DOE/EA-1075

ENVIRONMENTAL ASSESSMENT

PROPOSED

CASEY'S POND IMPROVEMENT PROJECT

MAY 1995

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DISCLAIMER

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LIST OF ABBREVIATIONS AND ACRONYMS

ADSD	Average Design Summer Day
ADWD	Average Design Winter Day
ANSI	American National Standards Institute
DCG	Derived Concentration Guidelines
DOE	Department of Energy
EDSD	Extreme Design Summer Day
FCC	Feynman Computing Center
Fermilab	Fermi National Accelerator Laboratory
FONSI	Finding of No Significant Impact
IAC	Illinois Administrative Code
ICW	Industrial Cooling Water
IDOC	Illinois Department of Conservation
IDOT	Illinois Department of Transportation
IEPA	Illinois Environmental Protection Agency
KTeV	Kaons at the Tevatron
LCW	Low Conductivity Water
MCL	Maximum Contaminant Level
MDSD	Maximum Design Summer Day
MSL	Mean Sea Level
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
URA	Universities Research Association, Inc.

DOCUMENT SUMMARY

This document contains information on the current Industrial Cooling Water (ICW) distribution system used in the fixed target experimental area at Fermi National Accelerator Laboratory (Fermilab) along with a proposed system upgrade to meet improved operational criteria. It covers available upgrade alternatives and explores the alternative deemed most feasible, covering the principal environmental issues related to the proposed actions.

The fixed target area is an integral component for the accomplishment of the Laboratory's mission of high energy physics. Experimental and other support equipment is served by the current ICW distribution system, which includes Casey's Pond, where thermal load due to electric power utilization is removed from cooling water via evaporation. In order to continue to provide cooling water that meets improved operational criteria, Fermilab proposes to expand the cooling capacity capabilities and improve the availability of the storage capacity for the ICW distribution system. The expanded system would assure uninterrupted operations, provide required system support for fire protection and ensure that the temperature of water that occasionally leaves the site does not exceed Illinois' General Use Water Quality Standards for thermal pollution.

The proposed actions consist of building a new pond to provide an additional 2.4 hectares (6 acres) of evaporative surface to enhance cooling performance and to install a transfer pipe directly connecting Lake Law to Casey's Pond and the ICW system to provide more efficient use of storage capacity. These two actions would be dealt with under different project schedules, the new pond construction being the most imminent. The new pond project would result in an increase in the average detention time of water in the pond system from 110 hours to 138 hours and increase the estimated cooling efficiency from 55% to 65% for an average design summer day. The pond would be excavated next to, and hydraulically connected to the existing Casey's Pond. Soil excavated from the proposed project area would be stored in an existing stockpile located to the southeast of the proposed pond site. The transfer pipe would utilize an existing abandoned gas main that extends from Lake Law north to Wilson Street. A new pipe would be connected to this one and would run along the north side of Wilson Street, crossing Road C West, to the ditch leading to Casey's Pond. It would reduce transfer losses and simplify complete filling of the site reservoir ponds from the Fox River during normal water levels of that waterway. A pumphouse would be built on the north side of Lake Law.

Feasible alternatives to the proposed new pond and transfer line would involve the utilization of other water sources (surface water or ground water) resulting in either a lower efficiency in the overall system and/or increased environmental impacts. Not pursuing a solution to the problems would jeopardize the laboratory's research program because the current system for cooling allows water temperature to rise to levels that

decrease heat-exchanger efficiency and the storage capacities for onsite surface water can reach levels that are inadequate to maintain fire protection systems. These problems can reach conditions which could dictate system shut-downs.

The proposed new pond site is in an area that is unoccupied by personnel, equipment and buildings and is composed primarily of an old field plant community. A study of threatened/endangered species conducted in 1985, in conjunction with direct observation of the proposed project area, supports the contention that no listed species utilize the site. A 1970 archaeological study which covered 93% of the Fermilab site not under construction, including the proposed project area, and a 1986 study just north of Casey's Pond found no evidence of important archaeological material. Construction of the required new pipe along Wilson Street and the pump house at Lake Law would impact similar areas as the new pond. Major thoroughfares for the laboratory (Wilson Street and Batavia Road) would provide easy access to the proposed project sites.

Adverse environmental or human health impacts of the proposed pond construction project are slight, resulting from a short period of construction activity and excavation of the pond basin. Mitigating these impacts are the following positive consequences of the proposed action:

- the addition of approximately 2.4 hectares (6 acres) of open water and emergent wetland habitat,
- an increase in flood storage capacity, and
- a decrease in the expected water temperature leaving the laboratory.

For the proposed transfer pipe project, adverse environmental or human health impacts are also slight. These would result from construction of the pumphouse at Lake Law and the excavation and laying of pipe along Wilson Street.

Fermilab would initiate a sediment and erosion control plan, as part of its inclusion in the Illinois National Pollutant Discharge Elimination System (NPDES) General Stormwater Permit for Discharges Due to Construction Activities, during each project. A joint application would be filed with the Illinois Environmental Protection Agency (IEPA), Illinois Department of Transportation (IDOT), Illinois Department of Conservation (IDOC), and U.S. Army Corps of Engineers, for construction of the new pond, as a result of the project's impact on existing floodplain. The DuPage County Department of Environmental Concerns would be consulted regarding the new pond constructions compliance with requirements of the local Countywide Stormwater and Flood Plain Ordinance.

1.0 INTRODUCTION

Fermilab is a Department of Energy (DOE) research laboratory operated by Universities Research Association, Inc (URA). The facility is located on 27.5 km^2 (6,800 acres) about 56 kilometers (35 miles) west of Chicago (Figure 1.1). High energy physics research at Fermilab concentrates on finding the ultimate building blocks of nature and on understanding the forces acting between them.

The laboratory consists of a series of large particle accelerators (Linac, Booster, Main Ring and Tevatron) which are used in the high energy physics program to investigate the structure of matter by using the collisions of particles to create new matter which is studied using large, complex detectors. Two different ways of study using the Tevatron are the "collider experiments," and the "fixed target experiments." Research programs designed for these operational modes are coordinated through and are the responsibility of the Laboratory's Research Division. In the fixed target mode, a focused beam of protons from the Tevatron is directed toward a stationary target made of ordinary matter. The collision produces subatomic particles which survive for short periods of time. Various techniques allow particular forms of the newly formed matter to be selectively examined by collecting specific particles into other well-defined beams that are directed into experimental detectors.

The operation of the accelerator and associated machinery in either the collider or fixed target modes requires large amounts of cooling water due to utilization of electrical power by magnets, radio frequency generators, pumps, and cryogenics. The Industrial Cold Water (ICW) system is the source of water for heat exchangers and cryogenic compressors throughout the fixed target experimental area, as well as air conditioning for Research Division facilities and the Feynman Computing Center (FCC). The approximate annual ICW flow rate is 31,000 liters/minute (8,300 gpm) under experimental running conditions and 13,000 liters/minute (3,500 gpm) under non-running conditions. Heat produced in magnets is dissipated through a two-staged heat exchange system. Heat is initially transferred directly from the magnet to the LCW closed-loop system. Heat energy is then passed on to the ICW system and removed to a cooling pond. The secondary transfer of heat from LCW to ICW accounts for approximately 60% of the ICW use. Cryogenic compressors are cooled for similar reasons. Cryogenic materials (e.g. liquid nitrogen and helium) are used under pressure to supercool sensitive equipment requiring very low temperatures to operate efficiently. Cooling cryogenic compressors uses approximately 10% of the ICW. Air conditioners are used throughout the lab buildings for ambient air control and account for roughly 30% of the ICW use.

Fermilab has developed an empirical set of cooling water temperature criteria[1] for a pond to meet the current and projected operational requirements for cooling. These criteria take into account pond water fouling of heat exchangers and consequent reduction in heat transfer efficiency and are dependent on the physical parameters of temperature, daily temperature range, humidity, solar radiation and relative humidity. These criteria are as

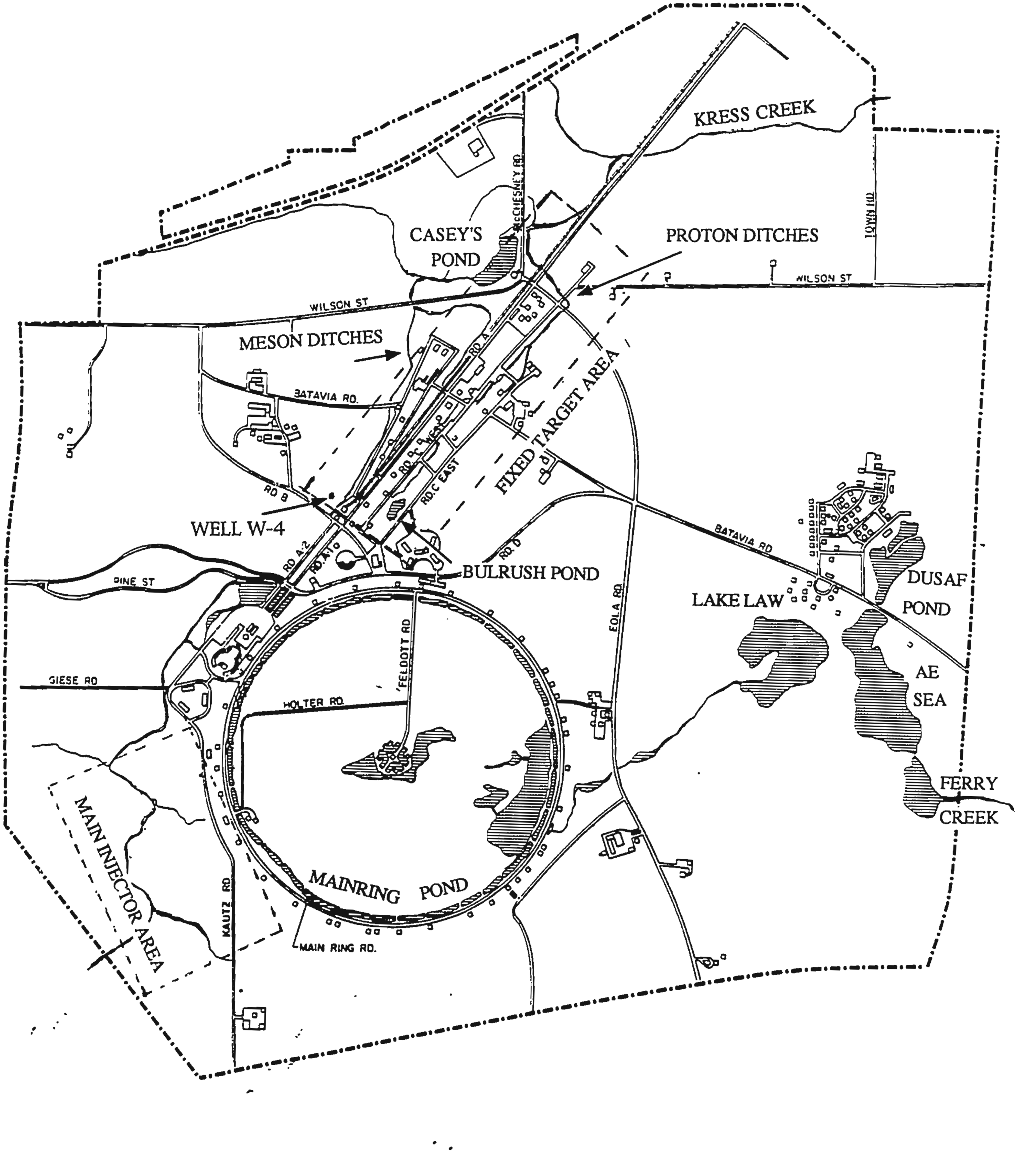


Figure 1.1 Fermilab Site Plan

follows (refer to the Glossary for related definitions):

1. Cooling water supply temperature from the pond should not exceed 85°F with Maximum Heat Load during an average design summer day (ADSD) thereby insuring that water cooled equipment may operate within normal optimal performance parameters.

2. Cooling water supply temperature from the pond should not exceed 90°F at 105% of Maximum Heat Load during a 99% maximum design summer day (MDSD), thereby insuring that water cooled equipment may operate within typical maximum recommended design parameters.

3. Cooling water supply temperature from the pond should not exceed 95°F at 105% of Maximum Heat Load during an extreme design summer day (EDSD), which is where equipment tends to trip out on high temperature overload.

