M&E®

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Engineers & Planners

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September 30, 1986

Mr. Harry Jackson, Superintendent
Augusta Sanitary District
Hospital Street
Augusta, ME 04330

Subject: Evaluation of Flow Allocation to the Winthrop Pump Station

Dear Mr. Jackson:

In accordance with our Amendment No. 2, dated August 20, 1986, to our Agreement for Professional Services, dated May 13, 1985, the following is our letter report summarizing our findings and recommendations concerning our Evaluation of Flow Allocation to the Winthrop Pump Station.

Introduction

Background. Carleton Woolen Mill is a major contributor of wastewater flow to the Inter-Community Trunkline of the Augusta Sanitary District. Changes in demand for fabric from Carleton have significantly increased the amount of wastewater generated by the wet processes. In 1984, Carleton was discharging an average of 680,000 gallons per day (gpd). Since this was in excess of their design allocation, Carleton arranged in 1985 to purchase flow capacity from the Winthrop Water District, increasing their average flow allocation to 800,000 gpd. In May 1986, Carleton again requested an increased flow allocation to an average of 1,200,000 gpd. In addition, Carleton requested an

increase in peak flow allocation so that they could match their pumping rate to the Winthrop Pump Station with the rate of inflow to their wastewater lagoons. Because of concerns over the capacity and instrumentation at the Winthrop Pump Station for handling the changes, the Augusta Sanitary District authorized Metcalf & Eddy, Inc., on August 20, 1986 to study the flow allocation to Winthrop Pump Station and report on the ways to meet Carleton's request. The capacity of the downstream facilities appear to be adequate to meet the additional flow allocation.

Approach to Problem. The existing allocation of average daily and peak flows for the three major contributors to the Pump Station were reviewed to ascertain the available allocation. The automatic pump control instrumentation was reviewed for possible modification. The Pump Station pumps, motors, and impellers were studied to determine if the pumping capacity could be increased. Flow equalization upstream of the Pump Station was evaluated.

Pump Station Characteristics

The Winthrop Pump Station, receives flow from Monmouth, Winthrop and Carleton Woolen Mill. The flow from Monmouth includes Tex Tech Industries, another woolen mill. The wetwell is 22 feet long by 9 feet wide by 15 feet deep, but only 7,900 gallons of wetwell storage volume are available at the high water level. Emergency overflow storage facilities, are available to hold up to 500,000 gallons of wastewater upstream of the pump station.

The wetwell capacity at the emergency storage overflow elevation is 13,200 gallons.

The Pump Station contains three sets of two Smith and Loveless Model 6D3A pumps driven by 60 HP, 1775 revolutions per minute (rpm) constant speed motors. Each pump set is capable of pumping 1,600 gallons per minute (gpm) against 208 feet total dynamic head (TDH). With two sets of pumps on line, the Station can pump approximately 2,600 gpm against approximately 238 feet TDH. The peak capacity of the pump station with three pumps operating would be approximately 3,000 gpm at a TDH of 250 feet, assuming a friction coefficient of C=120 (Attachment A). At present, instrumentation does not allow for the third set of pumps to come on. The third set is a manually actuated standby.

A Smith and Loveless differential pressure bubbler tube system is used to control the operation of the pumps. Mercury type pressure switches are used to activate the pumps. The wetwell was provided with lead, first lag, and second lag switches for activating all three sets of pumps; however, the necessary level for the second lag switch activation is above the wetwell level for overflow to the emergency storage. Thus, the emergency storage facilities would be initiated before the third pump set could ever be initiated with the existing instrumentation. This limitation could have a significant impact in the case of a lead or first lag pump failure, because the pump alternating circuits are unable to recognize the loss of a pump. The wetwell could overflow because of a pump failure, while a fully operable standby pump was available, but only by manual activation.

