

# WATCHTOWER

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## WATER SYSTEM ENGINEERING REPORT WATCHTOWER EDUCATIONAL CENTER AMENDED SITE PLAN

July 8, 2009

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## WATER SYSTEM ENGINEERING REPORT

This report gives a brief description of the existing approved potable water system for the Watchtower Educational Center (WEC) at Patterson, New York. It also describes the proposed work required to support the Watchtower Educational Center Amended Site Plan.

### **Existing Potable Water System**

The existing potable water system is divided into two components, the water supply component and the water distribution component. The NYSDEC water supply permit number 3-3724-0045/1-0 was issued on August 11, 1989, to the Watchtower Bible and Tract Society of New York, Inc. (The Applicant). The facility number is WSA 8240. The Applicant owns and operates the potable water system. The water supply component includes five (5) wells and the supply piping (force mains) and appurtenances, including well houses and a surge tank, between the wells and the Water Softening Facility (WSF). The distribution component includes the WSF, high level storage tank, and the distribution piping to the WEC buildings and the 152-room hotel (Inn). The NYSDOH approved the plans and specifications for the project, including installation of the new water system and appurtenances (clearwells for chlorination only) on December 20, 1989, to supply the WEC and 152-room hotel. The approval specified serving a population of 1,500 with a distribution system average daily demand of 165,000 gpd and a maximum daily demand of 330,000 gpd. In addition the NYSDOH approved on July 31, 1996, the plans and specifications for the installation of the WSF to treat the water hardness.

The general layout of the existing potable water system is shown on Figure 1 and a profile of the water system is shown on Figure 2. The raw water supply includes the three rock wells (W-2, W-4, and W-6) on the east side of Route 22, along with two sand wells (SW-1 and SW-2) on the west side of Route 22. These wells deliver water through 3-inch and 4-inch force mains to the surge tank, except for Rock Well W-2, which delivers directly to the WSF. The sand wells deliver initially through individual 3-inch pipes to the adjacent well house, which was designed to allow the addition of two more sand wells, SW-3 and SW-4. A 200-foot well head protection area is currently maintained around the sand wells.

Water from the sand wells continues on from the well house in two 4-inch force mains to a well control house located adjacent to Well W-6 east of Route 22. Flow metering and well pump control for the sand wells and Rock Well W-6 is done in the well control house. From there the three force mains, including the 3-inch force main from Rock Well W-6, continue crossing beneath Mountain Brook to the surge tank located upslope from Rock Well W-4. Rock Well W-4 also discharges into the surge tank. From the surge tank, well water is pumped through a 4-inch force main to the WSF. Once treated, the water is pumped through a 6-inch force main from the WSF to the 405,000-gallon high-level storage tank. This tank is sized to contain one-day's volume of potable water, 165,000 gallons, plus 240,000 gallons reserved for fire water storage.

The fire water storage is based upon ISO design standards and exceeds the volume required by NFPA for the largest building in the WEC, the Office Building. Thus, 165,000 gallons are reserved for distribution to the various other uses on the site. Fire flows are supplied from the potable water distribution system, with hydrants located throughout the existing project site. Sprinklers are provided in residential hallways and the below grade floors of the parking garages. Standpipes are provided in all exit stairways. A fire water demand of 2,000 gpm for a period of two hours was used for design of the main complex, as reviewed by the Patterson Fire Department. Quoting from page 4 of the September 4, 1989, Engineering Report, "Water

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Supply/Treatment/Distribution,” Exhibit “F,” it states: “As discussed with the Patterson Fire Department on March 24, 1988, a fire water demand of 2,000 gpm for a period of at least two hours will be provided, based on the size and nature of the proposed facility. The NFPA Code No. 1231, Table 5-5.1 (C), fire flow requirement for this facility is not less than 1,000 gpm.” The Patterson Inn was designed for a fire flow of 1,000 gpm. A network analysis was included in that report, demonstrating that the above requirements were met.

The existing surge tank provides approximately one hour of storage at maximum combined flow from the tributary wells. Two pumps are provided, each capable of lifting the combined flow to the WSF. The surge tank pumps are controlled by level sensors at the surge tank.

The WSF is described in the DEIS, Chapter 6, “Water Supply and Utilities.” The water distribution system is supplied by gravity through a 12-inch main from the high level storage tank to the compound fire flow meter near the WSF, and then into the distribution network. This network consists of one main loop generally along the circular loop road with four sub-loops. Branches from the main loop serve the Patterson Inn and other buildings outside the main loop. One of these is a 10-inch pipeline serving the Audio/Video Building, which is controlled by fire protection needs.

### **Proposed Adjustments to the Water System**

The proposed adjustments to the water system will require approval of plans and specifications by the NYSDOH and review of the plans by the PCDOH. A summary of the proposed additions to the existing potable water system to meet the needs of the WEC Amended Site Plan are as follows:

1. A larger two-compartment surge tank, pumps, and force mains adjacent to the existing surge tank and force main, will replace existing surge tank to provide greater flexibility in operation and redundancy in the event of mechanical failure or maintenance needs.
2. Increased capacity supernatant pumps and a provision of another lime feeder at the WSF to facilitate operation.
3. Addition of distribution mains and fire hydrants in the area of the proposed buildings to extend the potable water service to these buildings and meet fire protection needs. Modifications to the existing water mains are proposed where necessary to avoid conflict with new construction.
4. Cooling water for the cooling towers at the powerhouse to be supplied from a new treated effluent pump at the Wastewater Treatment Facility (WWTF), using a new dedicated 3-inch force main from the WWTF to the cooling towers. Regulatory approval by the NYSDEC and NYSDOH will be required for this adjustment prior to construction. If Regulatory approval is not granted, then potable water use will be continued. If approval is granted, potable water would no longer be used for this purpose except when the WWTF treated effluent is not available at the cooling towers

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Details of the above additions are described further for each category:

1. New Surge Tank, Pumps, and Force Main:

The new surge tank will be similar to the existing surge tank, but will have two compartments and be larger to give one hour detention for the new combined well flows as shown on Figure 3. The force mains from the connected wells will be valved to allow discharge to either compartment. A single larger pump capable of handling the combined flow will be provided in each compartment. The new pumps will discharge into the new 6-inch force main, but piping and valves will be provided to allow either surge tank compartment to operate with either force main to allow cleaning or other maintenance to be carried out on either compartment. The 6-inch force main will connect to the existing 6-inch line stubbed out from the WSF for this purpose.

2. Increased Capacity of Supernatant Pumps at Water Softening Facility:

This proposed change in the supernatant pump capacity from 25 gpm to 50 gpm will allow the WSF to meet its 10 percent supernatant allowance. A new lime feeder will also be installed in the space provided in the WSF to facilitate operation.

3. Addition of Distribution Mains and Fire Hydrants for New Buildings:

The proposed new water mains and fire hydrants needed to serve the new buildings are shown on the utility Drawings CU-101 and CU-102. The line sizes and fire hydrant locations shown are preliminary, and may change as detailed design progresses.

4. Cooling Water for Cooling Towers at Powerhouse:

The proposed powerhouse cooling tower demands are anticipated to require over 18,000 gpd during July and August. This represents a significant demand on the potable water system in this period and to a lesser extent during the remainder of the year. This demand can be avoided by the proposed use of WWTF effluent treated with hypochlorite to reduce biological fouling. Piping is proposed to allow use of potable water when effluent is not available. An air gap will be included for cross connection control. Level controls in the towers are proposed to control the WWTF pump and potable water makeup when needed.

### **Fire Protection**

Fire protection requirements are discussed in the DEIS, Chapter 4, "Community Services and Facilities." The proposed potable water system would be designed to conform to these requirements, including those for flow and pressure. Since the plumbing design is still at schematic stage, the pressure requirements for sprinklers and hose racks in the topmost floors of the proposed residence buildings may require the addition of booster pumps. This is a typical design solution to elevate the pressure and flow appropriately.

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### **Site-Wide Potable Water Usage**

Table 1 presents the potable water usage figures from the monthly reports submitted to the Putnam County Department of Health for the 31-month period from June 2006 through December 2008. It also presents the population and per capita water usage figures based on the population reported on the water supply report for that month. Table 1 has been corrected for a population figure error from 1,017 to 1,133, for February 2007 that was discovered after the report was submitted.

The average per capita potable water usage shown in Table 1 for the 31-month period is 79.30 gallons-per-capita-per-day (gpcd). The highest per capita daily water usage was 97.94 gpcd for July 2008. The typical powerhouse cooling tower potable water usage of about 18,000 gpd is one factor in this high usage. Another factor in the July 2008 water usage in particular appears to be the amount of water used for flushing the potable water mains during the month, estimated to have consumed a total of about 136,000 gallons. When this amount of flushing water is deducted, the average daily water usage in July drops from 110,476 gpd to 106,089 gpd. This is a more normal value for this time of year. Since the flushing water was discharged into the stormwater drains, this did not affect the wastewater flow to the WWTF. Also, since water main flushing could be deferred to less demanding months in the event of a water supply shortfall, it is conservative to include this high monthly value in the usage calculations. It should be noted that the NYSDOH approval is for an average daily demand of 165,000 gpd with a maximum day demand of 330,000 gpd. The amount of wastewater processed during the same month of July 2008 averaged 90,000 gpd with a population of 1,128 or 79.79 gpd.

The potable water usage figures are based on turbine water meter readings. In June 2006, a number of adjustments were made to the steam system; including steam trap repairs, blow-down reductions, and conversion of laundry dryers from steam to gas. It is estimated that these adjustments reduced water usage by about 10,000 gpd. Comparing the records for a two-year period from before and after these adjustments seems to show a 10 gpcd drop in per capita water usage from 87 gpcd to 77 gpcd.

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**TABLE 1: PATTERSON WATER REPORT FIGURE - 31 MONTHS**

	Avg	1167	Avg	92,432	Avg	79.30	
	Max	1289	Max	110,476	Max	97.94	
Date	Population		Avg Daily Water Plant Flow (gal)		Water Flow gal/person/day		
Jun-06	1103		92,880		84.21		Fixed long standing problem with steam trap leaks that used ~10,000 gpd
Jul-06	1112		92,301		83.00		
Aug-06	1113		95,593		85.89		
Sep-06	1289		95,896		74.40		
Oct-06	1213		93,075		76.73		
Nov-06	1146		87,497		76.35		
Dec-06	1149		80,538		70.09		
Jan-07	1137		84,361		74.20		
Feb-07	1133		85,359		75.34		
Mar-07	1224		84,396		68.95		
Apr-07	1186		80,150		67.58		
May-07	1148		88,280		76.90		
Jun-07	1109		87,454		78.86		
Jul-07	1104		89,719		81.27		
Aug-07	1153		103,443		89.72		
Sep-07	1199		93,700		78.15		
Oct-07	1240		102,468		82.64		
Nov-07	1250		90,829		72.66		
Dec-07	1233		86,633		70.26		
Jan-08	1137		82,790		72.81		
Feb-08	1130		85,580		75.73		
Mar-08	1134		85,463		75.36		
Apr-08	1120		92,797		82.85		
May-08	1222		94,414		77.26		
Jun-08	1138		98,068		86.18		
Jul-08	1128		110,476		97.94		
Aug-08	1153		104,269		90.43		
Sep-08	1170		107,798		92.14		
Oct-08	1286		105,431		81.98		
Nov-08	1173		90,880		77.48		
Dec-08	1147		92,854		80.95		

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A “Water Conservation/Reuse/Recycling Options Feasibility Study” was done with the goal of identifying options that had the potential for reducing potable water demands; and in most cases, reducing the amount of wastewater to be discharged to Mountain Brook. Options A through F listed in Table 2 were selected for implementation, with Option G (irrigation reuse) to be pursued if SPDES credit is given and some of the restrictions on reuse are removed. Options A through F are assumed to apply for this evaluation. These options are described in Table 2, along with the estimated water and wastewater use reductions for a population of 1,803.

**TABLE 2: WATER CONSERVATION/REUSE/RECYCLING OPTIONS**

<b>Options</b>	<b>Potable Water Use Reduction (gpd)</b>	<b>Wastewater Reduction (gpd)</b>
A: Premium Quality Reduction Flow Showerheads	13,300	13,300
B: Dual-Flush Flushometers In Women’s Rooms	1,200	1,200
C: Water Conserving Washing Machines (Personal Laundry)	3,200	3,200
D: High-Efficiency Urinals in High-Use Areas	1,100	1,100
E: Dual-Flush Tank Toilets in New Residences	1,200	1,200
<b>Subtotal:</b>	<b>20,000</b>	<b>20,000</b>
F: Reuse WWTF Effluent in Cooling Towers (Needs Regulatory Approval)	1,500 (Jan) 6,000 (Apr) 18,000 (Aug)	1,500 (Jan) 6,000 (Apr) 18,000 (Aug)

**Conclusion**

With the water reduction Options A through F implemented as indicated, the 31-month analysis results in projected water usages as shown in Table 3, both for a population of 1,803 (DEIS) and a population of 2,050 (bed count). Note that actual maximum population will be 1,803 due to facility operational requirements as explained in the DEIS. Table 3 shows that under the least favorable assumptions and with a maximum population of 2,050, the maximum projected potable water demand should not exceed the 165,000 gpd limit set by the NYSDEC water taking and SPDES permits.

**TABLE 3: PROJECTED WATER USE**

<b>Population: 1,803 (Used in DEIS)</b>	<b>No Reduction (gpd)</b>	<b>With Reduction (gpd)</b>
Average Flow @ 79.30 gpcd: $1,803 \times 79.30 =$	142,980	121,480*
Maximum Month (July 2008) Flow: $110,476 \times 1,803 \div 1,128 =$	176,580	138,580**

<b>Population: 2,050 (Bed Count)</b>	<b>No Reduction (gpd)</b>	<b>With Reduction*** (gpd)</b>
Average Flow @ 79.30 gpcd: $2,050 \times 79.30 =$	162,570	141,070*
Maximum Month (July 2008) Flow: $110,476 \times 2,050 \div 1,128 =$	200,780	162,780**

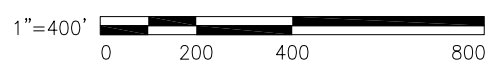
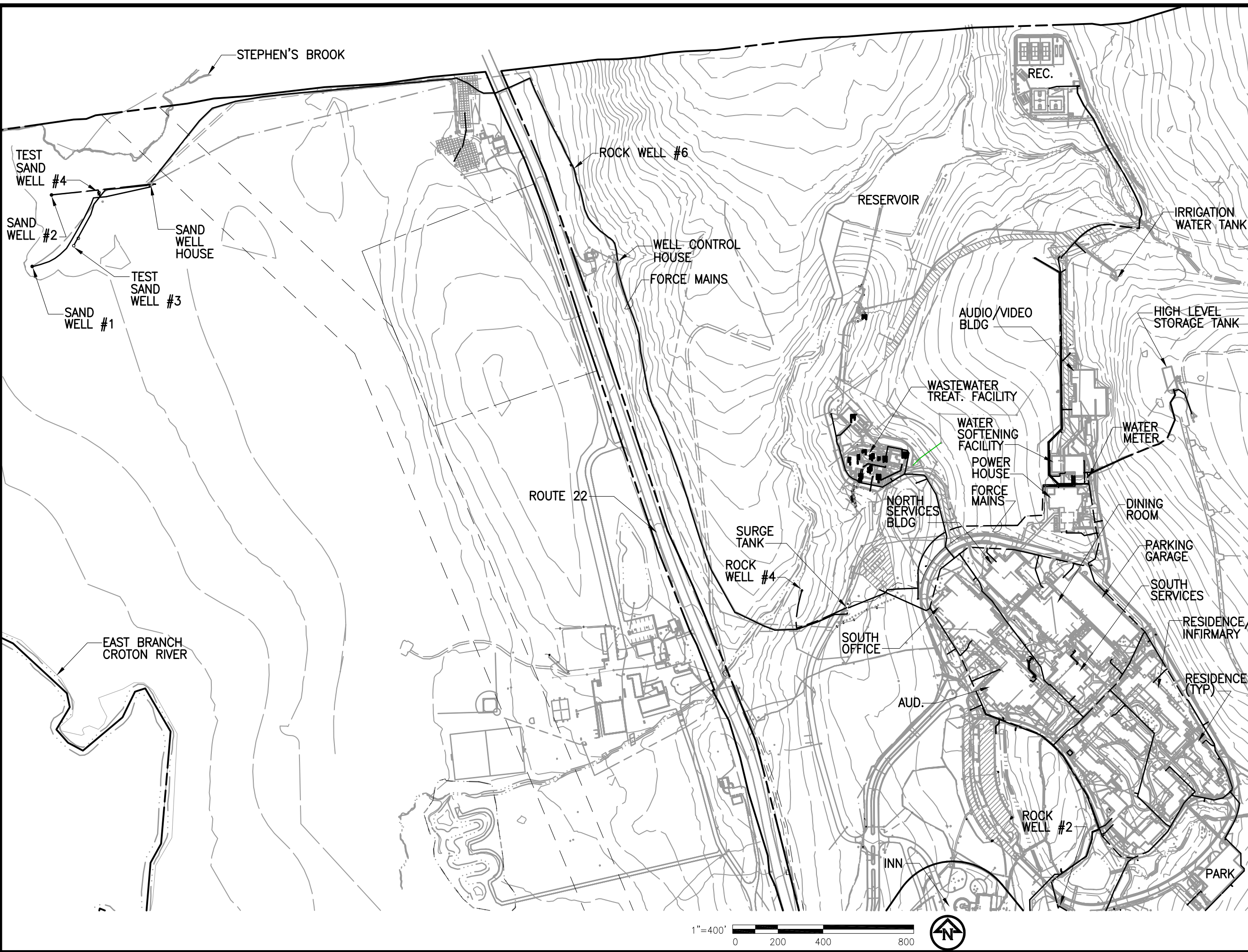
\*Option F Reduction Assumed = 1,500 gpd (Jan)

\*\*Option F Reduction Assumed = 18,000 gpd (Aug)

\*\*\*Reduction Same As 1,803 (Conservative)



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**WATCHTOWER**  
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 OF NEW YORK, INC.  
 25 COLUMBIA HEIGHTS  
 BROOKLYN,  
 NEW YORK, 11201

MARK:	DATE:	DESCRIPTION:

OWNER:  
**WATCHTOWER BIBLE & TRACT SOCIETY**  
 25 COLUMBIA HEIGHTS  
 BROOKLYN, NY 11201

ACCOUNT No.  
 PROJECT TITLE:  
**WEC AMENDED SITE PLAN**  
 100 WATCHTOWER DRIVE  
 PATTERSON, NY 12563

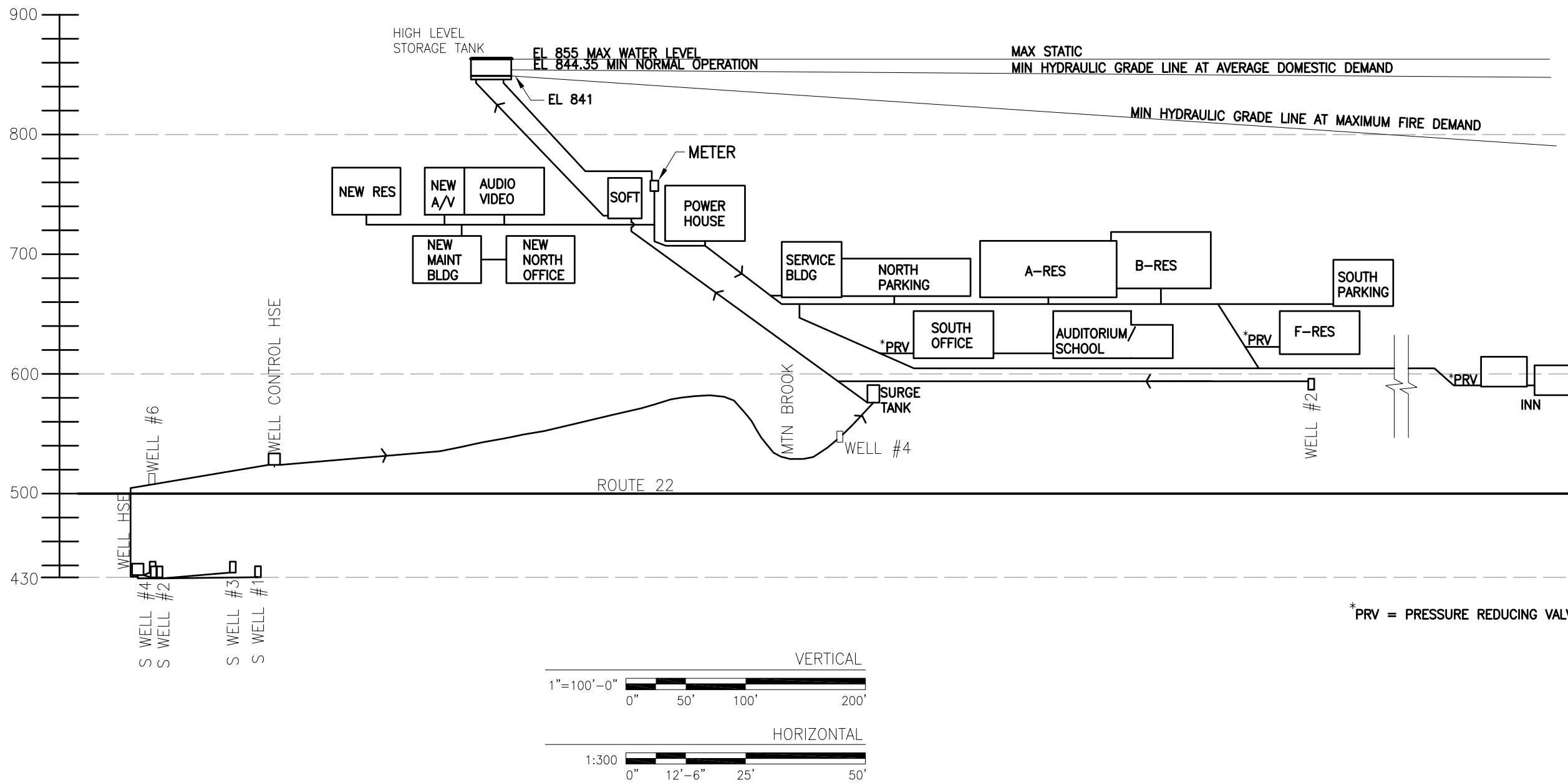
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SHEET No.  
**FIG 1**



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**WATCHTOWER**  
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 25 COLUMBIA HEIGHTS  
 BROOKLYN,  
 NEW YORK, 11201

MARK:	DATE:	DESCRIPTION:

OWNER:  
**WATCHTOWER BIBLE & TRACT SOCIETY**  
 25 COLUMBIA HEIGHTS  
 BROOKLYN, NY 11201

ACCOUNT No.  
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**WEC AMENDED SITE PLAN**  
 100 WATCHTOWER DRIVE  
 PATTERSON, NY 12563

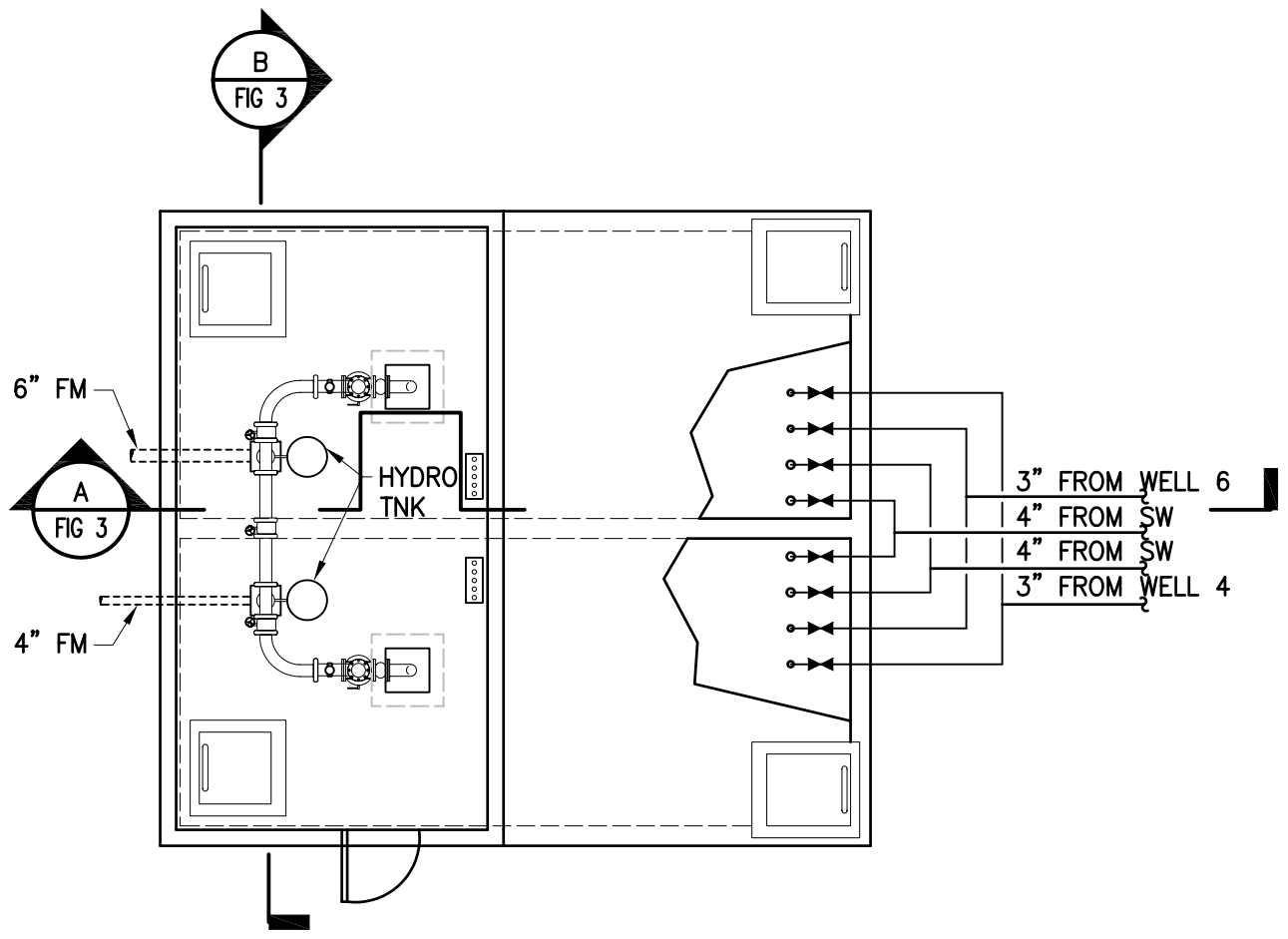
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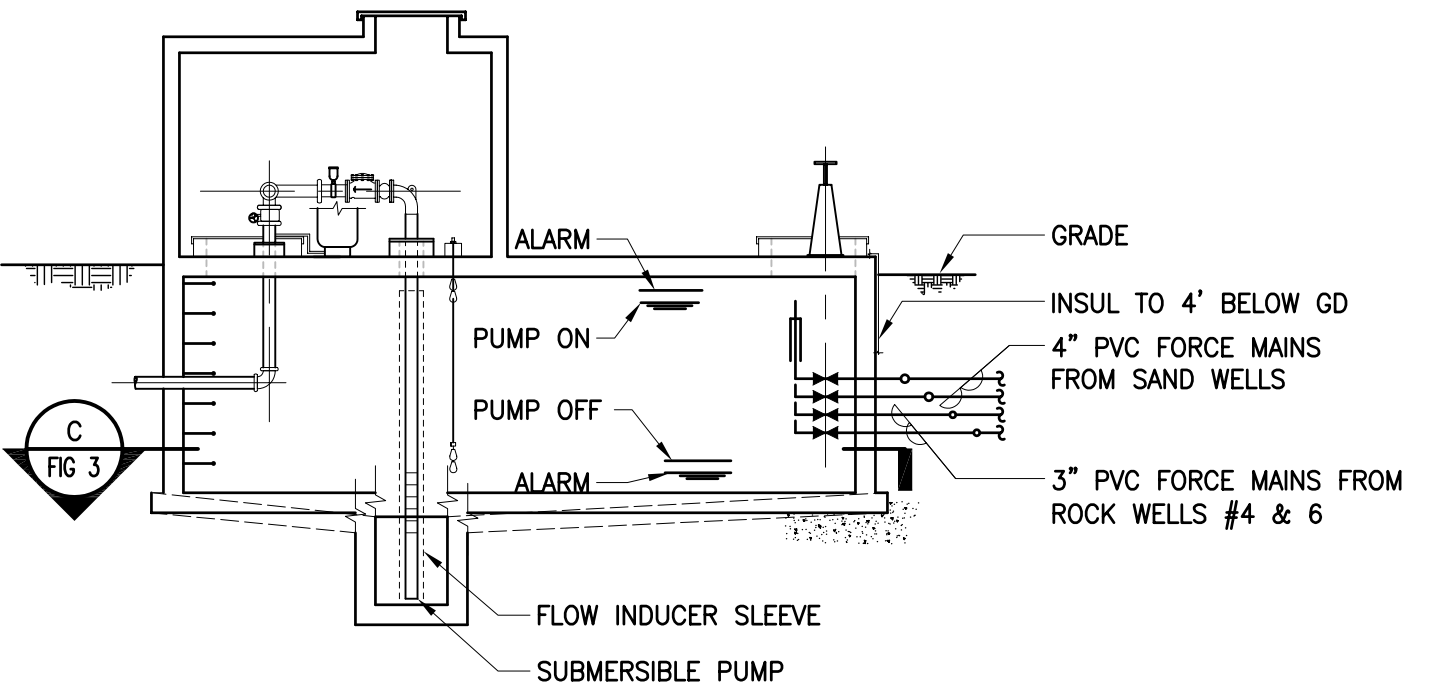
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**FIG 2**



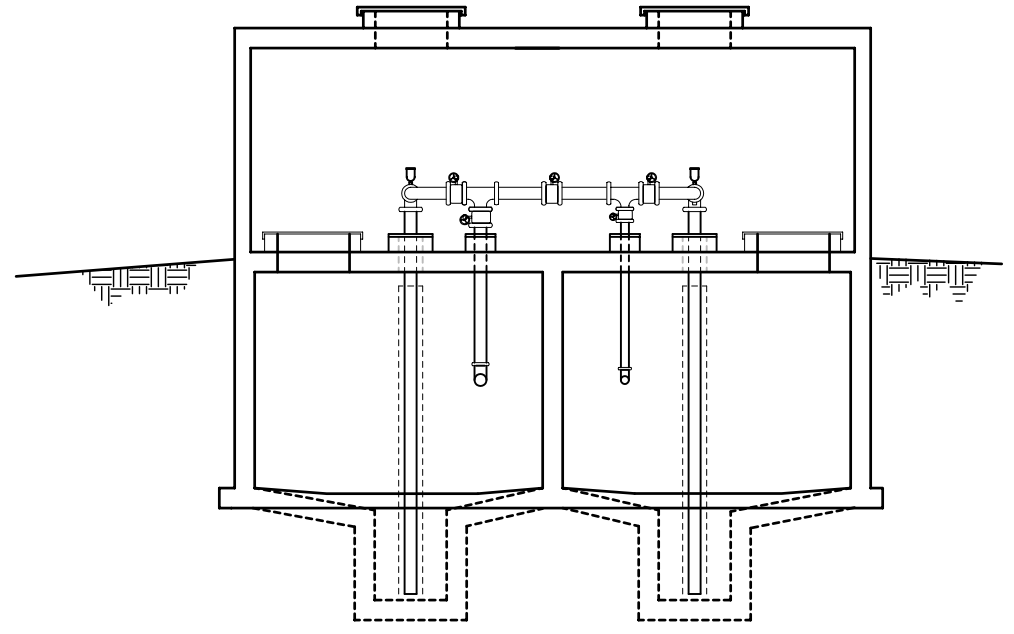
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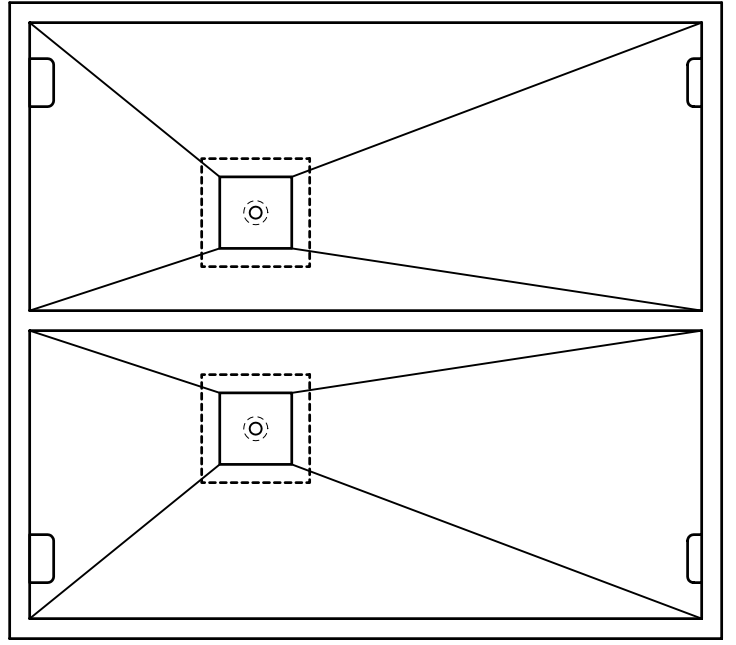
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 1/8"=1'-0"  
 0" 4' 8' 16'



**A SECTION - SURGE TANK**  
 1/8"=1'-0"  
 0" 4' 8' 16'



**B SECTION - SURGE TANK**  
 1/8"=1'-0"  
 0" 4' 8' 16'



**C SECTION - SURGE TANK**  
 1/8"=1'-0"  
 0" 4' 8' 16'

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ACCOUNT No.  
 PROJECT TITLE:  
**WEC AMENDED SITE PLAN**  
 100 WATCHTOWER DRIVE  
 PATTERSON, NY 12563

SHEET TITLE:  
**WATER SYSTEM SURGE TANK**

PROJECT No.  
**PPAT0104**  
 SHEET No.  
**FIG 3**



## WATER CONSERVATION/REUSE/RECYCLING OPTIONS FEASIBILITY STUDY

### Background on Current Usage and Reasons to Conserve/Reuse/Recycle

This study was initiated in response to the Watchtower Educational Center (WEC) amended site plan, which proposes to add 500 residents to the site. A major limiting factor to significant expansion is the SPDES permit which limits the flow at the Wastewater Treatment Facility (WWTF) to no more than a monthly average of 165,000 gpd. The proposed increase in resident population provides incentive to consider ways site-wide to reduce water consumption, reuse, and recycle water. Recent changes in New York State regulations are increasing the viability to reuse and recycle water such as treated effluent from the WWTF. In addition, Green Globes™ certification for the proposed new buildings will be a design objective. (Green Globes™ water-use targets are 11,000 gallons per year per apartment for residential buildings and 10 gallons per square foot per year for other buildings.)

This feasibility study tries to look at each of the potentially reasonable conservation/reuse/recycling options from the standpoint of life-cycle cost per 1,000-gpd water-use reduction, amount of water-use reduction, aesthetic issues, window-of-opportunity issues, economic payback time (if any), and permitting issues.

### Conclusions

- An average monthly overnight population of 1,803 people (approximately 500 more than existing) with no additional water conservation, reuse, or recycling; the monthly WWTF flow expected would average approximately 135,000 gpd. Past use indicates some months, will have higher flows than others. In that case, the monthly wastewater flow is statistically expected to exceed the permitted 165,000 gpd monthly average for about one month in every three years.
- Some form of additional water conservation, reuse, or recycling will need to be instituted so that the wastewater effluent discharge from the overnight population would not exceed the 165,000-gpd monthly average WWTF flow limit. In order to achieve this, the site-wide water usage at full population would need reduction by approximately 15,000 gpd.
- The first priority is to review water conservation/reuse/recycling options that appear to be cost effective.
- The second priority is water usage reduction options that are not cost effective but may be needed to remain below the 165,000-gpd SPDES permit limit. These options include a reuse-water system for toilets for new buildings, a laundry recycling system, and dual-flush gravity toilets for the residence buildings.
- The third priority includes water usage reduction options that can be implemented for a significantly lower cost when new buildings are constructed. These options include dual-flush gravity toilets for residences or a reuse-water system for the toilets. Regulatory approval would be needed to implement such options.
- Options involving reuse of WWTF effluent would only be justified if the reuse flow is not counted toward the SPDES permit limit. Separate from the DEIS application, a modification to the current SPDES permit is being pursued to get credit for such reuse.
- A responsive maintenance program will be required to conserve the potable water resources within regulatory limits. The program will continue to provide leak repair, hot water recirculation systems maintenance, monitoring steam trap operation, and the accurate calibration of the SPDES flow meter.

