HADDAM NECK NUCLEAR POWER PLANT, DISCHARGE CANAL
(Connecticut Yankee Nuclear Power Plant, Discharge Canal)
362 Injun Hollow Road
Haddam
Middlesex County
Connecticut

HAER CT-185-D
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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

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HAER No. CT-185-D

Location: On Injun Hollow Road, approximately 2 miles southeast of intersection with Rock Landing Road, on east bank of Connecticut River
Haddam
Middlesex County
Connecticut
U.S. Geological Survey Haddam & Deep River Quadrangles
UTM Coordinates 18.708748.4595057

Dates of Construction: Original construction 1965-1966 - Rock weir added ca. 1972

Engineers: Stone & Webster Engineering Corporation

Present Owners: Connecticut Yankee Atomic Power Company (CYAPCO)
362 Injun Hollow Road
Haddam Neck CT 06424-3022

Present Use: Decommissioned; partially filled/demolished, most left open

Significance: The Haddam Neck Nuclear Power Plant was one of the earliest commercial scale nuclear power stations in the United States, and was eligible for the National Register of Historic Places. The plant's Circulating Water System, pumped river water through the Turbine Building (HAER No. CT-185-C) condenser tubes and returned water to the river at a higher temperature. The canal made sure that heated water actually discharged and did not get back into the intake. The system included the 7000-foot-long discharge canal to reduce water temperature. A rock weir in the canal maintained water elevations in a discharge tunnel from the Turbine Building for operation of other Circulating Water System components. The discharge canal also diluted permitted chemical or radioactive releases to the river from a variety of other plant systems.

Project Information: CYAPCO ceased electrical generation at the Haddam Neck plant in 1996 and began decommissioning operations in 1998, subject to Nuclear Regulatory Commission (NRC) authority which brought the project under the purview of federal acts and regulation protecting significant cultural resources from adverse project effects.[1]

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[1] National Historic Preservation Act of 1966 (PL 89-655), the National Environmental Policy Act of 1969 (PL 91-190), the Archaeological and Historical Preservation Act (PL 93-291), Executive Order 11593, Procedures for the Protection of Historic and Cultural Properties (36 CFR Part 800).

Project Manager and Historian
Michael S. Raber
Raber Associates
81 Dayton Road, P.O. Box 46
South Glastonbury, CT 06073
860/633-9026

Steam, Electric, and Nuclear Power Historian
Gerald Weinstein
West 77th Street, Apt. 17b
New York, NY 10024
212/431-6100

Industrial Archaeologist
Robert C. Stewart
Historical Technologies
1230 Copper Hill Road
West Suffield, CT 06093
860/668-2928

Summary Description

The discharge canal began at the downstream end of the 12-foot-wide, 15-foot-high concrete discharge tunnel, which ran below the Turbine Building auxiliary bay (see HAER No. CT-185-C) and extended approximately 128 feet southeast of the building. The tunnel, with a bottom elevation of -5.5 feet (relative to mean sea level), originally terminated in a timber-sheet-pile weir with an upper elevation of 3.7, on which stop logs raised total weir height to an elevation of 5.2. From this weir, a 162-foot-long, steel-braced sheet-pile-sided flume dropped water from elevation 5.2 to 0.5 into the rounded upper end of the approximately 7000-foot-long earthen canal which discharged into the Connecticut River (Figures 1-5). The flume, with piling bases at elevation -18, was 34 feet wide along a 73.8-foot-long rectangular section, and narrowed to a 10-foot width along an 88.5-foot long lower section fitted with handrails. The canal bottom, at approximately elevation -10, was 65-80 feet wide. The sides of the canal, finished with gravel or riprap with side slopes between 2.5:2 and 3:l, reached typical widths of 130-160 feet. The berm on the east side was cut back and lowered along 180 feet near the upstream end of the canal ca.1974, to serve as a slip for possible barge traffic handling heavy plant equipment. At the river, the canal outfall widened to approximately 700 feet. Riprap was used to minimize erosion of the canal banks from the head of the canal to a point 100 feet downstream of the flume, and from the outfall area to a point 100 feet upstream of the outfall. The discharge canal was designed for flow velocities of between one foot per second under typical river levels to two feet per second at extremely low river levels, with velocities further reduced by the widened outfall section. The gradual decrease in flow velocity cooled the discharge flow, from sources discussed below, through ambient losses to reduce the maximum discharge temperature at the outfall. To mitigate effects on marine life, the rate of temperature change in the discharge canal was limited to 8^{O} F/hour. Original construction included a log boom across the outfall to control water depth at the weir; the boom was evidently replaced or enhanced with bar gates for greater security.[1]