Casey's Pond, located at the intersection of Wilson Street and McChesney Road, supplies the ICW system for operation of the fixed target area (Figure 1.2). This pond was constructed in 1973 as the main ICW reservoir at Fermilab. It has a surface area of approximately 4 hectares (10 acres) and a mean depth of 3.7 meters (12 feet). The present capacity at normal water level is 137,766,000 liters (36,394,000 gallons). The detention of water in Casey's Pond, along with return transport through the ditch system prior to reaching the pond, allows for evaporative cooling of the water before re-circulation in the cooling system.

Casey's Pond also provides the water needed for on site fire protection. The fire protection system does not have a regular percentage of ICW use, as it is utilized only under emergency conditions. However, the system is periodically flushed for maintenance purposes with ICW. Due to fire protection constraints, operation cannot occur unless a minimum volume of water in Casey's Pond is exceeded.

Other surface water bodies associated with the ICW system include Bulrush Pond, Kress Creek, and a series of ditches for transporting water. Bulrush Pond and the ditches were built for the purpose of water retention and storage. Bulrush Pond is located at the southern end of the cooling system. It has a surface area of approximately 0.8 hectares (2 acres) and an average depth of 2 meters (7 feet). This pond was built in 1988 as an additional retention area for water. Kress Creek originates north of Fermilab and flows through the northeast portion of the lab. Overflow from the ICW cooling system is periodically diverted into this creek via a stoplog dam and spillway. Meson and Proton ditch systems connect the surface water bodies. These two ditch systems are named after two of the experimental beamlines within the fixed target area. The Meson system contains

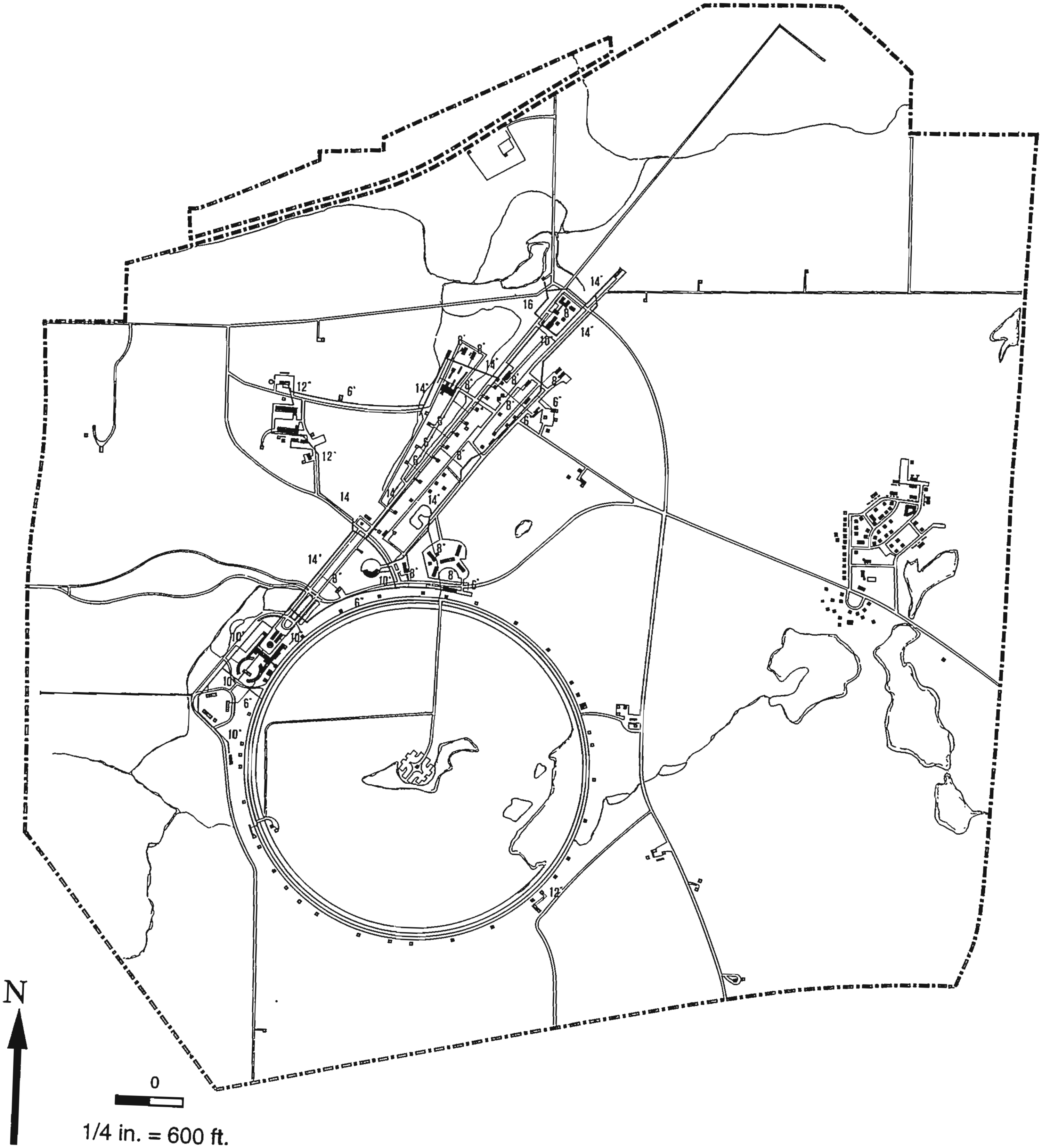


Figure 1.2 Industrial Cooling Water System

roughly 4,000 meters (13,000 feet) of ditches that run along the Meson and west Neutrino experimental beamlines. These ditches run from the Master Substation north along the experimental beamline and cross Wilson Street west of Road A before flowing into Casey's Pond through the south inlet. The Proton ditch system contains roughly 3,000 meters (10,000 feet) of ditches and runs between the Proton and Neutrino experimental beamlines north from the Industrial Complex crossing Wilson Street east of Road A before entering Casey's Pond through the north inlet.

Lake Law is located on the east side of Fermilab and is connected to other surface water bodies (DUSAF Pond and AE Sea). These surface water bodies, also constructed in the early 1970's as water retention units, have a combined surface area of 45 hectares (111 acres) and contain a usable reserve of 205,949,000 liters (54,406,000 gallons). Under natural conditions, overflow water from the Main Ring system and surface runoff flows into these lakes and into the Sea of Evanescence before leaving the site via Ferry Creek. Water can also be transferred into the Casey's Pond system by reversing the natural flow, pumping from these lakes into the Main Ring Pond and routing the water through a series of former gas pipes to Bulrush Pond. This has been done routinely in the drought months of July and August during past fixed target experimental runs.

Stormwater runoff from 530 hectares (1310 acres) in the northwestern portion of the site provides the bulk of the water for the Casey's Pond system. Bulrush Pond is located at the southern end of the system and provides a limited source of storage. The remainder of water is pumped from the Fox River, a surface water body located approximately 2.4 kilometers (1.5 miles) west of the Lab. During 1993, approximately 946,000,000 liters (250,000,000 gallons) were pumped from the Fox River. The withdrawal of water from the Fox River is regulated by a permit from the Illinois Department of Public Works (#12170). Mean flow for the river is about 25.5 m^3/sec (900 ft^3/sec). Under the permit conditions, water cannot be drawn from the river during drought conditions, when the mean river flow reaches 7.8 m^3/sec (275 ft^3/sec).

Water is drawn from Casey's Pond into the ICW system by pumps located in a pumphouse at the pond site. The water returns to Casey's Pond via Meson and Proton ditches. Meson ditch returns roughly 25% of the water to Casey's Pond and Proton the remaining 75%. During periods of high stormwater flow, control gates near Casey's Pond can be closed to divert excess water away from the pond, through a diversion ditch which runs around the north side of the pond, to the spillway. Water flowing over the spillway runs into a transfer ditch into Kress Creek.

In 1994, the routine water management procedures for filling the ponds and setting overflow levels were adjusted. The minimum water level for Casey's Pond was reset 1.2 meters (4 feet) lower, providing an additional 30,000,000 liters (8,000,000 gallons) of water reserve which will be critical to future operational demands. The normal water level for

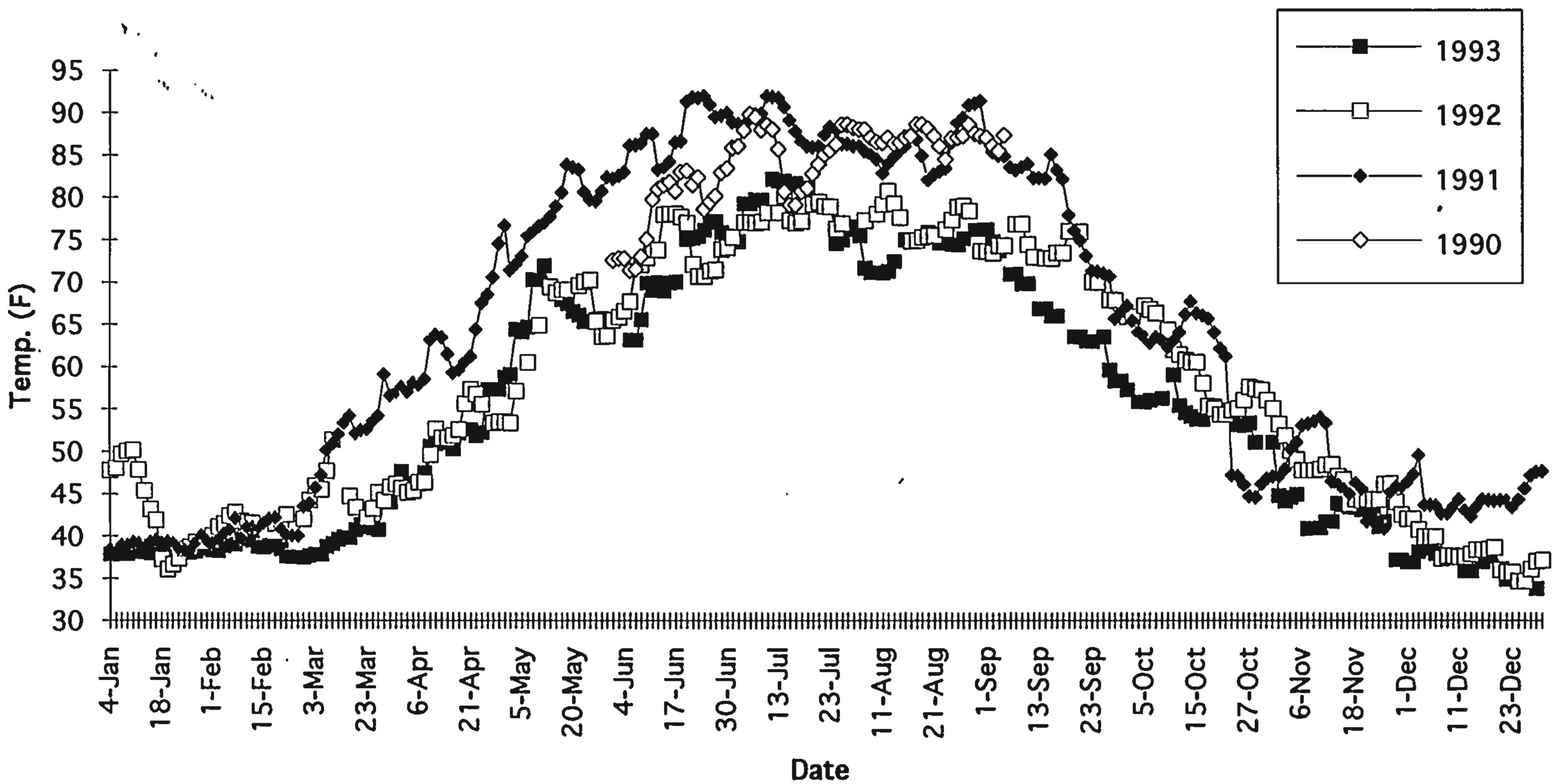
Casey's Pond was also lowered 15.2 cm (6 inches) to reduce excessive overflow into Kress Creek. The pumping rate of water from Bulrush Pond was moderated to prevent any excessive rise in Casey's Pond levels and reduce overflow to Kress Creek. This created an additional drought reserve which can be tapped whenever Casey's Pond falls below the critical level. A priority was also established for ensuring that the site pond system was fully charged during the spring months of March, April and May with regular field checks of stoplog dams to make sure that water was not flowing offsite unnecessarily.

