2655

SUSITNA
HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114

SURVEY OF EXPERIENCE IN OPERATING HYDROELECTRIC PROJECTS IN COLD REGIONS

VOLUME 2-APPENDIX C
RESPONSES TO QUESTIONNAIRE

FINAL REPORT

HARZA-EBASCO
SUSITNA JOINT VENTURE

JUNE 1985
DOCUMENT No. 2655

Alaska Power Authority

SUSITNA HYDROELECTRIC PROJECT

SURVEY OF EXPERIENCE IN OPERATING HYDROELECTRIC PROJECTS IN COLD REGIONS

VOLUME 2 - APPENDIX C

RESPONSES TO QUESTIONNAIRE

Prepared by
Harza-Ebasco Susitna Joint Venture

Prepared for
Alaska Power Authority

Final Report
June 1985

NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING
THIS REPORT SHOULD BE DIRECTED TO
THE ALASKA POWER AUTHORITY
SUSITNA PROJECT OFFICE

Alberta
ENERGY AND
NATURAL RESOURCES
Fish & Wildlife Division

File No. _____
Telephone: 403/427-6749

Mailing Address: Main Floor, North Tower, Petroleum Plaza, 9945 - 108 Street, Edmonton, Alberta, Canada T5K 2G6
Office Location: Assistant Deputy Minister's Office, 10th Floor, South Tower, Petroleum Plaza, 9915 - 108 Street, Edmonton, Alberta, Canada T5K 2G8

November 8, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
CHICAGO, Illinois
60606
U. S. A.

Dear Dr. Louie:

In response to your October 16, 1984 letter requesting information on matters relating to ice-control-engineering, there are no personnel employed by the Fish and Wildlife Division with state-of-the-art expertise in ice-control-engineering which affects the environment.

All policies and dam operating procedures are the responsibility of the Alberta Department of the Environment. By copy of this letter I am forwarding your request to:

Mr. Peter G. Melnychuk
Assistant Deputy Minister
Water Resources Management Services
Alberta Environment
14th Floor, Oxbridge Place
9820 - 106 Street
EDMONTON, Alberta T5K 2J6
(Telephone: 427-6252)

They may have some additional comments they may wish to make. In the Province of Alberta there has been limited documentation of problems between reservoirs/ reservoir operations and ungulates. Most of the documentation deals with habitat loss and management following reservoir construction. The existing reservoirs in Alberta are not in the path of any major ungulate migrations which minimize the likelihood for problems although some local problems may exist which we are not documented by us.

The Fish and Wildlife Division is presently developing water quality criteria for the protection of fish and other aquatic life. Suspended sediment will be one parameter for which criteria will be developed. All potential man related sources of sediment will be expected to comply with the criteria. However,

.../2

until we develop our own criteria we intend to use criteria established by the Inland Waters Directorate of Environment Canada which is 25 $mg.l^{-1}$.

I trust the foregoing has been of use to you.

Yours truly,

Dennis C. Surrendi
Assistant Deputy Minister

cc: K. Ambrock - A. Locke
P. G. Melnychuk

Alberta
ENERGY AND
NATURAL RESOURCES

File No.

2nd Floor, Pacific Plaza, 10909 Jasper Avenue, Edmonton, Alberta, Canada T5J 3M8 Telex 037-3676

October 31, 1984.

Dr. H. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois
60606-4176U.S.A.

Dear Dr. Louie:

With reference to your letter of October 16, 1984, the Department does not have an extensive program in the area of ice control engineering. However, there are some activities underway related to ice formation in culverts, freeze-up in settling ponds and protection of decant structures in settling ponds.

If you wish further information on these topics you may wish to contact Mr. D.T. Sneddon, Forest Research Branch, Alberta Forest Service, Spruce Grove, Alberta. Alternatively, you may wish to contact Mr. E.J. Barry, Vice President Planning, TransAlta Utilities Corporation, 110 - 12 Ave S.W., Calgary, Alberta T2R 0G7.

Yours truly,

R.D. McDonald
Executive Director

RDM:df

cc: T.D. Sneddon
E.J. Barry

Alberta
ENVIRONMENT
Environmental Evaluation
Services
Environmental Assessment Division

11th Floor, Oxbridge Place, 9820 - 106 Street, Edmonton, Alberta, Canada T5K 2J6 403/427-6209 Telex 037-2006, TWX 610-831-2636

November 16, 1984

Dr. David Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Dear Sir:

We are in receipt of your letter of October 16, 1984, inquiring about the state-of-the-art in ice control engineering which affects the environment.

Mr. M.E. Quazi, P.Eng., Branch Head of the River Engineering Branch, Alberta Environment and his staff have compiled a list of contacts specifically related to items 1, 3, and 4 of your request. Mr. Quazi may be contacted at (403-427-6280) or by writing to him at the above address, c/o the Technical Services Division, 10th Floor, Oxbridge Place.

We are unable to respond directly to item 2. I trust the attached information is of assistance to you.

Yours sincerely,

R.L. Stone, MCIP
Head
EIA Review Branch

RLS/cn
Att'd

State-of-the-Art
In Ice Control Engineering
Which Affects the Environment

Concerning procedures and/or operating policies to minimize the formation of ice jams, there are a large number of Canadian contacts who are deeply involved in the subject. The contacts which this Branch has made in its own field studies and efforts along these lines include: British Columbia Hydro and Power Authority (Vancouver); the British Columbia Ministry of the Environment (Victoria); TransAlta Utilities (Calgary); Acres Consulting Services Ltd. (Niagara Falls), and a host of Research Engineers in the field such as Dr. R.A. Harrington (Alberta Research Council, Edmonton), Dr. R. Gerard (the University of Alberta), Mr. C.R. Neill (Northwest Hydraulic Consultants Ltd., Edmonton), Dr. B. Michel (Laval University), as well as a few Research Engineers at the U.S. Army Corps of Engineer's 'Cold Regions Research and Engineering Laboratory' at Hanover, New Hampshire, which we are certain that Harza would be aware of as well.

As well as the above mentioned, our own staff have been involved in studying the operating procedures of two major hydro projects for purposes of minimizing the formation of ice jams at either freezeup or breakup of the Peace, North Saskatchewan and Bow Rivers in Alberta. Mr. Harold Cameron of Hydroelectric Branch may also be a useful source of information.

Concerning reservoir management to control crack formation for animal passage across the frozen reservoir, we do not get involved in that sort of study directly, however, we can suggest a few contacts who may have. These would include B.C. Hydro, the Canadian Electrical Association (CEA), perhaps TransAlta Utilities, definitely Acres Consulting Engineering Services (they have conducted a study for the CEA on ice 'hinging' action along river banks in response to fluctuations from the W.A.C. Bennett Dam on the Peace River). Again, Mr. Harold Cameron may also be of use to you in formulating your response to Harza.

Concerning bank erosion caused by breakup of ice and its movement, any of the contacts for Point 1 would be of assistance for this topic as well. These contacts may not be able to address the particular aspect of allowable turbidity, however, they should be able to address the mechanical processes. The turbidity aspects as related to fish may be able to be addressed by the two Hydro companies, B.C. Hydro and TransAlta, and additional information may be obtainable from the personnel of Fish and Wildlife Division of Alberta Energy and Natural Resources. A further source of information along this specific line may be Mr. Chris Katopodis, P.Eng. of the federal Freshwater Institute in Winnipeg (located on the University of Manitoba campus).

..../2

While thinking of persons in Manitoba who may be of use to Harza, the staff of Manitoba Hydro comes to mind, as does their chief consultants .... Crippen-Acres Engineering in Winnipeg. As it has been a while since the undersigned had any direct involvement in Manitoba, names (unfortunately) escape me at the present, except for an R. (Rick) Carson at Crippen-Acres.

Regarding Harza's Point 2, on environmental impact on terrestrial animals, we do not get involved in that type of study, so have no direct contacts we could name. The two hydro companies might be of use to Harza, as might Mr. Harold Cameron, in terms of the multi-disciplinary aspects of hydro projects.

Specific contacts with some of the above agencies who have not already been named include:

Mr. L.J. (Les) Parmley, P.Eng. - B.C. Hydro;

Mr. H.M. (Hugh) Hunt, P.Eng. - B.C. Environment

Mr. P.J. (Pat) Doyle, P. Eng. - TransAlta Utilities

Mr. T. (Tom) Lavender, P.Eng. - Acres Consulting Engineering Services, Niagara Falls; and

Mr. Gordon D. Fonstad, P. Eng., Head, River Studies Section, Technical Services Division, Alberta Environment

Alberta
ENVIRONMENT
Water Resources Management
Services
Technical Services Division

Office of the Director

10th Floor, Oxbridge Place, 9820 - 106 Street, Edmonton, Alberta, Canada T5K 2J6 Telex 037-2006 TWX 610-831-2636

November 19, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois
U.S.A.
60606

Dear Dr. Louie,

Your letter of October 16, 1984 addressed to Dr. D.C. Surrendi, Assistant Deputy Minister, Fish and Wildlife, Alberta Energy and Natural Resources regarding ice control engineering, was forwarded to Mr. P.G. Melnychuk, Assistant Deputy Minister, Water Resources Management Services, Alberta Environment. I understand that Mr. R.L. Stone of the Environmental Assessment Division, Environmental Protection Services, has already replied to a similar letter. Mr. Stone's reply will have included information from the River Engineering Branch of the Technical Services Division, and contains the most up-to-date information in this Department.

We would be keenly interested in the result of the extensive survey which you are presently undertaking. Will this information be made available to interested agencies?

Yours truly,

R.K. Deeprose, P. Eng.
DIRECTOR

cc: P.G. Melnychuk
R.L. Stone
D.C. Surrendi

Edmonton Power
Operations Operated by The City of Edmonton

Continental Bank Building 900, 10250 - 101 Street
Edmonton, Alberta T5J 3P4
Telephone: (403) 428-4330 Telex: 037-3620

December 5, 1984

Our Reference: 42040
File Number : 010-6.0

Harza Engineering Co.
150 South Wacker Drive
Chicago, Illinois
USA 60606

Attention: Mr. David S. Louie

Dear Sir:

In response to your enquiry dated October 16, 1984, I regret that we do not have any expertise within our organisation relevant to large reservoir operation since all our generation is by thermal means.

You may wish to contact Dr. John Railton, Manager of Environmental Planning, TransAlta Utilities Corporation, Box 1900, Calgary, Alberta, T2P 2M1 for information on this subject since TransAlta operates several hydro reservoirs. You may also wish to contact B.C. Hydro in Vancouver, British Columbia, who are virtually all hydro powered. You may also wish to contact Quebec Hydro whose experiences in this connection you will no doubt have recently heard about.

Regarding sediment levels in waters flowing from hydro reservoirs,neither the Alberta nor Canadian Federal Governments have definitive levels and rely on motherhood clauses based on possible impacts. Water quality from mine drainage settling impoundments are required to meet a 50 mg/l or 10 mg/l above natural background (whichever is the greater) requirement for suspended solids in both Alberta and British Columbia.

Yours truly,

L.M. Johnston, P.Eng.,
Environmental Manager

LMJ/pr

HARZA ENGINEERING COMPANY CONSULTING ENGINEERS

99

January 16, 1985

Prof. R. Gerard, Chairman
Department of Civil Engineering
University of Alberta
Edmonton, Alberta T6G 2G7

Gentlemen:

A few months ago, we sent to your office a letter soliciting information on the environmental impact cause by various ice conditions on reservoir and river. Also information on the operating procedures, if any, taken to control or minimize any adverse impact. For your convenient reference, a copy of the letter is enclosed.

Presently, we are still in the process of tabulating comments offered by various organizations contacted. We look forward to including your appraisal of the impact of ice control engineering on the environment in order that the final analysis will cover a broad range of knowledgeable participants.

Anticipating your reply, we appreciate your contribution in this effort.

Very truly yours,

David S. Louie
Chief Hydraulic Engineer

Enclosure

DSL/mmg

Mr. G. Fonstad
River Engineering Branch
Alberta Environment
Oxbridge Place
9820-106 St
Edmonton, Alberta, Canada
T5K 2J6

I just don't have time to respond in more detail. Gordon is the person most closely associated with such regulatory actions in Alberta — I believe the releases from the Big Horn & Brazeau Dams on the Nth. Sask. are restricted to avoid D/S ice problems. Certainly those from the Bennett Dam on the

150 SOUTH WACKER DRIVE CHICAGO, ILLINOIS 60606-4176
TEL. (312) 855-7000 CABLE: HARZENG CHICAGO TELEX 25-3540

TransAlta Utilities Corporation
110 - 12th Avenue S.W., Box 1900, Calgary, Alberta T2P 2M1 Telephone: (403) 267-7110

19th February, 1985.

HARZA Engineering Company,
150 South Wacker Drive,
Chicago, Illinois,
60606-4176,
U.S.A.

Attention: David S.Louie
Chief Hydraulic Engineer

Dear Sir,

Re: Ice Control - Hydro electric Plants
Your letter January 15, 1985

We offer the following comments on the points raised in your letter:

1. RE: CONTROL OF ICE LEVELS IN RIVERS DOWNSTREAM OF OUR DAMS. We do monitor ice levels at certain points and adjust plant operations to a degree to try to maintain ice/water levels below critical elevations. This is particularly true at our Bighorn operation on the North Saskatchewan River where problems arise as the ice pack is building past sensitive reaches of the river downstream of our development. The adjustments to plant operations are to the total daily flowby and the variation of the flow during the day.

2. RE: FORMATION OF ICE ON RESERVOIR BANKS. Not a problem for us, therefore no procedures in this regard.

3. RE: RESERVOIR FLUCTUATION MANAGEMENT. Not a problem for us, therefore no procedures in this regard.

4. RE: BANK EROSION. Gradual ice erosion rather than break-up occurs so this is not a problem either.

Please advise if you have any questions on these comments - tel: (403) 267-3614.

Yours truly,

R.W. Way, P.Eng.
Manager, Generation Scheduling.

RWW/bp/2a.8

Province of British Columbia

Ministry of Environment

Water Management Branch
Parliament Buildings
Victoria
British Columbia
V8V 1X5

File: 0322380-F
November 8, 1984

Dr. David S. Louie,
Harza Engineering Company,
150 South Wacker Drive,
CHICAGO, Illinois 60606,
U. S. A.

Dear Dr. Louie:

Re: State-of-the-art in ice control.

Thank you for your letter of October 16, 1984 addressed to Mr. A. Murray, Assistant Deputy Minister.

This Ministry has been involved in developing procedures to reduce ice flooding at the Town of Peace River (located on the Peace River in Alberta). B. C. Hydro operates two dams, the W. A. C. Bennett Dam and Peace Canyon Dam, at upstream locations. Operations of these two dams are being studied to minimize ice formation/ice break-up flood damage. Two other agencies working on this project are B. C. Hydro and Ministry of Environment, Alberta.

I understand that B. C. Hydro has already responded to your inquiry giving details of this project activity.

Yours very truly,

H. M. Hunt, Head,
Power & Special Projects.

c.c. Mr. A. Murray
Mr. P. M. Brady

B.C. Hydro
Box 12121 · 555 West Hastings Street
Vancouver B.C. V6B 4T6
Cable Address "Interpow"
Telex 04-54456

For Personal Contact

Dial _____

9 November 1984

Harza Engineering Company,
150 South Wacker Drive,
Chicago, Illinois,
60606, U.S.A.

Attention: Dr. David S. Louie.

Dear Sirs:

Your letter of 16 October asked for information on four topics related to reservoir ice problems. B.C. Hydro experience is outlined on the attached information sheet (listed in same order as your topics). You may also be interested in Report G138 "Behaviour of Ice Covers Subject to Large Daily Flow and Level Fluctuations" by the Canadian Electrical Association. We would appreciate receiving a copy of the results of your search and survey.

Yours very truly,

W. M. Walker,
Vice-President
and Chief Engineer.

Attachment

41
97

B.C. Hydro
Box 12121 · 555 West Hastings Street
Vancouver B.C. V6B 4T6
Cable Address "Interpow"
Telex 04-54456

For Personal Contact

Dial

12/3/84

Routed To
Classified for Filing by
Project Number
Classification
Subject Designation

9 November 1984

Harza Engineering Company,
150 South Wacker Drive,
Chicago, Illinois,
60606, U.S.A.

Attention: Dr. David S. Louie.

Dear Sirs:

Your letter of 16 October asked for information on four topics related to reservoir ice problems. B.C. Hydro experience is outlined on the attached information sheet (listed in same order as your topics). You may also be interested in Report G138 "Behaviour of Ice Covers Subject to Large Daily Flow and Level Fluctuations" by the Canadian Electrical Association. We would appreciate receiving a copy of the results of your search and survey.

Yours very truly,

ORIGINAL SIGNED BY
A. DWYER
for W. M. Walker,
Vice-President
and Chief Engineer.

BCHPA HE Gen Proj. Div.		
In Sequ. to	Init	Date
1 FJP		14-xi
2 JWF		15 xi
3 KF	RF	14
4 GMS		16
5 PVK		21
6		22
7 WJF		23/11/84
Action		
File		
Copies To	Ori	Date
GMS	1	14xi
File	2	14xi

AD/ja
Attachment
bcc: Mr. F.J. Patterson, Attn: G. Salmon
Mr. J.C. Stevens, Attn: H.M. Etter
Mr. W.M. Philip

w/c/att.

Note 27 Nov. 1984
Reply from B.C. Hydro was mailed to you Nov. 9/1984. G. Salmon

Rec'd 13-XI-84

ICE CONTROL ENGINEERING
INFORMATION REQUESTED BY HARZA ENGINEERING

1. Procedures and Operating Policies Used in the Control of Ice Levels

At present, winter operation procedures for the control of ice/water levels are required only on the Peace River downstream of B.C. Hydro's two hydroelectric developments: Portage Mountain and Peace Canyon. The upstream Portage Mountain project consists of the W.A.C. Bennett Dam, Williston Lake reservoir and G.M. Shrum generating station. The installed generation capacity is 2416 MW. At normal full pool level (el. 672 m) the reservoir surface area is 1740 sq. km and the live storage is approximately 24 x 10^9 m^3 with a drawdown of 17 m. Flow releases from the Portage Mountain project discharge into the Peace Canyon reservoir. The installed generation capacity at Peace Canyon is 700 MW, and the reservoir surface area is 94 sq. km. Drawdown of the Peace Canyon reservoir is usually less than 2 m to provide pondage for the daily or weekly re-regulation of releases from Portage Mountain.

No special winter operation procedures for either the Portage Mountain or the Peace Canyon reservoirs have been required for ice control upstream of the dams. However, downstream of the Peace Canyon project high river stages during the winter have been experienced and are the cause of concern at flood prone areas. Two areas where the winter flood hazard is of particular concern are at the Town of Peace River, Alberta, approximately 370 km downstream of Peace Canyon, and just upstream of Taylor, B.C. approximately 100 km downstream of Peace Canyon. As a result, a joint B.C.-Alberta Peace River Ice Task Force was formed in 1975 to monitor ice conditions and to recommend and co-ordinate operating procedures to minimize the flood hazard.

Winter operating procedures for Peace River projects, in general, emphasize power operation over ice-control, especially during December-February when the energy demand is relatively great. Nevertheless, we have been, in the past, able to provide an adequate degree of ice-related flood control, at critical times. During freeze-up, when the ice front is progressing upstream through the river reach at the Town of Peace River, relatively high, relatively constant turbine discharges at Peace Canyon are maintained, subject to limitations imposed on B.C. Hydro's integrated system by energy demands, are maintained. Because of the distance downstream from the Peace Canyon project (approximately 2 days flow travel time) hourly load/discharge fluctuations are almost completely attenuated at Town of Peace River, but daily average turbine flows are kept as constant as possible to reduce ice shoves at the leading edge of the ice cover and thereby minimize stage increase and backwater associated

with ice cover formation. Relatively constant discharges are maintained from the time backwater from the advancing ice cover affects river stage at Town of Peace River, until the ice front moves upstream of the area of concern. Depending on the river discharge and the severity of the weather, the time required for an ice cover to form on the 50 km long reach could vary from a few days to 2 or 3 weeks.

During this period it is important that discharges remain relatively high so the ice cover is formed at a high enough stage and of sufficient thickness and strength to allow full flexibility of turbine discharge throughout the winter. Discharges should not exceed the formation discharge until the ice cover has had a chance to strengthen as a result of thermal penetration and consolidation of the ice blocks forming the initial cover.

The same procedure is adopted if the ice front approaches the upstream flood hazard area near Taylor. Usually, the maximum upstream advance of the ice front is downstream of Taylor, and only during severe winters is the open water reach downstream of Peace Canyon less than 100 km in length. If the ice front does reach Taylor, the hourly discharge fluctuations are not completely attenuated at this point on the river, and turbine operation may be varied to moderate shoving and stage increase at the leading edge of the ice cover.

Prior to break-up at the Town of Peace River, turbine discharges are maintained relatively high to erode and weaken the ice as much as possible. Ideally, break-up of the Peace River ice at Town of Peace River should occur before break-up of the Smoky River, a major tributary which joins the Peace River just upstream of the town. However, the time and rate of break-up depend primarily on prevailing weather conditions and spring freshet flood peaks from downstream tributaries, and cannot be controlled by increased turbine discharges. When break-up of the Smoky River appears imminent, turbine releases at Peace Canyon (as permitted by system energy demands) are reduced to maintain peak river discharges downstream of the Smoky/Peace River confluence below flood hazard levels.

2/3 Environmental Impact on Terrestrial Animals/Method of Reservoir Fluctuation Management

B.C. Hydro presently takes no specific actions on its reservoirs to alter the state of the ice cover for wildlife safety reasons. Sporadic cases of deer drowning within ice-covered drawdown zones occur but we have no quantitative information on them. Routes for migratory species such as caribou do not cross any of B.C. Hydro's existing reservoirs.

4. Problems of Bank Erosion

The existing practice in B.C. is to enhance and manage fisheries in reservoirs which have suitable basic characteristics and minimal fluctuation in water levels, e.g. run-of-river reservoirs such as Peace Canyon. Both B.C. Hydro and the resource agencies accept that reservoirs with erodible banks, large draw-down zones and high sediment levels have limitations for fishery management.

