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MAXWELL HYDROELECTRIC PROJECT

FEASIBILITY ASSESSMENT REPORT

ALLEGHENY ELECTRIC COOPERATIVE

**HARRISBURG
PENNSYLVANIA**

R.W. BECK AND ASSOCIATES

ENGINEERS AND CONSULTANTS

PHOENIX, ARIZONA

SEATTLE, WASHINGTON

COLUMBUS, NEBRASKA

ORLANDO, FLORIDA

DENVER, COLORADO

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MARCH 1979

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R. W. BECK AND ASSOCIATES

ENGINEERS AND CONSULTANTS

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FILE NO. WW-6296-HG2-QA

March 14, 1979

3110

Mr. William F. Matson
Executive Vice President
and General Manager
Allegheny Electric Cooperative, Inc.
Post Office Box 1266
Harrisburg, Pennsylvania 17108

Dear Mr. Matson:

Subject: Maxwell Hydroelectric Project

We herewith submit the Feasibility Assessment Report describing our investigations and recommendations for the Maxwell Hydroelectric Project.

Our principal findings, conclusions and recommendations are set forth in the Summary of the Report. Details of the investigations, supporting data and conclusions are described in subsequent sections of the Report.

Respectfully submitted,

R. W. BECK AND ASSOCIATES

James V. Williamson
Partner and Assistant Manager
Western Design Office

CERTIFICATE OF ENGINEERS

ALLEGHENY ELECTRIC COOPERATIVE

HARRISBURG, PENNSYLVANIA

MAXWELL HYDROELECTRIC PROJECT

FEASIBILITY ASSESSMENT REPORT

The technical data and material contained in this report were prepared under the supervision and direction of the undersigned whose seals as professional engineers licensed to practice as such are affixed below.

A handwritten signature of Arthur T. Derby in cursive script.

Arthur T. Derby
Principal Engineer
R. W. Beck and Associates

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Richard Mascolo
Executive Engineer
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Principal Engineer
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FEASIBILITY ASSESSMENT REPORT
FOR THE
MAXWELL HYDROELECTRIC PROJECT

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SUMMARY

The report summarizes the results of a feasibility assessment study under a DOE grant for the Allegheny Electric Cooperative, Inc. of Harrisburg, Pennsylvania, to determine if it is economical to develop hydroelectric generation at the existing Maxwell Locks and Dam on the Monongahela River, which is a Corps of Engineer structure. The studies and investigations have included site reconnaissance, system loads, growth rate, site hydrology, conceptual project arrangements and layouts, power output, estimates of construction costs and annual costs, economic analyses, development of a design and construction schedule, and a preliminary environmental review of the proposed Maxwell Hydroelectric Project.

The Project is located in southwestern Pennsylvania about 30 miles south of Pittsburgh. The Monongahela River at this location is characterized by a 600-foot wide river in a valley about twice this width with rather precipitous banks of weathered sedimentary rocks rising 300 feet above the river.

The average annual discharge at the site is about 8,750 cfs. Upstream facilities regulating streamflow include Tygart Lake, operated by the Corps for flood control and low-flow augmentation, and Lake Lynn which is used by West Penn Power Company for peaking power.

The basic arrangement of the Project will consist of an intake structure, covered canal and powerhouse, located on the east side of the existing Maxwell Locks and Dam, and a mile long transmission line to connect to an existing line. Preliminary indications are that the most economic arrangement of the powerhouse will include four vertical units of 2-MW each in a modified open flume setting, located on the east side of the existing Maxwell Locks and Dam, which provides a normal differential head of 19.5 feet. The site is severely constricted between the dam abutment and the rail-

road on a cut bench of the riverbank about 60 feet above the stream-bed. In addition to constricting the plant arrangement, these physical constraints and high flood stages result in relatively expensive excavation and dewatering methods.

After deducting the water required for lock operation and gate leakage, power operation studies indicate that the 8,000 kW Project can develop average annual energy of 35.9 million kWh and an average annual capacity of 4,914 kW, delivered at the load center.

For the scheduled on-line date of January 1985, the Project is estimated to have a Total Investment Cost of \$17,801,000 assuming REA financing at 7% interest rate, equal to \$2,225/kW installed. The 7% rate is not available from REA at this time but is considered a possibility in the future. With normal REA financing at 9% the Total Investment Cost is estimated to be \$18,134,000. With a loan under the new National Energy Act administered by DOE, at 7-1/8% interest on 75% of the Project cost, and additional financing under REA conditions at 9% on the balance, the estimated Total Investment Cost is \$17,899,000.

Economic feasibility was studied by comparison of the project estimated cost with the projected cost of continued power purchases equal to the power output of the Project, with financing from loans from three alternative sources. The financing alternatives are 7% and 9% interest rate REA loans, and financing under the National Energy Act, referred to here as 7-1/8% DOE financing. With the best financing alternative (7%, REA) the Project's benefit-cost ratio during the first year is only 0.88. However, with costs based on REA financing at 7%, and benefits based on the projected power rates of West Penn Power Company, benefits begin to exceed the costs during the fifth year of operation and the accumulated present-worth (1985 level) becomes positive during the tenth year of the anticipated 50-year Project life. With the alternative of 9% REA and 7-1/8%-9% DOE financing, the accumulated present worth values

show that the Project benefits are less than the costs which indicates lack of viability.

The Project is considered technically feasible and without any major environmental issues. It shows economic feasibility providing satisfactory financing terms are available. Such satisfactory financing alternatives include a 7% REA loan or DOE financing under the new National Energy Act with the 25% portion for construction not covered being financed with 7% or lower interest loans (possibly through REA). The 7% rate can also be considered as a combination 5% and 9% financing should the REA deem the project deserving of low interest money. In addition, application should be made to DOE for demonstration grant funds. It should be noted that the feasibility of the Project will be jeopardized if not eliminated should Federal dam-user fees be charged.

If satisfactory construction financing arrangements can be arrived at, it is considered that an application should be made to DOE under the new Energy Act for a 90% loan for the cost of feasibility studies and preparing a License Application. A Preliminary Permit Application to FERC should be made to establish priority on the site.

SECTION I

INTRODUCTION

1. DOE PROPOSAL AND GRANT

In March 1978 Allegheny Electric Cooperative Inc. of Harrisburg, Pennsylvania (Allegheny), submitted a proposal to the Department of Energy (DOE) for financial support to study the feasibility of installing hydroelectric power at the existing Maxwell Locks and Dam. This navigation structure is owned and operated by the Corps of Engineers. It is located on the Monongahela River about 30 miles south of Pittsburgh.

The Allegheny proposal was in response to a DOE Program Research and Development Announcement (PRDA-78-D-07-1706). The objective of the program is to encourage private and non-Federal public sectors to accelerate the development of low-head hydroelectric resources. This particular phase of the DOE program was directed towards developing small hydroelectric plants, between 50 kW and 15,000 kW, at existing dams, with heads not exceeding 20 meters. Eventually some 54 studies were supported under this program.

The proposal to study the feasibility of developing about 13,500 kW at Maxwell Dam, which has a nominal navigation lift of 19.5 feet, was reviewed favorably by a committee of the Idaho Operations Office of DOE and qualified for a grant. Accordingly, Cooperative Agreement No. EW-78-F-07-1813 was concluded between DOE and Allegheny, and R. W. Beck and Associates (Beck) was retained by Allegheny under an Agreement for Engineering Services to assess the preliminary feasibility of this project.

2. AUTHORIZATION

The work presented in this report was defined by an Agreement for Engineering Services dated September 15, 1978. The Agreement was approved by the Allegheny Electric Cooperative, Inc. (Allegheny) on September 27, 1978.

3. SCOPE OF SERVICES

The Scope of Work was planned to provide engineering services to determine the preliminary feasibility of developing hydroelectric power at the existing Maxwell Locks and Dam on the Monongahela River. This proposed development is referred to as the Maxwell Hydroelectric Project (Project). The scope includes the following specific services:

- a. Expected configuration and capacity of the hydropower facility.
- b. Estimated performance characteristics of the hydroelectric power facility including the potential for peak power production and an estimate of average annual energy production.
- c. Expected impact of the hydropower installation on other known water resource needs of the area and the current use of the reservoir.
- d. Marketing potential of the power produced.
- e. Information made available to the Consulting Engineer relating to necessary requirements of the Federal Energy Regulatory Commission, (FERC) the U. S. Army Corps of Engineers (Corps), and other appropriate Federal, State, regional and local agencies.

f. Estimated capital investment per installed kilowatt and total estimated cost per kWh.

g. Anticipated annual operation and maintenance costs.

h. Anticipated project life.

i. An initial assessment of the environmental impact and socioeconomic and institutional factors.

j. An initial assessment of the safety hazard, if any, introduced by the addition of rehabilitation of a power plant and other hydropower appurtenances.

k. Appropriate analyses and recommendations as to the engineering acceptability of the proposed site for hydroelectric power development.

l. Investigation of the availability of suitable turbine(s), generator(s), and accessories required for the proposed hydroelectric power development.

m. Development plan (schedule) for putting power on line.

n. Furnishing technical data to the Client to support reports required by the Cooperative Agreement to be submitted to DOE by the Client.

4. BACKGROUND TO PRESENT STUDY

Within the last few years a national shortage of natural gas, fuel oil and the better grades of coal has occurred and is expected to continue. The decreased supply of fuel for thermal

generation was accompanied by significant increases in the costs of this fuel, and hence of power generated by facilities which use these depletable resources. Most recently the impending cost of oil is transended by the prospect being unable to obtain oil.

The current Federal support for the development of low-head hydroelectric power recognizes this as a clean, safe and renewable resource. Clean air is particularly important in this highly industrialized region near Pittsburgh. Hydroelectric power is not subject to substantial inflation of costs, since the major portion of the annual operating cost is debt service which is a sunk cost and will not change during the project life.

SECTION II

SITE CONDITIONS

1. GENERAL

The general area, surface conditions and existing facilities at the site were observed and are regarded to be appropriate for the proposed development. The general location of the proposed Maxwell Hydroelectric Project is shown in Fig. 1. Fig. 2. shows the area in more detail. Special aspects of the study which received attention included the existing locks and dam operation, foundation conditions and the Conrail Railroad at the left abutment.

2. CLIMATE

The Allegheny plateau in western Pennsylvania and northern Virginia, which includes the Monongahela River, is considered to have a humid continental type of climate. With prevailing winds primarily from the west the Atlantic Ocean exerts little influence on the climate of the region. In the vicinity of the Project the average annual precipitation is about 40 inches including about 35 inches of snowfall. This precipitation is well distributed through the year with a slight increase during the late spring and early summer months. Due to the orographic affect of the Allegheny Mountains the normal annual precipitation in the upper basin is about 50 inches including 100 inches of snowfall. The greatest recorded rainfall in 24 hours at Pittsburgh was 3.56 inches in 1954.

At the Project the temperature has varied from a low of minus 20° Fahrenheit in the winter to a maximum of over 100° F in the summer. The normal daily averages vary from about 13° F in the winter to about 70° F in the summer. Both the Monongahela River and the upper lakes are said to be subject to freezing for periods exceeding one month during the winter.

Extreme wind speeds are generally associated with the severe thunder storms, cold front passages, or intense large scale cyclonic activity. Wind speeds up to 73 mph have been reported at Pittsburgh.

3. TOPOGRAPHY

The Monongahela River basin is characterized by rolling, wooded hills and scattered farms and the lower basin within Pennsylvania but the topography becomes rough in the upper basin and extends south about 90 miles into West Virginia. From the headwaters in the Allegheny Mountains with a maximum elevation of 4,842 feet the tributaries drop sharply down the main stem of the Monongahela River. From elevation 857 at the confluence of the Tygart River in West Virginia the main stem drops 94 feet in the 70 miles down to the Project. From the Project the Monongahela River drops another 52 feet in the last 60 miles down to its confluence with the Allegheny River at Pittsburgh.

In the vicinity of the Project the river is in a well defined valley having rather precipitous sides which rise about 300 feet above the valley floor. Although the valley floor is occasionally 1,500 feet wide the river is only 500 to 700 feet wide and 10 to 25 feet deep with the navigation pools.

4. GEOLOGY

The main stem of the Monongahela River, and most of its drainage basin, is located in the Kanawha section of the Appalachian Plateau physiographic province. The rocks in the Project area are of sedimentary origin and are comprised primarily of sandstone, siltstone and of claystones and in generally horizontal layers in addition to organic rocks such as limestone and coal.

Overburden is limited to the residual soils of weathered rock in addition to some colluvium and alluvial deposits in the floodplains. This area is well south of the glacial front and is thus without glacial deposits.

At the Maxwell site the locks are located in the edge of the broad floodplain on the right bank, more than 600 feet from the base of the right wall of the valley. At the abutment the left wall of the valley rises 300 feet steeply behind the Conrail Railroad. Bedrock is exposed in this bluff above the tracks. The Pittsburgh coal was mined at the upper end of the town of Maxwell and across the river at the abutment.

As reported by the Corps on geology at the site the overburden in the streambed is a brown variably silty sand or gravel about 15 feet thick, capped locally with 3 to 6 feet of organic silt. Beneath the floodplain on the right bank the alluvium has two persistent layers: brown sandy clay on top and variably silty sand gravel on the bottom resting on the weathered surface of bedrock. On the left side of the river in the abutment area, the upper layer of the natural overburden is a colluvial lean to sandy clay with shale and sandstone fragments, and in the vicinity of the Pittsburgh coal horizon, some coal fragments.

Bedrock at the Maxwell site is a typical upper Conemaugh, somewhat cyclic series of shales, indurated clays, siltstones, thin limestones, coal and traces of bone. The upper part of the abutment area is basal Monongahela represented by the Pittsburgh sandstone and the roof shales of the Pittsburgh coal. The remainder of the section is upper Conemaugh from the top of the Pittsburgh coal down to the bottom of the deepest boring. This zone is not marked by readily recognizable key beds and only two strata seem reasonably subject to identification. The limestone beds beneath the Pittsburgh coal and occurring as far down as approximate elevation 710, belong under the general heading of Pittsburgh limestone.

The underlying persistent silt shale and its thin cap of sandstone and apparently equivalent sandstone should be designated as Connellsville member.

Weathering is shallow in bedrock beneath the dam and locks with a maximum of about 26 feet in the abutment area and 12 feet in the lock area where the cap rock limestone has not protected the immediately underlying indurated clay. Elsewhere disintegration is less than 5 feet deep except for scattered stained fractures and bedding planes.

The Maxwell site lies on a bench on the southeastern flank of the Belle Vernon anticline. This structure strikes northeastward, a few degrees north of the axis of the dam, by the attitude of these strata is not concordant with the anticline, being controlled by a tranversed bulge on the side of anticline.

The dam and lock walls are founded in bedrock at or below the firm rock line. In general, the foundation rock is the sound unweathered silt shale of the Connellsville member. This is a typical average Pennsylvanian shale of the Allegheny Plateau area, quite adequate for these structures. Toward the lower end of the lock walls the foundations are stepped up over the next higher indurated clay to its cap rock limestone, a normal procedure in this suite of rocks. The toe of the abutment wall is founded on the sandstone which caps the Connellsville member, and the heel of the wall is stepped over the overlying indurated clay to be founded on the 5 to 7 feet thick bed of hard gray sandy siltstone which overlies the indurated clay. This takes advantage of the rise in the firm rock line with consequent reduction in cost of this structure.