The weir at the end of the discharge tunnel was designed to maintain tunnel water at elevation 6.5 under normal operating conditions for various purposes discussed below. The sheet-pile weir appears to have been supplanted by a rock weir across the discharge canal at the flume outfall. The rock weir is not well documented, but available historic views suggest it was added ca.1972, in association with reconstruction of the downstream end of the flume. Rock was added in this area to prevent outward bowing of sheet piling (Figures 3-4).[2]

Discharge Canal Functions and Design Issues

The discharge canal was primarily a component of the Circulating Water System, a "once through" design which pumped river water through the tubing in the four Turbine Building condenser shells in one pass and then returned the water to the river at a higher temperature.[3] As discussed in HAER No. CT-185-A, this design had overlapping consequences for plant operations, some of which probably influenced the plan for a long canal to enhance cooling of discharged water and to prevent the warmed discharge from being taken back into the system via the circulating water pumps in the Screen-well House. Aside from localized river heating issues, higher ambient river temperature reduced plant efficiency. High cooling water temperatures in the summer reduced the amount of heat that could be pulled from the exhaust steam, and winter icing could restrict coolant ingress with the same effect.[4] These problems were aggravated by the fact that Connecticut Yankee's single-pass condensation system also used approximately 30% more water, and larger pumps and pipes, than designs in which the cooling water made two passes through the condensers before discharge to pull more heat. Water volume factored into discharge canal volume design (Figure 2).

When the discharge canal was used to maintain water elevations in the discharge tunnel, the circulating water pumps in the Screen-well House filled the discharge tunnel to the level of the rock weir. Due to the large difference in elevation between the suction of the circulating water pumps (elevation -15 feet) and the top of the main condenser water boxes (elevation +35.5 feet) the circulating water pumps did not develop enough head when starting up to completely fill the system and pump water through the main condenser tubes in upper portions of the water boxes.[5] The circulating water pumps were augmented by the Vacuum Priming System to completely fill the Circulating Water System and main condenser tubes on system startup and to maintain the water boxes full by removing any air or non-condensable gases which come out of solution during normal system operation. Maintenance of discharge tunnel water at elevation 6.5, 5 to 6 feet above the normal river level, limited the fill requirements placed on the Vacuum Priming System and provided the change in elevation necessary to Force Flow through the Circulating Water System de-icing line (Figure 5; see HAER No. CT-185-A).[6]

After ca. 1970, plant operators realized the "once through" condenser design left the condenser tubes vulnerable to fouling from marine growth and debris. This required relatively frequent backwashing of condenser water boxes to reduce the amount of marine growth fouling the condenser tubes. Clearing involved stopping one circulating water pump. As the pump coasted to a stop, flow reversed direction through the main condenser tubing, dislodging some of the accumulated marine growth and debris. The reverse flow was created by the siphon effect established by the elevations of the circulating water pump suction (-15), the water box (35.5), and the discharge canal (Figure 5).[7]

At the Screen Well house there were trash racks that prevented intrusion of large debris and traveling screens that prevented intake of smaller rubbish. The traveling screens were continually washed by spray nozzles that removed accumulations as they rotated.

Circulating water flow through the discharge canal diluted permitted chemical or radioactive releases to the river from a variety of other plant systems. The Service Water System, a heat sink for virtually all plant systems requiring external cooling water other than the main condensers, directed effluent from plant heat loads to the canal after radiation monitoring. The canal also received condensate from feedwater heaters in the Turbine Building, the Steam Generator Blowdown Tank in the Primary Auxiliary Building as part of the Component Cooling System, and the blowoff tank for the boilers in the Service Boiler Room (see HAER Nos. CT-185-C, CT-185-G, and CT-185-Q).[8]

Use of the discharge canal during for navigation appears to have been limited during the period of plant operations to the delivery of new low-pressure turbines to the Turbine Building in 1987 (see HAER No. CT185-C). Barges were used during decommissioning to remove a number of large equipment components from the Turbine Building and Reactor Containment.[9]

NOTES

[1] Connecticut Yankee Atomic Power Company/Stone & Webster Engineering Corp. 1965-1980, 1965-1997, 1993 [drawings]; Connecticut Yankee Atomic Power Company 1966-1974: 8.5-3 to 8.5-4; Connecticut Yankee Atomic Power Company 1987-1993: Chapter 41, pages 28-30; personal communication, Gerard van Noordennen.

