UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter	)	
	)	
PHILADELPHIA ELECTRIC COMPANY	)	Docket Nos. 50-352
	)	50-353
(Limerick Generating Station Units 1 and 2)	)	

TESTIMONY OF REX G. WESCOTT CONCERNING THE IMPACT OF RELOCATING THE INTAKE FOR THE PT. PLEASANT DIVERSION DUE TO DRAWDOWN OF THE POOL

Q1. Please state your name and position with the NRC.

A1. My name is Rex G. Wescott and I am employed by the US NRC as a hydrologist in the Division of Engineering, Office of Nuclear Reactor Regulation. A copy of my professional qualifications is attached to my testimony concerning the impact of Bradshaw Reservior on groundwater resources.

Q2. What is the purpose of your testimony?

A2. The purpose of my testimony is to respond in part to Contentions V-15 and V-16a which state: "The intake will be relocated such that it will have significant adverse impact on American shad and short-nosed sturgeon. The relocation will adversely affect a major fish resource and boating and recreation area due to drawdown of the pool."

Q3. What part of this contention will your testimony respond to?

A3. My testimony will respond to drawdown of water level as caused by the relocation of the intake.

Q4. Has relocation changed the relationship between water level and river flow at the intake site?

A4. No, both the originally proposed intake location and the presently proposed location are in the same pool. That is, water level is approximately the same at both locations and can be expected to vary in the same manner for similar changes in river flow and pumping rate.

Q5. Has a water level versus river flow relationship for the pool been determined?

A5. Yes, a water level versus river flow rating curve for the intake location is presented in Mr. E. H. Bourquard's letter of January 22, 1982 to Mr. Roy Denmark of the Army Corps of Engineers (Exhibit 1). E. H. Bourquard Associates, Inc. is the applicant's engineer and is responsible for the design of the intake.

Q6. How was this rating curve determined?

A6. This rating curve was determined using water level measurements made at the intake site and recorded flow measurements at the USGS gage at Trenton, along with corrections for river channel storage between the Point Pleasant intake and the Trenton gage.

Q7. Has the rating curve been verified?

A7. Yes, the USGS made a discharge measurement on the Delaware River at Lumberville, Pa. approximately 1.5 miles downstream of the intake on September 12, 1981. This discharge was corrected for flows in the Raritan Canal and Pannacussing Creek which were also measured by the USGS on the same date. The measured flow in the Delaware River and the measured water level at the intake site was found to match the rating curve very closely.

Q8. Do you agree with the procedures that were used by the applicant's engineer to construct and verify this rating curve?

A8. Yes.

Q9. Can this rating curve be used to estimate water level change (or drawdown) due to pumping?

A9. Yes, the pumping at the intake site will result in a decreased downstream flow. Because river flow is subcritical in this reach of the river, the water surface elevation will be controlled by downstream conditions rather then upstream conditions. Therefore, the decrease in water level can be determined directly from the rating curve by subtracting the water level for the river flow as decreased by the pumping rate from the water level that would result from the river flow with out pumping.

Q10. Will there be any change in water level at the Pt. Pleasant Pumping Station?

A10. Yes.

Q11. What do you estimate this change to be?

A11. For a river flow of 3,000 cfs at the intake site and the maximum withdrawal rate of 147 cfs, the change in water level caused by pumping would be less than one inch.

Q12. Would this represent the maximum drawdown?

A12. Yes, provided that 3,000 cfs is the lowest flow in the Delaware during which water may be withdrawn and 147 cfs is the maximum pumping rate.

Q13. Are you aware of other hydraulic studies conducted by the applicant's engineer at the intake site?

A13. Yes, I have looked at velocity measurements and other hydraulic data as presented in E. H. Bourquard's letter of January 22, 1982 to Roy Denmark (Exhibit 1) and the applicant's response to my Environmental Review Question E240.27 (Exhibit 2).

Q14. Can you draw any conclusions from these measurements at this time?

A14. No, I can not.

LIST OF EXHIBITS

Exhibit No.	Title
1	E. H. Bourquard's letter of January 22, 1982 to Roy E. Denmark, Jr. with pertinent attachments.
2	Applicant's response to Environmental Review Question 240.27.

Exhibit 1 - Wescott (Point Pleasant)

E. H. BOURQUARD ASSOCIATES, INC.
WATER RESOURCES ENGINEERING
1400 RANDOLPH STREET
(EXIT NO. 24E, INTERSTATE 83)
HARRISBURG, PA.
17104

TELEPHONE (717) 238-9505

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January 22, 1982

Mr. Roy E. Denmark, Jr.,
Chief, Permits Branch,
U. S. Corps of Engineers,
Custom House,
Second & Chestnut Streets,
Philadelphia, Pa. 19106

Re: Application No. NAPOP-R-80-0534-3
Point Pleasant Pumping Station

Dear Mr. Denmark:

Since submission of the referenced application on July 18, 1980, we have determined that certain revisions should be made in the plans for the project to improve the efficiency of the facility and to reduce to a minimum any environmental impact. These revisions are described in the following paragraphs and the reasons for each are given.

1. Further Extension of Intake into River Channel. The initial plans for the Point Pleasant Pumping Station called for a shoreline water intake with vertical travelling screens. In 1980 and prior to submission of the referenced Application, the intake was changed to one utilizing cylindrical Johnson wedge wire well screens located approximately 200 feet out into the River channel. The 200 foot distance was selected as it placed the intake beyond a back eddy in the River which extended out 150-160 feet from the west bank and, also, put the intake in a position where it would always be subject to positive, or downstream flow velocities. This was verified by RMC Ecological Division during field investigations for a report titled "Biological Evaluation of the Proposed Water Intake in the Delaware River at Point Pleasant, Pennsylvania" (copy furnished by letter of January 28, 1981 to R. E. Denmark), and by River flow velocities measured by RMC on July 23, 1981; which measurements are tabulated on Table No. 1 and discussed later herein. It should be reiterated that, at this location, the intake would not be in the backwater eddy portion of the River and, also, River flows past the screens would be in a downstream direction.

In connection with the above biological evaluation, the slots in the wedge wire screens were reduced from 1/4 inch to 2 mm which increased the diameter and length of the individual screens from 36 inches to 40 inches, in order to maintain a maximum inflow velocity of 0.5 feet per second (fps). This 2 mm slot provided assurance that no shad eggs would be entrained by the screens.

The River flow velocity measurements mentioned above showed that further extension of the intake into the River would increase the flow velocities past the screens, which should, in turn, lessen the likelihood of debris and aquatic life being impinged on or entrained in the intake screens. The small screen opening of 2 mm, combined with a definite River flow past the screens, precludes the entrainment of the vast majority of fish eggs and larvae and essentially eliminates impingement. It was felt, however, that consideration should be given to utilizing higher flow velocities to reduce even further the possibilities of entrainment. In this connection, reference is made to a paper* titled "Studies of Three Cylindrical Profile-Wire Screens Mounted Parallel to Flow Direction" by Brian N. Hanson, a Research Biologist with RMC Delmarva Ecological Lab., Middletown, Del. This paper presents the results of actual flow tests on cylindrical wedge wire screens with 2 mm slots, which tests measure the entrainment and impingement of fish eggs for three flow velocities. The test results indicated that as flow velocities increase from 0.5 to 1 foot per second (fps), the percentage of eggs entrained or impinged is drastically reduced, but higher velocities do not appreciably lessen this percentage. To provide for a flow velocity of 1 fps past the screens, the intake location is changed from Station 8+17 to Station 8+62, which positions the intake 45 feet further into the River, or about 245 feet from the west bank. The flow velocities at the new location, Station 8+62, may be noted by examination of Exhibits Nos. 1, 2 and 3 attached. Exhibit No. 1 is a plot of flow velocities measured in the River at the intake site on November 7, 1980 when the River flow was about 3,000 cfs and the water surface was at Elevation 70.8. Exhibit No. 2 shows flow velocity measurements on July 23, 1981, when the River flow was approximately 4,500 cfs and the water surface elevation was 71.4. The horizontal stationing used on the exhibits is that of the centerline of the River intake facilities, with the 0+00 Station located at the intersection of this centerline and a line connecting two permanent monuments on the Project site along State Route No. 32. (The stationing and the monuments are shown on Exhibit No. 5.) The transverse position of the intake assembly, both where originally proposed and where now planned, has been indicated on these exhibits by marking each with its centerline stationing, 8+17 and 8+62, respectively. Exhibit No. 3 is a plot of flow velocity measurements on November 7, 1980 and July 23, 1981, at the proposed intake site (Station 8+62) and at the elevations at which they were taken. There will be two rows of screens, as can be seen on Exhibit No. 5, and the velocities at the centerline of both rows are shown on Exhibit No. 3. The west screens are those in the row nearest the Pa. shore and the east screens are in the row furtherest away. Also shown on Exhibit No. 3 are the top and bottom elevations of the intake screens; thus indicating the range of flow velocities which will pass the screens. The Exhibit reveals that even with a low flow of 3,000 cfs, the flow velocities past the screen will range from 1.0 to 1.3 fps which is twice, or more, the maximum screen inflow velocity of 0.5 fps. In this connection, it should be noted that low flows do not normally occur during the major

* A copy of this paper has been furnished Richard Hassel, District Biologist.

fish spawning period of March thru June and, during that period, greater flows can be anticipated with even higher River flow velocities. In fact, flow velocities during the spawning period should be higher than those plotted on Exhibit No. 3 for a flow of 4,500 cfs which velocities are indicated by the lines marked "7-23-81" at the top.

The velocity measurements plotted on Exhibits Nos. 1, 2 and 3 were made by the Environmental Services Division - RMC on the days indicated.

Exhibit No. 4 is a cross section of the River channel at the intake and the various components of the intake are shown thereon, together with the approximate rock line.

2. Shift of Building Location and Intake Alignment. The pump station building was moved about 18 feet further away from State Route No. 32 and will be extended about 15 feet to the southeast. This provides more working space for placement of the Combined Transmission Main under the highway, reduces the amounts of earth and rock excavation required for the building installation, and provides a larger setback from the highway, permitting more landscaping at the front of the building to improve the general appearance of the facility. The building was lengthened to provide for a stairway and for additional equipment related to the River intake. The intake alignment was shifted as a result of the building movement and, also, to provide a straight run of pipe before entering the transition section of the pump sump. The straight run will give improved flow conditions in the pump sump, resulting in better pump operation and higher pumping efficiencies.

In conformity with suggestions of representatives of the Pennsylvania Historical and Museum Commission, the roof of the pumping station building was changed from a gambrel to a ridge roof, and some exterior architectural features were changed.

The original intake plans provided for the 42-inch intake pipes to be spaced 22.5 feet apart. In order to reduce the amount of earth and rock excavation in the channel and on shore for the installation, the pipes are now spaced 6 feet apart and will be installed in a single ditch. This will reduce the area of channel bottom that will be disturbed by the installation. With this closer pipe spacing, the size of the gate well was reduced. Also, the fill around the gate well was shifted landward lessening the volume and areal coverage. With the reduced fill and landward movement, the stone riprap on the fill has been eliminated and erosion-resistant vegetation will be utilized.

Exhibit No. 5 shows a general plan and profile of the pumping station and the water intake with the above revisions. The revisions will reduce the areas of wetlands affected to less than an acre and improve the appearance of the facilities when viewed from River Road and from the Delaware River. The

Pennsylvania Canal crossing will be shifted about 18 feet northward but the construction procedure will be the same as originally planned and the crossing, when complete, will restore the Canal to prior conditions.

3. Revised Water Level Elevations. A very preliminary stage-discharge curve was developed in 1969 on the basis of selected (2 consecutive days of about same flow) recorded flows at Reigelsville and recorded gage heights (gage washed out in 1955 Flood, and never replaced) at the Point Pleasant-Byram Bridge. Extrapolation of this data indicated that the water level at Point Pleasant might go as low as Elevation 68, and this was utilized in the preliminary studies as the minimum water level. However, actual water level readings at the intake site in 1980 and 1981, when related to recorded River flows at Trenton showed that even with low flows of less than 3,000 cfs, the water level at the site is above Elevation 70. A new stage-discharge relationship was developed in 1981 using recorded flows at Trenton and water level readings at the intake site. To confirm this relationship, the U.S.G.S. was requested and did make flow measurements of the Delaware River and the Raritan Canal at the Lumberville Bridge, and of Paunnacussing Creek at State Route No. 32. Attached as Exhibit No. 6 is a copy of the data provided by the U.S.G.S. Exhibit No. 7 tabulates and gives the sources of the discharge-water level relationship data for the Delaware River at the Intake site and includes a rating curve plotted from the data. Exhibit No. 8 is a sample of the computations which developed this data. On Sheet No. 3 of this exhibit, it will be noted that the drainage area of the Delaware River at the River intake is 97% of that at the Trenton gage.

Sheet No. 3 of Exhibit No. 7 explains how the minimum, normal, and maximum water levels were derived for the Delaware River at the PPPS site. The term minimum water level, as used herein, refers to a design condition; that is, this is the lowest water level when the withdrawal rate would be at the maximum.

4. Revisions to Pump Sump and Intake Conduit. As mentioned previously, the initial plans for the PPPS called for a shoreline intake having vertical travelling screens with 3/8-inch wire spacing. The change to a channel intake with circular wedge wire screens with 2 mm slots was made in order to provide the most environmentally advanced type of water intake. However, the new installation involved additional waterway structures: the gate well, three 42-inch pipes, the screen assembly piping, and the screens. All of these result in additional hydraulic losses over those of the shoreline intake and, to compensate for these losses and to provide for necessary submergence of the pumps, the pump sump was lowered and the conduit between the gate well and the transition was increased from 5-foot diameter to 6-foot diameter.

Exhibit No. 9, attached, are computations which calculate the hydraulic losses through the intake system and establish the floor elevation of

the pump sump. Developed below is the invert elevation of the 42-inch pipes at the connection to the screen assembly piping. Exhibit No. 10, attached, is a drawing showing the intake screen assembly in plan and section. Refer to Sheet No. 2 of Exhibit No. 9 when reviewing the tabulations below.

Minimum Water Surface Elevation			70.00
Minimum Water Cover over Screens			4.00
Elevation of Top of Screens			66.00
One-half Screen Diameter			1.67
Elevation of Screen Centerline			64.33
Piping Assembly -	To ℄ 36" Vert. Pipe	5.50'	
	To Flange of 36-Inch Tee	1.00	
	To ℄ of 36-Inch Tee	2.33	
	Total		8.83
Elevation of Centerline of 36-Inch Tee			55.50
One-half Diameter 42-Inch Pipe			1.75
Invert Elevation of 42-Inch Pipe at Intake Assembly			53.75

The above invert elevation of 53.75 may be noted on Exhibits Nos. 4 and 5.

In 1980, Converse Ward Davis Dixon, a firm of geotechnical consultants, made an investigation relating to the impact of using explosives in the construction of the proposed Point Pleasant Pumping Facilities and submitted a report to DRBC thereon dated 20 May 1980. In essence, the firm found that required blasting to install the pumping station and the pipe lines can reasonably be controlled so as to result in no noticeable damage to nearby structures or water wells. The installation of the channel intake and lowering of the pump sump constituted changes in plan so the firm was requested to make a new evaluation taking the changes into account. Also, additional subsurface information had been obtained and the data was provided the firm. Attached hereto, as Exhibit No. 11, is a letter report on this evaluation wherein it is stated that the conclusions and recommendations of their 20 May 1980 report are still valid. Also, attached as Exhibits Nos. 12, 13 and 14 are letters from the firm which provide additional information or clarify questions asked concerning their report. As may be noted, the firm has changed its name to Converse Consultants.

The previously described revisions will make no change in the construction procedures which were submitted to the District Engineer by letter dated

September 9, 1981. In fact, all except the further extension of the intake into the River were taken into account when the procedures were developed and this further extension does not alter the procedures.

In conjunction with discussions with DER regarding the construction activities within the Canal, DER has indicated it believes it would be convenient to perform repairs to Lock No. 13 at the same time as NWRA constructs the intake conduit under the Canal. These repairs are part of DER's continual routine maintenance program for the Canal and are not at all related to or caused by NWRA's proposed construction activities. To enable DER to accomplish these repairs, DER has indicated a desire to have a cofferdam constructed below Lock No. 13 with water delivered below the dam by NWRA. This cofferdam has been shown in plans submitted to the Bucks County Conservation District. It is, however, NWRA's intention for DER to obtain all necessary reviews, approvals and/or permits incident to the construction of the cofferdam. Only if DER obtains these approvals will the cofferdam be constructed.

