AN ASSESSMENT OF THE OFFSTREAM STORAGE REQUIREMENTS AND LOW-FLOW FREQUENCIES CHARACTERISTICS TO SUPPLY COAL SLURRY PIPELINES ORIGINATING IN SOUTHWESTERN VIRGINIA

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1. INTRODUCTION

The increasing importance of the coal industry has brought about new methods and technology to improve its traditional mining, processing and distribution systems. In particular, due to its technical reliability and apparent economic and environmental advantages, the slurry pipeline mode of coal transportation has gained increasing interest as an alternative to the conventional modes of transportation.

The region of Virginia, West Virginia and Kentucky is one of the major coal producing areas in the USA. There also exists the Hampton Roads area in Virginia, which has the largest coal exporting facilities on the East coast. The distance separating the coal producing areas and the Hampton Roads area is about 400 miles. Large coal production, long transporting distances, and relatively good distribution facilities have been found to be the three main general factors which would make a coal slurry pipeline cost efficient.

Another important factor to be considered for a coal slurry pipeline to be feasible is the availability of adequate amounts of water for pipeline utilization, with minimum impact on the environment. A report on the feasibility of coal slurry pipelines in Virginia was published in 1982, In one of the recommendations of this report it is stated that: "...the region seems quite manageable hydrologically from water resources point of view, namely to provide adequate supply of water for the slurry pipeline. However, a detailed study would be recommended not only to fully investigate the hydrologic characteristics of the region but also to assess the economics of various water supply alternative systems ...". The present work was undertaken to partially address the above recommendation.

The scope of the present study was restricted mainly to the determination of the capacity and reliability of offstream or man-made reservoirs using the historical stream flow data available. No attempt was made toward the evaluation of other technical aspects such as environmental impacts, availability of groundwater, actual locations of reservoirs, and detailed economics of supporting engineering structures.

Because of the uncertanties concerning the policies of pipeline operation and the relevant water use, the present analysis was designed to provide a spectrum of plausible solutions. For each of a number of annual pipeline capacities, a range of scenarios was applied to the allowable withdrawal from the stream, along with a series of capacity constraints assigned to the intake and conveyance structures. The solutions thus obtained are expected to provide at least a preliminary data base for any conceivable scenario or policy that may apply in the future.

In the subsequent sections, brief accounts are given of the general hydrologic characteristics of the region in Section 3, the data base employed in Section 4, the pipeline requirements, the methodology and the associated computer algorithm applied in this study to basically determine the storage requirements and the associated recurrence intervals, as refered to briefly in the preceding paragraphs and in more detail in sections 2, 5, 6, 7, and 8. The results of the calculations are presented in both tabular and graphical formats wherever appropiate. Finally, following a discussion of the results obtained, conclusions and recommendations are offered for future investigations.

2. OBJECTIVES AND SCOPE OF THE STUDY

The objectives and scope of this study can be summarized as follows :

(1) identification of the streams in the region which may be considered to supply the demand of the planned pipelines with alternative capacities and locations of origins as specified in a previous study [15];

(2) compilation of the natural flow characteristics of these streams based on the historical data available through the HISARS data base and USGS water year 1981 [13];

(3) identification of the scenarios that may be considered appropriate to define allowable withdrawals from each stream, in view of :

(a) minimum possible interaction with the natural stream environment, and,

(b) capacity of the intake and/or conveyance structures;

(4) determination of the capacities of offstream reservoirs, without considering such phenomena as evaporation, precipitation and seepage, required to satisfy the demand of the slurry pipeline on a continuous basis as well as in accordance with the specified scenarios of

withdrawal, by the application of the mass-curve analysis to the virtual stream withdrawal data created from the historical data pertaining to each stream considering the appropiate constrains.

(5) determination of the drought characteristics pertaining to each stream with the use of a partial-duration series analysis;

(6) determination of the recurrence interval characteristics of the offstream reservoir capacities calculated based on the virtual stream drought characteristics using the partial-duration series analysis.

(7) discussion of the results in an effort to provide a basis for :

(a) a preliminary evaluation of the physical availability of water for pipeline use with the specified constraints,

(b) an outlook for future development.

3. STREAMFLOW CHARACTERISTICS OF THE REGION

In view of the coal sources existing in Southwestern Virginia three possible origination points were suggested for the slurry pipeline: namely, Grundy, Pound, and Big Stone Gap [15]. Consequently, streamflow data available for the 13 neighboring gaging stations were considered [13]. The characteristics of these stations are summarized in Table 1. In view of the hydrologic characteristics and the probable pipeline origins in the region, however, only five of the gaging stations were selected for more detailed evaluation. These are indicated in Figure 1.

Data from two monitoring stations were considered on the Levisa Fork, which is the major stream near Grundy. One of these stations (USGS # 0307500), located at Grundy has an average streamflow of 286.0 cfs based on 43 years of records. The maximum discharge recorded is 13,500 cfs, while the minimum discharge being 0.3 cfs. The other station (USGS # 307550) is located at Big Rock, 8 miles dowstream form Grundy. During the 14 year period of records, the average annual streamfow was 396.0 cfs, with a highest daily flow of 56,000 cfs and a lowest daily flow of 5.0 cfs.

The main source of surface water near Pound is the Pound River, which also has on it the North Fork Pound River Lake. This is an artificial lake with a capacity of 11,290 acre-ft developed for multipurpose use, namely for flood control, low-flow augmentation and recreation. Two gaging stations were considered in the hydrological analysis of Pound River. The first station (USGS # 0320880), is located above Indian Creek. Its 16-year records indicate that the minimum daily observed flow is 0.5 cfs, while the maximum is 3,460 cfs. The overall mean daily flow is 61.7 cfs. The second station (USGS # 03208900) is located 6 miles downstream Georges Fork, has measured daily discharges as high as 10,900 cfs and as low as 1.7 cfs. The current daily average discharge is 127.0 cfs according to the record of 18 years.

Another potential source of water to serve either Grundy or Pound is the Russell Fork. Its location is approximately 18 miles from Pound and 12 miles from Grundy. A gaging station at Haysi (USGS # 03208500) shows a current daily average of 333.0 cfs for the recorded period of 55 years. The maximum recorded flood is 59,000 cfs while the lowest recorded flow is 0.2 cfs.

The major source of water supply near Big Stone Gap is

TABLE 1 STREAMFLOW GAGING STATIONS IN THE REGION

Station USGS NO.	Stream Name	Location in VA	lng. rec. mo.	drng area Sq mi	discharge		
					mean cfs	max 1000 cfs	min cfs
03207500	Levisa F.	Grundy	397.	235.	286.	33.2	0.2
03207800	Levisa F.	Big Rock	156.	297.	396.	56.0	5.0
03208000	Levisa F.	Fishtrap	498.	393.	481.	33.0	0.0
03208700	N F Pound	Pound	228.	19.	29.	4.5	0.0
03208800	Pound R.	Indian C.	156.	37.	60.	3.5	0.5
03208900	Pound R.	Georges F	140.	83.	127.	10.9	1.7
032089.5	Cranes N R	Clintwood	204.	66.	83.	18.0	0.5
03209000	Pound R.	Flannagan	492.	221.	277.	50.0	5.5
03208500	Russell F.	Haysi	648.	286.	333.	59.0	0.2
03209200	Russell F.	Barlick	216.	526.	694.	50.0	5.5
03521500	Clinch R.	Richlands	420.	139.	194.	9.6	3.2
03529500	Powell R.	Big S G.	24.	112.	202.	24.0	4.0
03535100	Powell R.	Jonesville	588.	319.	541.	57.0	17.0

△	STREAM GAGING STATIONS
L1	Levisa Fork near Grundy
L2	Levisa Fork at Big Rock
HY	Russell Fork at Haysi
PG	Pound River at Georges Fork
PJ	Powell River at Jonesville

●	PROSPECTIVE PIPELINE ORIGINS
GY	Grundy
PD	Pound
BG	Big Stone Gap

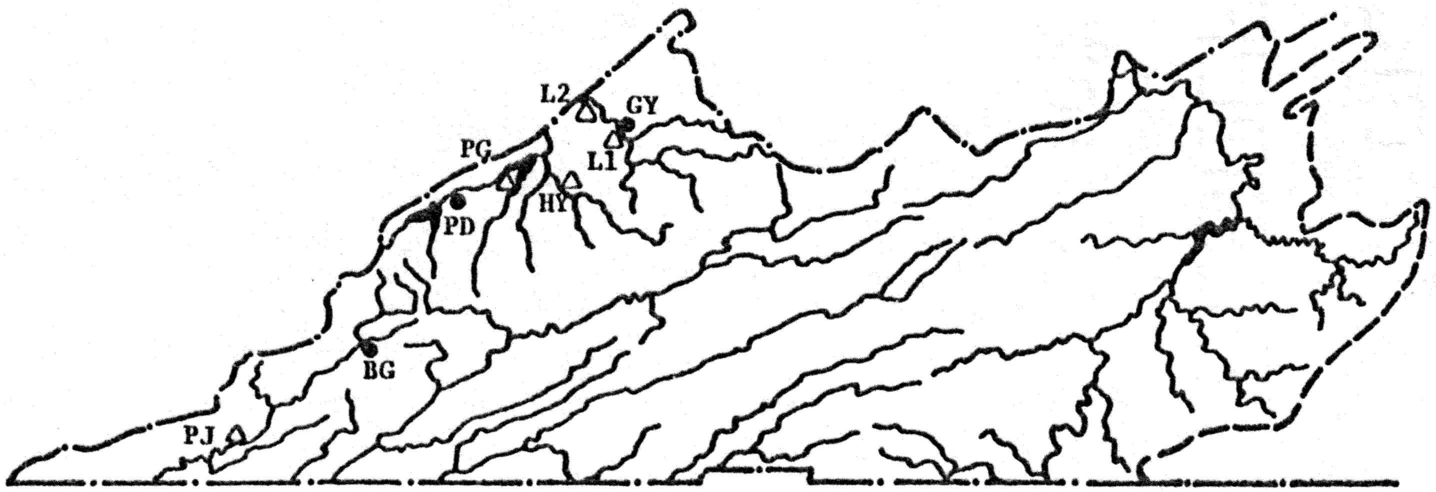


Figure 1 Stream Gaging Stations Evaluated in This Study

the Powell River. A station at Big Stone Gap, (USGS #03529500), has only partial records corresponding to a period of 18 years. These records indicate an average discharge of 202.0 cfs, whereas the maximum and the minimum values are 24,000 cfs and 4.0 cfs respectively. Another station is located at Jonesville (USGS # 03539500), about 19 miles dowstream from Big Stone Gap, with a continuous record of 50 years. The values for the average, maximum, and minimum discharges are 541.0 cfs, 57,000 cfs, and 17.0 cfs, respectively. Its drainage area is 319 sq.mi., which is about three times as large as that of the one at Big Stone Gap, which is 112 sq.mi. With the use of an appropriate factor of adjustment based on the relative sizes of the drainage areas involved, a reasonable interpretation of the Jonesville data could possibly be used in association with the hydrologic analysis of any upstream take-off point near Big Stone Gap.

The above data cearly indicates, that high variability is the predominant characteristic of the streamflows in the region. This is also documented in other studies. In one of these studies [2], Virginia was divided into 27 Hydrologic Planning Areas (HPA's). According to this division, Pound and Grundy are located in the Big Sandy HPA, and Grundy in the Tennessee 1 HPA. It was pointed out in the report that for both areas flooding is a relatively frequent problem, mainly caused by the steep topography as well as the impermeability of the soils of the region. The report also stated that water supply and enviromental problems could be encountered during drought periods. In the region, comsumptive use is low, namely less than 5% of the low flow, with no appreciable growth in domestic or industrial water use predicted for the future. Yet, the low flows of the streams in the region were found to be less than 10% of the average flow, which is a safe instream level for short term survival of the natural habitat in in streams, according to the widely accepted Montana Method. Consequently, the natural high variability of the streams discharges was identified as the main source of flood and drought related problems, and the need for adequate water management was emphasized.

4. HISARS DATA BASE

The main source of data used in the present study consists of streamflow records of USGS gaging stations on five streams in southwestern Virginia, which were directly obtained fromthe Hydrologic Information Storage and Retrieval System (HISARS). This is a computerized data system that allows access and use of various hydrologic information, such as streamflow, rainfall, evaporation, snowfall and temperature. The version of the system used in this study is the one that is implemented for Virginia's gaging stations, prepared by the Virginia Water Resources Research Center on Virginia Tech's computer system.

In addition, HISARS provides a limited analysis of data, such as determination of the main statistical parameters, frequency analysis, rank ordination of data, and mass-curve analysis. However,these processing facilities have some restrictions for use in the present study. For instance, the result of HISARS' mass-curve analysis is merely a plot of the cumulative monthly values. For the purposes of analysis of the various scenarios considered in this study, it was neccessary to develop a specific mass-curve program. On the other hand, the

HISARS' program on frequency analysis for each hydrologic year, is associated with the lowest continuous flow for various selected periods, such as 3 days, 7 days, or 30 days for each hydrologic year. It was considered for this study however, that a partial duration series is a more adequate base for analyzing drought frequencies. Therefore, a program was again developed specifically for the purposes of this study incorporating partial-duration frequency of low flows associated with various periods, namely 1 month through 1 to 12 months (=1 year) at 1 month intervals and furthermore for 15, 18, 24, 30, 36, 48, and 60 months, for the whole periods of record available, rather than only one year at a time.

5. METHODOLOGY

A system to supply water to a coal slurry pipeline originating in southwestern Virginia may be envisaged to have various different features, such as :

(a) use of surface water resources, namely streamflows and already existing reservoirs, with or without additional impoundment for dedicated pipeline use,

(b) use of groundwater resources,

(c) a slurry pipeline system with a second pipeline to return the water back to the pipeline origin for reuse.

Table 2 presents the approximate water requirements for the conceived pipelines as given in a report on the preliminary feasibility of coal slurry pipelines in Virginia [15].

This study deals with only the alternative of utilizing the resources of a nearby stream in association with an offstream impoundment dedicated entirely to the use of the pipeline. As compared to conventional instream reservoirs, offstream reservoirs are considered mainly in view of such advantages as the minimum interaction with the natural stream environment, particularly during low-flow periods, and the highly probable autonomy of pipeline

TABLE 2 APPROXIMATE WATER REQUIREMENTS FOR THE PROSPECTIVE COAL SLURRY PIPILINES !15

Annual Throughput (Million tons/yr)	2.5	5.0	10.0	15.0	20.0	25.0
Q (cfs)	2.967	5.934	11.868	17.802	23.736	29.670
Q (gpm)	1,332.183	2,664.366	5,328.732	7,993.098	10,657.464	13,321.830
Q (mgd)	1.918	3.837	7.673	11.510	15.347	19.183
Q (acre-ft/yr)	2,030.343	4,060.685	8,121.370	12,182.055	16,242.740	20,303.425
Q (mgd/yr)	661.829	1,323.657	2,647.314	3,970.971	5,294.628	6,618.285

management regarding the operation of the reservoir [16].

The standard method of mass-curve analysis was used to determine the capacities of off-stream reservoirs required to satisfy the continuous water demands of the pipeline, in view of the available streamflow data.

Two series of constraints were applied simultaneously for the withdrawal scenarios. According to the first one of these, the allowable diversion from the stream was considered to depend on the amount of the current streamflow relative to the mean discharge. The range of actual stream discharges was divided into five intervals limited by 10%, 25%, 50%, and 100% of the mean streamflow. For each of several hypothetical scenarios the amount of water that could be withdrawn was assigned as a percentage of the mean streamflow within each of these ranges. To protect the stream and other water users, withdrawals generally were restricted or eliminated during low flows, whereas for higher discharges, increasing percentages were permitted. For example, for one of these scenarios, no draft is permitted when the current streamflow, QS, is less than 25% of the mean streamflow, QM. Whenever QS has a value that is within 25% and 50% of the mean streamflow , up to 5% of QS can be diverted off the stream to feed the coal slurry pipeline. Similarily, for discharges within the interval between 50% and 100% of the mean flow, a maximum of 10% of QS can be diverted, and for streamflows larger than the mean flow, up to 15% of the current streamflow is allowed for diversion from the stream for pipeline use or storage. The nine different scenarios that were considered in this study are summarized in Table 3.

The second set of constraints applied related to the maximum amount of water that can be diverted at any given time due to the design capacity of the inlet and the conveyance conduit. Admittedly, such features should actually be the subject of a detailed engineering and economic analysis. Nevertheless, it was considered that at least the relative effects of such restrictions may be represented appropriately by multiples of the continuous demand rates of the pipeline. Thus quite arbitrarily capacities in terms of 5, 10, 15, and 20 times the continuous coal slurry demand were examined. In other words, for a 5-mty (million tons per year) coal slurry pipeline, which requires about 6.0 cfs of water on a continuous basis, the the combined intake stucture and conveyance line capacities of 30, 60, 90 and 120 cfs were investigated.

TABLE 3 DIVERSION SCENARIOS APPLIED

DIVERSION SCENARIOS EMPLOYED IN THIS STUDY

NUMBERS IN THE TABLE ARE ALLOWABLE DIVERSION AS % OF QS

SCENARIO #	CURRENT STREAMFLOW QS (% OF DAILY MEAN FLOW QM) <10%	10 TO 25%	25 TO 50%	50 TO 100%	>100%
1	0	0	5	10	15
2	0	0	10	15	20
3	0	0	10	10	10
4	0	0	5	15	25
5	0	2	5	10	15
6	0	5	5	10	10
7	0	10	10	10	10
8	0	5	10	15	20
9	0	2	4	7	10

According to the characteristics of each alternative, the appropriate restrictions referred to above were imposed to obtain the allowable daily withdrawal rates, which actually constitute the socalled "virtual stream data" used in this study. Subsequently, the analysis was directed toward the determination of the capacity of a reservoir that will guarantee the continuous supply of water for the coal slurry pipeline during the whole period considered, in view of the historical data available in the HISARS data base. The study also includes the determination of the reliability characteristics of these storages capacities in terms of their recurrence intervals based on the low flow frequencies of the virtual stream data using the partial duration series analysis.

6. STORAGE CAPACITY DETERMINATION

Approaches usually utilized in the design of storage capacity may be classified into three groups [6, 7, 14]. The first group consists of the application of Rippl's method of mass-curve analysis to the recorded streamflow data. The second one is simply the application of Rippl's method to a series of stochastically generated data, which allows for the empirical determination of the probability distribution of storage by counting the occurences of particular storage states. The third approach, the so-called stochastic theory of storage, "... derives the probability distribution for storage directly from the probabilistic structure of the inflow model without invoking any empirical frequencies ..." [3].

The entire storage analysis in this study was carried out using the first approach, that is, based on the historical daily streamflow data available for the selected stations. It was considered that the daily values provide sufficient detail to guarantee a constant amount of water continuously required by the coal slurry pipeline. In addition, it was simply assumed without any further statistical analysis, that the historical data for each stream will be repetitive, or will recur in the future following exactly the same hydrologic pattern.

Selected physical and environmental constraints were applied to the daily withdrawal rates from the stream. Subsequently, the required storage was determined by using the Rippl's method of mass-curve analysis to the generated sequence of streamflow data. Essentially the method determines the reservoir capacity as the maximum difference between cumulative inflow and cumulative outflow, over the entire period of records, whenever the required flow is less than the current discharge. Thus, a critical period was defined as the interval during which the reservoir is not competely full. Two subperiods can be considered within this critical period, namely the emptying and the filling periods of the reservoir.

The minimum amount of storage required to satisfy the pipeline demand continuosly during the design period is the volume necessary to cover the greatest deficit occuring among all the individual critical periods. In this approach, the reservoir is assumed to be full at the beginning of all critical periods, and the search is made in the forward direction of time. By this procedure two questions can be answered, namely, how much water would be necessary to prevent complete emptying of the reservoir and how long the emptying and filling periods would be.

7. FREQUENCY ANALYSIS

Two common techniques employed for estimating the frequency of extreme events, such as floods, or low-flows (droughts), are the methods of annual series and partial duration series [3, 4, 5, 6, 7, 10, 11, 12, 14]. In the method of annual series, the extreme flow during a selected period is chosen for each year. In the method of partial series, on the other hand, the extreme flows are listed without regard to the year that they occurred.

In the frequency analyses using annual series, annual events are assumed independent, and furthermore, the largest flood (or the lowest flow) occurring each year is used to form the annual series of extreme events. The standard methods such as plotting positions, frequency factors, Gumbel distribution, log-Pearson distribution, are then applied to this series of annual extreme events to arrive at the relevant frequency characteristics.

It is widely agreed that annual series has one major drawback. In many cases, the second largest flood (or the second lowest flow) in any given year, which is neglected by the method of annual series, may exceed the annual maximum (or be lower than the annual minimum) of one or more of the other years considered [8, 11, 12].

A number of methods developed under the general category of "partial duration series" do not have this drawback. The main principle used in this methods is that, rather than selecting the single most extreme event which has occurred during each year, all the extreme events which occurred during the entire record are ranked without regard to the year in which they occurred. Clearly, more than one of the extreme events contained in a partial series may occur in any one year, and some years may not be represented at all. In addition, because the analysis is directed toward the determination of all the extreme events in a selected duration, the origin of the interval analized is a mobile one, i.e, it changes from one single event to the other.

Since the flows with lesser extreme magnitudes are excluded the annual series, the magnitudes of the events with the same frequency would not necessarily be the same for the two series. It has been shown theoretically, and often confirmed by the results of the calculations made with actual streamflow data, however, that for periods of longer than ten years, these differences have the tendency to become quite small [11].

One frequent objection to the use of partial- duration series is that the flows listed may not be fully independent events. In other words, closely consecutive droughts may actually have been caused by the same climatic factors and should be considered as a single event. Therefore, when the partial duration method is used, a scheme to provide the independence of the events must be developed [12].

Several methods of partial duration analysis have been developed according to specific interests and the meaning of the extreme event [4, 5, 12]. In some methods, the study is directed only toward the determination of the number of events above (or under) a predetermined truncation level during the given period. Some of the other studies consider the extreme magnitude during the period as the major representative factor. Finally, certain others are concerned with the cumulative total for the period. In this study, the latter method was preferred due to its suitability for frequency analysis regarding reservoir volumes to compensate for shortage in supply for the pipeline during droughts.

Of greater interest are the methods employing partial series that consider average or cumulative values for a number of different periods. For example, 30-minutes, 1-hour, 3-hour,6-hour, or 24-hour durations are often used to form a family of partial duration series for the frequency analysis of extreme rainfall events. Similarly, 1-month to 60-months periods have been considered for the analysis of low-flows in conjunction with reservoir capacities [10].

Stall and Neill [11] explain the justification of the method as follows:

> since the critical period for reservoir design may exceed 1 year, it was required that the low flow series distribution be applicable to periods longer than 12 months .... Experience has indicated that in Illinois, during the more severe droughts, the duration of the period during which the draft rate from the reservoir exceed the rate of inflow may be from 24 to 48 months. However, it is desirable to have a knowledge of the low-flow probability for a wider range of durations in order that the actual critical duration can be found for each design, (Thus,) low-flow series have been derived for durations from 1 month to 60 months. Assigning various values to the duration in this manner makes it possible to evaluate the influence of the duration in the reservoir design ... (With) the generation of the low-flow series and ... the corresponding recurrence intervals ...the reservoir can readily be designed by methods similar to the traditional mass-curve analysis...

The apparent conditions prevailing in southwestern Virginia were considered to be quite similar to those in Illinois, thus favoring the partial duration method.

In this study, the partial duration method developed by Stall and Neill [11] was applied to a series of selected durations (SD), namely, 1 month through 1 to 12 months (=1 year) at 1 month intervals and furthermore for 15, 18, 24, 30, 36, 48 and 60 months. For a duration of 30 months, the method can be summarized as follows :

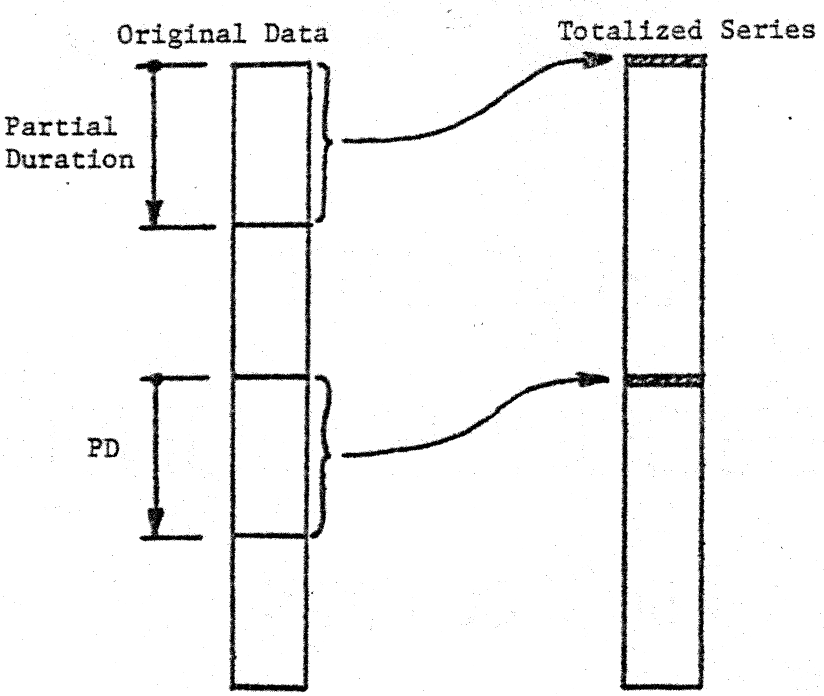
> The monthly data were converted to running totals for the 30 month duration .... These running totals were then inspected, and the lowest 30 month flow on record was noted ... This particular record was then marked off the tabulated data ... (then,) all the remaining running totals which overlapped to include any of the 30 months within this lowest period were excluded from further consideration. The remainder of the 45-years of record then was inspected to locate the 30 month low flow periods of descending mark,which were in turn marked off the tabulated data... (and so on)... [10].

This selective process was continued until 10 values were finally obtained, provided the length of data made this possible.

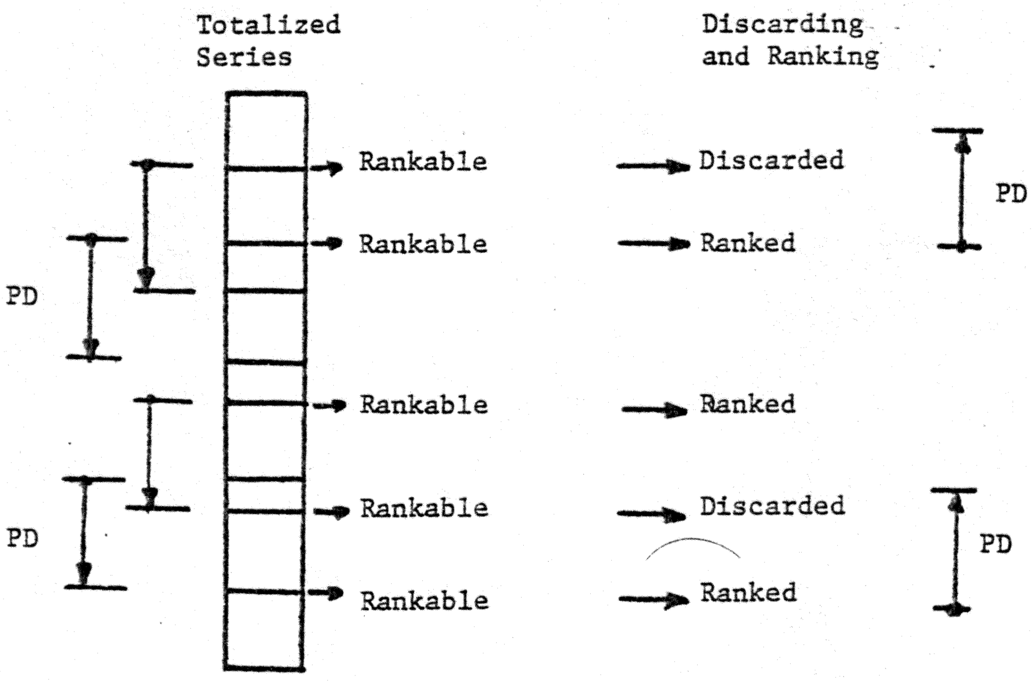
From a programming standpoint, the process described above can be abbreviated, and yet provide the same final results. The program developed and used in the present study allowed for the totalizing series in a continuous manner, so that the processes of ranking and discarding of the previously used parts of the series were made simultaneously. In the calculations, parallel to the original data, a totalized series is created with running totals by adding original historical data. In other words, a new series of data is created in which each value of the original series has its equivalent composed of the addition of the value itself plus a number of its subsequent SD-1 (selected duration minus one) values. Thus, for a partial duration series considering 30-day periods, for example, the value of the new series of running totals on any given day of any given year (say Oct. 24, 1954) is equal to the sum of the original data for 30 days beginning with the current day (that is from Oct 24, 1954 to Nov 23, 1954, inclusive). Obviously, the totalized series has SD-1 less values than the original one, since the last value of the new series of running totals corresponds to the sum of the last 30-days period of the original series.

The process of ranking the running totals is performed with the use of a vector with provisionally ranked values. Initially, all the running totals are compared within a partial duration period, say 30 days, which obviously contains 30 running totals. The running total with the lowest value (since low flow values are of interest in this study) is labeled as a rankable one. No discarding is performed at this stage. In the next step, the running totals are compared within the next partial duration period starting with the current running total labeled as rankable. If a running total with a lower value is found in this period, this new running total is also labeled as rankable, but the previous rankable running total is not discarded. Proceeding in this manner, the running totals are compared for all the duration periods starting with each rankable running total, until the data are exhausted.

However, considerable reduction is achieved in the number of calculations by applying a procedure as described in the following and as illustrated graphically in Figure 2. The first time a rankable running total is found to be the first running total within the partial duration period examined, the previous rankable running totals are reexamined. Starting with the latest rankable running total, all the running totals which overlap are discarded. It should be remarked, in this connection, that during this discarding process, some of the running totals with lower values may be discarded since they overlap with a subsequent lower-value running total, while those with higher values may be retained if a subsequent overlapping running total with lower value has already been discarded. At this point, all the nondiscarded running totals are ranked and registered in the provisional rank vector. When another rankable running total is found to be the first element within a partial duration period in the subsequent



(a) Creation of Series For Running Totals.



(b) Ranking and Discarding Processes.

Figure 2 Ranking Process

analysis, a similar procedure is performed with the previous running totals labeled as rankable. Thus, after the appropiate discarding, the whole set of remaining rankable running totals including the ones in the provisional rank vector is reranked and a new provisional rank vector is created. The above described procedure is repeated until data is exhausted, Since at the end of this calculations, the desired number (10 in this study) of nonoverlapping running totals have already been ranked, a new series of calculations is not required to analyze the running totals as was done in previous studies [10, 11].

Discarding of running totals with values contained in the original series that are previously ranked, is a process carried out in an attempt to assure the statistical independence of these partial duration events, according to the relevant theory [12]. Therefore, the recurrence interval T, namely the average length of time between exceedences, was computed as the ratio of the total number of years (t) and the rank of the event (m), or, $T= t/m$.

The calculations described above yield the rank and the return periods (or recurrence intervals) of the low flow of considered durations. The storage required for each return period is then given by the maximum difference between the total water demand and the expected minimum cumulative streamflow. This maximum value is determined by comparing the storage requrements for all the various durations considered, namely 1 to 60 months at increments referred to earlier. The reliability of each offstream storage reservoir is thus considered in terms of the associated recurrence interval.

8. COMPUTER MODEL

Because the large number of calculations and large size of memory needed for the analysis of the data used in this study, namely up to 50 years of daily streamflow data, the computer algorithm developed in this study was designed to save memory space and to guarantee independence between the processes of reading, calculating, printing and plotting. Thus, it actually consists of four separate programs, as schematized by the simplified block diagram given in Figure 3.

The program RD reads in recorded data consisting mainly of daily streamflows (retrieved directly from HISARS system) and the other relevant characteristics of the given station, such as the maximum and minimum observed flows, mean daily discharges and the length of record. The program RD processes this information to yield an unformatted file with the basic information of the station and a daily streamflow vector for easier handling. The program WSP makes all the necessary calculations regarding storage analysis. It consists of four major subroutines, namely INPUT, MASS,FREQ, and, OUT. Subroutine INPUT reads the appropriate data from two sources, one from the

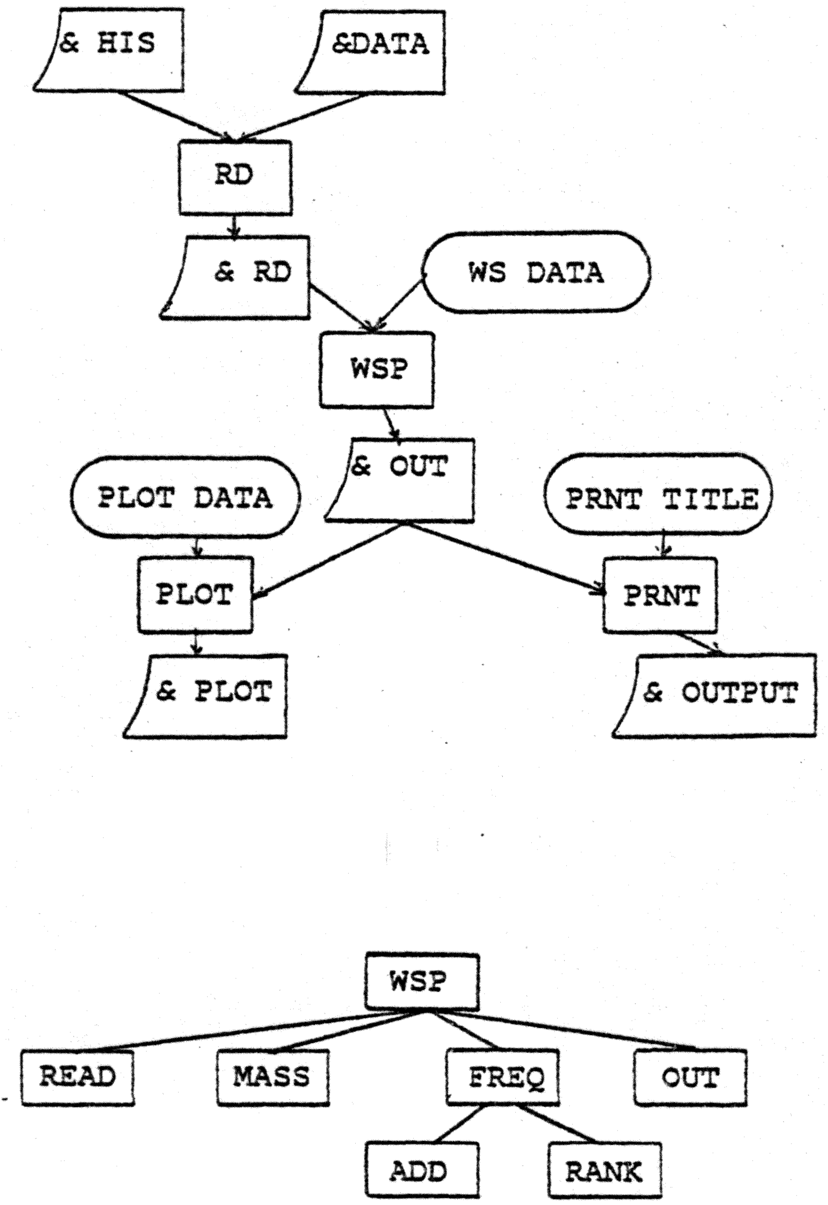


Figure 3 Computer Flow Chart.

unformatted output of RD, namely station information, and the other one from a file consisting of the various scenarios of the methodology employed, namely water demand, allowable withdrawals, capacity constraints, and selected durations for frequency analysis. Subroutine MASS performs the conventional mass-curve analysis based on the constrained streamflow data to determine the non-failure storage capacities. Subroutine FREQ performs partial duration frequency analysis over the constrained data, as well. The results are then printed in an unformatted way by the subroutine OUT, to be used by the programs PRINT and PLOT, which present the results of the mass-curve and the partial duration frequency analyses for the station, in tabular and graphical formats, respectively.

9. DISCUSSION OF RESULTS

The results of the calculations made in this study are discussed in two categories. The first group is associated with the storage requirements of the offstream reservoirs considered in view of the various scenarios and constraints assumed applicable to the withdrawal rates from the stream and the capacity of the intake/conveyance structures. Subsequently a discussion is presented on the relevant frequency or recurrence interval characteristics. Both categories of these results allowed for a series of typical or general conclusions, as well as specific ones pertaining to some of the streams and scenarios.

Regarding the methodology applied in this study, two major drawbacks must be pointed out in relation to the evaluation of these results. The first one refers to the basic assumption that historical data will repeat itself exactly in the future, while the second one is related to the fact that the some of the streamflow records were of relatively short periods. Although these are very common and almost inevitable situations, their consequences on the reliability of storage calculations and their relevant frequency characteristics should not be underestimated. In other words, the results obtained in this study should only be considered as quite preliminary. A more detailed analysis of the streamflow data involving more elaborate methods of stochastic hydrology may become necessary before realistic decisions can be made concerning the service reliability of the storage capacities calculated. The results presented should, however, prove quite useful at least in deciding which of the alternatives would need further investigation and which ones appear to be not feasible at all.

Storage Requirements

This study has revealed, in general, that relatively small-sized offstream reservoirs can well provide sufficient amounts of water for the coal slurry pipelines planned to originate in southwestern Virginia, without a major impact on the natural streamflow characteristics. For example, the storage requirements obtained with any of the scenarios and constraints applied remain below 10,000 acre-ft for a coal slurry pipeline to transport 10 million tons of coal per year, which is a reasonable size.

As expected, the actual magnitudes of storage requirements vary with the various withdrawal scenarios and intake capacity constraints applied. In general, the storage values decrease substantially with scenarios and constraints that allow for relatively larger fractions of the streamflow during flood periods, while restricting the withdrawals to extremely low fractions or none at all during low-flow periods, such as scenarios #2, #4 and, #8. The scenarios applied can be classified into three groups, in view of the relative magnitudes of storage they yield.

Scenario #9 is seen to require invariably the highest amounts of storage, while scenarios #6 and #3 also yield relatively large values. The second group, namely scenarios #1, #5 and #7 require somewhat intermediate storage values. Finally, the lowest storage requirements are obtained with scenarios #2, #4 and #8. These findings confirm the anticipated advantage the of scenarios allowing for relatively large withdrawals basically only under flood conditions, thus minimizing the environmental impact during low-flow periods as well as somewhat diminishing the adverse effects created during the flood periods. Concerning the intake/conveyance capacity constraints, on the other hand, it appears that the capacities larger than 10 times the pipeline demand are not necessary.

Examples to the tabular and graphical presentations of the results obtained with the offstream storage calculations are given in Table 4 and Figures 4 and 5. All of the results obtained for these storage requirements are presented in Appendix A, in a total number of 45 tables, namely 9 tables each for the five streams selected for detailed evaluation. The results are also presented graphically in Appendix B, which contains a total of 65 plots. For each of the five streams selected, the variations of storage capacity requirements with the various different scenarios are presented in 9 plots with different intake/conveyance capacity as a parameter, and the variations with the intake/conveyance capacity in 4 plots with the different scenarios as a parameter. The final decision regarding these storage capacities would naturally have to await economic studies taking into account the relevant construction and operation costs of the reservoirs as well as the intake and conveyance structures, in addition to the environmental, right-of-way, and such other factors.

Storage Recurrence Intervals

The results indicate that the offstream reservoirs would be seasonal ones for low pipeline demands, but may be multiannual for the high demands. Typical critical periods, namely the length of drought period during which

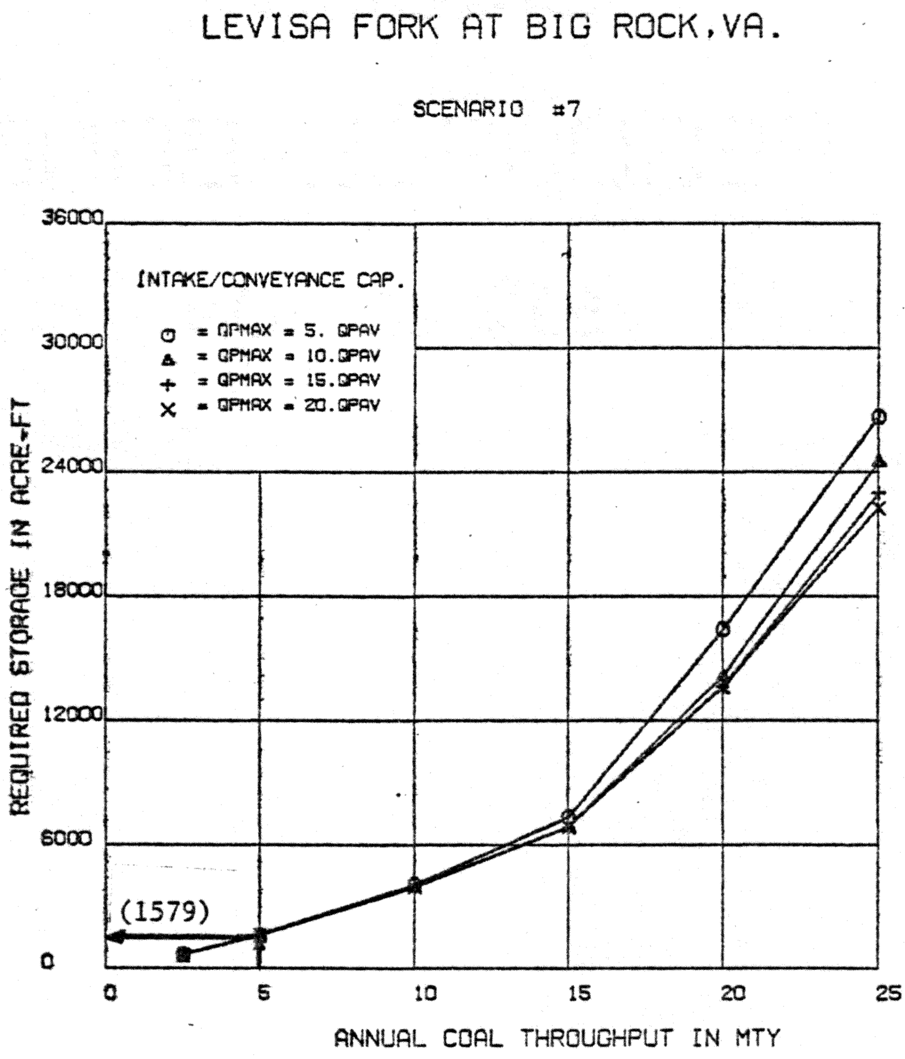


Figure 4 Typical Offstream Storage Requirements.

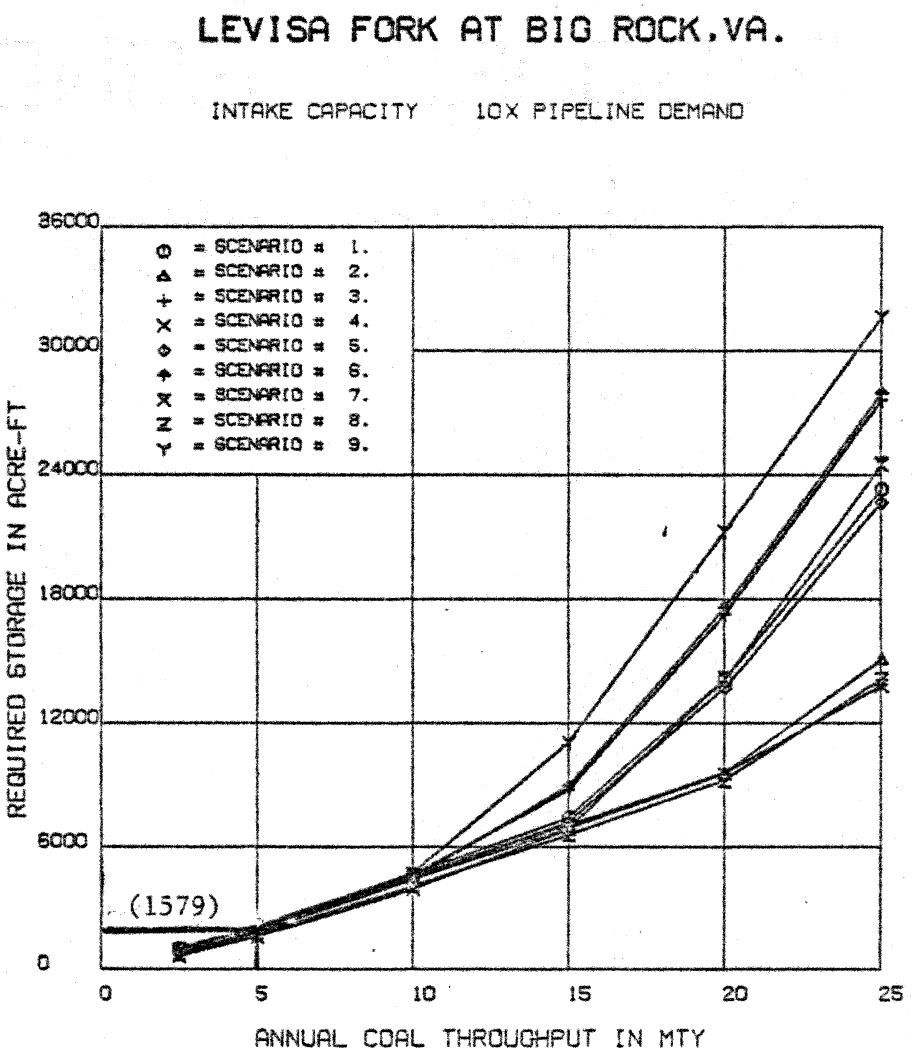


Figure 5 Typical Offstream Storage Requirements

TABLE 4 TYPICAL OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 7 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 10% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	212.	651.	136
			30.	19.4	211.	648.	136
			45.	29.1	211.	648.	136
			60.	38.8	211.	648.	136
5.0	6.0	3.9	30.	19.4	515.	1579.	156
			60.	38.8	515.	1579.	156
			90.	58.2	515.	1579.	156
			120.	77.6	515.	1579.	156
10.0	12.0	7.8	60.	38.8	1319.	4047.	221
			120.	77.6	1282.	3934.	221
			180.	116.4	1282.	3934.	221
			240.	155.1	1282.	3934.	221
15.0	18.0	11.6	90.	58.2	2386.	7322.	563
			180.	116.4	2235.	6857.	563
			270.	174.5	2235.	6857.	563
			360.	232.7	2235.	6857.	563
20.0	24.0	15.5	120.	77.6	5333.	16364.	929
			240.	155.1	4605.	14131.	929
			360.	232.7	4430.	13594.	571
			480.	310.3	4430.	13594.	571
25.0	30.0	19.4	150.	97.0	8688.	26660.	930
			300.	193.9	7980.	24486.	930
			450.	290.9	7479.	22949.	930
			600.	387.8	7254.	22258.	930

the pipeline would have to be supplied from the reservoir, are in the order of 7 months for the typical 10-mty pipeline, while for a typical 20-mty pipeline, the critical drought period appears to be about 2 years, with extreme values up to 5 years that were obtained in some cases. The durations of these critical drought periods in terms of days are also given in the tables contained in Appendix A.

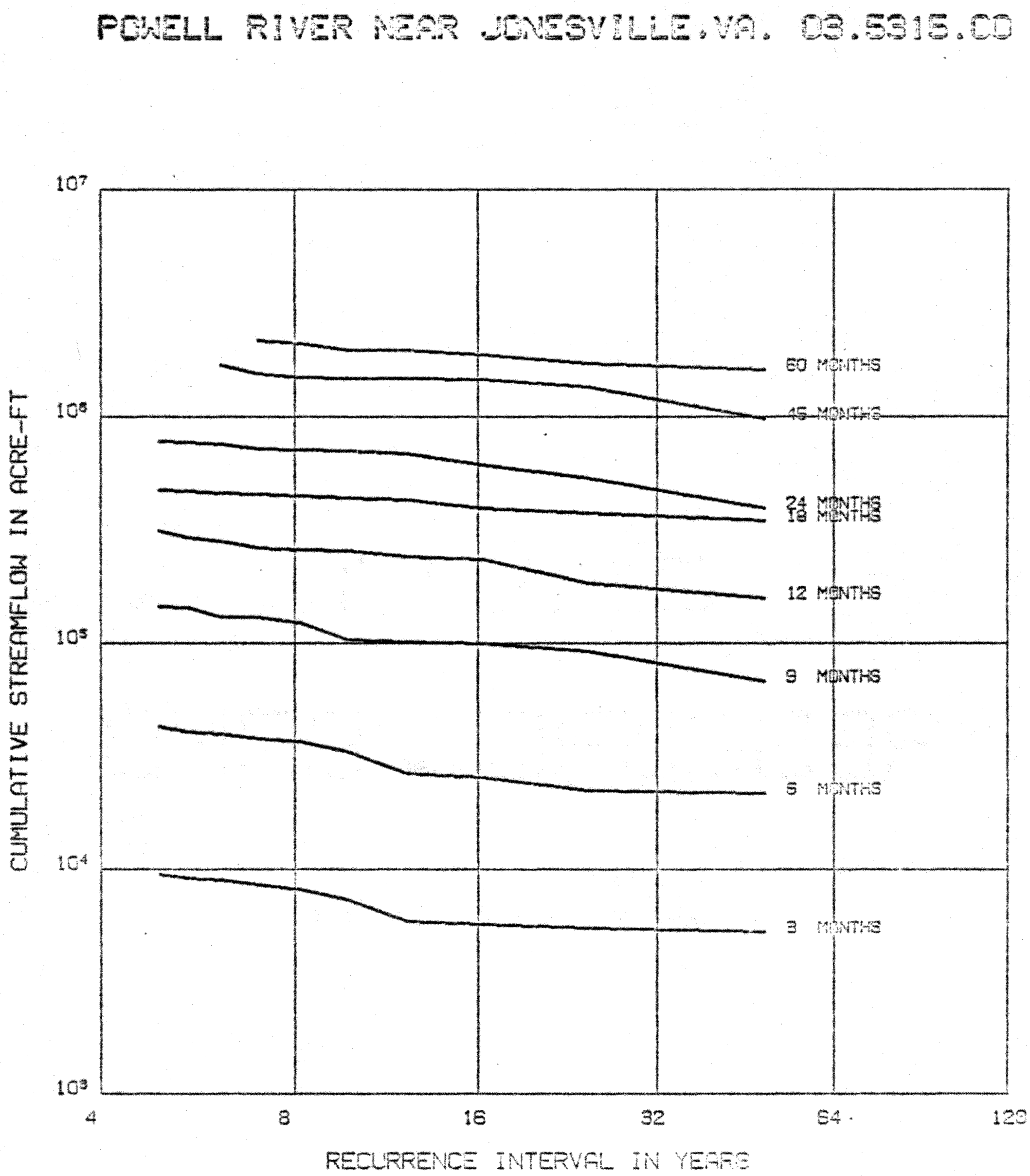
Recurrence intervals and various other frequency related characteristics of the natural streamflows as well as the offstream storage requirements are given in detail in Appendices C, D, E, and F. Appendices C and E show the minimum cumulative flow for different recurrence intervals. A sample is given in Figure 7. It shows that, according to the given conditions (for scenario #7, maximum intake capacity of 10 times the continuous demand or 60 cfs, and annual coal throughput of 5 mty), for an average period of 4 years, the minimum expected draft during any 3-months period is about 500 acre-ft.; while for a 6-month period it is about 2500 acre-ft. Cumulative withdrawals from the stream were used to determine the capacity of reservoirs for different recurrence intervals,which is given by the maximum cumulative difference between the water demand and the expected minimum draft for all of the selected partial duration period. Under the conditions of the above example, the required volume for the 4-year reservoir is about 596 acre-ft as seen in table 5 and indicated approximately by Figure 8. Selected results are plotted in Appendice F and tabulated in Appendice D.

According to these results obtained with the application of the method of partial-duration series, critical drought periods of various durations exhibit basically similar frequency characteristics for the five streams considered. An example to the natural stream partial-duration low-flow frequencies of these five streams is presented graphically in Figure 6. Results for all the streams are given in Appendix C, again graphically. A typical feature of these relationships is that the relevant curves are rather flat, that is, small variations in the cumulative streamflow for any given partial-duration will result in significant variations in the recurence interval. In other words, amounts of low flows of differents ranks for a given partial-duration do not vary significantly from one year to another. Of course, this means that the stream have quite constant low-flow characteristics. Since only offstream reservoirs are envisaged in this study, a detailed discussion of the drought frequency characteristics of the natural streamflows will not be presented herein. However, the graphs contained in

Appendix C would be useful for future investigations involving instream-type storage evaluations.

Examples given by Table 5, and Figures 7 and 8, as well as the detailed results given by the Tables and Figures contained in Appendices D, E and F, on the other hand, are based on the virtual-stream data produced by application of the various withdrawal scenarios to each stream. Consequently, these results pertain to the probabilistic or risk characteristics of the withdrawals from these streams, and for that matter, the adequacies of the associated offstream reservoirs to guarantee the supply of water demanded by the pipeline. The primary significance of the recurrence interval related results is that they provide the risks concerning not only the maximum "safe" capacities of the envisaged offstream reservoirs, but also various "smaller" reservoirs. In other words, if a certain amount of offstream storage is guaranteed to satisfy the prescribed pipeline demand for a certain number of years under the worst conditions of low-flow for a given stream, the corresponding safe period for a smaller volume of storage would be shorter, namely for the number of years indicated by the curve.

It should further be emphasized, in this respect, that



POWELL RIVER NEAR JONESVILLE,VA. 03.5315.00

Figure 6 Typical Stream Partial-Duration Low-Flow Frequencies.

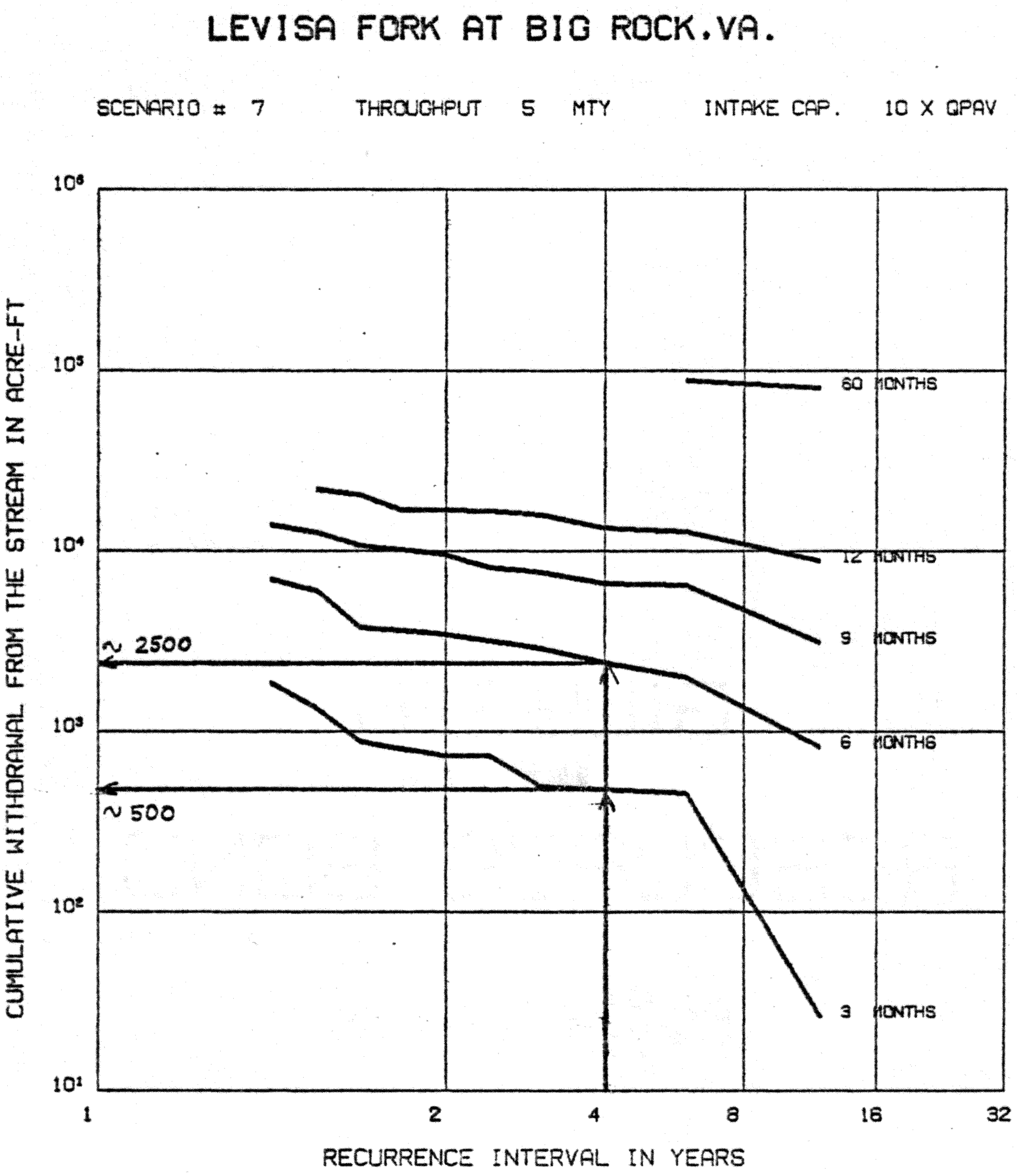


Figure 7 Typical Stream Withdrawal Partial-Duration Low-Flow Frequencies.

TABLE 5 TYPICAL OFFSTREAM STORAGE FREQUENCIES.

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

OFFSTREAM STORAGE REQUIREMENTS (ACRE-FT)
FOR INTAKE/CONVEYANCE CAPACITY 5 X WATER DEMAND

SCENARIO	RECURRENCE	ANNUAL THROUGHPUT OF COAL SLURRY PIPELINE(MTY)					
#	INT.(YRS)	2.5	5.0	10.0	15.0	20.0	25.0
2	12.00	938.	2059.	4480.	6993.	10036.	15447.
	6.00	615.	1386.	3159.	5658.	8157.	10657.
	4.00	434.	1137.	3010.	5152.	7363.	9731.
	3.00	358.	989.	2640.	4779.	7103.	9543.
	2.40	327.	922.	2216.	3976.	5763.	7759.
	2.00	305.	800.	2170.	3777.	5385.	7089.
	1.71	293.	751.	1888.	3517.	5303.	7042.
	1.50	254.	647.	1656.	2728.	4291.	6279.
	1.33	247.	554.	1260.	2056.	3009.	3961.
	1.20	210.	543.	1151.	1832.	2771.	3784.
7	12.00	620.	1566.	3946.	6813.	12878.	21898.
	6.00	311.	761.	2534.	4789.	7288.	12148.
	4.00	222.	612.	2335.	4592.	7032.	10392.
	3.00	179.	577.	1725.	3744.	6218.	8718.
	2.40	146.	366.	1513.	3300.	5303.	7913.
	2.00	144.	344.	1466.	3139.	5139.	7281.
	1.71	138.	316.	1393.	3047.	4944.	7086.
	1.50	117.	300.	1266.	2612.	4711.	6853.
	1.33	84.	263.	913.	1784.	2837.	4189.
	1.20	67.	246.	815.	1530.	2346.	3417.
9	12.00	949.	2123.	5055.	10605.	19060.	30631.
	6.00	582.	1454.	3953.	6453.	11682.	17499.
	4.00	487.	1368.	3546.	5946.	9930.	15629.
	3.00	401.	1157.	3426.	5868.	8342.	10841.
	2.40	340.	999.	2796.	5129.	7827.	10446.
	2.00	311.	991.	2622.	4595.	6737.	8993.
	1.71	303.	885.	2601.	4586.	6728.	8871.
	1.50	270.	782.	2129.	4146.	6288.	8431.
	1.33	183.	508.	1457.	2553.	4361.	6444.
	1.20	152.	495.	1314.	2327.	3373.	5260.

