KEYSTONE WOODS LAKE DAM (29-5)

2023 Dam Safety Inspection Report

Hamilton County, IN | December 2023

Inspection Date: August 2, 2023

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Prepared for:

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DISCLAIMER

This report was prepared by Christopher B. Burke Engineering, LLC (Burke) for the Woodlands Home Owners Association, Inc. (WHOA) for Keystone Woods Lake Dam using available data and observed conditions. Burke is not responsible for any conditions that could not be inspected during the field examination due to excessive vegetation, inundation, or other visual obstructions.

Information describing possible solutions to problems and concerns, repairs, and emergency actions are intended for guidance only. The dam owner should obtain detailed design plans and specifications from a qualified professional engineer experienced in dam design and construction before performing any repairs or modifications to the dam or its appurtenant works. Only qualified contractors should be employed to install necessary measures.

Permits from federal, state or local agencies may be required to perform dam remedial work or repairs, depending on the magnitude of the repairs. The dam owner should seek assistance from a qualified professional in determining the need for permits.

EXECUTIVE SUMMARY

Keystone Woods Lake Dam, also referred to as Woodland Addition Lake Dam, is located a half-mile east of Keystone Parkway between East 106th Street and East 116th Street in Carmel, Indiana. It is located in Section 5, Township 17N, Range 4E of the Public Land Survey System as shown on the Fishers USGS Quadrangle Map. The dam is an earthen embankment constructed across a tributary to Blue Woods Creek. The dam is collectively owned by the Woodland Home Owners Association, Inc and adjacent private properties.

According to the Indiana Department of Natural Resources (IDNR) records, Keystone Woods Lake Dam was constructed immediately downstream of Lake Woodland Dam, an unpermitted structure constructed in the late 1960's, for recreation and aesthetics. Records indicate that the embankment is approximately 14 feet high and 420 feet long, not including the auxiliary spillway. The crest is approximately 10 feet wide. The total surface area is about 53 acres which includes the upstream lake. For the purpose of this inspection report, overall spillway capacity, and recommendations, it is the opinion of Burke that the two lakes be considered one. The principal spillway is comprised of a 2.5-foot by 5-foot reinforced concrete drop inlet box with a 24-inch diameter discharge pipe. The auxiliary spillway is a 108-foot-wide open channel constructed on fill and lined with gravel and riprap.

Burke personnel performed a visual dam safety inspection of Keystone Woods Lake Dam on August 2, 2023. The inspection was performed by Joshua L. Erwood, P.E. and Maxwell V. Runningen, E.I. both having dam safety experience. The August 2, 2023 dam safety inspection revealed that the overall condition of the dam is considered "**Conditionally Poor**" based on IDNR rating criteria. Rehabilitation of the dam is needed to address surficial deficiencies and apparent lack of spillway capacity. Monitoring, maintenance, repairs, engineering analyses, and improvements are required to achieve an overall "Satisfactory" rating and improve the safety and performance of the dam. The risk of Type 1 and Type 2 dam failure is considered low to medium.

The component ratings, overall conditions rating, and recommendations to achieve a "Satisfactory" rating are summarized in the table on the next page.

Component	Rating	Recommendations	Schedule	Importance
Upstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual • Replace gravel covered slope with grass, riprap or other erosion resistant material • Relocate watercraft, docks, and furniture off the dam embankment and onto natural ground • Initiate rodent control program, backfilling burrows in accordance with the Indiana Dam Safety Inspection Manual • Monitor right side wooden seawall for deflection and deterioration; notify a registered professional engineer of observed changes • Seed bare areas along slope • Restabilize and armor scarp forming in bush on left side	• Within 1 year • Within 1 year • Immediately • Ongoing • Ongoing • Within 2 years • Within 2 years	• Medium • Medium • Low • Low • Low • Low • Medium
Crest	Deficient	• Remove trees and brush from the crest in accordance with the Indiana Dam Safety Inspection Manual • Remove concrete patio in its entirety and reestablish dam crest elevation by backfilling with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment • Seed bare areas on crest • Monitor soft area with roots on left side of crest	• Within 1 year • Within 2 years • Within 2 years • Ongoing	• Medium • High • Low • Low
Downstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual • Remove landscaping, decks, steps, and other encroachments and backfill as necessary with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment • Seed sporadic bare areas on right and left sides	• Within 1 year • Within 2 years • Within 2 years	• Medium • Medium • Low
Seepage	Good	• Monitor downstream slope and around concrete patio, steps, and decks for evidence of seepage; notify a registered professional engineer of observed changes • Monitor backyards of properties on right side of dam	• Ongoing • Ongoing	• Low • Low
Principal Spillway	Acceptable	• Seal leaking joints in concrete inlet riser • Clean and paint metal trash rack • Remove tree stumps around outlet • Clear debris in outlet channel • Cover exposed geotextile at outlet • Remove and replace metal end section at outlet	• Within 1 year • Within 1 year • Within 2 years • Within 2 years • Within 2 years • 2-4 years	• Low • Low • Low • Low • Low • Low
Auxiliary Spillway	Deficient	• Add appropriately sized riprap or other armoring to the spillway inlet section for erosion protection • Seed bare spots on left side • Evaluate options for removal of the large tree stump on left side and other tree stumps on right side in riprap; monitor areas adjacent to the stumps for seepage or other surficial deficiency monthly and/or after large rain events and notify a registered professional engineer of observed changes • Monitor start of headcut in the middle of the spillway • Spray and remove vegetation growing within spillway	• Within 2 years • Within 2 years • Within 1 year • Ongoing • Within 2 years	• Low • Low • Low • Low • Low
Maintenance and Repairs	Deficient	• Perform spillway capacity analysis in accordance with current IDNR requirements • Retain a geotechnical engineer to evaluate the stability of the dam under various loading conditions • Conduct a video inspection of the principal spillway outlet pipe; subsequent inspections should be performed every six years • Multiple owners to work to resolve dam inspection recommendations	• Within 1 year • Within 2 years • Within 1 year • Ongoing	• High • High • Low • High
Overall Conditions	**Conditionally Poor**	• **See above**	• N/A	• N/A

Notes:

1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

1.0 BACKGROUND

1.1 PROJECT LOCATION

Keystone Woods Lake Dam is an earthen embankment across a tributary to Blue Woods Creek constructed for aesthetic and recreational purposes. The dam is located in Carmel, Indiana about a half-mile east of Keystone Parkway between East 106th Street and East 116th Street. It is located in Section 5, Township 17N, Range 4E of the Public Land Survey System as shown on the Fishers USGS Quadrangle Map. The dam is collectively owned by Woodland Home Owners Association, Inc (WHOA) and adjacent private properties as referenced in a letter from the Indiana Department of Natural Resources (IDNR) dated July 31, 2020. See **Appendix 1**.

1.2 FILE REVIEW

Unless otherwise noted, information presented in this report is from the visual inspection, a review of information contained in IDNR files, Burke's files, aerial photography, topographic information, and maps publicly available through the Indiana Spatial Data Portal or Indiana Map. An extensive review of IDNR's file was not considered necessary for this inspection due to Burke's previous research of the file and recent involvement with the dam. Primary sources of information include:

- *Woodland Addition Lake Dam Phase I Inspection Report*, prepared by GRW Engineers, Inc. for the United States Army Corps of Engineers (USACE) – Louisville District (1980)
- *Hydraulics and Hydrology for Woodland Addition Lake Dam*, prepared by Clyde E. Williams and Associates, Inc. (1983)
- *High Hazard Dam Inspection Report Keystone Woods Lake Dam,* prepared by Cosmopolitan Consulting Engineers, Inc. (2004)
- *Keystone Woods Lake Dam Inspection Biennial Inspection Report,* prepared by Fink Roberts & Petrie, Inc. (FRP) (2009, 2011)
- *Dam Inspection Report Keystone Woods Lake Dam,* prepared by VHW Engineering Company (2016)
- Dam inspection reports and correspondence prepared by IDNR from 1981 to 2015.
- High hazard dam inspections performed by Burke (2019 and 2021)
- "Wabash Valley Seismic Zone". Central United States Earthquake Consortium. Accessed 29 September 2023 <https://cusec.org/wabash-valley-seismic-zone/ >.
- Gray, Walter E. and John C. Steinmetz. "Map of Indiana Showing Known Faults and Historic Earthquake Epicenters having Magnitude 3.0 and Larger". Indiana Geological Survey. Miscellaneous Map 84, revised 2015.
- "2018 National Seismic Hazard Model for the Conterminous United States, Peak Horizontal Acceleration with a 2% Probability of Exceedance in 50 Years, NEHRP Site Class D". United States Geological Survey. Accessed 29 September 2023 <https://www.sciencebase.gov/catalog>.
- "Earthquake Hazard Maps". Federal Emergency Management Agency. Accessed 29 September 2023. <https://www.fema.gov/earthquake-hazard-maps>.

1.3 HISTORY OF THE DAM

According to IDNR records, Lake Woodland Dam, located upstream of Keystone Woods Lake Dam, was constructed without permit approval in the late 1960's by developer Ralf Wolfong and his engineer Ken Thompson. Shortly after the construction of Lake Woodland Dam, Ken Thompson formed a partnership with John Schutz called Schutz & Thompson, Inc. Schutz & Thompson purchased the land south of Lake Woodland Dam to develop The Woodlands subdivision. In July 1972, Schutz & Thompson received approval from IDNR,

under Docket No. D-3086, for construction of Keystone Woods Lake Dam, referred to at that time as Woodlands Addition Lake Dam. The engineer of record was Clyde E. Williams & Associates, Inc. (CW). The dam was reportedly constructed between 1973 and 1974 without supervision from the design engineer. The contractor who constructed the dam is unknown.

The 1980 Phase 1 report outlined discrepancies between their measurements and the documents of record. The report indicated that the as-built dam crest was 1.8 feet lower than the approved design plans and that the spillways would only be able to safely pass 38% of the Probable Maximum Flood (PMF). In 1983, CW completed a hydrologic and hydraulic evaluation for modifications to the dam and spillway to address the inadequate spillway capacity noted in the Phase 1 report. Plans and technical specifications for raising the embankment crest, lowering the principal spillway crest, widening the auxiliary spillway, and lowering the auxiliary spillway crest were prepared by CW. Approval for construction of these modifications was issued by IDNR in March 1984 under Docket No. D-3086 (revised I). Construction of these modifications was apparently completed in November 1984 by an unknown contractor.

The 2003 Labor Day flood event resulted in significant erosion from activation of the auxiliary spillway. Following the event, the erosion in the auxiliary spillway was backfilled with clay and armored with riprap. In a June 2005 letter to WHOA in response to receiving the 2004 biennial inspection report which documented the 2003 Labor Day flood, IDNR recommended that a new hydrologic and hydraulic analysis be performed to address variations in drainage area previously determined as well as evaluate the anticipated performance of erosion protection through the auxiliary spillway during maximum discharge. No records of these evaluations were found.

In April 2015, a sinkhole formed above the principal spillway. A subsequent video inspection of the principal spillway outlet pipe revealed a hole in the bottom of the pipe likely to have contributed to the sinkhole. Due to the emergency nature of this condition, Burke submitted a letter request to IDNR on April 10, 2015, for Construction in a Floodway Permit approval in lieu of the formal permit application. Approval from IDNR was issued on April 15, 2015, referencing CTS-3965-Basin 14-Hamilton County Unnamed Tributary Blue Woods Creek. Midwest Mole, Inc. slip-lined the 42-inch diameter corrugated metal pipe (CMP) with a 24-inch diameter HOBAS centrifugally cast fiberglass reinforced polymer mortar (CCFRPM) pipe and backfilled the sinkhole. The work was considered substantially complete on October 8, 2015.

Following the 2019 dam safety inspection, WHOA facilitated several meetings with the other dam owners to review the recommendations from the 2019 dam safety inspection. WHOA prepared a drawdown plan for the lake, which was reportedly kept on file in the clubhouse. WHOA also significantly improved the areas around the principal spillway outlet and auxiliary spillway channel in November 2019 and April 2020, removing trees, brush, and unwanted vegetation encroachments. In addition, watercraft previously stored with the auxiliary spillway channel were removed. In July 2020, Wharff Excavating, LLC installed geotextile blankets and riprap armoring to the spillway channel and side slopes. At the principal spillway outlet, the deteriorated concrete outlet channel was replaced with riprap armoring and adjacent eroded areas were repaired.

In August 2020, a portion of the timber seawall along the right side of the dam deteriorated and sloughed into the lake. The property owner, in conjunction with WHOA, contacted IDNR with their plan to replace approximately 24 feet of the seawall with new 6-inch by 6-inch treated posts similar in nature to the original wall. Due to the urgency of the repair, IDNR did not require a formal permit submittal. The work was completed by Outdoor Designs, Inc. shortly thereafter.

1.4 PREVIOUS INSPECTIONS

In accordance with Indiana Code 14-27-7.5-9, high hazard dam owners must have a licensed professional engineer inspect the dam at least one time every two years and submit a report regarding the structure's condition. Prior to enactment of the code in 2002, Keystone Woods Lake Dam was inspected by IDNR nearly every year from 1984 to 1991. IDNR then performed inspections in 1991, 1995, 1997, and 2000. The dam was

inspected by Cosmopolitan Consulting Engineers, Inc. in 2004. Fink Roberts and Petrie, Inc. inspected the dam in both 2009 and 2011. VHW Engineering Company inspected the dam in 2016. Burke performed the most recent inspections in 2019 and 2021.

Table 1: Previous Inspection Ratings (2000 - 2021)

Component		Condition Ratings Per Inspection					
	2000	2004	2009	2011	2016	2019	2021
Upstream Slope	Acceptable	Acceptable	Acceptable	Acceptable	Good	Deficient	Deficient
Crest	Deficient	Acceptable	Acceptable	Acceptable	Deficient	Deficient	Deficient
Downstream Slope	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Deficient	Deficient
Seepage	Good	Good	Acceptable	Acceptable	Acceptable	Good	Good
Principal Spillway	Deficient	Good	Acceptable	Acceptable	Acceptable	Deficient	Acceptable
Auxiliary Spillway	Acceptable	Good	Deficient	Deficient	Deficient	Deficient	Deficient
Maintenance and Repairs	Deficient	Acceptable	Acceptable	Acceptable	Acceptable	Deficient	Deficient
Overall Conditions	**Conditionally Poor**	**Satisfactory**	**Fair**	**Fair**	**Fair**	**Poor**	**Conditionally Poor**

Notes:
1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

1.5 HISTORICAL EVENTS

The 2003 Labor Day event resulted in activation of the auxiliary spillway and erosion damage downstream. There were no other major historical events or records of peak water levels or discharges at the site noted in IDNR's file.

1.6 EMERGENCY PREPAREDNESS

Keystone Woods Lake Dam is classified as a high hazard structure. Starting in July 2022, Indiana Code 14-27-7.5-18 requires that the owner of a high hazard dam prepare and maintain an Incident and Emergency Action Plan (IEAP). Although there is mention in the 2009 inspection report by FRP of an Emergency Action Plan having been prepared, no document was found in either IDNR's file or the owner's file. However, WHOA is reportedly preparing an Incident and Emergency Action Plan (IEAP) for the dam, coordinating the documentation with Hamilton County Emergency Management. The dam is accessed by foot since there are no roads leading to the dam. No auxiliary power is necessary because the dam and spillways do not have electrical components. In 2019, the owner reportedly prepared a drawdown plan.

1.7 HYDROLOGY

Dams classified as high hazard by IDNR are required to safely pass the rainfall runoff from the 100% PMP event without overtopping. A PMP storm event is the Probable Maximum Precipitation that can be expected during specific storm durations. The design storm duration is generally dictated by the size of the dam's watershed. For the location and size of the Keystone Woods Lake Dam watershed, the 6-hour PMP (10 square mile basin) is 26.9 inches. Several hydrologic and hydraulic analyses have been performed with varying results due to differences in watershed size, top of dam and spillway elevations, and rainfall depths. A summary of

these analyses is provided below.

The 1972 Engineer's Report for Keystone Woods Lake Dam, prepared by CW, recorded a surface area of approximately 7 acres at normal pool, at an elevation of 774.5 feet mean sea level (MSL), with a corresponding storage volume of 19.2 acre-feet. The contributing watershed was 0.76-square mile (485 acres). Flood routing calculations, performed using a 6-hour rainfall depth of 25.5 inches, resulted in a maximum pool elevation of 779.85 feet (MSL) which is 0.15-foot below the top of dam.

The 1980 Phase 1 report noted a few differences from the original design based on measurements and calculations. The Phase 1 report found the top of dam elevation to be 778.2 feet (MSL), the auxiliary spillway crest to be 774.8 feet (MSL), and the contributing drainage area to be 1.1 square miles. In addition, the Phase 1 report noted that the flood routing should have been evaluated based on a 6-hour rainfall depth of 27 inches. As a result of these differences, the Phase 1 report determined that the overall spillway capacity was inadequate, passing only 38% of the recommended design flood.

In order to address the inadequate spillway capacity determined in the Phase 1 report, CW designed modifications in 1983 that included raising the dam crest to 778.7 feet (MSL), lowering the principal spillway crest to 774.2 feet (MSL), widening the auxiliary spillway eight feet, and lowering the auxiliary spillway crest to 774.6 feet (MSL). CW used a drainage area of 0.67-square mile and a 6-hour rainfall depth of 26.9 inches to determine that the dam could pass 100% of the recommended design flood without overtopping.

It should be noted that the 2015 principal spillway repair work included slip-lining the existing 42-inch diameter CMP with a 24-inch diameter CCFRPM pipe though no hydraulic analysis appears to have been completed.

1.8 GEOLOGIC, SEISMIC AND GEOTECHNICAL CONSIDERATIONS

The following paragraph describing geologic features is from the Phase 1 report:

"The site is located within the limits of the glacial till deposited when the various ice sheets receded. In this area, these glaciers left unconsolidated deposits of granular materials up to 150-ft. thick. The deposits are mostly loam till and are part of the Trafalgar formation. The site is underlain by bedrock of the Devonian period and consists mostly of limestone and dolomite of middle Devonian age. The Fortville Fault is located approximately ten miles to the southeast and extends in the southwesterly-northeasterly direction. The dam is within Seismic Zone 2 according to the Seismic Zone Map of contiguous States. Zone 2 indicates that moderate damage may result from the expected seismic activity."