A reconnaissance was made of the site on December 7, 1978, in company with Consulting Engineering Geologist, Kim de Rubertis. The purpose of the inspection was to note conditions which could affect feasibility of the proposed Project features and to provide data for preliminary cost estimates. The Consultant's report is included in Appendix A.

SECTION III

EXISTING DAM

1. GENERAL

The existing Maxwell Locks and Dam is located on the Monongahela River near Vestaburg, about 30 miles south of Pittsburgh as indicated in Fig. 1. It is one of nine river navigation facilities owned and operated by the Army Corps of Engineers on the main stem of the river.

The dam, a non-navigable high-lift gate structure, is located approximately halfway between old Locks and Dam, 5 and 6, which it replaced in 1965. The pool extends upstream to Locks and Dam 7 at Greensboro. Fig. 3 shows the general layout of the locks and dam facility and the Project location.

2. LOCKS

The two existing navigation locks are located on the right bank of the Monongahela River. The lock chambers are each 84 feet wide by 720 feet long. There are two pairs of service gates of the mitering type, which are hydraulically operated in each lock. Two bulkhead sections are provided at the upstream end of the locks for emergency closure to preclude the possibility of losing the navigation pool in the event of an accident.

As shown in Table IV-2, there are approximately 7,800 lockages per year and two out of three lockages require filling a chamber at Maxwell. Filling and emptying of the chambers is accomplished with a system of culverts within the walls of the locks which are controlled by reverse tainter valves.

3. DAM AND SPILLWAY

The dam is a concrete broad-crested weir structure with an overall length of 460 feet divided into five bays each with fixed-trunnion, radial type gates of which there are two single leaf gates and three double leaf gates. Each gate is 84 feet wide and is raised and lowered by means of individual electric hoists.

A service bridge, at El 818.5 spans from the landward lock wall pier to the left abutment pier. It carries a concrete deck, walkways, and a travelling bulkhead-hoist.

All of the concrete structures are founded on rock from 15 to 35 feet below the gate sills on the dam surface which are at El 737. In the direction of flow the width of the concrete dam and spillway apron are about 60 and 32 feet, respectively. Derrick stone and rock spalls are provided downstream to prevent erosion of the variously weathered, soft rock gravel in the streambed.

The construction drawings indicate the "Project Flood" at El 776.5 and this is the top elevation of the closure wall at the left abutment between Pier No. 6 and the railroad.

4. UPPER AND LOWER POOLS

The upper pool level is controlled by the five crest gates located at the spillway of the dam. The normal upper pool elevation of the facility is 763 feet, and never drops below this except with some malfunction of the river control system.

The lower pool has a minimum elevation of 743.5 but rises with the streamflow as shown in Fig. 4. With minimum streamflow, a 19.5-ft. differential head is developed across the dam but this decreases to about 1 foot with flows in excess of 90,000 cfs.

SECTION IV

HYDROLOGY

1. GENERAL

The project drainage area encompasses two thirds of the total Monongahela River drainage basin. The basin is located in western Pennsylvania, and northwestern Maryland and West Virginia and is oriented in a north-south direction. The project drainage area is 4,990 sq. mile and is characterized by rough terrain particularly in the head waters which lie in the Allegheny Mountains. Two reservoirs, Tygart River Lake on the Tygart River and Lake Lynn on the Cheat River, are in the basin.

2. STREAMFLOW

Streamflow at the Project was estimated from the records of USGS gage #03075000 which is 15 miles downstream at Charleroi. These records, from 1934 to 1972, were multiplied by 0.978, a proportion of the drainage areas, to arrive at the approximate streamflow at the Project.

The average annual streamflow of the Monongahela River at the site for the 43 year of record is 8,769 cfs with maximum and minimum average annual flows of 14,118 cfs and 5,570 cfs, respectively.

The monthly streamflows at the Charleroi gage from 1934 to 1972 is shown in Table IV-1. This 39 year period was used for the power study to correspond with a flow-duration curve of daily flows which was available for this period. These gaged flows were then adjusted to account for the different drainage area at the Project location, and for lockage and leakage, as discussed below. The resultant flows available for power generation, monthly and daily, are shown in Section VII, and are plotted in Fig. 4 as flow-duration curves.

3. FLOODS

The highest flows generally occur during the months of December through April when soils are already saturated or frozen and most conducive to high runoff. However, it is possible for major floods lasting several days to occur at any time of the year. Most of the floods during the winter/early spring period are the results of heavy, prolonged rainfall over large areas sometimes accompanied by snowmelt. Summer floods generally result from intense thunderstorm rainfall which may be very local in extent, and which is more likely to occur in the smaller tributary drainages.

The flood of maximum record is 158,000 cfs. As estimated by the Corps the 1 in 1, 10 and 100-year return frequency floods are estimated to be 80,000, 132,000 and 178,000 cfs respectively. Corps personnel have indicated the Standard Project Flood to be 213,500 cfs at stage El 780. The "as-built" drawings of the dam indicate the "Project Flood" to be at El 776.5 which corresponds to a flood of about 183,000 cfs and a 140 year return frequency.

The addition of the hydroelectric project will not affect the ability of the existing structure to pass major floods. Under PMF conditions the headwater and tailwater levels will be close to the same, since the dam offers little impedance to the flow.

4. UPSTREAM REGULATION

There are two major reservoirs currently in operation upstream of the Project and two additional reservoirs are authorized. The existing reservoirs are Tygart River Lake and Lake Lynn.

Tygart River Lake has a capacity of 288,000 acre-feet and is located on the Tygart River 89 miles upstream from the Project. It is owned and operated by the Corps for flood control,

recreation and low-flow augmentation for water quality and navigation. When flow releases are made from Tygart River Lake they are continuous but the occurrence and duration are not predictable.

Lake Lynn is located at the mouth of the Cheat River, 28 miles upstream of the Project. It is owned and operated by West Pennsylvania Power Company. The reservoir has an active capacity of 20,000 acre-feet and is operated primarily to produce peak load power. On the average, flow from the Cheat River constitutes about 25% of the flow at the Project site. If the Lake Lynn Plant is operating for 8 hours and is shut down and stores water for 16 hours a day, then the flow at the Project site will be 75% of the average for 16 hours and 150% of the average for the 8-hour peaking period. This increase is flows resulting from peaking power production at the Lake Lynn Plant. Almost 40% of the time flows would have to be spilled as the capacity of the proposed 8-MW Project is exceeded as Fig. 4 indicates.

5. WATER AVAILABLE FOR POWER

Some streamflow is not available for power generation due to operation of the locks and dam. Past records at Maxwell indicate that for every 3 lockages a chamber is filled twice. Table IV-2 shows an average of 7,700 lockages annually. Using peak usage months for analysis it is estimated that an average of 220 cfs of streamflow is required for operation of the locks. The Corps did a study on the leakage of the dam gates, and concluded that approximately 350 cfs is lost from the upper pool due to leakage.

Thus considering past experience at Maxwell, 570 cfs of streamflow is considered not available for power generation due to lockage and leakage losses. There is no indication that this situation will change in the future; therefore, 570 cfs is subtracted from streamflow for the purpose of computing the available discharge for power generation as shown in Fig. 4.

MAXWELL HYDROELECTRIC PROJECT
AVERAGE MONTHLY RUNOFF AT CHARLEROI GAGE IN CFS

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVG
1934	14230	3210	20510	10220	3015	1345	1337	2172	911	1430	3905	6076	5696
1935	16270	12110	18880	12730	17260	5541	3244	11000	5401	1328	5260	9948	9914
1936	17890	19900	34710	15170	3124	1009	4296	1501	581	2085	5380	10390	9668
1937	37460	13500	11240	14780	11480	7168	2799	3671	3813	13640	6513	11610	11491
1938	8130	15110	15100	10970	14490	8485	4002	2751	1336	869	2498	5965	7475
1939	8770	31000	16740	21140	2951	7438	7471	2280	1098	1024	1853	4230	8903
1940	3233	16280	15690	26500	9112	12290	6184	2524	3127	1960	8255	2616	9480
1941	10901	4347	10270	7609	2791	13890	5829	5071	3800	1513	4557	6001	6381
1942	6276	11790	15070	9435	8783	4352	3331	12330	5334	8988	14750	21170	10125
1943	19230	17160	17150	13610	10540	3651	6152	6503	1941	754	3735	2720	8595
1944	7793	12100	25230	17450	10540	7576	1622	937	1068	8263	4490	18370	9603
1945	17760	20920	29030	9070	11310	5999	2319	4926	13300	4128	13820	11280	11989
1946	12000	12810	12440	4786	11640	12430	2651	1311	622	392	1425	5075	6515
1947	16050	5849	13160	7370	8487	6949	4321	3797	2842	304	4166	4752	6553
1948	10910	20480	17490	22370	12280	7222	9883	5995	3265	2705	6210	22570	11773
1949	22400	20520	12770	10090	4522	2430	4513	3159	1337	1399	6715	15490	8820
1950	20370	25780	20740	9493	10610	12780	5449	2044	7022	3513	10750	21270	12485
1951	19150	23020	15350	18860	9811	13710	5225	1252	1227	668	5592	15050	10742
1952	26960	11160	15430	13490	14510	2727	1865	2012	827	843	1291	5682	8072
1953	16790	13900	14620	14470	11330	1578	1590	1783	713	475	400	2052	6641
1954	8256	4842	15160	7948	5018	3694	3459	9218	2610	15180	6550	13680	7984
1955	10230	22540	28730	6917	4736	4317	1699	4099	933	1424	3031	4304	7813
1956	6345	33110	23780	13680	16440	13580	8616	17890	4106	2544	4237	20290	13737
1957	17900	25210	10280	14240	3296	2408	2202	812	867	2569	3577	17600	6413
1958	11550	10730	13160	16290	17940	4227	13570	13900	2445	2019	4099	5495	9618
1959	15740	16260	10720	12220	7636	3039	1392	1639	1068	2313	6183	13930	7670
1960	16400	11760	10960	17270	9320	3421	1801	3044	4797	2271	5255	4040	7528
1961	7369	19910	27600	19780	10390	12040	5452	6258	1821	2872	2184	12490	11231
1962	15260	14630	23300	17520	3062	4447	1539	978	984	2829	13280	7773	8800
1963	9874	9159	41930	4868	4410	8618	2145	3092	2211	837	3699	6163	8084
1964	11980	6942	24050	17070	3865	4111	2032	1690	1046	2014	3142	13160	7608
1965	17290	10970	17140	19620	3603	1125	1049	813	1072	1205	1454	1991	6451
1966	5845	18720	9492	13550	11990	1414	915	1451	2301	3494	3478	9142	6249
1967	4662	9417	38970	9588	24980	2777	3101	2634	1961	3967	5981	12050	10008
1968	10300	8760	16470	9181	18440	6929	997	2305	1124	1354	6680	8394	7544
1969	9358	9372	6675	11940	6851	1461	5867	5598	2266	2085	4181	11220	6406
1970	14399	15690	14690	22450	3878	2849	2984	2965	2130	2409	6223	16740	9155
1971	16763	23090	13440	4478	12230	3510	1659	3850	12730	2843	5561	12930	9449
1972	17109	20210	24580	23560	10510	13730	9133	3022	1398	4586	15230	29760	14436
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AVG.	13851	15442	18531	13612	9414	6054	3951	4166	2756	3025	5763	11030	8967

MAXWELL HYDROELECTRIC PROJECT

RECORDED LOCKAGES

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug</u>	<u>Sept</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>
1968	663	587	730	652	686	699	828	877	760	478	563	566
1969	631	554	574	617	723	750	638	715	687	688	591	603
1970	641	649	703	631	822	771	776	961	808	739	601	632
1971	607	638	648	590	736	705	743	836	641	215	213	555
1972	566	514	600	582	724	620	741	859	667	569	519	510
1973	494	508	547	549	668	760	826	948	762	626	482	515
1974	572	517	627	595	718	727	959	944	705	668	257	301
1975	575	503	571	595	723	848	888	914	642	631	512	515
1976	531	533	609	573	685	818	790	712	733	607	536	549
<u>1977</u>	<u>437</u>	<u>495</u>	<u>649</u>	<u>605</u>	<u>774</u>	<u>798</u>	<u>776</u>	<u>678</u>	<u>746</u>	<u>578</u>	<u>546</u>	<u>183</u>
Avg	572	550	626	599	726	750	797	844	715	580	482	493

Avg. Annual Lockages 7,734

SECTION V

SYSTEM LOADS AND RESOURCES

1. GENERAL

Allegheny Electric Cooperative, Inc. is a nonprofit wholesaler of electric power incorporated under the laws of the Commonwealth of Pennsylvania in 1946. Allegheny has 14 member distribution rural electric cooperatives; 13 in central and northern Pennsylvania and one in western New Jersey. The load is entirely rural since under State law these cooperatives are limited to servicing areas outside of communities with populations of 2,500 or greater. Allegheny now supplies about 150,000 rural families through some 23,000 miles of distribution line. The service area of the 14 Pennsylvania Rural Electric Cooperatives served by Allegheny is shown in Fig. 8.

2. SYSTEM LOADS AND GROWTH

From 1970 through 1977, Allegheny's average growth rate for peak demand and energy has been at about 9% and 8% respectively. Future load growth is expected at a somewhat reduced rate approximately as shown in Fig. 8. The 1978 peak and energy were below earlier forecast values which is consistent with the national trend of reduced growth rate. By 1985, about the earliest date that the Project could be on the line, the peak demand is expected to be about 685 MW and energy consumption about 2,650 GWH. The annual load factor is expected to remain at about 48%.

3. RESOURCES

All of Allegheny's present power requirements are supplied through purchases from the Power Authority of the State of New York (PASNY) (Niagara Hydro), Pennsylvania Electric Company

(Penelec), Metropolitan Edison Company (Met. Ed.), Jersey Central Power and Light Company (Jersey Central) and West Penn Power Company (West Penn.).

Allegheny is presently in a transition stage having acquired a 10% ownership share (210 MW) of the Pennsylvania Power and Light Company's (PP & L) Susquehanna Steam Electric Station. When Unit No. 1 of this plant comes on line, possibly in late 1980, Allegheny will have become a Generation and Transmission Cooperative. Allegheny is presently negotiating with West Penn. of the Allegheny Power System (APS) for a 7.2% (90 MW) ownership share of the Pleasants Steam Electric Plant which may be on line this year. Negotiations are also underway with Jersey Central of the General Public Utilities System (GPU) for a small share of the Forked River Nuclear Unit.

Allegheny is also considering the possibility of constructing 2-600 MW coal fired units under its own name although such a program would almost certainly be developed by shared ownership. The Cooperative has a favorable report on this course of action dated February 1978 from the Sourthern Engineering Company of Atlanta, Georgia.

One factor that will bear decisively on Allegheny's future expansion plans is the ultimate outcome with regards to the renewal of the contract with PASNY for a 110 MW block of low-cost firm hydro power. This is by far the lowest cost power available from any source to the Cooperative. New York is refusing contract renewal as a reaction to a recent Pennsylvania State Tax on power exported from the Commonwealth.

