Bryce Resort
Lake Laura
Lake Management Plan

February 2017
Version 3.0

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Document Control

Change/Version Number	Date of Change	Sections Changed	Description
1.1	2011	All	Updated original plan
2.0	May 2014	All	Updated all sections of the plan – adopted by Board of Directors at May 10, 2014 meeting.
3.0	February 2017	3.2, 4, 6, 7.3	Incorporated description of dam renovation and associated management actions into the description of the dam and removed sections entitled "Lake Laura rehabilitation Project (3.8) and Management actions during and post dam rehabilitation. Shifted descriptive Lake Quality (4.0) material verbatim to Appendix E, updated Appendix C and made 1-2 minor corrections in other sections.

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Purpose of Document

Bryce Resort recognizes Lake Laura as a key strategic asset essential to its business operations for skiing, golfing and other recreational operations. The Bryce Resort Lake Laura Management Plan identifies the management strategies required for the safe and enjoyable operation of the lake.

The Resort has a Lake Committee that serves in an advisory role to the GM and the Board of Directors assisting in developing these management strategies. This plan focuses on the goals and objectives in the key areas of the lake's management to include:

- Operating the dam's flood controls
- Dam maintenance
- Bryce Resort profit-driven recreational activities
- Fishing and boating, water quality management
- Lake area property owners' responsibilities

This document is divided into 8 sections.

Section 1 details the Bryce Resort Lake Laura Committee

Section 2 describes the Lake, its morphometric characteristics, and provides an overview of the lake's watershed

Section 3 addresses the Lake Laura Dam, ownership, maintenance, emergency flood control operations and the anticipated upgrades to the dam

Section 4 discusses the Lake's water quality, issues impacting the water quality and management techniques available to the Resort to maintain water quality

Section 5 provides an overview of the recreational activities on the lake

Section 6 discusses the Lake Laura Adjacent Landowner Policy

Section 7 details the Goals, Objectives and Actions for the Management of Lake Laura

Section 8 provides an overview of what can be expected during and following the rehabilitation of Lake

1. Bryce Resort Lake Laura Committee

Bryce Resort chartered the Lake Laura Committee in October of 1999 to serve as an advisory body to recommend policies and procedures required to maintain and enhance the quality of the lake as a recreational facility of the Resort.

The Lake Laura Committee is strictly an advisory body. It reports to the Chief Operating Officer (COO)/General Manager (GM). The committee's authority does not extend beyond submitting recommendations to the COO/GM.

Neither the Lake Laura Committee nor its chairman has the authority to advise or instruct the COO/GM or department heads in the timeliness or manner in which they carry out their duties.

The Committee duties with the COO/GM include establishing the rules required for the safe and enjoyable operation of the lake. The committee chairman is also delegated the responsibility to make emergency evacuation decisions as "dam operator" and "rainfall gauge observer" in accordance with the Lake Laura Emergency Evacuation Plan. (See Appendix A – Lake Committee Charter and Appendix C – Lake Laura Emergency Plan)

2. Lake Laura

2.1. Background Information

Lake Laura is a 44 acre man-made lake owned by Bryce Resort and located in Basye, Virginia. The lake was created in 1971 when the Army Corps of Engineers built the Lake Laura Dam for the purpose of controlling flood waters and sedimentation emanating from the headwaters of the Stony Creek watershed, a tributary to the Potomac River Basin. Figure 1 depicts the lake and surrounding roads and tributaries.

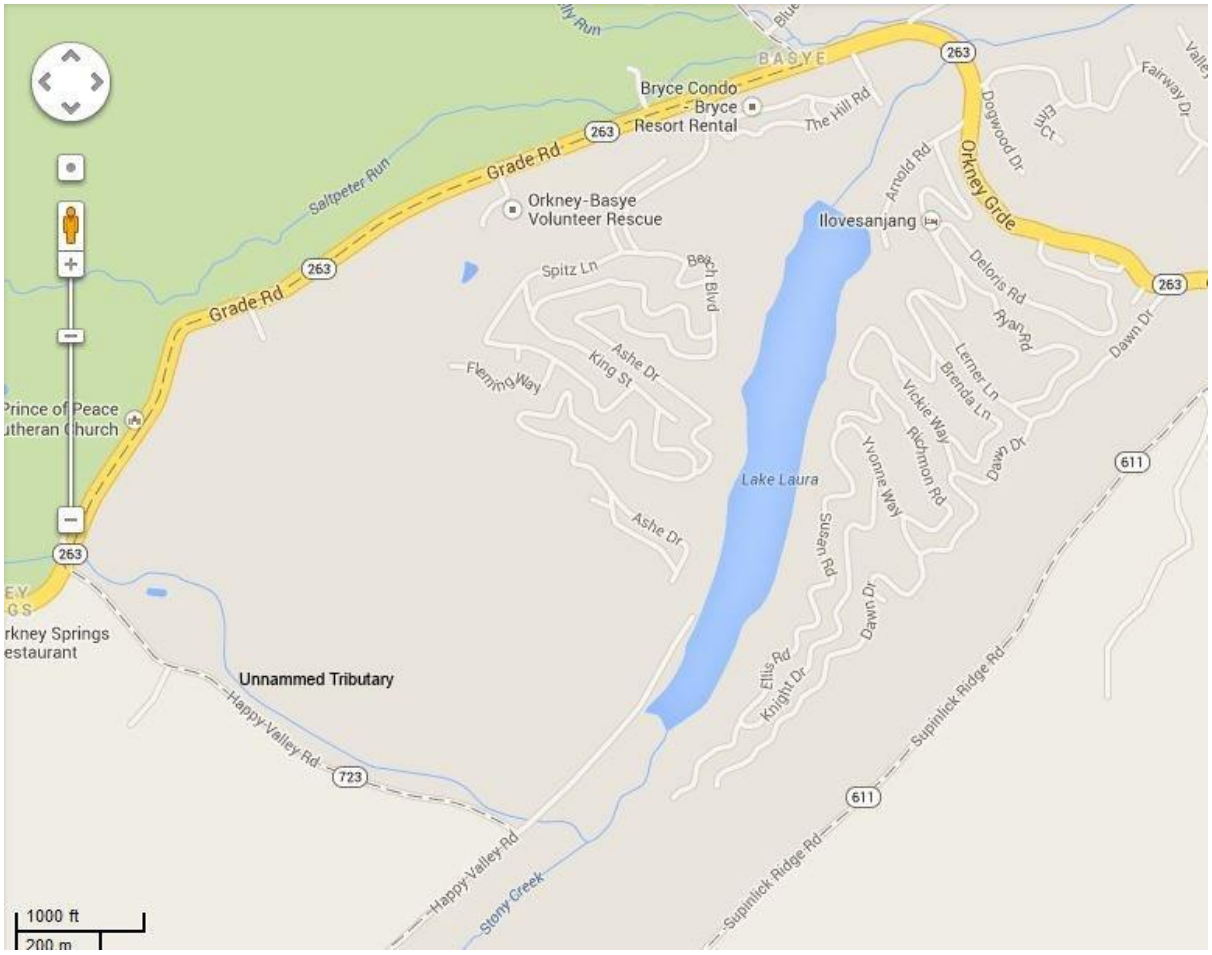

Figure 1 Lake Laura and surrounding area. Source: Google Maps.

2.2. Lake Watershed

The principal tributaries in the watershed are Stony Creek, Rinker Run, Anderson Run, and an unnamed tributary draining from the Orkney Springs area. An additional fraction of the drainage enters the lake directly from intermittent streams in the immediately surrounding area. The drainage areas of the major tributaries are shown in Table 1.

Table 1: Relative Drainage Areas of Major Tributaries to Lake Laura

Stream	Percent of Total Drainage Area	Drainage Area (Acres)
Stony Creek	35	1633
Rinker Run	25	1166
Anderson Run	10	467
Unnamed Tributary	20	934
Direct Drainage	10	467

Figure 2 illustrates the principal tributaries upstream from the lake.

