THOMPSON-NICOLA REGIONAL DISTRICT

Friday, March 10, 2006

WORKSHOP AGENDA

Time: 9:00 a.m.  
Place: Board Room  
4th Floor  
465 Victoria Street  
Kamloops, BC

1. HAZARD MITIGATION
   (a) North Thompson River Flood Hazard Risk Assessment  
   Report from Director of Development Services dated  
   February 27, 2006 attached.
   
   (b) Pritchard Unstable Soils  
   Report from Director of Development Services dated  
   March 1, 2006 attached.
   
   (c) Other

2. COMMITTEE APPOINTMENT PROCESS
   Verbal report to be provided by Chief Administrative Officer.

3. INVITATIONS TO BOARD OF DIRECTORS:
   (a) Presentation to NDP Economic Development Policy Committee  
   Thursday, March 16, 2006 at 1:00 p.m.
   
   (b) Proposed Meeting with School District No. 73 Board of  
   Trustees – Dinner Meeting on Thursday, April 6, 2006  
   Chair to provide verbal report.

4. PAYMENT FOR GROUP MEALS AT CONVENTIONS
MEMORANDUM

TO: Chief Administrative Officer
FROM: Director of Development Services
SUBJECT: North Thompson River Flood Hazard Risk Assessment

February 27, 2006

As requested by the Board of Directors, a flood hazard risk assessment has been completed for the North Thompson River between Exlou/Louis Creek and Vavenby. This project, funded 75% by the Provincial Natural Hazards Mitigation Fund, was carried out to determine what businesses, residences and transportation corridors would be subject to flooding during a 200 year event. An evaluation of existing flood protection works was also included, including recommendations and prioritization of new works and flood mitigation strategies that could be implemented.

The study has determined that there are approximately 456 residences or commercial buildings located within the limits of the 200 year floodplain in the study area plus many kilometres of public and private roads and part of the CN Rail mainline. In the area reviewed, there are currently only five (5) existing dikes, however the report suggests that structures and roads could receive additional flood protection by way of further diking along the river, ring dikes around subdivisions and, in some areas, raising of the houses. The total cost of the recommended mitigation works is in the order of $4 million. More detailed engineering investigations and economic analyses would be required to confirm these preliminary findings.

The consultants have recommended the following as priority works based on their benefit/cost analysis:

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost</th>
<th>Benefit/Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Flap gate installation on CNR culverts on *left bank upstream of Birch Island</td>
<td>$10,000</td>
<td>24 : 1</td>
</tr>
<tr>
<td>2. Building a dike around houses on *left bank at Birch Island</td>
<td>$114,000</td>
<td>2.9 : 1</td>
</tr>
<tr>
<td>3. Building dike around houses on Jenkins Road East in Blackpool</td>
<td>$180,000</td>
<td>7.8 : 1</td>
</tr>
<tr>
<td>Project</td>
<td>Cost</td>
<td>Benefit/Cost Ratio</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-------</td>
<td>-------------------</td>
</tr>
<tr>
<td>4. Building dike around houses on Jenkins Road – West in Blackpool</td>
<td>$90,000</td>
<td>3.3 : 1</td>
</tr>
<tr>
<td>5. Raising a 500m section of Birch Island Road across *right bank floodplain in Birch Island</td>
<td>$152,000</td>
<td>3.2 : 1</td>
</tr>
<tr>
<td>6. Raising a 170m section of the Birch Island-Lost Creek Road upstream of Birch Island</td>
<td>$38,000</td>
<td>17 : 1</td>
</tr>
</tbody>
</table>

*Facing downstream, left bank on left side and right bank on right side of river.

It is suggested that this information be presented to the Board of Directors by way of the Emergency Management Committee to obtain direction on how they may wish to proceed with respect to the report recommendations.

Respectfully submitted,

GREG S. TOMA, MCIP
Director of Development Services

GST/ji
PRIORITY SITES FOR IMPROVED FLOOD PROTECTION ON THE NORTH THOMPSON RIVER FROM EXLOU TO VAVENBY

Prepared for:

Thompson Nicola Regional District
Kamloops, BC

Prepared by:

Doyle Engineering
in joint venture with
Pentilchuk Engineering,
BC Rivers Consulting,
and
Juniper Consulting,
Kamloops, BC

JANUARY 2006
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APPENDIX A

Figure 1 – Key Map and Flood Protection Priority Areas

Flood Hazard Assessment Mapping Package and Digital Copy
of this Report in DVD Format

Flood Hazard Assessment Mapsheets for Priority Flood Protection Works
Map Sheet No 16 – Blackpool Area
Map Sheet No. 20 – Birch Island Area
Introduction

The North Thompson River has been a source of flooding concern to several communities along its banks for over a century. Flood protection works have been built over time to reduce flood damages but some communities remain at flood risk. The Thompson Nicola Regional District (TNRD) sought to quantify the developed properties and infrastructure at risk from a major flood over the most densely settled reach of the river within its jurisdiction, and then to determine, on a priority basis, the most critical flood mitigation measures to take within this reach. Federal-Provincial Floodplain Mapping (FPM) circa 1982 (partial revision in 1986) is available for the entire reach, as are digitized 1996-97 orthophotos. Only the extent of flooding (the estimated 1:200 year Flood Construction Level) is available in digital format; digitized topographical contours are not available. Digital cadastral information also exists.

A joint venture of four local consulting companies - BC Rivers Consulting, Pentilchuk Engineering, Juniper Consulting, and Doyle Engineering - was awarded a contract by TNRD to (1) establish what residences, businesses, and transportation corridors were subject to flooding during the 200 yr flood over the reach of the North Thompson from Exlou to Vavenby, (2) document and evaluate what flood protection structures currently existed in the reach, and (3) determine top half-dozen or so flood mitigation projects in the reach that might be funded in the future. Figure 1 (see Appendix A) shows the North Thompson River from Kamloops to Vavenby with the study reach highlighted and the top 6 flood relief project locations denoted.

Technical Assumptions

The following technical assumptions were used in the assessment:

- The FPM is accurate except where noted
- Level of flooding at any building is uncertain except where noted
- Damage at floods smaller than the 200 yr flood is not assessed
- Houses within the floodplain will suffer damage during a 1:200 year flood unless it is known that the living space is above the Flood Construction Level (FCL). No assessment of the flood susceptibility of the portion of the house below the main living level was made (occupied, used for storage of goods damageable by flood waters, subject to covenant / bylaw when constructed, etc.). No consideration was given to flooding of basements for houses not within the floodplain.
- Flooded residence damage is $50,000 for either a house or mobile home
- Flooded commercial damage is $50,000
- Access (e.g., a private driveway) to a residence within the floodplain is flooded unless otherwise noted
• No information is provided regarding residences constructed since 1996 (date of orthophotos used) unless observed in field
• Unit costs estimated for all flood mitigation measures are provided at the bottom of Table 2 which is shown in a subsequent section
• The life of all proposed flood mitigation works is 100 years.

Methodology

The area of the study was limited to the river reach from Exlou to Vavenby as stated previously. The horizontal limits were the lateral extent of the North Thompson River floodplain only. High river levels may result in additional backwater on major tributaries that could be concurrently high such as the Barriere River in Barriere but tributary flooding was not assessed.

Estimated damages and flood mitigation costs at selected sites are rough using average values for flood losses and typical unit costs for construction and anticipated costs for other mitigation activities.

The first step in the study was to locate and review public records that documented past flooding in the subject reach and constructed flood protection works. Second step was to merge the digitized floodplain mapping obtained from Ministry of Environment (MOE) with the digitized 1996 airphoto mosaics and cadastral data supplied by the TNRD. The combined working maps were then reviewed in the office to identify all residences, businesses, highways, and rail beds that appeared to be within the horizontal extent of the 200 yr floodplain and create a preliminary map notation for the variety of situations that might be encountered. Confirmation of flood prone buildings and infrastructure indicated on the FPM was done where possible by team members’ personal knowledge and the government record review. Larger clusters of residences were highlighted for consideration of more detailed field investigation for possible inclusion in a list of potential flood mitigation sites to be developed.

Only the elevation of the main floor of a dwelling was compared to the FCL for determining whether a dwelling was at risk of flooding – the existence of a basement was not considered. This is believed to be consistent with operating rules under the current building By-Law, enacted around 1990, that regulates new construction within the designated floodplain - demarcated as FCL.

The study area was divided into 3 zones for fieldwork and all field personnel took part in a joint field trip to “brainstorm” the assessment approach. Questions that arose from this joint field trip were then discussed with the TNRD project monitor to ensure that all parties knew what was wanted and what would be delivered. Several subsequent contacts between the consultants and the project monitor occurred mainly seeking building permit data toward confirmation that certain dwellings had been built to the Flood Construction Level (FCL).
Next, the fieldwork portion was done while the consultants resolved new questions that arose during this segment before moving into the analysis and reporting phase. The project monitor accompanied one of the consultants on one of the early field inspections so that both parties would have a better understanding of how the field portion of the work would be conducted. The consultants frequently reviewed the validity of assumptions that were necessary and the best way to portray the information it had gathered and analysed. Each of the existing 5 flood protection dikes was routinely inspected in the field and MOE office records for each dike were also reviewed.

A complete draft of the report was provided to the TNRD and a meeting was held with staff for their review and comment before the report was finalized. The mapping resulting from the project is cumbersome to provide in paper copy so the twenty-three project maps were submitted in electronic copy only except that a paper copy of two map sheets (covering all 6 top priority sites) was included in each paper copy of the final report as an example of the information supplied on the maps.

Level surveys were only carried out in the Birch Island area where it happened to be convenient and critical to do so. Topography in all the other areas was obtained from spot elevations, contours, and horizontal extent of the floodplain shown on the FPM, sometimes augmented by hand level readings and previously recorded flood data. In a few instances the TNRD was able to provide a record of those houses that had been built to the FCL and this helped to more accurately determine estimated 200 yr flood losses in the more densely populated areas chosen for preliminary assessment of possible future flood damage reduction priorities.

Staff from Ministry of Environment provided not just information on past floods and condition of the existing dikes but also helped with surveys of the existing dikes and conducted a level survey of a critically low portion of the floodplain at Birch Island. They were also generous with a loan of the FPM sheets for the study reach. Staff from Ministry of Transportation and Provincial Emergency Program also provided some background information on past floods and damage claim amounts. The North Thompson Indian Band Administrator, Water Utility operators and Public Health Officials also provided information on flood impacts on dwellings, water supply and wastewater disposal for the Indian Reserves and rural communities, respectively, and how these impacts have typically been addressed, including identification of flood prone dwellings (on the Reserve) and the condition of water supply wells and septic systems.
A full set of digitized maps was developed showing all dwellings and businesses in the floodplain in the entire study reach from an office review of 1996 photo mosaics compared with the earlier FPM that used 1974-75 photography. The office review also revealed (confirmed) which localities had higher densities of development at risk from a 200 yr flood. These would require a field inspection to better determine the flood threat, the current number of houses, businesses, and main transportation routes at risk of flooding, any obvious discrepancies in the FPM, and initial flood mitigation solutions to the flood threat. The office review suggested one more area not previously considered as a high priority area that could possibly be added to the seven high priority areas but a field investigation of the candidate area indicated that this new area did not warrant inclusion into the high priority group.

The original high-density areas that survived the field inspections were then ranked in priority by a rough benefit-cost (B/C) comparison of flood damages prevented by preliminary proposed mitigation works at each site. Recommendations for further investigations leading to possible flood reduction activities at the highest priority sites were then made based on other factors besides benefit-cost comparisons during the 200 yr flood.

Results

There are a total of 456 residences or commercial buildings located within the limits of the 200 yr floodplain of the North Thompson River from Exlou to just downstream of Vavenby where the FPM ends. A few more houses may be sprinkled elsewhere throughout the floodplain in the reach of the river studied that neither the office nor field review identified.

There are many kms of main roads that would be inundated and some CN Rail line. All these flood prone buildings and transportation routes are shown on the digitized maps. The five existing flood protection dikes are also shown on the maps and the present function of each dike is given in Table 1.
TABLE 1. Summary of current flood protection dikes in study area.

<table>
<thead>
<tr>
<th>Dike name</th>
<th>Dike location</th>
<th>MOE Dike #</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN Rail</td>
<td>RB ~ 3 km u/s Birch Island</td>
<td>354</td>
<td>New dike to keep river away from rail embankment. Protects no buildings.</td>
</tr>
<tr>
<td>No name</td>
<td>LB ~ 3 km u/s Birch Island</td>
<td>None</td>
<td>Old dike that prevents river from re-occupying abandoned channel. Protects no buildings.</td>
</tr>
<tr>
<td>Birch Island</td>
<td>RB at Birch Island</td>
<td>6 and 186</td>
<td>Two separate dikes recently combined into one. Emergency dikes that have been upgraded over the years to now provide flood protection on right floodplain to the FCL.</td>
</tr>
<tr>
<td>Clearwater</td>
<td>RB at Clearwater Flats</td>
<td>21</td>
<td>The CID dike provides flood protection for buildings on the right floodplain up to the prescribed FCL.</td>
</tr>
<tr>
<td>Nelson Rd</td>
<td>LB at south end of Barriere</td>
<td>371</td>
<td>This &quot;dike&quot; does not prevent flooding as the water comes overbank downstream and inundates the area downstream of it.</td>
</tr>
</tbody>
</table>

Abbreviations in Table:
RB = Right Bank (directions are always given as viewed FACING DOWNSTREAM)
LB = Left Bank
FCL = Flood Construction Level.

For the eight most densely populated areas in the study corridor, obvious discrepancies in the FPM (original versus digitized), 2005 status of buildings, some greater clarification of some building and transportation route elevations vis-à-vis the FCL, the best initial flood mitigation options (if any were apparent), and an economic priority ranking of qualifying sites for mitigation work were determined. Finally, recommendations, based on a number of important considerations, were made regarding the next steps to take in the process of reducing flood damages through structural means in the study reach. The eight sites were all different from one another in terms of flood impacts and practical mitigative works and not all presented themselves as good candidates for flood mitigation works.

In addition to the maps that show general flood impact information for the entire reach and more detailed flood information for the highest priority sites, Table 2 provides flood assessment details for the seven highest density sites.
**TABLE 2.** Summary of rough costs for favoured flood mitigation works, preliminary expected benefits of these works, estimates of average unit costs, general design specifications, and cost-benefit ratios for the 7 highest density areas.

