DESIGN AND CONSTRUCTION OF A NEW ENGLAND FISH HATCHERY

By

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In 1969, a new fish hatchery was constructed for the Massachusetts Division of Fisheries and Game in the Town of Belchertown, Massachusetts, which is off Route Nine, about twenty miles northeast of Springfield. It is located about a mile downstream from the Quabbin Reservoir on the banks of the Swift River. (See Figure 1.)

In the middle 1950's, the Director of the Massachusetts Division of Fisheries and Game, Charles L. McLaughlin, conceived the idea of a new hatchery in the Quabbin area and recognized the need for new State facilities. Due to his untimely and accidental death, he was not able to see the project completed; however, the facility has been named for him and was dedicated in 1969 in his honor, as the "Charles L. McLaughlin Trout Hatchery".

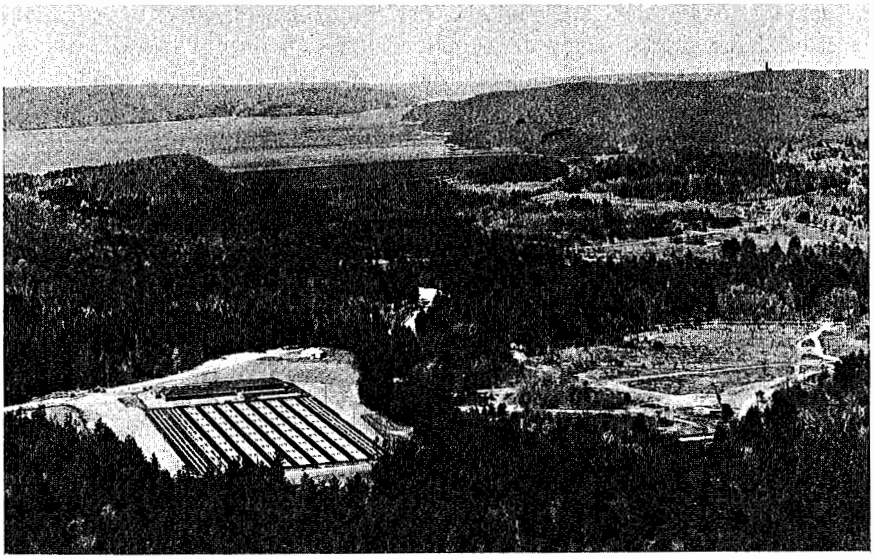

Figure 1 An aerial photograph showing Quabbin Reservoir in the background and the completed Fish Hatchery in the center of the picture, with three gravel packed wells adjacent to the building complex.

Mr. McLaughlin realized that the Division of Fisheries and Game was in serious trouble with its existing six hatcheries. These six hatchery facilities were each about fifty years old and many were becoming obsolete and unable to keep up with the State requirements for producing fish to be used for the State's stocking program of ponds and streams. For many years, it was necessary for the Division of Fisheries and Game to purchase stocking fish from commercial hatcheries in order to meet the necessary demands. Thus, a new hatchery was almost a necessity, if Massachusetts was to continue to meet the requirements of its sportsmen.

The amount of water and quality of water required at a fish hatchery are the very backbone of good fish production, since the rate of growth and production of fish is directly related to the quantity and quality of the water used. Based on prior experience by other state hatcheries and the results of federal hatcheries in New England, it was concluded that if a good quality water was available, between 10 and 15 mgd (million gallons per day) of supply would be needed to meet the requirements of the State.

Feasibility Study

In 1964, a feasibility report was prepared by Camp, Dresser & McKee on the availability of a water supply at the site of the new facility. Investigations revealed that a good groundwater supply could be obtained with a safe yield of about 1800 gpm (gallons per minute) using three separate wells. By sampling and testing the flow of water in the Swift River, it was concluded that the quality and quantity of water there were also suitable for fish hatchery use.

