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Rob H

RECEIVED
MAR 23 2012
Utah Division of Water Quality

March 21, 2012

Mr. Rob Herbert, P.G., Manager
Groundwater Protection Section
Division of Water Quality
Utah Department of Environmental Quality
P.O. Box 144870
Salt Lake City, Utah 84114-4870

Subject: ***Schreiber Foods, Inc. Proposed Evaporation Wetlands Predesign Report***
Schreiber Foods Cheese Plant
2180 West 6550 North
Amalga, Utah 84335-9677
BIO-WEST Project No: 1016.8

Dear Mr. Herbert:

BIO-WEST, Inc. (BIO-WEST), has been contracted by Schreiber Foods, Inc. (Schreiber), to oversee the design and construction of an evaporation wetland area for the Schreiber cheese plant located in Amalga, Utah. Our subcontractor, Cartwright Engineering, will be responsible for tasks related to surveying, geotechnical soils testing, grading plans, berm engineering, and compaction specifications. The need has arisen for Schreiber to dispose of additional wastewater from their cheese manufacturing operation. Schreiber is planning to construct an evaporation wetland area on a portion of the 110-acre land application site located adjacent to the Schreiber wastewater lagoons. Discussions with the Utah Division of Water Quality (DWQ) revealed that a predesign report was required because Schreiber wants to incorporate emerging, innovative, and alternate technologies for treatment and disposal of wastewater. A vicinity map (Figure 1), site map (Figure 2), and topographic survey map (Figure 3) showing the proposed evaporation wetlands design is included as Attachment 1.

This letter provides information about the construction of the proposed evaporation wetlands and is intended to satisfy the predesign report criteria. This Predesign Report should be reviewed concurrently with the Groundwater Discharge Report dated March 14, 2012, previously submitted to the Utah DWQ.

DW

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Summary of Process Design Criteria

The proposed evaporation wetlands are designed to provide additional wastewater storage and disposal through evapotranspiration for the Schreiber Amalga cheese plant. The proposed evaporation wetlands are designed to provide the greatest amount of surface area available for evapotranspiration while avoiding any impacts to the natural wetlands on the property or any surface water in the area. The design also includes berm heights and water depths below dam thresholds to avoid dam regulations.

Basis of Design

The proposed evaporation wetlands are designed to provide wastewater storage while preventing any impacts to existing natural wetlands located on the property or any surface water located in the area. The area is covered by a layer of Holocene to Uppermost Pleistocene sedimentary deposits of silt, clay, and minor sand from alluvial (flowing water), lacustrine (lake), or paludal (marsh) processes younger than Lake Bonneville deposits (Solomon 1999). These younger deposits commonly overlay, grade into, and consist of older reworked Lake Bonneville deposits. The typical thickness of these deposits is 3 to 10 feet (Solomon 1999). The underlying Lake Bonneville sediments consist of silt, clay, and minor fine grained sand. The estimated maximum thickness of this layer is approximately 50 feet (Solomon 1999). Because of the impermeability of this layer there is likely little to no hydraulic connection between the shallow, unconfined aquifer in the area and deeper aquifers. If there is a connection between the shallow, unconfined aquifer and deeper aquifers it is likely that groundwater flows in a upward direction from the deeper aquifers to the shallow, unconfined aquifer because the projects proposed location within a discharge zone. This Lake Bonneville sediment layer will act as a liner for the proposed evaporation wetlands.

Any natural wetland areas located within the proposed evaporation wetlands will be isolated from the evaporation wetlands by earthen berms approximately 2 feet tall by 10 feet wide with a 10-foot-wide buffer zone. The earthern berms will be constructed from native material excavated at the project site and will be compacted to engineered specifications as determined by geotechnical testing of the soil and associated geotechnical engineering recommendations.

Process and Hydraulic Profiles

Wastewater from cell 4 of the Schreiber wastewater treatment lagoons will be used to flood the proposed evaporation wetlands because it is the most highly treated and has the best water quality. Wastewater will be pumped from cell 4 of the wastewater treatment lagoons and discharged onto the proposed evaporation wetlands using an existing 4-inch sprinkler line with risers. A summary of the 2011 cell 4 wastewater quality sampling results is shown in Table 1. Each sample from cell 4 was analyzed for biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), nitrate-nitrite as N, total Kjeldahl nitrogen (TKN), total phosphorus, and pH. Laboratory analytical reports are included in Attachment 2.

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Table 1. Cell 4 Wastewater Sampling Analytical Results, 2011.

SAMPLE DATE	pH	TDS (mg/L) [a]	TSS (mg/L)	BOD (mg/L)	Nitrate-Nitrite as N (mg/L)	TKN (mg/L)	Total Phosphorus (mg/L)
7/13/2011	8.72	1,840	56.7	25	<0.1	21	12
9/2/2011	9.41	1,920	54.7	20	0.2	22	12
9/28/2011	9.01	2,220	263	121	2.2	28	13

[a] mg/L = milligrams per liter.

Approximately 39.8 acres of upland area will be flooded to an average depth of approximately 1 foot using treated wastewater from cell 4 of the lagoon system. Because of the natural slope of the land, water depths will range from 1 to 24 inches. An initial discharge of approximately 12,968,870 gallons of wastewater will be discharged into the proposed evaporation wetlands to fill the wetland to an average depth of approximately 1 foot.