<table>
<thead>
<tr>
<th>Location and Description of Area and Type of Buildings</th>
<th># of Units</th>
<th>Mitigation Cost</th>
<th>Expected Benefit</th>
<th>B/C Ratio</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birch Island-Left Bank (facing downstream)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>McLennan Rd. area upstream of BI on LB</td>
<td>22</td>
<td>$38,000</td>
<td>$660,000</td>
<td>17</td>
<td>Raise Lost Ck Rd for ~ 170 m (Priority 6 –see Conclusions Sec.)</td>
</tr>
<tr>
<td>Residences</td>
<td>7</td>
<td>$10,000</td>
<td>$210,000</td>
<td>24</td>
<td>Install 3 or 4 flap gates on CNR culverts. Damage from previous flood remains unrepaired (Priority 1 –see Conclusions Sec.)</td>
</tr>
<tr>
<td>Residence currently unfit for occupation</td>
<td>1</td>
<td></td>
<td>$30,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous two areas combined</td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>If protecting to 200 yr flood, these two should be combined. Second may not work w/o first.</td>
</tr>
<tr>
<td>Number of Residences – 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigation Cost - $48,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected Benefit - $900,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Just upstream of BI bridge on LB</td>
<td>10</td>
<td>$114,000</td>
<td>$330,000</td>
<td>2.9</td>
<td>Build ~ 850 m long dike between houses and river. (Priority 2 –see Conclusions Sec.)</td>
</tr>
<tr>
<td>Residences</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Church</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birch Island-Right Bank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Just upstream of BI bridge on RB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences</td>
<td>14</td>
<td>$152,000</td>
<td>$480,000</td>
<td>3.2</td>
<td>Raise Birch Island Rd for ~ 500 m (Priority 5 –see Conclusions Sec.)</td>
</tr>
<tr>
<td>Commercial</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to residences at FCL - 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated dwellings in BI area</td>
<td>3</td>
<td>$120,000</td>
<td>$90,000</td>
<td>0.8</td>
<td>Raise each house. One house flooded in December 2005. Not a favoured option</td>
</tr>
<tr>
<td>Houses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ring dike option for each of these 3 houses</td>
<td></td>
<td></td>
<td></td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Mit. Cost: $51,000; Exp. Benefit: $90,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # of flood prone developed properties in Birch Island area inspected in potential high priority sites</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2 (Cont’d):

<table>
<thead>
<tr>
<th>Location and description of area and type of buildings</th>
<th># of Units</th>
<th>Mitigation Cost</th>
<th>Expected Benefit</th>
<th>B/C Ratio</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackpool</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences - House</td>
<td>30</td>
<td>$1,200,000</td>
<td>$900,000</td>
<td>0.8</td>
<td>Raise individual Houses</td>
</tr>
<tr>
<td>Residences - Mobile Home</td>
<td>23</td>
<td>$460,000</td>
<td>$690,000</td>
<td>1.5</td>
<td>Raise individual Mobile Units</td>
</tr>
<tr>
<td>Less costly ring dikes may be suitable alternative for some of these sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences - Jenkins Rd West</td>
<td>10</td>
<td>$90,000</td>
<td>$300,000</td>
<td>3.3</td>
<td>Multi-dwelling dike 400 m long (Priority 4 – see Conclusions Sec.)</td>
</tr>
<tr>
<td>Residences - Jenkins Rd East</td>
<td>47</td>
<td>$180,000</td>
<td>$1,410,000</td>
<td>7.8</td>
<td>Multi-dwelling dike 800 m long (Priority 3 – see Conclusions Sec.) Benefit based on residences only</td>
</tr>
<tr>
<td>(Protects Telus Sta. as well)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial - Rivermount Motel</td>
<td>1</td>
<td>$115,000</td>
<td>$100,000</td>
<td>0.9</td>
<td>360 m longitudinal dike</td>
</tr>
<tr>
<td>(Major Facility - Benefit @ 2 x $50,000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rivermount Motel – river bank</td>
<td></td>
<td>$60,000</td>
<td></td>
<td></td>
<td>Riprap revetment on NTR bank</td>
</tr>
<tr>
<td>(Lack info. for benefit calculation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Blackpool</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences - House and Mobile Home</td>
<td>12</td>
<td>$315,000</td>
<td>$360,000</td>
<td>1.1</td>
<td>Multi-dwelling dike 1800 m long</td>
</tr>
<tr>
<td>Residences - House</td>
<td>13</td>
<td>$520,000</td>
<td>$390,000</td>
<td>0.8</td>
<td>Raise Individual Houses</td>
</tr>
<tr>
<td>Residences - Mobile Home</td>
<td>1</td>
<td>$20,000</td>
<td>$30,000</td>
<td>1.5</td>
<td>Raise Individual Mobile Home</td>
</tr>
<tr>
<td>Less costly ring dikes may be a suitable alternative for some of these sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # of flood prone developed properties</td>
<td>137</td>
<td></td>
<td></td>
<td></td>
<td>in Blackpool area inspected in potential high priority sites</td>
</tr>
</tbody>
</table>

Exlou to Little Fort

Exlou

| Residences (below FCL)                                  | 2          | $80,000         | $60,000          | 0.8       | Raise each house |
|                                                        |            |                 |                  |           | Ring dike option is same cost, but not attractive. |

South Barriere

| Residences (8 in FP, elevations relative to FCL unknown - no logical groupings) | 8          | $320,000        | $240,000        | 0.8       | Raise each house (if required) |

Little Fort

| Residences on RB (close together)                       | 2          | $80,000         | $60,000          | 0.8       | Raise each house |
| Residences on LB (scattered)                            | 2          | $80,000         | $60,000          | 0.8       | Raise each house |

Total # of flood prone developed properties               | 14         |                 |                  |           | in Exlou to Little Fort area inspected in potential priority sites |

Total Costs and Benefits (Costs reflect house raising option; not ring dike option): $3,874,000 $6,340,000
Cost Estimates Used in Table 2

House raising $40,000
Mobile home raising $20,000
Dike construction $25/cubic metre (see cost note below)
Asphalt roadway $35/square metre
Large flap gate $4,000
Small flap gate $2,000
Riprap supply & place $75/cubic metre
Environmental Remediation add 5% to construction costs
Flood Damage Cost (Residence) $50,000
Flood Damage Cost (Business) $50,000

Notes on Benefits and Costs:

(1) Benefit-Cost ratio = 0.6 (Expected Benefit/Mitigation Cost)
(2) Only the construction cost of the works are shown in mitigation cost estimates in Table 2. Engineering, surveying, and project supervision costs are not included in the mitigation cost shown. (See General Discussion section below regarding full engineering and surveying requirements associated with a complete determination of expected flood damages in each protected area).
Maintenance costs of works are not included.
(3) Dike maintenance costs (annually in the order of 2 to 5% of construction costs depending on project complexity) will exceed those for house raising.
(4) Dike maintenance costs assumed to be supported by fees collected from benefiting landowners by local diking authority.

Design Assumptions Used in Table 2

Typical dike configurations:

Ring dike (encircling protected area / house): Crest width of 3.5 m and sideslopes of 3H:1V
Ring Dike Typical Length - 140 lineal metres (In m)

Longitudinal dike (along river): Crest width of 4 m and sideslopes of 3H:1V
Dike length as required to tie into high ground at each end.
Approximate cost per lineal metre – for various dike heights:

<table>
<thead>
<tr>
<th>Dike Height</th>
<th>Volume Per Metre</th>
<th>Cost Per Metre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 m</td>
<td>7 m³/m</td>
<td>$175/m</td>
</tr>
<tr>
<td>2 m</td>
<td>20 m³/m</td>
<td>$500/m</td>
</tr>
<tr>
<td>3 m</td>
<td>39 m³/m</td>
<td>$975/m</td>
</tr>
</tbody>
</table>
In addition to the overall assessment of the 200 yr flood impact in the study reach and the more detailed assessment compiled for the high density areas, the writers note that there are 2 houses and a water intake pumphouse on the right bank of the river at the south end of Vavenby that appeared to have been inundated from backwater due to a brief but thick ice jam in January 2005. Vavenby is just upstream of the FPM and, thus, is outside the study area. However, since this report also serves as a compendium of vulnerable structures along the river for possible future response and recovery efforts, the locations of the toe of the responsible ice jam, and the two houses along with the pumphouse on the right bank, have been shown on the last map of the set of digitized maps provided as part of this project.

General Discussion

The flood assessments carried out were all done on a broad scale. Even the more detailed field investigations of the high priority sites were done on a preliminary basis using only the coarse elevations shown on the FPM. Costs of proposed flood mitigation works and benefits of resulting reduced flood damages were only roughly estimated. Construction costs were estimated conservatively to diminish the chances of unpleasant budget surprises in the future when construction material and labour costs could be better identified. A detailed design of proposed works should be undertaken by a qualified engineering firm prior to construction, and would include the following items:

- All construction material sources need to be located and detailed design of works along with method of construction are required in order to make an accurate estimate of project costs.
- Elevation surveys of buildings in floodplain, assessed values of these buildings, and the existence and finished state of basements to get a more accurate estimate of flood damages that would be prevented by selected works.
- Survey the geodetic elevation of the main living level of each house in the floodplain and record in a computerized database for use in current and future potential floodplain damage assessments.
- In cases where raising a house or building a ring dike around a house seems acceptable, a technical assessment of the structure’s suitability for being raised or encircled must be done prior to doing so.
- Ground surveys along expected overland flow routes also should be done to confirm that subject areas would, in fact, be flooded during the 200 yr event and to also confirm the dimensions of proposed protective works.

Residences in the floodplain on Indian Reserves are included in this study based not only on a review of the mapping but also on a very beneficial meeting with the North Thompson Band Administrator who supplied details and confirmation on dwellings at risk. These dwellings can be identified on the digitized maps by locating those dwellings that are located within the confines of the marked Reserve lands, all of which have been clearly distinguished on the maps. Since flood mitigation on Federal land is a Federal responsibility, no costs for raising dwellings located on Reserves are shown.
The rough costs shown herein do not include the cost of obtaining necessary rights-of-way or temporary access on private property. The important issue of having a responsible diking authority (TNRD or other) to maintain any new dike proposed for construction would also need to be resolved prior to construction approval. There are the usual Provincial and Federal permits needed for any construction as well.

Those people living or working in the floodplain that would directly benefit from any proposed flood mitigation work would obviously need to be in favour of the work for it to proceed. Some homeowners may oppose or want to modify proposed flood protection works if they felt that it would disrupt their lifestyle and/or affect property use. Modifications to designed works could either increase construction costs or reduce protection or both.

The existing flood protection dikes were only evaluated by a cursory office and field review. High flows and the passage of time will eventually weaken the dikes in some fashion and these will require remedial work to keep up the current level of protection. The same remedial work will be required from time to time on any new dikes constructed. Dike maintenance, land acquisition, and project financing are additional costs not factored into the very simple way of calculating the B/C ratio that the writers used in this report. Adding the annual operating and maintenance costs to a dike project could easily double the actual cost of the project over the life of the project. When the B/C ratios shown herein are 3 or less, a much more rigorous B/C calculation is required, particularly if the cost of land acquisition will be significant.

The average estimated costs and benefits assigned to raising a house, raising a mobile home, and ring-diking a house make the estimated B/C ratio for each of these activities 0.8, 1.5, and 1.8, respectively, for any house or any mobile home at a elevation of about 1 m below FCL. In each instance, where one or more of these activities is being contemplated, a more detailed analysis of the costs, benefits, feasibility, and suitability of the job for that particular structure is needed. Some of the factors that must be favourable before deciding on a ring dike are the proximity of outbuildings to a dwelling, access to dwelling in wet or icy conditions, willingness of landowner to accept a ring dike, dike maintenance, internal drainage, adverse impacts on neighbours, and possible detrimental changes to location of structures or access over time. A key determining factor in selecting the raising a house option is engineering confirmation that it can be raised without structural damage.

Destructive mid-winter ice jams on the North Thompson River, particularly in the vicinity of Birch Island, may become a more common occurrence as global warming begins to have an effect on the river ice regime. In January 2005 and again in December 2005, ice jams have caused flood damage to dwellings at Birch Island. Ice breakup and jamming on the North Thompson River, previously thought to be a rare event, may now warrant more consideration in floodplain management.
Specific Discussion of the Highest Priority Areas

Birch Island Left Bank (Looking downstream)

There are 3 distinct clusters of homes in the 200 yr floodplain: one cluster in the vicinity of McLennan Rd, another cluster to the south of the CN tracks immediately upstream of BI, and the third just upstream from the BI road bridge along the river. The proposed raising of Lost Ck Rd no more than 0.3 m for about 170 m of length at the topographic low point to FCL would protect the McLennan Rd. cluster. The raised road (dike) combined with installing flap gates on all culverts in the adjacent CN rail grade to turn the rail grade into a dike would protect the second cluster south of the rail line. A longitudinal dike about 0.8 m high tied into the rail embankment downstream of the abandoned school and running between the houses and the river for about 850 m until it tied into the left approach to the bridge at the FCL would protect the third cluster upstream of the bridge. The new dike must tie into the bridge approach road as far inland as possible to leave a wide overflow section along the roadway if the bridge opening is obstructed during a flood event. There is a new bridge under construction just upstream of the present bridge that will replace the present bridge in 2006. This same left bank approach overflow must be maintained with the new bridge alignment.

Limited elevations surveyed on the CN track indicate that the entire section of rail embankment downstream, through, and upstream of Birch Island to the upstream rail bridge is above the FCL even though the FPM shows large sections below the FCL. There are at least two culverts through the rail embankment that require flap gates and there may be two or so smaller culverts that need to be gated as well. CN will likely not be inclined to accept flap gates on their culverts. Most flood events will be short-lived in the Birch Island area so that could help persuade CN to allow their installation. If CN refuses the idea, an alternative way to protect the 8 houses south of the rail line, may be construction of a dike paralleling the rail line and immediately south of it. The cost of it will obviously be much greater than flap gates and there may be other impediments to the work. The feasibility and rough costing of a parallel dike would need to be assessed if CN will not permit flap gates on their culverts.

All the more detailed investigations mentioned in the previous section of the report must be done here as elsewhere to confirm these preliminary findings, but the large B/C ratios resulting from the proposed works make these 3 areas very good candidates for flood mitigation works. It should be noted that there is little benefit from raising the Lost Ck Rd as proposed until levels reach or exceed the 200 yr flood level since minimal raising of the road crest is required. However, the other two clusters of houses have been flooded in recent years by floods smaller than the 200 yr event and the proposed flood works would protect these houses on a more frequent basis from smaller floods. The small expense attached to installation of flap gates on a few CN culverts to protect several flood prone homes in the middle cluster – including one home that remains unoccupied due to flood damage incurred in the most recent flood - during modest and larger floods seems to be a particularly attractive choice.
One house in the floodplain, not in one of the 3 clusters, lying between the railroad and the river upstream of Birch Island is left unprotected on the floodplain if the 3 proposed flood mitigation works are completed.