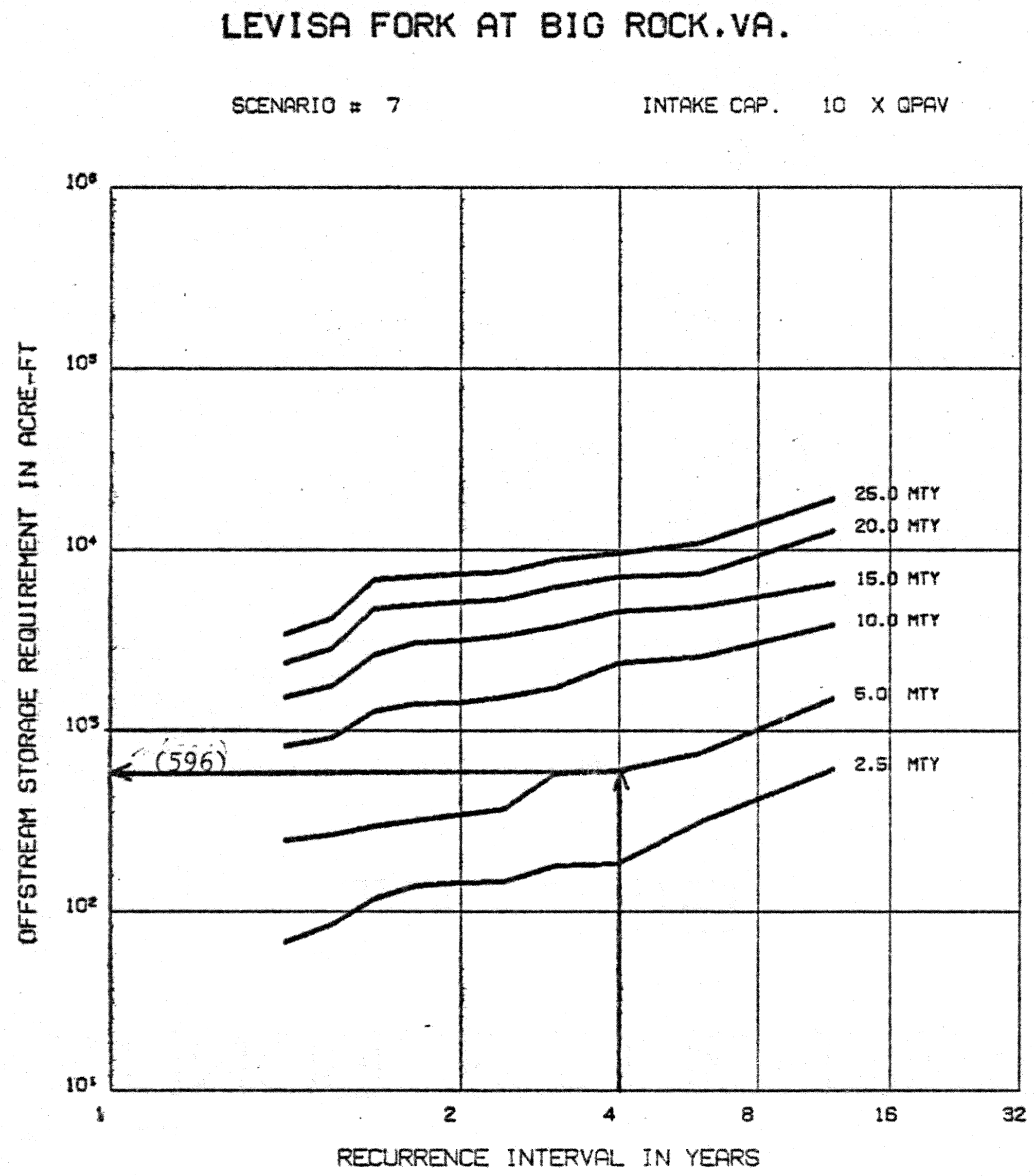


Figure 8 Typical Offstream Storage Frequencies.

the practical value of these recurrence interval related findings would be significantly enhanced by a more elaborate analysis of streamflow data, such as by the use of, for example, a time series analysis to generate additional "synthetic" data, particularly for such stations as Levisa Fork at Big Rock (14 years), and Pound River at Georges Fork (18 years), which have shorter historical records than the estimated pipeline project life (about 30 years).

Further Remarks

A careful comparison of the results obtained with the storage capacity and frequency portions of the calculations indicate a number of interesting points. The required storages calculated by the mass-curve analysis should be identical to those corresponding to the longest recurrence interval calculated by the partial duration method. However, not all of the maximum offstream storage requirements given by the two analyses are necessarily the same in all cases. There are possibly two reasons for this apparent discrepancy. One obvious reason is that the number of days for the drought periods accounted for by the storage capacities determined in the mass-curve analysis and in the partial-duration series analysis are generally different, since the latter analysis is based on multiples of 30-day months only. The second aspect, is that the maximum length of critical low-flow period considered in the partial-duration series analysis is 60 months, whereas the mass-curve analysis considers the lowest cumulative low-flow period, whatever its length, namely even if it is longer than 60 months or about 1800 days. Indeed, as it can be observed from the Tables in Appendix A, for some of the scenarios and constraints applied to the data of some of the streams indicate drought periods longer than 1800 days, as well as " * =No solution" results. The results found using the partial-duration analysis, on the other hand, always indicate a storage capacity to satisfy the pipeline demand, obviously for shorter "safe periods", however. Therefore, in a more detailed and realistic engineering study, partial-durations of appropriately longer periods than 60 months should be considered, such as at least as long as the length of the drought periods indicated by the mass-curve analysis. Both the economics and the tolerable risk considerations, should also affect final design related decisions, in this respect. The preceeding remarks are another indication of the versatility and overall superiority of the method of partial-duration series, in that it not only yields the maximum reservoir capacities required to fully satisfy a certain demand, but also those of smaller volumes along with their relevant recurrence intervals, or risk characteristics, which can then be utilized in engineering, environmental and economic decisions in the final design stage.

10. CONCLUSIONS

A preliminary hydrologic study has been carried out with the specific objective of assessing the overall physical availability characteristics of the surface water resources in southwestern Virginia, that are reasonably close to the prospective coal slurry pipeline origins, namely Grundy, Pound, and Big Stone Gap. Analysis of the historic streamflow data available for five major U.S.G.S. stream gaging stations available in the region, namely, Levisa Fork near Grundy, Levisa Fork at Big Rock, Russell Fork at Haysi, Pound River near Georges Fork, and Powell River at Jonesville, revealed the following general conclusions :

(1) The year-round flow pattern of the streams in the region are highly variable. Whereas extremely ow flows occur for appreciable periods generally during late summer and early fall months, the maximum flows during the flood seasons can be extremely high, on the other. A typical example, in this respect, is the Levisa Fork, which has an annual mean flow rate of about 400 cfs, whereas low-flows of 5.0 cfs and floods as high as 56,000 cfs have also been recorded. Therefore, with these extremely variable natural

streamflow characteristics, the streams in the region certainly appear ideal for water management considerations.

(2) The surface water resources available in the region of interest certainly appear adequate for supplying the water that would be demanded by a coal slurry pipeline with a prescribed throughput of up to 25 million tons of coal per year (mty). The amounts of offstream storages required appear quite reasonable, typically less than 10,000 acre-ft for a 10-mty pipeline, for example. Much smaller storage capacities have also been found to be adequate in many specific cases.

(3) Various scenarios have been applied for the instantaneous amounts of withdrawal from each stream to create an offstream-type rather than a conventional instream-type reservoir in each case, with the basic objective of minimizing interaction with the natural stream environment, such as allowing no more than 10% of the current streamflow for withdrawal when the current streamflow is less than 25% of the annual mean flow. Thus, the main portion of the water to fill the offstream reservoir is withdrawn during relatively high streamflow periods. The results obtained with the nine different withdrawal scenarios should prove quite useful in a more

detailed engineering analysis that would be carried out at the final design stage.

(4) Four different constraints have been applied in relation to the intake/conveyance capacity, namely 5, 10, 15, and 20 times the average continuous pipeline demand in each case. The results have clearly indicated for basically all of the withdrawal scenarios and streamflow data, that intake/conveyance capacities greater than 10 times the average pipeline demand are not significantly more effective in creating smaller storage capacities. Therefore, it was concluded that intake/conveyance capacities should remain in the order of 5 to 10 times the continuous pipeline demand, particularly in view of the associated costs of construction and operational practices.

(5) The recurrence interval characteristics of the offstream storage capacity requirements were obtained with the use of the method of partial-duration series. The versatility of this method allowed for producing information for not only the maximum storage capacities that would fully satisfy the pipeline demand for the calculated critical drought periods but also for smaller ones with the appropriate risk factors involved. However, based on the basically flat behavior of the functional

relationships obtained between the storage requirements and the associated recurrence intervals, it was concluded that both the natural streams and the various withdrawal scenarios from these streams exhibit quite consistent, and therefore, reliable low-flow characteristics. Obviously, this is a favorable feature that can be exploited effectively for any future offstream storage scenario that is reasonably similar to the ones employed in this study.

(6) Before a more realistic engineering design study is carried out, the quality of the available streamflow data should be improved with the application of more detailed methods of hydrologic data analysis, such as generating additional "synthetic" information, particularly for those streams with shorter historical records than the estimated pipeline project life, namely about 30 years.

(7) Finally, a realistic engineering design study should also incorporate a detailed evaluation of the economic characteristics of the various alternative scenarios referred to in this study, as well as others. These investigations would clearly involve not only general situations such as those considered in this study, but also more specific site and pipeline characteristics.

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APPENDICES

All of the results obtained in this study are presented in six sections of these appendices. Both tabular and graphical formats are utilized. The results obtained for the offstream reservoir capacity requirements using the mass-curve analysis are presented in Appendix A with a total number of 5x9=45 tables, namely with 9 tables for different scenarios assumed applicable for each of the five streams considered in this study.

The following terminology are used in these tables:

QM = Historic mean discharge of streamflow
QMN = Historic minimum discharge of streamflow
QMX = Historic maximum discharge of streamflow
QP = Discharge withdrawn from stream for pipeline use
QPAV = Continuous water discharge required by pipeline
QPMX = Maximum discharge allowed for diversion from the stream (= intake/conveyance capacity)
QS = Streamflow discharge at any given time
W = Annual throughput of coal slurry pipeline

V = Volume of offstream storage required for 100% guaranteed supply of pipeline demand

ND = Number of consecutive days pipeline is supplied from reservoir as well as from stream (drought period)

* = Impossible operation for the prescribed scenario

Each table has a heading section, where the identification and the main features of the stream are given as obtained from the HISARS data base as well as from the U.S.G.S. Wateryear publications, followed by a description of the applied scenario for the allowable withdrawals from the stream. Subsequently, the results of calculations are given for the reservoir storage requirements according to this scenario, for the different pipeline demands and intake/conveyance capacity constraints, namely equal to 5, 10, 15, and 20 times the continuous pipeline demand. Also given are the durations of the associated drought periods in days.

The results are also presented graphically in Appendix B, which contains a total of 5x13=65 plots. For each of the five streams selected, the first 9 plots show the variation of storage requirement with pipeline throughput, associated drought periods in days.

The results are also presented graphically in Appendix B, which contains a total of 5x13=65 plots. For each of the five streams selected, the first 9 plots show the variation of storage requirement with pipeline throughput, for each of the withdrawal scenarios applied using the intake/conveyance as a parameter. The remaining 4 plots exhibit the same variation for each of the intake/conveyance capacities applied as a constraint, this time using the withdrawal scenarios as a parameter.

Appendix C contains five graphs. Based on the results of partial-duration calculations, these graphs exhibit the recurrence intervals for the natural streamflows corresponding to the worst (lowest cumulative) low-flow (drought) conditions, for each of the five streams selected for this study, with the drought period in months used as a parameter.

Appendices D, E and F present selected results of the recurrence interval calculations carried out for the storage requirements with the use of the method of partial-duration series. Appendix D contains tabulated results for the recurrence intervals associated with the offstream reservoirs using the data for three of the five streams evaluated, namely Levisa Fork at Big Rock, Russell Fork at Haysi, and Powell River at Jonesville. For each of the streams, the results are presented for the maximum storage requirements obtained with three scenarios, namely for those typically yielding low, medium and high-volume storages. These results also correspond to an intake/conveyance capacity of 10 times the pipeline demand, as larger capacity withdrawals from the streams were found to be ineffective, and thus appear to be unnecessary. Recurrence intervals are given in years for the storage requirements corresponding to low-flow periods of ranks #1 through #10, calculated based on the partial-duration frequencies of withdrawals from the stream, for the purpose of providing a continuous supply for the slurry pipelines of six different annual throughputs of coal.

Appendices E and F present the same results of the recurrence interval calculations for the same three streams, but this time graphically. In an effort to save space, and furthermore, since the overall results and general patterns of these graphs are quite similar, these graphical representations are given only for the 5 and 10-mty capacity pipelines, intake/conveyance capacity of 10 times the continuous pipeline demand, and for the scenarios #2, #7, and #9. Appendix E shows the variations of recurrence intervals of the cumulative withdrawals from each of the three streams selected for these calculations, using the low-flow partial-durations as a parameter. Although only five different partial-durations are indicated in these graphs to avoid crowding, calculations were actually made for 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 18, 24, 30, 36, 48, and 60-month partial-durations, wherever possible.

Finally, for basically the same selected cases as for Appendix E, Appendix F presents the recurrence intervals for the maximum offstream storage requirements for the slurry pipelines with all the prescribed annual throughputs. Each curve on these graphs indicates the recurrence interval of a low-flow period during which any of the indicated offstream storages would provide just the right amount of water that is demanded by a slurry pipeline with the prescibed annual throughput.

Pages as well as Tables and Figures in the appendices are numbered with reference to each of the five streams selected for application. The following abbreviations have been used for the streams: L1 for Levisa Fork near Grundy, L2 for Levisa Fork at Big Rock, HY for Russell Fork at Haysi, PG for Pound River near Georges Fork, and PJ for Powell River near Jonesville.

APPENDIX A

OFFSTREAM RESERVOIRS CAPACITIES (TABLES)

TABLE A-L1- 1   OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA.   03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 1 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	460.	1411.	254
			30.	19.4	460.	1411.	254
			45.	29.1	460.	1412.	254
			60.	38.8	460.	1412.	254
5.0	6.0	3.9	30.	19.4	969.	2973.	268
			60.	38.8	969.	2974.	268
			90.	58.2	969.	2974.	268
			120.	77.6	969.	2974.	268
10.0	12.0	7.8	60.	38.8	2013.	6176.	269
			120.	77.6	2013.	6176.	269
			180.	116.4	2013.	6176.	269
			240.	155.1	2013.	6176.	269
15.0	18.0	11.6	90.	58.2	3584.	10999.	927
			180.	116.4	3066.	9407.	271
			270.	174.5	3066.	9407.	271
			360.	232.7	3066.	9407.	271
20.0	24.0	15.5	120.	77.6	6618.	20308.	929
			240.	155.1	5547.	17019.	929
			360.	232.7	5074.	15570.	571
			480.	310.3	5074.	15570.	571
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	9148.	28070.	1295
			450.	290.9	8288.	25433.	930
			600.	387.8	7758.	23805.	930

TABLE A-L1- 2 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 2 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	436.	1339.	254
			30.	19.4	432.	1326.	254
			45.	29.1	432.	1326.	254
			60.	38.8	432.	1326.	254
5.0	6.0	3.9	30.	19.4	925.	2838.	254
			60.	38.8	925.	2838.	254
			90.	58.2	925.	2838.	254
			120.	77.6	925.	2838.	254
10.0	12.0	7.8	60.	38.8	1943.	5961.	268
			120.	77.6	1943.	5961.	268
			180.	116.4	1943.	5961.	268
			240.	155.1	1943.	5961.	268
15.0	18.0	11.6	90.	58.2	2986.	9163.	269
			180.	116.4	2986.	9163.	269
			270.	174.5	2986.	9163.	269
			360.	232.7	2986.	9163.	269
20.0	24.0	15.5	120.	77.6	4140.	12704.	920
			240.	155.1	4037.	12386.	270
			360.	232.7	4037.	12386.	270
			480.	310.3	4037.	12386.	270
25.0	30.0	19.4	150.	97.0	7142.	21916.	929
			300.	193.9	5667.	17388.	929
			450.	290.9	5654.	17349.	571
			600.	387.8	5654.	17349.	571

TABLE A-L1- 3 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 3 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	437.	1340.	254
			30.	19.4	437.	1340.	254
			45.	29.1	437.	1340.	254
			60.	38.8	437.	1340.	254
5.0	6.0	3.9	30.	19.4	929.	2852.	254
			60.	38.8	929.	2852.	254
			90.	58.2	929.	2852.	254
			120.	77.6	929.	2852.	254
10.0	12.0	7.8	60.	38.8	1947.	5975.	268
			120.	77.6	1947.	5975.	268
			180.	116.4	1947.	5975.	268
			240.	155.1	1947.	5975.	268
15.0	18.0	11.6	90.	58.2	4188.	12852.	921
			180.	116.4	3517.	10792.	921
			270.	174.5	3376.	10360.	564
			360.	232.7	3376.	10360.	564
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	7287.	22360.	1295
			360.	232.7	6632.	20349.	1295
			480.	310.3	6235.	19133.	1295
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-L1- 4 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 4 :

WHEN QS < 10% OF QM : QP = 0

WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS

WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS

WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS

WHEN QS > 100% OF QM : QP = 25% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	460.	1410.	254
			30.	19.4	455.	1397.	254
			45.	29.1	455.	1397.	254
			60.	38.8	455.	1397.	254
5.0	6.0	3.9	30.	19.4	964.	2958.	268
			60.	38.8	964.	2960.	268
			90.	58.2	964.	2960.	268
			120.	77.6	964.	2960.	268
10.0	12.0	7.8	60.	38.8	2008.	6161.	269
			120.	77.6	2008.	6161.	269
			180.	116.4	2008.	6161.	269
			240.	155.1	2008.	6161.	269
15.0	18.0	11.6	90.	58.2	3051.	9363.	269
			180.	116.4	3051.	9363.	269
			270.	174.5	3051.	9363.	269
			360.	232.7	3051.	9363.	269
20.0	24.0	15.5	120.	77.6	4106.	12599.	270
			240.	155.1	4106.	12599.	270
			360.	232.7	4106.	12599.	270
			480.	310.3	4106.	12599.	270
25.0	30.0	19.4	150.	97.0	6611.	20286.	929
			300.	193.9	5195.	15940.	571
			450.	290.9	5158.	15829.	271
			600.	387.8	5158.	15829.	271

TABLE A-L1- 5 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 5 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	420.	1289.	254
			30.	19.4	420.	1289.	254
			45.	29.1	421.	1293.	254
			60.	38.8	421.	1293.	254
5.0	6.0	3.9	30.	19.4	928.	2847.	268
			60.	38.8	930.	2852.	268
			90.	58.2	930.	2852.	268
			120.	77.6	930.	2852.	268
10.0	12.0	7.8	60.	38.8	1973.	6054.	269
			120.	77.6	1973.	6054.	269
			180.	116.4	1973.	6054.	269
			240.	155.1	1973.	6054.	269
15.0	18.0	11.6	90.	58.2	3466.	10636.	927
			180.	116.4	3026.	9285.	271
			270.	174.5	3026.	9285.	271
			360.	232.7	3026.	9285.	271
20.0	24.0	15.5	120.	77.6	6500.	19945.	929
			240.	155.1	5428.	16656.	929
			360.	232.7	5004.	15356.	571
			480.	310.3	5004.	15356.	571
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	8983.	27566.	1295
			450.	290.9	8170.	25070.	930
			600.	387.8	7640.	23442.	930

TABLE A-L1- 6 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 6 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	360.	1105.	251
			30.	19.4	360.	1105.	251
			45.	29.1	361.	1108.	251
			60.	38.8	361.	1108.	251
5.0	6.0	3.9	30.	19.4	866.	2659.	268
			60.	38.8	868.	2663.	268
			90.	58.2	868.	2663.	268
			120.	77.6	868.	2663.	268
10.0	12.0	7.8	60.	38.8	1911.	5864.	269
			120.	77.6	1911.	5864.	269
			180.	116.4	1911.	5864.	269
			240.	155.1	1911.	5864.	269
15.0	18.0	11.6	90.	58.2	4304.	13208.	927
			180.	116.4	3633.	11148.	927
			270.	174.5	3454.	10598.	570
			360.	232.7	3454.	10598.	570
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	7664.	23516.	2829
			360.	232.7	6787.	20826.	1295
			480.	310.3	6391.	19610.	1295
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-L1- 7 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 7 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 10% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	309.	948.	176
			30.	19.4	309.	948.	176
			45.	29.1	309.	948.	176
			60.	38.8	309.	948.	176
5.0	6.0	3.9	30.	19.4	730.	2241.	251
			60.	38.8	730.	2241.	251
			90.	58.2	730.	2241.	251
			120.	77.6	730.	2241.	251
10.0	12.0	7.8	60.	38.8	1743.	5349.	268
			120.	77.6	1743.	5349.	268
			180.	116.4	1743.	5349.	268
			240.	155.1	1743.	5349.	268
15.0	18.0	11.6	90.	58.2	3579.	10981.	921
			180.	116.4	3016.	9256.	564
			270.	174.5	3016.	9256.	564
			360.	232.7	3016.	9256.	564
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	6442.	19767.	1295
			360.	232.7	5807.	17820.	929
			480.	310.3	5497.	16868.	929
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-L1- 8 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 8 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	336.	1033.	251
			30.	19.4	333.	1022.	251
			45.	29.1	333.	1022.	251
			60.	38.8	333.	1022.	251
5.0	6.0	3.9	30.	19.4	826.	2533.	254
			60.	38.8	826.	2533.	254
			90.	58.2	826.	2533.	254
			120.	77.6	826.	2533.	254
10.0	12.0	7.8	60.	38.8	1841.	5650.	268
			120.	77.6	1841.	5650.	268
			180.	116.4	1841.	5650.	268
			240.	155.1	1841.	5650.	268
15.0	18.0	11.6	90.	58.2	2885.	8852.	269
			180.	116.4	2885.	8852.	269
			270.	174.5	2885.	8852.	269
			360.	232.7	2885.	8852.	269
20.0	24.0	15.5	120.	77.6	3935.	12075.	270
			240.	155.1	3935.	12075.	270
			360.	232.7	3935.	12075.	270
			480.	310.3	3935.	12075.	270
25.0	30.0	19.4	150.	97.0	6839.	20985.	929
			300.	193.9	5483.	16823.	571
			450.	290.9	5475.	16799.	571
			600.	387.8	5475.	16799.	571

TABLE A-L1- 9 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

QM = 286.0 CFS-DAYS, QMN = 0.3 CFS, QMX = 13,500 CFS
LENGTH OF RECORD = 34 YRS (1941 TO 1974)

DIVERSION SCENARIO # 9 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 4% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 7% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	427.	1312.	254
			30.	19.4	427.	1312.	254
			45.	29.1	429.	1316.	254
			60.	38.8	429.	1316.	254
5.0	6.0	3.9	30.	19.4	944.	2896.	269
			60.	38.8	945.	2901.	269
			90.	58.2	945.	2901.	269
			120.	77.6	945.	2901.	269
10.0	12.0	7.8	60.	38.8	2142.	6574.	920
			120.	77.6	1994.	6120.	271
			180.	116.4	1994.	6120.	271
			240.	155.1	1994.	6120.	271
15.0	18.0	11.6	90.	58.2	5548.	17025.	2829
			180.	116.4	4558.	13986.	930
			270.	174.5	4196.	12876.	930
			360.	232.7	3981.	12216.	572
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	9166.	28127.	10695
			480.	310.3	7775.	23856.	1295
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-L2- 1 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 1 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	355.	1089.	220
			30.	19.4	319.	978.	220
			45.	29.1	309.	949.	167
			60.	38.8	309.	949.	167
5.0	6.0	3.9	30.	19.4	749.	2299.	221
			60.	38.8	710.	2179.	221
			90.	58.2	671.	2060.	221
			120.	77.6	633.	1943.	167
10.0	12.0	7.8	60.	38.8	1583.	4858.	226
			120.	77.6	1508.	4627.	226
			180.	116.4	1489.	4570.	226
			240.	155.1	1489.	4570.	226
15.0	18.0	11.6	90.	58.2	3019.	9264.	563
			180.	116.4	2414.	7406.	563
			270.	174.5	2376.	7291.	241
			360.	232.7	2376.	7291.	241
20.0	24.0	15.5	120.	77.6	5687.	17450.	929
			240.	155.1	4591.	14088.	571
			360.	232.7	4582.	14061.	571
			480.	310.3	4582.	14061.	571
25.0	30.0	19.4	150.	97.0	8783.	26951.	930
			300.	193.9	7591.	23294.	930
			450.	290.9	6997.	21470.	930
			600.	387.8	6801.	20870.	572

TABLE A-L2- 2 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 2 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	325.	998.	220
			30.	19.4	295.	904.	167
			45.	29.1	295.	904.	167
			60.	38.8	295.	904.	167
5.0	6.0	3.9	30.	19.4	710.	2178.	220
			60.	38.8	655.	2011.	220
			90.	58.2	618.	1898.	167
			120.	77.6	618.	1898.	167
10.0	12.0	7.8	60.	38.8	1516.	4653.	221
			120.	77.6	1439.	4415.	221
			180.	116.4	1377.	4226.	221
			240.	155.1	1365.	4189.	221
15.0	18.0	11.6	90.	58.2	2345.	7197.	225
			180.	116.4	2245.	6889.	225
			270.	174.5	2233.	6853.	225
			360.	232.7	2233.	6853.	225
20.0	24.0	15.5	120.	77.6	3574.	10967.	563
			240.	155.1	3111.	9546.	226
			360.	232.7	3111.	9546.	226
			480.	310.3	3111.	9546.	226
25.0	30.0	19.4	150.	97.0	5750.	17644.	921
			300.	193.9	4908.	15060.	563
			450.	290.9	4883.	14984.	563
			600.	387.8	4883.	14984.	563

TABLE A-L2- 3 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 3 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	325.	998.	220
			30.	19.4	295.	904.	167
			45.	29.1	295.	904.	167
			60.	38.8	295.	904.	167
5.0	6.0	3.9	30.	19.4	712.	2186.	220
			60.	38.8	673.	2066.	220
			90.	58.2	643.	1972.	220
			120.	77.6	637.	1954.	220
10.0	12.0	7.8	60.	38.8	1534.	4708.	221
			120.	77.6	1498.	4596.	221
			180.	116.4	1498.	4596.	221
			240.	155.1	1498.	4596.	221
15.0	18.0	11.6	90.	58.2	3156.	9683.	921
			180.	116.4	2857.	8766.	563
			270.	174.5	2857.	8766.	563
			360.	232.7	2857.	8766.	563
20.0	24.0	15.5	120.	77.6	6348.	19478.	929
			240.	155.1	5620.	17244.	929
			360.	232.7	5154.	15816.	929
			480.	310.3	5052.	15503.	571
25.0	30.0	19.4	150.	97.0	9703.	29773.	930
			300.	193.9	8994.	27599.	930
			450.	290.9	8494.	26062.	930
			600.	387.8	8269.	25372.	930

TABLE A-L2- 4 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 4 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 25% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	355.	1089.	220
			30.	19.4	316.	970.	220
			45.	29.1	309.	949.	167
			60.	38.8	309.	949.	167
5.0	6.0	3.9	30.	19.4	747.	2291.	221
			60.	38.8	692.	2124.	221
			90.	58.2	653.	2005.	221
			120.	77.6	633.	1943.	167
10.0	12.0	7.8	60.	38.8	1565.	4802.	226
			120.	77.6	1487.	4564.	226
			180.	116.4	1410.	4326.	226
			240.	155.1	1362.	4179.	226
15.0	18.0	11.6	90.	58.2	2403.	7373.	226
			180.	116.4	2286.	7016.	226
			270.	174.5	2233.	6853.	226
			360.	232.7	2233.	6853.	226
20.0	24.0	15.5	120.	77.6	3708.	11377.	563
			240.	155.1	3115.	9558.	226
			360.	232.7	3110.	9543.	226
			480.	310.3	3110.	9543.	226
25.0	30.0	19.4	150.	97.0	5561.	17064.	927
			300.	193.9	4496.	13797.	569
			450.	290.9	4412.	13539.	569
			600.	387.8	4412.	13539.	569

TABLE A-L2- 5 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK, VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 5 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	313.	961.	220
			30.	19.4	288.	883.	167
			45.	29.1	288.	883.	167
			60.	38.8	288.	883.	167
5.0	6.0	3.9	30.	19.4	706.	2167.	221
			60.	38.8	667.	2047.	221
			90.	58.2	628.	1928.	221
			120.	77.6	612.	1877.	167
10.0	12.0	7.8	60.	38.8	1540.	4726.	226
			120.	77.6	1465.	4495.	226
			180.	116.4	1446.	4438.	226
			240.	155.1	1446.	4438.	226
15.0	18.0	11.6	90.	58.2	2895.	8882.	563
			180.	116.4	2333.	7159.	241
			270.	174.5	2333.	7159.	241
			360.	232.7	2333.	7159.	241
20.0	24.0	15.5	120.	77.6	5484.	16828.	929
			240.	155.1	4467.	13707.	571
			360.	232.7	4458.	13680.	571
			480.	310.3	4458.	13680.	571
25.0	30.0	19.4	150.	97.0	8580.	26329.	930
			300.	193.9	7389.	22672.	930
			450.	290.9	6794.	20848.	930
			600.	387.8	6677.	20488.	572

TABLE A-L2- 6 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK, VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 6 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	257.	789.	156
			30.	19.4	257.	789.	156
			45.	29.1	257.	789.	156
			60.	38.8	257.	789.	156
5.0	6.0	3.9	30.	19.4	642.	1969.	221
			60.	38.8	603.	1849.	221
			90.	58.2	580.	1778.	167
			120.	77.6	580.	1778.	167
10.0	12.0	7.8	60.	38.8	1475.	4527.	226
			120.	77.6	1439.	4414.	226
			180.	116.4	1439.	4414.	226
			240.	155.1	1439.	4414.	226
15.0	18.0	11.6	90.	58.2	3243.	9950.	921
			180.	116.4	2918.	8953.	563
			270.	174.5	2918.	8953.	563
			360.	232.7	2918.	8953.	563
20.0	24.0	15.5	120.	77.6	6458.	19817.	929
			240.	155.1	5731.	17584.	929
			360.	232.7	5265.	16156.	929
			480.	310.3	5137.	15763.	571
25.0	30.0	19.4	150.	97.0	9814.	30113.	930
			300.	193.9	9105.	27939.	930
			450.	290.9	8604.	26402.	930
			600.	387.8	8379.	25711.	930

TABLE A-L2- 7 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 7 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 10% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	212.	651.	136
			30.	19.4	211.	648.	136
			45.	29.1	211.	648.	136
			60.	38.8	211.	648.	136
5.0	6.0	3.9	30.	19.4	515.	1579.	156
			60.	38.8	515.	1579.	156
			90.	58.2	515.	1579.	156
			120.	77.6	515.	1579.	156
10.0	12.0	7.8	60.	38.8	1319.	4047.	221
			120.	77.6	1282.	3934.	221
			180.	116.4	1282.	3934.	221
			240.	155.1	1282.	3934.	221
15.0	18.0	11.6	90.	58.2	2386.	7322.	563
			180.	116.4	2235.	6857.	563
			270.	174.5	2235.	6857.	563
			360.	232.7	2235.	6857.	563
20.0	24.0	15.5	120.	77.6	5333.	16364.	929
			240.	155.1	4605.	14131.	929
			360.	232.7	4430.	13594.	571
			480.	310.3	4430.	13594.	571
25.0	30.0	19.4	150.	97.0	8688.	26660.	930
			300.	193.9	7980.	24486.	930
			450.	290.9	7479.	22949.	930
			600.	387.8	7254.	22258.	930

TABLE A-L2- 8 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 8 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	244.	750.	156
			30.	19.4	243.	745.	156
			45.	29.1	243.	745.	156
			60.	38.8	243.	745.	156
5.0	6.0	3.9	30.	19.4	605.	1857.	220
			60.	38.8	565.	1733.	167
			90.	58.2	565.	1733.	167
			120.	77.6	565.	1733.	167
10.0	12.0	7.8	60.	38.8	1409.	4322.	221
			120.	77.6	1331.	4084.	221
			180.	116.4	1269.	3895.	221
			240.	155.1	1258.	3859.	221
15.0	18.0	11.6	90.	58.2	2238.	6866.	225
			180.	116.4	2137.	6559.	225
			270.	174.5	2126.	6522.	225
			360.	232.7	2126.	6522.	225
20.0	24.0	15.5	120.	77.6	3263.	10013.	563
			240.	155.1	3003.	9215.	226
			360.	232.7	3003.	9215.	226
			480.	310.3	3003.	9215.	226
25.0	30.0	19.4	150.	97.0	5243.	16088.	921
			300.	193.9	4597.	14105.	563
			450.	290.9	4572.	14030.	563
			600.	387.8	4572.	14030.	563

TABLE A-L2- 9 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

QM = 396.0 CFS-DAYS, QMN = 5.0 CFS, QMX = 56,000 CFS
LENGTH OF RECORD = 14 YRS (1967 TO 1980)

DIVERSION SCENARIO # 9 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 4% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 7% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	320.	981.	220
			30.	19.4	294.	903.	220
			45.	29.1	291.	892.	167
			60.	38.8	291.	892.	167
5.0	6.0	3.9	30.	19.4	725.	2223.	222
			60.	38.8	686.	2104.	222
			90.	58.2	655.	2010.	222
			120.	77.6	649.	1992.	222
10.0	12.0	7.8	60.	38.8	1798.	5518.	563
			120.	77.6	1525.	4681.	226
			180.	116.4	1525.	4681.	226
			240.	155.1	1525.	4681.	226
15.0	18.0	11.6	90.	58.2	4443.	13634.	929
			180.	116.4	3600.	11047.	929
			270.	174.5	3573.	10965.	571
			360.	232.7	3573.	10965.	571
20.0	24.0	15.5	120.	77.6	7659.	23502.	930
			240.	155.1	6931.	21269.	930
			360.	232.7	6466.	19841.	930
			480.	310.3	6133.	18819.	930
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	10313.	31644.	931
			450.	290.9	9812.	30107.	931
			600.	387.8	9587.	29416.	931

TABLE A-PG- 1 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V 03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 1 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	557.	1708.	550
			30.	19.4	529.	1622.	283
			45.	29.1	529.	1622.	283
			60.	38.8	529.	1622.	283
5.0	6.0	3.9	30.	19.4	2303.	7068.	2073
			60.	38.8	1223.	3753.	931
			90.	58.2	1116.	3425.	574
			120.	77.6	1090.	3346.	293
10.0	12.0	7.8	60.	38.8	*	*	*
			120.	77.6	*	*	*
			180.	116.4	6025.	18486.	2432
			240.	155.1	5671.	17400.	2432
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	*	*	*
			360.	232.7	*	*	*
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PG- 2 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V 03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 2 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	508.	1560.	283
			30.	19.4	508.	1560.	283
			45.	29.1	508.	1560.	283
			60.	38.8	508.	1560.	283
5.0	6.0	3.9	30.	19.4	1130.	3467.	930
			60.	38.8	1057.	3244.	283
			90.	58.2	1057.	3244.	283
			120.	77.6	1057.	3244.	283
10.0	12.0	7.8	60.	38.8	*	*	*
			120.	77.6	3107.	9534.	931
			180.	116.4	2709.	8314.	931
			240.	155.1	2603.	7988.	574
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	*	*	*
			360.	232.7	8955.	27480.	2432
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PG- 3 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V 03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 3 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	508.	1560.	283
			30.	19.4	508.	1560.	283
			45.	29.1	508.	1560.	283
			60.	38.8	508.	1560.	283
5.0	6.0	3.9	30.	19.4	1291.	3960.	930
			60.	38.8	1057.	3244.	283
			90.	58.2	1057.	3244.	283
			120.	77.6	1057.	3244.	283
10.0	12.0	7.8	60.	38.8	*	*	*
			120.	77.6	*	*	*
			180.	116.4	*	*	*
			240.	155.1	*	*	*
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	*	*	*
			360.	232.7	*	*	*
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PG- 4   OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V   03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 4 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 25% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	557.	1708.	550
			30.	19.4	529.	1622.	283
			45.	29.1	529.	1622.	283
			60.	38.8	529.	1622.	283
5.0	6.0	3.9	30.	19.4	1702.	5221.	931
			60.	38.8	1090.	3346.	293
			90.	58.2	1090.	3346.	293
			120.	77.6	1090.	3346.	293
10.0	12.0	7.8	60.	38.8	*	*	*
			120.	77.6	3489.	10706.	2074
			180.	116.4	2906.	8918.	933
			240.	155.1	2731.	8380.	576
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	8803.	27012.	2432
			360.	232.7	8099.	24850.	2432
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PG- 5 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V 03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 5 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	509.	1560.	283
			30.	19.4	509.	1560.	283
			45.	29.1	509.	1561.	283
			60.	38.8	509.	1561.	283
5.0	6.0	3.9	30.	19.4	1933.	5931.	2073
			60.	38.8	1105.	3390.	574
			90.	58.2	1067.	3275.	293
			120.	77.6	1067.	3275.	293
10.0	12.0	7.8	60.	38.8	*	*	*
			120.	77.6	*	*	*
			180.	116.4	5608.	17208.	2432
			240.	155.1	5254.	16122.	2432
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	*	*	*
			360.	232.7	*	*	*
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PG- 6 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V 03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 6 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	479.	1469.	280
			30.	19.4	479.	1469.	280
			45.	29.1	479.	1469.	280
			60.	38.8	479.	1469.	280
5.0	6.0	3.9	30.	19.4	1469.	4509.	931
			60.	38.8	1059.	3249.	574
			90.	58.2	1032.	3168.	293
			120.	77.6	1032.	3168.	293
10.0	12.0	7.8	60.	38.8	*	*	*
			120.	77.6	*	*	*
			180.	116.4	*	*	*
			240.	155.1	*	*	*
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	*	*	*
			360.	232.7	*	*	*
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PG- 7 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V 03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 7 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 10% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	434.	1331.	255
			30.	19.4	434.	1331.	255
			45.	29.1	434.	1331.	255
			60.	38.8	434.	1331.	255
5.0	6.0	3.9	30.	19.4	958.	2938.	280
			60.	38.8	958.	2938.	280
			90.	58.2	958.	2938.	280
			120.	77.6	958.	2938.	280
10.0	12.0	7.8	60.	38.8	*	*	*
			120.	77.6	4997.	15332.	2430
			180.	116.4	4692.	14396.	2430
			240.	155.1	4573.	14033.	2430
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	*	*	*
			360.	232.7	*	*	*
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PG- 8 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V 03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 8 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	459.	1407.	280
			30.	19.4	459.	1407.	280
			45.	29.1	459.	1407.	280
			60.	38.8	459.	1407.	280
5.0	6.0	3.9	30.	19.4	1007.	3090.	283
			60.	38.8	1007.	3090.	283
			90.	58.2	1007.	3090.	283
			120.	77.6	1007.	3090.	283
10.0	12.0	7.8	60.	38.8	4856.	14900.	2430
			120.	77.6	2714.	8329.	931
			180.	116.4	2415.	7409.	574
			240.	155.1	2381.	7305.	574
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	8302.	25473.	2432
			360.	232.7	7913.	24279.	2432
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PG- 9 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK,V 03.2089.00

QM = 127.0 CFS-DAYS, QMN = 1.7 CFS, QMX = 10,900 CFS
LENGTH OF RECORD = 12 YRS (1963 TO 1975)

DIVERSION SCENARIO # 9 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 4% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 7% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	533.	1635.	930
			30.	19.4	513.	1573.	283
			45.	29.1	513.	1573.	283
			60.	38.8	513.	1573.	283
5.0	6.0	3.9	30.	19.4	*	*	*
			60.	38.8	1538.	4720.	933
			90.	58.2	1339.	4110.	933
			120.	77.6	1289.	3956.	576
10.0	12.0	7.8	60.	38.8	*	*	*
			120.	77.6	*	*	*
			180.	116.4	*	*	*
			240.	155.1	*	*	*
15.0	18.0	11.6	90.	58.2	*	*	*
			180.	116.4	*	*	*
			270.	174.5	*	*	*
			360.	232.7	*	*	*
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	*	*	*
			360.	232.7	*	*	*
			480.	310.3	*	*	*
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-HY- 1 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 1 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	442.	1355.	254
			30.	19.4	431.	1321.	254
			45.	29.1	431.	1321.	254
			60.	38.8	431.	1321.	254
5.0	6.0	3.9	30.	19.4	1042.	3198.	549
			60.	38.8	928.	2848.	256
			90.	58.2	928.	2848.	256
			120.	77.6	928.	2848.	256
10.0	12.0	7.8	60.	38.8	3659.	11228.	965
			120.	77.6	2450.	7517.	965
			180.	116.4	1966.	6031.	965
			240.	155.1	1956.	6003.	268
15.0	18.0	11.6	90.	58.2	6684.	20509.	1114
			180.	116.4	5708.	17516.	965
			270.	174.5	5388.	16534.	965
			360.	232.7	5285.	16216.	965
20.0	24.0	15.5	120.	77.6	10401.	31916.	1124
			240.	155.1	9359.	28717.	1050
			360.	232.7	9066.	27818.	1050
			480.	310.3	8950.	27464.	966
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	13334.	40914.	1124
			450.	290.9	13068.	40098.	1124
			600.	387.8	12971.	39801.	1124

TABLE A-HY- 2 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 2 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	411.	1260.	254
			30.	19.4	393.	1206.	254
			45.	29.1	392.	1203.	209
			60.	38.8	392.	1203.	209
5.0	6.0	3.9	30.	19.4	886.	2717.	254
			60.	38.8	876.	2688.	254
			90.	58.2	876.	2688.	254
			120.	77.6	876.	2688.	254
10.0	12.0	7.8	60.	38.8	2531.	7766.	965
			120.	77.6	1871.	5742.	256
			180.	116.4	1871.	5742.	256
			240.	155.1	1871.	5742.	256
15.0	18.0	11.6	90.	58.2	5303.	16272.	965
			180.	116.4	3776.	11587.	965
			270.	174.5	3196.	9807.	965
			360.	232.7	2902.	8906.	268
20.0	24.0	15.5	120.	77.6	8325.	25546.	965
			240.	155.1	7071.	21696.	965
			360.	232.7	6644.	20387.	965
			480.	310.3	6506.	19963.	965
25.0	30.0	19.4	150.	97.0	11861.	36394.	1115
			300.	193.9	10581.	32467.	965
			450.	290.9	10268.	31507.	965
			600.	387.8	10171.	31209.	965

TABLE A-HY- 3 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 3 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	411.	1260.	254
			30.	19.4	399.	1224.	254
			45.	29.1	399.	1224.	254
			60.	38.8	399.	1224.	254
5.0	6.0	3.9	30.	19.4	891.	2735.	254
			60.	38.8	891.	2735.	254
			90.	58.2	891.	2735.	254
			120.	77.6	891.	2735.	254
10.0	12.0	7.8	60.	38.8	3356.	10298.	965
			120.	77.6	2729.	8374.	965
			180.	116.4	2516.	7719.	965
			240.	155.1	2447.	7507.	965
15.0	18.0	11.6	90.	58.2	6795.	20851.	1114
			180.	116.4	6258.	19204.	965
			270.	174.5	6170.	18932.	965
			360.	232.7	6112.	18754.	965
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	10241.	31425.	1124
			360.	232.7	10111.	31024.	1124
			480.	310.3	10033.	30786.	1124
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-HY- 4 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 4 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 25% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	442.	1355.	254
			30.	19.4	425.	1303.	254
			45.	29.1	415.	1274.	254
			60.	38.8	415.	1274.	254
5.0	6.0	3.9	30.	19.4	922.	2830.	256
			60.	38.8	913.	2801.	256
			90.	58.2	913.	2801.	256
			120.	77.6	913.	2801.	256
10.0	12.0	7.8	60.	38.8	3047.	9351.	965
			120.	77.6	1926.	5910.	268
			180.	116.4	1926.	5910.	268
			240.	155.1	1926.	5910.	268
15.0	18.0	11.6	90.	58.2	5706.	17509.	965
			180.	116.4	3627.	11130.	965
			270.	174.5	2966.	9100.	268
			360.	232.7	2966.	9100.	268
20.0	24.0	15.5	120.	77.6	8581.	26332.	965
			240.	155.1	6731.	20655.	965
			360.	232.7	6064.	18608.	965
			480.	310.3	5710.	17522.	965
25.0	30.0	19.4	150.	97.0	11861.	36395.	1115
			300.	193.9	10049.	30836.	965
			450.	290.9	9516.	29200.	965
			600.	387.8	9343.	28670.	965

TABLE A-HY- 5 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 5 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	405.	1241.	254
			30.	19.4	393.	1207.	254
			45.	29.1	393.	1207.	254
			60.	38.8	393.	1207.	254
5.0	6.0	3.9	30.	19.4	961.	2950.	549
			60.	38.8	890.	2731.	256
			90.	58.2	890.	2731.	256
			120.	77.6	890.	2731.	256
10.0	12.0	7.8	60.	38.8	3522.	10809.	965
			120.	77.6	2313.	7097.	965
			180.	116.4	1916.	5879.	268
			240.	155.1	1916.	5879.	268
15.0	18.0	11.6	90.	58.2	6513.	19986.	1040
			180.	116.4	5572.	17097.	965
			270.	174.5	5252.	16115.	965
			360.	232.7	5148.	15797.	965
20.0	24.0	15.5	120.	77.6	10231.	31395.	1124
			240.	155.1	9205.	28246.	1050
			360.	232.7	8912.	27347.	1050
			480.	310.3	8814.	27045.	966
25.0	30.0	19.4	150.	97.0	18435.	56567.	11587
			300.	193.9	13164.	40393.	1124
			450.	290.9	12898.	39578.	1124
			600.	387.8	12801.	39280.	1124

TABLE A-HY- 6 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 6 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	350.	1075.	208
			30.	19.4	350.	1075.	208
			45.	29.1	350.	1075.	208
			60.	38.8	350.	1075.	208
5.0	6.0	3.9	30.	19.4	837.	2567.	549
			60.	38.8	831.	2550.	256
			90.	58.2	831.	2550.	256
			120.	77.6	831.	2550.	256
10.0	12.0	7.8	60.	38.8	3525.	10815.	965
			120.	77.6	2898.	8891.	965
			180.	116.4	2684.	8236.	965
			240.	155.1	2615.	8024.	965
15.0	18.0	11.6	90.	58.2	7031.	21575.	1114
			180.	116.4	6427.	19721.	965
			270.	174.5	6338.	19449.	965
			360.	232.7	6280.	19271.	965
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	10482.	32164.	1124
			360.	232.7	10352.	31764.	1124
			480.	310.3	10274.	31526.	1124
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-HY- 7 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI, VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 7 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 10% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	328.	1007.	179
			30.	19.4	328.	1007.	179
			45.	29.1	328.	1007.	179
			60.	38.8	328.	1007.	179
5.0	6.0	3.9	30.	19.4	702.	2154.	246
			60.	38.8	702.	2154.	246
			90.	58.2	702.	2154.	246
			120.	77.6	702.	2154.	246
10.0	12.0	7.8	60.	38.8	2658.	8155.	965
			120.	77.6	2030.	6230.	965
			180.	116.4	1817.	5576.	965
			240.	155.1	1748.	5364.	965
15.0	18.0	11.6	90.	58.2	5997.	18403.	965
			180.	116.4	5560.	17060.	965
			270.	174.5	5471.	16788.	965
			360.	232.7	5413.	16610.	965
20.0	24.0	15.5	120.	77.6	10942.	33576.	3512
			240.	155.1	9372.	28758.	1124
			360.	232.7	9242.	28358.	1124
			480.	310.3	9164.	28120.	1124
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	19118.	58662.	11587
			600.	387.8	14941.	45846.	3512

TABLE A-HY- 8 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 8 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	344.	1055.	208
			30.	19.4	344.	1055.	208
			45.	29.1	344.	1055.	208
			60.	38.8	344.	1055.	208
5.0	6.0	3.9	30.	19.4	791.	2427.	254
			60.	38.8	781.	2397.	254
			90.	58.2	781.	2397.	254
			120.	77.6	781.	2397.	254
10.0	12.0	7.8	60.	38.8	2183.	6699.	965
			120.	77.6	1774.	5444.	256
			180.	116.4	1774.	5444.	256
			240.	155.1	1774.	5444.	256
15.0	18.0	11.6	90.	58.2	4955.	15205.	965
			180.	116.4	3428.	10520.	965
			270.	174.5	2848.	8740.	965
			360.	232.7	2800.	8592.	268
20.0	24.0	15.5	120.	77.6	7977.	24479.	965
			240.	155.1	6723.	20629.	965
			360.	232.7	6296.	19320.	965
			480.	310.3	6158.	18895.	965
25.0	30.0	19.4	150.	97.0	11428.	35066.	1115
			300.	193.9	10233.	31399.	965
			450.	290.9	9920.	30439.	965
			600.	387.8	9823.	30142.	965

TABLE A-HY- 9 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

QM = 333.0 CFS-DAYS, QMN = 0.2 CFS, QMX = 59,000 CFS
LENGTH OF RECORD = 54 YRS (1926 TO 1980)

DIVERSION SCENARIO # 9 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 4% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 7% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	413.	1266.	254
			30.	19.4	409.	1255.	254
			45.	29.1	409.	1255.	254
			60.	38.8	409.	1255.	254
5.0	6.0	3.9	30.	19.4	1286.	3945.	965
			60.	38.8	907.	2784.	257
			90.	58.2	907.	2784.	257
			120.	77.6	907.	2784.	257
10.0	12.0	7.8	60.	38.8	4190.	12858.	965
			120.	77.6	3563.	10934.	965
			180.	116.4	3350.	10279.	965
			240.	155.1	3281.	10067.	965
15.0	18.0	11.6	90.	58.2	8083.	24803.	1763
			180.	116.4	7223.	22164.	1050
			270.	174.5	7076.	21714.	1050
			360.	232.7	7001.	21484.	1050
20.0	24.0	15.5	120.	77.6	*	*	*
			240.	155.1	12025.	36899.	3513
			360.	232.7	11272.	34588.	1125
			480.	310.3	11194.	34350.	1125
25.0	30.0	19.4	150.	97.0	*	*	*
			300.	193.9	*	*	*
			450.	290.9	*	*	*
			600.	387.8	*	*	*

TABLE A-PJ- 1 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 1 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	351.	1078.	188
			30.	19.4	351.	1078.	188
			45.	29.1	351.	1078.	188
			60.	38.8	351.	1078.	188
5.0	6.0	3.9	30.	19.4	716.	2196.	188
			60.	38.8	716.	2196.	188
			90.	58.2	716.	2196.	188
			120.	77.6	716.	2196.	188
10.0	12.0	7.8	60.	38.8	1596.	4897.	239
			120.	77.6	1596.	4897.	239
			180.	116.4	1596.	4897.	239
			240.	155.1	1596.	4897.	239
15.0	18.0	11.6	90.	58.2	2607.	8000.	267
			180.	116.4	2565.	7869.	267
			270.	174.5	2565.	7869.	267
			360.	232.7	2565.	7869.	267
20.0	24.0	15.5	120.	77.6	3968.	12177.	502
			240.	155.1	3600.	11047.	267
			360.	232.7	3600.	11047.	267
			480.	310.3	3600.	11047.	267
25.0	30.0	19.4	150.	97.0	6769.	20769.	988
			300.	193.9	4647.	14258.	268
			450.	290.9	4647.	14258.	268
			600.	387.8	4647.	14258.	268

TABLE A-PJ- 2 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 2 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	345.	1059.	188
			30.	19.4	338.	1037.	188
			45.	29.1	338.	1037.	188
			60.	38.8	338.	1037.	188
5.0	6.0	3.9	30.	19.4	702.	2155.	188
			60.	38.8	702.	2155.	188
			90.	58.2	702.	2155.	188
			120.	77.6	702.	2155.	188
10.0	12.0	7.8	60.	38.8	1432.	4393.	188
			120.	77.6	1432.	4393.	188
			180.	116.4	1432.	4393.	188
			240.	155.1	1432.	4393.	188
15.0	18.0	11.6	90.	58.2	2337.	7172.	238
			180.	116.4	2337.	7172.	238
			270.	174.5	2337.	7172.	238
			360.	232.7	2337.	7172.	238
20.0	24.0	15.5	120.	77.6	3299.	10122.	266
			240.	155.1	3265.	10018.	239
			360.	232.7	3265.	10018.	239
			480.	310.3	3265.	10018.	239
25.0	30.0	19.4	150.	97.0	4318.	13250.	502
			300.	193.9	4278.	13128.	267
			450.	290.9	4278.	13128.	267
			600.	387.8	4278.	13128.	267

TABLE A-PJ- 3 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 3 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	345.	1059.	188
			30.	19.4	338.	1037.	188
			45.	29.1	338.	1037.	188
			60.	38.8	338.	1037.	188
5.0	6.0	3.9	30.	19.4	702.	2155.	188
			60.	38.8	702.	2155.	188
			90.	58.2	702.	2155.	188
			120.	77.6	702.	2155.	188
10.0	12.0	7.8	60.	38.8	1488.	4566.	234
			120.	77.6	1488.	4566.	234
			180.	116.4	1488.	4566.	234
			240.	155.1	1488.	4566.	234
15.0	18.0	11.6	90.	58.2	2414.	7406.	255
			180.	116.4	2411.	7397.	238
			270.	174.5	2411.	7397.	238
			360.	232.7	2411.	7397.	238
20.0	24.0	15.5	120.	77.6	4196.	12874.	920
			240.	155.1	3427.	10517.	266
			360.	232.7	3427.	10517.	266
			480.	310.3	3427.	10517.	266
25.0	30.0	19.4	150.	97.0	7433.	22807.	988
			300.	193.9	6342.	19459.	988
			450.	290.9	6106.	18737.	988
			600.	387.8	6012.	18447.	988

TABLE A-PJ- 4 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 4 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 0% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 25% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	351.	1078.	188
			30.	19.4	351.	1078.	188
			45.	29.1	351.	1078.	188
			60.	38.8	351.	1078.	188
5.0	6.0	3.9	30.	19.4	716.	2196.	188
			60.	38.8	716.	2196.	188
			90.	58.2	716.	2196.	188
			120.	77.6	716.	2196.	188
10.0	12.0	7.8	60.	38.8	1527.	4685.	239
			120.	77.6	1523.	4672.	239
			180.	116.4	1523.	4672.	239
			240.	155.1	1523.	4672.	239
15.0	18.0	11.6	90.	58.2	2489.	7637.	267
			180.	116.4	2449.	7516.	239
			270.	174.5	2449.	7516.	239
			360.	232.7	2449.	7516.	239
20.0	24.0	15.5	120.	77.6	3505.	10755.	267
			240.	155.1	3427.	10517.	267
			360.	232.7	3415.	10477.	267
			480.	310.3	3415.	10477.	267
25.0	30.0	19.4	150.	97.0	4657.	14290.	502
			300.	193.9	4450.	13655.	267
			450.	290.9	4450.	13655.	267
			600.	387.8	4450.	13655.	267

TABLE A-PJ- 5 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 5 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 15% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	307.	942.	188
			30.	19.4	307.	942.	188
			45.	29.1	307.	942.	188
			60.	38.8	308.	944.	188
5.0	6.0	3.9	30.	19.4	671.	2060.	188
			60.	38.8	672.	2063.	188
			90.	58.2	672.	2063.	188
			120.	77.6	672.	2063.	188
10.0	12.0	7.8	60.	38.8	1470.	4510.	239
			120.	77.6	1470.	4510.	239
			180.	116.4	1470.	4510.	239
			240.	155.1	1470.	4510.	239
15.0	18.0	11.6	90.	58.2	2470.	7580.	267
			180.	116.4	2428.	7449.	267
			270.	174.5	2428.	7449.	267
			360.	232.7	2428.	7449.	267
20.0	24.0	15.5	120.	77.6	3755.	11522.	502
			240.	155.1	3463.	10627.	267
			360.	232.7	3463.	10627.	267
			480.	310.3	3463.	10627.	267
25.0	30.0	19.4	150.	97.0	6443.	19771.	988
			300.	193.9	4510.	13838.	268
			450.	290.9	4510.	13838.	268
			600.	387.8	4510.	13838.	268

TABLE A-PJ- 6 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 6 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 5% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	252.	773.	166
			30.	19.4	252.	773.	166
			45.	29.1	252.	773.	166
			60.	38.8	252.	774.	166
5.0	6.0	3.9	30.	19.4	604.	1855.	187
			60.	38.8	605.	1856.	187
			90.	58.2	605.	1856.	187
			120.	77.6	605.	1856.	187
10.0	12.0	7.8	60.	38.8	1341.	4115.	190
			120.	77.6	1341.	4115.	190
			180.	116.4	1341.	4115.	190
			240.	155.1	1341.	4115.	190
15.0	18.0	11.6	90.	58.2	2260.	6936.	267
			180.	116.4	2251.	6908.	267
			270.	174.5	2251.	6908.	267
			360.	232.7	2251.	6908.	267
20.0	24.0	15.5	120.	77.6	4366.	13398.	987
			240.	155.1	3287.	10086.	267
			360.	232.7	3287.	10086.	267
			480.	310.3	3287.	10086.	267
25.0	30.0	19.4	150.	97.0	7730.	23718.	1006
			300.	193.9	6638.	20370.	1006
			450.	290.9	6403.	19648.	1006
			600.	387.8	6309.	19358.	1006

TABLE A-PJ- 7 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 7 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 10% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 10% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	226.	694.	123
			30.	19.4	226.	694.	123
			45.	29.1	226.	694.	123
			60.	38.8	226.	694.	123
5.0	6.0	3.9	30.	19.4	504.	1546.	166
			60.	38.8	504.	1547.	166
			90.	58.2	504.	1547.	166
			120.	77.6	504.	1547.	166
10.0	12.0	7.8	60.	38.8	1210.	3711.	187
			120.	77.6	1210.	3711.	187
			180.	116.4	1210.	3711.	187
			240.	155.1	1210.	3711.	187
15.0	18.0	11.6	90.	58.2	1943.	5963.	189
			180.	116.4	1943.	5963.	189
			270.	174.5	1943.	5963.	189
			360.	232.7	1943.	5963.	189
20.0	24.0	15.5	120.	77.6	2796.	8580.	502
			240.	155.1	2732.	8382.	266
			360.	232.7	2732.	8382.	266
			480.	310.3	2732.	8382.	266
25.0	30.0	19.4	150.	97.0	5780.	17736.	988
			300.	193.9	4720.	14483.	920
			450.	290.9	4485.	13761.	920
			600.	387.8	4390.	13471.	920

TABLE A-PJ- 8 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 8 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 5% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 10% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 15% OF QS
WHEN QS > 100% OF QM : QP = 20% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	246.	755.	166
			30.	19.4	239.	732.	166
			45.	29.1	239.	733.	166
			60.	38.8	239.	733.	166
5.0	6.0	3.9	30.	19.4	591.	1814.	187
			60.	38.8	592.	1815.	187
			90.	58.2	592.	1815.	187
			120.	77.6	592.	1815.	187
10.0	12.0	7.8	60.	38.8	1321.	4054.	188
			120.	77.6	1321.	4054.	188
			180.	116.4	1321.	4054.	188
			240.	155.1	1321.	4054.	188
15.0	18.0	11.6	90.	58.2	2058.	6315.	189
			180.	116.4	2058.	6315.	189
			270.	174.5	2058.	6315.	189
			360.	232.7	2058.	6315.	189
20.0	24.0	15.5	120.	77.6	2952.	9058.	266
			240.	155.1	2946.	9040.	239
			360.	232.7	2946.	9040.	239
			480.	310.3	2946.	9040.	239
25.0	30.0	19.4	150.	97.0	3969.	12178.	267
			300.	193.9	3931.	12063.	267
			450.	290.9	3931.	12063.	267
			600.	387.8	3931.	12063.	267

TABLE A-PJ- 9 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

QM = 541.0 CFS-DAYS, QMN = 17.0 CFS, QMX = 57,000 CFS
LENGTH OF RECORD = 50 YRS (1931 TO 1980)

DIVERSION SCENARIO # 9 :

WHEN QS < 10% OF QM : QP = 0
WHEN 10% OF QM < QS < 25% OF QM : QP = 2% OF QS
WHEN 25% OF QM < QS < 50% OF QM : QP = 4% OF QS
WHEN 50% OF QM < QS < 100% OF QM : QP = 7% OF QS
WHEN QS > 100% OF QM : QP = 10% OF QS

W	QPAV		QPMX		STOR. REQ'D, V		ND
MTY	CFS	MGD	CFS	MGD	MG	ACRE-FT	DAYS
2.5	3.0	1.9	15.	9.7	310.	950.	188
			30.	19.4	310.	950.	188
			45.	29.1	310.	950.	188
			60.	38.8	310.	952.	188
5.0	6.0	3.9	30.	19.4	674.	2069.	188
			60.	38.8	675.	2071.	188
			90.	58.2	675.	2071.	188
			120.	77.6	675.	2071.	188
10.0	12.0	7.8	60.	38.8	1566.	4806.	267
			120.	77.6	1538.	4719.	267
			180.	116.4	1538.	4719.	267
			240.	155.1	1538.	4719.	267
15.0	18.0	11.6	90.	58.2	2977.	9135.	987
			180.	116.4	2573.	7897.	267
			270.	174.5	2573.	7897.	267
			360.	232.7	2573.	7897.	267
20.0	24.0	15.5	120.	77.6	5985.	18364.	990
			240.	155.1	4667.	14320.	990
			360.	232.7	4265.	13088.	990
			480.	310.3	4157.	12755.	990
25.0	30.0	19.4	150.	97.0	9400.	28844.	1009
			300.	193.9	8309.	25496.	1009
			450.	290.9	8074.	24774.	1009
			600.	387.8	7979.	24484.	1009

APPENDIX B

OFFSTREAM RESERVOIRS CAPACITIES (FIGURES)

