Burnham Hall
Lincoln, Vermont
Dry Floodproofing Case Study

Overview

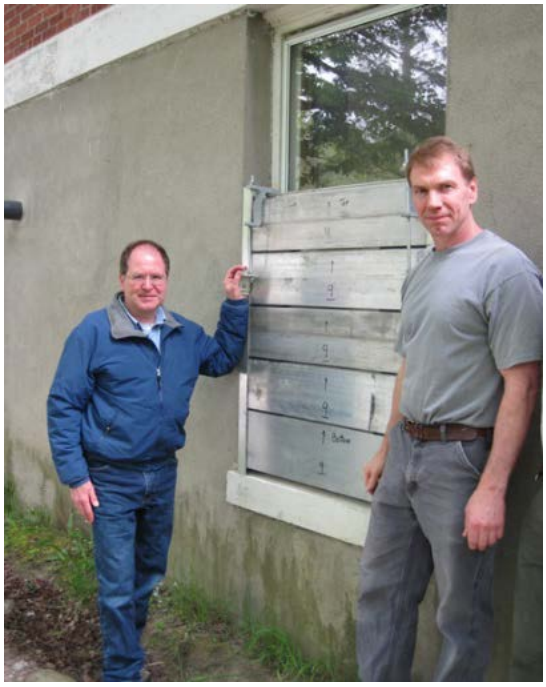
Burnham Hall, Lincoln, Vermont's community center, was built in the 1920s within 10 feet of the New Haven River. On average, it has flooded once every 12 years. In 1998, after the hall flooded with over five feet of water, the library had to be relocated. As the waterlogged books were being moved from the lower floor, Harriet Brown, a long-time Lincoln resident, rallied the community to support a project to protect Burnham Hall from future floods.

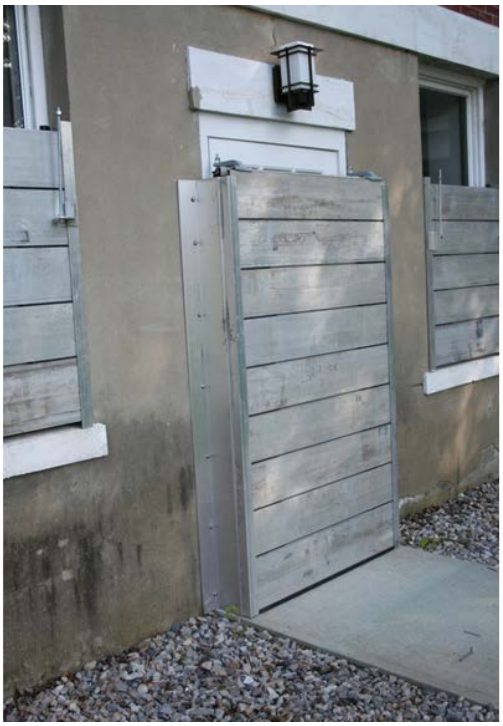
A volunteer community group obtained a grant from the Agency of Natural Resources to study how to relocate or retrofit the building. The goal was to "live with the river for the next 100 years." After reviewing the report, the committee decided to incorporate floodproofing techniques with a Hazard Mitigation grant from the State of Vermont and the Federal Emergency Management Agency (FEMA).

Pre-Disaster Mitigation Measures

Fifteen tasks were completed to protect Burnham Hall from future floods. The work was done between 2006 and 2009, at a cost of approximately $425,000. These tasks included the following:

- Relocation of the furnace and hot water heating system to the attic.
- Replacement of electrical wiring with water resistant cable to withstand floodwaters.
- Replacement of interior insulation and wallboard with water resistant materials.
- Inclusion of drain notches in the sill plates.
- Replacement of the heaters with cast iron radiators.
- Replacement of the kitchen components with flood-proof parts.
- Installation of watertight barriers on windows and doors on a temporary basis to keep out water during a flood. The barrier system is designed for a maximum flood water depth of seven feet.
- Construction of a stairway between the lower and upper floors, and the attic, where the furnace had been relocated.





