TECHNICAL MEMORANDUM

Technical Review of a Groundwater Mounding Analysis for a Proposed Development at 35th Street and Rhododendron Drive, Florence, Oregon

To: Mike Miller / City of Florence Public Works

From: Matt Kohlbecker, RG / GSI Water Solutions, Inc.
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Date: July 21, 2021

This Technical Memorandum (TM) summarizes a review of the Branch Engineering, Inc. (BEI) report titled *Geotechnical Evaluation of Groundwater Hydraulics, Florence Housing Development—Site A*, dated July 6, 2021. The purpose of the BEI report is to evaluate the potential for stormwater infiltration at a proposed development northeast of 35th Street and Rhododendron Drive in Florence, Oregon, to exacerbate erosion of a nearby bluff at the Sea Watch Subdivision.

1. Background

APIC Florence Holdings, LLC (APIC), has proposed a 120 planned unit development on a parcel located northeast of the intersection of 35th Street and Rhododendron Drive in Florence, Oregon (City of Florence, 2021). Currently, the site is undeveloped, and precipitation infiltrates into site soils or is conveyed offsite through a drainage ditch into the drainage system on Rhododendron Drive. Development of the site will create 231,733 square feet of impervious area, and all stormwater runoff from impervious surfaces will be infiltrated using 13 soakage trenches, 3 drywells, and 1 infiltration basin (3J Consulting, 2020; 3J Consulting and LRS Architects, 2020).

The proposed development is located near the Sea Watch Subdivision, which is located on a sand bluff bordering the Siuslaw River about 500 feet west of Rhododendron Drive. In the past, homeowners have raised concerns about erosion of the bluff. One geotechnical evaluation concluded that erosion is due to internal erosion of bluff sand by springs along the toe of the bluff, which are created by daylighting groundwater (Foundation Engineers, 1997). Another geotechnical evaluation additionally identified the preexisting steepness of the slope, wind erosion, and water erosion as contributing factors (GeoDesign, 2005).

Hypothetically, stormwater infiltration has the potential to increase the flow of springs at the toe of the bluff because infiltration from a constructed basin causes the groundwater level in an aquifer to rise into a mound-like shape. As infiltration continues, the groundwater mound spreads further away from the infiltration site. If the groundwater mound were to reach the springs at the toe of the bluff, spring flow could increase, potentially exacerbating bluff erosion. Specifically, the spring flow could increase because, according to Darcy's Law, a higher hydraulic gradient associated with the groundwater mound increases the groundwater discharge rate at the springs [see Equation (2.4) in Freeze and Cherry (1979)]. If the groundwater mound does not reach the springs at the toe of the bluff, then spring flow would not increase, and bluff erosion due to the springs would not be exacerbated by the stormwater infiltration.

The City of Florence (City) requested that APIC provide technical information demonstrating that stormwater infiltration at the proposed development would not exacerbate erosion of the Sea Watch Subdivision bluff, and retained GSI Water Solutions, Inc. (GSI) to conduct a third party review of the technical information. On July 6, 2021, APIC provided the City with a *Geotechnical Evaluation of Groundwater Hydraulics, Florence Housing Development—Site A*, prepared by BEI (BEI, 2021). On July 15, 2021, 3J Consulting provided GSI with additional information about the locations of soakage trenches at the proposed development (3J Consulting, 2021). The remainder of this TM presents GSI's technical review of the evaluation of groundwater mounding and potential impacts on springs documented in the BEI report, and is organized as follows:

- **Section 1: Background.**
- **Section 2: Technical Review.** Presents GSI's review of BEI's modeling approach to evaluating groundwater mounding and the parameters (e.g., aquifer properties) used in the evaluation.
- **Section 3: Re-Run of the Hantush (1967) Equation to Calculate Mounding from Soakage Trenches and Drywells.** Presents a re-run of the model used by BEI to evaluate whether including infiltration from soakage trenches and drywells changes the overall conclusion of BEI (2021).
- **Section 4: Conclusions.** Presents GSI's conclusion about BEI's modeling analysis.

2. Technical Review

BEI used the Hantush (1967) equation to calculate the groundwater mounding that occurs when stormwater is infiltrated into the infiltration basin at the proposed development. BEI calculated that the groundwater mound would be 0.06 feet at 120 feet west of the infiltration basin. Based on this result, BEI concluded that ". . . the degree of mounding (from stormwater infiltration) is expected to be negligible" (BEI, pg. 3, 2021).

The following sections present GSI's review of the approach that BEI used to evaluate mounding (Section 2.1) and the input parameters BEI used to calculate mounding (Section 2.2).

2.1 Technical Review of BEI Approach

Originally published in the scientific journal *Water Resources Research*, the Hantush (1967) equation is a peer-reviewed, widely-accepted method for estimating groundwater mounding beneath an infiltration basin under steady-state conditions (Carleton, 2010). Moreover, BEI performed the mounding calculations using a spreadsheet model developed by the U.S. Geological Survey (Carleton, 2010), so the implementation of the equation was performed using a peer-reviewed tool. However, BEI's evaluation only addressed groundwater mounding from the infiltration basin (i.e., BEI did not address groundwater mounding from the 13 soakage trenches or 3 drywells).

GSI concludes that the approach to evaluating groundwater mounding used acceptable equations, and that the equations were implemented correctly using a U.S. Geological Survey spreadsheet. However, GSI notes that the approach did not include the effects of mounding from soakage trenches and drywells.