### Overview of Options

The options below are lettered “A” through “P” and are listed in order from the most economical to the least economical. The chart below summarizes the options:

OPTIONS	WATER-USE REDUCTION (gpd)	AESTHETIC ISSUES	REGULATORY ISSUES
A: Premium-Quality Reduced Flow Showerheads (New & Existing)	Potable: 13,300 Wastewater: 13,300	Quality of shower experience may not be quite as good	None
B: Dual-Flush Flushometers in Women’s Rooms (New & Existing)	Potable: 1,200 Wastewater: 1,200	None	None
C: Water Conserving Washing Machines (In the small personal laundries in each residence building)	Potable: 1,800 - 3,200 Wastewater: 1,800 - 3,200	Confirm quality of wash and rinse	None
D: High-Efficiency Urinals in High-Use Areas	Potable: 1,100 Wastewater: 1,100	Likely none	None
E: Dual-Flush Gravity Tank Toilets in New Residences	Potable: 1,200 Wastewater: 1,200	None	None

<b>OPTIONS</b>	<b>WATER-USE REDUCTION (gpd)</b>	<b>AESTHETIC ISSUES</b>	<b>REGULATORY ISSUES</b>
F: Reuse WWTF Effluent in Cooling Towers	Up to 18,000 potable water-use reduction and possible SPDES credit in August but much less at other times of year	Likely none	Need approval
G: Irrigation with WWTF Effluent	Up to 30,000 possible SPDES credit in spring, summer, and early fall	None	Already approved but currently no SPDES credit & significant restrictions on how & when the water is used
H: WWTF Effluent Reuse for Toilets in New Buildings	Potable: 5,000 Wastewater: None Possible SPDES Credit: 5,000 gpd	Possible odor or discoloration in toilets	Need approval and SPDES credit to make it worthwhile
I: Waterless Urinals in High-Use Areas	Potable: 1,250 Wastewater: 1,250	Previous tests yielded significant complaints from odor, appearance and maintenance problems.—NOT RECOMMENDED (pursue Option “D” instead)	None
J: WWTF Effluent Reuse for Toilets in Existing Offices & Locker Rooms	Potable: 4,500 Wastewater: None Possible SPDES Credit: 4,500 gpd	Possible odor or discoloration in toilets	Need approval and SPDES credit to make it worthwhile
K: Shower Water Collection & Reuse for Toilets in New Buildings	Potable: 5,000 Wastewater: 5,000	Possible suds, odor, or discoloration in toilets plus maintenance problems—NOT RECOMMENDED	Need approval
L: Laundry Recycling System with Potable Water Makeup	Potable: 15,500 Wastewater: 15,500	Possible improvement or deterioration of garment appearance	None
M: High-Efficiency Urinals in Remaining Areas (Low Use )	Potable: 1,100 Wastewater: 1,100	Possible waste piping blockages after several years of use—NOT RECOMMENDED	None

OPTIONS	WATER-USE REDUCTION (gpd)	AESTHETIC ISSUES	REGULATORY ISSUES
N: Laundry Recycling System with WWTF Effluent Reuse for Makeup, Cooling Towers, and Toilets in New Buildings	Potable: 26,500 (Jan) 43,000 (Aug)  Wastewater: 15,500  Possible additional SPDES credit: 11,000 (Jan) 27,500 (Aug)	Possible improvement or deterioration of garment appearance	To pursue this option, close cooperation would be needed with regulatory agencies and developing regulations. Need approval and SPDES credit to make it worthwhile
O: WWTF Effluent Reuse for Toilets in Existing Residences	Potable: 10,400 Wastewater: None Possible SPDES credit: 10,400 gpd	Possible odor or discoloration in toilets	Need approval and SPDES credit to make it worthwhile
P: Dual-Flush Gravity Tank Toilets in Existing Residences	Potable: 3,100 Wastewater: 3,100	None	None

## Recommendations

**1. For the population proposed in the DEIS (add 500 more people for a total overnight population of 1,803 with 2,050 total beds), the following options are all recommended to save water with reasonable economics:**

- **Option A**—Premium-Quality Low Flow (1.5 gpm) Showerheads (New and Existing)
- **Option B**—Dual-Flush Flushometers in Women’s Rooms (New and Existing)
- **Option C**—Water Conserving Washing Machines in Personal Laundry (New and Existing)
- **Option D**—High-Efficiency Urinals in Men’s Rooms with High Usage
- **Option E**—Dual-Flush Gravity Toilets in New Residences
- **Option F**—Reuse WWTF Effluent in Cooling Towers

**Note: SPDES credit for WWTF effluent that is not sent to Mountain Brook but reused on-site for Cooling Towers, Toilets, and so forth is being pursued in parallel with this DEIS.**

**2. For the proposed new buildings at the time of construction:**

In addition to the options recommended above:

- IF** SPDES credit is granted for WWTF effluent reuse;
- AND IF** Approval is granted by DOH, DEC, and DEP;
- AND IF** More water savings for Green Globes™ credit or other non-economic incentives are desired;
- THEN** Pursue **Option H**—WWTF Effluent Reuse for Toilets in New Buildings.

(NOTE: If Option H is pursued, 250 regular gravity-flush toilets and 30 regular urinals from the existing buildings would be moved to the new buildings and 250 new dual-flush gravity toilets and 30 new high-efficiency urinals would be purchased and installed in the existing buildings to replace the old fixtures that are moved. In this way, we benefit from the water-use reduction in both areas.)

**3. For the Laundry, the following is recommended:**

**IF Laundry pilot tests demonstrate that a softener and/or filter is warranted to improve garment appearance, pursue Option L to install a recycling system at the same time since the life-cycle cost is the same and we can save a significant amount of water.**

**OTHERWISE Do not install a laundry recycling system at this time.**

**4. For the remaining options, the following is recommended:**

- **Do not pursue Options G, I, J, K, M, N, O, or P at this time.** These options are not warranted for the population proposed in the DEIS.

**APPENDIX**

Presented below are detailed descriptions of each option as well as the water-use reductions, aesthetic issues, permitting issues, and recommendations specific to that option.

Much of the data for these options came from previous studies done by Watchtower Bible and Tract Society of New York, Inc., and WEC personnel over the last few years. In addition, some information is provided for supporting the expected water usage figures and operating at or below the 165,000-gpd permit limit.

**OPTION A: Premium-Quality Reduced Flow Showerheads—Replace Existing and Install in New Installations****Description**

The existing showerheads provide a flow of about 2.5 gpm and a good quality shower experience. A study done in 2006 showed a usage of about 18.4 gpcd in our residential showers. There are a number of premium-quality ultra-low-flow showerheads now on the market. These save a significant amount of water and energy, but may not provide as vigorous of a spray. These premium-quality ultra-low-flow showerheads have patented features and claim to combine the water spray with air to provide a good quality shower experience (examples include Bricor, Jet-Stream, and Oxygenics). Some premium-quality 1.5-gpm showerheads have been tested at the WEC facility and were found to provide an acceptable quality shower experience (Oxygenics, Jet-Stream, Hansgrohe). Other showerheads are being tested as well. In contrast, showerheads with 1.0 gpm or less flow that have been tested at the WEC have not provided an acceptable shower experience.

The economic evaluation below conservatively assumes a high cost per showerhead due to the anticipated frequency of replacement. Even with the high assumed cost, this option demonstrates an early rate of return.

**Potable Water-Use Reduction at 1,803 Population: 13,300 gpd**

**WWTF Flow Reduction at 1,803 Population: 13,300 gpd**

**Aesthetic Issue: Quality of shower experience may not be quite as good.**

**Permitting Issues: None**

**Recommendation: Install premium-quality 1.5-gpm showerheads in all new and existing showers. Make sure that the model(s) chosen do not have an easily adjustable/removable flow restrictor that would allow much higher flow rates.**

**OPTION B: Dual-Flush Flushometers for Women's Restrooms—Replace Existing and Install in New Installations****Description**

The existing water-closet flushometers use 1.6 gallons per flush. Sloan makes a \$30 retrofit kit that allows a 1.1-gallon flush when the lever is pulled up instead of down. This saves half a gallon for each liquid-only flush. This flushometer has been tested at the WEC with good results. Installation is proposed for the women's restrooms. The men's restrooms already have urinals installed for liquid-only flushing. Residence room toilets are all of the gravity tank type that does not permit a retrofit for dual flush use.

**Potable Water-Use Reduction at 1,803 Population: 1,200 gpd**

**WWTF Flow Reduction at 1,803 Population: 1,200 gpd**

**Aesthetic Issue: None**

**Permitting Issues: None**

**Recommendation: Install in all flushometer-type water closets in women's restrooms.**

**OPTION C: Washing Machines in Personal Laundry—Replace Existing and Install in New Installations****Description**

The existing washing machines in the personal laundries use about 26 gallons per cycle. There is a current need to replace these washers due to age. Two options are being considered for replacement. Option No. 1 is to replacement with a commercial model (Wascomat) that can be expected to last about ten years and is somewhat more water efficient than the existing units. The same model of Wascomat washing machines is proposed for the personal laundries in the new residence buildings. Option No. 2 is to install a water efficient residential model (Miele) that is expected to demonstrate an operating life cycle of four years.

**Potable Water-Use Reduction at 1,803 Population: 1,800-3,200 gpd**

**WWTF Flow Reduction at 1,803 Population: 1,800-3,200 gpd**

**Aesthetic Issue:** The proposed equipment is more reliable than the existing washing machines. There is the possibility that wash/rinse quality may not be quite as efficient due to the water conservation per wash cycle.

**Permitting Issues:** None

**Recommendation:** Provide some of the Miele washing machines as replacements. If the units work well, provide adequate wash/rinse quality, and demonstrate the water and energy savings, then install the units in all the existing personal laundries. If the Miele machines do not perform as expected, install the longer life and more expensive Wascomat washing machines with a proven track record in applicant's other facilities.

**OPTION D: High-Efficiency Urinals for High-Use Installations in Men's Restrooms****Description**

The existing urinals use about one gallon per flush. Zurn makes a high-efficiency urinal that uses only 1/8-gallon per flush. These are currently being tested at the WEC. Testing is not complete but indications are that the units work satisfactorily. This saves 7/8-gallon for each liquid-only flush. (Vitra makes a similar 1/4-gpf urinal.)

There may be maintenance issues with mineral buildup in the plumbing in low-use installations so this option just considers high-efficiency urinals for the high-use areas. A total of about 30 new urinals will be needed for increasing the population to about 1,803. This option considers purchasing 30 new high-efficiency urinals. These are to be installed in the highest use areas of both the new and existing men's rooms. The units are expected to capture about 50 percent of the liquid flushes occurring at men's rooms during the work day. Existing urinals that will be replaced are to be relocated to the low-use areas of the new buildings.

**Potable Water-Use Reduction at 1,803 Population: 1,100 gpd**

**WWTF Flow Reduction at 1,803 Population: 1,100 gpd**

**Aesthetic Issue: None**

**Permitting Issues: None**

**Recommendation: Purchase 30 high-efficiency urinals and install in the highest use areas of both the proposed new and existing buildings. Relocate any existing urinals that are replaced to lower-use areas in new buildings.**

**If a grey-water system is designed for the new buildings, still purchase 30 high-efficiency urinals but install them all in existing men's restrooms and move the existing urinals to the new buildings. This provides benefits from the water-use reduction in both locations.**

**OPTION E: Dual-Flush Gravity Tank Toilets for New Installations in Residences****Description**

The existing gravity tank water closets in the residences use 1.6 gallons per flush. A study done in 2006 estimated that each resident uses their residential toilets about three times each day for liquid-only flushes. Kohler makes a dual-flush gravity tank water closet that allows a 0.8-gallon flush for liquid-only flushes. This saves 0.8 gallons for each liquid-only flush. This dual-flush toilet and a few others on the market have been tested at the WEC. They work satisfactory.

The cost of replacing existing toilets is not economical. For new construction, however, the cost is reasonable. This option considers installing 250 new residential toilets to increase the population to about 1,803.

**Potable Water-Use Reduction at 1,803 Population: 1,200 gpd**

**WWTF Flow Reduction at 1,803 Population: 1,200 gpd**

**Aesthetic Issue: None**

**Permitting Issues: None**

**Recommendation: Install in all new residences unless a grey-water system is pursued.**

**If a grey-water system is designed for the new residences, still purchase 250-dual-flush gravity tank toilets, but install the units in existing residences and move the existing gravity tank toilets to the new residences. This provides benefits from the water-use reduction in both locations.**

**OPTION F: Reuse WWTF Effluent in Cooling Towers****Description**

The cooling towers currently use about 2,400,000 gallons per year of potable water. A feasibility study was done in 2006 which addressed the health and permitting issues and showed an economic payback of 4.4 years with the current population. With a higher population, the economics are even more favorable. The reduction in WWTF flow counted towards the SPDES permit is seasonal and would only apply if approval is granted to modify the permitted metering location from regulatory agencies.

**Potable Water-Use Reduction at 1,803 Population: 1,500 gpd (January), 6,000 gpd (April), 18,000 gpd (August).**

**WWTF Flow Reduction at 1,803 Population: Same as above if SPDES credit is obtained.**

**Aesthetic Issue: Likely none.**

**Permitting Issues: Need regulatory approval. May or may not get SPDES credit.**

**Recommendation: Apply for Regulatory approval and install if approved. Try to get SPDES credit by moving the official meter for monitoring the WWTF flow to the effluent in the pipe downstream of the location where this water is diverted to reuse.**

**OPTION G: Irrigation with WWTF Effluent****Description**

The WEC already has approval to divert up to 30,000 gpd of WWTF effluent to irrigation use on-site. The current SPDES permit counts this water toward the 165,000-gpd limit and places other restrictions on when and how to irrigate with the effluent. Currently, due to no SPDES credit for irrigating with the effluent water, the cost is the same as using reservoir water, and the cumbersome operating restrictions; the WWTF effluent is not used for irrigation. This option provides additional capacity for population expansion during peak water usage during the summer season. However, it provides no reduction during the winter season.

**Potable Water-Use Reduction at 1,803 Population: None.**

**WWTF Flow Reduction at 1,803 Population: 0 gpd (Winter), 30,000 gpd (Summer) if SPDES credit is obtained.**

**Aesthetic Issue: Likely none.**

**Permitting Issues: Will not get SPDES credit. Restrictions on when and how we can irrigate.**

**Recommendation: Do not pursue this option further. Use as needed to supplement reservoir supply for irrigation even though no credit can be given towards the effluent flow volume from the WWTF.**

**OPTION H: WWTF Effluent Reuse for Toilets in New Residences, Offices, and Locker Rooms****Description**

The WWTF effluent is currently treated to the near potable water use. Microbiologically, virtually all pathogens have been killed. Physically and chemically, the effluent contains slightly more minerals, salts, and organics than potable water. Since the organics in the water provide a food source and absorb oxygen, the WWTF effluent is chlorinated to prevent the development of any discoloration or odors. (Even potable water can develop discoloration and odors if allowed to become stagnant.) WWTF effluent reuse for toilets in new residences, offices, and locker rooms can save significantly more water than dual-flush toilets since all the water for the toilets would be reused.

The main cost of this option is the installation of a separate piping system to supply the toilets. The costs are significantly less if the separate piping is designed and installed during the construction of the buildings. The reduction in WWTF flow counted towards the SPDES permit, however, this would only apply if regulatory agency approval is granted to modify the permit to move the metering location. This approval would likely also involve a variance from the State Plumbing Code.

**Potable Water-Use Reduction at 1,803 Population: 5,000 gpd**

**WWTF Flow Reduction at 1,803 Population: Same as above if SPDES credit is obtained.**

**Aesthetic Issue: Possible odor or discoloration in toilets.**

**Permitting Issues: Need regulatory approval. May or may not get SPDES credit.**

**Recommendation: A reasonable option to consider when the new buildings are built—if SPDES credit can be obtained and more water-use reduction is desired than the above options can provide.**

**OPTION I: Waterless Urinals for High-Use Installations in Men's Restrooms****Description**

The existing urinals use about one gallon per flush. Many manufacturers such as Falcon make waterless urinals that use replaceable chemical cartridges. The cost of the replacement cartridges, however, is substantial (about \$7,000 per year for the 30 urinals considered here). These have been tested at the WEC. They worked but there were complaints of a strong chemical smell from the cartridges and also lack of cleanliness. Because of these problems, some manufacturers have come out with waterless urinals that use proprietary oil instead of a cartridge for the seal. The sealing oil level and freshness is maintained by pouring a bit more in every couple of weeks or so. The Kohler K-4918 model is an example. This option looks at the more economical Kohler model. It is shaped a bit differently than a standard urinal so there may be some extra expense with a retrofit. It has not been tested at the WEC.

There may also be maintenance issues with mineral buildup in the plumbing to low use installations so this option just considers waterless urinals for the high-use areas. A total of about 30 new urinals will be needed for increasing the population to about 1,803. This option considers purchasing 30 new waterless urinals. These would be installed in the highest use areas of both the new and existing men's rooms. This would capture about 50 percent of the liquid flushes at men's rooms during the work day. Existing urinals that would be replaced would be relocated to the low-use areas of the new buildings.

**Potable Water-Use Reduction at 1,803 Population: 1,250 gpd**

**WWTF Flow Reduction at 1,803 Population: 1,250 gpd**

**Aesthetic Issues: Possible complaints from chemical smell. Looks significantly different than a normal urinal. Cleanliness issues.**

**Permitting Issues: None**

**Recommendation: Recommend pursuing Option D (High-Efficiency Urinals) instead since it saves almost as much water, pays off economically, and completely avoids the aesthetic issues.**

**OPTION J: WWTF Effluent Reuse for Toilets in Existing Offices and Locker Rooms****Description**

As described in Option H above, the WWTF effluent is currently treated to near potable water quality. A possibility exists for discoloration or odors. As noted there, a water-reuse system can save significantly more water than dual-flush toilets since all the water for the toilets would be reused. The costs are significantly more for a retrofit than for new construction. However, for offices and locker rooms, the retrofit toilets are concentrated in a few areas.

To supply the WWTF effluent, a non-potable main pipe can be installed through the tunnel system. The plumbing can be modified for the 250 or so existing toilets in the Dining Room lobby toilet rooms, South Services Building, North Services Building, South Office Building, Audio/Video Building, Main Lobby, and Auditorium/ School Building. Retrofitting these buildings is expected to capture about 75 percent of the non-residential restroom use. The reduction in WWTF flow counted towards the SPDES permit, however, this would only apply if we receive approval to modify our permit to move the metering location. We would need approval from regulatory agencies to implement this option. This approval would likely involve obtaining a variance from the State Plumbing Code.

**Potable Water-Use Reduction at 1,803 Population: 4,500 gpd**

**WWTF Flow Reduction at 1,803 Population: Same as above if SPDES credit is obtained.**

**Aesthetic Issue: Possible odor or discoloration in toilets.**

**Permitting Issues: Need regulatory approval. May or may not get SPDES credit.**

**Recommendation: A possible option to consider if SPDES credit can be obtained and more water-use reduction is desired than the above options can provide.**

**OPTION K: Shower Water Collection & Reuse for Toilets in New Residences, Offices, and Locker Rooms****Description**

Option H above described a water-reuse system for toilets using WWTF effluent. This option looks at a centralized system for using water collected from the shower drains. This option costs more since there are significant costs for the separate shower drainage piping in addition to the cost of the separate piping system to supply the toilets. (The costs would be significantly less if the separate piping is installed during the construction of the buildings.)

The water from the showers is likely to have a slight grayish color. This would require the injection of a defoamer chemical and chlorine to minimize problems with suds, odor, and discoloration. A filter system would likely also be needed to address hair removal and miscellaneous particles. Approval from regulatory agencies is required to implement this option. If a variance was not granted from the State Plumbing Code, separate systems would be required for each building, which would increase the costs.

**Potable Water-Use Reduction at 1,803 Population: 5,000 gpd**

**WWTF Flow Reduction at 1,803 Population: 5,000 gpd**

**Aesthetic Issue: Possible suds, odor, or discoloration in toilets.**

**Permitting Issues: Need regulatory approval.**

**Recommendation: Generally NOT RECOMMENDED due to concerns over appearance of water and maintenance issues with filters. Only consider this option if SPDES credit cannot be obtained for WWTF reuse and we want to allow for the most flexibility on-site.**

**OPTION L: Laundry Recycling System with Potable Water Make-up****Description**

The Laundry currently uses about 5,300,000 gallons per year of potable water. The Laundry has expressed interest in installing a softener or filter to address an ongoing problem with garment discoloration. A feasibility study was done in 2007, which included a review of the garment discoloration as well as treatment and recycling equipment that could be installed. A number of options were reviewed—many of which involved recycling a significant amount of water. One of those options (designated “3D” in that study) involved a laundry recycling system supplemented with potable water make-up that could reuse 80 percent of the water and had a life-cycle cost and garment quality that was comparable with the non-recycling option.

**Potable Water-Use Reduction at 1,803 Population: 15,500 gpd**

**WWTF Flow Reduction at 1,803 Population: 15,500 gpd**

**Aesthetic Issue: Possibly not quite as good garment quality as with softening and filtration without recycling. (Garment quality may be better than current situation.)**

**Permitting Issues: None**

**Recommendation: A good option to consider if it is decided to install softening and filtration for the Laundry. A reasonable option to consider if more water-use reduction is desired than the above options can provide.**

**OPTION M: High-Efficiency Urinals Retrofit for the Low-Use Urinal Locations Not Included in Option D****Description**

The existing urinals use about one gallon per flush. Zurn makes a high-efficiency urinal that uses only 1/8-gallon per flush. These have not been tested at Patterson but indications are that they work satisfactorily. This saves 7/8 gallon for each liquid-only flush. (Vitra makes a similar 1/4-gpf urinal.) The cost of replacing existing urinals is not as economical as new construction. There are concerns of mineral buildup in piping for such low use urinals. This option considers replacing the 72 existing urinals.

**Potable Water-Use Reduction at 1,803 Population: 1,100 gpd**

**WWTF Flow Reduction at 1,803 Population: 1,100 gpd**

**Aesthetic Issue: Possible pipe blockages and overflows after several years of operation.**

**Permitting Issues: None**

**Recommendation: Generally NOT RECOMMENDED due to concerns over mineral deposits in waste piping behind the wall.**

**OPTION N: Laundry Recycling System with WWTF Effluent for Make-up, Cooling Towers, and Toilets in New Buildings****Description**

This is the option designated “5K” in a previous feasibility study. It combines the above Options F, H, and L into one comprehensive system.

**Potable Water-Use Reduction at 1,803 Population: 26,500 gpd (January) and 43,000 gpd (August).**

**WWTF Flow Reduction at 1,803 Population: 15,500 gpd plus possibly an additional 11,000 SPDES credit (January). (Possibly an additional 27,500 SPDES credit in August.)**

**Aesthetic Issue: Possibly not quite as good garment quality.**

**Permitting Issues: Need regulatory approval.**

**Recommendation: This option would only be considered if additional water conservation was necessary.**

**OPTION O: WWTF Effluent Reuse for Toilets in Existing Residences****Description**

As described in Option J above, retrofitting existing buildings for non-potable piping is significantly more expensive than for new construction—especially in residences. There is, however, a possibility to save a significant amount of water since all the water for the toilets would be reused. This option looks at extending a non-potable main pipe from the offices to the existing residence buildings and Patterson Inn and modifying the plumbing for the 900 or so existing toilets in the residence buildings and Patterson Inn, including the tub rooms.

The reduction in WWTF flow counted towards the SPDES permit, however, this would only apply if we get approval to modify our permit to move the metering location. We would need approval from regulatory agencies to implement this option. This approval would likely involve obtaining a variance from the State Plumbing Code.

**Potable Water-Use Reduction at 1,803 Population: 10,400 gpd**

**WWTF Flow Reduction at 1,803 Population: Same as above if SPDES credit is obtained.**

**Aesthetic Issue: Possible odor or discoloration in toilets.**

**Permitting Issues: Need regulatory approval. May or may not get SPDES credit.**

**Recommendation: We would likely only consider this option if we were desperate to reduce water usage and SPDES credit could be obtained for WWTF effluent reuse.**

**OPTION P: Dual-Flush Gravity Tank Toilets Retrofit in Residences****Description**

The existing gravity tank water closets in the residences use 1.6 gallons per flush. Kohler makes a dual-flush gravity tank water closet that allows a 0.8-gallon flush for liquid-only flushes. This saves 0.8 gallons for each liquid-only flush. This dual-flush toilet and a few others on the market have been tested at Patterson. They work well. The cost of replacing existing toilets is not nearly as economical as for new construction. This option considers replacing the 800 existing residential toilets.

**Potable Water-Use Reduction at 1,803 Population: 3,100 gpd**

**WWTF Flow Reduction at 1,803 Population: 3,100 gpd**

**Aesthetic Issue: None**

**Permitting Issues: None**

**Recommendation: This option would only be pursued if we were desperate to reduce water usage and SPDES credit was not granted for WWTF effluent reuse.**

**(Note: If an existing toilet needs to be replaced anyway, it would be good to replace it with a dual-flush toilet. In that case the slight extra cost for dual flush is warranted by the water savings.)**

## PROJECTED WATER USAGE VERSUS GREEN GLOBES™ TARGETS

The recommendations above provide definite reductions in water usage. The reduction will assist in obtaining Green Globes™ certification. In deciding whether to pursue some of the options, it is helpful to compare the projected water usage in comparison to the Green Globes™ targets. This section looks at projected water usage for our new buildings and how those compare to the targets.

### Residential Buildings

With the existing residence buildings (2.5-gpm showerheads, 2.5-gpm kitchenette sink and bathroom sink, 1.6 gpf toilets, Maytag washing machines in personal laundries, 10 percent of beds empty) the current use per apartment is about 21,000 gallons per year. The Green Globes™ goal of 11,000 gallons per year per apartment would require a drastic reduction in water use to roughly half of the current residence building usage.

For that reason in the study presented above, the proposed new residences implement the following building reductions:

- Option A—1.5-gpm showerheads (projected 4,800 gallons per year per apartment reduction).
- Option C—Water conserving washing machines for personal laundries (700–1,200 gallons per year per apartment reduction depending on model chosen—Wascomats/Mieles).
- Option E—Dual-flush toilets (1,600 gallons per year per apartment projected reduction).

If Options A, C, and E are implemented, which have reasonable economics, the water usage reduction is expected to be approximately 13,400 gallons per year per apartment. This is close to the most stringent Green Globes™ target for residential buildings of 11,000 gallons per year per apartment but does not quite meet it. To meet this Green Globes™ target, Option H would be required, which is WWTF effluent recycling for toilets instead of dual-flush toilets. If all four options were implemented, the water usage could be reduced to about 9,800 gallons per year per apartment. However, due to unfavorable economics and the need for a variance from the Plumbing Code and DOH/DEC approval, this option cannot be assured at this time. Therefore, the reduced Green Globes™ goal of 33,000 gallons per year per apartment would be pursued instead.

### Other Buildings

The existing WEC Office Building has approximately 154,400 square feet of floor space with offices for about 400 people. The water meter records for the building show current use of about 11,000 gallons per week of cold water. In addition, hot water for sinks use about 4,000 gallons per week. (The hot water is not separately metered for the building.)

This calculates out to (11,000 + 4,000 gallons per week) times 52 weeks per year divided by 154,400 square feet equals 5 gallons per square foot per year, which is about half the 10 gallons per square foot per year Green Globes™ target.

For the new proposed building space part of the water conservation study, further reductions are expected from the use of high-efficiency urinals and dual-flush toilets. This is expected to drop the usage by 20 percent to about 4 gallons per square foot per year for a typical new office building.

The existing North Services Building and Audio/Video Building similarly have water usages that are well below the 10 gallons per square foot per year Green Globes™ target.

The existing Kitchen/Dining Room, South Services, and Powerhouse buildings, on the other hand, have significantly higher water usage. While these buildings are not part of the proposed site amendment, the Owner will be looking at voluntary measures to reduce water consumption in these buildings as well.

Since the new non-residential buildings being considered at this time are in the Office/Maintenance category, it appears that the mechanical design can meet the 10 gallons per square foot per year Green Globes™ goal for the proposed new non-residential buildings.

# ENGINEER'S REPORT

WATER SOFTENING FACILITY

WATCHTOWER EDUCATIONAL CENTER  
TOWN OF PATTERSON  
PUTNAM COUNTY, NEW YORK

MARCH 12, 1996





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## I. GENERAL INFORMATION & BACKGROUND

The Watchtower Educational Center (WEC) is a Bible educational complex on a portion of 600-acres of property located on Route 22 in Patterson, NY. Although still under construction, the complex currently has 20 buildings and over 800 residents. In the future over 1600 residents could be accommodated.

The potable water needs of the complex are served by a series of five wells located throughout the property. These wells can supply 230 gpm (twice the average day demand) with the largest well out of service. A small water treatment plant is presently in operation at the complex. Treatment consists of pH adjustment and chlorination.

The existing water treatment plant has been in operation for approximately 4 years. During this time facility personnel have had to mitigate problems in heat exchangers at the complex caused by calcium and magnesium hardness. Temporary mitigation of the effect on specific equipment is being achieved by means of point-of-use water softeners (Culligan).

For the permanent solution, the WEC has proposed a Water Softening Facility (WSF) that will incorporate lime / potassium carbonate softening and filtration. (This technology was chosen over ion-exchange because of anticipated limits on the total dissolved solids of our Waste Water Treatment Facility (WWTF) effluent.) It is expected that the new facility will greatly reduce the hardness of the water, improve its quality, and thus eliminate the undesirable effects of non-softened water at the complex. As a side benefit, it is expected that the installation of the water treatment facility will also allow for the possible future treatment of surface water.

The purpose of this Engineer's Report is to provide an addendum to the original Watchtower Educational Center Engineering Report for the Water Supply, Treatment, and Distribution as dated 11/7/88 and revised 9/4/89. This addendum supports the application (Form 296) for approval of plans for Public Water Supply Improvement. Although several features of the plans reflect a possible future treatment of surface water, at this time approval is only being sought for use of the plant as a groundwater softening facility.

The NYSDEC permit for the water supply and distribution system was issued 8/11/89. The NYSDOH issued approval of completed works 11/6/90 for phase I which included well #2 and #4, the water treatment plant, and the water supply and distribution system to serve the hotel, dining room, and construction related facilities. The NYSDOH then issued subsequent approval of completed works 5/18/92 for Phase II of the project which includes all the remaining works as per plans approved on 12/20/89 under [NYSDOH] log #6142-5 for which no completed works approval was issued on phase I. This allowed use of well #6, and sand and gravel wells #1 and #2. The temporary Culligan water softening systems were approved for use by NYSDOH on 2/14/94.

At a preliminary meeting with Mr. George Philip of NYSDOH in Albany on 12/15/93 we were directed to perform a pilot study of the proposed technology (CBI Walker ClariCone solids

contact units with Decel gravity filters) for the permanent water treatment plant adjustments. This study was endorsed by George Philip of the New York State Department of Health and was conducted from March 29 to July 14, 1994. The results of the pilot study were summarized in a report entitled "Water Softening Pilot Study Report" dated July 25, 1994 which was submitted to NYSDOH on 9/2/94 along with a sheet entitled "Equipment Sizing for Full Scale Design". On 10/4/94, NYSDOH endorsed this report and the full scale design parameters. Copies of these documents are included in the appendix.

## II. TREATMENT PROCESS CONSIDERATIONS

### A. OVERVIEW

The basic process to be implemented is Lime / Potassium Carbonate Softening. The process equipment and workspace will occupy approximately 7000 ft<sup>2</sup> of a proposed new 10,000 ft<sup>2</sup> building which is to be located adjacent to the existing water treatment plant. (See drawings for plans showing the location and layout of the new building and a Process & Instrumentation Diagram for the new facility.)

The treatment process consists of the following sequence of steps: 1) raw water blending, 2) chemical injection, 3) rapid mix, 4) flocculation, 5) clarification, 6) pH adjustment, 7) filtration, 8) alkalinity adjustment, 9) chlorination, and 10) storage. In addition to these basic steps, there will be equipment for: chemical storage, handling, and feed; sludge storage, thickening, and dewatering for the sludge from the solids contact unit and the filters; filter backwash supply, settling tanks, and supernatant recycle; and sampling and monitoring.

The design basis for the plant is 230 gpm which corresponds to double the average day demand (2 x 165,000 gpd) with the plant operating continuously. The justification for these figures is presented in the original engineering report for the water supply. The new plant will actually be capable of higher flowrates to account for periodic maintenance and potential future expansion. The plant will also be capable of operating with a daily startup and shutdown to allow for greater flexibility. Provision will also be made to allow for a possible future conversion of the plant to surface water treatment.

### B. RAW WATER BLENDING

Raw water blending is necessary to maintain a stable chemistry in the process. Each of the wells has a different degree of hardness and alkalinity. The chemical dosage necessary to soften the water varies with how much hardness and alkalinity is present in the raw water. If the raw water chemistry kept changing as different wells were pumped, it would be very difficult to properly dose the chemicals to soften the water. The raw water blending tanks prevent this problem by providing a place to maintain a fixed blend of raw water from the wells. When the level is low in the blending tanks, both the well #2 pump and the pump from the existing surge tank are turned on simultaneously thereby blending together at a fixed ratio. Both pumps stay on until the tank is full. Two tanks are provided to allow for periodic cleaning. Each tank is sized at over 14,000 gallons which corresponds to a two hour detention time at average flow with one tank in operation.

### **C. SOLIDS CONTACT UNIT (CLARICONE)**

Chemical injection, rapid mix, flocculation, and clarification are all accomplished in the solids contact unit (CBI Walker ClariCone). Three 12 ft diameter cones will be installed. Room will be left in the building for the addition of a future fourth cone for expansion. (This sizing is consistent with the preliminary design parameters which were endorsed by NYSDOH following the pilot study.) Water is pumped from the raw water blending tanks to a 24 ft high (18 inch diameter) "head tank" which provides the height necessary to allow gravity flow through the solids contact unit and filters to the existing clearwells. The variable speed pumps will be controlled by a level sensor in the head tank. The head tank also serves to remove gas bubbles and prevent backflow when the unit is shut down. The chemicals (lime, potassium carbonate, and anionic polymer) are injected at the base of the cone where a swirling action thoroughly mixes the chemicals with the raw water in the presence of a sludge blanket of previously formed solids. (The pilot study showed that an extra mechanical mixing chamber ahead of the cone is not necessary.) This rapid mix zone at the base of the cone is where the softening actually takes place. The degree of softening is controlled by the amount of lime and potassium carbonate injected at this point. In the middle of the cone is the flocculation zone. Gentle mixing in this zone allows the solids to grow to a size large enough to settle out. The anionic polymer helps the particles to grow to the proper size. The top of the cone is the clarification zone where the solids settle out and the clear softened water overflows the helical notch weir at the very top. (The pilot study demonstrated the effectiveness of the helical notch weir.) As the water flows through the cone, solids build up in the sludge blanket. Lighter solids are removed every few hours from the top of the sludge blanket by the automatic opening of a valve connected to a concentrator at the center of the cone. Heavy solids are removed every few days by opening a valve connected to the base of the cone. These solids flow by gravity to the sludge storage/thickening tanks where they are processed further.

### **D. PH CORRECTION**

When the softened water leaves the cone, it is highly alkaline (pH ~ 11). This is corrected by injecting sulfuric acid in the pipe between the cone and the filters. A pH controller regulates the amount of acid injected to maintain the set point pH. This pH set point will be operator selected to maintain a Langelier Saturation Index of approximately 0.5 for the finished water. The controller will be of a type to minimize the need for operator adjustments as the process conditions change. The water is pH corrected before the filters to avoid forming mineral deposits on the sand which could eventually cement the media into a solid block.

To adequately blend the acid into the water, a static mixer will be placed between the injection point and the pH probe. The static mixers will be of a high efficiency design to allow adequate mixing over a wide range of flowrates (from 50gpm to 480gpm). Two acid injection points, static mixers, and pH probes will be installed in the piping manifold to allow for maintenance without shutting down the plant.

## **E. FILTRATION**

Two dual-cell rectangular Decel filters will be installed (total of four filter cells). Each filter cell is 5' x 4.5' at the top of the media. Room will be provided in the building for the addition of a future dual-cell filter to accommodate expansion. (This sizing is consistent with the preliminary design parameters which were endorsed by NYSDOH following the pilot study.) To allow gravity flow through the filters, they are located at a lower elevation than the cones. As water flows through the filters, they become loaded with solids. As this occurs, the water level inside the filter rises to maintain the same flowrate through the filter. During the (manually initiated) backwash of a filter cell, the flow is split among the remaining filter cells. (An equal flow split between the filters is assured by the inlet trough weirs.) The backwash water is supplied from the high level storage through pressure reducing valves. The backwash waste water (containing all the solids) is sent to the upper zone of the sludge tanks. There, the solids settle out and fall to the bottom zone of the tank. The upper zones of each of the two sludge tanks will contain at least 7,500 gallons. This size allows for backwashing a filter cell at 20 gpm/ft<sup>2</sup> (based upon the 25 ft<sup>2</sup> area at the bottom of the media) for 15 minutes. The supernatant is then decanted to supernatant storage tanks and then recycled through the cones at up to 10% of the raw water flowrate. (Any solids which accumulate in the supernatant storage tanks would be pumped to the sludge tanks).

A level control loop in the pipe leaving the filter ensures that the filter media (1 ft of anthracite on 2 ft of sand) is always kept under water to prevent "air binding". Automatic valves will be used to operate the filters. These will have a manual override at the valve and operating controls on the level above the filters. Slow opening valves will be used for the filter backwash to allow time for the sand/anthracite media to fluidize. Air scour will be used to thoroughly clean the filter media. A low pressure blower in the building will supply the air. Backwash water flowrates can be set by the operator. Each filter will be provided with influent and effluent sample taps, an indicating rate-of-flow meter, and a graduated tape inside the filter (visible from the deck) to indicate the loss of head. An effluent sample line and pump will also be provided for each filter to allow continuous monitoring of turbidity. As a provision for possible future treatment of surface water, filter-to-waste valves and piping are installed on each filter.

## **F. CORROSION CONTROL / DISINFECTION**

The final treatment steps are to inject sodium bicarbonate (corrosion control) and sodium hypochlorite (disinfection). The sodium bicarbonate is added after the filters to raise the alkalinity in the finished water. (For adequate corrosion protection, total alkalinity levels above 40 mg/l as CaCO<sub>3</sub> are recommended.) This is the final step in adjusting the Langelier Saturation Index. The alkalinity is not raised until after the filters to avoid precipitating calcium carbonate on the filter media. (This problem with bicarbonate addition before the filters was noted in the pilot study.) At this point, there is also a provision for injecting potassium carbonate to allow for more precise control of the finished water pH.

The existing water treatment plant has provisions for injecting a metered dose of sodium hypochlorite in the piping between the clearwells and the high level storage tank. There is also a chlorine residual analyzer to monitor the residual of the water coming from the high level storage tank on its way to the distribution system. This analyzer controls a second hypochlorite metering pump to maintain the desired residual (approximately 0.5 ppm) in the distribution system piping. These two injection points will continue to be used after the new facility comes on-line. Several auxiliary injection points are also included for operational flexibility. The existing drum storage and metering pumps will be moved into the new facility to make the chemical handling more convenient.

## **G. WATER STORAGE**

The existing clearwells and high level storage are sufficient to handle the needs for storage of treated water. No new storage facilities are to be built in connection with these improvements of the water treatment plant.

## **H. CHEMICAL STORAGE, HANDLING, AND FEED**

Space is allocated for at least one month's storage of all chemicals. All chemical feed systems are designed with redundancy or spare parts on hand to allow for continuous operation of the plant. Provision will be made for flow proportional dosing of all chemicals (except the acid which is controlled by the resulting pH). A drum wash room, eyewash station, and safety shower will be provided. The powdered chemicals will be stored and fed with equipment that will minimize stirring up excessive dust during handling.

