Final Dam Inspection Report

Durham Upper Dam and Dyke

Municipality of West Grey,
County of Grey, Ontario

D.M. Wills Project Number 22-5540

D.M. Wills Associates Limited
Partners in Engineering, Planning and Environmental Services
Peterborough

February 2023

Prepared for:
Saugeen Valley Conservation Authority

Summary of Revisions

Rev. No.	Revision Title	Date	Summary of Revisions
1	Draft Report	January 1, 2023	Issued for Client Review
2	Final Report	February 3, 2023	Issues as Final

This report has been formatted considering the requirements of the Accessibility for Ontarians with Disabilities Act.

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1.0 Introduction

1.1 Purpose and Objectives

The Saugeen Valley Conservation Authority's (SVCA's) jurisdiction, the Saugeen watershed, covers an area of approximately 4,675 km^2 and encompasses the counties of Bruce, Dufferin, Grey, Huron and Wellington as well as the Saugeen River, Penetangore River, Teeswater River, Pine River and the shoreline of Lake Huron. Within this jurisdiction, the SVCA's mandate is to undertake watershed-based programs to protect people and property from floods and other natural hazards and to conserve natural resources for economic, social and environmental benefits. This includes the management of flood and erosion control structures.

In cooperation with their municipal partners and regulatory agencies, the SVCA maintains a number of flood and erosion control projects within their jurisdiction. The SVCA is currently responsible for coordinating the inspection, maintenance and repair of 21 flood and erosion control projects, including 10 dam and dyke projects, 7 slope stability and erosion control projects and 4 flood control channelization projects.

D.M. Wills Associates Limited (Wills) was retained by the SVCA to undertake the inspection of 20 flood and erosion control structures. In the past, annual inspections of the SVCA's flood and erosion control structures have been completed in-house by the SVCA; however, it is understood that past inspection documentation has ranged from photo records to the completion of a site inspection form. Given the importance of ensuring that this infrastructure is in good condition and to plan for future maintenance and repairs, the SVCA has recognized that a more formal inspection of the flood and erosion control infrastructure is required in order to re-establish a baseline condition for each structure.

The purpose of these inspections is to thoroughly document the existing condition of the dams through a visual inspection, including the completion of an underwater inspection where possible, identify operator and public safety deficiencies, and provide a prioritized list of recommendations for the remediation of the identified deficiencies, including the development of budget-level cost estimates and a recommended timeline for the completion of each measure.

The subject of this report is the Durham Upper Dam and Dyke. The inspection of the Durham Upper Dam and Dyke was completed on September 19, 2022, in the presence of SVCA staff.

1.2 Site Location and Access

The Durham Upper Dam and Dyke are located within the limits of the Town of Durham, Ontario, upstream of Highway 6 (Garafraxa Street North) on the Saugeen River. The dam can be accessed via the public road system and is generally publicly accessible. There is a parking area downstream of the dam and the dam and dyke can be accessed on foot from this point. The dam deck / pedestrian walkway gates are generally locked in the open position; however, keys from the SVCA may be required to

access the deck and cross the river if the gates are locked in the closed position. The location of the dam is shown in **Figure 1**.

1.3 Dam Description

The first dam at this site was constructed in 1847 to help power a grist mill. It is unclear when, or if, the dam was replaced; however, recent records indicate that there was a major rehabilitation to the north abutment and wingwall in 1966 and a reconstruction of the catwalk in 1978.

The existing dam is approximately 90 m long and is comprised of a concrete control structure between two earth embankment sections. The concrete control structure is approximately 44 m wide and includes five sluices made up of two abutments and four piers. The north (left) earth embankment includes a concrete gravity wingwall and the south (right) earth embankment is connected to the main structure with an abutment structure with a concrete wingwall.

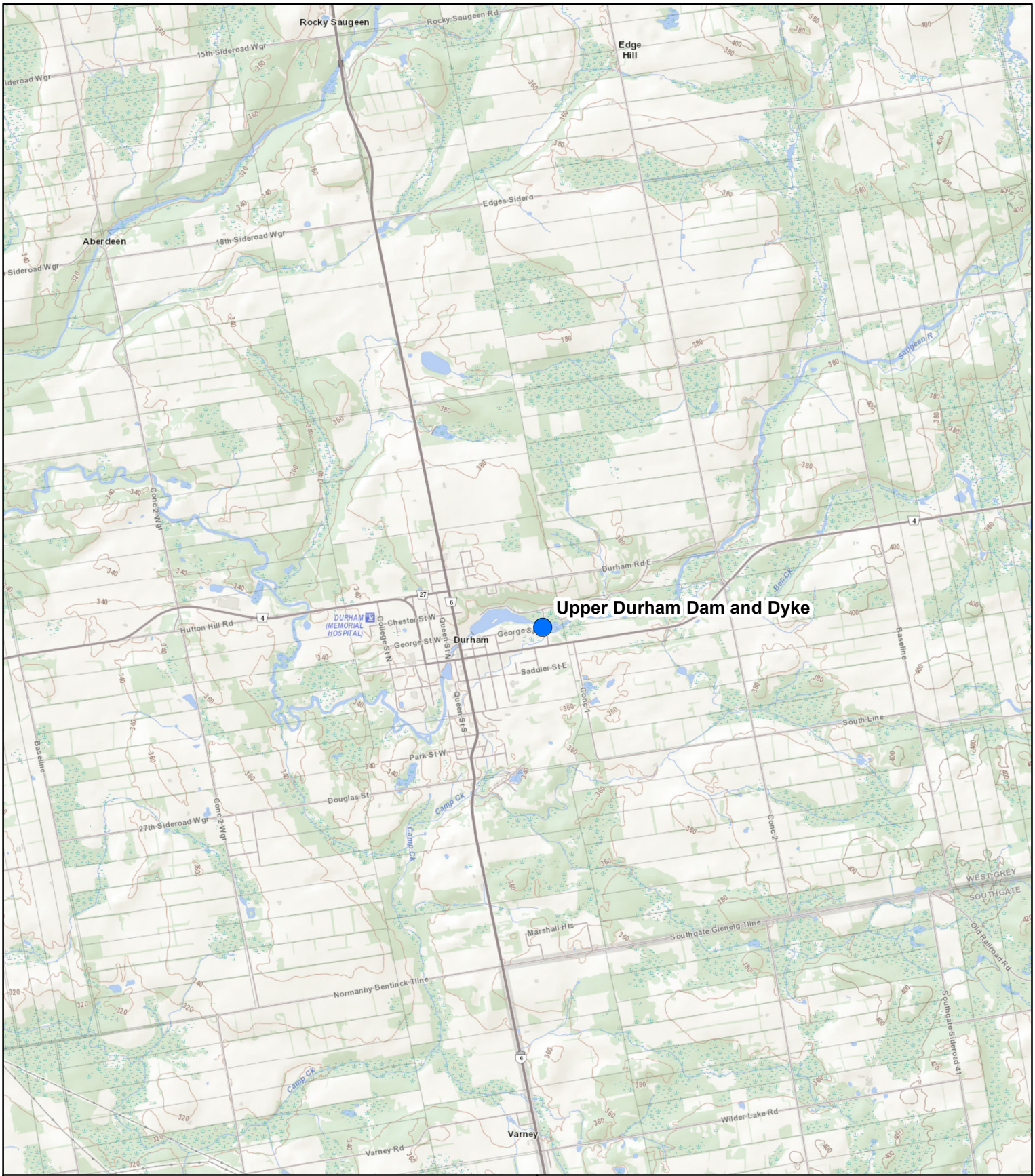
Repairs to the right (south) wingwall, including the installation of additional fencing, have been conducted by the SVCA in the past five (5) years to improve safety and to try to reduce the amount of leakage through the south abutment. Additionally extensive parging of concrete piers and the concrete apron have been conducted by SVCA staff in recent years.

In 1976, an earthen dyke was re-constructed along the right (south) bank of the Saugeen River to prevent floodwater from leaving the reservoir during high flow conditions. According to construction drawings, the dyke includes an impervious core. The dyke is tied into the concrete dam with a concrete key, measuring 9 m by 0.6 m wide. A toe drain is located on the south edge of the dyke and the north side of the dyke is covered with rip rap and/or concrete apron to minimize erosion.

The site plan is shown in **Figure 2**. The location of site features is referenced left to right facing upstream.