After the initial discharge, wastewater from cell 4 of the lagoon system will be discharged into the evaporation wetland at a rate that will maintain an average depth of approximately 1 foot of water in the center of the evaporation wetland. Based on the average wastewater lagoons evapotranspiration rates calculated by BIO-WEST the proposed evaporation wetlands will lose approximately 121,769 gallons to evapotranspiration daily. The proposed evaporation wetlands will lose approximately 44,445,785 gallons to evapotranspiration annually. Calculations showing evapotranspiration rates are included as Attachment 3.

Based on the soil infiltration rate for the adjacent wastewater lagoons of 0.008 inch of water per day (Brown and Caldwell 2004), approximately 8,646 gallons of wastewater will infiltrate into the soil daily from the proposed evaporation wetlands. The Brown and Caldwell report (2004) does not include the assumptions and variables used to calculate this infiltration rate. Based on observed soil types in the area, BIO-WEST calculations show a much smaller volume of water infiltrating into the soil.

During the construction of the proposed evaporation wetlands, BIO-WEST will conduct infiltration tests on the soil. The infiltration tests will be conducted using a dual ring infiltrometer according to the protocols documented by the American Society for Testing and Materials. Infiltration rates obtained from these infiltration tests will be used to refine the calculated volume of water that is infiltrating the evaporation wetland soil.

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Outline of All Appurtenant Facilities
Wastewater will be pumped from cell 4 of the wastewater treatment lagoons using an existing pump located on the southeast corner of the wastewater treatment lagoons. The wastewater will be applied to the proposed evaporation wetlands using pipes connected to an existing 4-inch sprinkler line. Valves are in place on the sprinkler line to control wastewater flow.

Supporting Information
Groundwater TDS levels in this part of Cache Valley are naturally high (Lowe et al. 2003). BIO-WEST has documented TDS concentrations as high as 44,000 milligrams per liter (mg/L) in monitor well MW-2 on the 110-acre land application site, however, TDS concentrations in the other monitor wells on both land application sites range from 8,500 to 18,000 mg/L. Because of the poor water quality in the area, wastewater infiltrating into the soil from the proposed evaporation wetlands has lower TDS concentrations than background concentrations within the shallow, unconfined aquifer. Schreiber is going to install an additional six monitor wells, in addition to the two monitor wells already in place on the property to monitor groundwater quality in the area. Background samples will be collected before any wastewater is discharged into proposed evaporation wetlands to document background concentrations of TDS, nitrate-nitrite as N, TKN, pH, and total soluble phosphorus. The 110-acre land application site monitor wells will be sampled monthly for 2 months after the discharge of wastewater to the evaporation wetlands has occurred. After the monthly sampling the monitor wells will be sampled on a quarterly basis for 2 quarters in 2012. After the quarterly sampling the monitor wells will be sampled on an annual basis in 2013 and beyond. Additional information regarding the project site location and hydrogeologic conditions at the proposed evaporation wetlands is located in the Schreiber Groundwater Discharge application dated March 14, 2012, previously submitted to the Utah DWQ.

The Utah DWQ has expressed the concern that wastewater from the proposed evaporation wetlands could enter the shallow, unconfined aquifer and discharge into nearby surface water. The primary surface water of concern is the natural wetland located adjacent to the southern boundary of the proposed evaporation wetlands. BIO-WEST performed groundwater velocity calculations to estimate the amount of time that it would take for water in the proposed evaporation wetlands to flow as groundwater into the adjacent natural wetlands. BIO-WEST also performed calculations to determine the daily volume of wastewater that could potentially flow from the proposed evaporation wetlands to the natural wetlands. This volume of water was then used in conjunction with TKN and phosphorus sampling data to estimate the potential annual load of these constituents into the adjacent natural wetlands from the proposed evaporation wetlands. These loads were then compared with current annual loads of nitrogen and phosphorus from Clay Slough into Cutler Reservoir.

Groundwater Velocity and Travel Time from Proposed Evaporation Wetlands to Adjacent Natural Wetlands

BIO-WEST estimated the rate of groundwater flow from the proposed evaporation wetlands to the adjacent natural wetlands by using the average linear velocity equation, which is a derivative of Darcy's law (Darcy 1856). This equation calculates the average rate at which groundwater flows between two points. The average linear velocity equation is as follows:

$$v_x = -K\,I / n_e$$

where

v_x	is the average linear velocity (feet/day)
K	is the hydraulic conductivity (feet/day)
I	is the hydraulic gradient between the proposed evaporation wetlands and the adjacent natural wetlands (feet/feet)
n_e	is the effective porosity (percent)

The hydraulic conductivity value used in this equation was based on published values for silty clay, which ranges between 10^{-3} and 10^{-4} feet/day (Heath 1983). The hydraulic conductivity of silty clay was used because this type of sediment was observed in the past while drilling three other wells near the project site (BIO-WEST 2006). Therefore, an average hydraulic conductivity value of $10^{-3.5}$ feet/day was used in this equation, although calculations were also performed using hydraulic conductivity values of 10^{-3} feet/day and 10^{-4} feet/day to better determine the possible range of groundwater velocity.

The effective porosity value used in the groundwater velocity equation was based on published values for clay and silt. Effective porosity of clay, as presented by McWorter and Sunada (1977), ranges between 0.01–0.18 with an arithmetic mean of 0.06, and the effective porosity of silt ranges between 0.01–0.39 with an arithmetic mean of 0.20. After considering these values, it was determined that the upper range value of clay (0.18) would provide a representative value of a silty clay.

