fighting service is needed, there usually is a fire well pump or two or more wells which together provide for fire service.

Q. MR. BIDDY OPPOSES USE OF A SINGLE MAXIMUM DAY TO DETERMINE USED AND USEFUL FOR WATER PLANT COMPONENTS. SHOULD A SINGLE MAXIMUM DAY BE USED?

A. Yes, the single maximum day water demand is the minimum design requirement as I stated in my direct testimony. The single maximum day demand is in accordance with design standards, FDEP rules and regulations and utility construction practice. The average "of the five highest maximum daily flows in the maximum month" is not in accordance with design standards, DEP rules, the Florida Statutes, or water utility construction practice in Florida. As I explained at length in my direct testimony, used and useful requirements must parallel design and regulatory requirements. Mr. Biddy does not directly address the many reasons I offered to support this conclusion. Yet, interestingly enough, throughout his testimony, Mr. Biddy acknowledges that a single maximum day is the design standard, for example on page 10, line 9 of his testimony.

Mr. Biddy argues that a single maximum day is not reliable for used and useful purpose because precise records of line breaks, leaks, and other water losses are difficult to keep. I think Mr. Biddy's argument is completely unpersuasive. As stated in SSU's direct testimony and in responses to discovery requests, SSU has excluded known unusual events such as line breaks from the maximum days used in the analysis. Besides, even if one accepts that leaks and various other water measurements are difficult to keep track of with precision, there is still no legitimate basis for wholesale rejection of the maximum day. The Commission should recognize the requirements of the State of Florida. To suggest that the drafters of the design manuals, engineering publications, and Florida regulations somehow failed to recognize these water measurement considerations is illogical. If the maximum day data is reliable for design purposes, it is reliable for used and useful purposes. The utility should not be placed in a position of having to explain to the permitting authority that its design to construct a well or pump did not use historic maximum day data because the Public Service Commission thinks a lower number is more appropriate.

Q. **MR. BIDDY ARGUES THAT THE CONSTRUCTION PERMIT CAPACITY OF A WASTEWATER PLANT SHOULD BE USED TO DETERMINE USED AND USEFUL RATHER THAN OPERATING PERMIT CAPACITY. DO YOU THINK HIS SUGGESTION IS APPROPRIATE?**

A. As a matter of principle, no. It is improper to assume a change to the ongoing and permitted process of an extended aeration plant to that of a contact stabilization plant. Many plants have the dual ratings Mr. Biddy discusses on page 8 of his testimony. With a change in the treatment method which Mr. Biddy presupposes, water quality, performance, sludge handling, operator staffing, electric usage, chemical usage and the sludge stabilization costs all dramatically change. Depending on the situation, additional investment of significant sums may be required to make the necessary alterations and the reliability of treatment and level of environmental protection could also be reduced by the conversion. These facilities have operating permits from DEP designating the treatment process to be used. It is wrong to presuppose a change in the treatment process for the sole purpose of lowering the used and useful percentage as Mr. Biddy advocates.

Q. DO YOU AGREE WITH MR. BIDDY'S FIRM RELIABLE CAPACITY ADJUSTMENTS?

A. No. Beginning on page 9 of his testimony, Mr. Biddy argues that firm reliable capacity should not be considered separately for wells, high service pumps, and treatment units. It appears from Mr. Biddy's explanation on page 9 that he discounts the probability that one of the components he refers to may be off-line for scheduled repairs while another may be off-line due to an emergency. Mr. Biddy states only that it is unlikely two components will be "scheduled for service at the same time." Based on my experience, I think Mr. Biddy errs by ignoring a confluence of scheduled and emergency events. Further, I would point out that Mr. Biddy's notion of excluding certain components from firm reliable capacity consideration is inconsistent with the Commission's order in SSU's last rate case in Docket No. 920199-WS. SSU's proposed firm reliable capacity formula is consistent with that decision.

SSU's method is also consistent with analogous requirements for wastewater plant component reliability as stated in the U.S. Environmental Protection Agency's MCD-05 publication. To illustrate, Provision 2.2.1.2 of that publication states,

> A backup pump shall be provided for each set of pumps which performs the same function. The capacity of the pumps shall be such that with any one pump out of service, the remaining pumps will have capacity to handle the peak flow. It is permissible for one pump to serve as a backup to more than one set of pumps.

Q. DO YOU AGREE WITH MR. BIDDY'S ASSESSMENT OF FIRM RELIABLE CAPACITY FOR WELLS?

A. No. Mr. Biddy on line 5, page 10, that when "storage or high service pumping facilities are available" SSU's firm reliable capacity methods should not be applicable. It should be pointed out that Mr. Biddy's statement is correct **only if** the storage he refers to is elevated distribution storage and the "or" in the statement is an "and." As thus restated, the single largest pumping unit could be out of service, assuming the elevated storage volume is adequate and on site, and elevated storage could be substituted for high service pumping firm reliable capacity. However, this alone does not justify accepting Mr. Biddy's proposal for all SSU plants.

Further support for SSU's firm reliable capacity calculations for wells can be found in the results of the 1989/1990 consumptive use permit case of the Corporation of the President of Jesus Christ of Latter Day Saints ("COP") v. the City of Cocoa. The final order of St. Johns River Water Management District (the "District") in that case accepted the findings of fact and conclusions of law of the Division of Administrative Hearings' Hearing Officer that reserve well capacity of twenty percent in excess of projected maximum day withdrawals is reasonable in order for the utility to meet demands during either routine maintenance or emergency well shutdowns. This ruling was made without consideration for storage, elevated or otherwise.

SSU's method for determining well firm reliable capacity is consistent with design standards, reliability design, and permitting practice.

Q. MR. BIDDY ARGUES THAT THE PEAK HOUR FACTOR SHOULD BE 1.3 TIMES THE MAXIMUM DAY DEMAND. DO YOU AGREE WITH HIS PROPOSED PEAKING FACTOR?

A. No. Mr. Biddy quotes AWWA M32 for a suggested range of 1.3 to 2.0. This manual applies to all water systems in the United States. It is recognized and accepted engineering practice that as a system becomes larger, the peaking factor is less. Large water systems such as those operated by 1) the City of Tampa, 2) the City of Jacksonville, 3) Miami-Dade Water and Sewer Authority, 4) the City of St. Petersburg, 5) the Orlando Utilities Commission, and 6) Pinellas County Water have all reported peaking factors between 1.3 to 1.6. The SSU water plants are quite small in comparison to these. Indeed, all of the SSU water plants <u>combined</u> do not serve as many customers as large metropolitan systems. The 2.0

factor reflects sound engineering practice for plants which are the size of the majority of SSU's plants. One should not just arbitrarily say, "I believe 1.3 should be used because it is the minimum requirement," as Mr. Biddy does. Mr. Biddy's proposed factor is insupportable and also inconsistent with the Commission's order in SSU's last rate case in Docket No. 920199-WS. SSU's proposed peaking factor is consistent with that decision, and consistent with the available and relevant facts and the design, construction and building practices for small water facilities in Florida.

Q. COULD YOU COMMENT ON MR. BIDDY'S USE OF EMERGENCY STORAGE?

A. Yes. Emergency storage does not have a specific design criteria in AWWA M32, yet it is standard practice in Florida to provide an amount for emergency storage. The amount of emergency storage built depends upon an assessment of risk and degree of system dependability. To eliminate emergency storage is to eliminate the degree of system reliability and maximize risk. Water plants are designed, constructed, and operated to protect the public's health, safety and welfare. I cannot agree with Mr. Biddy's elimination of all emergency storage in all SSU plants notwithstanding whether emergency storage was a specifically stated design consideration. Marco Island residents were well served by the emergency storage available during the last hurricane and when the 30" raw water supply line under the Marco River ruptured last year. The Deltona Lakes plant's emergency storage was crucial in saving lives during the huge forest fire in Deltona several years back.

Q. MR. BIDDY NEXT DISCUSSES "DEAD STORAGE." IS THERE DEAD STORAGE IN AN ELEVATED STORAGE TANK?

A. No.

Q. IS THERE DEAD STORAGE IN SSU'S GROUND STORAGE TANKS?

A. Yes. The vortex situation is rare <u>if</u> you can place the pumps at a grade low enough. Since the SSU ground storage tanks are typically built on flat ground, the centerline of the pumping units are above the bottom of the tanks. "Dead storage" is commonly encountered in Florida storage facilities and has been approved for used and useful storage calculations by the Commission (in the last Lehigh rate case) and by Sarasota County. FDEP also recognizes this situation in permitting.

Q. DO YOU AGREE WITH THE COMMENTS MR. BIDDY MAKES REGARDING HIGH SERVICE PUMPING BEGINNING ON LINE 12, PAGE 12, OF HIS TESTIMONY?

A. No. High service pumps at the source in many instances are the only pumping units for the SSU plants. High service pumps must meet all service conditions as are typical for the SSU service areas. Mr. Biddy assumes multiple high service pumping locations throughout the service area. Such situations exist only in a few of the large SSU service areas, and even there the hydraulics are such that the units are necessary as SSU reflected in the MFRs. In the two locations where elevated storage exists, Lehigh Acres and Keystone Heights, the elevated storage can offset the high service pumping needs to some extent, but that fact alone does not justify Mr. Biddy's proposed result. Besides, while Mr. Biddy espouses the virtues of distribution storage and asserts that it is more cost effective than sizing up high service pumps, he never provided or calculated the additional theoretical storage and additional plant costs required if such a convention is to be used.

Q. IS IT CORRECT TO USE HIGH SERVICE PUMPS TO HANDLE PEAK HOURLY FLOWS AND FIRE FLOWS, CONTRARY TO WHAT

MR. BIDDY ARGUES?

A. It should first be understood that when distribution storage is not available and fire flow service is available, the standard design condition according to the Insurance Services Office ("ISO") in Jacksonville, many of the county codes, city codes and related standards, is the <u>single</u> maximum day plus fire flows or peak hourly demand whichever is greater, not the average of the five highest maximum days of the maximum month. All storage facilities would be undersized if an average of the five maximum days were used. In small service areas, a couple of "jockey" pumps (50-250 gpm) may be used to meet the peak hour flows but are inadequate for fireflow demands. In such cases, a single fire rated pump of 750 gpm or 1500 gpm may be used to provide fireflow. Customer demands and pressures versus fireflow requirements must be recognized when providing pumping units for such plants. In large plants without dedicated fire pumps, the single maximum day plus the service area fireflow is used.

Q. **WHAT COMMENTS DO YOU HAVE REGARDING MR. BIDDY'S PROPOSALS TO ADJUST USED AND USEFUL FOR AUXILIARY POWER AND HYDRO TANKS?**

A. Both of these components should be 100% used and useful as indicated by my direct testimony and as supported by the Commission's order in Docket No. 920199-WS. Moreover, the existing customers would pay significantly more if auxiliary generators and hydro tanks were built in multiple phases, which is the result Mr. Biddy encourages by his suggestion for used and useful adjustments. Exhibit _____ (GCH-4) shows that with respect to auxiliary generators and hydro tanks.

Q. MR. BIDDY ARGUES IN FAVOR OF THE LOT-COUNT METHOD AS A MEANS FOR DETERMINE PIPELINE USED AND USEFUL. IS THE LOT COUNT METHOD APPROPRIATE FOR SUCH AN ANALYSIS?

A. No, for several reasons: (1) the lot count method only measures developed versus undeveloped lots or, in other words, the status of land development over which the utility has no control, and not utility service; (2) one home can occupy two or more lots; (3) a lot could be unbuildable due to a number of factors; (4) redevelopment can occur; (5) many lots are served by wells and/or septic tanks and will never be customers; (6) no less of a system is needed to serve six of ten lots as opposed to all ten lots on a street and, since the Commission requires the utility to provide service, the entire system is necessary; (7) in many instances the development code requires the water and sewer pipes to be built before the subdivision phase can get its first certificate of occupancy; (8) in most SSU service areas, pipeline installations are regulatory requirements for the protection of the public health, safety, sanitation and welfare; (9) the lot count method provides no consideration for the economy of scale and cost-effective construction practices for transmission and distribution facilities as are identified in Exhibit _________ (GCH-4) and which should be considered as FPSC policy; (10) the lot count method does not consider sizing lines to provide fireflow or consider system looping, both of which the utility is required to consider in design; (11) the lot count method does not consider sound engineering design and practice and State of Florida, county and city rules and regulations which also must be complied with as a FPSC requirement; and (12) the lot count method encourages the proliferation of septic tanks and individual well construction which increases the long-term cost to existing customers by creating internal competition and by decreasing the economy of scale.

The Commission staff policy memos identified as Exhibit _____ (GCH-7) reveal that the Commission did not strictly apply the lot count method historically; but rather, the method was considered as a base and appropriate adjustments made increasing the used and useful percentages to take into account the economy of scale which I have demonstrated for transmission and distribution facilities in Exhibit _____ (GCH-4).

Q. IS A HYDRAULIC ANALYSIS APPROPRIATE TO EVALUATE USED AND USEFUL?

A. Yes. Hydraulic analyses of water distribution facilities assists utilities and engineers formulate the most economic and reliable design and construction of those facilities. There is no rational reason to reject a hydraulic analysis in favor of a lot-count analysis for determining used and useful. The hydraulic modeling used and useful analysis (1) more accurately reflects the demands placed on the transmission and distribution facilities than the lot-count method, (2) parallels design considerations, and (3) provides an incentive to the utility to take advantage of the significant economies of scale which can be realized by reducing the installation costs associated with water distribution facilities.

Q. MR. BIDDY QUESTIONS WHETHER SSU'S PENDING RAW WATER SUPPLY SITE FOR MARCO ISLAND SHOULD BE ELIMINATED FROM RATE BASE IN THIS CASE. HAS AN EVALUATION OF THE TOTAL WATER SUPPLY CAPACITY OF MARCO ISLAND AND MARCO SHORES BEEN ACCOMPLISHED?

A. Yes, on many occasions, and the results have previously been submitted to the FPSC. Collier County's most recent version of the planning document for Marco Island shows the complete utilization of the Marco Island and Marco Shores raw water supply. In fact, this document, prepared with the participation of SSU Marco Island customers, recommends the expansion of the Marco R.O. facilities from 4 MGD to 6 MGD in the near future, the development of the new 160-acre site, significant new increases in reuse to curtail fresh water demand, new aquifer storage and recovery facilities to meet peaking needs and a new strict water conservation program on the island to allow present sources to meet just the short-term demand. All of the water supply facilities at Marco Island have previously been found to be 100% used and useful. The 160-acre site is needed to develop an adequate supply to meet current and short-term need. SSU witness Mr. Terrero will elaborate on the permitting required. The water supply capacity of the system is 9 MGD and the present demand has reached over 10 MGD. At present, the level of additional supply required is approaching 4 MGD, referring again to the District's decision in the COP v. City of Cocoa consumptive use permit case where adequacy of resource supply is addressed. Only by the efficient implementation of a combination of the supply sources stated above -- first securing the land and the permits, then the design, then the construction to eventually attain operations -- will permit SSU to meet the critical water supply needs of Marco Island in the coming five (5) years. Removing the 160 acre site from rate base has the effect of penalizing SSU for planning ahead and discourages SSU from meeting the water supply needs of Marco Island.

Q. MR. BIDDY AND MR. WOELFFER ASSERT THAT REUSE FACILITIES SHOULD NOT BE 100% USED AND USEFUL. IN PARTICULAR, MR. BIDDY STATES REUSE FACILITIES SHOULD NOT BE CONSIDERED 100% USED AND USEFUL "WITHOUT EVALUATION." HAVE ALL OF THE EFFLUENT

REUSE FACILITIES BEEN EVALUATED?

A. Yes, all effluent reuse facilities were evaluated by professional consultants, SSU staff, and DEP through the required reuse feasibility reports for each of the facilities having reuse. These reports are a matter of record and have been approved by each entity and regulatory agency.

Q. DO YOU MAINTAIN THAT REUSE FACILITIES SHOULD BE THE 100% USED AND USEFUL AS REQUESTED BY SSU?

A. Yes. I believe it is quite clear why reuse facilities should be 100% used and useful in my direct testimony and exhibits. The financial disincentive posed by a used and useful adjustment to reuse facilities would be very direct because the amount of investment required to provide reuse is often substantial. Staff witness Shafer's testimony speaks to this issue as well in that Mr. Shafer mentions resource protection as one of the Commission's goals. Reuse, as the Legislature has recognized, is a means of resource protection. If the Commission is to fulfill its resource protection goal, it should provide utilities the incentive to provide reuse which the Legislature directed and DEP has repeatedly recommended through a 100% used and useful percentage for reuse facilities.

Q. MR. BIDDY NEXT SUGGESTS A USED AND USEFUL ADJUSTMENT TO THE DEEP INJECTION WELL ON MARCO ISLAND. DO YOU THINK AN ADJUSTMENT SHOULD BE MADE TO THE INJECTION WELL ON MARCO?

A. No. 100% of the injection well's capacity is required for the reverse osmosis water plant, and the well also serves as back-up disposal source for effluent reuse. Moreover, no less of a facility could have been constructed to meet the present functions.

Q. DO YOU HAVE ANY GENERAL COMMENTS REGARDING THE ADJUSTMENTS MR. BIDDY RECOMMENDS AS THEY APPEAR IN THE EXHIBITS HE HAS ATTACHED TO HIS TESTIMONY?

A. Yes, I would like to note the following observations. In his exhibits, Mr. Biddy has not accepted any prior Commission decisions on used and useful. He makes no attempt to prove the Commission was unaware of or misunderstood the circumstances of its prior determination and therefore erred in establishing used and useful. A utility should not be penalized due to a witness's lack of research, review and prudent consideration of prior rate cases which were subjected to full disclosure, public hearings and a full rate case proceeding. Mr. Biddy completely ignored the authority I cited in my direct testimony for the proposition that used and useful should not decrease from one case to the next where capacity is unaffected, including Order No. PSC-93-1113-FOF-WS, issued July 30, 1993, in General Development Utilities, Inc.'s consolidated rate cases for Silver Springs Shores and Port Labelle and Order No. PSC-94-0739-FOF-WS, issued June 16, 1994, in Utilities, Inc.'s rate case for Marion and Pinellas Counties.

A practice of routinely readjusting used and useful such as Mr. Biddy and Mr. Woelffer urge would undermine the ability of the utility to continue operations. Decisions to invest in plant are made before plant is constructed. The prudence of management in deciding to build plant must be examined based on the facts and circumstances which existed when that decision was made. For instance, if a plant component is 100% used and useful at time T^1, that alone is fair justification showing the utility's decision to build the plant was prudent. The utility must be given the opportunity to recover its investment as well as a return on that plant. It is simply absurd to suggest that when the demand placed on the plant at time T^2 is 10% or 20% less than at time T^1 (whether due to conservation, price elasticity, rainfall, loss of customers or any reason), the utility should be denied recovery of and a return on a portion of investment which the Commission already held was prudent and needed when made. Putting it into focus this way, only math is required to subtract from rate base a dollar amount associated with a reduction in demand; however, it is impossible for the utility to similarly extract from plant-in-service a portion of the prudent investment it already made. Thus, a reduced used and useful percentage in such situations is quite simply punitive to the utility. Were the Commission to adopt the practice of used and useful readjustments as the intervenors suggest, investor owned utilities, at a minimum, would face higher capital costs caused by the pervasive risk of diminishing returns which readjustment poses. Utilities would be placed into financial crisis. Needless to say, utilities would also have no motivation whatsoever to promote conservation, for they would suffer used and useful readjustment and greater revenue losses if they did. Utilities would also have even less of an incentive than they do now to take advantage of economies of scale.

Mr. Biddy also errs in his recommendations by: 1) eliminating fire flows, 2) applying an inappropriate peaking factor of 1.3 versus 2.0, 3) lacking an understanding of SSU's ground tank construction as related to its high service pumping, 4) misapplying firm capacity to facilities in direct conflict with State of Florida rules, regulations, and determinations of law, 5) advocating minimal facilities contrary to sound engineering practice and the protection of the environment, public health, safety and welfare, 6) ignoring used and useful analyses as delineated in prior Commission actions, and 7) contrary to DEP's written recommendations, advocating removal of the margins of reserve without consideration of the resulting adverse impacts to sound long-term economic stability for the rate payer and the Company's ability to pay for prudently sized facilities to protect the public health and the environment an provide adequate service.

Mr. Biddy's testimony serves only to increase costs to the customer in the long run; to expose customers to minimal facilities, contrary to the interests of the public health, the environment and resource protection; and to increase the cost of regulation.

Q. **MR. HARTMAN, HAVE YOU REVIEWED MR. LARKIN'S AND MS. DERONNE'S DIRECT TESTIMONY?**

A. Yes.

Q. **DO YOU AGREE WITH THE ADJUSTMENTS REGARDING NON-USED AND USEFUL WHICH THEY CALCULATE?**

A. No. Previously, I have commented on Mr. Biddy's proposals. These witnesses adopt Mr. Biddy's erroneous work and therefore they and the calculations they propose are in error also. I will not at this time address the specific calculations Mr. Larkin and Ms. Deronne propose; therefore, my comments are more general in nature.

Q. **DO YOU AGREE WITH TOTAL INCREASE TO NON-USED AND USEFUL OF $51,552,603 IDENTIFIED IN MR. LARKIN AND MS. DERONNE'S TESTIMONY?**

A. No. Again, that value is based upon the erroneous work I previously identified.

Q. **MR. HARTMAN, HAVE YOU REVIEWED STAFF AUDIT EXCEPTION NUMBER 2, WHICH CONCERNS SSU'S CONDEMNATION OF THE PROPERTY REFERRED TO AS THE COLLIER PITS, AS WELL AS THE TESTIMONY OF STAFF AUDITOR ROBERT F. DODRILL AS IT RELATES TO THAT**

AUDIT EXCEPTION?

A. Yes, I have. I would also note that Mr. Larkin and Ms. DeRonne testify in support of Mr. Dodrill's audit exception number 2, making no arguments other than those made in the audit report.

Q. **ARE ALL OF THE 212.5 ACRES OF THE COLLIER PITS USED AS A WATER SUPPLY SOURCE?**

A. Yes. I recommended SSU purchase that amount of property as a minimum. First, the drawdown impacts of pumping from this facility impact the entire acreage condemned and more, as can be seen on Exhibit ______ (GCH-8). This Exhibit displays the drawdowns resulting from a 3.9 MGD withdraw during wet and dry months and the subsurface capture zones at various maturation stages. The South Florida Water Management District has permitted these impacts on the canal system which is hydraulically connected by porous lime rock to the adjacent pits. The Colliers' experts, my firm, and others all demonstrated that the pits/lake system use not only all 212.5 acres, but also water resources beneath the other remaining Collier property to the east of the canal. The wetlands clearly serve as additional storage as reported by all the experts involved in the case. It should also be noted that

DEP requires the control of a setback distance of a minimum of 500 feet from the wetted perimeter. This sanitary setback is necessary for pollution mitigation and source integrity.

All witnesses who would advocate that only the lake area is being used as a water supply source ignore the facts, reality, the experts' opinions, the regulatory analyses and such other requirements necessary for use of the lakes as a water supply source, such as access, pipeline easements, pump station and storage tank property, facility berm areas and the like. The facts as the experts have reported and the regulatory agencies have determined all conclude that the full acreage is used, as well as the surrounding acreage not purchased. The premise that the full 212.5 acres is something less than 100% used and useful as a water supply source is contrary to all the above and completely insupportable.

Q. **WERE YOU INVOLVED IN THE CONDEMNATION ACTION FILED BY SSU AGAINST THE COLLIER LAKES PROPERTY?**

A. Yes. SSU retained me as an engineering expert in the matter. I have participated in dozens of utility condemnation matters on behalf of both condemnors and condemnees in several states, both in cases where the acquisition concerned only certain utility assets and entire utilities. On each of the occasions where I have testified, I have been accepted as an engineering valuation expert.

Q. DID YOU MAKE ANY RECOMMENDATIONS TO SSU CONCERNING THE SETTLEMENT OF THE SSU CONDEMNATION ACTION?

A. Yes. Exhibit ______ (GCH-9) contains a copy of my recommendation to Southern States to settle the action for a wrap around cost of $8 million. The rationale for my recommendation is fully explained in the exhibit.

Q. MARCO ISLAND RESIDENTS AND THEIR COUNSEL HAVE SUGGESTED THAT SSU PAID TOO MUCH FOR THE MARCO LAKES WATER SUPPLY -- DO YOU AGREE?

A. No. The wrap around price paid by SSU for the water supply was prudent and reasonable. Assertions to the contrary have been unsubstantiated. Based on my knowledge and experience, I knew that the settlement, which I and others worked hard to achieve, was prudent and reasonable.

Q. HAVE YOU REVIEWED THE DIRECT TESTIMONY OF MARCO ISLAND CIVIC ASSOCIATION WITNESS MR. WOELFFER?

A. Yes.

Q. MR. WOELFFER QUESTIONS WHY THE ERC NUMBERS IN THE E SCHEDULES DO NOT MATCH THOSE IN THE F SCHEDULES. COULD YOU TELL US WHAT THE ERC'S PRESENTED IN THE F SCHEDULES REPRESENT?

A. The ERC's in the F Schedules represent ERC's based on plant flows and/or meter equivalency factors for used and useful purposes. The figures in the E Schedules are prepared for rate design purposes and need not match those for the F Schedules.

Q. ON PAGES 15 AND 16 OF HIS TESTIMONY, MR. WOELFFER ALLEGES YOU ARE INCONSISTENT BY ADVOCATING USE OF A SINGLE MAXIMUM DAY IN THIS CASE, WHEREAS YOU DID NOT IN AN ENGLEWOOD WATER DISTRICT MATTER. DO YOU HAVE ANY COMMENT REGARDING MR. WOELFFER'S TESTIMONY AND HIS EXHIBIT _____ (MTW-1)?

A. Yes, Mr. Woelffer makes several errors with respect to this portion of his testimony. First of all, the Exhibit he relies on for the notion that I have made inconsistent statements pertains to a **wastewater** facility, not a **water** facility. My testimony in this case is that used and useful for various water plant components be computed using a single maximum day; I make no such recommendation for wastewater plants. If Mr. Woelffer had selected the Englewood Water District ("EWD")

Report for **water** facilities, rather than the report for **wastewater** facilities, he would have seen I used the single maximum day demand for the EWD water facilities, just as I advocate in this case. Further, EWD, is a not-for-profit entity. The EWD report Mr. Woelffer attached to his testimony was a capital contribution charge study (Impact Fee Study) and not a used and useful study for a rate case.

Q. DO YOU HAVE ANY OTHER COMMENTS REGARDING MR. WOELFFER'S TESTIMONY?

A. Yes. Mr. Woelffer states that he should be considered a technical expert. I am personally knowledgeable that in the (1) West Charlotte Utilities rate case Mr. Woelffer refers to he was a customer intervenor; (2) in both the EWD matters he refers to he provided customer comments; and (3) his background, experience and training is not in water and wastewater utilities by his own admission and previous testimony; and (4) he has demonstrated on numerous occasions, as well as in this case, that he simply does not understand the necessary fundamentals to testify knowledgeably about water and wastewater utility matters. He does not know the appropriate demand condition for a water or wastewater plant, that an impact fee study for a publicly owned utility would employ a different methodology than an investor-owned used and useful analysis in a rate case would, and he otherwise demonstrates a lack of professional experience and knowledge relative to the Florida rules, regulations and statutes which are applied to water and wastewater facilities. Any opinions Mr. Woelffer offers in this case should be viewed as those of a customer (if he is one) or as a concerned citizen of the State.

Q. HAVE YOU REVIEWED THE PREFILED TESTIMONY OF JOHN STARLING?

A. Yes.

Q. DO YOU HAVE ANY COMMENTS REGARDING THAT TESTIMONY?

A. Yes. Mr. Starling has done a fine job in identifying the types of treatment, the number of plants, and performing his own theoretical cost analysis. However, I would call to the Commission's attention that there are many other costs not shown in Mr. Starling's analysis and that the validity of the exact values may vary by their exclusion, which Mr. Starling concedes. What is shown is that reverse osmosis ("R.O.") is significantly more expensive in all categories.

R.O. treats saline water, not fresh water; yet, all other conventional treatment techniques treat fresh or non-saline water. I do not dispute that each treatment type has different costs. However, it is quite evident that R.O. has the distinguishing characteristic of treating saline water and is considerably more expensive than conventional treatment techniques.

Q. DO YOU HAVE ANY OTHER COMMENTS REGARDING MR. STARLING'S TESTIMONY?

A. Yes. Mr. Starling calculated an average per unit cost for each type of treatment which he then multiplied by a capacity requirement to arrive at a hypothetical plant cost for each type of treatment. In calculating the average per unit costs, Mr. Starling did not account for the economies of scale which clearly impact the per unit costs of the various utility plants he examined. Had Mr. Starling considered the economies of scale, perhaps through a weighted average to calculate per unit costs, the values he arrived at would differ.

Q. YOU MENTIONED EARLIER THAT DR. BEECHER'S TESTIMONY ALSO REFERS TO ECONOMIES OF SCALE. WHAT COMMENTS WOULD YOU LIKE THE COMMISSION TO CONSIDER REGARDING HER TESTIMONY?

A. On page 10 of her testimony, Dr. Beecher correctly recites the various cost factors impacting the water and wastewater industry and refers to the attainment of economies of scale. On page 20 of her testimony, she seems to indicate that for the greatest economies of scale of production to result from single-tariff pricing, a physical interconnection of plants is required. She also seems to indicate that some economies of scale are derived without physical interconnection. I agree a physical interconnection of plants produces economies of scale in production. However, I do not believe economies of scale in production are entirely dependent upon a physical interconnection of plants for single-tariff pricing to impact economies of scale. Single-tariff pricing can serve to encourage economies of scale in production notwithstanding the physical interconnection of plants by virtue of its allowing the utility to make investment decisions to best accomplish or attain an economy of scale.

Q. IT HAS BEEN SUGGESTED BY SSU CUSTOMERS TESTIFYING AT THE MARCO ISLAND SERVICE HEARING THAT SSU SHOULD HAVE PURSUED OBTAINING WATER FROM THE CITY OF NAPLES AS OPPOSED TO CONDEMNING THE COLLIER PITS.

WERE YOU INVOLVED IN THE NEGOTIATIONS BETWEEN SSU AND THE CITY OF NAPLES CONCERNING THE POTENTIAL OF SSU'S SECURING WATER SUPPLIES FROM THE CITY?

A. Yes. As a result of my participation, I am aware that while the City of Naples never withdrew from the negotiations, the City indicated to SSU that SSU would be required to compensate the City for costs associated with building a new wellfield as demands required more flow in excess of present capacity to accommodate SSU's required capacity. This factor, when combined with the Company's cost for a pipeline, storage, pump stations, metering, valving, land, professional fees and other costs, which already exceeded the Collier Pit alternative, caused SSU to cease negotiations with the City.

Q. **COULD YOU EXPLAIN THE CITY'S NEW WELLFIELD SCENARIO FURTHER?**

A. Yes. During negotiations with the City, SSU learned that the City's coastal wellfield had experienced a water quality degradation in the past. Thus, a significant factor which the City and SSU confronted was whether incremental draws of water from the wellfield to sell to SSU would result in the loss of the wellfield as a supply source due to water quality difficulties. The City could not provide SSU with the exact cost of the new wellfield or provide a fixed dollar figure which SSU would be required to pay to the City. It was SSU's assessment of the situation was that SSU's cost of a pipeline, pumping facilities, capacity contribution costs, potential exposure to additional capacity contributions for a new wellfield and other costs of the project made the project less economical than the Collier Pit alternative. Also, the unknowns associated with when the City would build a new wellfield and how much SSU's contribution would be presented an unknown future liability.

Q. **DOES THIS COMPLETE YOUR REBUTTAL TESTIMONY?**

A. Yes, at this time. However, I note that several witnesses reserved the right to update their testimony at some future date. Of course if and when such updates occur, I would appreciate the opportunity to make such appropriate modifications to my testimony as would be warranted.

EXHIBIT (GCH-4)

PAGE 1 OF 284

[illegible]

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, surveyors & management consultants

ECONOMY OF SCALE EVALUATION

Prepared For

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FEBRUARY, 1996

HAI Project No. 95-145.00

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TABLE OF CONTENTS

SOUTHERN STATES UTILITIES
ECONOMY OF SCALE

TABLE OF CONTENTS

Section No.	Title		Page No.
1.0	INTRODUCTION		
	1.1	Background	1-1
	1.2	Objective	1-2
	1.3	Summary and Conclusions	1-3
2.0	METHODOLOGY		
	2.1	General	2-1
	2.2	Sources	2-1
		2.2.1 USEPA	2-1
		2.2.2 Culp/Wesner/Culp	2-2
		2.2.3 Manufacturers	2-3
		2.2.4 Bid Tabulations	2-7
	2.3	Curve Design Summary	2-7
		2.3.1 Updating Process	2-8
		2.3.2 Design Consideration	2-8
		2.3.3 Finalization	2-8
3.0	ANALYSIS		
	3.1	Threshold Sizing	3-1
		3.1.1 Inflection Points	3-1
		3.1.2 Economic Minimum Threshold Sizes	3-4
		3.1.3 Curve Fitting	3-6
		3.1.4 Regulatory	3-6
4.0	WASTEWATER TREATMENT PLANT FACILITIES		
	4.1	Extended Aeration Package "'WTP	4-1
	4.2	Contact Stabilization Package WWTP	4-4
	4.3	Blowers	4-7
	4.4	Filters	4-12
	4.5	Chlorination	4-12
	4.6	Standby Generator Sets	4-15

SOUTHERN STATES UTILITIES
ECONOMY OF SCALE

TABLE OF CONTENTS (Continued)

Section No.	Title		Page No.
5.0	WATER TREATMENT PLANT FACILITIES		
	5.1	Prestressed Concrete Ground Storage Tanks	5-1
	5.2	Steel Ground Storage Tanks	5-4
	5.3	Chlorination	5-4
	5.4	High Service Pumps	5-7
	5.5	Hydropneumatic Tanks	5-11
	5.6	Wells	5-14
	5.7	Lime Softening WTP	5-14
	5.8	Reverse Osmosis WTP	5-19
6.0	WASTEWATER COLLECTION/WATER DISTRIBUTION		
	6.1	Gravity Sewers	6-1
	6.2	Sewage Pump Stations	6-1
	6.3	Force Mains	6-4
	6.4	Water Mains	6-9

Appendix A - Extended Aeration Package WWTP Supporting Data
Appendix B - Contact Stabilization Package WWTP Supporting Data
Appendix C - WWTP Positive Displacement and Centrifugal Blower Supporting Data
Appendix D - WWTP Tertiary Filter Supporting Data
Appendix E - Chlorine Feed System Supporting Data
Appendix F - Standby Generator Supporting Data
Appendix G - Concrete Ground Storage Tank Supporting Data
Appendix H - Steel Ground Storage Tank Supporting Data
Appendix I - Water Distribution High Service Pump Supporting Data
Appendix J - Hydropneumatic Tank Supporting Data
Appendix K - Water Supply Well Supporting Data
Appendix L - Lime Softening WTP Supporting Data
Appendix M - Reverse Osmosis WPT Supporting Data
Appendix N - Gravity Sewer System Supporting Data
Appendix O - Sewage Pump Station Supporting Data
Appendix P - Wastewater Force Main Supporting Data
Appendix Q - Water Main Supporting Data

SOUTHERN STATES UTILITIES
ECONOMY OF SCALE

LIST OF TABLES

Table No.	Title	Page No.
1-1	Treatment Component Threshold Sizes	1-4

LIST OF FIGURES

Figure No.	Title	Page No.
3-1	Increasing and Decreasing Economy of Scale	3-2
3-2	Economy of Scale on Logarithmic Axes	3-3
3-3	Steel GST Inflection Point	3-5
4-1	Extended Aeration Unit Cost Curve	4-2
4-2	Extended Aeration Construction Cost Curve	4-3
4-3	Contact Stabilization Unit Cost Curve	4-5
4-4	Contact Stabilization Construction Cost Curve	4-6
4-5	Positive Displacement Blower Unit Cost Curve	4-8
4-6	Positive Displacement Blower Construction Cost Curve	4-9
4-7	Centrifugal Blower Unit Cost Curve	4-10
4-8	Centrifugal Blower Construction Cost Curve	4-11
4-9	Tertiary Treatment Filter Unit Cost Curve	4-13
4-10	Tertiary Treatment Filter Construction Cost Curve	4-14
4-11	Chlorine Feed System Unit Cost Curve	4-16
4-12	Standby Generator Unit Cost Curve	4-17
4-13	Standby Generator Construction Cost Curve	4-18

SOUTHERN STATES UTILITIES
ECONOMY OF SCALE

LIST OF FIGURES

Figure No.	Title	Page No.
5-1	Prestressed Concrete GST Unit Cost Curve	5-2
5-2	Prestressed Concrete GST Construction Cost Curve	5-3
5-3	Steel GST Unit Cost Curve	5-5
5-4	Steel GST Construction Cost Curve	5-6
5-5	Chlorine Feed System Unit Cost Curve	5-8
5-6	High Service Pump Unit Cost Curve	5-9
5-7	High Service Pump Construction Cost Curve	5-10
5-8	Hydropneumatic Tank Unit Cost Curve	5-12
5-9	Hydropneumatic Tank Construction Cost Curve	5-13
5-10	Supply Well Unit Cost Curve	5-15
5-11	Supply Well Construction Cost Curve	5-16
5-12	Lime Softening WTP Unit Cost Curve	5-17
5-13	Lime Softening WTP Construction Cost Curve	5-18
5-14	Reverse Osmosis WTP Unit Cost Curve	5-20
5-15	Reverse Osmosis WTP Construction Cost Curve	5-21
6-1	Gravity Sewer Design	6-2
6-2	Gravity Sewer Unit Cost Curve	6-3
6-3	Sewage Pump Station Unit Cost Curve	6-5
6-4	Sewage Pump Station Construction Cost Curve	6-6
6-5	PVC Force Main Unit Cost Curve	6-7
6-6	DIP Force Main Unit Cost Curve	6-8
6-7	PVC Water Main Unit Cost Curve	6-10
6-8	DIP Water Main Unit Cost Curve	6-11

SECTION 1

SECTION 1
INTRODUCTION

1.1 BACKGROUND

Individuals, companies, corporations, and institutions are all consumers. All purchase goods and services of others that are necessary to meet individual needs or supply materials and equipment necessary to produce a product that will be sold to others at a profit. In the case of the individual, consider a trip to the grocery store. The objective is to procure maximum food and supplies at the least cost. The way to optimize the purchase is by buying in bulk. In this way, a commodity is purchased for a lower unit price and the time before the next trip to the supermarket is maximized.

When a profit motive is involved, as is the case of a company or corporation, the market necessity of keeping operating costs low and profits high dictate that materials and goods be purchased at the lowest price possible. Most often, this is achieved by purchasing in bulk quantity. In this way, goods are procured at a lower unit price. Costs are thus kept low and/or profits are maximized, depending on market conditions.

Institutions, which provide services to the public, have an obligation to minimize costs and maximize services. Purchasing agents are usually astute at maximizing procurement of goods at a minimum price. This is accomplished through competitive bidding of bulk purchases.

This familiar everyday concept loosely known as "power buying" or "bulk purchases" is actually an economy of scale. An economy of scale exists when the unit cost decreases with size or amount purchased. In consumer products, economies of scale exist primarily due to manufacturer savings in packaging and handling. In many consumer situations, there exists an optimum point where the relative maximum economy of scale is achieved and beyond that point, the unit price of the product remains nearly constant. This would be known as an inflection point and it marks the range between the areas of increasing economy of scale and decreasing economy of scale. Provided one could use the commodity in a reasonable period of time, the most cost-effective purchase of the commodity would be made for the volume or quantity with the lowest unit price.

Economies of scale exist in the construction industry. For instance, a contractor who has just successfully bid two separate projects which utilize the same materials, such as blocks, will obtain a lower price by purchasing such material in a larger quantity and at a lower unit cost. Perhaps he made a calculated risk and won the projects with this strategy or will simply maximize his profit from the two projects. Economies of scale in construction are also maximized by elimination of "soft" costs. There are costs associated with engineering, permitting, contractor mobilization, building permit costs, etc. In the example above, if the two projects were within close proximity, the contractor would be able to bid lower mobilization costs for each project as a strategy for winning the jobs. If he won both projects, he would be moving men and material to essentially the same location, thus reducing his cost. If both projects were for the same owner, it would be to the owner's advantage to design, permit, bid, and construct the projects as a single project in which he would then certainly reap the financial benefits by obtaining an overall lower price for the same quantity of work performed.

The utility industry provides necessary services to the public. In order to meet the public need, it engages in the procurement of equipment, material, and construction services. Water and wastewater treatment, collection, and distribution systems consist of discrete components such as wells, tanks, pumps, etc., which, when combined together in proper proportion, serve the public need as a system with an overall reliable capacity. Upon the need for expansion of plant capacity, the utility must consider savings that would be derived through building fewer larger units rather than smaller multiple units. The prudent sizing and phasing of facilities allows the utility to provide cost-effective service to the public.

1.2 OBJECTIVE

The primary objective of this report is to demonstrate that economies of scale exist for the unit components that comprise water and wastewater facilities. In this light, more capacity can be obtained for a lower unit cost. The second objective is to demonstrate that there exists threshold sizes of unit components. This is the point where the increasing economy of scale ends and the decreasing economy of scale begins. In other words, threshold size is the minimum size component that should be considered due to its value on a cost per capacity basis. In the decreasing economy of scale range, the cost per capacity continues to decrease but at a much lower rate. Therefore, the minimum economic threshold size is the point at which the rate of change of the unit cost begins to decline.

The third objective is to demonstrate that economies of scale are achieved through savings in costs of engineering, mobilization, and permitting on projects in which there are not significant economies of scale in the materials.

1.3 SUMMARY AND CONCLUSIONS

Components and systems reviewed are classified as Wastewater Treatment Facilities, Water Treatment Facilities, and Wastewater Collection/Water Distribution. Economies of scale were found to exist on all unit components and systems. Table 1-1 presents the economic minimum threshold sizes for each component and system.

Such threshold sizes should not be construed or interpreted to mean that significant savings are not achieved above or greater than these values. They should be interpreted as the primary point at which the rate of change of the unit price begins to decrease. Thus, when considering system or component expansions, it is prudent to give serious consideration to construct or procure the component of the threshold size or larger.

The engineering economic considerations of the size of unit to construct are as follows:

- Initial demand of system
- Growth rate of system
- Projected build-out demand
- Useful life of the component
- Rules and Regulations
- Operational Considerations
- Interest rates and rate of inflation

If the initial or current demand of the system is less than the economic minimum threshold size, the selection of size must consider the build-out capacity of the facility and when it will be necessary to expand again, which can be computed using the growth rate. If the build-out demand is beyond the economic threshold size, it follows that phases of construction should be implemented in sizes to fully take advantage of the economy of scale offered.

TABLE 1-1

SOUTHERN STATES UTILITIES
ECONOMY OF SCALE

Treatment Component Threshold Sizes

	Component/System	Economic Minimum Threshold Size
	WASTEWATER TREATMENT FACILITY	
1)	Extended Aeration WWTP	0.25 MGD
2)	Contact Stabilization WWTP	0.5 MGD
3)	Pos. Displacement Blower	500 scfm
4)	Centrifugal Blower	2,000 scfm
5)	Tertiary Filters	0.25 MGD
6)	Generator	300 KW
	WATER TREATMENT FACILITY	
1)	Prestressed Concrete GST	600,000 gal.
2)	Steel Ground Storage Tank	100,000 gal.
3)	High Service Pumps	1,000 gpm
4)	Hydropneumatic Tank	10,000 gal
5)	250 ft. Deep Water Supply Well	1,440,000 gpd
6)	500 ft. Deep Water Supply Well	1,440,000 gpd

If build-out is less than the economic minimum size, it follows that it does not make sense to purchase capacity that is not needed. However, in smaller systems and units, there are the factors of operational flexibility and standard sizes to be considered. With small systems, it is often impossible to predict peak demands and loadings. In these cases, special consideration should be given to oversizing to standard sizes to ensure satisfactory service and for environmental protection.

SECTION 2

SECTION 2
METHODOLOGY

2.1 GENERAL

This section details the sources of information for this report; as well as, the method used to construct the unit cost curves.

2.2 SOURCES

In order to give a fair and accurate representation of the costs of constructing water and wastewater systems, information was obtained from many balancing sources. Previous curves were obtained from the United States Environmental Protection Agency (USEPA) and Culp/Wesner/Culp, an engineering firm. Also, quotes were obtained from Florida manufacturers and suppliers. Rounding out the information were bid tabulations from completed construction that took place in the State of Florida.

2.2.1 USEPA

Throughout the years, the United States Environmental Protection Agency (EPA) developed many reports involving the cost of the different components of water and wastewater collection, treatment, disposal, and distribution. The figures presented in these technical reports display the cost of the process versus the capacity (or size) of the component. The curves are typically accompanied by text which explains the function of the cost component and the assumptions made in determining the overall cost. The conversion of the overall cost to unit cost is accomplished by simply dividing the cost by the capacity of the component being studied.

The EPA references used for this study range in years from 1977 to 1984. Therefore, the cost must be updated in order to allow for a present day comparison. The EPA sources that were used are as follows:

(1) "State of the Art of Small Water Treatment Systems." U.S. Environmental Protection Agency, Office of Water Supply. Washington, D.C., August 1977.

(2) "The Cost Digest: Cost Summaries of Selected Environmental Control Technologies." U.S. Environmental Protection Agency. Washington, D.C., October 1984.

(3) "Construction Costs for Municipal Wastewater Treatment Plants: 1973-1978.: U.S. Environmental Protection Agency, Facility Requirements Division. Washington, D.C., April 1980.

(4) "Innovative and Alternative Technology Assessment Manual." U.S. Environmental Protection Agency, Office of Water Programs Operations. Washington, D.C., February 1980.

(5) "Costs of Wastewater Treatment by Land Application.: U.S. Environmental Protection Agency, Office of Water Program Operations. Washington, D.C., June 1975.

(6) "Construction Costs for Municipal Wastewater Conveyance Systems: 1973-1979." U.S. Environmental Protection Agency, Facility Requirements Division. Washington, D.C., January 1981.

(7) "Construction Cots for Municipal Wastewater Conveyance Systems: 1973-1977." U.S. Environmental Protection Agency. May 1978.

(8) "Report on Initial Investment Costs, Operation and Maintenance Costs, and Manpower Requirements for Conventional Wastewater Treatment Plants." U.S. Environmental Protection Agency, Water Quality Office. Black & Veatch, 1971.

2.2.2 Culp/Wesner/Culp

The engineering firm Culp/Wesner/Culp, based in Santa Ana, California, produced water treatment, transmission, and distribution cost reports for the United States Environmental Protection Agency. They also produced an independent water component cost summary. For each component, the overall cost versus capacity is illustrated along with the operation and maintenance costs. As with the EPA generated curves, the Culp/Wesner/Culp curves were adjusted using ENR indexes to the present day cost. Also, a detailed explanation of each component and the assumptions made to determine the cost are both included in each section. The Culp/Wesner/Culp sources that were used are as follows:

(1) "Estimating Water Treatment Costs, Volume 2, Cost Curves Applicable to 1 to 200 MGD Treatment Plants." Gumerman, R.C., et al. (Culp/Wesner/Culp) Santa Ana, CA, August 1979. (Produced for USEPA).

(2) "Estimating Water Treatment Costs, Volume 3, Cost Curves Applicable to 2,500 gpd to 1 MGD Treatment Plants." Hansen, S.P., et al. (Culp/Wesner/Culp) Santa Ana, CA, August 1979. (Produced for USEPA).

(3) "Small Water System Treatment Costs." Gumerman, R.C., et al. (Culp/Wesner/Culp) Santa Ana, CA, August 1986.

2.2.3 Manufacturers

In order to establish a contemporary cost for the components of water and wastewater systems, quotations from Florida Manufacturers and sales representatives were obtained for all the equipment included in this study. At least two manufacturers' quotes were obtained for each component and the overall cost for the component was taken as the average of the two. This allows the high, and low quotes to form a solid representation. The costs are uniform and comparable due to the usage of state sales representatives. These sales representatives and manufacturers who provided the information are as follows:

(1) Package Wastewater Treatment Plants

a. DAVCO, Davis Industries, Inc.
1828 Metcalf Avenue
Thomasville, Georgia

b. Sanitaire, via Moss/Kelley, Inc.
10100 West Sample Road
Coral Springs, Florida

(2) Blowers

a. Hoffman, via Jacobs Group
160 Scarlet Blvd.
Oldsmar, Florida 34677

b. Sutorbilt, via Jacobs Group
160 Scarlet Blvd.
Oldsmar, Florida 34677

(3) Wastewater Treatment Filters

a. DAVCO, Davis Industries, Inc.
1828 Metcalf Avenue
Thomasville, Georgia

b. Infilco-Degremont, via Moss/Kelley, Inc.
10100 West Sample Road
Coral Springs, Florida

(4) Chlorination Feed Systems

a. Capital Control, via Blankenship & Associates
3004 Konarwood Court
Oviedo, Florida

b. Wallace & Tiernan, via Heyward, Inc.
1865 North Semoran Boulevard
Winter Park, Florida

(5) Standby Generator Sets

a. Ringhaver Equipment Company
9901 Ringhaver Drive
Orlando, Florida 32824

b. Cummins Southeastern Power, Inc.
4820 North Orange Blossom Trail
Orlando, Florida 32810

(6) Ground Storage Tanks (Steel and Prestressed Concrete)

a. The Crom Corporation, Prestressed Composite Tanks
250 S.W. 36th Terrace
Gainesville, Florida

b. PRECON Corporation, Prestressed Concrete Tanks
115 S.W. 140th Terrace
Newberry, Florida

c. Florida Aquastore, Water & Wastewater Technologies
2650 North Military Trail
Boca Raton, Florida

(7) High Service Pumps

a. Worthington, via Barney's Pumps, Inc.
3907 Highway 98 South
Lakeland, Florida

b. Peerless Pump Company
811 North 50th Street
Tampa, Florida

(8) Hydropneumatic Tanks

a. Hydro-Air Systems, Inc.
P.O. Box 585654
Orlando, Florida

b. Modern Welding Company, Inc.
1801 Atlanta Avenue
Orlando, Florida

(9) Vertical Turbine Pumps

a. Peerless Pump Company
811 50th Street North
Tampa, Florida

b. Peabody-Floway, via Flanagan-Metcalf & Associates, Inc.
6708 Benjamer Road
Tampa, Florida

(10) Sewage Pump Stations (Precast items and Pumps)

a. Taylor Precast
P.O. Box 369
Deland, Florida 32721

b. Gorman Rupp Pumps, via Blankenship & associates
3004 Konarwood Court
Oviedo, Florida

c. Flygt Pumps, via Ellis K. Phelps & Company
2152 Sprint Boulevard
Apopka, Florida

(11) PVC and Ductile Iron Piping

a. B&H Sales, Inc.
11114 Satellite Boulevard
Orlando, Florida
PVC force main, water main, and gravity sewer.

b. CertainTeed
750 T.E. Suedesford Road
Valley Forge, PA., 19482
PVC force main, water main, and gravity sewer.

c. American Cast Iron Pipe Company
2301 Maitland Center Parkway
Maitland, Florida
DIP force main, water main, and gravity sewer.

d. Mitchell & Stark Construction Co., Inc.
Naples, Florida
Pipe pressure test, T.V. test, and disinfection.

2.2.4 Bid Tabulations

As a final source of information, bid tabulations from existing projects were gathered. The projects used in this analysis are all located in the State of Florida. The actual bids were obtained using "The Bid Reporter," which prints monthly Florida listings of projects to be constructed. Further information was obtained through the Hartman & Associates, Inc. project cost database. The HAI database contains bid tabulations, schedule of values and summary of work for numerous utility projects. Both sources contain project data for approximately the past five (5) to ten (10) years. Therefore, the prices, which are updated using the ENR construction costs index, present current indices of the cost of water and wastewater system components.

2.3 CURVE DESIGN SUMMARY

This section provides a detailed description of the method used to create the final unit cost curves for water and wastewater treatment systems. For water, curves are provided for the components of the collection, treatment, and distribution systems. The collection, treatment and disposal components were studied for wastewater systems.

2.3.1 Updating Process

The various sources of data utilized in this study, provided cost information at different time periods over the previous 25 years. In order for these values to be comparable, they were indexed. In other words, the costs must be updated to the time of this study, which is June, 1995. The costs are updated using established cost indexes. The two (2) indexes used during this study are the Engineering News Record (ENR) and The Handy-Whitman Index of Public Utility Construction Costs. In order to update the costs, original costs were multiplied by the ratio of the June, 1995 index number to the original index number. This cost updating method is shown below.

$$\text{June 1995 Cost} = \text{Original Cost} * \frac{\text{(June 1995 Index)}}{\text{(Original Index)}}$$

2.3.2 Design Considerations

To construct reliable cost curves, more than one (1) set of values were used for each component. However, these values are not comparable unless they involved the same design considerations. Therefore, the manufacturers and sales representatives were given the same criteria with which to evaluate the cost. Also, when the manufacturer's values were used in combination with the Environmental Protection Agency or Culp/Wesner/Culp curves, the manufacturer's values were adjusted to include the identical components as found in the source curves.

Some of the commonly added costs were electrical, piping, sitework, and installation. These components were adjusted by percentage on a case-by-case basis to reflect the different needs of the various components.

2.3.3 Finalization

Once the cost data was normalized, the values were compared and plotted. By plotting the values, the relationships of the cost values versus capacity are illustrated. So for a construction cost curve, which is the total cost for installation, the economy of scale is difficult to visualize. In order to see the economy of scale clearly, the cost curves were transformed into unit cost curves. These curves display the cost per unit on the y-axis and the capacity or other size measurement on the y-axis. For example, the unit cost curve involves cost in dollars per gallon ($/gal) versus gallon capacity for such components as: treatment plants, storage facilities, chlorine feed facilities, hydropneumatic tanks, water supply wells, etc. Other unit cost curve components are a follows:

- dollars per gpm ($/gpm) for pumps and pump stations
- dollars per lot ($/lot) for gravity sewers
- dollars per foot ($/Ft) for force and water mains
- dollars per scfm ($/scfm) for blowers

In this format, the graphs show that cost per unit capacity decreases with increased capacity.

SECTION 3

SECTION 3
ANALYSIS

3.1 THRESHOLD SIZING

This section discusses the reasons behind the design of water and wastewater systems with respect to sizing. The factors affecting the size of certain treatment systems are cost, regulations, and the health and safety of those served. There are plant capacities which are established minimums.

3.1.1 Inflection Points

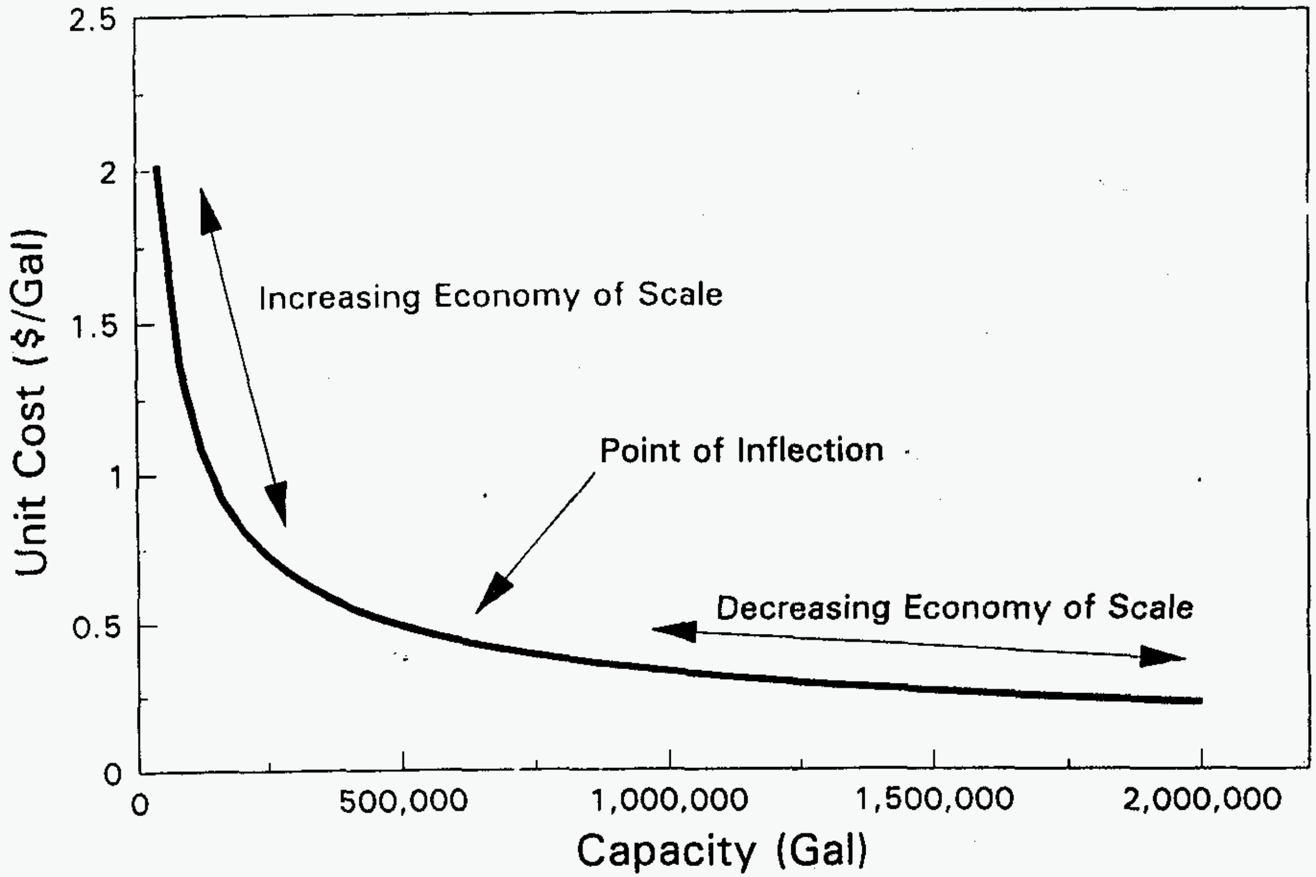
In the water and wastewater unit cost curves of this study, the economy of scale was apparent in all cases. However, the manner in which the economy of scale is displayed differs between two styles of graphical representation.

The first case, displayed in Figure 3-1, is best represented by the prestressed ground storage tank unit cost curve. The curve is basically an exponential type curve where the low capacity yields an extremely high unit cost and the high capacity has leveled out with a much lower unit cost. The beginning of the curve displays an increasing economy of scale. In other words, at the smaller capacities, the economy of scale is very large with each increase in capacity. The change in unit cost in this range is so significant that it makes it generally undesirable to design in this range to the left of the point of inflection. The point of inflection occurs when the slope of the curve begins to level out with respect to the X-axis. This is the point where the component design becomes economically feasible with respect to smaller and larger capacity options. Following the point of inflection, the economy of scale begins to decrease. Even though the economy of scale still exists in this range, the unit cost change between sizes is much less. However, the savings between capacities in this area of the curve remain very significant. This is a section of the curve where capacity options are not as obvious and the monetary savings should be balanced together with other factors.

The other type of unit cost curve, Figure 3-2, is well represented by the potable water well curve. In this curve, the unit cost appears to steadily decline with respect to the capacity plotted on the X-axis. The relationship, however, is identical to that of Figure 3-1. The differing factor is that

Ground Storage Tanks

Prestressed Concrete



Notes: 1) Costs include complete tank, concrete floor, prestressed wall, free-span concrete dome, aluminum interior and exterior ladders, vents, precast overflows, painting, and installation. These costs were obtained directly from manufacturers' quotes.

2) Includes 5% piping, 0% electrical, and 5% sitework.

3) Costs are based on the June 1995, ENR Index = 5433.

FIGURE 3-1

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, surveyors & management consultants

201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801
TELEPHONE (407) 839-3955 - FAX (407) 839-3790

INCREASING AND DECREASING ECONOMIES OF SCALE

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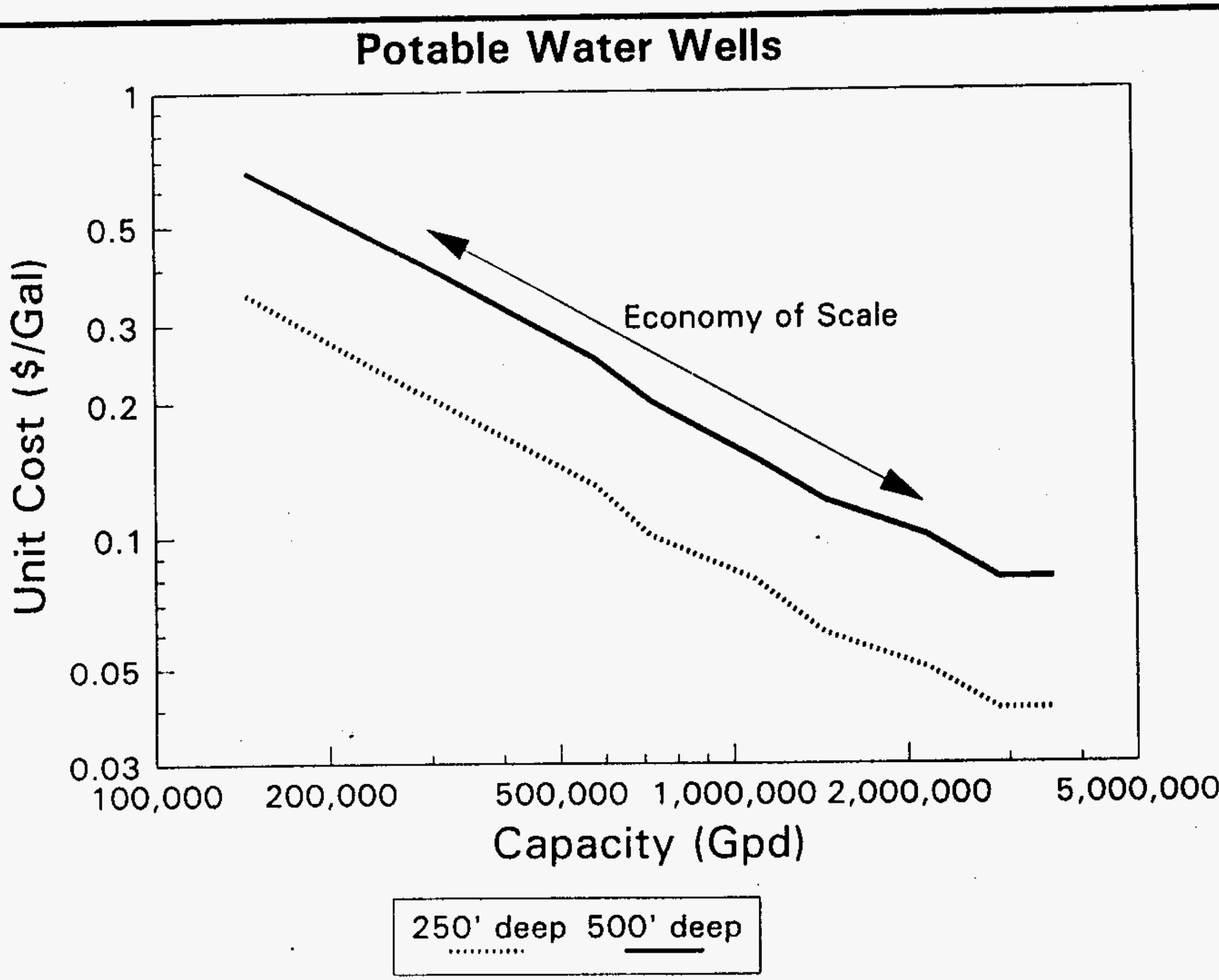
PAGE 26 OF 264



Notes: 1) Vertical turbine pump, cement grout, black steel well and surface casing, well screen, and well development costs from manufacturers' quotes and bid tabulations.
2) Includes 10% electrical, 15% well head, and 30% labor.
3) Costs are based on the June 1995, ENR Index = 5433.

FIGURE 3-2

HARTMAN & ASSOCIATES, INC.
engineers, hydrogeologists, surveyors & management consultants
201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801
TELEPHONE (407) 839-3955 - FAX (407) 839-3790

ECONOMY OF SCALE ON LOGARITHMIC AXES

the values in this curve are plotted on a logarithmic scale, due to the large capacity range. This unit cost curve presents the same economy of scale relationship as Figure 3-1 when plotted on a linear scale; however, determining individual values from the linear plots is more difficult. Therefore, to facilitate use of the graph, the data was plotted on a log-log axis.

3.1.2 Economic Minimum Threshold Sizes

The economic minimum threshold sizes were determined mathematically. The second derivatives of the unit cost curve equations were plotted to determine the domain value at which the rate of change of the slope of the unit cost curve equals zero, or no change. The majority of curves were modeled using third order or higher polynomials. The solution of the second derivative is valid for the range considered and produces an inflection point. An example of the polynomial equation and the derivatives are as follows:

Polynomial equation:	$f(x)$	=	$a_1 + a_2 x + a_3 x^2 + a_4 x^3 + a_5 x^4$
First derivative:	$f'(x)$	=	$a_2 + 2a_3 x + 3a_4 x^2 + 4a_5 x^3$
Second derivative:	$f''(x)$	=	$2a_3 + 6a_4 x + 12a_5 x^2$

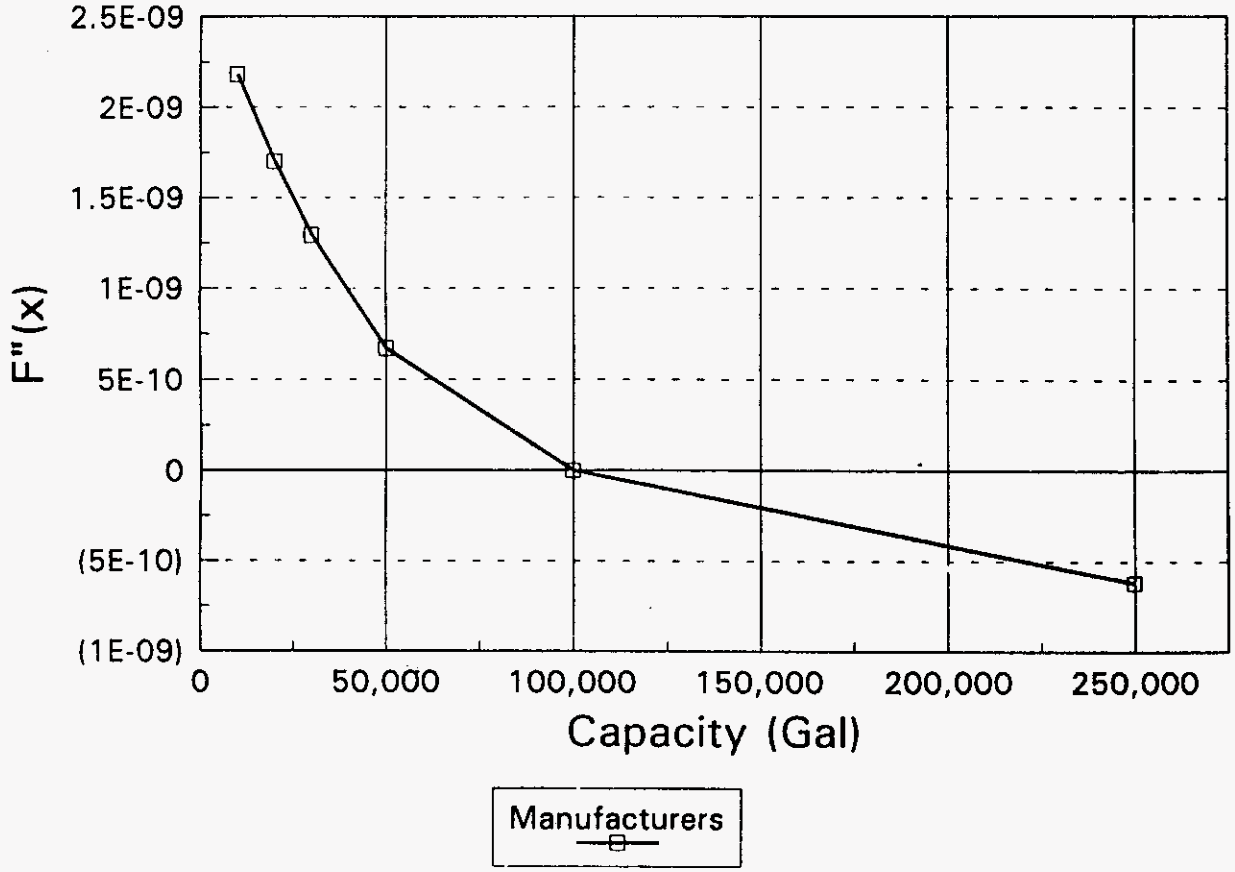
Some cost curves were modeled using power functions in which a plot of the second derivative does not cross the X-axis. The plot however is more pronounced and clearly indicates the inflection point. An example of the power function equation and its applicable derivatives are as follows

Power equation:	$f(x)$	=	$a_1 x^{b1}$
First derivative:	$f'(x$	=	$(b_1)(a_1) x^{b1-1}$
Second derivative:	$f''(x)$	=	$(a_1 b_1)(b_1-1) x^{b1-2}$

As an example, Figure 3-3 is a plot of the second derivative of the function for steel ground storage tanks. The plot crosses the X-axis at 100,000 gallons which indicates that the inflection point for rate of change of the unit cost occurs at 100,000 gallons. This point establishes the end of the domain for increasing economy of scale.

Ground Storage Tanks

Steel



Notes: 1) Polynomial equation for the Steel GST's unit cost curve is the following: $f(x) = 3.565 + (-9.337E\text{-}5)X + (1.3717E\text{-}9)X^2 + (-1.0034E\text{-}14)X^3 + (3.5115E\text{-}20)X^4 + (-4.6878E\text{-}26)X^5$

2) The second derivitive of the Steel GST unit cost polynomial is as follows: $f''(x) = 2.743E\text{-}9 + (-6.02E\text{-}14)X + (42.138E\text{-}20)X^2 + (-93.756E\text{-}26)X^3$

FIGURE 3-3	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	STEEL GST INFLECTION POINT

PAGE 21 OF 26

EXHIBIT

3.13 Curve Fitting

The curves determined to represent the manufacturers' and EPA cost curve data were generated with the use of either the Sigma Plot program by ©Jardel Scientific or the Hydrology and Water Quality Control course accompanied programs produced by ©John Wiley & Sons. The Sigma Plot program was used mainly to determine polynomial fits for the data, while the other program determined the equations for the data better represented by the power function equation. In all cases, the equations were determined to be the best fit for the given data.

3.1.4 Regulatory

For most instances, regulations do not affect the sizing of water and wastewater systems. Usually, the type of disposal or source of supply determine the stipulations on the plant type or size. However, there are occurrences where size regulates cost. The water supply wells must be double (one standby) above 150 connections, and over 150 connections necessitates an Auxiliary Power Supply.

SECTION 4

SECTION 4
WASTEWATER TREATMENT PLANT FACILITIES

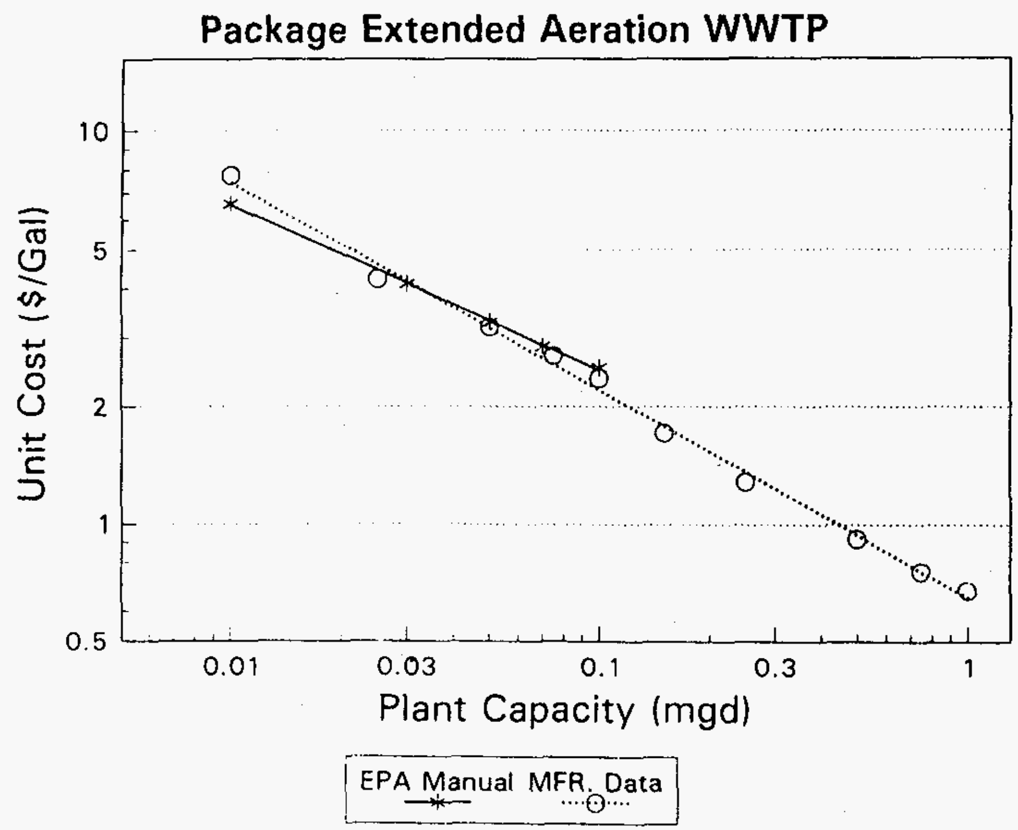
4.1 EXTENDED AERATION PACKAGE WWTP

The extended aeration treatment process is a version of the activated sludge process in which the detention time is approximately 24 hours. The extended detention time will require a larger volume than most activated sludge processes, which in turn will raise the costs. The costs do; however, display an economy of scale over the entire range of capacities. The unit cost of the extended aeration package plants, Figure 4-1, is a display of dollars per gallon of capacity versus gallon per day capacity. In this form, the economy of scale will be visible if the unit cost decreases as the capacity increases.

The unit cost curve of the package extended aeration plant shows a considerable economy of scale from the 0.01 MGD to the 1.0 MGD limits of the graph. The unit cost steadily decreases in a straight line from approximately $7/gallon at 0.01 MGD to $0.7/gallon at 1.0 MGD. The straight line relationship of the unit cost translates into considerable savings with increased sizing.

The curves in Figure 4-2 represent the construction cost as a function of package extended aeration treatment plant capacity. By examining the costs as they are related to capacity, the economy is apparent. For instance, the cost of a 500,000 gallon per day package plant is approximately $465,000, and the cost of a 1,000,000 gallon per day package plant is approximately $710,000. Therefore, in order to expand a 500,000 gallon per day facility to a 1,000,000 gallon per day plant, the cost would be approximately $930,000. The design of the 1.0 MGD plant originally would have saved approximately $220,000 overall. The savings would be greater if contractor mobilization, engineering, and permitting costs were considered.

The unit cost and construction cost curves were developed using an Environmental Protection Agency cost curve and manufacturers' quotations. The quotes from the manufacturers included the tankage (ring steel with internal clarifier), concrete slabs, sitework, electrical, piping, blowers and installation. To normalize these quotes with the EPA curve, a chlorination feed system cost had to be added to the overall cost. The chlorination feed system cost was obtained through other manufacturers' quotations. From this point, the two (2) curves are equivalent and can be compared.



Notes: 1) Costs include materials, electrical, piping, blowers, grading, installation, chlorination feed system, and conc. slab.
2) Costs exclude land, engineering, fencing, paving, drainage lighting, and building facilities.
3) All costs obtained from manufacturers' quotes and EPA cost curve
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-1	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	**EXTENDED AERATION UNIT COST CURVE**

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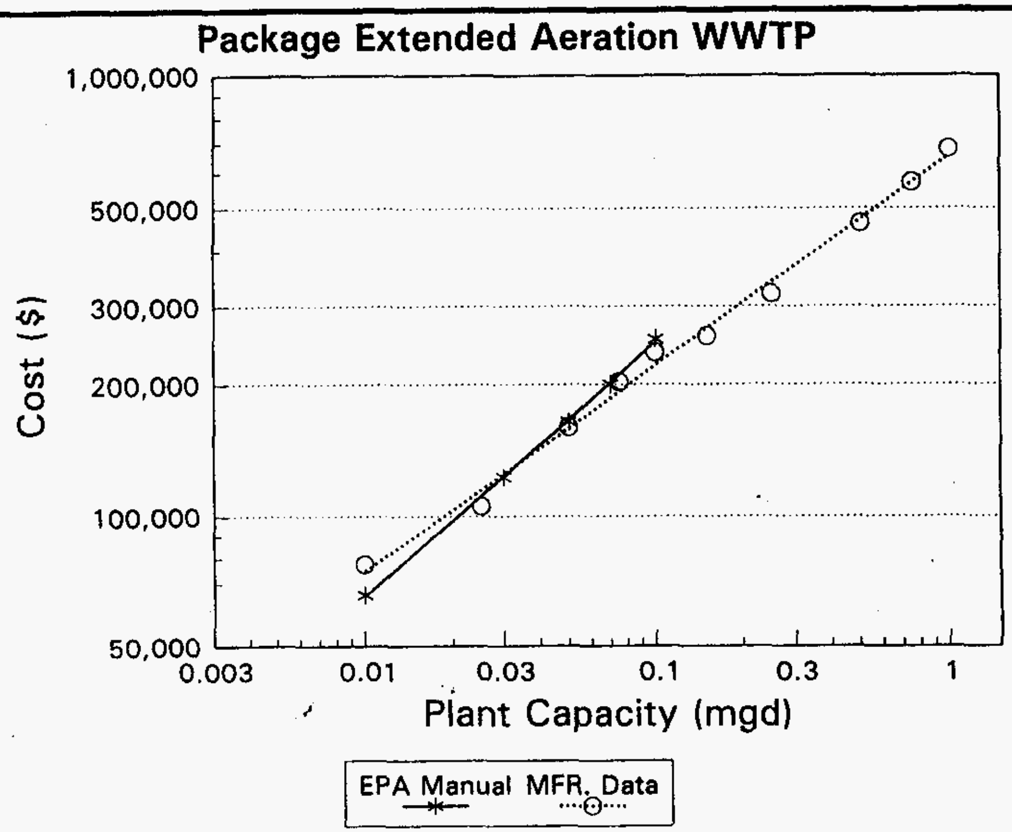


Notes: 1) Costs include materials, electrical, piping, blowers, grading, installation, chlorination feed system, and conc. slab.

2) Costs exclude land, engineering, fencing, paving, drainage, lighting, and building facilities.

3) All costs obtained from manufacturers' quotes and EPA cost curves.

4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-2	**HARTMAN & ASSOCIATES, INC.** engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	**EXTENDED AERATION CONSTRUCTION COST CURVE**

The extended aeration package treatment plant costs exclude the costs of land, engineering, paving, grading, drainage, lighting, fencing, and building facilities.

4.2 CONTACT STABILIZATION PACKAGE WWTP

The contact stabilization is a version of the activated sludge process that requires an average detention time of between 4 and 6 hours. When compared with the extended aeration process, the contact stabilization package plant will require less volume due to the considerable difference in detention time. Even though the overall cost differs, the economies of scale are still very evident in the contact stabilization package treatment plants. These costs versus capacity relationships are displayed on Figures 4-3 and 4-4, which are the unit cost and construction cost curves, receptively.