[2] Connecticut Yankee Atomic Power Company 1966-1974: 8.5-3; Connecticut Yankee Atomic Power Company 1987-1993: Chapter 41, page 30; personal communication, Gerard van Noordennen.

[3] Power 1982: 225.

[4] Ibid: 361.

[5] Connecticut Yankee Atomic Power Company 1987-1993: Chapter 42, page 1.

[6] Ibid: page 3; Connecticut Yankee Atomic Power Company 1966-1974: 8.5-5.

[7] Connecticut Yankee Atomic Power Company 1987-1993: Chapter 41, pages 41-2; personal communication, Gerard van Noordennen.

[8] Connecticut Yankee Atomic Power Company 1987-1993: Chapter 41, page 40; Chapter 43, pages 1,4; Chapter 30, page 2; Chapter 59, page 12.

[9] Personal communication, , Gerard van Noordennen.

SOURCES OF INFORMATION/BIBLIOGRAPHY

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Center, University of Connecticut, Storrs.

Connecticut Yankee Atomic Power Company/Stone & Webster Engineering Corp.
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1965-1997
Flume & Wier Details/Discharge Canal. No. 16103-56010. [reproduced as HAER No. CT185-D, Sheet 3 of 3]

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van Noordennen, Gerard (CYAPCO Regulatory Affairs Manager)
2009 Personal electronic communications.