Flow Allocation

The original design flow allocation for the Pump Station is presented in Table 1. The average design flow of 1493 gpm and peak of 2528 gpm are very close to the one pump (1600 gpm) and two pump (2600 gpm) capacities of the Pump Station. No excess pumping capacity is available, so all changes in the average and peak flow allocation must come from transfers between the major contributors.

In 1985, Carleton increased their average flowrate allocation from 0.6 mgd to 0.8 mgd by purchasing 0.2 mgd of average flow allocation from the Winthrop Water District. No change in peak flow allocation was involved. Presently, Carleton is seeking to increase its average flow allocation to 1.2 mgd (See 5/14/86 letter in Attachment B), and its peak flow allocation to match the inflow to its lagoons. In practical terms, Carleton's peak flow rate will be dictated by their new pumping capacity. A peak flow rate of 1200 gpm (1.73 mgd) appears most likely (Frank Murphy, Personnel Communication, 6/16/86).

The historical data for average daily flowrates during the peak month coming into the Winthrop Pump Station for the past two years are summarized in Table 2. Both Winthrop and Monmouth (Including Tex Tech) are well below their average flow allocation. Winthrop Water District has agreed to meet all of Carleton's average flow request by selling from their allocation subject to the limitations of their 6/6/86 letter (Attachment B). This would bring Winthrop's remaining average flow

TABLE 1. DESIGN FLOW ALLOCATION

Contributor	Average Flow MGD	Average Flow gpm	Peak Flow MGD	Peak Flow gpm
Carleton	0.60	417	1.20	833
Winthrop	1.08	750	1.50	1,042
Monmouth (Inc. Tex Tech)	0.47	326	0.94	653
TOTAL	2.15	1,493	3.64	2,528

TABLE 2. AVERAGE DAILY FLOWRATES DURING PEAK MONTH

	Average Daily Flowrates During Peak Month			
	1984		1985	
	Month	Flow, MGD	Month	Flow, MGD
Monmouth (Incl. Tex Tech)	June	0.16	January	0.15
Winthrop	April	0.35	April	0.28
Carleton	March	0.94	March	0.71

allocation down to 0.48 mgd. This allocation appears to be sufficient for the near future. Thus, the transfer of an additional 0.4 MGD of average flow allocation from the Winthrop Water District to Carleton is not a problem.

The flow from Winthrop is comprised of a combination of gravity and pump station flows, so historical data must be used to establish peak flowrates. Table 3 displays the peak flow rates in excess of 600 gpm for the past 2 1/2 years. The charts from which these peak flows were determined are displayed in Attachment C. These data indicate that Winthrop has utilized it's peak flow allocation on several occasions. Winthrop's high

TABLE 3. INSTANTANEOUS PEAK FLOWS FROM WINTHROP

Date	Peak		Rainfall	
	gpm	MGD	Previous Day, inch	That Day, inch
12/7/83	830	1.20	1.1	0.7
12/14/83	800	1.15	2.9	0.4
4/5/84	1,000+	1.44+	No data	
4/25/84	710	1.02	No data	
4/27/84	760	1.09	No data	
5/5/84	670	0.96	1.2	--
5/31/84	1,000+	1.44+	3.0	--
6/26/84	870	1.25	2.1	0.5
2/13/85	710	1.02	--	1.78
3/12/85	800	1.15	--	1.59
4/17/85	660	0.95	0.1	--
5/8/85	660	0.95	0.5	--
8/1/85	610	0.88	--	1.14
8/9/85	600	0.86	--	--
1/27/86	1,000+	1.44+	2.1	0.33
3/19/86	750	1.08	--	0.87
5/24/86	620	0.89	--	0.88

peak flow rates are due to inflow/infiltration problems. Unless improvements to the collection system are made to decrease I/I, these peak flowrates are likely to reoccur in the future. Thus, Winthrop does not have any available peak flow allocation to transfer to Carleton.