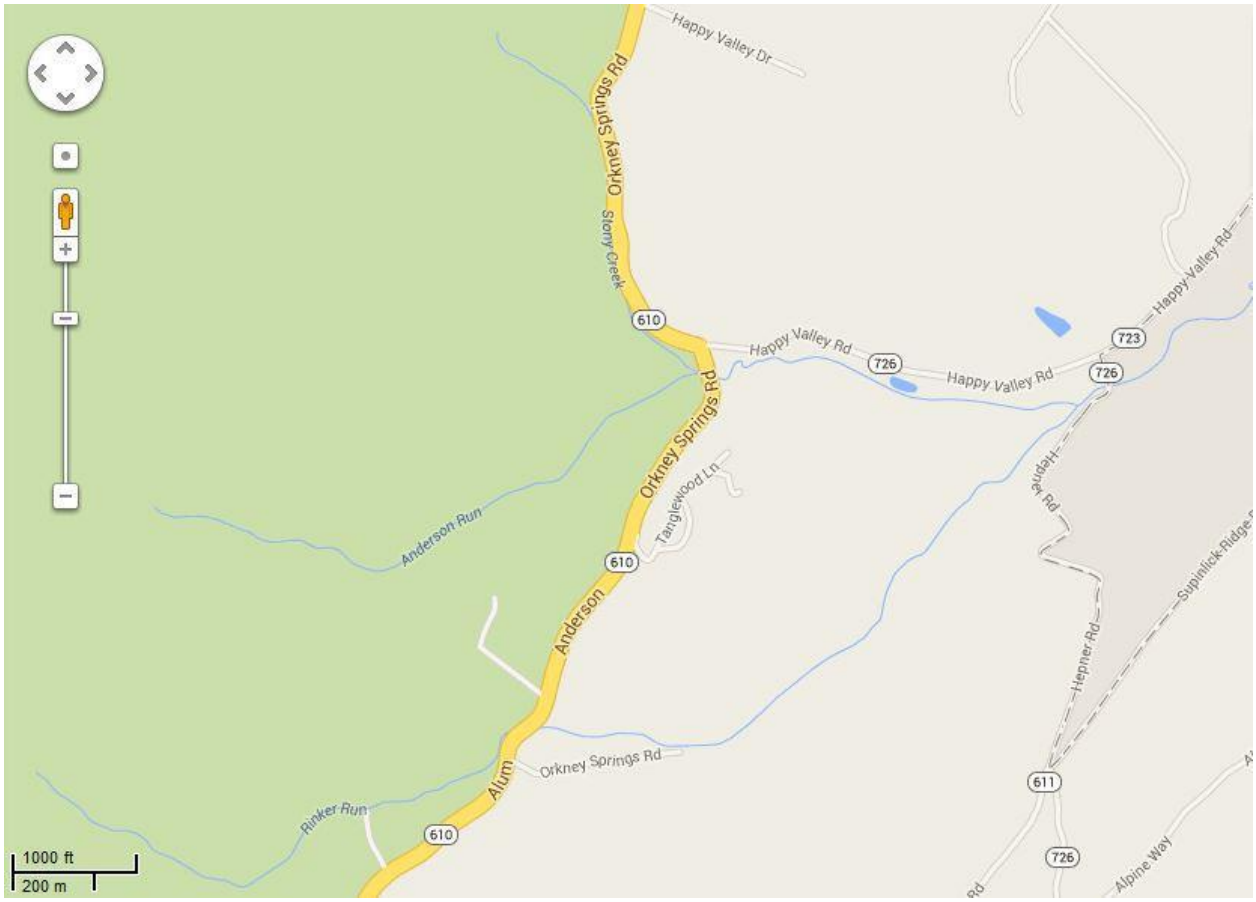

Figure 2 Principal tributaries in the watershed. Source: Google Maps.

Specific characteristics of the lake and its tributary watershed are shown in Table 2.[1]

Table 2 Morphometric Characteristics of Lake Laura

Shoreline, ft.	9600
Surface Area, acres (recreation pool)	44
Surface Area, acres (flood control pool)	94
Volume, acre-feet (recreation pool)	649
Volume, acre-feet (flood control pool)	1702
Maximum Depth, ft.	37
Mean Depth, ft.	15
Drainage Area, acres	4670

Stony Creek is the outlet stream from the lake. Bryce Resort owns the land under the lake and a strip of land around the circumference of the lake that averages about 25 feet in width.

The Lake Laura watershed is underlain with sedimentary rocks of Silurian and Devonian age. The structure is quite complex with a large syncline or fold with many minor folds. North Mountain and Supinlick Mountain contain the lake's watershed.[2]

2.3. Watershed Soils

The Lake Laura Watershed has two main soil areas:[3]

1. Weikert, Muskingum, Lehew, and Dekalb Association: The main soils which form this association are: Weikert, Calvin, Muskingum, Dekalb, Leetonia and Lehew with inclusions of Jefferson, Laidig, Allen and Leadvale. They are generally cobbly or Stony phases. They have developed from acid shales, sandstones and interbedding of shale and sandstone. The Weikert soils are the most extensive in this area. They are shallow, drouthy shale soils on slopes ranging from 6 to 60 percent. Runoff is rapid.

2. Pope, Hungtingon, Sequatchie Association: This soil association occurs on the flood plain. The main soils are Pope, Huntington and Sequatchie. Holston, Waynesboro and Monongahela occupy some of the better drained terraces. Atkins and Tyler are poorly drained soils found in the area. These are derivatives of colluvial material from surrounding uplands. These soils are subject to runoff and seepage hazards from surrounding upland. These flood plain soils, when not subjected to flooding, are among the most productive in the watershed.

2.4. Climate

[1] Dr. Thomas J. Grizzard, P.E., A Limnological Survey of Lake Laura, Executive Summary. (Grizzard, January, 1987) p.2

[2] Lord Fairfax Soil and Water Conservation District (LFSWCD), "Watershed Work Plan, Stony Creek Watershed. A Portion of the Potomac River Basin, Shenandoah County, Virginia." (Lord Fairfax Soil and Water Conservation District, March 1969) p.3

[3] Ibid., p. 3-4

The average rainfall is about 40 inches. Most of the storms which cause flooding occur during the growing season. However, floods have been recorded in all months. The average frost free season is 150 to 160 days – from early May to late October.[4]

2.5. Watershed Land Uses

The watershed basin consists principally of agricultural, forest, and modest amounts of urban land uses. Forest lands constitute the major land use, comprising almost 60 percent of the total area; agricultural lands are next with approximately 35 percent of the total area; and the remaining 5 percent is devoted to modest levels of urban land uses. The agricultural areas of the basin are concentrated along Stony Creek. Agricultural activities include timber harvesting, livestock operations (turkey and cattle), and other farming related activities.

The urban land uses in the basin consist of some residential homes, a hotel, and various roadway surfaces. Over 300 homes are located in the basin, with the majority concentrated in and around the town of Orkney Springs. The town residential areas and the hotel are sewered, and are served by the Stony Creek Sanitation District.

Until recently, the town was served by the Shrine Mont, Inc. sewage treatment plant. The plant had a Virginia Dept. of Environmental Quality Permit to discharge effluent into the tributary that flowed into the lake. In 2012 the Shrine Mont, Inc. sewage treatment plant was taken offline and the town was switched over to the Stony Creek Sanitation District.

Bryce Resort uses water from Lake Laura for snowmaking and golf course irrigation, and the local community also benefits from the lake. A number of homes border the lake, and Bryce operates a recreational area that provides boating, fishing, and swimming. The lake and the surrounding area provide ground water recharge and a haven for wildlife.

3. Lake Laura Dam

3.1. Background Information

Flow in Stony Creek and its tributaries is very irregular. Quite often during long dry spells there is little or no flow in the smaller tributaries and only a very small flow in the main channel. By contrast, after heavy thunderstorms or hurricane-like storms which occur rather frequently in summer and early autumn, and after prolonged rainfalls, stream flows of six to ten feet above bank full have been recorded. Flooding blocks roads and bridges and damages those structures as well.[5]

Erosion of the upland has been a very serious problem in the watershed. Sheet erosion on the uplands, in road cuts and fills and areas being developed for nonagricultural uses, are the chief sources of sediment.[6]

[4] Op. Cit., LFSWCD, p.4
[5] Op. Cit. LFSWCD, p.8
[6] Ibid. p.8

In the 1960s, the LFSWCD developed an overall watershed management plan for the Stony Creek Watershed to address frequent flooding issues that caused widespread damage and erosion of bottom lands. A series of treatment measures were initiated to alleviate the problems, one of which was the construction of Lake Laura Dam.

3.2. Dam Description

The original earthen dam was built in 1971 at a cost of $239,506. The primary purpose for the construction of the dam was to control flood waters in the headwaters of the Stony Creek watershed and trap sediment run-off from the lake's watershed.

Secondary to flood and erosion control, the dam provides water for irrigation and snowmaking for Bryce Resort. Additional benefits obtained from the dam and the lake include recreation activities at the Bryce Resort Beach, fishing, boating, wildlife habitat and a unique view-shed for nearby landowners.

The original earthen dam was 78.5 feet high by 705 feet long, with a Normal Pool area of 44 acres and watershed of 4,700 acres. It was designed to store all the water that would run off the watershed in a 100-year, 24-hour storm (6.5 inches in 24 hours). This water would be slowly released through the principal spillway in the concrete riser. The large grassy area at the side of the dam was the emergency, or auxiliary, spillway. When a storm event produces more runoff than could be stored by the dam, the excess water would flow through the emergency spillway rather than overtopping the dam. Water flowing through the emergency spillway would be directed away from the side of the dam by an earthen wall called a training dike. In 2006 LFSWCD contracted for engineering services to analyze the integrity of the emergency spillway using the NRCS SITES computer program. The study cost $33,600 and disclosed that failure during the design flood could occur through the emergency spillway.