Original construction drawings for the Keystone Woods Lake Dam include five soil borings that appear to have been taken in the vicinity of the embankment as well as in the lake area. However, no geotechnical engineering evaluation of the structure's stability is known to exist. Geotechnical engineering considerations should be made in accordance with the following guidelines outlined by IDNR and USACE:

- *General Guidelines for New Dams and Improvements to Existing Dams in Indiana, 2001 edition*
- *General Design and Construction Considerations for Earth and Rock-Fill Dams (U.S. Army Corps of Engineers, Engineering and Design Manual EM 1110-2-2300), dated July 30, 2004*

According to the Federal Emergency Management Agency (FEMA), the dam is within the limits of an area where seismic design category (SDC) "A" is applicable. This category is the lowest risk and is described as an area that "very small probability of experiencing damaging earthquake effects." The USGS has determined that the 50-year two-percent probability of exceedance peak ground acceleration near Keystone Woods Lake Dam is approximately 0.1g, where "g" is standard gravity. Although the perceived seismic risk is low, the dam is in an area that could be impacted by earthquakes from the Wabash Valley Seismic Zone in southwest Indiana and southeast Illinois and the New Madrid Seismic Zone centered in southeast Missouri, according to information from the Central United States Earthquake Consortium and the USGS. Three earthquakes of magnitude 7.3 or

greater occurred near New Madrid, Missouri in 1811 and 1812 which were undoubtedly felt in central Indiana. Indiana Geological Survey (IGS) records indicate that the closest earthquakes to the dam that occurred in Indiana with magnitude 3.0 or greater were:

- Magnitude 3.2 near Shelbyville in Shelby County on May 8, 1906
- Magnitude 3.8 near Shelbyville in Shelby County on September 12, 2004
- Magnitude 3.8 near Greentown in Howard County on December 30, 2010

Several other earthquakes have occurred in Indiana and Illinois, many since the dam was constructed. The most notable is a magnitude 5.2 that occurred on April 18, 2008, near Mount Carmel, Illinois about 138 miles southwest of Keystone Woods Lake Dam. Most recently, a magnitude 3.8 earthquake occurred northeast of Montezuma, Indiana on June 17, 2021 about 68 miles southwest of Keystone Woods Lake Dam. All earthquakes noted were reported to the USGS as felt in Hamilton County. There has been no documented damage to Keystone Woods Lake Dam because of earthquakes.

1.9 DAM AND LAKE CHARACTERISTICS

Keystone Woods Lake Dam is an approximately 14-foot-tall earthen embankment that is approximately 420 feet long, not including the auxiliary spillway, and has a crest width of 10 feet. The upstream and downstream slopes are approximately 3:1 (H:V). Although original construction drawings appear to show a toe drain, no outlet was observed in the field. For reference, left and right are based on a view looking downstream. For Keystone Woods Lake Dam, left and right correspond to east and west, respectively.

The principal spillway is comprised of a 2.5-foot by 5-foot reinforced concrete drop inlet box with an approximately 70-foot long, 24-inch diameter CCFRPM outlet pipe located near the center of the dam. The 24-inch CCFRPM pipe is slip lined within the original 42-inch CMP. Four anti-seep collars were constructed along the pipe with 10-foot spacing downstream of the drop inlet structure. The outlet pipe discharges into an armored channel consisting of a short CMP section at the upstream end followed by gabion mattresses. The auxiliary spillway is a 108-foot-wide open channel constructed on fill and lined with gravel and riprap located adjacent and to the left of the principal spillway.

The total surface area of the lake is about 53 acres which includes the upstream impoundment. For the purpose of this inspection report, overall spillway capacity, and recommendations, it is the opinion of Burke that the two lakes be considered one due to the uncertainties associated with current condition of the upstream embankment as well as the hydraulic connectivity between the lakes.

1.10 DOWNSTREAM FEATURES

The valley downstream of the dam is relatively broad and flat. The channel downstream known as Blue Woods Creek goes through a wooded area between tennis courts and a community swimming pool before it is piped under Lakeshore Drive East. The creek continues through residential and industrial areas for approximately 2.7-miles until its confluence with White River. Several houses located along Blue Woods Creek are likely within the dam breach inundation area.

2.0 OBSERVED CONDITIONS

Burke personnel performed a visual dam safety inspection of Keystone Woods Lake Dam on August 2, 2023. The inspection was performed by Joshua L. Erwood, P.E. and Maxwell V. Runningen, E.I., both having dam safety experience. The weather conditions during the inspection were mostly clear with a temperature of approximately 65 degrees Fahrenheit. The principal spillway was not engaged at the time of the inspection. The water surface elevation was slightly below normal pool.

Narrative descriptions of the inspection findings are provided below. The IDNR Inspection Report Form summarizing the inspection findings and containing descriptions of the rating criteria can be found in **Appendix 2**. A copy of the IDNR Inspection Report Form from the 2021 biennial inspection report is provided in **Appendix 3**. Refer to **Appendix 4** for photographs taken the day of the inspection. **Appendix 5** contains the dam inspection checklist completed during the inspection. Refer to the **Exhibits** section of this report for a USGS quadrangle map, aerial photograph, and inspection summary map.

2.1 UPSTREAM SLOPE

The upstream slope is generally grass-covered but has a large area on the left side of the dam that is covered with gravel. There is a timber seawall along the upstream slope right of the principal spillway that extends roughly 4 feet above the normal pool elevation. The timber seawall appeared to have a slight deflection toward the lakeside. The left side of the timber seawall is deteriorating and the entire sea wall appears to be rotting below normal pool but could not be inspected thoroughly. A rock seawall, approximately 2.5 feet above the normal pool elevation, is located near the left abutment area.

There were several encroachments throughout the upstream slope such as a Gazebo, docks, fences, watercraft, and patio furniture. In addition, a concrete patio was cut into the embankment near the principal spillway on the right side. The concrete patio had a longitudinal crack across it showing slight settlement into the lakeside of the embankment. Trees, brush, and residential landscaped areas were observed sporadically along property lines of owners along the embankment. There are two large diameter trees in the gravel area on the left side of the embankment and another tree on the right side of the dam above the timber seawall. There is a large bush on the left side near the waterline and one the right side of the dam.

A 10-inch deep and 10-foot-long scarp was observed inside of a bush on the left side of the dam. A few animal burrows about 1-inch in diameter were noted near the fence on the left side of the dam and in the gravel covered slope. A few small burrows were found behind the timber seawall on the right side. Bare areas were observed by the dock and wooden fence on the left side of the slope. The upstream slope was considered **"Deficient"** according to IDNR rating criteria.

2.2 CREST

Grass cover on the crest was generally adequate except for a bare area near the left abutment fence that was measured to be approximately 6 feet by 4 feet. The crest width was measured by tape to be 15 feet wide in this area on the left side. A garden bed encroaching near the right abutment also had bare spots surrounding it. There are two fire pits encroaching on both sides of the dam. There are trees and bushes near both right and left abutments along fences. A landscaped area and a stored watercraft were observed near the fence on the left side of the embankment. A soft spot with tree roots was observed on the left side of the dam. The concrete patio built into the embankment right of the principal spillway has resulted in a loss of crest width and freeboard. The loss of freeboard was estimated to be about 6 to 12 inches. The crest was considered **"Deficient"** according to IDNR rating criteria.

2.3 DOWNSTREAM SLOPE

The downstream slope was adequately covered with grass except for a few minor bare spots. One bare area was 3-foot by 3-foot next to a fence on the right side. Trees and brush were observed growing on the downstream slope at two areas on the middle-left embankment. Trees and brush were also observed near the left and right abutments. Several encroachments were observed on the right side of the dam including landscaping, fencing, steps, and a wood deck. A landscaped area with trees and bushes was observed near the fence on the left end. The right side had one property with several saturated areas along the slope and at the toe. The wet areas are likely due to yard irrigation and poorly drained areas. The downstream slope was considered **"Deficient"** according to IDNR rating criteria.

2.4 SEEPAGE

The right side of the dam had multiple areas of dampness and standing water in the back yards of some houses likely caused by recent rainfall and over irrigation. Though it appears that the natural ground in many areas was above normal pool. Seepage was considered **"Good"** according to IDNR rating criteria.

2.5 PRINCIPAL SPILLWAY

The visible portions of the principal spillway concrete riser structure showed minor surface deterioration, consistent with its age, with a thin layer of dried film from operation. A smaller diameter pipe was observed directly across from the outlet pipe, near the bottom of the riser, though it appears to have been capped and no longer operational. Possible seepage through the concrete structure was observed on the right side and left sides at the joints between the riser and retaining wall. Minor surface rust was observed on the inlet's metal trash rack. The metal end section has a rusted invert and holes on the side with some vegetation growing through. Some riprap has fallen into the outlet pipe invert creating potential flow obstructions. The outlet was observed to have tree stumps around it and areas of exposed geotextile fabric. The interior of the outlet pipe itself could not be thoroughly, thought, it should be noted that the reduction in cross sectional area of the pipe during the 2015 slip-lining work likely reduced its capacity. The principal spillway was considered **"Acceptable"** according to IDNR rating criteria.

2.6 AUXILIARY SPILLWAY

The open channel auxiliary spillway is located near the center of dam and appears to have been constructed on fill. The surface of the channel is covered in gravel and riprap which was observed to be sparse at the inlet section. Aquatic vegetation is growing along the inlet section of the spillway. There was a large tree stump left over from tree removal on the left side and a few smaller tree stumps within the riprap on the right side. A few small bare spots were observed on the left side slope at the interface with the downstream slope along with by the tree stump of the left side. The start of a headcut was noted in the middle of the auxiliary spillway due to periodic flow. Some vegetation is growing along the flow path. As noted previously, there is uncertainty with the spillway system's (principal spillway and auxiliary spillway) ability to safely pass the runoff from the 100% PMP storm event without overtopping the embankment. The auxiliary spillway was considered **"Deficient"** according to IDNR rating criteria.

2.7 MAINTENANCE AND REPAIRS

Keystone Woods Lake Dam has seen significant improvement regarding maintenance and repairs, particularly through the auxiliary spillway and at the outlet of the principal spillway. Some of the previously noted watercraft had been moved from the dam to the pool at the club house. However, several natural and manmade encroachments remain that will require enhanced monitoring, additional studies, removal and/or rehabilitation. In particular, trees, brush, and landscaping located on several portions of the dam. The concrete patio cut into the embankment effectively lowers the crest elevation of the dam. Further, critical analyses are needed to determine the actual spillway capacity and factors of safety for embankment slope stability in accordance with IDNR guidelines.

Based on the 2019 dam safety inspection review letter from IDNR dated July 31, 2020, multiple properties have been identified as owning parts of the dam. When there are multiple owners of a dam, no one party has authority to conduct work, limiting the dam from receiving proper maintenance. Thus, all owners have to work together to remedy dam safety issues. Keystone Woods Lake Dam was considered to be maintained in **"Deficient"** condition according to IDNR rating criteria.

2.8 OVERALL CONDITION

The overall condition of Keystone Woods Lake Dam was considered **"Conditionally Poor"** according to IDNR rating criteria. Based on IDNR guidelines, the potential overall condition ratings include, from worst to best, Unsatisfactory, Poor, Conditionally Poor, Fair, and Satisfactory. A "Conditionally Poor" dam is one that "A potential dam safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. Conditionally Poor may also be used with uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency; further investigations and studies are necessary". This rating primarily reflects uncertainties in spillway capacity and embankment stability as well as encroachments, both manmade and natural. A summary of inspection observations is provided in **Table 2.** Note that observation numbers correspond with the **Exhibit 3** Inspection Summary and **Appendix 4** Inspection Photograph numbering. Category colors correspond to **Exhibit 3** Inspection Summary locations.

Table 2: Inspection Observations Summary

Observation Number	Category	Component	Location	Description
1	Encroachment	Upstream Slope	Left	Dock on upstream slope with depression behind it
2	Encroachment	Upstream Slope	Left	Large bush, tree stump, post, and irrigation valve located on slope
3	Encroachment	Upstream Slope	Left	Trees and hammock on upstream slope
4	Encroachment	Upstream Slope	Left	Gazebo, ramp, dock, landscaping, trees on upstream and crest of dam in back yard
5	Surficial	Upstream Slope	Left	Bare area along fence line
6	Surficial	Upstream Slope	Left	Burrow hole
7	Surficial	Upstream Slope	Left	Burrow holes near dock
8	Surficial	Upstream Slope	Left	Bare area by dock
9	Surficial	Upstream Slope	Left	Burrow holes
10	Surficial	Upstream Slope	Left	10-inch deep by 10-foot wide scrap in bush
11	Surficial	Upstream Slope	Left	Gravel landscaping, undulating slope, and aquatic vegetation
12	Encroachment	Upstream Slope	Middle	Watercraft on slope
13	Surficial	Upstream Slope	Middle	Landscaping, watercraft, and flagpole
14	Vegetation	Upstream Slope	Middle	Vegetation above riprap, vegetation below riprap, sparse riprap
15	Encroachment	Upstream Slope	Right	Landscaping, vegetation, fireplace, and garden
16	Encroachment	Upstream Slope	Right	Dock built into upstream and crest, watercraft, patio furniture
17	Encroachment	Upstream Slope	Right	Tree on upstream slope
18	Structural	Upstream Slope	Right	Deteriorating wooden seawall angled toward lake
19	Structural	Upstream Slope	Right	Concrete slab cracking and settling into dam
20	Structural	Upstream Slope	Right	Wooden seawall angled toward lake, wood rotting at normal pool
21	Surficial	Upstream Slope	Right	3.5-foot-deep burrow 2-inches in diameter
22	Surficial	Crest	Left	Bare area 6-foot by 4-foot. Crest width measured by tape to be 15 feet wide.
23	Surficial	Crest	Left	Soft area with roots, possible tree removal
24	Encroachment	Crest	Middle	Fire pit with brush
25	Encroachment	Crest	Right	Garden and vegetation with bare spots around
26	Encroachment	Downstream Slope	Left	Trees and landscaping within 25 feet of the toe

27	Encroachment	Downstream Slope	Left	Trees and brush on downstream slope and within 25 feet of toe
28	Encroachment	Downstream Slope	Left	Tree within 25 feet of toe
29	Encroachment	Downstream Slope	Left	Fence along upstream, crest, and downstream
30	Drainage	Downstream Slope	Right	Wet area along fence line
31	Drainage	Downstream Slope	Right	Wet areas from irrigation
32	Drainage	Downstream Slope	Right	Saturated slope area 11 feet by 23 feet
33	Encroachment	Downstream Slope	Right	Deck on downstream slope could not inspect thoroughly
34	Drainage	Seepage	Right	Wet backyard, appears to be due to over irrigation
35	Structural	Principal Spillway	Inlet	Surface rust on trashrack, possible seepage in concrete drop inlet joints, minor vegetation and debris on inlet
36	Structural	Principal Spillway	Outlet	Outlet metal end section deteriorating with holes, tree roots around outlet, exposed geotextile, and riprap fallen into pipe outlet
37	Vegetation	Principal Spillway	Outlet	Vegetation in outlet channel
38	Vegetation	Auxiliary Spillway	Entire Component	Vegetation in riprap, varying riprap sizes.
39	Surficial	Auxiliary Spillway	Left	Bare area around stump with cracking
40	Slope	Auxiliary Spillway	Middle	Headcut forming from periodic flow in spillway with vegetation growth
41	Surficial	Auxiliary Spillway	Right	Exposed geotextile fabric
42	Vegetation	Auxiliary Spillway	Inlet	Aquatic vegetation along shoreline

3.0 RISK OF DAM FAILURE

Burke utilized the results of the dam inspection to evaluate the potential for failure of Keystone Woods Lake Dam. There are typically two types of dam failures that could occur:

- Type 1 – component failure of a structure that does not result in a significant release from the lake
- Type 2 – uncontrolled breach failure of a structure that results in a significant release from the lake

Refer to **Appendix 6** for more details of types of failure and definitions of risk levels. Burke evaluated the risk for both types of failures.

3.1 RISK OF DAM COMPONENT FAILURE (TYPE 1)

Burke evaluated the risk for Type 1 component failure at Keystone Woods Lake Dam after the inspection was completed by considering possible failure of each component. The components that were evaluated include the upstream embankment slope, downstream embankment slope, embankment crest, principal spillway, auxiliary spillway, and dam abutments. After considering the dam's current condition and the potential maximum loadings, Burke has estimated the risk of failure for each component as shown below. The estimated risk levels are based on Burke's visual observations during the inspection and do not necessarily account for uncertainties in critical analysis parameters which could impact the risk level.

Component	Risk Level
Upstream slope	Medium
Downstream slope	Medium
Embankment crest	Medium
Principal spillway	Low
Auxiliary spillway	Medium
Dam abutments	Low

3.2 RISK OF UNCONTROLLED BREACH FAILURE (TYPE 2)

Burke evaluated the potential for an uncontrolled breach failure of Keystone Woods Lake Dam after the inspection was completed by considering possible failure modes. Embankment dams such as Keystone Woods Lake Dam generally have three potential modes of uncontrolled breach failure: 1) hydraulic failure, 2) seepage failure, and 3) structural failure. The factors that pose a risk to embankment dams and can result in dam failure can be categorized into four groups: 1) structural factors, 2) natural factors, 3) human factors, and 4) operating factors. Refer to Appendix 6 for more information about failure modes and risk factors. **At the present time, Keystone Woods Lake Dam appears to have a low to medium risk for uncontrolled breach failure.**

Structural deficiencies were observed during the inspection that pose a low to medium risk of Type 2 failure of Keystone Woods Lake Dam. Structural factors are summarized below.

Structural factors	Risk Level	Failure Mode
Vegetation on embankment crest and slopes	Low	Structural/Seepage
Manmade encroachments on embankment	Medium	Hydraulic/Structural
Small animal burrows	Low	Seepage
Principal spillway inlet joints	Low	Seepage

Natural, human, and operating risk factors were also considered. Severe storms present a medium risk to Keystone Woods Lake Dam due to the perceived capacity of the lake and spillway system. Earthquakes present a low risk, but the dam's proximity to the Wabash Valley and New Madrid Seismic Zones should not be ignored. **It should be noted that there is always some risk for failure at all dams and that risk cannot be completely eliminated.**

Natural factors	Risk Level	Failure Mode
Severe storms	Medium	Hydraulic
Earthquakes	Low	Structural

Human factors	Risk Level	Failure Mode
Vandalism	Low	Structural
Terrorism	Low	Structural

Operating factors	Risk Level	Failure Mode
Maintenance Practices	Low	Hydraulic/Structural
Access	Low	Hydraulic/Structural

4.0 RECOMMENDATIONS

This section presents Burke's recommendations for action based on the findings of the dam safety inspection, Burke's assessment of the risk of dam failure at Keystone Woods Lake Dam, and Burke's assessment of the priority for repairs of each observed deficiency. Based on inspection findings, Keystone Woods Lake Dam requires monitoring, maintenance, engineering analysis, and improvements to achieve IDNR's "Satisfactory" overall conditions rating. Burke's objective is to make engineering recommendations that minimize the risk of

failure to an acceptable level. A summary of the 2023 inspection ratings and recommendations are provided in **Table 3**. **Table 4** on the subsequent page is a summary of inspection ratings from 2004-2023.