**Birch Island Right Bank**

There is a single cluster of homes that is protected by an existing dike. The dike crest is at FCL or higher for its entire length and has prevented flood damages during past flood events. Recent upgrades have improved the overall structure but bank erosion, a narrow crest and abundant tree growth are on-going problems with the dike. Two houses lie downstream of the dike on the floodplain and are not protected by the dike. One of these houses (located approximately 1.3 km downstream of BI bridge) was flooded by an ice jam in December 2005. At the time of the field inspection, new bridge construction necessitated breaching of the dike at its downstream end. This breach must obviously be repaired as soon as bridge construction is completed and no later than prior to spring freshet in 2006.

All the houses protected by the dike are upstream of the Birch Island Rd. The road itself is below FCL for about 500 m. Floods approaching the 200 yr flood will inundate the road from the downstream side and begin to flood all the houses below FCL on the upstream side of the road. Raising the road surface an average of about 0.6 m for about 500 m will prevent this backflooding of the diked area from happening.

All the more detailed investigations mentioned in the previous section of the report must be done here as elsewhere to confirm these preliminary findings, but the sizeable B/C ratio resulting from the proposed flood mitigation work make this area a potential candidate for flood mitigation work to complete the flood protection afforded by the current dike to the FCL.

**Clearwater**

All but two of the residential and commercial buildings inside the NTR floodplain are within the diked portion of the right bank (north) floodplain area protected by the Clearwater Improvement District (CID) dike. The protected area contains a total of 123 units consisting of 86 houses, 23 mobile homes, and 14 occupied commercial/other properties and one large, currently vacant, former forest products mill site. Two of these have been confirmed to be at FCL based on building permit records. Another residence and one industrial (CNR) building are outside the diked area on the left (south) floodplain on Station Road near the bridge.

The CID flood protection dike is a substantial works that is located along the top of the right bank. MOE information indicates that the dike crest is at or above the FCL and that the structure meets Provincial dike standards. Field observations confirmed that the structure is generally in fair-to-good condition. Observed dike components that may require attention in the near-to-medium term were discussed with CID operations personnel. These included: (i) questionable internal drainage CSP culvert with land-side
flap gate near the upper terminus, (ii) some riverbank undercutting upstream of the bridge and along the lower reach/secondary channel, (iii) woody growth along sections of the dike back-slope that could mask seepage during a flood event, (iv) woody growth and access issues (fence & stored materials) along dike crest near upper end, and (v) overly steep river-side dike slope – riprap appears stable, however, down-slope movement of riprap could become an issue. Item (i) requires investigation to ascertain its purpose.

A cost estimate for flood mitigation was not generated for the 125 properties. The existing dike, which the CID indicated it maintains on a regular basis, currently protects the 123 properties on the right floodplain – to the FCL. All new building construction (and major additions to existing buildings) within the floodplain must comply with the FCL elevation requirement. The 2 identified properties on the left (south) floodplain do not appear to require flood mitigation. The newer house (presently undergoing construction) is assumed to have been constructed to the FCL while the CNR building appears to be merely a “materials” storage facility although an inspection of the contents was not undertaken.

Blackpool

The north and south limits for Blackpool (the right floodplain) are consistent with that used for East Blackpool on the left floodplain with the Rivermount Motel being at the southern limit. The 205 identified properties include industrial, commercial, community facilities and 195 residential dwellings. The majority of dwellings are situated in an urban (small lot) density; however, a significant number are dispersed throughout the area on larger lots in a rural/agricultural setting. Included in the identified 205 sites are industrial properties belonging to Terasen (2) and Telus (1), a Firehall, a Community Hall, a Golf Clubhouse, the two commercial properties of Rivermount Motel and Nakiska (Guest/Resort) Ranch and three Mobile Home Parks that contain a total of 59 units. (Only one Park with 22 units is believed to be at FCL). Of the non-residences only the Motel and Guest Ranch would appear to be at risk during the design flood event and, apparently, only the motel is permanently occupied.

The assessment numbers for flood prone structures are based on contour and spot elevations from the FPM supplemented by some building permit approval data supplied by the TNRD that indicate a few newer buildings meet the FCL. There are, however, a significant number of newer dwellings, not reviewed by the TNRD, that display an elevated profile suggesting they too may conform to the FCL. The ground elevations for some dwelling sites within the Blackpool floodplain as marked on the FPM are clearly above the FCL and these are annotated as such on the FPM. Examples of these are located on Thompson Rd, Phillips Rd and a portion of Jenkins Rd. Other dwelling sites appear to be 0.6 m or less below the FCL and, thus, quite possibly meet the 1:200 flood level but do not meet the prescribed freeboard.

Using the information at hand, it was determined that mitigation for residential properties would include raising 53 dwellings anywhere from about 0.6 m to 2.0 m in order to conform to the FCL. In addition, multi-dwelling dikes c/w culvert structures would be
used to protect two clusters of dwellings on Jenkins Road. These include the West Jenkins cluster of 10 dwellings and the East Jenkins cluster of 48 buildings including a 22-unit mobile home park and a Telsus “switching” station. Approximate dike lengths are 400 lineal metres and 800 lineal metres, respectively. However, local topography includes swales and high ground area (above FCL) and a detailed assessment may identify less extensive and more economical dike alternatives (i.e. several short dike segments). A total of 87 dwellings were deemed to meet or exceed the FCL in so far as the main floor living area is concerned.

Two community facilities, a Firehall and the Community Hall, and the Golf Clubhouse are deemed to be at or very near the FCL. The Terasen tank farm and pumping station, and the Nakiska Guest Ranch were not inspected and are difficult to assess as to potential impact from the design flood. Ground elevations are below FCL but the nature of these facilities suggests mitigation is probably unnecessary. More information is required. The Rivermount Motel is at considerable risk being located very near the top of riverbank and at about 1.5 m below the FCL. According to the owners, the existing partial dike protected the property during the flood events of 1997 and 1999, however a major upgrade to and extension of the dike, and, perhaps a riprap revetment, are necessary to provide flood mitigation to the FCL.

While the two multi-dwelling dikes appear to be a good choice economically there are a number of matters that must be addressed before proceeding. Firstly, ground elevation in these two areas is difficult to quantify from the FPM and depth of flooding at the FCL may not be as significant as suspected. Secondly, the dike right-of-way is likely to be a contentious issue; the nearby watercourses and green belt are sure to raise environmental concerns where the dike would traverse a heavily wooded area near the rear of private properties. A detailed assessment and topographic survey is necessary to examine alignment options and location issues along with other standard dike issues. The B/C for the West Jenkins and East Jenkins multi-dwelling dykes were calculated at 3.3 and 7.8 respectively. The standard B/C ratio applies for raising individual dwellings.

Portions of Highway 5 and several of the local streets and roads within the floodplain are below the FCL as noted on the FPM. Access to dwellings will be compromised during the design flood event (200 yr flood) and probably any large flood event.

**East Blackpool**

For this assessment East Blackpool is defined as the entire left bank (east) floodplain accessed by Dunn Lake Road extending from just north of Little Fort to about 3 km south of the Village of Clearwater. It comprises two distinctly different dwelling distributions with residences that vary from very old to relatively new. There are a total of 26 dwellings with nearly one-half the units situated on relatively small lots directly across the river from the central portion of the community of Blackpool. The other dwellings are broadly dispersed on medium to large agricultural land parcels throughout this portion of the floodplain.
Based on elevations derived from the FPM, dwelling site ground elevations vary from 0.7 m to about 1.5 m below FCL. Some properties clearly indicate that the natural ground level and/or the dwelling has been raised as a flood proofing measure; however, visual observation and the FPM alone are insufficient to ascertain whether the FCL has been achieved. Much of the access road system including the Dunn Lake Rd and the CNR tracks are below FCL and might become impassable in a major flood. No engineering surveys were undertaken and no cost estimates produced for access upgrading.

Detailed survey information may establish that some dwellings are in fact, above FCL; however, this review concluded that flood mitigation would be required for all 26 dwellings identified as being below FCL. Twelve dwellings (10 houses and 2 mobile homes) are contiguous in relatively close proximity and appear to be suitable for a single dike about 1800 m long as shown on the FPM. The multi-dwelling dike would extend along the front of each property (edge of Dunn Lk. Rd. right-of-way) having flanks that tie into the hillside at the back of the lots at both ends. Three of the dwellings are situated fairly close to the front lot line and the resulting restricted construction space and impact on driveways and front yards may render this choice unacceptable to owners. The B/C for this mitigation work is calculated at 1.1 hence mitigation on an individual property basis may be preferred. A detailed assessment and costing would be required. Raising Dunn Lake Rd to the FCL (primary dike standard) is another option but construction cost would be considerably higher because this section of road is asphalt surfaced.

The remaining 14 dwelling (13 houses and 1 mobile home) would have to be raised or ring-diked with the former being selected for this analysis. Raising has been selected for the dispersed dwellings in this assessment because of negative issues associated with ring dikes. Some of the 13 houses appear to be quite old and raising may not be warranted or even structurally possible or economical, in which case the ring-dike option may prove to be a better choice. The typical B/C ratio for raising individual dwellings makes this undertaking uneconomical unless other favourable matters come to light during a detailed site-specific assessment that should be undertaken in the final decision making process.

**Little Fort**

There are 2 houses on the left bank in the 200 yr floodplain. They are not closely spaced and could not be protected together in a cost effective fashion. The only practical flood protection that could be suggested would be to raise each house individually. The B/C for this work would be the standard 0.8, using the standard raising and damage costs. The site is no different then any other individual house within the floodplain, and does not constitute a cluster of houses that might be a high priority to protect.

There are 2 houses on the right bank in the 200 yr floodplain. They are close together so a detailed cost estimate was prepared for a ring dike for the two houses. The dike cost is in excess of the cost of raising both houses. It would also have to be a steep, narrow dike to fit in the available area between houses and the river and would be unattractive to all concerned. The only practical flood protection that could be suggested would be to raise
each house individually. As is the case for the left bank, the right bank site at Little Fort does not constitute a cluster of houses that would be a higher priority to protect.

South Barriere

This area that has 8 houses within the 200 yr floodplain was added to the original high priority sites when this study uncovered that flooding took place here in 1999. Most house elevations are not known, relative to the FCL, although one house is clearly below the FCL. They are not closely spaced and could not be protected together in a cost-effective fashion.

The existing Nelson Road dike is not a factor in the area, and is really only a road fill. There is no fruitful way to extend this dike to protect houses in the area. The only practical flood protection that could be suggested would be to raise each house individually. The site is not a tight cluster of houses that could be efficiently protected as a unit from large floods.

Exlou

There are 9 houses within the 200 yr floodplain at this site. Most house elevations are estimated to be at the FCL, based on comparison with new houses constructed after the 2003 wildfire. Two adjacent houses lie below the FCL and could be protected by one ring dike. This particular site is very low and a dike would be very expensive and invasive for the property owners. Several other houses have basements that may be subject to flooding. A larger dike enclosing all houses in the area is not cost effective, and would be plagued by known seepage problems, requiring significant pumping capacity during times of high water / groundwater. Once again, the only practical flood protection that could be suggested would be to raise each house individually. The site does not thus constitute a cluster of houses that might qualify as a high priority site to protect.

Engineering Design Costs

As the next step in the sequence of events that may lead to construction of approved flood engineering works for the highest priority sites, estimates are provided for the engineering costs of final design of the high priority sites on the left bank of the river at Birch Island if this work were tendered out to consultants. The TNRD could then submit a timely proposal for funding the design of these works to the Provincial funding agency. During the engineering design process and certainly at the time the design was presented, the TNRD would gain a much better idea of the actual construction cost and any major obstacles with landowners and any other groups that might be affected by the designed works.

The design cost estimates provided below use the following rates:

   Engineer charge out - $100/hr.
   Technologist charge out - $50/hr
Technician charge out - $40/hr
Overnight travel - $100/day
Mileage - $0.45/km
Contingency - 20%

For the longitudinal dike upstream from the bridge, engineering design cost estimated to be $11,300 + GST (priority 2 in Conclusion Sec.).
For the raising of the Lost Creek Rd. bend upstream of BI, engineering design cost estimated to be 10,100 + GST (priority 6 in Conclusion Sec.).
For the installation of flap gates on CNR culverts upstream of BI, engineering design cost estimated to be $4200 + GST (priority 1 in Conclusion Sec.).
There would very likely be some savings on these individual project design costs if all 3 were done at the same time.

As another example of engineering design costs, using the proposed Jenkins Road and East Blackpool dikes, a reasonable estimate of engineering costs for field investigation, survey, and design of these dikes can be determined by applying a percentage to the estimated construction costs. A value of 15-20% of estimated construction cost is recommended.

Conclusions

This was a preliminary assessment undertaken to grossly determine which properties might benefit from future flood mitigation activities. More detailed engineering investigations and detailed economic analyses need to be done to confirm the preliminary findings of this study. At some point, the desires and concerns of those landowners affected by any new works will need to be determined and/or satisfied.

There were 432 residences/dwellings identified in the North Thompson River 200 yr floodplain from Exlou to the upstream mapped limit. This total includes 373 individual dwellings plus 59 dwellings within the three Mobile Home Parks. Additionally, there were 24 commercial/industrial/other buildings identified in this same study area. It is possible that there were a very limited number of buildings that were not identified by either the office or the field investigations.

Of the above totals, 211 residences and 4 of the other building types were thought to be below FCL or not protected by an existing dike built to the FCL. It is quite likely that further investigation would show that some of these buildings thought to be below the FCL are, in fact, at the FCL or above.

Level surveys of all floodplain buildings and transportation corridors would help assess what structures and which infrastructure is truly at risk at the complete range of flood levels. Compilation of a comprehensive database that includes most-recent building permit information (since the current building By-Law was enacted) would be very
useful. This information would assist with assessing benefits and costs for remediation options.

The 23 digitized floodplain assessment maps that were developed as part of this study are useful reference tools to determine not only where flood mitigation works are most needed but for use in flood emergency planning and response. Their format allows for easy updating as buildings are replaced or new development occurs thereby maintaining a current digital listing of buildings within the study portion of the floodplain. The maps would also have limited use in many other types of emergencies.

