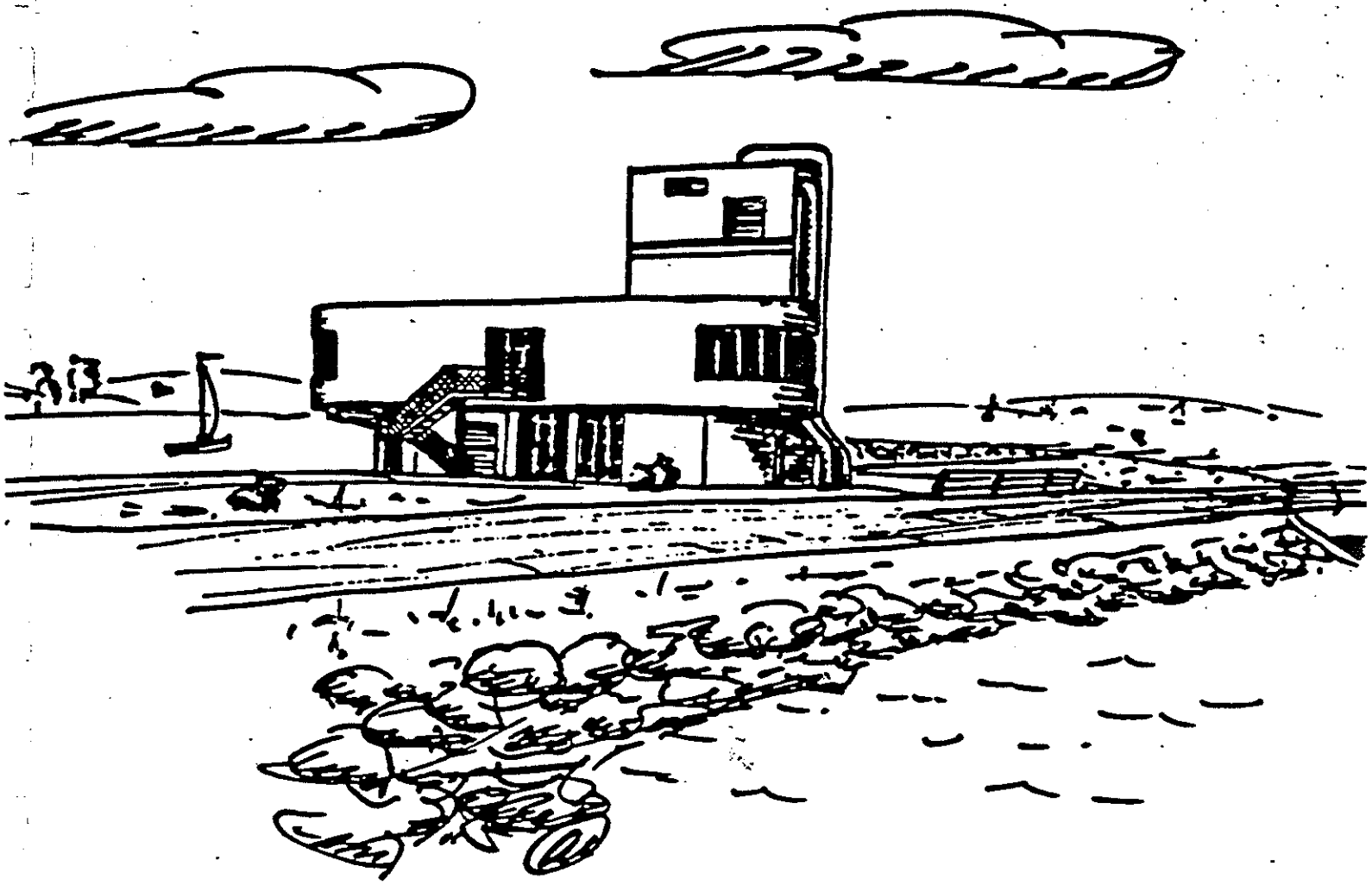

Headpond Water Level- Impacts and Mitigation

by

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THE ANNAPOLIS TIDAL POWER PROJECT

HEAD POND WATER LEVELS

IMPACTS AND MITIGATIONS

by

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SUMMARY

Operation of the Annapolis Tidal Generating Station will result in higher average levels on the Annapolis River. Studies have identified potential impacts on agricultural and non-agricultural land. Remedial works and other mitigating measures are being put in place to protect land from effects of the higher water levels. Compensation is necessary where it is not possible to mitigate damage.

1.0 INTRODUCTION

1.1 BACKGROUND

The Annapolis Tidal Generating Station is located on the Annapolis River at Hog Island which is within the limits of the Town of Annapolis Royal, Nova Scotia.

The Annapolis River originates some 65 kilometres upstream of the site at Berwick, Nova Scotia. It has a drainage area of 1580 square kilometres. The river's mean annual runoff is estimated to be 38.2 m^3/sec. The maximum daily flow for an 1:100 year event is 866 m^3/sec.