The hydraulic gradient between the proposed evaporation wetlands and the natural wetlands was determined based on a detailed topographic survey of the project site and Schreiber's plans for storage in the proposed evaporation wetlands. The highest hydraulic gradient from the proposed evaporation wetlands to the natural wetlands would exist in the southern portion of the project site because of its close proximity to the natural wetlands; the elevations of this area were used to determine the maximum hydraulic gradient. The elevation of the portion of the project site closest to the wetlands is 4,417.2 feet above mean sea level (amsl), and a water depth of approximately 1.5 feet within the deeper portions of the evaporation wetlands is anticipated. Water depth would be shallower in much of the other portions of the project site and may be slightly deeper next to the western berm (2 feet maximum). Based on this information, the water level of the southern portion of the proposed evaporation wetlands would be 4,418.7 feet amsl. The topographic survey identified the water surface elevation of the adjacent natural wetlands at 4,416.65 feet amsl. The distance between these points was 20 feet. With a head difference between these points of 2.05 feet and a distance of 20 feet, the resulting hydraulic gradient was 0.1025 vertical foot per horizontal foot (feet/feet).

After determining the aforementioned variables to the average linear velocity equation, it was possible to calculate groundwater velocity from the proposed evaporation wetlands to the adjacent natural wetlands. The groundwater velocities at high (10^{-3} feet/day), average ($10^{-3.5}$ feet/day), and low (10^{-4} feet/day) hydraulic conductivities were calculated. The high hydraulic conductivity value resulted in a groundwater velocity of 0.21 feet/year, the average value resulted in a groundwater velocity of 0.07 feet/year, and the low value resulted in a groundwater velocity of 0.02 feet/year. Using these velocities and the distance between the proposed evaporation wetlands and adjacent natural wetlands, the following groundwater travel times between these points were calculated: 96.2 years at the highest velocity, 304 years at the average velocity, and 962 years at the lowest velocity. These travel times are the fastest possible groundwater travel times from the proposed evaporation wetlands to the natural wetlands since the majority of the proposed evaporation wetlands are located farther than 20 feet from natural wetlands with surface water.

<u>Daily Discharge Volumes and Nutrient Loads from Proposed Evaporation Wetlands to Adjacent Natural Wetlands</u>

The estimated load of TKN and phosphorus was calculated by first determining the daily discharge from the proposed evaporation wetlands to the adjacent natural wetlands, which was determined using Darcy's law (Darcy 1856). An outline of these calculations is included in Attachment 4. Darcy's law is as follows:

$$Q = -K I A$$

where

Q	is the discharge (cubic feet/day)
K	is the hydraulic conductivity (feet/day)
I	is the hydraulic gradient (feet/feet)
A	is the cross-sectional aquifer area (square feet)

The hydraulic conductivity values and hydraulic gradient value used to solve this equation were the same values as those mentioned in the previous section. The cross-sectional area used in this equation was a calculated area per linear foot of berm. Well logs from borings previously drilled near the project site showed that the silty clay layer was present from the ground surface to an average depth of 4.7 feet, and that clay was present below this layer. Therefore, the cross-sectional area per linear foot of berm value used in the Darcy's law equation was 4.7 square feet.

After determining the aforementioned variables to the Darcy's law equation, it was possible to calculate daily groundwater discharge from the proposed evaporation wetlands to the adjacent natural wetlands per linear foot of berm. These values were then multiplied by the total "leachable berm length" to determine the total daily discharge from the proposed evaporation wetlands. The sections of leachable berm were determined to be the northern, southern, and western roughly rectangular evaporation wetland boundary, which is 5,240 feet long. The leachable berm length did not include all of the various turns and fingers of the berm because the groundwater in the subsurface flows independently from these turns. The eastern boundary was not considered to be leachable because it will border the existing wastewater lagoons. The leachable length of the southern berm is approximately 1,240 feet. This is the only section of the berm that is adjacent to surface water. The natural wetlands to the west and north of the berms do not contain surface water except as the result of storm-water runoff. Using 5,240 feet of leachable berm provides a "worst case" volume. A more conservative volume could have been calculated using 1,240 feet of leachable berm.

By multiplying the groundwater discharge per linear foot of leachable berm by the leachable berm length, the total daily discharge from the proposed evaporation wetlands to the natural wetlands was calculated. At a high hydraulic conductivity (10^{-3} feet/day), the daily discharge would be 19.0 gallons/day, at a medium hydraulic conductivity ($10^{-3.5}$ feet/day), the daily discharge would be 6.0 gallons/day, and at a low hydraulic conductivity (10^{-4} feet/day), the daily discharge would be 1.9 gallons/day.

The annual loads of total phosphorus and TKN were then calculated based on discharge from the proposed evaporation wetlands to the natural wetlands and existing concentrations of these nutrient constituents in Schreiber's wastewater. Using the results from the most recent wastewater lagoons cell 4 sampling event in September 2011, the daily discharge under average hydraulic conductivity conditions was multiplied by the total phosphorus and TKN concentrations measured in the wastewater and converted to an annual load. This yielded a TKN annual load of 0.231 kilograms/year and a total phosphorus annual load of 0.107 kilograms/year from the proposed evaporation wetlands to the adjacent natural wetlands. These values represent high load estimates since the hydraulic gradient used in these calculations was most likely higher than the actual hydraulic gradient throughout the majority of the project site. Additionally, based on the groundwater velocity calculations performed in the previous section, it is likely that it would take approximately 100 years or more for these loads to reach the adjacent natural wetlands. These calculations also ignored any attenuation factors, such as plant uptake and absorption, that would reduce total phosphorus and TKN loads to the adjacent natural wetlands.

