December 10, 2018

FACT SHEET
Virginia Water Protection Individual Permit No. 18-0302
Jefferson-Lakeside Club, Henrico County, Virginia

DEQ has reviewed the application for the Virginia Water Protection (VWP) Individual Permit Number 18-0302 and has determined that the project qualifies for an individual permit. Based on the information provided in the application and in compliance with § 401 of the Clean Water Act as amended (33 USC 1341 et seq.) and the State Water Control Law and regulations, DEQ has determined that there is a reasonable assurance that the activity authorized by this permit will protect instream beneficial uses, will not violate applicable water quality standards, and will not cause or contribute to significant impairment of state waters or fish and wildlife resources, provided the permittee complies with all permit conditions. Surface water impacts have been avoided and minimized to the maximum extent practicable.

The following details the application review process and summarizes relevant information for developing the Part I - Special Conditions for permit issuance.

1. Contact Information:

Permittee Legal Name and Address:
Jefferson-Lakeside Club
1700 Lakeside Avenue
Richmond, Virginia 23228
Attn: Mr. Carl DeRubeis, President
Phone: (804) 655-2240
Email: cderubeis01@yahoo.com

Additional Permittee Contact Information:
Mr. Bret Hespold
Phone: (804) 266-2456
Email: bret.herspold@jeffersonlakeside.com

Property Owner Legal Name and Address:
Lakeside Park, Inc.
c/o S.G. North, President
1700 Lakeside Avenue
Richmond, Virginia 23228

2. JPA Processing Dates:

Received Application:	March 1, 2018
Letters sent to VDH, VDGIF, VDCR,VMRC:	May 14, 2018
Coordinated with Water Supply Planning Program:	July 27, 2018
1st Request for Additional Information Sent:	May 15, 2018
Response to 1st Request for Additional Information Received:	May 17, 2018
2nd Request for Additional Information Sent:	May 21, 2018

Response to 2nd Request for Additional Information Received:	May 23, 2018
3rd Request for Additional Information Sent:	June 1, 2018
Response to 3rd Request for Additional Information Received:	June 1, 2018
Letter(s) sent to Local Government (Henrico County):	May 14, 2018
Letters sent to Commissioner of Revenue:	N/A
Letters sent to Riparian Land Owners:	N/A
Permit Fee Deposited by Accounting:	June 15, 2018
Application Complete:	June 15, 2018
Draft Permit Package Issued:	October 23, 2018
Public Notice Published:	October 31, 2018
Copy of Public Notice sent to Admin. Board Planning:	November 6, 2018
Received Verification of Publication:	November 6, 2018
Processing Deadline (120 days from Complete Application):	September 30, 2018
End of 30-Day Public Comment Period:	November 30, 2018
Permit Issuance Date:	December 10, 2018

3. Project Location:

The Jefferson-Lakeside Club operates a concrete dam that impounds North Run in Henrico County. North Run is a tributary to Upham Brook, which flows into the Chickahominy River approximately 4.25 miles downstream of the withdrawal point. The existing surface water withdrawal intake is located within the impoundment near the dam on the north side.

City/County:	Henrico County
Waterbody:	North Run
Basin:	James River Basin
Subbasin:	Chickahominy River
Section:	4
Class:	III
Special Standards:	m
HUC:	02080206
Latitude & Longitude of Intake:	37.6222 N, -77.4672 W
U.S.G.S. Quadrangle:	Richmond
State Watershed No.:	JL18

4. Project Description:

Project Purpose and Background

The project is an existing surface water withdrawal located in an impoundment of North Run in Henrico County. The purpose for the surface water withdrawal is solely for irrigation of an existing 18-hole golf course at the Jefferson Lakeside Country Club (Club). The golf course and impoundment have been in existence since the late 1890's, according to the Joint Permit Application (JPA). VWP 01-2015 was issued to the Club on July 26, 2002, authorizing dredging of the impoundment. The permit was modified on October 9, 2002 to alter the dredging authorization, and modified again on January 31, 2005 to authorize the construction and operation of an irrigation intake in the impoundment. The Club submitted a draft, unsigned JPA for permit reissuance on July 20, 2017. However, the permit expired on July 25, 2017, prior to receipt by DEQ of a complete application for reissuance. The Club signed a draft Consent Order on May 16, 2018 (finalized on July 12, 2018) which allowed continued authorization of the withdrawal while the application was reviewed and a new draft permit was prepared.

The impoundment (termed the "Lake" by the applicant) serves as the main irrigation source for the Club. The dam that forms the Lake was rebuilt in 2016, following authorization for instream work by Virginia Marine Resources Commission (VMRC) permit 15-0349. The intake is located adjacent to this dam. There are two existing wells on the property. According to the applicant, both wells can provide water during emergency situations, but do not have sufficient capacity to serve as main sources of irrigation supply. The Club is not within a groundwater management area so no permit is required for the groundwater withdrawals.