It is considered reasonable in assessing the viability of the Maxwell Hydroelectric Project, to base the feasibility on displacement of power purchases over the first ten years of operation, rather than generic alternatives. Since the Project is in the West Penn service area, it is this power which is considered displaced.

SECTION VI

PROJECT ARRANGEMENT

1. GENERAL

The proposed arrangement for the Maxwell Hydroelectric Project includes a powerhouse with four vertical units of 2-MW each together with appurtenant facilities as shown in Fig. 7. An alternative arrangement with a single 8-MW tube (non-standard) unit was also considered, and the arrangement is shown in Fig. 6.

The Project will be situated at the left (east) bank of the river between the abutment Pier No. 6 of the existing Maxwell Locks and Dam and the Conrail railroad. The Project is arranged and planned to operate so that it will not interfere or significantly alter existing conditions or operations. With the assistance and data received from personnel of the Pittsburgh District Office of the Corps of Engineers, the general arrangement proposed is considered to be reasonably acceptable to both the Corps and to Conrail. However, if the Project proceeds to the next stage of investigations, detailed discussions and negotiations will be required before final agreement is reached.

2. PHYSICAL CONSTRAINTS

This site imposes several major physical constraints on the alignment and capacity of the proposed arrangement. In addition to the hydrologic, topographic, and geologic conditions at the site, these constraints include the shape and depth of the existing Pier No. 6 and the elevation and proximity of the railroad. Relocation of the railroad or alteration of the dam is quite beyond the economic capability of this Project.

With the railroad about 60 feet above the riverbed and about 100 feet from the riverface of the abutment the area is very restricted. The arrangement is further complicated by the necessity to locate a concrete box type water conveyance structure (power conduit) over the top of the massive abutment foundation. Also the weathered rock cut slopes require extensive rock anchors to stabilize the slope considering the deep excavation involved.

3. ALTERNATIVE ARRANGEMENTS

a. Type of Units

The proposed arrangement contemplates four 2-MW vertically mounted propeller turbines with a modified open, flume setting. This was compared economically with a single 8-MW inclined tube unit alternative as shown in Fig. 6. Other alternative arrangements considered include bulb and straflo units as well as small standardized tube units. The single tube unit appears to be the most practical alternative but the estimated cost is in excess of the proposed vertical units as shown in Table VI-1.

The physical constraints of this site generally precluded other alternatives by the depth or width required for the powerhouse. The cost of an arrangement with 4 standard tube units of 2-MW each appears to be competitive with the vertical unit arrangement but the powerhouse would extend into the river below the dam spillway exposing the powerhouse to flood flows up to 12 fps and flows up to 30 fps if spillway gate No. 5 were opened without the high tailwater from flood flows. Hence this is not a practical arrangement, and the vertical unit concept is proposed for the later economic analyses.

b. Size of Plant

Comparative analyses were made of the benefit versus cost of various size installations. It is found, however, that

the value of capacity is not high enough to justify increasing the size of the plant, and the increase in available energy in so doing is inappreciable. On the contrary it does appear that reduction to a 6-MW installation could result in a slightly greater benefit to cost ratio, but the difference does not warrant a change at this stage. It appears that the 8-MW installation is close to optimum based on the power values used.

4. PROJECT FEATURES

a. Intake Structure and Power Conduit

An intake channel will be provided by excavating the riverbed to El 735. A retaining wall about 40 feet high will retain the backfill of the embankment for the access road at El 776.5 which is the same elevation as the top of the existing abutment cutoff wall, and is equivalent to the 1 in 100 year return frequency flood stage. In addition to the steel trashracks and stoplog slots for dewatering, the intake will include two slide gates with hydraulic cylinder hoists for startup, shutdown and emergency closures, and the necessary equipment for remote control. A mechanical rake is planned to clean the trashracks but emergency services would be provided by a mobile truck crane.

A concrete power conduit is provided over the abutment pier foundation to carry the maximum discharge of the plant of 6,500 cfs, at about 10 feet per second velocity. The switchyard will be located on backfill over the top of this conduit.

b. Powerhouse

An indoor type powerhouse with a steel-truss roof is planned along the left abutment below the dam. It will contain a service bay and four machine bays each with a vertical unit in a modified open flume setting with fixed-blade propeller runners operating under 17.3 feet rated head direct connected to an air

cooled generator. Synchronous speed will be 163 rpm and generator rating will be 2,500 kVA at 80% power factor. The plant will be automatic, operated by remote control, similar to the operation of the existing Lake Lynn Plant by West Penn Power Company from its office in Charleroi.

c. Tailrace

A tailrace with a width of 160 feet will provide a transition from the bottom of the draft tubes up to the riverbed at El 730. A single set of draft tube bulkheads to dewater one unit is planned to be serviced by a mobile truck crane.

d. Access Road

A permanent access road about 0.8 miles long as shown in Fig. 2, is planned to come down the left bank from the existing State highway No. 88. After dropping about 200 feet on an 8% to 10% grade the road will cross over the railroad on a concrete structure and extend down to the Project. This road will include a paved surface and guardrail where required. Although access from downstream appears to be shorter, the first 1,000 feet below the dam would require an expensive concrete structure and this route was therefore abandoned.

e. Power Transmission

The switchyard will contain one 3 phase transformer and a circuit breaker. A transmission line is planned to tie into the existing 25-kV system of the West Penn Power Company. It is apparent that the new lines would be about one mile long.

5. CONSTRUCTION METHODS

Due to the major commercial significance of the existing river navigation and railroad traffic as well as the large invest-

ment in the existing dam and spillway gates, project construction is predicated on the general principle of avoiding any interruption of existing operations as well as avoiding hazard to the structural integrity of existing facilities. With this principle a cellular cofferdam to El 775 is assumed to dewater the project area and the cutoff wall behind Pier No. 6 will be replaced by the intake structure during the late fall when the probability of major flooding is reduced. This schedule is estimated to ensure river control with a flood return frequency of about once in 10 years annually but during the critical periods of construction the frequency of flooding would be less than this. Additional precautions include a system of rock anchorage to ensure slope stability under the railroad.

Dewatering and construction is planned in two phases. After dewatering, construction will be completed in the intake area upstream, and then the cellular cofferdam will be re-used downstream to dewater the powerhouse area. For slope stability with the required excavation vertical rock anchors will be installed near the railroad and horizontal bolting will proceed with the excavation.

Although the proposed construction methods are generally conventional, the construction area will be severely restricted. Some subsurface exploration will be required for the foundation of the large cellular cofferdams as well as the anchorage required for slope stability.

MAXWELL HYDROELECTRIC PROJECT

COMPARATIVE COSTS OF ALTERNATIVES (1)

Item	Cost Estimate	
	Four 2 MW <u>Vertical Units</u>	One 8 MW <u>Tube Unit</u>
1. Preparatory Work.....	\$ 535,000	535,000
2. Cofferdams and Dewatering.....	1,153,000	1,153,000
3. Intake Channel.....	170,000	170,000
4. Power Conduit and Powerhouse Civil..	2,374,000	2,458,000
5. Powerhouse - Mechanical Equipment...	3,026,000	(7,148,000
6. Powerhouse - Electrical Equipment...	2,170,000	(
7. Transmission and Switchyard.....	<u>334,000</u>	<u>334,000</u>
DIRECT CONSTRUCTION COST.....	\$9,762,000	11,798,000

(1) Direct Construction Costs based on a 1/79 bid price level.

SECTION VII

PROJECT OPERATIONS AND POWER OUTPUT

1. GENERAL

Power output studies were performed using a mathematical model of Project operation. These studies were done for 39 years of average monthly flows (1934 through 1972) developed for the site from historical records (Table VII-2). Since flows in the Monongahela vary considerably during a month, energy generation estimates using monthly flows are misleading. For this reason the energy available from the Project is based on a daily flow duration curve which was developed by the State for this 39 year period of record. This power study concludes that with the proposed arrangement with four vertical units of 2-MW each, the Project will produce 36.8 million kWh of energy on an average annual basis at plant. The study further concludes that the average annual capacity of the Project is 5,119 kW.

2. BASIC ASSUMPTIONS

The flows available for power production as developed in Section IV together with the variable head and the available daily flow-duration curve shown in Fig. 4, are the primary basis for this power study. The basis for the operation studies is a turbine efficiency of 86%, and efficiencies of 98% and 99% for the generator and transformer, respectively. A summary of the basic data appears in Table VII-1.

Since the exit velocity from the conical draft tubes is high, a conservative average hydraulic head loss of 1.5 feet was assumed. With high tailwater during floods the plant was assumed to be drowned out when the gross head fell below 12.5 feet. With low flows, a minimum of about 750 cfs was assumed to be the practical limit of operation for a single 2-MW unit.

To reduce operating costs it was assumed that this plant would be operated by remote control similarly to the existing operation of the Lake Lynn Plant by West Penn Power from Charleroi. It is evident, of course, that coordination will be required with the lock operations by the Corps.

The Project operation is based on the general premise that the existing operation of locks will not be affected. It is assumed that fluctuations of several inches in the upper pool level, which are necessary for peaking operations of the Project will have no significant affect upon the lock operations, and should not exceed the existing limits.

3. ENERGY

Although a power study on a daily basis is beyond the scope of this report, a duration study of mean daily flows from 1934 through 1972 was conveniently available from the Pennsylvania Department of Environmental Resources, and this was used as the basis for determining the Project energy. As discussed above the daily flow data is considered more accurate than a study based on mean monthly flows. A study was also made with a computer model to simulate energy production from mean monthly flows for the same period from 1934 through 1972.

On Fig. 4 the average annual energy of the plant is indicated by the area under the power output curve and was calculated to be 36.8 million kWh. This energy is used as the basis for determining the Project benefits in the economic analysis in Section IX. Since this curve is based on mean daily flows it is accurate for energy evaluation and is representative of current conditions of the upstream regulation which have remained unchanged during nearly all of this 39 year study period.

Using the computer model with mean monthly flows, an average annual energy of 44.7 million kW was indicated as shown in Table VII-3, which is some 21% more than shown by the study of daily flows. This overstatement results primarily because monthly averaging tends to eliminate the extreme values of lead and flow which restrict power production. The maximum and minimum annual energy is observed to vary from 131% to 57% during the period of study. This indicates a firm annual energy of 21.0 million kW during the minimum year. The related turbine discharges and spills for the monthly analyses are shown in Tables VII-5 and VII-6.

4. CAPACITY

Under the rate structure of West Penn, all capacity has a value that is equal to the demand charge. To evaluate the capacity benefits, the average annual capacity over the 39 year period was calculated using monthly flows, and determining the average monthly capacity as shown in Table VII-4. The long-term average annual capacity, at the site, is determined to be 5,119 kW, assuming a uniform capacity in each month based on the monthly flows available.

The flows will vary throughout the month, and flows less than the average could result in a reduction in the available capacity. However, it is considered reasonable to use the monthly average capacity, since (1) peaking operations of the Lake Lynn plant should increase the available flows at the Maxwell site during the hours of peak demand, (2) by drafting the upstream pool by a few inches the peaking capacity can be developed, and (3) it is equally probable that lower and higher than the monthly average output will coincide with the monthly peak demand. It is this average annual capacity value then, which is a little larger than the "dependable" capacity as discussed further on, which establishes the capacity benefit of the Project in Section IX.

In Fig. 4 the power output curve based on daily flows indicates that with the 2-MW vertical units the plant would be shut

down about 2% of the time due to loss of head during flood flows in excess of 55,000 cfs, and about 15% of the time due to low flows insufficient to run a single unit. However, the Project can still operate during the hours of peak demand by minor fluctuations of the upper pool level. The curve also fails to reveal that the plant will not be drowned out during the winter peak demand when floods do not occur during cold days of peak demand. Most of the flooding occurs during the spring when the demand is significantly lower than the winter peaks.

A separate study of the last 16 years of daily flow records indicates, that by neglecting one of the 16 years on the basis of an improbable coincidence, a dependable flow of 820 cfs is available for power at the Project during peak demand in January. With a four-inch variation from the normal level at the upper pool the resulting "dependable" capacity for six hour daily peaking is 4,350 kW, somewhat less than the long term average capacity of 5,119 kW.

MAXWELL HYDROELECTRIC PROJECT

POWER STUDIES - SUMMARY OF BASIC DATA

FIRST YEAR OF RECORD 1934
 NUMBER OF YEARS IN PERIOD OF RECORD 39
 AREA ADJUSTMENT FACTOR .976
 DISCHARGE NOT AVAILABLE FOR GENERATION (CFS) 570
 TOTAL INSTALLED CAPACITY (KW) 8000
 NUMBER OF UNITS 4
 RUNNER DIA. (FT.) 10.0
 MINIMUM TURBINE FLOW REQUIRED FOR GENERATION (CFS) 812
 MINIMUM NET HEAD REQUIRED FOR GENERATION (FT.) 11.5
 HYDRAULIC CAPACITY OF TURBINES (CFS) 6500
 HYDRAULIC LOSSES (FT.) 1.5
 GENERATOR EFFICIENCY .98 TRANSFORMER EFFICIENCY .99

STREAMFLOW RATING CURVE

FLOW (CFS)	0	5000	10000	15000	20000	25000	30000	50000	70000
HEADWATER ELEVATION	763.0	763.0	763.0	763.0	763.0	763.0	763.0	763.0	763.0
TAILWATER ELEVATION	743.5	744.1	744.7	745.6	746.5	747.7	748.8	753.0	757.3