Hydrated lime will be obtained in bulk bags (supersacks) which will be stored on pallets. Approximately 12,000 pounds will be used each month. The bulk bags will be placed on a frame and connected to a volumetric screw feeder. Automatic controls will activate the feeder and water supply to maintain a constant strength "milk of lime" suspension (approximately 5% solids) in a small mixed tank. A recirculation system will transfer the milk of lime to the base of each cone where a peristaltic metering pump will provide the correct dosage. (This recirculation / peristaltic system was found to work well in the pilot study.) A 1500 pound bulk bag will last for over three days. Larger bags (up to 3000 pounds) will fit on the frame and may be more convenient to use. A sensor will alert the operator when a bag needs to be replaced. Plant water (i.e. soft water isolated from the distribution system with a backflow preventer) will be used to make the "milk of lime" to avoid excessive scale formation in the recirculation piping.

Potassium carbonate will be obtained in 50 pound bags on pallets. Approximately 3000 pounds will be used each month for full softening to 50 ppm. (Partial Softening to 100 ppm will require less potassium carbonate.) Two 100 gallon tanks and mixers will be provided for preparing and storing the solution. (200 gallons at 45% strength will last for over 11 days.) Metering pumps will provide the correct dosage to the base of each cone.

Anionic polymer (emulsion type) will be obtained in 5 gallon buckets. Approximately 5 gallons will be used each month. A special feeder will be provided under each Cone to properly activate and dilute the concentrate from the bucket. Flow proportional dosing will be achieved by a 4-20 mA signal to these feeders.

66° Baume Sulfuric Acid (93.2%) will be obtained in drums (approximately 45 gallons each). Approximately 5 drums will be used each month. They will be stored in a special room designed for corrosion resistance and containment. The floor of the room (flush with the main floor level) will be a corrosion resistant grating. Below the grating is the spill containment area which slopes to a sump for removal of any spilled acid. The containment area is over 3 inches deep and will easily contain the contents of an entire drum. An eyewash/safety shower will be located by the acid room. Metering pumps will be mounted directly above the drums. A pH controller will ensure proper dosing of the acid. An injection quill immediately before a static mixer will insure rapid mixing of the concentrated acid in the water flowing through the cone effluent manifold. The piping system will be designed to handle the corrosiveness of the acid.

Sodium bicarbonate will be obtained in 50 pound bags on a pallet. Approximately 3000 pounds will be used each month. Two 360 gallon tanks and mixers will be provided for preparing and storing the solution. (720 gallons at 7% will last almost 5 days.) Metering pumps will provide the correct flow proportional dosage. The bicarbonate will be fed into the filtered water line between the filters and the clearwells to avoid solids deposition on the filter media. (The pilot study showed that this is the best location for injecting the bicarbonate.)

Sodium hypochlorite will be obtained in 55 gallon drums. One drum will last about a month. The Hypochlorite will be stored in a special room designed for corrosion resistance and containment. Metering pumps will be mounted on a shelf directly above the drums. The existing injection points (clearwell pump discharge and the metering pit by the residual analyzer) will continue to be used in normal operation. Several auxiliary injection points are also included for operational flexibility.

Another special room designed for corrosion resistance and containment will be provided for future storage and feeding of liquid alum and cationic polymer. These chemicals would only be used if surface water is treated in the future.

## **I. SLUDGE HANDLING EQUIPMENT**

As mentioned above, sludge from the cones and filter mudwells will be collected in sludge storage / decant tanks. The two cylindrical tanks will be fabricated from carbon steel and located in a vault below the main floor level. There are two zones in each tank that are separated by a cone-shaped baffle. The upper zone is for settling while the lower zone is for sludge storage. The inside of the tanks will be visible from the main floor level through a grating. A curb will be provided around the grating. The bottom zone of each tank will be able to store at least 5000 gallons of sludge. At 10% solids, each tank will be capable of storing over 5 days worth of sludge from the cones. Centerline mounted axial mixers and baffles will be provided in these tanks to provide complete solids suspension of the bottom zone. Compressed air agitation will be used as

necessary to assist in startup of the mixers. This allows the operator to save energy by operating the mixer only as often as needed. Variable speed motors on the mixers will be used to allow the operator to save energy by providing only as much mixing as necessary.

One 30 ft<sup>3</sup> filter press will be provided for dewatering the sludge. The dewatered sludge will fall from the press into a dumpster for hauling. Provision will be made for sending the clear filtrate either back to the upper zone of the sludge storage tank (to maintain the level) or to the supernatant storage tanks (for recycling to the cone). Samples of the sludge from the pilot test were sent to JWI, Inc. and Netzsch, Inc. to evaluate the performance of a filter press for dewatering. The reports (see appendix) showed that a 100 psi press does an excellent job on the sludge without any conditioning. Provision will also be made for pumping the sludge to a truck. In addition to providing a backup system for handling the sludge, this may be useful if permission for land application of the sludge is granted at a future time.

## **J. SAMPLING AND MONITORING**

Provision will be made for sampling and monitoring of the treatment process to properly operate the plant and to provide a record of the quality of the water produced. Sample lines from the Cones will flow by gravity to a sampling room in the basement. A solenoid valve will close the sampling line when there is no flow. Filter effluent sample lines and pumps will be provided for each filter cell. These will also be routed to the sampling room. The pumps will shut off when there is no flow. Any of these sample lines described above can be directed to one of two continuous turbidimeters. A third continuous turbidimeter will be permanently connected to a pumped sample line from the combined filter effluent manifold. This turbidimeter will have an alarm to alert the operator if the effluent turbidity exceeds the set point. Turbine-type flowmeters will be installed at the inlet of each cone. The high accuracy of this type of meter is needed for accurate flow proportional chemical dosing across the entire range of flowrates. Paddlewheel-type flowmeters will be used at the outlet of each filter cell to allow monitoring of filtration rates. A turbine-type flowmeter and manual valve will be provided in the backwash water supply line to monitor and control backwash flowrates. pH probes will be located in each cone, after the acid injection points, and in the finished water piping. Chlorine residual monitoring is already provided for the water entering the existing distribution system. Since our groundwater does not have a significant chlorine demand, hypochlorite dosing is based strictly on flow, and therefore does not require an additional chlorine residual monitor in the new facility. Level sensors will monitor for overflow conditions in the cones and filters. Alarm signals from some of these instruments will be used to automatically shut down the plant and alert the operator on call during unattended operation. In addition to the sample lines described above, sample taps will be located at the raw water inlet manifold and on the influent line to each filter cell. These will allow monitoring of various parameters including calcium hardness, total hardness, total alkalinity, phenolphthalein alkalinity, temperature, turbidity, and iron.

## **K. PIPING**

Schedule 80 PVC will be used for the majority of the process piping inside the new facility. This will avoid problems with corrosion from the water before it is adjusted to the final pH, hardness, and alkalinity.

## **L. PROVISIONS FOR SURFACE WATER (FUTURE)**

To allow for the possible future conversion of the plant to surface water treatment, the following provisions will be made:

- \* A special corrosion resistant containment room for storage and feeding of liquid alum and cationic polymer from drums.
- \* Separate level control loops, filter-to-waste valves & piping, air scour, and sample lines for monitoring turbidity at each filter cell.
- \* Space allocated for pilot testing equipment and the potential need for a fourth cone and a third dual-cell filter.
- \* Provision for handling backwash water and sludge in the event that the water cannot be recycled.
- \* Provision for injecting hypochlorite into each cone.
- \* A Hypalon barrier between the raw water tank walls and existing clearwell tank walls to meet NYSDOH requirements.

### III. PROGRAM TO MINIMIZE INTERRUPTION OF SERVICE

During construction of the Water Softening Facility, work on the existing water system will involve: 1) the installation of valving to allow the new softening facility to be either brought on-line or bypassed at the operator's discretion, and 2) lowering the 3" and 4" water lines to avoid a conflict with a tunnel in the area of the new building. The 405,000 gallon high level storage tank will provide water to the distribution system during this brief interruption of water plant operation.

The affected piping will be disinfected according to AWWA procedures before being returned to potable water service.

#### IV. PROTECTION OF THE WATER SUPPLY

The following measures in connection with the design of the new facility will serve to protect the water supply from contamination:

1. Contamination from waste piping will be prevented. This will be accomplished by means of air gaps for all connections to the sewer.
2. All underground water supply piping is located at a sufficient distance from existing and proposed sewers. (At least 10 ft horizontal separation for parallel installation and at least 18 in vertical separation at crossings.)
3. No cross connections exist between the finished water and any raw or partially treated water.
4. A "plant water" piping system will be used to provide pressurized water for washdown of equipment, flushing of sludge & chemical lines, and dilution water for preparing chemical solutions. This "plant water" piping system will be isolated from the potable distribution water by means of a backflow preventer.
5. The backwash water supply will be isolated from the potable distribution water by means of a backflow preventer.
6. Four inch curbs are placed around access hatches to the mudwells and raw water blending tanks. A four inch curb is also provided around the grating above the sludge storage tanks.
7. The lowest elevation in the water softening facility is 714.00 whereas the flood plain is at 430.00. It is well above both the 100 and 500 year flood plain and over 1,000 feet from the nearest stream (Mountain Brook).
8. Chemical injection will be done with pumps which are designed to prevent overfeeding due to siphoning.
9. All new piping and equipment will be disinfected according to AWWA procedures before being put into potable water service.

## V. SUPPORT FACILITIES

Support facilities for the new water treatment facility include the following:

### A. LABORATORY

The WEC WSF/WWTF laboratory is being relocated from the wastewater control building to a separate building at that location as shown on the Laboratory Plan (see appendix). The laboratory layout is as shown to George Philip of NYSDOH on 12/15/93. It features the use of separate titration equipment for water and wastewater tests. Plant control tests are typically performed here by trained lab technicians. Analyses conducted to determine compliance with drinking water regulations are performed by a NYSDOH certified lab. Some space is also provided in the new water softening facility where some lab work can be performed.

### B. ELECTRICAL CONTROLS

The electrical room and control room are located on the floor above the ClariCones. In the event of catastrophic rupture of a tank, flooding of the electrical controls will not occur.

### C. STANDBY POWER

Standby power will be provided from the emergency generation system located at the on-site power house about 100 feet south of the proposed water works addition. This activates within 20 seconds of a public power outage. However the high level tank already contains 405,000 gallons of finished water available by gravity to the WEC. Thus emergency power should not need to be supplied for power outages of a few hours, but it is provided anyway.

### D. COMPRESSED AIR

High pressure (100psig) compressed air for the water softening facility will be supplied from a central system in the on-site power house. In addition to pneumatic valves, compressed air needs will involve diaphragm pumps, a filter press, air agitation for sludge tank mixer startup, and air agitation for the mudwells during sludge pumping.

A low pressure blower (5psig) located in the water softening facility will be used for air scour of the Decel filters.

### E. SHOP SPACE AND STORAGE

A work shop and parts storage area is provided along with both a metric and U.S. standard tool set. Sufficient work bench space and task lighting are available to perform maintenance repairs on pumps and feeders. Since the main plant floor elevation is the same throughout, work can also be performed at the various equipment locations.



# APPENDIX A



WATCHTOWER EDUCATIONAL CENTER

ENGINEERING REPORT

WATER SUPPLY, TREATMENT, AND DISTRIBUTION

PATTERSON, NEW YORK  
7 November, 1988

Revised 4 September, 1989

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APPENDIX A Preliminary Network Analysis

APPENDIX B Reports by C.A. Rich Consultants, Inc. Well Pumping Tests, Water Quality Analyses, and Well Driller's Logs

APPENDIX C Pump Selection and Head Loss Calculations

WATCHTOWER EDUCATIONAL CENTER

ENGINEERING REPORT

WATER SUPPLY, TREATMENT, AND DISTRIBUTION

PATTERSON, NEW YORK

November 7, 1988

Revision - September 4, 1989

A. DESCRIPTION OF PROJECT:

1. General:

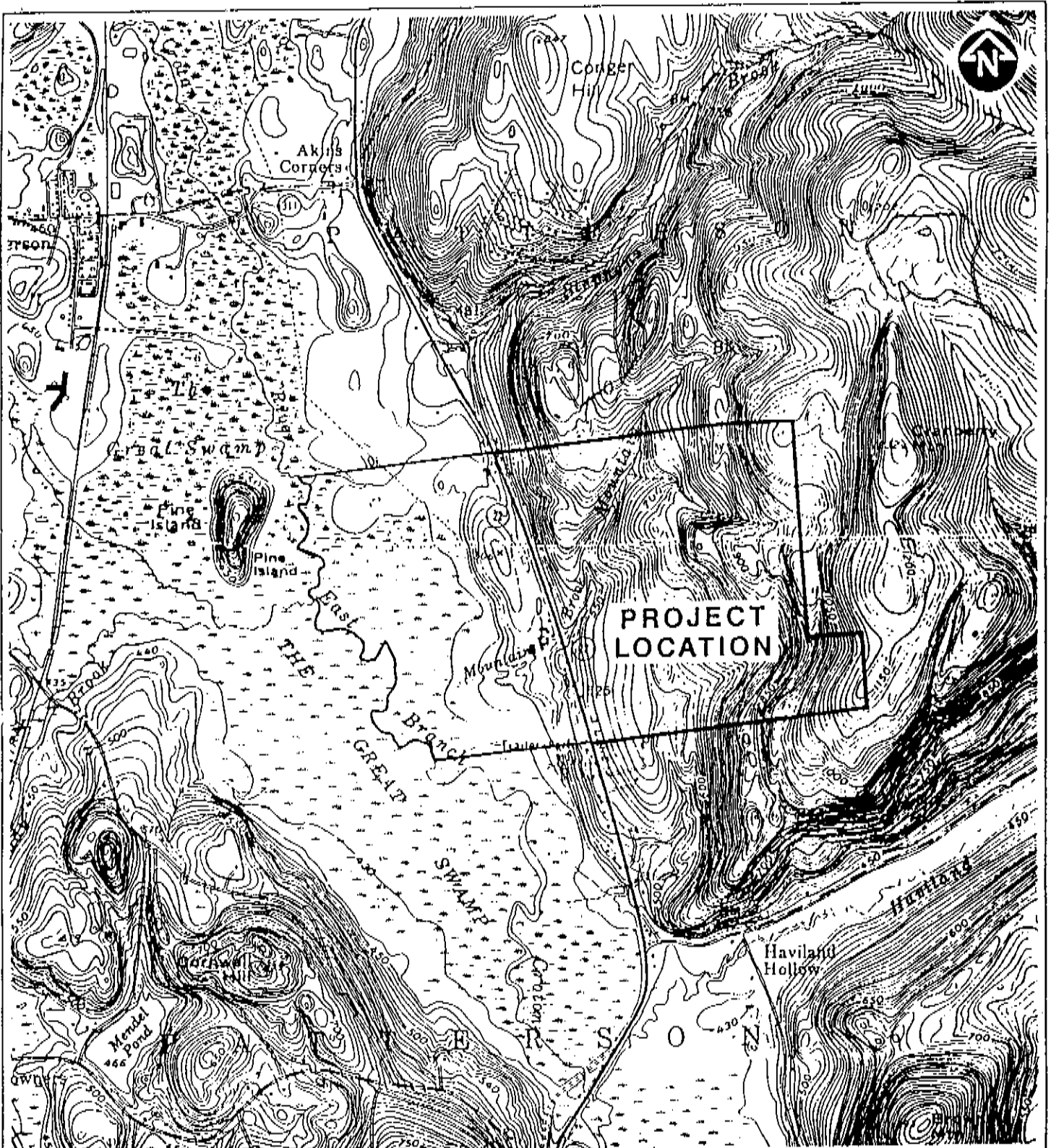
The project consists of an educational center on a 375 acre parcel east of Route 22, having approximately 624 one bedroom apartments to house a resident population of 1224 student, administrative, and support personnel. A central dining facility and central laundry as well as various administrative and support facilities are planned as part of the development. A 152 room hotel will also be constructed and operated on an adjoining 12 acre parcel, which will initially house construction workers for the educational center. The project location is shown on the attached Figures 1-1 and 3-1 extracted from the Environmental Impact Statement for the project.

2. Water System:

A site plan for the proposed educational center and hotel development is shown on Sheet D1. Water supply and wastewater aspects of the project will be developed on-site, because municipal or other alternative services are not available in the area. Subsurface sources of water supply will be developed in sufficient quantity to meet projected water requirements.

The subsurface source will consist of three rock wells east of Route 22 and two sand wells west of Route 22 which have been recently drilled. A system of force mains will transport the water from the wells to a common clearwell for chlorination prior to lifting to the high level storage tank, as shown on Sheet D1. Due to the low elevation of the two northern wells near Route 22, and the sand wells, these will pump to a small surge tank where the combined flow will be pumped to the clearwell. Profiles of the force mains are shown on Sheets C4.38 and C4.39.

Test results for well water quality and quantity based on concurrent pumping tests for the three rock wells together and the two sand wells together are presented in Appendix B of this report. A water treatment plant will be constructed to provide for control of the pumping, clearwell storage, and disinfection systems, as shown on Sheet D12. Facilities for chlorination of the well water prior to storage, and chlorine residual control in the distribution system will be provided at this building. The hypochlorite form of chlorination will be used consistent with Putnam County Department of Health requirements. Based on well water analyses from the pumping test samples, no treatment of well water other than chlorination for



SOURCE: U.S.G.S. 7.5 min. Topographic Quadrangles;  
 Brewster, NY-CT; Pawling, NY-CT

SCALE	1"=2000'
DATE	5/87
OWN BY	RAP
CK'D BY	
JOB NO.	
PRINT DATE	

SHEET TITLE SITE LOCATION PLAN	
PROJECT TITLE WATCHTOWER EDUCATION CENTER PATTERSON, NEW YORK	
<b>WATCHTOWER</b>	
BIBLE & TRACT SOCIETY OF N.Y., INC. 26 COLUMBIA HEIGHTS BROOKLYN, N.Y. 11201 U.S.A.	

FIGURE NO.
1-1



disinfection is anticipated to meet drinking water standards.

No waste streams are contemplated from the water treatment plant. The wastewater system is described in the report entitled "Watchtower Educational Center, Wastewater Collection, Treatment and Disposal" dated December 7, 1987 (Revised August 1, 1989) and included with the documentation submitted to the Putnam County Department Health on August 7, 1989.

The water supply system sufficient to satisfy the needs of the hotel will be constructed initially, to provide for the workers who will be engaged on the construction of the educational center. This initial system will include the wells, well water collection system and distribution system as needed, the water treatment plant and the high level storage tank. These facilities will be sized to meet both the domestic water and fire water requirements for the full development, but construction of those features not needed for occupancy of the hotel, such as portions of the distribution system and some of the well pumps and piping, may be deferred until needed. Well 4 will supply sufficient water to meet initial needs before the hotel is occupied. Well 2 will be placed in operation before the hotel is occupied, followed by Well 6 as needed. Finally, the sand wells will be brought into operation before the educational center is occupied.

B. WATER REQUIREMENTS:

The demand for water for this project will consist of domestic requirements and fire protection needs. The domestic requirements will be based on the number of persons served and their daily life pattern. The type, size, use and proximity of the buildings determine the fire protection needs.

## 1. Domestic Requirements:

The following is a summary of the estimated average daily domestic water demands:

<u>EDUCATIONAL CENTER</u>	<u>POPULATION</u>	<u>UNIT FLOW, gal/cap.d</u>	<u>TOTAL FLOW, gpd</u>
624 one bedroom apts.	1224	100	122,400
Central laundry	1224	10	12,240
Visitors	125/d	20	<u>2,500</u>
			137,140
<u>HOTEL</u>			
152 rooms (with kitchenettes)		150/rm.	22,800
Laundry, 5 machines		400/mach.	<u>2,000</u>
Total			161,940
Use 165,000 gpd for design			

The unit flow of 100 gal/cap.d is based on actual consumption at a similar facility, Watchtower Farms, near Wallkill, N.Y. The use there has averaged between 90 and 110 gal/cap.d over the past eight years, as shown in Table 1. This includes the water consumed in the cannery, slaughterhouse and other non-domestic uses at the Farm, which uses will not exist at the proposed location. Also, water-saving toilets will be required at Patterson, whereas conventional toilets are used at the Farm. Therefore, the assumed unit flow should have a margin of conservatism in the order of 20 percent.

The maximum day demand is assumed to equal twice the average demand, as required by the reviewing authorities. Actual maximum day to average ratio at Watchtower Farms is in the range of 1.5 to 1.8 over the past few years. The ratio at Patterson should be less in view of the absence of non-domestic use compared with Watchtower Farms, and absence of lawn-watering and other seasonal demands in typical municipalities. The peak flow for sizing domestic water mains is assumed to occur in the morning when showers are being taken. Based on previous experience a peak design flow for the total complex of 1200 gpm is assumed. High level storage equal to one day average demand of 165,000 gal was requested by the Putnam County Department of Health to provide for peak demands and emergency supply in the event of power failure or other unforeseen circumstance. However, the fire water storage requirements are in excess of this capacity and hence will control the size of the high level storage tank.

TABLE 1

## WATER USAGE AT WATCHTOWER FARM

YEAR	AVE. POP.	AVE. DEMAND 1,000 GAL/D	AVE. DAILY PER CAP. USAGE, GAL
1980	636	66.8	105.1
1981	615	60.7	98.5
1982	656	65.2	99.4
1983	762	70.7	92.8
1984	834	75.9	91.0
1985	902	90.4	100.2
1986	884	96.3	107.3
<u>1987</u>	<u>892</u>	<u>98.9</u>	<u>110.9</u>
8 YR AVERAGE	773	78.1	100.6

## 2. Fire Protection Requirements:

Fire flows will be supplied from the domestic water system, which will be designed to meet the storage and flow requirements of the combined system. Hydrants will be located throughout the built-up area, and critical building areas will be provided with automatic sprinklers, along with standpipes and hose racks where required, all to be supplied from the domestic water system.

As discussed with the Patterson Fire Department on March 24, 1988, a fire water demand of 2000 gpm for a period of at least two hours will be provided, based on the size and nature of the proposed facility. The NFPA Code No. 1231, Table 5-5.1(C) fire flow requirement for this facility is not less than 1,000 gpm. The water distribution system piping is sized based on flow and pressure requirements to meet the design water demands. A network analysis of fire flows in the proposed water distribution system is included as Appendix A, and is further discussed in the section on the water distribution system.

## 3. Storage:

The required storage to meet the design flow for fire purposes of 2,000 gpm for two hours is 240,000 gal. The Putnam County Department of Health requires that the one day average demand of 165,000 gal be additive to the fire storage, giving a total active storage requirement of 405,000 gal. This will be available from a high level storage tank located near the knoll above the water treatment plant as shown on Sheet C0.3. This 405,000 gallon storage exceeds the worst case volume required by NFPA Code No. 1231 for the largest building in the educational center, the office building. The layout of the high level storage tank is shown on Sheet D14.

## 4. Emergency Power Provisions:

Power to operate the water supply system is normally supplied from the NYSEG grid. In the event of a loss of power from the grid or other difficulty in the system, emergency power will be supplied from an

emergency diesel-electric generator located at the wastewater treatment facility. This is sized at 100 KVA, sufficient to meet emergency needs of both the water and wastewater systems. When the main complex is completed, additional emergency power can be drawn from the on-site powerhouse.

### C. SOURCES OF SUPPLY:

#### 1. Wells:

The proposed water supply for the project consists of three rock wells east of Route 22 and two sand wells west of Route 22 which have recently been drilled as shown on Sheet D1. Well 5 originally included in the well testing program will be used to serve the existing farm house ("B" House) adjacent to the well, and is not included in the system being proposed. Well 7 was found to interfere with the well at Magdis Diner, so will be used as an observation well rather than a supply well. Use of rock Well 1 is questionable due to proximity to the educational center and gravity sewer and so will not be used for potable water supply. Well 3 is located about 1800 feet upstream of Well 4 and yields only 24 gpm, so will not be included in the development at this time. The safe yields for the remaining three new rock wells have been determined by pumping tests carried out under the direction of C.A. Rich Consultants, Inc. The results of these tests and water quality analysis results are contained in the report by C.A. Rich Consultants, Inc, and included as Appendix B. The results for the sand well testing and the well driller's logs are also included in Appendix B. The safe yields are summarized as follows:

<u>Rock Well No.</u>	<u>Safe yield, gpm</u>
1	Not used
2	65 Excluded (largest rock well)
3	Not used
4	60
6	<u>30</u>
Total for rock wells 4 and 6	90 gpm
<u>Sand Well No.</u>	
1	75
2	<u>75</u>
Total for sand wells	150 gpm
Total for rock and sand wells	240 gpm (Largest rock well excluded.)

The total safe yield with the largest rock well out of service is 240 gpm. This exceeds the requirement of 230 gpm, or twice the average day demand, set by the Putnam County Department of Health.

## 2. Well Water Collection System:

The well water collection system consists of appurtenant facilities at or near the water supply wells, and force mains from the wells to the clearwell at the water treatment plant. In the case of Wells 4, 6 and the sand wells, a small surge tank is located near the concrete batch plant which receives flow from these wells, which is then pumped to the clearwell. Appurtenant facilities include a level sensor in each well, and a disconnect switch adjacent to each of the wells, which are of the pitless type. A nearby well house contains a bladder tank for waterhammer suppression, flow meter, check valve and shutoff valve, blowoff line and valve, air release valve, pressure gage and sampling tap for each well. At Well 2 and the sand wells, these facilities are located in two small well houses, as shown on Sheet D16. For Well 6 these facilities are provided in a well control house near the "B" House, as shown on Sheet D16. An additional bladder tank will be provided at this house for the two sand well force mains in view of their length. The well houses will be insulated and heated when needed for freezing protection. Well 4 discharges into the nearby surge tank, so only the flowmeter, shutoff and blowoff valves, and sampling tap are needed, which are located in the surge tank pump room.

The well water force mains will be AWWA C900 Class 200 psi PVC pipe, with ductile iron fittings, buried at least four feet for freezing protection. Concrete protection will be provided at the Mountain Brook stream crossing. Plans and profiles for the force mains are shown on Sheet C0.3, C4.38 and C4.39. The surge tank near the batch plant will provide approximately one hour of storage at maximum combined flow from the tributary wells. Two pumps will be provided at the surge tank, each capable of lifting the combined flow to the clearwell, as shown on Sheet P7.1. Submersible well pumps will be used initially for the hotel flow only, to be replaced by larger submersible pumps when the educational center is occupied. The pumps at the individual wells will be controlled from the wastewater treatment facility (WWTF) or the well houses, and the surge tank and clearwell pumps will be automatically controlled by level sensors in the surge tank and clearwell, respectively. The high level storage tank water level will be continuously recorded at the WWTF, along with flow monitoring for each well. This information will be used in scheduling well pump operation. Alarms and annunciation will be provided at the WWTF for abnormal conditions such as high and low tank levels, and low well levels.

Pump selection and head loss calculations for the well pumps, surge tank pumps, and clearwell pumps lifting to the high level storage tank, are included in Appendix C.

**D. PROTECTION OF WATER SUPPLY:**

Potential sources of contamination of the proposed water supply facilities consisting of the five new wells and the collection, storage and distribution systems include the following:

1. Sanitary sewers and sewerage facilities
2. Storm sewers and retention ponds
3. Surface water inflow from flooding or stream crossings
4. Cross connections with other systems
5. Chemical contamination from accidental spills or delcing of highways
6. Bird and animal contamination, insects and excess dust
7. Vandalism and sabotage

Methods of controlling contamination from the above sources are discussed below.

**1. Sanitary Sewers and Sewerage Facilities:**

Protection from contamination from sewage sources is achieved primarily by providing separation distances as required by the applicable regulations and codes. This is further enhanced by the use of piping materials and construction standards which minimize the potential for leakage from sewers. Sewers and manholes will be tested for leakage. Sanitary sewers will use PVC or ductile iron pipe with rubber gasketed joints. Where within 200 feet of a well, pipe will be of water supply equivalent and pressure tested to 100 psi (minimum). No sewer lines are to be within 100 feet of a public water supply well. Sewage force mains within 200 feet of a well shall be ductile iron, and shall be subjected to pressure and leakage tests.

The only septic systems in the site east of Route 22 are for the "B" house which is located about 600 feet south of Well 6, a temporary system serving the construction office trailers near the batch plant, as shown on Sheet D4, and a temporary system serving the construction kitchen, dining and locker room facilities in a metal building to be constructed near the southern boundary, the "storage/vehicle" building, as shown on Sheet D6. The "B" House septic tank and disposal field are located north of the house, and slightly below the ground elevation at Well No. 6 as shown on Sheet D4. The temporary system for the office trailers is about 500 feet from the nearest well, Well 4. The temporary disposal field near the southern boundary is below and 250 feet beyond Well 2 (180 feet to expansion area). The new sand wells are about 600 and 250 feet from the property line to the north, and the nearest septic system on Watchtower property is about 2,000 feet distant, at the "A" House.

The sewage force mains from the hotel and storage/vehicle building lift stations, gravity sewers, and effluent discharge pipe from the wastewater treatment facility, are all located beyond a 100 ft clearance radius from the wells, as shown on Sheets D1 and D4 through D6. These lines will have pressure tight joints and will be tested for leakage. Well 1 is about 55 ft from the gravity sewer serving the

educational center, and it is not feasible to relocate the sewer beyond the 100 ft clearance radius. Consequently, Well 1 will not be used except possibly for non potable purposes, such as lawn watering.

## 2. Storm Sewers and Retention Ponds:

As in the case of sanitary sewers, storm sewers will be separated from water mains in accordance with applicable regulations and codes wherever possible. In the few instances where this may not be practicable due to the nature of the site, special precautions such as gasketed joints or other means satisfactory to the reviewing authorities will be incorporated in the design. Due to the steep slopes at the site, standing water will not be a problem.

Two small retention ponds are located in the watercourse adjacent to Wells 1 and 2. Only the upper pond will have water in it normally, the lower pond only retaining water during storm runoff. In neither case will the maximum water surface for a 100 year flood come closer than about ten feet from the well site, and the well casing will terminate at least three feet above the 100 year flood level.

## 3. Surface Water Inflow from Flooding or Stream Crossings:

Surface water inflow will be prevented by setting the elevations of casings, pumphouse floors, tank walls and other features through which water could enter at such elevation as to be well above possible flood levels with due allowance of freeboard against possible wave action.

The sand wells are constructed adjacent to the wetlands, which are subject to flooding. The top of casing will be set at not less than three feet above the 100-year flood level. In the case of floors over potable water storage facilities, openings for piping, pumps, electrical cables, valve stems, instrumentation, etc., will be suitably sealed against entry of water or contaminants, using concrete curbs at least four inches above floor level around the opening.

Well construction details are described in the C.A. Rich Consultants Inc. report and the well driller's logs (Appendix B), and shown on Sheet C11.31. Wells will be of the pitless type.

Stream crossing will be required for the raw water force mains from Well 6 and the sand wells at Mountain Brook about 250 ft east of Route 22 as shown on Sheet C0.3. The crossing is at a constricted section of the stream where some ledge rock is exposed, giving stable bottom conditions. A minimum of three feet of cover will be provided over the pipe, which will be protected by concrete throughout the crossing. Flexible, watertight joints will be used for this piping. Similar construction will be used for the water distribution mains and well water force main from Well 2 where they cross the small streams feeding into the retention pond No. 1 between the educational center and the storage/vehicle building.

## 4. Cross Connections with Other Systems:

No cross connections with other systems will be used. Where the

possibility of back-siphonage exists, as with hoses used for washdown, approved backflow prevention devices will be used. A break tank, pump, and pressure tank will be used at the wastewater treatment facility for washdown water, with at least a 6-inch air gap above the break tank.

5. Chemical Contamination from Accidental Spills or Deicing of Roadways:

The risk of accidental spills is primarily related to traffic on Route 22. The only chemicals to be handled in significant quantity on the educational center site are those used for water or wastewater treatment, and cleaning supplies used in the laundry and food preparation areas. Minor quantities of solvents, paints, lubricants, etc., will be used for maintenance purposes, but special handling and disposal practices will be adopted to reduce risk of spills to a minimum. Bulk storage of liquid chemicals, fuel oil, and lubricants will be in vaults or with containment walls, capable of retaining the full volume of stored liquid in the event of a leak as per current DEC requirements.

All of the water supply rock wells are located upslope from Route 22, to minimize risk of chemical spills or deicing chemicals from this source. The sand wells are approximately 2,000 ft west of Route 22. The watershed upslope from the rock wells consists mainly of undeveloped woodlands and the educational center. Fruit trees are also being planted in certain of the cleared areas surrounding the center, as shown on Sheet D1. Runoff from these areas could contain pesticides and fertilizers, but would have negligible influence on well water quality due to well design.

Deicing chemicals will be used primarily on the paved surfaces in the educational center which have curbs and gutters. The discharge of deicing chemicals will be largely limited to the storm drainage system conveying this flow to a discharge point below Route 22 or into the stream leaving the property towards the south. Thus the deicing chemicals would have negligible effect on well water quality.

6. Bird and Animal Contamination, Insects and Dust:

Contamination from these sources will be controlled by providing watertight roofs over all water storage tanks and clearwells. Vents and overflows will be designed to prevent the entry of contaminants, consistent with their proper functioning.

7. Vandalism and Sabotage:

Protection of the drinking water supply from tampering or deliberate introduction of contaminants by vandals or terrorists is a growing concern worldwide. Hence it is prudent to design facilities to be as inconspicuous as possible, particularly along public highways, and to incorporate features to prevent unlawful access or introduction of contaminants. Wells will be of the pitless type with lockable covers at the wellhead as shown on Sheet C11.31, and surrounding vegetation

to screen them from Route 22 viewing. Points of access or openings to storage tanks, well houses, and other facilities will be provided with locked closures to prevent tampering with the water supply.

#### E. WATER TREATMENT:

##### 1. Raw Water Quality:

Based on present knowledge of well raw water quality and current maximum contaminant levels, it appears that well water will not require treatment other than chlorination for disinfection, and in the case of Well 2, corrosion control treatment as requested by the New York State Department of Health.

##### 2. Treatment:

The water treatment facilities will be housed in the water treatment plant as shown on Sheet D12. Raw water from the wells will be prechlorinated when needed and discharged to the clearwells, which will provide surge storage and blending. Two clearwells will be provided to allow cleaning without interruption of service although only one will be used at a time during the initial period. Pumps will transfer the water from the clearwells to the high level storage tank. Pump selection and head loss calculations are given in Appendix C. The pump discharge will be chlorinated and the required contact time in the high level storage tank will be achieved even with only one compartment in use. The high level storage tank will have two compartments of about 204,000 gal active storage each, as shown on Sheet D14. Finished water will be metered and chlorinated as it enters the distribution system, to provide the required chlorine residual in the event of loss of residual with the long detention time in the high level storage tank. Chlorine feed rate will be flow proportional and controlled by a continuous chlorine residual analyzer. Chlorine will be supplied in the hypochlorite form, using sodium hypochlorite as a liquid solution with approximately 15 percent available chlorine. Caustic soda will be added to the Well 2 discharge to the clearwell as required to raise the pH to about 8.0 for corrosion control.

#### F. DOMESTIC/FIRE WATER DISTRIBUTION SYSTEM:

##### 1. Layout:

The water distribution system is supplied by gravity from the high level storage tank located above the water treatment plant. An emergency bypass is provided to allow feeding the distribution system at reduced flow from the water treatment plant clearwell. In this case the flow would be limited by chlorine contact time available in the clearwell. The main complex is supplied via a pipe network consisting of one main loop with four sub-loops, as shown on Sheet D5. Branches from the main loop serve the hotel and other buildings outside the main loop as shown on Sheet D6. Fire protection requirements generally control line routing and sizing to meet

spacing, pressure and flow criteria at fire hydrants and building stand pipes. Plan and profile drawings of the proposed distribution system are shown on Sheets D5, D6, C4.37 through C4.40 and C4.8. Hydrant locations have been selected to achieve the required 500' maximum spacing and about 40' clearance from buildings requested by the Patterson Fire Department. A total of 17 hydrants are provided in the educational center area, plus 4 hydrants in the hotel area.

## 2. Pressure and Flow Requirements:

Due to the relatively steep terrain at the site, pressures at the lower end of the system would reach undesirably high pressures if pressure reducing valves (PRV's) were not provided, particularly for domestic uses. However, PRV's within the main loop introduce complications and risks under emergency or maintenance conditions where flow reversal may be needed. For this reason, the main loop is designed for the high pressures using ductile iron pipe, with PRV's on the building services within the building in the lower area, and at the point of entry to the tunnel servicing the hotel. A schematic profile of the water system is shown on Sheet D3. The maximum static pressure in the system is approximately 117 psi, at the bottom of the fire loop at the hotel. Flow will be metered entering the distribution system, to the hotel, and at selected points in the system.

The Patterson Fire Department has requested a minimum pressure of 50 psi at the fire hydrants with 2,000 gpm maximum flow in the educational center area. This can be achieved in all cases with the minimum operating level in the high level storage tank and the full loop in service. Under emergency or maintenance conditions where a portion of the loop was out of service and only a single 8-inch supply was available, fire flow of 2,000 gpm could still be maintained at a reduced pressure well above the minimum requirement of 20 psi to meet DOH requirements. Pressure requirements in the hotel area are the same as for the educational center, but a fire flow of 1,000 gpm is sufficient for this area. The hotel area will be served by an 8-inch supply, branching into a 6" fire loop, and a 4" line supplying the hotel domestic requirements through a pressure reducing and metering station where the line enters the tunnel system.

## 3. Network Analysis:

A simplified network analysis of the distribution system was performed to evaluate pressures and flows using various demand locations and pipe sizes. Results of this analysis are given in Appendix A of this report. As a result of this analysis, the pipe sizes shown on Sheet D5 were selected to maintain required pressures and flows. A 12-inch supply main from the high level storage tank feeds the main loop, which uses 8-inch ductile iron pipe except for a portion of the upper runs which are 10-inch. Although the velocities under fire flow conditions approach ten feet per second under some conditions for short reaches, this is considered acceptable to avoid excessively low velocities under low domestic flow conditions. Some water hammer

relief is provided by a bladder tank upstream of the pressure reducing valve at the hotel branch location, and the ductile iron pipe is rated at 350 psi. Ductile iron pipe will conform to AWWA C151, thickness Class 52, with cement mortar lining and polyethylene encasement. Restrained joint fittings will be used in critical locations.

