City of Brisbane
Agenda Report

TO: Honorable Mayor and City Council

FROM: Randy Breault, Director of Public Works/City Engineer via City Manager

SUBJECT: Supplemental Appropriation for Ice House Hill Rock Slope Mitigation

DATE: March 3, 2014

City Council Goals:

To provide public service that assures the safety of property and citizens residing, working, or visiting in Brisbane. (#9)

Purpose:

This work is not funded in the current city budget, and requires a supplemental appropriation; the proposed action is consistent with the community's value of safety.

Recommendation:

Provide a supplemental appropriation from the General Fund in the amount of $30,000 for the design of a wire mesh slope drapery slope protection project.

Background:

Concrete "k-rail" barriers were placed along the eastern edge of Bayshore Boulevard, between the driveway to the Police Department firing range and Guadalupe Canyon Parkway, approximately ten years ago. The purpose of this effort was to mitigate rock/debris fall on to the travelway.

Despite periodic cleaning of the buildup behind the k-rail, the accumulation of material seems to have accelerated. Based on that observation, staff contacted the consulting geotechnical firm of Cotton, Shires and Associates (CSA), and requested an engineering reconnaissance of the current situation.

Two days after staff's initial contact with CSA, a heavy rain and wind event resulted in multiple large rocks exceeding the k-rail barrier, landing in the travel lanes of Bayshore, and causing flat tires to three automobiles.

Discussion:

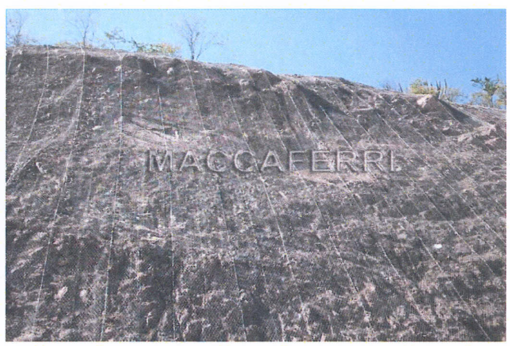
The attached geotechnical report discusses in detail the underlying nature of the slope's geology, and also discusses the nature of observed and potential failure modes (in general, the northern half of the slope has a higher percentage of shale and is subject to erosion when exposed to rainfall, resulting in small size "chips" moving downhill; the southern half of the slope has more "soil like" materials, and is capable of producing failed rocks up to 3 feet in diameter). Although the two sections of the slope act differently, they pose a similar level of risk to the roadway, and can benefit from the same mitigations.

The following mitigation alternatives are extracted from the geotechnical report, and presented in their recommended order:

1. Wire Mesh Slope Drapery — Construction Cost Estimate: $225,000

   This alternative involves removing loose rocks from the slope, clearing debris from behind the k-rail, and placing a wire mesh flat on the slope. This alternative has a low aesthetic impact, and may allow vegetation to take root under the mesh. The existing k-rail can be retained or removed.

   The photo on the right is an example of this material installed. The photo on the left is a close-up of the mesh.



2. Debris Catchment Fence — Construction Cost Estimate: $155,000

   This alternative involves removing loose rocks from the slope, clearing debris from behind the k-rail, and installing an approximately 8-foot high vertical catchment fence engineered to absorb the impact of bouncing rocks. This alternative has higher aesthetic impact, and requires the k-rail to remain in place.

   The photo on the left below shows this style of fence installed mid-slope. The photo on the right shows this style of fence installed as a protective barrier at an automobile racing venue.

3. K-Rail and Debris Fence Construction Cost Estimate: $50,000

   This alternative involves clearing debris from behind the k-rail, and installing a "standard" cyclone fence on top of the existing k-rail. There is no engineering basis to this alternative, and risk reduction would be low to moderate.

4. Debris Removal behind Existing K-Rail Construction Cost Estimate: $42,000

   This alternative involves clearing debris from behind the k-rail, and creating additional space behind the existing k-rail to afford more rock capture capacity. There is no engineering basis to this alternative, and risk reduction would be minimal to low.

5. Debris Catchment Wall Construction Cost Estimate: $500,000

   This alternative involves installation of an engineered 8' high retaining wall. Due to the aesthetics of such an imposing structure, this alternative is not recommended.