In Virginia dams are classified as: high hazard; moderate hazard; and low hazard. The area that would be under water in the event of a dam failure is called the Inundation Zone. Dams that have people living in the Inundation Zone are classified as high hazard dams. Lake Laura dam has always been a high hazard dam. Engineering studies in 2009 and 2010 resulted in maps that show the area of downstream flooding under various scenarios. There are approximately 212 homes, businesses or other buildings in the Inundation Zone and there could be an estimated 1,400 people at risk, along with potential infrastructure disruption to utilities, 17 roads and an airport. At the time, it was built, the dam met all safety standards.

Since September 2008, Virginia's Impounding Structures Regulation has required that high hazard dams such as Lake Laura safely convey a Probable Maximum Flood (PMF).

The PMF is defined as a flooding event resulting from a Probable Maximum Precipitation (PMP) event. The PMP is the theoretically greatest amount of precipitation for a given duration (6, 12, or 24 hour periods must be analyzed in accordance with Virginia's impounding regulations) that is meteorologically possible over a given size storm area at a particular geographic location. In such an event, there would have been 26 to 38 inches of rain. This is substantially greater than the 100 year storm that the original

earthen dam was designed to withstand therefore there could be excessive flooding both above and below the dam, if the such a storm were to occur.

Though professionals differ on the precise number, one engineer calculated that the Lake Laura Dam would withstand only 76% of the PMF. Consequently, LFSWCD initiated discussions with both the federal and State governments to explore possible engineering solutions and to obtain improvement funds. Fortunately, the State Legislature authorized a $20 million bond issue to fund improvements to dams throughout the State to meet the more stringent standards.

Lake Laura was among the first five on the list for improvement, and the Department of Conservation and Recreation (DCR) Design and Construction (DAC) selected Schnabel Dam Engineering, Inc. as the architect/engineer (A/E) to evaluate alternatives, select and design needed upgrades to the dam and oversee construction. Bryce Resort was a major supporter of the LFSWCD efforts to upgrade the dam.

Timeline:

- In September 2013, the Lord Fairfax Soil and Water Conservation District presented an update to the project underway to rehabilitate Lake Laura Dam and Bird Haven Dam.
- In October of 2014 the project was advertised to potential bidders to perform work
- In April 2015 construction contract was awarded
- In August 2015 Lake Laura was drained for construction and refilled in May 2016
- In October 2016 construction was complete and control returned to the dam owner

Description of Project:

- The upgraded design for Lake Laura Dam includes the replacement of the existing drain gate located at the upstream face and bottom of the riser and the installation of a second gate at a higher elevation to release water for snowmaking and irrigation activities at the Ski Bryce Resort.
- The Lake Laura Dam crest was raised approximately 2 feet.
- The existing auxiliary spillway was closed with earth fill and the crest of the dam was extended.
- The flat portion of the existing auxiliary spillway on the downstream side of the dam is available for Bryce Resort to use for whatever purposes it wishes.
- The new auxiliary spillway is located at the center of the dam and aligned with Stony Creek.
- The new spillway is a stepped concrete spillway that is covered with soil and vegetated with grass.
- A continuous walkway traverses the top of the dam, allowing for the existing contiguous lake trail to remain in place.

Removal of sediment to the South end of Lake Laura:

The rehabilitation design focused on the dam and its hydraulic structures (riser tower, spillways, etc.). Dredging the upper end of the lake and removing accumulate sediment were not authorize as part of

the LFSWCD work. Although deepening the upper end of the lake increases the lake storage capacity somewhat it does not significantly increase the dam's hydraulic capacity and flood control function.

However, Bryce Resort did take the opportunity, while the lake was drained, to dredge and remove 5000 cubic yards of silt and sediment materials from the upper end of the lake. This restored about 2 feet of water depth and reduced the impact of excessive vegetative growth. The project cost approximately $100,000. Half of the cost was authorized by Bryce Resort and the balance was funded through donations from property owners, resort members and supportive members of the public. The Friends of Lake Laura were instrumental in initiating this funding drive.

3.3. Dam Owner

The Lord Fairfax Soil and Water Conservation District (LFSWCD) is the Dam Owner. LFSWCD owns, maintains, and operates the Lake Laura Dam. According to law Bryce Resort, as owner of the land, is also owner of the dam.

3.4. Dam Operator

The Dam Owner is responsible for operation and maintenance of Lake Laura Dam.

Bryce Resort, through an agreement with the LFSWCD, acts as "dam operator". The Alternate Dam Operator is a designee of the LFSWCD.

As "dam operator", the Resort has the authority to operate the release gate located in the dam riser that controls water flow out of the lake through the release structure. See Appendix B - Operating the primary spillway gate.

The Dam Owner may order for the release of water from the dam. The Resort has the authority to release water through the release structure for a number of management activities, which include: water releases for irrigation and snow making needs; and water releases for lake management activities.

Releases of water through the use of the release structure should be conducted in a controlled manner and monitored.

3.5. Flood Control

The Dam Owner is responsible for operation and maintenance of Lake Laura Dam. Bryce Resort has an agreement with the LFSWCD to serve as the "rainfall gauge observer". The Resort also has the responsibility to make emergency evacuation decisions in accordance with the Lake Laura Emergency Evacuation Plan (EAP).

The purpose of the EAP is to safeguard the lives and reduce damage to the property of the citizens of Shenandoah County living or working along Stony Creek in the event of a failure of Stony Creek Dam #9, Inventory Number 17101, also known as Lake Laura Dam.[7]

[7] LFWSCD, Emergency Action Plan for Stony Creek Dam #9, aka Lake Laura. (LFSWCD, August 5, 2011) p.9

Uncontrolled releases of impounded water may threaten lives in the flow area downstream and may damage homes, roads, bridges and other infrastructure. An uncontrolled release occurs when the dam or a part of the dam breaks and water in the impoundment rushes out.[8]

The dam operator and the staff rainfall gauge observer are responsible for monitoring conditions at the dam and notifying the Emergency Services Coordinator (ESC) when emergency stage conditions are activated.

The dam owner may initiate the EAP based on the issuance of a flood warning in the area or when conditions at the dam indicate that the reservoir will continue to rise which will result in flows through the emergency spillway.

A synopsis of the EAP is found in Appendix C. LFSWCD maintains the current Emergency Action Plan for the Dam. In cooperation with the State and Shenandoah County Emergency Services, the EAP is revised annually and regular drills and exercises are conducted to ensure that the plan is current.

The Dam Operator and the dam rainfall gauge observer shall have copies of the EAP.

3.6. Flood Control Strategies

Bryce Resort has an agreement with the LFSWCD to act as "dam operator" and "rainfall gauge observer". The Resort also has the responsibility to make emergency evacuation decisions in accordance with the Lake Laura Emergency Evacuation Plan.

Current Control Strategies:

- Always keep the secondary spillway gate open at least 1 inch (to maintain Stony Creek flow)
- Implement Emergency Action Plan. (See Appendix C)
- Draw lake down if hurricane is forecast to hit our area. (See Appendix D)
- Work with Lord Fairfax Soil and Water District to help maintain the dam

3.7. Maintenance of the Dam

Bryce Resort, through an agreement with LFSWCD, is responsible for the general maintenance activities of the dam. LFSWCD is responsible for major maintenance activities.

General Maintenance:

It is important to keep the inlet tower clear of debris and to keep the earthen spillway clear of any structures such as fences and buildings. Disrupting the flow of the spillway could result in dam failure.

General maintenance activities include:

- mowing of grass on the dam itself and in the emergency spillway
- debris removal from the base of the dam
- maintaining access roads

[8] Ibid., p.9

4. Lake Water Quality

As discussed previously, Lake Laura was formed when the impoundment structure (the Lake Laura dam) was constructed at the north end of the lake. The dam was primarily built to trap sediment and control flood waters in the Stony Creek Watershed. Agricultural activities in the watershed generate nutrients, sediments and biologic agents that feed into the lake. These agents contribute to the lake's overall water quality.

Over the years, the Resort has commissioned several scientific surveys of Lake Laura. In addition, the advice of several biologists has been sought. The conclusions are very similar. The water quality in Lake Laura is good but the lake is rich in nutrients. Most of the nutrients come from farm activities.

The Virginia Department of Environmental Quality (DEQ) has stated on several occasions that the lake is in good condition. The Virginia Department of Game and Inland Fisheries (DGIF) recently declared Lake Laura as one of the best bass fisheries in the state.

Appendix E provides a fuller description of Lake Laura's sedimentation, nutrients, biological agents and aquatic vegetation, and provides water quality sampling results through the history of Lake Laura. The paragraphs below focus on control methods to address these factors.

4.1. Sedimentation Control

Mechanical removal of sediment from the lake is the only practical means of sediment control. While it is the only practical means, it also can be an expensive operation.

If the lake is drained, dry-land excavation machinery such as bulldozers can be used. Although digging and removing bottom sediments by hand is hard work, it represents a simple, economical, and efficient alternative to mechanical dredging. The dredge spoils should be moved below the pond basin to prevent soil runoff back into the pond.