Much of the land adjacent to lower 35 km of the river estuary is Acadian series soil consisting of silt and clay loam sediments which have been eroded by runoff and redeposited on flood plains by tidal action. The resulting formations are nearly level with a slight depression towards the uplands rather than towards the river. These soils are very fertile, free of rocks and stones, support good root development, and are capable of high crop yields. There are approximately 1500 hectares of this marshland used for agricultural purposes.

Prior to the 1960's the lower portion of the estuary was tidal. Since settlement of the area in the 1600's by the Acadians much of the river's adjacent marshlands were protected by dykes and tide control structures (aboideaux). Evidence of these structures including some of those built by the Acadians can still be found along river's banks.

1.2 CAUSEWAY

In the late 1950's the Federal Government's Maritime Marshlands Rehabitation Administration began construction of a barrage at Hog's Island consisting of a coarse rock fill causeway, a gated control structure, and fish passage. The purpose of this project was to effectively eliminate the maintenance of dyke and aboideaux, and to reclaim additional land by preventing the ingress of tidal water to the estuary.

1.0 INTRODUCTION (Cont'd)

1.2 CAUSEWAY (Cont'd)

Until construction of the tidal power station the provincial Department of Agriculture operated the gates and was responsible for river levels on a "best effort" basis. That is, it was attempted to maintain the river at a level of between 0 and +3 feet (0.91 m) above sea level, but under high runoff the level would frequently exceed +6 feet (1.83 m) and rose to over +9 feet (+2.7 m) on one occasion in the early 1960's.

In addition to the agricultural use of the land adjacent to the estuary, relatively constant river levels since construction of the causeway has made the area increasingly attractive for recreational purposes.

2.0 PROJECT DESCRIPTION

2.1 HEAD POND MANAGEMENT

The Annapolis Tidal Power Project involves construction of a submerged powerhouse to house a 7.6 m diameter horizontal axis Straflo turbine.

The turbine is used to generate towards the sea and to sluice to fill the head pond. The two existing sluice gates are also used for recharging the head pond, and to ebb sluice when necessary.

The operation of the tidal generating station will effect a change to the pre-construction head pond regime. It is proposed to raise the maximum head pond level initially to +1.83 m, and seek authority to go to a maximum level of +2.29 m for the long term. The average head pond/river level will, therefore, increase by approximately 0.5 m to 1.0 m.

2.2 ENVIRONMENTAL STUDIES

An environmental impact assessment prior to construction identified only one major concern with respect to higher water levels - that being impairment of drainage in certain sections of the upriver marshlands. Generally steep slopes of the river's banks and those of its tributaries precluded flooding of significant acreages of land.

The report recommended further study of other identified areas of concern including: salt water incursions into marsh soil, flood routing, detailed investigation of marsh drainages and specific mitigating measures, fisn mortality, and head pond bathymetry. These studies are in place or have been completed.

2.0 PROJECT DESCRIPTION (Cont'd)

2.3 IGEAC

An intergovernmental environmental advisory committee comprising representatives of relevant provincial and federal departments and agencies was formed to monitor activities during construction and to review operations as it relates to environmental concerns. Raising of the river will be staged, and subsequent incremental increases will only happen with the authority of this committee after is has reviewed whatever impacts may have occurred at the contemporary level.

3.0 IMPACTS

3.1 IMPAIRED DRAINAGE

The Report on Remedial Works Program - Annapolis River Marshlands investigated all of the various marshlands in the study area. The report identified all of the impacted areas of marshland for maximum operating levels between 1.69 m above sea level and 2.29 m above sea level in increments of 0.15 m. 5.5' 7.5'

The criteria for defining potential impairment of drainage was: 1.0668m
(a) land less than 3.5 feet above the maximum water level and
(b) land less than 4.0 feet above the mean water level. In all 1.37m
cases (a) was the ruling criterion. Considering that the land tends to be lower near the upland than that near the river, the criterion was modified to be the greater of 3.5 feet or the vertical distance required to provide defined drainage path slopes. A marsh or tract was considered impacted (requiring remedial measures) if the average elevation of the lowest third of the marsh or tract did not meet the above criteria.

Current land use of each of the marshes was not a factor in the determination of drainage impairment. That is to say, the criteria were applied as if the land was being utilized or is to be utilized for growing the most sensitive crops. Much of the land along the estuary, in fact, is used for pasture and/or hay production.

3.2 LIVESTOCK WATERING

An additional impact on agricultural operation is the effect that sluicing of sea water into the head pond will have on livestock watering. Prior to project construction the coarse rock fill causeway could discharge as much as 125 m^3/sec into the head pond, and the fish passage would discharge a maximum of about 150 m^3/sec. The resulting salt wedge was found to terminate 25 km to 35 km upstream of the barrage. The trip of the fresh water layer would, however, begin at the barrage or as far as 20 km upstream depending on wind and river flow.

