PLANNING & TRANSPORTATION
DIVISION

STAFF REPORT

TO: PLANNING & TRANSPORTATION COMMISSION

FROM: Curtis Williams, Interim Director

DEPARTMENT: Planning & Community Environment

DATE: September 24, 2008

SUBJECT: Study Session Regarding Basement Construction Impacts

RECOMMENDATION
Staff recommends that the Planning and Transportation Commission (PTC) provide comments regarding how the identified basement-related issues should be addressed. No action may be taken at the study session.

BACKGROUND AND PURPOSE
On March 12, 2008, the PTC reviewed proposed requirements for a Green Building ordinance for residential and nonresidential development in the city. The regulations were then considered and recommended for approval by the PTC on April 9, 2008. One of the concerns voiced by Commission members and the public at both meetings was that the sustainability implications of basements should be considered, particularly with respect to dewatering and the extent of concrete used for basement construction (see Attachments H, I and J). On May 12, 2008, the City Council reviewed and adopted the City’s Green Building regulations, and referred the basement issue back to the PTC for further consideration and recommendation.

On June 9, 2008, the Public Works Department provided an informational memo to the City Council, entitled “Basement Construction and Dewatering Impacts,” addressing several of the concerns raised regarding basement construction, groundwater impacts, and dewatering discharges, as well as impacts on adjacent properties.

The purpose of this study session is to provide the Commission with further information about some of those issues and about the green building implications of the use of concrete for basement construction, and to explore options for modifications to policies or codes that address public concerns and provide for an enhanced green building strategy. The review is not intended
to address zoning criteria for light wells and below grade patios, but the pertinent code section is provided and some of the issues may affect those provisions.

DISCUSSION
The discussion below summarizes recent basement construction statistics, the issues addressed in the Public Works memo, the existing Public Works dewatering policy, potential impacts on neighboring properties, and the use of concrete in basement construction and its implications for the City’s Green Building program. A few options for addressing public concerns are provided at the end of the section.

Recent Basement Construction
The City’s Building Division reports that there were permits for 65 new single family residential basements issued over the past 2 years (through June 30, 2008). In that timeframe, there were a total of 181 new single family home permits, excluding the detached condos for Sterling Park (96 units). Ten (10) of the basements (of the total 65) were constructed for major renovations/rebuilds. Basement construction has increased as compared to prior years, with an average of about 22 basement permits issued from 2001-2004.

The Public Works Department estimates that of the total number of permits for basements in recent years, approximately 5 per year require dewatering permits. In calendar year 2008 thus far, the Department has issued 3 dewatering permits, and does not anticipate issuing any others, given the proximity to the wet weather season. Attachment G provides a map of the depth of groundwater in Palo Alto, as mapped by the Santa Clara Valley Water District.

June 9 Public Works Informational Memo
The June 9, 2008 Informational Memo from Public Works (Attachment A) addresses many issues raised by the Council, Commission, and the public, including discharge volume of dewatering, pump noise, water table impacts, subsidence, tree impacts, contaminated groundwater migration, discharge of groundwater after basement construction, basement excavation, and storm drain capacity. In some areas of technical impact, such as water table and subsidence impacts, the memo refers to a study prepared by EIP Associates, Inc. in 2004 (Attachment D), which staff feels adequately addresses those specific concerns. Other concerns regarding pump noise, contaminated groundwater contamination, and discharge of groundwater after basement construction, are addressed in the Council memo but not discussed further here. The discussions below focus on the key issues of discharge volumes and dewatering policy, the impacts of basement excavation on neighboring sites, and the green building implications of basement construction.

Discharge Volumes
The Public Works Department’s “Basement Excavation Dewatering and Basement Drainage Rules” (Attachment B) require a dewatering plan and permit for each site where dewatering during basement construction is proposed. Groundwater levels must be identified in a geotechnical report prior to permit review. Drawdown wells are typically installed around the perimeter of the excavation and pump water out of the shallow aquifer to draw down the level of the groundwater so the basement can be constructed without water filling the excavation. Public Works estimates that drawdown well systems for dewatering during basement construction can pump approximately 30-50 gallons per minute of water non-stop for 3-6 months or more while
the basement is constructed. The rules now have been revised to limit dewatering to the months of April through October. The total volume of water pumped into the storm drain system from a dewatering operation is substantial, typically a few million gallons. However, the groundwater level is re-established rapidly after dewatering ceases and the discharged water ultimately remains within the water regime and may replenish aquifers downstream or may flow to a creek or the Bay. Nevertheless, some water is surely lost in the process and the storm drain system is burdened by the additional flow.

The Public Works Department’s Basement Exterior Drainage Policy (Attachment C), last revised October 1, 2006, prohibits the use of perforated pipe systems for basement drainage and requires that all new basements be designed so that ongoing discharge after construction is not required (with limited exceptions for basement-level exterior spaces).

The key issue for Commission discussion is whether it is appropriate to further limit or prohibit basement construction where dewatering is required.

**Impacts on Neighboring Properties**

Another set of concerns about basement construction relates to potential impacts to neighboring properties, including subsidence, effects on trees, and site stability.

- **Site stability** – Residents have reported concerns about the proximity of basement excavation to their property line, which might result in erosion or undermining of the property or nearby buildings. Various excavation shoring restrictions exist to protect neighboring sites, and shoring plans are required by the Building Division. The Zoning Code only allows basements below the main structure, so setbacks should be met, but light wells are permitted to encroach up to 3 feet from a side property line (for a distance of not more than 15 feet), and excavation for the basement wall may then extend to the property line. Attachment F outlines the zoning code provisions for basements in the R-1 zone district.

- **Trees** – Tree impacts on the subject property or an adjacent site could occur from either excavation damage to roots or from dewatering to a point where the roots dry out. The Planning Arborist, however, reviews all projects to determine whether basements would adversely impact an adjacent tree’s root system, and plans would need to be revised if impacts are identified. The Zoning Code requires that basement design would not adversely impact any mature trees. The Planning Arborist has also noted that water sources for most trees’ roots are not as deep as the groundwater table.

- **Subsidence** – Staff believes that subsidence impacts, if any, are negligible from dewatering, as the water table quickly returns to pre-dewatering levels and the duration of dewatering is not long enough for soils to compress. Staff is aware of no demonstrated subsidence impacts from basement construction dewatering, though some residents have maintained that such an impact has occurred. The EIP study and contact with USGS have also indicated negligible impact.

The key issue for Commission discussion is whether some change in policy or codes, such as a minimum setback for excavation, would better protect neighboring properties without unduly infringing on the potential for property owners to construct basements.
Green Building Regulations and Implications of Basement Construction

Basement construction has been identified as a “green building” issue due to the extensive amount of energy required to produce the concrete used for basements. Concrete creates more than 5 percent of the world’s CO₂ emissions, at a rate of about 400 pounds of CO₂ for each cubic yard of concrete (3,900 pounds). The cement component of concrete (7-15%) is the major source of greenhouse gas emissions, and about 0.9 pound of CO₂ is created per pound of cement produced, according to the Portland Cement Association. A second sustainability issue is the amount of water discharged during dewatering during basement construction (discussed above).

The City’s Green Building regulations (Attachment E) became effective on July 3, 2008. The regulations include requirements to comply with green point rating systems for both nonresidential (Table A) and residential (Table B) development. The definition of “square footage” includes basement square footage, and the green points required for residential development increase with each 70 additional square feet of house size. Thus, the ordinance does not directly limit basement construction, but does require compensation in the form of increased green point rating for a home with a basement. It should also be noted, however, that due to the insulating qualities of the surrounding earth, basements are often more energy efficient than above grade floor space.

For the Commission’s information, Attachment K is an article that outlines work currently underway by a Stanford professor to produce a “green” cement that would not only eliminate CO₂ emissions from cement production, but could also use CO₂ emitted from other sources, reducing those gases as well. A ways off, perhaps, but a potential solution to the adverse impacts of concrete use in basements.

The key issue for the Commission is whether there is a basis for either limiting basement construction or requiring further increases in green points criteria for basement construction to minimize the carbon emissions impacts of basements.

POTENTIAL OPTIONS

Staff believes that the City’s review policies generally protect neighboring properties from deleterious effects of basement dewatering and that dewatering does not have substantial effects on groundwater or result in the discharge of contaminated groundwater. However, water discharge from dewatering can be substantial and there may be opportunities for the City to enact policies or regulations to further minimize the loss of water from local sites as an enhanced sustainability effort. Similarly, the City’s Green Building regulations already require compensation for basement construction in the form of additional green building measures to achieve the stipulated point totals, but there may be revisions that would provide further green building benefits where basements are constructed or to encourage retention of existing basements in commercial areas. Some of the options available to the City may include, but are not limited to:

1. Continuing to permit basements, with continued staff analysis of technical data and impacts.
2. Prohibiting basement excavation within 3 feet of a low density residential property line.
3. Limiting basement construction based on the amount of water to be discharged or further limit the timeframe for basement dewatering.
4. Modifying green building requirements to double basement square footage to determine the number of GreenPoint Rated points required, and/or allowing reductions for the use of basement construction materials that reduce the embedded energy of concrete.
5. Allowing existing basements for nonresidential properties to be excluded from floor area calculations if restricted to non-habitable uses, even if the basement meets Building Code requirements for habitable space.

Subsequent to comments by the Commission, staff will return with specific recommendations for policy or code changes to address basement issues. The Commission would then forward these changes to Council for review and approval.

ENVIRONMENTAL REVIEW
No environmental review is required for a study session. The level of environmental review required, if any, for potential code or policy actions will be determined once those actions are identified.

ATTACHMENTS
A. June 9, 2008 “Basement Construction and Dewatering Impacts” Informational Memo to City Council from Public Works Department
B. Public Works “Basement Excavation Dewatering and Basement Drainage Rules”
E. Green Building Tables for Residential and Nonresidential Development
F. Section 18.12.090 of the Zoning Ordinance re: Basements in R-1 District
G. Map of Depth to First Water, Santa Clara Valley Water District, October 15, 2003
H. May 8, 2008 E-mail from Steve Broadbent
I. July 19, 2008 E-mail from David Stonestrom
J. April 22, 2008 E-mail from Jody Davidson
K. “Green Cement May Set CO₂ Fate in Concrete.” San Francisco Chronicle, September 2, 2008.

