MEMORANDUM TO
GEOTECHNICAL INVESTIGATION AND NATURAL HAZARDS EVALUATION

Proposed Water Treatment Plant and Storage Tank
Ogden City
Ogden, Utah

Prepared by:

Sunrise Engineering, Inc.
12227 South Business Park Drive, Suite 220
Draper, Utah 84020
Tel 801.523.0100 ● Fax 801.523.0990

January 10, 2014

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Cliff Linford, P.E.
Sunrise Engineering, Inc.- Salt Lake Municipality Group
12227 South Business Park Drive, Suite 220
Draper, UT 84020

Re: Memorandum to
Geotechnical Investigation and
Natural Hazards Evaluation
For Proposed Water Treatment Plant and Storage Tank
Ogden, Utah

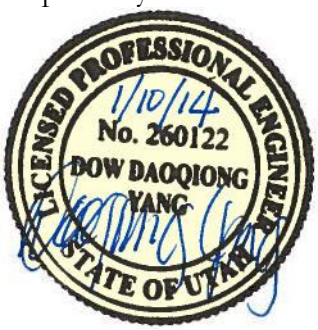
Dear Cliff:

Enclosed herein is a memorandum to the report of a geotechnical investigation and natural hazards evaluation for the above referenced project. This memorandum presents the results for the seismic lateral earth pressures on the basement and retaining walls due to earthquake motions.

We appreciate the opportunity to provide geotechnical services to you for this project. Should you have any questions about the report, or if we may be of further service in any way, please contact us at (801)523-0100.

Sincerely,
SUNRISE ENGINEERING, INC.

Prepared by:



Dao Yang, P.E.
Project Engineer/Hydrogeologist

Reviewed by:

Derek Anderson, P.E.
Service Center Manager

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1 INTRODUCTION

A geotechnical investigation was conducted for Ogden City's new water treatment plant and water storage tank replacement project in the southwestern quarter of Section 16, Township 6 North, Range 1 East, Salt Lake Base and Meridian (SLBM) in September 2012. However, the report did not provide seismic earth pressures. This memorandum presents a summary of dynamic evaluation of seismic earth pressures on the basement walls for the treatment plant and the water tank walls at the proposed project site.

2 PROPOSED CONSTRUCTION

A treatment plant will be constructed at the existing treatment plant site and a 300,000-gallon water storage tank will be constructed at an existing 200,000-gallon water storage tank site. The existing tank will be demolished before the new tank is constructed at the same location. At the present time, no outlines of the proposed construction are available.

3 SITE INVESTIGATION

3.1 General Geology

According to King (2001), the project site is underlain by the alluvium and colluvium (Qac) of Quaternary age. The formation includes stream and fan alluvium and colluvium, and, locally, mass-movement deposits. Beneath the alluvium and colluvium is the Humbug formation (Mh) of Mississippian age. The Humbug formation consists of dolomite, sandstone and dolomitic sandstone. It is about 800-1,000 feet in thickness.

The closest fault is approximately 3,000 feet southwest of the project site. The up-thrown block is on the east side of the approximately north-south-trending normal fault.

3.2 Subsurface Conditions

To evaluate the subsurface conditions at the project site, six borings (B-1 through B-6) were drilled to 50 feet below grade using an ODEX drilling rig from September 17 to 19, 2012. Four borings (B-1 through B-4) were drilled at the treatment plant site and the other two (B-5 and B-6) were drilled at the tank site. The following is a summary of the subsurface soil materials encountered during drilling:

At the treatment plant site:

> From the surface to a depth of approximately 45 feet, the subsurface soil consists primarily of gravel with clay, silt and sand at borings B-1 through B-4. At 45 feet, clay was encountered at borings B-1 and B-4, and sand with gravel was encountered at borings B-2 and B-3. At 50 feet, sand and gravel or sand with gravel was encountered at borings B-1 through B-4. Groundwater was encountered at a depth of approximately 18 feet below grade.

At the tank site:

> Fill material was encountered from the surface to a depth of approximately 3 feet at boring B-5 and 10 feet at boring B-6. At boring B-6, an approximately 5-foot thick layer of silt was encountered below the fill material. The surficial silt layer was not encountered at boring B-5. A large boulder with a thickness of 5 feet at boring B-6 and 6 feet at boring B-5 was encountered. Below the large boulder are interbedded sand, silt, gravel and clay. Groundwater was encountered at a depth of approximately 40 feet below grade.

Due to the presence of gravel, not much soil material could be collected from most sampling depths at the treatment plant site. Five soil samples collected from the tank site were delivered to Utah Testing and Engineering for gradation and classification testing. The five samples were classified as sand and silt (SM) or silt (ML).

3.3 Geologic Hazards

3.3.1 Active Fault and Surface Fault Rupture

In geology, an active fault is a fault which has had displacement or seismic activity during the geologically recent period. In the United States, an active fault is generally defined as a fault which has displaced earth materials during the Holocene Epoch (during the last 11,000 or so years before present). Active faults are the most common sources of earthquakes and tectonic movements.

There is no fault at the site and the closest fault is approximately 3,000 feet southwest of the project site (King, 2001). However, this fault is not an active fault. According to Christensen and Shaw (2008a), the closest Quaternary fault to the site is approximately 1 mile to the west. Therefore, a trench program is not required to study the hazards of surface fault rupture.

3.3.2 Site Class

Treatment Plant Site: Based on the soil samples collected during the drilling of borings B-1 through B-4, the treatment plant site can be classified as **Site Class C** (very dense soil and soft rock) as defined in Table 1613.5.2 of the International Building Code (International Code Council, 2009).

Tank Site: Based on the soil samples collected during the drilling of borings B-5 and B-6, the tank site can be classified as **Site Class D** (stiff soil) as defined in Table 1613.5.2 of the International Building Code (International Code Council, 2009).