The flowrate from Monmouth is dictated by the Steer House Pump Station which has two constant speed pumps with a combined capacity of 1000 gpm at 150 feet TDH. The Steer House Pump Station received flow from the North Monmouth Pump Station which has two 840 gpm constant speed pumps. The District has indicated that at times both of the Steer House Pumps come on line to meet the inflow from North Monmouth. This peak rate flow of 1000 gpm is in excess of the peak flow allocation of 653 gpm. The

Monmouth flume measures flows up to 500 gpm. Weekly charts displaying the regular occurrence of flows over 500 gpm are displayed in Attachment C. The charts are of interest because they display the cyclic nature of these peaks. If some flow equalization could be found upstream, the peak flowrate could be reduced significantly. However, no peak flow allocation is presently available for transfer from Monmouth to Carleton.

Alternatives

A variety of alternatives are available for meeting Carleton's peak flow allocation request including instrumentation changes, pump modifications, and flow equalization measures.

Instrumentation. The level control system in the Winthrop Pump Station Wetwell does not provide automatic activation of the second lag (standby) pump. A new pump control system will be necessary to provide reliable service with the heavier use. To correct the problems, it is recommended that the existing pump controls be replaced with a system as described below. This new system will allow more flexibility in setting start/stop elevations, pump alternation and the ability to adjust settings easily as future conditions change requirements.

The existing bubble tube and air supply will be reused. The backpressure sensed in the tube, which represents level, will be connected to a pressure transmitter. The output signal will be 4-20 mADC current directly proportional to wetwell level. A local indicator will display actual level in the wetwell at all times.

A purge line for the bubbler should be added if not already present. With this, the tube can be blown clean of sediment and accumulated coatings which might cause incorrect readings or a complete failure if totally plugged.

The 4-20 mADC current signal will be connected to a series of switches which will be assigned to function as start and stop contacts. These electronic switches are fully adjustable across the well level range, are very repeatable, and can be set precisely.

The switches would be assigned to start and stop the lead pump, lag pump, and the standby pump. Starting the standby pump would also initiate the high wetwell level alarm. The existing high level switch, a float type, would be retained as a redundant alarm.

Each pump would be equipped with an additional selector switch, assigning it to a lead/lag/standby position. Alternation of pump's service position will then become a manual operation, with selection based on run times, pump maintenance requirements and pump wear. The existing hand/off/automatic selectors and their functions would remain unchanged, as would the operation of the PARCO valve.

A back-up float switch at the bottom of the wetwell would stop all pumps on a low level which could damage the pumps and would be tied into the pump failure alarm. The pump failure alarm shall also be added to the telemetry system for annunciation at the Central Office Panel.

The estimated cost for the rehabilitation work is about $3500 installed. A schedule of about 10 weeks for procurement and implementation is expected. The actual on site work should not exceed 3 days for changeover, calibration and start-up. A minimal amount, maybe one night, of non-automated operation might be required during installation.

Pump Modifications. Modifications to increase the pumping capacity at the Winthrop Pump Station include changing the impeller diameter, motor, or the entire pumps. The peak capacity of the existing station, as previously stated, is approximately 2,600 gpm with two pump sets operating which corresponds to the peak flow allocation for the three contributors. The peak flow that is desired would be about 3,300 gpm as shown in Table 4. The alternatives available to increase the pumping capacity at the Winthrop pump station are discussed below.

1. Increase the impeller diameter of the existing pumps. Each Smith and Loveless Model 6D3A pump is fitted with a 12-inch diameter impeller which is the largest available for this

TABLE 4. PEAK FLOW FOR WINTHROP PUMP STATION

Source	Peak, gpm	Remarks
Carleton	1,200	Peak allocation requested.
Monmouth	1,000	Actual peak capacity.
Winthrop	1,042	
Total	3,242 gpm (3,300)	

pump model. Therefore, modifications can not be made to the pump impeller in order to provide additional pumping capacity.