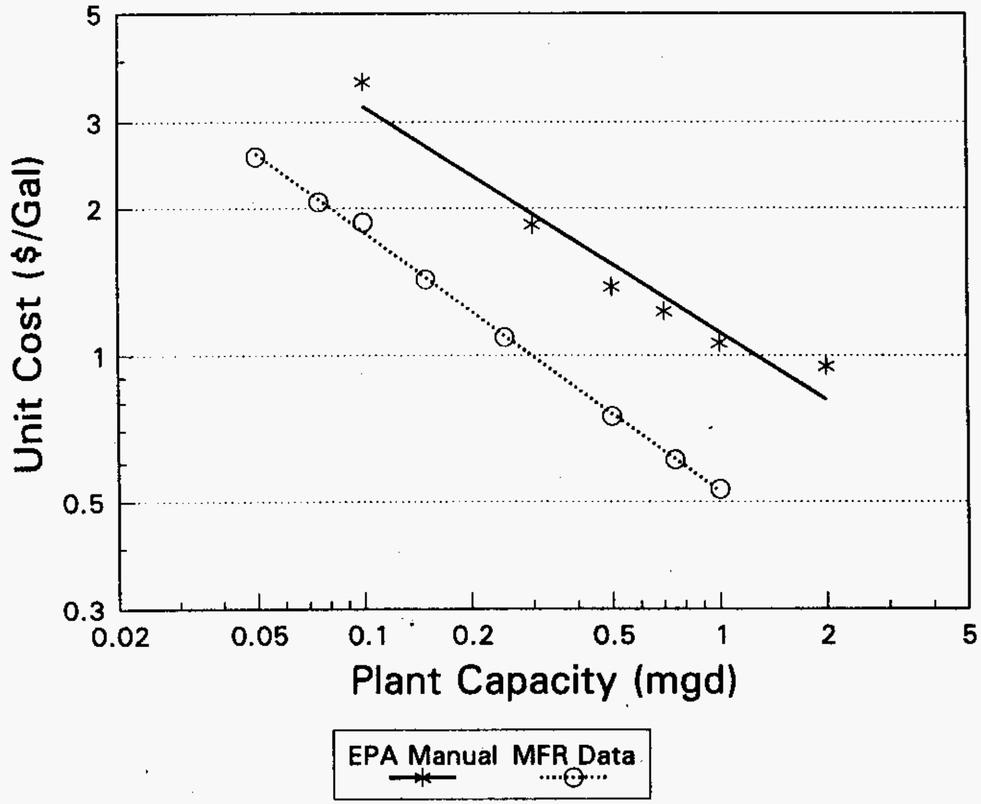
The unit cost curve, Figure 4-3, is a presentation of the relationship between the unit cost, dollars per gallon versus the capacity, gallons per day. From 0.05 MGD, the unit cost curve shows a solid economy of scale. Even though the values of the Environmental Protection Agency and the manufacturers are not identical, their relationship is identical. They both show a very similar economy of scale relationship that stretches from a little over $3/gallon to approximately $0.5/gallon.

The straight line decreasing aspect of the curve translates into considerable savings with the increase in design capacity. This relationship is further solidified when the capacities and unit costs are plotted on linear axes.

In Figure 4-4, the considerable savings in the sizing of package contact stabilization plants is noticeable. For instance, using the manufacturers' cost values, the cost to construct a 500,000 gallon per day contact stabilization plant would be approximately $375,000. On the other hand, the cost to build a 1,000,000 gallon per day treatment plant would be about $525,000. Therefore, the cost to build the smaller 500,000 gallon plant and then expand it by another 500,000 gallons would be $750,000. By comparing this cost to the $525,000 cost for the larger plant, a savings of $225,000 is realized for the addition of 500,000 gallons of capacity. This same trend is also represented by the EPA cost curve.

The unit cost and construction cost curves were created using values obtained from the Environmental Protection Agency and manufacturers' quotations. The manufacturers' costs

Package Contact Stabilization WWTP



Notes:
1) Costs include materials, electrical, piping, blowers, grading, installation, chlorination feed system, and conc. slab.
2) Costs exclude land, engineering, fencing, paving, drainage, lighting, and building facilities.
3) All costs obtained from manufacturers' quotes and EPA cost curves.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-3

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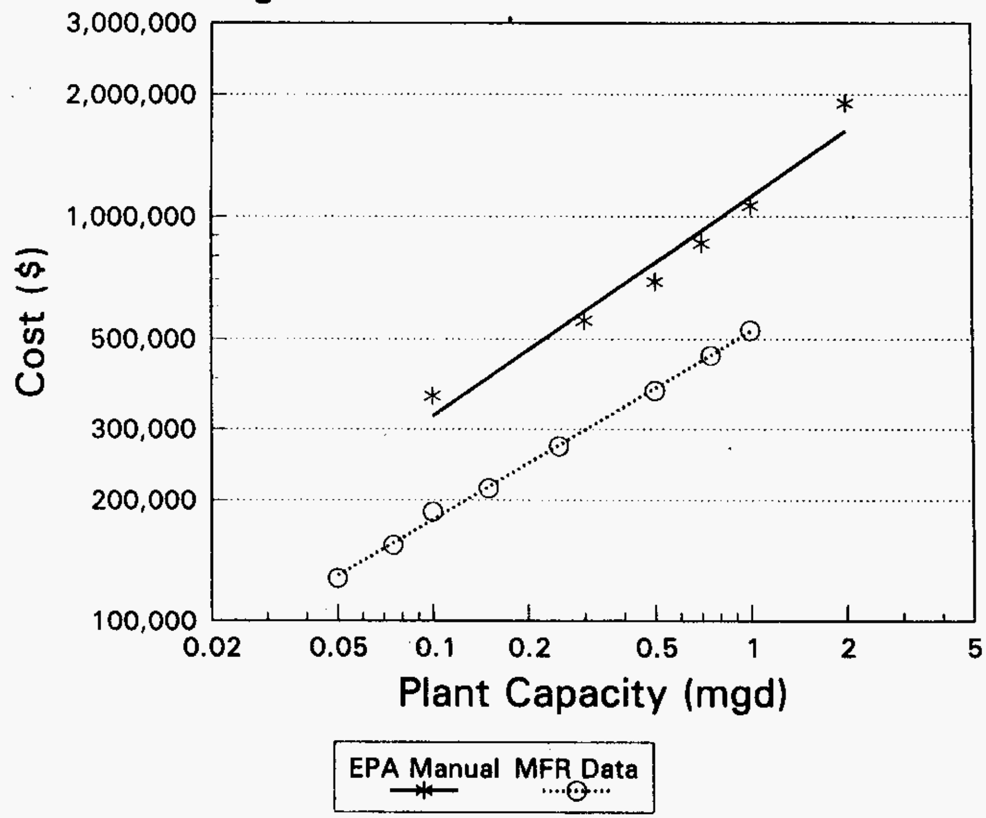
CONTACT STABILIZATION UNIT COST CURVE

Package Contact Stabilization WWTP



Notes: 1) Costs include materials, electrical, piping, blowers, grading, installation, chlorination feed system, and conc. slab.
2) Costs exclude land, engineering, fencing, paving, drainage, lighting, and building facilities.
3) All costs obtained from manufacturers' quotes and EPA cost curves.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-4	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants	CONTACT STABILIZATION CONSTRUCTION COST CURVE

EXHIBIT
PAGE 37 OF 284

included the plant itself, concrete slabs, site work, electrical, piping, blowers, and installation. In order to be able to compare these values with the EPA cost curve, a chlorination feed system was added using other manufacturers' quotations.

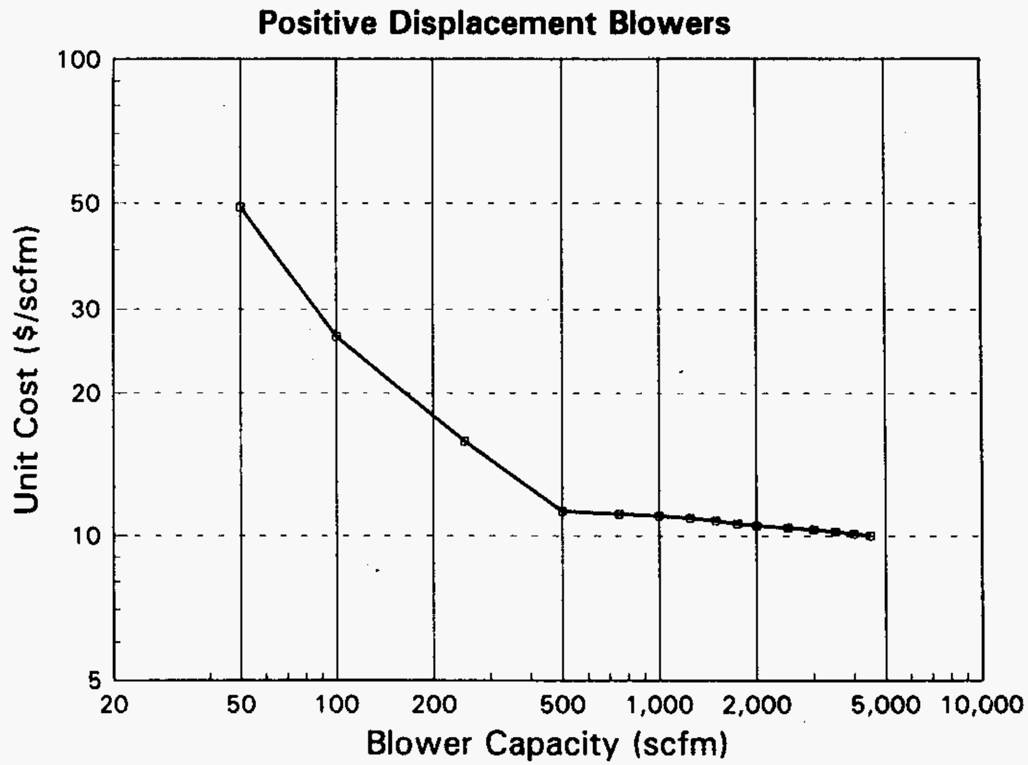
The package contact stabilization treatment plants costs exclude land, engineering, paving, grading, drainage, lighting, fencing, and building facilities.

4.3 BLOWERS

Blowers have an important role in supplying air to different parts of a treatment plant for process purposes and for airlifts in smaller facilities. Two common types of blowers used in the diffused air systems are centrifugal and positive displacement blowers.

The positive displacement blowers are more common in the lower standard cubic foot per minute (scfm) range than their centrifugal counterparts. As shown in Figure 4-5, the unit costs of the positive displacement blowers show an increasing economy of scale up to about 500 scfm. At this point, the economy of scale is decreasing. So the point of inflection lies at 500 scfm. To illustrate the benefit of designing a blower at 500 scfm or larger, the blower cost curve, Figure 4-6, will be used. The 500 scfm positive displacement blower costs approximately $5,500 and a 100 scfm blower costs about $2,750. Therefore, if the 100 scfm blower will need to be expanded to 500 scfm, the overall cost will easily exceed the original cost of the 500 scfm blower. By expanding with a 400 scfm blower, the total cost of the two (2) blowers is approximately $7,750, which is about $2,250 more expensive than one (1) 500 scfm blower.

For the centrifugal blowers, the higher capacity installations are more common. The range of blowers that are presented in the unit cost curve, Figure 4-7, are between 500 scfm and 4,500 scfm. The curve experiences an increasing economy of scale between 500 scfm and 2,000 scfm, where the point of inflection lies. However, the economy of scale does not decrease at a very rapid rate thereafter. Therefore, considerable economies of scale are apparent throughout the entire range. For instance, by using Figure 4-8, the blower cost curve, the economies of scale are detectable. A 2,000 scfm blower costs about $22,000, and a 4,000 scfm blower costs approximately $34,000. Therefore, one (1) 4,000 scfm blower is approximately $10,000 less than two (2) 2,000 scfm blowers.



Notes: 1) All costs obtained from manufacturer's quotes.
2) Costs include blower, TEFC motor, steel base, silencers, relief valve, pressure gauge, and check valve.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-5

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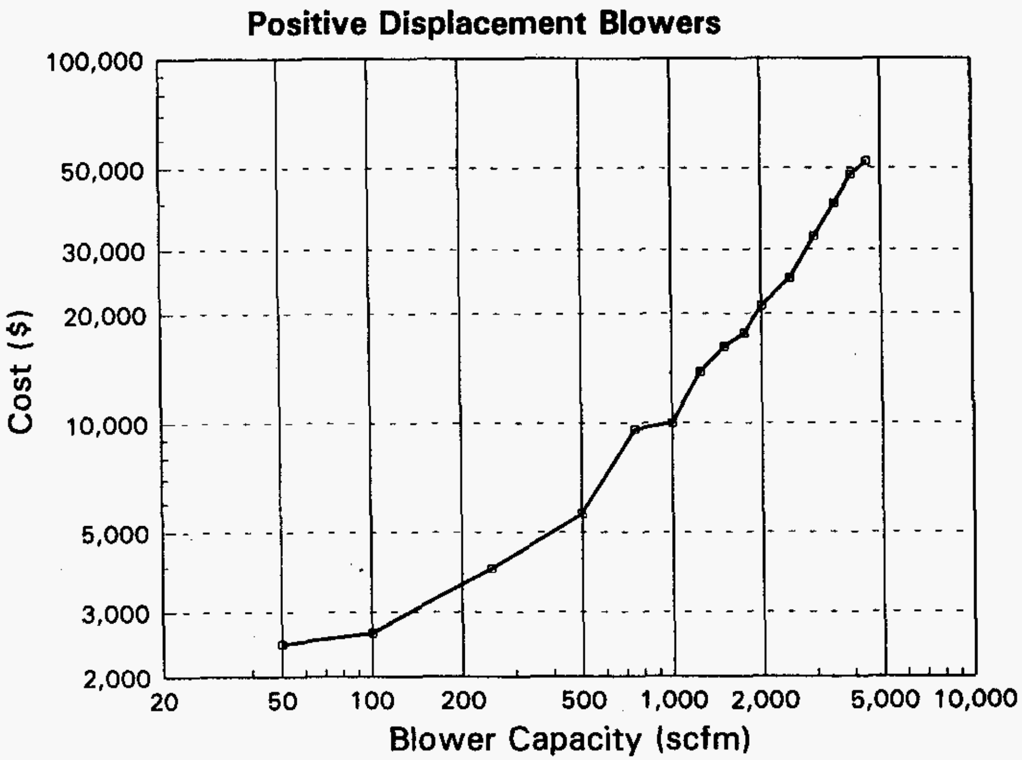
POSITIVE DISPLACEMENT BLOWER UNIT COST CURVE



Notes: 1) All costs obtained from manufacturer's quotes.
2) Costs include blower, TEFC motor, steel base, silencers, relief valve, pressure gauge, and check valve.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-6

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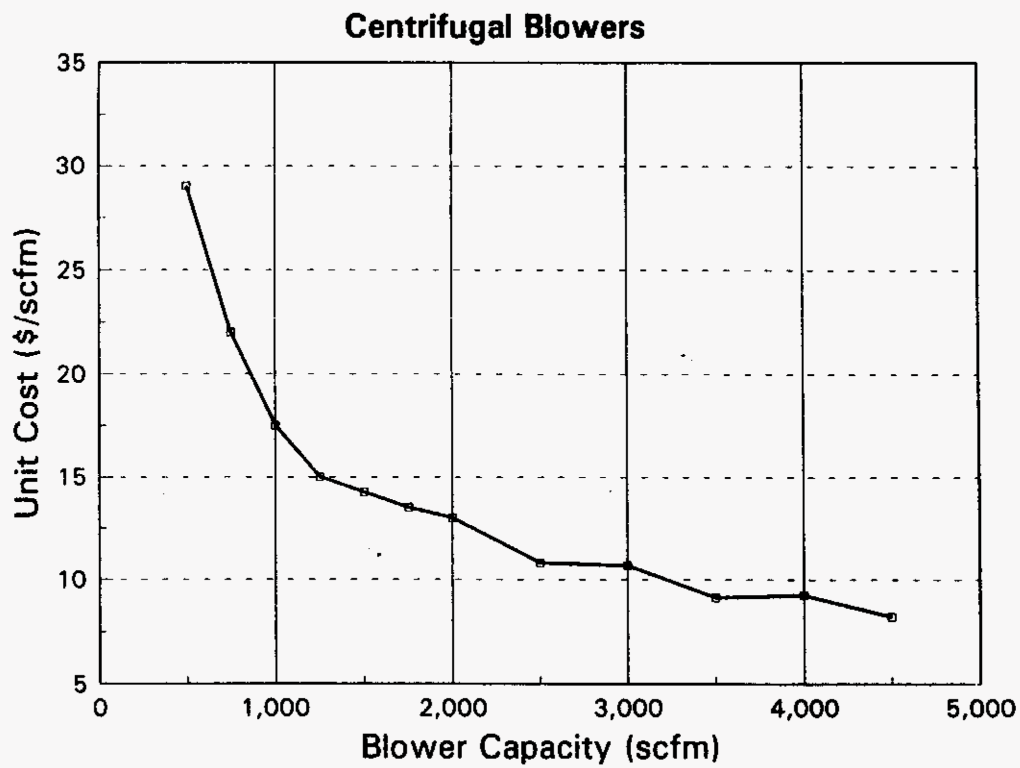
POSITIVE DISPLACEMENT BLOWER CONSTRUCTION COST CURVE

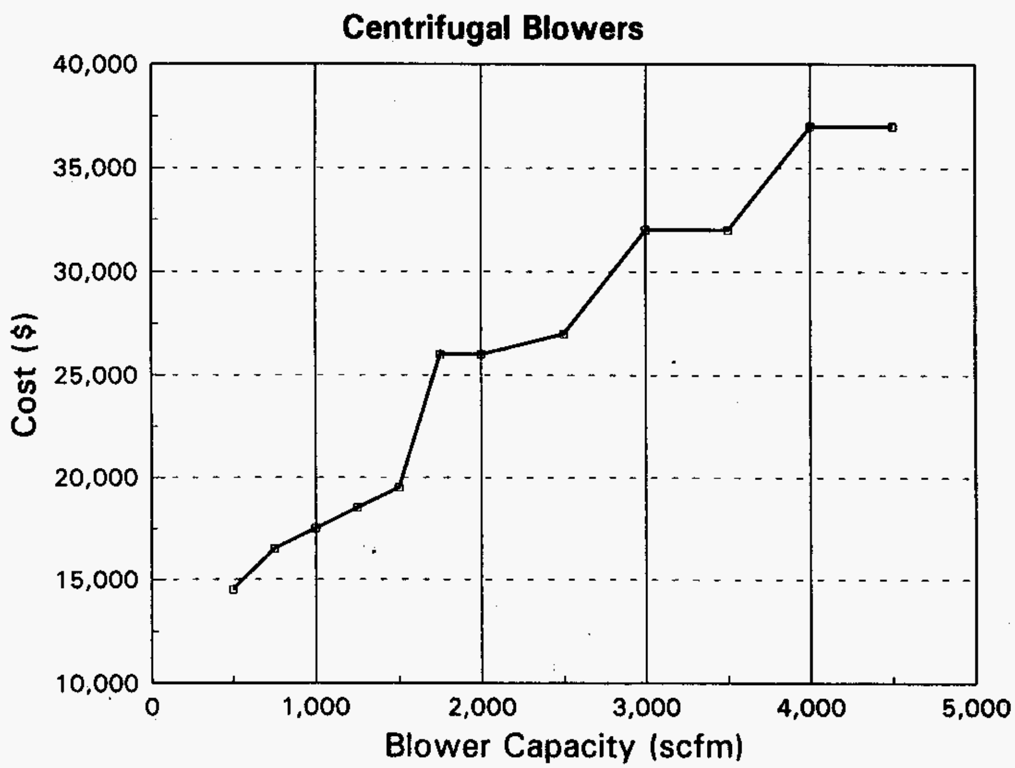
EXHIBIT ____ (JCH-4)
PAGE 40 OF 284



Notes: 1) All costs obtained from manufacturer's quotes.
2) Costs include a centrifugal blower and TEFC motor.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-7	HARTMAN & ASSOCIATES, INC.	CENTRIFUGAL BLOWER UNIT COST CURVE

PAGE 41 OF 284



Notes: 1) All costs obtained from manufacturer's quotes.
2) Costs include blower and TEFC motor.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-8

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CENTRIFUGAL BLOWER CONSTRUCTION
COST CURVE

The unit cost and blower cost curves were created using manufacturers' cost quotations. The positive displacement blower includes the blower, TEFC motor, steel base, silencers, relief valve, pressure gauge, and check valve. The centrifugal blowers include only the blower and TEFC motor.

4.4 FILTERS

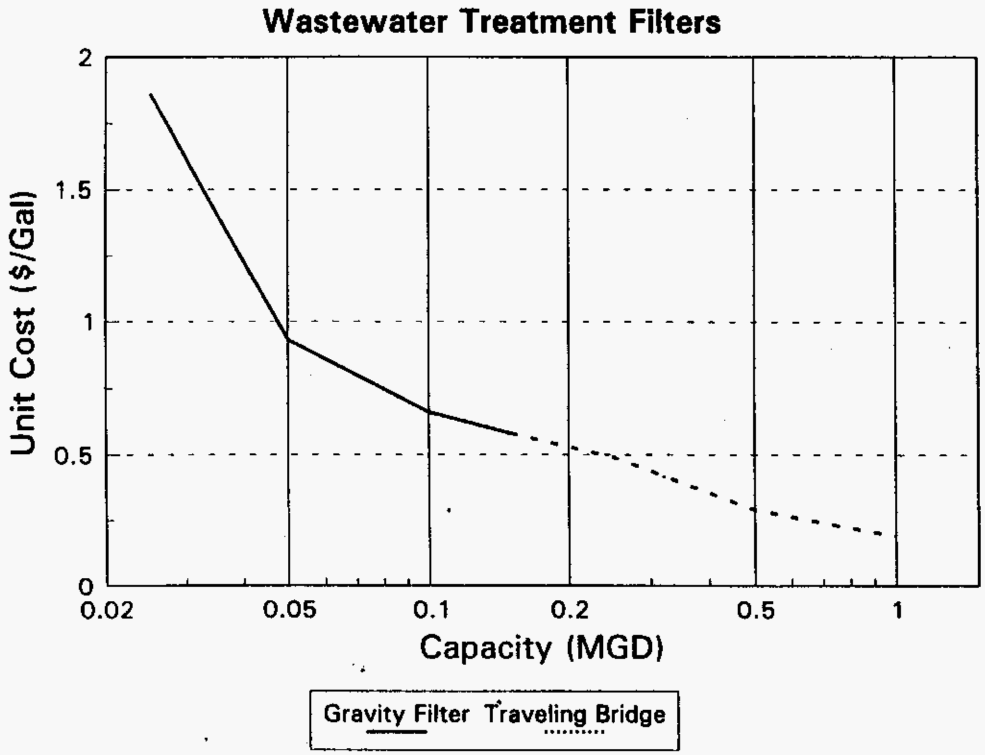
Filters are typically used for the tertiary treatment of wastewater. These filters help to remove the total suspended solids left in the effluent, and in so doing, allow the effluent to be available for reuse. The two (2) types of filters that were examined for this study were the standard gravity filter for flows less than 0.15 MGD, and traveling bridge filters for flows greater than 0.15 MGD.

The unit cost curve, Figure 4-9, shows the unit cost, dollars per gallon, versus the capacity of wastewater treated, in million gallons per day (MGD). From 0.05 MGD to 1.0 MGD, the gravity and traveling bridge filters experience a considerable economy of scale. The gravity and traveling bridge filter combination experiences a threshold at about 0.25 MGD. As can shown from Figure 4-10, the economic savings with increased capacity are substantial. For $50,000 a gravity filter will be of the capacity to treat 50,000 gallons per day and $85,000 a gravity filter with 150,000 gallon per day treatment capacity can be purchased.

The unit cost and construction cost curves for the wastewater treatment filters were constructed using quotations of costs from manufacturers. The costs included the filter, media, 15 percent for piping, 15 percent for electrical, 5 percent for sitework, 5 percent for the concrete slab, and 20 percent for installation. These percentages were applied to the material subtotal and summed to determine the total cost.

4.5 CHLORINATION

The chlorination of wastewater is commonly accomplished using gas chlorinators. The gas is fed to the chlorinators from 150 pound or 1 ton storage cylinders. The size of the storage cylinders is dependent on the quantity of wastewater to be treated. Typically, at a dosage of 10 milligrams per liter, the 150 pound, storage cylinders are used at treatment plant flows of up to 1 MGD. This means that the 1 ton cylinders are used for flows above this point. The costs of the feed system fluctuates with the size of the storage cylinders.



Notes: 1) Filter and media costs obtained from manufacturers' quotes.
2) Includes 15% piping, 15% electrical, 5% sitework, 20%installation, and 5% for the concrete slab.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-9

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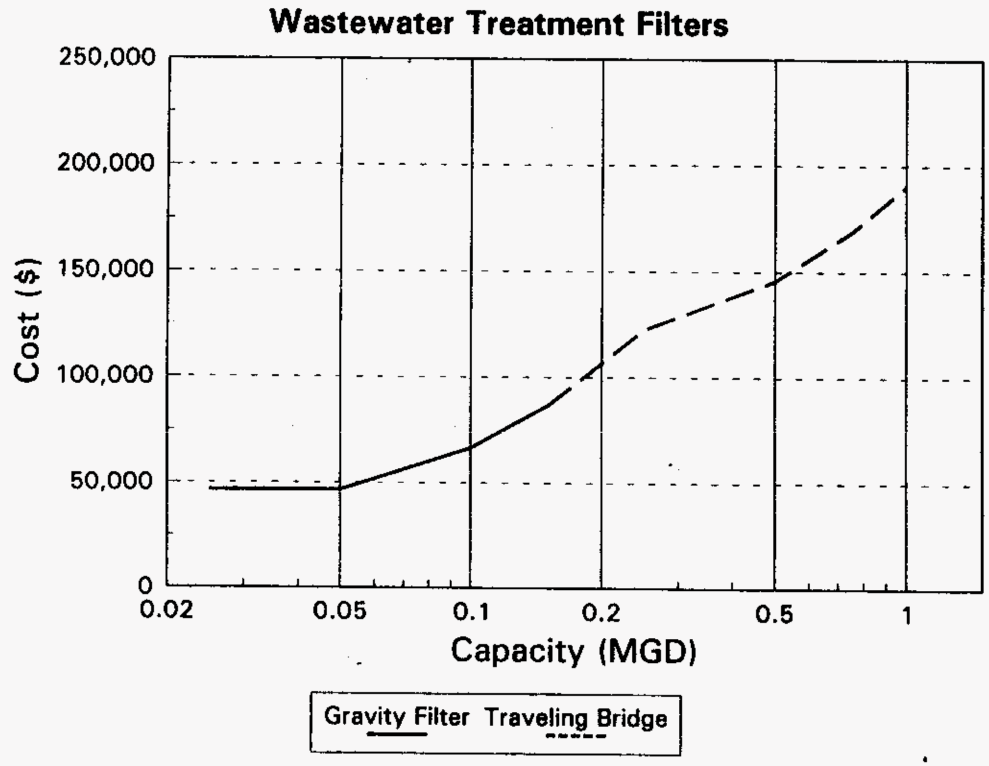
TERTIARY TREATMENT FILTER UNIT COST CURVE



Notes: 1) Filter and media costs obtained from manufacturers' quotes.
2) Includes 15% piping, 15% electrical, 5% sitework, 20% installation, and 5% for the concrete slab.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-10

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TERTIARY TREATMENT FILTER CONSTRUCTION COST CURVE

EXHIBIT ______ (5-04-4)

PAGE 45 OF 284

The unit cost curve, Figure 4-11, displays an economy of scale throughout the treatment capacities of 0.01 MGD to 5 MGD. This relationship is further emphasized when the components are plotted on linear axes. Where the storage cylinder sizes change, the costs slightly increase; however, the ton cylinder feed systems resume the continuous economy of scale. The overall cost, when compared with treatment plant cost, is a very low percentage. The larger capacity plants will have a much smaller unit cost for chlorine feed systems than the smaller capacity plants.

The chlorination feed equipment curve was constructed using manufacturers' quotations and EPA cost curves. Included in the cost of both size systems are dual chlorinators, dual scales, a gas detector, an alarm panel, a vacuum switch, booster pump, housing, hoists, 20% electrical, 15% piping, 20% installation, and no sitework.

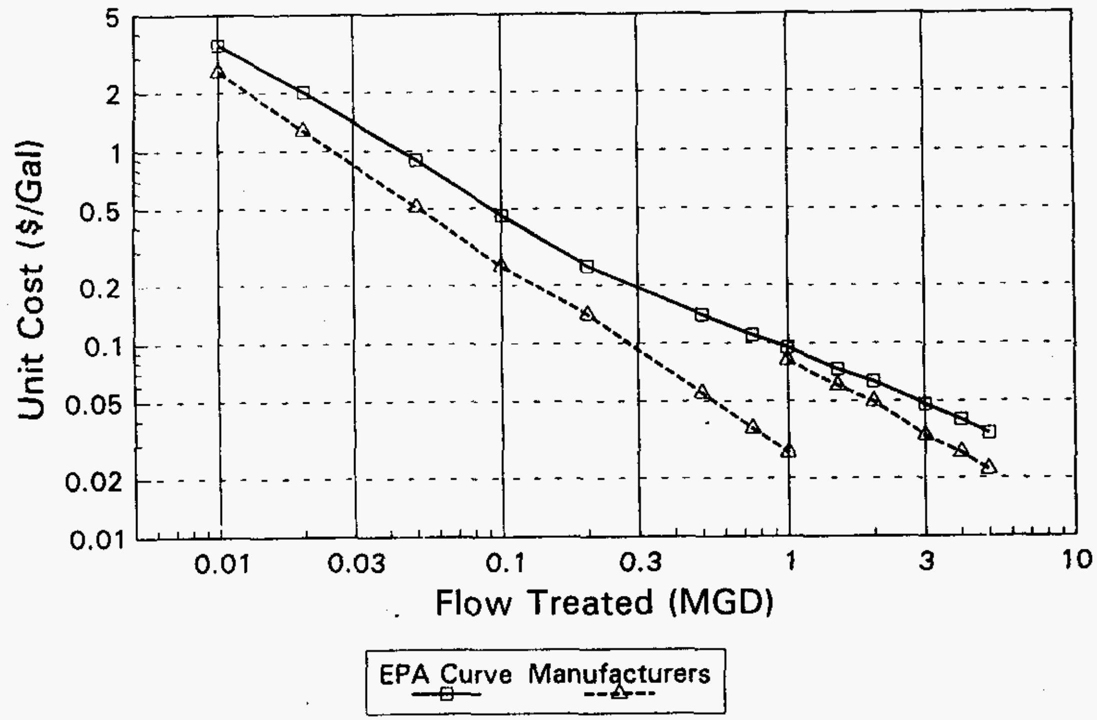
4.6 STANDBY GENERATOR SETS

The standby generator sets are used for emergency power situations for water and wastewater facilities. The generator packages studied for the economy of scale project consisted of a packaged diesel electric unit with base, control/monitoring panel, and a unit mounted radiator cooling system. The generator prices do not include cost adjustments for land, engineering, installation, fencing, building facilities, and design contingencies.

In general, the cost curves of Figure 4-12 and 4-13, present a significant economy of scale relationship. Although the relationship is not readily apparent in the construction cost curve, Figure 4-13, the unit cost curve shows a drastic change in unit prices with increase Kilowatt (kW) capacity. The unit prices begin with $1,088/KW at 8 KW capacity and reach values ranging between $124/KW and $153/KW between 300 KW and 1,500 KW capacities. This relationship places an importance on the overdesign of electrical equipment. The underdesign of a standby generator is both detrimental to public health and safety and costly to the customer.

The graphical presentations were formulated using manufacturers' quotations for the various standard sizes of standby generator packages.

Chlorine Feed Systems
Wastewater Treatment



Notes:
1) Gas chlorination unit with 10 mg/l feed rate at capacity.
2) Dual chlorinators w/ switchover, dual scales, gas detector, alarm panel, vacuum switch, booster pump, housing, and hoists all are included in the manufacturers' quotations.
3) Includes 20% electrical, 15% piping, and 20% installation costs.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 4-11

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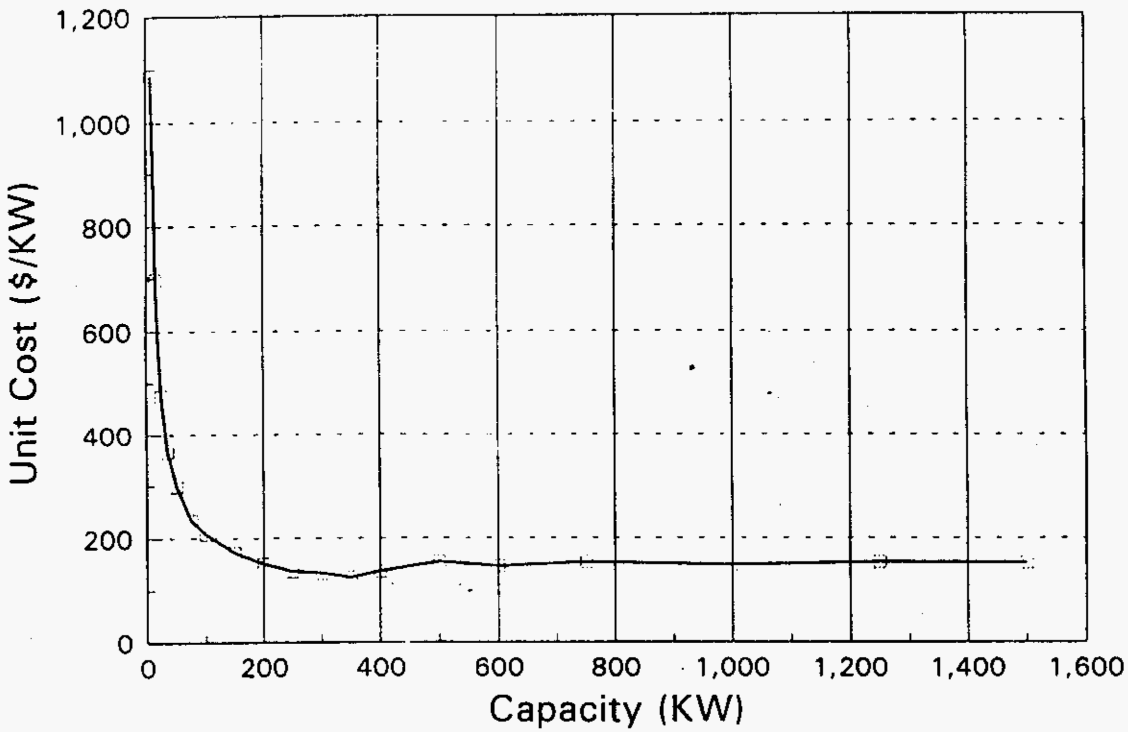
CHLORINE FEED SYSTEM UNIT COST CURVE

EXHIBIT (C-CH-4)
PAGE 47 OF 284

Standby Generator Sets

Diesel System

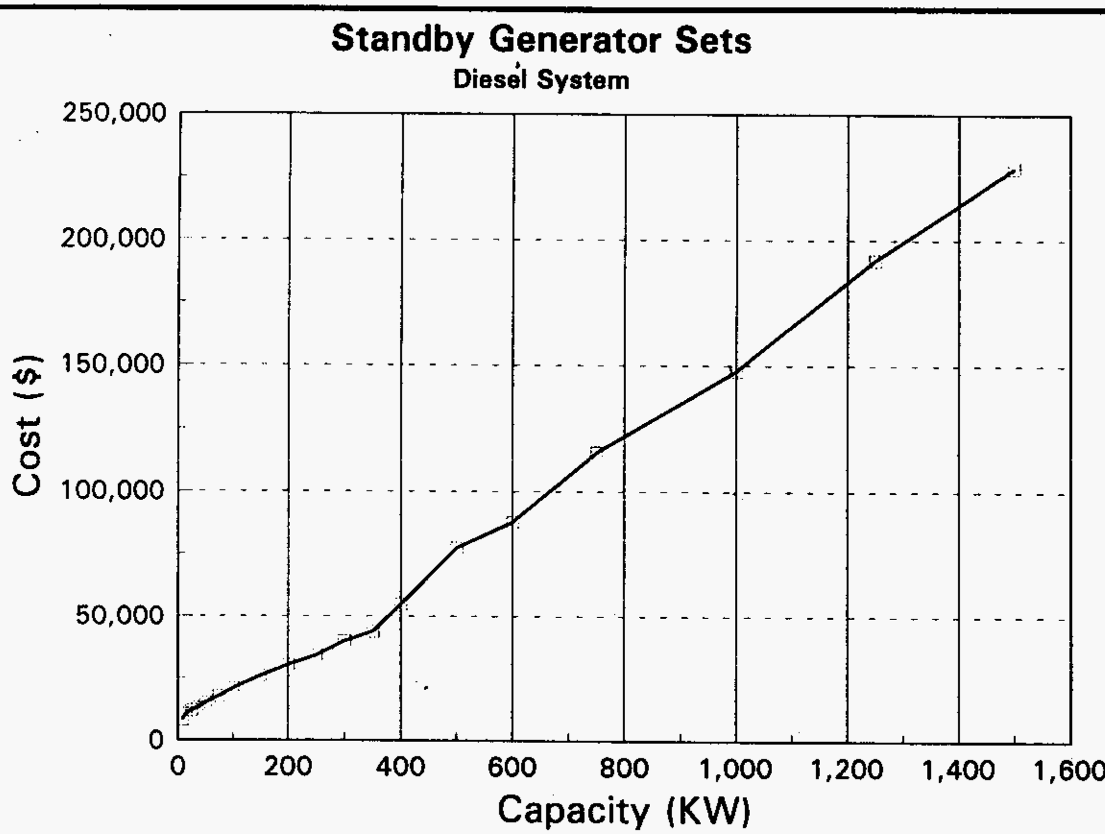


Notes:
1) Values obtained from manufacturer's quotations.
2) Costs include a packaged diesel electric set with base, a unit mounted radiator cooling system, and a control panel.
3) Costs are based on December 1995, ENR Index = 5471.

FIGURE 4-12	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	STANDBY GENERATOR UNIT COST CURVE

EXHIBIT ____ (SCH-4)

PAGE 48 OF 284



Notes: 1) Values obtained from manufacturer's quotations.
2) Costs include a packaged diesel electric set with base, a unit mounted radiator cooling system, and a control panel.
3) Costs are based on December 1995, ENR Index = 5471.

FIGURE 4-13

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STANDBY GENERATOR CONSTRUCTION COST CURVE

EXHIBIT (CCH-4)
PAGE 49 OF 284

SECTION 5

SECTION 5
WATER TREATMENT PLANT FACILITIES

5-1 PRESTRESSED CONCRETE GROUND STORAGE TANKS

In the State of Florida, prestressed concrete ground storage tanks are most often above-ground. The ground storage tanks typically store water before pumping to the distribution system. Also, the storage tank is usually fitted with an aeration unit on top of the tank which is for the removal of hydrogen sulfide. For this study, the ground storage tanks will be designed as above and will be represented by a unit cost curve and a construction cost curve.

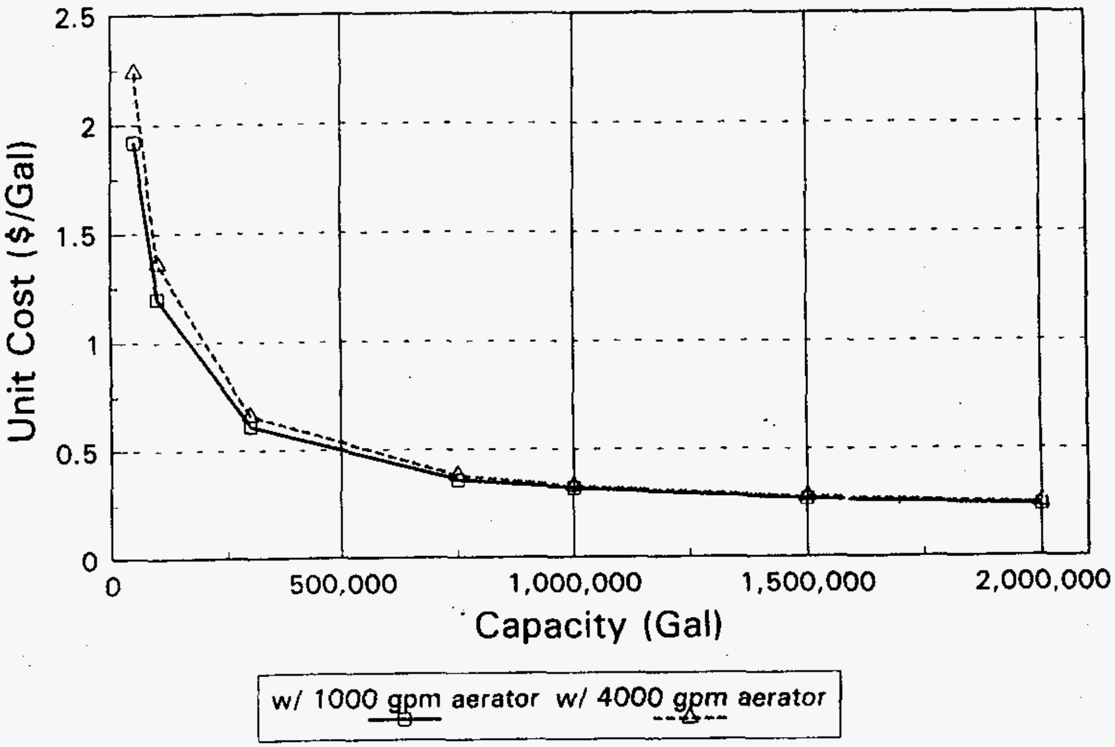
The unit cost curve, Figure 5-1, consists of a plot of the unit cost, dollars per gallon, of the ground storage tanks versus the capacity of the tank. The curve displays a strong economy of scale from the beginning to the end. The economy of scale is increasing between 50,000 gallons and 600,000 gallons. Therefore, if possible, the designer should avoid this area of the curve. The curve begins to flatten out and decrease after the inflection point, which lies at 600,000 gallons. Even though the economy of scale is decreasing up to 2,000,000 gallons, there still is a sizable cost savings between the two (2) design sizes.

To truly appreciate the continued savings even with the decreasing economy of scale, we must examine the construction cost curve, Figure 5-2. The cost to construct a 2,000,000 gallon facility is approximately $480,000, and the cost of a 1,000,000 gallon ground storage tank is about $320,000. Therefore, to build the 1 MG tank and then expand the storage capacity by 1,000,000 gallons, the total cost would be approximately $640,000. By designing for the future with the 2 MG prestressed concrete ground storage tank, the utility and customers would save $160,000 overall. As this shows, the savings are present in both increasing and decreasing states of economy of scale.

The unit cost and construction cost curves were produced from manufacturers' quotations. The prestressed concrete ground storage tanks include a concrete floor, prestressed wall, free-span concrete dome, aluminum interior and exterior ladders, vents, precast overflows, painting, an aeration unit, and installation. Then, 5% piping and 5% sitework costs were added to the total cost.

Ground Storage Tanks

Prestressed Concrete



Notes: 1) Prestressed concrete tank, concrete floor, prestressed wall, free-span concrete dome, aluminum interior and exterior ladders, vents, precast overflows, painting, aeration unit, and installation costs are included in the manufacturers' quotations.

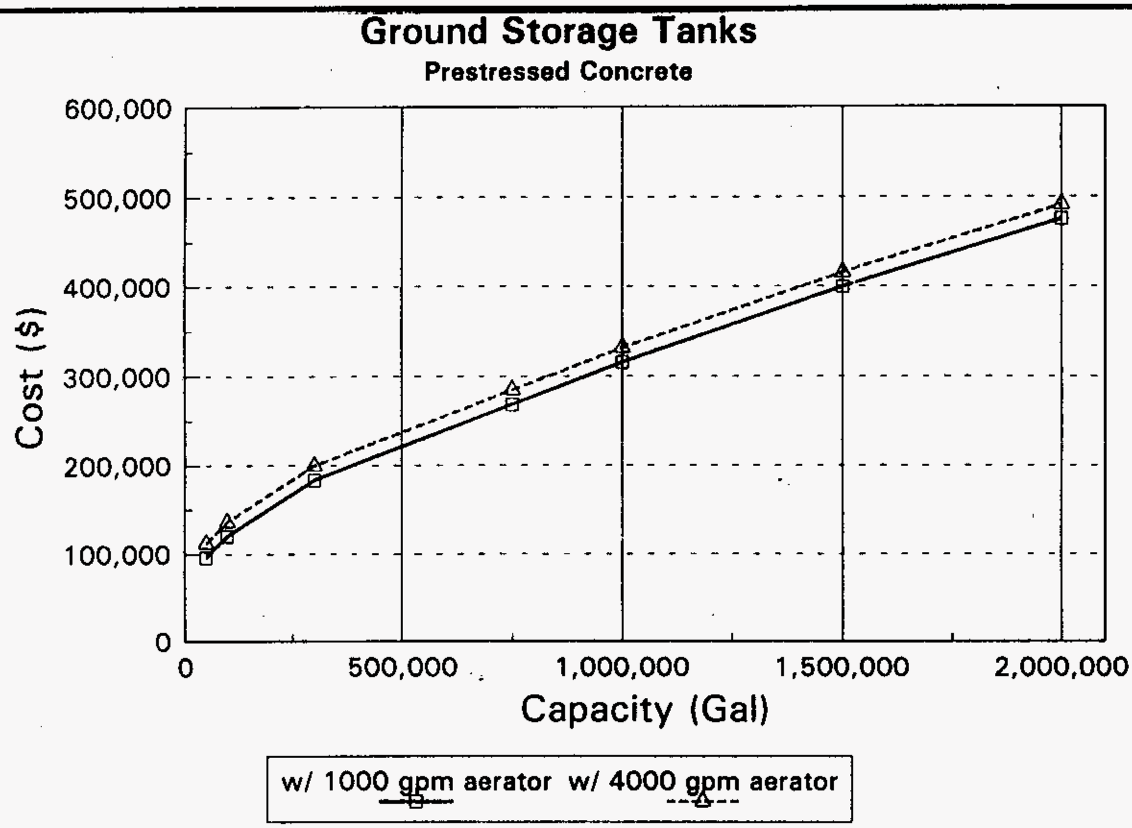
2) Includes 5% piping, 0% electrical, and 5% sitework costs.

3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-1	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	PRESTRESSED GST UNIT COST CURVE

EXHIBIT ___ (JCM-4)

PAGE 52 OF 284



Notes:
1) Prestressed concrete tank, concrete floor, prestressed wall, free-span concrete dome, aluminum interior and exterior ladders, vents, precast overflows, painting, aeration unit, and installation costs are included in the manufacturers' quotations.
2) Includes 5% piping, 0% electrical, and 5% sitework costs.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-2

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PRSTRESSED GST CONSTRUCTION
COST CURVE

5.2 STEEL GROUND STORAGE TANKS

Steel ground storage tanks are typically found in the smaller capacity range (10,000 gallon to 250,000 gallon). In this size range they are able to compete with the prestressed concrete ground storage tanks. The installations of the steel tanks in Florida are commonly above-ground. These tanks are commonly used for the storage of raw or finished water intended for the distribution system, but they can also store effluent or reuse flows. In order to study the cost relationships of these tanks, the design must be uniform throughout. Therefore, the steel tanks are above-ground and not equipped with an aeration unit.

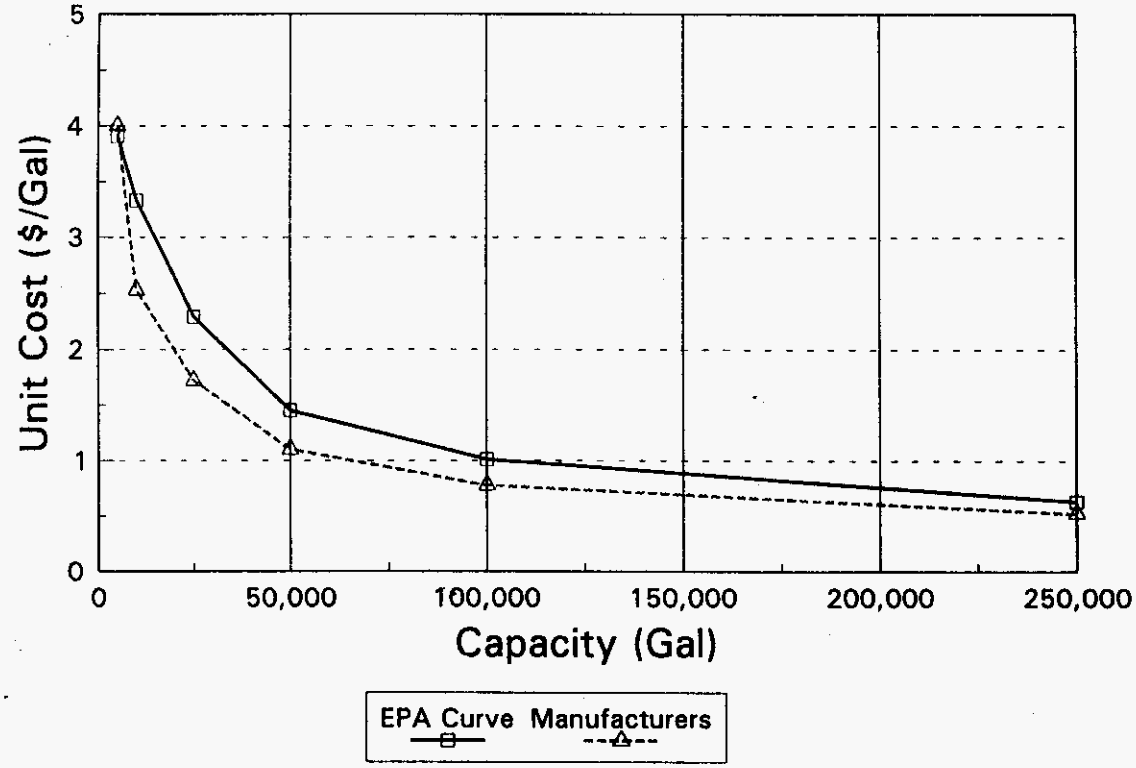
The unit cost curve, Figure 5-3, is very similar to the prestressed concrete ground storage tank with cost curve. There is a sharply increasing economy of scale in the small design capacity range, which lies between 10,000 and 100,000 gallons. The inflection point occurs at 50,000 gallons and thereafter the economy of scale begins to decrease. The decreasing economy of scale occurs between the 100,000 gallon and maximum 250,000 gallon capacity range. Since the unit cost is decreasing throughout the entire curve, the economy of scale is present through all sizes. This means that even though the economy of scale is decreasing in the larger sizes, there are still savings in the larger designs. The construction cost curve, Figure 5-4, shows these savings by plotting the total cost of the storage tank versus the capacity of the tank. For example, by taking the average of the two curves, the cost to construct a 250,000 gallon tank is approximately $145,000. The cost to construct a 150,000 gallon tank is about $108,000. Therefore, there is a savings of $50,000 by designing the tank for the larger capacity as opposed to expanding the steel ground storage tanks capacity by adding another 100,000 gallons of capacity.

The cost curves for steel ground storage tanks were prepared with values obtained from EPA cost curves and manufacturers' quotes. In order to compare the two sources of costs, the quotes were modified to meet the same criteria as the Environmental Protection Agencies cost curves. The steel tank costs include the complete tank, concrete foundation, roof, roof manway, gravity vent, bottom manway hatch, ladder and cage assembly, top manway platform, protective bolt caps, installation, 5% sitework, and 5% piping.

5.3 CHLORINATION

The chlorination of raw water is commonly accomplished using gas chlorinators. The gas is fed to the chlorinators via 150 pound, or 1 ton storage cylinders. The size of the storage cylinders is

Ground Storage Tanks
Steel



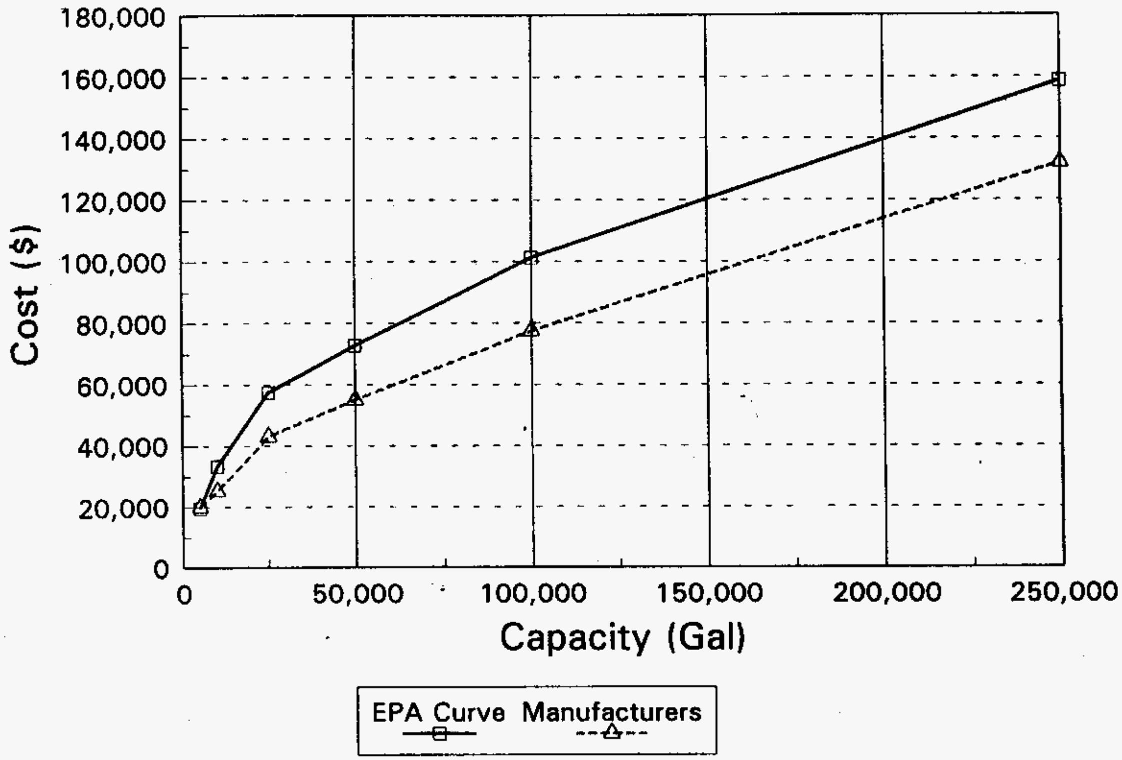
Notes:
1) Complete steel tank, concrete foundation, roof, roof manway, gravity vent, bottom manway hatch, ladder & cage assembly, top manway platform, protective bolt caps, and installation costs are included in the manufacturers' quotations.
2) Includes 5% piping, 0% electrical, and 5% sitework costs.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-3	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL [illegible] TELEPHONE (407) [illegible] - FAX (407) [illegible]	STEEL GST UNIT COST CURVE

EXHIBIT (JCH-4)
PAGE 55 OF 284

Ground Storage Tanks

Steel



Notes: 1) Complete steel tank, concrete foundation, roof, roof manway, gravity vent, bottom manway hatch, ladder & cage assembly, top manway platform, protective bolt caps, and installation costs are included in the manufacturers' quotations.
2) Includes 5% piping, 0% electrical, and 5% sitework costs.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-4	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	STEEL GST CONSTRUCTION COST CURVE

EXHIBIT (JCH-4)
PAGE 56 OF 284

dependent on the quantity of raw water to be treated. Typically, at a dosage of 5 milligrams per liter, the 150 pound storage cylinders are used at treatment plant flows of up to 2 MGD. This means that the 1 ton cylinders are used for flows above this point. The costs of the feed system fluctuates with the size of the storage cylinders.

The unit cost curve, Figure 5-5, displays an economy of scale throughout the treatment capacities of 0.01 MGD to 5 MGD. This relationship is further solidified when the capacities and unit costs are plotted on linear axes. Where the storage cylinder sizes change, the costs slightly increase; however, the ton cylinder feed systems resume the continuous economy of scale. The overall cost, when compared with treatment plant capacity, is not much of a concern. The larger capacity plants will have a much smaller unit cost for chlorine feed systems than the smaller capacity plants.

The chlorination feed equipment curve was constructed using manufacturers' quotations and EPA cost curves. Included in the cost of both size systems are dual chlorinators, dual scales, a gas detector, an alarm panel, a vacuum switch, booster pump, housing, hoists, 20% electrical, 15% piping, 20% installation, and no sitework.

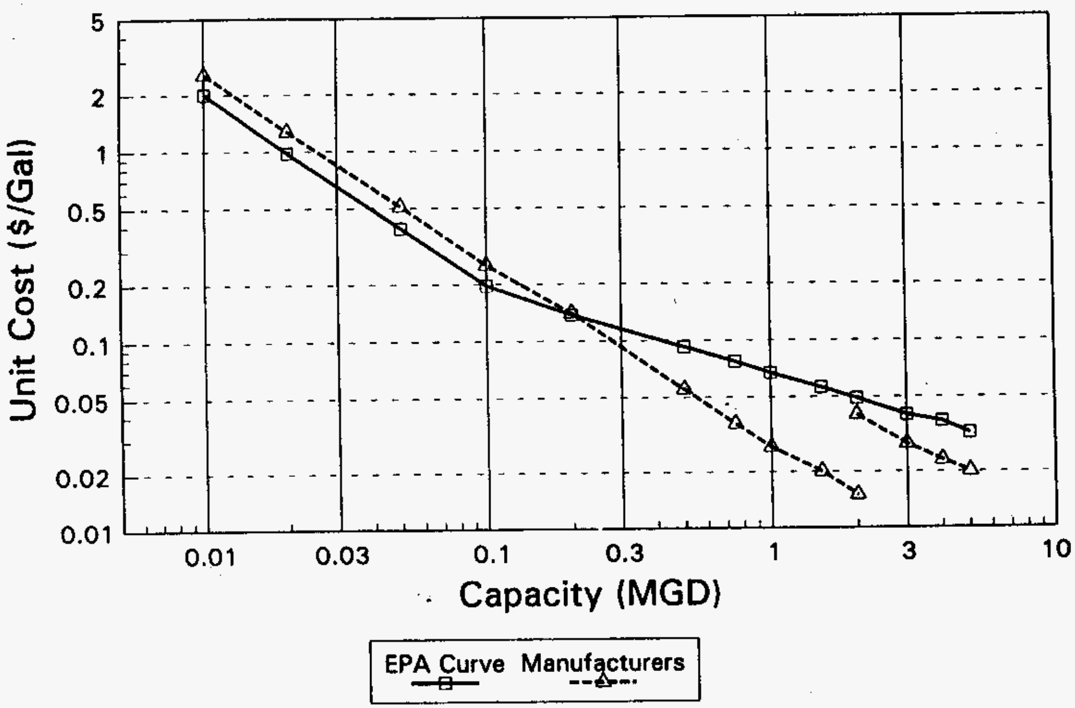
5.4 HIGH SERVICE PUMPS

High service pumps are commonly used in the water distribution system. The water is stored in a ground storage tank and then is distributed to the customers by a series of high-service pumps and water mains. In this study, the horizontal split-case pump was used to represent the typical high-service pumps. The pumps were plotted by their cost and unit cost versus capacity between 100 gpm and 5,000 gpm.

The unit cost curve, Figure 5-6, presents the pump cost in terms of dollars per gpm versus the gpm capacity of the pump. The smaller pumps, 100 gpm to 500 gpm, show an increasing economy of scale and the larger pumps, 1,000 gpm to 5,000 gpm, display a decreasing economy of scale. The transition of the unit cost curve is the inflection point which occurs around the 1,000 gpm pump. Therefore, 750 gpm pumps and larger are more economical in design than are the smaller pumps. For example, Figure 5-7 shows that a 5,000 gpm pump will cost approximately $30,000 and a 1,000 gpm pump will cost $9,000. The cost to upgrade the pump capacity by adding additional pumps will bring the total cost for 5,000 gpm of capacity to

Chlorine Feed Systems

Water Treatment



Notes:
1) Gas chlorination unit with 5 mg/l feed rate capacity.
2) Dual chlorinators w/ switchover, dual scales, gas detector, alarm panel, vacuum switch, booster pump, housing, and hoists are included in the manufacturers' quotations.
3) Includes 20% electrical, 15% piping, and 20% installation costs.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-5

HARTMAN & ASSOCIATES, INC.

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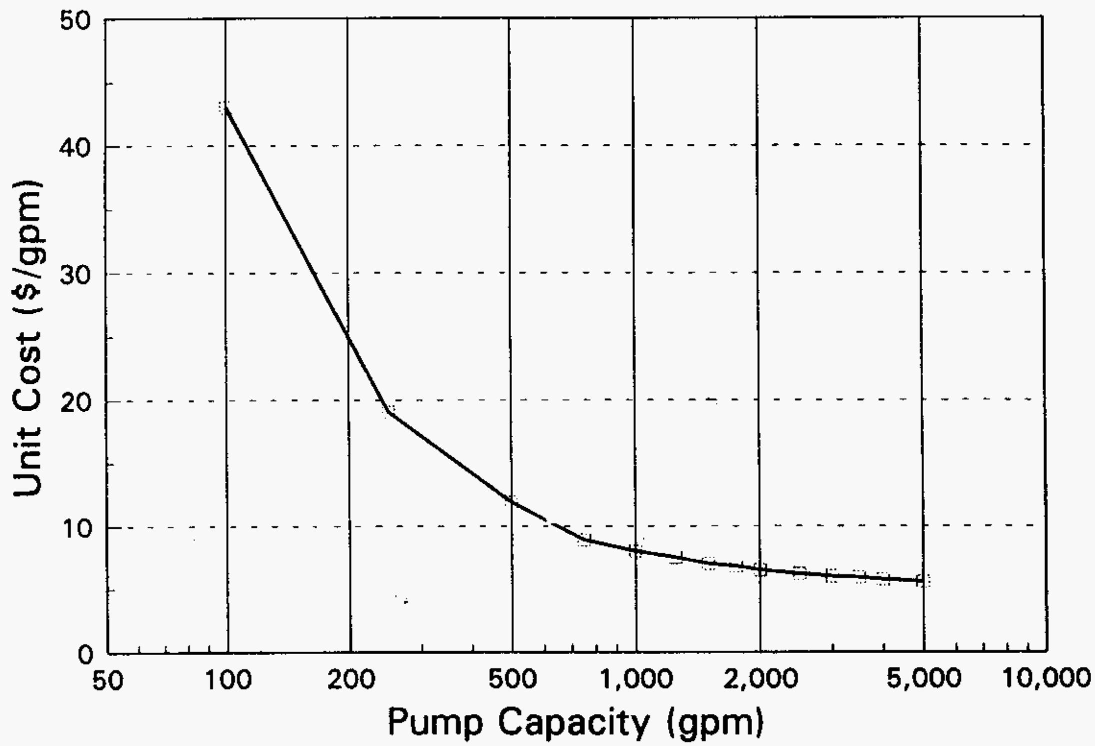
CHLORINE FEED SYSTEM UNIT COST CURVE

EXHIBIT

PAGE 58 OF 284

High-Service Pumps

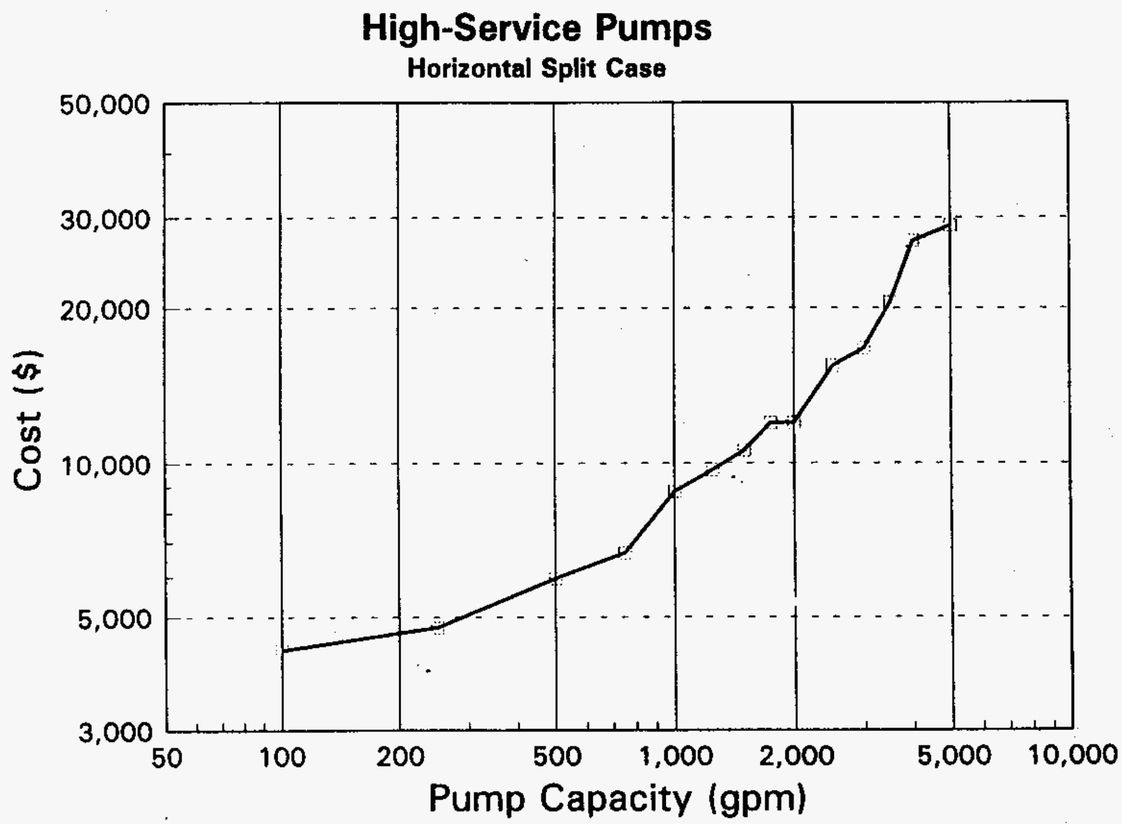
Horizontal Split Case



Notes: 1) All costs obtained from manufacturer's quotations include pumps, factory testing, and freight to jobsite.
2) Horizontal Split Case pumps and motors.
3) Pump head is 175 feet (76 psi).
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-6	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	HIGH SERVICE PUMP UNIT COST CURVE

EXHIBIT ______
PAGE 59 OF 284



Notes: 1) Values obtained from manufacturer's quotations include pumps, factory testing, and freight to jobsite.
2) Horizontal Split Case pumps and motors.
3) Pump head is 175 feet (76 psi).
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-7

HARTMAN & ASSOCIATES, INC.

HIGH SERVICE PUMP CONSTRUCTION COST CURVE

EXHIBIT ____ (GCH-4)

PAGE 60 OF 284

between $35,000 and $45,000. The overall saving would then be in the $10,000 range, which is considerable with horizontal split-case pumps.

The values for the construction cost and unit cost curves were quoted from manufacturers of horizontal split case pumps. The costs for the pumps include the pump, motor, factory testing, and freight to the jobsite. The pumps were sized using a head of 175 feet.

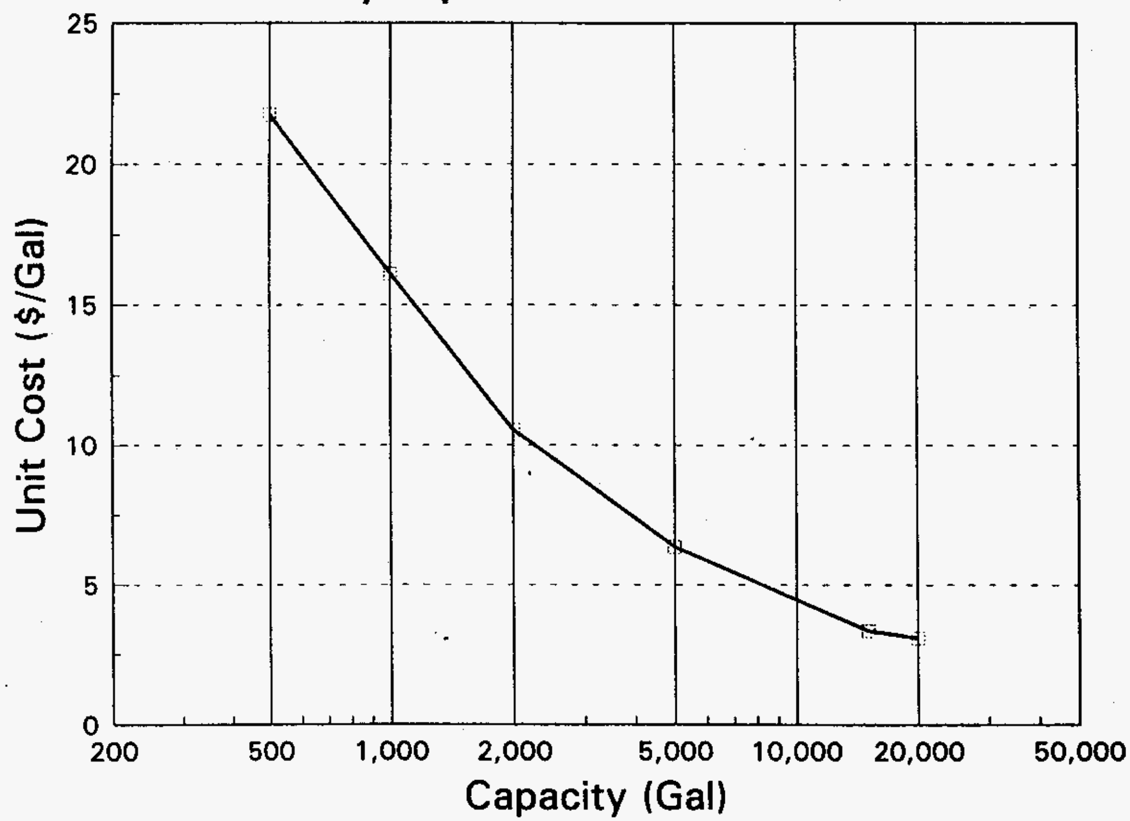
5-5 HYDROPNEUMATIC TANKS

Hydropneumatic tanks are an integral component in maintaining the required pressure of the water entering the distribution system. In this study, the hydropneumatic tanks are designed for a pressure rating of 100 pounds per square inch, and they are ASME rated. The tanks are the horizontal type cylinder tanks that are situated on a concrete base. The hydrotank system estimates are presented as both unit cost versus capacity and construction costs versus capacity.

The unit cost curve, Figure 5-8, is plot of the unit cost, dollars per gallon, versus capacity for hydropneumatic tanks between 500 gallons and 20,000 gallons. The curve shows an economy of scale that begins to slightly decrease near 10,000 gallons. Overall, there is considerable savings between each successive step of the design capacity. The unit cost curve virtually straight, which leaves the curve without a point of inflection. Without an inflection point, the curve possesses a strong economy of scale throughout the size range. The construction cost curve, Figure 5-9, strengthens this point. For example, the cost of a 500 gallon, 5,000 gallon, and 20,000 gallon hydropneumatic tank system is $11,000, $32,000, and $62,000, respectively. By adding to the 500 gallon tank to reach 5,000 gallon capacity, the cost would be considerably more than the original 5,000 gallon tank. For instance, adding a 500 gallon tank and then a 4,000 gallon tank to the existing 500 gallon tank, the total cost would be $52,000. This option is approximately $20,000 more than a 5,000 gallon tank would originally cost. This relationship also exists between the 5,000 gallon and 20,000 gallon tanks. In this case, the cost would be approximately $20,000 more to expand to 20,000 gallon capacity from 5,000 gallon capacity.

The unit cost and construction cost curves were formed using quotations from manufacturers. The quotes included the tank itself, an air volume control compressor, and a control panel. To these values, 15% piping, 20% electrical, 10% sitework, and 20% installation was added to determine the total cost of a hydropneumatic tank system.

Hydropneumatic Tanks



Notes:
1) Costs of the tank, air volume control compressor, and a control panel were included in the manufacturers' quotations.
2) 15% piping, 20% electrical, 20% installation, and 10% sitework were added to the quoted costs.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-6

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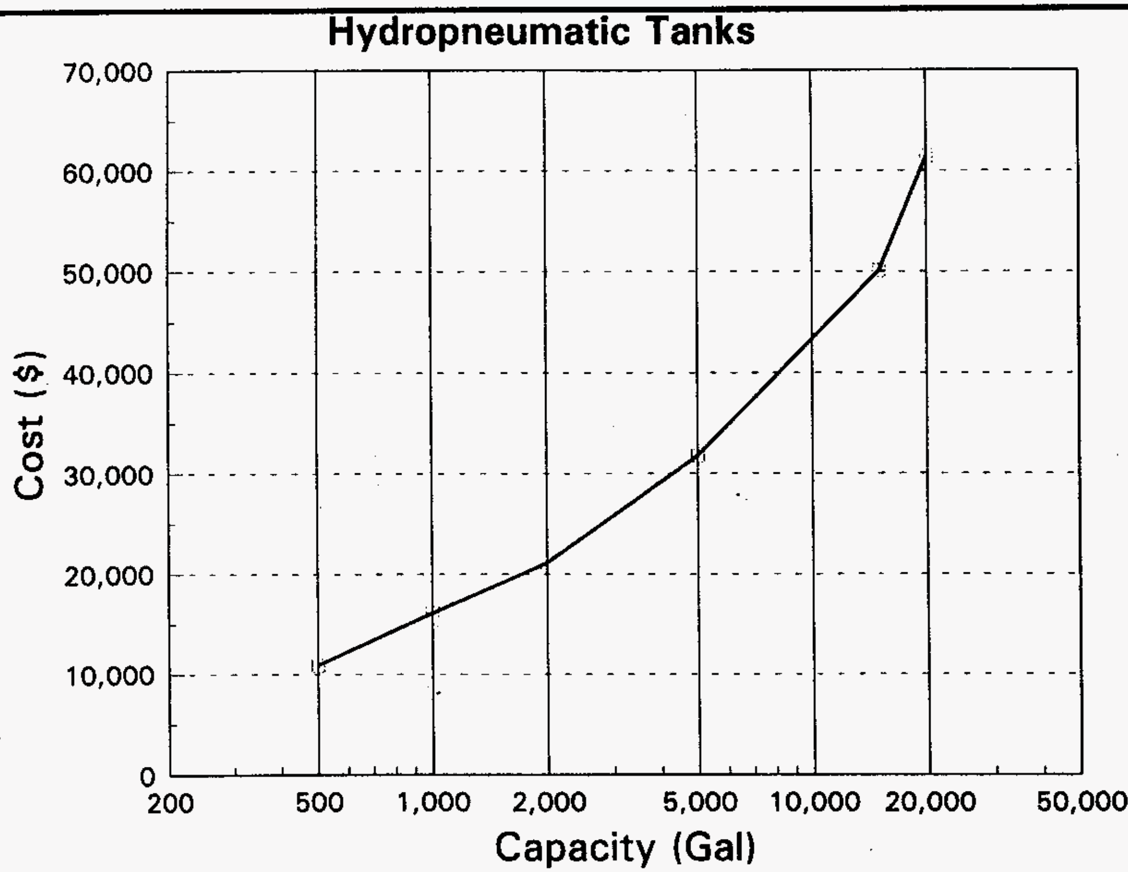
HYDROPNEUMATIC TANK UNIT COST CURVE



Notes: 1) Costs of the tank, air volume control compressor, and a control panel were included in the manufacturers' quotations.
2) 15% piping, 20% electrical, 20% installation, and 10% sitework were added to the quoted costs.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-9

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HYDROPNEUMATIC TANK CONSTRUCTION COST CURVE

EXHIBIT (SCH-4)
PAGE 63 OF 284

5.6 WELLS

Depending on the site, raw water wells can vary tremendously in the depth required to produce a functional well. In this case, deep wells of approximately 250 feet and 500 feet in depth were considered appropriate. The pumps designed for these wells are vertical turbine pumps. The cost of the well system includes only the well components and is represented in the unit cost and construction cost curves.

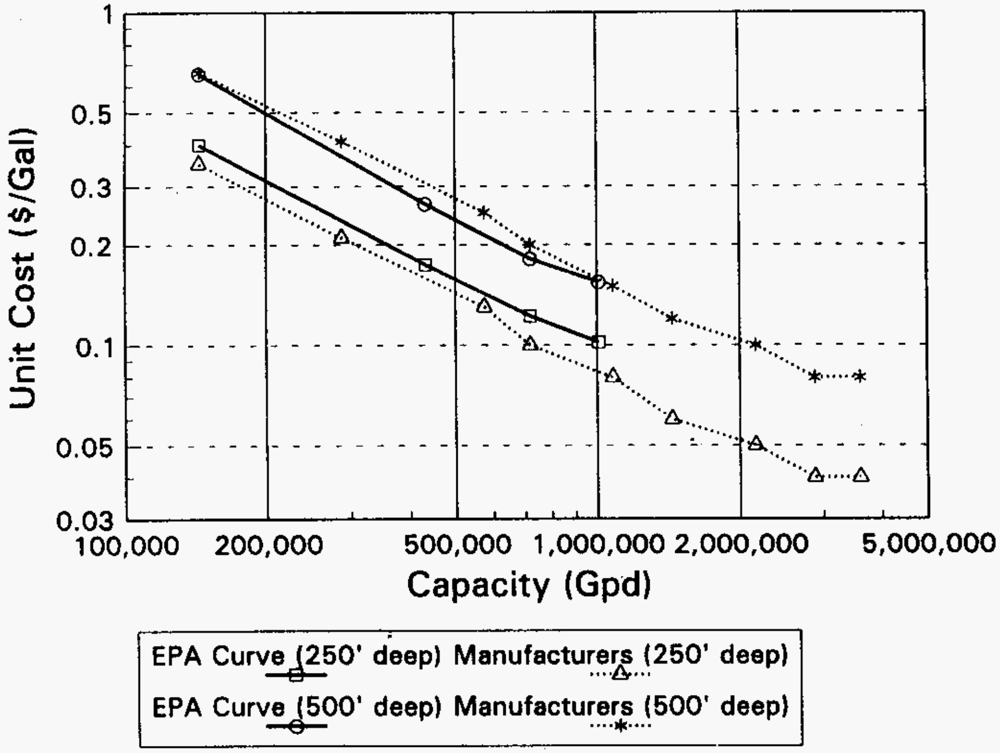
The unit cost curve, Figure 5-10, is based on the daily pumping capacity of the well. In other words, the unit cost is presented as dollars per gallon and the capacity is in gallons per day. Both the 250 foot and 500 foot deep wells display considerable economies of scale throughout the capacity range of the curve. The unit costs begin between $0.4/gal and $0.7/gal at 144,000 gallons per day and ends around $0.04/gal to $0.08/gal at approximately 3,500,000 gallons per day. The savings are apparent throughout the well sizes when looking at the construction cost curve, Figure 5-11. A well pumping at 2,800,000 gallons per day costs about $115,000 to construct, while a 720,000 gallon per day costs about $75,000 to construct. The economy of scale is primarily due to contractor mobilization and economies of scale in casing pipe and pumps.

The unit cost and construction cost curves were developed with the values received from manufacturers' quotations, EPA cost curves, and previously completed project bid tabulations. All curves for supply wells include a vertical turbine pump, cement grout, black steel well and surface casing, well screen, well development, 10% for electrical, 15% for well head, and 30% for labor needed for construction.