COURTESY COPIES
Architectural Review Board
Jody Davidson
Steve Broadbent
David Stonestrom
John Northway
Bob Morris, Public Works

REVIEWED BY: Julie Caporgno, Chief Planning and Transportation Official

DEPARTMENT/DIVISION HEAD APPROVAL: Curtis Williams
Interim Director

City of Palo Alto
City of Palo Alto
City Manager's Report

TO: HONORABLE CITY COUNCIL
FROM: CITY MANAGER DEPARTMENT: PUBLIC WORKS
DATE: JUNE 9, 2008 CMR:266:08
SUBJECT: BASEMENT CONSTRUCTION AND DEWATERING IMPACTS

This is an informational report and no Council action is required.

BACKGROUND
Residential and commercial basements and underground parking garages are constructed throughout Palo Alto, except where they are disallowed in the flood zones. If a basement or underground garage site has high groundwater, the contractor will need to dewater the site so they can construct the basement or garage without groundwater filling the excavation. Accordingly, the contractor prepares and submits a dewatering plan to Public Works. The plan typically includes pumping water from the shallow aquifer below the site to a settlement tank and then via a pipe or hose to the closest storm drain inlet in the street. Public Works reviews and approves the dewatering plan, charges a dewatering fee and issues a street work permit. Public Works inspectors confirm the dewatering is done per approved plans and with minimal impact to the community. Public Works currently issues 5-10 dewatering permits for residential basements annually.

Recently, a number of citizens have voiced their concerns to the Public Works Department that dewatering has many negative impacts on the community and should potentially be disallowed, especially in residential areas. The concerns have been about the discharge of large volumes of water into the storm drain system, pump noise, land subsidence, tree impacts, groundwater impacts and contaminated groundwater migration.

DISCUSSION
Public Works and Planning Division staff have been aware of construction dewatering impacts and concerns for a number of years. They have conducted research and sought the advice of experts to address these concerns. In 2004, the Planning & Transportation Commission raised some of the same concerns about dewatering that citizens recently have. Consequently, the Planning Division retained an environmental consultant, EIP Associates, to research and report on these concerns. In 2004, EIP prepared the attached report titled, “Draft Technical Memorandum: Correlation between New Basement Construction and the Groundwater Regime in Palo Alto, California.” Further, Public Works Engineering staff has consulted with representatives of the Santa Clara Valley Water District (SCVWD), the California Regional Water Quality Control Board (CRWQCB), the United States Geological Survey (USGS), dewatering contractors, basement contractors, architects, geotechnical engineers, and staff from Public Works’ Environmental Compliance Division and the Planning and Community Environment’s Planning and Building Divisions about dewatering impacts and concerns.
To assist Council in understanding the differences between shallow and deep aquifers (described more completely in EIP’s attached report), staff provides the following descriptions.

Shallow aquifers are formed by rain seeping through the ground and pooling close to the ground surface. The top surface of the shallow aquifer is called the water table and is typically 10-30 feet below the ground surface in most areas of Palo Alto other than the hills. This is the aquifer that basement excavations may extend into, necessitating dewatering. Shallow aquifer water is nonpotable as it does not meet drinking water standards.

Deep aquifers are separated from the shallow aquifers by impermeable sediment layers, like rock or clay, called aquicludes that prevent shallow aquifer water from reaching the deep aquifers. In Palo Alto, the deep aquifers are approximately 200 feet below the ground surface. Dewatering basement excavations has virtually no effect on the deep aquifers.

Certain layers of permeable sediment, like sand or gravel, may trap and hold pockets of groundwater temporarily between shallow and deep aquifers, but these are typically not affected by basement dewatering operations.

Below is a brief summary of the above research organized by community key concerns.

Discharge Volume
A soils report is required for all projects with basements or underground garages. This report determines the depth to the shallow aquifer below the ground surface. If a contractor believes the excavation will go into the groundwater, they will typically submit a drawdown well dewatering plan to Public Works. Drawdown wells are typically installed around the perimeter of the excavation and pump water out of the shallow aquifer to draw down the level of the groundwater so the basement can be constructed without groundwater filling the excavation. These drawdown well systems pump approximately 30-50 gallons per minute into the storm drain system non-stop for 3-6 months while the contractor constructs the basement.

The volume of water pumped into the storm drain system from a drawdown well dewatering operation is substantial, typically a few million gallons. It could be used as landscaping water, but it is too large a volume for individual use and too impractical to capture and reuse for other use.

The water pumped out of the ground is discharged into the storm drains, which typically discharge into the creeks. San Francisquito Creek is a losing creek, meaning that water is lost by seeping through the creek bed and into the shallow aquifers. So, in this case, water pumped out of the shallow aquifers is added back to it. For water pumped into lined creeks, the water flows to the bay and is lost to the aquifer.

The volume of groundwater pumped out of an excavation site is a small fraction of the total volume of the aquifer and does not deplete or lower the aquifer, except, of course, in the immediate vicinity of the excavation. The USGS reports that due to natural (rain) and manmade (irrigation, leaking sewer pipes, and the SCVWD’s groundwater recharge program) methods, more water is recharged into the shallow aquifers than is pumped out of it by all pumping in the Santa Clara Valley. The EIP report also confirmed that the water table is only drawn down
locally (within tens of feet of the excavation) and reestablishes itself quickly after dewatering ceases. Therefore, the cumulative effect of dewatering on the shallow aquifers is negligible.

**Pump Noise**
Dewatering pumps can make excessive noise if installed improperly, and this is a concern for neighboring residents since the pumps run 24 hours a day. Public Works is tightening the requirements for pump operation to eliminate this problem.

**Water Table Impacts**
While the City currently prohibits basements in flood zones, there is no blanket prohibition against construction in areas with shallow aquifers. Basements are not typically constructed so deep that they actually go into the water table, but they do in some cases. In other cases, the water table might rise up, as at the end of a particularly wet winter, and surround a basement. However, in these cases, the water table level and the flow of the groundwater are not changed due to the presence of basements, as reported by EIP.

**Subsidence**
Land settlement, or subsidence, caused by temporary (such as 6 months) construction dewatering is negligible, as reported by EIP and USGS. For subsidence to occur, dewatering needs to occur over a number of years.

**Tree Impacts Relative to Water Table Changes**
The Planning Division arborist reports that in most of the developed areas of Palo Alto the preponderance of absorbing tree roots are *not* found in lower soil horizon levels below seven feet. Therefore, the majority of temporary dewatering projects are not expected to impact trees. If a tree’s roots are however deep enough and have been determined, on the basis of a certified arborist report or other qualified assessment, to be dependent on the water table, then the mitigation would be for the contractor to provide separate irrigation for the tree(s) during the dewatering period.

**Contaminated Groundwater Migration**
Citizens have expressed a concern that large volumes of groundwater being pumped out of the aquifers might cause nearby contaminated groundwater plumes to migrate towards the pumping site. When an application is submitted, staff checks dewatering sites against known contaminated groundwater plume maps. If a site is within a certain proximity to a known plume, staff requires the water to be tested for contaminants prior to and during discharge. The contractor must retain an independent testing service, test for the contaminants Public Works specifies, and submit those results to Public Works. If the water is contaminated, as it was in one case near the Stanford Research Park superfund site, it must be treated before it can be released or discharged to the sanitary sewer under permit from Public Works. The CRWQCB is drafting requirements for contractors to test groundwater discharged to the storm drain system. Staff awaits the adopted version of these requirements, scheduled for this summer, and will implement them at that time. To date, there has been no evidence that contaminated groundwater has been discharged into the storm drain system or that contaminated groundwater plumes have migrated.
Discharge of Groundwater after Basement Construction
A few years ago, Public Works allowed the use of perforated drain pipes to be installed behind basement walls and under basement slabs when the geotechnical engineer reported that groundwater would not rise to the level of these pipes. The pipes are installed to capture rainwater that filters through the ground and collects behind basement walls in order to minimize the chance of the water leaking through the walls. The pipes drain to a sump where a pump then pumps the water to the street gutter. Unfortunately, after some wet winters, groundwater did rise up to these pipes and was then pumped continuously into the street gutter for long periods of time, creating a number of public nuisance and safety concerns. Accordingly, Public Works adopted a policy two years ago that prohibits the use of perforated drain pipes for basements in areas of the City with relatively high groundwater (east of Foothill Expressway) to eliminate these potential nuisances. Public Works also recommends that applicants for new basement projects retain a waterproofing consultant to ensure the basement does not leak.

Older basements that were permitted with perforated drain pipes still may occasionally discharge groundwater into the street gutter. Public Works addresses these cases by working with the homeowners to eliminate the discharge, typically accomplished by having the homeowner raise the pump in the sump above the level of the groundwater.

Basement Excavation
Some residents have expressed a concern that the excavation pit for a basement comes too close to adjacent properties, potentially jeopardizing the stability of these properties. Although this strictly does not relate to dewatering, staff recognizes it as a legitimate concern. As previously mentioned, the Building Division requires geotechnical reports for all projects that involve basements or underground structures. A standard feature of these reports is recommendations and requirements from the geotechnical engineer that specify measures to stabilize the excavation during construction. The Building Division inspects all basement construction to ensure conformance with the geotechnical report and to verify all recommended stabilization measures are implemented. In addition, Building Inspectors will require the contractor to install extra precautionary measures before work can continue.

Storm Drain Capacity
Staff is concerned that dewatering basement excavations may take up too much capacity in the City’s storm drain pipes, minimizing the system’s ability to accommodate storm water and potentially causing or exacerbating flooding. This is not a concern raised by citizens, nor has there been any incidents where dewatering has caused flooding, but staff is developing some guidelines for wintertime dewatering in an effort to avoid a problem. The draft guidelines currently disallow dewatering during the winter unless an exemption is granted by the Director of Public Works.

CONCLUSION
Staff has researched and analyzed each of the concerns about dewatering raised by citizens. Based on that research, staff believes that the cumulative effects of dewatering basement excavations has minimal impacts on the City and that the practice should be allowed to continue. The attached EIP report essentially comes to the same conclusion. The number of residential basements permitted in the City has increased from approximately 20 a year at the start of the decade to approximately 30 a year currently. However, Public Works only issues about 5-10
dewatering permits a year. So, most basements are built without requiring dewatering. Public Works will continue to monitor dewatering activities to ensure the City’s procedures remain sound and protective of Palo Alto.

POLICY IMPLICATIONS
Staff is currently updating dewatering requirements to ensure that dewatering has minimal impacts to the community. Limitations beyond those discussed in this report would likely result in a wholesale prohibition of basements where groundwater is present, which would be a major policy issue to be decided by Council.

Per direction from Council at the May 12, 2008 council meeting, staff will prepare a report on the array of basement construction impacts and issues, including dewatering, and present it to the Planning and Transportation Commission in the near future.

