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Wyoming
Water Development
Commission

HAMS FORK BASIN LEVEL II INVESTIGATIONS

EXECUTIVE SUMMARY

"PHASE I"

WATER RESOURCES ANALYSIS

NOVEMBER, 1984

GREENHORNE & O'MARA, INC.
Consulting Engineers
Denver, Colorado

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CONTRACT AUTHORIZATION

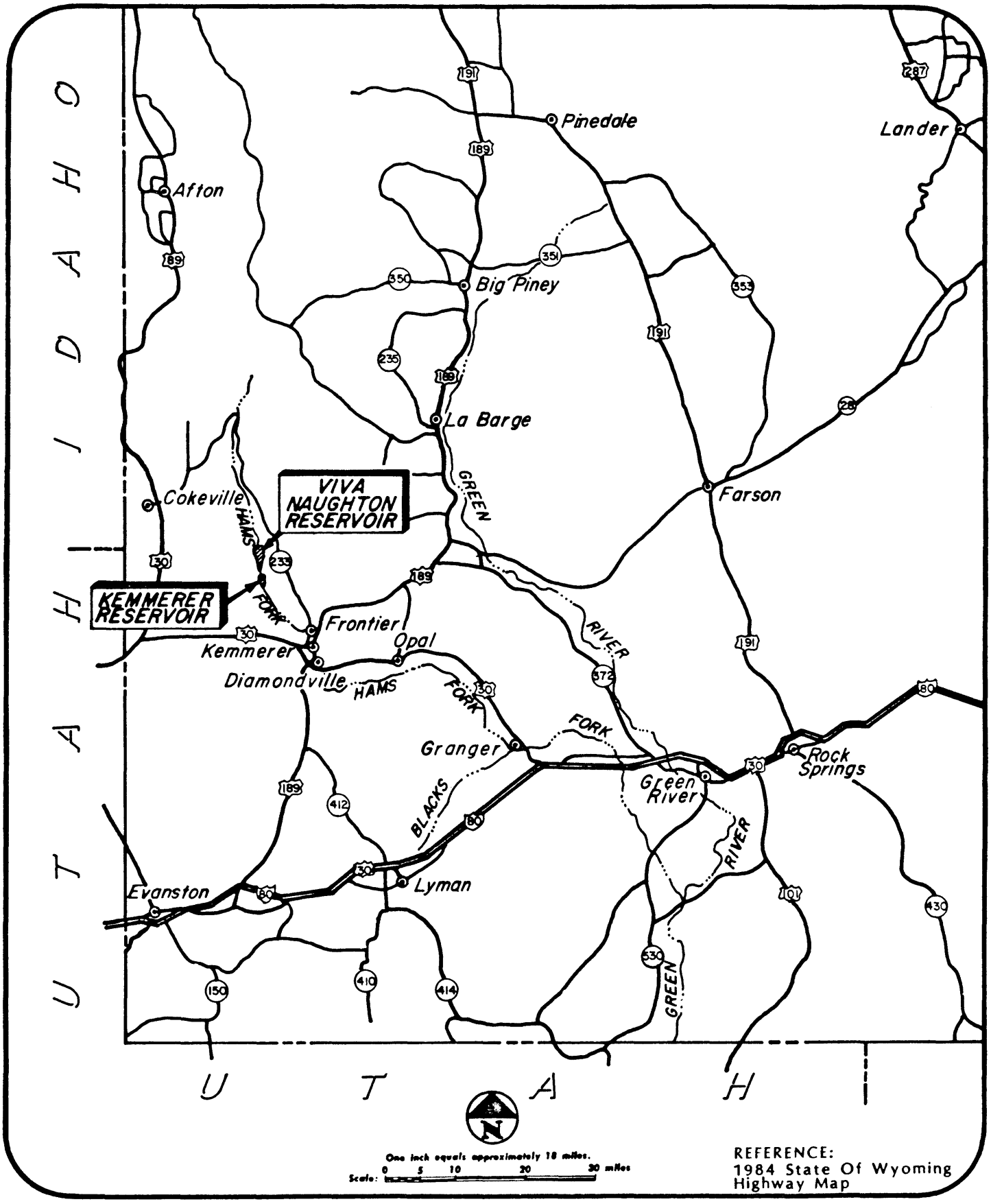
The Kemmerer Level II, Phase I, Water Resources Analysis was authorized under the terms of State of Wyoming Contract No. 0003911, between the Wyoming Water Development Commission (WWDC) and Greenhorne & O'Mara, Inc. (G&O). The Contract date is May 7, 1984.

