Evaluation of Public Safety at Run-of-River Dams

An Illinois Statewide Program
Executive Summary

Submitted To:

Capital Development Board of Illinois
July 20, 2007

CTE | AECOM

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Purpose and Scope of the Study

The Illinois Department of Natural Resources (IDNR) is authorized to carry out inspections of any dam within the State, and to establish standards and issue permits for the safe construction of new dams and the reconstruction, repair, operation and maintenance of all existing dams as stated in Section 23a of the Rivers, Lakes and Streams Act (615 ILCS 5/23a).

In an effort to increase public safety at run-of-river dams, the State of Illinois has commissioned this study to document and evaluate existing public safety measures at the 25 run-of-river dams listed to the side (further referred to as either "run-of-river dams" or simply "dams"). In addition, this report considers further public safety measures and presents temporary and permanent structural options, including dam removal that would eliminate or reduce the public safety hazards posed by run-of-river dams.

The scope of this study included review of existing documentation assembled and provided by IDNR for each dam. A visual reconnaissance and assessment was performed at each dam. Based upon the results of the initial assessments, additional assessments were made to determine the feasibility of dam removal. A survey questionnaire was developed and forwarded to municipal emergency responders (EMS) to solicit feedback. Based upon this information, a range of potential options was developed to address the public hazards at each dam. Options developed included guidelines for warning and informational signage at run-of-river dams, signage plans specific to each dam, a general public awareness program, and temporary and permanent structural options including dam removal. Each option was developed at a preliminary, concept level of detail adequate for planning purposes only. These options, along with preliminary cost opinions are presented here for consideration and review by the state.

This report is organized into an executive summary, a main report, and 5 appendices. The main report presents a general overview of this study, potential signage guidelines and a plan for each dam, a general public awareness program, and temporary and permanent structural options to improve public safety.

Dams Assessed

- **Kankakee River**
  - Momence
  - Kankakee
  - Wilmington
  - Wilmington Millrace
- **Rock River**
  - Oregon
  - Sinnissippi
  - Lower Sterling
  - Sears
  - Steel
- **Fox River**
  - McHenry (Stratton L&D)
  - Algonquin
  - Carpentersville
  - Elgin Kimball Street
  - South Elgin
  - St. Charles
  - Geneva
  - Batavia
  - North Aurora
  - Aurora East
  - Montgomery
  - Yorkville
- **Des Plaines River**
  - Hofmann
- **Vermillion River**
  - Danville
- **Sangamon**
  - Riverside Park
  - Petersberg

Run-of-river dams span the entire width of a river channel, and water continuously flows over the crest of the dam. The drop at the dam crest, and the often dangerous currents downstream, contribute to hazardous conditions for river users and pedestrians.

South Elgin Run-of-River Dam, Fox River

These currents may challenge even the best swimmer, canoeist, or kayaker, as seen in past incidents across the country. Air may also become entrained in the turbulent water, decreasing water density and buoyancy, making it more difficult to stay afloat. Even if an individual is wearing a safety vest, they may be forced and held under the water. Run-of-river dams and their surrounding areas are often considered attractive to fishermen, canoeists, kayakers, and children; however, river users and pedestrians may be unaware of the risks associated with these dams. Would be rescuers frequently underestimate the power of the water and become victims themselves.

Warning and Informational Signage

In an effort to increase public safety at run-of-river dams, this study examines current warning and informational signage for river and shoreline users at each dam, and presents guidelines and plans for signage.

Signage for recreational river and shoreline users can serve as an effective tool in the effort to enhance public safety at run-of-river dams. Guidelines presented within this report should be viewed as a basis for developing statewide standards.

The guidelines developed for this study were based upon warning Illinois river and shoreline users while incorporating standard signage guidelines from other state and federal agencies. There are additional considerations that should be taken into account in the development of signage standards that were beyond the scope of this study, ranging from maintenance to right-of-way considerations and community acceptance. As a result, the signage guidelines presented in this report are intended for use under optimal conditions (e.g. acquired right of ways, adequate access for posting, etc.); therefore, variations may be required due to site specific conditions not addressed herein.