2. Increase the motor horsepower. Currently, the pump motors are 60 HP and run at 1,775 rpm. Increasing the motor HP would increase the impeller speed. Metcalf & Eddy recommends that a pump not operate greater than 1,775 rpm when transporting sewage because of the increase in wear and tear to the pump components. Also, when pumps operate at high speeds, pump cavitation can be a potential danger. Cavitation reduces pump capacity and efficiency and can damage the pump.
3. Replace existing pumps to accomodate the peak flow of 3,300 gpm. This alternative may be restricted due to limitations in available dry well space. New pumps may require modifications to auxilliary equipment. The impact on downstream pump stations also would have to be reviewed. Nevertheless, replacing the pumps are a feasible alternative for provoiding increased peak flow capacity.

Flow Equalization. Methods for equalization of flow to the Winthrop Pump Station include building a larger wetwell, installing variable speed drives on various pump stations feeding Winthrop Pump Station, using Carleton's lagoons, using the emergency storage facilities, and pumping a portion of Carleton's flow directly into the 14-inch force main.

The existing wetwell has adequate volume, but, at present, the configuration does not provide adequate headboard before flooding the Monmouth flume or overflowing to emergency storage. The new electronic level switches included in the proposed instrumentation changes would overcome these problems with the wetwell. A large wetwell for flow equalization would have the advantage of making the pumping rate from Monmouth less significant than the total volume pumped. A detailed analysis of flow patterns in the Upper Trunkline would be necessary for proper design of the wetwell for reliable equalization. The retrofitting of the Pump Station may result in a significant amount of additional cost besides the new wetwell construction. Nevertheless, a new, large wetwell is a feasible alternative for meeting Carleton's peak flow request.

One way to reduce the peak flow from Monmouth would be to install variable speed drives on the North Monmouth and/or Steer House pumps. Variable frequency drives are the most likely choice. The drives could be used to reduce the flow rate to the peak flow allocation level or lower at a reasonable cost. A primary limitation to the degree that the peak flow can be reduced is the velocity in the force mains. The minimum acceptable flow rates for the North Monmouth and Steer House force mains are displayed in Table 5. The flowrate from North Monmouth Pump Station can only be reduced from 840 gpm to 734 gpm, so a variable speed drive would be of questionable benefit. The Steer House Pump Station flow can be reduced to as low as 470 gpm, so variable speed drives could be used to

TABLE 5. MINIMUM ACCEPTABLE FLOWRATES IN FORCE MAINS

Force Main	Diameter, Inches	Velocity, fps	Flowrate, gpm
North Monmouth	10	3	734
Steer House	8	3	470

attenuate the peak flow delivered to Winthrop Pump Station. The actual attenuation possible is uncertain, but the peak flowrates could reasonably be expected to decrease to the peak flow allocation of 653 gpm. More detailed information on the pumps at the Steer House Pump Station is necessary to determine the proper variable speed drive and prepare an accurate estimate. The approximate cost for two variable frequency drives would be $25,000 to $30,000.

One method of equalizing flows would be to use some of the volume available in Carleton's lagoons. Carleton has insisted that they need to match inflow with outflow in order to avoid odor problems. One compromise would be for Carleton to equalize only on days when peak flow from Winthrop exceeds 600 gpm. As shown in Table 3, Winthrop's peak flow exceeds 600 gpm approximately 6-7 days per year. When Winthrop's flow is below 600 gpm, there are over 442 gpm of peak flow capacity available to Carleton. This additional peak flow capacity is sufficient to meet Carleton's present peak flow allocation request. It should be noted that a variable speed drive, at the Steer House Pump Station is a necessary requirement for this alternative, since

the peak flow from Monmouth would have to be no higher than the design allocation. The necessary equipment for this alternative would include an alarm to be telemetered to Carleton indicating that flows from Winthrop were in excess of 600 gpm. The District may also desire automated reduction in Carleton's pumping capacity. An accurate estimate of costs would require more detailed information of the existing instrumentation.

