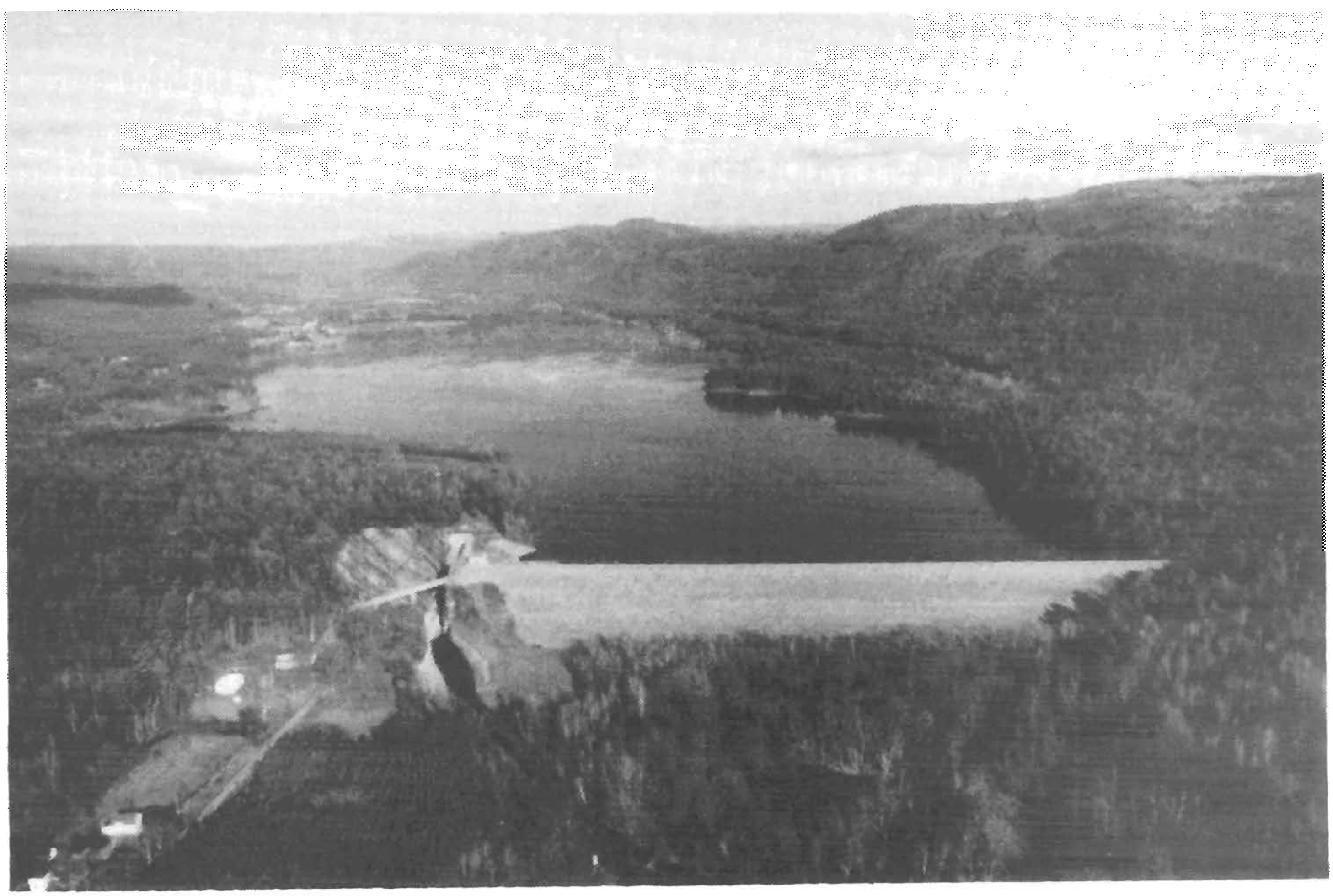
US Army Corps
of Engineers
New England District

Drought Contingency Plan

SEPTEMBER 1997

Surry Mountain Lake, Surry, New Hampshire



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New England District
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Waltham, MA 02254-9149

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13. ABSTRACT *(Maximum 200 words)*

The purpose of this study and report was to develop and set forth a possible drought contingency plan of operation for Surry Mountain Lake that would be reponsive to public needs during drought periods and identify possible modifications to the project regulation within the current administration and legislative constraints. However, the state of New Hampshire has withdrawn support as sponsor for using Surry Mountain Lake as a source of emergency supply; therefore, this plan is not implementable.

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SUMMARY

In the 1990's NED started updating drought contingency plans that were previously developed in the 1980's for some of our reservoirs. One of the requirements to updating the drought contingency plans, to make them fully implementable, is state sponsorship. If there is no state sponsorship then a nonfeasible plan will be published for that particular project.

In letter, dated February 14, 1997 (copy attached), the State of New Hampshire Department of Environmental Services (DES) withdrew its support as a sponsor for the drought contingency plan at Surry Mountain Lake. The DES indicated for a variety of reasons, mainly the timing of the proposed drought storage, they currently are not interested in sponsoring emergency storage at the project. Therefore, the New Hampshire DES is not interested in entering into a contract with the Corps.

Since there is no state sponsorship for drought storage at Surry Mountain Lake, the drought contingency plan developed in 1986 is presented herein for informational purposes only. If, at some future date, the state were to indicate an interest, drought contingency storage will be re-evaluated and this report updated as necessary to respond to the state request.

DROUGHT CONTINGENCY STORAGE FOR EMERGENCY WATER SUPPLY PURPOSES AT SURRY MOUNTAIN LAKE IS NOT IMPLEMENTABLE

State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES
NHDES
64 No. Main Street, P.O. Box 2008, Concord, NH 03302-2008
(603) 271-3406 FAX (603) 271-7894

February 14, 1997

Richard D. Reardon
Director of Engineering
Department of the Army
New England Div., Corps of Engineers
424 Trapelo Rd
Waltham MA 02254-9149

Dear Mr. Readon:

Your letter of February 4, 1997 requests information relative to the State of New Hampshire's participation in a Drought Contingency Plan and Memorandum of Agreement for the above referenced projects. By way of background, it is my understanding from previous studies and discussion with your staff that the contingency plan could only be implemented after declaration of a drought emergency by the State. At that time, the Corps would reduce discharge from the reservoirs to store the stipulated amount of water for later release as requested.

This approach presents a problem to us because once a drought emergency is declared we are already experiencing extremely depleted streamflows. Further reduction in streamflows to store water would increase the adverse effects already being experienced. Based upon this understanding, the state is not interested in participating in an agreement at this time.

We have advocated in the past for a permanent reallocation of a small portion of the flood control storage for streamflow maintenance and drought mitigation. Should you be able to raise the normal pool the two to three feet proposed in the drought plan on a permanent basis, this water would be available to mitigate drought impact.. This is a far more fundamental issue which must be addressed relative to the mission of the projects. More active management of some of the available storage for other purposes on a seasonal basis is an item for future discussion.

Thank you for inquiring as to our interest. Should you have any questions, please contact me at your convenience.

Sincerely,

Kenneth J. Stern, PE
Chief Water Resources Engineer

cc: Robert W. Varney, Commissioner
Edward J. Schmidt, Director
KJS\ss\h:\kjs\reardon.ltr

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION. CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

REPLY TO
ATTENTION OF

February 4, 1997

Engineering - Water Control

Mr. Kenneth Stern, Chief Engineer
New Hampshire Department of Environmental Services
Water Division
P.O. Box 2008
Concord, New Hampshire 03302-2008

Dear Mr. Stern:

The New England Division, Corps of Engineers, is currently updating previously developed plans for drought contingency storage at some of our reservoirs in New Hampshire. We have identified these projects as having merit in providing a source of water supply during drought emergency conditions. We are writing to you with respect to the State of New Hampshire's interest in emergency storage at these projects. Listed below are names and locations of each candidate reservoir in your State. Attachments 1 through 4 present fact sheets with pertinent information for each project, and attachments 5 and 6 show locations.