Proposed Signage along River Banks

Signage guidelines and individual signage plans were developed such that recreational river and shore users could clearly view the signs in order to be adequately informed of and be provided with enough time to avoid the hazard posed by each dam. Individual signage plans were developed for each dam. A summary of the signage opinions of cost for each dam is presented in Table E-1. Signage guidelines included optional additional signage that may be considered for each dam based upon state or community review. Hence, two opinions of cost are presented. These cost opinions are based on installation at a relatively flat, easily accessible area, and do not include potential increases to costs resulting from difficult installations. Details of the signage guidelines, plans and opinions of cost are given in Section 2 of the main report.

Public Awareness Campaign

A public awareness campaign should be implemented to inform recreational river and shoreline users of the hazards posed by run-of-river dams. The objective of such a campaign would be to reach people who might be put at risk through their interaction with dams. The public awareness campaign should explain the hidden dangers of dams, especially the reverse roller that may form downstream. The campaign should communicate a clear message: the only safe action is to stay out of the water near a run-of-river dam.

The target audience for the public awareness program should include river and pedestrian (i.e. shoreline) users, owners, and emergency responders. This includes boaters, fishermen, dam and shoreline visitors, and in some cases, adjacent land owners. Boaters and fisherman may be able to be reached through state licensing and registration programs. Dam or shoreline visitors can be educated, initially, through educational signage and exhibits or kiosks at the dam. Emergency responders should be provided public awareness information directly, and should be encouraged to share information among EMS personnel throughout the state. Adjacent land owners, including local units of government, such as municipalities, park districts and forest preserves, should also be contacted directly to receive public awareness information. The campaign should also explain to river and

Table E-1 – Signage Opinions of Cost

Dam	Opinion of Cost [1] Without Optional Signs	With Optional Signs
Momence	$ 55,000	$ 62,000
Kankakee	$ 76,000	$ 92,000
Wilmington	$ 195,000	$ 266,000
Wilmington Millrace	$ 50,000	$ 56,000
Oregon	$ 177,000	$ 300,000
Sinnissippi	$ 277,000	$ 416,000
Lower Sterling	$ 152,000	$ 170,000
Sears	$ 77,000	$ 86,000
Steel	$ 242,000	$ 320,000
McHenry (Stratton L&D)	$ 73,000	$ 88,000
Algonquin	$ 63,000	$ 71,000
Carpentersville	$ 86,000	$ 108,000
Elgin Kimball Street	$ 72,000	$ 92,000
South Elgin	$ 108,000	$ 142,000
St. Charles	$ 70,000	$ 83,000
Geneva	$ 94,000	$ 121,000
Batavia	$ 103,000	$ 146,000
North Aurora	$ 106,000	$ 144,000
Aurora East	$ 78,000	$ 97,000
Montgomery	$ 71,000	$ 79,000
Yorkville	$ 99,000	$ 118,000
Hofmann	$ 57,000	$ 65,000
Danville	$ 62,000	$ 68,000
Riverside Park	$ 24,000	$ 30,000
Petersberg	$ 57,000	$ 63,000
Total Cost	**$ 2,524,000**	**$ 3,283,000**

[1] These costs are based on limited information and are for planning purposes only. They do not include costs associated with land acquisition, maintenance, or difficult installation. See the main report for a more detailed discussion.

shoreline users why they should not attempt to rescue individuals caught in turbulent water, and instead what emergency actions could be taken if they witness someone caught in or near the turbulent water. The public awareness program is addressed in Section 3 of the main report.

Temporary Structural Options

The temporary and permanent structural options presented for each dam were developed using basic hydraulics and limited physical data at each dam. A detailed design for each structural option was beyond the scope of this study. Therefore, it is suggested that additional survey, a detailed hydraulic analysis, and a detailed design be completed prior to implementation of any of the structural options presented in this report. While additional analysis may delay construction, it will provide a needed level of confidence.

The temporary structural options presented in this study were limited to the placement of large rock downstream of the dam face. The rock would be placed to a distance downstream and graded to a slope and height that would prevent the formation of a reverse roller up to the 5 year storm event (i.e., the storm event that has a 20% probability of occurrence in any given year). However, rock fill is a temporary option with a limited capacity to reduce the public safety hazard at run-of-river dams. While the life-expectancy of the temporary rock fill option is not known, the rock was sized to be stable up to a 50 year storm event (i.e., the storm event that has a 2% probability of occurrence in any given year). The option provides an alternative that can be implemented in a shorter time-frame and at a lower cost than permanent structural options, while still addressing the public safety hazard at each dam.