2.2 Technical Review of BEI's Input Parameters

In order to calculate groundwater mounding, the Hantush (1967) equation requires that the user specify physical properties of the infiltration basin, aquifer properties, the infiltration rate, and the infiltration duration (called "input parameters" in this TM). The aquifer properties should be representative of the sandy sediments of the Dune Sand, which is the unit into which stormwater will be infiltrated, and from which spring discharges occur at the toe of the Sea Watch Subdivision (Hampton, 1963). GSI reviewed the input parameters used by BEI to determine if they were: (1) representative, as compared to published values for the Florence area and/or proposed development, and (2) conservative, meaning that the input parameter would over-predict mounding. The following bullets summarize GSI's review of the input parameters used in the Hantush (1967) equation:

- **Physical Properties of the Infiltration Basin.** According to 3J Consulting (2020) and personal communication (2021a, 2021b), the infiltration basin system is comprised of a 700 square foot water quality treatment basin (dimensions of 4 feet by 175 feet) and an approximately 1,430 square foot infiltration basin (dimensions of 13 feet by 110 feet). Stormwater is treated in the water quality treatment basin, and then overflows into the infiltration basin where it is infiltrated. In the Hantush (1967) mounding calculations, BEI (2021) uses the dimensions of the water quality treatment basin, which is smaller than the infiltration basin. The dimensions used by BEI (2021) are not representative of the infiltration basin; however, the dimensions used by BEI (2021) are conservative (because using a smaller basin area results in higher mounding).

- **Specific Yield.** A property of unconfined aquifers, specific yield is a dimensionless value that describes the volume of water stored in aquifer pores that is released per unit surface area of aquifer per unit decline in the water table (Freeze and Cherry, 1979). BEI used a value of 0.30 for specific yield, which is slightly lower than lab-measured values for the Dune Sand reported in Table 3 of Hampton (1963) (values range from 0.323 to 0.334). BEI's value for specific yield is representative of the Dune Sand and is conservative (because using a lower specific yield results in higher mounding).

- **Horizontal Hydraulic Conductivity.** Hydraulic conductivity is a measure of the permeability of porous media, and in groundwater systems is the flow rate per unit area of aquifer per unit hydraulic gradient (Freeze and Cherry, 1979). BEI used a value of 12 feet per day (ft/day) for hydraulic conductivity, which is lower than the average hydraulic conductivity of 62.8 ft/day for the Dune Sand in Table 3 of Hampton (1963)[1] and the calculated hydraulic conductivity of 62 ft/day based on a 4-hour aquifer test at the City of Florence Well No. 12[2] (OWRD, 2007). BEI's value for hydraulic conductivity does not appear to be representative of the Dune Sand; however, the hydraulic conductivity used by BEI (2021) is conservative (because using a lower hydraulic conductivity results in additional mounding).

- **Saturated Zone Thickness.** The saturated zone is the portion of subsurface soils that are saturated with groundwater (i.e., the aquifer) (Freeze and Cherry, 1979). BEI used a value of 50 feet for saturated zone thickness, which is thicker than the unsaturated zone thickness of 15 feet reported in a test borehole at the Sea Watch Subdivision by Foundation Engineers (1997). BEI's value for saturated zone thickness does not appear to be representative of the Dune Sand at nearby properties, and is not conservative (because a thicker saturated zone results in less mounding).

- **Infiltration Rate and Duration.** Infiltration rate is the amount of water that infiltrates into the basin per unit area per unit time (i.e., units of feet per day) (Carleton, 2010). BEI used an infiltration rate of 12 feet/day and a duration of one day, but did not provide an explanation of the method that was used to develop the infiltration rate. In order to evaluate the infiltration rate of 12 feet/day, GSI estimated an infiltration rate based on the following criteria:

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[1] Hampton (1963) presents values of 270 gpd/ft^2 (36.1 ft/day), 600 gpd/ft^2 (80.2 ft/day), 600 gpd/ft^2 (80.2 ft/day), and 410 gpd/ft^2 (54.8 ft/day). The average of these values is 470 gpd/ft^2 (62.8 ft/day).

[2] LANE 63365. Calculation is based on a transmissivity of 23,925 gpd/ft and an aquifer thickness of 51.6 feet (the length of the Well 12 screen).

- The 25-year storm is infiltrated into the infiltration basin. According to the *City of Florence Stormwater Design Manual* (City of Florence, 2011), the 25-year storm is 5.06 inches of precipitation in a 24 hour period.
- All precipitation runoff is conveyed to the infiltration basin, which drains 111,908 square feet of impervious area (3J Consulting, 2020).
- The infiltration basin is 13 feet long (*x*-direction) and 110 feet wide (*y*-direction) (i.e., 1,430 square foot recharge basin).
- Stormwater runoff volume is calculated by the following equation:

$$V = (p)(A) \tag{1}$$

Where:

V is the volume of stormwater runoff (cubic feet),
p is the precipitation during the 25-year storm (feet per day), and
A is the impervious area (square feet).

According to Equation (1), the resulting volume of stormwater runoff to the infiltration basin is 47,188 cubic feet. Assuming this runoff is infiltrated into a 1,430 square feet infiltration basin, the infiltration rate is 33 feet per day [which is significantly higher than the 12 feet per day used by BEI (2021)]. We do not comment in this TM on whether the BEI (2021) infiltration rate is representative or conservative, in recognition of the fact that the method used by BEI (2021) to calculate stormwater runoff from the 25-year storm may be more sophisticated than Equation (1). However, we do note the difference between the BEI (2021) infiltration rate and the infiltration rate calculated by Equation (1), and will evaluate the effect that this difference has on the model results in the following section.

