United States Department of the Interior

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SALT LAKE CITY, UTAH 84147

IN REPLY REFER TO: 722
500.2/123.8a-

SEP 29 1978

Memorandum

To: Commissioner, Washington, D.C.
Attention: 700

From: Regional Director, Salt Lake City, Utah

Subject: Peaking Power Investigations

A report on the status of the peaking power investigations has been prepared and five copies are enclosed for your information and use. Also, two copies of the appendix, Volumes 1 and 2, are enclosed.

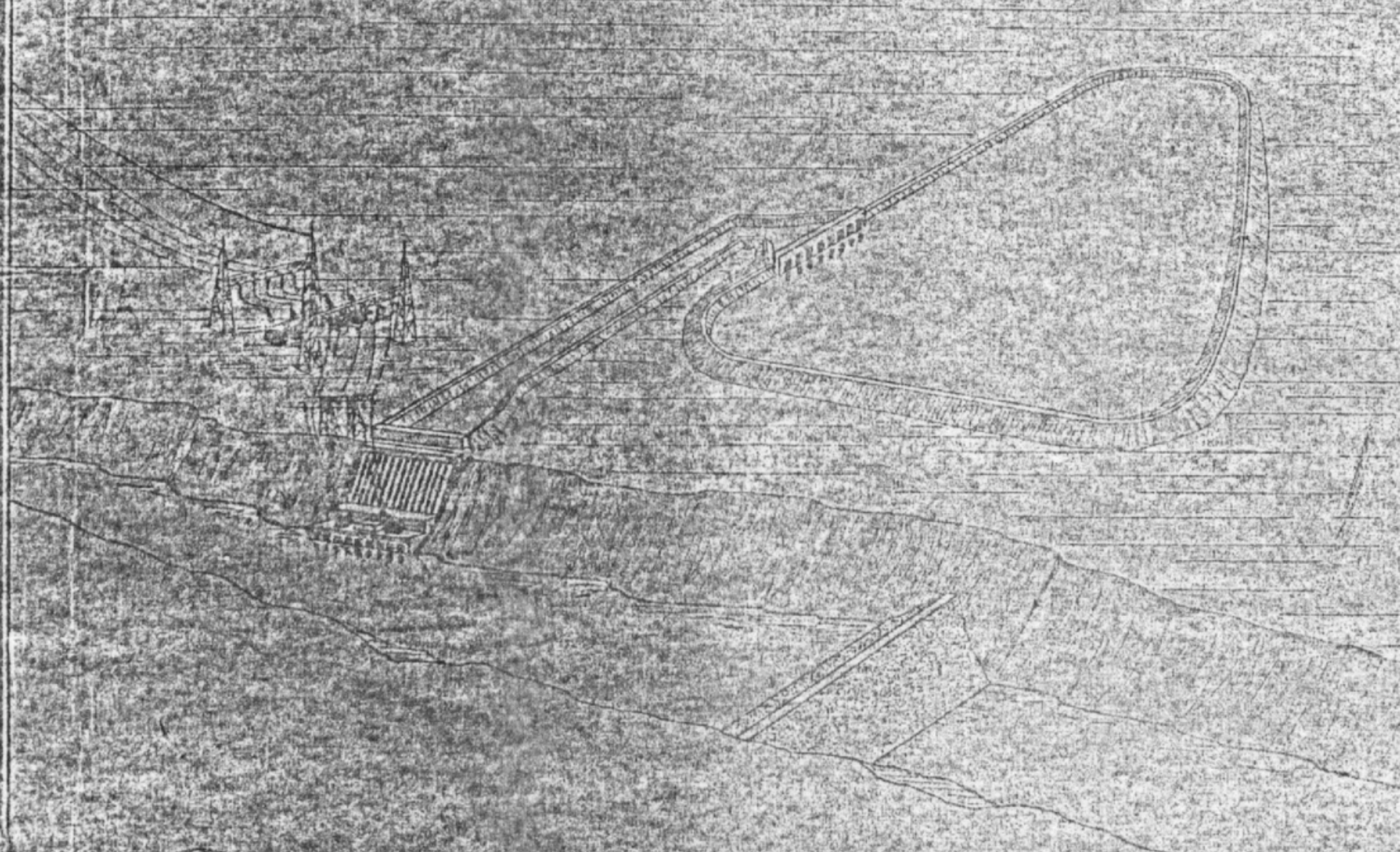
The report recommends that five candidate sites be studied for feasibility. Glen Canyon and Blue Mesa Outlet Works and Utah Lake Pumped Storage studies are recommended to begin in fiscal year 1979. Flaming Gorge Outlet Works and Dunham Point Pumped Storage investigations are recommended to start in fiscal year 1980. The report also recommends we conduct further future investigations and that similar peaking power studies be conducted in other Reclamation regions.

This report is also being distributed by copy of this letter to the E&R Center and members of the Multiple-Objective Planning Team.

Enclosures

cc: E&R Center, Denver, Colorado, Attn: 700
(w/8 cys report and 2 cys appendix)
MOP Team participants listed on acknowledgement, w/cy report

PEAKING POWER
Status Report



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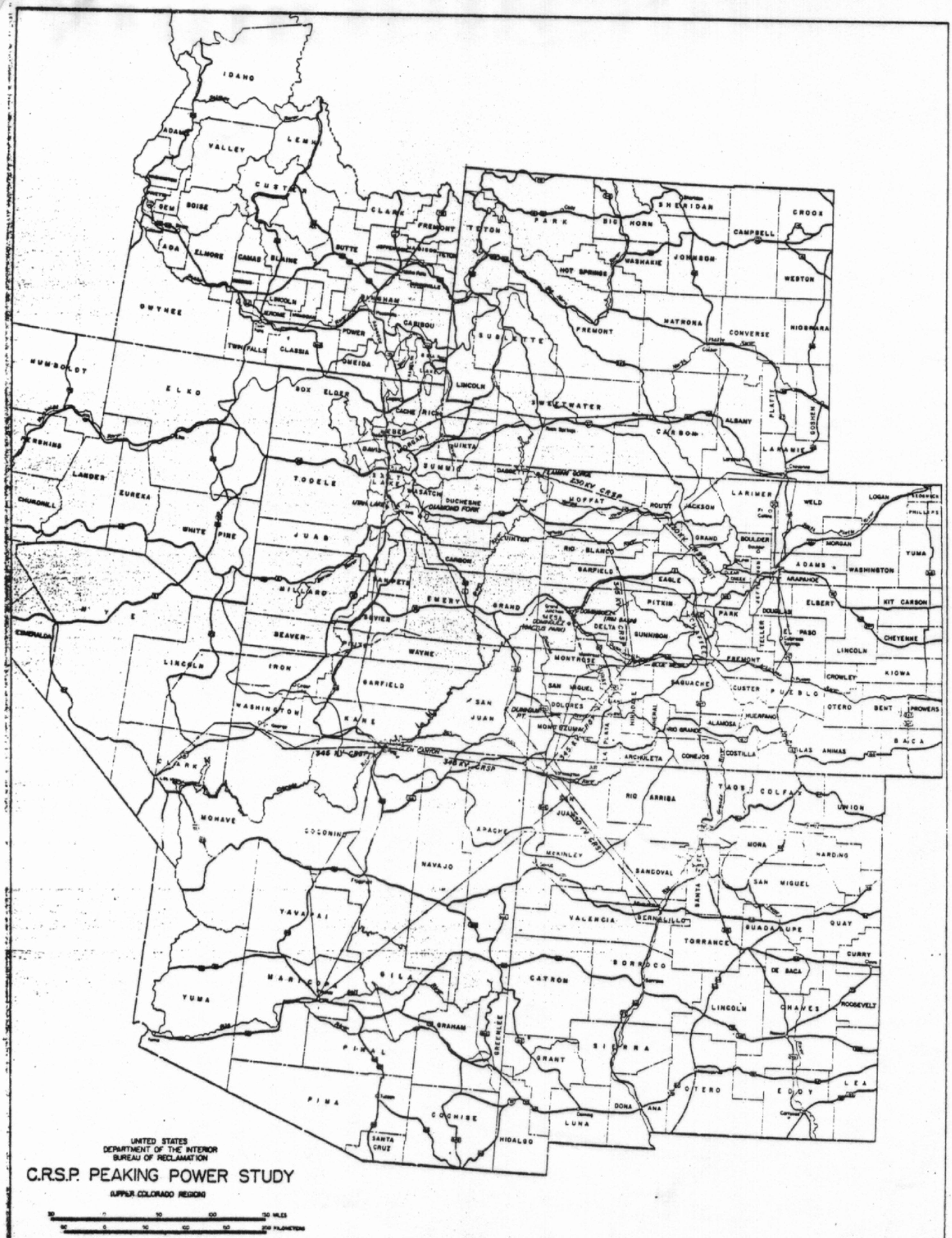
DEPARTMENT OF THE INTERIOR
Cecil D. Andrus, Secretary
BUREAU OF RECLAMATION
R. Keith Higginson, Commissioner
SEPTEMBER 1978


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
C.R.S.P. PEAKING POWER STUDY
(UPPER COLORADO REGION)
IDAHO
ADAMS
VALLEY
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SAN JUAN
DOLORES
MONTEZUMA
HINSDALE
MINERAL
RIO GRANDE
ALAMOSA
HUERFANO
OTERO
BENT
PROWERS
ARCHULETA
CONEJOS
COSTILLA
LAS ANIMAS
BACA
345 KV CRSP
GLEN CANYON
MOHAVE
COCONINO
APACHE
SAN JUAN
RIO ARRIBA
TAOS
COLFAX
UNION
MCKINLEY
MORA
HARDING
NAVAJO
SANDOVAL
SANTA FE
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YAVAPAI
VALENCIA
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GRAHAM
GREENLEE
SIERRA
PINAL
GRANT
OTERO
EDDY
LEA
PIMA
COCHISE
LUNA
DONA ANA
SANTA CRUZ
HIDALGO

ACKNOWLEDGMENTS

Pete Pemberton
Arizona Public Service Company
Box 21666
Phoenix, Arizona 85036
Telephone 602-271-2861

F.A. Kuhlemeier
Colorado-Ute Electric Assn., Inc.
P.O. Box 1149
Montrose, Colorado 81401
Telephone 303-249-4501

Raymond Keith
Colorado-Ute Electric Assn., Inc.
P.O. Box 1149
Montrose, Colorado 81401
Telephone 303-249-4501

Bruno Carrara
Public Service Company of New Mexico
P.O. Box 2267
Albuquerque, New Mexico 87103
Telephone 505-842-2970

Ron Franquero
Public Service Company of New Mexico
P.O. Box 2267
Albuquerque, New Mexico 87103
Telephone 505-842-2970

Kerry Franklin
Public Service Company of New Mexico
P.O. Box 2267
Albuquerque, New Mexico 87103
Telephone 505-842-2970

R.B. Lisbakken
Pacific Power & Light Company
920 S.W. 6th
Portland, Oregon 97204
Telephone 503-243-4442

Al Alspaugh
Pacific Power & Light Company
920 S.W. 6th
Portland, Oregon 97204
Telephone 503-243-4442

Harry Haycock
Utah Power & Light Company
P.O. Box 899
Salt Lake City, Utah 84110
Telephone 801-350-3316

Ralph Oberg
Utah Power & Light Company
P.O. Box 899
Salt Lake City, Utah 84110
Telephone 801-350-3316

Byron L. Miller
Nevada Power Company
P.O. Box 230
Las Vegas, Nevada 89151
Telephone 702-385-5765

George Bell
Federal Economic Regulatory Co
D.O.E. Room 415
555 Battery Street
U.S. Customs House
San Francisco, CA 94111
Telephone 415-556-3583 (Commercial)
556-3583 (FTS)

R.T. Van Slambrook
Federal Regulatory Commission
D.O.E. Room 415
555 Battery Street
U.S. Customs House
San Francisco, CA 94111
Telephone 415-556-3583 (Commercial)
556-3583 (FTS)

Joseph Fackrell
Intermountain Consumer Power Assn.
8722 So. 300 West, P.O. Box BB
Sandy, Utah 84070
Telephone 801-561-1436

Berry Hutchings
Bountiful City Light & Power
198 So. 200 West
Bountiful, Utah 84010
Telephone 801-295-9496

Dennis Strong
~~Paul Summers~~
Div. of Water Resources
Dept. of Natural Resources
435 State Capitol Bldg.
Salt Lake City, Utah 84114
Telephone 801-533-5401

Les Ormsby
Arizona Power Authority
1810 West Adams St., P.O. Box 6694
Phoenix, Arizona 85005
Telephone 602-271-4263 (Commercial)
765-4263 (FTS)

Harry Twohig
Salt River Project
P.O. Box 1980
Phoenix, Arizona 85001
Telephone 602-273-5411

Robert Mason
Salt River Project
P.O. Box 1980
Phoenix, Arizona 85001
Telephone 602-273-5411

William Gebhardt
Div. of Power, USBR
Room 7221, Federal Bldg.
125 So. State Street
P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5496(Commercial)
588-5496 (FTS)

C.M. Woodbury
City of Farmington
P.O. Box 900
Farmington, New Mexico 87401
Telephone 505-325-1981

W.J. Metheny
City of Farmington
P.O. Box 900
Farmington, New Mexico 87401
Telephone 505-325-1981

John Boaze
U.S. Fish and Wildlife Services
P.O. Box 302
Cherokee, N.C. 28719
Telephone 704-497-3811 (Commercial)
497-5201 (FTS)

Leon Colborn
Ecological Services, Fish and Wildlife Service
Room 1426, Federal Bldg.
125 So. State Street
Salt Lake City, Utah 84138
Telephone 801-524-5637 (Commercial)
588-5637 (FTS)

Richard Sanders
Intermountain Region
U.S. Forest Service
324 25th Street
Ogden, Utah 84401
Telephone 801-399-6141 (Commercial)
586-6141 (FTS)

Denis Nelson
Office of Energy Activities
Region VIII, Environmental Protection Agency
1860 Lincoln Street,
Denver, Colorado 80203
Telephone 303-837-5914 (Commercial)
327-5914 (FTS)

Gary Parker
Office of Energy Activities
Region VIII, Environmental Protection Agency
1860 Lincoln Street, Suite 900
Denver, Colorado 80203
Telephone 303-837-5914 (Commercial)
327-5914 (FTS)

Douglas Kirk
Office of Utah State Planning Coordinator
118 State Capitol Building
Salt Lake City, Utah 84114
Telephone 801-533-5245

Tom Newell
Region VIII, Department of Energy
1075 Yukon Street
P.O. Box 26247, Belmar Branch
Lakewood, Colorado 80226
Telephone 303-234-2476 (Commercial)
234-2476 (FTS)

Larry Stark
Public Service Co. of Colorado
550 15th Street., P.O. Box 840
Denver, Colorado 80201
Telephone 303-571-6122 (Commercial)
327-0111 (FTS)

Clarence A. Colyn
~~James A. Selby~~
Tri-State Generation and Transmission Assn, Inc.
P.O. Box 29198
Denver, Colorado 80229
Telephone 303-452-6111

Marvin Hein
Div. of Planning, Bureau of Rec.
Room 7004, Fed. Bldg.
125 So. State Street, P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5289 (Commercial)
588-5289 (FTS)

Gary Baker
Div. of Planning, Bureau of Rec.
Room 7416, Fed. Bldg.
125 So. State Street, P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5145 (Commercial)
588-5145 (FTS)

Wink Hastings
Div. of Water and Land Operations
Bureau of Reclamation., Room 7427
Federal Bldg., 125 So. State Street
P.O Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5579 (Commercial)
588-5579 (FTS)

Paul Sant
2137 Logan Avenue
Salt Lake City, Utah 84108
Telephone 801-583-2074

Glade Barney
Div. of Planning, Bureau of Rec.
Room 7404A, Fed. Bldg.
125 So. State., P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5522 (Commercial)
588-5522 (FTS)

Harold Tolley
Div. of Planning, Bureau of Rec.
Room 7404, Federal Building
125 So. State St., P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5531 (Commercial)
588-5531 (FTS)

Thayne Coulter
Div. of Planning, Bureau of Rec.
Room 7404, Federal Building
125 So. State St., P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5531 (Commercial)
588-5531 (FTS)

Richard Schaefer
Div. of Planning, Bureau of Rec.
E&R Center, Room 1380, Bldg. 67
Denver, Colorado 80225
Telephone 303-234-3321 (Commercial)
234-3321 (FTS)

Edward J. Currier
Colorado River Water Con. Dist.
P.O. Box 1120
Glenwood Springs, Colorado 81601
Telephone 303-945-8522 (Commercial)
Or Grand Junction
303-242-5202 [redacted] Commercial

Myrvin E. Noble
Denver Service Center, BLM
Code D-300, Bldg. 50
Denver Federal Center
Denver, Colorado 80225
Telephone 303-234-2368 (Commercial)
234-2369 (Commercial)
234-2368 (FTS)

Craig Bigler
Office of Utah State Planning Coord.
118 State Capitol Building
Salt Lake City, Utah 84114
Telephone 801-533-5245

Philip H. Schmuck
Director, State Clearinghouse
Colo. Div. of Planning
1845 Sherman Street
Denver, Colorado 80203
Telephone 303-892-2178

Charles N. Rorvik
Div. of Design and Construction, USBR
Rm. 7420A Federal Building
125 So. Street
P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5525 (Commercial)
588-5525 (FTS)

Ival Goslin, Executive Director
Upper Colorado River Commission
335 South 400 East
Salt Lake City, Utah 84111
Telephone 801-531-1150

William Michels
Heritage Conservation and
Recreation Service
Mid-Continent Region
Bldg. 41, Denver Federal Center
Denver, Colorado 80225
Telephone 303-234-3523 (Commercial)
234-3523 (FTS)

Mike Beaudry
Heritage Conservation and
Recreation Service
Mid-Continent Region
Bldg. 41, Denver Federal Center
Denver, Colorado 80225
Telephone 303-234-3523 (Commercial)
234-3523 (FTS)

Emanual Lauk
Heritage Conservation and
Recreation Service
Mid-Continent Region
Bldg. 41, Denver Federal Center
Denver, Colorado 80225
Telephone 303-234-3523 (Commercial)
234-3523 (FTS)

Harold Sersland
Office of Regional Director
USBR, Room 7003, Fed. Bldg.
125 So. State Street
P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5580 (Commercial)
588-5580 (FTS)

Clement Lord
Office of Wyoming State Engineer
Barrett Building
State of Wyoming
Cheyenne, Wyoming 82002
Telephone 307-777-7354

Jerry Olds
Div. of Water Rights
Dept. of Natural Resources
442 State Capitol Building
Salt Lake City, Utah 84114
Telephone 801-533-6071

Dave Gerke
Arizona Water Commission,
Suite 800
222 North Central Avenue
Phoenix, Arizona 85004
Telephone 602-258-7561

Stan Bazant
Plains Elec. Generation and
Transmission Corp.
2401 Aztec Road, N.E.
Albuquerque, New Mexico 87107
Telephone 505-344-3458

John Herbert
Save Our Rivers Committee
Box 116
Eden, Utah 84310

James Young
Ecological Services, Fish &
Wildlife Service, Room 1426
Federal Building
125 So. State Street
Salt Lake City, Utah 84138
Telephone 801-524-5637 (Commercial)
588-5637 (FTS)

Wallace N. Gibson
Federal Representative
Bear River Commission
Ebeling Bldg., 22 East Center St.
Logan, Utah 84321

L.D. Morrill
Colorado Water Con. Board
102 Columbine Bldg.
1845 Sherman Street
Denver, Colorado 80203
Telephone 303-892-3441

Bob Wilson
Upper Colorado River Commission
335 So. Fourth East
Salt Lake City, Utah 84111
Telephone 801-531-1150

Ed Bates
Region VIII, Dept. of Energy
1075 So. Yukon Street
P.O. Box 26247
Belmar Branch
Lakewood, Colorado 80226
Telephone 303-234-2476 (Commercial)
234-2476 (FTS)

Heber Hardman
Div. of Planning, USBR
Room 7406, Federal Building
125 So. State
P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5524 (Commercial)
588-5524 (FTS)

John Benson
Div. of Planning, BLM
Room 1504, University Club Bldg.
136 East South Temple Street
Salt Lake City, Utah 84111
Telephone 801-524-5431 (Commercial)
588-5431 (FTS)

John McComb
Southwest Office, Sierra Club
338 De Vargas Street
Santa Fe, New Mexico 87501

Brant Calkin
Southwest Office, Sierra Club
338 De Vargas Street
Santa Fe, New Mexico 87501

Eric B. Jones
Division of Resources
Colorado State Office, BLM
Colorado State Bank Building
1600 Broadway
Denver, Colorado 80202
Telephone 303-837-4888 (Commercial)
327-4888 (FTS)

Bruce P. Van Haveren
Division of Resources
Colorado State Office, BLM
Colorado State Bank Building
1600 Broadway
Denver, Colorado 80202
Telephone 303-837-4888 (Commercial)
327-4888 (FTS)