1.4 Description of Operations

The Durham Upper Dam is primarily used to reduce flooding associated with frazil ice formation. Dam operations are carried out manually by SVCA staff by removing and replacing stoplogs and flashboards in the sluices. Stoplogs and flashboards are typically installed in mid-May to create a swimming area upstream of the dam and are partially removed in the winter in a configuration best suited for ice management.



Legend

- Dam Location

Meters
0 650 1,300 2,600

Data Sources
Land Information Ontario 2022
Created In: ArcMap 10.7

NAD 1983 UTM Zone 17N 1:50,000

Figure 1 - Location Plan

Drawn By:	GB
Checked By:	DG
Map Date:	12/02/22
Project Number:	22-5540
Map File Number	Figure 1

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Legend

- Dam
- Intermittent Watercourse
- Parcel Fabric
- Dyke

Data Sources
Saugeen Valley Conservation Authority
Created In: ArcMap 10.7
Scale: N.T.S

Figure 2 - Site Plan

Drawn By:	GB
Checked By:	DG
Map Date:	12/05/22
Project Number:	22-5540
Map File Number	Figure 2

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2.0 Inspection Methodology

2.1 Background Review and Fieldwork Preparation

A review of the background information provided by the SVCA was completed prior to Wills' field inspection. This information included available drawings, site access plans, photographs, inspection records and reports. The background review and fieldwork preparation consisted of the following tasks:

- Coordination of access to the dam site with SVCA staff.
- Review of the available background information.
- Set-up of MNRF Form B-2 (Dam Inspection Form).
- Preparation of a Site-Specific Health and Safety Plan.
- Printing inspection forms and available drawings.

2.2 Dam Condition Assessment

Wills performed a visual and non-destructive structural inspection of the dam. The methodology for this inspection is summarized as follows:

- Visual inspection, along with recording and classification, of all observable deficiencies according to the Ontario Structure Inspection Manual (OSIM).
- Georeferenced photographs of all aspects of the dam.
- Where possible, aerial imagery of the dam and up and downstream areas collected using a Remotely Piloted Aircraft System.
- Where possible, underwater video of the underwater faces of the dam collected using a pole mounted GoPro camera.
- Review of previously identified deficiencies and their digression over time.
- Completion of MNRF Form B-2 (Dam Inspection Form).

Wills classified the structural deficiencies, including those in concrete, steel and wood, based on the 2008 OSIM. The OSIM reference checklist used for the inspection is provided in **Appendix C**.

2.3 Assessment of Public and Operator Safety Measures

Wills' inspection of the site included a thorough visual inspection of all public and operator safety measures at the dam. The methodology for the inspection and review of the public and operator safety measures is summarized below:

- Visual inventory and inspection of all signage.
- Visual inspection of dam access route(s).
- Visual inspection of existing public safety measures (railings, booms, buoys, etc.).

- Visual inspection of existing operator safety measures (railings, fall arrest).

The inspection of the public safety measures was carried out in accordance with the methodologies and requirements described in the Best Management Practices for Public Safety Around Dams (MNR, 2011), the Guidelines for Public Safety Around Dams (CDA, 2011) and the Ontario Building Code (OBC). The inspection of the operator safety measures was carried out in accordance with the Occupational Health and Safety Act (OSHA) and the Industrial Establishments Regulation.

3.0 Inspection Findings

3.1 Dam Condition Assessment

Wills performed the inspection of the Durham Upper Dam and Dyke on September 19, 2022. At the time of the inspection, the weather was sunny and approximately 17°C.

The dam inspection results are documented in the photographic record in **Appendix A** and the Dam Inspection Form B2 in **Appendix B**. Digital copies of all photographs and videos from the inspection will be provided to the SVCA by digital file transfer.

In general, the dam was observed to be in fair to poor condition with areas of concrete deterioration (cracking, efflorescence and scaling) throughout the abutments and piers. Seepage was noted downstream of the right abutment and there was minor erosion identified on the downstream left and right banks.

Wills developed the following rating scale in order to provide the SVCA with a high-level assessment of the condition of the various components at the site:

- **1 – Very Poor** – Major deficiencies throughout the component. The structural integrity of the component is likely compromised and/or the component does not function as intended.
- **2 – Poor** – Significant deficiencies throughout component and the component may not function as intended under certain conditions.
- **3 – Fair** – Some deficiencies throughout component that may affect the ability of the component to function as intended if not corrected.
- **4 – Good** – Some localized deficiencies that do not affect the ability of the component to function as intended.
- **5 – Very Good** – No significant deficiencies throughout the component. Only slight imperfections may exist.

Similar to the condition rating system described above, Wills developed the following rating scale in order to provide the SVCA with a high-level understanding of the risk of failure of the various components at the site:

- **1 – Low** – Failure of the component could occur but only in rare/unforeseen events or circumstances.
- **2 – Moderate** – Failure of the component may occur in extreme events or circumstances but is unlikely to occur during normal operations.
- **3 – High** – Failure of the component may occur during normal operations.

A detailed list of the site's components along with the identification of deficiencies, condition ratings and risk ratings is provided in **Table 1.**

3.2 Assessment of Public Safety Measures

Dams, and their associated structures and operational practices, present a number of potential hazards to the public. Protecting the public from these potential hazards is an important element of a dam owner's due diligence. Public safety should be considered throughout all stages of a dam's life cycle, from design to decommissioning; however, this is most important during the operational phase of the project. In Ontario, public safety around dams is managed in accordance with the Best Management Practices for Public Safety Around Dams (MNR, 2011).

The public safety measures that have been installed at the site include:

- Buoy line (inadequate as a public safety boom).
- Public safety signage.
- Railings around both wingwalls and retaining walls and along either side of the dam deck / pedestrian bridge.

Based on our site investigation, Wills identified the following potential public safety issues:

- There is no public safety boom present at the site and it has been reported the people (i.e. swimmers, kayakers) frequently go through the dam.
- There is a public swimming area immediately upstream of the dam.
- There is public safety signage present; however, some of it is obstructed and some of it does not meet Best Management Practices for Public Safety Around Dams (MNR, 2011).

3.3 Assessment of Operator Safety Measures

Operator safety measures are regulated under the Occupational Health and Safety Act (OHSA). The OHSA and its associated regulations are used to assess the adequacy of operator safety measures. For the majority of dam sites, there are two (2) primary

operator safety measures, railings and fall protection, the requirements for which depend on specific site conditions.

The Industrial Establishments Regulation of the OHSA (O.Reg. 851) requires a guard rail at the open side of any raised surface. The guard rail must have a top rail located not less than 910 mm and not more than 1070 mm above the surface to be guarded, have a mid rail, have a toe-board that extents at least 125 mm from the surface if tools or other objects may fall on other workers below, be free of splinters and protruding nails and be constructed to meet the structural requirements for guards as set out in the Ontario Building Code. The existing railing generally meets the requirements for a guard rail under O.Reg. 851.

O.Reg. 851 requires a fall arrest system where a worker is exposed to the hazard of falling and the surface to which they might fall is more than 3 m below the position where they are situated. Based on the drawings provided, the potential fall height is approximately less than 3 m; therefore, a fall arrest system for dam operators is not required.

Potential operator safety issues include:

- Working around the water may require the use of a life jacket or PFD.
- Installation/ removal of stoplogs/ flashboards during higher flows.
- Clearing of ice in the winter/spring.
- Grass cutting on the steep slopes of the flood dyke.

