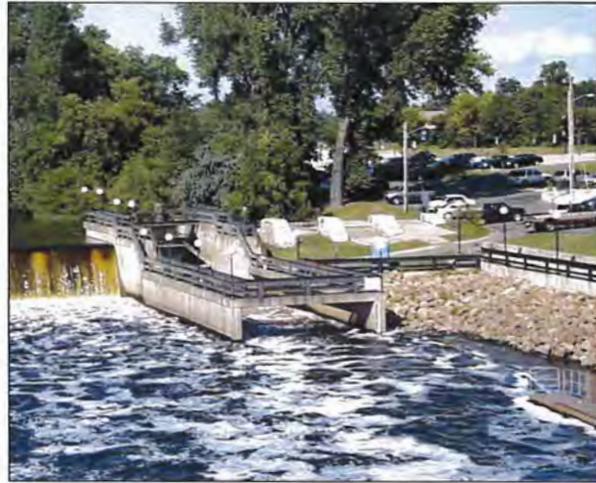


Rum River Dam Hydroelectric Project Reconnaissance Study



City of Anoka
Anoka, Minnesota

Draft
December 2002



Stanley Consultants INC.

A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

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Anoka, Minnesota

Draft
December 2002

I hereby certify that this plan, specification, or report was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: _____
Date: December 17, 2002

Typed or Printed Name: _____
Reg. No.: _____

Executive Summary

The City of Anoka operates the Anoka Municipal Utility (AMU). Created in 1909, AMU is a community-owned, not-for-profit public utility that meets the community's electric needs in the most cost effective and reliable manner. The City is also a member of the Minnesota Municipal Power Agency (MMPA). MMPA is responsible for providing wholesale power supply to its eight member cities. MMPA encourages member cities to identify renewable generation projects where MMPA can assist with the development and management of the projects.

The State of Minnesota requires that utilities make a good faith effort to provide 1 percent of their generation by renewable resources by the year 2005, incrementally increasing to 10 percent by 2015. Hydropower development at the Rum River Dam qualifies as a renewable resource.

Hydropower (i.e. mechanical milling power) was generated by the Rum River in Anoka for many years in the early 1900's. The dam was re-built in 1968 and is in good condition.

Approximately 550 kW of capacity and 2290 MWh of annual energy can be produced at a powerhouse adjacent to the Rum River Dam for a capital cost of \$3.5 million. Construction of the facility within the existing tainter gate bay reduces the capital cost to \$2.6 million. The latter would require a hydrologic/hydraulic study to prove that the gate can be eliminated without adverse impacts to upstream residents.

An unconventional, 420 kW installation can generate approximately 900 MWh of annual energy for a capital cost of \$1.5 million.

Significant incentives for hydropower are available from Xcel Energy. The State of Minnesota offers a \$0.015/kWh generation incentive for hydropower for project brought on line before 2006.

Life cycle economic analysis of a hydroelectric power installation at the Rum River Dam site is currently being investigated by MMPA.

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Table of Contents

- Section 1
 - Background Information 1-1
 - Dam Description..... 1-1
 - Previous Reconnaissance Report..... 1-3
 - Objectives of Current Study 1-3
- Section 2
 - Conceptual Development 2-1
 - Equipment Solicitation 2-1
 - Powerhouse Location 2-2
 - Conventional Powerhouse Location..... 2-2
 - Tainter Gate Bay..... 2-2
 - Unconventional Technology 2-4
 - Ancillary Facilities 2-5
 - Electrical Interconnect..... 2-5
 - Flashboards..... 2-6
 - Equipment Crane..... 2-6
 - Inlet Gate 2-7
 - Trashrack Cleaning Machine..... 2-7
- Section 3
 - Project Costs & Available Funding 3-1
 - Project Costs 3-1
 - Capital Costs..... 3-1
 - Operations & Maintenance Costs..... 3-8
 - Available Funding 3-8
 - Xcel Energy Renewable Energy Fund..... 3-8
 - Renewable Energy Credit..... 3-8
- Section 4
 - Energy 4-1
 - Energy Generation..... 4-1
 - Energy Revenue 4-3

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Section 5	
Regulatory Issues	5-1
Minnesota Department of Natural Resources.....	5-1
City of Anoka.....	5-1
State of Minnesota.....	5-1
Federal Energy Regulatory Commission.....	5-1
Section 6	
Development Schedule.....	6-1
Section 7	
Conclusions and Recommendations.....	7-1
Conclusions	7-1
Recommendations	7-2
Section 8	
References	8-1

TABLES

Table 2-1 Generating Equipment Solicitation Summary	2-2
Table 3-1 Cost Estimate - Conventional Installation.....	3-2
Table 3-2 Cost Estimate - Gate Bay Installation	3-4
Table 3-3 Cost Estimate - Unconventional Installation.....	3-6
Table 4-1 Capacity & Energy Summary	4-3

APPENDICES

Appendix A	
Figures.....	A-1
Appendix B	
Energy Computations	B-1
Appendix C	
Manufacturer Quotations.....	C-1

Background Information

Dam Description

The original dam in Anoka was a timber structure that was destroyed and re-built several times. The former powerhouse housed turbines with a combined capacity of 450 hp that were used to power a grain mill. Today, the remains of the powerhouse include foundations only.

The current Rum River Dam was constructed in 1969. The 236-foot long main overflow dam is a buttress type structure with 18-inch thick reinforced concrete apron supported by 2-foot wide intermediate piers spaced at 19'-9" on centers. The crest elevation of dam is 841.35 ft-msl. Timber flashboards are used to increase the overflow elevation to 844.24. The overflow dam is supported by a 3-foot thick reinforced concrete slab. The dam has a maximum structural height of 11.4 feet. Normal pool is 844.5.



Tainter Gate Bay & Left Abutment Area

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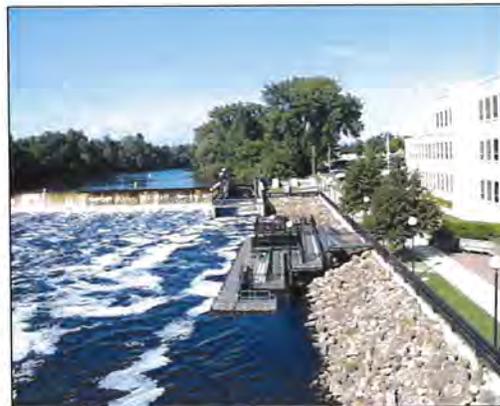
Water level control is provided by a tainter gate bay located on the left side of the dam. The bay includes a 20-foot wide by 15-foot high steel tainter gate, ogee type spillway with a crest elevation of 835.0, and 88-foot long stilling basin. The left abutment area includes a former powerhouse area and 5-foot thick abutment wall. The right concrete abutment includes an overlook structure and approach area.



Right Abutment Area

Electrical systems are powered from distribution enclosure located in the left abutment area. Electrical systems include the gate hoist, gate heaters, and lighting. A Met Council Environmental Services water quality station is also located in the left abutment area.

A boat docking facility and access ramp is located on the left bank approximately 200 feet downstream of the dam. The boat dock facility was constructed in 1997.



Downstream View of Dam & Boat Dock/Ramp

A project map is shown on Figure 1. A site plan, dam profile, and dam cross-sections are shown on Figures 2 through 5.

Previous Reconnaissance Report

A hydro reconnaissance report was prepared in 1982 by the University of Minnesota St. Anthony Falls Hydraulic Laboratory (SAFHL 1982). The report developed three alternative development scenarios, each located immediately adjacent to the dam's tainter gate bay. The most economical alternative was a horizontal Kaplan unit with a rated discharge of 650 cfs and rated capacity of 603 kW at 12.3 feet net head. The initial capital cost was \$2,113,000 (1982) and expected annual energy generation was 2.57 GWh. In 2003 dollars¹, the capital cost to install hydropower (per SAFHL) is \$3,592,000.

The 1982 report concluded that hydropower development at Rum River Dam was not economically feasible.

Objectives of Current Study

The objectives of this study include the following:

- Confirm/develop licensing and construction costs
- Confirm/develop annual energy generation
- Prepare project development schedule and flow chart
- Research available funding assistance
- Perform initial FERC licensing actions

¹ *Engineering News Record* reports construction cost indices one per month. Comparison of these indices between today and 1982 results in an escalation factor of about 1.7.

Conceptual Development

Equipment Solicitation

Conceptual equipment information and budgetary cost data were solicited from eight hydro turbine-generator manufacturers with experience in low head hydro. Manufacturers included the following:

- Alstom Power Inc.
- Canadian Hydro Components Ltd.
- GE Hydropower, Inc.
- Hydropower Turbine Systems/Ossberger
- Universal Electric Power Corp.
- VA TECH Hydro USA/Bouvier Hydro
- Voith Siemens Hydro Power Generation Inc./ESAC

Table 2-1 summarizes information received from turbine-generator vendors. All costs include turbine, generator, controls, and switchgear package. All costs exclude civil works, inlet control gate, transformer, and electrical interconnect.

Table 2-1 Generating Equipment Solicitation Summary

Name	Turbine Type	Rated Capacity, kW	Rated Q, cfs	Speed Increaser?	Delivery?	Site Rep?	Delivery Time, mo	Equipment Cost, \$1,000
Alstom	Vertical Kaplan	630	700	Yes			14	1,545
Canadian Hydro Comp.	Horizontal Kaplan/Bulb	600	650	Yes	No	No	11	850
GE	Vertical Kaplan	644	680	Yes	No	No	10	940
Hydropower Turbine Syst.	Horizontal Kaplan/Bulb (2)	622	680	Yes	Yes	No	10	775
UEP	Cross Flow	500	700	Yes	Yes	Yes	6	885 ^a
VAT/Bouvier	Horizontal Kaplan/Bulb	733	833	Yes	Yes	No	12	1,170
Voith	Did not respond							
^a Turnkey price.								

Each of the turbines in Table 2-1 can be described as “conventional” configurations in that they require a forebay, powerhouse, and draft tube. The UEP configuration is “unconventional” in that it does not require these civil works or at least it requires them to a much lesser extent. Additional discussion of the UEP unit is presented later in this report.

Powerhouse Location

Conventional Powerhouse Location

Conventional powerhouse arrangements seem to be well suited to the area immediately east of the tainter gate bay (see Figure 6). Not only is this area readily accessible for construction and operation, but the existing tainter gate structure would serve as a major portion of the cofferdam required for construction. Design for this location will need to consider the potential impacts that powerhouse discharges would have to the boat dock facility.

Tainter Gate Bay

Alternatively, the tainter gate bay itself could provide the bulk of the civil works required for a conventional powerhouse installation. The existing bay would provide sufficient space and tailwater submergence for a new powerhouse. Significant cost savings could be realized by the following:

- Reduced cofferdam costs – The “box” created by the existing tainter gate bay walls and floor will form the majority of the cofferdam. The tainter gate would remain in place to serve as an upstream cofferdam during construction. A downstream cofferdam would be required and could either be a temporary structure or a permanent stop log structure (panels and guides) mounted to the walls of the gate bay.

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- Reduced Earthwork – No earth excavation would be required for the new powerhouse structure.
- Reduced Site Restoration – Site restoration would be limited since little or no disturbance to the area east of the gate bay would be required.
- Reduce Utility Relocations – No disturbance to existing dam electrical service would be required. The existing MCES water quality station could remain in place.
- Reduced Inlet Gate Costs - The tainter gate would also serve as the powerhouse “control gate” during operation. Only minimal upgrade costs would be required for hydro operations.

The effect of hydro operations on the existing boat dock and ramp facility would be minimal since maximum flows through the tainter gate bay would be on the order of 700 cfs. Development of the tainter gate bay would likely require the addition of recreational opportunities (e.g. fishing access) to offset those lost to development.

Occupying the tainter gate bay with the powerhouse may require additional spillway capacity elsewhere on the dam. Additional spillway capacity could be provided by installing a new gate west of the existing tainter gate bay. The discharge capacity of the existing tainter gate is approximately 2000 cfs at pool elevation 845.0. The existing tainter gate and stilling basin were likely designed to contain the hydraulic jump that is expected to occur under various discharge scenarios. Cursory hydraulic analyses show that the critical discharges for stilling basin design are not extreme event flood flows, but are flows that may be expected on the order of every year or two.

An example of a gate system that would be well suited for this application is the “Obermeyer” gate system. The Obermeyer system consists of a steel gate leaf operated by an inflatable rubber bladder. The gate would be placed immediately adjacent to the tainter gate bay and would span across two spillway bays for a total of about 40 feet. Construction would require the following:

- Upstream cofferdam possibly consisting of structural steel/steel sheetpile wall mounted to existing concrete apron
- Downstream cofferdam constructed of earth and synthetic liner.
- Demolition of existing concrete crest slab, one buttress, baffle blocks, and end sill.
- Construction of new concrete stilling basin (approximately 25 feet downstream of existing basin).
- Installation of gate system including anchorage, air bladders, gate leaves, air piping, seals, heaters, etc.
- Installation of gate control system within new powerhouse.



Obermeyer Gate System

The necessity to replace the discharge capacity of the tainter gate may be subject to discussion. Back in the late 1960's, it is understood that the desired design of the new dam was to match the discharge capacity of the then existing timber crib dam and tainter gate. Review of City files did not reveal any comprehensive backwater analyses or flood impact studies in the reaches upstream of the dam with respect to the discharge capacity of the tainter gate. As flow in the Rum River rises, the tailwater elevation also rises and eventually has a submergence effect on the tainter gate spillway thus reducing its discharge capacity. High Mississippi River flow causes backwater into the Rum and has the same effect. Residences along the Rum upstream of the dam appear for the most part to be relatively high above the river. A hydrologic/hydraulic study may prove that the required discharge capacity of the dam may be reduced without adverse effects to residences upstream of the dam. This may then justify reducing the "replacement discharge capacity" required in association with development of hydropower within the existing tainter gate bay.

Unconventional Technology

Universal Electric Power (UEP) was founded in 1998 and is a manufacturer of a unique turbine-generator technology. The technology utilizes a "cross flow" type turbine, siphon water intake system, and a watertight turbine, generator, & controls enclosure. Installations are designed to minimize required civil work and thus reduce construction costs.



Example UEP Application

Figure 7 presents a conceptual layout of the UEP system installed at the Rum River Dam. New construction would include a trashrack, siphon penstock and supports, turbine-generator enclosure, flashboard bulkhead, and access walkways. All of this equipment would be located “in the river” with the only required land-side work being the transformer and electrical interconnect.

The UEP unit is an “impulse type” unit and open to the atmosphere, as opposed to a Kaplan unit that operates under a back pressure. Higher tailwater elevations will “flood” the turbine and prevent it from operating. Because of this, the unit cannot operate as often as a conventional unit and therefore its annual energy generation is greatly reduced. In addition, the available net head for a cross flow unit is generally less than a Kaplan unit and therefore less power can be generated for a given discharge.

Cross flow turbines may be better suited to higher head applications and in those instances where construction of a powerhouse is very difficult.

Ancillary Facilities

Electrical Interconnect

It is anticipated that output from the generator will be at 4160 volts. An Anoka Municipal Utility (AMU) 7200 V distribution line is located approximately 100 feet from the east end of the dam.

The electrical interconnect include a 4160V – 7200V step-up transformer and an overhead line to the existing distribution system. It is anticipated that the transformer will be rated at 1000kVA, standard oil-filled, pad-mounted unit, within a lockable enclosure. A digital metering unit for monitoring Kilowatts and Kilovars will be mounted to the transformer. Connected to the high-voltage side of the transformer will be a 15kV-class circuit breaker, and a set of lightning arrestors. 15kV-rated Type EPR cables will run from the circuit breaker, through approximately 100 feet of direct-buried PVC conduit, to a power pole riser where the circuit will be connected at the top of the pole.

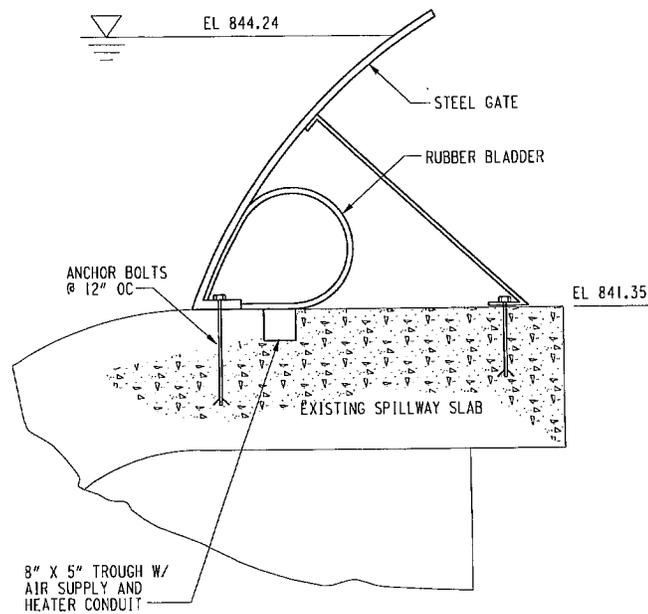
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Flashboards

The existing flashboard system use on the Rum River Dam consists of stacked 4" x 12" timbers supported by wide-flange steel columns and sacrificial tension rods. The flashboards add nearly three feet to the normal pool elevation of the dam. The flashboards are manually removed from the dam crest each fall and re-installed each spring once high flows have passed and it is once again safe for personnel to access the dam crest.

Hydroelectric power output from a turbine is directly related to net head. Therefore, the amount of time that the flashboards are in place should be maximized in order to maximize generation.

In 1996, Stanley Consultants performed a flashboard system replacement evaluation for the City of Anoka. This evaluation looked at various gate systems that could be installed with remote operation and thus eliminate the need for manual removal and re-installation of the existing timber system. The lowest capital cost system was the Obermeyer system consisting of hinged steel gates controlled by a rubber bladder. The estimated installed cost for this system is \$375,000.



Obermeyer Flashboard System

Equipment Crane

A crane is required for installation and removal of powerhouse equipment. The largest component anticipated for this facility is approximately 5-tons. It is anticipated that during and after construction, powerhouse equipment will be lifted by a mobile crane located on the shore. The powerhouse roof will include removable panels to allow for such operations. Alternatively, the powerhouse could be constructed with a permanent indoor crane. The anticipated installed cost for a 6-ton crane is \$13,000.

Inlet Gate

An upstream inlet gate system is required for flow control in the conventional powerhouse arrangements. Vertical sluice-type gates with motor operators are proposed for the Rum River application.

Trashrack Cleaning Machine

Many hydro installations have trashrack cleaning machines for removal of river debris. An example is shown in the photograph below. Anticipated installed cost for a cleaning machine is \$150,000.



Trashrack Cleaning Machine - Kankakee Project

Project Costs & Available Funding

Project Costs

Capital Costs

Reconnaissance level capital cost estimates were prepared for the following three scenarios:

- Conventional powerhouse adjacent to tainter gate bay
- Conventional Powerhouse within tainter gate bay
- Unconventional Development

Costs include equipment procurement and installation, cofferdams, powerhouse sub- and superstructure, site work and site finishing, electrical interconnect, engineering and administration, FERC licensing, and contingencies. In the case of the powerhouse within the tainter gate bay, costs include construction of the new control gate. Costs do not include powerhouse crane, trashrack cleaning machine, or interest during construction.

Results are shown below. Detailed estimates are shown as Tables 3-1, 3-2, and 3-3.

Conventional Powerhouse:	\$3.5 million
Gate Bay Installation:	\$3.2 million
Unconventional Development:	\$1.5 million

The “gate bay installation” alternative includes costs for installation of a new control gate adjacent to the tainter gate bay. The total cost for this replacement gate approaches \$600,000. See Section 2 for further discussion of replacing the tainter gate.

TABLE 3-1. COST ESTIMATE - CONVENTIONAL INSTALLATION

NO. ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL COST	COMMENTS
1000 EQUIPMENT PROCUREMENT					
1010 Turbine-Generator Package	ls	1	1,200,000	1,200,000	Based on Alstom, VATECH, & GE
1020 Transformer Package	ea	1	70,000	70,000	See Note 2
1030 Upstream Gates	ea	2	50,000	100,000	Northwestern Power Eq. quote
1040 Powerhouse Crane	ea	0	10,000		6-ton crane
1050 Trashrack Cleaner	ea	0	120,000		See Note 4
2000 SITEWORK					
2010 Relocations					
2011 Water Quality Station	ls	1	5,000	5,000	
2012 Electrical Distribution	ls	1	5,000	5,000	
2020 Site Preparation					
2021 Security & Erosion Control	ls	1	3,000	3,000	
2022 Water Service	ls	1	2,000	2,000	
2023 Electrical Service	ls	1	4,000	4,000	
2024 Telecommunications Service	ls	1	1,000	1,000	
2030 Cofferdams/Dewatering					
2031 Install & Remove Piles	sf	2800	23	64,400	
2032 Dewatering Operations	day	60	150	9,000	
2040 Demolition					
2041 Sheet Piling	sf	7300	3	21,900	
2042 Riprap	cy	500	10	5,000	
2043 Concrete Retaining Wall	cy	30	60	1,800	
2044 Curb & Gutter	lf	140	4	560	
2045 Asphalt/Sidewalk	sy	280	5	1,400	
2046 Concrete Powerhouse Remains	cy	300	60	18,000	
2047 Trees	ls	1	1,000	1,000	
2050 Earthwork					
2051 Excavation	cy	6000	4	24,000	
2052 Backfill/Compact	cy	1300	4	5,200	
2053 Waste	cy	4700	6	28,200	1 mile round trip haul
2054 Grading	sy	600	2	1,200	
2055 Riprap	cy	600	45	27,000	
2060 Site Finishing					
2061 Sidewalk	sf	500	4	2,000	
2062 Curb & Gutter	lf	120	9	1,080	
2063 Asphalt	sf	1200	2	2,400	
2064 Turf	ls	1	1,000	1,000	
2065 Fencing/Handrail	lf	400	25	10,000	
2070 Exterior Light Standards	ea	10	600	6,000	
2080 Interpretive Signs	ls	1	2,000	2,000	
3000 POWERHOUSE - STRUCTURAL					
3010 Aggregate Base	cy	200	40	8,000	
3020 Concrete					
3121 Structural	cy	900	450	405,000	
3122 Mass	cy	700	200	140,000	
3030 Trashrack (steel)	lb	18000	2	36,000	
3040 Equipment Installation					
3041 Turbine-Generator	ls	1	180,000	180,000	15% of procurement cost
3042 Gates	ls	1	13,000	13,000	25% of procurement cost
3043 Crane	ls	1	0		25% of procurement cost
3044 Trashrack Cleaner	ls	1	0		25% of procurement cost
3050 Superstructure	sf	900	70	63,000	See Note 1
3060 Sheetpile Cutoff Wall	sf	800	15	12,000	Similar to dam cutoff wall
4000 ELECTRICAL/MECHANICAL					
4010 Powerhouse Electrical/Mechanical	sf	900	27	24,300	
4020 Electrical Interconnect Installation	ls	1	18,000	18,000	25% of procurement cost
SUBTOTAL - CONSTRUCTION				1,152,000	
Mobilization/Demobilization	ls	1	115,000	115,000	10% construction (excluding equipment)
TOTAL - CONSTRUCTION				1,267,000	
TOTAL - EQUIPMENT				1,370,000	
Undeveloped Design Details	ls	1	264,000	264,000	10% construction + equipment.
SUBTOTAL				2,901,000	

TABLE 3-1. COST ESTIMATE - CONVENTIONAL INSTALLATION

NO. ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL COST	COMMENTS
10000 ENGINEERING & ADMINISTRATION					
10010	Engineering & Administration	ls	1	435,000	435,000 15% of subtotal.
10020	FERC Licensing	ls	1	100,000	100,000 Estimated.
10030 Subconsulting Services					
10031	Geotechnical Investigations	ls	1	5,000	5,000
10032	Surveying & Mapping	ls	1	8,000	8,000
TOTAL - ENGINEERING & ADMINISTRATION				548,000	
SUBTOTAL				3,185,000	
CONTINGENCY (10%)				319,000	
GRAND TOTAL				3,504,000	

1. 30' x 30' x 15', block & brick, steel roof support system, minimum architectural features.
2. Includes transformer, enclosure, pad, meter, circuit breaker, lightning arrestors, cable & conduit.
3. Includes design engineering, owner contract administration, owner's engineering, contractor administration, owner's field engineering.
4. Price based on bidding for Kankakee trashrack cleaning machines, 2000.

TABLE 3-2. COST ESTIMATE - GATE BAY INSTALLATION

NO. ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL COST	COMMENTS
1000 EQUIPMENT PROCUREMENT					
1010 Turbine-Generator Package	ls	1	1,200,000	1,200,000	Based on Alstom, VATECH, & GE
1020 Transformer Package	ea	1	70,000	70,000	See Note 2
1030 Upstream Gates	ea	0	50,000		N/A - Use tainter gate
1040 Powerhouse Crane	ea	0	10,000		6-ton crane
1050 Trashrack Cleaner	ea	0	120,000		See Note 4
1060 Control Gate System	ea	1	250,000	250,000	Obermeyer Quote
2000 SITEWORK					
2010 Relocations					
2011 Water Quality Station	ls	0	5,000		N/A
2012 Electrical Distribution	ls	0	5,000		N/A
2020 Site Preparation	ls	1	3,000	3,000	
2021 Security & Erosion Control	ls	1	3,000	3,000	
2022 Water Service	ls	1	2,000	2,000	
2023 Electrical Service	ls	1	2,000	2,000	
2024 Telecommunications Service	ls	1	1,000	1,000	
2030 Cofferdams/Dewatering					
2031 Install & Remove Piles	sf	0	23		N/A
2032 Dewatering Operations	day	0	150		N/A
2040 Demolition					
2041 Sheet Piling	sf	0	3		N/A
2042 Riprap	cy	0	10		N/A
2043 Concrete Retaining Wall	cy	0	60		N/A
2044 Curb & Gutter	lf	60	4	240	
2045 Asphalt/Sidewalk	sy	0	5		N/A
2046 Concrete Powerhouse Remains	cy	0	60		N/A
2047 Trees	ls	0	1,000		N/A
2050 Earthwork					
2051 Excavation	cy	0	4		N/A
2052 Backfill/Compact	cy	0	4		N/A
2053 Waste	cy	0	6		N/A
2054 Grading	sy	200	2	400	
2055 Riprap	cy	0	45		N/A
2060 Site Finishing					
2061 Sidewalk	sf	500	4	2,000	
2062 Curb & Gutter	lf	60	9	540	
2063 Asphalt	sf	1000	2	2,000	
2064 Turf	ls	1	500	500	
2065 Fencing/Handrail	lf	200	25	5,000	
2070 Exterior Light Standards	ea	5	600	3,000	
2080 Interpretive Signs	ls	1	2,000	2,000	
2100 NEW CONTROL GATE					
2110 Cofferdams/Dewatering					
2111 Upstream Sheetpile Wall System					
Steel	ton	12	2,000	24,000	
Divers	day	5	2,000	10,000	
Dredging	ls	1	2,000	2,000	
2112 Downstream Cofferdam (rock)	cy	250	40	10,000	
2113 Dewatering Operations	day	30	150	4,500	
2114 Barge	month	2	4,000	8,000	
2120 Demolition - Concrete	cy	100	60	6,000	
2130 New Concrete	cy	120	450	54,000	
2140 Riprap	cy	220	45	9,900	
2150 Install Gate	ls	1	38,000	38,000	15% of procurement cost
3000 POWERHOUSE - STRUCTURAL					
3010 Aggregate Base	cy	0	40		N/A
3020 Reinforced Concrete					
3021 Structural	cy	200	450	90,000	
3022 Mass	cy	820	200	164,000	
3030 Trashrack (steel)	lb	18000	2	36,000	
3040 Equipment Installation					
3041 Turbine-Generator	ls	1	180,000	180,000	15% of procurement cost
3042 Gates	ls	0	13,000		N/A - Use tainter gate
3043 Crane	ls	1	0		25% of procurement cost
3044 Trashrack Cleaner	ls	1	0		25% of procurement cost
3050 Superstructure	sf	900	70	63,000	See Note 1
3060 Sheetpile Cutoff Wall	sf	0	15		N/A
4000 ELECTRICAL/MECHANICAL					

TABLE 3-2. COST ESTIMATE - GATE BAY INSTALLATION

NO. ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL COST	COMMENTS
4010 Powerhouse Electrical/Mechanical	sf	900	27	24,300	See Note 1
4020 Electrical Interconnect Installation	ls	1	18,000	18,000	25% of procurement cost
SUBTOTAL - CONSTRUCTION				768,000	
Mobilization/Demobilization	ls	1	77,000	77,000	10% construction (excluding equipment)
TOTAL - CONSTRUCTION				845,000	
TOTAL - EQUIPMENT				1,520,000	
Undeveloped Design Details	ls	1	237,000	237,000	10% construction + equipment.
SUBTOTAL				2,602,000	
10000 ENGINEERING & ADMINISTRATION					
10010 Engineering & Administration	ls	1	355,000	355,000	15% construction + equipment. See Note 3
10020 FERC Licensing	ls	1	100,000	100,000	Estimated
10030 Subconsulting Services					
10031 Geotechnical Investigations	ls	1	5,000	5,000	
10032 Surveying & Mapping	ls	1	8,000	8,000	
TOTAL - ENGINEERING & ADMINISTRATION				468,000	
SUBTOTAL				2,833,000	
UNDEVELOPED DESIGN DETAILS (10%)				85,000	Apply to construction, not equipment
CONTINGENCY (10%)				283,000	
GRAND TOTAL				3,201,000	

1. 30' x 30' x 15' block & brick, steel roof support system, minimum architectural features.
2. Includes transformer, enclosure, pad, meter, circuit breaker, lightning arrestors, cable & conduit.
3. Includes design engineering, owner contract administration, owner's engineering, contractor administration, owner's field engineering.
4. Price based on bidding for Kankakee trashrack cleaning machines, 2000.