AD/ja

HARZA-EBASCO SUSITNA JOINT VENTURE

INTRA-OFFICE MEMORANDUM

LOCATION: Anchorage
DATE: April 23, 1985
TO: Files
NUMBER: 4.3.4.3
FROM: R. Fairbanks RF

SUBJECT: Susitna Hydroelectric Project
Meeting with Richard Bonar Regarding the Revelstoke, B.C. Hydro Project

During my attendance at the 21st North American Moose Conference in Jackson, Wyoming I met Richard L. Bonar of Revelstoke, British Columbia. Richard, who was a former employee of B.C. Hydro and Power Authority, presently is a biologist for the Wildlife Branch of the B.C. Ministry of Environment. He has conducted impact assessment studies on moose, black bear, and other species relative to the Revelstoke Dam on the Columbia River for about eight years. On April 18, 1985 I met with Richard and we discussed his observations and data that were relevant to the Susitna Project. Bill Steigers of LGL, who also participated in this meeting, tape-recorded most of it. A summary of our discussion is provided below. Also provided is Richard's address and phone number and the phone number of Keith Simpson, who was and still is the principal investigator for caribou and grizzly bear on the Revelstoke Project.

Addresses/Phone Numbers

Richard L. Bonar
Box 2624
Revelstoke, B.C. VOE 250

(604) 837-3285 in Revelstoke on weekends
(604) 374-9717 in Kamloops during the week

Keith Simpson
Revelstoke, B.C.

(604) 837-3723

Summary of Meeting

Revelstoke Project and Study Area (partially from Bonar 1983)

B.C. Hydro began construction of the Revelstoke Project in southeastern B.C. in 1977. The 25 mi^2 reservoir is about 85 mi. in length and stretches between two other Columbia River reservoirs including the very large Mica Reservoir at the upstream end. Reservoir clearing took place

→ to 30' below full - full by May 84

between 1977 and 1983 and filling was completed in fall 1983. Water level fluctuations are slight because the project is operated as a run-of-the-river project (max. fluctuation equals 15 ft.). The reservoir is in mountainous terrain and is generally steep-sided. Terraces, alluvial fans, and riparian floodplains were present within the mainstem valley and larger tributaries, and represented the only areas of shallow slope. Annual snowfall is heavy with snow depths on moose winter range usually exceeding 40 in. and occasionally surpassing 75 in for short periods. Snow often develops a hard crust (since winter temperatures can vary widely) sufficient to support a moose. The average January temperature at Revelstoke at the downstream end of the reservoir is 21.4°F while at Mica Creek at the upstream end the average is 13.3°F. Most of the area is covered by mature coniferous forests with seral stages present on extensive logged and burned areas as well as avalanche paths and along watercourses in riparian associations. The moose population in the study area was about 250-300 animals with about two-thirds of those utilizing the impoundment zone during winter prior to impoundment.

Reservoir Clearing

Clearing took place over a 6-7 year period. First, commercial harvest took place and then the remaining vegetation was cleared. Essentially all vegetation was removed including shrubs and herbs. Vegetation was piled and burned or buried. Some tracts of vegetation that would be well-submerged after filling were not totally cleared. Also, about a dozen tracts of high quality habitats, from a few to several hundred acres in size, were reserved from clearing until just prior to impoundment. Clearing had no measurable effect on the moose population largely because animals still utilized cleared areas, that rapidly regenerated browse, and the reserved tracts. Moose did not appear to be significantly disturbed by the clearing operation either. Radio-collared moose were often located wtihin a few hundred yards of clearing operations. Debris did not become a problem after filling because of the degree of clearing and the efforts B.C. Hydro went to after filling to clean-up floating debris with booms and boom boats with metal rakes, which were used to clean up stranded debris.

Open Water in Winter

Richard noted that moose showed no reluctance to cross the river in winter, prior to inundation, even though Mica Dam produced 4°C water all winter and kept the river open downstream. He noted that they crossed the open reservoir readily when it was cold, also. He said temperatures ranged down to -20°F in winter and even at these temperatures they would readily cross the river which had a winter flow of 25-30,000 cfs. Richard thought that aside from possible habitat changes resulting from flow regulation, open water in winter downstream from a dam would not be detrimental to moose. He said that in his study area when snows get very deep, moose will often concentrate along the river or reservoir shoreline which is often snow-free due to slight water level fluctuations, and will use this zone as a travel corridor, browsing on adjacent vegetation, and staying there for several days or more until travel becomes easier in adjacent forests. Richard also noted that open water in winter caused by upstream impoundment may increase river otter densities. Although he had no baseline data prior to filling Mica Dam, he felt that river otter densities were unusually high in the stretch downstream of the Dam because of the open water in winter.

Ice-related Problems

Richard said the reservoir often develops a complete ice cover in winter but that open water and partial ice covers occur as well, depending on the quite variable air temperature. Maximum ice thickness is about 1 ft. He said that moose readily and easily cross the reservoir on ice when it is stable and generally avoid crossing when it is not. Often the reservoir is mostly ice-covered except for along the shoreline. Moose avoid crossing at that time unless they can find an ice-bridge to the floating ice. As noted above, they also cross when the reservoir is mostly ice-free and they must swim. Richard noted that he has observed signs of about 20 instances where a moose had ventured onto the ice and fallen through, in the two winters since the reservoir was filled. He felt that these 20 instances represented the majority of these cases. He noted that only 2 mortalities occurred out of these 20 cases, and one was associated with the moose getting tangled in debris after breaking through. He said that, in most cases, as long as ice is strong enough,

the moose can climb back out of the water onto the ice after he has broken through, even without any solid footing under the water. He said he's watched them do it and it's a slow process, but they manage. He stated that more deer mortalities have been noted (about 10 or so?) but that deer tend to venture out into thinner ice than moose and when they break through they can't get back out because the ice is too thin. He noted that the woodland caribou in the area readily cross the reservoir during the winter, when ice conditions permit, in groups of 1 to 20 animals. He said that no ice-related caribou mortalities have been noted. Richard noted that the fractured ice which settles in the large drawdown zone (on the order of 100 ft.) of the Mica Reservoir presents no problems, that he is aware of, to moose or other ungulates. The surface of the ice is generally rough and the cracks and fissures do not seem to cause these critters any problems. He also noted that he is not aware of any problems related to snowdrifting resulting from winds blowing snow along or from impoundment zone ice.

Summer Reservoir Crossings

Moose, bear (both species), and caribou readily cross the reservoir in summer. Moose crossings were noted in areas where the reservoir is anywhere from 300 yds. to 1 mi. wide. Although these species readily cross the reservoir, their crossing frequency appears to be less than prior to reservoir fillings. This is particularly the case for the bears. No problems have been noted relative to ungulates and mud-flats (although most soil materials in the area are course). Erosion and sluffing of areas along the steep-sided reservoir are common.

Population-level Effects

Two winters after reservoir filling, population-level effects have not been noted for moose or other large mammals. The 1983-84 winter was relatively mild and the 1984-85 winter was a little more severe than normal. Richard is somewhat puzzled that moose numbers have not yet declined. In addition, he has not seen a reduction in cow:calf ratios or any problems related to bull:cow ratios. He still expects to see a population-level effect, but wonders why it has not yet occurred.

HARZA-EBASCO SUSITNA JOINT VENTURE

INTRA-OFFICE MEMORANDUM

LOCATION Anchorage

DATE April 23, 1985

TO Files

NUMBER 4.3.4.3

FROM R. Fairbanks

SUBJECT Susitna Hydroelectric Project
~~Meeting with Richard Bonar Regarding~~
the Revelstoke, B.C. Hydro Project

Miscellaneous

Richard noted that beavers seem to have increased along the shoreline since inundation, but he's not sure how long that will last. He also noted that transmission line corridors in the area are relatively heavily used by moose for foraging as are clearcuts. He noted that aside from the paper he presented at the 19th North American Moose Conference, no reports have been published in the last several years on his studies. He did note, however, that Keith Simpson had a few draft reports prepared on caribou and brown bear and that Simpson gave a paper at a Caribou Conference in Montreal last year regarding his studies.

cc: J. Thrall, HE
C. Elliott, HE
R. Lindsay, HE
G. Gemperline, HE
M. Bruin, HE
R. Densmore, HE
J. Durst, HE
P. Ames, HE
R. Bonar, B.C. Ministry of Environment, Wildlife Branch
W. Steigers, LGL
R. Sener, LGL

Manitoba

Environment and Workplace Safety and Health

Environmental Management

P.O. Box 7
Building 2
139 Tuxedo Avenue
Winnipeg, Manitoba, CANADA
R3N 0H6

19

November 13, 1984

Mr. David S. Louie,
Chief Hydraulic Engineer,
Harza Engineering Company,
Consulting Engineers,
150 South Wacker Drive,
Chicago, Illinois,
U.S.A. 60606

Dear Mr. Louie:

In response to your letter of October 16, 1984, I can advise that this Department does not have experiences with ice control engineering. You may, however, wish to contact the following persons who may have information they can share with you:

(1) Mr. Lynn Poyser,
Manager,
Environmental Services Department,
Corporate Planning,
Manitoba Hydro,
820 Taylor Avenue,
WINNIPEG, Manitoba.
R3M 3T1

2. Gene Bossenmaier,
Director, Resource Allocation,
Department of Natural Resources,
Room 200,
1495 St. James Street,
WINNIPEG, Manitoba.
R3C 0V8

I am also providing you with a copy of this Department's Water Quality Objectives which should answer your questions regarding permissible levels of turbidity etcetera.

Yours truly,

Carl Orcutt, Director,
Environmental Control Services.

CBO*ccb

Attachment.

cc: Norm Brandson, Director,
Environmental Management Services.

MANITOBA
DEPARTMENT OF NATURAL RESOURCES
Water Resources Branch
1577 Dublin Avenue
Winnipeg, Manitoba
R3E 3J5

November 27, 1984

File: 10.5.1
91.2

Dr. David S. Louie
Harza Engineering Company
150 South Wicker Drive
Chicago, Illinois 60606
U.S.A.

Dear Dr. Louie:

We are one of the agencies that your letter of October 16, 1984 to the Manitoba Department of Energy and Mines has been referred to for attention.

We have no information to offer on items 3 and 4 of your letter. We expect that other agencies of our department, which have also received a copy of your letter, might be able to provide you with that information.

This Branch operates three major flood control works; two of them have a reservoir. The reservoirs are operated for flood control during the spring and for water supply and recreation during the other seasons.

Portage Reservoir and Diversion:

When not needed for flood control, the Portage Reservoir is maintained near its full supply elevation of 869 feet. In October, the reservoir is drawn down to its winter level of about 853 feet. This takes about three weeks. The changes in water levels during the winter are very minimal and therefore the ice cover is quite stable. We are not aware of any problems with terrestrial animals.

During the spring break up period, the flows downstream in the river are controlled between 2500 and 5000 cfs. If the inflow exceeds these figures, the remainder is put into storage or is diverted out of the reservoir into Lake Manitoba via the Portage Diversion. A flow of 5000 cfs before ice in the channel has cleared out can result in ice jams. Thus to prevent ice jams which could cause overbank flows to occur flows through the spillway control structure are limited to 5000 c.f.s. Under open water conditions, the minimum channel capacity of the river in this reach is about 10,000 c.f.s.

. . . . 2

Shellmouth Reservoir:

During the summer, the reservoir is operated to maintain a level of between 1400.0 to 1402.5 feet. From October to April, the reservoir is gradually drawn down to elevation 1391$\pm$ 3 feet depending on the estimated inflow during the spring period. The ice cover is stable and we are not aware of any problems with terrestrial animals.

During the runoff period in the spring, most of the inflow goes into storage. The release downstream in the case of ordinary floods is not great enough to cause ice jams or flood problems. However, if and when the reservoir rises above the spillway crest discharges from the reservoir exceed the channel capacity downstream, the extent of which will depend on the magnitude of the flood.

Red River Floodway:

The Red River Floodway is an excavated channel which diverts flood waters of the Red River around the City of Winnipeg. At the point of diversion the river bed elevation is about 728 feet. The Floodway Inlet elevation is 750 feet. The amount of water to be diverted is controlled by the Inlet Control Structure located in the river downstream of the Floodway Inlet. During the break up period, the water level in the river is allowed to rise naturally to elevation 750 feet. At this point, if the ice is moving in the river then the water level is raised to at least elevation 751 feet. This is to prevent erosion at the entrance of the Floodway Inlet. However, if the ice in the river is stationary, we would delay raising the water level upstream of the Inlet Control Structure until the ice begins to move freely in the river. The objective here is to prevent ice flowing into the Floodway which could form ice jams at bridges across the Floodway and thus reduce the carrying capacity of the Floodway. Our experience to date has shown that as long as the ice is moving in the river it will not flow into the Floodway.

In addition to the above works, we also operate numerous in channel water supply dams. During freeze up, we increase the outflow from all water supply dams until a solid ice cover forms in the river. Then the outflow is reduced as required. This action permits the water to flow freely under the ice cover. Increasing outflows beyond the original release rate at freeze-up tends to lift the ice cover which causes ice build up resulting in increased backwater over the rest of the winter and ice jams during break up.

I trust that the above information will be of some assistance to you. I am also enclosing a brochure entitled "Flood Control" which describes our flood control works.

Yours truly

N. Mudry, P. Eng.
Chief of Water Management

c.c. T.E. Weber
Enclosure

MANITOBA HYDRO

BOX 815 • WINNIPEG, MANITOBA R3C 2P4

February 12, 1985

Harza Engineering Company
Consulting Engineers
150 South Wacker Drive
Chicago, Illinois
60606-4176

Attention: Dr. David S. Louie
Chief Hydraulic Engineer

Dear Sir:

This will reply to your letters of October 16, 1984 to Engineers in Manitoba Hydro requesting information on the State-of-the-Art in ice engineering which affects the environment.

1. Each of our plants has associated with it a unique set of restrictions or operating policies. These restrictions are usually established by licence constraints which restrict such things as range of fluctuation, maximum draw down, maximum rate of discharge, etc. These are usually established out of concern for the environment, but also with recognition of a preferred mode of operation for power production purposes. In one instance these restrictions are related to the formation of slush ice on a lake immediately downstream which is travelled in winter by local inhabitants.

   We attempt to mitigate the effects of flooding during the initial creation of reservoirs and compensate for damage when this occurs.

2. We have no regulation constraints established particularly for the protection of terrestrial animals. Furthermore, we are unaware of any significant impact that has occurred as the result of reservoir or river flow fluctuations. Most reservoir banks are gradual in slope and rates of change are slow. Because losses are minimal, it is our policy to compensate for such damages if and when they are shown to have occurred.

3. We have no operating restrictions designed to control the width or pattern of crack development in reservoirs. On occasion, we utilized ice booms to accelerate the formation of ice covers where velocities are critical in the formation of natural ice covers. In one location special operative techniques (controlled velocities) are utilized during the fall freeze up period to

enhance the orderly formation of an ice cover. The prime consideration is to minimize the formation of hanging dams, etc. in order to maximize winter discharge capacity.

We have no knowledge of terrestrial animals being injured or drowning due to crack patterns created by reservoir operations.

4. Bank erosion problems created by ice movement associated with development work are not considered to be particularly serious. Many of our northern rivers experience considerable erosion due to ice formation created in their natural state. Most bank erosion problems result from the inundation of new land with newly created reservoirs. In one instance this is further aggravated by the presence of permafrost which recedes, in time, after inundation.

We trust this information will assist you in your search for information on ice control engineering.

Yours truly,

K. J. Fallis
Executive Engineer
Corporate Planning

KJF/hl

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

OFFICE OF THE GENERAL MANAGER
BUREAU DU DIRECTEUR-GÉNÉRAL

515 RUE KING STREET
FREDERICTON, N.B.
E3B 4X1

1984-10-25

FILE: 6-000

Mr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606-4176
USA

Dear Mr. Louie:

I have your letter of October 16 and have asked Mr. MacLoon, Assistant General Manager of Engineering and Operations to review our position and respond if we can be helpful.

Yours very truly,

A. J. O'Connor

A. J. O'CONNOR
General Manager

AJO/sb

cc: Frank MacLoon

NB 200
1784-1984

DEPARTMENT OF NATURAL RESOURCES
P.O. Box 6000
Fredericton, N.B.
E3B 5H1

NEW BRUNSWICK
NOUVEAU-BRUNSWICK
CANADA

MINISTÈRE DES RESSOURCES NATURELLES

FISH AND WILDLIFE BRANCH

25 October 1984

Dr. David Louie
Harza Engineering Co.
150 South Wacker Drive
Chicago, Ill.
60606 - 4176

Dear Dr. Louie:

At the present time, the New Brunswick Department of Natural Resources is not involved in any ice control engineering activities. Our Province's Department of Environment and the New Brunswick Electric Power Commission are more liable to be involved in such studies and your request for information has been forwarded to these agencies.

Sincerely,

John Gilbert
Fish Habitat Biologist

/mem

P.O. BOX 6000
FREDERICTON, N.B.
E3B 5H1

DEPARTMENT OF FISHERIES

C.P. 6000
FREDERICTON, N.B.
E3B 5H1

MINISTERE DES PÊCHES

November 5, 1984

Dr. David S. Louie
Harza Engineering Co.
150 South Wacker Drive
Chicago, Illinois 60606,
U.S.A.

Dear Dr. Louie:

Reference is made to your letter dated October 16, 1984 in which you are seeking information on ice control engineering which affects the environment to contribute to your literature search on the subject.

We regret to inform you that New Brunswick Department of Fisheries is not involved in the above referred subject, therefore, no information can be forwarded to you. If you have not requested already, The National Research Council of Canada, Ottawa, Canada, K1A OR6, Telephone No. (613) 993-0357, may be helpful in your literature search.

Very truly yours,

M. Nihat Ozerdem
Director
Technical Services

MNO/mml

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION
LA COMMISSION D'ÉNERGIE ÉLECTRIQUE DU NOUVEAU-BRUNSWICK

515 King Street
Fredericton, N.B.
E3B 4X1

1984-11-20

Dr. David S. Louise
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois
60606, U.S.A.

Dear Dr. Louise:

I have been asked to respond to your letter of October 16, 1984 to our General Manager, Mr. A.J. O'Connor regarding state-of-the-art in ice control engineering which affects the environment.

I will try to answer each of your points as directly as I can although in some cases they do not directly apply to N.B. Power operation of our reservoirs along the Saint John, Tobique and Saint Croix Rivers.

1. The three major hydro developments in our system are located on the main stem of the Saint John River. Storage capacities of the headponds are very small and water level fluctuation in them is insignificant. These conditions allow for the establishment of stable solid ice covers over most of the length of the headponds. However peaking operating schemes of the plants could have some effects on the formation of the ice cover in areas immediately downstream of the tail races. In order to discourage frequent breakup during the initial freeze up process, discharges from the hydro plants are held constant, whenever possible, during this period until stable ice cover is formed.

   During break up season, efforts are made not to accelerate the breakup process and let the ice covers disintegrate in place whenever possible. This will normally reduce the possibility of ice jam formation in the upper end of the headponds. However, if flow and weather conditions cause the ice covers to break prematurely ice jams could form causing some flooding to the extreme low lying areas in the upper reach of the headpond.

   The effects of the water level at the dam on the formation and releases of ice jams in these areas had been studied by "Acres Consulting Services Ltd.", of Niagara Falls, using the "ICESIM" mathematical model. Results of these studies has been used to formulate our operation strategy when an ice jam is formed in the headpond. For further information about the

"ICESIM" model you may contact Mr. S.T. Lavender of Acres; telephone No. (416)-354-3831.

Analysis of ice and flow records show that the construction and the operation of our reservoirs system on the Saint John River has resulted in significant reduction in ice related floods downstream of the hydro plants. It is of interest to note that since the construction of the Mactaquac dam in 1966, ice jams and ice related floods have been eliminated completely in the downstream reach; an area subjected to frequent ice jam flooding before the construction of the Mactaquac development.

2. We have generally very small reservoir draw down in all of our reservoirs and most of them are in areas where wild animals do not seem to travel, therefore we have no known problems with animal injuries or drowning as a result of draw down.

3. Similar to #2 above we have no known problems with animals falling in cracks or openings along our reservoirs.

4. We have some bank erosion along our reservoirs, however, sediment in our reservoirs and river downstream is not identified as a problem. There is no known permissible degree of turbidity in the Saint John, Tobique or Saint Croix River systems.

I trust this information will assist you and if you are in the area at freeze up or break up time any year, we would be happy to give you a tour, and let you see our reports that are prepared by our field observers each year.

Yours sincerely,

THE NEW BRUNSWICK ELECTRIC POWER COMMISSION

Glen McCrea
Assistant Manager
Plant Operations (Hydro)

GM/sja

22 ~~24~~
18
24

ENVIRONMENT NEW BRUNSWICK | ENVIRONNEMENT NOUVEAU-BRUNSWICK

November 23, 1984

Mr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Co.
150 South Wacker Ave.
Chicago, Illinois
U.S.A., 60606-4176

Dear Mr. Louie

RE: ICE COVER REGULATION IN RESERVOIRS

In your letters of October 16th to:

Mr. H. Haswell, Director, Fish and Wildlife, Department of Natural Resources;

Mr. G.N.Hill, Coordinator of Information, Department of the Environment;

you requested information on procedures and operating policies used in the control of ice levels in rivers downstream and upstream of hydroelectric power plants. You were interested in how ice cover changes, due to reservoir regulation, affects terrestial animals and aquatic life.

I regret to inform you that neither of the above departments has any policies or regulations with respect to the environmental management of ice cover growth and formation in reservoirs.

The New Brunswick Electric Power Commission (NBEPC) operates several hydroelectric power dams in the Saint John River Basin. You may wish to write to the NBEPC

for information on their policies regarding reservoir regulation. A possible contact person is Dr. Sayed Ismail whose address is as follows:

Dr. Sayed Ismail
Systems Planning Division
New Brunswick Electric Power Commission
P.O. Box 2000
Fredericton, NB
E3B 4X1

Please contact me if I can be of any further assistance.

Yours truly

Brian C. Burrell
Surface Water Section
Water Resources Branch

BCB/dcp

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
DEPARTMENT OF CULTURE, RECREATION AND YOUTH

Wildlife Division
Building 810, Pleasantville
P.O. Box 4750
A1C 5T7

ST. JOHN'S

1984 11 06

Dr. David S. Louie
Harza Engineering Co.
150 South Wacker Drive
Chicago, Illinois
USA 60606

Dear Dr. Louie:

I am afraid that we have no information to offer concerning, re. control and the environment. We certainly have had concerns in this area, especially with hydroelectric developments in sensitive wildlife areas. In this regard I would suggest you contact Mr. David Keill, Manager, Environmental Services, Newfoundland and Labrador Hydro, Prince Philip Building, Elizabeth Avenue, St. John's, Newfoundland. Another good contact might be John Greer, Emergency Measures Organization, St. John's, Newfoundland. Finally, Hugh Bain, Department of Fisheries and Oceans, White Hills, St. John's, Newfoundland. I hope these resource people will be of assistance to you.