NATURE AND PURPOSE OF STUDY

The primary purpose of this study is to identify the "firm yield" water supply that is available in the Hams Fork Basin with a proposed expansion of the Viva Naughton Reservoir. The Hams Fork Basin is located in southwestern Wyoming and is part of the Green River Drainage Basin (Figure 1). The projected uses of the water supply include domestic use for the Towns of Kemmerer, Frontier and Diamondville, industrial water supply for Utah Power and Light (UP&L) and other local industries, and irrigation water supply for the Hams Fork Water Users Association.

Secondary objectives include an analysis of Viva Naughton Reservoir to determine the optimal reservoir and spillway sizes for economical expansion of the facility. Finally, the study addresses the flood control benefits of an expanded facility for the Towns of Kemmerer, Diamondville and Frontier.

A Level I study was previously completed for the Hams Fork Basin by the MSM/SP Group in 1982, and a subsequent water supply analysis was completed in-house by the WWDC Staff. These studies have raised several issues that are addressed in this Level II study, and direction has been provided to resolve these issues. Hence, this study presents the results of a detailed, although straight-forward analysis, using stochastic methods and simulation modelling, to reach firm and quantitative answers to water supply availability and usage.



REFERENCE:
1984 State Of Wyoming Highway Map

HAMS FORK BASIN

VICINITY MAP

SCALE AS SHOWN

FIGURE 1

SCOPE OF WORK

The Scope of Work for this project included the following:

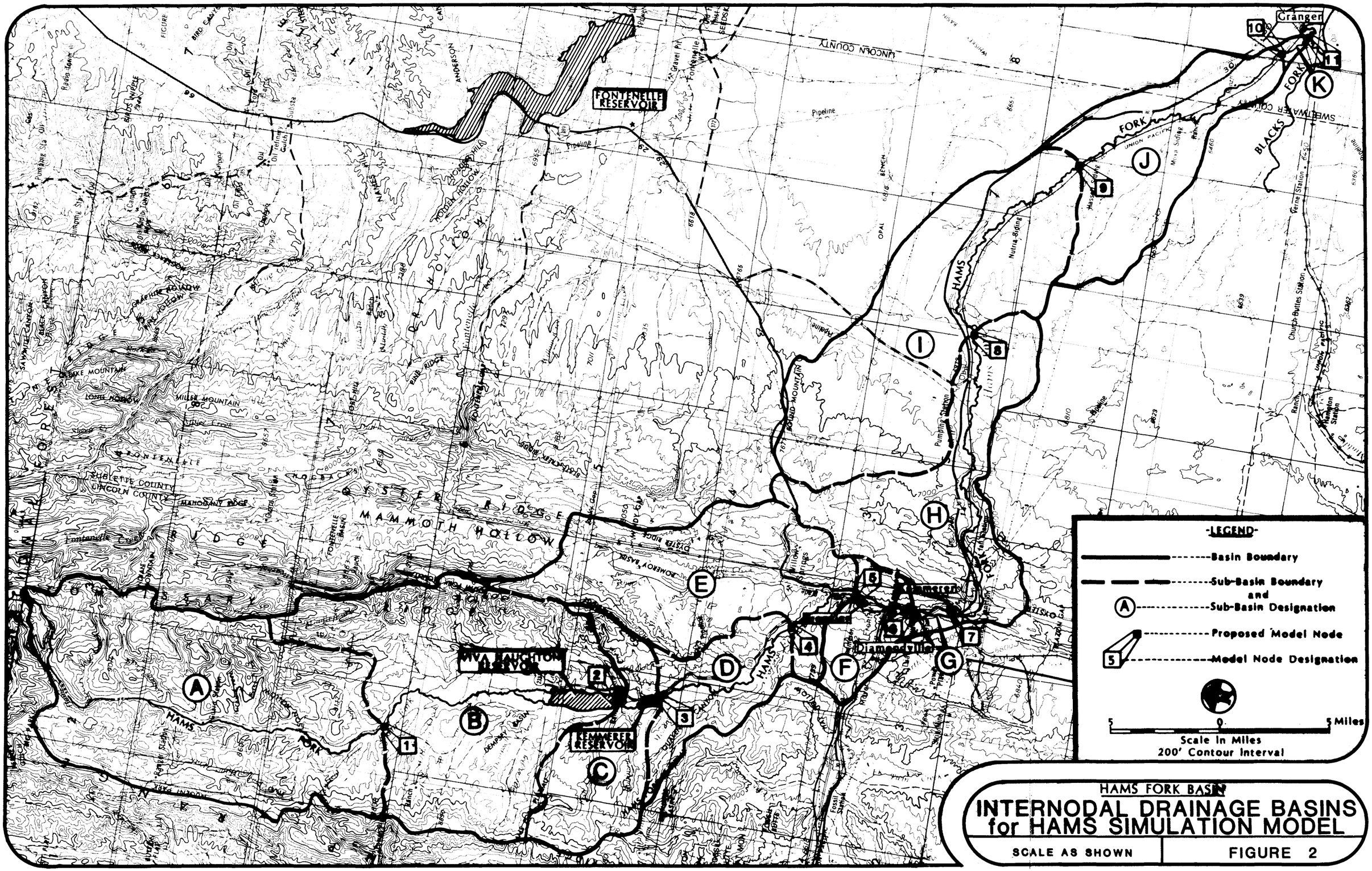
- A detailed hydrologic analysis was completed to determine the monthly inflow to the Viva Naughton Reservoir for a 50-year period. The streamflow records at the Upper Hams Fork Gaging Station (Station 9223000) were correlated with other gaging station records in the Hams Fork Basin and in the region to extend the record. The Upper Hams Fork Gaging Station record was further lengthened to a period of 50 years using extrapolation techniques.