3. Re-Run of the Hantush (1967) Equation to Calculate Mounding from Soakage Trenches and Drywells

As discussed in Section 2.1, BEI (2021) did not include infiltration from soakage trenches and drywells in the groundwater mounding analysis. Therefore, GSI re-ran the Hantush (1967) calculations to include the soakage trenches and drywells. GSI also updated some of the aquifer parameters in the Hantush (1967) equation so that they are representative of the Dune Sands and/or conservative, as shown in Table 1.

Table 1. Aquifer Parameters Used in the GSI Re-Run of the Hantush (1967) Equation.

Parameter	Value	Units	Comments
Specific Yield	0.30	dimensionless	Same as BEI (2021)
Horizontal Hydraulic Conductivity	62.8	feet/day	The average of hydraulic conductivities from Hampton (1963).
Initial Thickness of Saturated Zone	15	feet	From Foundation Engineers (1997).

The properties of the infiltration basin and soakage trenches, which were used to calculate the infiltration rate at each basin/trench, are shown in Table 2. Infiltration rate was calculated using Equation (1) shown above and dividing the flow volume by basin/trench area. Note that GSI conservatively assumed that impervious area drained by drywells would be conveyed to the infiltration basin. This assumption is conservative because the infiltration basin is the closest infiltration point to the springs, and is necessary because it is difficult to estimate the *x*- and *y*- dimensions for a drywell in the Hantush (1967) equation.

Table 2. Input Parameters for Soakage Trenches and the Infiltration Basin.

Infiltration Site	Length [1] (feet)	Width [1] (feet)	Basin Area (square feet)	Impervious Area Drained [2] (square feet)	Infiltration Volume [3] (cubic feet)	Infiltration Rate [4] (feet/day)
Infiltration Basin	13	110	1,430	118,879	50,127	35.05
Soakage Trench 1	223	3	670	6,971	2,939	4.39
Soakage Trench 2	223	3	670	6,971	2,939	4.39
Soakage Trench 3	131	3	394	3,900	1,645	4.17
Soakage Trench 4	383	3	1,148	11,232	4,736	4.13
Soakage Trench 5	383	3	1,148	11,232	4,736	4.13
Soakage Trench 6	383	3	1,148	11,232	4,736	4.13
Soakage Trench 7	3	259	778	8,160	3,441	4.42
Soakage Trench 8	3	174	523	5,088	2,145	4.10
Soakage Trench 9	3	224	673	6,971	2,939	4.37
Soakage Trench 10	3	404	1,213	12,120	5,111	4.21
Soakage Trench 11	3	424	1,213	12,060	5,085	3.99
Soakage Trench 12	449	3	1,348	14,517	6,121	4.54
Soakage Trench 13	104	3	313	2,400	1,012	3.23

Notes:
(1) For the purpose of the Hantush (1967) equation, length is the dimension in the *x*-direction (also the direction in which groundwater mounding is calculated), and width is the dimension in the *y*-direction. The infiltration basin dimensions are from personal communication (2021a). At soakage trenches, the shorter dimension is 3 feet (personal communication, 2021c) and the longer dimension can be found by dividing the "Actual Area" from 3J Consulting (2020) by 3 feet.
(2) From 3J Consulting (2020). The impervious area drained for the infiltration basin includes the 6,971 square feet of impervious area drained by drywells.
(3) Calculated by Equation (1). Assumes the 25-year storm (i.e., 5.06 inches in a 24 hour period) (City of Florence, 2011).
(4) Calculated by dividing "Infiltration Volume" by "Basin Area."

Incorporating groundwater mounding effects from all the infiltration basin and all soakage trenches was a two-step process. First, the Hantush (1967) equation was used to calculate the groundwater mound at the springs for each soakage trench/infiltration basin. Second, by the principle of superposition, the mounding from each soakage trench/infiltration basin was summed to calculate a total mounding from stormwater infiltration. The results of the Hantush (1967) analysis are summarized in Table 3. Note that any groundwater mounding less than 0.01 feet (which is the minimum that can be measured by an electronic water level meter) was assigned a value of "<0.01 feet." Output from the U.S. Geological Survey Hantush (1967) spreadsheets for each infiltration basin/soakage trench is provided in Attachment A. As shown in Table 3, the total groundwater mounding at the springs calculated by a re-run of the Hantush (1967) equation during a 25 year storm at the proposed development is 0.039 feet (0.47 inches).

Table 3. Output from Hantush (1967) Simulations

	IB-1	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7	ST-8	ST-9	ST-10	ST-11	ST-12	ST-13
Mounding at Spring (feet)	0.039	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:
IB = Infiltration Basin   ST = Soakage Trench

4. Conclusions of GSI's Technical Review

Using representative and conservative aquifer parameters, GSI calculated total groundwater mounding at the springs from stormwater infiltrated during a 25 year storm with a precipitation rate of 0.422 feet per day (5.06 inches per day). A storm of this size resulted in 0.039 feet (0.47 inches) of mounding at the springs due to infiltration. This additional increase in the groundwater level represents a less than 0.5% increase in the head (i.e., potential energy of groundwater) in the aquifer at the springs [1]. A head increase of less than 0.5% is considered to be negligible.

Although BEI (2021) did not calculate the mounding effects related to soakage trenches and drywells, and used some input parameters that are not representative of the sandy sediments of the Dune Sand and are not conservative (e.g., aquifer thickness), GSI's technical review agrees with the BEI (2021) conclusion that groundwater mounding at the springs is expected to be negligible. Specifically, GSI found that mounding is expected to be negligible for a 25 year storm and the input parameters listed in Tables 1 and 2.