The design of the Project, as shown on Exhibit Nos. 5 and 15, minimizes the impact on the wetlands at the Project site. In November 1980, RMC performed a field vegetation survey of the site and, based on the survey, prepared a report entitled "Vegetation of the Point Pleasant Intake Site" which was submitted both to DRBC and the Corps of Engineers. The report concluded that the wetland vegetation at the site is "typical" and "widely distributed throughout the Northeastern United States". According to RMC's description, the wetland habitat at the Point Pleasant Pumping Station appears to fall within Resource Category No. 4 of the United States Fish and Wildlife Service's mitigation policy guidelines for habitats that may be affected by Federally permitted land and water resource developments (The guidelines were published in the Federal Register of January 23, 1981). Category No. 4 habitats are characterized as of "medium to low value", and the mitigation goal set for these habitats is the minimization of the loss of habitat value, rather than the creation of compensatory habitat.

In accordance with this goal, NWRA has made every effort to minimize the impact of construction on wetlands. In order to give full consideration to the effect of the installation on the wetlands, the actual limits of the wetlands on the Project site were staked out by a biologist and these limits were then surveyed and placed on the site plan. They are shown on Exhibit No. 5, and on Exhibit No. 15. Through judicious design and planning, the total area of affected wetlands is only 0.30 acre which is about 1/3 of the 0.93 acre of wetlands at the site. Of this, only 0.22 acre of wetlands will be permanently affected by placement of fill. The ground surface of the remaining 0.08 acre of affected wetland will be restored to original grade and should return to pre-construction conditions.

As shown on Exhibit No. 15, the alignment of the intake conduit passes between the two principal wetland areas, minimizing the amount of wetlands affected. The fill around the gate well and for the access road covers some of the wetland area but these facilities are essential for the operation of the Project. Also, some wetland area must be excavated for installation of the intake conduit. There will be a settling basin in the upper part of the property near the Canal towpath, during the construction period. The settling basin will affect only 0.01 acre of wetlands and is an essential structure for sediment control. There will be no temporary stockpiling of excavated materials on wetland area.

Notwithstanding the successful efforts to minimize impacts of the Project on wetlands, NWRA is willing to provide compensatory wetlands if the Corps believes this is necessary. It should be noted that DRBC, after taking into account the marginal value of these wetlands and the small amount affected, did not consider this necessary.

It should be stressed that none of the above described revisions increase the pumping capacity of the Project. Attached as Exhibit No. 16 is a chart which shows the pumping capacity of the Station with one, two, three and four pumping units operating. These pumping units will be operating within the limits of the two relatively horizontal lines marked "Maximum Head" and "Minimum Head". The "Maximum" line is based on pumping against the highest operating pool level in Bradshaw Reservoir and the minimum low water level in the Delaware River. The "Minimum" line is based on the lowest operating pool level in Bradshaw Reservoir and an above normal water level (Elev. 75) in the River. With all four pumping units operating, the total production of the Station will range from 3.95 to 4.00 million gallons per hour and the maximum possible pumpage in a 24-hour day will be 94.8 to 96.0 million gallons. These amounts of pumpage are based on factory pumping tests which may be high and, also, the amounts are expected to decrease with wear on the pumps.

If additional information is desired, please advise.

Sincerely yours,

E. H. Bourquard

E. H. Bourquard

EHB/bs
Encl.

LIST OF EXHIBITS

Exhibit No.	Title
1	PPPS - Delaware River Flow Velocities at Intake Site - November 7, 1980.
2	PPPS - Delaware River Flow Velocities at Intake Site - July 23, 1981.
3	PPPS - Delaware River Flow Velocities with Intake at Station 8+62.
4	PPPS - Delaware River Channel Section at Water Intake.
5	PPPS - Location and Layout Plan, General Profile, Dec. 22, 1981, Rev. Jan. 13, 1982.
6	Forwarding Memo and Discharge Measurement Notes - Pennsylvania District, USGS, U. S. Dept. of the Interior.
7	Development of Relationship between Water Discharge and Water Surface Elevation, Delaware River at PPPS Site, Point Pleasant, Pennsylvania, January 4, 1981.
8	PPPS - Preliminary Design, Discharge-Stage Data at Intake Site, RES, 6-10-81, 4 Sheets.
9	Point Pleasant Pumping Station - Preliminary Design, Intake Screens, JJP Jr., 1-9-81, 10 Sheets.
10	Point Pleasant Pumping Station, Intake Screen Assembly and Piping Details, Sept. 1, 1981, Rev. Jan. 13, 1982.
11	Converse Ward Davis Dixon Letter of 28 August, 1981, to E. H. Bourquard Associates, Inc.
12	Converse Ward Davis Dixon Letter of October 13, 1981 to E. H. Bourquard Associates, Inc.
13	Converse Consultants Letter of October 27, 1981 to E. H. Bourquard Associates, Inc.
14	Converse Consultants Letter of November 27, 1981 to E. H. Bourquard Associates, Inc.
15	PPPS Site, Limits of Wetlands and Effected Areas.
16	PPPS - Head vs. Capacity Curves with 66/60 CTM and Peerless 28 HXB

Table No.	Title
1	Velocity Measurements of Delaware River Flow along PPPS River Intake Centerline.

TABLE NO. 1

Velocity Measurements of Delaware River Flow

along

PPPS River Intake Centerline

November 7, 1980

Water Depth in Feet	River Flow Velocity in Feet Per Second, at Centerline Station: 7+05	7+85	8+60	9+30	9+95	10+53	11+03
1	0.0	0.1	1.4	1.7	1.1	0.5	Slack, to
4	0.0	0.1	1.3	1.7	0.7	0.6	Slightly
7		0.0	1.1	1.6	0.8	0.5	Upstream
10			0.9	1.4			

W. S. Elev. - 70.8 Flow - 3000± cfs

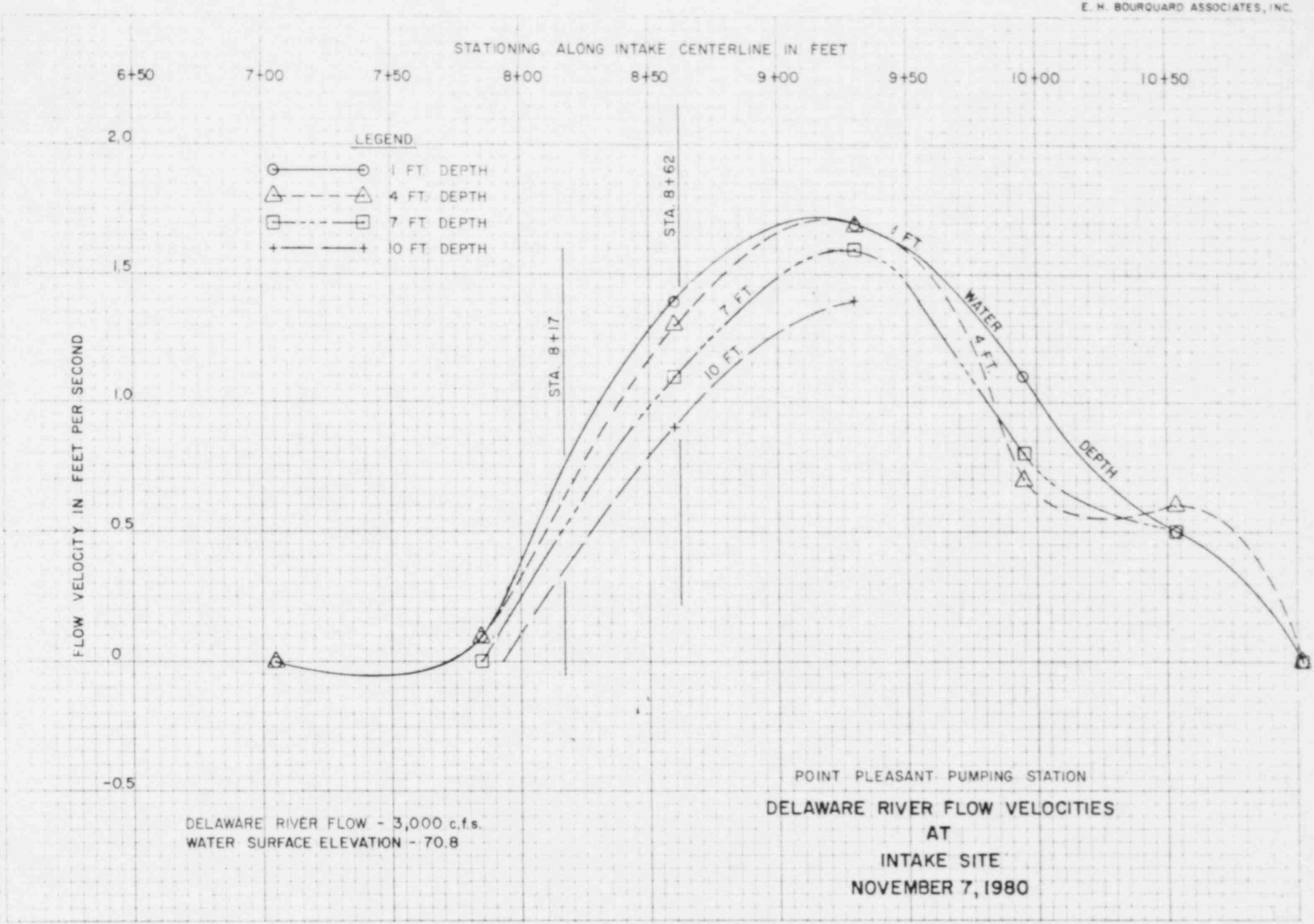
July 23, 1981

	River Flow Velocities in Feet Per Second, at Centerline Station: 6+49	6+74	6+99	7+24	7+49	7+74	7+99
1	0.1	0.1	-0.2	-0.2	0.05	±0.25	0.25
4			-0.2	-0.3	-0.1	±0.3	0.3
7				-0.15	-0.2	±0.2	0.4
10					-0.1	±0.15	0.2

	8+24	8+49	8+74	8+99	9+24	9+49	9+74
1	1.3	2.2	3.0	3.0	3.5	3.0	2.3
4	1.2	2.0	2.8	2.5	2.6	3.1	2.0
7	0.9	1.6	2.6	2.5	2.7	2.4	2.1
10	0.75	0.7	1.5	2.1	2.2	1.6	1.1

W. S. Elev. - 71.4 Flow - 4500± cfs

E. H. BOURQUARD ASSOCIATES, INC.



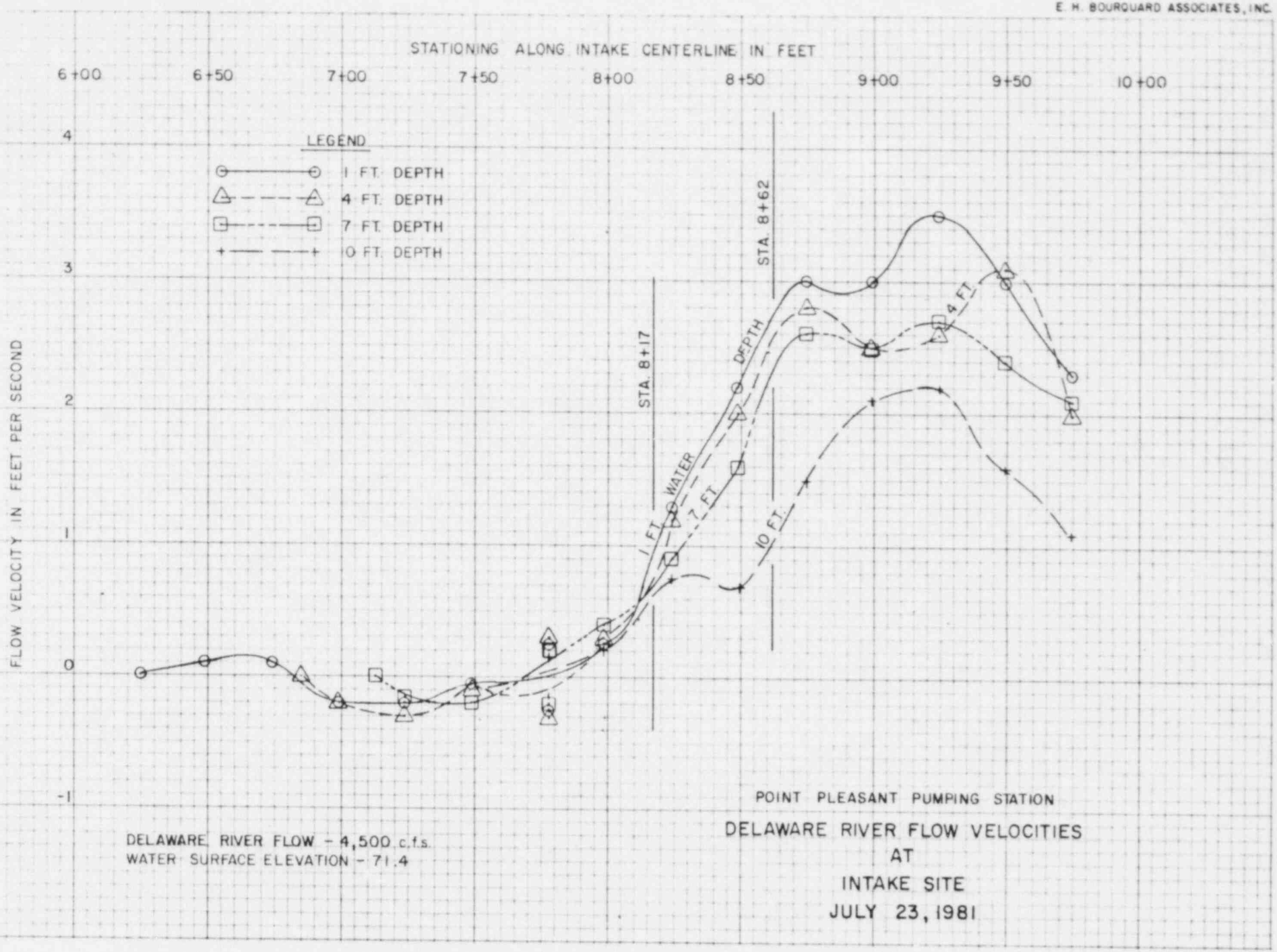
DELAWARE RIVER FLOW - 3,000 c.f.s.
WATER SURFACE ELEVATION - 70.8

POINT PLEASANT PUMPING STATION

DELAWARE RIVER FLOW VELOCITIES
AT
INTAKE SITE
NOVEMBER 7, 1980

EXHIBIT NO. 1

E. H. BOURQUARD ASSOCIATES, INC.



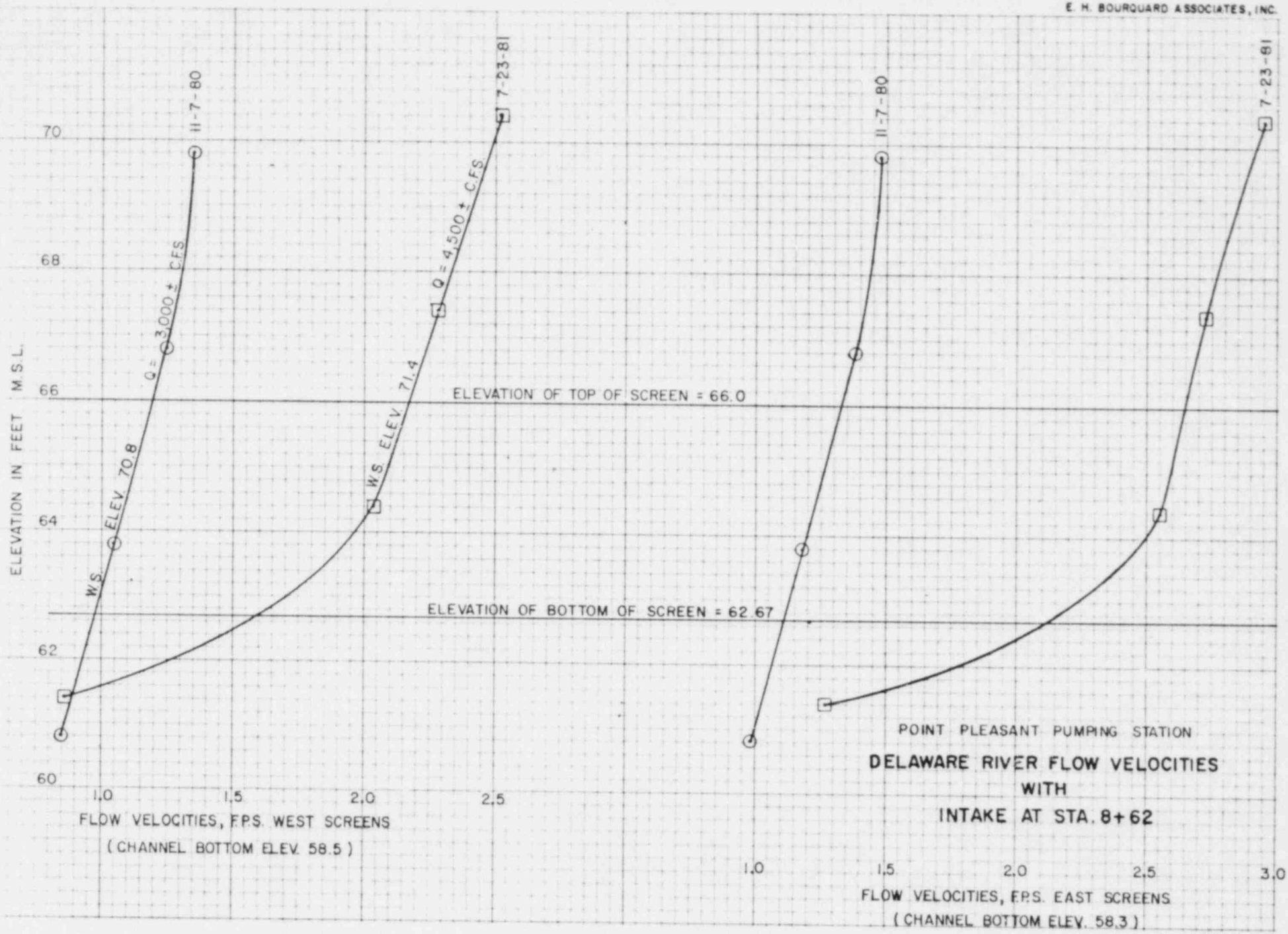
DELAWARE RIVER FLOW - 4,500 c.f.s.
WATER SURFACE ELEVATION - 71.4

POINT PLEASANT PUMPING STATION

DELAWARE RIVER FLOW VELOCITIES
AT
INTAKE SITE
JULY 23, 1981

EXHIBIT NO. 2

E. H. BOURQUARD ASSOCIATES, INC.



POINT PLEASANT PUMPING STATION

DELAWARE RIVER FLOW VELOCITIES WITH INTAKE AT STA. 8+62

EXHIBIT NO. 3

DOCUMENT/ PAGE PULLED

ANO. 8209230468

NO. OF PAGES 2

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Pennsylvania District

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MESHAMINY WATER RESOURCES AUTHORITY

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SEP 17 1981

EHBA, INC.

