A-3

Evaluation of Hydraulic Performance for SCA Final Cover Design

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CALCULATION PACKAGE COVER SHEET

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EVALUATION OF HYDRAULIC PERFORMANCE FOR SCA FINAL COVER DESIGN

INTRODUCTION

This package was prepared in support of the final cover design of the Sediment Consolidation Area (SCA) for the Onondaga Lake Bottom Site, located on Wastebed 13 (WB-13). This package presents an analysis of the hydraulic performance of the proposed SCA final cover system, which includes geosynthetics and soil components. The analysis presented in this package has three main objectives:

- 1. Evaluate the infiltration rate through the proposed SCA final cover system. The infiltration rate through the cover system is used to calculate the amount of liquid to be pumped through the base liner liquid management system (LMS) after placement of the final cover of the SCA in the calculation package titled "Sump and Riser Calculations for SCA Final Cover Design".
- 2. Evaluate the impingement rate on the proposed SCA final cover system. The impingement rate on the SCA final cover system is used to calculate the thickness of the geocomposite drainage layer and spacing of 4-inch diameter drainage collection pipes required to maintain an acceptable liquid head above the final cover geomembrane liner as discussed later in this package.
- 3. Calculate the liquid head on the proposed SCA final cover system. The liquid head on the SCA final cover system is used to analyze the veneer stability of the final cover system in the calculation package titled "Veneer Stability Analyses for SCA Final Cover Design".

METHODOLOGY

The water balance analysis of the SCA final cover system was performed using the "Hydraulic Evaluation of Landfill Performance" (HELP) software, Version 3.07 developed by the U.S. Environmental Protection Agency. HELP is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of landfills. The model accepts weather, soil, and design data and accounts for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, lateral drainage, and leakage through liners [Schroeder et al., 1994]. The outputs from HELP were used to calculate the liquid head above the geomembrane

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and infiltration rate through the geomembrane as discussed below. It is noted that the HELP software is limited in only being able to model one slope per simulation.

Due to the varying slopes comprising the SCA final cover system (i.e., the downstream slope is steeper than the upstream slope), the design method for liquid collection layers on two different slopes proposed by Giroud et al. [2000] was used to calculate the maximum liquid head above the geocomposite drainage layer on the slopes of the SCA final cover. The upstream slope is defined as the gently sloping areas of the top and main decks, including the side slopes along the top deck (referred to as "SCA top area"). The downstream slope is defined as the side slopes along the main deck (referred to as "main deck side slopes").

The maximum liquid head on the upstream slope $(t_{up max})$ was calculated using the following equation [Giroud et al., 2000]:

$$t_{up\,max} \approx \frac{q_h(L_{up})}{k_{up}(\sin\beta_{up})}$$

where,

| \mathbf{q}_{h} | = | liquid impingement rate (i.e., rate of liquid supply per unit horizontal area); |
|---------------------------|---|---|
| Lup | = | horizontal length of upstream slope; |
| kup | = | hydraulic conductivity of liquid collection layer on upstream slope; and |
| β_{up} | = | slope angle of liquid collection layer on upstream slope. |
| | | |

The maximum liquid head on the downstream slope (t_{down max}) was calculated using the following equation [Giroud et al., 2000]:

$$t_{down\,max} \approx \frac{q_h(L_{up} + L_{down})}{k_{down}(\sin\beta_{down})}$$

where,

 q_h = liquid impingement rate (i.e., rate of liquid supply per unit horizontal area);

 L_{up} = horizontal length of upstream slope;

L_{down} = horizontal length of downstream slope;

 k_{down} = hydraulic conductivity of liquid collection layer on downstream slope; and

 β_{down} = slope angle of liquid collection layer on downstream slope.

The liquid impingement rate was determined using the HELP model outputs. The above equations from Giroud et al. [2000] are applicable when a geosynthetic liquid collection layer (i.e.,

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geocomposite) is present on both the downstream and upstream slopes. An example calculation of the maximum liquid head is included in Attachment 1.

The infiltration rate through the SCA final cover system was calculated using the calculated liquid head and equation proposed by Giroud [1997]:

$$Q_{leakage \ per \ area} = \frac{n * 0.976 * C_{qo} * \left[1 + 0.1 * \left(\frac{h}{t_u}\right)^{0.95}\right] * d^{0.2} * h^{0.9} * k_u^{0.74}}{A}$$

where,

| Qleakage per area | = | leakage rate per geomembrane area; |
|-------------------|---|--|
| А | = | geomembrane area; |
| n | = | number of defects per geomembrane area; |
| C _{qo} | = | contact quality factor; |
| h | = | hydraulic head on top of the geomembrane; |
| tu | = | thickness of the underlying soil layer; |
| ku | = | hydraulic conductivity of the underlying soil layer; and |
| d | = | diameter of circular defect. |

The geomembrane was assumed to contain one hole per acre and have good contact with the soil layer below, both of which can typically be achieved during construction. The holes in the geomembrane were assumed to be 0.16 in^2 , following the recommendations of Giroud and Bonaparte [1989]. An example calculation of the infiltration rate through the geomembrane is included in Attachment 2.

SCA FINAL COVER DESIGN

In general, the SCA final cover system consists of gently sloping (i.e., approximately 1% slopes) areas of the top and main decks with maximum side slopes of 4 horizontal to 1 vertical (4H:1V or 25%) and 3.33 horizontal to 1 vertical (3.33H:1V or 30%) along the top and main decks, respectively.

The SCA final cover system consists of the following layers, from top to bottom, as shown in Figures 1 and 2:

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- Vegetative soil layer;
- Protective soil layer;
- Geocomposite drainage layer with drainage collection pipes;
- Geomembrane (GM) liner;
- Geotextile cushion layer; and
- Leveling layer.

The allowable maximum liquid head above the final cover geomembrane on the SCA top area was set to a target value of approximately 12 inches. An SCA final cover system without a geocomposite drainage layer was evaluated initially, which resulted in a saturated cover soil with a maximum peak daily liquid head greater than 24 inches. To reduce the maximum liquid head above the final cover geomembrane to the target value of approximately 12 inches, a geocomposite drainage layer and 4-inch diameter drainage collection pipes were added to the cover system. On the main deck side slopes, the allowable maximum liquid head must be contained within the geocomposite thickness.

CASES ANALYZED

Both the gently sloping areas of the SCA top area (i.e., upstream slope), and the main deck side slopes (i.e., downstream slope) have been considered as part of the analyses in this package. The target maximum peak daily liquid head above the GM cover is approximately 12 inches on the SCA top area and less than the thickness of the geocomposite drainage layer on the main deck side slopes.

For the SCA top area, the two following cases were evaluated:

- Case 1: SCA final cover system without a geocomposite drainage layer or 4-inch diameter drainage collection pipes; and
- Case 2: SCA final cover system with a geocomposite drainage layer and 4-inch diameter drainage collection pipes.

The geocomposite on the SCA top area is assumed to be single-sided with a nonwoven, needlepunched geotextile.

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For the main deck side slopes, the two following cases were evaluated:

- Case 3: SCA final cover system with a geocomposite drainage layer with the same thickness on the SCA top area; and
- Case 4: SCA final cover system with a thicker geocomposite drainage layer on the main deck side slopes.

For both of these cases, the geocomposite used for the drainage layer on the main deck side slopes is assumed to be double-sided with nonwoven, needle-punched geotextiles.

INPUT PARAMETERS

The HELP software accepts parameters for layer type, hydraulic conductivity (K) for each layer, drainage path length, slope, moisture storage values, and climate. These parameters are further discussed below.

Material Layer Properties

The material layers in the SCA final cover system include the vegetative soil layer, protective soil layer, geocomposite drainage layer, drainage collection pipes, GM liner, geotextile cushion layer, and leveling layer, as discussed above and shown in Figures 1 and 2. Specific properties for the different layers of materials are included in Table 1 and are discussed below. It is noted that the HELP default parameters were used to select the total porosity, field capacity, and wilting point of each layer, however, the hydraulic conductivity was modified to better represent expected or potentially critical conditions.

The proposed vegetative soil layer has a thickness of 6 inches and is modeled as a sandy silt with a hydraulic conductivity of 1.0×10^{-4} cm/s (based on the default hydraulic conductivity value [3.7×10^{-4} cm/s] for soils similar to sandy silts in HELP). The proposed protective soil layer has a thickness of 18 inches and is modeled as a sandy clay material with a hydraulic conductivity of 1.0×10^{-5} cm/s (based on the default hydraulic conductivity value [3.3×10^{-5} cm/s] for soils similar to sandy clays in HELP).

The purpose of the geocomposite drainage layer is to reduce the liquid head on the GM and in turn, improve the final cover veneer stability. A 200-mil, single-sided geocomposite with a measured transmissivity of $1.0 \times 10^{-3} \text{ m}^2/\text{s}$ (i.e., design hydraulic conductivity of approximately 2.7 cm/s considering reduction factors) was used for the SCA top area. Both 200-mil and 250-mil, double-sided geocomposites with measured transmissivities of $1.0 \times 10^{-4} \text{ m}^2/\text{s}$ (i.e., design hydraulic

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conductivity of approximately 0.27 cm/s considering reduction factors) and $5.0 \times 10^{-4} \text{ m}^2/\text{s}$ (i.e., design hydraulic conductivity of approximately 1.1 cm/s considering reduction factors), respectively, were analyzed for the main deck side slopes. The design hydraulic conductivity of the geocomposites was calculated assuming the following reduction factors:

 RF_{CR} = Reduction factor for creep = 1.20; RF_{IN} = Reduction factor for delayed intrusion = 1.10; RF_{CD} = Reduction factor for chemical degradation = 1.20; RF_{PC} = Reduction factor for particulate clogging = 1.20; RF_{CC} = Reduction factor for chemical clogging = 1.20; RF_{BC} = Reduction factor for biological clogging = 1.30; and FS = Overall factor of safety = 2.50.

An example calculation of the design hydraulic conductivity for the single-sided geocomposite on the SCA top area is shown in Attachment 3.

Drainage collection pipes with a 4-inch diameter were added beneath the geocomposite drainage layer to reduce the length of the longest possible drainage path on the SCA top area. The spacing of the drainage collection pipes was selected such that the calculated liquid head was less than the target liquid head (approximately 12 inches) on the SCA top area.

The cover GM was modeled using the HELP model parameters for a low-density polyethylene (LDPE) liner, available in the HELP database. As discussed previously, the GM was assumed to contain one hole per acre and have good contact with the soil layer below.

The leveling layer and geotextile cushion layer are not intended to serve as a low permeability barrier, and is not expected to have a significant impact on the infiltration through the GM cover or the liquid head build-up on top of the GM cover. Therefore, these layers were not modeled as part of these analyses.

Drainage Path Lengths and Slopes

As mentioned previously, the final cover slopes on the gently sloping areas of the top and main decks will be a minimum of 1.0% towards the side slopes. The transition between the top and main decks has maximum side slopes of 4H:1V. The longest possible drainage path along the SCA top area to the main deck side slopes is approximately 1,300 ft in length without drainage collection pipes, as shown in Figure 3. With 4-inch diameter drainage collection pipes spaced at approximately 100 ft, the longest possible drainage path along the SCA top area is reduced to 150

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ft as shown in Figure 4. A slope of 1% has been conservatively assumed for the entire drainage path length along the SCA top area.

For the main deck side slopes, the drainage path length is approximately 100 ft. The minimum side slope is 4H:1V and the maximum side slope is 3.33H:1V based on final design grades.

Climate Data

The data for precipitation, temperature, humidity, and solar radiation were modeled using the HELP software synthetic data generation function for Syracuse, New York for a 100-year modeling period. This generation used recorded mean monthly data for Syracuse, shown in Table 2, to stochastically generate daily data with approximately the same statistical characteristics as the historic data. The precipitation data were manually adjusted to account for the design storm event of a 25-year, 24-hour rainfall. The rainfall corresponding to the design storm event was selected to be 4.4 inches based on recommendations from the Natural Resources Conservation Service [NRCS, 1986], as shown in Figure 5. The evaporative zone depth, which is the maximum depth from which water may be removed by evapotranspiration, was assumed to be 24 inches, corresponding to the total thickness of the vegetative soil layer and the protective soil layer in the final cover system. For this analysis, it was assumed that a good stand of grass will be established on the final cover system; therefore, the leaf area index (i.e., the dimensionless ratio of leaf area of active vegetation to the nominal surface area) of 3.5 was selected. Values of the climate parameters are shown in Table 3.