5.7 LIME SOFTENING WTP

The Lime Softening WTP cost curves, Figures 5-12 and 5-13, represent the costs associated with the treatment facilities needed to treat raw water with lime and recarbonate the treated water with gaseous carbon dioxide. The lime softening plant is characteristically the same as a conventional filtration plant; however, lime is substituted for other chemicals and the treated water will need to be recarbonated. The unit cost curve, Figure 5-12, and the construction cost curve, Figure 5-13, were produced using documented EPA cost information and includes the following cost considerations: raw water pumping equipment, chemical addition facilities, rapid mix/flocculation equipment, sedimentation basin, filtration units, disinfection equipment, finished water storage and pumping equipment, and sludge disposal facilities.

Potable Water Wells



Notes: 1) Vertical turbine pump, cement grout, black steel well and surface casing, well screen, and well development costs from manufacturers' quotes and bid tabulations.

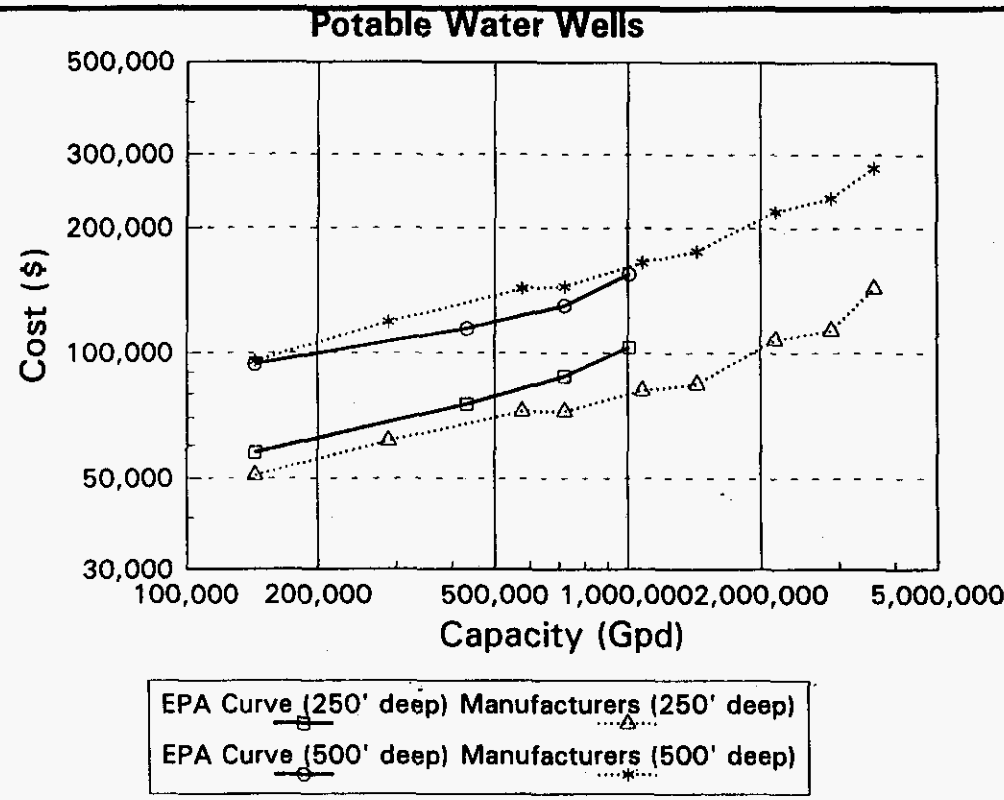
2) Includes 10% electrical, 15% for well head assembly, and 30% labor costs.

3) EPA cost curves contain all costs.

4) Costs are based on the June 1995, ENR Index = 5433.

FIGURE 5-10	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	SUPPLY WELL UNIT COST CURVE

EXHIBIT (SCH-4)
PAGE 65 OF 284



Notes: 1) Vertical turbine pump, cement grout, black steel well and surface casing, well screen, and well development costs from manufacturers' quotes and bid tabulations.
2) Includes 10% electrical, 15% for well head assembly, and 30% labor costs.
3) EPA cost curves contain all costs.
4) Costs are based on the June 1995, ENR Index = 5433.

FIGURE 5-11

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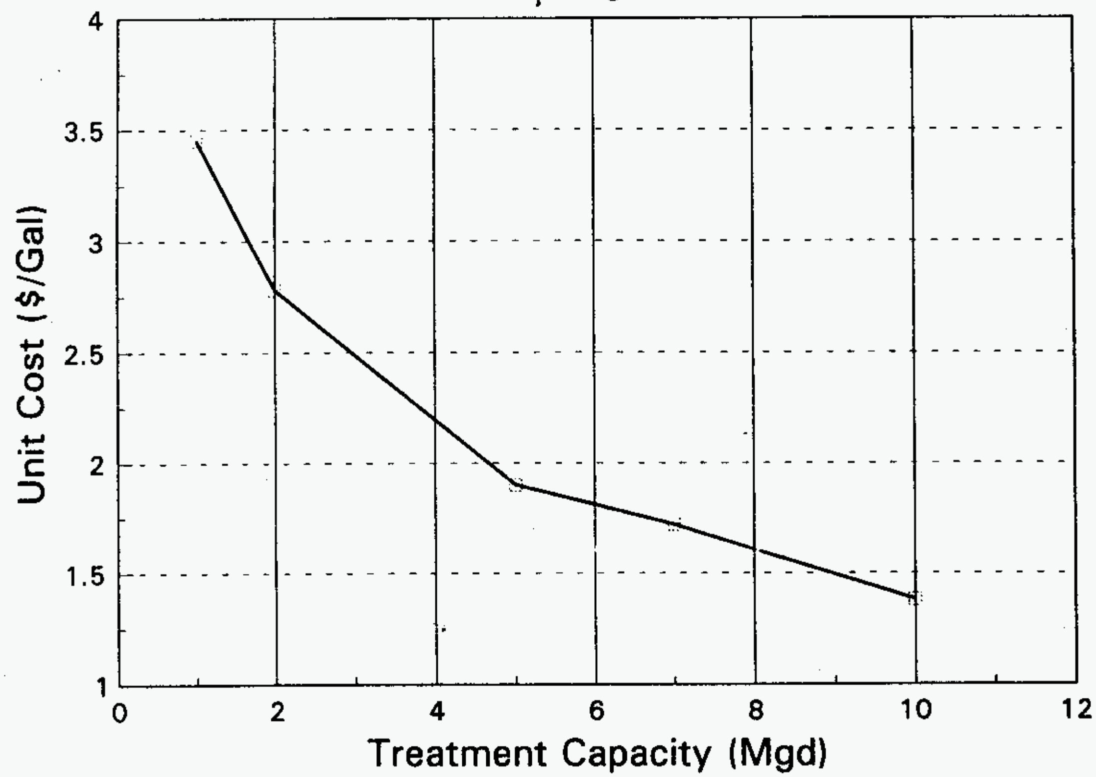
SUPPLY WELL CONSTRUCTION COST CURVE

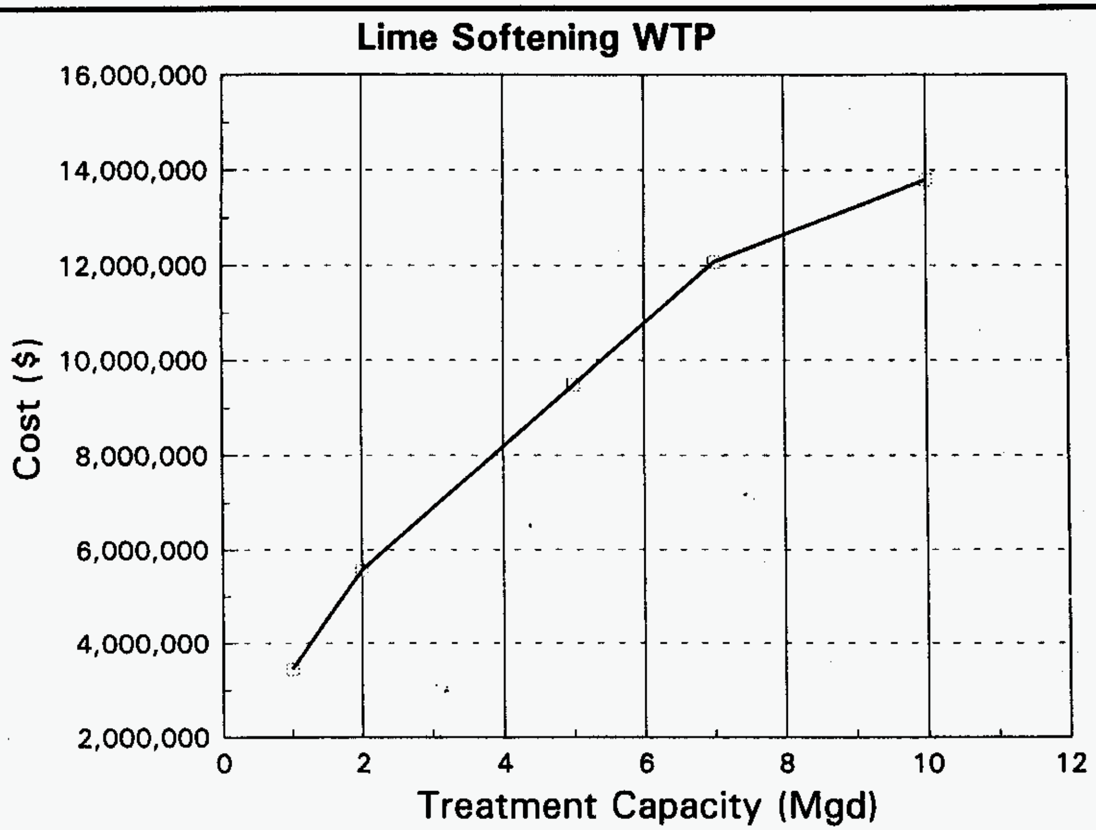
Lime Softening WTP



Notes: 1) Values obtained using EPA cost curves.
2) Costs include raw water influent pumping, chemical addition, rapid mix/ flocculation, sedimentation, filtration, disinfection, finished water storage, finished water pumping, and sludge disposal.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-12	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	LIME SOFTENING WTP UNIT COST CURVE

EXHIBIT (GOH-4)
PAGE 67 OF 284



Notes:
1) Values obtained using EPA cost curves.
2) Costs include raw water influent pumping, chemical addition, rapid mix/flocculation, sedimentation, filtration, disinfection, finished water storage, finished water pumping, and sludge disposal.
3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-13

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LIME SOFTENING WTP CONSTRUCTION COST CURVE

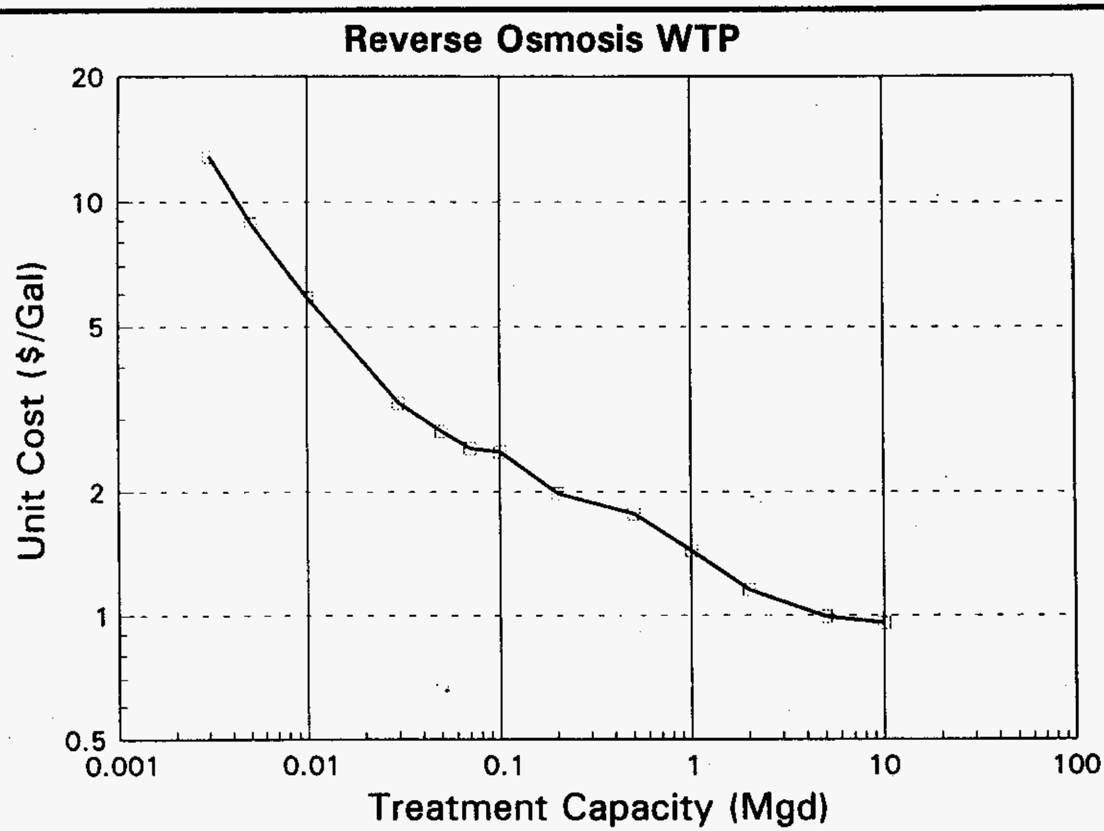
The Lime Softening WTP cost curves show a small economy of scale throughout the capacity ranges. The unit cost begins with approximately $3.5/gal at 1 MGD and ends with approximately $1.4/gal at 10 MGD. This shows that there is an economy of scale between these ranges of capacities.

The curves for Lime Softening Water Treatment Plants were constructed using information gathered from EPA cost curves.

5.8 REVERSE OSMOSIS WTP

The curves presented, Figure 5-14 and 5-15, in this Section were constructed using previous EPA cost curves and information contained in previous EPA reports. The treatment facilities that make up a Reverse Osmosis treatment plant and consequently, the cost curves contained in this report are as follows: reverse osmosis membrane elements and pressure vessels, flow meters, housing, structural steel, tanks, piping, valves, pumps, cartridge filters, acid and polyphosphate equipment, and cleaning equipment. The EPA cost curves have also added costs for contingencies, sitework, engineering and administration, and electrical.

The unit cost curve, Figure 5-14, shows a considerable economy of scale. The ranges of capacity begin with 0.003 MGD and end with 10 MGD. When plotted on a linear scale, the curve is more pronounced than the economy of scale curve shown in Figure 2-1. The unit cost is approximately $14/gal at 0.003 MGD and approximately $0.95/gal at 10 MGD.



Notes: 1) Values obtained using EPA cost curves.
2) Costs include housing, structural steel, tanks, piping, valves, pumps, reverse osmosis membrane elements and pressure vessels, flow meters, cartridge filters, acid and polyphosphate equipment, and cleaning equip.
3) The EPA cost curves have also added costs for contingencies, sitework, engineering & administration, and electrical.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-14

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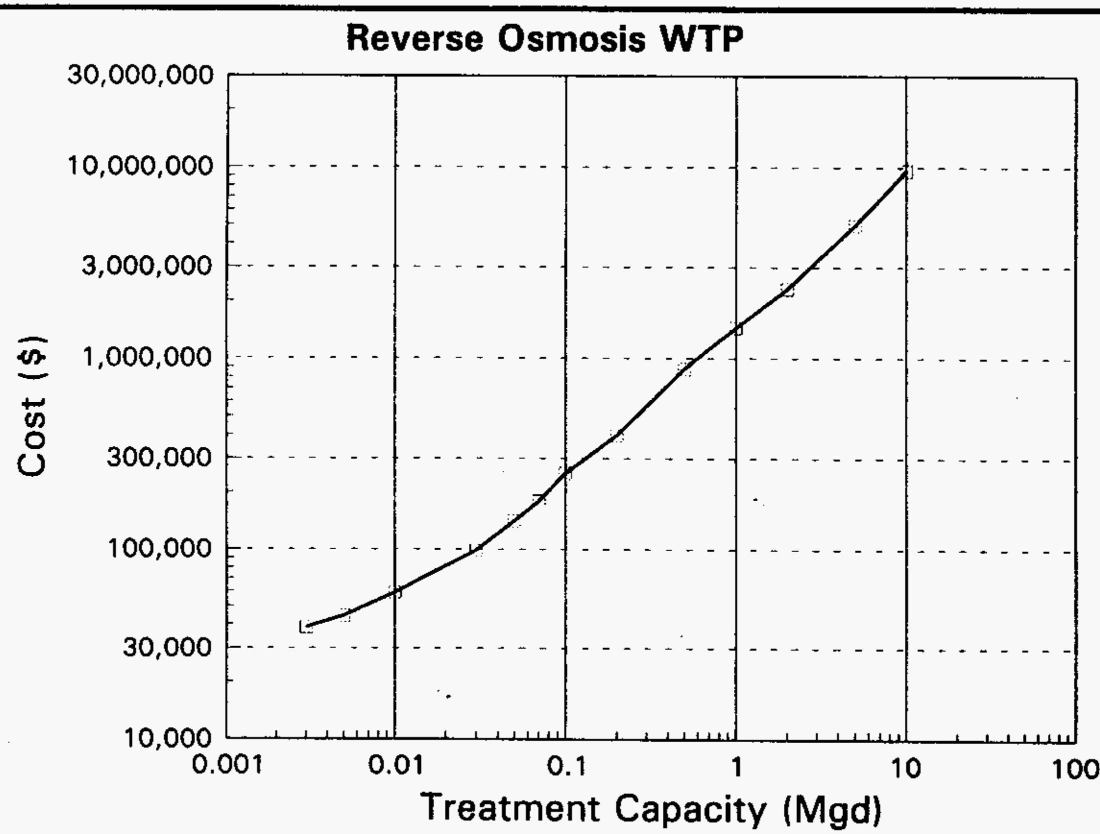
REVERSE OSMOSIS UNIT COST CURVE

EXHIBIT (GCH-4)
PAGE 70 OF 284



Notes: 1) Values obtained using EPA cost curves.
2) Costs include housing, structural steel, tanks, piping, valves, pumps, reverse osmosis membrane elements and pressure vessels, flow meters, cartridge filters, acid and polyphosphate equipment, and cleaning equip.
3) The EPA cost curves have also added costs for contingencies, sitework, engineering & administration, and electrical.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 5-15

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REVERSE OSMOSIS CONSTRUCTION COST CURVE

SECTION 6

SECTION 6
WASTEWATER COLLECTION/WATER DISTRIBUTION

6.1 GRAVITY SEWERS

The gravity sewer collection system consists of a series of PVC-SDR35 pipe, manholes, and sewage pump station. The cost analysis of this type of system must be done by looking at the number of services per section. The sections are defined by 400 foot lengths of pipe, as denoted in Figure 6-1. Since the lots are assumed to be 100 feet in width, there can only be four (4) lots on each side of the gravity line. For example, sewer installation A would include a beginning manhole, 400 feet of 8-inch PVC pipe, and a portion of the cost of the sewage pump station. The pump station cost for this example would be calculated by multiplying the total cost for the pump station by the ratio of the number of lots, in this case eight (8), over the total numbers of lots that a 100 gallon per minute pump station can serve, which is approximately 120. The total cost is attained by summing the costs of the gravity pipe, manholes, sewage pump station, permitting fee, line testing fee, mobilization, electrical, and installation.

The unit cost curve was produced by dividing the total cost of an installation by the number of lots that are serviced and then plotting this value versus the total number of lots. The design was carried all the way out to the 100 gallon per minute pump station capacity of 120 lots. The actual curve, Figure 6-2, shows that the gravity sewer installations experience an increasing economy of scale up to the inflection point, which is located at about 32 lots serviced. From this point, the economy of scale decreases all the way to the 120 lot endpoint. Therefore, the gravity sewer installations are much more economical on a large scale than they are when individual 400 foot sections are installed. This occurs due to the extra costs for permitting, mobilization, and engineering.

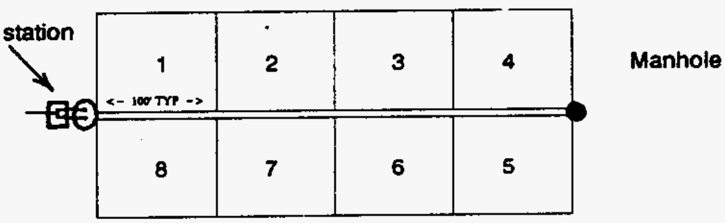
The unit cost curve for the gravity sewer installation was formed using the values obtained from manufacturers' quotations and bid tabulations from previously completed jobs.

6.2 SEWAGE PUMP STATIONS

The pump station configuration that was studied for this report is the submersible duplex pumps in a wet well with an adjoining valve box. The costs of these wastewater collection and

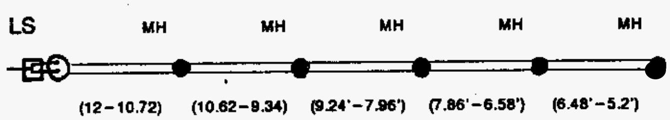
One Section (8 units)

400 lf 8" PVC–SDR 35 (10'–12'deep)



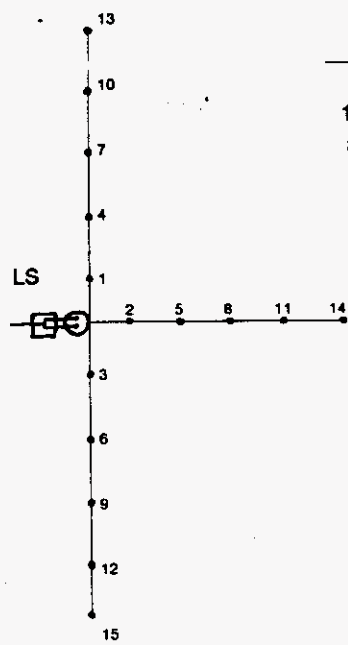
One Street (40 units)

** All pipe is 8" SDR 35 PVC (400' sections)



Whole Installation (120 units)

8" Gravity Sewer
10'–12' deep => 1782 lf
8'–10' deep => 1782 lf
6'–8' deep => 1689 lf
0'–6' deep => 750 lf



Depth	Manholes
10'–12'	1,2,3
8'–10'	4,5,6
6'–8'	7–12
0'–6'	13,14,15

90–144

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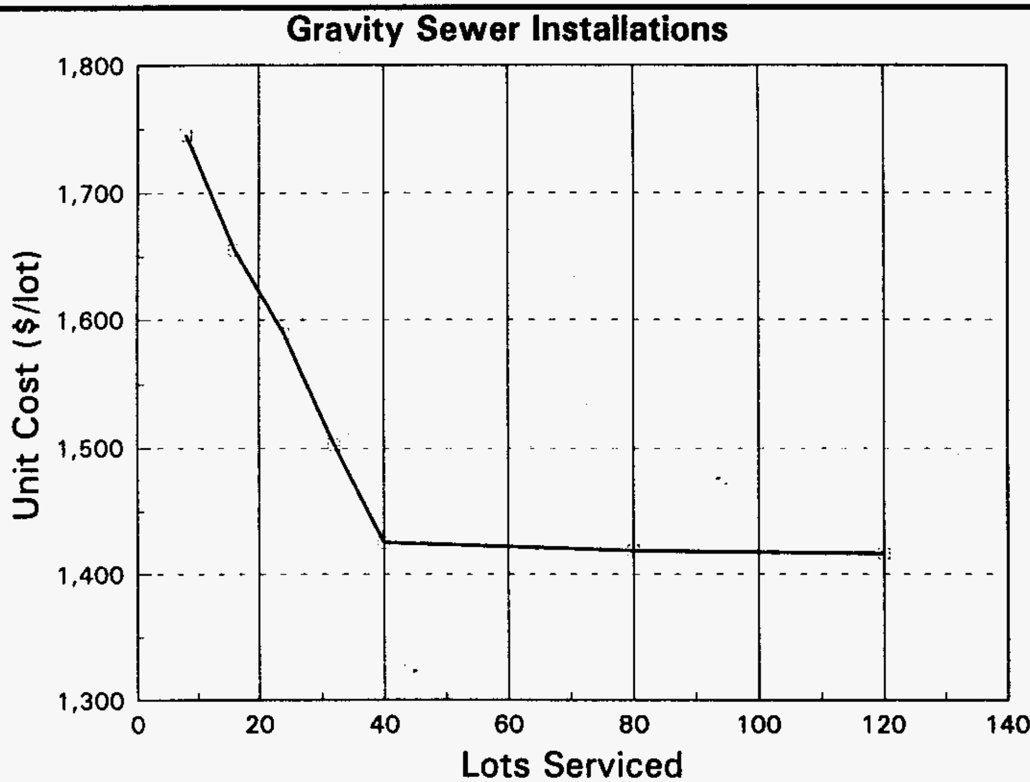
GRAVITY SEWER DESIGN

FIGURE 6-1



Notes:
1) Assumed 100 foot lots, 12 foot maximum pipe depth, and 120 lots served by a 100 gpm pump station.
2) Manufacturers' quotes and bid tabulations provided costs for precast manholes, pipe material, and the $1/ft line testing cost for low pressure air exfiltration.
3) Includes a $500 permitting fee, electrical, installation, and 10% for mobilization.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-2

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GRAVITY SEWER UNIT COST CURVE

EXHIBIT ____ (ECH-4)
PAGE 75 OF 284

transmission components is directly related to the amount of wastewater that is entering the wet well. The range of capacities of the pump stations are from 100 gallons per minute to 1,000 gallons per minute.

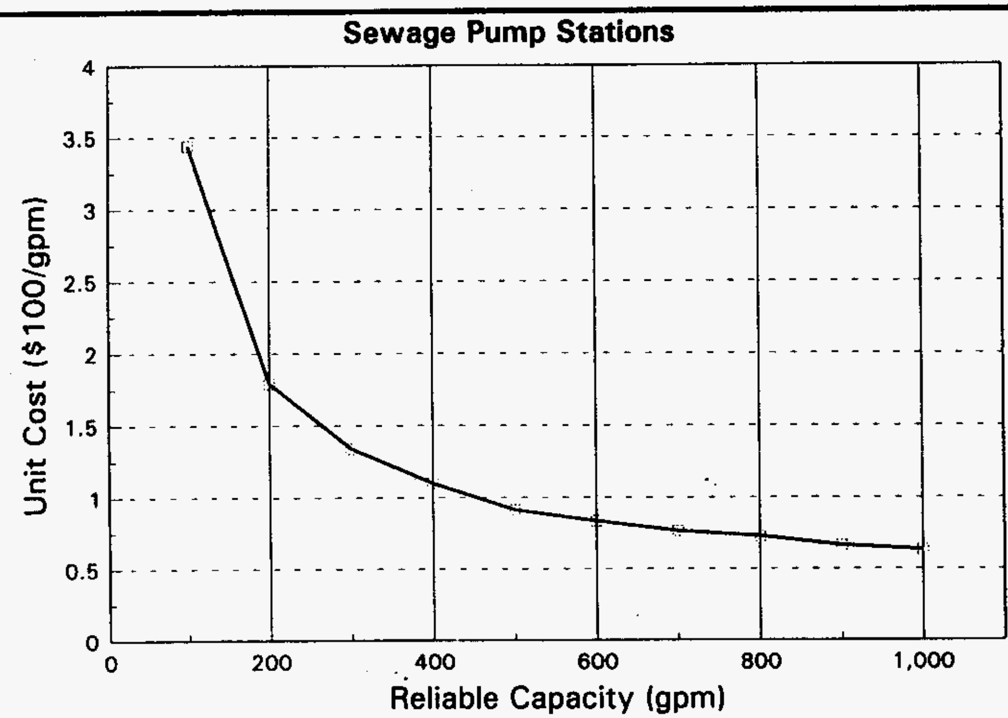
The unit cost curve, Figure 6-3, was produced by dividing the total cost of a submersible pump station by the capacity of the main pump and plotting this value, versus the capacity of the pump, in gallons per minute. This curve shows an increasing economy of scale between 100 gpm and 400 gpm. The inflection point lies around 400 gpm, and from 400 gpm to 1,000 gpm the economy of scale is slightly decreasing. Due to the unit cost relationship, the design of a pump station under 400 gpm should be avoided, if there are any possibilities for further expansion. After 400 gpm, there is still an economy of scale; however, it is not as significant. To show that there is still considerable savings after 400 gpm, we must study the construction cost curve, Figure 6-4. The cost of a 1,000 gpm duplex pump station is approximately $63,000, and the cost of a 500 gpm pump station is $46,000. Therefore, there is a $29,000 savings to build the 1,000 gpm pump station when compared to two (2) 500 gpm pump stations.

The unit cost and construction cost curves were produced using the quotations obtained from manufacturers. The cost includes two (2) equivalent submersible pumps, the precast wet well, precast valve box, piping, fittings, 20% for electrical, and installation, which includes excavating, backfilling, and dewatering. The pumps were designed to run on a 6-minute cycle time, which minimized wet well sizing.

6.3 FORCE MAINS

In the transmission of wastewater, force mains are used to convey wastewater from a sewage pump station directly to the treatment plant, another pump station, or a manhole. The force main materials that were studied in this project were the PVC (C900-DR25) and the Class 50 DIP with epoxy coating. These pipes are presented on unit cost curves as illustrated in Figure 6-5 and Figure 6-6.

The PVC force main unit cost curve, Figure 6-5, was produced for pipe sizes between 4-inches and 12-inches in diameter. The unit cost of the pipe is in dollars per linear foot and this is based on different lengths of pipe. In other words, there are three (3) different total lengths of pipe: 25,000 feet (large project), 2,500 feet (medium project) and 250 feet (small project). For these different lengths, manufacturers quoted the actual material prices per foot that would apply to



Notes:
1) Pump station design was based on a 6 minute cycle time, a peak factor of 3 to 4 respective of average flow, and a 3 ft high effective volume.
2) Costs include two (2) equal size pumps, precast wetwell, precast valve box, installation (excavating, backfilling, dewatering), piping, fittings, and 20% electrical.
3) Wet well sizes: 100-400 gpm => 6' diam., 500-600 gpm => 8' diam., 700-900 gpm => 10' diam., 1000 gpm => 12' diam.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-3

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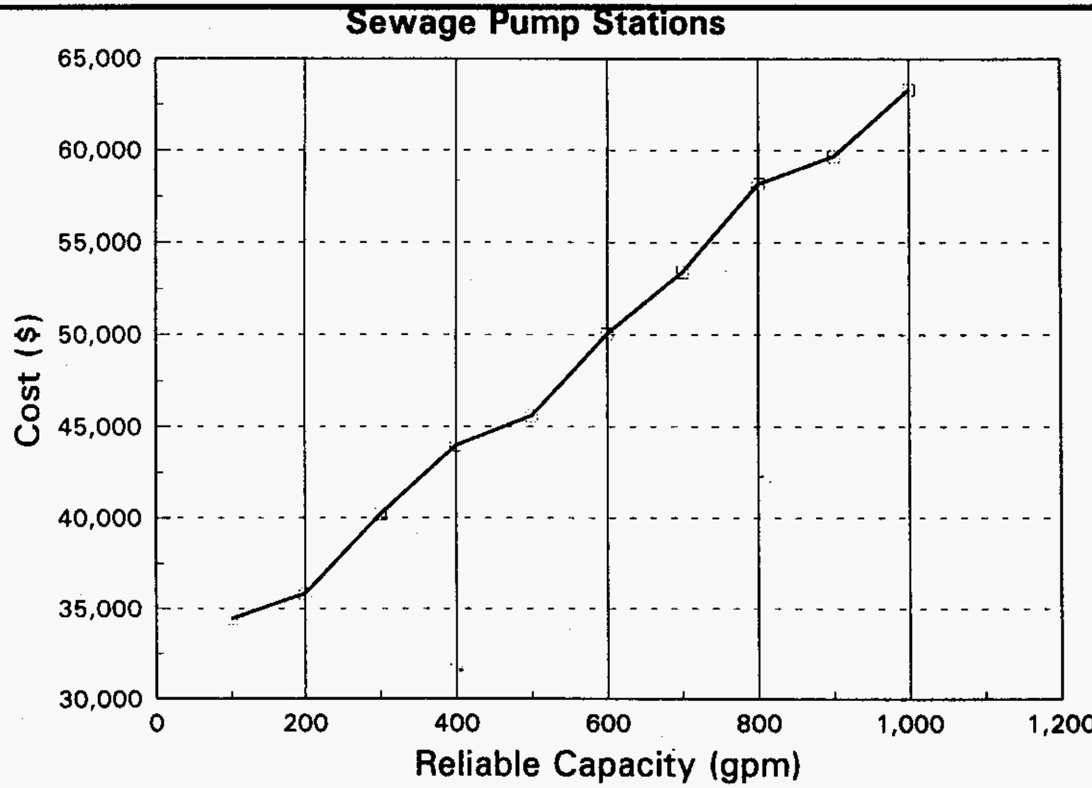
TELEPHONE (407) [illegible] - FAX (407) [illegible]

SEWAGE PUMP STATION UNIT COST CURVE



Notes: 1) Pump station design was based on a 6 minute cycle time, peak factor of 3 to 4 respective of average flow, and a 3 ft high effective volume.

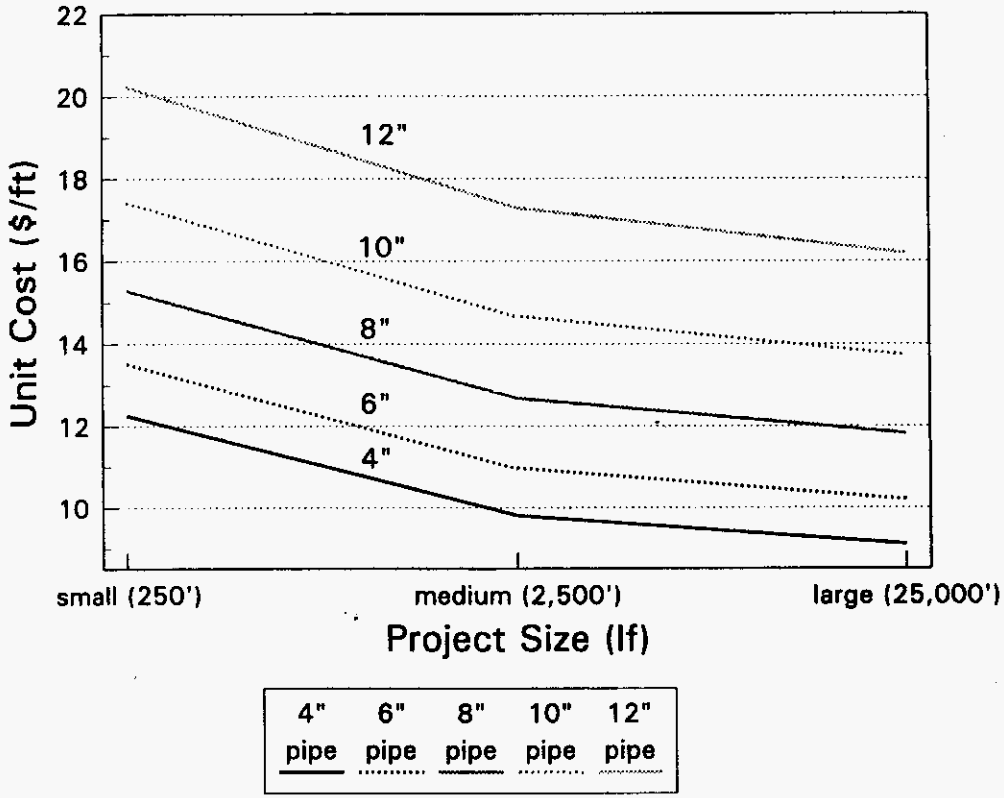
2) Costs include two (2) equal size pumps, precast wetwell, precast valve box, installation (excavating, backfilling, dewatering), piping, fittings, and 20% electrical.

3) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-4	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	SEWAGE PUMP STATION CONSTRUCTION COST CURVE

EXHIBIT ____ (SCH-4)
PAGE 78 OF 284

PVC (C900 - DR25) Force Main



Notes: 1) Material cost obtained from manufacturers' quotes.
2) Costs include $500 permitting, 10%-15% mobilization, $.25-$.75/ft for pressure testing, and $7/ft for excavating, backfilling, and compacting.
3) Costs exclude valves, fittings, and restoration work.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-5

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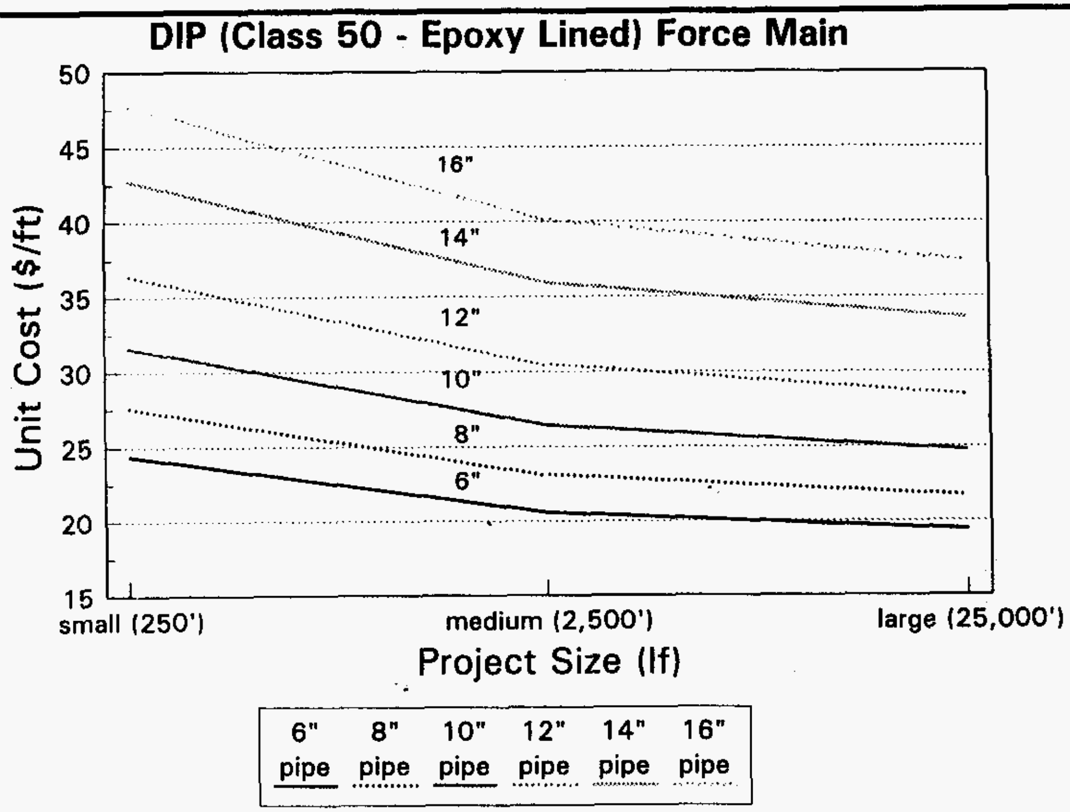
PVC FORCE MAIN UNIT COST CURVE

EXHIBIT ___ (JEH-4)

PAGE 79 OF 264



Notes: 1) Material cost obtained from manufacturers' quotes.
2) Costs include $500 permitting, 10%-15% mobilization, $.25-$.75/ft pressure testing, and $7/ft for excavating, backfilling, and compacting.
3) Costs exclude valves, fittings, and restoration work.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-6

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DIP FORCE MAIN UNIT COST CURVE

EXHIBIT (JCH-4)
PAGE 80 OF 384

each case. As the graph shows, it is apparent that the larger quantities of pipe receive the most economical unit costs for each of the pipe sizes that were examined.

The Class 50 DIP force main unit cost curve is very similar to the PVC force main unit cost curve. The DIP sizes range from 4-inches to 16-inches and the pipes are lined with an epoxy coating. The graph shows that on a dollar per linear foot basis, the DIP force main is the most economical when the project is of a large magnitude. This relationship is in agreement with the PVC force main unit costs. Therefore, regardless of the pipe material, one should consider the full design of a force main as a stronger option to the smaller separate installations.

Both the PVC and DIP unit cost curves are formed using values obtained from manufacturers' quotations. In order to present the costs as final installed costs, a permitting fee, mobilization, installation, and pressure testing values were added to the unit costs based on the size of the project.

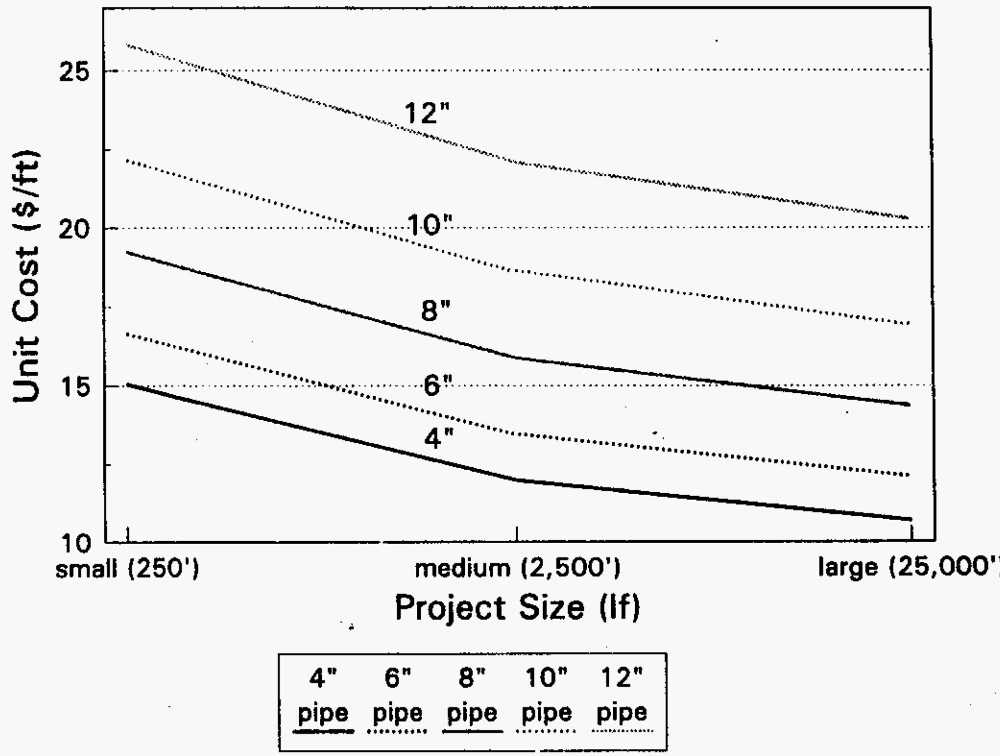
6.4 WATER MAINS

Typically, water mains will be made of either C900-DR18 PVC or Class 50 - cement lined DIP. In order to insure the safety and welfare of the customers, the water mains must be pressure tested and disinfected before they are put into use. For this study, PVC water mains from 4-inches to 12-inches in diameter and DIP water mains from 6-inches to 16-inches in diameter were studied to determine if an economy of scale existed.

The PVC C900-DR18 water main unit cost curve, Figure 6-7, shows the unit cost for three (3) different sized projects. The manufacturers were asked to give $/Ft prices for the pipe based on a small (250 ft), medium (2,500 ft), or large (25,000 ft) project. This footage represents the linear amount of certain diameter pipe to be installed in a certain project. As can be seen from the figure, the unit cost drops between $4/Ft and $5/Ft between the small and large projects for all the pipe sizes. Therefore, it is more economical to construct a single large scale project at one time than to construct many smaller projects.

In the other unit cost curve, Figure 6-8, the Class 50 - cement lined DIP also shows a significant economy of scale. For the DIP water main, the sizes ranged from 6-inches to 16-inches in diameter. For the 6-inch diameter water main, the unit cost dropped about $6.50/Ft between the small and large projects. For the 16-inch diameter water main, the unit cost declined by $12/Ft

PVC (C900 - DR18) Water Main



Notes:
1) Material cost obtained from manufacturers' quotes.
2) Costs include $500 permitting, 10%-15% mobilization, $1-$2/ft disinfection, $.25-$.75/ft for pressure testing, and $7/ft for excavating, backfilling, and compacting.
3) Costs exclude valves, fittings, and restoration work.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-7

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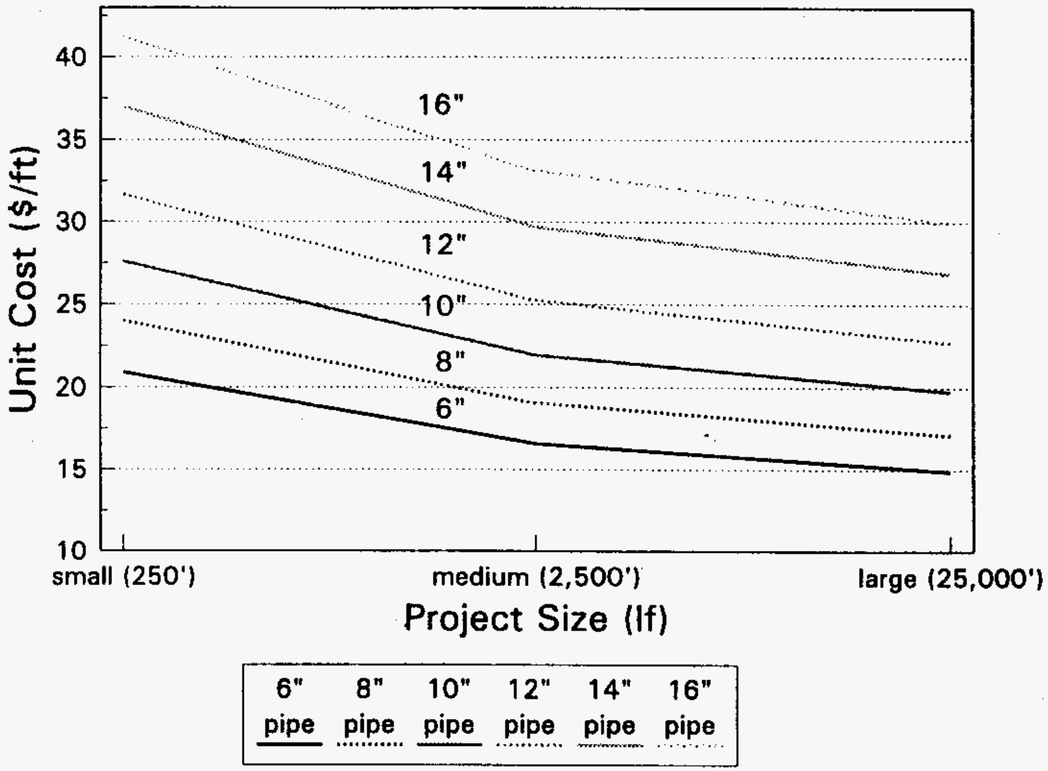
PVC WATER MAIN UNIT COST CURVE

EXHIBIT ____ (JCH-4)
PAGE 82 OF 284

DIP (Class 50 - Cement Lined) Water Main



Notes:
1) Material cost obtained from manufacturer's quotes.
2) Costs include $500 permitting, 10%-15% mobilization, $1-$2/ft disinfection, $.25-$.75/ft for pressure testing, $7/ft for excavating, backfilling, and compacting.
3) Costs exclude valves, fittings, and restoration work.
4) Costs are based on June 1995, ENR Index = 5433.

FIGURE 6-8	HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants 201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801 TELEPHONE (407) 839-3955 - FAX (407) 839-3790	DIP WATER MAIN UNIT COST CURVE

EXHIBIT (CH-4)
PAGE 83 OF 284

between the small and large projects. Once again, the unit costs prove the existence of a strong economy of scale in the water mains. Therefore, to capture the economy of scale it is desirable to construct as much water main as possible.

The unit cost curves for the PVC and DIP water mains were constructed from values obtained from manufacturers' quotes. The unit cost includes the material cost, a $7/foot trenching cost, a permitting fee, mobilization, disinfection of water mains, and the pressure testing on the water mains.

APPENDIX A

Package Wastewater Treatment Plants
Unit Costs

Capacity (MGD)	Davco Ext. Aer. ($)	Sanitaire Ext. Aer. ($)	Total Ext. Aeration Const. Cost ($)	Overall E.A. Cost w/ Chlor. ($)	Unit Cost ($/Gal)
0.01	50000	--	50000	77500	7.75
0.025	78000	--	78000	105500	4.22
0.05	135000	125495	130247.5	160248	3.205
0.075	185000	159630	172315	202315	2.6975
0.1	217000	184948	200974	235974	2.3597
0.15	210000	233535	221767.5	256768	1.7118
0.25	260000	309045	284522.5	319523	1.2781
0.5	375000	479368	427184	462184	0.9244
0.75	450000	622920	536460	571460	0.7619
1	533000	758860	645930	680930	0.6809

Notes: 1) Values include materials, electrical, piping, installation, blowers, grading, chlorination feed sys., and conc. slab; but exclude land, engineering, fencing, paving, drainage, lighting, and building facilities.

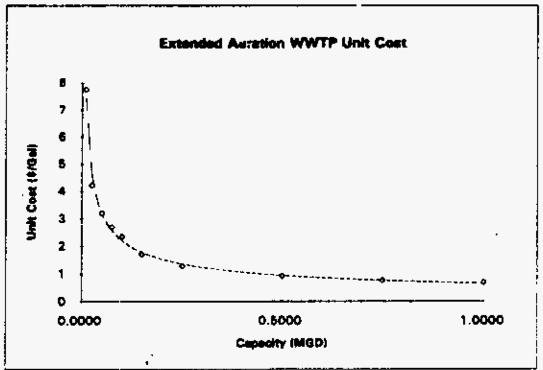
All costs obtained from manufacturer's quotes and EPA cost curves.

Costs are based on June 1995, ENR Index = 5433.

CURVE FORMULA (For any capacity on the curve)

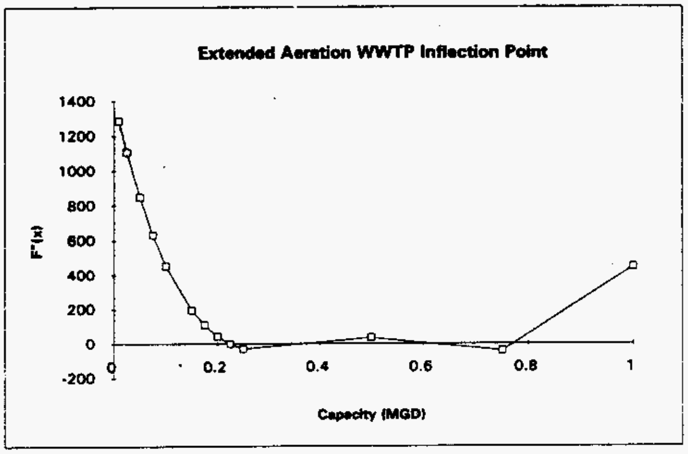
Y = (0.6521692)*X^(-0.5290282) **** See Example Below

Capacity (MGD)	Unit Cost ($/Gal)	Manuf. Unit Cost ($/Gal)
0.0100	7.45447	7.75
0.0250	4.59087	4.22
0.0400	3.58022	
0.0500	3.18157	3.20496
0.0650	2.76925	
0.0750	2.56735	2.69753
0.0900	2.33129	
0.1000	2.2049	2.35974
0.1150	2.04775	
0.1300	1.91915	
0.1500	1.77923	1.71179
0.1650	1.69174	
0.1800	1.61563	
0.1950	1.54865	
0.2100	1.48911	
0.2250	1.43573	
0.2400	1.38754	
0.2500	1.3579	1.27809
0.2650	1.31668	
0.2800	1.27888	
0.2950	1.24405	
0.3100	1.21184	
0.3250	1.18192	
0.3400	1.15404	
0.3550	1.12798	
0.3700	1.10355	
0.3850	1.0806	
0.4000	1.05897	
0.4150	1.03854	
0.4300	1.01922	
0.4450	1.00089	
0.4600	0.98349	
0.4750	0.96694	
0.4900	0.95116	
0.5000	0.94105	0.92437
0.5150	0.92645	
0.5300	0.91249	
0.5450	0.89911	
0.5600	0.88629	
0.5750	0.87398	
0.5900	0.86216	
0.6050	0.85078	
0.6200	0.83983	
0.6350	0.82927	
0.6500	0.8191	
0.6650	0.80927	
0.6800	0.79977	
0.6950	0.7906	
0.7100	0.78172	
0.7250	0.77312	
0.7400	0.76479	
0.7500	0.75938	0.76195
0.7650	0.75146	
0.7800	0.74378	
0.7950	0.73632	
0.8100	0.72908	
0.8250	0.72204	
0.8400	0.71519	
0.8550	0.70852	
0.8700	0.70203	
0.8850	0.69571	
0.9000	0.68955	
0.9150	0.68355	
0.9300	0.67769	
0.9450	0.67198	
0.9600	0.66641	
0.9750	0.66096	
1	0.65217	0.68093



EXTENDED AERATION WWTP INFLECTION POINT

Capacity (MGD)	F"(x)
0.01	1286.7
0.025	1107.93
0.05	847.924
0.075	631.193
0.1	453.15
0.15	195.964
0.175	108.824
0.2	44.38
0.225	-0.7796
0.25	-29.831
0.5	34.7526
0.75	-39.895
1	445.206



EXTENDED AERATION, MECHANICAL AND DIFFUSED AERATION — FACT SHEET 2.1.10

Description - Extended aeration is the "low rate" modification of the activated sludge process. The F/M loading is in the range of 0.05 to 0.15 lb BOD_5/d/lb MLVSS, and the detention time is about 24 hours. Primary clarification is rarely used. The extended aeration system operates in the endogenous respiration phase of the bacterial growth cycle, because of the low BOD_5 loading. The organisms are starved and forced to undergo partial auto-oxidation. Volatile compounds are driven off to a certain extent in the aeration process. Metals will also be partially removed, with accumulation in the sludge.

In the complete mix version of the extended aeration process, all portions of the aeration basin are essentially homogeneous, resulting in a uniform oxygen demand throughout the aeration tank. This condition can be accomplished fairly simply in a symmetrical (square or circular) basin with a single mechanical aerator or by diffused aeration. The raw wastewater and return sludge enter at a point (e.g., under a mechanical aerator) where they are quickly dispersed throughout the basin. In rectangular basins with mechanical aerators or diffused air, the incoming waste and return sludge are distributed along one side of the basin and the mixed liquor is withdrawn from the opposite side.

Common Modifications - Step aeration, contact stabilization, and plug flow regimes. Alum or ferric chloride is sometimes added to the aeration tank for phosphorus removal.

Technology Status - Extended aeration plants have evolved since the latter part of the 1940's. Pre-engineered, package plants have been widely utilized for this process.

Typical Equipment/No. of Mfrs. - Aerators/30; package treatment plants/21; air diffusers/19; compressors/44.

Applications - Commonly flows of less than 50,000 gal/d; emergency or temporary treatment needs; and biodegradable wastewater.

Limitations - High power costs, operation costs, and capital costs (for large permanent installations where the pre-engineered plants would not be appropriate).

Performance

BOD_5 Removal	85-95%
NH_4 - N Removed (Nitrification)	50-90%

Residuals Generated - Because of the low F/M loadings and long hydraulic detention times employed, excess sludge production for the extended aeration process (and the closely related oxidation ditch process) is the lowest of any of the activated sludge process alternatives, generally in the range of 0.15 to 0.3 lb excess total suspended solids/lb BOD_5 removed.

Design Criteria (39) - A partial listing of design criteria for the extended aeration modification of the activated sludge process is summarized as follows:

Volumetric loading, lb BOD_5/d/1,000 ft^3	5 to 10
MLSS, mg/l	3,000 to 6,000
F/M, lb BOD_5/d/lb MLVSS	0.05 to 0.15
Aeration detention time, hours (based on average daily flow)	18 to 36
Standard ft^3 air/lb BOD_5 applied	3,000 to 4,000
lb O_2/lb BOD_5 applied	2.0 to 2.5 (based on 1.5 lb O_2/lb BOD_5 removed + 4.6 lb O_2/lb NH_4-N removed)
Sludge retention time, days	20 to 40
Recycle ratio (R)	0.75 to 1.5
Volatile fraction of MLSS	0.6 to 0.7

Process Reliability - Good

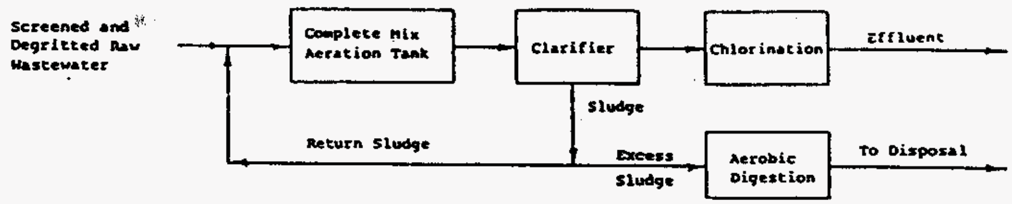
Environmental Impact - See Fact Sheet 2.1.1

References - 23, 26, 31, 39

EXTENDED AERATION, MECHANICAL AND DIFFUSED AERATION

FACT SHEET 2.1.10

FLOW DIAGRAM -

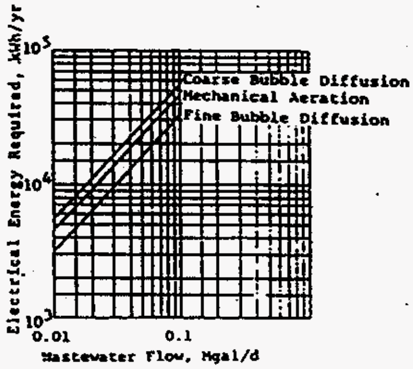


ENERGY NOTES - Assumptions: The hydraulic head loss through the aeration tank is negligible. Sludge recycle and sludge wasting pumping energy are included.

Water Quality:	Influent(mg/l)	Effluent(mg/l)
BOD_5	210	20
Suspended Solids	230	20
NH_4-N	20	1

Oxygen Transfer Rate (wire to water) in wastewater for:
- Mechanical Aeration = 1.8 lb O_2/hph
- Diffused Aeration
  - Coarse Bubble Diffusion - 1.5 lb O_2/hph
  - Fine Bubble Diffusion = 2.5 lb O_2/hph

Oxygen Requirement:
- 1.5 lb O_2/lb BOD_5 removed plus 4.6 lb O_2/lb of NH_4-N removed

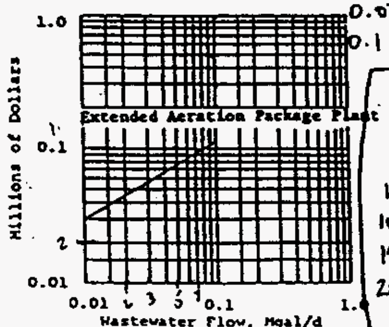


COSTS* - Assumptions: Construction cost includes comminutor, aeration basin, clarifier, chlorine contact chamber, aerobic digester, chlorine feed facility, building, fencing for extended aeration package plants between 0.01 and 0.1 Mgal/d. Detention time: 24 hours (based on average daily flow). ENR Index = 2475 Annual power costs based on coarse bubble diffuser.

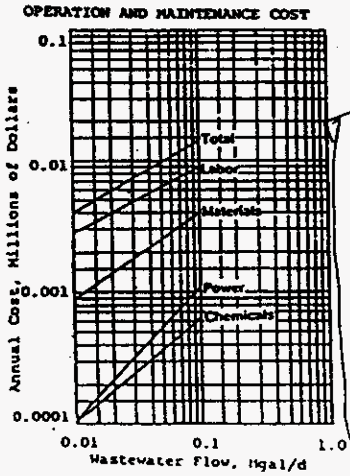
update ratio = 5433 / 2475

#'s	cost	updated cost	unit cost
0.01	30,000	65,855	6.59
0.03	56,000	122,928	4.10
0.05	75,000	164,636	3.29
0.07	91,000	199,759	2.85
0.1	115,000	252,442	2.52

CONSTRUCTION COST



OPERATION AND MAINTENANCE COST



REFERENCES - 3, 4

*To convert construction cost to capital cost see Table A-2.

MOSS KELLEY INCORPORATED

FACSIMILE TRANSMISSION

IF TRANSMISSION WAS NOT PROPERLY RECEIVED, CALL (305) 755-2092

DATE: 7-6-95

FROM: J Kelley FAX NUMBER: (305 341-9370

TO: Jamie Walsh FAX NUMBER:

COMPANY: Hartman NUMBER OF PAGES: 2

REFERENCE: Package Plant Budget Pricing

I hope the attached is sufficient.

Sanitaire doesn't make the smaller plants.

Please call if you have any questions.

J Kelley

10100 W. SAMPLE RD., SUITE 408, CORAL SPRINGS, FL 33065 (305) 755-2092 FAX (305) 341-9370

2180 WEST S.R. 434, SUITE 1178, LONGWOOD, FL 32779 (407) 774-7200 FAX (407) 774-7209

SANITAIRE

[illegible] Ring Steel List Costs

Capacity (gpd)	Extended Aeration List Price ($)	Extended Aeration Turn Key Install.	Contact Stabilization List Price ($)	Contact Stabilization Turn Key Install.
10,000	ø		ø	
25,000	ø		ø	
50,000	$82,000	$110,000	$75,000	$100,000
75,000	$100,000	$135,000	$81,000	$109,000
100,000	$115,000	$155,000	$96,000	$130,000
150,000	$142,000	$192,000	$109,000	$148,000
250,000	$185,000	$246,000	$148,000	$200,000
500,000	$268,000	$360,000	$215,000	$290,000
750,000	$325,000	$440,000	$260,000	$350,000
1,000,000	$385,000	$520,000	$308,000	$415,000

Blowers, concrete slab not included.

"SERVING THE WATER INDUSTRY SINCE 1956"

DAVCO

MEETING THE GROWING DEMAND FOR CLEAN WATER

1828 Metcalf Ave.
Thomasville, Georgia 31792
Phone 912-226-5733
Telefax No.
912-228-0312

FACSIMILE TRANSMITTAL SHEET

From: Tommy Tyson
Phone 941-646-7694
Fax. 941-644-6319

To: HAI - Jamie Wallace Re: Budget Estimates

Fax. number: 407-839-3790 Date: 7-2-95

Total number of pages including this page is: 2

REMARKS:

Budget estimates are for "DAVCO standard" equipment delivered to central Florida. DAVCO std is Aluminum grating and aluminum handrails. Also depending on size, duplex or triplex rotary positive blowers and controls are included. I have not included any accessories such as comminutor, flowmeter or telemetry equipment (or Cl2 feed eq).

Turn key price includes slabs, grout for clarifier (if applicable) and installation and finish coating of equipment (if applicable). As we discussed these prices are for "conventional" single train, single clarifier units and will not meet FDEP Class I, II or III Regulations. Mainly on clarifier requirements (multiple units).

Filter prices include media. Coarse bubble diffusers for plants was utilized. Chain & sprocket drive w/shear pin overload protection.

* Making changes such as: Aluminum weir launders or stainless steel Air headers and drop pipes, direct drive clarifier drive and so forth can add significantly to the prices I have given - Please adjust accordingly.

Factory Built and Davco Ring Steel ~~List~~ Budget Costs

Capacity (gpd)	Extended Aeration: Budget Price ($)	Extended Aeration: Turn Key Install.	Contact Stabilization: Budget Price ($)	Contact Stabilization: Turn Key Install.
10,000	36000	14000	N/A	N/A
25,000	60000	18000	N/A	N/A
50,000	110000	25000	65000	18000
75,000	150000	35000	100000	22000
100,000	175000	42000	125000	27000
150,000	140000	70000	120000	60000
250,000	175000	85000	155000	75000
500,000	250000	125000	215000	105000
750,000	300000	150000	250000	125000
1,000,000	358000	175000	280000	140000

FILTERS (NO INSTALLATION COSTS INCLUDED)

ES FILTER

0 to .05 MGD = 28000
> .05 ≤ .10 MGD = 40000
> .10 ≤ .15 MGD = 50000

AVELING BRIDGE FILTER

.25 MGD : 55000 or 2 @ .2 MGD = 107000
.50 MGD : 70000 or 2 @ .375 MGD = 135000
.75 MGD : 85000 or 2 @ .56 MGD = 145000
1.0 MGD : 98000 or 2 @ .75 MGD = 170000

APPENDIX B

Package Wastewater Treatment Plants
Unit Costs

Capacity (MGD)	Davco Con. Stab. ($)	Sanitaire Con. Stab. ($)	Total Con. Stab. Const. Cost ($)	Overall Con. Stab. w/ Chlor. ($)	Unit Cost ($/Mgd)
0.010	--	--	--	--	
0.025	--	--	--	--	
0.050	83,000	112,350	97,675	127,675	2.5535
0.075	122,000	127,225	124,613	154,613	2.0615
0.100	152,000	152,321	152,161	187,161	1.8716
0.150	180,000	177,950	178,975	213,975	1.4265
0.250	230,000	244,320	237,160	272,160	1.0886
0.500	320,000	356,540	338,270	373,270	0.7465
0.750	375,000	466,160	420,580	455,580	0.6074
1.000	420,000	560,430	490,215	525,215	0.5252

Notes: 1) Values include materials, electrical, piping, installation, blowers, grading, chlorination feed sys., and conc. slab; but exclude land, engineering, *fencing, paving, drainage, lighting, and building facilities.*

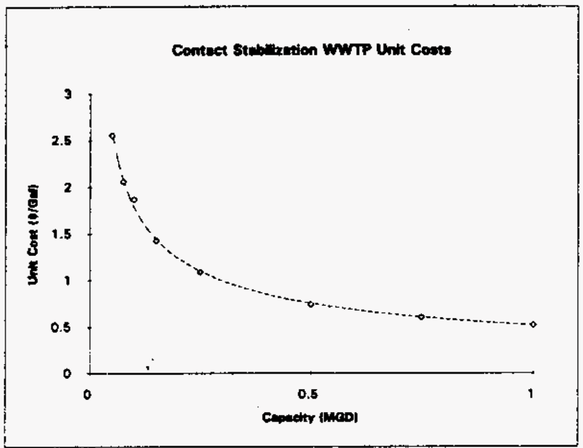
All costs obtained from manufacturer's quotes and EPA cost curves.

Costs based on June 1995, ENR Index = 5433.

CURVE FORMULA (For any capacity on the curve)

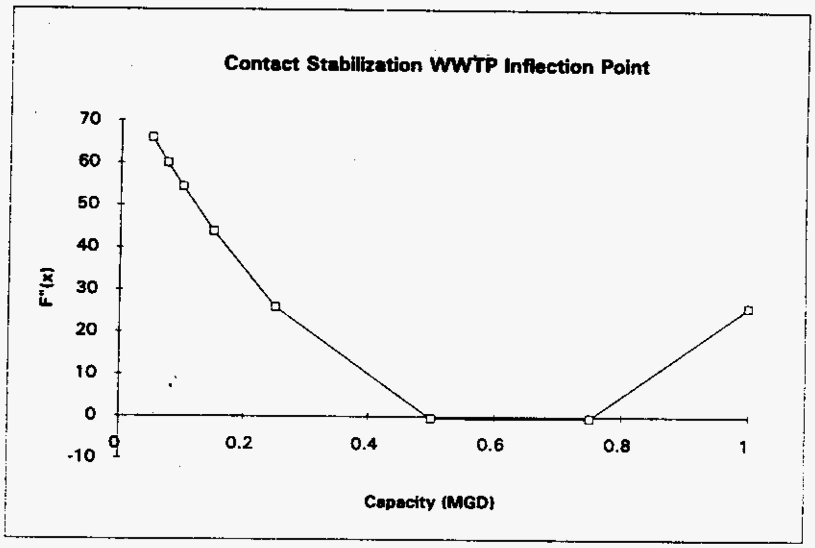
Y = (0.5249354)*X^(-0.5321867)

Capacity (MGD)	Cost ($)	Manuf. Cost ($)
0.05	2.58522	2.554
0.065	2.24832	
0.075	2.08345	2.062
0.09	1.89079	
0.1	1.78769	1.872
0.115	1.65955	
0.13	1.55472	
0.15	1.44072	1.427
0.165	1.36946	
0.18	1.30749	
0.195	1.25297	
0.21	1.20451	
0.225	1.16109	
0.24	1.12189	
0.25	1.09778	1.089
0.265	1.06426	
0.28	1.03353	
0.295	1.00522	
0.31	0.97903	
0.325	0.95472	
0.34	0.93207	
0.355	0.9109	
0.37	0.89105	
0.385	0.87241	
0.4	0.85484	
0.415	0.83825	
0.43	0.82256	
0.445	0.80769	
0.46	0.79356	
0.475	0.78013	
0.49	0.76733	
0.5	0.75912	0.747
0.515	0.74727	
0.53	0.73594	
0.545	0.72509	
0.56	0.71469	
0.575	0.70471	
0.59	0.69511	
0.605	0.68589	
0.62	0.67701	
0.635	0.66845	
0.65	0.66019	
0.665	0.65223	
0.68	0.64453	
0.695	0.63709	
0.71	0.62989	
0.725	0.62292	
0.74	0.61617	
0.75	0.61178	0.607
0.765	0.60537	
0.78	0.59914	
0.795	0.5931	
0.81	0.58723	
0.825	0.58152	
0.84	0.57597	
0.855	0.57057	
0.87	0.56532	
0.885	0.5602	
0.9	0.55521	
0.915	0.55035	
0.93	0.54561	
0.945	0.54098	
0.96	0.53646	
0.975	0.53206	
1	0.52494	0.525



CONTACT STABILIZATION WWTP INFLECTION POINT

Capacity (GPD)	F"(x)
0.05	65.9752
0.075	60.0467
0.1	54.3818
0.15	43.8428
0.25	25.9278
0.5	-0.4082
0.75	-0.3852
1	25.997



CONTACT STABILIZATION, DIFFUSED AERATION

FACT SHEET 2.1.8

Description - Contact stabilization is a modification of the activated sludge process (described more completely in Fact Sheet 2.1.1). In this modification, the adsorptive capacity of the floc is utilized in the contact tank to adsorb suspended, colloidal, and some dissolved organics. The hydraulic detention time in the contact tank is only 30 to 60 minutes (based on average daily flow). After the biological sludge is separated from the wastewater in the secondary clarifier, the concentrated sludge is separately aerated in the stabilization tank with a detention time of 2 to 6 hours (based on sludge recycle flow). The adsorbed organics undergo oxidation in the stabilization tank and are synthesized into microbial cells. If the detention time is long enough in the stabilization tank, endogenous respiration will occur, along with a concomitant decrease in excess biological sludge production. Following stabilization, the reaerated sludge is mixed with incoming wastewater in the contact tank and the cycle starts anew. Volatile compounds are driven off to a certain extent by aeration in the contact and stabilization tanks. Metals will also be partially removed, with accumulation in the sludge.

This process requires smaller total aeration volume than the conventional activated sludge process. It also can handle greater organic shock and toxic loadings because of the biological buffering capacity of the stabilization tank and the fact that at any given time the majority of the activated sludge is isolated from the main stream of the plant flow. Generally, the total aeration basin volume (contact plus stabilization basins) is only 50 - 75 percent of that required in the conventional activated sludge system. A description of diffused aeration techniques is presented in Fact Sheet 2.1.1.

Common Modifications - Used in a package treatment plant with clarification and chlorination facilities in one vessel. Other modifications include raw wastewater feed to aeration tank; flow equalization; integral aerobic digester.

Technology Status - Contact stabilization has evolved as an outgrowth of activated sludge technology since 1950 and seen common usage in package plants and some usage for on-site constructed plants.

Typical Equipment/No. of Mfrs. - Air diffusers/19; compressors/44; package treatment plants/21.

Applications - Wastewaters that have an appreciable amount of BOD_5 in the form of suspended and colloidal solids; upgrading of an existing, hydraulically overloaded conventional activated sludge plant; new installations, to take advantage of low aeration volume requirements; where the plant might be subject to shock organic or toxic loadings; where larger, more uniform flow conditions are anticipated (or if the flows to the plant have been equalized).

Limitations - It is unlikely that effluent standards can be met using contact stabilization in plants smaller than 50,000 gal/d without some prior flow equalization. Other limitations include operational complexity, high operating costs, high energy consumption and high diffuser maintenance. As the fraction of soluble BOD_5 in the influent wastewater increases, the required total aeration volume of the contact stabilization process approaches that of the conventional process.

Performance -

BOD_5 Removal	80 to 95 percent
NH_4-N Removal	10 to 20 percent

Residuals Generated - See Fact Sheet 2.1.1.

Design Criteria (39) - A partial listing of design criteria for the contact stabilization process is summarized as follows:

F/M, lb BOD_5/d/lb MLVSS	0.2 to 0.6
Volumetric loading, lb BOD_5/d/1,000 ft^3	30 to 50 (based on contact and stabilization volume)
MLSS, mg/l	1,000 to 2,500, contact tank; 4,000 to 10,000, stabilization tank
Aeration time, h	0.5 to 1.0, contact tank (based on average daily flow)
	2 to 6, stabilization basin (based on sludge recycle flow)
Sludge retention time, days	5 to 10
Recycle ratio (R)	0.25 to 1.0
Std. ft^3 air/lb BOD_5 removed	800 to 2,100
lb O_2/lb BOD_5 removed	0.7 to 1.0
Volatile fraction of MLSS	0.6 to 0.8

Process Reliability - Requires close operator attention.

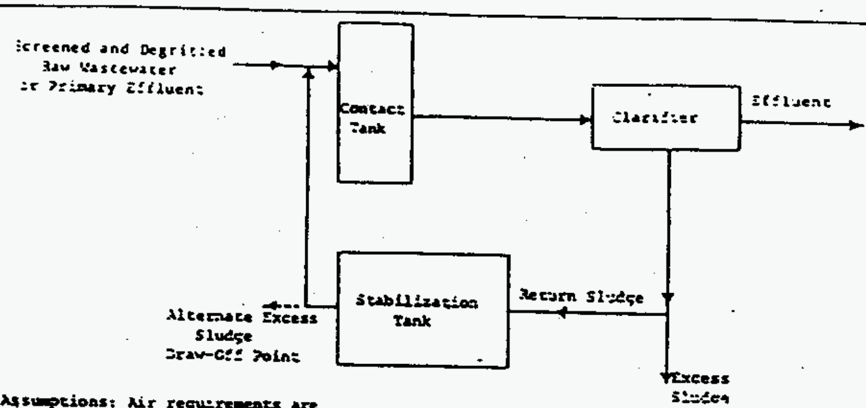
Environmental Impact - See Fact Sheet 2.1.1

References - 23, 26, 31, 39

CONTACT STABILIZATION, DIFFUSED AERATION

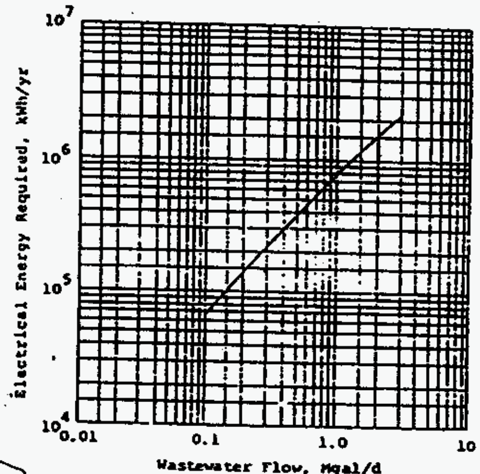
FACT SHEET 2.1.8

FLOW DIAGRAM -



ENERGY NOTES - Assumptions: Air requirements are based on 2100 ft^3/lb BOD_5 removed (2 lb BOD_5/1000 gal/d). Positive displacement blowers with 100% standby are provided. Electricity = $.03/kWh. Includes energy requirements for entire package plant.

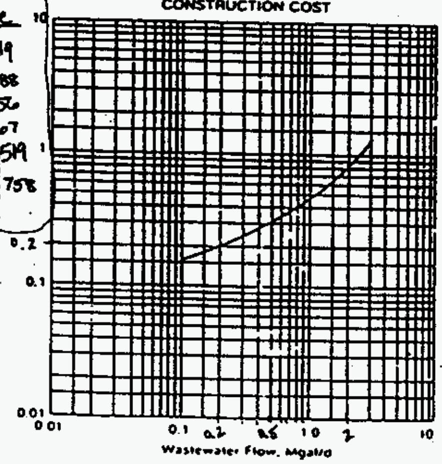
cost ratio = 5433 / 2401 =



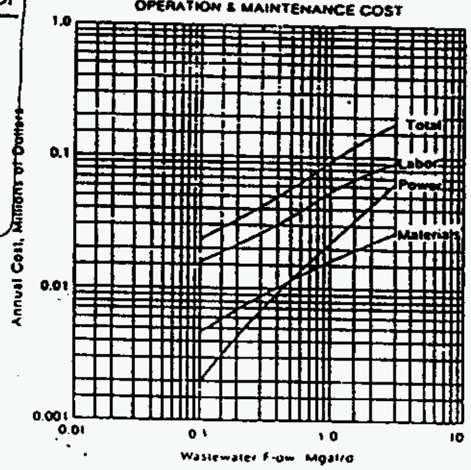
COSTS* - Assumptions: Costs are in 1976 dollars; ENR index = 2401.
1. Construction cost is for package plants and includes tankage and equipment in place for aeration chambers, chlorination equipment, clarification and sludge stabilization. Costs include concrete and yardwork, 15% contingency, electrical and instrumentation, and contractor's overhead and profit at 25% of equipment costs but exclude land, engineering, legal or financing during construction.
2. O&M costs are based on a labor rate of $9/h, including fringe benefits, with 7 d/wk staffing and electricity @ $.03/kWh. Maintenance materials include chlorine.

size	cost	update	unit cost
0.1	160,000	362,049	3.62
0.3	245,000	554,388	1.85
0.5	305,000	690,156	1.38
0.7	380,000	859,867	1.23
1.0	470,000	1,063,519	1.06
2.0	840,000	1,900,758	0.95

CONSTRUCTION COST



OPERATION & MAINTENANCE COST



REFERENCE - 16

MOSS
KELLEY
INCORPORATED

FACSIMILE TRANSMISSION

IF TRANSMISSION WAS NOT PROPERLY RECEIVED, CALL (305) 755-2092

DATE: 7-6-95

FROM: J Kelley FAX NUMBER: (305 341-9370

TO: Jamie Walsh FAX NUMBER:

COMPANY: Hartman NUMBER OF PAGES: 2

REFERENCE: Package Plant Budget Pricing

I hope the attached is sufficient.

Sanitaire doesn't make the smaller plants.

Please call if you have any questions.

J Kelley

10100 W. SAMPLE RD., SUITE 408, CORAL SPRINGS, FL 33065 (305) 755-2092 FAX (305) 341-9370
2180 WEST S.R. 434, SUITE 1178, LONGWOOD, FL 32779 (407) 774-7200 FAX (407) 774-7209

SANITAIRE

[illegible] Ring Steel List Costs

Capacity (gpd)	Extended Aeration List Price ($)	Extended Aeration Turn Key Install.	Contact Stabilization List Price ($)	Contact Stabilization Turn Key Install.
10,000	∅		∅	
25,000	∅		∅	
50,000	$82,000	$110,000	$75,000	$100,000
75,000	$100,000	$135,000	$81,000	$109,000
100,000	$115,000	$155,000	$96,000	$130,000
150,000	$142,000	$192,000	$109,000	$148,000
250,000	$185,000	$246,000	$148,000	$200,000
500,000	$268,000	$360,000	$215,000	$290,000
750,000	$325,000	$440,000	$260,000	$350,000
1,000,000	$385,000	$520,000	$308,000	$415,000

Blowers, concrete slab not included.