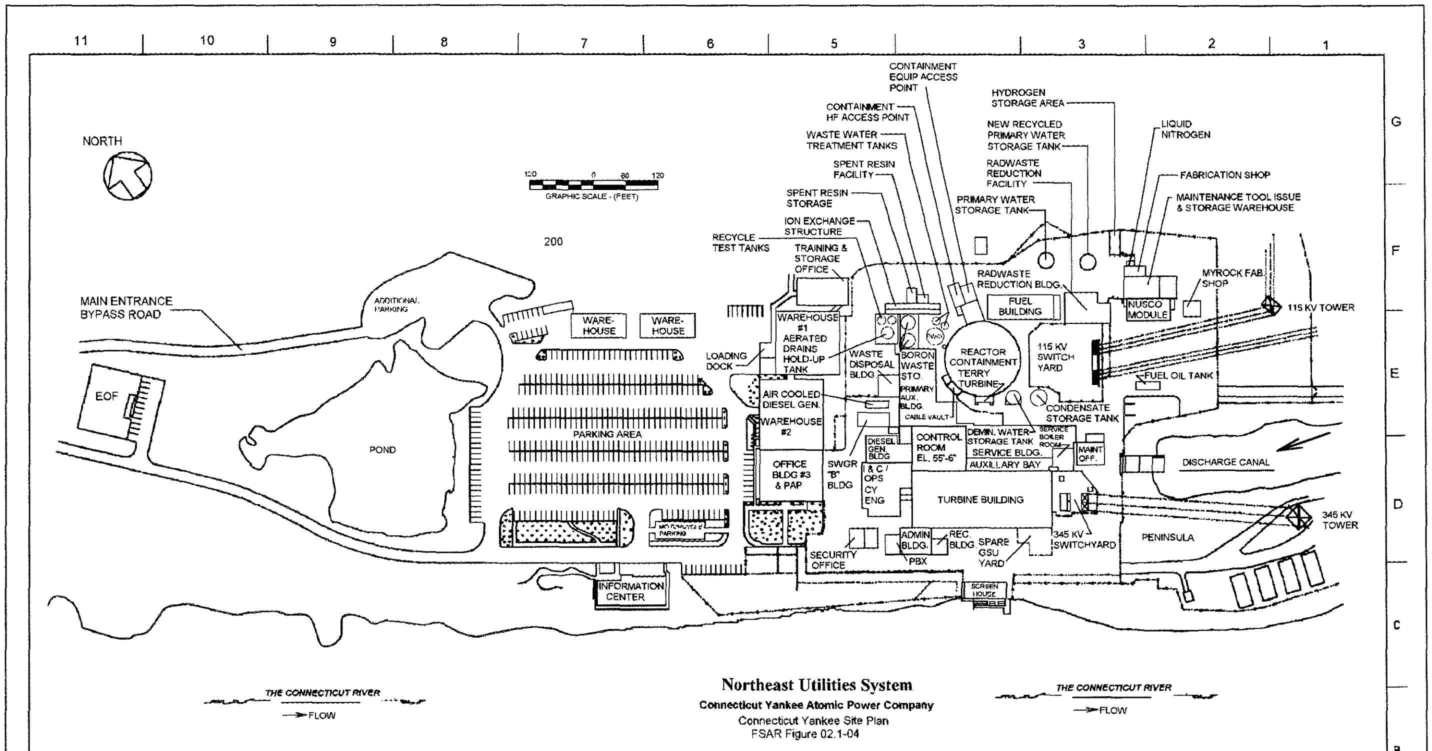

Figure 1. DISCHARGE CANAL LOCATION AT MAIN PLANT AREA

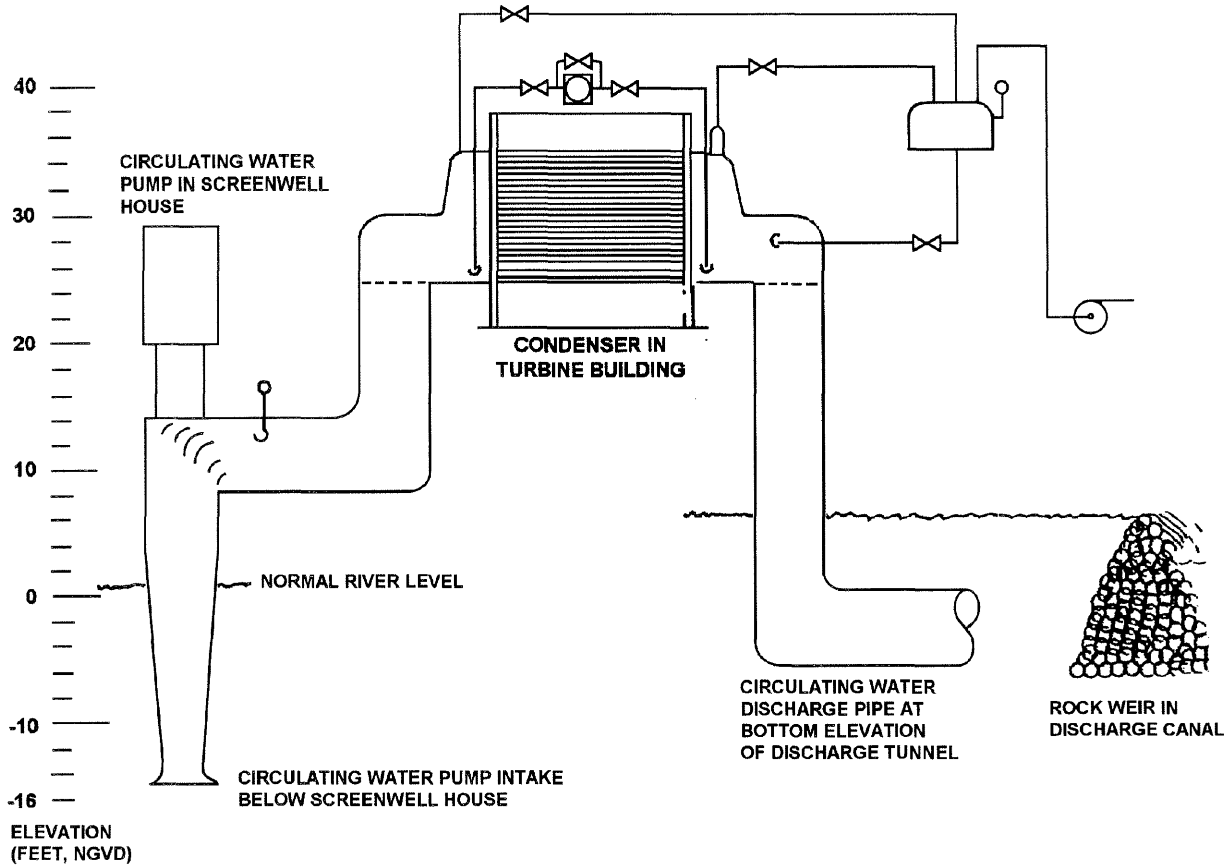

Figure 2. SCHEMATIC CIRCULATING WATER ELEVATION DIAGRAM WITH DISCHARGE CANAL ROCK WEIR
Base image: Connecticut Yankee Atomic Power Company 1987-1993: Chapter 41, page 48