J. Calvin Giddings
American White Water Affiliations
1425 Perry Avenue
Salt Lake City, Utah 84103
Telephone 801-521-9496

Carl Baird
Intermountain Region
U.S. Forest Service
324 25th Street
Ogden, Utah 84401
Telephone 801-399-6561 (Commercial)
586-6561 (FTS)

Jack R. Grieb
Division of Wildlife
Dept. of Natural Resources
6060 Broadway
Denver, Colorado 80216
Telephone 303-825-1192

J. Bryan Dewell
Save Our Rivers Committee
56 North 800 West
Woods Cross, Utah 84087
Telephone 801-295-2754

Dan Dufphey
Division of Wildlife Resources
Department of Natural Resources
1596 West North Temple Street
Salt Lake City, Utah 84116
Telephone 801-533-9333

Marvin Combs
Division of Water and Land Opr.
Bureau of Reclamation
Room 7432, Federal Building
125 So. State., P.O. Box 11568
Salt Lake City, Utah 84147
Telephone 801-524-5458 (Commercial)
588-5458 (FTS)

Robert L. Pearson
Public Service Co. of Colorado
550 15th Street, P.O. Box 840
Denver, Colorado 80201
Telephone 303-571-6122

Jim Johnson
Division of Resources
600 Colorado State Bank Bldg.
1600 Broadway
Denver, Colorado 80202
Telephone 303-837-4888 (Commercial)
327-4888 (FTS)

Robert B. Gervais
Division of Resources
600 Colorado State Bank Bldg.
1600 Broadway
Denver, Colorado 80202
Telephone 303-837-4888 (Commercial)
327-4888 (FTS)

Douglas Crow
Wyoming Game and Fish Department
5400 Bishop Blvd.
State of Wyoming
Cheyenne, Wyoming 82002
Telephone 307-777-7631

De Earl Woolenzien
Wyoming Game and Fish Department
5400 Bishop Blvd.
State of Wyoming
Cheyenne, Wyoming 82002
Telephone 307-777-7631

Clarence Council
Region VIII, Dept. of Energy
P.O. Box 26247, Belmar Branch
Lakewood, Colorado 80203
Telephone 303-234-2476 (Commercial)
234-2476 (FTS)

Don Metz
Field Supervispr
US Fish & Wildlife Service
2934 West Fairmount
Phoenix, Arizona 85107

Bruce Kaliser
Utah Geological and Mineral Survey
103 U.G.S. Bldg. University of Utah
Salt Lake City, Utah 84112
Telephone 801-581-6831

C.D. Brown
Central Utah Projects Office
160 N. 200 W.
P.O. Box 1338
Provo, Utah 84601
Telephone 374-8610 (Commercial)
584-0217 (FTS)

Bryce Lundell
Wyoming State Forestry Division
2424 Pioneer Avenue
State of Wyoming
Cheyenne, Wyoming 82202
Telephone 307-777-7586

Wm R. Keefer
U.S. Geological Survey
Bldg. 25, Denver Federal Center
Lakewood, Colorado 80225
Telephone 303-234-3625 (Commercial)
234-3625 (FTS)

~~Robert McPhee~~
Colorado State Land Board
Department of Natural Resources
1845 Sherman Street
Denver, Colorado 80203
Telephone 303-892-3451

Karl Starch
Bureau of Mines
Bldg 20, Denver Federal Center
Lakewood, Colorado 80225
Telephone 303-234-4161(Commercial)
234-4161(FTS)

Leslie A. Jones
WRGA, ACA, AWA, ARCC
Star Route
Heber, Utah 84032
Telephone 801-654-2156
or SLC 328-8292
(Pullman Torkelson)

Don Bock
National Park Service
Bureau of New Area Studies
655 Parfet Street
Box 25287, Denver Federal Center
Denver, Colorado 80225

James L. Isenogle
Rocky Mountain Regional Office
National Park Service
Room 2208, Federal Building
125 So. State Street
Salt Lake City, Utah 84138
Telephone 801-524-4112 (Commercial)
588-4112 (FTS)

Robert Stevenson
Wyoming Recreation Commission
604 East 25th Street
State of Wyoming
Cheyenne, Wyoming 82002
Telephone 307-777-7695

Tharold Green, Jr.
Utah Outdoor Recreation Agency
105 State Capitol
Salt Lake City, Utah 84114
Telephone 801-533-5691

Alan R. Everson
Coloardo Div. of Parks and Out. Rec.
Dept. of Natural Resources
1845 Sherman Street
Denver, Colorado 80203
Telephone 303-892-3437

Carl Haaser
Recreation and Lands Division
Intermountain Region
U.S. Forest Service
324 25th Street
Ogden, Utah 84401
Telephone 801-399-6666 (Commercial)
586-6666 (FTS)

Bill Brown
Bureau of Land Management
Denver Service Center, Bldg. 50
Denver Federal Center
Denver, Colorado 80225
Telephone 303-234-5094 (Commercial)
234-5094 (FTS)

Kim Crumbo
Utah Wilderness Coordinator
Sierra Club
P.O. Box 1860
Park City, Utah 84060

Brian Beard
Conservation Coordinator
Utah Chapter, Sierra Club
93 East 1st South
Logan, Utah 84321

Colorado Open Space Coordinating
Council
1325 Delaware
Denver, Colorado 80204

Utah Environmental Center
8 East Broadway
Salt Lake City, Utah 84111

Environmental Defense Fund
1130 Capitol Life Center
16th at Grant Street
Denver, Colorado 80203

Executive Director
Four Corners Regional Commission
238 Columbine Building
1845 Petroleum Plaza
3535 East 30th South
Farmington, New Mexico 87401

Mr. Dennis A. Davis
Executive Secretary
State Clearinghouse for Fed. Programs
Office of Economics Planning and Dev.
1624 Adams, Third Floor
Phoenix, Arizona 85007

Director
Central State Clearinghouse
338 East deVargas Street
Santa Fe, New Mexico 87501

State Planning Coordinator
Office of the Governor
2320 Capitol Avenue
State of Wyoming
Cheyenne, Wyoming 82002

Mr. Harris Sherman
Executive Director
Dept. of Natural Resources
1845 Sherman Street
Denver, Colorado 80203

Mr. John L. McKinley
Executive Secretary
Western Systems Coord. Council
39th Avenue, Engineering Center
P.O. Box 840
Denver, Colorado 80201

Mr. J.P. Paris
Division Manager
California Pacific Utilities Co.
P.O. Box 550
Cedar City, Utah 84720

Regional Solicitor
Department of the Interior
Room 6201, Federal Building
125 South State Street
Salt Lake City, Utah 84138

Commissioner
Attention: 700
Bureau of Reclamation
Washington, D.C. 20013

Regional Director
Upper Colorado Region
Bureau of Reclamation
P.O. Box 11568
Salt Lake City, Utah 84147

Project Manager
Central Utah Projects Office
Bureau of Reclamation
P.O. Box 1338
Provo, Utah 84601

Regional Sup. of Water & Land Oper.
Upper Colo. Reg., Bureau of Reclamation
P.O. Box 11568
Salt Lake City, Utah 84147

Area Manager
Western Area Power Administration
Department of Energy
P.O. Box ~~11568~~ 806
Salt Lake City, Utah 84147

Regional Planning Officer
Upper Colo. Reg., Bureau of Reclamation
P.O. Box 11568
Salt Lake City, Utah 84147

Wyoming Reclamation Representative
Bureau of Reclamation
P.O. Box 167
Cheyenne, Wyoming 82001

Project Manager
Western Colo. Projects Office
Bureau of Reclamation
P.O. Box 1728
Grand Junction, Colorado 81501

Chief, Plans and Engineering Branch
Division of Planning
Upper Colo. Reg., Bureau of Rec.
P.O. Box 11568
Salt Lake City, Utah 84147

Acting Regional Power Coordinator
Upper Colo. Reg., Bureau of Rec.
P.O Box 11568
Salt Lake City, Utah 84147

Chief, Reports Branch
Division of Planning
Upper Colo. Reg., Bureau of Rec.
P.O. Box 11568
Salt Lake City, Utah 84147

Regional Director
Attn: 600 and 700
Lower Colorado Region
Bureau of Reclamation
P.O. Box 427
Boulder City, Nevada 89005

Mr. Dick Carter
Utah Regional Representative
The Wilderness Society
4490 South 1300 East
Salt Lake City, Utah 84117

Darrell H. Nish
Division of Wildlife Resources
Department of Natural Resources
1596 West North Temple Street
Salt Lake City, Utah 84116
Telephone 801-533-9333

Project Manager [illegible]
Durango [illegible]
Telephone – 303-247-0247

STATUS REPORT

PEAKING POWER INVESTIGATIONS

Upper Colorado Region
Bureau of Reclamation
U.S. Department of the Interior
Salt Lake City, Utah
September 1978

SUMMARY AND CONCLUSIONS

Summary

A preliminary report on pumped storage investigations in the Upper Colorado Region was issued by the Bureau of Reclamation in March 1964.[1/] Results of the investigations led to the 1966 authorization of a study of the feasibility of developing peaking power in the Upper Colorado Region. Though authorized, the investigations were not funded until FY 1975.

A Multiple Objective Planning (MOP) Team was formed in April 1975 and several subteams were created to aid in the study process.

Power interests expressed a strong desire to explore the possibilities of Federally-sponsored hydropeaking power. Other interests suggested that conservation measures and load modification efforts, interties, etc., be explored before going into new construction. These suggestions were acknowledged. All things considered, it was deemed expedient to proceed with the hydropeaking studies while recognizing that it would be 1986 before anything recommended in the study could become a producer.

The peaking power needs for the Colorado River Storage Project marketing area were estimated for the target period from 1986 to 2000. Around 150 sites were identified and analyzed by the MOP Team members. Analytical methods involved ranged from field visits to computer ranking of the sites. The initial goal of this analysis was to formulate a plan from the sites analyzed which could meet the peaking needs projected. These sites would then be recommended for feasibility study. The goal was eventually changed so that the study would become an ongoing process. Sites were to be recommended for feasibility study on an individual basis as future needs were projected. The plan formulation process eventually resulted in the selection of 26 sites to be presented to the public. Six public meetings were held in different locations around the Region. The input gained from these meetings was combined with the previously accumulated data. As a result, three sites, Utah Lake Pumped Storage and Blue Mesa and Glen Canyon Outlet Works, were recommended for feasibility study in fiscal year 1979. The conclusions and recommendations reached and the reasoning behind these conclusions and recommendations are the subject of this report.

Conclusions

Based upon the defined objectives, it was concluded that there is an interest in Federally-sponsored hydroelectric peaking power to help meet future requirements during the periods of high use in the Colorado River Storage Project service area. Estimated peaking power demands of the CRSP

1/ Pumped Storage Investigations, Preliminary Reconnaissance Report, Bureau of Reclamation, Region 4, Salt Lake City, Utah, March 1964.

marketing area total about 14,000 megawatts (MW) for the year 2000, of which about 4,300 MW could be supplied from pumped storage facilities and an additional 1,500 MW could come from conventional or "flow-through" facilities.

The studies showed that there is a place for pumped storage in the overall mix of sources for electric power, but it must be competetive in price when considered with other alternatives. Power companies and preference customers are willing to pay a small premium for pumped storage in exchange for the small gamble they feel they face relating to the cost and availability of oil or natural gas, the principal sources of energy for combustion turbines or combined cycle processes and the chief competition to pumped storage. Biological and environmental interests (at the present time) appear to be more interested in the environment than in some services provided by the use of electric power in order that certain elements of the environment may be preserved.

The investigations have shown that there are numerous hydroelectric possibilities for helping to meet the estimated peaking power needs. The 150 or so pumped storage sites considered at one time or another by no means identified all the potential sites and the possibility of modifications at existing or under-construction facilities does not preclude other alternatives at these locations. In addition, both regulated and unregulated streamflows provide a potential source of electric power by using low-head turbines, some of which may be capable of providing peaking power.

One of the conclusions reached was that the possibility of developing peaking power at or near the point of use should be investigated. This means that such facilities to serve the Phoenix load center, for example, possibly could be more environmentally and economically feasible if located at Phoenix rather than situated in the Upper Colorado Region. However, because of the constraints of Regional boundaries, no investigation of this type of alternative was conducted.

The studies have identified several pumped storage sites that have the physical capability of developing up to 15,000 MW of capacity. For various reasons, not all of these were considered as alternative plans, but four emerged as possibilities. One was selected as a single-site alternative but because of transmission, operation and environmental considerations, it was concluded that this alternative was not as good as a subregional concept even though the economies of scale were present.

Considering environmental factors, economies of scale, operations, etc., some combination of sites and load centers was concluded to be a viable method to meet the estimated peaking power demands. One alternative by which this could be accomplished would be to divide the Upper Colorado Region into Southern Utah, Western Colorado, and Northern Utah Subregions and assign the load centers to one of the Subregions. The Southern Utah Subregion would serve the Phoenix and Las Vegas load centers, the Western Colorado Subregion would serve the Denver and Albuquerque load centers, and the Northern Utah Subregion would serve the Salt Lake City and Casper load centers. By using this approach some economies of scale could be possible while at the same time providing some possible solutions to operational, transmission, and environmental problems.

Early in the investigations it was recognized that the impacts of conservation measures, interregional interties, changes of rate schedules, etc., would affect the estimated needs for peaking capacity. The Power Subteam concluded that these effects would be felt differently in various parts of the CRSP service area and that each utility or major agency/distributor should, in estimating its future needs, also estimate the effects of the various measures. The end results of the estimates were combined and coordinated for the entire subteam and the total was allocated to each of the Subregions. These amounts were useful in deciding, among other things, the timing for which a candidate site was to be recommended for a feasibility study.

Power generation facilities were included in two studies that were underway at the beginning of the peaking power investigations. One of these studies is on the Diamond Fork power system, a part of the under-construction Bonneville Unit of the Central Utah Project (CUP). The system is being studied to determine if pumped storage can feasibly be added to a conventional "flow-through" system. The other study is on the power resources and needs associated with the Dominguez Project, on which feasibility studies have been authorized. This multipurpose project would develop water resources on the Gunnison River in the vicinity of Grand Junction, Colorado. The MOP Team concluded that the estimated amount of power that should be developed by these projects would be included as a part of the solution to the total peaking demand of 5,800 MW but that recommendations would not be appropriate because the studies were already underway.

The subteam investigations showed that oil consumption can be reduced through proper utilization of hydropeaking power facilities. The reduced consumption is calculated principally on the basis of what the estimated oil consumption would be with oil-fire combustion turbines or combined cycle facilities supplying the 5,800 MW of peaking capacity instead of it being generated from hydroresources. The amount of oil thus displaced is estimated to be in excess of 105 million barrels during the 1986-2000 period. Because of the efficiency of pumped storage about 27 million additional tons of coal would be required over the 15-year period to supply the pumping energy assuming all pump-back energy is supplied by coal-fired units.

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EXHIBITS

Introduction

By letter dated March 1, 1962, the Commissioner of Reclamation requested a preliminary reconnaissance appraisal of the potential for the development of peaking power in the Upper Colorado Region. A March 1964 report, in response to this request, resulted in Public Law 89-561 dated September 7, 1966, which, among other things, authorized the Secretary of the Interior to engage in feasibility studies on potential power peaking capacity in the Upper Colorado River Basin and the eastern part of the Bonneville Basin along the Wasatch Mountains in Utah. These studies remained unfunded until fiscal year 1975 when, partly as a result of the "energy crisis" in 1973, an appropriation was made to initiate the studies in order to assist the Nation in becoming energy self-sufficient.

After due notice to all parties thought to be concerned, a Multiple Objective Planning Team was organized as required by the "Principles and Standards."1/ A group of about 50 people assembled at the first team meeting which was held on April 30, 1975. Approximately 50 more who could not attend the meeting expressed interest to a greater or lesser degree and have participated in subteam investigations or have been kept informed.

Headed by the Bureau of Reclamation, this group of about 100 was formed into seven subteams. A Biological Resources and Needs Subteam, led by a representative of the U.S. Fish and Wildlife Service, included members having principally biologically-oriented interests. A Power Resources and Needs Subteam consisted of representatives of rural electric associations, municipalities, generation and transmission organizations, and power utility companies with leadership coming primarily from a utility company. A consulting engineer headed a Water Resources and Needs Subteam which is composed of representatives of State Engineers and Water Resources Divisions and others knowledgeable about water administration, resources, and development. Land resource and use specialists comprised a Land Resources and Needs Subteam with a representative from the Bureau of Land Management serving as the subteam leader. Those with recreation, archeological, and historical interests for the most part, are members of the Recreation and Cultural Resources and Needs Subteam, which is headed by a representative from the Heritage Conservation and Recreation Service (formerly Bureau of Outdoor Recreation). The other two subteams had to do with plan formulation and report writing and were headed by persons in Reclamation. A Public Involvement Subteam, headed by a representative from the Upper Colorado River Commission, was later formed. The public itself could not be expected to know of projected growth rates in population and energy use, generation, transmission and operation problems, and the economics associated with power production. As a result, the various subteams were considered as adequately representing the public during the early phases of the study.

1/ Principles and Standards for Planning Water and Related Land Resources, National Water Resources Council, Federal Register, September 10, 1973.

The first objective of the MOP Team was to determine from the utility companies and preference customers (communities, REA's, and qualified organizations) if there was a need for a Federally-sponsored hydroelectric power development program to help meet demands during peak use periods. After determining that such a need existed, the next objective was to determine the quantity, location, and timing of the need and how it could be developed.

The area of the study was defined as the market or service area of the Colorado River Storage Project except for southern California. This portion of the service area includes Arizona, Colorado, New Mexico, Utah, Wyoming, and part of Nevada. Representatives on the MOP Team came from every part of the study area.

The Power Subteam established that the study should aim at providing peaking power during the years 1986 through 2000. Through projections of populations, load growth, and other factors the Power Subteam determined that by the year 2000, about 1,050,000 kW of pumped storage capacity would be required in the eastern Colorado service area, 1,000,000 kW could be needed in Arizona, 900,000 kW in Utah, 610,000 kW in New Mexico, 360,000 kW in Wyoming, and 300,000 kW in southern Nevada. Some 100,000 kW were also identified for the area in western Colorado and parts of eastern Utah.

While these determinations were going on in the Power Subteam, some 150 potential peaking power sites were identified by the Plan Formulation Subteam. The Federal Power Commission, now part of the Department of Energy, had published a report naming pumped storage sites in Utah, Arizona, Nevada, and California identified from map reconnaissance studies.1/ Of the sites named in the report, 56 were located within the boundaries of the Upper Colorado Region and were included as a part of the 150 sites previously mentioned. Starting in about 1964, the Bureau of Reclamation had recognized, again principally from map studies, several potential pumped storage sites in the Upper Colorado Region. The Plan Formulation Subteam looked for more potential sites and, in addition to pumped storage, included the generation at existing Federal storage and power facilities in the Region. Suggestions from all resource subteams were submitted and reviewed.

1/ Federal Power Commission, Bureau of Power, Potential Pumped Storage Projects in the Pacific Southwest, 1975.

CHAPTER 1

DESCRIPTION OF THE REGION

Setting

The Upper Colorado Region is comprised of the drainage basin of the Upper Colorado River and its tributaries upstream of Lee Ferry, Arizona, and the Bonneville Basin in the eastern portion of the Great Basin. The Region encompasses an area of approximately 162,200 square miles including about 109,600 square miles in the Upper Colorado River Basin and 52,600 square miles in the Bonneville Basin. Located within the Region are parts of seven States including nearly all of Utah, the western third of Colorado, and the southwestern quarter of Wyoming. Also included are smaller portions of Arizona, New Mexico, Idaho, and Nevada. The area of the Region is shown below by State.

Area of Upper Colorado Region by State
(Unit--square miles)

State	Upper Colorado River Basin	Bonneville Basin	Total
Arizona	6,900		6,900
Colorado	38,600		38,600
Idaho		3,400	3,400
Nevada		3,900	3,900
New Mexico	9,700		9,700
Utah	37,300	43,800	81,100
Wyoming	17,100	1,500	18,600
Total	109,600	52,600	162,200

Settlement and Economic Development

The first white settlements in the Upper Colorado Region began in a unique way. In 1847, the first part of a mass migration of Mormon pioneers settled in the area which later became Salt Lake City and within 10 years 50,000 people had settled in the area. Families were soon dispatched to settle many of the present cities and towns in the Region. Water was diverted from streams to adjacent crop lands for irrigation and the production of food crops. Irrigation development spread throughout the Region and nearly 3.3 million acres are irrigated at present. In addition, nearly 2 million acres are dry farmed. The livestock industry soon became an important sector of the agricultural economy of the Region and is a major industry in most of the Region today.

Gold was discovered in north-central Colorado in 1859 and the production of minerals such as gold, silver, lead, copper, and zinc became economically important in parts of the Region during the next 10 years. Since about 1900 mining activities have been concentrated mostly on coal and iron. Uranium mining has also been important in western Colorado and eastern Utah. The production of oil and natural gas became of significance during the 1940's and 1950's although activity has tapered off in recent years.