RESULTS OF ANALYSIS

The results of the HELP model analyses for Cases 1 through 4 are summarized in Table 4, and the HELP output files are included in Attachment 4. For the SCA top area, the initial calculation for a 1300 ft drainage length without a geocomposite drainage layer resulted in a calculated maximum liquid head of approximately 34 inches (see Case 1). To achieve the target maximum peak daily liquid head of approximately 12 inches, a 200-mil single-sided geocomposite drainage layer must be installed and a drainage length of approximately 150 ft must be achieved (see Case 2). A drainage length of 150 ft can be achieved by installing 4-inch diameter drainage collection pipes within the SCA final cover system.

For the main deck side slopes, the initial calculation for a 200-mil double-sided geocomposite and 100 ft drainage length resulted in a maximum peak daily liquid head of 0.53 inches, which is more than twice the thickness of the 200-mil (i.e., 0.2 inches) geocomposite drainage layer (see

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Case 3). Using a 250-mil (i.e., 0.25 inches) thick double-sided geocomposite on the main deck side slopes results in a maximum peak daily liquid head of 0.14 inches, which can be contained within the geocomposites thickness (see Case 4).

SUMMARY AND CONCLUSIONS

This package presents the analyses of the hydraulic performance of the proposed SCA final cover system using the HELP model. The evaluation presented in this package has three main objectives: (i) evaluate the infiltration rate through the proposed SCA final cover system; (ii) evaluate the impingement rate on the SCA final cover; and (iii) evaluate the liquid head above the GM in the final cover system on the SCA. The analysis indicates a calculated average annual liquid infiltration rate through the SCA final cover system of approximately 0.1 gallons per minute. Additionally, the analysis indicates a calculated average annual liquid impingement rate on the SCA final cover system of approximately 0.02 inches per day.

To achieve the target liquid heads above the GM liner, a 250-mil double-sided geocomposite drainage layer is required on the main deck side slopes and a 200-mil single-sided geocomposite with 4-inch diameter drainage collection pipes spaced every 100 ft is required on the SCA top area. The drainage collection pipes should terminate where the geocomposite daylights in the SCA perimeter ditches at the base of the main deck side slopes. A cross section of the drainage collection pipes is shown in Figure 1, while a plan view of the layout of the drainage collection pipes is shown in Figure 4. When these components are included in the final cover system, the calculated peak daily liquid heads in the cover system are approximately 0.14 inches and 12 inches for the main deck side slopes and SCA top area, respectively.

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Tables

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Table 1: Material Properties of Layers within SCA Final Cover System

| Layer | Description ^[1] | Layer Type ^[2] | HELP Default ^[3] | HELP USCS Name | Thickness (in) | k (cm/s) ^[4] |
|-------|---|------------------------------|--------------------------------|--------------------------|-------------------|-------------------------|
| 1 | Vegetative Soil Layer | 1 | 8 | ML | 6.00 | 1.00E-04 |
| 2 | Protective Layer | 2 | 13 | SC | 18.00 | 1.00E-05 |
| | Geocomposite Drainage Layer (200-mil Single-Sided) | | | | 0.20 | 2.66E+00 |
| 3 | Geocomposite Drainage Layer (200-mil Double-Sided) | 2 | 20 | Drainage Net (0.5 cm) | 0.20 | 2.70E-01 |
| (| Geocomposite Drainage Layer (250-mil Double-Sided) | | | | 0.25 | 1.06E+00 |
| 4 | Geomembrane ^[5] | 4 | 36 | LDPE | 0.04 | 4.00E-13 |

Notes:

- 1. This is a general description of each layer.
- 2. The following layer types are available in the HELP model: 1 = Vertical Percolation, 2 = Lateral Drainage, 3 = Barrier Soil Liner, 4 = Geomembrane Liner (GM).
- 3. This is the HELP default soil texture number. It is noted that the hydraulic conductivity of each layer may be changed from the HELP default to better represent expected or potentially critical conditions. All input parameters can be found in the HELP output files provided in Attachment 2.
- 4. Geocomposite hydraulic conductivity values represent the design hydraulic conductivity considering reduction factors as discussed in Attachment 3.
- 5. This layer was modeled as low density polyethylene (LDPE) GM, using typical values from the HELP database. Selection of a different GM type will not affect the results significantly.

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Table 2: Normal Mean Precipitation and Temperature Data for Syracuse, NY

| Month | Precipitation (in.) | Temperature (°F) |
|-----------|---------------------|------------------|
| January | 2.61 | 22.80 |
| February | 2.65 | 24.00 |
| March | 3.11 | 33.30 |
| April | 3.34 | 46.10 |
| May | 3.16 | 57.00 |
| June | 3.63 | 66.30 |
| July | 3.76 | 70.90 |
| August | 3.77 | 69.30 |
| September | 3.29 | 62.10 |
| October | 3.14 | 51.30 |
| November | 3.45 | 40.60 |
| December | 3.20 | 28.30 |

Note:

These are the default normal mean monthly values of precipitation and temperature for Syracuse, NY, available in the HELP software.

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 Table 3: Climate Parameters for Syracuse, NY and Other Parameters for the SCA Final Cover

 System (HELP Default Values Unless Stated Otherwise)

| Parameter | Value | Units |
|--|--------------------|-----------------------|
| Fraction of Area allowing Runoff | 100% | percent of total area |
| Evaporative Zone Depth | 24 | inches |
| Latitude | 43.07 | degrees |
| Maximum Leaf Area Index | 3.5 ^[3] | |
| Start of Growing Season (date) | 124 ^[4] | |
| End of Growing Season (date) | 284 ^[4] | |
| Planar Area ^[1] | 1 | acre |
| Average Annual Wind Speed | 9.7 | miles/hr |
| Average 1st Quarter Relative Humidity | 72% | |
| Average 2nd Quarter Relative Humidity | 68% | |
| Average 3rd Quarter Relative Humidity | 75% | |
| Average 4th Quarter Relative Humidity | 76% | |
| Peak Daily Rainfall, 25-year, 24-hour storm event ^[2] | 4.40 | inches |

Notes:

- 1. The area was modeled as one acre to produce values on a per-acre basis. This was multiplied by the total number of acres to calculate total flow rates over the entire area of the SCA. The total area of the SCA is approximately 50 acres.
- 2. Value from National Resources Conservation Service data shown in Figure 5.
- 3. This value corresponds to a good stand of grass on top of the final cover.
- 4. These dates correspond to May 4 through October 11.

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| Client: I | Honeywell | Project: | Ononda Design | aga Lake SCA | Final Cover | Project/ Proposal No.: | GD5497 | Task No.: | 03 |

Table 4: Results of HELP Modeling, Giroud [1997], and Giroud et al. [2000] Calculations for the SCA Final Cover System

| | | G 1 | | | Peak Daily Values | | | | Average Annual Values | | | | |
|----------------|------|---------------------|-------------|-----------------------|---------------------------|--------------|-------------|----------------------|--------------------------|--------------|-------------|-------------|-----------------------|
| Taataa | C | Geocomposite | Drainage | Curve | Infiltration | Infiltration | Impingement | LL (in) | Infiltration | Infiltration | Impingement | Impingement | |
| Location | Case | 1 nickness (mil) | Length (ft) | Number ^[1] | Rate | Rate | Rate | п _{MAX} (Ш) | Rate | Rate | Rate | Rate | H _{AVG} (in) |
| | | (1111) | | | (ft ³ /ac-day) | (gal/min) | (in./day) | cover | (ft ³ /ac-yr) | (gal/min) | (in./yr) | (in./day) | cover |
| SCA Top Ama | 1 | - | 1300 | 69.1 | 1.1 | 0.3 | 0.00 | 34.1 | 140.6 | 0.1 | 0.1 | < 0.01 | 8.9 |
| SCA Top Alea | 2 | 200 | 150 | 72.8 | 0.4 | 0.1 | 0.24 | 12.2 | 18.3 | < 0.1 | 6.6 | 0.02 | 0.1 |
| Main Deck Side | 3 | 200 | 100 | 75.9 | < 0.1 | < 0.1 | 0.33 | 0.53 ^[3] | 0.2 | < 0.1 | 6.5 | 0.02 | < 0.1 ^[3] |
| Slopes | 4 | 250 | 100 | 75.9 | < 0.1 | < 0.1 | 0.35 | 0.14 ^[3] | 0.2 | < 0.1 | 6.5 | 0.02 | < 0.1 ^[3] |

Notes:

-

- 1. The curve number was calculated by HELP based on model inputs.
- 2. The target maximum peak daily liquid head (H_{MAX}) above the GM cover is 12 inches on the SCA top area and less than the thickness of the geocomposite on the main deck side slopes.
- 3. The equations of Giroud et al. [2000] were used to calculate the maximum peak daily liquid head (H_{MAX}) and average annual daily liquid head (H_{AVG}) for the main deck side slopes since the calculations involved a change in slope.
- 4. The SCA was assumed to have a total acreage of 50 acres.
- 5. The HELP Output files are included in Attachment 4.

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Figures



Figure 1: Cross Section of Final Cover System for SCA Top Area (i.e., Gently Sloping Areas of the Top and Main Decks and Top Deck Side Slopes)

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| | | | | | RUNOFF | | .5' 1.5' | | |
| | | GEOCOMPOSITE DRAINAGE LAYER- | | | PROTECTIVE SOIL | LAYER | VARIES | | |
| | | SLOTTED DRAINA COLLECTION PIPE 4" DIA (MIN)—— | GE | GE | OTEXTILE CUSHION | GEOTEXTILE TUBES | | | |

Figure 2: Cross Section of Final Cover System for Main Deck Side Slopes



Figure 3: Design Top of Final Cover Grading Plan

Note:

The grading plan shown here is based on a topographic survey of the SCA conducted December 7, 2014. It is noted that minor revisions to the grading plan are not expected to significantly impact the HELP calculation results.



Figure 4: Plan View of Drainage Collection Pipe Layout (100 ft distance between pipes reduces drainage length to approximately 150 ft).

Note:

The grading plan shown here is based on a topographic survey of the SCA conducted December 7, 2014. Drainage collection pipes terminate where the geocomposite drainage layer daylights in SCA perimeter ditches at the base of the main deck side slopes.

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Figure 5: NRCS Map for Calculation of 25-year, 24-hour Storm Event [NRCS, 1986]

Note:

The value selected for the model is 4.40 inches, based on the approximate location of Onondaga Lake.

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Attachment 1: Example Calculation of Liquid Head on Two Different Slopes [Giroud et al., 2000]

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| | | Onon | daga La | ke SCA F | Final Cover | Project/ Pro | posal No.: | GD | 5497 | Task No.: | |
| It: Honeywell | Projec | t: Desig | n 1.18E-07 | 7 m/s | < Peak Daily | Impingement I | Rate Calcula | ted in F | IELP | | |
| Impingement Rate, Slope Geometry | Projec | t: Desig in./day | 1.18E-07 | 7 m/s | < Peak Daily | Impingement F | Rate Calcula Main Deck Si | ted in F | IELP | | |
| Impingement Rate, of Slope Geometry Upstream Slope (i.e. Drainage Length, D _{in} | Projec h 0.4 . SCA Top Are 150 | t: Desig in./day ea) | 1.18E-07 | 7 m/s | < Peak Daily Downstrea | Impingement F m Slope (i.e., N ength, D _{rlown} | Rate Calcula Main Deck Si 100 ft | ted in F de Slop | HELP Des) 30.48 | m | |
| t: Honeywell Impingement Rate, of Slope Geometry Upstream Slope (i.e. Drainage Length, D _{up} Inclination, β _{up} | Projec h 0.4 SCA Top Are 150 0.57 | t: Desig in./day :a) ft | 1.18E-07 45.72 0.01 | 7 m/s m rad | < Peak Daily Downstrea Drainage L Inclination | Impingement F m Slope (i.e., Ν ength, D _{down} | Rate Calcula Main Deck Si 100 ft 14.03 ° | ted in H de Slop | IELP Des) 30.48 0.24 | m rad | |
| t: Honeywell Impingement Rate, Slope Geometry Upstream Slope (i.e. Drainage Length, D _{up} Inclination, β _{up} Horizontal Length, L | Projec | t: Desig in./day ra) ft ft | 1.18E-07 45.72 0.01 45.72 | 7 m/s m rad m | < Peak Daily Downstrea Drainage L Inclination Horizontal | Impingement F m Slope (i.e., N ength, D _{down} , β _{down} Length, L _{down} | Rate Calcula Main Deck Si 100 ft 14.03 ° 97 ft | ted in H de Slop | IELP Des) 30.48 0.24 29.57 | m rad m | |
| t: Honeywell Impingement Rate, of Slope Geometry Upstream Slope (i.e. Drainage Length, D _{up} Inclination, β _{up} Horizontal Length, L | Projec | t: Desig in./day ra) ft β _{up} | 1.18E-07 45.72 0.01 45.72 | 7 m/s m rad m | < Peak Daily Downstrea Drainage L Inclination Horizontal | Impingement F m Slope (i.e., N ength, D _{down} , β _{down} Length, L _{down} Ldown | Rate Calcula Main Deck Si 100 ft 14.03 ° 97 ft η = D _{down} * β _d | ted in H de Slop : : | IELP Des) 30.48 0.24 29.57 | m rad m | |
| t: Honeywell Impingement Rate, of <u>Slope Geometry</u> Upstream Slope (i.e. Drainage Length, D _{up} Inclination, β _{up} Horizontal Length, L | Projec Projec SCA Top Are 150 0.57 p 150 $L_{up} = D_{up} *$ ties of Geoco | t: Desig in./day a) ft β _{up} proposite Dr | 1.18E-07 45.72 0.01 45.72 | 7 m/s m rad m | < Peak Daily Downstrea Drainage L Inclination Horizontal | Impingement Γ m Slope (i.e., N ength, D _{down} , β _{down} Length, L _{down} L _{down} | Rate Calcula Main Deck Si 100 ft 14.03 ° 97 ft $n = D_{down} * \beta_d$ | ted in F de Slop : : | IELP 30.48 0.24 29.57 | m rad m | |
| t: Honeywell Impingement Rate, Slope Geometry Upstream Slope (i.e. Drainage Length, D _{up} Inclination, β _{up} Horizontal Length, L Hydraulic Conductiv Geocomposite Used | Projec | t: Desig in./day ft ft β _{up} pmposite Dr r, single-sid | 1.18E-07 45.72 0.01 45.72 rainage La led, 200-n | 7 m/s m rad m ayer nil | < Peak Daily Downstrea Drainage L Inclination Horizontal | Impingement f m Slope (i.e., Ν ength, D _{down} , β _{down} Length, L _{down} Lawn Lawn | Rate Calcula Main Deck Si 100 ft 14.03 ° 97 ft _n = D _{down} * β _d Biplanar, do | ted in F de Slop : : : : : : : : : : | HELP 9es) 30.48 0.24 29.57 ided, 250 | m rad m ⊢mil | |