TABLE 3-3. COST ESTIMATE - UNCONVENTIONAL INSTALLATION

NO. ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL COST	COMMENTS
1000 EQUIPMENT PROCUREMENT					
1010 Turbine-Generator Package	ls	1	900,000	885,000	Turnkey, based on UEP
1020 Transformer Package	ea	1	70,000	70,000	See Note 2
1030 Upstream Gates	ea	0	50,000		N/A
1040 Powerhouse Crane	ea	0	10,000		N/A
1050 Trashrack Cleaner	ea	0	120,000		See Note 4
2000 SITEWORK					
2010 Relocations					
2011 Water Quality Station	ls	0	5,000		N/A
2012 Electrical Distribution	ls	0	5,000		N/A
2020 Site Preparation					
2021 Security & Erosion Control	ls	1	3,000	3,000	
2022 Water Service	ls	1	2,000	2,000	
2023 Electrical Service	ls	1	4,000	4,000	
2024 Telecommunications Service	ls	1	1,000	1,000	
2030 Cofferdams/Dewatering					
2031 Downstream Cofferdam (rock)	cy	200	40	8,000	N/A
2032 Dewatering Operations	day	30	150	4,500	
2040 Demolition					
2041 Sheet Piling	sf	0	3		N/A
2042 Riprap	cy	0	10		N/A
2043 Concrete Retaining Wall	cy	0	60		N/A
2044 Curb & Gutter	lf	0	4		N/A
2045 Asphalt/Sidewalk	sy	0	5		N/A
2046 Concrete Powerhouse Remains	cy	0	60		N/A
2047 Trees	ls	0	1,000		N/A
2050 Earthwork					
2051 Excavation	cy	0	4		N/A
2052 Backfill/Compact	cy	0	4		N/A
2053 Waste	cy	0	6		N/A
2054 Grading	sy	0	2		N/A
2055 Riprap	cy	50	45	2,250	
2060 Site Finishing					
2061 Sidewalk	sf	0	4		N/A
2062 Curb & Gutter	lf	0	9		N/A
2063 Asphalt	sf	0	2		N/A
2064 Turf	ls	0	1,000		N/A
2065 Fencing/Handrail	lf	100	25	2,500	
2070 Exterior Light Standards	ea	0	600		N/A
2080 Interpretive Signs	ls	1	2,000	2,000	
3000 POWERHOUSE - STRUCTURAL					
Included in Item 1010					
3010 Aggregate Base	cy	0	40		N/A
3020 Concrete					N/A
3121 Structural	cy	0	450		N/A
3122 Mass	cy	0	200		N/A
3030 Trashrack (steel)	lb	0	2		N/A
3040 Equipment Installation					
3041 Turbine-Generator	ls	0	135,000		N/A
3042 Gates	ls	0	13,000		N/A
3043 Crane	ls	0	0		N/A
3044 Trashrack Cleaner	ls	0	0		N/A
3045 Barge	month	2	4,000	8,000	
3046 Misc.					
3050 Superstructure	sf	0	70		N/A
3060 Sheetpile Cutoff Wall	sf	0	15		N/A
3070 Dredging	ls	1	2,000	2,000	
3080 Ice/Debris Barrier	ls	1	50,000	50,000	
4000 ELECTRICAL/MECHANICAL					
4010 Powerhouse Electrical/Mechanical	sf	0	27		N/A
4020 Control Center	ls	1	20,000	20,000	Located in City Hall

TABLE 3-3. COST ESTIMATE - UNCONVENTIONAL INSTALLATION

NO. ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL COST	COMMENTS
4030 Electrical Interconnect Installation	ls	1	18,000	18,000	25% of procurement cost
SUBTOTAL - CONSTRUCTION				127,000	
Mobilization/Demobilization	ls	1	0		Included in Item 1010
TOTAL - CONSTRUCTION				127,000	
TOTAL - EQUIPMENT				955,000	
Undeveloped Design Details	ls	1	216,000	216,000	20% construction + equipment
SUBTOTAL				1,298,000	
10000 ENGINEERING & ADMINISTRATION					
10010 Engineering & Administration	ls	1	195,000	195,000	5% of subtotal, see Note 5
10020 FERC Licensing	ls	1	100,000	100,000	Estimated
10030 Subconsulting Services					
10031 Geotechnical Investigations	ls	1	5,000	5,000	
10032 Surveying & Mapping	ls	1	8,000	8,000	
TOTAL - ENGINEERING & ADMINISTRATION				308,000	
SUBTOTAL				1,390,000	
CONTINGENCY (10%)				139,000	
GRAND TOTAL				1,529,000	

1. N/A.
2. Includes transformer, enclosure, pad, meter, circuit breaker, lightning arrestors, cable & conduit.
3. Includes design engineering, owner contract administration, owner's engineering, contractor administration, owner's field engineering.
4. Price based on bidding for Kankakee trashrack cleaning machines, 2000.
5. Design engineering included in Item 1010.

Operations & Maintenance Costs

Normal operation requirements for the plant will include a daily visual inspection of the plant and monitoring data and weekly visual inspections of bearing oil levels, hydraulic pressure unit oil level, speed increaser oil level, seal systems, etc. On an annual basis, the plant will be shut down for approximately one week to perform a more comprehensive inspection of plant systems and to change/filter oil, replace packing, etc.

Annual operation, maintenance, and replacement costs for the facility are anticipated to be on the order of \$35,000. This is based on a 600 kW installed capacity and data compiled by Tudor Engineering Company (Tudor 1978), escalated to 2003.

Available Funding

Xcel Energy Renewable Energy Fund

Xcel Energy funds renewable energy research and renewable energy production projects through its Renewable Development Fund. The fund was created in May 1999 in accordance with a 1994 Minnesota law relating to storage of spent nuclear fuel. In 2001, \$16 million was awarded, \$5.1 million to Crown Hydro for the development of the 3.2 MW Crown Hydroelectric Project on the Mississippi River in Minneapolis.

Power is not required to be sold to Xcel Energy. However, Xcel retains a right of first refusal to purchase any or all electricity available for sale that is generated by funded projects. Xcel indicates that the earliest that funding would be available for projects that require a power purchase agreement would be after the PPA is signed. The earliest that funding would be available for project not selling electricity would be after substantial down payment for electrical equipment.

Funding through Xcel may be available from either the "production" or the "research" categories. The former would apply if a conventional hydroelectric station were constructed whereas the latter may apply if the unconventional technology is constructed as a research/demonstration project.

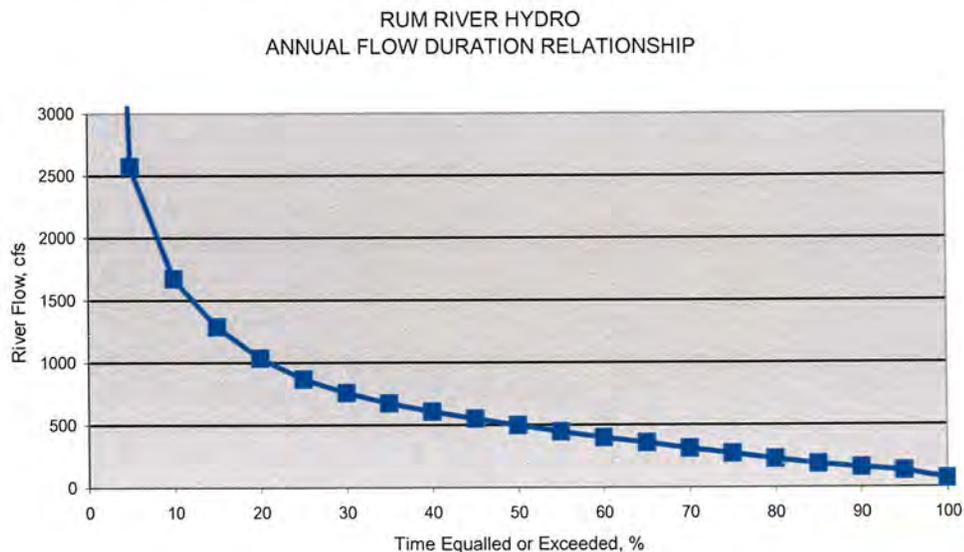
Renewable Energy Credit

The State of Minnesota offers an incentive of \$0.015/kWh for certain hydroelectric facilities that began generating after July 1, 1994 and before December 31, 2005. Qualifying projects will receive payments for ten years. Payments will be made until new wind capacity totals 100 MW statewide.

Energy

Energy Generation

Annual energy generation was estimated using a flow duration type analysis with streamflow data from the USGS gage located in St. Francis. Drainage areas at the gage and at the dam site are 1360 square miles and 1590 square miles respectively. Streamflow at the dam was estimated using the ratio of the drainage areas ($1590/1360 = 1.17$)². The resulting annual flow duration relationship is shown below.



² Metropolitan Council Environmental Services (MCES) has maintained a water quality gage at the dam site since 1996. MCES has attempted several methods of computing streamflow at the dam. MCES computed streamflow data was reviewed and found to significantly overestimate the flow at the dam.

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A minimum flow of 100 cfs is assumed to be required to be passed over the spillway at all times. This minimum flow may be required a) to maintain aquatic habitat immediately downstream of the dam, and/or b) to maintain the aesthetics of the water over the spillway (especially at night when the dam is illuminated). The 100 cfs spillway flow equates to approximately 3 inches of water over the spillway.

Tailwater elevations were obtained using the relationship developed by SAFHL. As a check, this tailwater relationship was compared to computed water surface elevations of the Mississippi River in Anoka. The Mississippi River elevations were computed using the HEC-2 backwater analysis program. The comparison shows that Rum River Dam tailwater elevations are above Mississippi River elevations by an average of about one foot for summer river flows.

Headwater elevation was based on the amount of water being passed over the spillway and the headwater relationship presented in the dam's Operation and Maintenance Manual. Headwater elevation was limited to 845.0 per the O&M. The O&M manual states that once the pool reaches 845.0, the tainter gate is to be opened and operated as required to maintain the pool at 845.0.

Maximum turbine flow was taken as 700 cfs, which is based upon information provided by manufacturers. Turbine efficiencies for the conventional installation were computed based upon historic adjustable blade turbine performance (USBOR 1976). Turbine efficiencies for the unconventional (cross flow) turbine were based upon manufacturer provided data.

As noted earlier, the flashboards on the dam crest are removed every fall and re-installed every spring. The energy computation was therefore divided into "summer" and "winter" periods in order to determine the effect that permanent flashboards might have on energy generation. "Summer" is the period between May 1 and October 31 and "winter" is between November 1 and April 30.

Detailed results are included in Appendix B. A summary is provided in Table 4-1 below. As shown in the table, it is expected that a nominal 550 kW hydro plant will generate about 2,290 MWh per year and the unconventional UEP system will generate about 900 MWh. Maintaining flashboards over the winter results in an additional 260 MWh for the conventional configuration and 140 MWh for the unconventional configuration. These annual generation estimates include a 5 percent reduction from gross production for scheduled outages, etc.

The significant reduction in generation of the unconventional UEP unit due to lower available net head and the fact that the unit is an "impulse type" unit and subject to operation limitations due to "flooding" from tailwater back pressure.

Table 4-1 Capacity & Energy Summary

Time Period	Conventional		Unconventional	
	Capacity (kW)	Energy (MWh)	Capacity (kW)	Energy (MWh)
Annual	--	2,290	--	900
Summer	--	1,450	--	560
Winter	--	840	--	340
Winter*	--	1,100	--	480
January	400	90	300	60
February	390	80	240	50
March	410	140	300	60
April	480	250	300	30
May	550	330	420	80
June	550	290	420	90
July	550	250	420	110
August	550	200	420	110
September	550	190	420	100
October	550	190	350	70
November	400	160	300	70
December	400	120	300	70

*With flashboards in place.

Energy Revenue

Determination of energy revenue and life cycle economic evaluation is not within the scope of this study. It is understood that the value of capacity and energy as they relate to the Minnesota Municipal Power Agency (MMPA) system is being investigated by the MMPA.

Section 5

Regulatory Issues

Minnesota Department of Natural Resources

According to the Minnesota DNR Dam Safety Unit, the Rum River Dam does not require an operating permit unless a change is proposed for its normal, historic operation. Development of hydropower would certainly require a DNR permit. This process could coincide with the FERC licensing process, which is described later in this report.

City of Anoka

City staff indicate that local ordinance exist stipulating requirements of setbacks from the river. The project would require modification of these ordinances or a special permit, etc.

State of Minnesota

The State of Minnesota requires that utilities make a good faith effort to provide 1 percent of their generation by renewable resources by the year 2005, incrementally increasing to 10 percent by 2015.

Federal Energy Regulatory Commission

An application for Preliminary Permit was filed with the Federal Energy Regulatory Commission (FERC) on October 16, 2002.

Non-Federal hydroelectric power plants are regulated by the FERC. Larger projects are issued "licenses." Smaller projects (5 MW or less) are eligible for "exemptions." The process for obtaining an exemption is basically the same as that required to obtain a license. The process involves three stages of consultation to promote coordination with the public and the various resource agencies involved in the project review. Two basic processes are available to applicants for exemptions – the "traditional process" and the "alternative process." The traditional process basically involves consultation with resource agencies, studies, and preparation of an exemption application. FERC then performs National Environmental Policy Act (NEPA) compliance

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measures including public comment solicitation, preparation of an Environmental Assessment (EA) and finally, issuance of the exemption. The alternative process basically involves overlap of agency consultation and the NEPA process and facilitates greater participation from the public and resource agencies. The applicant prepares the EA and includes it in the final exemption application. FERC then processes the exemption. The FERC is presently attempting to streamline the licensing process but implementation of streamlining measures may not occur until late 2003.

Every licensing process is different and hybrids of the traditional and/or alternative processes are certainly possible. The schedule presented in this report represents the traditional process.

In order to facilitate bringing the plant on line by December 2005, an aggressive development schedule must be undertaken. Should the City desire to pursue hydro development, meetings should be held with resource agencies early on in order to determine their desired environmental studies and operational characteristics. If it is determined that environmental requirements are manageable, a decision on licensing strategies can be made. The alternative process may prove to be more timely since the environmental report would be completed coincident with the exemption application.

It is expected that regulatory agencies that will have an interest in commenting on hydropower development on the Rum River may include the following:

- MN DNR (Dam Safety, Fisheries, Waters, Parks & Recreation)
- MN State Historic Preservation Office
- MN Pollution Control Agency
- US DOI National Park Service
- US Fish & Wildlife Service
- US Army Corps of Engineers
- US Environmental Protection Agency

Of special interest may be the recreational interests of the project since portions of the Rum River in the project area are classified by the Minnesota Department of Natural Resources as "recreational" and "scenic" river segments.

Development Schedule

A conceptual development schedule is presented on Figure 8. The schedule presents the “traditional” FERC exemption process and a “Design-Bid-Build” construction process for a “conventional” hydroelectric installation at the Rum River Dam. Long duration tasks in the development schedule include the FERC exemption process and major equipment procurement.

As shown by the schedule, it is anticipated that hydropower could be put on line by late 2005. This is however an aggressive schedule and highly dependent upon environmental aspects of the FERC exemption process. As discussed in Section 5, the alternative process may prove to be more timely since the environmental report would be completed coincident with the exemption application. Additional timesavings could be realized by contracting via a “Water to Wire” type EPC contract.

Conclusions and Recommendations

Conclusions

1. The State of Minnesota requires that utilities make a good faith effort to provide 1 percent of their generation by renewable resources by the year 2005, incrementally increasing to 10 percent by 2015. Hydropower development at the Rum River Dam qualifies as a renewable resource.
2. A conventional, 550 kW hydropower installation can be developed for approximately \$3.5 million and will generate approximately 2,290 MWh of electricity per year. If it can be shown through hydrologic and hydraulic studies, that the design discharge of the dam can be accommodated by the uncontrolled spillway alone, without the tainter gate; the 550 kW plant could be constructed within the tainter gate spillway for approximately \$2.6 million.
3. An unconventional, 420 kW hydropower installation can be developed for approximately \$1.5 million and will generate approximately 900 MWh of electricity per year.
4. Development and research incentives for hydropower are available from Xcel Energy. In 2001, \$5 million was awarded to a hydropower project in Minneapolis.
5. The State of Minnesota offers a \$0.015/kWh generation incentive for hydropower for projects brought on line before 2006.
6. Life cycle economic analysis of a hydroelectric power installation at the Rum River Dam site is currently being investigated by MMPA.

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Recommendations

1. MMPA should investigate the value of the hydropower generation at the Rum River site with respect to its generation mix and potential energy and capacity revenues.
2. The City of Anoka should consider pursuing development assistance from Xcel Energy.
3. If after completion of Items 1 and 2 above, hydropower remains desirable, the City should perform additional investigations to determine the most beneficial development scenario.

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Section 8

References

1. University of Minnesota St. Anthony Falls Hydraulic Laboratory. 1982. *Hydropower Feasibility at the Rum River Dam in Anoka, Minnesota.*
2. Tudor Engineering Company/Water and Power Resources Service – U.S. Department of Interior. 1980. *Reconnaissance Evaluation of Small, Low-Head Hydroelectric Installations.*
3. United States Department of the Interior Bureau of Reclamation. 1976. *Engineering Monograph No. 20 – Selecting Hydraulic Reaction Turbines.*

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Appendix A

Figures



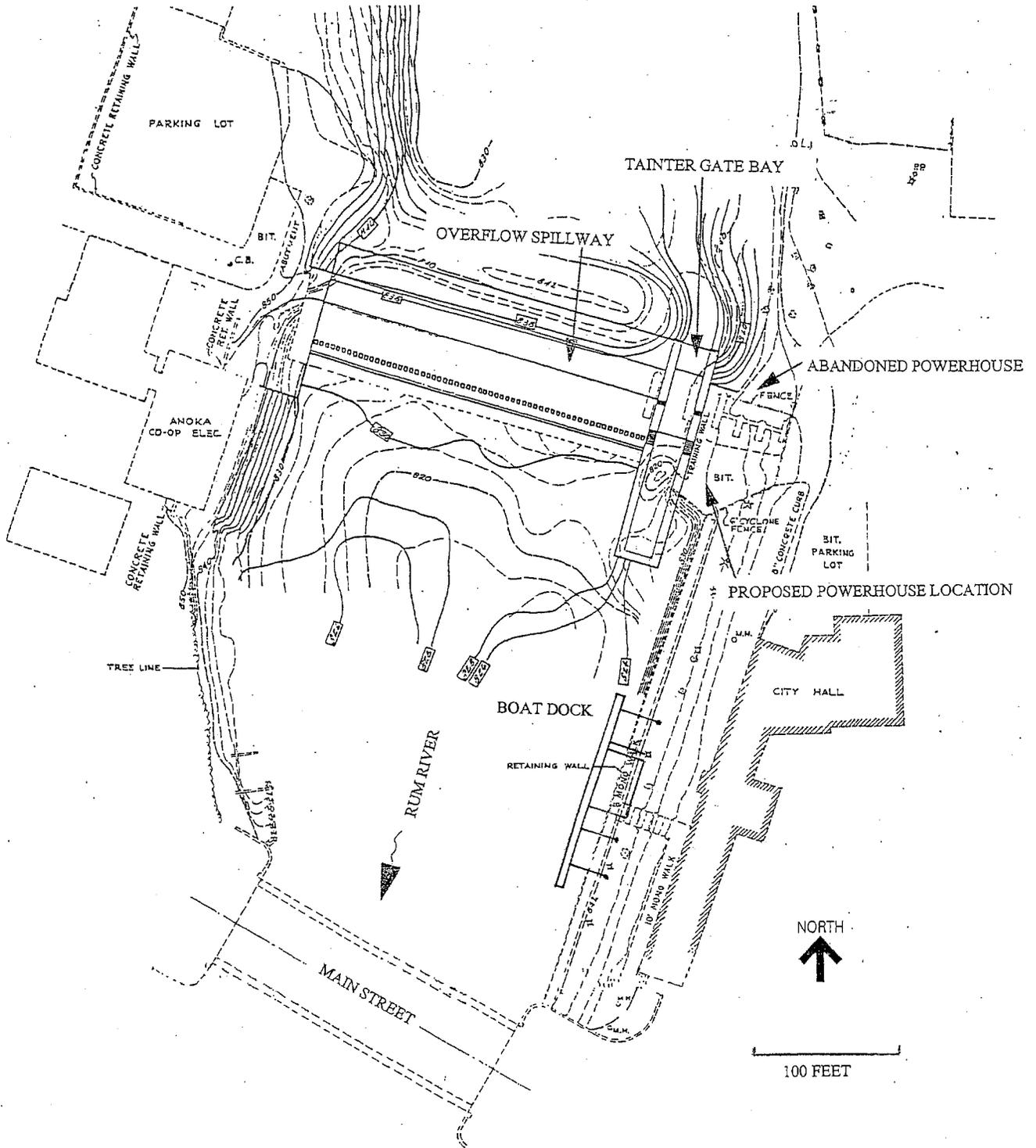
PROJECT MAP

FIGURE 1

2000'



Stanley Consultants INC.



SITE PLAN
FIGURE 2

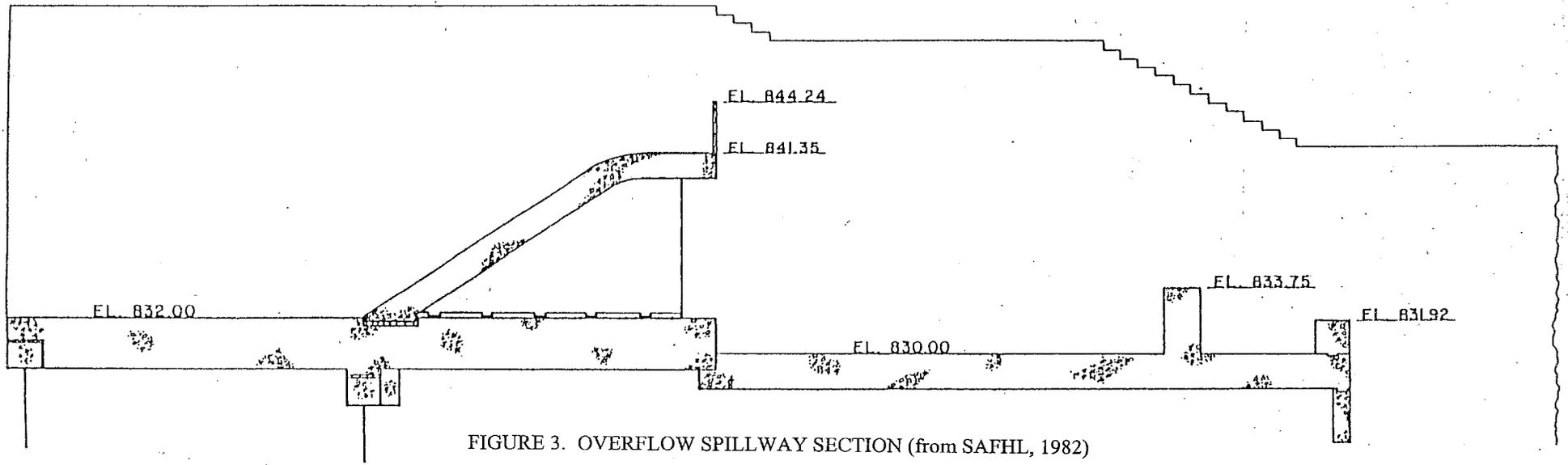


FIGURE 3. OVERFLOW SPILLWAY SECTION (from SAFHL, 1982)

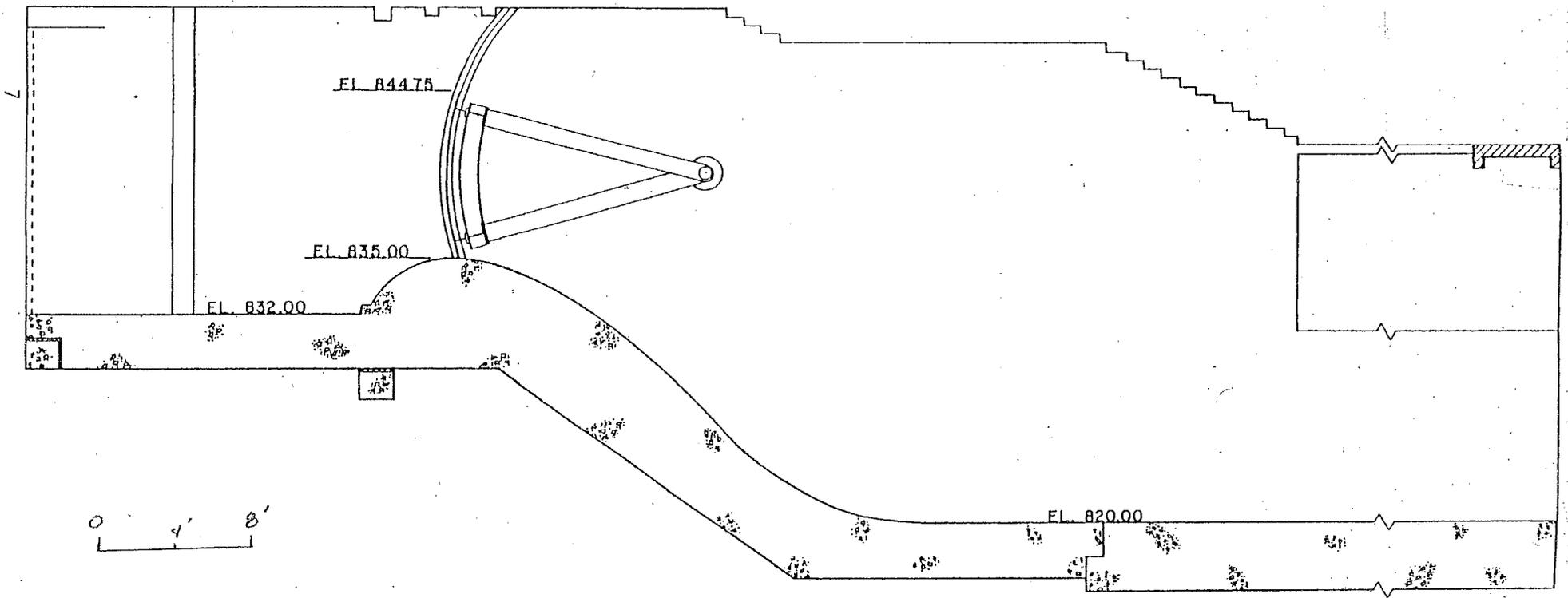


FIGURE 4. TAINTER GATE BAY SECTION (from SAFHL, 1982)

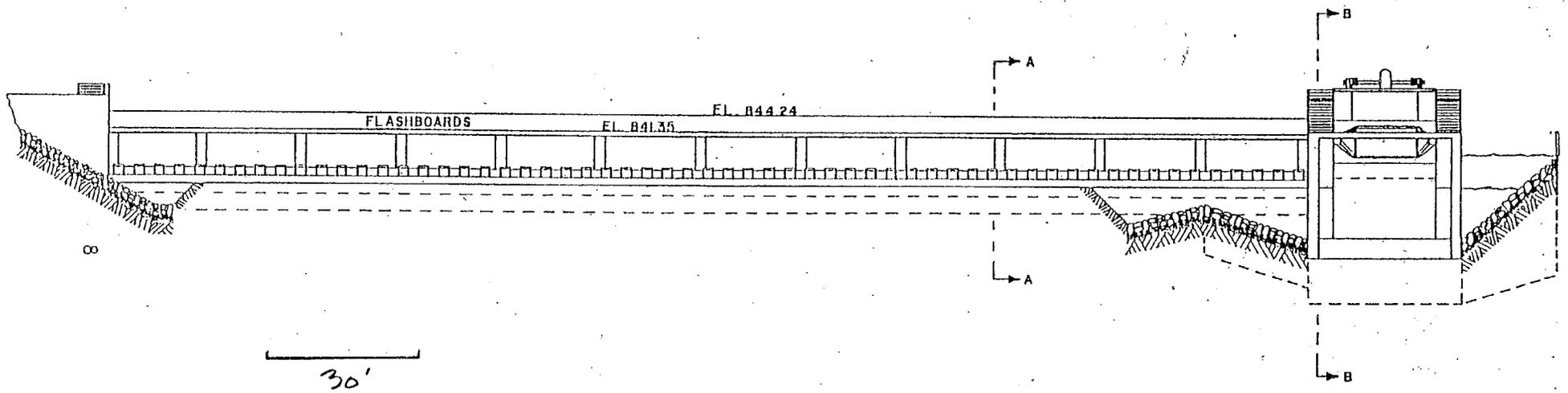


FIGURE 5. ELEVATION VIEW OF DAM (from SAFHL, 1982)