Timber harvesting began with the early settlers who produced lumber for home and business construction, fuel, and poles. With completion of the transcontinental railroad in 1869 several million railroad ties were produced until about 1905. Timber is of major importance to the local economy of the Region at present.

Tourism and recreation have become one of the largest industries in the Region in recent years. Each State within the Region depends heavily on income derived either directly or indirectly from recreational pursuits. Facilities and resources found within the Region are suitable for a recreational spectrum unequaled in any other part of the United States. Also, growing urban areas within or near the Region are becoming important industrial centers and have resulted in the relocation of thousands of workers and their families.

Recreational facilities or resources include local facilities such as parks, golf courses, and fairgrounds; private, State, and Federal intensive use areas such as ski resorts, camping and picnicking areas, reservoirs, fish hatcheries, and lakes; natural areas including National parks, monuments, and recreation areas, wildlife refuges and management areas, and outstanding geologic, historic, archeologic, or paleontologic features; and primitive and wilderness areas. Public lands, which are principally controlled by the Bureau of Land Management and the Forest Service, constitute nearly 90 percent of the existing recreation acreage in the Region.

Population

The population of the Upper Colorado Region was about 1,342,000 in 1970. About two-thirds of the total is located along the western slope of the Wasatch Mountains in northern Utah. The remainder of the population is scattered throughout the Region in towns of generally less than 10,000 people. The only communities away from northern Utah with populations in excess of 10,000 in 1970 were Grand Junction in western Colorado, Farmington in northwestern New Mexico, Durango in southwestern Colorado, and Rock Springs in southwestern Wyoming.

Topography and Geology

The topography and geology of the Region are quite varied. In the Upper Colorado River Basin highly dissected mountainous plateaus typified by deep canyons, river valleys, rolling ridges, and flat-topped mesas are prominent. The Bonneville Basin is characterized by parallel mountain ranges separated by broad desert basins. The Rocky Mountain Range, from the Wind River Mountains in central Wyoming to the San Juan Mountains in southwestern Colorado, forms the eastern boundary of the Region. The Uinta Mountains in northeastern Utah constitute the only major east-west trending mountain range in the continental United States. The Wasatch Range in central Utah divides the Upper Colorado River Basin from the Bonneville Basin. Elevations in the Region vary from about 3,100 feet at Lee Ferry, Arizona, to about 12,000 feet in the Wasatch Mountains, over 13,000 feet in the Uintas, and over 14,000 feet in the Rockies. Other mountain ranges in the Region generally do not exceed 10,000 feet in elevation.

The southern and southeastern portions of the Upper Colorado River Basin are predominantly characterized by severely eroded sedimentary rocks. High, flat-topped plateaus and mesas separated by narrow, nearly vertical-walled canyons are the products of continuing stream erosion which has exposed various rock layers of all ages. Several National parks and monuments have been designated in this area of dramatic erosional features and brilliant rock colors. The northern portion of the Upper Colorado River Basin is underlain mostly by sedimentary rocks having a more gentle topography than the southern and southeastern portions. Except for the Uinta Mountains, rolling plains with shallow stream valleys are the rule.

In the Bonneville Basin the present landscape is the result of intense and complex faulting and folding and periods of erosion which have subdued highlands and filled lowlands with sediment. The alternating processes of sedimentation, mountain building, and erosion have occurred repeatedly and at various times. Shoreline and beach features, common in much of the Bonneville Basin, were formed by ancient Lake Bonneville which covered about 20,000 square miles, mostly in western Utah. Great Salt Lake and Utah Lake are present-day remnants of Lake Bonneville.

Climate

The climate of the Upper Colorado Region is a product of its location, elevation, and topography. These three factors combine to produce wide variations in precipitation, temperature, and other climatic elements.

Precipitation

Average annual precipitation in the Region ranges from less than 5 inches in the Great Salt Lake Desert to approximately 60 inches in the higher portions of the northern Wasatch Mountains. Average precipitation in most of the populated and agricultural areas varies from about 10 to 20 inches a year.

Precipitation from late October through mid-April consists primarily of snow, particularly at higher elevations. Annual snowfall ranges from about 5 inches in some lower valleys to several hundred inches on the western slopes of the Wasatch Mountains. Snow accumulations occasionally exceed 100 inches at the higher elevations and do not completely melt until late summer. The driest part of the year is generally during the summer months in the northern and western parts of the Region and in the late spring and late fall in the southern and eastern parts where summer thunderstorms contribute significantly to total annual precipitation.

Temperature

Temperatures in the Upper Colorado Region vary widely as a result of elevation and latitude and seasonal and daily effects. Other things being equal, there is a decrease in average annual temperature of about 1.5° F with each degree of increased latitude and a decrease of roughly 3° F for each 1,000-foot increase in elevation. Actual temperatures, however, are quite dependent upon local exposure characteristics of each site.

At most climatological stations mean monthly temperatures are lowest in January and highest in July and generally show about a 50° F difference between the two seasons. Average annual temperatures vary from below freezing at elevations about 10,000 feet to about 50° F for river valleys below 5,000 feet. Extreme temperatures have varied from -60° F at Taylor Park, Colorado, to 115° F at Lees Ferry, Arizona.

The frost-free period, or consecutive days with minimum temperatures above 32° F, varies greatly with elevation. The period ranges from 20 days or less annually at elevations above 8,500 feet, where freezing temperatures can occur at any time of the year, to more than 200 days a year in the warmest portions of the Region.

Water Resources

The largest sources of water in the Upper Colorado Region are the Colorado River and its tributaries in the Upper Colorado River Basin and the Bear, Weber, Jordan, and Sevier Rivers and their tributaries in the Bonneville Basin. The Green, Gunnison, and San Juan Rivers are the largest tributaries of the Colorado River. The Green has, in turn, several major tributaries which are Blacks Fork and Hams Fork in southwestern Wyoming, the Yampa and White Rivers in northwestern Colorado, and the Duchesne, Price, and San Rafael Rivers in eastern Utah. Important streams that enter the Colorado River directly are the Roaring Fork, the Eagle, and Dolores Rivers in western Colorado and the Dirty Devil, Escalante, and Paria Rivers in southeastern Utah.

Most streamflows originate in the high mountainous areas of the Region where heavy snows accumulate. About 70 percent of the annual runoff occurs during the April to July snowmelt period, following which flows dwindle rapidly and remain at relatively low levels for the remainder of the year.

Large quantities of ground water underlie the Region. Ground water is an important resource and is used considerably in the Bonneville Basin. Only minor amounts of ground water are used in the Upper Colorado River Basin, however.

A few large natural lakes exist in the Region and several large reservoirs have been constructed for water storage. The principal lakes are Great Salt Lake (saline) and Utah Lake in north-central Utah and Bear Lake in southeastern Idaho and northeastern Utah. Nearly all of the large reservoirs were constructed as part of the Colorado River Storage Project, including Lake Powell on the Colorado River, Flaming Gorge Reservoir on the Green River, Navajo Reservoir on the San Juan River, and Blue Mesa, Morrow Point, and Crystal Reservoirs on the Gunnison River, a tributary of the Colorado River in west-central Colorado.

The major use of water in the Region is for irrigation. Other important uses are for municipal, industrial, domestic, stock, fish and wildlife, and recreation uses, and for power and mineral production.

The quality of surface water generally is very good in the Upper Colorado Region and, except in a few areas, is satisfactory for irrigation, livestock watering, and municipal and industrial purposes. The average concentration of total dissolved solids is generally less than 100 mg/l in headwater areas of streams and gradually increases downstream as a result of consumptive use and the pickup of minerals from the underlying rocks. Weighted average concentrations generally do not exceed 500 mg/l in the larger streams except in some lower reaches below irrigated lands.

Suspended sediment concentrations and loads vary widely throughout the Region. The load is normally light in the upper reaches of the major streams but increases in the middle and lower reaches. High sediment concentrations are detrimental to consumptive uses of water as well as to cold water fisheries and recreation. The construction of large reservoirs on several rivers in the Region has considerably reduced sediment concentrations in downstream reaches of those rivers.

Surface water quality, characterized by nutrients, dissolved oxygen, and bacteria concentrations, is generally good except for localized problems.

The quality of ground water varies widely but overall is not as good as surface water quality. Generally, the better quality ground water is found in alluvial aquifers near the headwaters of major streams. The quality generally declines downstream with the recommended limits for particular uses often being exceeded. Ground water from deeper aquifers is typically too highly mineralized for most uses.

Vegetal Cover and Land Use

Vegetal cover in the Upper Colorado Region includes the categories of alpine, forest, range, cropland, and barren. Cropland and barren, although not vegetal in nature, exist in lieu of vegetal cover and are, therefore, included.

Alpine areas have little or no vegetal cover and include shale, rock slides, snow fields, and glaciers at elevations usually higher than 11,000 feet. The principal use of alpine areas is as watershed.

Forest areas include those below alpine areas and above rangelands. At higher elevations spruce, fir, pine, and aspen are predominant, while at lower elevations brush and shrubs such as oak, mountain mahogany, and big sagebrush are prevalent. On foothills and low mountain areas pinyon pine and juniper are often abundant. The forests are used mostly for watersheds, wildlife forage, wood, and recreation.

Range areas are nonforest areas used mainly for grazing by wildlife and livestock. Vegetal cover on rangelands consists of grasses, northern desert shrubs such as big sagebrush, southern desert shrubs such as saltbush and blackbrush, and salt desert shrubs such as shadscale, greasewood, and saltbush.

Croplands include both irrigated and dry farmed areas. The principal crops produced on irrigated lands are meadow hay, alfalfa hay, corn, sugar beets, grain, and vegetables. Apple, peach, and cherry orchards are found in some areas protected from spring frost. Dry farmed areas generally produce winter wheat, pinto beans, and hay.

Barren areas include urban areas; areas used for transportation, utilities, and industries; intermittent lake beds; salt flats; active sand dunes; shale; rock slides; and lava flows.

Fish and Wildlife

Fish are found in many rivers, streams, lakes, and reservoirs in the Upper Colorado Region. Cutthroat trout and mountain whitefish are the only native game fish found in the Region. Four endemic non-game fishes are also present in the Region. These are the Colorado squawfish, the humpback chub, the bonytail chub, and the razorback sucker. The Colorado squawfish and the humpback chub are both considered endangered species. The most important introduced cold water species is the rainbow trout which is stocked in tremendous numbers each year. Introduced warm water species include channel catfish, bass, walleye, bluegill, crappie, and carp.

Numerous game and non-game species of wildlife are found throughout the Region. Major game species include deer, elk, moose, antelope, big horn sheep, rabbits, pheasants, sage grouse, doves, chukar, partridge, quail, turkeys, and several species of ducks and geese. Black bear, mountain lions, coyotes, and bobcats are also hunted. Most waterfowl hunting occurs around Utah Lake and along the eastern shores of Great Salt Lake and portions of the Colorado, Green, Yampa, Bear, Sevier, and San Juan River valleys. Several endangered species of wildlife inhabit portions of the CRSP area. These include the black-footed ferret, the Utah prairie dog, the American peregrine falcon, the whooping crane, and the bald eagle. Other species that are of particular concern to conservation interests include the golden eagle, the wolverine and the spotted bat.

Mineral Resources

Significant mineral resources occur in the Upper Colorado Region. Mineral fuels are of particular importance, particularly in the Upper Colorado River Basin.

Oil and natural gas have been discovered in more than 40 fields from southern Wyoming to northern New Mexico. Large deposits of oil shale are found in portions of eastern Utah, southwestern Wyoming, and northwestern Colorado. Coal reserves are extensive in much of southern Wyoming, northwestern and southwestern Colorado, central and northeastern Utah, and northwestern New Mexico. Uranium and associated vanadium deposits are abundant in east-central Utah and extreme west-central Colorado.

Other important minerals found in the Region are gold, silver, lead, copper, zinc, iron ore, molybdenum, limestone and dolomite, and phosphate. Also important are dawsonite, halite, gypsum, nahcolite, potash, pyrite, trona, salt, clays and sand and gravel.

Natural, Historical, and Archeological Resources

The Upper Colorado Region is rich in natural, historical, and archeological resources.

Natural areas in the study area vary from snowcapped mountains reaching elevations of over 14,000 feet to the spectacular scenic and swirling rapids of the Colorado River and its tributaries. Outstanding geological features include numerous natural bridges and arches and great wild canyons such as the Black Canyon of the Gunnison. Diverse landscapes are created by needles, spires, standing rocks, broad plains, steep scarps, and intricately dissected canyons.

History of the Region is closely associated with that of the entire west. Many of the mountains and streams bear the names of the early explorations made by Fathers Dominguez and Escalante, John Charles Fremont, and Major John Wesley Powell. Other historic events notable to the area include the migration along the Oregon Trail and the gold rush to California.

Many archeological ruins, petroglyphs, and pictographs are scattered throughout the Region. Evidence of ancient Indian occupation is found in village ruins and cliff dwellings dotting the mesa tops and valley floors. The most significant of these village ruins exist at Mesa Verde National Park and at Chaco Canyon, Aztec Ruins, Hovenweep, Pueblo Bonito, Navajo and Canyon de Chelly National Monuments.

The combination of these natural, historical, and archeological features protected in a system of National forests, parks, monuments, and recreation areas, as well as areas provided by State and local entities, are the much sought-after recreation resources of the study area.

CHAPTER II

SUBTEAM INVESTIGATIONS

Plan Formulation of the Peaking Power Study

The plan formulation process of the Peaking Power Study formally began after the various subteams had a firm start and were gathering data useful for their site analyses. Each subteam had approximately 120 sites to consider initially and 30 more over the course of the study.

The Power Subteam initiated plan formulation efforts by beginning their analysis of the hydropeaking needs of the Upper Colorado marketing area. Seven principal load centers were identified: Denver, Phoenix, Salt Lake City, Montrose, Las Vegas, Albuquerque, and Casper. The subteam was charged with developing power needs for each of these load centers for the 1986 to 2000 period, and these needs provided the framework upon which plans were to be developed.

Early planning efforts were aimed at producing the estimated power needs by means of both National Economic Development (NED) and Environmental Quality (EQ) types of plans. The Power Subteam spearheaded suggestions for the NED plans, and the Biological and Recreation Subteams the EQ plans. At the same time, the option for the recommendation for a no-action plan remained open. By the summer of 1976, through the accumulated data collected, the various subteams were ready to put forth their preferences for meeting the forecast needs. These recommendations served more to eliminate projects from further study rather than to suggest specific plans. This left a more workable number of sites, and enabled representatives of the MOP Team to visit most of the sites during the summer of 1976. This reconnaissance team included an engineer, a geologist and a biologist. They each considered the sites from their respective viewpoints and reported their findings to the MOP team. This information was studied through the winter of 1977 and by spring each subteam was requested to submit a list of 5 to 8 of the most favored and most disliked of the candidate sites.

Beginning about the summer of 1977 a number of significant changes evolved which changed the course of the plan formulation studies. The Power Subteam had been continuously analyzing the Region's hydropeaking needs. Early forecasts had indicated a need for 15,000 MW of peaking power by the year 2000. By coordinating loads this figure was soon lowered to 14,000 MW but it later became apparent that the available amount of off-peak pumping energy would limit pumped storage to providing only 4,300 MW of the peaking power needs. An additional 1,500 MW appeared to be possible from flow-through facilities, making a total of 5,800 MW to be planned for by the year 2000. This was a more workable number and allowed further additions to the planning framework.

Regardless of EQ or NED constraints, the needs of the Region could be met in one of three ways: one site could serve the entire Region, several sites could serve a number of Subregional load centers, or many sites could serve individual load centers. It was felt that a number of viable plans of each of these three alternatives should be formed and EQ and NED plans selected from the results. For plan formulation purposes three rough Subregions were designated: Northern Utah, Southern Utah, and Western Colorado. Which load center belonged in which Subregion was flexible in accordance with the overall plan being developed. Within this added framework were the additional considerations of emphasizing development at existing facilities, either conventional or pumped storage additions, or to emphasize new facility development. The former received the most emphasis as such sites could minimize environmental, sociological, and recreational impacts in relation to developing new areas which have not been impacted by large scale development.

The most significant change of the study occurred as a result of the 1977 Reclamation Programming Conference. The course of the study was changed so that rather than producing a number of recommended plans, the study was given an ongoing status. Individual sites could be selected for study on a feasibility level independent of the other peaking power projects. The intention of this move was to allow the Bureau to continue to help meet the peaking needs of the CRSP marketing area well into the future. This decision made working towards overall Regional NED or EQ plans infeasible, and made the creation of Regional, Subregional, and local load center type of plans the primary goal. As a future need was foreseen, attractive candidate sites could be proposed for feasibility study. A site could either be intended to meet the entire Region's needs, or just the needs of an individual load center. In the latter case, other sites would be proposed to meet other needs. Hopefully, this format would insure a measure of flexibility to the changing power needs in the future. At this point approximately 48 sites remained under active consideration by the MOP Team. To facilitate the further reduction of this list with a minimal introduction of biases of the subteam members, it was decided to use a numerical methods approach. A computer program was available from the recently completed Western Energy Expansion Study. With some minor modifications the program was suitable for use by the Peaking Power Study. The program called for each site to be scored on a 1 to 10 scale in each of 8 subfactor areas: physical feasibility, benefit-cost ratio, power marketability, recreation, environment, acceptability, social, and return on energy invested. The MOP Team created three "scenarios" which were defined by the weightings given each subfactor. These three scenarios were termed the most likely, the environmental, and the economic. Subteams scored each site in their respective areas of expertise. Total weighted scores were then calculated and tabulated by computer for each of the seven load centers. Following the recommendations of each subteam, Bureau personnel then selected 26 of the top-ranked sites to be presented to the public for their comment. (The sites are listed in the Engineering Section of Chapter III.)

Six public meetings were held in May 1978 and public comment was invited until June 30, 1978. The details of these meetings and comments are presented in the public involvement section of this report.

As a final step, a meeting of Subteam heads reconsidered the list of 26 sites in the light of the public comment. The following recommendations for future feasibility study funding were made. For fiscal year 1979, Glen Canyon Outlet Works, Blue Mesa Outlet Works, and Utah Lake Pumped Storage Site were recommended. For fiscal year 1980, Flaming Gorge Outlet Works and Dunham Point Pumped Storage Site were proposed. Planning for budgeting in subsequent fiscal years will require additional meetings at least once a year.

Power Resources and Needs Subteam Investigations

The Power Resources and Needs Subteam was created by the MOP Team to analyze the potential peaking power need in the Colorado River Storage Project service area. This section summarizes the findings, conclusions, and recommendations of the Power Subteam as contained in its report.[1/]

The objectives of the Subteam were: (1) to determine the interest that the power related organizations have in developing Federally-sponsored peaking power, (2) to gather pertinent information on the market area's loads, energy and peaking capacity demand patterns, and (3) to estimate how much of the total peaking power need could be met through development of peaking power at existing and new flow-through[2/] hydroelectric facilities and pumped storage projects. The Subteam was to develop and evaluate various peaking power expansion plans designed to serve the projected needs of the various load centers and the recommend to the MOP Team a plan for development, as well as methods of financing and operating these facilities.

The Subteam is composed of representatives from interested utilities and other entities located in the CRSP service area which, in general, is identified by the following load centers: Albuquerque, New Mexico; Casper, Wyoming; Denver, Colorado; Las Vegas, Nevada; Montrose, Colorado; Phoenix, Arizona; and Salt Lake City, Utah. Interest in Federally-sponsored peaking power was expressed at the first subteam meeting, which was also the meeting at which the MOP team was formed. All organizations, through

1/ Peaking Power Needs and Hydro-Peaking Projects 1985-2000. Prepared by the Power Resources and Needs Subteam for the Multi-Objective Planning Team of the United States Bureau of Reclamation, Upper Colorado Region, July 1977.

2/ In this report flow-through hydro is defined as facilities to generate electric power from stored water which is released for any purpose other than pumped storage.

these representatives agreed to proceed with the study even though their participation was at their own expense. In addition, interest is expressed by the progressive and continuous participation of these representatives. Participating organizations presently serve about 75 percent of the customers in the service area. Some nonparticipating groups asked to be kept informed, but could not take part.

Projections of growth in the service area are demonstrated in Exhibit 1. Participants in the study were asked to undertake an economic analysis of their individual systems and determine their pumped storage requirements for the year 1990. Requirements for 1995 and the year 2000 would be estimated from the 1990 results. Results of this analysis are tabulated in Exhibit 1 and show a total of 4,300 MW of pumped storage capacity could be utilized by the year 2000. This figure was arrived at by considering the individual responder's requirements as additive. In some cases, values for the years 1995 and 2000 were extrapolated from 1990 by using the percentage of pumped storage capacity to annual peak demand as reported by these particular participants for 1990 as a constant for the years beyond. In other cases, the participants reported the total required by the year 2000. For these latter cases, values for the years 1990 and 1995 were derived by dividing the total for the year 2000 by three.

The conclusions of this subteam are:

1. Forty-three hundred MW of pumped storage and 1,500 MW of flow-through hydroelectric power facilities should be developed to go on-line during the years 1986 through 2000 in order to supply a portion of the peaking power requirements in the CRSP service area.