ATTACHMENTS
Attachment A: Draft Technical Memorandum: Correlation between New Basement Construction and the Groundwater Regime in Palo Alto, California

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Draft Technical Memorandum: Correlation between New Basement Construction and the Groundwater Régime in Palo Alto, California

1. Statement of the Planning and Transportation Commission’s concerns.

At the 14 January 2004 Commission meeting, the planning staff presented a number of proposed changes to the existing regulation of basements in the R-1 zones. During the ensuing discussion, several Commission members expressed concerns about the impact of basement construction on groundwater levels and flow directions. Eight specific, interrelated issues were identified.

- Is groundwater pumping causing or contributing to land subsidence?
- What are the effects of pumping for months to dewater a basement construction site?
- Are basements being permitted in some inappropriate areas [where the water table is only a few feet below the ground surface], creating the need for continuous pumping?
- What groundwater effects occur if water is withdrawn from the water table and pumped into the sewers or creeks?
- What groundwater diversion effects occur if basement walls are built along creeks and/or perforate aquifers?
- What are the effects on landowners adjacent to, and down gradient from, pumping sites?
- What are the cumulative effects of basements on the groundwater régime?
- Can basement regulations be crafted to address the hydro-geology of specific building sites?

The general concern underlying these issues was expressed by Commissioner Annette Bailson: the Commission does not have the information needed to identify whether these are issues of concern, or to make informed decisions on the issues. The remainder of this technical memorandum seeks to respond to that underlying concern by provide some background information about the listed issues and about groundwater hydrology of the City relative to the construction of basements.
2. Differences between shallow (surface) and deep (confined) groundwater aquifers.

Defining the Aquifers

An aquifer is a body of geologic material, usually rock or some mixture of gravel, sand, silt and clay, that is sufficiently permeable to conduct groundwater. Some definitions include the stipulation that the body produce an economically significant flow of water before it may be considered an aquifer. For the purposes of this technical memorandum, the broader definition is applied to allow for easier discussion of the water-bearing formations underlying the City.

Of the various types of aquifers, two are of particular interest in this discussion: the shallow or surface aquifer, and the deep or confined aquifer. The relative terms ‘shallow’ and ‘deep’ refer to the depth of the aquifer below the surface of the ground (usually expressed as ‘number of feet bgs’ in hydrology studies).

A surface aquifer is so named because it is open to the surface of the ground. Rain falling on the ground surface seeps through the soil (infiltration) to some depth where it pools to form a more or less continuous body of water occupying the spaces between sediment particles or rock fragments (groundwater). The top of this body of groundwater is the water table. In the Santa Clara Plain, which forms the lowlands of Palo Alto, the water table occurs at depths of as little as ten feet below the ground surface.

Being open to the surface of the ground, the surface aquifer is subject to the influences of overlying land cover and land uses. Modern stream channels, such as the numerous reaches of San Francisquito Creek, intersect or overlie the surface aquifer, extracting water from it or adding water to it. Paving and construction create artificially impermeable surfaces that prevent local direct infiltration to the surface aquifer. Chemical constituents in urban and agricultural runoff enter the surface aquifer through infiltration from channels or detention basins, lowering the quality of the groundwater. Leaking landfill cells, leaking underground storage tanks, and liquid spills also contribute to the reduction of water quality in the surface aquifer. Although current stewardship has slowed water quality deterioration, the surface aquifer still cannot be used as a source of potable water.

A confined aquifer is one that is separated hydrologically from the overlying and underlying sediments and rock and from other aquifers. Usually the separating agent (called an aquiclue) is formed by a layer of impermeable sediment, such as clay, or by impermeable rock, such as unfractured granite. The confined aquifer is not connected directly to the overlying ground surface and is separated from the surface aquifer by an aquiclue. It is, in effect, a separate hydrologic system, gaining water from some distant source (i.e., not local
rainfall) and transmitting it to some other relatively distant discharge area. Because the confined aquifer is below, and hydrologically separated from, the surface aquifer, it is, by definition, a deep aquifer, irrespective of the number of feet it is below the ground surface.

Several aquifers may underlie each other. This is the case beneath the Santa Clara Plain where geologically recent stream-laid (alluvial) gravel, sand, silt, and clay form a sequence of deposits nearly 1500 feet thick between the foothills of the Coast Ranges and San Francisco Bay. Channels of ancient rivers depositing this material have been cut off and filled by succeeding intersecting channels, which, in turn, have been buried by the deposits of more modern channels. In this way a complex series of sediment layers of unconsolidated (loose), partially consolidated (dense), and consolidated (very dense) material has been built up as the Santa Clara Plain. The layers are discontinuous and of greater or lesser permeability, depending on their density and clay of silt content.

A complicating factor in examining such a series of aquifers is that often they are not completely confined. The aquicludes separating the aquifers may not be totally impermeable (in which case they are called aquitards) allowing water to seep from one aquifer to another. The aquifers may be connected within or outside the local area, arising from a common source or flowing to a common discharge area. The aquifers may be connected artificially through leaks in wells or along pilings passing through the aquifers. Beneath the portion of the Santa Clara Plain in Palo Alto, there is a confining clay layer that separates the surface aquifer from the deeper aquifers, but, on a regional level, this separation attenuates and, eventually, disappears farther south in San Jose.

Being separated from the surface aquifer in this part of the Santa Clara Plain, the confined aquifers beneath the City are not subject to the direct influences previously described for land cover and land uses above the surface aquifer. To the extent that groundwater migrates from the southern part of the Santa Clara Plain groundwater basin to the northern part, the effects of similar land cover and land uses in areas toward San Jose may affect water quality in the deep aquifers beneath Palo Alto.

**Construction-period Dewatering Effects**

In general, construction-period dewatering effects are limited to the surface aquifer. This would not necessarily be the case for major high-rise construction where foundations and below-grade levels may extend 100 or more feet beneath the ground surface, increasing the chances of encountering confined aquifers. It is, however, the case for the type of relatively shallow basement construction being considered in the Zoning Ordinance Update. In the Santa Clara Plain portion of Palo Alto, the uppermost sequence of unconsolidated and partially consolidated alluvium is about 200 feet thick. This sequence contains the
surface aquifer, the base of which is the previously mentioned clay aquiclude identified by the Santa Clara Valley Water District (SCVWD) in its 2001 Groundwater Management Plan. The general direction of groundwater flow in this area is northeast toward the Bay, so the surface aquifer and the deeper, confined aquifers tend to remain separated in Palo Alto until they reach the vicinity of the Bay margin.

The removal of groundwater from an excavation during below-ground-level construction is necessary to provide safety for the construction workers, and is a prerequisite for waterproofing the building's foundation and subsurface floors. One method for accomplishing this is to dig a small pit below the base of the foundation excavation, slope the excavation so groundwater drains to the pit, and then pump the water out of the pit and into the storm drainage system. Another method is to drill temporary wells around the building footprint and pump directly from the groundwater body to the storm drainage system until the local water table drops below the base of the excavation. In either case, groundwater flowing into the area of drawdown created by the dewatering process is deflected toward the base of the excavation, whence it is pumped to the storm drainage system. Groundwater beyond the influence of the dewatering process continues to flow normally.

Dewatering pumping continues until the foundation and subsurface floors are completed and the excavation is filled. The amount of water deflected depends on the level of the water table, the permeability of the material adjacent to the excavation, and the length of time the excavation needs to be kept open and dry. An increase in any of these factors increases the amount of water deflected. This amount is small when compared to the total volume of available groundwater directly beneath the Santa Clara Plain (see below). Because the deflection is temporary and very localized, and because groundwater levels at the sites recover rapidly once pumping has ceased, there appears to be no discernable long-term effect on the surface aquifer.

In the areas adjacent to the site being dewatered, the water table would be lowered temporarily by the dewatering process. This effect could extend from several feet to several tens of feet beyond the excavation depending on the method used, the level of the water table at the time dewatering began, the permeability of the material adjacent to the excavation, and the length of time the excavation needed to be kept open and dry. The possibility exists that adjacent landscaping could be experience deterioration from reduced groundwater availability.

**Deflection or Reduction of the rate of Groundwater Flow**

Although the amount of water pumped from an excavation may appear substantial as it
flows along a street to a storm drain inlet, it is small compared to the amount of groundwater directly beneath the Santa Clara Plain. The SCVWD’s current estimate is that there is more than 350,000 acre-feet of groundwater available in the Santa Clara Subbasin. An excavation dewatering flow of 1 cubic foot per second would deflect 1.98 acre-feet of water per day. Because groundwater would be pumped out of the excavation faster than could flow in, the alteration in groundwater flow rate would be less than the rate of dewatering. Because the resultant groundwater flow deflection is temporary, small, and very localized, there appears to be no discernable long-term effect on the surface aquifer. Because dewatering for basement construction occurs only in the uppermost portion of the surface aquifer, there would be no effect on the deep aquifer.

In a typical 3-month excavation period the 1.98 acre-feet per day dewatering flow would amount to 0.05% (one-twentieth of one percent) of the minimum known groundwater resource in the subbasin. No published information about the subbasin’s water budget has been found, so any attempt to predict how quickly the water would be replaced through recharge would be speculative. It is known, however, that the importation of potable water and the SCVWD controlled recharge program have assisted groundwater levels in the subbasin to rise 200 feet during the last 40 years. Most of that rise has been in the surface aquifer. The implication is that the subbasin is being recharged at a rate substantially higher than the rate of withdrawal from all pumping, including dewatering for basement construction. Consequently, it appears that the amount of flow from one, or even several, dewatering operations would not have long-term effects on the surface aquifer.

In the areas adjacent to the site being dewatered, the rate and flow directions of the groundwater would be altered temporarily by the dewatering process. Groundwater in the influenced area would move toward the base of the excavation at a rate lower than the rate of dewatering discharge. This effect could extend from several feet to several tens of feet beyond the excavation depending on the method used, the level of the water table at the time dewatering began, the permeability of the material adjacent to the excavation, and the length of time the excavation needed to be kept open and dry. Flow directions and rates would revert to near normal when dewatering ceased.

There would be some displacement of groundwater flow around the newly constructed basement, depending on the permeability of the surrounding soil materials. The volume of space displaced by the basement could be several thousand to several tens of thousands of cubic feet, which, although small compared to the volume of the surface aquifer, could be significant locally, especially if there were other similarly sized basements in the immediate vicinity. The flow of groundwater would readjust to this condition, possibly altering the level of the water table in the vicinity of the site for several weeks or months, but is unlikely to experience any major permanent change. The groundwater level in the surface aquifer
undergoes more significant changes during the rainy season than would be expected from long-term flow deflection caused by basements.