3.0 IMPACTS (Cont'd)

3.2 LIVESTOCK WATERING (Cont'd)

Surface salinity has been measured since prior to operation and has continued on a regular basis. No significant upstream migration of the salt water surface was found after head pond recharging was commenced.

3.3 RECREATIONAL PROPERTIES

The raising of the average level of the river will affect some recreational properties. There will be loss of waterfront, but it is believed that beaches will re-establish themselves.

A number of fixed structures such as wharves and boathouses will be affected by the higher water levels. One bridge is being raised to avoid being flooded at the maximum head pond level.

3.4 EROSION

Historically, erosion of the river's banks has been a continuing problem. Acadian series soil tends to erode very dramatically in large blocks. Studies so far are inconclusive with respect to the effects of the higher river levels. There are suggestions, however, that the higher levels may arrest or at least impede the process. Aerial photography has been flown each year to provide baseline data and the annual rate of erosion.

4.0 MITIGATION

4.1 MARSHLAND PROTECTION

On the marshes which have been identified as requiring protection tide gates or aboideaux, have been designed and are under construction.

There are two runoff conditions for which the structures were designed:

(1) to have an average design capacity to the maximum runoff when the water surface upstream is one foot below the low marsh elevation, and;

(2) to have an average design capacity equal to the normal runoff when the water surface is at the design level (3.5 feet below the low marsh elevation).

The maximum runoff is defined as that which results from the average maximum 24 hour storm for thirty years of records at three gauging stations within the drainage basin.

4.0 MITIGATION (Cont'd)

4.1 MARSHLAND PROTECTION (Cont'd)

The normal runoff is that which results from the maximum daily storm for the maximum month in the growing season. This "normal" runoff will occur less than twenty percent of the time.

At two sites insufficient storage dictated that pumps be installed to increase the discharge capacity and maintain design levels inside the aboideaux.

The principle of the aboideau is that water will discharge when the river is below the level inside of the structure, but the gate will close when the river is higher, thus prevent water flowing into the marsh area. The principle is the same as that of the Acadians structures and that of the marsh protective structures of more recent times.

Construction materials have, of course, changed over the years. Wooden sluices have been replaced by "Sclair" pipe or concrete pipe with concrete headworks, and the wooden or brass hinged gates have been replaced by free hanging steel gates. "Flexane 40" is used for the gate seal.

In two cases it was possible to thread the pipes through existing sluices. At all other sites the structures were constructed in the dry, and upon completion canals were opened to the creek and the river.

Acadian class soil is a most unforgiving construction material. While vertical excavation slopes were maintained in many instances, much gentler slopes failed in others. Fortunately, a dry construction season has kept problems to a minimum.

4.2 LIVESTOCK WATERING

The extent of alternate livestock watering facilities has not been established. As mentioned, under the present regime the fresh water lens has not been altered to a point where extensive facilities appear to be necessary. Current literature suggests a safe limit of 5000 ppm to 7000 ppm of total dissolved salts for cattle. This is the criterion by which we determine the need for an alternate water supply.

Should the salt wedge migrate upstream with higher river levels, a variety of remedial measures will have to be taken depending on the particular circumstance. In some cases farm ponds will be adequate, but in others it may require piping from fresh water sources or drilling of wells in the most extreme cases.

4.0 MITIGATION (Cont'd)

4.3 RECREATIONAL LAND COMPENSATION

Much of the recreational land for which mitigation and/or compensation is being considered is in a unique legal situation. Prior to construction of the causeway crown rights extended over the foreshore on which at present are located wharves, breakwaters, and cottages. The lower water levels enjoyed since the causeway was built, we believe, have not extinguished these rights. Because of a somewhat complicated and inconsistent system of tenure on the marshland this situation is true to a much lesser degree for agricultural land.

In spite of the above, the approach to compensation for recreational land is as follows:

1) There will be no compensation for loss of the use of a beach.

2) Land permanently flooded will be compensated for.

3) Raising of fixed structures will be compensated for.

4.4 TIDAL POWER CONTROLLER

One feature which will provide an enhancement to river level control is the on-site computer known as the Tidal Power Controller.

In addition to the computer's functions of plant control and optimization, it provides recuperation control, flow forecasting, and tide forecasting.

A single gauging station on the river above the influence of the tide is sufficient to yield accurate predictions of flow at Annapolis Royal. Tide forecasting which includes the effects of local aberrations provides sluicing capacity for precise recharging to the desired level.

When high river flows are predicted the computer will initiate reduced river levels in advance of the run off to provide additional storage and maintain maximum levels. When a major event is forecast, one for which lower river levels will not totally compensate, the computer will initiate ebb sluicing in addition to generating. With the operation of the station sluicing capacity has increased by about twenty-five percent.

5.0 CONCLUSION

During early operation of the Annapolis Tidal Generating Station it has been proven that head pond levels can be controlled satisfactorily. Later in the year when we begin to raise the levels it will even be more critical that this be the case. On-going monitoring of the effects of higher river levels will continue through the next phase of operation and for some time after the maximum level has been reached.

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