2. Hydropeaking projects will promote our National goals of oil independence and conservation of existing oil resources by reducing the amount of oil used for peaking power generation, albeit at the expense of increasing coal consumption.

3. Development of individual sites for each load center or of sites for a grouping of load centers consisting of Albuquerque-Denver-Montrose, Casper-Salt Lake City, and Las Vegas-Phoenix offers the lowest cost, including transmission of all the alternative plans considered.

4. Site recommendations should consider environmental conditions in addition to the conventional reasons for selection. The recent examples of the Kaiparowits and Intermountain Power Plant proposals have demonstrated that significant costs can be accrued due to delay alone if sites that appear to be damaging to the environment are considered. Where environmental mitigation measures were recognized, some costs were added to the estimates. Other cost estimates may be deceptively low in relation to what the final cost could be because environmental conditions were not fully recognized by the MOP Team. In most cases sites which were recognized as being damaging to the environment were dropped.

Exhibit 1
Pumped storage needs
Cumulative total for all load centers

Totals	Year 1985	1990	1995	2000
Pumped storage capacity needs (MW)	0	1,696	2,866	4,326
Percent of annual peak demand		5.1	6.8	8.0
Percent of estimated peaking load		18	24	28
Pumped storage energy generated* (MW-HRSx10^6)	0	1.7	2.9	4.3
Percent of annual energy		1.0	1.3	1.5
Percent of estimated peaking energy		33	44	50

*Based on 1,000 hours of operation annually.

5. Financing and operation of these projects can best be accomplished by either of two methods--predominantly Federal or predominantly private. For the former, long-term contracts (approximately 35 years) are essential because the magnitude of private investment required for transmission facilities makes contracts of a shorter term economically unattractive, assuming private ownership of the transmission.

6. Additional analysis, in far greater depth than that which has been detailed in this report, will be required before any commitment can be made to a specific amount of capacity, at a specific site, by any of the area's utilities.

7. The most logical agency to proceed with the followup work necessary to bring these hydropeaking projects into existance is the Bureau of Reclamation because of its experience with the CRSP system.

It is the recommendation of the Power Subteam that the USBR proceed with plans to develop the 5,800 MW of hydropeaking facilities needed to supply part of the participants' estimated peaking load. Specific areas of work which need to be undertaken by USBR to implement this recommendation are:

1. Additional review and, if warranted, detailed design information and costs for economically attractive sites. Final costs will directly impact the amount of capacity subscribed.

2. Investigation of sites outside the Upper Colorado Region closer to the Albuquerque, Denver, Las Vegas and Phoenix load centers. Closer sites would improve the economics of pumped storage for these centers by reducing transmission costs.

3. Study of transmission requirements in more detail to optimize the transmission system design and thereby minimize its cost.

Water Resources and Needs Subteam Investigations

The Water Resources and Needs Subteam was charged with developing hydrologic data, estimating impacts to water quality, establishing possible sources of water supply for candidate sites, studying the existing water rights involved, determining the existing water uses in a site's area, estimating reservoir sedimentation, and coordinating with State plans for water development. Due to the high number of candidate sites identified, some of the above duties were too detailed for the initial purposes of the study. As a result, the Water Resources Subteam concentrated on evaluating the candidate sites on their probable water availability. The remainder of the originally assigned duties were deferred until projects were studied on a feasibility level.

Several sites were eliminated in the early stages of the study because of either a total lack of water in the area, or because of an excessively high sediment load in the water supply. Areas where a water supply existed but was already over allocated were not totally avoided. In general, such problems were noted and an effort made to include acquisition of water rights in the cost estimates. This was either done on the MOP Peaking Power study level or planned to be done on a feasibility study level if the other features of the candidate site warranted further study.

Of the 26 sites presented to the public, the Lees Ferry proposals, Rim Basin, Cimarron Point, and Utah Lake were recommended by the Water Resources Subteam for further study. Areas where an existing water supply is already available for power purposes, such as the outlet works proposals are also recommended.

Land Resources and Needs Subteam Investigations

The purpose of the Land Resources and Needs Subteam was to assemble data pertaining to soils, land use, geology (both topographic and seismic), rights-of-way and ownership, access roads, status, use projections and erosion.

Basic data collected by the Subteam prior to January 1976 were used to make an initial ranking of the sites which had been identified. The sites were scored on a 1 to 5 scale (1 being most desirable for development from a land use point of view and 5 the least desirable). Eleven of the sites were later recommended by the Land Subteam for further study.

As was mentioned in the Plan Formulation Section, a USBR geologist participated in the MOP Team's field reviews. His site evaluations provided data for the Subteam to facilitate further consideration of the sites. In March of 1977 the subteam recommended 10 sites. Some of these sites had been recommended in 1976, some had not been, and some were new to the study since the initial recommendations were made.

When the goal of the study was changed to that of recommending individual sites for feasibility study, the Land Subteam was asked to help rank the sites remaining for consideration. Their input was primarily reflected in the physical feasibility and acceptability subfactor areas.

Biological Resources and Needs Subteam Investigations

The responsibilities of the Biological Subteam were to consider the possible impacts of peaking power developments upon aquatic biology, wildlife, vegetation, climate, air and noise quality, and agricultural chemicals in the aquatic environment. Initial data collection was made on climate, water quality, vegetative cover, and agricultural pesticides. To assist in the site elimination process, eleven criteria were established which outlined areas to be avoided. These areas included the following:

1. Areas having threatened or endangered plants or animals.
2. Unique fish or wildlife habitat or populations.
3. Sites which would have high reservoir level fluctuations.
4. Areas within close proximity to scenic or wild river segments.
5. Areas in which development would result in the inundation or dewatering of valuable stream habitat.
6. Remote areas that would require extensive access roads.
7. Sites which would block or hinder fish spawning runs.
8. Areas in which development would result in the inundation of valuable wildlife habitat.
9. Sites in which the operation or maintenance of the facility will detrimentally affect water quality or quantity.
10. Sites having a lengthy construction time which would impact air and noise quality.
11. Areas where the development would encourage other developments which would in turn impact fish and wildlife.

As the plan formulation process began, the Biological Subteam was given the responsibility of leading the development of the Environmental Quality (EQ) plan. The Recreation Subteam worked closely with the Biological Subteam for the development of an EQ plan. By late 1975, the Biological Subteam had attempted to classify all the inventoried sites into four classes: high probability of severe impacts, sites whose degree of impact would depend upon construction design and location, sites which appeared to have minimal impact based on available information, and sites whose impacts could not be determined because of a lack of information. By early spring of 1976 the Biological and Recreational Subteams had numerically ranked most of the sites and were able to make recommendations on ten sites as possible candidates for an EQ plan. At that time the outline of three possible EQ plans was proposed.

1. No development of peaking powerplants.

2. A plan of the best sites with regard to environmental considerations.

3. A plan of the best sites in regard to individual load centers.

As a result of the field inspections several of the sites recommended by the subteams were dropped. Reasons ranged from lack of water supply to serious environmental impacts that had not been anticipated. The Plan Formulation Subteam had also been continually identifying new sites, so the Biological Subteam had to reassess its recommended sites. By March 1977 the Biological and Recreational Subteams were prepared to recommend nine of the inventoried sites for EQ plan formulation.

At this time several changes occurred which temporarily halted the progress the subteam had made. Both the head of the Biological Subteam and the head of the Recreation Subteam left the area and were no longer able to lead their respective teams. Finding replacements for these positions and familiarizing the new personnel with the work already accomplished required time. In this same time period the course of the study was also changed so that development of an EQ plan was no longer of primary importance. Instead, the MOP Team was directed to emphasize recommending sites on an individual basis for feasibility study. For its part, the Biological Subteam was required to analyze and rank each of the remaining candidate sites upon their individual environmental merits.

During February 1978 the Biological Resources and Needs Subteam rated candidate sites on the basis of preliminary planning data provided by the Bureau of Reclamation and its general knowledge of the areas that would be affected. In a March 1, 1978 memorandum to the Bureau of Reclamation it recommended that only those candidate sites in the "low" impact classification be selected for further study. Ratings of the candidate sites submitted in the March 1 memorandum were as follows:

Site	Biological Impacts (+ = greater impact than -)
Dunham Point, PS, Colorado	Moderate -
Pine Creek Mesa, PS, Colorado	High -
Blue Mesa, OW, Colorado	Low -
Blue Mesa, MW, Colorado	Low -
Fawn Creek, PS, Colorado	High -
Dominguez-Cactus Prk, PS, Colorado	Low +
Rim Basin, PS, Colorado	Low -
Cimarron Point, PS, Colorado	High -
Leopard Creek, PS, Colorado	High +
Boulder Gulch, PS, Colorado	Extreme +
Cebolla Creek, PS, Colorado	Extreme +
Silver Lake, PS, Colorado	Extreme +
Boulder-Burnt Lakes, PS, Wyoming	Extreme +

Fontenelle, OW, Wyoming	Extreme -
Diamond Fork, PS-1, Utah (Hayes Site-DPR-6)	Moderate +
Diamond Fork, PS-2, Utah (Sixth Water)	Moderate +
Diamond Fork, PS-3, Utah (Fifth Water)	Moderate +
Monks Hollow, PS, Utah	Moderate +
Utah Lake, PS, Utah	Low -
McDonalds, PS, Utah	High +
Yellowstone, PS, Utah	Extreme -
Bear Mountain, PS, Utah	Extreme +
Moon Lake, PS, Utah	High -
Hatch Point, PS, Utah	Moderate -
Kane Springs, PS, Utah	Moderate +
Cataract Canyon, PS, Utah	Moderate +
Andy Miller Flats, PS, Utah	Moderate +
Point Lookout, PS, Utah	Moderate -
Rock Creek, PS, Utah	High -
Big Swale, PS, Utah	High +
Flat Canyon, PS, Utah	High +
Post Canyon, PS, Utah	Extreme -
Tuft Reservoir, PS, Utah	Moderate +
Circleville Canyon, PS, Utah	Moderate +
Nipple Bench, PS, Utah	Low -
Grand Bench, PS, Utah	Moderate -
Black Mountain, PS, Utah	Moderate +
Dry Fork, PS, Utah	Moderate +
Flaming Gorge, Modification, Utah	Extreme +
Flaming Gorge, OW, Utah	Extreme +
Quitchupah Creek, PS, Utah	High -
Went Ridge, PS, Utah	Moderate +
Lees Ferry, PS, Arizona	High +
Lees Ferry, Modification, Arizona	High +
Glen Canyon, OW, Arizona	High +
Bowl Canyon, PS, New Mexico	High +
Captain Tom Wash, New Mexico	High +

PS-Pumped Storage, OW-Outlet Works, MW- Megawatt

After the above ratings were developed, the subteam chairman received comments from the New Mexico Department of Game and Fish, the Arizona Game and Fish Department and the Utah Division of Wildlife Resources suggesting several modifications. The New Mexico Department of Game and Fish advised that adverse impacts associated with the Bowl Canyon and Captain Tom Wash sites warrant classifications of "Extreme." The Arizona Game and Fish Department pointed out that the Lees Ferry PS, Lees Ferry Modification, and Glen Canyon OW proposals would result in extreme damages to highly valuable cold water fisheries in the Colorado River between Glen Canyon Dam and Lees Ferry. Also, the Utah Division of Wildlife Resources suggested changing the classification of the Went Ridge site to "Extreme."

Although the subteam did not meet to review these suggestions, the final ratings were changed to conform. In the case of all but Went Ridge, field reviews had been made which were instrumental in arriving at the proposed ratings. So the subteam chairman felt the change in rating from "High +" to "Extreme" was justified. In the case of Went Ridge, a field review had not been made prior to the proposed ratings but a subsequent visit to the site resulted in the subteam chairman's concurrence with the State's suggestion to change the rating.

The Biological Subteam offered the following additional comments on sites that were selected by the MOP Team:

Cactus Park, PS, Colorado

This site was investigated as part of the separate Dominguez Project feasibility study, but was rejected because of the high costs of the long penstocks required. An alternative in the vicinity of Rim Basin is currently being considered for that planning effort. Should the Cactus Park site be selected for further study, the Biological Subteam believes plans could be developed to substantially reduce impacts upon biological resources. There would be a need to consider possible impacts upon the endangered Colorado River squawfish and humpback chub in accordance with the Endangered Species Act.

Glen Canyon, OW, Arizona

Additional generation units would increase peak releases to the Colorado River by about 6,000 second-feet and daily minimum flow durations would be lengthened. Boat fishermen access and fisheries productivity would be adversely affected by increased flows. Investigations in the project area should be carefully planned to avoid disturbance of nesting raptors. The bald eagle and golden eagle are protected by the Migratory Bird Treaty Act and the Bald Eagle Protection Act and disturbance of these birds could result in violations. Impacts of the project upon the bald eagle and humpback chub should also be considered in accordance with the Endangered Species Act. The humpback chub appears to be relatively abundant near the mouth of the Little Colorado River. Operational studies to show effects of the project upon water level fluctuations in Lake Powell and downstream flows and water temperatures will be needed to evaluate impacts upon fishery resources.

Blue Mesa, OW, Colorado

Units capable of provided 50 MW additional generation would approximately double discharges and reach flows of about 5,000 second-feet. The duration of release time would be reduced to about 5½ to 6½ hours per day. This proposal could affect fishery resources of Blue Mesa, Morrow Point, and Crystal Reservoirs. However, the Biological Subteam concluded that this proposal would be less damaging than most others under consideration.

Utah Lake, PS, Utah

Alternatives under consideration as part of the Central Utah Project include the construction of dikes to reduce the surface area of Utah Lake. This would affect the hydrology and fishery resources of the lake. Impacts of the pump-storage proposal without the construction of dikes, with the proposed Provo Bay dike, with the proposed Goshen Bay dike, and with both the Provo Bay and Goshen Bay dikes need to be considered in the recommended feasibility study. The Biological Subteam concluded that this pump-storage proposal would probably be less damaging than most other proposals under consideration for study.

Flaming Gorge, OW, Utah

Additional generation facilities would increase peak flows about 40 percent during peak power demand periods. This would lengthen periods of minimum flows during off-peak periods. The Biological Subteam concluded that this proposal would be extremely damaging to the downstream coldwater fishery. Impacts on the endangered Colorado River squawfish and humpback chub should be considered in accordance with the Endangered Species Act. Changes in flow regime have the potential for being very damaging to endangered warm water fishes. Operational studies to show effects upon water level fluctuations in Flaming Gorge Reservoir and downstream flows and water temperatures will be necessary to evaluate impacts upon fishery resources.

Dunham Point, PS, Colorado

A feasibility study for this proposal should include investigations of measures needed to offset direct losses to wildlife caused by construction, and indirect impacts upon the fishery resources of McPhee Reservoir.

General

The selection of some of these sites was contrary to recommendations submitted by the Biological Resources and Needs Subteam. However, this was because of ratings submitted by other interests involved in multiple objective planning.

If approved by the Congress, the feasibility studies would entail quantification of beneficial and adverse impacts. Each study approved by Congress would require investigations and preparations of reports by the Fish and Wildlife Service in cooperation with appropriate State conservation agencies under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

Recreation and Cultural Resources and Needs Subteam

Initial responsibility for chairing the Recreation Subteam was carried out by the recreation planning staff of the Upper Colorado Region of the Bureau of Reclamation. Membership on the team included Federal and State agencies with cultural and recreational interests as well as local governments and private interests. Chair responsibilities were later assumed by a representative of the Heritage Conservation and Recreation Service (formerly the Bureau of Outdoor Recreation).

The objectives of the Recreation and Cultural Subteam were (1) to identify and evaluate historical, archeological, and paleontological resources that may be associated with any candidate peaking power site, (2) to identify and quantify any recreational benefits and adverse impacts that may be developed at any candidate peaking power site, (3) to identify preliminary plans by which recreation, historic, archeologic, and paleontologic resources might be enhanced, preserved, or salvaged.

A contract was awarded to Fort Lewis College of Durango, Colorado, to inventory the historical and archeological resources of the Leopard Creek site. The report that was prepared under this contract assisted the MOP team in determining that this site, when considered socially, geologically, and biologically, should not be considered further at this time, though in engineering, economic, and operational aspects it appeared to be a viable candidate. No other sites have been examined with the detail that the Leopard Creek site has been studied.

The first field reconnaissance was made at the Leopard Creek site and included representation from the various subteams. Experience gained at the site inspection demonstrated that these field investigations could best be handled by a smaller three-man team. The remaining site inspections were completed by a three-man field reconnaissance team with expertise in engineering, geology, and biology. Access to the sites, some of which were at altitudes in excess of 10,000 feet, required the use of a helicopter which also limited the size of the field inspection team.

Data collected by the field reconnaissance team was made available to the Recreation Subteam for review. Environmental aspects of these field data were jointly reviewed by the Recreation and Cultural Resources Subteam and Biological Resources Subteam. Joint meetings were held in both

Colorado and Utah to carry out the review process and better obtain data from all members of both subteams.

Based on data provided by the field reconnaissance team and other available data sources, the Recreation and Cultural Resources Subteam selected candidate sites which would appear to have minimal losses to recreation and cultural resources if additional hydropower developments were to be installed. Emphasis was placed on current recreation land use patterns at proposed sites such as Bear Mountain, which would have drastically altered recreation patterns within portions of the Flaming Gorge National Recreation Area. At two sites, Utah Lake and Dry Fork, it appeared that some recreation benefits could be anticipated with hydropower development. A boat launching ramp, picnic area, and supporting recreation facilities would be beneficial at Utah Lake. The Dry Fork site near Vernal could support a visitor center where the principles of pumped storage may be demonstrated. [The remaining sites evaluated would provide no enhancement to recreation and cultural resources or would have adverse impacts on those resources.] Greater detail on these impacts can be determined if feasibility studies are conducted.

No Glen Cyn!

CHAPTER III

SPECIAL CONSIDERATIONS

Engineering Considerations

The initial engineering task to be dealt with by the MOP Study Team was that of site identification. The earlier identification of 41 potential sites by the Upper Colorado Region's project offices had already established a start in that direction. These sites had been identified following a request of the Commissioner in 1965 for such work to be done. Following the formation of the MOP Team an additional 90 sites were quickly identified. Fifty-six of these sites were located by the Federal Power Commission. The remaining 34 sites were identified by Bureau of Reclamation personnel through map reconnaissance. Several guidelines were established for the identification of these sites. The sources of these guidelines included E&R Center suggestions, information from a pumped storage seminar, and the criteria used by the FPC in their study. The primary guidelines were the following.

An inventoried site needed at least 700 feet of elevation differential between the reservoirs (head), but not more than 2,000 feet. Some exceptions to this were allowed. Heads exceeding 2,000 feet would probably require separate pumping or an intermediate pump generation station.

Penstock length, a major cost factor, needed to be less than 15,000 feet. Each reservoir required enough storage capability to generate at full capacity for 12 hours. Initially it was felt that sites should have a minimum capacity of 1,000 MW. Some sites initially inventoried were of capacities below 1,000 MW, but they were all quickly dropped as preliminary power forecasts indicated a total Regional need of 15,000 MW. When it became evident that available pumping energy limited the pumped storage needs to 4,300 MW, all sites, regardless of size, became of interest to the study.

Dams generally were planned as being earth-filled and of no more than 320 feet in height. A few exceptions were made when conditions warranted a concrete dam or when a fairly attractive site required a high dam. Horizontal crest length was rarely a concerning factor. Cost estimates established that a short distance between reservoirs was more crucial in controlling costs than finding natural reservoir basins. For this reason some sites essentially required the creation of a forebay in order to eliminate long penstocks.

Areas available for reconnaissance essentially included the entire Upper Colorado Region with the exception of the following: National and State parks, wilderness or primitive areas, and wild and scenic river areas. Some sites were inventoried that were within National recreation areas.

Site identification remained a continuing process and to date around 150 sites have been inventoried. Promising sites will continue to be inventoried and investigated.

Upon the initial identification of sites, the plan formulation process was started as the elimination of unacceptable sites began. From an engineering point of view this primarily involved arriving at rough but comparable cost estimates for most of the sites. These cost estimates were uniformly based on January 1976 figures. The following procedures were generally used. Earthen dam material quantities were found from data obtained from USGS quad maps and entered into a computer program derived by the Lower Colorado Region of the Bureau of Reclamation. The results of that program were then used to determine the unit costs as set by Appendix A cost curves of Reclamation Instructions.1/ General hydrologic data and design storm data were obtained from information developed by the Bureau's Regional hydrology personnel. These data were also used for figuring spillway and outlet works costs as set by the Appendix A cost curves. Penstock costs were usually figured for those of a buried steel conduit. Design thicknesses were calculated using Appendix A guidelines and design heads were increased by 50 percent to allow for waterhammer. Surge tanks were normally not considered. If buried steel penstock appeared impractical, a tunneled route was planned. In all cases the tunnels were steel-lined, but overburden pressure was allowed to compensate for hydraulic pressure. Tunneling costs were estimated from computerized Appendix A charts. Power capacities were calculated based on efficiencies of 80 percent and with penstock velocities of 20 feet per second. The design flow was dependent upon the available active capacity but was designed to produce 12 hours of operation. Powerplant costs were calculated using the computerized Appendix A costs. Sizes of units were generally planned at about 200 MW. Onsite substation and transmission costs were calculated as 16-17 percent of the powerplant cost. To each individual cost 25 percent was added for contingencies. These costs were totaled and 14 percent more added for unlisted items. This included such costs as land acquisition, road relocation and construction, gates, and valves. To this total 33 percent was then added for engineering and overhead costs. A base cost/kW value was then found for each site at its maximum size. Sites with ratios exceeding $600/kW were usually dropped from the study. Costs of transmission to the various load centers were figured on a $400/MW-mile basis.