6. Soil Nails and Sculpted Shotcrete Construction Cost Estimate: $5-$8M

   This alternative involves placing an engineered wall that will physically look (although much larger) similar to the wall installed in the 900 block of Humboldt. Although this alternative provides the highest level of risk reduction, it is not recommended due to its cost.

Fiscal Impact:

The design cost is $30,000, proposed to be funded from the General Fund.

Once the design is complete, and the construction costs estimates are finalized, staff will bring the project back to Council and request approval for a construction budget, plus a construction management budget for the geotechnical consultant to oversee the installation.

The right-of-way between city property and the adjoining property owner (UPC) does run through this slope. At a minimum, the city will need permission from the adjoining neighbor to access the upper portion of the slope for the proposed mitigation. As the design progresses, we will learn the actual extent of the slope that is on private property, and staff will be able to recommend the percentage, if any, that private landowner should share in the cost of the mitigation.

Measure of Success

Installation of a rockfall mitigation that protects the travelling public.

Attachments:

- Cotton Shires and Associates letter of January 27, 2014
- Orthodigital photo showing approximate location of ROW limits at Ice House Hill

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Director of Public Works/City Engineer

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City Manager

COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

January 27, 2014
G5063

TO: Mr. Randy Breault
Director of Public Works/City Engineer
CITY OF BRISBANE
50 Park Place
Brisbane, California 94005-1310

SUBJECT: **Engineering Geologic Reconnaissance, Mapping and Evaluation**
RE: Ice House Hill Rock Slope
Bayshore Boulevard at Guadalupe Canyon Parkway

Dear Mr. Breault:

In accordance with our proposal of December 2013, we have examined and evaluated the steep cut slope along the east side of Bayshore Boulevard extending approximately 700 feet south of the intersection with Guadalupe Canyon Parkway. We understand that rock debris from this slope has been an ongoing problem for the City, and resulted in the placement of the K-rail. Our fieldwork was completed December 23, 2013 by a Certified Engineering Geologist with specific expertise in rockfall hazards, and mapping and evaluating steep bedrock slopes. Geologic and physical data regarding the rock slope were recorded on a geologic map, with select profiles measured down the face of the slope. Engineering geologic cross sections were then generated from these profiles to help illustrate the site conditions (see attachments). We also collected data to characterize the volume of talus debris that has accumulated upslope of existing site K-rails. We have evaluated collected data and considered various mitigation design alternatives. We plan to meet with you in the near future to discuss slope conditions and mitigation options.

SITE CONDITIONS

Topography - The Ice House Hill rock slope consists of an approximate 700-foot long cut slope along the east side of Bayshore Boulevard. The cut slope attains a maximum vertical height of 110 feet in the central portion of the cut, which then gradually tapers to less than 10 feet to the north and south, and has a total surface area of approximately 50,000sq. ft. The cut has a relatively uniform inclination, and is precipitously steep (40- to 45-degree inclination). The base of the cut slope is at the eastern edge of Bayshore Boulevard, where a 3-foot high concrete K-rail extends along the entire 700-foot cut. A 4-foot wide bike lane is immediately outboard of the concrete K-rail, and an approximately 2-foot wide rumble strip separates the bike lane from the 10.5-foot wide automobile lane #2. A small (3.75-foot high) wood lagging retaining wall is located at the northern end of the cutslope, and has experienced some distress in the form of tilting support posts, and bulging wood lagging. There is little to no freeboard atop this wall. The top of the cut slope is a well-defined break in slope exposing bedrock materials within the cut portion of the slope. Relatively gently inclined to moderately steep natural, grass-covered slopes extend eastward from the top of cut. With the exception of a small building associated with an antenna, there are no structures atop the cutslope. The small building and antenna are located 32 feet from the top of slope at its closest point. Several large eucalyptus trees, up to 4 feet in diameter, are located from 2 to 10 feet from the top of cut.

Geology - The entire cutslope is composed of interbedded sandstone and shale of the Franciscan Complex. These materials are generally moderately weathered, and are intensely fractured to moderately fractured. A near-vertical shear zone is located in the south-central portion of the cut slope, and separates the slope into two distinct geologic domains. The northern domain, which is approximately 400 feet in length, is characterized by thin-bedded sandstone and shale where the structural orientation of the bedding planes in inclined out of slope. Sandstone beds in this domain are generally 4" to 12" thick. This domain has a relatively large percentage of shale compared with the southern domain. The shale is very thinly bedded to fissile, intensely fractured, and tends to be highly prone to slaking, which is a phenomenon that results in rapid deterioration of the rock when exposed to water. The fractured, slake-prone shale rapidly erodes when exposed to rainfall, and produces prodigious amounts of shale 'chips', which are generally less than ½"-1" in size. Significant accumulations of slope debris primarily composed of shale chips occur at the base of the slope along the northern slope domain.