The estimated annual total phosphorus and TKN loads from the proposed evaporation wetlands to the adjacent natural wetlands were compared with the annual loads of total nitrogen and total phosphorus into Cutler Reservoir from Clay Slough, as reported in the Cutler Reservoir Total Maximum Daily Load report (SWCA Environmental Consultants 2010). By using the seasonal flow of Clay Slough into Cutler Reservoir and the seasonal average nitrogen and phosphorus concentrations in Clay Slough, it was possible to calculate the annual load of these constituents from Clay Slough into Cutler Reservoir. The annual load of total phosphorus from Clay Slough to Cutler Reservoir was 8,871.8 kilograms and the annual load of total nitrogen from Clay Slough to Cutler Reservoir was 6,997.9 kilograms. These calculations are included in Attachment 5. The additional nitrogen load from the proposed evaporation wetlands to the adjacent natural wetlands would represent an increase of 0.003 percent, and the additional phosphorus load would represent an increase of 0.001 percent, assuming all of the groundwater discharged to the southwest wetlands and no attenuation took place. As previously noted, only part of the berms are located immediately adjacent to surface water, so these calculations are biased high.

<u>Groundwater Discharge Summary</u>

Groundwater velocity, discharge, and annual total phosphorus and TKN load calculations from the proposed evaporation wetlands to the adjacent natural wetlands were performed. The groundwater velocity calculations showed that by using an average hydraulic conductivity value for silty clay, it would take wastewater from the proposed evaporation wetlands approximately 300 years to flow as groundwater to the adjacent natural wetlands. The discharge calculations showed that when water from the proposed evaporation wetlands eventually flowed into the adjacent natural wetlands, a daily discharge of approximately 6 gallons could be expected to flow into the wetlands if all of the water discharged into surface water in the adjacent natural wetlands. The nutrient load calculations showed that this daily discharge would result in maximum theoretical annual loads of approximately 0.231 kilograms of TKN and 0.107 kilograms of total phosphorus to the adjacent natural wetlands, but that actual loads would be significantly less. It is likely that the velocity, discharge, and load calculations are all biased high, since the maximum hydraulic gradient at the project site and no attenuation factors were used in these calculations. Based on the substantial travel time, minor daily discharge, and minor annual total phosphorus and TKN loads from the proposed evaporation wetlands to the adjacent natural wetlands, construction of the proposed evaporation wetlands would have a negligible impact on the adjacent natural wetlands.

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BIO-WEST will conduct slug tests on three of the monitor wells before any wastewater is discharged onto the proposed evaporation wetlands. The slug tests will be used to determine the transmissivity and hydraulic conductivity of the shallow unconfined aquifer in the area. For each test a solid slug or known amount of water will be added to the well and the rate at which the water level in the well falls will be recorded using a pressure transducer. Once the water level in the well has returned to static conditions the slug or a known amount of water will be removed from the well and the rate at which the water level in the well rises will be recorded using a pressure transducer. The data collected from the slug tests will be used to determine the aquifer's transmissivity and hydraulic conductivity, as well as refine the horizontal velocity of groundwater movement and the existing flux of nutrients through the groundwater system calculations.

Conclusions

The proposed evaporation wetlands are designed to meet the additional storage and disposal needs of Schreiber while avoiding any direct impacts to natural wetlands on the property or surface water in the area. The proposed evaporation wetlands will be properly engineered and constructed to specifications designed by Cartwright Engineering. The proposed evaporation wetlands will not have any adverse impacts on groundwater or surface water quality in the area.

References

[BIO-WEST] BIO-WEST, Inc. 2006. Hydrogeological investigation of the shallow aquifer at the Earl Lindley Property Land Application Site. Project No. 1016.

Brown and Caldwell. 2004. Evaluation of wastewater facilities. Smithfield (Utah): Dairy Farmers of America. 30 p.

Darcy, H. 1856. Les fontaines publiques de la ville de Dijon. Paris: Victor Dalmont.

Heath, R.C. 1983. Basic ground-water hydrology. U.S. Geological Survey Water-Supply Paper 2220, 86 p.

Lowe, M., J. Wallace, and C.E. Bishop, 2003. Groundwater quality classification and recommended septic tank soil absorption system density maps, Cache Valley, Cache County, Utah. Salt Lake City (Utah): Utah Geological Survey, Special Study 101. 31 p.

McWorter, D.B., and D.K. Sunada, 1977. Groundwater hydrology and hydraulics. Fort Collins (Colorado): Water Resources Publications.

Solomon, B.J. 1999. Surficial geologic map of the West Cache Fault Zone and nearby faults, Box Elder and Cache Counties, Utah. Salt Lake City (Utah): Utah Geological Survey, Final Technical Report, National Earthquake Hazard Reduction Program Objective II.5. 20 p.

SWCA Environmental Consultants. 2010. Middle Bear River and Cutler Reservoir total maximum daily load. Prepared for Utah Division of Water Quality. 236 p.

Time is of the essence for this project as the Schreiber wastewater lagoons are anticipated to reach capacity in May 2012. Installation of additional monitor wells and geotechnical soil testing is scheduled to occur the week of March 26, 2012. A site visit could be scheduled to familiarize Utah DWQ personnel with the project site.

If you have questions or comments, please contact me at (435) 752-4202.