All the best,

Joe Brazil
Non-Game Biologist

JB:jc

~~45~~
47

Deer Lake Power Company Limited

P.O. Box 2000 Deer Lake, Newfoundland A0K 2E0
Canada

January 29, 1985

File D 1-1-1

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
U.S.A.

Dear Dr. Louie:

We hereby acknowledge your inquiry re ice control engineering which affects the environment. I must advise you that we have nothing to offer which would provide meaningful input to your study.

Please note that our company has recently changed ownership and is now operating as the Deer Lake Power Company Limited.

Yours truly,

DEER LAKE POWER COMPANY LIMITED

C. S. Stratton
Chief Engineer

CSS/rw

HYDRO

FILE: 2-00-0

NEWFOUNDLAND AND LABRADOR HYDRO
Head Office: St. John's, Newfoundland A1A 2X8 • Telephone (709) 737-1400 • Telex 016-4503

February 14, 1985

Dr. David S. Louie
Harza Engineering Company
150 South Wacher Drive
Chicago, Illinois
60606

Dear Dr. Louie:

I have been asked to reply to your request for information on the environmental impact of various ice conditions on reservoirs and rivers. My comments follow the same order as the questions posed in your letter.

1. The only ice condition that Newfoundland and Labrador Hydro (Hydro) attempts to control is the formation of frazil ice on trashracks. The formation of frazil ice is prevented by maintaining an ice cover on the power canal. Wind speed, air and water temperatures and head loss across the trashracks are monitored, and if frazil ice formation begins, water velocity in the power canal is reduced by shifting the load from the affected unit. Reducing water velocity facilitates formation of an ice cover.

2. There have be no reports of injuries or mortalities of large mammals in Newfoundland resulting from ice conditions on reservoirs. This hazard is not considered in Hydro's reservoir management program.

3. Same as (2)

4. There are no regulations or guidelines in Newfoundland which stipulate a permissible degree of turbidity for aquatic fauna. There are water quality regulations governing the levels of suspended solids (30 ppm above ambient) and total dissolved solids (1000 ppm) in water for human use.

If you should have any questions regarding my comments, please do not hesitate to contact me.

Yours truly,

David J. Kiell

D.J. Kiell, Manager
Environmental Services

DJK/lb

Nova Scotia

320-1

Department of the Environment

PO Box 2107
Halifax, Nova Scotia
B3J 3B7

October 31, 1984

Dr. David S. Louie
Harza Engineering Company
Consulting Engineer
150 South Wacker Drive
Chicago, Illinois 60606-4176

Re: ICE EFFECTS CONTROL ENGINEERING

Dear Dr. Louie:

Your letter of 16 October was referred to me since I am involved with flood damage in this Province. Your specific questions are not answered very precisely for reasons that will be apparent.

In Nova Scotia we have very few rivers that would pose a drowning threat to large mammals. Most of our rivers can be waded by a man by choosing a site within a mile of where he finds himself. These shallow rivers do not form smooth continuous ice covers such as you seem to have in mind. We do have several hydroelectric power reservoirs, but these are modified lakes, not drowned river valleys. Water levels are not regulated with effects on wildlife in mind, but only with the intent of maximum economic benefit from the power generation, or adequate water supplies for the users.

In response to your questions:

1. No attempts, that I know of, have been made to control ice levels to affect ice jamming or flooding. Reservoirs generally do not discharge ice and this, to some degree, reduces ice jams downstream.

2. No procedures, that we know of, have been taken to protect large animals from ice hazards. The hazards are not perceived to be significant.

3. No procedures are used to control cracks in reservoir ice that might be a hazard to animals.

4. There is considerable bank erosion, due in part to ice movement and freezing and thawing. It is a concern to landowners, and a lesser concern to fisheries managers, in the federal Department of Fisheries and Oceans. The principal concern by Fisheries with turbidity is the blanketing effect of silt on spawning beds. Erosion of stream banks is controlled to some extent by placement of large quarried rocks or boulders, on stream banks. Proposals to bulldoze gravel bars out of mid stream in rivers are viewed with disfavour by Fisheries and Environment departments staff. Removal of such bars is seen by others as an answer to ice jam problems, since the bars apparently initiate ice jams.

. . . /2

A call to Mr. Don Cox, of Canada Fisheries and Oceans, P. O. Box 550, Halifax, N. S., B3J 2S7, indicates they consider turbidity above 10 mg/L may be detrimental. Effluents regulations for the mining industry specify not more than 25 mg/L in effluent. Hatchery experience indicates 15 mg/L causes some mortality among small fry. You could contact Mr. Cox or his colleague Mr. David Morantz for further discussion on turbidity effects on salmon and trout.

A brief conversation with the Manager, Wildlife Resources in Nova Scotia Lands and Forests Department, Mr. Arthur Patton, failed to elicit concern about the effects of ice on wildlife, or at least any concern about reservoir management and its effects on large animals. You might wish to contact Mr. Patton or his supervisor, Merril Prime at P. O. Box 516, Kentville, N. S., B4N 3X3.

To summarize then, it appears we do not have any practices in reservoir operation that are affected by environmental protection concerns. Even this rather negative response may be of some help to you in your project I suppose.

Yours truly,

H. T. Doane

H. T. Doane, P. Eng.
Environmental Engineer
Water resources Planning

HTD/rg
c.c. Don Cox
Art Patton
R. Hand
C. L. Lin, P. Eng.

nova scotia power corporation

1984.11.12

HARZA ENGINEERING COMPANY,
150 South Wacker Dr.,
Chicago, Illinois
60606, U.S.A.

Attention: Mr. David S. Louie

Gentlemen:

I acknowledge your letter of 1984.10.16 forwarded to Mr. L.R. Comeau, President & Chief Executive Officer regarding a request for information on the state-of-the-art in ice control engineering which affects the environment.

The Nova Scotia Power Corporation does not have a written operating policy for the control of ice levels in rivers where Hydro installations exist. The problem has never been a serious one due mainly to the fact that we have a maritime climate greatly affected by the close proximity of the North Atlantic. Ice covers in moving water such as canals and forebays have caused us very little problem. Anchor ice from spring backup does retard flow to one of our installations but a bypass sluice permits us to dispose of this ice in quick fashion.

Probably of more concern in Nova Scotia is a phenomenon which occurs when turbulant waters reach the freezing point, millions of ice needles form which are referred to as Frazil Ice. This ice has on occassin plugged intakes and scroll cases and has to be dislodged by maintenance crews and flushed through the turbines. It does shut several of our units down for short periods of time. To my knowledge no one has come up with a sure and fast solution to preventing it.

0095F/WAS

Canseau Zone, Box 40, Port Hawkesbury B0E 2V0 / Eastern Zone, Box 1070, Stellarton B0K 1S0 / Halifax Metro Zone, Box 910, Halifax B3J 2W5 / Northern Zone, Box 70, Amherst B4H 3Y6 / Sydney Metro Zone, Box 610, Sydney B1P 6H8 / Western Zone, Box 1268, Liverpool B0T 1K0 / Central Zone, Box 910, Halifax B3J 2W5.

Bubblers are used to a fair extent upstream of spillways to keep areas clear of thick ice which might interfere with spilling or bypassing water.

I would suggest a contact with the Canadian Electric Association who presently have a research project proposal under consideration entitled "Hydro-Power Station Operations under Conditions of Supercooled water Supply Anchor Ice". A copy of the proposal is enclosed for your consideration.

Water fluctations in reservoirs and headponds are the standard for operation practise and do not cause us problems.

I can only recall one instance where a moose went through a thin cover of flowage ice but we managed to rescue the animal.

Bank erosions has to be watched and rock rip rap repaired or replaced on occasion. This is not a serious problem nd can be classed as normal maintenance.

I trust the enclosed comments will be of some assistance,

Yours truly,

L.R. Feetham,
Manager,
Hydro Production Department.

LRF:hp
C: Mr. L.R. Comeau

C.L.F.
File

0095F/WAS

Ministry of
Natural
Resources
Ontario

1984 11 02

Dr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606-4176
U.S.A.

Dear Dr. Louie:

Re: Ice Control Engineering

This is in reply to your letter of 1984 10 16, addressed to Mr. W. T. Foster, the former Deputy Minister, in which you request information on ice control engineering which affects the environment.

To our knowledge, very little information, if any, exists on the items listed in your letter. However, we are enclosing one set of the reports prepared by this Ministry which describe what we in Ontario have done in ice control. These are:

1. Ice Management Manual, November 1982 (This edition is out of print and a second edition is being printed).

2. Ice Management Seminar Proceedings, January 1980, London, Ontario.

3. Proceedings of the Ice Jam Seminar, June 2, 1982, Queen's Park, Toronto.

The names and affiliations of the authors or speakers listed in the Tables of Contents of the latter two reports may serve as a list of resource persons for further information. In addition, we suggest that you contact Mr. Tom Wigle, River Control Engineer, Ontario Hydro, 700 University Ave., Toronto, Ontario M5G 1X6 for information on operating procedures for their hydro-power plants.

We trust the information outlined above will be of help to you in compiling the literature on this important but little-known subject. We wish you success in your endeavours and would appreciate receiving a copy of your report when it is available.

Should further information be required, please do not hesitate to contact Mr. John Ding, Head, Model Development Unit of the Conservation Authorities and Water Management Branch at (416) 965-1271.

Yours truly,

H. A. Clarke
Executive Co-ordinator
Lands and Waters

Ontario

Ministry
of
Energy

Energy
Ontario

Queen's Park
Toronto, Ontario
M7A 2B7
Telex-06217880
965- 3041

October 30, 1984

Dr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
U.S.A.

Dear Dr. Louie:

Thank you for your letter of October 16th requesting information on the day-to-day operations at hydro power plants in the winter. These include the control of ice levels and the methods of minimizing the associated problems due to ice formation.

Ontario Hydro operates the province's large-scale hydraulic plants. I have, therefore, forwarded your letter to Mr. J.S. Pengelly, Manager of Government Relations, Ontario Hydro, H19A14, 700 University Avenue, Toronto, Ontario, Canada M5G 1X6, for response.

The attached Micro-Hydro Power -- Energy From Ontario Streams explains Ontario's approval process in developing privately-owned smaller plants. An environmental impact review to protect our natural resources precedes the approval system. I have also enclosed a copy of the Small Hydro Workshop proceedings held November 30, 1983 which you may find useful.

I hope the above is satisfactory. If you require further assistance, please contact me.

Yours truly,

Olga Carmen
Manager, Information Services
Communications Group

ontario hydro

700 University Avenue, Toronto, Ontario M5G 1X6

Mr. H.M. Steckley
Location: A5-H4
(416) 592-4258

December 3, 1984

Mr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
U.S.A.

Dear Mr. Louie:

This letter is in reply to your letter to me dated November 13, 1984 regarding ice control engineering.

We were forwarded a copy of your previous letter to Ontario Hydro dated October 16, 1984 and have provided our comments to someone in the Corporation who will be co-ordinating a reply from several other departments.

Thank-you for your interest.

Yours truly,

H.M. Steckley
Manager - Civil Works

:sim

ontario hydro

700 University Avenue, Toronto, Ontario M5G 1X6

December 4, 1984

Dr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive
CHICAGO, Illinois 60606

Dear Dr. Louie:

We are pleased to reply to your letter of October 16, 1984 in respect to ice control engineering and the related effects on the environment.

In respect to questions 1 and 4, we have the following comments:

The objective of ice control is to maintain the capability of channels to carry the prescribed releases from reservoirs. Ontario Hydro utilizes a number of strategies to handle ice conditions on a site specific basis.

Two types of river systems are generally encountered. They are described as follows:

1. The river velocity creates a situation not conducive to ice cover formation either through structural or procedural means.

2. River velocity creates a marginal situation for ice cover formation and where structural and procedural efforts can contribute significantly to the establishment of a smooth stable ice cover.

In the first case all effort is focused toward keeping the ice moving past critical intake areas. This assumes that there is infinite storage capability downstream where the ice can be flushed, such as a large deep lake that does not freeze over in the winter season. Excavations, channels, control works, special design intakes have been constructed to facilitate this. Ice breaking boats have been commissioned. Procedures have been established to cover:

1. Fundamental principles which must be applied to circumstances as they occur in each unique combination.

2. Detailed procedures and step-by-step methods of handling a particular circumstance.

Great effort is spent in programs for observing, recording and reporting ice conditions so that:

1. Operational decisions are based on current data.

2. Management can be kept up-to-date.

3. Government agencies can be supplied with required information.

4. Future operations may be improved.

In the second case, all efforts (physical and procedural) are directed towards forming an ice cover (eg, St. Lawrence River). Velocities are controlled to encourage the formation of a smooth stable ice cover. Depending on climatic conditions, once the cover has formed, higher flows can be scheduled. Generally, short-term power needs are sacrificed in order to ensure greater long-term production. During the ice breakup period, flows can be further adjusted to assist in wearing away the ice cover in a controlled fashion.

With respect to problems of such erosion caused by the breakup and movement of ice, little information is available. While some evidence of earth breaking away from the shore as the ice breaks up has been noticed, there is no formal documentation.

In respect to question 2, we do not have major concerns with caribou at our facilities in Ontario. The question, however, is addressed in the attached paper, in particular Mr. G. Doucet and Mr. P. Lamothe of McGill University and Hydro Quebec respectively. Contact with these two gentlemen may be of value. We also suggest that you contact Mr. David Kiell of Newfoundland and Labrador Hydro (709) 753-8990 for additional information on this subject.

In respect to turbidity changes as result of bank erosion, etc, a rough rule of thumb is to restrict a change of no greater than 10% beyond existing conditions for protection of aquatic life.

I hope these brief comments are of some value to you in your literature search on ice control engineering.

Yours truly,

W.G. Morison
Vice President
Design and Construction Branch

Attach.

PRINCE EDWARD ISLAND ENERGY CORPORATION
CHARLOTTETOWN
PRINCE EDWARD ISLAND
C1A 7N8

P.O. BOX 2000
PHONE: 892 - 1051

October 31, 1984

Mr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
Consulting Engineers
150 South Wacker Drive
Chicago, Illinois 60606-4176

Dear Mr. Louie:

I wish to acknowledge with thanks your letter of October 16, 1984 relating to a survey of state-of-the-art in ice control engineering.

Please be advised that the P.E.I. Energy Corporation is involved in renewable energy projects and that our local electric utility is Maritime Electric Company Ltd., a privately owned electric utility, and I have listed the name and telephone number of the General Manager at the bottom of this letter.

As far as P.E.I. is concerned, we do not have any hydro-electric power developments. Ninety-five percent of our electricity requirements is purchased from the province of New Brunswick and the balance is generated in thermal generation using oil.

Therefore, we are not in a position to comment on the questions raised in your letter.

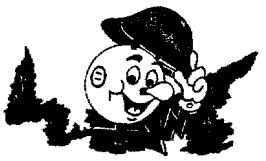
Sincerely yours,

A.J.HISCOCK
GENERAL MANAGER

mrh

Mr. Paul Newcombe
General Manager
Maritime Electric Co.Ltd.
P.O.Box 1328
Charlottetown, P.E.I. C1A 7N2
Phone: (902) 892-6531

TELEPHONE
902-892-6531
TELEX
014-44115



P.O. BOX 1328
C1A 7N2

MARITIME ELECTRIC COMPANY, LIMITED

(Incorporated 1917)

CHARLOTTETOWN
PRINCE EDWARD ISLAND

15 November, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606 U.S.A.

Dear Sir:

Re your inquiry of 8 November, 1984, Maritime Electric does not have any reservoirs and is not involved in erosion problems due to ice.

Yours very truly,

MARITIME ELECTRIC COMPANY, LIMITED

P. H. Newcombe
General Manager

PHN:jm

Gouvernement du Québec
Ministère du Loisir,
de la Chasse et de la Pêche
Direction générale de la faune

November 21, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois
60606 U.S.A.

Dear Sir:

I acknowledge receipt of your letter dated the October 16 inquiring about information on state-of-the-art in ice control engineering which affects the environment.

Although we have no information of this kind, we send your letter on his way to Hydro-Québec and the Bay James Energy Society for ulterior answer.

Here is the name and address of these contacts for your reference file:

Mr. Marcel Laperle
Société d'Energie de la
Baie James
Direction de l'Ingénierie
et de l'Environnement
800, boul. de Maisonneuve est
Montréal, Québec, Canada
H2L 4N8

Mrs. Denise Therrien
Hydro-Québec
Direction de l'Environnement
Les Atriums
870, boul. de Maisonneuve est
Montréal, Québec, Canada
H2L 4S8

Yours sincerely,

Rodrigue Bouchard

Rodrigue Bouchard, adjoint au
Directeur de la faune terrestre

RB/lld

c.c. M. Christian Potvin

150 est, boul. Saint-Cyrille
Québec, QC G1R 4Y1

UNIVERSITÉ LAVAL
FACULTÉ DES SCIENCES ET DE GÉNIE
CITÉ UNIVERSITAIRE
QUÉBEC G1K 7P4 CANADA

Department of
Civil Engineering

November 27, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
U.S.A.

Dear David:

It is a very great pleasure for me to hear about you and see that you are doing well and that you are still interested in ice problems.

I have received your letter concerning the survey you are making on state-of-the-art in ice control engineering which affects the environment.

It is extremely difficult to get information in this field. Here are some comments.

1 - Hydro power operations. No firm would admit it is causing any jam or modifying the ice cover. Example (New Brunswick Power Commission - Case in court - flooding by ice jams in the Mattakwac reservoir - B.C. Hydro - flooding downstream of Peace River).

2-3 - Environment Canada has given many contracts to study the effects of the ice on animal crossings in ship's tracks.

4 - J.C. Dionne, one of my colleague at Laval is studying very seriously this question. Included is a copy of one of his recent paper to set you on the way.

I consider this work that you are undertaking very important and I would appreciate very much getting a copy of your report.

Yours truly,

Bernard Michel, Dr. Eng.

BM/dd
Enclosure

March 19, 1985

Dr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
Consulting Engineers
150, south Wacker Drive
Chicago, Illinois 60606
U.S.A.

Dear Dr. Louie:

I apologize for the delay in answering to your letter of January 16, 1985 to my predecessor, Mr. J.-G. Dussault, regarding information on the environmental impact cause by various ice conditions on reservoir and river.

After reviewing your questionnaire with my staff, I feel that proper information would be available through the experts from the Environment Directorate and from the Operations Group of Hydro-Québec, and also from the original designers of the James Bay project.

Therefore, I have forwarded your questionnaire to the aforementionned authority which will answer directly to you.

If I can be of further assistance to you, please contact with me again.

Very truly yours,

J.-P. LARDEAU, ing.
Chef de service intérimaire
Hydraulique
14e étage

/jh
c.c.: MM. M. Drouin (SEBJ)
J.C. Rassam
D. Therrien

Our reference: 99-05-42-07

April 4th, 1985

Dr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
Consulting Engineers
150, south Wacker Drive
Chicago, Illinois 60606
U.S.A.

Dear Dr. Louie:

In response to your letter dated January 16, 1985 to Mr. J.G. Dussault, and which was forwarded to us on March 19, we are pleased to provide you will two examples with ice management cases that affects the environment.

1. In the case of the Eastmain - Opinaca diversion of the La Grande system (James Bay Project), the level of Lake Sakami is maintained at its highest level from the beginning of the winter in order to allow free access of the beavers to their huts. More details on the subject could be found in the E.O.L. diversion report which is to be requested from Mr. Marc Drouin of the Société d'Energie de la Baie James, 850 est de Maisonneuve, Montréal, Québec.

2. In the case of the lower La Grande River, a minimal outflow of 200 m^3/s is maintained at LG2 power plant in order to avoid saline intrusion under ice conditions, in the estuary which night affect the municipal water intake. In ice-free conditions the minimal outflow is 900 m^3/s. For more details, please find herein enclosed a paper drawn from the proceedings of the 1981 IAHR International Symposium on ice in Quebec.

.../ 2

HARZA EBASCO

APR 85 2 16

Hoping that these cases will be of any help in your present search, I remain.

Sincerely yours,

Jean-Claude Rassam, ing.
Chef de division
Gestion des systèmes hydriques
Service Prévisions et
Systèmes hydriques

J.-C.R./gd

Encl.

c.c.: Messrs M. Drouin (SEBJ)
J.-P. Lardeau
S. Robert

Société d'énergie de la Baie James
800, boul. de Maisonneuve est, Montréal (Québec) H2L 4M8 Tél.: (514) 844-3741

May 2nd, 1985

Mr. David S. Louie
Chief Hydraulic Engineer
150, South Wacker Drive
Chicago, Illinois 60606
U.S.A.

Dear Sir:

To answer your information request on the environmental impact of ice conditions in reservoirs and dowstream river, Hydro-Quebec requested that SEBJ answers your questions mostly concerning observations carried out at the La Grande Complex.

As soon as it began its activities, SEBJ formed an environmental team that had, among other things, as a mandate to monitor and evaluate the environmental impacts following the building and exploitation of the La Grande Complex. Actually, with the end of building works in site, the SEBJ environmental group is preparing a synthesis of environmental studies and works carried out at the La Grande Complex, but this document will not be available before 1986.

Nevertheless, on one hand, we will briefly describe the principal observations and measures that we carried out at the La Grande Complex and, on the other hand, we will give a specific answer to your questions.

But first, we believe that to understand our answers, it is necessary to give you some information concerning the technical description of the Complex.

The first phase of works of this Complex, which will end this year, is formed by three powerhouses on the La Grande River which are from downstream to upstream LG 2, LG 3 and LG 4. The building of this hydroelectric Complex also includes the diversion to the La Grande River of the upstream water basins of the Eastmain River in the south, and the Caniapiscau in the east. As a matter of fact, Opinaca reservoir on the Eastmain River and Caniapiscau reservoir on the Caniapiscau River allow by raising the water level, water transfer from their watershed to the La Grande River basin. At maximum flow, the contribution

.../2

Société d'énergie de la Baie James
800 est, boul. de Maisonneuve, Montréal, Qué. H2L 4M8 Tél.: (514) 844-3741

of the two diversions nearly doubles at the mouth, the flow of the La Grande River (see here attached map).

Furthermore, during the interruption of flow in the La Grande River to allow the filling of the LG 2 Reservoir, the temporary diversion works were done at the future LG 1 site.

Impacts related to ice action

Since the operation of the La Grande Complex reservoirs has begun, some impacts related to ice action have been observed and measured either along the shores of the reservoirs or either along the La Grande River downstream from the LG 2 powerhouse.