Name	Location
Edward MacDowell Dam*	Peterborough
Surry Mountain Lake	Surry
Everett Lake	Weare

* 1992 investigations indicated no interest from the town of Peterborough or other communities in the area

These are the remaining three Drought Contingency Plans (DCP) to be updated for your State. As you know, an updated plan for Otter Brook Lake was completed in 1992 and has been excluded from the above list. This implementable plan lists your agency as the lead agency to act as sponsor for the plan.

The DCP presents a basic planning aid assessment of Corps projects as a potential emergency short-term water supply source during a State-declared drought emergency, with each DCP identifying the following:

a. Hydrologic assessment of drought storage potential.

b. Standard operating procedure for drought storage and releases.

c. State participation in the plan.

d. Draft Memorandum of Agreement (contract) identifying how water will be received and distributed as well as cost.

In an effort to update the DCPs for these projects, we are requesting your agency forward a letter to this office expressing your interest (or lack of interest) in participating in the program for each of the remaining candidate reservoirs in your State. You are; therefore, encouraged to review the attached information on the proposed plans and determine your interest in the plans. If there is interest, your letter should identify the appropriate State-sponsored agency acting as signatory to the contract, potential water supply user, and method of transporting water (i.e., reservoir releases, trucking, etc.) for each project.

It should be noted that your 1992 investigations indicated no interest on the part of Peterborough, or other communities in the area, in the use of emergency storage from Edward MacDowell Dam for potable water supply. The attached information sheets on the proposed Edward MacDowell Dam emergency storage plan (attachment 1) and historic low flow data (attachment 2) are provided so you can decide whether there is State interest in the use of emergency storage.

In conclusion, your letter should be a response with respect to the State of New Hampshire's interest in Edward MacDowell Dam, Surry Mountain and Everett Lakes for emergency storage. If you have any questions regarding this request, please contact Mr. Steven Simmer at 617-647-8524.

Sincerely,

Richard D. Reardon
Director of Engineering

Attachments

CF:
Mr. Simmer - 115N
Reading Files
Engr Dir Files - 112S

CONNECTICUT RIVER BASIN
ASHUELOT RIVER WATERSHED

DROUGHT CONTINGENCY STORAGE PLAN
SURRY MOUNTAIN LAKE

SEPTEMBER 1986

NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

DROUGHT CONTINGENCY STORAGE PLAN
SURRY MOUNTAIN LAKE

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SYLLABUS

This report is a compilation of basic information on the Corps of Engineers Surry Mountain Dam and Lake to aid the assessment of the project as an emergency domestic water supply source. Included are sections on project description, operating procedure, available storage capacity, water quality, water supply systems in the region and potential impacts. It was not within the scope of the study to perform detailed analyses but mainly to address the emergency potential of the site and identify and discuss a variety of concerns to be considered in weighing Surry Mountain versus any other available sources of emergency supply. A review for compliance with all current applicable environmental, riparian or other laws would be required at the time of any decision to pursue drought contingency storage at the project. The Corps of Engineers would not consider drought storage activities at Surry Mountain without an official request from the State of New Hampshire.

The Surry Mountain flood control dam and lake could provide about 1,880 acre-feet (612 MG) of emergency water supply storage, made up of 559 acre-feet of infringement on flood control storage and 1,317 acre-feet of recreation storage. Surry Mountain's water quality should be adequate for municipal water supply with standard treatment processes. Special attention would need to be given bacteria, metals, and acidity levels of the stored waters. Emergency storage of waters to the 17-foot stage, 2 feet above the normal 15-foot recreation pool stage, should not produce appreciable added environmental impacts, and any would depend on the rate and duration of added filling. Water withdrawal during a drought emergency might accentuate low water levels which could impact reservoir fish populations. Other potential environmental impacts are discussed in the report.

The Surry Mountain Project is located in rural southwestern New Hampshire. Total population of the 22 towns in Cheshire County is about 66,000 and there are 10 public water supply systems in the county.

DROUGHT CONTINGENCY STORAGE PLAN
SURRY MOUNTAIN LAKE

1. PURPOSE AND SCOPE

The purpose of this study and report was to develop and set forth a drought contingency storage plan of operation for Surry Mountain Lake that would be responsive to public needs during drought periods and identify possible modifications to project regulation within current administrative and legislative constraints. This plan was based on preliminary studies utilizing readily available information. Included are a description of existing water supply conditions, the potential for allocation of reservoir storage within specified limits, an evaluation of water quality, a discussion of impacts on other project purposes, the effects on the environment, and a summary and conclusions.

2. AUTHORIZATION

The authority for the preparation of drought contingency storage plans is contained in ER 1110-2-1941, which provides that water control managers will continually review and, when appropriate, adjust water control plans in response to changing public needs. Drought contingency plans will be developed on a regional, basin-wide and project basis as an integral part of water control management activities.

3. PROJECT AUTHORIZATION CONDITIONS

Surry Mountain Lake was authorized by the Flood Control Act approved 22 June 1936 (Public Law No. 738, 74th Congress) as amended by Public Law No. 111, 75th Congress, approved 25 May 1937. Construction of the project was initiated in the summer of 1939, it became operational in October 1941 and was completed in June 1942. A permanent conservation-recreation pool was authorized at a stage of 15 feet by a letter from the Chief of Engineers dated 19 January 1960.

4. PROJECT DESCRIPTION

Surry Mountain Lake is a dual purpose flood control and recreation project located in Surry, New Hampshire on the Ashuelot River in the Connecticut River Basin. A map of the Connecticut River Basin is shown on plate 1, and an Ashuelot River watershed map is shown on plate 2.

The reservoir has a total storage capacity, at spillway crest, of 33,010 acre-feet, equivalent to 6.2 inches of runoff from the project's drainage area of 100 square miles. When filled to elevation 550 feet NGVD (spillway crest) a

986 acre lake would be created with a maximum depth of 65 feet. A capacity table is shown on plate 3.

The physical components of Surry Mountain Lake consist of a rolled earth-filled dam with rock slope protection, an L-shaped side channel spillway, the outlet works and recreational facilities. The outlet works consist of an approach channel, an intake structure, two 4-foot 6-inch high by 10 foot wide chain operated broome gates and a 10 foot diameter, 383 foot long horseshoe conduit. A 14.5 foot high concrete weir, with a 2 foot wide by 3 foot high weir gate, was constructed upstream of the flood control gates to maintain the 15 foot deep recreation pool.

A summary of pertinent data at Surry Mountain Lake is listed on plate 4.

5. PRESENT OPERATING REGULATIONS

a. Normal Periods. The normal setting for both conduit gates, during the non-freezing season, is 2 feet with the weir gate closed. During the non-freezing recreation season, a pool about 15 feet deep is maintained by the weir located immediately upstream of both flood control gates. During the freezing season, a 17-foot pool is maintained to keep the flood control gates free from ice. The weir gate is fully open, while one conduit gate is kept closed and the other partially open to regulate the winter pool.

b. Flood Periods. Surry Mountain Lake is operated to provide flood protection for the downstream community of Keene and other communities along the Ashuelot River and, in conjunction with other projects within the basin, to reduce downstream flood stages along the Connecticut River. Operations for floods may be considered in three phases: phase I - appraisal of storm and river conditions during development of a flood, phase II - flow regulation and storage of flood runoff at the reservoir, and phase III - emptying the reservoir during recession of the flood. The regulation procedures are detailed in Appendix E of the Master Water Control Manual for the Connecticut River basin.

c. Regulating Constraints

(1) Minimum Releases. A minimum release of 10 to 15 cfs is maintained during periods of flood regulation in order to sustain downstream fish life. During nonflood periods, the minimum outflow generally equals minimum inflow.

(2) Maximum Releases. The maximum nondamaging discharge immediately downstream of Surry Mountain Lake is about 800 cfs during the growing season and 1,200 cfs for the rest of the year.

