7/14/2016 3:29:23 PM
Velva L. Price
District Clerk
Travis County
D-1-GN-16-003020
Connie Jefferson

Cause No. D-1-GN-16-003020

TRAVIS COUNTY, TEXAS **Plaintiff,** **and** **THE TEXAS DEPARTMENT OF STATE HEALTH SERVICES** **a necessary and indispensable party** **v.** **AUSTIN PARK, LLC** **Defendant**	§ § § § § § § § § § § § § § § § § § § §	**THE DISTRICT COURT OF** **TRAVIS COUNTY, TEXAS** **53rd JUDICIAL DISTRICT**

ORIGINAL PETITION AND REQUEST FOR DISCLOSURE

Austin Park, LLC is building a public swimming pool without following the good public health engineering practices mandated by the Texas Health and Safety Code. Travis County has worked with Austin Park for more than two years to bring the pool into compliance with the law. Despite Travis County's best efforts, Austin Park has repeatedly failed to comply with State law. Accordingly, Travis County asks the court to prevent Austin Park from opening the pool to the public until it complies with the Texas Health and Safety Code.

1. Discovery

1.1 Discovery will follow a level two discovery control plan.[1]

1.2 This case is not subject to the restrictions of expedited discovery under Rule 169 because the County seeks non-monetary relief.

2. Parties

2.1 Travis County, Texas, is the plaintiff.

2.2 The State of Texas, on behalf of the Texas Department of State Health Services (DSHS), is a necessary and indispensable party to this suit.[2] DSHS requested service of process on its general counsel, Lisa Hernandez, at 1100 West 49th Street, Austin, Texas 78756.

2.3 Austin Park, LLC is a foreign company doing business in Texas and may be served through its registered agent, Capitol Corporate Services, Inc., at 206 E. 9th Street, Suite 1300, Austin, Texas 78701-4411.

3. Jurisdiction and Venue

3.1 Venue is proper in Travis County, the county where the alleged violations occurred.[3]

3.2 This Court has jurisdiction as Travis County seeks a monetary award in excess of $500.[4]

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[1] Tex. R. Civ. P. 190.3.
[2] Tex. Health & Safety Code § 341.092(e).
[3] Tex. Health & Safety Code § 341.092(g).

4. Applicable Law

4.1 The State defines a public swimming pool as "an artificial body of water, including a spa, maintained expressly for public recreational purposes, swimming and similar aquatic sports, or therapeutic purposes."[5]

4.2 Public swimming pools must comply with requirements imposed under the Texas Health and Safety Code and the Texas Administrative Code.

4.3 Public swimming pools must be built according to good public health engineering practices.[6] This requirement is implemented by minimum standards promulgated in the Texas Administrative Code.[7]

4.4 Minimum standards for public swimming pools include:

a. a volume of water equal to the pool's capacity must be circulated once every six hours (the turnover rate);[8]

b. potable water must be used to fill the pool;[9] and

c. a minimum free chlorine level of 1.0 part per million (ppm) must be maintained.[10]

4.5 Only the Texas Department of State Health Services may approve of a disinfection method employing less than a 1.0 ppm free chlorine level.[11]

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[4] Tex. Gov't Code § 24.007.
[5] Tex. Health & Safety Code § 341.064(m).
[6] Tex. Health & Safety Code § 341.064(g).
[7] 25 Tex. Admin. Code § 265.181(a).
[8] 25 Tex. Admin. Code §§ 265.182(147), 265.187(b)(1)(A).
[9] 25 Tex. Admin. Code § 265.194.
[10] Tex. Health & Safety Code § 341.064(b); 25 Tex. Admin. Code § 265.204(a).

4.6 Violations of the public swimming pool statutes and rules are subject to a civil penalty between $10 and $200 per violation per day.[12]

4.7 Travis County is authorized to file suit for civil penalties and injunctive relief.[13]

5. Background

5.1 Austin Park is developing a 160-acre site at or near 4836 Highway 71, Texas 78616 (the Surf Park).

5.2 The Surf Park's primary attraction will be a swimming pool called the Surf Lagoon (the Pool). The Pool is manmade, covers more than 10 acres, and contains approximately 11,600,000 gallons of water.

5.3 A wave generator runs down the middle of the Pool, creating waves of varying height. The bottom of the pool is lined and contoured to enhance the quality of the waves.

5.4 The Pool is designed to accommodate up to 200 surfers.

5.5 In addition to the Pool, the Surf Park contains a storage reservoir and a wet pond. The reservoir and wet pond are used to collect and store rainwater runoff. The runoff is used to fill the Pool.

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[11] Tex. Health & Safety Code § 341.064(b).
[12] Tex. Health & Safety Code § 341.092(b).
[13] Tex. Health & Safety Code § 341.092(d).

A. Austin Park's request for an exemption from the Texas Health and Safety Code is denied.

5.6 Austin Park has been planning the Pool for over two years. During that time, Travis County has consistently informed Austin Park that it is building a public swimming pool subject to various State health and safety requirements.

5.7 Austin Park's engineers recognized they were building a public swimming pool, and on September 9, 2014, they asked for a variance "that the proposed surf lagoon at the Blue Prairie Project not be classified as a pool…."[14]

5.8 This request was denied on November 7, 2014.[15] In that denial, Travis County reminded Austin Park that the Pool would have to comply with the State's public swimming pool rules and regulations.

B. Travis County issues a stop work order.

5.9 Approximately one year later, Travis County issued a notice of violation and stop work order.

5.10 Austin Park ignored the stop work order and continued building the Pool.

5.11 On February 1, 2016, Travis County notified Austin Park that ignoring the stop work order was unacceptable. Travis County requested information on how Austin Park would satisfy the State's legal requirements related

[14] Ex. A.
[15] Ex. B.

to "(1) turnover rate; (2) disinfection/filtration; and (3) fill/refill water source."[16] In closing, Travis County reiterated its desire to "work together to ensure NLand Surf Park is a safe and legal surf park."[17]

C. Austin Park's engineers admit the Pool will not satisfy the State's standards of good public health construction.

5.12 In response to Travis County's request for additional information, Austin Park submitted a March 7, 2016, *Technical Memorandum on the Anticipated Water Quality of NLand Surf Park* (the Memorandum).[18] Austin Park's engineer of record placed his seal on the Memorandum. Unfortunately, the Memorandum confirms that – without variances – the Pool will not satisfy the State's standards of good public health construction.

1. The Pool's free chlorine residual is half the required level.

5.13 The Memorandum contains a chart reciting the Texas Health and Safety Code and the Texas Administrative Code's requirements of a free available chlorine residual of at least 1.0 part per million.[19]

5.14 Just beneath that chart, the engineers note that "NLand Surf Park plans to maintain a FAC [free available chlorine] residual of 0.5 ppm in their Surf Lagoon…."[20]

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[16] Ex. C.
[17] Ex. C.
[18] Ex. D.
[19] Ex. D at 9.

5.15 The choice to use a FAC of 0.5 ppm was done with the knowledge that "[i]f NLand Surf Park maintains a 1.0 ppm chlorine residual their facility will be considered safe from a microbial inactivation standpoint based on Texas swimming pool regulations for disinfection."[21]

2. The Pool's water supply does not meet drinking water standards.

5.16 The Pool is not filled with drinking water from a water utility. Instead, it "is filled with rainwater runoff."[22]

5.17 The Memorandum identifies "some of the microorganisms that could be expected in the rainwater runoff collected for use at NLand Surf Park."[23]

5.18 Despite expecting microorganisms in the water, the "ozone disinfection system currently proposed at the NLand Surf Park is not designed to inactivate microorganisms to the extent specified by the EPA SWTR [surface water treatment rule] drinking standards, specifically *Cryptosporidium*."[24]

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[20] Ex. D at 9.
[21] Ex. D at 10.
[22] Ex. D at 14.
[23] Ex. D at 11, 14.
[24] Ex. D at 18.

3. The Pool cannot meet the turnover requirement.

5.19 Austin Park's engineer claims that the Pool's "average depth of 3.2 feet requires a turnover rate of 4.8 hours to comply with the [Texas Administrative Code]."[25]

5.20 Despite recognizing the legal requirement, as designed it "will take approximately 17 hours to recirculate the entire volume of the lagoon."[26]

5.21 The engineer concedes that NLand's "turnover rate is longer than the turnover rate calculated using the [Texas Administrative Code] turnover rate guidelines…."[27]

D. Austin Park threatens to open the Pool without meeting the State's Health and Safety requirements.

5.22 Despite the shortcomings described above, in a June 17, 2016, Facebook post, Austin Park's president wrote that NLand would be open "in early summer."

6. First Claim – Austin Park's construction is inconsistent with the State's good public health engineering practices.

6.1 Austin Park is violating the Texas Health and Safety Code by failing to construct the Pool pursuant to the State's good public health engineering practices.

[25] Ex. D at 23.
[26] Ex. D at 6.
[27] Ex. D at 23.

6.2 Specifically, the Pool fails to meet the following standards of good public health engineering:

(1) the Pool's turnover rate will be once every 17 hours, nearly three times longer than the required six hour turnover;[28]

(2) the Pool will be filled with rainwater runoff, not potable water;[29] and

(3) the Pool's minimum free chlorine level will only be 0.5 ppm, half of the required 1.0 ppm.[30]

6.3 Austin Park has been building the Pool without following the State's good public health engineering practices since at least December 7, 2015.

6.4 Travis County seeks a civil penalty for each day of this continuing violation.

7. Injunctive Relief

7.1 The Texas Health and Safety Code allows Travis County to obtain injunctive relief, without bond, to enjoin violations.[31]

7.2 As set forth above, Austin Park is currently violating the Texas Health and Safety Code and the Texas Administrative Code by building a public swimming pool without following good public health engineering practices. In addition,

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[28] 25 Tex. Admin. Code § 265.187(b)(1)(A).
[29] 25 Tex. Admin. Code § 265.194.
[30] Tex. Health & Safety Code § 341.064(b); 25 Tex. Admin. Code § 265.204(a).
[31] Tex. Health & Safety Code § 341.092(h).

Austin Park is threatening to violate both the Texas Health and Safety Code and the Texas Administrative Code by opening the Pool to the public without building it according to good public health engineering practices.

7.3 State statutes and regulations ensure a facility has complied with the standards necessary to protect public health. In this case, Austin Park has failed to demonstrate the adequacy of critical components related to its water quality

7.4 Austin Park's disinfection system uses a combination of ozone and chlorine, but it maintains only half of the State-required 1.0 ppm free chlorine residual. The Texas Department of State Health Services is the sole authority that can approve a disinfection system using less than 1.0 ppm free chlorine.[32] It is currently unknown whether Austin Parks's disinfection is adequate. The Pool's engineer states that "[l]ittle information is available regarding the use" of this type of system.[33]

7.5 The State's disinfection requirements presume that the Pool will be filled with drinking water, as is required by law. Austin Park, however, is filling the Pool with rainwater runoff from Highway 71 and nearby agricultural land. The quality of this water is unknown, as Austin Park has never provided Travis County with water quality testing results for the Pool.

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[32] Tex. Health & Safety Code § 341.064(b).
[33] Ex. D at 8.

7.6 In short, Austin Park is close to opening the Pool with an unapproved disinfection system using water of unknown quality.

7.7 Travis County asks that the Court issue a temporary restraining order, temporary injunction, and permanent injunction prohibiting Austin Park from allowing the public to use the Pool until it is compliant with good public health engineering practices.

7.8 Travis County asks the Court to grant it access to the Surf Park for the purpose of inspections to determine compliance with the Court's orders.

8. <u>Civil Penalties</u>

8.1 Travis County seeks civil penalties for each day of each violation.

8.2 Any civil penalty awarded by the Court must be evenly divided between Travis County and the State.[34]

9. <u>Request for Disclosure</u>

9.1 Travis County requests that Austin Park, LLC disclose, within 50 days of service, the information and materials described in Rule of Civil Procedure 194.2.