Saltwater Intrusion and Subsidence

Saltwater intrusion and subsidence in the Santa Clara Subbasin are documented regional effects of the excessive removal of groundwater from the deep aquifer (overdrafting) over many years. This practice was curtailed in the mid-1960s when the importation of potable water increased substantially. Since then, the SCVWD has been recharging the subbasin thereby raising groundwater levels, impeding saltwater infiltration of the surface aquifer, and virtually eliminating further overdraft-related subsidence (the effects of previous subsidence cannot be reversed because portions of the deep aquifer have been compressed permanently). Such basin-wide effects could recur only if the deep aquifer became overdrafted again. Because dewatering for basement construction occurs only in the uppermost portion of the surface aquifer and involves only a small amount of groundwater withdrawal, no effects would occur in the deep aquifer.

3. Palo Alto Public Works Department existing regulatory structure.

There are a number of policies in place that provide protection for the City’s groundwater resource and for property owners in the vicinity of new basement construction.

- The Public Works Department prohibits the long-term pumping of groundwater after a basement has been constructed. This eliminates the possibility that the water table in the vicinity of the project would be lowered permanently.

- The Public Works Department requires basements to be waterproofed and strengthened structurally below the expected groundwater level. This eliminates the need for groundwater pumping.

- The Public Works Department requires permit applicants whose projects would have basements to prepare a geotechnical investigation and report that would determine, among other information, the expected highest groundwater level in the local shallow aquifer. This allows the department to make informed decisions about the advisability of basement construction at a particular site and/or to set the conditions under which basement construction may proceed.

- If dewatering is necessary for basement construction, the Public Works Department sets the dewatering permit conditions based on the hydrology of the specific site under consideration. This ensures resource and property protection where it is needed.

- The Public Works Department allows the removal of seepage water that collects along basement walls above the water table. Normally this removal would need only a minimal amount of pumping, but may need to be monitored.
4. Recommendation regarding the advisability of codifying groundwater effects in the Zoning Ordinance Update

The above-listed Public Works Department policies dealing with basement construction and dewatering for such construction are intended to prevent substantial impacts to groundwater, either on an area-wide basis or in the vicinity of the construction site. Although the policies and their associated construction standards appear to address the issues adequately, it may be advisable for the Public Works Department to increase the community’s awareness of these issues through an out-reach program. Because these issues are, essentially, engineering concerns that are site-specific and already covered by existing regulations, there is no need to modify the zoning ordinance with respect to them.

Sincerely,

George J. Burwasser,
EIP Associates
BASEMENT EXCAVATION DEWATERING AND BASEMENT DRAINAGE RULES

BASEMENT DRAINAGE: Due to high groundwater throughout much of the City and Public Works prohibiting the pumping and discharging of groundwater, perforated pipe drainage systems at the exterior of the basement walls or under the slab are not allowed for this site. A drainage system is, however, required for all exterior basement-level spaces, such as lightwells, patios or stairwells. This system consists of a sump, a sump pump, a backflow preventer, and a closed pipe from the pump to a dissipation device onsite at least 10 feet from the property line, such as a bubblem box in a landscaped area, so that water can percolate into the soil and/or sheet flow across the site. The device must not allow stagnant water that could become mosquito habitat. Additionally, the plans must show that exterior basement-level spaces are at least 7” below any adjacent windowsills or doorsills to minimize the potential for flooding the basement. Public Works recommends a waterproofing consultant be retained to design and inspect the vapor barrier and waterproofing systems for the basement.

BASEMENT SHORING: Shoring for the basement excavation, including tiebacks, must not extend onto adjacent private property or into the City right-of-way without having first obtained written permission from the private property owners and/or an encroachment permit from Public Works.

DEWATERING: Basement excavations may require dewatering during construction. Public Works only allows groundwater drawdown well dewatering. Open pit groundwater dewatering is disallowed. Dewatering is only allowed from April through October due to inadequate capacity in our storm drain system. The geotechnical report for this site must list the highest anticipated groundwater level. We recommend a piezometer to be installed in the soil boring. The contractor must determine the depth to groundwater immediately prior to excavation by using the piezometer or by drilling an exploratory hole if the deepest excavation will be within 3 feet of the highest anticipated groundwater level. If groundwater is within 3 feet of the deepest excavation, a drawdown well dewatering system must be used, or alternatively, the contractor can excavate for the basement and hope not to hit groundwater, but if he does, he must immediately stop all work and install a drawdown well system before he continues to excavate. Public Works may require the water to be tested for contaminants prior to initial discharge and at intervals during dewatering. If testing is required, the contractor must retain an independent testing firm to test the discharge water for the contaminants Public Works specifies and submit the results to Public Works.

Public Works reviews and approves dewatering plans as part of a Permit for Construction in the Public Street ("street work permit"). The applicant can include a dewatering plan in the building permit plan set in order to obtain approval of the plan during the building permit review, but the contractor will still be required to obtain a street work permit prior to dewatering. Public Works has a standard dewatering plan sheet that can be used for this purpose and dewatering guidelines are available on Public Works’ website. Alternatively, the applicant must include the above dewatering requirements in a note on the site plan.
PUBLIC WORKS ENGINEERING
BASEMENT EXTERIOR DRAINAGE POLICY
EFFECTIVE OCTOBER 1, 2006

Policy

The Department of Public Works (Public Works) will not permit the use of basement exterior drainage systems consisting of perforated pipes located on the exterior of the basement walls or underneath the slab that collect water which is then pumped to the surface of the ground for discharge, either on-site or off-site, for all City of Palo Alto parcels northeast (the bay side) of Foothill Expressway.

Purpose

To ensure the public safety and health by preventing the discharge of groundwater into the City gutter system. The discharge of groundwater into the gutter system causes the following public safety, health and nuisance concerns:

- gutters are constantly wet and may enhance the growth of algae, thereby creating a slippery condition for pedestrians, bicyclists and motorists
- ponded water at the low spots of the gutter may be slippery to cross for pedestrians, bicyclists and motorists
- ponded water in the gutter may become mosquito habitat
- ponded water in the gutter may seep through cracks, undermining the subgrade and degrading the gutter and adjacent pavement
- groundwater discharge into the City’s storm drain system adversely affects others who need to discharge storm water run-off for which the system was designed

Background

In the past, Public Works allowed perforated pipe basement drainage systems to collect water behind basement walls and under basement slabs and discharge it at the ground. Architects proposed these systems in order to minimize the chances of water leakage through the basement walls and slabs. These systems were permitted with the intention of only collecting and discharging small amounts of rainwater that had seeped down through the soil. For proposed basement drainage systems, Public Works required geotechnical reports that estimated the highest expected groundwater level at the site and Public Works required that the perforated pipes be placed above this level. Recent experience indicates that oftentimes the groundwater level rose above the estimated level and entered the perforated pipes, resulting in the constant pumping of groundwater into the street gutter.

Analysis

Public Works has obtained a groundwater elevation contour map from the Santa Clara Valley Water District. These maps were established using data from numerous water monitoring wells the SCVWD maintains throughout the City. The contours are the depth below ground to the highest level the main groundwater aquifer has risen to since the monitoring wells were installed.
The area of town where there is relatively high groundwater (above 20 feet below-grade) is roughly northeast of Foothill Expressway.

The main aquifer depicted in the contour map is not the only source of groundwater. Due to soil properties, groundwater can get trapped between two relatively impermeable layers of soil. These lenses of perched groundwater can occur essentially anywhere and be of any size. Consequently, even though the SCVWD map may indicate a certain area of town has groundwater at 20 feet below-grade, for instance, there may currently be perched water closer to the surface or perched water may occur in the future closer to the surface.

Summary

Public Works feels that the public safety and health, potential nuisance, and maintenance concerns caused by the discharge of groundwater into street gutters outweigh the developers' desire for perforated pipe drainage systems. Although certain sites may seem appropriate for perforated pipe drainage systems because of current low groundwater levels, higher groundwater levels may occur in the future. Accordingly, Public Works will no longer permit perforated pipe basement drainage systems installed in order to discharge water at the ground surface northeast of Foothill Expressway.

Note

Drainage systems are required and will be permitted for basement-level exterior spaces, such as stairwells, lightwells and patios. These drainage systems consist of a sump, a sump pump, and a closed pipe from the pump to a dissipation device onsite, such as a bubbler box in a landscaped area, so that water can percolate into the soil and/or sheet flow across the site. The device must not allow stagnant water to occur that could become mosquito habitat. Additionally, the plans must show 8" of freeboard between the floor of any exterior basement-level space and any adjacent windowsills or doorsills.

Glenn Roberts, Director of Public Works

S:PWD/ENG/TYPING/Morris/Development/Basement Drainage/Basement Drainage Policy
Draft Technical Memorandum: Correlation between New Basement Construction and the Groundwater Régime in Palo Alto, California

1. Statement of the Planning and Transportation Commission’s concerns.

At the 14 January 2004 Commission meeting, the planning staff presented a number of proposed changes to the existing regulation of basements in the R-1 zones. During the ensuing discussion, several Commission members expressed concerns about the impact of basement construction on groundwater levels and flow directions. Eight specific, interrelated issues were identified.

- Is groundwater pumping causing or contributing to land subsidence?
- What are the effects of pumping for months to dewater a basement construction site?
- Are basements being permitted in some inappropriate areas [where the water table is only a few feet below the ground surface], creating the need for continuous pumping?
- What groundwater effects occur if water is withdrawn from the water table and pumped into the sewers or creeks?
- What groundwater diversion effects occur if basement walls are built along creeks and/or perforate aquifers?
- What are the effects on landowners adjacent to, and down gradient from, pumping sites?
- What are the cumulative effects of basements on the groundwater régime?
- Can basement regulations be crafted to address the hydro-geology of specific building sites?

The general concern underlying these issues was expressed by Commissioner Annette Bailson: the Commission does not have the information needed to identify whether these are issues of concern, or to make informed decisions on the issues. The remainder of this technical memorandum seeks to respond to that underlying concern by provide some background information about the listed issues and about groundwater hydrology of the City relative to the construction of basements.
2. Differences between shallow (surface) and deep (confined) groundwater aquifers.

Defining the Aquifers

An aquifer is a body of geologic material, usually rock or some mixture of gravel, sand, silt and clay, that is sufficiently permeable to conduct groundwater. Some definitions include the stipulation that the body produce an economically significant flow of water before it may be considered an aquifer. For the purposes of this technical memorandum, the broader definition is applied to allow for easier discussion of the water-bearing formations underlying the City.