**ENGINEERING REPORT  
SAFE YIELD STUDY  
FOR THE  
WATCHTOWER BIBLE AND TRACT SOCIETY, INC.  
PATERSON, NEW YORK**



**ENGINEERING REPORT**  
**SAFE YIELD STUDY**  
**FOR THE**  
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**PATERSON, NEW YORK**



CHA Project No. 4159.22.01

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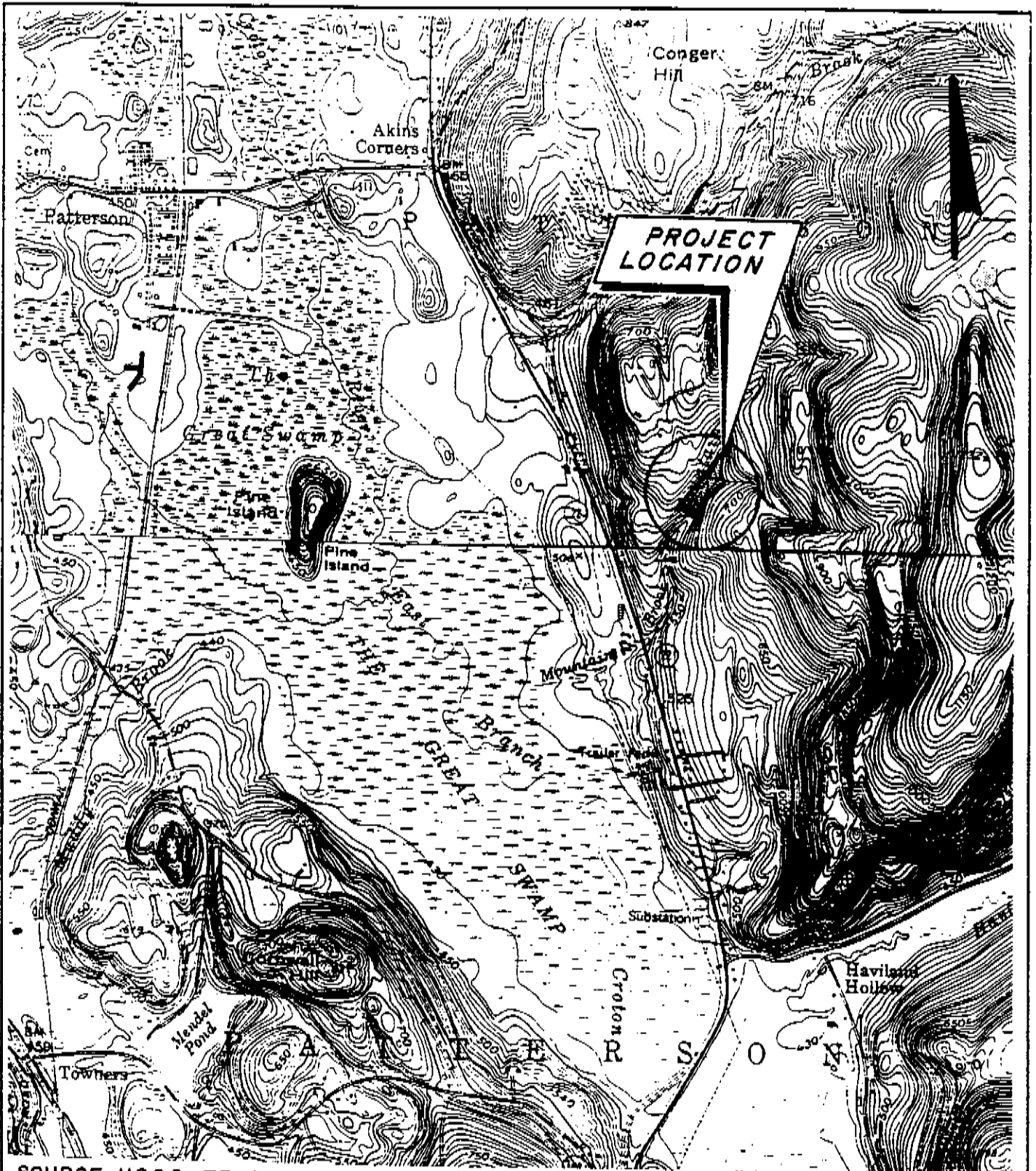
**ENGINEERING REPORT**  
**SAFE YIELD STUDY**  
**FOR THE**  
**WATCHTOWER BIBLE AND TRACT SOCIETY, INC.**  
**PATTERSON, NEW YORK**

**I. INTRODUCTION**

The purpose of this report is to determine the safe yield of the proposed high hazard dam located at the Watchtower Bible and Tract Society's (WBTS) Patterson, New York facility (Figure 1). This study evaluates capability of a proposed 127 acre feet (AF) reservoir to supply and average daily demand (ADD) of one hundred thirty-five thousand (135,000) gallons per day of water to the facility. The proposed zoned earthen dam will have a maximum reservoir surface elevation of 651.0; a normal reservoir surface elevation of 647.0; a single, side discharge spillway with a crest elevation of 647.0 and a normal pool capacity of forty-one million, four hundred thousand (41,400,000) gallons. As will be discussed in this report, this analysis assumes that 15% of this volume will be occupied by sediment over the lifetime of the reservoir. The total available storage of the reservoir, for the draft determination is thirty-five million, two hundred thousand (35,200,000) gallons. The maximum draft, from the reservoir, will be based on stream flow data from a nearby watershed, transferred to the project location, and will then be compared to three other methods. Additionally, the report evaluates a number of proposed yields and the associated required storage volumes.

**II. PRELIMINARY INVESTIGATION**

The watershed for the proposed reservoir is comprised of a total of four hundred forty-two (442) acres that is bounded by Cranberry Mountain, to the east, and the Great Swamp, to the west. The watershed is moderately to steeply sloped, heavily wooded and sparsely populated. The watershed surface drainage tends to flow from the northeast to the southwest, draining into the Great



SOURCE: U.S.G.S. 7.5 min. Topographic Quadrangles;  
Brewster, NY-CT; Pawling, NY-CT.

SCALE: 1" = 2000

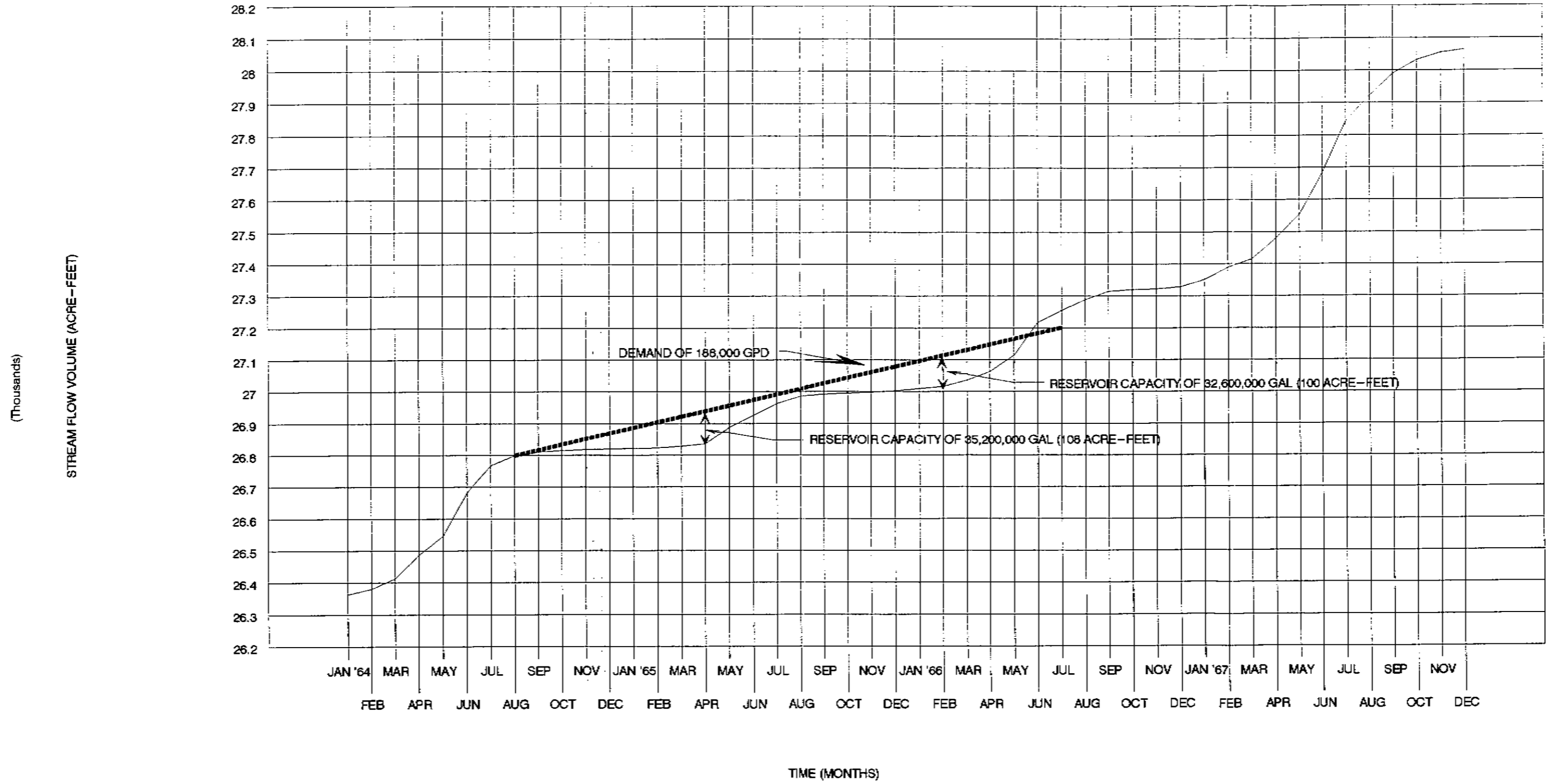
**CHA** CLOUGH, HARBOUR & ASSOCIATES  
ENGINEERS, SURVEYORS & PLANNERS

**PROJECT LOCATION MAP**

DATE:	BY:	CHK:	SKETCH:	REV:



**WATCHTOWER – PATTERSON PROJECT  
SAFE YIELD DETERMINATION  
(CUMULATIVE VOLUME SINCE 1929)**





Swamp. The surficial geology of the area can be broadly characterized as a variably textured, poorly sorted, till. These unconsolidated deposits consist of till, sands, gravel, and clay. Deposition of this material is typical of glacial deposits. The coefficient of permeability for till is relatively low.

### **III. METHODOLOGY**

#### **A. GENERAL:**

The determination of the safe yield for any given project is stochastic in nature. As such, in order to increase the reliability of the safe yield we will employ four different methods for making the determination of the safe yield, and are described as follows:

**1. Rippl Diagram Method** - This method is a standard mass runoff curve in which total stream flow volume is plotted as a function of time. The rate of flow can be taken from the slope of the curve at any given point. The required reservoir capacity for a desired continuous demand can be obtained by drawing a line with a slope equal to the demand and tangent to the mass curve at the beginning of a selected dry period ( See Figure 2)

**2. Rainfall/Evaporation Method** - This method was developed in Great Britain, and is dependent on what is referred to as a Lapworth Chart. An estimated amount of evaporation and transpiration are subtracted from the average annual rainfall for the area. The depth of runoff is computed for the watershed that would be needed to supply the reservoir with its available storage volume. Plotting these values on the Lapworth Chart, a projected yield for the reservoir can be derived.

**3&4. Putnam County and New England Composite Yield Curve Method** - These two methods utilize a graphical means of estimating the safe yields of reservoirs. The New England Composite Yield Curve Method was developed to predict safe yields for reservoirs in the New England area. The Putnam County Curve Method is very similar to the New England Composite Yield Curve Method and was developed for Putnam County. Both graphical means take into consideration transpiration, evaporation and drought periods.

The results of these four methods will be compared and a recommendation for the safe sustained yield will be made.

## **B. HYDROLOGY:**

### **1. Rippl Diagram:**

There are two streams within the project site watershed; Mountain Brook and an unnamed tributary to Mountain Brook. In order to construct the Rippl diagram it would be ideal to have daily stream flow data measured at the project site for a statistically significant period of record. However, as in this case, the ideal situation rarely exists. Daily stream flow readings were recorded for Mountain Brook and its tributary by WBTS from July, 1988 through October, 1990 (See Appendix A). This two year period of record is inadequate in length to produce a reliable prediction of the safe sustained yield for the proposed reservoir. In order to overcome this shortage of data, the data from a nearby stream gage, with a hydrologically similar watershed and an adequate period of record, was used. The data from the stream gage of the similar watershed is "translated" to the project site. Based on a review of all of the nearby gage stations, gage station no. 1372500 was chosen for use. This gage station is located on the Wappingers Creek in Red Oaks Mill, Dutchess County, New York and was chosen for the following reasons: (1) The period of record is sufficient, as it extends from 1929 to the present, (2) It is relatively close to the project site, (3) The data shows similar monthly fluctuations when compared to the WBTS stream flow data, and (4) The surficial geology topography, and vegetative cover of the two watersheds is roughly equivalent.

A review of all available information indicates that the two watersheds are very similar. The largest difference between the two watersheds is that the watershed for the gage station is 181 square miles and the watershed of the project site is 0.69 square miles. This large difference in watershed size does introduce a higher degree of uncertainty in the "translating" of the flows to the project site. However, there is a common period of time during which data for both sites was

recorded. A comparison of the overlapping data provided a good verification for the translated data. Appendix A contains the recorded daily stream flow data and the computations used to translate the data to the project site.

**2. Rainfall/Evaporation Method:**

The average annual rainfall, that was recorded at the Dutchess County Airport, was reduced by an estimated amount of transpiration and evaporation expected for the region. The evaporation was conservatively estimated to be 40% the total rainfall depth, whereas the amount of transpiration for the area was based on a coniferous vegetative cover and predicted to be six inches per year. In reducing the average annual amount of rainfall by these amounts, the average annual runoff volume for the watershed is projected. This method assumes that all the water that percolates into the ground will eventually emerge as surface runoff. The depth of surface runoff needed to supply the required available storage volume (35,200,000 gallons or 108 acre-feet, see Appendix B) was computed. The products from these computations are used to interpolate values from the Lapworth Chart, which yields the sustained safe yield for the reservoir.

**3. Putnam County and New England Composite Yield Method:**

These two methods are based on the volume water proposed to be stored in the reservoir divided by the watershed area, in square miles. These values are then plotted on a nomograph and the safe yield given in gallons per square mile. These values were then converted to safe yield for the reservoir based on the 0.69 square mile project watershed.

#### **IV. RESULTS**

Safe yield is defined as the maximum dependable draft which can be continuously made upon a water source during an extended drought period. This encompasses all demands on the stream, including proposed uses, demands due to fishlife, and any other requirement which is dependent on a continuous stream flow. The most severe drought ever recorded in New England extended from 1960 to 1966. Using the extended period of record from gage station no. 1372500, it can be verified that the Mountain Brook watershed experienced the effects of this record drought. As previously stated, four methods were used in predicting the safe yield of the proposed reservoir. It is our opinion that the safe sustained yield analysis using the Rippl Method is the most reliable because it is based on actual stream flow. The computations for all four methods are included in Appendix B.

Based on a available reservoir storage volume of 35,200,000 gallons or 108 acre-feet (127 acre-feet minus 15% for sediment storage) the safe yields predicted by the four methods are as follows:

<b>METHOD</b>	<b>SAFE YIELD</b>
Rippl Method	188,000 GPD
Rainfall/Evaporation Method	240,000 GPD
New England Composite Method	241,000 GPD
Putnam County Composite Method	217,000 GPD

As can be seen from the above results, the Rippl Method compares quite well with the Putnam County Composite Yield Method. The Rainfall/Evaporation Method and the New England Composite Yield Method showed somewhat higher results. The discrepancy between predictions can likely be attributed to differing watershed and meteorological conditions between the project watershed and the

data from which the empirical methods were developed. The Putnam County Composite Yield Method should yield a fairly reliable result because it was developed for Putnam County where the project is located.

## V. CONCLUSIONS

This report has evaluated the safe yield of the proposed reservoir at the WBTS's Patterson, New York facility. The safe yield determination is based on a comparison of synthetic yield predictions to that from a period of translated gaged stream flow data from 1929 to the present. Based on the following discussion of sediment storage, the amount of storage available for water supply in the proposed 127 AF reservoir is 108 AF. It was concluded that the safe yield from the a reservoir with 108 acre-feet of available water storage capacity is 188,000 GPD ADD, which is in excess of the required 135,000 GPD ADD. This safe yield prediction assumes that it is acceptable for there to be no outflow from the reservoir during extended drought periods. If, during subsequent phases of the design/permitting for this structure it is determined that a minimum flow must be released, then the predicted safe sustained yield would be reduced by the minimum release rate.

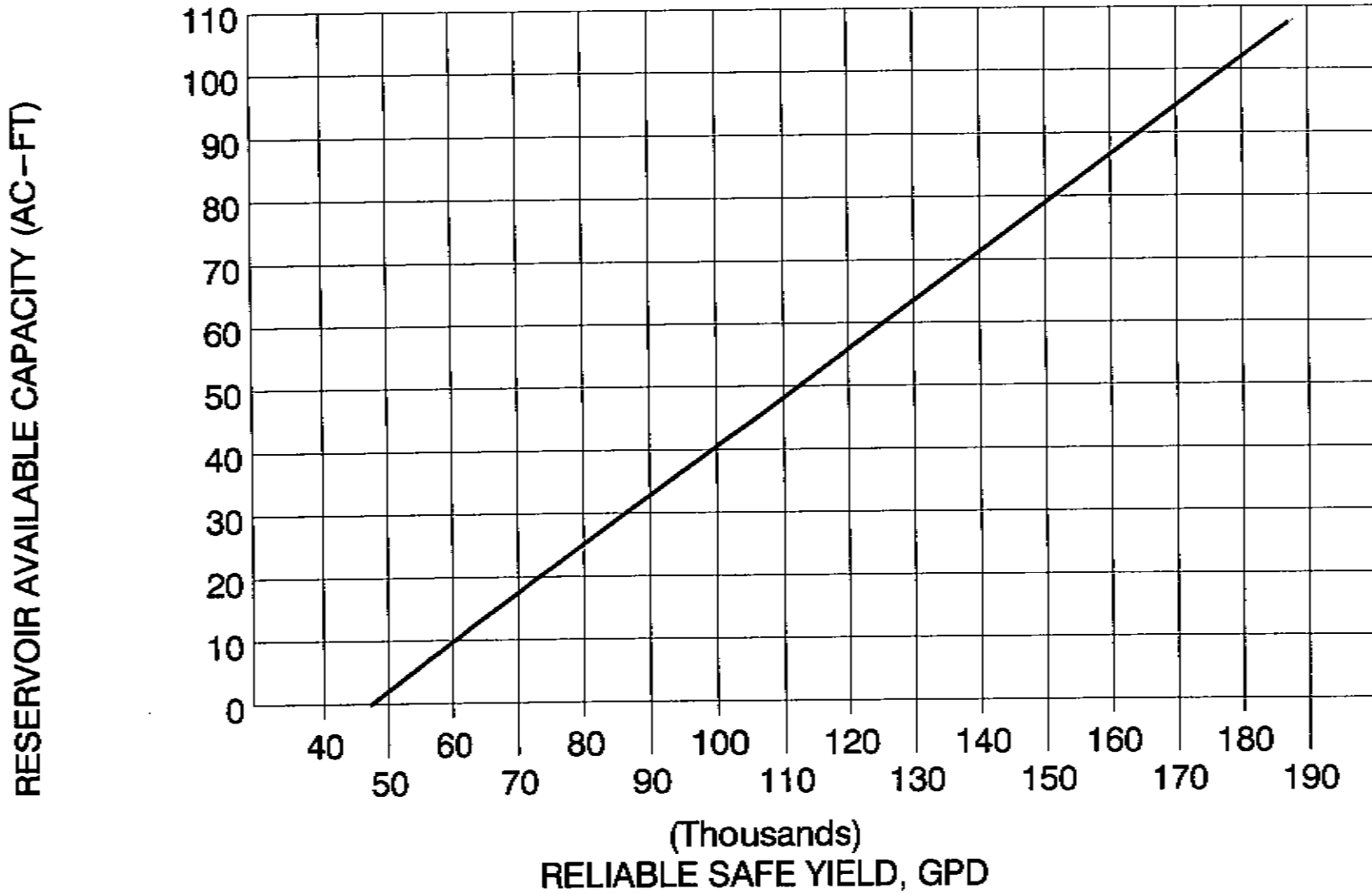
The above projection requires that 35,200,000 gallons of water storage capacity be available. Over time, a portion of the constructed storage capacity in the reservoir will be occupied by sediment. Sediment transport by the stream due to erosion, leaves, development within the watershed, and changing land use will reduce the amount of available water storage in the reservoir. The total capacity of the reservoir is proposed to be 41,400,000 gallons. For planning purposes we have assumed that 15% of the total reservoir volume will be utilized for sediment storage leaving 108 AF available for water storage.

Based on the projected average daily demand of 135,000 GPD, the required available reservoir storage volume would be 75 acre-feet. Therefore, the total required reservoir storage, including

sediment storage, is approximately 86 AF. Therefore, based on the proposed reservoir total storage capacity of 127 AF and a projected ADD of 135,000 GPD, there is an excess of 15 acre-feet (4,900,000 gallons) of available water storage volume in the reservoir.

It is our understanding that the proposed reservoir is intended to be a supplementary water supply source. The primary source supply is via existing wells. Further, it is our understanding that the desired yield from the proposed reservoir varies from 100,000 GPD ADD for landscaping water supply needs to 135,000 GPD ADD for landscaping plus other domestic needs. For this reason Figure 3 - Required Available Reservoir Capacity vs. Average Daily Demand is included. A review of this graph indicates that the required available reservoir capacity can be determined for any demand between 50,000 and 188,000 GPD ADD.

**AVAILABLE RESERVOIR CAPACITY VS. AVERAGE DAILY DEMAND  
WATCHTOWER – PATTERSON PROJECT**



**FIGURE 3**



**APPENDIX A**



JK 4/94

**WATCHTOWER – SAFE YIELD DETERMINATION  
PATTERSON, NY  
CHA JOB NO. 4159.22.01**

## TRANSFER COEFFICIENT COMPUTATION

**Purpose:** To establish a relationship between the recorded stream gage data at Watchtower Bible & Tract Society to the USGS gage station no. 1372500 located on the Wappinger Creek, Dutchess County, N.Y. In establishing this relationship, a longer period of stream flow information can be used to establish the safe yield of the Watchtower Reservoir.

The data, as supplied by Watchtower, shall be used in the comparison. Only the monthly data that had stream flow readings 75% of the days, during that month, was used.

Using the equation:  $(Q_2/Q_1) = (D_2/D_1)^x$

where:  $Q_1$  and  $D_1$  are the discharge and drainage area at the gage station  
 $Q_2$  and  $D_2$  are the discharge and drainage area for Watchtower  
"x" is the transfer coefficient.

Year	Month	Watchtower Ave. Daily Flow, cfs	USGS Gage 1372500 Ave. Daily Flow, cfs	Transfer Coeff. "x"
1988	July	0.18	275	1.31 *
	Aug	0.10	158	1.31 *
	Nov	1.68	334	0.95
	Dec	0.94	233	0.99
1989	Jan	0.85	173	0.95
	Mar	1.18	229	0.95
	Apr	1.97	453	0.95
	May	3.60	1204	1.03
	Jun	1.52	431	1.00
	Jul	0.26	118	1.10
	Aug	0.14	73.7	1.13
	Sept	0.21	86.8	1.08
	Oct	1.44	353	0.99
	Nov	1.76	280	0.91
	1990	Jan	1.76	336
Feb		3.04	595	0.95
Mar		1.72	555	1.03
Apr		1.86	483	1.00
May		2.51	443	0.93
Jun		0.75	181	0.99
Jul		0.26	78.7	1.03
Aug		2.51	287	0.85 *
Sept		0.29	80.3	1.00
Oct		0.56	204	1.05

Ave. "x" = 1.00

\* – values not used in average

**WATCHTOWER - PATTERSON PROJECT  
RAINFALL AND STREAM FLOW READINGS  
JULY 1938 - OCTOBER 1990**

**YEAR 1988**

DAY	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS
1													0.25	0.08		0.15		0.06		NR	0.10	1.25		1.70
2														0.07		0.15		0.05		0.45	1.40	0.70		1.50
3														0.06		0.15		0.05	0.90	0.05	0.10	0.95		1.30
4														0.06		0.10	1.50	0.60		0.015		0.50		1.20
5														0.10		0.08	0.15	0.07		NE		2.45		1.20
6														0.07		0.40		0.05		NE	1.00	2.45		1.10
7													0.20	0.07	0.80	0.20		0.04		NE		1.20		1.00
8														0.08		0.15		0.03	0.80	NE		0.80		0.90
9														0.08		0.08		NE		NE		0.70		0.80
10													0.10	0.06		0.08		NE		NR		0.70		0.80
11														0.08		0.07		NE		NR		0.50		F
12														0.125		0.07		0.20		NR		0.50		F
13														0.00		0.05	0.60	0.07		NR		1.70		F
14													0.90	0.125		0.05		0.03		NR	0.85	0.10		0.50
15														0.06		0.05		NE		NR		0.80		0.45
16													0.05	0.015		0.05		NE		NR		1.40		F
17													0.30	0.10	0.20	0.07	0.10	NE		NR	0.55	1.25		F
18														0.03		0.05		NE		NR		0.80		F
19														0.50		0.03		NE		NR		1.50		F
20													0.20	0.20		0.03		0.05		NR	0.75	2.40		0.70
21														0.25		0.015		NE		NR	2.00	5.70		0.70
22														0.20		NE		NE		NR		3.50		0.80
23														0.70		NE		NE		NR		2.70		0.60
24														0.40	1.10	NE		NE		NR		2.20		1.50
25													0.20	0.20	0.30	NE		NE		0.07		1.90		1.10
26														0.25		NE		NE		0.06		1.70		0.80
27														0.35		NE		NE		0.06	0.90	3.10		0.80
28														0.45		NE		NE	0.10	0.20		2.75		0.13
29													0.60	0.25	0.95	0.20		NE		0.20	0.10	2.25		1.25
30													0.30	0.255	0.10	0.08		NE		0.07		1.90		1.00
31														0.40		0.07				0.06				0.90

AVERAGE DAILY FLOW

MONTHLY VOLUME (ACFT)

::

	0.18	0.10	0.11	0.12	1.88	0.94
	11.24	6.21	6.44	7.59	99.84	57.71
	11.243	17.454	23.899	31.491	131.3	189.0

LEGEND: CFS - Cubic Feet per second  
D - Drizzle  
F - Frozen  
IN - Inches of Rainfall  
NE - Negative Reading  
NR - No Record  
S - Snow  
SF - Snow Flurries

\* Data provided by Watchtower Bible & Tract Society.

**WATCHTOWER - PATTERSON PROJECT**  
**RAINFALL AND STREAM FLOW READINGS**  
**JULY 1988 - OCTOBER 1990**  
**YEAR 1989**

	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS
1		0.85		0.80		0.85		2.75	1.30	1.75	0.75	2.30		0.40		0.15		0.05	0.10	0.35		1.90		0.85
2		0.90	S 2	0.80		0.75	0.10	2.50	0.50	4.78		1.30		0.40		0.20		0.05	0.80	0.50		1.90	S 2.0	F
3		0.75	0.10	0.80		0.75	0.23	2.45		2.75		1.00		0.40		0.15		0.04		0.50	0.20	1.70		F
4		F		F	0.08	0.70	0.98	2.25		2.25	0.35	1.25	0.05	0.40		0.15		0.03		0.45		1.50		F
5		F	S 3.75	F	0.07	0.70	0.70	3.25	1.01	4.20	0.05	0.90	0.70	0.70		0.15		0.03	0.10	0.50		1.40		F
6		F		0.80		0.70	0.20	3.60		5.25	0.35	1.20		0.45		0.05		0.02		NR	0.05	1.25		0.80
7		F		F		F	0.23	3.50	0.01	3.25	0.80	1.70		0.40	0.12	0.15		0.02		NR	0.05	1.20		0.75
8		F		0.75		F	0.10	3.10	0.25	2.25		1.50		0.25		0.10		0.015		NR	0.50	2.45		F
9		0.70		F		0.80		2.70	1.40	1.90	0.63	2.45		0.25		0.10		NR		0.25	0.75	2.70		F
10		0.70		F		0.80		2.25	0.10	5.81		1.90	0.50	0.40	0.25	0.25		NR	0.40	0.30		2.00		F
11		0.85		F		0.80		1.90		5.75		1.70		0.25	2.10	0.50		NR		0.25		1.80		F
12		1.05	SF	0.70		0.80		1.70		4.00	0.55	1.90		0.25	1.10	0.70		NR		0.20		1.55		F
13		0.85	0.35	NR	S 2.5	0.80	0.10	0.70		2.90	0.15	1.90		0.20	0.10	0.25		NR		0.20		1.50		F
14		1.20	0.10	0.75	0.10	0.70		1.50		2.30	0.55	2.25		0.20		0.20	0.65	0.085		0.25	0.10	1.45		F
15		1.20	0.28	0.90		0.70	0.25	2.80	0.10	2.50	0.50	2.80		0.20		0.10		0.04	0.10	0.20	0.30	1.45		F
16		0.90	SF	0.70		0.70	0.75	3.10	2.80	16.20	0.11	2.85	0.30	0.25		0.09		0.08		0.25	0.85	4.90		F
17		0.90		F		0.75		2.50	0.20	7.00		2.35		0.30		0.08	0.40		0.03	1.50	1.00	2.85		F
18		0.90		F	0.30	1.00	0.95	2.25		3.90		1.80		0.25		0.08		0.03	0.20	1.20		2.30		F
19		0.90		F		0.75		1.90		3.80		1.70		0.20	0.10	0.08		0.10	1.80	5.00		2.00		F
20		0.75	0.35	2.25	S 1.0	0.80		1.70		3.10	0.10	1.45	0.50	0.35		0.08		0.40	2.00	0.00	0.15	1.95	S 1.0	F
21		0.75	0.99	3.30		1.20		1.50		2.00		1.40		0.25	0.10	0.05		0.25		7.00	S 3.5	1.55		F
22		0.70	0.15	2.50		1.10		1.40		2.00	0.41	1.30		0.20	0.23	0.08		0.25		3.78		1.50		F
23		0.70	S 1.0	?		1.00		1.25	1.30	3.40	0.82	1.25		0.15		0.05		0.70		2.78		1.45		F
24		0.70		F	1.00	2.75		1.20	0.30	4.40		1.20		0.20		0.04		0.25		2.22		1.25		0.60
25		0.60		F		3.10		1.00	0.10	3.10		0.80		0.15		0.04	0.70	0.56		1.90		1.20		0.95
26	0.90	1.10		1.90		2.40		1.00	0.10	2.70	0.15	0.80		0.15		0.04	0.20	0.75		1.66	0.05	1.20		0.95
27		0.80		1.10		2.25		0.90	0.20	2.75		0.75		0.10		0.04		0.50		1.45	0.25	1.25		1.00
28		0.80		0.90	0.25	0.20		0.80		0.90		0.70	0.18	0.15		0.04		0.45		1.30		1.30		F
29	0.20	1.00			0.50	1.70		0.85		1.70		0.60		0.00	1.30	0.30		0.30		1.20		1.10	S 3.0	F
30		0.90			1.00	2.45		0.75		1.50		0.50		0.10	D	0.085		0.25		1.40		1.00	S 4.0	F
31		0.80			0.50	3.10				1.45				0.15		0.05				0.90	2.85			F

AVERAGE DAILY FLOW	0.85	1.26	1.18	1.97	3.80	1.52	0.26	0.14	0.21	1.44	1.76	0.84
MONTHLY VOLUME (ACFT)	52.13	77.66	72.28	121.00	221.14	93.64	16.08	8.66	12.58	88.66	104.40	51.81
CUMULATIVE VOLUME	241.1	318.8	391.1	512.1	733.28	826.90	842.97	851.62	864.19	952.84	1057.	1109.

::

LEGEND: CFS - Cubic Feet per second  
D - Drizzle  
F - Frozen  
IN - Inches of Rainfall  
NE - Negative Reading  
NR - No Record  
S - Snow  
SF - Snow Flurries

\* Data provided by Watchtower Bible & Tract Society.

**WATCHTOWER - PATTERSON PROJECT  
RAINFALL AND STREAM FLOW READINGS  
JULY 1988 - OCTOBER 1990  
YEAR 1990**

DAY	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS	IN	CFS
1		F		3.65		1.60	0.50	1.45		1.00		1.80	0.10	0.45		0.20		NR						0.20
2		F		3.45		1.70		1.90		0.85		1.50		0.35		0.15		NR						0.15
3		F		3.20		1.70	0.85	5.65		0.60		1.45		0.25		0.10		0.40						0.10
4		0.70	0.60	3.10		1.50		4.30		2.50		1.20		0.25		0.10		0.30	0.45					0.20
5		0.70		2.85	S 2.5	1.30		3.05	0.95	1.60		1.10		0.20	0.80	0.45		0.30						0.20
6		0.70		3.25	S 3.0	1.20		2.40	0.10	1.50	0.40	1.15		0.20	4.60	6.00		0.30						0.20
7		0.65		2.95		1.15	1.50	2.30	0.05	1.50		1.00		0.20	0.60	3.60		0.30						0.15
8	S 4.0	0.65		2.65		1.20		1.90		1.30	0.10	0.85		0.15		2.20		0.25	0.20					0.15
9		0.60		3.00		1.25		1.75	0.15	1.25	0.15	1.00		0.20		4.75	0.05	0.25						0.20
10	0.05	0.70	0.75	4.30		1.30	0.30	1.60	2.10	6.30		0.75		0.20	2.60	13.25		0.25	0.05					0.25
11		0.70		3.85		1.40		1.75		5.60		0.70	0.40	0.40	0.10	6.50		0.25						0.25
12		0.60		3.15		1.20		1.45		3.60		0.70	1.60	0.75		3.90		0.20	0.60					0.40
13		0.50		2.75		1.10		1.30	0.90	4.80		0.50		0.50		6.00		0.20	0.88					0.75
14	S 1.0	F		2.80		1.00		1.95		4.15	0.40	0.70		0.30		3.50		0.80	0.30					0.40
15	0.05	0.50	0.10	3.70		1.00	0.60	2.00	0.10	3.25		0.50	0.10	0.25		2.40	0.95	0.45						0.30
16		0.55	0.10	3.50		0.92		1.75	0.50	3.80		0.50		0.25		1.80	0.20	0.25						0.25
17	0.50	0.75		3.00	0.60	1.60	0.10	1.70	0.40	3.75		0.40		0.20		1.50		0.25						0.25
18	0.70	0.80		2.90		1.45		1.50		3.25		0.90		0.20		1.25		0.20	0.80					0.30
19		0.70		2.70		2.70		1.40		2.70	0.70	0.90		0.20	0.10	1.20	0.30	0.25						0.35
20	S 2.0	0.75		2.20		6.75		1.50	0.40	2.60		0.55		0.15		1.00		0.20						0.30
21	1.00	0.60		2.00	1.10	3.80	0.40	1.75	0.15	2.60		0.40		0.15		0.85		0.20						0.25
22	S 2.0	0.75	0.75	2.75		2.95		1.45		1.90		0.35	0.90	0.30		0.75	0.30	0.25	0.10					0.30
23	1.00	0.65		3.50		2.50		1.30		1.70		0.40	0.30	0.25	0.60	0.90		0.20	2.00					2.80
24		2.00	0.70	3.15		2.60	0.05	1.30		1.50		0.30		0.25	0.10	1.10		NR						2.50
25		6.00	S 8.0	2.75		1.65	0.20	1.40		1.30		0.30		0.20		0.80		NR						1.50
26	0.70	4.75	S 1.0	F		1.70		1.20		1.20		0.25		0.20		0.70		NR						1.20
27		3.50		F		1.45		1.10		1.20		0.25		0.20		NR		NR						0.90
28		2.75		1.95	S 2.0	1.25		1.00		1.05		0.25		0.15	0.15	NR		NR						0.80
29	S 4.0	5.30				1.20	0.25	1.10	1.60	3.10	0.90	0.70		0.15		NR		NR						NR
30		5.85			0.50	1.25	0.10	1.25		3.25	0.60	1.15		0.10		NR	0.20	NR						NR
31		4.30				1.40				2.30			1.15	0.60		NR		NR						NR

AVERAGE DAILY FLOW	1.76	3.04	1.72	1.86	2.51	0.75	0.26	2.51	0.29	0.58	ERR	0.00
MONTHLY VOLUME (ACF)	107.92	188.90	105.63	114.03	154.08	46.10	16.26	154.04	17.14	34.25	ERR	0.00
CUMULATIVE VOLUME	1216.	1403.	1509.	1623.	1777.6	1823.7	1839.9	1994.0	2011.1	2045.4	ERR	ERR

LEGEND: CFS - Cubic Feet per second  
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\* Data provided by Watchtower Bible & Tract Society.

## **APPENDIX B**



## WATCHTOWER BIBLE & TRACT SOCIETY SAFE YIELD DETERMINATION

### A. Assumptions:

1. Watchtower Reservoir Storage Volume = 41,400,000 gal.  
= 5,534,759.4 ft.<sup>3</sup>
2. 15% of the volume of the reservoir will be utilized for sediment storage  
15% of 41,400,000 gallons = 6,200,000 gallons  
Therefore, available storage = 35,200,000 gallons
3. Watchtower Reservoir Watershed Area = 0.69 mi<sup>2</sup>  
(See Figure No. A-1) = 19,236,096 ft.<sup>2</sup>

### B. Watchtower Reservoir Safe Yield Calculations:

#### 1. **Rippl Diagram Method (a.k.a. Mass Diagram Method)**

##### Assumptions:

- a. The recorded stream flow information contains a drought not expected to be exceeded during the life of the reservoir.
- b. Evaporation is expected to be offset by groundwater inflow and the reduction in pervious area due to the increase in water surface area.
- c. The recorded flows are to be representative of future flows.
- d. The transferred data from gage station #1372500 is representative of the inflow to the reservoir.