[34] Tex. Health & Safety Code § 341.092(i).

Prayer

Travis County requests:

1. the Court issue a temporary restraining order and temporary and permanent injunctions against Austin Park, LLC for the injunctive relief described above;
2. the Court grant judgment for appropriate civil penalties against Austin Park, LLC including post-judgment interest; and
3. for such other and further relief, at law and in equity, to which Travis County may show itself justly entitled.

Respectfully submitted,

DAVID A. ESCAMILLA
TRAVIS COUNTY ATTORNEY

By: */s/ Ryan P. Fite*
Ryan P. Fite
Assistant County Attorney
State Bar No. 24045873
ryan.fite@co.travis.tx.us

P.O. Box 1748
Austin, Texas 78767
512-854-9415
512-854-9316 (fax)

ATTORNEYS FOR TRAVIS COUNTY

AFFIDAVIT

STATE OF TEXAS }
}
COUNTY OF TRAVIS }

BEFORE ME, the undersigned authority, on this day personally appeared Robert Wright, a person whose identity is known to me. After I administered an oath to him, upon his oath, he said:

"My name is Robert Wright. I am over the age of eighteen years, of sound mind, and capable of making this affidavit. This affidavit is made on my personal knowledge and the statements herein are true and correct.

I am an environmental health officer supervisor of the Environmental Health Services Division of the Austin/Travis County Health and Human Services Department.

In connection with my duties, I have examined documents related to the property located at or near 4836 Highway 71, Texas 78616. I have carefully reviewed the factual allegations in part 5 of the attached *Plaintiff's Original Petition*. These factual allegations are true and correct."

Robert Wright
____
Robert Wright

SWORN TO and SUBSCRIBED before me by Robert Wright on July 14, 2016.

(Seal)

AMELIA BROWN
NOTARY PUBLIC
ID# 12586769-5
State of Texas
Comm. Exp. 10-06-2018

NOTARY PUBLIC STATE OF TEXAS

Amelia Brown
____
Notary Public in and for the State of Texas

My commission expires: 10/6/18

Travis County and the Texas Department of State Health Services v. Austin Park, LLC
Plaintiff's Original
Petition

Exhibit
A

Office Use Only		
Date Paid ______________	Amt $______________	Check # ______________
Received By______________	Receipt # ______________	

AUSTIN/TRAVIS COUNTY HEALTH AND HUMAN SERVICES DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES DIVISION
P.O. Box 142529
Austin, TX 78714
Phone: (512) 978-0300; Fax: (512) 978-0322

HACCP and/or Variance Request Application

Name of Food Enterprise: ______________

Address of Food Enterprise: ______________

Name of Owner: KBGE for Austin Park LLC

Contact Phone #: 512-439-0400

Email Address: Chad@kbge-eng.com

CITY OF AUSTIN/ILA REVIEW FEE (check one)	TRAVIS COUNTY (check one)
☐ HACCP: $150	☐ HACCP: no fee
☐ Variance Request: $150	☒ Variance Request: no fee

- A HACCP Plan and/or a Variance Request, along with this completed application and applicable fee, must be submitted to this Department for review and approval prior to implementing or utilizing a condition or process which requires a HACCP Plan and/or a Variance Request.
- Approved HACCP Plans and Variance Requests are final and no changes or modifications (including the addition of new foods, using the same or different process) may occur without prior review/approval by this Department. Changes or modifications to an approved HACCP Plan or Variance Request are subject to additional Review Fees.
- Failure to provide all required documentation may result in the need for additional Review Fees. An additional Review Fee will be assessed for the 3rd re-submittal and for each re-submittal thereafter.
- HACCP Plans and Variance Requests may be sent to this office via:
  - walk-in @ 1520 Rutherford Lane, Building 1, Suite 224, Mon thru Fri from 7:45 AM – 4:30 PM
  - email to ECHU.Service@austintexas.gov
  - fax to (512) 978-0322
  - USPS mail to City of Austin-EHSD, P.O. Box 142529, Austin, TX 78714 (all other couriers may deliver to physical address @ 1520 Rutherford Lane, Suite 224, Austin, TX 78754)

[signature] | Chad Kimbell | 9-9-2014

Signature of Applicant | **Print Name** | **Date**

ENGINEERING CONSULTING kbge
KIMBELL I BRUEHL I GARCIA I ESTES

105 W Riverside, Suite 110
Austin, Texas 78704
512 | 439 | 0400
kbge-eng.com

September 9, 2014

Robert Wright
Environmental Health Services Division Supervisor
Austin/Travis County Health & Human Services Department
(512) 978-0302

RE: Variance request to 265.182 and 265.183
Blue Prairie Development, 4836 E SH 71 EB, Austin, Texas

Dear Mr. Wright:

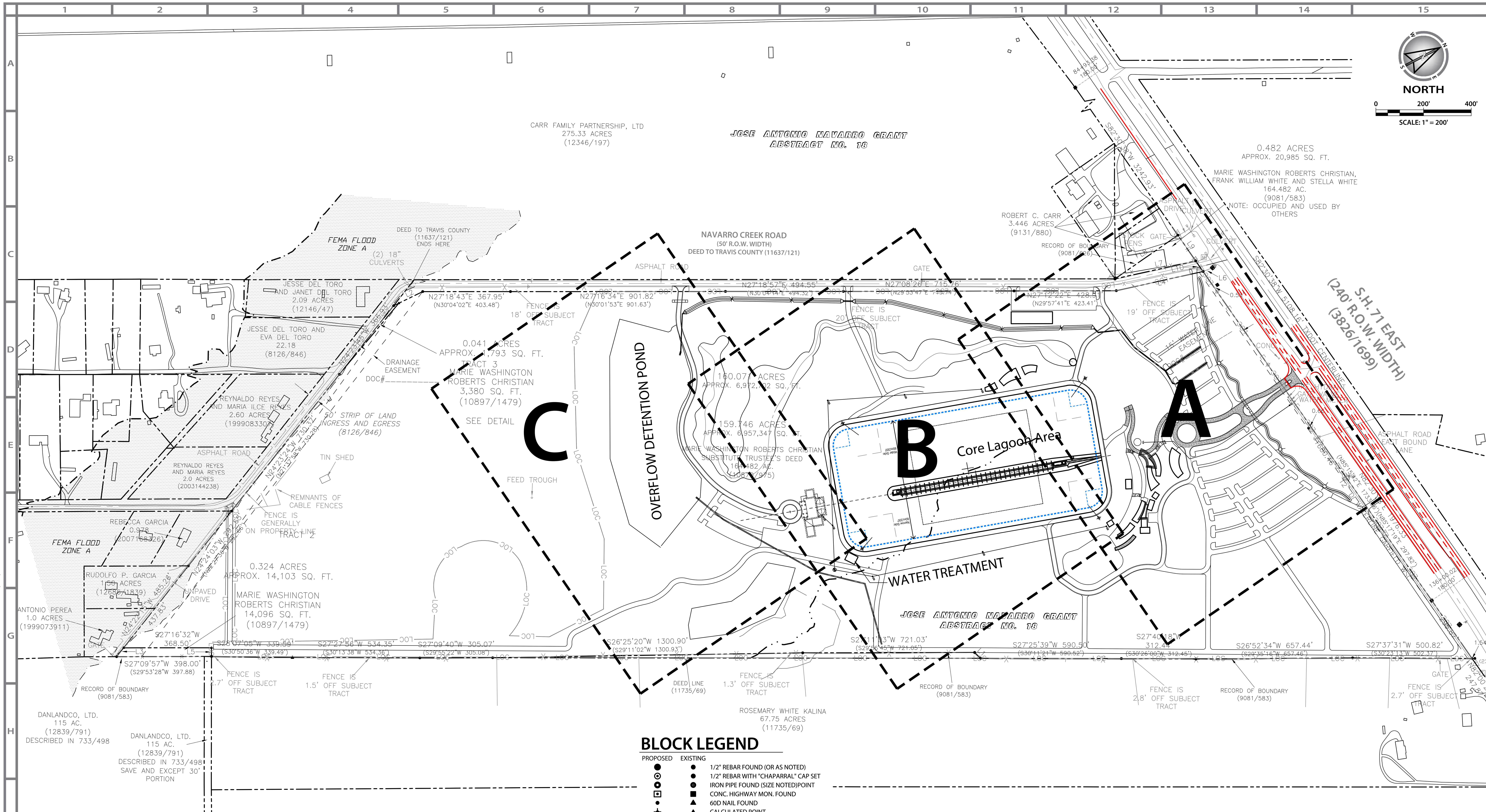
On behalf of my client, Austin Park LLC, KBGE is submitting a variance request to section 265.182 and 265.183 of the Texas Administrative Code. In particular, we are requesting that the proposed surf lagoon at the Blue Prairie Project not be classified a pool and be subject to the structural and operational requirements of this Code. The Park will be operated as a commercial recreational facility and will include this large lagoon as a key attraction.

As shown in the attached site plan, the lagoon is approximately 13 acres in size. A rainwater harvesting system in conjunction with a water treatment system will provide clean treated water for the lagoon. Our design consultant for this system, Cloward H20, has designed the water treatment system (Attachment B) which utilizes an ozone system for sanitation and a permanent media filtration technology to achieve 40 micron clarity and in combination interrupt algae life cycles. Filtration circulation has been be sized to achieve a 12-hour turnover rate in the lagoon primarily designed to reduce algae blooms in order to maintain water clarity. We also anticipate continuous water quality monitoring to ensure the proper dosing in line with standard practices in the industry. In addition, water will be removed from the lagoon to provide drinking water (subsequently treated again) and irrigation to the amusement park's landscape. The harvesting system will also provide safe conveyance of large rain events to the natural drainage ways. In effect, the system is not closed-loop system in the strict sense of the definition.

Please accept this as justification for the variance. If you have any questions, please don't hesitate to call.

Sincerely,

Chad Kimbell, P.E., Principal



BLOCK LEGEND

PROPOSED / EXISTING

- 1/2" REBAR FOUND (OR AS NOTED)
- 1/2" REBAR WITH "CHAPARRAL" CAP SET
- IRON PIPE FOUND (SIZE NOTED)POINT
- CONC. HIGHWAY MON. FOUND
- 60D NAIL FOUND
- CALCULATED POINT
- FENCE POST FOUND
- CONTROL POINT/BENCHMARK LOCATION
- PIPE CAP
- PIPE FLOW
- REDUCER
- UTILITY VALVE
- UTILITY METER
- FIRE HYDRANT
- WASTE WATER M.H.
- CLEANOUT
- STORM M.H.
- DOWN SPOUT
- AREA INLET
- CURB INLET
- HEADWALL
- SAFETY END TREATMENT
- DRAINAGE FLOW
- ELEC. M.H.
- UTILITY POLE
- GUY WIRE
- LIGHT FIXTURE
- ELECTRIC PULL BOX
- UNDERGROUND TELEPHONE MARKER
- TELEPHONE MANHOLE
- UNDERGROUND FIBER OPTIC MARKER
- SIGN
- MAILBOX
- BOLLARD/GUARD POLE
- POLE/FLAG POLE
- TREE

LINETYPE LEGEND

PROPOSED / EXISTING

- RIGHT OF WAY
- LOT BOUNDARY
- EASEMENT
- FENCE: BARBED
- FENCE: WOOD (PICKET)
- FENCE: WOOD (PRIVACY)
- FENCE: METAL
- MAJOR CONTOUR
- MINOR CONTOUR
- ELECTRIC LINE
- ELECTRIC LINE
- ELECTRIC LINE
- GAS LINE
- WASTE WATER LINE
- WATER LINE
- DEDICATED FIRE LINE
- ROAD CENTERLINE
- CURB & GUTTER
- STRIPING
- FIRE LANE STRIPING
- H.C. ACCESSIBLE ROUTE
- LIMITS OF CONSTRUCTION
- FLOODPLAIN
- CWQZ
- STORM SEWER
- DRAINAGE CHANNEL
- CONCRETE
- GRAVEL
- SAND