Of the various types of aquifers, two are of particular interest in this discussion: the shallow or surface aquifer, and the deep or confined aquifer. The relative terms 'shallow' and 'deep' refer to the depth of the aquifer below the surface of the ground (usually expressed as 'number of feet bgs' in hydrology studies).

A surface aquifer is so named because it is open to the surface of the ground. Rain falling on the ground surface seeps through the soil (infiltration) to some depth where it pools to form a more or less continuous body of water occupying the spaces between sediment particles or rock fragments (groundwater). The top of this body of groundwater is the water table. In the Santa Clara Plain, which forms the lowlands of Palo Alto, the water table occurs at depths of as little as ten feet below the ground surface.

Being open to the surface of the ground, the surface aquifer is subject to the influences of overlying land cover and land uses. Modern stream channels, such as the numerous reaches of San Francisquito Creek, intersect or overlie the surface aquifer, extracting water from it or adding water to it. Paving and construction create artificially impermeable surfaces that prevent local direct infiltration to the surface aquifer. Chemical constituents in urban and agricultural runoff enter the surface aquifer through infiltration from channels or detention basins, lowering the quality of the groundwater. Leaking landfill cells, leaking underground storage tanks, and liquid spills also contribute to the reduction of water quality in the surface aquifer. Although current stewardship has slowed water quality deterioration, the surface aquifer still cannot be used as a source of potable water.

A confined aquifer is one that is separated hydrologically from the overlying and underlying sediments and rock and from other aquifers. Usually the separating agent (called an aquiclude) is formed by a layer of impermeable sediment, such as clay, or by impermeable rock, such as unfractured granite. The confined aquifer is not connected directly to the overlying ground surface and is separated from the surface aquifer by an aquiclude. It is, in effect, a separate hydrologic system, gaining water from some distant source (i.e., not local
rainfall) and transmitting it to some other relatively distant discharge area. Because the confined aquifer is below, and hydrologically separated from, the surface aquifer, it is, by definition, a deep aquifer, irrespective of the number of feet it is below the ground surface.

Several aquifers may underlie each other. This is the case beneath the Santa Clara Plain where geologically recent stream-laid (alluvial) gravel, sand, silt, and clay form a sequence of deposits nearly 1500 feet thick between the foothills of the Coast Ranges and San Francisco Bay. Channels of ancient rivers depositing this material have been cut off and filled by succeeding intersecting channels, which, in turn, have been buried by the deposits of more modern channels. In this way a complex series of sediment layers of unconsolidated (loose), partially consolidated (dense), and consolidated (very dense) material has been built up as the Santa Clara Plain. The layers are discontinuous and of greater or lesser permeability, depending on their density and clay of silt content.

A complicating factor in examining such a series of aquifers is that often they are not completely confined. The aquicludes separating the aquifers may not be totally impermeable (in which case they are called aquitards) allowing water to seep from one aquifer to another. The aquifers may be connected within or outside the local area, arising from a common source or flowing to a common discharge area. The aquifers may be connected artificially through leaks in wells or along pilings passing through the aquifers. Beneath the portion of the Santa Clara Plain in Palo Alto, there is a confining clay layer that separates the surface aquifer from the deeper aquifers, but, on a regional level, this separation attenuates and, eventually, disappears farther south in San Jose.

Being separated from the surface aquifer in this part of the Santa Clara Plain, the confined aquifers beneath the City are not subject to the direct influences previously described for land cover and land uses above the surface aquifer. To the extent that groundwater migrates from the southern part of the Santa Clara Plain groundwater basin to the northern part, the effects of similar land cover and land uses in areas toward San Jose may affect water quality in the deep aquifers beneath Palo Alto.

**Construction-period Dewatering Effects**

In general, construction-period dewatering effects are limited to the surface aquifer. This would not necessarily be the case for major high-rise construction where foundations and below-grade levels may extend 100 or more feet beneath the ground surface, increasing the chances of encountering confined aquifers. It is, however, the case for the type of relatively shallow basement construction being considered in the Zoning Ordinance Update. In the Santa Clara Plain portion of Palo Alto, the uppermost sequence of unconsolidated and partially consolidated alluvium is about 200 feet thick. This sequence contains the
surface aquifer, the base of which is the previously mentioned clay aquiclude identified by the Santa Clara Valley Water District (SCVWD) in its 2001 Groundwater Management Plan. The general direction of groundwater flow in this area is northeast toward the Bay, so the surface aquifer and the deeper, confined aquifers tend to remain separated in Palo Alto until they reach the vicinity of the Bay margin.

The removal of groundwater from an excavation during below-ground-level construction is necessary to provide safety for the construction workers, and is a prerequisite for waterproofing the building’s foundation and subsurface floors. One method for accomplishing this is to dig a small pit below the base of the foundation excavation, slope the excavation so groundwater drains to the pit, and then pump the water out of the pit and into the storm drainage system. Another method is to drill temporary wells around the building footprint and pump directly from the groundwater body to the storm drainage system until the local water table drops below the base of the excavation. In either case, groundwater flowing into the area of drawdown created by the dewatering process is deflected toward the base of the excavation, whence it is pumped to the storm drainage system. Groundwater beyond the influence of the dewatering process continues to flow normally.

Dewatering pumping continues until the foundation and subsurface floors are completed and the excavation is filled. The amount of water deflected depends on the level of the water table, the permeability of the material adjacent to the excavation, and the length of time the excavation needs to be kept open and dry. An increase in any of these factors increases the amount of water deflected. This amount is small when compared to the total volume of available groundwater directly beneath the Santa Clara Plain (see below). Because the deflection is temporary and very localized, and because groundwater levels at the sites recover rapidly once pumping has ceased, there appears to be no discernable long-term effect on the surface aquifer.

In the areas adjacent to the site being dewatered, the water table would be lowered temporarily by the dewatering process. This effect could extend from several feet to several tens of feet beyond the excavation depending on the method used, the level of the water table at the time dewatering began, the permeability of the material adjacent to the excavation, and the length of time the excavation needed to be kept open and dry. The possibility exists that adjacent landscaping could be experience deterioration from reduced groundwater availability.

**Deflection or Reduction of the rate of Groundwater Flow**

Although the amount of water pumped from an excavation may appear substantial as it
flows along a street to a storm drain inlet, it is small compared to the amount of groundwater directly beneath the Santa Clara Plain. The SCVWD’s current estimate is that there is more than 350,000 acre-feet of groundwater available in the Santa Clara Subbasin. An excavation dewatering flow of 1 cubic foot per second would deflect 1.98 acre-feet of water per day. Because groundwater would be pumped out of the excavation faster than could flow in, the alteration in groundwater flow rate would be less than the rate of dewatering. Because the resultant groundwater flow deflection is temporary, small, and very localized, there appears to be no discernable long-term effect on the surface aquifer. Because dewatering for basement construction occurs only in the uppermost portion of the surface aquifer, there would be no effect on the deep aquifer.

In a typical 3-month excavation period the 1.98 acre-feet per day dewatering flow would amount to 0.05% (one-twentieth of one percent) of the minimum known groundwater resource in the subbasin. No published information about the subbasin’s water budget has been found, so any to attempt to predict how quickly the water would be replaced through recharge would be speculative. It is known, however, that the importation of potable water and the SCVWD controlled recharge program have assisted groundwater levels in the subbasin to rise 200 feet during the last 40 years. Most of that rise has been in the surface aquifer. The implication is that the subbasin is being recharged at a rate substantially higher than the rate of withdrawal from all pumping, including dewatering for basement construction. Consequently, it appears that the amount of flow from one, or even several, dewatering operations would not have long-term effects on the surface aquifer.

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There would be some displacement of groundwater flow around the newly constructed basement, depending on the permeability of the surrounding soil materials. The volume of space displaced by the basement could be several thousand to several tens of thousands of cubic feet, which, although small compared to the volume of the surface aquifer, could be significant locally, especially if there were other similarly sized basements in the immediate vicinity. The flow of groundwater would readjust to this condition, possibly altering the level of the water table in the vicinity of the site for several weeks or months, but is unlikely to experience any major permanent change. The groundwater level in the surface aquifer
undergoes more significant changes during the rainy season than would be expected from long-term flow deflection caused by basements.

**Saltwater Intrusion and Subsidence**

Saltwater intrusion and subsidence in the Santa Clara Subbasin are documented regional effects of the excessive removal of groundwater from the **deep aquifer** (overdrafting) over many years. This practice was curtailed in the mid-1960s when the importation of potable water increased substantially. Since then, the SCVWD has been recharging the subbasin thereby raising groundwater levels, impeding saltwater infiltration of the **surface aquifer**, and virtually eliminating further overdraft-related subsidence (the effects of previous subsidence cannot be reversed because portions of the deep aquifer have been compressed permanently). Such basin-wide effects could recur only if the deep aquifer became overdrafted again. Because dewatering for basement construction occurs only in the uppermost portion of the surface aquifer and involves only a small amount of groundwater withdrawal, no effects would occur in the deep aquifer.

3. **Palo Alto Public Works Department existing regulatory structure.**

There are a number of policies in place that provide protection for the City’s groundwater resource and for property owners in the vicinity of new basement construction.

- The Public Works Department prohibits the long-term pumping of groundwater after a basement has been constructed. This eliminates the possibility that the water table in the vicinity of the project would be lowered permanently.

- The Public Works Department requires basements to be waterproofed and strengthened structurally below the expected groundwater level. This eliminates the need for groundwater pumping.

- The Public Works Department requires permit applicants whose projects would have basements to prepare a geotechnical investigation and report that would determine, among other information, the expected highest groundwater level in the local shallow aquifer. This allows the department to make informed decisions about the advisability of basement construction at a particular site and/or to set the conditions under which basement construction may proceed.

- If dewatering is necessary for basement construction, the Public Works Department sets the dewatering permit conditions based on the hydrology of the specific site under consideration. This ensures resource and property protection where it is needed.

- The Public Works Department allows the removal of seepage water that collects along basement walls above the water table. Normally this removal would need only a minimal amount of pumping, but may need to be monitored.
4. Recommendation regarding the advisability of codifying groundwater effects in the Zoning Ordinance Update

The above-listed Public Works Department policies dealing with basement construction and dewatering for such construction are intended to prevent substantial impacts to groundwater, either on an area-wide basis or in the vicinity of the construction site. Although the policies and their associated construction standards appear to address the issues adequately, it may be advisable for the Public Works Department to increase the community’s awareness of these issues through an out-reach program. Because these issues are, essentially, engineering concerns that are site-specific and already covered by existing regulations, there is no need to modify the zoning ordinance with respect to them.