A scheme to run a pipeline from the Quabbin Reservoir to the site of the fish hatchery was also investigated. The scheme would have produced plenty of water; however, the cost of the pipeline plus the cost of buying M.D.C. (Metropolitan District Commission) water was found to be prohibitive. It was determined that, even if the M.D.C. would allow the sale of water from the Quabbin Reservoir, the cost would result in the most expensive fish in the country.

The State specified that the new installation should be large enough to produce about ½ of the total trout fish stock required for the entire State. This represents 200,000 to 250,000 lbs. of trout, or roughly 500,000 to 750,000 of 7-in. to 10-in. stocking fish. The water supply requirements for such a hatchery would be comparable to the demands of a municipality with a population of between 50,000 and 100,000 persons.

From data obtained at a U.S.G.S. (United States Geological Survey) gaging station on the Swift River, it was determined that flows in the Swift River were

normally sufficient to meet the operating requirements for the hatchery. By Massachusetts State Statute (Acts of 1927) a minimum flow of 20 mgd must be released from the Quabbin Reservoir to the Swift River. The only drawback to use of the water from the Swift River for the hatchery is that the State Statute has no specific requirement on the time over which the 20 mgd must be released. The M.D.C., therefore, is free to release the 20 mg over any time period within 24 hours they desire. However, since the M.D.C. operates a power plant at the dam, the 20 mg has normally been discharged within an 8-hour workday and the hatchery design had to take this into consideration, since the hatchery has to operate on a 24-hour basis. Using these data and the low flow data on the river, it was concluded that flow ranges from 1500 gpm to 6000 gpm could easily be obtained from the Swift River without causing any undue hardship on the river or operation of the hatchery.

The quality of water necessary for a fish hatchery is equally as important as the quantity of water available. Temperature and dissolved oxygen concentration are the two most critical items to be considered. Ideal temperatures for maximum fish (trout) propagation are 50° to 55°F. Water temperatures below 40°F reduce the growth rate of trout to practically zero and water temperatures above 70°F can be fatal to trout. Thus, many a mountain stream that has good, cold, clear water is not really a good breeding ground for trout. State personnel have told us that trout 5 to 6-years old in these cold streams may be only 2 or 3 in. long, whereas under proper temperatures, a hatchery can produce a 6 to 9-in. long trout in less than one year.

Dissolved oxygen concentrations greater than 5 mg/l (milligram per liter) are needed to promote good growth. D. O. much less than this can be fatal to trout. Saturation is desirable but seldom obtainable. The expense required to obtain D. O. saturation is not economical as long as the quality of the water is sufficient to promote adequate growth in the fish stock.

A slightly basic water also promotes fish growth. Any pollution is detrimental to trout production. Heavy metals such as zinc, copper and lead can only be tolerated in minute quantities, after which they become fatal to trout. During the hatching process, these metals have to be limited to practically zero. Thus, all piping, pumping equipment, etc. had to be so specified that practically no heavy metals could be dissolved into the water.

It is therefore necessary that the water quality requirements be adhered to very closely if the hatchery is to function properly. From the testing and sampling programs that were carried out in the study phase, it was concluded that, through proper mixing of well water and river water, the necessary quantity and quality of water could be obtained to supply a new hatchery at Quabbin.

The Facilities

In 1965, Camp, Dresser & McKee was retained by the Massachusetts Division of Fisheries and Game to complete final construction plans for the hatchery. These plans were completed in 1967. Bids were received in June 1967 and again in August of 1967, after sufficient funds were appropriated to construct the project. All the funds for this project (about $2,000,000) came from the sale of hunting, fishing and trapping licenses. The Division of Fisheries and Game is one State Department that is self-sufficient financially and does not rely on outside State funds for its operation.

The physical plant at the fish hatchery consists of the following: an administration building, a hatchery building, a food process building, two permanent residences, a river pumping station, three groundwater well pumping stations, ten sets of raceways or rearing ponds, and a display pool.

Many of the requirements for space and the necessary equipment needs were developed in cooperation with the Division of Fisheries and Game.