☐ Knowing of your interest in water resources in the Commonwealth of Pennsylvania, we are enclosing a copy of our latest State and Federal cooperative publication.

☐ Knowing of your interest in water resources in the Commonwealth of Pennsylvania, we are enclosing a copy of our latest publication.

☑ In response to your recent request, we are forwarding the enclosed information.

U. S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

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717-323-7736
Williamsport, Pa. 17701

Flow at Dol. R. at Lumberville - 3340 cfs
Plus- Raritan Canal - 304
Subcanal
3644 cfs
Less- Panuccio Irrig Ditch 1
Flow at PPPS Intake 3643 cfs

EXHIBIT NO. 6

(May 1971)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

DISCHARGE MEASUREMENT NOTES

Meas. No. ____
Comp. by DP
Checked by PM

Sta. No. ____

DELAWARE RIVER @ LUMBERVILLE

Date Sept 12 1981 Party V. CORCINO & D. PIERCE

Width 415 Area 2395 Vel. 1.39 G. H. — Disch. 3340

Method 2.8 No. secs. 40 G. H. change ____ in 3.6 hrs. Susp. SOC

Method coef. 1.0 Hor. angle coef. .92 Susp. coef. 1.0 Meter No. SR-70

GAGE READINGS				
Time		Recorder	Inside	Outside
0900		FEET		64.52
0940	S	″		
	9	7.22		
	10	.22		
	11	.24		
	12	.28		
	1	.32		
1315	F			
1345				64.61
Weighted M. G. H.		7.27		
G. H. correction				
Correct M. G. H.				

Type of meter PRICE

Date rated 3-5-70 for rod, other.

Meter 6 ft. above bottom of weight.

Spin before meas. 3.10 after FREE

Meas. plots ____ % diff. from rating

~~Wading, cable, ice boat~~ (upstr.) ~~downstr.~~, (side) (bridge) ____ feet, mile, above, below gage, and AT PARK BRIDGE

Check-bar, found —

changed to — at —

Correct —

Levels obtained YES ELEV.

Measurement rated excellent (2%), (good (5%)), fair (8%), poor (over 8%), based on following conditions: Cross section ROCKY

Flow MODERATE TO UNIFORM Weather SUNNY, CLEAR

Other MANY BOATS USING RIVER Air — °F@ —

Gage NONE ELEV. OBTAIN. FROM NESHAMINY WATER AUTHORITY Water — °F@ —

Record removed ____ Intake flushed U —

Observer NONE

Control CHANNEL CLEAR, SM. FISHING BOATS

Remarks WEIGHT HAD TO BE RAISED EVERY 5 FT. DUE TO CABLE STRUCTURE ON BRIDGE

G. H. of zero flow — ft.

OVER

9-275-F
(May 1971)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

DISCHARGE MEASUREMENT NOTES

Meas. No. ____
Comp. by PM
Checked by DP

Sta. No. ____

Delaware and Raritan Canal

Date SEPT 12 1981 Party R. DRUTCHAS & P. MOSES

Width 86.0 Area 233 Vel. 1.31 G. H. — Disch. 304

Method 6-2-8 No. secs. 32 G. H. change — in 1.1 hrs. Susp. Rod

Method coef. 1.0 Hor. angle coef. 1.0 Susp. coef. 1.0 Meter No. S-70

GAGE READINGS				
Time		Recorder	Inside	Outside
1025	S			
1135	F			
Weighted M. G. H.				
G. H. correction				
Correct M. G. H.				

Type of meter AA

Date rated 3-5-70 for rod, other.

Meter — ft. above bottom of weight.

Spin before meas. 1'57" after 2'00

Meas. plots ____ % diff. from rating

Wading, ~~cable, ice boat, upstr., downstr.~~, side bridge ____ feet, mile, above, below gage, and ____

Check-bar, found —

changed to — at —

Correct —

Levels obtained N. G.

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%), based on following conditions: Cross section SOFT MUD ON ENDS - HARD IN CENT

Flow UNIFORM Weather SUNNY - HOT - HUMID

Other ____ Air — °F@ —

Gage NONE Water — °F@ —

Record removed NONE Intake flushed U —

Observer NONE

Control CHANNEL / CLEAR

Remarks FEW STICKS ON ENDS

G. H. of zero flow ____ ft.

Paunacussing ?

9-278-Y
(May 1971)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

DISCHARGE MEASUREMENT NOTES

Meas. No. ____
Comp. by PM
Checked by ____

Sta. No. ____
Panacussing Creek @ Lumberville
Date Sept 12 1991 Party R. Dantzler & P. Malesky
Width 4.00 Area 1.16 Vel. 0.76 G. H. — Disch. 1.84
Method 2.5 No. sects. 9 G. H. change — in 1.2 hrs. Susp. Rod
Method coef. 1.0 Hor. angle coef. 1.0 Susp. coef. 1.0 Meter No. 570
Type of meter AA
Date rated 3-5-76 for rod, other
Meter — ft. above bottom of weight.
Spin before meas. 1'59 after 1'58
Meas. plots ____ % diff. from rating ____
Wading, ~~cable, ice boat, upstr., downstr., side~~ bridge 20 feet, ~~mile~~, above, ~~below~~ ~~gage~~ end Hwy 32 bridge
Check-bar, found —
changed to — at —
Correct —
Levels obtained No

GAGE READINGS

Time	Recorder	Inside	Outside
1235			
1245 F			
Weighted M. G. H.			
G. H. correction			
Correct M. G. H.			

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%), based on following conditions: Cross section Small + Md Rocks
Flow Uniform Weather ____
Other ____ Air ____ °F @ ____
Gage — Water ____ °F @ ____
____ Record removed None Intake flushed U
Observer —
Control Channel / Check
Remarks Water leaking out of canal + into creek - below Hwy. bridge 32
G. H. of zero flow ____ ft.

DEVELOPMENT OF RELATIONSHIP BETWEEN WATER DISCHARGE AND WATER SURFACE ELEVATION

January 4, 1982.

DELAWARE RIVER AT PPPS SITE
POINT PLEASANT, PENNSYLVANIA

Water Surface Elevation. Employees of Neshaminy Water Resources Authority determine water surface elevation, as needed, by using a surveying instrument and backsighting on a bench mark at the PPPS site.

Water Discharge Determination. The following discharge information was used for this analysis:

1. Current meter discharge measurements made by the USGS of flows in the Delaware River and the Raritan Canal on September 12, 1981 at the Park Bridge at Lumberville, Pa., 1.5 miles downstream from the PPPS site. Also, a discharge measurement was made of Paunnacussing Creek, which drains the only major contributing watershed on this 1.5 mile reach.

2. Numerous simultaneous determinations of water surface elevations at the PPPS site and water discharge at the USGS gaging station at Trenton, N. J., 22.7 miles downstream from the PPPS site. Where necessary, the discharge figures were corrected for change in storage in the 22.7 miles of channel and for the difference in drainage area. These determinations cover the period October 1, 1980 to October 23, 1981 and include the drought of 1980 when flows at Trenton, N.J. were as low as 2,770 cfs.

3. The Kingwood Township, N.J. Flood Insurance Study of May 4, 1981 provided water surface elevation and water discharge figures for the PPPS site which were calculated for floods of 10 year, 50 year, 100 year and 500 year recurrence interval.

EXHIBIT NO. 7

Those data used for this analysis are tabulated below.

Tabulation of Available Data

Item No.	Source of Data	Date	PPPS W. S. Elev. (ft.)	PPPS Discharge (cfs)
1	USGS Measurement	9/12/81	71.27	3,640
2	Trenton Gage	10/ 1/80	70.63	2,700
3	Trenton Gage	5/ 1/81	73.10	11,800
4	Trenton Gage	5/ 4/81	72.83	10,000
5	Trenton Gage	5/ 6/81	72.42	8,600
6	Trenton Gage	5/ 8/81	72.13	7,300
7	Trenton Gage	5/11/81	71.76	5,900
8	Trenton Gage	5/15/81	77.48	33,800
9	Trenton Gage	5/18/81	77.79	37,200
10	Trenton Gage	5/20/81	75.25	20,200
11	Trenton Gage	5/22/81	73.88	14,900
12	Trenton Gage	5/25/81	72.92	9,720
13	Trenton Gage	5/27/81	72.47	8,350
14	Trenton Gage	5/29/81	72.30	7,790
15	Trenton Gage	10/ 9/81	70.82	3,300
16	Trenton Gage	10/14/81	70.91	3,210
17	Trenton Gage	10/21/81	70.70	2,970
18	Trenton Gage	10/23/81	70.93	2,850
19	Kingwood FIS	5/ 4/81	93.0	170,000
20	Kingwood FIS	5/ 4/81	99.3	248,000
21	Kingwood FIS	5/ 4/81	101.9	284,000
22	Kingwood FIS	5/ 4/81	108.1	376,000

Rating. The above data were plotted on semi-log graph paper. A rating curve based on these points has been drawn and is identified by the date 12/10/81. A print of this graph is attached.

Minimum Water Level. For maximum withdrawal by the Point Pleasant Pumping Station, the minimum flow past intake will be 3000 cfs. The corresponding water surface elevation is 70.8, but to be conservative, use Elevation 70, which relates to a flow of 1400-1500 cfs.

Normal Water Level. According to Penna. Water Resources Bulletin No. 12 (page 92), the River flow 50% of the time is 8,000 cfs which flow will have a water surface elevation of 72.4 at the intake site.

Maximum Water Level. The most recent pertinent F.I.S. is for Kingwood Township, Hunterdon County, N.J. and is dated May 4, 1981. The computed water surface elevation for a 100 Year Flood is 101.9 at the intake site, to which 1.0 foot is added for allowable floodway encroachment to obtain a water surface elevation of 102.9, which has been rounded to Elevation 103.

Robert E. Steacy

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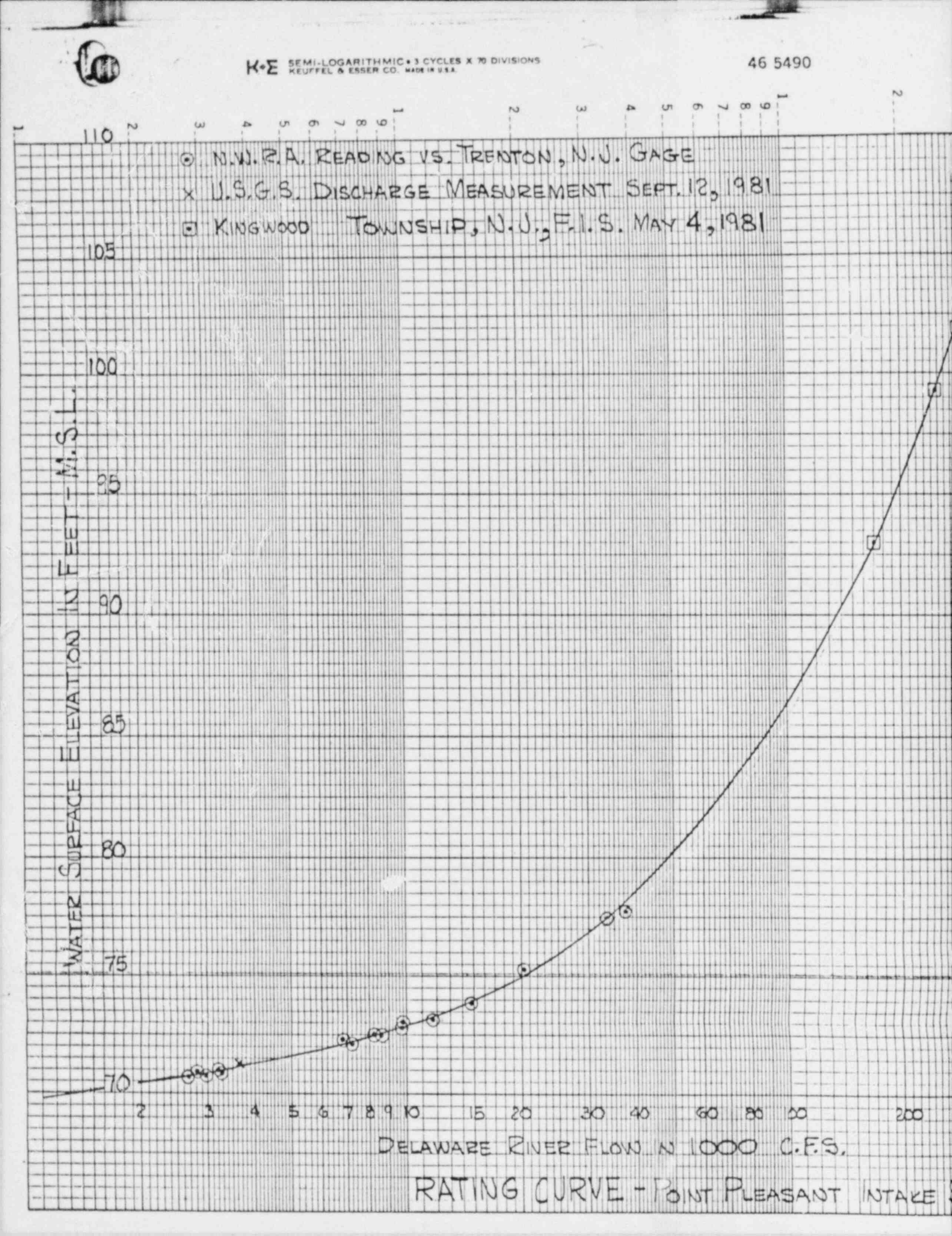
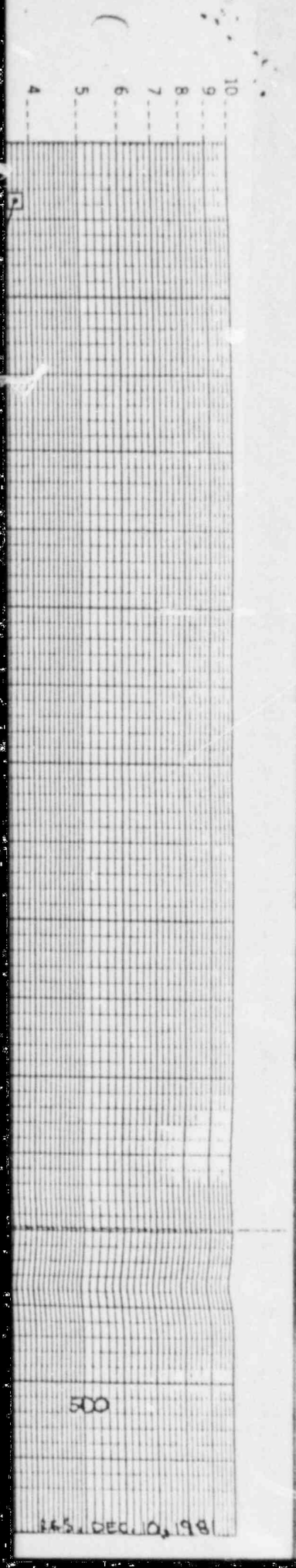



