Ice and Sediment Impacts on Muskegon Flood Risk

Stanford Gibson, PhD: USACE-Hydrologic Engineering Center
Mary Weidel, PE: USACE – Detroit District
1. River and Setting
2. Ice Jam Forensics
3. Hindcasting
4. Ice Jam Modeling
5. Sediment Modeling
6. Ice and Sediment Affected Frequency
7. Alternative Analysis
Road Map

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MECOSTA COUNTY FLOOD AREAS

MUSKEGON RIVER

Osborn Circle
Hemlock Park
183rd & 12 Mile Area
Riverside Drive
Maple Street

GREEN – Mecosta Township
ORANGE – Big Rapids Township
RED – City of Big Rapids
PURPLE – Shows areas most affected by flood waters on the Muskegon River from ice jams.

Canoe/Kayak/Small Boat Access
Large Boat Access

Portage Down an Embankment Behind Big Rapids Middle School at Mitchell Creek

BIG RAPIDS CITY
Osborn Circle

BIG RAPIDS TOWNSHIP
North End Riverside Park
Hemlock Park

183rd Street Access
183rd & 12 Mile Area
Portage Down an Embankment Behind Big Rapids Middle School at Mitchell Creek

Maple Street
Riverside Drive
Park Road Access

Ferris State University
Road Map

1. River and Setting
2. Ice Jam Forensics

What is the probability of Ice Jams?

- 1700 Newspapers
- 65 Tree Cores
Ice jam causes flooding locally...

It appears flooding along the Muskegon River which was apparently caused by high water and an ice jam is under control, at least for the time being.

For the past three days, continued sleet, rain and snowfalls raised the river’s water level. Temperatures hovering in the upper 20’s created a slushy ice pack which solidified when temperatures dropped during the night.

The combined elements created a massive ice jam in the area of a sand bar where 12 Mile Road nears the river in the Rogers Heights area.

Wednesday, water was creeping toward houses on the riverbank and in some instances, had already found its way into basements and boat houses.

The ice pack, which reached the end of width of the river would move for a few moments then stop, causing more water to flood from the river bed.

Wednesday night, the Consumers Power dam at Rogers Heights was opened. According to one resident along the river, “The guy running the dam didn’t even know how we did have high water until we got through to him on the phone last night.”

Once the dam was opened, the water level receded and the ice jam began to move.

During the night, water levels in some locations along the Muskegon were as much as 12 inches and open water is now visible along much of the bank.

...state of emergency in 1 county, 3 cities

Ice jam

Officials keeping close watch

DAVID L. BARBER

RIO RAPIDS — A one-mile long ice jam on the Muskegon River has Civil Defense officials keeping a close watch.

The ice jam is located about three miles upstream from the Rogers Hydroelectric facility and has caused minor flooding north of the area.

“We really don’t have a big problem yet,” said Muskegon County Undersheriff and Civil Defense Director James Stockwell. “If we get rain like some weather forecasters are predicting, we could have real problems real quick.”

No homes have been evacuated. The National Weather Service said Northern Lower Michigan can expect mostly cloudy skies today, with temperatures being in the 40s. There is a chance of rain and freezing rain.

Stockwell said the ice jam is retaining the natural flow of the river and has caused higher than normal water levels along the river banks in an area between 11 Mile Road and 12 Mile Road in Muskegon County.

“There is a large volume of water flowing through the ice jam,” Stockwell said, “but higher than normal levels will continue until the water cuts a better channel for itself through the ice jam.”

Consumers Power Company engineers have lowered the level of the hydroelectric plant’s reservoir downstream of the ice jam in an effort to help the situation.

A plant spokesman said operations at the hydro plant are normal and employees are continuing to monitor the situation.

“We really don’t have a big problem yet. If we get rain like some weather forecasters are predicting, we could have real problems real quick.”

James Stockwell

Residents needing assistance can call the Civil Defense office at 796-4811.
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\[ T_i = C \ (AFDD)^{0.5} \]
Road Map

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Uniform Transition Uniform Transition

"Equilibrium Section"

Ice Accumulation

Solid Ice Cover

Flow

Maximum Depth Given by Equilibrium Section

Modified From USACE (2011)
Volume Check

Loss Coefficient * Total surface area * 2013 ice thickness = (1-0.4) * 43 ft² * 0.9 ft = 23.2 million ft³

<table>
<thead>
<tr>
<th>Description</th>
<th>Volume</th>
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</thead>
<tbody>
<tr>
<td>Contributing Ice Volume computed from reach 3-5 before 2013 event.</td>
<td>23.2 million ft³</td>
</tr>
<tr>
<td>Ice Volume computed during the 2013 calibration in HEC-RAS</td>
<td>23.7 million ft³</td>
</tr>
</tbody>
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$Q_s = 0.0002 \times Q^{1.78}$
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Flow Frequency Curve

Return Period

Stage (ft)

Exceedance Probability

$P_{combined} = P_{Ice} + P_{Open} - P_{Ice} \times P_{Open}$

96% = 87% + 69% - 87% * 69%

#3 - 30,375 Forset Slope of the Reservoir Delta
Flow Frequency Curve

Return Period

Stage (ft)

Exceedance Probability

Mixed (Current)
Mixed (Future)
Ice Affected (Current)
Ice Affected (Future)
Open Water (Current)
Open Water (Future)

#2 - 16,782: 12 Mile Road - 1 Mile Upstream of the end of the Ice Jam
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