The emergency storage facilities could be used for equalization, but Metcalf & Eddy strongly recommends against it. The emergency storage should always be available for the case of compounding failures. In addition, it is unlikely that regulatory agencies would allow the emergency storage facilities to be used for equalization.

Another equalization alternative would be to allow Carleton to tie directly into the existing 14-inch discharge force main. Since Carleton desires to upgrade its pumping capacity to from 750 gpm to approximately 1200 gpm, they could supplement their existing capacity by building a pump station which would provide the peak flow capacity that is presently not available. The actual size of the pump station would depend on whether variable speed drives were installed at the Steer House Pump Station. Design of this alternative would have to account for the decreased capacity of Winthrop Pump Station when this supplemental pump station was on line. The decreased capacity is caused by the higher head that the Winthrop Pump Station pumps would see. This is another feasible means to meet Carlton's peak flow request.

Summary. The most cost effective alternative would be for Carleton to flow equalize on days that Winthrop's flow exceed 600 gpm. If Carleton desires greater flexibility, then there are several alternatives that would require more detailed consideration including new pumps, a new wetwell, and tying Carleton's additional pumping capacity directly into the Winthrop force main.

Conclusions

1. The Winthrop Water District has enough average flow allocation to transfer an additional 0.4 MGD to Carleton Woolen Mill.
2. Peak flow capacity is not available from the allocation for either Winthrop or Monmouth (including Tex Tech).
3. To meet Carleton's peak flow request, pump modifications and/or flow equalization measures must be capable of handling a combined peak flow rate of 3300 gpm from Winthrop, Monmouth, and Carleton.
4. Pump modifications to meet peak flow needs would include new impellers, motors or complete pumps. The existing 12 inch impellers are the largest that the existing pumps can handle. The pump motors should not be increased above their present size. New pumps are a feasible alternative for meeting the peak flow allocation.
5. Flow equalization alternatives are also a cost effective means to provide additional peak flow allocation. The most

feasible alternatives include a new wetwell, variable speed drives on upstream pump stations, use of Carleton's lagoons, and tying Carleton's additional peak flow capacity directly into the Winthrop force main.

6. The instrumentation for pump control at the Winthrop Pump station will not be adequate for reliable service at higher flowrates. The system could be overflowing while a fully operable standby pump waits for manual activation.

Recommendations

1. Reconfirm Carleton's desire to increase their peak flow allocation.
2. Regardless of Carleton's desire to increase peak flow, the District should consider instrumentation modifications which would increase the reliability of the station under automatic (unattended) operation.
3. If Carleton reconfirms their desire for increased peak flow allocation, determine if Carleton would be willing to flow equalize for the 6-7 days per year that Winthrop's flows exceed 600 gpm.
4. If Carleton is willing to equalize for the 6-7 days per year, then the following modifications should be sufficient to meet their peak flow request:
    a. Install variable speed drives on pumps at Steer House Pump Station.
    b. Provide instrumentation to telemeter Winthrop's flow

rate to Carleton. The District may want automatic reduction of Carleton's peak flow rate.

5. If Carleton desires the flexibility to match output with inflow to their lagoons, a more detailed analysis of the following alternatives should be considered:

    a. New pumps for Winthrop Pump Sation.

    b. A new wetwell for Winthrop Pump Station.

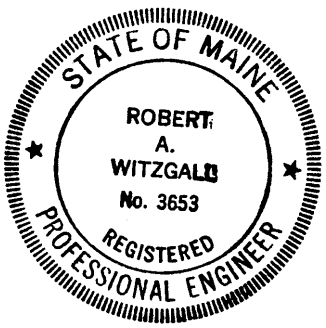
    c. Tie Carleton's additional peak flow capacity directly into the 14-inch force main.

Respectfully Submitted,

METCALF & EDDY, INC.

