McCurry Hydrology, LLC

Memorandum

To: Mr. David Rechberger, Twin Lakes Action Group
From: Gordon McCurry, Ph.D.
Date: November 16, 2015
Subject: Preliminary Hydrologic Analysis of the BVSD Properties at 6600 Twin Lakes Road

The Boulder Valley School District RE-2 (BVSD) owns a pair of undeveloped parcels totaling 10 acres located at approximately 6600 Twin Lakes Road. The northern property is 3.95 acres in area and is located on the south side of Twin Lakes Road while the adjacent southern property is 6.08 acres in area with an address of 0 Kalua Road (Figure 1). The BVSD has reportedly filed a request to change the land use designation of these parcels from Rural Residential to Mixed Use Residential. Residents of the surrounding community are concerned that developing the BVSD properties land could lead to an increase in basement flooding or other hydrologic impacts. This memorandum presents my preliminary analysis of the hydrology of these BVSD properties and surrounding areas, and provides recommendations on how to reduce flooding-related impacts related to their development.

Site Environmental Setting

The BVSD properties are located northeast of the City of Boulder in unincorporated Boulder County, in the south-central portion of Section 11of Township 1 North, Range 70 West. The land is undeveloped with a native grass cover (Figure 2). The property ranges in elevation from approximately 5165 to 5150 feet and slopes gently to the southeast towards Boulder Creek. South of the southern property are several small intermittent eastward-flowing streams that drain into Boulder Creek. Soils in the area consist of clay loam and clay, defined by the USDA Natural Resources Conservation Service as Nunn B clay loam and Longmont B clay soils (NRCS, 2015). The BVSD properties are predominantly Nunn clay loam with the southern portion containing Longmont clay soil types (Figure 3). Underlying the soils is the Pierre Shale, a regionally extensive and low-permeability bedrock layer (USDA, 1975). Borehole logs from wells drilled in the vicinity of the BVSD properties and the Twin Lakes neighborhood indicate that the depth to bedrock is approximately 20 to 25 feet below ground surface. A shallow aquifer exists within the soils that overlie the shale bedrock.

Hydrology Near the BVSD Properties

Several man-made features exist in the area that influence the hydrology of the BVSD and surrounding properties. Approximately 700 feet north of the northern property are two lakes on the 42-acre County Open Space Twin Lakes property and three regional irrigation ditches. The lakes have a combined area of 27 acres and storage capacity of 218 acre-feet. They have been in use since 1910 to store water used for agricultural purposes (BCPOS, 2004). The embankments for the lakes consist of compacted earth fill (GEI Consultants, 2014). Wetlands exist around the

lakes as a result of seepage through the lake bed and berms, creating shallow groundwater conditions (BCPOS, 2004).

Several ditches exist west and north of the BVSD property and contribute to shallow groundwater conditions in the area. The North Boulder Farmer's Ditch, the Boulder and Left Hand Ditch, and the Boulder and White Rock Ditch flow into the Twin Lakes. The first two of these ditches flow towards Twin Lakes from the southwest and cross 63rd Street several times. The North Boulder Farmer's Ditch and Left Hand Ditch merge west of 63rd Street just north of Twin Lakes Road and then the resulting two ditches run parallel to each other, traversing east toward the Twin Lakes and continuing to the east (Boulder County, 2000). Over at least the past 20 years an average of approximately 145 acre-feet per year has flowed through the ditches to supply the lakes (BCPOS, 2004). Like most ditches, these are unlined and leak a portion of their water to the underlying soils and shallow groundwater system, supporting the wetlands vegetation and lush growth around them.

Leakage from these ditches helps sustain the small pond and wetlands located south of Twin Lakes Road and east of Kalua Road. Seasonal outflow from this pond flows east and traverses the southern border of the southern BVSD property (Figure 1). The pond and intermittent outflow drainage also provide water to the underlying shallow aquifer system. The wetlands associated with the pond are an indication of shallow groundwater conditions in this portion of the residential area south of the BVSD property.

Hydrologic Limitations in the Vicinity of the BVSD Properties

Twin Lakes to the north, the two irrigation ditches to the west and north, and the pond with its outflow to the west and south are all located hydraulically upgradient of and in close proximity of the BVSD properties and surrounding residential areas. Collectively these provide much more water to feed the area's shallow groundwater system than occurs in other areas. The water table of the shallow groundwater system is located relatively close to the land surface as shown by the wetlands present in the area. The depth to impermeable bedrock is relatively shallow and this helps support and maintain the shallow aquifer overlying the bedrock. Many homes in the Twin Lakes neighborhoods have sump pumps which are further evidence of shallow groundwater. Future development of the BVSD properties must take these hydrologic factors into account to minimize impacts both on surrounding properties and on buildings that would be constructed.