TURBINE EFFICIENCY CURVE

NET HEAD (FT.)	3.0	11.5	16.2	20.0
TURBINE EFF.	.00	.86	.86	.86

MAXWELL HYDROELECTRIC PROJECT
MONTHLY AVERAGE FLOW AT SITE (CFS)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVG.
1934	13884	3132	20017	9974	2942	1312	1304	2119	889	1795	3911	5930	5559
1935	15877	11819	18426	12424	15845	5408	3166	10736	5271	1296	5133	9709	9676
1936	17463	19422	33876	14805	3049	984	4192	1464	567	2034	5231	10140	9435
1937	36580	13176	10970	14425	11204	6995	2731	3592	3721	13312	6355	11526	11214
1938	7934	14747	14737	10706	14142	8201	3905	2684	1303	848	2438	5821	7295
1939	8559	30256	16338	20632	2880	7308	7291	2225	1071	1790	1808	4128	8689
1940	3155	15869	15313	25864	8893	11995	6035	2463	3051	1912	2056	8409	9252
1941	10639	4242	10023	7426	2724	13556	5689	4949	3708	1476	4447	5855	6227
1942	6125	11507	14708	9208	8572	4247	3251	12034	5205	6674	14396	20661	9862
1943	18768	16748	16738	13283	10287	3563	6004	6346	1894	735	3645	2654	8388
1944	7605	11809	24624	17031	10287	7394	1583	914	1042	7869	4382	17929	9372
1945	17333	20417	28333	8952	11038	5855	2263	4807	12930	4028	13489	11009	11700
1946	11712	12502	12141	4671	11360	12131	2587	1279	607	968	1390	4953	6358
1947	15664	5709	12444	7193	8283	6782	4217	3705	2773	882	4066	4637	6396
1948	10550	19988	17070	21833	11995	7049	9645	5851	3196	2640	6060	22028	11490
1949	21862	20027	12463	9847	4413	2371	4404	3083	1304	1853	6553	15118	8508
1950	19981	25161	20242	9265	10355	12473	5317	1994	6853	3428	10492	20759	12185
1951	18690	22467	14981	18407	9575	13380	5099	1221	1107	651	5457	14688	10484
1952	26312	10892	15059	13166	14161	2661	1820	1963	875	822	1260	5545	7478
1953	16387	13566	14269	14124	11058	1540	1551	1740	695	463	390	2002	6461
1954	8057	4725	14796	7757	4897	3605	3375	8996	2547	15010	6392	13351	7792
1955	9984	21994	28040	6750	4622	4213	1558	4000	910	1389	3739	4200	7625
1956	6192	32315	23209	13351	16045	13254	8604	17460	4007	2452	4184	19803	13408
1957	17470	24604	10033	13898	3216	2350	2149	792	846	2507	3491	17177	8211
1958	11272	10472	12844	15899	17509	4125	13244	13566	2386	1970	4000	5363	9367
1959	15362	15869	10462	11926	7452	2966	1359	1599	1042	2257	6034	13498	7485
1960	16006	11477	10696	16055	9096	3339	1757	2970	4681	2216	5128	3943	7346
1961	7777	19432	26937	19305	10140	11751	5321	6117	1777	2803	7987	12190	10961
1962	14993	14278	22740	17099	2988	4340	1502	954	960	2761	12961	7586	8588
1963	9637	8939	40923	4751	4304	8411	2093	3017	2157	816	3600	6034	7890
1964	11692	6775	23472	16660	3772	4012	1983	1944	1020	1055	3066	12844	7425
1965	16875	10706	16728	19147	3516	1098	1023	793	1046	1253	1419	1943	6296
1966	5704	18270	9264	13224	11702	1380	893	1416	2245	3800	3394	8922	6684
1967	4550	9190	38034	3957	24380	2710	3026	2570	1913	3871	5837	11770	9767
1968	10052	8549	16074	7984	17997	6762	973	2249	1097	1321	6519	8778	7352
1969	9133	9147	6514	11653	6886	1425	5726	5463	2211	2034	4080	10950	6251
1970	14532	15313	14337	21911	3784	2760	2814	2893	2076	2351	8093	16338	8935
1971	16357	22535	13117	4370	11936	3425	1619	3767	12424	2774	5720	12619	9221
1972	16669	19724	23990	23111	10257	13400	9206	2949	1364	4475	14864	29045	14089
AVG.	13518	15071	18086	13285	9168	5913	3855	4066	2689	2452	5624	10755	8752

TABLE VII-2

MAXWELL HYDROELECTRIC PROJECT
MONTHLY AVERAGE ENERGY GENERATION (GWH)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1934	5.498	2.142	5.121	5.553	2.199	.000	.000	1.444	.000	.777	2.891	4.868	30.489
1935	5.375	5.081	5.219	5.408	5.317	4.258	2.403	5.692	4.151	.000	4.033	5.749	52.695
1936	5.279	4.659	4.059	5.266	2.297	.000	3.329	.837	.000	1.365	4.117	5.729	36.936
1937	.000	5.006	5.677	5.299	5.663	5.606	2.006	2.780	2.812	5.533	5.071	5.643	51.086
1938	5.822	4.918	5.446	5.510	5.483	5.620	3.071	1.963	.000	.000	1.681	4.773	44.286
1939	5.796	3.900	5.347	4.907	2.142	5.658	5.848	1.542	.000	1.130	1.119	3.272	40.661
1940	2.393	4.855	5.410	4.496	5.782	5.433	4.960	1.760	2.224	1.233	5.629	5.802	50.001
1941	5.698	3.048	5.735	5.654	2.000	5.340	4.657	4.004	2.801	.848	3.443	4.803	48.032
1942	5.038	5.098	5.448	5.594	5.796	3.270	2.480	5.612	4.095	5.731	5.291	5.068	56.570
1943	5.196	4.807	5.323	5.357	5.719	2.674	4.933	5.231	1.196	.000	2.745	1.936	45.119
1944	5.835	5.082	4.743	5.134	5.719	5.656	.948	.000	.000	5.824	3.387	5.250	47.577
1945	5.286	4.596	4.462	5.597	5.673	4.648	1.577	3.978	5.375	3.162	5.345	5.675	55.293
1946	5.632	5.043	5.605	3.636	5.654	5.425	1.874	.000	.000	.000	.743	4.098	37.620
1947	5.389	4.222	5.562	5.664	5.808	5.428	3.352	2.891	1.979	.000	3.113	3.727	47.132
1948	5.704	4.627	5.302	4.812	5.615	5.650	5.752	4.800	2.343	1.922	4.821	4.956	56.304
1949	4.970	4.625	5.586	5.558	3.527	1.622	3.519	2.327	.000	1.198	5.235	5.422	43.591
1950	5.130	4.246	5.102	5.581	5.715	5.105	4.330	1.329	5.487	2.640	5.522	5.060	55.549
1951	5.203	4.444	5.431	5.052	5.755	5.351	4.137	.000	.000	.000	4.310	5.449	45.132
1952	4.614	5.132	5.426	5.363	5.481	1.879	1.167	1.300	.000	.000	.000	4.531	34.894
1953	5.344	4.984	5.474	5.307	5.672	.973	.918	1.093	.000	.000	.000	1.335	31.006
1954	5.817	3.437	5.442	5.641	3.958	2.711	2.593	5.779	1.778	5.429	5.101	5.531	53.217
1955	5.738	4.479	4.484	5.401	3.713	3.240	1.017	3.157	.000	.767	2.827	3.337	38.161
1956	5.097	3.767	4.859	5.352	5.366	5.358	5.794	5.279	3.061	1.774	3.215	5.134	54.062
1957	5.278	4.296	5.735	3.320	2.447	1.603	1.472	.000	.000	1.901	2.611	5.296	35.850
1958	5.659	5.156	5.552	5.201	5.276	3.164	5.538	5.518	1.635	1.306	3.055	4.370	51.439
1959	5.407	4.856	5.709	5.437	5.841	2.149	.000	.963	.000	1.671	4.600	5.522	42.255
1960	5.368	5.100	5.695	5.144	5.774	2.477	1.109	2.225	3.645	1.533	4.028	3.105	45.203
1961	5.828	4.658	4.567	4.999	5.729	5.448	4.333	5.032	1.092	2.072	5.632	5.602	54.990
1962	5.436	4.945	4.398	5.130	2.241	3.350	.872	.000	.000	2.033	5.376	5.936	40.117
1963	5.752	5.221	.000	3.705	3.430	5.615	1.420	2.267	1.431	.000	2.706	4.950	36.507
1964	5.633	5.061	4.837	5.156	2.951	3.066	1.319	1.190	.000	1.302	2.237	5.552	38.313
1965	5.314	5.143	5.323	5.008	2.721	.000	.000	.000	.000	.000	.769	1.291	25.559
1966	4.670	4.723	5.767	5.360	5.632	.000	.000	.792	1.510	2.917	2.526	5.731	39.738
1967	3.649	5.212	.000	5.578	4.763	1.923	2.275	1.859	1.213	3.041	4.632	5.628	39.774
1968	5.734	5.236	5.363	5.632	5.245	5.412	.000	1.564	.000	.000	5.208	5.797	45.180
1969	5.773	5.213	5.377	5.453	5.526	.775	4.689	4.459	1.480	1.365	3.125	5.679	48.913
1970	5.453	4.887	5.471	4.805	2.953	1.995	2.092	2.154	1.361	1.659	5.628	5.347	43.798
1971	5.346	4.439	5.546	3.376	5.619	2.553	.981	2.947	5.406	2.045	4.533	5.576	48.369
1972	5.326	4.642	4.795	4.710	5.721	5.350	5.770	2.205	.000	3.582	5.262	4.408	51.772
AVG.	5.166	4.640	4.998	5.157	4.665	3.487	2.629	2.458	1.438	1.685	3.635	4.790	44.749

MAXWELL HYDROELECTRIC PROJECT
MONTHLY AVERAGE POWER OUTPUT (KW)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVG
1934	7390	3188	6883	7113	2956	0	0	1941	0	1038	4015	6513	3472
1935	7225	7561	7015	7511	7146	5928	3230	7650	5765	0	5601	7727	6029
1936	7095	6933	5455	7314	3087	0	4475	1125	0	1935	5718	7700	4228
1937	0	7449	7631	7345	7612	7786	2696	3737	3905	7437	7043	7525	5852
1938	7825	7319	7320	7653	7369	7806	4128	2649	0	0	2335	6415	5067
1939	7790	5304	7187	6815	2879	7839	7960	2072	0	1519	1554	4398	4644
1940	3216	7225	7272	6247	7772	7346	6667	2366	3089	1654	7818	7749	5725
1941	7658	4535	7709	7653	2628	7417	6260	5382	3690	1140	4782	6456	5480
1942	6772	7587	7322	7755	7790	4541	3334	7543	5687	7784	7348	6612	6689
1943	6987	7154	7154	7440	7687	3714	6630	7031	1661	0	3813	2602	5156
1944	7843	7562	6375	7130	7627	7855	1274	0	0	7228	4704	7056	5442
1945	7105	6839	5997	7774	7625	6455	2119	5213	7465	4277	7423	7628	6326
1946	7570	7504	7534	5050	7599	7535	2519	0	0	0	1032	5397	4310
1947	7243	6282	7476	7865	7806	7539	4505	3886	2748	0	4323	5009	5390
1948	7666	6885	7127	6683	7547	7847	7731	6451	3254	2544	6696	6661	6427
1949	6680	6882	7508	7720	4741	2253	4730	3128	0	1610	7272	7288	4984
1950	6895	6318	6858	7752	7682	7507	5820	1786	7621	3549	7670	6801	6354
1951	6993	6613	7300	7016	7735	7432	5561	0	0	0	5986	7324	5163
1952	6202	7637	7293	7449	7367	2610	1569	1747	0	0	0	6690	3997
1953	7183	7416	7358	7371	7624	1220	1234	1469	0	0	0	1795	3555
1954	7818	5115	7315	7835	5320	3765	3435	7766	2470	7237	7085	7434	6058
1955	7712	6665	6027	7502	4991	4500	1367	4243	0	1031	3927	4445	4370
1956	6651	5606	6531	7434	7212	7442	7788	7095	4252	2390	4465	6301	6163
1957	7094	6378	7708	7389	3291	2227	1978	0	0	2421	3626	7118	4102
1958	7606	7672	7476	7224	7091	4394	7443	7416	2271	1756	4243	5874	5672
1959	7268	7226	7673	7552	7851	2965	0	1294	0	2112	6666	7422	4837
1960	7215	7589	7654	7145	7761	3440	1491	2990	5062	2081	5593	4174	5181
1961	7934	6932	6138	6942	7700	7566	5924	6763	1516	2785	7822	7530	6279
1962	7307	7358	6583	7125	3012	4653	1172	0	0	2733	7466	7444	4604
1963	7731	7770	0	5146	4610	7799	1908	3047	1988	0	3759	6666	4202
1964	7571	7531	6502	7161	3967	4258	1772	1599	0	1750	3107	7476	4391
1965	7143	7653	7155	6955	3657	0	0	0	0	0	1068	1722	2946
1966	6277	7028	7752	7445	7570	0	0	1065	2097	4001	3508	7770	4542
1967	4905	7756	0	7747	6402	2671	3058	2498	1685	4027	6434	7565	4567
1968	7707	7791	7209	7822	7050	7516	0	2102	0	0	7233	7778	5184
1969	7759	7758	7227	7574	7427	1076	6303	5993	2055	1635	4340	7633	5561
1970	7337	7272	7353	6674	3982	2757	2798	2995	1890	2228	7816	7187	5015
1971	7186	6606	7454	4689	7551	3546	1319	3961	7511	2749	6296	7495	5530
1972	7158	6908	6445	6542	7690	7430	7755	2964	0	4815	7309	5925	5911
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AVG.	6944	6965	6717	7163	6270	4842	3533	3304	1996	2265	5048	6437	5119

MAXWELL HYDROELECTRIC PROJECT
DISCHARGE THROUGH TURBINES (CFS)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVG
1934	6500	2562	6500	6500	2372	0	0	1549	0	825	3241	5360	2950
1935	6500	6500	6500	6500	6500	4938	2596	6500	4701	0	4563	6500	5183
1936	6500	6500	6500	6500	2479	0	3622	894	0	1464	4661	6500	3601
1937	0	6500	6500	6500	6500	6425	2161	3012	3151	6500	5786	6500	4961
1938	6500	6500	6500	6500	6500	6500	3335	2114	0	0	1868	5251	4297
1939	6500	6500	6500	6500	2310	6500	6500	1655	0	1210	1238	3558	4080
1940	2585	6500	6500	6500	6500	6500	5465	1893	2481	1342	6500	6500	4938
1941	6500	3672	6500	6500	2154	6500	5119	4379	3138	905	3877	5236	4544
1942	5555	6500	6500	6500	6500	6500	3677	2681	4635	6500	6500	6500	5712
1943	6500	6500	6500	6500	6500	2993	5434	5776	1324	0	3075	2084	4432
1944	6500	6500	6500	6500	6500	6500	1013	0	0	6500	3812	6500	4735
1945	6500	6500	6500	6500	6500	5285	1693	4237	6500	3458	6500	6500	5556
1946	6500	6500	6500	4101	6500	6500	2017	0	0	0	220	4383	3651
1947	6500	5138	6500	6500	6500	6212	3647	3135	2203	0	3496	4067	4491
1948	6500	6500	6500	6500	6500	6478	6500	5281	2616	2078	5490	6500	5619
1949	6500	6500	6500	6500	3843	1801	3834	2513	0	1283	5993	6500	4313
1950	6500	6500	6500	6500	6500	6500	4747	1424	6283	2858	6500	6500	5609
1951	6500	6500	6500	6500	6500	6500	4529	0	0	0	4467	6500	4576
1952	6500	6500	6500	6500	6500	2091	1250	1393	0	0	0	4975	3517
1953	6500	6500	6500	6500	6500	970	981	1170	0	0	0	1432	3087
1954	6500	4155	6500	6500	4327	3035	2805	6500	1977	6500	5222	6500	5093
1955	6500	6500	6500	6180	4052	3643	1088	3430	0	319	3169	3630	3792
1956	5622	6500	6500	6500	6500	6500	6500	6500	3437	1912	3614	6500	5548
1957	6500	6500	6500	6500	2345	1780	1579	0	0	1737	2921	6500	3613
1958	6500	6500	6500	6500	6500	3555	6500	6500	1816	1400	3430	4793	5041
1959	6500	6500	6500	6500	6300	2396	0	1029	0	1597	5464	6500	4131
1960	6500	6500	6500	6500	6500	2762	1187	2400	4111	1546	4558	3373	4378
1961	6500	6500	6500	6500	6500	6500	4751	5547	1207	2233	6500	6500	5476
1962	6500	6500	6500	6500	2418	3770	932	0	0	2191	6500	6500	4025
1963	6500	6500	0	4181	3734	6500	1523	2447	1507	0	3030	5464	3455
1964	6500	6205	6500	6500	3202	3442	1413	1274	0	1395	2476	6500	3725
1965	6500	3500	6500	6500	2946	0	0	0	0	0	349	1373	2597
1966	5134	6500	6500	6500	6500	0	0	846	1675	3230	2824	6500	3850
1967	3980	6500	0	6500	6500	2140	2456	2000	1343	3301	5257	6500	3873
1968	6500	6500	6500	6500	6500	6192	0	1679	0	0	5349	6500	4401
1969	6500	6500	5944	6500	6115	853	5156	4893	1641	1464	3510	6500	4631
1970	6500	6500	6500	6500	3214	2210	2244	2323	1502	1781	6500	6500	4356
1971	6500	6500	6500	3800	6500	2855	1049	3197	6500	2204	5150	6500	4771
1972	6500	6500	6500	6500	6500	6500	6500	2379	0	3905	6500	6500	5398
AVG.	6086	6223	6152	6301	5341	4036	2692	2727	1636	1059	4175	5577	4418