The dam owner should consult with a registered professional engineer experienced in dam safety and, if necessary, IDNR, to determine which recommendations require detailed design plans and specifications prepared by a qualified registered professional engineer. Permits from federal, state, or local agencies may be required to perform dam remedial work or repairs, depending on the magnitude of the repairs. In general, routine monitoring and surficial maintenance such as seeding and debris removal do not require plans or permits. Tree and stump removals should be conducted under the supervision of a registered professional engineer due to the importance of proper backfill and compaction. Only qualified contractors should be employed to install necessary measures.

Table 3: Inspection Ratings and Recommendations

Component	Rating	Recommendations	Schedule	Importance
Upstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• Within 1 year	• Medium
		• Replace gravel covered slope with grass, riprap or other erosion resistant material	• Within 1 year	• Medium
		• Relocate watercraft, docks, and furniture off the dam embankment and onto natural ground	• Immediately	• Low
		• Initiate rodent control program, backfilling burrows in accordance with the Indiana Dam Safety Inspection Manual	• Ongoing	• Low
		• Monitor right side wooden seawall for deflection and deterioration; notify a registered professional engineer of observed changes	• Ongoing	• Low
		• Seed bare areas along slope	• Within 2 years	• Low
		• Restabilize and armor scarp forming in bush on left side	• Within 2 years	• Medium
Crest	Deficient	• Remove trees and brush from the crest in accordance with the Indiana Dam Safety Inspection Manual	• Within 1 year	• Medium
		• Remove concrete patio in its entirety and reestablish dam crest elevation by backfilling with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• Within 2 years	• High
		• Seed bare areas on crest	• Within 2 years	• Low
		• Monitor soft area with roots on left side of crest	• Ongoing	• Low
Downstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• Within 1 year	• Medium
		• Remove landscaping, decks, steps, and other encroachments and backfill as necessary with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• Within 2 years	• Medium
		• Seed sporadic bare areas on right and left sides	• Within 2 years	• Low
Seepage	Good	• Monitor downstream slope and around concrete patio, steps, and decks for evidence of seepage; notify a registered professional engineer of observed changes	• Ongoing	• Low
		• Monitor backyards of properties on right side of dam	• Ongoing	• Low
Principal Spillway	Acceptable	• Seal leaking joints in concrete inlet riser	• Within 1 year	• Low
		• Clean and paint metal trash rack	• Within 1 year	• Low
		• Remove tree stumps around outlet	• Within 2 years	• Low
		• Clear debris in outlet channel	• Within 2 years	• Low
		• Cover exposed geotextile at outlet	• Within 2 years	• Low
		• Remove and replace metal end section at outlet	• 2-4 years	• Low
Auxiliary Spillway	Deficient	• Add appropriately sized riprap or other armoring to the spillway inlet section for erosion protection	• Within 2 years	• Low
		• Seed bare spots on left side	• Within 2 years	• Low
		• Evaluate options for removal of the large tree stump on left side and other tree stumps on right side in riprap; monitor areas adjacent to the stumps for seepage or other surficial deficiency monthly and/or after large rain events and notify a registered professional engineer of observed changes	• Within 1 year	• Low
		• Monitor start of headcut in the middle of the spillway	• Ongoing	• Low
		• Spray and remove vegetation growing within spillway	• Within 2 years	• Low
Maintenance and Repairs	Deficient	• Perform spillway capacity analysis in accordance with current IDNR requirements	• Within 1 year	• High
		• Retain a geotechnical engineer to evaluate the stability of the dam under various loading conditions	• Within 2 years	• High
		• Conduct a video inspection of the principal spillway outlet pipe; subsequent inspections should be performed every six years	• Within 1 year	• Low
		• Multiple owners to work to resolve dam inspection recommendations	• Ongoing	• High
Overall Conditions	**Conditionally Poor**	• **See above**	• N/A	• N/A

Notes:

1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

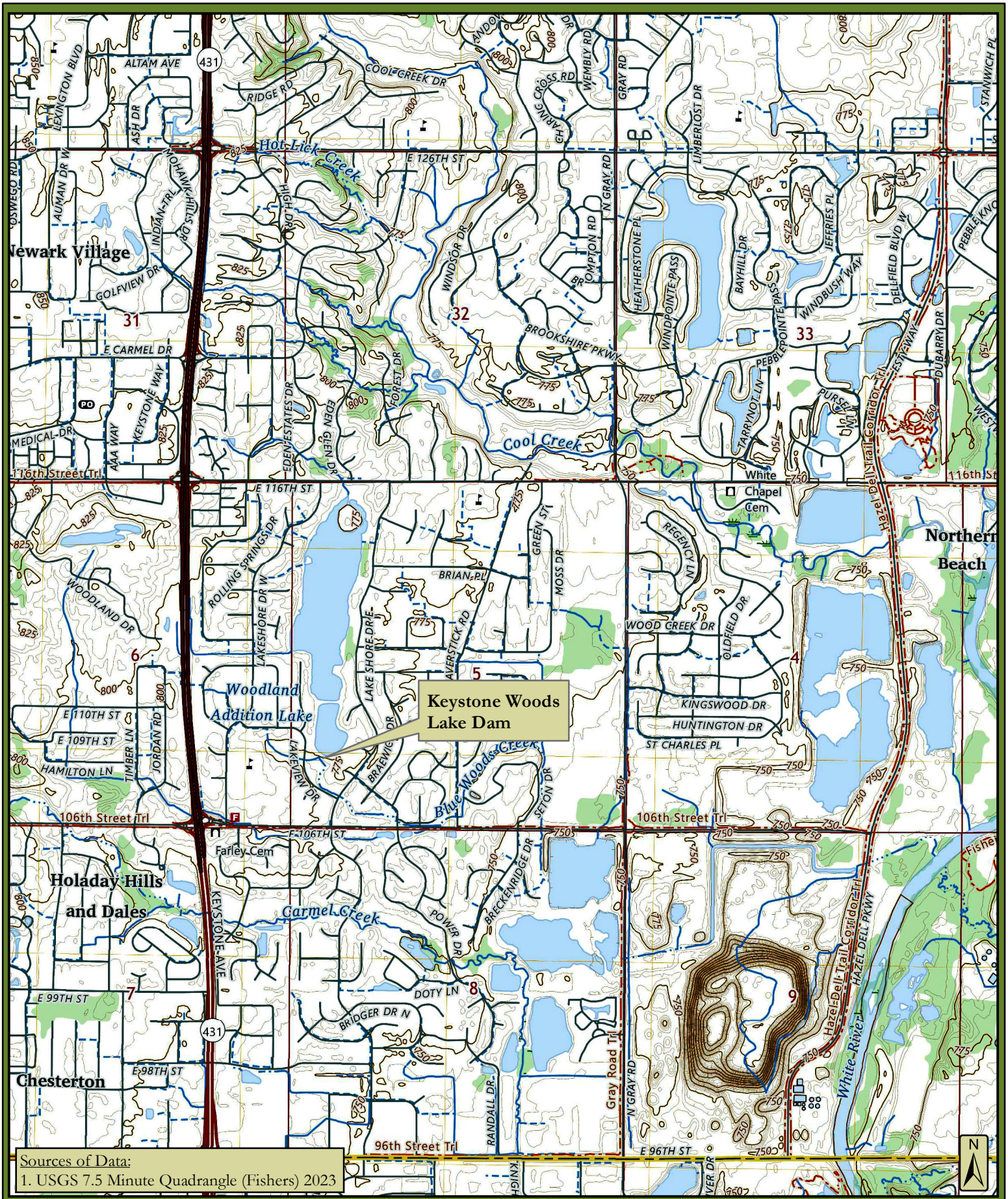
Table 4: Previous Inspection Ratings (2004 - 2023)

Component	Condition Ratings Per Inspection						
	2004	**2009**	**2011**	**2016**	**2019**	**2021**	**2023**
Upstream Slope	Acceptable	Acceptable	Acceptable	Good	Deficient	Deficient	Deficient
Crest	Acceptable	Acceptable	Acceptable	Deficient	Deficient	Deficient	Deficient
Downstream Slope	Acceptable	Acceptable	Acceptable	Acceptable	Deficient	Deficient	Deficient
Seepage	Good	Acceptable	Acceptable	Acceptable	Good	Good	Good
Principal Spillway	Good	Acceptable	Acceptable	Acceptable	Deficient	Acceptable	Acceptable
Auxiliary Spillway	Good	Deficient	Deficient	Deficient	Deficient	Deficient	Deficient
Maintenance and Repairs	Acceptable	Acceptable	Acceptable	Acceptable	Deficient	Deficient	Deficient
Overall Conditions	**Satisfactory**	**Fair**	**Fair**	**Fair**	**Poor**	**Conditionally Poor**	**Conditionally Poor**

Notes:

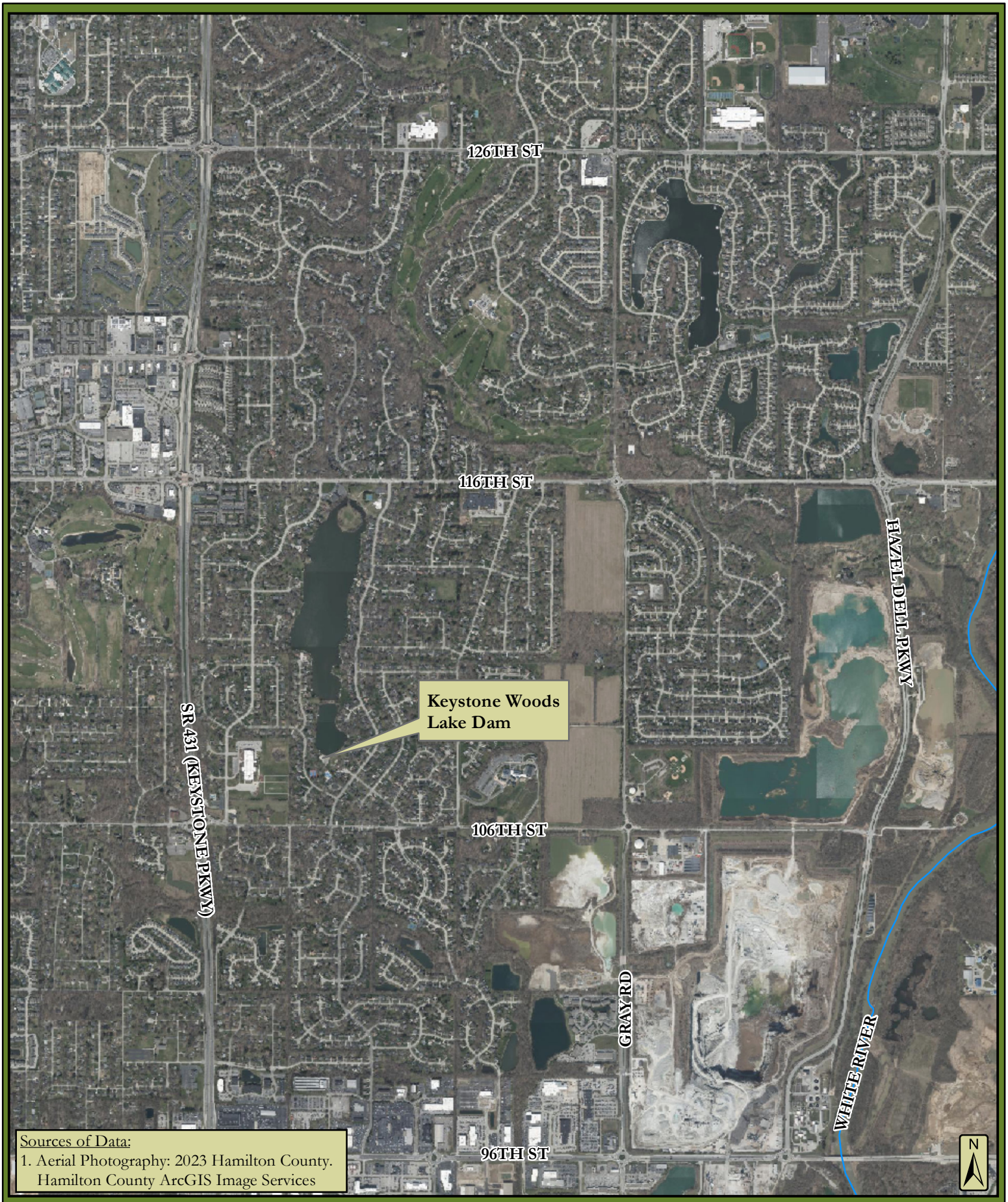
1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

EXHIBITS



Christopher B. Burke Engineering, LLC
PNC Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306

PROJECT: Keystone Woods Lake Dam 2023 Safety Inspection	PROJECT NO. 15-0171	APPROX. SCALE 1"=2,000'
TITLE: USGS Fishers Quadrangle Map		DATE: 8/2023
		EXHIBIT 1



Sources of Data:
1. Aerial Photography: 2023 Hamilton County. Hamilton County ArcGIS Image Services

Christopher B. Burke Engineering, LLC
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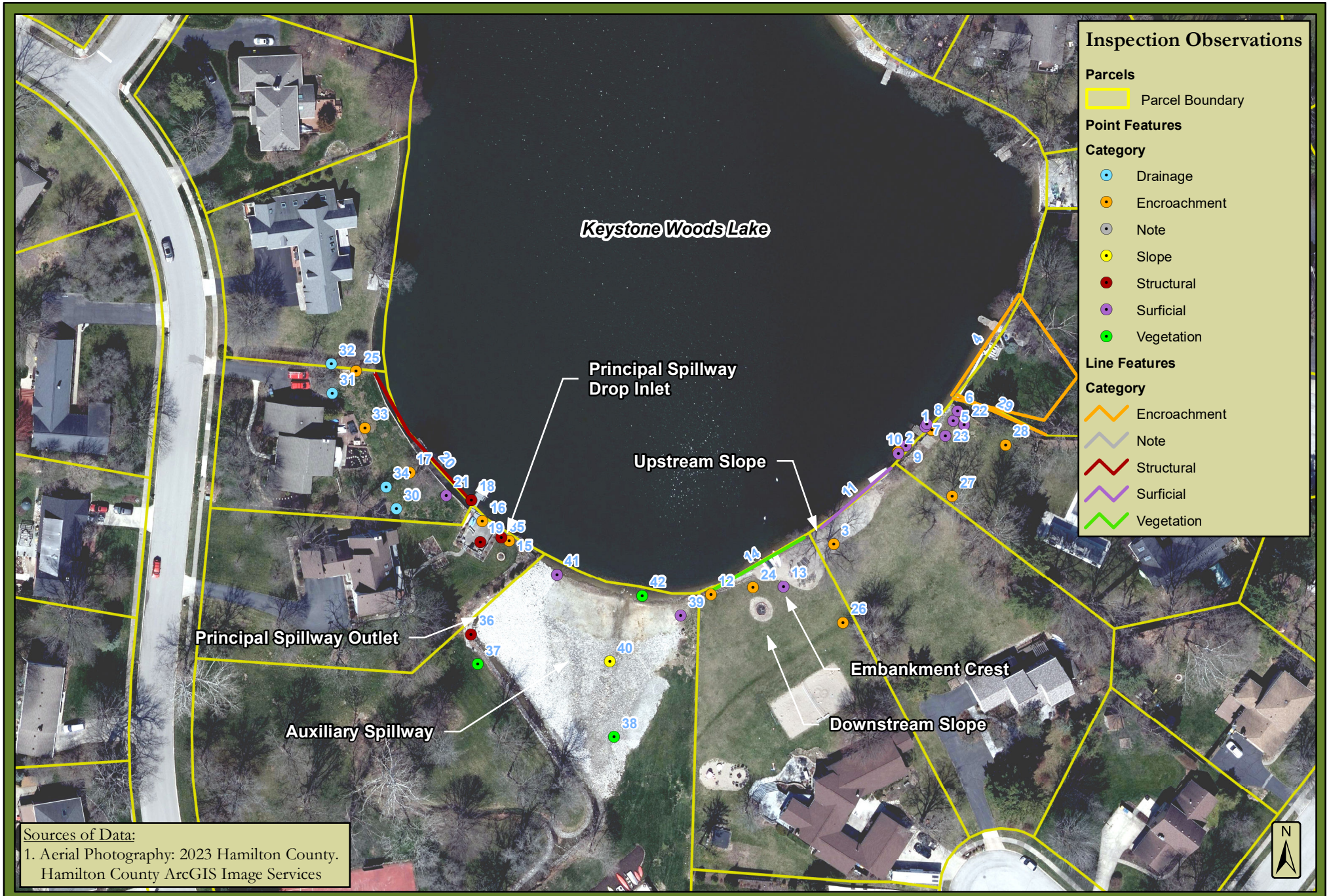
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306

PROJECT: Keystone Woods Lake Dam 2023 Safety Inspection		PROJECT NO. 15-0171	APPROX. SCALE 1"=2,000'
TITLE: Aerial Photograph			DATE: 8/2023
			EXHIBIT 2



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115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306

PROJECT: Keystone Woods Lake Dam 2023 Safety Inspection		PROJECT NO. 15-0171	APPROX. SCALE 1 "=100 '
TITLE: Inspection Summary			DATE: 8/2023
			EXHIBIT 3

APPENDIX 1: **2020 IDNR LETTER TO OWNERS**

July 31, 2020

Judith Rouhselang
Woodland Home Owners Association, Inc.
10700 Lakeshore Drive East
Carmel, IN 46033

Jane B & George P Sweet
10807 Lakeview Dr
Carmel, IN 46033

Bree E & Nathan E Simmons
10803 Lakeview Dr
Carmel, IN 46033

Hassan & Christine Kassebnia,
10801 Lakeview Dr
Carmel, IN 46033

Jeffrey R & Gwen V Kempson
45 Stratford Pl
Carmel, IN 46033

Kathryn Kempson
46 Stratford Pl
Carmel, IN 46033

Christopher Lee & Carajane D Moore
50 Beechwood Ct
Carmel, IN 46033

Lynn D & Beth A Eikenberry
51 Beechwood CT
Carmel, IN 46033

Re: High Hazard Dam - 2019 Biennial Inspection Report
Keystone Woods Lake Dam
Dam ID # 29-5 - Hamilton County

Dear Dam Owners,

Over the years, Woodlands Home Owners Association (HOA), Inc. has acted much like an owner of the Keystone Woods Lake Dam's principle spillway system, and have coordinated maintenance and repairs, etc. However, based on a review of the online Hamilton County GIS parcel information, confirmation from the HOA and the engineer involved in inspection, it appears that there are multiple owners of the entirety of the dam embankment and spillway. Please see the attached aerial imagery, available at Hamilton County GIS site that shows the footprint of the dam in black line and the multiple ownership parcels. This letter is being sent to all of you as it appears you each own parts of

this dam. If you feel that you are not an owner of the dam, you may want to hire a surveyor or an engineer to perform a detailed investigation of your property's title.

Keystone Woods Lake Dam is a **high hazard** dam.