5. Water Withdrawal Use, Need and Demand:

Purpose of Water Withdrawal

The purpose of the surface water withdrawal is for irrigation of an existing 18-hole golf course and adjacent landscaping associated with the grounds around the course's clubhouse.

Basis of Need

The stated need is for golf course irrigation. The golf course area consists of approximately 110 acres, about 70 of which are irrigated. Specific areas and acreages that are irrigated include the following:

- Greens: 2.75 acres (highest priority for irrigation)
- Tees: 2 acres
- Fairways, Collars and Approaches: 35 acres
- Rough: 30 acres (lowest priority for irrigation)

Water Demand

The applicant stated in the JPA that the requested water demand rates were based upon irrigation field data and climate information and knowledge of the irrigation system in place. Irrigation demands vary monthly. Maximum demands occur during June through September, with smaller amounts needed during March, April, October and November. No irrigation occurs during December through February. The JPA (Attachment E) stated that 14.5 million gallons (MG) were used in 2017, and that during a drought the demand could be 26 MG per year. Records of withdrawals reported by the Club to the Virginia Water Use Data System (VWUDS) indicated that annual withdrawal volumes averaged approximately 20 MG since 2006, with a maximum annual withdrawal during that period of 28.2 MG in 2007.

The requested maximum instantaneous, daily, monthly and annual withdrawal volumes are listed below (Table 1). The requested maximum instantaneous rate and maximum annual volume are the same as those authorized by the previous permit. The requested maximum daily volume is less than the 0.425 million gallons per day (mgd) limit that was authorized by VWP 01-2015.

Staff compared the reported historic monthly and annual withdrawals and requested demand volumes with estimates of golf course irrigation demands for both average and drought condition rainfall conditions using the USGA Water Budget Estimation Tool for Golf Courses. This tool calculates golf-course irrigation needs using local average or actual rainfall and evapotranspiration (ET) estimates. The historic reported monthly and annual withdrawals are generally less than the demands calculated using average values for Richmond, VA. The requested maximum monthly and maximum annual volumes are slightly less than those calculated for a drought year (2002) using actual monthly rainfall totals reported from the Richmond International Airport weather station. These data demonstrate that the requested withdrawals fall within the range of use expected for golf courses in the same area.

Table 1: Requested Maximum Surface Water Withdrawal Volumes:

Requested Withdrawal Type	Maximum Withdrawal Requested	Maximum Withdrawal Recommended
Maximum Instantaneous Withdrawal Rate	1000 gpm	1000 gpm
Average Daily Volume	0.07 mgd	-
Maximum Daily Volume	0.225 mgd	0.225 mgd
Maximum Monthly Volume	7 mg	7 mg
Maximum Annual Volume	30 mg	30 mg

Staff Recommended Maximum Withdrawal Volumes

The maximum volumes proposed by the applicant from the Lake for golf course irrigation are consistent with reported withdrawals and other sources of information for the proposed uses and are therefore recommended by staff (Table 1). An average daily withdrawal rate was not recommended because of the seasonal nature of the irrigation withdrawal. The volumes listed in Table 1 are projected to remain constant throughout the 15-year permit term and are therefore the basis for limits in the permit for this project.

Staff concluded that the water demand and statement of need is reasonable and has been adequately justified by the applicant through the information submitted in the VWP permit application process.

6. Alternatives Reviewed:

The alternatives described by the applicant included the two on-site wells mentioned above, plus the purchase of water from Henrico County. As mentioned above, the wells combined do not have the capacity to replace the surface water intake during irrigation periods and can therefore only be used as supplemental sources. Long-term purchasing of water from Henrico County is not cost effective for the Club, and would also not constitute the best use of potable water.

Based upon staff review of the proposed project, the preferred alternative avoids and minimizes surface water impacts to the maximum extent practicable and it is the least environmentally damaging and practicable alternative.

7. Water Withdrawal Volumes and Instream Flow Requirements:

Staff reviewed the proposed withdrawal using the irrigation demand volumes that were proposed and justified for the permit term (Table 1).

Return Flow / Consumptive Use

The proposed withdrawal is to be used entirely for irrigation of a golf course and therefore was considered fully (100%) consumptive.

Cumulative Impact Analysis

A cumulative impact analysis was conducted by staff on the proposed water withdrawal. This analysis reviewed the withdrawal volumes requested to evaluate any potential cumulative impacts to existing beneficial uses and existing water users. The analysis was used to determine instream flow requirements intended to limit any impacts to those existing beneficial uses. Based upon the results of the analysis,

staff determined the proposed project, as limited in the draft permit, will protect existing beneficial uses while meeting the permittee's purpose and need.