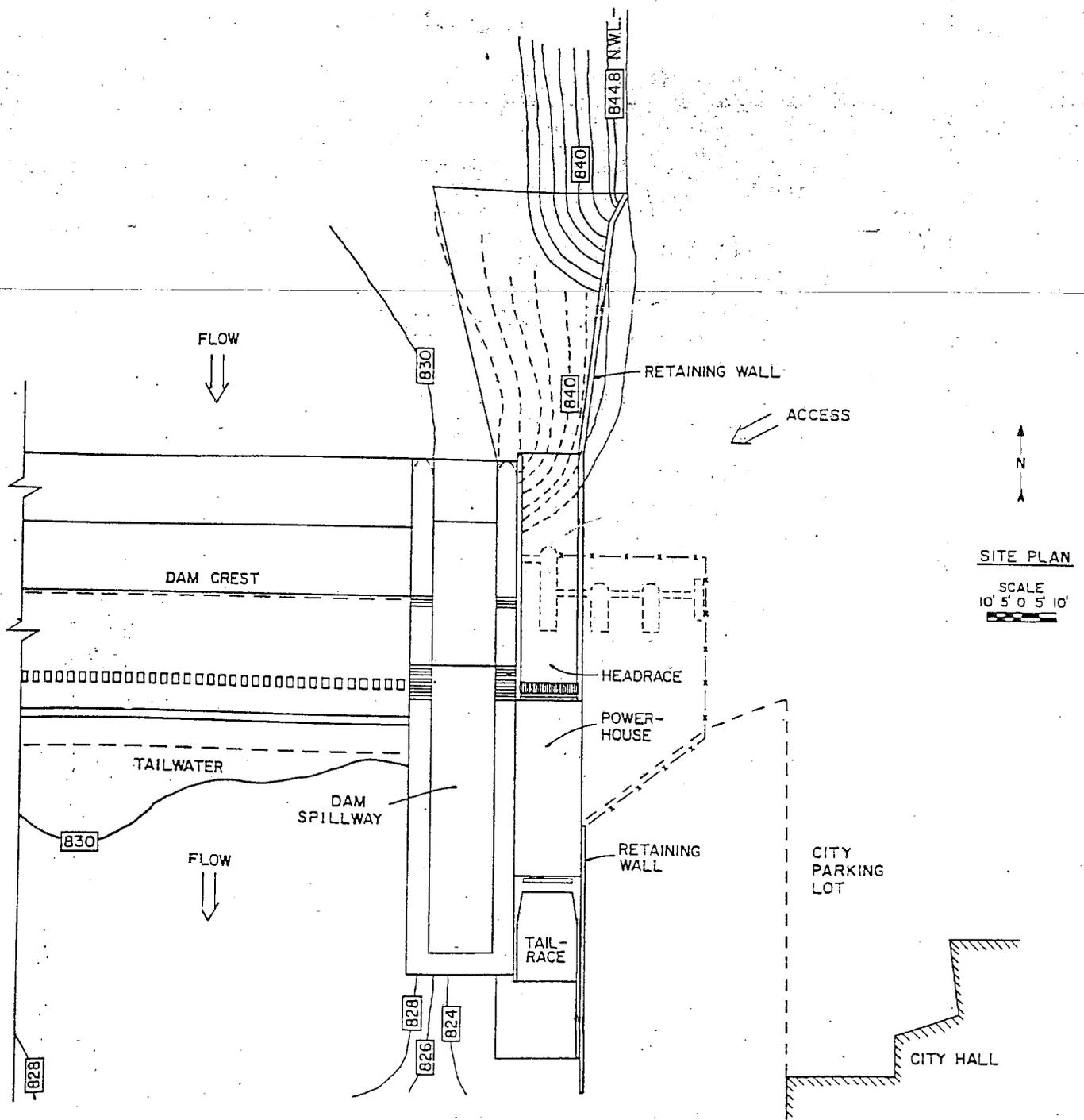
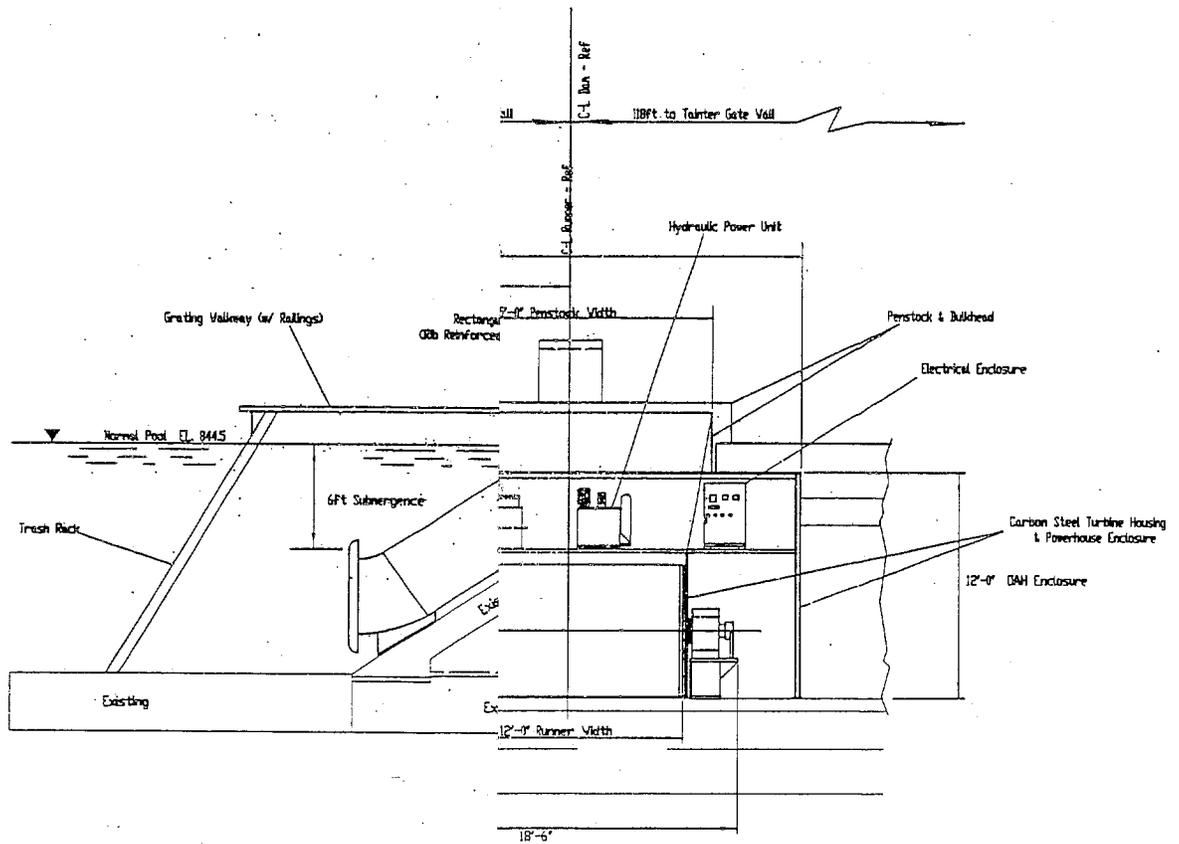


FIGURE 6. CONVENTIONAL POWERHOUSE ARRANGEMENT PLAN (from SAFHL, 1982)



LOOKING UPSTREAM

GENERAL ARRANGEMENT DRAWING
PRELIMINARY DIMENSIONAL LAYOUT

Submitted to: City of Anoka, Minnesota
Run River Hydroelectric Project
EST: 550kW @ 650cfs and 12.5' Head

FIGURE 7. UEP POWERHOUSE ARRANGEMENT

ID	Task Name	Duration	Start	Finish	5											
					Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	FERC PROCESS	543 days	9/11/02	10/8/04	[Gantt bar from Sep 2002 to Oct 2004]											
2	Preliminary Permit	15 wks	9/11/02	12/24/02	[Gantt bar from Sep 2002 to Dec 2002]											
3	Initial Consultation Package	105 days	2/17/03	7/11/03	[Gantt bar from Feb 2003 to Jul 2003]											
4	Prepare	4 wks	2/17/03	3/14/03	[Gantt bar from Feb 2003 to Mar 2003]											
5	Submit to Agencies	0 days	3/14/03	3/14/03	[Gantt bar from Mar 2003 to Mar 2003]											
6	Joint Meeting	0 days	5/9/03	5/9/03	[Gantt bar from May 2003 to May 2003]											
7	Comment Period	9 wks	5/12/03	7/11/03	[Gantt bar from May 2003 to Jul 2003]											
8	Study Execution	26 wks	7/14/03	1/9/04	[Gantt bar from Jul 2003 to Jan 2004]											
9	Draft Application	85 days	12/1/03	3/26/04	[Gantt bar from Dec 2003 to Mar 2004]											
10	Prepare	4 wks	12/1/03	12/26/03	[Gantt bar from Dec 2003 to Dec 2003]											
11	Submit to Agencies	0 days	12/26/03	12/26/03	[Gantt bar from Dec 2003 to Dec 2003]											
12	Comment Period	13 wks	12/29/03	3/26/04	[Gantt bar from Dec 2003 to Mar 2004]											
13	Final Application	20 days	3/29/04	4/23/04	[Gantt bar from Mar 2004 to Apr 2004]											
14	Prepare	4 wks	3/29/04	4/23/04	[Gantt bar from Mar 2004 to Apr 2004]											
15	Submit to FERC	0 days	4/23/04	4/23/04	[Gantt bar from Apr 2004 to Apr 2004]											
16	FERC Activities	120 days	4/26/04	10/8/04	[Gantt bar from Apr 2004 to Oct 2004]											
17	NEPA Compliance, etc.	24 wks	4/26/04	10/8/04	[Gantt bar from Apr 2004 to Oct 2004]											
18	Exemption Issued	0 days	10/8/04	10/8/04	[Gantt bar from Oct 2004 to Oct 2004]											
19	ENGINEERING	620 days	10/28/02	3/11/05	[Gantt bar from Oct 2002 to Mar 2005]											
20	Reconnaissance Study	50 days	10/28/02	1/3/03	[Gantt bar from Oct 2002 to Jan 2003]											
21	Study	8 wks	10/28/02	12/20/02	[Gantt bar from Oct 2002 to Dec 2002]											
22	City/MMPA Review	2 wks	12/23/02	1/3/03	[Gantt bar from Dec 2002 to Jan 2003]											
23	Feasibility Study	30 days	1/6/03	2/14/03	[Gantt bar from Jan 2003 to Feb 2003]											
24	Study	4 wks	1/6/03	1/31/03	[Gantt bar from Jan 2003 to Feb 2003]											
25	City/MMPA Review	2 wks	2/3/03	2/14/03	[Gantt bar from Feb 2003 to Feb 2003]											
26	Preliminary Engineering	15 wks	7/14/03	10/24/03	[Gantt bar from Jul 2003 to Oct 2003]											
27	Procurement Package	70 days	6/7/04	9/10/04	[Gantt bar from Jun 2004 to Sep 2004]											
28	Prepare	4 wks	6/7/04	7/2/04	[Gantt bar from Jun 2004 to Jun 2004]											
29	Bidding Period	6 wks	7/5/04	8/13/04	[Gantt bar from Jul 2004 to Aug 2004]											
30	Evaluation/Award	4 wks	8/16/04	9/10/04	[Gantt bar from Aug 2004 to Sep 2004]											
31	General Construction Package	110 days	10/11/04	3/11/05	[Gantt bar from Oct 2004 to Mar 2005]											
32	Prepare	12 wks	10/11/04	12/31/04	[Gantt bar from Oct 2004 to Dec 2004]											
33	Bidding Period	6 wks	1/3/05	2/11/05	[Gantt bar from Jan 2005 to Feb 2005]											
34	Evaluation/Award	4 wks	2/14/05	3/11/05	[Gantt bar from Feb 2005 to Mar 2005]											
35	TURBINE PROCUREMENT	220 days	9/13/04	7/15/05	[Gantt bar from Sep 2004 to Jul 2005]											
36	Shop Drawings	4 wks	9/13/04	10/8/04	[Gantt bar from Sep 2004 to Sep 2004]											
37	Manufacture	40 wks	10/11/04	7/15/05	[Gantt bar from Oct 2004 to Jul 2005]											
38	GENERAL CONSTRUCTION	210 days	3/14/05	12/30/05	[Gantt bar from Mar 2005 to Dec 2005]											
39	Mobilize	2 wks	3/14/05	3/25/05	[Gantt bar from Mar 2005 to Mar 2005]											
40	Cofferdams	2 wks	3/28/05	4/8/05	[Gantt bar from Mar 2005 to Mar 2005]											
41	Civil/Structural Work - 1	12 wks	4/11/05	7/1/05	[Gantt bar from Apr 2005 to Jun 2005]											
42	Turbine Installation	6 wks	7/18/05	8/26/05	[Gantt bar from Jul 2005 to Aug 2005]											
43	Civil/Structural Work - 2	8 wks	8/29/05	10/21/05	[Gantt bar from Sep 2005 to Nov 2005]											
44	Electrical/Controls Work	6 wks	10/24/05	12/2/05	[Gantt bar from Oct 2005 to Nov 2005]											
45	Remove Cofferdams	2 wks	12/5/05	12/16/05	[Gantt bar from Dec 2005 to Dec 2005]											
46	Commissioning/Testing	2 wks	12/19/05	12/30/05	[Gantt bar from Dec 2005 to Dec 2005]											
47	PROJECT OPERATIONAL	0 days	12/30/05	12/30/05	[Gantt bar from Dec 2005 to Dec 2005]											

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Appendix B

Energy Computations

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q = 100 cfs
 Min Powerhouse Q = 175 cfs
 Max Powerhouse Q = 700 cfs
 Rated Hnet = 12 ft
 Headloss Factor = 5.0 % Hnet

Speed Inverter Efficiency = 97 %
 Generator Efficiency = 98 %
 Transformer Efficiency = 99 %

January Energy Generation (Flashboards Down)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	842	100	742	700	142	832.6	841.6	9.0	0.4	8.5	505	100.0	71.0	84.2	400	-
5	620	100	520	520	100	832.1	841.5	9.4	0.5	8.9	391	74.3	74.1	89.2	328	13,555
10	585	100	485	485	100	832.1	841.5	9.4	0.5	8.9	368	69.3	74.6	89.7	310	11,883
15	527	100	427	427	100	832.0	841.5	9.5	0.5	9.1	328	61.0	75.5	90.6	280	10,974
20	456	100	356	356	100	831.7	841.5	9.8	0.5	9.3	280	50.9	77.3	90.2	237	9,612
25	433	100	333	333	100	831.6	841.5	9.9	0.5	9.4	264	47.6	78.0	90.0	223	8,568
30	410	100	310	310	100	831.6	841.5	9.9	0.5	9.4	248	44.3	78.7	89.7	209	8,048
35	388	100	288	288	100	831.5	841.5	10.0	0.5	9.5	232	41.1	79.3	89.5	196	7,532
40	360	100	260	260	100	831.4	841.5	10.1	0.5	9.6	212	37.1	80.2	88.0	175	6,902
45	316	100	216	216	100	831.2	841.5	10.3	0.5	9.8	179	30.9	81.5	84.8	143	5,919
50	293	100	193	193	100	831.1	841.5	10.4	0.5	9.9	161	27.6	82.2	83.1	126	4,999
55	246	100	146	0	246	830.9	841.7	10.8	0.5	10.2	0	0.0	85.3	0.0	0	2,344
60	214	100	114	0	214	830.8	841.7	10.8	0.5	10.3	0	0.0	85.9	0.0	0	-
65	193	100	93	0	193	830.7	841.6	10.9	0.5	10.4	0	0.0	86.3	0.0	0	-
70	166	100	66	0	166	830.6	841.6	11.0	0.5	10.4	0	0.0	86.8	0.0	0	-
75	158	100	58	0	158	830.6	841.6	11.0	0.5	10.4	0	0.0	86.9	0.0	0	-
80	144	100	44	0	144	830.5	841.6	11.0	0.6	10.5	0	0.0	87.2	0.0	0	-
85	132	100	32	0	132	830.5	841.5	11.0	0.6	10.5	0	0.0	87.4	0.0	0	-
90	128	100	28	0	128	830.5	841.5	11.1	0.6	10.5	0	0.0	87.5	0.0	0	-
95	109	100	9	0	109	830.4	841.5	11.1	0.6	10.5	0	0.0	87.8	0.0	0	-
100	82	82	0	0	82	830.3	841.5	11.2	0.6	10.6	0	0.0	88.3	0.0	0	-
400																
90,337																

February Energy Generation (Flashboards Down)

Gross Time = 28 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	1977	100	1877	700	1277	834.0	842.7	8.7	0.4	8.3	491	100.0	69.1	83.8	388	-
5	679	100	579	579	100	832.3	841.5	9.2	0.5	8.8	430	82.7	73.1	88.0	356	13,835
10	591	100	491	491	100	832.1	841.5	9.4	0.5	8.9	372	70.1	74.5	89.6	314	12,457
15	515	100	415	415	100	831.9	841.5	9.6	0.5	9.1	319	59.3	75.7	90.7	273	10,902
20	468	100	368	368	100	831.8	841.5	9.7	0.5	9.2	288	52.6	76.9	90.3	244	9,615
25	433	100	333	333	100	831.6	841.5	9.9	0.5	9.4	264	47.6	78.0	90.0	223	8,701
30	410	100	310	310	100	831.6	841.5	9.9	0.5	9.4	248	44.3	78.7	89.7	209	8,048
35	372	100	272	272	100	831.4	841.5	10.1	0.5	9.6	221	38.9	79.8	88.9	185	7,326
40	351	100	251	251	100	831.3	841.5	10.2	0.5	9.7	205	35.9	80.5	87.4	169	6,570
45	328	100	228	228	100	831.2	841.5	10.2	0.5	9.7	188	32.6	81.1	85.7	152	5,957
50	275	100	175	0	275	831.0	841.8	10.7	0.5	10.2	0	0.0	84.8	0.0	0	2,819
55	223	100	123	0	223	830.8	841.7	10.8	0.5	10.3	0	0.0	85.7	0.0	0	-
60	200	100	100	0	200	830.8	841.6	10.9	0.5	10.3	0	0.0	86.1	0.0	0	-
65	178	100	78	0	178	830.7	841.6	10.9	0.5	10.4	0	0.0	86.6	0.0	0	-
70	158	100	58	0	158	830.6	841.6	11.0	0.5	10.4	0	0.0	86.9	0.0	0	-
75	151	100	51	0	151	830.6	841.6	11.0	0.5	10.4	0	0.0	87.1	0.0	0	-
80	146	100	46	0	146	830.6	841.6	11.0	0.6	10.5	0	0.0	87.1	0.0	0	-
85	135	100	35	0	135	830.5	841.5	11.0	0.6	10.5	0	0.0	87.4	0.0	0	-
90	125	100	25	0	125	830.5	841.5	11.1	0.6	10.5	0	0.0	87.5	0.0	0	-
95	111	100	11	0	111	830.4	841.5	11.1	0.6	10.5	0	0.0	87.8	0.0	0	-
100	83	83	0	0	83	830.3	841.5	11.2	0.6	10.6	0	0.0	88.3	0.0	0	-
388																
86,231																

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q = 100 cfs
 Min Powerhouse Q = 175 cfs
 Max Powerhouse Q = 700 cfs
 Rated Hnet = 12 ft
 Headloss Factor = 5.0 % Hnet

Speed Inverter Efficiency = 97 %
 Generator Efficiency = 98 %
 Transformer Efficiency = 99 %

March Energy Generation (Flashboards Down)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	6891	100	6791	700	6191	835.8	845.0	9.2	0.5	8.7	518	100.0	72.8	84.6	412	-
5	2960	100	2860	700	2260	835.1	843.3	8.3	0.4	7.9	466	100.0	65.6	83.1	365	14,452
10	1895	100	1795	700	1195	833.9	842.7	8.7	0.4	8.3	492	100.0	69.1	83.8	388	14,000
15	1287	100	1187	700	587	833.3	842.2	8.9	0.4	8.4	498	100.0	70.1	84.0	394	14,548
20	995	100	895	700	295	832.9	841.8	8.9	0.4	8.4	501	100.0	70.4	84.1	396	14,699
25	821	100	721	700	121	832.5	841.5	9.0	0.4	8.5	506	100.0	71.1	84.2	401	14,826
30	702	100	602	602	100	832.3	841.5	9.2	0.5	8.7	445	86.0	72.8	87.3	366	14,258
35	620	100	520	520	100	832.1	841.5	9.4	0.5	8.9	391	74.3	74.1	89.2	328	12,907
40	550	100	450	450	100	832.0	841.5	9.5	0.5	9.0	344	64.3	75.2	90.3	292	11,539
45	483	100	383	383	100	831.8	841.5	9.7	0.5	9.2	298	54.7	76.5	90.4	253	10,141
50	421	100	321	321	100	831.6	841.5	9.9	0.5	9.4	256	45.9	78.3	89.9	216	8,729
55	377	100	277	277	100	831.4	841.5	10.1	0.5	9.6	224	39.6	79.7	89.2	188	7,522
60	357	100	257	257	100	831.4	841.5	10.1	0.5	9.6	210	36.7	80.3	87.8	173	6,725
65	303	100	203	203	100	831.2	841.5	10.3	0.5	9.8	169	29.0	81.9	83.8	133	5,700
70	262	100	162	0	262	831.0	841.7	10.7	0.5	10.2	0	0.0	85.0	0.0	0	2,478
75	208	100	108	0	208	830.8	841.7	10.9	0.5	10.3	0	0.0	86.0	0.0	0	-
80	190	100	90	0	190	830.7	841.6	10.9	0.5	10.4	0	0.0	86.3	0.0	0	-
85	170	100	70	0	170	830.6	841.6	11.0	0.5	10.4	0	0.0	86.7	0.0	0	-
90	160	100	60	0	160	830.6	841.6	11.0	0.5	10.4	0	0.0	86.9	0.0	0	-
95	137	100	37	0	137	830.5	841.6	11.0	0.6	10.5	0	0.0	87.3	0.0	0	-
100	89	89	0	0	89	830.3	841.5	11.1	0.6	10.6	0	0.0	88.2	0.0	0	-
															412	152,525

April Energy Generation (Flashboards Down)

Gross Time = 30 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	11700	100	11600	700	11000	835.8	846.2	10.4	0.5	9.9	586	100.0	82.3	86.4	476	-
5	5885	100	5785	700	5185	835.8	844.8	9.0	0.5	8.6	508	100.0	71.4	84.3	403	16,346
10	4107	100	4007	700	3407	835.8	844.0	8.2	0.4	7.8	460	100.0	64.7	82.9	359	14,174
15	3299	100	3199	700	2599	835.4	843.5	8.1	0.4	7.7	458	100.0	64.4	82.9	357	13,327
20	2831	100	2731	700	2131	834.9	843.3	8.3	0.4	7.9	469	100.0	66.0	83.2	367	13,482
25	2527	100	2427	700	1827	834.6	843.1	8.5	0.4	8.0	476	100.0	66.9	83.4	373	13,781
30	2235	100	2135	700	1535	834.3	842.9	8.6	0.4	8.2	485	100.0	68.2	83.6	382	14,044
35	1989	100	1889	700	1289	834.0	842.7	8.7	0.4	8.3	491	100.0	69.1	83.8	388	14,307
40	1790	100	1690	700	1090	833.8	842.6	8.7	0.4	8.3	492	100.0	69.2	83.8	389	14,435
45	1626	100	1526	700	926	833.7	842.4	8.7	0.4	8.3	492	100.0	69.2	83.8	389	14,453
50	1451	100	1351	700	751	833.5	842.3	8.8	0.4	8.3	494	100.0	69.4	83.9	390	14,473
55	1334	100	1234	700	634	833.4	842.2	8.8	0.4	8.4	497	100.0	69.9	84.0	393	14,553
60	1205	100	1105	700	505	833.2	842.1	8.9	0.4	8.5	501	100.0	70.4	84.1	396	14,681
65	1040	100	940	700	340	833.0	841.8	8.9	0.4	8.4	501	100.0	70.4	84.1	396	14,741
70	916	100	816	700	216	832.7	841.7	8.9	0.4	8.5	503	100.0	70.7	84.1	398	14,776
75	804	100	704	700	104	832.5	841.5	9.0	0.4	8.5	506	100.0	71.2	84.2	401	14,877
80	715	100	615	615	100	832.3	841.5	9.2	0.5	8.7	453	87.9	72.6	86.9	371	14,363
85	631	100	531	531	100	832.2	841.5	9.3	0.5	8.9	399	75.9	73.9	89.0	334	13,105
90	476	100	376	376	100	831.8	841.5	9.7	0.5	9.2	293	53.7	76.7	90.3	249	10,843
95	316	100	216	216	100	831.2	841.5	10.3	0.5	9.8	179	30.9	81.5	84.8	143	7,289
100	151	100	51	0	151	830.6	841.6	11.0	0.5	10.4	0	0.0	87.1	0.0	0	2,855
															476	264,706

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q =	100 cfs	Speed Incomer Efficiency =	97 %
Min Powerhouse Q =	175 cfs	Generator Efficiency =	98 %
Max Powerhouse Q =	700 cfs	Transformer Efficiency =	99 %
Rated Hnet =	12 ft		
Headloss Factor =	5.0 % Hnet		

May Energy Generation (Flashboards Up)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	9454	100	9354	700	8754	835.8	845.5	9.7	0.5	9.2	543	100.0	76.4	85.3	436	-
5	3826	100	3726	700	3126	835.7	845.3	9.5	0.5	9.1	537	100.0	75.6	85.1	431	16,120
10	2773	100	2673	700	2073	834.9	845.0	10.1	0.5	9.6	570	100.0	80.2	86.0	462	16,594
15	2129	100	2029	700	1429	834.2	845.0	10.8	0.5	10.3	611	100.0	85.9	86.9	499	17,874
20	1778	100	1678	700	1078	833.8	845.0	11.2	0.6	10.6	629	100.0	88.5	87.3	517	18,902
25	1544	100	1444	700	844	833.6	845.0	11.4	0.6	10.8	640	100.0	90.0	87.5	527	19,416
30	1427	100	1327	700	727	833.5	845.0	11.5	0.6	10.9	648	100.0	91.1	87.6	534	19,733
35	1287	100	1187	700	587	833.3	845.0	11.7	0.6	11.1	659	100.0	92.6	87.8	544	20,051
40	1182	100	1082	700	482	833.2	845.0	11.8	0.6	11.2	665	100.0	93.6	87.9	550	20,353
45	1080	100	980	700	380	833.0	844.8	11.8	0.6	11.2	665	100.0	93.5	87.8	550	20,455
50	980	100	880	700	280	832.9	844.7	11.8	0.6	11.2	665	100.0	93.5	87.8	550	20,444
55	883	100	783	700	183	832.7	844.5	11.9	0.6	11.3	667	100.0	93.8	87.9	552	20,488
60	823	100	723	700	123	832.5	844.4	11.9	0.6	11.3	669	100.0	94.1	87.9	553	20,560
65	773	100	673	673	100	832.4	844.4	11.9	0.6	11.3	647	96.1	94.6	88.6	539	20,319
70	707	100	607	607	100	832.3	844.4	12.1	0.6	11.5	590	86.7	95.6	90.1	500	19,324
75	652	100	552	552	100	832.2	844.4	12.2	0.6	11.6	541	78.9	96.5	91.2	464	17,936
80	590	100	490	490	100	832.1	844.4	12.3	0.6	11.7	485	70.0	97.5	91.6	418	16,421
85	532	100	432	432	100	832.0	844.4	12.4	0.6	11.8	432	61.7	98.4	91.9	374	14,734
90	468	100	368	368	100	831.8	844.4	12.6	0.6	12.0	373	52.6	99.9	91.4	321	12,925
95	386	100	286	286	100	831.5	844.4	12.9	0.6	12.3	297	40.9	102.3	90.4	253	10,678
100	174	100	74	0	174	830.7	844.5	13.8	0.7	13.2	0	0.0	109.6	0.0	0	4,704
															553	348,030

June Energy Generation (Flashboards Up)

Gross Time = 30 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	9395	100	9295	700	8695	835.8	845.4	9.6	0.5	9.2	543	100.0	76.3	85.3	436	-
5	3042	100	2942	700	2342	835.1	845.0	9.9	0.5	9.4	555	100.0	78.0	85.6	447	16,418
10	2340	100	2240	700	1640	834.4	845.0	10.6	0.5	10.1	596	100.0	83.9	86.6	486	17,357
15	1778	100	1678	700	1078	833.8	845.0	11.2	0.6	10.6	629	100.0	88.5	87.3	517	18,654
20	1486	100	1386	700	786	833.6	845.0	11.4	0.6	10.8	643	100.0	90.4	87.5	530	19,468
25	1275	100	1175	700	575	833.3	845.0	11.7	0.6	11.1	660	100.0	92.7	87.8	545	19,988
30	1142	100	1042	700	442	833.1	844.9	11.8	0.6	11.2	665	100.0	93.5	87.9	550	20,364
35	1007	100	907	700	307	832.9	844.7	11.8	0.6	11.2	664	100.0	93.4	87.8	549	20,442
40	918	100	818	700	218	832.7	844.6	11.8	0.6	11.2	666	100.0	93.7	87.9	551	20,464
45	842	100	742	700	142	832.6	844.5	11.9	0.6	11.3	668	100.0	94.0	87.9	553	20,536
50	773	100	673	673	100	832.4	844.4	11.9	0.6	11.3	647	96.1	94.6	88.6	539	20,311
55	714	100	614	614	100	832.3	844.4	12.1	0.6	11.5	596	87.7	95.5	89.9	504	19,404
60	654	100	554	554	100	832.2	844.4	12.2	0.6	11.6	543	79.1	96.5	91.2	466	18,044
65	594	100	494	494	100	832.1	844.4	12.3	0.6	11.7	489	70.6	97.4	91.6	421	16,504
70	545	100	445	445	100	832.0	844.4	12.4	0.6	11.8	444	63.6	98.2	91.9	384	14,979
75	487	100	387	387	100	831.9	844.4	12.5	0.6	11.9	390	55.3	99.3	91.6	337	13,401
80	412	100	312	312	100	831.6	844.4	12.8	0.6	12.2	322	44.6	101.5	90.7	275	11,372
85	365	100	265	265	100	831.4	844.4	13.0	0.7	12.4	277	37.9	103.0	89.1	232	9,433
90	317	100	217	217	100	831.2	844.4	13.2	0.7	12.5	230	31.0	104.4	85.1	184	7,750
95	267	100	167	0	267	831.0	844.6	13.6	0.7	12.9	0	0.0	107.9	0.0	0	3,427
100	96	96	0	0	96	830.4	844.4	14.0	0.7	13.3	0	0.0	111.0	0.0	0	-
															553	308,315

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q = 100 cfs
 Min Powerhouse Q = 175 cfs
 Max Powerhouse Q = 700 cfs
 Rated Hnet = 12 ft
 Headloss Factor = 5.0 % Hnet

Speed Inreaser Efficiency = 97 %
 Generator Efficiency = 98 %
 Transformer Efficiency = 99 %