The fixed target area requirement for ICW cooling fluctuates greatly with the number and type of experiments. The temperature of Casey's Pond varies directly with the use of the fixed target area. The temperature of the pond increased from a maximum of 89°F in 1990 to a maximum of 93°F in 1991. Temperatures have decreased in the years 1992 and 1993 (Figure 1.3) because the laboratory has been operating in the collider mode during that time. The amount of heat load in the magnet system is determined by the concentration of protons in the beam and required electrical demand. Average power load requirements during fixed target operation range from 12,000 to 14,000 Kw, whereas during non-operation, load requirements are between 5200 and 6500 Kw. Although the number of experiments being conducted in the fixed target experimental area is projected to decrease in the future, the cooling requirements are expected to increase due to an increase in the number of protons per incident beam and electrical load requirements.

A number of changes have been made to the operation of the fixed target area that add to the cooling demands placed on the ICW system. The pond cooling system was augmented until 1987 by 35 air towers located in 9 areas. LCW water is cooled at these locations by circulating it past two 15 Hp fans located in each tower. During 1987, approximately 25% of the cooling capacity represented by these towers was removed. Twelve (12) of the original 35 towers were removed from 4 areas. The switch to ICW heat exchangers increased primary cooling efficiency by reducing the temperature of the LCW supplied to the devices it cooled by 20 - 30°F. Because the LCW no longer comes into thermal contact with sub-freezing temperatures, the use of ethylene glycol, as anti-freeze, was also reduced. However, with the decommissioning of these air towers, the additional cooling requirement was transferred to Casey's Pond. These conversions increased the flow of ICW from Casey's Pond to 45,000 liters/minute (11,900 gpm), an average increase of 35% over that during the 1987 fixed target run of 33,300 liters/minute (8,800 gpm).

The construction of FCC was completed in 1989. FCC houses the main computer facility for Fermilab experimenters and requires considerable cooling for the high capacity computers and ambient air temperature control. These processes account for approximately 70% and 30% of FCC cooling requirements respectively. The flow from Casey's Pond was increased by approximately 13% to accommodate FCC. The Main Injector Project being constructed in the southwest portion of the site will increase the performance capabilities of the current accelerator. It will take over the current job of the

Figure 1.3 Casey's Pond Temperatures 1990 - 1993



Main Ring, alleviating some of the operational restraints currently imposed by that system, and will allow the Tevatron to achieve higher energies. The demand on cooling from Casey's Pond will be increased as a result of this project because the new injector system will allow for simultaneous operation of both collider and fixed target modes. The pond system associated with the Main Injector will also result in an annual water deficit of approximately 654,900,000 liters (17,300,000 gallons) to the site water balance, due to high evaporation rates.

2.0 PURPOSE AND NEED

The current ICW system is inadequate to meet cooling requirements. Cooling performance of a pond is related to the surface area available for evaporative cooling as well as air temperature, relative humidity, wind speed and solar radiation. The ability of the pond to cool increases with increasing surface area. However, as ambient temperatures rise, the cooling efficiency of a given surface area decreases, necessitating an increase in pumping to overcome the inefficiency and provide the necessary cooling. Relative humidity and wind speed are also important in determining the rate of evaporation from the pond surface. Relative humidity is the ratio of water vapor present in the air to the maximum quantity possible for saturated air at the same temperature. As relative humidity decreases, the ability of the airmass to diffuse water across the water-air interface increases. An increase in wind speed increases air movement across the pond surface increasing the rate of evaporation under conditions favorable to diffusion of water vapor across the water-air interface. Solar radiation is the main external heating source to the pond water. During summer months when the angle of incidence of solar radiation is greatest, natural heating of the pond surface water is at its maximum.

As pond water temperature increases, the efficiency of the ICW heat exchange system is lowered until a point is reached at which adequate cooling is not possible and system shutdowns can occur. Cooling efficiency (E_c) can be gauged by comparing the temperature of the water entering the pond (T_{enter}), to both the temperature of water as it is drawn from the pond system into the pumping station to be distributed (T_{leave}), and the natural reference temperature of a static water body under the same environmental conditions ($T_{reference}$), according to the following relationship:

$$E_c = 100\% * (T_{enter} - T_{leave}) / (T_{enter} - T_{reference}).$$

Under optimal cooling efficiency, the temperature of water as it leaves the pond would be reduced to the temperature of the pond under normal conditions, with no thermal load (i.e., $T_{leave} = T_{reference}$). The difference between the temperature entering and leaving the pond, under conditions where a thermal load is introduced, compared to this optimal condition is a measure of the cooling efficiency.

Computer simulations of the Casey's Pond system using the POND model, which was developed at Fermilab (see Appendix A), using a range of heat loading and environmental conditions, demonstrates that currently the pond system performs at a minimum average efficiency of 55%, for an ADSD (Table 2.1). The existing pond system is vulnerable to overheating under extreme conditions at present heat loads. System modifications and operational changes at the fixed target experimental area have caused water temperatures to rise. Current computer simulations indicate that cooling water could reach 101°F under extreme conditions during low pond water levels (Figure 2.1), at which point some shutdowns would begin to occur long before minimum drought water levels were reached. Actual operating temperatures in Casey's Pond during normal water levels reached 93°F at least twice during the 1991 fixed target run (Figure 1.3).

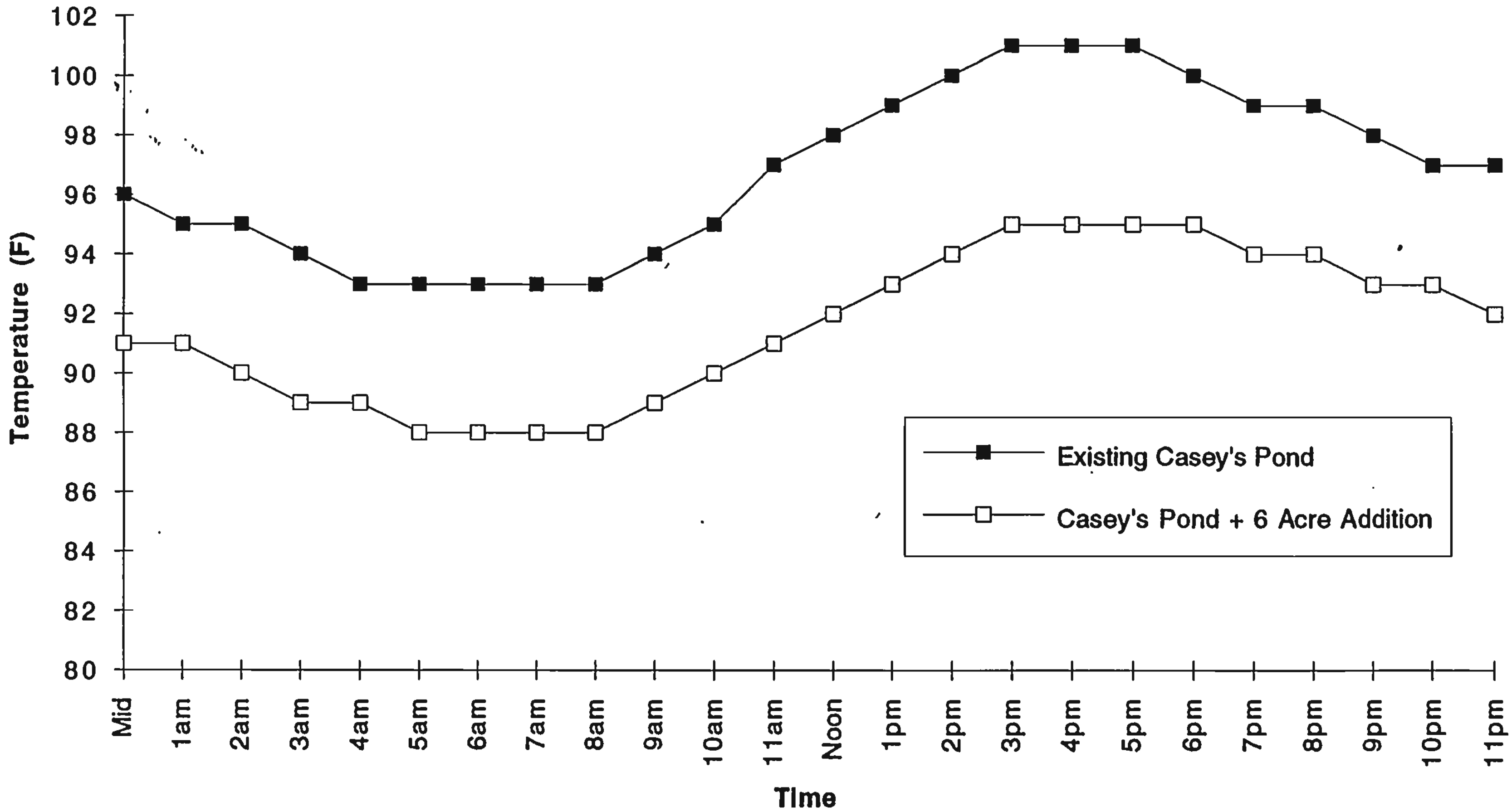
The current sitewide surface water utilization system is inadequate. Current deficiencies in the system adversely affect the utilization of reserve supplies. The water level in the system is currently maintained primarily through the collection of stormwater runoff and is augmented under normal conditions by water pumped from the Fox River. Surface water from the ponds on the east side of Fermilab (including DUSAF Pond, AE Sea, and Lake Law) are used as storage for supplementing the ICW system in the fixed target area. The system for transporting water from these east reservoirs results in an extreme loss of water due to evaporation and infiltration. Under extreme labwide drought conditions, water levels in Casey's Pond and Bulrush Pond can fall below fire protection reservoir requirements set by National Fire Protection Association guidelines which require a two hour reserve capacity. The lab currently maintains the ability to provide a pumping capacity of 31,400 liters/minute (8300 gpm) for this time period[5]. Under these extreme drought conditions, use of the Fox River for supplemental water is restricted. The violation of fire protection limits would result in operational shutdown.

During periods of high water, excess water from Casey's Pond flows over a spillway into a transfer ditch leading to Kress Creek. The elevation of the spillway is 222.2 meters (729.0 feet) above Mean Sea Level (MSL). Flow from Casey's Pond to Kress Creek is intermittent, depending on the amount of rainfall, evaporative rate and operational demand for cooling water at any time. Offsite flows into Kress Creek occur less than 80% of the days during the year. In some years, the percentage of days for which offsite flows occur has been less than 40%. The intermittent release of water from the ditch constitutes a discharge into waters of the state. Fermilab has received a permit from the IEPA (#IL0026123), under NPDES for this discharge. The primary pollutant in this effluent is thermal energy. The NPDES permit requires that the Illinois General Use Water Quality Standard for temperature must be maintained in Kress Creek. This standard requires that the effluent must not increase the temperature of Kress Creek by more than 5°F and in no case should the temperature of the creek exceed 93°F during the

Table 2.1 Extreme Design Summer Day Temperature Comparison at Low Water Levels

	Casey's Pond + 6 Acre Addition			Casey's Pond Alone		
TIME	ADSD	EDSD	MDSD	ADSD	EDSD	MDSD
MIDN	0.64	0.64	0.71	0.56	0.63	0.56
1 AM	0.67	0.71	0.69	0.53	0.56	0.53
2 AM	0.64	0.69	0.64	0.53	0.63	0.56
3 AM	0.64	0.71	0.71	0.59	0.56	0.56
4 AM	0.71	0.69	0.64	0.56	0.56	0.59
5 AM	0.64	0.64	0.64	0.53	0.63	0.56
6 AM	0.64	0.71	0.71	0.53	0.56	0.56
7 AM	0.64	0.71	0.71	0.53	0.56	0.56
8 AM	0.64	0.64	0.64	0.53	0.63	0.59
9 AM	0.64	0.69	0.69	0.56	0.56	0.56
10 AM	0.64	0.69	0.64	0.53	0.63	0.59
11 AM	0.64	0.64	0.64	0.56	0.56	0.56
NOON	0.64	0.71	0.71	0.53	0.56	0.56
1 PM	0.64	0.69	0.64	0.56	0.56	0.59
2 PM	0.64	0.69	0.64	0.53	0.63	0.56
3 PM	0.71	0.71	0.69	0.53	0.56	0.59
4 PM	0.64	0.64	0.71	0.56	0.56	0.56
5 PM	0.64	0.64	0.71	0.56	0.56	0.56
6 PM	0.71	0.71	0.64	0.53	0.56	0.59
7 PM	0.64	0.69	0.64	0.53	0.63	0.56
8 PM	0.64	0.64	0.69	0.59	0.56	0.56
9 PM	0.64	0.69	0.64	0.56	0.56	0.59
10 PM	0.67	0.69	0.71	0.53	0.60	0.56
11 PM	0.64	0.71	0.64	0.53	0.56	0.59
AVERAGE	0.65	0.69	0.67	0.55	0.58	0.57

Figure 2.1 Extreme Design Summer Day Temperature Comparison at Low Water Levels



summer months or 63°F in the winter months (Illinois Administrative Code (IAC), Title 35, §302.211).