SITE PLAN DATA

ITEM	QTY.
EXISTING ZONING	NA
PROPOSED ZONING	NA
LAND USE DESIGNATION	OUTDOOR RECREATION
SITE ACREAGE	105 AC
IMPERVIOUS COVERAGE: AREA	2.1 AC
IMPERVIOUS COVERAGE: PERCENT	20%
BUILDING SQUARE FOOTAGE	30,000 SF
NUMBER OF STORIES	1
MAXIMUM BUILDING HEIGHT	NA
REQUIRED PARKING (9'x17.5' SP)	NA
SPACES PROVIDED: STANDARD	608
SPACES PROVIDED: HANDICAP	30
SPACES PROVIDED: VAN ACCESS	15
SPACES PROVIDED: LOADING	1

FOR CITY USE ONLY:

SITE PLAN APPROVAL SHEET______OF______
FILE NUMBER__________APPLICATION DATE__________
APPROVED BY COMMISSION ON______UNDER SECTION______OF
CHAPTER_____ OF THE CITY OF AUSTIN CODE.
EXPIRATION DATE (25-5-81,LDC)______CASE MANAGER________
PROJECT EXPIRATION DATE (ORD.#970905-A)_____DWPZ____DDZ____

Director, Planning and Development Review
RELEASED FOR GENERAL COMPLIANCE:_______ZONING:_______
Rev.__________Correction 1__________
Rev.__________Correction 2__________
Rev.__________Correction 3__________

Final plat must be recorded by the Project Expiration Date, if applicable. Subsequent Site Plans which do not comply with the Code current at the time of filing, and all required Building Permit and/or a notice of construction (if a building permit is note required), must also be approved prior to the Project Expiration Date.

REV | REVISION / DESCRIPTION | DATE

CLIENT INFORMATION: BLUE PRAIRIE

kbge
ENGINEERING CONSULTING
KIMBELL | BRUEHL | GARCIA | ESTES
105 West Riverside Drive, Ste 110, Austin, Texas 78704
T (512) 439-0400 www.kbge-eng.com
TBPE No.F-12802

BLUE PRAIRIE
SITE DEVELOPMENT PLANS

CITY OF AUSTIN, TRAVIS COUNTY, TX

OVERALL SITE PLAN & KEY MAP

September 16, 2014

STATE OF TEXAS
CHAD KIMBELL
99810
LICENSED PROFESSIONAL ENGINEER

CHECKED BY:
CHAD KIMBELL, PE

JOB NUMBER: 267-001
ISSUE DATE: 09/16/14

SHEET:
04 OF 21

FILE: K:\PROJECTS\267 – BLUE PRAIRIE\001– BLUE PRAIRIE\CAD\PLANS\04 OVERALL SITE PLAN & KEY MAP.DWG PLOTTED BY: CHAD KIMBELL PLOTTED ON: 09/16/14 12:07:20 PM

Addendum:

CLOWARD H_2O provides the following summary in addendum to our Preliminary Water Treatment Design and Engineering Estimates of Construction Cost report dated 12 May 2014. This addendum discusses the proposed water treatment system's operational interface with the proposed storage reservoir intended for use as a source of irrigation and makeup water for the project as currently shown on the plans for the Honokea park in development in Austin Texas.

Lagoon and Storage Reservoir Water Characteristics

The volume contained in the Lagoon is estimated at 8.2 million gallons, with a water surface area of approximately 500,000 ft^2. An additional Storage Reservoir will be included onsite to be used for make-up water in the Lagoon. The required storage capacity of this reservoir at full capacity has been calculated to be 36 million gallons. The Lagoon and Reservoir will initially be filled with potable and/or approved quality well water. The site has been designed and will be graded with the intent to capture rain water from uncontaminated areas (deck and artificial turfed areas) and route the storm runoff to the Storage Reservoir to be treated and used for make-up. When rainfall is unable to keep up with the make-up water demand in the Lagoon, well water will be used to supplement keeping the Lagoon at operational water levels.

Water Treatment Summary

In order to maintain acceptable water quality within the surf Lagoon, water treatment equipment and circulation will be provided as summarized below.

<u>Main Surf Lagoon:</u>

- Treatment will be installed on the Lagoon to continuously circulate and treat the water.
- Screen filters are incorporated to remove suspended solids greater than 40 micron.
- Ozone is used as an extremely effective oxidizer and sanitizing agent removing organic and non-organic contaminants and destroying waterborne microorganisms.
  - Ozone effectively reduces TP, TN, COD, BOD and TOC through oxidation
  - Ozone destroys pathogens (both bacterial and viral) in the treatment stream.
  - Ozone facilitates micro-flocculation, further removing contaminants by trapping them in longer, filterable, molecular chains.
- A standby chlorine dosing system will be provided that can activate as needed when a residual oxidizer is necessary.

<u>Storage Reservoir:</u>

- Water in the Storage Reservoir will be made up of either water returning from the Lagoon, storm water runoff as previously described, or well water to meet demand.
- Water from the Storage Reservoir will be pumped through a robust treatment system before being injected into the Lagoon.
  - Regenerative media filters to effectively remove particles down to 3 micron.
  - Oxidation and sanitation with ozone.
- Chlorine dosing may be provided as necessary for residual oxidizer for water being injected into the Lagoon.

Both treatment systems will work together to continuously circulate in a manner designed to maintain acceptable water quality throughout the system.

Exhibit
B

AUSTIN/TRAVIS COUNTY HEALTH AND HUMAN SERVICES DEPARTMENT
Environmental Health Services Division
P.O. Box 142529
Austin, TX 78714
Phone: (512) 978-0300; Fax: (512) 978-0322

City of Austin

County of Travis

November 7, 2014

KBGE (for Austin Park, LLC)
105 W. Riverside Drive, Suite 110
Austin, TX 78704

Attn: Chad Kimbell, P.E., Principal

Re: Variance Request to 265.182 and 265.183
Blue Prairie Development 4836 E SH 71 EB, Austin, Texas

Dear Mr. Kimbell,

This Department's review of your variance request submitted on September 9, 2014 is complete and your variance request for the subject "surf lagoon" is not approved. Travis County Attorney staff has rendered an interpretation and advised this Department that the proposed surf lagoon meets the definition of "pool" as defined in TAC Chapter 265 – Standards for Swimming Pools and Spas and it must meet all of the criteria mandated/referenced in Chapter 265 and all permitting and inspection requirements in Chapter 61-Travis County Rules for Regulation and Permitting of Public Swimming Pools.

If the project is planned to move forward, plans must be submitted to and reviewed and approved by this Department, along with all required inspections and fees, before an Operating Permit can be issued. Please find attached an Operating Permit/Plan Review application which must be completed and submitted to this Department along with payment of a $50 plan review fee and 1 set of plans.

Please contact Gwen Meighan at 512-978-0300 if you have any questions regarding the plan review and permitting process.

Thank you,

Robert Wright, R.S., Supervisor
Environmental Health Services Division
Austin/Travis County Health and Human Services Department
Ph: (512) 978-0300 Fax: (512) 978-0322

Exhibit
C

TRAVIS COUNTY HEALTH and HUMAN SERVICES
& VETERANS SERVICE
502 E. Highland Mall Blvd. (78752), P. O. Box 1748, Austin, Texas 78767

Sherri E. Fleming
County Executive *for* HHS/VS
Main: (512) 854-4100 * Fax: (512) 279-2197

VIA CERTIFIED MAIL RRR NO. 7005 2570 0000 5002 2917

February 1, 2016

Doug Coors
Austin Park, LLC
700 12th St., Ste. 200
Golden, CO 80401

Mr. Coors:

On December 7, 2015, the Austin/Travis County Health and Human Services Department issued a construction stop work order to Austin Park, LLC d/b/a NLand Surf Park ("Austin Park"). Despite receiving the stop work order, it is apparent that Austin Park is continuing construction. Austin Park's choice to ignore the stop work order is unacceptable.

Austin Park is constructing a structure that meets the legal definition of a public swimming pool. In Travis County, public swimming pools must be built in accordance with chapter 341 of the Health and Safety Code, 25 Tex. Admin Code chapter 265, and Travis County Code chapter 61A. I have enclosed a copy of Travis County Code chapter 61A for your convenience. Sec. 61A.11 of the Travis County Code requires Austin Park to submit plans and specifications ("Plans") and to obtain a Statement of Plan Approval before beginning construction. Austin Park has been asked numerous times to submit Plans, but has not done so to date. Further, Travis County Code Sec. 61A.09 requires Austin Park to obtain a permit prior to commencing operations of NLand Surf Park. Austin Park has neither provided the required documents nor obtained the required permits.

Construction should stop immediately. In addition, Austin Park needs to submit a copy of Austin Park's Plans and relevant supporting documents for NLand Surf Park within the next five days so that Travis County can assess compliance with 25 Tex. Admin. Code Ch. 265. It is of upmost importance that my department determines Austin Park's ability to satisfy the requirements related to (1) turnover rate; (2) disinfection/filtration; and (3) fill/refill water source.

Once we receive the required documentation, I believe we can work together to ensure NLand Surf Park is a safe and legal surf park. If not, we will file suit to protect the public from an unpermitted swimming pool. I look forward to hearing from you.

Sincerely,

Sherri E. Fleming

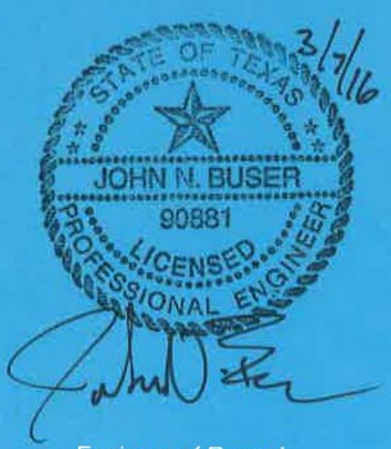
Sherri E. Fleming
County Executive
Travis County Health and Human Services and Veterans Services

Enclosure

Exhibit
D

AECOM

Technical Memorandum on the Anticipated Water Quality of NLand Surf Park



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March 7, 2016

AECOM Job No.: 60480647

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1. Introduction and Project Description

1.1. Overview of the NLand Surf Park Project

NLand Surf Park is a unique facility designed to bring the exciting sport of surfing to Austin, TX. This facility will provide access to surfers residing in the Austin area who are kept from mastering their sport due to the cost and inconvenience of having to travel to coastal waters. The Surf Park will also bring the opportunity of learning a new sport to residents of the surrounding communities who may have never before considered surfing. Upon completion, NLand Surf Park will be the first facility of its kind in North America and only the second such facility in the world. Surf Snowdonia in Wales, opened in 2015, is the only other inland surf facility. NLand Surf Park will attract surfers from around the world at its facility with the promise of ideal, consistent wave generation. The possibility of national and international surfing competitions at NLand Surf Park's state-of-the-art Surf Lagoon is also highly anticipated.