6. MONITORING OF HYDROLOGIC CONDITIONS

The Reservoir Control Center directs the reservoir regulation activities at 31 New England Division flood control dams and continually monitors rainfall, snow cover and runoff conditions throughout the region. When any of these hydrologic parameters have been well below normal for several months and it appears that possible drought conditions might develop, the Corps Emergency Operations Center (EOC) will be so informed. The EOC will then initiate discussions with the respective Federal and State agencies and other in-house Corps elements to review possible drought concerns and future Corps actions.

7. DESCRIPTION OF EXISTING WATER SUPPLY CONDITIONS

a. General. The area of concern is the extreme southwestern portion of New Hampshire, lying entirely within Cheshire County. Table 1 contains information about public water suppliers in the area based on information provided by the New Hampshire Water Supply and Pollution Control Commission. The information was taken from the Facilities and Policy Summary published in 1983. Of the 23 communities in the study area, portions of 9 are served by a public water supply system. No data is available for those communities dependent on private individual supplies.

b. Water Supply Systems. The primary objective of this analysis was to accumulate available data regarding water supply systems in the vicinity of Surry Mountain Lake that could benefit from storage at the project, and to present the data in a manner portraying existing water supply conditions. Projections of future demands were not developed because this study addresses only modifications in the operational procedures at Surry Mountain Lake in order to provide storage for water supply purposes when drought conditions exist, and not to meet normal water supply demands at some future date.

c. Southwestern New Hampshire Water Suppliers. As noted in table 1, the data given for each water supplier included: community served, estimated population served by the system, source of supply (ground or surface water), average and maximum day demands for 1983 and the estimated safe yield of each source where available. An analysis of the adequacy of existing sources during drought conditions has not been performed. The information has been accumulated to present a summary of existing water supply conditions for the southwestern New Hampshire area. Communities in the vicinity of Surry Mountain Lake without a water supply system include Alstead, Chesterfield, Dublin, Fitzwilliam, Gilsom, Harrisville, Marlow, Nelson, Richmond, Rindge, Stoddard, Sullivan, Surry, and Westmoreland.

TABLE 1
PUBLIC WATER SUPPLY SYSTEMS - SOUTHWESTERN NEW HAMPSHIRE
CHESHIRE COUNTY

COMPANY OR AGENCY	TOWNS SERVED	EST. POPULATION SERVED IN 1983	SOURCE OF SUPPLY (SW/GW)	1983 DEMAND AVG. DAY (MGD)	MAX. DAY (MGD)	SUPPLY SOURCE	SAFE YIELD (MGD)
Hinsdale Water & Sewer Works	Hinsdale	3,000	GW	.667	.840	GP Well (Two)	0.60
Jaffrey Water Works	Jaffrey	7,500	GW/SW	.700	1.100	Bullit Pond	0.13
						Poole Reservoir	0.12
						GP E. Main Street	0.20
						GP Contoocook L.	0.50
Keene Water Works	Keene	25,000	GW/SW	3.314	5.117	Babbidge Dam	2.30
						GP #1 West	0.75
						GP #2 Court St.	1.00
						GP #3 Court St.	1.00
						GP #4 Court St.	1.00
Marlboro Water Works	Marlboro	348	GW	No Meter		GP #1 School St. (Aux)	--
						GP #2 Fitch Court	--
	Roxbury	(60 Connections)				Keene Water Works	
North Swanzey Water Dept.	Swanzey	(380 Connections)				Keene Water Works	
Troy Water Works	Troy	1,200	GW/SW	.420	.480	Fassett Brook	--
						BR Well	--
Walpole Water Dept.	Walpole	850	GW	--	--	GPW Watkins Hill	0.22
						GPW River Well	0.50
N. Walpole Village District	Walpole	850	--	--	--		
Winchester Water Dept.	Winchester	2,500	GW	.537	.600	GP #1 Keene Rd.	0.32
						GP #2 Keene Rd.	0.46
						GP #3 Richmond Rd.	1.15

TABLE 2
POPULATION PROJECTIONS - SOUTHWESTERN NEW HAMPSHIRE
CHESHIRE COUNTY

Town	Actual 1980	1985	1990	1995	2000	Percent Change 1980-2000
Alstead	1,463	1,487	1,512	1,537	1,556	6.4
Chesterfield	2,559	2,939	3,372	3,823	4,169	62.9
Dublin	1,297	1,502	1,721	1,966	2,163	66.8
Fitzwilliam	1,768	2,027	2,304	2,554	2,749	55.5
Gilsum	643	706	750	787	813	25.4
Harrisville	855	991	1,143	1,312	1,444	68.9
Jaffrey	4,361	5,055	5,807	6,490	7,020	61.0
Keene	21,385	21,782	21,901	22,088	22,400	4.7
Marlow	544	586	631	677	710	30.5
Marlboro	1,850	1,963	2,054	2,130	2,188	18.3
Nelson	438	508	553	588	611	39.5
Richmond	516	598	690	792	871	68.8
Roxbury	193	208	224	238	248	28.5
Rindge	3,338	3,844	4,235	4,710	5,183	55.3
Stoddard	477	553	638	732	805	68.8
Sullivan	585	678	782	898	988	68.9
Surry	662	767	885	1,016	1,118	68.9
Swanzey	5,179	5,712	6,293	6,916	7,395	42.8
Troy	2,128	2,320	2,526	2,738	2,899	36.2
Walpole	3,178	3,340	3,502	3,638	3,736	17.6
Westmoreland	1,448	1,675	1,899	2,156	2,372	63.8
Winchester	3,440	3,612	3,793	3,965	4,084	18.7
TOTAL	58,307	62,853	67,215	71,751	75,522	29.5

d. Population Projections. Population projections for communities in southwestern New Hampshire are given in table 2 to show population trends for each community potentially affected by a prolonged dry period. The projections were provided by the New Hampshire Office of State Planning. This information indicates areas of potential future growth in Cheshire County in the southwestern New Hampshire area.

8. POTENTIAL FOR WATER SUPPLY REALLOCATION

a. General. There are several authorities that provide for the use of reservoir storage for water supply at Corps of Engineers projects. They vary from the provision of water supply storage as a major purpose in new projects to the discretionary authority to provide emergency supplies to local communities in need. In addition, guidance contained in ER 1110-2-1941 directs field offices to determine the short-term water supply capability of existing Corps reservoirs that would be functional under existing authorities. Congressional authorization is not required to add municipal and industrial water supply if the related revisions in regulation would not significantly affect operation of the project for the originally authorized purposes.

b. Drought Contingency Storage. It has been determined that a portion of the existing storage at Surry Mountain Lake could be utilized for emergency drought contingency storage without having an impact on the project's flood control and recreation functions. Storage could be made available to a pool elevation of approximately 502 feet NGVD (17-foot stage). This represents a total volume of about 1,880 acre-feet, equivalent to 612 MG or approximately 6 percent of the total reservoir storage. This volume is comprised of 559 acre-feet of flood control storage and 1,317 acre feet of recreational storage. The 559 acre-feet represents an infringement of about 0.1 inches of runoff in the flood control storage.

Based on an all season low flow duration analysis using 38 years of flow records for the gaging station on the Ashuelot River immediately downstream of Surry Mountain Lake (DA=101 square miles), it was determined that during a 10-year frequency drought, the volume of runoff could: a) fill the reservoir from elevation 500 to elevation 502 feet NGVD in a 32-day summer period provided no releases were made from the dam or b) fill the reservoir to elevation 502 feet NGVD in a 106-day period while maintaining an outflow equal to inflow or 10 cfs (0.1 cfs/sq.mi.), whichever is less. For this later condition, during a 10-year frequency drought, no storage would take place for about 60 days of the period because inflows would be less than 10 cfs. A minimum flow of 10 cfs before storage at Surry Mountain (0.1 cfs/sq mi) is about 3 times the present 10-year seven day "bench mark" low flow at Surry Mountain. However, during a 10-year frequency low flow spring season, the reservoir could be filled to elevation 502 feet NGVD in about a 6-day period in May while continuously releasing 10 cfs. The stored water, including that from the recreation pool, could be used for municipal supply with proper treatment, either by drawing directly from the reservoir or releasing the waters for downstream withdrawal. Drought contingency storage versus flow duration at Surry Mountain Lake is shown graphically on plate 5.

c. Effect of Regulated Flows. The curtailment of flows from Surry Mountain Lake during the drought emergency could adversely impact on the flowage rights of downstream riparian users. At this time, however, it is not possible to review all of the various drought emergency situations that could occur, nor is it within the scope of this report to identify all those with water rights. It is important to note that when a specific drought emergency does occur, the legal implications would have to be weighed.