  This provided monthly streamflow volumes at a point approximately 10 miles upstream of Viva Naughton Reservoir. These flow volumes were then adjusted to account for the intervening drainage area between this location and Viva Naughton, using correlations for unregulated flows and drainage area proportioning methods. This result provided an estimate of monthly inflows at the Reservoir Site for a 50 year flow period.

- A simulation model labeled HAMSIM was developed to determine the monthly flow releases at Viva Naughton Reservoir required to meet existing and future basin demands. These basin demands included municipal, industrial, and irrigation uses.

  The simulation model developed the flows at eleven nodal points in the basin beginning at the Upper Hams Fork Gaging Station and proceeding in a downstream direction to the Town of Granger at the confluence with the Blacks Fork (Figure 2). The simulation model was developed to represent all flow gains and losses along the river system, reported and/or estimated to the best extent possible. These included flow diversions, return flows, groundwater inflow/outflow, evapotranspiration, phreatophyte use, and surface water inflows. Considering these gains and losses to the system, the model determines the flow release from Viva Naughton Reservoir required to meet water rights in each model reach. These releases, therefore, are the demands on the reservoir system calculated for both the present and future conditions.

- The monthly inflows (supply) to Viva Naughton Reservoir and the monthly releases (demands) required to satisfy downstream water rights were input



HAMS FORK BASIN

INTERNODAL DRAINAGE BASINS for HAMS SIMULATION MODEL

SCALE AS SHOWN | FIGURE 2

to a "firm yield" hydrologic model (HEC-5) that determines the volume of reservoir storage required to meet those demands.

This "firm yield" analysis considers inflows, storage in the reservoir, losses from the reservoir, and demands; and determines the size of reservoir required to meet these demands through projected drought periods.

The "firm yield" analysis was completed for existing and future demand scenarios, as well as for conditions of recommended instream releases and no instream releases for fish habitat.

- Once the size of the proposed reservoir expansion was determined, consideration was given to spillway sizing. First, a Probable Maximum Flood (PMF) was determined and was routed through the reservoir to determine spillway size required to discharge this event. The outflow hydrograph through this spillway was then routed downstream to the Kemmerer-Diamondville Frontier Area.

  Subsequently, consideration was given to a spillway that would discharge one-half of the routed PMF. Under this scenario, the PMF event was again routed through the proposed reservoir. When overtopping occurred, the reservoir embankment was assumed to fail and a dam failure analysis was completed. This analysis produced a dam failure hydrograph that was again routed downstream to the Kemmerer-Diamondville-Frontier Area.

  This hydrograph was compared with the one obtained previously to evaluate the potential for spillway downsizing.

- Next, the study addressed the potential benefit of flood attenuation through the proposed reservoir expansion. In this case, the 100-year event in the Kemmerer-Diamondville-Frontier Area was determined for the existing condition, and for the condition of an expanded Viva Naughton Reservoir. The peak discharges were compared to determine the benefit of the expanded reservoir in reducing potential flood damages in the three town area.

HISTORICAL OVERVIEW OF PROJECT

Several studies on the Hams Fork hydrology and water supply availability have previously been conducted by others. An in-house annual reservoir operation study was performed by UP&L in 1978 in support of a proposed expanded Viva Naughton Reservoir to 82,000 acre-feet to meet projected future demands. The period of record used in the study was for the water years 1946 through 1977. This study identified two water years, 1961 and 1977, where no water could be allocated to irrigation whenever the reservoir contents fell below a two-year storage reserve. The period of record used in the 1978 study did not include the critical period of drought years experienced in the basin during the 1930's.