This evaluation addresses the additional stormwater infiltration that could result from the proposed development located northeast of 35th Street and Rhododendron Drive. As stated in Section 1, potential discharge from springs along the toe of the bluff are only one potential cause of erosion (other contributing factors include the steepness of the slope, presence or absence of vegetation, and wind or water erosion). With negligible mounding, there should be minimal impact to groundwater discharge at the springs which is believed to be exacerbating erosion of the Sea Watch Subdivision bluff.

5. References

3J Consulting. 2020. Preliminary Stormwater Management Report. Prepared for: APIC Florence Holdings, LLC. April 29.

3J Consulting and LRS Architects. 2020. Sheet C8: Composite Utility Plan, Rhododendron and 35th Street, Planned Unit Development. Prepared for: APIC Florence Holdings, LLC. April 29.

3J Consulting. 2021. Soakage Trench Distance Measurements, Rhododendron Dr. & 35th St. Planned Unit Development. Sheet No. EXH. 1.

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Carlton, G. B. 2010. Simulation of Groundwater Mounding Beneath Hypothetical Stormwater Infiltration Basins. U.S. Geological Survey Scientific Investigations Report 2010-5102. 76 p. Available online at: https://pubs.usgs.gov/sir/2010/5102/support/sir2010-5102.pdf.

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Foundation Engineers. 1997. Sea Watch Estates Slope Study: Florence, Oregon. Prepared for: Ward Northwest, Inc. July 18.

Freeze, R. A. and J. A. Cherry. 1979. Groundwater. Prentice Hall, Inc., Englewood Cliffs, New Jersey, 606 pg.

GeoDesign. 2005. Letter Report of Geotechnical Engineering Services, Sea Watch Estates. Prepared for: City of Florence. September 16.

Hantush, M. S. 1967. Growth and decay of groundwater mounds in response to uniform percolation. Water Resources Research, volume 3, p. 227-234.

OWRD. 2007. Pump Test Narrative to Accompany Pump Test of City of Florence Well 12. Completed October 9, 2007, Water Right Permit G-13344 (Application G-14541).

Personal Communication. 2021a. Email from Aaron Murphy (3J Consulting) to Matt Kohlbecker (GSI) RE: Soakage Trench Areas. 15 July 2021.

Personal Communication. 2021b. Email from Aaron Murphy (3J Consulting) to Matt Kohlbecker (GSI) RE: Soakage Trench Areas. 13 July 2021.

Personal Communication. 2021c. Email from Aaron Murphy (3J Consulting) to Matt Kohlbecker (GSI) RE: Soakage Trench Areas. 14 July 2021.

ATTACHMENT A

Output from Hantush (1967) Groundwater Mounding Simulations

INFILTRATION BASIN

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
35.0500	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
6.500	**x**	**1/2 length of basin (x direction, in feet)**
55.000	**y**	**1/2 width of basin (y direction, in feet)**
1.000	**t**	**duration of infiltration period (days)**
15.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

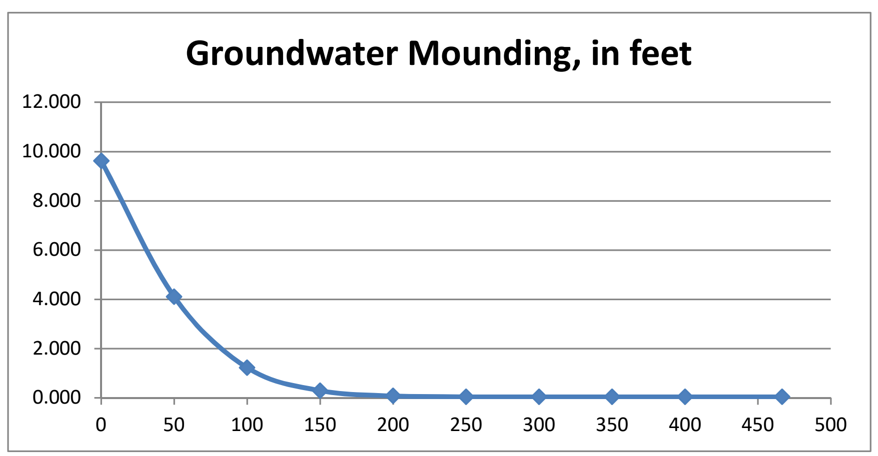
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

24.628	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
9.628	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
9.628	**0**
4.105	**50**
1.227	**100**
0.294	**150**
0.079	**200**
0.044	**250**
0.039	**300**
0.039	**350**
0.039	**400**
0.039	**467**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

SOAKAGE TRENCH 1

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.3900	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
111.500	**x**	**1/2 length of basin (x direction, in feet)**
1.500	**y**	**1/2 width of basin (y direction, in feet)**
1.000	**t**	**duration of infiltration period (days)**
15.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