The top 6 highest priority flood mitigation works, to protect against structures inundation during a 200 yr flood, ranked strictly in order of benefit/cost ratios, are:

- Flap gate installation on CNR culverts on LB upstream of Birch Island
- Raising Lost Creek Rd. upstream of Birch Island to FCL for a short length of the road
- Building dike around houses on Jenkins Rd. East
- Building dike around houses on Jenkins Rd. West
- Raising Birch Island Rd. across RB floodplain at Birch Island
- Building dike around houses on LB at Birch Island

However, there are other important factors to consider when developing a priority list such as feasibility of construction, significant flood damage at water levels below the FCL, and complete topographic surveys. For example, the recent repeated flood damage of Birch Island properties caused by smaller floods or the fact that preliminary surveys indicate a level of protection close to the FCL for some sites, suggest a shift in site rankings makes good sense. When these other factors are included, the priority list above changes to the following order:

1. Flap gate installation on CNR culverts on LB upstream of Birch Island
2. Building dike around houses on LB at Birch Island
3. Building dike around houses on Jenkins Rd. East
4. Building dike around houses on Jenkins Rd. West
5. Raising Birch Island Rd. across RB floodplain at Birch Island
6. Raising Lost Creek Rd. upstream of Birch Island to FCL for a short length of the road.

This is as much as the priority list can be refined at this time. The priority ranking could change again based on more detailed surveys and investigations.
Recommendations

The next logical step is to carry out detailed engineering investigations and designs for the proposed mitigation works for the two highest priority sites, either in-house or by seeking provincial government funding to hire external contractors, for the following sites (see Table 2 and text for site descriptions and details):

1. Flap gate installation on CNR culverts on LB upstream of Birch Island
2. Building dike around houses on LB at Birch Island

The detailed design cost of these two items is estimated at $15,500 plus GST. The initial construction cost estimates total $124,000 with an expected benefit of $570,000 if the work can be completed according to the conceptual design envisioned. This work should begin as soon as funding can be obtained.

The remaining four Birch Island and Jenkins Rd sites listed below should be augmented with detailed designs to clarify which of these proposed flood protection works should go forward to the construction phase.

3. Building dike around houses on Jenkins Rd. East
4. Building dike around houses on Jenkins Rd. West
5. Raising Birch Island Rd. across RB floodplain at Birch Island
6. Raising Lost Creek Rd. upstream of Birch Island to FCL for a short length of the road.

None of these four sites are prone to flooding at low flood levels. Each is close to the FCL and detailed site surveys will be required to determine the exact number of houses that will actually benefit from flood protection and to what extent (e.g., improving the existing (natural) protection from 1 in 50 year flood to the 1 in 200 year FCL). Equally, the actual cost of the works will only be determined precisely when detailed surveys and design has been completed. Once these detailed designs are completed, precise benefit cost figures will provide financial justification for funding applications for the protection works to be pursued towards construction.

TNRD should also embark on a schedule of surveying and recording in a computerized database the surrounding ground elevations and habitable floor elevations at all dwellings in the mapped floodplain in its jurisdiction to allow quicker, better assessments of potential flood damage impacts and costs. The collected information together with building permit data should be merged with the digital information and mapping generated in this assessment. The costs of this work have not been estimated and are not included in the estimates provided for detailed engineering design of the flood protection works at the priority sites.
Figure 1 - Key Map and Flood Protection Priority Locations
MEMORANDUM

TO: Chief Administrative Officer  March 1, 2006
FROM: Director of Development Services
SUBJECT: Pritchard Unstable Soils

On Tuesday, February 21, 2006, a public meeting was held with the residents of the Prichard Developments Subdivision to review recent events regarding groundwater and unstable soils in the area north of the subdivision and the potential impact on residents. Attached is information relating to the problem.

Attending the meeting with staff and the Area Director were representatives of MOT, PEP, and MOE, to discuss their role and involvement with these issues. The outcome of the meeting was a consensus that more detailed assessment was required and that potential opportunities for cost sharing should be explored. The residents were virtually unanimous in their contention that the TNRD play a leadership role in carrying out the study.

Unfortunately, the TNRD's emergency program budget does not contain any funding for mitigation works, including the necessary engineering study (estimated to cost in the order of $10,000 - $15,000). At the request of the Area Director and the Emergency Management Committee, this issue has been placed on the workshop agenda for discussion.

Respectfully submitted,

GREG TOMA, MCIP
Director of Development Services

GT/jl
Attachments
PUBLIC NOTICE

COMMUNITY MEETING
RE: GROUNDWATER AND UNSTABLE SOILS

Residents of the Pritchard Developments Subdivision are invited to attend a community meeting at 7:00 p.m. on Tuesday, February 21, 2006 at the Pritchard Community Hall on Duck Range Road. This meeting, hosted by the Thompson-Nicola Regional District, is being held to review recent events regarding groundwater and unstable soils in the area north of the subdivision.

Speakers at the meeting will provide an overview of recent events and discuss the potential for further work to address the issue.

We look forward to seeing you at the meeting.

For more information contact: Terry Kress
Manager of Emergency Services
Thompson-Nicola Regional District
Phone: (250) 377-8673
Toll free in BC: 1-877-377-8673
Email: tkress@tnrd.bc.ca
To: Mr. John Smith, Chief Administrative Officer
    Thompson Nicola Regional District

      Flood Hazard Geoscientist

Date: November 9, 2005

RE: Pritchard area unstable land above subdivision PEP task #063281

The Thompson Nicola Regional District (TNRD) operates a water system (reservoir and
conveyance pipe) that conveys water from an existing collapsed section of Quaternary
glaciolacustrine silt. This geomorphic landform is and has been failing from geological
processes including surface water discharge, subsurface groundwater piping, and ground
subsidence and bulging. The situation at present is a landslide prone area above an
existing subdivision. This report documents the issue and contributions to slope
instability, flooding, and erosion. This report will advise you that water flowing in your
area is causing slope instability, flooding, and erosion.

The TNRD and/or private landowner needs to obtain professional engineering help to
assess the drainage and remedy any potential for further slope failures or flooding. This
needs to be addressed immediately given the opportunity for high rainfall, snowmelt
and expected high runoff. There is potential that unless the situation is remedied a slope
failure could cause serious damage downslope to homes, access and utilities. Please
advise what action the TNRD or owners of the affected land propose to remedy the
problems with the seepage and ground movement.

I have also included notes from site investigations and research that I have carried out.

Introduction and Background

On behalf of the Provincial Emergency Program (PEP), I made a site inspection of the
area above Barb Canaba’s home on November 4, 2005 following a complaint from her to
the PEP. The seepage water and standing water from upslope is impacting landowner(s)
in this Pritchard subdivision.

Photographs from the complaint compared to photographs taken November 4, 2005 show
that there was no more recent failure.

Barb Cabana gave me the history which I paraphrase below. During the spring of 2004,
her driveway had eight inches of mud on it. She questioned TNRD and they said this was
local spring runoff. Mrs. Cabana was concerned that the water reservoir or pipe was
leaking. TNRD took samples of water and found no chlorine. A cinder block retaining
wall, drain rock and perforated big “O” pipe was installed on the toe of the hillslope in
2004 (photos 2895, 2926, 2927). There is rebar and concrete holding the wall together. In
the spring of 2005 or after the spring, Barb had a gravel and ditch system put in that
worked well until about ten days ago. About two days ago, the retaining wall area was
packed with silt and the wall leans to the South. Since then, the water has been flowing
across Garella Road and down Bostock Road.

Her husband had parked his highway transport rig near the telephone/hydro pole and it
sank up to the fuel tanks in the soft saturated ground. She noted that water was free
flowing out of the top of a plastic conduit pipe attached to this telephone pole and was
concerned that the pole would lean or fall over. Cabana noted even on days when it is
dry, wet spots occur under her gravel driveway.

I understand that the owner of the property north of the subdivision is Marylyn Lazar. I
have not contacted her about this matter.

Surficial Geology and Geomorphology

According to a report by Geological Survey of Canada\(^1\) the South Thompson River valley
has glaciolacustrine terraces which are prone to piping failures. A fine description of the
process is presented and quoted here:

“Water percolates into the silt during infrequent storms or spring runoff, until it reaches a
temporary water table. At the water table, movement is lateral. As saturated silt is
unstable, caving occurs where the laterally moving water seeps from a steep bank, such
as a gully wall… continued seepage from the area where caving commenced extends
the opening by headward erosion, forming a tunnel, when caving sufficiently weakens the
silt arc, the roof collapses thus forming a sink on the surface.” The surface sinks can be
up to 100 feet in diameter similar to the size of the one at Pritchard.

The South Thompson River valley lies within a plateau underlain by volcanic rocks. A
glaciolacustrine terrace is mapped as covering the hillside north of the river and west of
Gore Creek\(^2\). It is composed of horizontally layered couplets of silt and fine sand beds. A
glacial lake formed during deglaciation and likely filled the east-west valley. During the
Holocene (roughly the last 10,000 years), rivers and stream action as well as mass
movement have modified these terraces. Typically there is a colluvial apron of slope
deposits at the toe of the terrace.

The surficial geology here may include porous sandy gravel deposits beneath the
glaciolacustrine silts. These permeable deposits are interbedded with less permeable silt.
Shallow groundwater flow through these higher permeability beds and along bedding
planes deposits white salt precipitates as coatings on subaerial deposits.

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I have had prior experience with this type of condition. I attended a field trip in this valley on Saturday, September 19, 1998 led by a Geological Survey of Canada geologist, Dr. Lionel Jackson, who is also a landslide expert. For a perspective on the importance of this type of hazard I relate information gleaned from this engineering geology trip.

During that trip we inspected silt deposits with piping. The glacial lake was gone about 8,500 years ago. I have reference to a Pritchard drill hole that is 200 feet all in silt. The silts have a high void ratio and are susceptible to collapse. The void ratio is a measure of how much space is available for water to occupy between the mineral grains. In Barnhartvale, a crescentic rotational slump occurred in the 1970’s impacting a house foundation. The setback criterion for housing back from glaciolacustrine silts was 2.6:1. On Klune Drive, a pool full of water drained immediately. The cause being it was constructed over an infilled sinkhole, at another site surface runoff caused the collapse, and in 1984 a frozen waterline broke while people were away for the weekend resulting in a five-foot tunnel running the length of the property. The repair work was to dig it out and backfill.

Other examples of failures in Quaternary glaciolacustrine silt terraces include one in 1954(?) along the east side of Osoyoos Lake (Nasmith, 1962), the Ashcroft landslide of 1880 (Evans, 2001), and Spences Bridge landslide in 1908.

Site Inspection

On November 4, 2005 I did a site inspection. I met the landowner at her home at 4901 Gerella Road in Pritchard as well as Shane, her neighbour, and Don Swift who lives on the south side of the river. The subdivision is situated at the base of colluvium derived from the adjacent silt bluffs (photo 2869). Locations were determined with a handheld unit (Garmin etrex 12 channel GPS). Photographs were taken with a digital camera (Kodak EasyShare CX6200).

The free flowing spring in her back yard is located at N50 41.390’ W119 50.056’. The landowner put a plastic pail underneath the spring and connected a garden hose to drain water down to their lawn beside the driveway (photos 2893, 2894). The flow rate was determined at 11:40 am to be 1 litre/minute by using a watch and 1 litre bottle. Water temperature at the outlet of the spring was 8.5° C. Don Swift accompanied me up the reservoir access trail to show me the largest sinkhole. It is located at N50° 41.424’ W119° 50.078’. The sinkhole measures 240 to 245 cm deep, 140 cm across, and 330 cm long parallel to the access road (photos 2898, 2899). Water was running into this sinkhole from upslope at a similar rate to that coming from the spring at Cabana’s.

Don Swift showed me the rough area where eight dump truck loads were put into a sinkhole ten to twelve years ago below the reservoir (photo 2910). The GPS is N50° 41.425’ W119° 50.083’ below the chain link fence. Near the reservoir there is a small sinkhole, measuring 30 cm deep by 50 cm long and 35 cm wide in grass at N50° 41.439’ W119° 50.055’ (388 m elev) (photos 2900, 2901). There are two minor muddy slides above the reservoir road (almost flat road here) which are between 2 m and 4 m high on

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steep slopes (photos 2904, 2905, 2906, 2907). Approximate location is N50° 41.438’ W119° 50.106’ (393 m elev). Puddles exist at the toe of these small slides with murky water.

We climbed up to the bowl area, which is all saturated and covered in open tension cracks. Seepage water is evident near the surface and in the tension cracks. The location of photo 2909 is N50° 41.449’ W119° 50.119’ (394 m elev) (photo 2908). About 6 m of hard dry varved horizontal silt couplets is exposed in the arcuate headscarp (photo 2902, 2903). There is almost no bearing strength of the disturbed silt. I shot a gradient here with 16 slope to the North (Garella Road) and 13 to the cream brown doublewide trailer in the path of a potential slide (photo 2909). The bowl was estimated to be 30 m in length at the top. Photos 2916 and 2918 was taken from this point to show the potential slide area from this failure at N50° 41.449’ W119° 50.107’ (398 m elev). The area of potential slide material was measured using GIS at 1650 m³. The volume estimated is between 2000 and 5000 m³. The runout was approximated at an areal coverage of 2200 m² and 3800 m².

The terrace top is smooth and veneered in Aeolian (wind blown) silt. Ginseng and hay fields are present on the flat bench (photos 2913, 2914, 2915). We walked along the East side above the large terrace depression for more photos (2917, 2919, 2920, 2921) then back down the access road to Cabana’s. The BCTel pole near the intersection of Bostock Road and Garella Road is tagged 72 and located at N50° 41.377’ W119° 50.032’ (361 m elev) (photo 2925). Artesian water conditions are evident by water flowing up a 95 cm high conduit attached to this pole (photo 2925).

The concrete block retaining wall was photographed and measured at both East and West ends of the tool shed (photos 2926, 2927). The undeformed wall was 13 cm away from the tool shed wall and the deformed end was 4.8 cm away. Originally the retaining wall was parallel to the shed wall.

I drove out through the subdivision and noted standing water in puddles on some properties. I photographed the silt bluffs from near South Thompson River (photos 2928, 2929).

I did a follow up call to Ginny Garner, PEP manager at 14:00 and also called Mr. Bruce Bosdet at Golder Associates, Kamloops and left voicemail concerning glaciolacustrine silts. Bruce Bosdet called me back November 5, 2005.

Conclusions

The hazard has now been recognized. Its size is on the order of 2000 to 5000 m³. It is my opinion that this area has been unstable for some time. It ranks as Terrain Class V terrain indicated by recent failures, open, long tension cracks, and probable movement. Leakage of surface water and groundwater into the area is evident by the formation of the piping depression forming the circular bowl and cuspate depressions along the edge of the escarpment. This water acts to lower the strength of the soils by adding to their weight and allowing increased water pressure. In addition, piping by shallow subsurface flow may cause the slope to move laterally out and flow over downslope deposits down the access road causing an open face debris flow or mudflow.
Concentrated flow from surface and shallow groundwater into the soils cause developing tension cracks and piping holes. The flowing water has the capacity to erode through glaciolacustrine silt deposits and produce prolonged spring activity.