941 644 6319 P.01

"SERVING THE WATER INDUSTRY SINCE 19__"

DAVCO

MEETING THE GROWING DEMAND FOR CLEAN WATER

1828 Metcalf Ave.
Thomasville, Georgia 31792
Phone 912-226-5733
Telefax No.
912-228-0312

FACSIMILE TRANSMITTAL SHEET

From: Tommy Tyson
Phone 941-646-7694
Fax. 941-644-6319

To: HAI - Jamie Wallace Re: Budget Estimates

Fax. number: 407-839-3190 Date: 7-2-95

Total number of pages including this page is: 2

REMARKS:

Budget estimates are for "DAVCO standard" equipment delivered to central Florida. Davco std. is Aluminum grating and aluminum handrails. Also depending on size, duplex or triplex rotary positive blowers and controls are included. I have not included any accessories such as comminutor, flowmeter or telemetry equipment (or Cl2 feed eq).
Turn key price includes slabs, grout for clarifier (if applicable) and installation and finish coating of equipment (if applicable). As we discussed these prices are for "conventional" single train, single clarifier units and will not meet FDEP class I, II or III Regulations. Mainly on clarifier requirements (multiple units).
Filter prices include media. Coarse bubble diffusers for plants was utilized. Chain + sprocket drive w/shear pin overload protection.

* Making changes such as: Aluminum weir launders or stainless steel Air headers and drop pipes, direct drive clarifier drive and so forth can add significantly to the prices I have given - Please adjust accordingly.

FACTORY Built and Davco Ring Steel ~~List~~ Budget Costs

	Extended Aeration		Contact Stabilization	
Capacity (gpd)	Budget Price ($)	Turn Key Install.	Budget Price ($)	Turn Key Install.
10,000	36000	14000	N/A	N/A
25,000	60000	18000	N/A	N/A
50,000	110000	25000	65000	18000
75,000	150000	35000	100000	22000
100,000	175000	42000	125000	27000
150,000	140000	70000	120000	60000
250,000	175000	85000	155000	75000
500,000	250000	125000	215000	105000
750,000	300000	150000	250000	125000
1,000,000	358000	175000	280000	140000

FILTERS (NO INSTALLATION COSTS INCLUDED)

TES FILTER
- 0 to .05 MGD : 28000
- > .05 ≤ .10 MGD : 40000
- > .10 ≤ .15 MGD : 50000

TRAVELING BRIDGE FILTER
- .25 MGD : 55000 OR 2 @ .2 MGD = 107000
- .50 MGD : 70000 OR 2 @ .375 MGD = 135000
- .75 MGD : 85000 OR 2 @ .56 MGD = 145000
- 1.0 MGD : 98000 OR 2 @ .75 MGD = 170000

APPENDIX C

Sutorbilt
Positive Displacement Blowers
Construction Costs

Capacity @ 7 psig (scfm)	Motor Size (HP)	P.D. Blower Cost ($)	Blower Unit Cost ($/scfm)
50	5	2,450	49
100	5	2,625	26.25
250	15	3,950	15.8
500	25	5,625	11.25
750	40	9,600	12.8
1,000	50	10,000	10
1,250	60	13,850	11.08
1,500	75	16,225	10.81666667
1,750	75	17,675	10.1
2,000	100	21,000	10.5
2,500	125	25,000	10
3,000	150	32,500	10.83333333
3,500	200	40,000	11.42857143
4,000	200	48,000	12
4,500	200	52,000	11.55555556

NOTES:
1) All costs obtained from manufacturer's quotes.
2) Costs include blower, TEFC motor, steel base, silencers, relief valve, pressure gauge, and check valve.
3) Costs are based on June 1995, ENR Index = 5433.

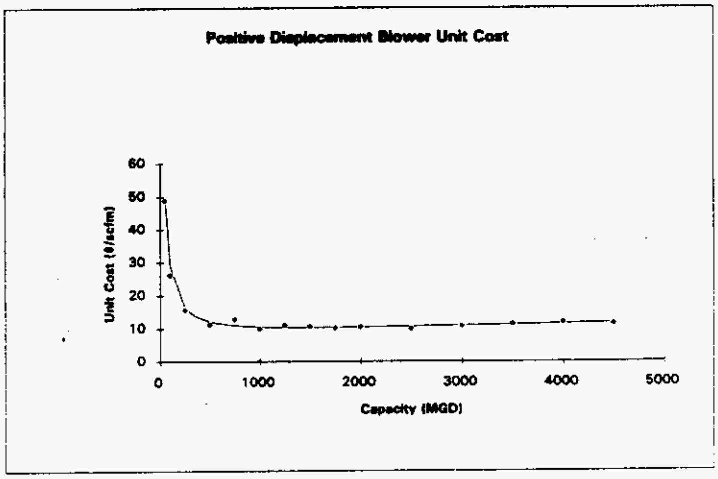
CURVE EQUATION:

Y = (2150.968)+(7.348993)X+(1.133403E-03)X^2+
(-5.4948E-08)X^3

*** For Unit costs, just divide the output by the blower capacity.

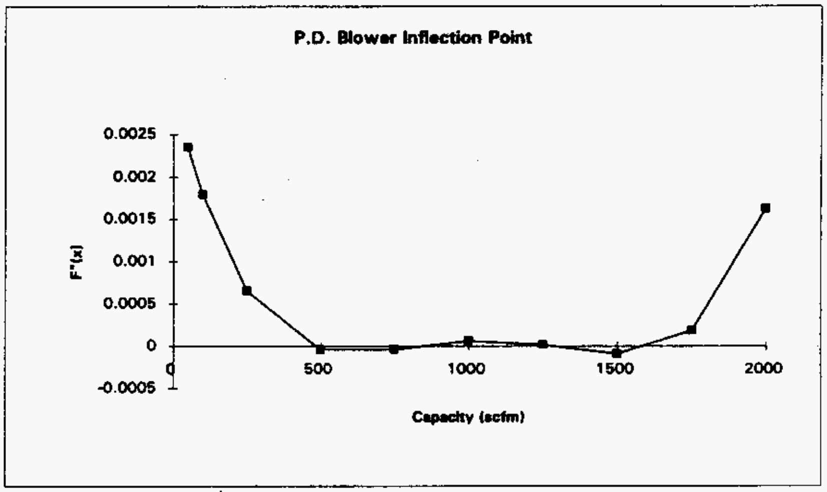
Capacity @ 7 psig (scfm)	P.D. Blower Cost ($)	Manuf. Blower Cost
50	50.42489	49
100	28.97146	26
250	16.23278	16
350	13.88458	
500	12.20389	11
600	11.5942	
750	11.03609	13
850	10.80324	
950	10.64031	
1000	10.57842	10
1100	10.48467	
1250	10.40066	11
1350	10.37225	
1500	10.35944	11
1600	10.36613	
1750	10.39329	10
1850	10.42041	
1950	10.45325	
2000	10.47149	11
2100	10.51109	
2200	10.55424	
2300	10.60035	
2400	10.6489	
2500	10.69946	10
2600	10.75169	
2700	10.80526	
2800	10.85993	
2900	10.91546	
3000	10.97166	10.83333
3100	11.02835	
3200	11.08539	
3300	11.14265	
3400	11.2	
3500	11.25735	11.42857
3600	11.31461	
3700	11.37169	
3800	11.42852	
3900	11.48504	
4000	11.54118	12
4100	11.5969	
4200	11.65214	
4300	11.70686	
4400	11.76103	
4500	11.8146	11.55556

Positive Displacement Blower Construction Cost Curve



POSITIVE DISPLACEMENT BLOWER INFLECTION POINT

Capacity (scfm)	F"(x)
50	0.00236
100	0.001796
250	0.000657
500	-4.4E-05
750	-4.2E-05
1000	6.29E-05
1250	1.64E-05
1500	-8.9E-05
1750	0.000184
2000	0.001623



Sutorbilt
Positive Displacement Blowers
Construction Costs

Capacity @ 7 psig (scfm)	Motor Size (HP)	P.D. Blower Complete Package Cost ($)
50	5	2,450
100	5	2,625
250	15	3,950
500	25	5,625
750	40	9,600
1,000	50	10,000
1,250	60	13,850
1,500	75	16,225
1,750	75	17,675
2,000	100	21,000
2,500	125	25,000
3,000	150	32,500
3,500	200	40,000
4,000	200	48,000
4,500	200	52,000

Hoffman
Centrifugal Blowers
Construction Costs

Capacity @ 7 psig (scfm)	Motor Size (HP)	Cent. Blower Cost ($)	Cent. Blower Unit Cost ($/scfm)
500	40	14,500	29
750	50	16,500	22
1,000	60	17,500	17.5
1,250	75	18,500	14.8
1,500	100	19,500	13
1,750	100	26,000	14.857143
2,000	100	26,000	13
2,500	125	27,000	10.8
3,000	150	32,000	10.666667
3,500	150	32,000	9.1428571
4,000	200	37,000	9.25
4,500	200	37,000	8.2222222

NOTES:

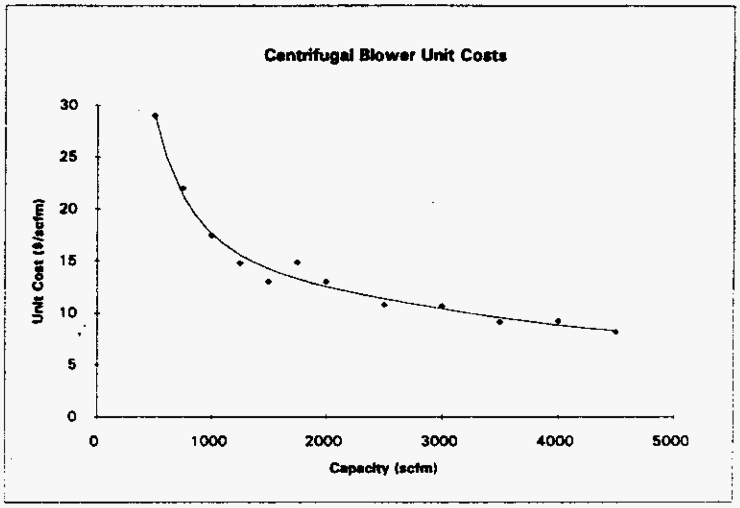
1) All costs obtained from manufacturer's quotes.
2) Costs include blower and TEFC motor.
3) Costs are based on June 1995, ENR Index = 5433.

CURVE EQUATION:

$$Y = (12737.73)+(1.53442)X+(4.666822E{-}03)X^{2}+(-1.435126E{-}06)X^{3}+(1.319283E{-}10)X^{4}$$

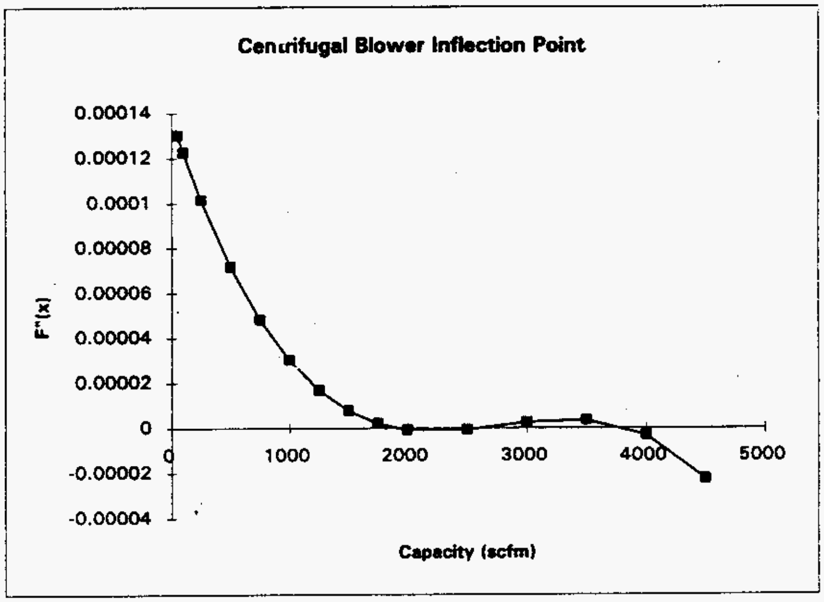
*** For Unit costs, just divide the output by the blower capacity.

Capacity @ 7 psig (scfm)	Cent. Blower Unit Cost ($/scfm))	Manuf. Blower Unit Cost
500	29.0009	29
600	25.07579	
750	21.26643	22
850	19.53076	
950	18.19376	
1000	17.63557	18
1100	16.68655	
1250	15.57317	15
1350	14.97879	
1500	14.2424	13
1600	13.82855	
1750	13.29169	15
1850	12.97653	
1950	12.68767	
2000	12.55145	13
2100	12.29279	
2200	12.04963	
2300	11.81915	
2400	11.59915	
2500	11.38791	11
2600	11.18408	
2700	10.98665	
2800	10.79485	
2900	10.60813	
3000	10.42613	10.66667
3100	10.24861	
3200	10.07549	
3300	9.906776	
3400	9.742579	
3500	9.583081	9.142857
3600	9.428531	
3700	9.27924	
3800	9.135568	
3900	8.997919	
4000	8.866736	9.25
4100	8.742496	
4200	8.625707	
4300	8.516901	
4400	8.416636	
4500	8.325491	8.222222



CENTRIFUGAL BLOWER INFLECTION POINT

Capacity (scfm)	F"(x)
50	0.00013
100	0.000123
250	0.000102
500	7.18E-05
750	4.82E-05
1000	3.01E-05
1250	1.69E-05
1500	7.77E-06
1750	2.13E-06
2000	-7E-07
2500	-6.4E-07
3000	2.58E-06
3500	3.59E-06
4000	-3E-06
4500	-2.3E-05



Hoffman
Centrifugal Blowers
Construction Costs

Capacity @ 7 psig (scfm)	Motor Size (HP)	Centrifugal Blower Complete Package Cost ($)
50	--	--
100	--	--
250	--	--
500	40	14,500
750	50	16,500
1,000	60	17,500
1,250	75	18,500
1,500	100	19,500
1,750	100	26,000
2,000	100	26,000
2,500	125	27,000
3,000	150	32,000
3,500	150	32,000
4,000	200	37,000
4,500	200	37,000

the JACOBS GROUP, inc.

160 SCARLET BOULEVARD • OLDSMAR, FLORIDA 34677 • (813) 854-5297 • FAX (813) 855-8821

FAX TRANSMITTAL SHEET

TO:	Jamey Wallace	FROM:	John Verscharen
COMPANY:	Hartman & Associates	DATE:	7-12-95
FAX NO.:	407-839-3790	PAGES (INCLUDING COVER):	4

SUBJECT: Blower Budget Estimates

MESSAGE: See rough blower budget estimates attached.

FORM 3/93

Hoffman ↙ ↙ Sutorbilt

Centrifugal & Positive Displacement Blower List Cost

Budget Price for Package as shown with TEFC motor

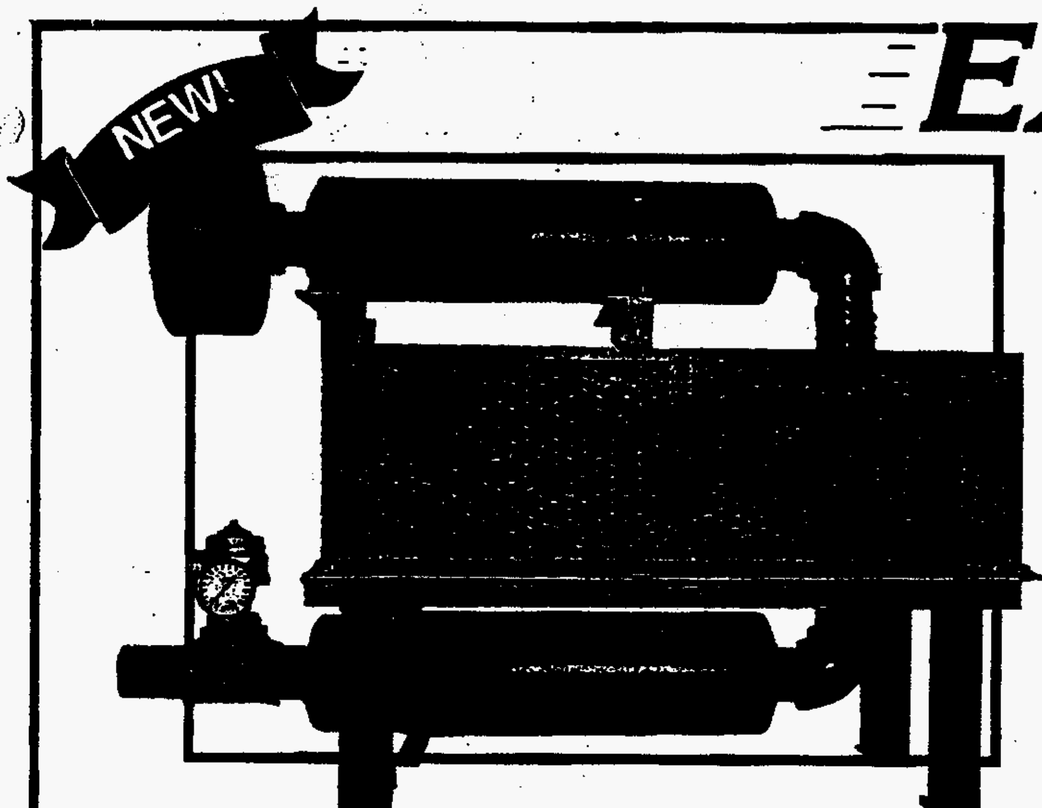
Budget Price for Filter Blower + Motor (TEFC) only

Capacity @ 7 psig (scfm)	Motor Size (HP)	Positive Displacement Complete Package Cost ($)		Centrifugal Complete Package Cost ($)
50	5	2450.00		N/A
100	5	2625.00		N/A
250	15	3950.00		N/A
500	25	5625.00	40	14,500.00
750	40	9600.00	50	16,500.00
1000	50	10,000.00	60	17,500.00
1250	60	13,850.00	75	18,500.00
1500	75	16,225.00	100	19,500.00
1750	75	17,675.00	100	20,000.00
2000	100	21,000.00	100	26,000.00
2500	125	25,000.00	125	27,000.00
3000	150	32,500.00	150	32,000.00
3500	200	40,000.00	150	32,000.00
4000	200	48,000.00	200	37,000.00
4500	200	52,000.00	200	37,000.00

Notes: (Any extra costs needed) 1) P.D.'s require B.V.'s
2) Centrifugal requires C.V.'s and B.V.'s

P.3

EXP



Universal Blower Pac, Inc.

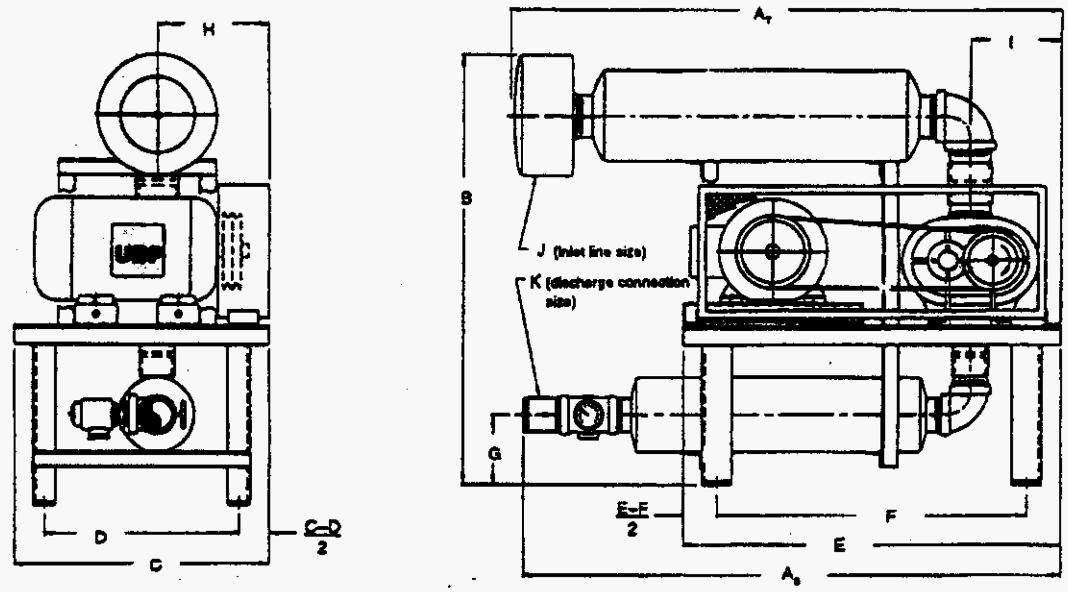
EXPRESS BLOWER PAC

For more than a decade, you've counted on ***UNIVERSAL BLOWER PAC, INC.*** for quality and economy. With the ***EXP*** package, ***EXPRESS*** delivery is added to the same high standards without ***EXPRESS***-related charges. This standard, pre-engineered ***EXP*** unit has an ***EXPRESS*** delivery time of ten to twenty days with drawings available for ***EXPRESSING*** on the same day as purchase. ***EXP*** units feature ***EXPRESS*** installation since all parts are assembled as a complete package.

STANDARD *EXP* FEATURES

- Featuring Sutorbilt Blowers
- Heavy duty steel base
- Dual take-up motor rails
- High efficiency electric motor
- Premium absorptive & chamber/absorptive silencers
- Dual silencer supports w/ holding straps
- V-belt drive 1.5 S.F.
- Tool gray machinery enamel paint
- Spring-loaded relief valve set at maximum blower pressure
- Pressure gauge w/ snubber & petcock protection
- Check valve w/ EPDM seal & stainless steel spring
- Rugged flex joints
- Inlet filter w/ weatherhood
- EZ access belt guard
- Completely assembled units

UNIVERSAL BLOWER PAC, INC. • 440 PARK 32 WEST DRIVE • NOBLESVILLE, IN 46060-9252 • 317-773-7256 • FAX 317-776-5086



BLOWER	A_T	A_B	B	C	D	E	F	G	H	I	J	K*	WEIGHT
2ML	**	33.5	35	24	17.5	40	33.5	10	10	8	1.5	1.25	300
2LL	**	46.5	34	24	17.5	40	33.5	8.5	10	8	2	2	300
3HL	**	39	60	24	17.5	40	33.5	8.5	10	8	2	1.5	400
3ML	**	46.5	62	24	17.5	40	33.5	8.5	10.5	8	2.5	2	400
3LL	**	56.5	73	24	17.5	40	33.5	8.5	12	8	3	2.5	450
4HL	**	47.5	64	34	26	50	41	9	14	9	2.5	2	550
4ML	**	57.5	75	34	26	50	41	10	14	9	3	2.5	650
4LL	**	61.5	82	34	26	50	41	8.5	15	9	3.5	3	750
5HL	**	59	76	34	26	50	41	10	14	10.5	3	2.5	900
5ML	**	62	84	34	26	50	41	8	15	10.5	3.5	3	1000
5LL	80	70.5	60	34	26	50	41	13.5	17	10.5	5	4	1200
6HL	**	64.5	87	34	26	50	41	9	14	12	3.5	3	1350
6ML	81	72	61	34	26	50	41	12	15	12	5	4	1600
6LL	75	65	85	38	28	60	48	13.5	19	15	6	6	1900
7HL	70	77	64	38	28	60	48	13	16	15	4	4	1650
7ML	75	85.5	82	38	28	60	48	17	18	15	6	5	2300
7LL	96	79	99	44	36.5	72	62.5	13.5	22	15	8	8	2800
8HL	84	75	70	44	36.5	72	62.5	14	20	15	5	4	2450
8ML	96	65	102	44	36.5	72	62.5	14.5	20	15	8	6	3400
8LL	97	79	110	44	36.5	72	62.5	17.5	22	15	10	8	4150

* 1"-5" are MPT, 6"-10" are 125/150 lb. ANSI flange.
** Inlet silencer is in vertical position.
All mounting holes are 5/8" diameter.
Dimensional tolerance to mounting holes is +/- 1/4".
Other dimensions are nominal, request certified drawing.

UNIVERSAL BLOWER PAC, INC.
440 PARK 32 WEST DRIVE
NOBLESVILLE, IN 46060-9252
Phone: 317/773-7256
Fax: 317/776-5086

APPENDIX D

Davco
Wastewater Treatment Filters
Construction & Unit Costs

Capacity (GPD)	Type of Filter	Filter Cost ($)	Filter (1) Construction Cost ($)	Unit Cost ($/gal)
50,000	Gravity	29,000	46,400	0.928
100,000	Gravity	41,500	66,400	0.664
150,000	Gravity	54,000	86,400	0.576
250,000	Traveling Bridge	76,500	122,400	0.4896
500,000	Traveling Bridge	91,000	145,600	0.2912
750,000	Traveling Bridge	105,500	168,800	0.22506667
1,000,000	Traveling Bridge	119,000	190,400	0.1904

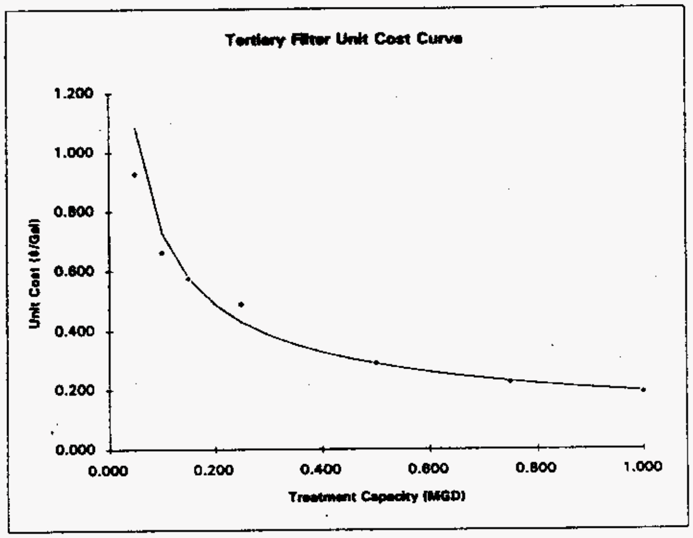
NOTES:

(1) Filter and media costs obtained from manufacturer's quotes.
(2) Costs include filter, media, 15% piping, 15% electrical, 5% sitework, 20% installation, and 5% for the concrete slab.
(3) Costs are based on June 1995, ENR Index = 5433.

CURVE EQUATION

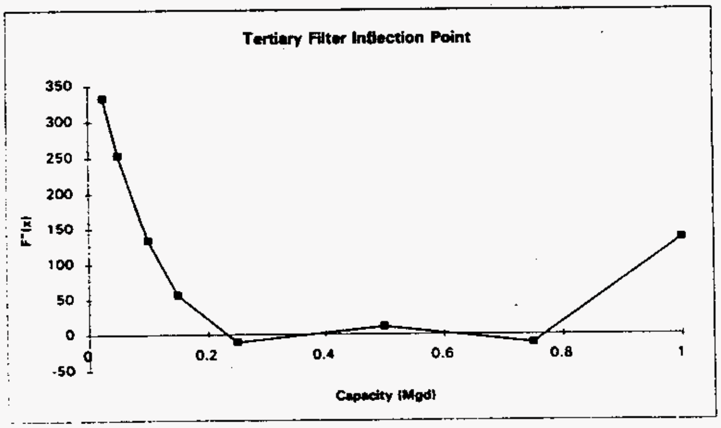
Y = (0.1940938)X^(-0.5751405)

Capacity (MGD)	Unit Cost ($/Gal)	Manuf. Unit Cost ($/Gal)
0.050	1.087	0.928
0.100	0.730	0.664
0.150	0.578	0.576
0.200	0.490	
0.250	0.431	0.490
0.300	0.388	
0.350	0.355	
0.400	0.329	
0.450	0.307	
0.500	0.289	0.291
0.550	0.274	
0.600	0.260	
0.650	0.249	
0.700	0.238	
0.750	0.229	0.225
0.800	0.221	
0.850	0.213	
0.900	0.206	
0.950	0.200	
1.000	0.194	0.190



TERTIARY FILTER INFLECTION POINT

Capacity (MGD)	F"(x)
0.025	332.944256
0.05	253.868194
0.1	134.067582
0.15	56.3672339
0.25	-10.894528
0.5	11.35955
0.75	-12.063528
1	136.3878



Davco
Wastewater Treatment Filters
Construction Costs

Capacity (GPD)	Type of Filter	Filter Cost ($)	Filter (1) Construction Cost ($)
50,000	Gravity	29,000	46,400
100,000	Gravity	41,500	66,400
150,000	Gravity	54,000	86,400
250,000	Traveling Bridge	76,500	122,400
500,000	Traveling Bridge	91,000	145,600
750,000	Traveling Bridge	105,500	168,800
1,000,000	Traveling Bridge	119,000	190,400

NOTES: (1) Values obtained from manufacturer's quotes.
(2) Costs include filter, media, 15% piping, 15% electrical, 5% sitework, 20% installation, and 5% for the concrete slab.

RECORD OF TELEPHONE COMMUNICATION

DATE: 10/19 TIME: 2:15

PROJECT NAME: SSU- Economy of Scale PROJECT NO.: 95-145.00

PARTY CALLING: Janey Wallace COMPANY: HAI

PARTY CONTACTED: Jim Kelley (Patty) COMPANY: Moss-Kelley

SUBJECT: Tertiary treatment filter costs

TELEPHONE COMMUNICATION SUMMARY (Including Decisions & Commitments)

Package Gravity Filter 50,000 GPD → # 30,000 } Freight to jobsite
100,000 GPD → # 43,000
150,000 GPD → # 58,000

ABW (Travelling Bridge)

6x16	0.25 MGD →	(Steel) # 98,000	
9x20	0.5 MGD →	(S) # 112,000	(Concrete) # 92,000
9x30	0.75 MGD →	(S) # 126,000	(C) # 101,000
9x40	1.0 MGD →	(S) # 140,000	(C) # 110,000

ACTION REQUIRED

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, scientists & management consultants

P.01

"SERVING THE WATER INDUSTRY SINCE 1894"

DAVCO

MEETING THE GROWING DEMAND FOR CLEAN WATER

1828 Metcalf Ave.
Thomasville, Georgia 31792
Phone 912-226-5733
Telefax No.
912-228-0312

FACSIMILE TRANSMITTAL SHEET

From: Tommy Tyson
Phone 941-646-7694
Fax. 941-644-6319

To: HAI - Jamie Wallace Re: Budget Estimates

Fax. number: 407-839-3790 Date: 7-2-95

Total number of pages including this page is: 2

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Filter prices include media. Coarse bubble diffusers for plants was utilized. Chain + sprocket drive w/shear pin overload protection.

* Making changes such as: Aluminum weir launders or stainless steel air headers and drop pipes, direct drive clarifier drive and so forth can add significantly to the prices I have given - Please adjust accordingly.

FACTORY Built and Davco Ring Steel ~~List~~ Budget Costs

	Extended Aeration		Contact Stabilization	
Capacity (gpd)	Budget Price ($)	Turn Key Install.	Budget Price ($)	Turn Key Install.
FACTORY BUILT + PAINTED Equipment				
10,000	36000	14000	N/A	N/A
25,000	60000	18000	N/A	N/A
50,000	110000	25000	65000	18000
75,000	150000	35000	100000	22000
100,000	175000	42000	125000	27000
FIELD ERECTED AND FIELD COATED EQUIPMENT				
150,000	140000	70000	120000	60000
250,000	175000	85000	155000	75000
500,000	250000	125000	215000	105000
750,000	300000	150000	250000	125000
1,000,000	358000	175000	280000	140000

FILTERS (NO INSTALLATION COSTS INCLUDED)

TES FILTER

- 0 to .05 MGD : 28000
- > .05 ≤ .10 MGD : 40000
- > .10 ≤ .15 MGD : 50000

TRAVELING BRIDGE FILTER

- .25 MGD : 55000 or 2 @ .2 MGD = 107000
- .50 MGD : 70000 or 2 @ .375 MGD = 135000
- .75 MGD : 85000 or 2 @ .56 MGD = 145000
- 1.0 MGD : 98000 or 2 @ .75 MGD = 170000

APPENDIX E

Wastewater Treatment Systems
Chlorine Feed Systems
Unit Costs

Chlorine Feed Rate (lb/day)	System Type (150# or 1 ton)	Package Cost ($)	Treatment Capacity (Mgd)	Overall Construction Cost ($)	Unit Cost $
100	150 lb. (1)	16,400	0.01	25,420	2.54
200	150 lb.	17,600	0.50	27,280	0.05
500	1 Ton (2)	52,200	1.00	80,910	0.08
1,000	1 Ton	63,900	2.00	99,045	0.05
2,000	1 Ton	71,145	5.00	110,275	0.02

NOTES:

(1) The 150 lb facilities are equipped with a 25 square foot shelter.

(2) The Ton systems are equipped with a 400 square foot shelter which consists of a concrete base, steel supports, a fiberglass panel roof, and an overhead crane.

(3) Costs include dual chlorinators w/ switchover, dual scales, gas detector, alarm panel, vacuum switch, booster pump, housing, and hoists all are included in the manufacturer's quotes.

(4) Includes 20% electrical, 15% piping, and 20% installation costs.

(5) Costs are vased on June 1995, ENR Index = 5433.

Heyward INCORPORATED

1865 N. SEMORAN BOULEVARD
SUITE NO. 240
WINTER PARK, FLORIDA 32792
PHONE: (407) 679-1333
FAX: (407) 657-6889

July 5, 1995

Hartman & Associates, Inc.
201 East Pine St.
Suite 1000
Orlando, FL 32801

Attention: Jamey Wallace

Subject: Wallace & Tiernan Chlorination System

Dear Jamey:

In response to your request for an estimate for Wallace & Tiernan Chlorine Gas Vacuum Systems with manual chlorinators, injectors, gas handling fixtures, cylinder scales, booster pump, gas detector and miscellaneous safety items, pricing is as follows:

Chlorinator Model	Feed Rate Per Day	Gas Supply	Estimated Cost
V-500	100	150# Cylinder	$ 22,300
V-500	200	150# Cylinder	$ 23,200
V-500	500	Ton Cylinder	$ 25,600
V-2000	1000	Ton Cylinder	$ 41,800
V-2000	2000	Ton Cylinder	$ 44,900

For the 150# cylinder systems, I have included a standard 4x6 FRP building with appropriate fixtures and safety devices. For the ton cylinder units, a facility for handling ton cylinders will be required. Also, you will find the scales required for the 150# systems are included along with the ton cylinder scales to be mounted in your handling facility.

Jamey Wallace
July 5, 1995
Page 2

The above are basic equipment costs and can be utilized for basic estimates. Please advise if any additional peripheral equipment is required, such as chlorine analyzers or pH recorders.

I have included the two (2) basic chlorinator sales information bulletins and can elaborate on other equipment if you require. Thank you very much.

Kindest regards,

HEYWARD INCORPORATED - FOR
WALLACE & TIERNAN, INC.

Richard E. Neal
Winter Park Office

REN/gl

Enclosure

20% Elect.
15% Pipe
10% ENG
10% Site work

* TON Chlorine Storage Bldg *

20'x20' concrete, fiberglass panels, overhead crane

(2/92) Concrete - 2,200
Structural Steel - 10,000
Fiberglass - 7,800
Overhead crane - 3,500
Painting - 4,000
27,500 ↓ ENR ↑ 30,000

Capital Controls Chlorine Feed System
List Costs

Type: Gas Chlorination => Includes: Dual trunnions, Dual chlorinators, Auto Switch over, Ejector, Booster pump, FRP housing (150 lb system), Leak detector, etc.

	Chlorine Feed Rate (lb/day)	Type of System (150 lb cyl.) or (1 ton)	Package Cost ($)
150	100 ①	150 #	$ 10,500 —
150	200 ①	150 #	12,000 —
	②	TON	18,200 —
TON	500 ②	TON	18,800 —
TON	1000 ③	TON	26,000 —
TON	2000 ③	TON	37,380 —

Note: (Any extra costs needed).

① 100/200 PPD, 150 # CYL SYSTEMS INCLUDE: COMPLETE CHLORINATOR W/ SWITCHOVER EJECTOR, GAS DETECTOR, DUAL SCALE, ALARM PANEL, VACUUM SWITCH, BOOSTER PUMP, 5'X5' FIBERGLASS SHELTER (2 CONTAINER MANIFOLD ON 200 PPD).

② 200/500 PPD, TON SYSTEMS INCLUDE: ALL OF ABOVE EXCEPT FIBERGLASS SHELTER BUT DUAL GAS DETECTORS, (2) TON SCALE, (2) PAIR TON STORAGE TRUNNIONS.

③ 1000/2000 PPD SYSTEMS INCLUDE: ALL OF ABOVE BUT (2) TWO TON MANIFOLD (1000 PPD) OR (2) 4 TON MANIFOLD (2000 PPD), WALL MOUNTED CHLORINATOR CABINET, (2) DUAL TON SCALES (1000 PPD) OR (2) 4-TON SCALES (2000 PPD), (4) PAIR STORAGE TRUNNIONS.

HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants	SH. NO.: 1	JOB NO.: 95-145.00
	MADE BY: JJW	DATE:
	CHECKED BY:	DATE:

Chlorination Curve! (wastewater)

Values 1,000,000 Gallon / Day and less ⇒ 150 lb cylinders
>1,000,000 GPD ⇒ ton cylinders

MANUFACT INFO

10,000 ⇒ $2.54	1,000,000 ⇒ $ 0.081
20,000 ⇒ $1.27	1,500,000 ⇒ $ 0.06
50,000 ⇒ $0.51	2,000,000 ⇒ $ 0.0495
100,000 ⇒ $0.25	3,000,000 ⇒ $ 0.033
200,000 ⇒ $0.14	4,000,000 ⇒ $ 0.027
500,000 ⇒ $0.055	5,000,000 ⇒ $ 0.022
750,000 ⇒ $0.036	
1,000,000 ⇒ $0.027	

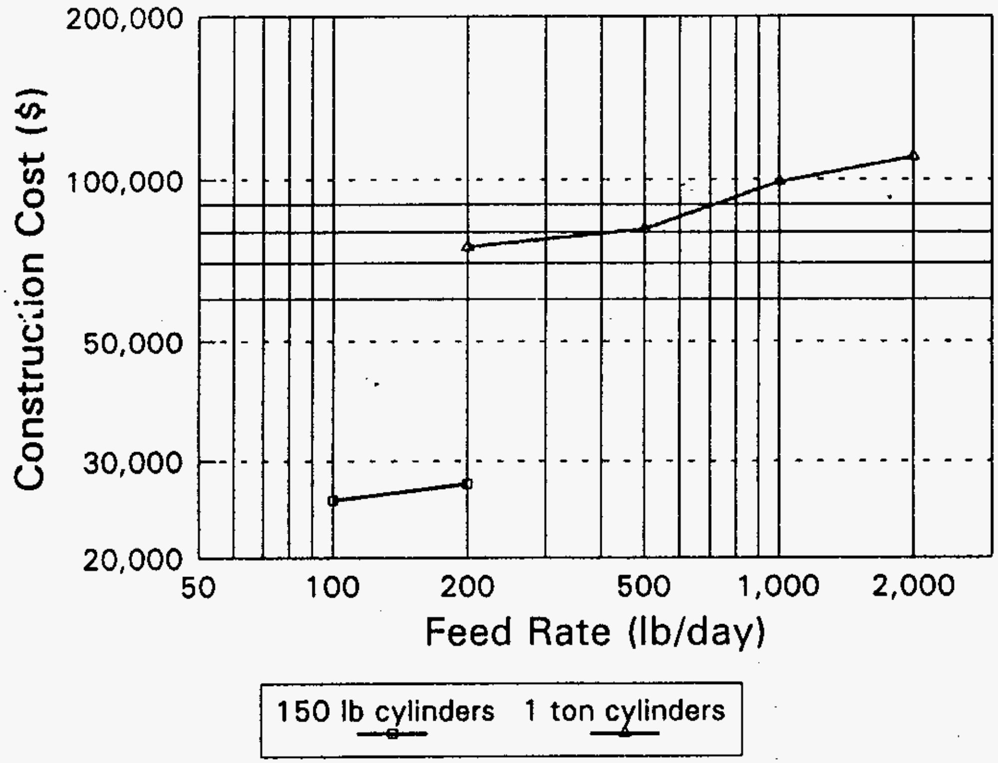
EPA INFO

10,000 ⇒ $3.5	1,500,000 ⇒ $ 0.073
20,000 ⇒ $2.0	2,000,000 ⇒ $ 0.063
50,000 ⇒ $0.90	3,000,000 ⇒ $0.048
100,000 ⇒ $0.46	4,000,000 ⇒ $ 0.04
200,000 ⇒ $0.25	5,000,000 ⇒ $ 0.034
500,000 ⇒ $0.14	
750,000 ⇒ $0.11	
1,000,000 ⇒ $0.095	

Notes: Same as before except
2nd Source is
EPA Wastewater Source E, pages 19-21.

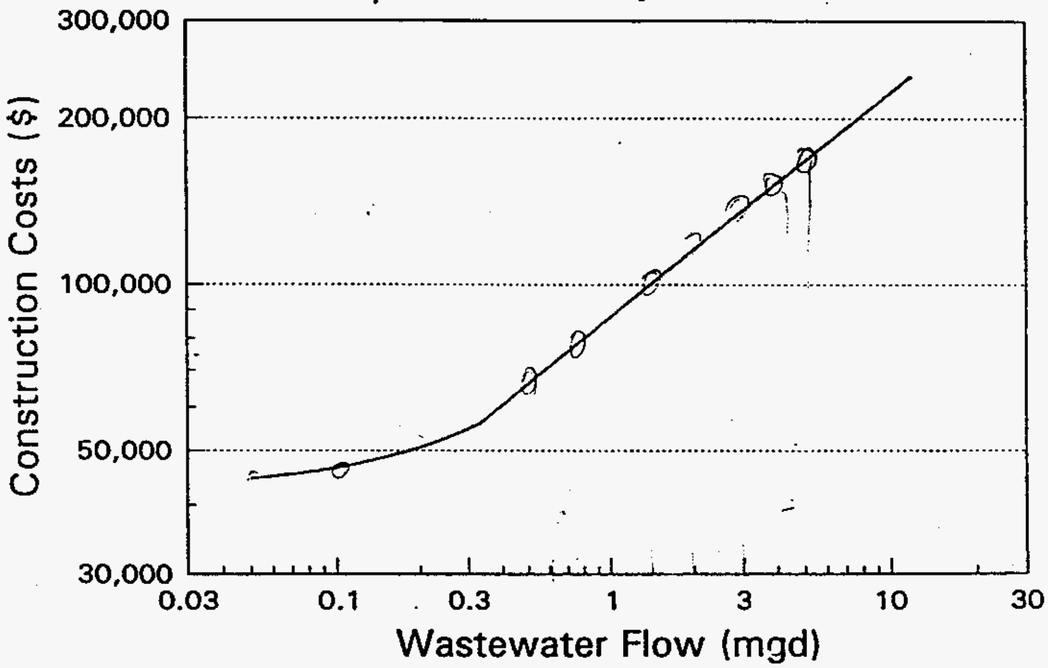
GRAPH #4

Chlorine Feed Systems



GRAPH #33

Chlorination Feed System



Note: Source E, Figure 10, pp. 19-21.

* Everything included.

Water Treatment Systems
Chlorine Feed Systems
Unit Costs

Chlorine Feed Rate (lb/day)	System Type (150# or 1 ton)	Package Cost ($)	Treatment Capacity (Mgd)	Overall Construction Cost ($)	Unit Cost $
100	150 lb. (1)	16,400	0.01	25,420	2.54
200	150 lb.	17,600	0.20	27,280	0.14
500	1 Ton (2)	52,200	2.00	80,910	0.04
1,000	1 Ton	63,900	4.00	99,045	0.02
2,000	1 Ton	71,145	5.00	110,275	0.02

NOTES:

(1) The 150 lb facilities are equipped with a 25 square foot shelter.
(2) The Ton systems are equipped with a 400 square foot shelter which consists of a concrete base, steel supports, a fiberglass panel roof, and an overhead crane.
(3) Costs include dual chlorinators w/ switchover, dual scales, gas detector, alarm panel, vacuum switch, booster pump, housing, and hoists all are included in the manufacturer's quotes.
(4) Includes 20% electrical, 15% piping, and 20% installation costs.
(5) Costs are vased on June 1995, ENR Index = 5433.

HARTMAN & ASSOCIATES, INC.	SH. NO.: 1	JOB NO.: 95-146.00
engineers, hydrogeologists, surveyors & management consultants	MADE BY: JJW	DATE:
	CHECKED BY:	DATE:

Chlorination Curve (Water)

Values
2,000,000 Gallon/Day and less ⇒ 150 lb cylinders
> 2,000,000 Gallon/Day ⇒ ton cylinders

MANUFACT. INFO.

10,000	⇒ $2.54	1,500,000	⇒ $0.02
20,000	⇒ $1.27	2,000,000	⇒ $0.015
50,000	⇒ $0.51	2,000,000	⇒ $0.04
100,000	⇒ $0.25	3,000,000	⇒ $0.028
200,000	⇒ $0.14	4,000,000	⇒ $0.023
500,000	⇒ $0.055	5,000,000	⇒ $0.02
750,000	⇒ $0.036		
1,000,000	⇒ $0.027		

EPA INFO

10,000	⇒ $2.0	1,000,000	⇒ $0.067
20,000	⇒ $0.98	1,500,000	⇒ $0.056
50,000	⇒ $0.392	2,000,000	⇒ $0.049
100,000	⇒ $0.196	3,000,000	⇒ $0.04
200,000	⇒ $0.137	4,000,000	⇒ $0.037
500,000	⇒ $0.0924	5,000,000	⇒ $0.032
750,000	⇒ $0.077		
1,000,000	⇒ $0.067		

Values based on Costs of System divided by Capacity of System

Notes: ① All values include sitework, piping, electrical, installation, and storage-feed facilities.

② Values obtained from Manufacturer's cost estimates and EPA Water Source B, pages 13-14.

GRAPH #4

Chlorine Feed Systems

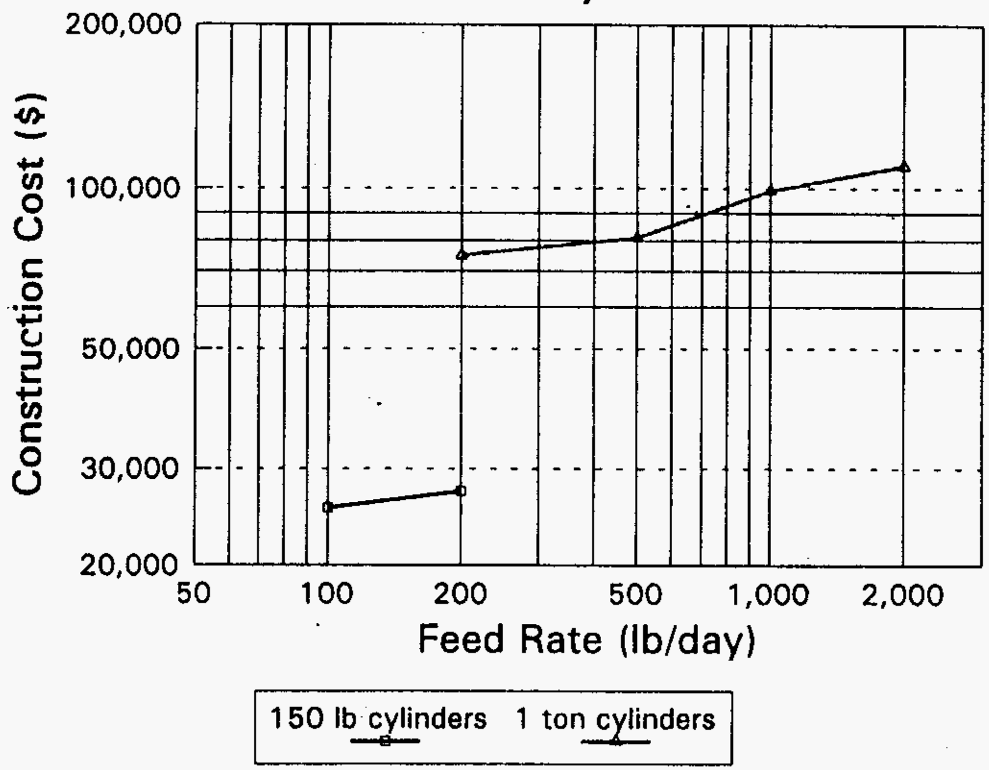


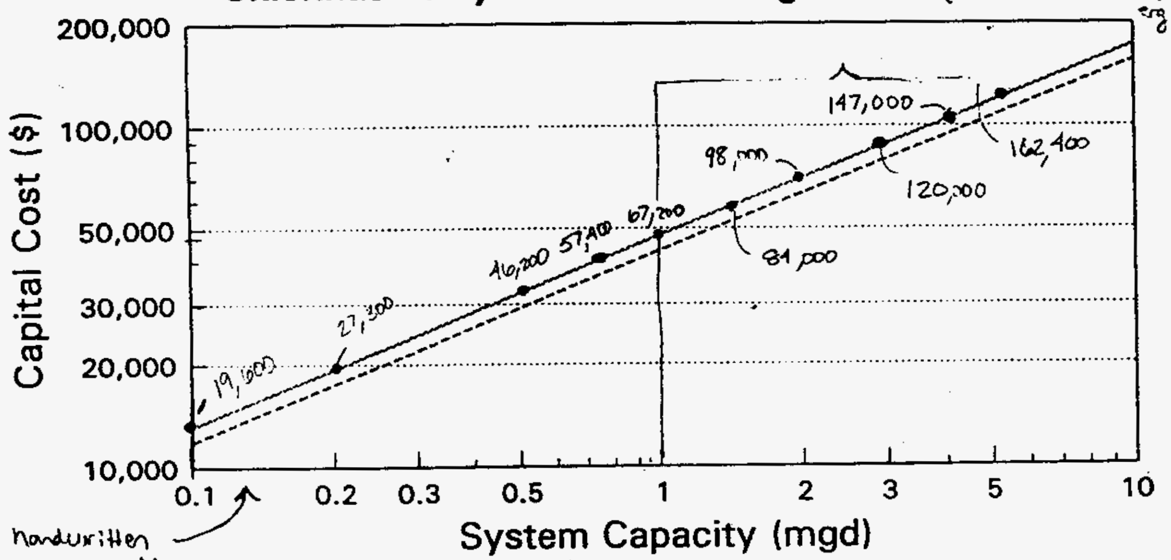
EXHIBIT (C-CH-4)
PAGE 135 OF 284

[illegible] ⇒ 18¢ = 43.6¢
200,000 ⇒ 14¢ = 33.9¢
500,000 ⇒ 9¢ = 21.8¢
1,000,000 ⇒ 7¢ = 16.9¢
2,000,000 ⇒ 5¢ = 12.1¢
5,000,000 ⇒ 3¢ = 7.3¢

DRINKING WATER

GRAPH #5

Chlorination System for Drinking Water (Adjust for Inst., site, eng., e



* All handwritten values are adjusted values.

ENR Index Handy Whitman

Note: Source B, Figure 2-6, pp. 13-14.

* For 100 lb/day + less ⇒ 150 lb cylinders + Feed houses
* > 100 lb/day ⇒ ton cylinders

Includes: Duplicate chlorinator, injector pumps, housing, 30-day storage capacity included, piping,

* Below 0.1 mgd ⇒ $7600 ⇒ $13,071 ⟹ $18,300 < 100,000 GPD

Add: Installation (50%), electrical (20%), site (0%), engineering (0%)

APPENDIX F

Standby Generator Set
Construction Costs

Capacity (KW)	Ringhaver GenSet Cost ($)	Cummins GenSet Cost ($)	GenSet Cost ($)	GenSet Unit Cost ($/KW)
8	$8,800	$7,524	$8,162	$1,088.27
15	$9,550	$11,357	$10,454	$696.90
25	$11,000	$12,760	$11,880	$475.20
35	$12,000	$13,629	$12,815	$366.13
50	$13,700	$16,152	$14,926	$298.52
75	$15,400	$19,666	$17,533	$233.77
100	$19,000	$22,378	$20,689	$206.89
150	$22,400	$29,137	$25,769	$171.79
200	$24,400	$35,947	$30,174	$150.87
250	$27,300	$40,773	$34,037	$136.15
300	$33,500	$46,175	$39,838	$132.79
350	$36,000	$51,396	$43,698	$124.85
400	$42,200	$66,818	$54,509	$136.27
500	$60,500	$93,896	$77,198	$154.40
600	$72,600	$102,521	$87,561	$145.93
750	$95,000	$135,697	$115,349	$153.80
1,000	$130,000	$165,798	$147,899	$147.90
1,250	$168,000	$215,888	$191,944	$153.56
1,500	$192,000	$265,200	$228,600	$152.40

NOTES:

1) All costs obtained from manufacturer's quotes.
2) Costs include a packaged diesel electric set with base, a unit mounted radiator cooling system, and a control panel.
3) Costs are based on December 1995, ENR Index = 5471.

RINGHAVER EQUIPMENT COMPANY
POWER SYSTEMS DIVISION
9901 RINGHAVER DRIVE 32824
P.O. BOX 590206
ORLANDO, FLORIDA 32859-0206
PHONE# 407-855-6195
FAX# 407-438-0922

DATE: Jan. 29, 96	PAGE 1 OF 3
TO: Pete Hoenshelt	FAX# 359-0748
COMPANY: EMI	
FROM: Bob Bohnert	EXT: 223

Pete -
Hopefully this is what you need for ... If not, let me know
Bob

Ringhaver
CAT

January 29, 1996

EMI Consulting Specialties, Inc.
Mr. Pete Hoenshelt
3001 Little Cypress Cove
Winter Park, FL 32792
FX# 359-0748

Subject: Standby Generator Set
Budgetary Pricing

Dear Pete:

The attached chart shows representative budget prices for unit sizes in our Caterpillar/Olympian and Caterpillar lines. The basic unit consists of a packaged diesel electric set with base, and unit mounted radiator cooling system and control/metering panel.

These are current prices, subject to change without notice. Please call if additional information is needed.

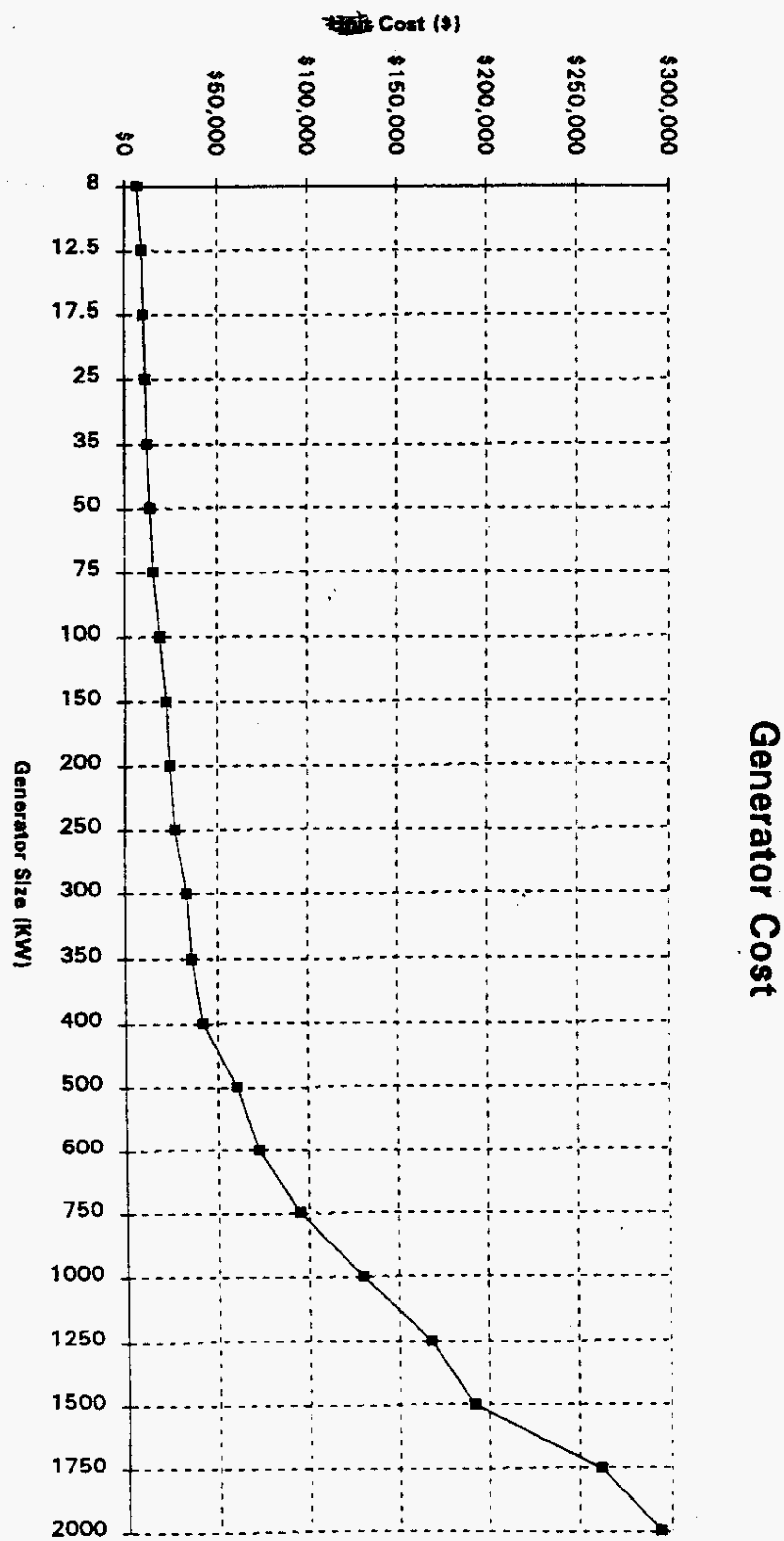
Very truly yours,

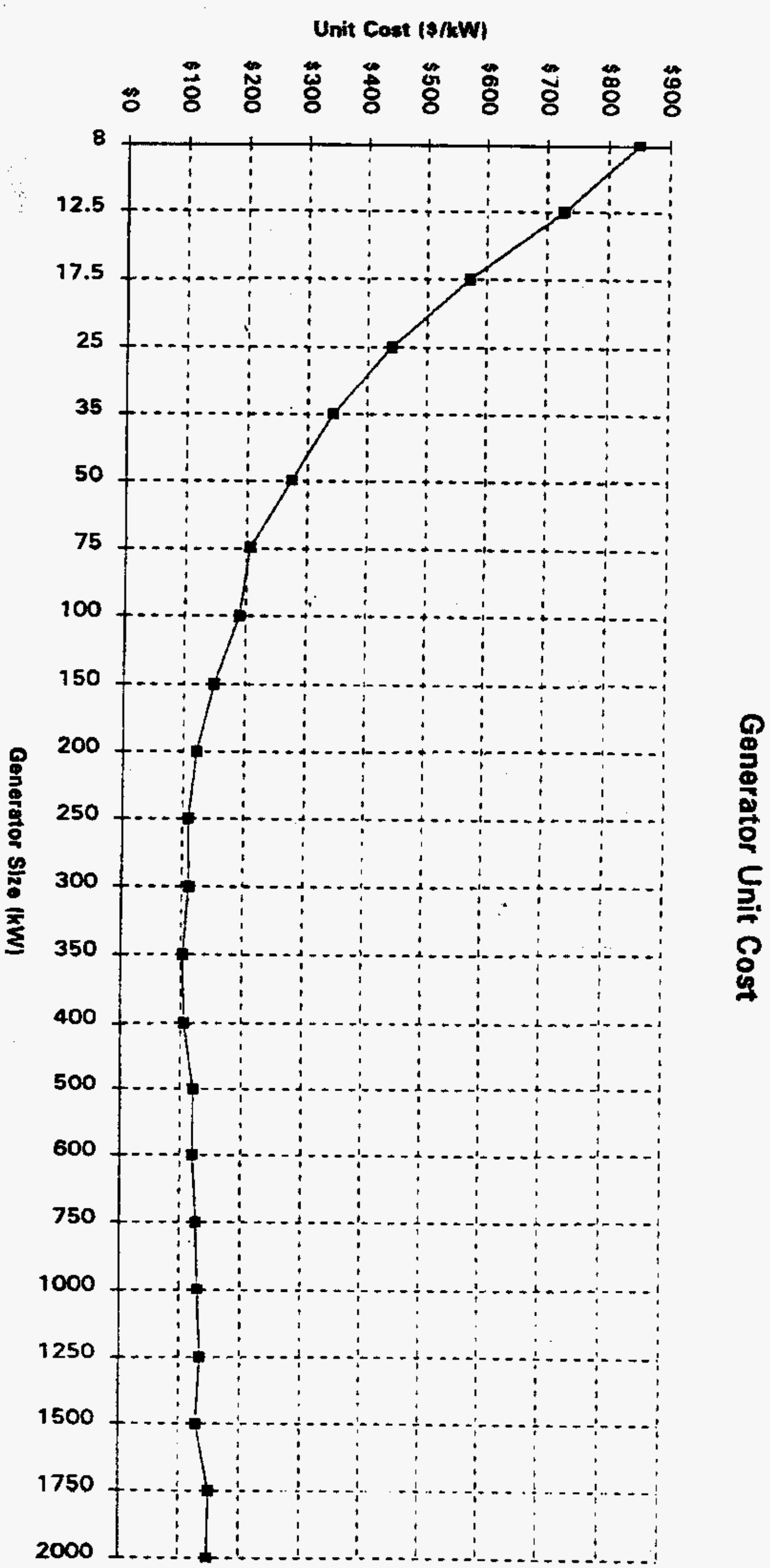
Bob Bohnert

Bob Bohnert
Sales Engineer

UNIT RATING (kW)	BUDGET PRICING
8	$8,800
12.5	$9,100
17.5	$10,000
25	$11,000
35	$12,000
50	$13,700
75	$15,400
100	$19,000
150	$22,400
200	$24,400
250	$27,300
300	$33,500
350	$36,000
400	$42,200
500	$60,500
600	$72,600
750	$95,000
1000	$130,000
1250	$168,000
1500	$192,000
1750	$262,000
2000	$294,000

Ringhaver


Generator Cost
Cost ($)
$0
$50,000
$100,000
$150,000
$200,000
$250,000
$300,000
Generator Size (KW)
8
12.5
17.5
25
35
50
75
100
150
200
250
300
350
400
500
600
750
1000
1250
1500
1750
2000


Generator Unit Cost
Unit Cost ($/kW)
$0
$100
$200
$300
$400
$500
$600
$700
$800
$900
Generator Size (kW)
8
12.5
17.5
25
35
50
75
100
150
200
250
300
350
400
500
600
750
1000
1250
1500
1750
2000

CUMMINS SOUTHEASTERN POWER INC.
4820 North Orange Blossom Trail
Orlando, Fla. 32810
(407) 298-2080 (Rick Cooper) FAX (407) 290-8727

FACSIMILE COVER LETTER

Date: 1/31/96

Company Name: EMI

FAX Number: 359-0748

Attention: PETE HOANSHELT

Subject: GENSET PRICING

Post-it™ Fax Note 7671	Date	# of pages ▶ 1
To James Wallace	From Pete Hoanshelt	
Co./Dept. HAI / ENV	Co. EMI	
Phone #	Phone # 359-0747	
Fax #	Fax # 359-0748	

PER YOUR REQUEST:

KW	PRICING	KW	PRICING
7.5	7,524	15	11,357
20	11,773	25	12,760
35	13,629	40	14,640
50	16,152	80	19,666
100	22,378	150	29,137
200	35,947	250	40,773
300	46,175	350	51,398
400	66,818	500	93,896
600	102,521	750	135,697
1000	165,798	1250	215,888
1500	265,200		

USE THIS INFORMATION WITH DISCRETION

IF I CAN BE OF ANY HELP WITH SPEC WRITING OR GENSIZING CALL ME AT YOUR CONVENIENCE
regards;

Rick Cooper

Rick G. Cooper
Energy System Sales Manager 813-664-5831

REPLY NEEDED YES ____ NO ____ AS SOON AS POSSIBLE ____ AT YOUR CONVENIENCE ____

This transmission consists of ____ pages, including this cover letter. If you do not receive all of the pages please notify our office at: 298-2080 OR FAX 290-8727

APPENDIX G

Prestressed Concrete Ground Storage Tanks
Construction & Unit Costs

Volume (Gal)	Uninstalled (1) Tank Cost ($)	Installed (2) Tank Cost ($)	w/ 1000 gpm Aerator ($)	w/ 4000 gpm Aerator ($)	Overall Cost ($)	Overall Unit Cost ($/Gal)
50,000	70,900	77,990	96,034	112,188	104,111	2.08221
100,000	92,500	101,750	120,010	136,164	128,087	1.280865
300,000	149,540	164,494	183,324	199,478	191,401	0.638003
750,000	226,000	248,600	268,195	284,349	276,272	0.368362
1,000,000	268,200	295,020	315,037	331,191	323,114	0.323114
1,500,000	344,150	378,565	399,341	415,495	407,418	0.271612
2,000,000	412,500	453,750	475,210	491,364	483,287	0.241643

NOTES:

(1) Prestressed concrete tank, concrete floor, prestressed wall, free-span concrete dome, aluminum interior and exterior ladders, vents, precast overflows, painting, aeration unit, and installation costs are included in the manufacturer's quotations.

(2) Includes 5% piping, 0% electrical, and 5% sitework costs.

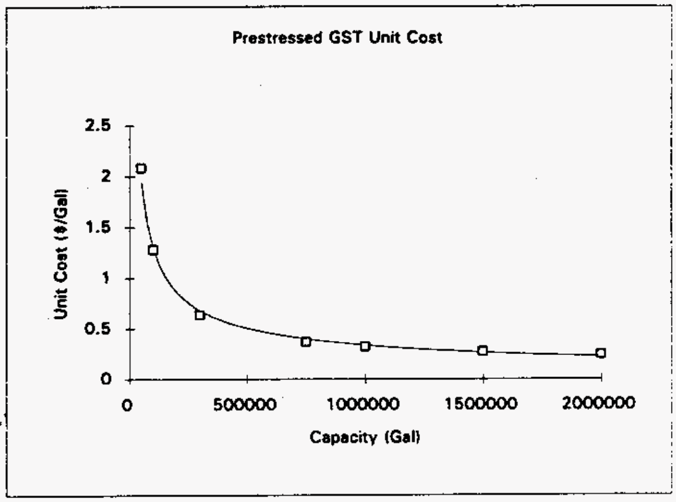
(3) Costs are based on June 1995, ENR Index = 5433.

UNIT COST CURVE & GRAPH

CURVE EQUATION:

Y = (1087.291)X^(-0.5848418)

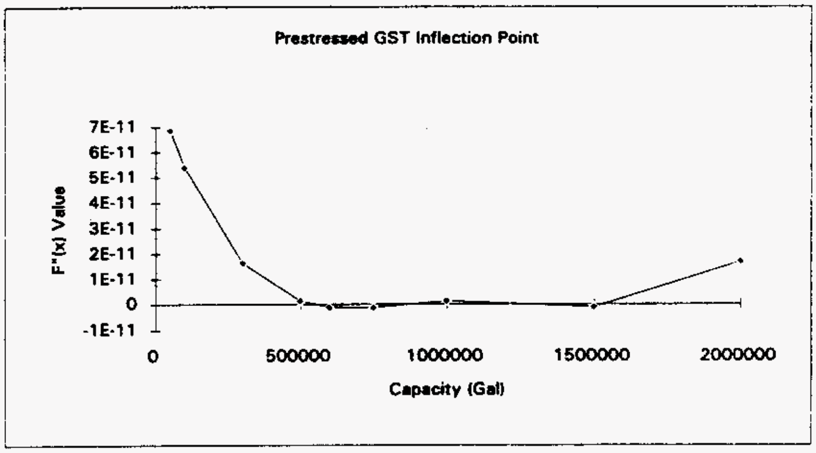
Capacity (MGD)	Cons. Cost ($)	Manuf. Cost ($)
50000	1.941743	2.08221
75000	1.531815	
100000	1.294604	1.280865
125000	1.136213	
150000	1.021295	
175000	0.93325	
200000	0.863141	
225000	0.805686	
250000	0.757539	
275000	0.716468	
300000	0.68092	0.638003
325000	0.64978	
350000	0.622219	
375000	0.597612	
400000	0.575476	
425000	0.555429	
450000	0.537169	
475000	0.520449	
500000	0.505068	
525000	0.49086	
550000	0.477685	
575000	0.465427	
600000	0.453985	
625000	0.443275	
650000	0.433223	
675000	0.423765	
700000	0.414847	
725000	0.40642	
750000	0.398441	0.368362
775000	0.390873	
800000	0.383683	
825000	0.376839	
850000	0.370317	
875000	0.364092	
900000	0.358143	
925000	0.352449	
950000	0.346995	
975000	0.341763	
1000000	0.33674	0.323114
1100000	0.318483	
1200000	0.302682	
1300000	0.288839	
1400000	0.276588	
1500000	0.26565	0.271612
1600000	0.25581	
1700000	0.246899	
1800000	0.238782	
1900000	0.231349	
2000000	0.224512	0.241643



INFLECTION POINT OF PRESTRESSED GST

Prestressed Concrete GST's

Capacity (GPD)	F"(x)
50000	6.86E-11
100000	5.41E-11
300000	1.64E-11
500000	1.32E-12
600000	-1.09E-12
750000	-1.26E-12
1000000	1.26E-12
1500000	-1.15E-12
2000000	1.68E-11



**** The y-axis values on the graphic are the same as f"(x) listed; however, you must choose the graphic window to see the values listed on the y-axis.

HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants	SH. NO.:	JOB NO.:
	MADE BY:	DATE:
	CHECKED BY:	DATE:

~~Ground Storage Tanks:~~ (Concrete)

MANUFACT INFO

Volume	Cost ($) 1000 Aer	Cost ($) 4000 Aer	Ratio ($/Gal) 1000 Aer	Ratio ($/Gal) 4000 Aer
50,000 gal	$ 96,034	$ 112,188	$ 1.92	$ 2.24
100,000 gal	$ 120,010	$ 136,164	$ 1.20	$ 1.36
300,000 gal	$ 183,324	$ 199,478	$ 0.61	$ 0.66
750,000 gal	$ 268,195	$ 284,349	$ 0.36	$ 0.38
1,000,000 gal	$ 315,037	$ 331,191	$ 0.32	$ 0.33
1,500,000 gal	$ 399,341	$ 415,495	$ 0.27	$ 0.28
2,000,000 gal	$ 475,210	$ 491,364	$ 0.24	$ 0.25

Note: ① All values include tank materials, sitework, concrete base, painting, aeration components, electrical, and installation.

② Values obtained by averaging Manufacturers Cost estimates.

THE CROM CORPORATION

Prestressed Composite Tanks

June 13, 1995

FAX: 407-839-3790

Mr. Jamie Wallace
Hartman & Associates, Inc.
201 East Pine Street, Suite 1000
Orlando, FL 32801

Subject: Preliminary Prices for Ground Storage Reservoirs

Dear Jamie:

Thank you for your call and interest in prestressed concrete reservoirs. We are always pleased to work up an estimate for you. In confirming our telephone conversation we estimate the following:

300,000-Gallon Domed Reservoir 50'-0" ID x 20'-6" SWD	$145,000
750,000-Gallon Domed Reservoir 65'-0" ID x 30'-3" SWD	$218,000
1.0-MG Domed Reservoir 80'-0" ID x 26'-8" SWD	$255,000

1.5 mg 332,000 90' + 31'
2 mg 392,000 100' + 34'
J.J.W. June 13 1995

The above estimates are based on open shop labor conditions with construction beginning in 1995. If construction should take place later, escalate accordingly.

Our estimates are for our standard tank and includes the following:

- Complete structural tank with concrete floor, prestressed composite wall and free-span concrete dome.
- Standard accessories: aluminum interior ladder, aluminum exterior ladder, fiberglass hatch, fiberglass vent and precast concrete overflows. Painting the exterior surface with one coat of primer and two coats of latex paint.

Not included in the above estimates are the costs of site preparation, excavation, piping, backfilling, landscaping and disinfecting the tank.

Mr. Jamie Wallace
Hartman & Associates, Inc.

June 13, 1995
Page 2

Also per your request, to add a 1300 GPM aerator to the above tanks would be approximately $11,100 and for a 2600 GPM aerator, $17,300. Also please note that if we add aerators to the tanks, we usually paint the underside of the dome and approximately 2 feet down the wall. The additional cost for this would be approximately $15,000 per tank.

We hope this information is sufficient for you and if you need any additional information, please give us a call.

Sincerely,

THE CROM CORPORATION

Richard L. Bice, P.E.
Project Manager

RLB/pd

EXHIBIT (GCH-4)

PAGE 151 OF 284

PRECON

PRECON CORPORATION

Prestressed Concrete Tanks

115 S.W. 140th Terrace
Newberry, Florida 32669
(904) 332-1200
Fax 332-1199

TO: JAMEY WALLACE
HARTMAN & ASSOC.

DATE: 6·22·95

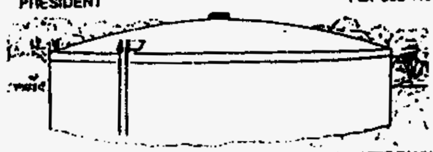
PAGE 1 OF 3

FAX NO.: (407) 839-3790
T 839-3955

FROM:

RICK MOORE, P.E.
PRESIDENT

(904) 332-1200
Fax 332-1199



PRECON CORPORATION
115 S. W. 140th TERRACE
NEWBERRY, FLORIDA 32669

PRESTRESSED CONCRETE TANKS
FOR WATER STORAGE
AND TREATMENT

SUBJECT: TYPICAL ESTIMATES

MESSAGE: CALL WITH QUESTIONS

THANKS FOR CALLING

PRECON
PRECON CORPORATION
Stressed Concrete Tanks
115 S.W. 140th Terrace
Newberry, Florida 32669
(904) 332-1200 (Fax) 332-1199

**ESTIMATE PRICE
CIRCULAR PRESTRESSED TANK
WITH AERATOR**

PROJECT DESCRIPTION:

Name: TYPICAL By: RICK MOORE

Location: CENTRAL FLORIDA Date: 6.23.95

Tank Capacity (Gal.): 0.05MG 0.1MG 0.3MG

Diameter (Ft.): 30'-0" 35'-0" 50'-0"

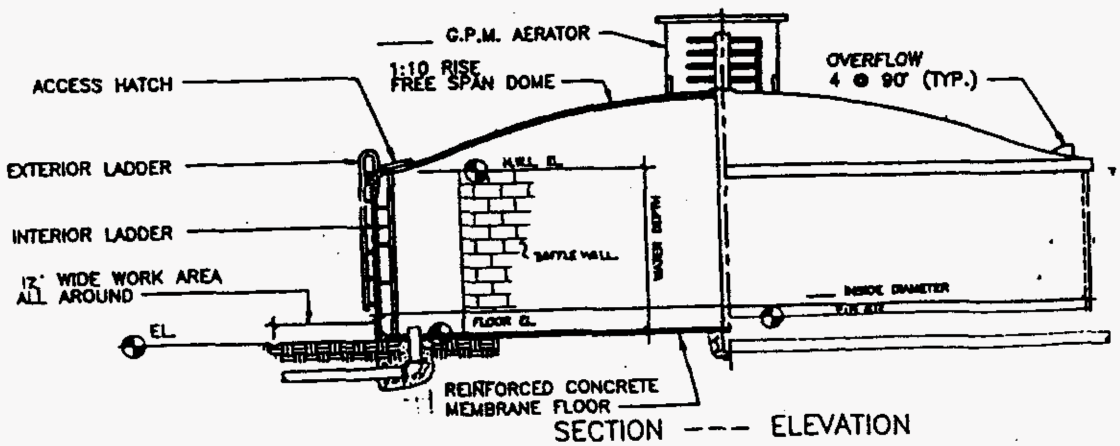
Water Depth (Ft.): 9'-6" 13'-11" 20'-6"

Aerator (GPM):

ESTIMATE:

		0.05MG	0.1MG	0.3MG
Base Tank (incl accessories, ext paint):	$	70,000	91,000	151,000
Aerator SEE BELOW	:			
Bafflewall (concrete block) $4.50 / SQ. FT.	:	+($900)	$1500	$3080
Interior paint (dome, 2' down wall) ADD 2% TO TANK PRICE	:			
Pipe (estimate) ADD 10% TO TANK PRICE.	:			
Site Work (estimate) ADD 5% TO 10% TO TANK PRICE	:			
	:			
	:			
TOTAL	$			

AERATOR PRICING
1000 GPM. $10,000
2500 GPM $17,000
4000 GPM $28,000



SECTION --- ELEVATION

PRECON

PRECON CORPORATION

Prestressed Concrete Tanks

115 S.W. 140th Terrace
Newberry, Florida 32669
(904) 332-1200 (Fax) 332-1199

ESTIMATE PRICE
CIRCULAR PRESTRESSED TANK

PROJECT DESCRIPTION:

Name: TYPICAL   By: RICK MOORE

Location: CENTRAL FLORIDA.   Date: 6-23-95

Tank Capacity (Gal.): 0.75MG   1MG   2MG

Diameter (Ft.): 65'-0"   80'-0"   100'-0"

Water Depth (Ft.): 30'-3"   26'-8"   34'-1"

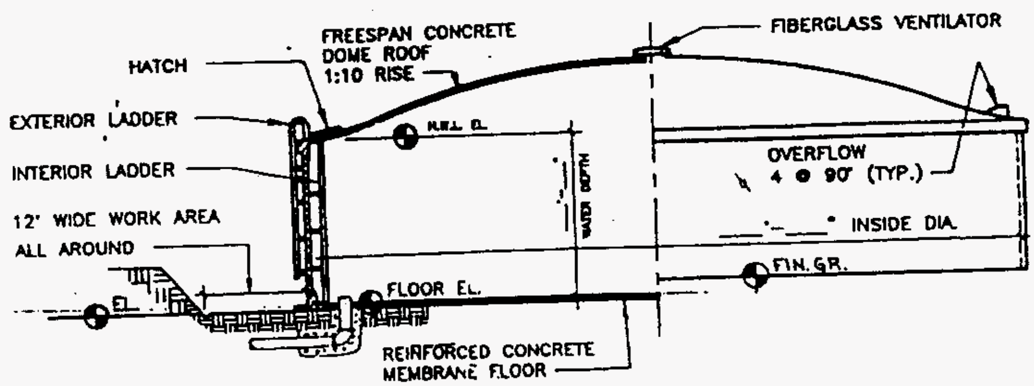
ESTIMATE:

		0.75MG	1MG	2MG
Base Tank (incl accessories, ext paint):	$	228,000	275,000	428,000
Pipe (estimate) (SEE NOTE BELOW)	:	[redacted]		
Site Work (estimate) USUALLY 5% TO 10% OF TANK PRICE.	:			
Baffle wall	:	+6000	+6400	$10,000
	:			
TOTAL	$			

for 1.5 MG $8,300

PIPE - WITHOUT AERATOR - 6% OF TANK PRICE.
- WITH AERATOR - 9% OF TANK PRICE.

[redacted]



SECTION --- ELEVATION

APPENDIX H

Steel Ground Storage Tanks

Construction & Unit Costs

Volume (Gal)	Manuf. Steel Tank Standard Cost ($)	Manuf. Steel Tank Installed Cost ($)	Overall Steel Tank Unit Cost ($/Gal)
10,000	23,000	25,300	2.53
20,000	37,000	40,700	2.035
30,000	40,000	44,000	1.4666667
50,000	50,000	55,000	1.1
100,000	70,500	77,550	0.7755
250,000	120,000	132,000	0.528

NOTES:

(1) Complete steel tank, concrete foundation, roof, roof manway, gravity vent, bottom manway hatch, ladder & cage assembly, top manway platform, protective bolt caps, and installation costs are included in the manufacturers' quotations.