Robert A. Witzgall

Robert A. Witzgall
Project Manager
Registered Professional Engineer
Maine License No. 3653



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Attachment A - Winthrop Pump Station Pump Curve

Attachment B - Correspondence

Attachment C - Winthrop Flume Charts

Attachment D - Monmouth Flume Charts

ATTACHMENT A

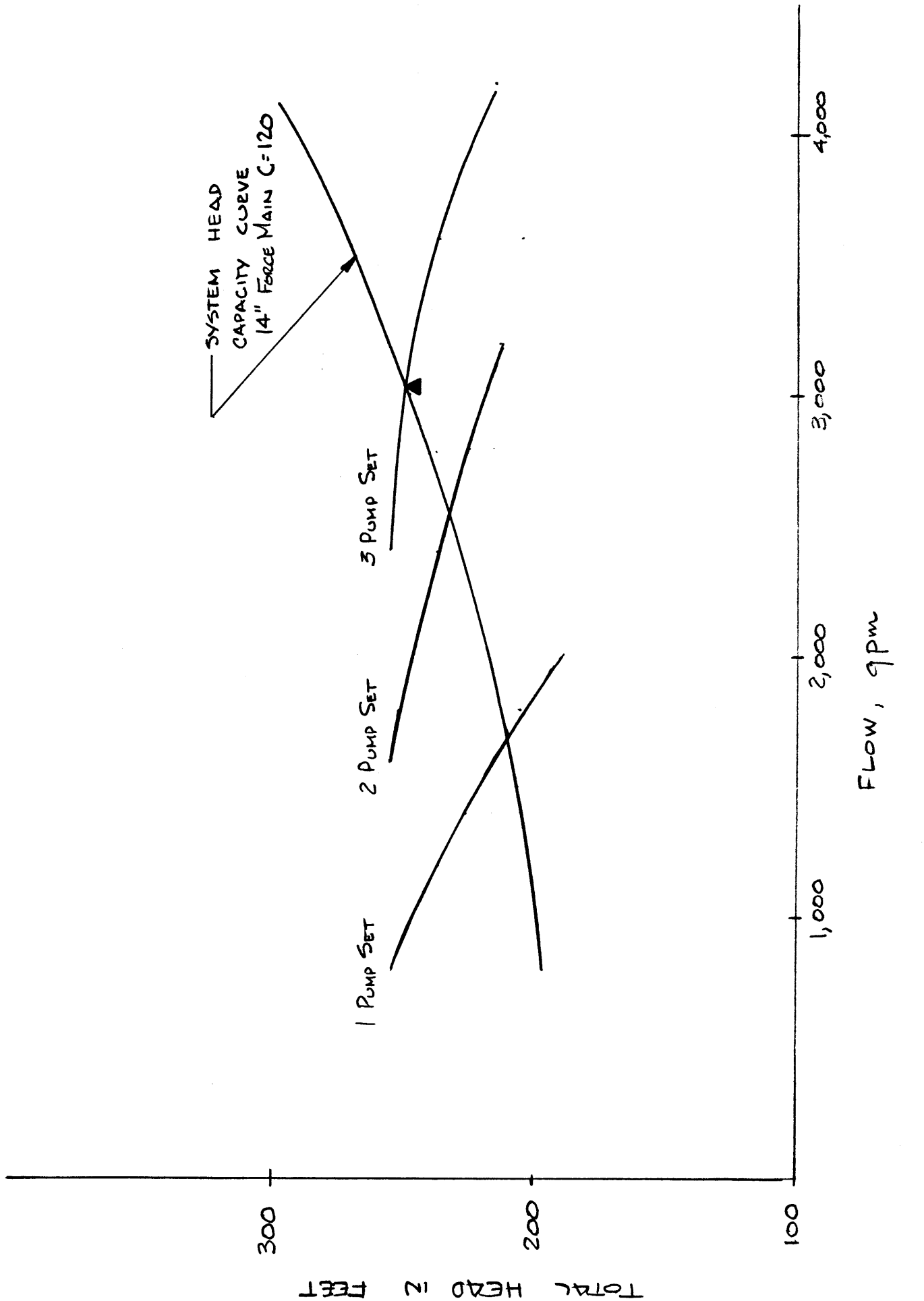
WINTHROP PUMP STATION

PUMP CURVE

Project Augusta P.S. Cap. Analysis Acct. No. 2245 Page ____ of ____

Subject System Cap Curve Comptd. By R. SCHERPF Date ____

Detail ____ Ck'd. By ____ Date ____



ATTACHMENT B

CORRESPONDENCE

Copy. H. Jackson

CARLETON WOOLEN MILLS, INC.
P.O. BOX 317 • WINTHROP, MAINE 04364 • (207) 377-2291
FINE FASHION FABRICS

May 14, 1986

Mr. Rodney Cumber
Superintendent
Winthrop Water District
Bowdoin Street
Winthrop, Maine 04364

Dear Rod:

When we arranged for an increase from 600,000 to 800,000 gallons allotement, we considered that that would be more than enough to cover our needs based on our capacity doing the sort of product that we were running and, indeed, expected to continue running.

However, we cater to a fashion business and the product mix changes with the requirements of the marketplace. Carleton's faced with either moving in the direction of heavier goods or being willing to take curtailments. As the latter was unacceptable, we have rather dramatically changed our mix and are now processing a lot more pounds of fabric with the same equipment.

This, in turn, has dramatically increased our water use, certainly beyond what we expected. Unfortunately, we never know whether this trend will continue, or for how long it will continue; however, it is a fact of life and we must be willing to accept it. Therefore, at this point, instead of requiring 800,000 gallons, we would probably require 1,000,000 or even up to 1,200,000 gallons to be covered under our license.

In view of this change, we find it necessary to look for additional capacity on our license and from previous discussion, we know that this capacity is only available through transfer from the Winthrop Water District. Under the circumstances, we find ourselves having to come back and request the additional capacity up to 1,200,000 gallons per day on a seven day basis.