Control strategies available:

- Remove pond bottom sediments when lake is lowered and the bottom is exposed and dry, and then build steep lake bank slopes (3:1 slope). Relocate spoils below lake.
- Remove sediment buildup every 10 years when possible.

4.2. Nutrient Control Strategies

The Resort has limited alternatives available to it to control nutrients entering into the lake and removing them once they are there.

Current Control Strategies:

- Hypolimnetic discharge of lake waters – a hypolimnetic discharge of water from the lake involves opening the release structure on the riser and allowing the hypolimnetic water to leave the lake and remove nutrients. Two scenarios for using hypolimnetic discharge are available:

  - Hypolimnetic discharge during a heavy rainfall event – this is the process of discharging water during heavy rainfall events at a rate equivalent to the increased water flow into the lake during major rain events. This discharge cycles out nutrients.
  - Hypolimnetic discharge of lake during summer – this is the process of releasing hypolimnetic waters during the summer. This scenario has the potential of degrading downstream water quality if only hypolimnetic water is released as is now the situation at Lake Laura.
- Implement Best Management Practices (BMPs) on Resort owned property – this includes activities in the Resort owned pasture south of Lake Laura. These practices involve a series of steps to possibly include:
  - fencing off water from livestock to prevent manure from entering into streams,
  - installing water tanks to prevent livestock entering water to drink,
  - installing water bars or berms on roads to stabilize against erosion,
  - planting grass on highly erodible surfaces
- Attempt to work with private landowners in the lake's watershed to implement BMPs that will control nutrient flow from livestock and agricultural activities.

4.3. Control of Biological Agents (Bacteria)

Bacteria will flow into the lake despite all efforts to prevent it from doing so. However, the implementation of Best Management Practices Methods in agricultural activities in the watershed above the lake can help reduce bacteria from entering into streams in the watershed.

According to water sampling surveying conducted by Bryce Resort and currently by other organizations, bacteria loads are generally very low most of the time. Appendix E contains historical results of sampling that has been conducted over the years by the Resort and other organizations. During significant rain events, bacteria adhere to sediment and flows into the lake in higher than normal numbers; water sampling during significant rain events does reflect significantly higher numbers.

Prior to 2012, the Sanitation Treatment Plant (STP) in Orkney Springs was permitted to discharge effluent in to the tributary that feeds into Lake Laura. In 2012, the STP was shutdown and Orkney Springs was placed on the Stony Creek Sanitation District Water Treatment System. This action has removed a potential source of bacteria. However, abundant wildlife in the Lake Laura Watershed, along with cattle and poultry farming activities, continue to contribute to the bacteria flow into the lake.

Control Strategies available:

- Implement agricultural or other BMPs for any Resort sponsored activity in the watershed. This includes the activities in the land adjacent to Stony Creek and south of the lake.
- Work with private landowners in the watershed to implement BMPs to improve agricultural activities that help reduce bacteria flow into streams.

- Monitoring of bacteria – water sampling for E. coli levels should conducted to determine if a situation is occurring that is out of the norm for the lake that will give the Resort the ability to make informed management decisions.

4.4. Aquatic Vegetation Control

When aquatic algae and weeds become a problem, there are several control methods. Aquatic plant control methods include:

- Remove sediment and deepen the lake – see section 3.2
- Harvest (manual or mechanical removal) weeds
- Manipulate water levels
- Use biological controls
- Use chemical controls

Table 3 provides details regarding each of the control methods.

Table 3. Details of vegetative control methods9

Method	Positive Impacts	Challenges
Remove sediment and deepen the lake	• Sediment removal reduces aquatic plant problems directly by removing the plants, bottom sediment, and associated nutrients. • Deepening shallow shoreline areas limits weed growth indirectly by exposing a soil layer that may be nutrient-poor or impervious to plant roots, and by decreasing the amount of sunlight available to plant life.	• Semi-short term fix. • Very expensive.

Harvest	• Physical removal of waterweeds from ponds is a good control technique.
	• Harvesting of aquatic plants consists of three essential steps. These are
	  ○ cutting or uprooting the weeds,
	  ○ collecting the cut weeds, and
	  ○ removing the weeds from the pond.
	• Harvesting can be accomplished with simple hand tools and physical labor or with the help of cutting machines.
	• Whole plant removal generally is better than cutting because some plants can reproduce from cuttings.
		• Short term fix.
		• Very expensive.
		• Coontail regenerates via cuttings so harvesting could create worse problem.

[9] Louis A. Helfrich, Richard Neves, G. Libey, T. Newcomb, "Control Methods For Aquatic Plants in Ponds and Lakes" (Viginia Cooperative Extension Service) p.2-5

Method	Positive Impacts	Challenges
Manipulate water levels	• Lowering the water level of a lake is an easy way to control nuisance aquatic plants. • Drawdown, particularly during the winter months, exposes weeds to harsh conditions including freezing, desiccation (drying out), strong wind action, and bottom sediment compaction. • Frost heaving of the bottom sediments uproots the weeds and aids in their destruction. • To insure effective over-winter control, the bottom muds should freeze to a depth of 4 inches for several weeks or longer.	• May not kill floating vegetation such as Coontail.
Biological controls	• Chinese grass carp (Ctenopharyngodon idella) is a plant-eating fish that can be stocked in ponds to provide effective, economical plant control. • The recommended stocking rate is about 12 fish (stock large fish 9-12 inches in length) per surface acre. • Lakes with very dense weeds may require more fish and those with less, fewer fish.	• Grass carp may not give us the control we want. • They could be escaping or being eaten by bass. Their body wastes act as fertilizers and stimulate aquatic plant growth.
Chemical controls	• Herbicides (plant poisons) are commonly used to manage land and water plants. • Herbicides are relatively easy to apply and may be the only practical method of control in some situations.	• Would only provide short term relief. • Can be very expensive. • May need additional treatments. • Could get rid of the weeds but make algae worse. • Cannot use water for irrigation for 30 days or until water tests ok.

5. Lake Recreation

Bryce Resort owns Lake Laura; this includes the land under and, with some exceptions, the land immediately surrounding Lake Laura.

Public access to the lake for recreational purposes was encouraged through development of a trail system circumventing the lake, a public beach area on the northeast side of the lake and a boat ramp access on the southwest side used primarily by fishermen. The beach area and boat landing have posted hours of access and rules for use.

Bryce Resort welcomes homeowners and the public to enjoy access to the lake from any point along the Resort owned property. The resort permits adjacent property owners to access the Resort property immediately from their property. The public and homeowners whose property is not adjacent to Resort property access the lakefront from the dam/beach area or the boat launch, rather than by traversing the property of adjacent landowners, unless authorized by the adjacent landowner.

5.1. Beach Area

Bryce Resort operates a private fenced in beach area at Lake Laura which is open to the public for a fee. There is a sandy beach play area and floating docks. The fenced area contains grassy areas exposed to the sun or shaded by trees. The Resort maintains attendants at the lake for sales and managing the area. The Resort does not have lifeguards on duty at the area.

Paddle Boards, paddleboats and canoes are available for rent at the beach area. The Resort rents out this equipment at hourly rates.

The Resort sells snacks, soft drinks and offers the rental of life jackets. Pets, alcoholic beverages and grills are not permitted.

Parking for the lake area is located at the base of Lake Laura dam; the walk to the beach area includes a large uphill section.

The resort maintains a Porta-Potty at the beach area.

5.2. Fishing

Fishing on the lake is open to the public. The Virginia Department of Game and Inland Fisheries Department (DGIF) regulates fishing and stocks bass, walleye, channel catfish, and bream.

DGIF manages the fisheries in Lake Laura through a cooperative agreement established between the DGIF and Bryce Resort in 1991. Through this agreement the DGIF agrees to be responsible for:

- the fish management in the lake including population adjustments,
- fishing regulations,
- habitat improvements,

- fisherman-use assessments and
- supplemental stockings.

In return, the Resort agrees to maintain Lake Laura as available for use by the public. This agreement remains in effect unless terminated by either the Resort or the DGIF.

5.3. Private Boating

Private boats[10] are permitted on Lake Laura throughout the year. Only electric motors are allowed. Boats stored on Resort property require a valid permit. An annual fee is charged to store boats on resort property. Boats are allowed for fishing with the restriction that, if powered, only electric motors are allowed.

A public boat launch is maintained at the south end of the lake. Access to the boat launch is controlled by the Resort to restrict access to specific hours. A gate controlled by the Resort controls access.

5.4. Hiking

Bryce Resort maintains two hiking trails at the lake; the Lake Laura Trail and the Nature Trail.

Lake Laura Trail

Bryce Resort maintains the Lake Laura Trail. Accessible any time of year, this trail takes approximately one-and-a-half to two hours to walk. It is a moderately easy hike or bike (but not handicap accessible). Access points include the Lake Laura Beach Area, the parking lot at the base of the dam, or the boat launch parking lot on the southern end of the lake. Hikers are asked to stay on the trail so as not to disturb local residents, flora and wildlife. The Resort's policy is that hikers should respect a policy of "take nothing, leave nothing" ensuring that any trash is deposited in trash receptacles at trail entrances. Bikes are permitted on the Lake Laura trail for free.