TABLE VII-5

MAXWELL HYDROELECTRIC PROJECT
MONTHLY AVERAGE SPILL (CFS)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVG
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1934	6818	0	12947	2904	0	742	734	0	319	0	0	0	2038
1935	8809	4749	11356	5354	9775	0	0	3666	0	726	0	2639	3922
1936	10390	12352	26906	7735	0	414	0	0	0	0	0	3070	5063
1937	36010	6105	3900	7355	4134	0	0	0	0	6242	0	4456	5663
1938	864	7677	7567	3636	7072	1211	0	0	733	278	0	0	2428
1939	1489	23186	9268	13562	0	238	221	0	501	0	0	0	4038
1940	0	8819	8243	18794	1823	4925	0	0	0	0	986	1339	3744
1941	3569	0	2953	356	0	6486	0	0	0	0	0	0	1113
1942	0	4437	7638	2133	1502	0	0	4964	0	1604	7326	13591	3600
1943	11639	9678	9668	6213	3217	0	0	0	0	165	0	0	3386
1944	535	4739	17554	9961	3217	324	0	344	472	799	0	10859	4067
1945	10263	13347	21263	1782	3968	0	0	0	5910	0	6418	3939	5574
1946	4642	5432	5071	0	4290	5061	0	709	37	398	0	0	2136
1947	8594	0	5774	123	1213	0	0	0	0	312	0	0	1334
1948	3480	12916	10000	14763	4915	0	2575	0	0	0	0	14958	5300
1949	14792	12957	5393	2777	0	0	0	0	734	0	0	8048	3725
1950	12811	18091	13172	2195	3285	5403	0	0	0	0	3422	13689	6005
1951	11520	15397	7911	11337	2505	6310	0	651	627	81	0	7618	5338
1952	19242	3822	7989	6096	7091	0	0	0	305	252	690	0	3790
1953	9317	6496	7199	7052	3568	0	0	0	125	0	0	0	2848
1954	987	0	7725	687	0	0	0	1926	0	7340	0	6281	2128
1955	2914	11929	20970	0	0	0	0	0	340	0	0	0	3262
1956	0	25245	16139	6281	8975	6184	1534	10390	0	0	0	12733	7290
1957	10400	17534	2963	6828	0	0	0	222	276	0	0	10107	4027
1958	4202	3402	5774	8829	10439	0	6174	6496	0	0	0	0	3776
1959	8292	8799	3392	4856	362	0	788	0	472	0	0	6428	2784
1960	8936	4407	3626	9735	2026	0	0	0	0	0	0	0	2398
1961	707	12362	19867	12235	3070	4681	0	0	0	0	917	5120	4913
1962	7323	7208	15670	10029	0	0	0	394	390	0	5891	516	3992
1963	2567	1869	40353	0	0	1341	0	0	0	246	0	0	3864
1964	4622	0	16402	9530	0	0	0	0	450	0	0	5774	3069
1965	9805	3636	9658	12079	0	528	453	223	476	693	0	0	3129
1966	0	11200	2194	6154	4632	810	323	0	0	0	0	1852	2263
1967	0	2120	37464	2287	17310	0	0	0	0	0	0	4700	5323
1968	2982	1479	9004	914	10927	0	403	0	527	751	0	1708	2391
1969	2063	2077	0	4583	0	0	0	0	0	0	0	3880	1050
1970	7462	8243	7267	14841	0	0	0	0	0	0	1023	9268	4008
1971	9287	15465	6047	0	4866	0	0	0	5254	0	0	5549	3880
1972	9619	12654	16920	16041	3187	6330	2136	0	794	0	7794	21975	9120
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AVG.	6861	8277	11364	6414	3277	1307	393	768	483	525	883	4617	3765

SECTION VIII

ESTIMATED CONSTRUCTION COST AND SCHEDULE

1. GENERAL

The cost estimate for the Project was based on preliminary arrangement and dimensions indicated in Fig. 7. Quantities were established for major civil features, to which unit costs were applied. For equipment and other features, costs per kilowatt were used from experience with similar installations, and, in part, developed from preliminary price quotations from equipment suppliers. The civil work costs are based on contractor bid prices, adjusted to a January 1979 level. The costs, therefore, generally have a built-in escalation assuming completion of the work in a 2-1/4-year period, which would correspond to the Project being on-line by April 1981. As discussed below, escalation was then applied to the costs to arrive at the estimated cost for the Project to enter into service by January 1985, considered to be the earliest practical schedule.

2. BASIS OF COST

a. Direct Construction Cost

This includes the total of all costs directly chargeable to the construction of the Project and, in essence, represents a contractor's bid.

Indirect costs are defined as those which are added to the Direct Construction Cost to result in the Total Construction Cost. Indirect costs include an allowance for contingencies, engineering and owner administration.

b. Contingencies

To allow for unforeseen difficulties during construction and to reflect possible omissions of estimate items, an allowance of 15% was applied to the Direct Construction Cost estimates.

c. Engineering and Owner Administration

Engineering costs for the Project were based on a comparison with actual costs for similar work. The item includes all preliminary engineering work, field investigations, feasibility and environmental studies, FPC licensing, design, field inspection of construction, and owner administration. An allowance of 15% of Direct Construction Cost plus Contingencies was included for this item.

d. Total Construction Cost

This includes the total of Direct Construction Cost, Contingencies, Engineering and Client Administration.

e. Interest During Construction

This was determined from an assumed cash flow developed from the construction schedule for each of the three alternative methods of financing as described in Section IX.

f. Total Investment Cost

This includes the Total Construction Cost plus Interest During Construction and represents the total investment in the Project.

g. Escalation

The cost estimate for this Project has been considered at a January 1979 bid level (current prices) which corresponds to a completion of construction by April 1981 (2-1/4-year construction period). Bid prices for the anticipated actual project schedule have been escalated from the January 1979 bid level to bid in October 1982 (corresponding to a project in-service date of January 1985) at an assumed annual rate of 7% for 3-3/4 years.

3. CONSTRUCTION COST ESTIMATE

A cost estimate summary for the proposed development of the Project is shown in Table VIII-1 for each of the three alternative methods of financing. With DOE financing (last column of Table VIII-1) the estimated Total Investment Cost for construction at the current price level (Project on-line in April 1981) is \$13,888,000 which is equivalent to \$1,736/kW for the 8,000 kW installed capacity. When escalated to the scheduled completion (on-line) date of January 1985 this cost is estimated to be \$17,899,000 with an equivalent unit cost of \$2,237/kW. With the alternative REA financing the total investment cost for completion in January 1985 is estimated to be \$17,801,000 and \$18,134,000 with interest at 7% or 9% respectively.

4. PROJECT SCHEDULE

A design and construction schedule is shown in Fig. 10. This schedule indicates commercial operation of the total Project by January 1985, which is considered to be the earliest reasonable date for project completion considering the time requirements for the next phase feasibility evaluation investigations, FERC License processing, final feasibility investigation, design and construction. The schedule provides 18 months for the processing of the FERC License, which is considered a minimum period. License pro-

cessing normally takes at least two years but FERC plans to reduce this for low-head projects at existing dams. The schedule further indicates the initiation of the design and contract documents phase work near the beginning of the licensing period. At that time, an indication of the approval of the License should be possible as input from Federal, State and local agencies and other interest groups should be available.

Final design and preparation of contract bid documents will proceed with bidding and award of the major civil contract and major equipment contracts by late 1982.

The access road, upstream cofferdam and dewatering of the intake area are to be completed during the initial phase of construction. The cofferdam will consist of sheet-pile cells extending about 250 ft upstream from Pier No. 6 to a point where a dike will tie into the bank providing access onto the cofferdam. Restricted operation of the gate in Bay No. 5 is anticipated to avoid erosion about the cofferdam. The existing cutoff wall behind Pier No. 6 will be replaced as soon as practical with the proposed intake gate structure. Rock anchorage for slope stability will be initiated as early as possible and continue with excavation of the intake area.

After the completion of the principle structures in the intake area the intake gates will be installed and the cofferdam will be removed to be placed downstream from Pier No. 6 to initiate the second phase of construction. This phase will include the completion of the downstream slope stabilization and excavation, and construction of the powerhouse and the power conduit.

Major mechanical and electrical equipment delivery and installation are scheduled to begin about halfway through the civil work construction period. The equipment delivery and installation phase will continue until project completion.

The schedule allows for a 3 month start up and testing period during the final stages of construction. Following start up and testing the Project would go on line in January 1985.

TABLE VIII-1

MAXWELL HYDROELECTRIC PROJECT

CONSTRUCTION COST ESTIMATE SUMMARY

Item	REA Financing		DOE Financing
	7%	9%	
1. Preparatory Work.....	\$ 535,000		
2. Cofferdams and Dewatering..	1,153,000		
3. Intake Channel.....	170,000		
4. Powerhouse Civil Work.....	2,374,000		
5. Powerhouse - Mechanical Equip	3,026,000		
6. Powerhouse - Electrical Equip.	2,170,000		
7. Transmission and Switchyard	<u>334,000</u>		
DIRECT CONSTRUCTION COST	\$ 9,762,000		
Contingencies.....	<u>1,462,000</u>		
Subtotal.....	11,224,000		
Engineering and Owner Administration.....	1,684,000		
TOTAL CONSTRUCTION COST.....	\$12,908,000	12,908,000	12,908,000
Interest During Construction....	<u>904,000</u>	<u>1,162,000</u>	<u>980,000</u>
TOTAL INVESTMENT COST..... (Bid 1/79, On-line 4/81)	\$13,812,000	14,070,000	13,880,000
Escalation.....	<u>3,989,000</u>	<u>4,064,000</u>	<u>4,011,000</u>
TOTAL INVESTMENT COST..... (Bid 10/82, On-line 1/85)	\$17,801,000	18,134,000	17,899,000
Installed Capacity - kW.....	8,000	8,000	8,000
Cost Per kW..... (Bid 1/79, On-line 4/81)	\$ 1,726	1,759	1,736
Cost Per kW..... (Bid 10/82, On-line 1/85)	2,225	2,267	2,237

R. W. Beck and Associates

CONSTRUCTION COST ESTIMATE

Bid Price Level January 1979

PROJECT Maxwell Hydroelectric Project FEATURE Powerhouse LOCATION Pennsylvania W.O. WW-6296-HG2-QA

TYPE EST. X PLANNING TAKE-OFF DG PRICED DG CALC. CHKD. AD APPROVED JVW DATE February 1979

[illegible]

TABLE VIII-2

R. W. Beck and Associates

CONSTRUCTION COST ESTIMATE

Eid Price Level January 1979
Pennsylvania **ww** WW-6296-HG2-QA

PROJECT Maxwell Hydroelectric Project FEATURE Powerhouse LOCATION _____

TYPE EST: X PLANNING- TAKE-OFF DG PRICED WHS CALC. CHKD. AD APPROVED JVW DATE February 1979

[illegible]

TABLE VIII-2

R. W. Beck and Associates

CONSTRUCTION COST ESTIMATE

Bid Price Level January 1979
Pennsylvania WW-6296-HG2-QA

PROJECT Maxwell Hydroelectric Project FEATURE Powerhouse LOCATION _____

TYPE EST. X PLANNING

TAK-0FF ARN

PRICED WHS

CALC. CHKD. AD

APPROVED JVW

DATE February 1979

[illegible]

R. W. Beck and Associates

CONSTRUCTION COST ESTIMATE

Bid Price Level January 1979
Pennsylvania WW-6296-HG2-QAPROJECT Maxwell Hydroelectric Project FEATURE PowerhouseLOCATION Pennsylvania W.O. WW-6296-HG2-QATYPE EST: X PLANNINGTAKE-OFF ARNPRICED WHSCALC. CHKD. ADAPPROVED JVWDATE February 1979

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	UNIT COST	TOTAL
4. Power Conduit and Powerhouse-Civil Work						2,374,000
4.1 Excavation & Removal						
4.1.1 Common	500	CY			3.00	2,000
4.1.2 Rock	26,600	CY			10.00	266,000
4.1.3 Removal of Dumped Rock fill	4,820	CY			2.50	12,000
4.1.4 Removal of Existing Concrete	3,350	CY			30.00	100,000
4.2 Rock Wall Anchorage						
4.2.1 Rock Bolts	3,480	LF			8.00	28,000
4.2.2 Wire Mesh	27,000	S.F.			0.30	8,000
4.2.3 Vertical Anchors	54	EA			5000.00	270,000
4.2.4 Shotcrete	9000	S.F.			2.00	18,000
4.3 Backfill	5000	CY			1.50	8,000
4.4 Concrete						
4.4.1 Power Conduit	3200	CY			150.00	480,000
4.4.2 Substructure	2100	CY			175.00	368,000
4.4.3 Superstructure	600	CY			250.00	150,000
4.4.4 Railroad Retaining Wall	250	CY			200.00	50,000
4.5 Cement	31,000	CF			3.50	110,000
4.6 Reinforcing Steel	754,000	LB			0.40	302,000
4.7 Roofing Steel	34,000	LB			0.50	17,000
4.8 Miscellaneous		L.S.				175,000
4.9 Grouting		L.S.				10,000

TABLE VIII-2

CONSTRUCTION COST ESTIMATE

Bid Price Level January 1979

PROJECT Maxwell Hydroelectric Project FEATURE Powerhouse LOCATION Pennsylvania W.D. WW-6292-HG2-QA

TYPE EST-X PLANNING TAKE-OFF ARN PRICED DKS CALC. CHKD. AD APPROVED JVW DATE February 1979

[illegible]

CONSTRUCTION COST ESTIMATE

PROJECT Maxwell Hydroelectric Project FEATURE Powerhouse LOCATION Pennsylvania W.O. WW-6296-HG2-QA

TYPE EST. X PLANNING TAKE-OFF FEB PRICED FEB CALC. CHKD. AD APPROVED JVW DATE February 1979

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	UNIT COST	TOTAL
6.	Powerhouse - Electrical Equipment						2,170,000
6.1	Generator and Excitation Equipment	4	EA			485,000	1,940,000
6.2	Miscellaneous Electrical Equipment		L.S			230,000	230,000
7.	Transmission and Switchyard						334,000
7.1	Transformer	1	EA			70,000	70,000
7.2	Switchgear	4	EA			52,500	210,000
7.3	Accessory Equipment		L.S				14,000
7.4	25-kV Transmission Line	1	MI			40,000	40,000

SECTION IX

ECONOMIC ANALYSIS

1. GENERAL

In a typical economic analysis for a hydroelectric project, the annual cost of a proposed project is compared with the annual value of the project power output, allowing comparison to be made between the benefits and costs of the Project which will show its viability. The value of the power generated by the Project is considered to be the cost of an equivalent amount of power from the most economical alternative source. The annual cost of the Project includes all costs for the debt service, operation, maintenance, interim replacements, insurance and taxes. In this analysis for the Maxwell Hydroelectric Project, the alternative source of power is considered to continue purchase of power under wholesale rates from West Penn Power Company (West Penn). The basic assumptions for the economic analysis are listed in Table IX-1.