- Individual planks, weighing approximately 15 pounds each, are carried to and installed at each window or door site.
- Sealing of holes made for utilities - electricity, telephone, and fuel – where water can enter.
- Installation of a backflow valve in the septic line to prevent flooding from the drainage system.
- Installation of pop-up valves in the floor to eliminate damage from water pressure under the floor to prevent it from buckling.
- Installation of a sump pump to collect water entering from the pop-up valves and leaks in the barriers and seals on the windows and doors.
- Installation of a discharge pump to help remove water during a flood.
- Installation of alternative electrical lines from the discharge pump to a back-up generator.
- Improvements to the river bank to protect the row of trees along the riverbank to decrease erosion and keep rushing water from striking the foundation.

On Saturday August 27th, Tropical Storm Irene headed for Vermont, with heavy rains and flash floods predicted for Lincoln. At 5:00 PM, it was still a sunny afternoon in Lincoln. A group of eleven community members spent 30 minutes to install the flood protection barriers over the windows and doors of Burnham Hall.

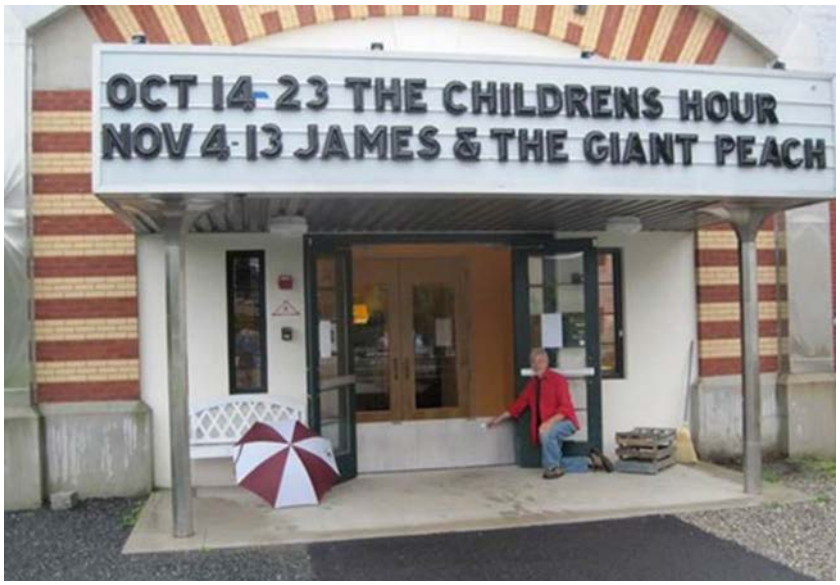
The rain arrived during the night and continued throughout Sunday at a fast and furious pace. Local rain gauges registered between six and eight inches of rain. The New Haven River rose quickly, flooding its banks, then the lawn of Burnham Hall, and finally up the walls to a level 47 inches above the first floor.

The planks held tight. Water and mud were kept out of the building. As the river raged by, the pressure of nearly four feet of water outside the building activated the pressure pop-up valves, and kept the floor from buckling upward. By design, a small amount of sand filtered water came in through these valves, and was easily handled by the sump pump system. Power failure during the afternoon, necessitated bringing a generator online to keep the sump pump operating. By Monday, the river receded, and clean up started.

Thanks to Mark G. Benz for providing the information for this case study.

New England Youth Theater
Brattleboro, Vermont
Wet and Dry Floodproofing Case Study

Overview



The New England Youth Theatre (NEYT) was designed and built in 2006. The building includes a renovated trucking facility and part new construction. It is a low-lying building located within the floodplain of the Whetstone Brook in Brattleboro, Vermont. In August 2005, just one year before construction began, Hurricane Katrina brought national attention to the inherent dangers of construction in flood prone areas.

Prompted by FEMA regulations, and with the encouragement of the NEYT Building Committee, the project design team, headed by Greenberg Associates Architects of Putney, took a number of measures to protect the building from flood damage. Those measures proved successful in the heavy flooding associated with Tropical Storm Irene.