July Energy Generation (Flashboards Up)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	11080	100	10980	700	10380	835.8	846.0	10.2	0.5	9.7	575	100.0	80.9	86.1	466	-
5	2445	100	2345	700	1745	834.5	845.0	10.5	0.5	9.9	589	100.0	82.9	86.4	479	17,587
10	1556	100	1456	700	856	833.6	845.0	11.4	0.6	10.8	639	100.0	89.9	87.5	526	18,707
15	1287	100	1187	700	587	833.3	845.0	11.7	0.6	11.1	659	100.0	92.6	87.8	544	19,910
20	1059	100	959	700	359	833.0	844.8	11.8	0.6	11.2	665	100.0	93.4	87.8	549	20,338
25	940	100	840	700	240	832.8	844.6	11.8	0.6	11.2	666	100.0	93.6	87.9	551	20,460
30	838	100	738	700	138	832.6	844.4	11.9	0.6	11.3	669	100.0	94.0	87.9	553	20,527
35	776	100	676	700	100	832.5	844.4	11.9	0.6	11.3	649	96.6	94.5	88.5	541	20,344
40	690	100	590	590	100	832.3	844.4	12.1	0.6	11.5	575	84.3	95.9	90.5	489	19,159
45	635	100	535	535	100	832.2	844.4	12.2	0.6	11.6	526	76.4	96.8	91.3	452	17,508
50	590	100	490	490	100	832.1	844.4	12.3	0.6	11.7	485	70.0	97.5	91.6	418	16,189
55	551	100	451	451	100	832.0	844.4	12.4	0.6	11.8	449	64.4	98.1	91.8	389	15,009
60	517	100	417	417	100	831.9	844.4	12.5	0.6	11.8	418	59.6	98.6	92.0	362	13,953
65	481	100	381	381	100	831.8	844.4	12.6	0.6	11.9	385	54.4	99.5	91.6	332	12,898
70	427	100	327	327	100	831.6	844.4	12.8	0.6	12.1	336	46.7	101.1	90.9	287	11,515
75	362	100	262	262	100	831.4	844.4	13.0	0.7	12.4	274	37.4	103.0	88.8	229	9,609
80	307	100	207	207	100	831.2	844.4	13.2	0.7	12.6	220	29.6	104.7	84.2	175	7,511
85	268	100	168	0	268	831.0	844.6	13.6	0.7	12.9	0	0.0	107.9	0.0	0	3,246
90	221	100	121	0	221	830.8	844.6	13.7	0.7	13.0	0	0.0	108.7	0.0	0	-
95	166	100	66	0	166	830.6	844.5	13.9	0.7	13.2	0	0.0	109.7	0.0	0	-
100	70	70	0	0	70	830.3	844.3	14.1	0.7	13.4	0	0.0	111.5	0.0	0	-
553																
264,472																

August Energy Generation (Flashboards Up)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	8436	100	8336	700	7736	835.8	845.1	9.3	0.5	8.9	526	100.0	74.0	84.8	420	-
5	1521	100	1421	700	821	833.6	845.0	11.4	0.6	10.8	641	100.0	90.1	87.5	528	17,626
10	1006	100	906	700	306	832.9	844.7	11.8	0.6	11.2	664	100.0	93.4	87.8	549	20,032
15	833	100	733	700	133	832.6	844.4	11.9	0.6	11.3	669	100.0	94.0	87.9	553	20,503
20	718	100	618	618	100	832.3	844.4	12.1	0.6	11.5	599	88.3	95.4	89.8	507	19,714
25	666	100	566	566	100	832.2	844.4	12.2	0.6	11.6	554	80.9	96.3	91.0	474	18,242
30	603	100	503	503	100	832.1	844.4	12.3	0.6	11.7	497	71.9	97.3	91.5	428	16,782
35	555	100	455	455	100	832.0	844.4	12.4	0.6	11.8	453	65.0	98.0	91.8	392	15,249
40	521	100	421	421	100	831.9	844.4	12.5	0.6	11.8	422	60.1	98.6	92.0	365	14,073
45	486	100	386	386	100	831.8	844.4	12.5	0.6	11.9	390	55.1	99.3	91.6	336	13,036
50	448	100	348	348	100	831.7	844.4	12.7	0.6	12.1	355	49.7	100.5	91.2	305	11,915
55	414	100	314	314	100	831.6	844.4	12.8	0.6	12.2	324	44.9	101.5	90.7	276	10,811
60	374	100	274	274	100	831.4	844.4	13.0	0.6	12.3	286	39.1	102.7	89.8	242	9,636
65	328	100	228	228	100	831.2	844.4	13.1	0.7	12.5	241	32.6	104.1	86.0	195	8,123
70	300	100	200	200	100	831.1	844.4	13.3	0.7	12.6	213	28.6	104.9	83.6	168	6,749
75	270	100	170	0	270	831.0	844.7	13.6	0.7	12.9	0	0.0	107.9	0.0	0	3,120
80	234	100	134	0	234	830.9	844.6	13.7	0.7	13.0	0	0.0	108.5	0.0	0	-
85	181	100	81	0	181	830.7	844.5	13.8	0.7	13.1	0	0.0	109.5	0.0	0	-
90	138	100	38	0	138	830.5	844.4	13.9	0.7	13.2	0	0.0	110.2	0.0	0	-
95	115	100	15	0	115	830.4	844.4	14.0	0.7	13.3	0	0.0	110.7	0.0	0	-
100	84	84	0	0	84	830.3	844.4	14.0	0.7	13.3	0	0.0	111.2	0.0	0	-
553																
205,612																

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q = 100 cfs
 Min Powerhouse Q = 175 cfs
 Max Powerhouse Q = 700 cfs
 Rated Hnet = 12 ft
 Headloss Factor = 5.0 % Hnet

Speed Inverter Efficiency = 97 %
 Generator Efficiency = 98 %
 Transformer Efficiency = 99 %

September Energy Generation (Flashboards Up)

Gross Time = 30 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	6470	100	6370	700	5770	835.8	846.7	10.9	0.5	10.3	613	100.0	86.2	86.9	501	-
5	1568	100	1468	700	868	833.7	845.0	11.3	0.6	10.8	639	100.0	89.8	87.5	526	19,108
10	987	100	887	700	287	832.9	844.7	11.8	0.6	11.2	665	100.0	93.4	87.8	549	20,000
15	796	100	696	696	100	832.5	844.4	11.9	0.6	11.3	666	99.4	94.2	88.0	552	20,482
20	702	100	602	602	100	832.3	844.4	12.1	0.6	11.5	585	86.0	95.7	90.2	497	19,505
25	655	100	555	555	100	832.2	844.4	12.2	0.6	11.6	544	79.3	96.4	91.2	467	17,919
30	594	100	494	494	100	832.1	844.4	12.3	0.6	11.7	489	70.6	97.4	91.6	421	16,517
35	535	100	435	435	100	832.0	844.4	12.4	0.6	11.8	435	62.1	98.3	91.9	376	14,833
40	496	100	396	396	100	831.9	844.4	12.5	0.6	11.9	398	56.6	99.0	91.7	344	13,391
45	457	100	357	357	100	831.7	844.4	12.7	0.6	12.0	363	51.0	100.2	91.3	312	12,203
50	410	100	310	310	100	831.6	844.4	12.8	0.6	12.2	320	44.3	101.6	90.7	273	10,887
55	380	100	280	280	100	831.4	844.4	12.9	0.6	12.3	292	40.0	102.5	90.3	248	9,689
60	351	100	251	251	100	831.3	844.4	13.1	0.7	12.4	264	35.9	103.4	87.9	218	8,667
65	308	100	208	208	100	831.2	844.4	13.2	0.7	12.6	221	29.7	104.7	84.3	175	7,321
70	289	100	189	189	100	831.1	844.4	13.3	0.7	12.6	202	27.0	105.2	82.6	157	6,188
75	264	100	164	0	264	831.0	844.6	13.6	0.7	13.0	0	0.0	108.0	0.0	0	2,924
80	226	100	126	0	226	830.9	844.6	13.7	0.7	13.0	0	0.0	108.7	0.0	0	-
85	201	100	101	0	201	830.8	844.5	13.8	0.7	13.1	0	0.0	109.1	0.0	0	-
90	167	100	67	0	167	830.6	844.5	13.9	0.7	13.2	0	0.0	109.7	0.0	0	-
95	128	100	28	0	128	830.5	844.4	13.9	0.7	13.3	0	0.0	110.4	0.0	0	-
100	98	98	0	0	98	830.4	844.4	14.0	0.7	13.3	0	0.0	111.0	0.0	0	-
552 199,636																

October Energy Generation (Flashboards Up)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	5979	100	5879	700	5279	835.8	846.4	10.6	0.5	10.1	599	100.0	84.2	86.6	488	-
5	1778	100	1678	700	1078	833.8	845.0	11.2	0.6	10.6	629	100.0	88.5	87.3	517	18,700
10	1346	100	1246	700	646	833.4	845.0	11.6	0.6	11.0	654	100.0	92.0	87.7	540	19,655
15	1085	100	985	700	385	833.0	844.8	11.8	0.6	11.2	665	100.0	93.5	87.8	550	20,262
20	913	100	813	700	213	832.7	844.6	11.8	0.6	11.2	667	100.0	93.7	87.9	551	20,475
25	700	100	600	600	100	832.3	844.4	12.1	0.6	11.5	584	85.7	95.7	90.2	496	19,471
30	606	100	506	506	100	832.1	844.4	12.3	0.6	11.7	500	72.3	97.2	91.5	430	17,225
35	569	100	469	469	100	832.0	844.4	12.4	0.6	11.7	466	67.0	97.8	91.7	402	15,491
40	508	100	408	408	100	831.9	844.4	12.5	0.6	11.9	409	58.3	98.8	91.9	354	14,069
45	468	100	368	368	100	831.8	844.4	12.6	0.6	12.0	373	52.6	99.9	91.4	321	12,558
50	432	100	332	332	100	831.6	844.4	12.8	0.6	12.1	341	47.4	100.9	91.0	291	11,396
55	376	100	276	276	100	831.4	844.4	13.0	0.6	12.3	288	39.4	102.6	90.0	244	9,954
60	326	100	226	226	100	831.2	844.4	13.2	0.7	12.5	239	32.3	104.1	85.8	193	8,125
65	285	100	185	185	100	831.1	844.4	13.3	0.7	12.6	198	26.4	105.4	82.3	153	6,445
70	259	100	159	0	259	831.0	844.6	13.6	0.7	13.0	0	0.0	108.1	0.0	0	2,853
75	243	100	143	0	243	830.9	844.6	13.7	0.7	13.0	0	0.0	108.3	0.0	0	-
80	216	100	116	0	216	830.8	844.6	13.7	0.7	13.1	0	0.0	108.8	0.0	0	-
85	184	100	84	0	184	830.7	844.5	13.8	0.7	13.1	0	0.0	109.4	0.0	0	-
90	156	100	56	0	156	830.6	844.5	13.9	0.7	13.2	0	0.0	109.9	0.0	0	-
95	131	100	31	0	131	830.5	844.4	13.9	0.7	13.2	0	0.0	110.4	0.0	0	-
100	99	99	0	0	99	830.4	844.4	14.0	0.7	13.3	0	0.0	110.9	0.0	0	-
551 196,680																

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q =	100 cfs	Speed In increaser Efficiency =	97 %
Min Powerhouse Q =	175 cfs	Generator Efficiency =	98 %
Max Powerhouse Q =	700 cfs	Transformer Efficiency =	99 %
Rated Hnet =	12 ft		
Headloss Factor =	5.0 % Hnet		

November Energy Generation (Flashboards Down)

Gross Time = 30 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	5230	100	5130	700	4530	835.8	844.5	8.7	0.4	8.3	491	100.0	69.1	83.8	387	-
5	1486	100	1386	700	786	833.6	842.3	8.7	0.4	8.3	492	100.0	69.2	83.8	389	14,434
10	1154	100	1054	700	454	833.1	842.0	8.9	0.4	8.5	501	100.0	70.4	84.1	396	14,602
15	959	100	859	700	259	832.8	841.7	8.9	0.4	8.5	502	100.0	70.5	84.1	397	14,760
20	819	100	719	700	119	832.5	841.5	9.0	0.4	8.5	506	100.0	71.1	84.2	401	14,846
25	749	100	649	649	100	832.4	841.5	9.1	0.5	8.6	475	92.7	72.0	85.8	384	14,596
30	679	100	579	579	100	832.3	841.5	9.2	0.5	8.8	430	82.7	73.1	88.0	356	13,760
35	632	100	532	532	100	832.2	841.5	9.3	0.5	8.9	399	76.0	73.9	89.0	334	12,843
40	565	100	465	465	100	832.0	841.5	9.5	0.5	9.0	354	66.4	74.9	90.0	300	11,799
45	538	100	438	438	100	832.0	841.5	9.5	0.5	9.0	335	62.6	75.4	90.5	286	10,891
50	477	100	377	377	100	831.8	841.5	9.7	0.5	9.2	294	53.9	76.7	90.4	250	9,955
55	421	100	321	321	100	831.6	841.5	9.9	0.5	9.4	256	45.9	78.3	89.9	216	8,663
60	380	100	280	280	100	831.4	841.5	10.1	0.5	9.5	226	40.0	79.6	89.5	191	7,564
65	347	100	247	247	100	831.3	841.5	10.2	0.5	9.7	202	35.3	80.6	87.1	166	6,627
70	314	100	214	214	100	831.2	841.5	10.3	0.5	9.8	177	30.6	81.6	84.6	141	5,710
75	273	100	173	0	273	831.0	841.7	10.7	0.5	10.2	0	0.0	84.8	0.0	0	2,628
80	234	100	134	0	234	830.9	841.7	10.8	0.5	10.3	0	0.0	85.5	0.0	0	-
85	200	100	100	0	200	830.8	841.6	10.9	0.5	10.3	0	0.0	86.1	0.0	0	-
90	177	100	77	0	177	830.7	841.6	10.9	0.5	10.4	0	0.0	86.6	0.0	0	-
95	163	100	63	0	163	830.6	841.6	11.0	0.5	10.4	0	0.0	86.8	0.0	0	-
100	117	100	17	0	117	830.4	841.5	11.1	0.6	10.5	0	0.0	87.7	0.0	0	-
															401	163,680

December Energy Generation (Flashboards Down)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	1989	100	1889	700	1289	834.0	842.7	8.7	0.4	8.3	491	100.0	69.1	83.8	388	-
5	995	100	895	700	295	832.9	841.8	8.9	0.4	8.4	501	100.0	70.4	84.1	396	14,577
10	831	100	731	700	131	832.8	841.5	9.0	0.4	8.5	506	100.0	71.1	84.2	401	14,821
15	725	100	625	625	100	832.4	841.5	9.1	0.5	8.7	460	89.3	72.4	86.6	375	14,421
20	644	100	544	544	100	832.2	841.5	9.3	0.5	8.8	407	77.7	73.7	88.8	340	13,297
25	591	100	491	491	100	832.1	841.5	9.4	0.5	8.9	372	70.1	74.5	89.6	314	12,162
30	550	100	450	450	100	832.0	841.5	9.5	0.5	9.0	344	64.3	75.2	90.3	292	11,264
35	491	100	391	391	100	831.9	841.5	9.6	0.5	9.1	303	55.9	76.2	90.5	258	10,228
40	433	100	333	333	100	831.6	841.5	9.9	0.5	9.4	264	47.6	78.0	90.0	223	8,952
45	390	100	290	290	100	831.5	841.5	10.0	0.5	9.5	234	41.4	79.3	89.6	197	7,817
50	351	100	251	251	100	831.3	841.5	10.2	0.5	9.7	205	35.9	80.5	87.4	169	6,800
55	316	100	216	216	100	831.2	841.5	10.3	0.5	9.8	179	30.9	81.5	84.8	143	5,793
60	293	100	193	193	100	831.1	841.5	10.4	0.5	9.9	161	27.6	82.2	83.1	126	4,999
65	257	100	157	0	257	831.0	841.7	10.7	0.5	10.2	0	0.0	85.1	0.0	0	2,344
70	221	100	121	0	221	830.8	841.7	10.8	0.5	10.3	0	0.0	85.8	0.0	0	-
75	194	100	94	0	194	830.7	841.6	10.9	0.5	10.4	0	0.0	86.3	0.0	0	-
80	173	100	73	0	173	830.7	841.6	10.9	0.5	10.4	0	0.0	86.6	0.0	0	-
85	160	100	60	0	160	830.6	841.6	11.0	0.5	10.4	0	0.0	86.9	0.0	0	-
90	146	100	46	0	146	830.6	841.6	11.0	0.6	10.5	0	0.0	87.1	0.0	0	-
95	129	100	29	0	129	830.5	841.5	11.0	0.6	10.5	0	0.0	87.5	0.0	0	-
100	75	75	0	0	75	830.3	841.5	11.2	0.6	10.6	0	0.0	88.5	0.0	0	-
															401	127,476

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q = 100 cfs
 Min Powerhouse Q = 175 cfs
 Max Powerhouse Q = 700 cfs
 Rated Hnet = 12 ft
 Headloss Factor = 5.0 % Hnet

Speed Inserter Efficiency = 97 %
 Generator Efficiency = 98 %
 Transformer Efficiency = 99 %

Summer Energy Generation (Flashboards Up)

Gross Time = 184 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	11080	100	10980	700	10380	835.8	846.0	10.2	0.5	9.7	575	100.0	80.9	86.1	466	-
5	2492	100	2392	700	1792	834.6	845.0	10.4	0.5	9.9	586	100.0	82.4	86.4	476	104,059
10	1708	100	1608	700	1008	833.8	845.0	11.2	0.6	10.7	633	100.0	88.9	87.3	520	109,992
15	1369	100	1269	700	669	833.4	845.0	11.6	0.6	11.0	652	100.0	91.7	87.7	538	116,809
20	1135	100	1035	700	435	833.1	844.9	11.8	0.6	11.2	665	100.0	93.5	87.9	550	120,119
25	972	100	872	700	272	832.8	844.7	11.8	0.6	11.2	665	100.0	93.5	87.8	550	121,402
30	851	100	751	700	151	832.6	844.5	11.9	0.6	11.3	668	100.0	94.0	87.9	553	121,717
35	766	100	666	666	100	832.4	844.4	12.0	0.6	11.4	641	95.1	94.7	88.7	535	120,089
40	686	100	586	586	100	832.3	844.4	12.1	0.6	11.5	571	83.7	96.0	90.5	487	112,812
45	625	100	525	525	100	832.2	844.4	12.2	0.6	11.6	517	75.0	96.9	91.4	445	102,829
50	572	100	472	472	100	832.0	844.4	12.3	0.6	11.7	469	67.4	97.8	91.7	405	93,762
55	525	100	425	425	100	832.0	844.4	12.4	0.6	11.8	425	60.7	98.5	92.0	368	85,327
60	482	100	382	382	100	831.8	844.4	12.6	0.6	11.9	386	54.6	99.4	91.6	333	77,363
65	433	100	333	333	100	831.6	844.4	12.7	0.6	12.1	341	47.6	100.9	91.0	292	68,989
70	380	100	280	280	100	831.4	844.4	12.9	0.6	12.3	292	40.0	102.5	90.3	248	59,633
75	330	100	230	230	100	831.3	844.4	13.1	0.7	12.5	243	32.9	104.0	86.2	197	49,119
80	288	100	188	188	100	831.1	844.4	13.3	0.7	12.6	201	26.9	105.3	82.6	156	39,008
85	247	100	147	0	247	830.9	844.6	13.7	0.7	13.0	0	0.0	108.3	0.0	0	17,250
90	199	100	99	0	199	830.8	844.5	13.8	0.7	13.1	0	0.0	109.1	0.0	0	-
95	145	100	45	0	145	830.6	844.5	13.9	0.7	13.2	0	0.0	110.1	0.0	0	-
100	70	70	0	0	70	830.3	844.3	14.1	0.7	13.4	0	0.0	111.5	0.0	0	-
															553	1,520,279

Winter Energy Generation (Flashboards Down)

Gross Time = 181 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	11,700	100	11600	700	11000	835.8	846.2	10.4	0.5	9.9	586	100.0	82.3	86.4	476	-
5	2,644	100	2544	700	1944	834.7	843.2	8.4	0.4	8.0	474	100.0	66.6	83.3	371	92,005
10	1,650	100	1550	700	950	833.7	842.5	8.7	0.4	8.3	493	100.0	69.2	83.8	389	82,532
15	1,182	100	1082	700	482	833.2	842.1	8.9	0.4	8.5	501	100.0	70.4	84.1	397	85,272
20	889	100	789	700	189	832.7	841.6	8.9	0.4	8.5	504	100.0	70.8	84.2	399	86,406
25	744	100	644	644	100	832.4	841.5	9.1	0.5	8.7	472	92.0	72.1	86.0	382	84,806
30	654	100	554	554	100	832.2	841.5	9.3	0.5	8.8	414	79.1	73.5	88.6	345	78,950
35	585	100	485	485	100	832.1	841.5	9.4	0.5	9.0	368	69.3	74.6	89.7	310	71,204
40	523	100	423	423	100	831.9	841.5	9.5	0.5	9.1	325	60.4	75.6	90.7	277	63,837
45	456	100	356	356	100	831.7	841.5	9.8	0.5	9.3	280	50.9	77.3	90.2	237	55,885
50	412	100	312	312	100	831.6	841.5	9.9	0.5	9.4	249	44.6	78.6	89.8	211	48,632
55	374	100	274	274	100	831.4	841.5	10.1	0.5	9.6	222	39.1	79.8	89.0	186	43,070
60	339	100	239	239	100	831.3	841.5	10.2	0.5	9.7	196	34.1	80.8	86.5	160	37,553
65	294	100	194	194	100	831.1	841.5	10.4	0.5	9.9	162	27.7	82.2	83.1	127	31,110
70	252	100	152	0	252	831.0	841.7	10.8	0.5	10.2	0	0.0	85.2	0.0	0	13,762
75	211	100	111	0	211	830.8	841.7	10.9	0.5	10.3	0	0.0	85.9	0.0	0	-
80	181	100	81	0	181	830.7	841.6	10.9	0.5	10.4	0	0.0	86.5	0.0	0	-
85	161	100	61	0	161	830.6	841.6	11.0	0.5	10.4	0	0.0	86.9	0.0	0	-
90	146	100	46	0	146	830.6	841.6	11.0	0.6	10.5	0	0.0	87.1	0.0	0	-
95	129	100	29	0	129	830.5	841.5	11.0	0.6	10.5	0	0.0	87.5	0.0	0	-
100	75	75	0	0	75	830.3	841.5	11.2	0.6	10.6	0	0.0	88.5	0.0	0	-
															476	875,025

Anoka Municipal Utility
Rum River Dam Hydro Reconnaissance Evaluation
Energy Analysis

Min Spill Q =	100 cfs	Speed Inverter Efficiency =	97 %
Min Powerhouse Q =	175 cfs	Generator Efficiency =	98 %
Max Powerhouse Q =	700 cfs	Transformer Efficiency =	99 %
Rated Hnet =	12 ft		
Headloss Factor =	5.0 % Hnet		

Winter Energy Generation (Flashboards Up)

Gross Time = 181 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Q	% Hn	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)	
0	11,700	100	11600	700	11000	835.8	846.2	10.4	0.5	9.9	586	100.0	82.3	86.4	476	-	
5	2,644	100	2544	700	1944	834.7	845.0	10.3	0.5	9.7	577	100.0	81.2	86.2	468	102,545	
10	1,650	100	1550	700	950	833.7	845.0	11.3	0.6	10.7	635	100.0	89.3	87.4	522	107,597	
15	1,182	100	1082	700	482	833.2	845.0	11.8	0.6	11.2	665	100.0	93.6	87.9	550	116,483	
20	889	100	789	700	189	832.7	844.5	11.8	0.6	11.3	667	100.0	93.8	87.9	552	119,677	
25	744	100	644	644	100	832.4	844.4	12.0	0.6	11.4	622	92.0	95.0	89.2	522	116,644	
30	654	100	554	554	100	832.2	844.4	12.2	0.6	11.6	543	79.1	96.5	91.2	466	107,307	
35	585	100	485	485	100	832.1	844.4	12.3	0.6	11.7	481	69.3	97.5	91.7	415	95,619	
40	523	100	423	423	100	831.9	844.4	12.4	0.6	11.8	423	60.4	98.5	92.0	367	84,844	
45	456	100	356	356	100	831.7	844.4	12.7	0.6	12.0	363	50.9	100.2	91.3	311	73,628	
50	412	100	312	312	100	831.6	844.4	12.8	0.6	12.2	322	44.6	101.5	90.7	275	63,656	
55	374	100	274	274	100	831.4	844.4	13.0	0.6	12.3	286	39.1	102.7	89.8	242	56,082	
60	339	100	239	239	100	831.3	844.4	13.1	0.7	12.4	252	34.1	103.7	86.9	206	48,618	
65	294	100	194	194	100	831.1	844.4	13.3	0.7	12.6	207	27.7	105.1	83.1	162	39,968	
70	252	100	152	0	252	831.0	844.6	13.7	0.7	13.0	0	0.0	108.2	0.0	0	17,591	
75	211	100	111	0	211	830.8	844.6	13.8	0.7	13.1	0	0.0	108.9	0.0	0	-	
80	181	100	81	0	181	830.7	844.5	13.8	0.7	13.1	0	0.0	109.5	0.0	0	-	
85	161	100	61	0	161	830.6	844.5	13.9	0.7	13.2	0	0.0	109.8	0.0	0	-	
90	146	100	46	0	146	830.6	844.5	13.9	0.7	13.2	0	0.0	110.1	0.0	0	-	
95	129	100	29	0	129	830.5	844.4	13.9	0.7	13.2	0	0.0	110.4	0.0	0	-	
100	75	75	0	0	75	830.3	844.4	14.1	0.7	13.4	0	0.0	111.4	0.0	0	-	
																552	1,150,259

Summary:	Month	Max Output (kW)	Energy (MWh)		Season	Max Output (kW)	Energy (MWh)	
			Gross	Net			Gross	Net
	Jan	400	90	86	Summer	553	1,520	1,444
	Feb	388	86	82	Winter	476	875	831
	Mar	412	153	145			2,395	2,276
	Apr	476	265	251				
	May	553	348	331	Winter w/ F'boards	552	1,150	1,093
	Jun	553	308	293			2,671	2,537
	Jul	553	264	251				
	Aug	553	206	195				
	Sep	552	200	190				
	Oct	551	197	187				
	Nov	401	164	155				
	Dec	401	127	121				
			2,408	2,287				

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q =	100 cfs	Turbine CL Elevation =	834.3 ft-msl
Min Powerhouse Q =	70 cfs	Turbine Shutdown Elevation =	832.6 ft-msl
Max Powerhouse Q =	700 cfs	Speed Increaser Efficiency =	97 %
Rated Hnet =	12 ft	Generator Efficiency =	98 %
Headloss Factor =	5.0 % Hnet	Transformer Efficiency =	99 %

January Energy Generation - UEP Unit (Flashboards Down)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	842	100	742	700	142	832.6	841.6	7.3	0.4	6.9	409	100.0	79.0	304	-
5	820	100	520	520	100	832.1	841.5	7.2	0.4	6.8	301	74.3	74.9	212	9,595
10	585	100	485	485	100	832.1	841.5	7.2	0.4	6.8	281	69.3	74.0	196	7,581
15	527	100	427	427	100	832.0	841.5	7.2	0.4	6.8	247	61.0	73.2	170	6,804
20	456	100	356	356	100	831.7	841.5	7.2	0.4	6.8	206	50.9	71.2	138	5,734
25	433	100	333	333	100	831.6	841.5	7.2	0.4	6.8	193	47.6	71.0	129	4,963
30	410	100	310	310	100	831.6	841.5	7.2	0.4	6.8	179	44.3	70.9	120	4,621
35	388	100	288	288	100	831.5	841.5	7.2	0.4	6.8	167	41.1	70.2	110	4,275
40	360	100	260	260	100	831.4	841.5	7.2	0.4	6.8	151	37.1	69.4	98	3,878
45	316	100	216	216	100	831.2	841.5	7.2	0.4	6.8	125	30.9	68.2	80	3,321
50	293	100	193	193	100	831.1	841.5	7.2	0.4	6.8	112	27.6	66.5	70	2,793
55	246	100	146	146	100	830.9	841.5	7.2	0.4	6.8	85	20.9	61.7	49	2,214
60	214	100	114	114	100	830.8	841.5	7.2	0.4	6.8	66	16.3	54.3	34	1,540
65	193	100	93	93	100	830.7	841.5	7.2	0.4	6.8	54	13.3	46.8	23	1,059
70	166	100	66	0	166	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	432
75	158	100	58	0	158	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	-
80	144	100	44	0	144	830.5	841.6	7.3	0.4	6.9	0	0.0	0.0	0	-
85	132	100	32	0	132	830.5	841.5	7.2	0.4	6.9	0	0.0	0.0	0	-
90	128	100	28	0	128	830.5	841.5	7.2	0.4	6.9	0	0.0	0.0	0	-
95	109	100	9	0	109	830.4	841.5	7.2	0.4	6.8	0	0.0	0.0	0	-
100	82	82	0	0	82	830.3	841.5	7.2	0.4	6.8	0	0.0	0.0	0	-
														304	58,810

February Energy Generation - UEP Unit (Flashboards Down)

Gross Time = 28 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	1977	100	1877	0	1977	834.0	843.2	8.9	0.4	8.4	0	0.0	0.0	0	-
5	679	100	579	579	100	832.3	841.5	7.2	0.4	6.8	335	82.7	76.5	241	4,056
10	591	100	491	491	100	832.1	841.5	7.2	0.4	6.8	284	70.1	74.0	198	7,382
15	515	100	415	415	100	831.9	841.5	7.2	0.4	6.8	240	59.3	72.9	165	6,094
20	468	100	368	368	100	831.8	841.5	7.2	0.4	6.8	213	52.6	71.5	143	5,176
25	433	100	333	333	100	831.6	841.5	7.2	0.4	6.8	193	47.6	71.0	129	4,572
30	410	100	310	310	100	831.6	841.5	7.2	0.4	6.8	179	44.3	70.9	120	4,174
35	372	100	272	272	100	831.4	841.5	7.2	0.4	6.8	157	38.9	69.8	103	3,747
40	351	100	251	251	100	831.3	841.5	7.2	0.4	6.8	145	35.9	69.2	95	3,326
45	328	100	228	228	100	831.2	841.5	7.2	0.4	6.8	132	32.6	68.5	85	3,019
50	275	100	175	175	100	831.0	841.5	7.2	0.4	6.8	101	25.0	65.0	62	2,471
55	223	100	123	123	100	830.8	841.5	7.2	0.4	6.8	71	17.6	66.6	38	1,678
60	200	100	100	100	100	830.8	841.5	7.2	0.4	6.8	58	14.3	49.4	27	1,090
65	178	100	78	78	100	830.7	841.5	7.2	0.4	6.8	45	11.1	38.1	16	724
70	158	100	58	0	158	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	272
75	151	100	51	0	151	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	-
80	146	100	46	0	146	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	-
85	135	100	35	0	135	830.5	841.5	7.2	0.4	6.9	0	0.0	0.0	0	-
90	125	100	25	0	125	830.5	841.5	7.2	0.4	6.9	0	0.0	0.0	0	-
95	111	100	11	0	111	830.4	841.5	7.2	0.4	6.9	0	0.0	0.0	0	-
100	83	83	0	0	83	830.3	841.5	7.2	0.4	6.8	0	0.0	0.0	0	-
														241	47,781