9. WATER QUALITY EVALUATION

a. Water Quality Classification. The New Hampshire Water Supply and Pollution Control Commission (NHWSPCC) rates the entire length of the Ashuelot River and its tributaries in New Hampshire as class B. In addition to having high aesthetic value, class B waters are acceptable for swimming and other recreation, fish habitat and, after adequate treatment, use as water supplies. The permanent pool is further classified a warm water fishery.

Class B waters are managed to prevent objectionable physical characteristics. Sewage or waste disposal is prohibited, unless adequately treated. Technical requirements include maintaining dissolved oxygen near saturation, pH in the range of 6.5 to 8.0 standard units or as naturally occurs, no more the 240 coliform bacteria per 100 milliliters and turbidity levels below 25 JTU.

b. Existing Water Quality. Surry Mountain Lake has good water quality generally meeting class B requirements, although there are areas of concern. The actual river condition flowing through the project is class B according to the NHWSPCC. With only minor residential develoments at the upstream villages of Gilsum, Marlow and Newport, New Hampshire, there are no significant point source discharges upstream from the dam. Since 1970, NED has monitored sampling stations in the area. No appreciable changes have been observed.

Indicators of good water quality are generally high dissolved oxygen (DO) readings, low turbidity levels and good warm water fish population diversity. Temperatures in the lake rarely exceed the 85 degree Fahrenheit maximum to support a good warm water fishery. On the other hand, several parameters such as coliform bacteria, pH, color and heavy metals have violated the water quality criteria in the past. For instance, high coliform bacteria readings occur periodically when low flows occur coincident with warm summer days. Grazing livestock in the upstream watershed and bathers at the recreation area contribute to excessive bacterial levels in the river and the lake, respectively. These bacteria can be treated to prevent health hazards in a water supply.

Also, there are frequent violations of criteria for minimum desirable pH and color. Natural conditions and acid precipitation on poorly buffered soils most likely cause low pH as there are no upstream wastewater treatment facilities. Average pH is about 6.3 SU, 0.2 SU below the recommended level of 6.5 SU. Low pH levels generally foster damaging corrosion and encourage leaching of metals from the surrounding watershed soils. Natural watershed conditions also cause the moderate to high color levels which are not appealing to water consumers. Standard treatment methods can correct low pH and undesirable color.

Additionally, water quality conditions for which there are no numerical state standards but are of possible concern in a public water supply include infrequently high iron, mercury and cadmium levels. While not a health hazard, iron causes taste and laundry staining problems and the development of growths in plumbing fixtures. The observed iron and mercury and cadmium readings are within the ranges found at other NED reservoir projects. Elevated cadmium levels are rare and not a real cause for concern; however, if drought storage is developed, monitoring for heavy metal concentrations is recommended. These periodic high metal concentrations are probably due to natural geologic conditions associated with acid rain leaching metals from the soil. Standard treatment processes can reduce metal concentrations.

Another aspect of water quality is an impoundment's trophic status. Surry Mountain is a borderline oligotrophic-mesotrophic reservoir that is weakly stratified to unstratified in the summer. Although nutrients are uniformly avail available throughout the lake, there is low biological productivity. Mean total phosphorus, the limiting nutrient, is approximately equal to the minimum threshold value, 0.015 mg/ l, proposed for algal blooms. However, under present operating conditions, discharge over the conservation weir passes surface waters downstream and helps reduce algal bloom development.

Furthermore, a reservoir's hydraulic residence time, computed by dividing volume by the inflow rate, affects water quality. Under normal summer flow conditions the hydraulic residence time at Surry Mountain is about 2 to 3 weeks. Under minimum flows, as would be experienced during a drought, the lake approaches stagnation.

c. Water Quality Requirements for Drought Storage. There are two requirements to be met. The waters must satisfy state standards for surface waters and must be of a quality appropriate for the water supply users. Standard water treatment processing of water rated class B in New Hampshire is usually sufficient to develop municipal water supply. Industrial processes dictate the industrial water quality needed. Drought contingency storage would always be suitable for firefighting and irrigation.

d. Effects for Drought Storage. Though somewhat degraded when compared to existing conditions, drought contingency storage will be adequate for municipal water supply after treatment. Anticipated increases in algal growth may diminish the fish population in the lake. Reduced downstream releases to maintain the drought pool could adversely impact downstream aquatic life. Levels of water quality, especially metals and fecal coliform, should be monitored frequently as long as the drought pool is established. If bacteria increase significantly, bathing should be restricted.

Two issues related to establishing drought capacity must be considered, namely, the effects of increased storage and the effects of drought conditions on water quality.

First, increasing capacity at Surry Mountain Lake, in itself, will not significantly affect impoundment water quality. With the proposed depth increase of 2 feet, an additional 36 acres of land would be flooded. The decay of organic material on this land may cause small increases in levels of color and soluble nutrients. The death of the vegetation in the newly inundated areas would also loosen the soil and cause accelerated erosion in these areas when the pool is lowered. Most of the eroded soil would settle in the lake, but some would be discharged downstream. This increased erosion and sedimentation will not affect the suitability of the water for water supply or recreation, but will diminish the aesthetics of the area. Additionally, present hydraulic residence time during normal summer flow conditions would increase from 2 to 3 weeks to 3 to 4 weeks and under minimum flows would approach stagnation. The trophic status of the lake is not likely to change.

Second, critical water quality conditions are usually associated with low flow periods. Current hydrologic conditions and reservoir regulation practices promote generally good water quality. However, drought water character will be affected by the consequences of reduced precipitation, surface runoff, inflows and discharges. Over an extended time of low flows, some deterioration in water quality can be expected in the influent water courses, the reservoir and the discharge. For instance, the greater pool volume coupled with minor releases will result in less flushing. As a result, algal blooms are possible. Drought flows coincident with increased bacterial decomposition in the summer accelerate dissolved oxygen depletion.

e. Summary. Surry Mountain's basically good water quality may be diminished somewhat under low flow drought conditions; however, it would be adequate with standard treatment processes to provide municipal water supply. Water quality parameters including metal and bacteria levels would be monitored and if coliform counts approach the maximum limit, swimming would be restricted. Downstream aquatic life could be adversely impacted if discharges from the reservoir are overly restricted.

Periodic coliform bacteria, color, metals and pH violations have been observed in the past. During a drought event, these violations may occur more frequently. Algal blooms and lower dissolved oxygen levels are likely. Increasing the pool elevation by 2 feet to provide extra storage may elevate levels of turbidity, erosion and sedimentation. Nonetheless, the suitability of the water for water supply or recreation is expected. Firefighting, irrigation and some industrial needs will be met without treatment.

10. DISCUSSION OF IMPACTS

a. General. Any action resulting in a temporary change of a reservoir's storage volume may have impacts upon other project purposes which must be evaluated before a storage reallocation plan can be implemented. An evaluation has been made of the impacts resulting from drought contingency storage on the flood control purpose of this project. Effects on recreation, sedimentation and the aquatic and terrestrial environments as well as the historic and archaeological resources are also discussed in the following paragraphs. Because of the minimal level of effort afforded this study, certain environmental concerns may require further consideration prior to project implementation.

b. Flood Control. A review of the regulation procedures at Surry Mountain Lake was undertaken to determine the volume of water that could be made available for drought contingency purposes. The water would be stored by temporarily utilizing existing flood control storage. It is recognized that major floods occur in every season of the year, thus any use of flood control storage would be continually monitored to insure that there would be no adverse impacts on downstream flood protection.

