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JUNE 10, 2024

Town of Arlington Conservation Commission
c/o Mr. David Morgan, Environmental Planner + Conservation Agent
Robbins Memorial Town Hall
730 Massachusetts Avenue
Arlington, Massachusetts 02476

RE: Stormwater Management, Soil Test Pits, and Groundwater Monitoring Summary
Thorndike Place Residential Development

Dear Members of the Arlington Conservation Commission,

In anticipation of additional peer review on the stormwater management design for the above referenced Project, BSC Group, Inc. (BSC) is providing this summary of information provided to the Commission regarding the stormwater management design, soil test pits performed, and groundwater data obtained on site. While the majority of this information has previously been provided, we believe this summary will be useful for the Commission and its peer reviewer to expedite final review of the stormwater management design for the Project.

Stormwater Design Information Submitted to Date

Site Plans and associated Stormwater Report were submitted to the Commission along with the Notice of Intent (NOI) for the Project on September 6, 2023. The Site Plans are titled *Thorndike Place Notice of Intent, Dorothy Road, Arlington, Massachusetts*, are dated September 6, 2023, and consist of 14 sheets. The Stormwater Report is dated November 2020 with revision dates of August 2021 and September 2023. This information was peer reviewed by Hatch Associates Consultants, Inc. (Hatch) in a series of memorandums dated January 23, 2024, February 7, 2024, and February 14, 2024, as well as an email from Ross Mullen, PE, CFM of Hatch on March 15, 2024. In response to these reviews, BSC submitted additional information in letters dated January 24, 2024, February 13, 2024, and February 28, 2024. In its February 14, 2024, memorandum, Hatch stated, "After review of the proposed Thorndike Place stormwater design relative to the Massachusetts Stormwater Handbook, Hatch has determined the project is in compliance with the following conditions:"[1].

1. Permanent establishment of vegetation on the south side of the senior living complex prior to runoff from the roof discharging to the wetland and verification of non-erosive velocities at this discharge.

   The Applicant has stated in public hearings that this vegetation establishment is acceptable and BSC has provided verification of non-erosive velocities in our February 13, 2024, letter.

2. Applicant verifies that at least ten feet of separation is provided between the R-Tank^{XD} features and the townhome basement foundations.

   As previously stated in a public hearing for the Project, while we do not agree with Hatch's interpretation of the separation requirements, the Project is willing to adjust the R-Tank^{XD} systems to provide the minimum 10-feet of separation to basements should the Commission request it.

3. Review and, if necessary, resubmission of groundwater mounding analysis of the Stormtrap ST1 infiltration feature to demonstrate compliance. Provide a defensible basis for the selected horizontal

[1] The Project Applicant has agreed to comply with all four conditions listed by Hatch in that memorandum as noted above.

hydraulic conductivity and duration of infiltration period. Verify adequate separation if provided between the senior living complex and the mounded groundwater table.

Based on discussions with the Commission, BSC has revised our groundwater mounding analysis and, it is our understanding, that this will be one of the items under additional peer review upon selection of a peer review consultant. A more detailed discussion of the revised groundwater mounding analysis is provided in the following sections.

4. If the applicant uses asphalt shingles on the townhomes, to manage the loose grit from the shingles:
   a. The roof drains shall remain disconnected from the Stormtrap ST1 infiltration system until after construction is substantially complete and connected prior to occupancy or
   b. The R-Tank^{XD} systems shall be inspected, and loose grit removed prior to occupancy.

These requirements were accepted and added to the Operation and Maintenance Plan with BSC's January 24, 2024, response to comments letter.

Soil Testing and Estimated Seasonal High Groundwater

As part of the Comprehensive Permit review process, BSC performed three (3) soil test pits on the Project site in November 2020, to determine soil types and estimated seasonal high groundwater (ESHGW) elevation for use in stormwater management design. Subsequent to the performance of these test pits, the project was revised to its current configuration and was unanimously approved by the Arlington Zoning Board's Decision to grant a Comprehensive Permit, as filed with the Town Clerk on December 1, 2021. A condition of the Comprehensive Permit required additional soil testing to be performed during April or May in the locations of the updated stormwater management systems. In May 2023, BSC performed an additional eight (8) soil test pits in the location of the updated stormwater management systems. Further, in accordance with the Comprehensive Permit condition, these test pits were witnessed and verified by an independent third-party, Whitestone Associates, as selected by the Town as their representative. As part of this May 2023 test pit work, three (3) groundwater measurement wells were installed – one in the location of the bio-retention area, one in one of the townhouse infiltration systems, and one in the larger infiltration system. These 2023 test pits resulted in the determination of an ESHGW elevation of 4.0 for the entirety of the site as this elevation was the highest elevation at which groundwater and/or redoximorphic features were found throughout all of the locations. This selection was made to provide a conservative approach to stormwater management design.