- A high hazard dam is a structure that may cause the loss of life, serious damage to homes, industrial and commercial buildings, or public utilities, or interruption of service to main highways, or railroads.
- Indiana Code 14-27-7.5-9, requires the owner(s) of a high hazard structure to have a licensed professional engineer make an engineering inspection of the high hazard structure at least one (1) time every two (2) years and submit a report of the inspection to IDNR.
- Indiana Code 14-27-7.5-7, requires the owner(s) to maintain and keep the structure in the state of repair and operating condition required by the following: the exercise of prudence; due regard for life and property; and the application of sound and accepted technical principles.
- Indiana Code 14-27-7.5-7, also requires the owner(s) to notify the department in writing of the sale or other transfer of ownership of the structure. The notice must include the name and address of the new owner(s) of the structure.

When there are multiple owners of a dam, often no one party has authority to conduct work, or remove / correct dam safety issues on all the properties that make up the dam and its footprint. All owners then have to figure out how to work together towards the resolution of all dam safety deficiencies.

The electronic report of the biennial inspection for the high hazard rated Keystone Woods Lake Dam was received in this office on November 6, 2019. Jeffrey D. Fox, P.E. – PE11100632 along with Aaron J. Fricke, P.E. – PE11100305 of Christopher B. Burke Engineering, LLC - Indianapolis, performed this biennial inspection on August 5, 2019. Your engineer rated the overall condition of the dam as "Poor CR".

The "Poor" rating for overall condition means that a potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended. Reservoir restrictions (such as lowered pool and other restrictions) may be necessary until the problem deficiencies are resolved.

In your report, your engineer has expressed the steps needed to correct the conditions needed to bring your overall rating to Satisfactory. Monitoring, maintenance, repairs, engineering analyses, and improvements will help to improve your rating in the future. Please refer specifically to "4.0 Recommendations" on page 9 in the report to review those recommendations. Page 3 of 6 of the Inspection Report Form included in the report also describes and explains the engineer's recommendations in more detail. We hope that you all have reviewed the document and discussed the results with your engineer. Guidance and advice given by your consulting professional engineer (firm) is most important and valuable.

As per your engineer, the level of maintenance of the dam needs significant improvement. In addition, significant rehabilitation of the dam is needed to address surficial deficiencies and apparent lack of spillway capacity. Continued neglect of maintenance and improvements may threaten the safety of the dam and safety of individuals and properties located below the dam. The next biennial inspection report should include a detailed report of the status of each of engineer recommended tasks, including the dates of completion and detailed description of work performed.

Please take necessary action to remove all manmade encroachments (concrete patio, steps, decks etc.) and also relocate watercraft, equipment and furniture from the dam and spillway.

Keystone Woods Lake Dam (#29-5)
July 31, 2020

Please note the Dam Safety Act, and particularly part (I.C. 14-27-7.5-9) requires a dam owner(s) to perform the recommended maintenance, repairs, or alterations that are necessary to remedy deficiencies in the structure or to maintain the safety of the dam. The attachment to this letter explains the importance of the recommendations and schedules presented by your engineer and the "Overall Condition Rating" system.

Please feel free to send me an e-mail at mmukherjee@dnr.in.gov if you have any questions regarding your dam or this inspection report. Your next biennial inspection is expected to be performed on or before August 5, 2021, and the electronic formal report in bookmarked PDF format should be submitted to this office within 60 days of the actual field inspection date.

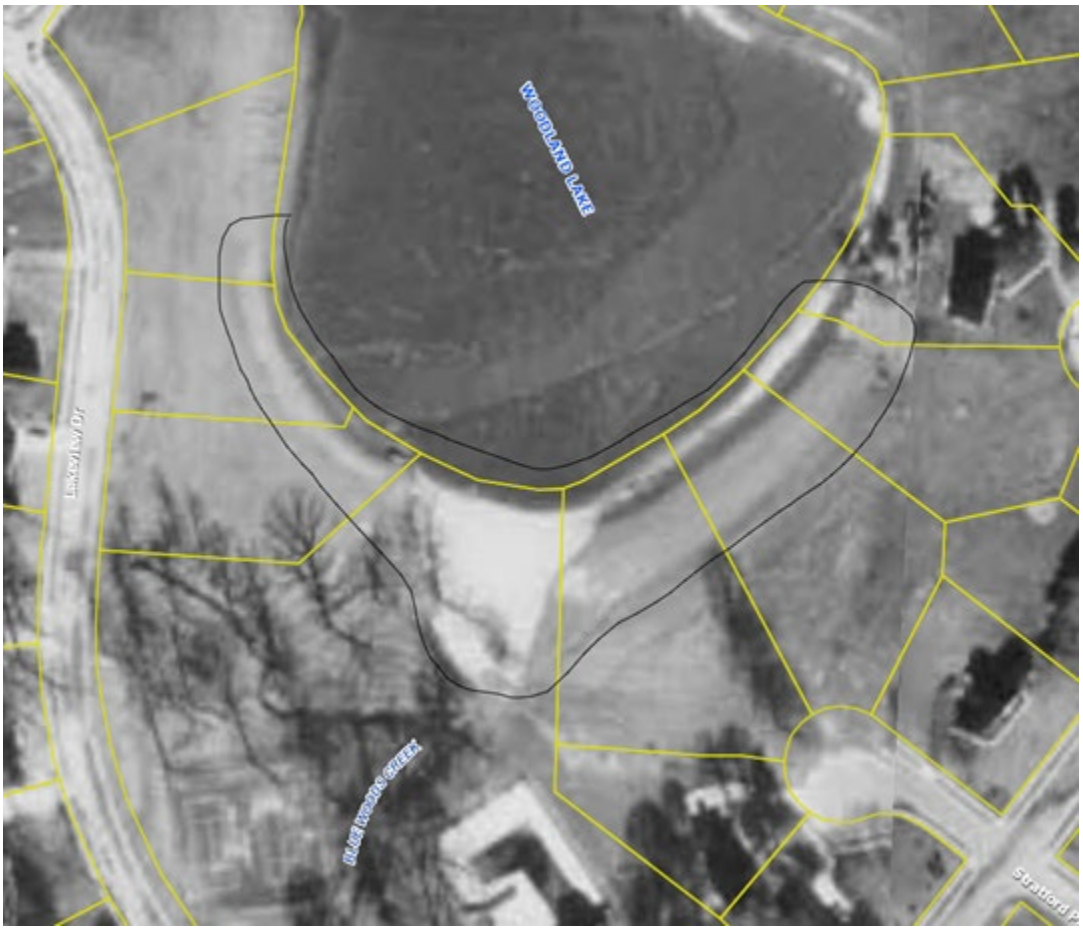
Respectfully,

Moumita Mukherjee

Moumita Mukherjee, Ph.D., P.E.
Manager, Dams & Levee Safety Section
mmukherjee@dnr.in.gov

Attachment: General Information and Guidance

Cc: Christopher B. Burke Engineering Ltd - Indianapolis, IN
Mr. Jon Eggen, Manager, Compliance and Enforcement Section, Division of Water, DNR
Shane Booker, Director, Hamilton County Emergency Management, 18100 Cumberland Rd., Noblesville, Indiana 46060



General Information and Guidance

(A letter attachment)

The Dam Safety Act, and particularly part (I.C. 14-27-7.5-9) places requirements on a dam owner.

IC 14-27-7.5-9 - High hazard structures; inspections; report; duty to make repairs or alterations; notice of violation

Sec. 9. (a) The owner of a high hazard structure shall:

(1) Have a professional engineer licensed under IC 25-31 make an engineering inspection of the high hazard structure at least one (1) time every two (2) years;

(2) Submit a report of the inspection in a form approved by the department to the department. The report must include at least the following information:

(A) An evaluation of the structure's condition, spillway capacity, operational adequacy, and structural integrity.

(B) A determination of whether deficiencies exist that could lead to the failure of the structure, and recommendations for maintenance, repairs, and alterations to the structure to eliminate deficiencies, including a recommended schedule for necessary upgrades to the structure.

(b) If after an inspection under subsection (a) the licensed professional engineer who conducted the inspection determines that maintenance, repairs, or alterations to a high hazard structure are necessary to remedy deficiencies in the structure, ***the owner shall perform the recommended maintenance, repairs, or alterations.***

Guidance and Considerations - for Scheduled Recommended Tasks

Remember that all recommendations made by your engineer that require ***a change in the characteristics*** of the dam must be performed under the direction of the engineer and only after a Permit for Construction in a Floodway has been obtained from IDNR. Work requiring ***a change in the characteristics*** of the dam is generally, but not all inclusively, those that, (1) alter the hydraulic capacity of the spillway system, or (2) modify the stability characteristics of the embankment, or (3) lessen the safety of the dam temporarily during construction.

Normal maintenance work does not require a permit. If you feel the work recommended by your engineer may need a permit or are unsure of the need for a permit, it is suggested that you consult with this office before beginning any work

IDNR would like to follow your progress in meeting the recommended tasks and schedules. The next inspection report should discuss the status of these recommendations so that we may better understand and follow your progress.

Overall Condition Rating System – Explained:

SATISFACTORY · No existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including such events as infrequent hydrologic and/or seismic events.

FAIR · No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.

CONDITIONALLY POOR · A potential safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. Conditionally poor may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam deficiency. Further investigations will be necessary.

POOR · A potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended. Reservoir restrictions (such as lowered pool and other restrictions) may be necessary until the problem deficiencies are resolved.

UNSATISFACTORY · A dam safety deficiency exists for normal conditions. Immediate remedial action is required for problem resolution.

A "CR" after the rating explains that the rating was determined by the professional engineer consultant that performed the inspection and is not a rating determined by the Indiana DNR.

APPENDIX 2: **IDNR DAM INSPECTION REPORT FORM**

Print Form

SUGGESTED DAM INSPECTION REPORT (Refer to pages 5 and 6 for instructions.)

Name of Professional Conducting Inspection	Professional License No. (Indiana)
Joshua L. Erwood, PE, Maxwell V. Runningen, EI	PE12100846
Business Address	**Phone: (day) 317 - 266 - 8000**
115 West Washington Street, Suite 1368 South, Indianapolis, IN 46204	(evening) ___ - ___ - ___

Company Name: Christopher B. Burke Engineering, LLC

INSPECTION PREPARATION: Reviewed all pertinent technical documentation related to this dam and site in the State's and the Owner's files: Yes ☒ No ☐ Comment

MULTIDISCIPINARY:I am experienced in the technical disciplines or I am working with other professionals experienced in the technical disciplines to properly inspect this dam and appurtenant works. Technical disciplines, in additional to the general civil engineering, may include geotechnical, geological, hydrologic, structural, and mechanical. Yes ☒ No ☐ Comment

Dam Name	Quad.	Date of Inspection
Keystone Woods Lake Dam	Fishers	8 / 2 / 23

State Dam ID	Permit (if unapproved see pg. 6)	County	Sec.	T.	R.	Last Inspection
29-5	D-6308	Hamilton	5	17 N	4 E	8 / 3 / 21

Owners Name	Owner's Phone
Woodlands Homeowners Association, Inc.	( )

Address/Zip Code: 10700 Lakeshore Drive East, Carmel, Indiana 46033

Contact's Name	Contact's Phone	Spillway Width	Ft. FBD.
Grant Morris	(day) 765 - 412 - 2307 (evening) ___ - ___ - ___	Top 108ft Bot. 108ft	4.1 FT

Hazard	Drainage Area	Surface Area	Height	Crest Length	Crest Width	Inlet Below Crest	Slope
High	1.1 MI^2	53 AC	14 FT	420 FT	10 FT	4.5 FT	Up 3:1 (H:V) Down 3:1 (H:V)

FIELD CONDITIONS OBSERVED

Water Level - Below Dam Crest 4.5 Ft.

Ground Moisture Condition: Dry ☒ Wet ☐ Snowcover ☐ Other

DRAWDOWN STRUCTURE

☐ Yes ☒ None

Comment: Abandoned

MONITORING ☐ Yes ☒ None [☐ Gage Rod ☐ Piezometers ☐ Seepage Weirs ☐ Survey Monuments ☐ Other]

Comments

A UPSTREAM SLOPE

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (A-1) None ☒ (A-2) Riprap - Missing, Sparse, Displaced, Weathered ☒ (A-3) Wave Erosion-with Scarps ☐ (A-4) Cracks-with Displacement ☐ (A-5) Sinkhole ☐ (A-6) Appears Too Steep ☐ (A-7) Depressions or Bulges ☐ (A-8) Slides ☒ (A-9) Animal Burrows ☒ (A-10) Trees, Brush, Briars ☒ (A-11) Other Encroachment / Surface Cover

Comments:

(A-2) Nonuniform riprap along slope; wooden seawall on right side rotting at water level, deteriorated on leftside

(A-3) Scarp 10" deep by 10ft long, observed on left side but partially hidden by a large bush

(A-9) Few animal burrows observed along slope

(A-10) Trees and brush on slope and within 25 feet of toe and abutments

(A-11) Concrete patio constructed into embankment slope; watercraft, docks, and furniture on dam; portion of slope covered in small gravel; Bare area near wooden deck on left side

B CREST

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (B-1) None ☐ (B-2) Ruts or Puddles ☐ (B-3) Erosion ☐ (B-4) Cracks with Displacement ☐ (B-5) Sinkholes ☐ (B-6) Not Wide Enough ☒ (B-7) Low Area ☐ (B-8) Misalignment ☐ (B-9) Inadequate Surface Drainage ☒ (B-10) Trees, Brush, Briars ☒ (B-11) Other Bare Area, soft spot

Comments:

(B-7) Concrete patio and stairs constructed into embankment slope has resulted in a loss of crest width and freeboard. Concrete patio also has cracking, settlement, and hairline cracks

(B-10) Trees, brush and landscaping on crest

(B-11) Bare area near left abutment; soft area with tree roots on left side of crest; garden bed near right abutment with surrounding bare spots

Spillway Width refers to the open channel (typically the emergency or auxiliary spillway) at the control section.
Ft. FBD. refers to the vertical distance from the emergency (auxiliary) spillway control section to the lowest point of the crest of the dam.
Inlet Below Crest refers to the vertical distance from the inlet of the principal spillway to the crest of the dam.

C DOWNSTREAM SLOPE

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (C-1) None ☐ (C-2) Livestock Damage ☐ (C-3) Erosion or Gullies ☐ (C-4) Cracks with Displacement ☐ (C-5) Sinkholes ☐ (C-6) Appears too Steep ☐ (C-7) Depression or Bulges ☐ (C-8) Slide ☒ (C-9) Soft Areas ☒ (C-10) Trees, Brush, Briars ☐ (C-11) Animal Burrows ☒ (C-12)Other Encroachment/Bare Area

Comments:

(C-9) Damp areas on right property back yard
(C-10) Trees and brush on slope and within 25-feet of toe and abutments
(C-12) Landscaping, fencing, wood deck and deck construction, and steps along slope on right side; 3'x3' bare areas on right side

D SEEPAGE

GOOD (NONE)	☒
ACCEPTABLE	☐
DEFICIENT	☐
POOR	☐

PROBLEMS NOTED: ☐ (D-1) None ☒ (D-2) Saturated Embankment Area ☐ (D-3) Seepage Exits on Embankment ☐ (D-4) Seepage Exits at Point Source ☐ (D-5) Seepage Area at Toe ☐ (D-6) Flow Adjacent to Outlet ☐ (D-7) Seepage Clear/Muddy

[**DRAIN OUTFALLS SEEN** X No ___ Yes ☐ (D-8) Flow Clear/Muddy ☐ (D-9) Dry/Obstructed]

☐ (D-10) Other _____ Describe location of drains and indicate amount and quality of discharge.

Comments:

(D-2) Damp areas with soft ground on right side by fence property line, possible yard irrigation

E PRINCIPAL SPILLWAY

GOOD	☐
ACCEPTABLE	☒
DEFICIENT	☐
POOR	☐

DESCRIPTION: 5'x2.5' Concrete Riser Inlet with a 24" CCFRPM Outlet Pipe

PROBLEMS NOTED: ☐ (E-1) None ☒ (E-2) Deterioration ☐ (E-3) Separation ☐ (E-4) Cracking ☒ (E-5) Inlet, Outlet Deficiency ☐ (E-6) Stilling Basin Inadequacies ☒ (E-7) Trash Rack ☒ (E-8) Other Decreased Pipe Capacity, Debris

Comments:

(E-2) Metal end section at outlet has rusted invert and small holes on side
(E-5) Possible seepage observed in joints of concrete inlet riser
(E-7) Minor surface rust observed on metal trash rack
(E-8) Slip-lining work reduced outlet pipe from a 42" CMP to a 24" CCFRPM; Wood debris at inlet; Tree stumps around outlet; exposed geotextile at outlet; some riprap had fallen into the pipe outlet invert

F AUXILIARY SPILLWAY

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

DESCRIPTION: 108' Wide Open Channel in Fill and Lined with Riprap

PROBLEMS NOTED: ☐ (F-1) None ☐ (F-2) No Auxiliary Spillway Found ☐ (F-3) Erosion-with Backcutting ☐ (F-4) Crack with Displacement ☐ (F-5) Appears to be Structurally Inadequate ☒ (F-6) Appears too Small ☐ (F-7) Inadequate Freeboard ☐ (F-8) Flow Obstructed ☐ (F-9) Concrete Deteriorated/Undermined ☒ (F-10) Other Riprap Size at Inlet, bare spots, stump

Comments:

(F-3)Start of headcut in middle, (F-6) Uncertain spillway capacity,with lowered crest section and slip-lined principal spillway outlet, (F-10) Riprap is sparse and appears too small along inlet section; few bare spots on left side; large tree stump on left side and a few in riprap on right side; bare area around stump with dry cracking

G MAINTENANCE AND REPAIRS

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (G-1) None ☐ (G-2) Access Road Needs Maintenance ☐ (G-3) Cattle Damage ☒ (G-4) Spillway Obstruction ☒ (G-5) Brush, Weeds, Tall Grass, on Upstream Slope, Crest, Downstream Slope, Toe ☒ (G-6) Trees on Upstream Slope, Crest, Downstream Slope ☒ (G-7) Rodent Activity on Upstream Slope, Crest, Downstream Slope, Toe ☐ (G-8) Deteriorated Concrete-Facing, Outlet, Spillway ☐ (G-9) Gate and/or Drawdown Need Repair ☒ (G-10) Other Additional Investigations/Analyses

Comments:

Although maintenance and repair activities have increased in the auxiliary spillway and principal spillway outlet areas, the remaining portions of the dam need improvement. See comments for individual components. Spillway capacity and embankment stability analyses are needed.

H OVERALL CONDITIONS

Based on this inspection and recent file review, the overall surficial condition is determined to be: ☐ (H-1) Satisfactory ☐ (H-2) Fair ☒ (H-3) Conditionally Poor ☐ (H-4) Poor ☐ (H-5) Unsatisfactory

IMPORTANT: IF THIS RATING IS DIFFERENT THAN PREVIOUS IDNR RATING, PLEASE ATTACH EXPLANATION AND REASONS FOR CHANGE ON PAGE 4.