A summary of staff's cumulative modeling analysis is attached to this fact sheet (Attachment A).

8. Water Supply Plan Review:

The JPA was coordinated with DEQ Water Supply Planning (DEQ-WSP) staff on July 27, 2018, who responded on July 30, 2018. The Jefferson-Lakeside Country Club (Club) is listed as a large self-supplied user in the Cumberland, Goochland, Henrico, Powhatan Regional WSP (WSP). The water use at the Club was assumed to remain constant over the 30 year planning horizon. Current irrigation use (2010) for the Club is listed in the WSP as 20.8 MGY.

Henrico County anticipates a deficit in water supply by the year 2045 (3.75 MGD). Henrico obtains water directly from the James River and purchase from the City of Richmond. There are five emergency back-up wells in the Henrico County system.

The City of Richmond is a possible source alternative for the Club. Richmond, according to their WSP, does not anticipate a deficit in water supply by the year 2060. DEQ-WSP staff acknowledged that the Club would evaluate this purchase alternative as cost prohibitive, similar to a purchase from Henrico County.

The preferred alternative proposed in the JPA is consistent with the WSP as described. The applicable sections of the plan were considered in staff's evaluation of the proposed project.

9. Surface Water Impacts:

The proposed withdrawal activity does not anticipate any new surface water impacts.

Water quality impacts are expected to be temporary and minimal provided the permittee abides by the conditions of the permit.

10. Compensation for Unavoidable Impacts:

Compensation is not required because impacts to surface waters are not proposed.

11. Site Inspection:

A site inspection was conducted on August 10, 2017, prior to submittal of the signed JPA. A summary of this site inspection is located in VWP Permit File No. 18-0302.

12. Relevant Regulatory Agency Comments:

As part of the application review process, DEQ contacted the appropriate state regulatory agencies. Any relevant agency comments were addressed in the VWP individual permit Part I - Special Conditions. Therefore, the staff anticipates no adverse effect on water quality and fish and wildlife resources provided the permittee adheres to the permit conditions.

Summary of Agency Comments and Actions

By email dated May 14, 2018, comments were requested from the following state agencies: Virginia Department of Game and Inland Fisheries (DGIF), Virginia Department of Conservation and Recreation (DCR), Virginia Marine Resources Commission (VMRC), and the Virginia Department of Health (VDH). Comments were also requested from the U. S. Army Corps of Engineers (USACE) and the U. S. Fish and

Wildlife Service (USFWS). Failure to provide comments within 45 calendar days of the DEQ request for comments infers that the agency has no comments on the project activities. The comments received from the other agencies are summarized below.

DCR

DCR provided the following comments in a memorandum dated June 26, 2018, and transmitted by email on the same day:

- The DCR Division of Natural Heritage commented that:
  - Natural heritage resources have not been documented within two miles of the project boundary. The absence of data may indicate that the project area has not been surveyed, rather than confirm that the area lacks natural heritage resources.
  - There are no State Natural Area Preserves under DCR's jurisdiction in the project vicinity.
  - The current activity will not affect any documented state-listed plants or insects.
- The DCR Division of Dam Safety and Floodplain Management commented that:
  - Mapping from the Federal Emergency Management Agency (FEMA) shows that the project is in a mapped special flood hazard area (SFHA) on FIRM 51087C0130C. The SFHA is an AE Zone that has a delineated floodway and a base flood elevation (BFE) of about 141 feet (NAVD 1988).
  - The project is located in Henrico County. Henrico County participates in the NFIP. The project is considered development within the County's SFHA and must therefore comply with the County's floodplain ordinance, including being permitted by the County. Because the project is in a delineated floodway, 44 CFR 60.3(d) and the County's floodplain ordinance require an H&H analysis to determine if the project affects the BFE. A Zero-Rise Certificate must be provided to the County.
  - The Flood Plain Management Program of DCR does not object to this project as long as it is performed in compliance with Henrico County's floodplain ordinance.

Staff forwarded the comments from DCR to the applicant on August 21, 2018.

DGIF

DGIF provided comments to DEQ by email dated July 6, 2018. Although the comments were not received within the 45 day comment period, DEQ accepted them because they were relevant and late by less than one week. The comments are summarized below:

- No listed wildlife or designated resources under the jurisdiction of DGIF are documented from the project area.
- Recommended that no more than 10% of inflow be captured for irrigation, allowing for 90% of inflow to be released downstream, maintaining suitable habitats for resident aquatic species.
- Stated that while it is recommended that the intake be fitted with a 1 mm mesh screen and that the intake velocity should not exceed 0.25 fps to best protect aquatic residents from impingement and entrainment, the priority of DGIF is to ensure appropriate downstream flows.