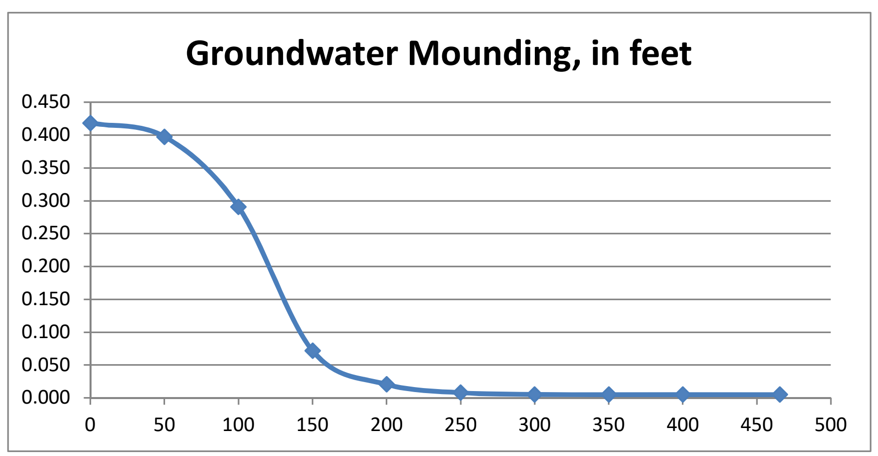
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.419	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.419	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.419	**0**
0.398	**50**
0.291	**100**
0.072	**150**
0.021	**200**
0.008	**250**
0.005	**300**
0.005	**350**
0.005	**400**
0.005	**466**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

SOAKAGE TRENCH 2

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.3900	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
111.500	x	**1/2 length of basin (x direction, in feet)**
1.500	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

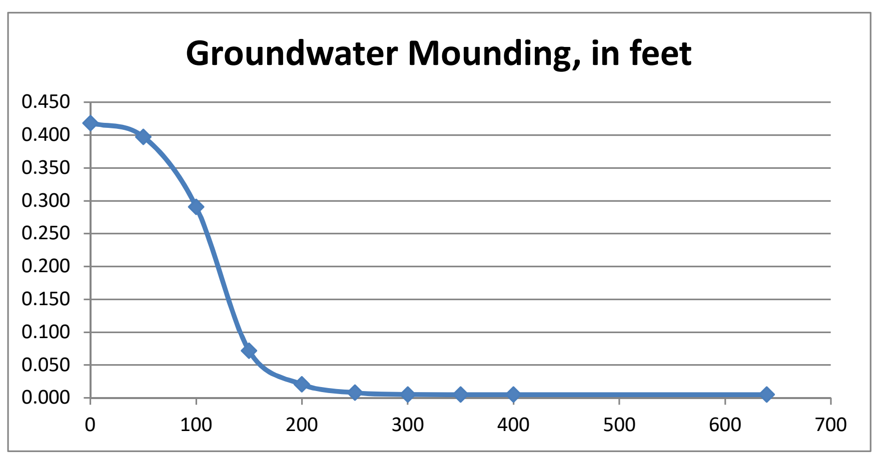
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.419	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.419	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.419	0
0.398	50
0.291	100
0.072	150
0.021	200
0.008	250
0.005	300
0.005	350
0.005	400
0.005	639

Re-Calculate Now



Disclaimer

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SOAKAGE TRENCH 3

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values			
4.1700	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
65.500	x	**1/2 length of basin (x direction, in feet)**
1.500	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

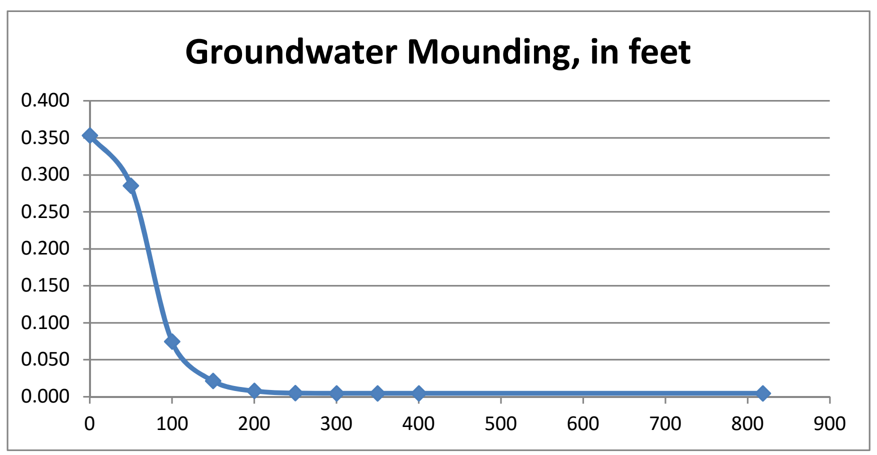
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.353	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.353	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.353	0
0.285	50
0.075	100
0.021	150
0.008	200
0.005	250
0.005	300
0.005	350
0.005	400
0.005	818

Re-Calculate Now



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SOAKAGE TRENCH 4

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values

4.1300	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
191.500	x	**1/2 length of basin (x direction, in feet)**
1.500	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**
15.408	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.408	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

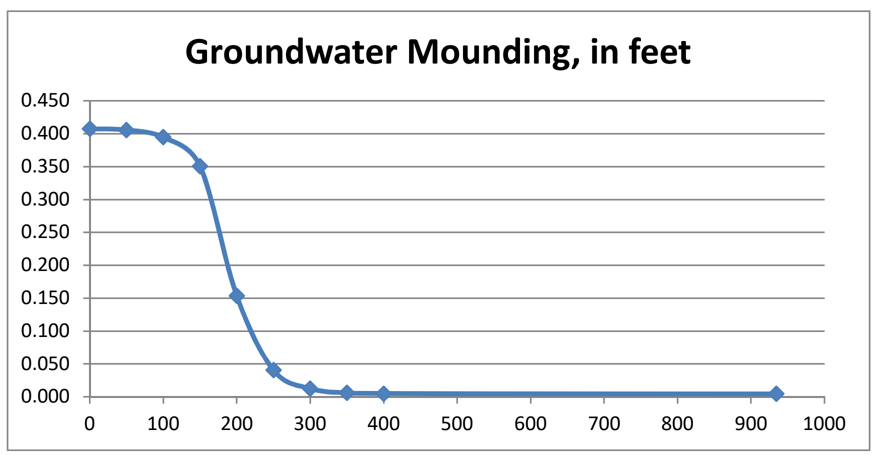
Conversion Table

inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.408	0
0.406	50
0.395	100
0.351	150
0.154	200
0.040	250
0.012	300
0.006	350
0.005	400
0.005	935