DAM NAME Keystone Woods Lake Dam STATE DAM I.D. 29-5 DATE 8 / 2 / 23

RECOMMENDATIONS AND ITEMS REQUIRING ACTION BY OWNER TO IMPROVE THE SAFETY OF THE DAM

MAINTENANCE-MINOR REPAIR-MONITORING

☒ (1) Provide Additional Erosion Protection: Auxiliary spillway inlet section and upstream slope
☒ (2) Mow: Continue regular mowing; vary mowing pattern to avoid rutting; mow during dry conditions
☒ (3) Clear Trees and/or Brush From: Upstream and downstream slopes, crest, and within 25' of toe and abutments
☒ (4) Initiate Rodent Control Program and Properly Backfill Existing Holes: Upstream slope
☒ (5) Repair: Seal joints in concrete riser; seed bare areas
☐ (6) Provide Surface Drainage For: _____
☒ (7) Monitor: Wooden seawall on right side for deflection and deterioration; downstream slope for seepage
☒ (8) Other: Relocate watercraft, furniture, and other equipment off of embankment; clean and paint metal trash rack
☒ (9) Other: Remove manmade encroachments or provide engineering evaluation of structure and potential impact

ENGINEERING-EMPLOY AN ENGINEER EXPERIENCED IN DESIGN AND CONSTRUCTION OF DAMS TO:

(Plans & Specifications must be approved by State prior to construction.)

☐ (10) Prepare Plans and Specifications for the Rehabilitation of the Dam: _____
☐ (11) Prepare As-Built Drawings of: _____
☒ (12) Perform a Geotechnical Investigation to Evaluate the Stability of the Dam: No record of detailed analysis
☒ (13) Perform a Hydrologic Study to Determine Required Spillway Size: Uncertainties in past analyses and modifications to dam
☐ (14) Prepare Plans and Specifications for an Adequate Spillway: _____
☐ (15) Set up a Monitoring Program: _____
☐ (16) Refer to Unapproved Status of Dam: _____
☒ (17) Develop an Emergency Action Plan: To be completed in 2024
☒ (18) Other: Perform a video inspection of the principal spillway outlet pipe as part of next biennial dam safety inspection
☒ (19) Other: Multiple owners to work to resolve dam inspection recommendations

Recommended schedule for upgrades/comments (Please prioritize and note importance of each item.)

See attached table of recommendations.

Photographs ☒ Attachments ☒

ENGINEER'S INSTRUCTION Instructed owner on the safety concerns with the structure and how to monitor and inspect the dam and appurtenant works in the interim period between the regulatory two-year inspections. Yes ☒ No ☐

Comment

Professional Engineer's Signature _____ Date 12/21/2023

Reviewed By _____ Date 12/21/2023
Owner/Owner's Representative

EXPLANATION FOR CHANGE IN RATINGS (Describe all repairs, upgrades or improvements made if dam conditions and rating have improved since the last inspection. Describe deteriorating conditions if ratings have worsened.)

REASONS FOR RATING CHANGE:

PREVIOUS RECOMMENDATIONS FOR MAINTENANCE, REPAIRS, AND UPGRADES:

HAVE THEY BEEN PERFORMED ☒ YES ☒ NO (If no, please explain:)

See inspection report recommendations.

Supporting Documentation

Photographs ☒ Attachments ☒ Calculations ❒ Drawings ❒ Other ❒

Comments:

Keystone Woods Lake Dam 2023 Dam Safety Inspection Report

Component	Rating	Recommendations	Schedule	Importance
Upstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• Within 1 year	• Medium
		• Replace gravel covered slope with grass, riprap or other erosion resistant material	• Within 1 year	• Medium
		• Relocate watercraft, docks, and furniture off the dam embankment and onto natural ground	• Immediately	• Low
		• Initiate rodent control program, backfilling burrows in accordance with the Indiana Dam Safety Inspection Manual	• Ongoing	• Low
		• Monitor right side wooden seawall for deflection and deterioration; notify a registered professional engineer of observed changes	• Ongoing	• Low
		• Seed bare areas along slope	• Within 2 years	• Low
		• Restabilize and armor scarp forming in bush on left side	• Within 2 years	• Medium
Crest	Deficient	• Remove trees and brush from the crest in accordance with the Indiana Dam Safety Inspection Manual	• Within 1 year	• Medium
		• Remove concrete patio in its entirety and reestablish dam crest elevation by backfilling with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• Within 2 years	• High
		• Seed bare areas on crest	• Within 2 years	• Low
		• Monitor soft area with roots on left side of crest	• Ongoing	• Low
Downstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• Within 1 year	• Medium
		• Remove landscaping, decks, steps, and other encroachments and backfill as necessary with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• Within 2 years	• Medium
		• Seed sporadic bare areas on right and left sides	• Within 2 years	• Low
Seepage	Good	• Monitor downstream slope and around concrete patio, steps, and decks for evidence of seepage; notify a registered professional engineer of observed changes	• Ongoing	• Low
		• Monitor backyards of properties on right side of dam	• Ongoing	• Low
Principal Spillway	Acceptable	• Seal leaking joints in concrete inlet riser	• Within 1 year	• Low
		• Clean and paint metal trash rack	• Within 1 year	• Low
		• Remove tree stumps around outlet	• Within 2 years	• Low
		• Clear debris in outlet channel	• Within 2 years	• Low
		• Cover exposed geotextile at outlet	• Within 2 years	• Low
		• Remove and replace metal end section at outlet	• 2-4 years	• Low
Auxiliary Spillway	Deficient	• Add appropriately sized riprap or other armoring to the spillway inlet section for erosion protection	• Within 2 years	• Low
		• Seed bare spots on left side	• Within 2 years	• Low
		• Evaluate options for removal of the large tree stump on left side and other tree stumps on right side in riprap; monitor areas adjacent to the stumps for seepage or other surficial deficiency monthly and/or after large rain events and notify a registered professional engineer of observed changes	• Within 1 year	• Low
		• Monitor start of headcut in the middle of the spillway	• Ongoing	• Low
		• Spray and remove vegetation growing within spillway	• Within 2 years	• Low
Maintenance and Repairs	Deficient	• Perform spillway capacity analysis in accordance with current IDNR requirements	• Within 1 year	• High
		• Retain a geotechnical engineer to evaluate the stability of the dam under various loading conditions	• Within 2 years	• High
		• Conduct a video inspection of the principal spillway outlet pipe; subsequent inspections should be performed every six years	• Within 1 year	• Low
		• Multiple owners to work to resolve dam inspection recommendations	• Ongoing	• High
Overall Conditions	**Conditionally Poor**	• **See above**	• N/A	• N/A

1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

INSTRUCTIONS FOR COMPLETING DAM VISUAL INSPECTION REPORT

1. Complete all items that are applicable; if not applicable, write in "N/A". For concrete dams, complete all applicable items and use "comments" section to cover items not included in the check boxes. Also indicate that the dam is concrete in the comments section.

2. Use page 6 to determine ratings of each dam component (items A through G) and for Overall Conditions (Item H).

3. Please write legibly and concisely.

4. Inspector must be knowledgeable with the type of dam, materials, and components being inspected. If not, qualified assistance shall be engaged.

5. The inspector shall review the dam owner's and IDNR project files prior to the inspection. Previous inspection reports shall be closely reviewed for previous problems and deficiencies.

6. If the ratings of the components (items A through G) or the Overall Conditions (item H) of the dam have changed since the last inspection, please complete page 4. If a rating has improved, dam repairs, improvements, analyses, or maintenance must have been performed and documented on page 4.

7. For a dam to have a satisfactory "Overall Conditions" rating, it must have no existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including infrequent hydrologic events (PMP for high hazard dams) and seismic events. The dam owner's project files must contain hydrologic and hydraulic analyses of the dam and its spillways to verify performance. The files must also contain slope stability analyses to verify embankment stability under full reservoir conditions and rapid-draw down conditions. The dam and all of its components must meet current IDNR and design standards. "Normal" deficiencies such as minor erosion, minor seepage, or normal concrete aging may not make a dam unsatisfactory or unacceptable. For a satisfactory "Overall Conditions" rating to be assigned, items A through G generally should all have a "good" rating; however, in some cases an "acceptable" rating may be satisfactory if the "Problems Noted" are minor, or "normal" conditions, such as minor erosion rills, small puddles on crest, or if grass needs mowed, but is in good condition.

8. An inspection report form must be submitted to IDNR along with a formal technical inspection report as described in Chapter 4.0 of Part 3 of the Indiana Dam Safety Inspection Manual.

9. Please sign and date this page in the space below to verify that you have read and understand these instructions.

Inspector's Signature: Joshua Inwood Date: 12/21/2023

GUIDELINES FOR DETERMINING CONDITIONS

CONDITIONS OBSERVED - APPLIES TO UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, PRINCIPAL SPILLWAY, AUXILIARY SPILLWAY

GOOD	ACCEPTABLE	DEFICIENT	POOR
In general, this part of the structure has a good appearance, and conditions observed in this area do not appear to threaten the safety of the dam.	Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new condition. Conditions in this area do not currently appear to threaten the safety of the dam.	Continued deterioration and/or unusual loading may threaten the safety of the dam.	Conditions observed in this area appear to threaten the safety of the dam. Conditions observed in this area are unacceptable.

CONDITIONS OBSERVED - APPLIES TO SEEPAGE

GOOD (NONE)	ACCEPTABLE	DEFICIENT	POOR
No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.	Some seepage exists at areas other than the drain outfalls, or other designed drains. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.	Excessive seepage exists at areas other than drain outfalls and other designed drains. Seepage needs to be evaluated. Increased flow and/or continued deterioration in seepage conditions may threaten the safety of the dam.	Excessive seepage conditions observed appear to threaten the safety of the dam and is unacceptable. Examples: 1) Designed drain or seepage flows have increased without increase in reservoir level. 2) Drain or seepage flows contain sediment. i.e., muddy water or particles in jar samples. 3) Widespread seepage, concentrated seepage or ponding appears to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO MAINTENANCE AND REPAIR

GOOD	ACCEPTABLE	DEFICIENT	POOR
Dam appears to receive effective on-going maintenance and repair, and only a few minor items may need to be addressed.	Dam appears to receive maintenance, but some maintenance items need to be addressed. No major repairs are required.	Level of maintenance of the dam needs significant improvement. Major repairs may be required. Continued neglect of maintenance may threaten the safety of the dam.	Dam does not receive adequate maintenance. One or more items needing maintenance or repair has begun to threaten the safety of the dam. Level of maintenance is unacceptable.

OVERALL CONDITIONS

SATISFACTORY - No existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including such events as infrequent hydrologic and/or seismic events. Project Files contain necessary hydrologic, and other engineering calculations to verify dam safety and performance.

FAIR - No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.

CONDITIONALLY POOR - A potential safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. CONDITIONALLY POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency; further investigations and studies are necessary.

POOR - A potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended; reservoir restrictions may be necessary until problem resolution.

UNSATISFACTORY - A dam safety deficiency exists for normal conditions. Immediate remedial action is required for problem resolution.

HAZARD CLASSIFICATIONS OF DAMS (STRUCTURE)

LOW HAZARD- A structure the failure of which may damage farm buildings, agricultural land, or local roads

SIGNIFICANT HAZARD- A structure the failure of which may damage isolated homes and highways, or cause the temporary interruption of public utility services.

HIGH HAZARD-A structure the failure of which may cause the loss of life and serious damage to homes, industrial and commercial buildings, public utilities, major highways, or railroads.

UNAPPROVED STATUS OF DAM

A dam that has been given an unapproved status (see entry for permit) means that plans, construction specifications, hydraulic analyses, and/or a geotechnical investigation on your dam, proving the safety of the structure, have not been received and approved by the Indiana Department of Natural Resources (IDNR). IDNR records indicate that no progress has been made to secure this approval. The fact that the dam is inspected under the Regulation of Dams Act (IC 14-27-7.5) in no way alters the illegal status of the structures.

If your dam is indicated to be unapproved, it is requested that your engineer contact the Indiana Department of Natural Resources,

APPENDIX 3: **PREVIOUS IDNR DAM INSPECTION REPORT FORM**

Print Form

SUGGESTED DAM INSPECTION REPORT (Refer to pages 5 and 6 for instructions.)

Name of Professional Conducting Inspection	Professional License No. (Indiana)
Jeffrey D. Fox, PE / Joshua L. Erwood, EI	PE11100632
Business Address	**Phone: (day) 317 - 266 - 8000**
115 West Washington Street, Suite 1368 South, Indianapolis, IN 46204	(evening) ___ - ___ - ___

Company Name: Christopher B. Burke Engineering, LLC

INSPECTION PREPARATION: Reviewed all pertinent technical documentation related to this dam and site in the State's and the Owner's files: Yes ☒ No ☐ Comment

MULTIDISCIPINARY:I am experienced in the technical disciplines or I am working with other professionals experienced in the technical disciplines to properly inspect this dam and appurtenant works. Technical disciplines, in additional to the general civil engineering, may include geotechnical, geological, hydrologic, structural, and mechanical. Yes ☒ No ☐ Comment

Dam Name	Quad.	Date of Inspection
Keystone Woods Lake Dam	Fishers	8 / 3 / 21

State Dam ID	Permit (if unapproved see pg. 6)	County	Sec.	T.	R.	Last Inspection
29-5	D-6308	Hamilton	5	17 N	4 E	8 / 5 / 19

Owners Name	Owner's Phone
Woodlands Homeowners Association, Inc.	( )

Address/Zip Code: 10700 Lakeshore Drive East, Carmel, Indiana 46033

Contact's Name	Contact's Phone	Spillway Width	Ft. FBD.
Judy Rouhselang	(day) 317 - 407 - 6192 (evening) ___ - ___ - ___	Top 108ft Bot. 108ft	4.1 FT

Hazard	Drainage Area	Surface Area	Height	Crest Length	Crest Width	Inlet Below Crest	Slope
High	1.1 MI^2	53 AC	14 FT	420 FT	10 FT	4.5 FT	Up 3:1 (H:V) Down 3:1 (H:V)

FIELD CONDITIONS OBSERVED

Water Level - Below Dam Crest 4.7 Ft.

Ground Moisture Condition: Dry ☒ Wet ☐ Snowcover ☐ Other ___

DRAWDOWN STRUCTURE

☐ Yes ☒ None

Comment Abandoned

MONITORING ☐ Yes ☒ None [☐ Gage Rod ☐ Piezometers ☐ Seepage Weirs ☐ Survey Monuments ☐ Other]

Comments ___

A UPSTREAM SLOPE

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (A-1) None ☐ (A-2) Riprap - Missing, Sparse, Displaced, Weathered ☒ (A-3) Wave Erosion-with Scarps ☐ (A-4) Cracks-with Displacement ☐ (A-5) Sinkhole ☐ (A-6) Appears Too Steep ☐ (A-7) Depressions or Bulges ☐ (A-8) Slides ☒ (A-9) Animal Burrows ☒ (A-10) Trees, Brush, Briars ☒ (A-11) Other Encroachment / Surface Cover

Comments:

(A-3) Scarp, previously observed on left side, unable to be inspected due to large bush near waterline
(A-9) Few animal burrows observed along slope
(A-10) Trees and brush on slope and within 25 feet of toe and abutments
(A-11) Concrete patio constructed into embankment slope; watercraft, docks, and furniture on dam; portion of slope covered in small gravel

B CREST

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (B-1) None ☐ (B-2) Ruts or Puddles ☐ (B-3) Erosion ☐ (B-4) Cracks with Displacement ☐ (B-5) Sinkholes ☐ (B-6) Not Wide Enough ☒ (B-7) Low Area ☐ (B-8) Misalignment ☐ (B-9) Inadequate Surface Drainage ☒ (B-10) Trees, Brush, Briars ☒ (B-11) Other Bare Area

Comments:

(B-7) Concrete patio and stairs constructed into embankment slope has resulted in a loss of crest width and freeboard
(B-10) Trees, brush and landscaping on crest
(B-11) Bare area near left abutment

Spillway Width refers to the open channel (typically the emergency or auxiliary spillway) at the control section.
Ft. FBD. refers to the vertical distance from the emergency (auxiliary) spillway control section to the lowest point of the crest of the dam.
Inlet Below Crest refers to the vertical distance from the inlet of the principal spillway to the crest of the dam.

C DOWNSTREAM SLOPE

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (C-1) None ☐ (C-2) Livestock Damage ☐ (C-3) Erosion or Gullies ☐ (C-4) Cracks with Displacement ☐ (C-5) Sinkholes ☐ (C-6) Appears too Steep ☐ (C-7) Depression or Bulges ☐ (C-8) Slide ☐ (C-9) Soft Areas ☒ (C-10) Trees, Brush, Briars ☐ (C-11) Animal Burrows ☒ (C-12)Other Encroachment/Bare Area
Comments:

(C-10) Trees and brush on slope and within 25-feet of toe and abutments
(C-12) Landscaping, wood deck, and steps along slope particularly on right side; 3'x3' bare areas on right side

D SEEPAGE

GOOD (NONE)	☒
ACCEPTABLE	☐
DEFICIENT	☐
POOR	☐

PROBLEMS NOTED: ☒ (D-1) None ☐ (D-2) Saturated Embankment Area ☐ (D-3) Seepage Exits on Embankment ☐ (D-4) Seepage Exits at Point Source ☐ (D-5) Seepage Area at Toe ☐ (D-6) Flow Adjacent to Outlet ☐ (D-7) Seepage Clear/Muddy
[**DRAIN OUTFALLS SEEN** X No ___ Yes ☐ (D-8) Flow Clear/Muddy ☐ (D-9) Dry/Obstructed]
☐ (D-10) Other _____ Describe location of drains and indicate amount and quality of discharge.
Comments:

(D-1) No seepage was observed at the time of the inspection; no known records of observed seepage

E PRINCIPAL SPILLWAY

GOOD	☐
ACCEPTABLE	☒
DEFICIENT	☐
POOR	☐

DESCRIPTION: 5'x2.5' Concrete Riser Inlet with a 24" CCFRPM Outlet Pipe

PROBLEMS NOTED: ☐ (E-1) None ☒ (E-2) Deterioration ☐ (E-3) Separation ☐ (E-4) Cracking ☒ (E-5) Inlet, Outlet Deficiency ☐ (E-6) Stilling Basin Inadequacies ☒ (E-7) Trash Rack ☒ (E-8) Other Decreased Pipe Capacity
Comments:

(E-2) Metal end section at outlet has rusted invert and small hole on side
(E-5) Seepage observed in joints of concrete inlet riser
(E-7) Minor surface rust observed on metal trash rack
(E-8) Slip-lining work reduced outlet pipe from a 42" CMP to a 24" CCFRPM

F AUXILIARY SPILLWAY

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

DESCRIPTION: 108' Wide Open Channel in Fill and Lined with Riprap

PROBLEMS NOTED: ☐ (F-1) None ☐ (F-2) No Auxiliary Spillway Found ☐ (F-3) Erosion-with Backcutting ☐ (F-4) Crack with Displacement ☐ (F-5) Appears to be Structurally Inadequate ☒ (F-6) Appears too Small ☐ (F-7) Inadequate Freeboard ☐ (F-8) Flow Obstructed ☐ (F-9) Concrete Deteriorated/Undermined ☒ (F-10) Other Riprap Size at Inlet, bare spots, stump
Comments:

(f-6) Uncertain spillway capacity, particularly with lowered crest section and slip-lined principal spillway oultet
(F-10) Riprap is sparse and appears too small along inlet section; few bare spots on left side; large tree stump on left side and a few in riprap on right side

G MAINTENANCE AND REPAIRS

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (G-1) None ☐ (G-2) Access Road Needs Maintenance ☐ (G-3) Cattle Damage ☐ (G-4) Spillway Obstruction ☒ (G-5) Brush, Weeds, Tall Grass, on Upstream Slope, Crest, Downstream Slope, Toe ☒ (G-6) Trees on Upstream Slope, Crest, Downstream Slope ☒ (G-7) Rodent Activity on Upstream Slope, Crest, Downstream Slope, Toe ☐ (G-8) Deteriorated Concrete-Facing, Outlet, Spillway ☐ (G-9) Gate and/or Drawdown Need Repair ☒ (G-10) Other Additional Investigations/Analyses
Comments:

Although maintenance and repair activities have increased in the auxiliary spillway and principal spillway outlet areas, the remaining portions of the dam need improvement. See comments for individual components. Spillway capacity and embankment stability analyses are needed.