In March 2024, during the course of the Commission's public hearings on the Project, it was requested that the Applicant perform additional test pits on site along with an additional groundwater well in the large infiltration system and monitor all four wells on site.

On April 17, 2024, BSC performed five (5) additional soil test pits in the area of the large infiltration system and installed one (1) additional groundwater well (TP-9). BSC coordinated the installation of the additional test pits with the Commission, and the same was observed by a representative from the Arlington Department of Public Works Engineering Division. The May 2023 and April 2024 test pit data is summarized in the table below.

Test Pit	Existing Grade	Total Depth (in.)	Depth Fill (in.)	Depth Standing GW (in.)	Depth Weeping GW (in)	Depth to Redox (in.)	ESHGW
TP-1	10.66	120	90	114	108	n/a	1.66
TP-2	8.79	104	83	97	n/a	n/a	0.71
TP-3	7.88	87	27	82	n/a	51	3.63
TP-4	7.08	96	64	72	68	n/a	1.41
TP-5	7.98	74	33	60	60	48	3.98
TP-6	6.87	132	30	110	110	64	1.54

TP-7	8.92	114	108	110	n/a	n/a	-0.24
TP-8	11.83	120	120	n/a	112	n/a	2.50
TP-9	11.47	118	100	116	90	n/a	3.97
TP-10	11.27	130	130	126	94	n/a	3.44
TP-11	11.09	114	114	111	93	n/a	3.34
TP-12	8.37	76	76	68	53	n/a	3.95
TP-13	7.96	74	74	67	57	n/a	3.21

In addition to the preliminary groundwater level observations from November 2020, the May 2023 groundwater observations of the eight test pits within the infiltration systems, and the April 2024 groundwater observations in five additional test pits, BSC performed seven (7) additional groundwater level measurements of the on-site wells during March, April, and May 2024. During the final two (2) readings, David Morgan, Conservation Agent observed the measurements per the request of the Commission. The measurements are summarized below (all elevations in NAVD88):

Well	3/15/24	4/1/24	4/17/24	4/24/24	5/2/24	5/9/24	5/16/24
TP-1	2.26	2.94	3.01	2.87	2.69	2.74	2.64
TP-6	2.37	3.00	2.95	2.68	2.28	2.79	2.05
TP-7	2.82	3.41	3.47	3.30	3.05	3.26	2.95
TP-9	n/a*	n/a*	3.97*	3.78	3.59	3.30	3.30

* TP-9 was installed on 4/17/24. Groundwater elevation shown for that date is observed groundwater in the test pit.

Additionally, it should be noted that the month of March 2024 was one of the wettest months since 1895. The attached graphics from the National Oceanic and Atmospheric Administration (NOAA) demonstrate the severity of precipitation that occurred in March. As such, groundwater elevations during this time would be expected to be above normal conditions. This information further demonstrates that the use of 4.0 as ESHGW elevation is appropriate as no observed or measured groundwater elevations during this Spring have reached or exceeded this elevation.

BSC believes that the estimated seasonal high groundwater (ESHGW) elevation has been determined on observed groundwater levels over the course of no less than seven readings taken during the spring months in full compliance with the Massachusetts Stormwater Handbook. With the additional test pit data and groundwater monitoring within the 2024 spring season supporting the ESHGW determined by BSC upon the results of test pits and monitoring wells first read in Spring 2023, the ESHGW of 4.0 is the correct and appropriate value for use in the project's stormwater management design.