Re-Calculate Now



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SOAKAGE TRENCH 5

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values

4.1300	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
191.500	x	**1/2 length of basin (x direction, in feet)**
1.500	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

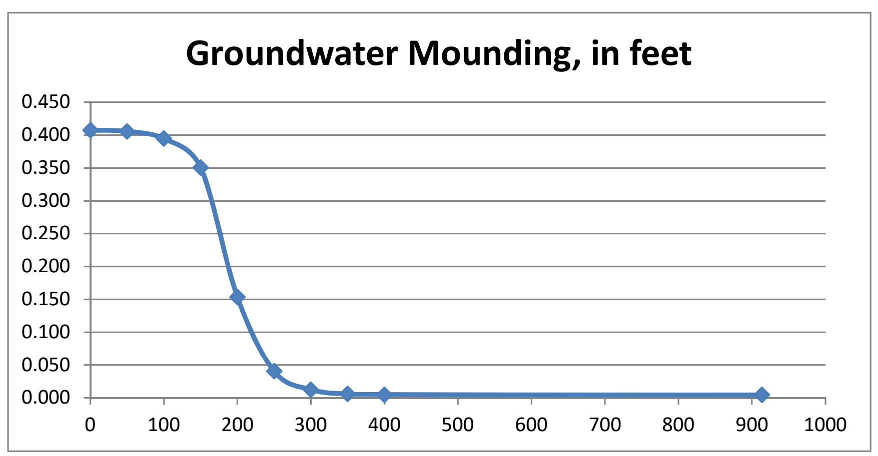
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.408	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.408	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.408	0
0.406	50
0.395	100
0.351	150
0.154	200
0.040	250
0.012	300
0.006	350
0.005	400
0.005	914

Re-Calculate Now



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SOAKAGE TRENCH 6

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.1300	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
191.500	x	**1/2 length of basin (x direction, in feet)**
1.500	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

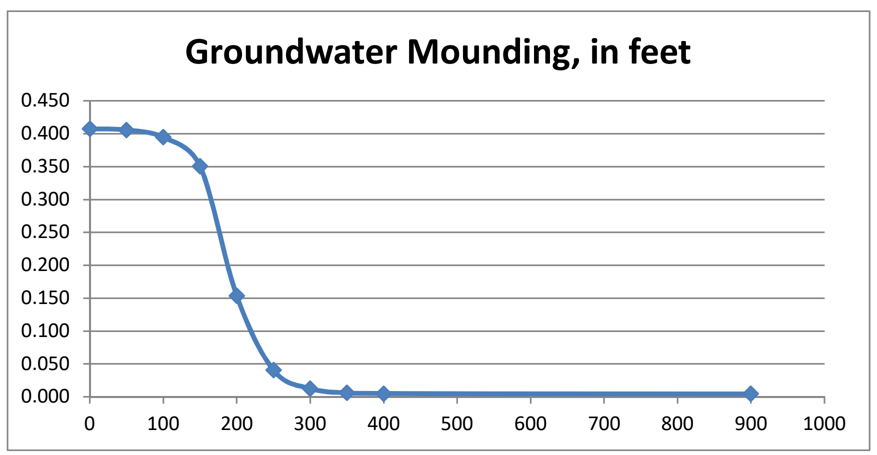
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.408	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.408	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.408	0
0.406	50
0.395	100
0.351	150
0.154	200
0.040	250
0.012	300
0.006	350
0.005	400
0.005	900

Re-Calculate Now



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SOAKAGE TRENCH 7

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values			
4.4200	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
1.500	x	**1/2 length of basin (x direction, in feet)**
129.500	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

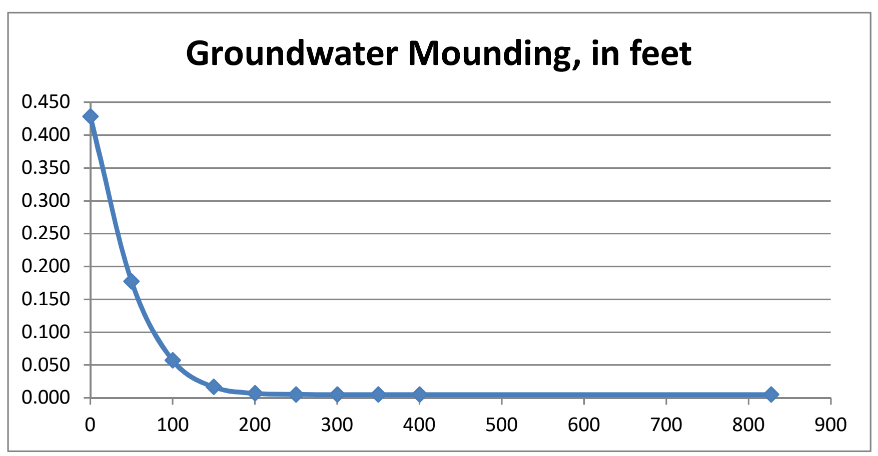
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.428	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.428	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.428	0
0.177	50
0.057	100
0.017	150
0.007	200
0.005	250
0.005	300
0.005	350
0.005	400
0.005	828