H OVERALL CONDITIONS

Based on this inspection and recent file review, the overall surficial condition is determined to be: ☐ (H-1) Satisfactory ☐ (H-2) Fair ☒ (H-3) Conditionally Poor ☐ (H-4) Poor ☐ (H-5) Unsatisfactory

IMPORTANT: IF THIS RATING IS DIFFERENT THAN PREVIOUS IDNR RATING, PLEASE ATTACH EXPLANATION AND REASONS FOR CHANGE ON PAGE 4.

DAM NAME Keystone Woods Lake Dam STATE DAM I.D. 29-5 DATE 8/3/21

RECOMMENDATIONS AND ITEMS REQUIRING ACTION BY OWNER TO IMPROVE THE SAFETY OF THE DAM

MAINTENANCE-MINOR REPAIR-MONITORING

- [x] (1) Provide Additional Erosion Protection: Auxiliary spillway inlet section and upstream slope
- [x] (2) Mow: Continue regular mowing; vary mowing pattern to avoid rutting; mow during dry conditions
- [x] (3) Clear Trees and/or Brush From: Upstream and downstream slopes, crest, and within 25' of toe and abutments
- [x] (4) Initiate Rodent Control Program and Properly Backfill Existing Holes: Upstream slope
- [x] (5) Repair: Seal joints in concrete riser; seed bare areas
- [ ] (6) Provide Surface Drainage For:
- [x] (7) Monitor: Wooden seawall on right side for deflection and deterioration; downstream slope for seepage
- [x] (8) Other: Relocate watercraft, furniture, and other equipment off of embankment; clean and paint metal trash rack
- [x] (9) Other: Remove manmade encroachments or provide engineering evaluation of structure and potential impact

ENGINEERING-EMPLOY AN ENGINEER EXPERIENCED IN DESIGN AND CONSTRUCTION OF DAMS TO:

(Plans & Specifications must be approved by State prior to construction.)

- [ ] (10) Prepare Plans and Specifications for the Rehabilitation of the Dam:
- [ ] (11) Prepare As-Built Drawings of:
- [x] (12) Perform a Geotechnical Investigation to Evaluate the Stability of the Dam: No record of detailed analysis
- [x] (13) Perform a Hydrologic Study to Determine Required Spillway Size: Uncertainties in past analyses and modifications to dam
- [ ] (14) Prepare Plans and Specifications for an Adequate Spillway:
- [ ] (15) Set up a Monitoring Program:
- [ ] (16) Refer to Unapproved Status of Dam:
- [x] (17) Develop an Emergency Action Plan: To be completed in 2022
- [x] (18) Other: Perform a video inspection of the principal spillway outlet pipe as part of next biennial dam safety inspection
- [x] (19) Other: Multiple owners to work to resolve dam inspection recommendations

Recommended schedule for upgrades/comments (Please prioritize and note importance of each item.)

See attached table of recommendations.

Photographs [x] Attachments [x]

ENGINEER'S INSTRUCTION Instructed owner on the safety concerns with the structure and how to monitor and inspect the dam and appurtenant works in the interim period between the regulatory two-year inspections. Yes [x] No [ ]

Comment

Professional Engineer's Signature _____ Date 10/29/2021

Reviewed By Judith K. Rossbeck, Grounds Director, Woodlands HOA Date 10-29-21

Owner/Owner's Representative

Component	Recommendations	Schedule	Importance
Upstream Slope	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
	• Replace gravel covered slope with grass, riprap or other erosion resistant material	• 2 years	• Medium
	• Relocate watercraft, docks, and furniture off the dam embankment and onto natural ground	• Immediately	• Low
	• Initiate rodent control program, backfilling burrows in accordance with the Indiana Dam Safety Inspection Manual	• Ongoing	• Low
	• Monitor right side wooden seawall for deflection and deterioration; notify a registered professional engineer of observed changes	• Ongoing	• Low
Crest	• Remove trees and brush from the crest in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
	• Remove concrete patio in its entirety and reestablish dam crest elevation by backfilling with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• 2-4 years	• High
	• Seed bare area near left abutment	• Within 1 year	• Low
Downstream Slope	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
	• Remove landscaping, decks, steps, and other encroachments and backfill as necessary with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• 2-4 years	• Medium
	• Seed sporadic bare areas on right and left sides	• 2 years	• Low
Seepage	• Monitor downstream slope and around concrete patio, steps, and decks for evidence of seepage; notify a registered professional engineer of observed changes	• Ongoing	• Low
Principal Spillway	• Seal leaking joints in concrete inlet riser	• 2 years	• Low
	• Clean and paint metal trash rack	• 2 years	• Low
Auxiliary Spillway	• Add appropriately sized riprap or other armoring to the spillway inlet section for erosion protection	• 2-4 years	• Low
	• Seed bare spots on left side	• 2 years	• Low
	• Evaluate options for removal of the large tree stump on left side and other tree stumps on right side in riprap; monitor areas adjacent to the stumps for seepage or other surficial deficiency monthly and/or after large rain events and notify a registered professional engineer of observed changes	• 2 years	• Low
Maintenance and Repairs	• Perform spillway capacity analysis in accordance with current IDNR requirements	• 2 years	• High
	• Retain a geotechnical engineer to evaluate the stability of the dam under various loading conditions	• 2-4 years	• High
	• Conduct a video inspection of the principal spillway outlet pipe; subsequent inspections should be performed every six years	• 2 years	• Low
	• Multiple owners to work to resolve dam inspection recommendations	• Ongoing	• High
Overall Conditions	• **See above**	• N/A	• N/A

EXPLANATION FOR CHANGE IN RATINGS (Describe all repairs, upgrades or improvements made if dam conditions and rating have improved since the last inspection. Describe deteriorating conditions if ratings have worsened.)

REASONS FOR RATING CHANGE:

Principal Spillway – The rating was changed from "Deficient" to "Acceptable" to reflect the recent clearing and armoring improvements to the principal spillway outlet.

Overall Conditions – The rating was changed from "Poor" to "Conditionally Poor" to reflect improvements to the principal spillway outlet and auxiliary spillway channel along with the preparation of risk reduction documents including the lake drawdown plan and IEAP.

PREVIOUS RECOMMENDATIONS FOR MAINTENANCE, REPAIRS, AND UPGRADES:

HAVE THEY BEEN PERFORMED ☒ YES ☒ NO (If no, please explain:)

Previous Recommendations Completed:

Principal Spillway
- Trees and brush cleared around outlet
- Outlet channel armored and erosion repaired

Auxiliary Spillway
- Vegetation growing in riprap channel removed
- Relocated all watercraft, trailers and other equipment obstructing spillway
- Riprap added along channel, particularly on right side

Maintenance and Repairs
- Drawdown plan prepared
- IEAP being prepared and due to be completed in 2022
- All residential owners of dam informed of 2019 recommendations and actions needed to achieve a "Satisfactory" rating. Ongoing coordination with owners to be continued for further improvements

Other recommended actions are currently be planned and budgeted.

Supporting Documentation

Photographs ☒ Attachments ☒ Calculations ❒ Drawings ❒ Other ❒

Comments:

Keystone Woods Lake Dam 2021 Dam Safety Inspection Report

INSTRUCTIONS FOR COMPLETING DAM VISUAL INSPECTION REPORT

1. Complete all items that are applicable; if not applicable, write in "N/A". For concrete dams, complete all applicable items and use "comments" section to cover items not included in the check boxes. Also indicate that the dam is concrete in the comments section.

2. Use page 6 to determine ratings of each dam component (items A through G) and for Overall Conditions (Item H).

3. Please write legibly and concisely.

4. Inspector must be knowledgeable with the type of dam, materials, and components being inspected. If not, qualified assistance shall be engaged.

5. The inspector shall review the dam owner's and IDNR project files prior to the inspection. Previous inspection reports shall be closely reviewed for previous problems and deficiencies.

6. If the ratings of the components (items A through G) or the Overall Conditions (item H) of the dam have changed since the last inspection, please complete page 4. If a rating has improved, dam repairs, improvements, analyses, or maintenance must have been performed and documented on page 4.

7. For a dam to have a satisfactory "Overall Conditions" rating, it must have no existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including infrequent hydrologic events (PMP for high hazard dams) and seismic events. The dam owner's project files must contain hydrologic and hydraulic analyses of the dam and its spillways to verify performance. The files must also contain slope stability analyses to verify embankment stability under full reservoir conditions and rapid-draw down conditions. The dam and all of its components must meet current IDNR and design standards. "Normal" deficiencies such as minor erosion, minor seepage, or normal concrete aging may not make a dam unsatisfactory or unacceptable. For a satisfactory "Overall Conditions" rating to be assigned, items A through G generally should all have a "good" rating; however, in some cases an "acceptable" rating may be satisfactory if the "Problems Noted" are minor, or "normal" conditions, such as minor erosion rills, small puddles on crest, or if grass needs mowed, but is in good condition.

8. An inspection report form must be submitted to IDNR along with a formal technical inspection report as described in Chapter 4.0 of Part 3 of the Indiana Dam Safety Inspection Manual.

9. Please sign and date this page in the space below to verify that you have read and understand these instructions.

Inspector's Signature: _____ Date: 10/29/2021

GUIDELINES FOR DETERMINING CONDITIONS

CONDITIONS OBSERVED - APPLIES TO UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, PRINCIPAL SPILLWAY, AUXILIARY SPILLWAY

GOOD	ACCEPTABLE	DEFICIENT	POOR
In general, this part of the structure has a good appearance, and conditions observed in this area do not appear to threaten the safety of the dam.	Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new condition. Conditions in this area do not currently appear to threaten the safety of the dam.	Continued deterioration and/or unusual loading may threaten the safety of the dam.	Conditions observed in this area appear to threaten the safety of the dam. Conditions observed in this area are unacceptable.

CONDITIONS OBSERVED - APPLIES TO SEEPAGE

GOOD (NONE)	ACCEPTABLE	DEFICIENT	POOR
No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.	Some seepage exists at areas other than the drain outfalls, or other designed drains. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.	Excessive seepage exists at areas other than drain outfalls and other designed drains. Seepage needs to be evaluated. Increased flow and/or continued deterioration in seepage conditions may threaten the safety of the dam.	Excessive seepage conditions observed appear to threaten the safety of the dam and is unacceptable. Examples: 1) Designed drain or seepage flows have increased without increase in reservoir level. 2) Drain or seepage flows contain sediment. i.e., muddy water or particles in jar samples. 3) Widespread seepage, concentrated seepage or ponding appears to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO MAINTENANCE AND REPAIR

GOOD	ACCEPTABLE	DEFICIENT	POOR
Dam appears to receive effective on-going maintenance and repair, and only a few minor items may need to be addressed.	Dam appears to receive maintenance, but some maintenance items need to be addressed. No major repairs are required.	Level of maintenance of the dam needs significant improvement. Major repairs may be required. Continued neglect of maintenance may threaten the safety of the dam.	Dam does not receive adequate maintenance. One or more items needing maintenance or repair has begun to threaten the safety of the dam. Level of maintenance is unacceptable.

OVERALL CONDITIONS

SATISFACTORY - No existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including such events as infrequent hydrologic and/or seismic events. Project Files contain necessary hydrologic, and other engineering calculations to verify dam safety and performance.

FAIR - No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.

CONDITIONALLY POOR - A potential safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. CONDITIONALLY POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency; further investigations and studies are necessary.

POOR - A potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended; reservoir restrictions may be necessary until problem resolution.

UNSATISFACTORY - A dam safety deficiency exists for normal conditions. Immediate remedial action is required for problem resolution.

HAZARD CLASSIFICATIONS OF DAMS (STRUCTURE)

LOW HAZARD- A structure the failure of which may damage farm buildings, agricultural land, or local roads

SIGNIFICANT HAZARD- A structure the failure of which may damage isolated homes and highways, or cause the temporary interruption of public utility services.

HIGH HAZARD-A structure the failure of which may cause the loss of life and serious damage to homes, industrial and commercial buildings, public utilities, major highways, or railroads.

UNAPPROVED STATUS OF DAM

A dam that has been given an unapproved status (see entry for permit) means that plans, construction specifications, hydraulic analyses, and/or a geotechnical investigation on your dam, proving the safety of the structure, have not been received and approved by the Indiana Department of Natural Resources (IDNR). IDNR records indicate that no progress has been made to secure this approval. The fact that the dam is inspected under the Regulation of Dams Act (IC 14-27-7.5) in no way alters the illegal status of the structures.

If your dam is indicated to be unapproved, it is requested that your engineer contact the Indiana Department of Natural Resources,

APPENDIX 4: **INSPECTION PHOTOGRAPHS**

Top: Upstream slope left side. Dock encroaching on upstream slope. Note bare areas and depressions behind dock.
Bottom: Upstream slope left side. Large bush, tree stump, post, and water valve located on the upstream slope.

Top: Upstream slope left side. Trees and hammock located on upstream slope.

Bottom: Upstream left side. Gazebo, ramp, dock, landscaping, and trees located on upstream slope and crest.

Top: Upstream slope left side. Bare area along fence line.

Bottom: Upstream slope on left side, typical burrow hole.

Top: Upstream slope on the left side, burrow holes by dock.

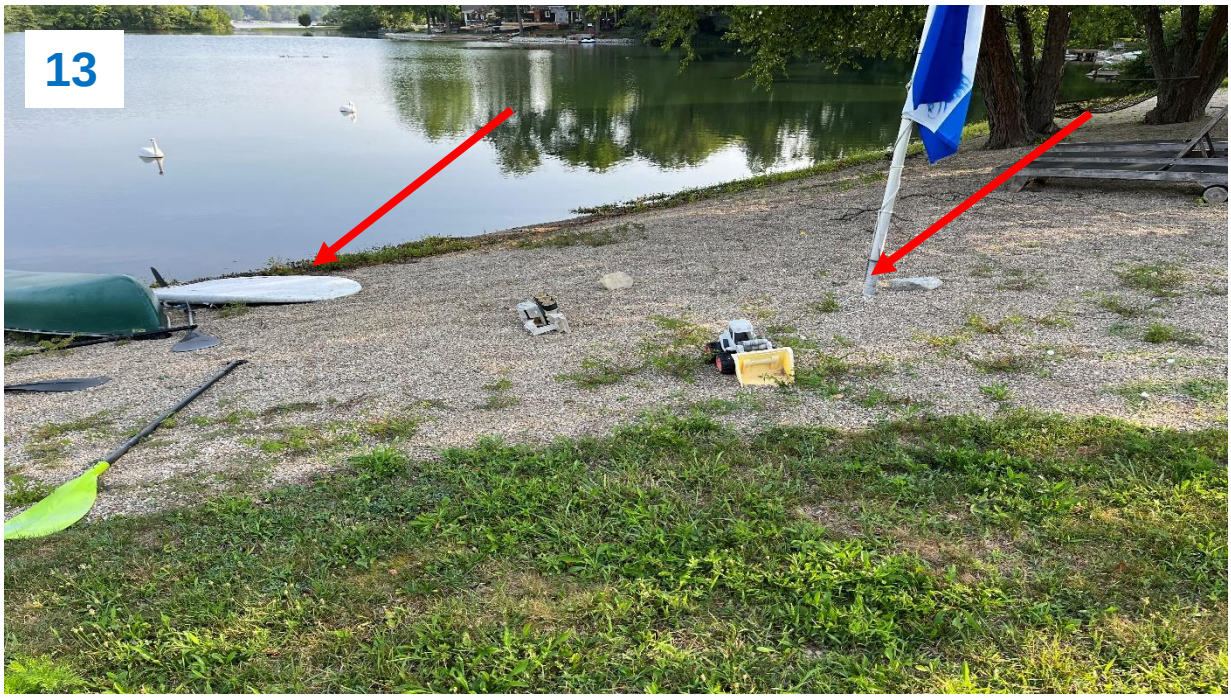
Bottom: Upstream slope on the left side, bare area near dock.

Top: Upstream slope on the left side, burrow holes near bush.

Bottom: Upstream slope on the left side, ten inch deep, ten-foot-wide scrap inside of bush.

Top: Upstream slope on left side, gravel landscaping, undulating slope, and aquatic vegetation.

Bottom: Upstream slope near middle, note watercraft along slope.



Top: Upstream slope near middle, watercraft, flagpole, and landscaping found on slope.

Bottom: Upstream slope near middle, vegetation below, within, and above sparse riprap protection.

Top: Upstream slope right side, landscaping, fireplace, and garden on embankment.

Bottom: Upstream slope right side, dock built into embankment with patio furniture and watercraft.

Top: Upstream slope right side, note tree on slope.

Bottom: Upstream slope right side, area of deterioration on left side of wooden sea wall.

Top: Upstream slope right side, concrete slab cracking and settling into dam.

Bottom: Upstream slope right side, **w**ooden seawall rotting below normal pool and angling toward lake.

Top: Upstream slope right side, 2-inch, 3.5 feet deep animal burrow.

Bottom: Crest on left side, bare area next to fenceline.

Top: Crest on left side, soft area with tree roots.

Bottom: Crest in the middle of the dam. large fire pit with brush.

Top: Crest near right abutment, garden and vegetation with surrounding bare areas.