The MSM/SP Group, in the Level I Reconnaissance Study, recommended a reservoir to meet future water demands above Kemmerer of 28,000, 8,000 and 18,000 acre-feet for projected industrial, municipal and agricultural uses, respectively.

This totals 54,000 acre-feet, and the recommendation was to construct an enlarged Viva Naughton Reservoir with an optimum active storage capacity equal to 96,000 acre-feet to meet these projected basin demands, with allowances for reservoir evaporation and other use contingencies. UP&L owns Viva Naughton Dam and Reservoir, which was constructed in 1961 under Permit No. 6418 R, with an available storage capacity of 42,393 acre-feet. Expansion Permit Nos. 7476 R and 7599 R have subsequently been obtained by UP&L for additional storage rights of 27,252 and 12,250 acre-feet, respectively. Thus, additional storage rights equal to 14,105 acre-feet would be required for a proposed reservoir expansion to 96,000 acre-feet.

RESULTS OF CURRENT INVESTIGATIONS

- Inflows to Viva Naughton Reservoir were determined on a monthly basis for a 50-year period and are reported in Chapter III of the Hams Fork Level II Investigations, Phase I Water Resources Analysis (Hams Fork Study). The average annual inflow for the 50-year period is 99,900 acre-feet.

- Results of the Hams Fork Basin Simulation Model (HAMSIM) provide, on a monthly basis, the flow demands at each of eleven nodal points throughout the basin. The eleven nodal points are shown on Figure 2. A tabulation

of the monthly demands at each nodal point is presented in Chapter III of the Hams Fork Study. Table A presents the annual demands for existing and future conditions, and separates these demands into municipal, industrial, and agricultural uses.

TABLE A
ANNUAL DEMANDS - HAMS FORK BASIN

	Existing (1983) (acre-feet)	Future (2029) (acre-feet)
Agricultural	50,750	50,750
Municipal	1,323	4,413
Industrial	11,752	27,618
TOTAL	63,825	82,781

Actual irrigated land is 8,486 acres, and adjudicated/permitted land is 14,043 acres. Irrigation demands were based upon Wyoming State Law for adjudicated acreages, that is, 1 cfs per 70 acres under normal conditions, and 2 cfs per 70 acres during flood flows for lands permitted prior to March 1, 1945.

- The results of the "firm yield" analysis for the Viva Naughton Reservoir indicate that it is presently adequately sized to meet existing demands. This reservoir, at a storage of 42,393 acre-feet, subject to an average annual demand of 24,539 acre-feet would be drawn down to a minimum pool of approximately 28,000 acre-feet. Under this scenario, the two-year reserve storage contingency of 24,500 acre-feet established by Utah Power and Light (UP&L) would not be utilized.

  This analysis assumes no instream release for fish habitat above those required to meet the downstream demands.

- The fish maintenance releases recommended by the Wyoming Game and Fish Department for the Hams Fork below Viva Naughton Reservoir are the following:

- 50 cfs from July through September to maintain habitat conditions to support the present standing crop of fish.

- 35 cfs from October through March to provide maintenance of winter habitat, and

- 100 cfs from April through June to optimize the extent of a spawning habitat for rainbow trout.

With these minimum streamflow requirements, and existing basin demands, a reservoir of 53,000 acre-feet would be required to meet demands on a "firm yield" basis. Hence, the present facility would need to be expanded by approximately 10,600 acre-feet. At this reservoir size, no contingency storage is provided above the "firm yield" storage.

o A "firm yield" analysis for future basin demands was also developed. These demands are described in the following:

- The projected municipal water demands for the Town of Kemmerer are based upon population and consumption estimates for the year 2029 as presented in the Level I Reconnaissance Study and in the WWDC report "Water Supply Needs Analysis". For the projected population of 17,250, the future Kemmerer water requirement reportedly will be 4,000 acre-feet annually. The future water demand for the Town of Granger is assumed to be full use of the adjudicated diversion right of 412.6 acre-feet annually.

- The future industrial water demands of UP&L were estimated assuming an 800-megawatt expansion of the power plant (as proposed by UP&L). Annual water requirements would increase from the existing 10,700 acre-feet to an estimated 25,000 acre-feet. Other industrial uses of Hams Fork water are assumed to remain unchanged.

- The future irrigation water demands are based upon the total acreage permitted under the existing adjudicated water rights (i.e., 14,042.94 acres).