3.3.3 Response Spectra Associated with Site-Specific Seismic Hazards

The site-specific response spectra were obtained from the U.S. Geological Survey (USGS) Website and are presented below.

3.3.3.1 Treatment Plant Site

USGS Design Maps Summary Report

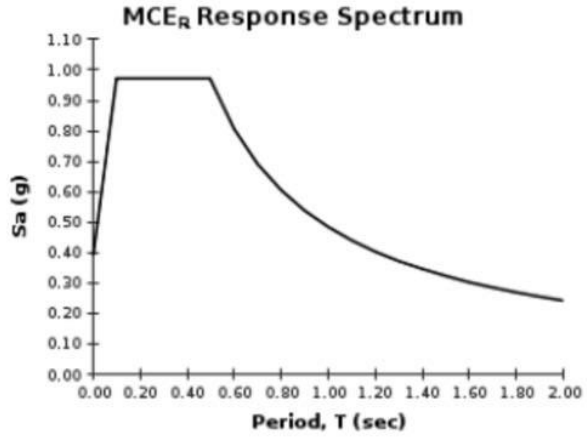
User–Specified Input

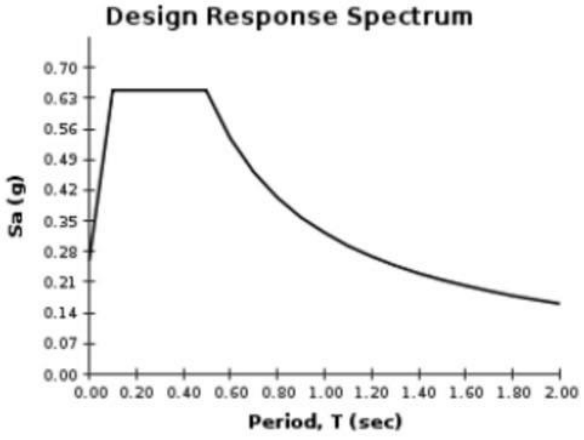
Report Title	Ogden Treatmetn Plant Thu January 9, 2014 23:32:32 UTC
Building Code Reference Document	ASCE 7-10 Standard (which utilizes USGS hazard data available in 2008)
Site Coordinates	41.254°N, 111.848°W
Site Soil Classification	Site Class C – "Very Dense Soil and Soft Rock"
Risk Category	I/II/III

USGS–Provided Output

S_S =	0.955 g	S_{MS} =	0.972 g	S_{DS} =	0.648 g
S_1 =	0.329 g	S_{M1} =	0.484 g	S_{D1} =	0.323 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





3.3.3.2 Tank Site

USGS Design Maps Summary Report

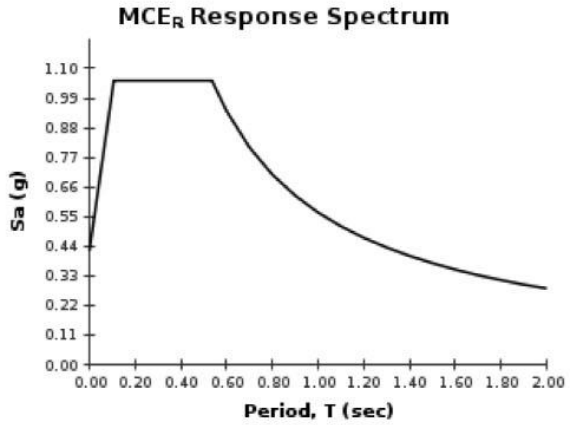
User–Specified Input

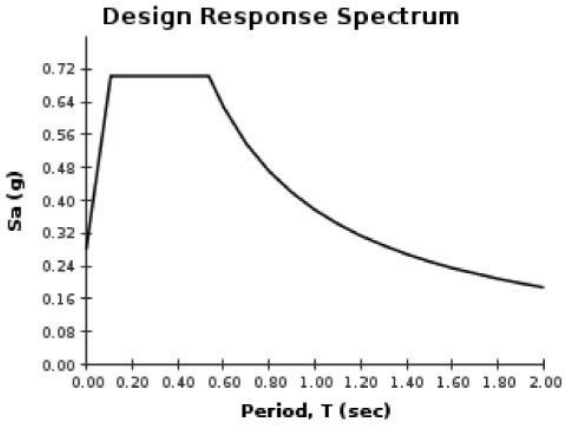
Report Title	Ogden Water Tank Site Fri January 10, 2014 18:38:16 UTC
Building Code Reference Document	ASCE 7-10 Standard (which utilizes USGS hazard data available in 2008)
Site Coordinates	41.25°N, 111.84°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_S =	0.937 g	S_{MS} =	1.055 g	S_{DS} =	0.703 g
S_1 =	0.322 g	S_{M1} =	0.565 g	S_{D1} =	0.377 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





3.3.4 Seismic Design Category

Based on the response spectra at the project site, the tank and treatment plant will need to be designed to meet the Seismic Design Category D requirements.

3.3.5 Seismic Lateral Earth Pressures

Seismic activity can generate increased lateral earth pressures acting on basement walls at the treatment plant and the walls of the water storage tank. The increase is influenced by the horizontal ground acceleration. Based on Mononobe-Okabe procedures for a vertical wall with horizontal backfill, the additional lateral pressures due to earthquake motions were estimated for the project as presented below:

$\Delta P_{ae} = 12*H^2$ for the treatment plant basement walls

$\Delta P_{ae} = 13*H^2$ for the tank walls

Where ΔP_{ae} = seismic lateral pressures in pounds per foot acting at a distance of 0.6*H from the base of the wall and H is the height of retained soil in feet.