The purpose for the proposed action is to meet the required cooling criteria, allow the fixed target experiments to operate more efficiently and without the threat of overheating, ensure that the Illinois Water Quality Standards are consistently achievable, provide needed additional water storage for fire protection, and maximize the efficiency in utilizing existing site surface water storage.

3.0 DESCRIPTION OF ALTERNATIVES

3.1 The Proposed Action

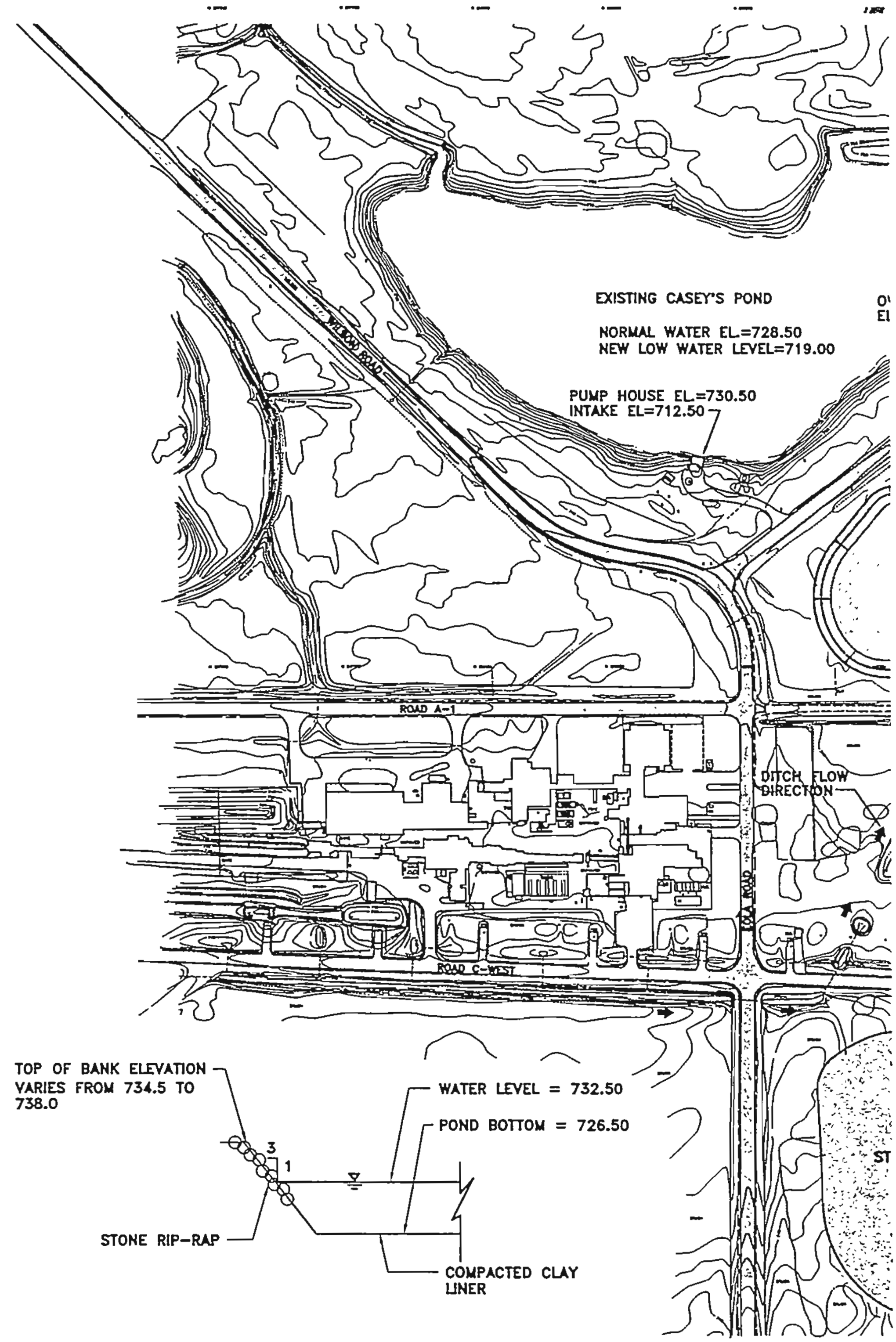
The proposed action is to build an additional 2.4 hectare (6 acre) pond southeast of Casey's Pond and to build a transfer pipe from Casey's Pond to Lake Law. The proposed new pond would be located southeast of the current Casey's Pond, across McChesney Road, in a currently vacant area characterized by weedy, old-field vegetation (Figure 3.1).

3.1.1 The Pond Addition

This additional pond would increase the available evaporative surface by 2.4 hectares (6 acres) and the detention time of water in the pond system from 110 to 138 hours, enhancing the cooling performance of the system (E_c) from 55% to 65%.

3.1.1.1 Construction

Construction of the new pond would proceed in the following general sequence (see Table 3.1 for schedule):

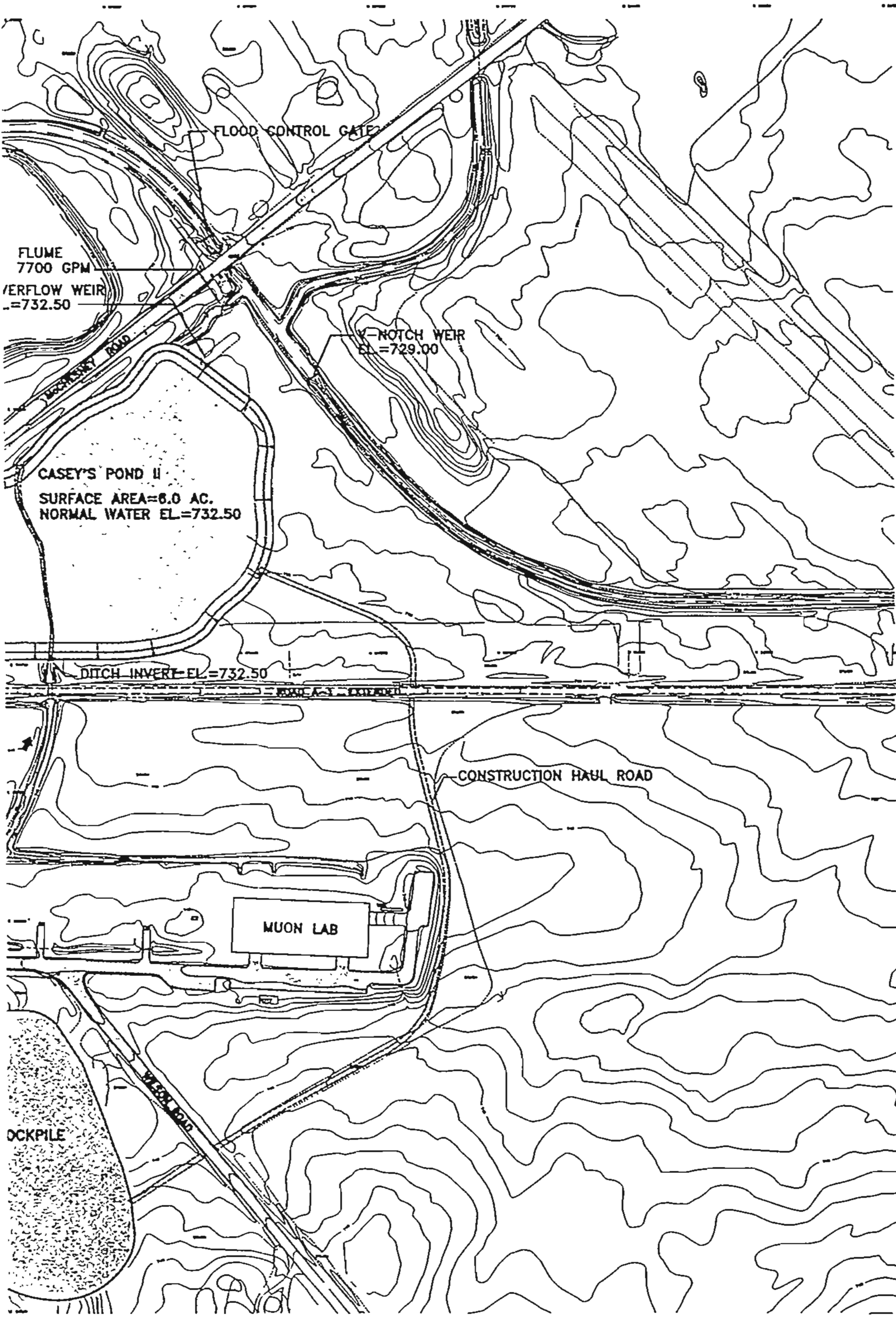


TYPICAL POND SECTION

REV	DATE	DESCRIPTIONS
		REVISIONS

Figure 3.1

Layout of Proposed Pond with Typical Pond Section



Transfer Ditch
to Kress Creek

	NAME	DATE
DESIGNED	P. MURRAY	FEB. 1994
DRAWN	P. MURRAY	FEB. 1994
CHECKED	C. FEDEROWICZ	FEB. 1994
APPROVED	E. CRUMPLEY	
SUBMITTED		

NORTH

SCALE: 1" = 100'-0"

FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

CASEY'S POND IMPROVEMENTS

CONCEPT PLAN

DRAWING NO 3-5-63 C-1 REV

Table 3.1 Construction Schedule

Begin Design	August, 1994
Floodplain Public Notice of Involvement	September, 1994
Publish Notification of Decision	October, 1994
Design Complete	November, 1994
DOE Approval of EA	March, 1994
FONSI Determination	March, 1994
Stormwater Pollution Prevention Plan Complete	March, 1995
Submit Notice of Intent to IEPA	March, 1995
Award Contract	April, 1995
Start Construction	April, 1995
Construction Complete	September, 1995

1. A temporary access road from the pond site to the soil stockpile site would be constructed to accommodate large earthmoving equipment, which cannot use public roadways due to size restrictions. This temporary road would be constructed mainly of compacted dirt and would only use crushed stone, in limited amounts, if absolutely necessary. The temporary road would run east from the new pond site to Powerline Road, then southeast, past the Muon Lab along the edge of a field currently planted with row crops, and then south, crossing Wilson Street, to the stockpile site. After construction, any stone would be removed and the original environment restored.

2. The existing soil would be excavated to a bottom elevation of 726 feet above MSL. This would require the removal of an average of ten feet of soil (100,000 cubic yards). Selected clay from the excavation would be used on the pond bottom to prevent seepage. The remaining soil would be transported to a pre-existing stockpile for storage. This stockpile was established before 1989 and would be covered, before use by this proposed project, by a NPDES Stormwater Construction Permit due to its

expansion beyond 2.0 hectares (5 acres). Topsoil and subsoil would remain segregated for storage.

3. The Proton ditch would be rerouted immediately south and west of the excavation area until completion of the proposed pond when it would be connected to the new pond at the southeast corner along with a new stop-log dam at the pond outlet, in the northwest corner, to control pond level.

3.1.1.2 Operation

The new pond would be constructed along the Proton ditch to Casey's Pond and would have the same catchment area as Casey's Pond. The water level in the new pond would normally be maintained at an elevation of 223.3 meters (732.5 feet) above MSL by use of a stoplog dam. This level would be allowed to drop to 222.7 meters (730.5 feet) above MSL during periods of drought. The new pond would have a mean water depth of 1.8 meters (6 feet) in order to maximize surface to volume ratio and thus increase evaporative cooling (see Figure 3.1 "Typical Pond Section"). This proposed addition to the Casey's Pond system would eliminate the potential for ICW supply temperatures to exceed 95°F under EDSD conditions (Figure 2.1) and the annual ICW flow rate would also be slightly reduced. The average expected detention time in the proposed new pond would be 28 hours, increasing the average detention time of the total system to 138 hours. The higher volume and detention time of the existing pond would act to decrease expected diurnal temperature fluctuations. All of these factors would effectively increase the system's efficiency (E_c) from 55% to 65% based on the current T_{enter} for an ADSD. In addition, lower ICW temperatures would conservatively save about 1100 megawatts annually in power consumption because mechanical cooling equipment typically consumes 1.4% more power per degree Fahrenheit increase in condenser water. At typical efficiencies of about 0.85 kilowatts per ton (0.24 Kw per cooling load Kw) of mechanical cooling capacity, this would be 0.0034 kilowatts per degree.