The administration building (40 ft x 60 ft) contains an office, conference room, biological laboratory, lunchroom, public and private toilet facilities, living quarters that sleep four, and the main control panel for the entire operation. All pumps and major equipment can be operated from this control panel. Flow recorders, pump controls, temperature recorders, alarms and the instrumentation for all units are centralized at the main control panel.

The hatchery building (42 ft x 140 ft) houses eleven double hatching tanks where the young fish are hatched from eggs in fiberglas troughs and then allowed to grow to a 1 to 2-in. size in the concrete tanks (22 nursery tanks, 28 ft long x 30-in wide by 36-in deep) before being placed in the larger outside raceways for full growth.

Water temperatures for the entire hatching process are controlled through a heat exchanger that has the ability to raise the temperature of the well water from 45°F to 55°F for a flow of up to 200 gpm. Mechanical aeration in the piping system also adds oxygen to the water at this critical point.

Hatching of the trout eggs takes between 20 and 50 days duration, everything being dependent upon temperature and specie. Chemical treatment for control or prevention of disease is often added during this phase of the operation.

The food process building and garage (38 ft x 150 ft) houses the following: a walk-in refrigerator for storage of pelleted foot (35°F), a walk-in freezer for storage of frozen meat food (0°F), food processing rooms, a storage room, a boiler room, maintenance shop, and a six-stall garage. Also contained in this area is the domestic water booster pumping facilities that produce enough pressurized water for all domestic usage within the hatchery complex and the two residences.

Fifteen and twenty years ago, the hatchery trout diets consisted mainly of waste products from the meat packing industry, choice morsels like liver, spleens, horse meat, canned carp and similar delicacies. Today, there is greater economy and nutritional value from the dry fish foods that have been developed. The dry pelleted foods, that are mostly vegetable, lend themselves to modern feed methods using automatic equipment that spray feed from trucks directly into the raceway pools.

Two permanent residences were also constructed as a part of the installation since full-time around-the-clock supervision is needed. The superintendent and assistant superintendent live in the two structures. Each house is situated on high ground above the hatchery in order that visual observation can be maintained. Floodlights for the entire complex are controlled from either house and the alarm system for the hatchery is wired to each in order to notify the operator of a power failure, low water or other malfunction of the equipment.

At present, the facilities require about ten people for operation and maintenance work at the site. Figure 2 is an overall view of the hatchery complex.

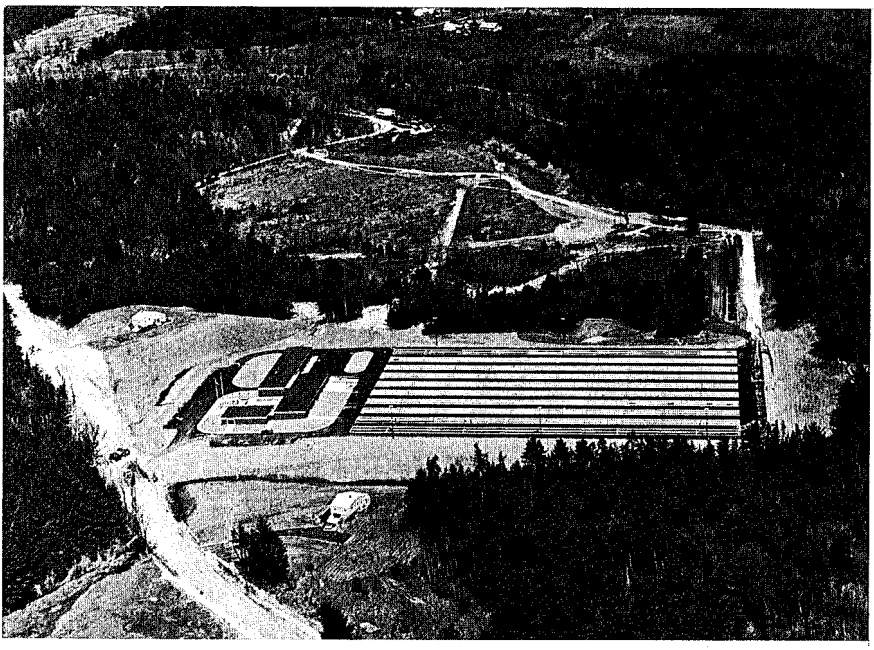

FIGURE 2 An aerial photograph showing the completed hatchery complex, two residences, and the raceway area.