Groundwater Mounding Analysis

In accordance with the requirements of Stormwater Standard 3, as detailed in DEP's Massachusetts Stormwater Handbook, a groundwater mounding analysis was performed for the infiltration systems as these systems would be used to attenuate peak flows for the 10-year storm event and larger and have less than 4-feet of separation to ESHGW. During the course of the public hearings on the Project, it was requested that the previously performed mounding analysis be revised to utilize a duration of 24-hours. Attached are updated analyses for the large infiltration system and the smaller, townhouse infiltration systems. This analysis has been performed using the Hantush Method as prescribed by Volume 3, Chapter 3 of DEP's Massachusetts Stormwater Handbook. The following details how each variable in the calculation was selected:

1. Recharge (infiltration rate): The recharge rate is equal to the required recharge volume divided by the bottom area of the infiltration system divided by the duration of infiltration period. This calculation

demonstrates that the required recharge volume will be completely infiltrated during the infiltration period.

a. Large Infiltration System = (1,638 cft)/(8,137 sft)/(1 day) = 0.2013 ft/day

b. Small Infiltration System = (22.42 cft)/((294 sft)/(1 day) = 0.0762 ft/day

2. Specific yield taken from US Department of the Interior Geological Survey Water Supply Paper 1662-D, Table 29, average value for silt (conservative value based on observed on-site soils) = 0.080. A copy of this table is attached.

3. Horizontal hydraulic conductivity is generally accepted as ten times the vertical hydraulic conductivity. The vertical hydraulic conductivity is taken from the Rawls rates included in the DEP's Massachusetts Stormwater Handbook for silt loam (conservative value based on observed on-site soils) = 5.40 ft/day

4. Duration of infiltration period is 24 hours or 1 day to comply with requests received during the Commission's public hearings on the Project.

5. Initial saturated thickness is based on the bottom of the test pit elevations compared to the ESHGW elevation of 4.0 = 5 feet. This value assumes that a confining layer exists immediately below the bottom of test pits excavated on site and is expected to be a very conservative value.

Utilizing the variable documented above and the dimensions of the infiltration systems, the maximum groundwater mounding beneath the infiltration systems are calculated to be 1.845-feet and 0.199-feet for the large and small systems, respectively. Both of these values are less than the provided separation to ESHGW, which is at least 2-feet in all systems. As such, the mounding analysis complies with the requirements of the DEP's Massachusetts Stormwater Handbook as groundwater mounds will not impact the systems' ability to infiltrate the required recharge volume nor will it break out above the land or water surface of a wetland. Please see the attached Hantush Method calculation sheet for details.

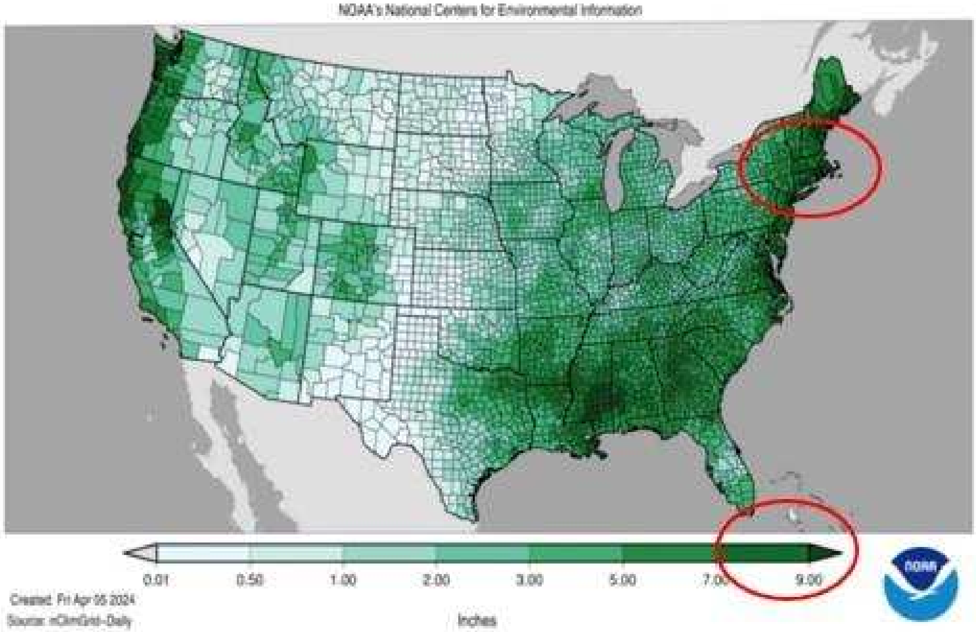
As previously stated during the Commission's public hearings on the Project, BSC believes that this information demonstrates full compliance with all the Stormwater Standards of the Wetlands Protection Act as detailed in the DEP's Massachusetts Stormwater Handbook. We look forward to discussing this matter further with the selected peer review consultant and the Commission as the public hearing process moves forward. Please feel free to contact me at (617) 896-4386 or drinaldi@bscgroup.com should you have any questions on the information in this report.