As the plan formulation process developed, it became apparent that some sites would probably not be developed to the full size for which the cost had been estimated. In a few cases, costs had been estimated for several sizes of plants and the cost/kW values increased dramatically with decreased size. A number of cost estimates were made for each of several sites. The values determined were plotted on a graph showing the ratios of partial plant capacity over full capacity vs. partial cost over full cost. A rough curve was developed and used to make cost estimates for any size of plant. These engineering costs helped to eliminate sites from further study and thus reduced the list of candidate sites to a more workable number.

1/ Reclamation Instructions, Appendix A, Bureau of Reclamation, Denver, Colo., October 27, 1969

As a final step, the sites which appeared the best with all categories being considered, including engineering, were visited by MOP Team personnel. This team usually included a planning engineer, a biologist, and a geologist. Several characteristics were looked at from an engineering point of view, including construction material quality and availability, soundness of penstock alignments, dam and reservoir foundations, access to and around the site, and water supply availability.

The plan formulation process eventually yielded 26 candidate sites to be presented to the public. The following is an engineering evaluation of each site.

1. Blue Mesa Modification--There may be problems associated with possible increased leakage in the dam from the new penstocks. Space limitations for a new powerplant could also cause problems.

2. Blue Mesa Outlet Works--The only problem expected is a possible space limitation at the existing powerplant. The cost may be high for the capacity gained.

3. Boulder-Burnt Lakes--The primary engineering problem would be to get adequate designs for the penstock and enlarged dams and reservoirs which would all be in morainal material.

4. Bowl Canyon--The small quantity of surface water at this site would need to be supplemented from ground water sources and probably from the Navajo Indian Irrigation Project on the San Juan River. The San Juan River is already over allocated. Landslide conditions are evident in the afterbay dam and reservoir. Construction materials to complete the large dams are scarce within an economic haul distance.

5. Cimarron Point--This site has a head of about 2,200 feet. Technology does not presently exist for reversible pump-turbines to operate efficiently at this head. Additional engineering could be required to continue the usability of existing recreational facilities that would otherwise be useless due to the large drawdown on Morrow Point Reservoir.

6. Circleville Canyon--The major engineering problem with this site would be the relocation of the existing U.S. Highway 89.

7. Diamond Fork Conventional Plan--This site could have some problems with the foundation for the dam and reservoir on Sixth Water Creek.

8. Diamond Fork Sixth Water Alternative--This site could have some problems with the foundation for the Sixth Water Dam and Reservoir.

9. Diamond Fork Fifth Water Alternative--This alternative would involve a number of features which would border on the technological frontier of pumped storage. An underground powerplant is required 4 miles

inside the mountain. The geological conditions for such a chamber have only been speculated. The site would also have a high head with which to deal.

10. Dry Fork — Water supply for this site would have to be supplied from another drainage. With the presence of Vernal and a new subdivision downstream of the afterbay the existing geological faults in the area would be a problem.

11. Dunham Point--The forebay would require lining, but has a good foundation for a dam and reservoir. Some energy dissipation might be required for releases into McPhee Reservoir.

12. Flaming Gorge Outlet Works--Due to space limitations this could be the most difficult of the outlet works modifications to complete. A multiple level structure would need to be installed on the intake to the outlet works as was recently done on the intake of the existing units.

13. Fontenelle Outlet Works--Adequate space exists and there appear to be no special engineering problems at this site.

14. Glen Canyon Outlet Works—Adequate space for construction exists in the machine shop area. This project would probably present few unforeseen engineering problems.

15. Lees Ferry Modification--Studies are needed to determine the need for a reregulation dam and reservoir. There could be some problems finding an adequate foundation for the reregulation reservoir. A concrete structure is anticipated designed to spill over the crest of the dam in flood conditions. The new penstocks required are anticipated to be drilled through plugs in the old diversion tunnels used during construction of Glen Canyon Dam. Foundation conditions at Glen Canyon Dam would need to be examined.

16. Lees Ferry Pumped Storage--This site would require a downstream dam and, to this extent, would have the same problems as the Lees Ferry Modification, but to a higher degree because of a larger downstream reservoir. With the addition of large capacity penstocks and generators some space limitation problems might occur.

17. Nipple Bench—Both reservoirs would probably require lining. Construction materials are a considerable distance. Access to the forebay might also be difficult.

18. Pine Creek Mesa--The forebay would probably require lining and a relatively long penstock is required. Some special energy dissipation might be required for releases into Blue Mesa Reservoir.

19. Quitchupah Creek--Geological conditions in the afterbay could cause difficulties in finding a suitable foundation. Construction materials and water supplies could also present problems.

20. Rim Basin--A great deal of embankment is now planned to create an adequately sized forebay. Seepage from the forebay would need to be controlled.

21. Tuft Reservoir--This site could have foundation problems in the afterbay. Large dams are required and construction materials appear to be scarce in the immediate vicinity of the site.

22. Utah Lake--The large forebay dam will need to be designed for earthquake loading and the reservoir adequately lined. The afterbay area may require special diking to prevent siltation and reduce the disruption of Utah Lake.

23. Went Ridge--Construction materials availability, water supply, and access would all be severe problems. Good dam and reservoir foundations exist for both reservoirs.

24. Cactus Park--Penstocks of 15,000 feet length are required.

25. McDonalds --Some type of energy dissipation would be required to reduce erosion in the afterbay and minimize impacts upon recreational use. Minimizing recreational impacts due to large drawdowns would also have to be dealt with from an engineering point of view.

26. Rock Creek--This site would require high head hydraulic units and an extremely large afterbay dam. Access to this site would be difficult and a probable shortage of construction material exists.

With the preceeding information in mind, all the outlet works and modification candidate sites, in general, have fewer engineering problems and are worth additional study. Because of the availability of existing facilities, resources, and ability to start generating by about 1986, these should receive early consideration for authorization for a feasibility study. Then, if the studies show that these sites should not be built, alternatives could be recommended. Particular interest should be given to finding accurate costs and determining the actual benefits of the resulting new operation over the old operation. In some cases a shorter, but higher capacity, peaking period might be replacing a period of longer peaking capability. Other candidate sites that appear to be engineeringly acceptable include the Diamond Fork Alternatives, Rim Basin, Dunham Point, Utah Lake, Circleville Canyon, Pine Creek Mesa, and Nipple Bench.

Geological Considerations

Geological field analysis of the inventoried candidate sites began after the site elimination process was well advanced. Input on all of the sites identified would have required extensive literature research and without field reconnaissance the results would be rather speculative.

Instead it was decided that more thorough studies could be obtained by waiting until the candidate site list had been reduced. This enabled field visits to individual sites and further literature analysis into their geologic quality. The field visits began in the summer of 1976, and the reconnaissance team included a USBR staff geologist. The geologist had a number of items which were evaluated both in the field and in literature for each site. These are as follows.

The seismic activity of the area was always considered from two viewpoints. Preliminary research could easily establish the seismic risk zone within which the candidate site was located. This was followed by research to locate on paper the existing faults and fault zones of the area and their activity. The field visits often helped to verify the location or absence of the faults with respect to project features. Proximity of faults to dams, reservoir foundations, and penstock alignment often was a primary reason for discountinuing the study of the site.

The geological formations of a candidate site's location were also of primary importance. In each case the quality of the formation was judged with respect to developing a hydroelectric project upon it. Field inspection further revealed the rock types involved and the bedding sequences and orientation.

The field visits were extremely important in the analysis of the geologic structure of the area. Attention was paid to the extent and types of fracturing, especially jointing, due to folding and faulting. Again, the data obtained were applied to judge the geological competency of a candidate site's project features.

Analysis of potential and existing landslide areas was important due to the operational nature of peaking power projects. Such projects, particularly pumped storage, require large daily fluctuations of reservoir water levels. This could easily lead to massive slides in areas of such potential. As a result, severe environmental damage, structural damage, and significant reduction in reservoir capacity might occur.

The materials of a candidate site's area were analyzed from several points of view, foremost of which was the quality and availability of materials for embankments and linings. Erosiveness, density, and gradation of the material were the primary characteristics considered. The importance of the results increased in proportion to the size of the dams required.

The permeability of the alluvial deposits and underlying rock formations was also a consideration. Highly fractured and porous sedimentary formations and areas of morainal deposits caused the most concern. This was particularly true if underlying formations could become unstable due to a rise in the water table or due to a new contact with water.

A final consideration was that of man's activities. Mining within a site could have significantly weakened the geological structure of a site. In turn, mining, agricultural, commercial, and residential activities could be affected by a rising water table. In addition, the location of sites in the proximity of large populated areas presents an added safety risk. This is particularly true in areas of seismic activity.

Data derived from the study of each site were analyzed, and recommendations were made to the Lands Subteam. For the most part, poor geologic conditions were encountered. Almost every site had problems which caused concern in at least one of the above listed areas. In some cases, these problems were serious enough that the site was no longer considered. However, some sites with serious geologic problems have remained in the study due to other features which are quite attractive. Further study could establish a means by which the problem could be solved by careful engineering design. If further study does not show a solution to be possible, such projects would be dropped.

The following is a discussion of the geologic quality of a partial listing of the sites currently proposed for feasibility study.

1. Glen Canyon Outlet Works, Flaming Gorge Outlet Works, and Blue Mesa Outlet Works--Due to the minimal construction involved, all three of these sites should pose few, if any, geological problems. All additions would probably be on existing structural foundations, and no new penstock is anticipated.

2. Utah Lake--This site presents the most difficult geologic problems of the sites proposed for feasibility study. The site is located in a high seismic risk area, but at this time, a dam failure would pose little safety hazard to man-oriented activities. Future development in the area downstream of the forebay could hopefully be prevented. An additional problem is caused by the calcite mining and the formations of the area. Mine shafts and natural caverns could make the forebay structure too weak for a large reservoir.

3. Dunham Point--The forebay would rest on the Dakota Sandstone formation. While this is adequate structurally, a complete lining would be required as this formation is usually fractured.

Social Considerations

As part of the multiple objective planning effort to comparatively rank the alternative sites for meeting peaking power needs, social aspects have been considered throughout the planning process. The depth of analysis has been commensurate with the amount of detail available on each site. Initially only the locations of the sites were known. As a result, as in the example of the Grass Canyon site southeast of Cortez, Colo., the only social characteristic which could be considered was the proximity to archeological sites and numerous areas of significance to the Indians. The importance of social considerations intensified as the selection of alternative sites narrowed, and a comparative ranking of 48 sites was completed. Since detailed plans have not been developed for the sites, only general estimates of construction costs were available. Although these estimates were considered, for the purpose of social analysis and ranking, emphasis was placed primarily on the type of local area to be impacted. No detailed survey, analysis, or investigation was conducted in keeping with the level of inquiry maintained in the other disciplines' rankings of the sites. Far more specific studies will be necessary as sites are eliminated and more details become available such as the length and phasing of construction. The following general social factors were considered:

1. Community type in terms of location, diversity, structure, and predominant beliefs and values (cosmopolitan, farming, ranching, isolated).

2. Community size and settlement pattern (metropolitan, urban, rural, scattered, uninhabited).

3. Community growth experience and attitudes (boom town past and present vs. small quiet villages or large cities).

4. Distance to community and road conditions (interstate vs. no road or seasonally accessible).

5. Land ownership and usage (Federal, State and private, also grazing, big game habitat, recreation, farming, etc.).

6. Minorities (predominantly Indians).

Each site was ranked on a scale from one to ten with ten being the highest ranking. The main purpose of these rankings was to compare the alternative developments.

Also included in the analysis was a ranking of the various developments' acceptability emphasizing the regional, rather than local perspective. Overlap between the local social and regional acceptability rankings was unavoidable, but there were issues which tended to separate the two rankings. The purpose of both rankings was to assess the relative merit of each alternative development in a general way.

Based on the preliminary analysis the general types of alternative sites ranked as follows:

1. Proposed alteration of outlet works ranked favorably. The communities being affected have already experienced the effects of construction and indeed some were founded as construction sites.

2. Pumped-back storage sites on existing reservoirs, while eliminating part of the need for large facilities, tended to disrupt established patterns of resource use.

3. New pumped-back storage sites were more favorably ranked if a construction camp was necessary than if a small- to medium-sized community was affected.

4. Sites located near a large power demand center tended to rank quite high.

5. Extremely large sites tended to rank lower due to the concentration of potential impacts.

A series of public meetings was held to discuss the higher ranked sites. Generally these meetings substantiated the findings of the social factors and acceptability analysis. Affected publics voiced their concern and provided useful input to the evaluation of sites. Opposition was voiced concerning potential changes in existing land and resource use patterns which would also affect existing social structures. The need for peaking power was generally accepted and occasionally strongly supported. Some of the areas which are presently exporting power strongly advocated that power be produced nearer to the load centers. Support was presented for further study of existing sites.

The selection of sites proposed for feasibility investigations was influenced by the above social considerations. The evaluations presented are preliminary and site specific study will be necessary as part of the feasibility investigations. As further details of specific site proposals become available appropriate indepth studies will be completed.

Economic Considerations

To assist in evaluating and comparing various peaking powerplant potentials, benefit-cost ratios were determined. In this analysis only the benefits resulting from power production were used and only the costs of the project works and facilities required for power production were included. All costs and benefits were based on 1976 values. It is recognized that at many of the sites there may be incidental benefits resulting from fish and wildlife enhancement, recreation, flood control, etc., but as the scope of these benefits is presently unknown, they have not been included in the benefit-cost analysis. How?

Basically two types of power peaking plants were considered: (1) modification of existing hydroplants to produce additional capacity without an increase in annual energy production and (2) pumped-back storage plants.

The hydroplant modifications usually entail operating at higher loads for shorter periods of time and their benefit is evaluated as the value of the increased capacity.

Pumped storage plants are a net user of energy, but like a battery, they have the capacity to store energy during times when it is not needed for use at other times when it is needed. Benefits accrue from both the additional capacity and from the timing of the energy use.

Reclamation policy is to evaluate power benefits based on the cost of the most comparable alternative source which would perform the electric supply function (baseload, peaking, etc.) for the same power market area that would be supplied by the power facility being evaluated.

Alternative cost studies have been made for several different thermal plants categorized in broad ranges based on plant factors. Values have been taken from recent cost studies using 50 percent public and 50 percent private financing. These costs are shown below.

Type of plant	Plant factor (percent)	Capacity cost (dollars/ kW year)	Energy cost (mills/ kWh)
Combustion turbine	0-10	27.13	40.8
Combined cycle	11-39	35.82	24.0
Coal-fired steam plant	40-100	116.88	7.4

Most of the peaking plants are in the 11-39 percent range and a capacity value of $36 per kilowatt year has been used as a measure of the capacity benefit. An energy benefit of 24 mills per kilowatt hour has been used for the energy produced. However, this is partially offset by an energy requirement of 1½ times the energy produced. It is assumed that the energy requirement can be purchased in off-peak hours for 7.4 mills. It is also assumed that in most hydroelectric modifications there would not be an energy benefit.

The costs of the various peaking plants vary as a function of the load center. Transmission costs would be higher for some load centers than for others. Benefit-cost ratios for each of the peaking powerplants by load center is shown on Exhibit 2.

It is suggested that when selection of peaking power projects for further study has been made that benefits for each plant being studied be evaluated using specific alternatives rather than using broad general categories. Consideration should be given to systems analysis and viability and likelihood of the alternative being built. A realistic and probable alternative should be used as the measure of benefits.

Exhibit 2
Comparison of benefit-cost ratios

Proposed peaking powerplants	Load centers: Denver	Salt Lake City	Montrose	Casper	Phoenix	Albuquerque	Las Vegas
Rim Basin PS, CO	1.50	1.44	1.75	1.32	1.25	1.36	1.18
Blue Mesa OW, CO	.91	.83	1.06	.81	.78	.84	.74
Dunham Point PS, CO	1.93	1.68	2.06	1.53	1.71	1.96	1.55
Utah Lake PS, UT	1.38	1.86	1.42	1.29	1.32	1.32	1.32
Cimarron Point PS, CO	1.86	1.62	2.18	1.53	1.51	1.66	
Pine Creek Mesa PS, CO	1.87	1.65	2.27		1.53	1.41	
Quitchupah Creek PS, UT	1.66	2.10	1.20	1.41	1.54	1.64	1.58
Blue Mesa 83 MW, CO	.79	.73	.90		.69		
Nipple Bench PS, UT	1.13	1.40	1.15	1.02	1.38	1.29	1.32
Dominguez-Cactus Park, CO	1.40	1.31			1.16		
Diamond Fork Conventional, UT	1.17	1.32	1.21	1.15	1.13	1.16	1.16
Went Ridge PS, UT	1.78	2.10		1.55	1.52		
Diamond Fork Fifth Water, UT	1.15	1.39	.86	1.03	1.09	1.13	.96
Monks Hollow PS, UT	1.24	1.57			1.17		
Hatch Point PS, UT	1.44	1.65			1.41		
Diamond Fork, Sixth Water, UT	1.09	1.30	.88	1.05	1.04	1.07	1.00
Kane Springs PS, UT	1.27	1.47			1.28		
Dry Fork PS, UT	1.42	1.63	1.45	1.37	1.15	1.21	1.15
Glen Canyon OW, AZ	.81	1.00			1.03	.94	1.04
Flat Canyon PS, UT	1.63	1.81			1.36		
Fawn Creek PS, CO	1.67	1.60		1.45	1.22		
Big Swale PS, UT	1.60	1.79			1.36		
Tufts Reservoir PS, UT	1.46	1.91			1.63	1.49	1.59
Circleville Canyon PS, UT	1.33	1.70			1.47		1.46
Lees Ferry PS, AZ	1.42	1.71	1.44	1.23	1.77	1.62	1.69
Black Mountain PS, UT	1.35	1.61			1.43		1.30
Leopard Creek PS, CO	2.01	1.67	2.31		1.68		
Flaming Gorge OW, UT	.83	.94		.86	.68		
Grand Bench PS, UT	1.25	1.48			1.49		1.48
Lees Ferry Modification, AZ	.91	1.15	.96	.82	1.18	1.08	1.14
Yellowstone Creek PS, UT	1.90	2.40	2.03	1.88	1.47		1.52
Post Canyon PS, UT	1.60	1.75			1.33		
Rock Creek PS, UT	1.20	1.17			.90		
McDonalds Little Valley PS, UT	1.63	2.18	1.65	1.54	1.39		1.42
Point Lookout PS, UT	1.46	1.60			1.63	1.64	
Moon Lake PS, UT	1.80	2.17			1.39		
Cebolla Creek PS, CO	2.24	1.80	2.53		1.70		
Bowl Canyon PS, NM	1.58	1.56			1.82	1.77	
Cataract Canyon PS, UT	1.41	1.63			1.53		
Silver Lake PS, CO	1.88	1.60	2.18		1.63		
Bear Mountain PS, UT	1.86	2.08		1.78	1.35		
Captain Tom Wash PS, NM	1.42	1.39			1.59	1.58	
Boulder Gulch PS, CO	1.74	1.45			1.55		
Andy Miller Flats PS, UT	1.20	1.40			1.34		
Flaming Gorge PS, UT	1.10	1.21		1.07	.92		
Boulder-Burnt Lakes, WY	1.55	1.80		1.60	1.25		
Fontenelle OW, WY	.51	.56		.54	.45		
Flaming Gorge 129, UT	.82	.93		.85	.67		

Environmental Considerations

When the Multiple Objective Planning Team was organized, it was recognized that very early participation by environmental interests would be advantageous to the overall study. Consequently, many environmental organizations were invited, several of which have attended and have participated.

The U.S. Fish and Wildlife Service was chosen and agreed to lead the Biological Subteam. This subteam was given the overall responsibility for the environmental considerations relating to peaking power study. Input has been provided to the MOP Team by this and other subteams that have expressed the estimated adverse and beneficial impacts to the environment at each of the approximately 150 identified sites. The input for some of the sites was more extensive than for others because there was more immediately available knowledge of them. Even though conditions at some of the sites were relatively unknown, an evaluation was made based on what was known and what the conditions were in the area surrounding the site.

Using this method of evaluation, not only from an environmental point of view but also from hydrological, engineering, economical and other viewpoints, some 40 sites were ultimately selected for a field review. The details of this field review were discussed in the Plan Formulation section of Chapter II. The leader of the Biological Subteam presented the information gained at the field reconnaissance to the subteam. Many times this required a meeting in Utah and in Colorado to accommodate members who had travel restrictions.