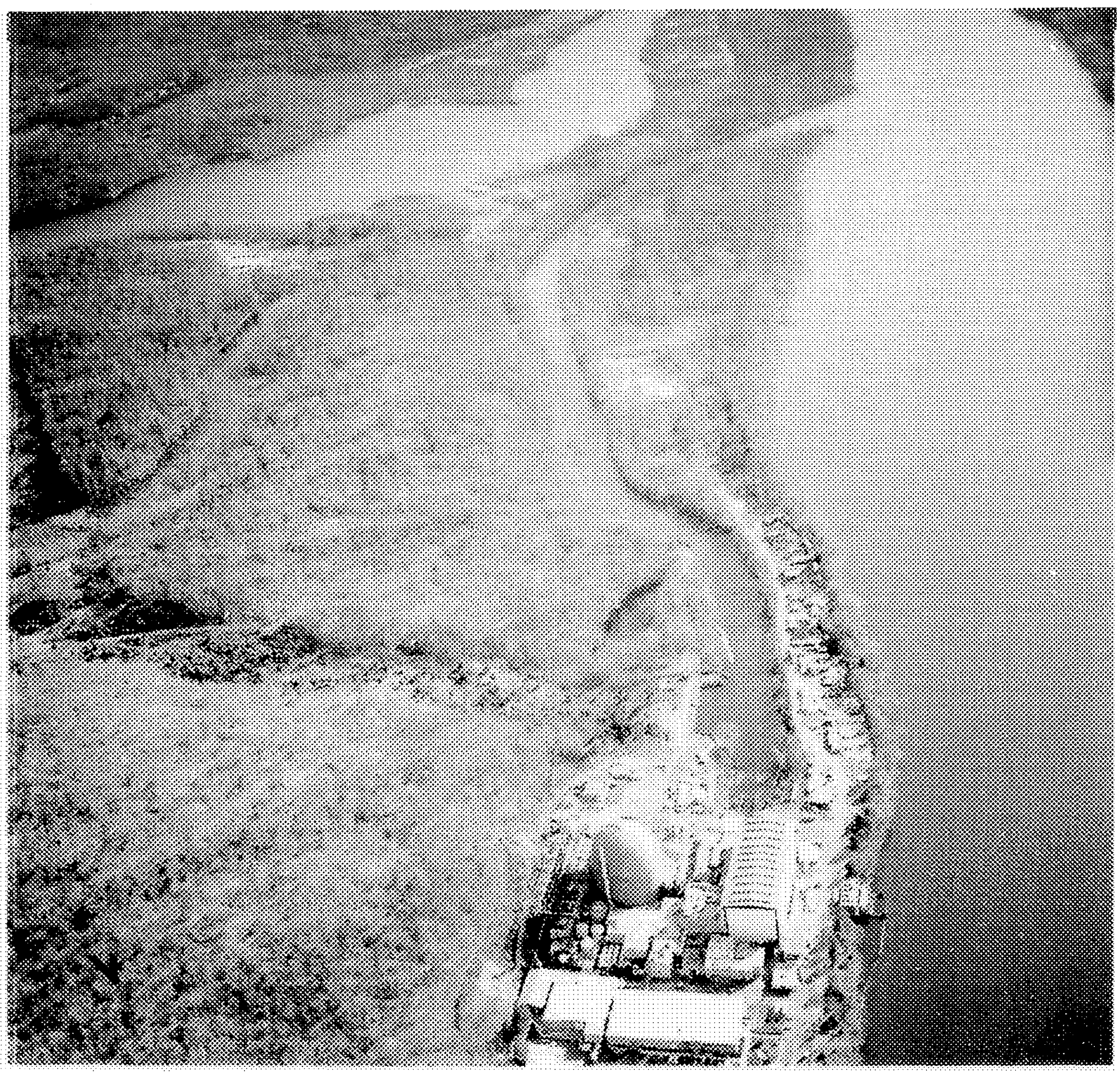

Figure 3. 1966 AERIAL VIEW SOUTHEAST OF DISCHARGE CANAL (CENTER RIGHT) WITH TURBINE BUILDING AND REACTOR CONTAINMENT AT LOWER CENTER RIGHT).
SOURCE: HISTORIC CY SITE PHOTOS 04262000.PDF-No. 366