Nature Trail

This public park area is adjacent to Stony Creek between Arnold Road and the Public Pool which is located on The Hill Road. Signage identifying various plant life is located along the trail. The nature trail is an easy walk and suitable for young children. The Nature Trail is accessible from the parking lot at the base of the Lake Laura dam and from the Public Pool parking lot.

6. Lake Laura – Landowners Adjacent to Bryce Resort Property

As previously stated, Bryce Resort owns most of the land directly bordering the lake. Immediately adjacent to the Resort owned land is land privately owned in the form of residential lots.

In the 1960's, the area on the east side of the Lake was developed for residential use, the plotting and residential development of Section 11 on the east side of the lake included a considerable number of lots directly facing the lake above the Bryce-owned property.

[10] "Boats" is defined to include all watercraft, including but not limited to: rowboats, canoes, kayaks, paddleboards, surfboards, windsurfers, sailboats and paddle boats.

Over the years, an informal agreement was granted to these property owners by the Resort to keep a boat alongside the lake. Eventually the Resort implemented a registration and permit system with a fee for keeping a boat on the property. These property owners were allowed to build a modest boat dock, provided it was removable.

In recent years, in the absence of a written policy governing use of Bryce Resort lakefront property, there has been some increase in construction on and use of Bryce property adjacent to the lake for personal use. With an increase in the number of homes built on the east side of the lake, there are some properties with steps down to the lake, both above and below the lake-side path. Some homeowners have cleared or pruned trees on Bryce property to improve their views. More permanent (non-moveable) docks have been built and ground cover has been removed. In the past some homeowners have kept three or more boats at the lakefront.

To ensure that the Lake Laura lakefront retains a natural character for the benefit of both adjacent homeowners and the public, the Resort has established a policy for property owners of land immediately adjacent to Resort owned land. The overarching principle of this policy is to ensure that both homeowners and the public enjoy the natural aesthetic properties of the lake and lakefront. See Appendix F for the policy.

7. Goals, Objectives and Actions for the Management of Lake Laura

Bryce Resort has identified a set of goals, objectives and actions for managing Lake Laura.

7.1. Goals

Over the long term, Bryce Resort wishes to accomplish the following goals for Lake Laura.

1. Protect and manage the lake as a strategic asset for the Resort in order to maintain its resources for its operational needs.
2. Protect and improve the lake's overall water quality.
3. Maintain the lake and adjacent resort-owned property so that it continues to provide recreational benefits to include swimming, fishing, boating, hiking, while maintaining its natural aesthetic qualities.

7.2. Objectives

In order to achieve the goals established for the lake, the Resort hopes to accomplish the following in the near term for Lake Laura.

1. Continue the Resort's ongoing cooperation with LFSWCD in maintaining the dam, acting as the dam operator, and acting as "rain-gauge" observer.
2. Work with LFSWCD in the effort to rehabilitate the Lake Laura Dam until that effort is completed (estimated to be completed in 2015).
3. Continue working with DGIF to maintain the best fisheries possible for Lake Laura.

4. Remove sediment from the lake when deemed necessary.
5. Continue to control the lake's vegetation and prevent it from reaching nuisance stage.

7.3. Actions

In order to achieve the objectives established for the lake, the Resort hopes to accomplish the following steps in managing Lake Laura:

1. Ensure the Resort's Board of Directors recognizes the lake as a key strategic asset through recognition in the Resort's Strategic Plan.
2. Ensure that lake operations and adjacent land owners respect the goals of the Lake Laura as stated in the introduction to the Lake Management Plan
3. Maintain the dam and riser in cooperation with LFSWCD
4. Implement the EAP when government authorities require
5. Implement BMPs in the pasture south of the lake owned by the resort for any agricultural or livestock operations
6. Stock grass carp to control vegetation, especially floating vegetation such as Coontail.
7. Conduct a winter drawdown every year to control rooted vegetation.
8. During heavy rainfall discharge hypolimnetic water from the riser's secondary gate.
9. Always keep the secondary spillway gate open at least 1 inch (to maintain Stony Creek flow)
10. Draw lake down as directed by authorities if a significant rain event is forecast to hit our area.
11. Conduct a general water analysis once a year in September.
12. Test the water for E. coli during the swimming season.
13. Maintain the highest possible water level during the summer to control weeds.
14. Remove sediment from the shallow area approximately every 10 years.
15. Evaluate the effectiveness of weed control measures to determine if additional action is necessary.
16. Find means to work with private landowners in the watershed to reduce the impact of agricultural activities on nutrient and bacterial flows into the lake.
17. Host an annual lake clean up day to remove debris and trash from around the lake prior to Memorial Day.

Appendix A - Bryce Resort Lake Committee Charter

The Lake Laura committee shall consist of at least five, but not more than nine members, including the chairman. The committee shall meet at the call of the chairman, as determined to be necessary by the chairman and/or the COO/GM. Three committee members shall constitute a quorum. Minutes will be maintained for all meetings and will be presented to the COO/GM in a timely fashion.

This committee, as with all committees of Bryce Resort, is strictly an advisory body. It reports to the COO/GM. The committee authority will not extend beyond submitting recommendations to the COO/GM. Recommendations to the COO/GM must include the opinion of the appropriate department head, but in no way does this charter give this committee or its chairman the authority to advise or instruct the COO/GM or department heads in the timeliness or manner in which they carry out their duties.

The duties of the Lake Laura committee chairman will be as follows:

1. The chairman will become familiar with the provisions of the Lake Laura Emergency Evacuation plan. The chairman will make decisions as "dam operator" and "rainfall gauge observer" under this plan.
2. The chairman will interface with the COO/GM or his/her representative in regard to the flow of water through the release pipe, ensuring that there is enough water released for snow making and irrigation of the golf course.
3. The chairman will appoint a co-chairman who will be a member of the committee and who shall assume the above duties in the absence of the Lake committee chairman. The name of the co-chairman will be provided to the COO/GM.

The duties of the Lake Laura committee will be as follows:

1. Recommend to the COO/GM all policies and procedures required to maintain and enhance the quality of Lake Laura as a recreational facility of the Resort.
2. Review capital improvements needed to enhance Lake Laura with the COO/GM. Make recommendations to COO/GM on all capital improvements.
3. Establish with the COO/GM the rules required for safe and enjoyable operation of the Lake Laura facilities.

The committee will, in addition to its other duties, review, recommend and put into effect other projects assigned to the committee by the COO/GM.

The committee may, at the discretion of the chairman, establish subcommittees as needed.

Appendix B - Operating the primary spillway gate.

- There are 7 turns of the crank for each 1/2/ inch of gate travel. (inch = 14 turns)
- There are approximately 5 turns of slop (gate does not move) each time you change direction.
- The gate should always be open at least 1 inch (Shut whole way then open 19 turns)
- Do not open more than 6 inches. (Might not be able to close)
- When water drops from normal level, water flow from pipe will suddenly decrease
- It takes several hours for the water to get from the discharge riser to the pump pond

Appendix C - Synopsis of the Complete Emergency Action Plan

Lord Fairfax Soil and Water Conservation District (LFSWCD0 intends to update the master Emergency Action Plan (EAP) now that the new dam has been completed. This Appendix will be updated at that time and will constitute an integral part of the Lake Laura Lake Management Plan.

Bryce Resort, as 'rainfall gauge observer,' currently designates its Property Maintenance Supervisor and the Lake Committee chair, or her designee, as its observers. As of January 2017, these individuals are respectively: Danny Mumaw and Dick Perry (Lake Committee member designated by the Committee Chair since he resides lakeside).

Pending update of the EAP, and to provide interim guidance if emergency action is required before then, the text of Appendix C as it appeared in the earlier version of the Lake Management Plan, is provided below (with names deleted for individuals who may no longer carrying out these functions), and bearing in mind that some technical parameters cited in it have changed.

January 2017

Stage 1 - **During exceptional rain with warnings of flooding or a possible situation developing.**

Danny Moomaw or Dick Perry (rain gauge observers) should call the following:

Dam Owner (540) 465-2724 X3 or (540) 459-5209

Emergency Coordinator (540) 459-6167 or 911

Alternate Observer (540) 856-8063 (Dick Perry)

Tell them we are watching the situation at Lake Laura Dam #9 on a daily basis.

Stage 2 - **Any flow through the spillway**

or 7.5 inches per 6 hrs

or 8.5 inches per 12 hrs.

or 9.5 inches per 24 hrs.

Danny Mumaw or Dick Perry (rain gauge observer) should call the following:

Dam Owner (540) 465-2724 X3 (540) 459-5209

Emergency Coordinator (540) 459-6167 or 911

Alternate Observer (540) 856-8063 (Dick Perry)

Tell them we are watching the lake and that the conditions for a stage 2 alert exists. Tell them they should mobilize personnel in case an evacuation is necessary. We will continue to observe the spillway at least twice per day.