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q =	100 cfs	Turbine CL Elevation =	834.3 ft-msl
Min Powerhouse Q =	70 cfs	Turbine Shutdown Elevation =	832.6 ft-msl
Max Powerhouse Q =	700 cfs	Speed Increaser Efficiency =	97 %
Rated Hnet =	12 ft	Generator Efficiency =	98 %
Headloss Factor =	5.0 % Hnet	Transformer Efficiency =	99 %

March Energy Generation - UEP Unit (Flashboards Down)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avall Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	6891	100	6791	0	6891	835.8	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
5	2960	100	2860	0	2960	835.1	843.7	9.4	0.5	9.0	0	0.0	0.0	0	-
10	1895	100	1795	0	1895	833.9	843.1	8.8	0.4	8.4	0	0.0	0.0	0	-
15	1287	100	1187	0	1287	833.3	842.7	8.4	0.4	8.0	0	0.0	0.0	0	-
20	995	100	895	0	995	832.9	842.5	8.2	0.4	7.8	0	0.0	0.0	0	-
25	821	100	721	700	121	832.5	841.5	7.2	0.4	6.9	407	100.0	79.0	303	5,627
30	702	100	602	602	100	832.3	841.5	7.2	0.4	6.8	348	86.0	77.0	253	10,324
35	620	100	520	520	100	832.1	841.5	7.2	0.4	6.8	301	74.3	74.9	212	8,641
40	550	100	450	450	100	832.0	841.5	7.2	0.4	6.8	260	64.3	73.9	181	7,312
45	483	100	383	383	100	831.8	841.5	7.2	0.4	6.8	222	54.7	71.9	150	6,158
50	421	100	321	321	100	831.6	841.5	7.2	0.4	6.8	186	45.9	71.0	124	5,101
55	377	100	277	277	100	831.4	841.5	7.2	0.4	6.8	160	39.6	69.9	105	4,272
60	357	100	257	257	100	831.4	841.5	7.2	0.4	6.8	149	36.7	69.3	97	3,768
65	303	100	203	203	100	831.2	841.5	7.2	0.4	6.8	118	29.0	67.4	75	3,192
70	262	100	162	162	100	831.0	841.5	7.2	0.4	6.8	94	23.1	63.5	56	2,429
75	208	100	108	108	100	830.8	841.5	7.2	0.4	6.8	63	15.4	52.8	31	1,620
80	190	100	90	90	100	830.7	841.5	7.2	0.4	6.8	52	12.9	44.3	22	981
85	170	100	70	0	170	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	404
90	160	100	60	0	160	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	-
95	137	100	37	0	137	830.5	841.6	7.3	0.4	6.9	0	0.0	0.0	0	-
100	89	89	0	0	89	830.3	841.5	7.2	0.4	6.8	0	0.0	0.0	0	-
														303	59,830

April Energy Generation - UEP Unit (Flashboards Down)

Gross Time = 30 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avall Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	11700	100	11600	0	11700	835.8	846.1	11.8	0.6	11.2	0	0.0	0.0	0	-
5	5885	100	5785	0	5885	835.8	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
10	4107	100	4007	0	4107	835.8	844.3	10.0	0.5	9.5	0	0.0	0.0	0	-
15	3299	100	3199	0	3299	835.4	843.9	9.6	0.5	9.1	0	0.0	0.0	0	-
20	2831	100	2731	0	2831	834.9	843.7	9.4	0.5	8.9	0	0.0	0.0	0	-
25	2527	100	2427	0	2527	834.6	843.5	9.2	0.5	8.7	0	0.0	0.0	0	-
30	2235	100	2135	0	2235	834.3	843.3	9.0	0.5	8.6	0	0.0	0.0	0	-
35	1989	100	1889	0	1989	834.0	843.2	8.9	0.4	8.4	0	0.0	0.0	0	-
40	1790	100	1690	0	1790	833.8	843.1	8.8	0.4	8.3	0	0.0	0.0	0	-
45	1626	100	1526	0	1626	833.7	843.0	8.7	0.4	8.2	0	0.0	0.0	0	-
50	1451	100	1351	0	1451	833.5	842.8	8.5	0.4	8.1	0	0.0	0.0	0	-
55	1334	100	1234	0	1334	833.4	842.8	8.5	0.4	8.0	0	0.0	0.0	0	-
60	1205	100	1105	0	1205	833.2	842.7	8.4	0.4	7.9	0	0.0	0.0	0	-
65	1040	100	940	0	1040	833.0	842.5	8.2	0.4	7.8	0	0.0	0.0	0	-
70	916	100	816	0	916	832.7	842.4	8.1	0.4	7.7	0	0.0	0.0	0	-
75	804	100	704	700	104	832.5	841.5	7.2	0.4	6.8	406	100.0	79.0	301	5,427
80	715	100	615	615	100	832.3	841.5	7.2	0.4	6.8	356	87.9	77.0	258	10,070
85	631	100	531	531	100	832.2	841.5	7.2	0.4	6.8	307	75.9	75.2	217	8,557
90	476	100	376	376	100	831.8	841.5	7.2	0.4	6.8	218	53.7	71.7	147	6,559
95	316	100	216	216	100	831.2	841.5	7.2	0.4	6.8	125	30.9	68.2	80	4,089
100	151	100	51	0	151	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	1,444
														301	36,146

**Anoka Municipal Utility
Rum River Dam Hydro Reconnaissance Evaluation
Energy Analysis**

Min Spill Q =	100 cfs	Turbine CL Elevation =	834.3 ft-msl
Min Powerhouse Q =	70 cfs	Turbine Shutdown Elevation =	832.6 ft-msl
Max Powerhouse Q =	700 cfs	Speed Inceaser Efficiency =	97 %
Rated Hnet =	12 ft	Generator Efficiency =	98 %
Headloss Factor =	5.0 % Hnet	Transformer Efficiency =	99 %

May Energy Generation - UEP Unit (Flashboards Up)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Qrated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	9454	100	9354	0	9454	835.8	845.7	11.4	0.6	10.8	0	0.0	0.0	0	-
5	3826	100	3726	0	3826	835.7	845.7	11.4	0.6	10.8	0	0.0	0.0	0	-
10	2773	100	2673	0	2773	834.9	845.1	10.8	0.5	10.3	0	0.0	0.0	0	-
15	2129	100	2029	0	2129	834.2	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
20	1778	100	1678	0	1778	833.8	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
25	1544	100	1444	0	1544	833.6	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
30	1427	100	1327	0	1427	833.5	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
35	1287	100	1187	0	1287	833.3	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
40	1182	100	1082	0	1182	833.2	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
45	1080	100	980	0	1080	833.0	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
50	980	100	880	0	980	832.9	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
55	883	100	783	0	883	832.7	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
60	823	100	723	700	123	832.5	844.4	10.1	0.5	9.6	570	100.0	79.0	424	7,885
65	773	100	673	673	100	832.4	844.4	10.1	0.5	9.6	546	96.1	78.2	402	15,367
70	707	100	607	607	100	832.3	844.4	10.1	0.5	9.6	493	86.7	77.0	357	14,123
75	652	100	552	552	100	832.2	844.4	10.1	0.5	9.6	448	78.9	75.8	320	12,585
80	590	100	490	490	100	832.1	844.4	10.1	0.5	9.6	398	70.0	74.0	277	11,096
85	532	100	432	432	100	832.0	844.4	10.1	0.5	9.6	351	61.7	73.3	242	9,655
90	468	100	368	368	100	831.8	844.4	10.1	0.5	9.6	299	52.6	71.5	201	8,242
95	386	100	286	286	100	831.5	844.4	10.1	0.5	9.6	232	40.9	70.2	153	6,592
100	174	100	74	74	100	830.7	844.4	10.1	0.5	9.6	60	10.6	36.1	20	3,231
														424	88,776

June Energy Generation - UEP Unit (Flashboards Up)

Gross Time = 30 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Qrated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	9395	100	9295	0	9395	835.8	845.7	11.4	0.6	10.8	0	0.0	0.0	0	-
5	3042	100	2942	0	3042	835.1	845.2	10.9	0.5	10.4	0	0.0	0.0	0	-
10	2340	100	2240	0	2340	834.4	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
15	1778	100	1678	0	1778	833.8	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
20	1486	100	1386	0	1486	833.6	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
25	1275	100	1175	0	1275	833.3	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
30	1142	100	1042	0	1142	833.1	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
35	1007	100	907	0	1007	832.9	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
40	918	100	818	0	918	832.7	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
45	842	100	742	700	142	832.6	844.5	10.2	0.5	9.6	572	100.0	79.0	425	7,653
50	773	100	673	673	100	832.4	844.4	10.1	0.5	9.6	546	96.1	78.2	402	14,893
55	714	100	614	614	100	832.3	844.4	10.1	0.5	9.6	498	87.7	77.0	361	13,742
60	654	100	554	554	100	832.2	844.4	10.1	0.5	9.6	450	79.1	75.8	321	12,278
65	594	100	494	494	100	832.1	844.4	10.1	0.5	9.6	401	70.6	74.1	280	10,812
70	545	100	445	445	100	832.0	844.4	10.1	0.5	9.6	361	63.6	73.7	251	9,546
75	487	100	387	387	100	831.9	844.4	10.1	0.5	9.6	314	55.3	72.1	213	8,346
80	412	100	312	312	100	831.6	844.4	10.1	0.5	9.6	253	44.6	70.9	169	6,877
85	365	100	265	265	100	831.4	844.4	10.1	0.5	9.6	215	37.9	69.6	141	5,578
90	317	100	217	217	100	831.2	844.4	10.1	0.5	9.6	176	31.0	68.2	113	4,570
95	267	100	167	167	100	831.0	844.4	10.1	0.5	9.6	136	23.9	64.1	82	3,507
100	96	96	0	0	96	830.4	844.4	10.1	0.5	9.6	0	0.0	0.0	0	1,472
														425	99,273

Anoka Municipal Utility
 Run River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q =	100 cfs	Turbine CL Elevation =	834.3 ft-msl
Min Powerhouse Q =	70 cfs	Turbine Shutdown Elevation =	832.6 ft-msl
Max Powerhouse Q =	700 cfs	Speed Inceasrer Efficiency =	97 %
Rated Hnet =	12 ft	Generator Efficiency =	98 %
Headloss Factor =	5.0 % Hnet	Transformer Efficiency =	99 %

September Energy Generation - UEP Unit (Flashboards Up)

Gross Time = 30 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	6470	100	6370	0	6470	835.8	847.0	12.7	0.6	12.1	0	0.0	0.0	0	-
5	1568	100	1468	0	1568	833.7	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
10	987	100	887	0	987	832.9	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
15	796	100	696	696	100	832.5	844.4	10.1	0.5	9.6	565	99.4	78.9	419	7,650
20	702	100	602	602	100	832.3	844.4	10.1	0.5	9.6	489	86.0	77.0	354	13,825
25	655	100	555	555	100	832.2	844.4	10.1	0.5	9.6	451	79.3	75.9	322	12,164
30	594	100	494	494	100	832.1	844.4	10.1	0.5	9.6	401	70.6	74.1	280	10,824
35	535	100	435	435	100	832.0	844.4	10.1	0.5	9.6	353	62.1	73.4	244	9,427
40	496	100	396	396	100	831.9	844.4	10.1	0.5	9.6	321	56.6	72.3	219	8,330
45	457	100	357	357	100	831.7	844.4	10.1	0.5	9.6	290	51.0	71.2	194	7,433
50	410	100	310	310	100	831.6	844.4	10.1	0.5	9.6	252	44.3	70.9	168	6,516
55	380	100	280	280	100	831.4	844.4	10.1	0.5	9.6	227	40.0	70.0	150	5,716
60	351	100	251	251	100	831.3	844.4	10.1	0.5	9.6	204	35.9	69.2	133	5,083
65	308	100	208	208	100	831.2	844.4	10.1	0.5	9.6	169	29.7	67.8	108	4,328
70	289	100	189	189	100	831.1	844.4	10.1	0.5	9.6	153	27.0	66.2	96	3,661
75	264	100	164	164	100	831.0	844.4	10.1	0.5	9.6	133	23.0	63.7	80	3,158
80	226	100	126	126	100	830.9	844.4	10.1	0.5	9.6	102	18.0	57.4	55	2,432
85	201	100	101	101	100	830.8	844.4	10.1	0.5	9.6	82	14.4	49.9	39	1,688
90	167	100	67	0	167	830.6	844.5	10.2	0.5	9.7	0	0.0	0.0	0	694
95	128	100	28	0	128	830.5	844.4	10.1	0.5	9.6	0	0.0	0.0	0	-
100	98	98	0	0	98	830.4	844.4	10.1	0.5	9.6	0	0.0	0.0	0	-
														419	102,930

October Energy Generation - UEP Unit (Flashboards Up)

Gross Time = 31 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	5979	100	5879	0	5979	835.8	846.8	12.5	0.6	11.9	0	0.0	0.0	0	-
5	1778	100	1678	0	1778	833.8	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
10	1346	100	1246	0	1346	833.4	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
15	1085	100	985	0	1085	833.0	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
20	913	100	813	0	913	832.7	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
25	700	100	600	600	100	832.3	844.4	10.1	0.5	9.6	487	85.7	77.0	353	6,565
30	606	100	506	506	100	832.1	844.4	10.1	0.5	9.6	411	72.3	74.5	288	11,919
35	569	100	469	469	100	832.0	844.4	10.1	0.5	9.6	381	67.0	74.0	265	10,285
40	508	100	408	408	100	831.9	844.4	10.1	0.5	9.6	331	58.3	72.7	226	9,144
45	468	100	368	368	100	831.8	844.4	10.1	0.5	9.6	299	52.6	71.5	201	7,952
50	432	100	332	332	100	831.6	844.4	10.1	0.5	9.6	270	47.4	71.0	180	7,089
55	376	100	276	276	100	831.4	844.4	10.1	0.5	9.6	224	39.4	69.9	147	6,091
60	326	100	226	226	100	831.2	844.4	10.1	0.5	9.6	183	32.3	68.5	118	4,939
65	285	100	185	185	100	831.1	844.4	10.1	0.5	9.6	150	26.4	65.9	93	3,930
70	259	100	159	159	100	831.0	844.4	10.1	0.5	9.6	129	22.7	63.2	77	3,159
75	243	100	143	143	100	830.9	844.4	10.1	0.5	9.6	116	20.4	61.3	67	2,674
80	216	100	116	116	100	830.8	844.4	10.1	0.5	9.6	94	16.6	54.8	49	2,150
85	184	100	84	84	100	830.7	844.4	10.1	0.5	9.6	68	12.0	41.2	26	1,396
90	156	100	56	0	156	830.6	844.5	10.2	0.5	9.7	0	0.0	0.0	0	492
95	131	100	31	0	131	830.5	844.4	10.1	0.5	9.6	0	0.0	0.0	0	-
100	99	99	0	0	99	830.4	844.4	10.1	0.5	9.6	0	0.0	0.0	0	-
														353	77,785

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q =	100 cfs	Turbine CL Elevation =	834.3 ft-msl
Min Powerhouse Q =	70 cfs	Turbine Shutdown Elevation =	832.6 ft-msl
Max Powerhouse Q =	700 cfs	Speed Increaser Efficiency =	97 %
Rated Hnet =	12 ft	Generator Efficiency =	98 %
Headloss Factor =	5.0 % Hnet	Transformer Efficiency =	99 %

November Energy Generation - UEP Unit (Flashboards Down)

Gross Time =		30 days/year														
Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)	
0	5230	100	5130	0	5230	835.8	844.8	10.5	0.5	10.0	0	0.0	0.0	0	-	
5	1486	100	1386	0	1486	833.6	842.9	8.6	0.4	8.1	0	0.0	0.0	0	-	
10	1154	100	1054	0	1154	833.1	842.6	8.3	0.4	7.9	0	0.0	0.0	0	-	
15	959	100	859	0	959	832.8	842.5	8.2	0.4	7.8	0	0.0	0.0	0	-	
20	819	100	719	700	119	832.5	841.5	7.2	0.4	6.9	407	100.0	79.0	302	5,443	
25	749	100	649	649	100	832.4	841.5	7.2	0.4	6.8	376	92.7	77.5	274	10,378	
30	679	100	579	579	100	832.3	841.5	7.2	0.4	6.8	335	82.7	76.5	241	9,280	
35	632	100	532	532	100	832.2	841.5	7.2	0.4	6.8	308	76.0	75.2	218	8,268	
40	565	100	465	465	100	832.0	841.5	7.2	0.4	6.8	269	66.4	74.0	187	7,297	
45	538	100	438	438	100	832.0	841.5	7.2	0.4	6.8	254	62.6	73.5	175	6,531	
50	477	100	377	377	100	831.8	841.5	7.2	0.4	6.8	218	53.9	71.8	147	5,810	
55	421	100	321	321	100	831.6	841.5	7.2	0.4	6.8	186	45.9	71.0	124	4,888	
60	380	100	280	280	100	831.4	841.5	7.2	0.4	6.8	162	40.0	70.0	107	4,157	
65	347	100	247	247	100	831.3	841.5	7.2	0.4	6.8	143	35.3	69.1	93	3,594	
70	314	100	214	214	100	831.2	841.5	7.2	0.4	6.8	124	30.6	68.1	79	3,102	
75	273	100	173	173	100	831.0	841.5	7.2	0.4	6.8	100	24.7	64.8	61	2,528	
80	234	100	134	134	100	830.9	841.5	7.2	0.4	6.8	78	19.1	59.5	43	1,880	
85	200	100	100	100	100	830.8	841.5	7.2	0.4	6.8	58	14.3	49.4	27	1,266	
90	177	100	77	77	100	830.7	841.5	7.2	0.4	6.8	45	11.0	37.6	16	769	
95	163	100	63	0	163	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	284	
100	117	100	17	0	117	830.4	841.5	7.2	0.4	6.9	0	0.0	0.0	0	-	
														302	75,476	

December Energy Generation - UEP Unit (Flashboards Down)

Gross Time =		31 days/year														
Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)	
0	1989	100	1889	0	1989	834.0	843.2	8.9	0.4	8.4	0	0.0	0.0	0	-	
5	995	100	895	0	995	832.9	842.5	8.2	0.4	7.8	0	0.0	0.0	0	-	
10	831	100	731	700	131	832.6	841.5	7.2	0.4	6.9	408	100.0	79.0	303	5,638	
15	725	100	625	625	100	832.4	841.5	7.2	0.4	6.8	362	89.3	77.0	262	10,515	
20	644	100	544	544	100	832.2	841.5	7.2	0.4	6.8	315	77.7	75.5	224	9,040	
25	591	100	491	491	100	832.1	841.5	7.2	0.4	6.8	284	70.1	74.0	198	7,847	
30	550	100	450	450	100	832.0	841.5	7.2	0.4	6.8	260	64.3	73.9	181	7,050	
35	491	100	391	391	100	831.9	841.5	7.2	0.4	6.8	226	55.9	72.2	154	6,227	
40	433	100	333	333	100	831.6	841.5	7.2	0.4	6.8	193	47.6	71.0	129	5,255	
45	390	100	290	290	100	831.5	841.5	7.2	0.4	6.8	168	41.4	70.3	111	4,461	
50	351	100	251	251	100	831.3	841.5	7.2	0.4	6.8	145	35.9	69.2	95	3,824	
55	316	100	216	216	100	831.2	841.5	7.2	0.4	6.8	125	30.9	68.2	80	3,251	
60	293	100	193	193	100	831.1	841.5	7.2	0.4	6.8	112	27.6	66.5	70	2,793	
65	257	100	157	157	100	831.0	841.5	7.2	0.4	6.8	91	22.4	62.9	54	2,303	
70	221	100	121	121	100	830.8	841.5	7.2	0.4	6.8	70	17.3	56.1	37	1,689	
75	194	100	94	94	100	830.7	841.5	7.2	0.4	6.8	54	13.4	46.3	24	1,129	
80	173	100	73	73	100	830.7	841.5	7.2	0.4	6.8	42	10.4	35.5	14	704	
85	160	100	60	0	160	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	263	
90	146	100	46	0	146	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	-	
95	129	100	29	0	129	830.5	841.5	7.2	0.4	6.9	0	0.0	0.0	0	-	
100	75	75	0	0	75	830.3	841.5	7.2	0.4	6.8	0	0.0	0.0	0	-	
														303	71,990	

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
 Energy Analysis

Min Spill Q =	100 cfs	Turbine CL Elevation =	834.3 ft-msl
Min Powerhouse Q =	70 cfs	Turbine Shutdown Elevation =	832.6 ft-msl
Max Powerhouse Q =	700 cfs	Speed In increaser Efficiency =	97 %
Rated Hnet =	12 ft	Generator Efficiency =	98 %
Headloss Factor =	5.0 % Hnet	Transformer Efficiency =	99 %

Summer Energy Generation - UEP Unit (Flashboards Up)

Gross Time = 184 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	11080	100	10980	0	11080	835.8	846.1	11.8	0.6	11.2	0	0.0	0.0	0	-
5	2492	100	2392	0	2492	834.6	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
10	1708	100	1608	0	1708	833.8	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
15	1369	100	1269	0	1369	833.4	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
20	1135	100	1035	0	1135	833.1	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
25	972	100	872	0	972	832.8	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
30	851	100	751	0	851	832.6	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
35	766	100	666	666	100	832.4	844.4	10.1	0.5	9.6	541	95.1	78.0	397	43,831
40	686	100	586	586	100	832.3	844.4	10.1	0.5	9.6	476	83.7	76.7	344	81,761
45	625	100	525	525	100	832.2	844.4	10.1	0.5	9.6	426	75.0	75.0	301	71,141
50	572	100	472	472	100	832.0	844.4	10.1	0.5	9.6	383	67.4	74.0	267	62,670
55	525	100	425	425	100	832.0	844.4	10.1	0.5	9.6	345	60.7	73.1	237	55,678
60	482	100	382	382	100	831.8	844.4	10.1	0.5	9.6	310	54.6	71.9	210	49,389
65	433	100	333	333	100	831.6	844.4	10.1	0.5	9.6	270	47.6	71.0	181	43,112
70	380	100	280	280	100	831.4	844.4	10.1	0.5	9.6	227	40.0	70.0	150	36,473
75	330	100	230	230	100	831.3	844.4	10.1	0.5	9.6	187	32.9	68.6	120	29,834
80	288	100	188	188	100	831.1	844.4	10.1	0.5	9.6	153	26.9	66.1	95	23,786
85	247	100	147	147	100	830.9	844.4	10.1	0.5	9.6	119	21.0	61.8	69	18,146
90	199	100	99	99	100	830.8	844.4	10.1	0.5	9.6	80	14.1	48.9	37	11,747
95	145	100	45	0	145	830.6	844.5	10.2	0.5	9.7	0	0.0	0.0	0	4,084
100	70	70	0	0	70	830.3	844.3	10.0	0.5	9.5	0	0.0	0.0	0	-
														397	531,651

Winter Energy Generation - UEP Unit (Flashboards Down)

Gross Time = 181 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Grated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	11,700	100	11600	0	11700	835.8	846.1	11.8	0.6	11.2	0	0.0	0.0	0	-
5	2,644	100	2544	0	2644	834.7	843.6	9.3	0.5	8.8	0	0.0	0.0	0	-
10	1,650	100	1550	0	1650	833.7	843.0	8.7	0.4	8.2	0	0.0	0.0	0	-
15	1,182	100	1082	0	1182	833.2	842.6	8.3	0.4	7.9	0	0.0	0.0	0	-
20	889	100	789	0	889	832.7	842.4	8.1	0.4	7.7	0	0.0	0.0	0	-
25	744	100	644	644	100	832.4	841.5	7.2	0.4	6.8	373	92.0	77.4	272	29,489
30	654	100	554	554	100	832.2	841.5	7.2	0.4	6.8	321	79.1	75.8	229	54,341
35	585	100	485	485	100	832.1	841.5	7.2	0.4	6.8	281	69.3	74.0	196	46,085
40	523	100	423	423	100	831.9	841.5	7.2	0.4	6.8	245	60.4	73.1	168	39,522
45	456	100	356	356	100	831.7	841.5	7.2	0.4	6.8	206	50.9	71.2	138	33,279
50	412	100	312	312	100	831.6	841.5	7.2	0.4	6.8	181	44.6	70.9	121	28,079
55	374	100	274	274	100	831.4	841.5	7.2	0.4	6.8	159	39.1	69.8	104	24,408
60	339	100	239	239	100	831.3	841.5	7.2	0.4	6.8	138	34.1	68.8	90	21,051
65	294	100	194	194	100	831.1	841.5	7.2	0.4	6.8	112	27.7	66.6	70	17,379
70	252	100	152	152	100	831.0	841.5	7.2	0.4	6.8	88	21.7	62.4	52	13,256
75	211	100	111	111	100	830.8	841.5	7.2	0.4	6.8	64	15.9	53.5	32	9,125
80	181	100	81	81	100	830.7	841.5	7.2	0.4	6.8	47	11.6	39.7	17	5,416
85	161	100	61	0	161	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	1,900
90	146	100	46	0	146	830.6	841.6	7.3	0.4	6.9	0	0.0	0.0	0	-
95	129	100	29	0	129	830.5	841.5	7.2	0.4	6.9	0	0.0	0.0	0	-
100	75	75	0	0	75	830.3	841.5	7.2	0.4	6.8	0	0.0	0.0	0	-
														272	323,329

Anoka Municipal Utility
 Rum River Dam Hydro Reconnaissance Evaluation
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Max Powerhouse Q =	700 cfs	Speed Increaser Efficiency =	97 %
Rated Hnet =	12 ft	Generator Efficiency =	98 %
Headloss Factor =	5.0 % Hnet	Transformer Efficiency =	99 %

Winter Energy Generation - UEP Unit (Flashboards Up)

Gross Time = 181 days/year

Time (%)	River Flow (cfs)	Min Spill Flow (cfs)	Avail Powerhouse Flow (cfs)	Actual Powerhouse Flow (cfs)	Actual Spill Flow (cfs)	Tail Elev (ft-msl)	Head Elev (ft-msl)	Gross Head (ft)	Head Loss (ft)	Net Head (ft)	Gross Power (kW)	%Crated	Turbine Efficiency (%)	Net Power (kW)	Energy (kWh)
0	11,700	100	11600	0	11700	835.8	846.1	11.8	0.6	11.2	0	0.0	0.0	0	-
5	2,644	100	2544	0	2644	834.7	845.1	10.8	0.5	10.2	0	0.0	0.0	0	-
10	1,650	100	1550	0	1650	833.7	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
15	1,182	100	1082	0	1182	833.2	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
20	889	100	789	0	889	832.7	845.0	10.7	0.5	10.2	0	0.0	0.0	0	-
25	744	100	644	644	100	832.4	844.4	10.1	0.5	9.6	523	92.0	77.4	381	41,356
30	654	100	554	554	100	832.2	844.4	10.1	0.5	9.6	450	79.1	75.8	321	76,211
35	585	100	485	485	100	832.1	844.4	10.1	0.5	9.6	394	69.3	74.0	274	64,632
40	523	100	423	423	100	831.9	844.4	10.1	0.5	9.6	343	60.4	73.1	236	55,427
45	456	100	356	356	100	831.7	844.4	10.1	0.5	9.6	289	50.9	71.2	194	46,672
50	412	100	312	312	100	831.6	844.4	10.1	0.5	9.6	253	44.6	70.9	169	39,379
55	374	100	274	274	100	831.4	844.4	10.1	0.5	9.6	222	39.1	69.8	146	34,231
60	339	100	239	239	100	831.3	844.4	10.1	0.5	9.6	194	34.1	68.8	126	29,523
65	294	100	194	194	100	831.1	844.4	10.1	0.5	9.6	157	27.7	66.6	99	24,373
70	252	100	152	152	100	831.0	844.4	10.1	0.5	9.6	123	21.7	62.4	72	18,590
75	211	100	111	111	100	830.8	844.4	10.1	0.5	9.6	90	15.9	53.5	45	12,797
80	181	100	81	81	100	830.7	844.4	10.1	0.5	9.6	66	11.6	39.7	25	7,596
85	161	100	61	0	161	830.6	844.5	10.2	0.5	9.7	0	0.0	0.0	0	2,665
90	146	100	46	0	146	830.6	844.5	10.2	0.5	9.7	0	0.0	0.0	0	-
95	129	100	29	0	129	830.5	844.4	10.1	0.5	9.6	0	0.0	0.0	0	-
100	75	75	0	0	75	830.3	844.4	10.1	0.5	9.6	0	0.0	0.0	0	-
														381	453,452

Summary:

Month	Max Output (kW)	Energy Gross (MWh)	Energy Net (MWh)
Jan	304	59	56
Feb	241	48	45
Mar	303	60	57
Apr	301	36	34
May	424	89	84
Jun	425	99	94
Jul	425	112	107
Aug	425	112	106
Sep	419	103	98
Oct	353	78	74
Nov	302	75	72
Dec	303	72	68
		943	896

Season	Max Output (kW)	Energy Gross (MWh)	Energy Net (MWh)
Summer	397	532	505
Winter	272	323	307
		855	812
Winter w/ Fboards	381	453	431
		885	836

DRAFT

Appendix C

Manufacturer Quotations



FAX

To: Martin Weber
Stanley Consultants

From: Dominique Bruneau
Marketing

Fax:
cc:

Tel: 450.746.6500 Ext: 5135
Fax: 450.746.6590
Email: dominique.bruneau@power.alstom.com

N° of pages: 7

Date: 10/10/2002

Subject: Budget proposal

Ref.: 83-0031 – Rum River

Dear Mr. Weber,

In answer to your request, we are pleased to submit this budget proposal covering the design, manufacturing and supply of electromechanical equipment for your hydro project.

Our offer is based on the supply of the following:

- One (1) "KAF" Kaplan, dia. 1900 mm, 600 rpm, 0.67 MW

The solution comes complete with generator, control panels, protection equipment, switchgear, mechanical and electrical auxiliaries, supervision during equipment installation, commissioning and transport to site.

The vertical configuration of the unit will allow the draft tube to be rotated toward the center of the river to minimize the impact on the boat docking facility located downstream.

The supply features turbines from ALSTOM's new Mini-AQUA standard range of products to provide proven and cost efficient equipment. Other solutions may also be possible; we would be pleased to discuss any other alternatives that may be advantageous to you.