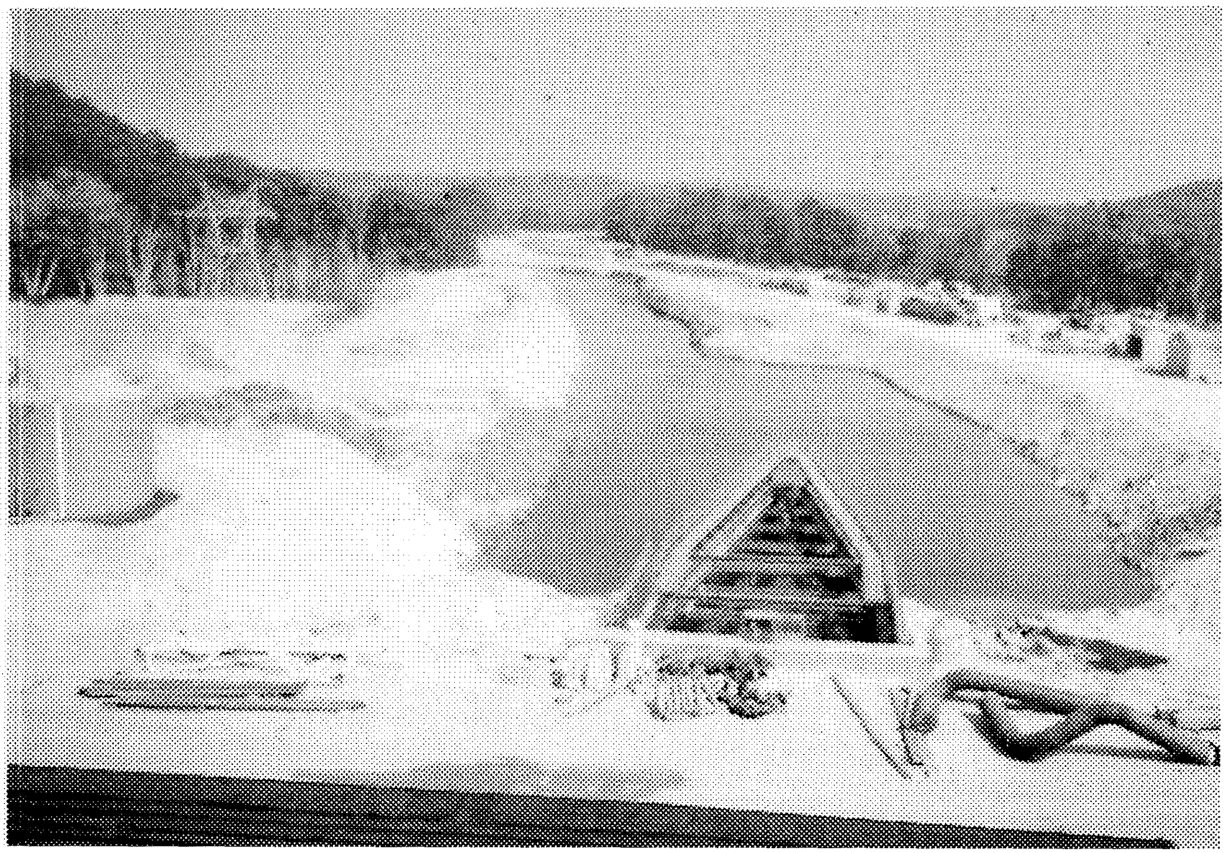

Figure 4, 1996 - VIEW SOUTHEAST OF FLUME AT HEAD OF DISCHARGE CANAL
SOURCE: HISTORIC CY SITE PHOTOS 04262000.PDF-No. 109