Table E-2 summarizes the quantities and opinions of cost for those dams where a rock fill option was considered practical. It should be noted that the assumptions used to estimate the volume of rock fill are extremely conservative, based on extremely limited field survey. This may result in an over estimation of the actual quantity of rock fill required for some dams. As a result, a range of the opinion of cost has been provided using volume estimates based on improved field surveys from two dams (see Table E-2, Reference 2). A detailed discussion of the temporary rock fill options may be found in Section 4 of the main report.

Table E-2 – Temporary Rock Fill Opinions of Cost

Dam	Opinion of Cost[1]
Momence	$ 470,000
Kankakee	*not practical*
Wilmington	$ 2,170,000
Wilmington Millrace	*not practical*
Oregon	$ 38,130,000
Sinnissippi	$ 4,150,000
Lower Sterling	$ 18,030,000
Sears	$ 3,790,000
Steel	$ 1,670,000
McHenry (Stratton L&D)	$ 720,000
Algonquin	$ 1,460,000
Carpentersville	$ 1,640,000
Elgin Kimball Street	$ 2,860,000
South Elgin	$ 660,000
St. Charles	$ 1,820,000
Geneva	$ 860,000
Batavia	$ 3,210,000
North Aurora	$ 850,000
Aurora East	$ 490,000
Montgomery	$ 1,360,000
Yorkville	*not practical*
Hofmann	$ 900,000
Danville	$ 2,190,000
Riverside Park	*not practical*
Petersberg	$ 1,020,000
Total Cost [2]	**$ 88,810,000**

[1] These costs are based on limited information and are for planning purposes only. They do not include costs associated with land acquisition, final engineering design, and permitting. See the main report for a more detailed discussion.

[2] Additional survey data at Oregon and Sinnissippi dam resulted in a reduced cost of as much as 38%. If additional data is gathered at each dam, the total opinion of cost could range from $55,060,000 to $88,810,000.

Permanent Structural Options

Five permanent structural options intended to reduce or eliminate the public safety hazard at run-of-river dams were considered in this report. Four of these options can significantly reduce, but do not eliminate, the hazard, while the remaining option, dam removal, would.

Of the 25 dams assessed, 15 dams were studied for potential removal. Dams providing hydropower, power plant cooling water, or major upstream recreation were not considered for potential removal.

Table E-3 – Dam Removal Opinions of Cost

Dam	Opinion of Cost[1]	
Momence	$	380,000
Lower Sterling	$	8,290,000
Carpentersville	$	940,000
Elgin Kimball Street	$	3,290,000
South Elgin	$	720,000
St. Charles	$	2,250,000
Geneva	$	2,380,000
Batavia	$	2,030,000
North Aurora	$	1,550,000
Aurora East	$	2,900,000
Montgomery	$	670,000
Hofmann	$	1,850,000
Danville	$	2,050,000
Riverside	$	270,000
Petersburg	$	290,000

[1] These costs are based on limited information and are for planning purposes only. More detailed information on sediment may result in a substantial increase in dam removal costs. See the main report for a more detailed discussion.

For each dam that was considered for potential removal, a concept layout was developed to show how removal could be accomplished. An opinion of cost for removal was also determined. It should be noted that costs herein for dam removal are very preliminary in nature. Since sediment removal costs can represent a significant portion of dam removal costs, an accurate estimate of construction costs is dependent on this information. Because complete information regarding the sediment characteristics is not currently available, the final costs associated with sediment removal could increase the overall dam removal cost substantially. A list of dams considered for removal and preliminary opinions of cost are given in Table E-3. Details are given in Section 4 of the main report.

The four other permanent structural options that were considered included a full bypass channel, a riffle pool rock ramp, an in-stream bypass channel, and a dam face modification.

The four other permanent structural options are listed in a general sequence of benefit with regard to improving public safety at the dam site. While dam removal would provide a substantial benefit to public safety by eliminating the hazard posed by the dam, the alternative structural options presented in this report will reduce the hazard. In addition, these options may also provide positive recreational, cost, and environmental benefits when compared to dam removal. A matrix of potential permanent structural options, along with opinions of cost is presented in Table E-4 on the following pages. Details are given in Section 4 of the main report.