4
5
6
7
8
9
10
500
E&S. DEC. 10, 1981

E. H. BOURQUIN ASSOCIATES, INC. BY

PROJECT PPPS - Prelim Design SHEET NO. 1 OF 4

SUBJECT Discharge - Stage Data at Intake Site

COMPUTED BY RES DATE 6-10-81 CHECKED BY KPB

Area of Delaware River PPPS site to Trenton Gage

Dist. Downstr From PPPS (Feet)	Width (Feet)	Av. Width (Feet)	Area (1000 Ft²)
0	450		
		450	4,500
10,000	450		
		425	4,250
20,000	400		
		500	5,000
30,000	600		
		700	7,000
40,000	800		
		710	7,100
50,000	620		
		610	6,100
60,000	600		
		590	5,900
70,000	580		
		690	6,900
80,000	800		
		780	7,800
90,000	760		
		755	7,550
100,000	750		
		875	8,750
110,000	1000		
		1050	10,500
120,000	1100		

Total 81,350,000 Ft²

Change in storage in Delaware River, PPPS to Trenton Gage in Ft³/sec =

$$\frac{\text{Area} \times \text{change in stage in Ft/Hour}}{60 \times 60}$$

$$= \frac{81{,}350{,}000 \times \text{Ft per Hour}}{3600} = 22{,}600 \times \text{Ft/Hour in cfs}$$

EXHIBIT NO. 8

E. H. BOURQUARD ASSOCIATES, INC.

PROJECT: PPPS - Prelim Design SHEET NO. 2 OF 4
SUBJECT: Discharge - Stage Data at Intake Site
COMPUTED BY: KES DATE: 6-10-81 CHECKED BY: KPB

May 1981

May 1981

Day	PPPS W.S. Elev (Ft)	Trenton Gage Height (Ft) 8:00 a.m.	dh/dt (Ft/Hr)	Change in Storage (cfs)	Trenton Discharge (cfs)	Calculated PPPS Discharge (cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	73.10	10.00	+0.030	+680	11,500	11,800
4	72.83	9.82	-0.007	-160	10,500	10,000
6	72.42	9.58	-0.016	-360	9,210	8,600
8	72.13	9.26	-0.006	-140	7,660	7,300
11	71.76	8.86	+0.006	+140	5,910	5,900
13	81.77	14.18	+0.092	+2080	52,200	52,700
15	77.48	12.80	-0.042	-950	35,800	33,800
18	77.79	13.12	-0.045	-1020	39,400	37,200
20	75.25	11.46	-0.016	-360	21,200	20,200
22	73.88	10.70	-0.021	-470	15,800	14,900
25	72.92	9.78	-0.012	-270	10,300	9,720
27	72.47	9.46	0.000	0	8,610	8,350
29	72.30	9.34	0.000	0	8030	7,790

1. Day of month
2. From NWRA ltr. of 6-2-81
3. From USGS, Trenton. (Letter dated June 5, 1981)
4. From plot of USGS Data
5. (4) × 22,600. See Sheet 1
6. From USGS Trenton (Letter dated June 5, 1981)
7. [Col. (6) × 0.97] + Col. (5), 0.97 corrects for difference in drainage area.

PROJECT PPPS - Prelim. Design SHEET NO. 3 OF 4

SUBJECT Discharge vs Elev. Data at Intake Site

COMPUTED BY RES DATE 7-6-81 CHECKED BY KPB

Drainage Area at Intake Site

D.A. at Riegelsville, N.J. (includes Musconetcong River D.A.)	6328	Sq. Mi.
Intervening Streams		
Pa. Tinicum Cr.	24	
Tohicken Cr.	112	
Direct Flow 18 mi x 1.5 mi	27	
N.J. Direct Flow 18 mi x 5.0 mi	90	
Rough Estimate for Pt. Pleasant	6581	
Say	6600	
D.A. at Trenton, N.J.	6780	
Diff. Intake Site to Trenton, N.J.		
6780 − 6600 =	180	Sq. Mi.
Intake Site as per cent of Trenton		
6600 ÷ 6780 =	97.3	%

Use flows at Trenton reduced by 97.7%

USGS Current Meter Discharge Measurements of Sept. 2, 1981 Received from NWRA

		CFS
Delaware River at Lumberville Footbridge		3340
Raritan Canal at Raven Rock	+	304
Total at Lumberville		3644
Less inflow from Paunnacussing Creek	−	1
		3643
Use		3640

Water Surface Elev. at Intake Site at time of USGS Measurement from NWRA letter of Sept. 14, 1981 Average 7.27 Ft MSL

Kingwood, N.J. Flood Insurance Study of May 4, 1981

Elevations for floods of 10 year, 50 year, 100 year, and 500 year recurrence interval for a point 9,000 ft upstream from the corporate limits are shown on Panel 01P

Corresponding discharges are listed on page 11 of the above report under the heading: "Delaware River at Confluence of Tohicken Creek"

PROJECT POINT PLEASANT PUMPING STAT. - PUMP DESIGN SHEET NO. 1 OF

SUBJECT INTAKE SCREENS

COMPUTED BY L.C.P.J. DATE 1-9-81 CHECKED BY

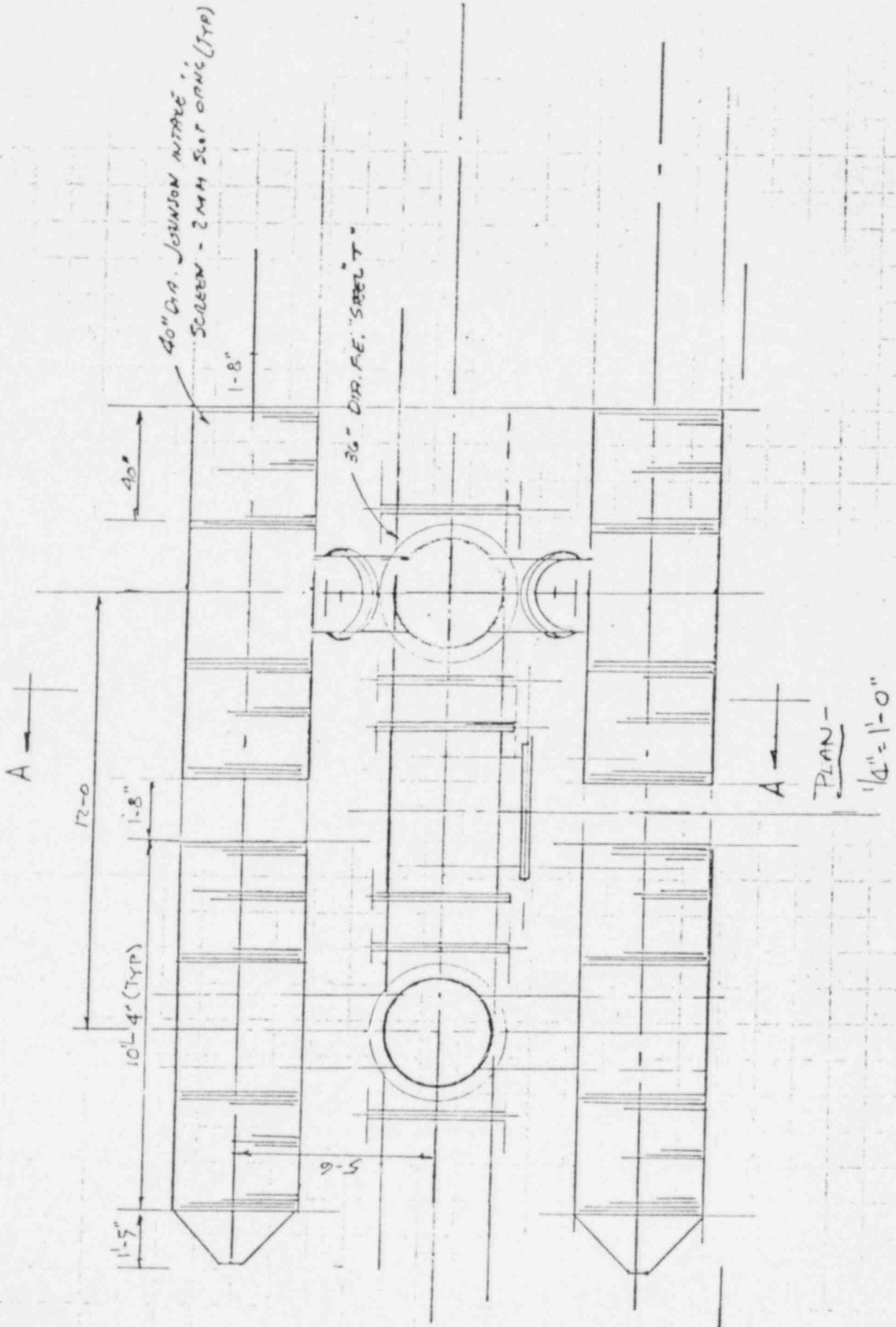
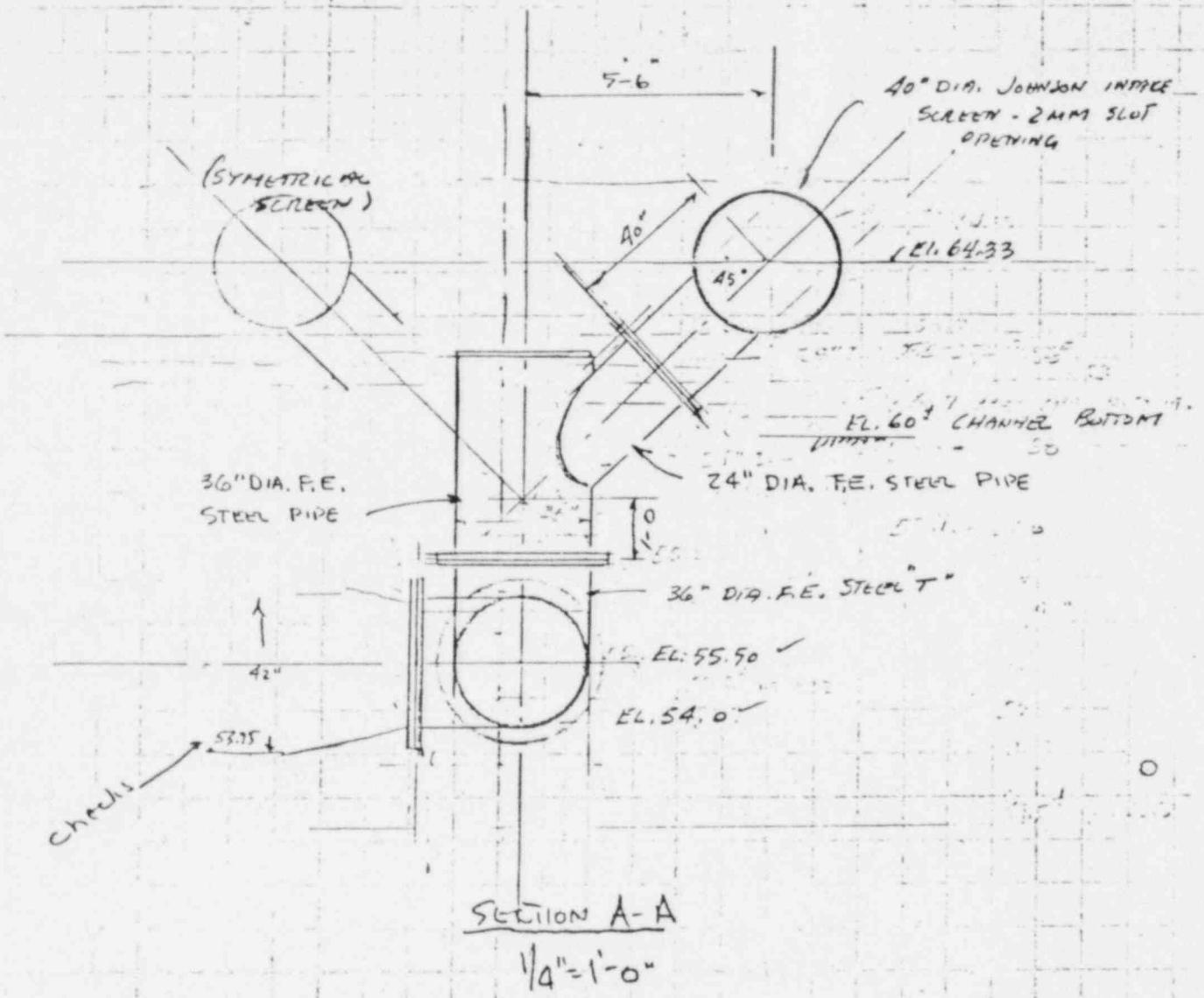


EXHIBIT NO. 9

PROJECT POINT DIAMANT PUMPG STA. SHEET NO. 2 OF

SUBJECT INTAKE SCREENS -

COMPUTED BY JJPJr DATE 1-9-81 CHECKED BY EHD



SECTION A-A

1/4"=1'-0"

Intake Structure

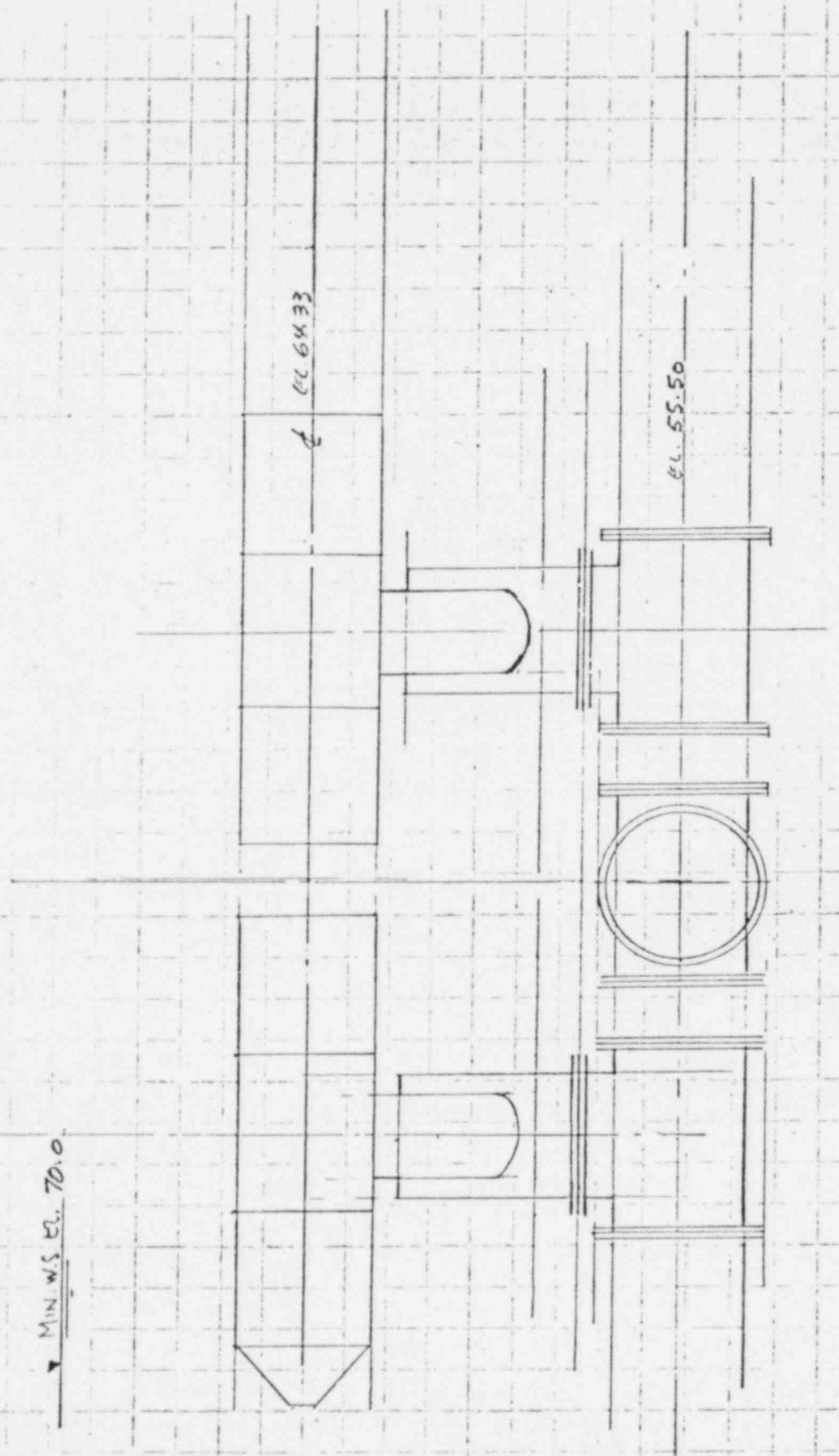
½ Screen Dia. 40/2 ÷12	=	1.67
5'-6" - 45° 5'-6"	=	5.50
1'-0" to Flange	=	1.00
℄ 36" Tee 28 ÷12 =	=	2.33
½ 42-Inch Pipe, 21÷12	=	1.75

W.S. Elev.	70.00
Submergence	4.00
Top of Screen	66.00
½ Screen Dia	1.67
Elev. ℄ Screen	64.33 ←
To ℄ 36" Tee	8.83
Elev. ℄ 36" Tee	55.50 ←
½ 42" Pipe	1.75
Inv. 42" Pipe	53.75 ←

PROJECT _____ SHEET NO. 3 OF _____

SUBJECT _____

COMPUTED BY _____ DATE 1-12-81 CHECKED BY _____



ELEV 1/4" = 1'-0"

PROJECT DPPS - Prelim. Design SHEET NO. 4 OF

SUBJECT Water Intake Hydraulics

COMPUTED BY EHD DATE 1-12-81 CHECKED BY JSP

Re: Project Report No. 177, Experimental Flow Studies with the Dual Screen Cooling Water Intake Assembly for the James H. Campbell Electric Power Generating Plant, Unit No. 3, by Stefan, Dahlin, Ripken, Wood and Winterstein; St. Anthony Falls Hydr. Laboratory, Univ. of Minnesota, Dec. 1978 Library No. 210.06A, page 34.