| t _{up,max} 0.02 m | t _{down,max} 3.45E-03 m |
|----------------------------|----------------------------------|
| 0.80 in | 0.14 in |

 $t_{up max} \approx \frac{q_h L_{up}}{k_{up} \sin \beta_{up}}$

 $t_{down max} = \frac{q_h \left(L_{up} + L_{down} \right)}{k_{down} \sin \beta_{down}}$

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Attachment 2: Example Calculation of Infiltration Rate through Geomembrane [Giroud, 1997]

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| Input Parameters | Eng | lish Units | S | I Units |
|--|----------|------------|----------|----------------|
| Geomembrane (GM) area, A | 1 | acre | 4047 | m ² |
| Liquid Head on top of GM, h | 12.2 | in | 0.31 | m |
| Thickness of underlying layer, t _u | 2 | ft | 0.61 | m |
| Permeability of underlying layer, k _u | 1.85E-07 | ft/s | 5.65E-08 | m/s |
| Contact quality factor, C _{go} | 0.21 | - | 0.21 | - |
| Number of defects, n | 1 | - | 1 | - |
| Diameter of circular defect, d | 0.45 | in. | 0.01 | m |

| Calculated Leakage Rate Per GM Area | En | glish Units | SI Units | |
|-------------------------------------|------|--------------|---|--|
| Q _{leakage per area} | 3.00 | gal/acre/day | 3.29E-11 m ³ /s/m ² | |

$$Q_{leakage \ per \ area} = \frac{n * 0.976 * C_{qo} * \left[1 + 0.1 * \left(\frac{h}{t_u}\right)^{0.95}\right] * d^{0.2} * h^{0.9} * k_u^{0.74}}{A}$$

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Attachment 3: Example Calculation of Geocomposite Transmissivity

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The specified value of transmissivity measured in a laboratory can be converted to a design hydraulic transmissivity by accounting for several reduction factors and an overall factor of safety, with the following equation:

$$\theta_{des} = \frac{\theta_{lab}}{RF_{CR} * RF_{IN} * RF_{CD} * RF_{PC} * RF_{CC} * RF_{BC} * FS}$$

Where:

- θ_{des} = Transmissivity for Design;
- θ_{lab} = Laboratory Measured Transmissivity = 1.0x10⁻³ m²/s (i.e., 200-mil, single-sided geocomposite on SCA top areas);
- RF_{CR} = Reduction factor for creep = 1.20;
- RF_{IN} = Reduction factor for delayed intrusion = 1.10;
- RF_{CD} = Reduction factor for chemical degradation = 1.20;
- RF_{PC} = Reduction factor for particulate clogging = 1.20;
- RF_{CC} = Reduction factor for chemical clogging = 1.20;
- RF_{BC} = Reduction factor for biological clogging = 1.30; and
- FS = Overall factor of safety = 2.50.

Based on the above equation, the calculated design transmissivity for the geocomposite on the SCA top areas is 1.35×10^{-4} m²/s. This can be converted to hydraulic conductivity using the following equation:

$$k = \frac{\theta}{t}$$

Where:

- k = Hydraulic conductivity;
- θ = Geocomposite transmissivity = 1.35x10⁻⁴ m²/s (as calculated above); and
- $t = \text{Geocomposite thickness} = 5.08 \times 10^{-3} \text{ m}$ (i.e., 200 mil or 0.2 in.).

Therefore, the calculated hydraulic conductivity for design is 2.66 cm/s.

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Attachment 4: HELP Output Files

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CASE 1: SCA TOP AREA WITHOUT A GEOCOMPOSITE DRAINAGE LAYER OR DRAINAGE COLLECTION PIPE

engineering p.c. an affiliate of Geosyntec Consultants Page 30 of 55 Ray Wu / Clinton Written by: Date: 08/20/2015 Reviewed by: Sowmya Bulusu / Jay Beech Date: 08/20/2015 Carlson **Onondaga Lake SCA Final Cover** Project: Project/ Proposal No.: Client: Honeywell GD5497 Task No.: 03 Design ** * * * * * * * * HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE * * * * HELP MODEL VERSION 3.07 (1 NOVEMBER 1997) * * * * DEVELOPED BY ENVIRONMENTAL LABORATORY * * * * USAE WATERWAYS EXPERIMENT STATION * * * * FOR USEPA RISK REDUCTION ENGINEERING LABORATORY * * * * * * ** * * PRECIPITATION DATA FILE: \OLPRECIP.D4 TEMPERATURE DATA FILE: \OLTEMP.D7 SOLAR RADIATION DATA FILE: \OLSOLAR.D13 EVAPOTRANSPIRATION DATA: \OL LAI35.D11 SOIL AND DESIGN DATA FILE: \1-NO GC.D10 OUTPUT DATA FILE: \1-NO_GC.OUT TIME: 12:1 DATE: 6/30/2015 ******* TITLE: Onondaga Lake SCA Closure NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM. LAYER 1 _____ TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 108 THICKNESS = 6.00 INCHES 0.4630 VOL/VOL POROSITY = FIELD CAPACITY 0.2320 VOL/VOL = 0.1160 VOL/VOL WILTING POINT = INITIAL SOIL WATER CONTENT = 0.4575 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-04 CM/SEC LAYER 2 ____ TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 113 THICKNESS 18.00 INCHES = 0.4300 VOL/VOL POROSITY = 0.3210 VOL/VOL FIELD CAPACITY = WILTING POINT = 0.2210 VOL/VOL INITIAL SOIL WATER CONTENT = 0.4317 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-05 CM/SEC = 1.00 PERCENT SLOPE = 1300.0 DRAINAGE LENGTH FEET

Beech and Bonaparte

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| | | | | layer 3 | | | | | | | | |
| | | TYPI | E 4 - I | FLEXIBLE MEM | BRANE LINER | | | | | | | |
| | THICKNE | MZ | ATERIAI | L TEXTURE NU | MBER 36 | IF S | | | | | | |
| | POROSIT | Y | | = | 0.0000 VOL/ | VOL | | | | | | |
| | FIELD C | APACITY | | = | 0.0000 VOL/ | VOL | | | | | | |
| | WILTING | POINT | FFR COM | | 0.0000 VOL/ | VOL | | | | | | |
| | EFFECTI | VE SAT. H | HYD. CO | DND. = 0. | 3999999993000E | -12 CM/SEC | | | | | | |
| | FML PIN | HOLE DENS | SITY | = | 0.00 HOLE | IS/ACRE | | | | | | |
| | FML INS FMI. PI.A | CEMENT O | N DEFE(TALTTY | CTS = 3 | 1.00 HOLE | S/ACRE | | | | | | |
| | | | | - | | | | | | | | |
| | SCS RUNOFF FRACTION O AREA PROJE | GOOD STAN AND A SLO CURVE NU F AREA AN CTED ON H | ND OF (DPE LEN JMBER LLOWIN(HORIZON | GRASS, A SUR IGTH OF 1300 G RUNOFF ITAL PLANE | FACE SLOPE OF . FEET. = 69.10 = 100.0 = 1.000 | ' 1.% PERCENT ACRES | | | | | | |
| | EVAPORATIV | E ZONE DI | EPTH | | = 24.0 | INCHES | | | | | | |
| | UPPER LIMI | TER IN EV T OF EVAI | PORATIN | TIVE ZONE /E STORAGE | = 10.516 = 10.518 | INCHES | | | | | | |
| | LOWER LIMI | T OF EVAL | PORATIV | /E STORAGE | = 4.674 | INCHES | | | | | | |
| | INITIAL SN | OW WATER | VED M7 | יחביסדאד פ | = 0.000 | INCHES | | | | | | |
| | TOTAL INIT | IAL WATER | 3.1717 1.17 | TERIADS | = 10.516 | INCHES | | | | | | |
| | TOTAL SUBS | URFACE II | NFLOW | | = 0.00 | INCHES/YEAR | | | | | | |
| | | EVAPOTI | RANSPIE | RATION AND W | EATHER DATA | | | | | | | |
| | NOTE: EV | APOTRANSI | PIRATIO | ON DATA WAS | OBTAINED FROM | I | | | | | | |
| | | SIRACUSE | | NEW | YORK | | | | | | | |
| | STATI | ON LATIT | JDE | | = 43 | .07 DEGREES | | | | | | |
| | MAXIM | UM LEAF A | AREA IN | NDEX ASON (TUTTAN | = 3 | 124 | | | | | | |
| | END O | F GROWIN | G SEAS | N (JULIAN D | ATE) = | 284 | | | | | | |
| | EVAPO | RATIVE ZO | ONE DEI | PTH | = 24 | .0 INCHES | | | | | | |
| | AVERA AVERA | GE ANNUAI GE 1ST OT | L WIND | SPEED RELATIVE HI | = 9 10 MTDTTY = 72 | ./U MPH | | | | | | |
| | AVERA AVERA AVERA | GE 2ND QU GE 3RD QU GE 4TH QU | JARTER JARTER | RELATIVE HU RELATIVE HU | MIDITY = 68 MIDITY = 75 MIDITY = 76 | | | | | | | |