Sincerely,

George J. Burwasser,
EIP Associates
Table A
City of Palo Alto
Green Building Standards for Compliance for Private Development
Nonresidential Construction and Renovation

<table>
<thead>
<tr>
<th>Nonresidential Construction and Renovation</th>
<th>Building Improvements</th>
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<tr>
<td>Checklist Required</td>
<td>Minimum Threshold</td>
</tr>
<tr>
<td>New construction ≥ 25,000 sf</td>
<td>LEED-NC Checklist</td>
</tr>
<tr>
<td>New construction ≥ 5,000 sf and &lt; 25,000 sf</td>
<td>LEED-NC Checklist</td>
</tr>
<tr>
<td>New construction ≥ 500 sf and &lt; 5,000 sf</td>
<td>LEED-NC Checklist</td>
</tr>
<tr>
<td>Renovation ≥ 5,000 sf and ≥ 50% of building sf and ≥ $500,000 valuation</td>
<td>LEED-NC Checklist</td>
</tr>
<tr>
<td>Other renovation ≥ $100,000 valuation</td>
<td>LEED-CI Checklist</td>
</tr>
<tr>
<td>New construction &lt; 500 sf and renovation &lt; $100,000 valuation</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

Mixed Use or Other Development | Commercial and residential criteria as applicable

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1 Cumulative new construction or renovations over any 2-year period following adoption of these requirements shall be considered as a single project, unless exempted by the Planning Director as impractical for compliance.
2 Compliance with other LEED® checklists, including but not limited to LEED-CS (Core & Shell), LEED-CI (Commercial Interiors), or LEED-EB (Existing Buildings) may be substituted for the designated rating system where deemed appropriate by the Planning Director, after recommendation by the Architectural Review Board (if ARB review is required).
3 Pro-rated formula = \((\text{new construction sf} / 5,000) \times 33\) points, but not less than 17 points.
4 To be determined by the Planning Director; generally the provisions of Table A will apply to the commercial portion of the development, and the provisions of Table B will apply to the residential portions of the development.
5 Exemptions and incentives may be available for historic structures, pursuant to Section 18.44.070 of the ordinance. The Compliance Official may allow the use of alternative checklists for historic buildings or for buildings that retain or re-use substantial portions of the existing structure.
6 To be adjusted annually to reflect changes to the City's valuation per square foot of new construction.
Note: Applicants are advised to use this table only in conjunction with the entirety of requirements in Chapter 18.44 (Green Building Regulations)

### Table B
City of Palo Alto
Green Building Standards for Compliance for Private Development
Residential Construction and Renovation

<table>
<thead>
<tr>
<th>Type of Project</th>
<th>Building Improvements</th>
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<tbody>
<tr>
<td></td>
<td>Checklist Required</td>
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<tr>
<td>Multi-Family Residential³</td>
<td>Multifamily GreenPoint Checklist</td>
</tr>
<tr>
<td>New construction of 3 or more (attached) units²</td>
<td>Multifamily GreenPoint Checklist</td>
</tr>
<tr>
<td>Additions and/or renovations with permit valuation ≥ $100,000⁵</td>
<td>Multifamily GreenPoint Checklist</td>
</tr>
<tr>
<td>Additions and/or renovations with permit valuation &lt; $100,000⁵</td>
<td></td>
</tr>
<tr>
<td>Single-Family and Two-Family Residential³</td>
<td>Multifamily GreenPoint Checklist</td>
</tr>
<tr>
<td>New construction of ≥ 2,550 sf</td>
<td>Multifamily GreenPoint Checklist</td>
</tr>
<tr>
<td>New construction of ≥ 1,250 sf and &lt; 2,550 sf</td>
<td>Multifamily GreenPoint Checklist</td>
</tr>
<tr>
<td>Additions &lt; 1,250 sf and/or renovations ≥ $75,000⁵</td>
<td>Home Remodeling Green Building Checklist</td>
</tr>
<tr>
<td>Additions and/or renovations of &lt; $75,000⁵ permit valuation</td>
<td></td>
</tr>
<tr>
<td>Mixed Use or Other Development</td>
<td>Commercial and residential criteria as applicable³</td>
</tr>
</tbody>
</table>

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¹ Cumulative new construction or renovations over any 2-year period following adoption of these requirements shall be considered as a single project, unless exempted by the Planning Director as impractical for compliance.

² For any multi-family residential project with 30 or more new units proposed, a LEED-ND (Neighborhood Development) checklist shall also be completed and submitted with the application, for information only.

³ To be determined by the Planning Director; generally the provisions of Table A will apply to the commercial portion of the development, and the provisions of Table B will apply to the residential portions of the development.

⁴ Exemptions and incentives may be available for historic structures, pursuant to Section 18.44.070. The Compliance Official may allow the use of alternative checklists for historic buildings or for buildings that retain or re-use substantial portions of the existing structure, and may reduce the minimum threshold (points) required as outlined in Section 18.44.050.

⁵ To be adjusted annually to reflect changes to the City’s valuation per square foot of new construction.

⁶ Points shall include GPR minimum points across all resource categories.
attained the compliance threshold as indicated for the Covered Project type as set forth in the Standards for Compliance outlined in Section 18.44.040.

(u) “Single-family or two-family residential” means a single detached dwelling unit or two units in a single building.

(v) “Square footage,” for the purposes of calculating commercial, multi-family residential, and single-family and two-family new construction square footage, means all new and replacement square footage, including basement areas (7 feet or greater in height) and garages, except that unconditioned garage space shall only count as 50% of that square footage. Areas demolished shall not be deducted from the total new construction square footage.

(w) “Threshold Verification by LEED AP” means verification by a LEED accredited professional certifying that each LEED checklist point listed was verified to meet the requirements to achieve that point. The LEED AP shall provide supporting information from qualified professionals (e.g. civil engineer, electrical engineer, Title 24 consultant, commissioning agent, etc.) to certify compliance with each point on the checklist. Documentation of construction consistent with building plans calculated to achieve energy compliance is sufficient verification in lieu of post-construction commissioning.

18.44.040 Standards for Compliance.

The City Council shall establish by resolution, and shall periodically review and update as necessary, Green Building Standards for Compliance. The Standards for Compliance shall include, but are not limited to, the following:

(a) The types of projects subject to regulation (Covered Projects);
(b) The green building rating system to be applied to the various types of projects;
(c) Minimum thresholds of compliance for various types of projects; and
(d) Timing and methods of verification of compliance with these regulations.

The Standards for Compliance shall be approved after recommendation from the Director of Planning and Community Environment, who shall refer the Standards for recommendation by the Architectural Review Board, prior to Council action.

18.44.050 Incentives for Compliance.

(a) In addition to the required standards for compliance, the City Council may, through ordinance or resolution, enact financial, permit review process, or zoning incentives and/or award or recognition programs to further encourage higher levels of green building compliance for a project.
18.12.090 Basements

Basements shall be permitted in areas that are not designated as special flood hazard areas as defined in Chapter 16.52, and are subject to the following regulations:

(a) Permitted Basement Area
Basements may not extend beyond the building footprint and basements are not allowed below any portion of a structure that extends into required setbacks, except to the extent that the main residence is permitted to extend into the rear yard setback by other provisions of this code.

(b) Inclusion as Gross Floor Area
Basements shall not be included in the calculation of gross floor area, provided that:
(1) basement area is not deemed to be habitable space, such as crawlspace; or
(D) the cumulative length of any excavated area or portion thereof that extends into a required side or rear yard does not exceed 15 feet;

(E) the owner provides satisfactory evidence to the planning director prior to issuance of a building permit that any features or portions of features that extend into a required side or rear yard will not be harmful to any mature trees on the subject property or on abutting properties;

(F) such features have either a drainage system that meets the requirements of the public works department or are substantially sheltered from the rain by a roof overhang or canopy of a permanent nature;

(G) any roof overhang or canopy installed pursuant to subsection (F) is within and is counted toward the site coverage requirements established in Section 18.12.040;

(H) such areas are architecturally compatible with the residence; and

(I) such areas are screened to off-site views by means of landscaping and/or fencing as determined appropriate by the planning director.

(2) basement area is deemed to be habitable space but the finished level of the first floor is no more than three feet above the grade around the perimeter of the building foundation.

Basement space used as a second dwelling unit or portion thereof shall be counted as floor area for the purpose of calculating the maximum size of the unit (but may be excluded from calculations of floor area for the total site). This provision is intended to assure that second units are subordinate in size to the main dwelling and to preclude the development of duplex zoning on the site.

(c) **Lightwells, Stairwells, Below Grade Patios and other Excavated Features**

(1) Lightwells, stairwells, and similar excavated features along the perimeter of the basement shall not affect the measurement of grade for the purposes of determining gross floor area, provided that the following criteria are met:

(A) such features are not located in the front of the building;

(B) such features shall not exceed 3 feet in width;

(C) the cumulative length of all such features does not exceed 30% of the perimeter of the basement;

(D) such features do not extend more than 3 feet into a required side yard nor more than 4 feet into a required rear yard, but where a side yard is less than 6 feet in width, the features shall not encroach closer than 3 feet from the adjacent side property line;

(E) the cumulative length of any features or portions of features that extend into a required side or rear yard does not exceed 15 feet in length;

(F) the owner provides satisfactory evidence to the planning division prior to issuance of a building permit that any features or portions of features that extend into a required side or rear yard will not be harmful to any mature trees on the subject property or on abutting properties; and

(G) such features have either a drainage system that meets the requirements of the public works department or are substantially sheltered from the rain by a roof overhang or canopy of a permanent nature.

(2) Below-grade patios, sunken gardens, or similar excavated areas along the perimeter of the basement that exceed the dimensions set forth in subsection (1), are permitted and shall not affect the measurement of grade for the purposes of determining gross floor area, provided that:

(A) such areas are not located in the front of the building;

(B) all such areas combined do not exceed 2% of the area of the lot or 200 square feet, whichever is greater; that each such area does not exceed 200 square feet; and that each such area is separated from another by a distance of at least 10 feet. Area devoted to required stairway access shall not be included in the 200 square foot limitation.

(C) such features do not extend more than 2 feet into a required side yard nor more than 4 feet into a required rear yard;
This map depicts the depth to first groundwater in the Santa Clara County groundwater subbasins. The depth to water measurements at fuel leak sites and at selected water level wells were used to generate this map. This map presents the shallowest depth to water ever measured for an area, it does not represent the water level at any particular time.