The economic analyses presented herein consist of the following comparisons: (1) the estimated costs of power from the Project during its first year of operation versus the cost of an equivalent amount of power from the alternative considered, and (2) the estimated total cost of power from the Project in the first ten years of operation versus the estimated cost of an equivalent amount of power from the purchase alternative for the same ten year period, on a present-worth basis. The analyses are performed for three financing alternatives. Two of these are with REA financing with different interest rates, and a third assumes financing under the terms of Title IV, Small Hydroelectric Power Projects of the recently passed Public Utilities Regulatory Policies Act, being administered by DOE. It is assumed in this analysis that the Project would be completed and on-line by January 1985 as shown in Fig. 10.

For economic evaluation purposes the useful life of a hydroelectric project can be considered to be 50 years, although such projects can have a longer useful life. FERC has used periods up to 100 years to evaluate hydroelectric projects and the procedure for filing License Applications identifies the basis for financial feasibility should be for a period of 50 years, and that for economic feasibility is 100 years. However, the economic analysis herein has been based on the period of analysis imposed by either the REA or DOE loans, which of course results in a conservative view of the economic viability of the Project.

2. BASIS FOR COST OF ALTERNATIVE

The Maxwell Hydroelectric Project would serve to displace power purchases by Allegheny in the amount of 35,880,000 kWh of energy on an average annual basis, and 4,914 kW of average annual capacity (allowing for transmission losses), delivered at the load centers.

The estimated unit costs of purchased power, both capacity and energy, used in this analysis, are based on a study made by Southern Engineering Company of Georgia in its long-range planning studies for Allegheny. Purchase rates have been developed for West Penn as shown in Table IX-2, from 1979 through 1994. It may be observed that these projected rates have an annual escalation rate of between 6% and 6-1/2% for the 15 years from 1979 to 1994.

3. HYDROELECTRIC PROJECT COSTS

a. Capital Costs

The Total Investment Cost for the Project on an on-line date of January 1985 was developed in Section VIII and is \$17,801,000 with 7% REA financing, \$18,134,000 with 9% REA financing, and \$17,899,000 with 7-1/8%-9% DOE financing, as shown in Table IX-3.

The economic feasibility was based on these total investments and the corresponding loan terms for the different methods of financing.

b. Annual Costs

(1) Amortization Cost

The debt service on the loans for the various methods of financing were determined on the following bases:

(a) In addition to the normal 9% interest rate financing from REA, a lower 7% interest rate has been assumed to be available with the same REA financing terms. This would be a 7% interest, 35 year term loan. For the first 7 years principal payments are deferred and only the interest is paid. In the following 28 years both interest and principal are paid. This has been done to display the advantage of lower interest financing. The possibility that REA could obtain this lower interest financing for small scale hydroelectric development has been generally discussed in the past as a possibility under the current Federal policy of accelerating small hydro development. The advisability of lower REA interest rates for hydro was also the subject of Resolution No. D-17 of the 1978 NRECA annual meeting.

The 7% interest is also pertinent to alternative REA financing with half of the loan at 5% interest and the balance of the loan at 9%. It is believed that much a combination of financing is possible should the REA deem the project to be especially deserving of some low interest money.

(b) 9% interest, 35 year term loan from REA. For the first 7 years principal payments are deferred and only the interest is paid. The following 28 years both interest and principal are paid.

(c) 7-1/8% interest, 30 year term loan from the Department of Energy (DOE) under Title IV, Small Hydroelectric Power Project section of the Public Utilities Regulatory Policies Act (part of the National Energy Act). Under the terms of this Act 75% of the construction loan would be furnished by DOE but the remaining 25% would have to be obtained from other sources. It is assumed that this additional 25% would be financed with a 9%, 30 year term loan. The 7-1/8% interest rate is determined under Section 80 of the Water Resources Development Act of 1974, and has been increased by 1/4% from the 1978 value. For convenience this combined loan is referred herein simply as 7-1/8% loan without explicit mention of the 9% fraction.

(2) Operating Costs

Annual costs consist of amortization costs and operating costs for the various methods of financing. The general bases for for the operation and maintenance cost of the Project are stated in Table IX-1. Annual costs of operation and maintenance of the Project were developed for a remotely operated plant based on experience with comparable plants and were compared with numbers developed by the FERC. Other costs are based on historic cost data published by the FERC and include administration and general, insurance and interim replacements. The resultant annual costs for the first year of operation are shown in Table IX-3.

(3) Charge For Use of Federal Project

Preliminary discussions with the Corps, were inconclusive as to what if any charge would be made by the Federal Government for use of the Maxwell Locks and Dam for development of a hydroelectric project. However, such fees have been assessed in the past on the licenses of hydroelectric developments at some other Federal dams. Certainly if this was done for the Maxwell Hydroelectric Project it would unquestionably make the Project infeasible for development.

For low head projects the concept of Federal Dam-user fees flies in the face of the current concentrated Federal program for development of small hydro, and in most cases imposition of such fees would inevitably preclude development here and elsewhere.

(4) Transmission Wheeling and Losses

Cost of transmission wheeling will depend upon negotiations between Allegheny and West Penn for delivery of power from this small project. Although information is available in the region for long distance high voltage transmission wheeling rates, there is no corresponding data for lower voltage and smaller deliveries as are required for the Project. It seems probable that the cost of wheeling can be eliminated on a displacement basis. For the purpose of the economic feasibility it is assumed that there would be no wheeling charges for the Project.

Transmission losses of the Project are considered to be 4% for peaking, and 2.5% for energy.

(5) Total Annual Costs

Total annual costs for the first year of operation are shown in Table IX-3, and for the first ten years of operation in Table IX-4 for the various financing alternatives.

c. Forced Outage Reserves

The experience with hydroelectric projects is that their reliability is usually much greater than thermal installations. It is considered reasonable to set aside a forced outage reserve of 5% of the average annual capacity of the Project as delivered to the load centers. This agrees reasonably with the 4% value used for hydro by the East Central Area Reliability Council. Hence the value of the average annual capacity is reduced from 5,119 kW to

4,668 kW (including transmission losses), and it is this latter number which is used in establishing the annual capacity benefit of the Project.

4. ANNUAL BENEFITS

The annual value, or benefit, from the Project is considered equal to the annual cost of wholesale purchase of the same amount of power as available from the Project. The estimated capacity and energy rates are shown in Table IX-2. The resultant annual project benefits from 1985 through 1994 are shown in Table IX-5.

5. ANNUAL COSTS OVER A TEN YEAR PERIOD

It is common current practice to perform economic analyses for hydroelectric projects over the first ten years of project operation to reflect the future escalation of costs of the alternatives. If a longer period is used the results are not considered meaningful since the value of the dollar continues to decrease. In determining the annual costs over a ten year period for the three methods of financing, the debt service portion of the annual costs for the Project remains fixed, and operating costs are considered to escalate at an annual rate of 7%. The annual surplus or deficit amounts for the Project annual benefits as compared to its costs, were developed on a present-worth basis in accordance with conventional practice and a simple annual basis in accordance with REA practice and are summarized in Tables IX-6, 7 and 8, for the three methods of financing.

As can be seen in all cases the Project benefits in the first year are less than the Project cost. Hence, the first year benefit cost ratio is less than one for all methods of financing (B-C ratio = 0.88 for 7%, REA financing).

The 7% REA financing shows a positive net benefit in the fifth year of operation, a cumulative net benefit in the ninth year, and a cumulative present-worth savings for the Project over the alternative of purchasing the same amount of power of \$108,000 over the first ten years of Project operation. However, the 7-1/8% DOE financing with 25%-9% interest on conventional loans shows cumulative negative net benefits in the amount of \$1,321,000 over this same ten year period. Similarly the 9% REA financing method results in a negative present cumulative worth in the amount of \$2,525,000 over the ten year period. This means in the latter two cases that power from the Project would cost more than to purchase the same amount of power. The same result occurs if the REA test of feasibility is applied which is whether the Project show a savings over the first ten years (without present worth).

The comparison of the ten year cost and benefits is shown graphically in Fig. 9. With 7% REA financing a breakeven point of cost of the Project and the cost of power purchases, occurs about 5 years after the Project enters into service. For 7-1/8% DOE financing a breakeven point occurs at about the eighth year. For 9% financing a breakeven point occurs within the ninth year.

6. RESULTS OF ECONOMIC ANALYSIS

The economic analysis shows that if Allegheny can obtain financing at a lower interest rate than normal (7% or less) from REA, the Maxwell Hydroelectric Project shows economic feasibility when compared with the cost of purchasing the same amount of power over the initial ten years of Project operation. The 7% rate can also be regarded as a combination of 5% and 9% money. In fact using the REA test for minimum economic feasibility the project would breakeven for the first 10 year summation of benefits and costs of an interest rate of 7.2% (i.e. 45% at a 5% interest rate and 55% at a 9% rate). However, if only 9% REA financing is available, the Project does not show economic feasibility over the the ten year

period. Further the Project does not show economic feasibility with DOE financing (under the National Energy Act) if the 25% component is at a 9% interest rate. It is probable, however, that if the 25% component could be obtained at a 7% or less interest rate that this would also indicate economic feasibility for the Project.

MAXWELL HYDROELECTRIC PROJECT
BASIC ASSUMPTIONS FOR ECONOMIC ANALYSIS
(JANUARY 1985 LEVEL)

PROJECT: (1)

On-Line Date	1/85
Economic Life	50 years
Loan Alternatives	
a. REA	35 years at 7% interest with 7 year deferral of principal (or a combination loan of half at 5% and half at 9% interest)
b. REA	35 years at 9% interest with 7 year deferral of principal
c. DOE	30 years with 75% at 7-1/8% and 25% at 9% interest
Working Capital	45 days of O & M
Operation and Maintenance	\$15.00/kW
Administration and General	39% of O & M
Insurance	0.1% of Total Investment
Interim Replacements	0.3% of Total Investment
Property Taxes	none
Transmission Losses - Peak	4%
Transmission Losses - Energy	2.5%
Escalation Rate for Operating Costs	7%
Forced Outage Reserves	5%
Discount Rate for Present Worth	
Analysis	7%

POWER PURCHASE ALTERNATIVE

Capacity and Energy Costs	Table IX-2
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(1) Operating costs shown are for the first year of operation, 1985.

MAXWELL HYDROELECTRIC PROJECT
PROJECTED RATES OF WEST PENN POWER COMPANY

ALLEGHENY ELECTRIC COOPERATIVE, INC.

LOAD SERVED BY WEST PENN^{/1}

<u>Year</u>	<u>Load</u> MW	<u>Energy</u> GWH	<u>Capacity Cost</u> ^{/2} \$/kW/Yr.	<u>Energy Cost</u> mills/kWh
1979	36.4	158.6	83.44	15.54
1980	34.4	142.0	92.07	16.42
1981	33.9	134.4	93.48	17.28
1982	32.4	119.9	94.98	18.42
1983	31.2	107.1	95.97	19.65
1984	30.4	96.1	97.57	21.21
1985	30.1	87.1	99.90	23.66
1986	30.3	80.2	100.98	25.20
1987	31.0	75.5	102.52	26.58
1988	32.2	73.2	103.97	27.84
1989	35.6	82.2	122.54	29.33
1990	42.3	109.7	123.84	30.69
1991	51.3	149.1	149.98	32.39
1992	61.2	192.7	151.32	34.01
1993	72.0	240.0	217.57	34.98
1994	83.0	288.4	217.02	36.73

/1
/2

Net of Plesants Capacity and Energy
Excludes Transmission Wheeling Charges

MAXWELL HYDROELECTRIC PROJECT

ESTIMATED COSTS - FIRST PROJECT YEAR

	<u>REA Financing</u>		<u>DOE Financing</u>
CAPITAL COSTS	<u>7%</u>	<u>9%</u>	<u>7-1/8%-9%</u>
Total Investment Cost	\$17,801,000	18,134,000	17,899,000
Working Capital	<u>15,000</u>	<u>15,000</u>	<u>15,000</u>
TOTAL CAPITAL REQUIREMENTS	\$17,816,000	18,149,000	17,914,000
<u>ANNUAL COSTS</u>			
<u>AMORTIZATION OF DEBT</u>			
Interest Payment	\$ 1,247,000	1,633,000	-----
Debt Service	<u>-----</u>	<u>-----</u>	<u>1,531,000</u>
TOTAL AMORTIZATION COSTS	\$ 1,247,000	1,633,000	1,531,000
<u>OPERATING COSTS (1)</u>			
Operation and Maintenance	\$ 120,000	120,000	120,000
Administration & General	47,000	47,000	47,000
Insurance	18,000	18,000	18,000
Interim Replacements	54,000	54,000	54,000
Taxes	<u>-----</u>	<u>-----</u>	<u>-----</u>
TOTAL OPERATING COSTS	\$ 239,000	239,000	239,000
TOTAL ANNUAL COSTS	\$ 1,468,000	1,872,000	1,770,000

(1) All costs are for 1985, the first year of operation.

MAXWELL HYDROELECTRIC PROJECT
ANNUAL PROJECT COSTS (1)

Year	REA Financing at 7%			REA Financing at 9%			DOE Financing		
	Debt Service	Operating Costs	Total Costs	Debt Service	Operating Costs	Total Costs	Debt Service	Operating Costs	Total Costs
1985	\$1,247,000	\$239,000	\$1,486,000	\$1,633,000	\$239,000	\$1,872,000	\$1,474,000	\$239,000	1,770,000
1986	1,247,000	256,000	1,503,000	1,633,000	256,000	1,889,000	1,474,000	256,000	1,787,000
1987	1,247,000	274,000	1,521,000	1,633,000	274,000	1,907,000	1,474,000	274,000	1,805,000
1988	1,247,000	293,000	1,540,000	1,633,000	293,000	1,926,000	1,474,000	293,000	1,824,000
1989	1,289,000	313,000	1,602,000	1,633,000	313,000	1,977,000	1,474,000	313,000	1,844,000
1990	1,375,000	335,000	1,710,000	1,727,000	335,000	2,062,000	1,474,000	335,000	1,866,000
1991	1,468,000	359,000	1,827,000	1,794,000	359,000	2,153,000	1,474,000	359,000	1,890,000
1992	1,468,000	384,000	1,852,000	1,794,000	384,000	2,178,000	1,474,000	384,000	1,915,000
1993	1,468,000	411,000	1,879,000	1,794,000	411,000	2,205,000	1,474,000	411,000	1,942,000
1994	1,468,000	439,000	1,907,000	1,794,000	439,000	2,233,000	1,474,000	439,000	1,970,000

(1) Total of debt service and operating costs.