The southern domain, which is approximately 300 feet in length, in contrast to the northern domain, contains thick-bedded sandstone with a smaller percentage of shale. The sandstone interbeds are up to 6 feet thick in the southern domain, and the structural orientation of the bedding planes is inclined back into the slope. A relatively thick (up to 10 feet in thickness) interbed of shale extends along a near-horizontal trend near the upper portion of the slope, and thinner, folded shale beds also occur in the southern domain. However, the shale is not nearly as prominent in the southern portion of the slope as it is to the north. The thick-bedded sandstone in the southern domain is generally widely to moderately fractured, resistant, and strong.

The upper 5 to 15 feet of the cut slope contains deeply weathered bedrock and a thin soil mantle. These materials are more soil like and contain disrupted blocks of sandstone in the soil-like matrix. A prominent shallow (less than 3-foot thick) rockslide is located high on the slope within the deeply weathered portion of the cut. This rockslide debris is right at the shear boundary between the northern and southern domains. Elsewhere on the slope, shallow (less than 2 feet thick) disrupted zones of slope debris mantle the bedrock.

Slope Instability - The propensity of the shale to slake and rapidly deteriorate is the primary destabilizing agent on this slope. As the shale deteriorates, it erodes from beneath the more competent sandstone beds, which become unstable as support is removed. This results in the gradual fracturing, weakening, toppling and ultimately the failure of individual resistant sandstone blocks. This progressive weakening produces a dilated and fractured outer rind on the slope that is susceptible to shallow rockslides, rock toppling, and spalling of individual rock blocks, primarily during rainfall and/or seismic events. The greater percentage of shale along the northern slope domain results in a dramatically greater amount of corresponding debris at the base of slope. In contrast, the southern slope domain contains much less slope debris; however, due to the thick-bedded nature of the sandstone, this portion of the slope has the ability to produce rockfalls of much greater size (although at a much lower rate of production). Failed rocks up to 3 feet in diameter are at the base of slope, attesting to the potential for larger rocks to fail from this area.

FINDINGS

The results of our field reconnaissance geologic mapping reveal that the Ice House Hill cut slope is precipitously steep, up to 110 feet in height, and has experienced one slope instability event in December 2013 that exceeded the existing low concrete barrier. It is our opinion that due to the fractured and slake-prone nature of the geologic materials, this slope will continue to experience slope failures in the future, with a gradually increasing hazard to Bayshore Boulevard as the debris behind the K-rail continues to increase, thereby reducing its capacity and ability to stop debris from reaching the pavement. We understand that the existing 3-foot high concrete K-rail barrier has been in place for approximately 10-years, and material accumulated behind the wall has been periodically removed during this time span. The K-rail currently has less than 1-foot of freeboard for a distance of approximately 300 feet, and nearly 100 lineal feet contains no freeboard. We calculate that approximate 600 cubic yards of slope debris is currently behind the K-rail.

CONCLUSIONS AND RECOMMENDATIONS

It is our opinion that the Ice House Hill slope presents a shallow rockslide and rockfall hazard to Bayshore Boulevard where shallow surficial rock debris and individual rock blocks generally less than 3 feet in diameter present a high risk of impacting the pedestrian/bicycle lane and roadway driving surface. The rockfall/rockslide events are most likely to occur during heavy rainfall events or during intense seismic activity. The northern slope domain appears to produce greater volumes of slope debris than the southern domain, and has essentially filled the available storage space behind the K-rail; however, the southern domain appears to be capable of shedding larger rock blocks. As a consequence, it is our opinion that the northern and southern slope domains present a similar risk level to the roadway facility. The southern domain has a lower return period for failure, but the consequence of failure is higher. The similarity of their slope angle and height facilitates similar consideration for mitigation.

As with any geologic hazard, mitigation alternatives for this slope must balance economics, effectiveness, and consequence of failure. We are providing several mitigation alternatives for your consideration, presented in order of decreasing costs.

