RAILWAY OCCURRENCE REPORT

CANADIAN NATIONAL RAILWAY COMPANY
DERAILMENT
TRAIN NO. 303-18
MILE 133.5, CARAMAT SUBDIVISION
NAKINA, ONTARIO
2035 EDT, 19 JULY 1992

REPORT NUMBER R92T0183

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

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SYNOPSIS

A Canadian National Railway Company (CN) westward freight train derailed four locomotives and eight freight cars near Nakina, Ontario. The subgrade underneath the track at the derailment site had collapsed into Green Lake prior to the arrival of the train. As the front of the train travelled onto the portion of the track suspended in mid air, it fell into the lake, submerging the four locomotives.

Two members of the three-man train crew were fatally injured and the third sustained serious injuries.

The Transportation Safety Board of Canada determined that the derailment was caused by a breach in a beaver dam, which resulted in a sudden lowering of the water level in the lake, destabilizing the track subgrade and resulting in its collapse. Contributing to the accident was the placement of the embankment across the end of the lake, on a base composed of a mixture of peat and silt.

09 September 1993

Ce rapport est également disponible en français.

1.0 FACTUAL INFORMATION

1.1 The Accident

Canadian National Railway Company (CN) freight train No. 303-18 (train 303) departed from Hornepayne, Ontario, at 1700 eastern daylight time (EDT) on 19 July 1992, bound for Winnipeg, Manitoba.

The trip was without incident from Hornepayne to Nakina, Ontario. Train 303 passed the west dual control switch at Nakina, Mile 131.7 of the Caramat Subdivision, at 2026 EDT. As the train entered a right-hand curve at Mile 133.5, the trainman commented that Green Lake on the right side appeared muddy. All crew members then momentarily focused their attention on the unusual condition of this small lake and remarked to each other that the beaver dam forming the lake had broken.

Approximately 700 feet into the curve, the crew observed the track structure suspended in mid air about 200 feet ahead. The train travelled onto the unsupported track at an estimated speed of 35 mph and all four locomotives fell into the lake. The lead locomotive, which contained the operating crew, came to rest lying on its right side under water. Eight cars that were immediately behind the four locomotives also derailed.

Both the conductor and trainman apparently suffered injuries serious enough to render them either unconscious or unable to make an attempt to exit the cab. When the cab filled with water, the locomotive engineer floated up in total darkness to where he remembered the window was located. He was able to get the window open, escape the cab, float to the surface and swim to shore. He remained in this location until he was found by his rescuer.

When the grade gave way, several wayside poles carrying the Centralized Traffic Control System (CTC) code line and the communication system wires used for communications between the rail traffic controller (RTC) and trains fell over. The derailment or the embankment collapse resulted in a break in the wires and caused a code line failure indication to be displayed in the RTC office in Toronto, Ontario, and was reported to the signals and communications officer on duty. This code line failure was passed on through normal procedures, culminating in notification to the signal maintainer at Nakina.

Within this same period, three other trains were located in the vicinity. CN eastward freight train No. 218 (train 218) had entered the siding at Exton, two miles west of the derailment site, and was waiting there to meet train 303. The crew on this train overheard the crew of train 303 announce the indication displayed on the advance signal to Exton, and assumed that train 303 would arrive within minutes. However, when this did not occur, the crew of train 218 called train 303 by radio to determine its location. As no response was received, the crew of train 218 also attempted to contact the RTC in Toronto, without success. After approximately 13 minutes, the conductor of train 218 decided to walk eastward to determine what had happened to train 303 and provide assistance should it be required.

At approximately 2120 EDT, the conductor of train 218 arrived at the derailment site and heard cries for help. He found the injured locomotive engineer covered in oil and diesel fuel, cold and unable to move at the edge of the lake down the embankment. From this location, the conductor of train 218 was unable to contact the locomotive engineer of train 218 on the portable radio. The conductor then covered the injured engineer with his coat, climbed up the bank and ran westward approximately one mile toward his train at Exton. At approximately 2145 EDT, he established radio contact with the locomotive engineer on train 218 and instructed him to call for help. The locomotive engineer on train 218 relayed this information to CN eastward freight train No. 212 (train 212), which had entered the siding at Cavell, 13 miles west of the derailment, to meet westward train 303. The crew on train 212 had overheard the radio calls made by the crew of train 218 to establish contact with train 303 and the RTC in Toronto. As the crew members of train 212 were unsuccessful in their own attempt to contact the RTC in Toronto, this train's conductor walked to a nearby CN track maintenance facility and contacted the RTC by telephone. He remained at this location throughout the night to relay information between the RTC in Toronto and the accident site.