The results of this analysis again indicate that the Viva Naughton Reservoir is presently adequately sized to meet these future demands. This reservoir, at a storage of 42,393 acre-feet, subject to an average annual demand of 37,721 acre-feet would be drawn down to a minimum pool of approximately 13,000 acre-feet. Under this scenario, approximately one-half of UP&L's storage contingency would be utilized during the major drought event.

Again, no allowance is made for in-stream fish releases above basin demand releases.

o When recommended fish releases, as described above, are added to future demands, the storage requirement of the reservoir greatly increases. Under this scenario, the average annual demand increases to 77,244 acre-feet. To meet this demand on a "firm yield" basis, a reservoir of 87,000 acre-feet is required. Again, for the expanded reservoir, no contingency is provided above "firm yield" storage.

For the 87,000 acre-foot reservoir described above, additional water supply could be provided for agricultural uses based upon a yield delivered 7 and 8 out of 10-years. The yield available for irrigated new acreage, under this scenario, would be 14,656 acre-feet and 12,556 acre-feet respectively. On this basis, adjudicated lands could be increased by 3,768 acres and 3,228 acres, respectively.

o The Probable Maximum Flood (PMF) considering the general-type Probable Maximum Precipitation (PMP) storm and the local-storm (thunderstorm) PMP were determined at the Viva Naughton Reservoir.

The estimated peak flood inflow rate during the PMF is 73,800 cfs and was the result of the general-type storm. This storm also contained the greater storm volume. The estimated runoff to rainfall ratio is about 76 percent for this storm event which is considered reasonable under significant flooding conditions.

The PMF hydrograph was routed through the expanded 87,000 acre-foot reservoir

with a spillway designed to discharge the entire routed flow. In this case, the peak routed discharge of the reservoir was 36,600 cfs. This flow was then stream routed down to the Kemmerer-Diamondville-Frontier Area and was combined with the PMF event in the drainage basin below the reservoir. The peak discharge at the three town area was 39,600 cfs.

Next, the expanded reservoir's spillway was assumed to discharge one-half of the routed PMF or 18,300 cfs. THe PMF routed through the reservoir overtopped the embankment and dam failure was assumed to occur. The breach discharge was estimated to be 432,000 cfs. This flow was stream routed to the Kemmerer-Diamondville-Frontier Area with a resultant peak discharge of 402,000 cfs.

This potential dam failure would produce a peak discharge at the three town area of over ten-times the PMF. Because of the potential of such a dam failure, the recommendation is to construct a full PMF spillway if the reservoir is enlarged.

- Flooding investigations were also completed to evaluate the benefit of increased reservoir attenuation in an enlarged impoundment in reducing flood damage potential in the Kemmerer-Diamondville-Frontier Area. The results of this analysis showed that the peak discharge for the 100-year event in this area is reduced from 15,960 cfs to 12,300 cfs. The peak discharge cannot be further reduced by flood storage in Viva Naughton since a peak of 12,300 cfs is generated from the 118 square mile drainage area non-tributary to the reservoir.

RECOMMENDATION

The existing reservoir at Viva Naughton has a "firm yield" sufficient to meet the projected municipal water supply, full adjudicated irrigation rights, and existing industrial demands in the Hams Fork Basin. This would, however, require a new operating scheme for the reservoir where UP&L's operating contingency would be reduced from 24,500 acre-feet to 13,000 acre-feet. This contingency, however, is storage excess above that required for a "firm yield" reservoir meeting the future demands described above.

In addition, no certain demand for increased industrial uses has been identified for the forseeable future. UP&L has considered an 800-megawatt expansion of their power plant which would significantly increase storage requirements. However, this expansion is on hold at present with no certainty that it will be constructed in the future. Without this expansion, it is difficult to see the economic support for an expansion of the existing facility.

Therefore, the study recommendation is that no expansion of the Viva Naughton Reservoir be pursued until substantial new industrial demands are established in the basin. UP&L should be approached with a new operating scheme that allows for drawdown of the reservoir to 13,000 acre-feet. If additional irrigation demands are substantial in the basin, these demands should be quantified and the potential for further operational drawdown should be pursued before considering a costly reservoir expansion.

No allowance is made under this scenario for instream fish releases beyond those of reservoir spill and the releases required to meet downstream water demands. Again, if additional fish releases are warranted, consideration should be given to further reservoir drawdown before pursuing reservoir expansion.

If, in the future, expansion by UP&L is again proposed, the reservoir could be expanded to meet these demands and additional industrial and irrigation demands. The estimated present day cost of an expansion to 87,000 acre-feet capacity is 15 million dollars.