The data presented in this map are regional and general in nature. The Santa Clara Valley Water District (District) does not guarantee that the groundwater data presented here accurately reflects conditions at any particular site or time. The District makes no guarantee of accuracy or completeness, or adequacy of this data for any use or particular purpose.

In consideration of the District making this information available, any user of the data accepts it as is and assumes responsibility for its use. User agrees to defend, indemnify and hold the District harmless from and against all damage, loss or liability arising from any use of the data. Groundwater data may vary greatly from site to site. A site-specific investigation may be necessary to determine site-specific conditions.
May 8, 2008

Honorable Mayor Larry Klein and Council Members
City of Palo Alto
250 Hamilton Ave
Palo Alto, CA 94301
Via email

Re: Green Building Ordinance – Request to Prohibit Basement Construction

Honorable Mayor Klein and Council Members:

I urge City Council to strengthen City ordinances to prohibit the construction of residential basements, especially basements which require dewatering during construction.

The mechanical removal of millions of gallons of groundwater from a construction site has detrimental environmental impacts, and it is disingenuous for a construction project to be considered “green” when it builds a basement in an aquifer. One so called “green” project in Old Palo Alto pulled an estimated 100,000 gallons of water per day from our underground aquifer for a period of 6 months. The Green Building Ordinance under consideration by the City Council does not adequately address this abhorrent practice, and you should amend the ordinance to prohibit basement construction.

The Planning & Transportation Division Staff Report for the April 9, 2008, study session on the proposed Green Building Criteria for Private Development recognized basement construction as an issue needing further scrutiny, but staff has failed to pursue satisfactory resolution:

“The Commission and the public asked several questions about basements, including a) groundwater discharged, b) the effects of dewatering on groundwater and potential toxic plumes, c) the amount of concrete used, and d) impact on trees.

“The Public Works Department has, in the past few years, revised its basement policy to prohibit dewatering basements after construction. Dewatering from basements during construction is still allowed …
"During the Zoning Ordinance Update, staff commissioned EIP Associates to study the impacts of extensive basement construction on groundwater …

"Staff believes that the use of basements deserves continued scrutiny … Planning has included provision in the green building criteria that larger homes (including basement floor area) must achieve a greater number of green point credits than smaller homes to help compensate for these resource impacts. Other approaches would require extensive discussion as to when or whether to continue to allow basements … In recent ordinance discussions, this issue was broached but not pursued."

I agree with staff that the use of basements deserves continued scrutiny, but I am disappointed that staff believes green point credits can mitigate the serious impacts basement construction has on our city. Public Works has attempted to dismiss concerns raised by many residents by declaring the impacts as “negligible” or by disavowing specific knowledge. A response that “staff is not aware” should not be considered closure on the issues raised.

I take exception to a number of the conclusions put forth by Public Works, and I ask that Council direct staff to reconsider their findings, including but not limited to:

- Impact to neighboring properties
- Land subsidence
- Impact on trees and landscaping
- Waste of water
- Other detrimental impacts

**Impact to Neighboring Properties**

Staff asserts “the study concluded that the impacts of basement construction were negligible on the groundwater system and on the groundwater on neighboring sites.” However, the EIP study clearly stated that

“In the areas adjacent to the site being dewatered, the rate and flow directions of the groundwater would be altered temporarily by the dewatering process. Groundwater in the influenced area would move toward the base of the excavation … This effect could extend from several feet to several tens of feet beyond the excavation.”

My concern is not with the long term impact on the broader Santa Clara Valley groundwater system. My issue is with the site-specific impacts on neighboring properties and the local community. You should not allow macro responses to obscure the micro view of real damage that residential basements cause.

There may be no discernable long-term effect on the broader surface aquifer beneath the Santa Clara Plain (macro view), but the prolonged extraction of groundwater from 2164
Webster Street most certainly sucked the groundwater from underneath neighboring properties, including mine (micro view).

Although small compared to the volume of the surface aquifer (macro view), the volume of space displaced by a basement could be several tens of thousands of cubic feet which would displace groundwater flow around a newly constructed basement. This could be significant locally (micro view), especially if there were other similarly sized basements in the immediate vicinity (refer to EIP study, page 5). Several residents have horror stories of how the utility basements in their established homes began flooding after the construction of neighboring basements.

The Foundation Engineering Handbook, by Hsai-Yang Fang (1991), confirms that "... the process of dewatering can have side-effects that are harmful to the project under construction, the other facilities nearby, or to the environment ... Improper dewatering ... can cause damage to the structures being built or to adjacent structures."

Land Subsidence

It is well established that subsidence can occur with groundwater extraction, and the effects of subsidence cannot be reversed where portions of the aquifer have been compressed.

"Saltwater intrusion and subsidence in the Santa Clara Subbasin are documented regional effects of the excessive removal of groundwater from the deep aquifer over many years ... the SCVWD has been recharging the subbasin [with potable water] thereby raising groundwater level ... and virtually eliminating further overdraft-related subsidence. Such basin-wide effects could recur only if the deep aquifer became overdrafted again. Because dewatering for basement construction occurs only in the uppermost portion of the surface aquifer and involves only a small amount of groundwater withdrawal [relative to the broader Santa Clara Subbasin], no effects would occur in the deep aquifer." (macro view, refer to EIP study, page 6)

Take that "macro view" and bring it up to the surface aquifer underlying my home. My "micro view" is that the drawdown of the groundwater under adjacent properties can and does cause localized subsidence depending on the soil properties in the area. After 75 years, my home shouldn’t be "settling" any more, but cracks in the plaster and cracks in the pavement developed during the extended dewatering at 2164 Webster.

Fang confirms that "ground settlement can occasionally be a problem. Lowering the water table increases the effective stress in the soil. The stress increase is usually modest, and most soils are not affected significantly. But if there are compressible soils in the vicinity ... settlement may occur. Whether the settlement causes significant damage depends on the thickness and consolidation characteristics of the compressible deposit, the depth of drawdown and the duration of pumping, the foundations of the structures within the zone affected, and the type of their construction."
Impact on Trees and Landscaping

Not only do I disagree with the Planning Arborist’s assertion that “the localized drawdown of the water table during dewatering does not impact trees as their roots do not typically extend to that depth,” the EIP study contradicts that assertion:

“The possibility exists that adjacent landscaping could experience deterioration from reduced groundwater availability.” (refer to EIP study, page 4)

Fang also confirms that, "trees or other plantings in urban parks may be affected [by dewatering]." Regardless of whether tree roots extend into the aquifer or not, the strong pull of drawdown wells during a dewatering operation accelerates the percolation of surface waters and induces drought-like conditions as the soil dries out. Landscape irrigation cannot and should not be considered sufficient mitigation of the drought-like stress inflicted on trees during prolonged dewatering.

Waste of Water

The City has been studying the use of recycled water for landscape irrigation and other non-potable uses, and a multimillion dollar recycled water project is being considered. The City clearly recognizes the need for water conservation, yet it permits the intentional discharge of millions of gallons of water into our storm drains. That simply doesn’t make sense.

Public Works has stated that the water pumped from the shallow aquifers typically goes into the storm drain system and then into the creeks, some of which are “losing” creeks, meaning they lose their water back to the shallow aquifers. Public Works asserts that the water is pumped out of the aquifer and then added back to it. But Public Works fails to acknowledge that there are no “losing” creeks in my neighborhood, only engineered channels.

- Adobe is all concrete bottom and sides from Hwy 101 to Alma.
- Matadero is all concrete bottom and sides from Hwy 101 to Alma, except from Greer to hwy 101
- Barron is all concrete bottom and sides from Hwy 101 to Alma except for about 800 feet just upstream of Hwy 101.

Concrete channels are not “losing” creeks, and since the natural aquifer flow is from the foothills to the bay, any recharge in the short sections near Hwy 101 does not replenish the impacted neighborhood.
Other Detrimental Impacts

In addition to the unnecessary waste of water, the large volume of water pumped into our storm drains could rupture our aging storm drains, damage streets and underground utilities, and cause a sinkhole to develop.

Fang also notes that groundwater in the vicinity of a dewatering operation may be affected “by temporary reduction in the yield of supply wells, by salt water intrusion, or by the expansion of contaminant plumes.”

Call for Action

Mayor Klein and Council Members, I call upon you to take action to restrict residential basement construction and stop the destructive practice of dewatering. Palo Alto wants to be a leader in the Green Building movement. Please amend the Green Building Ordinance to prohibit residential basement construction in Palo Alto.

Sincerely,

Steve Broadbent
Honorable Council and Planning and Transportation Committee Members:

I am writing to express my concerns about dewatering and basement construction in Palo Alto. I am a professional scientist who has specialized in groundwater hydrology since 1975. I have a BS in Geology from Dickinson College and MS and PhD degrees in Hydrology from Stanford University. I have lived in Palo Alto for 31 years. The following statements are my personal views as a resident.

I recently received a call from another Palo Alto resident who purchased an older home near property that was being outfitted with a new house. Excavation for the new home's basement required pumping over 18-million gallons of groundwater 35 feet to land surface, where the water was discarded into the City's storm sewer. According to the caller, this dewatering was carried out with the approval of the City, without the need for a variance. The resident reported that dewatering volumes on the order of millions of gallons have been produced in multiple instances in Palo Alto, as mega basements have become popular.

I do not advocate a complete ban on basement construction. Nevertheless, it is clear that large parts of the City are unsuitable for the sorts of basements being built. Projects that require large-scale dewatering should not be allowed. The reasons are simple:

(1) Construction of finished (dry) space where any part of that space is below the water table is not advisable and should rarely if ever be allowed. This is necessary not only to protect the newly constructed space, but also to conserve energy and water resources and to prevent overloading of the storm-sewer system. Building codes prohibit basements that would be “subject to flooding.” The maximum elevation of the water table during normal rainy seasons, plus a reasonable safety margin, sets the limit for allowable subsurface construction. The need for large-scale dewatering indicates that the structure being built is subject to flooding by groundwater. It is not to anyone’s advantage to build basements in unsuitable locations. The City must uphold existing law.

(2) Extensive low-lying areas of Palo Alto have shallow water tables, rendering them unsuitable for basements. These areas were prone to flooding prior to “reclamation” projects that “channelized” the downstream reaches of creeks and diked off the Palo Alto Baylands. Sea-level rise from global warming is underway. Sea-level rise will increase water-table elevations in low-elevation areas of the City. Empirical projections based on JCPP scenarios call for 0.5 to 1.4 meters (1.6 to 4.6 feet) of sea-level rise by 2100 (http://www.sciencemag.org/cgi/content/abstract/315/5810/368). These projections are likely low (http://www.sciencemag.org/cgi/content/abstract/317/5841/1084).