MAXWELL HYDROELECTRIC PROJECT
PROJECT BENEFITS AT WEST PENN POWER RATES

<u>Year</u>	<u>Item</u>	<u>Benefits</u>	<u>Sum of Benefits</u>
1985	Capacity (1)	\$466,000	
	Energy (2)	849,000	\$1,315,000
1986	C	471,000	
	E	904,000	1,375,000
1987	C	479,000	
	E	954,000	1,433,000
1988	C	485,000	
	E	999,000	1,484,000
1989	C	572,000	
	E	1,052,000	1,624,000
1990	C	578,000	
	E	1,101,000	1,679,000
1991	C	700,000	
	E	1,162,000	1,862,000
1992	C	706,000	
	E	1,220,000	1,926,000
1993	C	1,016,000	
	E	1,255,000	2,271,000
1994	C	1,013,000	
	E	1,318,000	2,331,000

(1) Based on 4,668 kW delivered at load centers.

(2) Based on 35,880,000 kWh delivered at load centers.

MAXWELL HYDROELECTRIC PROJECT

PRESENT WORTH ANALYSIS - REA FINANCING AT 7%

<u>Calendar Year</u>	<u>Project Cost</u>	<u>Project Benefits</u>	<u>Net Benefits</u>	<u>Accumulated Net Benefits</u>	<u>Accumulated Present Worth of Net Benefits (1)</u>
1985	\$1,486,000	\$1,315,000	\$ - 171,000	\$ - 171,000	\$ - 165,000
1986	1,503,000	1,375,000	- 128,000	- 299,000	- 281,000
1987	1,521,000	1,433,000	- 88,000	- 387,000	- 355,000
1988	1,540,000	1,484,000	- 56,000	- 443,000	- 399,000
1989	1,602,000	1,624,000	22,000	- 421,000	- 383,000
1990	1,710,000	1,679,000	- 31,000	- 452,000	- 404,000
1991	1,827,000	1,862,000	35,000	- 417,000	- 381,000
1992	1,852,000	1,926,000	74,000	- 343,000	- 336,000
1993	1,879,000	2,271,000	392,000	49,000	- 115,000
1994	1,907,000	2,331,000	424,000	473,000	108,000

(1) Discounted at 7%; 1985 level.

MAXWELL HYDROELECTRIC PROJECT

PRESENT WORTH ANALYSIS - REA FINANCING AT 9%

<u>Calendar</u> <u>Year</u>	<u>Project</u> <u>Cost</u>	<u>Project</u> <u>Benefits</u>	<u>Net</u> <u>Benefits</u>	<u>Accumulated</u> <u>Net Benefits</u>	<u>Accumulated</u> <u>Present Worth of</u> <u>Net Benefits (1)</u>
1985	\$1,872,000	\$1,315,000	\$-557,000	\$- 557,000	\$- 538,000
1986	1,889,000	1,375,000	-514,000	-1,071,000	-1,002,000
1987	1,907,000	1,433,000	-474,000	-1,545,000	-1,402,000
1988	1,926,000	1,484,000	-442,000	-1,987,000	-1,751,000
1989	1,977,000	1,624,000	-353,000	-2,340,000	-2,011,000
1990	2,062,000	1,679,000	-383,000	-2,723,000	-2,275,000
1991	2,153,000	1,862,000	-291,000	-3,014,000	-2,462,000
1992	2,178,000	1,926,000	-252,000	-3,266,000	-2,614,000
1993	2,205,000	2,271,000	66,000	-3,200,000	-2,577,000
1994	2,233,000	2,331,000	98,000	-3,102,000	-2,525,000

(1) Discounted at 7%; 1985 level.

MAXWELL HYDROELECTRIC PROJECT

PRESENT WORTH ANALYSIS - DOE FINANCING

Calendar Year <u>Period</u>	<u>Project Cost</u>	<u>Project Benefits</u>	<u>Net Benefits</u>	<u>Accumulated Net Benefits</u>	<u>Accumulated Present Worth of Net Benefits (1)</u>
1985	\$1,770,000	\$1,315,000	\$-455,000	\$- 455,000	\$- 440,000
1986	1,787,000	1,375,000	-412,000	- 867,000	- 812,000
1987	1,805,000	1,433,000	-372,000	-1,239,000	-1,126,000
1988	1,824,000	1,484,000	-340,000	-1,579,000	-1,394,000
1989	1,844,000	1,624,000	-220,000	-1,799,000	-1,566,000
1990	1,866,000	1,679,000	-187,000	-1,986,000	-1,685,000
1991	1,890,000	1,862,000	- 28,000	-2,104,000	-1,703,000
1992	1,915,000	1,926,000	11,000	-2,003,000	-1,696,000
1993	1,942,000	2,271,000	329,000	-1,674,000	-1,511,000
1994	1,970,000	2,331,000	361,000	-1,313,000	-1,321,000

(1) Discounted at 7%; 1985 level.

SECTION X

ENVIRONMENTAL CONSIDERATIONS

1. GENERAL

a. Purpose

This section evaluates the potential for significant adverse environmental impacts created by the addition of the proposed hydro generation to Maxwell Locks and Dam. Adverse environmental impacts are emphasized because they generally have more effect on the Project than beneficial impacts.

Hydroelectric power has beneficial impacts compared to some other forms of electrical energy generation because it is a clean energy source. The relative cost of hydroelectric power as compared to power sources dependent on oil has become more favorable since the oil embargo. The cost effectiveness of the Maxwell Project is discussed elsewhere in this report. Suffice to say that hydroelectric energy generation can have a positive impact.

b. Process

An on-site evaluation was made in December 1978. From on-site observations and discussions with relevant agencies, a basic outline of issues and sources was constructed. Follow up telephone conversations and data acquisition was made on those issues believed to be significant. Excerpts from this data acquisition process form the basis of information for this section.

c. Potentially Significant Resources - Definition

Environmental resources be they physical, social or economic, are potentially significant in relation to a proposed project if, as a consequence of the construction or operation of the

project, the resource is increased, decreased or changed in character. For instance, in the case of a small hydroelectric project (such as Maxwell), dissolved oxygen levels could be decreased due to the change in water discharge from the surface of a gated dam structure to a submerged discharge. Energy would be a commodity which would be increased by such a project. Visual impacts associated with the power substation and transmission line might be a good example of a resource which would be changed in character.

2. ENVIRONMENTAL RESOURCES RELATED TO THE PROJECT

a. Construction Phase

An access road to the east bank would be constructed from the top of the riverbank off a local roadway, cross the Conrail Railroad via an overpass and approach the dam site from the north. The upper portion of the roadway would follow the south side of a natural drainage swale (see Fig. 2 for the approximate roadway location). The riverbank is relatively steep at the proposed roadway location, and the difference in elevation between the top of the bank and the lower roadway is about 190 feet. The lower portion of the road would be parallel to the railroad track.

Clearing and grading operations on this steep slope would provide a relatively erosion-prone source of sediment. During periods of rainfall, heavy sediment loads could be carried to the Monongahela River upstream from the present dam. To the extent that natural vegetation became re-established along the steep slopes along the roadway, the severity of this impact would be reduced. Attention should be given to ensure natural drainage patterns along the roadway are not interrupted and that excessive water pooling or backup does not occur.

Construction of a mile long transmission line between the generating unit and its existing 25 kV distribution line State Route 88 would be required. It is planned to locate the transformer and circuit breakers required at the powerhouse. The transmission line would probably be a wooden pole line.

Installation of generating facilities in the existing Maxwell Dam would require construction of a cofferdam near the east bank and dewatering of this portion of the river channel. Water discharged during the dewatering activity is likely to increase the turbidity of the Monongahela River.

Machinery used during construction will constitute a source of noise and air pollution but there is no habitation within 1/4 mile of the project.

Maximum labor force is not expected to exceed 100 persons. Impacts of this increased work force on the surrounding communities include increased housing demand, increased use of public facilities such as hospitals, and an increase in local retail trade for items such as food and clothing.

b. Operation and Maintenance

(1) Dissolved Oxygen

Description: Oxygen from the atmosphere enters a body of water at the surface. In general, flow velocity and turbulence are important factors affecting the transfer of oxygen to the water. The amount of oxygen which can be held in the water is a function of temperature, the higher the temperature the less dissolved oxygen that can be held. Generally, dissolved oxygen concentrations in unpolluted surface waters range from about 11 mg/l to 6 mg/l.

Importance: Inadequate dissolved oxygen levels in the water are detrimental to fish and other aquatic life which uses the oxygen in the water for respiration. In addition to its role in sustaining aquatic life, dissolved oxygen is used in the decomposition (oxidation) process.

Impact: Several studies of dam effects on river reaeration have been done. Damming a river causes flow velocities to decrease in the pool behind the dam, thus reducing the transfer rate of atmospheric oxygen to the water. For instance, field studies on the pool above Markland Dam on the Ohio River showed a decrease of about 30% in the waste assimilative capacity after the dam was built to replace five low head wicket dams (Corps of Engineers, 1975). This effect very likely occurred on the Monongahela River when the original system of navigation locks and dams was built in the last half of the 19th century and early 1900's.

Although the overall effect in the dam pool is to decrease dissolved oxygen (DO) levels over free flowing conditions, downstream from dams reaeration may occur depending on the type of discharge. In a study by Haller (1970) flow through moveable gated structures (such as those at the Maxwell Locks and Dam) on the Ohio River was found to be a significant source of oxygen reaeration. Broad crested overflow structures are expected to be less effective aerators than moveable gated underflow structures (Corps of Engineers, 1975).

In another study done in 1973 of reaeration downstream of the McAlpine Locks and Dam on the Ohio River, flows through the hydro plant showed an increase of between .2 - .6 mg/l DO which was not affected appreciably by the magnitude of discharge. However, flows through the lower gate discharge point showed DO levels approaching saturation on all days studied. The study concluded that dissolved oxygen concentrations downstream from the dam could be increased if flows were discharged through the lower gates

rather than the hydro plant. (Report of investigation of reaeration of Ohio River, McAlpine Locks and Dam.)

A survey of water quality on the Monongahela River in 1975 found no dissolved oxygen deficiencies between river miles (RM) 25 - 90 (the Maxwell Locks and Dam are at RM 61.2) in late July during low flow conditions. Below RM 25 low DO concentrations (below 6 mg/l) were observed in some pools and low DO caused by stratification was observed in the two upper pools. Limited reaeration was observed below some structures, particularly at Locks and Dam 2 and 3. However, no structure was considered to have the reaeration potential observed at some structures on the Ohio River. This was attributed to the difference in low flow characteristics of the two rivers, the Monongahela being a low yielding stream at base flow (U.S. Corps of Engineers, 1976).

The proposed hydro plant on the Maxwell Dam would use an average flow of about 3,750 cfs through the turbines. During high flows water would be spilled. During low flows water for lockage and leakage would always be met first. Depending on the number and size of turbines installed, a minimum flow anywhere from 2,000 cfs to 750 cfs above that required for lockage and leakage would be needed to operate the plant. If flows were lower than the required level, the plant would be shut down and the water spilled.

Although the above mentioned studies on the Ohio River show that lower gates increase the DO more than the turbines installation on that location, it is not considered that these results have direct application to Maxwell. The Project site has a broad crested overflows structure, not a lower gate, and the type of turbine is not the same.

Even if the DO is decreased by turbine operation, the magnitude of this effect is not expected to be great, but considering the fact that downstream DO problems occur, it should be studied in more detail in the future to establish its importance and if necessary, any premedial measures.

(2) Aquatic Biology

Water quality investigations conducted from 1967-1973 on the Monongahela River found that the number of fish present in the river is increasing. In 1967 no fish were found when the Maxwell Locks were sampled. In 1973 sixteen fish were found (Corps of Engineers, 1975). These numbers may indicate a general improvement in the ability of the river to provide an acceptable habitat for fish life.

The power intake structure of the proposed hydro plant would not be screened against fish damage, although a trashrack would be provided to prevent damage to the machinery. Although the number of fish is small, fish entrainment is therefore considered an impact of the project as proposed.

(3) Terrestrial Biology

Construction of the Project would eliminate about 2 acres of wildlife habitat along the east bank of the Monongahela River. The riverbank in the vicinity of the Project area now supports a deciduous woodland. Dominant trees of the riparian deciduous forest include oak, hickory, maple, birch, and willows (U.S. Corps of Engineers, 1975, p. 38). No survey of vegetation near the study area was conducted. Generally, vegetation is more diverse (and thus has more value for wildlife habitat) along riverbanks and in floodplain areas than in upland regions (Corps of Engineers, 1975, p. 83).

Removal of vegetation in the Project area would result in some direct habitat loss and a general degradation in the usefulness of habitat for wildlife. Species which may be affected (based on information contained in the Final Environmental Statement for the Monongahela Navigation System, 1975) include warblers, kingfisher, vireos, cedar waxwings, mice and voles, rabbits, squirrels, racoon, and several species of amphibians and reptiles.

(4) Water Quality

Increased sedimentation caused during construction of the roadway along the steep river bank will contribute to a minor extent to the sediment load in the Monongahela River.

Mitigation: Bank stabilization, revegetation, and provision of culverts to intercept runoff could mitigate sedimentation impacts.

(5) Traffic

Traffic in the area would be limited since the plant will be operated remotely.

(6) Visual

The switching equipment and electrical transmission lines which may be built from the hydro plant to the Town of Vestaburg about 2 miles away, or to an existing power line along State Route 88, would be a change from the naturalness of the existing river-bank area. To the extent that people dislike the intrusion of man-made structures in the environment, a visual impact may result.

(7) Natural Resources

The Maxwell Project would generate about 35,000,000 kW of electricity per year. If used as a replacement for other fossil fuels, this hydroelectric project would save about 3,500,000 gallons of fuel oil per year. Over the life of the project of 50 years, about 3.2 million barrels of oil could be saved; a significant contribution to conservation of the nation's depletable resources.

3. SUMMARY

There is the potential for an impact on the DO content of the river due to the reaeration characteristics of the hydraulic turbines. Although reaeration below dams on the Monongahela River is not considered to be as pronounced an effect as in the Ohio River system due to the lower base flows of the Monongahela, dissolved oxygen problems in the lower 25 river miles do exist and reaeration upstream contributes to the control of the problem. This subject will be studied in more detail as part of the FERC Licensing.