Conducting site-specific investigations will be necessary to evaluate potential limitations to development that may exist on the BVSD properties. Prior to doing so, an assessment of site soils and their suitability to different uses of the properties provides insight into those limitations.

The USDA Natural Resources Conservation Service has compiled soils data and developed a web-based graphical database that allows the user to examine the suitability of a given area to a

set of potential uses (NRCS, 2015). The suitability analyses are based on geotechnical and engineering properties of the soils. The soils beneath the BVSD properties (Figure 3) were evaluated as part of this preliminary hydrologic analysis as to their suitability for the construction of dwellings, both including and not including basements. Dwellings are defined by the NRCS as single-family houses of three stories or less. For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of approximately 7 feet. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper.

Each soil type in the area of interest is assigned a suitability rating based on the limitations posed by individual soil properties. Two sets of criterion are applicable to dwellings: (1) properties that affect the ability of the soil to support a load without movement and (2) properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (inferred from the Unified Soil Classification System classification of the soil). The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Ratings indicate the extent to which the soils are limited by each of the applicable soil properties that affect the specified use, in this case the construction of dwellings. Numeric ratings are provided and indicate the severity or degree with which a given soil property contributes to the overall suitability rating. An assigned rating of "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected. An assigned rating of "Somewhat limited" indicates that the soil has features that are moderately unfavorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. An assigned rating of "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected (NRCS, 2015).

The suitability of soils for accommodating dwellings on and near the BVSD properties was found to be somewhat limited for dwellings with basements in all but the southwest corner, where the suitability is very limited (Figure 4). The main reasons were due to the shrink-swell potential of the soils, flooding potential and shallow depth to groundwater. The shrink-swell limitation is associated with the shrinking of soil when dry and the swelling when wet. This is a common feature of many clay-rich soils, including those that comprise most of the properties. Shrinking and swelling of soil can damage roads, dams, building foundations, and other

structures (NRCS, 2015). The flooding potential and shallow depth to groundwater are expected outcomes given the number and proximity of water sources in the immediate vicinity.

Perhaps more important is that the suitability of the soils to accommodate dwellings without basements was found to be very limited, for the same reasons of shrink-swell potential, flooding and shallow depth to groundwater.

Hydrologic Concerns Associated with Development of the BCHA Property

The preceding discussion suggested potential limitations associated with constructing dwellings on the BVSD properties but did not address potential hydrologic impacts to adjacent residential buildings associated with development of the property. Homes located adjacent to the BVSD properties are most likely to experience impacts from development and includes homes south of Twin Lakes Road along Tally Ho Trail and Starboard Drive, and homes in the eastern end of Kalua Road. Possible impacts include:

- a higher risk of basement flooding,
- increases in the frequency and/or volume needed to be pumped by existing sump pump systems, and
- the need for homes to have sump pump systems installed that previously have not had them.

The causes of these potential impacts relate to increases in groundwater levels associated with constructing buildings, building foundations and foundation footers, and the sump or drain systems that might be installed for the new buildings. Typically the soil beneath a building foundation supports some of the weight of that building with the remaining load supported by foundation footers. The weight of a structure compresses the underlying soil. The clay-rich soils beneath the BVSD properties are likely to have a relatively high soil compression potential. It is possible that compressed soils could extend below the water table in areas of shallow groundwater. If this were to occur, the groundwater previously occupying the pore spaces in the soil would be displaced and would migrate elsewhere. Depending on the density of building construction and how close those buildings were to existing residences, at least some of the displaced groundwater could migrate toward existing residences with a resulting rise in the water table and an increased risk of basement flooding. Deep foundation footers or foundations that extended to the underlying bedrock would displace existing groundwater and force it to flow into adjacent areas, also potentially increasing the risk of basement flooding to nearby homes.

Sump or drain systems that might be installed in new buildings could also pose an addition hydrologic risk to nearby homes. It is common for water extracted from sump/drain systems to be discharged into nearby gutters or storm drains. Depending on how the storm drain system for

the new buildings is designed, the extracted water may end up infiltrating along the edges of the BVSD properties which would lead to higher groundwater conditions for the adjacent residences.

Conclusions

Before any structures are built on the BVSD properties the developer must undertake appropriate site-specific studies and monitoring to characterize soil properties and the shallow groundwater conditions that likely exist in the region so that existing homes are not adversely affected. Any structures built should be designed to overcome the limitations posed by shrink-swell conditions of the soil, flooding potential, and shallow depth to water. Installing monitoring wells on the properties and instrumenting them to characterize the depth to groundwater in the shallow aquifer, over the course of at least one year, and performing geotechnical testing on soils are necessary to gain a better understanding of potential impacts to adjacent residences.