LEVISA FORK NR GRUNDY.VA. 03.2075.00

SCENARIO #1

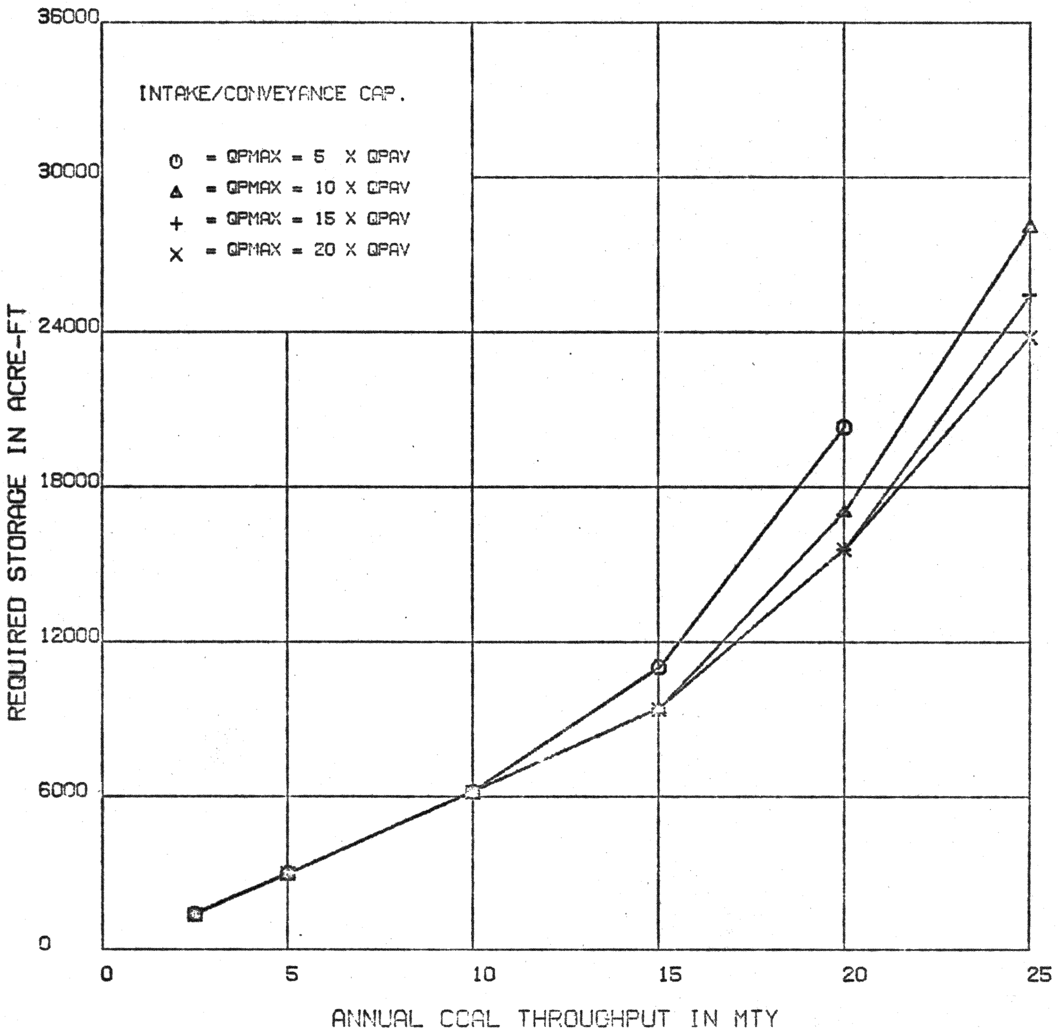


FIGURE B-L1-1 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY.VA. 03.2075.00

SCENARIO #2

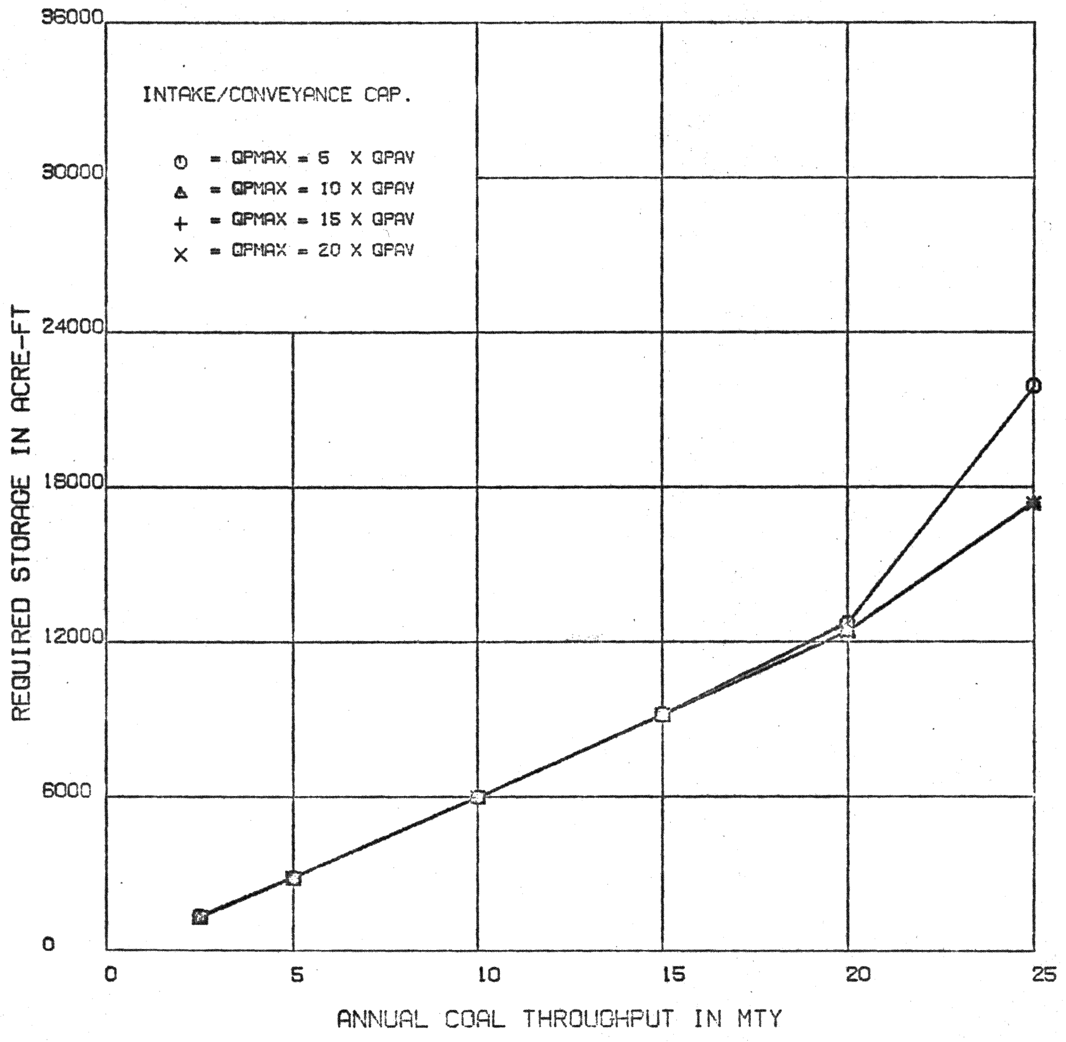


FIGURE B-L1-2 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY.VA. 03.2075.00

SCENARIO #3

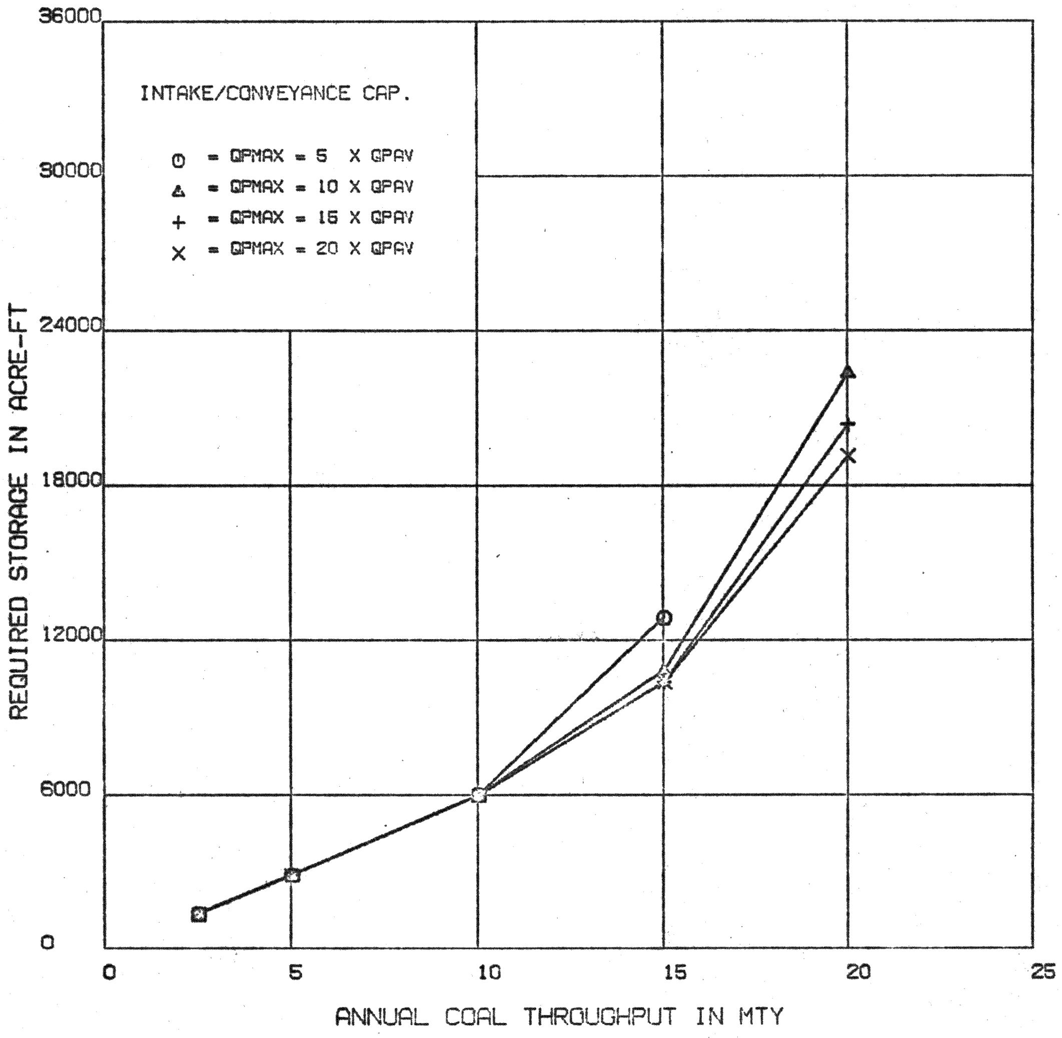


FIGURE B-L1-3 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY.VA. 03.2075.00

SCENARIO #4

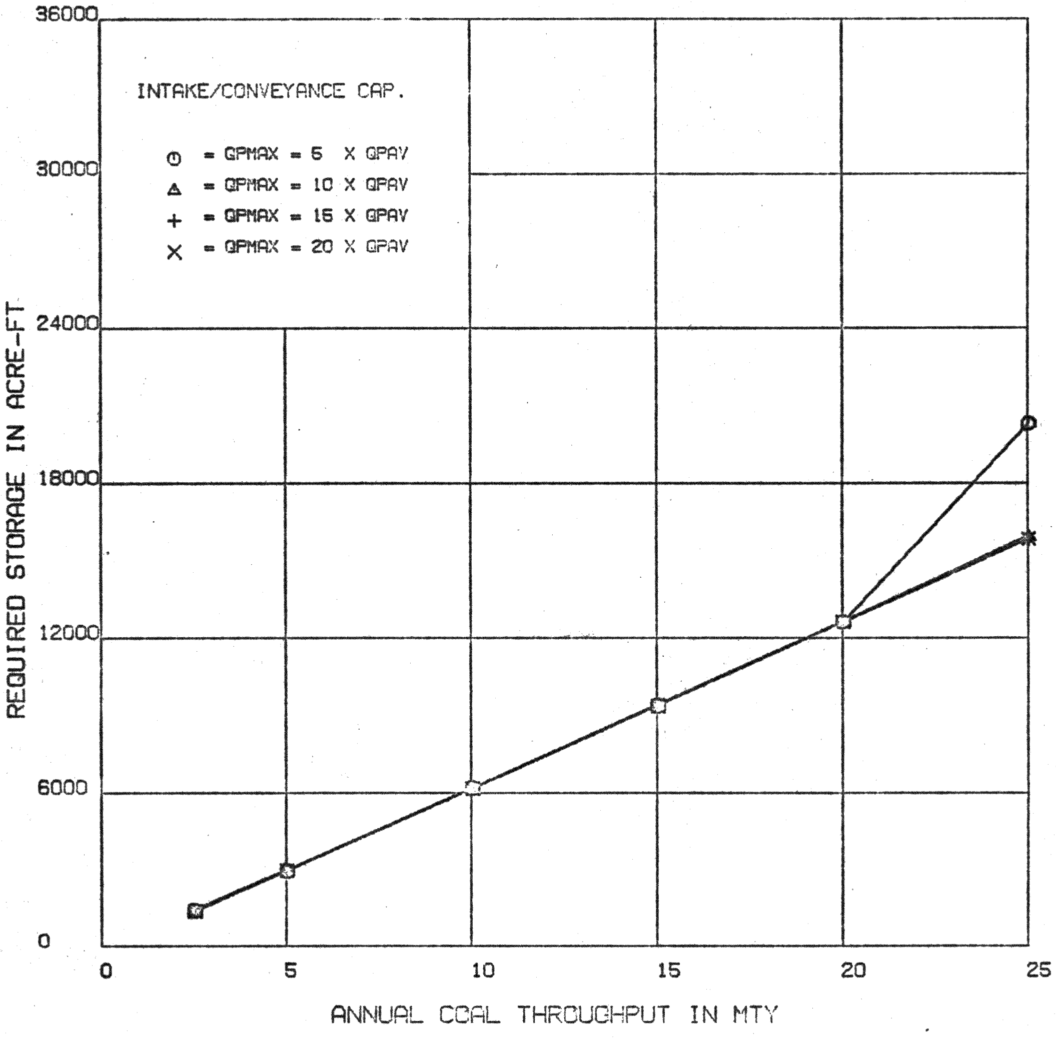


FIGURE B-L1-4 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY.VA. 03.2075.00

SCENARIO #5

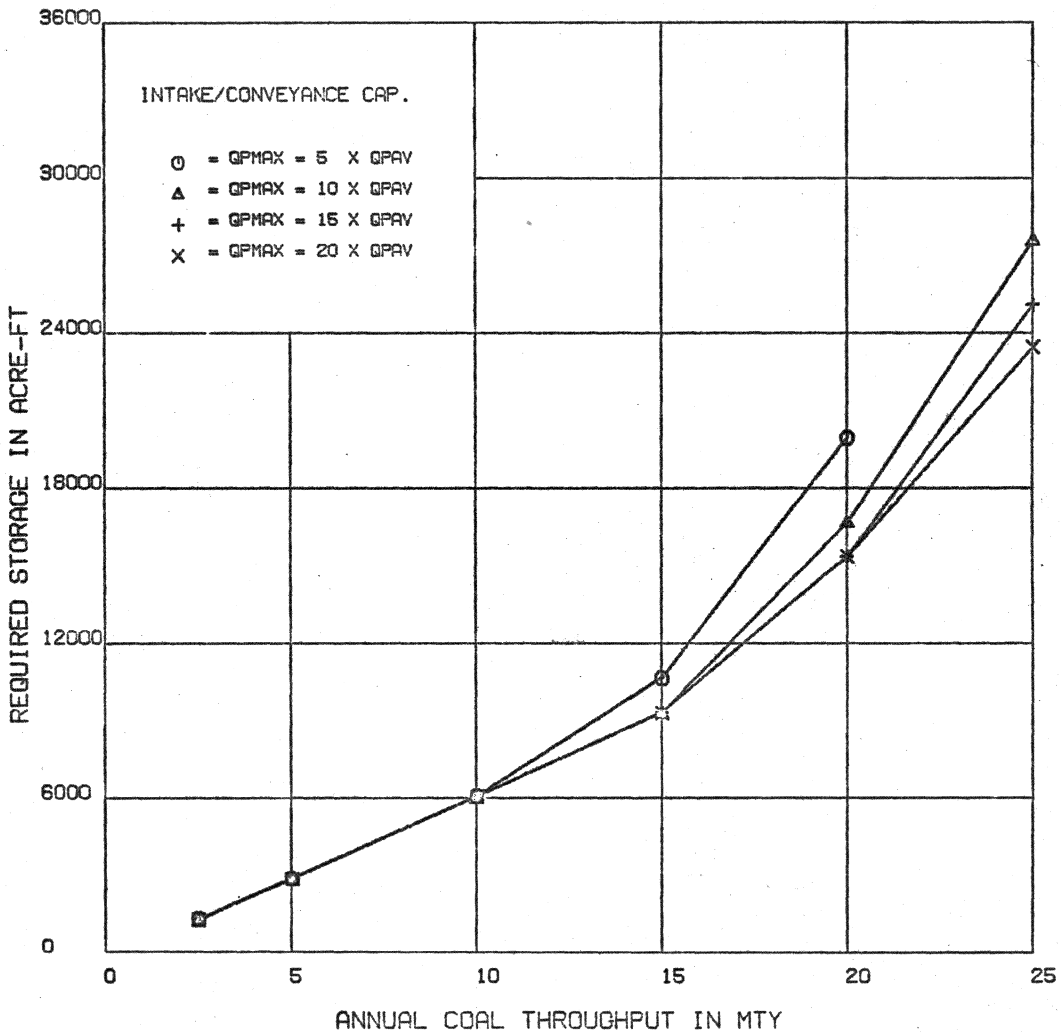


FIGURE B-L1-5 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY.VA. 03.2075.00

SCENARIO #6

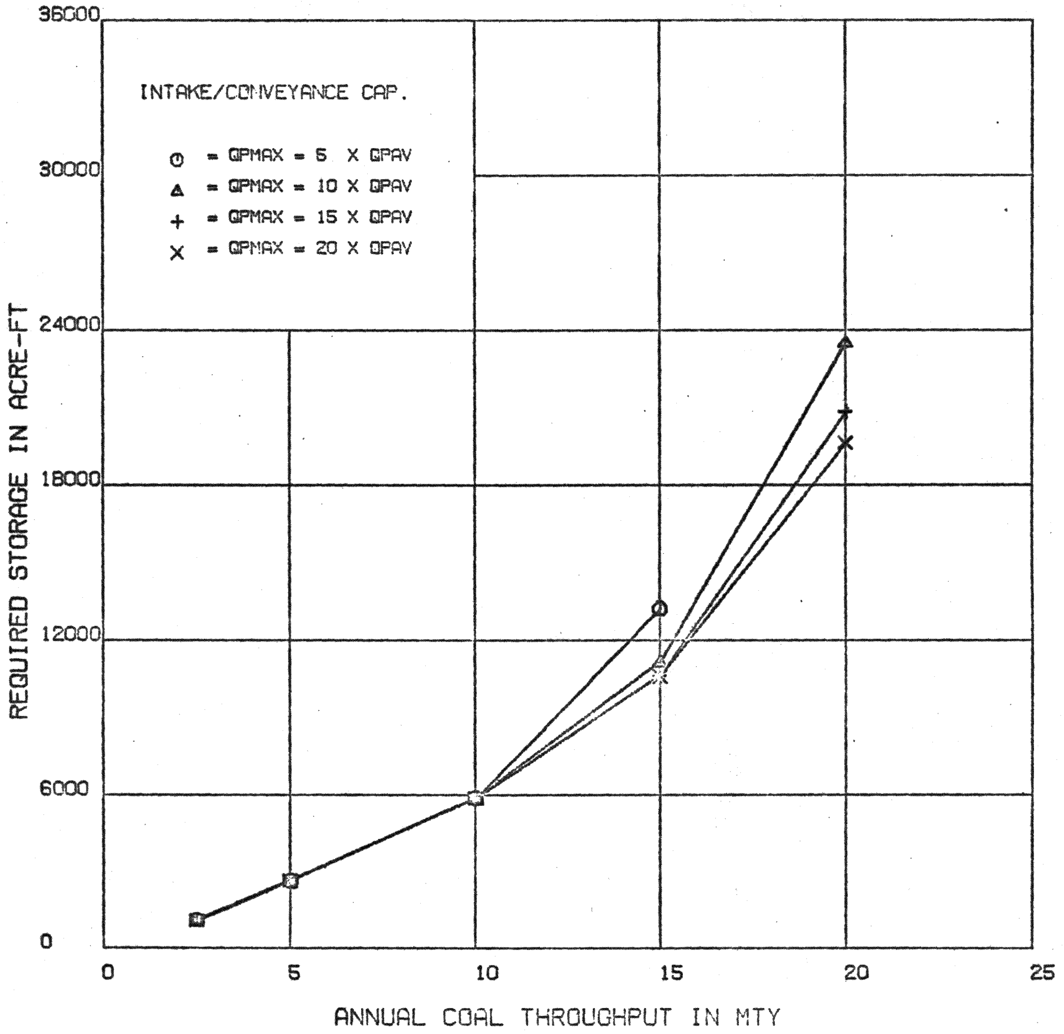


FIGURE B-L1-6 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

SCENARIO #7

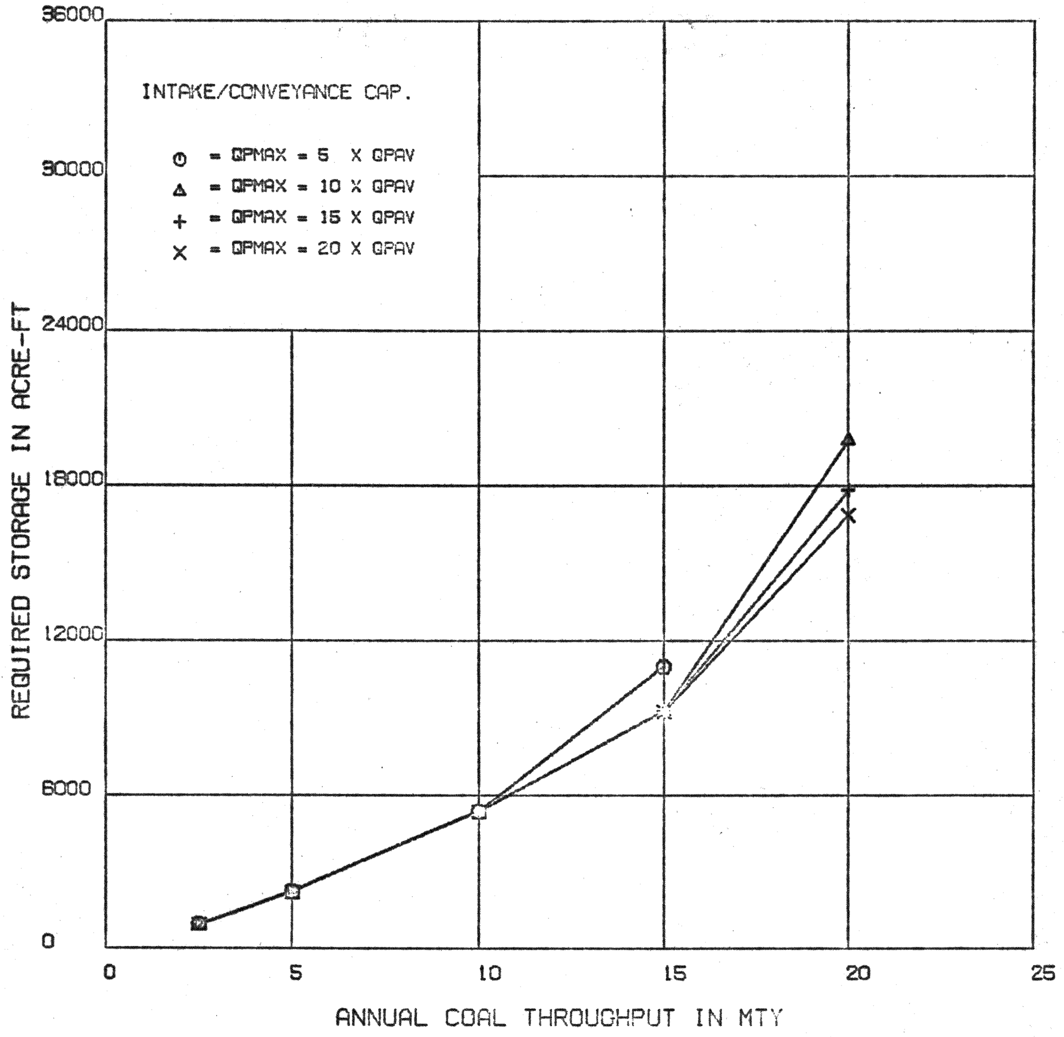


FIGURE B-L1-7 OFFSTREAM STORAGE REQUIREMENTS

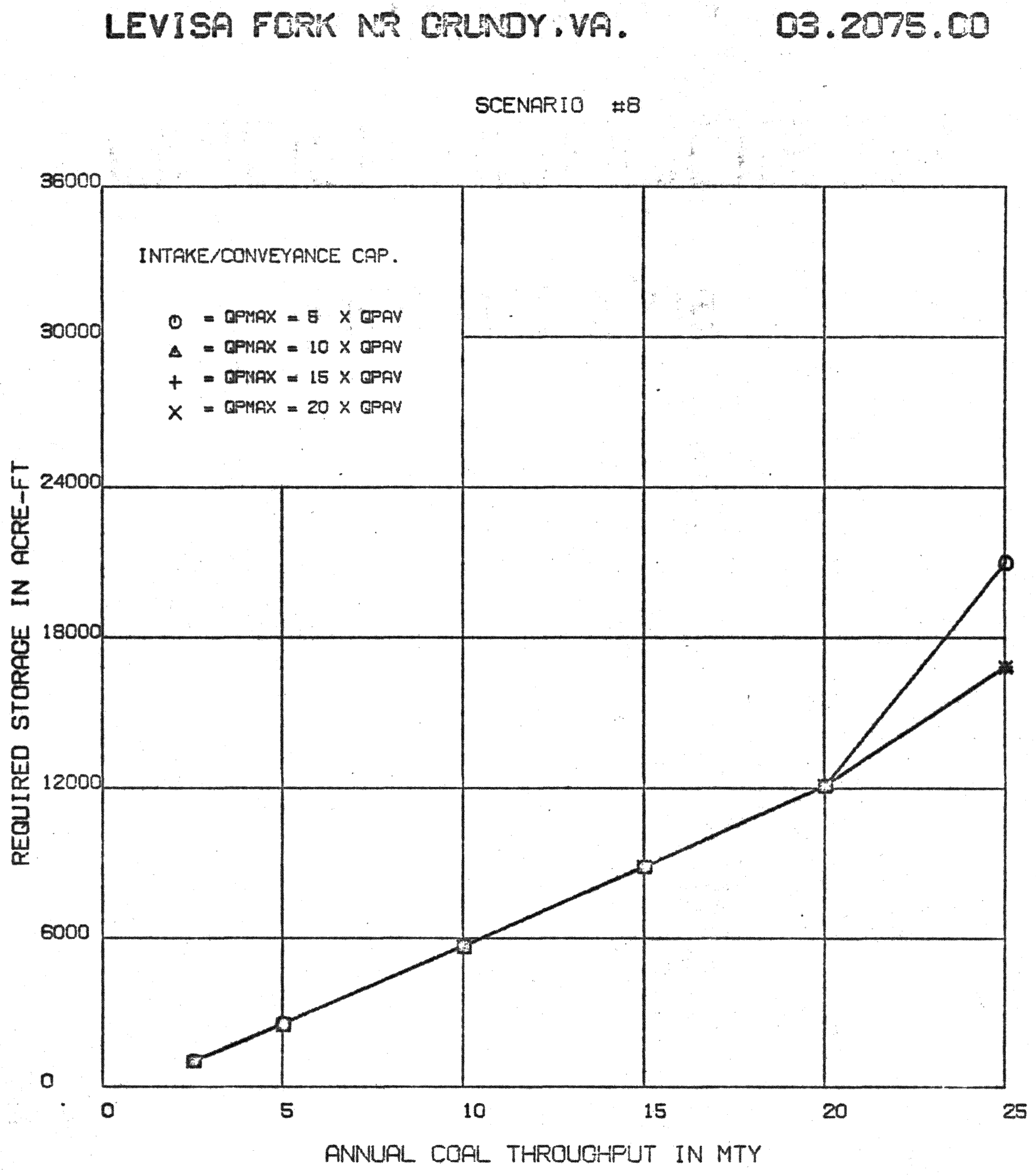


FIGURE B-L1-8 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY,VA. 03.2075.00

SCENARIO #9

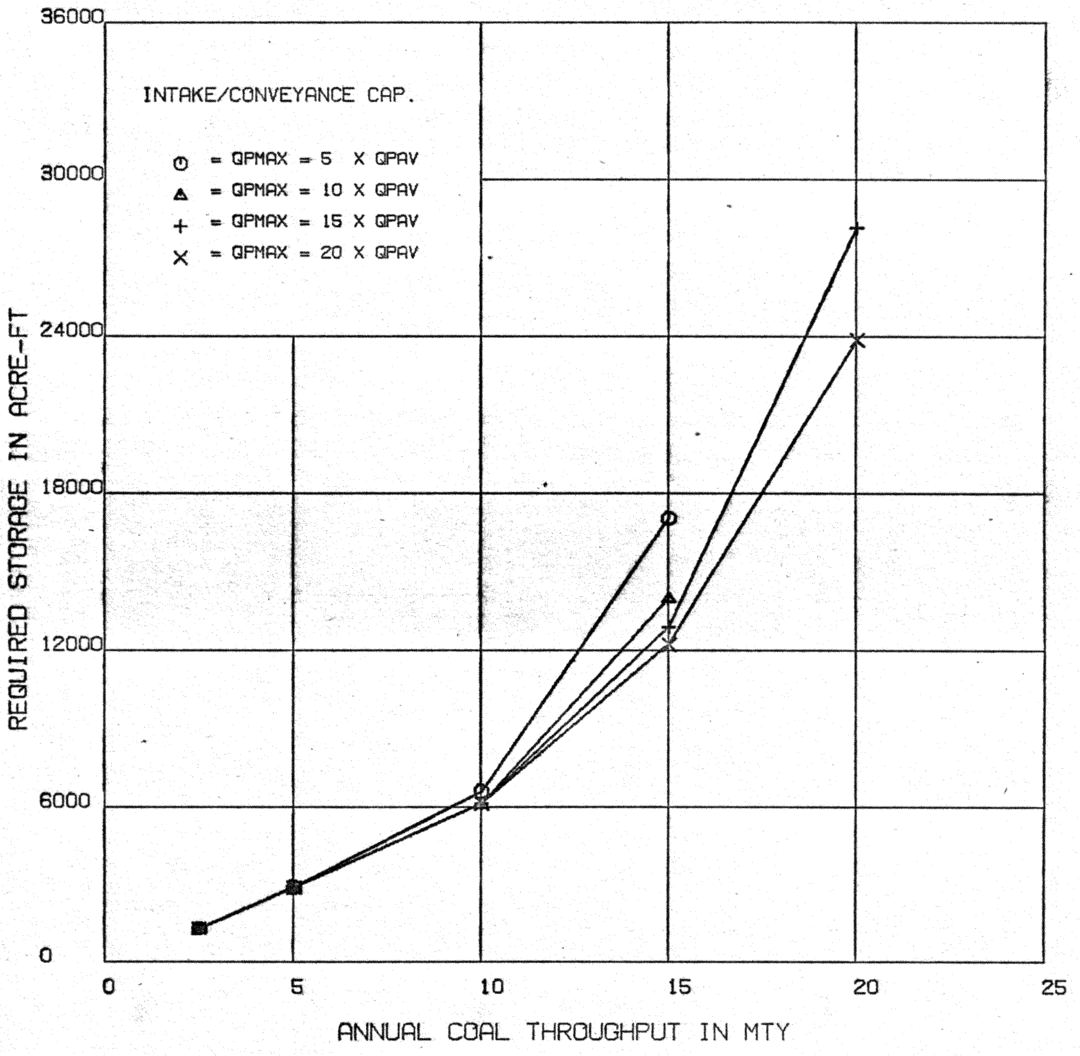


FIGURE B-L1-9 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY.VA. 03.2075.00

INTAKE CAPACITY 5 X PIPELINE DEMAND

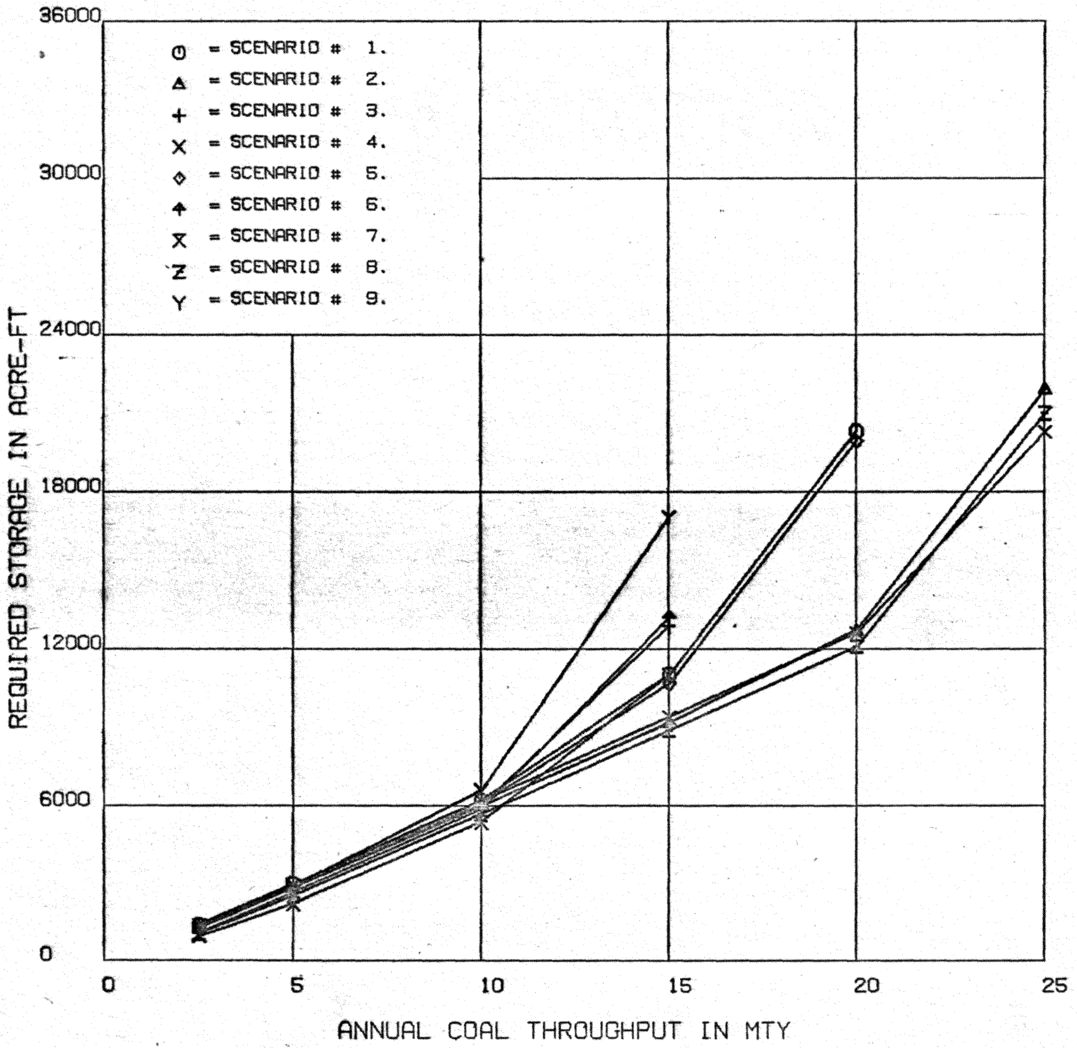


FIGURE B-L1-10 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK NR GRUNDY.VA. 03.2075.00

INTAKE CAPACITY 10X PIPELINE DEMAND

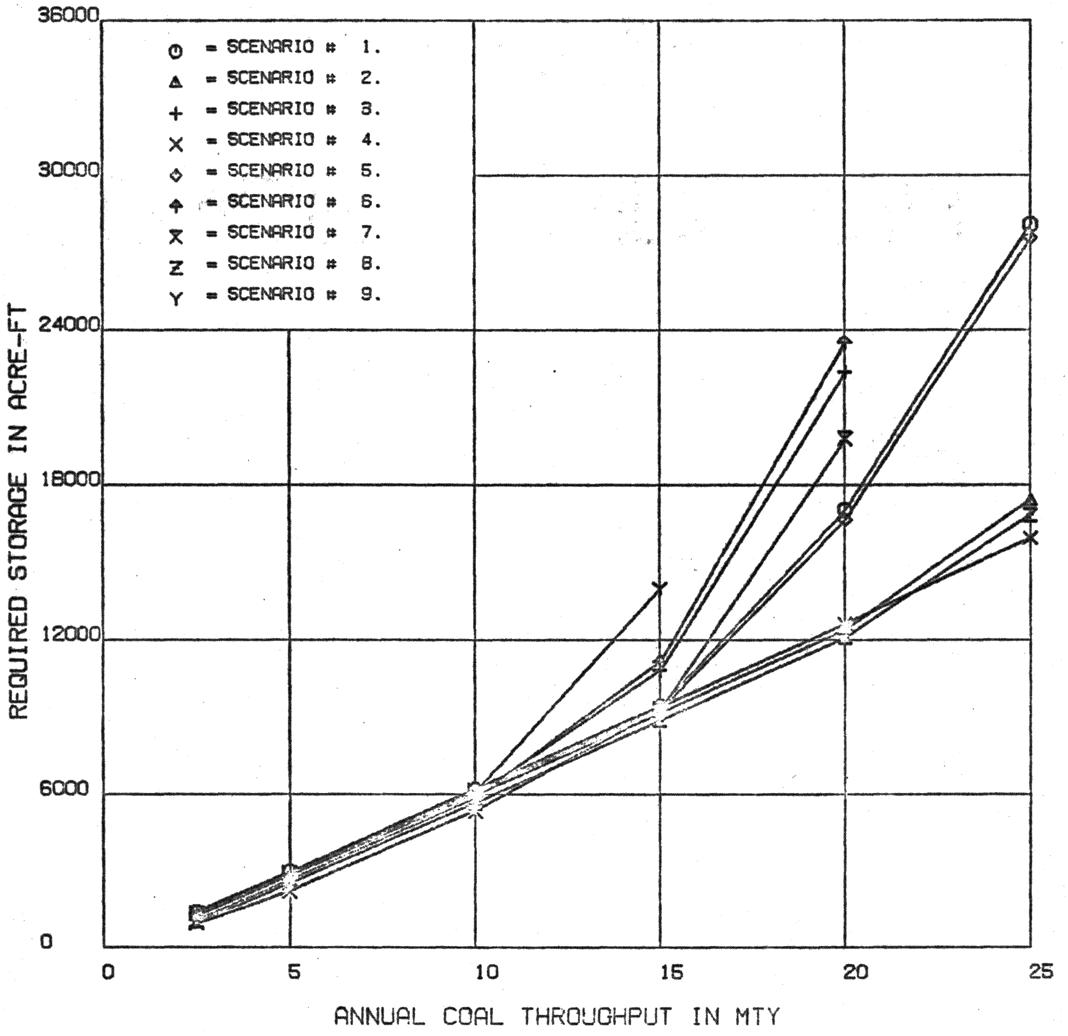


FIGURE B-L1-11 OFFSTREAM STORAGE REQUIREMENTS

LE _ FORK NR GRUNDY,VA. 03.2075.00

I... KE CAPACITY 15X PIPELINE DEMAND

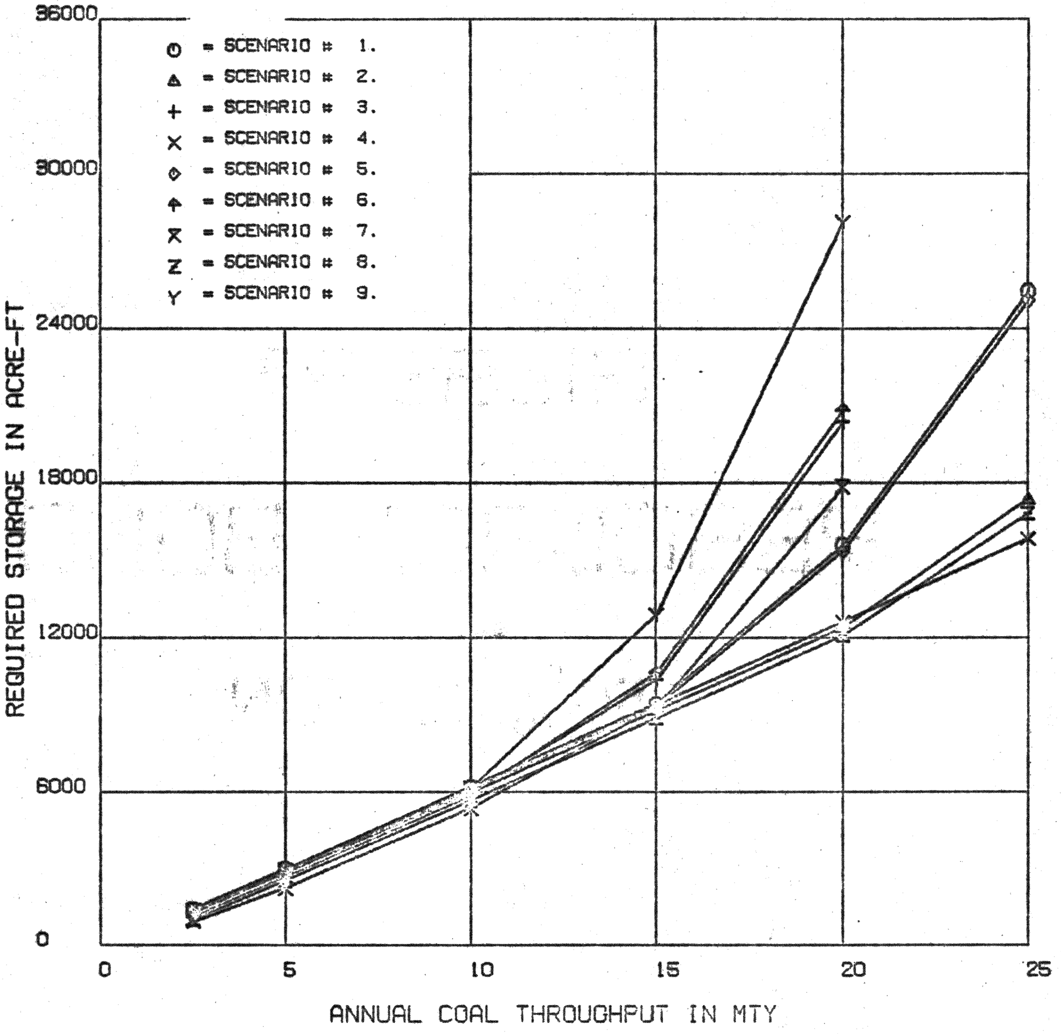


FIGURE B-L1-12 OFFSTREAM STORAGE REQUIREMENTS

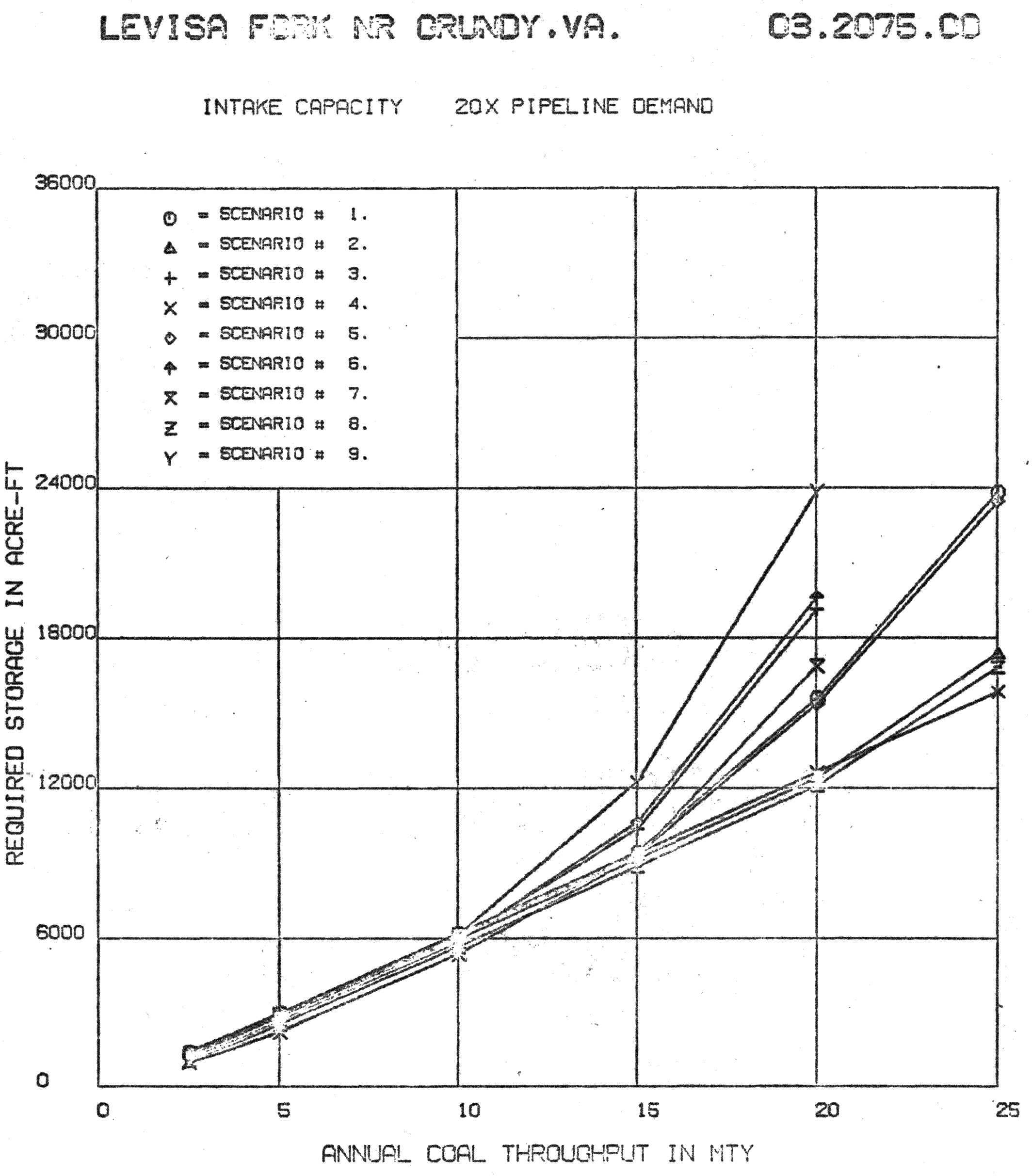


FIGURE B-L1-13 OFFSTREAM STORAGE REQUIREMENTS

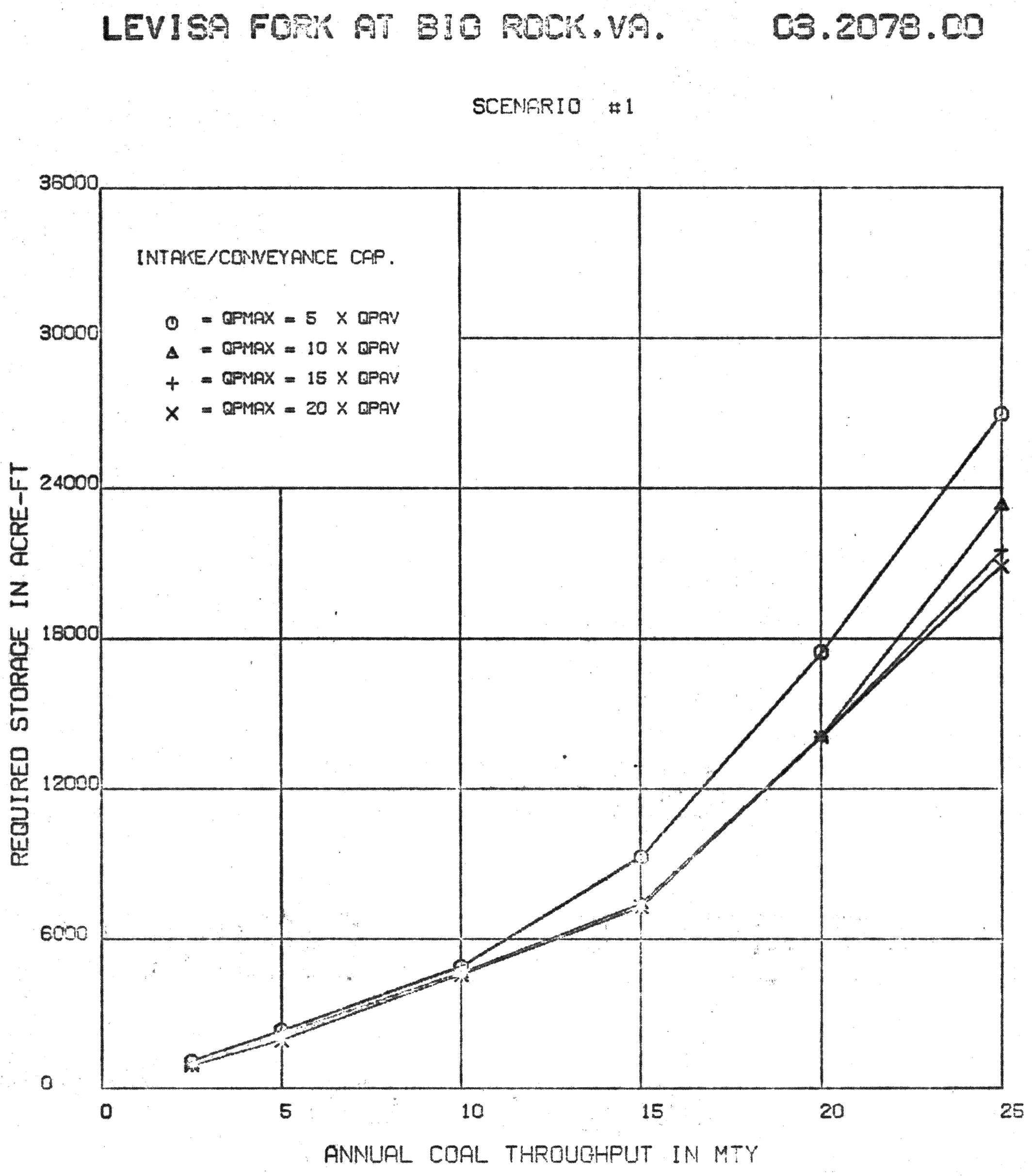


FIGURE B-L2-1 OFFSTREAM STORAGE REQUIREMENTS

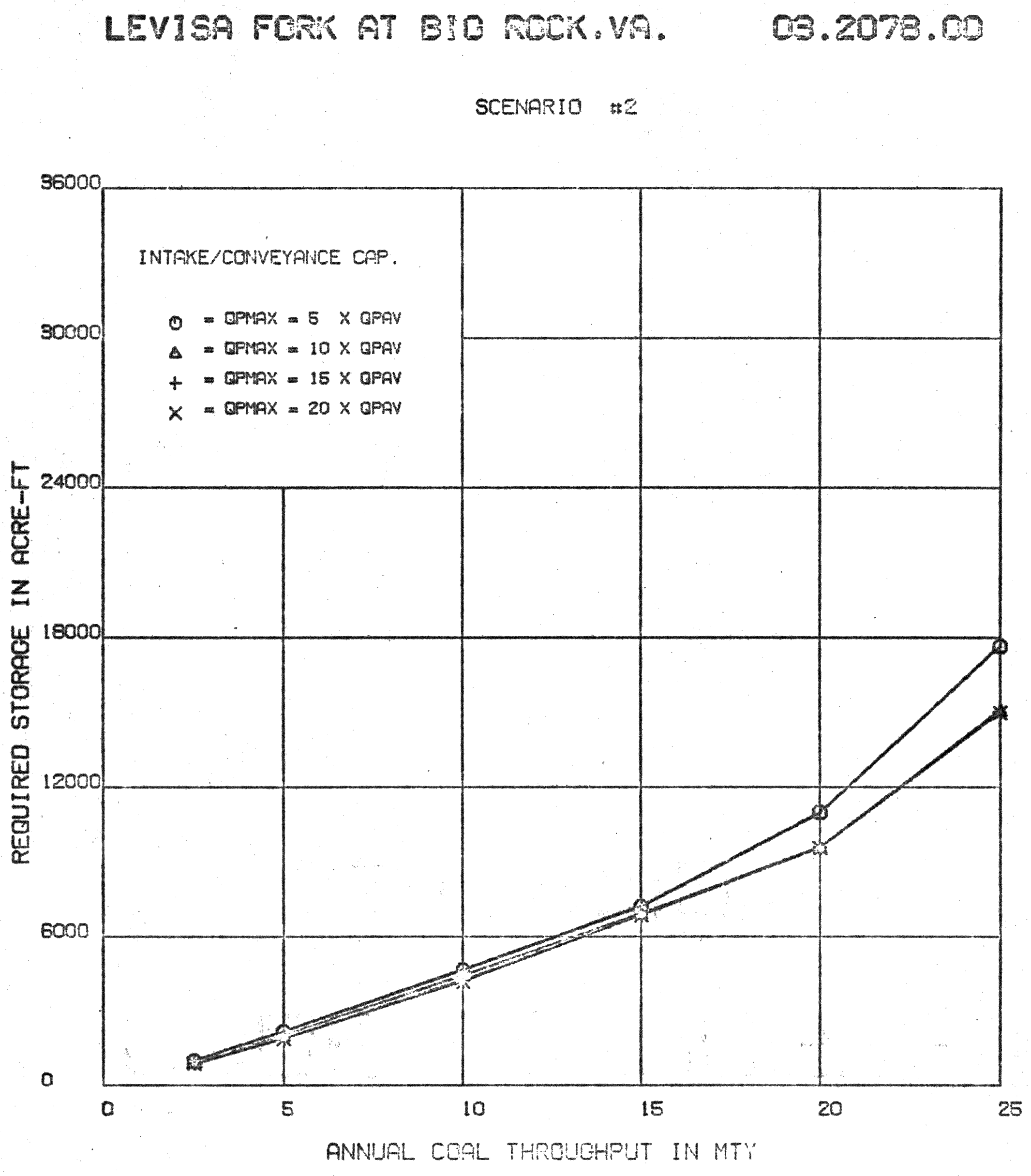


FIGURE B-L2-2 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK.VA. 03.2078.00

SCENARIO #3

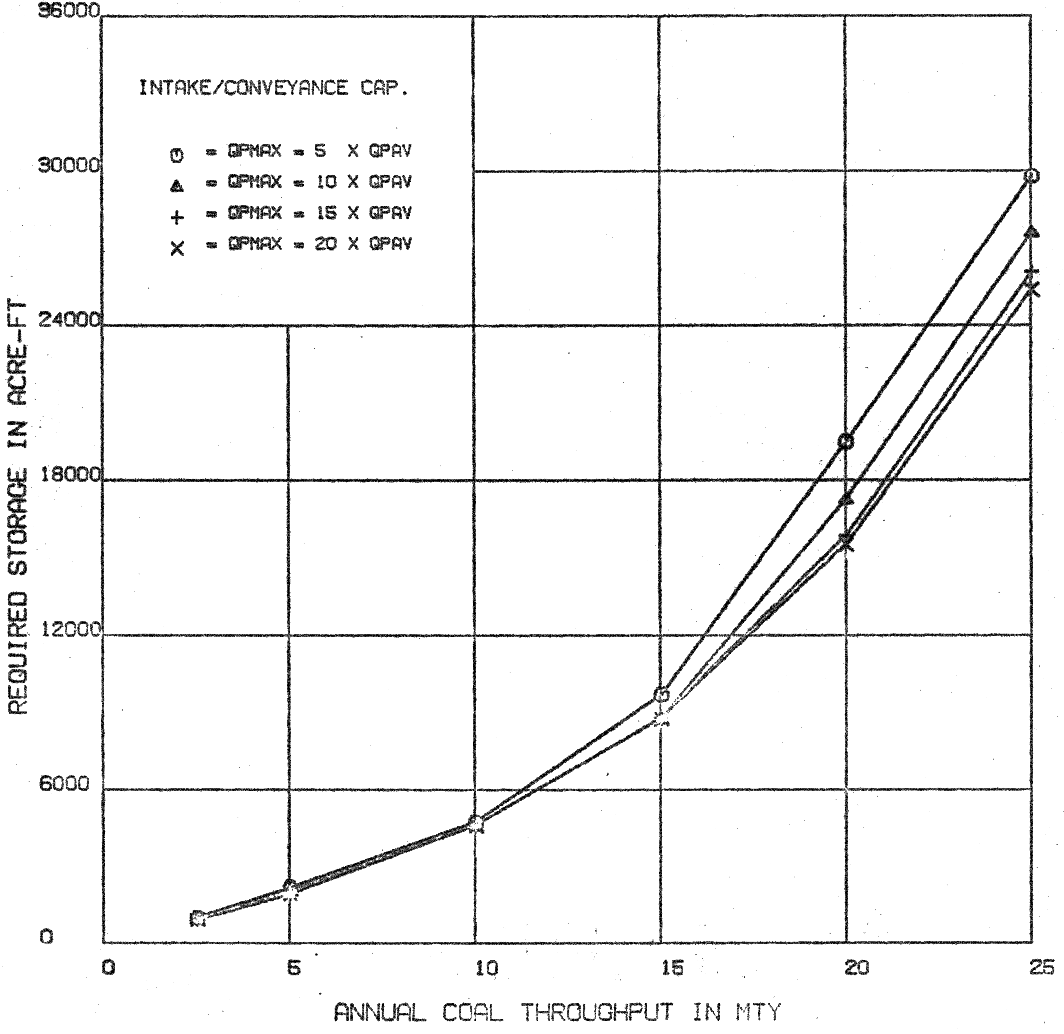


FIGURE B-L2-3 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK.VA.   03.2078.00

SCENARIO #4

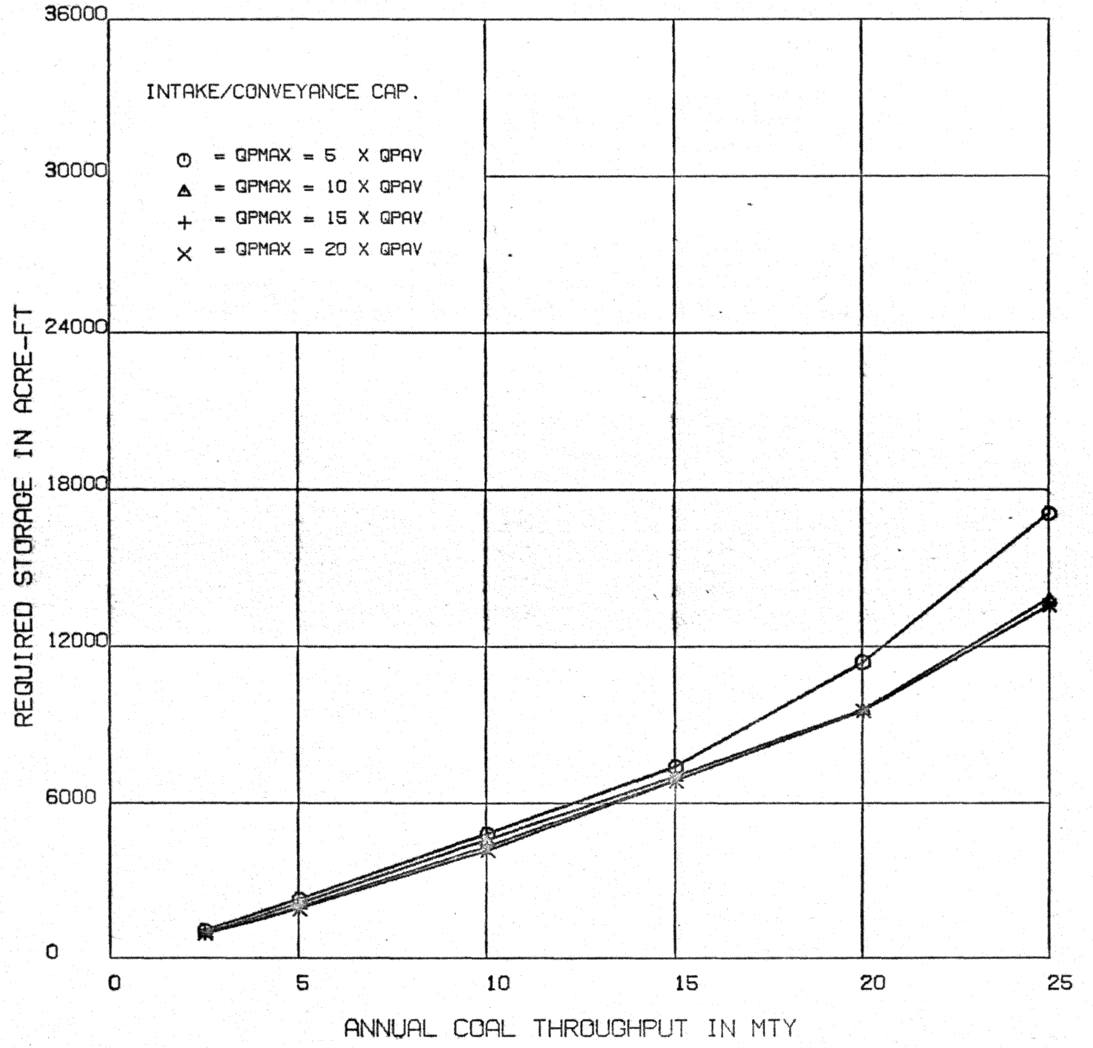


FIGURE B-L2-4 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK, VA.   03.2078.00