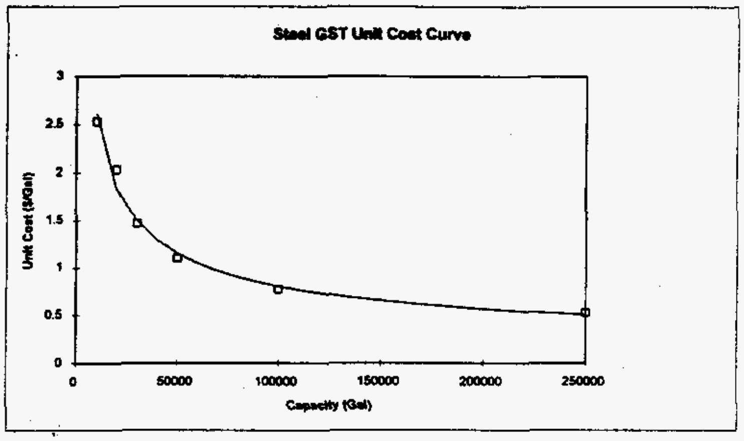
(2) Includes 5% piping, 0% electrical, and 5% sitework costs.

(3) Costs are based on June 1995, ENR Index = 5433.

CURVE EQUATION:

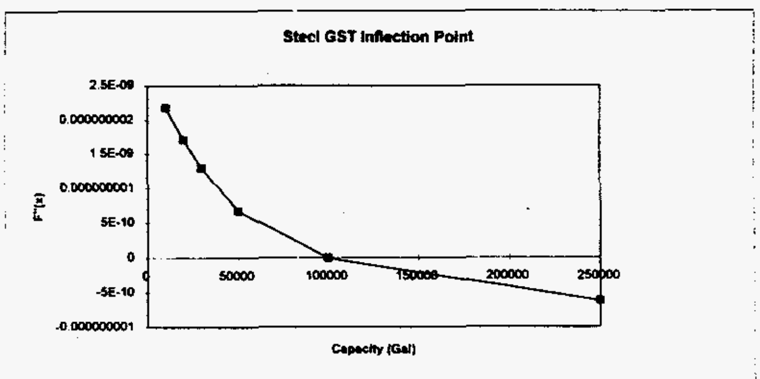
Y = (284.0798)X^(-0.5089866)

Capacity (MGD)	Cons. Cost ($)	Manuf. Cost ($)
10000	2.61513404	2.53
20000	1.83769621	2.035
30000	1.49501527	1.46666667
40000	1.2913783	
50000	1.15272998	1.1
60000	1.05057097	
70000	0.97129326	
80000	0.90747204	
90000	0.85466772	
100000	0.81004166	0.7755
110000	0.77168318	
120000	0.7382529	
130000	0.70878042	
140000	0.6825432	
150000	0.65899066	
160000	0.63769501	
170000	0.61831807	
180000	0.60058858	
190000	0.58428603	
200000	0.56922913	
210000	0.55526724	
220000	0.54227402	
230000	0.53014263	
240000	0.51878203	
250000	0.50811407	0.528



STEEL GST INFLECTION POINT

Capacity (Gal)	F"(x)
10000	2.1822E-09
20000	1.7001E-09
30000	1.2909E-09
50000	6.6926E-10
100000	-7.6E-13
250000	-6.2012E-10



HARTMAN & ASSOCIATES, INC.	SH. NO.:	JOB NO.:
engineers, hydrogeologists, surveyors & management consultants	MADE BY:	DATE:
	CHECKED BY:	DATE:

Ground Storage Tanks (Steel)

Values include: sitework, conc., steel, elect., contingencies, inst.

EPA INFO

Capacity	Cost	Ratio ($/Gal)
5,000 gal	⇒ $19,564	⇒ $3.91
10,000 gal	⇒ $33,312	⇒ $3.33
25,000 gal	⇒ $57,370	⇒ $2.29
50,000 gal	⇒ $72,700	⇒ $1.45
100,000 gal	⇒ $101,125	⇒ $1.01
250,000 gal	⇒ $158,628	⇒ $0.63

MANUFACT INFO

Capacity	Cost	Ratio ($/Gal)
5000 gal	$20,000	$4.00
10,000 gal	$25,300	$2.53
25,000 gal	$43,000	$1.72
50,000 gal	$55,000	$1.10
100,000 gal	$77,550	$0.776
250,000 gal	$132,000	$0.528

* Note: ① All values include materials, sitework, concrete base, electrical, contingencies and installation.

② Values obtained using manufactures cost data and water treatment component Source C, pages 412-415.

[illegible] 407 838 3780 HARTMAN ASSOC 613 P01 JUN 21 '95 11:1

Florida Aquastore Water Reservoirs

List Costs

Capacity (Gal)	Standard Tank w/ Concrete Floor	Model	Standard Tank w/ Glass Coated, Bolted Steel Floor (Conc Foot Onl…
10,000	$23,000	1410	$25,000
20,000	$37,000	1419	$39,000
30,000	$40,000	1719	$42,200
50,000	$50,000	2024	$53,000
100,000	$70,500	3119	$77,500
250,000	$120,000 *	4224	$130,000

* with Temcor Dome

Notes: (Any variations or extra costs required)

Must Add for any tank piping/Nozzles, liquid level gauge, color selection, etc...

Std. tank includes concrete foundation, roof, roof manway, gravity vent, bottom manway hatch, exterior protective bolt caps, ladder + cage assembly, top manway platform, cobalt blue color. (Delivered + installed with tax)

~~Mechanical 20%~~
~~Piping 5%~~
~~Site Prep - 10%~~
~~Engineering 10%~~

CLEARWELL STORAGE

Construction Costs

Product filtered water is commonly stored in a clearwell at the plant site which serves as a supplement to distribution system storage before high-service pumping. In many cases, filter backwash pumps also draw from the clearwell, eliminating the need for a separate sump. Clearwell storage may be either below ground in reinforced concrete structures, or above ground in steel tanks. Conceptual designs for below and above-ground level clearwells are shown in Table 171.

TABLE 171. CONCEPTUAL DESIGNS FOR CLEARWELL STORAGE

Below-Ground Concrete Clearwells				Ground-Level Steel Clearwells		
	Size, ft				Size, ft	
Capacity, gal	Length	Width	Depth	Capacity, gal	Diameter	Depth
5,000	8	8	10	1,000	5.7	5
10,000	11	11	12	5,000	8.5	12
50,000	18	18	20	10,000	12	12
100,000	26	26	20	25,000	15	20
500,000	58	58	20	100,000	23.5	32
				500,000	52	32
				1,000,000	74	32

Construction costs are shown in Table 172 for below-ground reinforced corcrete clearwells and in Table 173 for ground-level steel clearwells. Costs for ground-level clearwells are based on field erected welded steel tanks designed to meet AWWA D100 for 18.93 m^3 (5,000 gal) and more, and on shop fabricated welded steel tanks for the 3.79 m^3 (1,000 gal) tank. Steel tanks are painted inside and out and are installed on a concrete ring wall with oiled sand cushion. Cathodic protection is included for tanks with capacities of 94.63 m^3 (25,000 gal) and larger. A typical ground-level storage reservoir is shown in Figure 166. Figure 167 presents the construction costs for both types of clearwells.

TABLE 172. CONSTRUCTION COST SUMMARY FOR BELOW-GROUND CONCFETE CLEARWELL STORAGE

Cost Category	Clearwell Capacity, gal 5,000	10,000	50,000	100,000	500,000
Excavation and Sitework	$ 3,300	$ 5,700	$16,800	$ 25,300	$ 75,400
Concrete	9,800	16,500	37,000	64,000	216,400
Steel	300	400	500	500	600
Electrical, Instrumentation	2,600	2,600	2,600	2,600	2,600
Subtotal	16,000	25,200	56,600	92,400	295,000
Design Contingencies	2,400	3,800	8,500	13,900	44,300
Total	$18,400	$29,000	$65,100	$106,300	$299,300

TABLE 173. CONSTRUCTION COST SUMMARY FOR GROUND-LEVEL STEEL CLEARWELLS

Cost Category	Clearwell Capacity, gal 1,000	5,000	10,000	25,000	100,000	500,000	1,000,000
Excavation and Sitework	$ 100	$ 100	$ 100	$ 100	$ 200	$ 400	$ 500
Concrete	3,100	5,300	6,600	8,400	11,400	25,700	37,100
Steel Tank	3,000	4,900	12,600	26,600	52,300	121,200	191,000
Electrical, Instrumentation	2,600	2,600	2,600	2,600	2,600	2,600	2,600
Subtotal	8,800	12,900	21,900	37,700	66,500	149,900	231,200
Design Contingencies	1,300	1,900	3,300	5,700	10,000	22,500	34,700
Total	$10,100	$14,800	$25,200	$43,400	$76,500	$172,400	$265,900

Notes: 1. Oiled sand cost is included in concrete category.
2. Cathodic protection cost is included in the steel tank category.

EXHIBIT (GCH-4)
PAGE 159 OF 284

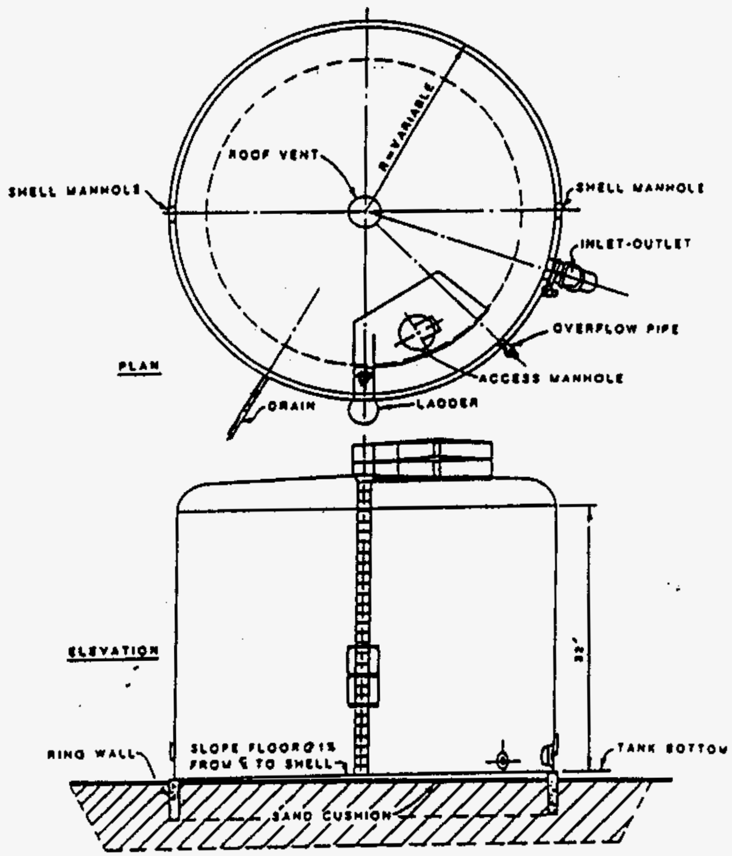


Figure 166. Typical ground-level steel clearwell.

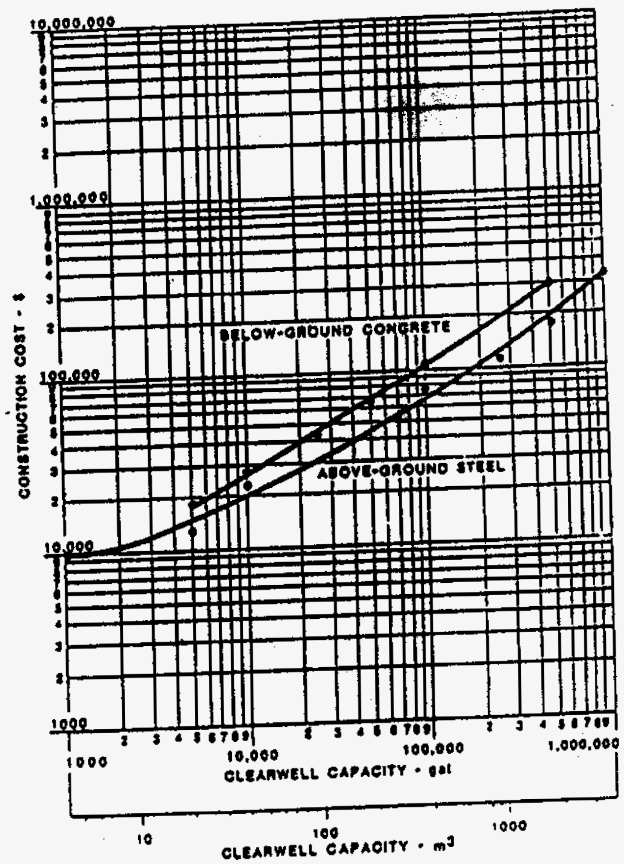


Figure 167. Construction cost for clearwell storage.

EXHIBIT (GCH-4)
PAGE 160 OF 284

APPENDIX I

High Service Pumps
Standard Horizontal Split Case Pumps
Package Costs

Capacity @ 175' of Head (gpm)	Motor Size (HP)	Worthing. Package Cost ($)	Peerless Package Cost ($)	Worthing. Const. Cost ($)	Peerless Const. Cost ($)	Overall Package Cost ($)	Overall Unit Cost ($/gpm)
100	20	4,300	--	4,300	--	4,300	43
250	25	4,600	4,925	4,600	4,925	4,763	19.05
500	40	5,700	6,185	5,700	6,185	5,943	11.885
750	50	6,000	7,350	6,000	7,350	6,675	8.9
1,000	60	8,000	--	8,000	--	8,000	8.7875
1,000	75	--	9,575	--	9,575	9,575	8.7875
1,250	75	8,600	10,800	8,600	10,800	9,700	7.76
1,500	100	9,500	11,650	9,500	11,650	10,575	7.05
1,750	125	10,800	13,150	10,800	13,150	11,975	6.8429
2,000	125	10,800	13,150	10,800	13,150	11,975	5.9875
2,500	150	14,700	16,200	14,700	16,200	15,450	6.18
3,000	200	15,600	17,800	15,600	17,800	16,700	5.5667
3,500	200	--	17,800	--	17,800	17,800	5.8571
3,500	250	23,200	--	23,200	--	23,200	5.8571
4,000	250	23,200	30,700	23,200	30,700	26,950	6.7375
5,000	300	24,600	33,200	24,600	33,200	28,900	5.78

Notes:
1) All costs obtained from manufacturers' quotations include pumps, factory testing, and freight to jobsite.
2) Horizontal Split Case pumps and motors.
3) Pump head is 175 feet (76 psi)
4) Costs are based on June 1995, ENR Index = 5433.

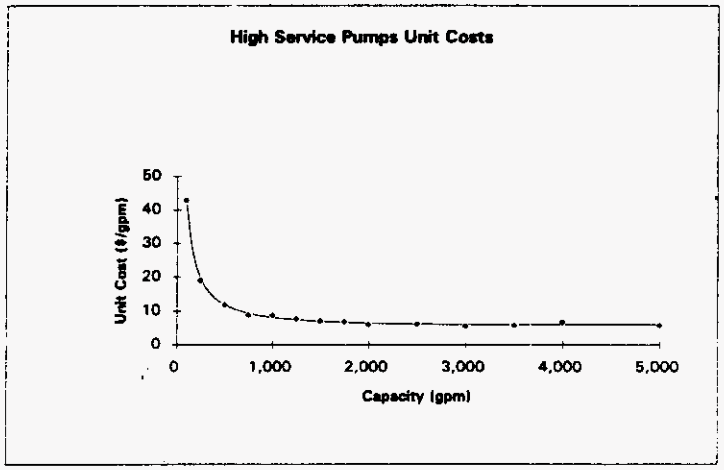
CURVE EQUATION:

Y = (3818.44)+(4.108873)X+(2.262538E-04)X^2

*** Const. Cost curve, divide by capacity for unit cost values.

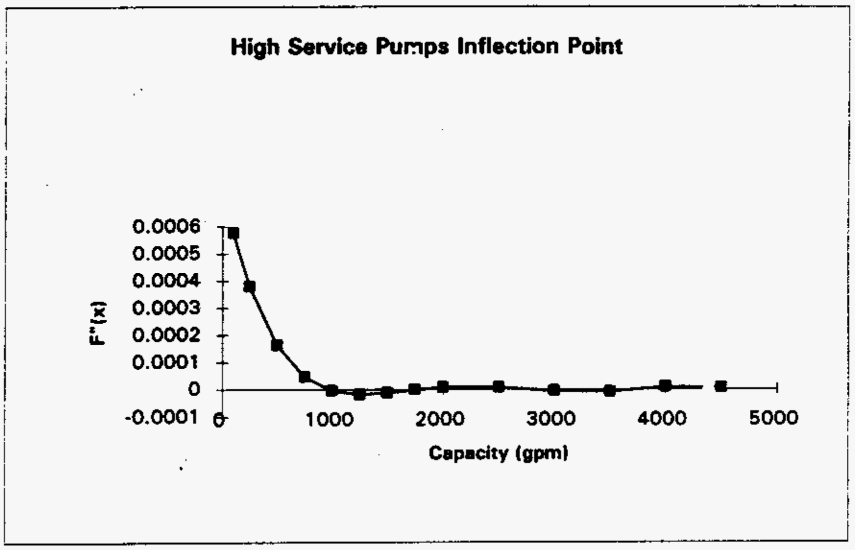
Capacity @ 175' of Head (gpm)	Curve Unit Cost ($/gpm)	Manuf. Unit Cost ($/gpm)
100	42	43
150	30	
200	23	
250	19	19.05
300	17	
350	15	
400	14	
450	13	
500	12	11.885
600	11	
750	9	8.9
850	9	
950	8	
1,000	8	8.7875
1,250	7	7.76
1,500	7	7.05
1,750	7	6.84286
2,000	6	5.9875
2,250	6	
2,500	6	6.18
2,750	6	
3,000	6	5.56667
3,250	6	
3,500	6	5.85714
3,750	6	
4,000	6	6.7375
4,250	6	
4,500	6	
4,750	6	
5,000	6	5.78

High Service Pump Unit Cost Curve



HIGH SERVICE PUMP INFLECTION POINT

Capacity (gpm)	F"(x)
100	0.0006
250	0.0004
500	0.0002
750	5E-05
1000	-4E-06
1250	-2E-05
1500	-1E-05
1750	-1E-06
2000	8E-06
2500	8E-06
3000	-5E-06
3500	-8E-06
4000	1E-05
4500	7E-06



Peerless Pump Company

811 North 50th Street
Tampa, FL 33619

Fax Message

Number of pages including cover: 2

Phone:
Fax:

To:	HARTMAN & ASSOCIATES	*Date:*	07/07/95
Fax Number:	407-839-3790		
From:	JIM GOSSETT	*Copy to:*	

Subject: REQUEST FROM JAMEY WALLACE FOR VARIOUS PRICING.

I HAVE ENCLOSED PRICING THAT YOU ASKED FOR, SEE NOTES AS TO WHAT IS, AND WHAT ISN'T INCLUDED.

LET ME KNOW IF I CAN BE OF FURTHER SERVICE TO YOU.

Peerless High Service Pumps
List Costs

Type: Standard Horizontal Split Case

Capacity @ 175' of Head ≈ 76 psi (gpm)		Motor Size (HP)	Package Cost ($)
125 GPM @ 176' (PE-835) 100		10	$ 730.00
250	2AE-11	25	4,925.00
500	3AE-14	40	6,185.00
750	5AE-14N	50	7,350.00
1000	5AE-14	75	9,575.00
1250	6AE-16G	75	10,800.00
1500	6AE-16	100	11,650.00
1750	6AE-14G	125	13,150.00
2000	6AE-14G	125	13,150.00
2500	8AE-15G	150	16,200.00
3000	8AE-15	200	17,800.00
3500	8AE-15	200	17,800.00
4000	8AE-17	250	30,700.00
5000	10AE-16	300	33,200.00

Note: (Any extra costs needed).

**** THESE COSTS INCLUDE A NON WITNESSED FACTORY TEST, AND FREIGHT TO JOBSITE, BUT NO TAXES, ELECTRICAL OR INSTALLATION.

BARNEY'S PUMPS INC.

FT. LAUDERDALE • JACKSONVILLE • LAKELAND

BARNEY'S PUMPS INC.
3907 HIGHWAY 98 SOUTH
P.O. BOX 3529
LAKELAND, FLORIDA 33802

PHONE : (813) 665-8500
FAX: (813) 666-3858

TO: JAMEY WALLACE

COMPANY: HARTMAN & ASSOC.

FROM:: DAVID THOMPSON

SUBJECT: WORTHINGTON HORIZONTAL SPLIT CASE PUMPS

SELECTIONS ATTACHED!

REGARDS

FAX NUMBER: (407) 839-3790

COVER PAGE PLUS 1 PAGES FOR A TOTAL OF 2 PAGE(S)

SIGNED: David J Thompson

Worthington High Service Pumps
List Costs

Type: Standard Horizontal Split Case

Capacity @ 175' of Head ≈ 76 psi (gpm)	Motor Size (HP)	Package Cost ($)	PUMP
100	20	4,300	2.5LR10
250	25	4,600	2.5LR13
500	40	5,700	4LR14
750	50	6,000	4LR14
1000	60	8,000	5LR15
1250	75	8,600	5LR15
1500	100	9,500	5LR15
1750	125	10,800	6LR16
2000	125	10,800	6LR16
2500	150	14,700	6LR18
3000	200	15,600	6LR18
3500	250	23,200	8LR18S
4000	250	23,200	8LR18S
5000	300	24,600	8LR18S

Note: (Any extra costs needed).

APPENDIX J

Hydropneumatic Tank
Construction & Unit Costs

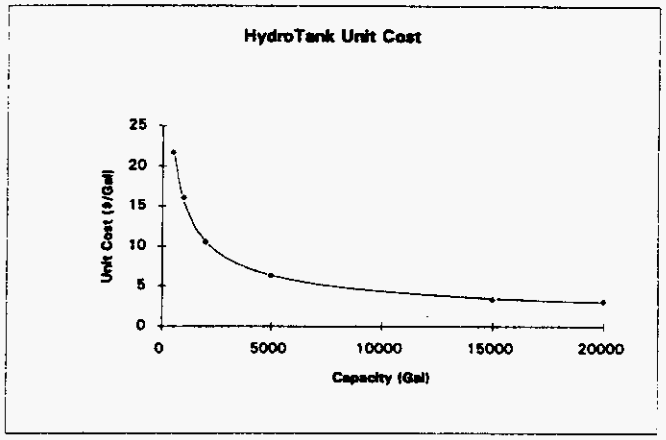
Capacity (Gal)	System Estimate ($)	Manufacturer Cost ($)	Manufacturer Unit Cost ($)
500	6,594	10,880	22
1,000	9,751	16,089	16
2,000	12,786	21,097	11
5,000	19,241	31,748	6
15,000	30,344	50,068	3
20,000	37,241	61,448	3

Notes: (1) Costs of the tank, air volume control compressor, and a control panel were included in the manufacturers' quotations.
(2) 15% piping, 20% electrical, 20% installation, and 10% sitework were added to the quoted costs.
(3) Costs are based on June 1995, ENR Index = 5433.

CURVE EQUATION:

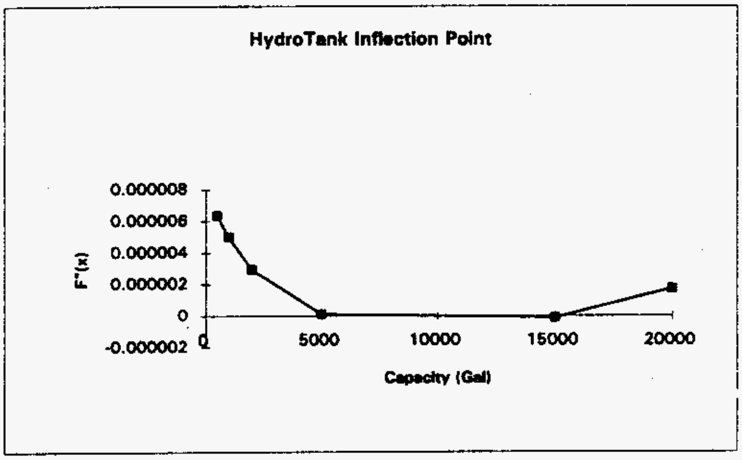
Y = (680.1492)X^(-0.5484723)

Capacity (Gal)	Curve Unit Cost ($/Gal)	Manuf. Unit Cost ($/Gal)
500	23	21.7602
600	20	
700	19	
800	17	
900	16	
1000	15	16.08915
1500	12	
2000	11	10.54845
2500	9	
3000	8	
3500	8	
4000	7	
4500	7	
5000	6	6.34953
6000	6	
7000	5	
8000	5	
9000	5	
10000	4	
11000	4	
12000	4	
13000	4	
14000	4	
15000	3	3.33784
16000	3	
17000	3	
18000	3	
19000	3	
20000	3	3.072383



HYDROTANK INFLECTION POINT

Capacity (gpm)	F"(x)
500	6.36E-06
1000	5.02E-06
2000	2.93E-06
5000	1.3E-07
15000	-1.2E-07
20000	1.74E-06



HYDRO-AIR SYSTEMS, INC.

P.O. Box 585654
Orlando, Fl 32858-5654
Phone or Fax (407)-352-1531

***** FAX TRANSMISSION *****

This transmission consists of 1 pages including this page, if you do not receive all pages please notify this office immediately.

DATE: June 27, 1995

TO: Hartman & Associates, Inc.

REF: Hydropneumatic Tank System Estimate

ATTN: Jamey Wallace

FROM: Ken Miller

Pursuant to your request we are pleased to offer the following for your consideration and approval. All systems include the Hydro-Tank, Air volume control compressor control panel and all accessories to provide an operable system. All systems are based on a maximum pressure of 100psi, potable water and do not include installation cost or applicable taxes. We will be happy to provide a detailed proposal on any of the six systems upon request. If we can be of further assistance please feel free to call me at any time.

CAPACITY GALLONS	SYSTEM ESTIMATE
500	$5,387.00
1,000	$9,102.00
2,000	$12,972.00
5,000	$21,982.00
15,000	$28,688.00
20,000	$36,482.00

Ken Miller

RECORD OF TELEPHONE COMMUNICATION

DATE: 10/19 TIME: 9:50

PROJECT NAME: SSU- Economy of Scale PROJECT NO.: 95-145.00

PARTY CALLING: Bob Black COMPANY: Modern Tanks

PARTY CONTACTED: James Wallace COMPANY: HAI

SUBJECT: Costs for Hydropneumatic Tanks

Modern Welding Company Incorporated

TELEPHONE COMMUNICATION SUMMARY (Including Decisions & Commitments)

+ extras (15% piping, 20% elect., 20% install., 10% site)

500 Gal	→ $4,800 + $3000	compressor + valves	= 7800 (1.65) = 12,870
1000 Gal	→ $6,400 + $4000		= 10,400 (1.65) = 17,160
2000 Gal	→ $8,600 + $4000		= 12,600 (1.65) = 20,790
5000 Gal	→ $12,500 + $4000		= 16,500 (1.65) = 27,225
16,000 Gal	→ $27,000 + $5000		= 32,000 (1.65) = 52,800
20,000 Gal	→ $33,000 + 5000		= 38,000 (1.65) = 62,700

ACTION REQUIRED

c.c.

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, scientists & management consultants

APPENDIX K

Potable Water Supply Wells

Construction Costs

Capacity (Gpd)	Manuf. 250' deep Const. Cost ($)	Manuf. 250' deep Unit Cost ($/Gal)	Manuf. 500' deep Const. Cost ($)	Manuf. 500' deep Unit Cost ($/Gal)
144,000	50,794	0.353	95,573	0.664
288,000	61,582	0.214	118,753	0.412
576,000	72,416	0.126	143,026	0.248
720,000	72,494	0.101	144,731	0.201
1,080,000	81,468	0.075	165,253	0.153
1,440,000	84,413	0.059	175,948	0.122
2,160,000	107,648	0.050	219,108	0.101
2,880,000	113,538	0.039	236,174	0.082
3,600,000	143,298	0.040	278,582	0.077

NOTES:

(1) Vertical turbine pump, cement grout, black steel well and surface casing, well screen, and well development costs from manufacturers' quotes and bid tabulations.

(2) Includes 10% electrical, 15% for well head assembly, and 30% labor costs.

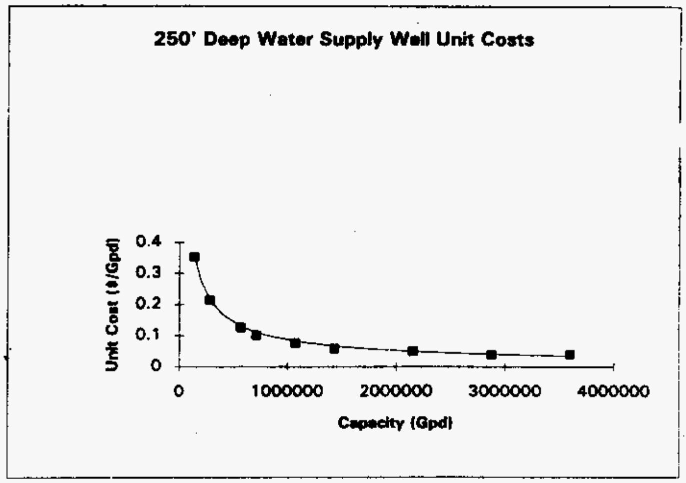
(3) Costs are based on June 1995, ENR Index = 5433.

CURVE EQUATION:

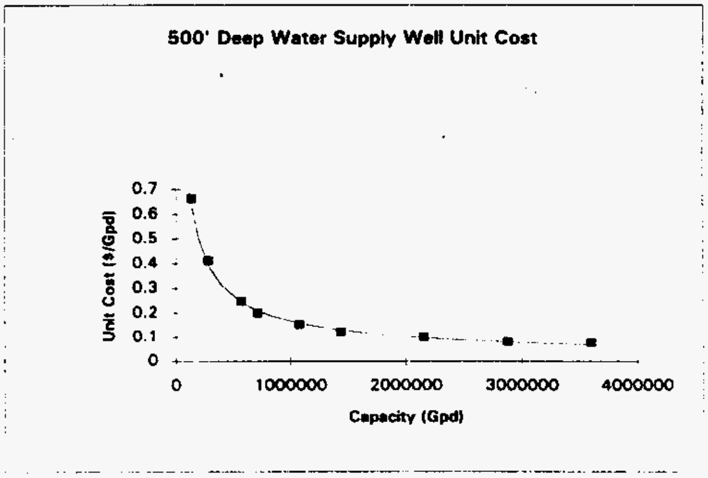
(250' deep) Y = (1780.326)X^(-0.7180454)

(500' deep) Y = (2064.79)X^(-0.6817897)

Capacity (GPD)	250' Curve Cost ($/Gal)	250' Manuf. Cost ($/Gal)
144000	0.352014923	0.35
200000	0.278047715	
288000	0.213997092	0.21
400000	0.169030909	
576000	0.130093221	0.13
600000	0.126335269	
720000	0.110832946	0.10
850000	0.098380166	
1080000	0.082837572	0.08
1200000	0.076801801	
1440000	0.067377621	0.06
1750000	0.058575335	
2160000	0.050358659	0.05
2500000	0.045340692	
2880000	0.040960238	0.04
3000000	0.039777035	
3600000	0.034896083	0.04



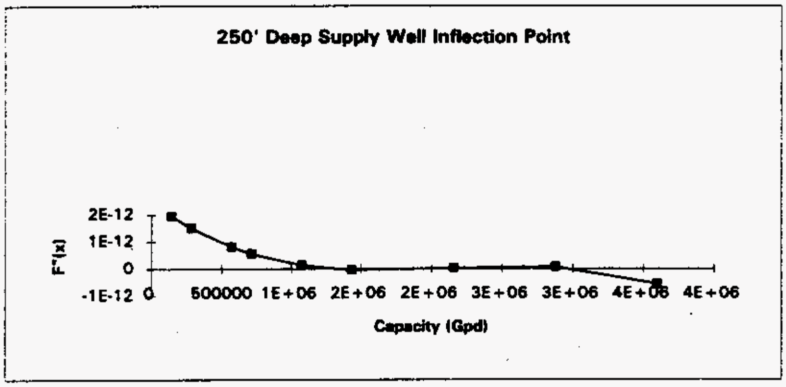
Capacity (GPD)	500' Curve Cost ($/Gal)	500' Manuf. Cost ($/Gal)
144000	0.62799686	0.66
200000	0.501982108	
288000	0.39148788	0.41
400000	0.31293136	
576000	0.244050202	0.25
600000	0.237351445	
720000	0.20960755	0.20
850000	0.187179868	
1080000	0.158982644	0.15
1200000	0.147962864	
1440000	0.130667557	0.12
1750000	0.114402852	
2160000	0.099108423	0.10
2500000	0.089706991	
2880000	0.081457039	0.08
3000000	0.079221184	
3600000	0.069961059	0.08



WATER SUPPLY WELL INFLECTION POINTS (250' & 500')

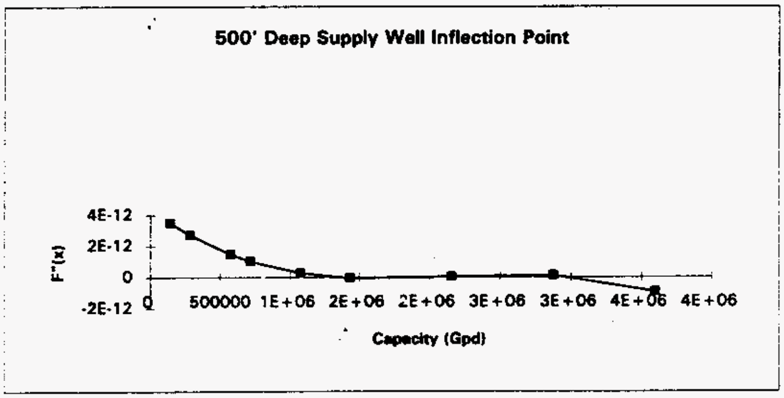
Potable Water Wells (250' deep)

Capacity (gpd)	F"(x)
144000	1.9547E-12
288000	1.50714E-12
576000	8.13596E-13
720000	5.56933E-13
1080000	1.35295E-13
1440000	-3.8732E-14
2160000	2.25217E-14
2880000	7.36539E-14
3600000	-5.5238E-13



Potable Water Wells (500' deep)

Capacity (gpd)	F"(x)
144000	3.52E-12
288000	2.72E-12
576000	1.49E-12
720000	1.03E-12
1080000	2.73E-13
1440000	-5.2E-14
2160000	3.11E-14
2880000	1.29E-13
3600000	-9.1E-13



**** The y-axis values are the same as those listed in the table; however, they are too small to show up on this graph. Just click on the graph to see a larger version with the values.

Capacity (Gpd)	Design Cost	(15%) Well Head	(30%) Labor	(10%) Electrical	Total	Unit Cost ($/Gal)
144,000	32,770	4,916	9,831	3,277	$50,794	0.35
288,000	39,730	5,960	11,919	3,973	$61,582	0.21
576,000	46,720	7,008	14,016	4,672	$72,416	0.13
720,000	46,770	7,016	14,031	4,677	$72,494	0.10
1,080,000	52,560	7,884	15,768	5,256	$81,468	0.08
1,440,000	54,460	8,169	16,338	5,446	$84,413	0.06
2,160,000	69,450	10,418	20,835	6,945	$107,648	0.05
2,880,000	73,250	10,988	21,975	7,325	$113,538	0.04
3,600,000	92,450	13,868	27,735	9,245	$143,298	0.04
144,000	61,660	9,249	18,498	6,166	$95,573	0.66
288,000	76,615	11,492	22,985	7,662	$118,753	0.41
576,000	92,275	13,841	27,583	9,228	$143,026	0.25
720,000	93,375	14,006	28,013	9,338	$144,731	0.20
1,080,000	106,615	15,992	31,985	10,662	$165,253	0.15
1,440,000	113,515	17,027	34,055	11,352	$175,948	0.12
2,160,000	141,360	21,204	42,408	14,136	$219,108	0.10
2,880,000	152,370	22,856	45,711	15,237	$236,174	0.08
3,600,000	179,730	26,960	53,919	17,973	$278,582	0.08

Final
Well
Costs

Design Well Costs

Adders: (surface casing, well casing, well screen, boring, [redacted], cement grout, well Development, [redacted],)

Flow	Cost	w/200' column	Casing	Cost	Surface Casing	Cost	Grout	Cost
100	11,000	4,870	6"	3,750	10"	1,650	4 yd³	2,000
200	12,500	5,480	10"	4,950	16"	2,300	6 yd³	3,000
400	14,200	6,020	12"	6,000	18"	2,500	10 yd³	5,000
500	14,700	6,020	12"	6,000	18"	2,500	10 yd³	5,000
750	18,700	7,810	12"	6,000	18"	2,500	10 yd³	5,000
1000	20,600	7,810	12"	6,000	18"	2,500	10 yd³	5,000
1500	29,500	10,250	16"	6,900	20"	3,300	12 yd³	6,000
2000	33,300	10,250	16"	6,900	20"	3,300	12 yd³	6,000
2500	46,000	13,450	18"	7,500	24"	3,750	15 yd³	7,500
		W/400' column						
100	14,300	14,610	6"	9,375	10"	4,125	10 yd³	5,000
200	17,300	16,410	10"	12,375	16"	5,750	18 yd³	7,500
400	20,200	19,500	12"	15,000	18"	6,250	25 yd³	12,500
500	21,300	19,500	12"	15,000	18"	6,250	25 yd³	12,500
750	28,900	25,140	12"	15,000	18"	6,250	25 yd³	12,500
1000	35,800	25,140	12"	15,000	18"	6,250	25 yd³	12,500
1500	48,600	32,010	16"	17,250	20"	8,250	30 yd³	15,000
2000	57,000	34,620	16"	17,250	20"	8,250	30 yd³	15,000
2500	68,000	43,230	18"	18,750	24"	9,375	38 yd³	19,000

HARTMAN & ASSOCIATES, INC.
engineers, hydrogeologists, surveyors & management consultants

SH. NO.: 1 | JOB NO.: 95-145.00
MADE BY: JJW | DATE:
CHECKED BY: | DATE:

EXHIBIT (JH-4)
PAGE 180 OF 284

Design Well Costs

Adders (surface casing, well casing, well screen, boring, cement grout, well development)

Flow	Well Screen	Cost	Drill/Bore	Cost	Well Development (6 hrs.)
100	6"	3,500	6" ($15)	$3,750	6,000
200	10"	5,500	10" ($17.5)	$4,375	6,000
400	12"	6,550	12" ($20)	$5,000	6,000
500	12"	6,550	12" ($20)	$5,000	6,000
750	12"	6,550	12" (20)	$5000	6,000
1000	12"	6,550	12" ($20)	$5,000	6,000
1500	16"	7,500	16" ($25)	$6,250	6,000
2000	16"	7,500	16" ($25)	$6,250	6,000
2500	18"	8,250	18" ($27.5)	$6,875	6,000
100	6"	5,250	6" ($15)	$7,500	9,000
200	10"	8,250	10" ($17.5)	$8,750	9,000
400	12"	9,825	12" ($20)	$10,000	9,000
500	12"	9,825	12" ($20)	$10,000	9,000
750	12"	9,825	12" ($20)	$10,000	9,000
1000	12"	9,825	12" ($20)	$10,000	9,000
1500	16"	11,250	16" ($25)	$12,500	9,000
2000	16"	11,250	16" ($25)	$12,500	9,000
2500	18"	12,375	18" ($27.5)	$13,750	9,000

Included in installation.

HARTMAN & ASSOCIATES, INC.
engineers, hydrogeologists, surveyors & management consultants

SH. NO.: 2
JOB NO.: 95-145.00
MADE BY: JJW
DATE:
CHECKED BY:
DATE:

EXHIBIT (SCH-4)
PAGE 181 OF 284

Well Design

Design Parameters

				Enclosure
100 GPM	4" colum ⇒	6" casing →	10" OD casing	40 ft²
200 GPM	5-6" column ⇒	10" casing ⇒	16" OD casing	50 ft²
400 gpm	6" column ⇒	12" casing ⇒	18" OD Casing	70 ft²
500 gpm	6" column ⇒	12" Casing ⇒	18" OD casing	80 ft²
750 gpm	8" Column ⇒	12" Casing ⇒	18" OD Casing	100 ft²
1000 gpm	8" column ⇒	12" casing ⇒	18" OD casing	120 ft²
1500 gpm	10" Column ⇒	16" casing ⇒	20" OD casing	150 ft²
2000 gpm	10" column ⇒	16" casing ⇒	20" OD casing	175 ft²
2500 gpm	12" column ⇒	18" casing ⇒	24" OD casing	200 ft²

for 250' wells

OD. casing Depth ⇒ 50' — Screen-perf. pipe ⇒ 50'

ID casing Depth ⇒ 150'

Grout ⇒ 50'

Drilled-Bore ⇒ 250'

for 500' wells

O.D. casing Depth ⇒ 125' — Screen-perf. pipe ⇒ 75'

ID. casing Depth ⇒ 375'

Grout ⇒ 125'

Drilled-Bore ⇒ 500'

FLANAGAN-METCALF & ASSOCIATES, INC.

WATER AND WASTEWATER EQUIPMENT

6708 BENJAMIN RD. SUITE 300 TAMPA, FL 33634
PHONE (813) 884-2663 FAX (813) 884-1898

FAX MESSAGE TO:

NAME: JAMEY WALLACE FROM: MIKE BITTING

COMPANY: HARTMAN & ASSOC DATE: 8/16/95

FAX NO.: 407 839 3790 TOTAL NUMBER OF PAGES: 2

SUBJECT: FLOWAY VERTICAL TURBINE BUDGET PRICES

THE ATTACHED PRICES INCLUDE TEFC PREMIUM EFF MOTORS, 1770 RPM, 100' OF COLUMN SIZED PER AWWA STANDARDS, FREIGHT & START-UP SERVICE.

PLEASE CALL IF YOU HAVE ANY QUESTIONS.

• NEED 200' OF COLUMN FOR 25: [illegible]
• NEED 450' " " " 5: [illegible]

$/FT FOR COLUMN PIPE BASED ON DIAMETER

VALERIE: COST FILE FOR WELL INFO

HARTMAN & ASSOCIATES, INC.	SH. NO.:	JOB NO.:
engineers, hydrogeologists, surveyors & management consultants	MADE BY:	DATE:
	CHECKED BY:	DATE:

FAX

DATE 3/10	PAGES 7	FROM MIKE BITTING
TO JAMEY WALLACE		CO. FLANAGAN-METCALF
CO. HARTMAN & ASSOC		PHONE 813-884-2882
FAX # 407 839 3955		FAX # 813-884-1898

MESSAGE

Peabody - Floway

Vertical Turbine Pump Costs

Flow (GPM)	Head (psi)	Motor Size (HP)	Cost ($)	Column Assem. Per 10' Length
100	130	15	$11,000	$487
200	130	25	12,500	548
400	130	50	14,200	602
500	130	50	14,700	602
750	130	75	18,700	781
1000	130	100	20,600	781
1500	130	150	29,500	1025
2000	130	200	33,300	1025
2500	130	250	46,000	1345
100	250	25	$14,300	487
200	250	50	17,300	548
400	250	100	20,200	650
500	250	100	21,300	650
750	250	150	28,900	838
1000	250	200	35,800	838
1500	250	300	48,600	1067
2000	250	400	57,000	1154
2500	250	500	68,000	1441

NOTES: (Any Extra Costs provided or needed).

Peerless Pump Company
811 50th Street No. • Tampa, FL 33619
Tampa Sales Office
Phone (813) 247-1521 • Fax (813) 247-4342

HARTMAN & ASSOCIATES, INC.
201 EAST PINE STREET--SUITE 1000
ORLANDO, FL. 32801

ATTEN: JAMEY WALLACE

RE: PRICING ON VERTICAL TURBINE PUMPS:

GPM	TDH	H.P. REQ.	$
100	130	7.50	7,225.00
200	130	10	8,500.00
400	130	20	9,400.00
500	130	25	9,100.00
750	130	40	11,000.00
1000	130	40	11,000.00
1500	130	75	14,000.00
2000	130	100	17,000.00
2500	130	100	21,500.00

JAMEY, I HAVE INCLUDED FREIGHT TO JOBSITE, BUT NO ELECTRICAL, OR INSTALLATION, OR FITTINGS OTHER THAN THE PUMP ARE INCLUDED.

SINCERELY,

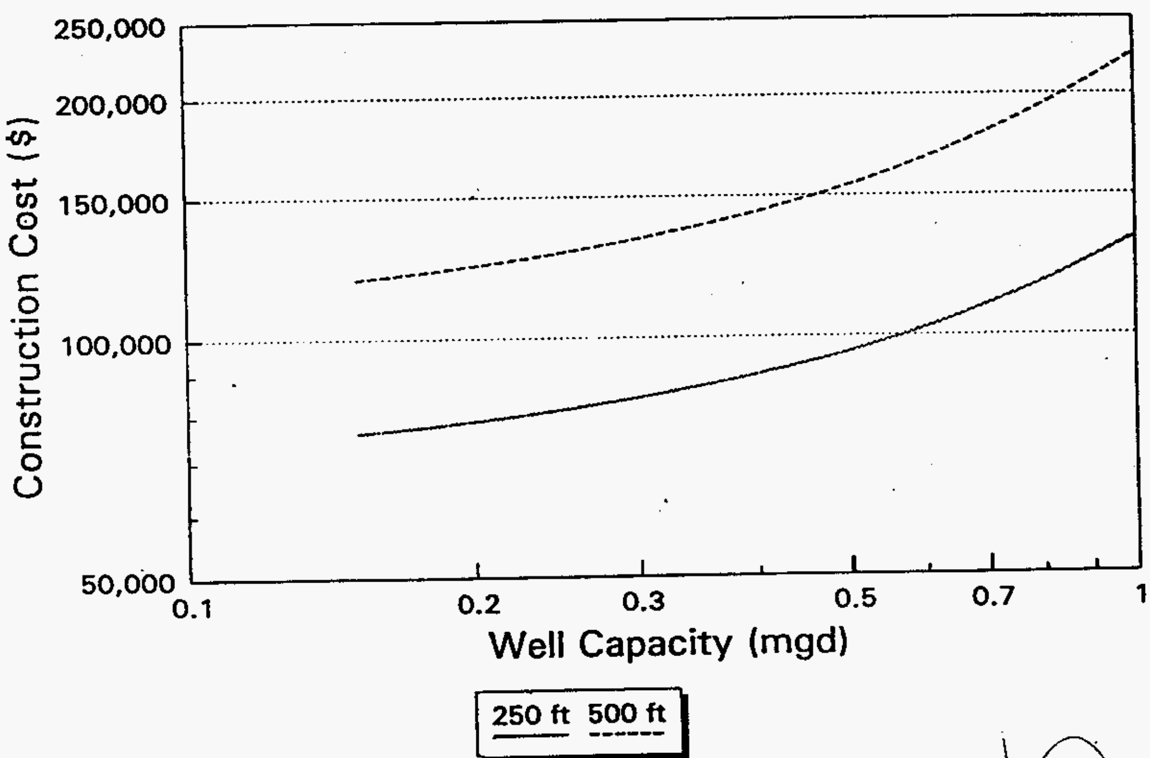
Jim Gossett

JIM GOSSETT
SALES ENGINEER
PEERLESS PUMP CO.

Wells -

Pumps, pipes, electrical, contingencies, installation, excavation, housing

GRAPH #9



Note: Source C, Figure 147, and pages 374-381.

Same Comments

WATER WELLS

Introduction

Water wells are drilled by the cable tool, hydraulic rotary or reverse rotary methods, with hydraulic rotary currently the most common method. Construction of these types of water wells is covered by "American Water Works Association Standard for Deep Wells, AWWA A100-66" and by "Manual of Water Well Construction Practices, EPA-570/9-75-001."[1,2]

Construction of water wells by the hydraulic rotary method takes place in the following sequence:

1. Install protective casing and grout in place for sanitary seal.
2. Drill 15.2 to 30.5 cm (6 to 12 in) diameter pilot hole.
3. Electric log pilot hole to help determine location of water bearing formations.
4. Ream hole to required diameter and depth.
5. Install blank and perforated casing or well screen.
6. Place gravel pack and grout seals.
7. Develop well by pumping and bailing.
8. Conduct pumping test to verify capacity before permanent pump is installed.
9. Install pump and construct enclosure.

Conceptual design criteria for wells are shown in Table 154 and a cross-section for a typical well is shown in Figure 146.

TABLE 154. CONCEPTUAL DESIGNS FOR WATER WELLS

Well Capacity, gal/day	Well Capacity, gal/min	Casing Diameter, in	Well Depth, ft	Pump Motor Size, hp	Enclosure, sq ft
144,000	100	8	250	10	40
			500	20	
432,000	300	10	250	25	60
			500	50	
720,000	500	12	250	40	80
			500	75	
1,008,000	700	16	250	50	100
			500	100	

Notes: 1. Maximum pumping depth 50-100 ft less than well depth.
2. Enclosure has a 10 ft height.

Construction Costs

Construction costs were developed for water well construction by the hydraulic rotary method, as outlined in the previous section. The protective casing and grout was installed to a depth of 7.62 m (25 ft). Casing is blank and perforated copper bearing steel, with gravel packing and grout seals. After construction, the well is developed by bailing and pumping to remove drilling mud, silt and fine sand. The completed well is then test pumped until the water has sufficient clarity for potable use. This often requires pumping for up to 60 hours.

The permanent pump is the oil lubricated, deep-well turbine type and the electric motor is 220/440 volt. A submersible type pump at somewhat reduced cost could be used in some cases, particularly for shallow, small capacity wells. Pump motor sizes and casing diameter used in the cost development are shown in Table 154.

The electrical cost includes all work required at the well but does not include providing service to the site. Costs include a valve and totalizing flow meter on the discharge, but no other piping or equipment. An enclosure is provided over the motor, totalizing meter, and valve.

Construction costs are summarized in Table 155 and presented in Figure 147 for wells capable of producing 545, 1,635, 2,725, and 3,815 m^3/d (144,000, 432,000, 720,000 and 1,008,000 gpd) from wells 76.2 and 152.4 m (250 and 500 ft) deep.

Operation and Maintenance Requirements and Costs

Electricity requirements are based on continuous operation of the motor, at a pumping head 15.24 m (50 ft) less than the well depth. No energy is included for the housing, as it was assumed that heating and ventilation are unnecessary, and that lighting requirements are minimal. Many wells do not operate continuously and in these cases the energy requirements will be reduced according to the actual load factor. Material requirements are based on necessary lubricants and other routine maintenance items and servicing the pump and motor once in five years. Labor requirements are based on daily visits for inspection and routine maintenance. Labor and material required to remove and service the pump and motor once every five years are included in the average annual values.

Operation and maintenance requirements and costs are summarized in Table 156 and presented in Figures 148 and 149.

References

1. "AWWA Standard for Deep Wells," AWWA A100-66, January 23, 1966, American Water Works Association, 2 Park Avenue, New York, N. Y. 10016

2. "Manual of Water Well Construction Practices," EPA-570/9-75-001, U.S. Environmental Protection Agency, Office of Water Supply, Washington, D.C.

TABLE 155. CONSTRUCTION COST SUMMARY FOR WATER WELLS

Cost Category	Well Capacity: 144,000 gpd (100 GPM), Well Depth 250 ft	144,000 gpd, 500 ft	432,000 gpd, 250 ft	432,000 gpd, 500 ft	720,000 gpd, 250 ft	720,000 gpd, 500 ft	1,008,000 gpd (700 GPM), 250 ft	1,008,000 gpd, 500 ft
Excavation & Sitework	$ 1,100	$ 1,100	$ 1,600	$ 1,600	$ 2,100	$ 2,100	$ 2,700	$ 2,700
Manufactured Equipment	10,300	13,400	15,500	18,500	18,500	21,600	21,600	25,800
Concrete	1,600	2,900	1,800	3,100	2,000	3,200	2,100	40,900
Labor	17,300	31,200	49,000	36,200	20,800	39,300	22,500	42,400
Pipe & Valves	5,600	10,300	7,500	13,300	9,200	16,100	12,900	23,000
Electrical, Instrumentation	7,200	10,100	11,600	13,900	13,900	16,200	16,200	19,300
Housing	3,400	3,400	4,700	4,700	6,100	6,100	10,100	10,100
Subtotal	47,000	74,400	61,700	91,300	72,600	104,600	88,100	164,200
Design Contingencies	7,100	11,200	9,300	13,700	10,900	15,700	13,200	24,600
Total	$54,100	$85,600	$71,000	$105,000	$83,500	$120,300	$101,300	$188,800

Subtract out

EPA #'s

July 1995

w/o labor, housing, cont.

	250'	500'	250'	500'
100 GPM	26,300	37,800	34,766	49,968
300 GPM	38,000	50,400	50,232	66,624
500 GPM	45,700	59,200	60,411	78,257
700 GPM	55,500	74,890	73,366	98,997

w/o housing & Des. cont.

	250'	500'
100 GPM	57,635	93,855
300 GPM	75,348	114,477
500 GPM	87,906	130,207
700 GPM	103,108	155,046

TABLE 156. OPERATION AND MAINTENANCE SUMMARY FOR WATER WELLS

Well Capacity, gpd	Energy, kwh/yr Building	Process	Total	Maintenance Material, $/yr	Labor, hr/yr	Total Cost, $/yr
Well Depth - 250 ft						
144,000	--	44,100	44,100	1,300	450	9,300
432,000	--	132,000	132,000	1,800	500	16,600
720,000	--	220,200	220,200	2,300	550	23,800
1,008,000	--	308,300	308,300	2,700	600	30,900
Well Depth - 500 ft						
144,000	--	99,700	99,100	1,800	500	14,300
432,000	--	297,300	297,300	2,500	550	29,400
720,000	--	495,600	495,600	2,800	600	44,100
1,008,000	--	693,700	693,700	3,300	650	59,000

Notes:
1. Total cost is based on $0.07/kwh of electrical energy and $11.00/hour of labor.
2. Pumping heads are 200 ft for the 250 ft deep well, and 450 ft for the 500 ft deep well.
3. Pumping is continuous, 24 hours/day, 365 days/year.

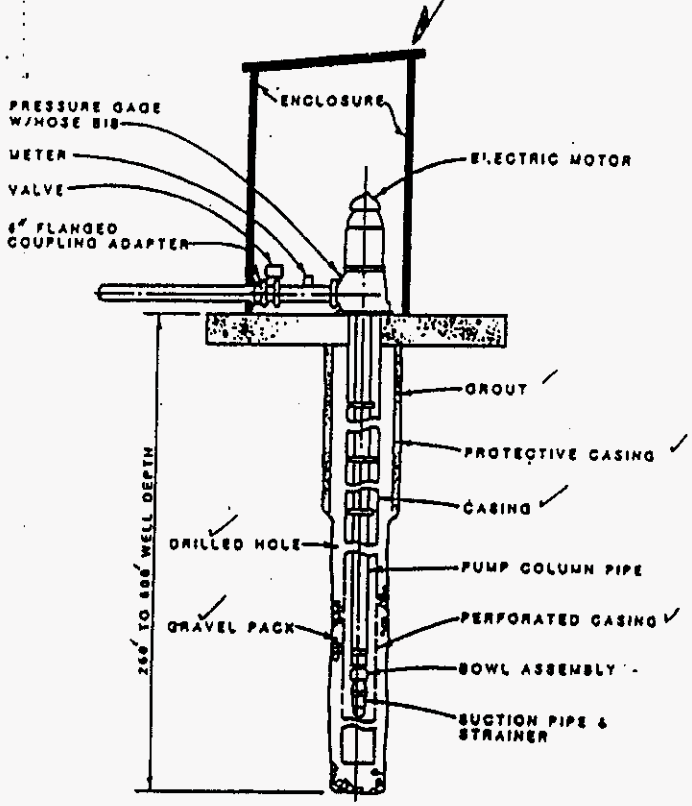


Figure 146. Typical water well.

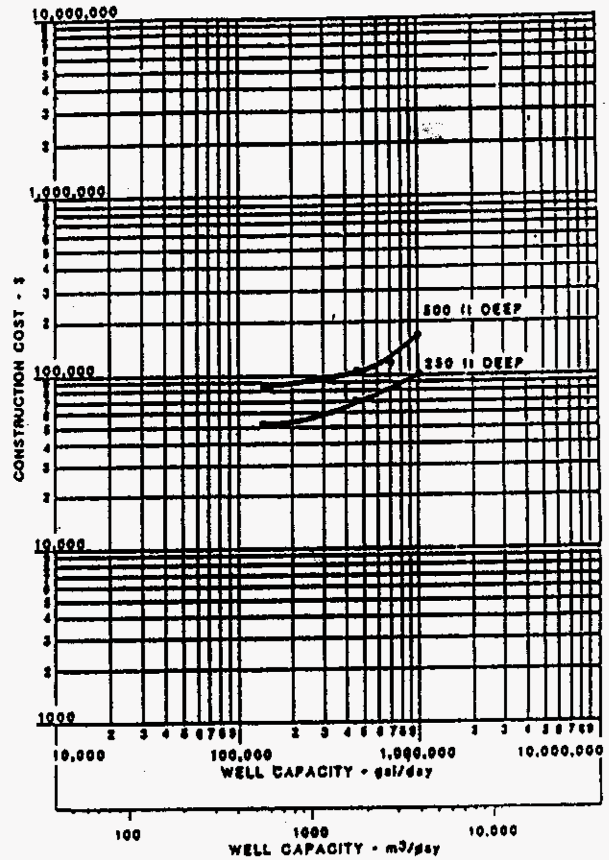


Figure 147. Construction cost for water wells.

APPENDIX L

Lime Softening WTP

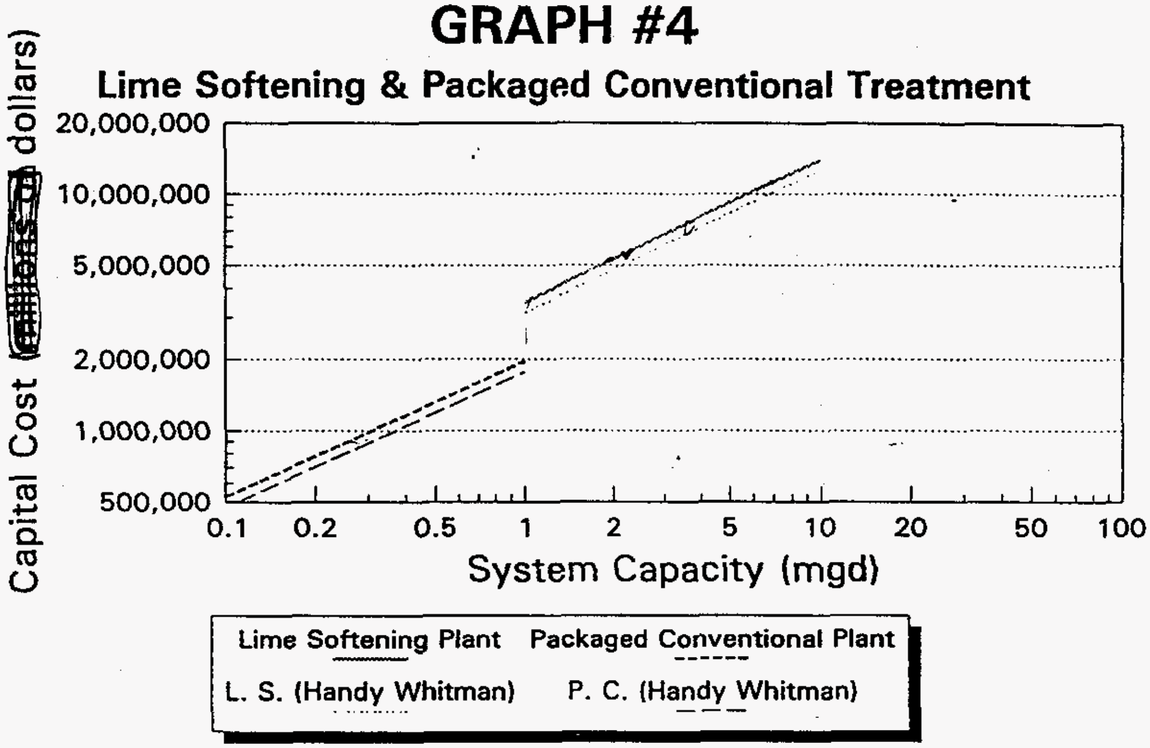
Construction & Unit Costs

Treatment Capacity (Mgd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cons. Cost ($)	Current Unit Cost ($/Gal)
1	2,000,000	3,150	5,433	3,449,524	3.45
2	3,225,000	3,150	5,433	5,562,357	2.78
5	5,500,000	3,150	5,433	9,486,190	1.90
7	7,000,000	3,150	5,433	12,073,333	1.72
10	8,000,000	3,150	5,433	13,798,095	1.38

NOTES:
(1) Values obtained using EPA cost curves.
(2) Costs include raw water influent pumping, chemical addition, rapid mix/ flocculation, sedimentation, filtration, disinfection, finished water storage, finished water pumping, and sludge disposal.
(3) Costs are based on June 1995, ENR Index = 5433.

GRAPH #4

Lime Softening & Packaged Conventional Treatment



Note: Source B, Figure 2-2, pp. 11-12.

Cost Summaries of Selected Env. Technologies

GRAPH #3
Hydrated Lime Chemical Feed (Fig. 23)

Treatment Capacity (Mgd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
200 mg/l							
0.3	24,000	2494	5433	52,282	158	319	48,456
0.5	24,000	2494	5433	52,282	158	319	48,456
0.7	25,000	2494	5433	54,461	158	319	50,475
1.0	29,000	2494	5433	63,174	158	319	58,551
1.3	35,000	2494	5433	76,245	158	319	70,665
100mg/l							
0.3	15,000	2494	5433	32,676	158	319	30,285
0.5	15,000	2494	5433	32,676	158	319	30,285
0.7	16,000	2494	5433	34,855	158	319	32,304
1.0	22,000	2494	5433	47,925	158	319	44,418
1.3	24,000	2494	5433	52,282	158	319	48,456
50 mg/l							
0.3	15,000	2494	5433	32,676	158	319	30,285
0.5	15,000	2494	5433	32,676	158	319	30,285
0.7	15,000	2494	5433	32,676	158	319	30,285
1.0	15,000	2494	5433	32,676	158	319	30,285
1.3	15,000	2494	5433	32,676	158	319	30,285

GRAPH #4
Lime Softening & Packaged Conventional (Fig. 2-2)

Treatment Capacity (Mgd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
--- Lime Softening ---							
0.1	0	3150	5433	0	205	319	0
0.5	0	3150	5433	0	205	319	0
1.0	2,000,000	3150	5433	3,449,524	205	319	3,112,195
5.0	5,500,000	3150	5433	9,486,190	205	319	8,558,537
10.0	8,000,000	3150	5433	13,798,095	205	319	12,448,780
--- Packaged Conventional Plant ---							
0.1	300,000	3150	5433	517,429	205	319	466,829
0.5	800,000	3150	5433	1,379,810	205	319	1,244,878
1.0	1,100,000	3150	5433	1,897,238	205	319	1,711,707
5.0	0	3150	5433	0	205	319	0
10.0	0	3150	5433	0	205	319	0

discharge to a municipal sewer or hauled to a landfill for disposal. Clarified water then flows to the filter unit.

The filters consist of one or more steel or concrete vessels containing granular materials such as graded sands, anthracite, and garnet. Solids are strained from the water as it passes through the filters. When the pressure drop through the filters becomes great enough due to accumulated solids, a backwash stream of filtered water passes through the units in reverse flow to clean the solids from the filter bed. The spent backwash stream is sent to a sewer. Backwashing is intermittent; the backwash cycle depends on the character and concentration of solids in the water, as well as on filter design parameters such as application rate and filter medium particle size.

Filtered water is disinfected with chlorine and stored. From storage it is pumped to the water supply distribution system.

Direct Filtration (2,4,5)

A direct filtration plant is essentially the same as the conventional filtration plant shown in Figure 2-1 except the sedimentation step is deleted.

Direct filtration is applicable to any drinking water supply where suspended solids levels are sufficiently low to result in a reasonable backwash cycle on the filter units. Unlike conventional filtration plants, there is an upper limit to the influent suspended solids concentration that can be tolerated. This upper limit must be determined by testing. Above such a level, conventional treatment procedures or sedimentation prior to filtration are required.

Lime Softening (2,4,5)

The major features of a lime softening plant are also essentially the same as those for a conventional filtration plant, except that lime is substituted for other chemicals and a recarbonation step is added after sedimentation. A lime softening plant is typically used to treat raw water with a higher concentration of dissolved minerals, such as calcium and magnesium, than can be treated in a conventional or direct filtration plant. In the context of the Safe Drinking Water Act, a lime softening plant can also be expected to achieve a greater removal of toxic mineral substances. For example, a lime softening plant operating in a pH range of 8.5 to 11 can reduce cadmium concentrations from 0.5 mg/l to 0.01 mg/l. To achieve the same cadmium concentration in the treated effluent, a conventional filtration plant using alum or iron salts can only accommodate a cadmium concentration up to 0.1 mg/l of cadmium in the raw water (2). The choice of overall treatment process therefore depends on individual raw water characteristics.

Lime can be added directly to the influent raw water as a solid, or as a pre-mixed water slurry. If a slurry is used, the solid lime is usually purchased and the slurry prepared on-site. Details of lime feed systems are described elsewhere (6, 7).

Recarbonation is the addition of gaseous carbon dioxide (CO_2) to the lime-treated water to neutralize excess alkalinity resulting from lime addition. Gaseous CO_2 may be obtained from liquid CO_2 stored onsite, submerged burners, or stack gas compressed through a sparger system. The choice of carbonation method depends on site specific considerations.

2.1.2 Design Basis and Costs (2,4,5)

The design basis in this report for conventional filtration plant costs includes the following major process modules and design parameters:

- Raw water pumping.
- Chemical addition.
- Rapid mix/Flocculation.
- Sedimentation.
- Filtration.
- Disinfection.
- Finished water storage.
- Finished water pumping.
- Sludge disposal.

As stated in the process descriptions, there is no sedimentation step in direct filtration. The filtration directly follows the rapid mix and flocculation step. The chemical feed system consists of chemical storage and metering pump facilities. The rapid mix tank and flocculation vessel is one vessel partitioned into separate sections. Filtration units are gravity flow steel or concrete vessels. The clear well is a concrete storage basin. System design parameters depend on raw water quality and the finished water quality required.

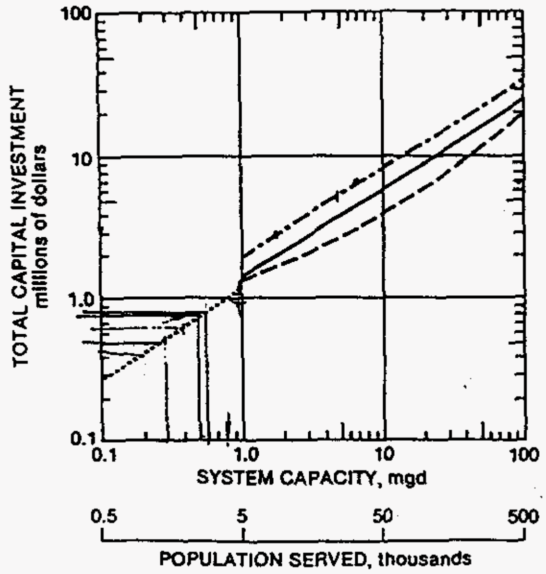
The major process modules for the lime softening plant are very similar to those for conventional filtration, except for modifications to the chemical feed system and addition of recarbonation equipment. Recarbonation basins are reinforced concrete, and submerged natural gas burners are used for the CO_2 source in the system considered here based on the configuration and costs in Reference 2.

The plant cases represented here include chlorine disinfection, the usual procedure in conventional plants. Alternative disinfectants such as chlorine dioxide, ozone, or ammonia added with chlorine can also be used. The disinfection systems for each of these alternatives are discussed in Section 2.2

Total capital investment for conventional filtration, direct filtration, and lime softening is presented in Figure 2-2. Net annual operating expenses are shown in Figure 2-3. Figure 2-4 shows corresponding unit annualized costs.

Figure 2-2. Filtration plants for drinking water treatment - Total capital investment (March, 1980 dollars).

Conventional Filtration Plant ————
Direct Filtration Plant – – – – –
Lime Softening Plant –·–·–·–
Packaged Conventional Plant ··········



LIME SOFTENING
· PACKAGED
CONVENTIONAL

nking water treatment (March, 1980 dollars).

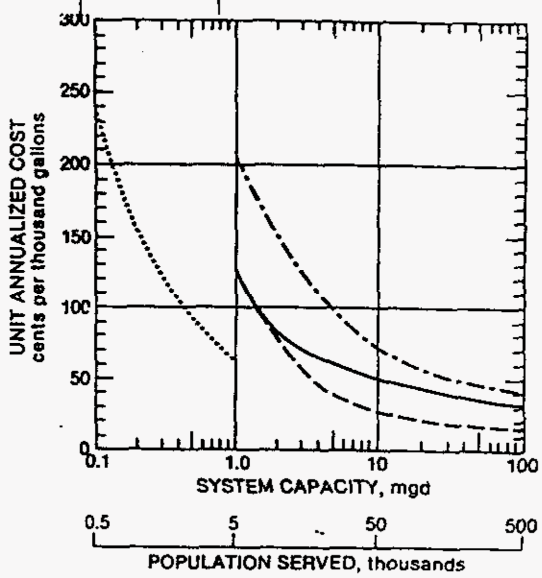
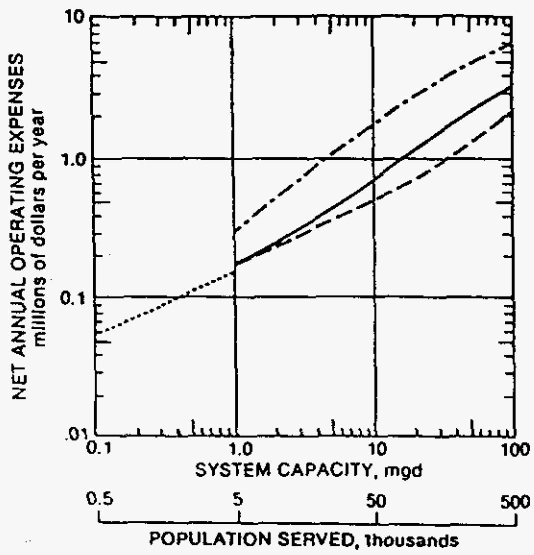


Figure 2-3. Filtration plants for drinking water treatment - Net annual operating expenses (March, 1980 dollars).

Conventional Filtration Plant ————
Direct Filtration Plant – – – – –
Lime Softening Plant –·–·–·–
Packaged Conventional Plant ··········



Also provided in the figures are costs for packaged conventional filtration plants which can be used for small treatment systems (5). These plants would have the same unit processes as their larger field-constructed counterparts but would be primarily shop fabricated and brought to the field for final installation.

2.1.3 Major Variables Affecting Costs

For any of the filtration plants discussed here, the large number of process steps and associated variables result in many possible combinations of equipment sizes and specifications. These factors largely depend on site specific requirements with raw water quality the primary variable. A complete analysis of the cost impacts of changes in design is beyond the scope of this report. However, examination of the cost profile for capital investment reveals that the greatest portion of the investment is in the filter portion of the plant. Therefore, changes in design requirements for the filters have a very large impact on total plant capital costs. For lime softening plants lime dosage is an important variable. Also, as can be seen from the figures, costs for shop fabricated packaged plants are less than for field constructed plants of similar size. Operating expenses, specifically electricity costs for pumping, are affected by frequency of backwashing in the filtration unit which

APPENDIX M

Reverse Osmosis WTP

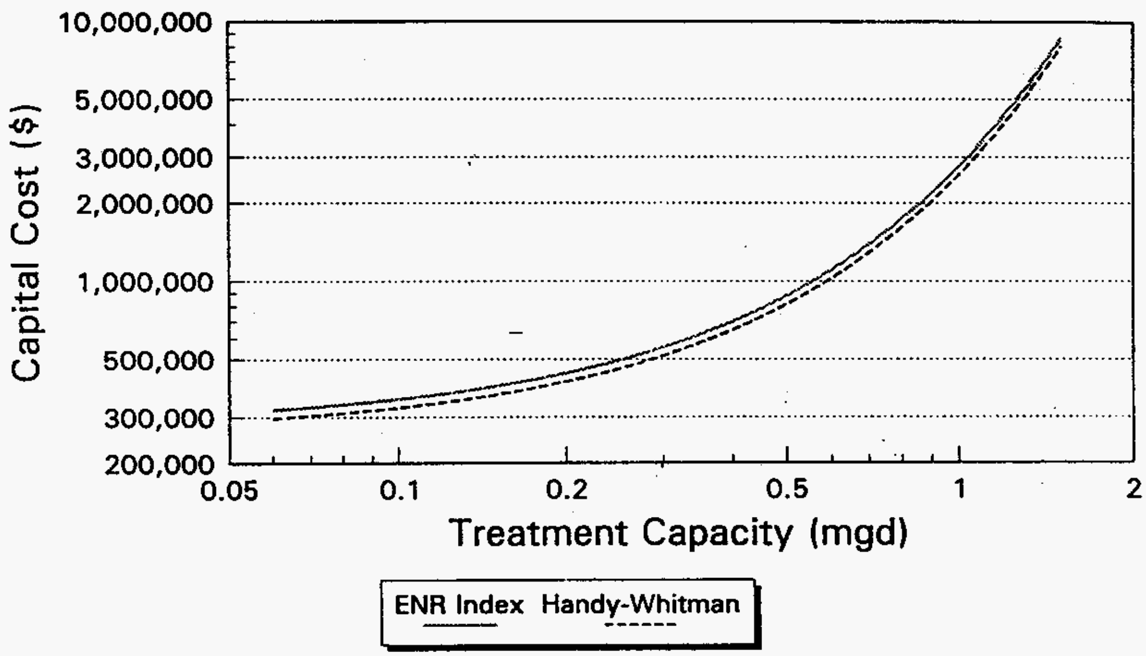
Construction & Unit Costs

Treatment Capacity (Mgd)	Graph #1 Const. Cost ($)	Graph #8 Const. Cost ($)	Graph #11 Const. Cost ($)	Graph #4 Const. Cost ($)	Overall Const. Cost ($)	Overall Unit Cost ($/Gal)
0.003		51,333		25,731	38,532	12.844
0.005		58,667		29,961	44,314	8.863
0.01		73,333		44,061	58,697	5.870
0.03		105,111		91,647	98,379	3.279
0.05		140,963		139,232	140,098	2.802
0.07		174,167		182,235	178,201	2.546
0.10	282,658	220,000		246,740	249,799	2.498
0.20	423,987	366,667		396,547	395,734	1.979
0.50	1,059,968	794,444		793,094	882,502	1.765
1.00		1,588,889	1,382,105	1,339,448	1,436,814	1.437
2.00			2,303,509		2,303,509	1.152
5.00			4,961,404		4,961,404	0.992
10.00			9,568,421		9,568,421	0.957

NOTES:
(1) Values obtained using EPA cost curves.
(2) Costs include housing, structural steel, tanks, piping, valves, pumps, revese osmosis membrane elements and pressure vessels, flow meters, cartridge filters, acid and polyphosphate equipment, and cleaning equipment.
(3) The EPA cost curves have also added costs for contingencies, sitework, engineering & administration, and electrical.
(4) Costs are based on June 1995, ENR Index = 5433.

GRAPH #1

Reverse Osmosis



Note: Source A, Figure 19, page VI-11.

State of the Art of Small WTPs

GRAPH #1
Reverse Osmosis (Fig. 19)

Treatment Capacity (Mgd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
0.07	125,000	2494	5433	272,304	158	319	252,373
0.1	140,000	2494	5433	304,980	158	319	282,658
0.3	280,000	2494	5433	609,960	158	319	565,316
0.5	525,000	2494	5433	1,143,675	158	319	1,059,968
1.0	1,500,000	2494	5433	3,267,642	158	319	3,028,481
1.5	3,250,000	2494	5433	7,079,892	158	319	6,561,709

GRAPH #2
Reverse Osmosis Enclosure (Fig. 20)

Treatment Capacity (Mgd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
0.07	7,000	2494	5433	15,249	158	319	14,133
0.1	8,000	2494	5433	17,427	158	319	16,152
0.3	19,000	2494	5433	41,390	158	319	38,361
0.5	29,000	2494	5433	63,174	158	319	58,551
0.7	40,000	2494	5433	87,137	158	319	80,759
1.0	58,000	2494	5433	126,349	158	319	117,101

A. CAPITAL COSTS

Cost curves were developed for treatment processes judged applicable to small water treatment systems. These curves relate capital costs to quantities of water treated and to population served. Estimates of complete water treatment plants or additions to existing plants may be developed on the basis of these relationships.

Yard piping, fencing (where applicable), and sitework have been included in the curve for each unit process. When adding unit process costs together some of these items may overlap; this may cause the total cost to exceed actual plant costs by 10 to 25 per cent.

Cost data, developed specifically for this report, are based on information from various manufacturers and on the experience and judgment of the investigators. Preliminary designs and engineering cost estimates were developed for each unit process at various low rates. Estimates of construction costs are representative of average price levels as of January, 1977. The Engineering News Record Building Cost Index of that date had a value of 1489.

Included in the capital costs are necessary construction costs, a contingency amount and engineering, legal and administration fees. A cost for fencing is provided for mechanical aeration, diffused aeration, rapid mix, flocculation, sedimentation, ozone contact chamber and waste disposal (lagoons). For each of the other treatment methods an enclosure is recommended and separate cost curves are provided.

Capital costs for unit proceses, package plants and enclosures are developed as follows:

(1) Construction cost – included are necessary costs for equipment, materials, installation, freight and start-up.

(2) Sitework – estimated as 10 per cent of the construction cost.

(3) Electrical – estimated as 20 per cent of the construction cost.

Graph #1&2

m. Electrodialysis. The electrodialysis capital cost curve was developed for a complete multiple-stage electrodialysis system. Costs were obtained for standard units as rated by the manufacturer for operation with a raw water TDS concentration of 1500 to 4000 mg/l. For these electrodialysis units, predicted per cent water recovery ranges from 65 to 85 and predicted per cent TDS removal ranges from 82 to 96. Local water quality may change the rated capacity of these units.

Electrodialysis capital costs include costs for the following equipment and materials: skid-mounted reverse polarity electrodialysis unit with membrane stacks, rectifiers, low pressure feed pump, brine recirculation pump, chemical cleaning equipment, cartridge filters, necessary valves, piping and automatic controls. Refer to Figure 17 for the electrodialysis capital cost curve. The enclosure capital cost curve for electrodialysis is shown on Figure 18.

n. Reverse Osmosis. The reverse osmosis capital cost curve was developed for a complete reverse osmosis treatment system. Costs obtained were for standard units as rated by the manufacturer for operation with a feed of 1500 mg/l NaCl at 400 psi, 25°C (77°F), and 75 per cent conversion. Local water quality may change the rated capacity of these units.

