ASSESSMENT OF CONSTRUCTION NOISE FROM A HYDROELECTRIC PROJECT ON LOCAL COMMUNITIES

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INTRODUCTION

B.C. Hydro conducted development studies for a potential hydroelectric project on the Columbia River in Southeastern British Columbia, Canada. The proposed site of the Murphy Creek Project is located about 200 m from the nearest residences. An eight year construction period would include approximately 4 years of major activity, including about 2.5 million cubic metres of rock excavation. An initial study with a limited amount of field work was completed in 1982 to assess the effects of construction noise and vibration. Responses from the local residents and other government agencies indicated that further field tests were necessary. Community representatives were involved in drawing up the Terms of Reference for the expanded noise study, which was undertaken in the fall of 1990.

Since sound attenuation due to ground effect and shielding is difficult to estimate theoretically over irregular terrains, various source-to-receiver path attenuations were measured. Following consultation with local community representatives, it was decided to use rock drills as noise emitters and seven representative receiver locations were selected for the attenuation testing. As a possible mitigation option at the request of the communities, an alternative project site 1 km upstream from the proposed site was included in the test program. During the tests, direct community input was obtained through community meetings and interviews with key stakeholders.

Test data obtained were then supplemented by noise data from other sources and extrapolated to model a full construction site. Noise and vibration impact were assessed. Source control and moving the project site 1 km upstream were the most significant mitigation measures considered. This noise impact study integrated engineering evaluation, project economics, environmental impacts, health concerns and property issues within the framework of a community consultation process.

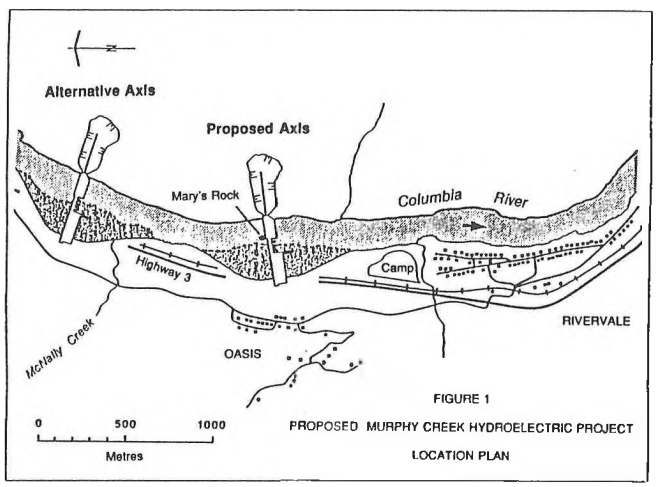

FIGURE 1
PROPOSED MURPHY CREEK HYDROELECTRIC PROJECT
LOCATION PLAN

TEST PROGRAM

There are two possible sites for the dam construction, namely the Mary's Rock axis (originally proposed) and the McNally Creek axis. As indicated in Figure 1, the closest communities potentially affected would be Oasis and Rivervale. A field study was conducted to obtain both existing ambient sound data and reliable sound propagation data.

On the first day of testing, existing ambient sound levels at the selected receiver locations were measured continuously for 24 hours in A-weighted decibels (dBA). This information is required to fully assess the potential impact of construction noise. On the second day, drilling operations were conducted separately at the two possible powerplant sites and resulting noise was measured, both at 15m from the drills, and at various receiver locations. Both the pneumatic drill and the more time-efficient and quieter hydraulic drill were used separately as noise sources. This exercise provided source noise data for drills, and most importantly, noise attenuation values for various source to receiver paths.

Since the project would involve the realignment of the railway and the highway westward, ground vibration levels from trains passing east of Oasis were also measured. In addition, noise levels at various locations were measured during the operation of a loaded dump truck at various work areas and on designated routes. Before and throughout the test program, the procedures and significance of the above testing were explained to the residents, and their feedback was requested.

EVALUATION METHODOLOGY AND ASSESSMENT OF IMPACT

Based upon previous experience and certain assumptions made in designing the project, B.C. Hydro personnel estimated the number and types of construction equipment that might be used during various phases and at major work areas throughout the construction project. Source levels at 15m for each type of equipment were obtained from equipment manufacturers, technical literature, and from measurements conducted by Barron Kennedy Lyzun & Associates personnel. The amount of sound attenuation that occurs between various work areas and the representative receiver locations was estimated primarily based on data from the field program. Noise levels at the receiver locations resulting from each noise source, or group of sources, were estimated by subtracting the expected attenuations from the source levels. Duty factors of the equipment and numbers of equipment were taken into account. The total project noise level at each receiver location was then calculated for each phase of the construction.

There were no local noise and vibration by-laws; hence, the most applicable assessment criteria were drawn from other sources. Since people react differently to impulsive noise than they do to non-impulsive noise, impulsive sources were evaluated separately. Criteria for low risk of complaints due to blasting peak noise levels, and for low degree of annoyance due to blasting induced ground vibration were used. Also evaluated separately were permanent changes in noise and vibration due to the proposed

highway and railway realignment. Specifically, ground vibration levels due to trains were compared to the perception threshold and the reduced comfort threshold stated in ISO Standard 2631[1].