SECTION XI

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS

From this feasibility assessment of the Maxwell Hydro-electric Project it is concluded that:

a. The basic arrangement of the Project will consist of an intake structure, open canal and powerhouse, located on the east side of the existing Maxwell Locks and Dam on the Monongahela River.

b. Preliminary indications are that the most economic arrangement of the powerhouse will include four vertical units of 2-MW each in a modified open-flume setting with conical draft tubes.

c. The selected Project arrangement is technically feasible, but the site has physical constraints due to the limited space between the locks and the railroad. Rock anchorage will be critical for the slope stability of the required excavations.

d. The Project will have an installed capacity of 8,000 kW and will generate 35.9 million kWh of energy on an average annual basis delivered to the load center. The Project will be capable of providing an average annual capacity of 4,914 kW at the load center.

e. For the scheduled on-line date of January 1985 the Project is estimated to have a Total Investment Cost of \$17,801,000, assuming REA financing at 7% interest rate. With REA financing at

9% the Total Investment Cost is estimated to be \$18,134,000. With a loan under the new National Energy Act administered by DOE, at 7-1/8% interest on 75% of the Project cost, and conventional financing at 9% on the balance, the estimated Total Investment Cost is \$17,899,000.

f. Economic feasibility was studied by the comparison of the Project estimated cost with the projected cost of continued power purchases equal to the power output of the Project, with financing from loans from three alternative sources. These alternatives are 7% and 9% interest rate REA loans, and financing under the National Energy Act, referenced to as 7-1/8% DOE financing.

g. With costs based on REA financing at 7%, and benefits based on the projected power rates of West Penn Power Company, benefits begin to exceed the costs during the fifth year of operation and the accumulated present-worth (1985 level) becomes positive during the tenth year of the anticipated 50-year Project life. With the alternative of 9% REA and 7-1/8% and 9% DOE financing, the accumulated present worth values show that the project benefits are less than the costs, which indicates lack of viability.

h. Since the project shows a savings over continued power purchases with 7% REA financing it is therefore regarded as economically feasible if this financing can be obtained. This is so even though the first year benefit-cost ratio is well below unity. Also it is probable that economic feasibility could be obtained with 7-1/8% DOE financing, if the 25% portion could be financed at a 7% or less interest rate. The feasibility of the Project will be eliminated if Federal dam-user fees are charged.

i. Construction and operation of the Project will not result in any significant adverse environmental effects.

j. The Project shows sufficient promise of feasibility to justify proceeding with the recommended additional investigations. This effort should be initiated as soon as possible so that if the Project continues to show feasibility, the evaluation studies and FERC licensing may proceed according to the proposed development schedule for completion of the Project by January 1985.

2. RECOMMENDATIONS

It is recommended that:

a. Allegheny respond to the second PON (DOE Program Opportunity Notice) whereby a grant may be obtained to defray up to 25 percent of the cost of installing generating facilities. This is expected to be announced in April 1979 with proposals submitted by about June 1979.

b. An application be made to obtain a low interest loan under Title IV, Small Hydroelectric Power Projects of the Public Utilities Regulatory Policies Act (part of the new) National Energy Act), to defray up to 90 percent of the costs of feasibility studies and preparation of a License Application.

c. Discussions be held with REA regarding obtaining low interest (7% or less) financing for development of the Project.

d. If the REA discussions on financing are positive, application be made to the FERC for a Preliminary Permit to establish priority on the site and to undertake the next stage of the investigations.

e. Further discussions should be held with the Corps to clarify the situation on Federal dam-user fees.

f. Detailed evaluation studies be initiated leading to preparation of a License Application, assuming that suitable financing can be obtained.

NOTE: MILE 0.0 IS AT THE MOUTH OF THE MONONGAHELA RIVER AT PITTSBURGH, PA.

LEGEND

- Canalized Section
- Lock & Dam (Existing)
- Dam

NOTE:

Map reproduced from Monogahela River navigation projects, annual water quality report USCE, 2/76.

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ALLEGHENY ELECTRIC COOPERATIVE
HARRISBURG, PENNSYLVANIA

MAXWELL HYDROELECTRIC PROJECT

LOCATION MAP

DATE: March 1979

DRAWN: PJG

APPROVED: RM

FIG: 1

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MAXWELL HYDROELECTRIC PROJECT

AREA MAP

DATE:
March 1979

DRAWN:
PJG

APPROVED:
RM

FIG: 2

SECTION THROUGH LOCKS

NON-OVERFLOW GATE SECTION
(NO'S 2 & 3 RT. to LT.)

VICINITY MAP

FAYETTE CO.
PENNSYLVANIA

PLAN

MOVABLE-CREST GATE SECTION
(NO'S 1, 4 & 5 RT. to LT.)

UNITED STATES PROPERTY

NOTE

Drawing reproduced from project data for periodic inspection USCE Maxwell Lock and Dam Monongahela River.

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MAXWELL HYDROELECTRIC PROJECT

EXISTING MAXWELL LOCKS AND DAM

DATE: March 1979 DRAWN: PUG APPROVED: RM FIG: 3

HEADWATER AND TAILWATER CURVES

NOTES:

1. Gross Head = Headwater elevation - tailwater elevation at Maxwell Locks and Dam based on data from U.S. Army Corps of Engineers.
2. Assumed head loss 1.0 foot for tube and 1.5 feet for vertical units.

FLOW-DURATION, GROSS HEAD AND POWER OUTPUT VS. PERCENT TIME

3. Available discharge is based on mean daily or mean monthly records (1934-1972) from Charleroi Gage, adjusted to Maxwell Project, less 570 CFS for lockage and leakage.

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MAXWELL HYDROELECTRIC PROJECT

HYDRAULIC DATA

DATE: March 1979

DRAWN: PJG

APPROVED: RM

FIG: 4

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MAXWELL HYDROELECTRIC PROJECT
ANNUAL ENERGY VERSUS
PLANT CAPACITY

DATE:
March 1979

DRAWN:
PJG

APPROVED:
RM

FIG: 5

LEGEND

- Existing Structure
- Existing Structure - Concealed

20' 0 20'
Scale

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ALLEGHENY ELECTRIC COOPERATIVE
HARRISBURG, PENNSYLVANIA
MAXWELL HYDROELECTRIC PROJECT
PROJECT ARRANGEMENT
TUBE UNIT ALTERNATIVE

DATE: March 1979	DRAWN: PJG	APPROVED: RM	FIG: 6
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Member Co-op	No. of Consumers	Miles of Line	Consumers per Mile of Line	Total KWH Purchased	Annual Peak Demand
Adams	14,016	2,057	6.8	180,948,800	47,603
Bedford	6,052	988	6.1	72,523,736	17,923
Central	18,576	2,681	6.9	152,502,600	34,136
Claverack	11,106	2,141	5.2	128,312,467	32,352
New Enterprise	2,319	235	9.9	29,712,800	7,452
Northwestern	13,460	2,111	6.4	170,515,212	41,317
Somerset	8,545	1,696	5.0	126,810,200	31,418
Southwest Central	15,156	2,014	7.5	188,639,742	43,647
Sullivan	3,957	702	5.6	35,654,607	9,972
Sussex	6,561	375	17.5	68,933,500	18,656
Tri-County	12,771	2,441	5.2	106,063,208	30,996
United	13,439	2,451	5.5	108,438,306	27,602
Valley	12,932	1,937	6.7	140,320,900	35,914
Warren	7,311	931	7.9	37,967,132	11,482
TOTAL	146,201	22,760	6.4	1,547,343,210	390,470

NOTE:

Data reproduced from Allegheny Annual Report 1977.

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ALLEGHENY ELECTRIC COOPERATIVE
HARRISBURG, PENNSYLVANIA

MAXWELL HYDROELECTRIC PROJECT

SYSTEM LOADS AND RESOURCES

DATE:
March 1979

DRAWN:
PJG

APPROVED:
RM

FIG:
8

NOTES

1. Project annual cost with a 35 year REA loan at 7%, or half at 5% and half at 9%.
2. Project annual cost with a 35 year REA loan at 9%
3. Project annual cost with a 30 year DOE loan at 7-1/8 % for 75% of the total loan, and the balance at 9% with a 30 year conventional loan.
4. Project benefits based on West Penn Power Company wholesale power costs as projected by Southern Engineering Company.

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ALLEGHENY ELECTRIC COOPERATIVE
HARRISBURG, PENNSYLVANIA

MAXWELL HYDROELECTRIC PROJECT

ECONOMIC COMPARISON

PROJECT COSTS AND BENEFITS

DATE:
March 1979

DRAWN:
P/JG

APPROVED:
RM

FIG: 9

LEGEND

- Major effort
- Continuing effort

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ALLEGHENY ELECTRIC COOPERATIVE
HARRISBURG, PENNSYLVANIA

MAXWELL HYDROELECTRIC PROJECT

DESIGN AND CONSTRUCTION SCHEDULE

DATE: March 1979	DRAWN: PJG	APPROVED: RM	FIG: 10
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APPENDIX A

MAXWELL HYDROELECTRIC PROJECT

PENNSYLVANIA

GEOTECHNICAL OBSERVATIONS

By

Kim de Rubertis

February 1979

KIM DE RUBERTIS
CONSULTING ENGINEER

Mr. Richard Mascolo
R. W. Beck and Associates
200 Tower Building
Seattle, Washington 98101

February 15, 1979

Gentlemen:

The purposes of this letter are to report the results of a geologic reconnaissance of the site of the existing Maxwell Locks and Dam and to describe the site geology and how it relates to the design for the proposed project features.

General

Maxwell Locks and Dam are located on the Monongahela River near Vestaburg, Pennsylvania. A reconnaissance was made of the site on 7 December 1978 in the company of Mr. Derby and Ms. Maykut of R. W. Beck and Associates.

The existing project consists of a pair of navigation locks at the right bank and a 460-ft long, 19.5-ft high gated concrete spillway structure spanning the river from the locks to the left abutment.

The proposed project would site a powerhouse at the left bank of the river between Pier No. 6 and the railroad.

Reviewed in the preparation of this letter were several as-built drawings prepared by A. M. Kinney, Inc. for the Pittsburgh District of the Corps of Engineers.

Regional Geology

Maxwell Locks and Dam are located within the Kanawha Plateau Region of the Appalachian Plateau Province of North America.

February 15, 1979

Geologic History The geologic history of the region is characterized by sedimentation upon the Precambrian basement throughout the Paleozoic era followed by widespread deformation during the Appalachian Revolution. Erosion has been the dominant process since the deformation produced the series of folds reflected in the ridges and valleys of the region. Drainage patterns were interrupted and, to some extent, changed during various episodes of glaciation during the Pleistocene.

Stratigraphy The rocks exposed in the region range from Devonian to Permian in age. Devonian rocks consist mainly of shales and sandstones. Sandstones, shales and limestones characterize the Mississippian. Coal, along with shales and limestones, is typical of the Pennsylvanian deposits. Permian sandstones close the stratigraphic record indicating the onset of regional deformation and erosion. Other than thin deposits of residual soils and colluvium, the alluvium deposited along the major drainages provides the only substantial overburden in the region.

Geologic Structure The region presents a succession of nearly parallel folds trending northeast-southwest. For the most part, ridges are anticlines and valleys are synclines. The ridges gain altitude and consequently fold amplitude from west to east with a general direction of plunge to the southwest. Although minor faulting has been observed associated with folding, faulting of a regional nature has not been recognized at the surface.

Earthquake Hazard As shown on the attached Figure 1, the site is located within seismic hazard zone 1 as designated by the Corps of Engineers. Earthquake hazard is considered minor and is not believed to have an influence upon the future stability of existing structures or upon the design for the proposed project features.

Site Geology

The site occupies the Monongahela River valley with the upper navigation pool extending upstream to Lock No. 7.

Geologic History Paralleling the regional history, the site displays a record of Paleozoic deposition followed by folding and erosion. The site was not glaciated during the Pleistocene.

Stratigraphy At the site are Pennsylvanian rocks of the Monongahela and Conemaugh Formations. These consist of alternating layers of siltstone, sandstone, shale, limestone, and coal. The contact between Monongahela and Conemaugh occurs at the base of the Pittsburgh coal, about elevation 760 at the site.

February 15, 1979

Geologic Structure The site lies on the west flank of the Port Royal syncline, a weak fold of low amplitude. Dips of strata at the site are gentle, flat to a few degrees to the northwest. Neither localized folds nor faults were noted during the reconnaissance. Two sets of tight joints striking northeast and northwest and spaced about two ft. were observed.

Original Design and Construction

A number of as-built drawings prepared for the Corps of Engineers were reviewed. The drawings revealed that a prudent job of exploration was accomplished prior to design and that the major project features were well conceived and constructed relative to the geology of the site.

Current Condition

The dam and locks appear to be in excellent condition. A representative of the Corps of Engineers operating crew, Mr. D. L. Dillon stated that some distress had been noticed in the riverward lock wall. He attributed the distress to settlement. The relocation of the railroad on the left bank occasioned a steep cut (est 1:3) in the abutment, and this cut has performed well for nearly 15 years. Less stable has been the left bank at the river which exhibits progressive erosion into a prominent coal bed which results in undercutting and failure of the overlying sandstone.

Proposed Project

The proposal to construct an intake, water conductor, and powerhouse involve several geologic considerations.

Excavation in rock between Pier No. 6 and the railroad track for an intake and water conductor involves substantial stability questions, particularly to the extent that such excavation is carried below the lower pool elevation of 743.5. Excavation below this level will require measures to insure the stability of Pier No. 6 and the railroad, measures which will include installation of high-strength anchors prior to excavation and will involve continuous slope reinforcement during excavation. From a geological point of view, minimizing excavation in the area between Pier No. 6 and the railroad would be desirable. Such excavations as may be required should be designed with a view toward their exposure. Those slopes above normal tailwater to receive concrete backfill within a short period of time following excavation will not require extensive reinforcement and may be vertical or nearly vertical. Slopes permanently exposed may be cut to an overall 1:3, suitably reinforced. Benching may be required where weak beds are encountered. Tightly controlled light blasting methods will be required to prevent damage to the existing structure and to preserve existing and excavated slopes.

February 15, 1979

The logs of both the A and D series of boring (Corps Drawings 037-Lma 40/142, 10/13, and 10/14) in the area of the proposed work indicate both coal and indurated clay at various elevations in the foundation. To the extent possible, care should be exercised to avoid founding the powerhouse on such materials. It appears that siltstones offer the best available foundation in the range of elevation being considered.

Drawing 40/142 indicates a cutoff wall in the left abutment. If disturbed, this wall should be restored.

Some consideration should be given to protecting the weaker beds, coal and shale, along the left bank from continued erosion which might threaten the stability of the bank. Protective measures may involve riprap and/or concrete dental work.

Access to the proposed powerhouse is planned from the top of the left abutment hill upstream from the existing dam. The maximum permissible grades are not known; however, it is suggested that as much descent as possible be accomplished within the side valley. Long diagonal cuts across the face of the abutment hill will involve large excavation volumes and may raise long-term stability and maintenance problems.

The proposed project features appear to be feasible from the geologic point of view. Prior to final design, it is suggested that a modest program of exploration be accomplished to obtain certain critical design parameters. The nature and quality of the powerhouse foundation and the geometry and reinforcement requirements for permanent slopes should be investigated in some detail.

Thank you for this opportunity to participate in the planning for Maxwell Hydroelectric Project. If you have any questions concerning this letter, please let me know.

Yours very truly,

Kim de Rubertis

GEOTECHNICAL OBSERVATIONS

Figure 1