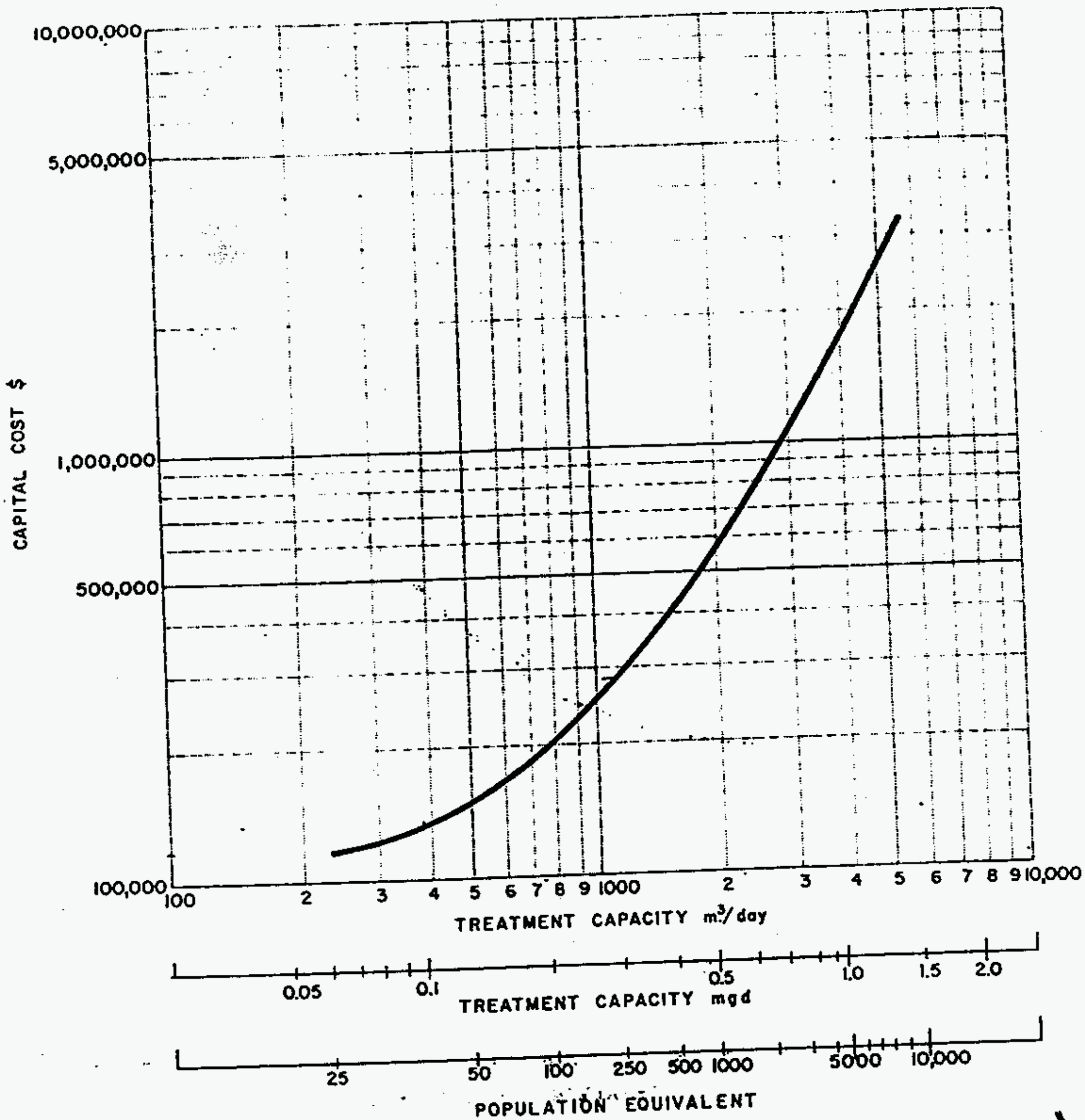
Capital costs for reverse osmosis include costs for the following equipment and materials: skid-mounted, membrane-type reverse osmosis unit with hollow fine fiber membranes, high pressure pumps, cartridge filters, acid and polyphosphate feeding equipment, necessary valves, piping and automatic controls. Refer to Figure 19 for the reverse osmosis capital cost curve. Presented on Figure 20 is a capital cost curve for an enclosure for this unit process.

o. Chemical Feed. Capital costs have been determined for the following chemical feed systems:

(1) powdered activated carbon.

(2) coagulants.

(3) hydrated lime.



Graph 1

UNIT PROCESS COST CURVE INCLUDES:

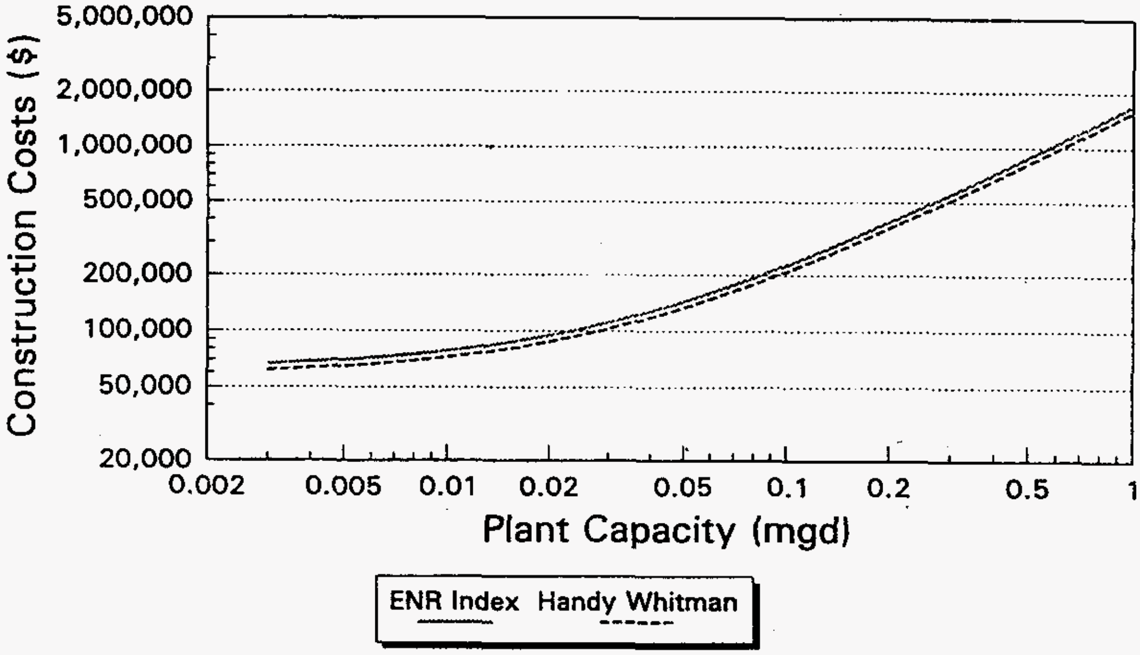
- CONTINGENCIES
- ENGINEERING & ADMINISTRATION
- SITEWORK
- ELECTRICAL
- MEMBRANE TYPE REVERSE OSMOSIS SYSTEM

REVERSE OSMOSIS
CAPITAL COST

FIGURE 19

Graph #8

Reverse Osmosis



Note: Source C, Figure 37, pp. 111-121.

Small Water System Treatment Costs

GRAPH #7
Package Lime Softening Plants (Fig. 12)

Treatment Capacity (gpd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
20,000	86,000	4110	5433	113,683	261	319	105,111
40,000	95,000	4110	5433	125,580	261	319	116,111
70,000	100,000	4110	5433	132,190	261	319	122,222
100,000	115,000	4110	5433	152,018	261	319	140,556
200,000	140,000	4110	5433	185,066	261	319	171,111
500,000	190,000	4110	5433	251,161	261	319	232,222
1,000,000	290,000	4110	5433	383,350	261	319	354,444

GRAPH #8
Reverse Osmosis (Fig. 37)

Treatment Capacity (gpd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
3,000	42,000	4110	5433	55,520	261	319	51,333
5,000	48,000	4110	5433	63,451	261	319	58,667
10,000	60,000	4110	5433	79,314	261	319	73,333
30,000	86,000	4110	5433	113,683	261	319	105,111
60,000	130,000	4110	5433	171,847	261	319	158,889
100,000	180,000	4110	5433	237,942	261	319	220,000
200,000	300,000	4110	5433	396,569	261	319	366,667
500,000	650,000	4110	5433	859,234	261	319	794,444
1,000,000	1,300,000	4110	5433	1,718,467	261	319	1,588,889

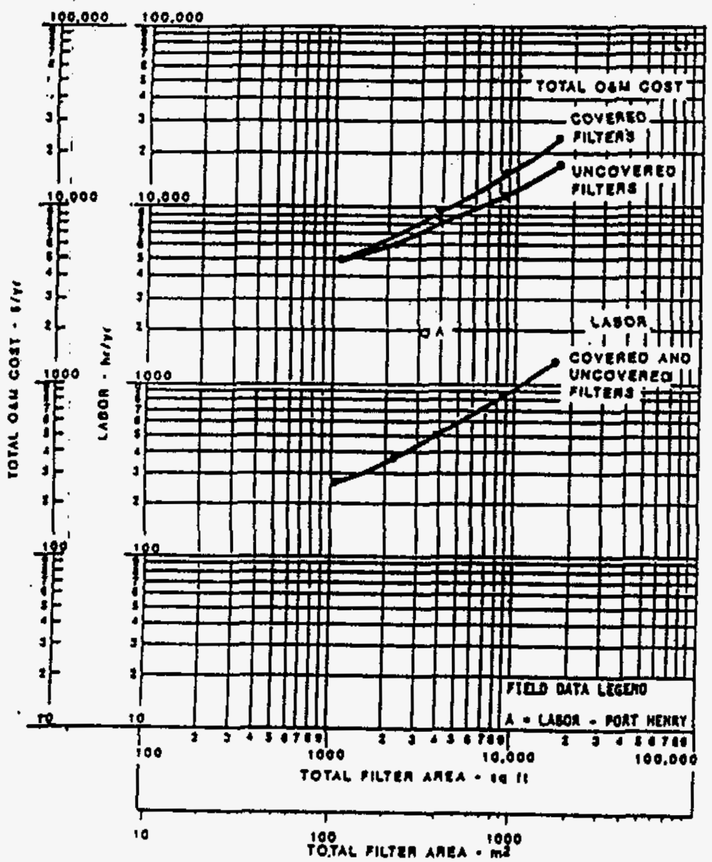


Figure 35. Operation and maintenance requirements for covered and uncovered slow sand filters - labor and total O&M cost.

REVERSE OSMOSIS

Introduction

Reverse osmosis utilizes semi-permeable membranes to remove a high percentage of almost all inorganic ions, turbidity, bacteria, and viruses. Most organic matter is also removed, with the exception of many halogenated and low-molecular-weight compounds.

There are differences between different membrane types in their ability to handle variations in pH, turbidity, and chlorine. The cellulose acetate membranes generally require the feedwater pH to be between 5 and 6 to minimize hydrolysis of the membrane. Polyamide type membranes are damaged by exposure to chlorine. The two most commonly used membrane configurations are hollow fine fiber and spiral wound. The spiral wound element has a higher tolerance for suspended solids and is less susceptible to fouling than the hollow fine fiber element.

The efficiency of the membrane elements in reverse osmosis systems may be impaired by scaling (because of slightly soluble or insoluble compounds) or by fouling (because of the deposition of colloidal or suspended materials). Because of the possibility of scaling and/or fouling, a very important consideration in the design of reverse osmosis systems is the provision of adequate pretreatment to protect the membrane from excessive scaling and fouling and to avoid frequent cleaning requirements. In the development of cost data for reverse osmosis, adequate pretreatment was assumed to precede the reverse osmosis process, but costs for pretreatment facilities such as chemical clarification and filtration are not included.

Brine disposal can also be a major cost consideration. Potential disposal methods include sewer discharge, evaporation ponds, ocean disposal and well injection. Brine disposal facilities and costs are not included in the reverse osmosis systems presented in this section. A separate section is included in this report for brine disposal.

Advances in membrane technology have led to the development of membranes which are capable of operating at low pressures, about 14.06 kg/cm² (200 psi), in contrast to high pressure membranes which operate at 28.12 kg/cm² (400 psi) or more. Advantageously, low pressure membranes result in a substantial savings in process electrical energy. There may be disadvantages to the use of low pressure membranes however. Disadvantages relative to high pressure membranes include lower percentage removal of many contaminants[1], lower allowable feed water TDS or lower percent water recovery, and membrane technology which is still developing.

In the following discussion, low pressure refers to systems operated at 14.06 kg/cm² (200 psi) and high pressure to systems operated at 28.12 kg/cm² (400 psi).

Impact of Raw Water Quality on Treatment Cost

Pretreatment Cost--

Pretreatment chemicals customarily utilized are sodium hexametaphosphate and sulfuric acid, with quantities required being highly variable, depending upon raw water quality. Another important parameter is silica, which may necessitate pretreatment for its removal. Costs for pretreatment chemicals and for silica pretreatment are not included in the following cost data.

Reverse osmosis units may be used for TDS removal, as well as the removal of individual contaminants addressed in the Interim Primary Drinking Water Regulations. The following paragraphs discuss the impact of raw water TDS, as well as individual contaminants in the raw water, upon treatment cost.

Total Dissolved Solids--

Feed water concentrations above 5,000 mg/L can lead to excessively high brine concentrations (>20,000 mg/L), which will generally result in a decrease in product water quality. To prevent this brine concentration buildup, it is necessary to lower the percentage of product water recovery. Lower product water recovery does not require a major change in the reverse osmosis unit, but does necessitate pumping larger quantities of feed water to the reverse osmosis unit. A revision in piping between the pressure vessels may also be required to change vessels to parallel operation, rather than operating some in series. This increases capital cost only slightly, due to the need for larger feed water pumps, but can create a large increase in electrical consumption and pretreatment chemicals, due to the larger quantity of water passed through the reverse osmosis units. A single pass unit will normally have a rejection of over 85% of feed water TDS. If a higher salt rejection is required, a high rejection membrane can be used, or the system can be operated at lower water recovery.

Individual Contaminants--

Little work has been conducted to determine the impact of varying feed concentrations of individual contaminants upon their percentage removal or the cost of removal. A recent publication by Huxstep[1] on work at Charlotte Harbor, Florida, indicated that arsenic (III), arsenic (V), fluoride, and nitrate percentage rejections were all independent of the feed concentrations. These contaminants were each added by spiking a natural groundwater of known concentration. High pressure membranes removed significantly higher percentages of these four components than did low pressure membranes.

Construction Costs

Construction cost data was developed for single stage (only one pass through the membrane) treatment systems which are capable of treating TDS concentrations up to about 2,000 mg/L for low pressure membranes and 10,000 mg/L for high pressure membranes. An operating pressure of 14.06 kg/cm² (200 psi) was utilized for low pressure membranes, and 28.12 kg/cm² (400 psi) for high pressure membranes. Construction costs are comparable for high and low pressure systems.

The temperature of the feedwater was assumed to be between 18.3° and 29.4°C (65° and 85°F), and the pH of the feedwater was assumed to be adjusted using acid injection to about 5.5 to 6.0 before the reverse osmosis process. The acid injection will prolong the life of a cellulose acetate membrane, but the primary function is to prevent calcium carbonate scale formation in the system. A degasifier following reverse osmosis will remove dissolved gases such as carbon dioxide and hydrogen sulfide from the product water, and will reduce neutralization requirements.

At TDS concentrations up to 5,000 mg/L, the assumed water recoveries for different flow ranges are as follows:

Feed Water Flow Range	Water Recovery (%)
2,500 - 10,000 gpd	40
10,000 - 50,000 gpd	50
50,000 - 100,000 gpd	65
100,000 gpd - 1.0 mgd	75

At concentrations above 5,000 mg/L, the percent recovery should be decreased in order to maintain a brine concentration less than 20,000 mg/L, which is necessary to limit osmotic pressure on the brine side of the membrane as well as to maintain quality of the product water. Salt rejections of over 85% should be achieved under these operating conditions. To maintain 20,000 mg/L in the brine, the following percent water recoveries are necessary:

TDS Concentration	Water Recovery (%)
5,000 mg/L	75
6,000 mg/L	70
7,000 mg/L	65
8,000 mg/L	60
9,000 mg/L	55
10,000 mg/L	50

It may be assumed that the capital cost of reverse osmosis treatment remains essentially unchanged as the TDS increases up to 10,000 mg/L, although the water recovery is decreased. This does increase the capacity (and therefore the capital cost) of the feedwater pumps, but this would increase the overall reverse osmosis system cost less than 5 percent. Thus, no separate cost data is presented for systems treating TDS concentrations greater than 5,000 mg/L. The largest effect is on O&M costs since the energy and pretreatment costs would increase in proportion to the increase in flow rate.

Commercial reverse osmosis systems are available from numerous manufacturers as either complete skid-mounted units or custom systems. For sizes ranging from 9.47 m³/d (2,500 gpd) up to between 378.5-946.3 m³/d (100,000-250,000 gpd), skid-mounted systems are generally used. Above 946.3 m³/d (250,000 gpd), either skid-mounted or custom systems are used. An advantage of using multiple standard systems above 946.3 m³/d (250,000 gpd), is the reliability provided by having several systems in case one unit needs to be shut down for repairs. This cost analysis used skid-mounted units, or multiples of such units, for all size ranges.

Components taken into account in the construction cost estimates include housing, structural steel and miscellaneous metalwork, tanks, piping, valves, high pressure feed water pumps, reverse osmosis membrane elements and pressure vessels, flowmeters, cartridge filters, acid and polyphosphate feed equipment, cleaning equipment, caustic feed equipment, and a degasifier. The cost data are based on the use of either spiral-wound or hollow fine-fiber reverse osmosis membranes. Membrane materials can be cellulose acetate, polyamide, or thin film composite. A layout of a typical small system reverse osmosis system is shown in Figure 36.

Brine disposal costs and product water pumping costs are not included in the estimates. Construction cost estimates are presented in Table 46 and also in Figure 37.

<u>Operation and Maintenance Requirements and Costs</u>

Process electrical energy is required for the feed water pumps, pre- and post-treatment chemical feed pumps, and the degasifier. The combined feed water pump/motor efficiency increases as flow increases. The feed water pump/motor efficiencies which were used in the calculations were: 40% up to 37.85 m^3/d (10,000 gpd) plant capacity, 50% up to 378.5 m^3/d (100,000 gpd) plant capacity, and 60% over 378.5 m^3/d (100,000 gpd) plant capacity. Energy requirements used for the chemical feed pumps and degasifier were 10% of the high pressure pump energy for plant capacities less than 189.3 m^3/d (50,000 gpd), and 5% for plant capacities over 189.3 m^3/d (50,000 gpd).

Process energy varies with the percent water recovery. As discussed under Construction Costs, higher percent water recoveries are typically used as system size increases, resulting in lower process energy requirements per unit of water produced. However, as TDS increases above 5,000 mg/L, lower percent water recoveries are necessary to maintain a reasonable brine concentration and to prevent deterioration of product water quality. Process electrical data has been developed for feed water TDS concentrations of 2,000 mg/L for low pressure systems and 5,000, 8,000, and 10,000 mg/L for high pressure systems.

Electrical energy for building lighting, heating, and ventilating was calculated based on an estimated floor area required for complete housing of the reverse osmosis equipment, with the exception of the degasifier, which is located outside. A building energy requirement of 209.8 $kwh/m^2/y$ (19.5 kwh/sq ft/yr) was used for lighting, heating, and ventilation. This requirement is based upon a lighting use factor of three hours per day.

The largest maintenance material requirement is for membrane replacement; a membrane life of three years was used in the cost estimates. Other maintenance material requirements are for replacement of cartridge filters, for membrane cleaning chemicals, and for materials needed for periodic repair of pumps, motors, and electrical control equipment. Costs for pretreatment chemicals, such as acid and polyphosphate, and post-treatment chemicals, such as caustic, are not included in the maintenance material estimates, but they

TABLE 46. CONSTRUCTION COST SUMMARY FOR REVERSE OSMOSIS SYSTEMS

Cost Category	Plant Capacity, gpd					
	2,500	10,000	50,000	100,000	500,000	1,000,000
Manufactured Equipment	$20,300	$30,000	$ 69,600	$123,000	$454,800	$ 877,400
Labor	800	1,200	1,500	2,800	7,500	14,600
Electrical, Instrumentation	3,200	4,600	10,700	18,700	45,900	62,100
Housing	11,900	13,900	16,400	18,500	38,400	52,500
Subtotal	36,200	49,700	98,200	163,000	546,600	1,006,600
Design Contingencies	5,400	7,500	14,700	24,500	82,000	151,000
Total	$41,600	$57,200	$112,900	$187,500	$628,600	$1,157,600

Notes: 1. Housing requirements from smallest plant capacity to largest are 140, 170, 210, 250, 800, and 1,500 sq ft. Ceiling height in buildings is 14 ft.
2. Costs are valid for feed water TDS concentrations up to 10,000 mg/L. However, percentage recovery of feed water decreases above 5,000 mg/L TDS.

are discussed in the following section. Maintenance material costs increase slightly as the percent recovery drops, due to increased pumping to the reverse osmosis unit.

Labor requirements are for cleaning and replacing membranes, replacing cartridge filters, maintaining the high pressure and other pumps, preparing treatment chemicals and determining proper dosages, maintaining chemical feed equipment, and monitoring performance of the reverse osmosis membranes. Membrane cleaning was assumed to occur monthly. In estimating labor requirements, a minimum of about one hr/day of labor was assumed for the smallest plant.

Operation and maintenance requirements are summarized in Table 47 for low pressure systems and in Table 48 for high pressure systems, and are illustrated for both high and low pressure systems in Figures 38 and 39.

TABLE 47. OPERATION AND MAINTENANCE SUMMARY FOR LOW PRESSURE REVERSE OSMOSIS SYSTEMS

Average Plant Flow Rate, gpd	Energy, kwh/yr			Maintenance Material, $/yr	Labor, hr/yr	Total Cost, $/yr
	Building	Process	Total			
2,500	2,800	9,900	12,700	500	340	5,100
10,000	3,300	26,300	29,600	1,700	360	7,800
50,000	4,100	100,100	104,200	8,000	480	20,600
100,000	4,900	180,400	185,300	14,600	610	34,300
500,000	15,600	853,200	868,800	67,100	870	137,500
1,000,000	29,300	1,606,000	1,635,300	117,900	1,130	244,800

Note: Total cost is based on $0/07/kwh of electrical energy and $11.00/hour of labor.

Typical Chemical Requirements and Costs

The principal chemicals required in small reverse osmosis systems are sodium hexametaphosphate for control of scaling and fouling, sulfuric acid for pH adjustment prior to treatment, and sodium hydroxide to increase the pH following treatment. The required cost for each chemical is a function of the dosage, the unit cost of the chemical and the percent water recovery. Using the percentage of water recovery discussed previously in the text, and the following dosages and unit chemical costs, the annual chemical costs in Table 49 were calculated.

Chemical	Dosage	Unit Cost
Sodium Hexametaphosphate	6 mg/L	$1.10/lb
Sulfuric Acid	75 mg/L	$0.08/lb
Sodium Hydroxide	15 mg/L	$0.17/lb

TABLE 48. OPERATION AND MAINTENANCE SUMMARY FOR REVERSE OSMOSIS SYSTEMS

Average Plant Flow Rate, gpd	Energy, kwh/yr			Maintenance Material, $/yr	Labor, hr/yr	Total Cost, $/yr
	Building	Processs	Total			
Feed Water TDS Concentrations Up to 5,000 mg/L						
2,500	2,800	18,000	20,800	500	340	5,700
10,000	3,300	48,200	51,500	1,700	360	9,300
50,000	4,100	191,100	195,200	8,000	480	27,000
100,000	4,900	344,400	349,300	14,600	610	45,800
500,000	15,600	1,629,000	1,644,600	67,100	870	191,800
1,000,000	29,300	3,066,000	3,095,300	117,900	1,130	347,000
Feed Water TDS Concentrations = 8,000 mg/L						
2,500	2,800	18,000	20,800	500	340	5,700
10,000	3,300	48,200	51,500	1,700	360	9,300
50,000	4,100	191,100	195,200	8,000	480	27,000
100,000	4,900	371,000	377,900	14,900	630	48,300
500,000	15,600	2,036,200	2,051,800	70,200	940	224,200
1,000,000	29,300	3,832,500	3,861,800	122,900	1,220	406,700
Feed Water TDS Concentrations = 10,000 mg/L						
2,500	2,800	18,000	20,800	500	340	5,700
10,000	3,300	48,200	51,500	1,700	360	9,300
50,000	4,100	191,100	195,200	8,000	480	27,000
100,000	4,900	447,700	452,600	15,500	680	54,700
500,000	15,600	2,443,500	2,45[illegible],100	73,200	1,020	256,600
1,100,000	29,300	4,599,000	4,628,300	127,700	1,310	466,100

Note: Total cost is based on $0.07/kwh of electrical energy and $11.00/hour of labor.

TABLE 49. TYPICAL CHEMICAL COSTS FOR REVERSE OSMOSIS SYSTEMS

Average Plant Flow Rate, gpd	Sodium Hexametaphosphate, $/yr	Sulfuric Acid, $/yr	Sodium Hydroxide, $/yr	Total Chemical Cost, $/yr
Feed Water TDS Concentrations Up to 5,000 mg/L				
2,500	130	120	50	300
10,000	500	460	200	1,160
50,000	2,000	1,830	780	4,610
100,000	3,100	2,800	1,200	7,100
500,000	13,400	12,200	5,200	30,800
1,000,000	26,800	24,300	10,300	61,400
Feed Water TDS Concentrations = 8,000 mg/L				
2,500	130	120	50	300
10,000	500	460	200	1,160
50,000	2,000	1,830	780	4,610
100,000	3,400	3,000	1,300	7,700
500,000	16,800	15,200	6,500	38,500
1,000,000	33,500	30,400	12,900	76,800
Feed Water Concentrations = 10,000 mg/L				
2,500	130	120	50	300
10,000	500	460	200	1,160
50,000	2,000	1,830	780	4,610
100,000	4,000	3,700	1,600	9,300
500,000	20,100	18,300	7,800	46,200
1,000,000	40,200	36,500	15,500	92,200

Note: Chemical dosages and costs used in this table were:
Sodium Hexametaphosphate - 6 mg/L; $1.10/lb
Sulfuric Acid - 75 mg/L; $0.08/lb
Sodium Hydroxide - 15 mg/L; $0.17/lb

The required chemical dosages will vary widely between water supplies, and laboratory or pilot plant testing should be used to determine requirements. Additionally, the cost of chemicals will be a function of the geographical area and the quantity of chemical purchased.

Field Data Collection

Operating data on reverse osmosis treatment systems were collected at the Charlotte Harbor Water Association, Harbor Heights, Florida, and the Bryn Mawr Water Company, Vero Beach, Florida. The Charlotte Harbor plant has two treatment modules which operate at 27.4 kg/cm² (390 psi) and have a combined treatment capacity of 1,136 m³/d (0.3 mgd) and one low pressure unit which operates at 16.5 kg/cm² (235 psi) and has a treatment capacity of 568 m³/d (0.15 mgd). The total operating flow rate of both the high and low pressure units is 1,120 m³/d (0.296 mgd). The TDS concentration in the raw water supply was not obtained during the field sampling.

The Bryn Mawr plant at Vero Beach has an installed capacity of 454 m³/d (0.12 mgd) and an operating flow rate of 163 m³/d (0.043 mgd). The operating pressure is 28.1 kg/cm² (400 psi). The TDS in the raw water supply was not noted during collection of field data.

A comparison of field operating data and information from Figures 38 and 39 is shown following:

	Charlotte Harbor		Yero Beach	
	Field Data	Data From Figures 38 and 39	Field Data	Data From Figures 38 and 39
Electrical Energy, kwh/hr				
Process	-	750,000	-	160,000
Building	-	14,000	-	4,000
Total	788,200	764,000	218,800	164,000
Maintenance Material, $/yr	10,400	38,000	890	6,000
Labor, hr/yr	5,140	800	640	480

Maintenance material requirements are low at both plants because replacement of membranes has not been necessary at either plant. However, Figure 38 data include a cost for membrane replacement every three years. The large difference in labor requirement at Charlotte Harbor is believed to be the result of an inappropriate division of labor between the treatment plant and the water distribution system.

References

1. Huxstep, M.R., "Inorganic Contaminant Removal From Drinking Water By Reverse Osmosis," EPA Report 600/S2-81-115, October, 1981.

EXHIBIT (SAH-4)
PAGE 269 OF 284

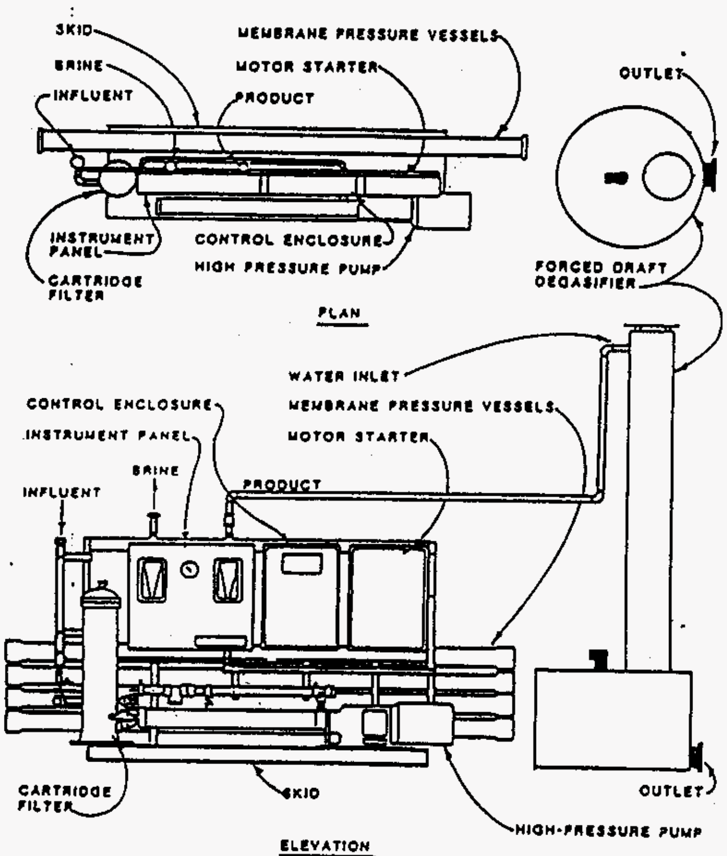


Figure 36. Typical-skid mounted reverse osmosis installation

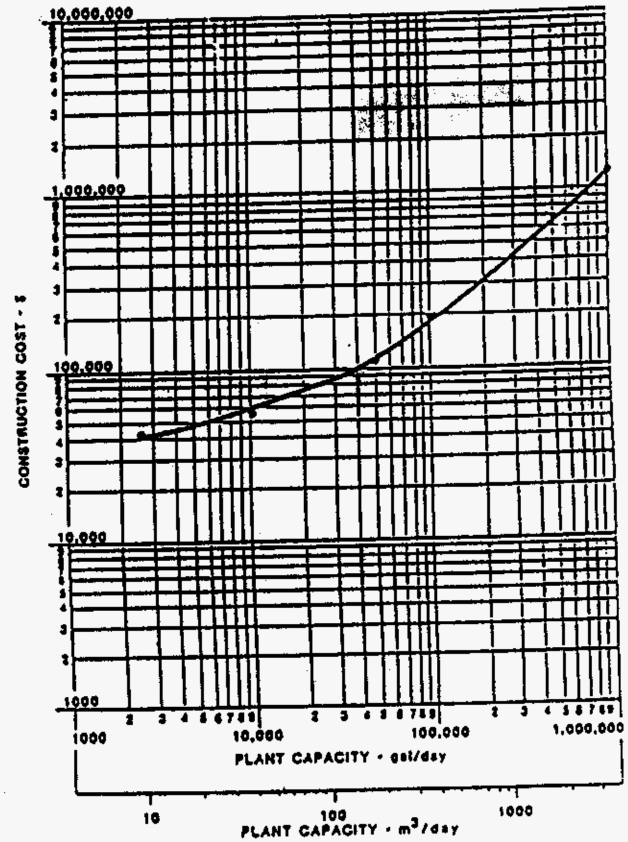
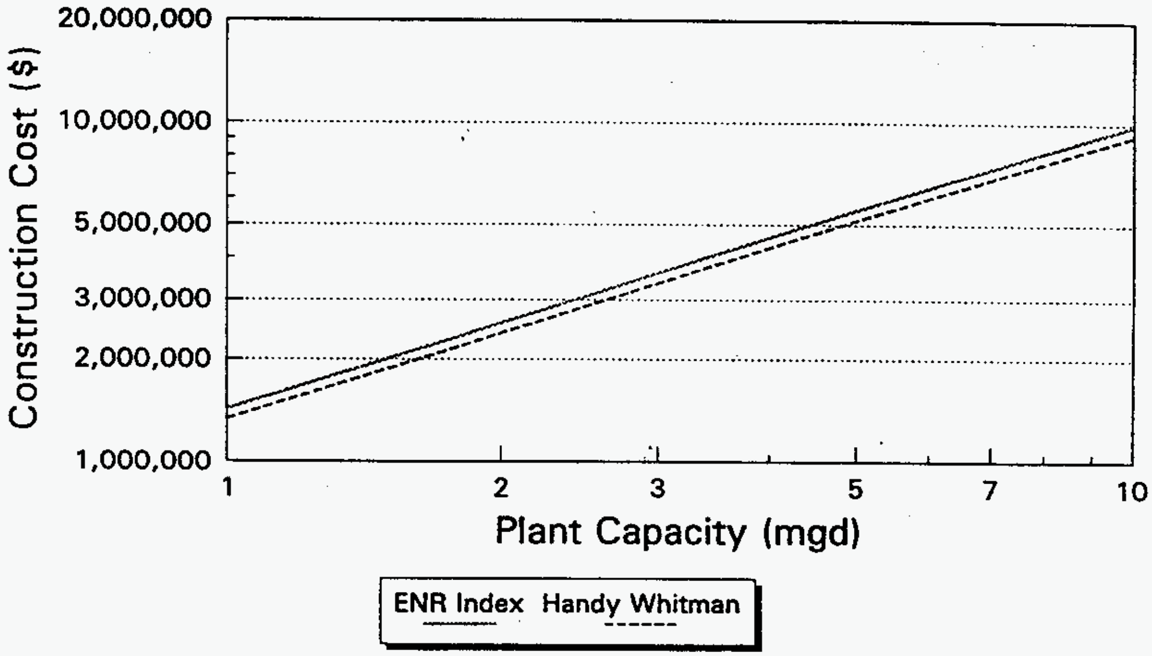


Figure 37. Construction cost for reverse osmosis system

Graph #11

Reverse Osmosis



Note: Source D, Figure 113, pp. 246-250.

Estimating Water Treatment Costs - Vol. 2

GRAPH #11
Reverse Osmosis (Fig. 113)

Treatment Capacity (mgd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
1	780,000	2851	5433	1,486,405	171	303	1,382,105
2	1,300,000	2851	5433	2,477,341	171	303	2,303,509
5	2,800,000	2851	5433	5,335,812	171	303	4,961,404
10	5,400,000	2851	5433	10,290,495	171	303	9,568,421

GRAPH #12
Raw Water Pumping Facilities (Fig. 201)

Treatment Capacity (mgd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
30 Feet TDH							
1	20,000	2851	5433	38,113	171	303	35,439
2	25,000	2851	5433	47,641	171	303	44,298
5	37,000	2851	5433	70,509	171	303	65,561
10	55,000	2851	5433	104,811	171	303	97,456
20	86,000	2851	5433	163,886	171	303	152,386
50	180,000	2851	5433	343,016	171	303	318,947
100	325,000	2851	5433	619,335	171	303	575,877
100 Feet TDH							
1	26,000	2851	5433	49,547	171	303	46,070
2	31,000	2851	5433	59,075	171	303	54,930
5	49,000	2851	5433	93,377	171	303	86,825
10	74,000	2851	5433	141,018	171	303	131,123
20	125,000	2851	5433	238,206	171	303	221,491
50	250,000	2851	5433	476,412	171	303	442,982
100	490,000	2851	5433	933,767	171	303	868,246

EPA - Estimating WTP costs
1-200 MGD

Culp + Culp
Cost Curves

SECTION 4

COST CURVES

CONSTRUCTION COST CURVES

The construction cost curves were developed using equipment cost data supplied by manufacturers, cost data from actual plant construction, unit takeoffs from actual and conceptual designs, and published data. When unit cost takeoffs were used to determine costs from actual and conceptual designs, estimating techniques from Richardson Engineering Services Process Plant Construction Estimating Standards,[19] Mean's Building Construction Cost Data,[20] and the Dodge Guide for Estimating Public Works Construction Costs[21] were often utilized. An example illustrating how costs were determined using unit cost takeoffs from an actual design for a reinforced concrete wall (similar to a wall for a clarifier or a filter structure) is presented in Appendix C. The cost curves that were developed were then checked and verified by a second engineering consulting firm, Zurheide-Herrmann, Inc., using an approach similar to that a general contractor would utilize in determining his construction bid. Every attempt has been made to present the conceptual designs and assumptions that were incorporated into the curves. Adjustment of the curves may be necessary to reflect site-specific conditions, geograpnic or local conditions, or the need for standby power. The curves should be particularly useful for estimating the relative economics of alternative treatment systems and in the preliminary evaluation of general cost level to be expected for a proposed project. The curves contained in this report are based on October 1978 costs.

The construction cost was developed by determining and then aggregating the cost of the following eight principal components: (1) Excavation and site work; (2) manufactured equipment; (3) concrete; (4) steel, (5) labor; (6) pipe and valves; (7) electrical equipment and instrumentation; and (8) housing. These eight categories were utilized primarily to facilitate accurate cost updating, which is discussed in a subsequent section of this chapter. The division will also be helpful where costs are being adjusted for site-specific, geographic and other special conditions. The eight categories include the following general items:

Excavation and Site Work. This category includes work related only to the applicable process and does not include any general site work such as sidewalks, roads, driveways, or landscaping.

Manufactured Equipment. This category includes estimated purchase cost of pumps, drives, process equipment, specific purpose controls, and other items that are factory made and sold with equipment.

Concrete. This category includes the delivered cost of ready mix concrete and concrete-forming materials.

Steel. This category includes reinforced steel for concrete and miscellaneous steel not included under manufactured equipment.

Labor. The labor associated with installing manufactured equipment, and piping and valves, constructing concrete forms, and placing concrete and reinforcing steel are included here.

Pipe and Valves. Cast iron pipe, steel pipe, valves, and fittings have been combined into a single category. The purchase price of pipe, valves, fittings, and associated support devices are included within this category.

Electrical Equipment and Instrumentation. The cost of process electrical equipment, wiring, and general instrumentation associated with the process equipment is included in this category.

Housing. In lieu of segregating building costs into several components, this category represents all material and labor costs associated with the building, including heating, ventilating, air conditioning, lighting, normal convenience outlets, and the slab and foundation.

The subtotal of the costs of these eight categories includes the cost of material and equipment purchase and installation, and subcontractor's overhead and profit. To this subtotal, a 15-percent allowance has been added to cover miscellaneous items not included in the cost takeoff as well as contingency items. Experience at many water treatment facilities has indicated that this 15-percent allowance is reasonable. Although blanket application of this 15-percent allowance may result in some minor inequity between processes, these are generally balanced out during the combination of costs for individual processes into a treatment system.

The construction cost for each unit process is presented as a function of the most applicable design parameter for the process. For example, construction costs for package gravity filter plants are plotted versus capacity in gallons per minute, whereas ozone generation system costs are presented versus pounds per day of feed capacity. Use of such key design parameters allows the curves to be utilized with greater flexibility than if all costs were plotted versus flow.

The construction costs shown in the curves are not the final capital cost for the unit process. The construction cost curves do not include costs for special site work, general contractor overhead and profit, engineering, or land, legal, fiscal, and administrative work and interest during construction. These cost items are all more directly related to the total cost of a project rather than the cost of the individual unit processes. They are therefore most appropriately added following cost summation of the individual unit processes, if more than one unit process is required. The examples presented in a subsequent section of this volume illustrate the recommended method for the addition of these costs to the construction cost.

Construction costs are presented for wash water storage tanks in Table 91 and Figure 112.

REVERSE OSMOSIS

Construction Cost

Reverse osmosis utilizes membranes to remove a high percentage of almost all inorganic ions, turbidity, bacteria, and viruses. Most organic matter is also removed, with the exception of several materials, including most halogenated and low molecular weight compounds.

Commercial units are available in sizes up to about 5,000 gpd for the membrane elements and up to 30,000 gpd for the reverse osmosis modules (pressure vessels). Therefore, large-scale plants would be composed of many small, parallel modules. Components taken into account in the construction cost estimates include housing, structural steel and miscellaneous metalwork, tanks, piping, valves, pumps, reverse osmosis membrane elements and pressure vessels, flow meters, cartridge filters, acid and polyphosphate feed equipment, and cleaning equipment. The cost curves are based on the use of either spiral-wound or hollow fine-fiber reverse osmosis membranes.

The efficiency of the membrane elements in reverse osmosis systems may be impaired by scaling because of slightly soluble or insoluble compounds, or by fouling as a result of the deposition of colloidal or suspended materials. Because of this, a very important consideration in the design of a reverse osmosis system is the provision of adequate pretreatment to protect the membrane from excessive scaling and fouling and to avoid frequent cleaning requirements. In the development of the cost curves, adequate pretreatment was assumed to precede the reverse osmosis process, and costs for pretreatment are not included in the estimates.

The construction cost curve applies to waters with a total dissolved solids (TDS) concentration ranging up to about 10,000 mg/l. Other considerations, such as calcium sulfate and silica concentrations and also the desired water recovery, affect costs more than the influent TDS concentration. The temperature of the feedwater is assumed to be between 65° and 95°F, and the pH of the feedwater is adjusted to about 5.5 to 6.0 before the reverse osmosis process. A single-pass treatment system (only one pass through the membrane) is assumed, with an operating pressure of 400 to 450 psi. The assumed water recoveries for different flow ranges are as follows:

Flow Range (mgd):	Water Recovery (%)
1 - 10	.80
10 - 200	.85

Brine disposal costs are not included in the estimates.

Construction costs are presented in Table 92 and also in Figure 113.

Table 92

Construction Cost for

Reverse Osmosis

Cost Category	Plant Capacity (mgd) 1.0	10	100	200
Manufactured Equipment	$474,210	$ 3,456,480	$29,174,260	$56,438,930
Labor	70,420	346,850	2,312,340	2,837,870
Electrical and Instrumentation	65,740	486,270	3,635,690	6,947,480
Housing	64,260	462,650	2,409,660	4,176,740
SUBTOTAL	674,630	4,754,250	37,531,950	70,401,020
Miscellaneous and Contingency	101,190	713,140	5,629,790	10,560,150
TOTAL	775,820	5,467,390	43,161,740	80,961,170

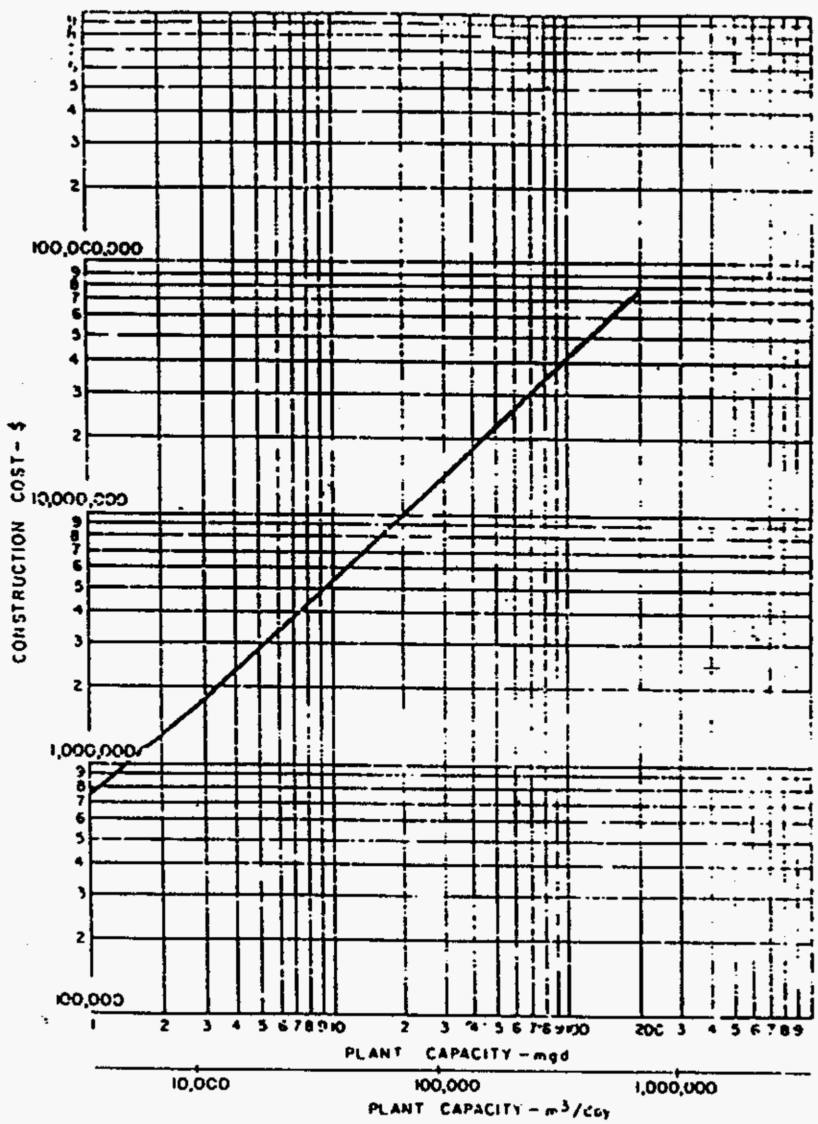
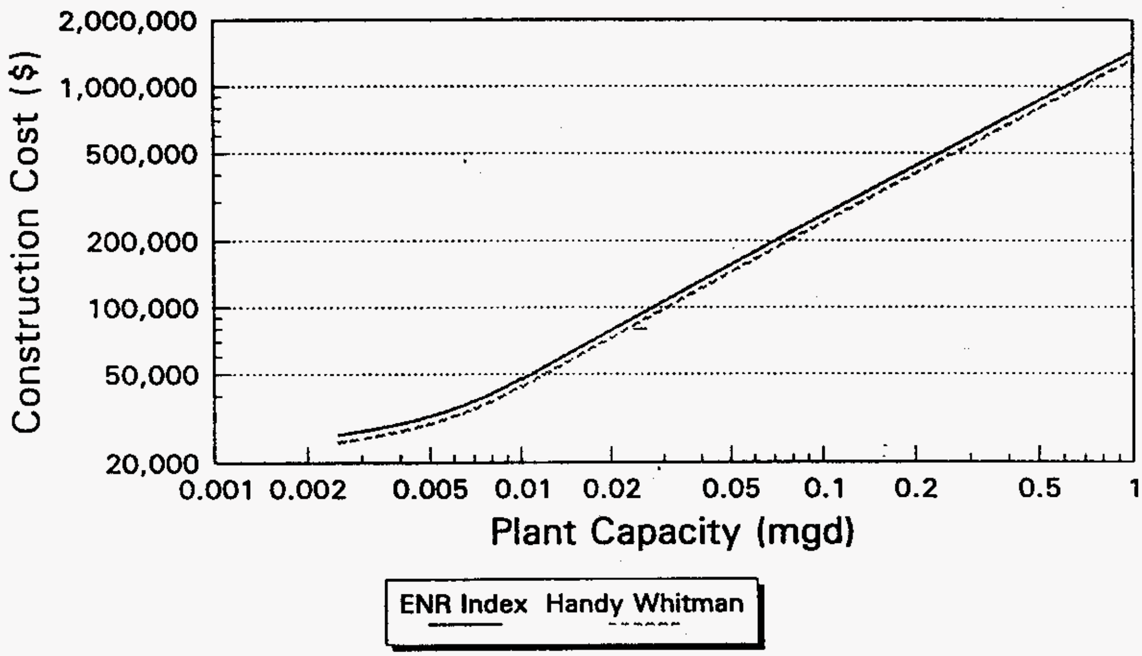


Figure 113. Construction cost for reverse osmosis.

GRAPH #15

Reverse Osmosis



Note: Source E, Figure 35, pp. 88, 92-95.

Estimating Water Treatment Costs - Vol. 3

GRAPH #15
Reverse Osmosis (Fig. 35)

Treatment Capacity (gpd)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
2,500	14,000	2851	5433	26,679	181	319	24,674
5,000	17,000	2851	5433	32,396	181	319	29,961
7,000	20,000	2851	5433	38,113	181	319	35,249
10,000	25,000	2851	5433	47,641	181	319	44,061
50,000	79,000	2851	5433	150,546	181	319	139,232
100,000	140,000	2851	5433	266,791	181	319	246,740
200,000	225,000	2851	5433	428,771	181	319	396,547
500,000	450,000	2851	5433	857,541	181	319	793,094
1,000,000	760,000	2851	5433	1,448,292	181	319	1,339,448

GRAPH #16
Package High–Service Pump Stations (Fig. 53)

Treatment Capacity (gpm)	Const. Cost ($)	ENR Index	June 1995 ENR Index	Current Cost ($)	Handy Whitman	Current Handy Whitman	Current Cost ($)
30	12,500	2851	5433	23,821	155	259	20,887
50	13,000	2851	5433	24,773	155	259	21,723
70	14,000	2851	5433	26,679	155	259	23,394
100	14,500	2851	5433	27,632	155	259	24,229
200	16,000	2851	5433	30,490	155	259	26,735
500	18,000	2851	5433	34,302	155	259	30,077
1,000	20,000	2851	5433	38,113	155	259	33,419

was assumed, with only occasional shutdown to clean cells and replace weak ultraviolet lamps. Building energy is for heating, lighting, and ventilation.

Maintenance materials are related to the replacement cost of the ultraviolet lamps, which are generally replaced after operating continuously for about 8,000 hr.

Labor requirements are related to occasional cleaning of the quartz sleeves and periodic replacement of the ultraviolet lights.

Operation and maintenance requirements are summarized in Table 38 and also presented in Figures 33 and 34.

REVERSE OSMOSIS

Construction Cost

Reverse osmosis utilizes membranes to remove a high percentage of almost all inorganic ions, turbidity, bacteria, and viruses. Most organic matter is also removed, with the exception of several materials, including most halogenated and low-molecular-weight compounds.

Construction costs were developed for complete reverse osmosis plants in the size ranges from 2,500 gpd to 1 mgd. Commercial units are available in sizes up to about 5,000 gpd for the membrane elements and up to 30,000 gpd for the reverse osmosis modules (pressure vessels). Therefore, large-scale plants are composed of many smaller, parallel modules. Components taken into account in the construction cost estimates include housing, structural steel and miscellaneous metalwork, tanks, piping, valves, pumps, reverse osmosis membrane elements and pressure vessels, flow meters, cartridge filters, acid and polyphosphate feed equipment, and also cleaning equipment. The cost curves are based on the use of either spiral-wound or hollow fine-fiber reverse osmosis membranes.

The efficiency of the membrane elements in reverse osmosis systems may be impaired by scaling (because of slightly soluble or insoluble compounds) or by fouling (because of the deposition of colloidal or suspended materials). Because of this possibility, a very important consideration in the design of a reverse osmosis system is the provision of adequate pretreatment to protect the membrane from excessive scaling and fouling and to avoid frequent cleaning requirements. In the development of the cost curves, adequate pretreatment was assumed to precede the reverse osmosis process, but costs for pretreatment are not included in the estimates.

The construction cost curve applies to waters with a total dissolved solids (TDS) concentration ranging up to about 10,000 mg/1. Other considerations, such as calcium sulfate and silica concentrations and also the desired water recovery, affect cost more than the influent TDS concentration. The temperature of the feedwater is assumed to be between 65° and 95° F, and the pH of the feedwater is adjusted to about 5.5 to 6.0 before the reverse osmosis process. A single-pass treatment system (only one pass through the membrane) is assumed, with an operating pressure of 400 to 450 psi. The assumed water recoveries for different flow ranges are as follows:

Flow Range	Water Recovery (%)
2,500 - 10,000 gpd	60
10,000 - 100,000 gpd	70
100,000 gpd - 1.0 mgd	75

Brine disposal costs are not included in the estimates. Construction cost estimates are presented in Table 39 and also in Figure 35.

Operation and Maintenance Cost

Electrical energy usage is included for the high-pressure feedwater pumps, based on an operating pressure of 450 psi and on the water recoveries listed in the construction cost write-up. For other pumps and chemical feed equipment, an energy usage of 10 percent of the usage for the high-pressure pumps was assumed . Electrical energy for lighting, heating, and ventilating was calculated, based on an estimated floor area required for complete housing of the reverse osmosis equipment.

The largest maintenance material requirement is for membrane replacement; a membrane life of 3 years was used in the cost estimates. Other maintenance material requirements are for replacement of cartridge filters, for membrane cleaning chemicals, and for materials needed for periodic repair of pumps, motors, and electrical control equipment. Costs for pretreatment chemicals, such as acid and polyphosphate, are not included in the estimates. The chemicals utilized and the dosages required will show great variability between different water supplies and should be determined from pilot plant testing.

Labor requirements are for cleaning and replacing membranes, replacing cartridge filters, maintaining the high-pressure and other pumps, preparing treatment chemicals and determining proper dosages, maintaining chemical feed equipment, and monitoring performance of the reverse osmosis membranes. Membrane cleaning was assumed to occur monthly. In estimating labor requirements, a minimum of about 1.5 hr/day of labor was assumed for the smallest plant.

Operation and maintenance requirements are summarized in Table 40 and illustrated in Figures 36 and 37.

PRESSURE ION EXCHANGE SOFTENING

Construction Cost

Cation exchange resins can be utilized for the removal of hardness, barium, trivalent chromium, lead, manganese, mercury, and radium. Construction costs were developed for pressure ion exchange softening systems using the conceptual information presented in Table 41. The contact vessels were fabricated steel, with a baked phenolic lining added after fabrication and constructed for 100 psi working pressure. The depth of resin was 6 ft,

Table 39

Construction Cost for

Reverse Osmosis

Cost Category	Plant Capacity (gpd) 2,500	10,000	100,000	1,000,000
Manufactured Equipment	$ 3,710	$11,140	$81,050	$ 474,210
Labor	770	2,210	16,080	70,420
Electrical and Instrumentation	4,190	4,710	10,680	65,740
Housing	2,680	4,070	6,430	64,260
SUBTOTAL	11,350	22,130	114,240	674,630
Miscellaneous and Contingency	1,700	3,320	17,140	101,190
TOTAL	13,050	25,450	131,380	775,820

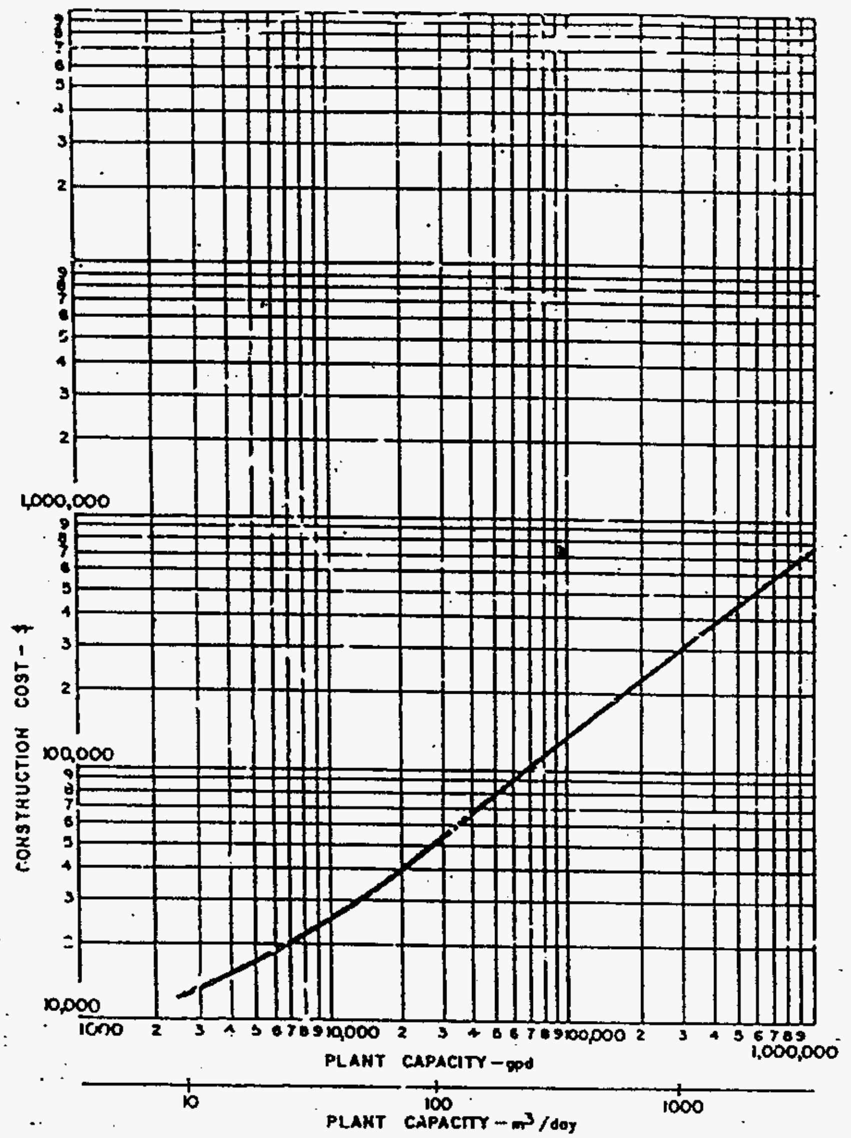
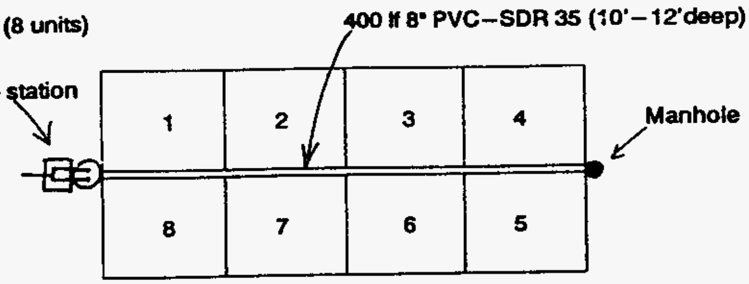


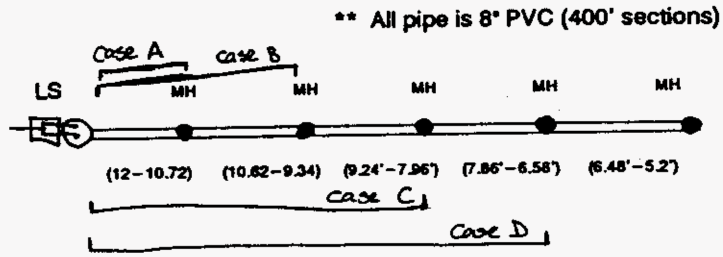
Figure 35. Construction cost for reverse osmosis.

APPENDIX N

One Section (8 units)



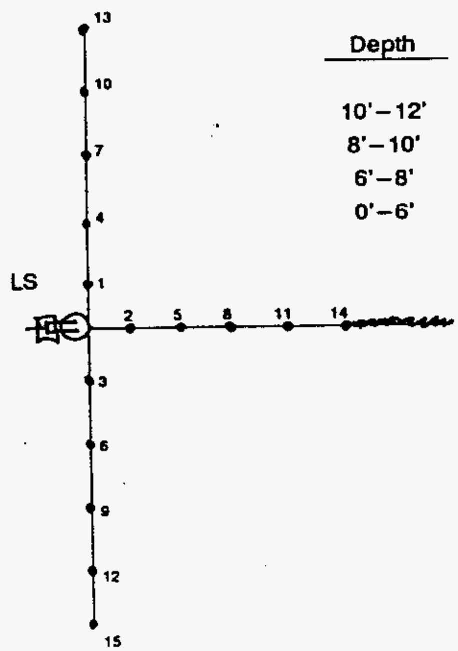
One Street (40 units)



Whole Installation (120 units)

8" Gravity Sewer

10'–12' deep => 1782 lf
8'–10' deep => 1782 lf
6'–8' deep => 1689 lf
0'–6' deep => 750 lf



Depth	Manholes
10'–12'	1,2,3
8'–10'	4,5,6
6'–8'	7–12
0'–6'	13,14,15

Case E

Gravity Sewer Costs

① 8" Gravity Sewer (SDR 35 – PVC)

0-6' ⇒ $9.25/ft
6-8' ⇒ $12.00/ft
8-10' ⇒ $16.00/ft
10-12' ⇒ $18.50/ft

② Full Installation Adders

a) Mobilization ≈ 10%
b) Testing ≈ $1/ft
c) Permitting ≈ $500

③ Manholes * (Installed Cost using Bid Tabs & precast manufacturers values)

0-6' ⇒ $1300/ea.
6-8' ⇒ $1550/ea.
8-10' ⇒ $1800/ea.
10-12' ⇒ $2100/ea.

Cost Calculations

* CASE A

manhole ⇒		= $2100
pump station ⇒	(34,411.2)(8/120)	= $ 2,294.08
400' 8" sewer ⇒	(400)(18.5)	= $7,400
400' Testing ⇒	(400)($1)	= $400
Permitting ⇒		= $500
Mobilization ⇒	(12,694)(0.1)	= $ 1269.41

TOTAL ⇒ $13,963.50

\# units / lots = 8 lots

UNIT COST ⇒ $/LOT = $1,745.44

HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants	SH. NO.: 3	JOB NO.: 95-145.00
	MADE BY: JJW	DATE: 10/1/95
	CHECKED BY:	DATE:

Cost Calculations

Case B

			Cost ($)
Manholes ⇒ (10-12') $2100 (8-10') $1800		→	$3,900
pump station ⇒ (34,411.2)(16/120)		→	$4,588.16
8" gravity sewer ⇒ (10-12') $10,989 (8-10') $3,296		→	$14,285
800' Testing ⇒ (800)($1/ft)		=	$800
Permitting ⇒		=	$500
Mobilization ⇒ (24,073.16) (0.1)		=	$2,407.32

TOTAL $26,480.5

units / lots = 16 lots

UNIT COST ⇒ $/lot = $1,655.03

HARTMAN & ASSOCIATES, INC.	SH. NO.: 4	JOB NO.: 95-145.00
engineers, hydrogeologists, surveyors & management consultants	MADE BY: JJW	DATE: 10/1/95
	CHECKED BY:	DATE:

Cost Calculations

Case C

Cost ($)

Manholes ⇒ (10-12') $2100; (8-10') $1800; (6-8') $1550 = $5,450

Pump station ⇒ (34,411.2) (24/120) = $6,882.24

8" gravity sewer ⇒ (10-12') $10,989; (8-10') $9,504; (6-8') $144 = $20,637

1200' Testing ⇒ (1200)($1/ft) = $1,200

Permitting ⇒ = $500

Mobilization ⇒ (34,669.24) (0.1) = $3466.92

TOTAL $38,136.16

units / lots = 24 lots

UNIT COST ⇒ $/lot = $1,589.01

HARTMAN & ASSOCIATES, INC.	SH. NO.: 5	JOB NO.: 95-195.00
engineers, hydrogeologists, surveyors & management consultants	MADE BY: JJW	DATE: 10/1/95
	CHECKED BY:	DATE:

Cost Calculations

Case D

			Cost ($)
Manholes ⇒	(10-12') $2100 (8-10') $1800 (6-8') $3100	=	$7,000
1 pump station ⇒	(34,411.20)(32/120)	=	$9,176.32
8" gravity sewer ⇒	(10-12') $10,989 (8-10') $9,504 (6-8') $4,944	=	$25,437
1600' Testing ⇒	(1600)($1/ft)	=	$1600
Permitting ⇒			$500
Mobilization ⇒	(43,713.32)(0.1)	=	$4,371.33

TOTAL $48,085

lots/units = 32 lots

UNIT COST = $/lot = **$1502.65**

HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants	SH. NO.: 6	JOB NO.: 95-145.00
	MADE BY: JJW	DATE: 10/1/95
	CHECKED BY:	DATE:

Case E Cost

				Cost ($)
Manholes ⇒	(10-12')	($2100)(3) =	$6300	
	(8-10')	($1800)(3)	$5400	= $24,900
	(6-8')	($1550)(6)	$9300	
	(0-6')	($1300)(3)	$3900	
Pump Station ⇒	34,411.20			$34,411.20
8" gravity sewer ⇒	(10-12')	(1782)(18.50) =		
	(8-10')	(1782)(16.00) =		= $88,684.50
	(6-8')	(1689)(12) =		
	(0-6')	(750)(9.25) =		
6000' Testing ⇒	(6000)($1/ft)			= $6000
Permitting ⇒				= $500
Mobilization ⇒	(154,495.7)(0.1)			= $15,449.57

TOTAL = $169,945.27

lots/units = 120 lots

UNIT COST = $ 1416.21

80 units ⇒ $1418.50

40 units ⇒ $1425.05

RECORD OF TELEPHONE COMMUNICATION

DATE: 9/8/95 TIME: 9:30

PROJECT NAME: SSU - Economy of Scale PROJECT NO.: 95-145.00

PARTY CALLING: Janey Wallace COMPANY: HAI

PARTY CONTACTED: Scott Edwards COMPANY: Taylor Precast

SUBJECT: Manhole Costs 4' diameter Susan Pope
Todd Phillips

TELEPHONE COMMUNICATION SUMMARY (Including Decisions & Commitments)

Depth	$	
		* 8" Wall thickness *
0-6	$578	
6-8	$698	
8-10	$836	
10-12	$950	* No Economies of Scale *
12-14	$1076	

ACTION REQUIRED

c.c.

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, scientists & management consultants

RECORD OF TELEPHONE COMMUNICATION

9/7/95 TIME: 3:40

PROJECT NAME: SSU - Economy of Scale PROJECT NO.: 95-145.00

PARTY CALLING: JJW COMPANY: HAI

PARTY CONTACTED: Brian Penner COMPANY: Mitchell & Stark

SUBJECT: Pipe install. costs (813) 597-2165

TELEPHONE COMMUNICATION SUMMARY (Including Decisions & Commitments)

* Pressure testing (W+F.M.) Avg. 50¢/ft small job → 75¢/ft
  large job → 25¢/ft
* Disinfection (W.M.) Avg. $1/ft small job → $2/ft
  $1.50 ≈ large job → $1/ft
* Gravity Sewer - T.V. Test $1.00/ft

ACTION REQUIRED

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, scientists & management consultants

SANITARY SEWER 9/19/94

	SIZE	DESCRIPTION	PROJECT	QUANTITY	UNIT	UNIT PRICE	BIDDER	YEAR
FITTINGS	8"	90 DEG. BEND	2	4	EA	$285.00	MEYER	1994
	8" X 22	1/2" BEND	2	1	EA	$275.00	MEYER	1994
		D.I. (MISC. FITTINGS)	1	20.5	TN	$5,000.00	MEYER	1988
		FITTINGS (OFF SITE)	2	1	LS	$1,300.00	BRIAR	1994
	16" X 6"	D.I. CROSS FITTINGS	1	2	EA	$1,080.00	MEYER	1988
	20" X 6"	D.I. CROSS FITTINGS	1	2	EA	$1,400.00	MEYER	1988
	24" X 6"	D.I. CROSS FITTINGS	1	3	EA	$1,710.00	MEYER	1988
	30" X 6"	D.I. CROSS FITTINGS	1	2	EA	$3,110.00	MEYER	1988
	8" X 6"	WYE WITH 45 DEG. BEND	2	58	EA	$37.00	MEYER	1994
	10" X 6"	WYE WITH 45 DEG. BEND	2	19	EA	$80.00	MEYER	1994
	6" X 4"	DOUBLE WYE	2	56	EA	$28.00	MEYER	1994
	4"	PLUG	2	112	EA	$2.60	MEYER	1994
	6"	PLUG	2	83	EA	$4.70	MEYER	1994
DUCTILE IRON PIPE	8"	DIP (RESTRAINED)	2	120	LF	$48.00	MEYER	1994
	10"	DIP (12'-14' CUT)	2	20	LF	$38.00	BRIAR	1994
	10"	DIP (10'-12' CUT)	2	20	LF	$35.75	MEYER	1994
	8"	DIP FM	3	80	LF	$37.00	JMHC	1994
	10"	DIP FM		150	LF	$24.15	ESTERSON	1986
	10"	DIP FM	3	40	LF	$49.50	JMHC	1994
	12"	DIP FM		455	LF	$28.26	ESTERSON	1986
	8"	DIP FM		180	LF	$20.89	ESTERSON	1986
	8"	DIP FM (0'-6' CUT)		18	LF	$18.00	HUBBARD	1990
	8"	DIP FM (0'-6' CUT)		18	LF	$19.70	GOPHER	1990
	8"	DIP FM (0'-6' CUT)		18	LF	$20.00	WITHERINGTON	1990
	8"	DIP (0'-6' CUT)		18	LF	$26.80	B & D	1990
	8"	DIP (6'-8' CUT)		20	LF	$1,500.00	X-RDS	1988
	8"	DIP (8'-10' CUT)		36	LF	$28.15	B & D	1990
	8"	DIP FM (8'-10' CUT)		36	LF	$20.00	HUBBARD	1990
	8"	DIP FM (8'-10' CUT)		36	LF	$21.95	GOPHER	1990
	8"	DIP FM (8'-10' CUT)		36	LF	$22.00	WITHERINGTON	1990
	16"	DIP FM (CL 50)	1	3250	LF	$31.20	MEYER	1988
	16"	DIP FM (CL 50)	1	3250	LF	$30.00	MEYER	1988
	16"	DIP FM (CL 50)	1	250	LF	$43.15	MEYER	1988
	20"	DIP FM (CL 50)	1	250	LF	$55.90	MEYER	1988
	20"	DIP FM (CL 50)	1	3265	LF	$37.00	MEYER	1988
	20"	DIP FM (CL 50)	1	3265	LF	$40.20	MEYER	1988
	24"	DIP FM (CL 50)	1	5645	LF	$48.90	MEYER	1988
	24"	DIP FM (CL 50)	1	5645	LF	$45.00	MEYER	1988
	24"	DIP FM (CL 50)	1	410	LF	$64.30	MEYER	1988
	30"	DIP FM (CL 50)	1	425	LF	$87.00	MEYER	1988
	30"	DIP FM (CL 50)	1	5600	LF	$60.00	MEYER	1988
PVC PIPE	8"	PVC (0'-6' CUT)		338	LF	$8.50	X-RDS	1988
	8"	PVC (0'-6' CUT)		707	LF	$6.80	HUBBARD	1990
	8"	PVC (0'-6' CUT)		707	LF	$7.70	GOPHER	1990
	8"	PVC (0'-6' CUT)		707	LF	$7.00	WITHERINGTON	1990
	8"	PVC (0'-6' CUT)		707	LF	$11.70	B & D	1990
	8"	PVC (0'-6' CUT)	2	2906	LF	$10.00	MEYER	1994
	8"	PVC (0'-6' CUT)	2	2950	LF	$8.00	BRIAR	1994
	8"	PVC/DI (0'-8' CUT)	7	30	LF	$13.00	SOUTHWEST	1994
	8"	PVC/DI (0'-8' CUT)	7	30	LF	$13.75	ROCKET	1994
	8"	PVC/DI (0'-8' CUT)	7	30	LF	$14.00	MUSTANG	1994
	8"	PVC (6'-8' CUT)		1055	LF	$7.90	HUBBARD	1990
	8"	PVC (6'-8' CUT)		1055	LF	$8.75	GOPHER	1990
	8"	PVC (6'-8' CUT)		1055	LF	$8.50	WITHERINGTON	1990
	8"	PVC (6'-8' CUT)		648	LF	$14.50	X-RDS	1988
	8"	PVC (6'-8' CUT)		1055	LF	$12.35	B & D	1990
	8"	PVC (6'-8' CUT)	2	243	LF	$9.12	BRIAR	1994
	8"	PVC (6'-8' CUT)	2	700	LF	$8.60	BRIAR	1994
	8"	PVC (6'-8' CUT)	2	601	LF	$11.50	MEYER	1994
	8"	PVC/DI (6'-8' CUT)	7	635	LF	$15.00	SOUTHWEST	1994
	8"	PVC/DI (6'-8' CUT)	7	635	LF	$21.00	ROCKET	1994
	8"	PVC/DI (6'-8' CUT)	7	635	LF	$18.00	MUSTANG	1994

SANITARY SEWER 9/19/94

SIZE	DESCRIPTION	PROJECT	QUANTITY	UNIT	UNIT PRICE	BIDDER	YEAR
8"	PVC (8'-10' CUT)		675	LF	$9.37	HUBBARD	1990
8"	PVC (8'-10' CUT)		675	LF	$9.95	GOPHER	1990
8"	PVC (8'-10' CUT)		675	LF	$9.00	WITHERINGTON	1990
8"	PVC (8'-10' CUT)		675	LF	$13.05	B & D	1990
8"	PVC (8'-10' CUT)	2	1480	LF	$8.90	BRIAR	1994
8"	PVC (8'-10' CUT)	2	800	LF	$9.25	JMHC	1994
8"	PVC (8'-10' CUT)	2	1513	LF	$14.00	MEYER	1994
8"	PVC/DI (8'-10' CUT)	7	390	LF	$20.00	SOUTHWEST	1994
8"	PVC/DI (8'-10' CUT)	7	390	LF	$24.00	ROCKET	1994
8"	PVC/DI (8'-10' CUT)	7	390	LF	$25.00	MUSTANG	1994
8"	PVC (10'-12' CUT)		317	LF	$11.26	HUBBARD	1990
8"	PVC (10'-12' CUT)		317	LF	$12.45	GOPHER	1990
8"	PVC (10'-12' CUT)		317	LF	$11.00	WITHERINGTON	1990
8"	PVC (10'-12' CUT)		317	LF	$14.90	B & D	1990
8"	PVC (10'-12' CUT)	2	20	LF	$9.75	JMHC	1994
8"	PVC (12'-14' CUT)		418	LF	$13.25	HUBBARD	1990
8"	PVC (12'-14' CUT)		418	LF	$15.45	GOPHER	1990
8"	PVC (12'-14' CUT)		418	LF	$13.00	WITHERINGTON	1990
8"	PVC (12'-14' CUT)		418	LF	$16.05	B & D	1990
8"	PVC/DI (12'-14' CUT)	7	183	LF	$30.00	SOUTHWEST	1994
8"	PVC/DI (12'-14' CUT)	7	183	LF	$31.00	ROCKET	1994
8"	PVC/DI (12'-14' CUT)	7	183	LF	$45.00	MUSTANG	1994
8"	PVC (14'-16' CUT)		166	LF	$16.35	HUBBARD	1990
8"	PVC (14'-16' CUT)		166	LF	$16.35	HUBBARD	1990
8"	PVC (14'-16' CUT)		166	LF	$15.00	WITHERINGTON	1990
8"	PVC (14'-16' CUT)		166	LF	$17.50	B & D	1990
8"	PVC (16'-18' CUT)		357	LF	$21.80	HUBBARD	1990
8"	PVC (16'-18' CUT)		357	LF	$19.95	GOPHER	1990
8"	PVC (16'-18' CUT)		357	LF	$17.00	WITHERINGTON	1990
8"	PVC (16'-18' CUT)		357	LF	$19.35	B & D	1990
4"	PVC FM		20	LF	$10.00	HENSON	1986
4"	PVC FM	7	675	LF	$6.00	SOUTHWEST	1994
4"	PVC FM	7	675	LF	$7.50	ROCKET	1994
4"	PVC FM	7	675	LF	$10.00	MUSTANG	1994
6"	PVC FM		20	LF	$10.00	ESTERSON	1986
6"	PVC FM	5	198	LF	$10.00	JENKINS	1993
6"	PVC FM	1	1125	LF	$17.60	MEYER	1988
8"	PVC FM		3425	LF	$9.00	HENSON	1986
8"	PVC FM	2	7050	LF	$6.50	MEYER	1994
8"	PVC FM	3	1360	LF	$8.00	JMHC	1994
8"	PVC FM (ON SITE)	2	3730	LF	$7.40	BRIAR	1994
8"	PVC FM (ON SITE)	2	3720	LF	$8.00	JMHC	1994
8"	PVC FM (OFF SITE)	2	3060	LF	$7.84	BRIAR	1994
8"	PVC FM (OFF SITE)	2	3180	LF	$8.00	JMHC	1994
10"	PVC FM		1950	LF	$10.56	HENSON	1986
10"	PVC FM	3	244	LF	$15.00	JMHC	1994
12"	PVC FM		2975	LF	$12.00	ESTERSON	1986
4"	PVC SERVICE LATERAL		350	LF	$5.30	X-RDS	1988
6"	PVC SERVICE LATERAL		1986	LF	$12.45	B & D	1990
6"	PVC SERVICE LATERAL		1986	LF	$10.16	GOPHER	1990
6"	PVC SERVICE LATERAL		1986	LF	$5.00	WITHERINGTON	1990
6"	PVC SERVICE LATERAL		1986	LF	$7.80	HUBBARD	1990
6"	PVC SERVICE LATERAL		535	LF	$8.10	VANNICE	1990
6"	DOUBLE SERVICE LATERALS	2	77	EA	$328.62	BRIAR	1994
6"	DOUBLE SERVICE LATERALS	2	60	EA	$275.00	JMHC	1994
6"	DOUBLE SERVICE LATERALS	3	50	LF	$265.00	JMHC	1994
6"	DOUBLE SERVICE LATERALS	7	18	EA	$275.00	SOUTHWEST	1994
6"	DOUBLE SERVICE LATERALS	7	18	EA	$310.00	ROCKET	1994
6"	DOUBLE SERVICE LATERALS	7	18	EA	$450.00	MUSTANG	1994
6"	SINGLE SERVICE LATERALS	2	3	EA	$301.67	BRIAR	1994
6"	SINGLE SERVICE LATERALS	2	1	EA	$245.00	JMHC	1994
6"	SINGLE SERVICE LATERALS	3	14	EA	$245.00	JMHC	1994
6"	SINGLE SERVICE LATERALS	7	5	EA	$225.00	SOUTHWEST	1994
6"	SINGLE SERVICE LATERALS	7	5	EA	$280.00	ROCKET	1994
6"	SINGLE SERVICE LATERALS	7	5	EA	$350.00	MUSTANG	1994

APPENDIX O

HARTMAN & ASSOCIATES, INC.	SH. NO.: 1	JOB NO.: 95-145.00
engineers, hydrogeologists, surveyors & management consultants	MADE BY: JJW	DATE: 10/1/95
	CHECKED BY:	DATE:

Calculations (L.S. Flow)

① 100 gpm ⇒ 144,000 gpd (÷ 4) = 36,000 gpd (ADF)
36,000 gpd / 300 gpd/unit = **120 units**

② 200 gpm ⇒ 288,000 gpd (÷ 4) = 72,000 gpd (ADF)
72,000 gpd / 300 gpd/unit = **240 units**

③ 300 gpm ⇒ 432,000 gpd (÷ 3.5) = 123,429 gpd (ADF)
123,429 gpd / 300 gpd/unit = **411 units**

④ 400 gpm ⇒ 576,000 gpd (÷ 3.5) = 164,571 gpd (ADF)
164,571 gpd / 300 gpd/unit = **549 units**

⑤ 500 gpm ⇒ 720,000 gpd (÷ 3.5) = 205,715 gpd (ADF)
205,715 gpd / 300 gpd/unit = **686 units**

⑥ 600 gpm ⇒ 864,000 gpd (÷ 3.5) = 246,857 gpd (ADF)
246,857 gpd / 300 gpd/unit = **823 units**

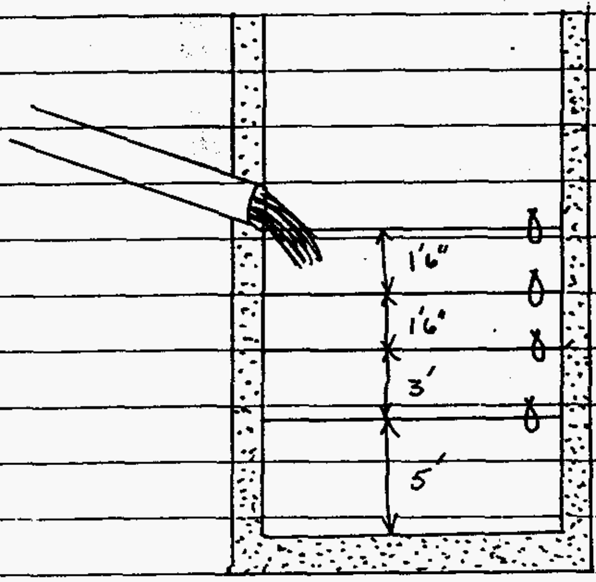
⑦ 700 gpm ⇒ 1,008,000 gpd (÷ 3) = 336,000 gpd (ADF)
336,000 gpd / 300 gpd/unit = **1120 units**

⑧ 800 gpm ⇒ 1,152,000 gpd (÷ 3) = 384,000 (ADF)
384,000 gpd / 300 gpd/unit = **1280 units**

⑨ 900 gpm ⇒ 1,296,000 gpd (÷ 3) = 432,000 gpd (ADF)
432,000 gpd / 300 gpd/unit = **1440 units**

⑩ 1000 gpm ⇒ 1,440,000 gpd (÷ 3) = 480,000 gpd (ADF)
480,000 gpd / 300 gpd/unit = **1600 units**

Sewage Pump Station Design



① 100 GPM Pump ⇒ $\forall = QT/4 = (100 gpm)(6 min)/4 = 150$ gal

$\forall = 150$ gal $= 20.05\ ft^3$

6' ø well $h = \frac{\forall}{\pi R^2} = \frac{(20.05\ ft^3)}{\pi (3 ft)^2} = 1.06$ ft

6' Diameter Well

② 200 GPM Pump ⇒ $\forall = QT/4 = \frac{(200 gpm)(6 m)}{4} = 300$ gal

$\forall = 40.1\ ft^3$

6' ø well $h = \frac{\forall}{\pi R^2} = \frac{(40.1\ ft^3)}{\pi (3 ft)^2} = 1.42$ ft

6' Diameter Well

Sewage Pump Station Design

③ 300 gpm pump ⇒ $V = QT/4 = \frac{(300 gpm)(6 m)}{4} = 450 gal$

$V = 60.16 ft^3$

6' Diam well $h = \frac{(60.16 ft^3)}{\pi (3 ft)^2} = 2.13 ft$

6' Diameter Well

④ 400 gpm pump ⇒ $V = QT/4 = \frac{400 gpm (6m)}{4} = 600 gal$

$V = 80.21 ft^3$

6' Diam. Well

$h = \frac{(80.21 ft^3)}{\pi (3 ft)^2} = 2.84 ft$

6' Diameter Well

⑤ 500 gpm pump ⇒ $V = QT/4 = \frac{(500 gpm)(6 min)}{4} = 750 gal$

$V = 100.27 ft^3$

8' Diam Well

$h = \frac{(100.27 ft^3)}{\pi (4 ft)^2} = 1.99 ft$

8' Diameter Well

Sewage Pump Station Design

⑥ 600 gpm pump ⇒ $V = QT/4 = \frac{(600 gpm)(6 min)}{4} = 900$ gal

$V = 120.32$ ft^3

8' ø well

$h = \frac{(120.32\ ft^3)}{\pi\ (4 ft)^2} = \underline{2.39\ ft}$

~~8'~~ Diameter Well

⑦ 700 gpm pump ⇒ $V = QT/4 = \frac{(700 gpm)(6 min)}{4} = 1050$ gal

$V = 140.4$ ft^3

8' ø well

$h = \frac{(140.4\ ft^3)}{\pi\ (4 ft)^2} = \underline{2.79\ ft}$

10' ø well

$h = \frac{(140.4\ ft^3)}{\pi\ (5 ft)^2} = \underline{1.79\ ft}$

10' Diameter Well

⑧ 800 gpm pump ⇒ $V = QT/4 = \frac{(800 gpm)(6 min)}{4} = 1200$ gal

$V = 160.4$ ft^3

10' ø well

$h = \frac{(160.4\ ft^3)}{\pi\ (5 ft)^2} = 2.04$ ft

10' Diameter Well

Sewage Pump Station Design

(9) 900 gpm pump ⇒ $V = QT/4 = \frac{(900\text{gpm})(6\text{min})}{4}$ = ~~1350 gal~~

$V = 180.48\ ft^3$

10' ø well [redacted] $h = \frac{(180.48\ ft^3)}{\pi (5ft)^2} = \underline{2.30\ ft}$

10' Diameter Well

(10) 1000 gpm pump ⇒ $V = QT/4 = \frac{(1000\text{gpm})(6\text{min})}{4}$ = ~~1500 gal~~

$V = 200.5\ ft^3$

10' ø well [redacted] $h = \frac{(200.5\ ft^3)}{\pi (5ft)^2} = \underline{2.55\ ft}$

12' ø well $h = (200.5\ ft^3) / \pi (6ft)^2 = \underline{1.77\ ft}$

12' Diameter Well

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 1 Submersible

Installed 1995 Depth (ft): 15 Diameter (ft): 6

Precast Well

Wet Well(ft)	15.00	$125/FT	COST=	$1,875
Top Slab(cy)	0.70	$450/cy	COST=	$314
Base Slab(cy)	3.11	$450/cy	COST=	$1,398

Excavation

Surface Diameter (ft)	(2*Depth)+10ft+Dia.=	"SD"=	46
Surface Area (ft)	((3.1415)*("SD")^2)/4=	"SA"=	1662
Base Diameter (ft)	Dia+10ft=	"BD"=	16
Base Area (ft)	((3.1415)*("BD")^2)/4=	"BA"=	201.1
Volume (cy)	(1/3*("SA")*(Depth+"BD")-1/3*("BA")("BD"))/27=	"Vol"=	596
	$1.25/cy	COST=	$745
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27=	"BK"=	533
	$1.25/cy	COST=	$667

Dewatering

Circumference	2* (3.1415)(("SD"+2)/2f 150.8		
	$75/LF	COST=	$11,310

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $17,748.87

Pumps: 2 — **Motors:** 2
Horsepower 5 — 5
GPM 100
Manufacturer Flyght/ABS
Model No.