After evaluating the information collected during the field reconnaissance, some 26 sites were chosen as candidate sites to present at public meetings where additional environmental concern was often expressed. Some of this concern from the public was valid while some requires further study and documentation. None of the environmental considerations have been disregarded but all have been weighed according to factual conditions.

At this point, full environmental evaluation of any of the sites has not been accomplished. There has been, however, sufficient information available to enable the MOP Team to identify certain areas of special concern at each of the candidate sites. Assistance and all available data will be given to the feasibility study team. It is expected that NEPA compliance will be accomplished during the feasibility investigations. Contracts will be made to responsible firms if needed to collect and evaluate data. Invitations for participation in the feasibility study MOP process will include environmentally oriented agencies and interests.

Public Involvement of the Peaking Power Study

A key objective in making the Peaking Power Study a true MOP process was to gain input from the public about the study's proposals. In general, unless a person was involved through participation on a MOP subteam, members of the public were not informed of progress in the initial and secondary stages of the study. To gain public input, formal preparation for public meetings began in the summer of 1976. A Public Involvement Subteam was formed which was led by the Executive Director of the Upper Colorado River Commission with assistance by the Public Information Officer of the Upper Colorado Region of the Bureau of Reclamation. After a presentation of the peaking power program at a Commission meeting in Jackson, Wyo., on July 7, 1976, the Upper Colorado River Commission agreed that the Executive Director would serve as coordinator of the public meetings. To the extent possible, Commission staff would be available to assist in the studies.

In early 1978, the candidate site list had been narrowed down sufficiently to begin planning public meetings. Six locations were chosen to represent various areas in the Upper Colorado Region: Page, Ariz., Cortez, Colo., Montrose, Colo., Rock Springs, Wyo., Vernal, Utah, and Provo, Utah. A brochure was prepared which explained the idea of peaking power, listed basic design data about each of the 26 candidate sites, and provided a map of each of the sites. Press releases about the meetings were sent out to local and regional newspapers and radio stations in the week preceeding the first meetings. No local individuals were specifically contacted unless they had been involved in a subteam's activities. Subteam chairmen were asked to have at least one representative of the subteam at each meeting to answer questions.

With the preparations completed, the meetings began in Page on May 16, 1978, and culminated in Provo on May 25. The format of the meetings generally involved a welcome, introduction, and history of the study by the chairman of the Public Involvement Subteam which was followed by an explanation of peaking power and a slide presentation of the candidate sites of interest in the area of the meeting. The meeting was then turned over to the public for questions and answers. The Public Involvement Subteam chairman served as moderator and qualified members of other subteams responded to the questions. Comments on these meetings were asked to be sent by June 30, 1978.

Attendance at the Rock Springs and Page meetings was good with active participation. Newspaper announcements of the meetings seemed to often go unnoticed by the majority of the public. Perhaps earlier notification of local officials and individuals thought to be interested would have resulted in better participation. Written and telephone responses were often critical of the pre-meeting publicity.

The following is a general summary of the written and oral comments from the public meetings.

1. Blue Mesa Modification--Presented at the Cortez, Montrose, and Vernal meetings. Public comment generally favored the use of existing

Bureau facilities but some concern was expressed by Colorado Fish and Wildlife personnel over possible impacts on Blue Mesa and Morrow Point Reservoirs.

2. Blue Mesa Outlet Works--See Blue Mesa Modification plan.

3. Boulder-Burnt Lakes--Presented at the Rocks Springs meeting. The site has received some of the strongest criticism of any of the candidate sites. This concern was primarily aimed at the impacts on recreation, scenery, existing water use, and the social structure of the area. Geological safety and total cost were also areas of concern.

4. Bowl Canyon--This project was presented on two different scales. A small capacity size of about 600 MW would serve only Albuquerque and was presented at the Cortez meeting. A large scale 4,300 MW plan, capable of meeting the needs of all seven principal load centers, was presened at all six public meetings. Neither plan generated any public comment.

5. Cimarron Point--Presented at Cortez, Montrose, Rock Springs, and Vernal. Drawdown on Morrow Point Reservoir and its resulting impacts on recreation were cause for criticism.

6. Circleville Canyon--Presented at Page and Provo. No comment on this site was expressed.

7-9. Diamond Fork Alternatives--Presented at Rock Springs, Vernal, and Provo. Public comment was generally favorable, particularly towards the possible environmental, power, and energy aspects of the Fifth Water Plan.

10. Dry Fork--Presented at Rock Springs and Vernal. Little comment was expressed at the public meetings, but written comments have been numerous. Areas of concern were water supply, environmental impacts, and safety.

11. Dunham Point--Presented at Cortez, Montrose, and Vernal. Colorado Fish and Wildlife personnel expressed concern with the possible impacts on the excellent fishing and recreation expected for McPhee Reservoir.

12. Flaming Gorge Outlet Works--Presented at Provo, Rock Springs, and Vernal. Concern was expressed as to possible impacts on recreation safety and fish habitat downstream.

13. Fontenelle Outlet Works--Presented at Rock Springs. Concern was expressed about the effects of a reregulation reservoir, but such a feature is no longer considered necessary.

14. Glen Canyon Outlet Works--Presented at Page and Cortez. Concern was expressed as to the possible impacts on the large amounts of boating and fishing currently done below Glen Canyon Dam.

15. Lees Ferry Modification--Presented at Page and Cortez. The plan has generated a great deal of oral and written criticism, primarily from recreation users of the area.

16. Lees Ferry Pumped Storage--This site was presented at Page and Cortez and has generated the same criticism as the Modification Plan except the criticism was even stronger.

17. Nipple Bench--Presented at Cortez, Page, and Provo. No public comment has been expressed.

18. Pine Creek Mesa--Presented at Vernal and Montrose. As with the Blue Mesa proposals concern was expressed as to possible impacts upon recreation and the fishery of Blue Mesa Reservoir.

19. Quitchupah Creek--Presented at Cortez, Page, Provo, and Vernal. Some comment was expressed over possible wildlife impacts.

20. Rim Basin--Presented at Vernal, Montrose, and Cortez. Most comments were favorable toward the project.

21. Tuft Reservoir--Presented at Page and Provo. No comment has been expressed on this site.

22. Utah Lake--Presented at all six public meetings. This site has been considered an environmentally viable plan, but some concern was raised at the public meetings as to possible drawdown impacts on Utah Lake.

23. Went Ridge--Presented at Provo and Vernal. Concern was expressed as to the possible impacts on wildlife and the roadless area in which this site lies.

24. Cactus Park--Presented at all meetings. Except for concerns over recreation impacts due to drawdowns, this site is generally looked upon favorably by the public.

25. McDonalds--Presented at all meetings. No comment was expressed on this site.

26. Rock Creek--Presented at all meetings. The Bureau of Land Management continued to voice strong opposition to this candidate site because of probable environmental impacts.

An informal public meeting was held in Pinedale, Wyo., on July 20. This meeting was requested by the Sublette County Commissioners to discuss the Boulder-Burnt Lakes site and the Fontenelle outlet works. Comments following this meeting were requested by August 3. Those attending the meeting were unanimously opposed to the Boulder-Burnt Lakes site.

CHAPTER IV

ALTERNATIVE PLANS

It is obvious that the hydroelectric pumped storage plan proposed is not the only alternative for meeting the needs projected by the MOP study. A number of alternatives have been and should continue to be examined.

As previously indicated, the sites proposed for feasibility study are only a few of about 150 sites studied. Sites not currently recommended were passed over for various reasons. However, as future needs, technology, fuel prices, and other factors change, many of the sites could become more viable. The sites currently proposed for feasibility study could be proven infeasible and one of the sites not currently recommended could be selected to replace it. It is also emphasized that the 150 sites studied by no means constitute every possible pumped storage site in the Upper Colorado Region. It is likely that additional sites could come to the attention of the MOP Team and receive further study.

The studies proposed by the MOP Team would meet the projected power needs to the year 2000 through a Subregional load center type of alternative. Although not recommended for future funding, the MOP Team selected the Dominguez-Cactus Park candidate site as a single site alternative. Should the Subregional load center plans appear to be unreasonable in the feasibility study, the single site plan could be further examined. Preliminary planning indicates a single site serving the entire Region would be more expensive, primarily because of transmission costs. However, with rising fuel costs such a site still could be economically attractive.

Additional possibilities exist in meeting projected needs by means of hydroelectric power. The Congressional funding did not authorize this study to examine sites outside of the Upper Colorado Region even though the power marketing area encompasses a much larger area. As a result, high environmental and economic costs occur due to the extensive transmission lines required to serve the outlying load centers. Therefore, it might be prudent to serve such load centers as Phoenix, Denver, Albuquerque, Casper, and Las Vegas with hydroelectric sites outside of the UC Region and closer to the load center. This was a recommendation of both the Biological and Power Subteams. Some study is underway in both the Lower Missouri and Lower Colorado Regions.

Alternatives which are not hydroelectrically oriented also exist. A greater number of interties with other areas are a possibility. Some utilities could continue to use older thermal plants for peaking purposes, but this is an inefficient use of coal and contributes to pollution. Load following capability of thermal plants is restricted and, as more of the low-pressure units are retired, this capability will be further restricted because of the preponderance of high-pressure units. Oil and gas combustion turbines are a likely alternative, particularly in the south. These facilities can be constructed quickly and would have a low installation cost. However, the cost of oil and gas could become prohibitive to such development, and in the event of an oil embargo, impossible to run.

There are additional possibilities on the borders of technology. Synthetic fuels, combined cycle plants, and air pumped storage are nearly cost competitive. Such concepts as load management are also new ideas which will probably be introduced. "management," eh?

Conservation, whether forced or voluntary, is also a very real alternative. This is particularly true of residential consumers as they are the source of a great deal of peak demand as opposed to continuously operating heavy industry.

The above are the most obvious alternatives to hydropower in meeting peaking power needs in the Upper Colorado Region. If the Power Subteam forecasts are correct some of these alternatives will definitely be needed as pumped storage can handle only 30 percent of that projected load.

CHAPTER V

RECOMMENDATIONS FOR FEASIBILITY STUDIES

As a result of the study conducted to date by the Peaking Power MOP Team, the following candidate sites are recommended for feasibility study in FY 1979 and 1980. It should first be noted, however, that planning for budgeting in subsequent fiscal years will require additional meetings at least once a year.

Glen Canyon Outlet Works could meet some of the needs of the southern portion of the marketing region. A minimal amount of new construction is involved as the site is at an existing facility. Existing transmission corridors would probably be available. A feasibility study would examine the potential benefits to power and impacts on fish, wildlife, recreation, historic culture, and economics. If the feasibility study shows that the addition of 250 MW is impractical it might indicate what lesser amount, if any, is feasible and that probably no greater amount would be feasible. This site is proposed for study in FY 1979.

Blue Mesa Outlet Works also has the advantage of being at an existing facility. Its possible environmental and recreational impacts are probably the least of any site studied. Although this candidate site does not produce a great deal of capacity, the minimal construction required could mean a relatively short construction time, so this power could be brought on line quickly to meet the early projected needs. This site is proposed for study in FY 1979.

There are a number of reasons for recommending Utah Lake Pumped Storage. This site could conveniently serve the Northern Utah Subregion and, for a period of time, could serve the entire service area if necessary. Even though this candidate site is a new facility, its environmental, social, and recreational impacts appear to be small when compared to other sites. Some study would be necessary to determine the drawdown impacts upon Utah Lake. This is the final site proposed for study in 1979, the two sites discussed immediately following are proposed for study in FY 1980.

Dunham Point Pumped Storage again would make use of existing facilities. This is under the assumption that McPhee Reservoir is completed as part of the Dolores Project. The economics of the site are attractive and the site is convenient to a number of load centers. The environmental and recreational impacts upon McPhee Reservoir are two important areas of future study.

Like three of the four preceeding recommended sites, Flaming Gorge Outlet Works is at an existing facility. As with the other outlet works proposals, the addition could probably be completed relatively quickly and meet the early anticipated demands. However, the environmental and

and recreational impacts revealed in the feasibility study could easily lead to the elimination of this site.

In addition to the above recommendations, a few of the alternative plans should be kept in mind. It is strongly recommended that other USBR regional offices begin, or continue to look at, peaking power resources in their regions. Power utilities should continue to consider alternatives such as oil fired turbines, combined cycle plants, load management, and conservation. Finally, the USBR should establish firm and realistic standards to determine the true benefits of hydropeaking power. This could mean using specific alternatives and consideration of the likelihood of the alternative actually being built. In this way, the economics of the proposals of the MOP Team can be accurately compared to the above mentioned alternatives of the power utilities.

The following table shows one possible combination of site development that would reasonably meet the estimated future peaking power needs.

Government pays for Glen Canyon Outlet works; utilities pay for Alternatives!!

Exhibit 3

Estimated generation

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Southern Utah															
Diamond Fork	76	51	26	106	106	106	106	106	106	106	0	0	0	6	0
Glen Canyon Outlet Works	-	125	250	250	250	250	250	250	250	250	250	250	250	250	250
Utah Lake	-	-	0	0	150	200	270	340	220	90	0	0	0	0	120
Nipple Bench	-	-	-	-	-	-	-	-	200	400	696	796	916	990	990
Accumulated subtotals	76	176	276	356	456	556	626	696	776	846	946	1,046	1,166	1,246	1,360
Estimated	80	190	300	380	460	540	620	700	780	860	960	1,060	1160	1260	1360
Western Colorado															
Diamond Fork	76	215	240	105	125	125	125	125	125	125	241	231	211	205	207
Blue Mesa Outlet Works	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Rim Basin	19	19	319	519	519	519	519	519	519	519	519	519	519	519	519
Utah Lake	-	-	-	120	260	380	440	510	590	650	650	580	500	440	220
Flaming Gorge Outlet Works	-	-	-	40	40	40	40	40	40	40	40	40	40	40	40
Nipple Bench	-	-	-	-	-	-	-	-	0	0	4	194	74	0	0
Dunham Point	-	-	-	-	-	-	-	-	-	-	-	-	360	600	940
Accumulated subtotals	145	264	609	834	994	1,114	1,174	1,244	1,324	1,384	1,504	1,614	1,734	1,854	1,976
Estimated	229	446	663	847	1006	1087	1168	1249	1330	1411	1524	1637	1750	1863	[illegible]
Northern Utah															
Diamond Fork	96	210	210	265	245	245	245	245	245	245	235	245	265	265	269
Utah Lake	-	-	180	240	360	500	550	590	630	700	790	860	940	1,000	1,100
Fontenelle Outlet Works	-	-	-	-	10	10	10	10	10	10	10	10	10	10	10
Accumulated subtotals	96	210	390	505	615	755	805	845	885	955	1,035	1,115	1,215	1,275	1,379
Estimated	120	257	394	509	619	692	765	838	911	984	1063	1142	1221	1300	1379
Accumulated totals															
Estimated generation	317	670	1,275	1,695	2,065	2,425	2,605	2,785	2,985	3,185	3,485	3,775	4,135	4,375	4,715
Estimated needs	429	893	1,357	1,736	2,085	2,319	2,553	2,787	3,021	3,255	3,547	3,839	4,131	4,423	4,715

CRSP PEAKING POWER
LEE'S FERRY - NO PUMPING

Location: 0.5 mile east of Lee's Ferry, Arizona

USGS Quad. - Leche - e Rock, Arizona; Lee's Ferry, Arizona (15 m)
Land Ownership: Glen Canyon National Recreation Area (NPS)
Land Required = 1,710 acres

Reservoirs: Forebay - Lake Powell
Afterbay - Area capacity (3,180 feet) = 43,280 acre-feet
Surface area (3,180 feet) = 1,141 acres

The afterbay is strictly for regulation of peaking releases
No pumping is involved

Penstock: 4 tunnels
Length = 2,400 feet
Diameter = 22.7 feet
$Q = 32,300\ f^3/s$
$Q' = 8,080\ f^3/s$

Power Potential: Head = 460 feet
Power = 1,006 MW

Make-up Water: At 6 acre-feet per year evaporation losses = (6) (1,141 acres) = 6,850 acre-feet per year

Roads Required: Some improvement of existing roads at Lee's Ferry.

Transmission Lines: 300 miles of 500 kV line

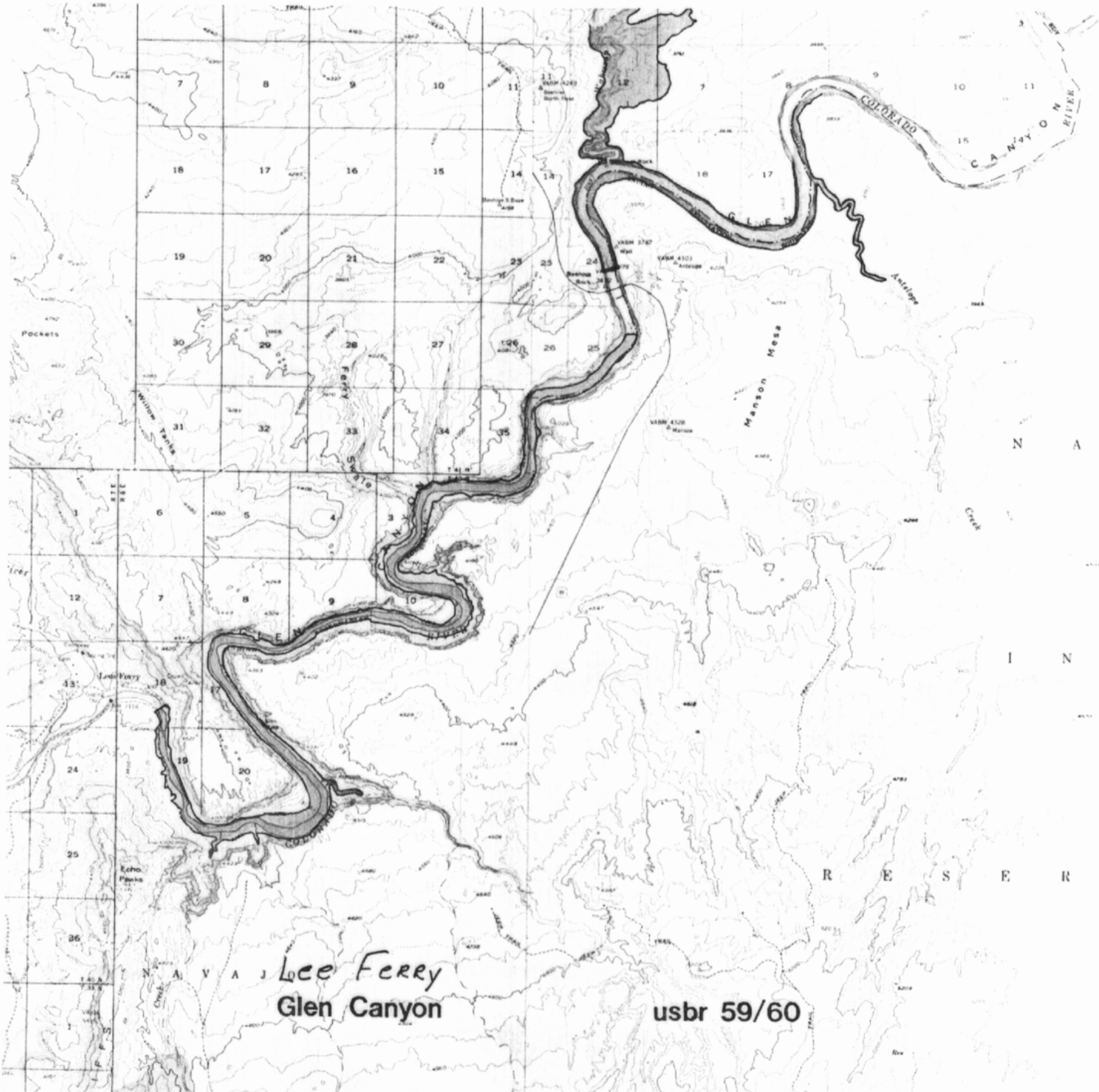
Flora - Mixed desert shrub - desert grassland
Barren ground
Riparian

Lee's Ferry Modification (cont.)

Description: The Lee's Ferry modification project would place up to 1,000 MW of additional generation capability at Glen Canyon Dam. Consequently, flows could be increased up to 68,000 F^3/S for six hours per day, and reduced to 2,000 F^3/S the remaining portion of the day. Although these flows are considerably less than the historic once in 4 years of 100,000 F^3/S and could be allowed to go down to Lake Mead, it is anticipated that a reregulation dam at Lee's Ferry would be required for environmental and recreation purposes. Flows could then be sent down through the Grand Canyon at a constant 12,000 F^3/S, or at variable rates predetermined by environmental or recreational needs. The reregulating dam would be a 60-foot concrete structure, and the resulting reservoir in the remaining portion of Glen Canyon would fill up and drain more or less on a daily basis.

As the annual amount of water released is controlled by the Colorado River Compact, the annual output of energy will not be increased. However, daily and weekly peak demands could be met more easily with this proposal. It could be operated continuously in emergency situations unless the continuous high flows (once the afterbay was filled) created unacceptable problems in Grand Canyon. Such a situation might also result in longer periods of low flows in remaining portions of the year.