Reservoirs

In the reservoirs, the operation mode, that generally requests a drawdown during winter, favours, in the drawdown zone, ice action as a natural wood clearing agent. La Grande Complex reservoirs wood clearing plan was planified, taking into account said effect.

La Grande River downstream from LG 2

During the filling of LG 2, while the river flow was interrupted, the ice-cover allowed to maintain the saltwater wedge near the mouth of the river, this also allowed to protect the fish population. As a matter of fact, the site of the future LG 1 works (km 37), an important rapid, forms an impassable obstacle for fish. Thus, the fish population living downstream from this site is a very important resource for the Chisasibi crees whose village is situated near the mouth of the River (km 15); their annual catch for food in the region being some 50 000 kg of fish. A model study showed that if the flow was cut to fill the LG 2 reservoir in open water, the saltwater wedge would climb up to the LG 1 site and would endanger the fish population in that part of the River. However, that study also showed that with an ice-cover, the saltwater wedge was kept sufficiently downriver to keep a freshwater portion of the river sufficiently vast to accommodate the fish that swim up the river pushed by the saltwater wedge. It is consequently for environmental reasons that the filling of the LG 2 reservoir was begun in winter in order to take advantage of the conditions offered by the presence of an ice-cover in the downstream part of the river.

.../3

Société d'énergie de la Baie James
600, boul. de Maisonneuve est, Montréal (Québec) H2L 4M8 Tél.: (514) 844-3741

Since the LG 2 powerhouse and other works of the Complex have been put in operation, the downstream part of the La Grande River presents an increase and a regularized flow and since the electric demand is more important in winter the flow is also more important in winter. In general, this flow increase does not cause ice jams downstream from LG 2 powerhouse but has a tendency to increase water levels that, due to the steepness of the river banks, do not cause inundation.

However, this winter flow increase causes ice-cover instability in front of the Chisasibi community. This is the most important repercussion since some Chisasibi cree trappers cross the River on the ice-cover to get to their hunting territories. The unstable ice-cover, at that spot, reduces the period while trappers can safely cross the river. Nevertheless, to counteract this problem, SEBJ built at the site of the future LG 1 powerhouse, a bridge that allows cree trappers to cross safely the river.

Specific answers to your questions

Procedures or operating policies used in the control of ice levels

From a technical point of view, the La Grande Complex works operating modalities have been optimized to reduce all inconvenients related to the ice-cover instability or to the formation of frasil ice. Nevertheless, in particular for the diversion zone, some environmental criteria have been included in the optimization of operating modalities of the La Sarcelle (discharge of Opinaca reservoir) and Brisay (discharge of Caniapiscau Reservoir) regulation works in order that the ice condition on the path of diverted waters be stable enough to stop the formation of ice jams and consequently stop supplementary inundation due to the increase of water levels. Furthermore, in these areas, some environmental works (canalization, construction of protection dykes and bunds) were carried out to control the water flow and by doing so reduce the inundated surfaces.

Environmental impact on terrestrial animals

In the La Grande Complex, the formation of the ice-cover or the breakage of the ice-cover due to the drawdown effect has caused no impact on the various animal population such as caribou, moose, wolf, etc. The animal the most liable to use the bare reservoir zones are caribous. Even if caribou is found in the Caniapiscau, Laforge diversion, LG 4 and LG 3 regions, the reservoirs are not used as a migration zone. On the other hand, in some sectors, the edge of the reservoir forms an ecotone zone that is used by small mammals or by predators.

.../4

Société d'énergie de la Baie James
800, boul. de Maisonneuve est, Montréal (Québec) H2L 4M8 Tél.: (514) 844-3741

Method of reservoir fluctuation management

Since the reservoirs are not used by the fauna and since they are not used as migration path, no precaution or reservoir fluctuation management is needed to control the width of opening and pattern of crack development in the ice sheet.

Bank erosion and water quality

On the shores of the La Grande Complex reservoirs, bank erosion is a minor phenomenon and in general the principal erosion agent is not ice action but the combined effect of wind and waves.

On the other hand, downstream from LG 2, La Grande River bank erosion is much more important since the combined effect of level variation resulting from flow control and waves form the principal erosion agent.

As far as turbidity in the reservoir is concerned, it can increase by a few parts per million during the first few years of operation. In the La Grande River, the active shores give more sediments to the river and turbidity can increase by some 10 ppm mostly during summer and fall but these turbidity conditions do not affect the fish population characteristics of this northern milieu (whitefish, walley, pike, etc.).

In conclusion, we have to recall that the integration of environmental consideration in the conception of works in La Grande Complex allowed to benefit from, to reduce or minimize the ice effect on the environment.

We hope to have answered your questions.

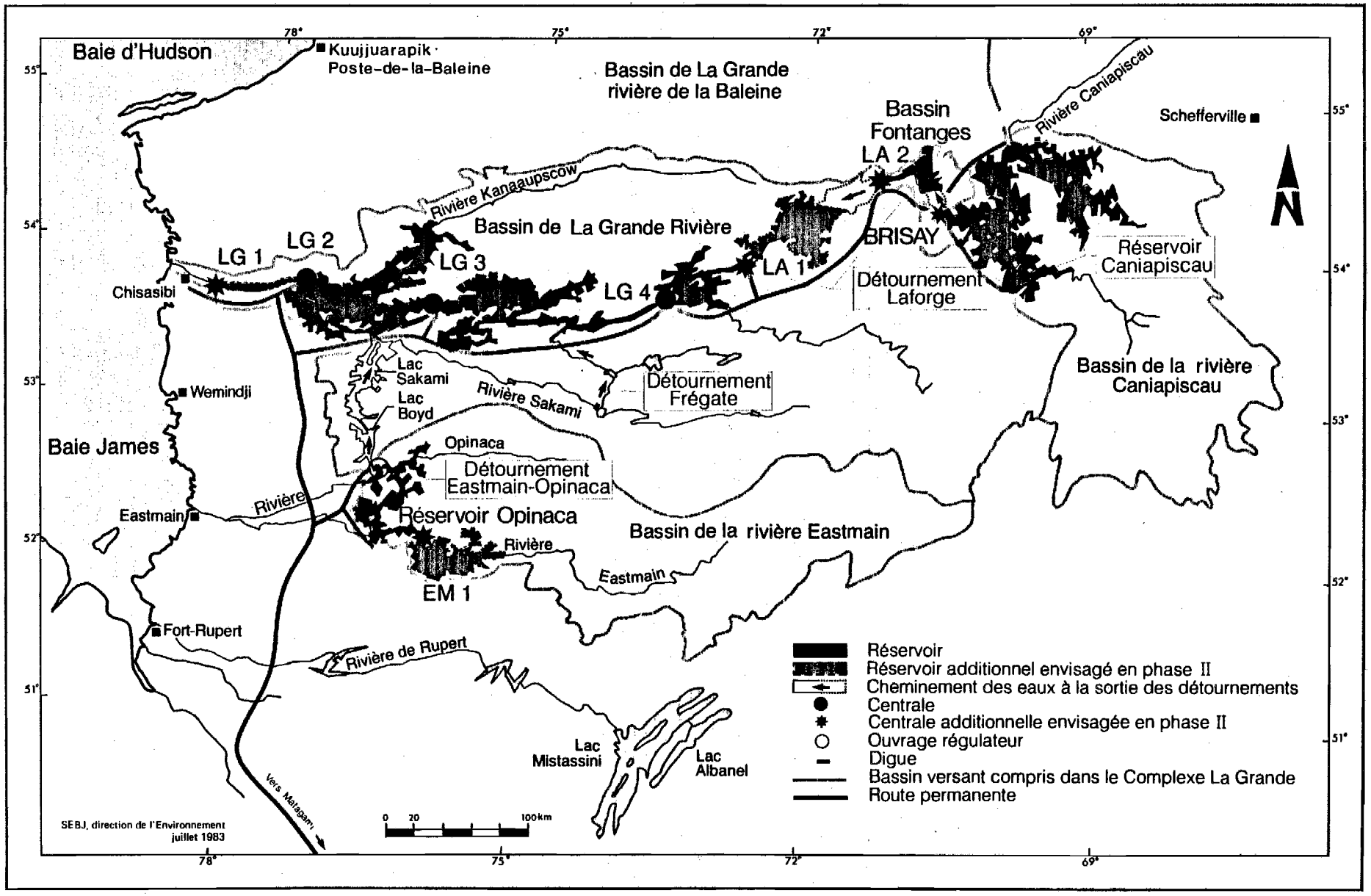
Yours truly,

Onil Faucher
Chief of department
Environmental Studies

c.c.: Mr. Jacques Perreault
Mr. Jean-Pierre Lardeau (H.Q.)

947-3623

Complexe hydroélectrique de La Grande Rivière



Saskatchewan

Saskatchewan
Environment

Walter Scott Building
3085 Albert Street
Regina, Canada
S4S 0B1

File: M2-1

October 30, 1984

Dr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois
U.S.A. 60606

Dear Dr. Louie:

State of the Art Survey - Ice Control Engineering

I am in receipt of your letter dated October 16, 1984, in which you requested information about ice control engineering and its environmental effects. Unfortunately, I am unable to provide you with much information on this topic.

A review of the limited number of environmental impact assessments which have been carried out for reservoir development in Saskatchewan revealed that duration of ice cover and timing and amount of winter drawdown were the major concerns. These concerns related more to the fisheries resource than to terrestrial animals. Bank erosion was a recognized problem not only with ice break-up and movement in the spring, but also with wave action during the summer months. Some studies suggested that sediment levels downstream of the dam might even be reduced from that which naturally occurs.

With respect to other organizations/persons that might be able to help you with your survey, I suggest you contact the following individuals:

1. Ray B. Richards
   President
   Corporate Affairs
   Saskatchewan Water Corporation
   3rd Floor, 2121 Saskatchewan Drive
   Regina, Saskatchewan
   S4P 4A7

2. G. W. Pepper
   Acting Director
   Wildlife Branch
   Saskatchewan Parks and Renewable Resources
   3211 Albert Street
   Regina, Saskatchewan
   S4S 5W6

3. Paul Naftel
Chief of Fisheries Operations
Fisheries Branch
Saskatchewan Parks and Renewable Resources
3211 Albert Street
Regina, Saskatchewan
S4S 5W6

4. R. J. Stedwill
Manager, Environmental Studies
Saskatchewan Power Corporation
2025 Victoria Avenue
Regina, Saskatchewan
S4P 0S1

I trust the above information will be of some assistance to you and I wish you success with your survey.

Yours sincerely,

H. S. Maliepaard
Executive Director
Environmental Information, Co-ordination and
Assessment Service
Phone: (306)565-6131

SASKATCHEWAN POWER CORPORATION

2025 Victoria Avenue,
Regina, Saskatchewan,
S4P 0S1
1984 November 07.

OUR FILE NO.
E4.1.11

Dr. David S. Louie,
Harza Engineering Company,
150 South Waker Drive,
Chicago, Illinois. 60606
U.S.A.

Dear Dr. Louie:

Re: State of the Art Survey
- Ice Control Engineering

In response to your letter of 1984 October 16 regarding ice control engineering, the following is provided.

Point No. 1

Procedures or operating policies used in control of ice upstream and downstream of hydroelectric facilities is normally facility specific; and in the case of Saskatchewan Power Corporation operations, these are worked out on an annual basis with the Saskatchewan Water Corporation. These procedures are also dependent on existing water conditions and forecasts.

A contact person within the Saskatchewan Water Corporation is:

D. Richards,
Saskatchewan Water Corporation,
3rd Floor,
2121 Saskatchewan Drive,
Regina, Saskatchewan.
S4P 4A7

Point No. 2

At this point in time, injuries or drownings of animals due to poor ice conditions has never been a problem to my knowledge. However, a principle which has been used to ensure proper ice development is to stabilize water levels during ice formation, and thereby reduce broken ice at the shoreline by creating a hinge at the shoreline in which the ice surface can move.

Point No. 3

The procedure outline above may be applied here as well. Additionally, a slow drawdown during the winter is recommended.

Point No. 4

In response to this particular question, I believe the actual impact of turbidity in the water on fish directly is not as severe as the impact which affects the fish indirectly. Silting of fish rearing grounds and feeding areas are far more significant than direct exposure.

Cole (1941), Van Oosten (1945), and Wallen (1951) suggest that fish could be harmed in exceptionally turbid waters under very unusual conditions; however, Pentelow (1949) has noted that sea trout regularly pass up a river through china clay with no apparent harm.

It should also be noted that scouring of river edges and increased turbidity is a natural phenomenon and reservoirs upstream of dams do, in fact, reduce turbidity levels during the spring run-off as well as at other times of the year.

Should you require any further elaboration on these points, feel free to contact this office.

Yours truly,

R. J. Stedwill,
Manager, Environmental Studies,
Environmental Programs.

RJS/bjf

Saskatchewan

Saskatchewan Parks and Renewable Resources

Fisheries Branch

Box 3003
Prince Albert, SK
S6V 6G1, Canada

Your File:
Our File:

November 16, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
USA

Dear Dr. Louie:

A copy of your letter requesting information on the environmental effects of fluctuating ice levels related to hydroelectric power production has been forwarded to me for response.

Saskatchewan currently has only two major hydro-electric generating stations; a third is scheduled to come on stream toward the end of 1985. Although both the existing hydroelectric reservoirs are subject to winter drawdowns, we are not aware of any adverse environmental effects caused by fluctuating ice levels or formation of ice jams downstream.

You may be able to obtain better information regarding the effect of these reservoirs by contacting Mr. R.W. Nordquist, Director of Environmental Programs, with Saskatchewan Power Corporation, the public utility which operates the hydroelectric stations. He may be reached at the following address:

Mr. R.W. Nordquist
Director, Environmental Programs
Saskatchewan Power Corporation
2025 Victoria Avenue
Regina, Saskatchewan, Canada
S4P OS1

Yours sincerely,

B. Christensen

B.L. Christensen
Fish Habitat Protection Coordinator

BLC:peb

Saskatchewan

Saskatchewan
Parks and
Renewable
Resources

3211 Albert Street
Regina, Canada
S4S 5W6

Your File:
Our File:

November 28, 1984

Mr.David S. Louie,
Chief Hydraulic Engineer,
Harza Engineering Co.,
150 South Wacker Drive,
CHICAGO, Illinois, 60606

Dear Mr. Louie:

I am sorry that I can offer little assistance in your ice research. We have not done any work on ice problems on reservoirs.

Yours sincerely,

G.W. Pepper,
A/Director,
Wildlife Branch

Fisheries Branch
Box 3003
Prince Albert, SK
S6V 6G1, Canada

November 16, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
USA

Dear Dr. Louie:

A copy of your letter requesting information on the environmental effects of fluctuating ice levels related to hydroelectric power production has been forwarded to me for response.

Saskatchewan currently has only two major hydro-electric generating stations; a third is scheduled to come on stream toward the end of 1985. Although both the existing hydroelectric reservoirs are subject to winter drawdowns, we are not aware of any adverse enfironmental effects caused by fluctuating ice levels or formation of ice jams downstream.

You may be able to obtain better information regarding the effect of these reservoirs by contacting Mr. R.W. Nordquist, Director of Environmental Programs, with Saskatchewan Power Corporation, the public utility which operates the hydroelectric stations. He may be reached at the following address:

Mr. R.W. Nordquist
Director, Environmental Programs
Saskatchewan Power Corporation
2025 Victoria Avenue
Regina, Saskatchewan, Canada
S4P 0S1

Yours sincerely,

B. Christensen

B.L. Christensen
Fish Habitat Protection Coordinator

BLC:peb
b.c.c. P.C. Naftel

(185)

Saskatchewan

Saskatchewan Parks and Renewable Resources

3211 Albert Street
Regina, Canada
S4S 5W6

Your File:
Our File:

January 29, 1985

Mr. David S. Louie,
Chief Hydraulic Engineer,
Harza Engineering Company,
150 South Wacker Drive,
Chicago, Illinois,
60606.

Dear Mr. Louie:

This is in response to your January 16, 1985 letter requesting information on fluctuating ice levels.

Attached for your information is our earlier reply to you on this subject. As noted therein, further information can be obtained from Mr. R. W. Nordquist of the Saskatchewan Power Corporation.

Future correspondence should be directed to Mr. Nordquist.

Yours truly,

P. C. Naftel, Director,
Fisheries Branch.

Att.

National Research Council Canada
Conseil national de recherches Canada

Division of Building Research
Division des recherches en bâtiment

Ottawa, Canada
K1A 0R6

File Référence

M43-3-212

84 11 01

Mr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Co.
150 South Wacker Drive
Chicago, Illinois, 60606-4176
U.S.A.

Dear Mr. Louie:

Your letter to Dr. E.P. Cockshutt, Director, Division of Energy of the National Research Council of Canada, requesting information concerning ice control engineering, has been brought to my attention for reply. The organizations with the greatest practical experience in this area are the provincial power utilities. Following are the addresses of the principal ones that have extensive experience with respect to ice control, and names of individuals that you might contact.

1. Mr. J-G. Dusseault
   Chef de service hydraulique
   Hydro Québec
   855 Ste Catherine East
   Montréal (Québec), H2L 4P7

2. Mr. Steckley
   Manager, Civil Works, A5 H4
   Ontario Hydro
   700 University Avenue
   Toronto, Ontario, M5G 1Z5

3. Mr. Peter M. Abel
   Reservoir & Energy Resources Engineer
   Manitoba Hydro
   P.O. Box 815
   Winnipeg, Manitoba, R3C 2P4

4. Mr. U. Sporns
   Hydrologist
   B.C. Hydro,
   c/o 970 Burrard Street
   Vancouver, B.C., V6Z 1Y3

...2/

Some university professors have extensive experience in this area and I suggest that you contact the following:

1. Prof. B. Michel
   Faculté des Sciences
   Université Laval
   Québec (Québec), G1K 7P4

2. Prof. R. Gerard (Chairman)
   Department of Civil Engineering
   University of Alberta
   Edmonton, Alberta, T6G 2G7

3. Prof. K. Davar
   Dept. of Civil Engineering
   University of New Brunswick
   P.O. Box 4400
   Fredericton, N.B., E3B 5A3

Several Canadian companies have extensive experience in ice control engineering. Following are some that you may wish to contact.

1. Mr. C.H. Atkinson,
   Manager, Environmental & Special Studies
   Acres Consulting Services Ltd.
   5259 Dorchester Road
   Niagara Falls, Ontario, L2E 6W1,

2. Mr. F.E. Parkinson
   LaSalle Hydraulic Laboratory Ltd.,
   0250 St. Patrick Street,
   LaSalle (Québec), H8R 1R8

3. Mr. A.E. Richard, President
   Montreal Engineering Co. Ltd.
   P.O. Box 6086, Station "A"
   Montreal (Québec), H3C 3Z9

4. Mr. R.J. Cooper, President
   Northwest Hydraulic Consultants
   4823-99 Street
   Edmonton, Alberta, T6E 4Y1

5. Mr. K.M. Adam
   Interdisciplinary Engineering Co.
   966 Waverley Street
   Winnipeg, Manitoba, R3C 2Z1

....3/

Some work on the formation of ice on lakes and rivers has been carried out at the National Water Research Institute of the Federal Department of the Environment. You can check on the current situation by writing or calling Dr. G. Tsang, Hydraulics Laboratory, National Water Research Institute, P.O. Box 5050, Burlington, Ontario, L7R 4A6. The telephone number for the Institute is 416-637-4303. I suggest you write to Mr. Charles Lawrie, Canadian Coast Guard, 6th Floor, Tower "A", Place de Ville, Ottawa, Ontario, K1A ON7 for information with respect to ice control for power generation on the St. Lawrence River.

I hope the above information will be of assistance to you.

Yours sincerely,

L.W. Gold
Associate Director

LWG/EB

84-DO-1100

Energy, Mines and Resources Canada
Ottawa, Ontario
K1A 0E4

Énergie, Mines et Ressources Canada
Ottawa (Ontario)
K1A 0E4

6

Your file Votre référence

Our file Notre référence CN 3605-1

November 6, 1984

Dr. David S. Louie,
Chief Hydraulic Engineer,
Harza Engineering Company,
150 South Wacker Drive,
Chicago, Illinois 60606,
U.S.A.

Dear Dr. Louie:

This is in reply to your letter of October 16, 1984, addressed to my predecessor, Mr. A.R. Scott.

It was my intention to refer you to the Inland Waters Directorate of Environment Canada, among others, but I understand you have already made enquiries in that direction and that they have suggested that you also contact a number of Canadian electric utilities.

In addition to these contacts, I suggest that you write to:

Dr. E. Ezer,
Director,
Research and Development,
Canadian Electrical Association,
Suite 580,
1 Westmount Square,
Montreal, P.Q.
H3Z 2P9

Dr. Ezer will be able to provide you with R&D related references in connection to the above field.

Yours sincerely,

C Marriott

Charles Marriott,
Director General,
Electrical Energy Branch.

Canada

The St. Lawrence Seaway
Transport Canada

La Voie maritime du Saint-Laurent
Transports Canada

P.O. Box 97
St. Lambert, Quebec
J4P 3N7

File: 7-1-1-3-
November 7, 1984.

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606 U.S.A.

Dear Sir:

This letter is written in response to your literature search on ice control engineering and its environmental effects, which request was addressed to our Chief Engineer.

The ice control measures we exercise within our system are innocuous to the environment, and moreover are not put into effect as a consequence of environmental dictates but rather to facilitate the flow of shipping.

Water levels, hence ice levels are essentially controlled by the IJC and the provinces of Ontario and Quebec. These entities have a broader perspective relevant to the environmentally orientated questions you have raised. Our interests as a maritime agency are conveyed to the IJC through various committees and boards in the person of Mr. C.J.R. Lawrie, P. Eng. who is with the Canadian Coast Guard in Ottawa. His address is:

Aids & Waterways Coast Guard,
Tower A, Transport Canada Building,
320 Queen St.,
Ottawa, Ontario, K1R 5A3.

The effects of ice jams on power generation and water levels in the upper reaches of the Seaway are very well addressed by Mr. David Witherspoon, P. Eng. Mr. D. Witherspoon's address is:

Great Lakes - St. Lawrence Study Office,
Environment Canada, Suite 235,
111 Water Street East,
Cornwall, Ontario, K6H 6S2.

File: 7-1-1-3
November 8, 1984.

Reservoir sedimentation resulting from bank erosion is not a problem in our system mainly because the two major generating stations are essentially run of the river types.

In regards to the references about animal and aquatic life, Hydro Quebec may be helpful. The person to contact is:

M. Roger Larivière, ing., MSc,
Administrateur d'ingénierie,
Avant projet archipel,
Direction équipement de production,
Place Dupuis, lle étage,
855 rue Ste-Catherine est,
Montréal, H2L 4P5.