Table 1 – Summary of Inspection Results

Structure	Location	Deficiency / Description	Condition Rating	Risk Rating
Earth Embankment				
Earth Embankments	Flood Dyke	Steep slopes on the left side of the embankment, grass cut short exposing bare soil, Concrete culverts through dyke partially filled with sediment (Photos: 97-106)	4	1
	Right Embankment	None (Photo: 49)	4	1
	Left Embankment	None (Photo: 95)	4	1
Concrete Structures				
Abutment	Left Abutment	Light scaling and cracking. Localized spalling (Photos: 40, 70-71)	4	1
	Right Abutment	Repaired area has delaminated. Moss growth, severe scaling, large spall. Seepage through abutment, exiting through concrete block retaining wall. (Photos: 11, 12, 49, 50, 52)	2	1
Piers	Pier 1	Medium scaling. Cracking with efflorescence along cold joint (Photos: 35-38, 67-69)	3	1
	Pier 2	Medium scaling, large spalling. Medium to wide cracking (Photos: 28-32, 63-65)	3	1
	Pier 3	Medium scaling, localized spalling (Photos; 21-24, 58-60)	3	1
	Pier 4	Medium scaling and spalling. Cracking with efflorescence (Photos: 15-18, 54-56)	3	1
Wingwalls	Upstream Right	None (Photos: 7-10)	4	1
	Upstream Left	None (Photos: 41-42)	4	1

Structure	Location	Deficiency / Description	Condition Rating	Risk Rating
Spillways	Downstream	None (Photos: 53, 57, 61, 66, 70)	4	1
Wooden and Metal Structures				
Pedestrian Bridge	Above	Some degree of corrosion, recently recoated. Needs to be constantly repaired due to ice loading (Photos: 83, 85, 86-87)	3	2
Railings	Throughout	None (Photos: 43, 79, 86)	4	1
Flow Control Equipment				
Stoplogs	Sluiceway 1	4-ply 2x10s bending severely (Photos: 38-39)	1	3
	Sluiceway 2	None (Photo: 34)	4	1
Flashboards	Sluiceways 3, 4, 5	None (Photos: 13-14, 19-20, 25-26)	4	1

4.0 Recommendations

The inspection recommendations along with prioritization and cost estimates for each recommendation are provided in **Table 2.** The degree of accuracy for the cost estimates is approximately +/-50% and are based the best information available at the time of report production. The priorities are classified as "Immediate", "High", "Medium", "Low" and "Ongoing" and are defined as follows:

- **Immediate** – Remedial action that needs to be carried out as soon as possible because the deficiency is an immediate high-risk dam safety hazard with a high likelihood of occurrence of loss of life and /or serious environment and/or serious economic consequences.
- **High** – Remedial action is required within the next two years to meet current regulations and/or dam safety requirements and is a high-risk dam safety hazard.
- **Medium** – These items may include additional work that could improve the performance or issues that may become serious dam deficiencies. These items typically should be addressed within five years.
- **Low** – These are opportunities to improve safety or deficiencies that may only become a serious dam safety deficiency in the long term. The recommendation can be carried out at the SVCA's convenience, or the recommended remedial action is expected to be required six years from now or later.
- **Ongoing** – These items may need to be reviewed and completed on a regular basis to ensure that the function of the dam and public safety measures is maintained.

The recommendations are prioritized based on the risk of occurrence, the significance of potential negative impacts and the resources (cost, time, effort) required to implement. The recommendations have been categorized as Dam Safety Management, Public Safety, Operator Safety, Minor Maintenance (repairs < $100,000) and Major Maintenance (repairs > $100,000).

Table 2 – Dam Inspection Recommendations

Recommendation	Description of Deficiency	Priority	Estimated Cost	Additional Comments
Dam Safety Management				
1. Prepare an updated Dam Safety Assessment/Review for the Durham Upper Dam prior to, or as part of, any major decisions regarding the management and maintenance of the structure. The Dam Safety Assessment/Review should be completed in accordance with the Lakes and Rivers Improvement Act Technical Bulletins and Best Management Practices (MNR, 2011).	There is limited Dam Safety information available for the Durham Upper Dam and Dyke. A hydraulic assessment study was completed by OEL Hydrosys/WESA in 2009. The study was completed in accordance with the Draft Ontario Dam Safety Guidelines (MNR, 1999). A Hazard Potential Classification of Low and an Inflow Design Flood of the 100-year flood were recommended and it was determined that the dam has sufficient hydraulic capacity to convey the IDF. It is noted that this study did not include a stability analysis of the concrete or earth embankment sections or complete a detailed analysis of a dyke failure, likely due to the limits of the modelling software at that time.	Medium	$75,000	The estimated cost assumes that the SVCA would retain the services of a qualified consulting engineering firm to complete a full Dam Safety Review. Cost efficiencies would be gained by completing the Dam Safety Review for the Durham Upper and Lower Dams at the same time. The SVCA may want to consider completing Hazard Potential Classification studies for all of their dams before full Dam Safety Reviews so that the full Dam Safety Reviews can be prioritized for the High hazard structures. The cost of completing the Hazard Potential Classification study would be approximately $30,000 for this structure. The scope of work would include a hydrology study, the development of a hydraulic model, a dam breach assessment and an incremental loss assessment. The price per structure could be reduced if several Hazard Potential Classification studies are completed by the same consultant at the same time.
2. Establish a regular frequency for engineering inspections (i.e. annually or bi-annually) as well as routine inspections by staff (i.e. monthly).	The records of past engineering inspections included reports completed by B.M. Ross in 2015 and 2021. There were no records of past routine inspections, other than photos taken in 2017, 2018, 2019, 2020 and 2021. The SVCA would benefit from establishing a regular frequency of engineering inspections (i.e. annually or bi-annually) as well as routine inspections by staff (i.e. monthly).	Immediate	$2,500	The estimated cost shown is for the completion of an annual or bi-annual inspection by a qualified consulting engineering firm and assumes that the SVCA would have a number of flood and erosion control structures inspected as part of the same contract. The cost for a standalone dam inspection would be estimated as $10,000. It is assumed that the routine inspections would be completed by SVCA staff as part of their regular duties.

Recommendation	Description of Deficiency	Priority	Estimated Cost	Additional Comments
Public Safety				
3. Remove all yellow hazard signs and replace them with signs that meet the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011).	There are a number yellow hazard signs posted at the site. These signs do not meet the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011) which could lead to confusion for members of the public because the signs are not consistent with other dams in the area.	High	$2,500	It is assumed that the SVCA would purchase new signs but that the labour to remove the old signs and install the new ones would be completed by SVCA staff as part of their regular duties.
4. When public safety signs need to be replaced, replace them with signs that meet the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011).	Some signs do not meet the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011) and this standard should be followed when adding new public safety signs.	Low	$0	No cost at this time. The purpose of this recommendation is to serve as a reminder of the signage requirements listed in the Best Management Practices for Public Safety Around Dams (MNR, 2011).
5. Clear the vegetation from around the upstream warning sign.	The upstream warning sign is partially obscured by vegetation and may not be visible from some locations upstream.	High	$0	It is assumed that this would be completed by SVCA staff as part of their regular duties.
6. Install a public safety boom upstream of the dam. The public safety boom should be installed in accordance with the Guidelines for Public Safety Around Dams (CDA, 2011).	There is no public safety boom at the site. A Public Safety Plan, including a Public Safety Risk Assessment, was completed by B.M. Ross and Associates Limited in 2021. B.M. Ross and Associates Limited identified swimming (upstream and downstream), boating/canoeing, and walking/standing on the walkway above the dam as High-risk activities. SVCA staff have indicated that there have been a number of instances of members of the public jumping off the dam and swimming immediately upstream of the dam. There were also reports of swimmers being passed through the dam and kayakers going through the dam during high flow conditions. These High-risk activities have the potential to lead to a fatality.	High	$300,000	The cost estimate assumed an inverted “v” boom layout with an upstream in-water anchor. This layout would require 2 shore anchors and 1 in-water anchor. Estimated cost includes design by the supplier or supplier’s engineer.
7. Implement a public education plan to describe the hazards and risks associated with recreating at or near the dam to the general public as well as visitors to the Durham Conservation Area. Monitor and record public activities at the site using the CDA Public Safety Incidents Form that can be found in the Guidelines for Public Safety Around Dams (CDA, 2011).	There is a significant amount of public interaction at the site and the public routinely undertakes activities that have the potential to lead to fatalities.	Immediate	$0	It is assumed that this would be completed by SVCA staff as part of their regular duties. Ongoing monitoring and recording of public safety incidents and activities at the site will be very important for the future update of the Public Safety Risk Assessment and Public Safety Plan.