The NLand Surf Park will be located in Travis County less than ten miles east of the Austin-Bergstrom International Airport along State Highway 71. An aerial map of the proposed Surf Park including the facility's Surf Lagoon, Wet Pond, and Storage Reservoir is shown below in **Figure 1.1.**

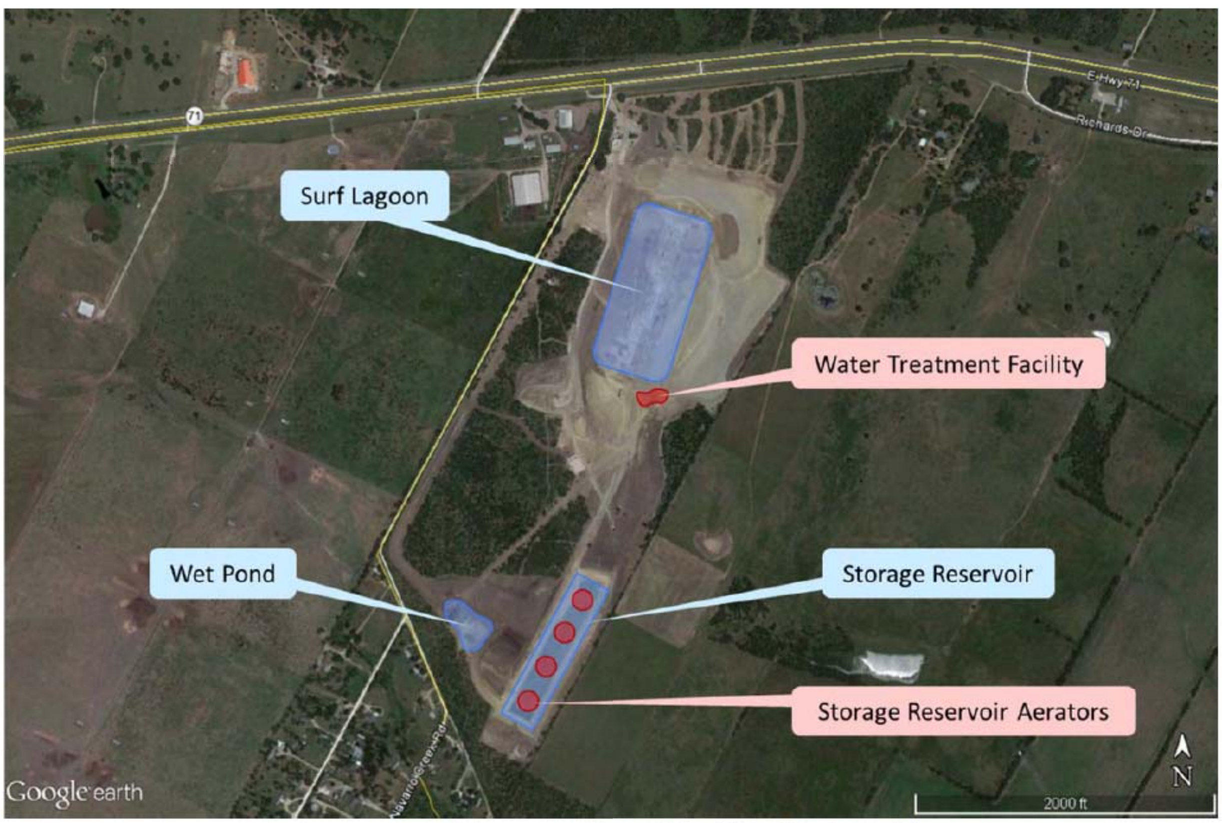

Figure 1.1 Aerial Image of the NLand Surf Park Facility

The Surf Lagoon at NLand Surf Park will be filled and maintained with stored surface runoff in the same way the previous natural pond existed on this property. This facility will be completely self-sustaining in regards to the Surf Lagoon's water supply needs. The runoff from the surrounding drainage area is collected in a wet pond. Runoff collected in this wet pond flows by gravity into an aerated Storage Reservoir. Stored water from the Storage Reservoir will be used for the initial fill of the Surf Lagoon, and for replenishing the water lost through evaporation to maintain the desired level of the Surf Lagoon. All water entering the Surf Lagoon will pass through an onsite water treatment facility. The onsite water treatment facility includes a 40 micron filtration unit, followed by a disinfection system using ozone, followed by chlorine to ensure a safe surfing environment.

Currently there are no separate regulatory classifications for Surf Park operations and their water quality requirements. It can be argued that a Surf Park could be classified as a "wave action pool" by the State of Texas regulatory agencies. Classifying the NLand Surf Park as a wave action pool does not fully recognize the unique nature of this facility. Although the majority of the regulatory requirements can be met, there are a couple of requirements that prove difficult or impossible to adhere to and would be inappropriate for the proposed operations. As such, NLand Surf Park has asked AECOM to conduct an independent investigation to evaluate whether the proposed water quality treatment system provides a water quality that is adequate for its intended use.

1.2. Planned Operations of the Surf Park

The NLand Surf Park will be a 160-acre privately owned recreational water facility with a Surf Lagoon spanning an area approximately equal to nine football fields that will be available for public use for a fee. With an anticipated surfer load of no more than 200 surfers during normal operations, each surfer would have over 2,600 square feet of surfing area. Proprietary wave foil technology engineered by the Spanish company Wavegarden will produce 1, 4, and 6 foot waves that can offer a surfing experience of up to 35 seconds per wave. Every hour, hundreds of distinct waves will be generated, and surfers will be able to experience these waves in one of ten different surfing areas that exist within the lagoon. These surfing areas are categorized by surfer experience level ranging from beginner to expert.

1.3. Sources of Water Supply for the Surf Park

The NLand Surf Park is constructed to operate entirely on surface water runoff from the surrounding area. As shown in **Figure 1.1,** the areas adjacent to the NLand Surf Park are primarily rural, and any contamination in the runoff is assumed to come from natural sources.

This rainwater water runoff is initially collected in a wet pond where the surface runoff is settled and filtered using a typical City of Austin (CoA) wet pond. Per the CoA Environmental Criteria Manual (ECM), this type of wet pond is expected to provide effluent concentrations of 22.4 mg/L chemical oxygen demand (COD) and 20.6 mg/L total suspended solids (TSS) (CoA ECM, §1.6). Once the wet pond is full, water from the surface of that pond flows over a weir into a Storage Reservoir that is aerated to maintain adequate dissolved oxygen levels. The Storage Reservoir is equipped with weirs at multiple elevations that allow excess water to flow to nearby creeks. From the Storage Reservoir, water is pumped through the Surf Park's water treatment system and discharged into the Surf Lagoon.

1.4. Summary of Treatment

The Nland Surf Park Surf Lagoon is filled using the collected rainwater runoff in the aerated Storage Reservoir. Once filled, the lagoon water is recirculated through a treatment process consisting of filtration, ozone injection, chlorine addition in the form of sodium hypochlorite, and acid addition to adjust pH. A simplified schematic of this treatment process is shown in **Figure 1.2**. During normal operations of the park, water in the lagoon is lost to the environment. In order to maintain the volume desired in the lagoon, supplemental water is added to the recirculated water prior to the treatment process. This "make-up" water comes from the aerated Storage Reservoir, and is routed through a smaller, lower capacity treatment process prior to its addition into the recirculated lagoon water flow. The "make-up" water volume is small compared to the overall recirculation flow. Due to the small volume of "make-up" water introduced to the lagoon, this investigation will not consider the impact of this water addition on the overall water quality of the lagoon.

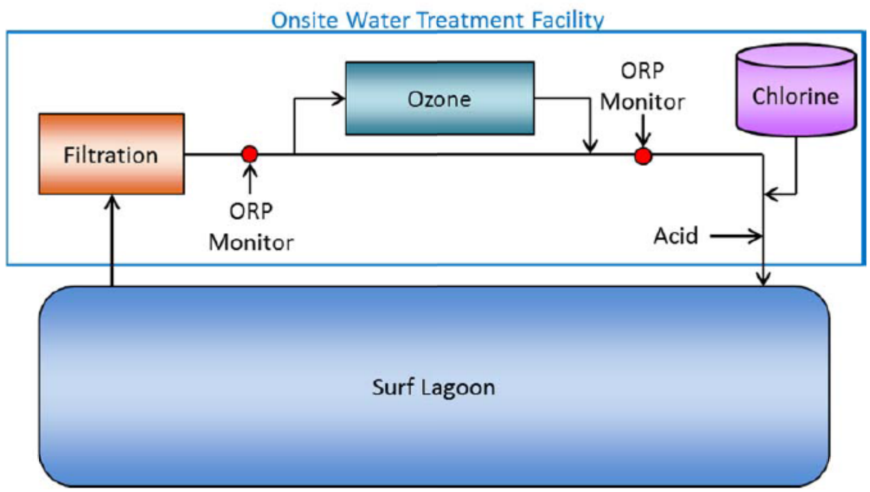

Figure 1.2 Simplified Treatment System Schematic

After the water has been treated it reenters the Surf Lagoon through a series of diffusers located along the shores and along the center of the Surf Lagoon to promote mixing and to evenly distribute the treated water over the volume of the lagoon. Further mixing in the lagoon is accomplished during wave generation. Water that is drawn from the lagoon and sent back to the onsite treatment facility is collected from drains along the center of the lagoon, the deepest parts of the lagoon, and from skimming gutters along the ends of the lagoon. **Figure 1.3** shows a schematic of the locations of the treated water inlets to the lagoon (in blue) and of the drains and gutters used to collect water to be sent to treatment (in purple). The following sections discuss the primary treatment processes in regards to water quality in more detail.

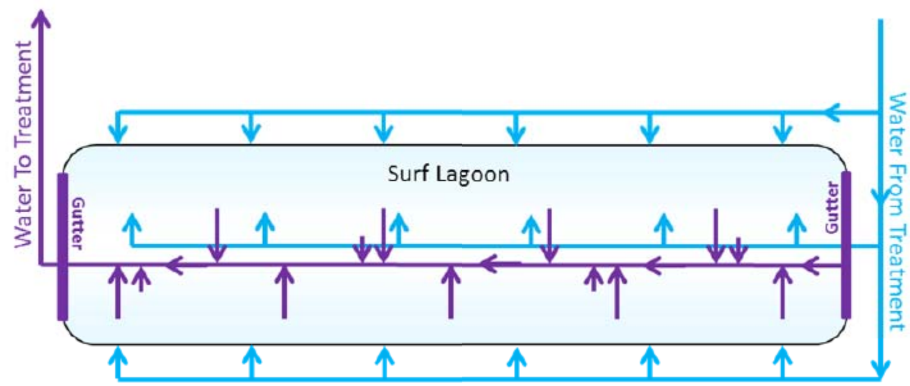

Figure 1.3 Schematic of Water Inlets from Treatment and Outlets to Treatment

1.4.1. Treatment Facilities

The treatment process at Nland Surf Park consists of recirculation pumping, filtration, ozone injection, and chlorine addition in the form of sodium hypochlorite. In addition, acid addition is used to adjust the water pH. A summary of the water quality treatment facilities follows:

- The total recirculation rate at Nland Surf Park is 11,800gpm. Recirculation pumping is accomplished using two, 5,900 gpm vertical turbine pumps. Lagoon water is drained to the sump through inlets in the center of the lagoon and skimming gutters along the ends of the lagoon. The pumps then recirculate the water through the treatment process and return to the lagoon.
- The filtration system consists of four (4), 40-micron stainless steel filter units intended to remove large solids from the raw water. These filters also serve to filter the recirculated lagoon water, removing hair and other suspended particles collected in the Surf Lagoon. At the total recirculation rate of 11,800 gpm, all filters are required to be on-line.
- Following filtration a side stream of the treatment flow is diverted for ozone injection. This ozone injection system consists of a 600 cubic feet per hour (ft^3/hr) oxygen concentrator, an 800 grams per hour (gm/hr) (42.3lbs/day) ozone generator, four (4) ozone injectors, a 1200 gallon ozone contact tank, and an ozone destruct unit. After concentrated ozone is injected into the side steam, this stream is reintroduced into the full treatment flow.
- The final process is the addition of supplemental sodium hypochlorite. A 10.5% solution of sodium hypochlorite is stored on site in a 4,000 gallon storage tank. Two, 480 gal/day metering pumps withdraw the solution from the tank and apply it to the full treatment flow. The total capacity of the sodium hypochlorite feed system is 960 gal/day.
- After application of the sodium hypochlorite solution, the full treatment flow travels through two 24-inch diameter PVC pipes and discharges, through a series of diffusers, both along the shore and down the center of the Surf Lagoon. At the total flow rate of 11,800 gpm, with a lagoon volume of 11,607,617 gallons, it will take approximately 17 hours to recirculate the entire volume of the lagoon.
- Multiple injection points within the Surf Lagoon serve to mix the recirculated water with the lagoon water. The wave action of the Surf Lagoon is also expected to provide substantial mixing.