SCENARIO #5

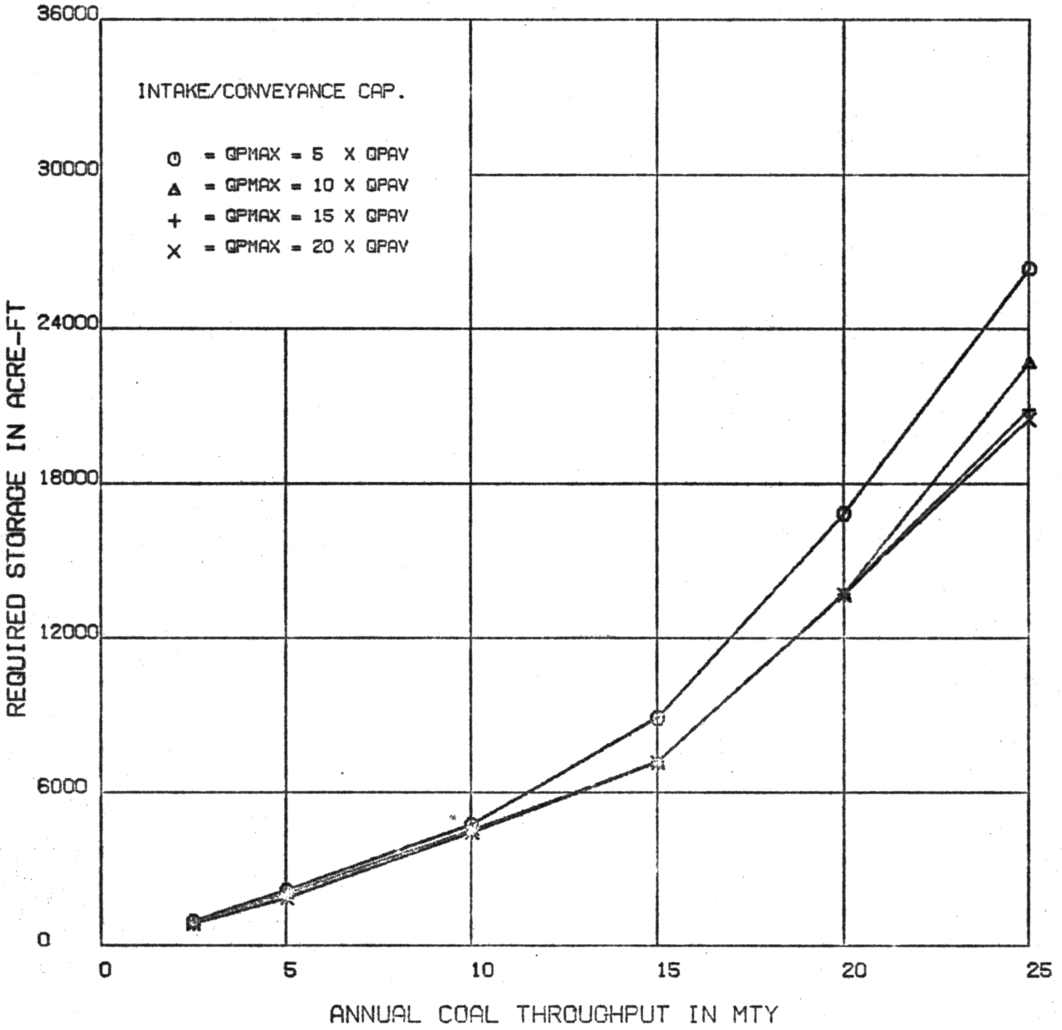


FIGURE B-L2-5 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

SCENARIO #6

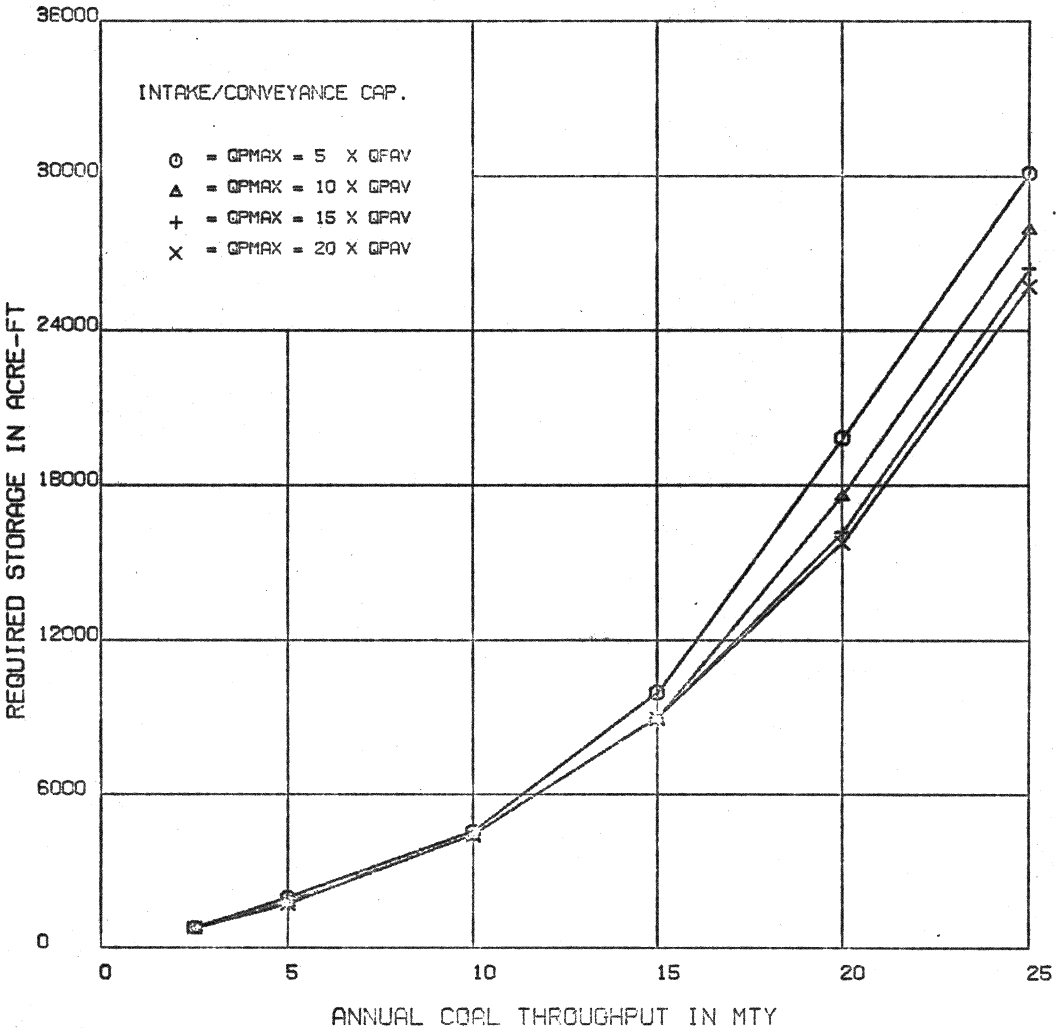


FIGURE B-L2-6 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

SCENARIO #7

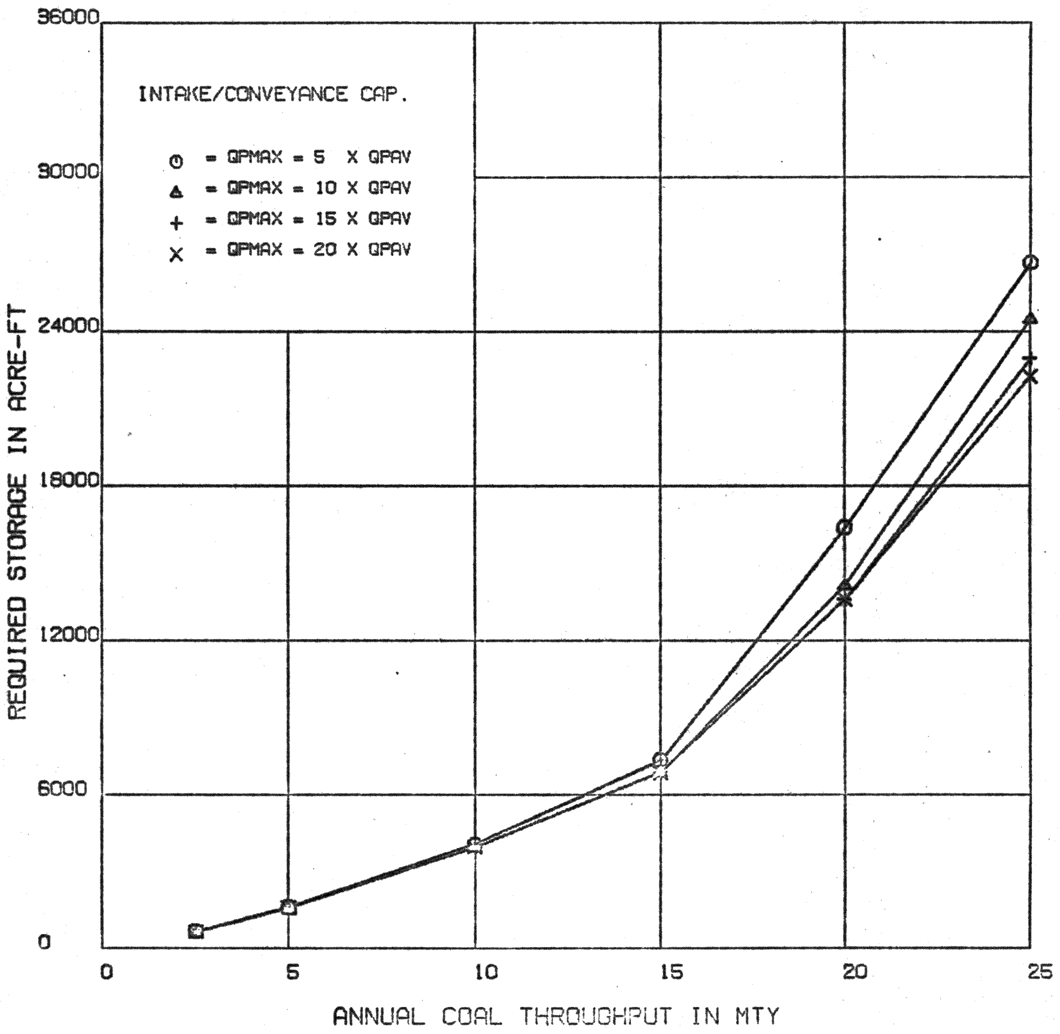
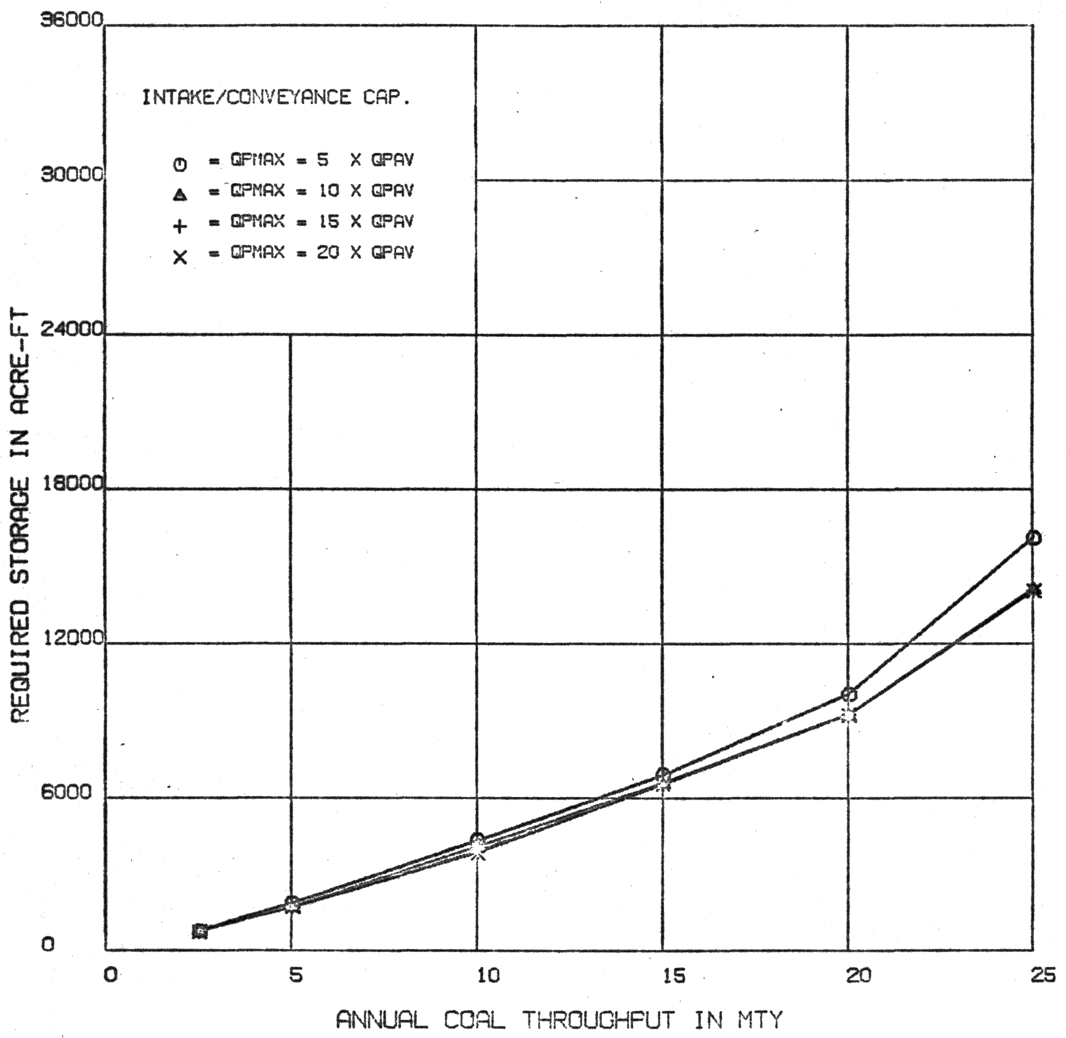


FIGURE B-L2-7 OFFSTREAM STORAGE REQUIREMENTS



LEVISA FORK AT BIG ROCK,VA. 03.2078.00

SCENARIO #8

FIGURE B-L2-8 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK.VA. 03.2078.00

SCENARIO #9

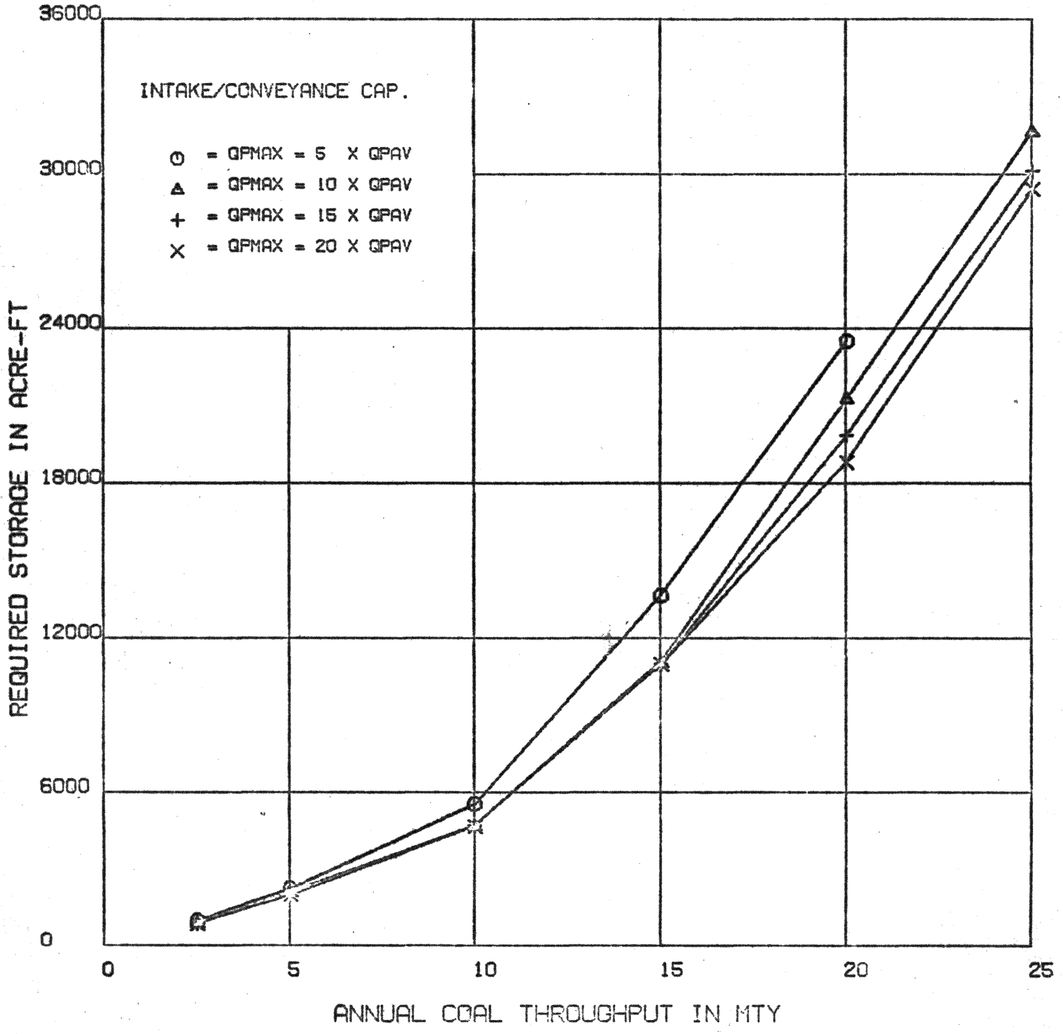


FIGURE B-L2-9 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK.VA. 03.2078.00

INTAKE CAPACITY 5 X PIPELINE DEMAND

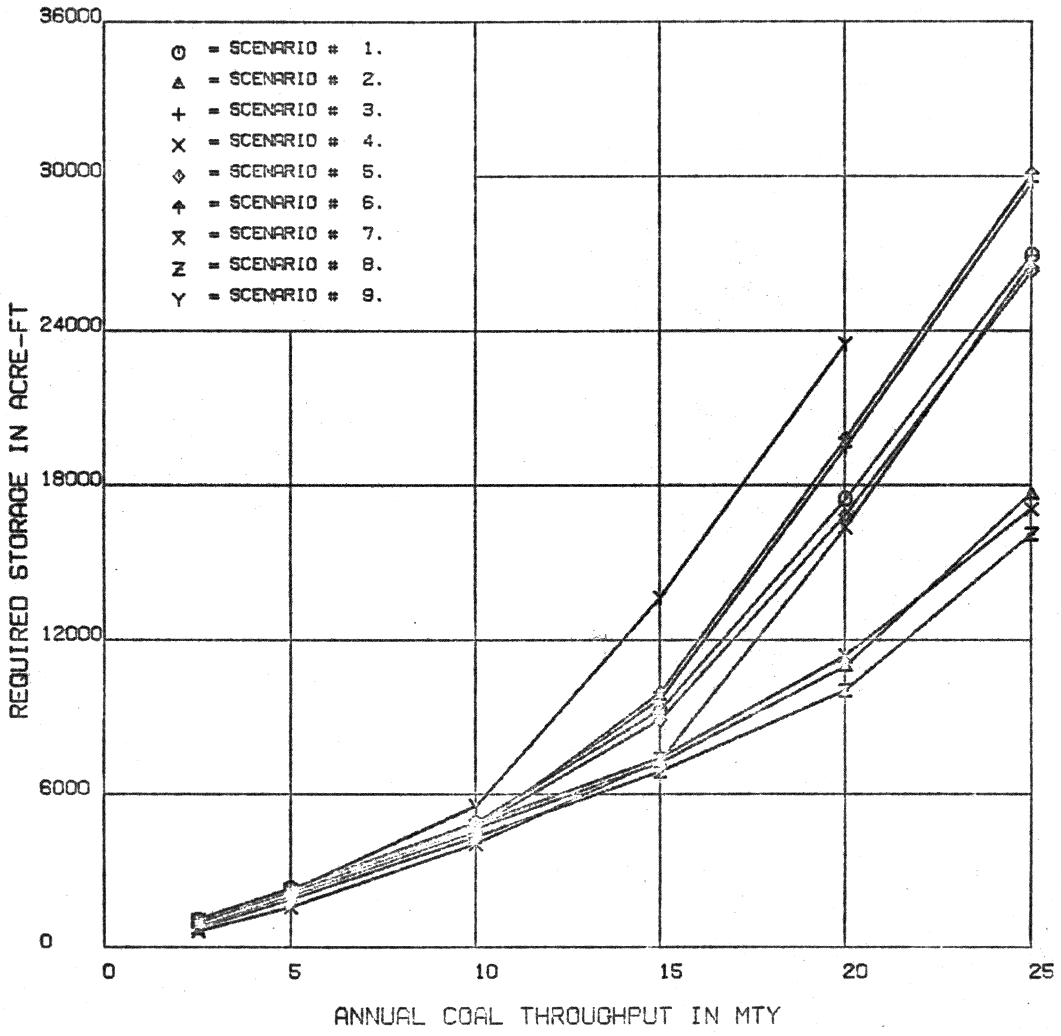


FIGURE B-L2-10 OFFSTREAM STORAGE REQUIREMENTS

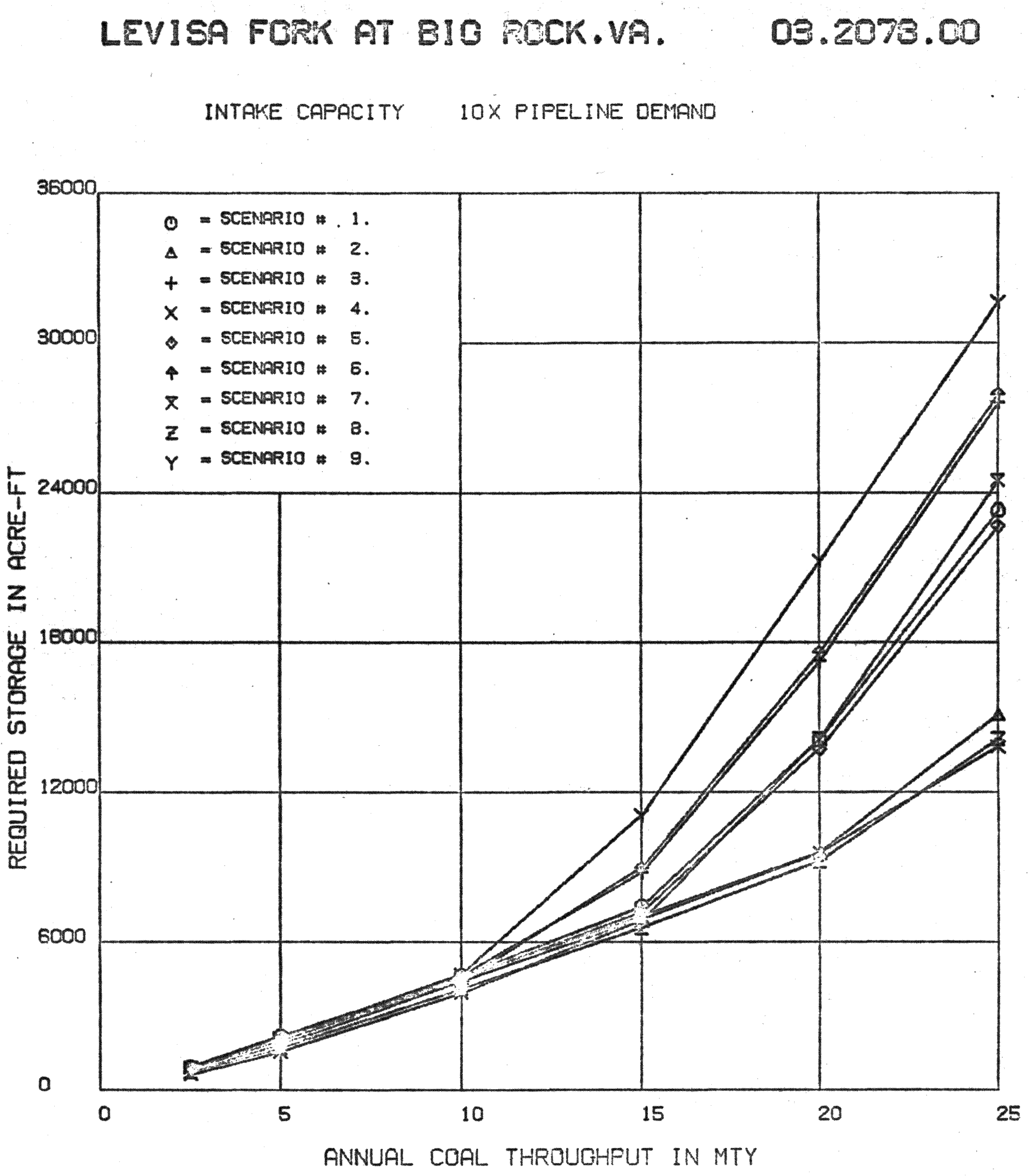


FIGURE B-L2-11 OFFSTREAM STORAGE REQUIREMENTS

LEVISA FORK AT BIG ROCK.VA.   03.2078.00

INTAKE CAPACITY   15X PIPELINE DEMAND

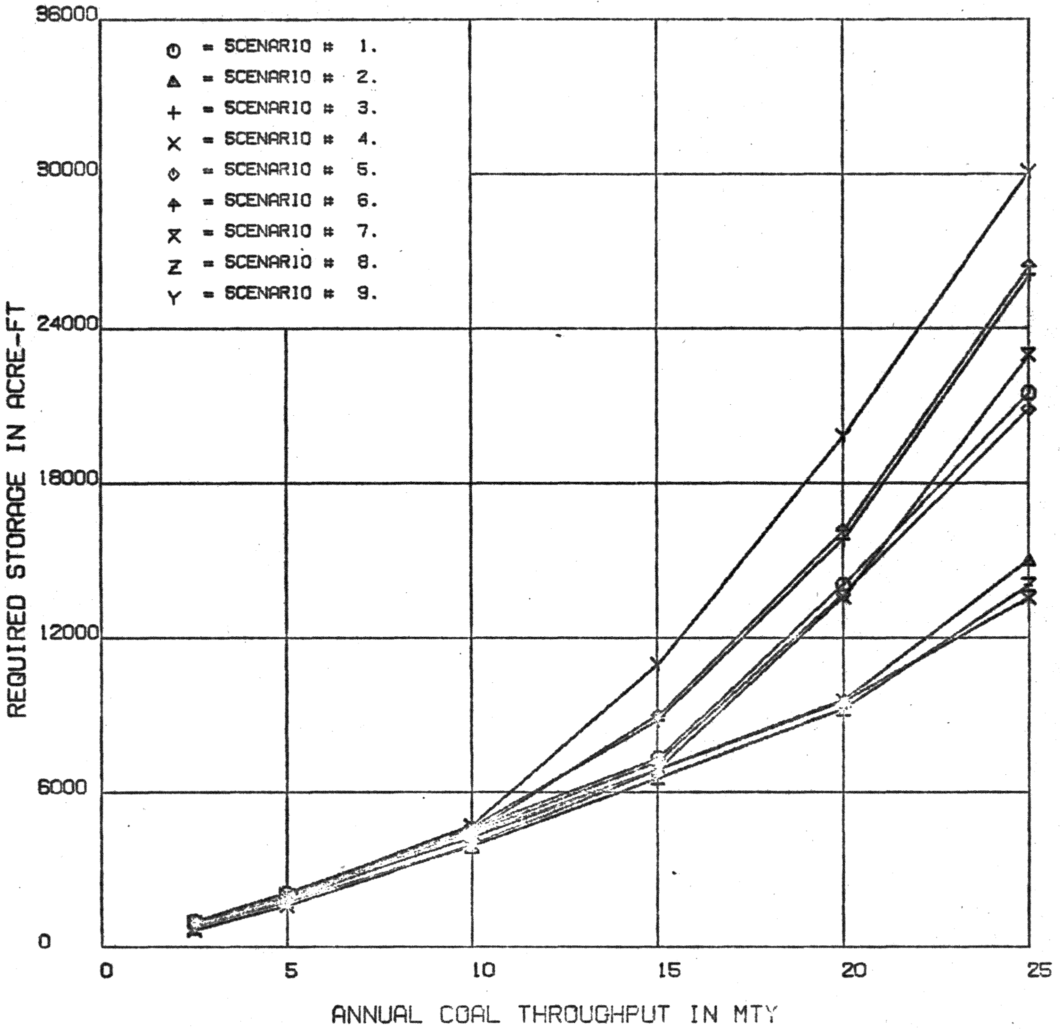


FIGURE B-L2-12 OFFSTREAM STORAGE REQUIREMENTS

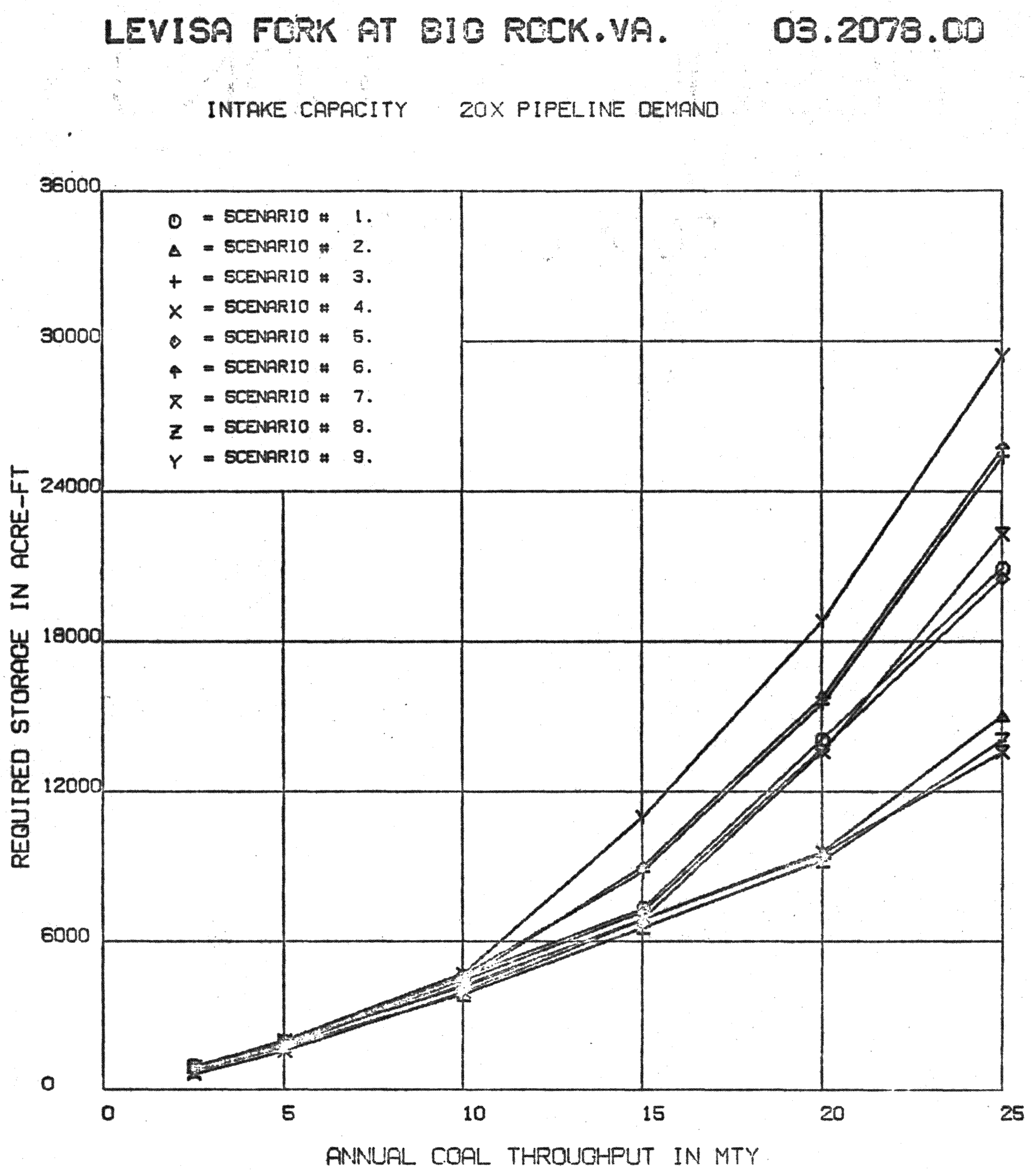


FIGURE B-L2-13 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

SCENARIO #1

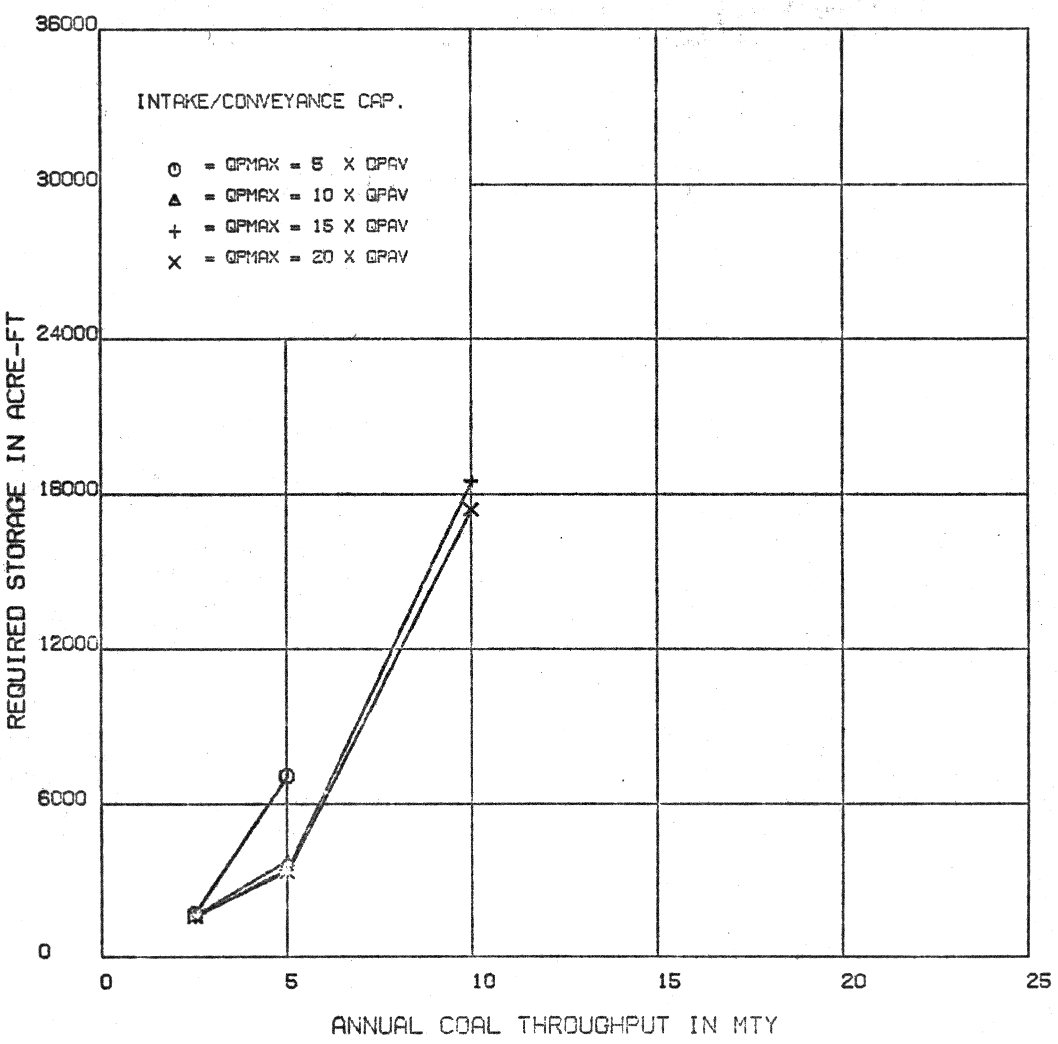


FIGURE B-PG-1 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

SCENARIO #2

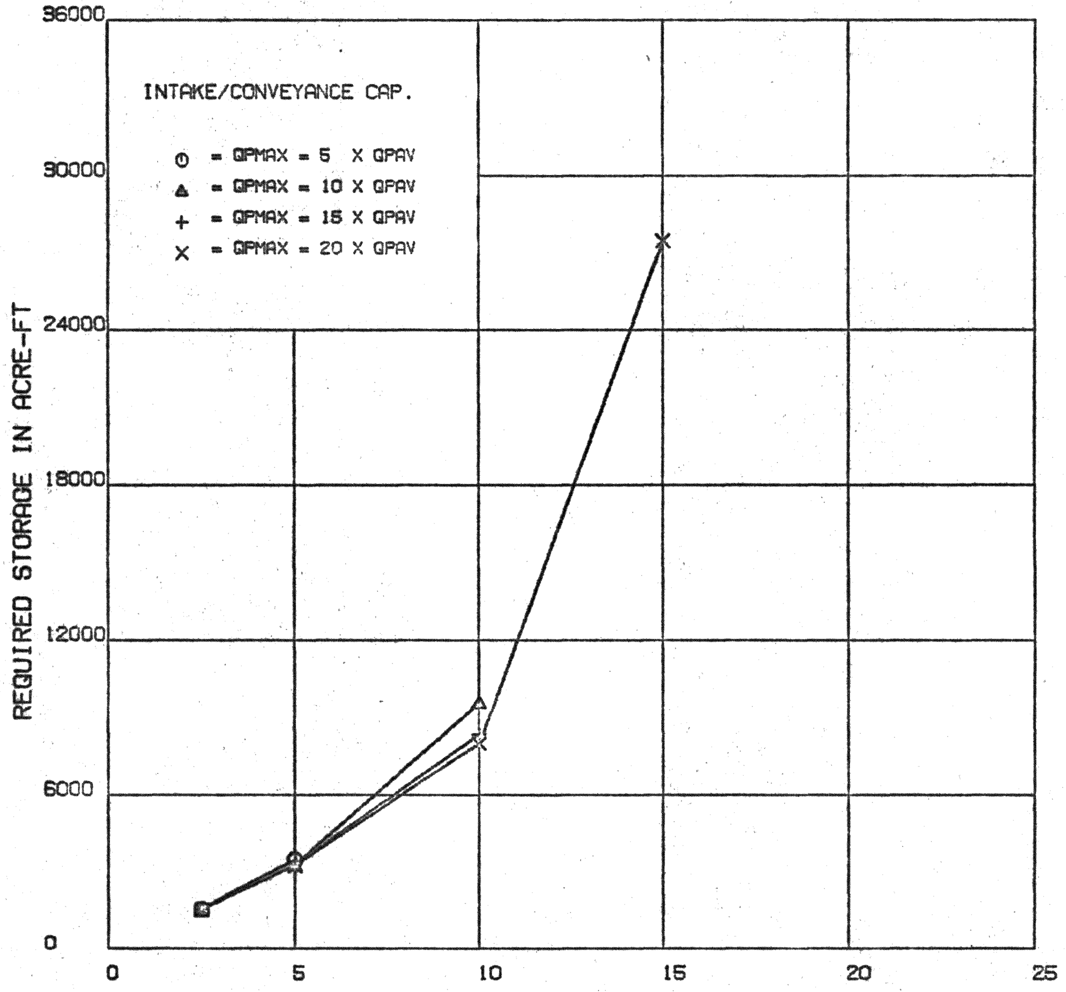


FIGURE B-PG-2 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK, 03.2089.00

SCENARIO #3

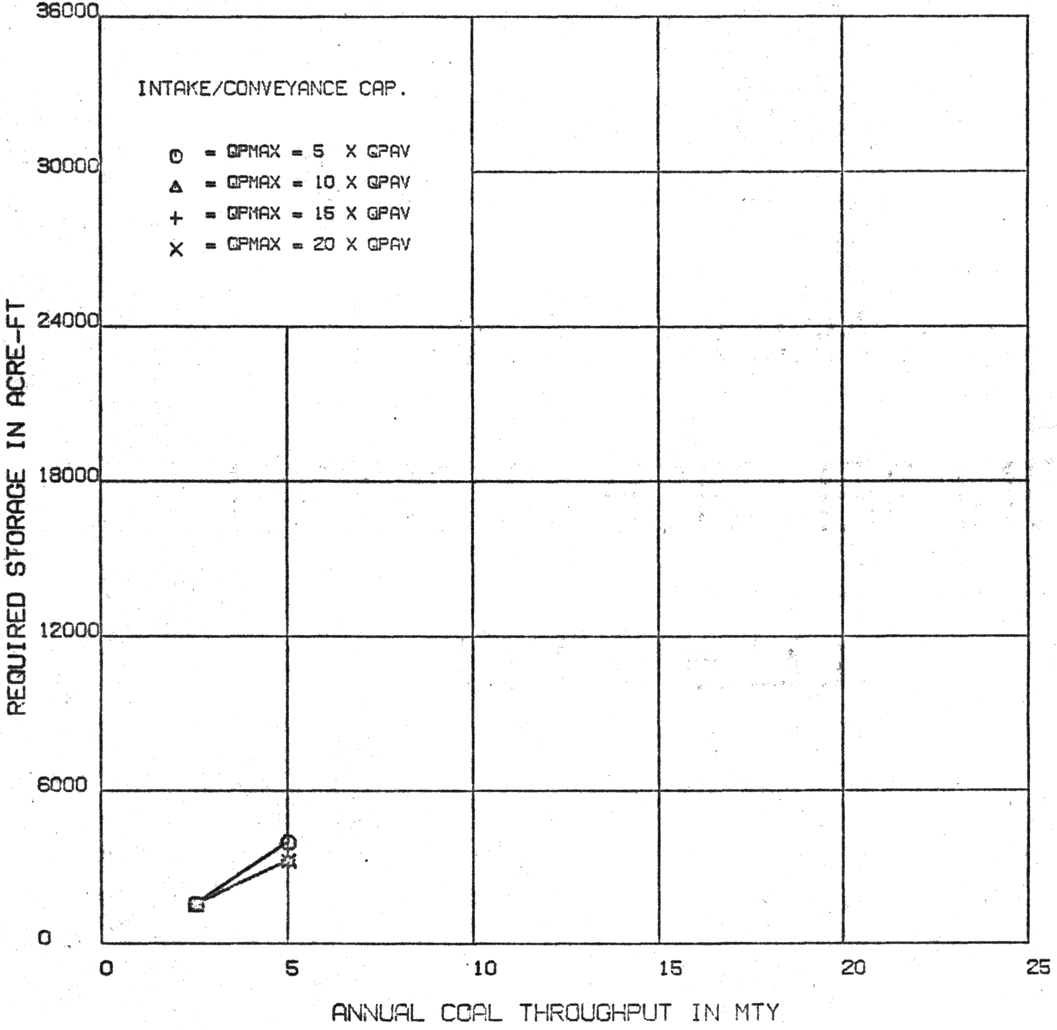


FIGURE B-PG-3 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

SCENARIO #4

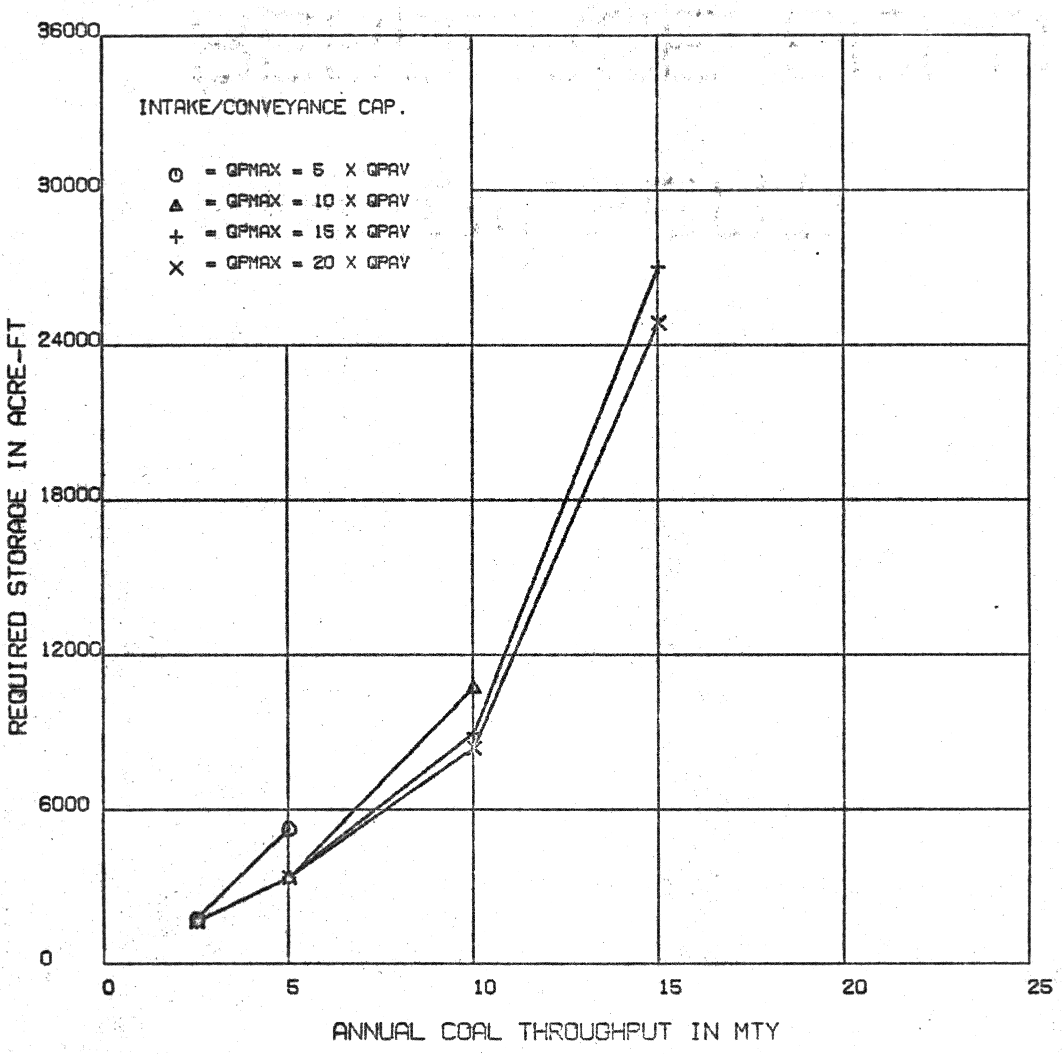


FIGURE B-PG-4 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

SCENARIO #5

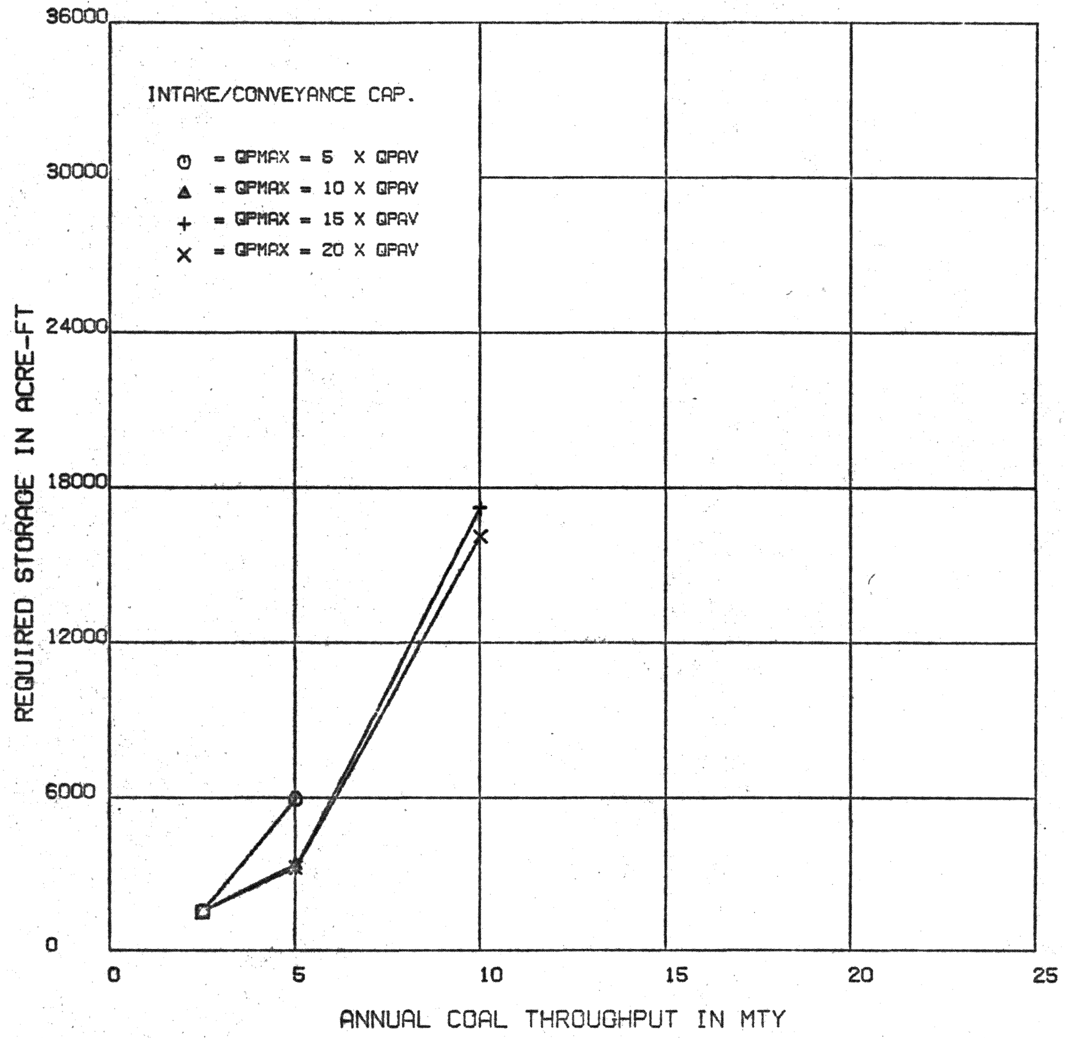


FIGURE B-PG-5 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

SCENARIO #6

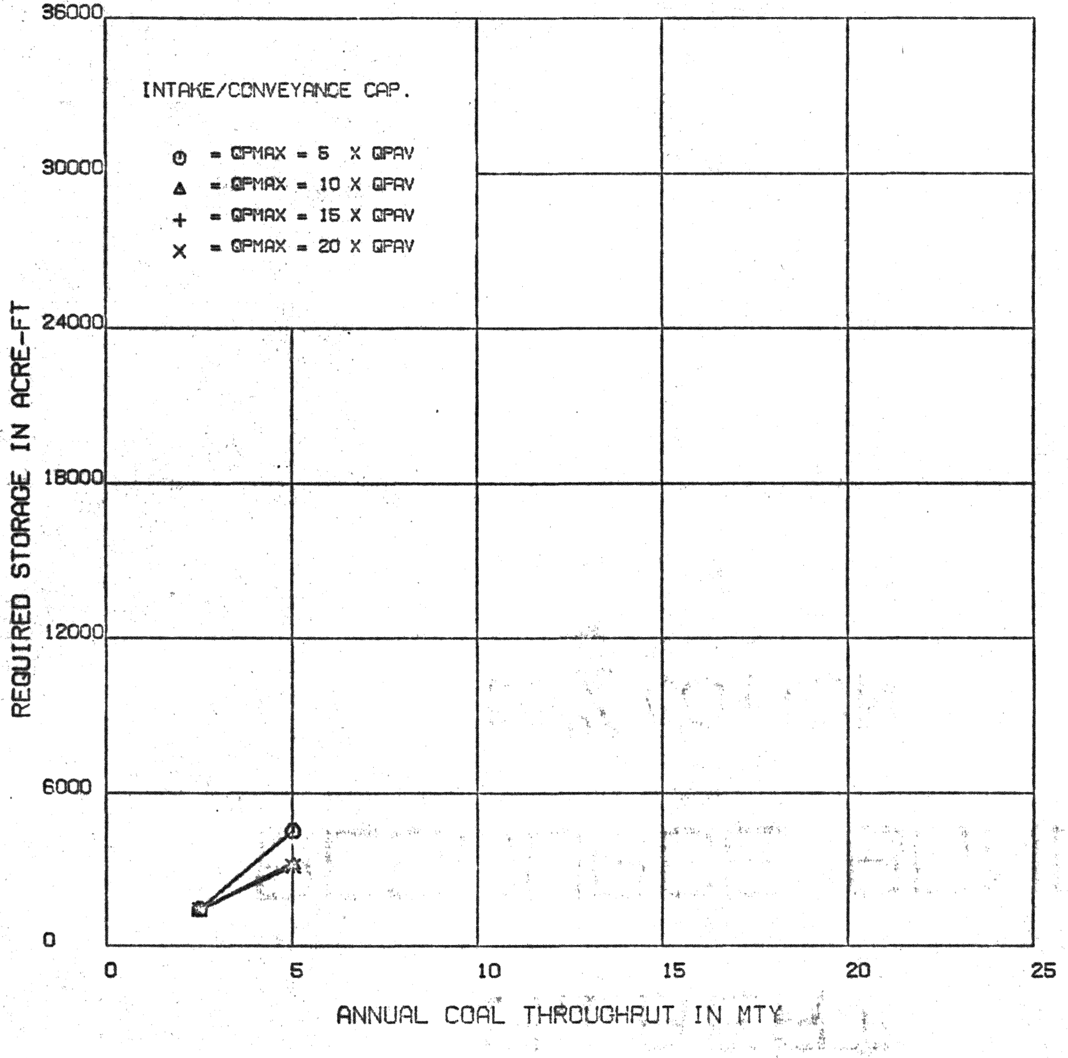


FIGURE B-PG-6 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

SCENARIO #7

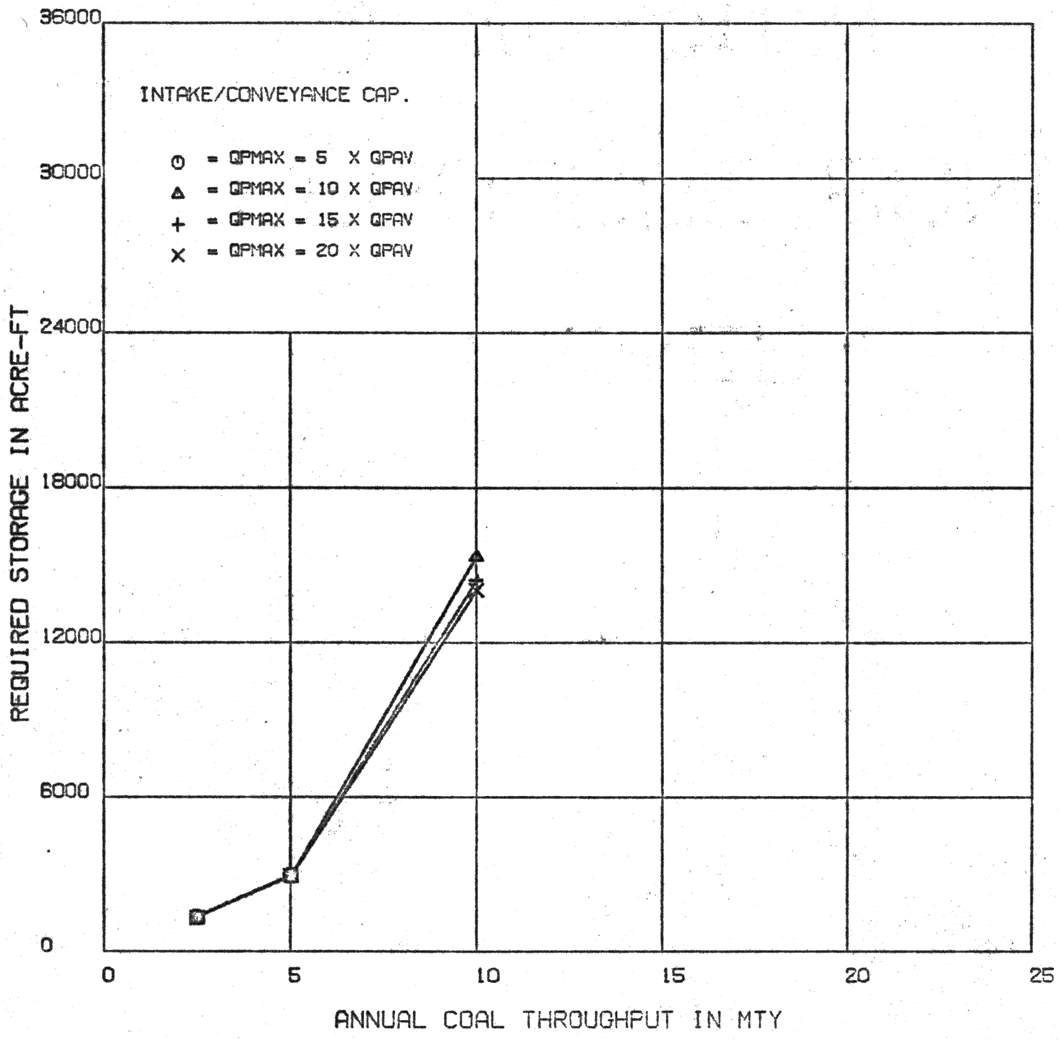


FIGURE B-PG-7 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

SCENARIO #8

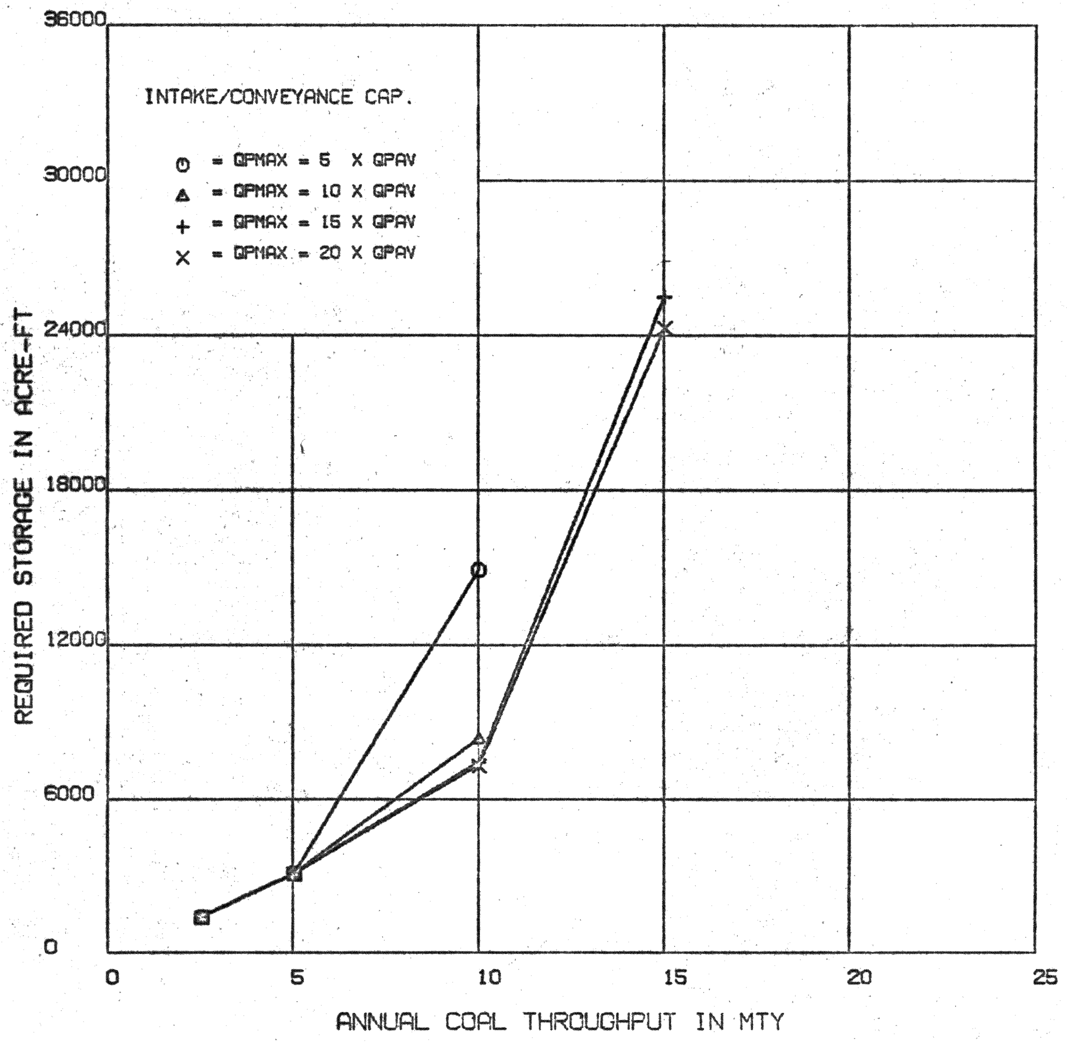


FIGURE B-PG-8 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

SCENARIO #9

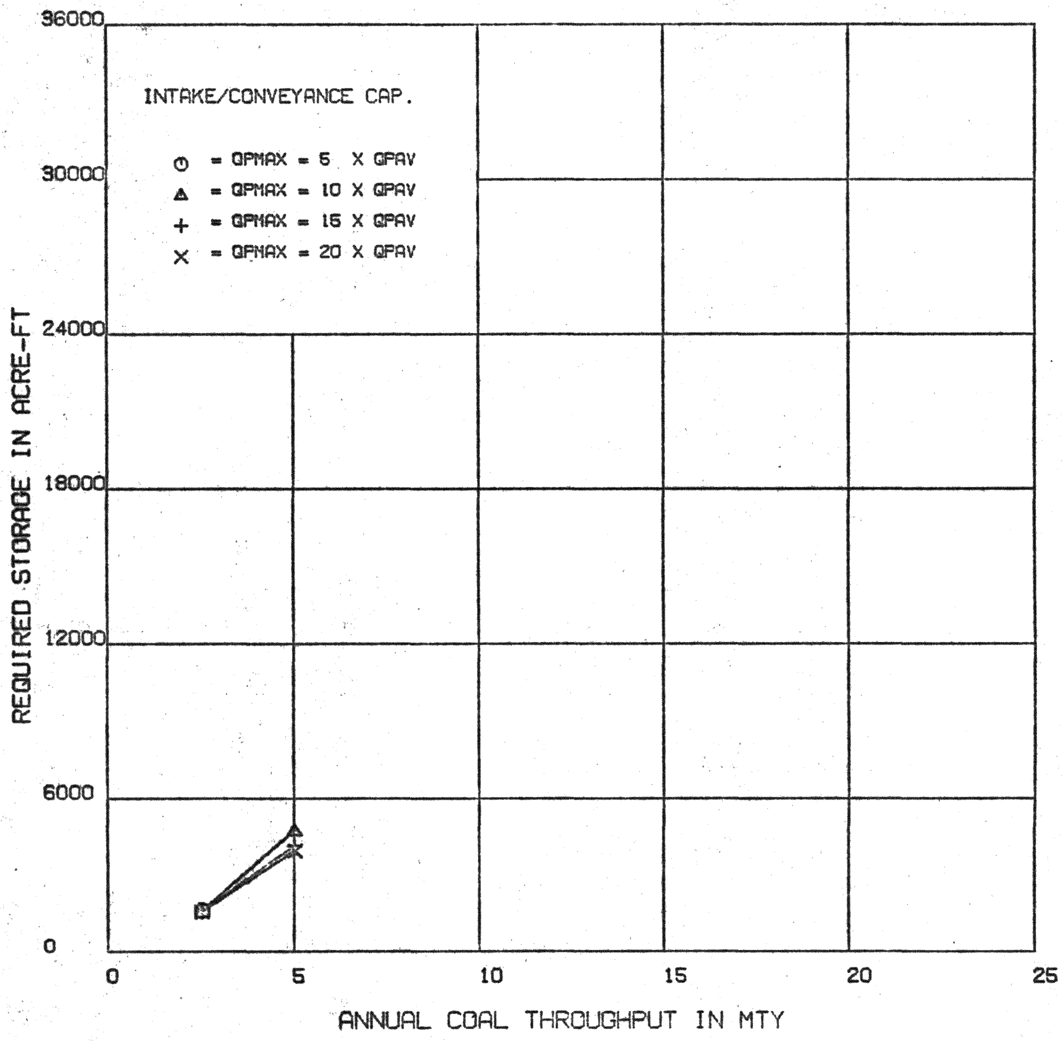


FIGURE B-PG-9 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

INTAKE CAPACITY 5 X PIPELINE DEMAND

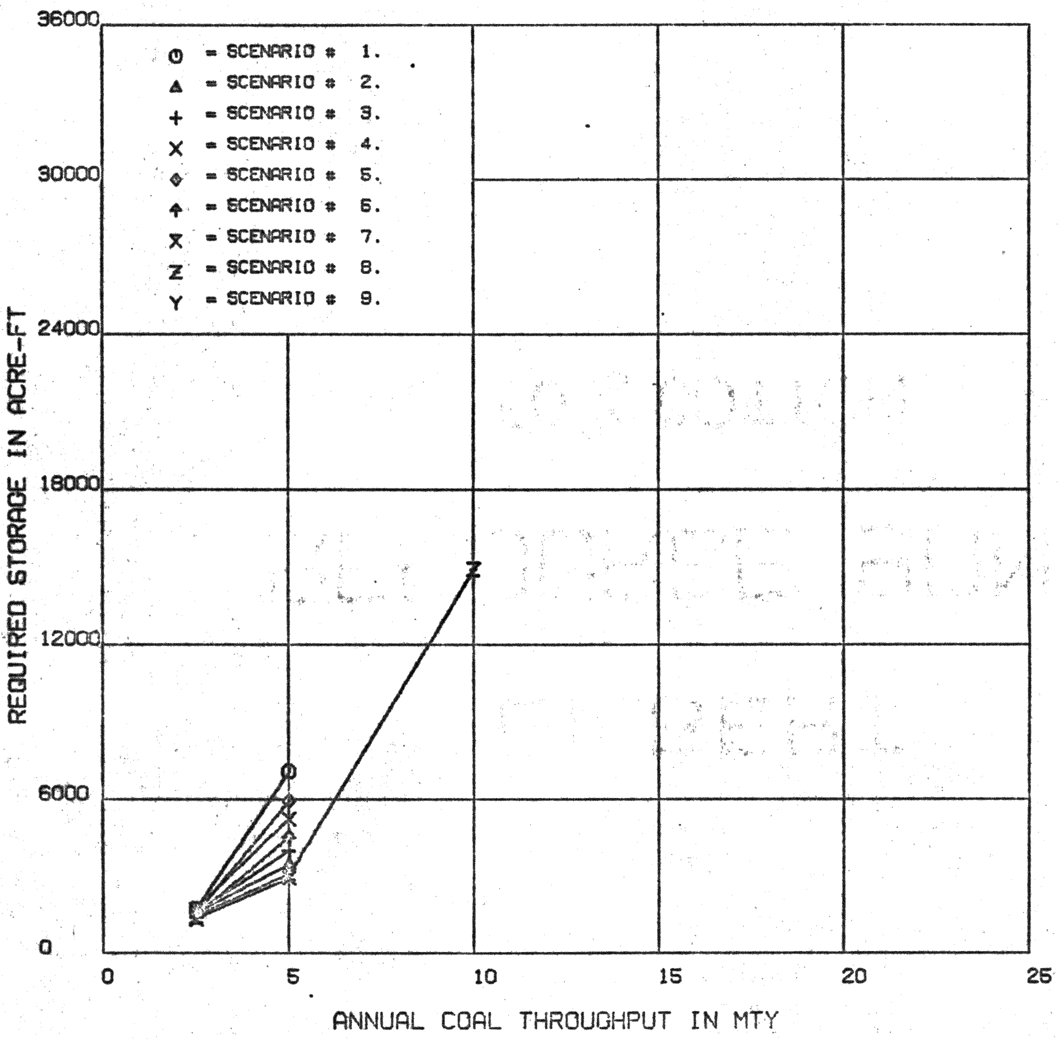


FIGURE B-PG-10 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK. 03.2089.00