Recommendation	Description of Deficiency	Priority	Estimated Cost	Additional Comments
8. Review/update the Public Safety Plan and Public Safety Risk Assessment within five years and use the data collected on the CDA Public Safety Incident Forms to determine if the public safety measures have been effective. If the public safety measures have not been effective, implement additional public safety measures.	The current Public Safety Plan that was completed by B.M. Ross and Associates recommended a number of new public safety measures be implemented. Ongoing monitoring and recording of public safety incidents and activities at the site over the next five years will help support the updated Public Safety Risk Assessment and the determination of the implemented public safety measures were effective.	Low	$15,000	The cost estimate assumes that the SVCA would retain the services of a qualified consulting engineering firm to complete this work; however, this could be completed by SVCA staff if they have the appropriate knowledge and experience. The appropriate public safety measures and their costs would be identified as part of the Public Safety Risk Assessment.
Operator Safety				
9. Develop an Operation, Maintenance, Surveillance and Safety (OMSS) Manual for the dam. This should include a detailed review of the operation and maintenance practices used by SVCA staff with a particular focus on operator health and safety.	An Operation, Maintenance, Surveillance and Safety (OMSS) Manual was not provided for review as part of the background material and operator safety issues associated with the installation and removal of stoplogs, ice and debris management, and grass cutting on the flood dyke were identified during the dam inspection.	High	$20,000	It is assumed that the SVCA would retain a qualified consultant to complete this work.
Minor Maintenance				
10. Maintain the grass on the flood dyke at a longer length to reduce the risk of it drying out and exposing the underlying soil which could lead to an increased risk of soil erosion. Restore grass cover on any bare spots.	The grass on the embankment slopes and crest is quite short resulting in bare spots and increasing the potential for soil erosion	Ongoing	$0	It is assumed that this would be completed by SVCA staff as part of their regular duties. Grass should be cut shorter just before the engineering and routine inspections so that any deficiencies can be more easily identified.
11. Replace the staff gauge.	The staff gauge is in very poor condition.	Immediate	$1,000	It is assumed that this would be completed by SVCA staff as part of their regular duties with purchased materials.

Recommendation	Description of Deficiency	Priority	Estimated Cost	Additional Comments
Major Maintenance				
12. Complete a full rehabilitation of the dam structure, including the rehabilitation of the concrete piers/abutments, the addition of bracing for the stoplogs/flashboards that utilizes the piers for support rather than the steel truss for the dam deck/pedestrian walkway, replacing the dam deck/pedestrian walkway, and the remediation of the seepage through the right embankment/abutment.	Overall, the dam is in fair to poor condition with a significant number of concrete deficiencies, seepage through the right abutment, ice damage to the steel truss for the dam deck/pedestrian walkway and improper bracing of the stoplogs against the dam deck/pedestrian walkway.	Medium	$750,000	The SVCA may want to consider completing a Class Environmental Assessment (Conservation Ontario) prior to moving forward with the rehabilitation. This is because the Class Environmental Assessment would allow for a full study of all options available to address the deficiencies at the Durham Upper Dam. This may lead to a longer-term solution that would have a lower life-cycle cost than the dam rehabilitation and may better suit the SVCA's operational needs. The cost of a Class Environmental Assessment study, including public consultation, is estimated as $100,000. A permit under the Lakes and Rivers Improvement Act from the Ministry of Natural Resources and Forestry may be required prior to the implementation of the preferred alternative.

5.0 Conclusion

Wills completed this Dam Inspection Report to provide the SVCA with an understanding of the overall existing condition of the structure, address any potential public or operator safety concerns and provide recommendations to better direct the SVCA with respect to long term management of the structure.

In general, the dam was observed to be in fair to poor condition with areas of concrete deterioration (cracking, efflorescence and scaling) throughout the abutments and piers. Seepage was noted downstream of the right abutment and there was minor erosion identified on the downstream left and right banks.

The dam should continue to be monitored for future deterioration and remedial action should be completed on an as needed basis.

The detailed inspection findings are presented in **Section 3.0** and the recommendations are presented in **Section 4.0**. The following highlights the Urgent, Important and Future priority items for the dam:

Urgent Priority Items

- None.

Important Priority Items

- Prepare an updated Dam Safety Assessment/Review for the Durham Upper Dam prior to, or as part of, any major decisions regarding the management and maintenance of the structure. The Dam Safety Assessment/Review should be completed in accordance with the Lakes and Rivers Improvement Act Technical Bulletins and Best Management Practices (MNR, 2011).
- Establish a regular frequency for engineering inspections (i.e. annually or bi-annually) as well as routine inspections by staff (i.e. monthly).
- Develop an Operation, Maintenance, Surveillance and Safety (OMSS) Manual for the dam. This should include a detailed review of the operation and maintenance practices used by SVCA staff with a particular focus on operator health and safety.
- Remove all yellow hazard signs and replace them with signs that meet the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011).
- Clear the vegetation from around the upstream warning sign.
- Install a public safety boom upstream of the dam. The public safety boom should be installed in accordance with the Guidelines for Public Safety Around Dams (CDA, 2011).
- Implement a public education plan to describe the hazards and risks associated with recreating at or near the dam to the general public as well as visitors to the Durham Conservation Area. Monitor and record public activities at the site using

the CDA Public Safety Incidents Form that can be found in the Guidelines for Public Safety Around Dams (CDA, 2011).

- Maintain the grass on the flood dyke at a longer length to reduce the risk of it drying out and exposing the underlying soil which could lead to an increased risk of soil erosion. Restore grass cover on any bare spots.
- Replace the staff gauge.

Future Priority Items

- Complete a full rehabilitation of the dam structure, including the rehabilitation of the concrete piers/abutments, the addition of bracing for the stoplogs/flashboards that utilizes the piers for support rather than the steel truss for the dam deck/pedestrian walkway, replacing the dam deck/pedestrian walkway, and the remediation of the seepage through the right embankment/abutment.
- When public safety signs need to be replaced, replace them with signs that meet the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011).
- Review/update the Public Safety Plan and Public Safety Risk Assessment within five years and use the data collected on the CDA Public Safety Incident Forms to determine if the public safety measures have been effective. If the public safety measures have not been effective, implement additional public safety measures.

If you have any questions with regards to the information contained herein, please do not hesitate to contact the undersigned.

Respectfully Submitted,

David Green, P.Eng.
Group Leader, Dam Engineering

Alex Payette, EIT
Structural Engineer in Training

James Chambers
Project Designer,
Water Resources Engineering

Appendix A

Photographic Record

Photo 1 - September 19, 2022
Durham Upper Dam and Dyke
Aerial View of Upstream Side of Dam

Photo 2 - September 19, 2022
Durham Upper Dam and Dyke
Right Side Buoy Line Anchor

Photo 3 - September 19, 2022
Durham Upper Dam and Dyke
Buoy Line from Right Bank

Photo 4 - September 19, 2022
Durham Upper Dam and Dyke
Buoy Line from Walkway

Photo 5 - September 19, 2022
Durham Upper Dam and Dyke
Buoy Line from Left Bank

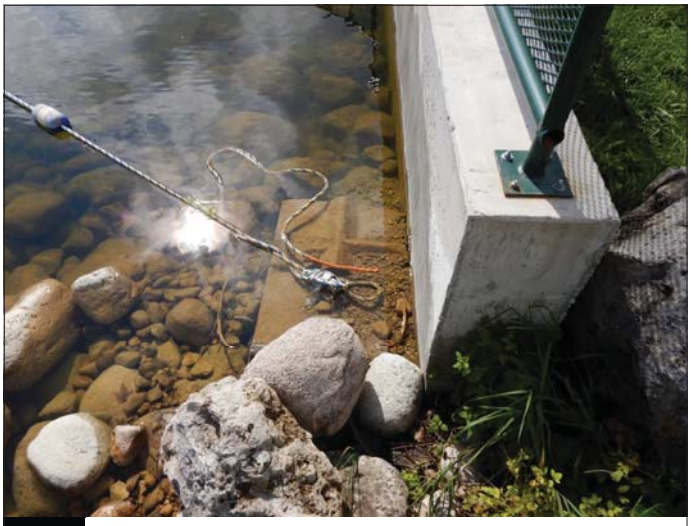

Photo 6 - September 19, 2022
Durham Upper Dam and Dyke
Left Side Buoy Line Anchor

Photo 7 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Right Wingwall

Photo 8 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Right Wingwall

Photo 9 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Right Wingwall

Photo 10 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Right Wingwall

Photo 11 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 6

Photo 12 - September 19, 2022
Durham Upper Dam and Dyke
Sluice 5 at Right Abutment