This site was recommended for further study by the Peaking Power Study's Power Subteam.



Lee Ferry
Glen Canyon
usbr 59/60

CRSP PEAKING POWER
GLEN CANYON OUTLET WORKS

Location: Glen Canyon Dam, Arizona

USGS Quad - Lee's Ferry, Arizona, 15 m.
Land Ownership - Bureau of Reclamation Power Withdrawal
Land Required - Probably use the area of the existing machine shop at the base of Glen Canyon Dam

Reservoirs: Forebay - Lake Powell

Afterbay - None. The proposed facility will increase the peak releases into the Colorado River by approximately 6,000 cubic feet per second

Dams: None

Penstock: Use existing outlet works

Power: 250 MW
Head - 460 feet

Roads: None

Transmission Lines: Use existing corridors or lines

Make-up Water: None

Description: This project would place generation units on the existing outlet works at Glen Canyon Dam. This addition would change the operational pattern of the existing generation facilities at Glen Canyon Dam. Flows for a peak 6-hour period could be increased up to 40,000 F^3/S with corresponding longer periods each day when releases would be at the minimum flow level.

This added capacity could be operated continuously in emergency situations unless such an operation created unacceptable problems in Grand Canyon.

This site was recommended by the Peaking Power Study's Power Subteam for further study.

CRSP PEAKING POWER
NIPPLE BENCH

Location: 30 miles north of Page, Arizona

USGS Quad. - Nipple Butte, Utah-Arizona 15 m.
Area Required = 1,270 acres

Reservoirs: Forebay
Area capacity (5,154 feet) = 26,500 acre-feet
Active capacity (5,154 feet) = 26,100 acre-feet
Dead storage (5,014 feet) = 400 acre-feet
Surface area (5,154 feet) = 314 acres
Minimum water surface = 5,014 feet
Drawdown = 140 feet

Afterbay
Area capacity (4,579 feet) = 28,100 acre-feet
Active capacity (4,579 feet) = 26,100 acre-feet
Dead storage (4,467 feet) = 2,000 acre-feet
Surface area (4,579 feet) = 446 acres
Minimum water surface = 4,467 feet
Drawdown = 112 feet

Penstock: 3-1,894-foot tunnels
Diameter = 24 feet
$Q = 26{,}100\ f^3/s$
$Q' = 8{,}700\ f^3/s$

Power Potential: Head = 560 feet
Power = 990 MW
12-hour operation

Make-up Water: Requires a 56,800-foot pipeline from the Wahweap drainage area of Lake Powell

Q losses = 8.4 f^3/s = 6,081 acre-feet per year

Roads Required: Approximately 11 miles of new road running from US Highway 89 through the afterbay, up to Nipple Bench, and around to the forebay.

Nipple Bench, P.S. (cont.)

Nipple Bench would be a pumped storage project on the edge of the Kaiparowits Plateau, 30 miles north of Page, Arizona. It is not in the National Recreation Area, and it is not in any of the areas proposed for wilderness designation at this time. Use by fish and wildlife is minimal, and the site is recommended by the Biological subteam for further study.

The facility will require a 200-foot-high forebay, and a 232-foot-high afterbay in Nipple Creek. The two bays would be connected by a 1,900-foot tunneled penstock. Water would need to be supplied by a pipeline from Lake Powell. Due to the porosity of the area, both reservoir basins would need to be lined.

Transmission lines could tie into the existing corridors leading out of Glen Canyon Dam. The site could produce 990 MW for a 12-hour period.

CRSP PEAKING POWER
ROCK CREEK - GREEN RIVER

Location: 18 miles east of Sunnyside, Utah, and 4 miles west of Desolation Canyon on the Green River

USGS Quad. - Flat Canyon 15 m.
Land Required - 6,850 acres

Reservoirs: Forebay
Area capacity (8,042 feet) = 34,600 acre-feet
Area = 265 acres
Active capacity (8,042 feet) = 32,600 acre-feet
Dead storage = 2,000 acre-feet
Minimum water surface = 7,826 feet
Drawdown = 216 feet

Afterbay
Area capacity (5,987 feet) = 107,800 acre-feet
Active capacity (5,987 feet) = 32,600 acre-feet
Dead storage = 75,200 acre-feet*
Surface area (5,987 feet) = 463 acres
Minimum water surface = 5,910 feet
Drawdown = 77 feet

Penstock: 5-20 foot diameter above ground or buried steel penstock
Q = 32,600 f^3/s
Head = 2,000 feet

Power Potential: 4,412 MW
12-hour operation

Make-up Water: Make-up flow = 50 f^3/s
Fill time = 3 years
Diameter = 2½ feet
Length = 26,400 feet = 5 miles pipe
Fill source = Green River
Annual fill = (6 acre-feet per year)(265 acres + 463 acres) = 4,368 acre-feet per year

Roads Required: 5 miles road and pipeline down Rock Creek to the Green River
Improvement of 24 miles of dirt road to Sunnyside, Utah
Forebay and afterbay connected by a tunnelled cable car system; tunnel would be at a 34 percent grade

Transmission Lines: 1,000 miles of 500 kV

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* Large dead storage is to bring the generating head within the range capable of being handled by hydro equipment developed in the near future

Flora and Fauna: Flora - Mixed desert shrub - desert grassland
Fauna - Winter range for deer; summer range for cattle; Squawfish in Green River; rainbow trout in Rock Creek; Desolation Canyon prime wilderness candidate

Description: The Rock Creek P.S. proposal is a site capable of meeting the entire market area's peaking needs. The facility would require two new dams, a 370-foot forebay dam and a 300-foot to 400-foot afterbay dam. The afterbay dam would be on Rock Creek approximately 6 miles west of its confluence with the Green River. Access to the site would be from the west with transmission lines tying into existing corridors from the coal-fired plants in the area.

Water supply would have to be supplemented by a pipeline from the Green River. However, once initial fillup was completed only flows to replace seepage and evaporation losses would need to be diverted.

The generating head between the two reservoirs would be in excess of 2,000 feet. At the present time reversible pump-turbine units are not capable of pumping back against a head of this magnitude. This technology could be obtained in the near future, but if not, separate pumping and generating units would be installed.

The Rock Creek drainage currently has some recreational use for pack trips. The drainage is also a common stop for rafters floating down Desolation Canyon of the Green River.

CRSP PEAKING POWER
FLAMING GORGE OUTLET WORKS

Location: Flaming Gorge Dam

USGS Quad. - Dutch John, Utah-Wyoming 7½ m.
Land Ownership - Bureau of Reclamation Power Withdrawal, U.S. Forest Service
Land Requirements - Small area around existing outlet works

Reservoirs: Forebay - Flaming Gorge Dam

Afterbay - None. For peaking power purposes, peak releases would be increased approximately 40% (up to around 4,800 cubic feet per second). Consequently, minimum flows would occur for longer periods of time. Length of time would depend on the peaking operation.

Penstock: Use existing outlet works

Power: 40 MW
Head = 370 feet

Roads: None

Transmission Lines: Existing lines and corridors can probably be used.

Make-up Water: None

Description: An addition of generation facilities on the outlet works at Flaming Gorge Dam could increase generation capacity by 40 MW. This is approximately a 40 percent increase, and would result in a 40 percent increase of peak flows during peak power demands. This would result in longer periods of minimum flows during off-peak periods.

The project would have the potential of producing this added capacity continuously during emergency demand periods if the resulting downstream impacts were acceptable.

CRSP PEAKING POWER
FONTENELLE OUTLET WORKS

Location: Fontenelle Dam, Wyoming

USGS Quad - Fontenelle Reservoir SE, Wyoming 7½ m
Land Ownership -
Land Required - 190 acres of bottomland below Fontenelle Dam

Reservoirs: Forebay - Fontenelle Reservoir

Afterbay - Active capacity = 2340 acre-feet
Drawdown = 13 feet
Area = 184 acres

Dams: Forebay - Fontenelle Dam

Afterbay - 16-foot concrete

Penstock: 1 14-foot diameter tunnel
Length - 200 feet

Power: 19.6 MW
Head - 90 feet

Roads: None

Transmission Lines: Existing lines may be able to handle the load, but if not, existing corridors could be used

Make-Up Water: None

Description: This project would triple the present power output of Fontenelle Dam from 10 to 30 MW. The only new facilities at the dam site would be generation units on the outlet works, but due to the resulting higher flows, a 10-foot-high concrete reregulation dam would be required approximately 1½ miles downstream. This would probably adversely affect fishing recreation in the present tailwater area.

CRSP PEAKING POWER
MCDONALD'S LITTLE VALLEY

Location: 0.2 mile north of Jordanelle, Utah

USGS Quad. - Park City East, Utah; Heber City, Utah; Francis, Utah (All 7.5 m.)

Land Ownership -
Land Required -

Reservoirs: Forebay Total capacity (7,192 feet) = 72,500 acre-feet
Active capacity (7,192 feet) = 70,500 acre-feet
Dead storage (7,040 feet) = 2,000 acre-feet
Drawdown = 152 feet
Area = 800 acres

Afterbay Total capacity (6,187 feet) = 382,300 acre-feet
Active capacity (6,187 feet) = 70,100 acre-feet
Dead storage (6,060) = 87,800 acre-feet
Drawdown = 18 feet
Area (6,187 feet) = 2,880 acres

Penstock: 8-24 foot diameter above ground or buried penstock
Length = 6,300 feet

Power: 4,300 MW
Head = 990 feet
12-hour operation

Roads: Improve 5 miles of access road

Transmission Line: 1,250 miles of 500 kV line

Make-up Water: Evaporation losses = 36 inches per year
Assume total losses = 4 acre-feet per year
Total loss = 2,000 acre-feet

Description: This alternative would supply the complete peaking power needs for the entire CRSP service area. McDonald's would require an enlargement of the proposed Jordanelle Reservoir of the Central Utah Project for use as an afterbay. A large forebay would be constructed south of the east-west arm of Jordanelle. The primary forebay dam would be around 152 feet high, but three smaller dikes would also be required. This size plant would be capable of producing more than 4,300 MW of capacity for 12 hours. The drawdown created by the pumped storage operation would cause severe impacts on the recreational use planned for Jordanelle Reservoir.

Service the entire service area from one site would require extensive construction of new transmission lines.

CRSP PEAKING POWER
DOMINGUEZ - CACTUS PARK

Location:

USGS Quad -
Land Ownership -
Land Required - 2,000 acres

Reservoirs: Forebay Total (6,262 feet) = 62,500 acre-feet
Active (6,262 feet) = 46,200 acre-feet
Drawdown = 62 feet
Area = 1,070 acres

Afterbay Domingues Reservoir

Penstock: 8-19 foot diameter tunnels
Length = 15,000 feet

Power: 4,300 MW
Head = 1,440 feet
12-hour operation

Roads: 7.2 miles of road will need to be relocated

Transmission Lines: 1,250 miles of 765 kV line
60 miles of new corridor

Make-up Water: 4,300 acre-feet per year

Description: The construction of this project would enable the supply of the entire power region's peaking needs to come from this one site. Cactus Park would use the proposed Dominguez Reservoir as an afterbay, and a new forebay would be placed in Cactus Park. The bays would be interconnected by 15,000-foot tunneled penstocks. The forebay dam would be up to 125 feet high.

Generation of 4,300 MW of capacity would cause 30- to 40-foot fluctuations in Dominguez Reservoir. This would cause problems with the planned recreational use there.

Service the entire region from one site would require extensive construction of new transmission lines.

This site was recommended by the Peaking Power Subteam's Biological Subteam.

CRSP PEAKING POWER
BOWL CANYON

Location: 45 miles north of Gallup, New Mexico

USGS Quad. - Washington Pass, New Mexico
Land Ownership - Navajo Indian Reservation
Land Requirements - 5,760 acres

Reservoirs: Forebay
Total capacity 68,900 acre-feet (8,992 feet)
Active capacity 63,500 acre-feet (8,992 feet)
Dead storage 5,400 acre-feet (8,920 feet)
Drawdown 72 feet
Area (8,992 feet) 1,300 acres

Afterbay
Total capacity 64,000 acre-feet (8,004 feet)
Active capacity 63,500 acre-feet (8,004 feet)
Dead storage 500 acre-feet (7,843 feet)
Drawdown 161 feet
Area (8,004 feet) 900 acres

Penstock: 8-26 foot diameter tunnels
Length = 5,184 feet

Power: 4,300 MW
Head = 1,010 feet
12 hour operation

Roads required - Relocating of 2.5 miles of a 2-lane gravel road. No new roads required, but some improvement of existing roads necessary.

Transmission Lines: 440 miles of 500 kV line 50 miles of new corridor would be required.

Make-up Water: Evaporation Rate = 50 inches per year = 4.2 acre-feet per year.
Assume total losses per year = 5.2 acre-feet per year
Total loss = 10,400 acre-feet per year

Bowl Canyon P.S. (Cont.)

The Bowl Canyon P.S. project would be located on the Navajo Indian Reservation, approximately 45 miles north of Gallup, New Mexico. The site has the potential to produce up to 7,000 MW of capacity, but at the present time the site would be planned on a much smaller scale.

Water supply could present problems. Water could be piped from the San Juan, but this would present sedimentation problems and the river's water is already over-allocated. Another possibility is to use water from the proposed Gallup Project of the Southwestern Region of the Bureau of Reclamation.

Transmission corridors from Phoenix to Farmington are within a few miles.

This site was recommended by the Peaking Power Study's Power Subteam.

CRSP PEAKING POWER
WENT RIDGE

Location: 60 miles west and 13 miles north of Grand Junction, Colorado

USGS Quad: Florence Canyon 1 southwest, Utah 7½ m
Land Ownership:
Land Requirements: 430 acres

Reservoirs:

Forebay: Total capacity - (8760 feet) = 9,900 acre-feet
Active capacity - (8760 feet) = 100 acre-feet
Dead storage - (8,485 feet) = 9,800 acre-feet
Area - (8,760 feet) = 127 acres

Afterbay: Total capacity (7,379 feet) = 10,800 acre-feet
Active capacity (7,379 feet) = 9,800 acre-feet
Dead storage (7,271 feet) = 1,000 acre-feet
Area - (7,379 feet) = 159 acres

Penstock: One tunnel 25 feet in diameter, length = 4,167 feet

Power: 871 MW
Head = 1,313 feet
12-hour operation

Roads: Improve 55 miles of existing road, build 20 miles of new road

Transmission Lines: 350 miles of 345 kV line, 150 miles of new corridor

Make-up Water: 1,140 acre-feet per year

Description:

The Went Ridge P.S. project would be located in the Roan Cliff area, south of the Hill Creek Extension of the Uintah and Ouray Indian Reservation. The site is economically attractive, but access, water supply and geological problems could prove expensive to solve.

The facility would require two new reservoirs formed behind a 326-foot upper dam, and a 192-foot lower dam. Materials could be difficult to obtain for the sizes of dams required.

Access would require improvement of existing roads through the length of the reservation, or a lengthy new road would have to be constructed through the rough terrain to the south. Such a road could be beneficial in the event of future development of oil shale in the area.

New transmission corridor would be needed from the site to the area of Green River, Utah.

Utah Lake P.S. (cont.)

Utah Lake is a proposed pumped storage project which would use Utah Lake as an afterbay. The forebay would be located in the Lake Mountains west of Utah Lake behind a 370-foot-high dam. Due to possible turbulence and sedimentation problems, some levees may need to be placed in Utah Lake to control flows and restrict access. The possibility of establishing recreational facilities on these levees led to this site's recommendation by the Peaking Power Study's Recreation Subteam for further study. The site has also been recommended by the Power and Biological Subteams for further study.

As this site is in the Wasatch Front area, there is a potential for seismic activity. The site is close to existing transmission corridor.

CRSP PEAKING POWER
DESIGN DATA

Utah Lake:

Location: 9.5 miles southeast of Saratoga Springs, Utah

USGS Quad. - Soldiers Pass, Utah; Pelican Point, Utah; Lincoln Point, Utah; Saratoga Springs, Utah - All 7.5 m.
Land Required - 1,710 acres

Reservoirs: Forebay - Area capacity (5,300 feet) = 29,500 acre-feet
Active capacity (5,300 feet) = 29,000 acre-feet
Surface area (5,300 feet) = 251 acres
Minimum water surface = 5,000 feet
Drawdown = 300 feet

Afterbay - Utah Lake
Elevation = 4,490 feet

Penstock: 3-25 foot diameter - 2,200 foot tunnels
Q = 29,000 f^3/s
Head = 736 feet

Power Potential: 1,444 MW
12-hour operation

Make-up Water: Use Utah Lake
1,255 acre-feet per year

Roads Required: There is an existing dirt road to forebay. Plant would require a ½ mile road from State Highway 68.

Transmission Lines: 200 miles of 345 kV line
The nearest transmission line corridor can be joined by a 2.0 mile route from the powerplant directly to the corridor. One mile of line over steep ridge terrain.

Flora and Fauna: Project site includes sagebrush, pinyon-juniper and wet grasses.

No known winter range. Small impact on Utah Lake fishery due to 6" to 1' drawdown of Utah Lake

CRSP PEAKING POWER
TUFT RESERVOIR

Location: 27 miles south of Richfield, Utah

USGS Quad: Marysvale, Utah 15 m.
Land Ownership: Fish Lake National Forest
Land Required: 330 acres

Reservoirs: Forebay - Total = 10,200 acre-feet
Active = 10,000 acre-feet
Dead = 200 acre-feet
Drawdown = 178 feet
Area = 131 acres

Afterbay - Total = 10,500 acre-feet
Active = 10,000 acre-feet
Dead = 500 acre-feet
Drawdown = 215 feet
Area = 90 acres

Penstock: 2 18-foot diameter tunnels
Length = 5,930 feet

Power: 1,039 MW
Head = 1,535 feet

Roads: Improve 21 miles of road

Transmission Lines: 10 miles of new corridor
350-750 miles of new line

Make-up Water: From Dry Creek and Sevier River
(7-foot losses per year)(221 acres) = 1,550 acre-feet per year

Description:

This pumped storage proposal would be located in the Fish Lake National Forest, approximately 30 miles southeast of Richfield, Utah. The facility would be composed of two dams, a 221-foot-high earthfill forebay dam and a 300-foot-high earthfill afterbay dam. The two reservoirs would be connected by 2 6,000-foot tunneled penstocks. The site could produce up to 1,039 MW for a 12-hour period.

Five to ten miles of new transmission corridors would connect with the existing UP&L corridor from Sigurd to Page.

CRSP PEAKING POWER
RIM BASIN P.S.

Location: Approximately 15 miles southeast of Grand Junction, Colorado

USGS Quad. - Whitewater, Co., 7½ m., Triangle Mesa, Co., 7½ m.
Land Ownership -
Land Required - (In addition to land required for Dominguez Reservoir) 200 acres

Reservoirs: Forebay - Active capacity = 7,900 acre-feet
Drawdown - 200 feet
Surface area - 124 acres

Afterbay - Dominguez Reservoir
Active capacity for pumped storage - 7,900 acre-feet
Drawdown - 1½ - 2 feet

Penstock: 3,200 feet of either tunneled or above-ground penstock

Power: 500 MW for 8-hour daily operation
314 MW for 12-hour daily operation
Head - 674 feet

Roads: 5 to 10 miles of improved road. A new road down to the powerplant would need to be constructed through difficult terrain.

Transmission Lines: 60-150 miles of new line, probably use some existing corridor.

Make-up Water: From Dominguez Reservoir.

Rim Basin P.S. (cont.)

The Rim Basin P.S. proposal would be constructed in conjunction with the Bureau of Reclamation's Dominguez Project. Feasibility reports are in the process of being prepared for submittal to Congress for its authorization.

The Rim Basin phase would require a forebay be formed behind a 210-foot high earthfill dam. The Dominguez Reservoir would be used as an afterbay, but the fluctuations caused by the pumped storage operation are not expected to detract from the recreational use planned for the reservoir.

Rim Basin is planned for a 500 MW capacity, but at this capacity it could only operate for 8 hours. The majority of sites in this study are designed to operate for 12 hours.

New transmission line corridor would need to be established to tie into the CRSP system at Rifle and Montrose.

The Rim Basin site has been recommended by the Peaking Power Study's Biological and Recreation Subteams.