Sincerely,

Wes Thompson, P.G.
Principal Hydrogeologist

WESLEY KENT THOMPSON
LICENSE NUMBER
5540557
3-15-2012
STATE OF UTAH
LICENSED PROFESSIONAL GEOLOGIST

Attachment 1: Figures

Attachment 2: Laboratory Analytical Reports

Attachment 3: Evapotranspiration Calculations

Attachment 4: Groundwater Discharge and Load Calculation Summary

Attachment 5: Clay Slough Load Calculations

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Attachment 1:

Figures

Figure 1
Vicinity Map
Schreiber Foods 110-acre
Land Application Site
3000 West 7000 North
Amalga, Utah

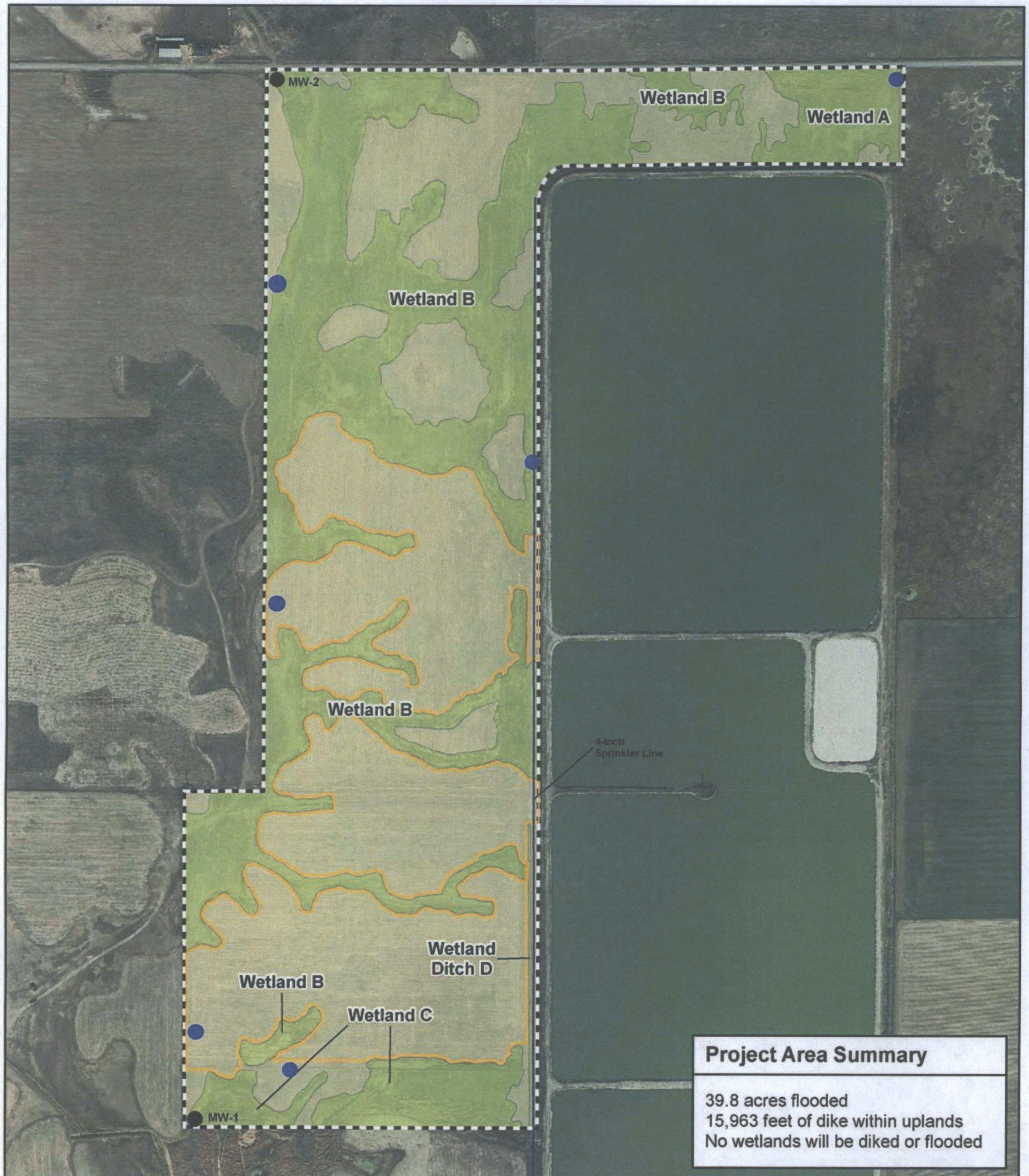

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Figure 2
Site Map
Schreiber Foods 110 Acre Land Application Site
3000 West 7000 North
Amalga, Utah

N

0 250 500 1,000 Feet

Existing Monitor Well
Proposed Monitor Well
Proposed Dike Area
Upland
Project Boundary
Wetland