INTAKE CAPACITY 10X PIPELINE DEMAND

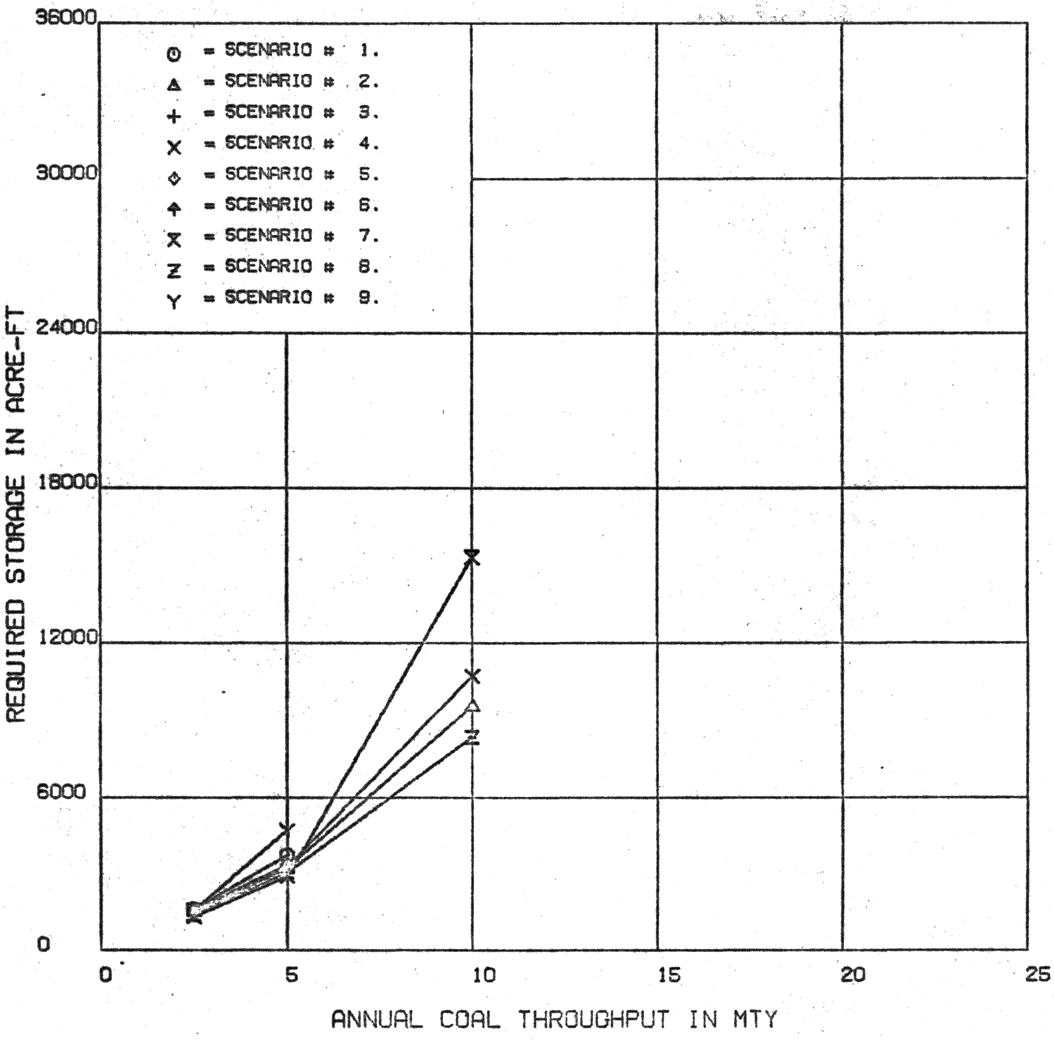


FIGURE B-PG-11 OFFSTREAM STORAGE REQUIREMENTS

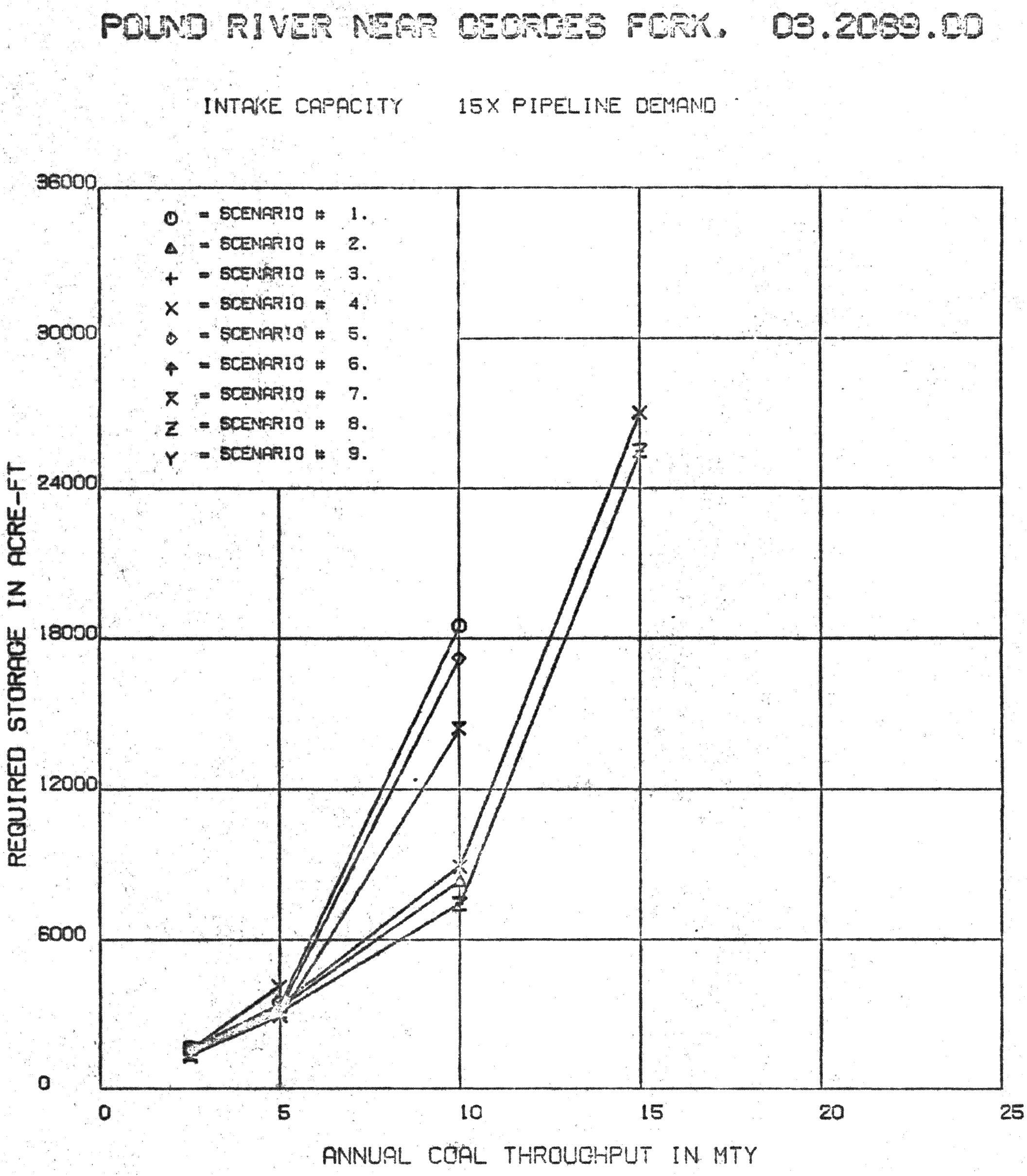


FIGURE B-PG-12 OFFSTREAM STORAGE REQUIREMENTS

POUND RIVER NEAR GEORGES FORK, 03.2089.00

INTAKE CAPACITY 20X PIPELINE DEMAND

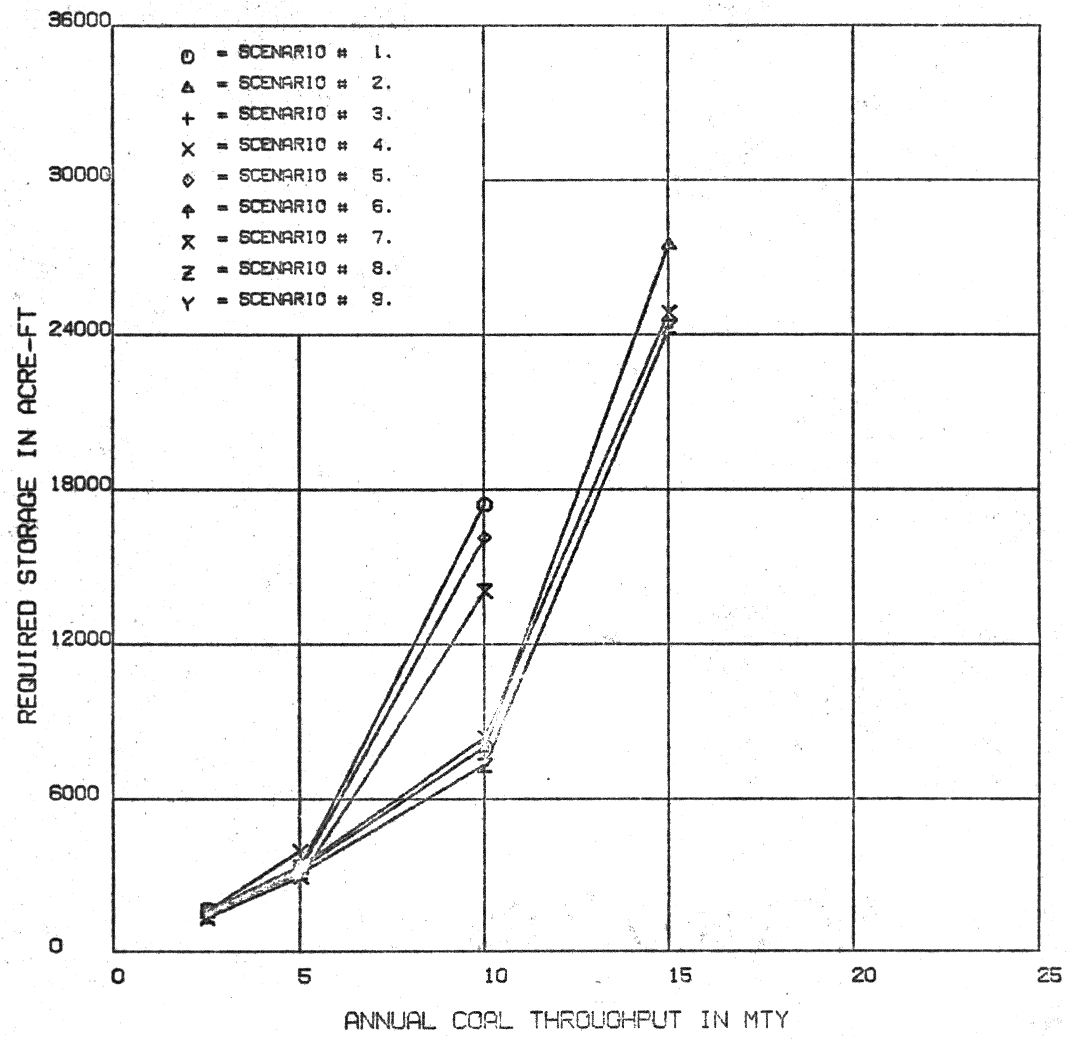


FIGURE B-PG-13 OFFSTREAM STORAGE REQUIREMENTS

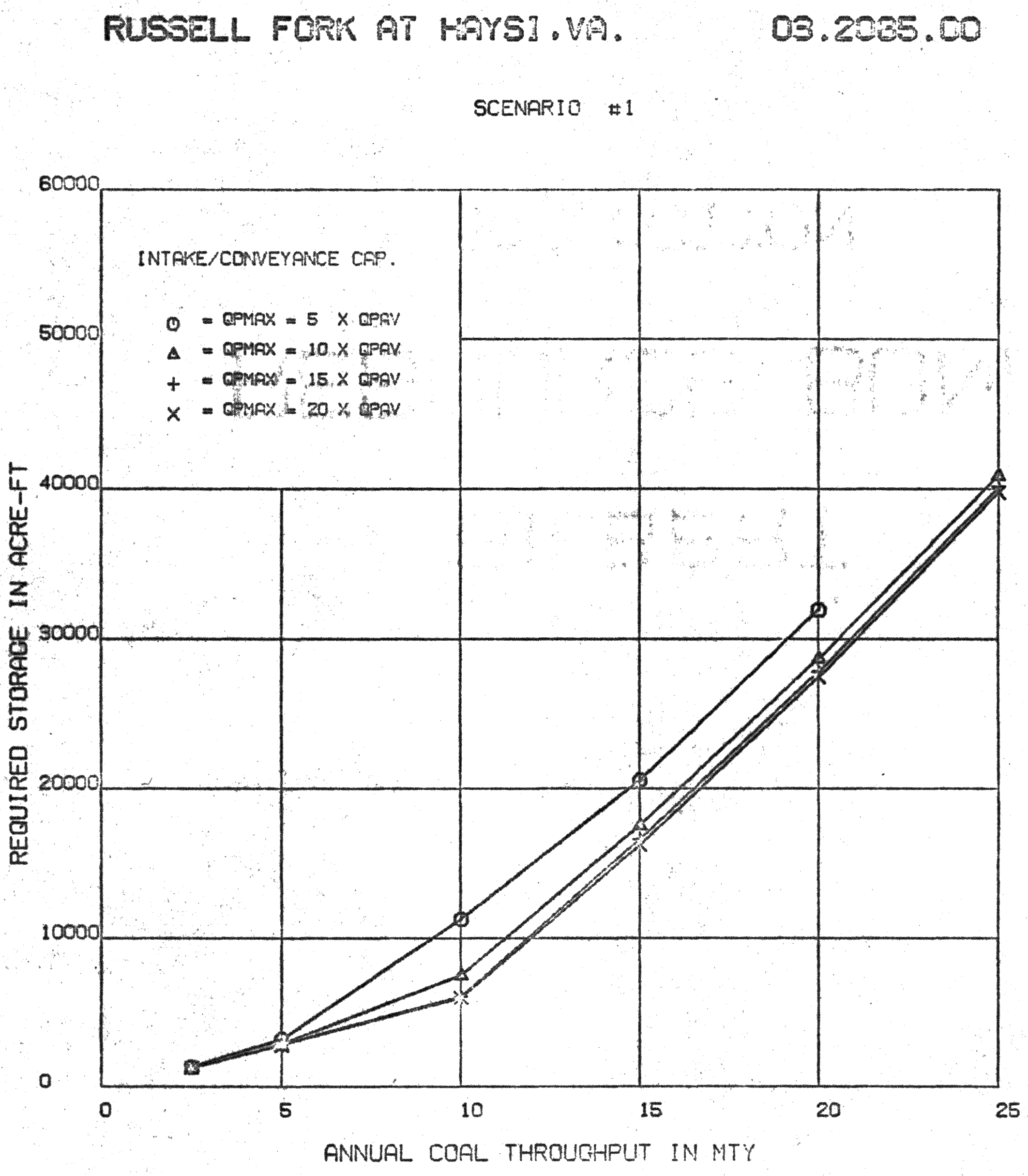


FIGURE B-HY-1 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI.VA. 03.2085.00

SCENARIO #2

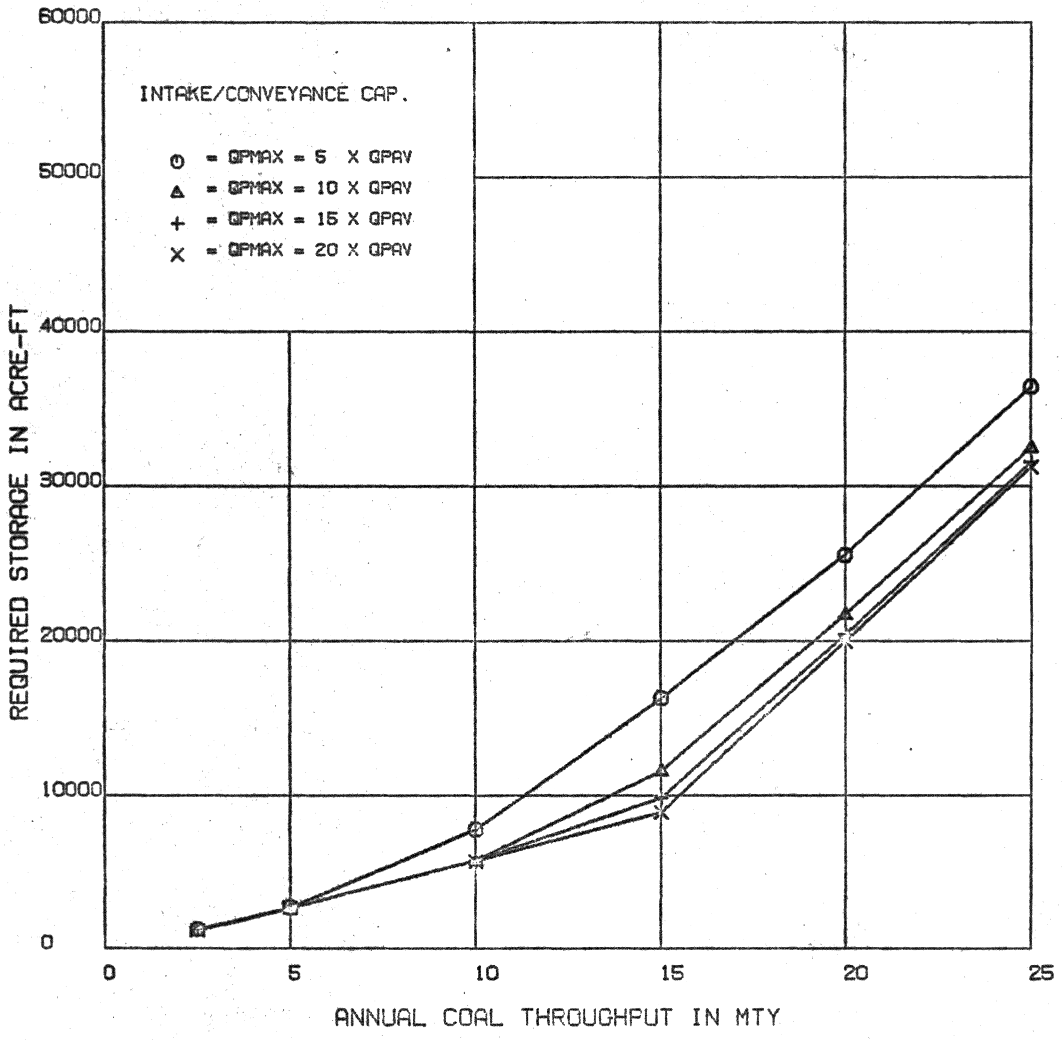


FIGURE B-HY-2 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2085.00

SCENARIO #3

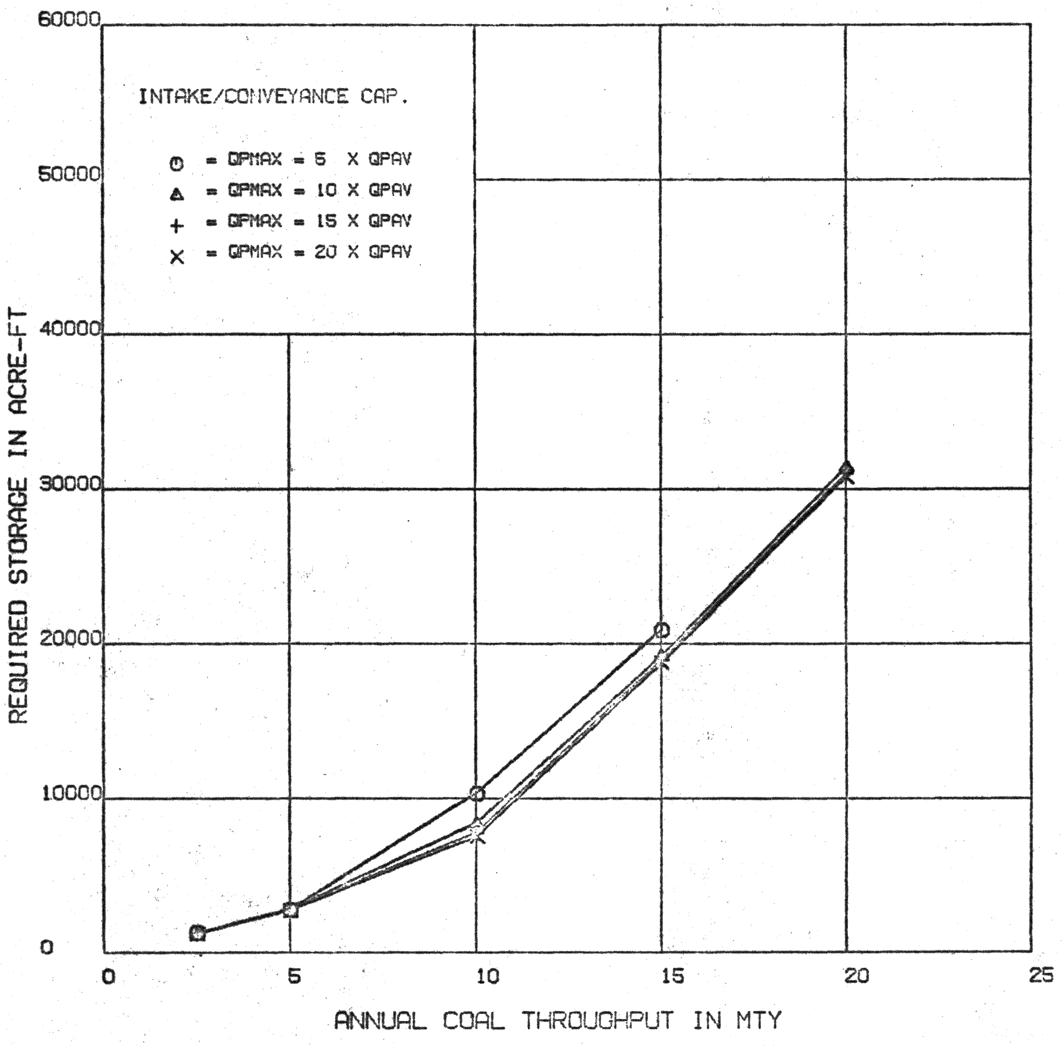


FIGURE B-HY-3 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI, VA. 03.2085.00

SCENARIO #4

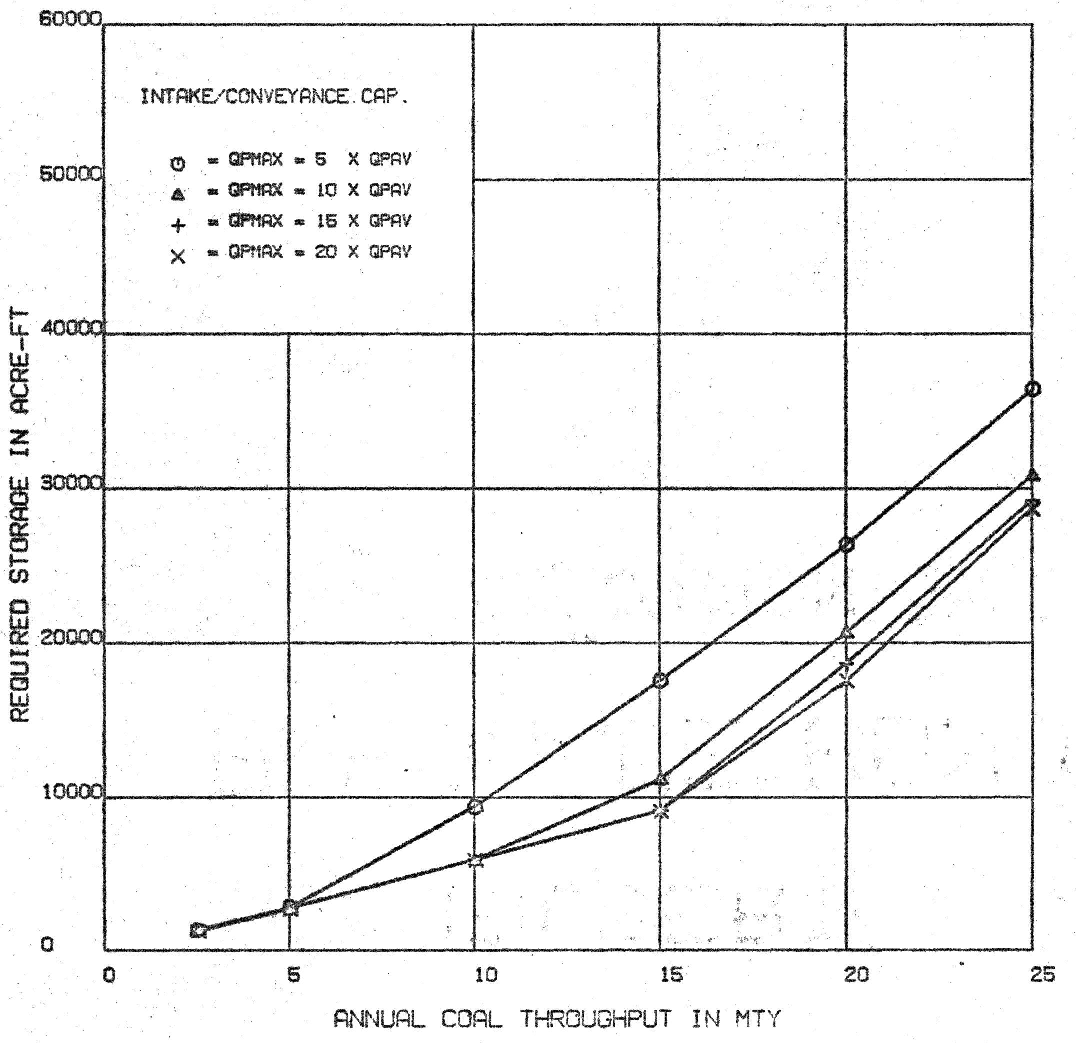


FIGURE B-HY-4 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI, VA. 03.2085.00

SCENARIO #5

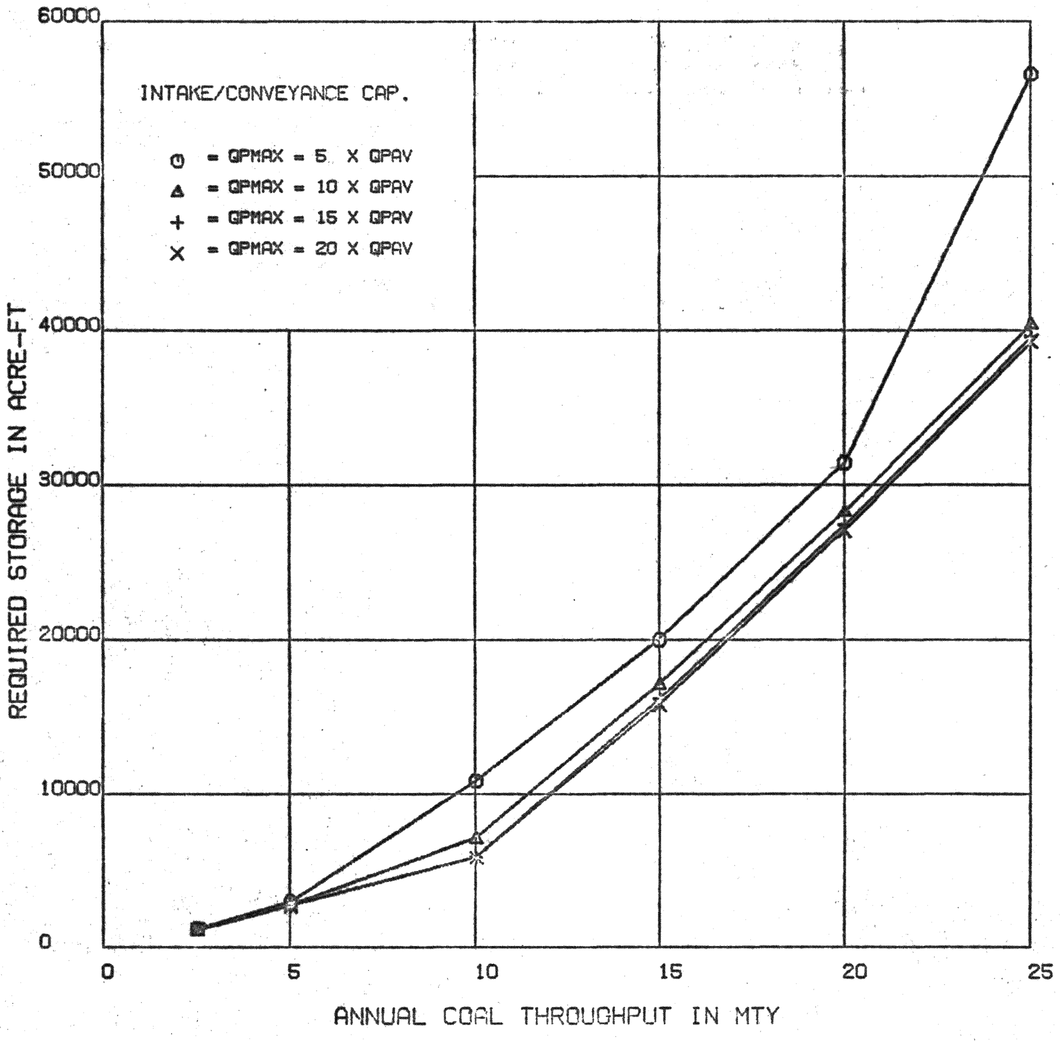


FIGURE B-HY-5 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI.VA. 03.2085.CO

SCENARIO #6

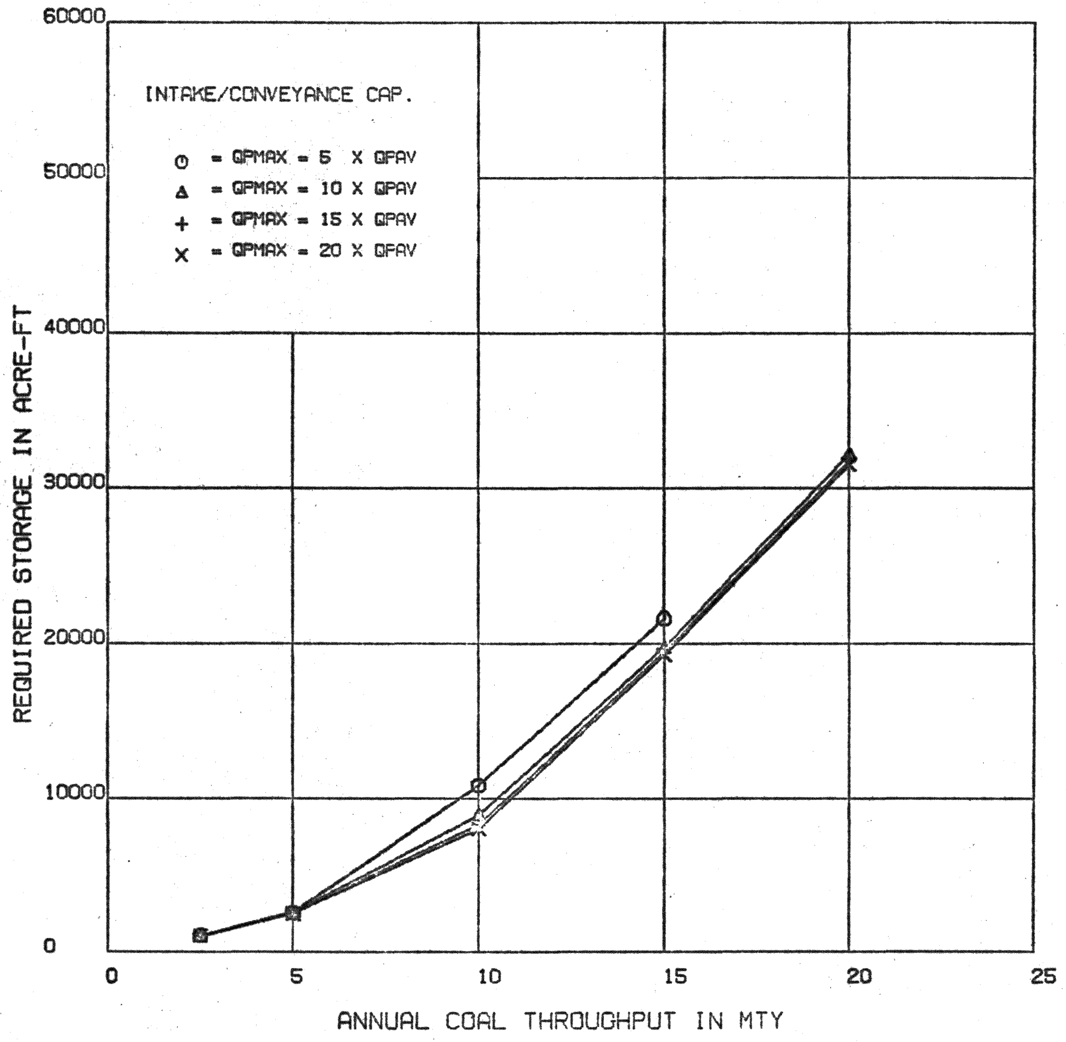


FIGURE B-HY-6 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI, VA.   03.2085.00

SCENARIO #7

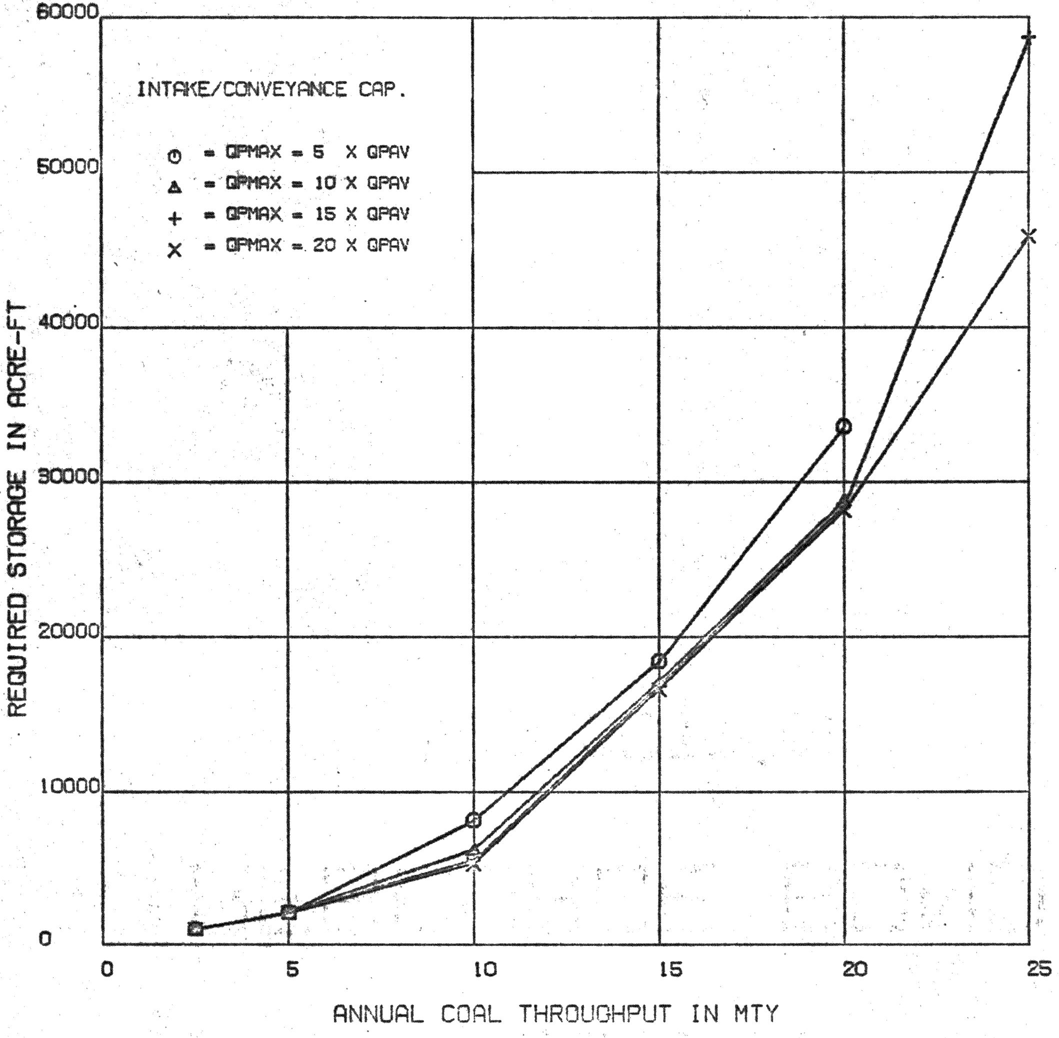


FIGURE B-HY-7 OFFSTREAM STORAGE REQUIREMENTS

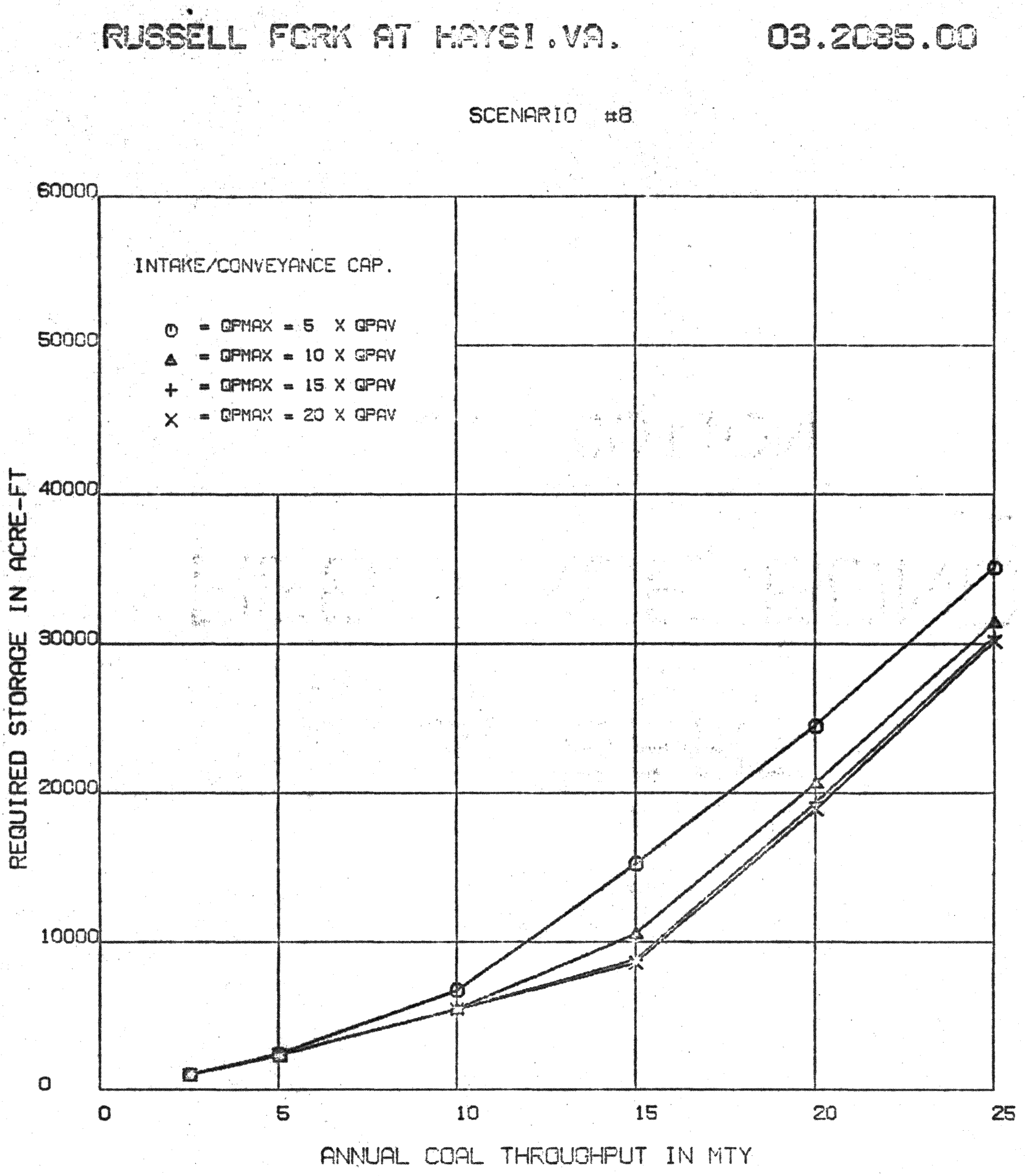


FIGURE B-HY-8 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI,VA. 03.2065.00

SCENARIO #9

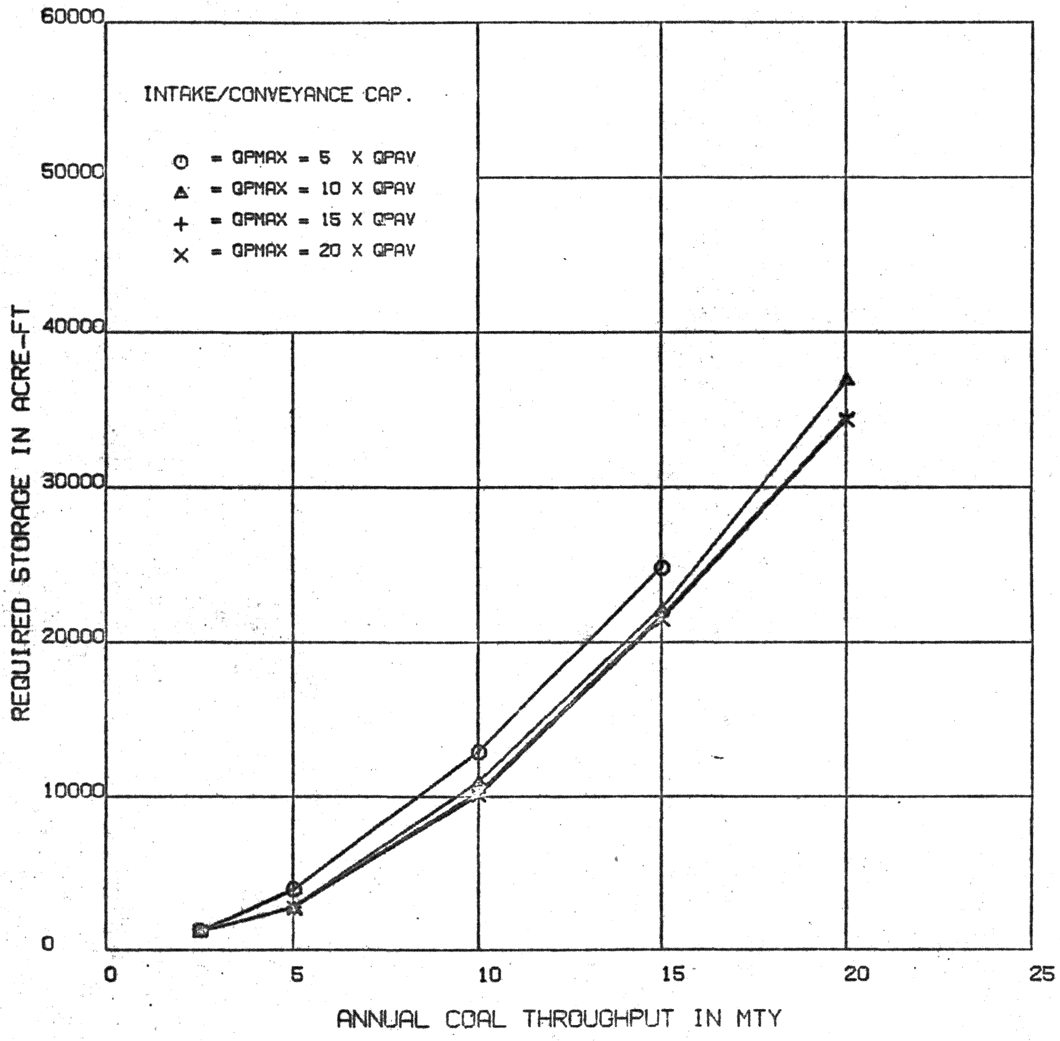
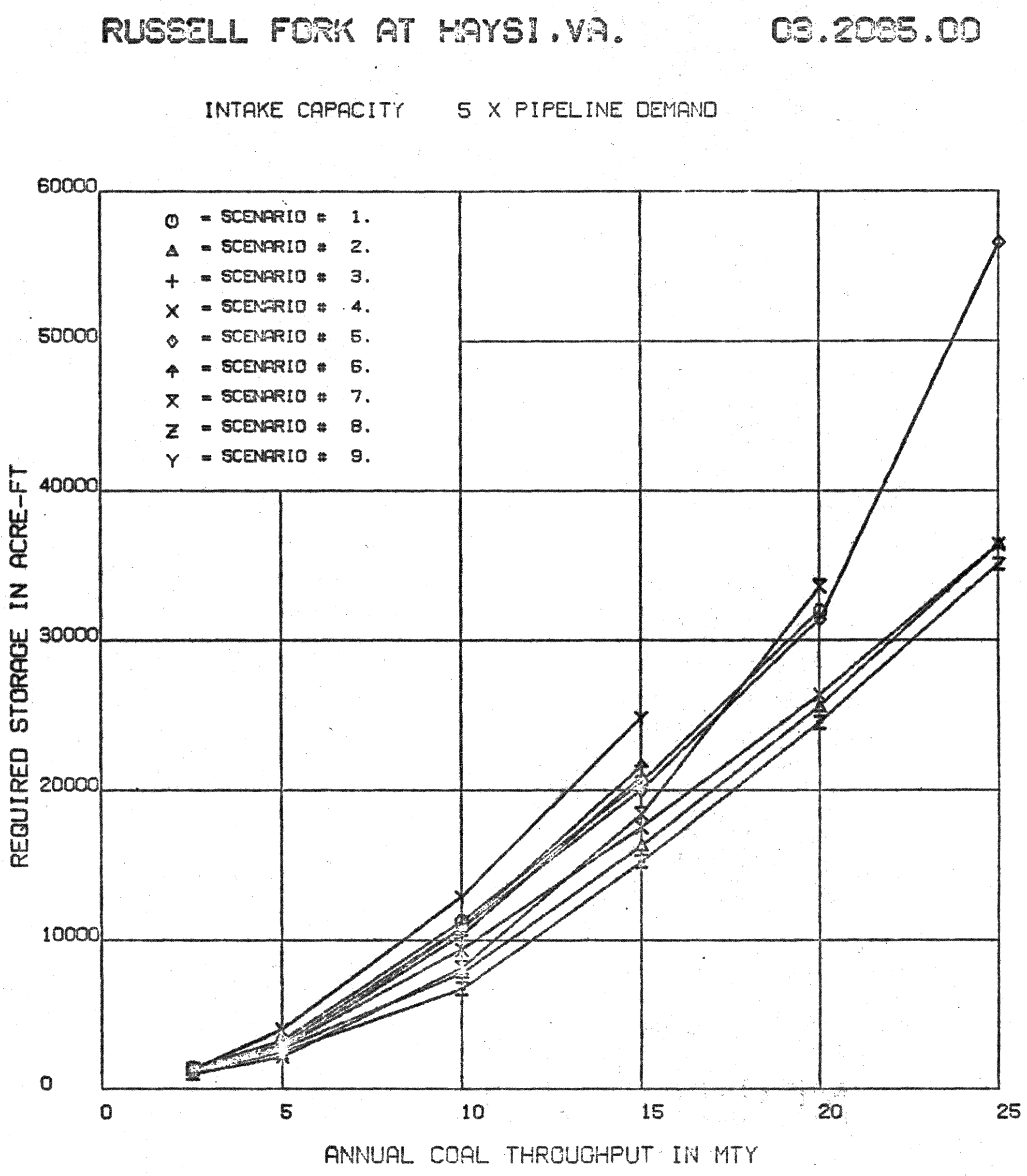