TOTAL PUMP COST= $11,200.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $2,800.00
TOTAL EQUIPMENT COST= $2,662.33

Piping/Fittings/Equipment:

4" Plug Valve (2)
4" Check Valve (2)
4" connector
Emergency pump out
4" DI piping

TOTAL LIFT STATION COST= $34,411.20

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 2 Submersible

Installed 1995 Depth (ft): 16 Diameter (ft): 6

Precast Well

Wet Well(ft)	16.00	$125/FT	COST=	$2,000
Top Slab(cy)	0.70	$450/cy	COST=	$314
Base Slab(cy)	3.11	$450/cy	COST=	$1,398

Excavation

Surface Diameter (ft)	(2*Depth) + 10ft + Dia. =	"SD" =	48
Surface Area (ft)	((3.1415)*("SD")^2)/4 =	"SA" =	1810
Base Diameter (ft)	Dia + 10ft =	"BD" =	16
Base Area (ft)	((3.1415)*("BD")^2)/4 =	"BA" =	201.1
Volume (cy)	(1/3*("SA")*(Depth + "BD")-1/3*("BA")("BD"))/27 =	"Vol" =	675
	$1.25/cy	COST=	$844
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27 =	"BK" =	608
	$1.25/cy	COST=	$760

Dewatering

Circumference	2* (3.1415)(("SD" + 2)/2f 157.1		
	$75/LF	COST=	$11,781

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $18,537.00

Pumps: 2 Motors: 2
Horsepower 6 5
GPM 200
Manufacturer Flyght/ABS
Model No.

TOTAL PUMP COST= $11,600.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $2,900.00

Piping/Fittings/Equipment: TOTAL EQUIPMENT COST= $2,780.55

4" Plug Valve (2)
4" Check Valve (2)
4" connector
Emergency pump out
4" DI piping

TOTAL LIFT STATION COST= $35,817.55

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 3 Submersible

Installed 1995 Depth (ft): 18 Diameter (ft): 6

Precast Well

Wet Well(ft)	18.00	$125/FT	COST=	$2,250
Top Slab(cy)	0.70	$450/cy	COST=	$314
Base Slab(cy)	3.11	$450/cy	COST=	$1,398

Excavation

Surface Diameter (ft)	(2*Depth)+10ft+Dia.=	"SD"=	52
Surface Area (ft)	((3.1415)*("SD")^2)/4=	"SA"=	2124
Base Diameter (ft)	Dia+10ft=	"BD"=	16
Base Area (ft)	((3.1415)*("BD")^2)/4=	"BA"=	201.1
Volume (cy)	(1/3*("SA")*(Depth+"BD")-1/3*("BA")("BD"))/27=	"Vol"=	852
	$1.25/cy	COST=	$1,065
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27=	"BK"=	776
	$1.25/cy	COST=	$970

Dewatering

Circumference	2* (3.1415)(("SD"+2)/2f 169.6		
	$75/LF	COST=	$12,723

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $20,160.38

Pumps: 2 Motors: 2
Horsepower 9 5
GPM 300
Manufacturer Flyght/ABS
Model No.

TOTAL PUMP COST= $12,800.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $3,200.00

Piping/Fittings/Equipment:

TOTAL EQUIPMENT COST= $4,032.08

6" Plug Valve (2)
6" Check Valve (2)
6" connector
Emergency pump out
6" DI piping

TOTAL LIFT STATION COST= $40,192.46

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 4 Submersible

Installed 1995 Depth (ft): 20 Diameter (ft): 6

Precast Well

Wet Well(ft)	20.00	$125/FT	COST=	$2,500
Top Slab(cy)	0.70	$450/cy	COST=	$314
Base Slab(cy)	3.11	$450/cy	COST=	$1,398

Excavation

Surface Diameter (ft)	(2*Depth)+10ft+Dia.=	"SD"=	56
Surface Area (ft)	((3.1415)*("SD")^2)/4=	"SA"=	2463
Base Diameter (ft)	Dia+10ft=	"BD"=	16
Base Area (ft)	((3.1415)*("BD")^2)/4=	"BA"=	201.1
Volume (cy)	(1/3*("SA")*(Depth+"BD")-1/3*("BA")("BD"))/27=	"Vol"=	1055
	$1.25/cy	COST=	$1,319
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27=	"BK"=	971
	$1.25/cy	COST=	$1,214

Dewatering

Circumference	2* (3.1415)(("SD"+2)/2f 182.2		
	$75/LF	COST=	$13,666

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $21,850.47

Pumps: 2 **Motors:** 2
Horsepower 12 5
GPM 400
Manufacturer Flyght/ABS
Model No.

TOTAL PUMP COST= $14,200.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $3,550.00

Piping/Fittings/Equipment: TOTAL EQUIPMENT COST= $4,370.09

6" Plug Valve (2)
6" Check Valve (2)
6" connector
Emergency pump out
6" DI piping

TOTAL LIFT STATION COST= $43,970.57

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 5 Submersible

Installed 1995 Depth (ft): 18 Diameter (ft): 8

Precast Well

Wet Well(ft)	18.00	$125/FT	COST =	$2,250
Top Slab(cy)	1.24	$450/cy	COST =	$559
Base Slab(cy)	4.42	$450/cy	COST =	$1,991

Excavation

Surface Diameter (ft)	(2*Depth)+10ft+Dia.=	"SD" =	54
Surface Area (ft)	((3.1415)*("SD")^2)/4=	"SA" =	2290
Base Diameter (ft)	Dia+10ft=	"BD" =	18
Base Area (ft)	((3.1415)*("BD")^2)/4=	"BA" =	254.5
Volume (cy)	(1/3*("SA")*(Depth+"BD")-1/3*("BA")("BD"))/27=	"Vol" =	961
	$1.25/cy	COST =	$1,202
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27=	"BK" =	827
	$1.25/cy	COST =	$1,034

Dewatering

Circumference	2* (3.1415)(("SD"+2)/2f 175.9		
	$75/LF	COST =	$13,195

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST =	$1,440

TOTAL STRUCTURAL COST= $21,670.09

Pumps: 2 **Motors:** 2
Horsepower 13.5 5
GPM 500
Manufacturer Flyght/ABS
Model No.

TOTAL PUMP COST = $14,800.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST = $3,700.00

Piping/Fittings/Equipment:

TOTAL EQUIPMENT COST = $5,417.52

8" Plug Valve (2)
8" Check Valve (2)
8" connector
Emergency pump out
8" DI piping

TOTAL LIFT STATION COST = $45,587.61

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 6 Submersible

Installed 1995 Depth (ft): 20 Diameter (ft): 8

Precast Well

Wet Well(ft)	20.00	$125/FT	COST=	$2,500
Top Slab(cy)	1.24	$450/cy	COST=	$559
Base Slab(cy)	4.42	$450/cy	COST=	$1,991

Excavation

Surface Diameter (ft)	(2*Depth)+10ft+Dia.=	"SD"=	58
Surface Area (ft)	((3.1415)*("SD")^2)/4=	"SA"=	2642
Base Diameter (ft)	Dia+10ft=	"BD"=	18
Base Area (ft)	((3.1415)*("BD")^2)/4=	"BA"=	254.5
Volume (cy)	(1/3*("SA")*(Depth+"BD")-1/3*("BA")("BD"))/27=	"Vol"=	1183
	$1.25/cy	COST=	$1,479
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27=	"BK"=	1034
	$1.25/cy	COST=	$1,293

Dewatering

Circumference	2* (3.1415)(("SD"+2)/2f	188.5		
	$75/LF		COST=	$14,137

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $23,398.00

Pumps: 2 **Motors:** 2
Horsepower 17.5 5
GPM 600
Manufacturer Flyght/ABS
Model No.

TOTAL PUMP COST= $16,640.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $4,160.00

Piping/Fittings/Equipment:

TOTAL EQUIPMENT COST= $5,849.50

- 8" Plug Valve (2)
- 8" Check Valve (2)
- 8" connector
- Emergency pump out
- 8" DI piping

TOTAL LIFT STATION COST= $50,047.50

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 7 Submersible

Installed 1995 Depth (ft): 20 Diameter (ft): 10

Precast Well

Wet Well(ft)	20.00	$125/FT	COST=	$2,500
Top Slab(cy)	1.94	$450/cy	COST=	$873
Base Slab(cy)	5.98	$450/cy	COST=	$2,689

Excavation

Surface Diameter (ft)	(2*Depth)+10ft+Dia.=	"SD"=	60
Surface Area (ft)	((3.1415)*("SD")^2)/4=	"SA"=	2827
Base Diameter (ft)	Dia+10ft=	"BD"=	20
Base Area (ft)	((3.1415)*("BD")^2)/4=	"BA"=	314.2
Volume (cy)	(1/3*("SA")*(Depth+"BD")-1/3*("BA")("BD"))/27=	"Vol"=	1319
	$1.25/cy	COST=	$1,648
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27=	"BK"=	1086
	$1.25/cy	COST=	$1,357

Dewatering

Circumference	2* (3.1415)(("SD"+2)/2(194.8		
	$75/LF	COST=	$14,608

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $25,116.18

Pumps: 2
Horsepower 20.5
GPM 700
Manufacturer Flyght/ABS
Model No.

Motors: 2
5

TOTAL PUMP COST= $17,600.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $4,400.00

Piping/Fittings/Equipment:

TOTAL EQUIPMENT COST= $6,279.04

8" Plug Valve (2)
8" Check Valve (2)
8" connector
Emergency pump out
8" DI piping

TOTAL LIFT STATION COST= $53,395.22

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 8 Submersible

Installed 1995 Depth (ft): 20 Diameter (ft): 10

Precast Well

Wet Well(ft)	20.00	$125/FT	COST=	$2,500
Top Slab(cy)	1.94	$450/cy	COST=	$873
Base Slab(cy)	5.98	$450/cy	COST=	$2,689

Excavation

Surface Diameter (ft)	(2*Depth)+10ft+Dia.=	"SD"=	60
Surface Area (ft)	((3.1415)*("SD")^2)/4=	"SA"=	2827
Base Diameter (ft)	Dia+10ft=	"BD"=	20
Base Area (ft)	((3.1415)*("BD")^2)/4=	"BA"=	314.2
Volume (cy)	(1/3*("SA")*(Depth+"BD")-1/3*("BA")("BD"))/27=	"Vol"=	1319
	$1.25/cy	COST=	$1,648
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27=	"BK"=	1086
	$1.25/cy	COST=	$1,357

Dewatering

Circumference	2* (3.1415)(("SD"+2)/2f 194.8		
	$75/LF	COST=	$14,608

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $25,116.18

Pumps: 2
Horsepower 21
GPM 800
Manufacturer Flyght/ABS
Model No.

Motors: 2
5

TOTAL PUMP COST= $18,400.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $4,600.00

Piping/Fittings/Equipment:

TOTAL EQUIPMENT COST= $10,046.47

10" Plug Valve (2)
10" Check Valve (2)
10" connector
Emergency pump out
10" DI piping

TOTAL LIFT STATION COST= $58,162.65

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 9 Submersible

Installed 1995 Depth (ft): 20 Diameter (ft): 10

Precast Well

Wet Well(ft)	20.00	$125/FT	COST=	$2,500
Top Slab(cy)	1.94	$450/cy	COST=	$873
Base Slab(cy)	5.98	$450/cy	COST=	$2,689

Excavation

Surface Diameter (ft)	(2*Depth)+10ft+Dia.=	"SD"=	60
Surface Area (ft)	((3.1415)*("SD")^2)/4=	"SA"=	2827
Base Diameter (ft)	Dia+10ft=	"BD"=	20
Base Area (ft)	((3.1415)*("BD")^2)/4=	"BA"=	314.2
Volume (cy)	(1/3*("SA")*(Depth+"BD")-1/3*("BA")("BD"))/27=	"Vol"=	1319
	$1.25/cy	COST=	$1,648
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27=	"BK"=	1086
	$1.25/cy	COST=	$1,357

Dewatering

Circumference	2* (3.1415)(("SD"+2)/2f 194.8		
	$75/LF	COST=	$14,608

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $25,116.18

Pumps: 2
Horsepower 27.5
GPM 900
Manufacturer Flyght/ABS
Model No.

Motors: 2
5

TOTAL PUMP COST= $19,600.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $4,900.00

TOTAL EQUIPMENT COST= $10,046.47

Piping/Fittings/Equipment:
10" Plug Valve (2)
10" Check Valve (2)
10" connector
Emergency pump out
10" DI piping

TOTAL LIFT STATION COST= $59,662.65

Sheet No.	Job No. 95-145.00	
Made By	JJW	Date: 8/14/95
Checked By		Date:

Station No. 10 Submersible

Installed 1995 Depth (ft): 20 Diameter (ft): 12

Precast Well

Wet Well(ft)	20.00	$125/FT	COST=	$2,500
Top Slab(cy)	2.79	$450/cy	COST=	$1,257
Base Slab(cy)	7.76	$450/cy	COST=	$3,492

Excavation

Surface Diameter (ft)	(2*Depth) + 10ft + Dia. =	"SD" =	62
Surface Area (ft)	((3.1415)*("SD")^2)/4 =	"SA" =	3019
Base Diameter (ft)	Dia + 10ft =	"BD" =	22
Base Area (ft)	((3.1415)*("BD")^2)/4 =	"BA" =	380.1
Volume (cy)	(1/3*("SA")*(Depth + "BD")-1/3*("BA")("BD"))/27 =	"Vol" =	1462
	$1.25/cy	COST=	$1,828
Backfill(cy)	"Vol"-((3.1415)(Dia.)^2(Depth))/27 =	"BK" =	1127
	$1.25/cy	COST=	$1,409

Dewatering

Circumference	2* (3.1415)(("SD" + 2)/2f 201.1		
	$75/LF	COST=	$15,080

Valve Box:

Length(ft)	5		
Width(ft)	5		
Walls	8"		
Base Slab (ft)	25		
Top Slab	Aluminum Hatch	COST=	$1,440

TOTAL STRUCTURAL COST= $27,005.01

Pumps: 2 **Motors:** 2
Horsepower 30 5
GPM 1000
Manufacturer Flyght/ABS
Model No.

TOTAL PUMP COST= $20,400.00

Controls/Electrical: Estimated at 20% of Total Package Cost

TOTAL CONTROL COST= $5,100.00

Piping/Fittings/Equipment:

TOTAL EQUIPMENT COST= $10,802.00

10" Plug Valve (2)
10" Check Valve (2)
10" connector
Emergency pump out
10" DI piping

TOTAL LIFT STATION COST= $63,307.02

Directory: C:\AUS
Filename: PRECAST.WK3
Date: 30-Mar-95
Time: 10:02 AM

PRECAST WETWELL INSTALLED COST SUMMARY

Diameter (feet) — Material Cost

	4	6	8	10	12
Cost ($/ft of depth)	$65	$125	$175	$300	$375
Base	$645	$1,045	$1,825	$2,821	$3,605
Top	$125	$225	$500	$1,000	$1,400

Diameter (feet) — Installation Adder @ 30%

	4	6	8	10	12
Cost ($/ft of depth)	$20	$38	$53	$90	$113
Base	$194	$314	$548	$846	$1,082
Top	$38	$68	$150	$300	$420

Diameter (feet) — Total Installed Cost

	4	6	8	10	12
Cost ($/ft of depth)	$85	$163	$228	$390	$488
Base	$839	$1,359	$2,373	$3,667	$4,687
Top	$163	$293	$650	$1,300	$1,820

Base

Nominal Diameter (ft)	Actual Diameter (ft)	Thickness (ft)	Actual Area (sq.ft.)	Quantity of Concrete (cu.ft.)	Quantity of Concrete (cu.yd.)	Item Cost @ $275 cu.yd. ($)
4	7.33	1.50	42	63	2	$645
6	9.33	1.50	68	103	4	$1,045
8	12.33	1.50	119	179	7	$1,825
10	15.33	1.50	185	277	10	$2,821
12	17.33	1.50	236	354	13	$3,605

Top

Nominal Diameter (ft)	Actual Diameter (ft)	Thickness (ft)	Actual Area (sq.ft.)	Quantity of Concrete (cu.ft.)	Quantity of Concrete (cu.yd.)	Item Cost @ $275 cu.yd. ($)
4	5.33	0.67	22	15	1	$152
6	7.33	0.67	42	28	1	$287
8	9.33	0.67	68	46	2	$465
10	11.33	1.00	101	101	4	$1,027
12	13.33	1.00	140	140	5	$1,422

ELLIS K. PHELPS & COMPANY

2152 Sprint Boulevard
Apopka, Florida 32703

Phone: (407) 880-2900
FAX: (407) 880-2962

To: Hartman & Associates
Bobby Wyatt
407-839-3790 (Fax)

From: Juan Citarella

Reference #	Reference HP	Package Estimate	Current Flygt Pump
3825-1	9.4	$21,000	CP 3127
3825-1	5	$18,000	CP 3102
?	5	$18,000	CP 3102
5443A	7.5	$21,000	CP 3127
80-200/3085	2.5	$16,000	CP 3085
C-3082	3	$16,000	CP 3085
C-3101	2.5	$16,000	CP 3085
3085	3	$16,000	CP 3085
3085	1.5	$16,000	CP 3085
C-3101	5	$18,000	CP 3102
C-3101	10	$21,000	CP 3127
3126	9.4	$21,000	CP 3127
?	2	$16,000	CP 3085
CP 3127	9.4	$21,000	CP 3127
CP 3127	10	$21,000	CP 3127
CP 3127	9.5	$21,000	CP 3127
CP 3152	20	$26,000	CP 3152
3085.181	2.3	$16,000	CP 3085
3085	2	$16,000	CP 3085

Note: Package estimates include (2) Flygt submersible pumps, accessories, control panel, and access covers.

Thank you for your inquiry!

$$BHP = \frac{(Q)(TDH)(S.G.)}{3960\ (eff.)} = \frac{(100\ gpm)(60\ ft)(1)}{(3960)(0.5)} = 3.03$$

(ex. 100gpm)

ABS
A company in the Cardo Group

ABS • *Scanpump*
Lawrence Pump & Engine

MEMO ABS FLORIDA BRANCH

TO: HARTMAN & ASSOCIATES **DATE:** 3/18/95

ATTN: BOBBY WYATT

FROM: COLIN MARTIN

SUBJECT: YOUR FAX INQUIRY 3/2/95
CITY OF PORT ST.LUCIE REPLACEMENT COSTS

Mr. Wyatt,
In response to your subject inquiry I would like to offer the following pricing for the pump models you requested. I have indicated the old pump model number as well as the new current model number. Please note that the pricing is per pump with accessories. For a typical duplex station multiply price by two. Controls are priced seperately.
The CP3127 model no. is a Flygt, equal to the 8 HP ABS model.

OLD MODEL	HP	NEW MODEL	PRICE EACH UNIT WITH ACCESSORIES
AF15-4-4	2	AFP1040M15/4-11.60-4"	$2,380.00
AF22-4-4	3	AFP1040M22/4-11.60-4"	2,550.00
AF40-4-4	6	AFP1042M46/4-21.60-4"	2,990.00
AF60-4-4	8	AFP1046M70/4-22.60-4"	3,300.00
AF90-4-4	12	AFP1046M90/4-22.60-4"	3,400.00

DUPLEX CONTROLS PER ST.LUCIE SPECS HP	PRICE EACH DUPLEX CONTROL W/FLOATS
2 or 3	$4,700.00
6	4,800.00
8 or 10	5,000.00
12 or 15	5,300.00

Pricing is for budgetary usage only. Taxes are <u>not</u> included. Freight and startup are included.

Should you have any questions or require additional information, please do not hesitate to contact me.

Regards,

Colin Martin

To: Rusty Nelson

From: Bobby Wyatt

Page 2 of 2

Date: June 2, 1995

Gorman Rupp

Lift station pump package (pump, guide rails, controls, floats, etc.)

MODEL	HP	PACKAGE ($)
T4A3-B (Duplex)	20 hp	$65,570 —
T4A3-B (Duplex)	15 hp	65,152 —
T4A3-B (Duplex)	5 hp	64,156 —
T4A3-B (Duplex)	7.5 hp	64,356 —
T4A3-B (Duplex)	10 hp	64,571 —
T3A3-B (Duplex)	7.5 hp	63,026 —
T6A3-B (Duplex)	15 hp	68,407 —

ALL THESE STATIONS ARE BELOW GROUND, DRY PIT DESIGN SO GUIDE RAILS ARE NOT USED. THESE PRICES INCLUDE BUBBLER LEVEL CONTROLS, IF FLOATS ARE USED, PLEASE DEDUCT $1,363 — FROM EACH OF THE ABOVE PRICES.

STATIONS ARE PRICED AS A PACKAGE SO I CAN NOT GIVE INDIVIDUAL COMPONENT PRICES. HOWEVER, BELOW ARE LISTED APPROXIMATE CONTROL PANEL PRICES WHICH ARE INCLUDED IN THE ABOVE PRICES, ALL STATIONS ASSUMED TO BE 460 VOLT.

5 HP	-	$5,408 —
7.5 HP	-	5,408 —
10 HP	-	5,408 —
15 HP	-	5,686 —
20 HP	-	5,702 —

PLEASE CALL IF YOU HAVE QUESTIONS.

THANKS,

RUSTY NELSON

BWW/dt/MS/pumps.bww

DATE: 3/7/95 TIME: 2:30 pm

PROJECT NAME: City of Port St. Lucie PROJECT NO.: 94-354.12

PARTY CALLING: Scott Edwards COMPANY: Taylor Precast 1-800-342-7099

PARTY CONTACTED: Bobby Wyatt COMPANY: HAI

SUBJECT: Replacement costs for city of Port St. Lucie, and wetwell Replacement costs

TELEPHONE COMMUNICATION SUMMARY (Including Decisions & Commitments)

Following costs were given by Mr. Edwards:

Manholes: Depth	$	Wetwells Diameter	$/ft		Bases/top ($)
0-6	500	4'	65	w/paint	125
6-8	615	6'	125		225
8-10	725	8'	175		500
10-12	875	10'	300		1000
12-15	995	12'	375		1400
15+	1125				

ACTION REQUIRED

C.C.

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, scientists & management consultants

APPENDIX P

Piping Costs

PVC (C900 – DR 25) Force Main

Size (in)	Small Job (250') ($/ft)	Med. Job (2,500') ($/ft)	Large Job (25,000') ($/ft)
4"	12.25	9.80	9.10
6"	13.51	10.97	10.22
8"	15.28	12.68	11.82
10"	17.42	14.68	13.74
12"	20.23	17.29	16.19
--- PVC (C905 – DR 25) ---			
16"	27.08	23.76	22.26

Notes:
1) Values obtained using manufacturer's quotes.
2) Costs include $500 permitting, 10%–15% mobilization, $7/ft installation, and $.25–$.75 per foot pressure testing.
3) Costs exclude valves, fittings, and restoration work.

Piping Costs

DIP (Class 50 – Epoxy Lined) Force Main

Size (in)	Small Job (250') ($/ft)	Med. Job (2,500') ($/ft)	Large Job (25,000') ($/ft)
4"	24.39	20.57	19.39
6"	27.58	23.13	21.71
8"	31.58	26.44	24.75
10"	36.41	30.49	28.50
12"	42.76	35.93	33.59
16"	47.75	40.13	37.47

Notes:
1) Values obtained using manufacturer's quotes.
2) Costs include $500 permitting, 10%–15% mobilization, $7/ft installation, and $.25–$.75 per foot pressure testing.
3) Costs exclude valves, fittings, and restoration work.

HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants	SH. NO.: 1	JOB NO.: 95-#15.00
	MADE BY: JJW	DATE:
	CHECKED BY:	DATE:

Pipe Costs

* Includes pressure testing + Disinf. (for w.m.)

trench & backfill

① PVC (C900 – DR 25) Force Main

	15% Small job 250' ($ / ft)		12% Med. job 2500' ($ / ft)		10% large job 25,000' ($ / ft)	
4"	1.91	12.25	1.57	9.80	1.25	9.10
6"	3.01	13.51	2.62	10.97	2.27	10.22
8"	4.55	15.28	4.14	12.68	3.73	11.82
10"	6.41	17.42	5.93	14.68	5.47	13.74
12"	8.85	20.23	8.26	17.29	7.70	16.19
* (C905 – DR25)						
16"	14.81	27.08	14.04	23.76	13.22	22.26

x 2.22

MOB — Add $500 permit plus mobil. plus percentage plus $7/ft Trenching & backfill

MOBILIZATION 10-15
PERMITS $500
Installation $7/ft

$7/FT Trench & BACKFILL

② PVC (C900 – DR18) Water Main

	Small job		med. job		large job	
4"	4.34	15.04 [redacted]	3.51	11.97	2.69	10.68
6"	5.74	16.65	4.84	13.46	4.00	12.12
8"	7.98	19.23	6.99	15.87	6.04	14.36
10"	10.52	22.15	9.47	18.65	8.41	16.97
12"	13.71	25.82	12.53	22.07	11.42	20.28

③ PVC – (SDR 35) Gravity line

	small	medium	large
8"	2.33	2.26	2.22

$1/ft T.V. Test

HARTMAN & ASSOCIATES, INC.	SH. NO.: 2	JOB NO.: 95-145.00
engineers, hydrogeologists, surveyors & management consultants	MADE BY: JJW	DATE:
	CHECKED BY:	DATE:

Pipe Costs

* Includes pressure testing

④ DIP (Fastite Cement Lined Class 50) Force Main

	small job 250' ~~100'~~ ($/ft)		med. job 2500' ~~1,500'~~ ($/ft)		large job 25,000' ($/ft)		Epoxy lining
6"	[15] 7.69	18.89	[13] 6.28	15.07	[11] 5.61	13.89	5.50
8"	[24] 10.40	22.01	[19] 8.50	17.56	[14] 7.65	16.14	5.57
10"	[33] 13.50	25.58	[24] 11.07	20.44	[16] 10.03	18.75	6.00
12"	[25] 17.05	29.66	[23] 14.02	23.74	[19] 12.75	21.75	6.75
14"	21.70	35.01	17.98	28.18	16.47	25.84	7.75
16"	[35] 25.39	39.25	[33] 21.06	31.63	[29] 19.32	28.97	8.50
20"	[52] 33.17	48.20	[49] 27.55	38.90	[46] 25.34	35.59	9.25
24"	41.65	[redacted]	34.62		31.90		11.40
30"	55.57		51.02		43.23		15.50

⑤ DIP (Restrained Joint Class 50) Force Main

	small job		med. job		large job		Epoxy lining
6"	11.94	23.78	10.53	19.83	9.86	18.57	5.50
8"	15.28	27.62	13.38	23.03	12.52	21.49	5.57
10"	19.56	32.54	17.14	27.24	16.09	25.42	6.00
12"	24.30	38.00	21.27	31.86	20.00	29.72	6.75
14"	32.01	46.86	28.29	39.72	26.78	37.18	7.75
16"	38.21	53.99	33.187	45.97	32.13	43.06	8.50
20"	50.17		44.55		42.34		9.25
24"	64.15		57.12		54.40		11.40
30"	85.57		76.65		73.23		15.50

* Add $1/ft for water main on a big job.
$1.50/ft for water main on a medium job.
$2.00/ft for water main on a small job.

Also force mains must be epoxy lin

RECORD OF TELEPHONE COMMUNICATION

DATE: 9/7/95 TIME: 3:40

PROJECT NAME: SSU - Economy of Scale PROJECT NO.: 95-145.00

PARTY CALLING: JJW COMPANY: HAI

PARTY CONTACTED: Brian Penner COMPANY: Mitchell & Stark

SUBJECT: Pipe install. costs (813) 597-2165

TELEPHONE COMMUNICATION SUMMARY (Including Decisions & Commitments)

* Pressure testing (W + F.M.) Avg. 50¢/ft small job → 75¢/ft
  large job → 25¢/ft

Disinfection (W.M.) Avg. $1/ft small job → $2/ft
$1.50 ≈ large job → $1/ft

* Gravity Sewer – T.V. Test $1.00/ft

ACTION REQUIRED

C.

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, scientists & management consultants

B H
SALES

FLORIDA DISTRIBUTION CENTERS
11114 SATELLITE BLVD., ORLANDO, FL 32837 (407) 855-8510
1101 WEST 17TH STREET, RIVIERA BEACH, FL 33404 (407) 848-4696
6761 26TH COURT, EAST, SARASOTA, FL 34243 (813) 756-8765
3884-A PROSPECT AVENUE, NAPLES, FL 33942 (813) 434-8666

COVER SHEET

TO: Jamey Wallace - Hartman & Assoc.

FROM: Ed M.

DATE: 9-1

OF PAGES SENT (INC. COVER SHEET) 5

IF YOU DID NOT RECEIVE TOTAL # OF PAGES PLEASE CALL 407-855-8510 / 800-531-6998 / FAX # 407-240-1901 AND NOTIFY US IMMEDIATELY.

MESSAGES: Pipe estimates for your economy of scale projections.

Thx
Ed

SENDING FAX TO # ____________

PVC – C900 DR 25

Force Mains (Green)

Size (in.)	Cost 150 ft. ($/LF)	Cost 1,500 ft. ($/LF)	Cost 25,000 ft. ($/LF)
4"	1.26	1.15	1.04
6"	2.36	2.21	2.11
8"	3.99	3.86	3.71
10"	5.89	5.71	5.53
12"	8.59	8.26	7.99
-- C905 DR 25 --			
16"	14.22	13.89	13.39

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, surveyors & management consultants

201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801
TELEPHONE (407) 839-3955 - FAX (407) 839-3790
FAX (ADMIN/UTILITY ENG./HYDRO.) - (407) 839-3790
FAX (CIVIL ENG./SURVEY/FINANCE) - (407) 481-8447

From Jim Gunter Corrected

FACSIMILE TRANSMITTAL

~~TO: John Gulkins~~ to FROM: Jamey Wallace

DATE: 9/1/95

RE: Costs for PVC piping - Economy of Scale

WE ARE SENDING YOU 5 PAGES, INCLUDING THIS COVER SHEET.
THESE PAGES ARE BEING TRANSMITTED AS INDICATED BELOW:

- ☐ AS REQUESTED
- ☐ FOR YOUR USE
- ☒ FOR YOUR COMMENTS
- ☐ FOR YOUR APPROVAL

HARD COPY:

- ☐ WILL BE SENT VIA REGULAR MAIL
- ☐ WILL BE SENT VIA OVERNIGHT MAIL
- ☒ WILL BE SENT BY FACSIMILE ONLY

MESSAGE:

John, what I'm looking for are costs based on linear footage of the job, As we both know there typically is a considerable savings for a much larger job than for a smaller job based on the circumstances. Therefore, if maybe you could quote the prices as three (3) different jobs one w/ 150' lengths, one-1,500', one 25,000'. That way we could see the savings. Your help & professional opinion would be greatly appreciated. Thanks, JJW

IF THERE ARE QUESTIONS OR PROBLEMS WITH THIS TRANSMITTAL,
PLEASE CALL (407) 839-3955

PVC – C900 DR 25

Force Mains

Size (in.)	Cost 150 ft. ($/LF)	Cost 1,500 ft. ($/LF)	Cost 25,000 ft. ($/LF)
4"	1.05	.88	.85
6"	2.15	2.02	1.93
8"	3.60	3.41	3.25
10"	5.42	5.15	4.90
12"	7.61	7.25	6.80
-- C905 DR 25 --			
16"	13.90	13.18	12.55

AMERICAN CAST IRON PIPE COMPANY

2301 MAITLAND CENTER PARKWAY, SUITE 430
MAITLAND, FLORIDA 32751
PHONE (407) 660-8786 FAX (407) 660-1851

DATE: 8/1/95
fax 407 839-3790

NO. OF PAGES 4
(including this page)

TO: JANEY WALLACE – HARTMAN & ASSOC

FROM: Jerry Swanson

SUBJECT: ESTIMATING PRICES
SOUTHERN STATES UTILITIES

ATTACHED ARE 3 PRICE LISTS FOR SMALL, MED. & LARGE JOBS. NOTE THE PRICE DIFFERENCES IN CLASS 50, BUT ALSO NOTICE THE SAVINGS IN PRESSURE CLASS PIPE 150, 200 & 250 IN SIZES 14" THRU 30".

RJ = RESTRAINED JOINT PIPE

POLYBOND OR CTG = PER FOOT ADDERS TO ALL PRICES SHOWN.

Jerry

LARGE

American Cast Iron Pipe Company

Ductile Iron Pipe Price Sheet

Pricing Calculations

FASTITE CEMENT LINED PER FT ESTIMATING PRICES

	Class 30	Class 51	Class 52	Class 53	Class 150	Class 200	Class 250	Class300	Class 350	R. J. 50	R. J. 51	R. J. 350	R. J. 300	R. J. 250	R. J. 200	R. J. 150
3"	N/A	4.72	5.23	5.73					4.71	N/A	N/A	N/A				
4"	N/A	5.17	5.78	6.31					5.10	N/A	9.17	9.10				
6"	5.36	5.93	6.50	7.07					5.33	9.61	10.18	9.58				
8"	7.40	8.14	8.90	9.64					6.96	12.27	13.01	11.84				
10"	9.78	10.73	11.63	12.58					8.99	15.84	16.79	13.05				
12"	12.50	13.61	14.72	15.83					11.54	19.75	20.86	18.79				
14"	16.22	17.56	18.91	20.26			14.33	14.93	15.28	26.53	27.88	25.59	25.25	24.64		
16"	19.07	20.61	22.14	23.65			17.42	18.05	18.95	31.88	33.42	31.77	30.86	30.23		
18"	22.02	23.74	25.47	27.20			20.20	21.43	22.46	36.64	38.37	37.08	36.08	34.82		
20"	25.09	27.01	28.93	30.85			23.53	25.09	26.35	42.09	44.01	43.33	42.09	40.53		
24"	31.65	33.95	36.26	38.53		28.72	31.45	33.26	35.54	54.15	56.45	58.04	55.76	53.95	51.22	
30"	42.98	47.05	51.13	55.20	37.63	41.71	43.80	48.86	52.88	72.98	77.05	82.88	78.86	75.80	71.71	67.63
36"	59.31	64.85	70.35	75.85	53.27	57.71	63.26	67.70	73.23	100.25	105.78	114.16	108.64	104.20	98.65	94.21
42"	73.23	80.94	89.84	97.58	66.06	73.79	80.28	86.90	95.38	121.54	129.25	143.89	135.21	128.59	122.10	114.37
48"	99.09	109.40	119.72	129.97	92.63	101.51	110.39	119.24	128.06	158.78	169.09	187.75	178.93	170.07	161.19	152.31
54"	133.08	147.92	162.80	177.57	122.33	135.44	148.49	161.53	174.57	204.58	219.42	246.07	233.03	219.99	206.94	193.83
60"					161.39	176.67	191.88	209.25	224.39					299.38	284.17	268.89
64"					174.62	193.34	217.00	230.56	246.79					324.50	305.84	287.12

	POLYBOND or CTE
3"	N/A
4"	5.25
6"	5.50
8"	5.57
10"	6.00
12"	6.75
14"	7.75
16'	8.50
18"	9.00
20"	9.25
24"	11.40
30"	15.50
36"	18.00
42"	22.50
48"	28.00
54"	34.00
60"	
64"	

EXHIBIT (G-H-4)

PAGE 268 OF 284

MEDIUM

American Cast Iron Pipe Company

Ductile Iron Pipe Price Sheet

Pricing Calculations

FASTITE CEMENT LINED PER FT ESTIMATING PRICES

	Class 50	Class 51	Class 52	Class 53	Class 150	Class 200	Class 250	Class300	Class 350	R. J. 50	R. J. 51	R. J. 350	R. J. 300	R. J. 250	R. J. 200	R. J. 150		POLYBOND or CTE
3"	N/A	4.96	5.49	6.01					4.94	N/A	N/A	N/A					3"	N/A
4"	N/A	5.46	6.11	6.67					5.38	N/A	9.46	9.38					4"	5.25
6"	5.78	6.40	7.01	7.63					5.74	10.03	10.65	9.99					6"	5.50
8"	8.00	8.80	9.63	10.42					7.51	12.88	13.67	12.39					8"	5.97
10"	10.57	11.60	12.60	13.60					9.69	16.64	17.67	15.76					10"	6.00
12"	13.52	14.72	15.92	17.12					12.45	20.77	21.97	19.70					12"	6.75
14"	17.48	18.93	20.38	21.84			15.39	16.07	16.45	27.79	29.25	26.76	26.39	25.71			14"	7.75
16"	20.56	22.22	23.87	25.50			18.72	19.43	20.42	33.37	35.03	33.23	32.24	31.53			16"	8.50
18"	23.74	25.60	27.46	29.33			21.70	23.09	24.19	38.36	40.22	38.81	37.72	36.33			18"	9.00
20"	27.03	29.12	31.19	33.26			25.31	27.02	28.38	44.05	46.12	45.38	44.02	42.31			20"	9.25
24"	34.12	36.60	39.09	41.54		30.86	33.83	35.82	38.29	56.62	59.10	60.79	58.32	56.53	53.36		24"	11.40
30"	46.15	50.52	54.89	59.27	40.39	44.77	49.16	52.43	56.76	76.15	80.52	86.76	82.45	79.16	74.77	70.39	30"	15.50
36"	63.49	69.48	75.43	81.38	56.96	61.76	67.77	73.56	78.54	104.43	110.42	119.47	113.50	108.70	102.70	97.90	36"	18.00
42"	78.53	86.86	96.40	104.76	70.77	79.12	86.13	93.28	102.59	126.84	135.18	150.90	141.59	134.45	127.43	119.08	42"	22.50
48"	103.65	116.80	127.95	139.03	98.63	108.23	117.83	127.40	136.93	165.34	176.48	196.62	187.09	177.52	167.92	158.32	48"	28.00
54"	141.44	157.36	173.32	189.16	129.88	143.94	157.92	171.91	185.90	212.94	228.86	257.40	243.41	229.42	215.44	201.38	54"	34.00
60"					161.39	176.67	191.88	209.25	224.39					299.38	284.17	268.89	60"	
64"					174.62	193.34	212.00	230.56	246.79					324.50	305.84	287.12	64"	

SMALL

American Cast Iron Pipe Company

Ductile Iron Pipe Price Sheet

Pricing Calculations

PASTITE CEMENT LINED PER FT ESTIMATING PRICES

	Class 50	Class 51	Class 52	Class 53	Class 150	Class 200	Class 250	Class300	Class 350	R.J.50	R.J.51	R.J.350	R.J.300	R.J.250	R.J.200	R.J.150		POLYBOND or CTE
3"	N/A	5.60	6.20	6.79					3.57	N/A	N/A	N/A					3"	N/A
4"	N/A	6.27	7.02	7.65					6.15	N/A	10.27	10.15					4"	5.25
6"	6.94	7.68	8.42	9.15					6.87	11.19	11.93	11.12					6"	5.50
8"	9.65	10.61	11.61	12.58					9.02	14.53	15.49	13.90					8"	5.57
10"	12.75	13.99	15.20	16.40					11.63	18.81	20.06	17.69					10"	6.00
12"	16.30	17.75	19.19	20.64					14.94	23.35	25.00	22.19					12"	6.75
14"	20.95	22.69	24.43	26.16			18.32	19.20	19.67	31.26	33.00	29.98	29.51	28.63			14"	7.75
16"	24.64	26.63	28.61	30.36			22.28	23.21	24.42	37.46	39.44	37.24	36.02	35.09			16'	8.50
18"	28.45	30.68	32.91	35.15			25.83	27.58	28.93	43.07	45.31	43.55	42.21	40.45			18"	9.00
20"	32.42	34.90	37.38	39.86			30.19	32.31	33.94	49.42	51.90	50.94	49.31	47.19			20"	9.25
24"	40.90	43.87	46.85	49.79		36.72	40.36	42.85	45.80	63.40	66.37	68.30	65.35	62.86	59.22		24"	11.40
30"	54.82	60.01	65.21	70.41	47.96	53.17	58.37	62.28	67.40	84.82	90.01	97.40	92.28	88.37	83.17	77.96	30"	15.50
36"	80.60	86.59	92.53	98.47	73.88	78.69	84.71	89.51	95.51	121.53	127.52	136.45	130.45	125.68	119.63	114.82	36"	18.00
42"	95.36	103.88	115.87	124.41	87.90	96.25	103.26	110.76	122.15	143.87	152.19	170.47	159.07	151.57	144.56	136.21	42"	22.90
48"	139.66	150.82	162.02	173.11	132.89	142.48	152.07	161.66	171.19	199.35	210.51	230.88	221.34	211.76	202.17	192.58	48"	28.00
54"	175.70	191.61	207.57	223.42	164.12	178.18	192.17	206.17	220.16	247.20	263.11	291.66	277.67	263.67	249.68	235.62	54"	34.00
60"					229.87	245.19	260.38	277.75	292.88					367.88	352.69	337.37	60"	
64"					241.22	260.20	279.06	297.79	314.15					391.56	372.70	353.72	64"	

EXHIBIT (ECA-4)
PAGE 270 OF 284

APPENDIX Q

Piping Costs

PVC (C900 – DR 18) Water Main

Size (in)	Small Job (250') ($/ft)	Med. Job (2,500') ($/ft)	Large Job (25,000') ($/ft)
4"	15.04	11.97	10.68
6"	16.65	13.46	12.12
8"	19.23	15.87	14.36
10"	22.15	18.65	16.97
12"	25.82	22.07	20.28

Notes:
1) Values obtained using manufacturer's quotes.
2) Costs include $500 permitting, 10%–15% mobilization, $7/ft installation, $1–$2 per foot disinfection and $.25–$.75 per foot pressure testing.
3) Costs exclude valves, fittings, and restoration work.

Piping Costs

DIP (Class 50 – Cement Lined) Water Main

Size (in)	Small Job (250') ($/ft)	Med. Job (2,500') ($/ft)	Large Job (25,000') ($/ft)
6"	20.89	16.57	14.89
8"	24.01	19.06	17.14
10"	27.58	21.94	19.75
12"	31.66	25.24	22.75
14"	37.01	29.68	26.84
16"	41.25	33.13	29.97

Notes:
1) Values obtained using manufacturer's quotes.
2) Costs include $500 permitting, 10%–15% mobilization, $7/ft installation, $1–$2 per foot disinfection and $.25–$.75 per foot pressure testing.
3) Costs exclude valves, fittings, and restoration work.

HARTMAN & ASSOCIATES, INC.
engineers, hydrogeologists, surveyors & management consultants

SH. NO.: 1 | JOB NO.: 95-445.00
MADE BY: JJW | DATE:
CHECKED BY: | DATE:

Pipe Costs

* Includes pressure testing, trench & backfill + Disinf. (for w.m.)

Add $500 permit plus mobil. plus percentages $7/ft plus trench & backfill

① PVC (C900 – DR 25) Force Main

	15% Small job 250' ($/ft)		12% Med. Job 2500' ($/ft)		10% large Job 25,000' ($/ft)	
4"	1.91	12.25	1.57	9.80	1.25	9.10
6"	3.01	13.51	2.62	10.97	2.27	10.22
8"	4.55	15.28	4.14	12.68	3.73	11.82
10"	6.41	17.42	5.93	14.68	5.47	13.74
12"	8.85	20.23	8.26	17.29	7.70	16.18
* (C905 – DR25)						
16"	14.81	27.08	14.04	23.76	13.22	22.26

MOBILIZATION 10-15
PERMITS $500
Installation $7/ft
$7/FT include TRENCH & BACKFILL

② PVC (C900 – DR18) Water Main

	Small job		med. job		large job	
4"	4.34	15.04 [redacted]	3.51	11.97	2.69	10.68
6"	5.74	16.65	4.84	13.46	4.00	12.12
8"	7.98	19.23	6.99	15.87	6.04	14.36
10"	10.52	22.15	9.47	18.65	8.41	16.97
12"	13.71	25.82	12.53	22.07	11.42	20.28

③ PVC – (SDR 35) Gravity line

	small	medium	large
8"	2.33	2.26	2.22

$1/ft T.V. TEST

HARTMAN & ASSOCIATES, INC. engineers, hydrogeologists, surveyors & management consultants	SH. NO.: 2	JOB NO.: 95-145.00
	MADE BY: JJW	DATE:
	CHECKED BY:	DATE:

Pipe Costs*

* Includes pressure testing

(4) DIP (Fastite Cement Lined Class 50) Force Main

Adder for W.M. → Epoxy lining

Size	small job 250' ~~100'~~ ($/ft)		med. job 2500' ~~1,500'~~ ($/ft)		large job 25,000' ($/ft)		Epoxy lining
6"	[15] 7.69	18.89	[13] 6.28	15.07	[11] 5.61	13.89	5.50
8"	[24] 10.40	22.01	[19] 8.50	17.56	[14] 7.65	16.14	5.57
10"	[33] 13.50	25.58	[24] 11.07	20.44	[16] 10.03	18.75	6.00
12"	[25] 17.05	29.66	[23] 14.02	23.74	[19] 12.75	21.75	6.75
14"	21.70	35.01	17.98	28.18	16.47	25.84	7.75
16"	[35] 25.39	39.25	[33] 21.06	31.63	[29] 19.32	28.97	8.50
20"	[52] 33.17	48.20	[49] 27.55	38.90	[46] 25.34	35.59	9.25
24"	41.65	[redacted]	34.62		31.90		11.40
30"	55.57		51.02		43.23		15.50

(5) DIP (Restrained Joint Class 50) Force Main

Size	small job		med. job		large job		Epoxy lining
6"	11.94	23.78	10.53	19.83	9.86	18.57	5.50
8"	15.28	27.62	13.38	23.03	12.52	21.49	5.57
10"	19.56	32.54	17.14	27.24	16.09	25.42	6.00
12"	24.30	38.00	21.27	31.86	20.00	29.72	6.75
14"	32.01	46.86	28.29	39.72	26.78	37.18	7.75
16"	38.21	53.99	33.18	45.97	32.13	43.06	8.50
20"	50.17		44.55		42.34		9.25
24"	64.15		57.12		54.40		11.40
30"	85.57		76.65		73.23		15.50

* Add
$1/ft for water main on a big job.
$1.50/ft for water main on a medium job.
$2.00/ft for water main on a small job.

Also force mains must be epoxy lined

RECORD OF TELEPHONE COMMUNICATION

DATE: 9/7/95 TIME: 3:40

PROJECT NAME: SSU - Economy of Scale PROJECT NO.: 95-145.00

PARTY CALLING: JJW COMPANY: HAI

PARTY CONTACTED: Brian Penner COMPANY: Mitchell & Stark

SUBJECT: Pipe install. costs (813) 597-2165

TELEPHONE COMMUNICATION SUMMARY (Including Decisions & Commitments)

Pressure testing (W+F.M.) Avg. 50¢/ft small job → 75¢/ft
large job → 25¢/ft

Disinfection (W.M.) Avg. $1/ft small job → $2/ft
$1.50 ≈ large job → $1/ft

Gravity Sewer – T.V. Test $1.00/ft

ACTION REQUIRED

C.

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, scientists & management consultants

B H
SALES

FLORIDA DISTRIBUTION CENTERS
11114 SATELLITE BLVD., ORLANDO, FL 32837 (407) 855-8510
1101 WEST 17TH STREET, RIVIERA BEACH, FL 33404 (407) 848-4806
6761 26TH COURT, EAST, SARASOTA, FL 34243 (813) 756-6765
3884-A PROSPECT AVENUE, NAPLES, FL 33942 (813) 434-0666

COVER SHEET

TO: Janny Wallace - Hartman & Assoc.

FROM: Ed M.

DATE: 9-1

OF PAGES SENT (INC. COVER SHEET) 5

IF YOU DID NOT RECEIVE TOTAL # OF PAGES PLEASE CALL 407-855-8510 / 800-531-6998 / FAX # 407-240-1901 AND NOTIFY US IMMEDIATELY.

MESSAGES: Pipe estimates for your economy of scale projections.

Thx
Ed

SENDING FAX TO # ____________

PVC – C900 DR 18 — (Blue)

Water Mains

Size (in.)	Cost 150 ft. ($/LF)	Cost 1,500 ft. ($/LF)	Cost 25,000 ft. ($/LF)
4"	1.66	1.57	1.48
6"	3.12	2.98	2.89
8"	5.48	5.23	5.06
10"	8.04	7.84	7.56
12"	11.41	11.06	10.81

Paint

EnG

HARTMAN & ASSOCIATES, INC.
engineers, hydrogeologists, surveyors & management consultants
201 EAST PINE STREET - SUITE 1000 - ORLANDO, FL 32801
TELEPHONE (407) 839-3955 - FAX (407) 839-3790
FAX (ADMIN/UTILITY ENG/HYDRO) - (407) 839-3790
FAX (CIVIL ENG/SURVEY/FINANCE) - (407) 481-8447

From Jim Gunter Compacted

FACSIMILE TRANSMITTAL

~~TO: John Gulkins~~ FROM: Jamey Wallace

DATE: 9/1/95

RE: Costs for PVC piping - Economy of Scale

WE ARE SENDING YOU 5 PAGES, INCLUDING THIS COVER SHEET.
THESE PAGES ARE BEING TRANSMITTED AS INDICATED BELOW:

- ☐ AS REQUESTED
- ☐ FOR YOUR USE
- ☒ FOR YOUR COMMENTS
- ☐ FOR YOUR APPROVAL

HARD COPY:

- ☐ WILL BE SENT VIA REGULAR MAIL
- ☐ WILL BE SENT VIA OVERNIGHT MAIL
- ☒ WILL BE SENT BY FACSIMILE ONLY

MESSAGE:

John, what I'm looking for are costs based on linear footage of the Job, As we both know there typically is a considerable savings for a much larger job than for a smaller job based on the circumstances. Therefore, if maybe you could quote the prices as three (3) different jobs one w/ 150' lengths, one- 1,500', one 25,000'. That way we could see the savings. Your help & professional opinion would be greatly appreciated. Thanks, JJW

IF THERE ARE QUESTIONS OR PROBLEMS WITH THIS TRANSMITTAL,
PLEASE CALL (407) 839-3955

FAX_ORIG

PVC – C900 DR 18

Water Mains

Size (in.)	Cost 150 ft. ($/LF)	Cost 1,500 ft. ($/LF)	Cost 25,000 ft. ($/LF)
4"	1.52	1.45	1.39
6"	2.85	2.70	2.60
8"	4.98	4.75	4.52
10"	7.50	7.10	6.76
12"	10.50	10.00	9.53

4 HR TEST @ 150 PSI

Pressure Test
Disinfect
Newest
600

AMERICAN CAST IRON PIPE COMPANY

2301 MAITLAND CENTER PARKWAY, SUITE 430
MAITLAND, FLORIDA 32751
PHONE (407) 660-8786 FAX (407) 660-1851

DATE: 8/1/95
fax 407 839-3790

NO. OF PAGES 4
(including this page)

TO: SANCY WALLACE – HARTMAN & ASSOC

FROM: Jerry Seaman

SUBJECT: ESTIMATING PRICES
SOUTHERN STATES UTILITIES

ATTACHED ARE 3 PRICE LISTS FOR SMALL, MED. & LARGE JOBS. NOTE THE PRICE DIFFERENCES IN CLASS 50, BUT ALSO NOTICE THE SAVINGS IN PRESSURE CLASS PIPE 150, 200 & 250 IN SIZES 14" THRU 30".

RJ = RESTRAINED JOINT PIPE

POLYBOND OR CTE = PER FOOT ADDERS TO ALL PRICES SHOWN.

Jerry

LARGE

American Cast Iron Pipe Company

Ductile Iron Pipe Price Sheet

Pricing Calculations

FASTITE CEMENT LINED PER FT ESTIMATING PRICES

	Class 30	Class 31	Class 32	Class 33	Class 150	Class 200	Class 250	Class300	Class 350	R.J. 50	R.J. 51	R.J. 350	R.J. 300	R.J. 250	R.J. 200	R.J. 150		POLYBOND or CTE
3"	N/A	4.72	5.23	5.73					4.71	N/A	N/A	N/A					3"	N/A
4"	N/A	5.17	5.78	6.31					5.10	N/A	9.17	9.10					4"	5.25
6"	5.36	5.93	6.50	7.07					5.33	9.61	10.18	9.58					6"	5.50
8"	7.40	8.14	8.90	9.64					6.96	12.27	13.01	11.84					8"	5.57
10"	9.78	10.73	11.65	12.58					8.99	15.84	16.79	15.05					10"	6.00
12"	12.50	13.61	14.72	15.83					11.54	19.75	20.86	18.79					12"	6.75
14"	16.22	17.56	18.91	20.26			14.33	14.93	15.28	26.53	27.88	25.59	25.25	24.64			14"	7.75
16"	19.07	20.61	22.14	23.65			17.42	18.05	18.95	31.88	33.42	31.77	30.86	30.23			16'	8.50
18"	22.02	23.74	25.47	27.20			20.20	21.45	22.46	36.64	38.37	37.08	36.08	34.82			18"	9.00
20"	25.09	27.01	28.93	30.85			23.53	25.09	26.35	42.09	44.01	43.35	42.09	40.53			20"	9.25
24"	31.65	33.95	36.26	38.53		28.72	31.45	33.26	35.54	54.15	56.45	58.04	55.76	53.95	51.22		24"	11.40
30"	42.98	47.05	51.13	55.20	37.63	41.71	43.80	48.86	52.88	72.98	77.05	82.88	78.86	75.80	71.71	67.63	30"	15.50
36"	59.31	64.85	70.35	75.85	53.27	57.71	63.26	67.70	73.23	100.25	105.78	114.16	108.64	104.20	98.65	94.21	36"	18.00
42"	73.23	80.94	89.84	97.58	66.06	73.79	80.28	86.90	95.38	121.54	129.25	143.89	135.21	128.59	122.10	114.37	42"	22.50
48"	99.09	109.40	119.72	129.97	92.63	101.51	110.39	119.24	128.06	158.78	169.09	187.75	178.93	170.07	161.19	152.31	48"	28.00
54"	133.08	147.92	162.80	177.57	122.33	135.44	148.49	161.53	174.57	204.38	219.42	246.07	233.03	219.99	206.94	193.83	54"	34.00
60"					161.39	176.67	191.88	209.25	224.39					299.38	284.17	268.89	60"	
64"					174.62	193.34	212.00	230.56	246.79					324.50	305.84	287.12	64"	

EXHIBIT (SCH-4)

PAGE 282 OF 284

MEDIUM

American Cast Iron Pipe Company

Ductile Iron Pipe Price Sheet

Pricing Calculations

FASTITE CEMENT LINED PER FT ESTIMATING PRICES

	Class 50	Class 51	Class 52	Class 53	Class 150	Class 200	Class 250	Class300	Class 350	R.J. 50	R.J. 51	R.J. 350	R.J. 300	R.J. 250	R.J. 200	R.J. 150		POLYBOND or CTE
3"	N/A	4.96	5.49	6.01					4.94	N/A	N/A	N/A					3"	N/A
4"	N/A	5.46	6.11	6.67					5.38	N/A	9.46	9.38					4"	5.25
6"	5.78	6.40	7.01	7.63					5.74	10.03	10.65	9.99					6"	5.50
8"	8.00	8.80	9.63	10.42					7.51	12.88	13.67	12.39					8"	5.57
10"	10.57	11.60	12.60	13.60					9.69	16.64	17.67	15.76					10"	6.00
12"	13.52	14.72	15.92	17.12					12.45	20.77	21.97	19.70					12"	6.75
14"	17.48	18.93	20.38	21.84			15.39	16.07	16.45	27.79	29.25	26.76	26.39	25.71			14"	7.75
16"	20.56	22.22	23.87	25.50			18.72	19.43	20.42	33.37	35.03	33.23	32.24	31.53			16"	8.50
18"	23.74	25.60	27.46	29.33			21.70	23.09	24.19	38.36	40.22	38.81	37.72	36.33			18"	9.00
20"	27.05	29.12	31.19	33.26			25.31	27.02	28.38	44.05	46.12	45.38	44.02	42.31			20"	9.25
24"	34.12	36.60	39.09	41.54		30.86	33.83	35.82	38.29	56.62	59.10	60.79	58.32	56.33	53.36		24"	11.40
30"	46.13	50.52	54.89	59.27	40.39	44.77	49.16	52.45	56.76	76.15	80.52	86.76	82.45	79.16	74.77	70.39	30"	15.50
36"	63.49	69.48	75.43	81.38	56.96	61.76	67.77	71.56	78.54	104.43	110.42	119.47	113.50	108.70	102.70	97.90	36"	18.00
42"	78.53	86.86	96.40	104.76	70.77	79.12	86.13	93.28	102.59	126.84	135.18	150.90	141.59	134.45	127.43	119.08	42"	22.50
48"	103.65	116.80	127.95	139.03	98.63	108.23	117.83	127.40	136.93	163.34	176.48	196.62	187.09	177.52	167.92	158.32	48"	28.00
54"	141.44	157.36	173.32	189.16	129.88	143.94	157.92	171.91	185.90	212.94	228.86	257.40	243.41	229.42	215.44	201.38	54"	34.00
60"					161.39	176.67	191.88	209.25	224.39					299.38	284.17	268.89	60"	
64"					174.62	193.34	212.00	230.36	246.79					324.50	305.84	287.12	64"	

EXHIBIT (5-CH-4)

SMALL

American Cast Iron Pipe Company

Ductile Iron Pipe Price Sheet

Pricing Calculations

PASTITE CEMENT LINED PER FT ESTIMATING PRICES

	Class 50	Class 51	Class 52	Class 53	Class 150	Class 200	Class 250	Class300	Class 350	R. J. 50	R. J. 51	R. J. 350	R. J. 300	R. J. 250	R. J. 200	R. J. 150		POLYBOND or CTB
3"	N/A	5.60	6.20	6.79					5.57	N/A	N/A	N/A					3"	N/A
4"	N/A	6.27	7.02	7.65					6.15	N/A	10.27	10.15					4"	5.25
6"	6.94	7.68	8.42	9.15					6.87	11.19	11.93	11.12					6"	5.50
8"	9.65	10.61	11.61	12.58					9.02	14.53	15.49	13.90					8"	5.57
10"	12.75	13.99	15.20	16.40					11.63	18.81	20.06	17.69					10"	6.00
12"	16.30	17.75	19.19	20.64					14.94	23.35	25.00	22.19					12"	6.75
14"	20.95	22.69	24.43	26.16			18.32	19.20	19.67	31.26	33.00	29.98	29.51	28.63			14"	7.75
16"	24.64	26.63	28.61	30.56			22.28	23.21	24.42	37.46	39.44	37.24	36.02	35.09			16"	8.50
18"	28.45	30.68	32.91	35.15			25.83	27.58	28.93	43.07	45.31	43.55	42.21	40.45			18"	9.00
20"	32.42	34.90	37.38	39.86			30.19	32.31	33.94	49.42	51.90	50.94	49.31	47.19			20"	9.25
24"	40.90	43.87	46.85	49.79		36.72	40.36	42.85	45.80	63.40	66.37	68.30	65.35	62.86	99.22		24"	11.40
30"	54.82	60.01	65.21	70.41	47.96	53.17	58.37	62.28	67.40	84.82	90.01	97.40	92.28	88.57	83.17	77.96	30"	15.50
36"	80.60	86.59	92.53	98.47	73.88	78.69	84.71	89.51	95.51	121.53	127.52	136.45	130.45	125.65	119.63	114.82	36"	18.00
42"	95.56	103.88	115.87	124.41	87.90	96.25	103.26	110.76	122.15	143.87	152.19	170.47	159.07	151.57	144.56	136.21	42"	22.50
48"	139.66	150.82	162.02	173.11	132.89	142.48	152.07	161.66	171.19	199.35	210.51	230.88	221.34	211.76	202.17	192.58	48"	28.00
54"	175.70	191.61	207.57	223.42	164.12	178.18	192.17	206.17	220.16	247.20	263.11	291.66	277.67	263.67	249.68	235.62	54"	34.00
60"					229.87	245.19	260.38	277.75	292.89					367.88	352.69	337.37	60"	
64"					241.22	260.20	279.06	297.79	314.15					391.56	372.70	353.72	64"	

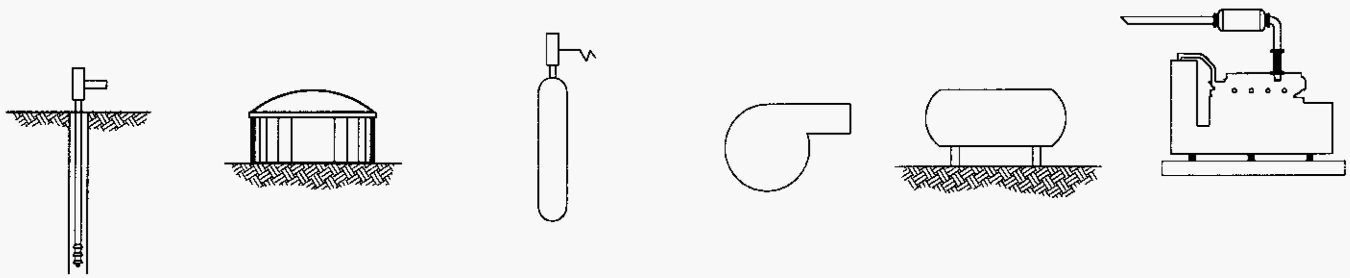
EXHIBIT (GCH-4)

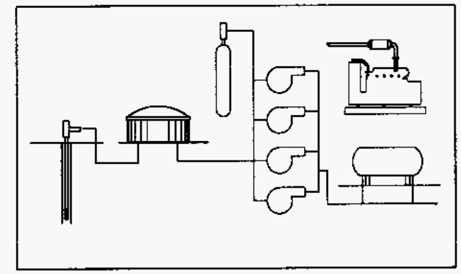
PAGE 284 OF 284

95-144.00/14400R02

UNIT COST RELATIONSHIP OF FACILITY EQUALS THE SUM OF ITS COMPONENTS

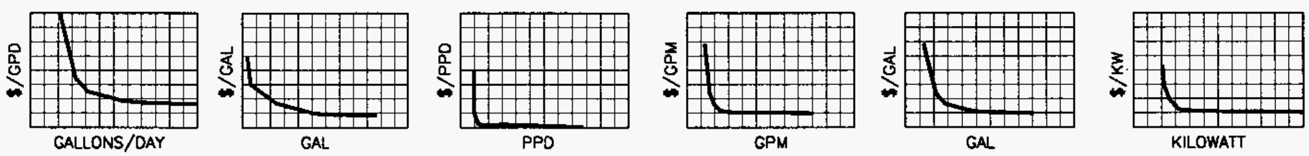
WATER TREATMENT PLANT FACILITY COMPONENTS



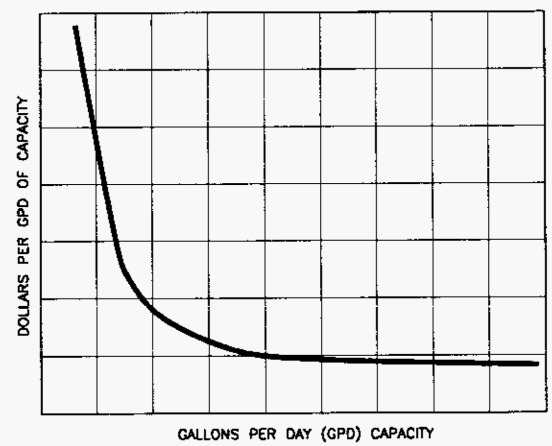


WATER TREATMENT FACILITY

WELL + GROUND STORAGE TANK + CHLORINATION SYSTEM + HIGH SERVICE PUMP + HYDRO-PNEUMATIC TANK + EMERGENCY POWER GENERATOR = COMPOSITE UNIT COST CURVE



UNIT COST CURVES



WATER TREATMENT FACILITY COMPOSITE UNIT COST CURVE

EXHIBIT (GCH-5)

PAGE 1 OF 1

EXHIBIT __ (GCH-6)

SPONSORED BY GERALD C. HARTMAN, P.E.

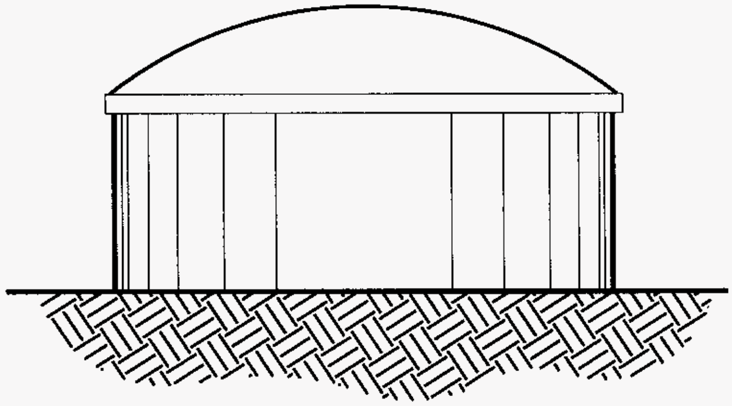
DESCRIPTION:

ECONOMY OF SCALE COMPENDIUM
ILLUSTRATIONS: STEEL GROUND
STORAGE TANK USED AND USEFUL,
MARGIN RESERVE

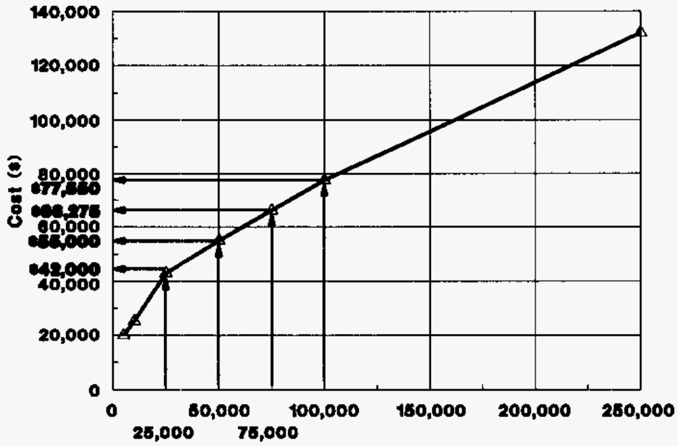
SUMMARY ON STEEL GROUND STORAGE TANK COST AND UNIT CURVE

- THE COST CURVE ON THE ATTACHED PAGE ILLUSTRATES THE RELATIVE COST FOR VARIOUS SIZE STORAGE TANKS
- THE UNIT COST CURVE ON THE ATTACHED PAGE ILLUSTRATES THE ECONOMY OF SCALE
- THESE COST CURVES ARE USED IN ALL FOLLOWING CHARTS, TABLES AND GRAPHS

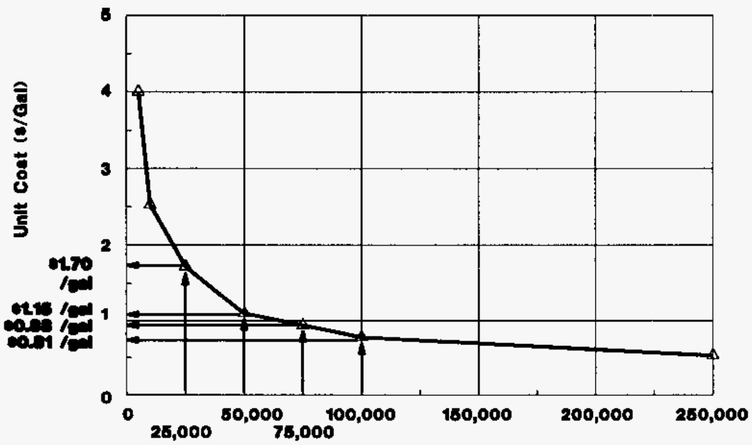
STEEL GROUND STORAGE TANK



COST



CAPACITY UNIT COST



Notes:

1) Complete steel tank, concrete foundation, roof, roof manway, gravity vent, bottom manway hatch, ladder & cage assembly, top manway platform, protective bolt caps, and installation costs are included in the manufacturers' quotations.

2) Includes 5% piping, 0% electrical, and 5% sitework costs.

3) Costs are based on June 1995, ENR Index = 5433.

EXHIBIT GCH-6	STEEL GROUND STORAGE TANK COST CURVES

COMMENTARY ON EXAMPLE PHASING PLANS/ANALYSIS

SUMMARY

THE FOLLOWING THREE PAGES ILLUSTRATE BY GRAPH/DIAGRAM THE FOLLOWING AS TO STORAGE TANK: PHASING SCHEDULES, CASH FLOW, FACILITY CAPACITY, CUMULATIVE INVESTMENT/DOLLARS IN USED AND USEFUL AND PERCENT USED AND USEFUL. THE FIGURES REFLECT A 3% GROWTH RATE WHEREBY DEMAND INCREASES FROM 25,000 GPD TO 100,000 GPD. THE ANALYSIS ASSUMES 0% INFLATION AND A 0% DISCOUNT RATE. USED AND USEFUL IS ASSUMED TO EQUAL EXISTING NEED DIVIDED BY TOTAL CAPACITY.

CONCLUSION

THE FIGURES ILLUSTRATE THAT EXPANSION WITH THE SMALLER UNITS PRODUCES A SIGNIFICANTLY HIGHER VALUE IN USED AND USEFUL AND THUS, RATE BASE, THAN EXPANSION WITH LARGER UNITS.