Aerial Imagery from ESRI (2009 HRO - 1 Foot)
Map dated February 23, 2012

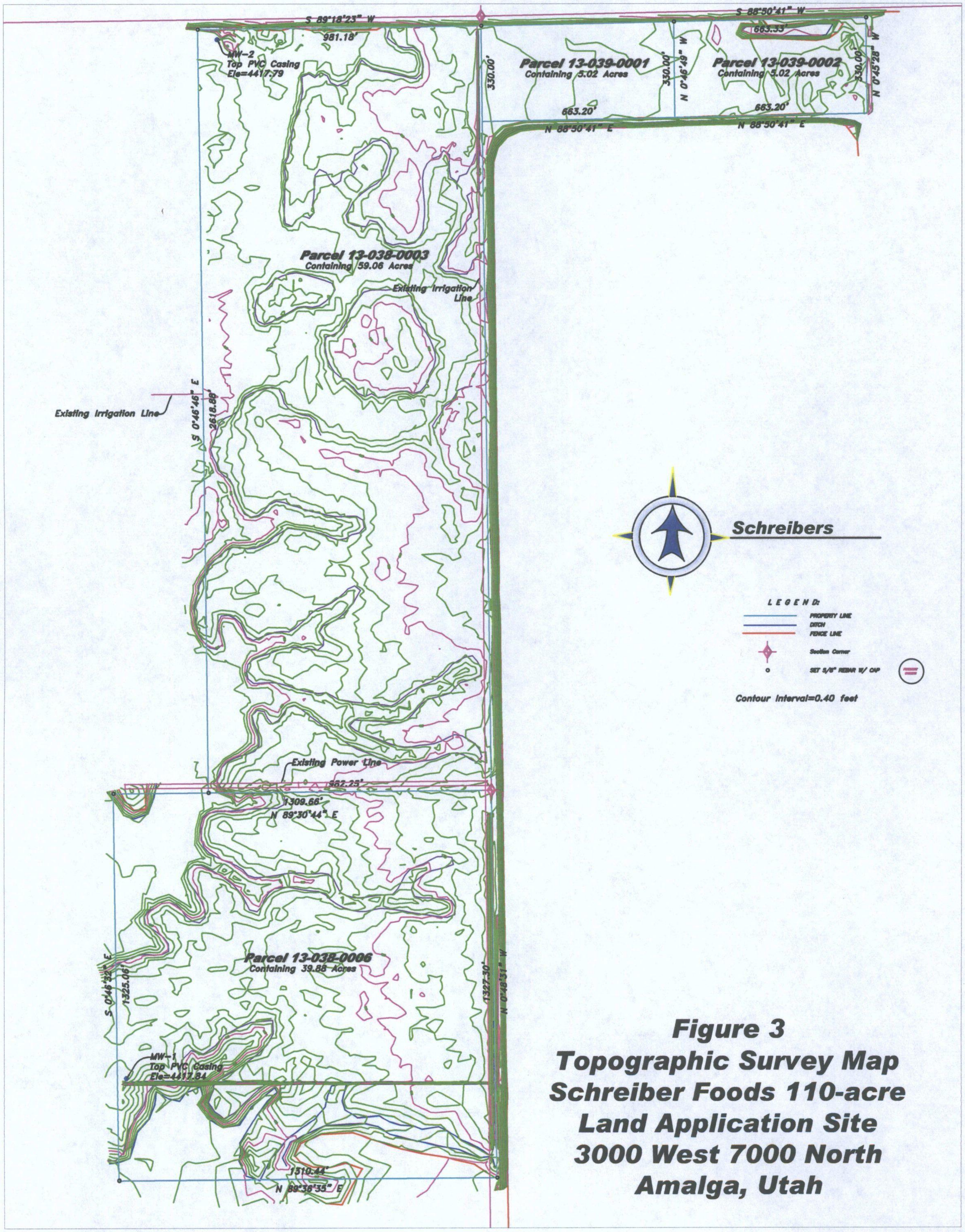

Figure 3
Topographic Survey Map
Schreiber Foods 110-acre
Land Application Site
3000 West 7000 North
Amalga, Utah

BIO-WEST, Inc.

Attachment 2:

Laboratory Analytical Reports

Symbiotics, LLC.

975 South State Highway
Logan, UT 84321
435-752-2580

LABORATORY RESULTS

July 25, 2011

Schreiber Foods
ATTN: Paul Bytheway
2180 W 6550 N
Smithfield, UT 84335

Group #: 2011271

Sample Date: July 13, 2011
Sample Time: 09:00

Date Received: July 13, 2011
Time Received: 09:15

Sample Location: Cell 4

Receiving Temperature (°C): 25.0
pH of preserved sample: <2
Log Number: 110738

PARAMETER	RESULT	UNITS	RL*	STD Methods (18th Ed)	DATE/TIME ANALYZED	ANALYZER INITIALS
pH (at 24.4°C)	**8.72**	SU		4500-H+B	07/13, 09:23	RW
BOD_5	**<25**	mg/L	1	5210B	07/13, 12:00	SW
Total Suspended Solids	**56.7**	mg/L	1	2540 D	07/13, 10:30	RW

RL: Reporting Limit

HEMTECH-FORD LABORATORIES

Certificate of Analysis

Lab Sample No.: 1105501-02

Name:	Symbiotics LLC	**Sample Date:**	7/13/2011 12:00 AM
Sample Site:	SFI 110738	**Receipt Date:**	7/13/2011 4:40 PM
Comments:	Cell 4 Waste	**Sampler:**	Paul Bytheway
Sample Matrix:	Wastewater	**Project:**	

Parameter	Sample Result	Minimum Reporting Limit	Units	Analysis Date/Time	Analyst Initials	Analytical Method	CAS No.	Flag
Inorganic								
Nitrite as N	ND	0.1	mg/L	7/14/2011 13:00	FAJ	SM 4500 NO2-B	14797-65-0	
Nitrate + Nitrite (Total)	ND	0.1	mg/L	7/14/2011 16:33	PNM	SM 4500 NO3-F		
Phosphorus, Total	12	0.50	mg/L	7/18/2011 14:00	TSM	SM 4500 PB5E	7723-14-0	
Total Dissolved Solids (TDS)	1840	10	mg/L	7/15/2011 14:51	JSH	SM 2540 C	TDS_LAB	
Total Kjeldahl Nitrogen	21	1	mg/L	7/19/2011 10:00	TP	SM 4500 NH3-D		

6100 South Stratler
Murray, UT 84107
801-262-7299 Office

Symbiotics, LLC.