At the present time, I realize that our use is running at approximately 900,000 gallons per week with some day peaks at 1,100,000. However, in view of what I've just said and in view of our highly inadequate requests just last year, I am trying to cover for any forseeable circumstances. Please convey this request to your board and I would appreciate your consideration. Also, we will be happy to meet with the board and go over our request in more detail and answer any questions you may have.

Sincerely,

J. D. Lucas

J. D. Lucas
Exec. V. Pres., Mfg.

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LINDA B. GIFFORD

LESTER F. WILKINSON, JR.
MARK S. O'BRIEN
JOSEPH J. WATHEN

June 6, 1986

Mr. J. D. Lucas, Executive Vice President, Mfg.
Carleton Woolen Mills, Inc.
P.O. Box 317
Winthrop, Maine 04364

Re: Intercommunity Agreement

Dear Mr. Lucas:

The Trustees of the Winthrop Water District have asked me to respond to your recent request to adjust your company's gallonage allotment for the trunkline from 800,000 gallons to 1,200,000 gallons.

The Trustees approved your request at their May meeting, subject to the approval of the remaining signatories to the Intercommunity Agreement and subject to the following:

1. Carleton remains at 1,200,000 gallons for at least 5 years, subject to Paragraph 2 herein.
2. Winthrop Water District reserves the right to withdraw any portion of the new 400,000 gallons to use as its own allocation caused by any expanded need.
3. Carleton pays the capital cost share for the new 400,000 gallons.

Please signify your assent to the two conditions prior to the monthly Intercommunity meeting scheduled for noon, June 18, 1986. You may communicate same either to me or to Mr. Cumber at the District.

Very truly yours,

Richard M. Schade

RMS/dm
cc: Mr. Rodney H. Cumber, Superintendent
Winthrop Water District

Mr. Harry Jackson, Superintendent
Augusta Sanitary District