Recommendations

I recommend mitigation of the landslide potential for this feature. This may include barricade and sign installation warning of landslide hazard in area, water management through dewatering wells and a drainage system, infilling sink holes for stability, roadway ditching for surface water runoff and monitoring slope, headscarp, tension cracks and bulging at this time. Evans\(^4\) identifies examples of reducing slow slide movement by modification of slope geometry, stabilization berm at toe of slope, and internal drainage to reduce water pressure in the slope.

The entire bowl area and gully opening present a slump and earthflow hazard to property and dwellings below. For this reason, a detailed study and survey by a qualified registered professional on the ground to assess seepage and slope stability aspects should be undertaken. Ask for a risk assessment using the methodology of Oldrich Hungr. Remediation efforts should be carried out to re-establish surface drainage and improve stability to previously slopes from impacting local residents. The points of weakness exist at both the upper bowl depression, headscarp, and toe of slope. Mass movement may trigger a rupture in the reservoir conveyance system and electrical connections. This could release a maximum 70,000 gallons onto a silt material subject to liquefaction (turning from solid silt to liquid mud). Runout will be much greater under this condition.

The TNRD and landowner(s) should take these recommendations into consideration. I also recommend identifying the hazard area and runout of landslide or mud material and relaying this information to the property owners/renters below the reservoir area. You may share this information presented within this report with affected persons.

It would be prudent to explain that any heavy rainfall, snowmelt, over irrigation or ground movement (earthquake/blasting) may initiate a slide. Residents of the subdivision in the runout zone and on the periphery should be watchful especially in the spring or a rapid thaw after the ground is frozen. If you have any questions please call 371-6271 and speak to Ted Fuller regarding the investigation.

Yours truly,

Ted Fuller

Ted Fuller M.Sc. P.Geo.
Flood Hazard Geoscientist
Ministry of Environment

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References


Unstable Glaciolacustrine Terrace with runout area
Pritchard Silts
Pritchard Developments Community Meeting

February 21, 2006

Agenda

- Introductions
- Background information and review of events - TNRD
- Technical Overview – BC Ministry of Environment
- Roles & Responsibilities – Provincial Emergency Program, Ministry of Transportation, TNRD
- Next Steps
- Questions

Review of Events
TNRD Issues

Water System:
- Reservoir
- Waterline
- Sinkhole

Emergency Program:
- Imminent threat – Life safety
- Evacuation
- Monitor
- Advise residents
Next Steps?

- Address sinkhole/access road
- Detailed Engineering Study
- Responsibility/Cost-sharing
- Timing
THOMPSON-NICOLA REGIONAL DISTRICT
EMERGENCY MANAGEMENT COMMITTEE MEETING

Wednesday, February 15, 2006

MINUTES of a Meeting of the EMERGENCY MANAGEMENT COMMITTEE of the THOMPSON-NICOLA REGIONAL DISTRICT held in the Board Room, 4th Floor, 465 Victoria Street, Kamloops, B.C. on Wednesday, February 15, 2006, commencing at 1:00 p.m.

PRESENT:

Director R.H. Elliott, Chair
Director R. Stanke
Director G. Fraser

Board of Directors
Board of Directors
Board of Directors

STAFF:

Mr. J. Smith
Mr. G. Toma
Mr. K. Kierans
Mr. S. Gill
Mr. J. McBride
Mr. B. Finley
Mr. T.L. Kress
Mr. D. May
Mr. R. Popoff
Mr. K. Nightingale
Ms. J. Kirkey
Ms. J. Lewis

Chief Administrative Officer
Director of Development Services
Director of Libraries
Director of Finance
Clerk/Director of Community Services
Manager of Planning Services
Manager of Emergency Services
Manager of Environmental Health Services
Manager of Building Inspection Services
Manager of Information Technology
Manager of Library and Support Services
Steno II/Recording Secretary

PRESS:

Mr. C. Fortems
Kamloops Daily News

1. MINUTES:

a) Meeting of July 14, 2005

Moved by Director Stanke
Seconded by Director Fraser

That the minutes of the meeting of July 14, 2005 be adopted as circulated.

CARRIED Unanimously
2. REPORTS:

a) Emergency Preparedness Program (EPP)


The Director of Development Services advised that in 2005 there was no fire threat and no evacuations except for Birch Island. The TNRD issued its first ever Local State of Emergency for Birch Island flooding in January 2005.

b) Emergency Preparedness Program 2006 Objectives


The Director of Development Services outlined the objectives for 2006 including:

- risk assessment – build and add where necessary
- mitigative risks – continue to focus on implementing as part of the land use approval process
- program organization – continue to work building on the existing
- IHA Flu Pandemic workshop will be held this spring to improve local government’s readiness to cope with an outbreak
- A database has been developed for all water license users taking water out of the South Thompson River in case of a hazardous material incident. There are 203 domestic water intakes from the junction of the South/North Thompson Rivers to Little Shuswap Lake. Over time, this database will be enlarged to cover other major watercourses.
- In 2006 we will continue to improve on the program, as time and resources permit.

Discussion occurred as follows:

- The TNRD works co-operatively with all adjoining jurisdictions
- The TNRD will continue to work with the Interior Health Authority to flag people with health problems in the case of an emergency.
- Contact has been made with members from Big Bar Lake Strata Council regarding their access and Fire Smart information was provided for distribution to residents.
- Preparedness for the upcoming Summer Games in Kamloops will be the responsibility of the City of Kamloops, but we will continue to pursue joint training opportunities.

Moved by Director Stanke  
Seconded by Director Fraser

That the Emergency Management Committee recommends to the Board of Directors that the Action Plan for 2006 be accepted as presented and incorporated within the Emergency Preparedness Program as 2006 Objectives.

CARRIED Unanimously
c) **Level One Emergency Social Services**

Report from Director of Development Services dated February 6, 2006.

The Director of Development Services stated that the Province has advised that the Canadian Red Cross will no longer be providing personal disaster assistance directly to rural areas of the TNRD. Local authorities will be required to either take on the service through ESS or enter into an agreement with another local service provider. Upon question, the Manager of Emergency Services advised that there are areas in the region where there are no ESS volunteers, so it may take some time to get volunteer assistance to victims.

TNRD will not be responsible for payment for the actual response including overnight expenses. Invoices will go to PEP for payment, although paperwork will still be processed through the TNRD.

**Moved by Director Stanke**  
**Seconded by Director Fraser**

*That the Emergency Management Committee recommends to the Board of Directors that the Thompson-Nicola Regional District acknowledge responsibility for ESS Level One response, arrange for a service provider (Red Cross, Victim Services, Social Assistance or ESS) and try to ensure coverage in all Electoral Areas.*

**CARRIED Unanimously**

d) **North Thompson River Flood Hazard Assessment**


The Director of Development Services outlined the following:

- A consultant was hired to carry out a hazard risk assessment in the North Thompson from Exlou north to Vavenby to identify construction/development at risk from flooding.
- 456 homes/businesses were found to have been constructed within the 200-year floodplain.
- Estimated costs of recommended works totaled $4 million. More detailed investigation would be required to confirm both costs and benefits.
- Currently the Emergency Preparedness Plan budget does not contain any funding for mitigative works.

Discussion occurred as follows:

- The TNRD has applied in the past for funding for diking to the Provincial and Federal governments, but to no avail.
- The Fraser Basin Management Council’s Joint Program Committee has developed an Integrated Flood Hazard Management Plan. This Plan does not recommend widespread diking as a solution to floodplain management.
- It was suggested that owners of the properties identified in the Flood Hazard Risk Assessment Report be contacted to advise them of the recommendations of the report to determine if they are willing to assume these costs

Motion by Director Stanke  
Seconded by Director Fraser

That the Emergency Management Committee recommends that the North Thompson River Flood Hazard Risk Assessment Report be referred to the Board of Directors Workshop on March 10, 2006 for discussion.

CARRIED Unanimously

e) Pandemic Influenza Preparedness Workshop

The Director of Development Services reported that a meeting was held February 15, 2006 with the Interior Health Authority to develop a response plan in the event of pandemic influenza in the TNRD. A joint TNRD/IHA one-day workshop will be held this spring for local government, first responders and First Nation representatives.

f) Pritchard Groundwater and Unstable Soils

The Director of Development Services reported that a Public Meeting will be held on February 21, 2006 at the Pritchard Community Hall to discuss the issue. The registered property owners of Pritchard Developments were mailed information regarding the meeting. Representatives from the Ministry of Environment, Ministry of Transportation and the Provincial Emergency Program will be in attendance.

Discussion included:

- The property owner located at the bottom of the access road to the Pritchard Developments reservoir voiced concerns regarding groundwater and sinkholes to PEP and TNRD in 2004 and again in 2005.
- Ministry of Transportation was the approving authority for subdivisions. This subdivision was approved in 1972.
- An engineering consultant was hired to look at our water system and reported no significant risk to the water reservoir. It appears the water system is not causing the problem, as the groundwater found at the bottom of the hill was tested and did not contain chlorine.
- Ministry of Environment sent out a geoscientist to assess the situation. The geoscientist reported while there were issues and risks associated, there was no imminent threat to residents.
- TNRD will be advising property owners of the situation as recommended by the geoscientist. A detailed engineering assessment would cost between $10-20,000. Mitigative works would cost significantly more.
• Consensus of the Committee was that the issue of funding hazard mitigative works to be raised at the Board Workshop (March 10th) as it is currently not part of the program.

g) ESS Expenses

The Director of Development Services reported that TNRD has been advised that the Province will not pay expenses for ESS training. Volunteers currently must pay for their expenses out of their own pockets.

It was discussed that general funds could be used for this year, but money should be set aside for expenses.

Moved by Director Stanke
Seconded by Director Fraser

That the Emergency Management Committee recommends to the Board of Directors that $5,000 be added to the Emergency Preparedness Program annual budget to cover the travel and training expenses of Emergency Social Services and other volunteers who support the Emergency Program.

CARRIED Unanimously

3. CORRESPONDENCE:

a) UBCM – Elected Official Emergency Preparedness Workshop

Receive and file. Director Elliott and Director Fraser have been enrolled in the workshop.

4. OTHER BUSINESS

The Manager of Emergency Services indicated that UBCM has $5,000.00 in UBCM funding for preparedness and training purposes. An application is being prepared for submission to the Board of Directors.

5. ADJOURNMENT

The meeting adjourned at 3:08 p.m.

Minutes reviewed by
Terry Kress (Initials)
Moved by Director Stanke
Seconded by Director Fraser

That the Emergency Management Committee recommends that the North Thompson River Flood Hazard Risk Assessment Report be referred to the Board of Directors Workshop on March 10, 2006 for discussion.

CARRIED Unanimously
MEMORANDUM

TO: Chief Administrative Officer
FROM: Director of Development Services
SUBJECT: North Thompson River Flood Hazard Risk Assessment

February 27, 2006

As requested by the Board of Directors, a flood hazard risk assessment has been completed for the North Thompson River between Exlou/Louis Creek and Vavenby. This project, funded 75% by the Provincial Natural Hazards Mitigation Fund, was carried out to determine what businesses, residences and transportation corridors would be subject to flooding during a 200 year event. An evaluation of existing flood protection works was also included, including recommendations and prioritization of new works and flood mitigation strategies that could be implemented.

The study has determined that there are approximately 456 residences or commercial buildings located within the limits of the 200 year floodplain in the study area plus many kilometres of public and private roads and part of the CN Rail mainline. In the area reviewed, there are currently only five (5) existing dikes, however the report suggests that structures and roads could receive additional flood protection by way of further diking along the river, ring dikes around subdivisions and, in some areas, raising of the houses. The total cost of the recommended mitigation works is in the order of $4 million. More detailed engineering investigations and economic analyses would be required to confirm these preliminary findings.

The consultants have recommended the following as priority works based on their benefit/cost analysis:

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost</th>
<th>Benefit/Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Flap gate installation on CNR culverts on *left bank upstream of Birch Island</td>
<td>$10,000</td>
<td>24 : 1</td>
</tr>
<tr>
<td>2. Building a dike around houses on *left bank at Birch Island</td>
<td>$114,000</td>
<td>2.9 : 1</td>
</tr>
<tr>
<td>3. Building dike around houses on Jenkins Road East in Blackpool</td>
<td>$180,000</td>
<td>7.8 : 1</td>
</tr>
<tr>
<td>Project</td>
<td>Cost</td>
<td>Benefit/Cost Ratio</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------</td>
<td>-------------------</td>
</tr>
<tr>
<td>4. Building dike around houses on Jenkins Road – West in Blackpool</td>
<td>$90,000</td>
<td>3.3 : 1</td>
</tr>
<tr>
<td>5. Raising a 500m section of Birch Island Road across *right bank floodplain in Birch Island</td>
<td>$152,000</td>
<td>3.2 : 1</td>
</tr>
<tr>
<td>6. Raising a 170m section of the Birch Island-Lost Creek Road upstream of Birch Island</td>
<td>$38,000</td>
<td>17 : 1</td>
</tr>
</tbody>
</table>

*Facing downstream, left bank on left side and right bank on right side of river.

It is suggested that this information be presented to the Board of Directors by way of the Emergency Management Committee to obtain direction on how they may wish to proceed with respect to the report recommendations.

Respectfully submitted,

GREG S. TOMA, MCIP
Director of Development Services

GST/JJ
PRIORITY SITES FOR IMPROVED FLOOD PROTECTION ON THE NORTH THOMPSON RIVER FROM EXLOU TO VAVENBY

Prepared for:
Thompson Nicola Regional District
Kamloops, BC

Prepared by:
Doyle Engineering
in joint venture with
Pentilchuk Engineering,
BC Rivers Consulting,
and
Juniper Consulting,
Kamloops, BC

JANUARY 2006
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APPENDIX A

Figure 1 – Key Map and Flood Protection Priority Areas

Flood Hazard Assessment Mapping Package and Digital Copy
of this Report in DVD Format

Flood Hazard Assessment Mapsheets for Priority Flood Protection Works
   Map Sheet No 16 – Blackpool Area
   Map Sheet No. 20 – Birch Island Area
Introduction

The North Thompson River has been a source of flooding concern to several communities along its banks for over a century. Flood protection works have been built over time to reduce flood damages but some communities remain at flood risk. The Thompson Nicola Regional District (TNRD) sought to quantify the developed properties and infrastructure at risk from a major flood over the most densely settled reach of the river within its jurisdiction, and then to determine, on a priority basis, the most critical flood mitigation measures to take within this reach. Federal-Provincial Floodplain Mapping (FPM) circa 1982 (partial revision in 1986) is available for the entire reach, as are digitized 1996-97 orthophotos. Only the extent of flooding (the estimated 1:200 year Flood Construction Level) is available in digital format; digitized topographical contours are not available. Digital cadastral information also exists.