975 South State Highway
Logan, UT 84321
435-752-2580

LABORATORY RESULTS

September 23, 2011

Schreiber
ATTN: Paul Bytheway
2180 W 6550 N
Smithfield, UT 84335

Group #: 2011347
Sample Date: September 2, 2011
Sample Time: 08:45

Date Received: September 2, 2011
Time Received: 09:07

Sample Location: Cell #4 Outlet

Receiving Temperature (°C): 19.1
pH of preserved sample: <2
Log Number: 111001

PARAMETER	RESULT	UNITS	RL*	STD Methods (18th Ed)	DATE/TIME ANALYZED	ANALYZER INITIALS
pH (at 19.7°C)	**9.41**	**SU**		4500-H+B	09/02, 09:09	SW
BOD_5	**<20**	**mg/L**	1	5210B	09/02, 11:30	RW
Total Suspended Solids	**54.7**	**mg/L**	1	2540 D	09/07, 10:30	RW

RL: Reporting Limit

CHEMTECH-FORD
LABORATORIES

Certificate of Analysis

Lab Sample No.: 1107283-02

Name:	Symbiotics LLC	***Sample Date:***	9/2/2011 12:00 AM
Sample Site:	SFI 111001	***Receipt Date:***	9/2/2011 2:20 PM
Comments:	Cell 4	***Sampler:***	Paul Bytheway
Sample Matrix:	Wastewater	***Project:***	

Parameter	Sample Result	Minimum Reporting Limit	Units	Analysis Date/Time	Analyst Initials	Analytical Method	CAS No.	Flag
Inorganic								
Nitrite as N	0.3	0.2	mg/L	9/2/2011 15:00	FAJ	SM 4500 NO2-B	14797-65-0	
Nitrate + Nitrite (Total)	0.2	0.1	mg/L	9/6/2011 12:33	PNM	SM 4500 NO3-F	CTFID10163	
Phosphorus, Total	12	0.25	mg/L	9/2/2011 18:00	TSM	SM 4500 PB5E	7723-14-0	
Total Dissolved Solids (TDS)	1920	20	mg/L	9/7/2011 14:10	JSH	SM 2540 C	CTFID10226	
Total Kjeldahl Nitrogen	22	1	mg/L	9/12/2011 12:00	TP	SM 4500 NH3-D	CTFID10234	

6100 South Stratler
Murray, UT 84107
801-262-7299 Office

Symbiotics, LLC.
975 South State Highway
Logan, UT 84321
435-752-2580

LABORATORY RESULTS

October 14, 2011

Schreiber
ATTN: Paul Bytheway
2180 W 6550 N
Smithfield, UT 84335

Group #: 2011385
Sample Date: September 28, 2011
Sample Time: 10:30

Date Received: September 28, 2011
Time Received: 11:00

Sample Location: Cell #4 Outlet

Receiving Temperature (°C): 21.2
pH of preserved sample: <2
Log Number: 111103

PARAMETER	RESULT	UNITS	RL*	STD Methods (18th Ed)	DATE/TIME ANALYZED	ANALYZER INITIALS
pH (at 21.2°C)	**9.01**	**SU**		4500-H+B	09/28, 11:30	RW
BOD_5	**121**	**mg/L**	1	5210B	09/29, 10:00	SW
Total Suspended Solids	**263**	**mg/L**	1	2540 D	09/29, 07:30	SW

RL: Reporting Limit

CHEMTECH-FORD
LABORATORIES

Certificate of Analysis

Lab Sample No.: 1108155-02

Name: Symbiotics LLC
Sample Site: SFI 111103
Comments: Schreibers Smithfield - Cell 4
Sample Matrix: Wastewater

Sample Date: 9/28/2011 10:30 AM
Receipt Date: 9/28/2011 2:30 PM
Sampler: Paul Bytheway
Project:

Parameter	Sample Result	Minimum Reporting Limit	Units	Analysis Date/Time	Analyst Initials	Analytical Method	CAS No.	Flag
Inorganic								
Nitrate as N	0.2	0.1	mg/L	9/29/2011 15:00	TSM	EPA 300.0	14797-55-8	
Nitrite as N	2.0	0.5	mg/L	9/29/2011 11:00	FAJ	SM 4500 NO2-B	14797-65-0	
Phosphorus, Total	13	0.25	mg/L	10/4/2011 13:30	TSM	SM 4500 PB5E	7723-14-0	
Total Dissolved Solids (TDS)	2220	10	mg/L	9/29/2011 15:54	JSH	SM 2540 C	CTFID10226	
Total Kjeldahl Nitrogen	28	1	mg/L	10/3/2011 12:00	TP	SM 4500 NH3-D	CTFID10234	

BIO-WEST, Inc.