FIGURE B-HY-9 OFFSTREAM STORAGE REQUIREMENTS



RUSSELL FORK AT HAYSI.VA. 03.2085.00

INTAKE CAPACITY 5 X PIPELINE DEMAND

FIGURE B-HY-10 OFFSTREAM STORAGE REQUIREMENTS

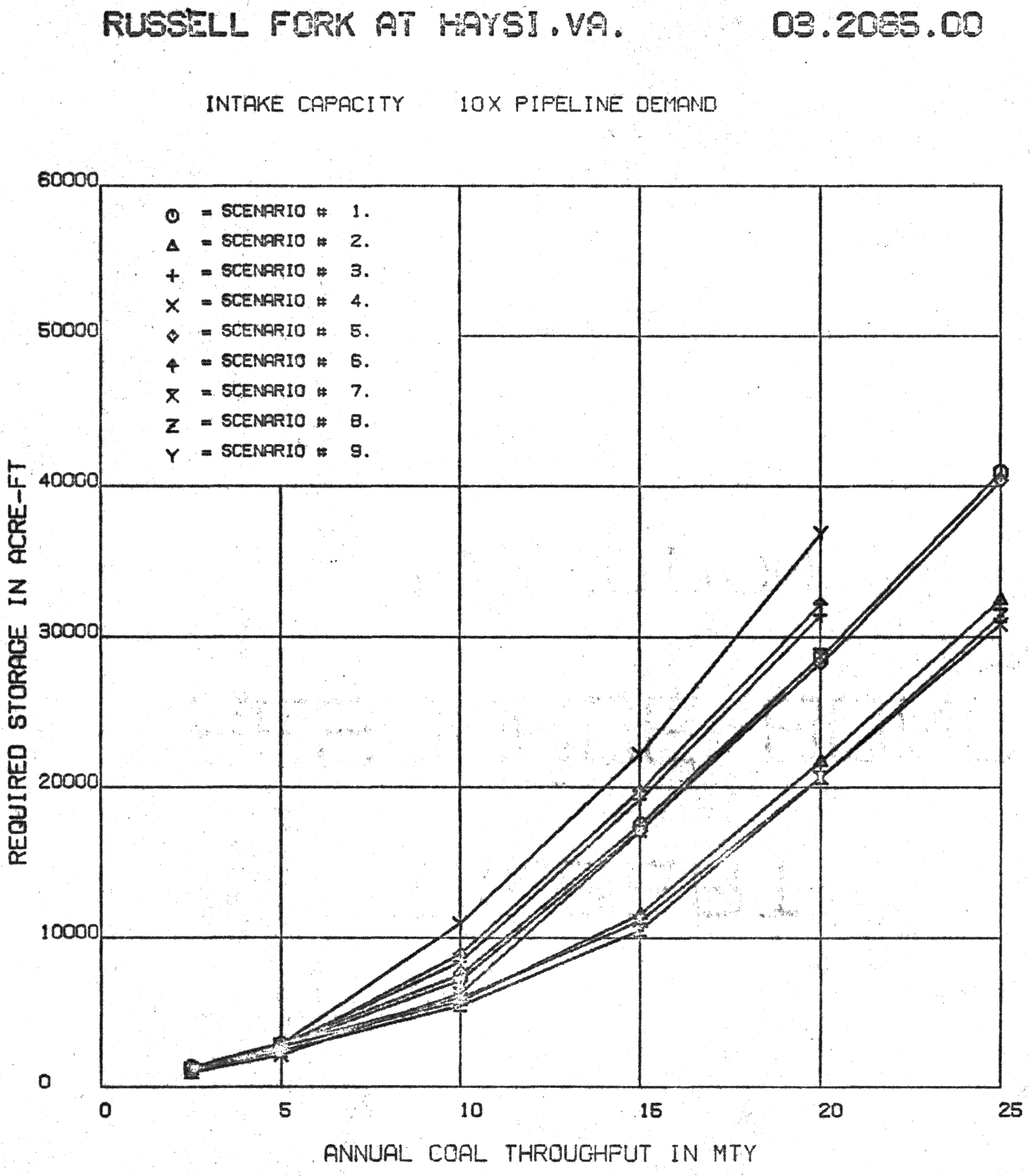


FIGURE B-HY-11 OFFSTREAM STORAGE REQUIREMENTS

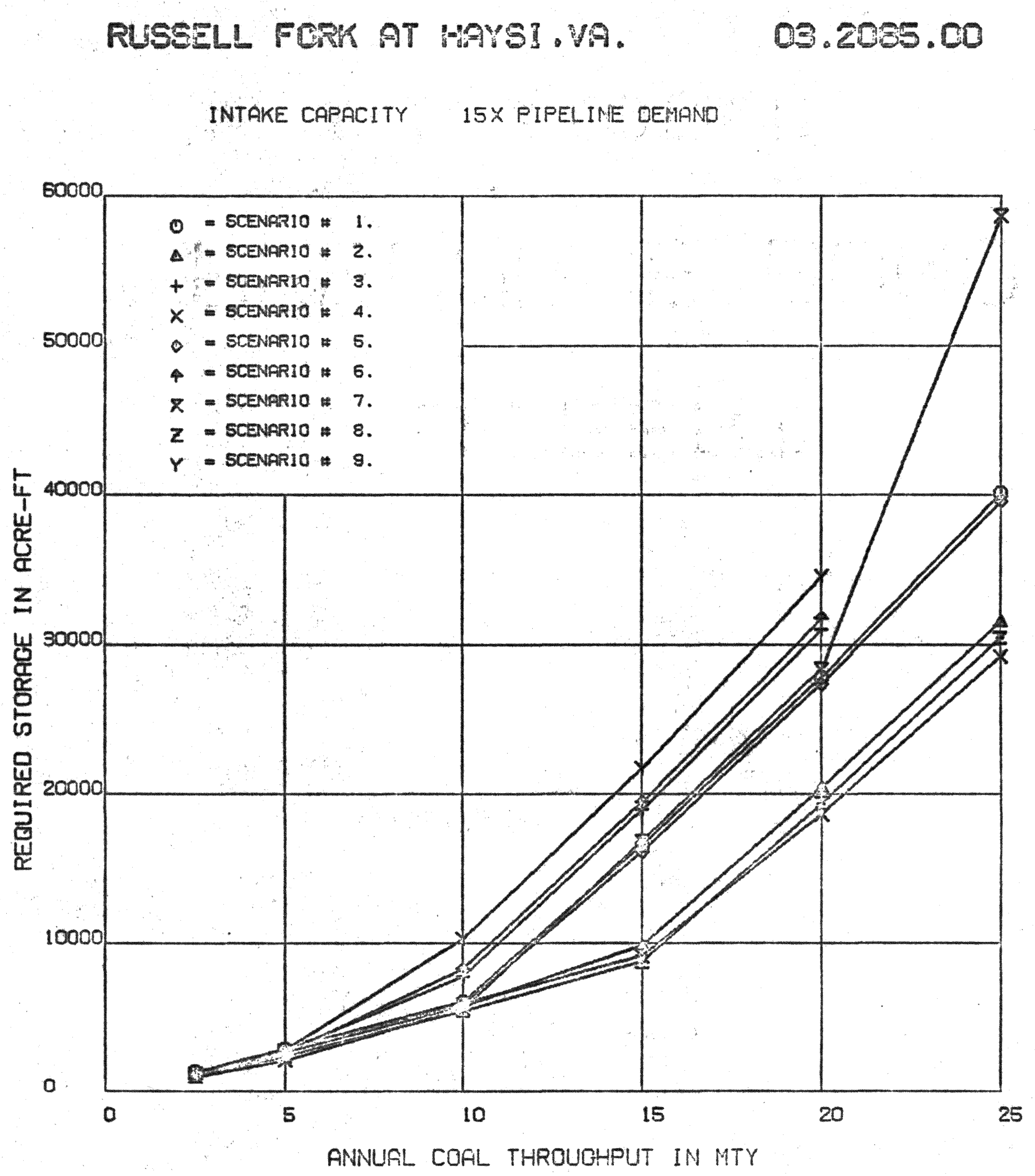


FIGURE B-HY-12 OFFSTREAM STORAGE REQUIREMENTS

RUSSELL FORK AT HAYSI.VA. 03.2085.00

INTAKE CAPACITY 20X PIPELINE DEMAND

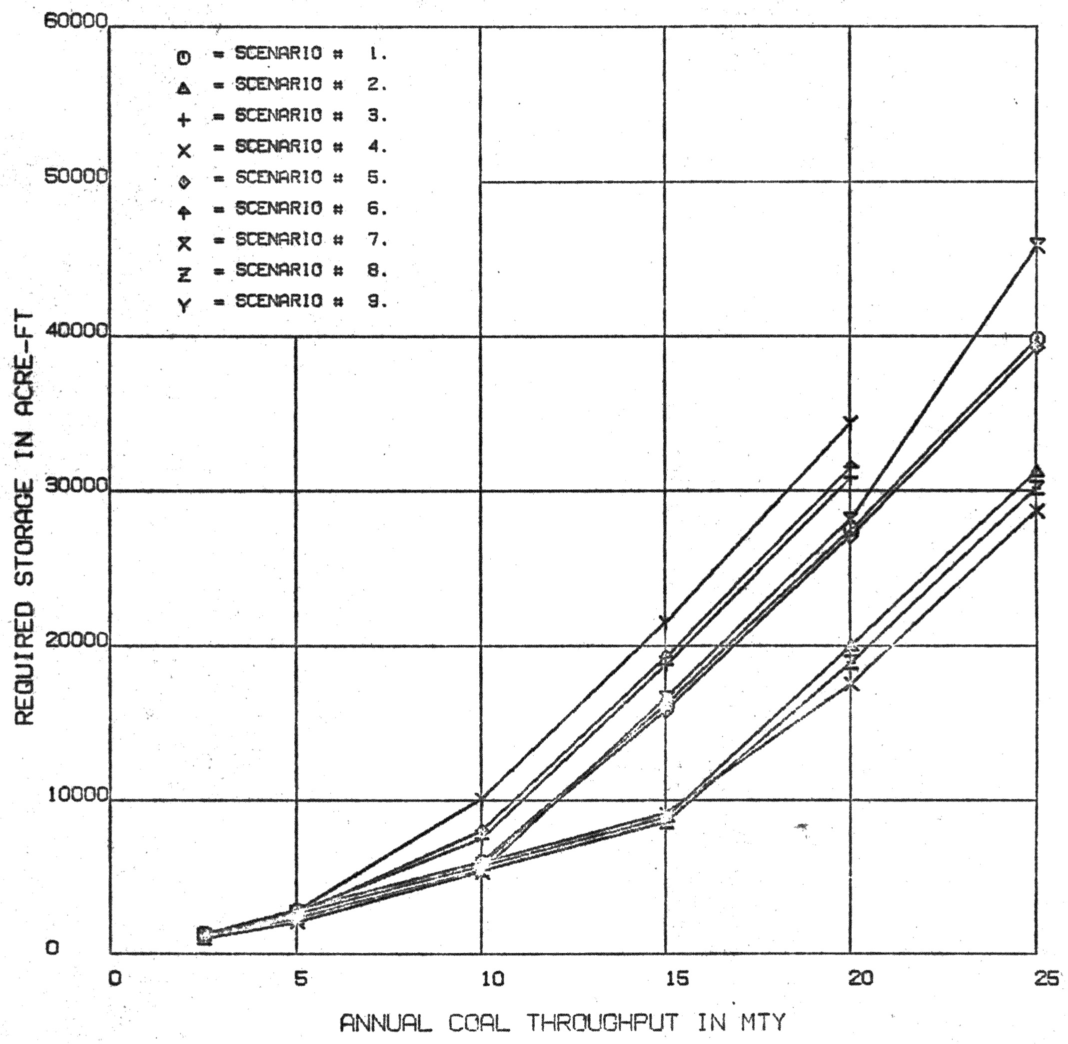


FIGURE B-HY-13 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO #1

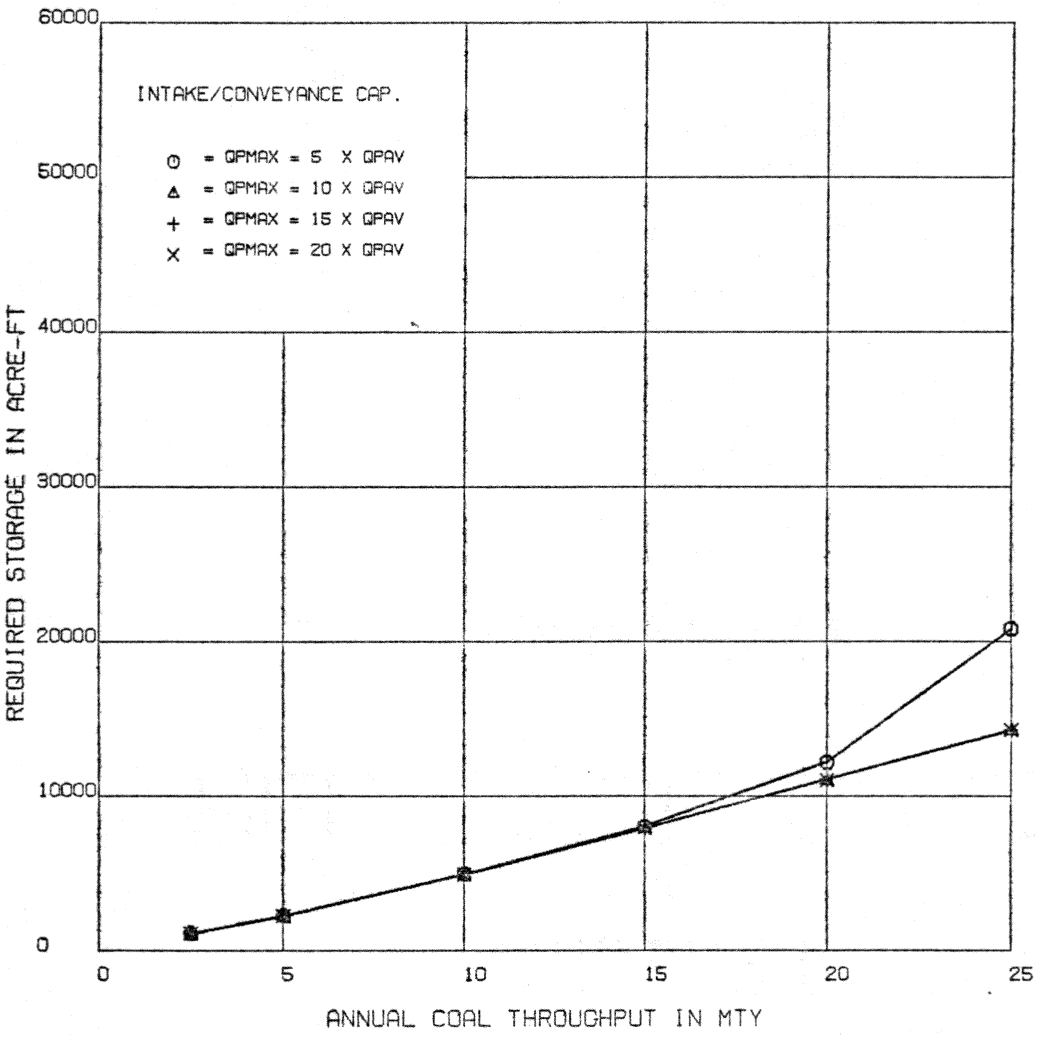


FIGURE B-PJ-1 OFFSTREAM STORAGE REQUIREMENTS

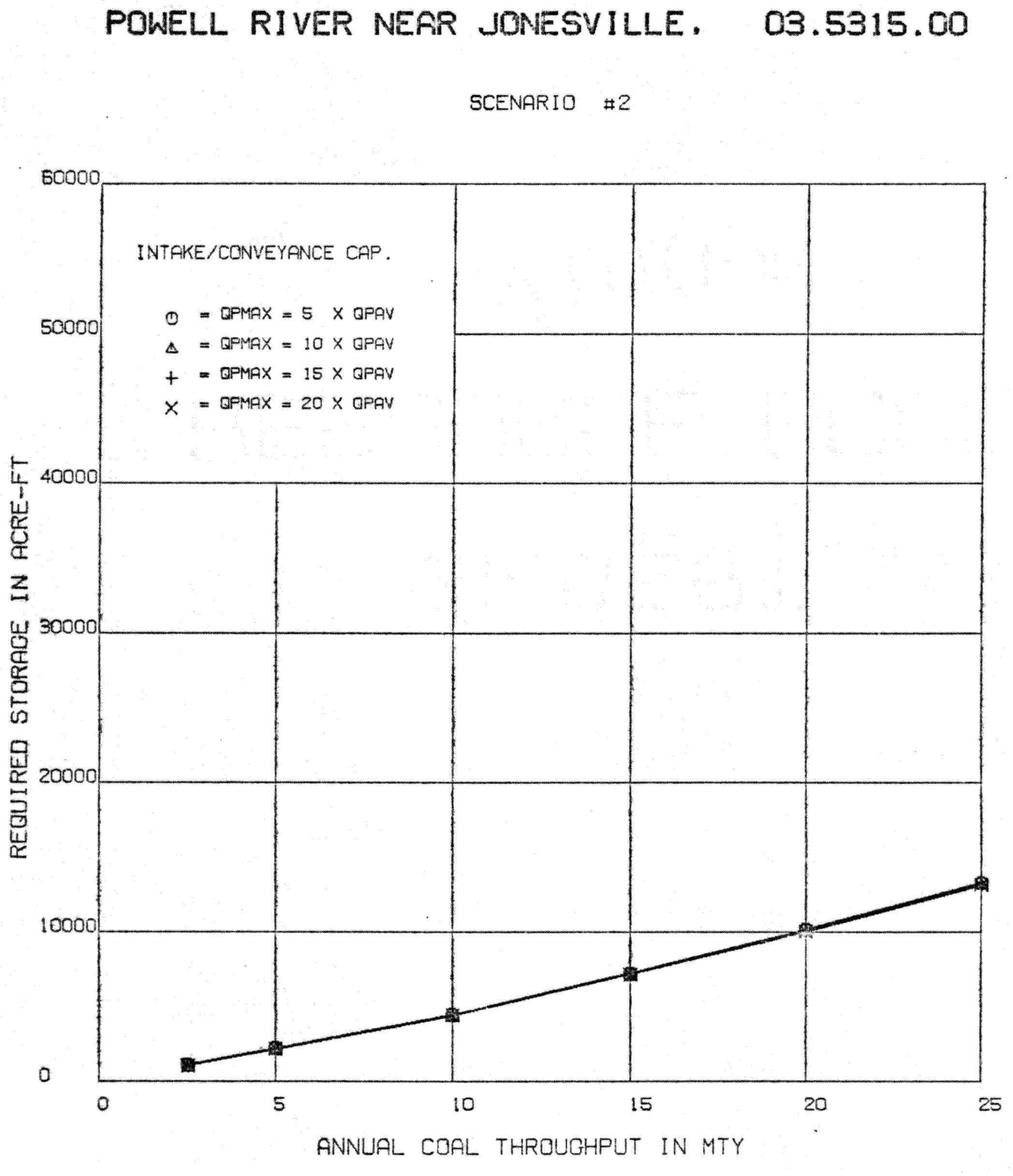


FIGURE B-PJ-2 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO #3

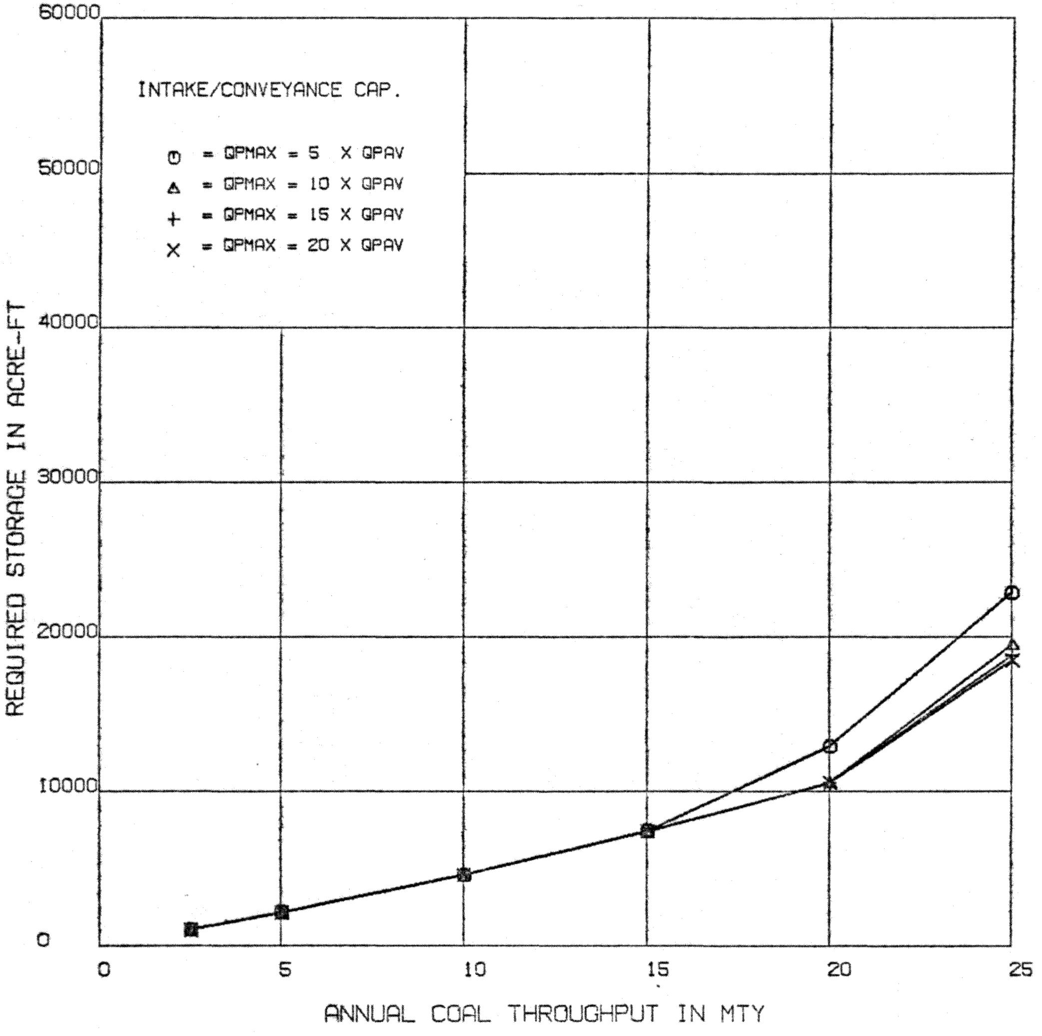


FIGURE B-PJ-3 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO #4

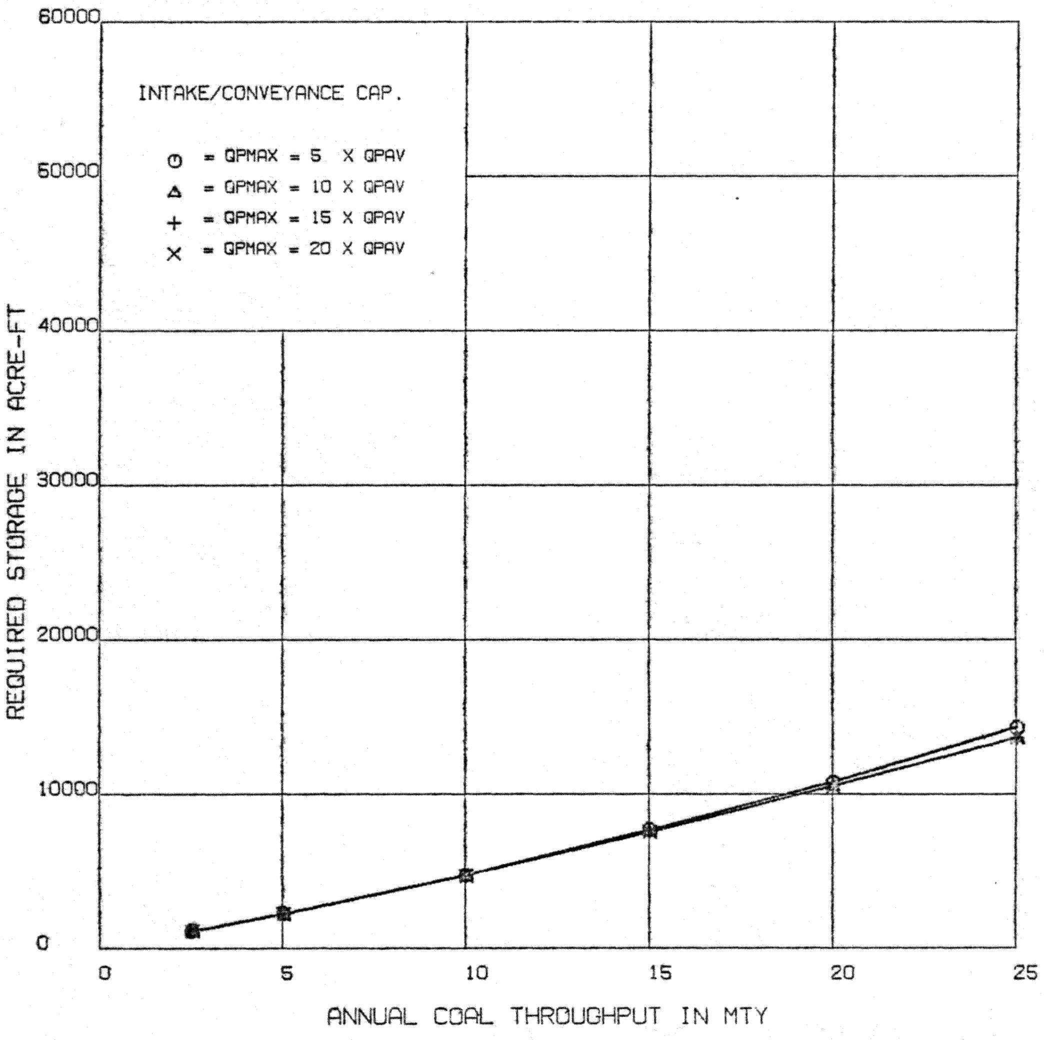


FIGURE B-PJ-4 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO #5

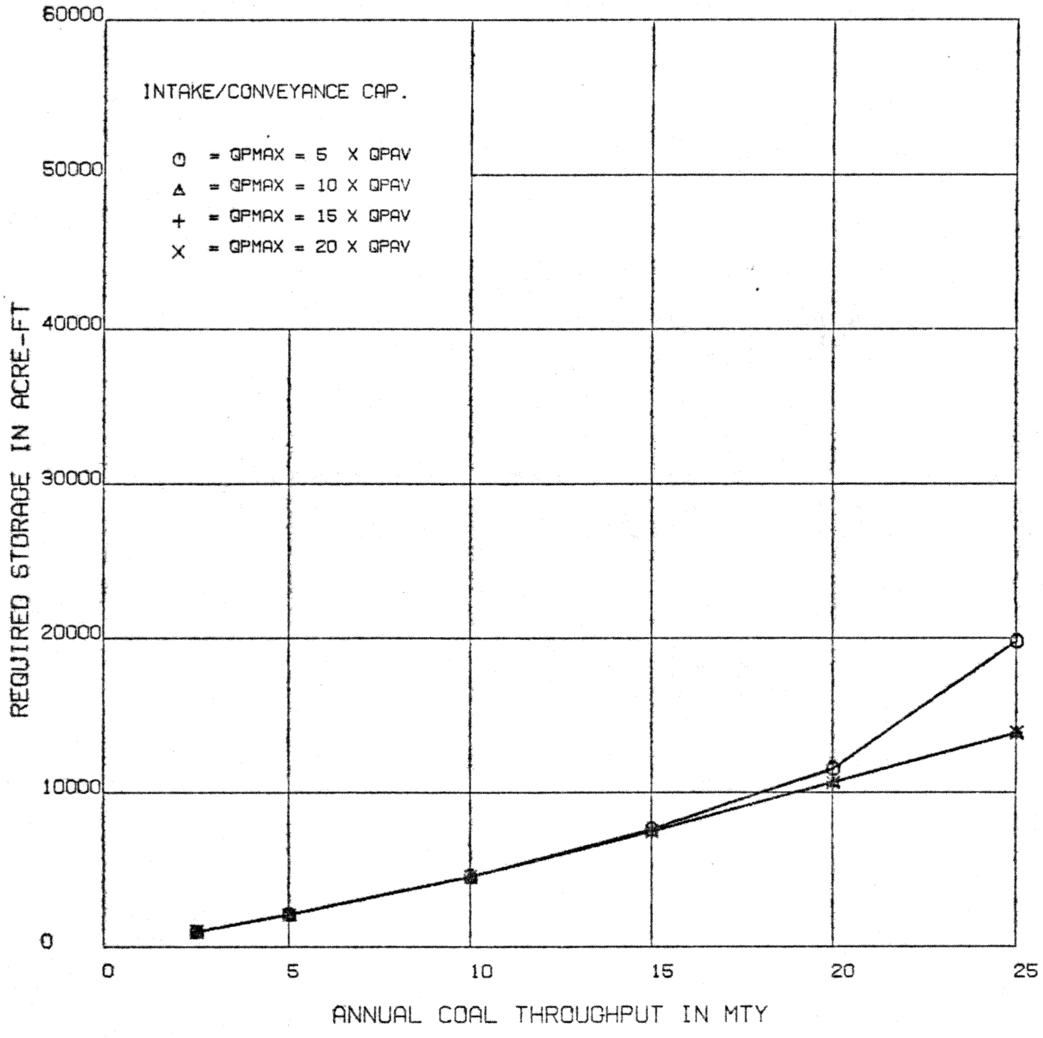


FIGURE B-PJ-5 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO #6

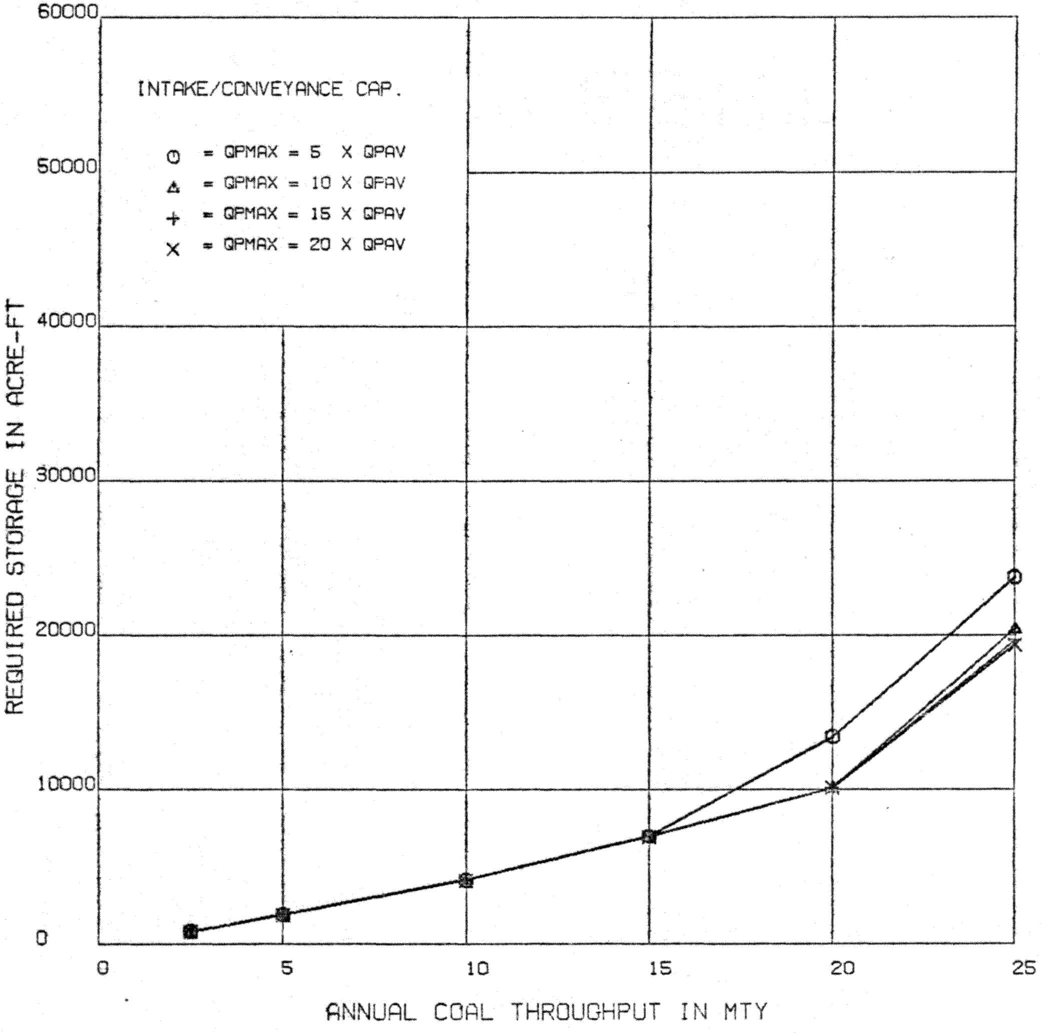


FIGURE B-PJ-6 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO #7

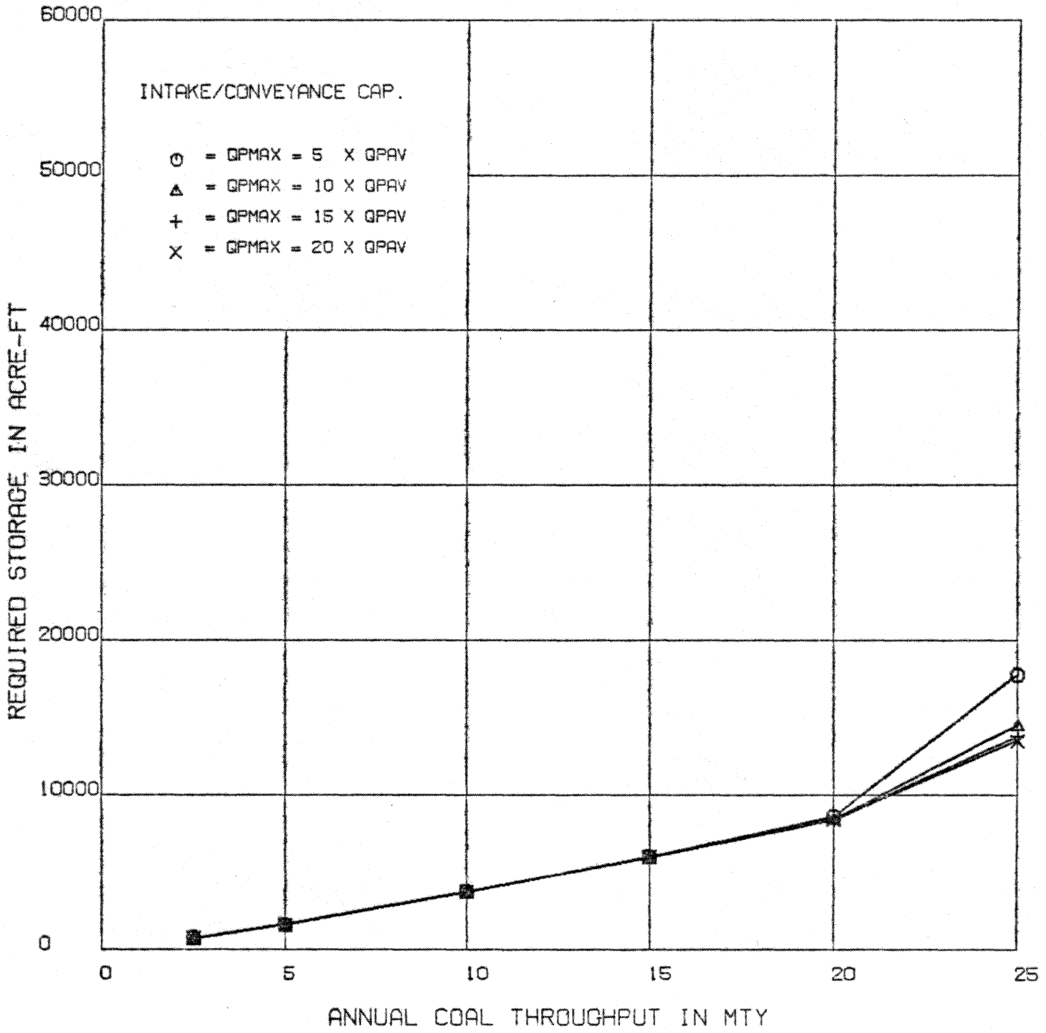


FIGURE B-PJ-7 OFFSTREAM STORAGE REQUIREMENTS

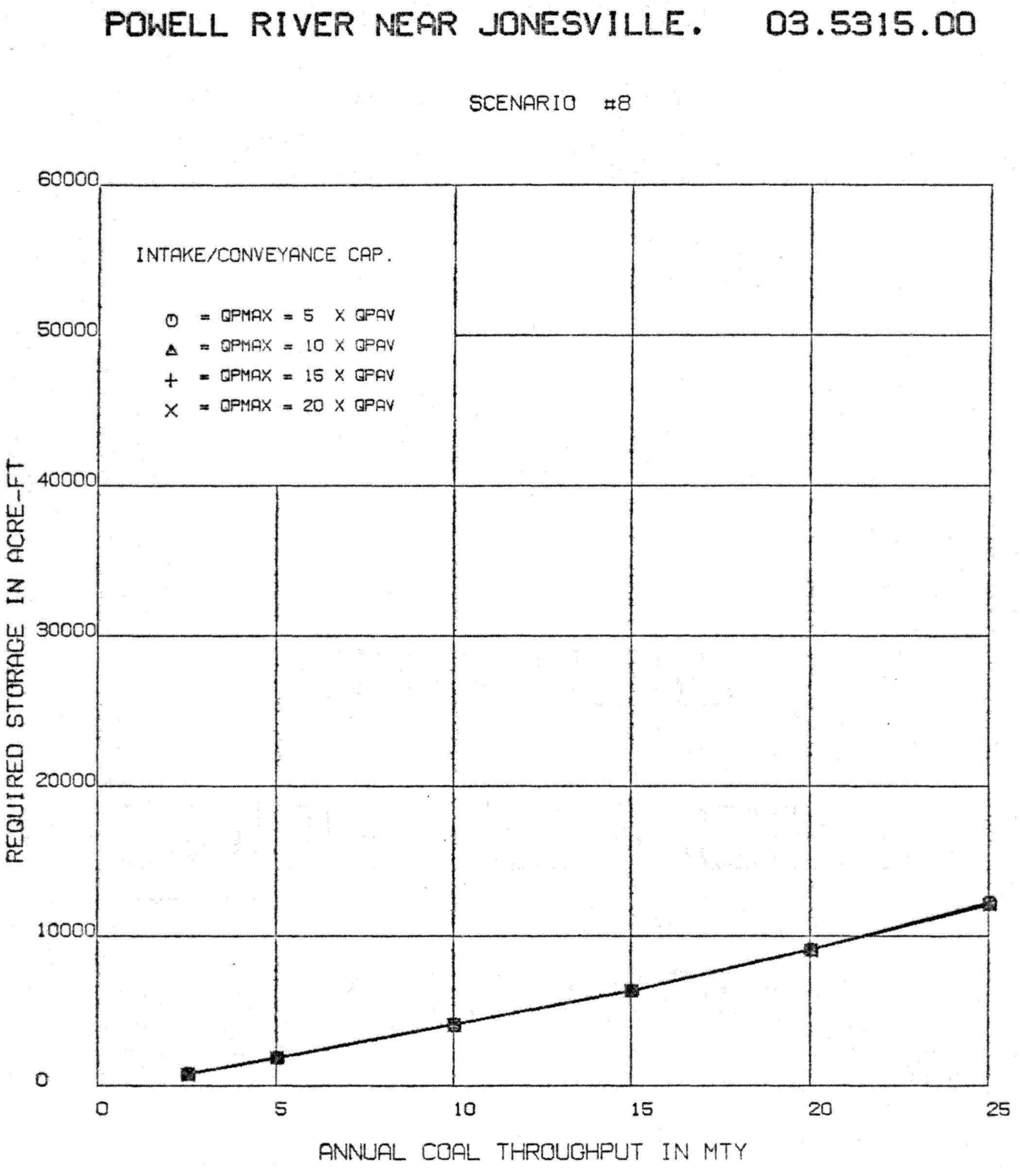


FIGURE B-PJ-8 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO #9

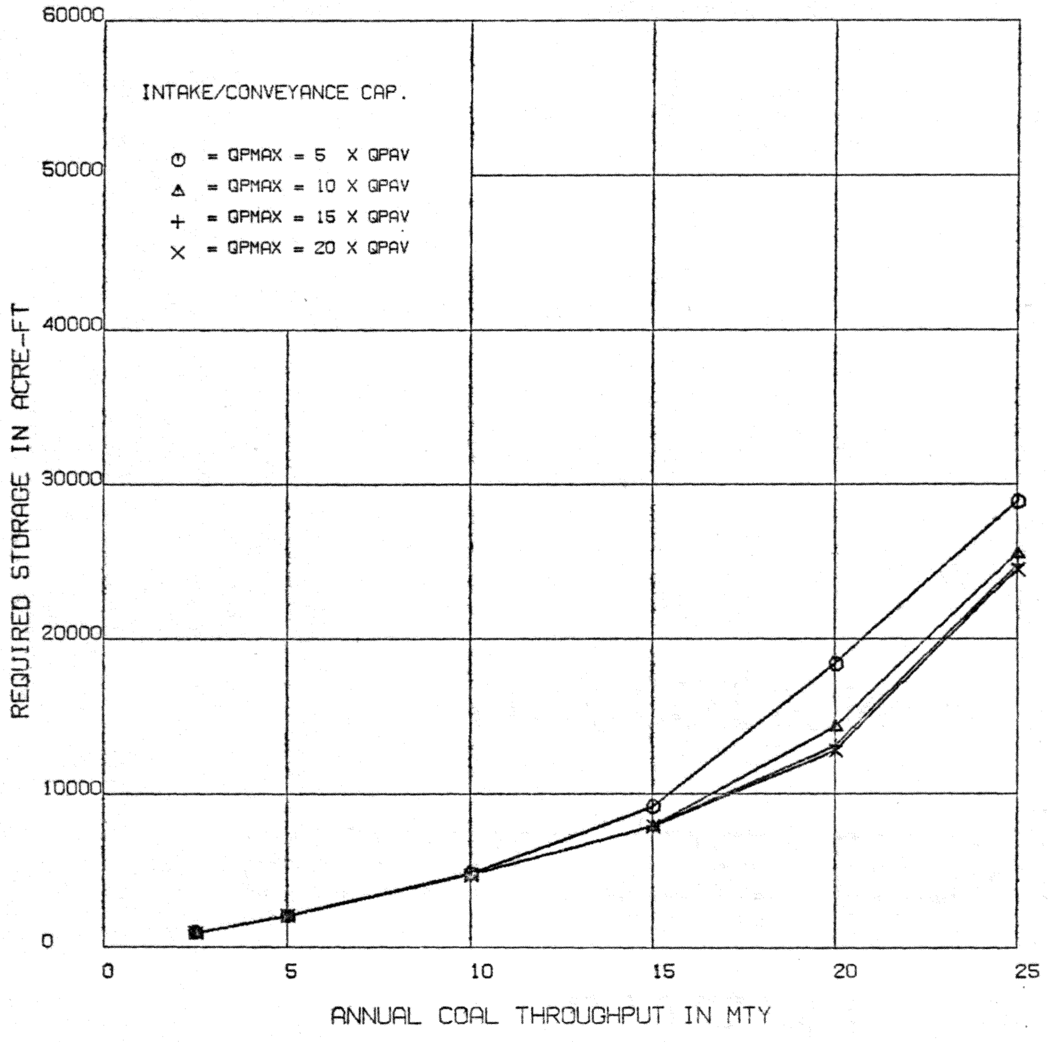


FIGURE B-PJ-9 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

INTAKE CAPACITY 5 X PIPELINE DEMAND

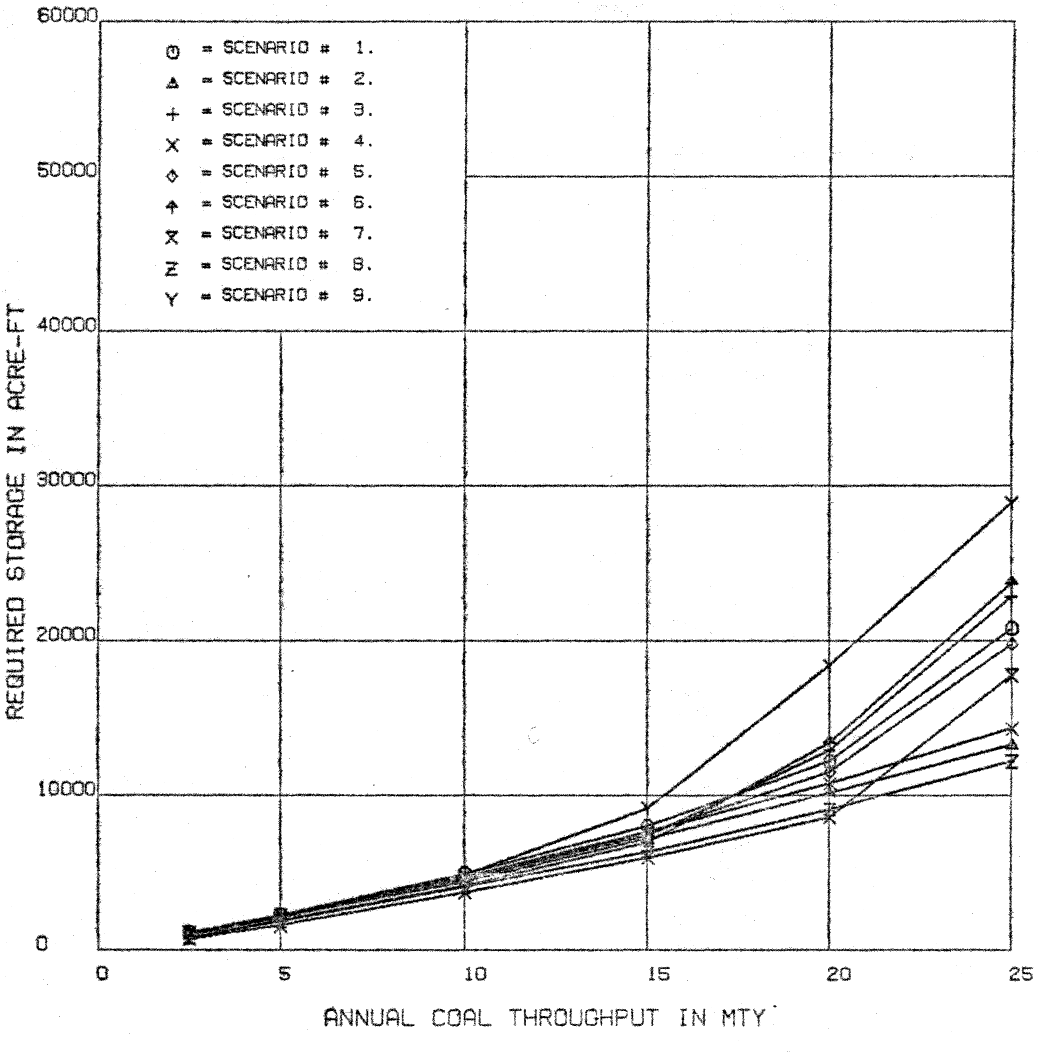
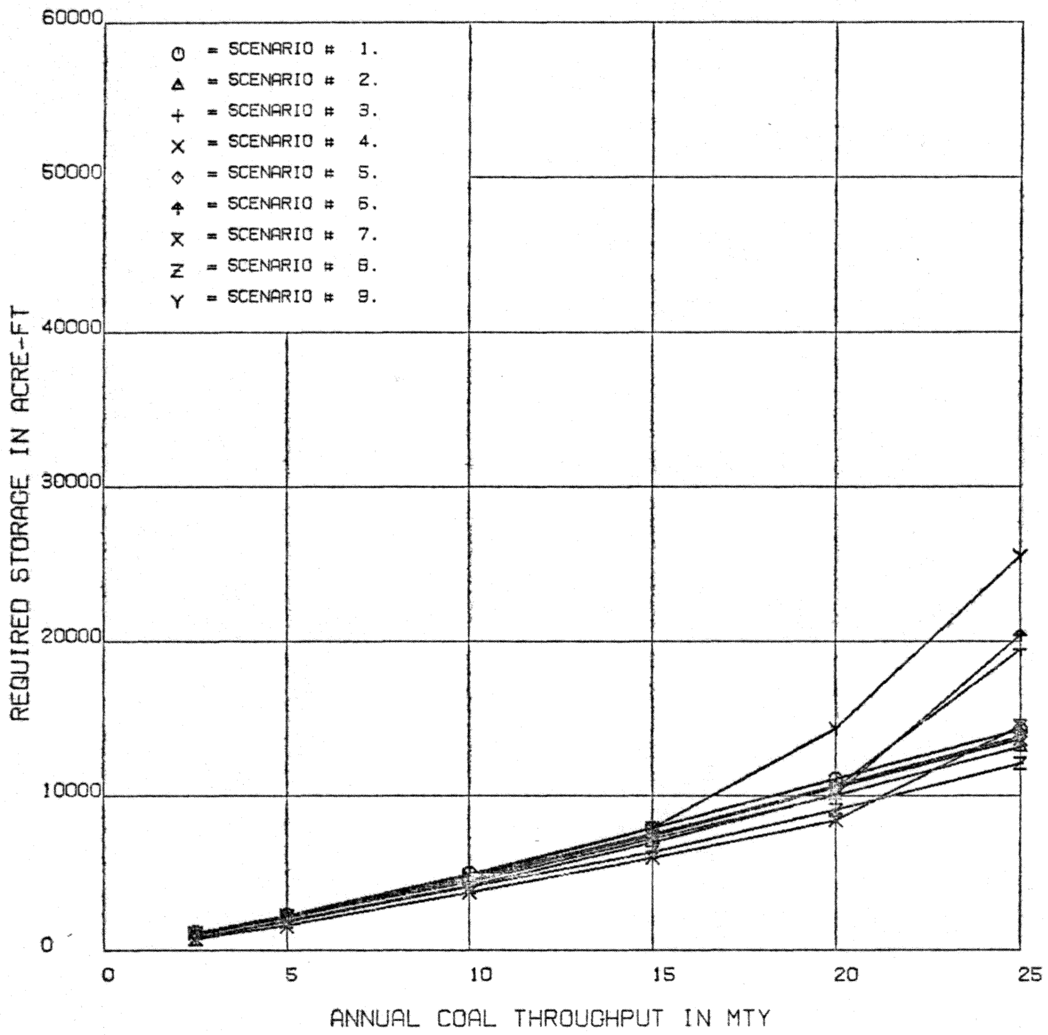


FIGURE B-PJ-10 OFFSTREAM STORAGE REQUIREMENTS



POWELL RIVER NEAR JONESVILLE. 03.5315.00

INTAKE CAPACITY 10X PIPELINE DEMAND

FIGURE B-PJ-11 OFFSTREAM STORAGE REQUIREMENTS

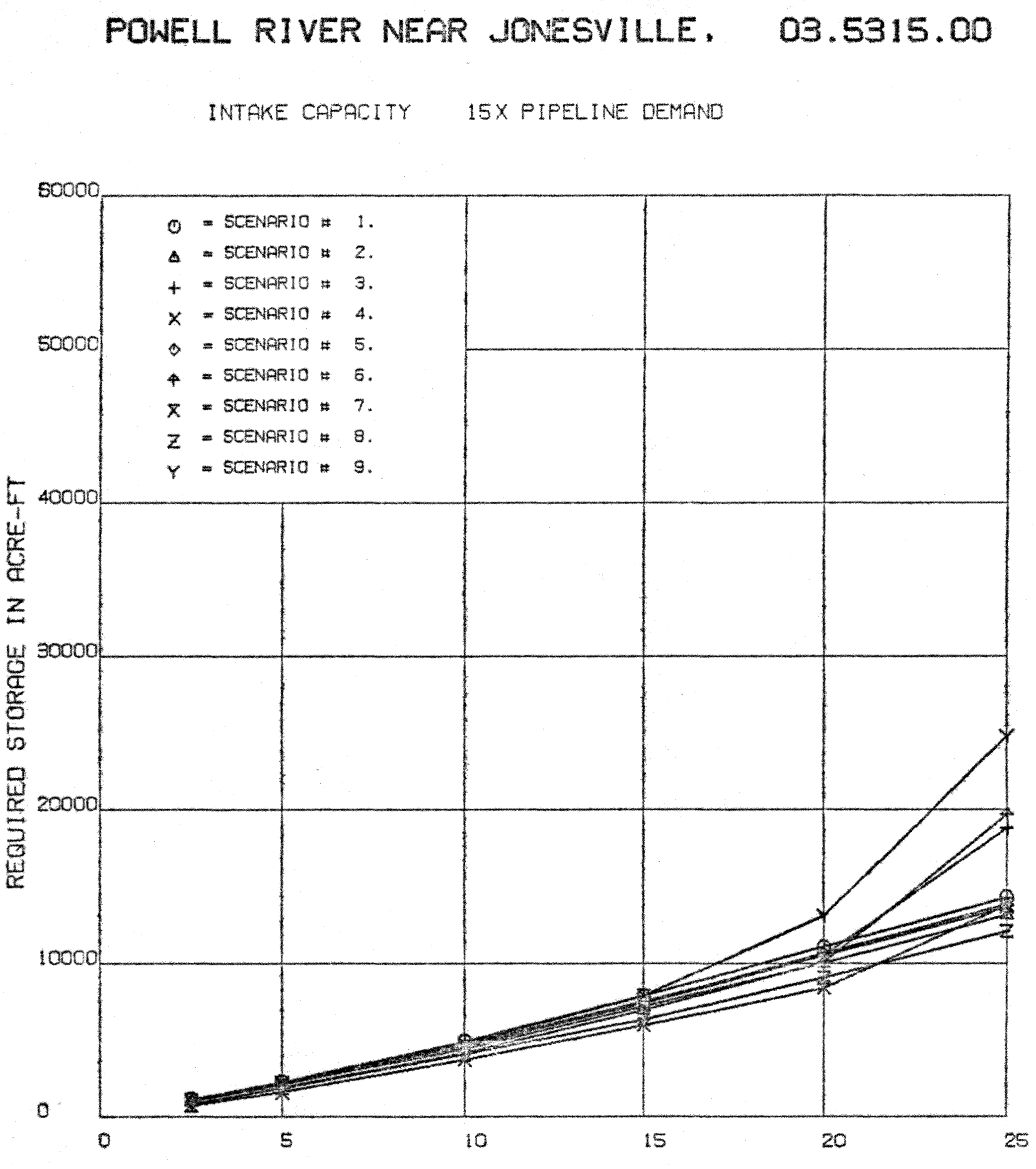


FIGURE B-PJ-12 OFFSTREAM STORAGE REQUIREMENTS

POWELL RIVER NEAR JONESVILLE. 03.5315.00

INTAKE CAPACITY 20X PIPELINE DEMAND

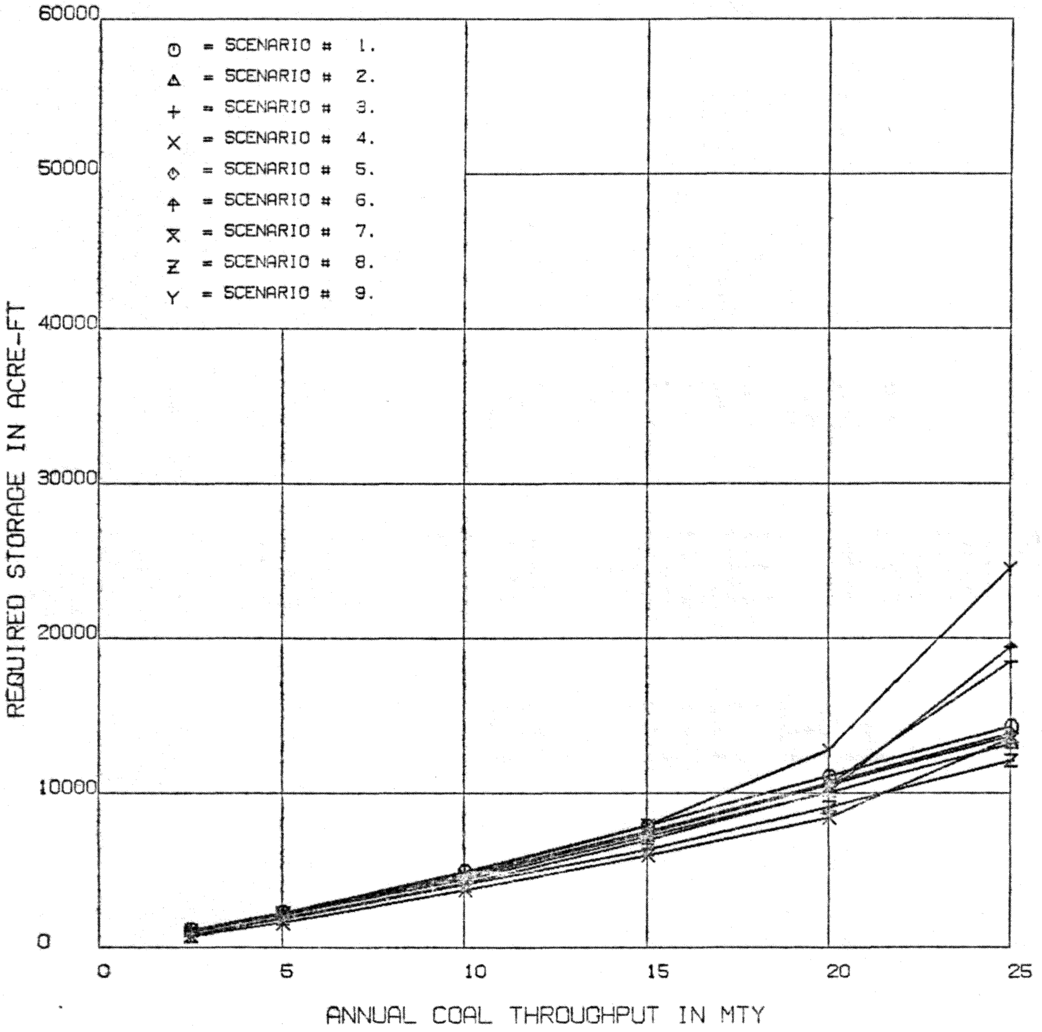


FIGURE B-PJ-13 OFFSTREAM STORAGE REQUIREMENTS

APPENDIX C

STREAM PARTIAL-DURATION LOW-FLOW FREQUENCIES (FIGURES)

LEVISA FORK NR GRUNDY.VA. 03.2075.00

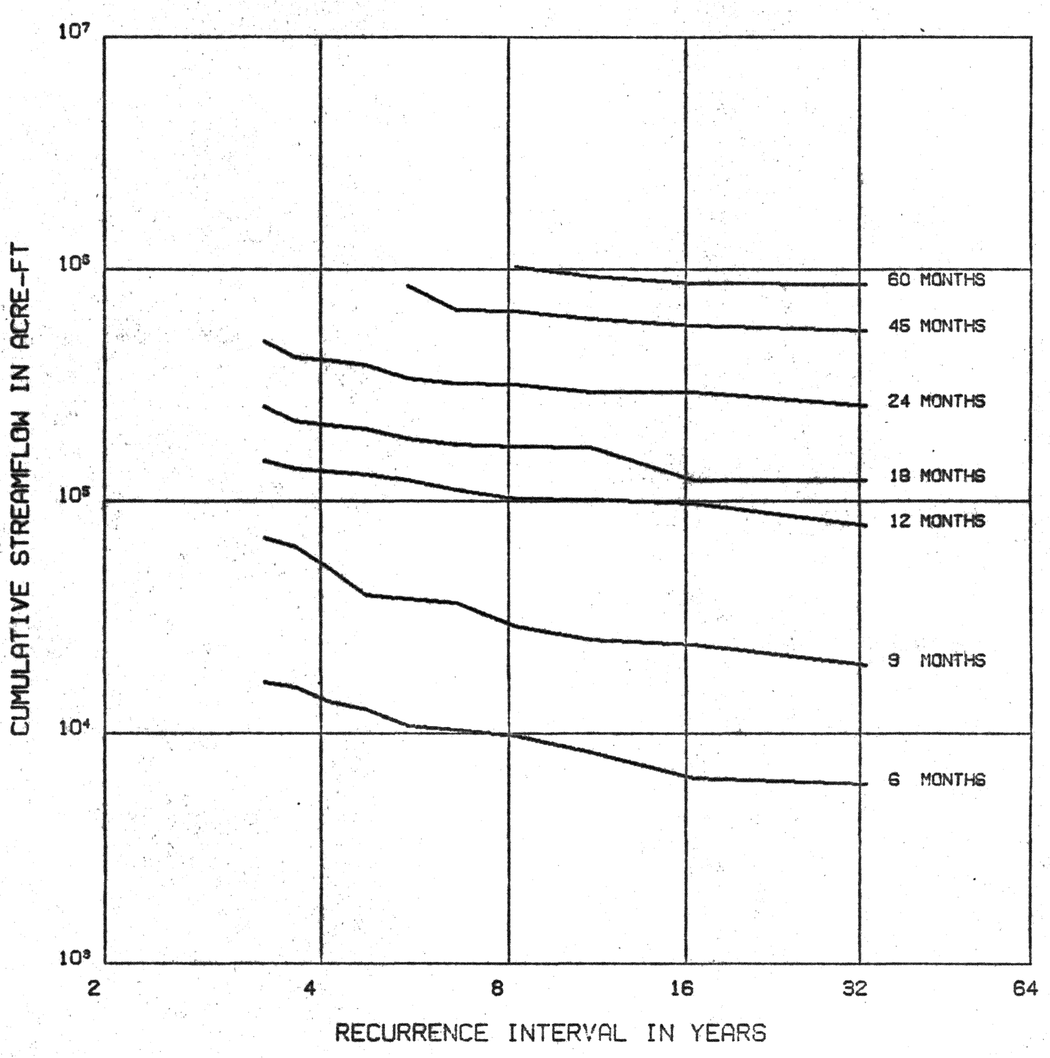


FIGURE C-L1 STREAM PARTIAL-DURATION LOW-FLOW FREQUENCIES

LEVISA FORK AT BIG ROCK.VA. 03.2078.00

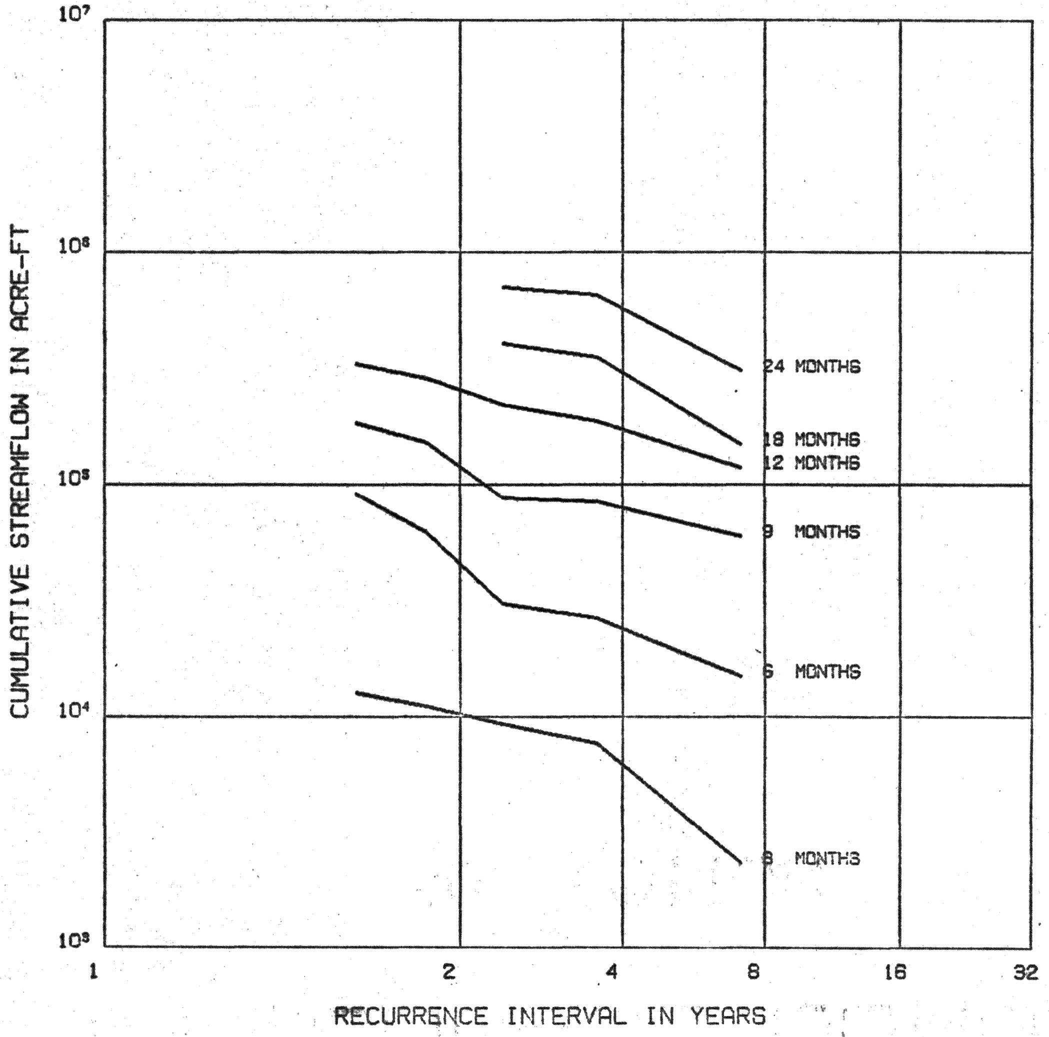


FIGURE C-L2 STREAM PARTIAL-DURATION LOW-FLOW FREQUENCIES

POUND RIVER NEAR GEORGES FORK,VA 03.2089.00

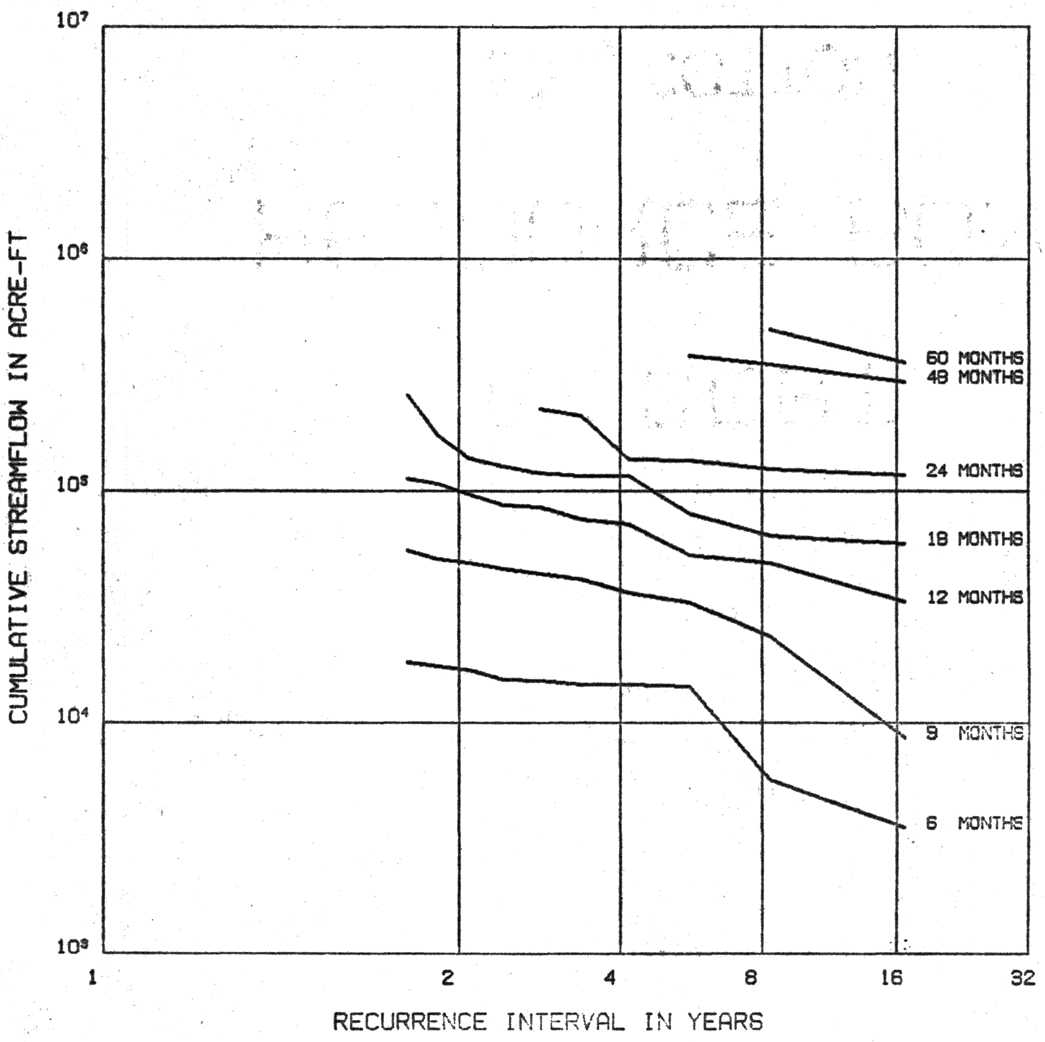


FIGURE C-PG STREAM PARTIAL-DURATION LOW-FLOW FREQUENCIES

RUSSELL FORK AT HAYSI.VA. 03.2085.00

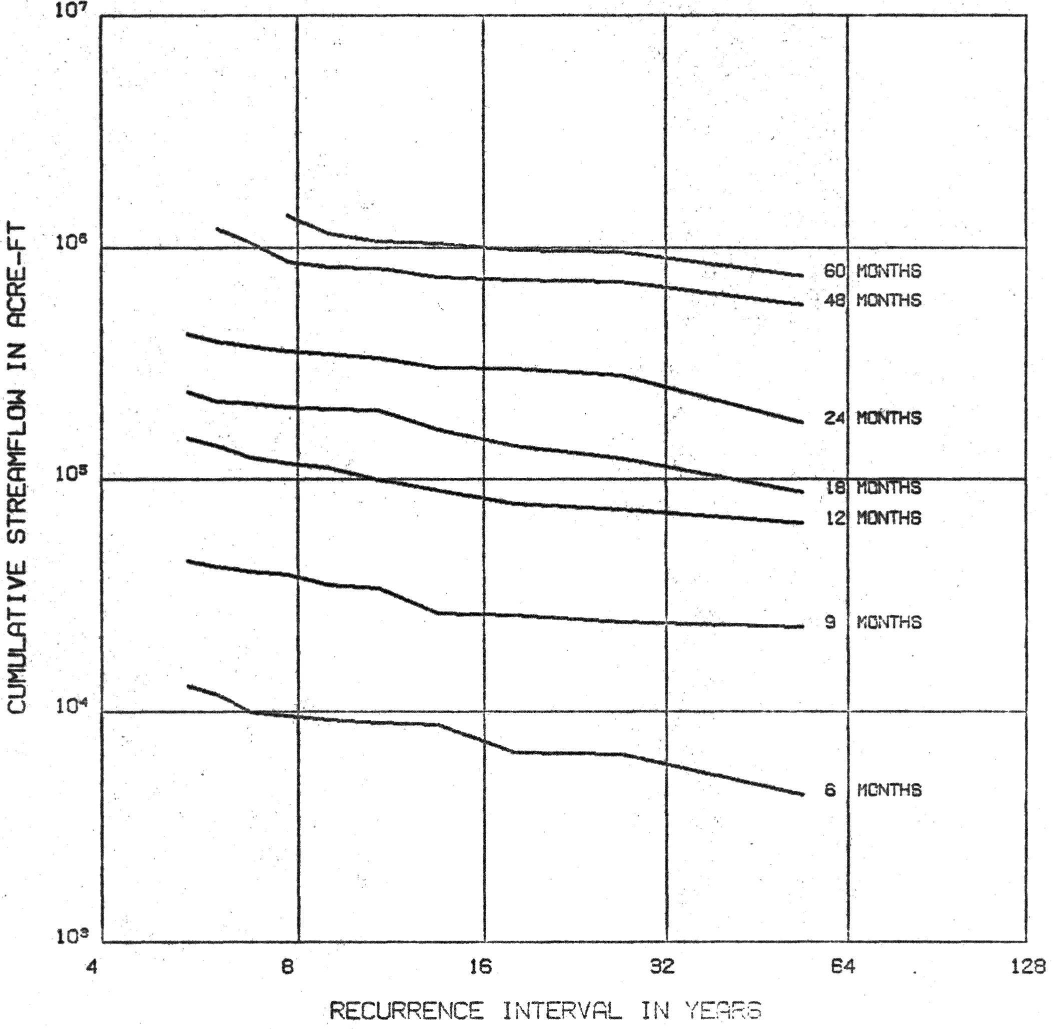


FIGURE C-HY STREAM PARTIAL-DURATION LOW-FLOW FREQUENCIES

POWELL RIVER NEAR JONESVILLE,VA. 03.5315.00

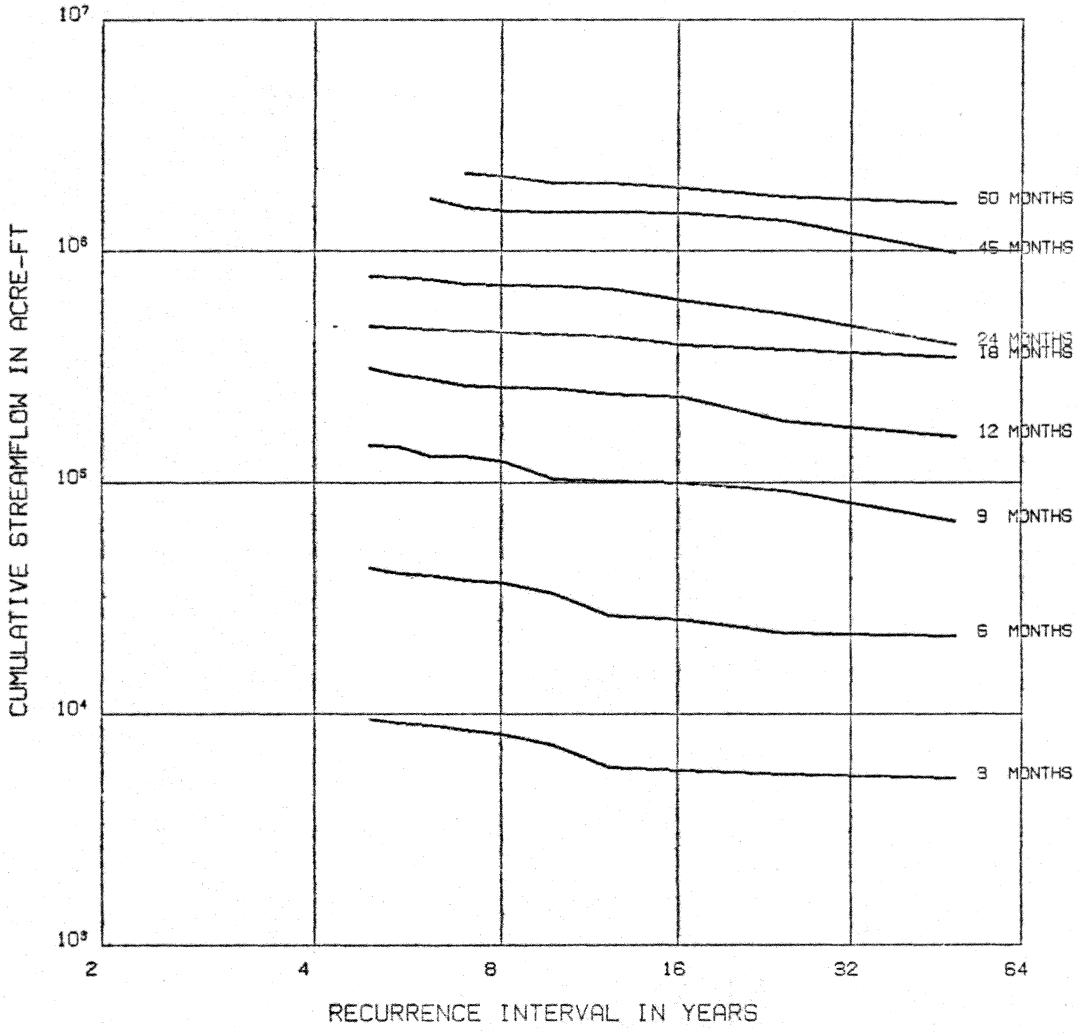


FIGURE C-PJ STREAM PARTIAL-DURATION LOW-FLOW FREQUENCIES

APPENDIX D

OFFSTREAM RESERVOIRS FREQUENCIES (TABLES)