At Surry Mountain Lake the maximum pool level for drought contingency storage would be at elevation 502 feet NGVD. This increase represents an infringement on the flood control storage of about 0.1 inches of runoff or 6 percent of the total storage volume. This loss of storage is within acceptable limits established by the Corps of Engineers.

c. Project Operations. In order to maintain the Surry drought storage pool at elevation 502 feet NGVD, it will be necessary to regulate gates since the control weir is limited to a top elevation of 500 feet NGVD. All costs associated with adjusting gates for drought storage, removal of abnormal amounts of floating trash at the log boom and removal of any vegetation that dies as a result of long term flooding will be the responsibility of the requestor.

d. Effects on the Aquatic Ecosystem. The aquatic habitats of the Surry Mountain Dam project consist of Surry Lake and the Ashuelot River. Surry Lake is classified Lacustrine-Limnetic-Open water-Permanent according to the U.S. Fish and Wildlife Service, National Wetlands Inventory. The physical characteristics of Surry Lake are described in the "Existing Water Quality" section of this report. The Ashuelot River is classified Riverine-Upper Perennial-Open water-Permanent.

The aquatic habitats support both warm water and cold water fish populations. The warm water species inhabit the recreation pool. The major species of this fishery are largemouth bass (Micropterus salmoides), smallmouth bass (M. dolomieui), pumpkinseed (Lepomis gibbosus), chain pickerel (Esox niger), brown bullhead (Ictalurus nebulosus), and golden shiner (Notemigonus crysoleucas). The New Hampshire Fish and Game Department stocks the Ashuelot River with approximately 3,000 brown trout (Salmo trutta) and 1,100 rainbow trout (S. gairdneri) each year for put and take fishing. Native inhabitants of the coldwater fishery include redfin pickerel (E. americanus), smallmouth bass, common shiner (Notropis cornutus), blacknose dace (Rhinichthys atratulus), creek chub (Semotilus atromaculatus), and longnose dace (R. cataractae).

No comprehensive vegetation studies have been performed for the aquatic habitats of Surry Mountain Lake. The lake does not appear to support large amounts of aquatic vegetation. Small beds of emergent pickerelweed (Pontederia cordata) are present along the shore.

Under existing conditions a 15-foot deep pool is maintained at Surry Mountain Lake. A concrete weir upstream of the dam gates helps to maintain a fairly constant water level with minimal day-to-day fluctuations in the absence of flood events. Essentially every spring, however, the lake is filled to over 30 feet in depth, and during the winter freeze season, a 17-foot pool is maintained to keep the floodgates free of ice. Drought contingency waters would be stored to this 17-foot stage.

It is estimated that under conditions of a 10-year frequency drought the reservoir could be filled to the 17-foot level in 106 days, or this level could be attained in 6 days with a 10 cfs release during May. Depending on the time that storage of drought contingency water is started and the length of time it takes for the lake to fill, additional spawning habitat could be made available. Largemouth bass, smallmouth bass and other species of the sunfish family spawn primarily during May and June, and chain pickeral spawn earlier in the spring. Increases in flooded area during this time could make additional spawning area available. If storage conditions favored an increase in the amount of spawning habitat, an extra large year class of warmwater species and a general increase in productivity and carrying for a short time could result. Drought conditions and withdrawal of water during the drought emergency could result in accentuated low water levels. This would concentrate the fish populations into a smaller pool. The effects of concentrating the population could be either positive or negative. Predator species could reduce prey populations because of increased predator/prey interactions in the smaller area. If water quality criteria reach critical levels with the reduced pool size, adverse conditions could result.

The expected increase in hydraulic residence time is likely to impact water quality (see Water Quality Effects of Drought Storage section) and therefore the aquatic ecosystem. Algal blooms, lower dissolved oxygen levels, higher temperatures, and lower pH levels, which are already a concern, may result. Algal blooms can cause a reduction in rooted vascular aquatic vegetation which may serve as cover for the fish populations, and may accentuate low DO levels. Low DO levels and high pH levels can be limiting to aquatic communities. These two variables may interact, causing accentuated adverse conditions for fisheries. Most warm water game fish cannot successfully reproduce at pH´s below 4.5-6.0. DO levels below 5 milligrams/liter (mg/l) are limiting to warm water fisheries and DO levels below 6 mg/l are limiting to cold water fisheries. Maximum temperature to which warm water species are tolerant is 85 degrees Fahrenheit and the maximum for a sustainable cold water fishery is 68 degrees Fahrenheit. Each of these parameters should be monitored during a drought contingency operation and ameliorative measures should be taken when the results approach the criteria given.

Reduction of downstream flows during storage of drought contingency waters could result in fishery impacts. Restricted flows would concentrate the existing aquatic community into waters which may, because of the drought conditions and low dam releases, be exhibiting low dissolved oxygen levels and higher temperatures and therefore lowered carrying capacity. Minimum releases of 0 and 10 cfs are described in this report for buildup and maintenance of the drought contingency storage waters; the 0 cfs release is cited only as a reference and would not be implemented since it would create unacceptable impacts. Under current operating procedures, a 10 cfs release is maintained during periods of flood regulation in order to sustain downstream fisheries. The 10-year, seven-day low flow from Surry Mountain Dam is 2.5 cfs. This is the 10-year worst case flow over a seven day period.

e. Effects on Wetlands and Upland Vegetation. Wetlands of the Surry Mountain lake Project area have been classified for the U.S. Fish and Wildlife Service, National Wetlands Inventory. Most of the non-open water wetlands are within the Palustrine system. Classes and subclasses of these wetlands are: forested broad-leaved deciduous; forested needle-leaved evergreen; scrub-shrub broad-leaved deciduous; and emergent wetland.

The forested wetlands contain a mixture of red maple (*Acer rubrum*), black ash (*Fraxinus nigra*), and American elm (*Ulmus americana*). Dominant life forms of the scrub-shrub wetlands include tall shrubs, dogwood (*Cornus* sp.), low compact shrubs, sweet gale (*Myrica gale*), and low sparse shurubs, meadow sweet (*Spirea Latifolia*). The herbaceous vegetation of the scrub-shrub wetland includes: sedges (*Carex* spp.), spike-rush (*Eleocharis* sp.), Iris (*Iris* sp.), and sensitive fern (*Onoclea sensibilis*).

The upland shorelines adjacent to Surry Mountain Lake and its wetlands are very steep (to 100 percent) in most locations. Forest types surrounding the wetlands and aquatic habitats include white pine (*Pinus strobus*), and hemlock (*Tsuga canadensis*). Sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and gray birch (*Betula populifolia*) are also present along the shoreline.

Approximately 36 acres of stream, wetland and upland shoreline habitat will be flooded with the storage of drought contingency waters to the 17-foot stage. As mentioned previously, the reservoir is raised to the 17-foot stage each year during the winter freeze season. Flooding during the dormant season does not affect trees systemically; however, the mechanical action of ice can injure vegetation. Frequent inundations are causing the cover type to change from forest to open land. Because of the existing water level fluctuations, forest vegetation is practically nonexistent in the area below the 17-foot stage; therefore, there will not be impacts to forest vegetation. Most of the storage would impact the wetlands because of the steep slopes surrounding the lake and wetland areas.

The impacts to flooded soils result from exclusion of oxygen from the roots, carbon dioxide accumulation in the soil, production of toxins (organic acids and gases) by soil anaerobes, and anaerobic conditions around the roots. Low oxygen is the primary limiting factor. The effects flooding will have on a plant species depend on the species' tolerance to flooding and on the individual plant's acclimatization to flooding.

Drought tolerance classifications for tree species are provided in "Flood Tolerance in Plants: A State of the Art Review" by Whitlow and Harris (1979). Classifications for the wetland and upland shrubs at Surry Mountain Lake are not available. An estimate of the possible drought tolerances of these species can be derived by comparing the habitat typical of these species with that of the tree species which have been classified. The wetland and upland shoreline shrubs at Surry Mountain Lake would most likely be classified tolerant (able to survive flooding for one growing season) or slightly tolerant (able to survive flooding or saturated soils for 30 consecutive days during the growing season). This vegetation could be impacted by flooding exceeding these limits.