Photo 13 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Sluiceway 5

Photo 14 - September 19, 2022
Durham Upper Dam and Dyke
Stoplogs in Sluiceway 5

Photo 15 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 4

Photo 16 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Pier 4

Photo 17 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Pier 4

Photo 18 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 4

Photo 19 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Sluiceway 4

Photo 20 - September 19, 2022
Durham Upper Dam and Dyke
Stoplogs in Sluiceway 4

Photo 21 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 3

Photo 22 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Pier 3

Photo 23 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Pier 3

Photo 24 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 3

Photo 25 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Sluiceway 3

Photo 26 - September 19, 2022
Durham Upper Dam and Dyke
Stoplogs in Sluiceway 3

Photo 27 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Facing Public Safety Sign

Photo 28 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 2

Photo 29 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 2

Photo 30 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Pier 2

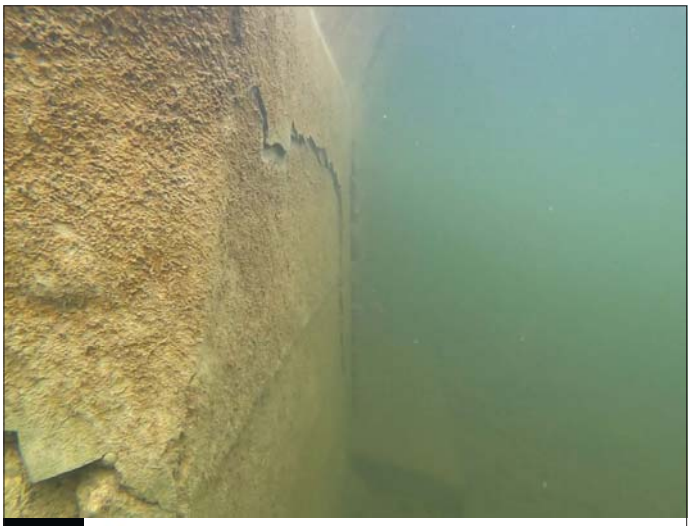

Photo 31 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Pier 2

Photo 32 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 2

Photo 33 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Sluiceway 2

Photo 34 - September 19, 2022
Durham Upper Dam and Dyke
Stoplogs in Sluiceway 2

Photo 35 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 1

Photo 36 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Pier 1

Photo 37 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Side of Pier 1

Photo 38 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 1

Photo 39 - September 19, 2022
Durham Upper Dam and Dyke
Stoplogs in Sluiceway 1

Photo 40 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Left Abutment

Photo 41 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Left Wingwall

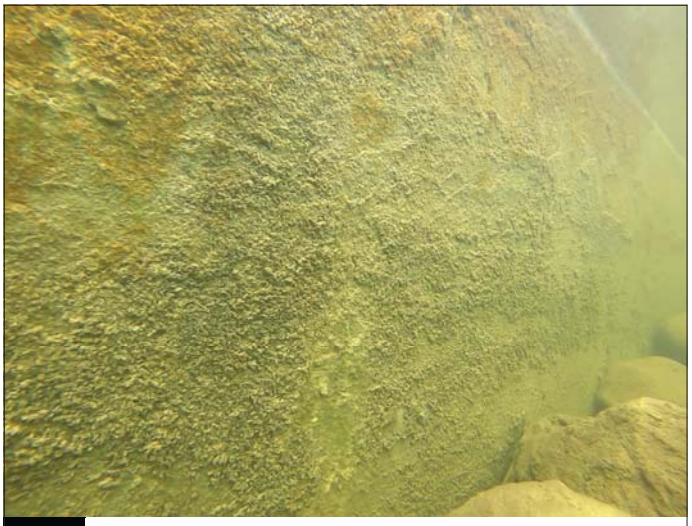

Photo 42 - September 19, 2022
Durham Upper Dam and Dyke
Upstream Left Wingwall

Photo 43 - September 19, 2022
Durham Upper Dam and Dyke
Railing on Upstream Left Wingwall

Photo 44 - September 19, 2022
Durham Upper Dam and Dyke
Aerial View of Upstream Side of Dam

Photo 45 - September 19, 2022
Durham Upper Dam and Dyke
Public Safety Sign Upstream of Dam

Photo 46 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Watercourse

Photo 47 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Dam from Right Bank

Photo 48 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Right Bank

Photo 49 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Right Bank

Photo 50 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Right Abutment

Photo 51 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Facing Public Safety Sign

Photo 52 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Right Abutment

Photo 53 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Sluiceway 5

Photo 54 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 4

Photo 55 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Pier 4

Photo 56 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 4

Photo 57 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Sluiceway 4

Photo 58 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 3

Photo 59 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Pier 3

Photo 60 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 3

Photo 61 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Sluiceway 3

Photo 62 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Facing Public Safety Sign

Photo 63 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 2

Photo 64 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Pier 2

Photo 65 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 2

Photo 66 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Sluiceway 2

Photo 67 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pier 1

Photo 68 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Pier 1

Photo 69 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Pier 1

Photo 70 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Left Abutment

Photo 71 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Side of Left Abutment

Photo 72 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Left Bank

Photo 73 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Watercourse

Photo 74 - September 19, 2022
Durham Upper Dam and Dyke
Public Signs on Downstream Right Bank

Photo 75 - September 19, 2022
Durham Upper Dam and Dyke
Downstream Right Bank

Photo 76 - September 19, 2022
Durham Upper Dam and Dyke
Right Embankment

Photo 77 - September 19, 2022
Durham Upper Dam and Dyke
End of Upstream Right Wingwall

Photo 78 - September 19, 2022
Durham Upper Dam and Dyke
Right Facing Public Safety Sign

Photo 79 - September 19, 2022
Durham Upper Dam and Dyke
Railing on Upstream Right Wingwall

Photo 80 - September 19, 2022
Durham Upper Dam and Dyke
Right Facing Public Safety Sign

Photo 81 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Dam and Pedestrian Walkway

Photo 82 - September 19, 2022
Durham Upper Dam and Dyke
Right Facing Public Information Sign

Photo 83 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Pedestrian Walkway

Photo 84 - September 19, 2022
Durham Upper Dam and Dyke
Right Facing Public Safety Sign

Photo 85 - September 19, 2022
Durham Upper Dam and Dyke
Pedestrian Walkway

Photo 86 - September 19, 2022
Durham Upper Dam and Dyke
Pedestrian Walkway

Photo 87 - September 19, 2022
Durham Upper Dam and Dyke
Underside of Pedestrian Walkway

Photo 88 - September 19, 2022
Durham Upper Dam and Dyke
Left Facing Public Safety Sign

Photo 89 - September 19, 2022
Durham Upper Dam and Dyke
Left Facing Public Safety Sign

Photo 90 - September 19, 2022
Durham Upper Dam and Dyke
Left Facing Public Information Sign

Photo 91 - September 19, 2022
Durham Upper Dam and Dyke
Left Facing Public Safety Sign

Photo 92 - September 19, 2022
Durham Upper Dam and Dyke
Left Facing Public Safety Sign

Photo 93 - September 19, 2022
Durham Upper Dam and Dyke
Left Facing Public Safety Sign

Photo 94 - September 19, 2022
Durham Upper Dam and Dyke
Left Embankment and Overflow Spillway

Photo 95 - September 19, 2022
Durham Upper Dam and Dyke
Beach and Picnic Area on Upstream Left Bank

Photo 96 - September 19, 2022
Durham Upper Dam and Dyke
Aerial View of Dyke

Photo 97 - September 19, 2022
Durham Upper Dam and Dyke
Left Side of Dyke

Photo 98 - September 19, 2022
Durham Upper Dam and Dyke
Crest of Dyke

Photo 99 - September 19, 2022
Durham Upper Dam and Dyke
Right Side of Dyke

Photo 100 - September 19, 2022
Durham Upper Dam and Dyke
Overhead View of Dyke

Photo 101 - September 19, 2022
Durham Upper Dam and Dyke
Manhole in Dyke

Photo 102 - September 19, 2022
Durham Upper Dam and Dyke
Manhole in Dyke

Photo 103 - September 19, 2022
Durham Upper Dam and Dyke
Outlet Pipe in Dyke

Photo 104 - September 19, 2022
Durham Upper Dam and Dyke
Inside Outlet Pipe

Photo 105 - September 19, 2022
Durham Upper Dam and Dyke
Crest of Dyke

Photo 106 - September 19, 2022
Durham Upper Dam and Dyke
Aerial View of Dyke

Photo 107 - September 19, 2022
Durham Upper Dam and Dyke
End of Dyke

Photo 108 - September 19, 2022
Durham Upper Dam and Dyke
Aerial View of Downstream Watercourse

Appendix B

Dam Inspection Form B2

Form B2

Dam Inspection Form

Date:	Monday, September 19, 2022
Name of Dam:	Durham Upper Dam and Dyke
Municipality:	Municipality of West Grey, County of Grey
Location:	Lot 25, Concession 1, East of Owen Sound Road, Geographic Township of Glenelg
GPS Coordinates:	515289.00 m E, 4891775.00 m N, UTM Zone 17T
Inspected By:	David Green, P.Eng., Alex Payette, EIT
Weather:	Sunny, 17°C

1 – Earth Embankment

Flood Dyke – There is a flood dyke that extends from downstream of the dam, near the parking area, following the watercourse for approximately 200 m and then angling south to Lambton Street East.