CN westward freight train No. 219 (train 219) had followed train 303 from Hornepayne to Nakina. At Nakina, the train was stopped by a stop signal, which was considered normal with train 303 preceding close ahead. The crew on train 219 also attempted to contact the crew of train 303 and the RTC in Toronto, without success. The signal maintainer at Nakina tested the circuitry and determined that the area of failure was immediately west of Nakina. He drove to the highway crossing at Mile 132.83, where he observed the rear portion of train

303 just west of the crossing. He overheard trains 218 and 219 calling train 303 on the radio. As there was no response from train 303, he suspected that a derailment had occurred. He then contacted the conductor of train 219 by radio, and instructed him to enter the signal maintainer's office at Nakina, contact the RTC and the fire department and call for an ambulance. The signal maintainer then returned to Nakina to shut off the electricity feeding the track side wires toward the suspected derailment site.

The ambulance was directed to proceed to a road crossing at Mile 135.3, where the locomotives from train 218 were used to transport the ambulance personnel to the accident site; the ambulance personnel arrived at the site at approximately 2230 EDT. The locomotives then returned to the road crossing at Mile 135.25 to pick up fire department personnel and transport them to the accident site. The injured locomotive engineer was removed from the lakeside shortly after midnight, transported from the accident site to the road crossing at Mile 135.25 in the signal maintainer's vehicle, and taken by ambulance to the Geraldton hospital.

The injured locomotive engineer remained conscious and was able to tell his rescuers that both his fellow crew members were in the leading locomotive at the time of the accident. A search of the lakeside area was conducted for the two men who were not accounted for, but it did not prove successful.

1.2 Injuries

The conductor and the trainman died in the accident. The locomotive engineer sustained serious injuries.

1.3 Damage to Equipment

Four locomotives were lost in the lake. There was extensive damage to eight cars.

1.4 Other Damage

Four hundred feet of main track and track-side communication lines were destroyed, including the subgrade to a depth of 32 feet. A carload of clothes dryers was destroyed and seven loads of steel pipe were damaged or lost in the lake.

1.5 Personnel Information

The crew of train 303 included a conductor, a locomotive engineer and a trainman, all of whom were riding in the lead locomotive. They were all qualified for their positions and met fitness and rest standards established to ensure the safe operation of trains.

1.6 Train Information

Train 303 was powered by two locomotives and followed by two non-operating locomotives. The train was hauling 82 cars, 20 of which were empties, and was operating without a caboose. It was approximately 5,500 feet in length and weighed nearly 5,000 tons.

At Hornepayne, the train was inspected by the incoming crew, the locomotives were refuelled, the crew was changed, and the train brakes were tested by the outbound crew. No irregularities were noted.

1.7 Particulars of the Track

At the point of derailment, the Caramat Subdivision is a single main track located on a four-degree right-hand curve on a 0.2 per cent descending grade in the westward direction.

The traffic over this portion of the subdivision in 1991 totalled 25 million gross tons. The maximum speed limit is 50 mph for passenger trains and 40 mph for freight trains between Mile 131.6 and Mile 140.2.

The track structure is comprised of 136-pound Sydney continuous welded rail that was rolled and laid in 1981 on concrete ties with Pandrol fasteners. All components were in good condition. Rail wear on this curve was negligible.

Up to the point of derailment, the ballast was crushed slag. Full cribs and shoulders extended two feet on the south side and four feet on the north side. The subgrade consisted of a 25- to 29-foot-high embankment made up of a permeable fill of sand and gravel, with some silt. The toe of the slope on the north side of the fill was submerged in a small lake. The south side of the subgrade culminated in a ponded ditch, which after the derailment contained water to a depth of one metre.

The track was last inspected on 17 July 1992 by a relieving assistant track supervisor during his patrol in a Hi-rail vehicle. No irregularities were noted. The line, gauge and cross-levels were last measured by the track geometry car on 20 May 1992. A curve exception report (alert) was generated by the geometry car with reference to this curve as the superelevation was 11/16 of an inch too high. However, the variance was judged to be minor and within the safe parameters of the speed zone at that location.