We trust the following to be to your entire satisfaction and remain available for any other information you may require.

Yours sincerely

Dominique Bruneau
Proposal Manager

940, André-Liné
Granby (Quebec) Canada
J3J 1E2
Tel : (450) 378-0595
Fax : (450) 375-6367



PRELIMINARY PRICING:

- Turbine and auxiliaries
- Hydraulic pumping unit
- Generator and safety accessories
- Parallel shaft speed increaser
- Control and protection panels
- Switchgear
- Auxiliary services equipment, motor control centre, DC system, distribution panel
- Site supervision during equipment installation and commissioning
- Engineering, project management, purchasing and procurement, Q/A, etc.
- Transport to site.

TOTAL:

\$ 1 545 000 USD

All prices are in US funds and preliminary for the delivery period quoted within. Pricing is valid for 60 days and excludes all taxes except Import Duty taxes where applicable.

DELIVERY:

Equipment delivery: 14 months
Commissioning complete: 17 months

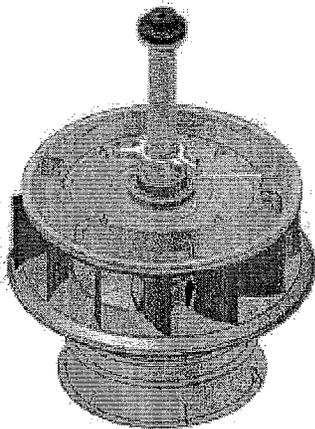
DESCRIPTION OF SUPPLY:

Turbine type :	KAF
Nb. of units :	1
Head (nominal) :	3.81 m (12.5 ft)
Flow (nominal) :	19.822 m ³ /s (700cfs)
Speed :	120 / 600 rpm
Output :	630 kW
Setting :	+ 1.5 m (3.93 ft)

1/ THE TURBINE

Inlet gate and outlet stop-log

The KAF has no adjustable distributor. Therefore, it is necessary to have a system to stop the flow of water in the turbine. This is ensured by a sliding or rolling gate located in the inlet water passage of the turbine. For larger sized units, two gates can be used in parallel, on each side of the upstream pier. A stop log is installed in the draft tube, to isolate the unit from the river for maintenance operations, a dewatering pumping set taking care of the turbine dewatering.



For civil works or environmental constraints, there exist a few cases where the gate is located at the turbine outlet while the stop-log is located at the inlet.

For the lowest heads, and when the downstream water level do not vary too much, it is even possible to install the turbine in a siphon position, over the upstream and downstream water levels. For such cases, no gate nor stop-log are required. The turbine watering is ensured by a vacuum pumping set, while the turbine dewatering is ensured by an air admission valve.

Semi-spiral case

The spiral case as a quasi-rectangular section, providing simple forms to facilitate its fabrication in concrete, on site.

Embedded parts and removable parts

Parts embedded in concrete are limited the metallic part of the draft tube and some anchorage plates where you find the turbine guide vanes and the turbine cover.

The rest of the turbine is connected to these fixed elements through flanges, and is easily accessible and removable. Shaft bearing and shaft seal are accessible through a visit gallery without dismantling the gear box nor the generator.

Runner

The runner is made up 4 blades. These blades are movable to optimise the turbine performances according to the flow variations. Their movement is ensured by an oil servomotor located in the runner hub. The oil distributing ring is the standard type available in the market and is mounted at the end of the generator or gear-box shaft.

Shaft seal

The shaft seal is a packing type.

Unit bearings, thrust bearing and counter-thrust bearing

The turbine bearing is the sleeve type, water-lubricated, and is located in the distributor cone, close to the runner.

The thrust and counter-thrust bearings are integrated in the speed increaser, and the generator has one upper bearing.

Alternatively, for direct coupled generators, the thrust and counter-thrust bearings are integrated in the generator, most often they are combined with the generator upper bearing. Thrust and counter-thrust bearings are lubricated by oil circulation.

Generator versus turbine coupling

The coupling is a direct coupling using flanges, pins and studs, either between generator and speed increaser, or between generator and turbine.

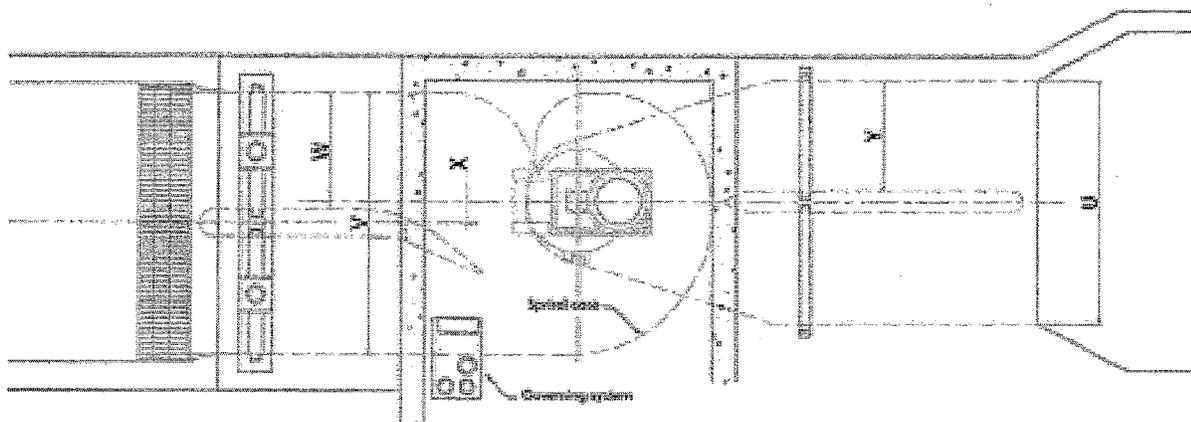
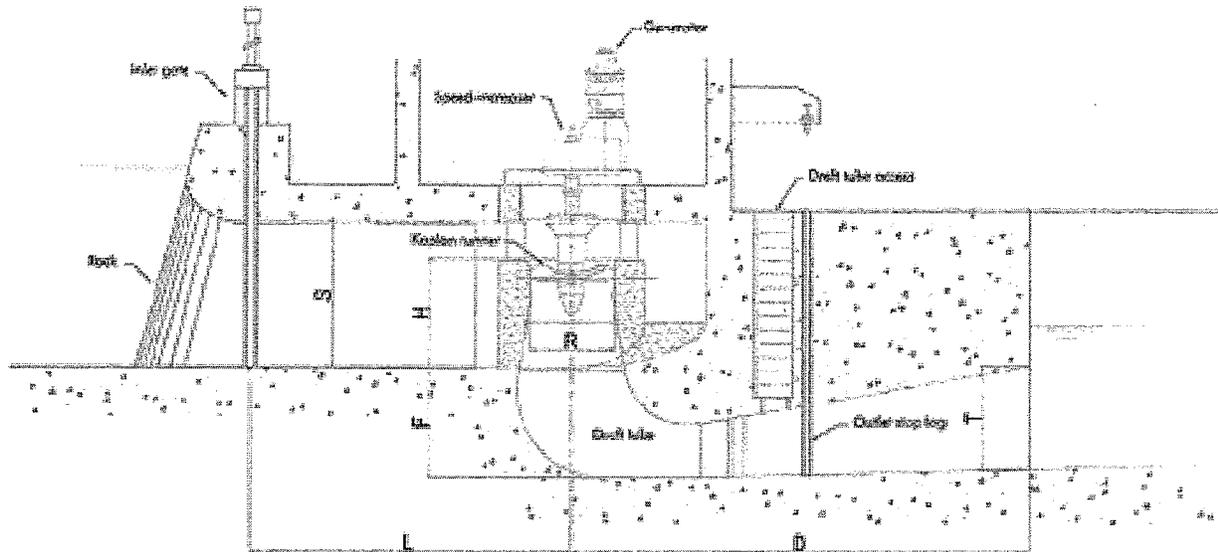
Oil control system

The oil power pack is a fully equipped sump tank on which take place :

- an electric motor-driven pump,
- an oil filter,
- check valve assemblies controlling opening and closing of blades and eventually distributor,
- a safety set (pressure switch, temperature probe, level),

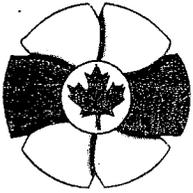
2/ THE GENERATOR

At rated speed the generator has sufficient capacity to continuously match the rated output of the turbine under extremes of site ambient conditions. The generator is of the salient pole or cylindrical rotor type and sustains all efforts induced by the turbine, including runaway speed.



RUNNER DIAMETER	R	1900
Inlet length	L	7130
Draft tube length	D	10070
Semi-spiral case depth	K	3010
Inlet width	V	5740
Inlet gate width	W	2620
Semi-spiral case height	S	3220
Draft tube height	F	2460
Outlet width	U	5420
Outlet stop-log width	Y	2460
Outlet height	T	2380
Concrete support diameter	C	3420
Concrete support height	H	2420
Outlet / Inlet axes distance	X	495
Inlet wall thickness	-	500
Outlet wall thickness	-	500

** Dimensions in mm



CANADIAN
HYDRO
COMPONENTS LTD.

16 Main Street
Box 640
Almonte, Ont.
K0A 1A0

Tel: (613) 256-1983
Fax: (613) 256-4235
email: hydro@istar.ca
www.canadianhydro.com

RECEIVED

OCT 31 2002

STANLEY CONSULTANTS
MINNEAPOLIS

October 21, 2002

Martin J. Weber
Stanley Consultants, Inc.
5775 Wayzata Blvd. Suite 955
Minneapolis, MN
55416

Re: Rum River Project

Dear Mr. Weber,

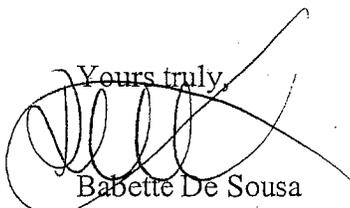
Kindly find enclosed our proposal for the Rum River Project as per your emailed request dated September 12, 2002.

Our proposal consists of a budgetary price, performance curves at various heads and preliminary drawing of the proposed equipment.

Delivery on this water-to-wire package would be 44-48 weeks ARO.

If you have any questions please do not hesitate to contact our office.

Yours truly,



Babette De Sousa
General Manager

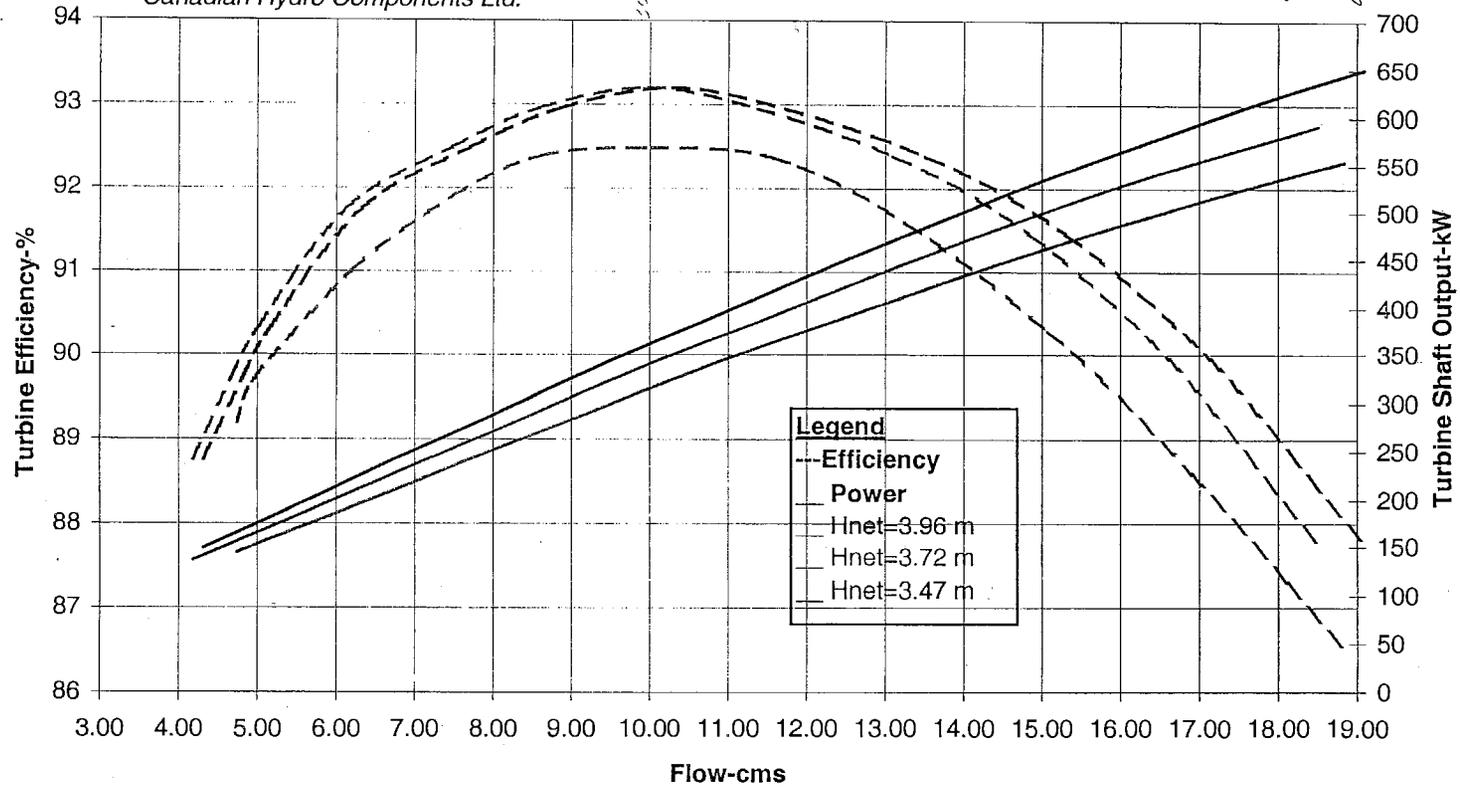
Encl.

Rum River Project (Performance Curves at various Heads)

Axial Flow Bevel Gear Double Regulated Turbine (4 blade)

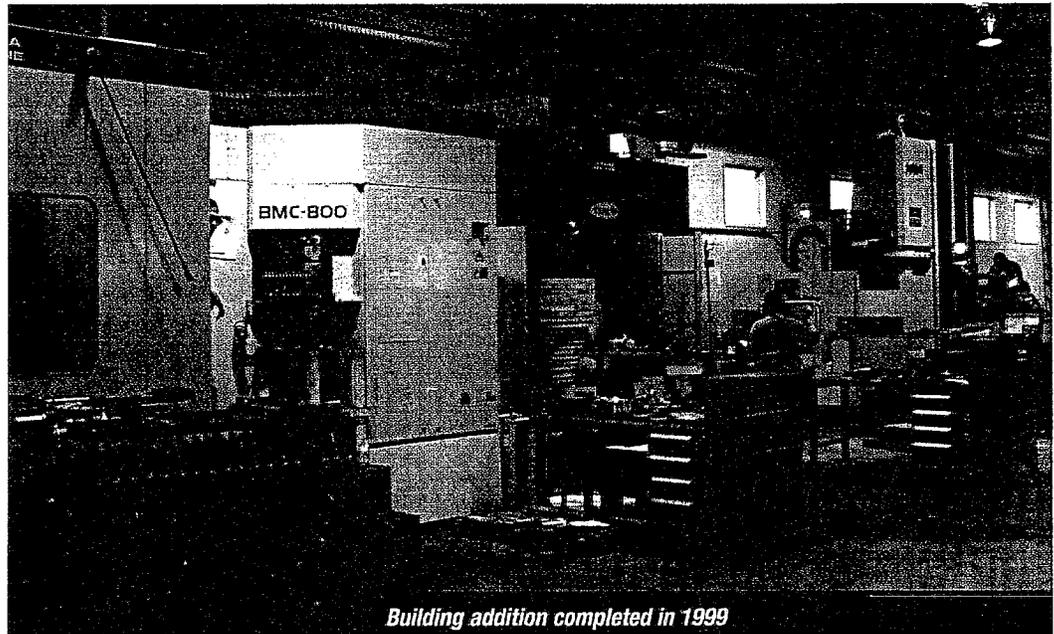
1700 mm / 220 rpm

Canadian Hydro Components Ltd.





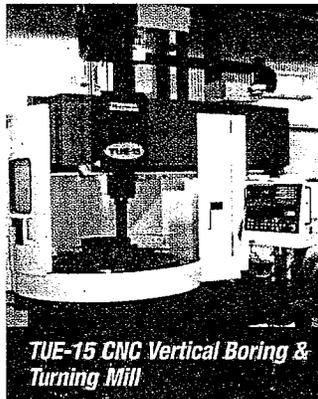
Manufacturing Facility



Building addition completed in 1999

The **Canadian Hydro Components** facility consists of close to 20,000 square feet of manufacturing space with a crane capacity of 10 tons.

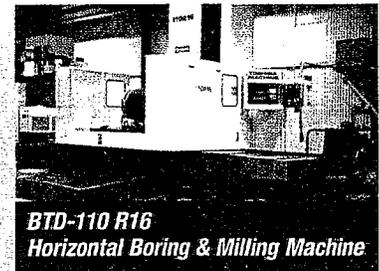
A number of CHC's work centers are equipped with state-of-the-art Toshiba Machine Tools which allows for the production of a quality product.



TUE-15 CNC Vertical Boring & Turning Mill

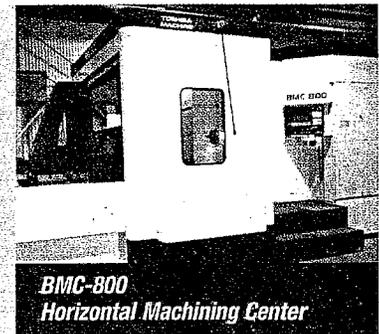
1500 mm table diameter
1800 mm max. swing
1500 mm max. cutting height
8000 kg. max. table load
CNC FANUC Series 18-TB system

Table load 6300 kg.
X-axis travel: 2000 mm
Y-axis travel: 1800 mm
Z-axis travel: 1450 mm
CNC TOSNUC 888 control



**BTD-110 R16
Horizontal Boring & Milling Machine**

X-axis travel: 1600 mm
Y-axis travel: 1250 mm
Z-axis travel: 1200 mm
CNC system TOSNUC 888



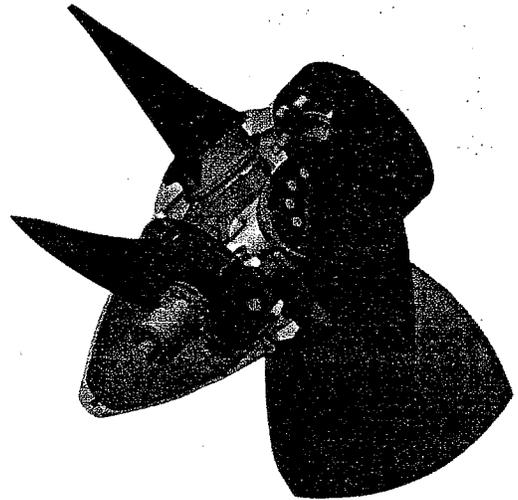
**BMC-800
Horizontal Machining Center**

Canadian Hydro Components Ltd.

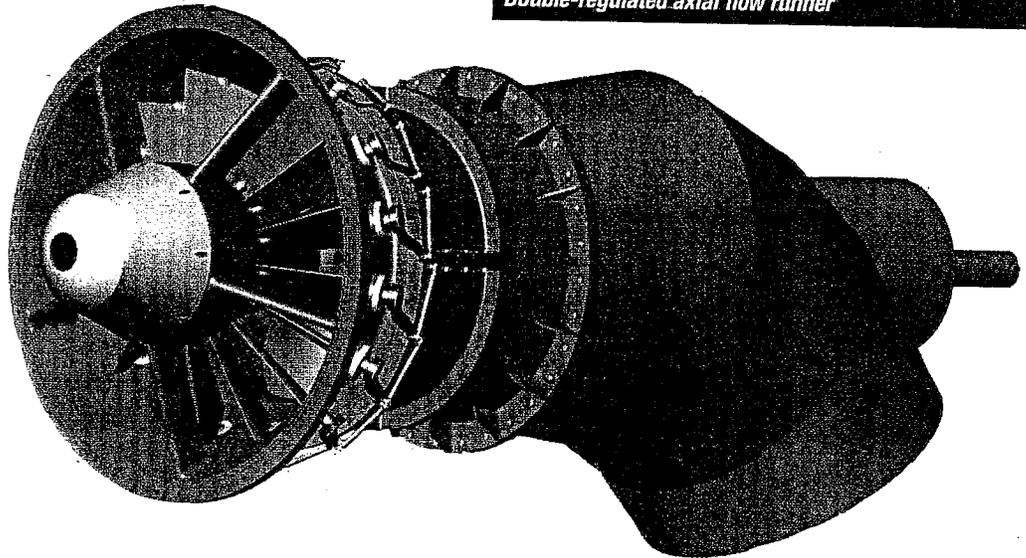
Small Hydro Specialists



Our team of highly qualified professionals uses specialized computer software to aid in the 3-D design and CNC programming for the manufacture of precision turbine components.



Double-regulated axial flow runner



1500 mm "S" type axial flow KAPLAN turbine

Almost all the manufacturing processes from design, pattern work, machining and welding are completed in house which gives CHC complete control over product quality while ensuring a reliable delivery.



1500 mm axial flow turbine patterns

Canadian Hydro Components Ltd. — 16 Main Street, P.O. Box 640, Almonte, Ontario Canada K0A 1A0
Phone: (613) 256-1983 • Fax: (613) 256-4235
Email: inquiries@canadianhydro.com • www.canadianhydro.com

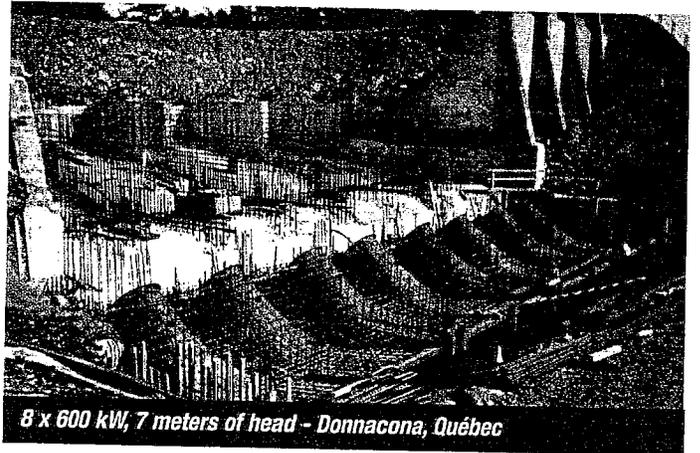


New Turbines

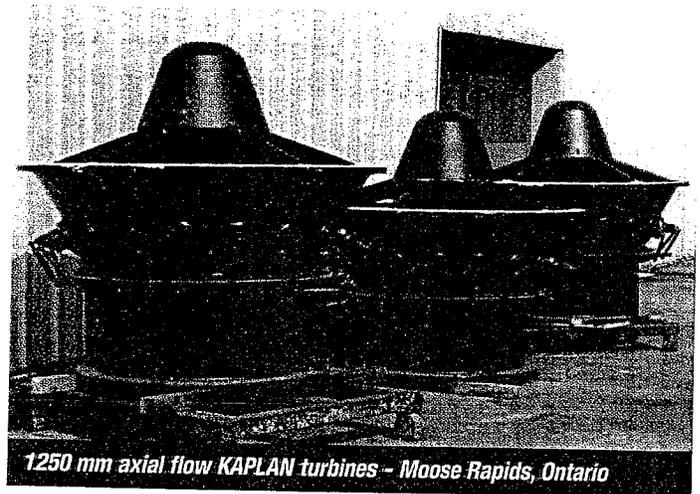
Canadian Hydro Components (CHC)

designs and manufactures a wide range of hydroelectric turbines designed specifically for low to medium head sites ranging in outputs from 50 kW to 15 MW. Our technology and modern manufacturing techniques have enabled us to produce a line of turbines that will guarantee maximum output power at a cost-effective price. We can supply the turbine heart alone or a complete water-to-wire package designed to suit our customers' needs.

Our current line of high performance axial flow turbines includes eight standard sizes from a minimum 500 mm up to 2000 mm in runner throat diameter. Our double regulated turbines, with adjustable blades and wicket gates, allow for optimum efficiency over a wide range of flow. A more economical alternative is our single regulated turbine consisting of fixed blades and adjustable wicket gates and is more suitable when a constant flow is available. As a result of growing customer demand, CHC plans to expand its product range to include a 2500 mm axial flow turbine.



8 x 600 kW, 7 meters of head - Donnacona, Québec



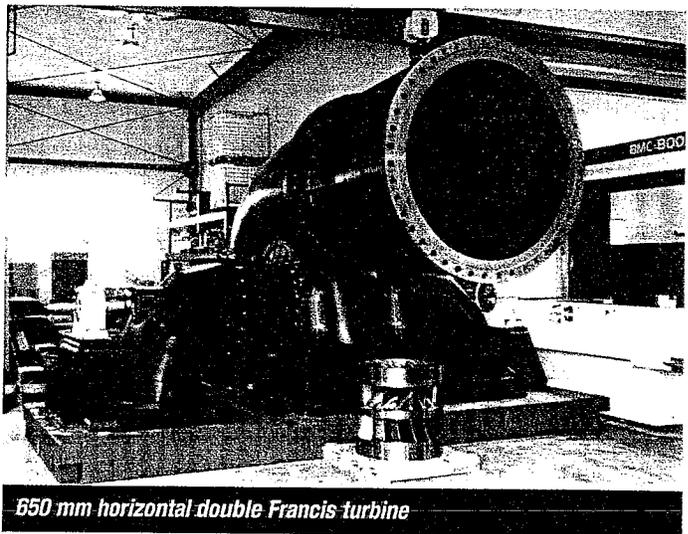
1250 mm axial flow KAPLAN turbines - Moose Rapids, Ontario

Canadian Hydro Components Ltd.

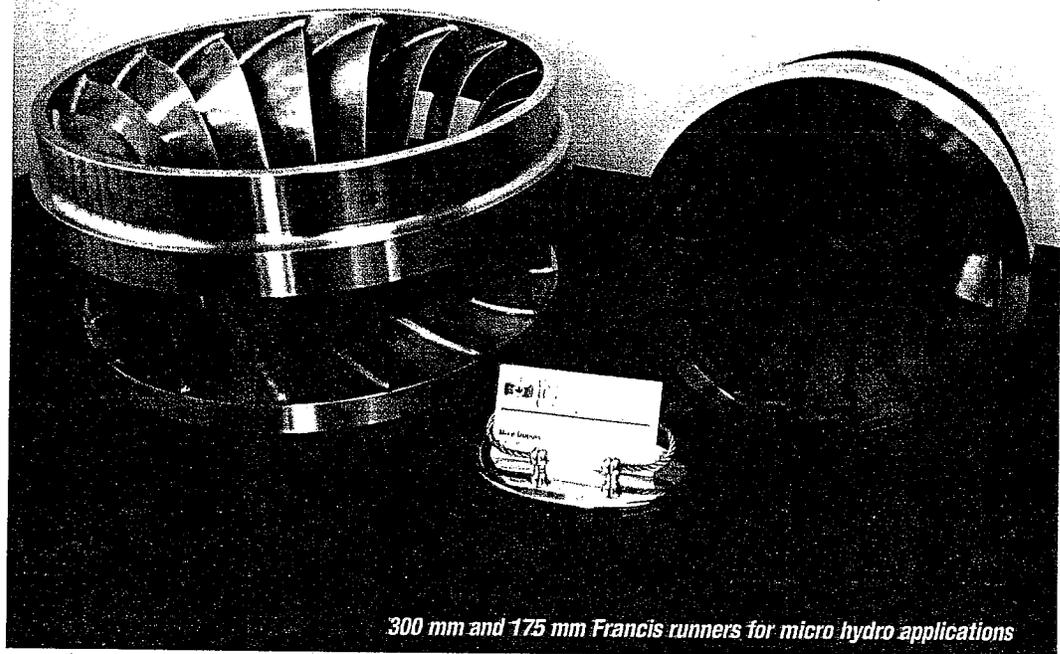
Small Hydro Specialists



Our Francis turbines feature single or double runners in diameters designed specifically to suit each individual site. We have standardized our engineering and manufacturing approach to quickly and efficiently build a custom designed site specific Francis turbine. Our designs allow for both vertical and horizontal shaft configurations.



650 mm horizontal double Francis turbine



300 mm and 175 mm Francis runners for micro hydro applications



TABLE OF CONTENT

SCOPE OF SUPPLY
DESIGN DATA
ALTERNATIVES
SUPPLY / SOURCING
DRAWINGS

SCOPE OF SUPPLY

Our scope of supply covers one Vertical Full Kaplan Turbine coupled to a Synchronous generator of 600 kW rated output through speed increasing gearbox as per the detailed scope specified below.

Sl.No.	Description	Quantity
1.	Vertical Full Kaplan Turbine	1 No.
2.	Power House auxiliaries	1 Set
3.	Hydraulic Power Pack	1 No.
4.	Gear Box	1 No.
5.	0.415 kV, 600 kW, 0.85 pf, 750 rpm Vertical Synchronous Generator	1 No.
6.	Indoor Switch Gear and Out Door Yard Equipment	1 Set
7.	Essential Spares	1 Set
8.	Tools & Tackles	1 Set

The following are not considered in our scope of supply

- Any of the civil works
- Gates & Trash racks
- Penstocks
- Items, which are not specified in the scope of supply



DESIGN DATA

Description	
TURBINE:	
Type of Turbine	Vertical Kaplan
No. of units x Rating	1 x 600 kW
Rated turbine output	644.47 kW
Rated head	3.65 M (12 ')
Runner diameter	2500 mm
Rated speed	125 rpm
Specific speed	628.99 kW-rpm
Discharge at 100% load	19.312 m ³ /s
Efficiency at 100% load	93.20%
Runaway Speed	375 rpm
GENERATOR:	
Type of generator	Vertical Synchronous
Rated output	600 kW
Rated speed	750 rpm
Rated voltage	0.415 kV
Power Factor	0.85
Efficiency at 100% load	94.0%

ALTERNATIVES

An S-type (Horizontal Full Kaplan) is another option for this application. The S-type will be a more expensive solution (in lower head and output ranges), but will require less civil work. The reasons for the price difference are e.g.:

- For the same size turbine less material content for the Vertical Full Kaplan (VFK) compared to S-type because spiral will be formed with concrete instead of steel plate lining.
- We normally avoid providing cooling water system and de-watering system for VFKs. Whereas S-type require cooling water system as mandatory because of water-cooled bearing. A Drainage Water System is also needed for the S-type.
- The auxiliary system will also be simpler for a VFK.