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| ritten by: | Ray Wi Ca | u / Clinton arlson | Date: | 08/20/201 | 5 Review | ved by: S | owmya Bul | usu / Jay Beech | | : 08/20 |)/2015 | |
| lient: H e | oneywell | Project: | Onond Design | aga Lake S | CA Final C | over I | Project/ Prop | osal No.: GI | 05497 | Task No.: | . 0. | |
| | NOTE: | PRECIPITAT COEFFICI | TION DAT | 'A WAS SYI DR SYRA | NTHETICALI ACUSE | Y GENERAJ | TED USING EW YORK | | | | | |
| | | NORMAL N | iean mon | THLY PRE | CIPITATION | (INCHES) | | | | | | |
| | JAN/JUL | FEB/AUG | MAR/ | SEP A | APR/OCT | MAY/NOV | / JUN/ | DEC | | | | |
| | 2.61 3.76 | 2.65 3.77 | 3. 3. | 11 29 | 3.34 3.14 | 3.16 3.45 | 3. 3. | 63 20 | | | | |
| | NOTE: | TEMPERATUF COEFFICI | RE DATA TENTS FO | WAS SYNTI DR SYRA | HETICALLY ACUSE | GENERATEI NE | D USING EW YORK | | | | | |
| | N | ORMAL MEAN N | IONTHLY | TEMPERAT | JRE (DEGRE | ES FAHREN | JHEIT) | | | | | |
| | JAN/JUL | FEB/AUG | MAR/ | SEP 2 | APR/OCT | MAY/NOV | / JUN/ | DEC | | | | |
| | 22.80 70.90 | 24.00 69.30 | 33. 62. | 30 10 | 46.10 51.30 | 57.00 40.60 | 66. 28. | 30 30 | | | | |
| | NOTE: | SOLAR RADI COEFFICI AND SI | ATION E ENTS FO ATION I | DATA WAS S DR SYRI ATITUDE | SYNTHETICA ACUSE = 43.07 | ALLY GENEF NF DEGREES | RATED USIN EW YORK | G | | | | |
| *** | ********* AVERA | ************ GE MONTHLY \ | ******* /ALUES I | N INCHES | FOR YEARS | ********** 5 1 THF | *********** ROUGH 100 | **** | | | | |
| | | | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC | | | | |
| PR | ECIPITATIO | - N | | | | | | | | | | |
| | TOTALS | _ | 2.59 | 2.72 | 3.16 | 3.27 | 3.09 | 3.71 | | | | |
| | STD. DEVIA | TIONS | 0.70 1.67 | 0.96 1.76 | 1.19 1.60 | 1.19 1.16 | 1.31 1.19 | 1.57 0.76 | | | | |
| RU | NOFF | | | | | | | | | | | |
| | TOTALS | | 0.889 0.055 | 1.771 0.023 | 5.193 0.039 | 2.052 0.252 | 0.492 1.048 | 0.308 1.446 | | | | |
| | STD. DEVIA | TIONS | 0.970 0.413 | 1.706 0.165 | 2.501 0.182 | 1.404 0.561 | 0.701 | 0.666 1.062 | | | | |

EVAPOTRANSPIRATION TOTALS
0.491
0.405
0.470
1.837
2.914
5.448
5.583
3.820
2.212
1.093
0.761
0.507

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| | | | | | | | P | age | 33 | of | 33 |
|----------------------------------|--|--|---|---|---|--|---|---|------------------|----------|---------------|
| tten b | oy: Ray | y Wu / Clinton Carlson | Date: | 08/20/2015 | Reviewe | d by: S | owmya Bul | ısu / Jay Be | e ch Date | : 08/20 | 0/20 1 |
| ent: | Honeywell | Project: | Onond Design | aga Lake SCA | A Final Co | ver | Project/ Prop | osal No.: | GD5497 | Task No. | : |
| | STD. DE | VIATIONS | 0.080 1.135 | 0.076 1.332 | 0.172 0.695 | 0.717 0.183 | 0.835 0.146 | 0.656 0.120 | | | |
| | LATERAL D | RAINAGE COLLECT | ED FROM | i layer 2 | | | | | | | |
| | TOTALS | | 0.0001 | 0.0000 | 0.0001 | 0.0005 | 5 0.0006 2 0.0005 | 0.0003 0.0006 | | | |
| | STD. DE | VIATIONS | 0.0001 0.0001 | 0.0000 | 0.0001 0.0001 | 0.0002 | 2 0.0001 3 0.0004 | 0.0001 0.0003 | | | |
| | PERCOLATI | ON/LEAKAGE THRO | UGH LAY | ER 3 | | | | | | | |
| | TOTALS | | 0.0045 | 0.0038 | 0.0045 0.0016 | 0.0100 | 5 0.0155 9 0.0103 | 0.0118 0.0117 | | | |
| | STD. DE | VIATIONS | 0.0013 0.0032 | 0.0004 | 0.0011 0.0038 | 0.0036 | 5 0.0005 5 0.0067 | 0.0013 0.0046 | | | |
| | DAILY AVE | RAGE HEAD ON TO | P OF LA | YER 3 | | | | | | | |
| | DAILY AVE | RAGE HEAD ON TO | P OF LA | YER 3 | | | | | | | |
| | AVERAGE | RAGE HEAD ON TO | P OF LA 4.4064 4.7325 | YER 3 3.8803 1.4559 | 4.3791 2.1355 | 13.9741 6.3271 | L 20.8395 L 14.0326 | 16.2045 14.9159 | | | |
| | AVERAGE STD. DE | RAGE HEAD ON TO | P OF LA 4.4064 4.7325 1.8106 4.2548 | 3.8803 1.4559 0.4340 3.6065 | 4.3791 2.1355 1.5550 5.2027 | 13.9741 6.3271 5.4595 8.7343 | 20.8395 14.0326 0.6349 9.3103 | 16.2045 14.9159 1.8954 6.4841 | | | |
| ** | DAILY AVE | RAGE HEAD ON TO | P OF LA 4.4064 4.7325 1.8106 4.2548 ******* | YER 3 3.8803 1.4559 0.4340 3.6065 *********************************** | 4.3791 2.1355 1.5550 5.2027 ******** ******** | 13.9741 6.3271 5.4595 8.7343 ******** ******** | L 20.8395 L 14.0326 5 0.6349 3 9.3103 | 16.2045 14.9159 1.8954 6.4841 ********* ********* | * | | |
| ** | DAILY AVE | RAGE HEAD ON TO | PP OF LA 4.4064 4.7325 1.8106 4.2548 ******* ******* | .YER 3 3.8803 1.4559 0.4340 3.6065 ************************************ | 4.3791 2.1355 1.5550 5.2027 ******** | 13.9741 6.3271 5.4595 8.7343 ******** EARS | L 20.8395 L 14.0326 5 0.6349 3 9.3103 ********** 1 THROUGH FEET | 16.2045 14.9159 1.8954 6.4841 ********* 100 | * | | |
| * * E | AVERAGE | RAGE HEAD ON TO S VIATIONS ************************************ | P OF LA 4.4064 4.7325 1.8106 4.2548 ******* & (STE & (STE | .YER 3 3.8803 1.4559 0.4340 3.6065 ************************************ | 4.3791 2.1355 1.5550 5.2027 ******** (S) FOR Y 4.823) | 13.9741 6.3271 5.4595 8.7343 ******** EARS CU. H | L 20.8395 L 14.0326 5 0.6349 3 9.3103 ********** 1 THROUGH FEET | 16.2045 14.9159 1.8954 6.4841 ********* 100 PERCENT 100.00 | * | | |
| ** ** I F | AVERAGE | RAGE HEAD ON TO | PP OF LA 4.4064 4.7325 1.8106 4.2548 ******* & (STE | .YER 3 3.8803 1.4559 0.4340 3.6065 ************************************ | 4.3791 2.1355 1.5550 5.2027 ******** (S) FOR Y 4.823) 3.4003) 2.5085 | 13.9741 6.3271 5.4595 8.7343 ******** EARS CU. H 1422 492 | L 20.8395 L 14.0326 5 0.6349 3 9.3103 ********** 1 THROUGH FEET 279.7 254.68 | 16.2045 14.9159 1.8954 6.4841 ********* 100 PERCENT 100.00 34.618 | * | | |
| ** ** F F E I | AVERAGE | RAGE HEAD ON TO S VIATIONS ************************************ | PP OF LA 4.4064 4.7325 1.8106 4.2548 ******* & (STE | .YER 3 3.8803 1.4559 0.4340 3.6065 ************************************ | 4.3791 2.1355 1.5550 5.2027 ******** (S) FOR Y 4.823) 3.4003) 2.5085) 0.00107) | 13.9741 6.3271 5.4595 8.7343 ******** EARS CU. H 1422 492 927 | L 20.8395 L 14.0326 5 0.6349 3 9.3103 ********** 1 THROUGH FEET 279.7 254.68 712.91 11.233 | 16.2045 14.9159 1.8954 6.4841 ********* 100 PERCENT 100.00 34.618 65.162 0.00790 | * | | |
| *** F F I I F | AVERAGE STD. DE STD. DE STD. DE AVERAGE AVERAG PRECIPITAT RUNOFF EVAPOTRANS CATERAL DR FROM LAY PERCOLATIO LAYER 3 | RAGE HEAD ON TO S VIATIONS ************************************ | PP OF LA 4.4064 4.7325 1.8106 4.2548 ******** * ******* * (STE | <pre>3.8803 3.8803 1.4559 0.4340 3.6065 ***********************************</pre> | 4.3791 2.1355 1.5550 5.2027 ******** (S) FOR Y 4.823) 3.4003) 2.5085) 0.00107) 0.02064) | 13.9741 6.3271 5.4595 8.7343 ******** EARS CU. H 1422 492 927 | L 20.8395 L 14.0326 5 0.6349 9.3103 ********** 1 THROUGH FEET 279.7 254.68 712.91 11.233 807.617 | 16.2045 14.9159 1.8954 6.4841 ********* 100 PERCENT 100.00 34.618 65.162 0.00790 0.21621 | * * - | | |

engineering p.c. an affiliate of Geosyntec Consultants Page 34 of 55 Ray Wu / Clinton Written by: Date: 08/20/2015 Reviewed by: Sowmya Bulusu / Jay Beech Date: 08/20/2015 Carlson **Onondaga Lake SCA Final Cover** Project: Project/ Proposal No.: Client: Honeywell GD5497 Task No.: 03 Design CHANGE IN WATER STORAGE -0.002 (1.3963) -6.77 -0.005 PEAK DAILY VALUES FOR YEARS 1 THROUGH 100 _____ (INCHES) (CU. FT.) _____ _____ PRECIPITATION 4.40 15972.000 RUNOFF 4.342 15759.7324 DRAINAGE COLLECTED FROM LAYER 2 0.00003 0.12346 PERCOLATION/LEAKAGE THROUGH LAYER 3 0.000582 2.11189 AVERAGE HEAD ON TOP OF LAYER 3 24,000 MAXIMUM HEAD ON TOP OF LAYER 3 34.066 LOCATION OF MAXIMUM HEAD IN LAYER 2 377.3 FEET (DISTANCE FROM DRAIN) 9.62 SNOW WATER 34911.7891 MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4383 MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1948 *** Maximum heads are computed using McEnroe's equations. *** Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270. FINAL WATER STORAGE AT END OF YEAR 100 _____ _____ _____ LAYER (INCHES) (VOL/VOL) ____ _____ ____ 2.7450 1 0.4575 2 7.5390 0.4188 0.0000 3 0.0000 SNOW WATER 0.046

Beech and Bonaparte

| | | | | | Beech an e: | d Bona ngineeri | iparte 🗗 | • | | |
|-------------|-----------------------------|-----------------|---------------|--------------|---------------------------------------|--------------------|-----------|------|--|--|
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| | | | | | Page | 35 | of | 55 | | |
| Written by: | Ray Wu / Clinton Carlson | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay Beech | Date: | 08/20/ | 2015 | | |
| Client: Hor | eywell Project: | Onond Design | laga Lake SCA | Final Cover | Project/ Proposal No.: GI |)5497 | Task No.: | 03 | | |

CASE 2: SCA TOP AREA WITH A 200-MIL GEOCOMPOSITE DRAINAGE LAYER AND 4-INCH DIAMETER DRAINAGE COLLECTION PIPE

engineering p.c. an affiliate of Geosyntec Consultants Page 36 of 55 Ray Wu / Clinton Written by: Date: 08/20/2015 Reviewed by: Sowmya Bulusu / Jay Beech 08/20/2015 Date: Carlson **Onondaga Lake SCA Final Cover** Project: Project/ Proposal No.: Client: Honeywell GD5497 Task No.: 03 Design * * * * * * * * HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE * * * * * * HELP MODEL VERSION 3.07 (1 NOVEMBER 1997) * * DEVELOPED BY ENVIRONMENTAL LABORATORY * * * * USAE WATERWAYS EXPERIMENT STATION * * * * FOR USEPA RISK REDUCTION ENGINEERING LABORATORY * * ** * * * * * * PRECIPITATION DATA FILE: C:\OLPRECIP.D4 TEMPERATURE DATA FILE: C:\OLTEMP.D7 SOLAR RADIATION DATA FILE: C:\OLSOLAR.D13 EVAPOTRANSPIRATION DATA: C:\OL LAI35.D11 SOIL AND DESIGN DATA FILE: C:\1-FN200D.D10 OUTPUT DATA FILE: C:\1-FN200D.OUT TIME: 33:50 DATE: 4/ 7/2015 TITLE: Onondaga Lake SCA Closure NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM. LAYER 1 TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 108 THICKNESS INCHES = 6.00 POROSITY = 0.4630 VOL/VOL FIELD CAPACITY = 0.2320 VOL/VOL WILTING POINT = 0.1160 VOL/VOL INITIAL SOIL WATER CONTENT = 0.4565 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-04 CM/SEC LAYER 2 _____ TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 113 THICKNESS = 18.00 INCHES 0.4300 VOL/VOL POROSITY = FIELD CAPACITY = 0.3210 VOL/VOL = WILTING POINT 0.2210 VOL/VOL 0.4109 VOL/VOL INITIAL SOIL WATER CONTENT =