(See Attached graphs of Stream Flow Volume vs. Time)

Safe Yield = 188,000 GPD

#### 2. **Rainfall/Evaporation Method:**

##### Assumptions:

- a. Average annual rainfall based on recorded rainfall at the Dutchess County Airport.  
= 38.03 inches
- b. Evaporation = 40% of the annual rainfall  
Transpiration = 6 inches/year (based on coniferous trees)
- c. All rainfall entering the groundwater is eventually discharged to the streams within the drainage area of the reservoir.
- d. Deacon diagram, Lapworth charts developed for Great Britain will give a reasonably close approximation for New England Watersheds.

$$\begin{aligned} \text{Average Annual Runoff} &= \text{Annual Rainfall} - \text{Evaporation} - \text{Transpiration} \\ &= 38.03 \text{ in/yr} - (0.40)38.03 \text{ in/yr} - 6 \text{ in/yr.} \\ &= 16.82 \text{ inches/year} \end{aligned}$$

$$\begin{aligned} \text{Storage} &= (\text{Volume of Reservoir/Watershed Area}) \\ &= (4,705,882.4 \text{ ft}^3) / (19,236,096 \text{ ft}^2) \\ &= 0.24 \text{ feet} = 2.94 \text{ inches} \end{aligned}$$

Extrapolating the Lapworth chart for the storage of 2.94 inches and interpolating for the average annual runoff of 14.20 inches, the yield is approximately:

$$(7.31 \text{ ins./2.94 ins.}) \times (35,200,000 \text{ gals./365 days/yr.}) = \underline{240,000 \text{ GPD}}$$

**3. New England Composite Yield Curve Method:**

Assumptions:

- a. Yield curve of Watersheds in New England based on composite from N.E.W.W.A. Reports of 1914 & 1945 will give a close approximation to the Watchtower Reservoir Watershed.

$$\text{Storage} = (35.2 \text{ MG}) / (0.69 \text{ mi}^2) = 51 \text{ MG/mi}^2$$

From the composite yield curve:

$$\underline{\text{Safe Yield} = 241,000 \text{ GPD}}$$

**4. Putnam County Composite Yield Curve Method**

$$\text{Storage} = 51 \text{ MG/mi}^2$$

From composite yield curve:

$$\underline{\text{Safe Yield} = 217,000 \text{ GPD}}$$

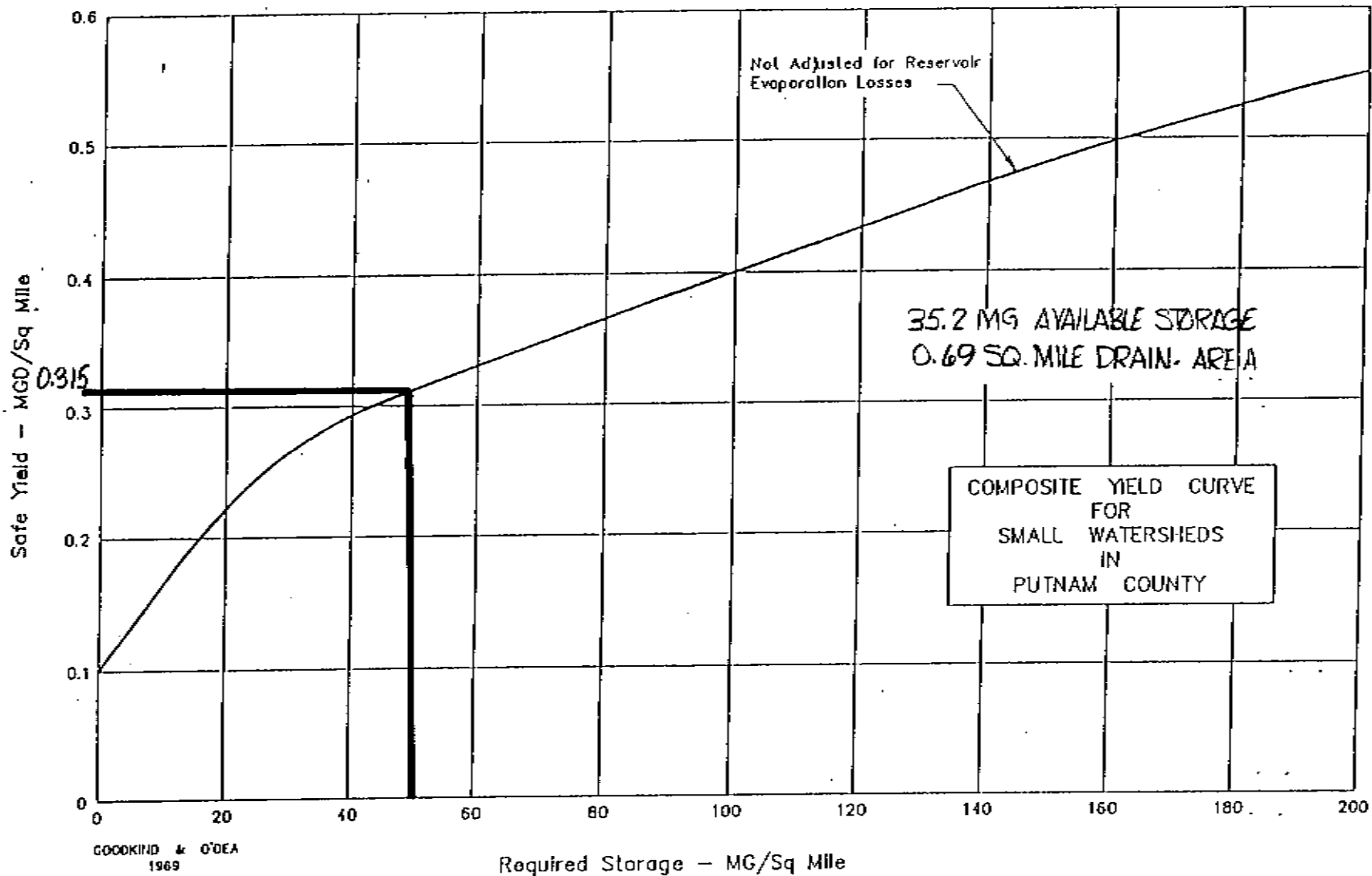
**C. CONCLUSION:**

Safe yield is defined as the maximum dependable draft which can be continuously made upon a water source during an extended drought period. The most severe drought recorded in New England is the 1960 to 1966 drought. Since the recorded streamflow data accounts for this drought period and this draft is a result of actual stream flow data, the safe yield of the Watchtower Reservoir is 188,000 GPD.

**LAPWORTH CHART**  
**YIELD STORAGE RELATION FOR VARIOUS RUNOFFS**

Average Runoff from Gathering Ground (inches)	Storage In Inches					
	5	10	15	20	25	30
	Yield In Inches					
10	5	7.5	9.0	10.0	-	-
20	10.5	14.0	16.2	18.0	20.0	-
30	15.0	19.7	22.5	24.5	26.5	28.0
40	18.5	24.5	28.5	31.0	33.0	35.0
50	21.0	29.0	33.9	37.0	40.0	42.2
60	23.0	32.3	38.7	43.3	47.0	50.0
70	25.0	35.2	42.9	48.2	53.0	57.0
80	27.0	38.2	46.0	53.0	58.0	63.0

Lapworth Chart obtained from Deacon Diagram in the thirteenth edition of Encyclopedia Britannica article on Water Supply.



$$0.315 \text{ MGD/SQ.MI} \times 0.69 \text{ SQ.MI} = 0.217 \text{ MGD}$$



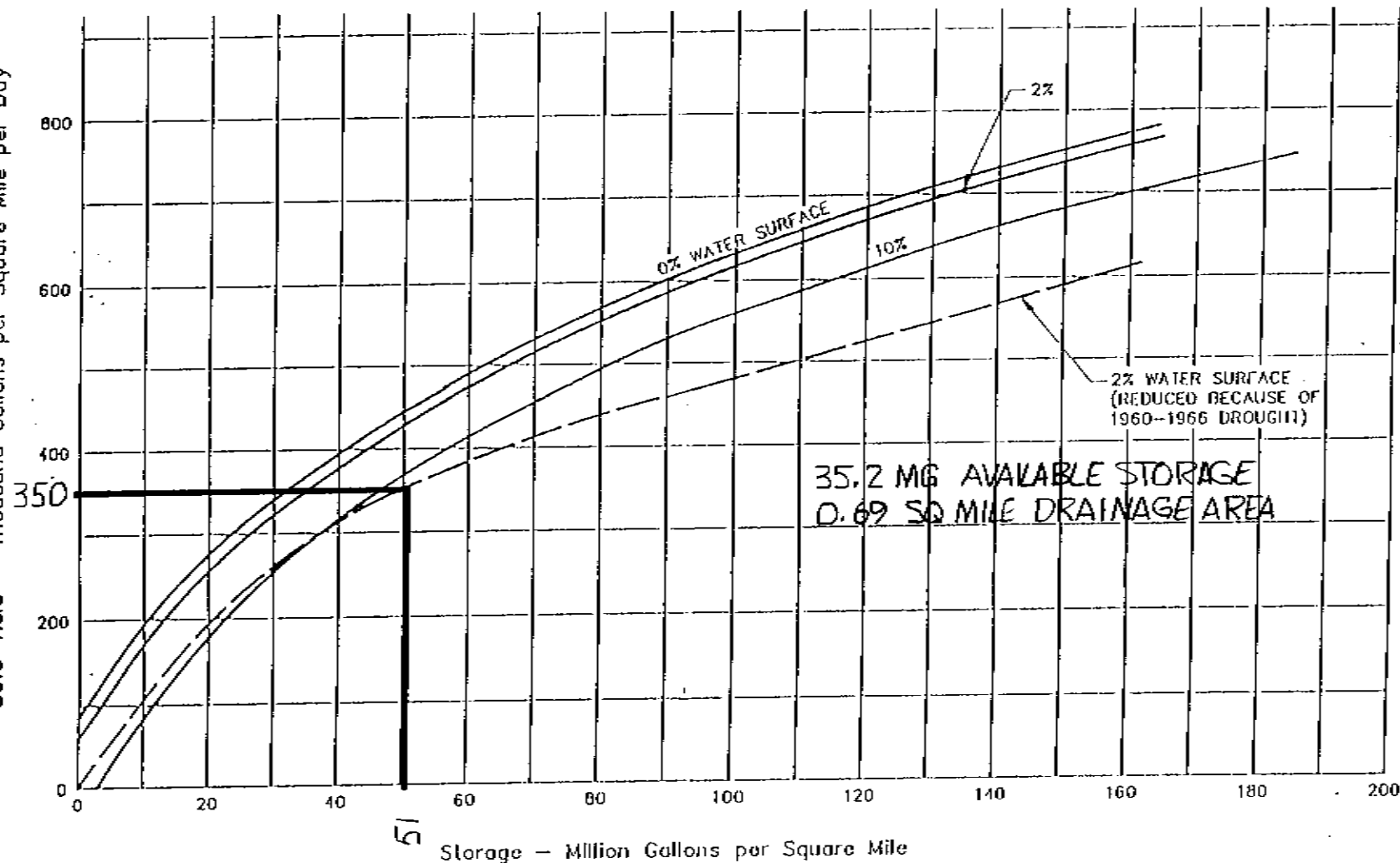
**CLOUGH, HARBOUR  
& ASSOCIATES**  
ENGINEERS, SURVEYORS & PLANNERS

111 WINNERS CIRCLE ALBANY, NEW YORK 12205 518-453-4500

DWG. NO.

## WATCHTOWER SAFE YIELD DETERMINATION

Safe Yield - Thousand Gallons per Square Mile per Day



35.2 MG AVAILABLE STORAGE  
0.69 SQ MILE DRAINAGE AREA

YIELD OF WATERSHEDS IN NEW ENGLAND  
Based on Composite from N.E.W.W.A. Reports of 1914 & 1945

$$350,000 \text{ GPD/MI}^2 \times 0.69 \text{ MI}^2 = 241,000 \text{ GPD}$$



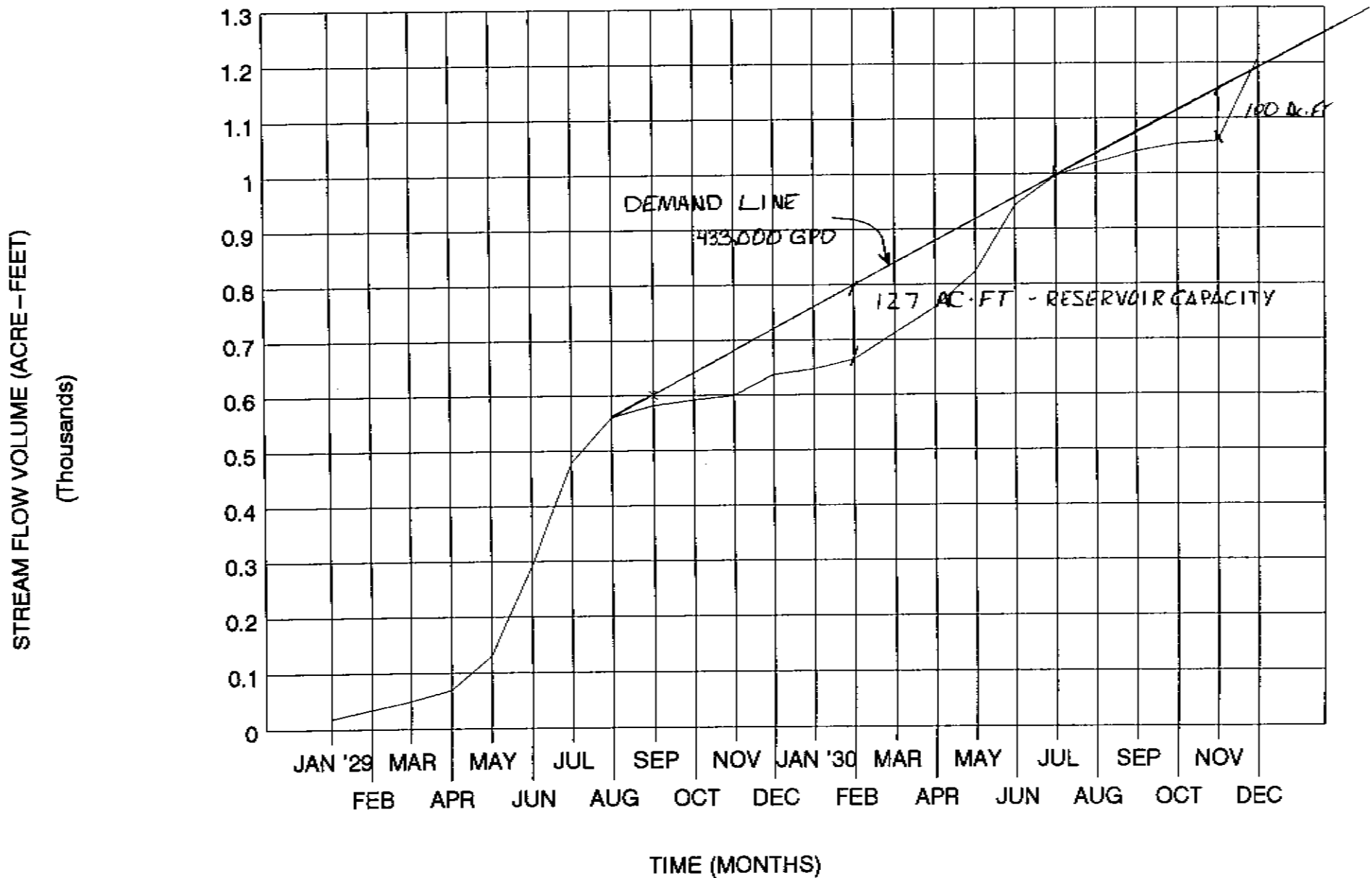
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111 WINNERS CIRCLE ALBANY, NEW YORK 12205 518-453-4500

## WATCHTOWER SAFE YIELD DETERMINATION

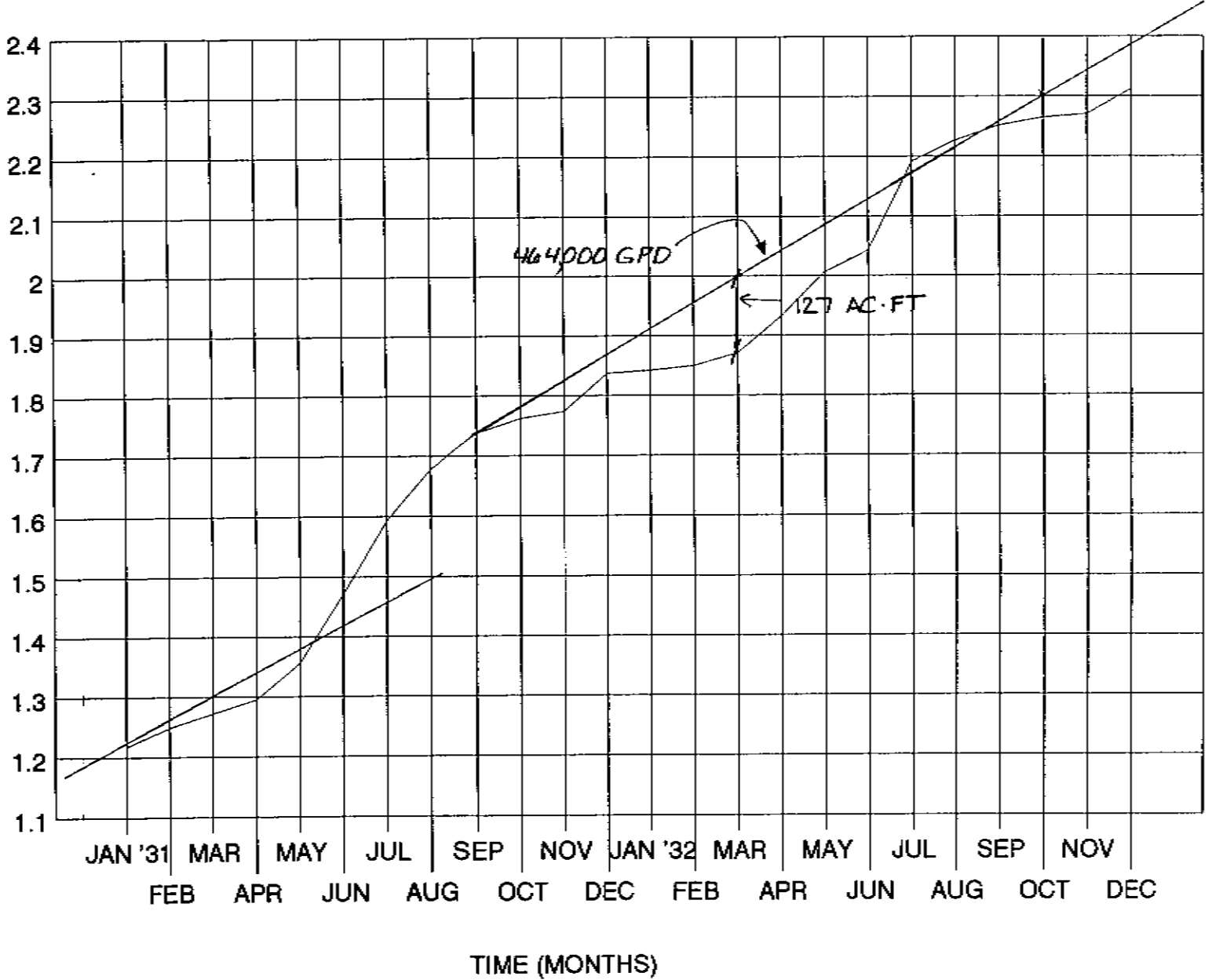
OWG. NO

**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAMFLOW FOR 1929-1930  
(CUMULATIVE VOLUME SINCE 1929)**

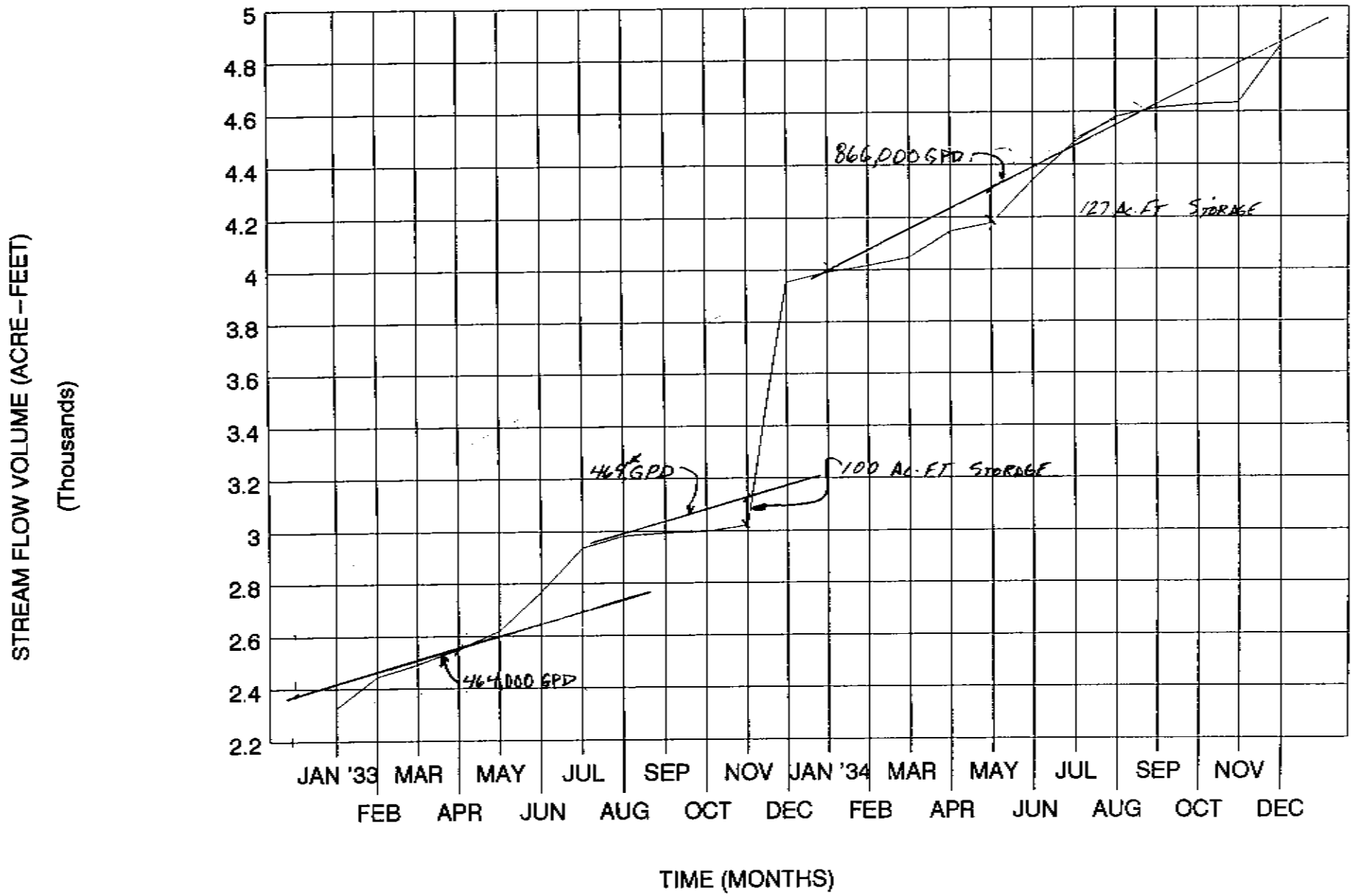


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAMFLOW FOR 1931-1933  
(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE- FEET)  
(Thousands)

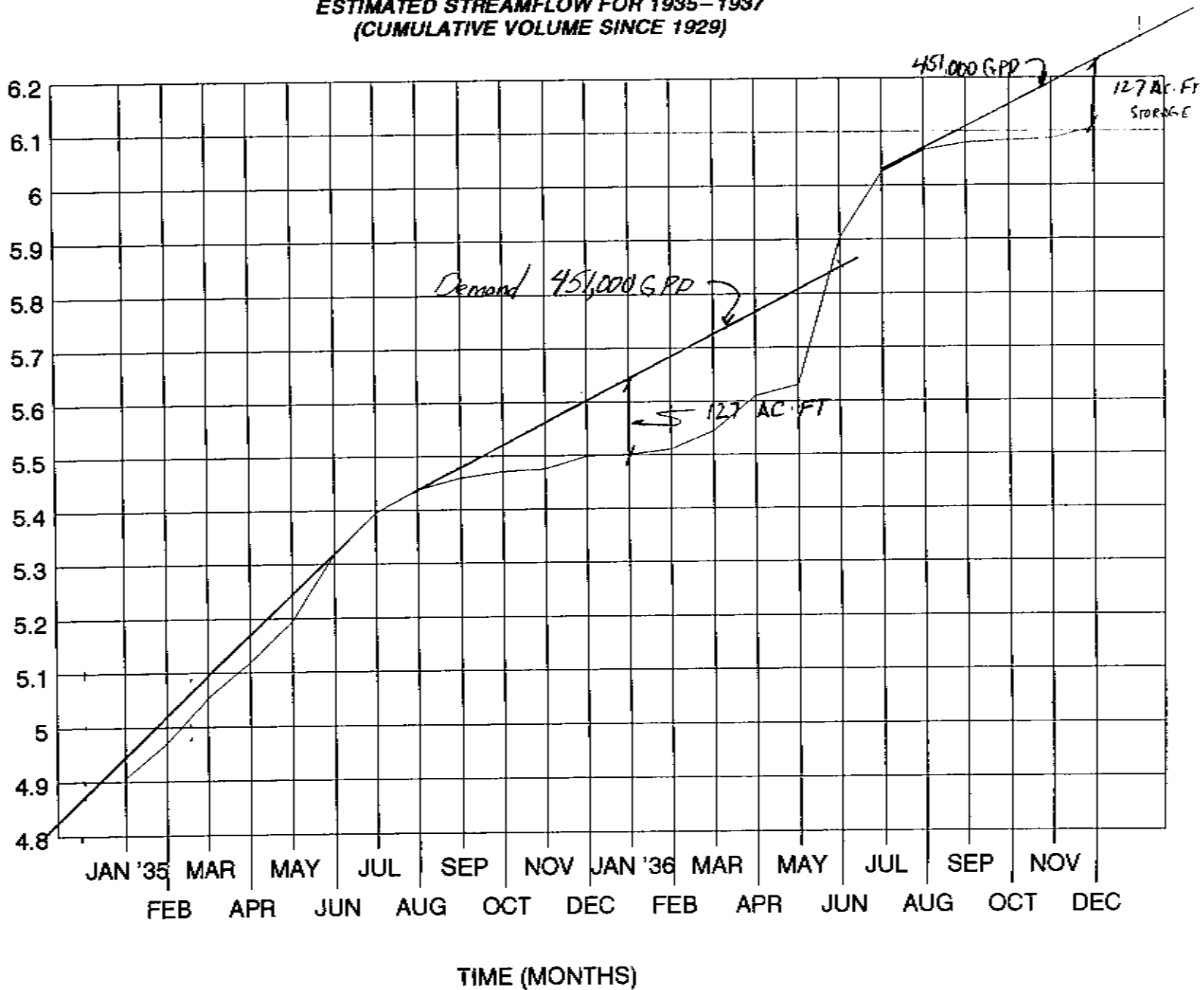


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAMFLOW FOR 1933-1935  
(CUMULATIVE VOLUME SINCE 1929)**

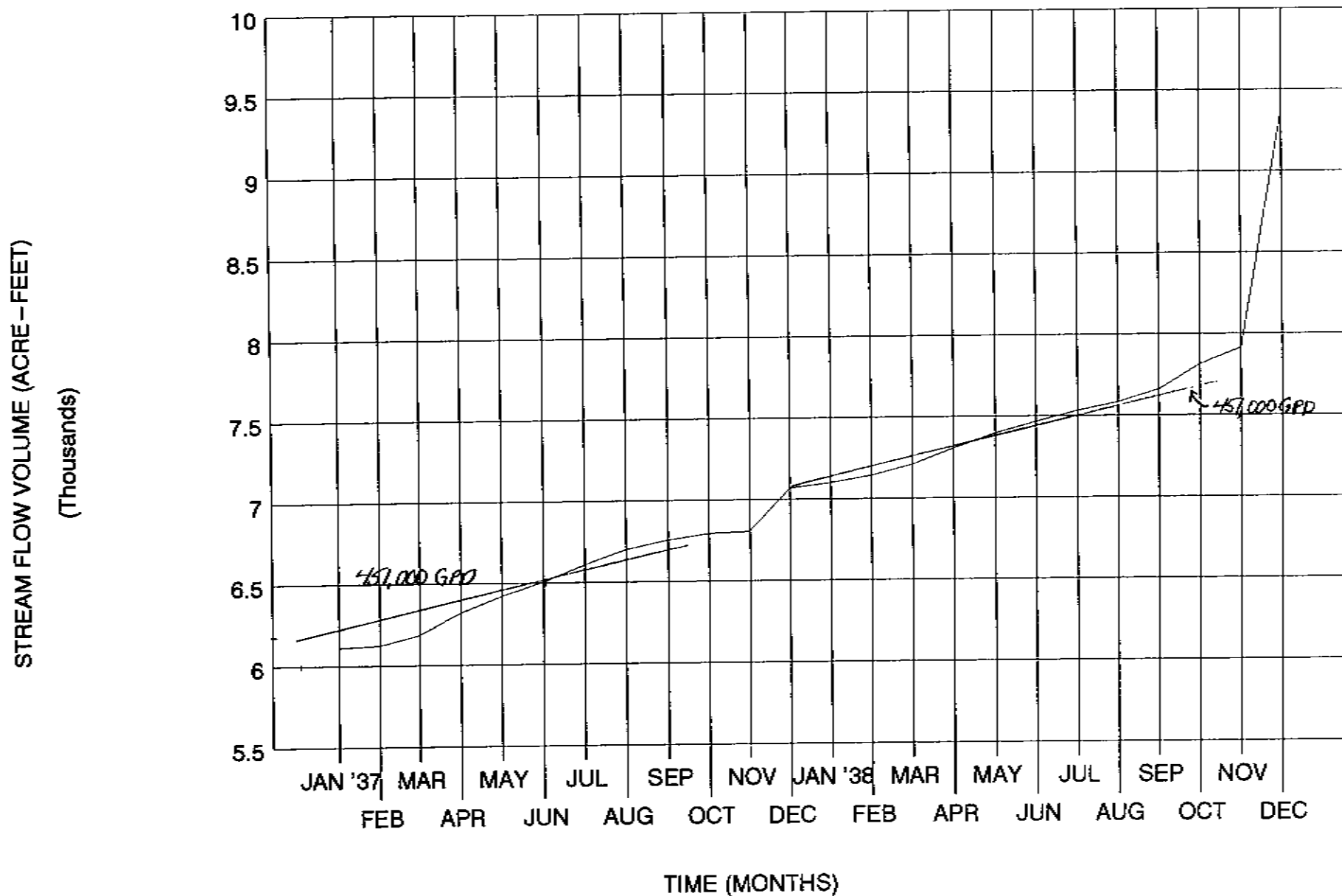


WATCHTOWER - PATTERSON PROJECT  
 ESTIMATED STREAMFLOW FOR 1935-1937  
 (CUMULATIVE VOLUME SINCE 1929)

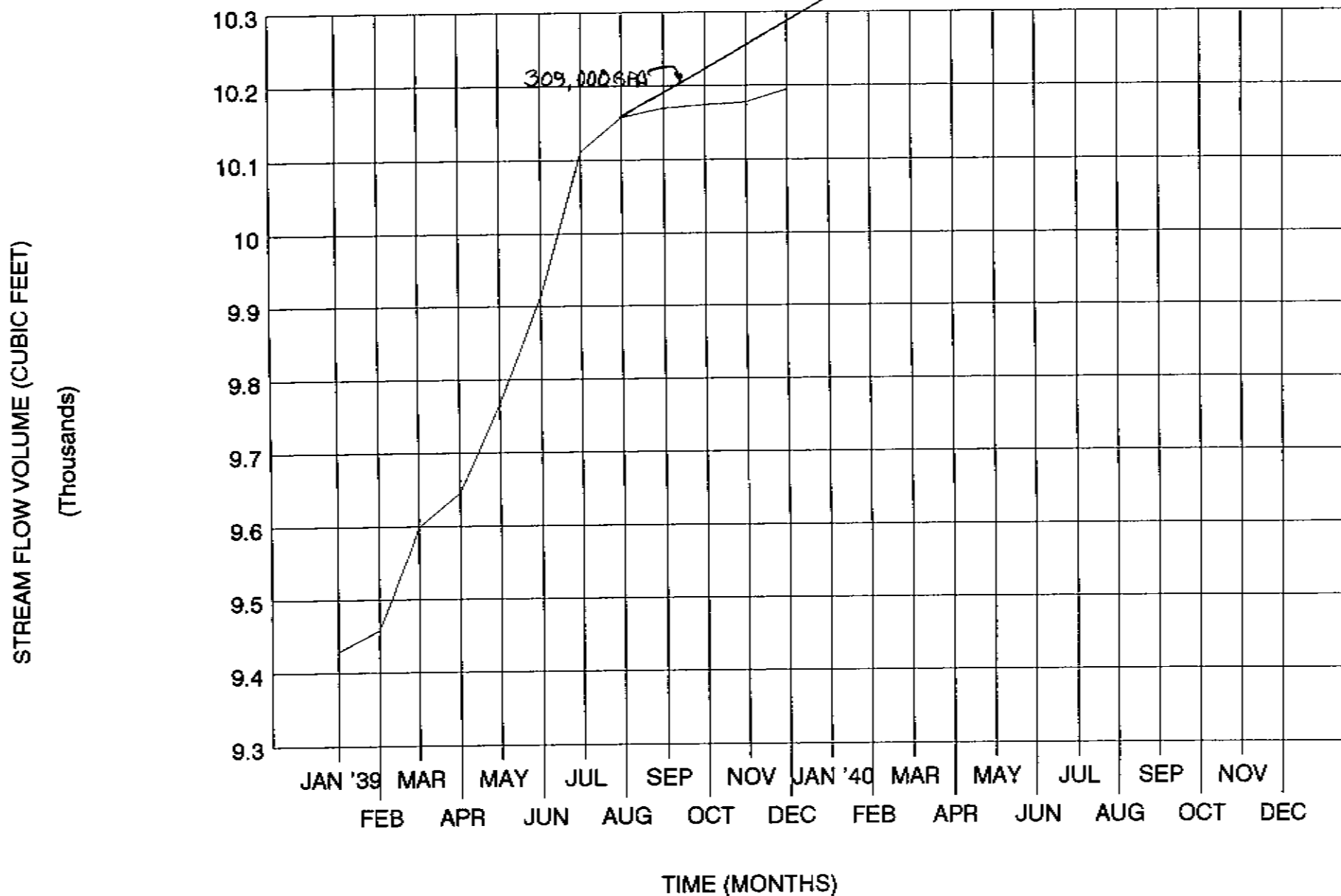
STREAM FLOW VOLUME (ACRE- FEET)  
 (Thousands)



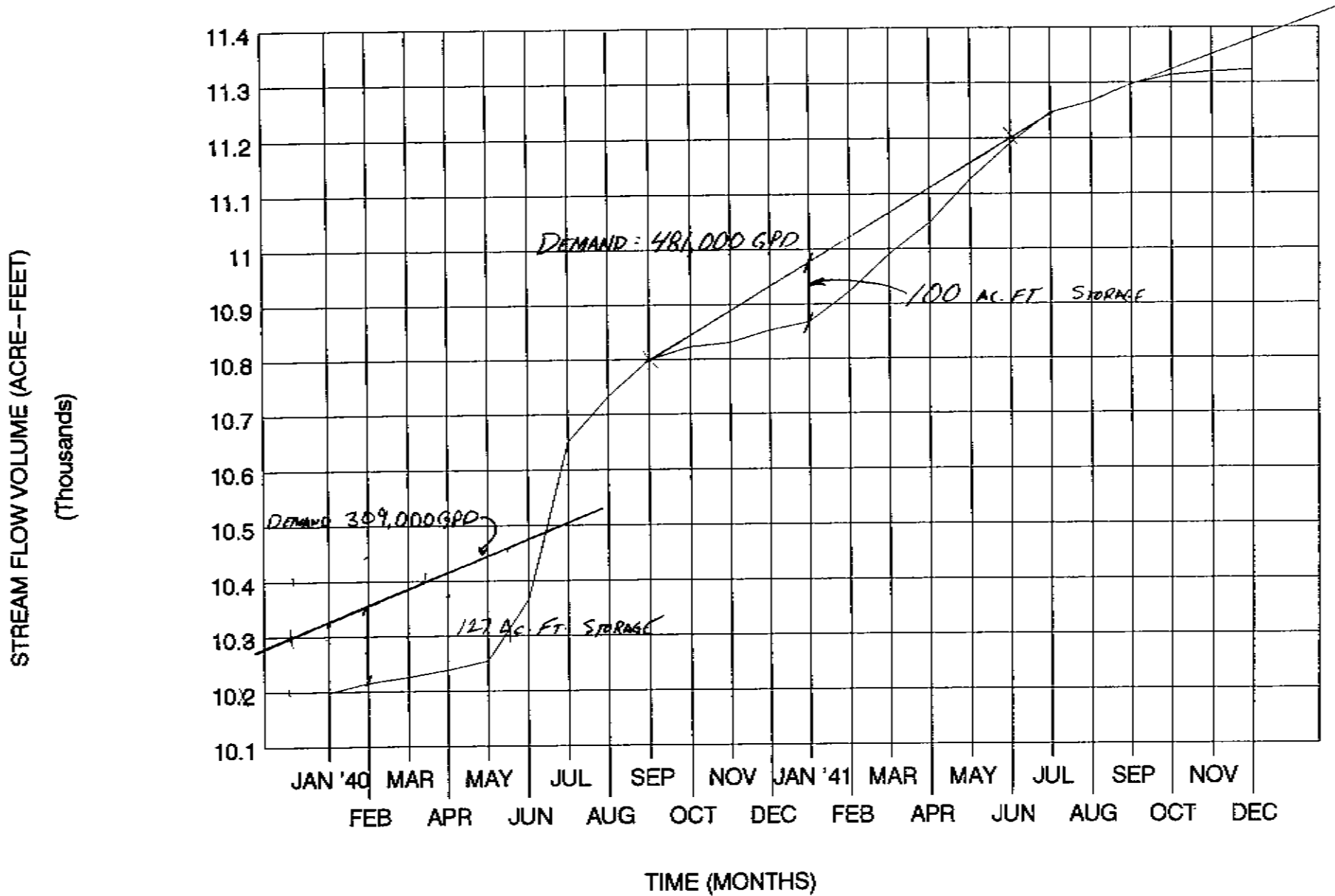
WATCHTOWER - PATTERSON PROJECT  
 ESTIMATED STREAMFLOW FOR 1937-1939  
 (CUMULATIVE VOLUME SINCE 1929)