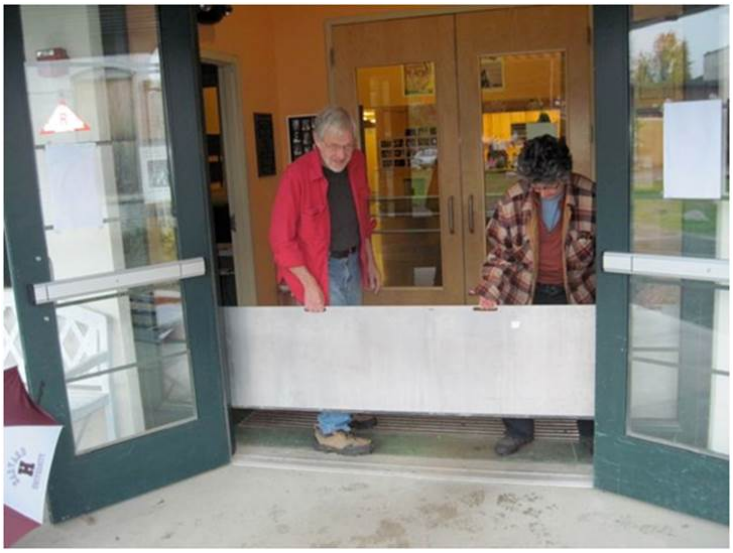
Pre-Disaster Mitigation Measures

The flood defenses of the building included five significant construction elements.

- **Floor resistant to hydrostatic pressure.** The floor of the newly constructed part of the building is an 11" thick concrete slab – heavy enough to resist buckling from rising groundwater. The weight of the concrete, plus specifically designed reinforcements, contribute to its strength. In the renovated portion of the building, 6" of concrete was added to the existing slab (with 2" of rigid insulation in between) for the same purpose. A reinforced sump pump was put into the floor to contain water entering the building when flood barriers were breached.
- **High perimeter wall.** The height of foundation wall was increased three feet above the floor slab. Fortunately, the original garage building also had a high foundation wall providing a flood barrier at that section of the building. The perimeter wall protects against high water. The riverbanks outside of this corner was also strengthened with heavy stones.
- **Impact protection.** The southwest corner, closest to the brook and facing upstream, was the most susceptible to impact from debris carried by a flooding river. All other flood control measures would be ineffective if the perimeter wall was damaged by a floating tree trunk. To reduce this threat, an eight ton block of concrete, reinforced with steel bars, was constructed into this corner of the building.

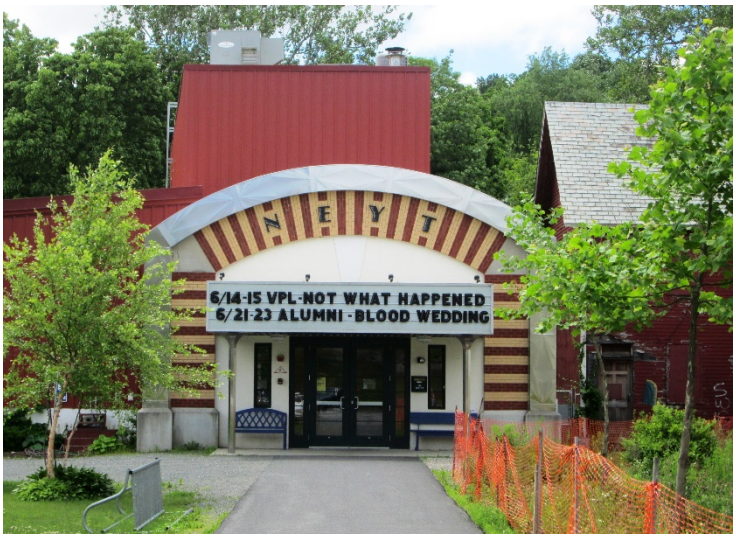
- **Water resistant materials.** A Dry floodproofing design technique assumes that some water may get in. Therefore, there is a need to reduce the damage if it does. To this end, all the gypsum wallboard – a material that absorbs water – was removed and cement board was installed one foot above floor level. The cement board retains its integrity when wet, and it does not wick water up into other parts of the wall, which often causes mildew.