Intermittent drains in the middle of the lagoon and skimming gutters along the ends of the lagoon collect the lagoon water and recirculate it through the water quality treatment process. A Computational Fluid Dynamics (CFD) model was not available for review during the completion of this report. For the purposes of this analysis, it was assumes substantial mixing was achieved through multiple injection points and the generated wave action.

1.4.2. Filtration

The entire recirculated flow of 11,800 gpm is filtered continuously using screen filters with a nominal screen size of 40 microns. As shown in **Figure 1.4**, a filter of this size will remove particulates such as sand, human hair, pollen and dust. However, smaller particles including protozoa, bacteria, and viruses will not be removed in substantial quantities. It is likely that some passive removal of a limited amount of microorganisms will occur through their attachment to larger particles; however, the extent and credit for this removal, if any, would have to be determined by field measurements once the treatment systems are in place and operational. At this time, because of lack of field measurements and availability of data, it is assumed that such removal is negligible and no credit for such removal is taken in this study.

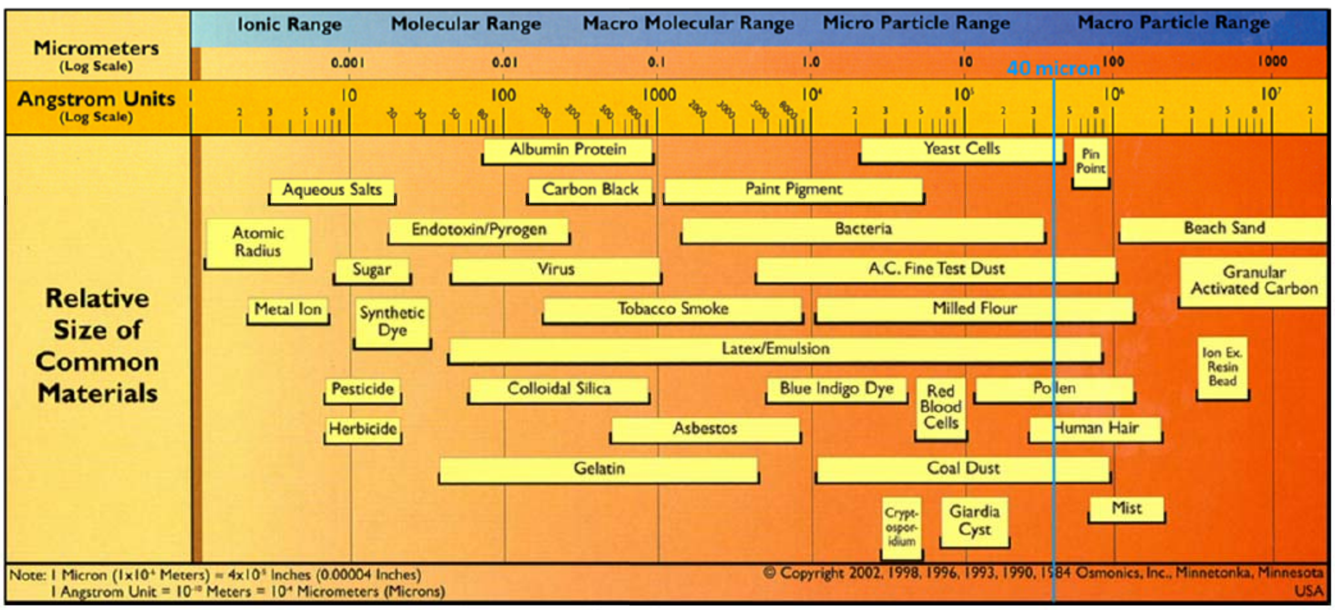

Figure 1.4 Filtration Spectrum

The filtration process at NLand Surf Park will improve clarity and remove a portion of the organic content of the water. For the inactivation of microorganisms, however, disinfection will be critical.

1.4.3. Ozone

Ozone gas is used as the initial disinfectant at NLand Surf Park. Ozone is a more powerful oxidizer than other common disinfectants, such as chlorine and bromine, and can achieve greater oxidation of contaminants over a much shorter period of time. For example, at 25°C and a pH of 7.5, chlorine at a concentration of 1 mg/L will remove 99.9% of *Giardia* cysts after 45 minutes, while ozone at a concentration of 1 mg/L can achieve the same percent removal in approximately 30 seconds (calculated using CT tables from EPA, 2003).

Although ozone can be a very efficient disinfectant at sufficient concentrations, it decays rapidly and therefore is not suitable for use as a residual disinfectant. As such, chlorine will be added as a supplemental disinfectant to achieve a measurable residual within the Surf Lagoon. This addition of chlorine will serve as an additional disinfectant and also as an indicator for the effectiveness of the ozone addition in neutralizing contaminants. More discussion on the use of ozone at NLand Surf Park is presented in **Section 3.**

1.4.4. Sodium Hypochlorite

Chlorine is added to the treatment stream at NLand Surf Park after ozone injection in the form of a 10.5% sodium hypochlorite solution. The dose of chlorine is controlled by metering pumps and will vary based on ORP readings to maintain the desired residual chlorine concentration within the Surf Lagoon. This residual concentration will also provide some level of protection from accidental releases such as vomiting or diarrhea which can introduce a substantial point load of microorganisms to a recreational water environment. See **Section 4** for more detail on the use of sodium hypochlorite at NLand Surf Park.

1.4.5. Combined Disinfection with Ozone and Chlorine

Most swimming pool regulations and guidelines specify a disinfection protocol based on the use of chlorine or bromine as the sole disinfectant. Little information is available regarding the use of a combined disinfection system for swimming pools. Combined disinfection utilizes the strengths of two different disinfectants which can provide an overall more effective disinfection system. In the case of NLand Surf Park, ozone works as a powerful oxidizer to quickly reduce the initial oxidant demand and provide some microbial inactivation while chlorine is instrumental in providing a residual disinfectant concentration in the Surf Lagoon. Because of the work done by ozone to lower oxidant demand and provide some disinfection, the system is less dependent on disinfection provided by the chlorine residual. **The World Health Organization (WHO) has recognized this quality of a combined disinfection system noting that "lower free [residual] chlorine concentrations (0.5 mg/L or less) will be adequate where chlorine is used in conjunction with ozone or UV disinfection" (WHO, 2006).** An additional benefit to using a combined ozone and chlorine disinfection process is that ozone can oxidize precursors of disinfectant by-products (DBPs) produced by chlorine disinfection which may cause eye and respiratory irritation in swimmers (WHO, 2006).

2. Applicable Regulations and Guidelines

This section discusses regulations and guidelines that are applicable to the operations of NLand Surf Park and to the scope of work of this project.

2.1. Free Available Chlorine Residual

The commonly accepted method for ensuring adequate swimming pool disinfection is to maintain a specified residual disinfectant concentration. Chlorine and bromine are the two most commonly used disinfectants to provide this residual disinfectant concentration in swimming pools. NLand Surf Park plans to use chlorine as their residual disinfectant. The concentration of chlorine residual is measured as the free available chlorine (FAC) present in the water. FAC residual refers to the concentration of chlorine in the pool that is available to disinfect. This available chlorine could be in the form of molecular chlorine (Cl_2), hypochlorous acid (HOCl), or hypochlorite (OCl^-). **Table 2.1** shows regulations and guidelines for FAC residuals in swimming pools.

Table 2.1 Free Available Chlorine Residual

Regulation/Guideline	Free Available Chlorine Rule
Texas Health and Safety Code (THSC, §34.064)	Minimum of 1.0 ppm *"or any other method of disinfectant approved by the department"*
Texas Administrative Code (TAC, Ch. 265)	1.0 - 8.0 ppm
American National Standard for Water Quality in Public Pools and Spas (ANSI/APSP, 2009)	1.0 - 4.0 ppm
WHO Guidelines for Safe Recreational Water Environments: Volume 2 (WHO, 2006)	1.0 - 3.0 ppm *"Lower free chlorine concentrations (0.5 mg/L or less) will be adequate where chlorine is used in conjunction with ozone or UV disinfection"*
Model Aquatic Health Code (HHS/CDC, 2014)	Minimum of 1.0 ppm Minimum of 2.0 ppm if using cyanuric acid

NLand Surf Park plans to maintain a FAC residual of 0.5 ppm in their Surf Lagoon due to the anticipated efficacy of their combined disinfection process. This residual concentration is supported by the WHO guidelines as shown in **Table 2.1**. Conversely, any swimming pool maintaining a 1 ppm (mg/L) FAC residual would comply with all of the regulations presented in **Table 2.1**.

2.2. Inactivation of Microorganisms

Swimming pool regulations and guidelines do not contain rules for microbial inactivation based on percent removal of specified microorganisms. Instead, residual disinfectant concentrations are specified that have been shown to provide adequate disinfection and protection from accidental releases (i.e. vomiting or diarrhea).

If NLand Surf Park maintains a 1.0 ppm chlorine residual their facility will be considered safe from a microbial inactivation standpoint based on Texas swimming pool regulations for disinfection (**Table 2.1**).

The design residual for NLand Surf Park is 0.5 mg/L. This design residual concentration is consistent with the WHO regulations which specify that a 0.5 mg/L chlorine residual, when combined with ozone disinfection, is adequate (WHO, 2006). However, guidance on the required ozone dose for a combined ozone and chlorine disinfection process is not provided. For the purpose of this report it was deemed necessary for all harmful microorganisms to be sufficiently removed by ozone to justify a 0.5 ppm chlorine residual. This is because the residual chlorine concentration is not intended to achieve significant microbial inactivation and is instead intended to protect surfers from potential additional contamination from bather shedding or accidental releases.

In order to provide a conservative approach to determining the inactivation of microorganisms using ozone at NLand Surf Park, the EPA Surface Water Treatment Rule (SWTR) for disinfection using ozone was used. The EPA SWTR specifies that if ozone achieves a 4-log removal of viruses, 3-log removal of *Giardia* cysts, and 2-log removal of *Cryptosporidium* the water is properly disinfected to drinking water standards. The conservative assumption in using the EPA SWTR to prove adequate ozone disinfection at NLand Surf Park is that if water is treated with ozone to an extent that it is safe to drink it will most certainly be safe for surfing and swimming.

In order to achieve the EPA SWTR specified removal of viruses, *Giardia*, and *Cryptosporidium,* a specific "CT" value must be obtained. A CT value is the product of concentration ("C") and time ("T") where C is the disinfectant residual concentration and T is the time that the disinfectant is in contact with the water (EPA, 2003). **Table 2.2** lists the EPA SWTR CT values for viruses, *Giardia*, and *Cryptosporidium* in the top section of the table. CT values from various sources for other microorganisms that are likely present in surface water are also included in **Table 2.2** to demonstrate the wide variety of microorganisms that may be inactivated by ozone.