**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAMFLOW FOR 1939-1940  
(CUMULATIVE VOLUME SINCE 1929)**

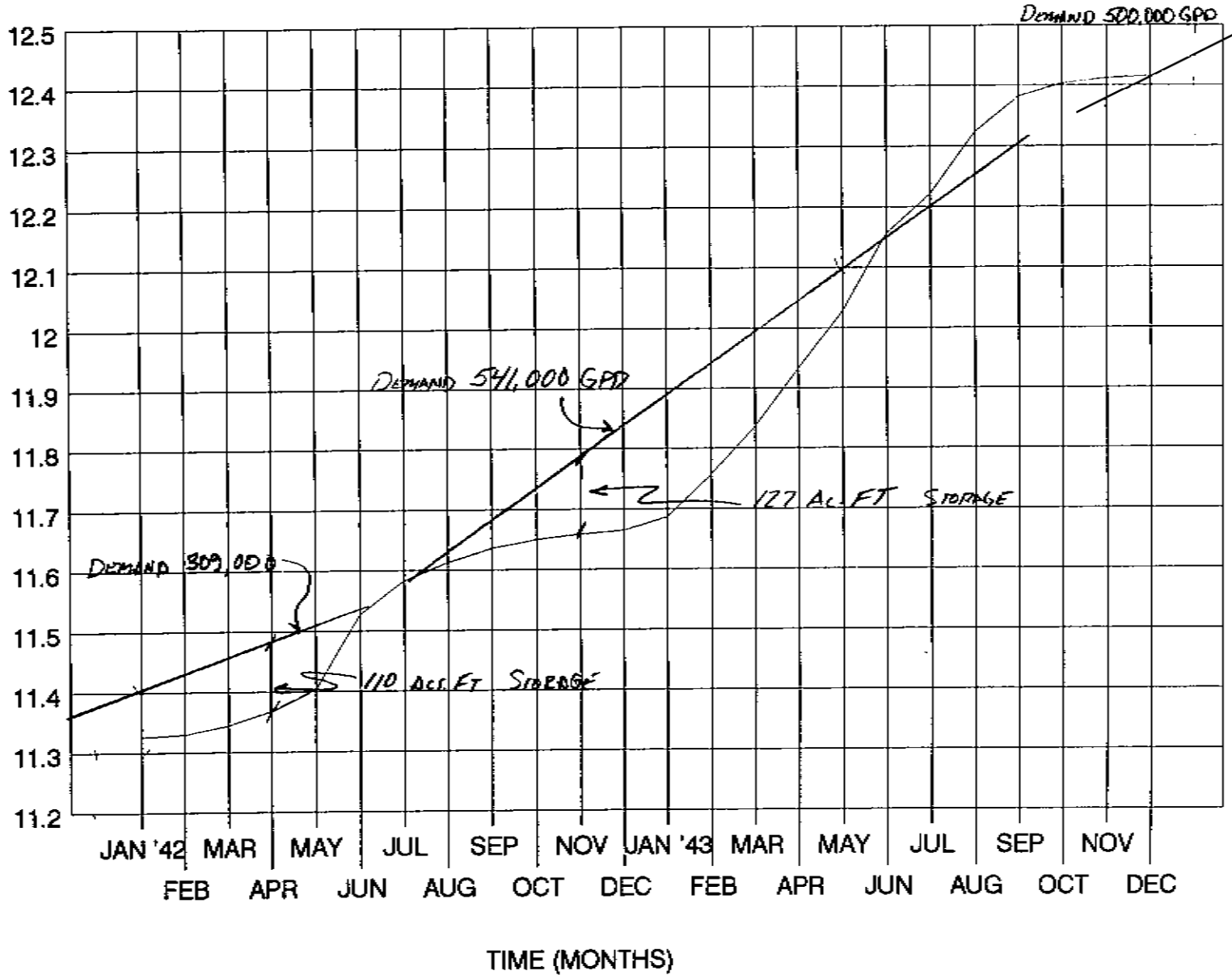


**WATCHTOWER - PATTERSON PROJECT  
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(CUMULATIVE VOLUME SINCE 1929)**

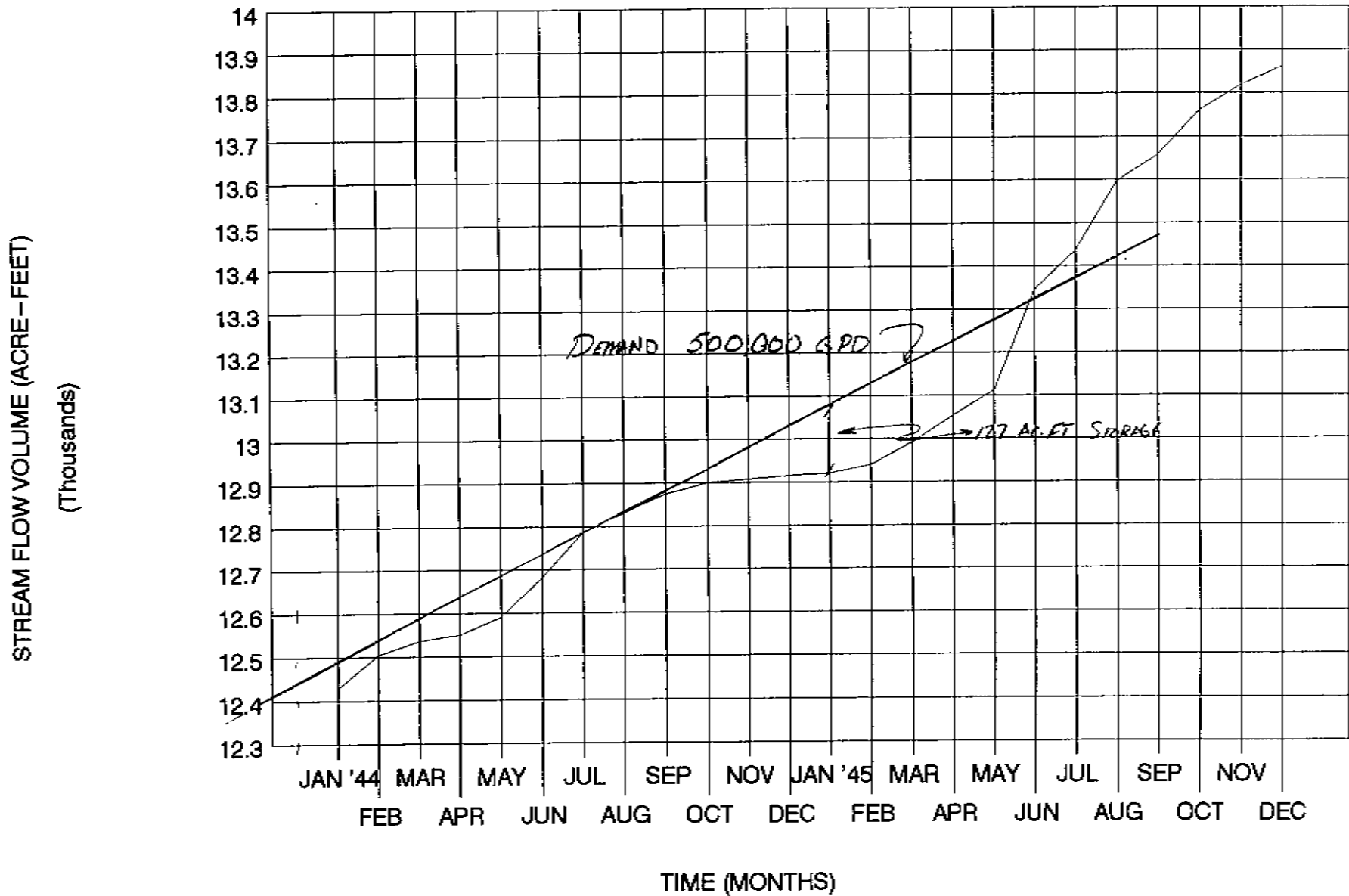


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1942 TO 1944  
(CUMULATIVE SINCE 1929)**

STREAM FLOW VOLUME (ACRE-FEET)  
(Thousands)



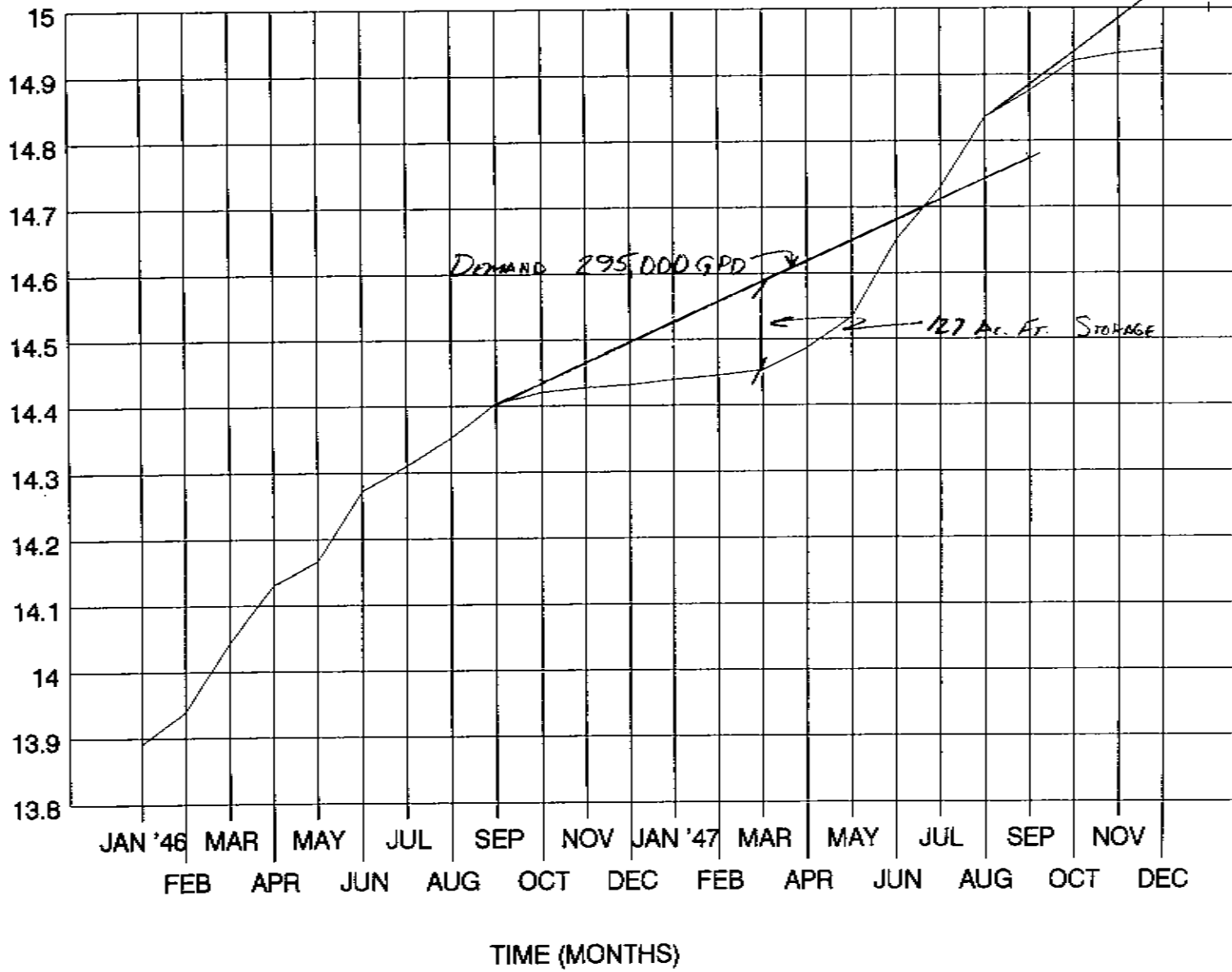
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(CUMULATIVE SINCE 1929)**



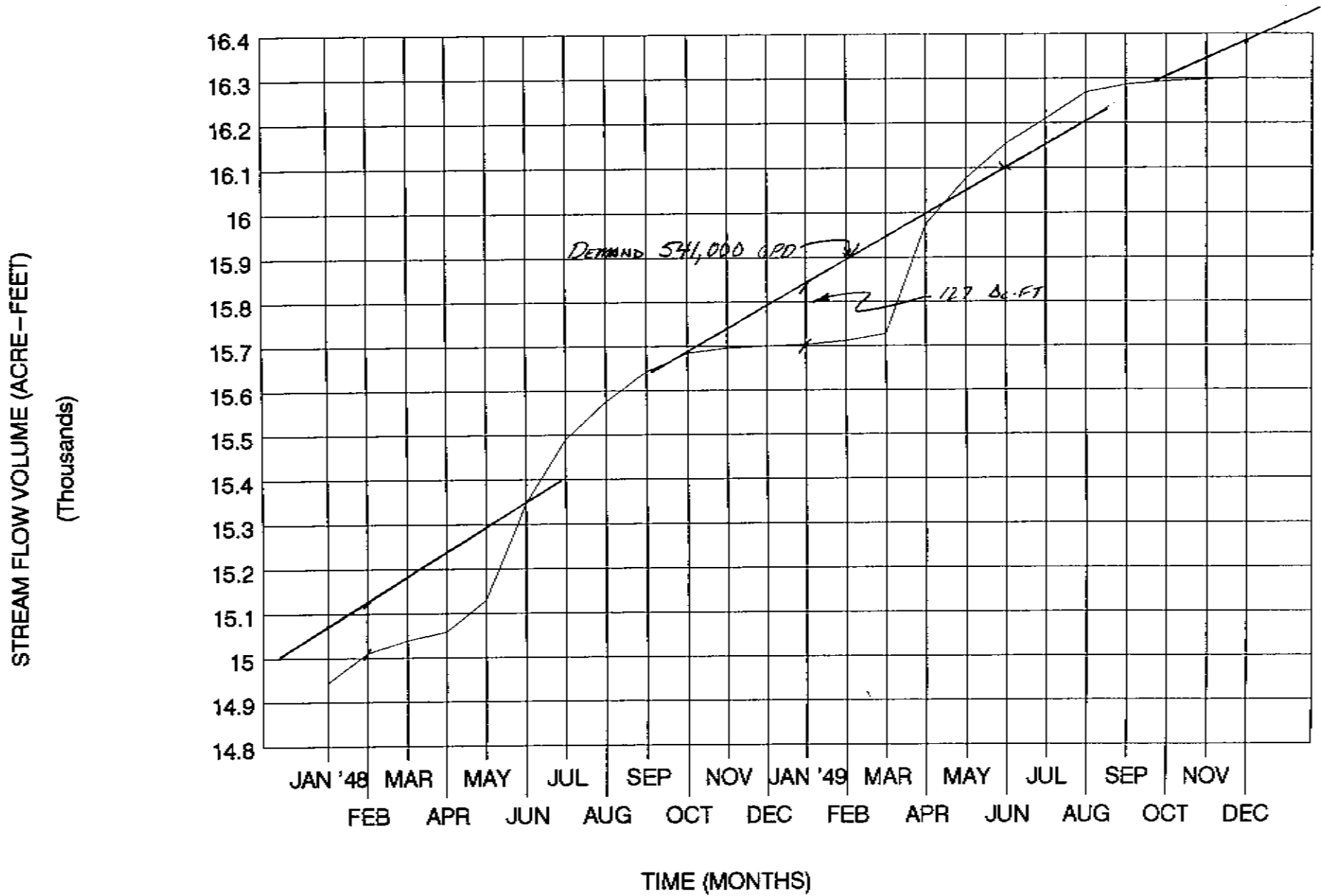
**WATCHTOWER - PATTERSON PROJECT**  
**ESTIMATED STREAM FLOW FOR 1946 TO 1948**  
**(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE-FOOT)

(Thousands)

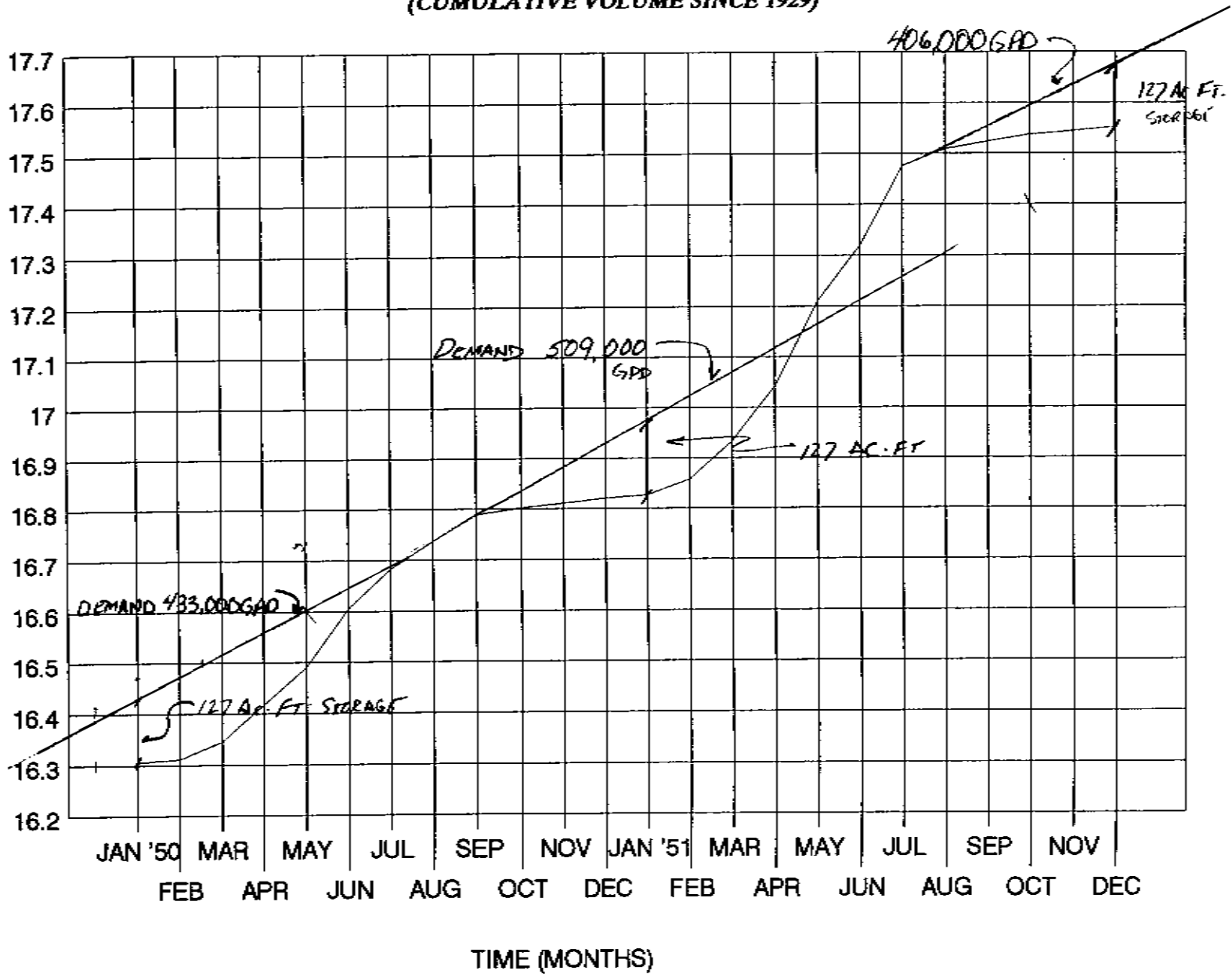


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1948 TO 1950  
(CUMULATIVE VOLUME SINCE 1929)**



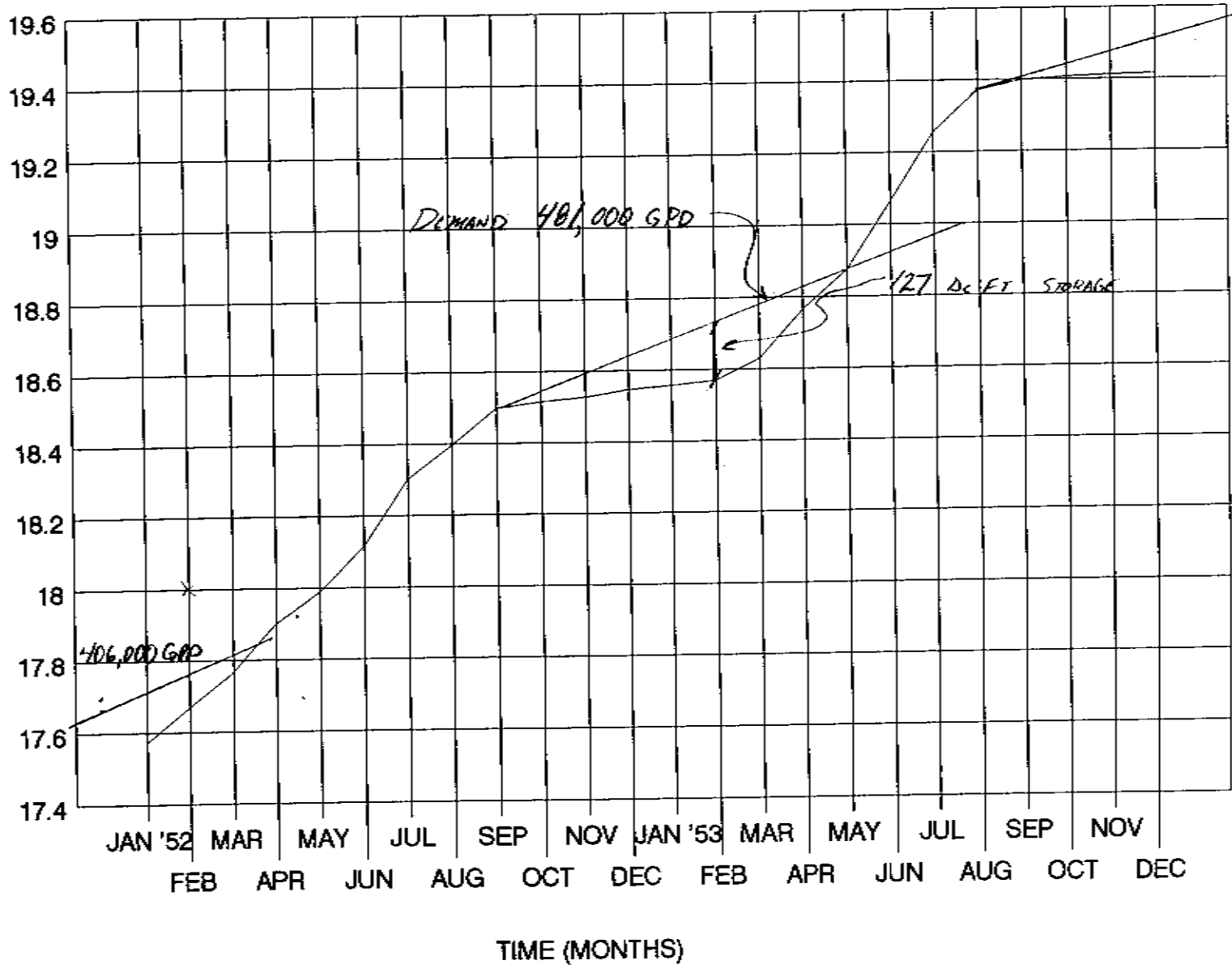
**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1950 TO 1952  
(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE-FOOT)  
(Thousands)



**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1952 TO 1954  
(CUMULATIVE VOLUME SINCE 1929)**

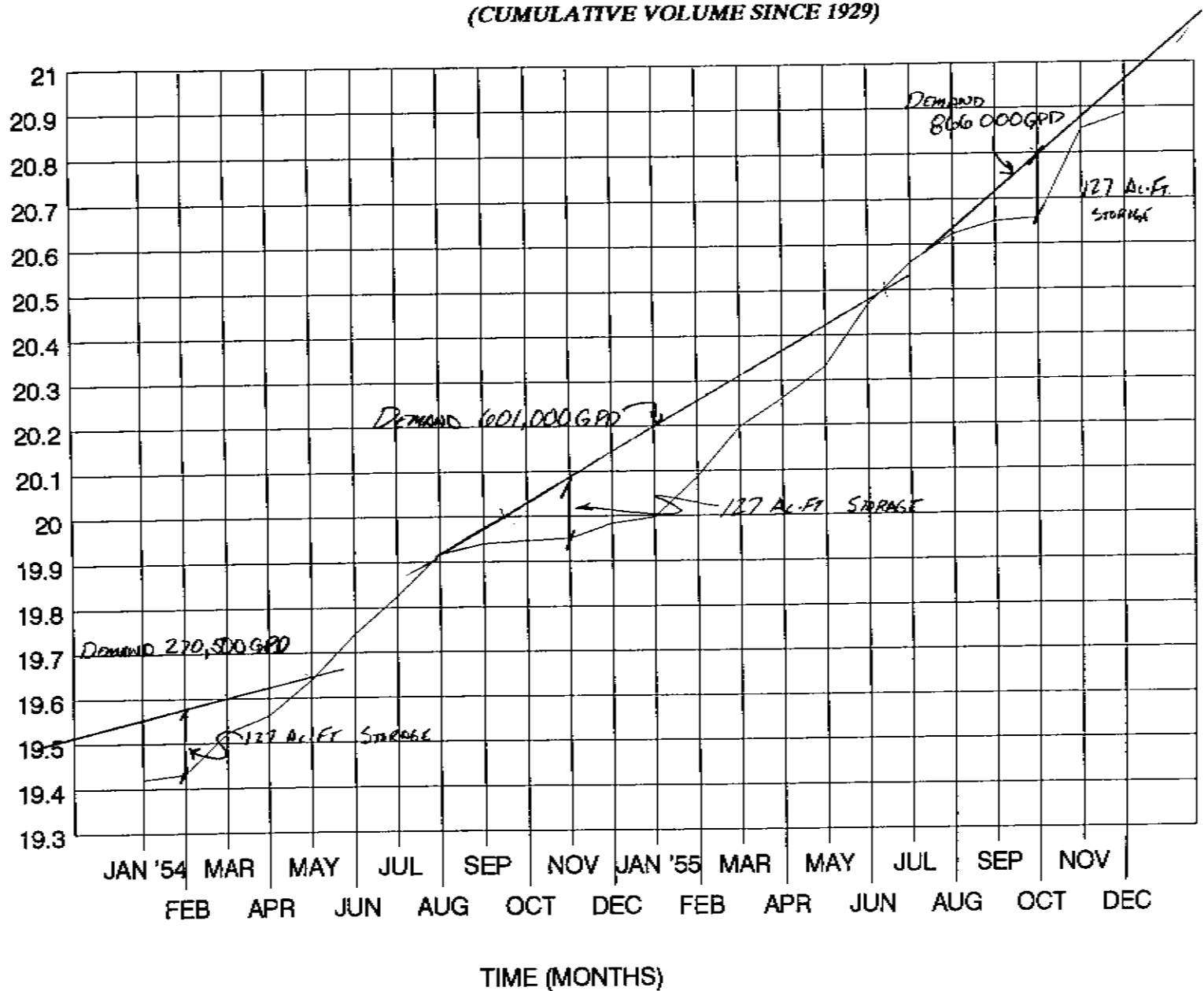
STREAM FLOW VOLUME (ACRE-FEET)  
(Thousands)



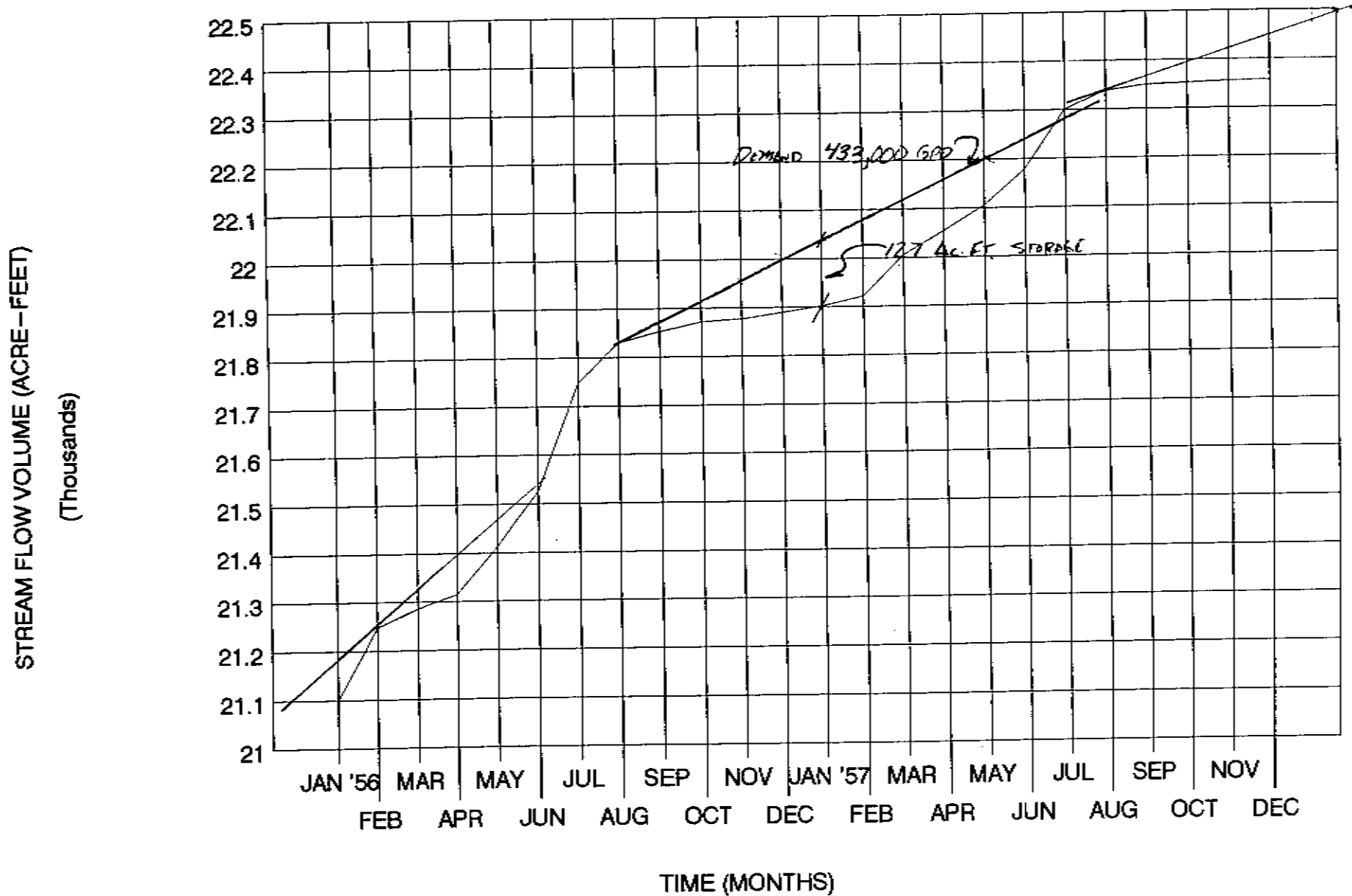
**WATCHTOWER - PATTERSON PROJECT**  
**ESTIMATED STREAM FLOW FOR 1954 TO 1956**  
**(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE- FEET)

(Thousands)

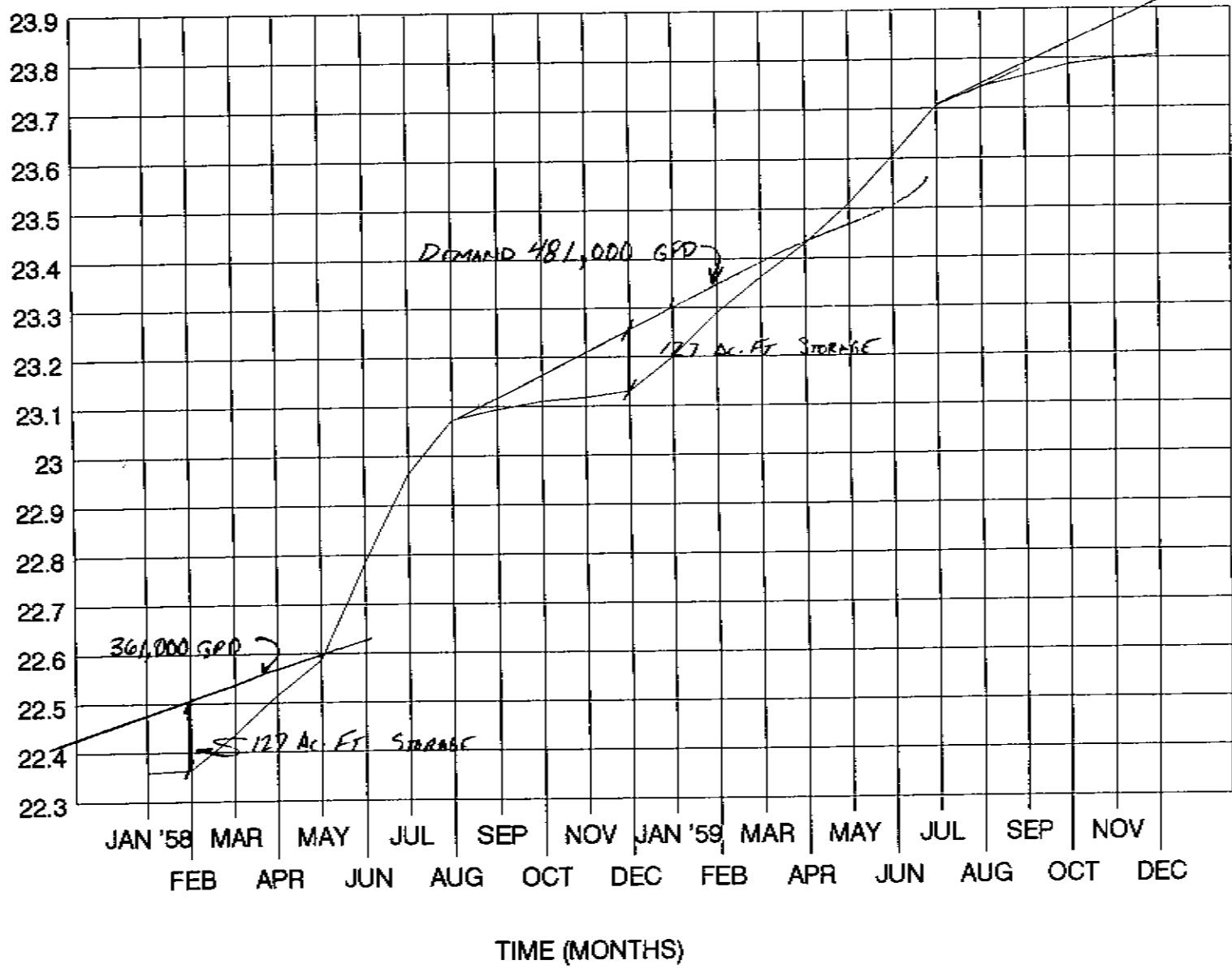


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1956 TO 1958  
(CUMULATIVE VOLUME SINCE 1929)**

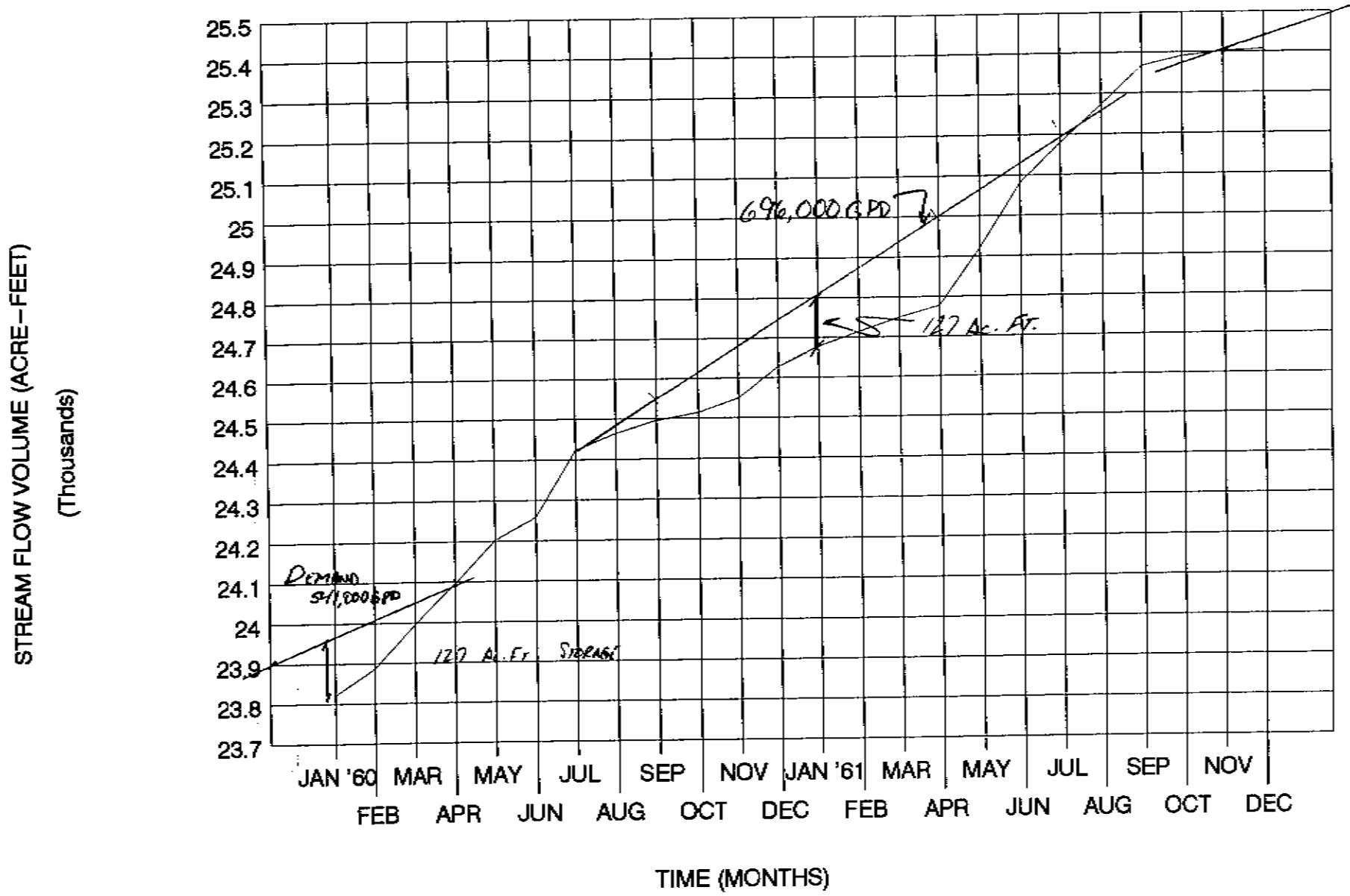


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1958 TO 1960  
(CUMULATIVE VOLUME SINCE 1929)**