After completion of the pond excavation, surface water would enter the new pond through its south bank from the Proton return ditch. Cooled water would flow from the north bank of the new pond through a ditch into the existing Casey's Pond. The water flow from the Meson ditch would not be changed. Cooling water would continue to be pumped from Casey's Pond into the distribution system for bromine contact and then to cooling and fire protection systems. The water is treated with a halogen compound, Nalco 85wt-037/7343 (1-bromo-3-chloro-5,5-dimethyl hydantoin), in a continuous feed system. This treatment discourages biological fouling of the ICW distribution system and equipment utilizing the ICW for cooling. The residual levels would be monitored at heat exchangers and the East Spillway of Casey's Pond and the feed rate adjusted to maintain a total halogen concentration between 0.1 and 0.2 mg/l. Halogen level is monitored at the transfer ditch confluence with Kress Creek as a condition of the site NPDES permit. Water would recycle via the return ditches after use (Figure 3.2). Excess storm flows would be released from the pond system, via the bypass ditch, over the existing spillway into the transfer ditch leading to Kress Creek.

The pond system operational cycle would be affected by three main sources of variation; fixed target experimental physics program activity, seasonal ambient temperature differences, and variable storm water flow. Since the major requirement for cooling water comes from the operation of the fixed target experimental area, demands for cooling decrease and the flow through the system diminishes during periods when the accelerator is not operating in fixed target mode. During such periods, flow would be maintained and the system would operate normally to provide cooling water for uses other than experimental equipment cooling, but at a reduced water temperature.

Seasonal fluctuations in ambient air and water temperature and stormwater flow, along with wind speed and relative humidity, would affect the ability of the system to provide efficient evaporative cooling. The design criteria of the project incorporate these fluctuating environmental conditions. Offsite flow would normally be associated with large influxes of stormwater and thus significant temperature reductions over the long term would be expected due to mixing prior to release. Initial transient increases in temperature are expected to occur as runoff begins to displace heated water over the spillway.

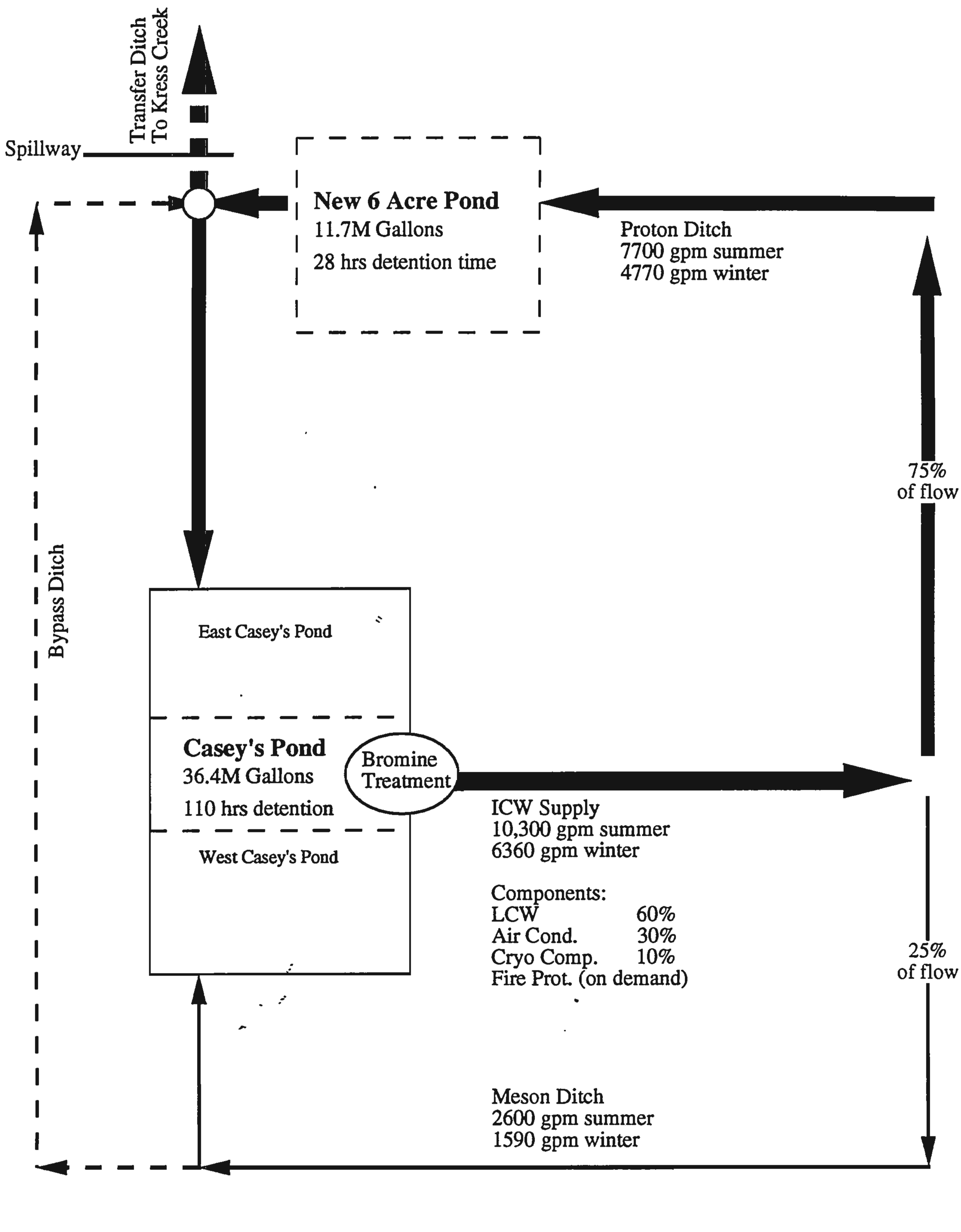
3.1.2 The Transfer Line

A transfer line would be built directly connecting Casey's Pond and the ICW system to the surface water bodies on the east side of Fermilab. An abandoned gas main that extends north from Lake Law would be used for transporting water to Wilson Street. In 1989, the integrity of this gas main pipe was tested by injecting water into it at a known rate and monitoring for loss at the end. It was found to be able to transport water efficiently with minimal or no leakage. The pipe is constructed of 8 inch welded steel. Additional pipeline would be laid along the north side of Wilson Street and Road C West (Figure 3.3). A pumphouse would be built on the north side of Lake Law to house equipment required for pumping water between Casey's Pond and Lake Law.

3.1.2.1 Construction

Construction of the transfer pipeline from Lake Law to the Casey's Pond ICW system would consist of the following elements:

Figure 3.2 Casey's Pond System Schematic Diagram at Full Beam Operation



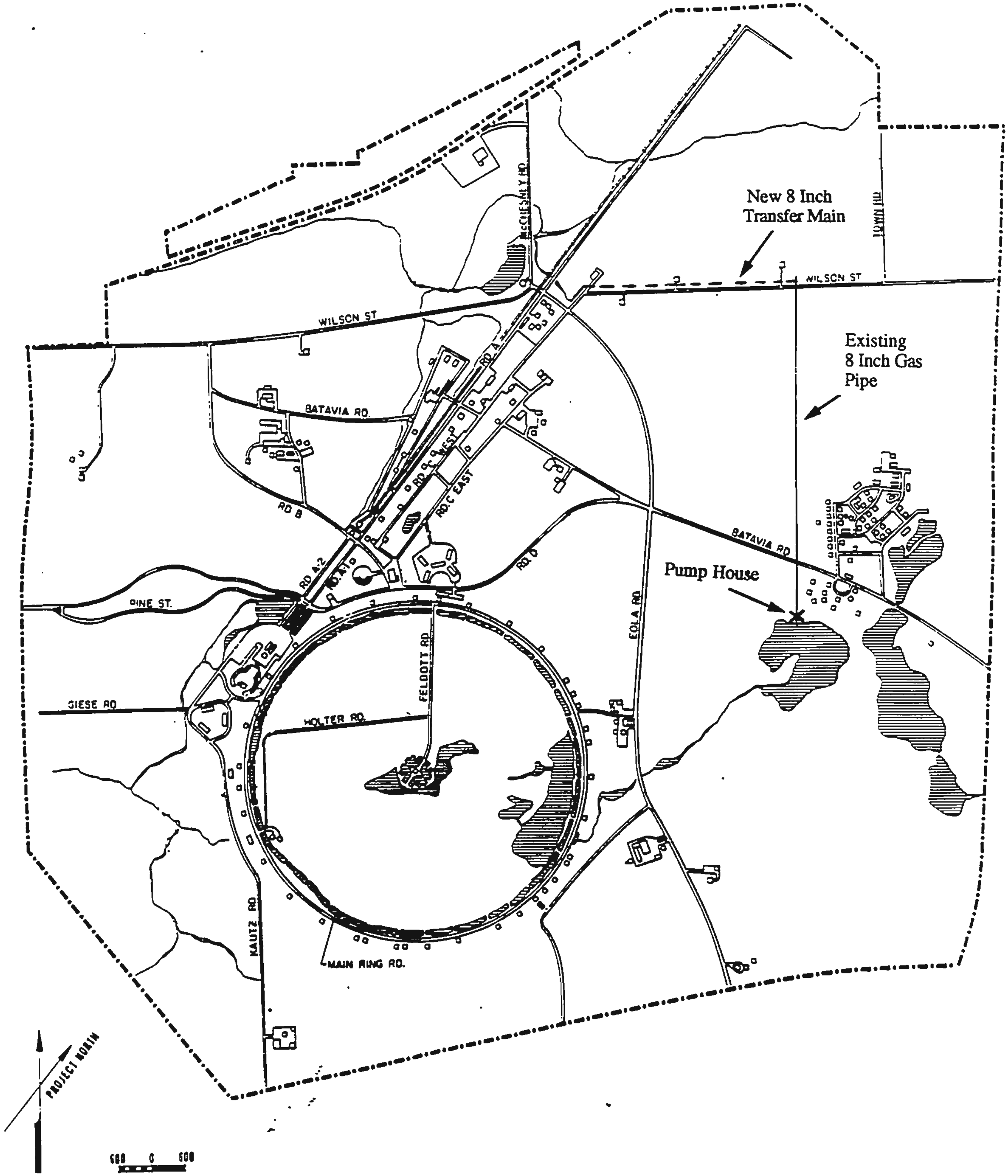


Figure 3.3 Layout of Proposed Transfer Line

1. Trench and lay approximately 1219 meters (4000 feet) of new 20.3 cm (8 inch) ductile iron mechanical joint pipeline from the point where the existing pipeline intersects Wilson Street. The pipeline would follow along the north side of Wilson Street west to Road C West and then along the west side of Road C West. The pipe would be connected at this point directly to the ICW system piping along with a discharge to Proton ditch leading to the new pond.

2. Build the pumphouse and install all pumping equipment on the north side of Lake Law. The building would be approximately 2.4 x 2.4 x 31 meter (8 x 8 x 10 feet), with only 0.6 meters (2 feet) exposed above grade. The pump station would contain a 3785 liters/minute (1000 gpm) simplex pump.

3. Make all necessary connections and valve installations: existing pipeline at Lake Law to pumphouse, old pipeline to new pipeline at Wilson Street, and new pipeline direct to ICW system and Casey's Pond Return ditch leading to the new pond.

3.1.2.2 Operation

During periods of dry weather when makeup water for the ICW system is unavailable from the Fox River, water from the surface water bodies on the east side of Fermilab (Lake Law, DUSAF Pond and AE Sea) would be pumped back through the transfer line into Casey's Pond. Water would be pumped from Casey's Pond through the transfer pipe to Lake Law for storage during periods of rainwater overflow to Kress Creek and normal flow in the Fox River. Water from Lake Law would be allowed to flow through flow control devices into the other surface water bodies, DUSAF Pond and AE Sea. Water levels would be maintained in these three surface water bodies by controlling flow over the spillway into the Sea of Evanescence and offsite into Ferry Creek.

3.2 Alternatives to the Proposed Action

Any reasonable alternative to the proposed action must meet the purpose and need of the project as stated herein to increase the cooling capacity, fire protection water availability and the ability to efficiently utilize site storage capacity, while complying with NPDES permit conditions and Illinois Water Quality Standards.

3.2.1 The "No Action" Alternative

No action in this case would result in the continuation of the present cooling system utilizing Casey's Pond as it has operated in the past and continued inefficient utilization of site surface water storage capacity. This alternative would result in higher water temperatures at the outfall than would result from the preferred alternative and would not eliminate the risk of system shut-downs due to inadequate cooling and storage capabilities. Also, occasional discharges of excess water to Kress Creek could exceed the limits for thermal pollution established by the NPDES permit and Illinois Water Quality Standards. The land in the area of the proposed project would be left undisturbed.