Table 2.2 CT Values and Log Inactivation of Microorganisms Using Ozone

Microorganism	Ozone Conc. (mg/L)	Contact Time (minutes)	Estimated CT (mg-min)	Percent Inactivated	Log Inactivation
Viruses, *Giardia*, and *Cryptosporidium* from the EPA SWTR (EPA, 2003; EPA, 2010)					
Viruses, all (20°C)	Not Specified	Not Specified	0.5	99.99	4
Giardia Cysts (20°C)	Not Specified	Not Specified	0.72	99.9	3
Cryptosporidium Oocysts (20°C)	Not Specified	Not Specified	7.8	99	2
Bacteria					
Bacteria, all[a]	0.10	1.00	0.1	>99.99	> 4
Bacillus Bacteria[b]	0.20	0.50	0.1	>99.99	> 4
Bacteriophage f2[b]	0.41	0.17	0.068	99.99	4
Diphtheria Pathogen[b]	2.00	Not Specified	Not Specified	>99.99	> 4
Eberth Bacillus (Typhus abdomanalis)[b]	2.00	Not Specified	Not Specified	>99.99	> 4
Escherichia Coli Bacteria (from feces)[b]	0.20	0.50	0.1	>99.99	> 4
Salmonella Bacteria[b]	0.01	1.00	0.01	~99.99	~4
Staphylococci[b]	2.00	Not Specified	Not Specified	>99.99	> 4
Streptococcus Bacteria[b]	0.20	0.50	0.1	>99.99	> 4
Coliform Bacteria (22°C)[c]	0.10	1.00	0.1	99.4	2.2
Protozoa					
Protozoa, all[a]	1.50	5.00	7.5	~99.99	~4
Cryptosporidium Oocysts[a]	1.50	5.00	7.5	>99.99	> 4
Viruses					
Herpes Virus[b]	0.80	0.50	0.4	>99.99	> 4
Coxasackie Virus B5[b]	0.40	2.50	1.0	>99.99	> 4
Influenza Virus[b]	0.50	Not Specified	Not Specified	>99.99	> 4
GDVII Virus[b]	0.80	0.50	0.4	>99.99	> 4
Enterovirus Virus[b]	0.80	0.50	0.4	>99.99	> 4
Hepatitis A Virus[b]	0.25	0.03	0.008	99.5	2.3
Poliovirus type 1[b]	2.50	1.60	4.0	99.5	2.3

[a] (Eagleton, 1999); [b] (Ozone Solutions, 2014); [c] (Sharrer & Summerfelt, 2007); [d] (EPA, 2003); [e] (CFR, 2009)

2.3. Bather Load

Bather load defines the maximum number of bathers allowed in a pool at one time. Regulations express the bather load as the total surface area of a pool divided by the amount of surface area required by each bather based on pool type or depth. **Table 2.3** shows a summary of surface areas required per bather from different regulations and guidelines.

Table 2.3 Pool Surface Area Required Per Bather

Texas Administrative Code (TAC, Ch. 265)				
Pool Type	Shallow/Instructional or Beginning or Wading Areas	Deep Area (Not Including Diving Area)	Diving Area (Per Each Diving Board)	
Ft^2 Per Bather	15	25	300	
WHO Guidelines for Safe Recreational Water Environments: Volume 2 (WHO, 2006)				
Pool Depth	<1 meter	1.0-1.5 meters	>1.5 meters	
Ft^2 Per Bather	24	29	43	
Model Aquatic Health Code (HHS/CDC, 2014)				
Pool Type	Flat Water	Agitated Water	Hot Water	Interactive Play
Ft^2 Per Bather	20	15	10	10

Applying the Texas Administrative Code's surface area per bather requirements, the NLand Surf Park could accommodate a bather load of ~20,000 bathers, which is approximately 100 times the Surf Park's design bather load.

2.4. Turnover Rate

The turnover rate for a swimming pool refers to the amount of time, typically expressed in hours, required to recirculate the volume of water in a pool. **Table 2.4** shows a summary of turnover rate regulations and guidelines for swimming pools.

Table 2.4 Turnover Rates

Texas Administrative Code (TAC, Ch. 265)						
Average Pool Depth	≥ 4 feet			< 4 feet		
Turnover Rate	6 hours			Average Depth (ft) x 1.5*		
WHO Guidelines for Safe Recreational Water Environments: Volume 2 (WHO, 2006)						
Type of Aquatic Venue**	Competition Pools 50 m long	Diving Pools	Leisure waters 0.5-1 m deep	Leisure waters 1-1.5 m deep	Leisure waters over 1.5 m deep	Teacher/ learner/ training pools
Turnover Rate	≤2 hours	≤8 hours	≤1 hours	≤1 hours	≤2 hours	≤6 hours
Model Aquatic Health Code (HHS/CDC, 2014)						
Type of Aquatic Venue	Activity Pools	Diving Pools	Plunge Pools	Wading Pools	Wave Pools	All Other Pools
Turnover Rate	≤2 hours	≤8 hours	≤1 hours	≤1 hours	≤2 hours	≤6 hours

*Example: A pool with an average depth of 3.5 feet would have a 3.5 x 1.5 = 5.25 hour turnover rate

**Select aquatic venue types presented (6 of 11 total) to represent the range of turnover rates from this Guideline

It is important to note that the turnover rates presented in **Table 2.4** may work well for typical pools but may be difficult to achieve for atypical pools with, for example, low bather loading rates or large pool volumes.

2.5. pH

The pH for a swimming pool can affect the efficacy of disinfectants (particularly chlorine) used and the chemical species present in the water. It is important to maintain pH at sufficient levels to ensure adequate disinfection is being achieved. **Table 2.5** shows the recommended swimming pool pH levels from various regulations and guidelines.

Table 2.5 pH

Regulation/ Guideline	**Texas Health and Safety Code** (THSC, §34.064)	**Texas Administrative Code** (TAC, Ch. 265)	**American National Standard for Water Quality in Public Pools and Spas** (ANSI/APSP, 2009)	**WHO Guidelines for Safe Recreational Water Environments: Volume 2** (WHO, 2006)	**Model Aquatic Health Code** (HHS/CDC, 2014)
pH Rule	Water may not show an acid reaction to a standard pH test	7.0 - 7.8	7.2 - 7.8	7.2 - 7.8 for chlorine disinfectants and 7.2 - 8.0 for bromine-based and non-chlorine processes	7.2 - 7.8

2.6. Water Clarity

Water clarity in swimming pools is important from both a safety and water quality standpoint. It is important to be able to see all swimmers in a pool clearly at any point in time to ensure their safety and minimize drowning risks. Additionally, poor water clarity can indicate that treatment processes are not working properly and that water quality may be compromised. **Table 2.6** shows regulations and guidelines for monitoring swimming pool water clarity.

Table 2.6 Water Clarity

Regulation/ Guideline	**Texas Administrative Code** (TAC, Ch. 265)	**American National Standard for Water Quality in Public Pools and Spas** (ANSI/APSP, 2009)	**WHO Guidelines for Safe Recreational Water Environments: Volume 2** (WHO, 2006)	**Model Aquatic Health Code** (HHS/CDC, 2014)
Water Clarity Rule	Bottom and main drain shall be clearly visible at the deepest part of the pool or spa	An 8-inch diameter black and white Secchi disc or main suction outlet located on the bottom of the pool at its deepest point should be clearly visible up to 30 feet away	Lane markings or other features on the pool bottom at its greatest depth should be clearly visible when viewed from the side of the pool	The water in an AQUATIC VENUE shall be sufficiently clear such that the bottom is visible while the water is static.

3. Water Quality and Ozone Disinfection

3.1. Potential Contaminants in Supply Water

The NLand Surf Park Surf Lagoon is filled with rainwater runoff. As stated previously, the areas surrounding the Surf Park are predominately rural and it is anticipated that any contamination in the rainwater runoff will primarily originate from natural sources. It is likely that nearby surface waters would encounter similar contaminates from rainwater runoff as would the Surf Park. Water quality records from the Lower Colorado River Authority (LCRA) for the two closest monitoring sites with current data (sites 12469 and 12466) were used to approximate the water quality of the rainwater runoff to fill the Surf Lagoon. The most current three years (2013 – 2015) of data from each site were averaged to produce an estimate of the typical E. coli concentration, dissolved oxygen content, total organic carbon content, total ammonia content and pH at these two sites as shown in **Table 3.1**. Maximum and minimum water temperatures are also shown in **Table 3.1** as an average of the maximum and minimum temperatures from each year.

Table 3.1 Water Quality Summary of Two Nearest LCRA Monitoring Sites (2013 – 2015)

Site	E. Coli (MPN/100 mL)	Dissolved Oxygen (mg/L)	Total Organic Carbon (mg/L)	Total Ammonia (mg N/L)	Max. Water Temp. (°C)	Min. Water Temp. (°C)	pH
12466	51	7.8	5.5	0.09	31	14	7.9
12469	58	8.3	4.9	0.12	31	14	7.9

In addition to these contaminants, there is likely a variety of microorganisms present in the water. **Table 2.2** provides a list of some of the microorganisms that could be expected in the rainwater runoff collected for use at NLand Surf Park.

3.2. Chick-Watson Law for Removal/Inactivation

The Chick-Watson Law is commonly used in determining disinfection kinetics, and was the basis for the development of CT values. This law relates microorganism concentration in water over time to disinfectant concentration. The Chick-Watson Law, as presented in the *Water and Wastewater Calculation Manual* (Lin, 2001) is expressed as follows:

$$N = N_0 e^{-k'_p C^n t} \quad \textbf{(Equation 3-1a)}$$

OR

$$k'_p = \frac{ln\left(\frac{N_0}{N}\right)}{C^n t} \quad \textbf{(Equation 3-1b)}$$

OR

$$ln\left(\frac{N}{N_0}\right) = -k'_p C^n t \quad \textbf{(Equation 3-1c)}$$

Where N = Number of organisms remaining after treatment (at time t)
N_0 = Initial number of organisms (at time 0)
k'_p = corrected microbial inactivation rate (dependent on microorganism)
t = contact exposure time for microorganisms (minutes)
C = Residual concentration of disinfectant in the water (mg/L)
n = coefficient of dilution

The corrected microbial inactivation rate, k'_p, is calculated as follows:

$$k'_p = \frac{k}{C^n} \quad \textbf{(Equation 3-2)}$$

Where k = microbial inactivation rate (dependent on microorganism)

and all other terms are previously defined.

Using the Chick-Watson Law, tables providing CT values (product of residual disinfectant concentration and contact time) and resulting percent removal for a variety of microorganism/disinfectant combinations have been developed by a variety of sources. In 1989, the EPA published the Surface Water Treatment Regulations which specify that water treatment plants using surface water or groundwater under the influence of surface water must utilize CT values to ensure sufficient removal of viruses, *Giardia,* and *Cryptosporidium* (Lin, 2001; EPA, 2003). **Table 2.2** presented a summary of different CT values for ozone.

3.3. ORP Measurement as an Indicator of Water Quality

Oxidation Reduction Potential (ORP) measures the oxidation (sterilization) capacity of water, regardless of the source of the disinfectant, with larger ORP readings indicating greater microbial inactivation (Bastian and Brondum, 2009). ORP monitoring can be a reliable means for determining water quality as it measures the overall oxidation potential of the water and not just the concentration of one disinfectant. Several studies have found that ORP can be as good if not better at indicating bacterial contamination in swimming pools than free chlorine residual (Theus et al, 1985; Victorin, 1974; Carlson, 1968). However, it is often recommended to use ORP monitoring in conjunction with typical chemical sampling.

Several states (Arizona, Colorado, Iowa, Idaho, Ohio, Maine, Montana and Wyoming) include ORP measurement in their state pool codes as a supplement to chlorine and pH measurements, and these codes specify that a minimum ORP value of 650 mV should be maintained (Bastian and Brondum, 2009). The WHO states that a minimum ORP of 720 mV (using an ORP monitor with a silver/silver chloride electrode) or 680 mV (using an ORP monitor with a calomel electrode) suggests that water is in "good microbial condition" (WHO, 2006).