- **Floodgates.** Finally, the five doorways had to be protected from floodwaters. The solution was inexpensive and effective: flood gates were made for each door, the gates consisting of ¼" thick aluminum sheets that slide into tracks at each side of the door frame, and tighten against gaskets with a set of thumbscrews. The gates are located inside rather than outside to allow the doors to swing outwards and let people out. And the doors themselves bear the brunt of the surging water, relieving the gates of most of the water pressure.



Withstanding Tropical Storm Irene

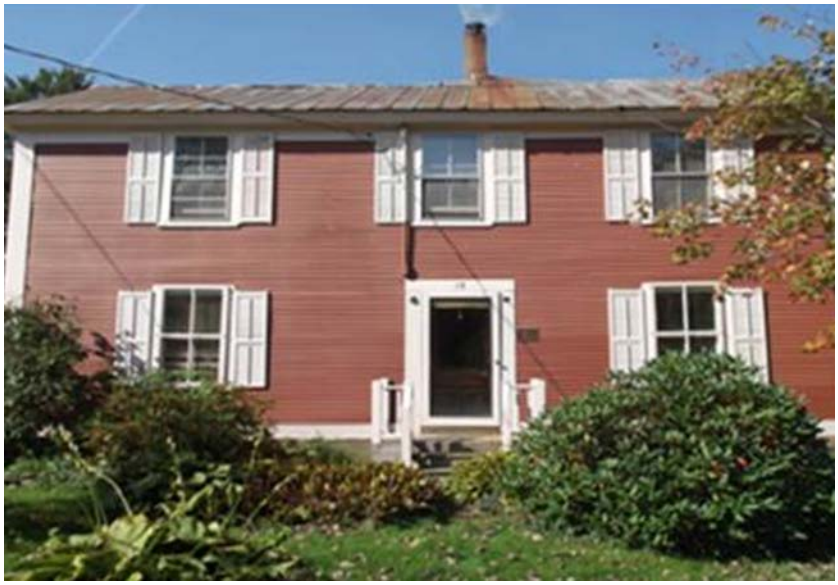
Although the 20" high floodgates exceeded FEMA requirements by almost a foot, waters from the overflowing Whetstone Brook came to 4" from the top of the gates. NEYT is now considering raising the gates another 10" higher. While many of the control measures described above were built into the foundation of the building, floodgates like NEYT's can fairly easily be adapted into an existing building that has adequate foundation strength to resist infiltration of floodwaters. In those cases, this technique may be the best insurance against "the next one."



Jenkauskas Farmhouse

Jeffersonville, Vermont
Wet Floodproofing Case Study

Overview



Jean and Sean Jenkauskas are proud of their Jeffersonville farmhouse, built in 1825 and listed on the National Register of Historic Places. Before they bought it, their home had seen many uses, including a nursing home and apartment building. The couple was determined to return it to its original state as a single family home.

Repeated flooding got in the way of their dream. "Flooding changed our lifestyle," says Jean. After a flood destroyed their furnace in 1995, they received Federal Emergency Management Agency (FEMA) assistance and advice to make their home more floodproof.

Pre-Flood Mitigation Measures

FEMA recommended they raise their utilities at least 14 inches above the base flood elevation. They raised their furnace and their utility panel six and five feet off the ground, respectively. In the kitchen, they raised the refrigerator six inches. They also elevated an antique dresser on plastic milk crates.

Warped drywall in the living room was replaced with concrete board, which resists mold better. Empty plastic containers stored in closets are used to safeguard precious photos and other keepsakes, at a moment's notice.

The Jenkauskases are especially proud of their latest floodproofing upgrade–the water heater in their first floor bathroom. They raised it 14 inches off the ground and decorated it with a wood-trimmed, removable façade.

Withstanding Tropical Storm Irene

After years of planning and hard work, the Jenkauskases achieved their dream of restoring their historic house while also protecting it from future floods. When Tropical Storm Irene hit Vermont in late August 2011, the Jenkauskases received six and a half inches of floodwater on the first floor and it did not affect their utilities.

The Jenkauskases now always look for a new mitigation project. Says Jean: "There's always something more you can do."

Thanks to FEMA for providing this case study.