Three gravel packed wells with a capacity of 180 gpm, supply all the domestic water requirements, the hatchery water, and the necessary water during hot and cold weather to buffer the river water supply. During periods when water being pumped from the river is either too warm or too cold, the well water is mixed with the river water to improve the temperature conditions. A lesser flow of water at near optimum temperature will promote more fish growth than a large quantity of water where the temperature varies considerably from the optimum. The operation and control of the hatchery, therefore, can vary extensively, and the operators are thus required to change rates of flows and temperature almost daily.

The pipe lines from each of the three wells connect at a common point from which a separate 12-in. pipe line connects to the hatchery building. The pressure regulating valve in the hatchery building maintains a constant pressure system for hatching water whereas the booster pumping system maintains pressure for the domestic water supply. All excess well water that is not used in the domestic system and the hatching water system is diverted to the mixing chamber, where river water and the spent water from the hatching process are mixed in the concrete mixing chamber through a baffle system, prior to supplying the raceway area. The well water diversion is also arranged so that the entire excess supply that comes from the hatchery building can be fed into a portion of the raceway area. It may be beneficial at times to feed only well water to certain trout species, or during periods when diseases may require special treatment of the fish.

The river pumping station is located on the bank of the Swift River some 2,000 feet from the hatchery complex. Three vertical turbine constant-speed pumps with capacities of 1500 gpm, 2000 gpm, and 2500 gpm, pump water directly from the river to the raceway area. The scheduling and controlling of the pumping rate is determined by the flow and temperature in the river, and is controlled accordingly.

All the river water is pumped to the mixing chamber ahead of the raceway, yet downstream from the well supplies. A 20-in. force main extends from the river pumping station to the mixing chamber. Controls at the mixing chamber can be altered so that diversion of flow can be varied to supply one or ten of the raceways or any combination thereof. It is arranged so that no river water can get into the domestic water system. The river pumping station also houses the electrical switchgear and controls. A 150 kw diesel generator with automatic starting is also contained in this structure. The generator will supply enough power to run about 50 percent of all pumping facilities plus the required domestic demand for the hatchery complex and the two houses.

The raceways or rearing tanks are the mainstay of the entire facility. They

contain ten double tanks, 16 ft. wide, with a varying depth of water of 4 to 5 ft. that can be altered as necessary. Each raceway is 50 feet long, and there are ten units in each section; therefore each extends for a total length of 500 feet. If these tanks were all connected, continuously, they would constitute a 16-ft. wide tank, 5,000 feet long, comprising 200 individual areas. A 16-ft. roadway separates each raceway so that feeding and loading of fish can be done mechanically. The entire raceway area encompasses about 8 acres. Each 50-ft. tank is separated by screens and stop logs in order that control, sizing and feeding of each batch of fish is maintained. A 1.5-ft. drop in elevation between each raceway helps to promote aeration through a natural waterfall.

Each set of raceways has a separate supply line that runs off of the main distribution line from the mixing chamber. By regulating the necessary valves, the flow of water to each raceway can be varied to meet the requirements. Depending on the size and age of the fish being reared, the supply system has enough flexibility so that the operators can vary the demand as needed.

In order to supplement the oxygen concentration, mechanical aerators that are electrically operated can be placed at every other 50-ft. tank, for the entire raceway area.

Drainage facilities are provided for every other 50-ft. raceway tank. These drains are normally used only to clean or to drain the raceways, the normal flow of water running the entire 500-ft. length before being wasted. The dissolved oxygen concentration, of course, decreases along the raceway as the water flows from tank to tank; however, the operators arrange the number and poundage of the fish so that as you proceed from the upper end to the lower end, less of a load is placed on the flowing-through supply.