No. of Risers or Assemblies - 12

Max. Flow / Assembly - 95 MGD ÷ 12 = 7.92, say 8.0 MGD

147 cfs ÷ 12 = 12.25, say 12.5 cfs.

$Re = \frac{DV\rho}{\mu}$ D = 2 ft.

V = Q/A = 12.5 / 3.1416 = 4.0 fps

$= \frac{2 \times 4 \times 62.4}{1.1/1488}$ ρ = 62.4 #/cf μ = 1.1/1488

= 675,281 say 675,000

Figure III-17 & Sect. IV, Sta. No. 4 - K_p = 5.8

$H_p = K_p V^2/2g$ = 5.8 (4²/64.32) = +1.44 ft

$h_v = V^2/2g$ = 4²/64.32 = -0.25

Allowance for Screen Debris Losses +1.00 or +2.00

Energy Loss 2.19' or 3.19'

Vertical 36-Inch Pipe and 36-Inch Tee and Pipe

Q = 12.5 + 12.5 = 25 cfs

V = 25 ÷ (π3²/4) = 25 ÷ 7.07 = 3.54 fps

Equiv. Pipe Length - Pipe + Tee + Pipe = 7 + 200* + 5 = 212 ft

R_e = (3 × 3.54 × 62.4) ÷ (1.1/1488) = 896,436, say 900,000

ε/D = 0.00015/3 = 0.00005 f = 0.013 from Fig. 42, p. 3-128. Use 0.015

$h_f = f(L/D)(V^2/2g)$ = 0.015 (212/3) (3.54²/64.32) = 0.21'

* Pgs. 3-125-130 of Piping Handbook (Lib. No. 2591)

Horiz. 36-Inch Tee $Q = 25 + 25 = 50$ cfs

Equiv. Length = 200 ft $V = 50/7.07 = 7.07$ fps

$h_f = 0.015\,(200/3)\,(7.07^2/64.32) = 0.78'$

$\Delta h_v = (7.07^2 - 3.54^2) \div 64.32 = 0.58$

Total 1.36'

36-Inch to 42-Inch Reducer $Q = 50$ cfs

Assume $h_f = \Delta h_v$ $A_{42} = \pi 3.5^2/4 = 9.62$ □'

$= \dfrac{7.07^2 - 5.20^2}{64.32}$ $V = 50/9.62 = 5.20$ fps

$= 0.36'$

8+62
-6
8+56
5+54
302

42-Inch Pipe $Q = 50$ cfs $L = 302$ ft

$h_f = 0.015\,(302/3.5)\,(5.20^2/64.32) = 0.54$ ft.

Gate Well

W.S. Max. Flow = River W.S. minus h_v and Losses

$= 70.0 - 0.25 - (2.19 + 0.21 + 1.36 + 0.36 + 0.54)$

$= 70.0 - 4.91 = 65.09$

or $-5.91 = 64.09$

Conduit to Pump Sump $Q = 147$ cfs. $L = 400$ ft

Table 42, p. 3-123
$\epsilon = 0.001-0.010$
$= 0.0055$

Try RCP sizes of:	60-Inch	66-Inch	72-Inch
$A = \pi D^2/4$ in sq ft	19.63	23.76	28.27
$V = Q/A$ in fps	7.49	6.19	5.20
$R_e = DV\rho/\mu$	3.2×10^6	2.9×10^6	2.6×10^6
$\epsilon/D = 0.0055/D$	0.0011	0.0010	0.00092
f from Fig 42, p 3-128	0.020	0.020	0.020
$h_f = 0.020\,(400/D)\,(V^2/64.32)$	1.40	0.87	0.56
$1.3h_v = 1.3\,(V^2/64.32)$	1.13	0.77	0.55
$H = h_f + 1.3h_v =$	2.53	1.64	1.11

Pump Sump W.S.

65.09 − H =	62.56	63.45	63.98
64.09 − H =	61.56	62.45	62.98 ←

PROJECT PPPS - Prelim. Design SHEET NO. 6 OF

SUBJECT Water Intake - Hydraulics

COMPUTED BY E.H.B DATE [redacted] 1-12-81 CHECKED BY JGP

Pump Sump Data Peerless Catalog - Vert. Turb. Data Bk.

Pump Discharge = 95 MGD ÷ 4 = 24 MGD, 16,800 GPM

NPSH Data - Pgs. 49 & VTDB - (See Sheet 6A)

Bowl - 28 HXB

Speed - 1185 RPM

Capacity - 16,500 GPM - Max = 17,800 GPM

Curve - 2832698 - (Also see Sheet No. 6A, 5-16-80, CTM)

NPSH Required - From Sh. No. 7, 5-17-80, CTM, Hydraulic, the min. hd. would be 378 ft with one pump operating. From curve for cut Impeller, the flow would be 17,800 gpm and Rqd. NPSH would be 36 ft

Service - Long pumping periods so, continuous

Sump - Std. 2D Sump - 1D from wall, ½D from floor

Altitude - 60 ft MSL

Water Temp - 90° F

Step 1 - Capacity x Col. 5 - 17,800 x 0.13 = 2314 GPM

Step 2 - Model Submr. 31.2"

Step 3 - Mod. Submr. x Col. 3 - 31.2" x 2.48 = 77.4" - 6.4' Cen.

x Col. 4 - x 2.26 = 70.5" - 5.9' L.F.

Step 4 - Compare with E - 15¾" vs 6.4 for Continuous

vs 5.9' for Low Flow

Step 5 - Rqd. NPSH vs Aval. NPSH

Rqd. NPSH - 36 ft. from Curve 2832698 (17,800 GPM)

Aval NPSH - Atmos. Pres.* - Vapor Pres.* + Submr.

33.9 - 1.62 + 6.4 = 38.68'

33.9 - 1.62 + 5.6 = 37.88'

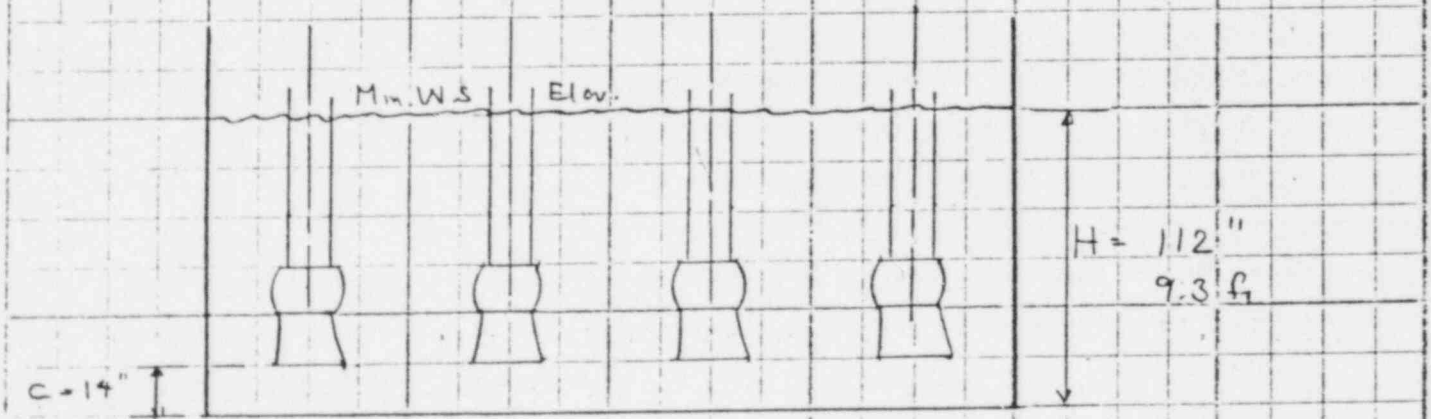
* See Sheet No. 6B attached

PUMP SUMP DATA (Con't'd)

Item	Cont. Flow & Conduit of: 60"	66"	72"	Low Flow & Conduit of: 60"	66"	72"
W.S. in Pump Sump.	61.4	62.4	63.0	61.4	62.4	63.0
Less Submergence	6.4	6.4	6.4	5.9	5.9	5.9
Bot. of Suction Bell	55.2	56.0	56.6	55.7	56.5	57.1
Clearance ½ Dia. Bell	1.1	1.1	1.1	1.1	1.1	1.1
Floor of Sump.	54.1	54.9	55.5	54.6	55.4	56.0

Peerless Letter of July 24, 1980 _ Sump Floor = 61.6 - 8.2 = 53.4
62.4 - 8.2 = 54.2
63.0 - 8.2 = 54.8

SUMP DIMENSIONS PER HYDRAULIC INSTITUTE. p. 110 & 111
Fig. 6.8 - 16,500 GPM - See Sheet No. 7A
(Pumping unit selected on basis of low bid)



Floor of Sump - 60-Inch _ 61.6 - 9.3 = 52.3
66-Inch _ 62.4 - 9.3 = 53.1
72-Inch _ 63.0 - 9.3 = 53.7 ←

Make Floor at same level as invert elevation of 42-Inch Pipe at Water Intake _ 53.75

and use 72-Inch Conduit Pipe

Sheet No. 7A

SUMP DIMENSIONS VERSUS FLOW

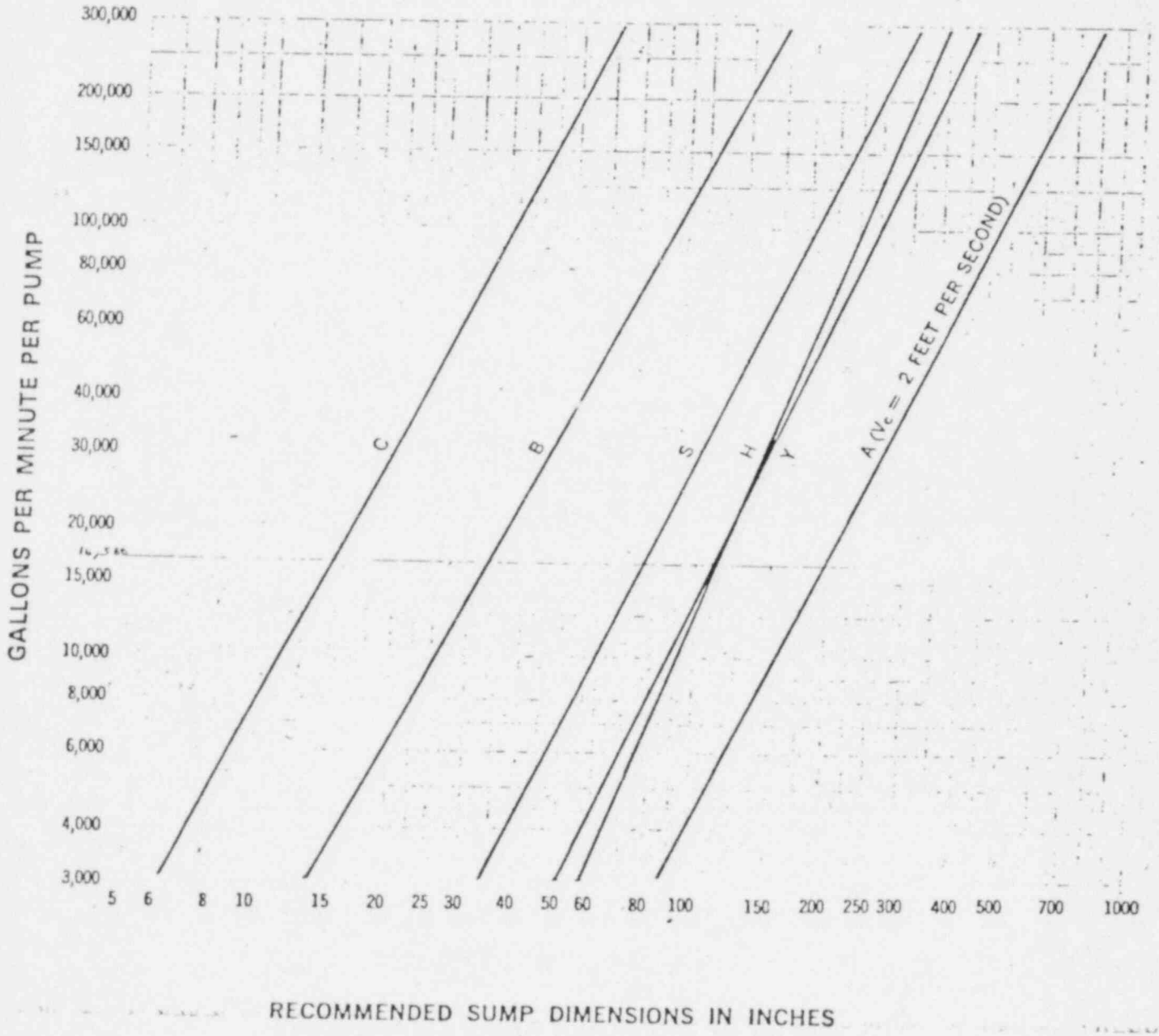


Fig. 68 SUMP DIMENSIONS VERSUS FLOW

See explanatory notes in Text under Intake Design.

"[illegible]" and "HH" Vertical Turbine Pumps

	E	D	Col. 3	Col. 4	Col. 5
[illegible]	12-1/2	9-1/4	.885	.805	1.71
[illegible]	9-3/4	10-5/8	1.02	.925	1.21
[illegible]	13-1/4	10-15/16	1.05	.951	1.13
[illegible]	9-3/16	13	1.24	1.13	.736
[illegible]	11	15	1.44	1.31	.515
16 [illegible]	11	15	1.44	1.31	.515
16 HH	11	17-7/8	1.71	1.55	.335
18 [illegible]	14-1/2	16-1/2	1.58	1.44	.405
18 HH	13-7/8	18-3/4	1.79	1.63	.295
20 [illegible]	14	17-1/2	1.67	1.52	.352
24 [illegible]	19	21	2.01	1.83	.224
24 HH	15-1/2	24-1/4	2.32	2.11	.155
24 [illegible]	18-1/2	24-5/8	2.35	2.14	.149
24 HH	17-7/8	28	2.68	2.44	.109
28 [illegible]	15-3/4	26	2.48	2.26	.130
30 HH	14-3/4	34-5/8	3.32	3.02	.064
32 [illegible]	20-5/8	30	2.87	2.61	.092
34 [illegible]	24	34-5/8	3.32	3.02	.064
36 HH	18-1/8	38	3.64	3.31	.051
42 [illegible]	26	40	3.83	3.48	.044
48 [illegible]	31	48-1/8	4.61	4.19	.028
48 HH	31	59	4.95	4.58	.024
56 HH	32	75	5.94	5.50	.0153

SUMP DATA

The following information has been obtained from model tests performed in the Peerless Hydraulic Laboratory. It is designed to predict full size pump performance in Sumps which are identical to those shown on the following pages. The submergence values obtained by using this data are for vortexing only and do not imply sufficient submergence to meet the NPSH requirements of the pump. Check the performance curve to see that the NPSH provided by the submergence calculated from this data is adequate to meet the pump requirements. The available NPSH is calculated by adding the atmospheric pressure at the pump site, less the liquid vapor pressure, to the submergence obtained from the above. This value should equal or exceed the NPSH values shown on the curve. Note - submergence for vortex prevention is not affected by altitude or liquid temperature.