Re-Calculate Now



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SOAKAGE TRENCH 8

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use consistent units (e.g. feet & days **or** inches & hours)

Input Values

4.1000	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
1.500	x	**1/2 length of basin (x direction, in feet)**
87.000	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

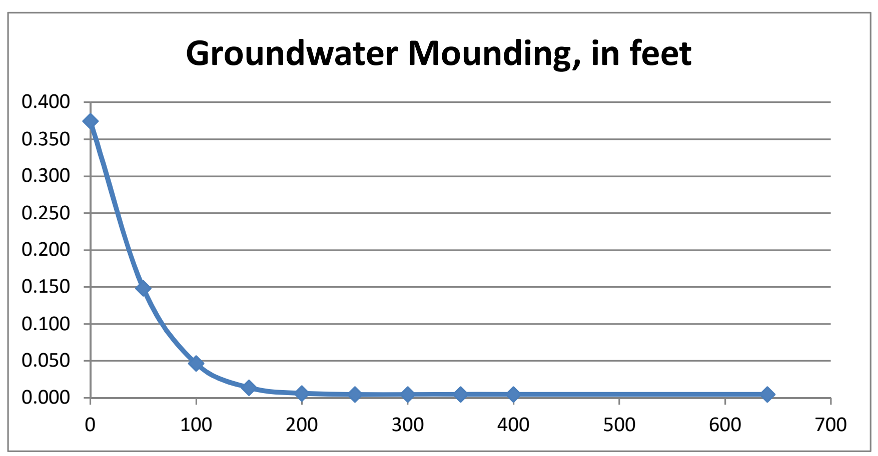
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.375	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.375	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.375	0
0.148	50
0.047	100
0.014	150
0.006	200
0.005	250
0.005	300
0.005	350
0.005	400
0.005	640

Re-Calculate Now



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SOAKAGE TRENCH 9

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values			
4.3700	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
1.500	x	**1/2 length of basin (x direction, in feet)**
112.000	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

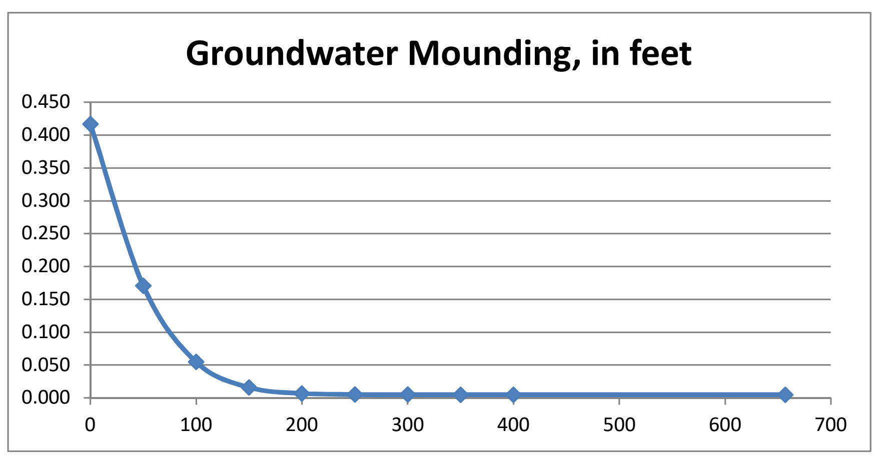
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.417	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.417	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.417	0
0.171	50
0.055	100
0.016	150
0.007	200
0.005	250
0.005	300
0.005	350
0.005	400
0.005	657

Re-Calculate Now



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SOAKAGE TRENCH 10

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The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.2100	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
1.500	x	**1/2 length of basin (x direction, in feet)**
202.000	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

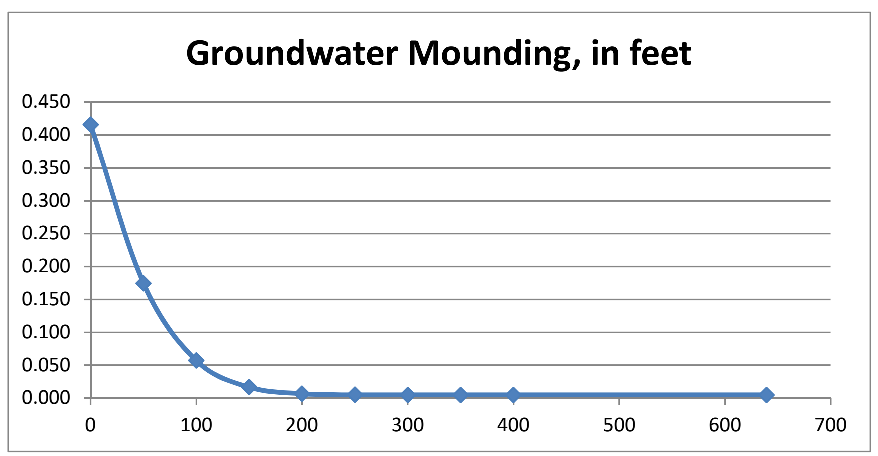
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.416	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.416	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.416	0
0.175	50
0.057	100
0.017	150
0.007	200
0.005	250
0.005	300
0.005	350
0.005	400
0.005	639

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

SOAKAGE TRENCH 11

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values				
3.9900	*R*	**Recharge (infiltration) rate (feet/day)**		
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**		
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***		
1.500	x	**1/2 length of basin (x direction, in feet)**		
212.000	y	**1/2 width of basin (y direction, in feet)**		
1.000	t	**duration of infiltration period (days)**		
15.000	hi(0)	**initial thickness of saturated zone (feet)**		