We hope this letter will provide some guidance for you, and should your client allow the dissemination of your findings we would like to share them with you.

Yours truly,

THE ST. LAWRENCE SEAWAY AUTHORITY

E. Dumalo

E. Dumalo, P. Eng.
Engineering Services Branch

ED/cr

c.c. Mr. M.A. Hanson - Cornwall

INTERNATIONAL JOINT COMMISSION

COMMISSION MIXTE INTERNATIONALE

100, RUE METCALFE STREET
OTTAWA, ONTARIO
K1P 5M1

November 1, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606 USA

Dear Dr. Louie:

In reply to your letter of October 16 concerning your state-of-the-art survey in ice control engineering which affects the environment, I suggest contacting the following individuals:

1. Mr. Doug Cuthbert and Mr. G. Tsang
   Canada Center for Inland Waters
   Environment Canada
   P.O. Box 5050
   867 Lakeshore Road
   Burlington, Ontario, L7R 4A6
   (416) 637-4531

2. Mr. David Witherspoon
   Great Lakes-St. Lawrence Study Office
   Environment Canada
   Suite 235, New Federal Building
   111 Water Street East
   Cornwall, Ontario K6H 6S2
   (613) 932-4325

3. Mr. Derek Foulds
   R.R. #4
   Uxbridge, Ontario LOC 1KO
   (416) 852-6416

4. Mr. Tom Wigle
   Ontario Hydro
   700 University Avenue
   Toronto, Ontario M5G 1X6
   (416) 592-4475

5. Mr. René Hausser
LaSalle Hydraulic Laboratory
0250 St. Patrick Street
LaSalle, Québec
(514) 366-2970

6. Dr. R.W. Newbury
Department of Fisheries and Oceans
Freshwater Institute
501 University Crescent
Winnipeg, Manitoba R3T 2N6
(204) 269-7379

As you can see I have restricted my list to Canadian names, as I assume you are or will be informed of U.S. experts.

I would appreciate seeing the results of your work, if that is possible.

Sincerely,

Dr. Murray Clamen, P. Eng.
Engineering Adviser
International Joint Commission

Environment Canada | Environnement Canada

National Water Research Institute
Canada Centre for Inland Waters
867 Lakeshore Road,
P.O. Box 5050
Burlington, Ontario
L7R 4A6
CANADA

Your file Votre référence

Our file Notre référence
1202-2 (1632a)

October 29, 1984

Dr. David S. Louie
Chief Hydraulic Engineer
HARZA Engineering Company
Consulting Engineers
150 South Wacker Drive
Chicago, IL 60606-4176
U.S.A.

Dear Dr. Louie:

Your letter of October 16, 1984, has been brought to my attention.

The Hydraulics Division, National Water Research Institute, has been conducting research on the mechanics of ice jams for a number of years. Dr. Spyros Beltaos is the primary researcher in this area and I am enclosing several of his reports on ice jam theory which you may find useful.

Because of the complexity of the phenomenon, a complete understanding of ice jam behaviour is still not available. Therefore, many of the operational procedures at dams and hydro power plants are still based on operators' experience. The engineers at Ontario Hydro and Hydro-Québec may be able to provide you with some of this operating information. They may also be able to help you with information concerning animal control.

I am forwarding a copy of your letter to the Department of Fisheries and Oceans here at the Centre. Their scientists may be able to provide you with information concerning the effects of turbidity on various species of fish.

Please do not hesitate to contact us if you wish further information.

Yours sincerely,

T. Milne Dick, Chief
Hydraulics Division

Encl.

cc: Dr. P.V. Hodson, DFO

Canada

Environment Canada | Environnement Canada
Environmental Conservation | Conservation de l'environnement

Water Planning and Management Branch
Ottawa, Ontario
K1A 0E7

Your file / Votre référence

November 13, 1984

Our file / Notre référence 3668-1

Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
U.S.A.

Attention: Dr. David S. Louie

Dear Sir:

This is in response to your enquiry of October 16, seeking information on ice control engineering which affects the environment. Comments are offered in a numbered sequence corresponding to the points raised in your letter.

1. Private and public utilities would be useful sources to investigate for information of this type. We are not aware of any specific "environmental water releases" that cause ice problems and therefore require appropriate operating policies. However there are certainly control dams and power plants in this country which have operating procedures designed to discourage the formation of ice jams and minimize flooding. For example, generating flows through power plants on the St. Lawrence River, at times of ice formation, take into account the need to establish, as quickly as possible, a firm and smooth ice cover that will permit winter discharges sufficient to regulate the level of Lake Ontario as prescribed by the International Joint Commission. Hydro Quebec, Ontario Hydro and the New York State Power Authority would be the agencies to contact for information on this practice. It is also believed that the New Brunswick Electric Power Commission has well defined operating policies on some plants related to control of ice conditions.

2. Again we can suggest provincial and private power utilities and other commissions and corporations, particularly those in the northern areas such as the Northwest Territories and the Yukon. The Canadian Electrical Association, of which most utilities are members, may also be a useful source. Provincial energy and environmental agencies should be able to provide information too.

3. The only sources we can suggest for information on this subject, aside from power utilities, are the authors of "The Western Reservoir and Stream Habitat Improvement Handbook" in Fort Collins, Colorado.

4. A suggested source for information on bank erosion is Volume 41, Number 4, Canadian Journal of Fisheries and Aquatic Services. The authors - Newburg, Hecky and others - could be contacted personally at the Freshwater Institute in Winnipeg, Manitoba. Another person to contact would be Dr. R. Baxter at the National Water Research Institute in Burlington, Ontario. Power agencies may also have information on the subject.

Permissible levels of turbidity are difficult to define and vary in this country from province to province. They can either be absolute or defined as a permissible degree of change. Usually they are given for drinking water standards and seldom for aquatic life. The province of Manitoba, however, has attempted stream classifications applicable to fish, i.e.:

Class 2A - warm and cold water sport and commercial fish
- limit = 10 JTU

Class 2B - warm and cold water sport and commercial fish
- limit = 25 JTU

Class 2C - rough fish - limit = 25 JTU

The province of Ontario, for instance does not permit Secchi disc readings to change by more than 10%. Alberta's objectives suggest changes be less than 25 JTU's over natural turbidity. Saskatchewan also suggests less than 25 JTU's over natural.

The problem of erosion is much more complex than just turbidity; for example, the raising of South Indian Lake in Manitoba elevated natural mercury levels. The nature or cause of the turbidity is also important. Large colloidal particles causing the turbidity may also cause an abrasive effect on fish gills, etc.

For specific limits for particular fish, it is best to contact provincial environmental departments and federal and provincial fisheries agencies.

Hopefully some of the above information may be of help to you. Addresses for the agencies referred to are attached, as well as some reference material.

Yours sincerely,

J. Bathurst
Chief
Engineering and Development Division

Attachment

Government of Canada | Gouvernement du Canada
Fisheries and Oceans | Pêches et Océans

Your file *Votre référence*

Our file *Notre référence*

December 4, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
U.S.A.

Dear Dr. Louie:

Please find enclosed several reprints of recent articles dealing with the erosion of permafrost shorelines in large northern reservoirs. We are not directly involved in river ice studies at the Institute but have some peripheral involvement with litigation arising from drownings of fishermen caused by rapid fluctuations in reservoirs and tailraces and subsequent deterioration of competent ice covers. If you wish to pursue these claims you could contact Mr. Joe Keeper, Northern Flood Committee, 310-260 St. Mary Avenue, Winnipeg, Manitoba R3C 0M6.

Please write if you require further information.

Yours truly,

R. W. Newbury
Hydrologic Studies

RWN/sr
Encl.

cc: Dr. R.E. Hecky
Project Leader
Aquatic Ecosystems
Freshwater Institute

C.L. Dominy
Fish Habitat Management Branch
Ottawa

Freshwater Institute
501 University Crescent
Winnipeg, Manitoba
R3T 2N6
(204) 949-5000

Institut des eaux douces
501 University Crescent
Winnipeg (Manitoba)
R3T 2N6
(204) 949-5000

Environment Canada | Environnement Canada
Environmental Conservation | Conservation de l'environnement

December 4, 1984

Your file Votre reference

Our file Notre reference

Mr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606-4176
U.S.A.

Dear Mr. Louie:

I wish to acknowledge your letter of October 16 in which you request information about ice control engineering that affects the environment. I apologize for the delay in responding to your inquiry.

I do not know specifically any persons who could be helpful to you, but I suggest that the following people might be helpful.

1. For information on water levels and control:

J.E. Slater
Director
Water Resources Branch
Inland Waters Directorate
Environment Canada
Ottawa, Ontario
K1A 0E7

2. Environmental impact on terrestrial animals due to the formation of ice on reservoir banks:

Dr. V. Geist
Professor of Environmental Management
University of Calgary
2500 University Drive, N.W.
Calgary, Alberta
T2N 1N4

.../2

3. Effect of turbidity on fish:

Dr. N.J. Campbell
Director
Marine Sciences and Information
Directorate
Department of Fisheries and Oceans
Ottawa, Ontario
K1A OE6

Yours sincerely,

A.W. Rathwell
Head
Communications Section
Canadian Wildlife Service
Ottawa, Ontario
K1A OE7

Your file Votre référence

Our file Notre référence

Environment Canada / Environnement Canada

Environmental Management / Gestion de l'environnement

Suite 235, Lionel Chevrier Bldg.,
111 Water Street, East,
Cornwall, Ontario, K6H 6S2,
10 December 1984.

Mr. David S. Louis,
Chief Hydraulic Engineer,
Harza Engineering Company,
150 South Wacker Drive,
Chicago, Illinois, 60606.

Dear Mr. Louis:

In reply to your enquiry of 20 November 1984 concerning state-of-the-art ice control engineering which affects the environment, I would suggest you contact

Mr. T. Wigle,
River Control Engineer,
Ontario Hydro,
700 University Avenue, A5 H5,
Toronto, Ontario, M5G 1X6.

Quebec Hydro,
75 West Dorchester Blvd.,
Montreal, P.Q., H2Z 1A4.

Yours sincerely,

J. R. Robinson,
A/Engineer-in-Charge,
Great Lakes-St. Lawrence
Study Office

Environment Canada | Environnement Canada
Environmental Conservation | Conservation de l'environnement

Water Planning and Management Branch
Ottawa, Ontario
K1A 0E7

Your file Votre référence

Our file Notre référence

December 4, 1984

Harza Engineering Company
150 Sound Wacker Drive
Chicago, Illinois 60606
U.S.A.

Attention: Dr. David S. Louie

Dear Sir:

This is in response to your letter of November 8, requesting information on ice control engineering which affects the environment.

Mr. J. Bathurst, Chief of Engineering and Development Division which is a component of this Branch, has already replied to your enquiry under date of November 13. I cannot add anything to the information he has already supplied.

Yours sincerely,

R.L. Pentland
Director

Canadian Coast Guard | Garde côtière canadienne

Ottawa, Ontario
K1A 0N7

102

Your file Votre référence

Our File Notre référence

MAR 13 1985

Dr. David S. Louie,
Harza Engineering Company,
150 South Wacker Drive,
Chicago, Illinois 60606

Dear Sir:

Thank you for your letter of 16 January 1985 concerning your survey on the state-of-the-art in ice control engineering as it affects the environment of reservoirs and rivers, and operating procedures taken to minimize any adverse impact.

The Canadian Coast Guard has traditionally undertaken ice breaking operations in the St. Lawrence River below Montréal, partly to keep the navigation channel to Montréal open, but mainly for the control of flooding. Before the commencement of this service, flooding and shore property damage was a serious problem in the reach between Montréal and Québec City. Flooding would occur during the winter and spring due to the formation of ice jams caused by collapse of the river ice cover, and the blockage of the river by ice during the spring freshet. Today, the reach between Québec and Trois-Rivières is kept open with ice breaker assistance throughout the winter. From Trois-Rivières to Montréal, however, the situation is more complex and additional ice control works are employed to control the ice problem.

.../2

Canada

Between Trois-Rivières and Montréal it has been necessary to install floating ice booms and permanent ice control islands at several locations, to aid in the formation and stability of the ice cover. Ice booms have been installed annually at Lavaltrie since 1969 and at l'Ile St-Ours (Lanoraie) since 1971. These booms have proven to be very effective in fostering the formation of an early cover and retaining the cover so that the incidence of large ice sheets breaking loose and blocking the channel is now rare.

In addition to the ice booms described above, seven artificial ice control islands have been constructed in Lac St-Pierre, since 1967. The purpose of these islands is to assist the formation of an ice cover on the lake and retain it to the north and south of the navigation channel which runs through the lake. The islands, which are about 140 ft. x 140 ft. on the surface, are constructed of material dredged from the river channel and are covered with stone rip-rap.

Further brief descriptions of the ice breaking operations and the composition and operation of the ice booms and artificial islands described above, are contained in the attached papers, namely "Ice Control Measures on the St. Lawrence River", 1972 and excerpts from "Le Controle des Glaces dans le secteur de Montréal à Notre- Dame de Portneuf de 1966 à 1973", 1973. The latter is an internal report prepared in French only.

Since 1975 Coast Guard has also provided ice breaking services in the mouths of eight or nine tributaries of the St. Lawrence River below Montréal during spring freshet. The purpose of this work, which is done by a small air cushion vehicle, is to assist in the efficient flushing of the river systems, thereby avoiding jamming and flooding. Although ice breaking of this nature is, speaking, the responsibility of the provincial government, and is outside mandate of the federal government, the service is provided gratuitously to the Province whenever the ACV can be made available.

Since 1972, the Coast Guard's air cushion vehicle fleet on the West Coast has provided occasional ice breaking in the lower Fraser River at Vancouver. Ice formation in that system is infrequent, and ice greater than 2 to 3 inches in thickness forms only during sever winters.

Coast Guard also provides ice breaking services in the Great Lakes and their connecting channels, in support of commercial shipping. The service, which has been going on since the early 1960s, is aimed at keeping shipping lanes open towards the end of the navigation season and re-opening them as early as possible in the spring. Most of the icebreaking activity has occurred at Lakehead Harbour (Thunder Bay), Midland, (Georgian Bay) and the Detroit and St. Clair Rivers.

In addition to the above-mentioned Coast Guard ice control measures on the St. Lawrence River, several power entities also undertake control of ice cover formation and stabilization in connection with major power installations on the river. Québec Hydro have operated ice booms and controled current velocities to maintain a stable ice cover upstream of their Beauharnois generating station above Montréal, since 1949-50. Likewise, since 1959 Ontario Hydro and the New York Power Authority have jointly operated several ice booms above the Saunders-Moses generating plant at Cornwall to form and stabilize the ice cover above the dam. The latter two power authorities have also jointly operated an ice boom across the entrance to the Niagara River each winter since 1946-65. The main purpose of this boom is to restrict the entry of floes of lake ice into the river, in order to reduce the serious losses to the hydro-power generating stations on the river which occurred frequently before installation of the boom.

Should you wish to contact the above-mentioned power entities to obtain further information on their ice control engineering, you may write to the following addresses:

Mr. F. Santerre
Head, Resources and Load Division,
Québec Hydro - Electric Commission,
75 Dorchester Boulevard, West,
Montréal, Québec,
H2Z 1A4

Mr. T.E. Wigle,
River Control Engineer,
Ontario Hydro,
700 University Avenue H7-A22,
Toronto, Ontario
M5G 1X6

Mr. J. Bartholemew,
New York Power Authority,
P.O. Box 700,
Massena, N.Y. 13662

The foregoing is a brief summary of the nature and extent of the Canadian Coast Guard's main involvement in ice control measures which have an effect on the environment. Certain of these measures have as one of their goals, the amelioration of the adverse effects of flooding in river systems used as principal commercial shipping routes. Most of the measures are undertaken to control ice for commercial shipping, either by helping to form and hold a stable ice cover to keep ice sheets out of the main channels, or by breaking channels through the ice to allow ships to pass. Although I feel this type of ice control exercised by the Canadian Coast Guard is not of the nature of ice control "engineering" in which you are particularly interested, I have provided this overview for your understanding of our involvement in the matter. The ice control measures exercised by the above-named power entities may be of more interest to you in this regard.

If you feel this office can be of any further assistance to you on this matter, please write again, and we will endeavour to provide answers to your specific questions, or direct your inquiries to the appropriate branch for response.

C.J.R. Lawrie

Encl.

Fisheries and Oceans | Pêches et Océans

Ottawa, Ontario
K1A 0E6
March 19, 1985

Your file / Votre reference

Our file / Notre reference

5300-1-9

Dr. D.S. Louie
Harza Engineering Co.
150 South Wacker Drive
Chicago, Illinois
60606 USA

Dear Dr. Louie,

In the event that a copy of the enclosed information was not sent directly to you by our people in Vancouver, I am enclosing a copy for your use.

Yours truly,

C.L. Dominy
Chief
Freshwater Habitat Division
Fish Habitat Management Branch

Encl.

Government of Canada / Gouvernement du Canada

MEMORANDUM **NOTE DE SERVICE**

TO

C.L. Dominy
Chief, Freshwater Habitat

FROM

G.L. Ennis, A/Chief
Water Use Unit
Habitat Management Division

SECURITY - CLASSIFICATION - DE SÉCURITÉ	
OUR FILE/NOTRE RÉFÉRENCE	
YOUR FILE/VOTRE RÉFÉRENCE	5300-1-9
DATE	20 February 1985

SUBJECT / OBJET INFORMATION REQUEST FROM HARZA ENGINEERING CO.

With reference to your 22 November 1984 request to O.E. Langer for selected technical references, please find attached our response.

G.L. Ennis

GLE/dl
Encl.

cc: F.C. Boyd
O.E. Langer

SELECTED REFERENCES REGARDING: BANK EROSION CAUSED BY BREAKUP AND MOVEMENT OF ICE; RESULTING SEDIMENT INCREASES IN RESERVOIR AND DOWNSTREAM, SEDIMENT CONCENTRATIONS AND IMPACTS ON AQUATIC LIFE

Acres Consulting Services Ltd. 1980. Behaviour of ice covers subject to large daily flow and level fluctuations. Report to Canadian Electrical Association, Montreal PQ 121pp.

Anonymous. 1983. A rationale for standards relating to the discharge of sediments into Yukon streams from placer mines. Dept. of Fish. and Oceans and Environment Can. New Westminster, B.C. February, 1983. 24 p.

Birtwell, I.K., G.F. Hartman, B. Anderson, D.J. McLeay, and J.G. Malick. 1984. A brief investigation of Arctic grayling (Thymallus arcticus) and aquatic invertebrates in the Minto Creek drainage, Mayo, Yukon Territory; An area subjected to palcer mining. Can. Tech. Rep. Fish. Aquatc Sci. 1287: 57 p.

Bulatov, S.N., B.M. Ginzburg and I.V. Balashova. 1972. Calculation of thawing ice cover strength and freeze-up and break-up periods in reservoirs. International Association of Hydraulic Research Symposium on Ice Problems. Leningrad USSR. 1972.

Croadsale, K.R., Metge, M. and P.H. Verity. 1978. Factors governing ice-ride-up on sloping beaches. I.A.H.R. Symposium on Ice Problems. Part I. Lulea Sweden. p405.

Donchenko, R.V. 1973. Pecularities of ice cover formation on reservoirs. Role of ice and snow in hydrology symposium. International Association of Scientific Hydrology Publication #107. P. 564-574.

Keenhan, T, U.S. Panu and V.C. Kartha. 1982. Analysis of freez-up ice jams on the Peace River near Taylor, B.C. Canadian Journal of Civil Engineering, Vol. 9, p. 176-188.

Lloyd, D.S. 1985. Turbidity in freshwater habitats of Alaska. A review of published and unpublished literature relevant to the use of turbidity as a water quality standard. Alaska Dept. Fish and Game, Juneau, Alaska. Report No. 85-1 January 1985. 101 p.

McLeay, D.J., A.J. Knox, J.G. Malick, I.K. Birtwell, G.F. Hartman and G.L. Ennis. 1983. Effects on Arctic grayling (Thymallus arcticus) of short term enposure to Yukon placer mining sediments, laboratory and field studies. Can. Tech. Rep. Fish. Aquat. Sci. 1171: xvii and 134 pages.

McLeay, D.J., G.L. Ennis, I.K. Birtwell, and G.F. Hartman. 1984. Effefcts on Arctic grayling (Thymallus arcticus) of prolonged exposure to Yukon placer mining sediment: A laboratory study. Can. Tech. Rep. Fish. Aquat. Sci 1241: xiii + 96 p.

Shea, Mary and Mathers, J.S. 1978. An annotated bibliography on the effects of roads on aquatic systems. Ontario Ministry of Natural Resources and Ministry of Transportation and Communications. Toronto, Ontario. 55 p.

This annotated bibliography summarizes the physical, chemical and biological effects of roads on aquatic systems. Roads have the greatest effect on the aquatic environment through suspended sediments and sediment deposition and this bibliography contains extensive (cross-indexed) references on this subject.

Smith, D.G. 1979. Effects of channel enlargement by river ice processes on bankful discharge. Alberta Water Resources Research. Vol 15 #2.

Sokolov, I.N. 1970. Ice conditions in reservoirs of pumped storage power plants. I.A.H.R. Symposium on Ice Problems. Paper 49. Reykjavik, Iceland.

Tsang G. 1974. Ice piling on lakeshores with special reference to the occurrences on Lake Simcoe in the spring of 1973. Environment Canada Scientific Series #35.

Turkheim, R.J. 1975. Biophysical impacts of Arctic hydroelectric developments. Renewable Resource Project Report Vol. 5. Inuit Tapirisat of Canada. U. of Waterloo and Western Ontario. 199 pp.

Some Suggested Contacts:

Otto Langer, Senior Habitat Biologist, Department of Fisheries and Oceans, Pacific Region, Habitat Management, New Westminster, B.C. 604-524-7147.

Terry Keenham, Hydrology Section, British Columbia Hydro and Power Authority, Vancouver, Canada (flow releases on the Peace River to maintain stable downstream ice).

Fred Parkinson, Lasalle Hydraulic Laboratories Montreal, Quebec, Canada (consultant to B.C. Hydro on Peace and Liard River ice studies).