"L" and "M" Vertical Turbine Pumps

PUMP	E	D	Col. 3	Col. 4	Col. 5
8 LA	10-1/2	9-1/2	.906	.825	1.61
10 LB	8-9/16	9-1/4	.885	.805	1.71
[illegible]	10	10	.956	.870	1.42
[illegible]	9-1/2	11	1.05	.956	1.10
12 MB	9-3/4	11-1/2	1.10	1.00	1.00
14 LC	11-1/2	13	1.24	1.13	.736
14 MC	11-7/8	13	1.24	1.13	.736
13 MA	11	15	1.44	1.31	.515
16 MC	11-5/8	13-3/4	1.31	1.19	.636
18 MA	9	13-3/4	1.31	1.19	.636
[illegible] MA	19-3/4	18	1.72	1.56	.326
16 MA	16	18-3/4	1.79	1.63	.296
17 MA	16-1/4	27	2.58	2.35	.119
[illegible] MA	20-1/2	28-1/4	2.70	2.45	.106

To find the submergence required, multiply the capacity by column 5; for this capacity read the model submergence required from the attached sketches for an identical sump. Multiply the submergence value thus obtained by column 3 for submergence required for continuous service or by column 4 for submergence required at low water level or for intermittent service. If the values calculated from the above are less than E, use E for submergence. If the values calculated are more than E, use the values calculated.

EXAMPLE

- 30 HH
- 885 rpm
- 22,000 gpm
- 2841575
- Required - 21.4 ft
- Continuous
- Standard 2D
- 5000 ft
- Temperature - 90°F

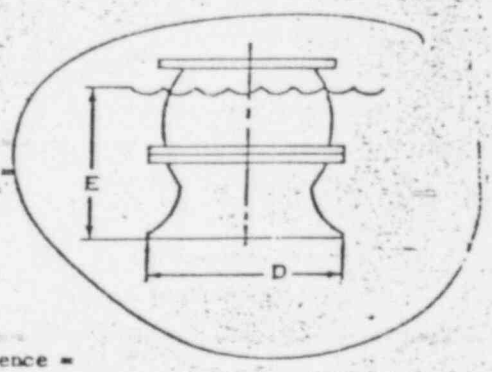
Step 1 - Capacity x column 5 = Model Capacity
22,000 gpm x .064 = 1408 gpm

Step 2 - Read model submergence from curve - 22"

Step 3 - Model submergence x column 3 (continuous service) =
30 HH pump submergence required
22" x 3.32 = 73" or 6'-1"

Step 4 - Compare with E. E = 14½" therefore use 6'-1"

Step 5 - Check NPSH required vs NPSH available.
Atmospheric pressure - Vapor pressure + Submergence =
NPSH available. 28.3 ft - 1.62 ft + 6.08 ft = 32.76 ft available.
NPSH required from curve = 21.4 ft
Selection satisfactory.



ATMOSPHERIC PRESSURE IN FEET OF WATER (75°F)
AT VARIOUS ALTITUDES

Altitude	Feet of Water
0 (100 - 33.9 ←)	34.0
500	33.4
1000	32.8
1500	32.2
2000	31.6
2500	31.0
3000	30.5
3500	29.9
4000	29.4
4500	28.8
5000	28.3
5500	27.8
6000	27.3
6500	26.7
7000	26.2
7500	25.7
8000	25.2
8500	24.8
9000	24.3
9500	23.8
10000	23.4

PROPERTIES OF WATER AT SATURATION PRESSURE

Temp °F	Vapor Press PSIA	Ft. Hd.	Specific Gravity
32	.0885	.20	.9999
33	.0922	.21	.9999
34	.0960	.22	.9999
35	.1000	.23	1.0000
36	.1040	.24	1.0000
37	.1082	.25	1.0000
38	.1126	.26	1.0000
39	.1171	.27	1.0000
40	.1217	.28	1.0000
41	.1265	.29	1.0000
42	.1315	.30	1.0000
43	.1367	.32	1.0000
44	.1420	.33	.9999
45	.1475	.34	.9999
46	.1532	.35	.9999
47	.1591	.37	.9999
48	.1653	.38	.9998
49	.1716	.40	.9998
50	.1781	.41	.9997
51	.1849	.43	.9997
52	.1918	.44	.9996
53	.1990	.46	.9996
54	.2064	.48	.9995
55	.2141	.50	.9994
56	.2220	.51	.9994
57	.2302	.53	.9993
58	.2386	.55	.9992
59	.2473	.57	.9991
60	.2563	.59	.9990
62	.2751	.64	.9989
64	.2951	.68	.9987
66	.3164	.73	.9985
68	.3390	.79	.9982
70	.3631	.84	.9980
75	.4298	.99	.9974
80	.5069	1.17	.9966
85	.5959	1.39	.9959
→ 90	.6982	1.62	.9950
95	.8153	1.89	.9941

Temp °F	Vapor Press. PSIA	Ft. Hd.	Spec. Gravi
100	.949	2.21	.9931
110	1.275	2.98	.9906
120	1.692	3.96	.9868
130	2.223	5.21	.9857
140	2.889	6.79	.9833
150	3.718	8.75	.9803
160	4.741	11.20	.9773
170	5.992	14.2	.9735
180	7.510	17.9	.9702
190	9.339	22.3	.9667
200	11.53	27.7	.9632
210	14.12	34	.9592
220	17.19	42	.9552
230	20.78	50	.9512
240	24.97	61	.9467
250	29.83	73	.9423
260	35.43	87	.9373
270	41.85	104	.9331
280	49.20	123	.9281
290	57.56	144	.9232
300	67.01	169	.9180
310	77.68	197	.9127
320	89.66	228	.9076
330	103.1	264	.9019
340	118	304	.8964
350	135	350	.8904
360	153	400	.8845
370	173	455	.8787
380	196	519	.8725
390	220	587	.8659
400	247	664	.8594
410	277	750	.8529
420	309	845	.8457
430	344	948	.8387
440	382	1061	.8317
450	423	1182	.826
460	467	1319	.817
470	515	1472	.809
480	566	1632	.801

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ConverseWardDavisDixon

Geotechnical Consultants

91 Roseland Avenue
Post Office Box 91
Caldwell, New Jersey 07006
201 226-9191 212 964-0405
Cable: Conward Caldwell NJ

28 August 1981

E.H. Bourquard Associates, Inc.
Water Resources Engineering
1400 Randolph Street
Harrisburg, Pennsylvania 17104

Attention: Mr. J.J. Powers, Jr.

RE : Point Pleasant Pumping Facilities
Intake Revision
(81-07162-01)

Gentlemen:

In accordance with your request expressed in your letter of 13 August 1981, we evaluated new data gathered for the design and construction of the referenced facility. The purpose was to evaluate the impact (if any) of the new data on the conclusions and recommendations of our report of 20 May 1980, entitled "Report of Evaluation of Rock Excavation and Impact of Blasting for the Proposed Point Pleasant Pumping Facility."

In order to assist us with our evaluation, you provided the following:

1. Field logs of borings G-1 through G-12 and R-1 through R-21. Borings performed by F.T. Kitlinski & Associates.

2. Drawing entitled "Boring Profile Plan from Subsurface Investigation for N.W.R.A., T.M.P. 34-20-65, 66 and 69," dated 21 April 1981.

3. Two drawings entitled "Boring Profile Plan from Subsurface Investigation for N.W.R.A., T.M.P. 34-20-65, 66 and 69," dated 21 April 1981.

4. Drawing No. PPPS-C entitled "Location and Layout Plan - General Profile," undated.

EXHIBIT NO. 11

Mr. Syed Pasha, Senior Geologist, who examined cores from a previous study, examined some of the rock cores. A summary of his observations is presented in Table 1. Most cores were of AX or BX size and the usefulness of data for these core was therefore limited compared to NX size cores.

EVALUATION AND CONCLUSIONS

Intake Conduit - Off-shore Portion: The invert of conduit is shown to be at elevation 53.75. Based on boring data, the elevation to rock surface in the off-shore portion is between 57.6 and 60.2. Thus, there would be at least 6 feet of rock excavation in some locations to allow construction of pipe. In other locations where rock is below pipe invert, rock excavation would not be needed. Examination of rock cores suggest that the rock may be rippable. However, depending on the method of construction, the rock may have to be scraped. In such case some blasting involving light charges may be required to allow loosening of the rock. We do not anticipate that there would be unusual problems in enforcing the blasting criteria given in our report of 20 May 1980. The effect, if any, of blasting on marine life is not within the scope of our services.

Intake Conduit - Land Portion: Based on boring data, and our examination of rock cores, top of rock is of elevations varying from elevation 57 to elevation 73. The thickness of rock to be removed may therefore be limited. The degree of rippability varies along the pipe route. We recommend that ripping be attempted first and blasting be restricted to non-rippable rock. Table 1 provides guidance where ripping is most likely. We do not anticipate unusual problems in enforcing the blasting criteria given in our report of 20 May 1981.

Based on borings G-5 and G-7, top of rock beneath the Pennsylania Canal crossing is at elevation 60.2 to 61.6. Boring G-5 indicated tha top 6 feet of rock is likely to be rippable while boring G-7 indicated non-rippable rock. Thus, blasting is likely to be required either to loosen the rock allowing scraping or to fracture rock. In any event, we do not anticipate problems in enforcing the blasting criterion in our 20 may 1980 report.

If sheeted excavation is planned, we recommend removing rippable rock prior to blasting in the off-shore portion and the Pennsylvania Canal crossing.

Pump Station: Based on borings G-1 and G-2, elevation to top of rock varies from elevation 66 to elevation 84. Rock cores of boring G-2 suggests that the top 5 to 10 feet of rock may be rippable. Thus, we anticipate that blasting would be required. We do not anticipate unusual problems in enforcing the blasting criteria of our 20 May 1980 report.

CONCLUSIONS

Please be informed that we have examined the revisions in the intake design and evaluated the new subsurface data and wish to advise that the conclusions and recommendations of our report of 20 May 1980 are still valid providing that blasting criteria specified in the report are followed. The nearby structures mentioned in the report includes the Canal locks. The rippability evaluations are to aid the contractor in the performance of excavation.

We trust that this letter is responsive to your needs. Please call if you have any questions.

Yours very truly,

CONVERSE WARD DAVIS DIXON, INC.

Issa S. Oweis, Ph.D., P.E.
Vice President

ISO:rt

Encl.: Table 1

Boring No.	Core Depth(ft.) (elevation)	Core Size	RQD %	Remarks
G-2	30-35.9 (69-63.1)	Nx	10	Argillite Rock
	35.2-50	Bx		Argillite, Dark Gray to Black Highly Fractured and Broken (Fracture Spacing 2 inches - 6 inches) up to 43 feet (elevation 56 feet)
G1-A	29-55	Ax		Argillite, Broken, Fractured (Fracture Spacing 2 inches - 10 inches)
G-2	27-31 (66.1-62.1)	Nx	33	
	31-32.4 (62.1-60.7)	Nx	0	From 27 feet to 45 feet (elevation 60.1 to 48.1 feet) Dark Gray to Black, Moderately to
	37.4-35 (60.7-58.1)	Nx	63	Slightly Weathered Argillite Average Fracture/Joint Spacing 6 inches - 10 inches
	35-37 (58.1-56.1)	Nx	0	Broken and Fragmented from 27 feet - 29 feet (elevation 66.1 feet - 69.1 feet) 34.4 feet - 45 feet (elevation 58.7 feet -
	39-45 (54.1-48.1)	Nx	0	48.1 feet). Mostly Open Joints with Solution Markings. Inferred Top of Rock at 27 feet Depth (elevation 66.1)

Boring No.	Core Depth (ft.) (elevation)	Core Size	RQD %	Remarks
G-4	30.8-33.3 (62.1-59.6)	Nx	57	Inferred Top of Rock at 19.8 feet (elevation 73.1 feet)
	33.3-35 (59.6-57.9)	Nx	25	30.8 feet - 33.8 feet (elevation 62.1 - 59.1) Dark Gray to Black, Moderately to Slightly Weathered, Moderately Fractured Argillite (non-rippable)
	35-37.9 (57.9-55)	Nx	17	
	37.9-40.9 (55-52)	Nx	44	
	40.9-42.8 (52-50.1)	Nx	47	
	42.8-45 (50.1-47.9)	Nx	33	
G-5	31.5-37.5 (60.2-54.2)	Nx	0	Very Broken and Rippable Top of Rock Depth of 31.5 feet (elevation 60.2 feet)
	37.5-41.5 (54.2-50.2)	Nx	29	Fractures at 2 inch - 6 inch spacing
	41.5-44 (50.2-47.7)	Nx	40	Fractures at 2 inch - 6 inch spacing

Boring No.	Core Depth (ft.) (elevation)	Core Size	RQD %	Remarks
G-7	22.7-25.9 (61.6-58.4)	Nx	63	
	25.9-30.2 (58.4-54.1)	Nx	79	Dark Gray to Black, Slightly Weathered, Fractured, Massive Argillite, Fracture Spacing 10 inches, Frequency one per foot, Top of Rock at 22.7 feet (elevation 61.6)
	30.2-34 (54.1-50.3)	Nx	80	
	34-36 (50.3-48.3)	Nx	80	
G-8	19.5-22.5 (61.6-58.1)	Nx	81	Top of Rock at 19.5 feet (elevation 61.6)
	22.5-30.2 (58.1-50.4)	Nx	83	Argillite, Slightly Weathered, Massive, Slightly Fractured
	30.2-31.8 (50.4-48.8)	Nx	26	
	31.8-33 (48.8-46.6)	Nx	90	
G-9	20-22.7 (58.5-55.8)	Nx	77	Top of Rock at 20 Feet (elevation 58.5) Dark Gray to Black Argillite, Moderately to Slightly Weathered, Fractured. Broken from 24.7-31 feet (elevation 53.8-47.5)
	22.7-24.7 (55.8-53.8)	Nx	21	
	24.7-31 (53.8-47.5)	Nx	0	

Boring No.	Core Depth (ft.) (elevation)	Core Size	RQD %	Remarks
G-10	21-30 (57.1-47.7)	Ax		Appears Rippable Top 4 - 5 feet
G-11	19.5-21.5 (57-55)	Nx	63	
	21.5-23 (55-53.5)	Nx	61	From 22.5-23 feet (elevation 54-53.5) and 25-27.5 (elevation 51-49) Argillite Rock is Highly Fractured and Probably Rippable
	23-28.5 (53.5-48.5)	Nx	50	
G-12		Ax		Top of Rock at 20.5 feet (elevation 53.5 feet) Rock Appears Non-Rippable
R-1		Ax		Top 8 - 9 feet of Rock may be Rippable (?)
R-2	13.3-17.5 (58.7-54.5)	Nx	16	
	17.5-21 (54.5-51)	Nx	19	Appears Rippable
	21-24 (51-48)	Ax		

Boring No.	Core Depth (ft.) (elevation)	Core Size	RQD %	Remarks
R-3		Ax		Rock Appears to be Rippable in Top 3 - 5 feet
R-4		Ax		Fracture/Joint Spacing 2 inches - 6 inches
R-5	11.8-16 (59.24-55.04)	Nx	26	Upper Few Feet Appears Rippable (?)
R-6		Ax		Low Quality Indicated Because of Ax Core Size. Rock Quality Should be Better than what is Indicated by Ax Core.
R-7		Ax		Rock Quality Appears Good Below 20 feet (elevation 51.86)
R-8		Ax		Rock Appears Rippable (?) in Top 3 - 4 feet of Core Runs (i. e., elevation 57 -53)
R-9	11.5-12.5 (60.5-59.5)	Nx	0	
	12.5-17.5 (59.5-54.5)	Nx	0	Rock Appears Rippable
R-10		Ax		Moderately Weathered, Rock Appears Rippable (?)