Bottom: Downstream slope left side, trees and landscaping within 25 feet of toe.

Top: Downstream slope left side, trees and brush within 25 feet of toe of slope.

Bottom: Downstream slope left side, tree within 25 feet of toe of slope.

Top: Downstream slope left side, property line fence traversing embankment.

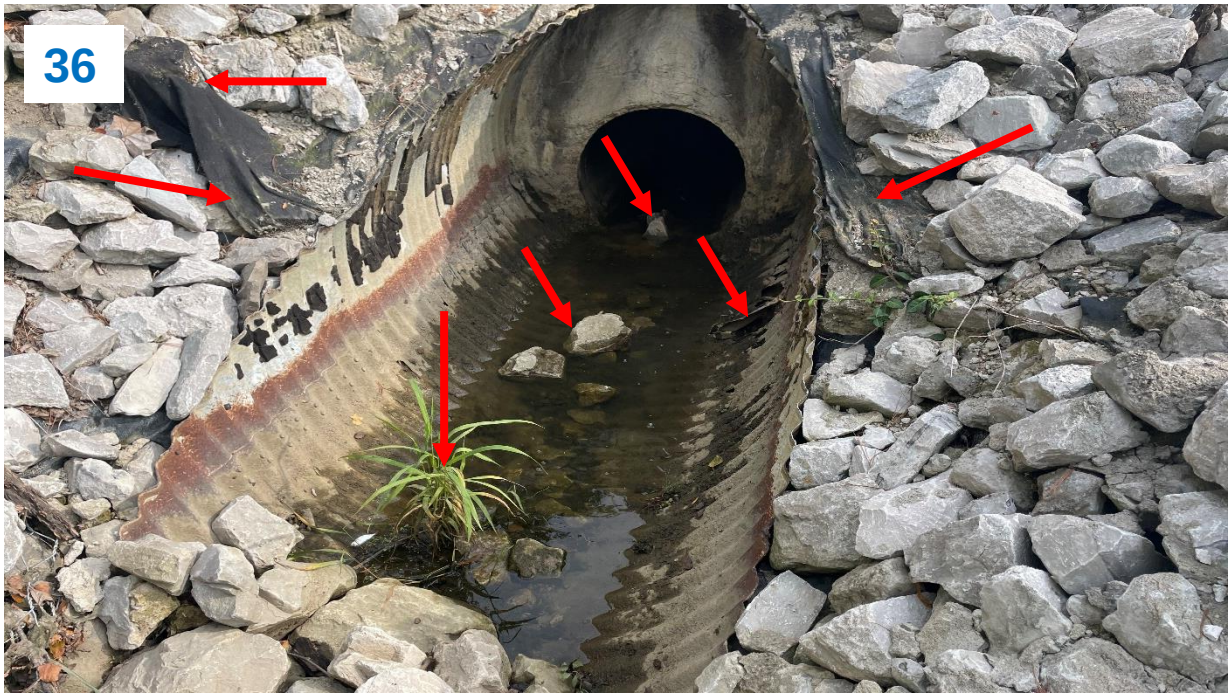
Bottom: Downstream slope right side, wet area along fence line likely due to yard irrigation

Top: Downstream slope right side, wet area with standing water near deck construction area likely due to yard irrigation.

Bottom: Downstream slope right side, saturated dam slope approximately 11 foot by 23 foot likely due to yard irrigation.

Top: Downstream slope right side, deck with furniture encroaching on slope.

Bottom: Downstream slope right side, **s**aturated backyard likely due to yard irrigation.



Top: Principal spillway inlet, note rust on trash rack, vegetation, and leafy debris.

Bottom: Principal spillway outlet, Note deterioration of metal end section with holes in invert, roots around outlet, exposed geotextile fabric, and riprap fallen into pipe outlet.

Top: Principal spillway outlet, vegetation in outlet channel.

Bottom: Auxiliary spillway, note vegetation in riprap and varying riprap sizes.

Top: Auxiliary spillway left side, bare area around tree stump.

Bottom: Auxiliary spillway near middle, head cut forming from low flow in auxiliary spillway with vegetation growth.

Top: Auxiliary spillway right side, exposed geotextile fabric.

Bottom: Auxiliary spillway inlet, aquatic vegetation along shoreline.

APPENDIX 5: **DAM INSPECTION CHECKLIST**

Dam Safety Inspection Checklist

Complete All Portions of This Section (Pre-inspection)
Date of Inspection: 8/2/2023
Name of Dam: Keystone Woods Lake Dam File Number: 29-8
EAP: (yes, no) OM&I: (yes, no)

Review Inventory - Highlight missing information (Pre -inspection)
Owner=s Name(s): Woodlands Homeowners Association, Inc.
Address: 10700 Lakeshore Dr. E.
City: Carmel State: IN Zip (+4): 46033

Telephone (Home): Telephone (Work):
Contact Person: Telephone:
Designed By:
Constructed By:
Year Completed: Plans Available (Yes, No) (location):
Purpose of dam:

Interview with Owner (at the site):
Owner/Representative present: (Yes, (No)) Name(s):

Double check address, telephone #, purpose (check ->) G
How long have you owned dam - previous name/owner?

EAP/OM&I: up-dated-(yes, no) & location:
Operate lake drain (times per year, accessibility):

Mowing (times per year):
Prior problems (wet areas, erosion, slides):

Repair or modification (what & when):

Failure/Incident/Breach (max. pool):

Downstream hazard status (recent changes):

Do you know the in-depth details of the construction of your dam? (If yes - ask next three questions, if no - go to Field Information Section)
Core trench material and location:
Volume of fill (earth or rock) in dam:
Foundation (earth or rock) of dam:

Field Information (while at site)
Pool Elevation (during inspection): N.P. Time: 8:00 (a.m) p.m.)
Site Conditions (temp., weather, ground moisture): 65°F, Sunny, Wet

Inspection Party: Joshua Erwood, P.E., Max Runnigan, E.I., Dawson Smith
Maximum Height: (measured or inventory appears correct)
Normal Pool Surface Area: (measured or inventory appears correct)

SEE INSPECTION REPORT FOR RECOMMENDED ACTION.

Required Action

None Monitor Maintenance Engineer

UPSTREAM SLOPE

Gradient: Horizontal: 2.5 Vertical: 1 (est, meas.)

☑ ***VEGETATION*** [no problem]

☑ Trees: Quantity: (<5, sparse, dense)
Diameter: (<6", 6-12", >12")
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: Several trees on slope

☑ Brush: Quantity: (sparse, dense)
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: Left bush had scarp on shoreline. Right side landscaping and at fencelines

☑ Ground Cover: Type: (grass, crown vetch) Other:
Quantity: (bare, sparse, adequate, dense) Bare spot next to wooden dock bit flat
Appearance: (too tall, too short, good)
Notes:

☑ ***SLOPE PROTECTION*** [no problem, could not inspect thoroughly]

☐ None

☑ Riprap: Average Diameter: 9" - One property - Variable throughout
(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)
Notes: Weedy vegetation above riprap, some within riprap

☐ Wave Berm:
Vegetation: (adequate, bare, sparse, improper vegetation)
Notes:

☐ Concrete Slabs: (cracked, settlement, undermined, voids, deteriorated, vegetation)
Notes:

☑ Other: Gravel on left side, 1.5ft tall block seawall on one property
Notes: Wooden seawall tilted into lake 30° and rotting at normal pool 19" wooden seawall on right side - vegetation growth in some cracks in the wall

☑ ***EROSION*** [no problem, could not inspect thoroughly]

☑ Wave Erosion (Beaching): Scarp: Length: 10ft Height: 10"
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: Scarp next to bush

☐ Runoff Erosion (Gullies): Quantity:
Depth: Width: Length:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ ***INSTABILITIES*** [no problem, could not inspect thoroughly]

☐ Slides: Transverse Length: Longitudinal Length:
Scarp: Width: Length:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Crack: Width: Depth:
Notes/Causes

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other
Quantity: Length: Width: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

None Monitor Maintenance Engineer

Required Action

Required Action: None | Monitor | Maintenance | Engineer

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐
Quantity: Length: Width: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Bulges ☑ Depressions ☐ Hummocky ☐ ☐ ☐ ☐
Size: Height: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes: Above wooden dock, irregular slope

☐ Bulges ☐ Depressions ☑ Hummocky ☐ ☐ ☐ ☐
Size: Height: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes: Undulating slope

☑ ***OTHER*** [no problem, could not inspect thoroughly]
☑ Rodent Burrows: (few, numerous) ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: 2"-dia left end, a few minor burrows 1" diameter
2"-dia & 3.5ft deep rightside
☐ Ruts: ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Depth: Width: Length:
Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)
☑ Other: Patio furniture, boats, docks ☐ ☐ ☐ ☐
Notes: on each property

CREST Length: Width: 15' LT (est, meas.)
14' RT

☑ ***VEGETATION*** [no problem]
☐ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐
Diameter: (<6", 6-12", >12")
Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)
Notes:

☑ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐
Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg) At left fence
Notes: At right fences

☑ Ground Cover: Type: (grass, crown vetch) Other: ☐ ☐ ☐ ☐
Quantity: (bare, sparse, adequate, dense) Bare area 6'x4' on left side
Appearance: (too tall, too short, good)
Notes: Landscaping at property line
Bare spot next to garden bed

☑ ***EROSION*** [no problem, could not inspect thoroughly]
☐ Runoff Erosion (Gullies): Quantity: Depth: Width: Length: ☐ ☐ ☐ ☐
Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)
Notes/Causes:

Required Action: None | Monitor | Maintenance | Engineer

Required Action

None Monitor Maintenance Engineer

☑ ***ALIGNMENT*** [no problem, could not inspect thoroughly]

☐ Vertical: ☐ Low Area: ☐ ☐ ☐ ☐

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Elevation Difference: Length:

Notes/Causes:

☐ ☐ ☐ ☐

☐ Horizontal:

Notes/Causes:

☑ ***WIDTH*** [no problem]

☐ Too Narrow

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg) ☐ ☐ ☐ ☐

Notes/Causes:

☑ ***INSTABILITIES*** [no problem, could not inspect thoroughly]

☑ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐

Quantity: Length: 21ft Width: 2" Depth:

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg) concrete cracking

Notes/Causes: Patio Settlement, some hairline cracks

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐

Quantity: Length: Width: Depth:

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐

Size: Height: Depth:

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐

Size: Height: Depth:

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes/Causes:

☑ ***OTHER*** [no problem, could not inspect thoroughly]

☐ Rodent Burrows: (few, numerous) ☐ ☐ ☐ ☐

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes:

☐ Ruts: ☐ ☐ ☐ ☐

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Depth: Width Length:

Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Other: Left side soft area with tree roots - like from vegetation ☐ ☐ ☐ ☐

Notes: removal

None Monitor Maintenance Engineer

Required Action

Required Action

DOWNSTREAM SLOPE Gradient: Horizontal: 3 Vertical: 1 (est, meas.)

None Monitor Maintenance Engineer

☐ ***VEGETATION*** [no problem]

☑ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐
Diameter: (<6", 6-12", >12")
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: On slope and within 25ft of toe. Landscaping around left abt trees

☑ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐
Location:(adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: on slope and within 25ft of dam. At property lines

☑ Ground Cover: Type: (grass, crown vetch) Other: ☐ ☐ ☐ ☐
Quantity: (bare, sparse, adequate, dense)
Appearance: (too tall, too short, good) Bare spot at right abutment next to garden bed
Notes:

☑ ***EROSION*** [no problem, could not inspect thoroughly]

☐ Runoff Erosion (Gullies): Quantity: Depth: Width: Length: ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☑ ***INSTABILITIES*** [no problem, could not inspect thoroughly]

☐ Slides: Transverse Length: Longitudinal Length: ☐ ☐ ☐ ☐
Scarp: Width: Length:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Crack: Width: Depth:
Notes/Causes

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐
Quantity: Length: Width: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐
Quantity: Length: Width: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐
Size: Height: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐
Size: Height: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

None Monitor Maintenance Engineer

Required Action

Required Action

None | Monitor | Maintenance | Engineer

☑ ***OTHER*** [no problem, could not inspect thoroughly] ☐ ☐ ☐ ☐

☐ Rodent Burrows: (few, numerous)

Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)

Notes:

☐ Ruts: ☐ ☐ ☐ ☐

Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)

Depth: Width: Length:

Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Other: A few damp areas on right Property Rightside garden and deck built into slope ☐ ☐ ☐ ☐

Notes:

☑ ***SEEPAGE*** [no problem, could not inspect thoroughly]

☑ Wet Area ☐ Flow ☐ Boil ☐ Sinkhole ☐ ☐ ☐ ☐

Flow Rate: ϕ Size: 750 Sqft

Location: Right Side by Fence property line

☐ Aquatic Vegetation ☐ None

☐ Rust Colored Deposits ☐ None

☐ Sediment in Flow ☐ None

☑ Other: Soft ground

Notes/Causes: Possible yard irrigation drainage

☑ Wet Area ☐ Flow ☐ Boil ☐ Sinkhole ☐ ☐ ☐ ☐

Flow Rate: ϕ Size: 23ft x 11ft

Location: Downstream toe right side

☐ Aquatic Vegetation ☐ None

☐ Rust Colored Deposits ☐ None

☐ Sediment in Flow ☐ None

☐ Other:

Notes/Causes:

☑ ***EMBANKMENT DRAINS*** [none, none found, no problem, could not inspect thoroughly]

Type: ☐ Toe Drain ☐ Relief Wells ☐ Other: ☐ ☐ ☐ ☐

Flow Rate: Size: Number:

Location:

Notes: One within spill inlet

☐ ***MONITORING INSTRUMENTATION*** [none, none found, no problem, could not inspect thoroughly]

☐ None Found ☐ Piezometers ☐ Weirs/Flumes ☐ Other ☐ ☐ ☐ ☐

☐ Periodic Inspections by:

Notes:

None | Monitor | Maintenance | Engineer

Required Action

PRINCIPAL SPILLWAY

Required Action: None | Monitor | Maintenance | Engineer

☑ ***GENERAL INLET*** [no problem, could not inspect thoroughly] ☐ ☐ ☐ ☐

☐ Anti-Vortex Plate [None] Dimensions:_____ (adequate, too small,)
Type: (steel, concrete, aluminum, stainless steel, corrugated metal wood, other):_____
Deterioration: (missing sections, rusted, collapsed)_____
Notes:_____ ☐ ☐ ☐ ☐

☐ Flash Boards [None]
Type: (metal, wood):_____
Deterioration:_____
Notes:_____

☑ Trashrack [None] Opening Size: 14"X10" Top (adequate, too small, too large) 10"x9" on side ☐ ☐ ☐ ☐
Type: (metal bars, fence, screen, concrete, baffle, other):_____
Deterioration: (broken bars, missing sections, rusted, collapsed) Surface Rust
Notes:_____

☑ ***INLET OBSTRUCTION*** [no problem, could not inspect thoroughly]
☑ Debris: (leaves, trash, logs, branches, ice) Woody Debris - minor ☐ ☐ ☐ ☐
☐ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐
Diameter: (<6", 6-12", >12")
Location: (entire inlet, lt side, rt side, middle, see dwg)
Notes:

☐ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐
Location: (entire inlet, lt side, rt side, middle, see dwg)
Notes:

☐ Other:(beaver activity, trashrack opening too small, partially/completely blocked, i.e.)_____ ☐ ☐ ☐ ☐
Notes:

☑ ***INLET MATERIALS*** [no problem, could not inspect thoroughly]
☑ Metal
(loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out, pipe deformation) Trash Rack ☐ ☐ ☐ ☐
Dimensions:_____
Location:_____
Notes/Causes:_____

☑ Concrete
(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location: Headwall, possible seepage in joints at riser
Notes/Causes:_____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

☐ Plastic
(deterioration, cracking, deformation)_____ ☐ ☐ ☐ ☐
Dimensions:_____
Location:_____
Notes/Causes:_____

Required Action: None | Monitor | Maintenance | Engineer

Required Action — None | Monitor | Maintenance | Engineer

☐ Earthen
- ☐ Ground Cover: Type: (grass, crown vetch) Other: ☐ ☐ ☐ ☐
  Quantity: (bare, sparse, adequate, dense)
  Appearance: (too tall, too short, good)
  Notes:
- ☐ Erosion: (wave, surface runoff) ☐ ☐ ☐ ☐
  Description (height/depth/length/etc):
  Notes:
- ☐ Ruts: ☐ ☐ ☐ ☐
  Location: (entire inlet, lt side, rt side, middle, see dwg)
  Depth: Width: Length:
  Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)
- ☐ Riprap: Average Diameter: ☐ ☐ ☐ ☐
  (adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)
  Notes:

☐ Rock-Cut (weathered, erosion) ☐ ☐ ☐ ☐
Description:
Notes:

☐ Other: ☐ ☐ ☐ ☐

☑ ***OTHER INLET PROBLEMS*** [no problem, could not inspect thoroughly]
- ☐ Mis-Alignment:(pipe, chute, sidewall, headwall) ☐ Pipe Deformation ☐ ☐ ☐ ☐
  Location/Description:
  Notes/Causes:
- ☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐
  Location/Description:
  Notes/Causes:
- ☐ Undermining: ☐ ☐ ☐ ☐
  Location/Description:
  Notes/Causes:
- ☐ Other: ☐ ☐ ☐ ☐

☐ ***OPEN CHANNEL CONTROL SECTION*** [no problem, could not inspect] **Width** (est., ms.) **Brdth** (est., ms.)
Notes: ☐ ☐ ☐ ☐

☑ ***OUTLET OBSTRUCTION*** [no problem, could not inspect thoroughly]
- ☑ Debris: (leaves, trash, logs, branches, ice) ☐ ☐ ☐ ☐
- ☐ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐
  Diameter: (<6", 6-12", >12")
  Location: (entire outlet, lt side, rt side, middle, see dwg)
  Notes:
- ☑ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐
  Location:(entire outlet, lt side, rt side, middle, see dwg)
  Notes: Downstream of outlet minor aquatic vegetation

Required Action — None | Monitor | Maintenance | Engineer

☐ Other:(beaver activity, partially/completely blocked, i.e.) ☐ ☐ ☐ ☐
Notes:

{Upstream Slope, Crest, Downstream Slope, Seepage, **Principal Spillway-Inlet/Outlet**, Emergency Spillway, Lake Drain}

Required Action

☑ ***OUTLET MATERIALS*** [no problem, could not inspect thoroughly]

☑ Metal (loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out, pipe deformation) _____ ☐ None ☐ Monitor ☐ Maintenance ☐ Engineer

Dimensions: _____

Location: Holes IN CMP apron

Notes/Causes: _____

☑ Concrete

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location: _____

Notes/Causes: _____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location: _____

Notes/Causes: _____

☐ Plastic (deterioration, cracking, deformation) _____ ☐ ☐ ☐ ☐

Dimensions: _____

Location: _____

Notes/Causes: _____

☐ Earthen

☐ Ground Cover: Type: (grass, crown vetch) Other: ☐ ☐ ☐ ☐

Quantity: (bare, sparse, adequate, dense)

Appearance: (too tall, too short, good)

Notes:

☐ Erosion: (other, surface runoff) ☐ ☐ ☐ ☐

Description (width/depth/length/etc): _____

Notes: _____

☐ Ruts: ☐ ☐ ☐ ☐

Location: (entire inlet, lt side, rt side, middle, see dwg)

Depth: Width Length:

Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Riprap: Average Diameter: 9" ☐ ☐ ☐ ☐

(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)

Notes: Exposed geotextile on sides

☐ Rock-Cut (weathered, erosion) _____

Description/Notes: _____ ☐ ☐ ☐ ☐

☑ Other: Tree stumps around outlet ☐ ☐ ☐ ☐

☐ ***OTHER OUTLET PROBLEMS*** [no problem, could not inspect thoroughly]

☐ Mis-Alignment:(pipe, chute, sidewall, headwall) ☐ Pipe Deformation _____ ☐ ☐ ☐ ☐

Location/Description: _____

Notes/Causes: _____

☐ None ☐ Monitor ☐ Maintenance ☐ Engineer

☐ Separated Joint ☐ Loss of Joint Material

Location/Description: _____

Notes/Causes: _____

☐ Undermining: _____ ☐ ☐ ☐ ☐

Location/Description: _____

Notes/Causes: _____

☐ Other: _____ ☐ ☐ ☐ ☐

Required Action: None | Monitor | Maintenance | Engineer

OUTLET EROSION CONTROL STRUCTURE (Stilling Basins)

☐ None

☐ (endwall/headwall, plunge pool, impact basin, flip bucket, USBR, baffled chute, rock lined channel)

Notes:

Components (baffle blocks, chute blocks, endsill)

☑ ***MATERIAL*** [no problem, could not inspect thoroughly]

☑ Riprap: Average Diameter: 9"

(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)

Notes:

☐ Concrete

(bug holes, hairline crack, efflorescence)

(spalling, popouts, honeycombing, scaling, craze/map cracks)

(isolated crack, exposed rebar, disintegration, other)

Dimensions/Location:

Notes/Causes:

(bug holes, hairline crack, efflorescence)

(spalling, popouts, honeycombing, scaling, craze/map cracks)

(isolated crack, exposed rebar, disintegration, other)

Dimensions/Location:

Notes/Causes:

☑ ***OTHER*** [no problem, could not inspect thoroughly]

☐ Mis-Alignment:(sidewall, headwall, entire struct.)