February 18, 1985
DER/dl
d12ice

HARZA-EBASCO SUSITNA JOINT VENTURE

PHONE LOG

PERSON CONTACTED Bob Cornelius TASK NUMBER 4

AFFILIATION Acting Chief Ranger DATE February 4, 1985

HARZA-EBASCO REPRESENTATIVE Bob Lindsay PHONE NUMBER (303) 641-2337

COPIES TO Chuck Elliott, Randy Fairbanks, Gene Gemperline

SUBJECT Loss of elk/mule deer on the Blue Mesa Reservoir

NOTES Mr. Cornelius indicated that generally losses of big game of the reservoir are restricted to a few lone animals. About 1978 there was a mass drowning of about 60 elk. There was no indication of the exact time of the break through of the herd as they were found under sheets of ice as the reservoir was being drawn down. He mentioned that some ice thinning occurs along the reservoir margins as a result of drawdown. The herd was found very near shore. There was another mass drowning several years ago but Mr. Cornelius was not sure as to when and had no details. Another problem they encounter is animals getting out on the ice, falling down and being unable to get up. They have actually had to stage a few rescues where they would go out and drag the animal back to shore. They have no idea why the 60 elk went out onto the ice in 1978. There was a special hunt going on at the time and although they had closed hunting in a buffer zone around the reservoir, several violations were recorded. There was also a great number of people taking pictures of the herd during this severe winter (1978). Either one of these situations could have spooked the lead cow onto the reservoir ice.

HARZA-EBASCO SUSITNA JOINT VENTURE

PHONE LOG

PERSON CONTACTED Bob Cornelius TASK NUMBER 42

AFFILIATION Acting Chief Ranger DATE February 6, 1985

HARZA-EBASCO REPRESENTATIVE E.J. Gemperline PHONE NUMBER 307-641-2337

COPIES TO B. Lindsay, R. Fairbanks, C. Elliott, D.S. Louie, Files

SUBJECT Loss of elk/mule deer on the Blue Mesa Reservoir

NOTES I called Mr. Cornelius to follow-up on a conversation of his with Bob Lindsay (copy attached).

Mr. Cornelius indicated that when the Blue Mesa Reservoir freezes over, it freezes first at the upstream end and proceeds downstream. There are a lot of shallow areas at the upstream end. In some years the reservoir doesn't completely freeze over. Freeze-up normally begins in mid to late December and is complete by mid January. This year a recent cold spell caused freeze-up later than normal. The ice thickness is normally 30 to 36 inches and, in the year that the elk were drowned it was particularly cold. However, he did not know ice thickness that year.

He confirmed that year the animals were under a lot of stress. There had been a lot of snow and a feeding program had been instituted. The elk had apparently crossed the reservoir from the north side and travelled a mile or more to the south shore where it appears they fell through the ice. Mr. Cornelius speculated that the elk may have fallen through near the edge of the reservoir where the cracks resulting from drawdown occur.

The drowned elk were found above the water level in the spring. It appears they had been hidden from view by 20 inch ice. It is not known how or why 60 elk all perished. Mr. Cornelius is sending us an incident report and some information on Blue Mesa.

PHONE LOG

PERSON CONTACTED Bob Cornelius TASK NUMBER 42

AFFILIATION Acting Chief Ranger DATE February 6, 1985

HARZA-EBASCO REPRESENTATIVE E.J. Gemperline PHONE NUMBER (307) 641-2337

COPIES TO B. Lindsay, R. Fairbanks, C. Elliott, DS. Louie, Files

SUBJECT Loss of elk/mule deer on the Blue Mesa Reservoir

NOTES I asked Mr. Cornelius some more questins about Blue Mesa. Apparently it is the storage reservoir for the Morrow Point and Crystal Projects. It reaches its maximum level in August and may be down between 40 and 100 feet in winter. It is on the Gunnison River a tributary of the Colorado and drawdown is dependent on forecasted inflows in the spring. This year (or last year) there was a big drawdown. He didn't know offhand the drawdown in 1978.

He said there is an effort made to keep the elk from crossing Highway 50 on the north side of the reservoir to prevent highway kills. This also minimizes the number of elk crossing the reservoir from the north. Prior to Blue Mesa construction the elk normally crossed the Gunnison at this site and Blue Mesa inundated the habitat area. However, the elk now are normally able to feed all they need on the north side of the reservoir and don't need to cross. The elk don't normally swim across the reservoir in summer in large numbers but an occasional elk will swim across.

HARZA-EBASCO SUSITNA JOINT VENTURE

PHONE LOG

PERSON CONTACTED Bob Rosette TASK NUMBER 4

AFFILIATION Former Regional Director of USFWS DATE February 18, 1985

HARZA-EBASCO REPRESENTATIVE Bob Lindsay PHONE NUMBER (303) 249-7615

COPIES TO C. Elliott, G. Gemperline, Files

SUBJECT Big game accidents - ice related

NOTES Mr. Rosette told me again of the drowning of 69 elk on the Blue Mesa reservoir(1.* He also recalled an earlier incident of 20 elk being lost as a reslut of breaking through on the ice. He said the elk are following a traditional migration route. Most drownings occur in spring. After crossing all winter elk look at the ice and think it is solid and venture out. A mitigation plan was being developed as he was leaving the USFWS by Jim Olterman the senior biologist in the region. I plan to contact him as soon as possible to see what progress has been made. Another problem Mr. Rosette mentioned was shelf ice. Elk attempting to cross the Colorado River sometimes run into the shelf ice when they're trying to exit on the opposite side. The animals will literally wear themselves out trying to climb out and eventually drown.

1) * See phone log of February 4, 1985 to Bob Cornelius NPS Corecanti office.

HARZA-EBASCO SUSITNA JOINT VENTURE

PHONE LOG

PERSON CONTACTED Jim Olterman TASK NUMBER 4

AFFILIATION USFWS SW Region DATE February 25, 1985

HARZA-EBASCO REPRESENTATIVE Bob Lindsay PHONE NUMBER (303) 249-3431

COPIES TO Chuck Elliott, Gene Gemperline

SUBJECT Reservoir ice and shelf ice impacts to big game.

NOTES Mr. Olterman indicated that there is mitigation being undertaken for the Blue Mesa Reservoir. It consists of acquisition of lands near the reservoir and enhancement of habitat for elk. Much of this land is currently used for cattle grazing.

Mr. Olterman knows of no other cases of elk drowning in reservoirs or in rivers due to shelf ice. He mentioned the two elk drownings which happened at Blue Mesa. (See phone log of 2/4/85 w/Bob Cornelius NPS Curecanti office).He suggested I call the north western regional office at (303) 248-7175 and ask about ice shelf problems on the Colorado River.

Apparently there have been problems in Mr. Olterman's region with deer drowning in concrete lined canals.

Handwritten Memorandum from
Bob Cornelius to E.J. Gemperline

Mr. Gemperline:

In addition to information on this case incident report, it should also be noted that:

1) 78 - 79 was a severe winter with heavy snow accumulations and cold temperatures. A feeding program by the Division of Wildlife was instituted but thousands of animals died in the vicinity of the lake.

2) According to Perry Thompson, Blue Mesa District Ranger, there was a poaching incident near Big Game Hill on the north side of the reservoir in early winter.

3) A special hunting season was in progress in late fall east of Stueban Creek, however some hunters drifted west along the lake shore.

4) There were problems with travelers on U.S. Highway 50 stopping to view and photograph animals.

5) Twelve (12) elk were known to have fallen through ice on the Soap Creek arm around 1975.

6) Individual animals on occasion get in trouble crossing ice by losing their footing but it appears it is the weight of large herds that can break through.

HARZA-EBASCO SUSITNA JOINT VENTURE

PHONE LOG

PERSON CONTACTED Jack Whitman TASK NUMBER 4

AFFILIATION ADF&G DATE March 4, 1985

HARZA-EBASCO REPRESENTATIVE Bob Lindsay PHONE NUMBER 822-3461

COPIES TO C. Elloitt, Files

SUBJECT Moose Calf Mortality

NOTES No formal write-up of the recent moose calf mortality studies has been completed. Jack indicated that 2 and possibly 3 calves were drowned (out of approximately/equal 44 mortalities) in the river or its tributaries. 1 in mainstream, 1 in Tsusena and 1 questionable drowning in Watana creek (not known if other factors e.g. caused by preditor entered into the accident). The ages of the 2 confirmed drownings were about 6 days for one calf and 2 weeks for the other.

HARZA-EBASCO SUSITNA JOINT VENTURE

PHONE LOG

PERSON CONTACTED Dr. James Peak TASK NUMBER 4

AFFILIATION Professor of Wildlife & Range Science DATE March 6, 1985

HARZA-EBASCO REPRESENTATIVE Bob Lindsay PHONE NUMBER (208) 885-7120

COPIES TO Gene Gemperline, Chuck Elliott

SUBJECT Moose Calf Mortality - Drowning, moose and ice mortality

NOTES Peak doesn't think that moose calf drownings are a major mortality factor. It is more a function of the individual animals overall condition. Weakened calves would be subject to drowning because of poor physical condition because of waves on a reservoir or swiftness of a river current. Peak pointed out that moose cows often use islands for calving as a predator avoidance strategy and he has observed calves as young as 2 days old crossing swift rivers.

Peak also gave me a very good personal observation concerning caribou. He observed a calf swimming in a lake 12 miles wide. The main body of a caribou herd had just crossed the lake and the calf and its mother had been separated. The cow was also out in the water looking for its calf. Both animals were 5 miles from shore.

Finally, Peak indicated that moose drowning from breaking through the ice was not a major mortality factor on natural bodies of water. He indicated however, that if cracks and polygons of ice on the shore lines were encountered (such as in Susitna) it could be of greater concern.

BEAK CONSULTANTS INCORPORATED
Corporate Headquarters

Eighth Floor Loyalty Bldg.
317 S.W. Alder
Portland, Oregon 97204

Telephone 503/248-9507

March 27, 1985

Dr. David S. Louie
Harza Engineering Company
150 South Wacher Drive
Chicago, Illinois 60606

Dear Dr. Louie:

I was interested to see your ad in the Fisheries Journal (Jan-Feb 1985). I have been working with this type of problem for years. My work has included studies on big game in Alaska and Canada, as well as the lower 48. The questions you ask are good ones but there seems to be very little "hard data" on which to base mitigation. One of the worst "killers" that I'm aware of is Lucky Peak Reservoir near Boise. The reservoir is in prime deer winter range and many deer (no accurate estimates are available to my knowledge) are lost through the ice each year. When talking to the Idaho game folk, they are not aware of any feasible ways to reduce this impact.

As with many of these problems, the actual events are either relatively rare or not well documented. I would encourage you to first assess the likelihood that a significant problem exists. For example, if the reservoir is not in a wintering area there is probably not going to be a problem. Second, and most important, if there is a case made for such an impact, try to determine if mortality on a population level with and without the ice problem is likely to be significantly different. To my way of thinking the icing problem is not likely to be very important on a population level, considering the usual high mortality during winter. If you do determine that there is a significant increase in winter mortality, which is less expensive: fix the icing problem, or increase survival of the remaining animals via mitigation? I suspect the standard winter mitigation measures will be called for. If you give them good water and cover away from the reservoir, perhaps they won't be drawn close to the dangerous conditions.

In summary, good questions, good luck, and please send me a copy of your report when it goes public.

Sincerely yours,

Paul H. Whitney, Ph.D.
Project Manager
BEAK CONSULTANTS INCORPORATED

PHW:KH

HARZA-EBASCO SUSITNA JOINT VENTURE

INTRA-OFFICE MEMORANDUM

LOCATION Chicago Office DATE April 5, 1985

TO Files NUMBER

FROM D.S. Louie

SUBJECT Susitna Project 1563-142
Winter Operation
Record of Telephone Conversation

I made a follow-up on the information provided in Dr. Paul Whitney of Beak Consultants, Inc.'s letter regarding Lucky Peak Reservoir.

Person contacted:

Mr. Daniel Brownell, Manager
Lucky Peak Project Office
Corps of Enginers, Walla Walla District
HC-33, Box 1020
Boise, Idaho 83706
Phone (208)343-0671

Lucky Peak Dam is located on the Boise River near the City of Boise, Idaho. It was completed in 1956. Structural height is 340 ft with a reservoir capacity of 306,000 ac ft. At normal reservoir level the lake surface is 2800 ac. The project is for irrigation and flood control.

The lake is on a number of major deer migration routes. As late as 12 to 15 years ago the loss was as much as 150 to 175 deer a year. However, in recent years, by maintaining the reservoir level constant during freeze-up supporting the forming ice sheet the casualty has been held to 5 or 6 per year.

Originally the greatest casualty occurs just after ice cover formation when the ice thickness is thin and weak. Thereafter, the reservoir was allowed to be drawn down soon after cover formation. This leaves an air-pocket or void between the weak ice and the water surface. Cracks may even develop. At this stage the strength of the thin ice alone is inadequate to support the animals.

The width of the reservoir is in the order of 1500 ft. It was found that if the reservoir level is kept fairly constant supporting the forming ice even with a thin sheet a small herd of animals could cross the lake (or river) safely.

HARZA-EBASCO SUSITNA JOINT VENTURE

INTRA-OFFICE MEMORANDUM

LOCATION Chicago Office DATE April 5, 1985

TO Files NUMBER

FROM D.S. Louie

SUBJECT Susitna Project 1563-142
Winter Operation
Record of Telephone Conversation

The current practice at Lucky Peak reservoir is to maintain the water surface at a constant level during ice cover formation. This water level is kept until the ice cover has develop adequate thickness and strenght before lake drawdown is permissible.

Return migration is virtually completed by spring ice-break-up at Lucky Peak. There has been no drawing in recent years during this period.

DSL

David S. Louie

DSL/mmg

HARZA-EBASCO SUSITNA JOINT VENTURE

PHONE LOG

PERSON CONTACTED Jerry Scholten TASK NUMBER 4

AFFILIATION Idaho Fish and Game DATE April 17, 1985

HARZA-EBASCO REPRESENTATIVE Bob Lindsay PHONE NUMBER (208)344-9790

COPIES TO Files, Gene Gemperline, Chuck Elliott, Randy Fairbanks

SUBJECT Deer Mortality at Lucky Peak Reservoir, Idaho

NOTES The large mortalities of deer at Lucky Peak occurred before Jerry joined the department. He indicated that he had heard about them and had actually read some field reports on the mortalities. He said the 150-175 animals per year was a good estimate for that period of time (late '60's early '70's).

Currently, they lose only 30-35 animals per year to the reservoir. Most accidents occur during peak migration and the condition of the reservoir greatly affects the magnitude of the accidents. The types of accidents include:

1) falling on the ice and pulling ligaments (usually results in mortality),

2) breaking through the ice and drowning,

3) being unable to exit the reservoir on the opposite shore due to ice sheets on the reservoir banks,

4) becoming mired in the mud around the reservoir perimeter.

Jerry indicated that some animals are strong enough to get to the opposite shore after breaking through the ice by continued breaking of ice to form a path through all the way to the bank.

Again, it should be noted that differences in types of accidents and numbers of accidents depend upon the reservoir conditions at the time of migration which in the case of Lucky Peak are apparently quite variable.

HARZA-EBASCO SUSITNA JOINT VENTURE

PHONE LOG

PERSON CONTACTED Mike Passmore TASK NUMBER

AFFILIATION Corps of Engineers, Walla Walla District DATE April 10, 1985

HARZA-EBASCO REPRESENTATIVE Bob Lindsay PHONE NUMBER (509) 522-6624

COPIES TO R. Fairbanks, E. Elliott, G. Gemperline

SUBJECT Deer Mortality on the Dworshak Reservoir

NOTES I called Passmore to obtain information on lucky Peak. He referred me to Jerry Scholter, Idaho Fish and Game (208) 344-9790. He did mention that significant deer mortality was observed on the Dworshak reservoir in Northern Idaho. The reservoir was filled in 1972. The reservoir was not cleared properly, however, and slash, trees, etc. were left in the impoundment zone. This vegetative debris floated to the surface and was frozen into the impoundment surface. When deer came onto the ice to browse on the vegetation, they were either killed by predators or fell through the ice. This mortality tailed off in a couple of years and currently few mortalities are observed among local deer.

DEPARTMENT OF
INLAND FISHERIES AND WILDLIFE
284 STATE STREET
STATE HOUSE STATION 41
AUGUSTA, MAINE 04333

LENN H. MANUEL
COMMISSIONER

NORMAN E. TRASK
PUTY COMMISSIONER

October 25, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Dear Dr. Louie:

Copies of your letter requesting information about ice-control engineering have been sent to the following individuals/agencies for their possible response to your questions in item No. 1.

(1) Dana Murch, Hydropower Coord., Maine DEP, State House Station #17, Augusta, Maine 04333

(2) Fred Michaud, Maine Dept. of Defense, Civil Emergency Preparedness, State House Station #72, Augusta, Maine 04333

Our Department's response to items No. 2 and 3 are that we apparently experience few problems with animals slipping into reservoirs or through cracks in the ice. At least to the best of my knowledge at this time it has not been identified as a problem so no policies or measures have been developed to deal with it.

Item No. 4 regarding turbidity is also best answered by the Dept. of Environmental Protection pursuant to their overall jurisdiction under State Water Quality Classification. Again, our Department has no established accepted or "permissible" degree of turbidity for waters containing salmonids.

Sincerely,

Frederick B. Hurley, Jr.
Director, Bureau of Resource Management

FBH:SAT:jmk

cc: D. Murch
F. Michaud

STATE OF MAINE
Department of Environmental Protection

MAIN OFFICE: RAY BUILDING, HOSPITAL STREET, AUGUSTA
MAIL ADDRESS: State House Station 17, Augusta, 04333

JOSEPH E. BRENNAN
GOVERNOR

HENRY E. WARREN
COMMISSIONER

October 30, 1984

Dr. David S. Louie
Harza Engineering Co.
150 South Wacker Drive
Chicago, Illinois 60606

Dear Dr. Louie:

Your recent request for information on state-of-the-art ice control engineering was forwarded to me by the Maine Department of Inland Fisheries and Wildlife.

The Department has no regulations or policies with respect to the control of ice levels in Maine's rivers. Your best source of information will probably be the major hydropower development interests in the State. I suggest that you contact the following companies:

(1) Central Maine Power Co.
ATTN: John Arnold, Environmental Effects Coordinator
Edison Drive
Augusta, Maine 04336

(2) Union Water Power Co.
ATTN: William Grove, Agent and Engineer
150 Main Street
Lewiston, Maine 04240

(3) Kennebec Water Power Co,
ATTN: Alan Corson, Chief Engineer
8 Water Street
Waterville, Maine 04901

(4) Great Northern Paper Co.
ATTN: Paul Firlotte, Power Systems Manager
Millinocket, Maine 04462

(5) Bangor Hydro-Electric Co.
ATTN: Doug Morrell, Hydraulic Engineer
33 State Street
Bangor, Maine 04401

(6) Georgia-Pacific Corp.
ATTN: Kenneth Gordon
Woodland, Maine 04694

In response to your question on turbidity, I am enclosing a copy of the State Laws classifying inland and tidal waters. Basically, there are five classifications of inland waters: A, B-1, B-2, C, and D. Class A standards specify that "there shall be no disposal of any matter or substance in these waters which would impart...turbidity...other than that which naturally occurs in said waters." The standards for all other classifications specify that "there shall be no disposal of any matter or substance in these waters which imparts...turbidity...which would impair the usages ascribed to" these classifications.

Please feel free to call me at 207-289-2111 if I can be of any further assistance.

Sincerely,

DANA PAUL MURCH
Hydropower Coordinator
Bureau of Land Quality Control

DPM/jp

Enclosure

cc: Steve Timpano, IF&W
Fred Michaud, SPO

CMP Central Maine Power Company
GENERAL OFFICE, EDISON DRIVE, AUGUSTA, MAINE 04336
(TWX NUMBER, CMP-AGUA 710-226-0195)
(207) 623-3521

February 20, 1985

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, IL 60606

Dear Dr. Louie:

Having reviewed your request regarding information on state-of-the art ice control engineering, I must inform you that there is little we can contribute to your survey.

To date this company has not experienced any continuing recognizable environmental or flood control problems for which specific ice control measures have had to be adopted or developed.

Normally after ice has formed, we attempt to maintain reservoir water levels below full pond to minimize surface stress, which is the primary cause of surface cracking.

Tubidity resulting from movement of suspended solids is generally not a problem in this area. The soils in this region are largely of glacial origin, primarily rock, gravel and coarse sand. After years of natural scouring, the characteristics and weight of the remaining soils inhibit extended suspension or movement. We have never experienced any water quality deterioration due to excessive turbidity at any of our hydro facilities, which has been obviously detrimental to resident aquatic life.

I hope that we have been of some assistance in this matter.

Sincerely yours,

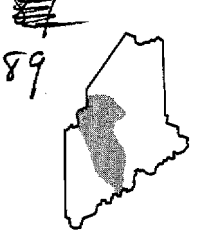
William B Campbell

William B. Campbell
Environmental Specialist
Environmental Studies Department

WBC/gss

Kennebec Water Power Co.

Established 1893



Allen J. Corson
River Engineer

January 31, 1985

Mr. David S. Louie
Harza Engineering Co.
150 So. Wacker Drive
Chicago, Illinois 60606

Dear Mr. Louie:

I will attempt to respond to the information you recently requested, relative to ice control:

1. We control only the headwaters of the Kennebec River, therefore the operating policies of Central Maine Power Company on downstream plants might shed some light on your request.

2. I am not aware of any environmental impacts as a result of reservoir drawdowns.

3. In Maine, most large animals stay off the ice as they are unable to maintain mobility- especially the hooved animals.

4. We have had erosion of embankments due to spring break-up, but attempt to keep reservoir levels below full pond at break-up to minimize impacts. The Maine Department of Environmental Protection maintains standards for water quality classifications.

I trust these comments have been of some assistance.

Sincerely,

Allen J. Corson

AJC/rl

P.O. BOX 103 • WATERVILLE, MAINE 04901 • (207) 872-6624

Union Water Power Company

SINCE 1878

150 MAIN STREET
LEWISTON, MAINE 04240

ROBERT S. HOWE
Treasurer

PHONE 207 784-4501

WILLIAM M. GROVE
Agent and Engineer

February 19, 1985

Harza Engineering Company
150 South Wacker Drive
Chicago, Ill 60606-4176

Atten: David F. Louie

Sir:

In response to your questionnaire regarding state-of-the-art in ice control, please accept my apology for not responding more promptly. In general we find little natural peril for terrestrial animals and in fact can find some benefit from reservoir drawdown. More on this later. Specifically I will answer the survey in order of presentation.

1. The winter operating procedure on the Androscoggin River is one of run-of-river at all hydro power stations. This allows a steady formation of ice both above and below the station. Above the station of course, the slowed velocity of water freezes more quickly and to a greater depth than below the station where the velocity is inherently greater. We have a greater problem of ice jamming that is created more from natural causes than from power station operation. This river has several natural constrictions in the form of 'doubling bends' that restrict river flows and act as gathering areas for tributary ice discharges created by unseasonable freshets. Power stations on this river are well separated from these problem areas and cannot be considered to be a contributing factor to flooding.