1.8 Method of Train Control

Traffic is controlled by CTC, authorized by the Canadian Rail Operating Rules, and supervised by an RTC located in Toronto.

1.9 Weather

In the 24 hours preceding the derailment, continuous rainfall was reported. On the afternoon of the accident, a local area of extremely heavy rainfall had been observed in the vicinity of Nakina by an Ontario Provincial Police Officer. Records at the Geraldton airport, 40 miles from the accident site, indicate a rainfall of 13.2 mm and a maximum temperature of 18.2 degrees Celsius on 19 July 1992.

1.10 Recorded Information

Although the event recorders from the leading and second locomotives were recovered, the recorded information was lost as a result of the power loss that occurred when water contaminated the batteries and electrical circuitry that sustain the memory function.

1.11 Occurrence Site Information

The first car behind the locomotives, a boxcar loaded with clothes dryers, came to rest lying on its side on the south side of the main track. The following car, an empty flatcar, derailed but remained upright and on top of the remaining portion of the embankment. Of the next seven flatcars, all of which were loaded with steel pipes, one entered the lake, five derailed toward the north side and down the embankment, and one remained on the track but dislodged its load. The pipes loaded on these flatcars broke through their restraints and fell to the ground or came to rest in the lake on top of the submerged locomotives.

The terrain in the area is comprised of numerous lakes and muskeg interspersed with sand and gravel hills. At the accident location, part of a sand hill had been used to fill in the edge of a lake during the construction of this railway line at the turn of the century. The subgrade had been constructed across a corner of the lake, over a base of silt and peat.

At the northwest corner of the lake, a 2.4-metre-high and 40-metre-long beaver dam, which according to experts had been in place for well over 100 years, sustained a breakthrough. Freshly disturbed material in the dam and water damage on the trees beyond the dam indicated that the occurrence was recent and catastrophic. Water marks on the shore of the lake indicated that the water level had been 2.1 metres higher before the breach of the beaver dam. Examination of the shoreline also revealed no damage or washed-up debris which would have indicated the passage of a pressure wave across the lake surface.

The soil at the base of the railway subgrade was displaced into the pond in a fluid, flow-like manner.

Twenty hours after the derailment, the water level in the ditch to the south of the track was noted to be 0.3 metre lower than the high water mark. Forty-eight hours after the derailment, the water had lowered a further 0.7 metre, and the ditch was dry, attesting to the permeability of the subgrade.

1.12 Dangerous Goods

An estimated 3,000 gallons of diesel fuel and some lube oil escaped from the derailed locomotives and entered the lake. Booms and absorption materials were placed in the water to control the polluting effects. Most of the diesel fuel and lube oil was recovered. While the potential for further oil/diesel fuel emission is extremely minimal, booms continue to protect the site where the submerged locomotives rest.

1.13 Tests and Research

Soil testing was carried out by a geotechnical consultant and the results were evaluated independently by TSB investigators and a specialist from Energy, Mines and Resources' Geological Survey of Canada Terrain Sciences Division on TSB's behalf. It was determined that part of the subgrade embankment forming the shoreline rested on lake bed bottom deposits, which consisted of silt with interbedded peat. Computer analyses of the subgrade stability, using various track loading scenarios, indicated that the rapid draw down of water would have been sufficient to destabilize the bank whereas the temporary imposition of a heavy load typical of a freight train would not. It was also established that the rapid decrease in hydrostatic pressure, resulting from the sudden withdrawal of two metres of water from the side of the railway embankment, would have destabilized the subgrade and triggered its failure. The failure mechanism involved a slip-out of the subgrade across the peat/silt lake bed. There would have been no prior visual indications that a potential for failure existed, nor could failure have been forecast without a geotechnical analysis. This had never been done.

1.14 Other Information

In the 24 hours preceding the accident, 16 trains had traversed the derailment location. None of these trains' crews reported any abnormality at Mile 133.5.

At approximately 1716 EDT, train 219 passed the derailment location. The crew did not observe anything unusual about the lake at Mile 133.5 and did not experience a bump or rough spot on the track structure.

The members of the track maintenance crew on duty on the day of the occurrence stated that they had not experienced any problem with the stability of the embankment at this location. As the water level was well below the rail and the water flow was away from the tracks, the beaver dam had not been considered by the railway to be a factor which would affect the integrity of the track.