NLand Surf Park plans to continuously monitor ORP both upstream and downstream of their ozone injection process. The ORP measurement upstream of ozone injection will provide an indication of residual disinfectant concentrations in the lagoon while the ORP measurement downstream of ozone injection will provide an indication of the disinfection achieved by ozonation. Based on the downstream

ORP readings, chlorine metering pumps will adjust their chlorine pump rate to achieve a desired ORP reading (to produce sufficient chlorine residual) for the influent lagoon water.

As ORP is not a direct measurement of chlorine residual, NLand Surf Park plans to take multiple grab samples per day to monitor chemical water quality parameters such as pH and free chlorine residual. Over time, it is possible that NLand Surf Park will be able to calibrate their ORP readings to the free chlorine residual concentrations obtained from grab sampling.

3.4. Ozone Treatment

Ozone treatment is the process of injecting ozone gas into an influent water treatment stream with the purpose of oxidizing contaminants and inactivating microorganisms. Ozone can be injected into the full treatment stream, but is instead often added to a small fraction side stream of the total treatment flow. This more commonly used method is preferable as it reduces the required size of the ozone injectors and the cost of the overall ozone treatment system. Ozone must be added at sufficient concentrations to the side stream so that when the side stream is reintroduced to the full treatment flow the remaining ozone concentration is sufficient to achieve the desired concentration and disinfection.

Ozone decays rapidly in water as the compound is highly reactive, unstable, and is prone to off-gassing (White, 1992) and is therefore unable to maintain a lasting residual. **Figure 3.1** below presents an ozone decay profile demonstrating the ozone decay rates up to and after one minute. Prior to the one minute mark, ozone decays at a rate of -0.554 min^{-1} (a half-life of 1.3 minutes) whereas after one minute, the decay rate is -0.208 min^{-1} (a half-life of 3.3 minutes) (Rakness, 2005). Depending on the initial concentration of ozone, it is likely that this disinfectant will be entirely depleted within 10 minutes of introduction.

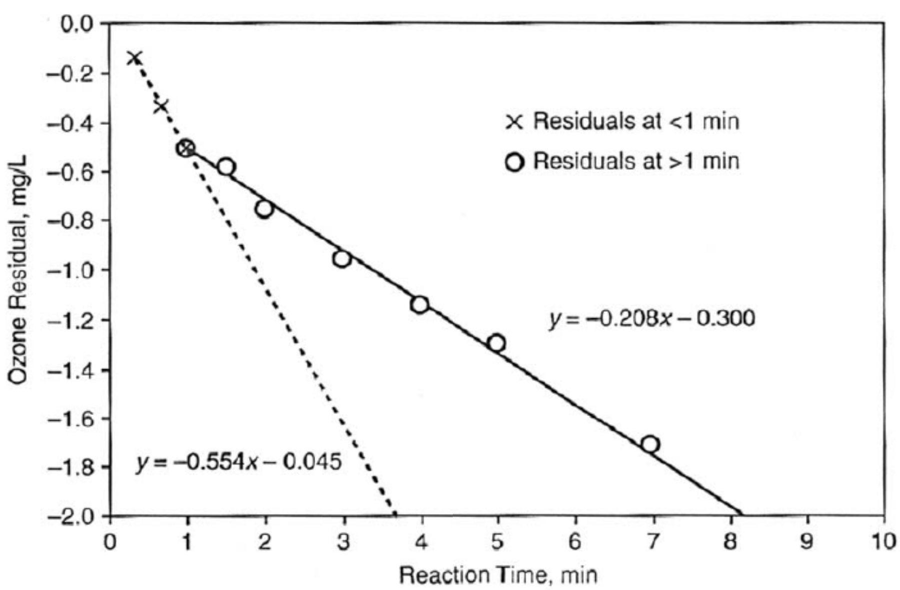

Figure 3.1 Ozone Decay Profile (Rakness, 2005)

Figure 3.1 was developed from data collected in Solution Ozone Test (SOT) and Ozone Contactors. Both of these test units have head space where some ozone is released from the solution. Because of the availability of the head space the measured dissipation of ozone is higher. In a closed conduit filled with water there is no head space for ozone release and all ozone is transferred into the water. As a result, actual ozone dissipation in closed conduits filled with water is expected to be lower than that indicated by **Figure 3.1**.

Due to the inability of ozone to provide a lasting residual, the use of chlorine or bromine as an additional disinfectant to provide a residual concentration is common. It is important to note that the use of ozone prior to the addition of a residual disinfectant can significantly reduce the disinfectant (oxidant) demand of the water. Further, "this lower disinfectant demand may allow pool operators to achieve the desired residual with a lower applied chlorine (or bromine) dose" (WHO, 2006).

3.5. Design Ozone Dosage, Initial Demand, and Contact Time

3.5.1 Design Ozone Dosage

The design dosage of ozone depends greatly on the influent water quality. Ozone is highly reactive and will oxidize many organic and inorganic chemical compounds. It is very important to know the immediate (initial) oxidant demand from organic and inorganic chemicals as this will lessen the amount of ozone remaining for microbial inactivation.

Contact time also plays a significant role in determining the required ozone dosage. The longer the contact time, the lower the dosage required to achieve the same inactivation. This concept is taken into account with CT values. Previously, **Table 2.2** itemized CT values for various microbial constituents in surface water. For example, to achieve 99.99% removal of viruses with ozone a CT value of 0.5 min-mg/L is required. Since CT is a function of residual disinfectant concentration and contact time, to achieve 99.99% removal of viruses a residual ozone concentration of 1.0 mg/L would require 30 seconds of contact time while 0.5 mg/L would require 1 minute of contact time. It is important to note that the "residual" disinfectant concentration refers to the concentration at the end of the specified contact time; in this case, the concentration at the first inlet to the Surf Lagoon. Therefore, the dose of ozone would have to be large enough to maintain a specified residual concentration at the inlet nearest to the treatment facility.

At NLand Surf Park, ozone treatment occurs following filtration where a side stream (1,200 gpm) of the total treatment flow (11,800 gpm) is diverted for ozone injection. This ozone injection system consists of a 600 cubic feet per hour oxygen concentrator, an 800 grams per hour ozone generator, four (4) ozone injectors, a 1,200 gallon ozone contact tank, and an ozone destruct unit. After concentrated ozone is injected into the side steam at an approximate concentration of 2.94 mg/L, this stream is reintroduced into the full treatment flow prior to the addition of chlorine. The design flow rate of the full treatment flow is 11,800 gpm. With an 800 grams per hour ozone generator, **the achievable dose of ozone at the point of injection into the full treatment stream is 0.3 mg/L.**

3.5.2 Initial Demand

The oxidant demand at NLand Surf Park is likely to be greatest during the initial fill of the Surf Lagoon from the onsite surface water runoff Storage Reservoir. As the water in the lagoon is recirculated through the onsite treatment facility it will continue to be treated and disinfected until essentially the only contamination being treated is that which is introduced directly into the lagoon (primarily bather contamination).

3.5.3 Contact Time

As mentioned previously, CT values are the product of residual disinfectant concentration and contact time. The contact time for ozone at NLand Surf Park is calculated as the time from ozone injection until treated water reaches the first inlet of the Surf Lagoon. This is estimated based off of the flow rate of the treated water from the treatment facility to the lagoon inlets (5900 gpm per pipe, two pipes total), the diameter of the pipes (24 inches each) and the distance from ozone injection to the first inlet of the lagoon (estimated to be about 350 feet from site drawings). Using these parameters, **the contact time for ozone was calculated to be 1.39 minutes.**

Treated water is injected into the lagoon through a series of diffusers located along the shores and down the middle of the lagoon to promote mixing and even distribution of treated water into the lagoon. Ozone will have had a longer contact time before entering the lagoon at inlets further from the ozone injection point. However, to be conservative, the closest inlet was chosen to calculate ozone contact time.

3.6. Ozone CT Values and Microbial Inactivation

As shown in **Table 2.2**, the majority of microorganisms including viruses and *Giardia* cysts will be inactivated by ozone with a CT value of 1.0 min-mg/L. However, the remaining microorganism, *Cryptosporidium,* requires a much larger CT value. To meet the EPA SWTR for *Cryptosporidium* removal using ozone disinfection, NLand Surf Park would have to provide a CT that could inactivate 99% of *Cryptosporidium*, requiring a CT of 7.8 min-mg/L. With a contact time of 1.39 minutes, the resultant residual ozone concentration would need to be 5.6 mg/L.

An estimation of the ozone dose required to maintain a 5.6 mg/L residual at the point where ozone reaches the lagoon inlets was calculated assuming (1) an initial demand of 0.5 mg/L and (2) that the ozone decays by one-third (due to contact in closed conduits without any headspace) of the initial concentration by the time it reaches the nearest inlet. Using these two assumptions, a concentration of 8.9 mg/L ozone would be required to inactivate microorganisms to the standards set in the EPA SWTR.

The ozone disinfection system currently proposed at the Nland Surf Park is not designed to inactivate microorganisms to the extent specified by the EPA SWTR drinking standards, specifically *Cryptosporidium*. With the understanding that the initial fill of the Surf Lagoon will require the greatest inactivation, and considering that the lagoon water is recirculated, it is reasonable to assume that with proper mixing in the lagoon the initial ozone demand will continue decrease with each pass through treatment until a relatively steady oxidant demand equal to that introduced by surfers is reached. As ozone dosage guidelines do not exist for Surf Lagoons, and the EPA SWTR assumes that microorganism inactivation with ozone is a single pass process; the appropriate dose of ozone to support an acceptable level of water quality will likely have to be determined experimentally and through field measurements.

To maintain water quality in the Surf Lagoon while more information is collected on the efficacy of the ozone treatment, the Surf Park should ensure that they are maintaining sufficient chlorine residual.

4. Chlorine Disinfection and Residual

This section discusses the purpose of the addition of free available chlorine (FAC) and the NLand Surf Park facilities that are provided for chlorine addition in the form of sodium hypochlorite. This section also discusses the operations needed to achieve a 0.5 mg/L and 1.0 mg/L free chlorine residual in the Surf Lagoon.

4.1. Purpose of Chlorine Disinfection and Residual

Chlorine disinfection is the process of adding chlorine to a treatment stream (either in the form of a solution such as sodium hypochlorite, a solid such as calcium hypochlorite, or as chlorine gas) with the purpose of inactivating microorganisms and improving water quality. Chlorine is typically added to swimming pools to maintain a free available chlorine residual.

Free available chlorine residual is the amount of chlorine in the pool available to disinfect after the initial oxidant demand has been satisfied and initial microbial inactivation has occurred. This residual chlorine concentration protects swimmers from additional microbial contamination coming, primarily, from other bathers. This microbial contamination can be from microorganisms passively shed by bathers, or by accidental releases from bathers such as vomiting or diarrhea.

4.2. Design Chlorine Residual

Influent water quality is an important consideration in determining chlorine dosage. Similar to ozone, there is an initial oxidant demand due to the quick, almost instantaneous reactions of chlorine with organic matter and some inorganic chemical compounds. Additionally, as outdoor swimming pools are open to the environment, losses of residual chlorine can also occur due to UV degradation. The chlorine dose must be sufficient to overcome the initial oxidant demand and any losses due to UV radiation and still provide the desired residual concentration.

NLand Surf Park plans to utilize a 10.5% sodium hypochlorite solution for chlorine disinfection. For the purposes of this report the solution will be stored in a 4,000 gallon tank and pumped into the treatment stream using two chemical metering pumps each with a capacity of 0.48 to 480 gallons per day (combined capacity of 0.96 to 960 gallons per day). Utilizing both metering pumps, **the minimum and maximum chlorine dose that can be provided into the 11,800 gpm treatment stream is 5.8 µg Cl_2/L and 5.8 mg Cl_2/L, respectively**.