SUPPLY / SOURCING

GE Hydro has long experience supplying Small Hydro Solutions worldwide. Within GE Hydro a dedicated team is working with Small Hydro. This team - the GE Hydro Small Hydro Centre of Excellence (CoE) has the overall responsibility for the product line, which include supplies the product, technology, performance and QA responsibility and supervision of supplier partners.

This delivery is planned based on our supplier partner Boving Fouress Ltd., India. Boving Fouress Ltd. is 38% owned by GE Hydro, and have successfully supplied hydro power equipment under a licence agreement with GE Hydro the last 15 years.

DRAWINGS (typical)

Station Arrangement Elevation

Station Arrangement (Elevation and Plan)

Weber, Martin

From: david.henzl@ps.ge.com
Sent: Monday, October 21, 2002 5:12 PM
To: Weber, Martin
Cc: robert.balletti@ps.ge.com; robert3.young@ps.ge.com
Subject: RE: Rum River Hydro



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Marty,

In response to your request for a preliminary cost estimate for the Rum River Hydroelectric Project, GE Hydro Power, Inc. (GEHPI) is pleased to provide the following budgetary proposal.

Please see attached "Preliminary Spec" document and preliminary arrangement drawings. Budgetary price for these items, based on a vertical Kaplan turbine arrangement: approx USD\$ \$940,000.

An alternate arrangement is a horizontal S-type Kaplan turbine. The equipment cost will be approx 10 - 15% higher, however the civil cost may be less. This is further described in the attachment.

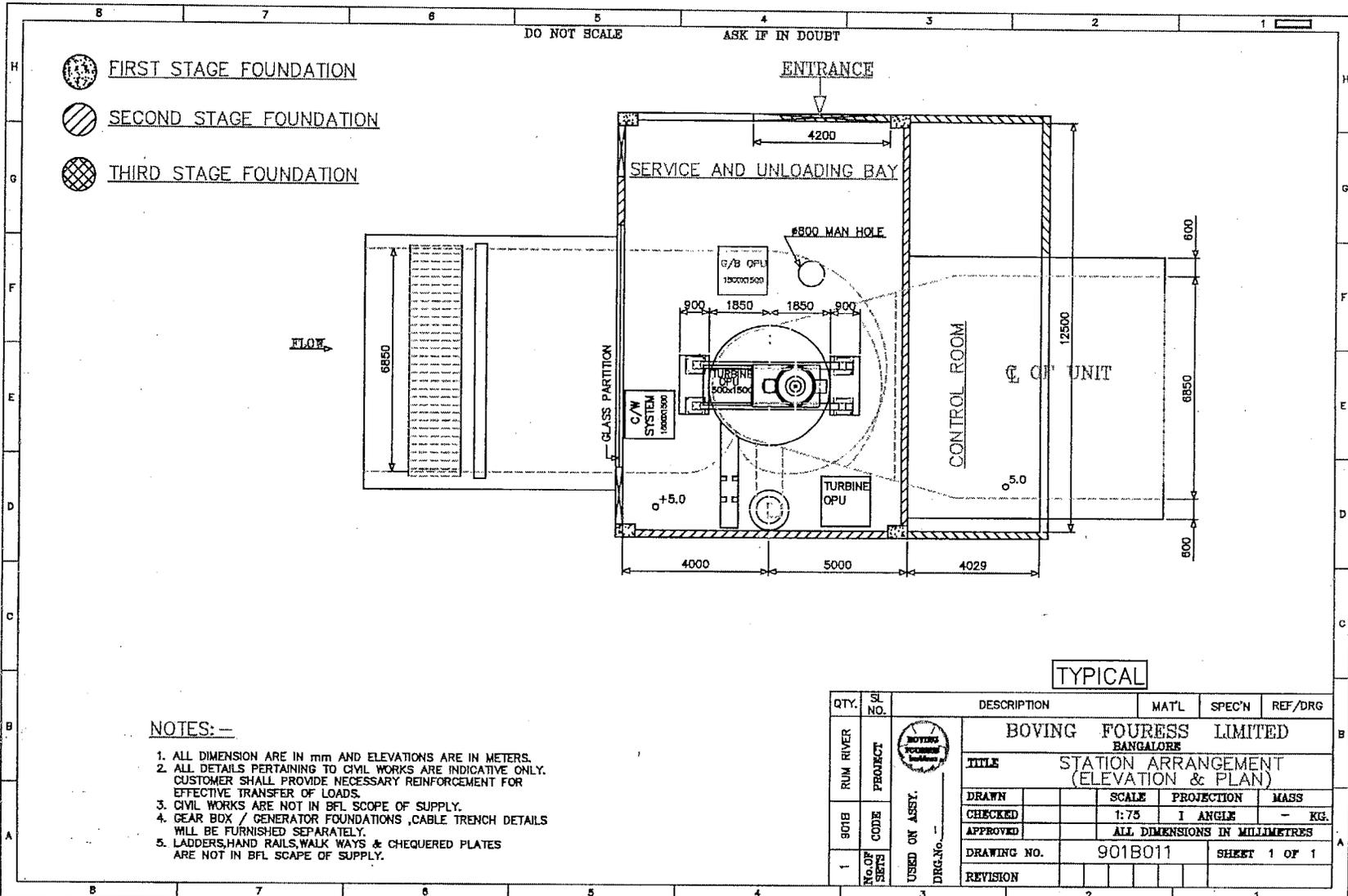
This cost estimate is preliminary, non-binding, and is based on the following:

- The cost estimate includes the design, manufacture, and preparation for shipment of the listed items.
- Shipping cost is not included.
- Import duty is not included.
- Taxes are not included.
- Unloading and/or storage at the jobsite is not included.
- Installation is not included.
- Supervision of installation is not included.
- Progress payments (no finance costs are included).
- Current cost levels for labor and materials.
- Current currency exchange rates.
- No sourcing restrictions.
- Standard delivery times (no overtime is included): approx 9 - 10 months.
- Standard GE terms and conditions.

We hope that this information will be beneficial for your study of this project, and please don't hesitate to contact me if you have any questions or require any additional information at this time.

Best regards,
David Henzl
GE Hydro Power, Inc.

6130 Stoneridge Mall Road, Suite 275
Pleasanton, CA 94588 USA
Office Phone: 925-750-6107 DC 8*299-6107
Cell Phone: 415-298-3681
Office Fax: 925-924-1338
Email: David.Henzl@ps.ge.com
Website: www.GEpower.com

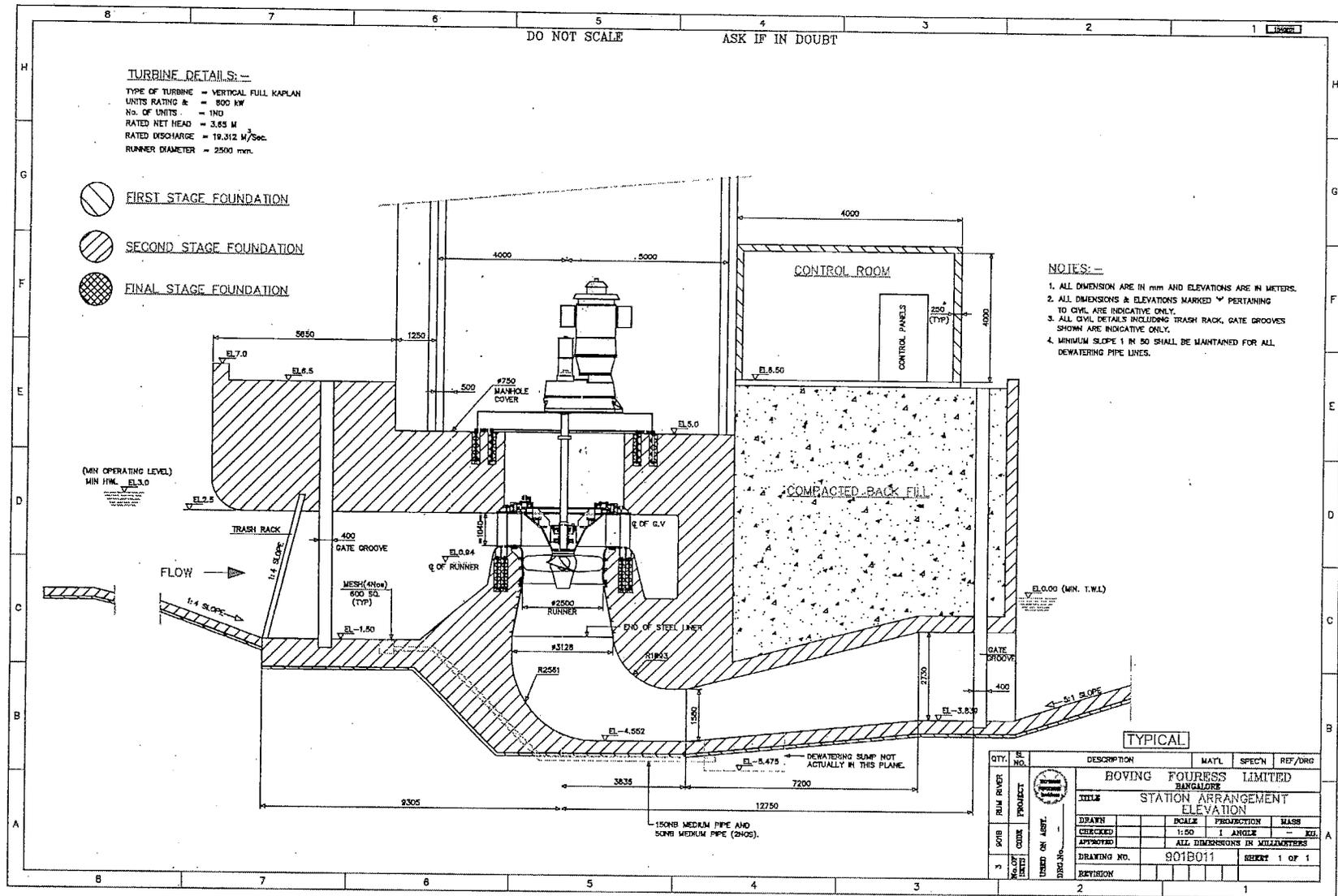


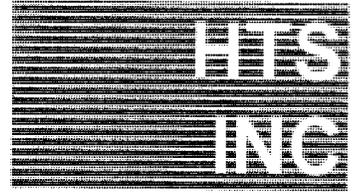
-  FIRST STAGE FOUNDATION
-  SECOND STAGE FOUNDATION
-  THIRD STAGE FOUNDATION

- NOTES: —**
1. ALL DIMENSION ARE IN mm AND ELEVATIONS ARE IN METERS.
 2. ALL DETAILS PERTAINING TO CIVIL WORKS ARE INDICATIVE ONLY. CUSTOMER SHALL PROVIDE NECESSARY REINFORCEMENT FOR EFFECTIVE TRANSFER OF LOADS.
 3. CIVIL WORKS ARE NOT IN BFL SCOPE OF SUPPLY.
 4. GEAR BOX / GENERATOR FOUNDATIONS ,CABLE TRENCH DETAILS WILL BE FURNISHED SEPARATELY.
 5. LADDERS,HAND RAILS,WALK WAYS & CHEQUERED PLATES ARE NOT IN BFL SCAPE OF SUPPLY.

TYPICAL

QTY.	SL NO.	DESCRIPTION	MAT'L	SPEC'N	REF/DRG
		BOVING FOURESS LIMITED BANGALORE			
		TITLE STATION ARRANGEMENT (ELEVATION & PLAN)			
		DRAWN	SCALE	PROJECTION	MASS
		CHECKED	1:75	I ANGLE	— KG.
		APPROVED	ALL DIMENSIONS IN MILLIMETRES		
		DRAWING NO.	901B011	SHEET 1 OF 1	
		REVISION			





HYDROPOWER TURBINE SYSTEMS, INC.

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Wednesday, 20 November 2002

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კვნუხ პსნკტკკლ
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Mr. Martin J. Weber, PE
STANLEY CONSULTANTS, INC.
5775 Wayzata Blvd., Suite 955
Minneapolis, MN 55416

PROPOSAL

REFERENCE NUMBER: P - 2126
PROJECT NAME: RUM RIVER HYDRO at ANOKA, MN

We are pleased to offer in accordance with our TERMS AND CONDITIONS OF SALE AND DELIVERY and the INTERNATIONAL CODE FOR THE FIELD ACCEPTANCE TESTS OF HYDRAULIC TURBINES, without engagement:

Two Turbine/Generator Sets suitable for asynchronous operation, based on the "Flow Duration Power Analysis – Rum River at Anoka, MN" data provided by Client, comprising the following:

Two Kaplan Bulb turbines type MAVEL KB1290K3. Each turbine set would include the following:

- automatic position transmitters for runner blades and guide vanes
- complete set of sensors
- belt drive with pulleys (belt Type Habasit Aramid TF150)
- hydraulic pressure unit
- steel draft tube
- asynchronous generator with belt tensioner
- corrosion protection
- technical documentation

1.1 Turbine type

The Kaplan turbine MAVEL KB1290K3 has a horizontal shaft. The turbine is double regulated. The four blade runner has a diameter of 1290 mm.

The turbine guide vanes will be able to reduce the water flow to such an extent that the turbine can be stopped. In case of an emergency shutdown, the guide vanes will be closed by weight.

1.2 Technical data

Rated head	3,69 m (= 12.1 ft)
Rated discharge	9,0 m ³ /s (= 255 cfs)
Rated turbine power	311 kW
Proposed turbine setting and maximum suction head	0,5 m (= 1.6 ft)
Rated speed	280,6 rpm
Runaway speed	753 rpm

	Time		River flow		No. of units	Turbine flow	Gross head		Head loss		Net head	Turbine power	Gen. power	Total power	Energy production
	%	[days]	[h]	cfs			[m ³ s ⁻¹]	[m ³ s ⁻¹]	ft	[m]					
5	18,25	438	2572	72,8	2	9,6	12	3,66	0,6	0,18	3,47	294,1	265,3	530,6	232425
10	18,25	438	1672	47,3	2	9,6	12,2	3,72	0,6	0,18	3,54	300,2	270,8	541,6	237213
15	18,25	438	1286	36,4	2	9,6	12,4	3,78	0,6	0,18	3,60	305,7	275,8	551,5	241570
20	18,25	438	1035	29,3	2	9,6	12,4	3,78	0,6	0,18	3,60	305,7	275,8	551,5	241570
25	18,25	438	865	24,5	2	9,6	12,5	3,81	0,6	0,18	3,63	308,6	278,4	556,8	243887
30	18,25	438	758	21,5	2	9,6	12,5	3,81	0,6	0,18	3,63	308,6	278,4	556,8	243887
35	18,25	438	671	19,0	2	9,5	12,7	3,87	0,6	0,18	3,69	311,2	280,7	561,4	245901
40	18,25	438	606	17,2	2	8,6	12,8	3,90	0,6	0,18	3,72	283,5	255,8	511,6	224064
45	18,25	438	549	15,5	2	7,8	12,9	3,93	0,6	0,18	3,75	263,3	237,5	475,0	208064
50	18,25	438	497	14,1	2	7,0	13	3,96	0,7	0,21	3,75	239,4	214,8	429,6	188158
55	18,25	438	444	12,6	2	6,3	13,2	4,02	0,7	0,21	3,81	218,0	195,6	391,2	171343
60	18,25	438	398	11,3	2	5,6	13,3	4,05	0,7	0,21	3,84	197,0	176,8	353,5	154853
65	18,25	438	357	10,1	2	5,1	13,4	4,08	0,7	0,21	3,87	178,0	159,7	319,3	139868
70	18,25	438	311	8,8	2	4,4	13,6	4,15	0,7	0,21	3,93	156,7	139,9	279,7	122511
75	18,25	438	271	7,7	1	7,7	13,7	4,18	0,7	0,21	3,96	274,8	247,9	247,9	108574
80	18,25	438	226	6,4	1	6,4	14	4,27	0,7	0,21	4,05	236,2	211,9	211,9	92817
85	18,25	438	187	5,3	1	5,3	14,1	4,30	0,7	0,21	4,08	197,1	176,9	176,9	77461
90	18,25	438	158	4,5	1	4,5	14,1	4,30	0,7	0,21	4,08	163,5	146,7	146,7	64257
95	18,25	438	132	3,7	1	3,7	14,2	4,33	0,7	0,21	4,11	137,9	123,1	123,1	53916
100	18,25	438	70	2,0	1	2,0	14,2	4,33	0,7	0,21	4,11	68,8	60,7	60,7	26604

Total energy production kWh

2306739

These parameters were calculated with head losses specified by client. We reserve the right to specify head losses after completion of layout and design according to actual site conditions.

- Outside guide vane ring is produced of cast steel.
- Complete control mechanism of the turbine distributor with guide vanes, leverage, shear pins and regulation ring are parts of distributor. All DU bushings are self-lubricated.
- Material of guide vanes including pins is GGG50. Stainless steel for guide vanes is optional.
- Inside guide vane ring is part of pear in the turbine body.
- Guide vanes are CNC mill machined

condition with auto-restart feature upon fault clearance.

Power supply: 480V/3/60

Level sensor unit with junction box sensor, protection tube, pressure sensor with interference resistive digital signal and over voltage protection.

Signal cable between sensor and power house excluded.

3.2 Mode of operation:

Manual (set turbine flow at fixed position)

Automatic (water level control - run of the river)

3.3 Switchgear

The electric switchgear holds a 3-phase contactor or circuit breaker (one per unit) and a multi-function basic generator protection device with data display and instrumentation.

An itemized list of required grid protection features is generally provided by the utility company.

4. PRICE

Budget pricing for (2) sets, FOB Anoka, Minnesota:

\$ 775,000

Prices are without U.S. Sales Taxes – per OTI terms and Incoterms 2000.

5. TERMS

5.1 Delivery

Delivery would be 10 months from the date of signing the contract.

5.2 Warranties

Standard warranties are for 24 months.

5.3 Offer Validity

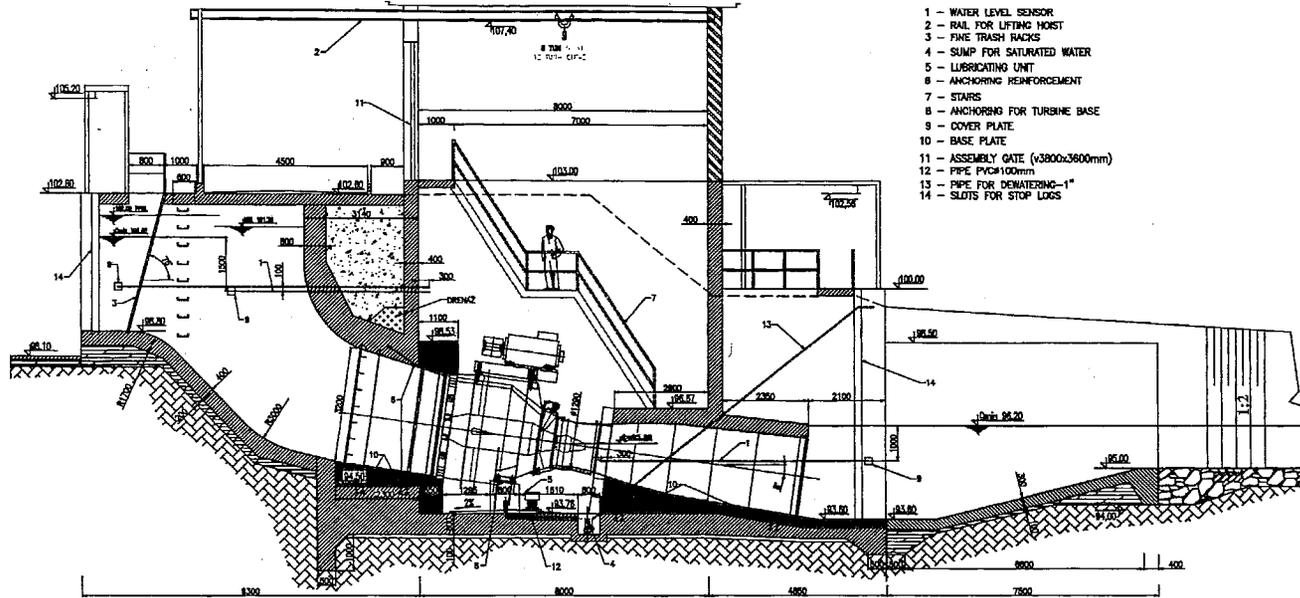
This offer is valid until 30th January, 2003.

HYDROPOWER TURBINE SYSTEMS, INC.

Enclosure: Reference drawing 2126-00

SHPP ANOKA - PROJECT

THIS DRAWING IS FOR INFORMATION ONLY. — elevation will be changed after final design

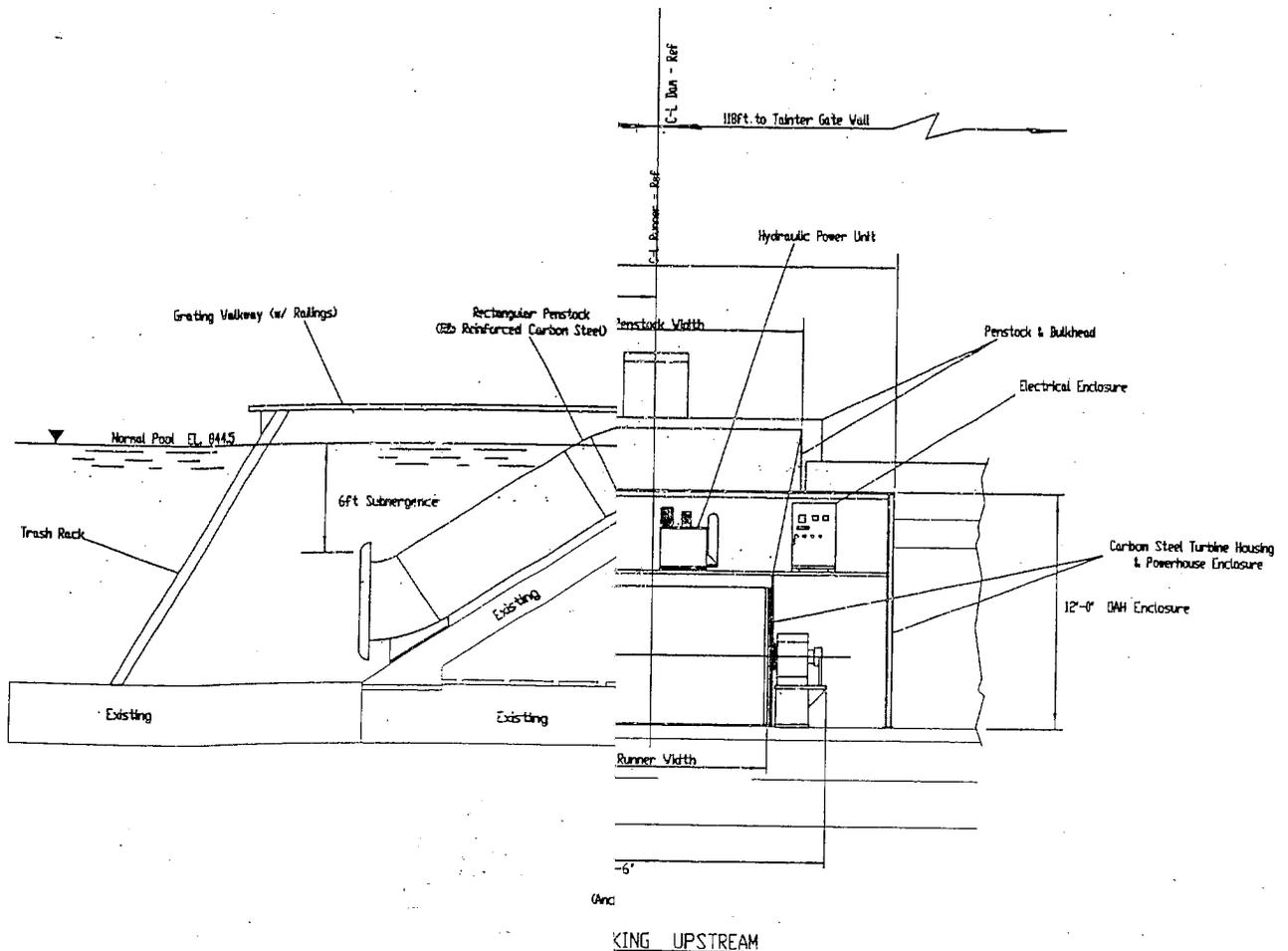


- 1 - WATER LEVEL SENSOR
- 2 - RAIL FOR LIFTING HOIST
- 3 - FINE TRASH RACKS
- 4 - SUMP FOR SATURATED WATER
- 5 - LUBRICATING UNIT
- 6 - ANCHORING REINFORCEMENT
- 7 - STAIRS
- 8 - ANCHORING FOR TURBINE BASE
- 9 - COVER PLATE
- 10 - BASE PLATE
- 11 - ASSEMBLY GATE (x3800x3600mm)
- 12 - PIPE PVCØ100mm
- 13 - PIPE FOR DOWATERING-1"
- 14 - SLOTS FOR STOP LOGS

- PRIMARY CONCRETE KONSTRUKCE
- SECONDARY CONCRETE
- NATURE GROUND
- BASE CONCRETE

Project	Project	Year	HTS INC	
D. Svedahl	Proj. 12/2008	Proj. 12/2008		
Investor	Oscarberger	White study Anoka		
		K.C.	USA	
Name	SHPP ANOKA		Date	12/2008
Client	2126-00		Scale	1:50
Check			Exp. No.	001
			Exp. Date	12/2008

AN - 001



GENERAL ARRANGEMENT DRAWING
PRELIMINARY DIMENSIONAL LAYOUT

Submitted to: City of Anoka, Minnesota
Run River Hydroelectric Project
EST: 550kW @ 650cfs and 12.5' Head

Weber, Martin

From: David Sinclair
Sent: Thursday, December 12, 2002 3:04 PM
To: webermartin@stanleygroup.com
Subject: Fw: Anoka Hydro

Dear Martin,

Thanks for your message and the associated questions. Let me first introduce myself, I am David Sinclair and I have recently joined the team at UEP. I have worked with that team to provide the answers to your questions below. If you need further assistance please don't hesitate to contact me directly.

Regards

David Sinclair

David C. Sinclair
VP Business Development
Universal Electric Power
Visit us at www.uepholdings.com
+1 330 535 7115
+1 330 535 7250 (fax)
+1 440 724 9900 (mobile)

----- Original Message -----

1. During our phone conversation of 10/14/02, you indicated that UEP could provide a 500 kW installation for \$885,000. Is that number still good? Does your cost include dewatering, access, trashrack, etc.?
The price is still \$885,000 turnkey installation including the trashrack, walkway etc. It assumes that crane access is readily available. No dewatering is required as we intend to use a syphon system to charge the penstock. It does not include any special provisions for heavy ice flow or other heavy duty protection as we do not have specific site knowledge of what may be required.
2. You also provided operating characteristics ranging from 500 kW @ 700cfs to 75 kW @ 100 cfs. Are these still valid?
Yes, although the low end operation may be more like 70kW depending on the overall efficiency. I have put your data into the RETScreen program (see attached) and although this is based on generic cross flow turbine operation it may be usefull as a project tool for you. The front page has the information on how to download the software free. According to these calculations one can expect to generate over 2,200 MWHrs per annum. How does this compare with your findings?
3. Unit is shown in the center of the dam, wouldn't it be better located next to one of the abutments?
The unit can be placed as you deem fit, noting that we need to have full flow conditions so as not to starve the unit hydraulically when it is placed too close to the river bank or abutment.
4. Would the installation require removal of the existing stilling basin baffle blocks and end sill?
No
5. Is any protection required for ice or debris?
The short answer is; yes. However as indicated above we do not have data for the protection requirements so we would need to work closely

12/16/02

with you to determine requirements.

6. What warranty does UEP general offer with the equipment?

UEP offers a 5 year warranty on its equipment on parts and labor, which is by far the best in the industry. For major purchased items such as the speed increaser and generator we will pass through the manufacturer's warranty.

7. How often is maintenance required on equipment (e.g. grease, oil, etc.)?

Typically every 6 months for about 3-4 hours excluding trashrack cleaning

8. Do you have any noise data for a running unit?

Each system's noise profile is dependent on site conditions and the type of enclosure we utilize. This will be estimated during the detailed design stage, however we would not expect this system to add significantly to the prevailing local noise level from the spillway etc.

9. Can you provide a photo of the demonstration project for inclusion in my report?

Please see the pictures attached

10. How is turbine discharge controlled (e.g. during low river flow to accommodate min spillway flow)?

The turbine flow is controlled automatically by the inlet nozzle that can regulate down to 2% of nominal flow. If the unit is to interface with the tainter gate controls we will need to look closely at the required algorithm.

11. Is startup and shutdown remote?

The system as quoted is fully automatic. If remote access and control is required this can be provided at additional cost. The access would be via phone line and dial-up modem or some other media. Depending on the features required, this can cost from \$5,000 to \$15,000 to accomplish.

12. If flashboards are lost and pool lowers to say 842, what is effect on unit operation and efficiency?

If the flashboards are lost we would assume a loss of around 2ft. of available head. Thus proportionally the power output would be reduced and somewhat reduced efficiency. At 700cfs we can expect around 450kW of output. The unit will continue to operate safely and without damage to the runner.

13. Does powerhouse enclosure need to be heated?

We do not expect so as the equipment generates heat. However we will be providing heating pads or wires to specific items in the power house in case the system is down for an extended period during winter conditions. The syphon system will be heated.

14. How is siphon started and stopped?

There is an automated or manual start-up sequence which will be included as part of the training. A remote option can be engineered at extra cost.

15. Is cooling required for bearings or generator, etc.?

UEP will included the cooling system as part of its turnkey enclosure.

I hope these answers are helpful. As I said earlier, if you have further questions, please don't hesitate to contact us directly. We wish you success in your presentation tomorrow. We would like to hear how it went! We also look forward to working closely with you on implementing this exciting project.