Two feet of water will be stored above the recreation pool stage. This water may completely inundate herbaceous vegetation and seedlings. Vegetation which is completely inundated for a substantial length of time would likely be destroyed. Soil erosion may result in those areas where vegetation is destroyed, especially on the steep upland slopes. An exposed clay layer which is vulnerable to erosion is present along portions of the Surry Lake shoreline. The erosion of topsoil and destruction of herbaceous vegetation and seedlings could alter postdrought storage colonization of the devegetated areas and soil erosion may increase turbidity, which could affect water quality.

When water is removed during a drought, the pool water level could be reduced to unusually low levels. Wetland vegetation could experience low moisture stress and reduced growth if this occurred.

Downstream riparian vegetation could be subjected to low moisture stress because of the drought conditions compounded by low releases from the dam. This could result in a poor growth year.

f. Effects on Wildlife. The Surry Mountain Lake Project supports a variety of habitats with varied juxtapositioning. Aquatic furbearers at the project include: beaver (*Castor canadensis*), muskrats (*Ondatra ziebethicus*), mink (*Mustela vison*), and river otter (*Lutra canadensis*). Terrestrial mammals include Eastern chipmunk (*Tamias striatus*), fisher (*Martes pennanti*), raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*). Avifauna include black-capped chickadee, kestrel, red-tailed hawk, ruffed grouse, and woodcock, in addition to the following waterbirds: wood duck, black duck, Canada geese, green heron, and osprey.

Wetland wildlife, upland wildlife partially dependent on the wetlands, and wildlife dependent on the vegetated shoreline would be impacted by the unusual flooding conditions. The storage will remove approximately 40 acres of habitat. The area displacement of habitat would be significant for wetlands. Animals, particularly reptiles and amphibians, which would normally make use of these habitats during the growing season would be displaced, and animals which normally feed in these habitats, such as raccoons, would be forced to feed elsewhere. Wildlife which make use of the vegetated shoreline-open water edge could be impacted by the destruction of shoreline cover vegetation which could occur. Semi-aquatic mammals such as beaver, mink, and muskrat which often establish dens in river banks would probably not be impacted by den flooding since flooding to the drought contingency elevation occurs each spring under existing flood control conditions. Ground-nesting and shrub-nesting birds such as waterfowl and red-winged blackbirds would be impacted if their nests are inundated.

No endangered or threatened species have been identified in the project area.

g. Historical and Archaeological Resources. A cultural resource reconnaissance of Surry Mountain Lake was performed in the spring and summer of 1979. The report identified a total of 18 historical sites having visible features, while 17 others had subsurface remains. Most of the sites with surface evidence and some portion of those with subsurface remains may be eligible for inclusion in the National Register of Historic Places.

Three historic sites lie below elevation 515 feet and two (sites 23 and 26) extend to elevation 502 feet NGVD. These historic sites all date from prior to 1900; some date as early as the mid-eighteenth century.

The cultural resource rconnaissance document recommends regular monitoring of possible impacts upon a small number of sites, including yearly inspections of certain sites to determine damage from erosion. (Refer to: A Cultural Resource Reconnaisance for the Operation and Maintenance of Surry Mountain Lake, Surry, New Hampshire, prepared by John S. Wilson - Division Archaeologist with Meredith Weiss Belding, co-investigator).

11. SUMMARY AND CONCLUSIONS

The Surry Mountain flood control dam and lake is located on the Ashuelot River in rural southwestern New Hampshire where the total population of 22 towns in the region is about 66,000. The Surry Mountain Project could provide about 1,880 acre-feet (612 MG) of emergency water supply storage, comprised of 559 acre-feet of infringement on flood control storage and 1,317 acre-feet of recreation storage. Stored waters would be basically good quality with standard treatment. Special attention would need to be given bacteria, metals and acidity levels. Emergency storage over and above the normal recreation storage during the summer season could produce added environmental impacts and any would depend on the rate and duration of filling. Withdrawals during a drought, to the extent of accentuating low water levels, could impact reservoir fish populations. There could be other related environmental impacts, which may require mitigation.

A review for compliance with all applicable environmental, riparian and other laws would be required at the time of any decision to pursue drought contingency storage at the project. The Corps of Engineers would not consider drought storage activities at Surry Mountain without an official request from the State of New Hampshire.

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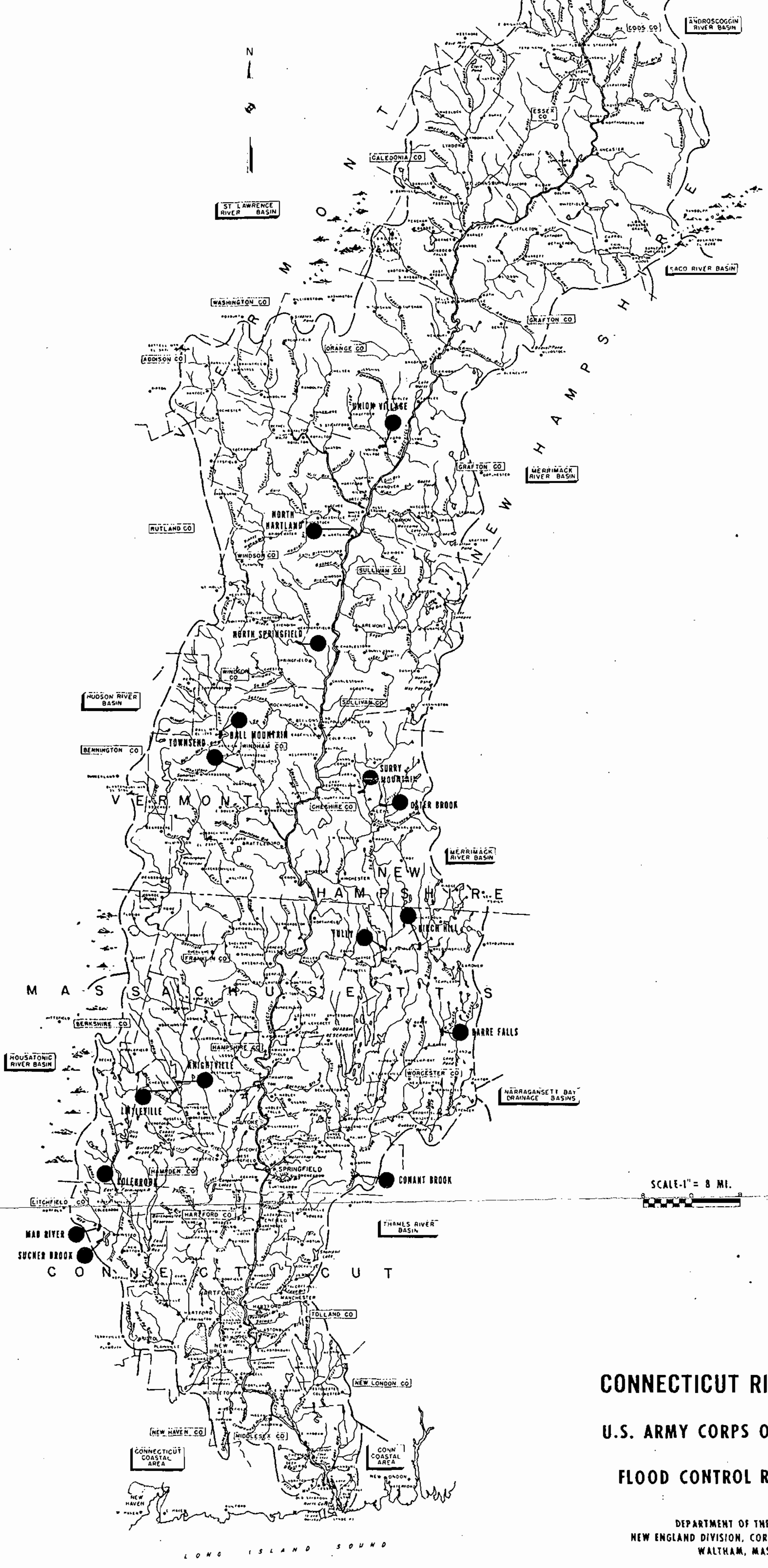