There is evidence of cable concrete matting along a portion of the left side of the dyke and rip-rap toe protection along the majority of the left side of the dyke. Vegetation has been left long at the water's edge but the grass on the embankment slopes and crest is quite short resulting in bare spots and increasing the potential for soil erosion. The left side slopes of the dyke are quite steep, and it is understood that this makes grass cutting operations difficult. There appears to be some vehicle tracks/rutting along the embankment, likely from the grass cutting operations.

There is a manhole structure in the crest of the embankment with a steel grate that is locked shut. There are concrete culverts that lead into the manhole structure from both sides of the flood dyke. It's understood that this was installed to allow for drainage of a local development. There is a valve on the inside of the manhole structure that can be closed to prevent floodwaters from flowing through the flood dyke. The valve requires manual operation during a flood event. The concrete culverts are filled with sediment and debris but otherwise appear to be in good condition.

Right Embankment – The right embankment extends from the right abutment to the flood dyke and is retained partially by the right abutment wingwalls. Based on historical information provided by the SVCA, it is understood that the earth section was at one point lowered as an emergency spillway and cable concrete was added to provide the required erosion protection. Some of this cable concrete is visible at the surface, particularly on the upstream slope. There is a gravel access trail that follows the downstream side of the embankment. Adjacent to the right abutment and wingwalls, the embankment is retained by large precast concrete blocks. The blocks appear to have shifted over time and there is active seepage in this area.

Left Embankment – The left embankment is similar to the right embankment where there is a concrete wingwall section that transitions to an earth embankment. There are round field stones that are armouring the gently sloping grass embankment at the

end of the concrete wingwall and there is a public swimming area with a sandy beach upstream of the embankment. There is a buried concrete wall that runs perpendicular to the watercourse starting at the left abutment. Only the top face of this wall is visible so the height and geometry of the wall below the ground surface are unknown. SVCA staff explained that during flood conditions, the watercourse overtops the embankment and concrete wall and travels down a walking path running parallel with the river, ultimately discharging back into the river a few hundred meters downstream.

2 – Concrete Structures (wingwalls, piers, deck, spillways, apron, etc.)

Left Abutment – The left abutment has light scaling at the base, cracking with efflorescence concentrated to the top half of the wall with some localized spalling on the corner of the top and inside face, and small pop-outs and spalls throughout the wall face.

Right Abutment – The right abutment is in poor condition. The entire inside face has been repaired with cementitious parging and the repaired area has delaminated. On the downstream face of the abutment, the previously repaired area has spalled on the corner of the face. The concrete in this spalled area is severely weathered and is beginning to disintegrate. A wide horizontal crack starting in this spalled area has spalling along the length of the crack. There is moss growth and severe scaling along the base of the abutment. Adjacent to the underside of the deck/pedestrian bridge structure, the concrete acting as the bearing seat is spalled and disintegrating.

Pier 1 – There is medium scaling at the base of the pier and there is horizontal cracking with efflorescence along apparent cold joints.

Pier 2 – There is medium scaling at the base of the pier on both sides and a large area of spalling in the center of the downstream face. From this area of spalling propagates a wide crack that extends along the length of the right inside face of the pier. There is also medium to wide cracking on the left inside face of the pier.

Pier 3 – There is medium scaling at the base of the pier on both sides and a wide crack on the downstream face of the pier with a localized spall along the crack.

Pier 4 – Pier 4 (first from the right abutment) has cracking with efflorescence on the inside, outside and downstream faces. There are also two areas of spalling on the corners towards the tops of the piers. There is medium scaling at the base of the pier on both sides.

Wingwalls – The upstream right wingwall is described in the earth embankment section of this report as loose poured concrete over rock and is in good condition. The wingwall appears to have been recently capped with newer concrete and a metal railing has been installed. The upstream left wingwall is cast-in-place concrete and is in good condition. There is one localized spall at the edge of the wingwall and abutment. Apparent repairs are present along the top of the wall where the metal railing has been installed.

Spillways/Aprons – Inspection on the spillways/aprons was limited due to the fast-flowing water but where reviewed, the concrete appeared to be in good condition with scaling that is consistent with the presence of constantly flowing water.

3 – Wooden and Metal Structures (decks, gains, railings, conduits, etc.)

Dam Deck / Pedestrian Bridge – A steel deck/pedestrian bridge sits atop the abutments and piers to provide operator access to the various parts of the dam and allow members of the public to cross the dam. The structure is constructed with open web steel joists as the main girders with various steel angles acting as sway bracing and lateral bracing. The wearing surface consists of individual steel sections welded to the girders. The structure is in fair to good condition although SVCA staff explained that the structure was recently recoated and may be hiding some deficiencies that were visible before recoating. Upon inspection, the majority of the steel appears to be experiencing some degree of corrosion. It is difficult to determine the extent of corrosion due to the recent coating but there are some members where the cross section of steel observed was thin, which would indicate corrosion of the steel. The bridge is anchored into each pier and abutment with steel base plates and anchors. The plates are in good condition and the number of anchors seem adequate for the current use of the bridge. The grating on the structure generally appears to be in good condition.

It was noted by SVCA staff that ice sometimes comes into contact with the girders on the underside of the structure, causing the girders to deform, needing repairs. This deformation may also be due to the fact that the supports for the flashboards and stoplogs rely on the dam deck/pedestrian bridge structure to provide lateral support and when the ice is pushed downstream it causes excessive lateral stresses that cannot be absorbed by the dam deck/pedestrian bridge structure without deforming.

Railings – Steel pipe railing runs on either side of the dam deck/pedestrian bridge and on the retaining walls. Steel grating is attached to the inside of the railing. The railing and grating appears to be in good condition. The height of the railing is approximately 1.18 m. There are gates on both sides of the dam deck/pedestrian bridge that can be closed and locked by SVCA staff to prevent access by the pubic. The gates were locked in the open position during the inspection and appeared to be in good condition.

4 – Gates and/or Stop Logs

Flashboards – Sluiceways 3, 4 and 5, on the right side of the dam, have single-ply 2x6's that act as the flashboards. The flashboards are supported by vertical 6x6's that sit behind the flashboards and rest on the upstream side of the dam deck/pedestrian bridge structure. The posts are attached to the dam deck/pedestrian bridge structure with a single piece of wire. The flashboards appear to be generally in good condition.

Sluiceways 1 and 2, on the left side of the dam, have more standard square stoplogs that appear to be in good condition. Similar to Sluiceways 3, 4 and 5, the support for the stoplogs in Sluiceway 2 are attached to the upstream side of the dam

deck/pedestrian bridge structure with a vertical H-beam. Sluiceway 1 has 4-ply 2x10's on top of the stoplogs. This member is bending severely.

5 – Water Level Gauge (reading and condition)

The staff gauge is mounted to the upstream side of the right abutment and is in very poor condition. The staff gauge is almost illegible and does not reach below the water surface (broken). It also appears as though the staff gauge is in imperial units (ft) rather than metric units (m).

6 – Winches (type and number)

There are no winches associated with the Durham Upper Dam.

7 – Valves (type and number)

There are no valves associated with the Durham Upper Dam.

8 – Boom (driftwood, chains, anchors)

There is no public safety boom installed at this site; however, there is a buoy line that has been installed across the front of the dam and around the designated swimming area at the beach. The buoy line is inadequate for public safety as it is too close to the dam and will not stop a swimmer from passing under/over it. The buoy line also does not meet the current guidance for public safety booms listed in the Guidelines for Public Safety Around Dams (CDA, 2011).