Beech and Bonaparte

| | | | | | | Beech | Beech and Bonaparte P engineering p.c. | | | |
|-------------|--|---|--|--|---|-------------|---|---------|-------------|------|
| | | | | | | an affilia | te of Geos | yntec C | Consultants | |
| | | | | | F | age | , | 37 | of | 55 |
| Written by: | Ray Wu / Clinton Carlson | Date: 0 |)8/20/2015 | Reviewed by: | Sowmya Bul | usu / Jay I | Beech | Date: | 08/20/ | 2015 |
| Client: Hon | eywell Project: | Onondag Design | a Lake SCA | A Final Cover | Project/ Prop | oosal No.: | GD54 | 197 | Task No.: | 03 |
| | EFFECTIVE SAT. | HYD. CONE | D. = 0 | .999999975000E | -05 CM/SEC | | | | | |
| | | | LAYER 3 | | | | | | | |
| | THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WA EFFECTIVE SAT. SLOPE DRAINAGE LENGTH | TER CONTE HYD. CONE | = = = ENT = 0. = 2 = | 0.20 INCH 0.8500 VOL/ 0.0100 VOL/ 0.0100 VOL/ 0.0100 VOL/ 2.66000009000 1.00 PERC 150.0 FEET | ES VOL VOL VOL CM/SEC ENT | | | | | |
| | | | LAYER 4 | | | | | | | |
| | TYP M THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WA EFFECTIVE SAT. FML PINHOLE DEN FML INSTALLATIO FML PLACEMENT Q | E 4 - FLE ATERIAL T TER CONTE HYD. CONE SITY N DEFECTS UALITY | EXIBLE MEN EXTURE NU = = = ENT = 0. = 0 = 5 = 3 = 3 | MBRANE LINER JMBER 36 0.04 INCH 0.0000 VOL/ 0.0000 VOL/ 0.0000 VOL/ 0.0000 VOL/ 399999993000E 0.00 HOLE 1.00 HOLE - GOOD | ES VOL VOL VOL -12 CM/SEC S/ACRE S/ACRE | | | | | |
| | GENERAL | DESIGN A | AND EVAPOR | RATIVE ZONE DA | TA | | | | | |
| | NOTE: SCS RUNOFF SOIL DAT GOOD STA AND A SL | CURVE NU A BASE US ND OF GRA OPE LENGI | JMBER WAS SING SOIL ASS, A SUI TH OF 150 | COMPUTED FROM TEXTURE # 8 W RFACE SLOPE OF). FEET. | DEFAULT ITH A 1.% | | | | | |

| SCS RUNOFF CURVE NUMBER | = | 72.80 | |
|------------------------------------|---|--------|-------------|
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 24.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 10.136 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 10.518 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 4.674 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 10.138 | INCHES |
| TOTAL INITIAL WATER | = | 10.138 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |
| | | | |

| | | | Beech and Bonapart engineering p. | | | | | | | |
|-------------|-----------------------------|-----------------|--------------------------------------|---------------|---------------------------------------|-------|-----------|-------|--|--|
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| | | | | | Page | 38 | of | 55 | | |
| Written by: | Ray Wu / Clinton Carlson | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay Beech | Date: | 08/20 | /2015 | | |
| Client: Hor | neywell Project: | Onond Design | laga Lake SCA | A Final Cover | Project/ Proposal No.: GD | 5497 | Task No.: | 03 | | |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM SYRACUSE NEW YORK

| STATION LATITUDE | = | 43.07 | DEGREES |
|-------------------------------------|------|-------|---------|
| MAXIMUM LEAF AREA INDEX | = | 3.50 | |
| START OF GROWING SEASON (JULIAN DAT | E) = | 124 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 284 | |
| EVAPORATIVE ZONE DEPTH | = | 24.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 9.70 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDI | ΓY = | 72.00 | 00 |
| AVERAGE 2ND QUARTER RELATIVE HUMIDI | ΓY = | 68.00 | 010 |
| AVERAGE 3RD QUARTER RELATIVE HUMIDI | ΓY = | 75.00 | 90 |
| AVERAGE 4TH QUARTER RELATIVE HUMIDI | ΓY = | 76.00 | 90 |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SYRACUSE NEW YORK

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---------|-----------------------------|---|---|---|
| | | | | |
| 2.65 | 3.11 | 3.34 | 3.16 | 3.63 |
| 3.77 | 3.29 | 3.14 | 3.45 | 3.20 |
| | FEB/AUG 2.65 3.77 | FEB/AUG MAR/SEP 2.65 3.11 3.77 3.29 | FEB/AUG MAR/SEP APR/OCT 2.65 3.11 3.34 3.77 3.29 3.14 | FEB/AUG MAR/SEP APR/OCT MAY/NOV 2.65 3.11 3.34 3.16 3.77 3.29 3.14 3.45 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SYRACUSE NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---------|---------|---------|---------|---------|---------|
| | | | | | |
| 22.80 | 24.00 | 33.30 | 46.10 | 57.00 | 66.30 |
| 70.90 | 69.30 | 62.10 | 51.30 | 40.60 | 28.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SYRACUSE NEW YORK AND STATION LATITUDE = 43.07 DEGREES

 AVERAGE MONTHLY VALUES IN INCHES FOR YEARS
 1 THROUGH
 100

 JAN/JUL
 FEB/AUG
 MAR/SEP
 APR/OCT
 MAY/NOV
 JUN/DEC

 PRECIPITATION
 ------ ------ ------ ------ ------

 TOTALS
 2.59
 2.72
 3.16
 3.27
 3.09
 3.71

 3.87
 3.95
 3.27
 2.95
 3.40
 3.22

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| itten | by: Ray Wi | u / Clinton arlson | Date: 0 | 8/20/2015 | Reviewe | d by: S | Sowmya Bulu | su / Jay B | eech Dat | e: 08/20/2 | 20 |
|-------|-----------------------------|---------------------------|--------------------|---------------------|-------------------|-----------------|-------------------------|------------------|----------|------------|----|
| ent: | Honeywell | Project: | Onondaga Design | a Lake SCA | Final Cov | ver | Project/ Propo | sal No.: | GD5497 | Task No.: | |
| | STD. DEVIA | TIONS | 0.70 1.67 | 0.96 1.76 | 1.19 1.60 | 1.19 1.16 | 1.31 1.19 | 1.57 0.76 | | | |
| | RUNOFF | | | | | | | | | | |
| | TOTALS | | 0.506 0.031 | 1.384 0.035 | 4.816 0.062 | 1.516 0.039 | 0.049 0.067 | 0.080 0.256 | | | |
| | STD. DEVIA | TIONS | 0.713 0.211 | 1.475 0.150 | 2.374 0.204 | 1.470 0.163 | 0.193 0.217 | 0.292 0.496 | | | |
| | EVAPOTRANSPI | RATION | | | | | | | | | |
| | TOTALS | | 0.490 4.158 | 0.404 3.533 | 0.468 2.211 | 1.855 1.141 | 2.949 0.788 | 5.254 0.510 | | | |
| | STD. DEVIA | TIONS | 0.081 1.412 | 0.077 1.227 | 0.174 0.713 | 0.734 0.197 | 0.830 0.149 | 0.736 0.122 | | | |
| | LATERAL DRAII | NAGE COLLECI | ED FROM L | AYER 3 | | | | | | | |
| | TOTALS | | 0.0484 0.0417 | 0.0000 0.0418 | 0.1201 0.0842 | 1.378 0.441 | 9 0.6625 5 1.1764 | 0.2505 1.1200 | | | |
| | STD. DEVIA | TIONS | 0.1498 0.1538 | 0.0000 0.2041 | 0.3439 0.2653 | 0.582 0.691 | 0 0.5506 9 0.8863 | 0.3269 0.8028 | 8 | | |
| | PERCOLATION/ | LEAKAGE THRC | UGH LAYER | 4 | | | | | | | |
| | TOTALS | | 0.0084 0.0119 | 0.0000 0.0076 | 0.0355 0.0187 | 0.359 | 0 0.1667 2 0.2373 | 0.0747 0.2163 | | | |
| | STD. DEVIA | TIONS | 0.0264 0.0371 | 0.0000 0.0362 | 0.1000 0.0565 | 0.149 0.148 | 9 0.1341 8 0.2086 | 0.0653 0.1744 | | | |
| - | | AVERAGES OF | MONTHLY | AVERAGED | DAILY HE | ADS (IN | CHES) | | - | | |
| | DAILY AVERAG | e head on tc |)P OF LAYE | R 4 | | | | | | | |
| | AVERAGES | | 0.0049 0.0047 | 0.0000 0.0046 | 0.0776 0.0167 | 0.667 0.089 | 8 0.1156 2 0.2918 | 0.0216 0.2201 | | | |
| | STD. DEVIA | TIONS | 0.0351 0.0383 | 0.0000 0.0301 | 0.2186 0.0668 | 0.330 0.229 | 7 0.2758 7 0.4472 | 0.0771 0.3309 | | | |
| * | * * * * * * * * * * * * * * | * * * * * * * * * * * * * | ***** | * * * * * * * * * * | * * * * * * * * * | * * * * * * * * | * * * * * * * * * * * * | ****** | * | | |
| Ŷ | AVERAGE AI | NNUAL TOTALS | 5 & (STD. | DEVIATION | S) FOR Y | EARS | 1 THROUGH | 100 | | | |
| - | | | | INCHES | | CU. | FEET | PERCENT | - | | |

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| Writter | ı by: | Ray Wu / C Carlso | linton n | Date: | 08/20/20 | 015 | Reviewed by | : Sowmya | Bulusu / Jay B | eech Dat | e: 08/20/2 | 015 |
|---------|--------------|--------------------------|-------------------------------|------------------------------------|--|-----------------------------|--|--|-------------------------|----------|------------|-----|
| Client: | Hone | eywell | Project: | Onon Desig | daga Lake n | SCA | A Final Cover | Project/ F | Proposal No.: | GD5497 | Task No.: | 03 |
| | PRECI | PITATION | | | 39.20 | (| 4.823) | 142279.7 | 100.00 | | | |
| | RUNOF | F | | | 8.841 | (| 2.4182) | 32094.07 | 22.557 | | | |
| | EVAPO | TRANSPIRATIC | N | | 23.762 | (| 2.7230) | 86255.23 | 60.624 | | | |
| | LATER FRO | AL DRAINAGE M LAYER 3 | COLLECTE | D | 5.36610 | (| 1.92120) | 19478.934 | 13.69060 | | | |
| | PERCO LAY | LATION/LEAKA ER 4 | GE THROU | GH | 1.22639 | (| 0.42197) | 4451.789 | 3.12890 |) | | |
| | AVERA OF | GE HEAD ON T LAYER 4 | OP | | 0.126 (| | 0.060) | | | | | |
| | CHANG | E IN WATER S | TORAGE | | 0.000 | (| 1.2771) | -0.39 | 0.000 | | | |
| | ***** | * * * * * * * * * * * * | * * * * * * * * * | * * * * * * | * * * * * * * * * | * * * * | * * * * * * * * * * * * * | * * * * * * * * * * * | * * * * * * * * * * * * | * | | |
| | * * * * * * | * * * * * * * * * * * * | ****** | * * * * * * | ******* | * * * * | * * * * * * * * * * * * * * * * | * * * * * * * * * * * | * * * * * * * * * * * * | · | | |
| | | PE | AK DAILY | VALUE | S FOR YEA | ARS | 1 THROUGH | H 100 | | | | |
| | | | | | | | (INCHES) | (CU. | FT.) | | | |
| | | PRECIPITATIC | N | | | | 4.40 | 1597 | 2.000 | | | |
| | | RUNOFF | | | | | 4.213 | 1529 | 2.6318 | | | |
| | | DRAINAGE COL | LECTED FI | ROM LA | AYER 3 | | 0.24285 | 5 88 | 1.55237 | | | |
| | | PERCOLATION/ | LEAKAGE ' | THROUG | GH LAYER | 4 | 0.10726 | 54 38 | 9.36798 | | | |
| | | AVERAGE HEAD | ON TOP | OF LAY | YER 4 | | 10.022 | | | | | |
| | | MAXIMUM HEAD | ON TOP | OF LAY | YER 4 | | 12.203 | | | | | |
| | | LOCATION OF (DISTA | MAXIMUM I NCE FROM | HEAD I DRAIN | IN LAYER 1) | 3 | 74.5 FEB | ΞT | | | | |
| | | SNOW WATER | | | | | 9.62 | 3491 | 1.7891 | | | |
| | | MAXIMUM VEG. | SOIL WAY | IER (V | VOL/VOL) | | | 0.4379 | | | | |
| | | MINIMUM VEG. | SOIL WAY | TER (N | /OL/VOL) | | | 0.1948 | | | | |
| | | *** Maximu | um heads a | are co | omputed u | sing | g McEnroe's e | equations. | * * * | | | |
| | | Refere | ence: Max by ASC Vol | ximum Bruce CE Jou 1. 119 | Saturated M. McEni arnal of 1 M. No. 2, | d De roe, Envi Mai | epth over Lar University ironmental Er cch 1993, pp | ndfill Line of Kansas ngineering . 262-270. | r | | | |
| | * * * * * * | * * * * * * * * * * * * | * * * * * * * * * | * * * * * * | ***** | * * * ; | * * * * * * * * * * * * * * * | * * * * * * * * * * * * | * * * * * * * * * * * * | | | |