2. The nature of reservoir freezing during drawdown does not allow wet reservoir banks to exist. The drawdown is gradual thus allowing solid freezing of the water. There are no exposed areas where an animal would become entrapped in a combination of wet mire and reservoir ice. At the time of freezing, the reservoir ice has formed sufficiently to support the weight of animals. Our experience of over 100 years of operation is that we do not have migratory animals in the true sense of the word. Never have my people reported seeing moose or deer on the reservoir surface of their own accord. The deer especially are at far greater hazard from packs of predator coy-dogs that drive them on to the ice where they lose their footing and become easy prey. Bears hibernate in the winter.

3. The formation of ice cracks/ridges is far more severe on natural lakes where the only relief for ice pressure is the formation of ridges. The very nature of reservoir operation relieves these pressures as the reservoir is drawn. The formation of these ridges is practically non existent on our reservoirs. Our reservoirs do not fluctuate as such. The draw is continually downward and does not reverse itself until the spring fill period has started. Reservoir fluctuation is annual in that the reservoirs are filled once in the spring and drawn over the rest of the year reaching their lowest level on the last day of March (average).

4. The reverse is true at so called break-up time. This period is marked by a closing of the reservoir discharge gates thereby stilling the reservoir waters from any flow. As the reservoir rises the ice that was formed during the drawdown period and which is still in place along the shore, merely falls into place with the rising water level. This prevents movement from wind and restricts any subsequent shore line damage. While there are years that late melting ice fields can create problems when the wind blows, this is no different from natural lakes that have problems annually and can create severe shore line damage. Therefore there is virtually no problem beyond what occurs naturally in the way of turbidity. My biologists tell me that this is a non problem and therefore has not been worthy of study. Downstream of the reservoir is much the same as above. Since the gates have been closed except for minimum flow requirements, there is insufficient flow to create river bank erosion. Any shore ice melts rather uneventfully as nature takes its course.

In addition to the above there are advantages to reservoir shore ice formation. It shields the reservoir surface from freezing temperatures thus allowing open water to the many wildlife who depend upon water for their very existence. We have otter and muskrat and mink who could not exist without the formation of ice shelves for access. These shelves provide protection against their natural enemies and the harsh New England weather that is their habitat.

This reservoir system has been in operation continuously for over 100 years and we have not observed any calamity to wildlife that has not occurred in non reservoir conditions.

In the case of migrating caribou where thousands of animals constituting tons of hoof striking force on any questionably frozen surface, it is a lot to expect that the ice surface will always support them under all conditions or that some interruption in the ice surface will not create some hazard. Wind blown ice gives little if any traction to cloven hooved animals. Similarly hazardous conditions exist in drifted snow fields and concealed brooks and streams.

Having observed winter conditions first hand, it seems somewhat facetious to consider that any manipulation of reservoir levels could or would affect ice formation or ridges or cracks that would be any more or less hazardous than naturally frozen lakes.

I will appreciate the results of your survey, which you may send to the above address.

Sincerely,

William M. Grove
Agent and Engineer

WMG:sr

0020E

HARZA ENGINEERING COMPANY

PHONE LOG

Person Called: H. Harrington
Affiliation: Div. of Land & Resources Develop. Dept. of Natural Resources
Harza Rep.: D.S. Louie
Copies To:

P.O. Box 30028
Lansing, MI 48909

Project: Susitna
Project #: 1563-142
Date: Oct. 31, 1984
Phone #: (517) 373-0133

Subject: Ice Control Engineering - Susitna Project

Notes: The department has no policy on questions 1, 2 and 3.

Regarding question 4 - permissible increase in turbidity due to bank erosion by ice break-up and movement:

1. Cold water rivers 10% above back ground turbidity level in mg/l
2. Warm water rivers 20%-25% above back ground turbidity level in mg/l.

Background turbidity level is the turbidity of water during normal flow conditions for the month in question.

3. Maximum water surface fluctuation is 8"-10" per day for cold water rivers (salmon, char, trout etc.)

12"-18" per day for warm water rivers (bass, walleyes etc.)

David S. Louie

STATE OF MONTANA
ENVIRONMENTAL QUALITY COUNCIL
STATE CAPITOL
HELENA, MONTANA 59620
(406) 444-3742

Deborah B. Schmidt, Executive Director

October 23, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Dear Dr. Louie:

Thank you for your letter requesting information on ice-control engineering and related environmental problems in Montana. Although ice jams and flooding are concerns in the lower Yellowstone River basin, I am not aware of specific concerns or work related to impacts on terrestrial animals.

The following persons may have useful information:

Richard Bondy, Chief
Engineering Bureau
Department of Natural Resources & Conservation
Helena, MT 59620

James A. Posewitz, Leader
Resource Assessment Unit
Department of Fish, Wildlife & Parks
Helena, MT 59620

Mr. Robert Periman
Manager, Hydro-Engineering
Montana Power Company
40 East Broadway
Butte, MT 59701

Mr. Don Willems
Environmental Sciences Division
Department of Health & Environmental Sciences
Helena, MT 59620

Sincerely,

Howard E. Johnson

HEJ/nf

Howard E. Johnson
Environmental Scientist

WATER2/Louie 10/23/84

Montana Department of Fish, Wildlife & Parks

1420 East Sixth Avenue
Helena, Montana 59620

November 7, 1984

Mr. David S. Louie
Chief, Hydrolic Engineer
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Dear Sir:

The Montana Department of Fish, Wildlife and Parks has not investigated any of the issues associated with ice impacts on wildlife mentioned in your October 29th letter. I am also not aware of any studies that address these issues; consequently, I regret we are unable to be of any assistance to you.

Sincerely,

James A. Posewitz
Leader
Resource Assessment Unit

JAP/bfs

DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

TED SCHWINDEN, GOVERNOR — COGSWELL BUILDING

STATE OF MONTANA

HELENA, MONTANA 59620

January 30, 1985

HARZA ENGINEERING CO.
Date Received 2/4/85
Routed To [illegible]
Classified for Filing by
Project Number
Classification
Subject Designation

Dr. David S. Lowe
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Re: Ice Control

Dear Dr. Lowe:

In response to your letter dated January 17, 1985, I am recommending that you contact Dr. Donald R. Reichmuth at:

Dr. Donald R. Reichmuth
Geomax
622 South Sixth Avenue
Bozeman, Montana 59715

Please do not hesitate in contacting me, if I can be of any further assistance.

Sincerely,

Ken Chrest

Ken Chrest
Agricultural Specialist
Water Quality Bureau
Environmental Sciences Division

KC:ls

Nebraska Public Power District

GENERAL OFFICE
P.O. BOX 499, COLUMBUS, NEBRASKA 68601-0499
TELEPHONE (402) 564-8561

January 29, 1985

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Dear Dr. Louie:

In response to your request for information on environmental impact caused by various ice conditions on reservoirs and rivers, the following information is supplied:

1. At Gentleman Station, a 1300 MW total coal fired steam electric generating station on the south shore of Sutherland Reservoir, warm water recirculation to the water intake structure occurs during the winter months to minimize icing conditions. Other than that we have no procedures or operating policies used in the control of ice levels in rivers downstream and upstream of dams and hydro-plants in our system.

2. We have no procedures to minimize the hazard of animals falling into the reservoir due to slippage on ice on wet reservoir banks.

3. We have no procedures to reduce hazards of animals falling into or being trapped in cracks which may develop from reservoir fluctuation management.

4. The Nebraska Water Quality Standards state that turbidity caused by human activity shall not import more than a 10 percent increase in turbidity, as measured in Jackson Turbidity Units, to the receiving water.

Sincerely,

Eric N. Sloth

Eric N. Sloth, Ph.D.
Division Manager
Environmental Affairs

ENS/cl

PACIFIC POWER & LIGHT COMPANY
920 S.W. SIXTH AVENUE • PORTLAND, OREGON 97204 • (503) 243-1122

January 31, 1985

Dr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606-4176

Dear Dr. Louie:

Your letter of January 17, 1985, requested information about control of ice levels in rivers upstream and downstream of dams and hydropower plants. Pacific does not operate any project at which ice formation in the river is of any consequence. There is one small reservoir within Pacific's system that periodically freezes over, but no special procedures are required for operation during such occasions.

Very truly yours,

S. A. deSousa
Manager, Civil Engineering

deS:sh

78

JOHN SPELLMAN
Governor

FRANK LOCKARD
Director

STATE OF WASHINGTON
DEPARTMENT OF GAME
600 North Capitol Way, GJ-11 • Olympia, Washington 98504-0091 • (206) 753-5700

November 8, 1984

David S. Louie
Harza Engineering Company
150 South Walker Drive
Chicago, Illinois 60606

Dear Mr. Louie:

If your letter of October 16, you asked several questions about ICE control engineering. I talked to several biologists and our engineering division and could find no one who could provide you the information you requested.

Sincerely,

THE DEPARTMENT OF GAME

James G. Fenton
Major Projects Coordinator
Habitat Management Division

JGF:ks

Booth Gardner
~~XXXXXXXXXXXX~~
Governor

WILLIAM R. WILKERSON
Director

STATE OF WASHINGTON
DEPARTMENT OF FISHERIES
115 General Administration Building • Olympia, Washington 98504 • (206) 753-6600 • (SCAN) 234-6600

February 4, 1985

Mr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
Consulting Engineers
150 South Wacker Drive
Chicago, Illinois 60606-4176

Dear Mr. Louie:

Please excuse my tardy response to your recent inquiry re ice control engineering.

We don't really have a lot of expertise in this field. However, it might be worthwhile for you to contact Russ Webb,* the Chief of our Engineering Division at (206) 753-6610 and Ken Bates Habitat Management Division Engineer at (206) 753-3632.

Additionally, we suggest you contact the U.S. Bureau of Reclamation, Phil Bargi* Engineering Research Center in Denver, Colorado and Hosey and Associates* in Bellevue, Washington.

Sincerely,

William R. Wilkerson,
Director

* Have previously contacted by phone:
No operating policy
No info. available.
David Louie

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P.O. BOX 631
VICKSBURG, MISSISSIPPI 39180-0631

REPLY TO
ATTENTION OF

November 14, 1984

Executive Office

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Dear Dave:

I have forwarded your letter of November 1 to the Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire, for reply. I believe they should have the answers to most of the questions you raised. Please let me know if I can be of further assistance.

It was good to hear from you. Why don't you come to see us sometime?

Sincerely,

F. R. Brown
Engineer
Technical Director

Enclosure

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P.O. BOX 631
VICKSBURG, MISSISSIPPI 39180-0631

REPLY TO
ATTENTION OF

November 14, 1984

Executive Office

Dr. Lloyd R. Breslau
Technical Director
USA Cold Regions Research and
Engineering Laboratory
72 Lyme Road
Hanover, New Hampshire 03755-1290

Dear Lloyd:

Inclosed is a copy of some correspondence which I think is self-explanatory. Dave Louie is a good friend and I hope you can supply him with the information sought.

Thanks.

Sincerely,

F. R. Brown
Engineer
Technical Director

Enclosure

DEPARTMENT OF THE ARMY

DETROIT DISTRICT, CORPS OF ENGINEERS
BOX 1027
DETROIT, MICHIGAN 48231

December 6, 1984

REPLY TO
ATTENTION OF

Planning Division - PF

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Dear Dr. Louie:

This is in response to your letter of November 1, 1984, concerning your literature search on the state-of-the-art in ice control engineering which affects the environment.

Concerning the control of ice in rivers downstream and upstream of dams and power plants, we have both studies and practical experience in stabilizing ice cover to allow passage of vessels and still maintain a stable flow of water for hydropower and prevent the formation of ice jams, through the use of floating log ice booms. Work in this area has been done primarily on the St. Marys River at Sault Ste. Marie, Michigan, on the Niagara River at Buffalo, New York, and along the St. Lawrence River. Activities on the St. Marys River included a model study followed by a demonstration program to test an ice boom's effectiveness at the head of the Little Rapids Cut just downstream of the Soo Locks and Government and private hydropower facilities at Sault Ste. Marie, Michigan. This work was done during the Congressionally authorized Great Lakes - St. Lawrence Seaway Navigation Season Extension Program which was concluded in September of 1979. A photocopy of the Little Rapids Cut model study is available at a cost of $52.00. The boom proved so successful that it is now part of our normal operations activities. However, the effects of the boom on water levels, flows, and ice cover continue to be analyzed and a report is released annually by our Great Lakes Hydraulics and Hydrology Branch. Should you desire specific details on operating procedures or policies associated with the ice boom, please contact Mr. Jim Bray, Soo Area Engineer, U.S. Army Corps of Engineers, St. Marys Falls Canal, Sault Ste. Marie, Michigan 44783; telephone number (906) 632-3311.

In an effort to control ice problems on the St. Marys River, the present Lake Superior regulation plan, Plan 1977, contains a requirement limiting the discharge through the Lake Superior control structures (three power plants, navigation locks, and compensating works) into the St. Marys River to 85,000 cfs from December through April. This limitation was set as a "safe" maximum as a result of past experiences with flooding due to ice jamming in the Soo Harbor and the lower St. Marys River, caused in part when higher flows are discharged.

There is also an ice boom placed annually at the head of the Niagara River by permission of the International Joint Commission. The ice boom accelerates the formation of, and stabilizes the natural ice arch that forms near the head of the Niagara River every winter. The boom reduces the severity and duration of ice runs from Lake Erie into the Niagara River, and lessens the probability of large-scale ice blockages in the river which can cause reductions in hydropower generation and flooding of shoreline property along the Niagara River. Additional information on this ice boom can be obtained from Colonel Robert R. Hardiman, Buffalo District Engineer and Chairman of the International Niagara Working Committee of the Internatonal Niagara Board of Control. Colonel Hardiman can be reached at this address:

U.S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, New York 14207

Ice related studies performed by the Corps of Engineers are conducted by our Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire. Activities conducted on the St. Lawrence River have been conducted by the two operating entities; the St. Lawrence Seaway Authority in Canada and the St. Lawrence Seaway Development Corporation in the United States. Representatives of these organizations can be contacted at the following addresses:

Commander
U.S. Army Cold Regions Research and
Engineering Laboratory
P.O. Box 282
Hanover, New Hampshire 03755

President
St. Lawrence Seaway Authority
Place de Ville
Ottawa, Ontario, Canada K1R 5A3

Honorable James L. Emery, Administrator
St. Lawrence Seaway Development Corporation
800 Independence Ave., S.W.
Washington, D.C. 20591

The Detroit District is involved in the operation of only one reservoir; the Lake Winnebago Pool on the Fox River in Wisconsin. This reservoir is operated primarily for flood control and to provide consistent water levels for navigation. As such, the reservoir does not experience frequent fluctuations, but is drawn down gradually beginning in late fall to

provide for spring runoff from the surrounding watershed. Under the plan of operation, the pool is not drawn down until a substantial ice cover has been established. Thus the banks are not exposed when the pool level is drawn down. With this method of operation, we do not experience adverse effects on wildlife using the pool for watering; nor are we aware of problems for wildlife relating to cracks in the ice cover. The Cold Regions Lab in New Hampshire may have done some studies relating to the size and pattern of crack development in ice cover in relation to ship movement. Other possible points of contact for these issues might be the Corps of Engineers' Water Resources Support Center, the U.S. Fish and Wildlife Service, and the Canadian Ministry of the Environment. Addresses for these agencies are provided below.

U.S. Army Engineers Water Resources
Support Center
Casey Building
Fort Belvoir, Virginia 22060

Regional Director
U.S. Fish and Wildlife Service
Room 642
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

Mr. R.E. Moore, Director
Southeast Region
Ministry of the Environment
153 Dalton Street
Kingston, Ontario, Canada K7L 4X6

The Detroit District does not have any studies on the problems of bank erosion caused by break-up and movement of ice and increased sediment in reservoirs. However, during the Great Lakes and St. Lawrence Seaway Navigation Season Extension Program, a study on "Shoreline Conditions and Bank Recession along the U.S. Shoreline of the St. Marys, St. Clair, Detroit, and St. Lawrence Rivers" was conducted as part of an investigation of the effects of ice caused erosion on these rivers. The Environmental Protection Agency has also funded some research on sedimentation in the Winnebago Pool in Wisconsin. For information on turbidity effects on aquatic life, you may wish to contact the U.S. Fish and Wildlife Service and Region 5 of the Environmental Protection Agency. The EPA's address is shown below.

Regional Administrator
Region 5, EPA
230 South Dearborn Street
Chicago, Illinois 60604

I hope this information is helpful to you. If I can be of any further assistance, please feel free to contact me at (313) 226-6768.

Sincerely,

C. Argiroff

C. Argiroff, P.E.
Chief, Planning Division

DEPARTMENT OF THE ARMY
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY, CORPS OF ENGINEERS
HANOVER, NEW HAMPSHIRE 03755

December 5, 1984

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Dear Dave:

I'm afraid that we can't help you much regarding environmental studies but can supply the names of other organizations who should be able to help you. They are:

Planning Division
U. S. Army Engineer District, Detroit
P. O. Box 1027
Detroit, Michigan 48231

Fish and Wildlife Service
U. S. Dept. of Interior
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

Resident Manager
Power Authority of The State of New York
P. O. Box 700
Massena, New York 13662

Operations Division
U. S. Army Engineer Division, Missouri River
P. O. Box 103, Downtown Station
Omaha, Nebraska 68101

U. S. Forestry Service
Rocky Mountain Extension Service
316 East Myrtle
Boise, Idaho 83702

L. Billfalk
Swedish State Power Board
The Hydraulic Laboratory
S-870 71 Alvkarleby
SWEDEN

Our library may have foreign articles or reports that I am not aware of. You may want to have someone visit CRREL to review the reports that may be in our library.

I'm sorry that I could not supply what you were looking for. There is still a lot to be done in this field.

Have a very happy holiday season.

Sincerely,

Guenther E. Frankenstein
Chief, Ice Engineering
Research Branch

United States Department of the Interior

FISH AND WILDLIFE SERVICE
WASHINGTON, D.C. 20240

ADDRESS ONLY THE DIRECTOR,
FISH AND WILDLIFE SERVICE

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

NOV 16 1984

Dear Dr. Louie:

Thank you for your letter requesting information on the effects of ice control engineering on the environment. The following comments are in response to your concerns.

1. "Procedures and operating policies used in the control of ice levels and methods of reservoir fluctuation management used to control crack development in ice."

   The U.S. Fish and Wildlife Service does not have the expertise to establish operating policies for reservoirs. A good source of information are Federal reservoir managers, such as the U.S. Army Corps of Engineer (U.S. Army Corp of Engineer, Chief, Construction Operations Division, Room 6233, Pulaski Building, 20 Massachusetts Avenue, Washington, D.C. 20314, (202) 272-0196) and the Bureau of Reclamation (Department of Interior, Bureau of Reclamation, Chief, Division of Land and Water, 18th and C Streets, N.W., Washington, D.C. 20240, (202) 343-5471).

2. "Environmental impact on terrestial animals due to the formation of ice on wet reservoir banks."

   There is the potential, if reservoirs freeze, for terrestial animals to become stranded on ice and become easy prey to predators. Animal loss can be prevented by predator control, fencing of reservoirs and providing access to winter feeding areas away from iced surfaces.

3. "Problem of bank erosion caused by the break-up and movement of ice resulting in an increase in sediment."

   Biologically, salmon and trout are very sensitive to stream turbidity. Sensitivity varies with life stage, time of year, water temperature and other factors. For a detailed description of suitable habitat for salmon and trout, please refer to the enclosed habitat suitability models. Additional information on fish habitat

can be obtained from: Director, USFWS, National Fisheries Center Leetown, P.O. Box 700, Kearneysville, West Virginia, 25430, (304) 725-8461 and the Director, USFWS, Seattle National Fisheries Research Center, Building 204, Naval Station, Seattle, Washington, 98115, (206) 527-6282.

If we can be of further assistance, please let us know.

Sincerely,

Associate
Director

Enclosures

HARZA ENGINEERING COMPANY
PHONE LOG

Person Contacted Dean Parsons
Affiliation National Marine Fishery Serv. (NMFS)
Harza Rep. D.S. Louie
Copies To

Project 1563-142-42-010 -09
Project #
Date Feb 15/85
Phone #

Subject Ice Control - Susitna Project

Notes In response to our letter on Susitna Ice Study, Mr. Dean Parsons of National Marine Fishery Service, Washington DC called.

D.C. office does not have information to reply our questionnaire letter. Suggest that we call the following persons:

Ted Myers - Alaska of NMFS
907-586-7221

* Del Evans - Portland Oregon
503-230-5400

David Louie
Feb 15 '85

* Contacted Charles Bennett. - Anchorage at same phone number

HARZA ENGINEERING COMPANY

PHONE LOG

Person Contacted _____ Project _____

Affiliation _____ Project # _____

Harza Rep. _____ Date _____

Copies To _____ Phone # _____

Subject _____

Notes Mr. Bennett states that there is no hard and fast rules for turbidity standards for fish - Generally different for each state. Mostly base on previous floods as experience to guide future operations..

As a starter, one may use 10% over the background values.

REPUBLIK ÖSTERREICH
BUNDESMINISTERIUM
FÜR LAND- UND FORSTWIRTSCHAFT

WIEN, 1984 11 21

Zl. 42.013/01-IV 2/84
Sachbearbeiter: Dipl.-Ing. Flicker
Tel.: 7500/6965 DW

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606 U.S.A.

Gegenstand: Maßnahmen, um schädliche Umweltbeeinflussungen durch Eisbildung in Flüssen und Stauräumen hintanzuhalten.

Sehr geehrte Herren!