S**tage 3** - **Flow through the spillway at the 2 foot level.**

or

8.5 inches per 6 hrs

9.5 inches per 12 hrs

10.5 inches per 24 hrs

Danny Mumaw or Dick Perry (rain gauge observer) should call the following:

Dam Owner (540) 465-2724 (540) 459-5209

Emergency Coordinator (540) 459-6167 or 911

Alternate Observer (540) 856-8063 (Dick Perry)

Tell them you are at the dam and the water is flowing over the spillway at the 2 foot or more level. Please alert your personnel to evacuate the people listed in the EAP and close the roads downstream from the dam. We will remain at the dam until the dam breaks or the water level recedes to safe levels.

Appendix D - Guidelines for Dropping the Water Level in Anticipation of Major Flooding

- If the water level is already down 2 ½ feet or more, leave it as is.
- If the water level is above 2 ½ feet take the necessary action that will lower the water level to 2 ½ feet below normal by the time the storm is forecast to hit our area.
- The water level should be dropped at the rate of no more than 6 inches per day.

Appendix E - Lake Laura Water Quality

General

Mesotropohic State

In general the results of the surveys of the lake indicate it is in a mesotrophic state: a lake with an intermediate level of productivity. Mesotrophic lakes are commonly clear water lakes with beds of submerged aquatic plants and medium levels of nutrients.

Thermal Stratification

Lake Laura forms a thermally stratified layer of water early in the summer season, usually no later than mid-June. The thermal stratification in the lake is quite pronounced from May through August; however, it breaks up starting in September. This is the norm for lakes in the region; only the shallowest of lakes do not stratify in the summer and create a thermocline.

The water from about 10 feet below the surface (the thermocline) to the bottom, is noncirculating, and remains perpetually cold. This hypolimnetic layer is also anoxic, has a significant accumulation of degraded organic matter, and holds high concentrations of phosphorus and other nutrients that feed or have the potential to feed algal blooms or other plant life.

Plants and Algae

High nutrient levels in a lake generally result in an overabundance of vegetation, especially in the shallow area of the lake. Most of the time the lake is clear and relatively weed and algae free. However, during late July and August much of the shallow portion of the lake does contain a significant amount of aquatic vegetation, having the potential to make swimming and boating a challenge in that area. Also in the summer the water has a light green color because of a mild algae bloom. Most Virginia lakes have high nutrient levels and experience the same problems. There are different ways to deal with the vegetation.

Numerous studies and years of water quality sampling have been conducted on Lake Laura. The tables and text below capture some of the results of those efforts.

Table 4 presents the findings of a Study conducted by Aquatic Services in 1995 and results of the Resorts own sampling conducted in 2005 and again in 2009.

Table 4. 14 years of comparative water analysis.

	Aquatic Services		**Bryce Resort In-House**	**Bryce Resort In-House**	
	September 1, 1995		**September 1, 2005**	**September 1, 2009**	
Parameter	**Beach**	**Shallow**		**Beach**	**Shallow**
Turbidity (Meters)	8	B	8	3.5M	6M
pH	7.7	7.6	8	8.8	8.6

Tot Alkalinity(mgll)	45	80	49	51	45
Tot Hardness(mg/l)	68	68	58	52	48
Ammonia(mgll)	0.9	0.7	0.2	<0.2	<0.2
Nitrate (mg/l)	<0.05	0.13	<0.05	<0.50	<0.50
Orthophosphate(mg/l)	<0.05	<0.05	0.01	<0.05	<0.05
Fecal Coliform (colonies/100 ml)				<1	2

In 2010 a James Madison Study was conducted. On May 28, 2010, water quality samples of the lake and tributaries feeding it were sampled. The results are as follows.

Table 5. Trophic state parameters measured for Lake Laura to establish the trophic state index

Location	Chlorophyll a ppb	Phosphorus P ppb	Ammonia N-NH3 ppm	Nitrate N-NO3 ppm
LLSC Upper	-	27	0.055	0.244
LL West	-	27	0.037	0.176
LL Upper	2.5	112	0.087	ND
LL Middle	4.0	16	0.090	0.002
LL Riser	4.2	12	0.085	0.003
LLSC Lower	-	18	0.077	0.037

May 28, 2010.

Also sampled during the JMU study was the lake bottom sediments. Sediment samples collected in the upper reaches of the lake were found to contain all three primary nutrients in significant amounts. Table 10 details the results of the samples.

Table 6. Nutrients found in sediment in upper Lake Laura.

Location	Phosphorus P ppm	Ammonia N ppm	Nitrate N ppm
Upper	30.5	21.3	25.7
East	14.9	34.3	3.8
Middle	17.2	40.1	3.6
West	13.8	16.2	25.3
Average	**19.1**	**27.9**	**14.6**

Beginning in the spring of 2011, the Friends of the North Fork of the Shenandoah (FNFSR) began conducting a long term comprehensive water quality study of the tributaries feeding into Lake Laura and Lake Laura. The study is anticipated to conclude in 2014. When it is complete, additional results from that study will be included in this Appendix. The following tables and graphs show some of the results to date.

For the FNFSR, Table 7 lists the sample points that were used throughout the study.

Table 7 Sample points used throughout WQ studies

Site Identification Number	Site Description (brief description used on form)	Stream	Location (detailed location description)
OS01	Orkney Springs tributary at bridge on Rt. 263	Unnamed tributary hereafter known as Orkney Springs	This site is just upstream of the bridge on Rt. 263
OS02	Orkney Springs tributary downstream of sewage treatment plant	Unnamed tributary hereafter known as Orkney Springs - CURRENTLY INACTIVE	This site is just downstream of the Orkney Springs sewage treatment plant
OS2A	Orkney Springs tributary downstream of sewage treatment plant	Unnamed tributary hereafter known as Orkney Springs - Replaced OS2 which was on private property and not accessible	This site is just downstream of the Orkney Springs sewage treatment plant
OS03	Orkney Springs tributary before confluence with Stoney Creek	Unnamed tributary hereafter known as Orkney Springs Run	This site is between the road to Lake Laura and Stoney Creek
OS04	Orkney Springs tributary upstream of Shrine Mont hotel and at culvert on Rt. 263	Unnamed tributary hereafter known as Orkney Springs Run	This site is upstream of Shrine Mont hotel and at culvert on Rt. 263
OS05	Orkney Springs tributary downstream of Shrine Mont pond	Unnamed tributary hereafter known as Orkney Springs Run	This site is downstream of Shrine Mont pond
STY01	Stoney Creek upstream of Lake Laura	Stoney Creek	This site is on Stoney Creek just upstream of the gas pipeline clearing
STY02	Stoney Creek below dam on Lake Laura	Stoney Creek	This site is just below the dam of lake Laura as Stoney Creek reforms
STY03	Stoney Creek upstream of Lake Laura at Rt. 726	Stoney Creek	This site is upstream of STY01
LL01	Lake Laura between two coves	Lake Laura	This site is at the midpoint between the two coves on the west side and in the middle of Lake Laura
LL02	Lake Laura boat landing	Lake Laura	This site is in the middle of Lake Laura between the boat landing and the shore on the east side

Figure 3 illustrates the results of E. Coli sampling in sites in Lake Laura for 2010 – 2011. The solid lines for WQS1 and WQS2 are the standards for sampling. WQS1 is for ongoing sampling WQS2 for one-time concentrations. The acceptable risk level for total body contact recreation, which involves activities such as swimming or water skiing, is 126 colonies of organisms (referred to as colony forming units or cfu) per 100 milliliters (ml) of water or less based on a geometric mean (calculated over 30 days with at least 5 samples) or a one-time concentration of 235 cfu/100 ml.