A joint venture of four local consulting companies - BC Rivers Consulting, Pentilchuk Engineering, Juniper Consulting, and Doyle Engineering - was awarded a contract by TNRD to (1) establish what residences, businesses, and transportation corridors were subject to flooding during the 200 yr flood over the reach of the North Thompson from Exlou to Vavenby, (2) document and evaluate what flood protection structures currently existed in the reach, and (3) determine top half-dozen or so flood mitigation projects in the reach that might be funded in the future. Figure 1 (see Appendix A) shows the North Thompson River from Kamloops to Vavenby with the study reach highlighted and the top 6 flood relief project locations denoted.

Technical Assumptions

The following technical assumptions were used in the assessment:
- The FPM is accurate except where noted
- Level of flooding at any building is uncertain except where noted
- Damage at floods smaller than the 200 yr flood is not assessed
- Houses within the floodplain will suffer damage during a 1:200 year flood unless it is known that the living space is above the Flood Construction Level (FCL). No assessment of the flood susceptibility of the portion of the house below the main living level was made (occupied, used for storage of goods damageable by flood waters, subject to covenant / bylaw when constructed, etc.). No consideration was given to flooding of basements for houses not within the floodplain.
- Flooded residence damage is $50,000 for either a house or mobile home
- Flooded commercial damage is $50,000
- Access (e.g., a private driveway) to a residence within the floodplain is flooded unless otherwise noted
- No information is provided regarding residences constructed since 1996 (date of orthophotos used) unless observed in field
- Unit costs estimated for all flood mitigation measures are provided at the bottom of Table 2 which is shown in a subsequent section
- The life of all proposed flood mitigation works is 100 years.

Methodology

The area of the study was limited to the river reach from Exlou to Vavenby as stated previously. The horizontal limits were the lateral extent of the North Thompson River floodplain only. High river levels may result in additional backwater on major tributaries that could be concurrently high such as the Barriere River in Barriere but tributary flooding was not assessed.

Estimated damages and flood mitigation costs at selected sites are rough using average values for flood losses and typical unit costs for construction and anticipated costs for other mitigation activities.

The first step in the study was to locate and review public records that documented past flooding in the subject reach and constructed flood protection works. Second step was to merge the digitized floodplain mapping obtained from Ministry of Environment (MOE) with the digitized 1996 airphoto mosaics and cadastral data supplied by the TNRD. The combined working maps were then reviewed in the office to identify all residences, businesses, highways, and rail beds that appeared to be within the horizontal extent of the 200 yr floodplain and create a preliminary map notation for the variety of situations that might be encountered. Confirmation of flood prone buildings and infrastructure indicated on the FPM was done where possible by team members’ personal knowledge and the government record review. Larger clusters of residences were highlighted for consideration of more detailed field investigation for possible inclusion in a list of potential flood mitigation sites to be developed.

Only the elevation of the main floor of a dwelling was compared to the FCL for determining whether a dwelling was at risk of flooding – the existence of a basement was not considered. This is believed to be consistent with operating rules under the current building By-Law, enacted around 1990, that regulates new construction within the designated floodplain - demarcated as FCL.

The study area was divided into 3 zones for fieldwork and all field personnel took part in a joint field trip to “brainstorm” the assessment approach. Questions that arose from this joint field trip were then discussed with the TNRD project monitor to ensure that all parties knew what was wanted and what would be delivered. Several subsequent contacts between the consultants and the project monitor occurred mainly seeking building permit data toward confirmation that certain dwellings had been built to the Flood Construction Level (FCL).
Next, the fieldwork portion was done while the consultants resolved new questions that arose during this segment before moving into the analysis and reporting phase. The project monitor accompanied one of the consultants on one of the early field inspections so that both parties would have a better understanding of how the field portion of the work would be conducted. The consultants frequently reviewed the validity of assumptions that were necessary and the best way to portray the information it had gathered and analysed. Each of the existing 5 flood protection dikes was routinely inspected in the field and MOE office records for each dike were also reviewed.

A complete draft of the report was provided to the TNRD and a meeting was held with staff for their review and comment before the report was finalized. The mapping resulting from the project is cumbersome to provide in paper copy so the twenty-three project maps were submitted in electronic copy only except that a paper copy of two map sheets (covering all 6 top priority sites) was included in each paper copy of the final report as an example of the information supplied on the maps.

Level surveys were only carried out in the Birch Island area where it happened to be convenient and critical to do so. Topography in all the other areas was obtained from spot elevations, contours, and horizontal extent of the floodplain shown on the FPM, sometimes augmented by hand level readings and previously recorded flood data. In a few instances the TNRD was able to provide a record of those houses that had been built to the FCL and this helped to more accurately determine estimated 200 yr flood losses in the more densely populated areas chosen for preliminary assessment of possible future flood damage reduction priorities.

Staff from Ministry of Environment provided not just information on past floods and condition of the existing dikes but also helped with surveys of the existing dikes and conducted a level survey of a critically low portion of the floodplain at Birch Island. They were also generous with a loan of the FPM sheets for the study reach. Staff from Ministry of Transportation and Provincial Emergency Program also provided some background information on past floods and damage claim amounts. The North Thompson Indian Band Administrator, Water Utility operators and Public Health Officials also provided information on flood impacts on dwellings, water supply and wastewater disposal for the Indian Reserves and rural communities, respectively, and how these impacts have typically been addressed, including identification of flood prone dwellings (on the Reserve) and the condition of water supply wells and septic systems.
A full set of digitized maps was developed showing all dwellings and businesses in the floodplain in the entire study reach from an office review of 1996 photo mosaics compared with the earlier FPM that used 1974-75 photography. The office review also revealed (confirmed) which localities had higher densities of development at risk from a 200 yr flood. These would require a field inspection to better determine the flood threat, the current number of houses, businesses, and main transportation routes at risk of flooding, any obvious discrepancies in the FPM, and initial flood mitigation solutions to the flood threat. The office review suggested one more area not previously considered as a high priority area that could possibly be added to the seven high priority areas but a field investigation of the candidate area indicated that this new area did not warrant inclusion into the high priority group.

The original high-density areas that survived the field inspections were then ranked in priority by a rough benefit-cost (B/C) comparison of flood damages prevented by preliminary proposed mitigation works at each site. Recommendations for further investigations leading to possible flood reduction activities at the highest priority sites were then made based on other factors besides benefit-cost comparisons during the 200 yr flood.

Results

There are a total of 456 residences or commercial buildings located within the limits of the 200 yr floodplain of the North Thompson River from Exlou to just downstream of Vavenby where the FPM ends. A few more houses may be sprinkled elsewhere throughout the floodplain in the reach of the river studied that neither the office nor field review identified.

There are many kms of main roads that would be inundated and some CN Rail line. All these flood prone buildings and transportation routes are shown on the digitized maps. The five existing flood protection dikes are also shown on the maps and the present function of each dike is given in Table 1.
TABLE 1. Summary of current flood protection dikes in study area.

<table>
<thead>
<tr>
<th>Dike name</th>
<th>Dike location</th>
<th>MOE Dike #</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN Rail</td>
<td>RB ~ 3 km u/s Birch Island</td>
<td>354</td>
<td>New dike to keep river away from rail embankment. Protects no buildings.</td>
</tr>
<tr>
<td>No name</td>
<td>LB ~ 3 km u/s Birch Island</td>
<td>None</td>
<td>Old dike that prevents river from re-occupying abandoned channel. Protects no buildings.</td>
</tr>
<tr>
<td>Birch Island</td>
<td>RB at Birch Island</td>
<td>6 and 186</td>
<td>Two separate dikes recently combined into one. Emergency dikes that have been upgraded over the years to now provide flood protection on right floodplain to the FCL.</td>
</tr>
<tr>
<td>Clearwater</td>
<td>RB at Clearwater Flats</td>
<td>21</td>
<td>The CID dike provides flood protection for buildings on the right floodplain up to the prescribed FCL.</td>
</tr>
<tr>
<td>Nelson Rd</td>
<td>LB at south end of Barriere</td>
<td>371</td>
<td>This &quot;dike&quot; does not prevent flooding as the water comes overbank downstream and inundates the area downstream of it.</td>
</tr>
</tbody>
</table>

Abbreviations in Table:
RB = Right Bank (directions are always given as viewed FACING DOWNSTREAM)
LB = Left Bank
FCL = Flood Construction Level.

For the eight most densely populated areas in the study corridor, obvious discrepancies in the FPM (original versus digitized), 2005 status of buildings, some greater clarification of some building and transportation route elevations vis-à-vis the FCL, the best initial flood mitigation options (if any were apparent), and an economic priority ranking of qualifying sites for mitigation work were determined. Finally, recommendations, based on a number of important considerations, were made regarding the next steps to take in the process of reducing flood damages through structural means in the study reach. The eight sites were all different from one another in terms of flood impacts and practical mitigative works and not all presented themselves as good candidates for flood mitigation works.

In addition to the maps that show general flood impact information for the entire reach and more detailed flood information for the highest priority sites, Table 2 provides flood assessment details for the seven highest density sites.
<table>
<thead>
<tr>
<th>Location and Description of Area and Type of Buildings</th>
<th># of Units</th>
<th>Mitigation Cost</th>
<th>Expected Benefit</th>
<th>B/C Ratio</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birch Island—Left Bank (facing downstream)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>McLennan Rd. area upstream of BI on LB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences</td>
<td>22</td>
<td>$38,000</td>
<td>$660,000</td>
<td>17</td>
<td>Raise Lost Ck Rd for ~ 170 m (Priority 6—see Conclusions Sec.)</td>
</tr>
<tr>
<td>Houses south of CNR just upstream of BI on LB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences</td>
<td>7</td>
<td>$10,000</td>
<td>$210,000</td>
<td>24</td>
<td>Install 3 or 4 flap gates on CNR culverts. Damage from previous flood remains unrepaird (Priority 1—see Conclusions Sec.)</td>
</tr>
<tr>
<td>Residence currently unfit for occupation</td>
<td>1</td>
<td></td>
<td>$30,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous two areas combined</td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>If protecting to 200 yr flood, these two should be combined. Second may not work w/o first.</td>
</tr>
<tr>
<td>Number of Residences — 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigation Cost - $48,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected Benefit - $900,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Just upstream of BI bridge on LB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences</td>
<td>10</td>
<td>$114,000</td>
<td>$330,000</td>
<td>2.9</td>
<td>Build ~ 850 m long dike between houses and river. (Priority 2—see Conclusions Sec.)</td>
</tr>
<tr>
<td>Church</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birch Island—Right Bank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Just upstream of BI bridge on RB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences</td>
<td>14</td>
<td>$152,000</td>
<td>$480,000</td>
<td>3.2</td>
<td>Raise Birch Island Rd for ~ 500 m (Priority 5—see Conclusions Sec.)</td>
</tr>
<tr>
<td>Commercial</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to residences at FCL — 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated dwellings in BI area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Houses</td>
<td>3</td>
<td>$120,000</td>
<td>$90,000</td>
<td>0.8</td>
<td>Raise each house. One house flooded in December 2005.</td>
</tr>
<tr>
<td>Ring dike option for each of these 3 houses</td>
<td></td>
<td></td>
<td></td>
<td>1.8</td>
<td>Not a favoured option</td>
</tr>
<tr>
<td>Mit. Cost: $51,000; Exp. Benefit: $90,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # of flood prone developed properties in Birch Island area inspected in potential high priority sites</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

57
Table 2 (Cont’d):

<table>
<thead>
<tr>
<th>Location and description of area</th>
<th># of Units</th>
<th>Mitigation Cost</th>
<th>Expected Benefit</th>
<th>B/C Ratio</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>and type of buildings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Blackpool</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences - House</td>
<td>30</td>
<td>$1,200,000</td>
<td>$900,000</td>
<td>0.8</td>
<td>Raise individual Houses</td>
</tr>
<tr>
<td>Residences - Mobile Home</td>
<td>23</td>
<td>$460,000</td>
<td>$690,000</td>
<td>1.5</td>
<td>Raise individual Mobile Units</td>
</tr>
<tr>
<td>Less costly ring dikes may be suitable alternative for some of these sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences - Jenkins Rd West</td>
<td>10</td>
<td>$90,000</td>
<td>$300,000</td>
<td>3.3</td>
<td>Multi-dwelling dike 400 m long (Priority 4 – see Conclusions Sec.)</td>
</tr>
<tr>
<td>Residences - Jenkins Rd East</td>
<td>47</td>
<td>$180,000</td>
<td>$1,410,000</td>
<td>7.8</td>
<td>Multi-dwelling dike 800 m long (Priority 3 – see Conclusions Sec.)</td>
</tr>
<tr>
<td>(Protects Telus Sta. as well)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Benefit based on residences only 360 m longitudinal dike</td>
</tr>
<tr>
<td>Commercial - Rivermount Motel</td>
<td>1</td>
<td>$115,000</td>
<td>$100,000</td>
<td>0.9</td>
<td>Riprap revetment on NTR bank</td>
</tr>
<tr>
<td>(Major Facility - Benefit @ 2 x $50,000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lack info. for benefit calculation</td>
</tr>
<tr>
<td>Rivermount Motel – river bank</td>
<td></td>
<td>$60,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>East Blackpool</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences - House and Mobile Home</td>
<td>12</td>
<td>$315,000</td>
<td>$360,000</td>
<td>1.1</td>
<td>Multi-dwelling dike 1800 m long</td>
</tr>
<tr>
<td>Residences - House</td>
<td>13</td>
<td>$520,000</td>
<td>$390,000</td>
<td>0.8</td>
<td>Raise Individual Houses</td>
</tr>
<tr>
<td>Residences - Mobile Home</td>
<td>1</td>
<td>$20,000</td>
<td>$30,000</td>
<td>1.5</td>
<td>Raise Individual Mobile Home</td>
</tr>
<tr>
<td>Less costly ring dikes may be a suitable alternative for some of these sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total # of flood prone developed properties 137</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>in Blackpool area inspected in potential high priority sites</td>
</tr>
</tbody>
</table>

**Exlou to Little Fort**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exlou</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences (below FCL)</td>
<td>2</td>
<td>$80,000</td>
<td>$60,000</td>
<td>0.8</td>
<td>Raise each house</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ring dike option is same cost, but not attractive.</td>
</tr>
<tr>
<td><strong>South Barriere</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences (8 in FP, elevations relative to FCL unknown - no logical groupings)</td>
<td>8</td>
<td>$320,000</td>
<td>$240,000</td>
<td>0.8</td>
<td>Raise each house (if required)</td>
</tr>
<tr>
<td><strong>Little Fort</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residences on RB (close together)</td>
<td>2</td>
<td>$80,000</td>
<td>$60,000</td>
<td>0.8</td>
<td>Raise each house</td>
</tr>
<tr>
<td>Residences on LB (scattered)</td>
<td>2</td>
<td>$80,000</td>
<td>$60,000</td>
<td>0.8</td>
<td>Raise each house</td>
</tr>
<tr>
<td><strong>Total # of flood prone developed properties 14</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>in Exlou to Little Fort area inspected in potential priority sites</td>
</tr>
</tbody>
</table>

**Total Costs and Benefits (Costs reflect house raising option; not ring dike option):**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>$3,874,000</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>$6,340,000</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cost Estimates Used in Table 2

House raising .......................... $40,000
Mobile home raising .................. $20,000
Dike construction ...................... $25/cubic metre (see cost note below)
Asphalt roadway ....................... $35/square metre
Large flap gate ......................... $4,000
Small flap gate ......................... $2,000
Riprap supply & place .................. $75/cubic metre
Environmental Remediation ......... add 5% to construction costs
Flood Damage Cost (Residence) .... $50,000
Flood Damage Cost (Business) ...... $50,000

Notes on Benefits and Costs:

(1) Benefit-Cost ratio = 0.6(Expected Benefit/Mitigation Cost)
(2) Only the construction cost of the works are shown in mitigation cost estimates in Table 2. Engineering, surveying, and project supervision costs are not included in the mitigation cost shown. (See General Discussion section below regarding full engineering and surveying requirements associated with a complete determination of expected flood damages in each protected area).
Maintenance costs of works are not included.
(3) Dike maintenance costs (annually in the order of 2 to 5% of construction costs depending on project complexity) will exceed those for house raising.
(4) Dike maintenance costs assumed to be supported by fees collected from benefiting landowners by local diking authority.