(3) The cone-of-depression from construction dewatering involving extraction wells with only a few feet of horizontal setback from adjoining properties will definitely extend beneath the adjoining properties, with potentially harmful effects from desiccation and differential settling. Palo Alto’s soils are heavily textured “adobes” in which the dominant minerals of the fine fraction are montmorillonitic (smectitic) clays. Smectitic clays swell with wetting and shrink with drying. Although modern foundations are designed to avoid
failure in soils that shrink and swell, older structures are vulnerable to harm. Dewatering removes water from adjacent properties. It seems prudent to avoid situations where one person’s allowed dewatering can harm neighboring properties.

(4) Wasteful consumption of City water resources is a serious issue. Eighteen million gallons of water is about 24-thousand CCF (hundred cubic feet). If applied to a medium-sized City park with 200,000 square feet of irrigated turf—roughly the size of the Mitchell Park soccer fields—the depth of the applied water would be about 12 feet. This represents one hundred weeks of irrigation—five years’ worth at 20 irrigation weeks per year. Virtually all water removed during construction ends up in the Bay via lined storm-runoff conveyances. Virtually none of it recharges groundwater or soil moisture. Waste on this scale is unconscionable.

(5) The possibility of groundwater contaminants being captured by construction wells poses risks at multiple locations throughout the City. As more commercial and industrial areas are rezoned to residential uses, the number of risks increases. Many contaminant plumes are mapped, but others are poorly characterized. Such risks additionally weigh against construction dewatering.

In summary, basements must be restricted to areas that have adequately thick unsaturated zones—not all areas of Palo Alto are suitable. Large-scale dewatering should not be permitted. Preservation of property and avoidance of contaminant entrainment are compelling reasons to reassess current practices. The public costs of construction dewatering are unacceptably high. Groundwater is a City resource so precious that no one should be permitted to squander it on grand scales.

Prudent restriction of dewatering and basement construction will protect all parties.

My only interest in this matter was a promise to a fellow Palo Altan—concerned by groundwater impacts—to assess the situation and communicate my findings to you.

With best regards,

David A. Stonestrom

David A. Stonestrom
1000 S. California Ave.
Palo Alto, CA 94306
Hi Curtis,

These are some photos to help explain what I meant when I was trying to explain that the underground footprint of basements was too large.

On the smaller size lots, the builders often excavate closer to the allowed set backs.

Many often excavate right up to the lot line, and then the builders start putting in the concrete and rebar.

I have seen this many times.

People in adjacent homes have told me that they believe that the excavation has ruined the foundation of their homes. Since the side yard is all concrete, there is no where for the water to flow, except laterally.

This causes flooding to neighboring homes. Additionally, there is simply not enough side yard to allow for planting, and the rear set backs are really too small to allow for tree planting when the tree grows.

Basically, the homes on these lots are all home and no yard.

I hope that the city will consider reviewing their policies on the allotted size of a new home on these smaller lots.

Allowing this building practice has caused a lot of disharmony within our community.

Many residents feared that their homes could actually fall into the adjacent excavation site, and in many cases they had to pay for fencing to protect their property.

Many felt that the chain link fence was simply not enough protection when the builders excavate to the lot line.

Please remember that some of the adjacent older homes on the smaller lots may not have this 6 foot side allowance.

Regards,

Jody Davidson
(09-01) 19:18 PDT -- Call him cement man.

Back when Stanford Professor Brent Constantz was 27 he created a high-tech cement that revolutionized bone fracture repair in hospitals worldwide. People who might have died from the complications of breaking their hips lived. Fractured wrists became good as new.

Now, 22 years later, he wants to repair the world.

Constantz says he has invented a green cement that could eliminate the huge amounts of carbon dioxide spewed into the atmosphere by the manufacturers of the everyday cement used in concrete for buildings, roadways and bridges.

His vision of eliminating a large source of the world's greenhouse CO\(-2\) has gained traction with both investors and environmentalists.

Already, venture capitalist Vinod Khosla is backing Constantz's company, the Calera Corp., which has a pilot factory in Moss Landing (Monterey County) churning out cement in small batches.

And Carl Pope, executive director of the Sierra Club, says it could be "a game changer" if Constantz can do it quickly, on a big scale and at a decent price.

"It changes the nature of the fight against global warming," said Pope, who has talked with Constantz about his work.

That might sound like hyperbole, but the reality is that for every ton of ordinary cement, known as Portland cement, a ton of air-polluting carbon dioxide is released during production. Worldwide, 2.5 billion tons of cement are manufactured each year, creating about 5 percent of the Earth's CO\(-2\) emissions.

When Constantz learned about the high CO\(-2\) levels, he thought he could do better. After all, the majority of his 60 patents have to do with medical cement.

He claims his new approach not only generates zero CO\(-2\), but has an added benefit of reducing the amount of CO\(-2\) power plants emit by sequestering it inside the cement.
Green cement may set CO2 fate in concrete

To make traditional cement, limestone is heated to more than 1,000 degrees Celsius, which turns it into lime - the principal ingredient in Portland cement - and CO\(-2\), which is released into the air.

Constantz uses a different approach, the details of which remains secret pending publication of his patent.

At his pilot factory, a former magnesium hydroxide facility that made metal for World War II bombs, magnesium crunches underfoot as Constantz, wearing a pressed, blue button-down shirt with rumpled shorts and sandals, outlines how the process works.

He pointed to two enormous smokestacks billowing flue gases full of carbon dioxide next door at Dynegy, one of the West's biggest and cleanest power plants.

Constantz takes that exhaust gas and bubbles it through seawater pumped from across the highway. The chemical process creates the key ingredient for his green cement and allows him to sequester a half ton of carbon dioxide from the smokestacks in every ton of cement he makes.

Constantz believes his cement would tackle global warming on two fronts. It would eliminate the need to heat limestone, which releases CO\(-2\). And harmful emissions can be siphoned away from power plants and locked into the cement.

The same process can also be used to make an alternative to aggregate - the sand and gravel - that makes up concrete and asphalt, which would sequester even more carbon dioxide from power plants.

"The beauty here is we're taking this old industrial polluting infrastructure and turning it into something that will save the environment," Constantz said.

On a per-person basis, the United States is the world's worst CO\(-2\) polluter from all sources. But according to the Netherlands Environmental Assessment Agency, China just surpassed the U.S. for total carbon dioxide emissions.

China is expected to produce 47 percent of the world's 2.5 billion tons of cement this year, Constantz said.

To power its new buildings and sustain its building boom, China constructs at least one coal-fired power plant a week. Each one belches out enough CO\(-2\) to cancel the benefits of every hybrid on U.S. roadways, said Constantz.

A CO\(-2\) molecule can travel from Beijing to San Francisco in less than a day through atmospheric circulation, he said. So even with California mandating that CO\(-2\) emissions fall to 1990 levels by 2020, a crisis remains.
"Carbon dioxide is a global problem, not a regional problem," he said.

As far as cost, Constantz estimates his cement would retail for $100 a ton versus roughly $110 for Portland.

The reason no one invented it before now, he said, is that people didn’t truly understand the dangers of CO$_2$ until less than a decade ago.

**Skeptics question product**

He has skeptics.

Portland cement has a track record of more than 100 years, and any new material would have to get incorporated into building codes, noted Rick Bohan, director of construction and manufacturing technology for the Portland Cement Association in Skokie, Ill.

And Tom Pyle, a Caltrans engineer who serves on the cement subgroup of Gov. Arnold Schwarzenegger’s Climate Action Team, acknowledged that the technology is possible, but he still wants to examine Constantz’s cement.

"We hope they have a carbon-reducing viable construction material," he said. "They need to show up with a bag of this so we can test it."

Constantz is confident he will prove himself. Initially, he proposes mixing his new invention with Portland cement to ease a conservative industry into a new product. Concrete bigwigs have invited him to speak about Calera cement at their annual World of Concrete in Las Vegas next February.

**Power plant partnerships**

Constantz envisions building cement factories next to power plants the world over. A team is scouting out U.S. locations. While Dynegy has supplied Constantz with some flue gas, it hasn’t entered into a formal agreement.

"As we're looking into the future, we're very interested in technology that would help capture CO$_2$ from the flue gases and turn it into a product that offers a benefit," said Dynegy spokesman David Byford.

It could be good for business. California has mandated emissions reductions. And Congress is working on legislation that would allow high polluters to buy credits from those with low emissions. Power plants would have a huge incentive to sequester their CO$_2$ in cement.

But even if Constantz succeeds, the world would still need to do much more to fight CO$_2$ emissions, said Chris Field, director of the department of global ecology at the Carnegie Institution.
for Science at Stanford. "It's a big, long complicated game," he said. "As we develop each new segment of the solution we need to embrace it and deploy it and work hard to develop the next segment of the solution."

**Coral basis of idea**

Big ideas can form in haphazard ways. The one for bone cement began during a televised football game, when Constantz read an osteoporosis article in the New England Journal of Medicine. Three weeks later, as he studied a coral reef, it occurred to him he could maybe synthesize coral skeletons in human bones.

His new cement mimics how coral reefs form, too. Coral uses the magnesium and calcium present in seawater to create carbonates much as he's using CO$_2$ and seawater to make carbonate.

This latest invention took 18 months to conceive and execute. He feels it's one of the most important things he's ever done.

"Climate change is the largest challenge of our generation," he said.

**Who is Brent Constantz?**

**Profession:** An associate consulting professor in Stanford's department of geological and environmental sciences and founder of the Calera Corp. Created and sold three other companies - Norian Corp., Corazon Technologies Inc. and Skeletal Kinetics.

**Education:** UC Santa Barbara, bachelor's of science (1981); UC Santa Cruz, doctorate (1986)

**Family:** Married and father of four.

**Pastime:** Surfing and rock climbing.

**Concrete facts about cement**

2.5 billion tons of hydraulic cement is produced worldwide annually. Add sand and gravel and that makes more than 9,000 million cubic yards of concrete. That's more than enough concrete to pave an eight-lane highway from the Earth to the moon and back again - twice.

If you stayed on the planet, that same eight-lane highway would circle the Earth almost 40 times.

**Source:** Portland Cement Association

E-mail Carrie Sturrock at csturrock@sfchronicle.com.

http://sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/09/02/MNGD12936I.DTL

http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/09/02/MNGD12936I.DTL&type=primary