Boring No.	Core Depth(ft.) (elevation)	Core Size	RQD %	Remarks
R-11		Ax		Rock Appears Rippable to 23 feet (elevation 49)
R-12		Ax		Rock Appears Rippable to 16 feet (elevation 55)
R-13		Ax		Rock Appears to Have Broken during Drilling. At Core Rock Appears to be of Better Quality than Indicated by Recovery.
R-14		Bx		Rock Appears to be Rippable (?) to 20 feet (elevation 51.4)
R-15		Bx		Rock Appears to be Rippable (?) in its Upper Zones
R-16		Ax		Rock Appears to be Rippable (?) in its Upper Zones
R-17		Bx		Upper Portions Appear Rippable
R-18		Ax		Upper Portions Appear Rippable
R-19		Ax		Upper Portions Appear Rippable

Boring No.	Core Depth (ft.) (elevation)	Core Size	RQD %	Remarks
R-20		Ax		Argillite is Highly Fractured and Broken
R-21		Ax		Rock Appears of Good Quality (Non-Rippable)

ConverseWardDavisDixon

Geotechnical Consultants

91 Roseland Avenue
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201 226-9191 212 964-0405
Telex: 232005 ASAS

October 13, 1981

E. H. Bourquard Associates, Inc.
1400 Randolph Street
Harrisburg, Pennsylvania

Attention: Mr. E. Bourquard

Subject: Point Pleasant Pumping Facilities
Intake Revision
(81-07162-01)

Gentlemen:

In accordance with your request, we reviewed and evaluated the results of tests on intake rock cores perfcrmed by F. T. Kitlinson and Associates. Based on these tests, we "revised" the remarks column of Table I included in our report of August 28, 1981. The revised Table I is attached, together with the results of core tests. The text of our report of August 28, 1981 remains unchanged.

We trust that this letter is responsive to your request. Please call if you have any questions.

Very truly yours,

CONVERSE WARD DAVIS DIXON, INC.

Issa S. Oweis, Ph.D., P.E.
Vice President

ISO:gp

Enclosures: Table I
Results of Core Tests

EXHIBIT NO. 12

RESULTS OF TESTS FOR
DETERMINATION OF UNCONFINED COMPRESSIVE
STRENGTH OF INTACT ROCK CORE SPECIMENS
(ASTM DESIGNATION: D 2938-71a)

Proposed
Water Intake and Pumping Facilities
Point Pleasant
Bucks County, Pennsylvania

Boring No.	Depth (ft.)	Area (in^2)	Applied Load (lbs.)	Correction Factor	Compressive Strength (p.s.i.)
G-1A	$35^{\pm}$	1.04	33,920	1.00	32,620
G-2	$40^{\pm}$	2.14	67,370	1.00	31,480
G-7	$29^{\pm}$	3.63	133,000	1.00	36,640
G-12	$24^{\pm}$	1.04	38,330	1.00	36,860
R-2	$22^{\pm}$	1.04	30,010	1.00	28,860
R-11	$21^{\pm}$	1.04	14,425	1.00	13,870
R-21	$23^{\pm}$	1.04	28,675	1.00	27,570

NOTES:

1. The core from G-7 is NX size, and the core from G-2 is BX size. All other cores are AX size.
2. Core from R-11 contained seam faults and chips.
3. The breaks on all cores were vertical.

September 1981

F. T. Kitlinski & Associates, Inc.
Harrisburg, Pennsylvania

Table I

Summary of Observations

Rock Cores

Boring No.	Core Depth(ft.) (elevation)	Core Size	RQD %	Remarks
G-2	30-35.9 (69-63.1)	Nx	10	Argillite Rock - likely rippable
	35.2-50	Bx		Argillite, Dark Gray to Black Highly Fractured and Broken (Fracture Spacing 2 inches - 6 inches) up to 43 ft (elevation 56 feet) - likely rippable
G1-A	29-55	Ax		Argillite, Broken, Fractured (Fracture Spacing 2 inches - 10 inches) Rippable or blast to loosen
G-2	27-31 (66.1-62.1)	Nx	33	Blast to loosen
	31-32.4 (62.1-60.7)	Nx	0	From 27 feet to 45 feet (elevation 60.1 to 48.1 feet) - rippable
	37.4-35 (60.7-58.1)	Nx	63	Dark Gray to Black, Moderately to Slightly Weathered Argillite Average Fracture/Joint - blast to loosen. Spacing 6 inches - 10 inches
	35-37 (58.1-56.1)	Nx	0	*Broken and Fragmented from 27 feet - 29 feet (elevation 66.1 feet - 69.1 feet) 34.4 feet - 45 feet (elevation 58.7 feet -
	39-45 (54.1-48.1)	Nx	0	48.1 feet). Mostly Open Joints with Solution Markings. Inferred Top of Rock at 27 feet Depth (elevation 66.1) *Rippable

Boring No.	Core Depth (ft.) (elevation)	Core Size	RQD %	Remarks
G-4	30.8-33.3 (62.1-59.6)	Nx	57	Inferred Top of Rock at 19.8 feet (elevation 73.1 feet) - blast to loosen
	33.3-35 (59.6-57.9)	Nx	25	30.8 feet - 33.8 feet - rippable or blast to loosen (elevation 62.1 - 59.1)
	35-37.9 (57.9-55)	Nx	17	Dark Gray to Black, Moderately to Slightly Weathered, Moderately Fractured Argillite, rippable or blast to loosen
	37.9-40.9 (55-52)	Nx	44	Non-rippable - blast to loosen
	40.9-42.8 (52-50.1)	Nx	47	Non-rippable - blast to loosen
	42.8-45 (50.1-47.9)	Nx	33	Non-rippable - blast to loosen
G-5	31.5-37.5 (60.2-54.2)	Nx	0	Very Broken and Rippable Top of Rock Depth of 31.5 feet (elevation 60.2 feet)
	37.5-41.5 (54.2-50.2)	Nx	29	Fractures at 2 inch - 6 inch spacing Non-rippable - blast to loosen
	41.5-44 (50.2-47.7)	Nx	40	Fractures at 2 inch - 6 inch spacing Non-rippable - blast to loosen

Boring No.	Core Depth (ft.) (elevation)	Core Size	RQD %	Remarks
G-7	22.7-25.9 (61.6-58.4)	Nx	63	Non-rippable - blast to loosen
	25.9-30.2 (58.4-54.1)	Nx	79	Dark Gray to Black, Slightly Weathered, Fractured, Massive Argillite, Fracture Spacing 10 inches, Frequency one per foot, Top of Rock at 22.7 feet (elevation 61.6)
	30.2-34 (54.1-50.3)	Nx	80	
	34-36 (50.3-48.3)	Nx	80	Non-rippable - blast to fracture
G-8	19.5-22.5 (61.6-58.1)	Nx	81	Top of Rock at 19.5 feet (elevation 61.6)
	22.5-30.2 (58.1-50.4)	Nx	83	Argillite, Slightly Weathered, Massive, Slightly Fractured
				Non-rippable - blast to fracture
	30.2-31.8 (50.4-48.8)	Nx	26	Rippable or blast to loosen
	31.8-33 (48.8-46.6)	Nx	90	Non-rippable - blast to fracture
G-9	20-22.7 (58.5-55.8)	Nx	77*	Top of Rock at 20 Feet (elevation 58.5) Dark Gray to Black Argillite, Moderately to Slightly Weathered, Fractured.
	22.7-24.7 (55.8-53.8)	Nx	21**	Broken from 24.7-31 feet (elevation 53.8-47.5)
				*Non-rippable - blast to fracture
				**Rippable or blast to loosen
	24.7-31 (53.8-47.5)	Nx	0	Rippable

Boring No.	Core Depth(ft.) (elevation)	Core Size	RQD %	Remarks
G-10	21-30 (57.1-47.7)	Ax		Appears Rippable Top 4 - 5 feet
G-11	19.5-21.5 (57-55)	Nx	63	Non-rippable - blast to loosen
	21.5-23 (55-53.5)	Nx	61	From 22.5-23 feet (elevation 54-53.5) and 25-27.5 (elevation 51-49) Argillite Rock is Highly Fractured and Probably Rippable
	23-28.5 (53.5-48.5)	Nx	50	
G-12		Ax		Top of Rock at 20.5 feet (elevation 53.5 feet) Rock Appears Non-Rippable
R-1		Ax		Top 8 - 9 feet of Rock may be Rippable or blast to loosen
R-2	13.3-17.5 (58.7-54.5)	Nx	16	Rippable
	17.5-21 (54.5-51)	Nx	19	Rippable
	21-24 (51-48)	Ax		Appears rippable

Boring No.	Core Depth(ft.) (elevation)	Core Size	RQD %	Remarks
R-3		Ax		Rock Appears to be Rippable in Top 3 - 5 feet
R-4		Ax		Fracture/Joint Spacing 2 inches - 6 inches Rippable
R-5	11.8-16 (59.24-55.04)	Nx	26	Upper Few Feet Appears Rippable Lower portion blast to loosen
R-6		Ax		Low Quality Indicated Because of Ax Core Size. Rock Quality Should be Better than what is Indicated by Ax Core. Rock probably rippable.
R-7		Ax		Rock Quality Appears Good Below 20 feet (elevation 51.86)
R-8		Ax		Rock Appears Rippable in Top 3 - 4 feet of Core Runs (i. e., elevation 57 -53)
R-9	11.5-12.5 (60.5-59.5)	Nx	0	Rippable
	12.5-17.5 (59.5-54.5)	Nx	0	Rippable
R-10		Ax		Moderately Weathered, Rock Appears Rippable

Boring No.	Core Depth(ft.) (elevation)	Core Size	RQD %	Remarks
R-11		Ax		Rock Appears Rippable to 23 feet (elevation 49)
R-12		Ax		Rock Appears Rippable to 16 feet (elevation 55)
R-13		Ax		Rock Appears to Have Broken during Drilling. At Core Rock Appears to be of Better Quality than Indicated by Recovery.
R-14		Bx		Rock Appears to be Rippable to 20 feet (elevation 51.4)
R-15		Bx		Rock Appears to be Rippable in its Upper Zones
R-16		Ax		Rock Appears to be Rippable in its Upper Zones
R-17		Bx		Upper Portions Appear Rippable
R-18		Ax		Upper Portions Appear Rippable
R-19		Ax		Upper Portions Appear Rippable

Boring No.	Core Depth(ft.) (elevation)	Core Size	RQD %	Remarks
R-20		Ax		Argillite is Highly Fractured and Broken, Rock Appears Rippable
R-21		Ax		Rock Appears of Good Quality (Non-Rippable)

Converse Consultants

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October 27, 1981

Mr. E. Bourquard
E. H. Bourquard Associates, Inc.
1400 Randolph Street
Harrisburg, Pennsylvania

Subject: Point Pleasant Pumping Facilities
Intake Revision
(81-07162-01)

Dear Mr. Bourquard:

We received your letter of October 26, 1981 and attached documents.

As I explained to you on the phone, the blasting specifications in our May 20, 1980 report are general guidelines to help our client establish site specific specifications and were not intended to be project specifications for construction of the Point Pleasant Pumping Facilities. In fact, the guidelines were the result of editing previous specifications we wrote on unrelated project. Because of editing, some blank spaces resulted. Such blanks and references to structures not related to Point Pleasant should not be construed as either deletions or source of confusion. Appendix A of our May 1980 report provides general guidelines and such guidelines also include extracts from the Pennsylvania Explosive and Blasting Laws.

Based on the premise that the subsurface conditions underlying the Canal are reasonably dense as indicated by the general subsurface conditions, it is our opinion that controlled blasting, under proper supervision as is recommended, would not adversely affect the stability of the Canal. If soil conditions encountered during construction are substantially less favorable than anticipated, then the blasting criteria should be adjusted as necessary, and further exploration and testing may be required.

Continued ...

Mr. Bourquard, please call if you have any questions.

Very truly yours,

CONVERSE CONSULTANTS, INC.

Issa S. Oweis, Ph.D., P.E.
Vice President

ISO:gp

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November 27, 1981

Mr. E. Bourquard
E. H. Bourquard Associates, Inc.
1400 Randolph Street
Harrisburg, Pennsylvania

Subject: Point Pleasant Pumping Facilities
Intake Revision
(81-07162-01)

Dear Mr. Bourquard:

We reviewed the letter from Mr. Beemer to R. L. Baldwin. The driller's descriptions of rock cores on the boring logs are not complete to the satisfaction of a geologist. However, we examined most of the rock cores, and the conclusions in our letter of August 28, 1981 and October 13, 1981 are not changed.

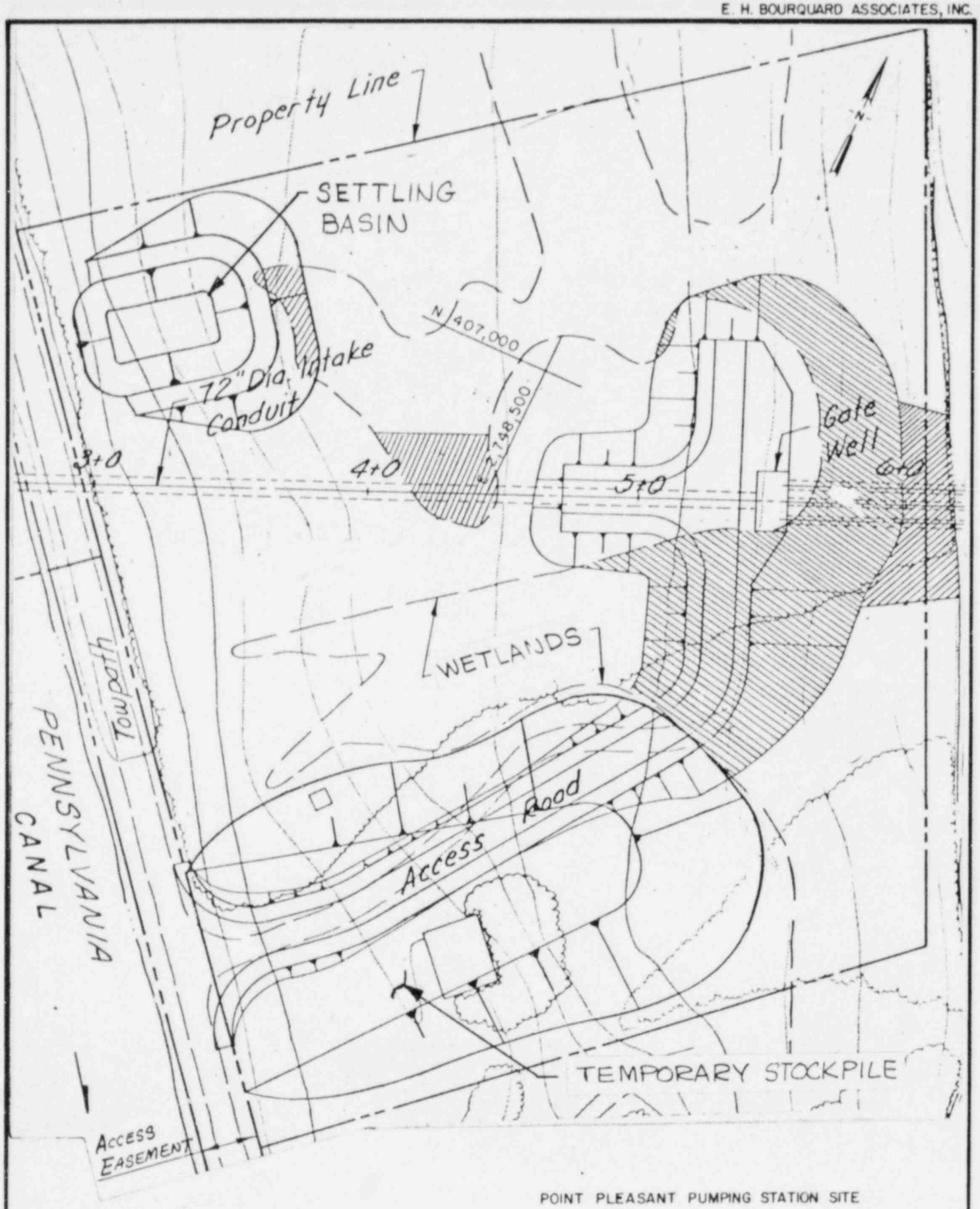
Very truly yours,

CONVERSE CONSULTANTS, INC.