3.2.2 Excavation of a New Pond at a Different Location

Theoretically, a new pond could be constructed in any location on the Fermilab site, and the water pumped to Casey's Pond. However, this alternative would not avoid any potential impacts of pond construction, and would entail a significant added cost as well as additional environmental impacts from constructing new mains and pumping facilities. This would not be an environmentally preferred alternative.

3.2.3 Utilization of Groundwater

Cooling water could be extracted from a well drilled in the area of Casey's Pond or from the existing Well W-4 (see Figure 1.1). While this alternative would avoid any impact of pond construction, it would use an essentially limited and valuable resource (ground water) unnecessarily. Well W-4 is currently designated as emergency backup for ICW but because it is unable to pump for extended periods it is not considered a reasonable option for routine use. In addition, this alternative would not increase the surface area of the system, and therefore would not improve its cooling efficiency. It is therefore not a feasible alternative.

3.2.4 Increase the Volume of Water Pumped from the Fox River

This alternative could provide sufficient water for the system only by the addition of considerable upgrades to the pumping station. In addition, the costs of pumping from the river would increase significantly. Pumping is also restricted, through a permit with the Illinois Department of Public Works (#12170), when river flow falls below 7.8 m^3/second (275 ft^3/sec). Therefore, because the use of the Fox River as a cooling water source is unreliable (especially when water levels are low and it is most needed) this alternative would not meet the needs of the Laboratory for reliable, adequate cooling capacity.

3.2.5 Installation of Air Towers

This alternative could provide sufficient cooling capacity for the system. However, air to water cooling is less efficient than water to water cooling. The lower temperatures achieved by water-water cooling would conservatively save about 1100 megawatts annually in power consumption because mechanical cooling equipment typically consumes 1.4% more power per degree of condenser water increase. This alternative would require the use of ethylene glycol in the system to eliminate the chance of freezing during sub-freezing weather. Ethylene glycol waste is regulated and would require disposal as a Special Waste. Even though the use of air towers would avoid any impacts from pond construction this alternative is not an environmentally feasible alternative and it would not address the problem of storage capacity.

3.2.6 Alternative Route to Stockpile

This alternative to the temporary road is not feasible due to the fact that the earthmoving equipment that will be used for transporting soil cannot travel on public roadways because of size restrictions.

3.3 Relationship of the Proposed Action to Other Actions

This project is not "similar" or "connected" to other planned future, funding-dependent projects at Fermilab. That is, the proposed project can proceed without any future projects and no future project would be affected by the current proposal. A similar pond addition project was previously approved by DOE in 1986 after the preparation and submittal of a Memorandum to File. This earlier pond project was to be located just west of Casey's Pond and was to act as a precooling pond for water coming from both the Meson and Proton ditches. No action was taken for this project due to budgetary constraints.

Fermilab is currently constructing the Fermilab Main Injector, a major upgrade of the scientific apparatus, in the southwest portion of the laboratory site (see Figure 1.1). The relationship of this project to Casey's Pond is discussed in § 1.0. The other major project being constructed at Fermilab is the Kaons at the Tevatron (KTev) experiment, for which a Finding of No Significant Impact (FONSI) was recently approved. KTeV will be carried out in the experimental area of the laboratory. It will utilize existing air tower cooling systems in the area of the experiment.

4.0 THE AFFECTED ENVIRONMENT

4.1 Site Description

The proposed pond project site is located in an area of the laboratory unoccupied by personnel, equipment or buildings at the northeastern end of the fixed target area. To the north, east and west of the site are open fields and agricultural lands. The new pond would be located immediately southeast of Casey's Pond at the northeast corner of the intersection of Wilson Street and McChesney Road. McChesney Road is the controlled access road to the Railhead Storage area and Wilson Street is closed at the east site boundary making them unsuitable for public use.

The existing soil storage area, which would be used in this project, is approximately 2.4 hectares (6 acres) and is located 0.4 km (0.25 miles) east of the proposed pond site at the southeast corner of the intersection of Wilson Street and Road C West. The area of the proposed temporary road is currently planted with row crops and grass (Figure 3.1).

The environment in the area of the proposed transfer pipeline is old field and row crop from the north side of Lake Law until Wilson Street, where the existing pipeline lies, and from this point west to the proposed pond is composed of grass easement. The environment over the existing pipeline would not be disturbed. The area where the pumphouse would be located is characterized by old field community and turf grasses.

4.2 Surface Water

The pond project falls entirely within the watershed of Kress Creek, a tributary to the West Branch of the DuPage River. Kress Creek enters the laboratory property from the north, then runs approximately 2.5 km (1.6 miles) roughly east, and exits the laboratory property to the east. The flow of Kress Creek is highly erratic, but normally varies between approximately 0.06 to 0.42 m^3/second (2.0 to 15.0 ft^3/sec). The confluence of Kress Creek with the West Branch of the DuPage River is approximately 1.7 km (1.1 miles) downstream.

The transfer line component of the proposed action would lie in both the Kress Creek and the Ferry Creek watersheds. Ferry Creek originates onsite and leaves the laboratory property to the southeast. Ferry Creek is also a tributary of the DuPage River but with lower flow rates than Kress Creek. The confluence of Ferry Creek with the West Branch of the DuPage River is approximately 3.2 km (2.0 miles) downstream.

Water within the existing system is regularly monitored for the presence of radionuclides as part of the laboratory's routine environmental monitoring program. The radioactivation of soil occurs from the interaction of particles produced during accelerator operations at Fermilab. Leachable radionuclides, mainly ^{22}Na along with ^{3}H, migrate with water as it moves through the soil. Design criteria for source areas at Fermilab utilize underdrain systems that remove portions of the water containing these leachable radionuclides and discharge them to the ICW ditch system. Analyses of water samples from Proton ditch, the immediate source of water for the proposed pond, revealed average tritium concentrations from 1991-93 of 0.38 pCi/ml. ^{22}Na was not detected at the LLD of 0.03 pCi/ml. This corresponds to less than 0.02% of the limit of 2,000 pCi/ml set for surface water by DOE Order 5400.5, Chapter III, Derived Concentration Guidelines (DCG) and 2% of the Maximum Contaminant Level (MCL) for public water supplies set by IAC Title 35, Subtitle F: Public Water Supplies. The DCG value for internal exposure is based on a committed effective dose equivalent of 100 mrem for the radionuclide taken into the body by ingestion during one year. The MCL for a drinking water supply is calculated by assuming an average annual concentration that would produce a total body dose of 4 mrem to a full-time consumer. The concentration of radionuclides in the pond itself is typically below detection limits. Chemical analyses were conducted on water samples taken from the outflow of Casey's Pond to Kress Creek to support the application for a sitewide NPDES permit. These samples were also analyzed for gross alpha and beta radiation, and tritium. Water analytical results are in Table 4.1. Water temperatures and levels regularly fluctuate within the surface water system as a result of variable water use.

Table 4.1 Summary of Background Water Quality Data*

Sampling Date	12/13/91	2/26/92	8/25/92	4/8/93
BOD_5	6	2	na	na
Total Organic Carbon	11.04	4.14	na	na
Chemical Oxygen Demand	<10	15	na	na
Nitrogen (Total as N)	0.78	<0.1	na	na
Nitrate (Total as N)	5.10	0.87	na	na
Nitrite (Total as N)	0.014	na	na	na
Oil and Grease	2	14	na	na
pH (S. U.)	7.9	7.4	na	na
Total Suspended Solids	25	11	na	na
Temperature (°C)	13.4	2.9	28.9	na
Gross Alpha (pCi/ml)	na	na	na	<0.003
Gross Beta (pCi/ml)	na	na	na	0.010
Tritium ^3H (pCi/ml)	na	na	na	<0.410

* All units are in mg/l unless noted.
na Not analyzed for.

4.3 Flora and Fauna

The preferred pond site is characterized as uninhabited upland old field. This area is dominated by plant species typical of this community, such as tall goldenrod (*Solidago altissima*), gray dogwood (*Cornus racemosa*) and various non-native grasses. Crown vetch (*Coronilla varia*) has also invaded the area from nearby plantings intended as erosion control. There are scattered red cedar trees in the area (*Juniperus virginiana*) along with box elder (*Acer negundo*), buckthorn (*Pyrus sp.*), and honeysuckle (*Lonicera sp.*). The soil is classified as Mundelein silt-loam, a non-hydric soil[2], but the area has been highly disturbed historically and the original soil profiles may not be in place. The north side of Wilson Street is also a disturbed area with similar vegetative species.

A study of endangered and threatened species at Fermilab was conducted in 1985 by the Illinois Natural History Survey[3]. The authors found that 26 of 59 threatened, endangered, or federal candidate plants known for Kane and DuPage counties might find suitable habitat at Fermilab. The proposed site does not offer any critical habitat for the threatened or endangered plant species in the area.

The authors[6] also identified 66 total Federal and/or State endangered or threatened animal species in Illinois. Of these, potential habitat exists at Fermilab and the adjacent counties for 42 species. Five species, all birds, might be expected to utilize the project site to some degree. Three of these species (Northern harrier, Peregrine falcon, and Short-eared owl) are raptors whose use of the area would be only as a minor portion of their foraging territories. A fourth species, Yellow-headed blackbird, has been sighted sporadically at Fermilab, but no stable or breeding population has ever been established. The fifth species, Upland sandpiper, is known to breed at Fermilab, but in a restricted area of dry grassland approximately one mile from the project site. Byre's extensive study of the birds of Fermilab in 1989[4] confirms these observations.

4.4 Cultural Resources

Fermilab has performed a Phase I archaeological survey of the Fermilab site to determine whether any archaeological or historic resources are present. A 1970 archaeological study[5] which covered 93% of the Fermilab site not under construction, including the proposed project area, and a 1986 study[6], which covered the area north of Casey's Pond between the pond and the bypass ditch, found no evidence of important archaeological material. It is unlikely that any unidentified sites exist in the proposed project area.

5.0 ENVIRONMENTAL, SAFETY AND HEALTH CONSEQUENCES OF THE PROPOSED ACTION

5.1 Impacts Due to Construction

The potential adverse impacts of the proposed action are due entirely to the effects of construction. The proposed pond would be constructed partially in the base (100 year) floodplain of Kress Creek, and is therefore a floodplain action as defined in DOE

"Compliance with Floodplain/Wetlands Environmental Review Requirements" at 10 CFR 1022 (Appendix B: Floodplain Assessment). There are no wetlands or high hazard areas as defined in 10 CFR 1022 within the area of the proposed project. The net impact on flood storage capacity within this reach of Kress Creek would be positive because the additional pond volume would increase the capacity of the floodplain to retain floodwaters. If a potentially significant archaeological discovery were made during construction, reasonable efforts would be made to avoid or minimize harm until the appropriate consultation had taken place.

Cumulative effects of the construction of the pond would be minimal. Because the area to be excavated is greater than 2 hectares (5 acres), Fermilab would be required to obtain an NPDES Stormwater Permit for Industrial Activities related to construction. As part of the NPDES permit requirements, a sediment and erosion control plan would be prepared to avoid the loss of any soil from the site due to stormwater transport. The plan would include measures to keep disturbed areas as small as possible, stabilize disturbed areas, maintain runoff to low velocities, protect disturbed areas from stormwater runoff, retain sediment within the site boundaries, and would implement a thorough maintenance and follow-up program. There are no other sources of sediment to Kress Creek from the Fermilab site. The transfer pipeline construction would occur along an existing roadway easement and the pumphouse at Lake Law would be built on an existing berm dam. The impacts to these areas would be limited to minor disturbance of soil and vegetation in previously disturbed areas.

Additional construction noise and dust created by the proposed project would be minimized by the implementation of standard construction best management practices that have been developed from outside reference standards, including Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI). The proximity of existing roads means that only minor construction would be necessary to provide access to the site. Soil would be moved from the pond excavation site to the spoil pile via a 0.4 km (0.25 miles) road built exclusively for this purpose. Roughly 100,000 cubic yards of soil would be moved during construction. Large earthmoving equipment capable of hauling average loads of 20 cubic yards will travel the 0.8 km (0.5 miles) round trip approximately 5000 times for a total of 4000 km (2500 miles). Additional traffic due to minimal use of McChesney Road, which runs between Casey's Pond and the new pond, and Powerline Road, which lies east of the new pond, would not pose a hazard to public use due to the fact that neither are through roads accessed by the public and travel by equipment would be at low speeds. The use of Wilson Street during the construction of the transfer pipe would have a similar minimal impact for the same reasons.