2.0 ANALYSIS

2.1 Consideration of the Facts

Train 303 was operated in compliance with company operating procedures and government regulations. The forward sight-lines, which were restricted by the curve and topography, gave the crew only a few seconds' warning of the damage to the roadbed, which was not enough time to stop the train and avert the accident.

The derailment location did not have a prior history as a track or roadbed problem area, and recent track inspections had not detected irregularities at Mile 133.5. However, the roadbed had been constructed early in the century, before modern geotechnical analysis techniques were available. With its routing across the end of a lake and construction on a base of peat and silt, the subgrade apparently needed only a triggering mechanism such as the rapid draw down of water to cause collapse of the waterlogged embankment.

In this case, the beaver dam gave way, in all probability because heavy rainfall led to excessive water flow over the dam until a large breach developed. The water level was reduced by approximately 2.1 metres in a very short period of time.

The sudden drop of water and the withdrawal of hydrostatic support from the railway embankment resulted in a major "slip-out" displacement of the subgrade at the derailment point.

The possibility that the embankment gave way, causing a major pressure wave across the lake which precipitated the dam failure, was not borne out by the evidence.

The destruction of the wayside CTC communication system lines prevented other train crews from establishing radio contact with the RTC. The fortuitous accessibility of the public telephone system provided the required emergency communication network in this instance.

3.0 CONCLUSIONS

3.1 Findings

1. The train was operated in compliance with company operating procedures and government regulations.

2. Forward sight-lines just east of the accident site were restricted by the curve and the topography, giving the crew little warning that the roadbed had slid away.

3. The derailment location had no prior history as a track or roadbed problem area, and the required track inspections had not detected irregularities at Mile 133.5. The crews on the 16 trains that had traversed this location during the 24 hours prior to the occurrence detected no abnormalities or irregularities.

4. A breach in the beaver dam that maintained the water level in Green Lake adjacent to the accident location resulted in a sudden 2.1-metre drop in the water level.

5. The resulting loss of hydrostatic support for the roadbed resulted in a major displacement of subgrade at the derailment point.

6. Placement of the subgrade on the silt and peat lake bed created the condition that lead to the subgrade failure.

7. Damage to the CTC code line and the communication systems wires resulted in a breakdown in communications between the RTC and trains in the Nakina area.

3.2 Cause

The derailment was caused by a breach in a beaver dam, which resulted in a sudden lowering of the water level in the lake, destabilizing the track subgrade and resulting in its collapse. Contributing to the accident was the placement of the subgrade across the end of a lake, on a base composed of a mixture of peat and silt.

4.0 SAFETY ACTION

4.1 Action Taken

4.1.1 Transportation Safety Board of Canada

In August 1992, the TSB issued a Safety Advisory to Transport Canada (TC) indicating that the potential for other track embankment failures existed on the Caramat Subdivision. The railway company lowered the water in Upper Lake, which is approximately 120 metres east of Green Lake, under controlled conditions, to rid the area of beaver activity. It also completed an aerial survey of the subdivision to identify other similar problem areas.

In July 1993, the Board recommended that the Department of Transport institute a collaborative program to identify other potential locations of incipient failure where main track has been laid over weak sediments or where waters adjacent to main track may be subject to rapid draw down (R93-04), that restricted speeds be imposed for trains traversing those sites identified as most vulnerable to failure caused by draw down of adjacent waters (R93-05), that corrective measures be identified and implemented to increase soil stability with an acceptable factor of safety at those locations identified as being vulnerable to terrain slump (R93-06), and that the adequacy of current roadbed design criteria for laying roadbed over peat, silt, or other weak sediments be reviewed (R93-07).

4.1.2 Transport Canada

TC has reviewed this accident with senior officers of CN, and has discussed the potential severe water conditions in Northern Ontario with Canadian Pacific Limited. Further, the railway is being requested to carry out a geotechnical analysis to determine if there are other locations which are susceptible to collapse under similar conditions. TC is also concerned that cutting the fibre-optic cable put the area radio system out of action. Therefore, TC is asking the railway to develop improvements which will minimize the likelihood of similar disruptions as experienced in this occurrence.

4.1.3 Radio Communications

CN has installed an automatic fallback to its radio communications system that will restore communications within 30 seconds of failure caused by a broken line and has rectified two locations identified as radio dead spots on the Caramat Subdivision.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson, John W. Stants, and members Gerald E. Bennett, Zita Brunet, the Hon. Wilfred R. DuPont and Hugh MacNeil, has authorized the release of this report.