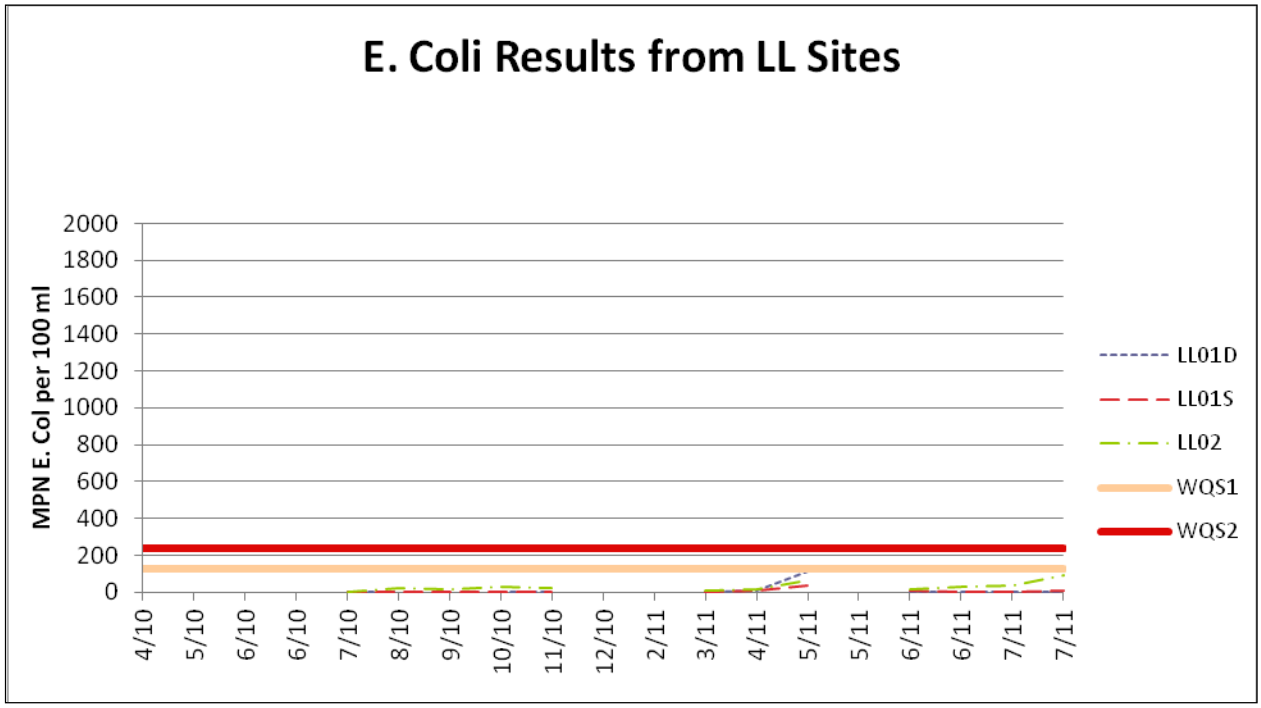

Figure 3 E. Coli Results from LL Sites 2010 - 2011.

Sedimentation

Sedimentation is the tendency for particles in suspension to settle out of the fluid in which they are entrained, and come to rest against a barrier.[11]

In the Stony Creek/Lake Laura watershed erosion is well-documented and a concern. Its soils and topology are highly susceptible to erosion from natural water and wind forces. The resulting sediments then enter into streams and eventually the lake.

One of the primary purposes of the Lake Laura dam was to create a large "still water" in Stony creek that would impound sediment. Lake Laura is performing this function as planned.

Sedimentation has impacted the south end of Lake Laura located by the boat landing where the Stony Creek tributary feeds into the lake. Over the already 40+ years of existence of the dam, the south end of

[11] Wikipedia <http://en.wikipedia.org/wiki/Sedimentation>

the lake has become shallower. This has in turn improved conditions for aquatic vegetation and algae to grow in the south end of the lake during the summer season.

Because the watershed's soils and topography are highly conducive to erosion, there is little opportunity to prevent erosion from occurring in the watershed; it is a natural process and sediment will always flow into the lake.

Until the period of the dam renovation, the Resort had removed sediment from the shallow area twice in the lake's history, once in 1991 and again in 2001.

Nutrients

Nutrients are chemicals that organisms need to live and grow or a substance used in an organism's metabolism which must be taken in from its environment.[12] Nutrients in lakes serve the same basic functions as nutrients in a garden. They are essential for growth. In a garden, growth and productivity are considered beneficial, but this is not necessarily so in a lake. The additional algae and other plant growth allowed by the nutrients may be beneficial up to a point, but may easily become a nuisance.[13]

The term eutrophication refers to the natural and artificial addition of nutrients to lake waters and the effects of these added nutrients. Eutrophication is an aspect of lake aging; it is a process that increases the rate at which lakes disappear or become unsuitable for human use.

Nutrients in lakes come from two kinds of sources; point sources and non-point sources:

> **Point-sources** are those which enter the lake concentrated at a specific location such as upstream sewage treatment plants, feedlots, and storm drains. These sources readily are identified, concentrated, and, therefore, easier to treat.
>
> **Non-point sources** are those which originate as nutrient-rich runoff from agricultural fields and pastures, fertilized lawns and gardens, leaf litter, and groundwater or rainfall, and seepage from septic tank systems – all high in nutrients. These diffuse sources are much more difficult to pinpoint and to treat.14

Excess nutrients such as nitrogen and phosphorus can accelerate eutrophication in surface waters, often resulting in excessive plant growth, declining oxygen levels and changes in the aquatic community. Often, phosphorus is the nutrient in the shortest supply relative to the organisms' needs in fresh water systems, and even a modest increase in phosphorus can set off a chain of undesirable events. This includes accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals. Sources of nutrients can be both natural and human. Table 8 lists the sources of natural and human nutrients in the lake.

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[12] Elanor Whitney and Sharon Rolfes. Understanding Nutrition, 10th edition, (Thomson-Wadsworth, 2005) p 6.
13 Joy P. Michaud, A Citizen's Guide to Understanding & Monitoring Lakes and Streams. (Washington State Department of Ecology, 1994) p. 14

[14] Louis A. Helfrich, James Parkhurst and Richard Neves, "Guide to Understanding and Managing Lakes: Part I (Physical Measurements)" (Viginia Cooperative Extension Service) p.2

Table 8 Sources of Natural and Human nutrients

Natural sources include:	• decaying soil and rocks • decaying plant material
Human sources include:	• discharge from wastewater treatment plants, • runoff from fertilized lawns and cropland, • failing septic systems, • animal manure inputs, storm water runoff, and • disturbed land areas.

Biological Agents (Bacteria)

Biological agents also have a potential to impact lake water quality. Bacteria are the most prevalent form of these agents that are of primary concern to the Resort. Bacteria are microscopic, single-celled organisms that are the most numerous organisms on earth. Bacteria can live in numerous environments and perform many complex actions, some of which are beneficial and some harmful. Bacteria that are disease producing are referred to as pathogenic. Viruses and some protozoans can also be pathogenic.[15]

Coliform bacteria are part of the Enterobacteriaceae family and individual cells cannot be seen with the naked eye due to their small size (but colonies can be seen.) While some coliform bacteria can be naturally found in soil, the type of coliform bacteria that lives in the intestinal tract of warm-blooded animals and originates from animal and human waste is called fecal coliform bacteria.[16]

Escherichia coli (E. coli) is one subgroup of fecal coliform bacteria. Even within this species, there are numerous different strains, some of which can be harmful. However, the release of these naturally-occurring organisms into the environment is generally not a cause for alarm. But, other disease causing bacteria, which can include some pathogenic strains of E. coli, or viruses, may also be present in these wastes and pose a health threat.[17]

Bacteria in water can originate from the intestinal tracts of both humans and other warm-blooded animals, such as pets, livestock and wildlife. Table 9 lists potential sources of bacteria.

Table 9. Potential Sources of E. Coli bacteria

Human sources include:	• failing septic tanks, • leaking sewer lines, • wastewater treatment plants, and • sewer overflows

[15] Op. Cit., Michaud, p.7
[16] Ibid., p.7
[17] Ibid., p.7

Animal sources include:	• manure spread on land, • livestock in runoff or in streams, • improperly disposed farm animal wastes, • wildlife (deer, elk, raccoons, etc.), and • birds (geese, pigeons, ducks, gulls, etc.)[18]

E. coli bacteria enter into Lake Laura via Stony Creek by water runoff from the land. Fecal material is transported to waterways through the runoff. How quickly these materials are transported partially depends on the type of land use. Non-developed lands including grasses and other vegetation tend to soak up rainfall, thereby increasing infiltration into the ground and reducing runoff to waterways. Lands that support domesticated animals, such as cattle or horses can also be a source of bacteria, particularly if animals enter the water for drinking or if heavy rains wash manure from the land into receiving waters.[19]

The Resort is concerned about the risk that bacteria may pose to human health. When numbers are above health standards, people exposed to water that contain bacteria may exhibit fever, diarrhea and abdominal cramps, chest pain, or hepatitis. While E. coli by itself is not generally a cause for alarm, other pathogens of fecal origin that are health threats include Salmonella, Shigella, and Psuedomonas aeruginosa. Criteria for concentrations of indicator bacteria in recreational waters have been developed by the US Environmental Protection Agency, and the presence of E. coli is used as the primary indicator in freshwater recreational areas.[20]

The acceptable risk level for total body contact recreation, which involves activities such as swimming or water skiing, is 126 colonies of organisms (referred to as colony forming units or cfu) per 100 milliliters (ml) of water or less based on a geometric mean (calculated over 30 days with at least 5 samples) or a one-time concentration of 235 cfu/100 ml. The risk of getting sick increases as total numbers of colonies is exceeded.[21] Table 10 details the cfu allowed based on the usage of the area.

Table 10. One-Time Concentration Samples (USEPA 1986, 2002b)

One-Time Concentration Samples	Designated swimming area	Moderate swimming area	Light swimming area	Infrequent swimming area
E. coli (colony forming units/100 ml of water)	235	298	410	576

Even with good watershed management measures, there will always be fecal material in the environment.