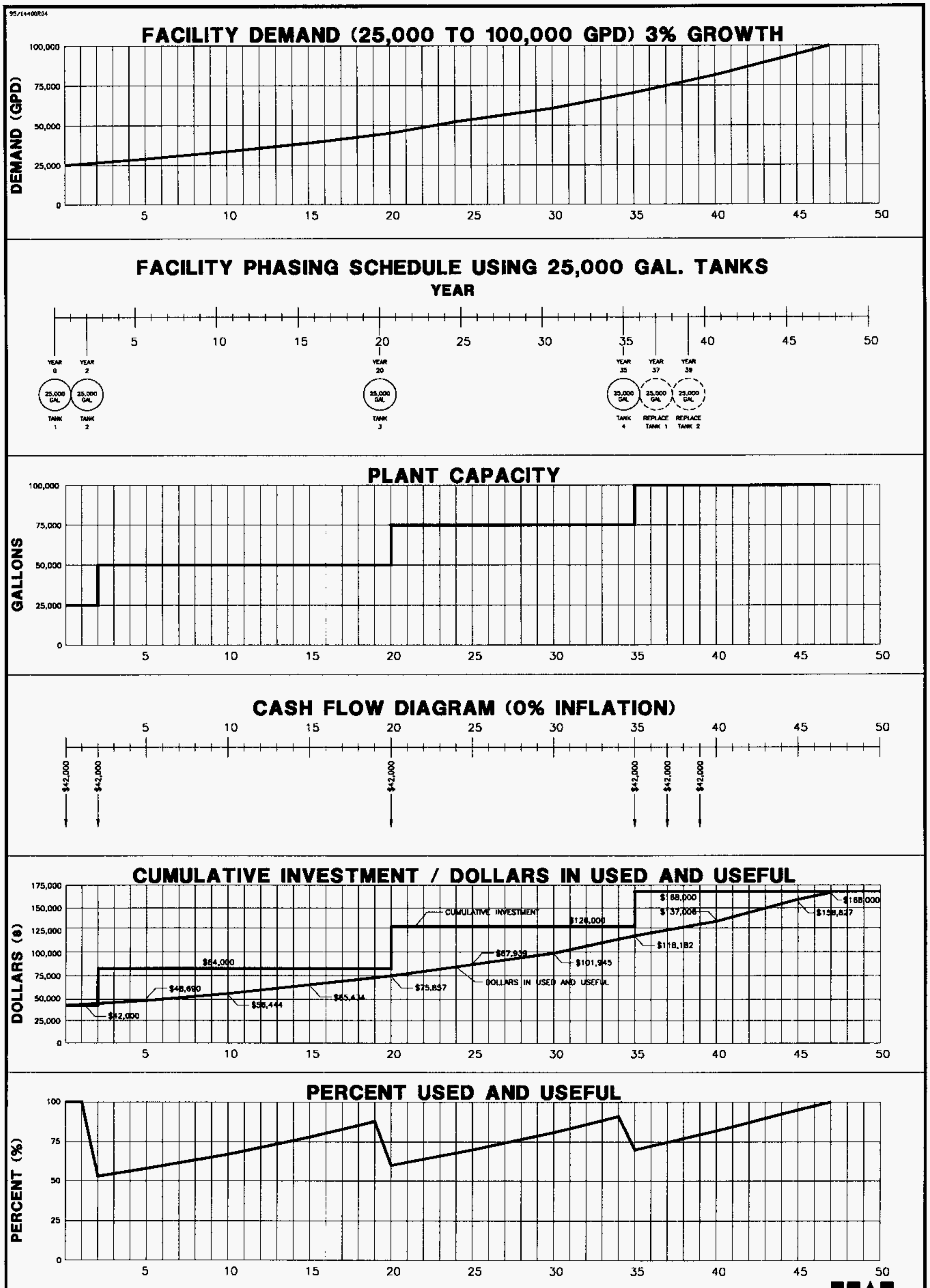
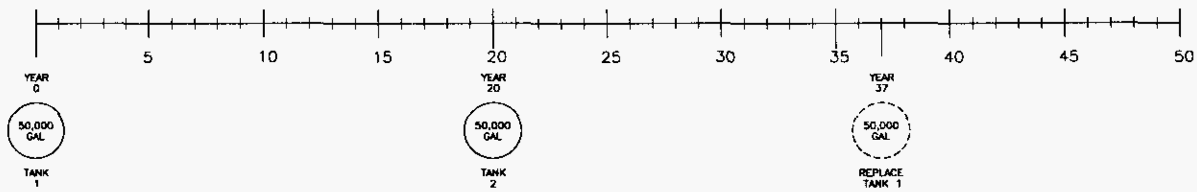


EXHIBIT GCH-6 | **EXPANSION USING 25,000 GAL. TANKS**

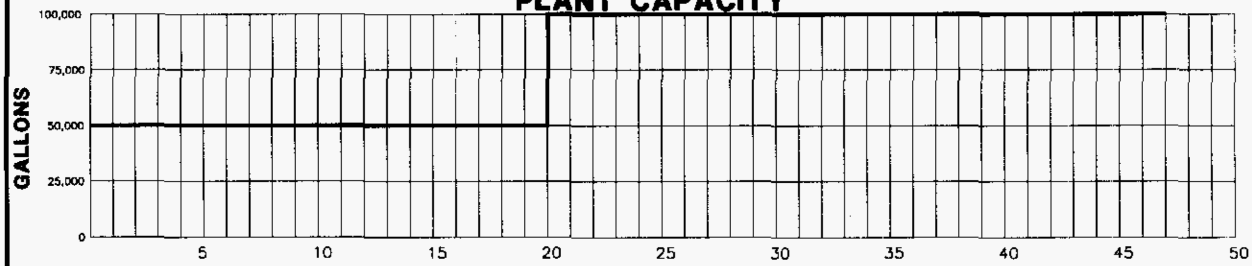
EXHIBIT (GCH-6)
PAGE 5 OF 19

FACILITY DEMAND (25,000 TO 100,000 GPD) 3% GROWTH

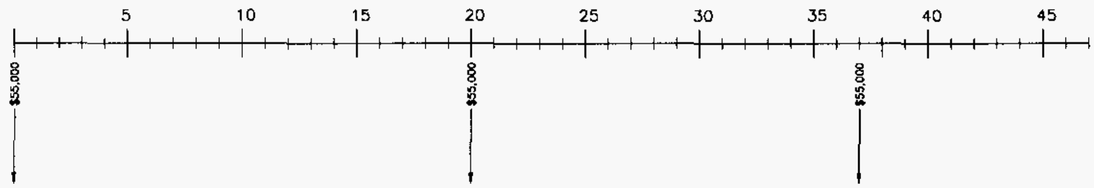
FACILITY PHASING SCHEDULE



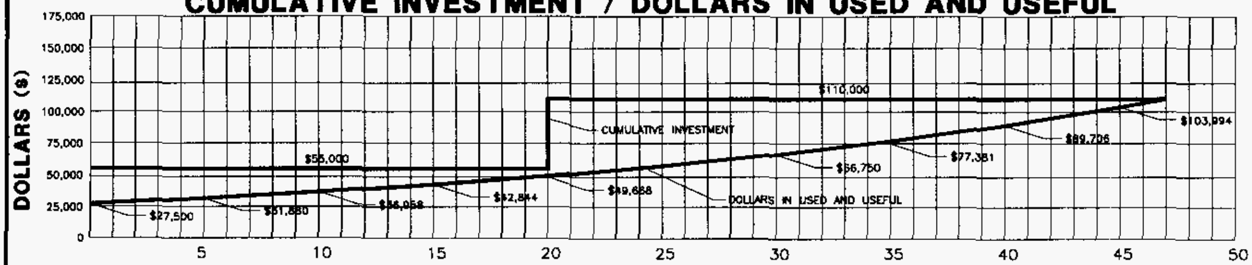
PLANT CAPACITY



CASH FLOW DIAGRAM (0% INFLATION)



CUMULATIVE INVESTMENT / DOLLARS IN USED AND USEFUL



PERCENT USED AND USEFUL

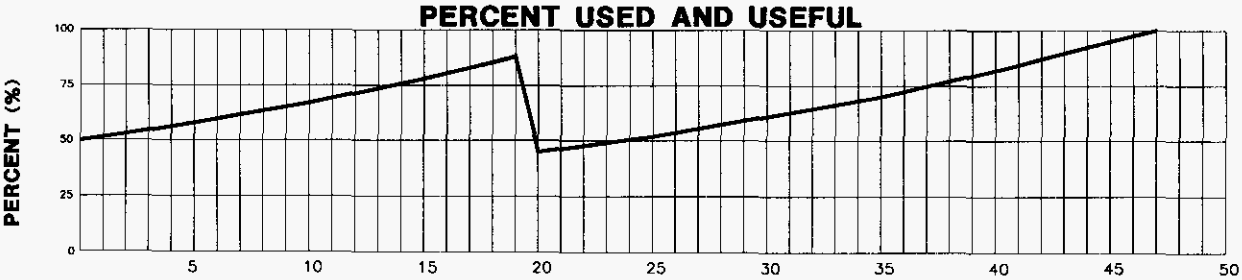
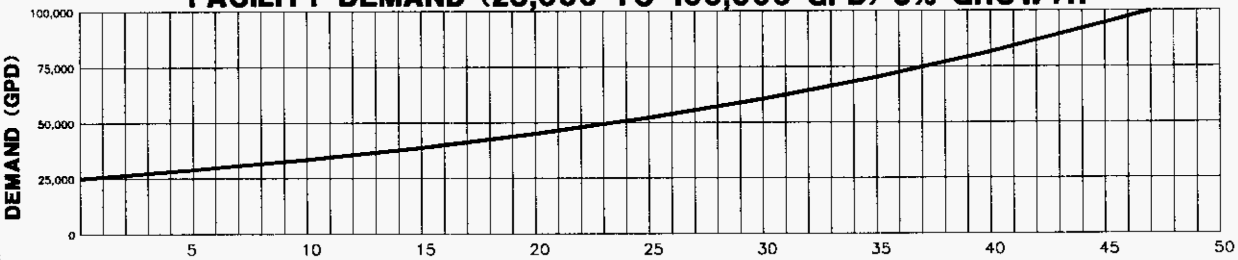


EXHIBIT GCH-6	EXPANSION USING 50,000 GAL. TANKS

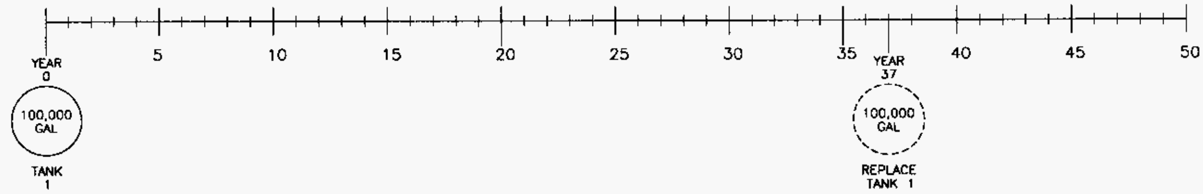
EXHIBIT (GCH-6)
PAGE 6 OF 19

95/14400R06

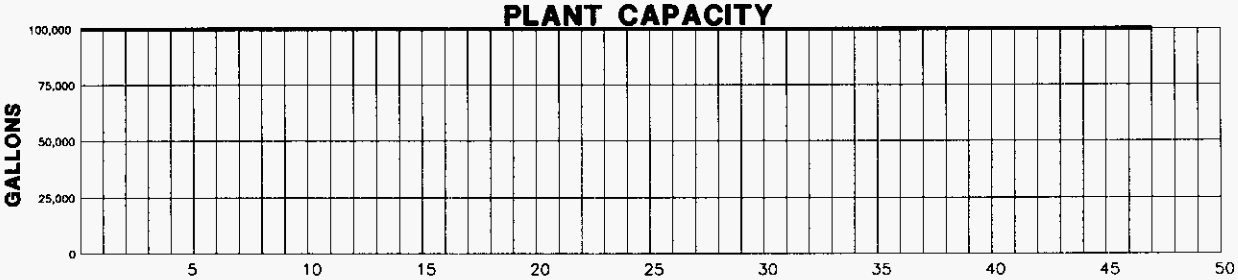
FACILITY DEMAND (25,000 TO 100,000 GPD) 3% GROWTH



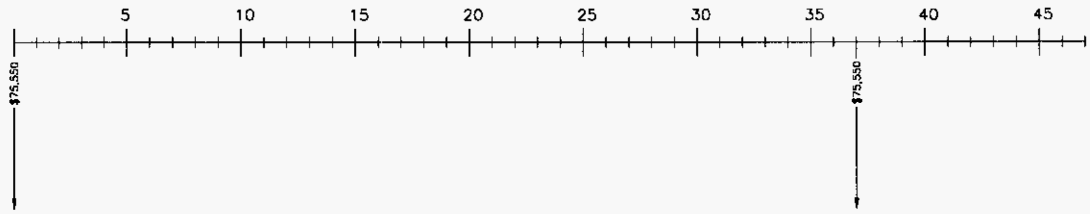
FACILITY PHASING SCHEDULE



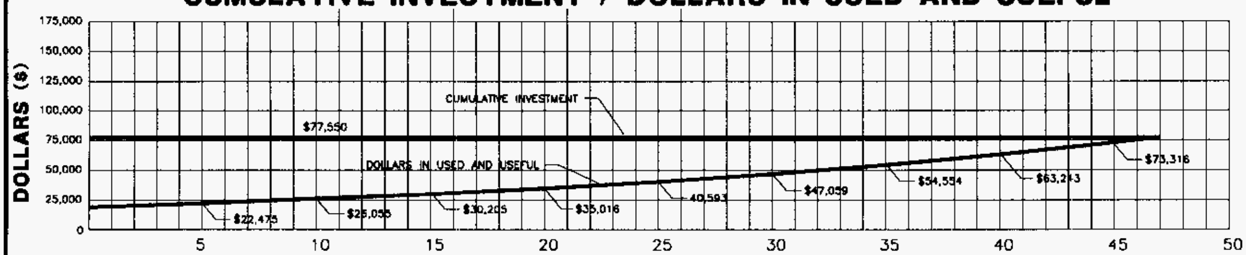
PLANT CAPACITY



CASH FLOW DIAGRAM (0% INFLATION)



CUMULATIVE INVESTMENT / DOLLARS IN USED AND USEFUL



PERCENT USED AND USEFUL

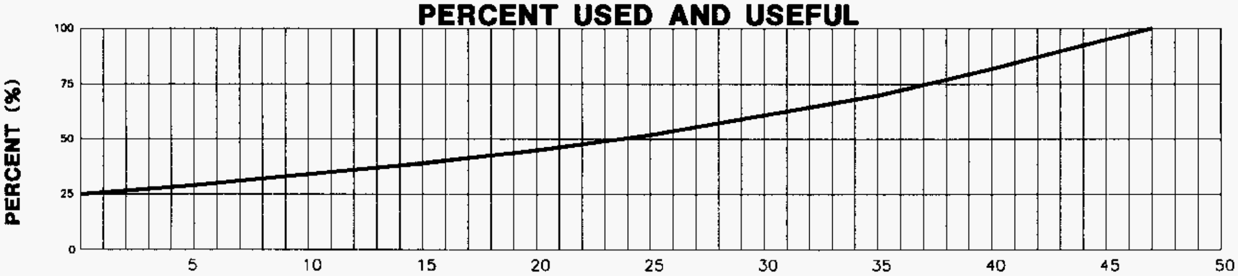


EXHIBIT GCH-6	EXPANSION USING 100,000 GAL. TANKS

COMMENTARY ON CUMULATIVE DOLLAR AND USED AND USEFUL COMPARISON BETWEEN UNIT SIZES

SUMMARY

THE TWO FIGURES ON THE FOLLOWING PAGES PLOT CUMULATIVE INVESTMENT MADE OVER TIME FOR VARYING TANK SIZES. THE FIRST FIGURE SHOWS INVESTMENT IN 25,000 AND 50,000 GPD TANKS AND USED AND USEFUL VALUES, ASSUMING 0% INFLATION AND 3% GROWTH. THE SECOND SHOWS INVESTMENTS IN 25,000 AND 50,000 GPD TANKS AND USED AND USEFUL VALUES, ASSUMING 0% INFLATION AND 10% GROWTH.

THE SHADED REGIONS ILLUSTRATE THE SAVINGS WHICH COULD BE REALIZED WITH THE USE OF LARGER TANKS.

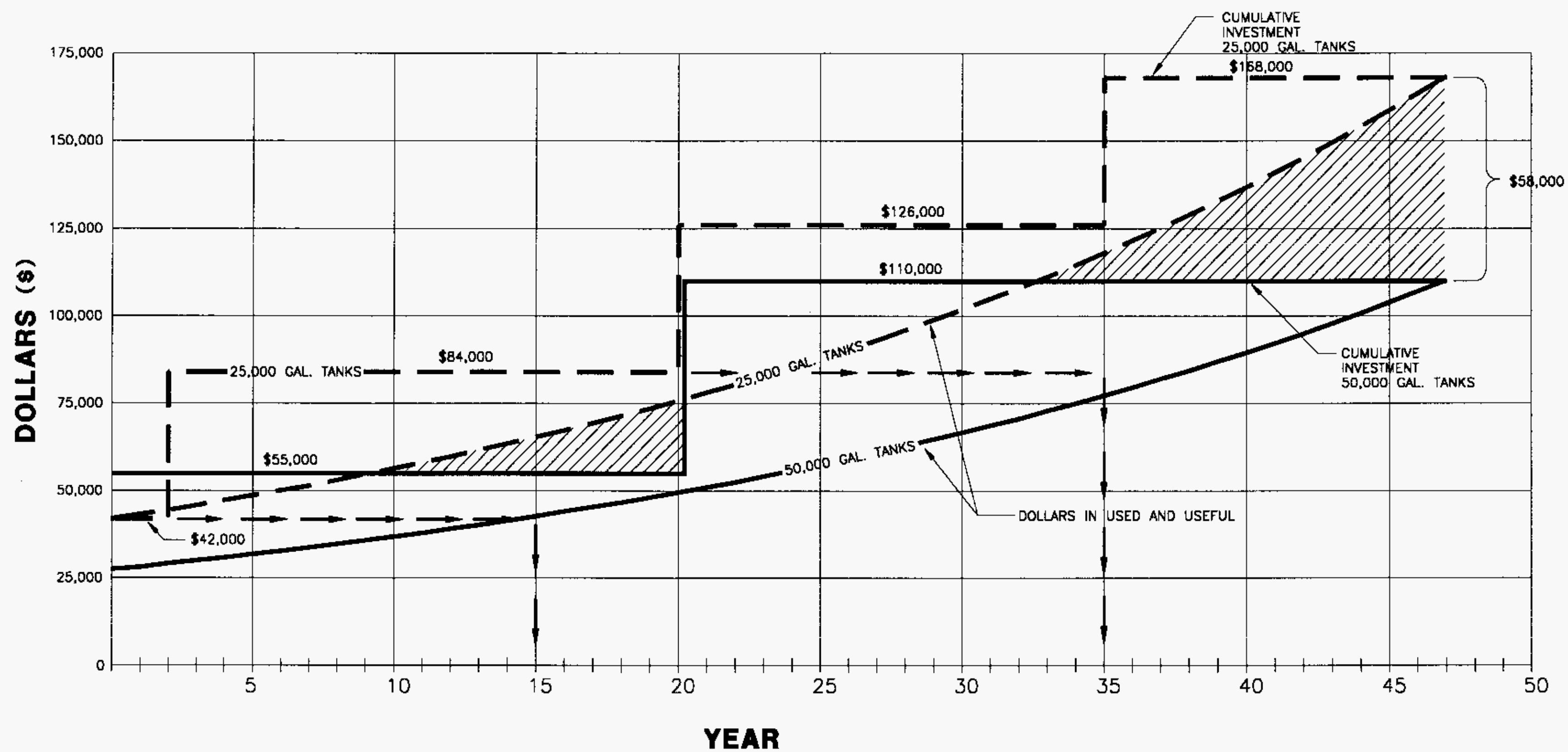
ON THE FIRST FIGURE, THE INITIAL COST OF THE 25,000 GALLON TANK IS $42,000. IF A LINE WERE EXTENDED TO THE RIGHT ALONG THE $42,000 VALUE, IT WOULD INTERSECT THE 50,000 GALLON USED AND USEFUL PLOT AT YEAR 15. SIMILARLY, IF THE $84,000 LINE WERE EXTENDED, IT WOULD INTERSECT THE 50,000 GALLON USED AND USEFUL PLOT AT APPROXIMATELY YEAR 35. THIS WOULD JUSTIFY

ESTABLISHING A 15-YEAR MARGIN RESERVE IN THIS EXAMPLE.

THE SECOND FIGURE ILLUSTRATES THE COST EFFECT OF BUILDING 25,000 GPD TANKS OVER TWO- AND FIVE-YEAR INCREMENTS VERSUS BUILDING A 100,000 GPD TANK AND UTILIZING A 15-YEAR MARGIN RESERVE. AS THE GRAPH ILLUSTRATES, BUILDING IN 25,000 GPD INCREMENTS RESULTS IN OVER TWICE THE COST AS BUILDING THE 100,000 GPD TANK OVER A 15-YEAR MARGIN RESERVE PHASE, WITH SAVINGS BEGINNING AS EARLY AS YEAR SEVEN.

CONCLUSION

THE FIGURES ILLUSTRATE THAT SIGNIFICANTLY HIGHER COST IS ATTRIBUTED TO EXPANSION WITH SMALLER TANKS UNDER BOTH SCENARIOS. WITH HIGHER GROWTH RATES, LARGER CAPACITY UNIT PHASING IS MORE ECONOMICAL.



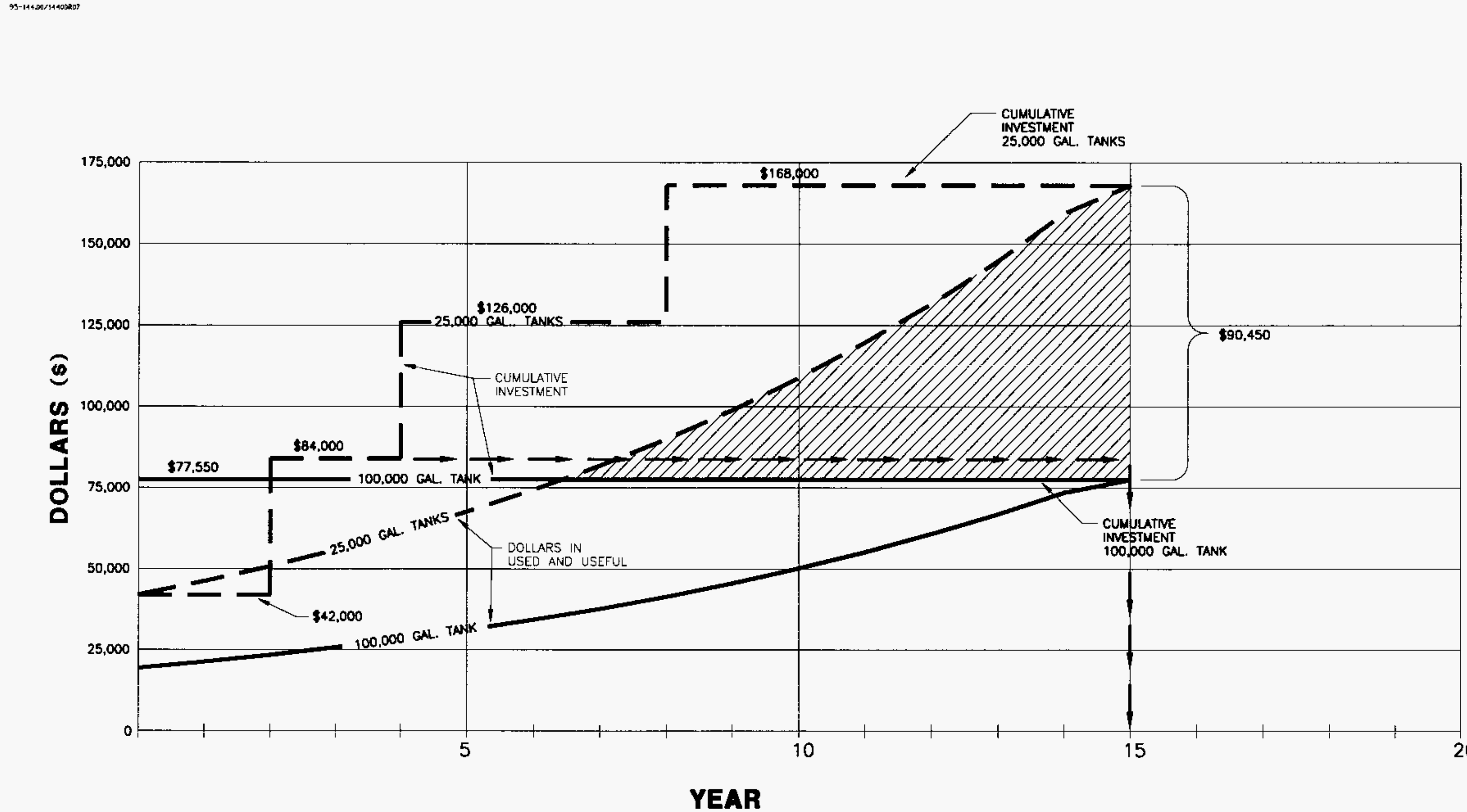
NOTE: 3% GROWTH RATE
0% INFLATION

= POTENTIAL $ SAVED BY USING 50,000 GAL. TANKS

EXHIBIT GCH-6	**CUMULATIVE INVESTMENT / DOLLARS IN USED AND USEFUL FOR EXPANSION WITH 25,000 GAL. TANKS AND 50,000 GAL. TANKS**

EXHIBIT GCH-6

PAGE 10 OF 19



NOTE: 10% GROWTH RATE
0% INFLATION

= POTENTIAL $ SAVED BY USING 100,000 GAL. TANK

EXHIBIT GCH-6	**CUMULATIVE INVESTMENT / DOLLARS IN USED AND USEFUL FOR EXPANSION WITH 25,000 GAL. TANKS AND 50,000 GAL. TANKS**

COMMENTARY ON COMPARISON OF COST PER ERC TABLES

SUMMARY

THE FOLLOWING TWO TABLES SHOW THE CUSTOMER COST SAVINGS ON AN ERC BASIS RESULTING FROM EXPANSIONS MADE WITH LARGER, RATHER THAN SMALLER TANKS WHEN USED AND USEFUL EQUALS NEEDED CAPACITY DIVIDED BY TOTAL CAPACITY. THE FIRST TABLE SHOWS SAVINGS FROM 50,000 GPD TANK VERSUS 25,000 GPD TANK EXPANSIONS, ASSUMING 3% GROWTH AND 0% INFLATION. THE SECOND SHOWS SAVINGS FROM 25,000 GPD TANK VERSUS 100,000 GPD TANK EXPANSIONS, ASSUMING 10% GROWTH AND 0% INFLATION.

CONCLUSION

THE LARGE TANK ALTERNATIVES PRODUCE ANNUAL SAVINGS PER ERC OF 53% AND 117%, RESPECTIVELY.

Comparison of Cost per ERC Based On
25,000 Gallon vs. 50,000 Gallon Tank Phasing Schedules — 0 % Inflation

			25,000-gal Tank Phasing				50,000-gal Tank Phasing					
Year	Demand (gpd)	Number of ERC's (1)	Cumulative Investment	Percent Used and Useful	Dollars Used and Useful	Annual Cost per ERC (2)	Cumulative Investment	Percent Used and Useful	Dollars Used and Useful	Annual Cost per ERC (2)	Annual Savings per ERC	Percent Savings
0	25,000	95	$42,000	100.0%	$42,000.00	$53.05	$55,000	50.0%	$27,500.00	$34.74	$18.32	53%
1	25,750	98	$42,000	103.0%	$43,260.00	$52.97	$55,000	51.5%	$28,325.00	$34.68	$18.29	53%
2	26,523	100	$84,000	53.0%	$44,557.80	$53.47	$55,000	53.0%	$29,174.75	$35.01	$18.46	53%
3	27,318	103	$84,000	54.6%	$45,894.53	$53.47	$55,000	54.6%	$30,049.99	$35.01	$18.46	53%
4	28,138	107	$84,000	56.3%	$47,271.37	$53.01	$55,000	56.3%	$30,951.49	$34.71	$18.30	53%
5	28,982	110	$84,000	58.0%	$48,689.51	$53.12	$55,000	58.0%	$31,880.04	$34.78	$18.34	53%
6	29,851	113	$84,000	59.7%	$50,150.20	$53.26	$55,000	59.7%	$32,836.44	$34.87	$18.39	53%
7	30,747	116	$84,000	61.5%	$51,654.70	$53.44	$55,000	61.5%	$33,821.53	$34.99	$18.45	53%
8	31,669	120	$84,000	63.3%	$53,204.34	$53.20	$55,000	63.3%	$34,836.18	$34.84	$18.37	53%
9	32,619	124	$84,000	65.2%	$54,800.47	$53.03	$55,000	65.2%	$35,881.26	$34.72	$18.31	53%
10	33,598	127	$84,000	67.2%	$56,444.49	$53.33	$55,000	67.2%	$36,957.70	$34.92	$18.41	53%
11	34,606	131	$84,000	69.2%	$58,137.82	$53.26	$55,000	69.2%	$38,066.43	$34.87	$18.39	53%
12	35,644	135	$84,000	71.3%	$59,881.96	$53.23	$55,000	71.3%	$39,208.42	$34.85	$18.38	53%
13	36,713	139	$84,000	73.4%	$61,678.42	$53.25	$55,000	73.4%	$40,384.68	$34.86	$18.38	53%
14	37,815	143	$84,000	75.6%	$63,528.77	$53.31	$55,000	75.6%	$41,596.22	$34.91	$18.40	53%
15	38,949	148	$84,000	77.9%	$65,434.63	$53.06	$55,000	77.9%	$42,844.10	$34.74	$18.32	53%
16	40,118	152	$84,000	80.2%	$67,397.67	$53.21	$55,000	80.2%	$44,129.43	$34.84	$18.37	53%
17	41,321	157	$84,000	82.6%	$69,419.60	$53.06	$55,000	82.6%	$45,453.31	$34.74	$18.32	53%
18	42,561	161	$84,000	85.1%	$71,502.19	$53.29	$55,000	85.1%	$46,816.91	$34.89	$18.40	53%
19	43,838	166	$84,000	87.7%	$73,647.25	$53.24	$55,000	87.7%	$48,221.42	$34.86	$18.38	53%
20	45,153	171	$126,000	60.2%	$75,856.67	$53.23	$110,000	45.2%	$49,668.06	$34.85	$18.38	53%
21	46,507	176	$126,000	62.0%	$78,132.37	$53.27	$110,000	46.5%	$51,158.10	$34.88	$18.39	53%
22	47,903	181	$126,000	63.9%	$80,476.34	$53.35	$110,000	47.9%	$52,692.84	$34.93	$18.42	53%
23	49,340	187	$126,000	65.8%	$82,890.63	$53.19	$110,000	49.3%	$54,273.63	$34.83	$18.36	53%
24	50,820	192	$126,000	67.8%	$85,377.35	$53.36	$110,000	50.8%	$55,901.84	$34.94	$18.42	53%
25	52,344	198	$126,000	69.8%	$87,938.67	$53.30	$110,000	52.3%	$57,578.89	$34.90	$18.40	53%
26	53,915	204	$126,000	71.9%	$90,576.83	$53.28	$110,000	53.9%	$59,306.26	$34.89	$18.39	53%
27	55,532	210	$126,000	74.0%	$93,294.14	$53.31	$110,000	55.5%	$61,085.45	$34.91	$18.40	53%
28	57,198	217	$126,000	76.3%	$96,092.96	$53.14	$110,000	57.2%	$62,918.01	$34.79	$18.35	53%
29	58,914	223	$126,000	78.6%	$98,975.75	$53.26	$110,000	58.9%	$64,805.55	$34.87	$18.39	53%
30	60,682	230	$126,000	80.9%	$101,945.02	$53.19	$110,000	60.7%	$66,749.72	$34.83	$18.36	53%
31	62,502	237	$126,000	83.3%	$105,003.37	$53.17	$110,000	62.5%	$68,752.21	$34.81	$18.36	53%
32	64,377	244	$126,000	85.8%	$108,153.48	$53.19	$110,000	64.4%	$70,814.78	$34.83	$18.36	53%
33	66,308	251	$126,000	88.4%	$111,398.08	$53.26	$110,000	66.3%	$72,939.22	$34.87	$18.39	53%
34	68,298	259	$168,000	68.3%	$114,740.02	$53.16	$110,000	68.3%	$75,127.40	$34.81	$18.35	53%
35	70,347	266	$168,000	70.3%	$118,182.22	$53.32	$110,000	70.3%	$77,381.22	$34.91	$18.41	53%
36	72,457	274	$168,000	72.5%	$121,727.69	$53.31	$110,000	72.5%	$79,702.65	$34.91	$18.41	53%
37	74,631	283	$168,000	74.6%	$125,379.52	$53.16	$110,000	74.6%	$82,093.73	$34.81	$18.35	53%
38	76,870	291	$168,000	76.9%	$129,140.91	$53.25	$110,000	76.9%	$84,556.55	$34.87	$18.39	53%
39	79,176	300	$168,000	79.2%	$133,015.13	$53.21	$110,000	79.2%	$87,093.24	$34.84	$18.37	53%
40	81,551	309	$168,000	81.6%	$137,005.59	$53.21	$110,000	81.6%	$89,706.04	$34.84	$18.37	53%
41	83,997	318	$168,000	84.0%	$141,115.75	$53.25	$110,000	84.0%	$92,397.22	$34.87	$18.38	53%
42	86,517	328	$168,000	86.5%	$145,349.23	$53.18	$110,000	86.5%	$95,169.14	$34.82	$18.36	53%
43	89,113	338	$168,000	89.1%	$149,709.70	$53.15	$110,000	89.1%	$98,024.21	$34.80	$18.35	53%
44	91,786	348	$168,000	91.8%	$154,201.00	$53.17	$110,000	91.8%	$100,964.94	$34.82	$18.36	53%
45	94,540	358	$168,000	94.5%	$158,827.03	$53.24	$110,000	94.5%	$103,993.89	$34.86	$18.38	53%
46	97,376	369	$168,000	97.4%	$163,591.84	$53.20	$110,000	97.4%	$107,113.70	$34.83	$18.37	53%
47	100,000	379	$168,000	100.3%	$168,499.59	$53.35	$110,000	100.3%	$110,327.11	$34.93	$18.42	53%

Notes:

(1) Based on a average day unit demand of 264 gpd.
(2) Calculated as follows : Cost per ERC = [(Dollars Used and Useful) * 0.12] / Number of ERC's.
(Assuming a 12 % rate of return with no adjustments made for taxes, etc.)

Comparison of Cost per ERC Based On
25,000 Gallon vs. 100,000 Gallon Tank Phasing Schedules
0 % Inflation

			25,000-Gallon Tank Phasing				100,000-Gallon Tank Phasing					
Year	Demand (gpd)(1)	Number of ERC's (2)	Cumulative Invested	Percent Used and Useful	Dollars Used and Useful	Annual Cost per ERC (3)	Cumulative Invested	Percent Used and Useful	Dollars Used and Useful	Annual Cost per ERC (3)	Annual Savings per ERC	Percent Savings
0	25,000	95	$42,000	100%	$42,000.00	$53.05	$77,550	25%	$19,387.50	$24.49	$28.56	117%
1	27,500	104	$42,000	110%	$46,200.00	$53.31	$77,550	28%	$21,326.25	$24.61	$28.70	117%
2	30,250	115	$84,000	61%	$50,820.00	$53.03	$77,550	30%	$23,458.88	$24.48	$28.55	117%
3	33,275	126	$84,000	67%	$55,902.00	$53.24	$77,550	33%	$25,804.76	$24.58	$28.66	117%
4	36,603	139	$126,000	49%	$61,492.20	$53.09	$77,550	37%	$28,385.24	$24.51	$28.58	117%
5	40,263	153	$126,000	54%	$67,641.42	$53.05	$77,550	40%	$31,223.76	$24.49	$28.56	117%
6	44,289	168	$126,000	59%	$74,405.56	$53.15	$77,550	44%	$34,346.14	$24.53	$28.61	117%
7	48,718	185	$126,000	65%	$81,846.12	$53.09	$77,550	49%	$37,780.75	$24.51	$28.58	117%
8	53,590	203	$168,000	54%	$90,030.73	$53.22	$77,550	54%	$41,558.83	$24.57	$28.65	117%
9	58,949	223	$168,000	59%	$99,033.80	$53.29	$77,550	59%	$45,714.71	$24.60	$28.69	117%
10	64,844	246	$168,000	65%	$108,937.18	$53.14	$77,550	65%	$50,286.18	$24.53	$28.61	117%
11	71,328	270	$168,000	71%	$119,830.90	$53.26	$77,550	71%	$55,314.80	$24.58	$28.67	117%
12	78,461	297	$168,000	78%	$131,813.99	$53.26	$77,550	78%	$60,846.28	$24.58	$28.67	117%
13	86,307	327	$168,000	86%	$144,995.39	$53.21	$77,550	86%	$66,930.91	$24.56	$28.65	117%
14	94,937	360	$168,000	95%	$159,494.93	$53.16	$77,550	95%	$73,624.00	$24.54	$28.62	117%
15	100,000	379	$168,000	100%	$168,000.00	$53.19	$77,550	100%	$77,550.00	$24.55	$28.64	117%

Notes :

(1) Growth Rate = 10 %.
(2) Based on a average day unit demand of 264 gpd.
(3) Calculated as follows : Cost per ERC = [(Dollars Used and Useful) * 0.12] / Number of ERC's.
(Assuming a 12 % rate of return with no adjustments made for taxes, etc.)

COMMENTARY ON PRESENT WORTH COSTS OF EXPANSIONS UNDER VARYING GROWTH AND ECONOMIC CONDITIONS

SUMMARY

THE FOLLOWING THREE PAGES OF FIGURES ILLUSTRATE THE PRESENT WORTH COSTS OF TANK EXPANSIONS ASSUMING DIFFERENT GROWTH RATES UNDER VARIOUS ECONOMIC CONDITIONS. EACH PAGE REFLECTS A DIFFERENT GROWTH RATE, 1%, 3% AND 5%, RESPECTIVELY. PRESENT WORTH VALUES ARE LISTED ACROSS THE BOTTOM OF EACH OF THE THREE FIGURES DISPLAYED ON A PAGE. THE PRESENT WORTH VALUES REPRESENT THE TOTAL COST TO THE UTILITY IN TODAY'S DOLLARS FOR INSTALLING STORAGE TANKS ONLY OF THE SIZE SHOWN IN THE ROW ABOVE PRESENT WORTH AND ASSUMING (1) THE ECONOMIC CONDITIONS OF THE TWO PRECEDING ROWS, AND (2) THE PHASING PARAMETERS AT THE TOP OF THE FIGURE, SUCH AS THE PROGRESSION FROM 25,000 GPD TO 100,000 GPD ON THE TOP FIGURE OF EACH PAGE. PRESENT WORTH VALUES VARY FROM ONE PAGE TO THE NEXT BECAUSE THE GROWTH RATES SPECIFIC TO EACH PAGE DICTATE THE TIMING OF THE TANK INSTALLATIONS. THE TANK PHASING OPTION WITH THE LOWEST TOTAL PRESENT WORTH ASSUMING THE CONDITIONS ABOVE IS ENCLOSED IN A BOX.

CONCLUSION

IN ALL CASES THE SMALLEST TANK ALTERNATIVE PRODUCES THE HIGHEST PRESENT WORTH COST.

95-14440/14460W06

PHASE: 25,000 GPD TO 100,000 GPD — LEFT OF INFLECTION POINT

Total present worth ($) by tank size (1000 gals.)

Inflation Rate (%)	Discount Rate (%)	25	50	100
0.00	5	$93,265	**$64,044**	$90,302
0.00	7	$85,121	**$59,499**	$83,894
0.00	9	$80,541	**$57,268**	$80,747
2.45	5	$114,997	**$77,146**	$108,776
2.45	7	$96,631	**$66,018**	$93,085
2.45	9	$87,090	**$60,553**	$85,380
5.00	5	x	x	x
5.00	7	$123,463	**$82,363**	$116,132
5.00	9	$101,277	**$68,791**	$96,995

PHASE: 50,000 GPD TO 150,000 GPD — TRANSITION

Total present worth ($) by tank size (1000 gals.)

Inflation Rate (%)	Discount Rate (%)	50	75	100
0.00	5	$122,134	**$88,071**	$90,302
0.00	7	$111,469	**$77,119**	$83,894
0.00	9	$105,469	**$71,740**	$80,747
2.45	5	$150,591	$119,648	**$108,776**
2.45	7	$126,541	**$92,829**	$93,085
2.45	9	$114,047	**$79,958**	$85,380
5.00	5	x	x	x
5.00	7	$161,676	$132,220	**$116,132**
5.00	9	$132,625	$99,510	**$96,995**

PHASE: 100,000 GPD TO 500,000 GPD — RIGHT OF INFLECTION POINT

Total present worth ($) by tank size (1000 gals.)

Inflation Rate (%)	Discount Rate (%)	100	250
0.00	5	$172,209	**$153,706**
0.00	7	$157,171	**$142,799**
0.00	9	$148,711	**$137,442**
2.45	5	$212,333	**$185,151**
2.45	7	$178,423	**$158,443**
2.45	9	$160,806	**$145,327**
5.00	5	x	x
5.00	7	$227,963	**$197,672**
5.00	9	$187,002	**$165,098**

EXHIBIT GCH-6 — 1% SYSTEM GROWTH RATE – PHASED EXPANSION OF STEEL GROUND STORAGE TANK

EXHIBIT (GCH-6)

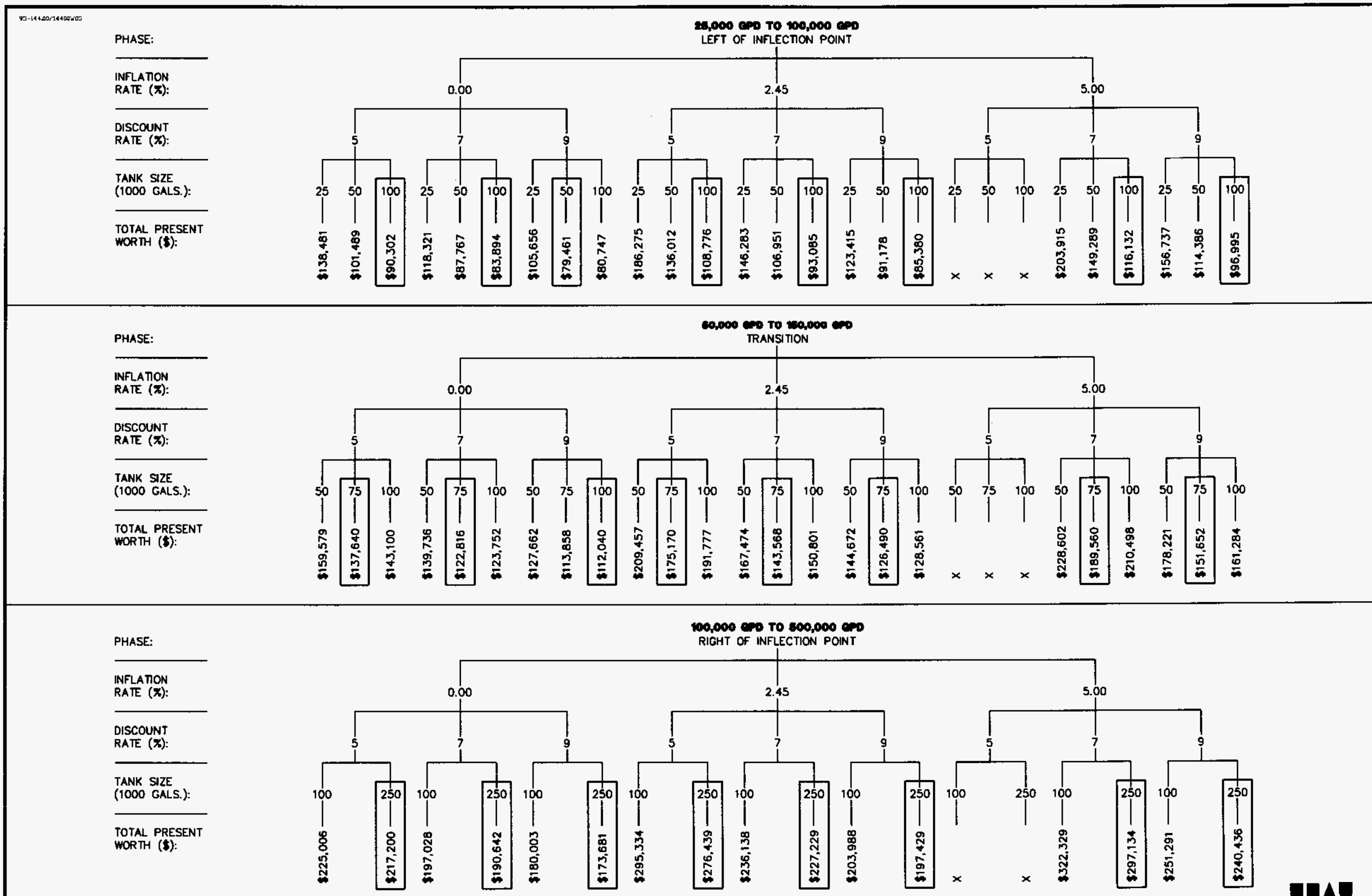


EXHIBIT GCH-6

5% SYSTEM GROWTH RATE - PHASED EXPANSION OF STEEL GROUND STORAGE TANK

EXHIBIT (GCH-6)

PAGE 18 OF 19

95-144.00/14400V04

PHASE: 25,000 GPD TO 100,000 GPD — LEFT OF INFLECTION POINT

INFLATION RATE (%)	DISCOUNT RATE (%)	TANK SIZE 25 (1000 GALS.) TOTAL PRESENT WORTH ($)	TANK SIZE 50 (1000 GALS.) TOTAL PRESENT WORTH ($)	TANK SIZE 100 (1000 GALS.) TOTAL PRESENT WORTH ($)
0.00	5	$116,411	**$84,773**	$90,302
0.00	7	$99,713	**$73,713**	$83,894
0.00	9	$89,971	**$67,081**	$80,747
2.45	5	$158,056	$110,783	**$108,776**
2.45	7	$123,093	**$89,082**	$93,085
2.45	9	$103,826	**$76,478**	$85,380
5.00	5	x	x	x
5.00	7	$173,583	$120,075	**$116,132**
5.00	9	$132,152	**$94,829**	$96,995

PHASE: 50,000 GPD TO 150,000 GPD — TRANSITION

INFLATION RATE (%)	DISCOUNT RATE (%)	TANK SIZE 50 (1000 GALS.) TOTAL PRESENT WORTH ($)	TANK SIZE 75 (1000 GALS.) TOTAL PRESENT WORTH ($)	TANK SIZE 100 (1000 GALS.) TOTAL PRESENT WORTH ($)
0.00	5	$134,660	**$117,860**	$119,530
0.00	7	$121,752	$105,388	**$103,935**
0.00	9	$113,374	$97,003	**$94,585**
2.45	5	$163,144	**$144,791**	$156,204
2.45	7	$139,504	**$122,469**	$125,605
2.45	9	$125,066	$108,628	**$107,834**
5.00	5	x	x	x
5.00	7	$173,038	**$154,127**	$169,305
5.00	9	$145,867	**$128,494**	$133,709

PHASE: 100,000 GPD TO 500,000 GPD — RIGHT OF INFLECTION POINT

INFLATION RATE (%)	DISCOUNT RATE (%)	TANK SIZE 100 (1000 GALS.) TOTAL PRESENT WORTH ($)	TANK SIZE 250 (1000 GALS.) TOTAL PRESENT WORTH ($)
0.00	5	$225,011	**$189,062**
0.00	7	$188,702	**$164,042**
0.00	9	$168,254	**$150,327**
2.45	5	$319,505	**$253,116**
2.45	7	$239,858	**$199,279**
2.45	9	$197,521	**$170,095**
5.00	5	x	x
5.00	7	$355,655	**$276,981**
5.00	9	$260,208	**$213,200**

EXHIBIT GCH-6 | 3% SYSTEM GROWTH RATE - PHASED EXPANSION OF STEEL GROUND STORAGE TANK

EXHIBIT (GCH-6)

RE: A METHOD TO EVALUATE A WATER UTILITY

BY: WILLIAM A. BECKER AND WILLIAM C. FLOWERS
AUGUST 25, 1975

1.00 Information from a recent rate case is used in this example. Most of the following information was obtained by onsite investigation of the utility. This phase is very important since the investigating engineer can obtain much information about the physical plant and the operation of the utility that does not appear on a cold fact sheet.

1.01 A full treatment plant rate @ 1.0 MGD

1.02 Raw Water Source - Three 8" wells rated @ .72 MGD each for a total of 2.16 MGD

1.03 Ground Storage - 1.0 MGD Prestressed concrete tank

1.04 Clearwell - 10,000 Gallon Capacity

1.05 High Service Pumps - 1 @ 700 GPM - 1 @ 1400 GPM and 1 @ 2100 GPM

1.06 Test year - A maximum of 1000 ERC's on line

1.07 Growth - Annual report for following year shows 300 ERC's added. If this information is not available, use 10% for Following year.

1.08 Fire Flows - Single family residence area 500 GPM - Multi-family and commercial area 1250 GPM - by local ordinance

2.00 Evaluation - from the preceding information, make these assumptions:

(a) Single family area fire flows four hours sustained (by ordinance)

(b) Multi-family and commercial area fire flows sustained four hours (by ordinance)

(c) Clearwell capacity is insignificant for reserve

(d) Use .243 GPM/ERC/Day to establish average day pumping(24 hr)

(e) Use .364 GPM/ERC for average 16 hr day (150% x 24 hr. flow)

(f) Use .55 GPM/ERC/Day to establish maximum day pumping

(g) Use 1.1 GPM for maximum hr. (200% maximum day)

(h) Use 150% average Day pumping for 16 hour demand

(i) Use ½ high service capacity for emergency

(j) Think "economy of size" in final analysis

2.01 Calculate average day demand for reference

.243 x 1000 x 1440 = 349,920 gallons

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(i) Use ½ high service capacity for emergency

(j) Think "economy of size" in final analysis

2.01 Calculate average day demand for reference

.243 x 1000 x 1440 = 349,920 gallons

2.02 Calculate average 16 hour day for reference, and check on average day - .364 x 100 x 960 = 349,920 gal.

2.03 Calculate maximum day demand to establish a maximum baseline for test year - .55 GPM x 1000 ERC's x 960 = 528,000 gal.

2.04 Calculate maximum day demand for 1 year's growth to determine need for expansion - .55 GPM x 1300 ERC's x 960 = 686,400 gal.

2.05 Calculate maximum hour demand (200% max. day) -

2.0 x 528,000 = 1,056,000 gal.

2.06 Calculate four hour peak demand -

1.1 GPM x 1000 ERC's x 240 min. = 264,000 gal.

2.07 Calculate four hour peak demand @ 1 year's growth

264,000 x 130% = 343,200 gallons

2.08 Calculate four hour fire flow - Use 1250 GPM overriding 500 GPM - 1250 GPM x 240 Min. = 300,000 gal.

2.09 Determine total four hour peak demand

Domestic peak demand - 264,000 gal.

Four hour fire flow - 300,000 gal.

Assumed Utility Plant use - 20,000 gal.

Maximum 4 hour peak demand- 584,000 gal.

2.10 Calculate Maximum high service @ 4 hour pumping rate

2100 GPM x 240 Min. = 504,000 gal.

2.11 Calculate 4 hour plant throughput

1.0 MGD = 695 GPM x 240 Min. = 166,800 Gal.

2.12 Determine if 4 hour maximum is available

Ground Storage -	1,000,000 gal.
Plant throughput -	166,800 gal.
4 hr. total available water	1,166,800 gal.

2.13 Calculate 16 hour plant throughput

695 GPM x 960 Min. = 667,200 gal.

2.14 Determine if throughput and ground storage are sufficient for 16 hour demand -

16 hr plant throughput	- 667,200 gal.
Ground storage	- 1,000,000 gal.
16 hr total water avail.	- 1,667,200 gal.

2.15 Determine if high service pumping is sufficient for 16 hour maximum and fire flow -

16 hr max. flow - 528,000÷960 min.	=550 GPM
Fire Flow	=1,250GPM
Total pumping demand in 16 hr per.	=1,800GPM

3.00 Actual usage from plant records - Max. day-May-finished water 617,000 gal.

3.01 ~~Max.~~ MIN. Day - August - 168,000 Gal.

3.02 Calculate average day

Max. Column Total 4863 ÷ 12 = 405,000 Gal.

3.03 Calculate Max. usage/ERC

617,000 ÷ 1000 ERC = 617 Gal/Day

3.04 Calculate Min. usage/ERC

168,000 ÷ 1000 ERC = 168 Gal/Day

3.05 Calculate average usage/ERC

405,000 ÷ 1000 ERC = 405 Gal/Day

3.06 Calculate excess % of Max. Day over H/D allowable of 350 Gal.

617-350 = 267 ÷ 350 = 76% More

3.07 Calculate excess % of average

405-350 = 55 ÷ 350 = 16% more

3.08 1974 max. day - April - 1,101,000 Gal.

1974 Max. Day - July - 370,000 Gal.

3.09 1975 Max. Day - Feb. - 959,000 Gal.

1975 Max. Day - April - 245,000 Gal.

3.10 Calculate actual demand on system using average day of 405,000 Gal.

Max Day 225% x 405,000 = 911,250 Gal.

3.11 10% Growth - 911,250 + 91125 = 1002375

3.12 20% Contingency - Utility use, line Breaks Etc.

1002375 + 200475 = 1,202,850

4.00 Conclusions and recommendations

4.01 Item 2.03 - Test year - Plant capacity is sufficient

.53 MGD ÷ 1.0 MG = 53% capacity

4.02 Item 2.04 - An expansion program is indicated

300 ERC's brings plant demand to 686,400 Gallons (Approx. 70%)

4.03 Item 2.09 and 2.12 four hour peak demand is within plant capability using ground storage - 584,000 gal. required vs 1,166,800 available

4.04 Item 2.10 and item 2.15 - High service pumping would be deficient at worst possible condition of a 4 hr peak domestic demand and fire flow, but is more than adequate for 16 hr. max. and fire flow - 1800 GPM demand vs 2100 GPM available - This is a very flexible pump combination.

4.05 Items 2.10 and 2.12 - Plant throughput and ground storage sufficient for 16 hour demand by a comfortable margin - 1,188,000 gal. demand vs 1,667,200 gal. available.

EXHIBIT (GCH-7)

PAGE 5 OF 17

4.06 There is an apparent excess of ground storage capacity, however, with the "economy of size" concept, the capacity was doubled for approximately 25% more cost.

WAB:kg

9/17/75

M E M O R A N D U M

November 14, 1982

TO : DALE A. KNAPP, DIRECTOR, WATER AND SEWER DEPARTMENT

FROM: J. O. COLLIER, ASSISTANT DIRECTOR, WATER AND SEWER DEPARTMENT

RE : USED AND USEFUL DETERMINATIONS - WATER AND SEWER CASES
PROJECT WE-81-11-012

Our most recent research and restudy of the used and useful determinations made in water and sewer cases is complete.

The result is a composition of methodology and standards. This composition is intended to guide each person making a used and useful determination in a professional and consistent manner. It is proposed that the resultants from the engineer's used anduseful calculations be noted on pre-prepared data sheets and presented with each docketed case. These data sheets will provide a clear accountability for the key computations and adjustments made as a result of the computations.

The Florida Waterworks Association has expressed a desire to participate in discussions of this subject with the Commissioners when it is scheduled for their consideration.

JOC/w
Attachments

USED AND USEFUL DETERMINATIONS IN WATER AND SEWER CASES

INTRODUCTION

The Commissioners, in considering water and sewer cases at agenda conferences, have voiced concern over the seeming lack of consistency in used and useful computations. Several attempts were made to clarify individual measurement terms used that were confusing to the Commissioners and the Administrative staff.

A presentation was made by the Water and Sewer staff at the May 3, 1982 Internal Affairs conference with the Commissioners. This meeting clearly brought to light the ambiguities that the Commissioners were facing in understanding the methodology used in making used and useful determinations.

This Internal Affairs conference served well to identify those specific concerns and to provide guidance in our efforts to design an understandable working formula in determining used and useful plant for rate-making purposes.

The Commissioners have expressed a desire for a "formula". Naturally we all visuali a formula as a fixed procedure with little or no room for flexibility which is so necessary in used and useful determinations.

We have interpreted the need of a formula to be a requirement to establish and identify key standards applied in used and useful determinations. These standards are expected to be constant and utilized in a step by step manner so that any necessary deviation can be readily recognizable and properly judged by the Commissioners.

To solidify these standards and avoid future conflicts we have thoroughly researched those that are proposed to be utilized with the Department of Environmental Regulation and the Florida Waterworks Association. This will assure consistency and less variables in used and useful determinations.

An identifiable basis and legal authority should be established. This we have provided through research and interpretation of applicable law and rules and regulations.

METHODOLOGY

The engineering investigation develops the necessary information used in making the used and useful determinations. The steps taken in this process are as follows:

1) Accomplish a complete evaluation and inventory of plant and system components.

2) Make a study of the service area, numbers and types of customers.

3) Make a comprehensive review and analysis of plant operational data.

4) Make an evaluation of the capacity of the existing plant and system.

5) Make an economy of scale and prudency determination regarding the design and construction of the plant and system.

6) Complete a study of the past and future utility customer growth.

Having completed these essential actions the Engineer should have all of the necessary information upon which to base his conclusions and computations. The standard used in applying and measuring this information are listed later in this document.

A single formula which would be totally usable in all cases is not feasible as we previously mentioned. However, a very simplified formula is noted here to illustrate the functions of key considerations in determining the percentage of a plant or system to be used and useful.

TREATMENT PLANT FORMULA

Components

1) Capacity of plant in gallons per day

2) Maximum daily flow in test year in gallons per day

3) Average daily flow in test year in gallons per day

4) Fire flow requirements in test year in gallons per day

5) Margin reserve in gallons per day

6) Excessive infiltration or excessive unaccounted for Water in gallons per day

Formula - Water Plant - $\frac{[(2 + 5) + 4] - 6}{1}$ = % used and useful

Formula - Sewage Treatment Plant - $\frac{(3 + 5) - 6}{1}$ = % used and useful

Note: Gallons per day shall be expressed in thousands

Water Transmission or Sewage Collection System Formula

Components

1) Capacity of system in ERCs

2) Number of connections during test year in ERCs

3) Margin reserve in ERCs

Formula

$\frac{2 + 3}{1}$ = % used and useful

Note: ERCs = Equivalent Residential Connections

It should be noted that in some cases this percentage would not apply to all of the NARUC accounts covering plant and systems. Some plant components are not capacity oriented and therefore would be 100% used and useful. Therefore, the Engineer will designate those accounts that are 100% and justify this reasoning.

Attached are data sheets which would show the final computations for used and usefu They would be available to be included with staff recommendations for agendas.

STANDARDS

The standards used must be consistent in use and set in quality. Consistency will facilitate identification of variances when required. Definitive standards insure fairness and quality of determinations.

All of the standards utilized are arranged in an alphabetical glossary for referenc Selected critical and most readily used standards are mentioned as follows:

1. AVERAGE DAILY FLOW - An average of the daily flows during the peak usage month during the test year. Care should be exercised to be sure the flow data is not influenced by abnormal infiltration due to rainfall periods.

2. CAPACITY 1) General - The quantity that can be contained exactly, or the rate of flow that can be carried exactly. The load for which a machine, apparatus, station or system is rated.

   2) Treatment Plants - The hydraulic rated capacity expressed in "thousands gallons per day".

   3) "Water Distribution and Sewage Collections Systems" - The capacity in terms of ability to serve a designated number of Equivalent Residential Connections. The capacity then can be related to actual connected density in terms of ERCs.

3. EQUIVALENT RESIDENTIAL CONNECTION - A basic design criteria tool. Based on 100 gallons per day per person. A single family connection is considered to serve 3.5 persons @ 100 gpdc which makes the ERC equate to 350 gallons per day. Other types

of connections have different flow characteristics and can be equated to ERC Equivalencies. For example:

ERC EQUIVALENTS

Single Family	1.0	@	350 GPD
Duplex or Triplex	0.86	@	300 GPD
Townhouse	0.86	@	300 GPD
Mobile Home	0.86	@	300 GPD
Apartment	0.71	@	250 GPD

4. FIRE FLOW CAPABILITY - A recognition of the utilities' ability to furnish fire protection for their customers' general protection. The standards will be those as set by the Insurance Service Organization or by a governmental agency ordinance. The minimum standards to date are 500 gpm in residential areas for a two hour period or 1500 gpm for a four hour period when customers are a mix of residential and sizeable commercial connections. Higher standards can prevail in higher density conditions.

   Fire-flow capabilities are usually calculated over and above maximum daily requirements. Therefore, any water system that provides fire protection capacity over and above maximum daily consumptive needs should be reimbursed for the cost of the excess capacity, which it cannot use for the sale of revenue producing water. The excess capacity is determined from the formula; water supply capacity - Maximum Daily Consumption Rate.

   Note: The excess capacity for fire capability shall not exceed the needed fire flow requirements.

5. INFILTRATION - The quantity of groundwater that leaks into a pipe through joints, porous walls or breaks. This amount is measured above the peak sanitary flows. Sanitary sewers are designed to carry unavoidable amounts of groundwater infiltration or seepage in addition to the peak sanitary flows. Infiltration specificatior are generally in the range of 250 to 500 gallons per day/inch diameter/mile. The standard reference used is Water Pollution Control Federation Manual or Practi

No. 9 entitled "Design and Construction of Sanitary and Storm Sewers". This is a joint preparation of the WPCF and the American Society of Civil Engineers.

6. MARGIN RESERVE - A proportionate share of the existing treatment facilities or water distribution system or sewage collection system. This share is intended to afford the utility the ability to accept additional connections as noted in 367.111. Plants cannot be constructed rapidly and economically to always just have the capacit to serve only the test year customers. There will more often always be some excess capacity available.

   Margin reserve is to recognize an appropriate and fair amount of "readiness to serve capacity" and not to unjustly burden the existing customers with an unnecessar amount of excess plant in rate base.

   To determine margin reserve the yearly growth rate in ERCs is averaged for the most recent 5 year period. A construction period necessary to add capacity to the existing facilities is established. Then the growth rate in ERCs for the constructi period is developed as the margin reserve. A representative construction period is 18 months for an average treatment plant and 12 months for collection and distributi systems but can vary depending on many facets to be considered by the Engineer. Generally margin reserve should not be permitted to exceed 15-20% of plant serving existing customers.

7. MAXIMUM DAILY FLOW - An average of the 5 days with the highest pumpage rate from the month with the highest pumpage rate during the test year. These five days should be verified against fire, line breaks or other unusual occurances that would effect the pumpage rate.

8. PRUDENCE - Care, caution and good judgment as well as wisdom in looking ahead. Examples of an imprudent investments in water or sewer facilities would be:

   a. Economies of scale were not considered
   b. Present customers would be burdened for considerable future periods
   c. Mismanagement of construction
   d. Improper engineering input
   e. Excessive construction costs

9. UNACCOUNTED-FOR-WATER - Water that is taken from a source into a distribution system which is not delivered to the customers or otherwise accounted for.

The proper amount of unaccounted-for-water in any given system is a function of that system alone. A fair average of unaccounted-for-water might be 10-20 percent for ful metered systems with good meter maintenance programs and average conditions of service.

The standard reference used is Amercian Waterworks Association Manual No. 8 entitled "Water Distribution Training Course".

Note: All technical terms used in the used and useful determinations will adhere to the Glossary, Water and Wastewater Control Engineering. This Glossary is a joint publication of the American Public Health Association, American Society of Civil Engineers, American Waterworks Association and Water Pollution Control Federation. This will insure consiste in terminology and definition.

CONSIDERATIONS IN EVALUATING PLANTS AND SYSTEMS

Preparing to apply the aforementioned criteria and formula to a used and useful conclusion will require a considerable amount of technical judgment and appraisal. The following are items to be considered during the Engineer's evaluation of data and utility systems.

1) Design criteria imposed by the State, Local and Federal Regulatory Agencies.
2) The requirements of the community to meet the needs of the public for safe, adequate, sufficient, responsive and economic service to serve all those that apply.

   Such factors shall include but not be limited to peak demands, fire flows, connection to regional systems, sizes of mains, type of construction, pollutior control, air and ground and service waters, availability of service and any other demand of the community affecting the utility.
3) Regulatory requirements for standby wells, emergency power and other standby facilities should be considered used and useful.
4) Any facility required to be installed by a regulatory agency other than lines

required by real estate regulatory agencies, should be considered used and useful.

5) Actual operating data shall be utilized in computations when available and reliable. Accepted design criteria shall be used in the absence of experienced, historical data.

6) Marginal reserves should be determined on a case by case basis considering all the factors of community needs, lead time for managerial decisions, engineering, construction and regulatory approvals.

7) The utility should have capacities sufficient to allow for down time for maintenance of portions of its plant.

8) Seasonal variations should be taken into account for population changes, occupancy rates, infiltration or usage variations.

9) Safe withdrawal levels from water wells for prevention of salt water intrusion and all other safe well levels of operation shall be considered.

10) When determining required storage capacity consideration should be given to peak hour and fire flow requirements.

11) An economy of scale cost determination should be made and compared to hydraulic share cost allocation.

12) A formula for the very small systems is often very difficult or impossible to apply. It requires a great amount of flexibility to develop reasonable allocations which will result in reasonable rates to the customers.

CONCLUSIONS

The sole purpose of this presentation is to provide standards and formulization for an engineering determination. There will no doubt be cases where other rate-making philosophies and concepts will be considered. None of these have been considered here because the variables that would be involved are too numerous.

Application of these foregoing standards and methodology will provide for a consistent and equitable engineering evaluation of the plant and system necessary to render safe and efficient service to the utility's customers.

WATER TREATMENT PLANT — USED AND USEFUL DATA

Docket No. ____________ Utility ____________ Date ________

1) Capacity of Plant ____________ gallons per day

2) Maximum Daily Flow ____________ gallons per day

3) Average Daily Flow ____________ gallons per day

4) Fire Flow Capacity ____________ gallons per day

a) Needed Fire Flow ____________ gallons per day

5) Margin Reserve ____________ gallons per day
*Not to exceed 20% of present customers

a) Test Year Customers in ERC's - Begin ________ End ________ Av. ________

b) Average Yearly Customer Growth in ERC's For Most Recent 5 Years Including Test Year ________ ERC's

c) Construction Time for Additional Capacity ________ Years

$$(b) \times (c) \times \left[\frac{2}{(a)}\right] =$$ ____________ gallons per Day Margin Reserve

6) Excessive Unaccounted for Water ____________ gallons per day

a) Total Amount ____________ gallons per day ________ % of Av. Daily Flow

b) Reasonable Amount ____________ gallons per day ________ % of Av. Daily Flow

c) Excessive Amount ____________ gallons per day ________ % of Av. Daily Flow

PERCENT USED AND USEFUL FORMULA

$$\frac{\left[(2 + 5) + 4a\right] - 6}{1} =$$ ________ % Used and Useful

WATER DISTRIBUTION SYSTEM USED AND USEFUL DATA

Docket No. ____________ Utility ____________ Date ____________

1) Capacity ____________ ERC's (Number of potential customers without expansion)

2) Number of Test Year Connections ____________ ERC's

a) Begin Test Year ____________ ERC's

b) End Test Year ____________ ERC's

c) Average Test Year ____________ ERC's

3) Margin Reserve ____________ ERC's
*Not to exceed 20% of present customers

a) Average Yearly Customer Growth in ERC's for Most Recent 5 Years Including Test Year ____________ ERC's

b) Construction Time for Additional Capacity ____________ Years

(a) X (b) = ____________ ERC's Margin Reserve

PERCENT USED AND USEFUL FORMULA

$\frac{2 + 3}{1}$ = ____________ % Used and Useful

____________ Engineer

SEWER TREATMENT PLANT USED AND USEFUL DATA

Docket No. ______________ Utility ______________________________ Date ______________

1) Capacity of Plant __________________ gallons per day

2) Maximum Daily Flow __________________ gallons per day

3) Average Daily Flow __________________ gallons per day

4) Fire Flow Requirements NOT APPLICABLE gallons per day

5) Margin Reserve __________________ gallons per day
*Not to exceed 20% of present customers

a) Test Year Customers in ERC's - Begin __________ End __________ Av. __________

b) Average Yearly Customers Growth in ERC's For Most Recent 5 Years Including Test Year __________________ ERC's

c) Construction Time for Additional Capacity __________________ Years

$$(b) \times (c) \times \left[\frac{3}{(a)}\right] =$$ __________________ gallons per day

6) Excessive Infiltration __________________ gallons per day

a) Total Amount __________ gallons per day __________% of Av. Daily Flow

b) Reasonable Amount __________ gallons per day __________% of Av. Daily Flow

c) Excessive Amount __________ gallons per day __________% of Av. Daily Flow

PERCENT USED AND USEFUL FORMULA

$$\frac{\left[(3) + (5)\right] - 6}{1} =$$ __________% Used and Useful

______________________________ Engineer

SEWAGE COLLECTION SYSTEM — USED AND USEFUL DATA

Docket No. ____________ Utility ______________________ Date ____________

1) Capacity ____________ ERC's (Number of potential customers without expansion)

2) Number of Test Year Connections ____________ ERC's

   a) Begin Test Year ____________ ERC's

   b) End Test Year ____________ ERC's

   c) Average Test Year ____________ ERC's

3) Margin Reserve ____________ ERC's
   *Not to exceed 20% of present customers

   a) Average Yearly Customer Growth in ERC's for Most Recent 5 Years Including Test Year ____________ ERC's

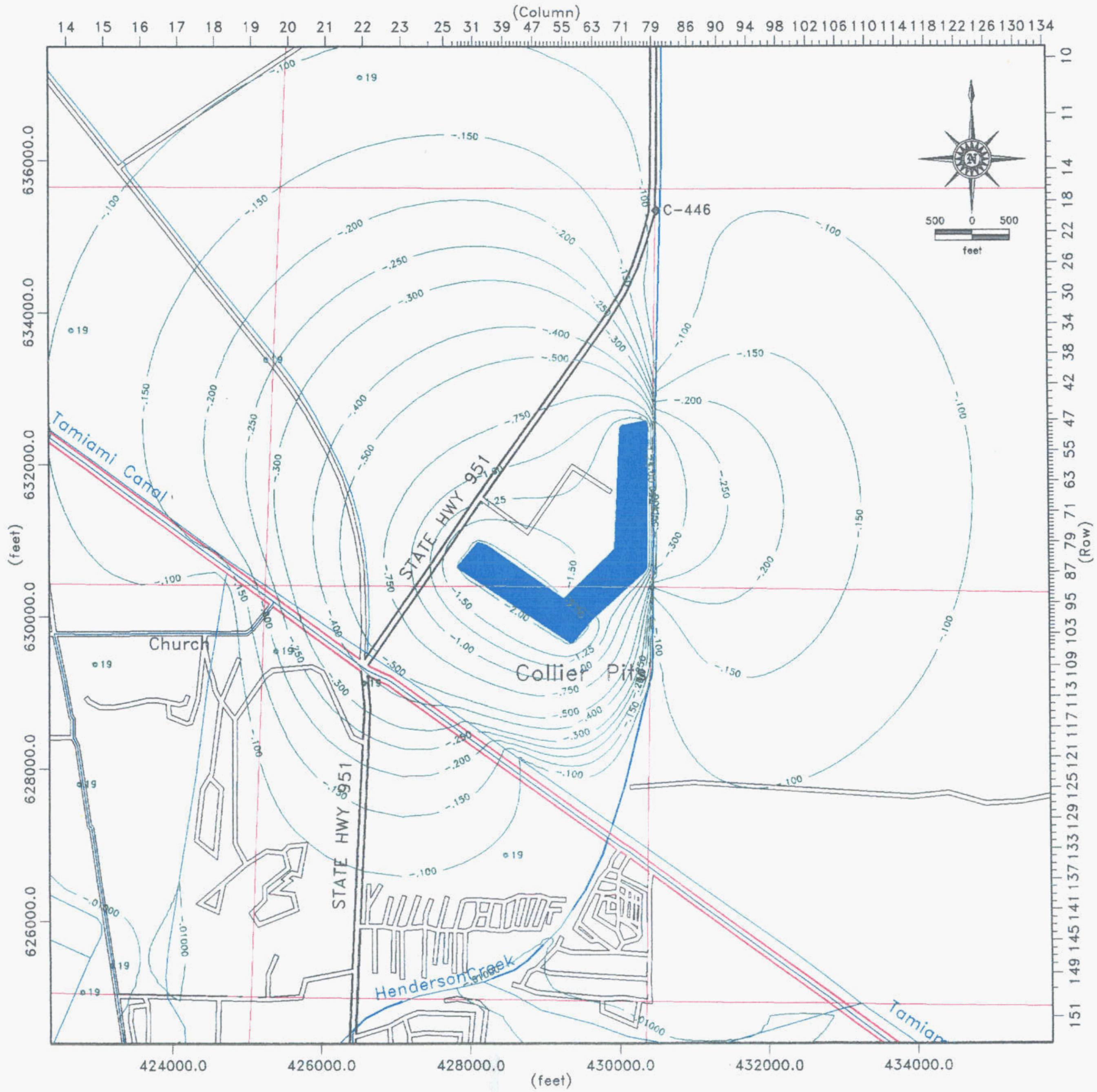
   b) Construction Time for Additional Capacity ____________ Years

   (a) X (b) = ____________ ERC's Margin Reserve

PERCENT USED AND USEFUL FORMULA

$\frac{2 + 3}{1}$ = ____________ Used and Useful

____________________ ____________ Engineer



Drawdown at 3.9 MGD During Wet Month

EXHIBIT GCH-8

PAGE 1 OF 3

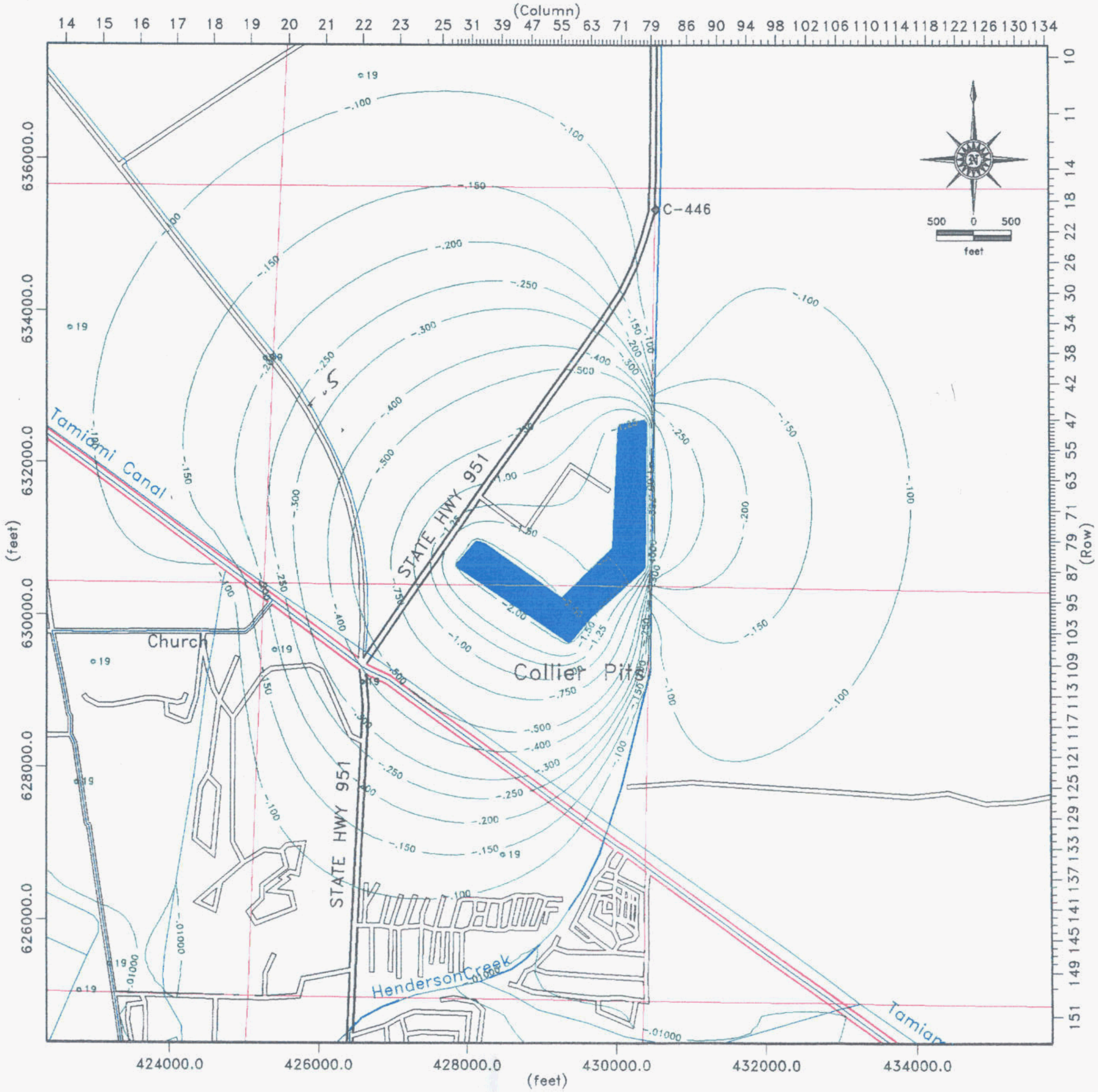


EXHIBIT GCH-8
PAGE 2 OF 3

Drawdown at 3.9 MGD During Dry Month

CAPTURE ZONES: 1 YR, 2YR, 5YR, 20YR

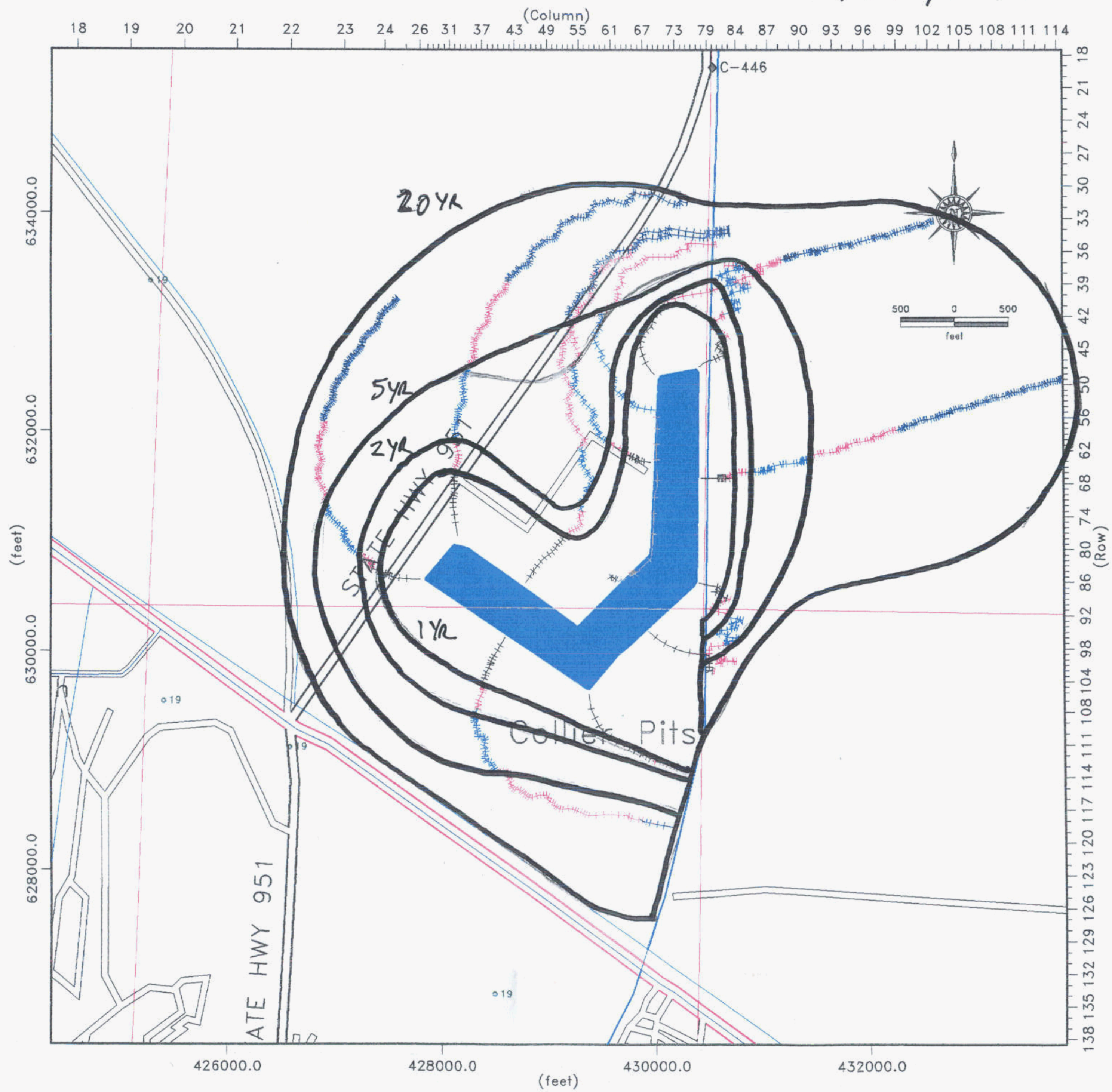


EXHIBIT GCH-8
PAGE 3 OF 3

EXHIBIT GCH-9

PAGE 1 OF 2

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July 20, 1995 HAI #94-025.00

Brian Armstrong, Esquire
General Counsel
Southern States Utilities, Inc.
1000 Color Place
Apopka, Florida 32703

Subject: **Case No. 94-0793-CA-01-CTC**
Engineering Comments Regarding the Settlement of Litigation

Dear Mr. Armstrong:

Our firm participated in the above-referenced case as technical expert witnesses and support on behalf of Southern States Utilities, Inc. (SSU). This letter addresses the technical merits of securing water resources for SSU's Marco Island and Marco Shores utility customers.

Previously, the source of water and the property upon which the water supply facilities, improvements, storage and pumping station facilities were built was controlled by the Colliers under a lease agreement. The Colliers refused to extend or renegotiate the lease for the existing water supply facilities. For several years, SSU attempted to obtain an appropriate raw water supply from the Colliers and others. Company efforts at the "Dude" property failed. Company efforts at the 160-acre lime sludge disposal site continue through the permitting process and remain difficult due to environmental concerns with respect to development. Collier County had only brackish water which is unsuitable for the Marco Shores and Marco Island lime treatment facilities. The Collier County cost of potable water service was prohibitively expensive. Finally, Collier County did not commit to serving the present and future needs. The only viable option left to the Collier property was the City of Naples regional facilities. Negotiations between SSU and the City of Naples continued until SSU determined that the cost and timing were comparatively less attractive than the continuance of the existing supply source.

A few factors influencing this decisions was that SSU would be

1) in perpetual control of its raw water supply source,

2) able to continuously serve the Company's customers, and

3) able to treat the source with existing facilities.

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In addition, the previous FPSC rate case found that the supply facilities were 100 percent used and useful. If the same functional use was maintained, then it is highly probable that the acquired property would also be 100 percent used and useful.

The Company condemned the property underlying the water supply facilities. In the course of the process, it was learned that the Colliers were claiming extensive damages and costs. The valuation, interim use, damages and costs were addressed by the Company's special counsel, appraisers and experts.

The settlement reached attains the goal of securing the raw water supply for the Company and provides reasonable terms and conditions which may not otherwise have been obtained.

I expect that the appraisers will provide to you the reasonableness of the purchase price and the attorneys the reasonableness of the acquisition costs. Our firm believes that the terms and conditions negotiated are superior to those anticipated as a result of litigation, and from an engineering and viability standing, the source of supply acquired is the optimal long-term source for SSU's Marco Island customer base, given the limited alternatives. Moreover, the annual resource lease cost is eliminated.

If you desire any other assistance in this regard, please do not hesitate to call us.

Very truly yours,

Hartman & Associates, Inc.

Gerald C. Hartman, P.E.
President

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