Sincerely,
BSC GROUP, INC.

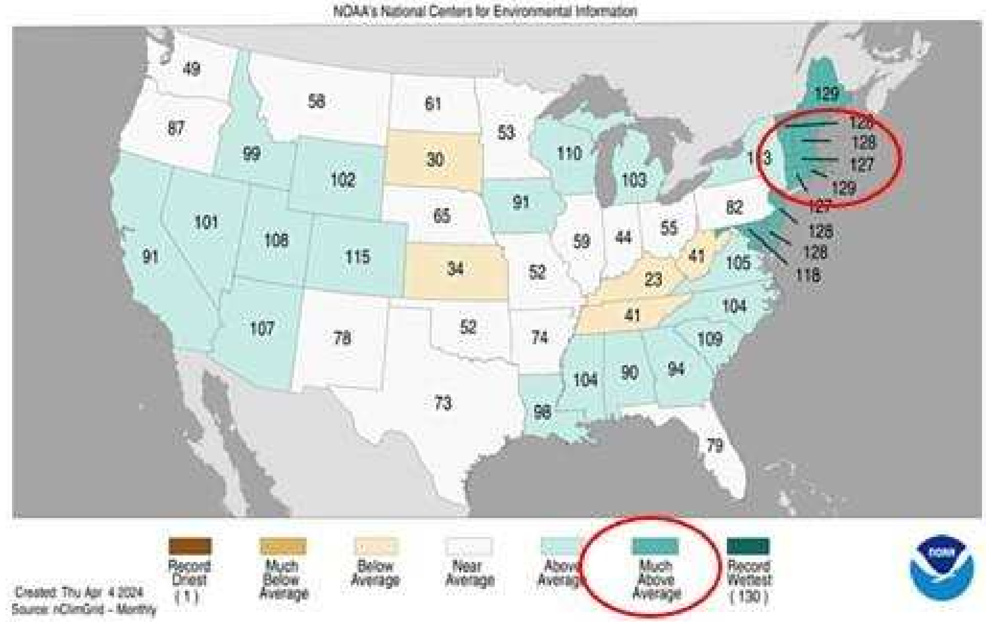
Dominic Rinaldi, PE
Senior Associate

Attachments: NOAA Precipitation Information March 2024
Revised Groundwater Mounding Analyses
US Department of the Interior Geological Survey Water Supply Paper 1662-D, Table 29

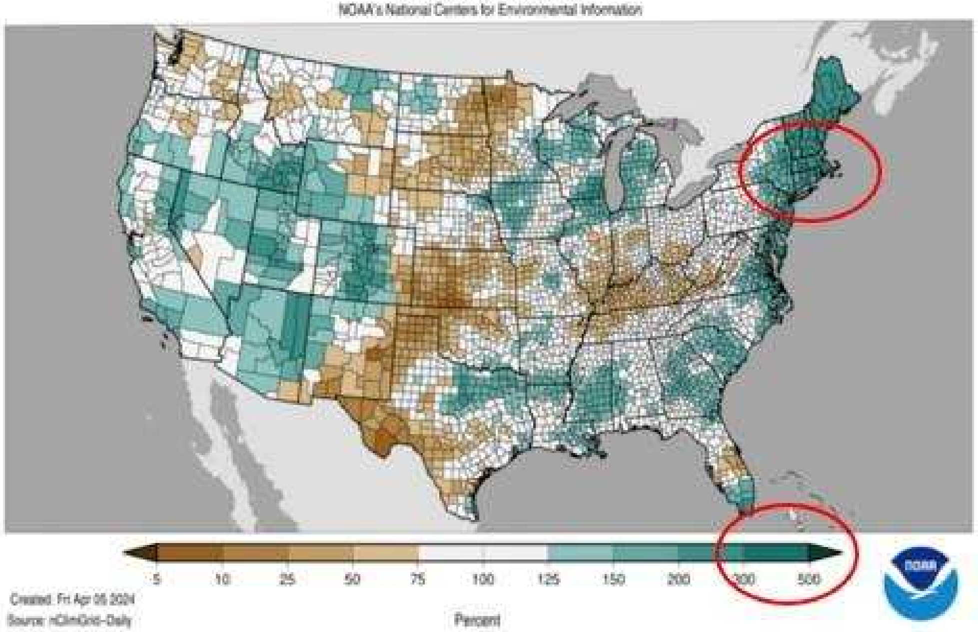
Total Precipitation
March 01–31, 2024
NOAA's National Centers for Environmental Information