As construction nears completion, an alternative chlorine feed system is being considered. This alternate system utilizes two chlorine feed pumps each with a capacity of up to 2,400 gal/day with the intent to have one (primary) pump in operation with the other as back-up incase the primary pump fails. The proposed chlorine solution strength and storage would remain unchanged. **With the alternate chlorine feed rate of 2,400 gal/day, the maximum chlorine dose that could be provided into the 11,800 gpm treatment stream is 14.6 mg Cl_2/L.**

The dose of chlorine that NLand Surf Park will need to apply to maintain a desired residual can be estimated using the following formula:

$$Chlorine\ Dose \left(\frac{mg}{L}\right) = Residual \left(\frac{mg}{L}\right) + Initial\ Demand \left(\frac{mg}{L}\right) + UV\ Degradation \left(\frac{mg}{L}\right) \quad \textbf{(Equation 4-1)}$$

Using the equation above, the initial oxidant demand present to consume chlorine is assumed to be relatively low because of the ozone treatment applied upstream of the chlorine injection point. For the purposes of identifying the required chlorine dose for the Nland Surf Park to maintain a 0.5 mg/L and 1.0 mg/L chlorine residual in the lagoon, the initial demand was assumed to be 0.5 mg/L.

The Surf Lagoon is a 11,607,617 gallon body of water, open to the atmosphere, and subject to chlorine degradation due to UV radiation. The losses of chlorine due to UV degradation can be approximated as 0.5 mg/L per hour (White, 1992). Given the volume of the lagoon (11,607,617 gallons) and estimating that the sun is out for a maximum of 14 hours per day, a calculated 307,580 grams of chlorine per day could be lost to UV degradation. This equates to an hourly average concentration of 4.7 mg/L. It is important to note, however, that this hourly concentration was averaged over 24 hours and that over the course of the day UV degradation will be greater during sunlight hours and negligible during dark hours.

Based on the above data and using **Equation 4-1**, the chlorine dose required to achieve a chlorine residual of 0.5 mg/L and 1.0 mg/L in the lagoon was calculated as follows:

For a residual concentration of 0.5 mg/L:

$$Chlorine\ Dose \left(\frac{mg}{L}\right) = 0.5\frac{mg}{L}\ Residual + 0.5\frac{mg}{L} Initial\ Demand + 4.7\frac{mg}{L} UV\ Degredation = \mathbf{5.7\frac{mg}{L}}$$

For a residual concentration of 1.0 mg/L:

$$Chlorine\ Dose \left(\frac{mg}{L}\right) = 1.0\frac{mg}{L}\ Residual + 0.5\frac{mg}{L} Initial\ Demand + 4.7\frac{mg}{L} UV\ Degredation = \mathbf{6.2\frac{mg}{L}}$$

4.3. Chlorine Residual Maintenance

Chlorine residual concentrations will be continuously monitored at NLand Surf Park using ORP meters as discussed in **Section 3.3.** The ORP meter upstream of ozone injection will provide an estimate of the chlorine residual concentration in the lagoon by measuring the oxidants present in the recirculated water. The higher the ORP reading, the more oxidants are present. In addition to ORP monitoring, several grab samples per day from multiple locations within the Surf Lagoon will be collected and analyzed for residual chlorine concentration. The number of samples and locations will be coordinated between the Surf Park and the regulatory agencies. These residual measurements serve to demonstrate adherence to the regulatory requirements while the ORP is used to control the dosing process.

It is important that grab samples for residual chlorine monitoring be taken from various locations within the Surf Lagoon so that the measurements are representative of the entire lagoon. A Computational Fluid Dynamics (CFD) model of the lagoon could be a useful tool in determining the mixing profile of the lagoon, and therefore appropriate sampling locations. It is likely, however, that the lagoon is relatively well mixed due to the wave action of the lagoon, along with the multiple inlet and outlet locations.

5. Surfer Loading in Surf Lagoon and Turnover Rates

This section discusses the bather load and turnover rate of the NLand Surf Park. Comparisons are made between the proposed bather load and turnover rate of the NLand Surf Park Surf Lagoon and regulatory bather loads and turnover rates for swimming pools.

5.1. Purpose of Turnover Rate Guidelines and Relationship to Bather Load

Regulations for turnover rate are established for swimming pools as the circulation rate of water through a swimming facility can have a substantial impact on water quality. The slower the turnover rate is, the longer the pool has to accumulate contaminants between treatment cycles. After the initial fill water routes through the treatment process, and as the lagoon water is recirculated through the treatment process daily, the main contribution to lagoon contamination comes from the surfers. The NLand Surf Park proposes a substantially lower bather load per available square foot of lagoon than specified in the governing regulations. Due to the low number of planned users and the large surface area of the lagoon, it is assumed that the lagoon water quality will remain relatively constant between complete recirculation events, despite the longer turnover rate proposed.

5.2. Regulatory Bather Load for NLand Surf Park

Bather loads, as presented in applicable regulations and guidelines, are determined based on the type of swimming pool facility or the depth of the pool (see **Table 2.3**). These regulations provide a surface area of water that must be provided per person ranging from 10 square feet (in the MAHC for hot water pools/spas) to 300 square feet (in the TAC for diving areas). The bather load for a pool is calculated as the surface area of the pool divided by this per bather surface area. Based on the TAC, the majority of NLand Surf Park's Surf Lagoon would likely be classified as a "Shallow/Instructional or Beginning or Wading Areas" with portions of the lagoon possibly being more related to the "Deep Area (Not Including Diving Area)" classification. To be conservative, the per bather surface area associated with the "Deep Area (Not Including Diving Area)" classification, 25 square feet per user, was used to calculate the TAC compliant maximum bather load for the NLand Surf Lagoon. **Using this per bather surface area, the maximum capacity of the Surf Lagoon would be 19,500 bathers.** As a point of reference, an Olympic sized swimming pool (50m long by 25 meters wide) would have a maximum capacity under the same regulation of 540 bathers, and standard small (~200 square feet) and large (~1,000 square feet) residential swimming pools would have a maximum capacity of 8 and 40 bathers, respectively.

5.3. NLand Surf Park Design Surfer Loading

The design maximum bather load for NLand Surf Park is 200 surfers during normal operations. This is approximately 100 times fewer surfers than the allowed maximum capacity for the Surf Park based on the TAC as discussed in **Section 5.2.**

5.4. Regulatory Turnover Rate for NLand Surf Park

Based on the TAC regulation for swimming pool turnover rates (**Table 2.4**) the turnover rate that the NLand Surf Park should achieve to comply with TAC code is described by the following equation:

$$Turnover\ Rate\ (hr) = Average\ Pool\ Depth\ (ft) x\ 1.5 \qquad \textbf{(Equation 4-2)}$$

The average depth of the NLand Surf Lagoon is calculated as the volume of the lagoon (11,607,617 gallons) divided by the surface area (487,960 square feet) and is equivalent to 3.2 feet. Using **Equation 4-2**, an average depth of 3.2 feet requires a turnover rate of 4.8 hours to comply with the TAC.

This turnover rate is based on 100 times the bather load used for the operation of the Surf Lagoon. One could assume that since the bather load in the Surf Lagoon is 1/100th of what is allowed, the contamination of the lagoon water from surfers could also be assumed to be closer to 1/100th of what is allowed. Assuming this proportionality to be true, the lagoon turnover rate at the NLand Surf Park could be as much as 480 (=4.8*100) hours. The actual turnover rate of the Surf Lagoon is estimated to be about 17 hours and is much smaller than that estimated by bather loading proportionality.

5.5. Design Turnover Rates of Surf Park

The design turnover rate for NLand Surf Park is approximately 17 hours given the large volume of the Surf Lagoon and the flow rate through the onsite treatment facility. This turnover rate is longer than the turnover rate calculated using the TAC turnover rate guidelines as discussed in **Section 5.4.** However, the NLand Surf Lagoon is not a typical swimming pool given the massive surface area and volume of the lagoon.

Due to the large volume of the Surf Lagoon and low surfer loading rate, and assuming complete mixing of the treated, recirculated water, it is understood that the water quality of the lagoon will be adequate to support a longer turnover rate. The Model Aquatic Health Code remarks that, “the authority having jurisdiction may grant a turnover time variance for aquatic venues with extreme volume or operating conditions based on proper engineering justification” suggesting that a modification to the regulatory turnover rates may be suitable for atypical pools (HHS/CDC, 2014). Routine monitoring of the chlorine residual and demonstration that the required residual is maintained will further support that a longer turnover rate is adequate to maintain the desired water quality in the lagoon.

6. Conclusions

According to the WHO Guidelines for Safe Recreational Water Environments, maintaining a 0.5 mg/L chlorine residual, when combined with ozone disinfection will ensure that recreational water is adequately disinfected. However, information on the required ozone and chlorine dosages to achieve this desired residual are not provided in the guidelines/regulations. This report has performed an evaluation of the ozone/chlorine disinfection system at NLand Surf Park to determine its ability to provide the desired water quality established by the regulations in an equivalent manner as chlorine disinfection alone. The EPA SWTR was used as a reference to verify this because it defines the required CT times and residuals required for a surface water to meet drinking water quality standards. Using the EPA SWTR as the comparison regulation is a conservative approach to verification because the SWTR does not take into account multiple passes through a treatment system, and instead dictates the microbial disinfection required for a single pass treatment system.

The ozone system currently in place at NLand Surf Park, alone, does not provide adequate ozone doses to meet the EPA SWTR requirements. However, per the WHO, ozone disinfection used in conjunction with chlorine addition to maintain a residual chlorine concentration of 0.5 mg/L would provide adequate water quality for a recreational water environment. The Surf Park has the facilities to add chlorine to the recirculated water after ozone treatment at a dose that is sufficient to maintain a chlorine residual of 0.5 mg/L using the assumptions outlined in this report. **Maintaining this desired residual during daily park operations, coupled with the low surfer load, large water volume, and recirculation of the lagoon water through the treatment system every 17 hours should provide a water quality consistent with the intent of the WHO guidelines and the HHS/CDC Model Aquatic Health Code.**

This report considered the capacity of the designed chlorine disinfection system when verifying the anticipated chlorine residual remaining in the Surf Lagoon. Utilizing the recommendations of the WHO regarding disinfection with ozone, followed by chlorine, the desired residual is 0.5 mg/L. However, during construction an alternate, larger capacity chlorine feed system is being considered. A brief review of the larger capacity system followed to determine the anticipated chlorine residual given the assumptions utilized throughout this report. Implementing the larger capacity chlorine feed pumps, in conjunction with the designed 10.5% sodium hypochlorite solution, appears to provide the capacity for the Surf Park to maintain a 1.0 mg/L chlorine residual in the Surf Lagoon. Implementing this change during construction results in more frequent deliveries of sodium hypochlorite, but no change to the storage capacity is required if the frequency of chemical delivery is not an issue. Alternatively, utilizing a 12.5% sodium hypochlorite solution with the designed chlorine feed pumps (combined pump rate of 960 gpd) would provide a dose of 7.0 mg/L which would also be sufficient to provide a 1.0 mg/L chlorine residual within the lagoon, according to the assumptions in this report. Ultimately, purchase of the chemical feed pumps and the concentration of sodium hypochlorite solution is left to the Owner for consideration. In either case, it appears feasible to meet the WHO recommendations for chlorine residual.

Over the course of daily operations at the surf park, additional data can be collected and monitored, using the routine, residual grab samples and the constant ORP measurements to further define the efficacy of the ozone treatment system. It is feasible that as the park operates over an extended period of time, the amount of chlorine dose required to maintain the specified residual may diminish due to the upstream ozone treatment. This collected data could then be used by other facilities wishing to utilize ozone for disinfection.

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