CONNECTICUT RIVER BASIN

U.S. ARMY CORPS OF ENGINEERS

FLOOD CONTROL RESERVOIRS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

JANUARY 1981

PLATE I

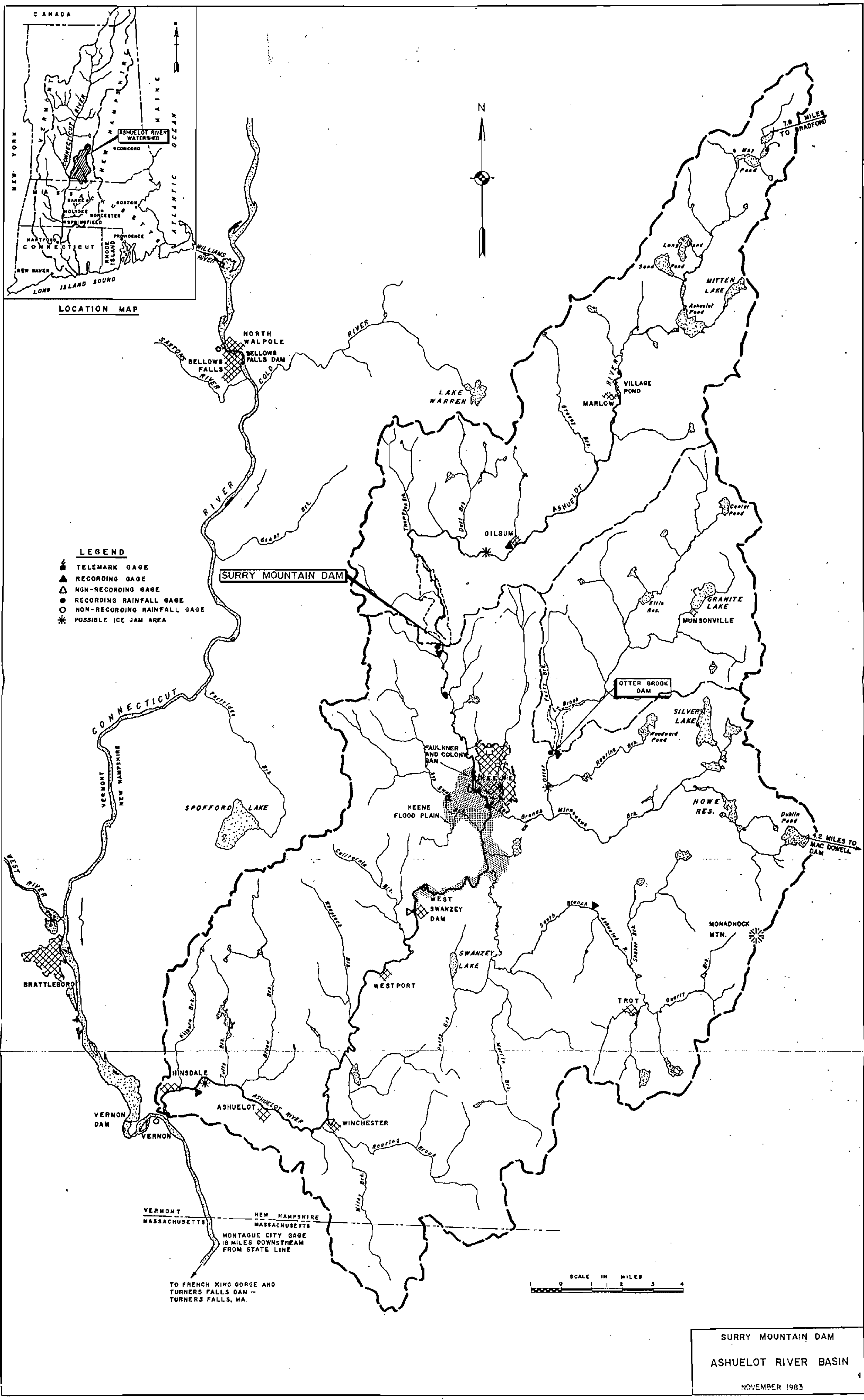

LOCATION MAP
CANADA
NEW YORK
VERMONT
NEW HAMPSHIRE
MAINE
CONNECTICUT RIVER
ASHUELOT RIVER WATERSHED
CONCORD
MASSACHUSETTS
BARRE
HOLYOKE
WORCESTER
BOSTON
SPRINGFIELD
HARTFORD
CONNECTICUT
RHODE ISLAND
PROVIDENCE
NEW HAVEN
LONG ISLAND SOUND
ATLANTIC OCEAN
LEGEND
TELEMARK GAGE
RECORDING GAGE
NON-RECORDING GAGE
RECORDING RAINFALL GAGE
NON-RECORDING RAINFALL GAGE
POSSIBLE ICE JAM AREA
SURRY MOUNTAIN DAM
OTTER BROOK DAM
FAULKNER AND COLONY DAM
KEENE
KEENE FLOOD PLAIN
WEST SWANZEY DAM
WILLIAMS RIVER
NORTH WALPOLE
BELLOWS FALLS DAM
BELLOWS FALLS
SAXTONS RIVER
COLD RIVER
LAKE WARREN
CONNECTICUT RIVER
VERMONT
NEW HAMPSHIRE
SPOFFORD LAKE
WEST RIVER
BRATTLEBORO
VERNON DAM
VERNON
HINSDALE
ASHUELOT
ASHUELOT RIVER
WINCHESTER
WESTPORT
SWANZEY LAKE
TROT
MONADNOCK MTN.
HOWE RES.
SILVER LAKE
GRANITE LAKE
MUNSONVILLE
GILSUM
MARLOW
VILLAGE POND
MITTEN LAKE
7.8 MILES TO BRADFORD
4.2 MILES TO MAC DOWELL DAM
VERMONT
MASSACHUSETTS
NEW HAMPSHIRE
MASSACHUSETTS
MONTAGUE CITY GAGE 18 MILES DOWNSTREAM FROM STATE LINE
TO FRENCH KING GORGE AND TURNERS FALLS DAM — TURNERS FALLS, MA.
SCALE IN MILES
1 0 1 2 3 4
N
SURRY MOUNTAIN DAM
ASHUELOT RIVER BASIN
NOVEMBER 1983

PLATE 2

SURRY MT. RESERVOIR
AREA AND CAPACITY

DRAINAGE AREA = 100 S.M.

ELEV. M.S.L.	STAGE FEET	AREA ACRES	CAPACITY AC. FT.	CAPACITY INCHES
485	0	0		
486	1	15	5	
487	2	30	12	
488	3	40	22	
489	4	55	32	
490	5	70	42	
491	6	85	62	.01
492	7	100	92	.02
493	8	120	132	.03
494	9	140	243	.05
495	10	155	383	.07
496	11	175	500	.09
497	12	195	700	.13
498	13	215	900	.17
499	14	240	1105	.21
499.5	14.5	250	1200	.23
500	15	260	1317	.25
	RECREATION POOL - 500'			
501	16	278	269	.05
502	17	296	559	.10
503	18	314	864	.16
504	19	332	1187	.22
505	20	350	1528	.29
506	21	364	1885	.35
507	22	378	2256	.42
508	23	392	2641	.49
509	24	407	3041	.57
510	25	423	3456	.65
511	26	438	3887	.73
512	27	453	4333	.81
513	28	468	4794	.90
514	29	483	5270	.99
515	30	498	5761	1.08
516	31	512	6266	1.17
517	32	526	6785	1.27
518	33	540	7318	1.37
519	34	554	7865	1.47
520	35	567	8426	1.58