In accordance with the DGIF recommendation regarding a 90% flowby, Part I.D.4 of the permit requires releases from the impoundment whenever the lake is not full and not spilling water over the top of the dam. Staff forwarded the comments from DGIF to the applicant on August 21, 2018.

VDH

VDH provided a response to DEQ via a letter dated May 29, 2018. The letter stated that the nearest downstream water intake is located approximately 42 miles below the proposed withdrawal and that the proposed project will not adversely impact that existing withdrawal.

The applicant was copied by VDH in this correspondence; thus no further action by Staff was required.

VMRC
VMRC copied DEQ on a letter sent directly to the applicant which stated that the proposed project is located on a man-made lake and not over State-owned submerged bottomlands. Therefore, no authorization from VMRC was required. VMRC did not provide comments to DEQ regarding the proposed project.

Summary of Federal Agency Comments and Actions
No comments were received from the USACE or the USFWS.

13. Public Involvement during Application Process:

Local Government and Riparian/Adjacent Landowner Notifications
Staff notified Henrico County regarding the reissuance application on May 14, 2018. No comments were received from the County. Staff did not notify riparian landowners because the application is for reauthorization of an existing withdrawal (the golf course intake) with no proposed impacts to surface waters and no proposed increase in withdrawal volumes.

14. Draft Permit Public Comment Period:

Comments received during Public Comment Period
The public notice was published in the Richmond Times-Dispatch on October 31, 2018. The public comment period ran from November 1, 2018 to November 30, 2018.

Staff notified the Richmond Regional Planning District Commission (RRPDC) of the publication of the public noticing of the draft permit on November 6, 2018. The RRPDC responded on November 30, 2018 via email that, after sharing information about the proposed permit with staff of member localities, they received no comments in response. After RRPDC review of the Public Notice, RRPDC staff also had no comments.

No other public comments were received during the public comment period. Therefore, no changes have been made to the permit conditions.

15. Special Conditions:

The following conditions were developed to protect instream beneficial uses, to ensure compliance with applicable water quality standards, to prevent significant impairment of state waters or fish and wildlife resources, and to provide for no net loss of wetland acreage and function through compensatory mitigation and success monitoring and reporting.

Section A Authorized Activities

Nos. 1-2 address the activities authorized by this permit, including the withdrawal of surface water, impact types and limits.
No. 3 states that the authorized activities shall be conducted in accordance with the application materials and any subsequent materials received during the application process.
No. 4 requires the permittee to notify DEQ of any changes to the authorized activities or of new activities which require a VWP permit.

Section B Permit Term

Nos. 1 and 2 address the permit term and re-issuance process to ensure that all permit conditions are completed.

Section C Standard Project Conditions

No. 1 addresses the requirement for the minimization of adverse impacts to instream beneficial uses.
No. 2 ensures that the project will be executed in a manner that limits the disruption of the movement of aquatic life.
No. 3 ensures that downstream flows will be maintained to protect both instream and off-stream beneficial uses
No. 4 ensures the minimization of adverse effects on navigation.
No. 5 ensures the passage of high flows.
No. 6 provides requirements and limitations on the entry of various materials (including concrete, fill, construction and waste material, fuels, lubricants, and untreated stormwater runoff) into state waters.
No. 7 prohibits the violation of Water Quality Standards in surface waters as a result of project activities
Nos. 8 through 12 set forth all reporting requirements concerning construction, monitoring, compensation, and restoration as required by current law and regulations.

Section D Surface Water Withdrawals and Minimum Release Requirements

No. 1 states the use of the water withdrawal is authorized only for irrigation of a golf course.
No. 2 establishes the water withdrawal limits for the intake on the impoundment on North Run. The limits in the permit were determined through staff evaluation of the water demand using standard calculations (see Section 5 for more details).
No. 3 identifies the method the permittee shall use to estimate the previous day's stream flow at the intake. This equation is to be used to determine the minimum daily release from the impoundment as described by Part I.D.4.
No. 4 establishes the minimum daily release requirements from the outfall structure on the North Run impoundment.
No. 5 requires the submittal of a drought management plan within 180 days of permit issuance that includes the development of specific drought stages with corresponding conservation measures, as well as a long-term water conservation plan.
No. 6 requires conservation measures be implemented to protect instream flows when a drought emergency is declared.
No. 7 requires the submittal of a plan for Department review and approval to install a new screen structure at the intake with specifications to protect aquatic wildlife resources.