9 – Erosion (upstream and downstream)

Minor erosion was identified on the downstream left and right banks.

10 – Seepage or Leaks

Seepage through the right abutment was noted. SVCA staff reported that they are consistently having to place additional gravel material on top of the structure to fill in depressions. SVCA provided a historical photograph that was interpreted to show a penstock through what is now the right abutment as well as another spillway on the right side of what is now the right abutment. It is possible that a proper sealing of the structure was not completed when the penstock and additional spillway were removed. The underwater inspection did not reveal any major openings on the upstream side of the right abutment; however, it appears as though additional stone/concrete has been added to the upstream face at some point.

11 – Access Route (location of gate keys, winch handles and keys)

The dam is accessed via the public road system and is generally publicly accessible. There is a parking area downstream of the dam and the dam and dyke can be accessed on foot from this point. The dam deck/pedestrian walkway gates are generally locked in the open position; however, keys from the SVCA may be required to access the deck and cross the river if the gates are locked in the closed position.

12 – Safety Issues (public and operator)

Public Safety – A Public Safety Plan, including a Public Safety Risk Assessment, was completed by B.M. Ross and Associates Limited in 2021. B.M. Ross and Associates Limited identified swimming (upstream and downstream), boating/canoeing, and walking/standing on the walkway above the dam as High-risk activities. SVCA staff have indicated that there have been a number of instances of members of the public jumping off the dam and swimming immediately upstream of the dam. There were also reports of swimmers being passed through the dam and kayakers going through the dam during high flow conditions. These High-risk activities have the potential to lead to a fatality.

Operator Safety – Operator safety issues that were identified by Wills through conversation with SVCA staff were the installation/removal of stoplogs/flashboards and the clearing of ice in the winter/spring. In addition, grass cutting on the steep slopes of the flood dyke are also a hazard for maintenance staff.

13 – Signage

There are large (4 ft by 8 ft) public safety signs mounted to the upstream and downstream sides of the metal railing. The upstream facing sign reads "Keep Out, DANGER, Access Beyond This Point May Result in Drowning." and includes the old SVCA logo as well as the name and address of the dam and instructions to call 911 in an emergency. This sign is generally in good condition with some paint scratches and generally meets the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011); however, the wording on the sign does not perfectly conform. The downstream facing sign reads "DANGER, Keep Out, Access Beyond This Point May Result in Drowning." and includes the old SVCA logo as well as the name and address of the dam and instructions to call 911 in an emergency. This sign is generally in good condition with some paint scratches and generally meets the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011); however, the wording on the sign does not perfectly conform.

There is a large public safety sign mounted to a tree upstream of the dam. The sign reads "WARNING, Dam Downstream" and includes the old SVCA logo as well as the name and address of the dam and instructions to call 911 in an emergency. The sign is generally visible from the watercourse although it is somewhat obstructed by trees. The sign is showing some signs of weathering but is generally in good condition.

There are small "DANGER, KEEP OUT" signs mounted to the railings on the upstream wingwalls (two signs total). The signs are in good condition but do not meet the requirements of the of the Best Management Practices for Public Safety Around Dams (MNR, 2011).

There are yellow drowning hazard signs mounted to the railings on the upstream left and right wingwalls and on the railing at the right abutment (three signs total). The signs are in good condition but do not meet the requirements of the of the Best Management Practices for Public Safety Around Dams (MNR, 2011).

There are small (16 inch by 20 inch) public information signs mounted to the railings on the left and right abutments. The signs indicate that the dam is owned and operated by the SVCA and include the old SVCA logo as well as a contact phone number and email address. These signs are in good condition.

There are small "No Trespassing" signs mounted to the gates on the left and right sides of the dam. The signs are generally in good condition with some corrosion/staining, fading and paint scratches. The signs do not meet the requirements of the of the Best Management Practices for Public Safety Around Dams (MNR, 2011).

There is a small "WARNING, THESE PREMISES PROTECTED BY VIDEO SURVEILLANCE" sign facing the right side of the dam mounted to a steel post above the gate on the left side of the dam. The sign appears to be in good condition.

There is a yellow fall hazard (or slippery surface) sign mounted to a utility pole on the downstream left side of the dam. The sign is in good condition but does not meet the requirements of the of the Best Management Practices for Public Safety Around Dams (MNR, 2011).

There is a "NO BEACH PATROL, Swim at own risk" sign mounted to a utility pole on the downstream left side of the dam. The sign includes the old SVCA logo and the SVCA web address. The sign appears to be in good condition with some fading of the paint.

14 – Divestment and/or Decommissioning Opportunities

The Durham Upper Dam is the site of the Durham Conservation Area which is owned and operated by the SVCA. The beach on the upstream left side of the dam is a popular place for swimming. The dyke on the upstream right side of the dam provides flood protection for parts of the Town of Durham. Based on these factors, it is anticipated that there would be limited divestment or decommissioning opportunities for the Durham Upper Dam.

15 – General Remarks

A hydraulic assessment study was completed by OEL Hydrosys/WESA in 2009. The study was completed in accordance with the Draft Ontario Dam Safety Guidelines (MNR, 1999). A Hazard Potential Classification of Low and an Inflow Design Flood of the 100-year flood were recommended and it was determined that the dam has sufficient hydraulic capacity to convey the IDF. It is noted that this study did not include a stability analysis of the concrete or earth embankment sections or complete a detailed analysis of a dyke failure, likely due to the limits of the modelling software at that time.

B.M. Ross and Associates Limited completed a structural review of the dam in 2021 and made a number of recommendations regarding repairs to the concrete and the installation of new steel beams to brace the flashboards.

The records of past engineering inspections included reports completed by B.M. Ross in 2015 and 2021. There were no records of past routine inspections, other than photos taken in 2017, 2018, 2019, 2020 and 2021. The SVCA would benefit from establishing a

regular frequency of engineering inspections (i.e. annually or bi-annually) as well as routine inspections by staff (i.e. monthly).

16 – Recommendations

- Prepare an updated Dam Safety Assessment/Review for the Durham Upper Dam prior to, or as part of, any major decisions regarding the management and maintenance of the structure. The Dam Safety Assessment/Review should be completed in accordance with the Lakes and Rivers Improvement Act Technical Bulletins and Best Management Practices (MNR, 2011).
- Establish a regular frequency for engineering inspections (i.e. annually or bi-annually) as well as routine inspections by staff (i.e. monthly).
- Complete a full rehabilitation of the dam structure, including the rehabilitation of the concrete piers/abutments, the addition of bracing for the stoplogs/flashboards that utilizes the piers for support rather than the steel truss for the dam deck/pedestrian walkway, replacing the dam deck/pedestrian walkway, and the remediation of the seepage through the right embankment/abutment.
- Develop an Operation, Maintenance, Surveillance and Safety (OMSS) Manual for the dam. This should include a detailed review of the operation and maintenance practices used by SVCA staff with a particular focus on operator health and safety.
- Remove all yellow hazard signs and replace them with signs that meet the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011).
- When public safety signs need to be replaced, replace them with signs that meet the requirements of the Best Management Practices for Public Safety Around Dams (MNR, 2011).
- Clear the vegetation from around the upstream warning sign.
- Install a public safety boom upstream of the dam. The public safety boom should be installed in accordance with the Guidelines for Public Safety Around Dams (CDA, 2011).
- Implement a public education plan to describe the hazards and risks associated with recreating at or near the dam to the general public as well as visitors to the Durham Conservation Area. Monitor and record public activities at the site using the CDA Public Safety Incidents Form that can be found in the Guidelines for Public Safety Around Dams (CDA, 2011).
- Review/update the Public Safety Plan and Public Safety Risk Assessment within five years and use the data collected on the CDA Public Safety Incident Forms to determine if the public safety measures have been effective. If the public safety measures have not been effective, implement additional public safety measures.

- Maintain the grass on the flood dyke at a longer length to reduce the risk of it drying out and exposing the underlying soil which could lead to an increased risk of soil erosion. Restore grass cover on any bare spots.
- Replace the staff gauge.