CRSP PEAKING POWER
QUITCHUPAH CREEK

Location: 8½ miles west and 2 miles south of Emery, Utah

USGS Quad: Acord Lakes, Utah, 7½ m
Land Ownership: Fish Lake National Forest
Land Requirements: 300 acres

Reservoirs: Forebay - Total capacity = (8,374 feet) = 9,800 acre-feet
Active capacity = (8,374 feet) = 9,700 acre-feet
Dead storage = (8,169 feet) = 100 acre-feet
Area = (8,374 feet) = 85 acres

Afterbay - Total capacity = (7,067 feet) = 10,700 acre-feet
Active capacity = (7,067 feet) = 9,700 acre-feet
Dead storage (6,920 feet) = 1,000 acre-feet
Area = (7,067 feet) = 116 acres

Penstock: One tunnel, 25 feet in diameter, 3488 feet long

Power: 839 MW
Head - 1,278 feet
12-hour operation

Roads: 3 miles of new road, 14 miles of road improvement required

Transmission Lines: 550 miles of 345 kV line, 25 miles of new corridor

Make-up water: 940 acre-feet per year

Description:

This proposal is located on the headwaters of the Muddy River, about 8 miles west of Emery, Utah. The site requires a new 260-foot-high forebay dam on the Old Woman Plateau, and a 280-foot afterbay dam in the Convulsion Canyon arm of Quitchupah Creek. The two bays would be connected by a 3,500-foot tunneled penstock. Transmission corridor of the proposed UP&L Huntington to Sigurd line is nearby.

Supplying initial fill-up and the required annual makeup water could be difficult to obtain. There also could be some conflicts with coal mining interests.

This site has not been visited, and as a result, all impacts are of a suspected nature.

CRSP PEAKING POWER
PINE CREEK MESA

Location: 30 miles east and 2½ miles south of Montrose, Colorado

USGS Quad: Sapinero, Colorado, 7½ m
Land Ownership
Land Required: 1,050 acres

Reservoirs: Forebay - Total capacity (8,460 feet) = 9,650 acre-feet
Active capacity (8,460 feet) = 9,600 acre-feet
Dead Storage (8,415 feet) = 50 acre-feet
Area (8,460 feet) = 700 acres

Afterbay - Total capacity (7,519 feet) = 941,000 acre-feet
Active capacity (7,519 feet) = 749,000 acre-feet
Minimum power operating elevation = 7,393 feet

Penstock: One above-ground or buried steel penstock 25 feet in diameter, length = 7,103 feet

Power: 669 MW
Head = 995 feet
12-hour operation

Roads: Improve 3 miles of roads, build 1 mile of new road

Transmission Lines: 500 miles of 345 kV line

Make-up Water: 2,800 acre-feet per year

Description: This is a pumped storage proposal which would use the Bureau's existing Blue Mesa Reservoir as an afterbay. The forebay would be formed behind a 59-foot-high earthfill dam on Pine Creek Mesa. The bays would be connected by approximately 7,100 feet of above-ground or buried steel conduit. The facility would be capable of producing 669 MW continuously for 12 hours.

Turbulent flows caused by the pumped storage operation would occur in the Lake Fork arm of Blue Mesa Reservoir, and as a result, might necessitate the closing of that arm to recreational use. Model studies would need to be undertaken to determine the impacts.

Geological problems may occur due to landslides and faults in the area of the forebay. This problem may require lining of the forebay and tunneling of the penstocks.

CRSP Peaking Power
Dunham Point

DESIGN DATA

Location: 17 miles north and 2 miles east of Cortez, Colorado

USGS Quad: Trimble Point, Colorado 7½ M.

Land Ownership: San Juan National Forest

Land Required: 220 acres

Reservoirs:

Forebay: Total Capacity (8026') = 5000 acre-feet

Active Capacity (8026') = 4900 acre-feet

Dead Storage (7940') = 100 acre-feet

Area (8026') = 148 acres

Afterbay - (McPhee Reservoir):

Total Capacity (6924') = 381,100 acre-feet

Active Capacity (6924') = 229,000 acre-feet

Dead Storage (6855') = 100 acre-feet

Penstock: 2-above ground or buried steel penstocks

20' diameter

Length = 5614'

Power: 969 MW

Head = 1109'

12-hour operation

Roads: Requires improvement of 4 miles of road.

Transmission Lines: 500 miles of 500-kV line

4 miles of new corridor

Make-Up Water: 600 acre-feet/year

Dunham Point P.S. (cont.)

The Dunham Point P.S. proposal would use the now under construction McPhee Reservoir as an afterbay. McPhee is a part of the Bureau of Reclamation's Dolores Project. The forebay on Dunham Point would be filled behind a 166-foot-high earthfill dam. Due to the turbulence created by the pumped storage operation the Dry Canyon area of McPhee Reservoir would possibly be closed to recreational boating. This turbulence might also breakup the thermocline in the reservoir which could improve the fishery.

Existing transmission corridors are nearby, and the site is convenient to Colorado-Ute's proposed coal-fired plant at Dove Creek. This plant would be attractive as a source of pumping power for the Dunham Point facility.

Dunham Point could produce up to 970 MW of capacity.

CRSP PEAKING POWER
DRY FORK

Location: 13 miles northwest of Vernal, Utah

USGS Quad. - Dry Fork, Utah 7.5 m.
Land Required - 537 acres

Reservoirs: Forebay Total (7,727 feet) = 19,600 acre-feet
Active (7,727 feet) = 19,500 acre-feet
Drawdown = 247 feet
Area (7,727 feet) = 140 acres

Afterbay Total (6,877 feet) = 19,600 acre-feet
Active (6,877 feet) = 19,500 acre-feet
Drawdown = 187 feet
Area (6,877 feet) = 218 acres

Penstock: 2-25 feet diameter tunnels
Length = 3,800 feet

Power: 1,075 MW
Head = 815 feet
12-hour operation

Roads: Relocate 0.5 mile of 2-lane gravel
0.5 mile of new road

Transmission Lines: 300 miles of 500 kV Line
150 miles of new corridor

Make-up Water: 1,430 acre-feet per year

Description:

This proposal is a pumped storage facility located 13 miles northwest of Vernal, Utah. Two new dams are required: a 287-foot earthfill forebay and a 207-foot-high earthfill afterbay just off the Red Cloud Loop highway. The two bays would be connected by 3,800 feet of tunneled penstock and would produce 1,075 MW of capacity.

Transmission lines could tie into existing CRSP corridors from Flaming Gorge to Vernal. Water is planned to be piped from the Ashley Creek drainage to the site to supplement water from Dry Fork.

The site's proximity to Vernal lends itself to possible visitor recreational development. For this reason the Peaking Power Study's Recreation Subteam recommended Dry Fork P.S. for further study.

CRSP PEAKING POWER
DIAMOND FORK

Location: 15 miles southeast of Spanish Fork, Utah

USGS Quad: Billies Mountain, Utah; Rays Valley, Utah 7.5m
Land Ownership: Uinta National Forest

Plan 1 - DPR Alternative
Reservoirs

Strawberry Reservoir	Total Capacity (7602') = 1,106,500 acre-feet Active capacity = 1,955 acre-feet Drawdown = minimal
Syar Reservoir	Total capacity (7,185') = 930 acre-feet Active capacity (7185') = 680 a.f. Drawdown = 27'
Sixth Water Reservoir	Total capacity (6385') = 1,020 acre-feet Active capacity (6385') = 500 acre-feet Drawdown = 23 feet
Hayes Reservoir	Total capacity (5150') = 51,500 acre-feet Active capacity (5150') = 43,400 acre-feet Drawdown = 100'

Penstock: Strawberry to Syar - Syar Tunnel 34,200' long, diameter - 8'
Syar to Sixth Water - Corona Aqueduct 4820' long, dia. 12.5'
Sixth Water penstock - 1400' long, dia. 10.0'
Sixth Water to Monks Hollow - Dyne Aqueduct - 13,630' long, diameter - 8.5'
Dyne penstock - 2,600' long, diameter - 7.0'

Power: Syar Powerplant - conventional - 10.5 MW
Sixth Water - conventional - 90.0 MW
Dyne - conventional - 33 MW
6-hour normal operation

Roads: 3½ miles of new road - up Creek Gully to Sixth Water Reservoir
6 miles of improved road to Syar Reservoir

Transmission Lines: 100 miles of 345 kV or 138 kV

Make-up Water: Estimated reservoir surface area - 320 acres
Evaporation losses = 42 inches
Assume total losses = 4.5 acre-feet per year
Total losses = 1440 acre-feet per year

Diamond Fork (cont,)

Plan 2 - Sixth Water Alternative

Reservoirs - Strawberry — No change

Syar — Total capacity (7215') = 3,026 acre-fe
Active capacity (7215') = 2,600 a.f.
Drawdown = 55 feet

Sixth Water — Total capacity (6368') = 620 acre-feet
Active capacity (6368) = 100 a.f.
Drawdown = 6'

Monks Hollow — Total capacity (5550') = 32,250 a.f.
Active capacity (5550') = 14,000 a.f.
Drawdown = 38 feet
Area = 350 acres (approx.)

Penstock: Sixth Water to Monks Hollow - Dyne Aqueduct - 13,600' long, diam.- 17.0'
Dyne Penstock - 2,600' long, diam. 15.0'

Strawberry to Syar - Syar Tunnel, 34,000' long, 9.5' diameter
Syar Penstock, 1100' long, 8.0' diameter

Syar to Sixth Water - Corona Aqueduct, 4,820' long, 17.0' diameter
Sixth Water Penstock, 1400' long, 13.5 diameter

Power: Dyne pump storage - 190 MW
Sixth Water P.S. - 194 MW
Syar - conventional - 15.6 MW

Roads, transmission lines - No change

Make-up Water: 1700 acre-feet per year

Plan 3 - Fifth Water Alternative

Reservoirs Strawberry — No change

Fifth Water — Total capacity (7150') = 75,000 a.f.
Active Capacity (7150') = 7,600 a.f.
Drawdown = 11 feet

Monks Hollow — Total capacity (5461') = 9,756 a.f.
Active capacity (5461') = 5,800 a.f.
Drawdown = 40 feet

Penstock: Strawberry to Fifth Water - Syar Tunnel, 28,900' long, 10.75' diam.
Syar Penstock, 680' long, 9.0' diam.

Diamond Fork (cont.)

Penstock (cont.): Fifth Water to Monks Hollow - Fifth Water Penstock, 1850' long, 14.0' dia.
Fifth Water Discharge, 21,969' long, 20.5' diam.

Power: Syar - conventional - 20.6 MW
Fifth Water P.S. - 456 MW

Description: This proposal consists of three different alternatives. Whichever of the alternatives is selected will be included as a part of the Congressionally authorized Bonneville Unit of the Central Utah Project. All three alternatives are similar in that water is taken from Strawberry Reservoir through the Diamond Fork system for municipal, industrial, and irrigation use along the Wasatch Front. All three alternatives are unique in the Peaking Power Study as they are the only proposals which are net energy producers. The 197,000 acre-feet of water diverted annually into the Great Basin can be converted into over 300 GWh of energy. Pumping requirements of the Fifth Water P.S. and the Sixth Water P.S. do reduce this amount, but the net energy remains positive.

Diamond Fork Conventional - This is the alternative proposed in the Definite Plan Report. The project would have no pumped storage, but would have three conventional hydroelectric plants: Syar, Sixth Water, and Dyne. The Syar and Sixth Water plants would both have small reregulation reservoirs immediately below the plants, but the Dyne plant would release water into the Diamond Fork or into the Wasatch Aqueduct. Water released into the Diamond Fork would be stored in the large Hayes Reservoir downstream. This plan would have a total capacity of 133 MW.

Sixth Water - The Sixth Water proposal would follow a similar alignment as the DPR plan, but with a few major changes. The Syar and Sixth Water Reservoirs would be enlarged, and the Hayes Reservoir would be relocated to immediately below the Dyne plant at Monks Hollow. This is to allow for pumped storage operations at the Dyne and Sixth Water plants. This alternative could produce 400 MW of capacity.

Fifth Water - The Fifth Water alternative would initially transfer the water into the Fifth Water rather than the Sixth Water drainage. After passing through a conventional hydro plant, the water would be stored in the large Fifth Water Reservoir. In a pumped storage operation water would then fluctuate between the Fifth Water and Monks Hollow Reservoirs. The pumped storage plant would be located 4 miles inside the mountain. This project could produce 476 MW of capacity, and its engineering features would be fairly unique in the United States. Drilling of the site this summer will indicate the geological feasibility of the project.

CRSP PEAKING POWER
CIRCLEVILLE CANYON

Location: 10 miles east and 15 miles south of Beaver, Utah

USGS Quad: Bull Rush Peak, Utah, 7½m
Land Ownership: Private and National resource land
Land Required: 1,930 acres

Reservoirs: Forebay - Total = 13,200 acre-feet (7,354 feet)
Dead = 100 acre-feet (7,169 feet)
Active = 13,100 acre-feet
Drawdown = 185 feet
Area = 185 acres

Afterbay - Total = 32,500 acre-feet
Dead = 19,400 acre-feet (for sediment)
Active = 13,100 acre-feet
Drawdown = 23 feet
Area = 1,105 acres

Dams: Forebay - 7360 feet - 7120 feet = 240 feet

Afterbay - 6358 feet - 6264 feet = 94 feet

Penstock: 2 21-foot diameter tunneled penstocks
Length - 4,440 feet

Power: 830 MW
Head = 936 feet

Roads: 5 miles of U.S. 89 will have to be relocated. Two to three miles of new road. Railroad will have to be relocated.

Transmission Lines: 50-350 miles of new corridor, 350-750 miles of new line

Make-up Water: From Sevier River (7-foot total losses per year)(1190 acres) = 8,300 acre-feet per year

Description: This is a pumped storage project located 6 to 7 miles south of Circleville, Utah. The afterbay would be located on the Sevier River, and would require the relocation of U.S. 89 and the existing railroad tracks. The afterbay dam would be a 94-foot earthfill structure. The forebay would be to the east of the canyon behind a 240-foot dam. The bays would be connected by 4,400-foot penstock, and the site could produce up to 830 MW of capacity. Transmission lines could tie into the nearby UP&L corridor from Sigurd to Page.

CRSP PEAKING POWER
CIMARRON POINT

Location: 3.5 miles northeast of Cimarron, Colorado

USGS Quad. - Curecanti Needle, Colorado 7.5 m.
Cimarron, Colorado 7.5 m.
Land Ownership - Curecanti Recreation Area (NPS)
Required land = 850 acres

Reservoirs: Afterbay - Morrow Point Reservoir Drawdown = 23 feet

Forebay - Total capacity (9,400 feet) = 14,510 acre-feet
Active capacity (9,400 feet) = 14,510 acre-feet
Dead storage (9,150 feet) = 0
Surface area (9,400 feet) = 400 acres
Minimum water surface = 9,150 feet
Drawdown = 250 feet

Penstock: 2 above ground or buried steel penstock
Length = 6,325 feet
Diameter = 22 feet
Q = 14,500 f^3/s
Q' = 7,250 f^3/s

Power Potential: Head = 2,220 feet
Power = 1,630 MW

Make-up Water: 2,000 acre-feet per year

Roads Required: A direct line from forebay to afterbay is a 42 percent grade. In order to prevent cutting a road down steep cliffs, or an excessively long tunnel, some type of cable car will be required to connect the forebay and afterbay

Existing roads should be sufficient for access to both bays

Transmission Lines: 500 miles of 500 kV line
2 miles of new corridor to the Morrow Point Corridor

Cimarron Point P.S. (cont.)

Cimarron Point P.S. project would use the existing Morrow Point Reservoir as an afterbay. The forebay would be located on the plateau north of Morrow Point behind up to a 260-foot high dam. This dam location means an elevation difference between the two reservoirs of 2,200 feet. Current technology can produce reversible pump turbines capable of pumping against heads of up to 1,500 feet. It is possible that a 2,000-foot plus pumping capability could be developed in the near future. If not, separate pumping and generating units would be installed.

Established transmission corridors are nearby for the power operations of the Curecanti Unit. The project would create up to a 23-foot drawdown in Morrow Point Reservoir, but due to its difficult access, little recreational use would be impacted.

The site is capable of producing up to 1,630 MW of capacity, and it was recommended for further study by the Peaking Power Study's Power Subteam.

CRSP PEAKING POWER
BLUE MESA OUTLET WORKS

Location: Blue Mesa Dam, Colorado

USGS Quad: Sapinero, Colorado, 7½ m
Land Ownership: Bureau of Reclamation Power Withdrawal
Land Required: Small area around existing outlet works.

Reservoirs: Forebay - Blue Mesa Reservoir (existing)

Afterbay - Morrow Point Reservoir (existing)

With both existing facilities and the proposed outlet works operating, flows would about double to around 5,000 cubic feet per second. Release time would be decreased to 5½-6½ hours per day. No pumping would take place.

Dams: No new facilities

Penstock: No new facilities

Power: 50 MW
Head - 314 feet

Roads: Probably existing roads are adequate

Transmission Lines: Existing lines may be able to handle load, but if not, existing corridors could be used.

Make-up Water: None required

Description:

This proposal would place generation units on the outlet works of Blue Mesa Dam capable of producing 50 MW. No new energy would be produced annually, but the project would allow greater flexibility in meeting daily and weekly peak demands. Depending upon operational compatability with the Morrow Point and Crystal Reservoirs downstream, this proposal would be capable of supplying emergency power over extended periods of time.

This site is recommended by the Peaking Power Study's Biological, Recreational, and Power Subteams for further study.

CRSP PEAKING POWER
BLUE MESA 83 MW (MODIFICATION)

Location: Blue Mesa Dam, Colorado

USGS Quad: Sapinero, Colorado, 7½ m
Land Ownership: Bureau of Reclamation Power Withdrawal
Land Required: Space for additional generation facilities

Reservoirs: Forebay - Blue Mesa Reservoir (existing)

Afterbay - Morrow Point Reservoir (existing)

With both the existing facilities and the proposed modification operating, flows would more than double to 6,320 cubic feet per second. Release time would be decreased to 5 hours.

Dams: No new facilities

Penstock: 1 2,000-foot long 16-foot diameter tunnel

Power: 83 MW
Head - 314 feet

Roads: Probably existing roads are adequate

Transmission lines: Existing lines may be able to handle the load, but if not, existing corridors could be used.

Make-up Water: None required.

Description:

Blue Mesa 83 MW is a project which would place additional generation capacity at Blue Mesa Dam. New penstock would be formed by drilling around the dam. No new energy would be produced on an annual basis, but the project would allow greater flexibility in meeting daily and weekly peak demands. Depending upon operational compatibility with the Morrow Point and Crystal Reservoirs downstream, this proposal would be capable of supplying emergency power over extended periods of time.

This site is recommended by the Biological and Recreational Subteams for further study.

CRSP PEAKING POWER
BOULDER - BURNT LAKE

Land Required: 4,000 acres

Reservoirs: Forebay Total (7,929 feet) = 11,500 acre-feet
Active (7,924 feet) = 11,500 acre-feet
Drawdown = 13 feet
Area (7,929 feet) = 919 acres

Afterbay Total (7,297 feet) = 35,000 acre-feet
Active (7,297 feet) = 11,500 acre-feet
Drawdown = 7 feet
Area (7,297 feet) = 1,750 acres

Penstock: 1-28 foot diameter tunnel
Length = 3,360 feet

Power: 500 MW
12-hour operation

Transmission Lines: 500 miles of 235 or 340 kV line

Roads: Improve 3 miles of road

Make-up Water: 10,700 acre-feet per year

Description: This pumped storage proposal is located on the western side of the Wind River Mountains, about 8 miles southeast of Pinedale, Wyoming. The existing Boulder and Burnt Lakes would be enlarged by dam structures, and interconnected by 3,300 feet of tunneled penstock. The site is capable of producing up to 3,500 MW of capacity with a 106-foot-high dam at Burnt Lake, and a 78-foot-high structure at Boulder Lake. However, the site would more likely be developed for only a capacity of 300 to 500 MW. In this case the forebay and afterbay structures would be 29 feet and 22 feet high, respectively. As the site is located on glacial moraine material, the reservoirs would need to be lined to prevent excessive leakage and possible landslides.

Depending upon the drawdowns, moderate to severe adverse impacts on the existing recreation area could be seen.

This site was recommended for further study by the Peaking Power Study's Power Subteam.

CRSP PEAKING POWER
BOULDER - BURNT LAKE

Location: 8 miles southeast of Pinedale, Wyoming

USGS Quad. - Scab Creek, Wyoming; Boulder Lake, Wyoming; Fayette, Wyoming All 7.5 m.
Land Ownership - Bridger-Teton National Forest
Land Required - 7,680 acres

Reservoirs: Forebay
(Burnt Lake) Total capacity (8,000 feet) = 83,600 acre-feet
Active capacity (8,000 feet) = 83,500 acre-feet
Dead storage (7,916 feet) = 100 acre-feet
Drawdown = 84 feet
Area (8,000 feet) = 1,134 acres

Afterbay
(Boulder Lake) Total capacity (7,353 feet) = 83,600 acre-feet
Active capacity (7,353 feet) = 83,500 acre-feet
Dead storage (7,290 feet) = 100 acre-feet
Drawdown = 63 feet
Area (7,353 feet) = 2,543 acres

Penstock: 8-26 foot diameter penstock
Length = 3,300 feet

Power: 3,475 MW
Head = 615 feet
12-hour operation

Roads: 3 miles of road between lakes would need improvement

Transmission Lines: 750 miles of 500 kV line 90 miles of new corridor

Make-up Water: Evaporation losses = 28 inches per year
Assume total losses = 3½ acre-feet per year
Total loss = (3½ acre-feet per year)(1,134 + 2,543) = 12,900 acre-feet per year