Section E Monitoring, Recordation and Reporting Conditions

No. 1 requires the permittee to monitor withdrawals from the impoundment on North Run daily using flow totalizer technology to determine compliance with the permit. The condition also includes percent accuracy for such meters and measures the permittee should take in case of a defective meter.
No. 2 requires the daily monitoring and recording of water withdrawals and releases from the impoundment to determine compliance with the withdrawal and minimum release conditions, and specify daily monitoring requirements.
No. 3 requires the submittal of a plan within 120 days of permit issuance for monitoring withdrawals and releases on a daily basis and a schedule for installation of any equipment to begin daily monitoring within 2 years of permit issuance
No. 4 requires the permittee to submit a water withdrawal monitoring report to DEQ semi-annually on the schedule stipulated in the condition. The information shall be submitted electronically using the

Virginia Water Withdrawal Reporting System, and in the event the system is not available, via electronic mail. These reporting requirements will also satisfy the annual reporting requirement of 9VAC25-200 et seq.

No. 5 states that the monitoring and reporting activities shall comply with the permit. Any records shall be retained for the life of the permit and potentially longer due to any unresolved litigation.

16. General Conditions:

General Conditions are applied to all VWP individual permits, as stated in the VWP Permit Program regulation.

17. General Standard:

This project may result in minimal, temporary impacts to beneficial uses related to the propagation and growth of aquatic life as defined in the General Standard. Provided the permittee abides by the conditions of the permit, no substances shall enter state waters in concentrations, amounts or combinations that would contravene established standards or interfere with beneficial uses or are inimical or harmful to human, animal, plant, or aquatic life.

18. Staff Findings and Recommendations:

- The proposed activity is consistent with the provisions of the Clean Water Act and State Water Control Law, and will protect beneficial uses.
- The proposed permit addresses avoidance and minimization of surface water impacts to the maximum extent practicable.
- The effect of the withdrawal will not cause or contribute to significant impairment of state waters or fish and wildlife resources.
- This permit is proposed to prevent unpermitted impacts.
- The draft permit reflects the required consultation with and full consideration of the written recommendations of DCR, DGIF, and VDH. The staff invited, but did not receive, written comments regarding the application from VMRC, USACE and USFWS.

Staff recommends VWP Individual Permit Number 18-0302 be issued as proposed.
Approved:

Director, Office of Water Supply

12/5/18

Date

Attachment A – DEQ Modeling Summary

Introduction

On March 1, 2018 DEQ received a JPA for the reauthorization of an existing surface water withdrawal located in an impoundment of North Run, a tributary to Upham Brook, which flows into the Chickahominy River approximately 4.25 miles downstream of the withdrawal point. The existing surface water withdrawal intake is located within the impoundment near the dam on the north side.

A modeling analysis was conducted to determine whether the proposed withdrawal volumes from the lake on North Run can be carried out while maintaining enough volume to release sufficient water for downstream beneficial uses. The assigned withdrawals were based on the annual and monthly irrigation demand volumes justified for the project. Two simulation periods were evaluated: 1) the drought of record (DOR), and 2) a long-term period (1984-2005) to evaluate how often storage in the lake might be depleted while maintaining releases during low-flow periods.

Existing Water Supply System and Irrigation Demands

A fixed irrigation intake was constructed adjacent to the dam that impounds the lake near the golf course clubhouse. Water is pumped from this intake for distribution to the golf course facility's irrigation system. The volume and surface area of the lake vary depending upon inflow from upstream in North Run. Information provided to support the application included an estimate of total storage of approximately 4.69 MG (14.38 acre-ft). The estimated usable storage, based upon the elevation of the surface water intake, is about 4.45 MG (13.66 acre-ft). Available imagery indicates that, at low water levels, the water is limited to the deeper part of the impounded stream channel, with relatively deep pools near the dam. The drainage area upstream of the existing intake is approximately 16.5 mi^2 in size, based upon the USGS StreamStats program. Table 1 lists the maximum withdrawal volumes and rates that were justified for the project, based on the irrigation demands included in the permit application.

There are no known existing legal surface water withdrawals on North Run upstream of the Jefferson Lakeside intake.

The dam impounding North Run at the intake location is a concrete structure that spans the entire width of North Run. It was reconstructed in 2016 and contains a 4 ft x 4 ft box culvert discharge outlet with an invert elevation of 119.9 ft msl. The reported water surface elevation of the lake when full is 133.3 ft msl, resulting in a maximum head of 13.4 ft. The discharge from the outlet is controlled with a motorized sluice gate covering the box culvert.