1. <u>**Soil Nails and Sculpted Shotcrete Slope Protection**</u> – Due to the slake-prone nature of the shale materials on this slope, if rainfall could be kept from interacting with the earth materials, then the slope degradation process would be greatly reduced. This alternative mitigates the slaking and resultant slope degradation by installing soil nail stabilization anchors, and covering the slope with shotcrete. Of the 5 alternatives presented, this alternative would provide the highest level of mitigation with a corresponding high degree of risk reduction, and very little maintenance.

   Total Estimated Cost = $5 to $8 million

2. <u>**Debris Catchment Wall**</u> – An engineered retaining wall could be constructed along the toe of the slope to contain rock slope debris. We estimate that this structure would be approximately 600-700 feet in length and be approximately 8 feet in height. This structure could be constructed with wood lagging or concrete, and if concrete, it could be sculpted to provide an aesthetically pleasing appearance. Periodic maintenance would be needed to clear debris from behind the wall.

   Approximate Construction Cost = $300,000-$500,000

3. <u>**Wire Mesh Slope Drapery**</u> – This mitigation alternative includes the installation wire mesh from the top of the slope to the toe, and thus, would attempt to control future slope failures and reduce the potential for rock debris to fail onto the roadway. The mesh would not prevent rainfall from interacting with the earth materials, but would help prevent these loosened materials from bounding over the K-rail at the base of the slope. The slope mesh is anticipated to trap and

collect fine grained surficial materials against some portions of the slope and promote establishment of vegetation in such areas. This mitigation alternative should be combined with scaling of loose rocks from the slope, and clearing the existing slope debris from behind the K-rails. In the future, the existing K-rails could be removed or retained in their current location, or be replaced with a lower wall.

Drape Cost = 50,000sq. ft x $3sq. ft = $150,000-$175,000
Debris Removal/Scaling Cost= $40,000-$50,000
Total Construction Cost = $190,000-$225,000

4. **Engineered Slope Debris Catchment Fence** – A Geobrugg style engineered catchment fence could be installed near the existing K-rail to provide a more robust barrier than the K-rail to capture future slope debris. This type of catchment fence would be engineered to account for anticipated impact loads and would be designed to account for potential bouncing rocks. We anticipate that an approximate 8-foot high fence would be necessary at this site:

   Fence Cost (Appr. $130-150/l. ft) = $90,000-105,000
   Debris Removal/Scaling = $40,000-$50,000
   Total Construction Cost = $130,000-$155,000

5. **K-rail and Debris Fence** – The existing K-rail could be modified to include a cyclone style fence to help capture additional slope debris. This mitigation alternative would not have an engineering basis. Risk reduction would be low to moderate.

   Debris Removal and Fence Cost = $40,000 - $50,000

6. **Debris Removal and Replacement of K-rail** – This alternative would include removing the existing slope debris from behind the K-rail and replacing the K-rail in its current location. The additional space behind the K-rail would reduce debris impact to the roadway. We estimate this risk reduction to be minimal to low.

   Debris Removal Cost = 600cu yrds x $50-$70/cu. = $30,000-$42,000

7. **Do Nothing** – This alternative would include doing nothing other than clearing debris after slope failures occur. Since approximately half of the lineal footage of K-rail has either no freeboard or less than 1 foot of freeboard, future slope

failures present a high risk of failing onto the roadway. This alternative has no risk reduction. This alternative would carry additional risk since future failures would gradually fill more of the freeboard space behind the K-rails, gradually increasing the frequency with which debris fails onto the roadway and bike path.

Cost = $0

The above costs are general ballpark figures only and should not be relied upon for budgeting. Additional costs should be anticipated, depending upon the alternative chosen, such as engineering costs, and construction observation and testing costs.

LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted engineering geology and geotechnical engineering principles and practices. No warranty, expressed or implied, or merchantability of fitness, is made or intended in connection with our work, by the proposal for consulting or other services, or by the furnishing of oral or written reports or findings.

We hope that this provides you with the information that you need at this time. If you have any questions, or need additional information, please feel free to call.

Respectfully submitted,

COTTON, SHIRES AND ASSOCIATES, INC.

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TS:JW:kd

Attachments: Site Plan
Engineering Geologic Cross Section 1-1′
Engineering Geologic Cross Section 2-2′
Engineering Geologic Cross Section 3-3′

Bayshore Boulevard ROW at Ice House Hill

City of Brisbane
For Planning Purposes Only
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