| | Beech and Bonapar engineering p. | | | | | | | • | |
|--------------|-------------------------------------|-----------------|---------------|---------------|---------------------------------------|-------|-----------|------|--|
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| | | | | | Page | 41 | of | 55 | |
| Written by: | Ray Wu / Clinton Carlson | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay Beech | Date: | 08/20/ | 2015 | |
| Client: Hone | eywell Project: | Onond Design | laga Lake SCA | A Final Cover | Project/ Proposal No.: GI |)5497 | Task No.: | 03 | |

| ****** | * * * * * * * * * * * * * | * * * * * * * * * * * * * * * * * * | ********** |
|---|---------------------------|-------------------------------------|------------|
| FIN | AL WATER STOR | AGE AT END OF Y | YEAR 100 |
| LA | YER (I | NCHES) (\ | /OL/VOL) |
| | 1 | 2.7450 | 0.4575 |
| | 2 | 7.3342 | 0.4075 |
| | 3 | 0.0020 | 0.0100 |
| | 4 | 0.0000 | 0.0000 |
| SNOW | WATER | 0.046 | |
| * | * * * * * * * * * * * * * | * * * * * * * * * * * * * * * * | **** |
| * | * * * * * * * * * * * * * | ******* | ***** |

| | | | | | Beech an er | d Bona ngineeri | iparte ^D ng p.c. | |
|-------------|-----------------------------|-------|---------------|---------------|---------------------------|--------------------|--------------------------------|---|
| | | | | | an affiliate of G | eosyntec Co | onsultants | |
| | | | | | Page | 42 | of 55 | |
| Written by: | Ray Wu / Clinton Carlson | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay Beech | Date: | 08/20/2015 | |
| Client: Hon | eywell Project: | Onond | laga Lake SCA | A Final Cover | Project/ Proposal No.: GI |)5497 | Task No.: 0. | 3 |

CASE 3: SCA MAIN DECK SIDE SLOPES WITH A 200-MIL GEOCOMPOSITE DRAINAGE LAYER

engineering p.c. an affiliate of Geosyntec Consultants Page 43 of 55 Ray Wu / Clinton Written by: Date: 08/20/2015 Reviewed by: Sowmya Bulusu / Jay Beech 08/20/2015 Date: Carlson **Onondaga Lake SCA Final Cover** Project: Project/ Proposal No.: Client: Honeywell GD5497 Task No.: 03 Design ***** ** * * * * * * * * HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE * * * * HELP MODEL VERSION 3.07 (1 NOVEMBER 1997) * * DEVELOPED BY ENVIRONMENTAL LABORATORY * * * * USAE WATERWAYS EXPERIMENT STATION * * * * FOR USEPA RISK REDUCTION ENGINEERING LABORATORY * * * * * * ** * * PRECIPITATION DATA FILE: \OLPRECIP.D4 TEMPERATURE DATA FILE: \OLTEMP.D7 SOLAR RADIATION DATA FILE: \OLSOLAR.D13 \OL LAI35.D11 EVAPOTRANSPIRATION DATA: SOIL AND DESIGN DATA FILE: \S-FN200A.D10 OUTPUT DATA FILE: \S-FN200A.OUT TIME: 18:45 DATE: 4/14/2015 ***** TITLE: Onondaga Lake SCA Closure NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM. LAYER 1 _____ TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 108 THICKNESS = 6.00 INCHES 0.4630 VOL/VOL POROSITY = FIELD CAPACITY 0.2320 VOL/VOL = 0.1160 VOL/VOL WILTING POINT = INITIAL SOIL WATER CONTENT = 0.4560 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-04 CM/SEC LAYER 2 ____ TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 113 = THICKNESS 18.00 INCHES 0.4300 VOL/VOL POROSITY = 0.3210 VOL/VOL FIELD CAPACITY = WILTING POINT = 0.2210 VOL/VOL INITIAL SOIL WATER CONTENT = 0.4115 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-05 CM/SEC

Beech and Bonaparte

| | | | | | | Beech | n and Bon enginee | aparte ^D ring p.c. | • | | |
|--------------------|---------------|-------------------|-----------------|--------------|--------------|---------------------------------------|----------------------|----------------------------------|------|--|--|
| | | | | | | an affiliate of Geosyntec Consultants | | | | | |
| | | | | | | Page | 44 | of | 55 | | |
| Written by: | Ray Wu Car | / Clinton Ison | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay H | Beech Date | : 08/20/2 | 2015 | | |
| Client: H o | oneywell | Project: | Onond Design | aga Lake SCA | Final Cover | Project/ Proposal No.: | GD5497 | Task No.: | 03 | | |
| | | | | LAYER 3 | | | | | | | |

| TYPE 2 - LATERA | L DE | RAINAGE LAYE | IR | |
|----------------------------|------|--------------|---------|--------|
| MATERIAL TEXI | URE | NUMBER 220 | | |
| THICKNESS | = | 0.20 | INCHES | |
| POROSITY | = | 0.8500 | VOL/VOL | |
| FIELD CAPACITY | = | 0.0100 | VOL/VOL | |
| WILTING POINT | = | 0.0050 | VOL/VOL | |
| INITIAL SOIL WATER CONTENT | = | 0.0100 | VOL/VOL | |
| EFFECTIVE SAT. HYD. COND. | = | 0.27000011 | 000 | CM/SEC |
| SLOPE | = | 25.00 | PERCENT | |
| DRAINAGE LENGTH | = | 100.0 | FEET | |

LAYER 4

| | TET | MEMDDANE IINED |
|----------------------------|-------|---------------------------|
| IIPE 4 - FLEAID | L D I | MEMORANE LINER |
| MATERIAL TEXT | URE | NUMBER 36 |
| THICKNESS | = | 0.04 INCHES |
| POROSITY | = | 0.0000 VOL/VOL |
| FIELD CAPACITY | = | 0.0000 VOL/VOL |
| WILTING POINT | = | 0.0000 VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0000 VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.399999993000E-12 CM/SEC |
| FML PINHOLE DENSITY | = | 0.00 HOLES/ACRE |
| FML INSTALLATION DEFECTS | = | 1.00 HOLES/ACRE |
| FML PLACEMENT QUALITY | = | 3 - GOOD |
| | | |

GENERAL DESIGN AND EVAPORATIVE ZONE DATA -----

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

| SCS RUNOFF CURVE NUMBER | = | 75.90 | |
|------------------------------------|---|--------|-------------|
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 24.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 10.143 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 10.518 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 4.674 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 10.145 | INCHES |
| TOTAL INITIAL WATER | = | 10.145 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

| | | | | | | | Beech | n and en | l Bon gineer | aparte ¹ ring p.c. | > |
|-------------------|----------------|---|--|---|--|---|---|-------------|-----------------|----------------------------------|-------|
| | | | | | | | an affilia | te of Ge | osyntec (| Consultants | |
| | | | | | | | Page | | 45 | of | 55 |
| vritten by: | Ray W | /u / Clinton arlson | Date: | 08/20/2015 | Reviewed by: | So | owmya Bulusu / Jay I | Beech | Date | 08/20 | /2015 |
| lient: H o | oneywell | Project: | Onond Design | aga Lake SCA | Final Cover | Р | roject/ Proposal No.: | GD | 5497 | Task No.: | 03 |
| | | EVAPOT | RANSPIF | RATION AND W | EATHER DATA | | | | | | |
| | NOTE: | EVAPOTRANS SYRACUSE | PIRATIC | DN DATA WAS NEW | OBTAINED FRC | M | | | | | |
| | NOTE : | AXIMUM LEAF START OF GROWIN EVD OF GROWIN EVAPORATIVE Z AVERAGE ANNUA AVERAGE 1ST Q AVERAGE 2ND Q AVERAGE 3RD Q AVERAGE 4TH Q : PRECIPITAT | AREA IN ING SEA G SEASC ONE DEE L WIND UARTER UARTER UARTER UARTER | DEX SON (JULIAN D TH SPEED RELATIVE HU RELATIVE HU RELATIVE HU RELATIVE HU | = I DATE) = PATE) = (MIDITY = 7 MIDITY = 7 MIDITY = 7 MIDITY = 7 MIDITY = 7 MIDITY = 7 | 3.50 124 284 4.0 9.70 2.00 8.00 5.00 6.00 | INCHES MPH % % % % | | | | |
| | | COEFFICI NORMAL M | ents fo Ean mon | DR SYRACU | ISE PITATION (INC | NE HES) | W YORK | | | | |
| | JAN/JUL | FEB/AUG | MAR/ | SEP APR | A/OCT MAY | /NOV | JUN/DEC | | | | |
| | 2.61 3.76 | 2.65 3.77 | 3. 3. | 11 3 29 3 | .34 3 .14 3 | .16 .45 | 3.63 3.20 | | | | |
| | NOTE : | : TEMPERATUR COEFFICI | E DATA ENTS FC | WAS SYNTHET DR SYRACU | 'ICALLY GENEF 'SE | ATED NE | USING W YORK | | | | |
| | 1 | IORMAL MEAN M | ONTHLY | TEMPERATURE | (DEGREES FA | HREN | HEIT) | | | | |
| | JAN/JUL | FEB/AUG | MAR/ | SEP APR | /OCT MAY | /NOV | JUN/DEC | | | | |
| | 22.80 70.90 | 24.00 69.30 | 33. 62. | 30 46 10 51 | .10 57 .30 40 | .00 | 66.30 28.30 | | | | |
| | NOTE : | : SOLAR RADI COEFFICI AND ST | ATION E ENTS FC ATION I | DATA WAS SYN DR SYRACU LATITUDE = | THETICALLY G ISE 43.07 DEGRE | ENER. NE ES | ATED USING W YORK | | | | |
| **** | ***** | * * * * * * * * * * * * * | * * * * * * * | **** | * * * * * * * * * * * * | * * * * | * | * | | | |
| | AVERA | AGE MONTHLY V | ALUES I | N INCHES FO | R YEARS 1 | THR | OUGH 100 | | | | |
| | | J | AN/JUL | FEB/AUG M | IAR/SEP APR/ | OCT | MAY/NOV JUN/DEC | : | | | |
| PR | ECTPTTATT | - DN | | | · | | | | | | |