Table 1: Withdrawal Limits

Volume/Rate	Justified Withdrawal Limits
Maximum Instantaneous Rate (gpm)	1000
Maximum Daily Rate (mgd)	0.225
Maximum Monthly Volume (mg)	7
Maximum Annual Volume (mg)	30

Affected Stream Reach

The affected stream reach, as defined by 9VAC25-210-300, was determined by comparing the proposed withdrawal to downstream low-flow rates using the USGS StreamStats for Virginia website. Low flow statistics were obtained for stream-gaging station number 02042426 (Upham Brook near Richmond, Va), a currently inactive station with daily values available from December, 1989 to December, 1994. This station was located approximately 1.25 miles upstream of the confluence of Upham Brook with the Chickhominy River. The estimated 7-day, two year low flow (7Q2) at this station was 0.928 cfs (0.6 mgd), and the estimated 7-day, ten year low flow (7Q10) is 0.106 cfs (0.07 mgd). The next downstream station with a daily flow values available is station number 02042500 (Chickahominy River near Providence Forge). This station, which is located approximately 25 miles downstream of the Upham Brook confluence, has a 7Q2 of 12.3 cfs (7.9 mgd) and a 7Q10 of 1.37 cfs (0.9 mgd). Therefore, the proposed maximum daily withdrawal has the potential to reach approximately 25% of natural stream flow within much of the Chickahominy River basin during severe drought periods. Maintaining releases from the lake during low flow periods that mimic natural flow is essential for the protection of downstream beneficial uses.

Determination of the Drought of Record Period

The closest stream-gaging station with a long-term period of record of daily flow data is Station 01673550 (Totopotomoy Creek near Studley, Va.). This station is located approximately 5.6 miles northeast of the project on Totopotomoy Creek, a tributary to the Pamunkey River. Although located in a different river basin, Station 01673550 has a drainage area (25.5 mi^2) that is on the same scale as that of the withdrawal point (16.5 mi^2). The lowest daily mean flow, lowest annual 7-day minimum flow, and the lowest annual mean flow for this station all occurred during 2002. Station 02037500 (James River near Richmond) is located on the James River 6.1 miles to the southwest. This station, which measures flow for nearly all of the non-tidal James River (drainage area of 6753 mi^2), also had its lowest annual mean recorded for 2002. Daily mean flows at Station 02042500 on the Chickahominy River were less than 1 cfs for all but six days between July 7, 2002 and September 2, 2002. Therefore, the 2002 water year (10/1/2001 through 9/30/2002) was determined to be the drought of record (DOR) for the project.

Model Input and Assumptions

The justified golf course irrigation demands vary monthly. Maximum demands occur during June through September, with smaller amounts needed during March, April, October and November. No irrigation occurs during December through February. Daily withdrawal rates for the simulations were estimated by determining each month's average percentage of the reported annual withdrawal total over the previous 10 years (2007 – 2017, no data were reported for 2013). The proposed maximum annual withdrawal volume was multiplied by this percentage and the resulting monthly volume was divided by the number of days in each month. The resulting maximum monthly volumes listed in Table 2 indicate the seasonal nature of the proposed withdrawal.

Table 2: Monthly Withdrawal Volumes used for the Analysis

Month	Avg Monthly Pct of Annual	Withdrawal/month (MG)
Jan	0.00%	0.00
Feb	0.00%	0.00

Month	Avg Monthly Pct of Annual	Withdrawal/month (MG)
Mar	3.40%	1.02
Apr	8.54%	2.56
May	12.01%	3.60
Jun	14.80%	4.44
Jul	20.02%	6.01
Aug	19.64%	5.89
Sep	12.78%	3.83
Oct	6.59%	1.98
Nov	2.21%	0.66
Dec	0.00%	0.00

The analysis included the following additional assumptions:

- Direct precipitation and evaporation to/from the lake surface are insignificant.
- Surface area of the lake when full equals 7.3 acres (based upon a bathymetry map provided by the applicant.
- The elevation of the surface water intake is 125.5 ft msl; below which storage is unusable.
- The stage-storage relationship for the lake is as listed in Table 3.

Table 3: Stage-Storage Relationship for Lake

Stage (ft msl)	Surface area (ac)	Storage (ac-ft)	Storage (MG)
133.3	7.3	14.38	4.686
132	4.36	8.79	2.864
130	2.44	5.01	1.631
128	0.72	1.62	0.527
126	0.27	0.73	0.238
124	0.09	0.38	0.123
122	0.007	0.21	0.070
119	0	0	0.000

Release Criteria

When the simulated water level is at the maximum, outflow is over the top of the dam (spillage). When the simulated water level is below the top of the dam (133.3 ft msl) no outflow is simulated unless a release (from the box-culvert outflow structure) is specified in the input parameters. Release criteria were determined that would allow storage to be maintained in the impoundment while also approximating the natural variation in streamflow. The rules are also meant to require the project to generally adhere to the standard DGIF recommendation that the withdrawal should not exceed 10% of stream flow. To determine the criteria, monthly flow percentiles for North Run at the intake were calculated (Table 4) using the monthly flow percentiles reported for Station 10673550 in StreamStats. The average of the

summer month (July-October) 25th percentile (drought watch) and 5th percentile (drought warning) flows were incorporated as release criteria (Table 5). The required release rates were based upon the rate of inflow during the previous day. When simulated inflow was greater than the value representing the average of the summer month 25th percentiles, no release was required. Inflows between the 25th and 5th percentile average values (2.73 cfs and 0.64 cfs, respectively) required a release of 90% of the estimated inflow on the following day. When the daily inflow dropped below the average of the summer month 5th percentiles, the next day's required release equaled 100% of that inflow.