Attachment 3:

Evapotranspiration Calculations

Schreiber Wastewater Wetlands
Evapotranspiration Rates
Calculated by BIO-WEST

Acres 39.8 **Square Feet** 1,733,694.77

Month	Mean 24 Hour Temp (°F)	Average Pan Evaporation (In)	Adjusted Pan/Real World Evaporation (reduced by a factor of 0.8) (In)	Adjusted Pan Evaporation (ft)	Total Monthly Evaporation (ft^3)	Total Monthly Evaporation (gal)	Total Daily Evaporation (gal)
Jan	20.8	0.00	0.00	0.0000	0.00	0.00	0.00
Feb	25.8	0.00	0.00	0.0000	0.00	0.00	0.00
Mar	36.0	3.30	2.64	0.2200	381,412.85	2,852,968.11	92,031.23
Apr	45.8	4.57	3.66	0.3047	528,199.01	3,950,928.56	131,697.62
May	54.7	6.58	5.26	0.4387	760,514.10	5,688,645.50	183,504.69
Jun	62.6	8.53	6.82	0.5687	985,894.42	7,374,490.29	245,816.34
Jul	69.7	10.08	8.06	0.6720	1,165,042.88	8,714,520.76	281,113.57
Aug	67.9	8.96	7.17	0.5973	1,035,593.67	7,746,240.68	249,878.73
Sep	57.8	5.88	4.70	0.3920	679,608.35	5,083,470.45	169,449.01
Oct	46.8	3.51	2.81	0.2340	405,684.58	3,034,520.62	97,887.76
Nov	34.3	0.00	0.00	0.0000	0.00	0.00	0.00
Dec	22.7	0.00	0.00	0.0000	0.00	0.00	0.00
Total					**5,941,949.86**	**44,445,784.96**	

Reference

Western Regional Climate Center. 3/13/2012. Climate and evaporation data for Logan, Utah. Location: http://www.wrcc.dri.edu

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Attachment 4:

Groundwater Discharge and Load Calculations Summary

Phosphorus and Nitrogen Loads from Proposed Evaporation Wetlands to Adjacent Natural Wetlands

- Calculating discharge per linear foot using Darcy's law:
  - o Darcy's law: Q = - K i A
    - § Q = discharge, K = hydraulic conductivity, i = hydraulic gradient, and A = area.
  - o Determining hydraulic conductivity (K):
    - § Well logs and hydrometer laboratory data in the area show that the upper sediment is composed of silty clay (55% clay, 40% silt, and 5% sand) (BIO-WEST 2006).
    - § Hydraulic conductivity of this sediment is approximately $10^{-3} – 10^{-4}$ ft/day (Heath 1983).
  - o Determining area per linear foot of leachable dike (A):
    - § Area = 1 ft width x *X* ft depth
    - § Depth based on well logs (MW-1, MW-2, and MW-3) from the 160-acre field. The upper silty clay unit was present at each of these locations from the surface to the following depths: MW-1: 9 ft, MW-2: 2.5 ft, and MW-3: 2.5 ft. Clay underlies the silty clay in each of these locations (BIO-WEST 2006). Obtained depth for calculations by averaging the thickness of the silty clay in these three locations.
    - § Area = 1 ft width x 4.7 ft depth = 4.7 sqaure feet per linear foot leachable dike.
  - o Determining hydraulic gradient from evaporation wetlands to natural wetlands (i):
    - § $i = (h_1 – h_2)/L$
      - · h_1 = Evaporation wetland head at southern portion of site (assumed to be 1.5 ft above ground surface [4,417.2 ft amsl], so h_1 = 4,418.7 ft amsl)
      - · h_2 = Natural wetland water level at southern portion of site (surveyed at 4416.65 ft amsl)
      - · L = Length between h_1 and h_2 (L = 20 ft)

- § i = 2.05 ft / 20 ft = 0.1025 feet/feet

- o Solving Darcy's law equation:

  - § **Q = -($10^{-3.5}$ ft/day)(4.7 ft^2)(0.1025) = 0.000152343 cubic feet/day per linear foot leachable dike**

- <u>Determining Proposed Evaporation Wetlands Daily Discharge to Natural Wetlands:</u>

  - o 5,240 feet leachable dike

    - § **Daily Discharge = 5,240 linear feet x 0.000152343 cubic feet/day = 0.7983 cubic feet/day = 6.0 gallons/day (Assumes 1.5 feet of water depth along entire dike).**

- <u>Determining Annual Total Phosphorus and TKN Loads to Natural Wetlands:</u>

  - o Converting daily discharge from gallons/day to liters/day:

    - § Daily discharge in liters/day = Daily discharge in gallons/day x 3.7854

    - § **6.0 gallons/day x 3.7854 = 22.7124 liters/day**

  - o Determining annual loads of total phosphorus and TKN:

    - § Annual Load (in kg/day) = Daily Discharge (in liters/day) x wastewater concentration (in milligrams/liter) x 0.000001 (unit conversion factor) x 365 days

    - § Annual Phosphorus Load: 22.7124 liters/day x 13 milligrams/liter x 0.000001 x 365 days = **0.107 kilograms/year**

    - § Annual TKN Load: 22.7124 liters/day x 28 milligrams/liter x 0.000001 x 365 days = **0.231 kilograms/year**

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Attachment 5:

Clay Slough Load Calculations

Annual Clay Slough Total Phosphorus and Total Nitrogen Loading to Cutler Reservoir.[a]

Season	Daily Flow (liters/day)	Total Phosphorus Concentration (milligrams/liter)	Total Nitrogen Concentration (milligrams/liter)	Total Phosphorus Load (kilograms)	Total Nitrogen Load (kilograms)
Summer Season (184 days)	43,588,000	0.621	0.2	4,980.5	1,604.0
Winter Season (181 days)	42,572,000	0.505	0.7	3,891.3	5,393.9
Annual	Not Applicable	Not Applicable	Not Applicable	8,871.8	6,997.9

[a]Daily flow and concentration source: SWCA Environmental Consultants 2010.