At the midpoint of the raceway area, 250 ft. from each end, an auxiliary supply line can introduce fresh water from the mixing chamber. Thus, there is enough built-in flexibility so that during critical periods of high temperatures, low temperatures, low flows, or during other problem situations, the operators can vary the water supply in order to maintain optimum conditions.

A lighting system and a public address system in the raceway area reduce the risk of thievery and poaching by unsportsmanlike sportsmen.

The effluent water or wastewater from the raceway area is returned to the Swift River through a series of underground pipes and an open channel that has three series of stop log dams that help to create a free waterfall and thus, to some degree, aerate the effluent from the hatchery. All of the effluent can be recirculated through the River Pumping Station, if necessary, by means of placing stop logs at a diversion structure located adjacent to the Swift River outfall. This was done once last year when the dissolved oxygen concentration and the temperature of the river water were less favorable than the recirculated effluent.

See Figure 3 for a schematic diagram of the water distribution system for the entire hatchery operation.

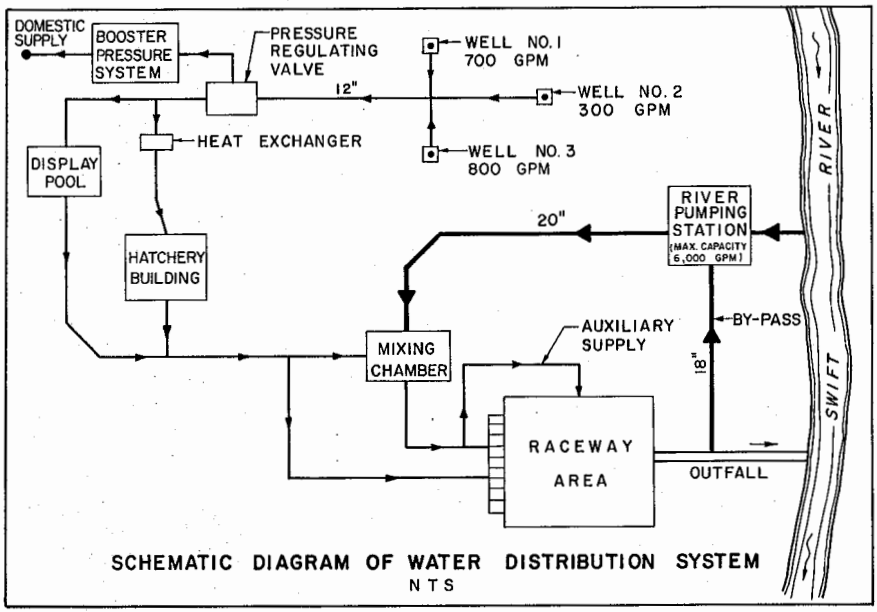

FIGURE 3 A schematic diagram of the water distribution system.

Operation

Information obtained from hatchery personnel reveals that for the first full year of operation, the hatchery produced 200,000 pounds of fish or about 450,000 fish of an 8-in. to 12-in. size, which was about 43% of the total for the State. The total for the State was 470,000 pounds or about 1,000,000 trout in the 8-in. to 12-in. size. The rate of growth at the Quabbin Hatchery has been ¾ of an inch per month; in other terms, a 9-in. trout can be produced in one calendar year. This growth rate exceeds the other State hatcheries by about 1/3.

The operating budget at the hatchery for the last year was about $100,000 which means that the average cost was $0.50 per pound of fish produced. The trout produced at the other State hatcheries were costing an average of about $1.00 per pound.

One problem encountered at the hatchery is the number of visitors that frequent the area. The hatchery is open to the public seven days per week, and

during the first full year's operation, about 60,000 people toured the area. During the summer months, a full-time guide is hired to escort visitors over the site. Since Quabbin Reservoir is only about a mile up the river, many people are probably visiting both areas at the same time.

The design and construction of the Charles L. McLaughlin Trout Hatchery has been a very interesting and challenging engineering project. The new facility will provide adequate stocking trout for the Massachusetts sportsmen for many years to come.