Issa S. Oweis, Ph.D., P.E.
Vice President

ISO:gp

EXHIBIT NO. 14



POINT PLEASANT PUMPING STATION SITE

LIMITS OF WETLANDS AND EFFECTED AREAS

LEGEND

EFFECTED WETLANDS

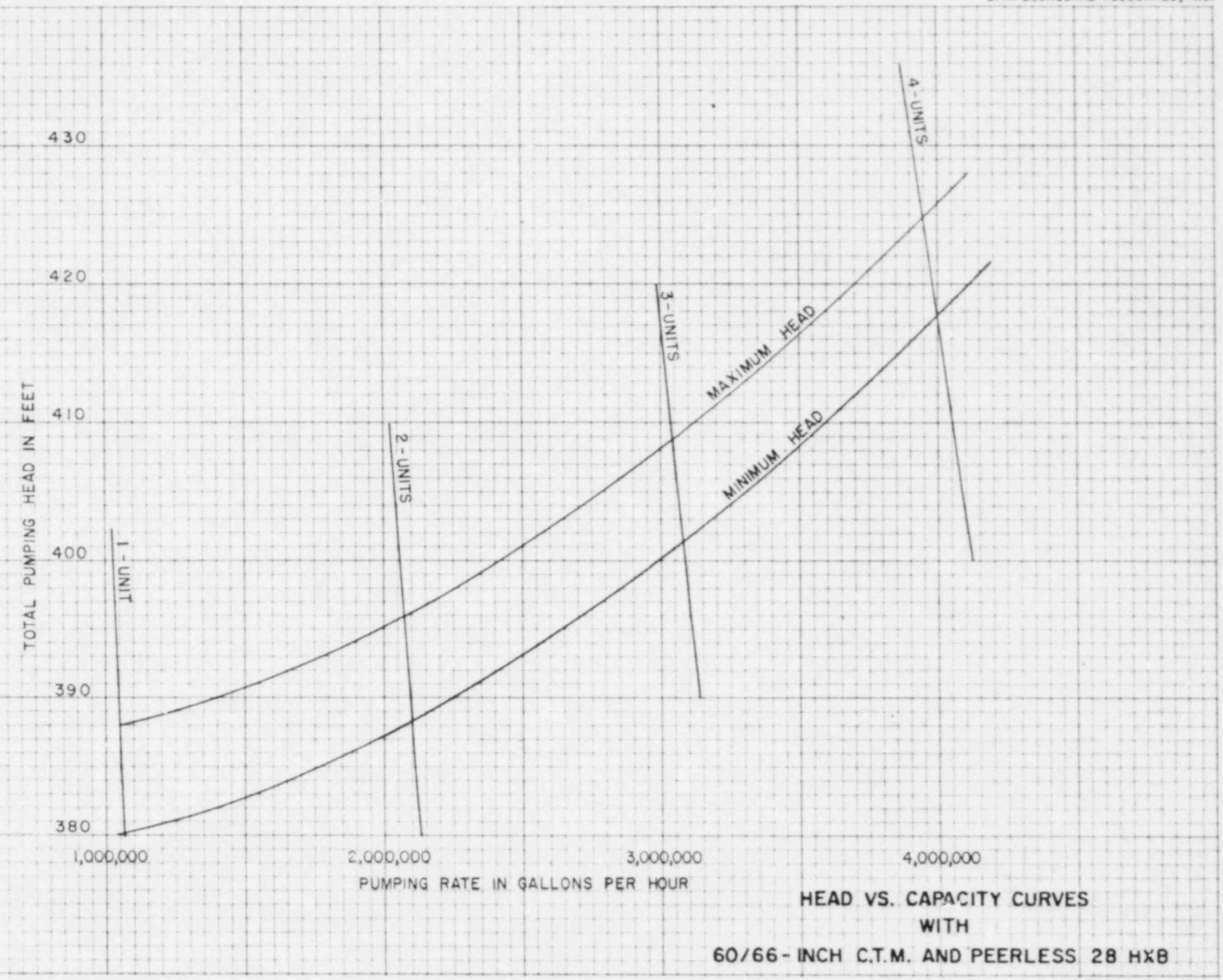
50 0 50

SCALE IN FEET

JAN. 4, 1982

EXHIBIT NO. 15

E. H. BOURQUARD ASSOCIATES, INC.



HEAD VS. CAPACITY CURVES
WITH
60/66 - INCH C.T.M. AND PEERLESS 28 HX8

EXHIBIT NO. 16

Exhibit 2
Wescott
(Point Pleasant)

QUESTION E240.27

A. Please provide all velocity profiles that were taken under various flow conditions in the Delaware River along the centerline of the intake. Please provide a cross section profile of the bottom bathymetry across the entire width of the river at this point. Where velocity measurements exist across the entire width of the river, calculate the river discharge using the measurements and compare this value with the measured discharge at the Trenton gage.

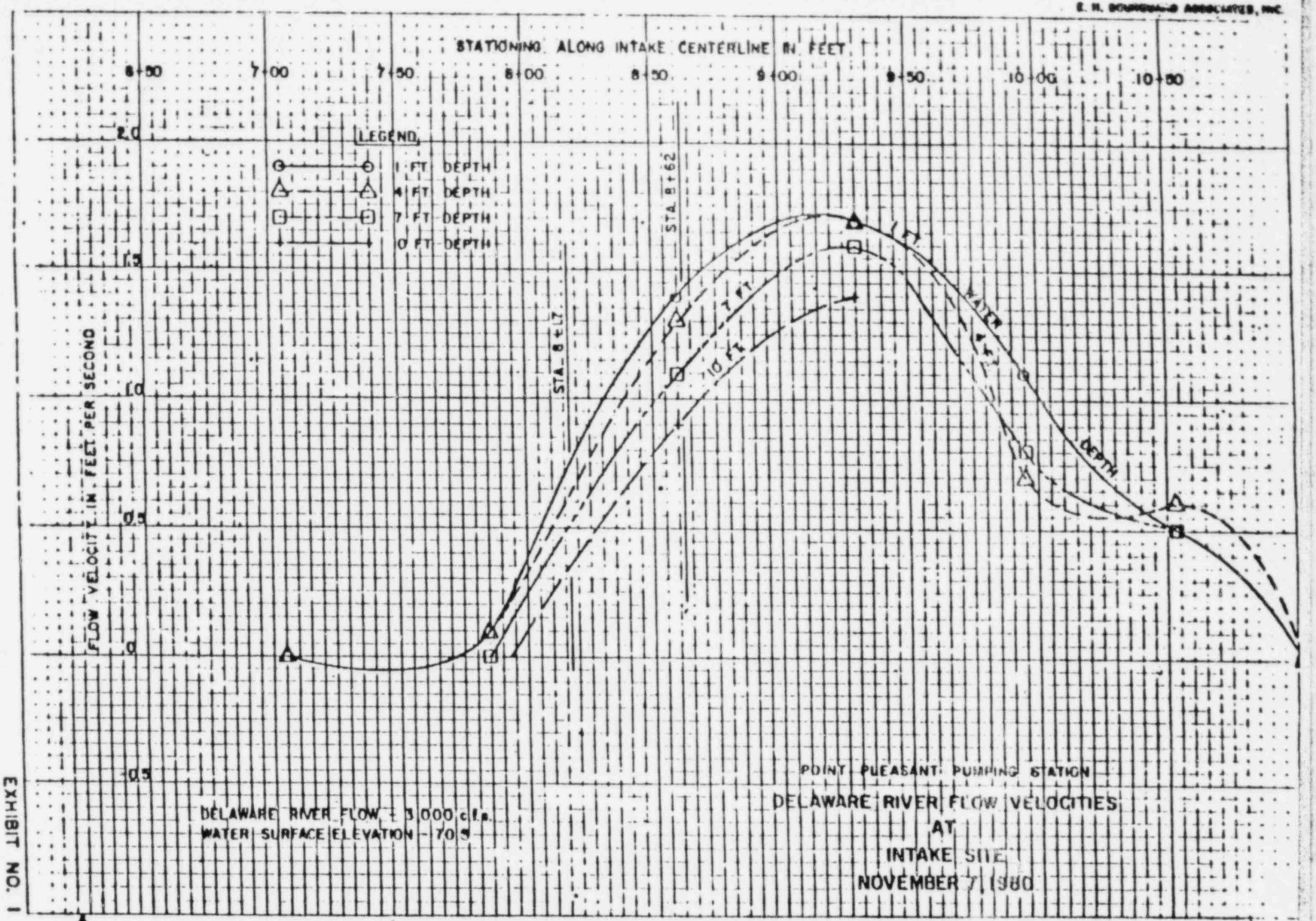
B. Provide a curve of velocity at the intake screen versus depth over the range of flows during which you plan to withdraw water showing measured velocities, as well as calculated velocities on this curve. Describe the assumptions and data used in your calculations.

RESPONSE

A. Two velocity profiles were taken in the Delaware River along the centerline of the intake. One profile was taken November 7, 1980, when the river flow was approximately 3000 cfs. Figure E240.27-1 is a plot of stationing along the intake centerline versus flow velocity at 4 different depths on this date. Profile number two was taken July 23, 1981, when the river flow was approximately 4500 cfs. Figure E240.27-2 is a plot of stationing along the intake centerline versus flow velocity at 4 depths on this date. A cross section of the Delaware River at the Point Pleasant intake is shown in Figure E240.27-4.

The November 7, 1980, velocity measurements were made for the full width of the river. The calculated discharge on this date was 2840 cfs. The measured flow at Trenton was 2950 cfs.

B. Figure E240.27-3 is a plot of measured velocity versus depth at the locations of the east and west screens on November 7, 1980, and July 23, 1981.



Above Line 6+25

FIGURE E 240.27-1

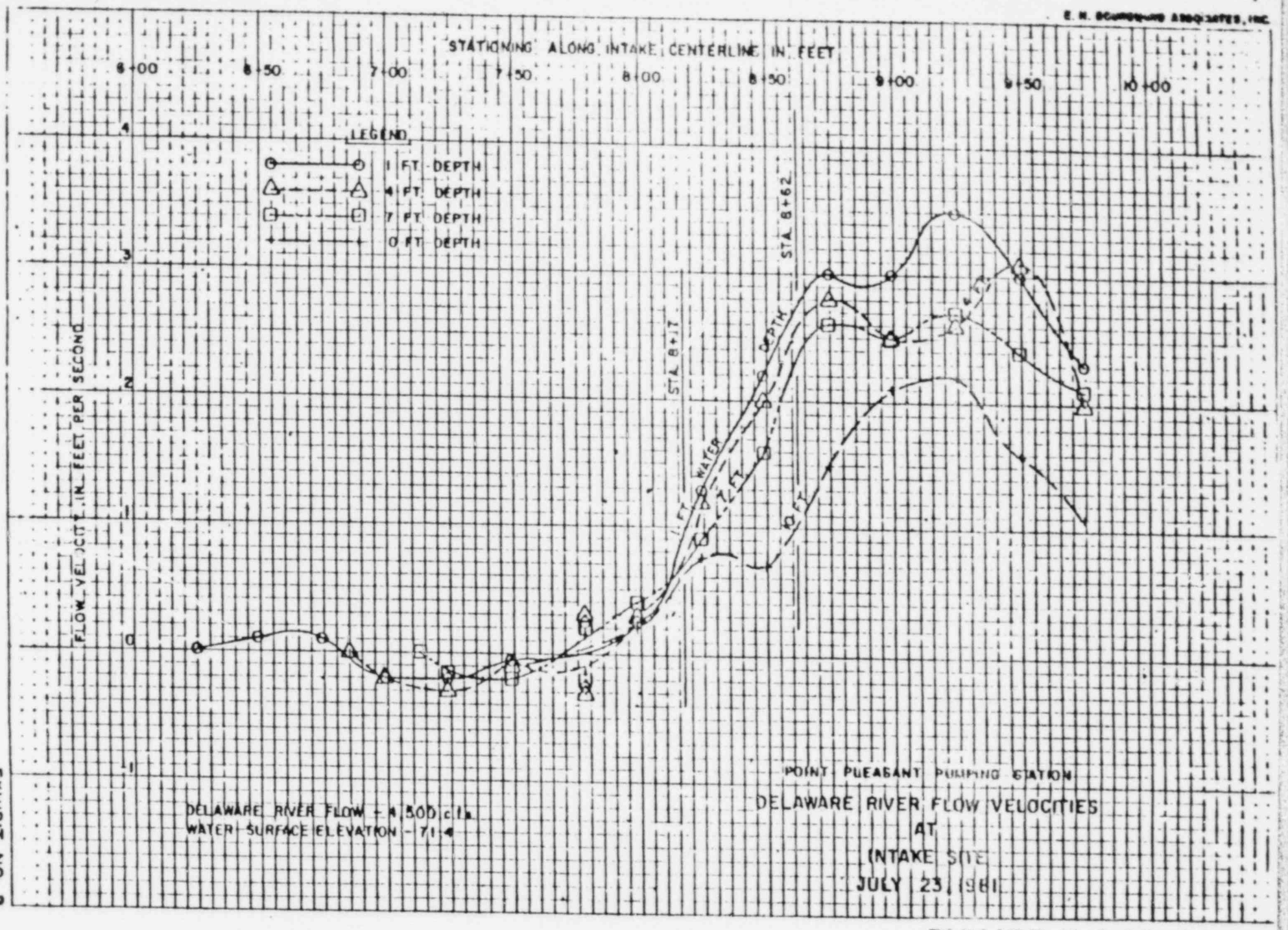


EXHIBIT NO. 2

FIGURE E 240.27-2

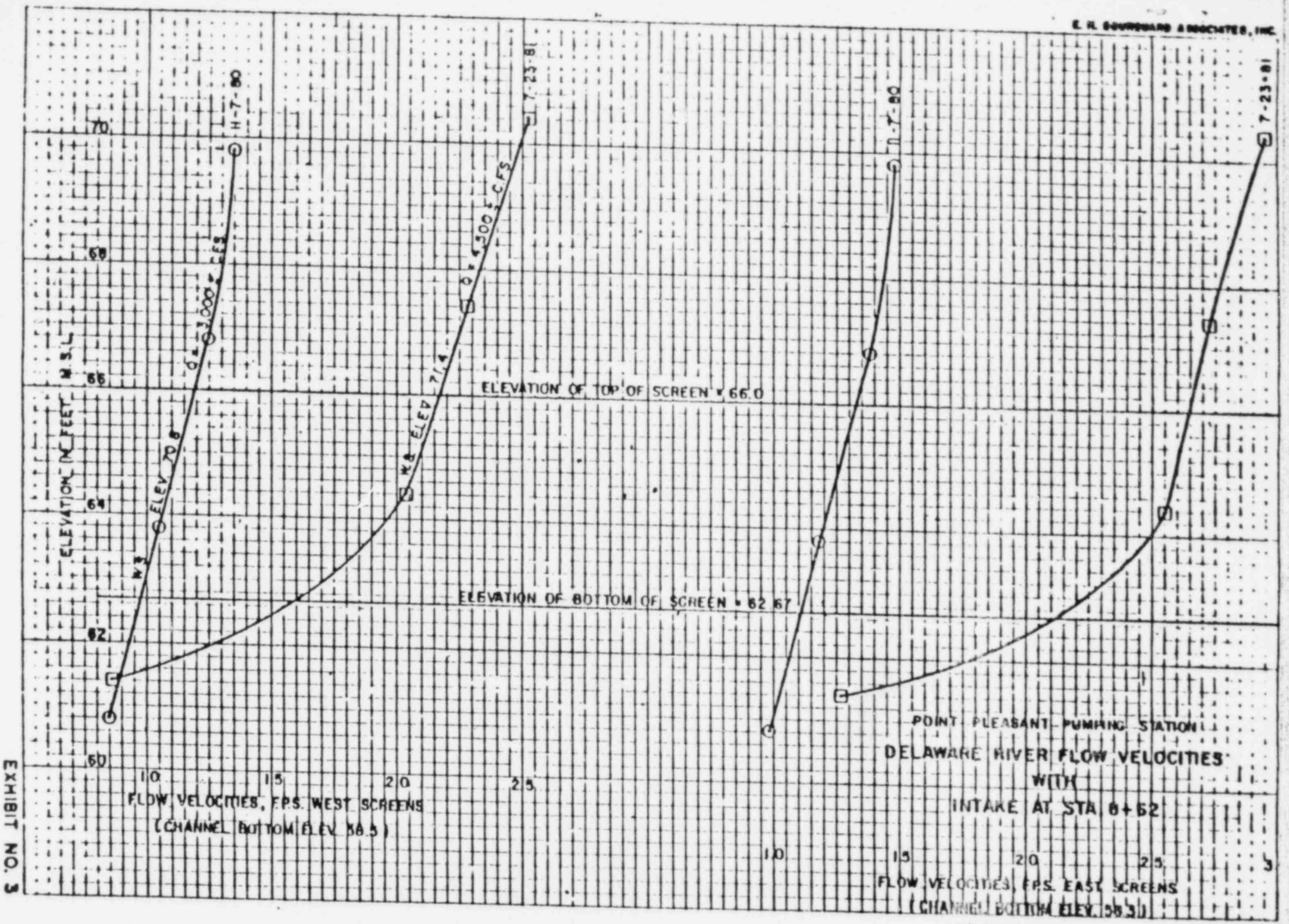


EXHIBIT NO. 3

FIGURE E 240.27-3