TABLE D-L2- 1 OFFSTREAM STORAGE FREQUENCIES

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

OFFSTREAM STORAGE REQUIREMENTS (ACRE-FT)
FOR INTAKE/CONVEYANCE CAPACITY 5 X WATER DEMAND

SCENARIO	RECURRENCE	ANNUAL THROUGHPUT OF COAL SLURRY PIPELINE(MTY)					
#	INT.(YRS)	2.5	5.0	10.0	15.0	20.0	25.0
2	12.00	938.	2059.	4480.	6993.	10036.	15447.
	6.00	615.	1386.	3159.	5658.	8157.	10657.
	4.00	434.	1137.	3010.	5152.	7363.	9731.
	3.00	358.	989.	2640.	4779.	7103.	9543.
	2.40	327.	922.	2216.	3976.	5763.	7759.
	2.00	305.	800.	2170.	3777.	5385.	7089.
	1.71	293.	751.	1888.	3517.	5303.	7042.
	1.50	254.	647.	1656.	2728.	4291.	6279.
	1.33	247.	554.	1260.	2056.	3009.	3961.
	1.20	210.	543.	1151.	1832.	2771.	3784.
7	12.00	620.	1566.	3946.	6813.	12878.	21898.
	6.00	311.	761.	2534.	4789.	7288.	12148.
	4.00	222.	612.	2335.	4592.	7032.	10392.
	3.00	179.	577.	1725.	3744.	6218.	8718.
	2.40	146.	366.	1513.	3300.	5303.	7913.
	2.00	144.	344.	1466.	3139.	5139.	7281.
	1.71	138.	316.	1393.	3047.	4944.	7086.
	1.50	117.	300.	1266.	2612.	4711.	6853.
	1.33	84.	263.	913.	1784.	2837.	4189.
	1.20	67.	246.	815.	1530.	2346.	3417.
9	12.00	949.	2123.	5055.	10605.	19060.	30631.
	6.00	582.	1454.	3953.	6453.	11682.	17499.
	4.00	487.	1368.	3546.	5946.	9930.	15629.
	3.00	401.	1157.	3426.	5868.	8342.	10841.
	2.40	340.	999.	2796.	5129.	7827.	10446.
	2.00	311.	991.	2622.	4595.	6737.	8993.
	1.71	303.	885.	2601.	4586.	6728.	8871.
	1.50	270.	782.	2129.	4146.	6288.	8431.
	1.33	183.	508.	1457.	2553.	4361.	6444.
	1.20	152.	495.	1314.	2327.	3373.	5260.

TABLE D-L2- 2 OFFSTREAM STORAGE FREQUENCIES

LEVISA FORK AT BIG ROCK,VA. 03.2078.00

OFFSTREAM STORAGE REQUIREMENTS (ACRE-FT)
FOR INTAKE/CONVEYANCE CAPACITY 10 X WATER DEMAND

SCENARIO	RECURRENCE	ANNUAL THROUGHPUT OF COAL SLURRY PIPELINE(MTY)					
#	INT.(YRS)	2.5	5.0	10.0	15.0	20.0	25.0
2	12.00	832.	1892.	4154.	6618.	9438.	13855.
	6.00	493.	1265.	3159.	5658.	8158.	10657.
	4.00	426.	1054.	2839.	4665.	7046.	9525.
	3.00	327.	854.	2447.	4486.	6934.	9433.
	2.40	305.	828.	2192.	3979.	5764.	7633.
	2.00	300.	741.	1918.	3519.	5304.	7090.
	1.71	255.	705.	1890.	3373.	5158.	6999.
	1.50	221.	585.	1658.	2730.	4056.	6180.
	1.33	197.	546.	1263.	1978.	2784.	3855.
	1.20	186.	437.	1118.	1832.	2602.	3673.
7	12.00	615.	1508.	3833.	6525.	12775.	19202.
	6.00	311.	749.	2535.	4789.	7288.	10925.
	4.00	183.	596.	2335.	4523.	7022.	9521.
	3.00	179.	577.	1722.	3719.	6218.	8718.
	2.40	146.	366.	1515.	3300.	5303.	7493.
	2.00	144.	340.	1414.	3139.	5139.	7282.
	1.71	138.	316.	1394.	3047.	4944.	7086.
	1.50	117.	295.	1268.	2613.	4711.	6853.
	1.33	84.	263.	913.	1766.	2838.	4190.
	1.20	68.	246.	815.	1530.	2347.	3418.
9	12.00	871.	2003.	4665.	10140.	16566.	27497.
	6.00	533.	1454.	3954.	6453.	10168.	16276.
	4.00	456.	1349.	3387.	5877.	8376.	14307.
	3.00	352.	1053.	3343.	5843.	8342.	10842.
	2.40	335.	1003.	2791.	4848.	7289.	10026.
	2.00	312.	887.	2624.	4596.	6738.	8881.
	1.71	287.	868.	2490.	4586.	6729.	8871.
	1.50	246.	782.	2007.	4147.	6289.	8431.
	1.33	155.	508.	1344.	2475.	4299.	6441.
	1.20	153.	495.	1230.	2302.	3374.	4735.

TABLE D-HY- 1 OFFSTREAM STORAGE FREQUENCIES

RUSSELL FORK AT HAYSI,VA. 03.2085.00

OFFSTREAM STORAGE REQUIREMENTS (ACRE-FT)
FOR INTAKE/CONVEYANCE CAPACITY 5 X WATER DEMAND

SCENARIO	RECURRENCE	ANNUAL THROUGHPUT OF COAL SLURRY PIPELINE(MTY)					
#	INT.(YRS)	2.5	5.0	10.0	15.0	20.0	25.0
2	54.00	1210.	2556.	6769.	14956.	24690.	35440.
	27.00	1177.	2510.	5248.	8049.	11234.	16854.
	18.00	1042.	2198.	4676.	7647.	11029.	15723.
	13.50	973.	2174.	4603.	7250.	10446.	13858.
	10.80	951.	2036.	4460.	7003.	9832.	12997.
	9.00	912.	2021.	4405.	6964.	9701.	12942.
	7.71	872.	1838.	4238.	6793.	9593.	12450.
	6.75	804.	1754.	4022.	6498.	9171.	11965.
	6.00	754.	1743.	3999.	6468.	9130.	11911.
	5.40	743.	1687.	3970.	6329.	9124.	11803.
7	54.00	1013.	2160.	6864.	17940.	30789.	49759.
	27.00	914.	2110.	4941.	9242.	19080.	33684.
	18.00	875.	1923.	4474.	7887.	15689.	32238.
	13.50	846.	1887.	4345.	7610.	14604.	30727.
	10.80	696.	1744.	4250.	7082.	11756.	23098.
	9.00	671.	1687.	4061.	6899.	11031.	20372.
	7.71	641.	1686.	4058.	6848.	9840.	16730.
	6.75	581.	1594.	3981.	6662.	9357.	15081.
	6.00	578.	1397.	3570.	6221.	9138.	14482.
	5.40	549.	1309.	3456.	6103.	8964.	14283.
9	54.00	1207.	3369.	12432.	23556.	41435.	60406.
	27.00	1181.	2559.	5761.	12695.	26201.	43284.
	18.00	1067.	2283.	5513.	11009.	24940.	42569.
	13.50	1042.	2275.	5186.	9657.	23897.	41647.
	10.80	960.	2178.	4858.	8600.	16656.	32445.
	9.00	952.	2138.	4832.	8576.	15789.	29318.
	7.71	901.	2097.	4808.	7698.	13396.	25463.
	6.75	851.	1995.	4570.	7501.	12398.	19831.
	6.00	806.	1917.	4565.	7468.	11894.	17839.
	5.40	803.	1890.	4498.	7465.	11526.	16937.

TABLE D-HY- 2 OFFSTREAM STORAGE FREQUENCIES

RUSSELL FORK AT HAYSI,VA. 03.2085.00

OFFSTREAM STORAGE REQUIREMENTS (ACRE-FT)
FOR INTAKE/CONVEYANCE CAPACITY 10 X WATER DEMAND

SCENARIO #	RECURRENCE INT.(YRS)	ANNUAL THROUGHPUT OF COAL SLURRY PIPELINE(MTY) 2.5	5.0	10.0	15.0	20.0	25.0
2	54.00	1215.	2536.	5398.	9821.	19080.	30570.
	27.00	1082.	2391.	5175.	8036.	10959.	15125.
	18.00	1041.	2177.	4681.	7365.	10936.	14506.
	13.50	946.	2104.	4422.	6978.	10186.	13756.
	10.80	914.	1989.	4414.	6941.	9797.	12998.
	9.00	892.	1906.	4304.	6809.	9665.	12522.
	7.71	764.	1792.	4240.	6740.	9594.	12451.
	6.75	698.	1747.	3884.	6343.	9111.	11968.
	6.00	694.	1736.	3815.	6178.	8807.	11664.
	5.40	643.	1671.	3799.	5979.	8479.	11103.
7	54.00	1018.	2174.	5547.	15648.	28017.	44370.
	27.00	914.	2085.	4949.	8608.	14942.	25859.
	18.00	852.	1938.	4422.	7888.	13304.	25135.
	13.50	816.	1845.	4350.	7602.	11172.	24142.
	10.80	673.	1750.	4227.	7083.	10289.	17177.
	9.00	616.	1698.	4065.	6900.	9910.	14600.
	7.71	615.	1669.	4059.	6849.	9706.	13879.
	6.75	578.	1598.	3835.	6394.	9251.	13539.
	6.00	544.	1407.	3555.	6225.	9081.	13037.
	5.40	525.	1314.	3459.	6041.	8898.	12304.
9	54.00	1200.	2642.	9658.	21291.	34955.	55016.
	27.00	1131.	2538.	5483.	10854.	20354.	35470.
	18.00	1034.	2296.	5477.	10520.	18326.	33293.
	13.50	1025.	2182.	5063.	8635.	16111.	31809.
	10.80	939.	2159.	4863.	8341.	12293.	24574.
	9.00	913.	2101.	4836.	7922.	11373.	22241.
	7.71	869.	2093.	4793.	7650.	10978.	20504.
	6.75	826.	1892.	4570.	7429.	10921.	16552.
	6.00	804.	1883.	4325.	7183.	10684.	15955.
	5.40	800.	1881.	4232.	6982.	10478.	15116.

TABLE D-PJ- 1 OFFSTREAM STORAGE FREQUENCIES

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

OFFSTREAM STORAGE REQUIREMENTS (ACRE-FT)
FOR INTAKE/CONVEYANCE CAPACITY 5 X WATER DEMAND

SCENARIO	RECURRENCE	ANNUAL THROUGHPUT OF COAL SLURRY PIPELINE(MTY)					
#	INT.(YRS)	2.5	5.0	10.0	15.0	20.0	25.0
2	49.00	1012.	2061.	4340.	7188.	10047.	12906.
	24.50	836.	1813.	3986.	6751.	9549.	12348.
	16.33	775.	1775.	3955.	6443.	8914.	11413.
	12.25	714.	1629.	3915.	6414.	8906.	11406.
	9.80	686.	1562.	3749.	6235.	8736.	11237.
	8.17	626.	1518.	3581.	5892.	8392.	10892.
	7.00	625.	1366.	3370.	5707.	8207.	10708.
	6.13	625.	1349.	3238.	5326.	7682.	10183.
	5.44	565.	1284.	3172.	5287.	7556.	10056.
	4.90	506.	1160.	2863.	4849.	6886.	8970.
7	49.00	677.	1539.	3685.	5828.	8323.	13660.
	24.50	644.	1359.	3483.	5762.	8262.	13543.
	16.33	614.	1328.	3370.	5651.	8150.	10649.
	12.25	530.	1245.	2684.	5106.	7607.	10317.
	9.80	313.	1028.	2555.	4882.	7417.	10176.
	8.17	222.	896.	2529.	4822.	7322.	10006.
	7.00	195.	861.	2483.	4630.	7101.	9600.
	6.13	158.	849.	2456.	4601.	7009.	9509.
	5.44	46.	738.	2211.	4297.	6744.	9244.
	4.90	28.	687.	2124.	4178.	6316.	8587.
9	49.00	934.	2007.	4751.	8141.	14701.	25404.
	24.50	828.	1887.	4494.	7296.	12322.	18207.
	16.33	815.	1886.	4363.	7044.	11462.	16552.
	12.25	678.	1739.	4252.	6805.	9579.	14832.
	9.80	629.	1701.	4212.	6718.	9219.	14178.
	8.17	583.	1613.	4069.	6571.	9071.	12047.
	7.00	582.	1571.	3950.	6455.	8956.	11456.
	6.13	554.	1527.	3740.	6243.	8744.	11243.
	5.44	551.	1408.	3726.	6231.	8731.	11231.
	4.90	494.	1313.	3340.	5496.	7905.	10411.

TABLE D-PJ- 2 OFFSTREAM STORAGE FREQUENCIES

POWELL RIVER NEAR JONESVILLE,VA 03.5315.00

OFFSTREAM STORAGE REQUIREMENTS (ACRE-FT)
FOR INTAKE/CONVEYANCE CAPACITY 10 X WATER DEMAND

SCENARIO	RECURRENCE	ANNUAL THROUGHPUT OF COAL SLURRY PIPELINE(MTY)					
#	INT.(YRS)	2.5	5.0	10.0	15.0	20.0	25.0
2	49.00	990.	2063.	4334.	7194.	10052.	12908.
	24.50	742.	1776.	3945.	6577.	9378.	12235.
	16.33	714.	1772.	3918.	6415.	8914.	11413.
	12.25	714.	1579.	3908.	6408.	8907.	11406.
	9.80	686.	1486.	3737.	6240.	8740.	11240.
	8.17	613.	1439.	3570.	5894.	8394.	10893.
	7.00	602.	1319.	3373.	5710.	8210.	10710.
	6.13	587.	1305.	3185.	5330.	7685.	10184.
	5.44	504.	1199.	3147.	5292.	7559.	10058.
	4.90	446.	1162.	2601.	4627.	6760.	8902.
7	49.00	678.	1543.	3687.	5829.	8324.	12369.
	24.50	644.	1363.	3488.	5764.	8263.	12210.
	16.33	614.	1329.	3370.	5651.	8150.	10650.
	12.25	531.	1256.	2689.	5108.	7608.	10317.
	9.80	314.	1039.	2557.	4884.	7383.	9934.
	8.17	182.	902.	2534.	4823.	7322.	9822.
	7.00	147.	877.	2489.	4632.	7102.	9601.
	6.13	135.	865.	2459.	4602.	7010.	9509.
	5.44	24.	742.	2172.	4299.	6745.	9244.
	4.90	0.	696.	2128.	4175.	6317.	8460.
9	49.00	936.	2010.	4761.	7618.	11905.	21210.
	24.50	816.	1898.	4414.	7271.	10876.	16915.
	16.33	815.	1887.	4366.	7046.	9903.	13400.
	12.25	679.	1753.	4262.	6763.	9303.	12810.
	9.80	630.	1713.	4221.	6722.	9222.	11865.
	8.17	583.	1621.	4072.	6572.	9071.	11571.
	7.00	583.	1577.	3957.	6458.	8957.	11457.
	6.13	554.	1519.	3745.	6245.	8745.	11244.
	5.44	541.	1403.	3733.	6233.	8733.	11232.
	4.90	487.	1207.	3281.	5425.	7668.	10280.

APPENDIX E

STREAM WHITDRAWAL PARTIAL-DURATION LOW-FLOW FREQUENCIES (FIGURES)

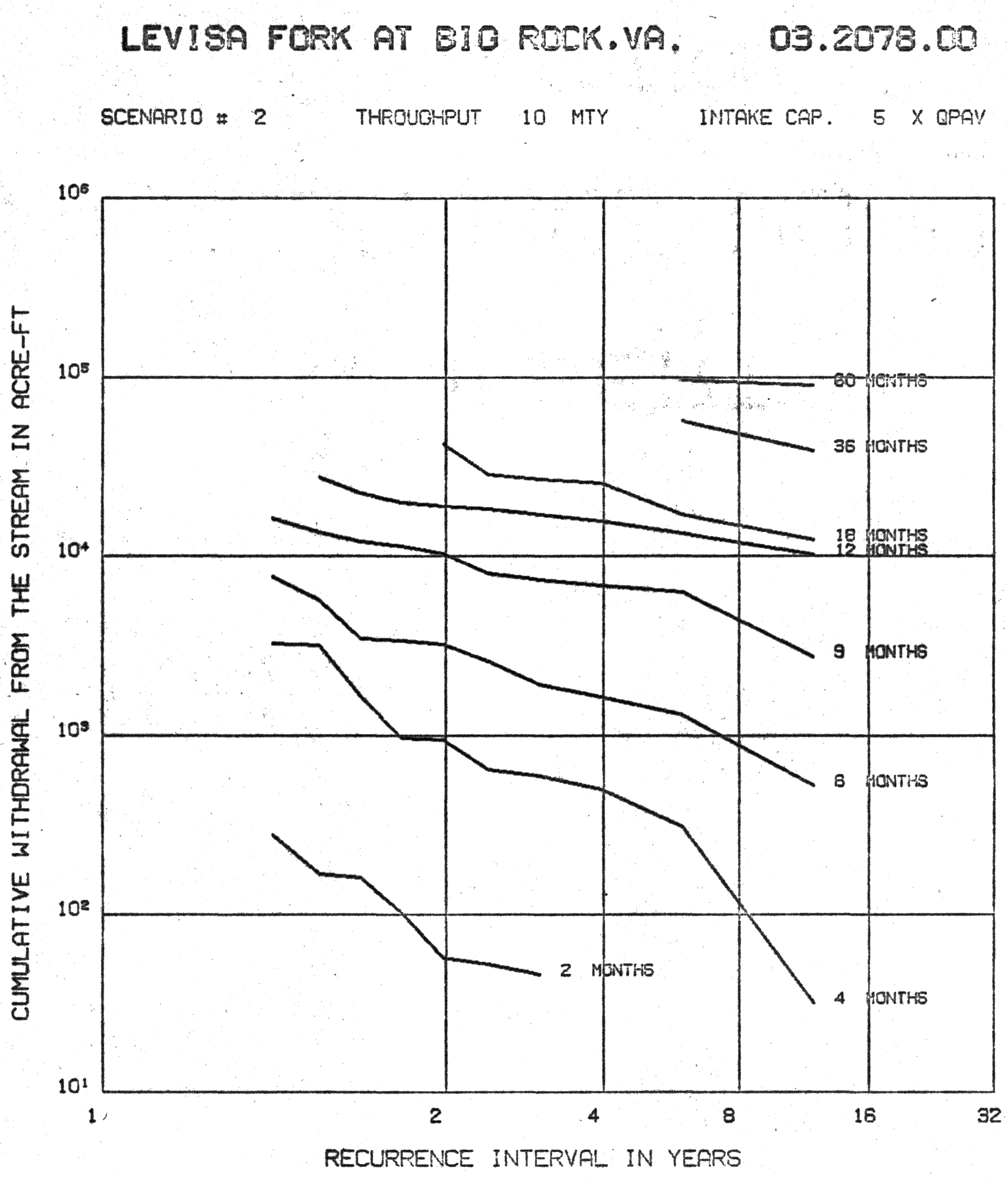


FIGURE E-L2-1 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

LEVISA FORK AT BIG ROCK.VA. 03.2078.00

SCENARIO # 7 THROUGHPUT 10 MTY INTAKE CAP. 5 X QPAV

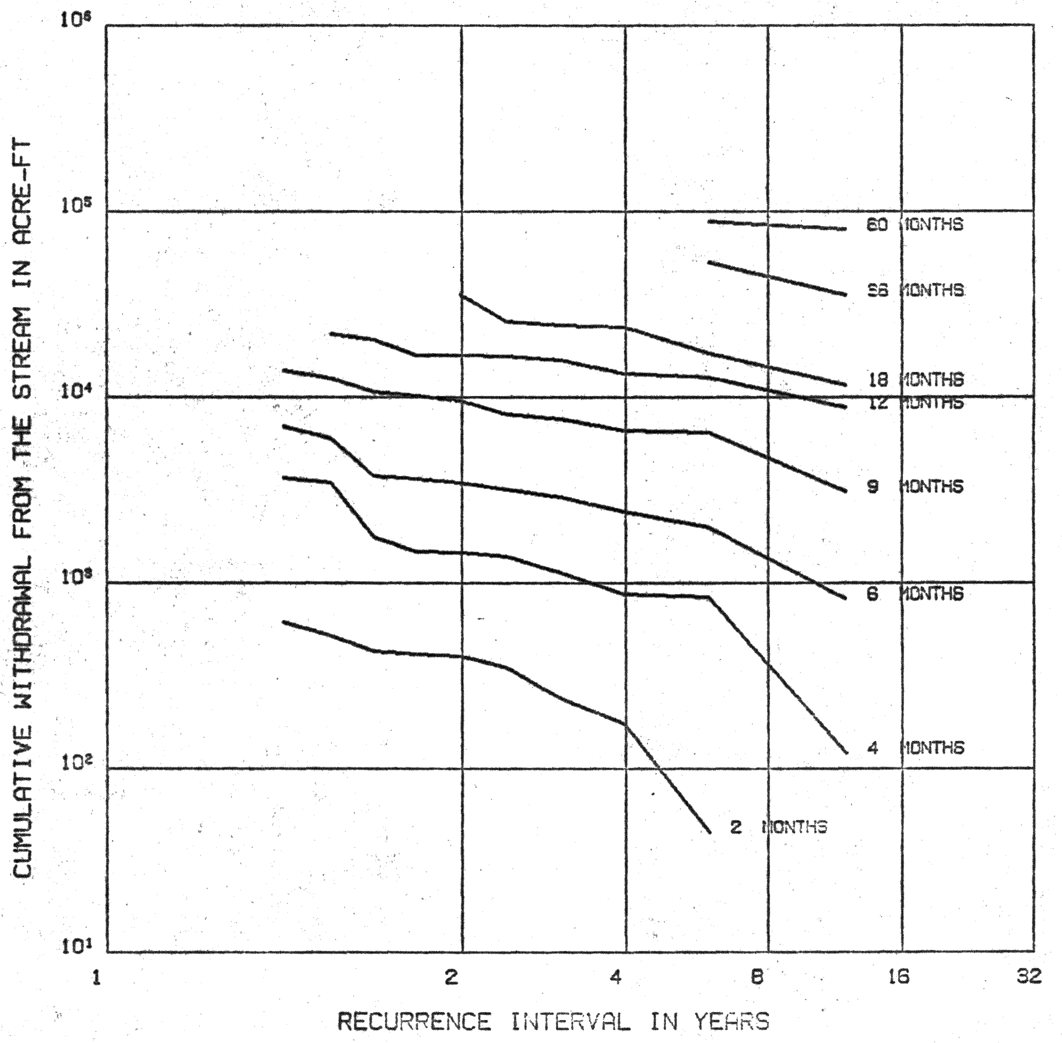
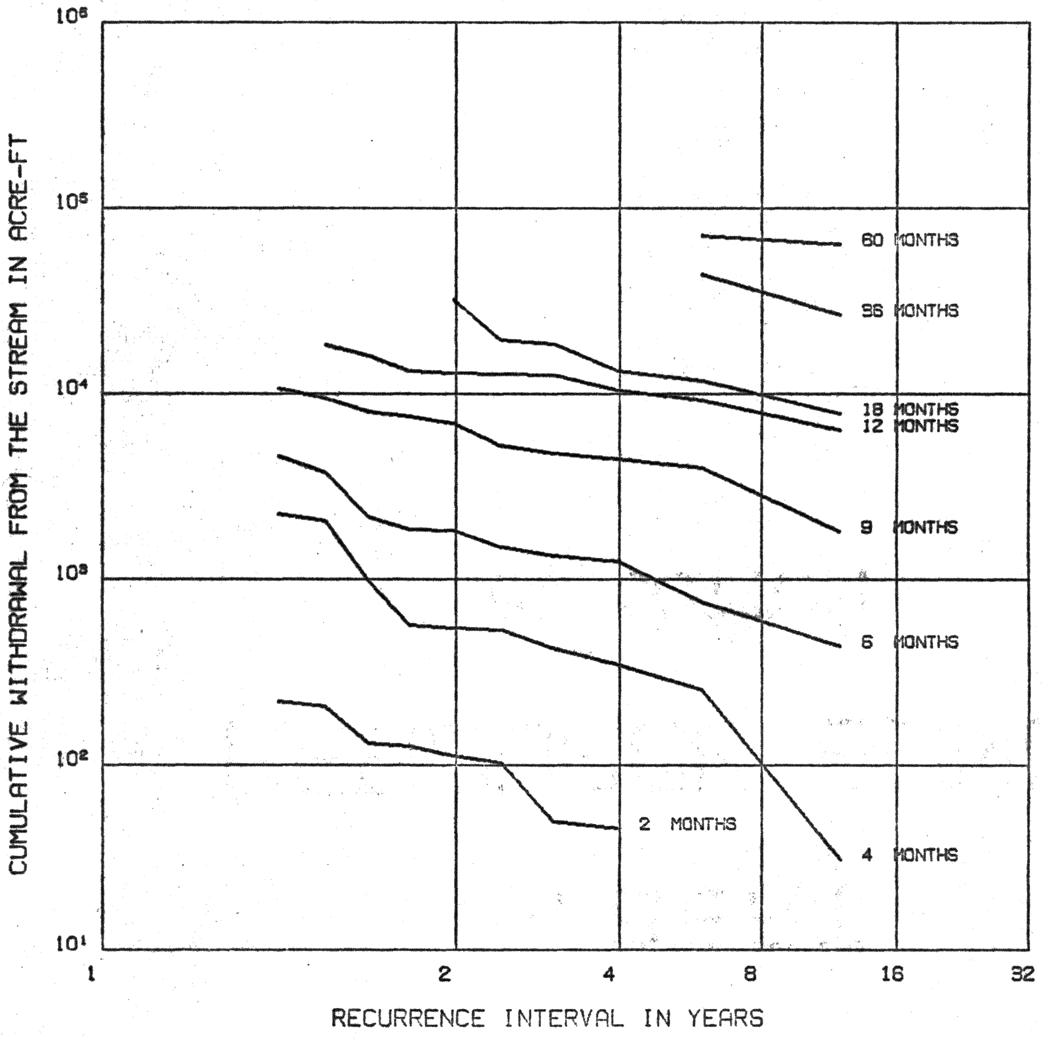