2.592.723.163.273.093.713.873.953.272.953.403.22

TOTALS

an affiliate of Geosyntec Consultants

of 55 46 Page

| tten ł | by: Ray Wu Ca | / Clinton :lson | Date: (| 08/20/2015 | Reviewe | d by: | Sowmya Bul | usu / Jay Bo | eech Dat | e: 08/20/2 | 201 |
|--------|--|-----------------------|--------------------------|------------------|----------------------|----------------|----------------------|-------------------|----------|------------|-----|
| ent: | Honeywell | Project: | Onondag Design | a Lake SCA | Final Cov | ver | Project/ Prop | osal No.: | GD5497 | Task No.: | |
| | STD. DEVIAT RUNOFF | IONS | 0.70 1.67 | 0.96 1.76 | 1.19 1.60 | 1.19 1.16 | 1.31 1.19 | 1.57 0.76 | | | |
| | TOTALS | | 0.510 0.035 | 1.388 0.040 | 4.823 0.070 | 1.526 0.051 | 0.058 0.080 | 0.088 0.262 | | | |
| | STD. DEVIAT | IONS | 0.716 0.213 | 1.478 0.151 | 2.376 0.217 | 1.470 0.173 | 0.204 0.224 | 0.304 0.499 | | | |
| | EVAPOTRANSPIR | ATION | | | | | | | | | |
| | TOTALS | | 0.490 4.163 | 0.404 3.531 | 0.468 2.208 | 1.854 1.139 | 2.949 0.787 | 5.252 0.510 | | | |
| | STD. DEVIAT | IONS | 0.080 1.409 | 0.077 1.225 | 0.174 0.712 | 0.733 0.197 | 0.831 0.148 | 0.738 0.122 | | | |
| | LATERAL DRAIN | AGE COLLECT | TED FROM I | AYER 3 | | | | | | | |
| | TOTALS | | 0.0466 0.0473 | 0.0000 0.0447 | 0.1571 0.0897 | 1.653 0.490 | 0 0.7225 3 1.3411 | 0.2818 1.2196 | | | |
| | STD. DEVIAT | IONS | 0.1503 0.1722 | 0.0000 0.2194 | 0.4386 0.2881 | 0.661 0.781 | 8 0.6178 5 1.0325 | 0.3567 0.9122 | | | |
| | PERCOLATION/L | EAKAGE THRO | DUGH LAYEF | k 4 | | | | | | | |
| | TOTALS | | 0.0034 0.0053 | 0.0000 0.0032 | 0.0063 0.0067 | 0.084 0.033 | 3 0.0715 8 0.0830 | 0.0374 0.0788 | | | |
| | STD. DEVIAT | IONS | 0.0109 0.0136 | 0.0000 0.0141 | 0.0179 0.0198 | 0.034 0.048 | 8 0.0270 0 0.0532 | 0.0232 0.0453 | | | |
| | | AVERAGES OF | 7 MONTHLY | AVERAGED | DAILY HE | ADS (IN | CHES) | | - | | |
| | DATLY AVERAGE | HEAD ON TO | POFIAYE | | | | | | - | | |
| | AVERAGES | | 0.0004 | 0.0000 | 0.0014 | 0.015 0.004 | 3 0.0065 4 0.0124 | 0.0026 0.0109 | | | |
| | STD. DEVIAT | IONS | 0.0013 0.0015 | 0.0000 0.0020 | 0.0039 0.0027 | 0.006 0.007 | 1 0.0055 0 0.0096 | 0.0033 0.0082 | | | |
| *: | * * * * * * * * * * * * * * | * * * * * * * * * * * | * * * * * * * * * * | ***** | * * * * * * * * | * * * * * * * | * * * * * * * * * * | * * * * * * * * * | * | | |
| *: | ************************************** | *********** | *********** 6 & (STD. | DEVIATION | ******** S) FOR Y | ****** EARS | 1 THROUGH | 100 | * | | |
| | | | | INCHES | | CU. | FEET | PERCENT | - | | |
| 1 | PRECIPITATION | | 39. | 20 (| 4.823) | | 279.7 | 100.00 | | | |

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47 55 of Page

| Writter | itten by: Ray Wu / Clinton Carlson | | Date: | 08/20/20 | 15 | Reviewed by: | Sowmya B | ulusu / Jay B | eech Dat | e: 08/20/2 | 015 |
|---------|---------------------------------------|---------------------------------------|---|--|-----------------------------|---|---|-----------------------|----------|------------|-----|
| Client: | Honey | well Projec | t: Onon Desig | daga Lake n | SCA | A Final Cover | Project/ Pr | oposal No.: | GD5497 | Task No.: | 03 |
| | RUNOFF | | | 8.932 | (| 2.4161) | 32422.89 | 22.788 | | | |
| | EVAPOTE | RANSPIRATION | | 23.756 | (| 2.7218) | 86235.50 | 60.610 | | | |
| | LATERAI FROM | L DRAINAGE COLLEC LAYER 3 | CTED | 6.09367 | (| 2.15624) | 22120.031 | 15.54687 | | | |
| | PERCOLA LAYEF | ATION/LEAKAGE THE R 4 | ROUGH | 0.41371 | (| 0.13082) | 1501.749 | 1.05549 |) | | |
| | AVERAGE OF LA | e head on top Ayer 4 | | 0.005 (| | 0.002) | | | | | |
| | CHANGE | IN WATER STORAGE | | 0.000 | (| 1.2799) | -0.49 | 0.000 | | | |
| | PF | PEAK DAI | LY VALUE | ES FOR YEA | 1RS | 1 THROUGH (INCHES) 4.40 | 100 (CU. 15972 | FT.) .000 | | | |
| | RU | JNOFF | | | | 4.215 | 15300 | .2031 | | | |
| | DF | RAINAGE COLLECTEI |) FROM LA | AYER 3 | | 0.32939 | 1195 | .67102 | | | |
| | PI | ERCOLATION/LEAKAO | E THROUG | GH LAYER | 4 | 0.01076 | 6 39 | .08068 | | | |
| | A | VERAGE HEAD ON TO | OF LAY | (ER 4 | | 0.091 | | | | | |
| | MZ | AXIMUM HEAD ON TO | OP OF LAY | (ER 4 | 2 | 0.185 | | | | | |
| | ΓC | DCATION OF MAXIMU (DISTANCE FI | IM HEAD I ROM DRAIN | IN LAYER 1) | 3 | 0.0 FEE | Т | | | | |
| | SI | NOW WATER | | | | 9.62 | 34911 | .7891 | | | |
| | MZ | AXIMUM VEG. SOIL | WATER (N | /OL/VOL) | | | 0.4371 | | | | |
| | MI | INIMUM VEG. SOIL | WATER (\ | /OL/VOL) | | | 0.1948 | | | | |
| | ł | *** Maximum head | ls are co | omputed us | sing | g McEnroe's e | quations. | * * * | | | |
| | | Reference: | Maximum by Bruce ASCE Jou Vol. 119 | Saturated M. McEnr urnal of E M. No. 2, | l De coe, Invi Mar | epth over Lan University Fronmental En Sch 1993, pp. | dfill Liner of Kansas gineering 262-270. | | | | |
| | * * * * * * * * * | * * * * * * * * * * * * * * * * * * * | * * * * * * * * * | * * * * * * * * * * | * * * * | * * * * * * * * * * * * * | * * * * * * * * * * * | * * * * * * * * * * * | r. | | |

| | | | | | | | enginee | ering p.c. | |
|----------------------------|------------------|---|--------------------|--|---|---|-----------------|-------------|-------|
| | | | | | | an affilia | te of Geosyntec | Consultants | |
| | | | | | | Page | 48 | of | 55 |
| Written by: | Ray Wu / Carl | Clinton son | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay H | Beech Date | e: 08/20 | /2015 |
| liont. II. | nevwell | Project: | Onond Design | laga Lake SCA | Final Cover | Project/ Proposal No.: | GD5497 | Task No.: | 03 |
| _nent: Hor | | | Design | | | | | | |
| inent: Hor | | | Design | | | | | | |
| ***** | **** | * * * * * * * * * * | ****** | **** | * * * * * * * * * * * * * * * | * | * | | |
| ***** | **** | ********** FINAL W | ******* | ************************************** | *************** D OF YEAR 10(| ************************************** | * | | |
| ***** | **** | ********** FINAL W. LAYER | ******* ATER SI | ************************************** | **************** D OF YEAR 10((VOL/VOL) | ************************************** | * | | |
| ***** | **** | *********** FINAL W. LAYER 1 | ******* | CORAGE AT EN | ************************************** | ************************************** | * | | |
| ***** | ***** | ********** FINAL W. LAYER 1 2 | ******* | TORAGE AT EN (INCHES) 2.7450 7.3386 | ************************************** | ************************************** | * | | |
| -11ent: Hor ***** | **** | *********** FINAL W. LAYER 1 2 3 | ******* | CORAGE AT EN (INCHES) 2.7450 7.3386 0.0020 | <pre>************************************</pre> | ************************************** | * | | |
| -nent: Hor ***** | **** | ************************************** | ****** ATER SI | CORAGE AT EN (INCHES) 2.7450 7.3386 0.0020 0.0000 | ************************************** | ************************************** | * | | |

Beech and Bonaparte **>**

| | | | | | Beech an er | d Bona ngineeri | ıparte ♥ ng p.c. | |
|-------------|-----------------------------|-------|---------------|--------------|---------------------------|--------------------|---------------------|-----|
| | | | | | an affiliate of G | eosyntec Co | onsultants | |
| | | | | | Page | 49 | of 5 | 5 |
| Written by: | Ray Wu / Clinton Carlson | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay Beech | Date: | 08/20/20 | 015 |
| Client: Hon | eywell Project: | Onond | laga Lake SCA | Final Cover | Project/ Proposal No.: GL |) 5497 | Task No.: | 03 |

CASE 4: SCA MAIN DECK SIDE SLOPES WITH A 250-MIL GEOCOMPOSITE DRAINAGE LAYER

engineering p.c. an affiliate of Geosyntec Consultants Page 50 of 55 Ray Wu / Clinton Written by: Date: 08/20/2015 Reviewed by: Sowmya Bulusu / Jay Beech Date: 08/20/2015 Carlson **Onondaga Lake SCA Final Cover** Project: Project/ Proposal No.: Client: Honeywell GD5497 Task No.: 03 Design ***** ** * * * * * * * * HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE * * * * HELP MODEL VERSION 3.07 (1 NOVEMBER 1997) * * * * DEVELOPED BY ENVIRONMENTAL LABORATORY * * * * USAE WATERWAYS EXPERIMENT STATION * * * * FOR USEPA RISK REDUCTION ENGINEERING LABORATORY * * * * * * ** * * **** PRECIPITATION DATA FILE: \OLPRECIP.D4 TEMPERATURE DATA FILE: \OLTEMP.D7 SOLAR RADIATION DATA FILE: \OLSOLAR.D13 EVAPOTRANSPIRATION DATA: \OL LAI35.D11 SOIL AND DESIGN DATA FILE: \s-FN250.D10 OUTPUT DATA FILE: \S-FN250A.OUT TIME: 20: 8 DATE: 4/15/2015 ******* TITLE: Onondaga Lake SCA Closure NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM. LAYER 1 _____ TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 108 THICKNESS = 6.00 INCHES 0.4630 VOL/VOL POROSITY = FIELD CAPACITY = 0.2320 VOL/VOL WILTING POINT = 0.1160 VOL/VOL INITIAL SOIL WATER CONTENT = 0.4555 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-04 CM/SEC LAYER 2 _____ TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 113 THICKNESS INCHES = 18.00 POROSITY = 0.4300 VOL/VOL 0.3210 VOL/VOL FIELD CAPACITY = WILTING POINT = 0.2210 VOL/VOL INITIAL SOIL WATER CONTENT = 0.4120 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-05 CM/SEC

Beech and Bonaparte

| | | | | | | Beec | h and Bo engine | naparte ⁽ ering p.c. | > |
|--------------------|------------------|-------------------------|----------------------|--|--|------------------------|--------------------|------------------------------------|--------|
| | | | | | | an affilia | ate of Geosyntee | c Consultants | |
| | | | | | | Page | 51 | of | 55 |
| Written by: | Ray Wu / Carl | Clinton son | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay | Beech Dat | te: 08/20 |)/2015 |
| Client: H o | oneywell | Project: | Onond Design | laga Lake SCA | Final Cover | Project/ Proposal No.: | GD5497 | Task No.: | : 03 |
| | | | | LAYER 3 | | | | | |
| | THICK POROS | TYE M NESS ITY | PE 2 - I MATERIAI | LATERAL DRAI L TEXTURE NU = = | NAGE LAYER MBER 220 0.25 INCH 0.8500 VOL/ | ies /vol | | | |

| FIELD CAPACITY | = | 0.0100 | VOL/VOL | |
|----------------------------|---|-----------|---------|--------|
| WILTING POINT | = | 0.0050 | VOL/VOL | |
| INITIAL SOIL WATER CONTENT | = | 0.0100 | VOL/VOL | |
| EFFECTIVE SAT. HYD. COND. | = | 1.0599999 | 4000 | CM/SEC |
| SLOPE | = | 25.00 | PERCENT | |
| DRAINAGE LENGTH | = | 100.0 | FEET | |

LAYER 4

| TYPE 4 - FLEXIB | LE I | MEMBRANE LINER |
|----------------------------|------|--------------------------|
| MATERIAL TEXT | URE | NUMBER 36 |
| THICKNESS | = | 0.04 INCHES |
| POROSITY | = | 0.0000 VOL/VOL |
| FIELD CAPACITY | = | 0.0000 VOL/VOL |
| WILTING POINT | = | 0.0000 VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0000 VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.39999993000E-12 CM/SEC |
| FML PINHOLE DENSITY | = | 0.00 HOLES/ACRE |
| FML INSTALLATION DEFECTS | = | 1.00 HOLES/ACRE |
| FML PLACEMENT QUALITY | = | 3 - GOOD |