Design Assumptions Used in Table 2

Typical dike configurations:

Ring dike (encircling protected area / house): Crest width of 3.5 m and sideslopes of 3H:1V
Ring Dike Typical Length - 140 lineal metres (ln m)

Longitudinal dike (along river): Crest width of 4 m and sideslopes of 3H:1V
Dike length as required to tie into high ground at each end.
Approximate cost per lineal metre – for various dike heights:

<table>
<thead>
<tr>
<th>Dike Height</th>
<th>Volume Per Metre</th>
<th>Cost Per Metre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 m</td>
<td>7 m³/m</td>
<td>$175/m</td>
</tr>
<tr>
<td>2 m</td>
<td>20 m³/m</td>
<td>$500/m</td>
</tr>
<tr>
<td>3 m</td>
<td>39 m³/m</td>
<td>$975/m</td>
</tr>
</tbody>
</table>
In addition to the overall assessment of the 200 yr flood impact in the study reach and the more detailed assessment compiled for the high density areas, the writers note that there are 2 houses and a water intake pump house on the right bank of the river at the south end of Vavenby that appeared to have been inundated from backwater due to a brief but thick ice jam in January 2005. Vavenby is just upstream of the FPM and, thus, is outside the study area. However, since this report also serves as a compendium of vulnerable structures along the river for possible future response and recovery efforts, the locations of the toe of the responsible ice jam, and the two houses along with the pump house on the right bank, have been shown on the last map of the set of digitized maps provided as part of this project.

General Discussion

The flood assessments carried out were all done on a broad scale. Even the more detailed field investigations of the high priority sites were done on a preliminary basis using only the coarse elevations shown on the FPM. Costs of proposed flood mitigation works and benefits of resulting reduced flood damages were only roughly estimated. Construction costs were estimated conservatively to diminish the chances of unpleasant budget surprises in the future when construction material and labour costs could be better identified. A detailed design of proposed works should be undertaken by a qualified engineering firm prior to construction, and would include the following items:

- All construction material sources need to be located and detailed design of works along with method of construction are required in order to make an accurate estimate of project costs.
- Elevation surveys of buildings in floodplain, assessed values of these buildings, and the existence and finished state of basements to get a more accurate estimate of flood damages that would be prevented by selected works.
- Survey the geodetic elevation of the main living level of each house in the floodplain and record in a computerized database for use in current and future potential floodplain damage assessments.
- In cases where raising a house or building a ring dike around a house seems acceptable, a technical assessment of the structure's suitability for being raised or encircled must be done prior to doing so.
- Ground surveys along expected overland flow routes also should be done to confirm that subject areas would, in fact, be flooded during the 200 yr event and to also confirm the dimensions of proposed protective works.

Residences in the floodplain on Indian Reserves are included in this study based not only on a review of the mapping but also on a very beneficial meeting with the North Thompson Band Administrator who supplied details and confirmation on dwellings at risk. These dwellings can be identified on the digitized maps by locating those dwellings that are located within the confines of the marked Reserve lands, all of which have been clearly distinguished on the maps. Since flood mitigation on Federal land is a Federal responsibility, no costs for raising dwellings located on Reserves are shown.
The rough costs shown herein do not include the cost of obtaining necessary rights-of-way or temporary access on private property. The important issue of having a responsible diking authority (TNRD or other) to maintain any new dike proposed for construction would also need to be resolved prior to construction approval. There are the usual Provincial and Federal permits needed for any construction as well.

Those people living or working in the floodplain that would directly benefit from any proposed flood mitigation work would obviously need to be in favour of the work for it to proceed. Some homeowners may oppose or want to modify proposed flood protection works if they felt that it would disrupt their lifestyle and/or affect property use. Modifications to designed works could either increase construction costs or reduce protection or both.

The existing flood protection dikes were only evaluated by a cursory office and field review. High flows and the passage of time will eventually weaken the dikes in some fashion and these will require remedial work to keep up the current level of protection. The same remedial work will be required from time to time on any new dikes constructed. Dike maintenance, land acquisition, and project financing are additional costs not factored into the very simple way of calculating the B/C ratio that the writers used in this report. Adding the annual operating and maintenance costs to a dike project could easily double the actual cost of the project over the life of the project. When the B/C ratios shown herein are 3 or less, a much more rigorous B/C calculation is required, particularly if the cost of land acquisition will be significant.

The average estimated costs and benefits assigned to raising a house, raising a mobile home, and ring-diking a house make the estimated B/C ratio for each of these activities 0.8, 1.5, and 1.8, respectively, for any house or any mobile home at a elevation of about 1 m below FCL. In each instance, where one or more of these activities is being contemplated, a more detailed analysis of the costs, benefits, feasibility, and suitability of the job for that particular structure is needed. Some of the factors that must be favourable before deciding on a ring dike are the proximity of outbuildings to a dwelling, access to dwelling in wet or icy conditions, willingness of landowner to accept a ring dike, dike maintenance, internal drainage, adverse impacts on neighbours, and possible detrimental changes to location of structures or access over time. A key determining factor in selecting the raising a house option is engineering confirmation that it can be raised without structural damage.

Destructive mid-winter ice jams on the North Thompson River, particularly in the vicinity of Birch Island, may become a more common occurrence as global warming begins to have an effect on the river ice regime. In January 2005 and again in December 2005, ice jams have caused flood damage to dwellings at Birch Island. Ice breakup and jamming on the North Thompson River, previously thought to be a rare event, may now warrant more consideration in floodplain management.
Specific Discussion of the Highest Priority Areas

Birch Island Left Bank (Looking downstream)

There are 3 distinct clusters of homes in the 200 yr floodplain: one cluster in the vicinity of McLennan Rd, another cluster to the south of the CN tracks immediately upstream of BI, and the third just upstream from the BI road bridge along the river. The proposed raising of Lost Ck Rd no more than 0.3 m for about 170 m of length at the topographic low point to FCL would protect the McLennan Rd. cluster. The raised road (dike) combined with installing flap gates on all culverts in the adjacent CN rail grade to turn the rail grade into a dike would protect the second cluster south of the rail line. A longitudinal dike about 0.8 m high tied into the rail embankment downstream of the abandoned school and running between the houses and the river for about 850 m until it tied into the left approach to the bridge at the FCL would protect the third cluster upstream of the bridge. The new dike must tie into the bridge approach road as far inland as possible to leave a wide overflow section along the roadway if the bridge opening is obstructed during a flood event. There is a new bridge under construction just upstream of the present bridge that will replace the present bridge in 2006. This same left bank approach overflow must be maintained with the new bridge alignment.

Limited elevations surveyed on the CN track indicate that the entire section of rail embankment downstream, through, and upstream of Birch Island to the upstream rail bridge is above the FCL even though the FPM shows large sections below the FCL. There are at least two culverts through the rail embankment that require flap gates and there may be two or so smaller culverts that need to be gated as well. CN will likely not be inclined to accept flap gates on their culverts. Most flood events will be short-lived in the Birch Island area so that could help persuade CN to allow their installation. If CN refuses the idea, an alternative way to protect the 8 houses south of the rail line, may be construction of a dike paralleling the rail line and immediately south of it. The cost of it will obviously be much greater than flap gates and there may be other impediments to the work. The feasibility and rough costing of a parallel dike would need to be assessed if CN will not permit flap gates on their culverts.

All the more detailed investigations mentioned in the previous section of the report must be done here as elsewhere to confirm these preliminary findings, but the large B/C ratios resulting from the proposed works make these 3 areas very good candidates for flood mitigation works. It should be noted that there is little benefit from raising the Lost Ck Rd as proposed until levels reach or exceed the 200 yr flood level since minimal raising of the road crest is required. However, the other two clusters of houses have been flooded in recent years by floods smaller than the 200 yr event and the proposed flood works would protect these houses on a more frequent basis from smaller floods. The small expense attached to installation of flap gates on a few CN culverts to protect several flood prone homes in the middle cluster – including one home that remains unoccupied due to flood damage incurred in the most recent flood - during modest and larger floods seems to be a particularly attractive choice.
One house in the floodplain, not in one of the 3 clusters, lying between the railroad and the river upstream of Birch Island is left unprotected on the floodplain if the 3 proposed flood mitigation works are completed.

Birch Island Right Bank

There is a single cluster of homes that is protected by an existing dike. The dike crest is at FCL or higher for its entire length and has prevented flood damages during past flood events. Recent upgrades have improved the overall structure but bank erosion, a narrow crest and abundant tree growth are on-going problems with the dike. Two houses lie downstream of the dike on the floodplain and are not protected by the dike. One of these houses (located approximately 1.3 km downstream of BI bridge) was flooded by an ice jam in December 2005. At the time of the field inspection, new bridge construction necessitated breaching of the dike at its downstream end. This breach must obviously be repaired as soon as bridge construction is completed and no later than prior to spring freshet in 2006.

All the houses protected by the dike are upstream of the Birch Island Rd. The road itself is below FCL for about 500 m. Floods approaching the 200 yr flood will inundate the road from the downstream side and begin to flood all the houses below FCL on the upstream side of the road. Raising the road surface an average of about 0.6 m for about 500 m will prevent this backflooding of the diked area from happening.

All the more detailed investigations mentioned in the previous section of the report must be done here as elsewhere to confirm these preliminary findings, but the sizeable B/C ratio resulting from the proposed flood mitigation work make this area a potential candidate for flood mitigation work to complete the flood protection afforded by the current dike to the FCL.

Clearwater

All but two of the residential and commercial buildings inside the NTR floodplain are within the diked portion of the right bank (north) floodplain area protected by the Clearwater Improvement District (CID) dike. The protected area contains a total of 123 units consisting of 86 houses, 23 mobile homes, and 14 occupied commercial/other properties and one large, currently vacant, former forest products mill site. Two of these have been confirmed to be at FCL based on building permit records. Another residence and one industrial (CNR) building are outside the diked area on the left (south) floodplain on Station Road near the bridge.

The CID flood protection dike is a substantial works that is located along the top of the right bank. MOE information indicates that the dike crest is at or above the FCL and that the structure meets Provincial dike standards. Field observations confirmed that the structure is generally in fair-to-good condition. Observed dike components that may require attention in the near-to-medium term were discussed with CID operations personnel. These included: (i) questionable internal drainage CSP culvert with land-side
flap gate near the upper terminus, (ii) some riverbank undercutting upstream of the bridge and along the lower reach/secondary channel, (iii) woody growth along sections of the dike back-slope that could mask seepage during a flood event, (iv) woody growth and access issues (fence & stored materials) along dike crest near upper end, and (v) overly steep river-side dike slope – riprap appears stable, however, down-slope movement of riprap could become an issue. Item (i) requires investigation to ascertain its purpose.

A cost estimate for flood mitigation was not generated for the 125 properties. The existing dike, which the CID indicated it maintains on a regular basis, currently protects the 123 properties on the right floodplain – to the FCL. All new building construction (and major additions to existing buildings) within the floodplain must comply with the FCL elevation requirement. The 2 identified properties on the left (south) floodplain do not appear to require flood mitigation. The newer house (presently undergoing construction) is assumed to have been constructed to the FCL while the CNR building appears to be merely a “materials” storage facility although an inspection of the contents was not undertaken.

**Blackpool**

The north and south limits for Blackpool (the right floodplain) are consistent with that used for East Blackpool on the left floodplain with the Rivermount Motel being at the southern limit. The 205 identified properties include industrial, commercial, community facilities and 195 residential dwellings. The majority of dwellings are situated in an urban (small lot) density; however, a significant number are dispersed throughout the area on larger lots in a rural/agricultural setting. Included in the identified 205 sites are industrial properties belonging to Terasen (2) and Telus (1), a Firehall, a Community Hall, a Golf Clubhouse, the two commercial properties of Rivermount Motel and Nakiska (Guest/Resort) Ranch and three Mobile Home Parks that contain a total of 59 units. (Only one Park with 22 units is believed to be at FCL). Of the non-residences only the Motel and Guest Ranch would appear to be at risk during the design flood event and, apparently, only the motel is permanently occupied.

The assessment numbers for flood prone structures are based on contour and spot elevations from the FPM supplemented by some building permit approval data supplied by the TNRD that indicate a few newer buildings meet the FCL. There are, however, a significant number of newer dwellings, not reviewed by the TNRD, that display an elevated profile suggesting they too may conform to the FCL. The ground elevations for some dwelling sites within the Blackpool floodplain as marked on the FPM are clearly above the FCL and these are annotated as such on the FPM. Examples of these are located on Thompson Rd, Phillips Rd and a portion of Jenkins Rd. Other dwelling sites appear to be 0.6 m or less below the FCL and, thus, quite possibly meet the 1:200 flood level but do not meet the prescribed freeboard.