Structures built on the BVSD properties may require additional components to minimize the impacts posed by the site soils and shallow groundwater conditions. These may include:

- addition foundation footers,
- exterior tile drains around the foundations,
- sump pumps in basements and crawl spaces or elimination of basements,
- setbacks for landscaping, and
- gutter downspouts that extend beyond a critical setback distance from the buildings.

Results of the field investigations and the size, number and density of proposed buildings would affect the need for these components but some would likely be needed and should be factored into early planning should the BVSD properties be developed.

References

BCPOS, 2004. Twin Lakes Open Space Draft Resource Evaluation & management Plan. Boulder County Parks and Open Space.

Boulder County, 2005. Boulder County Ditch and Reservoir Map. Prepared by Boulder County, Colorado. September.

DWR, 2005. Task 5 – Key Structure Operating Memorandum for City of Boulder. Submitted to the Colorado Division of Water Resources, as part of the South Platte Decision Support System.

GEI Consultants, 2014. Hayden Reservoir Dam and Davis Dam No. 1 Dam Breach Inundation Mapping Report. GEI Consultants Inc, submitted to Boulder and Left Hand Ditch Company.

NRCS, 2015. Web-based soil survey database. Accessed June 2015 http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

USDA, 1975. Soil Survey of Boulder County Area, Colorado. United States Department of Agriculture, Soil Conservation Service.

Figure 1. Map showing the BVSD and surrounding properties.


Figure 2. View looking southwest at the BVSD properties from Twin Lakes Road.

Figure 3. Soils in the vicinity of the BVSD properties.

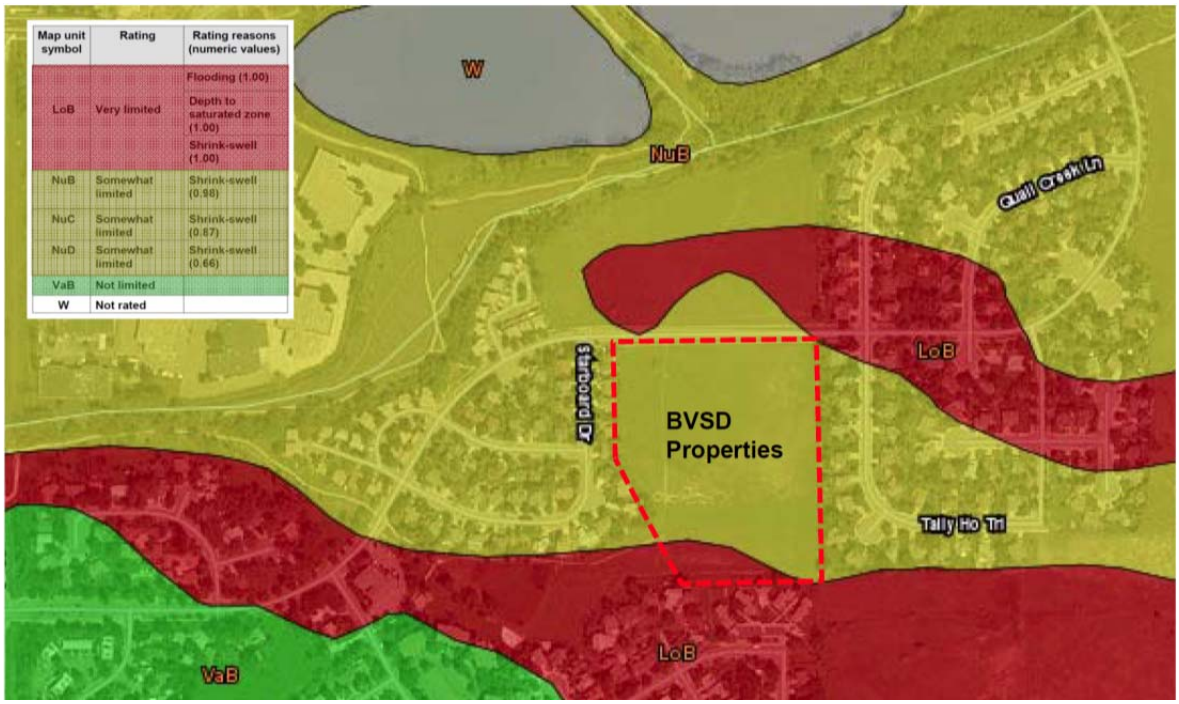

Figure 4. Limitations for construction of dwellings with basements.