Table 4: Monthly Flow Percentiles estimated for intake location (cfs)

Month	Min flow	P5(1)	P10	P25(2)	P30	P50	Max
Jan	3.82	6.47	7.12	10.51	11.65	16.18	345.53
Feb	4.46	14.24	16.82	13.91	12.94	18.12	363.65
Mar	4.34	0.00	11.00	12.94	13.59	19.41	396.00
Apr	3.88	7.12	10.35	12.78	13.59	18.12	345.53
May	1.75	3.75	6.47	8.41	9.06	13.59	361.71
Jun	0.17	1.62	3.93	4.96	5.31	7.76	214.82
Jul	0.00	0.69	2.39	3.12	3.36	5.73	236.18
Aug	0.00	0.32	2.01	2.59	2.78	5.08	2484.71
Sep	0.00	0.78	1.68	1.97	2.07	3.82	590.76
Oct	0.08	0.78	2.59	3.22	3.43	5.63	366.88
Nov	1.55	3.56	5.56	6.73	7.12	10.35	325.47
Dec	3.56	5.69	7.76	9.08	9.51	12.94	188.29

(1): average of July-Oct 5th percentile = 0.64 cfs
(2): average of July-Oct 25th percentile = 2.73 cfs
("P" refers to percentile of monthly flows)

Table 5: Release Criteria:

Previous Day's Inflow (cfs)	Required Release Rate (cfs)
>2.73	zero
Between 0.64 and 2.73	90% of inflow
<0.64	100% of inflow

Analysis of the Proposed Water System

Drought of Record and Long-term simulations

Daily values for inflow and outflow to/from the lake were simulated using the VaHydro operational model for the period from October 1, 2001 through September 30, 2002. Inflow values were estimated using two methods: 1) the VaHydro model to directly estimate flow from upstream in North Run, and 2) Station 01673550 was used as a surrogate gage to estimate upstream inflow. With the latter method, the daily flows from Station 01673550 reported for the simulation period were multiplied by a factor of 0.65, which is the ratio of the drainage area of the intake (16.5 mi^2) divided by the drainage area of Station 01673550 (25.5 mi^2). For both inflow estimation methods, the VaHydro operational model calculates the water level of the impoundment, available storage, and outflow from the impoundment based upon the estimated inflow values and the stage-storage relationship listed in Table 3. Simulations were run using each inflow estimation method for the DOR (2002 water year) to determine whether storage could be maintained in the lake during the DOR with the release criteria described above. Simulations were also

run for a long-term period (10/1/1984 through 9/30/2005) to estimate how often usable storage cannot be maintained. The simulations are listed in Table 6.

Table 6: Description of Simulation

Simulation No.	Time Period	Inflow Estimation Method
1	10/1/2001-9/30/2002	VaHydro
2	10/1/2001-9/30/2002	Surrogate Gage 01673550
3	10/1/1984-9/30/2005	VaHydro
4	10/1/1984-9/30/2005	Surrogate Gage 01673550
5	10/1/2001-9/30/2002	Surrogate Gage 01673550-with conservation

Results

Impoundment inflows estimated for the DOR period by the two methods are generally similar,with significant differences occurring during late 2001 and July-August of 2002 (Figure 1). The very low flows estimated by VaHydro during late 2001 (simulation 1) did not affect the simulated storage values because the low flows occurred after the irrigation season. The surrogate gage method (simulation 2) produced much lower flows during July and August of 2002 because Station 01673550 reported zero flows for much of that period. As a result, usable storage was less than the irrigation demand for 53 days during that two-month period (Table 7), indicating that the release rule used may not retain enough storage to meet the justified golf course irrigation demand throughout the DOR.