Conversion Table

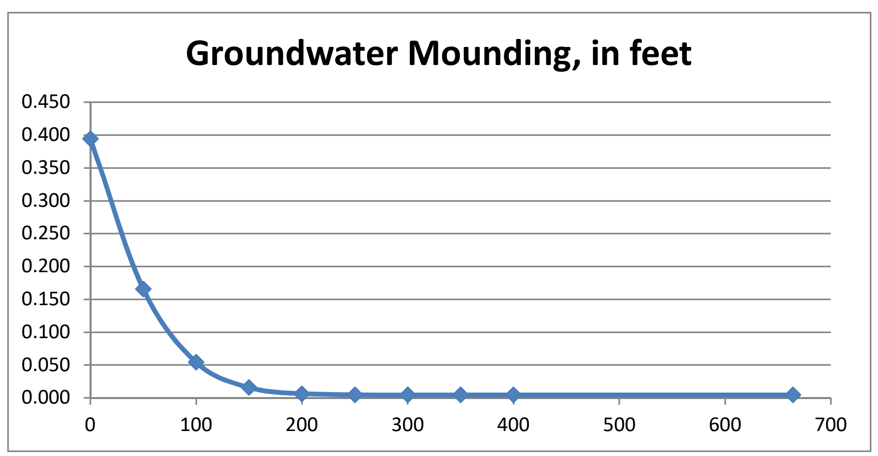
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.394	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.394	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.394	0
0.166	50
0.054	100
0.016	150
0.006	200
0.005	250
0.004	300
0.004	350
0.004	400
0.004	664

Re-Calculate Now



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SOAKAGE TRENCH 12

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values

Input Values			
4.5400	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
62.80	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
224.500	x	**1/2 length of basin (x direction, in feet)**
1.500	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
15.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

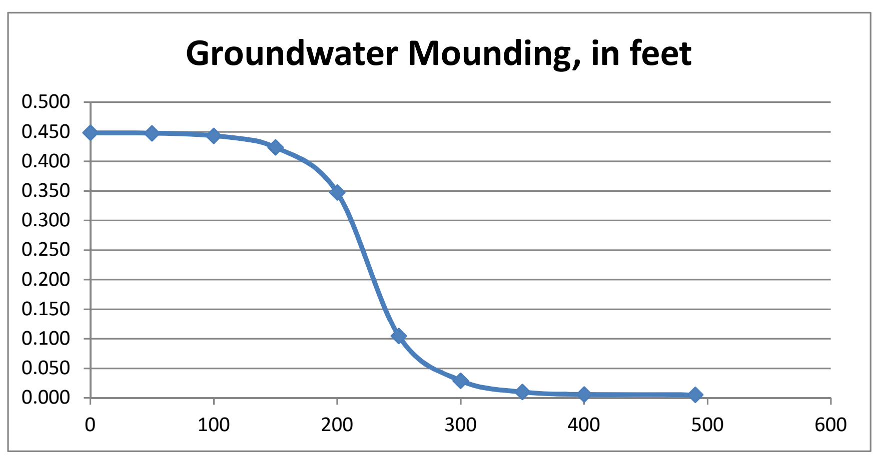
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.448	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.448	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.448	0
0.448	50
0.443	100
0.424	150
0.347	200
0.104	250
0.029	300
0.010	350
0.006	400
0.005	490

Re-Calculate Now



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SOAKAGE TRENCH 13

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values				
3.2300	***R***	**Recharge (infiltration) rate (feet/day)**		
0.300	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**		
62.80	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***		
52.000	**x**	**1/2 length of basin (x direction, in feet)**		
1.500	**y**	**1/2 width of basin (y direction, in feet)**		
1.000	**t**	**duration of infiltration period (days)**		
15.000	**hi(0)**	**initial thickness of saturated zone (feet)**		

Conversion Table

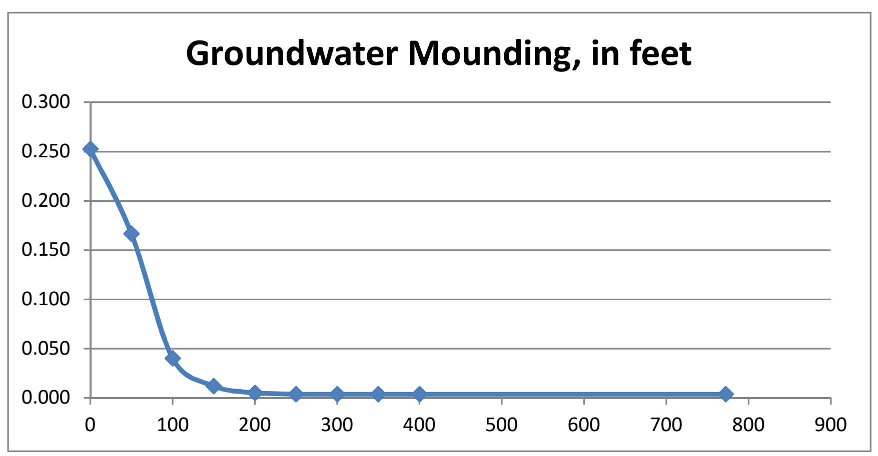
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

15.253	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.253	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.253	**0**
0.167	**50**
0.040	**100**
0.012	**150**
0.005	**200**
0.004	**250**
0.004	**300**
0.004	**350**
0.004	**400**
0.004	**772**

Re-Calculate Now



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