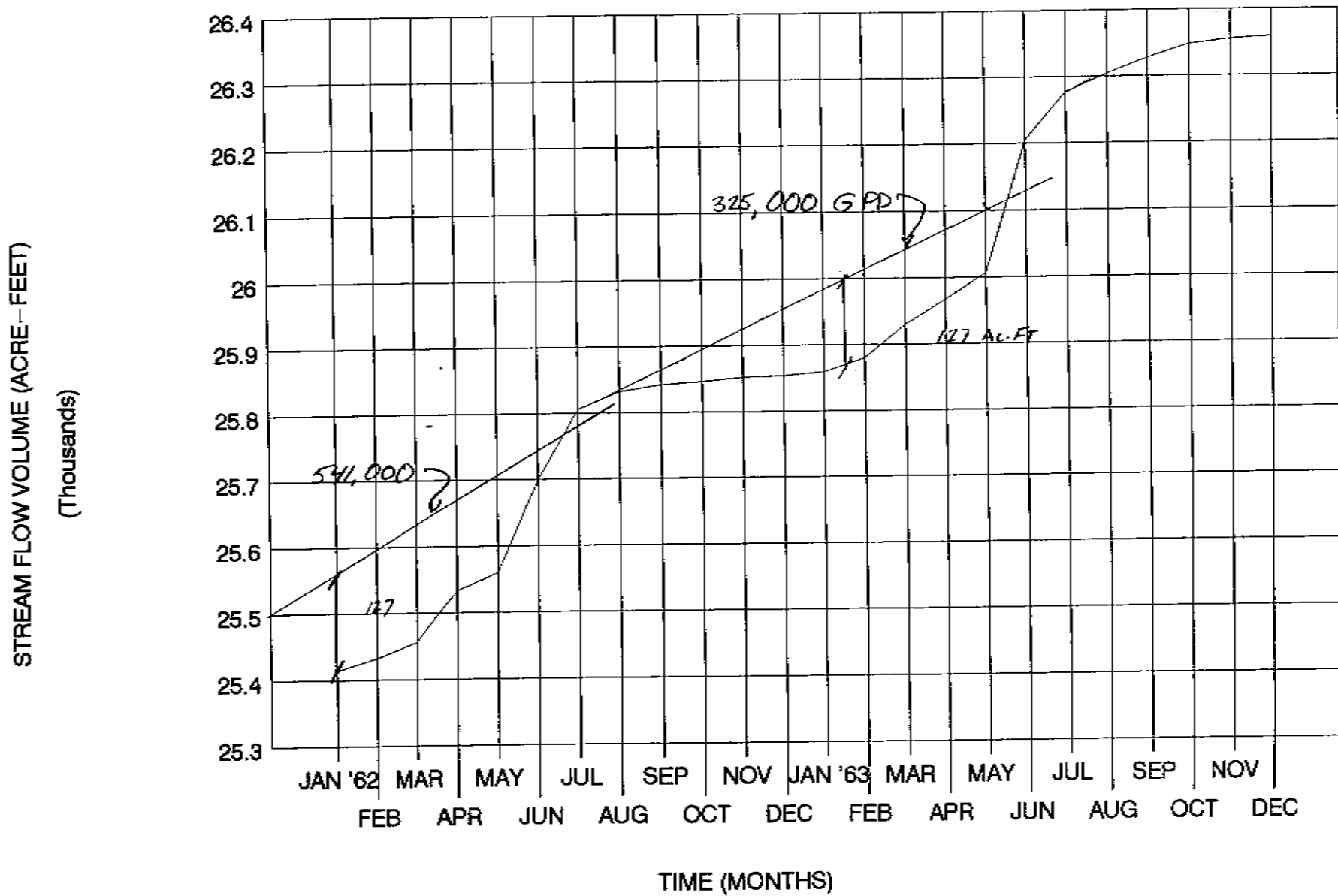
STREAM FLOW VOLUME (ACRE- FEET)  
(Thousands)



**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1960 TO 1962  
(CUMULATIVE VOLUME SINCE 1929)**



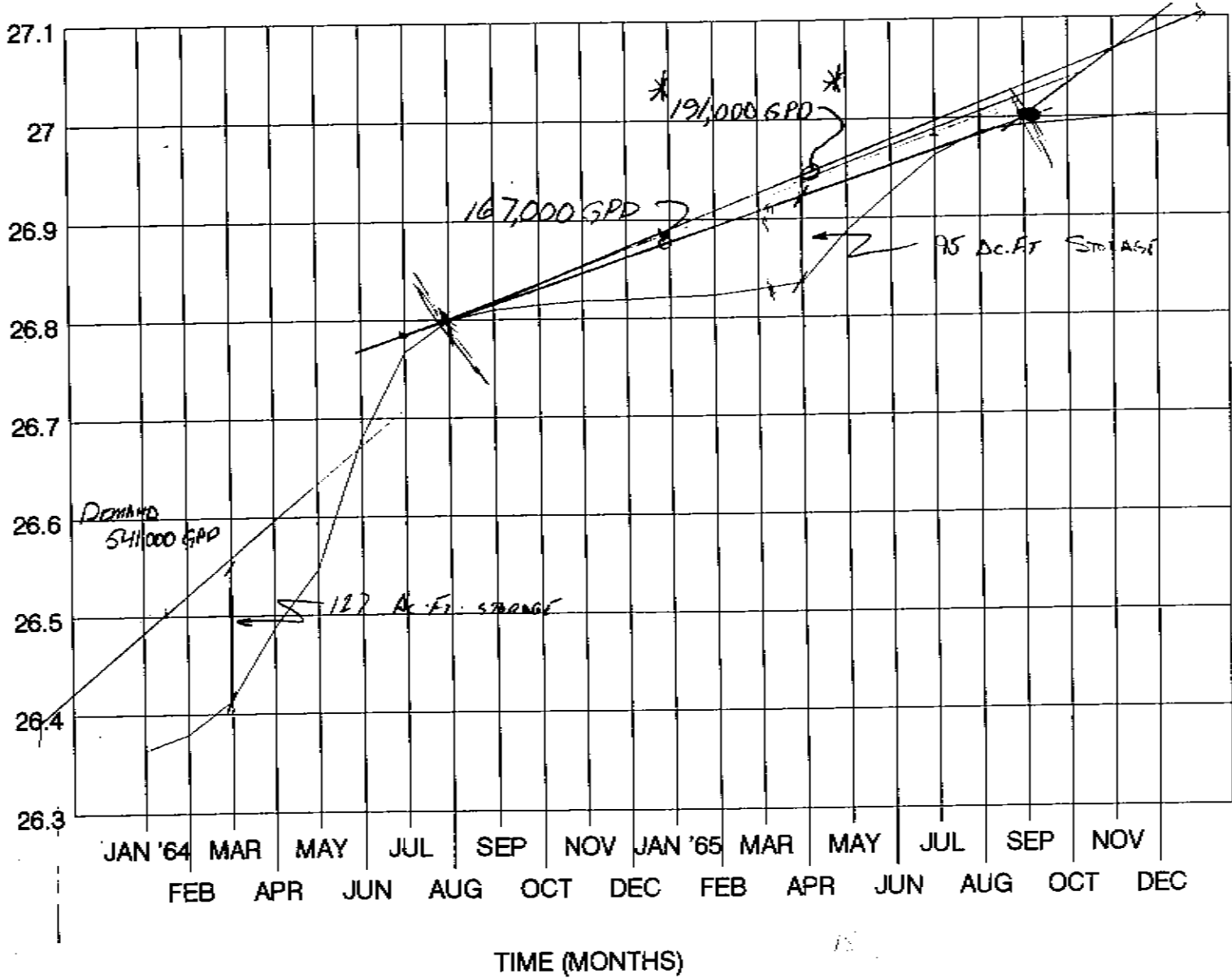
**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1962 TO 1964  
(CUMULATIVE VOLUME SINCE 1929)**



**WATCHTOWER - PATTERSON PROJECT**  
**ESTIMATED STREAM FLOW FOR 1964 TO 1966**  
**(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE-FEET)

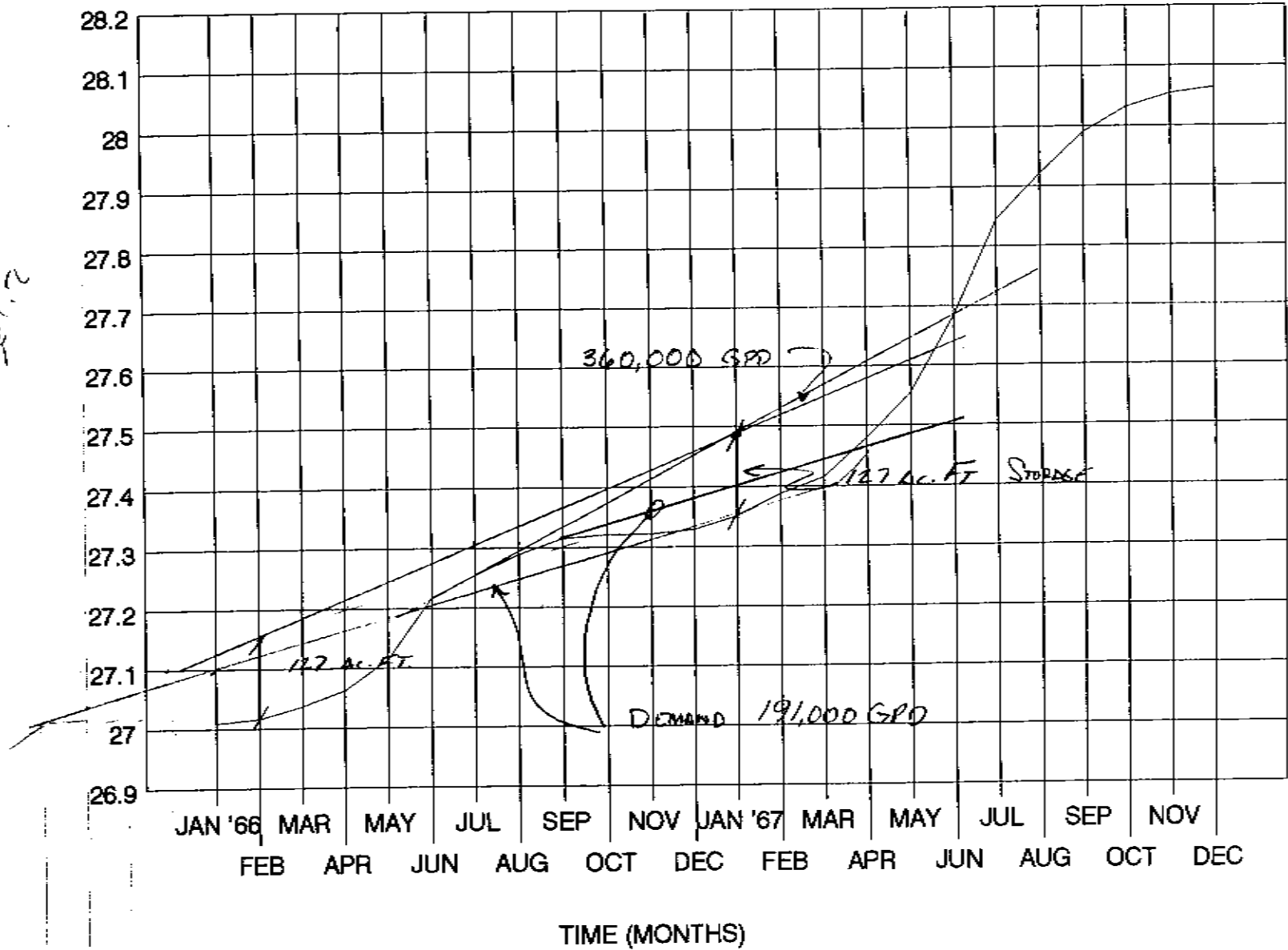
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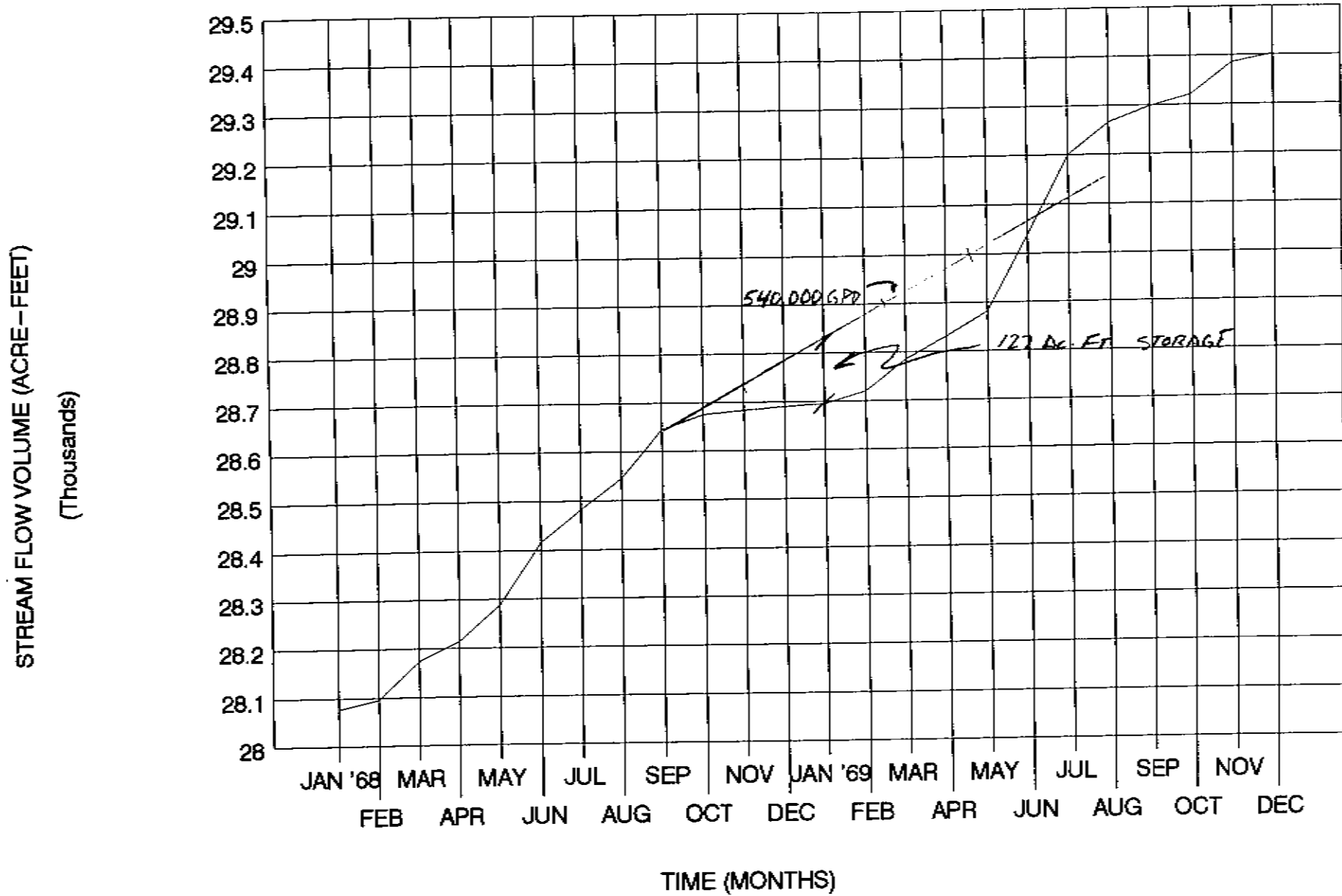
**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1966 TO 1968  
(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE- FEET)  
(Thousands)

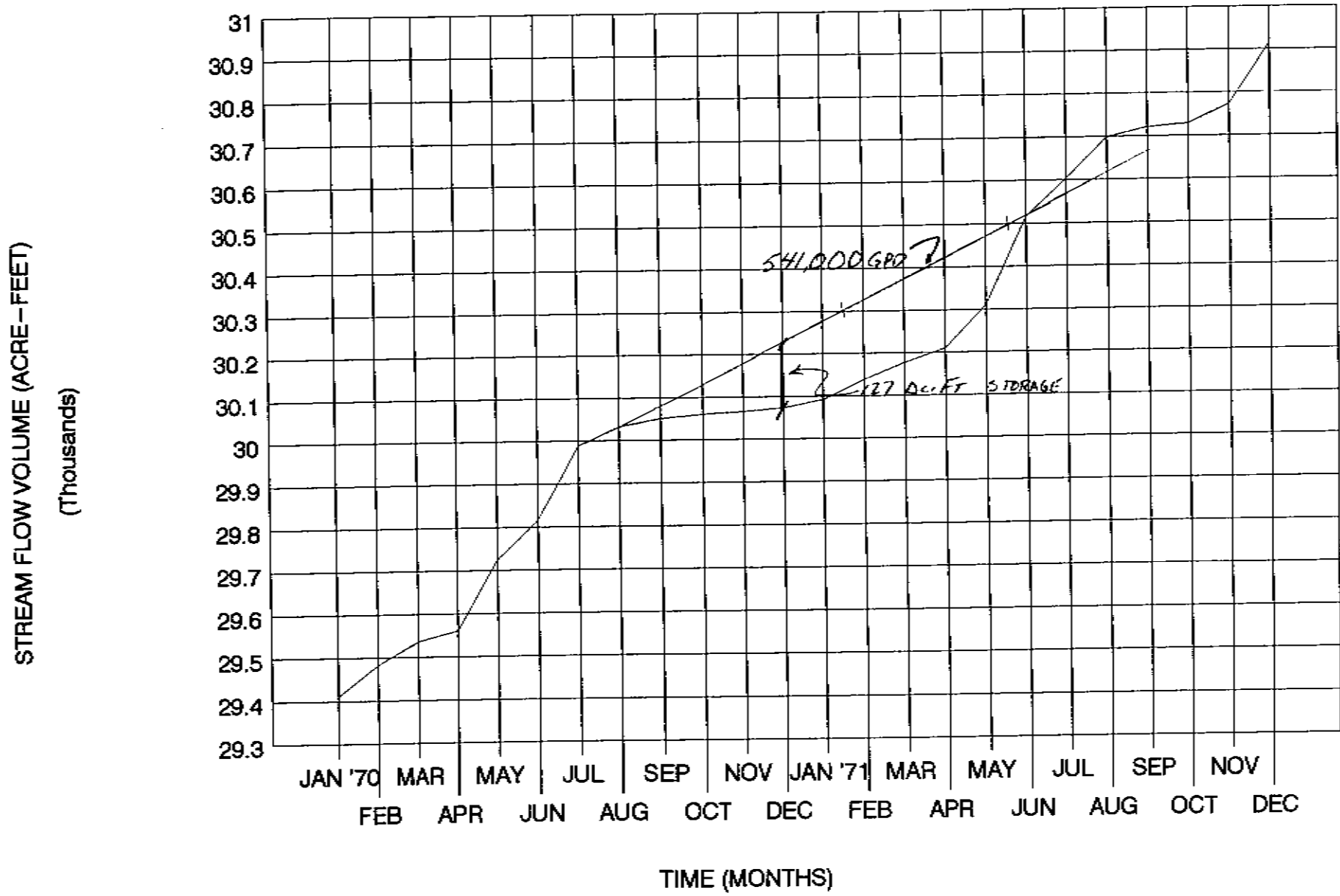
551.2



**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1968 TO 1970  
(CUMULATIVE VOLUME SINCE 1929)**

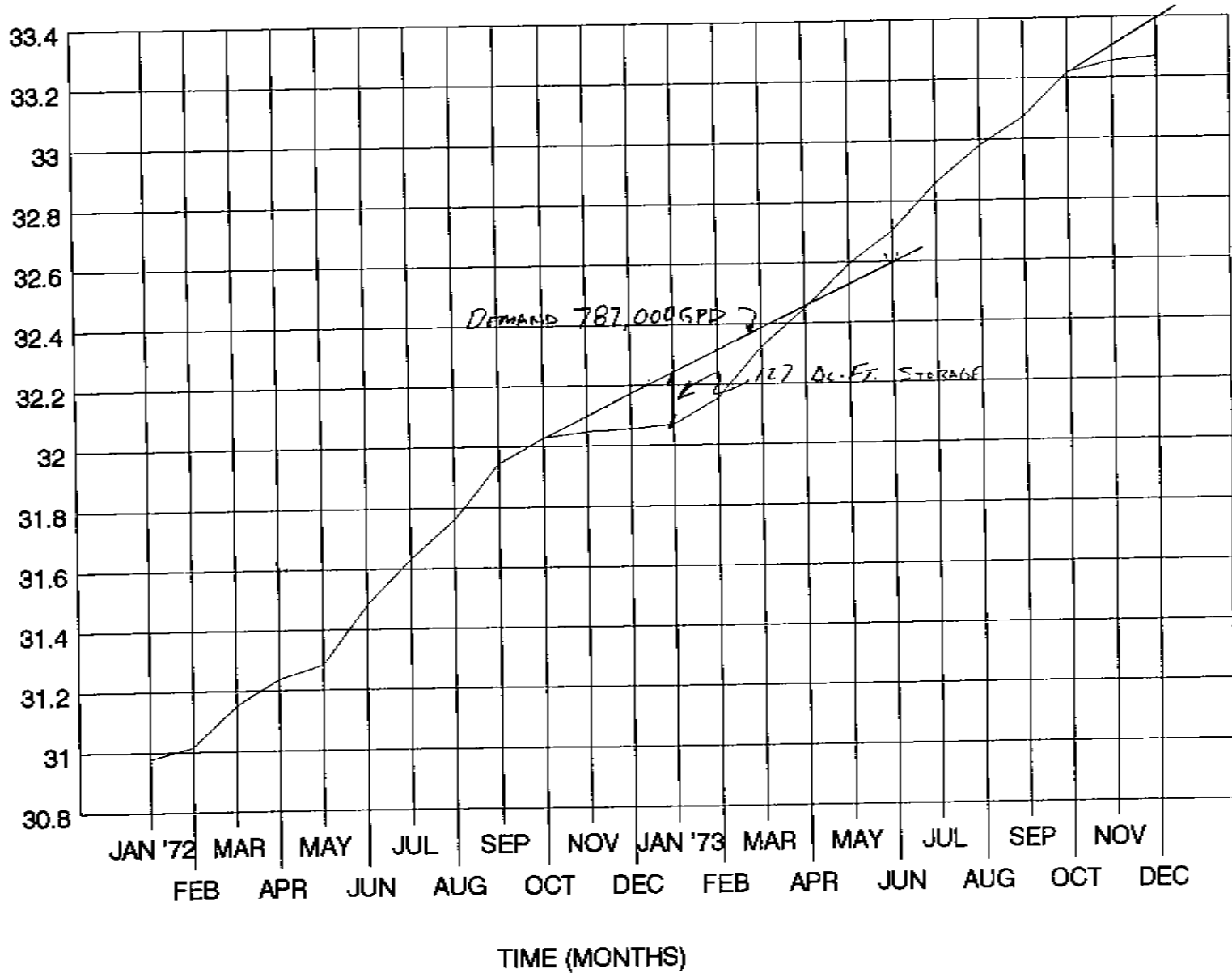


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1970 TO 1972  
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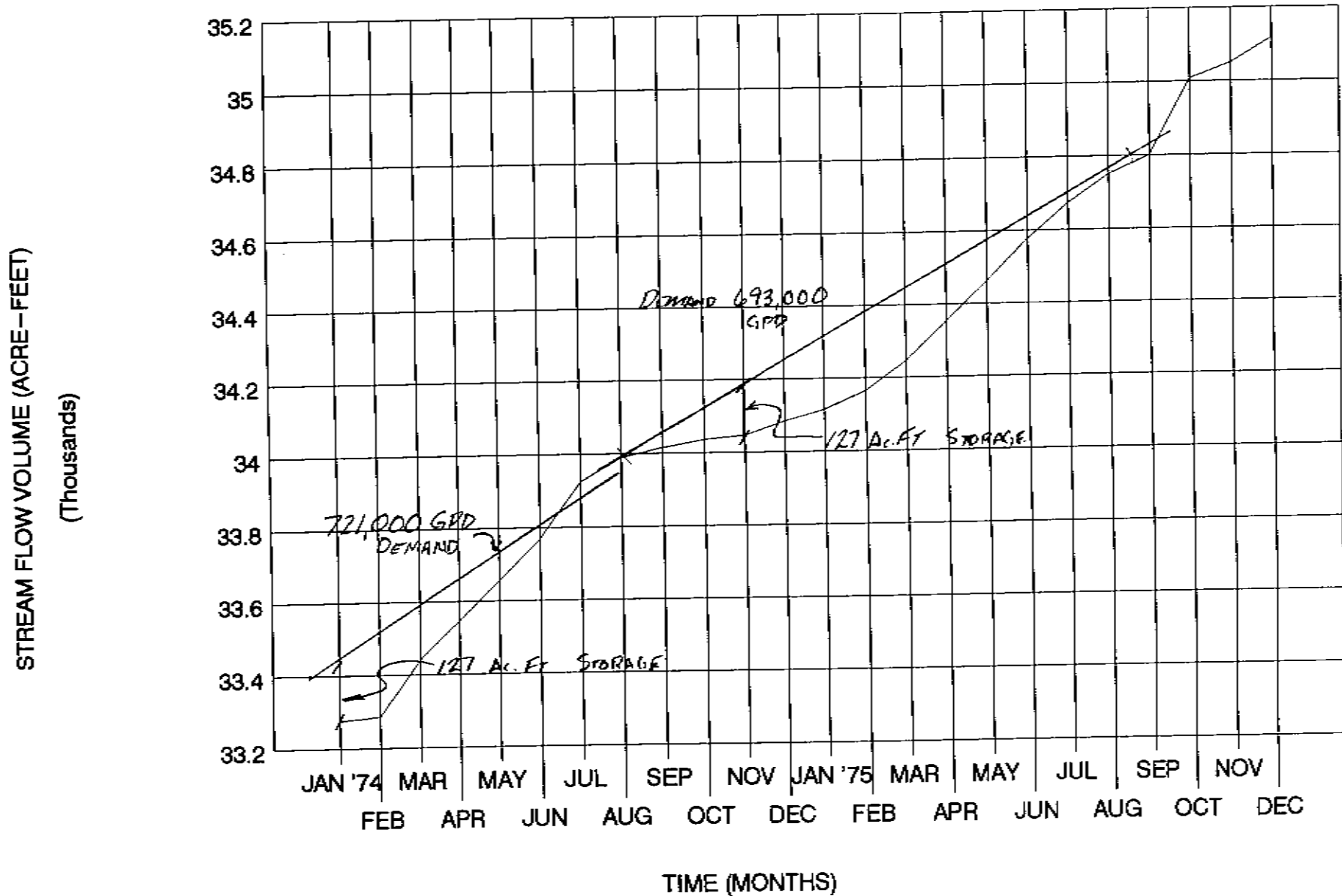


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1972 TO 1974  
(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE-FOOT)  
(Thousands)

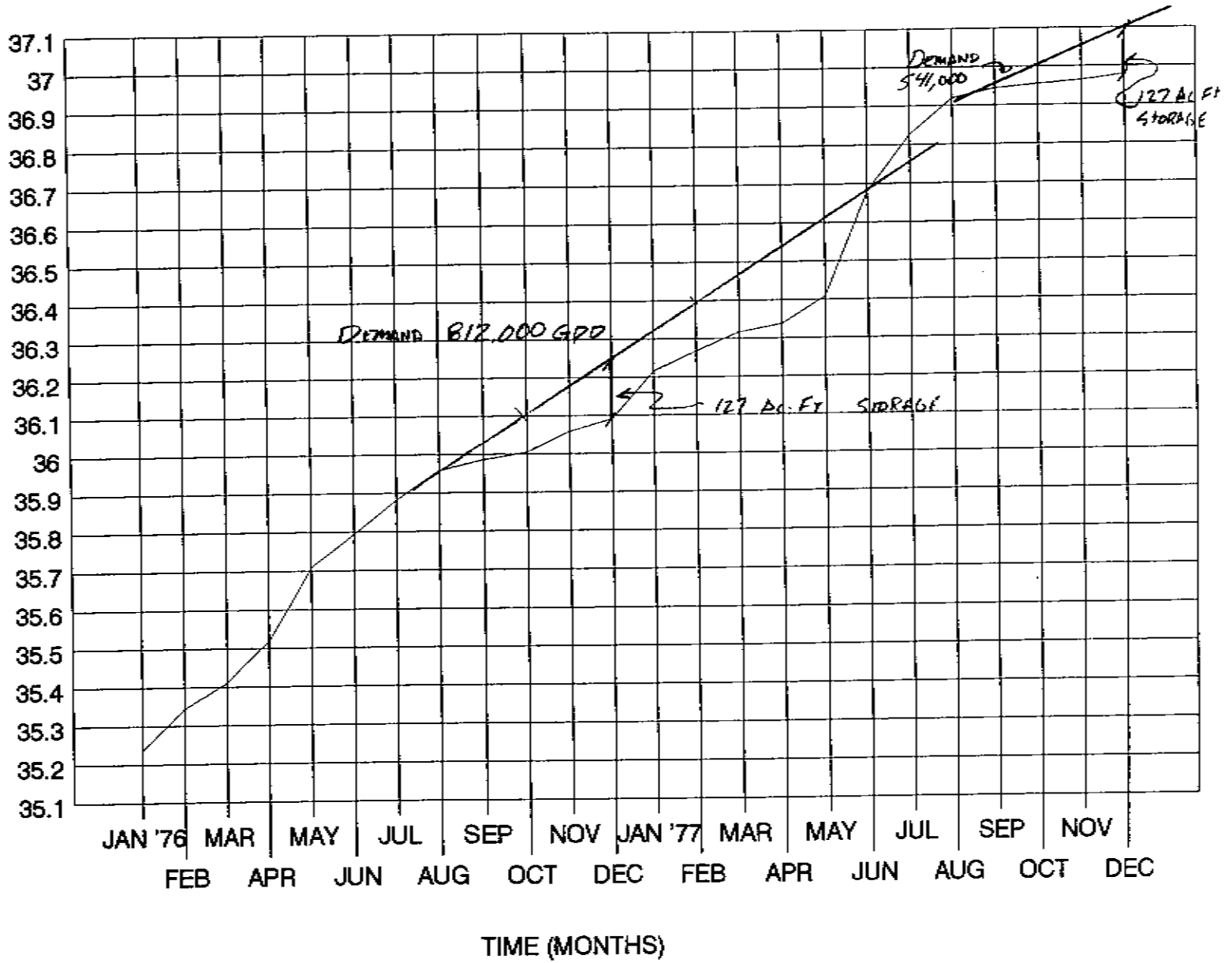


**WATCHTOWER - PATTERSON PROJECT**  
**ESTIMATED STREAM FLOW FOR 1974 TO 1976**  
**(CUMULATIVE VOLUME SINCE 1929)**

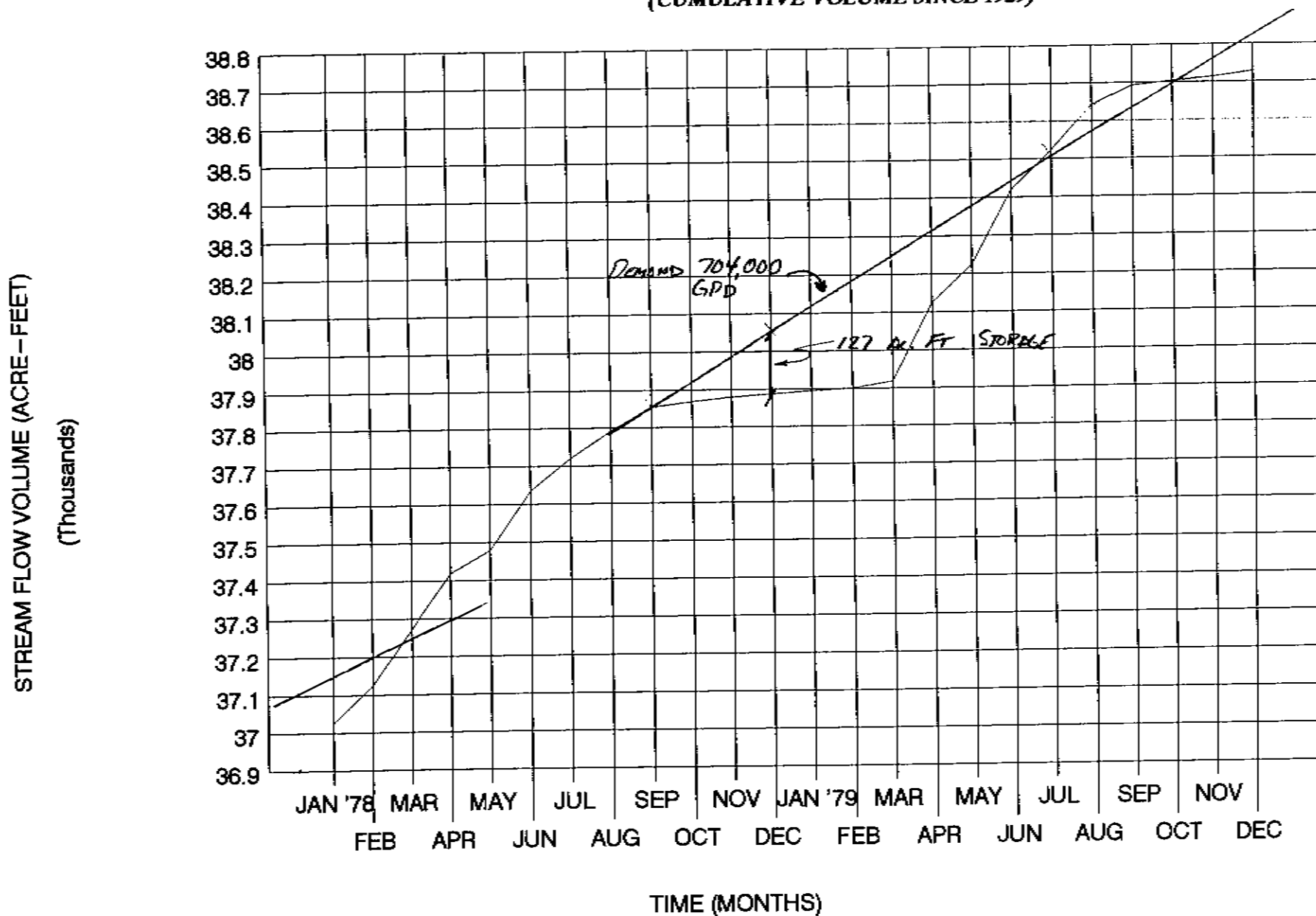


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1976 TO 1978  
(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE- FEET)  
(Thousands)

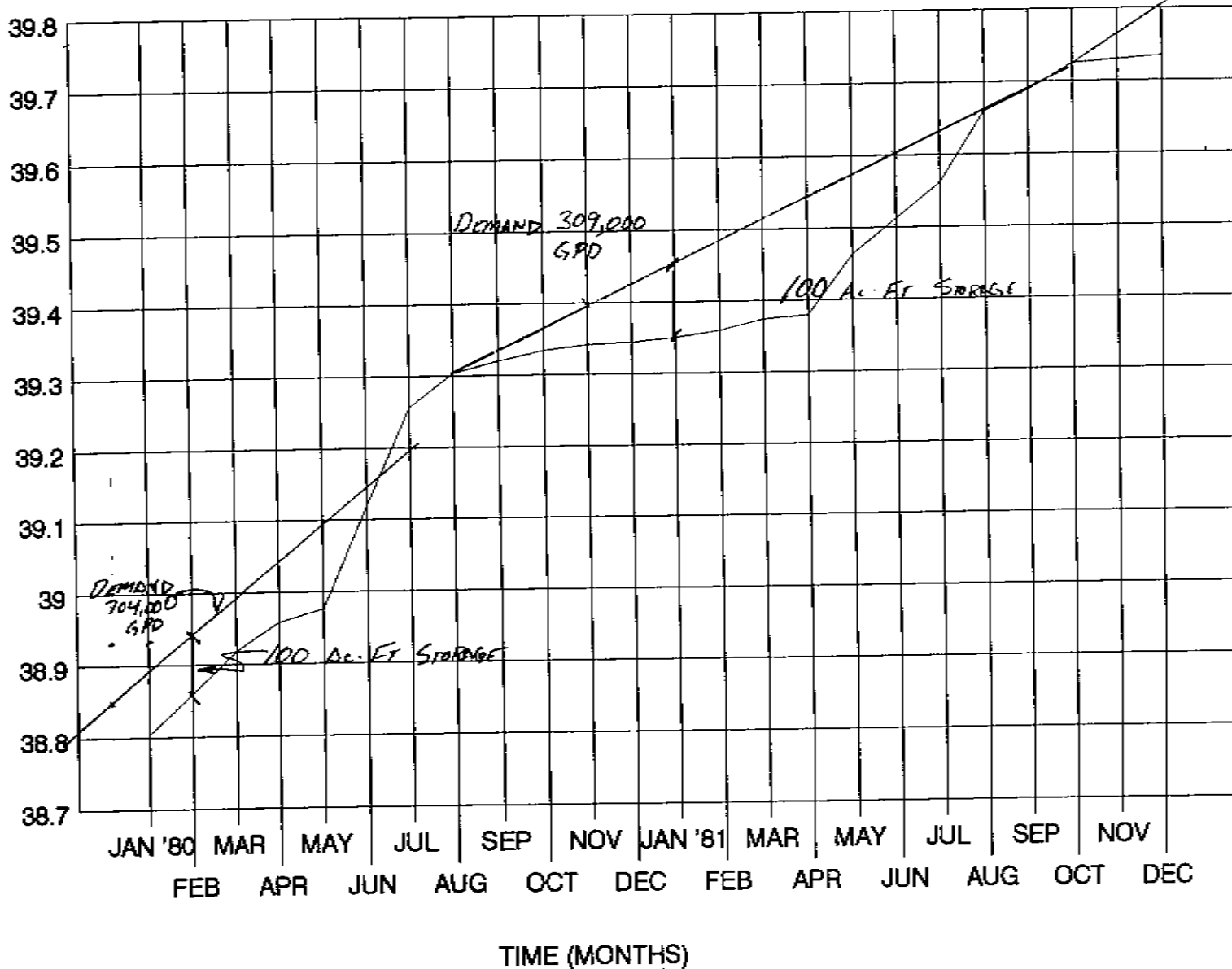


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1978 TO 1980  
(CUMULATIVE VOLUME SINCE 1929)**