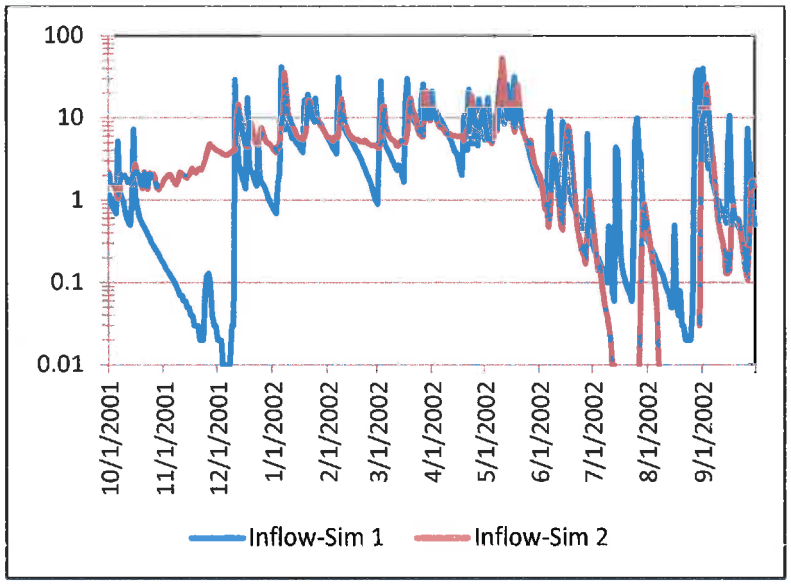

Figure 1: Impoundment inflow estimated for the drought of record simulations

An additional simulation (number 5) was run to estimate the effect of conservation upon simulated storage. The applicant submitted a conservation plan with the application (Attachment D) that outlined reductions in irrigation that would occur with various levels of drought. During severe droughts, irrigation would be reduced to only hand-watering of greens. For simulation 5, irrigation demand during July and August was reduced to 20,000 gallons per day (0.02 mgd). As a result, usable storage was maintained through the summer of 2002 (Table 7), even though impoundment inflow was zero for 35 days during July and August.

With the assigned release rule, it is possible that there would be no outflow from the dam when it is not full and spilling, but the previous day's inflow exceeds 2.73 cfs. A review of the results from both long-term simulations indicated only three (nonconsecutive) days during which there was zero simulated outflow when the lake was partially full (usable storage > zero). The low number of these occurrences is because full volume of usable storage (4.45 MG) can be reached in one day at an inflow rate of approximately 6.9 cfs. If the lake is partially full, a lower rate of inflow will refill it within one day. For example, when the usable storage is 60% full, inflow at a rate of 2.74 cfs (just above the level requiring a release) will refill the lake in one day.

Table 7: Drought of Record simulations: number of days that usable storage is less than demand

Month	Simulation 1	Simulation 2	Simulation 5
Oct-01	0	0	0
Nov-01	0	0	0
Dec-01	0	0	0
Jan-02	0	0	0
Feb-02	0	0	0
Mar-02	0	0	0
Apr-02	0	0	0
May-02	0	0	0
Jun-02	0	0	0
Jul-02	0	23	0
Aug-02	8	30	0
Sep-02	0	0	0

The results of the long-term (21-year) simulations indicate that usable storage was maintained throughout all but 6 years using VaHydro to estimate inflow, and all but 4 years using Station 01673550 as a surrogate gage (Table 8). Therefore, the release rule assigned to the simulations allowed the withdrawal system to mimic natural flows with significant reductions in storage expected during the summer in approximately once every 4-5 years.

Table 8: Long-term simulations: Years and number of days that usable storage < demand

Year[1]	Simulation 3	Simulation 4
1986	2	0
1987	2	0
1993	3	0
1995	0	24
1997	0	15
1998	2	0
2001	0	5
2002	8	57
2005	15	0

(1): Zero days for both simulations in 1984, 1985, 1988-1992, 1994, 1996, 1999, 2000, 2003 & 2004

Conclusion and Recommendations

The results of the simulations indicated that application of a rule governing releases from the impoundment when it is not full and spilling will maintain storage during most years while allowing

outfalls to mimic natural low flow events. Storage cannot be maintained without significant water conservation efforts during the drought of record, but it can probably be maintained with appropriate conservation measures during lesser drought events. Station 01673550 can be used as a surrogate gage to estimate inflows to the impoundment and to base subsequent release rates as needed.

The following special conditions regarding estimation of impoundment inflow and required releases are recommended for a draft permit prepared for the proposed withdrawal:

- The previous days inflow to the impoundment should be estimated using the following equation:
  - $Q_{in} = Q_{01673550} * 0.65$, where
  - Q_{in} = estimated inflow to the impoundment
  - $Q_{01673550}$ = the provisional previous day's mean daily flow recorded for gaging station 01673550 (Totopotomoy Creek near Studley, Virginia)
  - 0.65 = the ratio of the drainage area of the impoundment (16.5 mi^2) to the drainage area of station 01673550 (25.5 mi^2)
- The permittee shall release from the outfall structure within the Jefferson Lakeside dam whenever the lake is not full and not spilling water over the top of the dam in accordance with the table below. The permittee shall adjust the release rate on a daily basis based upon the estimated inflow determined (as above).
  - Inflow > 2.73 cfs: no release required
  - Inflow between 0.64 cfs and 2.73 cfs: release 90% of inflow
  - Inflow < 0.64 cfs: release 100% of inflow
- A plan should be required that outlines the procedures and milestones needed to comply with the above conditions