Appendix C

OSIM Inspection Deficiency Classifications

OSIM Checklist		
Concrete		
Scaling - loss of portion of concrete surface or mortar due to freeze thaw. Common with non-air entrained concrete or poorly finished concrete.	Light	Loss of mortar up to 5 mm
	Medium	6 to 10 mm, some coarse aggregate visible
	Severe	11 to 20 mm aggregate pocking
	Very Severe	More than 20 mm
Disintegration - breakdown of concrete. Starts as scaling and its disintegration when it's beyond the level of very severe scaling.	Light	Loss of depth up to 25 mm
	Medium	25 to 50 mm
	Severe	50 to 100 mm
	Very Severe	More than 100 mm
Erosion - deterioration of concrete by water, sand or gravel scrubbing against the surface.	Light	Loss of depth up to 25 mm
	Medium	25 to 50 mm
	Severe	50 to 100 mm
	Very Severe	More than 100 mm
Corrosion of Reinforcement	Light	Rust stains on concrete surface
	Medium	Exposed reinforcement, loss of section 10%
	Severe	Loss of reinforcing steel section 10% to 20%
	Very Severe	Loss of section more than 20%
Delamination - discontinuity of the surface concrete, which becomes substantially separated but not completely detached. Hollow sounding when tapped.	Light	Measured area less than 150 mm in any direction
	Medium	150 mm to 300 mm
	Severe	300 mm to 600 mm
	Very Severe	More than 600 mm
Spalling - fragments of concrete become detached.	Light	Measured area less than 150 mm in any direction, or less than 25 mm deep
	Medium	150 mm to 300 mm, or 25 mm to 50 mm deep
	Severe	300 mm to 600 mm, or 50 mm to 100 mm deep
	Very Severe	More than 600 mm, or greater than 100 mm in depth
Crack - linear fracture.	Hairline	Less than 0.1 mm
	Narrow	0.1 mm to 0.3 mm
	Medium	0.3 mm to 1.0 mm
	Wide	More than 1.0 mm
AAR - aggregate reaction with the alkalis in cement, product is highly expansive substance called alkali-silica gel. The expansion of the gel and aggregate under damp conditions causes cracking.	Light	Hairline cracks, widely spaced, no visible expansion of concrete mass
	Medium	Narrow pattern cracks, closely spaced, with visible expansion of concrete mass
	Severe	Medium to wide pattern cracks, closely spaced, with visible expansion and deterioration of concrete
	Very Severe	Wide pattern cracks, closely spaced, with extensive expansion and deterioration of concrete

OSIM Checklist

Concrete Surface Defects		
Stratification - separation of concrete into horizontal layers in over wetted or over vibrated concrete.		
Segregation - differential concentration of the components of mixed concrete resulting in non-uniform properties in mass. Caused by concrete falling from height, with the coarse aggregate setting to the bottom and fine aggregate to the top.		
Cold Joints - caused from delay between placements of successive pours of concrete and incomplete bond develops.		
Deposits - water percolates through the concrete and dissolves or leaches chemicals from it and deposits them on the surface.	Efflorescence	A deposit of salts, usually white and powdery
	Exudation	A liquid or gel-like discharge through pores or cracks in the surface
	Incrustation	A hard crust or coating formed on the concrete surface
	Stalactite	A downward pointing formation hanging from the concrete surface, usually shaped like an icicle
Honeycombing - improper or incomplete vibration, which leaves voids in the concrete where mortar failed to completely fill the space between aggregate.	Light	Measured area less than 150 mm in any direction
	Medium	150 mm to 300 mm
	Severe	300 mm to 600 mm
	Very Severe	more than 600 mm
Pop-outs - shallow, conical depressions caused by small portions of concrete surface breaking away due to frost or expansion of aggregate.	Light	Holes up to 25 mm diameter
	Medium	25 mm to 50 mm
	Severe	50 mm to 100 mm
	Very Severe	More than 100 mm
Abrasion - vehicles or snow plow blades scraping against concrete.		
Wear- dynamic and/or friction forces from vehicles, dirt, debris, sand, water & ice. Surface appears polished.		
Slippery- as a result of polishing of concrete deck by vehicular traffic.		
Steel		
Corrosion - deterioration of steel by chemical or electro-chemical reaction.	Light	Loose rust formation, no noticeable section loss
	Medium	Loose rust with scales or flakes. Up to 10% sectional loss
	Severe	Stratified rust with pitting of metal. 10% to 20% section loss
	Very Severe	Localized perforation or rusting through. More than 20% section loss
Permanent Deformation - bending, buckling, twisting or elongation, or any combination thereof.	Note location of deformation	
Crack - a linear fracture in the surface of steel or weld.	Cracks perpendicular to direction of stress are critical	
Loose Connections - caused by corrosion of connector plates or fasteners, excessive vibration, overstressing, cracking or the failure of the individual fasteners.	Light	up to 5% of fasteners loose or missing
	Medium	5% to 10
	Severe	10% to 20%
	Very Severe	more than 20%

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Wood		
Weathering, Checks, Splits and Shakes - deterioration of wood due to sun, rain, wind, frost and atmospheric pollutants.	Light	tissue separation short and extends less than 5% into member
	Medium	separation long and 5% to 10% into member
	Severe	10% to 20%
	Very Severe	more than 20%
Rot and Decay - breakdown of wood by microorganisms.	Light	slight change in colour, wood cannot be penetrated by sharp object
	Medium	surface discolored with black and brown streak. Hollow sounding when tapped
	Severe	surface fibrous, checked or crumbly with fungal fruiting growing on it
	Very Severe	wood can be crumbled and disintegrated with ease
Insect Damage - tunneling and boring by larvae or mature insects.	Light	occasional exit or entrance hole
	Medium	several entrances and exit holes
	Severe	extensive tunneling and holes
	Very Severe	extensive tunneling, holes and larvae insects present
Abrasion and Wear - deterioration caused by vehicles or snowplow blades scarping against wood.	Light	5% section loss
	Medium	5% to 10% section loss
	Severe	10% to 20%
	Very Severe	more than 20%
Cracking, Splintering, Crushing and Shattering - physical damage from vehicular collision or overloading of member.	Light	5% section loss
	Medium	5% to 10% section loss
	Severe	10% to 20%
	Very Severe	more than 20%
Fire and Chemical Damage – charring.	Light	slight charring and 5% section loss
	Medium	5% to 10% section loss
	Severe	10% to 20%
	Very Severe	more than 20%
Loose Connections - loosened due to repetitive or dynamic loading, wear or decay.	Light	up to 5% of fasteners loose or missing
	Medium	5% to 10
	Severe	10% to 20%
	Very Severe	more than 20%
Masonry		
Crack - incomplete separation into one or more parts with or without space between.	Hairline	less than 0.1 mm
	Narrow	0.1 mm to 0.3 mm
	Medium	0.3 mm to 1.0 mm
	Wide	more than 1.0 mm
Splitting, spalling and disintegration - opening of seams, chipping away of pieces of stones or gradual breakdown of stone.	Light	hairline cracks and minor loss of stone surface up to 50 mm section loss
	Medium	narrow cracks and 50 mm to 100 mm section loss
	Severe	spalling and disintegration of stone with 100 mm to 150 mm section loss
	Very Severe	extensive spalling and disintegration of stone with 100 mm to 150 mm section loss
Loss of mortar and stone - loss of mortar due to frost, erosion, plant	Light	loss of mortar from joints of depth up to 20 mm
	Medium	20 to 50 mm

OSIM Checklist		
growth or softening by water containing dissolved sulfate or chlorides.	Severe	extensive loss of mortar resulting in loss of stone
	Very Severe	extensive loss of stones jeopardizing the stability of structure
Aluminum		
Corrosion - gradual oxidation of the surface in the presence of moisture.	Light	loose rust formation, no noticeable section loss
	Medium	loose rust with scales or flakes. Up to 10% sectional loss
	Severe	stratified rust with pitting of metal. 10% to 20% section loss
	Very Severe	localized perforation or rusting through. More than 20% section loss
Crack - a linear fracture which may extend partially or completely through the material		
Loose Connections - may occur in bolted or riveted connection.	Light	up to 5% of fasteners loose or missing
	Medium	5% to 10
	Severe	10% to 20%
	Very Severe	more than 20%
Coatings		
Coating Related Defects	***Adhesion Related Defects***	
Checking or crazing	Undercutting	
Cracking	Blisters	
Alligatoring	Intercoat delamination	
Chemical attack	Peeling	
Chalking	Underfilm corrosion	
Coating Related Defects		
Bridging	Pinholing	
Edge effects	Runs	
Shadows	Sags	
Overspray	Pinpoint rusting	