Table E-4 – Permanent Structural Options Opinions of Cost

Dam	Full Bypass Channel	Riffle-Pools	In-stream Bypass Channel	Dam Face Modification
Momence	X Private property and development on banks. Bypass could negatively impact upstream pool.	○ Riffles downstream without dam removal. Further studies needed to examine potential for downstream flooding. **$690,000**	X Narrow width and low height makes it infeasible. River passage is possible through the main channel. Bypass could negatively impact upstream pool.	X Not viable given condition of dam
Kankakee	X Infeasible due to hydropower operations and development on banks.	X Dam is relatively high with a variable dam crest height mechanism, making design of consistently available boat passage infeasible. Would also interfere with hydropower discharge, which is located 150 ft downstream.	X Incompatible with hydropower operations and variable height hydraulic bladder.	X Not viable given hydropower operations
Wilmington	X Millrace currently conveys lower flow events, but cannot convey the 5-yr event and has a safety hazard in the steep temporary dam currently in place. Millrace could be regraded with riffles and made passable, however would lack conveyance for the 5 yr event. (See Wilmington Millrace Riffle-Pools)	○ Riffles downstream without dam removal. Further studies needed to examine tributary on downstream left bank and effect on existing floodplain. **$5,270,000**	X Infeasible due to large flow rates over dam.	○ Stepped face extending 22 ft. **$3,890,000**
Wilmington Millrace	X Potential path around left abuttment with riffles. However, option is equivalent to Riffle-Pools / regrading channel.	○ Riffles upstream and downstream in conjunction with dam removal / extensive regrading. May require land acquisition. **$1,450,000**	X Not viable due to the narrow width of the channel and temporary state of the dam.	X Not viable given condition of dam
Oregon	X Infeasible. Option would negatively Impact Byron Power Plant.	X Would require dam removal and extreme bottom regrading. Bottom is 25 ft deep downstream of dam. Channel is also very wide.	X Infeasible. Option would negatively Impact Byron Power Plant.	X Not viable given the excessive cost resulting from the size of the dam
Sinnissippi	X Significant hydropower operations, limited to rock placement.	X Significant hydropower operations, limited to rock placement.	X Significant hydropower operations, limited to rock placement.	X Not viable given gate operations
Lower Sterling	X Infeasible due to development on banks.	X Dam is extremely wide (960 ft).	○ Possible option D/S. Requires investigation into impacts on U/S hydropower at Sinnissippi. **$1,960,000**	○ Stepped face extending 45 ft. **$14,980,000**

X Option eliminated
○ Option considered

[1] These costs are based on limited information and are for planning purposes only. They do not include costs associated with land acquisition, final engineering design, permitting, or environmental considerations such as sediment quality. See the main report for a more detailed discussion.

Table E-4 – Permanent Structural Options Opinions of Cost (Continued)