FIGURE E-L2-2 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES



LEVISA FORK AT BIG ROCK,VA. 03.2078.00

SCENARIO # 9 THROUGHPUT 10 MTY INTAKE CAP. 5 X QPAV

FIGURE E-L2-3 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

LEVISA FORK AT BIG ROCK,VA.   03.2078.00

SCENARIO # 2   THROUGHPUT 10 MTY   INTAKE CAP. 10 X QPAV

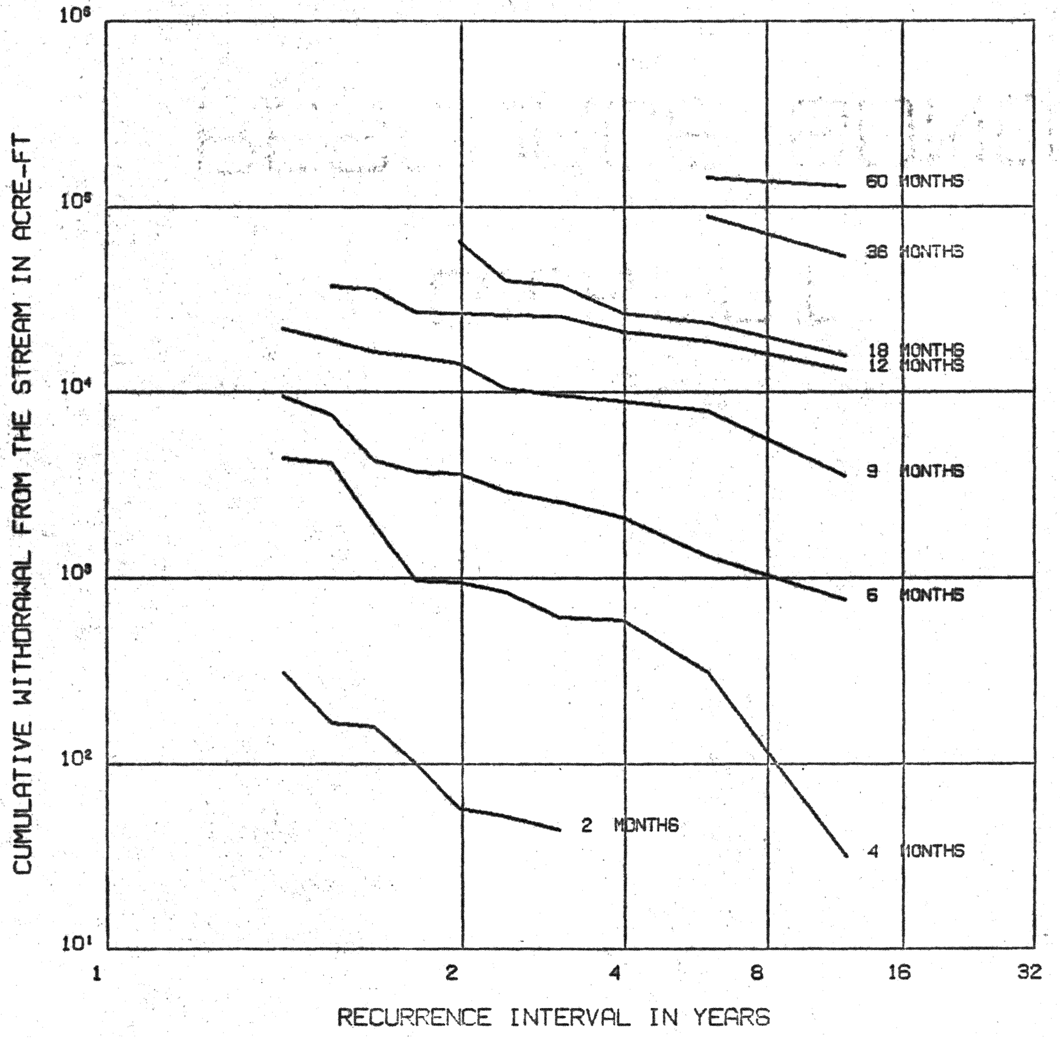


FIGURE E-L2-4 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

LEVISA FORK AT BIG ROCK.VA.   03.2078.00

SCENARIO # 7   THROUGHPUT 10 MTY   INTAKE CAP. 10 X QPAV

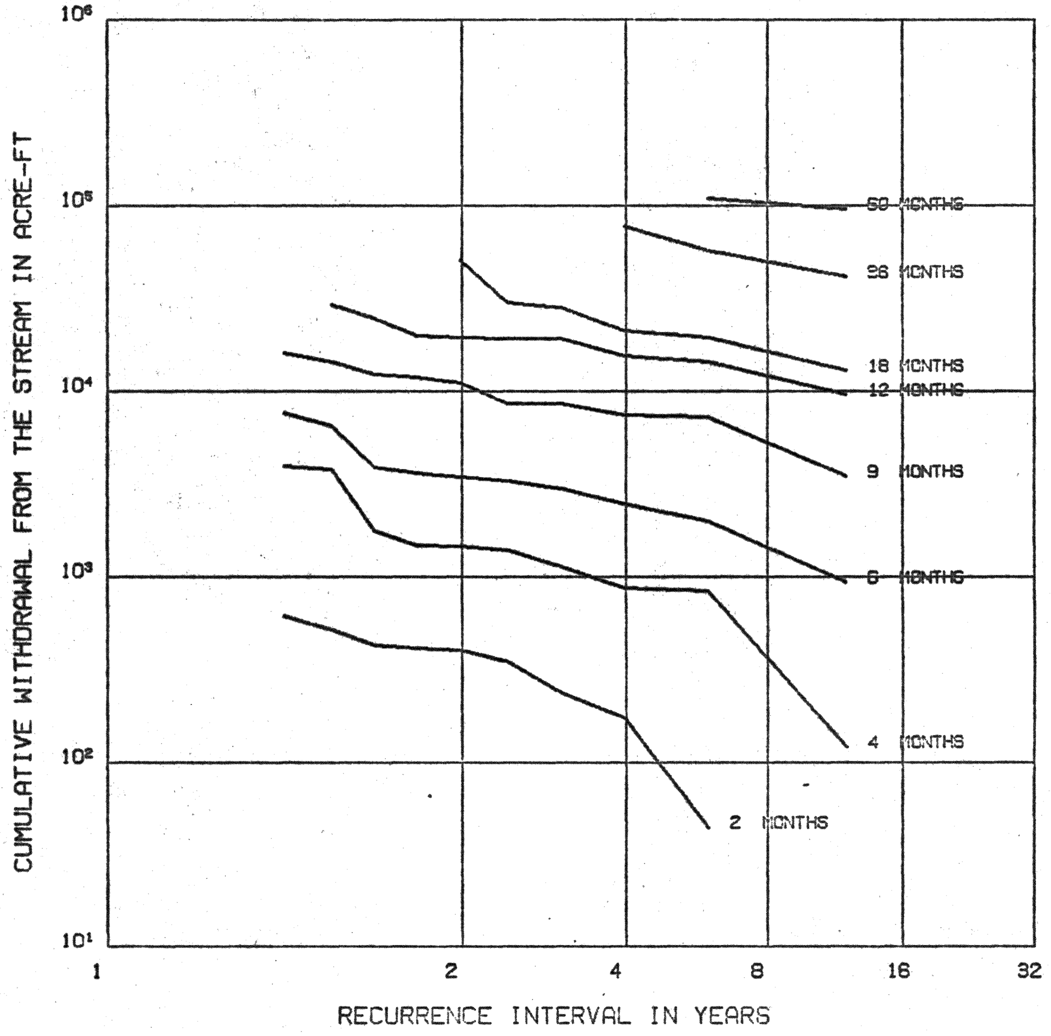


FIGURE E-L2-5 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

LEVISA FORK AT BIG ROCK,VA.   03.2078.00

SCENARIO # 9   THROUGHPUT 10 MTY   INTAKE CAP. 10 X QPAV

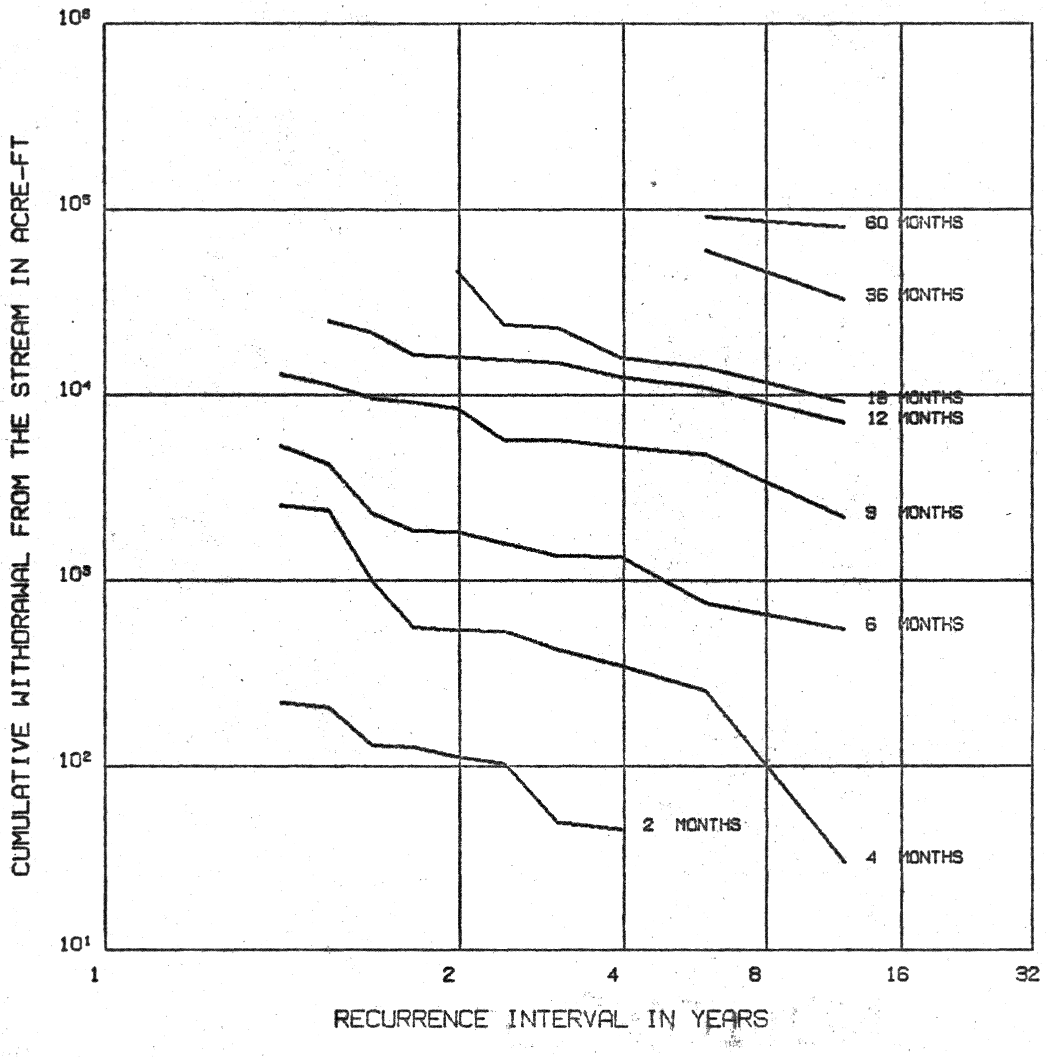


FIGURE E-L2-6 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

RUSSELL FORK AT HAYSI.VA. 03.2085.00

SCENARIO # 2 THROUGHPUT 10 MTY INTAKE CAP. 5 X QPAV

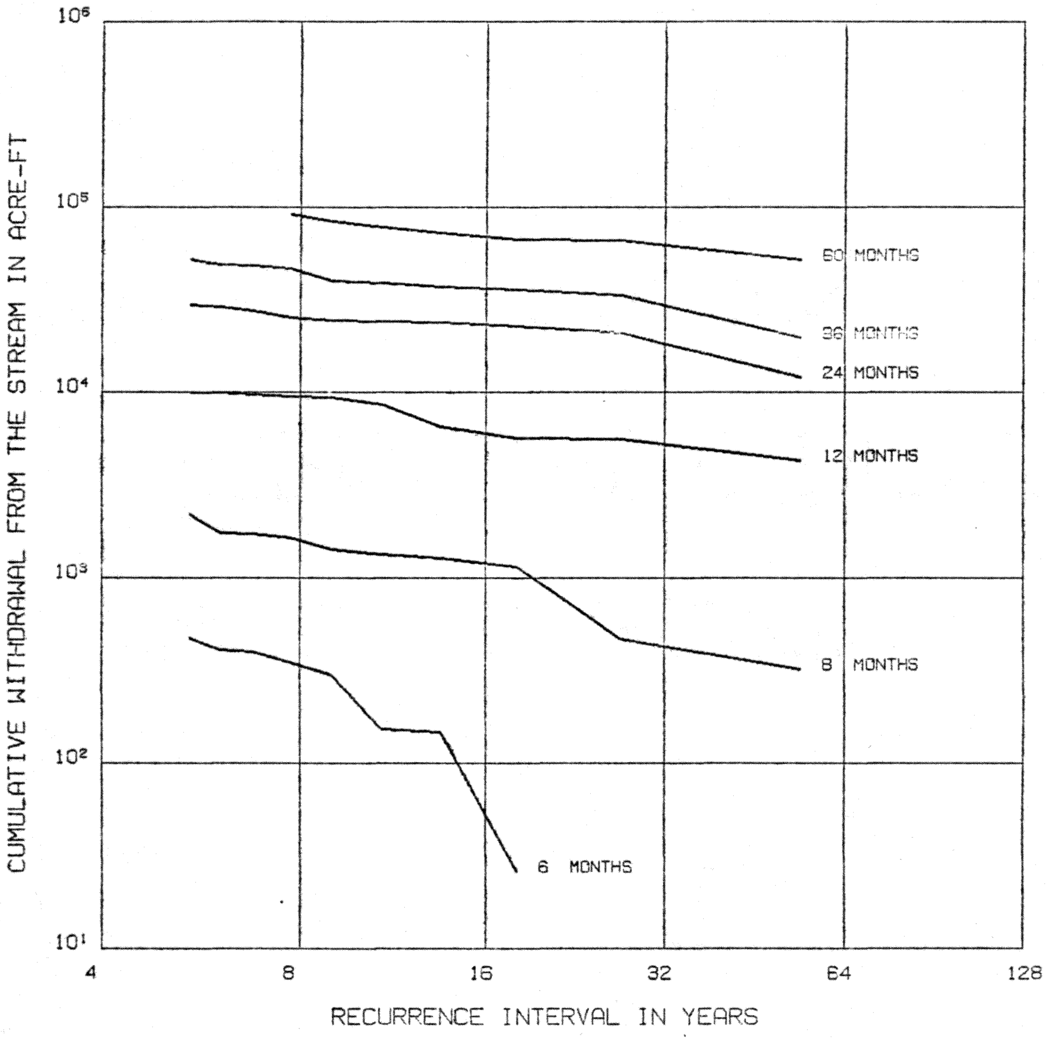


FIGURE E-HY-1 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

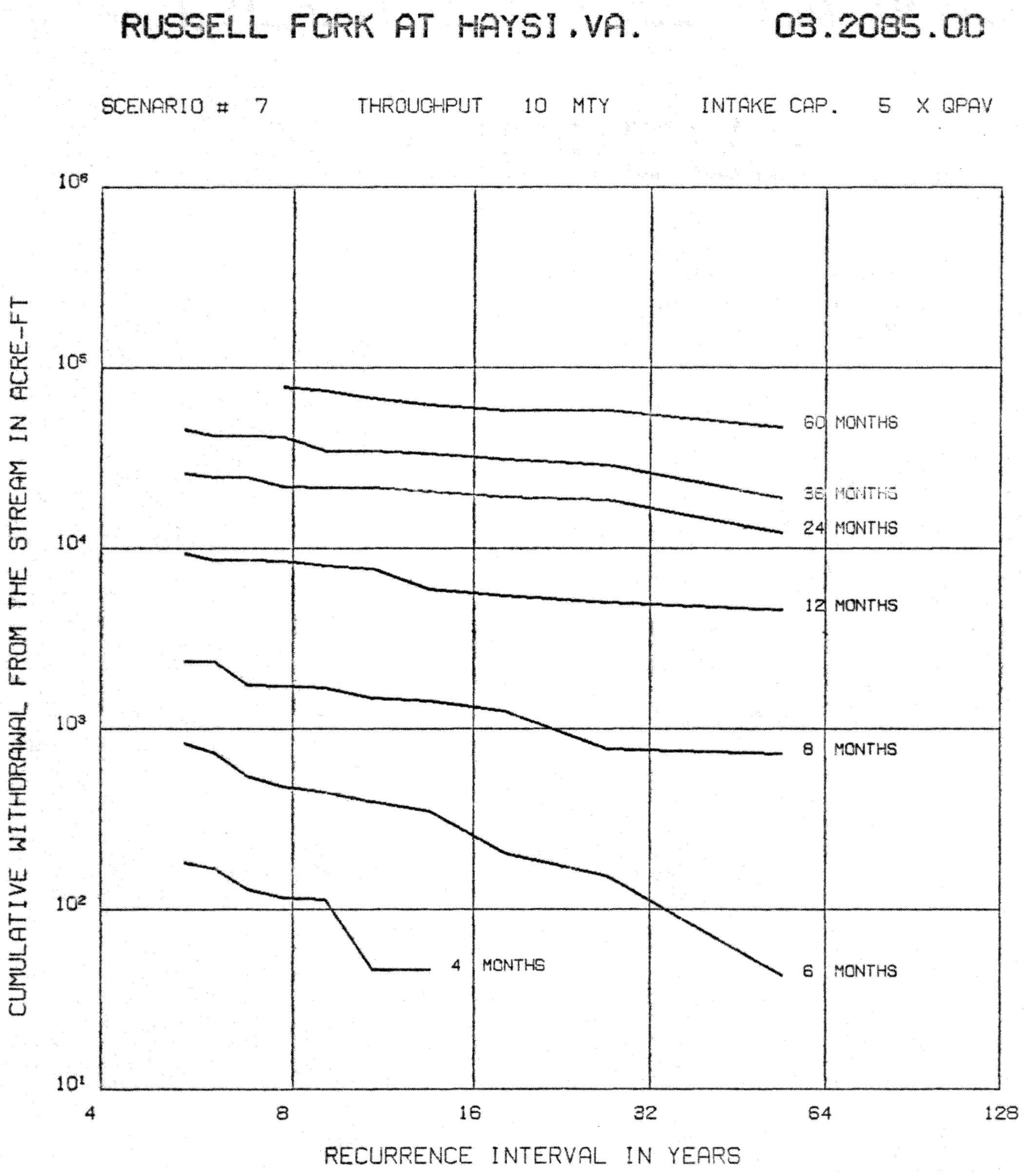


FIGURE E-HY-2 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

RUSSELL FORK AT HAYSI, VA.   03.2085.00

SCENARIO # 9   THROUGHPUT 10 MTY   INTAKE CAP. 5 X QPAV

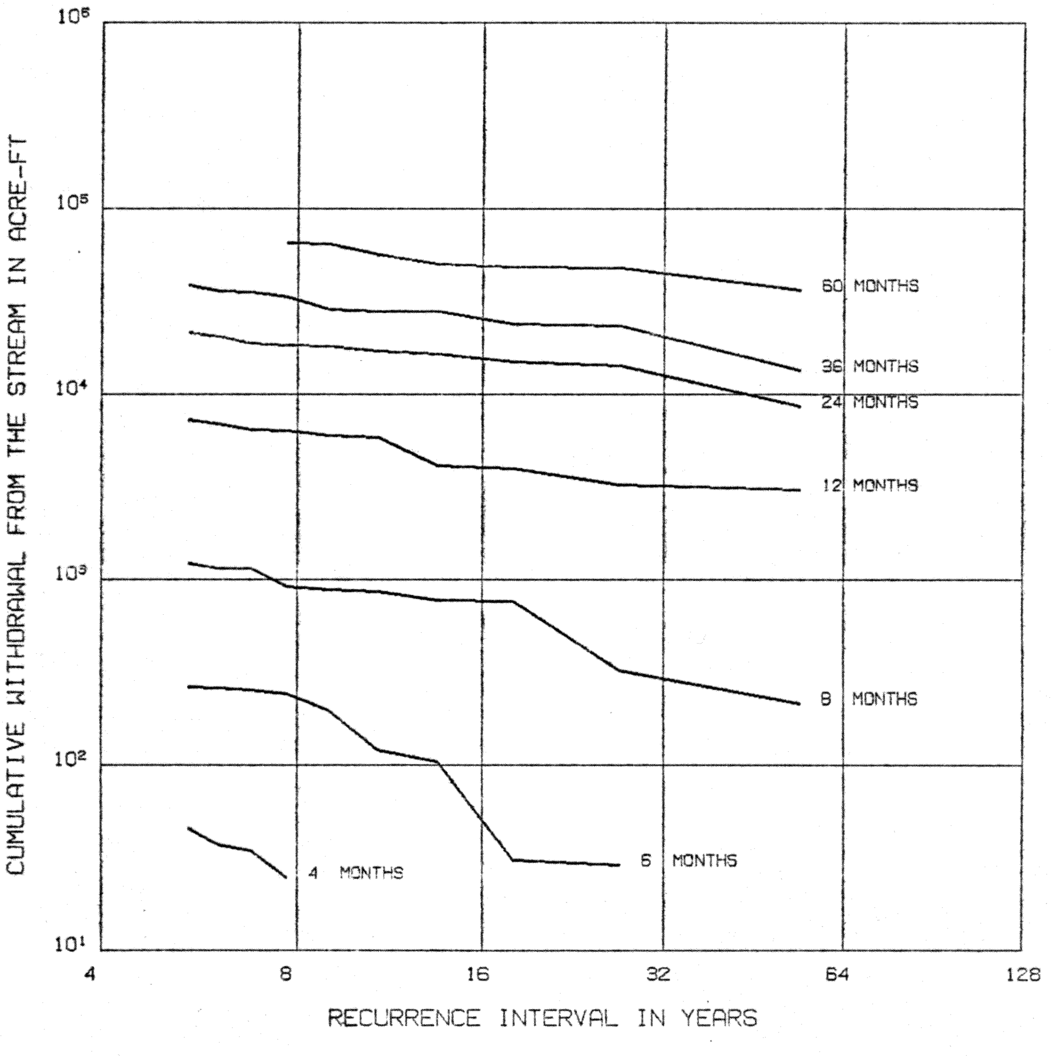


FIGURE E-HY-3 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

RUSSELL FORK AT HAYSI.VA. 03.2085.00

SCENARIO # 2 THROUGHPUT 10 MTY INTAKE CAP. 10 X QPAV

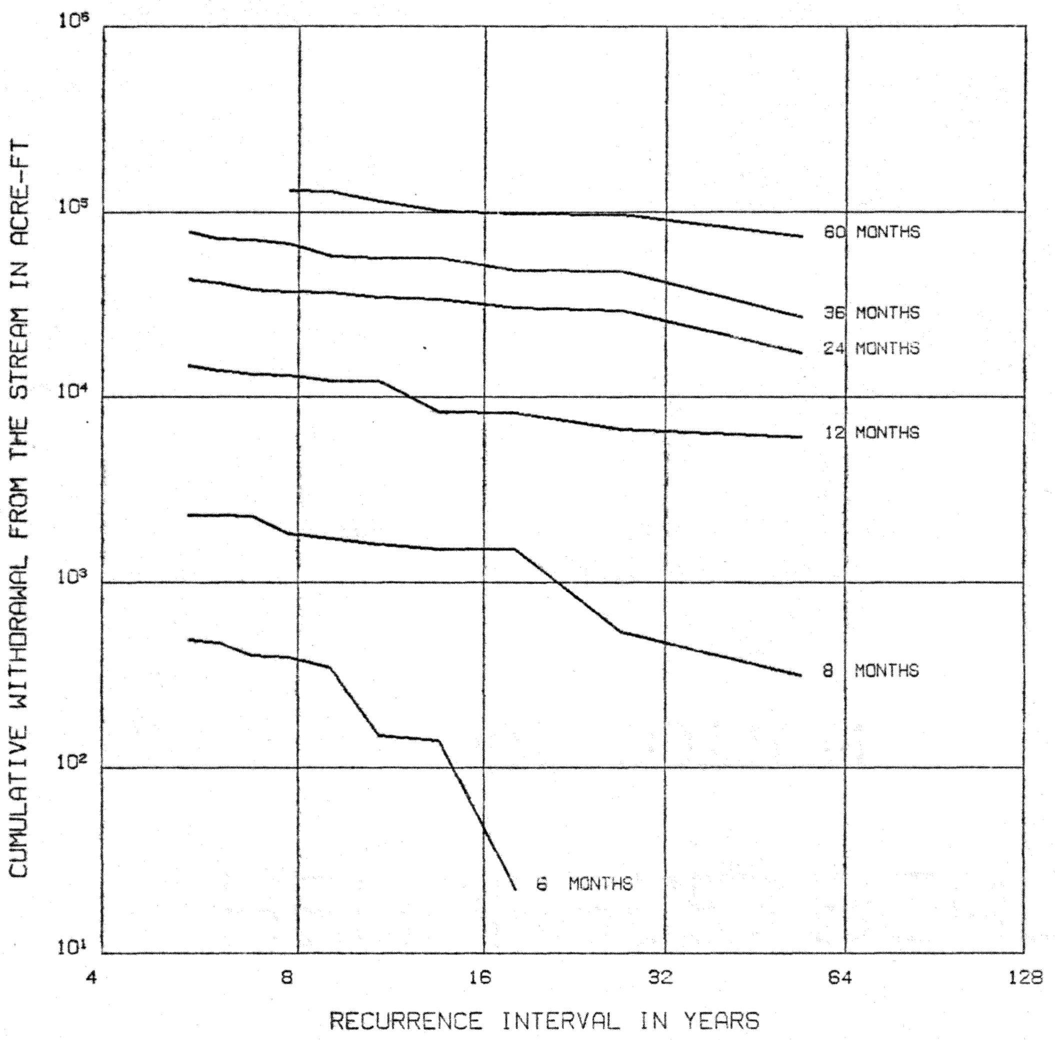


FIGURE E-HY-4 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

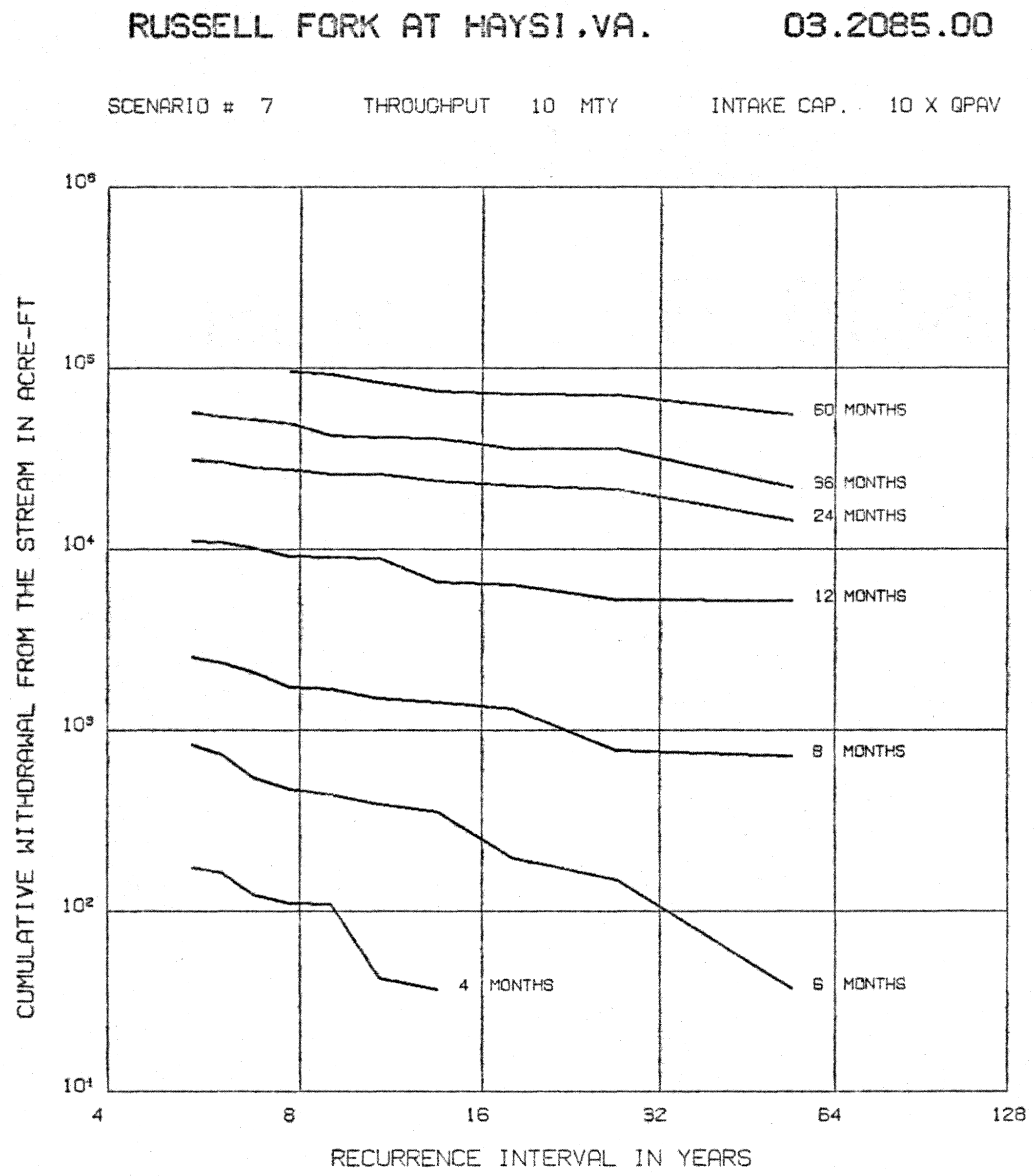


FIGURE E-HY-5 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

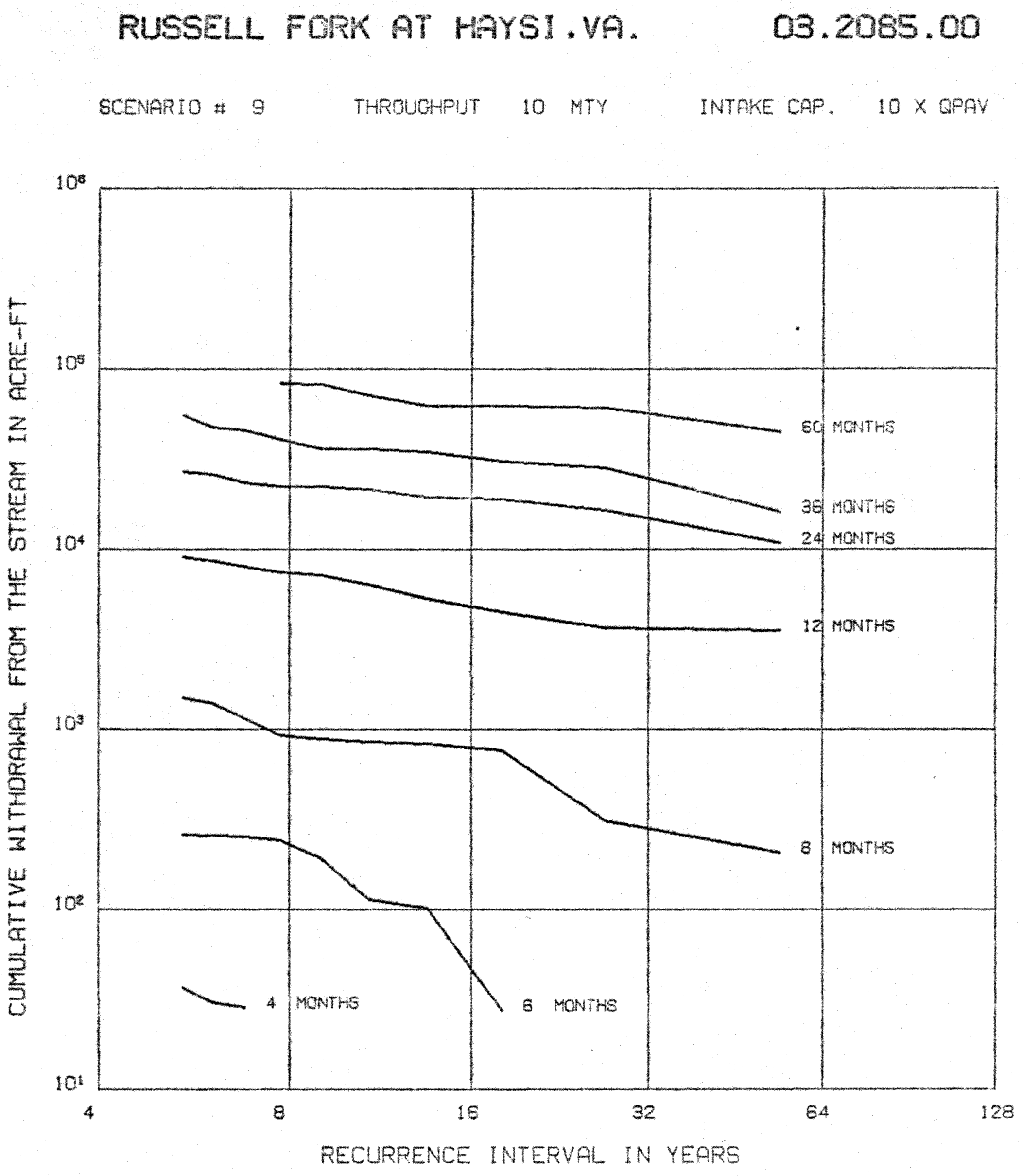


FIGURE E-HY-6 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO # 1 THROUGHPUT 10 MTY INTAKE CAP. 5 X QPAV

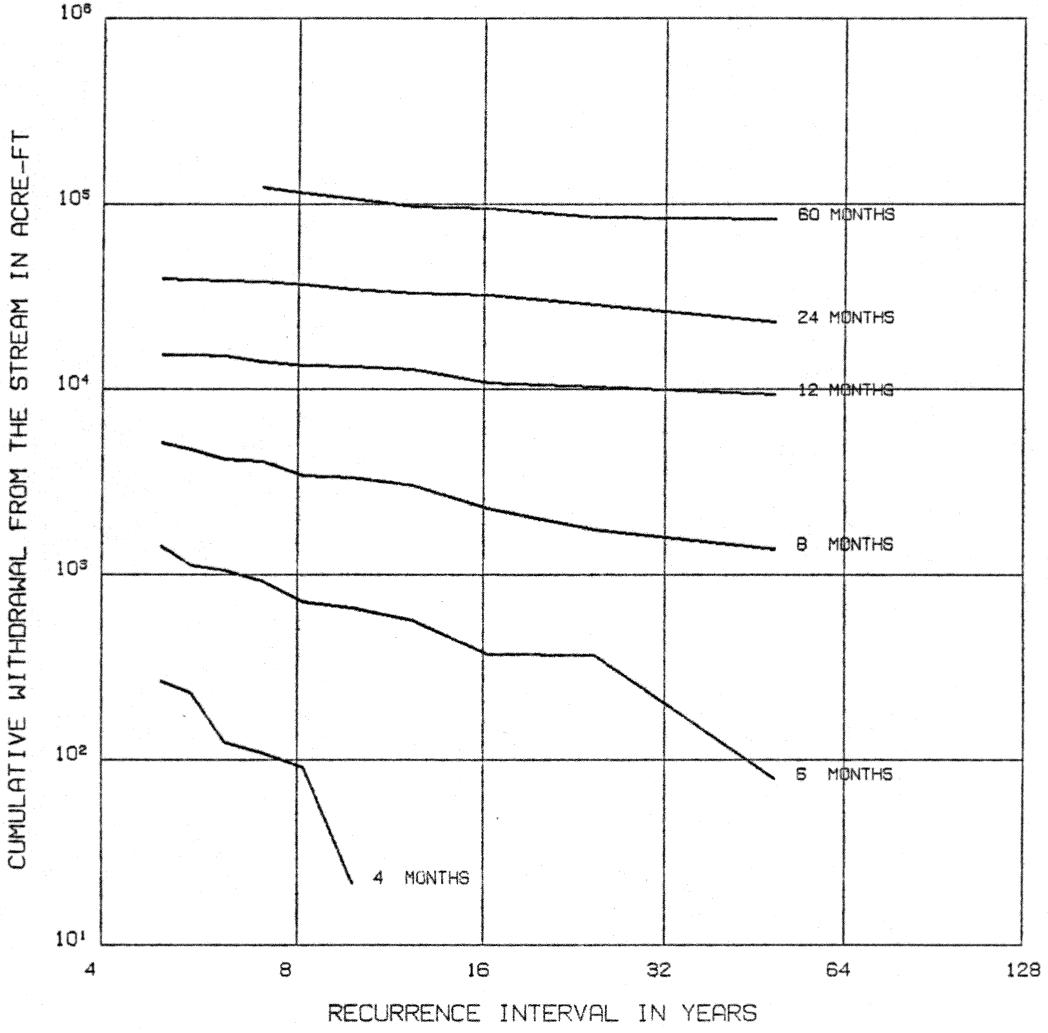


FIGURE E-PJ-1 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

POWELL RIVER NEAR JONESVILLE, 03.5315.00

SCENARIO # 2 THROUGHPUT 10 MTY INTAKE CAP. 5 X QPAV

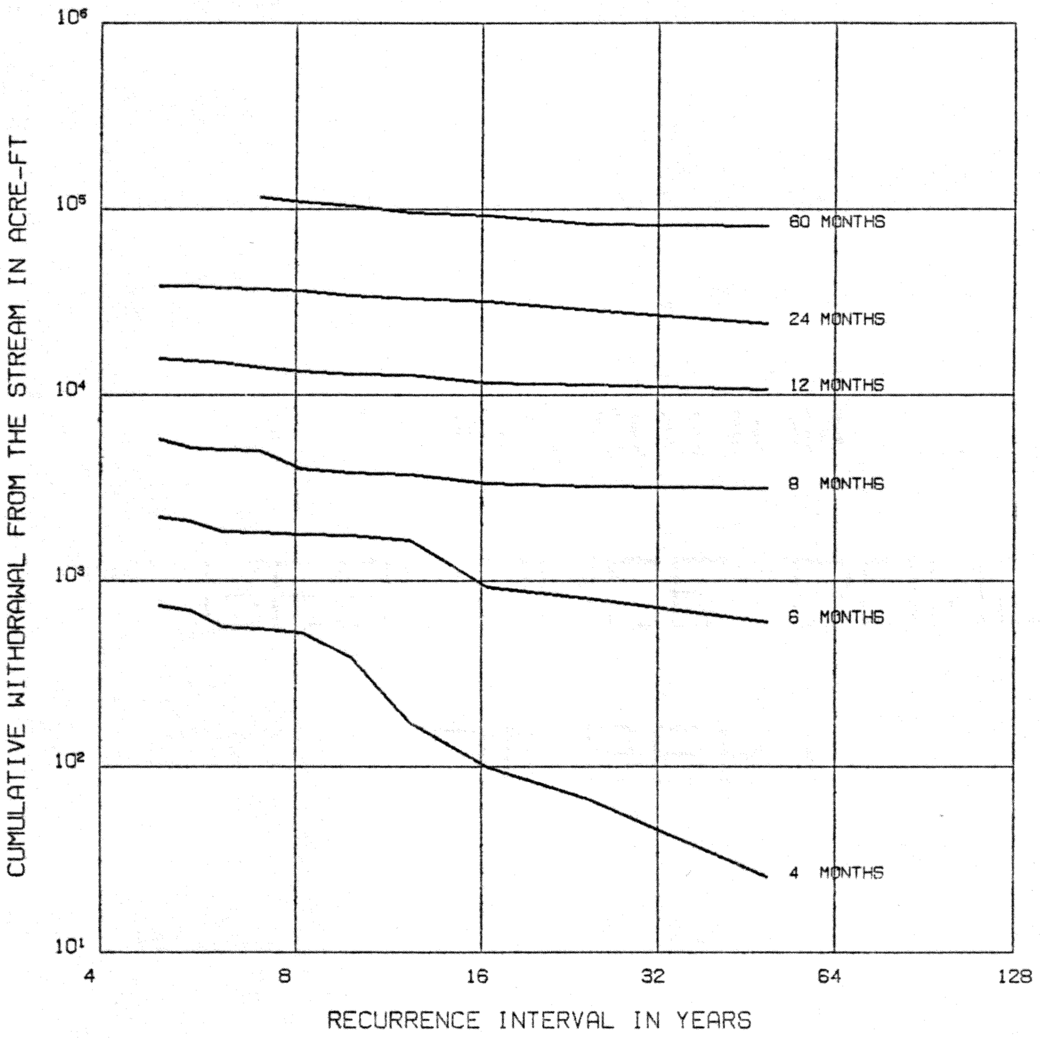


FIGURE E-PJ-2 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

POWELL RIVER NEAR JONESVILLE, 03.5315.00

SCENARIO # 3 THROUGHPUT 10 MTY INTAKE CAP. 5 X QPAV

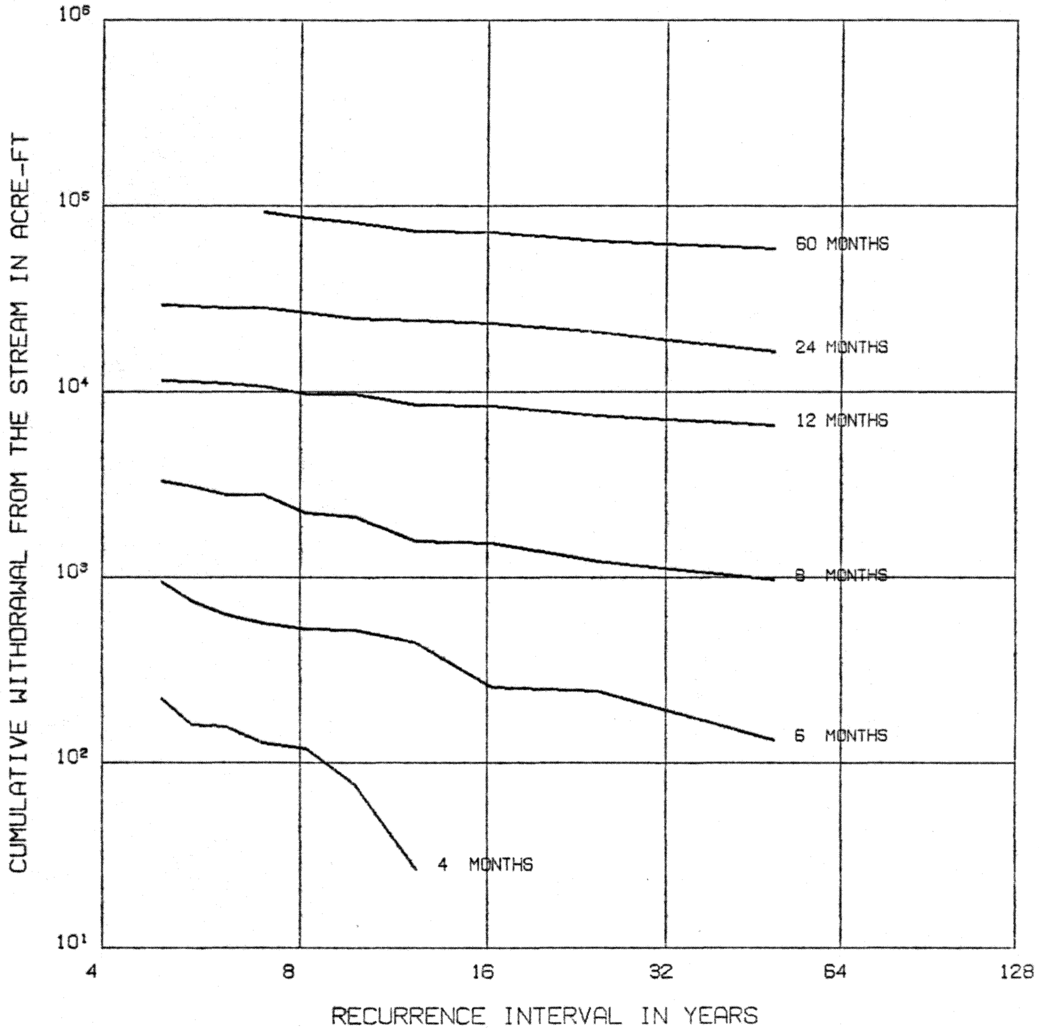


FIGURE E-PJ-3 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

POWELL RIVER NEAR JONESVILLE. 03.5315.00

SCENARIO # 1 THROUGHPUT 10 MTY INTAKE CAP. 10 X QPAV

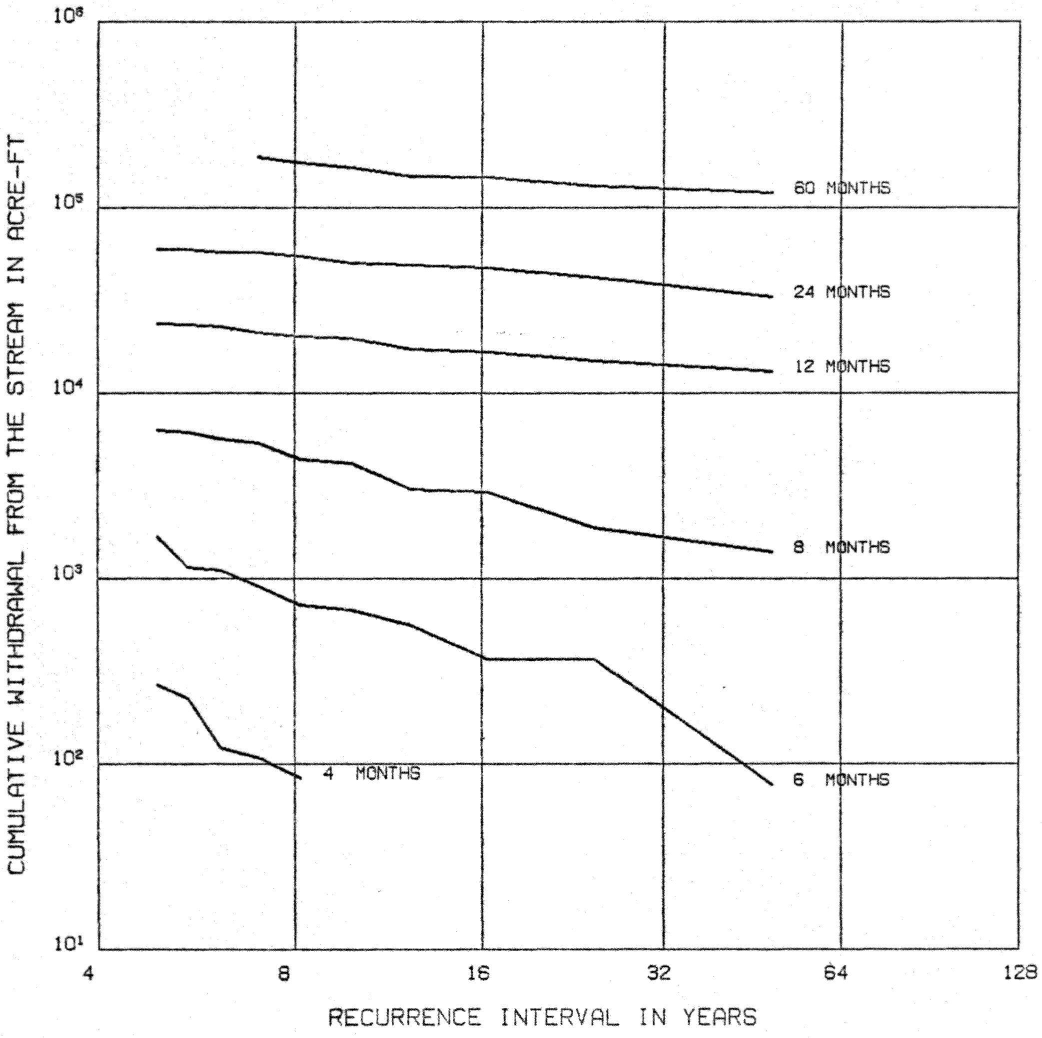


FIGURE E-PJ-4 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

POWELL RIVER NEAR JONESVILLE, 03.5315.00

SCENARIO # 2 THROUGHPUT 10 MTY INTAKE CAP. 10 X QPAV

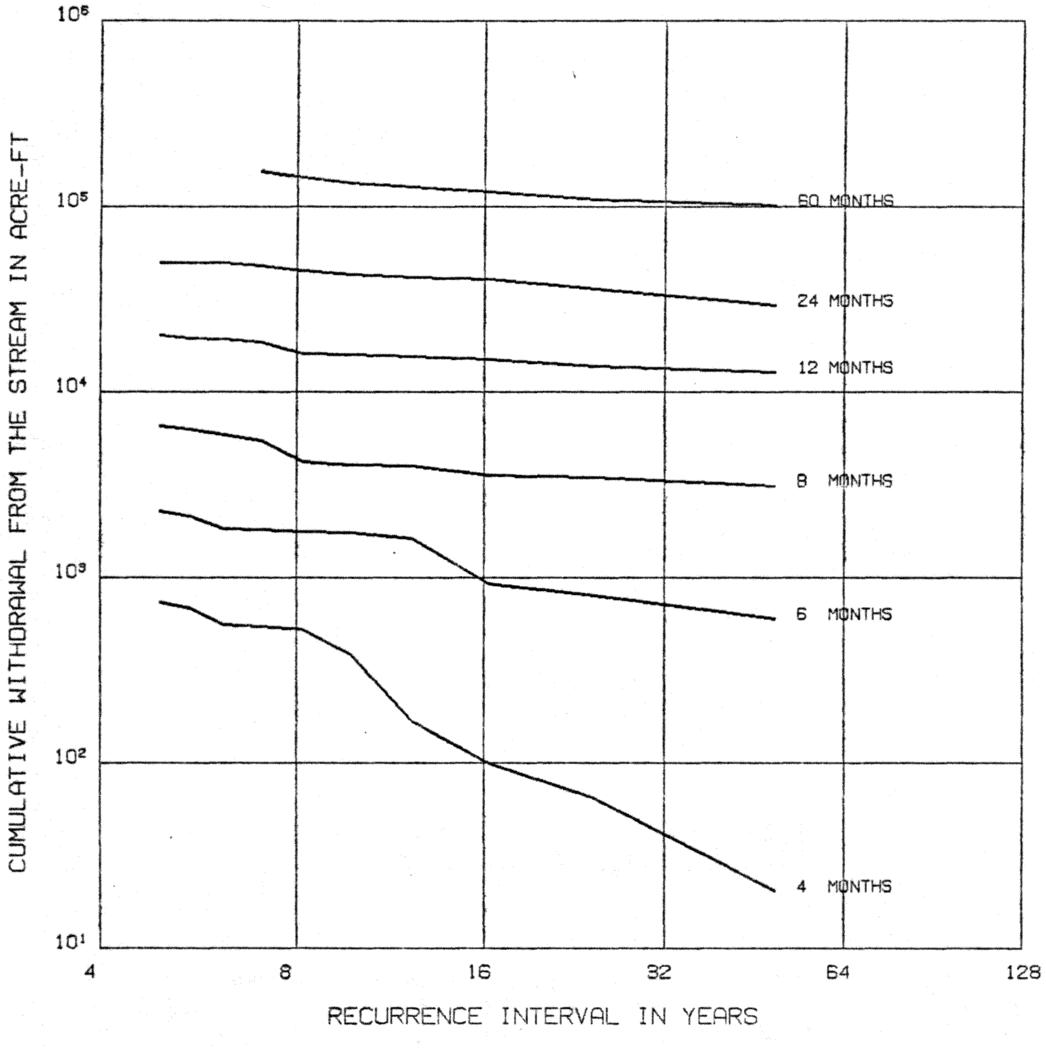


FIGURE E-PJ-5 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

POWELL RIVER NEAR JONESVILLE, 03.5315.00

SCENARIO # 3 THROUGHPUT 10 MTY INTAKE CAP. 10 X QPAV

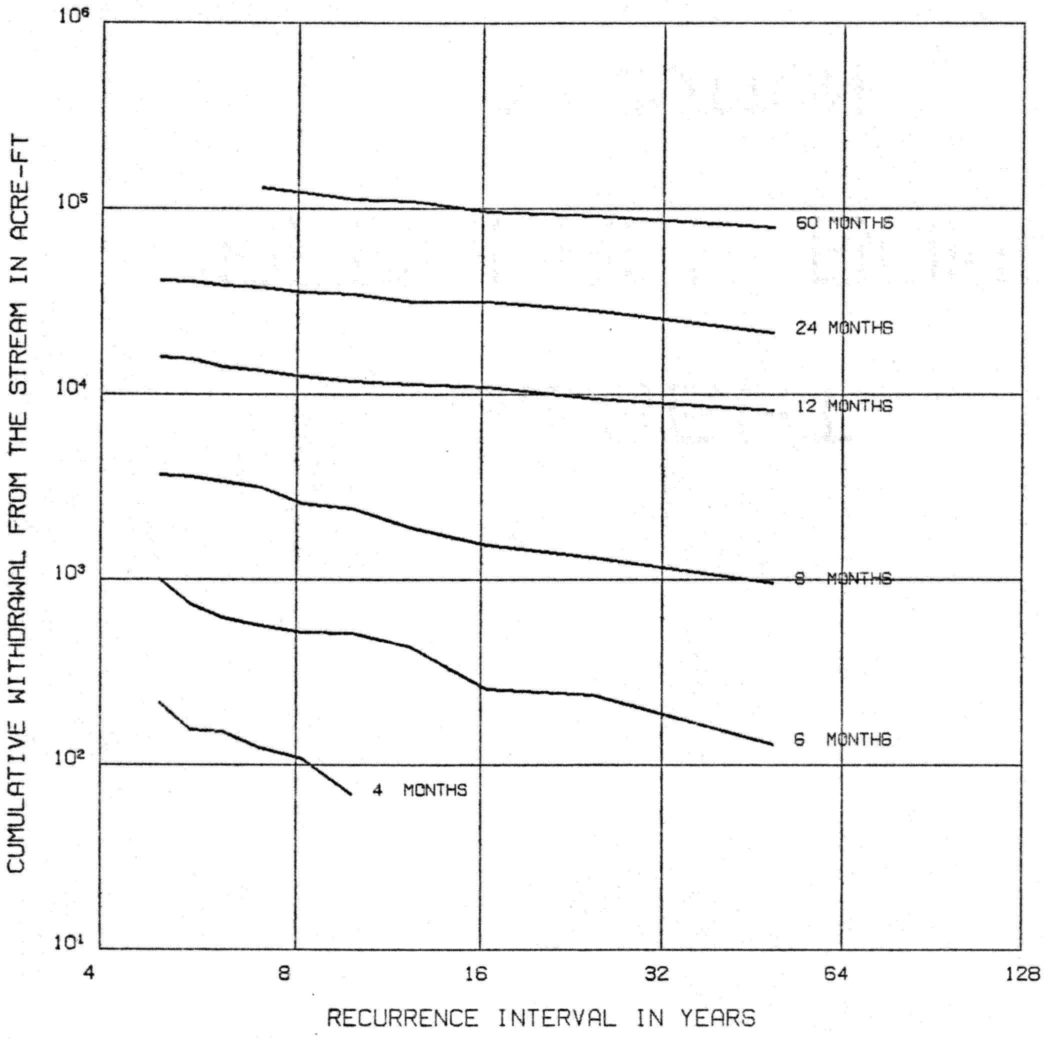


FIGURE E-PJ-6 STREAM WITHDRAWAL PARTIAL-DURATION FREQUENCIES

APPENDIX F

OFFSTREAM RESERVOIRS FREQUENCIES (FIGURES)

LEVISA FORK AT BIG ROCK, VA.   03.2078.00

SCENARIO # 2   INTAKE CAP. 10 X QPAV

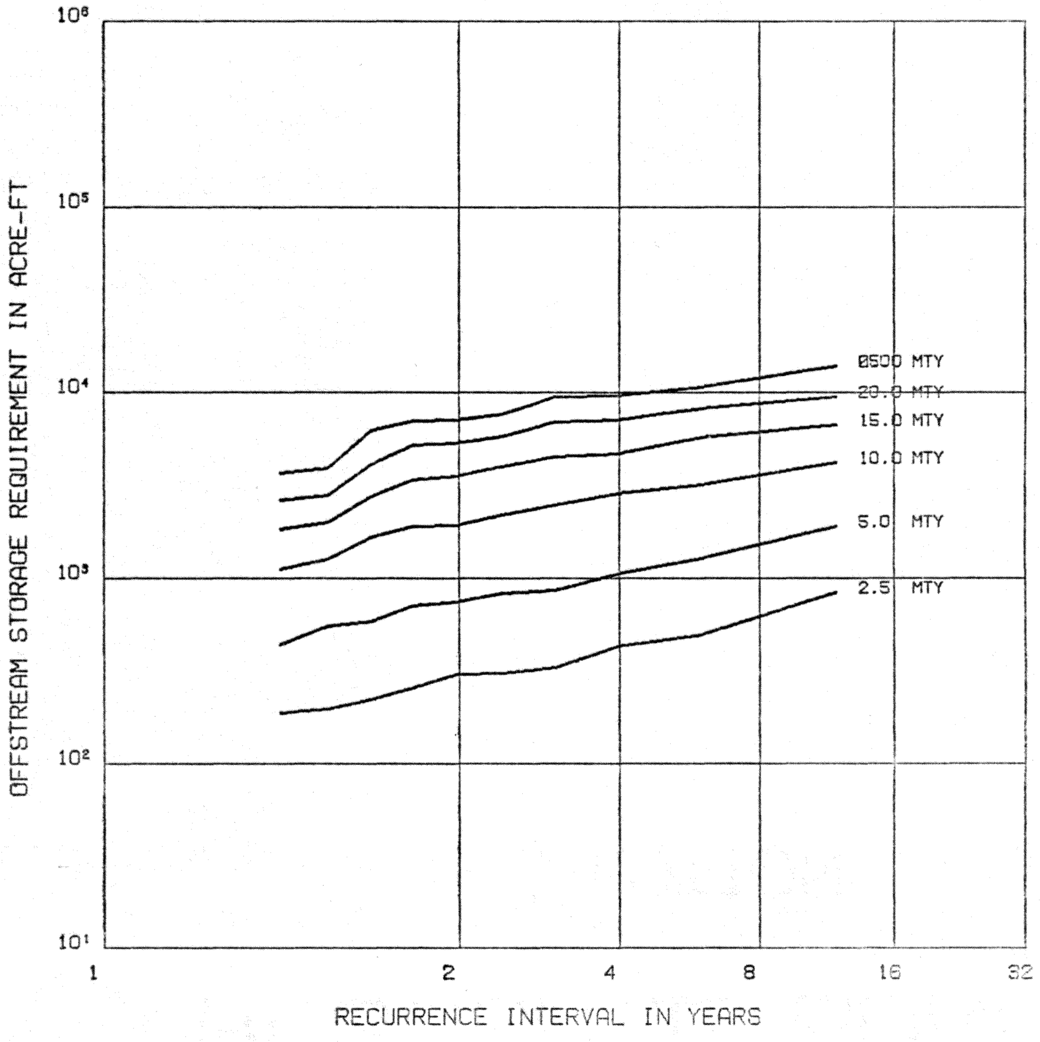


FIGURE F-L2-1 OFFSTREAM STORAGE FREQUENCIES

LEVISA FORK AT BIG ROCK.VA.   03.2078.00

SCENARIO # 7   INTAKE CAP. 10 X QPAV

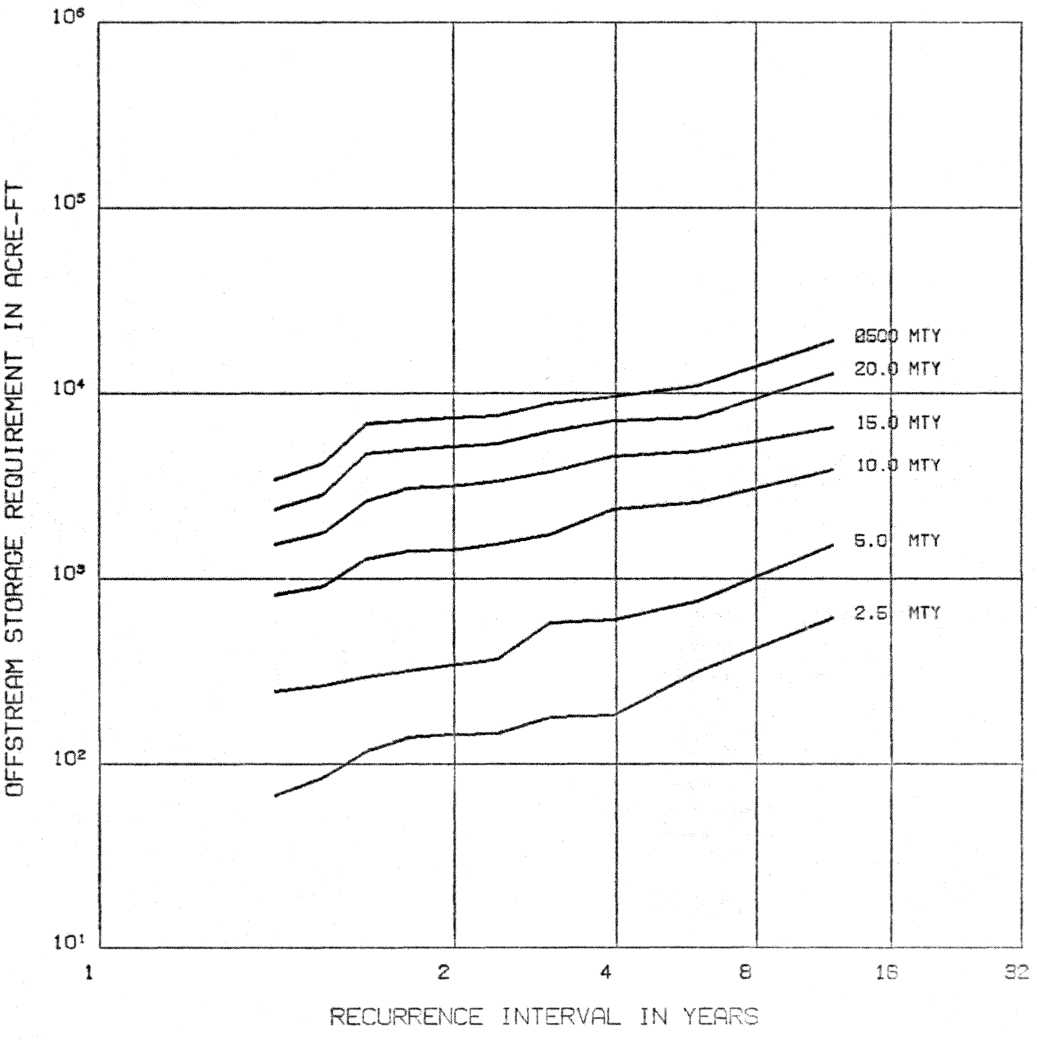


FIGURE F-L2-2 OFFSTREAM STORAGE FREQUENCIES

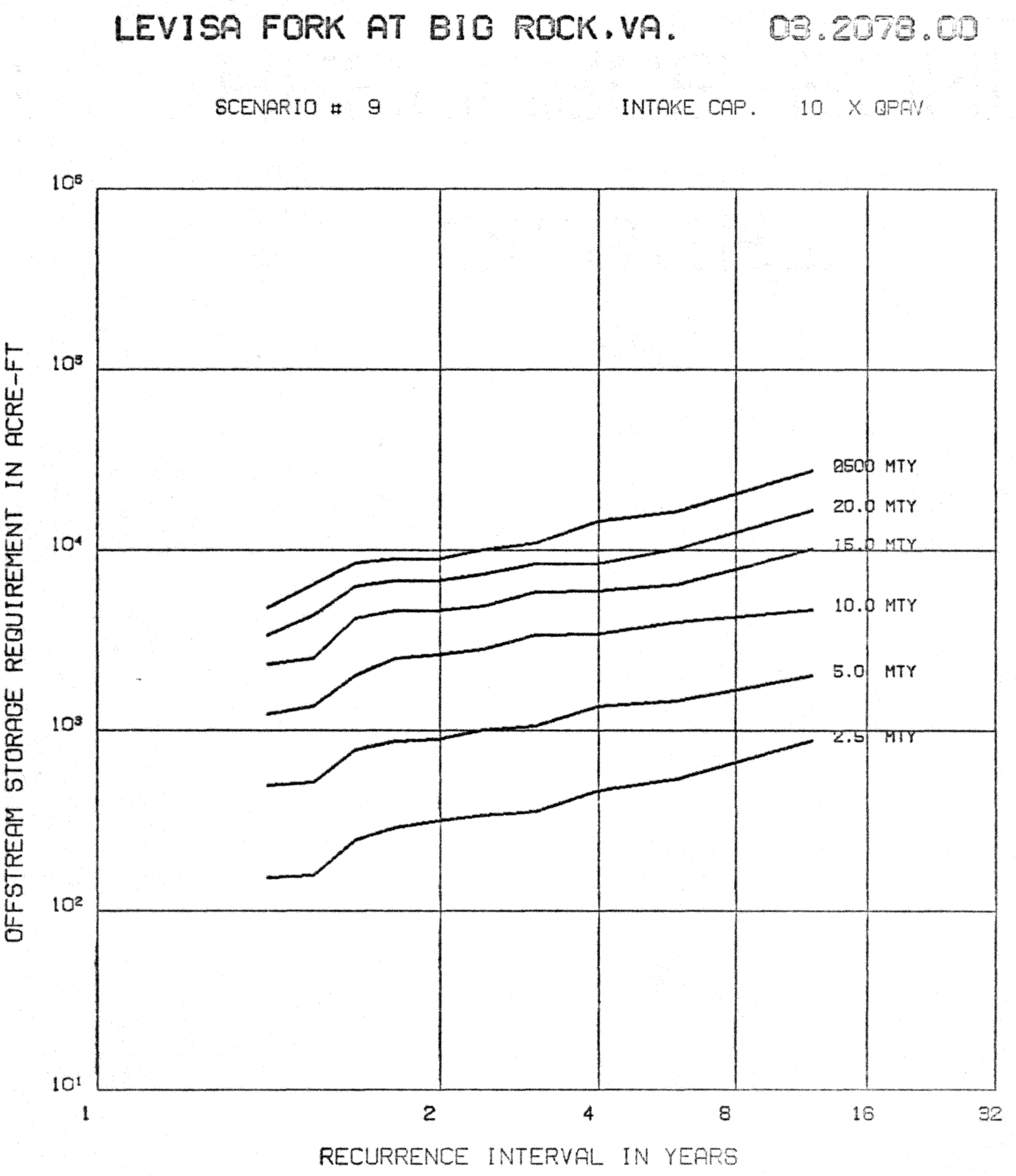
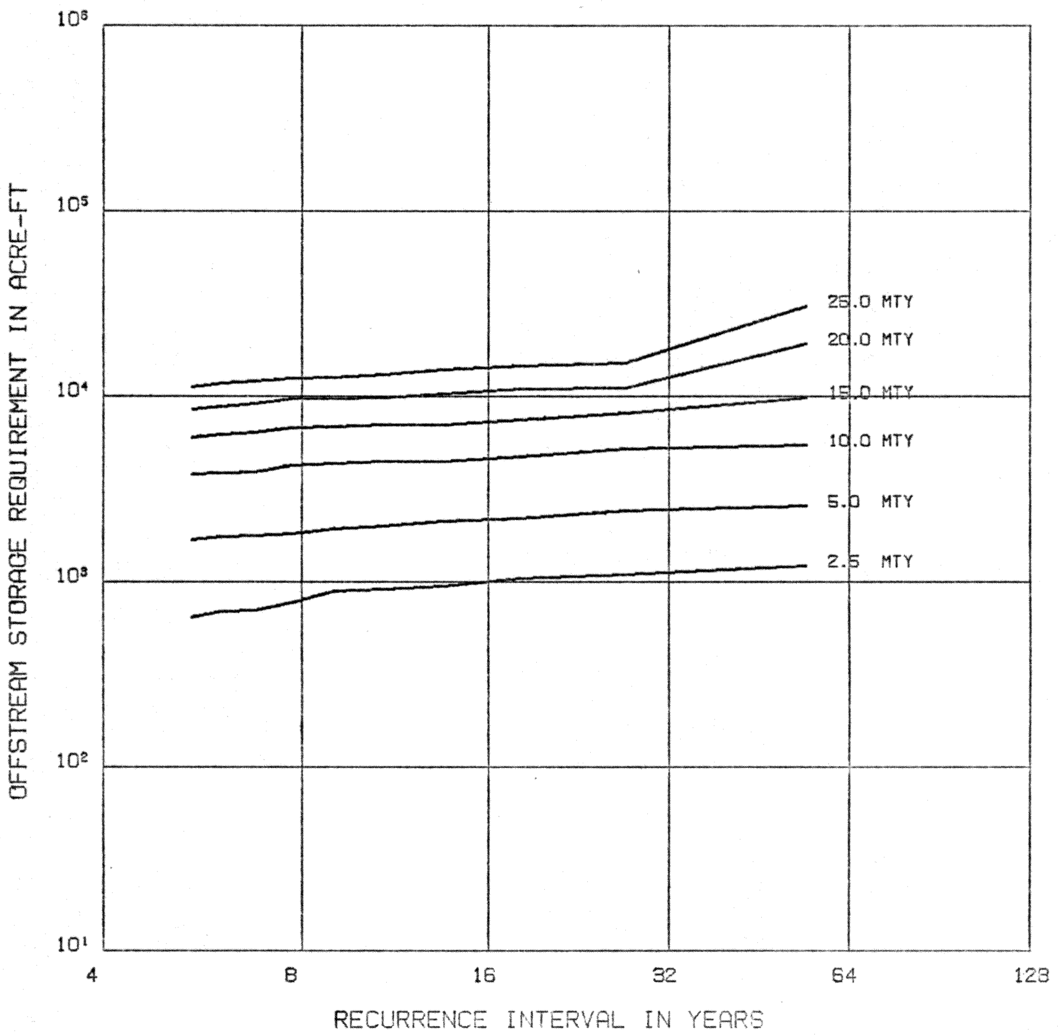


FIGURE F-L2-3 OFFSTREAM STORAGE FREQUENCIES



RUSSELL FORK AT HAYSI,VA.   03.2085.00

SCENARIO # 2   INTAKE CAP. 10 X QPAV

FIGURE F-HY-1 OFFSTREAM STORAGE FREQUENCIES

RUSSELL FORK AT HAYSI.VA. 03.2085.00

SCENARIO # 7 INTAKE CAP. 10 X QPAV

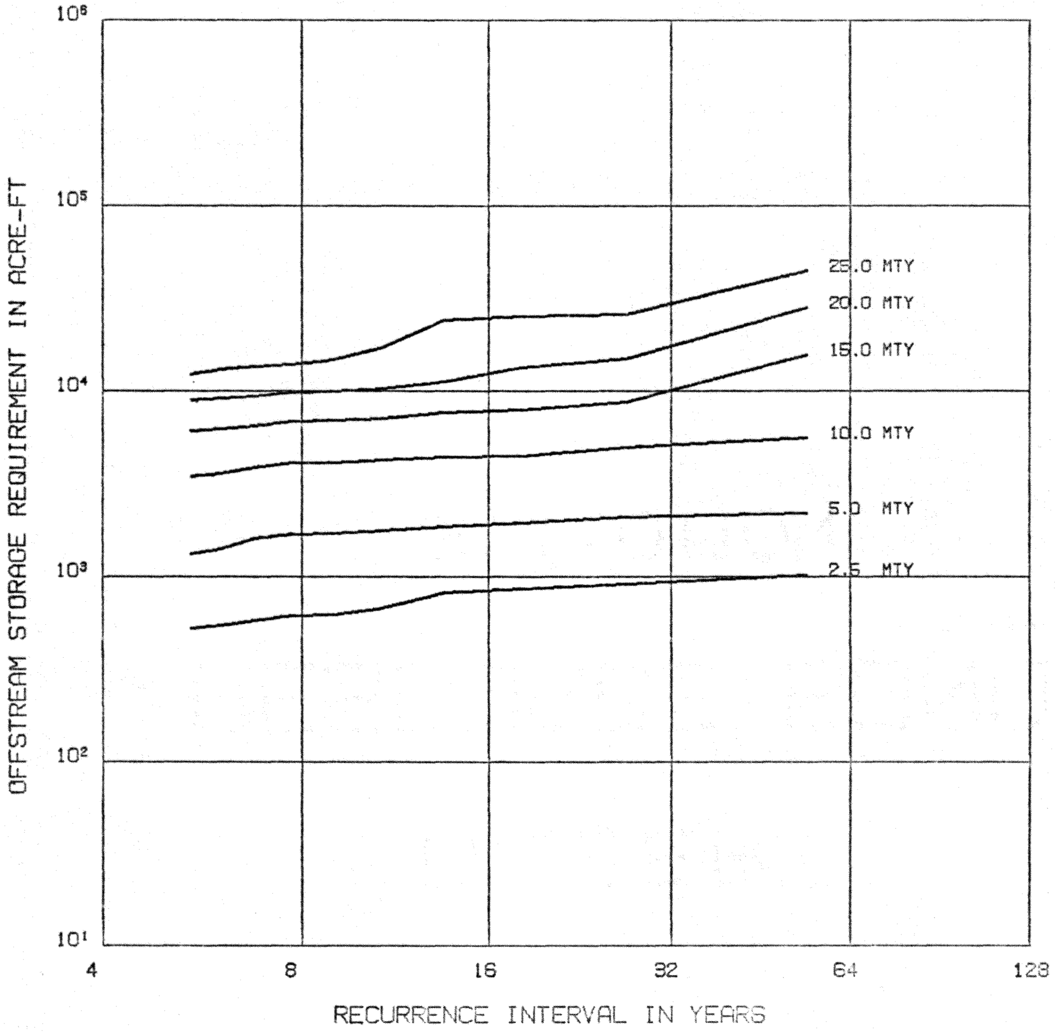


FIGURE F-HY-2 OFFSTREAM STORAGE FREQUENCIES

RUSSELL FORK AT HAYSI.VA. 03.2085.00

SCENARIO # 9 INTAKE CAP. 10 X QPAV

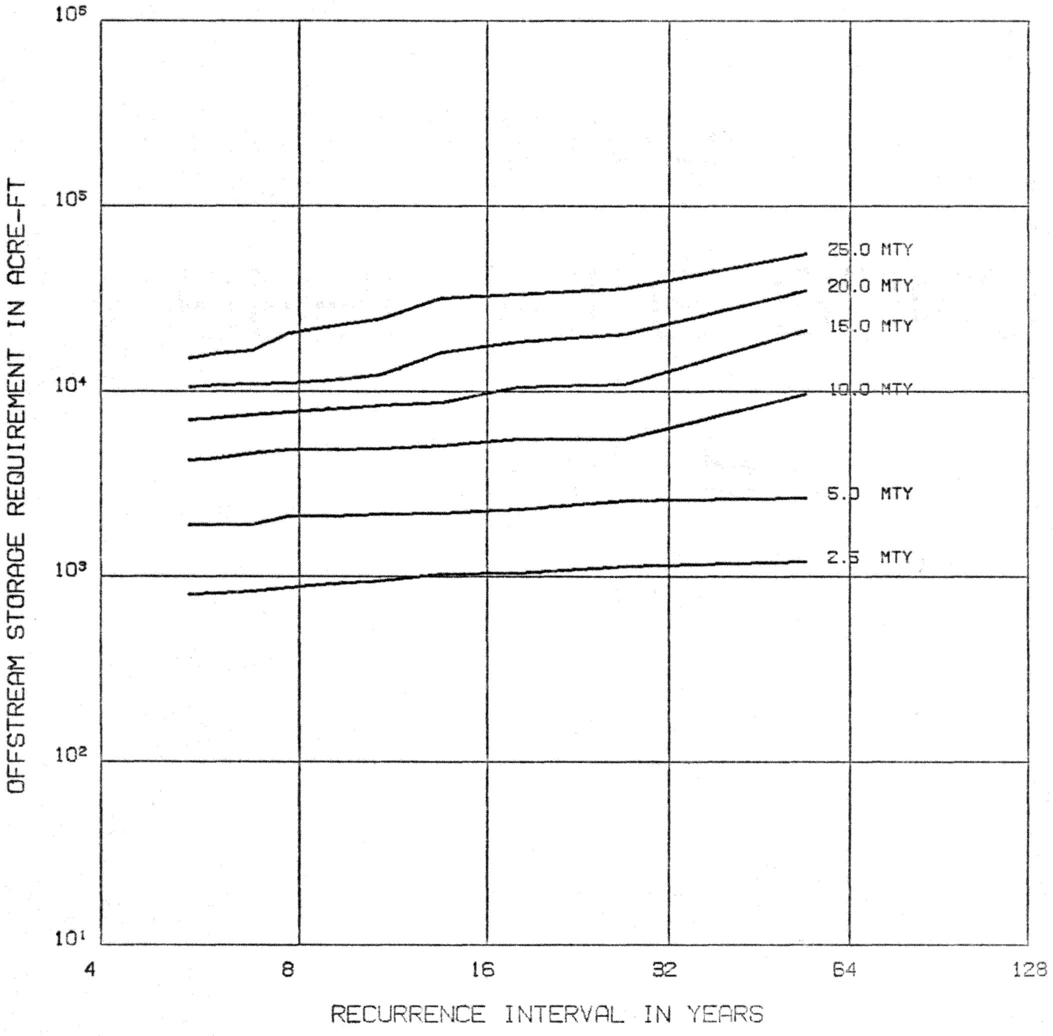


FIGURE F-HY-3 OFFSTREAM STORAGE FREQUENCIES

POWELL RIVER NEAR JONESVILLE, 03.5315.00

SCENARIO # 1 INTAKE CAP. 10 X QPAV

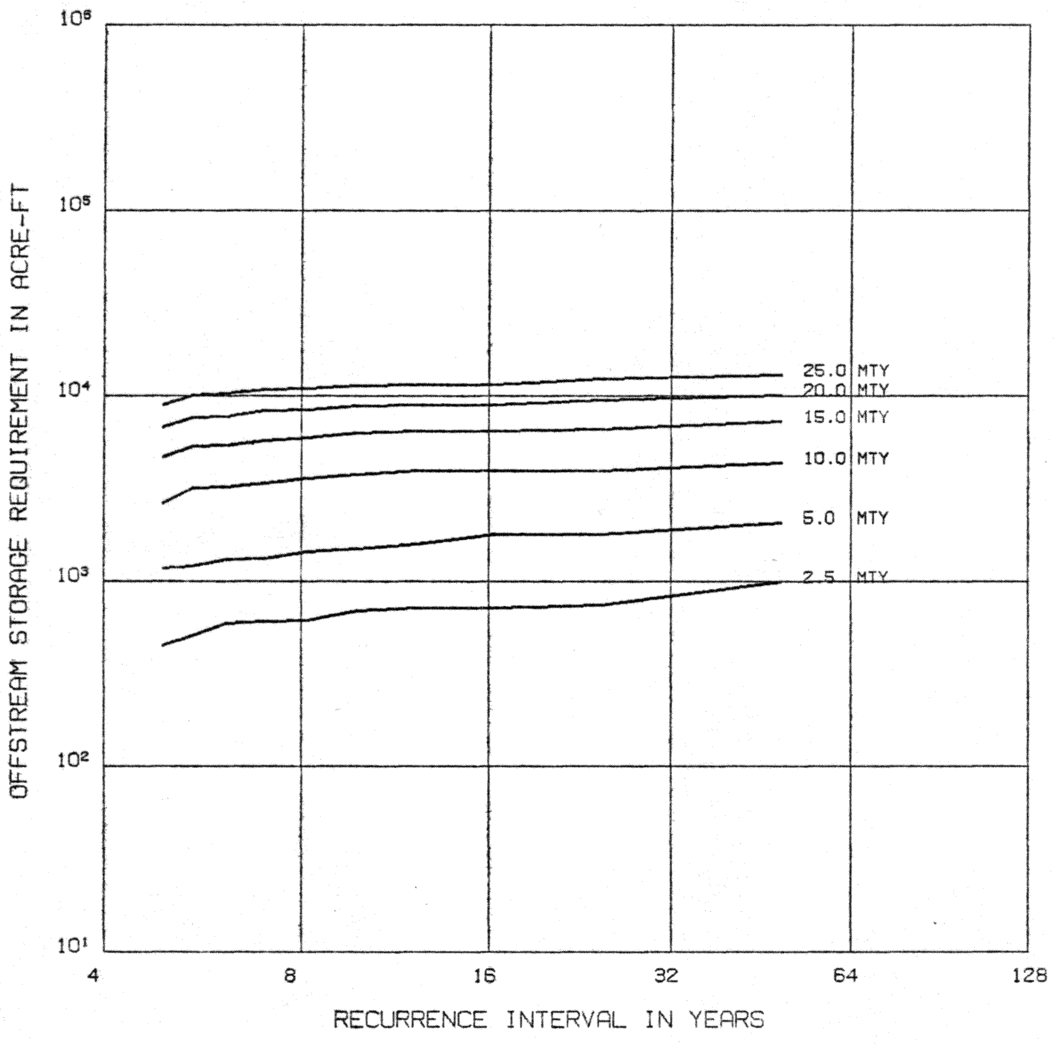


FIGURE F-PJ-4 OFFSTREAM STORAGE FREQUENCIES

POWELL RIVER NEAR JONESVILLE, 03.5315.00

SCENARIO # 2 INTAKE CAP. 10 X QPAV

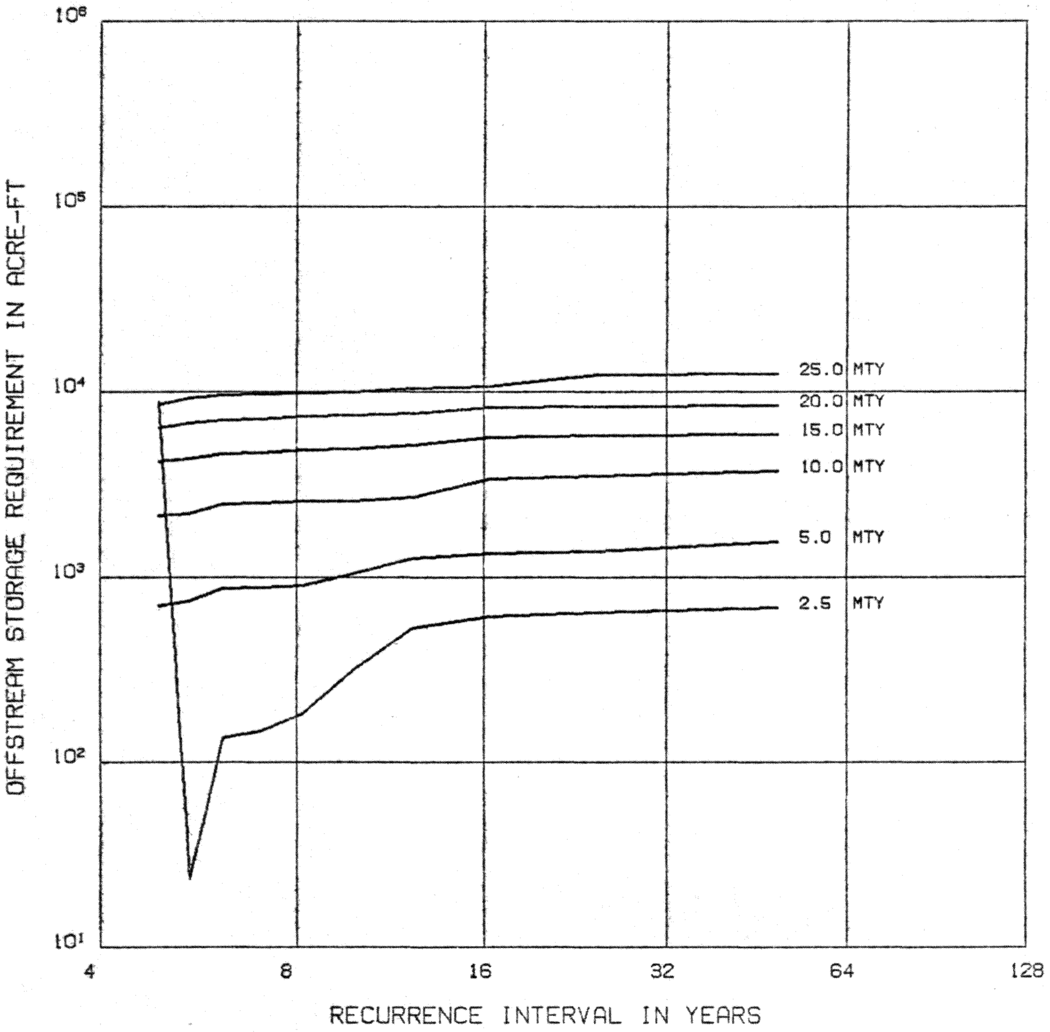


FIGURE F-PJ-5 OFFSTREAM STORAGE FREQUENCIES

POWELL RIVER NEAR JONESVILLE, 03.5315.00

SCENARIO # 3 INTAKE CAP. 10 X QPAV

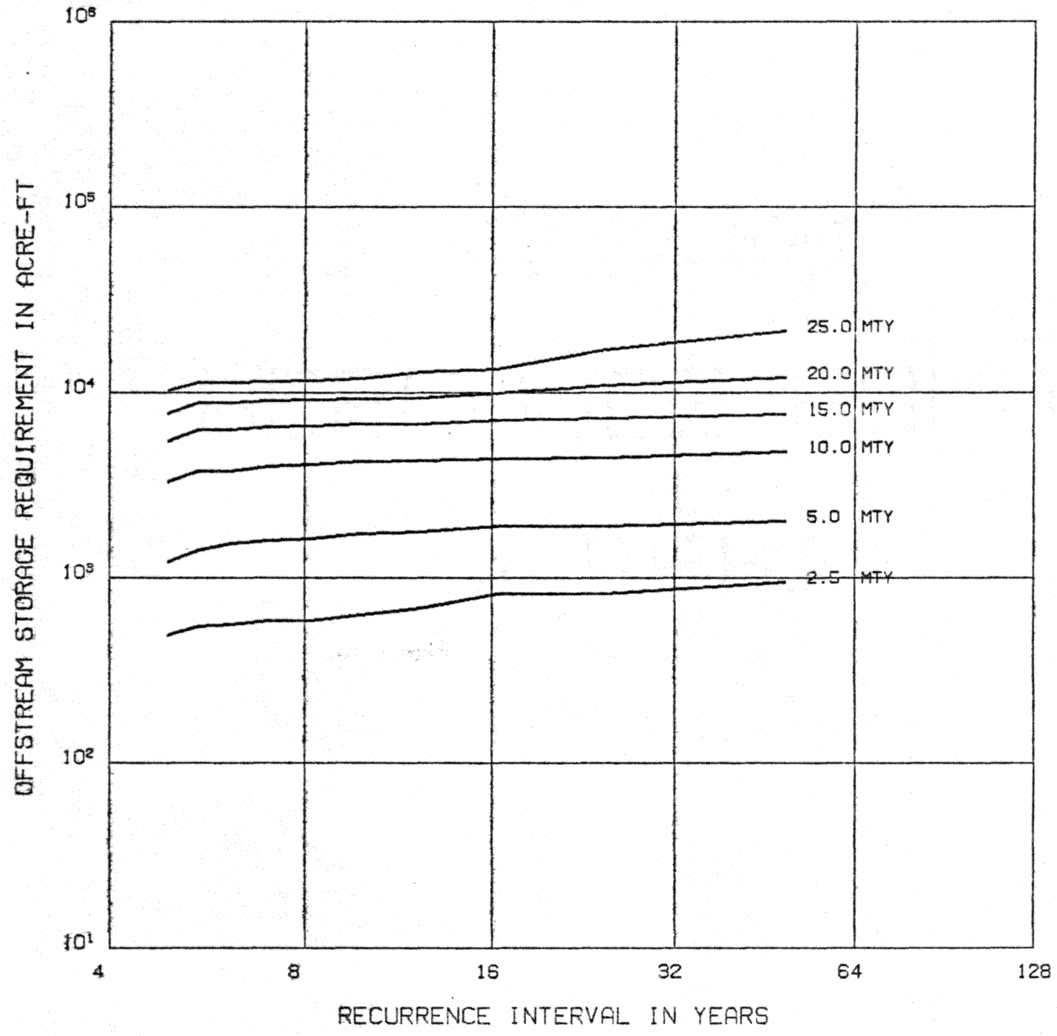


FIGURE F-PJ-6 OFFSTREAM STORAGE FREQUENCIES

AN ASSESSMENT OF THE OFFSTREAM STORAGE REQUIREMENTS AND LOW-FLOW FREQUENCY CHARACTERISTICS TO SUPPLY COAL SLURRY PIPELINES ORIGINATING IN SOUTHWESTERN VIRGINIA

by

German Ricardo Santos

(ABSTRACT)

Concerning the physical availability of water in southwestern Virginia for a prospective coal slurry pipeline, a preliminary investigation was undertaken to determine the capacity requirements for offstream-type reservoirs dedicated to pipeline use only. Offstream-type reservoirs were considered in view of their several apparent advantages, such as minimum interaction with the normal environment of the stream, and that its operation would probably be left entirely to the pipeline management.

Five local streams in the vecinity of the probable pipeline origins were considered in this study. The calculations were made according to several different scenarios conceived for future application to diversion from the stream. Each scenario assumes a series of different diversion rates from the stream when the stream discharge is within different fractional ranges of the mean

discharge.

Also considered as constrains in these calculations is a series of alternatives for the maximum diversion rates allowed from the stream at any time, to account for the capacity of the diversion or intake structure, as well as that of the conveyance line between the intake and the reservoir, as the latter would not probably be located directly next to the intake structure. These capacity alternatives were based on the predicted continuous demands of the pipeline with various annual throughputs.

Mass curve analysis was used in the determination of a reservoir that will guarantee the continuous supply of water for the coal slurry pipeline during the whole period considered. The study was further complemented by determining the reliability characteristics of smaller-size reservoirs in terms of their recurrence intervals based on a partial duration low-flow series analysis.