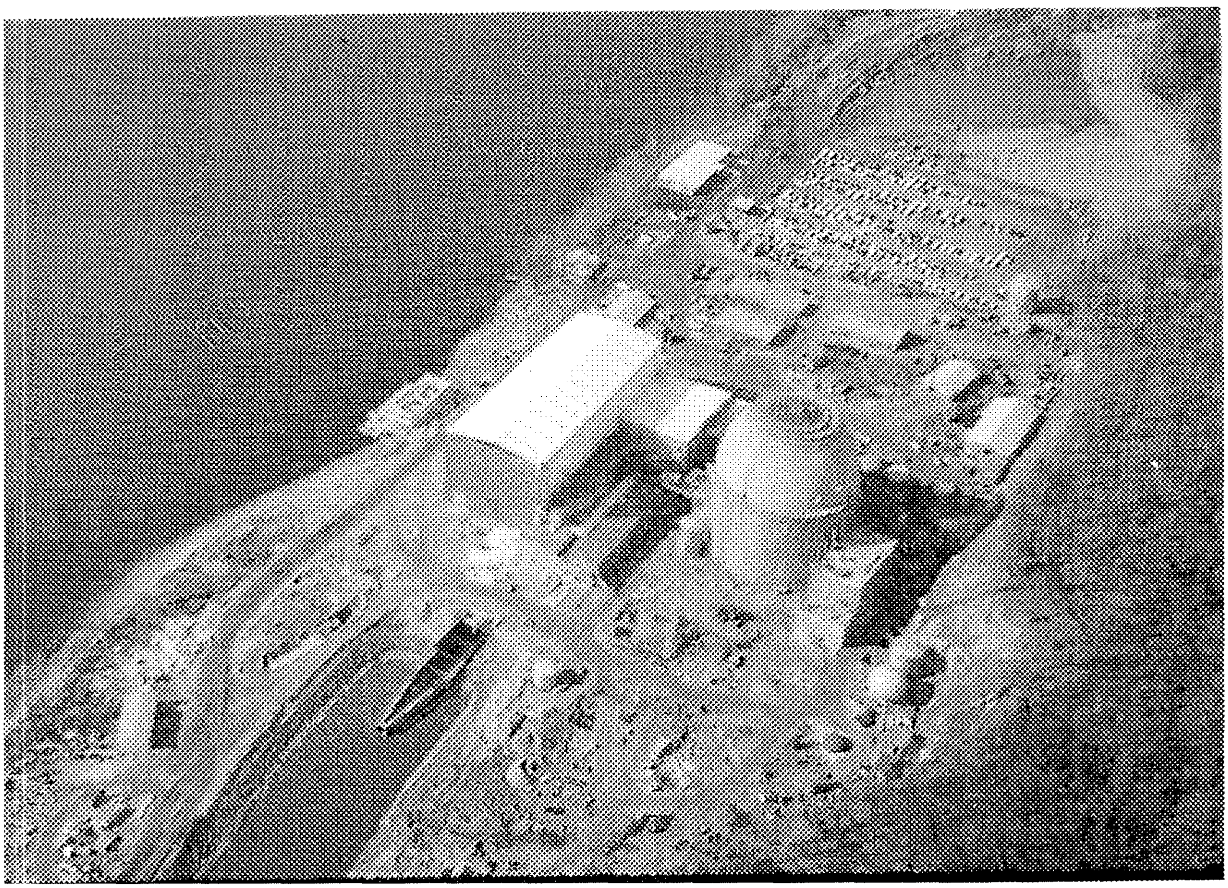

Figure 5. 1966 ARIAL VIEW NORTHWEST OF HEAD OF DISCHARGE CANAL (LOWER LEFT), TURBINE BUILDING AT CENTER LEFT AND REACTOR CONTAINMENT AT CENTER RIGHT