VA TECH HYDRO**RECEIVED**

SEP 19 2002

STANLEY CONSULTANTS
MINNEAPOLIS

September 13, 2002

Stanley Consultants, Inc.
5775 Wayzata Blvd., Suite 955
Minneapolis, MN 55416

Attention: Mr. Martin J. Weber

Subject: Rum River Hydro Project

Dear Mr. Weber:

Thank you for your recent inquiry requesting information on hydroturbine equipment for the subject application. We have reviewed the site characteristics you had provided in your e-mail of September 12, 2002 and we have selected an equipment arrangement which we feel may be the most economical and least obtrusive to the surroundings. Based on the site net head and plant discharge figures you had submitted, we propose an equipment supply scope including one propeller type turbine, induction generator and hydraulic pressure unit. Also proposed is a controls/switchgear package.

The unit configuration suggested is a horizontal (or slightly inclined) propeller turbine driving the generator through a speed increaser, both of which are mounted within a watertight bulb assembly immediately upstream of the runner. The turbine is proposed to have fixed vanes and adjustable runner blades resulting in a wide operating flow range. This would, however, require the use of an intake gate or draft tube gate for unit start-up and shutdown (gate not proposed herein). The unit arrangement is designed to be installed in a flume intake to be constructed adjacent to the tainter gate bay at the left abutment area. Attached are drawings of similar units recently provided for the Windsor Project in Canada.

The unit electrical/hydraulic lines can be brought directly into a simple housing where the controls/switchgear line-up would be mounted. You will note that with this design approach a complex and costly powerhouse structure can be avoided.

VA TECH HYDRO

Page 2) 09/13/02

The following technical data is submitted:

Turbine Type - Horizontal Bulb Type with Fixed Vanes, Adjustable Blades

Number of Units - 1

Net Head - 11.6 feet (3.54m)

Max. Discharge/Unit - 833 cfs (23.6 m³/s)

Runner Diameter - 2240 mm

Turbine Speed - 134 rpm

Intake Type - Axial, Open Flume

Draft Tube Type - Straight

Max. Turbine Output
at 3.54m (11.6 feet) net head: - 733 KW per turbine

Turbine Performance at 3.54m net head:

Turbine Discharge (m ³ /s)	Efficiency (%)	Output (KW)
23.6	89.4	733
21.2	92.4	682
18.9	91.9	603
16.5	90.4	519
14.2	89.4	440
11.8	87.9	360
7.08	79.9	196

Generator Type - Horizontal Induction

Generator Rating - 680 KW (Nominal)

Speed - 900 rpm (60 Hz)

Voltage - 4160 V

Temperature Rise - 80°C over 40°C Ambient

VA TECH HYDRO

Page 3) 09/13/02

Budget Price for Turbine, Generator,
HPU and Controls/switchgear - US\$ 1,170,000

Price quoted above is F.O.B. Jobsite and includes any applicable import duties. Delivery time for the proposed equipment is approximately 12 months after contract award.

The controls/switchgear will have full manual and automatic operation capability and include limited DC backup equipment and station service equipment. Main power transformer and high voltage switchyard equipment are not included.

Attached for your reference are turbine performance curves and drawings of similar units installed at the Windsor Project. Please note that the unit draft tube may be angled somewhat to provide a discharge in a direction away from the existing boat launch. This would need to be looked at as the overall plant arrangement is developed.

Should you have any questions or wish to discuss this or other possible unit arrangements, please contact me at:

VA TECH HYDRO
115 Central Avenue
West Caldwell, NJ 07006

Tel. No.: 973 403 8210
FAX No.: 973 403 7914
e-mail: mbarandy@vatechhydro.com

Very truly yours,

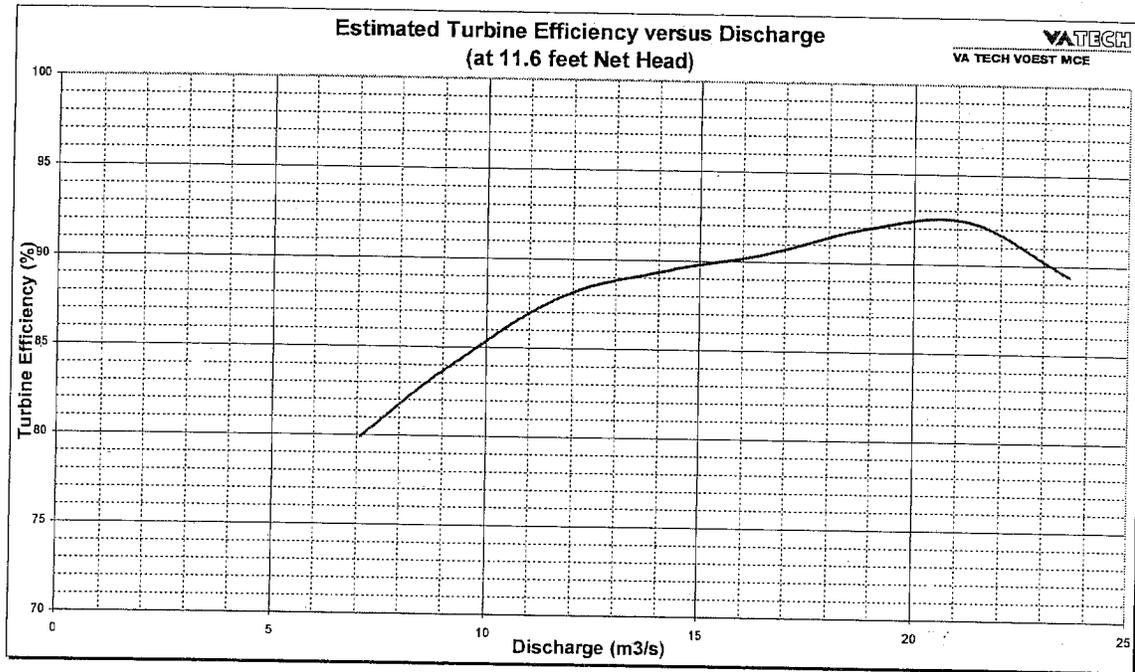
VA TECH HYDRO



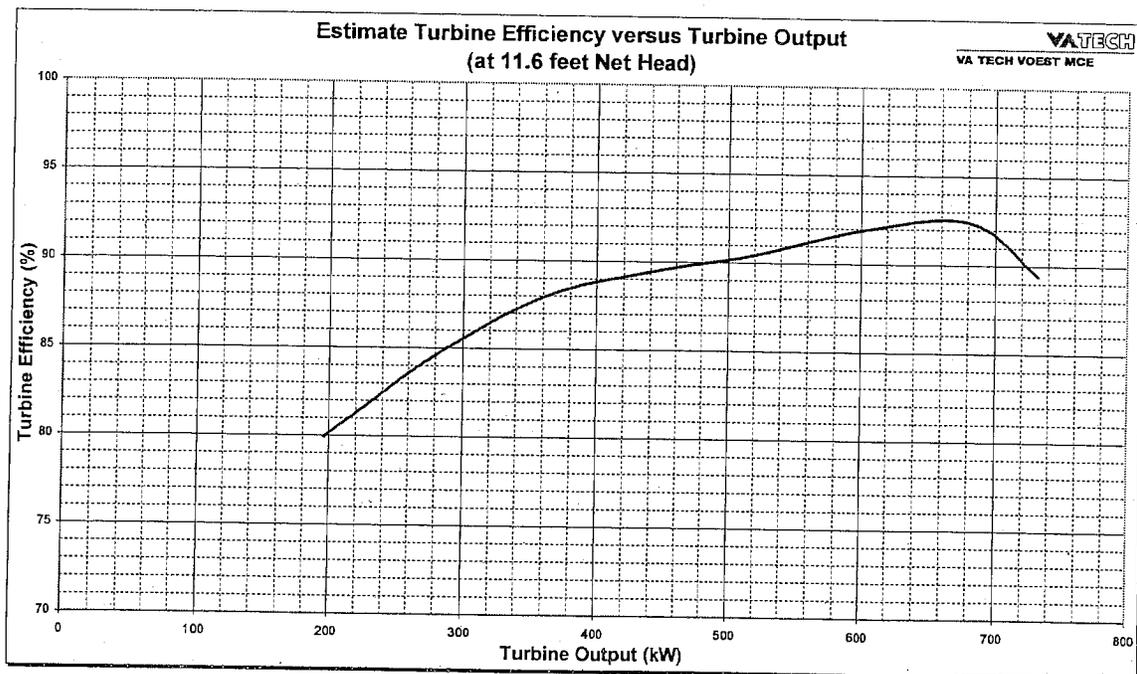
Mark Barandy

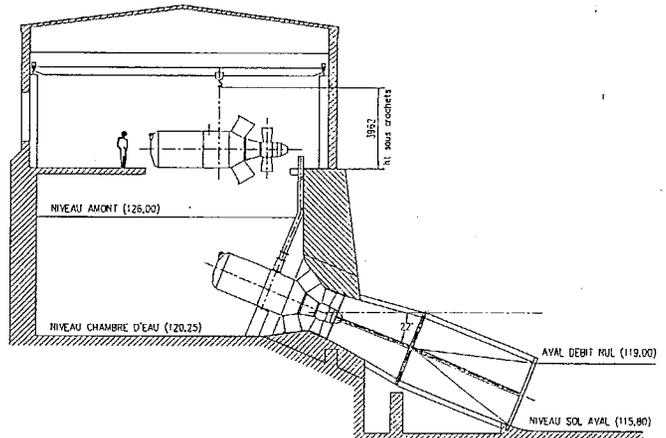
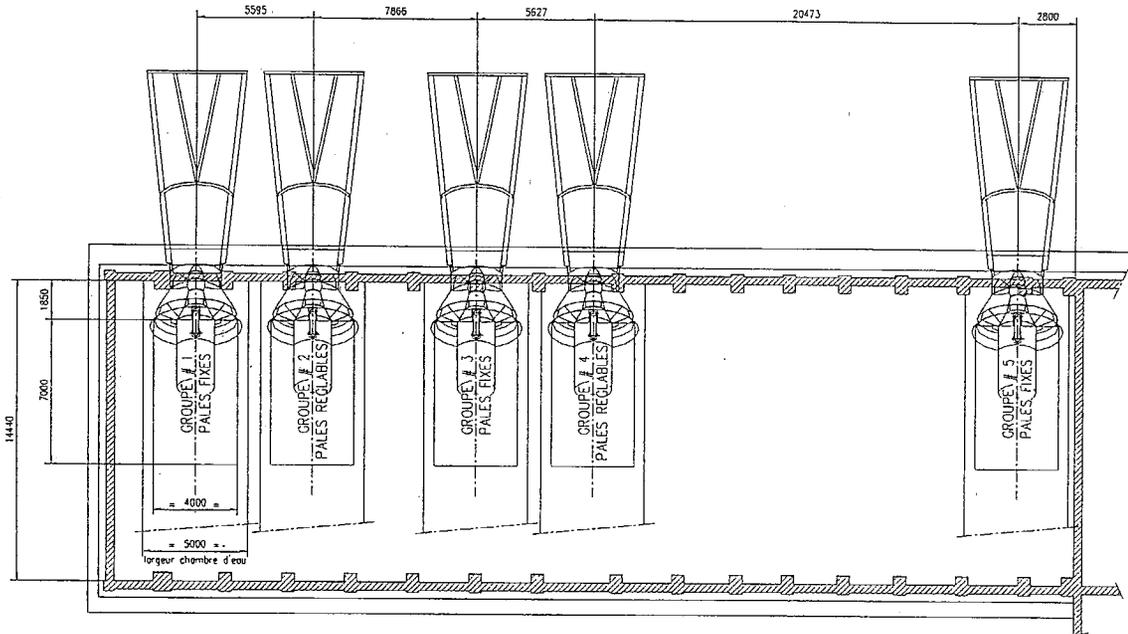
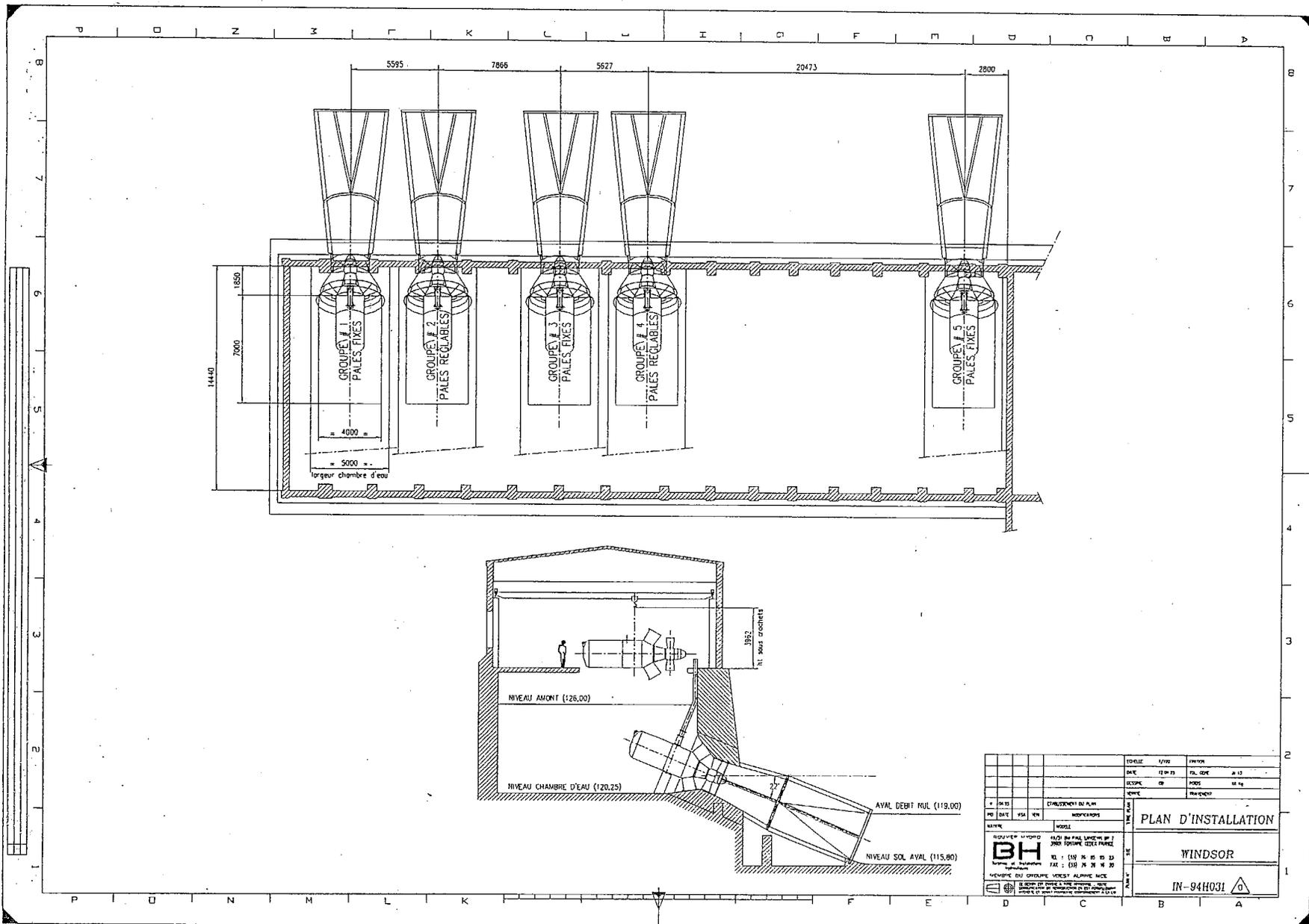
cc V. Ames; VA TECH HYDRO
J. Eppley; VA TECH HYDRO

Rum River
1 Adjustable Blade Turbine (Runner Ø 2240 mm)



Rum River
1 Adjustable Blade Turbine (Runner Ø 2240 mm)

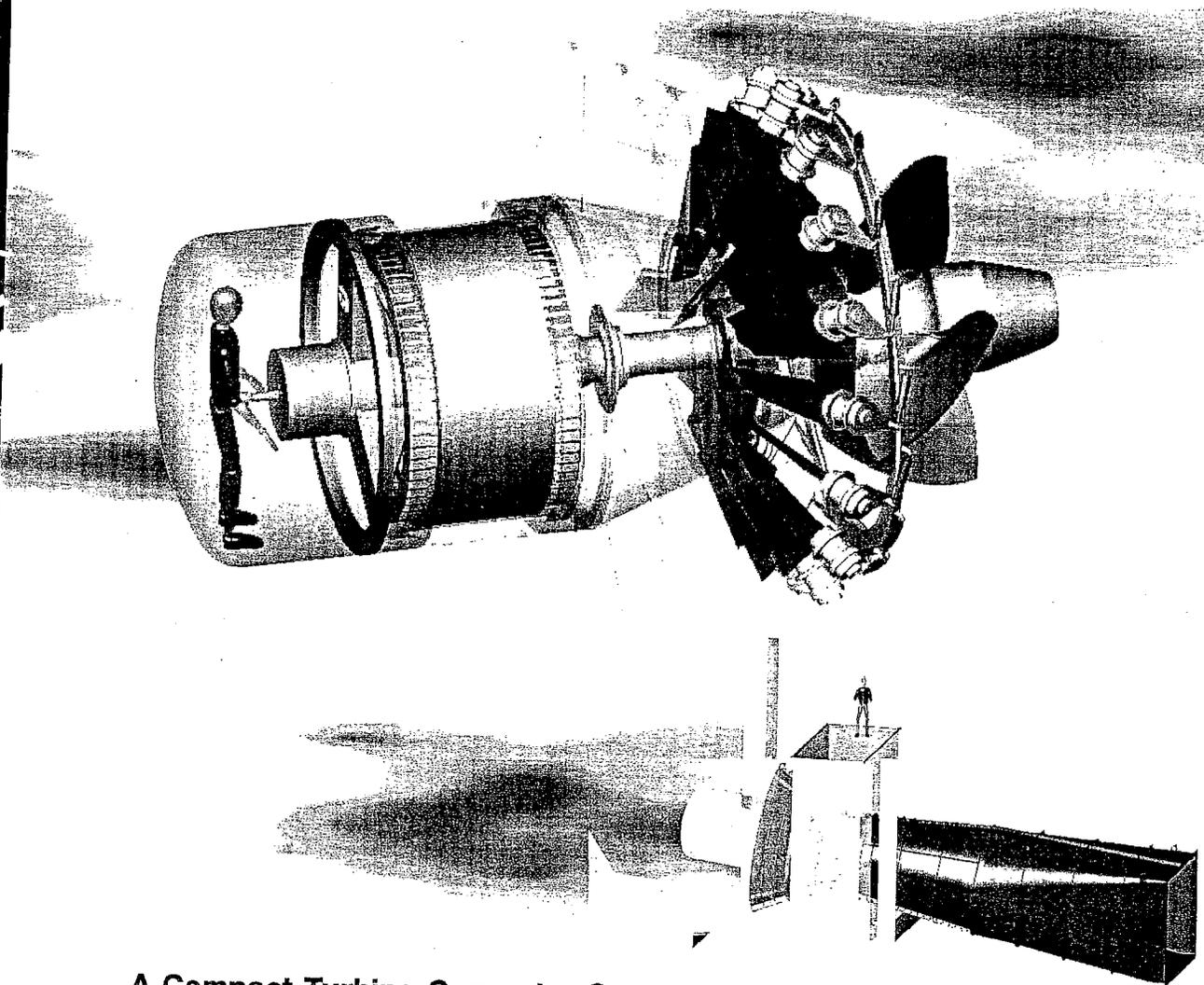




EDUCATION	1/70	PROF.																											
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Compact ECOBulb Turbine-Generator

ECOBulb



A Compact Turbine-Generator System for low head application

Head between 2 and 15 m

Discharge between 15 and 120 m³/s

Output between 500 and 5000 kW

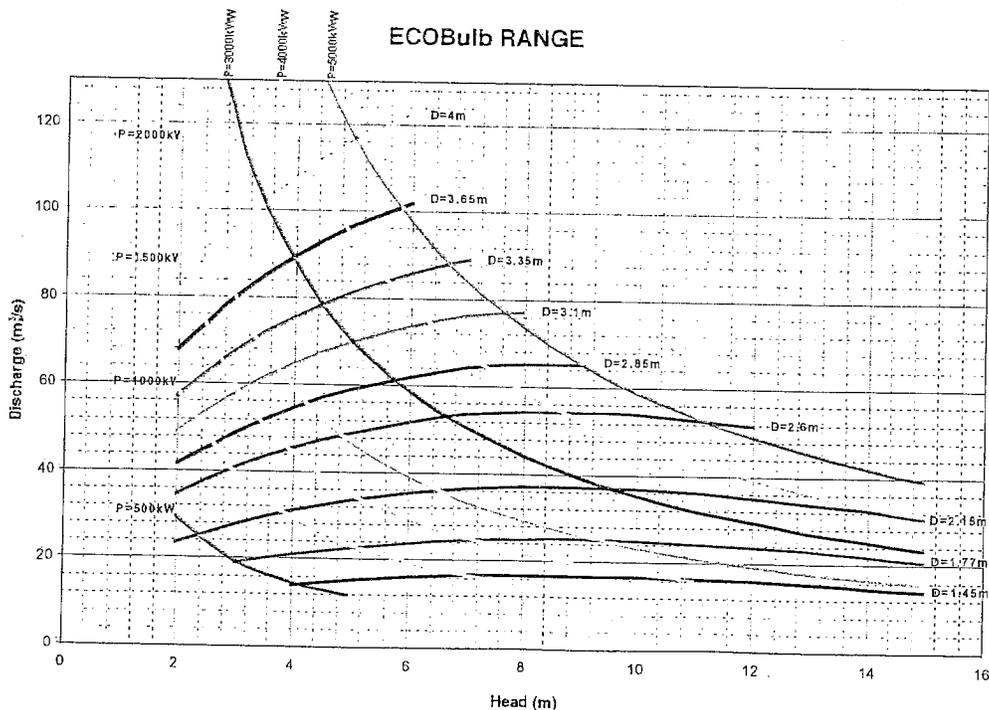
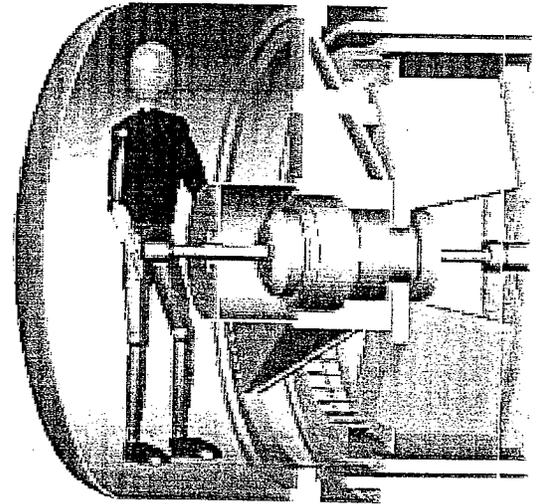
ECOBulb Turbine-Generator

VA TECH Hydro, a world leader in low head Compact turbines, introduces the development of the ECOBulb Turbine-Generator. The unit design minimizes investment in civil work and electromechanical equipment, and significantly reduces maintenance costs throughout the life cycle of the plant. The result is the economical development of sites having low head potential while minimizing the ecological impact.

The ECOBulb unit is the unique combination of a single or double regulated axial turbine with a direct coupled low speed synchronous generator, integrated into a air pressurized bulb which prevents any water leakage into it.

The removal of the step-up gear allows a reduction of the size of the bulb, a simplification of the mechanical elements (only two bearings, autonomous cooling and lubrication) and a dramatic life extension of the generating unit. The ECOBulb Turbine-Generator unit offers efficiency and reliability levels not previously achieved.

The hydraulic profiles used have been developed and tested in our hydraulic laboratories and the electrical and thermal technologies are derived from large bulb generator units built by VA TECH Hydro.



HYDRO

Pe
pc

ECOBulb

Two bearing shaft line with fully autonomous bearings, lubricated by biodegradable oil and grease

Minimum maintenance through removal of the step-up gear and its large quantity of lubricating oil

High hydraulic efficiency thanks to the axial flow technology and a small ratio between bulb diameter and runner diameter

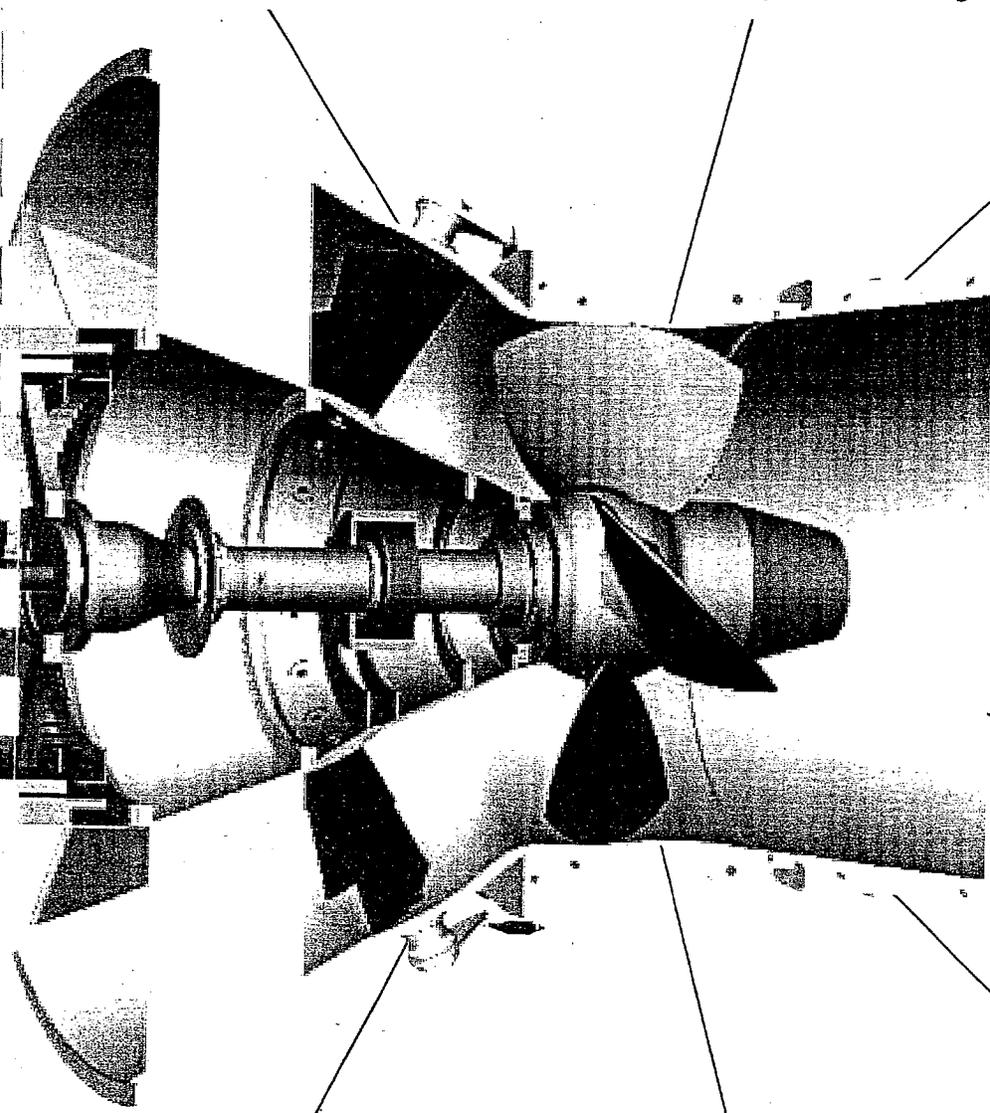
Excellent electrical efficiency through the use of the synchronous technology

Full mechanical and electrical integration resulting in a simplified design and reduction of parts

Possibility to tap very low head potential with economic results

Reduced civil work costs, both in excavation and concreting, thanks to the axial unit type, the high specific discharge and excellent cavitation resistance

Generator cooling using river water through the bulb skin, without external auxiliary systems



OBERMEYER HYDRO, INC

PO: BOX 668 FORT COLLINS, CO 80522 USA TEL 970-568-9844 FAX 970-568-9845
E-MAIL: hydro@obermeyerhydro.com WWW: <http://www.obermeyerhydro.com>

November 5, 2002

Mr. Martin J. Weber, P.E.
Principal Civil Engineer
Stanley Consultants, Inc.
5775 Wayzata Blvd., Suite 955
Minneapolis, MN 55416

RE: Rum River Dam

Dear Mr. Weber,

Thank you for the information you sent concerning the Rum River Dam Project in Anoka, Minnesota. Attached is a cross section drawing that shows the details of the clamp system and relative size of the gate panel and air bladder.

The gate will be attached to the concrete using a 4" wedge clamp system. This system uses a stainless steel embed in conjunction with a ductile iron casting to secure the gate system. The 2-1/2" stainless steel anchor bolts can be cast in place for new construction or can be drilled and epoxied for retrofit projects.

Obermeyer Hydro, Inc. can supply this set of gates FOB project site for the budgetary price of USD 249,521.00. This price is valid until December 31, 2002 and includes the following items:

1. Steel gate panels, misc. steel components, air bladders, anchor bolts, abutment seals, embeds, bronze nuts, restraining straps, and castings for one 12.2' high by 38' long spillway gate.
2. Stainless steel heated abutment plates.
3. Abutment plate heater, circulation pump, and control system.
4. (1) 15-horsepower air compressor with dryer and filters.
5. (1) OHI model 10-3 Siemens PLC based water level control system.
6. (1) Druck water level transmitter.
7. PLC cabinet with Siemens PLC and other related electrical control components.
8. Freight FOB job site.

In addition to this equipment, OHI can provide on-site installation supervision for USD 500.00 per day plus travel related expenses. The pricing does not include the following items:

1. Installation except for any purchased installation supervision.
2. Interconnecting wiring or piping.
3. Any required anchor bolt epoxy.
4. Propylene glycol solution for the abutment plates.
5. Bid, supply, or performance bond.
6. Federal, state, or local tax.

I hope this information is sufficient at this time. If you have any questions or require any additional information please don't hesitate to call, fax, or E-mail

Regards,
Obermeyer Hydro, Inc.
Robert Eckman
Vice President