For the total project noise assessment, noise level estimates were described in terms of the long term (i.e. several months) day-night average sound level, L_{dn}. For existing residences, the percentage of the population likely to be "highly annoyed" (% HA) was estimated from the total project L_{dn} levels using relationships established for both non-impulsive noise (Schultz[2]) and impulsive noise (CHABA[3]). In order to assess the cumulative effect of blast noise plus other non-impulsive noise, a method recommended by the U.S. National Research Council was used (CHABA[3]). First, the above relationships were used to determine the non-impulsive level which would result in the same % HA as was estimated for impulsive blasting noise. This equivalent non-impulsive noise level was then added to the levels of other non-impulsive sources to obtain the total project L_{dn} level, which allowed an estimate of % HA due to all sources.

The relationships between % HA and noise levels do not take into account the existing ambient noise levels or attitudes of the community. To account for the existing ambient, relative changes in noise levels and % HA were also reviewed. The % HA value corresponding to the existing ambient L_{dn} level at each receiver location was calculated to provide further insight into the assessment results. These estimated "existing" % HA values were relatively low at approximately 5%. Since the local communities have not indicated dissatisfaction with the current noise climate, this verified that the methodology was reasonably accurate. With respect to community attitudes, it is well known that a negative attitude often leads to greater annoyance than what would otherwise occur. The community consultation effort was intended to include concerns of the residents, such that a dissatisfied community attitude would not develop. It should be mentioned that although the CHABA assessment mothod does not include every factor that may lead to annoyance, it served well for the purpose of comparing the project axes, construction phases, and receiver locations.

At the camp site proposed for the Mary's Rock axis to house construction workers (see Figure 1), land use compatibility criteria (ANSI[4]) based on total project L_{dn} were used, because predictions of % HA are only valid for an existing population.

The primary conclusions arrived at were as follows. Estimated levels of noise and vibration from blasting would not exceed accepted criteria for either axis provided that a sufficient number of sequential delays are used and no nighttime blasting is allowed. With respect to ground vibration due to the realigned railway, only the Mary's Rock axis needed consideration because the McNally Creek axis would not change the distance between the railway and the communities. At the Mary's Rock axis, measured levels at a distance representing the future situation were below the reduced comfort threshold but well above the perception threshold. However, considering the relative change of +3 dB in both ground vibration and noise due to the distance reduction, the highway and railway realignments were considered to be insignificant.

Assuming a continuous work pattern of three shifts per day and seven days per week, total project noise levels for either axis were estimated for the seven receiver locations, as well as the proposed construction camp for the Mary's Rock axis. If the project is constructed at the Mary's Rock axis, noise levels at many receiver locations, primarily in Oasis, would increase during most phases of major construction by 10 dBA or more, relative to the existing ambient. Worst case increases were estimated to be 17 dBA. The estimated values of % HA vary widely from nearly unchanged at about 5% to as high as 49%, depending upon receiver location and phase of construction. If the project is constructed at the McNally Creek axis, receiver locations would be subjected to noise levels up to 6 dBA above present levels, and estimates of % HA would not exceed 10%. For the Mary's Rock axis, the construction camp site was assessed to be marginally compatible with the proposed use but building sound insulation and possibly exterior noise barriers would be required at the camp.

MITIGATION

Source control was a significant mitigation measure considered. In the project noise estimates, it was assumed that recently manufactured equipment would be used throughout the construction project. It was expected that such conditions likely would form part of the construction contract, reinforced by on-going site monitoring. Placing further noise limits was not considered practical. With regard to blasting, sequential blasting was recommended, with maximum charge per delay required for a typical daily blast specified.

However, the most significant mitigation measure considered was moving the project to the McNally Creek axis. As indicated by the impact assessment, impact from this alternative site was relatively minor. However, 1% to 2% increase in construction costs was estimated, and a net energy loss would be incurred once the project commenced operation. An alternative work pattern with two shifts per day and five days per week was also evaluated as a mitigation measure. However, the improvements were not very significant for either axis. Since the construction equipment would be scattered over a very large area, noise barriers around the work areas would not be effective.

COMMUNITY CONSULTATION PROGRAM

A community consultation program was designed to ensure that the concerns of the nearby residents were fully considered. It is called a community consultation program because it was targeted to deal with the concerns of the smaller, potentially directly affected communities. First, a notice about the studies for the potential hydroelectric project was placed in local newspapers. Then a meeting was held with the community association to plan for the tests, and to identify test sites and key concerns. Other efforts included an information handout delivered to all households in Oasis and Rivervale prior to the testing, as well as interviews with key stakeholders before and during the testing. After the testing, preliminary findings were reviewed with the community association. Active development of the project has now been deferred indefinitely. Any future consideration of the project would involve a review of community concerns and possible mitigation measures for perceived impacts.

FUTURE INVESTIGATIONS

When a decision is made to resume the development of the Murphy Creek Project, results of completed studies will be reviewed and further studies may be required. Feasible target noise levels will be set in consultation with the communities, such that mitigation options can be finalized for either axis. These options include source control, building facade upgrades and exterior noise barriers, temporary or permanent relocation of residents, and compensation in the form of easements. In consideration of project economics, environmental and social factors, a project site could be determined.

REFERENCES

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