Using the information at hand, it was determined that mitigation for residential properties would include raising 53 dwellings anywhere from about 0.6 m to 2.0 m in order to conform to the FCL. In addition, multi-dwelling dikes c/w culvert structures would be
used to protect two clusters of dwellings on Jenkins Road. These include the West Jenkins cluster of 10 dwellings and the East Jenkins cluster of 48 buildings including a 22-unit mobile home park and a Telus “switching” station. Approximate dike lengths are 400 lineal metres and 800 lineal metres, respectively. However, local topography includes swales and high ground area (above FCL) and a detailed assessment may identify less extensive and more economical dike alternatives (i.e. several short dike segments). A total of 87 dwellings were deemed to meet or exceed the FCL in so far as the main floor living area is concerned.

Two community facilities, a Firehall and the Community Hall, and the Golf Clubhouse are deemed to be at or very near the FCL. The Terasen tank farm and pumping station, and the Nakiska Guest Ranch were not inspected and are difficult to assess as to potential impact from the design flood. Ground elevations are below FCL but the nature of these facilities suggests mitigation is probably unnecessary. More information is required. The Rivermount Motel is at considerable risk being located very near the top of riverbank and at about 1.5 m below the FCL. According to the owners, the existing partial dike protected the property during the flood events of 1997 and 1999, however a major upgrade to and extension of the dike, and, perhaps a riprap revetment, are necessary to provide flood mitigation to the FCL.

While the two multi-dwelling dikes appear to be a good choice economically there are a number of matters that must be addressed before proceeding. Firstly, ground elevation in these two areas is difficult to quantify from the FPM and depth of flooding at the FCL may not be as significant as suspected. Secondly, the dike right-of-way is likely to be a contentious issue; the nearby watercourses and green belt are sure to raise environmental concerns where the dike would traverse a heavily wooded area near the rear of private properties. A detailed assessment and topographic survey is necessary to examine alignment options and location issues along with other standard diking issues. The B/C for the West Jenkins and East Jenkins multi-dwelling dykes were calculated at 3.3 and 7.8 respectively. The standard B/C ratio applies for raising individual dwellings.

Portions of Highway 5 and several of the local streets and roads within the floodplain are below the FCL as noted on the FPM. Access to dwellings will be compromised during the design flood event (200 yr flood) and probably any large flood event.

**East Blackpool**

For this assessment East Blackpool is defined as the entire left bank (east) floodplain accessed by Dunn Lake Road extending from just north of Little Fort to about 3 km south of the Village of Clearwater. It comprises two distinctly different dwelling distributions with residences that vary from very old to relatively new. There are a total of 26 dwellings with nearly one-half the units situated on relatively small lots directly across the river from the central portion of the community of Blackpool. The other dwellings are broadly dispersed on medium to large agricultural land parcels throughout this portion of the floodplain.
Based on elevations derived from the FPM, dwelling site ground elevations vary from 0.7 m to about 1.5 m below FCL. Some properties clearly indicate that the natural ground level and/or the dwelling has been raised as a flood proofing measure; however, visual observation and the FPM alone are insufficient to ascertain whether the FCL has been achieved. Much of the access road system including the Dunn Lake Rd and the CNR tracks are below FCL and might become impassable in a major flood. No engineering surveys were undertaken and no cost estimates produced for access upgrading.

Detailed survey information may establish that some dwellings are in fact, above FCL; however, this review concluded that flood mitigation would be required for all 26 dwellings identified as being below FCL. Twelve dwellings (10 houses and 2 mobile homes) are contiguous in relatively close proximity and appear to be suitable for a single dike about 1800 m long as shown on the FPM. The multi-dwelling dike would extend along the front of each property (edge of Dunn Lk. Rd. right-of-way) having flanks that tie into the hillside at the back of the lots at both ends. Three of the dwellings are situated fairly close to the front lot line and the resulting restricted construction space and impact on driveways and front yards may render this choice unacceptable to owners. The B/C for this mitigation work is calculated at 1.1 hence mitigation on an individual property basis may be preferred. A detailed assessment and costing would be required. Raising Dunn Lake Rd to the FCL (primary dike standard) is another option but construction cost would be considerably higher because this section of road is asphalt surfaced.

The remaining 14 dwelling (13 houses and 1 mobile home) would have to be raised or ring-diked with the former being selected for this analysis. Raising has been selected for the dispersed dwellings in this assessment because of negative issues associated with ring dikes. Some of the 13 houses appear to be quite old and raising may not be warranted or even structurally possible or economical, in which case the ring-dike option may prove to be a better choice. The typical B/C ratio for raising individual dwellings makes this undertaking uneconomical unless other favourable matters come to light during a detailed site-specific assessment that should be undertaken in the final decision making process.

**Little Fort**

There are 2 houses on the left bank in the 200 yr floodplain. They are not closely spaced and could not be protected together in a cost effective fashion. The only practical flood protection that could be suggested would be to raise each house individually. The B/C for this work would be the standard 0.8, using the standard raising and damage costs. The site is no different then any other individual house within the floodplain, and does not constitute a cluster of houses that might be a high priority to protect.

There are 2 houses on the right bank in the 200 yr floodplain. They are close together so a detailed cost estimate was prepared for a ring dike for the two houses. The dike cost is in excess of the cost of raising both houses. It would also have to be a steep, narrow dike to fit in the available area between houses and the river and would be unattractive to all concerned. The only practical flood protection that could be suggested would be to raise
each house individually. As is the case for the left bank, the right bank site at Little Fort does not constitute a cluster of houses that would be a higher priority to protect.

South Barriere

This area that has 8 houses within the 200 yr floodplain was added to the original high priority sites when this study uncovered that flooding took place here in 1999. Most house elevations are not known, relative to the FCL, although one house is clearly below the FCL. They are not closely spaced and could not be protected together in a cost-effective fashion.

The existing Nelson Road dike is not a factor in the area, and is really only a road fill. There is no fruitful way to extend this dike to protect houses in the area. The only practical flood protection that could be suggested would be to raise each house individually. The site is not a tight cluster of houses that could be efficiently protected as a unit from large floods.

Exlou

There are 9 houses within the 200 yr floodplain at this site. Most house elevations are estimated to be at the FCL, based on comparison with new houses constructed after the 2003 wildfire. Two adjacent houses lie below the FCL and could be protected by one ring dike. This particular site is very low and a dike would be very expensive and invasive for the property owners. Several other houses have basements that may be subject to flooding. A larger dike enclosing all houses in the area is not cost effective, and would be plagued by known seepage problems, requiring significant pumping capacity during times of high water / groundwater. Once again, the only practical flood protection that could be suggested would be to raise each house individually. The site does not thus constitute a cluster of houses that might qualify as a high priority site to protect.

Engineering Design Costs

As the next step in the sequence of events that may lead to construction of approved flood engineering works for the highest priority sites, estimates are provided for the engineering costs of final design of the high priority sites on the left bank of the river at Birch Island if this work were tendered out to consultants. The TNRD could then submit a timely proposal for funding the design of these works to the Provincial funding agency. During the engineering design process and certainly at the time the design was presented, the TNRD would gain a much better idea of the actual construction cost and any major obstacles with landowners and any other groups that might be affected by the designed works.

The design cost estimates provided below use the following rates:

Engineer charge out - $100/hr.
Technologist charge out - $50/hr
Technician charge out - $40/hr
Overnight travel - $100/day
Mileage - $0.45/km
Contingency - 20%

For the longitudinal dike upstream from the bridge, engineering design cost estimated to be $11,300 + GST (priority 2 in Conclusion Sec.).
For the raising of the Lost Creek Rd. bend upstream of BI, engineering design cost estimated to be 10,100 + GST (priority 6 in Conclusion Sec.).
For the installation of flap gates on CNR culverts upstream of BI, engineering design cost estimated to be $4200 + GST (priority 1 in Conclusion Sec.).
There would very likely be some savings on these individual project design costs if all 3 were done at the same time.

As another example of engineering design costs, using the proposed Jenkins Road and East Blackpool dikes, a reasonable estimate of engineering costs for field investigation, survey, and design of these dikes can be determined by applying a percentage to the estimated construction costs. A value of 15-20% of estimated construction cost is recommended.

Conclusions

This was a preliminary assessment undertaken to grossly determine which properties might benefit from future flood mitigation activities. More detailed engineering investigations and detailed economic analyses need to be done to confirm the preliminary findings of this study. At some point, the desires and concerns of those landowners affected by any new works will need to be determined and/or satisfied.

There were 432 residences/dwellings identified in the North Thompson River 200 yr floodplain from Exlou to the upstream mapped limit. This total includes 373 individual dwellings plus 59 dwellings within the three Mobile Home Parks. Additionally, there were 24 commercial/industrial/other buildings identified in this same study area. It is possible that there were a very limited number of buildings that were not identified by either the office or the field investigations.

Of the above totals, 211 residences and 4 of the other building types were thought to be below FCL or not protected by an existing dike built to the FCL. It is quite likely that further investigation would show that some of these buildings thought to be below the FCL are, in fact, at the FCL or above.

Level surveys of all floodplain buildings and transportation corridors would help assess what structures and which infrastructure is truly at risk at the complete range of flood levels. Compilation of a comprehensive database that includes most-recent building permit information (since the current building By-Law was enacted) would be very
useful. This information would assist with assessing benefits and costs for remediation options.

The 23 digitized floodplain assessment maps that were developed as part of this study are useful reference tools to determine not only where flood mitigation works are most needed but for use in flood emergency planning and response. Their format allows for easy updating as buildings are replaced or new development occurs thereby maintaining a current digital listing of buildings within the study portion of the floodplain. The maps would also have limited use in many other types of emergencies.

The top 6 highest priority flood mitigation works, to protect against structures inundation during a 200 yr flood, ranked strictly in order of benefit/cost ratios, are:

- Flap gate installation on CNR culverts on LB upstream of Birch Island
- Raising Lost Creek Rd. upstream of Birch Island to FCL for a short length of the road.
- Building dike around houses on Jenkins Rd. East
- Building dike around houses on Jenkins Rd. West
- Raising Birch Island Rd. across RB floodplain at Birch Island
- Building dike around houses on LB at Birch Island

However, there are other important factors to consider when developing a priority list such as feasibility of construction, significant flood damage at water levels below the FCL, and complete topographic surveys. For example, the recent repeated flood damage of Birch Island properties caused by smaller floods or the fact that preliminary surveys indicate a level of protection close to the FCL for some sites, suggest a shift in site rankings makes good sense. When these other factors are included, the priority list above changes to the following order:

1. Flap gate installation on CNR culverts on LB upstream of Birch Island
2. Building dike around houses on LB at Birch Island
3. Building dike around houses on Jenkins Rd. East
4. Building dike around houses on Jenkins Rd. West
5. Raising Birch Island Rd. across RB floodplain at Birch Island
6. Raising Lost Creek Rd. upstream of Birch Island to FCL for a short length of the road.

This is as much as the priority list can be refined at this time. The priority ranking could change again based on more detailed surveys and investigations.
Recommendations

The next logical step is to carry out detailed engineering investigations and designs for the proposed mitigation works for the two highest priority sites, either in-house or by seeking provincial government funding to hire external contractors, for the following sites (see Table 2 and text for site descriptions and details):

1. Flap gate installation on CNR culverts on LB upstream of Birch Island
2. Building dike around houses on LB at Birch Island

The detailed design cost of these two items is estimated at $15,500 plus GST. The initial construction cost estimates total $124,000 with an expected benefit of $570,000 if the work can be completed according to the conceptual design envisioned. This work should begin as soon as funding can be obtained.

The remaining four Birch Island and Jenkins Rd sites listed below should be augmented with detailed designs to clarify which of these proposed flood protection works should go forward to the construction phase.

3. Building dike around houses on Jenkins Rd. East
4. Building dike around houses on Jenkins Rd. West
5. Raising Birch Island Rd. across RB floodplain at Birch Island
6. Raising Lost Creek Rd. upstream of Birch Island to FCL for a short length of the road.

None of these four sites are prone to flooding at low flood levels. Each is close to the FCL and detailed site surveys will be required to determine the exact number of houses that will actually benefit from flood protection and to what extent (e.g., improving the existing (natural) protection from 1 in 50 year flood to the 1 in 200 year FCL). Equally, the actual cost of the works will only be determined precisely when detailed surveys and design has been completed. Once these detailed designs are completed, precise benefit cost figures will provide financial justification for funding applications for the protection works to be pursued towards construction.

TNRD should also embark on a schedule of surveying and recording in a computerized database the surrounding ground elevations and habitable floor elevations at all dwellings in the mapped floodplain in its jurisdiction to allow quicker, better assessments of potential flood damage impacts and costs. The collected information together with building permit data should be merged with the digital information and mapping generated in this assessment. The costs of this work have not been estimated and are not included in the estimates provided for detailed engineering design of the flood protection works at the priority sites.
Figure 1 - Key Map and Flood Protection Priority Locations
APPENDIX 'A'
Message forwarded from reception.
Marina

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Thompson-Nicola Regional District
#300-485 Victoria St
Kamloops BC V2C 2A9
1-877-377-9673

Subject: Invitation to present to NDP Economic Policy Ctte
From: "May, Ed" <Ed.May@leg.bc.ca>
Date: Fri, 24 Feb 2006 14:07:28 -0800
To: <admin@tnrd.bc.ca>

Thompson-Nicola Regional District,

My name is Edward May and I am a Legislative Assistant to Rob Fleming, the Chair of the NDP Caucus Economic Development Committee. The NDP Caucus will be in Kamloops in March, and I would like to extend an invitation to the TNRD to present to the members of our Economic Policy Committee.

The time we have available would be for an hour at some point between 12 pm and 4 pm on Thursday Mar 16th.

Please contact me at the contact info below to discuss availability.

Thank you

The Committee is...

Chair Public Accounts Committee Chair – Rob Fleming

Aboriginal Relations and Reconciliation – Scott Fraser
Advanced Education and Research – Gregor Robertson
Agriculture and Lands – Bruce Ralston
Crown Corporations – Guy Gentner
Economic Development – Mike Farnworth
Energy and Mines – Corky Evans
Environment – Shane Simpson
Ferries and Ports – Gary Coons
Fisheries – Robin Austin
Forests and Range – Bob Simpson  
Labour – Chuck Puchmayr  
Municipal Affairs – Norm Macdonald  
Olympics – Harry Bains  
Small Business, Revenue and Deregulation – Maurine Karagianis  
Tourism, Sports and the Arts – Nicholas Simons  
Transportation – David Chudnovsky  
Finance – Jenny Kwan  

Intergovernmental Relations – Michael Sather  

Edward May  
Legislative Assistant  
Official Opposition  
(250) 953-4705
BOARD OF DIRECTORS’ MEETING – SEPTEMBER 22, 2005

The Chief Administrative Officer advised that Directors Ranta and Wallace had requested that the issue of payment of meals by municipalities when their Councillors and staff attend TNRD group meals at conventions be a topic of discussion at the next Board of Directors’ Workshop.