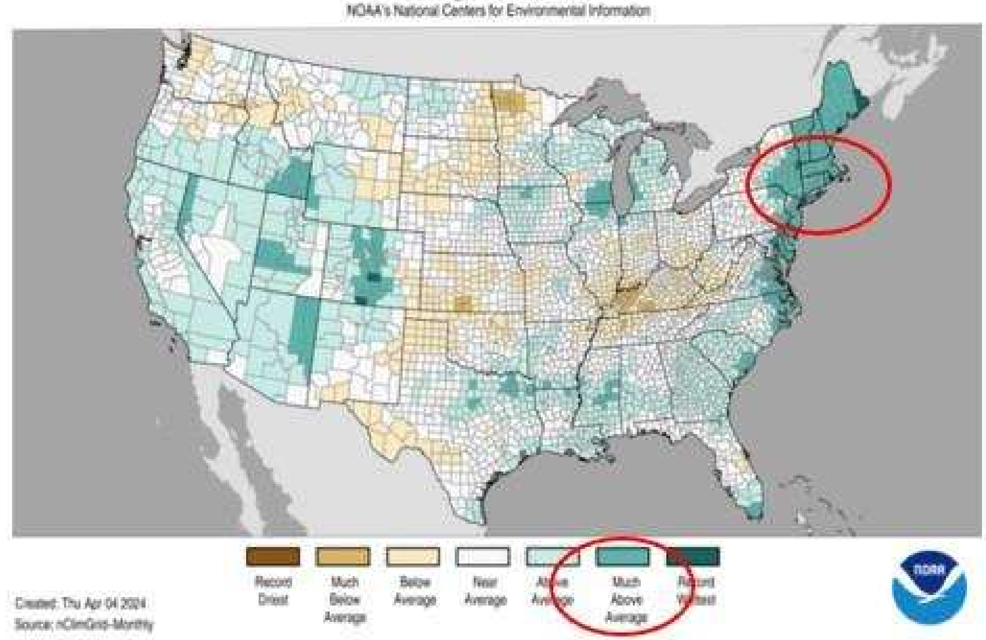
Statewide Precipitation Ranks
March 2024
Ranking Period: 1895–2024
NOAA's National Centers for Environmental Information



Precipitation Percent of Average
March 01–31, 2024
Average Period: 1991–2020
NOAA's National Centers for Environmental Information



County Precipitation Ranks
March 2024
Ranking Period: 1895–2024
NOAA's National Centers for Environmental Information



StormTrap Infiltration

Pond 1P Mounding - Results

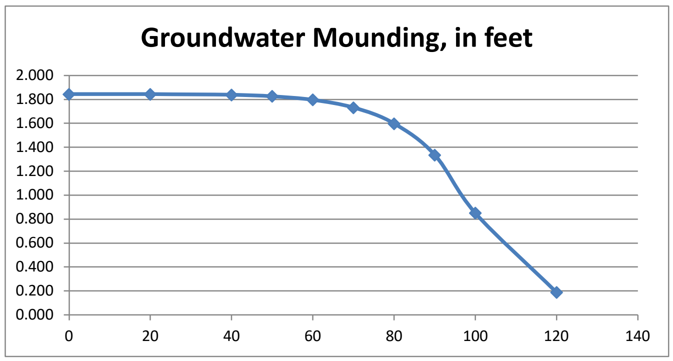
Input Values			inch/hour	feet/day
0.2013	***R***	**Recharge (infiltration) rate (feet/day)**	0.67	1.33
0.080	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**		
5.40	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***	2.00	4.00
98.420	**x**	**1/2 length of basin (x direction, in feet)**		
20.670	**y**	**1/2 width of basin (y direction, in feet)**	**hours**	**days**
1.000	**t**	**duration of infiltration period (days)**	36	1.50
5.000	**hi(0)**	**initial thickness of saturated zone (feet)**		

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).