5.2 Impacts of Normal Operations

Operation of the proposed project would not affect water quality within the pond and ditch system and the effect on Kress Creek would be minimal. The cooling process would not increase background chemical variable concentrations as presented in recent analysis in Table 4.1. The increased efficiency of cooling would also result in an elimination in the potential for thermal pollution to Kress Creek. This would be done by increasing detention time of water in the pond system and maximizing the surface area to volume ratio of the new pond. Computer simulations of the Casey's Pond system using the POND model show that temperatures of water downstream of the confluence of the transfer ditch and Kress Creek would no longer have the potential to exceed 93°F during summer months (Figure 5.1) and temperature differences in creek water upstream and downstream of the transfer ditch confluence would no longer have the potential to exceed 5°F during winter months (Figure 5.2). The increase of water temperature can severely upset aquatic life and alter the physical structure of the stream. The avoidance of this threat would be accomplished by increasing the ability of the pond system to maintain cooler water temperatures. This project would have no impact on chemical or radiological water quality. Volumes of water leaving the laboratory via Kress Creek would not change appreciably once the system came to equilibrium. Currently, aquatic species are effected by fluctuations in temperature and water levels within the surface water environments that make up this system. The proposed action will have a minimal impact on these populations.

Cumulative adverse impacts due to the operation of this project would be negligible. The potential positive environmental consequences are substantial, however. The existing Casey's Pond is utilized by numerous wading and shore birds, waterfowl, and other wildlife, and the proposed pond would likely augment this use. As mentioned previously, the pond would increase the volume of flood storage in the area, potentially alleviating flooding impacts downstream.

6.0 CONCLUSIONS

Impacts from the construction and operation of this proposed action are primarily positive. The construction of the pond would increase the available open water habitat for foraging birds and other wildlife, and the pond would provide extra flood storage capacity for this reach of the Kress Creek watershed. Potential negative impacts would be limited to transient effects of construction, primarily due to the possibility of erosion and sedimentation, and added dust and noise. Erosion and sedimentation impacts would be mitigated by the implementation of a sediment and erosion control plan. Impacts due to transportation, impacts on human health, and credible accident scenarios are considered to be negligible due to the nature of the project.

Figure 5.1 Violations of 93° F for Kress Creek Downstream of Transfer Ditch Confluence from Computer Simulations

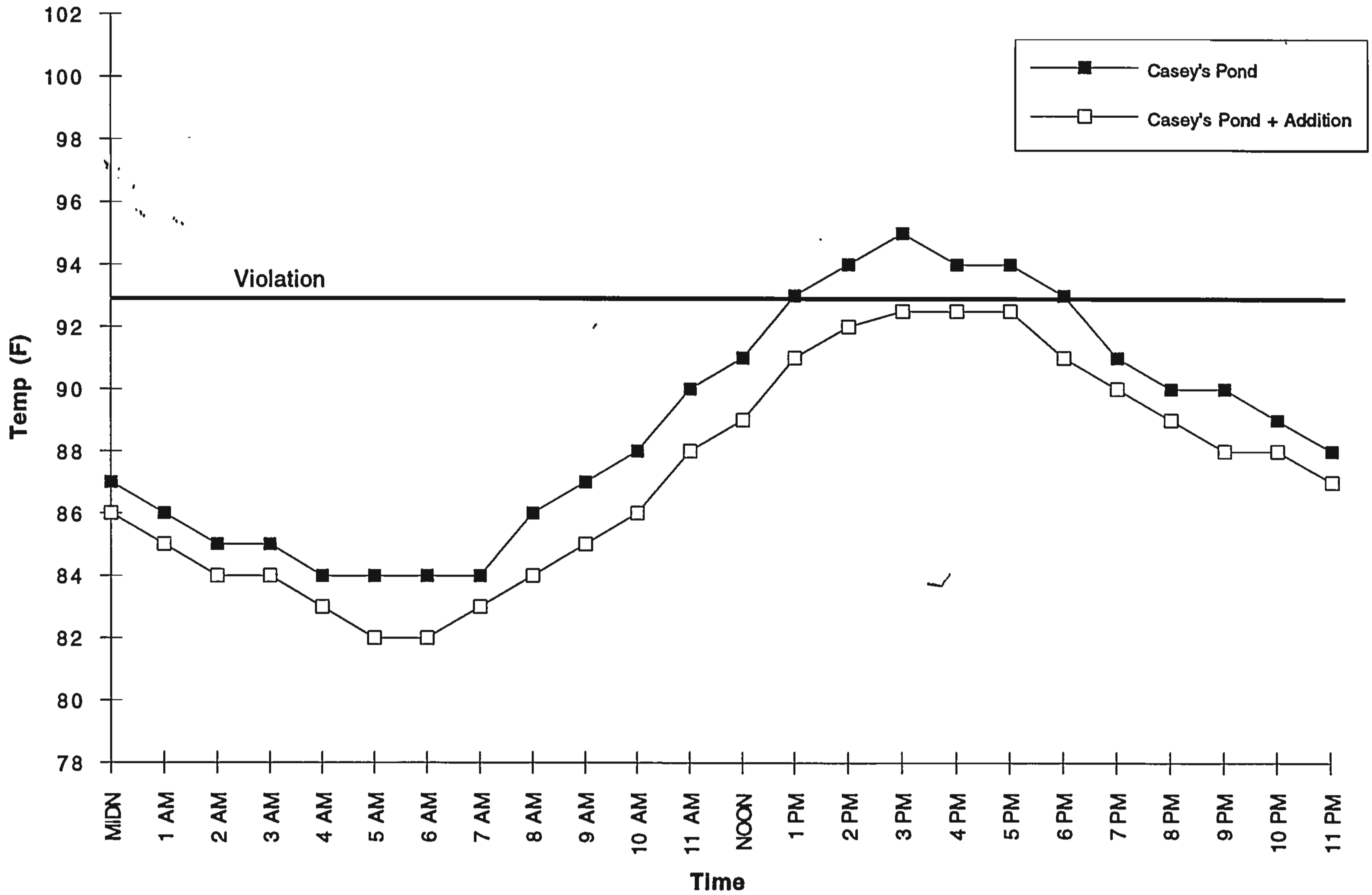
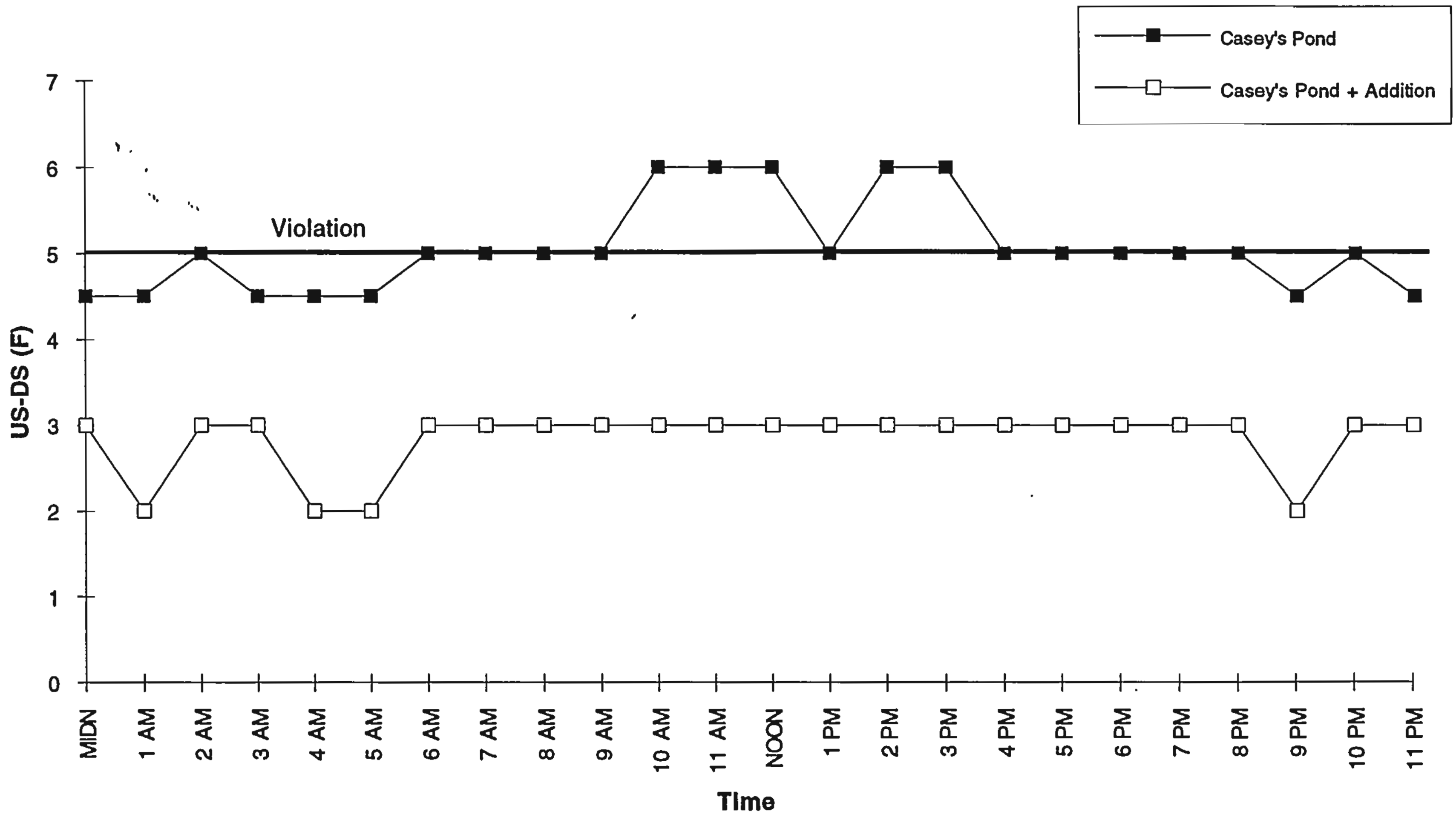


Figure 5.2 Kress Creek Violations of 5° F Difference Between Temperatures Upstream and Downstream of Transfer Ditch Confluence from Computer Simulations



GLOSSARY

Average Design Summer Day (ADSD) is defined as having a -8.3°C (17°F) daily range, 28.9°C (84°F) maximum temperature at 55% relative humidity, 70% of the total possible solar radiation available under clear conditions, and 3 m/s (6.8 mph) wind speed. This is the average summer operating condition and has been statistically defined in the "FY 1993 Technical Site Information Manual[7]."

Maximum Design Summer Day (MDSD) is defined as -6.7°C (20°F) daily range, 33.9°C (93°F) maximum temperature at 45% relative humidity, 100% solar radiation and 3 m/s (6.8 mph) wind speed. This is planned to be the normal maximum design summer operating condition covering 99% of the time and has been statistically developed for this area from the "ASHRAE 1993 Fundamentals Handbook[8]."

Extreme Design Summer Day (EDSD) is defined as -1.1°C (30°F) daily range, 39.4°C (103°F) maximum temperature at 40% relative humidity, 100% solar incidence, and 3 m/s (6.8 mph) wind speed. This is the worst anticipated summer operating condition, planned to occur less than 1% of the time, and has been determined from National Oceanographic and Atmospheric Administration (NOAA)[9] data for this area.

Average Design Winter Day (ADWD) is defined as -10.0°C (14°F) daily range, 0.6°C (33°F) at 50% relative humidity maximum daily temperature, and 3 m/s (6.8 mph) wind speed. This is the average winter operating condition, which has been statistically defined in the "FY 1993 Technical Site Information Manual[1]." At these conditions with 100% solar incidence the worst situation for overflow warming of Kress Creek more than 5°F beyond its natural temperature exists. Although this effect is most pronounced in winter, since water temperature cannot drop below 32°F, colder weather actually mitigates its occurence.

Maximum heat loading is defined as the load encountered on the system when all operating equipment is running and demanding cooling from the ICW system. It is equal to 105% of the full load and is approximately 14.7 kW.

Daily range is defined as the number of degrees difference between the minimum and maximum temperature within a day.

Percent solar radiation is the average daily available solar radiation in BTU/ft^2 compared to the average solar radiation for the Fermilab area, 150 BTU/ft^2.

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(2) Soil Survey of DuPage and Part of Cook Counties, Illinois. U.S. Department of Agriculture, Soil Conservation Service. May 1979.

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(8) ASHRAE Fundamentals Handbook, 1993. American Society of Heating Refrigeration and Air Conditioning Engineers.