ELEV. M.S.L.	STAGE FEET	AREA ACRES	CAPACITY AC. FT.	CAPACITY INCHES
521	36	580	8999	1.69
522	37	594	9586	1.80
523	38	608	10187	1.91
524	39	621	10802	2.02
525	40	635	11430	2.14
526	41	649	12072	2.26
527	42	664	12729	2.39
528	43	678	13400	2.51
529	44	693	14086	2.64
530	45	708	14786	2.77
531	46	722	15501	2.90
532	47	736	16230	3.04
533	48	750	16973	3.18
534	49	765	17731	3.32
535	50	780	18503	3.47
536	51	794	19290	3.61
537	52	808	20091	3.77
538	53	822	20906	3.92
539	54	836	21735	4.07
540	55	850	22578	4.23
541	56	862	23434	4.39
542	57	874	24302	4.55
543	58	887	25183	4.72
544	59	900	26076	4.89
545	60	913	26983	5.06
546	61	925	27902	5.23
547	62	937	28833	5.40
548	63	948	29776	5.58
549	64	959	30729	5.76
550	65	970	31694	5.94
	CREST ELEVATION - 550'			
551	66	986	32672	6.12
552	67	1002	33666	6.31
553	68	1018	34676	6.50
554	69	1034	35702	6.69
555	70	1050	36744	6.89
556	71	1067	37802	7.08
557	72	1084	38878	7.29
558	73	1100	39970	7.49

PERTINENT DATA
SURRY MOUNTAIN LAKE

LOCATION — Ashuelot River, Surry, New Hampshire

DRAINAGE AREA — 100 square miles

STORAGE USES
Flood Control
Recreation

RESERVOIR STORAGE

	Elevation msl	Stage feet	Area acres	Capacity Acre-Feet	Capacity Inches on Drainage Area
Inlet Elevation	485.0	0	0	0	0
Recreation Pool	500	15	260	1,320	0.25
Spillway Crest	550.0	65.0	970	31,680 (net)	5.9 (net)
Maximum Surcharge	562.4	77.4	1,195	13,400 (net)	2.5 (net)
Top of Dam	568.0	83.0			

EMBANKMENT FEATURES

Type	Rolled earth fill, rock slope protection, impervious core
Length (ft)	1,800
Top Width (ft)	30
Top Elevation (ft,msl)	568.0
Height (ft)	86
Volume (cy)	1,105,000
Dike	None

SPILLWAY

Location	Right-West Abutment
Type	Uncontrolled, ogee weir L-shaped side channel spillway
Crest Length (ft)	338
Crest Elevation (ft,msl)	550.0
Surcharge (ft)	12.4
Design Head (ft)	13.0
Maximum Discharge Capacity (cfs)	50,000

OUTLET WORKS

Type	Boston Horseshoe
Tunnel Inside Diameter (ft)	10
Tunnel Length (ft)	383
Service Gate Type	Broome
Service Gate Size	Two, 4'6" x 10'
Emergency Gate Type	Broome
Emergency Gate Size	Two, 4'6" x 10'
Downstream Channel Capacity	
Growing Season (cfs)	800
Non-Growing Season (cfs)	1,200
Maximum Discharge Capacity	
Spillway Crest Elevation (cfs)	3,700
Stilling Basin	None

RECREATION WEIR

Type	Concrete
Location	Upstream of both gates
Weir Length (ft)	25 (approx.)
Stop Logs	None
Crest Stage (ft)	14.5
Recreation Pool Stage (ft)	15 (approx.)
Manually Operated Gate	2' x 3'

RECREATION POOL

Length (ft)	5,900
Shoreline Length (ft)	20,100
Area (acres)	260

LAND ACQUISITION

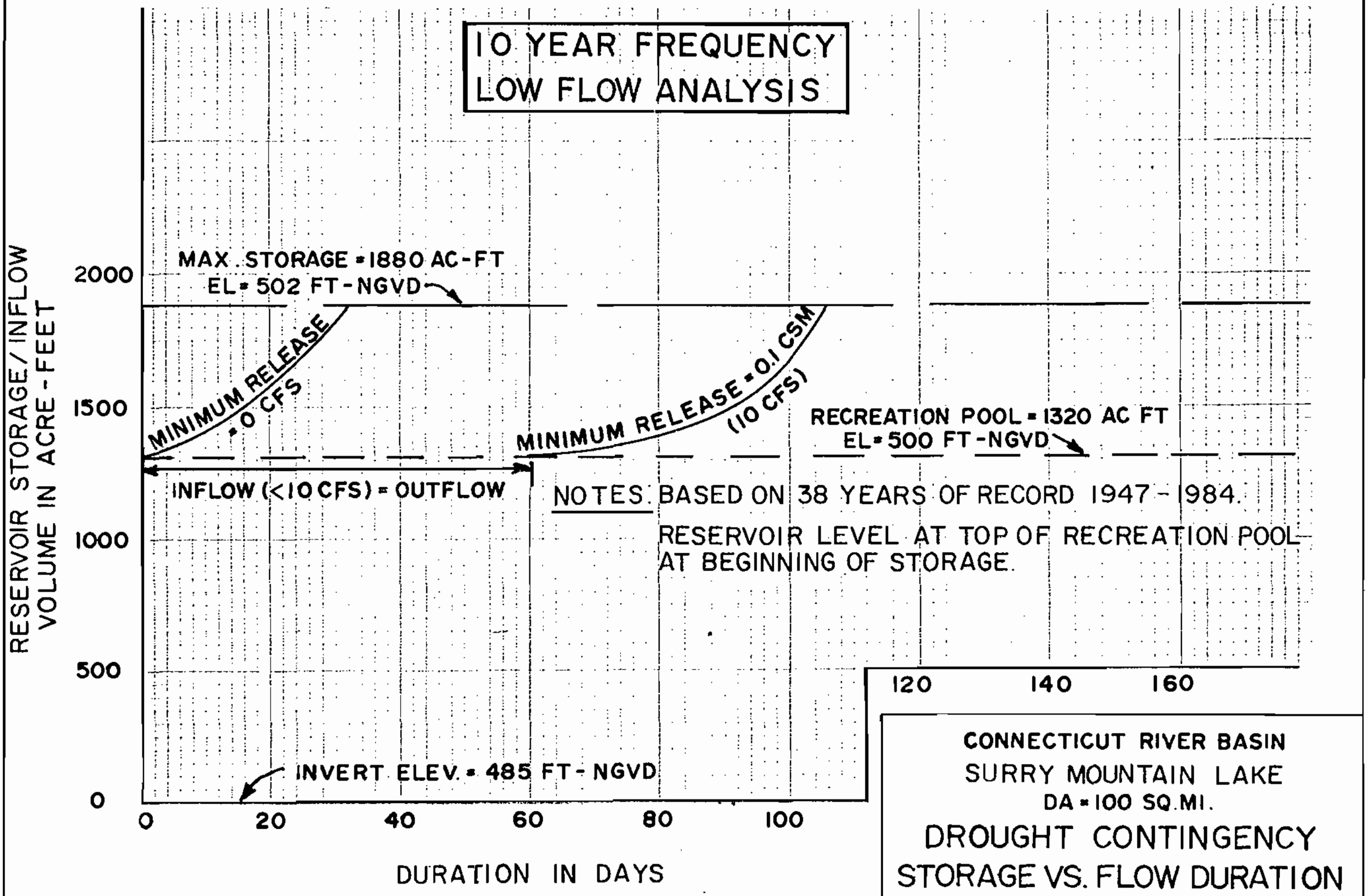
Fee Elevation (ft, msl)	550
Fee (acres)	1,688
Easement (acres)	18
Clearing Elevation (ft, msl)	502±

MAXIMUM POOL OF RECORD

Date	March 29, 1948
Stage (ft)	57.6
Percent Full	79

SPILLWAY DESIGN FLOOD

	Original Design 1939	1961 Analysis
Peak Inflow (cfs)	44,800	63,000
Peak Outflow (cfs)	40,900	54,000*
Volume Runoff (acre-ft)	76,200	104,500



CONNECTICUT RIVER BASIN
SURRY MOUNTAIN LAKE
DA = 100 SQ. MI.
DROUGHT CONTINGENCY
STORAGE VS. FLOW DURATION

HES SEPTEMBER 1986