Location:

Description:

Notes/Causes:

☐ Separated Joint ☐ Loss of Joint Material

Location:

Description:

Notes/Causes:

☐ Undermining:

Location:

Description:

Notes/Causes:

☑ Other: No trespassing signs

☑ ***DRAINS*** [none, none found, no problem, could not inspect thoroughly] (See ***SEEPAGE*** Section for Toe Drains & Relief Wells)

Type: ☐ Weep Holes ☐ Relief Drains ☐ Other:

Flow Rate: Size: Number:

Location:

Notes:

Type: ☐ Weep Holes ☐ Relief Drains ☐ Other:

Flow Rate: Size: Number:

Location:

Notes:

Required Action: None | Monitor | Maintenance | Engineer

EMERGENCY SPILLWAY

Required Action: None | Monitor | Maint. | Engineer

☐ None Found ☐ ☐ ☐ ☐

☑ ***GENERAL INLET*** [no problem, could not inspect thoroughly]

☐ Anti-Vortex Plate [None] Dimensions:_____ (adequate, too small,) ☐ ☐ ☐ ☐

Type: (steel, concrete, aluminum, stainless steel, corrugated metal wood, other):_____

Deterioration: (missing sections, rusted, collapsed)_____

Notes:_____

☐ Flash Boards [None] ☐ ☐ ☐ ☐

Type: (metal, wood):_____

Deterioration:_____

Notes:_____

☐ Trashrack [None] Opening Size:_____ (adequate, too small, too large) ☐ ☐ ☐ ☐

Type: (metal bars, fence, screen, concrete, baffle, other):_____

Deterioration: (broken bars, missing sections, rusted, collapsed)_____

Notes:_____

☑ ***INLET OBSTRUCTION*** [no problem, could not inspect thoroughly]

☐ Debris: (leaves, trash, logs, branches, ice)_____ ☐ ☐ ☐ ☐

☐ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐

Diameter: (<6", 6-12", >12")

Location: (entire inlet, lt side, rt side, middle, see dwg)

Notes:

☑ Brush: Quantity: (sparse, dense)

Location: (entire inlet, lt side, rt side, middle, see dwg) Minor vegetation ☐ ☐ ☐ ☐

Notes:

☐ Other:(beaver activity, trashrack opening too small, partially/completely blocked, i.e.)_____ ☐ ☐ ☐ ☐

Notes:

☑ ***INLET MATERIALS*** [no problem, could not inspect thoroughly]

☐ Metal

(loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out, pipe deformation)_____ ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

☐ Concrete

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

☐ Plastic ☐ ☐ ☐ ☐

(deterioration, cracking, deformation)_____

Dimensions/Location:_____

Notes/Causes:_____

Required Action: None | Monitor | Maintenance | Engineer

Required Action: None | Monitor | Maintenance | Engineer

☑ Earthen

☐ Ground Cover: Type: (grass, crown vetch) Other: Some minor bare spots along inlet — ☐ ☐ ☐ ☐
Quantity: (bare, sparse, adequate, dense)
Appearance: (too tall, too short, good)
Notes:

☐ Erosion: (wave, surface runoff) — ☐ ☐ ☐ ☐
Description (height/depth/length/etc):
Notes:

☐ Ruts: — ☐ ☐ ☐ ☐
Location: (entire inlet, lt side, rt side, middle, see dwg)
Depth: Width: Length:
Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Riprap: Average Diameter: Gravel – too small in middle — ☐ ☐ ☐ ☐
(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)
Notes: None at shoreline

☐ Rock-Cut (weathered, erosion) — ☐ ☐ ☐ ☐
Description:
Notes:

☐ Other: — ☐ ☐ ☐ ☐

☐ **OTHER INLET PROBLEMS** [no problem, could not inspect thoroughly]

☐ Mis-Alignment:(channel, chute, sidewall, headwall) ☐ Pipe Deformation — ☐ ☐ ☐ ☐
Location/Description:
Notes/Causes:

☐ Separated Joint ☐ Loss of Joint Material — ☐ ☐ ☐ ☐
Location/Description:
Notes/Causes:

☐ Undermining: — ☐ ☐ ☐ ☐
Location/Description:
Notes/Causes:

☑ Other: Tree stump left side, Exposed geotextile on right side, Bare area around stump with dry cracking – 4" wide — ☐ ☐ ☐ ☐

☑ **OPEN CHANNEL CONTROL SECTION** [no problem, could not inspect] **Width** (est., ms.) **Brdth** (est., ms.) — ☐ ☐ ☐ ☐
Notes:

☑ **OUTLET OBSTRUCTION** [no problem, could not inspect thoroughly]

☐ Debris: (leaves, trash, logs, branches, ice) — ☐ ☐ ☐ ☐
☐ Trees: Quantity: (<5, sparse, dense) — ☐ ☐ ☐ ☐
Diameter: (<6", 6-12", >12")
Location: (entire outlet, lt side, rt side, middle, see dwg)
Notes:

☑ Brush: Quantity: (sparse, dense) — ☐ ☐ ☐ ☐
Location:(entire outlet, lt side, rt side, middle, see dwg)
Notes: Some aquatic vegetation

Required Action: None | Monitor | Maintenance | Engineer

☐ Other:(beaver activity, partially/completely blocked, i.e.) — ☐ ☐ ☐ ☐
Notes:

Required Action: None | Monitor | Maint. | Engineer

☑ ***OUTLET MATERIALS*** [no problem, could not inspect thoroughly]

☐ Metal (loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out, pipe deformation)_____ ☐ ☐ ☐ ☐
Dimensions:_____
Location:_____
Notes/Causes:_____

☐ Concrete (bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

☐ Plastic (deterioration, cracking, deformation)_____ ☐ ☐ ☐ ☐
Dimensions:_____
Location:_____
Notes/Causes:_____

☑ Earthen
☑ Ground Cover: Type: (grass), crown vetch) Other: few bare spots on left side ☐ ☐ ☐ ☐
Quantity: (bare), sparse, adequate, dense)
Appearance: (too tall, too short, good)
Notes:

☐ Erosion: (other, surface runoff) ☐ ☐ ☐ ☐
Description (width/depth/length/etc):_____
Notes:_____

☐ Ruts: ☐ ☐ ☐ ☐
Location: (entire inlet, lt side, rt side, middle, see dwg)
Depth: Width Length:
Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Riprap: Average Diameter: 9" ☐ ☐ ☐ ☐
(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - (yes), no)
Notes: Sparse in middle upper section

☐ Rock-Cut (weathered, erosion)
Description:_____ ☐ ☐ ☐ ☐
Notes:_____

☑ Other: start of headcut through rock due to low flow. ☐ ☐ ☐ ☐

☑ ***OTHER OUTLET PROBLEMS*** [(no problem), could not inspect thoroughly]

☐ Mis-Alignment:(channel, chute, sidewall, headwall) ☐ Pipe Deformation_____ ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

Required Action: None | Monitor | Maintenance | Engineer

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Undermining: ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Other:_____ ☐ ☐ ☐ ☐

{Upstream Slope, Crest, Downstream Slope, Seepage, Principal Spillway, **Emergency Spillway-Outlet**, Lake Drain}

Required Action

Required Action

None Monitor Maint. Engineer

OUTLET EROSION CONTROL STRUCTURE (Stilling Basins)

☐ None ☐ ☐ ☐ ☐

☐ (endwall/headwall, plunge pool, impact basin, flip bucket, USBR, baffled chute, rock lined channel) ☐ ☐ ☐ ☐

Notes:

Components (baffle blocks, chute blocks, endsill)

☑ ***MATERIAL*** [no problem, could not inspect thoroughly]

☑ Riprap: Average Diameter: 9"

(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no) ☐ ☐ ☐ ☐

Notes:

☐ Concrete

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:

Notes/Causes:

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:

Notes/Causes:

☐ ***OTHER*** [no problem, could not inspect thoroughly] ☐ ☐ ☐ ☐

☐ Mis-Alignment:(sidewall, headwall)

Location:

Description:

Notes/Causes:

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐

Location:

Description:

Notes/Causes:

☐ Undermining: ☐ ☐ ☐ ☐

Location:

Description:

Notes/Causes:

☐ Other: ☐ ☐ ☐ ☐

☑ ***DRAINS*** [none, none found, no problem, could not inspect thoroughly] (See ***SEEPAGE*** Section for Toe Drains & Relief Wells)

Type: ☐ Weep Holes ☐ Relief Drains ☐ Other: ☐ ☐ ☐ ☐

Flow Rate: Size: Number:

Location:

Notes:

Type: ☐ Weep Holes ☐ Relief Drains ☐ Other: ☐ ☐ ☐ ☐

Flow Rate: Size: Number:

Location:

Notes:

None Monitor Maintenance Engineer

Required Action

{Upstream Slope, Crest, Downstream Slope, Seepage, Principal Spillway, **Emergency Spillway-Outlet Erosion Control Structure**, Lake Drain}

LAKE DRAIN

Required Action: None | Monitor | Maint. | Engineer

☑ ***GENERAL***

☐ None Found ☑ Does not have one — Capped at principal spillway — ☐ ☐ ☐ ☐

☐ Type of Lake Drain (isolated control/intake tower, valve vault w/ outlet conduit, valve in riser/drop inlet, siphon) ☐ ☐ ☐ ☐

Notes:

☐ Operated During Inspection (yes, no) ☐ ☐ ☐ ☐

Notes:

☑ ***ACCESS TO VALVE/SLUICE GATE*** [no problem, could not inspect thoroughly]

☑ Type (not accessible, from shore, boat, walkway, other) ☐ ☐ ☐ ☐

Notes: ON private property

☐ Walkway/Platform:

☐ Concrete Deterioration ☐ Cracks (platform, piers, end supports, railing) ☐ ☐ ☐ ☐

Location:

Notes:

☐ Wood Deterioration ☐ ☐ ☐ ☐

Notes:

☐ Metal Deterioration ☐ ☐ ☐ ☐

(minor, moderate, extensive, other)

Notes:

☐ ***LAKE DRAIN COMPONENTS*** [no problem, could not inspect thoroughly]

☐ Concrete Structure ☐ ☐ ☐ ☐

Location:

Description: (deterioration, misalignment, cracks):

Notes/Causes:

☐ Valve Control (Operating Device)

☐ No Operating Device ☐ No Stem ☐ Bent/Broken Stem ☐ Other ☐ ☐ ☐ ☐

Notes/Operability:

☐ Valve / Sluice Gate ☐ ☐ ☐ ☐

☐ Metal Deterioration: (surface rust, minor, moderate, extensive, other)

Location:

Flow Rate:

Notes/Causes:

☐ Misalignment ☐ ☐ ☐ ☐

Notes/Causes:

☐ Leakage - Flow Rate: ☐ ☐ ☐ ☐

Notes/Causes:

☐ Valve / Sluice Gate ☐ ☐ ☐ ☐

☐ Metal Deterioration: (surface rust, minor, moderate, extensive, other)

Location:

Flow Rate:

Notes/Causes:

☐ Misalignment - Notes/Causes: ☐ ☐ ☐ ☐

☐ Leakage - Flow Rate: ☐ ☐ ☐ ☐

Notes/Causes:

Required Action: None | Monitor | Maintenance | Engineer

Required Action

None | Monitor | Maintenance | Engineer

☐ Outlet Conduit

☐ Metal:(loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out) ☐ ☐ ☐ ☐
Location:_____
Notes/Causes:_____

☐ Concrete (bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

☐ Plastic:(deterioration, cracking)_____ ☐ ☐ ☐ ☐
Location:_____
Notes/Causes:_____

☐ Conduit Deformation ☐ Mis-Alignment: ☐ ☐ ☐ ☐
Location:_____
Notes/Causes:_____

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Undermining: ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Vegetation (trees, brush)_____ ☐ ☐ ☐ ☐
Notes:_____

☐ Other:_____ ☐ ☐ ☐ ☐
Notes:_____

☐ Energy Dissipator

☐ Type (endwall, plunge pool, impact basin, stilling basin, rock-lined channel, none) ☐ ☐ ☐ ☐
Notes:_____

☐ Riprap: Average Diameter: ☐ ☐ ☐ ☐
(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no))
Notes:

☐ Concrete (bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

☐ Mis-Alignment:_____ ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Undermining: ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Other:_____ ☐ ☐ ☐ ☐
Notes:_____

Required Action

None | Monitor | Maintenance | Engineer

APPENDIX 6: EMBANKMENT DAM FAILURE MODES AND RISK FACTORS

Failure Modes of Embankment Dams

IDNR classifies dam failures in two categories: Type 1, component failure of a structure that does not result in a significant reservoir release; and, Type 2, uncontrolled breach failure of a structure that results in a significant reservoir release.

Type 1 failures include localized seepage and structural failures of dam components that do not breach the dam into the reservoir. Type 1 failures are generally local failures of a dam feature, such as an embankment slide that does not breach the crest, a spillway structural failure, a piping condition in its early stage of formation, a trash rack failure, or settlement on an earth dam embankment that does not extend to the water level. Type 1 failures are critical, require immediate attention, and may lead to a Type 2 failure. However, they do not result in a significant release of reservoir water and generally do not pose an immediate dam safety risk.

Type 2 failures are failures that do result in a significant release of the reservoir and may eventually result in a dam breach with total release of the reservoir. There are three general categories of Type 2 failures: (1) hydraulic failures, (2) seepage failures, and (3) structural failures. Type 2 failures often result from Type 1 failures that were improperly corrected or were ignored.

Embankment dams have three potential modes for Type 2, uncontrolled breach failure:

1. hydraulic failure (dam overtopping, wave erosion, dam toe erosion, severe erosion)
2. seepage failure (pervious reservoir rim or bottom, pervious foundation, pervious dam, leaking conduits, cracks in dam, piping through dam or along conduits, inappropriate vegetation, windblown trees, animal burrows)
3. structural failure (dam and foundation slides, dam failure, dam settlement, spillway cracks or failure)

The presence of any of these conditions poses a degree of risk for dam failure, however, failure typically will not occur until the conditions become severe enough to allow water to flow out of the reservoir in an uncontrolled manner. Therefore, when the dam deficiencies are minor and do not threaten the stability or safety of the dam, the risk of dam failure is low. If the deficiencies are serious and do pose a likely threat to the dam safety, the risk of dam failure is high.

Risk Factors that can Cause Dam Failure

The factors that pose a risk to embankment dams can be categorized into four groups:

1. structural factors (design, construction, and condition of embankment, foundation, abutments, and spillways)
2. natural factors (earthquakes, storms, floods, landslides, sedimentation)
3. human factors (vandalism, terrorism, mistakes, operational mismanagement)
4. operating factors (poor maintenance practices, lack of operator training, poor access, lack of proper inspection program, reliability of electrical and mechanical equipment)

For purposes of this report, the potential risk of dam failure is defined as follows:

Low risk – the dam or its appurtenant works has a minor deficiency that does not pose an imminent threat to the dam safety. However, if left unattended, these deficiencies may progress and ultimately lead to a dam failure.

Low risk conditions should be monitored and/or repaired within 4 years. If the deficiency is minor and is progressing very slowly, it may be appropriate to monitor the condition, and reassess it every year. In some cases, it may be appropriate to complete the repairs immediately and be done with it. If the dam is a high hazard dam, a shorter time limit for performing low risk repairs may be warranted to ensure that the work will be completed before the next formal technical safety inspection. Repairs or correction of low-risk deficiencies are typically a low priority. A minor deficiency with a low risk of dam failure may be assigned a medium priority repair schedule if the deficiency makes it impossible or difficult to perform a visual inspection. An example of this is excessive vegetation of the embankment; the excessive vegetation may present a low risk of dam failure, but because it prevents a proper visual inspection, removal of the brush may be assigned a medium or high priority.

Medium risk - the dam or its appurtenant works has a deficiency that lies between minor and serious. Medium risk conditions should be corrected as soon as possible, but no later than 3 years. Corrective repairs may need to be performed sooner if the deficiency is progressing rapidly. Repairs or correction of medium risk deficiencies are typically a medium priority.

High risk – the dam or its appurtenant works has a severe deficiency that poses an imminent threat to the dam safety. The dam will fail if the deficiency is not corrected. High risk conditions must be corrected within 1 year. Repairs or correction of high-risk deficiencies are typically a high priority.

The risk assessment should always be tempered with the potential downstream safety hazards. A minor deficiency on a low hazard dam may have a lower priority for repair than the same deficiency on a high hazard dam