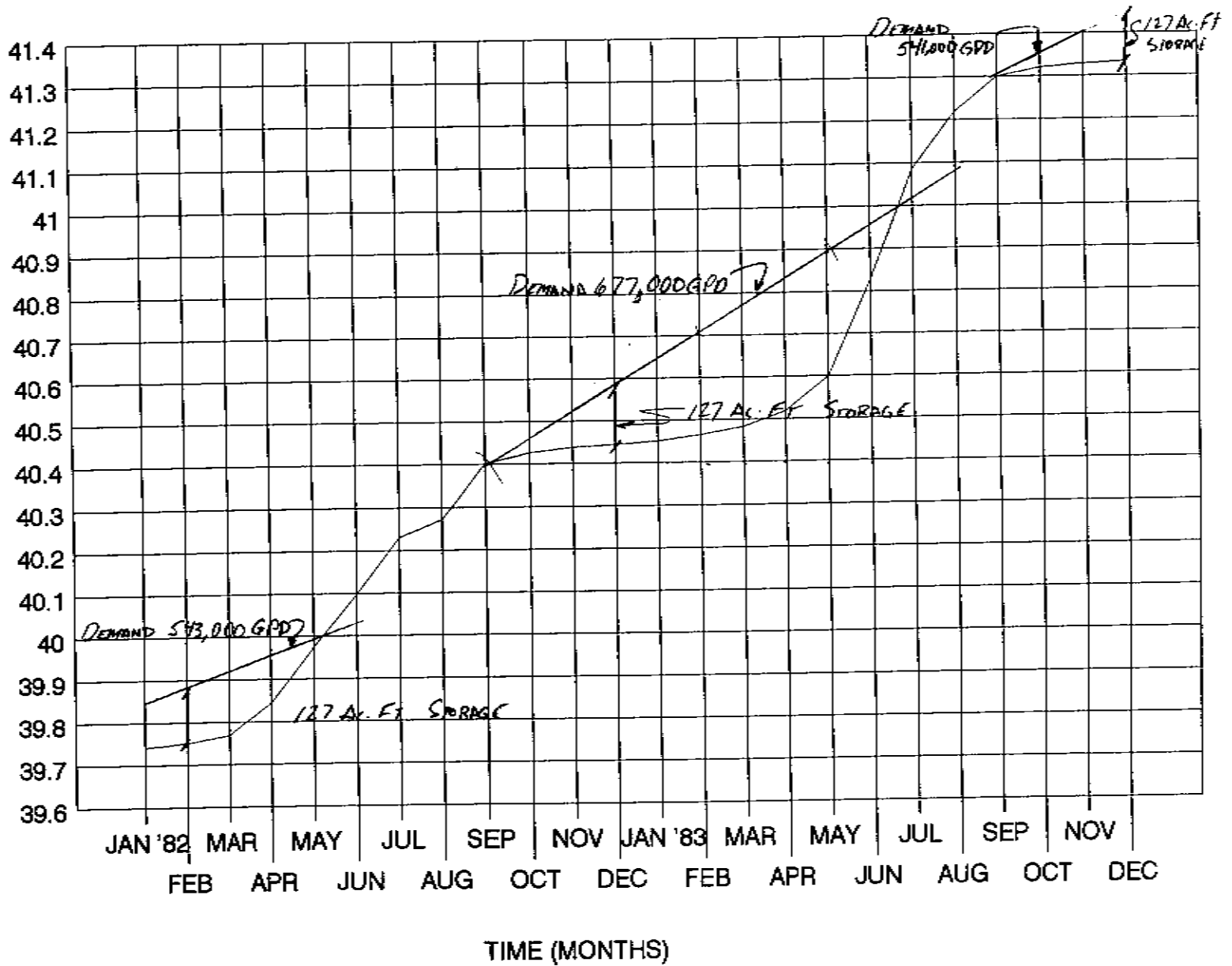
**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1980 TO 1982  
(CUMULATIVE VOLUME SINCE 1929)**

STREAM FLOW VOLUME (ACRE- FEET)  
(Thousands)

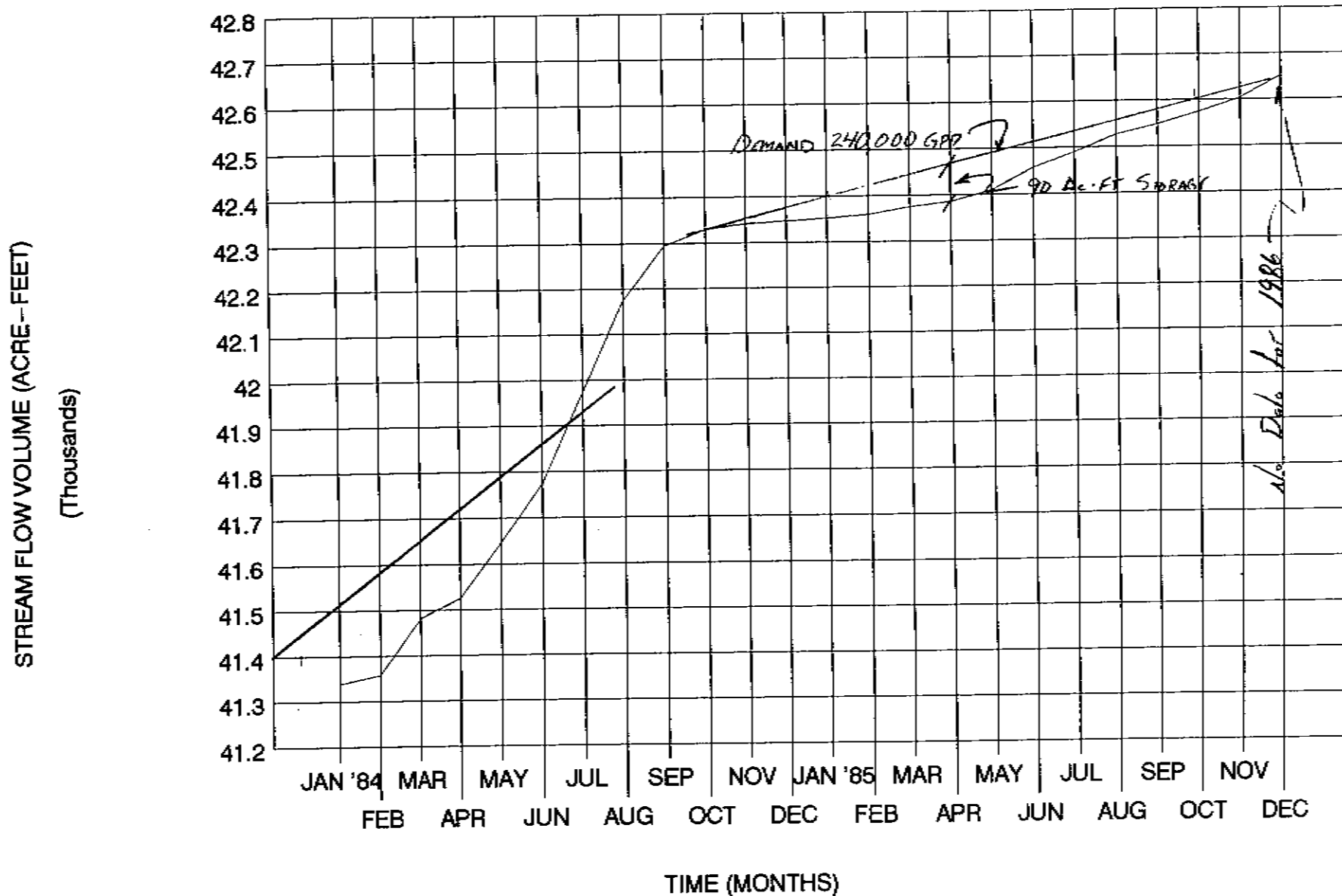


**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1982 TO 1984  
(CUMULATIVE VOLUME SINCE 1929)**

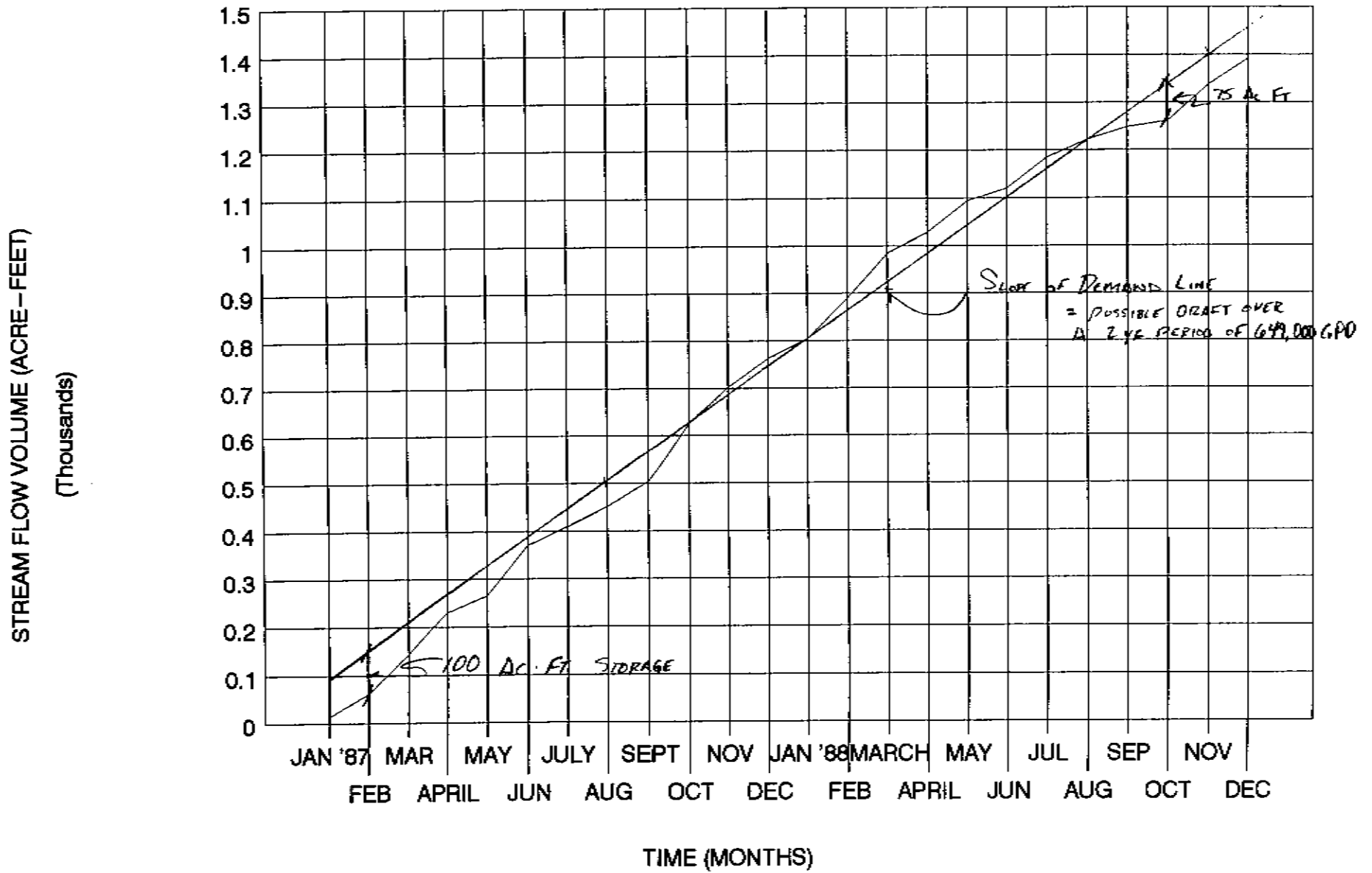
STREAM FLOW VOLUME (ACRE- FEET)  
(Thousands)



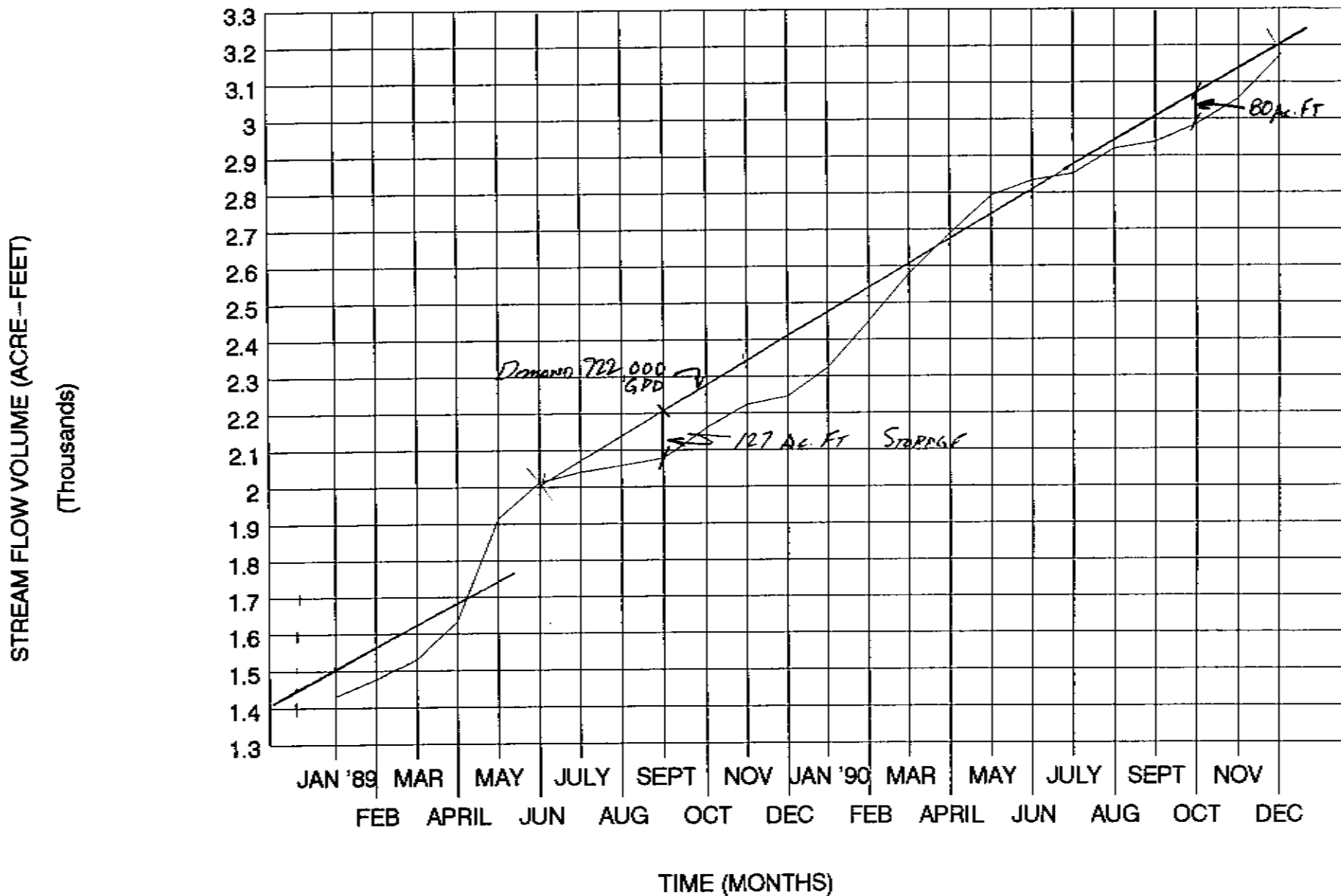
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ESTIMATED STREAM FLOW FOR 1984 TO 1986  
(CUMULATIVE VOLUME SINCE 1929)**



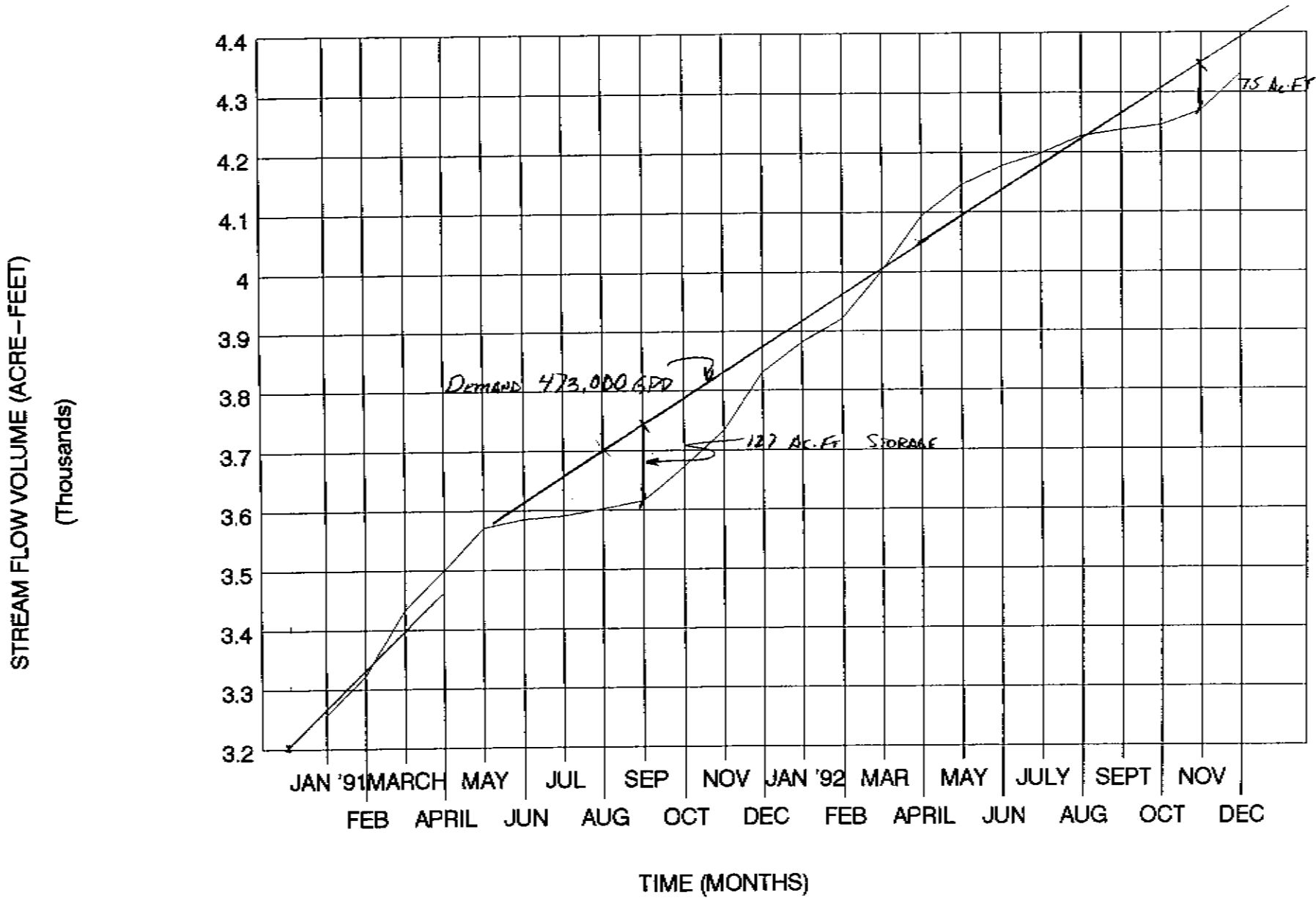
**WATCHTOWER - PATTERSON PROJECT**  
**ESTIMATED STREAM FLOW FOR 1987 TO 1989**  
**(CUMULATIVE VOLUME SINCE 1987)**



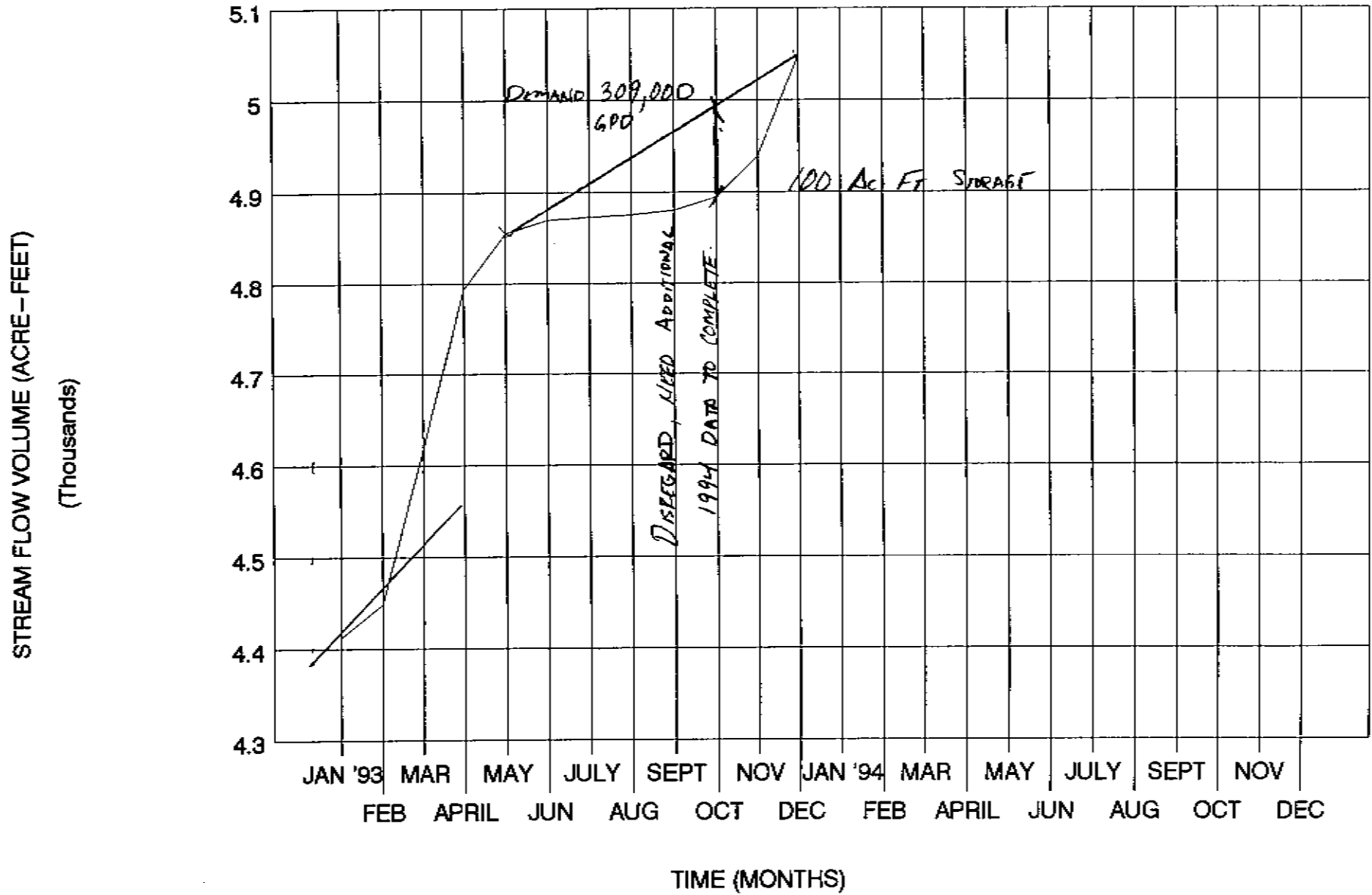
**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1989 TO 1991  
(CUMULATIVE VOLUME SINCE 1987)**



**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1991 TO 1993  
(CUMULATIVE VOLUME SINCE 1987)**



**WATCHTOWER - PATTERSON PROJECT  
ESTIMATED STREAM FLOW FOR 1993 TO 1994  
(CUMULATIVE VOLUME SINCE 1987)**



***Annual Drinking Water Quality Report for 2008***  
***Watchtower Water Supply***  
***100 Watchtower Drive, Patterson, NY 12563***  
***(Public Water Supply ID# 3921721)***

**INTRODUCTION**

Last year, the Watchtower Water Supply served an average of 1,161 residents with high quality drinking water. It is the goal of Water Systems Operators to continually provide you with safe drinking water, from point of source to your tap.

We encourage you to take the time to read this report completely. It is an overview of the quality of our water last year and is designed to educate you, the consumer. Included are details about the source of our water, the water treatment system, and how it compares to Environmental Protection Agency (EPA) and New York State standards. If you have questions or for more information about your water, please call Water Systems Operators at 45810.

**WHERE OUR WATER COMES FROM AND THE WATER TREATMENT SYSTEM**

The Watchtower Water Supply receives water from five groundwater wells. Well 2, Well 4, and Well 6 are located east of Route 22. Sandwell 1 and Sandwell 2 are located west of Route 22. The water from our wells has naturally dissolved minerals which cause hard water. To reduce the hardness, water from these wells is blended together and treated in a lime softening system. Our total hardness before softening averages 236 mg/l. After softening the total hardness averages 65 mg/l.

After softening, your water is filtered and disinfected to make it ready for drinking. Water Systems Operators chlorinates all water to destroy or inactivate disease-causing organisms that may be present in the water. Chlorine levels are monitored daily to ensure proper dosing. We are required to have a chlorine residual of at least 0.20 mg/l to meet the New York State standard. We met this standard daily last year.

**ARE THERE CONTAMINANTS IN OUR DRINKING WATER?**

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activities. Contaminants that may be present in source water include microbial contaminants, inorganic contaminants, pesticides and herbicides, organic chemical contaminants, and radioactive contaminants.

In order to ensure that tap water is safe to drink, the State and EPA prescribe regulations which limit the amount of certain contaminants in water provided by public water systems. The State Health Department's and the FDA's regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline (800-426-4791) or by calling the Putnam County Health Department (845-278-6130).

Some people may be more vulnerable to disease-causing microorganisms or pathogens in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice from their health care provider about their drinking water. EPA/CDC guidelines on appropriate

means to lessen the risk of infection by Cryptosporidium, Giardia and other microbial pathogens are available from the Safe Drinking Water Hotline (800-426-4791).

EPA and State regulations require that we routinely test our drinking water for numerous contaminants. These contaminants include total coliform, metals, nitrates, lead, copper, primary organic compounds, synthetic organic compounds, MTBE/Ketones, and radiological contaminants. New York State and EPA allow us to test for some of these contaminants less than once per year because the concentrations of these contaminants do not change frequently.

Although contaminants were detected, they were in such small quantities that they formed no health risk to the general public. In all these cases the levels detected were well below the EPA's and New York State's allowable limit for safe drinking water.

Table of Detected Contaminants							
Contaminant	Violation Yes/No	Date of Sample	Level Detected (Avg/Max) (Range)	Unit of Measurement	MCLG	Regulatory Limit (MCL, TT or AL)	Likely Source of Contamination
<b>Inorganic Contaminants</b>							
Barium	No	8/08	0.05 (0.02 – 0.05)	mg/l	2	MCL=2	Erosion of natural deposits.
Nickel	No	8/08	6.4 (1.0 – 6.4)	ug/l	n/a	n/a	Naturally occurring
Nitrate	No	8/08	1.71 (0.33 – 1.71)	mg/l	10	MCL=10	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits.
Sulfate	No	8/08	26.0 (9.4 – 26.0)	mg/l	n/a	MCL=250	Naturally occurring
<b>Principle Organic Contaminants</b>							
Chloromethane (Methyl Chloride)	No	8/08	0.7 (ND – 0.7)	ug/l	n/a	MCL=5	Disinfection byproducts
<b>Disinfection Byproducts</b>							
Total Trihalomethanes	No	7/06	4.10	ug/l	n/a	MCL=80	Disinfection byproducts
<b>Radiological Contaminants</b>							
Gross Beta <sup>1</sup>	No	Quarterly	73.79 (23.16-73.79)	pCi/L	n/a	n/a	Potassium carbonate used in water softening

**Notes:**

1 - The Gross Beta is due to potassium-40, which is not regulated by U.S. drinking water standards.

**Definitions:**

**Maximum Contaminant Level (MCL):** The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible.

**Maximum Contaminant Level Goal (MCLG):** The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

**Maximum Residual Disinfectant Level Goal (MRDLG):** The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination.

**Action Level (AL):** The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

**Treatment Technique (TT):** A required process intended to reduce the level of a contaminant in drinking water.

**Non-Detects (ND):** Laboratory analysis indicates that the constituent is not present.

**Milligrams per liter (mg/l):** Corresponds to one part of liquid in one million parts of liquid (parts per million - ppm).

**Micrograms per liter (ug/l):** Corresponds to one part of liquid in one billion parts of liquid (parts per billion - ppb).

**Picocuries per liter (pCi/L):** A measure of the radioactivity in water.

DEC PERMIT NUMBER 3-3724-0045/1-0
FACILITY/PROGRAM NUMBER(S)  WSA No. 8240



**PERMIT**  
Under the Environmental Conservation Law

EFFECTIVE DATE 8/11/89
EXPIRATION DATE(S)  See Additional General Condition #12

- |  |  |   |
|--|--|---|
| <input type="checkbox"/> Article 15, Title 3; 6NYCRR 327, 328, 329: Aquatic Pesticides | <input type="checkbox"/> 6NYCRR 608: Water Quality Certification         | <input type="checkbox"/> Article 25: Tidal Wetlands                                   |
| <input type="checkbox"/> Article 15, Title 5: Protection of Water                      | <input type="checkbox"/> Article 17, Titles 7, 8: SPDES                  | <input type="checkbox"/> Article 27, Title 7; 6NYCRR 360: Solid Waste Management*     |
| <input checked="" type="checkbox"/> Article 15, Title 15: Water Supply                 | <input type="checkbox"/> Article 19: Air Pollution Control*              | <input type="checkbox"/> Article 27, Title 9; 6NYCRR 373: Hazardous Waste Management  |
| <input type="checkbox"/> Article 15, Title 15: Water Transport                         | <input type="checkbox"/> Article 23, Title 27: Mined Land Reclamation    | <input type="checkbox"/> Article 34: Coastal Erosion Management                       |
| <input type="checkbox"/> Article 15, Title 15: Long Island Wells                       | <input type="checkbox"/> Article 24: Freshwater Wetlands                 | <input type="checkbox"/> Article 36: Floodplain Management                            |
| <input type="checkbox"/> Article 15, Title 27: Wild, Scenic and Recreational Rivers    | N—New, R—Renewal, M—Modification, C—Construct (*only), O—Operate (*only) | <input type="checkbox"/> Articles 1, 3, 17, 19, 27, 37; 6NYCRR 380: Radiation Control |

PERMIT ISSUED TO Watchtower Bible & Tract Society of New York, Inc.			
ADDRESS OF PERMITTEE 25 Columbia Heights, Brooklyn, New York 11201			
AGENT FOR PERMITTEE/CONTACT PERSON Richard Eldred		TELEPHONE NUMBER (914) 878-9090	
NAME AND ADDRESS OF PROJECT/FACILITY (if different from Permittee) Watchtower Educational Center & Hotel, RR 3, Box 191, Patterson, NY 12563			
LOCATION OF PROJECT/FACILITY east side of Rte 22	COUNTY Putnam	TOWN/CITY/VILLAGE Patterson	UTM COORDINATES
DESCRIPTION OF AUTHORIZED ACTIVITY Installation of a complete water supply and distribution system to serve the proposed 624 one-bedroom apartments for the educational center and 152 unit hotel and the taking of a supply of water in amounts estimated to average 165,000 gallons per day from the 5 wells described in special condition number 1.			

**GENERAL CONDITIONS**

**By acceptance of this permit, the permittee agrees that the permit is contingent upon strict compliance with the ECL, all applicable regulations and the conditions specified herein or attached hereto.**

- The permittee shall file in the office of the appropriate regional permit administrator, or other office designated in the special conditions, a notice of intention to commence work at least 48 hours in advance of the time of commencement and shall also notify him/her promptly in writing of the completion of the work.
- The permitted work shall be subject to inspection by an authorized representative of the Department of Environmental Conservation which may order the work suspended if the public interest so requires pursuant to ECL §71-0301 and SAPA §401(3).
- The permittee has accepted expressly, by the execution of the application, the full legal responsibility for all damages, direct or indirect, of whatever nature, and by whomever suffered, arising out of the project described herein and has agreed to indemnify and save harmless the State from suits, actions, damages and costs of every name and description resulting from the said project.
- The Department reserves the right to modify, suspend or revoke this permit at any time after due notice, and, if requested, hold a hearing when:
  - the scope of the project is exceeded or a violation of any condition of the permit or provisions of the ECL and pertinent regulations are found; or
  - the permit was obtained by misrepresentation or failure to disclose relevant facts; or
  - newly discovered information or significant physical changes are discovered since the permit was issued.
- The permittee is responsible for keeping the permit active by submitting a renewal application, including any forms, fees or supplemental information which may be required by the Department, no later than 30 days (180 days for SPDES or Solid or Hazardous Waste Management permits) prior to the expiration date.
- This permit shall not be construed as conveying to the applicant any right to trespass upon the lands or interfere with the riparian rights of others in order to perform the permitted work or as authorizing the impairment of any rights, title or interest in real or personal property held or vested in a person not a party to the permit.
- The permittee is responsible for obtaining any other permits, approvals, lands, easements and rights-of-way which may be required for this project.
- Issuance of this permit by the Department does not, unless expressly provided for, modify, supersede or rescind an order on consent or determination by the Commissioner issued heretofore by the Department or any of the terms, conditions, or requirements contained in such order or determination.
- Any modification of this permit granted by the Department must be in writing and attached hereto.

PERMIT ISSUANCE DATE 8/11/89	PERMIT ADMINISTRATOR Ralph Manna, Jr.	ADDRESS 21 South Putt Corners Road New Paltz, NY 12561-1696
AUTHORIZED SIGNATURE <i>Ralph Manna, Jr.</i>		Page 1 of 4

**ADDITIONAL GENERAL CONDITIONS FOR ARTICLE 15, TITLE 15 (Water Supply)**

10 Prior to starting work on any construction authorized herein, detailed plans of the structures proposed to be built and specifications for such work shall have been submitted to and approved by the Department. Thereafter such construction work shall be entirely completed in full accordance with the plans and specifications which have been submitted and approved.

**NOTE:** Approval by this Department of final plans and specifications, and of completed works, will not be issued until equivalent approvals have been issued by the NYS Department of Health.

11 Section 15-1529 of the Environmental Conservation Law forbids the

operation of any of these works until, as constructed, they have been approved by the Department. Such final approval will be given only on written request. In general, such approval will not be given until all provisions affecting quality of the water and safety of the works have been complied with in full.

12. The Department reserves the right to rescind this permit or to take whatever action it may deem suitable and proper if the works authorized

to be constructed herein are not initiated by August 31, 1991

**SPECIAL CONDITIONS**

SEE ATTACHED CONDITIONS

DEC PERMIT NUMBER  
3-3724-0045/1-0

PROGRAM/FACILITY NUMBER  
WSA No. 8240



### SPECIAL CONDITIONS

For Article 15 ( Water Supply )

1. The water supply source will consist of sand and gravel wells SG-1 and SG-2 each with an installed pumping capacity of 75.0 gallons per minute and bedrock wells W-2, W-4 and W-6 with installed pumping capacities of 65.0, 60.0 and 30.0 gallons per minute respectively.
2. Meters shall be provided to measure water usage. Master meters shall be installed on all sources of supply to measure all water pumped to the system.
3. The permittee is required to submit a Water Conservation Program to the Department within six months after the permit issuance date.
4. The Department reserves the right to modify this permit after reviewing the Water Conservation Program.
5. The permittee shall provide corrosion control treatment for Well W-2.
6. All land within 200 feet of any well shall be protected and controlled in order to prevent pollution of the ground or groundwater by direct ownership of the land or by the acquisition of protective easements or other appropriate measures.
7. This area shall further be protected from pollution by surface waters originating outside thereof by the construction of suitable diversion ditches or embankments and the development of the water sources shall be so carried out that there shall be no opportunity for pollution entering the water sources.
8. The physical pumping facilities and controls shall be protected against damage or tampering either by a fence or other suitable enclosure or by their manner of construction and installation.
9. Before any water from the well(s) may be used for any purpose, after prolonged pumping test(s), the applicant shall have caused a sample of the water from each to be collected and analyzed, shall have submitted the results of such analyses to the New York State Department of Health in Albany and shall have been advised by that Department either that the water is of a satisfactory sanitary quality or that certain specified treatment or purification thereof is necessary. In this last case such water shall be used only after full compliance with all of the requirements of that Department.
10. Nothing contained in this permit and approval shall be held to authorize the applicant to supply, sell or distribute water from this source of supply for any purpose unless all such water shall first have been treated and purified by disinfection (and filtration, if necessary) in a manner satisfactory to the Department.
11. The Department reserves the right to require the taking of further sanitary precautions or the further treatment or purification of the water from this source should conditions in the future indicate a need for such action.

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### SPECIAL CONDITIONS

For Article 15 ( Water Supply )

12. A minimum water pressure of 20 pounds per square inch shall be provided to customers at all times. An auxiliary source of power shall be provided to assure continued operation of the water supply during periods of electrical power failure.
13. An alarm system shall be provided with automatic signaling apparatus which will report when primary source equipment malfunctions. Plans for this alarm system shall be submitted to and approved by the Public Service Commission prior to placing the water supply system in service.
14. Nothing contained herein shall be held to authorize the permittee to distribute water to any other district or service area which has not already been approved by the Department or its predecessors without having received a further permit from the Department.
15. Provisions shall be made to provide an adequate supply of water to those residents whose private well water systems are diminished or rendered non-productive by the use of the wells developed by the Permittee.
16. Provisions shall be made to minimize erosion during the construction of the project and to prevent increased sedimentation in any water body on or adjacent to the project.
17. Water used for disinfecting mains, if discharged to area streams, must have a chlorine residual not exceeding 0.05 mg/l at point of discharge.
18. The permittee is hereby prohibited from developing any new sources of water, replacement sources of water, or increasing the pumping rate from existing sources above the levels approved in this permit, without first obtaining a Water Supply permit from this Department.

#### STATE ENVIRONMENTAL QUALITY REVIEW ACT

Under the State Environmental Quality Review Act (SEQR), the project associated with this permit is classified as a Type 1 Action with the Town of Patterson Planning Board designated as the lead agency. It has been determined that the project may have a significant effect on the environment and, accordingly, Draft and Final Environmental Impact Statements (EIS) have been prepared, filed and reviewed. As a result of our review, findings supporting our decision have been prepared.

#### DISTRIBUTION

P. Keller  
 J. Marcogliese/A. Crawford  
 G. Behn (3504)  
 G. Faustel, NYSDOH  
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 R. Laurent, Laurent Engineering Assoc.

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