In Beantwortung Ihres Schreibens vom 16.10.1984 geben wir bekannt:

ad 1) Bei den österreichischen schiffbaren Flüssen ist es nicht notwendig, für Zwecke der Schiffahrt stets eine befahrbare Rinne in der sonst geschlossenen Eisdecke offen zu halten, da für diese kurzen Zeiträume extremen Frostes die Schiffahrt eingestellt werden kann. Daraus ergibt sich, daß das Aufbrechen der Eisdecke nur dann in Frage kommt, wenn es die Gefahr von Überschwemmungen reduziert. Ein laufendes Aufbrechen der Eisdecke in Stauräumen und Abdriften der Schollen über ein einziges Wehrfeld erfolgt nicht, da diese Vorgangsweise das Problem des Eisganges und eventuellen Eisstoßes nur zum Unterlieger verschiebt, weiters im Vergleich zu einer geschlossenen Eisdecke zu vermehrter Eisbildung führt und überdies die Erosion der Flußsohle im Unterwasser nicht toleriert werden kann. In der Regel

./.

das Hochgebirge insbesonders im Winter wenig Tieren Lebensraum bietet und überdies großräumige Wanderungen der Tiere nicht stattfinden, ist von Problemen, wie unter Punkt 2 und 3 Ihres Schreibens geschildert, hierorts nichts bekannt.

ad 4) Ein plötzliches Driften von Eisschollen, die sich im Stauraum angesammelt haben, findet nicht statt, um Sohlerosionen zu vermeiden, es sei denn eine akute Hochwassersituation macht diesen Schritt erforderlich. Der kontinuierliche natürliche Abgang von Eisschollen führt zu keiner nennenswerten Sohl- und Böschungserosion und kann auch die Lebensbedingungen der Wassertiere nicht nachhaltig negativ beeinflussen. Allfällige lokale Uferbeschädigungen sind nach der Frostperiode, so wie andere Frostschäden auch, zu beheben. Da in den natürlichen Eisabgang kaum eingegriffen wird, ist es auch nicht üblich, in diesem Zusammenhang besondere Auflagen bzgl. des zulässigen Schwebstoff- und Geschiebegehalts zu erteilen.

Bei Eingriffen, die zu nennenswertem Geschiebe- und Schwebstoffanfall führen, wird fallweise ein oberer Grenzwert für nicht im Wasser lösbare Stoffe von 30 mg/l vorgegeben bzw. eine Mindestsichttiefe von 1 m verlangt, oder der Zeitpunkt des vermehrten Geschiebeanfalls wird so gewählt, daß im Unterwasser günstige Abflußverhältnisse, d.h. hohe Wasserstände (über Mittelwasser), vorliegen.

An Stellen, die von den angeschnittenen Problemen unmittelbar betroffen sind, und deshalb weitere Angaben machen können, wären zu nennen:

1) DoKW, Parkring 12, 1010 Wien
2) ÖDK, Kohldorferstraße 98, 9010 Klagenfurt

Translation by H.A. Wagner

Subject: Preventive measures to avoid harmful influences on the environment by formation of ice in rivers and reservoirs.

Gentlemen:

Re: Your letter dated October 16, 1984

1) The rivers in Austria are not open for freezing navigation during the short periods of extreme frost. The navigation can be halted. Therefore, ice will be broken up only if it reduces the danger of flooding. The surface ice of the reservoirs will not be broken up continuously and released over a single weir, because this procedure will shift the problem of ice jams downstream only and will lead to a heavier ice formation. Besides, the erosion of the downstream riverbed can not be tolerated. As a rule the water level is low during extreme low temperatures, so that the banking-up of the river, due backwater level to higher friction and reduced cross-section by the ice cover, can be tolerated. When the banking-up of the river threatens flooding, the ice cover will be broken up by means of ice-ploughs, ice-breakers or blasting. In case water from powerhouses discharges into the river (temp. approx. 3°C) a reduction of ice formation will be caused.

   The dams of powerhouses in high mountains are often protected from the ice cover by a curtain of air bubbles, which bring the warmer water up. This measure is necessary to protect the jointing and cementing from the ice cover and furthermore, the pressure from the ice cover on the dam will be prevented.

2) and 3) It appears that the influence of the ice formation on the animal kingdom in Austria cannot be compared with the one in Northamerica.

   The water levels do not fluctuate noteworthy, so that the reservoir banks will not be covered unduly with ice. Also, extreme periods of frost do not occur in Austria. However, the reservoirs in the high mountains are regularly covered with ice and the river banks are partly covered with heavy ice, due to often changing water levels. No problems, as mentioned under paragraph 2 and 3 of your letter, are known in Austria, due to the fact that few animals live in the high mountains especially during the winter. Besides, migrations don't occur.

4) A sudden drift of ice, which collected on the reservoir does not occur. Measures to avoid bank erosion will be taken only

in extreme flooding situations. The continuous natural exit of the ice does not cause bed or bank erosion and does not influence the living conditions of the animals. Possible local damages of the banks after periods of frost have to be repaired.

Repairs which will cause noteworthy water pollution will be performed during favorable high downstream water levels (above middle water). The upper limit for insoluble matter in water is 30 mg/l or a minimum visibility of 1 m.

For further references see:

IVO
Consulting Engineers Ltd

H. Partanen

Date: January 16, 1985

Our reference: 1702/85

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive

CHICAGO ILLINOIS 60606 U.S.A.

ICE CONTROL ENGINEERING

Dear Dr. Louie,

From your letter of November 8, 1985 we note that you are conducting a literature search concerning the ice control engineering.

We forwarded a copy of your letter to Mr. Tapio Kovanen, who is the chief hydrologist of our parent company Imatran Voima Oy. His answer is here:

Unfortunately we do not have any written reports in English, but in the following I try to answer your questions.

1. Operating policies

We have successfully tested the maintaining of steady discharge in a river in Northern Finland to obtain early ice formation. The early ice formation is essential to minimize the formation of frazil ice. The steady discharge was obtained with a hydro power plant which has a large reservoir. This method is promising, but its application in practice is rather difficult. The electricity production requirements are often opposite to the ice formation operating policy.

2. Environmental impact on terrestial animals

According to my knowledge hazards you mention are not common in our country.

3. Reservoir fluctuation management

The crack development is not a problem in our country. Warm water flowing from a reservoir has weakened the ice cover in Northern Finland.

Mailing address | Street address: Imatran Voima Oy | Telephone | Telex | Telefax | Telegram

4. Bank erosion

Bank erosion is not usually a problem in big rivers. We have no regulations or norms for turbidity.

The above was Mr. T. Kovanen's answer to your inquiry. If you wish further clarification you may contact Mr. Kovanen directly.

We also forwarded a copy of your letter to our sister companies Kemijoki Oy and Oulujoki Oy, who have designed and are operating hydro power plants in Northern Finland. Unfortunately even they did not have any particular reports on this subject.

We hope the above information, even if short, will be of some help to you.

Yours very truly,

for IVO CONSULTING ENGINEERS LTD

Sune Norrbäck
Executive Vice President

INSTITUT FÜR WASSERBAU UND KULTURTECHNIK

VERSUCHSANSTALT FÜR WASSERBAU
"Theodor-Rehbock-Laboratorium"
UNIVERSITÄT KARLSRUHE
Leiter: o.Prof. Dr. Techn. Peter Larsen

Postanschrift:
Universität Karlsruhe
Institut für Wasserbau
Kaiserstr. 12
D-7500 Karlsruhe 1

Telefon: (0721) 608 21 94
Telex: 07-826 521 uni d

Mr. David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
15o South Wacker Drive
Chicago, Illinois 6o6o6
USA

Ihr Zeichen:

Unser Zeichen: PL/IB

Sachbearbeiter: Prof. Larsen

Karlsruhe, den October 19, 1984

Dear Dave:

In answer to your telegram, directed to Prof. Mosonyi, I would like to suggest that you contact the Swedish State Power Board (SPB), where you might get some useful information. Their major hydro power developments are situated in northern Sweden and in several cases involved reindeer country. Moose are also abundant in some areas and of course ice during about 5 months of winter-time. My successor at the Älvkarleby Laboratory, SPB, Dr.L.Billfalk, Director, Älvkarleby Laboratory, S-81o7o Älvkarleby, Sweden, has specialized in ice problems.

Being an IAHR member you of course are aware of the Section on Ice Problems and its numerous symposia proceedings. Also POAC is a source of information. Your Canadian neighbors you probably know better than I do.

I take this opportunity to announce the change of directorship of the Theodor Rehbock Laboratory, that took place April 1, 1983. Prof. Mosonyi enjoys a status of emeritus and still has an office at the institute.

Yours sincerely,

(Prof.Dr.Techn.Peter Larsen)

DER BUNDESMINISTER DES INNERN

Geschäftszeichen (bei Antwort bitte angeben)
U III 4 - 520 080 II

☎(0228) 681-3465

Datum
8. November 1984

Der Bundesminister des Innern, Postfach 170290,5300 Bonn 1

Dienstgebäude Nr. 1

Herrn
Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive
Chicago
Illinois 60606, USA

Betr.: Informationsmaterial;
hier: Stand der Technik auf dem Gebiet des Schutzes gegen Eisschäden

Bezug: Ihr Telegramm vom 24.10.1984

Sehr geehrter Herr Dr. Louie,

für Ihr Schreiben vom 24.10.1984 sowie Ihr Interesse für die Belange des Umweltschutzes danke ich Ihnen.

Zuständigkeitshalber habe ich Ihr Schreiben an den Deutschen Verband für Wasserwirtschaft und Kulturbau e.V. weitergeleitet. Von dort erhalten Sie weitere Nachricht.

Mit freundlichen Grüßen
Im Auftrag

Malek

DER BUNDESMINISTER DES INNERN Kennziff. 29

Beglaubigt:
Angestellte

Dienstgebäude
Nr. 1 Graurheindorfer Straße 198 (Hauptgebäude)
Nr. 2 Dietkirchenstraße 28
Nr. 3 Graurheindorfer Straße 35
Nr. 4 Husarenstraße 30
Nr. 5 Kaiser-Karl-Ring 9
Nr. 6 Karl-Legien-Straße 156
Nr. 7 Hohe Straße 67
Nr. 8 Hohe Straße 73
☎ Vermittlung Nr. 1-6: 681-1, Nr. 7, 8: 66 84-1
Telex 8 86 896
Teletex 228 341 = BMI
Telefax 681-46 65

Kontoverbindungen: Bundeskasse Bonn, Landeszentralbank Bonn 380 010 60 (BLZ 380 000 00) · Postgirokonto Köln 119 00-505 (BLZ 370 100 50)

DVWK

Deutscher Verband für Wasserwirtschaft und Kulturbau e.V.
DVWK · Gluckstraße 2 · D-5300 Bonn 1 · Tel. (02 28) 63 14 46

THE MANAGING DIRECTOR

Dr.David S. Louie
Chief Hydraulic Engineer
Harza Engineering Company
150 South Wacker Drive

Chicago, Illinois 60606/USA

Ref. No. 4.5.2.2/DI/Gi

Bonn, October 31, 1984

Subject:- Ice Control Engineering

Dear Dr. Louie,

Thank you very much for your cable of 24th October, 1984, requesting information and detailed literature on the above-mentioned subject.

The enclosed text of your cable was sent to the relevant experts of our Association, namely:

Prof.Dr.-Ing. Hans Blind
Technische Universität
Arcisstr. 21
D-8000 München 2

and

Prof.Dr.-Ing. Karl Heinz Idel
Potthoffs Börde 15
D-4300 Essen 1.

I am sure, you will hear from our specialists in due course. For your information I enclose in English a pamphlet on the structure, tasks and activities of our organization.

With kindest regards,

Sincerely yours,

Dr.-Ing. W. Dirksen
Secretary, ICID National Committee
of the Federal Republic of Germany

c.c. Prof.Dr.-Ing. H. Blind; Prof.Dr.-Ing. K.H. Idel

Cable 24th October, 1984

from: Dr. David S. Louie, Harza Engineering Company,
150 South Wacker Drive, Chicago, Illinois 60606/USA

Text:

Attn.: Dr.-Ing. W. Dirksen, DVWK, Gluckstr. 2, 5300 Bonn 1

Gentlemen:

We are conducting a literature search and writing to various agencies and specialists to survey the state-of-the-art in ice control engineering which affects the environment. We would appreciate any information you and/or your organization could offer or suggest names of persons and organizations which we might contact on the following:

One - Procedures or operating policies used in the control of ice levels in rivers downstream and upstream of dams and hydropower plants caused by environmental water releases and power generating flow fluctuations in order to minimize the formation of ice jams and more importantly to minimize the associated flooding.

Two - Environmental impact on terrestrial animals such as caribou, elk, bear, moose, etc. Due to the formation of ice on wet reservoir banks exposed by reservoir drawdown or due to reservoir surface ice which has broken up at the banks. This ice may cause the animals to lose their footing and slip into the reservoir, resulting in injuries or drownings. What procedures, if any, have been adopted to minimize this hazard?

Three- The method of reservoir fluctuation management or precautions used in order to control the width of opening and pattern of crack development in the ice sheet such that after snowfall with cracks covered, the traversing animals would not fall into and be trapped in the cracks.

Four - Problems of bank erosion caused by break-up and movement of ice resulting in increase of sediment in the reservoir and in the river downstream. What is the permissible degree of turbidity in parts per million or its equivalent that is acceptable for aquatic life such as salmon, trout, etc.?

Please send reply to the attention of Dr.David S. Louie, Harza Engineering Company, 150 South Wacker Drive, Chicago, Illinois 60606/USA

VITUKI — VÍZGAZDÁLKODÁSI TUDOMÁNYOS KUTATÓKÖZPONT
НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЙ ЦЕНТР ВОДНОГО ХОЗЯЙСТВА ● RESEARCH CENTRE FOR WATER RESOURCES DEVELOPMENT
CENTRE DE RECHERCHES DES RESSOURCES HYDRAULIQUES ● FORSCHUNGSZENTRUM FÜR WASSERWIRTSCHAFT
ESPLORA CENTRO POR AKVOMASTRUMADO ● CENTRO DE INVESTIGACIONES PARA EL DESARROLLO DE RECURSOS HÍDRICOS
BUDAPEST — ВЕНГРИЯ ● HONGRIE ● HUNGARIO ● HUNGARY ● UNGARN ● HUNGRÍA

225

№: IAHR-[illegible]-1984.
Ref.:

Budapest, 19 26 Nov 1984

HARZA ENGINEERING CO.
Date Received 12/13/84
Routed To DSL
Classified for Filing by
Project Number
Classification
Subject Designation

HARZA ENGINEERING
151 South Wacher Drive
Chicago Il 60606
USA

Dear Sirs,

Referring to your cable no 244.21 1659 I suggest to contact in relation to question 1 and 2

- Dr.G.D.Ashton, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire 03755 (Editor of IAHR Manual on River and Lake Ice Engineering)
- Mr.G.E.Frankenstein at the same address, President IAHR Section on Ice Problems
- Prof.J.F.Kennedy, Director, Iowa Institute of Hydraulic Research University of Iowa, Iowa City, Iowa 52240

In relation to question 2 I have no strong feeling. You may try to contact

- Mr.S.Angelin, Chief Engineer, Swedish State Power Board, Civil Engineering, S-162 87 Vallingby.
- Mr.E.V.Kanavin, Ice Office, Water Resources and Electricity Board, Middelttrani gt 29, Oslo 3.

Yours sincerely

Ü.Starosolszky

Mail: VITUKI, H—1453 Budapest Pf. 27. ● Telephone: 36—1—338160 ● Telegram: Vízgaz Budapest ● Telex: 224959—h

SCHWEIZERISCHES NATIONALKOMITEE FÜR GROSSE TALSPERREN
COMITÉ NATIONAL SUISSE DES GRANDS BARRAGES
SWISS NATIONAL COMMITTEE ON LARGE DAMS

Präsident: G. Lombardi
Via A. Ciseri 3
CH-6601 Locarno
Tel. (093) 31 60 41

Sekretariat: c/o Ingenieurbüro für
bauliche Anlagen
der Stadt Zürich
Postfach 6936
CH-8023 Zürich
Tel. (01) 435 26 03

Dr. David S. Louie
Harza Engineering Company
150 South Wacker Drive

CHICAGO Illinois 60606
USA

Zurich, 12th december 1984 Bf/mb

Ice control engineering

Dear Sirs,

according to the distribution of your questionnaire inside Switzerland we admit, that question Nr. 1 will be answered by ETH-Zurich. Concerning Nr. 2 and Nr. 3 we have never heard of accidents with animals due to ice covered reservoir banks. Normally the ice on the reservoir banks is covered with snow, which avoids animals to slip down. Hunters too, did not report on such kind of accidents.

Also your question Nr.4 seems to make no important problems in our country, since we have had a three days symposium on reservoir sedimentation in october 1981 at the Swiss Federal Institut of Technology in Zurich and nobody reported on increase of sedimentation in the reservoir due to ice action.

Very trouly yours

SWISS NATIONAL COMMITTEE
ON LARGE DAMS

The Secretary:

R. Bischof

VST Ltd. CONSULTING ENGINEERS
Ármúli 4, 105 Reykjavík, Iceland Tel: (91) 84499 Telex: 2040 vst is

Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
U.S.A.

Your ref.	Your letter	Our ref.	Date
			November 6, 1984

Attention: David S. Louie
Chief Hydraulic Engineer

Subject: Ice Control Engineering
Your telegram of oct. 31.

Dear dr. Louie,

Environmental impact due to ice formations at dams and hydropower plants is very limited here in Iceland and I am not aware of any Icelandic literature on the subject.

There have been some problems due to increased winter discharge after construction of power plants and reservoirs and minor remedial works (levees) have been carried out. However I think that the operation is solely governed by the power demand.

We do not know of problems in connection with cracks or broken up ice at reservoir banks. In most cases the ice cover follows the water level fluctuations without opening up.

Problems with turbidity due to erosion by ice are irrelevant compared to other sediment problems.

For further information I suggest that you contact The National Power Company (Landsvirkjun, Háaleitisbraut 68, 108 Reykjavik) and The Nature Preservation Council (Náttúruverndarráð, Hverfisgata 26, 101 Reykjavik).

Very truly yours,

Sigmundur Freysteinsson

Sigmundur Freysteinsson.

INSTITUTE OF FRESHWATER FISHERIES
HÓLAR I HJALTADAL
551 SAUÐÁRKRÓKUR
ICELAND

9/11 1984

Dr. David S. Louie
Chief hydraulic engineer
Harza Engineering Company
150 South Wacker Drive
Chicago
Illinois 60606
U.S.A.

Dear Sir.

In reference to your telegram dated 17/10 1984, I am afraid there is little I can do to help. I have contacted several individuals and agencies in Iceland in connection with your request. The questions you ask have been little studied in Iceland as these have not become problem areas in our hydraulic management. It might be more profitable for you to hunt for information in Norway and Sweden where reservoir management has been and still is an issue of major concern.

Sincerely yours,

Tumi Tómasson

Tumi Tómasson

PS I am sorry about the late reply, but your telegram got delayed by a strike by city and state employees in Iceland.

IBW PAN

INSTYTUT BUDOWNICTWA WODNEGO
POLSKIEJ AKADEMII NAUK

INSTITUTE OF HYDROENGINEERING
OF THE POLISH ACADEMY OF SCIENCES

80-953 GDAŃSK-5, CYSTERSÓW 11, Tel. 52-20-11
Telex 0512845 IBWPL

Our ref. 6/3366/84

Gdańsk, Nov. 14, 19 84

dr David S. LOUIE
Harza Engineering Company
150 South Wacker Drive
CHICAGO, Illinois 60606
U S A

Dear Sir,

Answering to your telex dated Oct. 19,1984 we would like to inform you that the Institute does not carry the Scientific research in the four mentioned problems. Some of the problems concerning the topics you are interested in could be found in the following publications:

1/ Kołodko J., Jackowski B.:
Jamming tendency of floating ice in rivers and reservoirs, IAHR Ice Symposium 1984, Hamburg, August 27-31, Proceedings, Vol. I., pp 251-254.

2/ Majewski W.:
Backwater profiles on hydroelectric reservoir with ice cover IAHR Ice Symposium 1984, Hamburg, August 27-31, Proceedings, Vol. I., pp 255-264.

3/ Kołodko J., Jackowski B.:
Ice floods caused by wind action. Proceedings of the International Conference on Hydraulic Design in Water Resources Engineering: Channels and Channel Control Structures, Southampton, 11-13 April 1984.

Your telex has been sent to Hydroprojekt in Włocławek where some of the above mentioned subjects are investigated.
With kind regards,

Yours sincerelly,

Professor Piotr Wilde
Director of the Institute of Hydroengineering of the Polish Academy of Sciences

Vattenfall

Referee L Billfalk

Our date 1984-10-30
Your date

Our reference UL-LB/gp-023
Your reference

Dr David S Louie
Harza Engineering Company
150 South Wacker Drive
Chicago
Illinois 60606
USA

Dear Dr Louie,

I have received your cable regarding various ice problems affecting the environment and will try go give some answers to your questions.

Regarding question no one I can refer to experience from recent tests in Sweden on "Controlled ice cover formation". The result of these tests are summarized in the enclosed paper from the recent IAHR-Symposium in Hamburg.

Regarding questions two and three I have contacted the Environment and Concession department within our company. As far as they know there are no injuries or drownings of animals reported as a result of icing of banks or shore cracks in the ice covers. Some potential problems related to the need for reindeers to pass regulated rivers have been discussed when planning for new hydro power stations and in some cases the Power Board has constructed special reindeer bridges where "natural crossings" cannot be used any more.

Regarding your fourth question I have asked the Environment and Concession departement to prepare an answer. There paper will be sent to you as soon as I get it.

Sincerely yours

Lennart Billfalk

Dr Lennart Billfalk
Director

THE SWEDISH STATE POWER BOARD
ALVKARLEBY LABORATORY
Postal address
S-810 71 ALVKARLEBY
SWEDEN
Telephone
Telefax

Vattenfall

Referee L Billfalk

Our date
1984-12-14

Your date

Our reference
LB/gp-023

Your reference

Dr David S Louie
Harza Engineering Company
150 South Wacker Drive
Chicago
Illinois 60606
USA

Dear Dr Louie,

Please find enclosed our answer to the remaining fourth question in your October cable.

Sincerely yours

Lennart Billfalk

Dr Lennart Billfalk
Director

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S-814 71 ALVKARLEBY
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Telefax

Request from Harza Engineering Company

Referring to the request, dated oct 18 1984, concerning some potential effects of water regulation, the following comments may be given:

The formation of ice on the reservoir banks is not considered a problem for reindeer and moose in northern Sweden. One has distinguished the risk but inquiries and observations have indicated that it must be of minor importance as a mortality factor. This conclusion is also applicable to the question of crack formation due to water regulation.

Bank erosion in connection with the movement of ice is a common phenomenon i North Swedish rivers. Normally the load of suspended particles is far below the amount causing damage to fish. The kind of soil, dominating in northern Scandinavia, consists of comparatively coarse particles, and problems only arise in connection with construction work.

I have not been able to trace any publications on the Swedish experiences in the above fields. The work most frequently referred to with respect to the last topic is a report by the European Inland Fisheries Advisory Commission (EIFAC). The English title is unknown to me, but the Swedish translation indicates that it is an interim report dealing with fine particulate solids and fishery.

I hope the above information may be of some use.

Björn Svensson
ecologist at the hydro power department