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APPENDICES

ABSTRACT

[Based on Appendix B of the National Energy Software Center, Installation Representative Guide, ANL/NESC-1 (Rev.)]

1. **Identification and KWIC Title**

POND

2. **Computer for Which Software Is Written and Other Machine Versions Available**

The software was written for the IBM Personal Computer. It will also run on IBM compatible computers and Compaq computers. No other machine versions are available.

3. **Description**

The program consists of LOTUS 1-2-3 software templates built up from dozens of macros and thousands of interactive formulas used to generate thermal performance profiles for the evaluation and design of cooling ponds, pools and hydrothermal heat sources. The program addresses both ponds where influent water temperature is controlled and where it is allowed to drift. Extended applications covered in the manual include cascade ponds, rivers, lakes and pools. The system offers the following four (4) basic types of analysis:

a. Daily Pond EQUILIBRIUM Performance Profile - which portrays hour-by-hour performance when a pond reaches equilibrium with user defined conditions. Among its uses, the user may estimate pond performance under prolonged conditions of a particular nature.

b. Daily Pond DYNAMIC Performance Profile - which portrays hour-by-hour performance of a pond from a user specified initial state in response to user defined daily conditions. Among its uses, the user may chain together daily profiles to create complex multiday scenarios, test "what-if" criteria to get a feel for pond reaction patterns, and optimize pool warm-up cycles.

c. Annual Pond MEAN Performance Profiles - which portray (12) twelve monthly "typical day" hour-by-hour performance profiles based on the Root-Mean-Square values of user defined environmental conditions. Among its uses, the user may estimate pond performance in conjunction with heat pumps and cooling systems for energy conservation and life cycle cost studies.

d. Annual Pond EXTREME Performance Profiles - which portray (12) twelve monthly "typical day" hour-by-hour performance profiles based on the actual design values of user defined environmental conditions. Among its uses, the user may identify possible system operating limits due to over-heating in summer, or ice and over-cooling in winter.

The program allows the user to input the following variables in order to estimate design performance characteristics:

a. Monthly hour-by-hour patterns of heat taken from and/or given to ponds.

b. Whether variable flow pumping with a specified temperature difference is used, or constant flow pumping with a specified flow rate.

c. The submerged depth of the pond effluent.

d. The distance between pond influent and effluent.

e. The average pond width and depth in the flow area.

f. The total pond surface area.

g. All environmental conditions including wind speed patterns, outdoor air temperatures and humidity, sunshine over-cast and location latitude and hemisphere.

In addition to producing textual reports, the program contains many easy to use macro routines for displaying and printing profile graphs for six-point thermal analysis, flow, wind and loading.

4. Method of Solution

The program is completely menu driven with two levels of input options, for basic and more advanced users. All of the factors used in the program are derived solely from formulas developed by the author or published by sources such as ASHRAE for public use; no look-up tables or lists from other sources are used. Among the factors derived from formulas or modifications of formulas in the public domain are values for hourly solar angle, direct normal solar intensity, surface reflectance, temperature and humidity profiles, air velocity effects on evaporation and heat transmission, water vapor pressures and the psychrometric properties of air. Formulas pertaining to pond performance as a heat exchanger were derived from Fermilab Technical Memo TM-1530 entitled "Technical Manual for Calculating Cooling Pond Performance". This work was prepared by the author in July 1988 as part of work on cooling ponds for Fermilab. It involved the mathematical modeling of ponds thru extension of conventional compact heat exchanger formulas in the public domain, and the development of methods to perform the analysis. This software further develops and enhances the formulas in TM-1530 to make the program more marketable and useful in a larger range of applications. That involved going from the constant load, constant flow, steady state heat rejection equilibrium models of TM-1530 to dynamic models which include options for computer estimation of useable surface area and volume due to channeling, dispersion, draw-down and thermoclines.

. **Restrictions on the Complexity of the Problem**

Due to the nature of the problem being solved, the program is not geared to be highly precise or to handle in detail sophisticated and complex systems. Due to the difficulty in handling the multitude of exponential and logarithmic functions in the program, output may flutter slightly in certain conditions. In general, the solutions are thought to be accurate within plus or minus one degree Fahrenheit, but this is not certifiable. Environmental profiles are simulated mathematically from user input, so that correlation with actual conditions is imperfect.

6. **Timing**

Typical program processing times on computers using 286 chip technology range from less than a minute for simple "DYNAMIC" profiles, to about 15 minutes for "ANNUAL" runs which may involve more than 250,000 formula solutions.

7. **Unusual Features of the Software**

To our knowledge, there are currently no other programs of this nature commercially available. The nearest related software uncovered by search are privately developed mainframe programs used in the electrical utility industry.

8. **Related and Auxiliary Software**

This program consists of LOTUS 1-2-3 templates, and as such, it is designed for operation on computers running LOTUS 1-2-3 software.

9. **Status**

To be supplied by NESC.

10. **References**

a. Technical Manual for Calculating Cooling Pond Performance - Fermi National Accelerator Laboratory TM-1530, S.F. Krstulovich, 1988

b. Fan Engineering Handbook, Buffalo Forge Company, 1983

c. ASHRAE Fundamentals Handbook, American Society of Heating Refrigeration and Air Conditioning Engineers, 1989

d. POND MANUAL, S.F. Krstulovich, 1990

11. **Hardware Requirements**

The following hardware components are essential for full utilization of the software:

a. 512 K memory

b. 3.5" floppy drive

c. graphics printer

d. monitor

12. **Programming Language**

The entire software package is written in LOTUS 1-2-3 spreadsheet command language.

13. **Operating System**

The software was written using:

a. DOS Version 3.2

b. LOTUS 1-2-3, Version 2.01

14. **Other Programming or Operating Information or Restrictions**

Standard LOTUS 1-2-3 capabilities for data representation and structure, error checking, error messages and software organization are inherent in this package as a LOTUS 1-2-3 template.

15. **Name and Establishment of Author or Contributor**

The software was developed by Stephen F. Krstulovich an employee of Universities Research Association, Inc. the operating contractor for the Fermi National Accelerator Laboratory.

16. **Material Available**

The software package consists of one (1) 3.5" floppy POND SYSTEM DISK and one (l) POND MANUAL containing operating instructions, documentation and an extended applications section.

17. **Category**

H. Heat Transfer and Fluid Flow

Keywords

Computerized Simulation, Convection, Cooling, Energy Accounting, Engineering, Heat Flow, Hydrothermal Systems, Natural Convection, Process Heat, Swimming Pools, Temperature Monitoring, Water - Other keywords to be supplied by NESC.

18. **Sponsor**

Funding for the software development effort was supplied under Contract No. DE-

AC02-76CH3000 awarded by the U.S. Department of Energy. Fermi National Accelerator Laboratory (Fermilab) is operated for the U.S. Department of Energy by the Universities Research Association, Inc.

PROPOSED CASEY'S POND IMPROVEMENT PROJECT

FLOODPLAIN ASSESSMENT

Project Description

The proposed action is to build an additional 6 acre pond southeast of Casey's Pond and to build a transfer pipe from Casey's Pond to Lake Law. The additional pond would allow the fixed target experiments to operate more efficiently and without the threat of overheating, ensure that the Illinois Water Quality standards are consistently achievable and provide needed additional water storage for fire protection and the transfer line would maximize the efficiency in utilizing existing site surface water storage. The proposed new pond would be located southeast of the current Casey's Pond, across McChesney Road, in a currently vacant area characterized by weedy, old-field vegetation. The transfer line would be built directly connecting Casey's Pond and the ICW system to the surface water bodies on the east side of Fermilab using an abandoned gas main that extends north from Lake Law to Wilson Street. Additional pipe would be trenched along the north side of Wilson Street and Road C West. A pumphouse would be built on the north side of Lake Law to house equipment required for pumping water between Casey's Pond and Lake Law. The proposed pond would be constructed partially in the base (100 year) floodplain of Kress Creek (Figure 1), and is therefore a floodplain action as defined in DOE "Compliance with Floodplain/Wetlands Environmental Review Requirements" at 10 CFR 1022. No floodplain would be impacted by the transfer pipeline. There are no high hazard areas as defined in 10 CFR 1022 within the area of the proposed project.

Floodplain Effects

There are no potential adverse impacts of the proposed action on floodplain. The net impact on flood storage capacity within this reach of Kress Creek would be positive because the additional pond volume would increase the capacity of the floodplain to retain floodwaters.

Alternatives

Because there are no adverse effects to floodplain as a result of this construction, no alternatives or mitigation measures are considered.

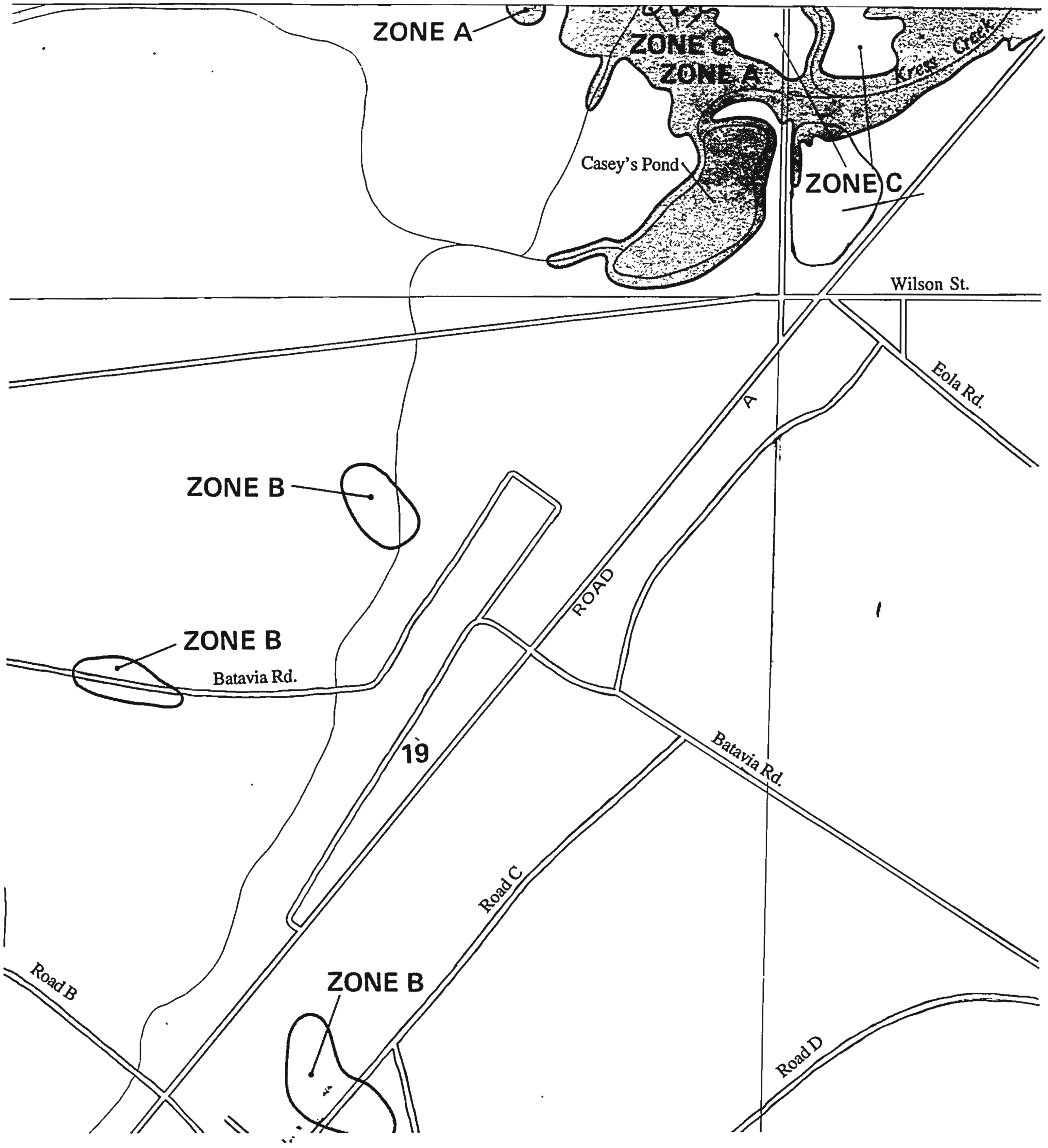

Figure 1: 100 Year Floodplain (Zone A) in the area of the proposed pond action for the Expansion of the Fixed Target Area Cooling Pond System. From the National Flood Insurance Program Flood Insurance Rate Map, Federal Emergency Management Agency, Effective Date: April 15, 1982.