The number of bacteria colonies can be influenced by weather and seasonal effects. This variability makes the bacterial concentrations in natural water difficult to predict at any one time. Bacteria numbers often increase following a heavy storm, snow melt or other excessive runoff. E. coli bacteria

[18] Op. Cit., Michaud, p.8
[19] Ibid., p.8
[20] Ibid., p.9
[21] Ibid., p.9

are often more prevalent in turbid waters because they live in soil and can attach to sediment particles. Bacteria can also remain in streambed sediments for long periods of time. If the streambed has been stirred up by increased flow or rainfall, samples could have elevated bacteria levels.

A number of other weather influences may affect bacteria levels in the stream. Higher E. coli counts may be found in warmer waters because they survive more easily in these waters. (E. coli are used to living in the warm environment of the intestines of warm-blooded animals). Ultraviolet rays of sunlight, however, can also kill bacteria, so a warm sunny day may produce numbers lower than expected.

Aquatic Vegetation

The Resort and landowners living adjacent to the lake are concerned over the level of aquatic plant growth in the lake. Several water quality studies commissioned by the Resort note numerous types of aquatic algae and weeds present in the lake. A slight phytoplankton bloom is sometimes evident in the lake as apparent by the light green color of the water. As identified in section 3.1, sediment build-up in the south end of the lake has exacerbated this issue.

Aquatic algae and weed growth in the lake in itself is not bad. It actually is an important part of a lake's ecology. This growth provides cover for small fish, takes up nutrients, and produces oxygen during photosynthesis.

In the 1995 study, the most abundant nuisance aquatic weed noted was Elodea (Elodea canadensis).

Small mats of filamentous algae were seen floating near the shoreline and inter-dispersed with and growing on Elodea. The Study also identified a number of other submersed aquatic plants; Chara (Chara spp.), Leafy-Pondweed (Potamogeton foliosus), and Floatingleaf Pondweed (Potamogeton natans).[22]

More recently Coontail (Ceratophyllum demersu***l***) has become prevalent in the lake. This is a free-floating submerged plant that does not root into the lake bottom. Because it is free-floating, it can migrate around the lake, making it a nuisance.

Anything over 20-25% coverage of the lake can be considered a nuisance infestation. Not only is this a problem from an aesthetic and recreational standpoint (not being able to get a boat out on the lake), but it can eventually cause a lake to die. Dense growths of plants can cause night time oxygen depletion and fish will suffocate if there is not sufficient oxygen in the water column.

[22] Aquatic Services, "Bryce Resort Lake Evaluation," (Aquatic Services. September 21, 1995) p.5

Appendix F - Adjacent Landowner Land Use Policy

Why is Bryce Resort Issuing This Policy?

The overarching principle of this policy is to ensure that both homeowners and the public enjoy the natural aesthetic properties of the lake and lakefront. In order to ensure that the Lake Laura lakefront retains a natural character for the benefit of both homeowners and the public, the Resort has established an Adjacent Landowner Land Use Policy.

Limitations on this Policy

Bryce Resort is the owner of Lake Laura including most of the land directly bordering the Lake. For the few property owner's whose property extends to the water's edge, only the portions of this policy regarding the lake itself strictly apply. To achieve the overarching principles described above, it is requested that all property owners, including those for whom this policy doesn't strictly apply, participate voluntarily to the full extent of this policy. Prior to recommending or taking any corrective actions for possible violations of this policy, Bryce Resort will take great care to validate property ownership assertions. Any property owners who deems that their property is exempt from the policy are welcome to inform the Resort, providing validation of property boundaries.

Background on Adjacent land and Resort Land use

Immediately adjacent to the Resort owned property is land privately owned in the form of residential lots. Over the years, an informal agreement was granted to these property owners by the Resort to keep a boat alongside the lake. Eventually the Resort implemented a registration and permit system with a fee for keeping a boat on Resort Property. Additionally, some property owners were allowed to build a modest boat dock provided it was removable.

In recent years there has been some increase in construction on and use of Bryce property adjacent to the lake for personal use. With an increase in the number of homes built on the east side of the lake, there are some properties with steps down to the lake, both above and below the lake-side path. Some homeowners have cleared or pruned trees on Bryce property to improve their views. More permanent (non moveable) docks have been built and ground cover has been removed.

Bryce Resort Lake Laura Land Use Policy

Adjacent Landowners Access to Lake Laura

1. Bryce Resort Property located adjacent to a landowner's property is not to be considered for use as an extension of their personal property or to create their personal beachfront for other recreational purposes.
2. Bryce Resort does not permit the construction, modification or alteration of Resort owned Property by anyone including landowners who own property immediately adjacent to Resort owned property.

3. Bryce Resort permits homeowners immediately adjacent to Resort property around the lake direct access to the lake [for purposes of accessing the lake] for boating, swimming or other recreational purposes via the Bryce Resort owned property that borders the lake. Adjacent property owners may access Resort property directly from their property. The public and homeowners whose land is not adjacent to Bryce property should use the public access points--the beach/dam or boat launch, rather than by traversing adjacent landowners property, unless so authorized by the adjacent property owners.

Special Permission to Modify Bryce Lake Property

1. A landowner owning property immediately adjacent to Resort Property may petition the Resort's Board of Directors for permission to perform construction, modification or alteration of Resort owned Property. Petitions should be forwarded to the Bryce Resort General Manager for submission to the Board of Directors. The General Manager may request clarifications from the petitioner or require the petitioner to solicit agreements on the proposal from neighboring landowners.
2. Petitioning for construction upon and/or alteration or modification of Resort Property. The Resort may permit an adjacent landowner to construct upon and/or alter or modify Resort Property if it meets the criteria listed below plus any additional criteria as a condition of approval by the Bryce Resort Board of Directors:
    a. Is not permanent
    b. Is accessible and open to the public for use
    c. Is at the lakefront that as close as possible to the homeowner's property
    d. Minimizes or avoids excavation or alteration of lakefront
    e. Must be maintained in good repair and safe condition
3. Structures built on Bryce Resort property will normally be limited to:
    a. Steps that provide for safe descent down steep slopes
    b. Removable docks designed for ease of accessing boats or the lake
    c. Rack to hold up to two suitable boats
4. Land cover: No trees may be felled or pruned without permission of the Bryce Resort General Manager. Clearing of brush when constructing steps or a dock should be minimized. Shrubs and brush may not be removed, particularly along the lakefront.
5. Privately owned boats[23] placed on the lake by landowners owning property immediately adjacent to the lake. The following criteria must be met for the placement of boats on the lake:
    a. All boats must be registered annually and an annual fee paid.

[23] "Boats" is defined to include all watercraft, including but not limited to: rowboats, canoes, kayaks, paddleboards, surfboards, windsurfers, sailboats and paddle boats.

b. Homeowners may store up to two boats on Bryce Resort property at their own risk. Boats should be placed to be as inconspicuous as possible, for example behind shrubs and above the path.
c. Boats are not allowed to be permanently moored in the lake itself.
d. Homeowners are welcome to keep additional boats beyond the two allowed at lakeside at the boat storage area adjacent to the beach.

The Bryce Resort General Manager at his/her sole discretion retains authority to require removal of any structure, beach equipment, furniture, and any other personal property in violation of the criteria cited above.

Appendix G - Definitions

Anoxic waters - Areas of sea water, fresh water or groundwater that are depleted of dissolved oxygen. This condition is generally found in areas that have restricted water exchange.

Dissolved Oxygen - (DO) relative measure of the amount of oxygen that is dissolved or carried in a given medium. The standard unit is milligrams per litre (mg/l) or parts per million (ppm).

Epilimnion - The top-most layer in a thermally stratified lake, occurring above the deeper hypolimnion. It is warmer and typically has a higher pH and higher dissolved oxygen concentration than the hypolimnion.

Eutrophic - A eutrophic body of water, commonly a lake or pond, has high biological productivity. Due to excessive nutrients, especially nitrogen and phosphorus, these water bodies are able to support an abundance of aquatic plants. Usually the water body will be dominated either by aquatic plants or algae. When aquatic plants dominate the water tends to be clear. When algae dominate the water it tends to be darker. The algae engage in photosynthesis which supplies oxygen to the fish and biota which inhabit these waters. Occasionally an excessive algae bloom will occur and can ultimately result in fish kills due to respiration by algae and bottom living bacteria. The process of eutrophication can occur naturally and by human impact on the environment.

Hypolimnion - The dense, bottom layer of water in a thermally-stratified lake. It is the layer that lies below the thermocline.

Mesotrophic - Lakes with an intermediate level of productivity. These lakes are commonly clear water lakes and ponds with beds of submerged aquatic plants and medium levels of nutrients.

Morphometric - Refers to the quantitative analysis of *form*, a concept that encompasses size and shape.

Oligotrophic - Lake with low primary productivity, the result of low nutrient content. These lakes have low algal production, and consequently, often have very clear waters, with high drinking-water quality. The bottom waters of such lakes typically have ample oxygen; thus, such lakes often support many fish species, like lake trout, which require cold, well-oxygenated waters. The oxygen content is likely to be higher in deep lakes, owing to their larger hypolimnetic volume.