Dam	Full Bypass Channel	Riffle-Pool	In-stream Bypass Channel	Dam Face Modification
Sears	X No available route and cannot disrupt hydropower operations. Should consider a canoe chute to avoid dam (See Steel Dam Full Bypass, below).	X A bridge is located immediately downstream. Would require dam removal which would interfere with hydropower operations.	X Would lower existing pool and disrupt hydropower.	○ Stepped face extending 45 ft. **$5,690,000**
Steel	○ Bypass through state park canal adjacent to Steel Dam on left channel diverting the 5-year flow is infeasible; cannot disrupt hydropower. However, a minimal canoe chute was considered which would allow boaters to avoid both dams. **$3,470,000**	○ Dam is very wide (775 ft), but option could provide passage to avoid both Sears and Steel dams. Further hydraulic studies needed to analyze effect on existing floodplain. **$4,770,000**	X Instream bypass would lower pool and affect Sears hydropower generation.	X Not viable given range of alternatives
McHenry (Stratton L&D)	X Would lower existing pool and be detrimental to major recreation.	X Would interfere with adjacent spillway.	X Would lower existing pool and be detrimental to major recreation.	○ Stepped face extending 22 ft. **$1,260,000**
Algonquin	X Would lower existing pool and be detrimental to major recreation.	X Would significantly impact stages in Crystal Creek and cause flooding to adjacent park.	X Would lower existing pool and be detrimental to major recreation.	○ Stepped face extending 28 ft. **$2,300,000**
Carpentersville	○ Bypass dam through raceway channel. **$5,250,000**	○ Possible option, downstream around the island. **$6,620,000**	X Full Bypass adequate.	X Not viable given range of alternatives
Elgin Kimball Street	X Private property and development on banks. Railroad on right bank.	X Insufficient length to achieve desired slope due to adjacent bridges.	○ Possible option on left bank. **$1,430,000**	○ Stepped face extending 56 ft. **$4,360,000**
South Elgin	○ Around right abutment. Would significantly affect existing park. **$7,790,000**	○ Riffle Pool Rock Ramp downstream. **$3,940,000**	○ Possible option on right bank. **$480,000**	X Not viable given range of alternatives
St. Charles	X Private property and development on banks.	X Riffles would need to be placed upstream due to adjacent bridge. Requires dam removal.	X Would significanly lower pool, effecting existing major recreation.	○ Stepped face extending 39 ft. **$3,100,000**
Geneva	X Private property and development on banks.	X Riffles would need to be placed upstream due to adjacent bridge. Requires dam removal.	○ Potentially along either bank. Use right bank. **$780,000**	○ Stepped face extending 16 ft. **$1,410,000**
Batavia	X Private property and development on banks.	X Riffles would need to be placed upstream because cannot increase downstream stages. Requires dam removal.	X Requires dam rebuilding. Would significanly lower pool, effecting existing recreation.	X Not viable given condition of dam

X Option eliminated
○ Option considered

[1] These costs are based on limited information and are for planning purposes only. They do not include costs associated with land acquisition, final engineering design, permitting, or environmental considerations such as sediment quality. See the main report for a more detailed discussion.

Table E-4 – Permanent Structural Options Opinions of Cost (Continued)

Dam	Full Bypass Channel	Riffle-Pool	In-stream Bypass Channel	Dam Face Modification
North Aurora	X Flows too large to use adjacent left millrace. Cannot expand millrace width. However, potential for a canoe chute exists through millrace.	X Requires Dam Removal.	○ Along either bank. Use right bank. **$1,610,000**	○ There is an existing dam face modification; however, a stepped face was sized according to this report. The stepped face would extend 28 ft. **$3,860,000**
Aurora East	X Private property and development on banks.	X Not enough distance for required slope due to adjacent upstream and downstream bridges.	X Not enough distance for required slope due to adjacent upstream and downstream bridges. Would re quire diversion of flows from east and west channels.	○ Stepped face extending 22 ft. **$1,560,000**
Montgomery	X Insufficient slope to create riffles and convey required flow. Potential exists for canoe chute in left millrace.	○ Riffles downstream without dam removal. **$7,530,000**	X Not viable given range of alternatives	X Not viable given existing dam face modification
Yorkville	X Presently being built.	X Counter to the proposed modifications	X Full bypass under construction.	X Not viable given existing dam face modification
Hofmann	X Private property and development on banks	X Riffles would need to be placed upstream due to adjacent bridge. Requires dam removal.	○ Potentially along either bank. Use left bank to avoid Hofmann Tower. **$1,290,000**	○ Stepped face extending 28 ft. **$2,820,000**
Danville	X Bypass width approximately equal to existing dam width.	○ Begins at downstream face of dam Regrading required. **$7,220,000**	X Bypass width approximately equal to existing dam width.	○ Stepped face extending 45 ft. **$2,520,000**
Riverside Park	X Not viable given condition of dam.	X Not viable given condition of dam.	X Bypass exists on left side.	X Not viable given condition of dam
Petersberg	X Bypass width approximately equal to existing dam width.	X Not viable given condition of dam.	X Bypass width approximately equal to existing dam width.	X Not viable given condition of dam

X Option eliminated
○ Option considered

[1] These costs are based on limited information and are for planning purposes only. They do not include costs associated with land acquisition, final engineering design, permitting, or environmental considerations such as sediment quality. See the main report for a more detailed discussion.