GENERAL DESIGN AND EVAPORATIVE ZONE DATA -----

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

| SCS RUNOFF CURVE NUMBER | = | 75.90 | |
|------------------------------------|---|--------|-------------|
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 24.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 10.148 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 10.518 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 4.674 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 10.151 | INCHES |
| TOTAL INITIAL WATER | = | 10.151 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

| | | | | | | | | Beecl | h and en | l Bon ginee | naparte ring p.c. | D |
|------------------|--|--|--|--|---|--|---|-------------------------------------|-------------|----------------|----------------------|--------|
| | | | | | | | | an affilia | te of Geo | osyntec (| Consultants | |
| | | | | | | | | Page | | 52 | of | 55 |
| ritten by: | Ray Wu Car | / Clinton Ison | Date: | 08/20/2015 | Review | wed by: | Sowmya I | Bulusu / Jay I | Beech | Date | |)/2015 |
| ient: H o | oneywell | Project: | Onond Design | laga Lake SC | CA Final C | Cover | Project/ P | roposal No.: | GD5 | 5497 | Task No. | : 03 |
| | | F177 DO1 | יסאאפסדנ | AMTON AND | MENTUED | ኮእሞአ | | | | | | |
| | NOTE: | EVAPOTRANS | SPIRATIC | ON DATA WAS | G OBTAIN | ED FROM | | | | | | |
| | ST MA ST EV AV AV AV AV | ATION LATIT XIMUM LEAF ART OF GROWIN D OF GROWIN APORATIVE 2 ERAGE ANNUA ERAGE 1ST (ERAGE 1ST (ERAGE 2ND (ERAGE 3RD (ERAGE 4TH (| CUDE AREA IN VING SEA IG SEASC CONE DEB AL WIND QUARTER QUARTER QUARTER QUARTER | NDEX ASON (JULIAN PTH SPEED RELATIVE H RELATIVE H RELATIVE H RELATIVE H | AN DATE) DATE) HUMIDITY HUMIDITY HUMIDITY HUMIDITY | $\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$ | 07 DEGREF 50 24 84 0 INCHES 70 MPH 00 % 00 % 00 % 00 % | 2S 5 | | | | |
| | NOTE: | PRECIPITAT COEFFICI | TION DAT | TA WAS SYNT DR SYRAG | THETICALI CUSE | LY GENER | ATED USIN NEW YORK | NG | | | | |
| | | NORMAL N | iean moi | NTHLY PREC | IPITATIO | N (INCHE | S) | | | | | |
| | JAN/JUL | FEB/AUG | MAR/ | SEP AI | PR/OCT | MAY/N | 0V JU | JN/DEC | | | | |
| | 2.61 3.76 | 2.65 3.77 | 3. 3. | .11 .29 | 3.34 3.14 | 3.1 3.4 | 6 5 | 3.63 3.20 | | | | |
| | NOTE: | TEMPERATUR COEFFICI | RE DATA IENTS FO | WAS SYNTHE DR SYRAC | ETICALLY CUSE | GENERAT | ED USING NEW YORK | | | | | |
| | NO | RMAL MEAN N | IONTHLY | TEMPERATU | RE (DEGRE | EES FAHR | ENHEIT) | | | | | |
| | JAN/JUL | FEB/AUG | MAR/ | SEP AI | PR/OCT | MAY/N | ov ju | JN/DEC | | | | |
| | 22.80 70.90 | 24.00 69.30 | 33. 62. | .30 4 | 46.10 51.30 | 57.0 40.6 | 0 6 0 2 | 56.30 28.30 | | | | |
| **** | NOTE: *********** AVERAG | SOLAR RADI COEFFICI AND ST ************ | TATION I TENTS FO TATION I | DATA WAS SY DR SYRA(LATITUDE = | YNTHETIC CUSE = 43.07 ********* FOR YEARS | ALLY GEN DEGREES ******** 5 1 T | ERATED US NEW YORK ********* HROUGH 1 | SING *************** 100 | * * | | | |
| | | : - | JAN/JUL | FEB/AUG | MAR/SEP | APR/OC | T MAY/NC | DV JUN/DEC | C | | | |
| PR | ECIPITATION | | | | | | | | | | | |
| | TOTALS | | 2.59 3.87 | 2.72 3.95 | 3.16 3.27 | 3.27 2.95 | 3.09 3.40 | 3.713.22 | | | | |

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| nt:] | Honeywell STD. DEVIAT | Project: | Onondag Design | a Lake SCA | Final Co | vor | | | | |
|--------|---------------------------|-------------------------|-------------------|-------------------|------------------|----------------|-----------------------|-------------------|--------|-----------|
| H | STD. DEVIAT RUNOFF | IONS | | | | vci | Project/ Propo | sal No.: | GD5497 | Task No.: |
| - - | RUNOFF | | 0.70 1.67 | 0.96 1.76 | 1.19 1.60 | 1.19 1.16 | 1.31 1.19 | 1.57 0.76 | | |
| - | | | | | | | | | | |
| | TOTALS | | 0.512 0.037 | 1.391 0.044 | 4.826 0.073 | 1.528 0.053 | 0.059 0.082 | 0.093 0.264 | | |
| | STD. DEVIAT | IONS | 0.717 0.221 | 1.479 0.160 | 2.377 0.222 | 1.469 0.178 | 0.207 0.228 | 0.315 0.501 | | |
| Ι | EVAPOTRANSPIR | ATION | | | | | | | | |
| - | TOTALS | | 0.490 4.168 | 0.404 3.530 | 0.468 2.205 | 1.854 1.139 | 2.949 0.786 | 5.256 0.510 | | |
| | STD. DEVIAT | IONS | 0.080 1.408 | 0.077 1.223 | 0.174 0.708 | 0.732 0.197 | 0.831 0.148 | 0.736 0.122 | | |
| 1 | LATERAL DRAIN | AGE COLLECT | ED FROM L | AYER 3 | | | | | | |
| | TOTALS | | 0.0467 0.0495 | 0.0000 0.0453 | 0.1626 0.0916 | 1.701 0.508 | 1 0.7606 0 1.3934 | 0.2958 1.2583 | | |
| | STD. DEVIAT | IONS | 0.1533 0.1786 | 0.0000 0.2222 | 0.4515 0.2922 | 0.668 0.805 | 5 0.6241 3 1.0617 | 0.3591 0.9364 | | |
|] | PERCOLATION/L | EAKAGE THRO | DUGH LAYER | 4 | | | | | | |
| - | TOTALS | | 0.0012 0.0019 | 0.0000 0.0012 | 0.0026 | 0.034 0.013 | 1 0.0271 3 0.0329 | 0.0140 0.0307 | | |
| | STD. DEVIAT | IONS | 0.0041 0.0054 | 0.0000 0.0055 | 0.0074 0.0077 | 0.013 0.018 | 6 0.0108 9 0.0212 | 0.0093 0.0185 | | |
| | | AVERAGES OF | MONTHLY | AVERAGED | DAILY HE | ADS (IN | CHES) | | - | |
| I | DAILY AVERAGE | HEAD ON T(| OP OF LAYE | R 4 | | | | | | |
| | AVERAGES | | 0.0001 0.0001 | 0.0000 0.0001 | 0.0004 | 0.004 0.001 | 2 0.0019 2 0.0035 | 0.0008 0.0031 | | |
| | STD. DEVIAT | IONS | 0.0004 | 0.0000 0.0005 | 0.0011 0.0007 | 0.001 0.001 | 7 0.0015 9 0.0027 | 0.0009 0.0023 | | |
| *** | * * * * * * * * * * * * * | * * * * * * * * * * * | ***** | * * * * * * * * * | * * * * * * * * | ***** | * * * * * * * * * * * | * * * * * * * * * | * | |
| **; | * * * * * * * * * * * * * | * * * * * * * * * * * * | ****** | ****** | ****** | * * * * * * * | * * * * * * * * * * * | * * * * * * * * | * | |
| | AVERAGE AN | NUAL TOTALS | 5 & (STD. | DEVIATION | S) FOR Y | EARS | 1 THROUGH | 100 | _ | |
| | | | | INCHES | | CU. | FEET | PERCENT | | |

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| Written | by: Ray Wu / Carls | Clinton son | Date: | 08/20/20 | 015 | Reviewed by: | Sowmya B | ulusu / Jay B | eech Dat | e: 08/20/2 | 2015 |
|---------|-------------------------------------|-----------------------------|------------------------------------|--|-----------------------------|---|---|-----------------------|----------|------------|------|
| Client: | Honeywell | Project: | Onono Design | daga Lake 1 | SC | A Final Cover | Project/ Pro | oposal No.: | GD5497 | Task No.: | 03 |
| | RUNOFF | | | 8.962 | (| 2.4162) | 32533.42 | 22.866 | | | |
| | EVAPOTRANSPIRAT | ION | | 23.759 | (| 2.7202) | 86244.54 | 60.616 | | | |
| | LATERAL DRAINAGI FROM LAYER 3 | E COLLECTE | D | 6.31278 | (| 2.22009) | 22915.404 | 16.10589 | | | |
| | PERCOLATION/LEAN LAYER 4 | KAGE THROU | GH | 0.16169 | (| 0.05215) | 586.931 | 0.41252 | | | |
| | AVERAGE HEAD ON OF LAYER 4 | TOP | | 0.001 (| | 0.000) | | | | | |
| | CHANGE IN WATER | STORAGE | | 0.000 | (| 1.2801) | -0.64 | 0.000 | | | |
| * | ************* | *********** PEAK DAILY | ****** VALUE | ******** S FOR YE2 | ***; ARS | 1 THROUGH | 100 | ******** | | | |
| | | | | | | (INCHES) | (CU. | FT.) | | | |
| | PRECIPITAT | ION | | | | 4.40 | 15972 | .000 | | | |
| | RUNOFF | | | | | 4.216 | 15303 | .1348 | | | |
| | DRAINAGE CO | OLLECTED F | ROM LA | yer 3 | | 0.34649 | 1257 | .74072 | | | |
| | PERCOLATION | N/LEAKAGE ' | THROUG | H LAYER | 4 | 0.00548 | 5 19 | .91227 | | | |
| | AVERAGE HEA | AD ON TOP | OF LAY | ER 4 | | 0.025 | | | | | |
| | MAXIMUM HEA | AD ON TOP | OF LAY | ER 4 | | 0.034 | | | | | |
| | LOCATION OF | F MAXIMUM I FANCE FROM | HEAD I DRAIN | N LAYER) | 3 | 25.9 FEE | Γ | | | | |
| | SNOW WATER | | | | | 9.62 | 34911 | .7891 | | | |
| | MAXIMUM VE | G. SOIL WA' | TER (V | OL/VOL) | | | 0.4372 | | | | |
| | MINIMUM VEC | G. SOIL WA' | TER (V | OL/VOL) | | | 0.1948 | | | | |
| | *** Maxir | num heads | are co | mputed us | sing | g McEnroe's e | quations. | * * * | | | |
| | Refe | rence: Ma by AS Vo | ximum Bruce CE Jou l. 119 | Saturated M. McEni rnal of F , No. 2, | d De coe, Env: Mai | epth over Lan , University ironmental En rch 1993, pp. | dfill Liner of Kansas gineering 262-270. | | | | |
| * | * * * * * * * * * * * * * * * * * * | * * * * * * * * * * | * * * * * * | * * * * * * * * * | * * * ; | * * * * * * * * * * * * * | * * * * * * * * * * * * | * * * * * * * * * * * | | | |

| | | | | | Beec | ch and en | d Bor ginee | naparte ering p.c | |
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| Vritten by: | Ray Wu / Clinton Carlson | Date: | 08/20/2015 | Reviewed by: | Sowmya Bulusu / Jay | Beech | Date | e: 08/2 | 20/2015 |
| | | | | - | | | | — 1.11 | 02 |
| Client: Honey | well Proje | ect: Onon Desig | daga Lake SCA n | *********************** | Project/ Proposal No.: | GD: ** | 5497 | Task No | J U 3 |
| Client: Honey | well Proje | ect: Onon Desig | daga Lake SCA n *********************************** | • Final Cover | Project/ Proposal No.: ************************************ | GD: ** | 5497 | Task No | 03 |
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| 2lient: Honey ******** | well Proje | ect: Onon Desig | daga Lake SCA n *********************************** | ************************************** | Project/ Proposal No.: ************************************ | GD : | 5497 | Task No | 03 |
| Client: Honey | well Proje | ect: Onon Desig | daga Lake SCA n STORAGE AT EN (INCHES) 2.7450 7.3398 0.0025 0.0000 | ************************************** | Project/ Proposal No.: | GD : | 5497 | Task No | 03 |