6.845	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
1.845	**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
1.845	**0**
1.845	**20**
1.839	**40**
1.827	**50**
1.798	**60**
1.733	**70**
1.599	**80**
1.337	**90**
0.851	**100**
0.189	**120**

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.

Townhouse Infiltration

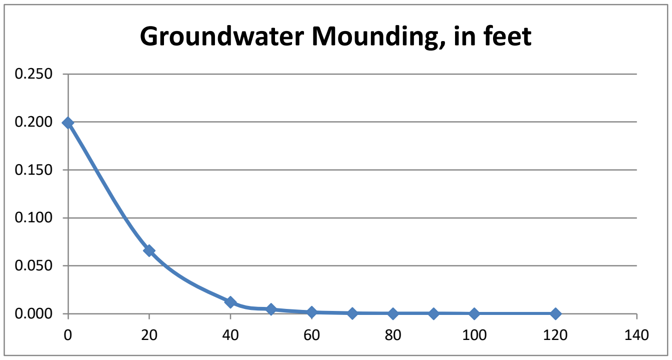
Pond 104P Mounding - Results

Input Values			inch/hour	feet/day	
0.0762	*R*	Recharge (infiltration) rate (feet/day)	0.67	1.33	
0.080	Sy	Specific yield, Sy (dimensionless, between 0 and 1)			
5.40	K	Horizontal hydraulic conductivity, Kh (feet/day)*	2.00	4.00	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).
10.670	x	1/2 length of basin (x direction, in feet)			
6.900	y	1/2 width of basin (y direction, in feet)	hours	days	
1.000	t	duration of infiltration period (days)	36	1.50	
5.000	hi(0)	initial thickness of saturated zone (feet)			

5.199	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
0.199	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
0.199	0
0.066	20
0.012	40
0.005	50
0.002	60
0.001	70
0.000	80
0.000	90
0.000	100
0.000	120

Re-Calculate Now



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Specific Yield--

Compilation of Specific Yields for Various Materials

GEOLOGICAL SURVEY WATER SUPPLY PAPER 1662-D

Prepared in cooperation with the California Department of Water Resources

TABLE 29.—*Compilation of specific yields for various materials*

[All values rounded off to nearest whole percentage]

Material	Valley fill, California (Eckis, 1934)	Mokelumne area, California (Piper and others, 1939)	Santa Ynez River basin, California (Upson and Thomasson, 1951)	Sacramento Valley, Calif. (Poland and others, 1949)	Smith River plain, California (Back, 1957)	Ventura County, Calif. (Calif. Water Resources Board, 1956)	Santa Margarita Valley, Calif. (Calif. Dept. Public Works, 1956)	Tia Juana Basin, Calif. (Calif. Water Rights Board, 1957)	San Luis Obispo County, Calif. (Calif. Water Resources Board, 1958)	San Joaquin Valley, Calif. (Davis and others, 1959)	Eureka area, California (Evenson, 1959)	Santa Ynez Basin, Calif. (Wilson, 1959)	Rechna Doab, Pakistan (Kazmi, 1961)	Napa-Sonoma Valleys, Calif. (Kunkel and Upson, 1960)	Humboldt River Valley, Nev. (Cohen, 1963)	Unconsolidated alluvium (Preuss and Todd, 1963)	Little Bighorn River valley, Montana (Moulder and Others, 1960)	Average specific yield
Clay	1	4	2	3	1	0	1	1	3	3	3	5	3	3	1	-----	-----	2
Silt	10	4	12	3	-----	3	10	10	5	5	10	5	5	5	19	4	17	8
Sandy clay	10	4	12	3	5	5	5	5	5	5	10	-----	-----	10	-----	-----	-----	7
Fine sand	21	26	12	10	10	25	28	25	25	10	20	20	27	20	26	23	32	21
Medium sand	31	26	30	20	15	25	28	30	25	25	20	30	28	20	28	28	32	26
Coarse sand	31	35	35	20	25	25	28	32	25	25	20	30	23	20	27	28	32	27
Gravelly sand	31	35	35	20	25	21	22	28	21	25	20	-----	23	20	-----	22	32	25
Fine gravel	27	35	35	25	25	21	22	26	21	25	25	25	26	25	19	17	25	25
Medium gravel	21	-----	-----	25	25	21	22	23	21	25	25	25	26	25	-----	13	25	23
Coarse gravel	14	-----	-----	25	25	21	22	18	21	25	25	25	26	25	-----	12	-----	22