Condition 24	Liquefaction

Prior to completion of the improvement plans for the proposed project, a geotechnical report that addresses liquefaction hazards shall be prepared and approved by the Planning Director. The geotechnical report shall state the recommended actions for the collection system, effluent disposal system, treatment plant site, and all appurtenant facilities so that potential impacts from seismically-induced liquefaction would be reduced to less than significant. These recommendations shall be incorporated into the design of all proposed facilities that are part of the collection system and at the treatment plant site.

Evidence of compliance:

The potential for Liquefaction at the project site was evaluated by Fugro West, Inc., and the findings of their evaluations and recommendations for the design of the wastewater system to protect against significant impacts from liquefaction are contained in the project Geotechnical Report dated March 9, 2004, the Addendum and Update to the Geotechnical Report dated October 24, 2011, and the Preliminary Geotechnical Report prepared for the Giacomazzi site dated July 17, 2007.

Since Los Osos has areas with high groundwater and is underlain with soils that are granular and that are in a low to medium state of relative density the potential for liquefaction exists within the project area. Specifically within the low-lying areas of the collection system and along the shoreline of Morro Bay where various pump stations will be located. The severity of liquefaction will depend on the intensity and duration of the seismically induced ground motion.

Design of the Los Osos Wastewater Project is based on recommendations contained within the above referenced reports. The findings and recommendations in the Geotechnical Report and Addendum are as follows:

Section 5.8 of Geotechnical Report:
"We evaluated the potential for liquefaction and seismic settlement to impact the various components of the project. For the purpose of our evaluation we considered the design basis ground motion of approximately 0.4g, and a corresponding earthquake magnitude of 6.8. The analysis was performed using procedures described in the 1997 NCEER guidelines for performing liquefaction analyses using CPT data. Seismic settlement can also occur in non-liquefiable soil. Field data from the current supplemental field exploration and previous CPT soundings were obtained electronically using an onboard-computerized data acquisition system. These data were then imported into a geographic information system (GIS) to configure the digital information, and analyze liquefaction potential using programmed algorithm."

Liquefaction is a loss of soil strength due to a rapid increase in soil pore water pressures due to cyclic loading during a seismic event. In order for liquefaction to occur, three general geotechnical characteristics are typically present: 1) groundwater is present within the liquefiable zone; 2) the soil is granular; 3) the soil is in a low to medium state of relative density. If those criteria are met and those soils are subjected to strong ground motions, then those soils may liquefy, depending upon the intensity and cyclic nature of the strong ground motion. Seismically induced settlement or collapse can occur in soils that are loose, soft, or that are moderately dense and weakly cemented, or in association with liquefaction.

Manifestations of liquefaction can consist of sand boils, loss of bearing capacity, lateral spreads, and slope instability, and differential and areal settlement. The severity of the consequences of liquefaction is dependent on relative density of the soil and intensity and duration of the ground motions; however, not all soils that liquefy experience the same degree mobility or ground failure. For the purposes of this report, we evaluated the potential for soils to liquefy based on the previous data available and the supplemental field exploration."

Section 4.1.1 of Addendum:
"Liquefaction and seismic hazards were evaluated as part of the 2004 report, and can be considered applicable to the design of the current collection and pump stations. Generally, potentially liquefiable soils were encountered within low-lying areas within the collection system area and along the shoreline of Morro Bay where various pump stations are also planned that extend to depths of roughly 10 feet below the ground surface and could result in approximately 1 to 2 inches of seismic settlement in response to the design earthquake. The structures are generally to be designed to tolerate the additional settlement. Seismic data for the updated building code based design considered the potential for liquefaction."

Pipeline Network
Section 5.8.2 of Geotechnical Report:
The soils encountered within the pipeline network vary from soils having a relatively high potential for liquefaction, to soils having a relatively low potential for liquefaction. The potentially liquefiable soils were typically encountered in areas that are either low in elevation or relative topographic relief, such as the shoreline areas along Morro Bay and interdunal depressions along Morro Avenue, Paso Robles Avenue, Santa Ynez Avenue, and Ramona Avenue-Mitchell Drive. These areas are typically characterized as being underlain by relatively loose sand and shallow groundwater. The potentially liquefiable sand is typically less than 10 feet deep.

Pump Stations and Standby Power Buildings
Section 5.8.3 of Geotechnical Report:
"….. The liquefaction potential at the pump station sites is mainly dependent on the relative density of the sand, the groundwater elevation, and whether or not potentially liquefiable dune sand near the ground surface can be removed relatively easily during the site grading. We estimate that the soil within approximately 5 to 7 feet of the ground surface in selected pump station and power building areas is susceptible to seismic settlement and liquefaction. We have provided grading recommendations in the report to remove the more loose and potentially liquefiable soil within the pump station areas, and thereby reduce the potential for seismic settlement and liquefaction to impact the structure."

Broderson Site
Section 5.8.5.1 of Geotechnical Report:
"….. The existing depth to groundwater is greater than 100 feet below the existing ground surface, and except for the near-surface loose dune sand deposits the deeper soils encountered beneath the site are generally dense and not susceptible to liquefaction or seismic settlement. The near-surface loose dune would be considered potentially liquefiable in the event that they were saturated at the time of an earthquake; however, the groundwater depths will not be permitted to rise within 20 feet of the ground surface at the site…

and

Dense to very dense sand materials are generally not vulnerable to liquefaction or seismic settlement as a result of their relatively high state of density. There is therefore a low potential for liquefaction to occur within the anticipated depths of mounding…

and

As discussed above, there is low potential for liquefaction to occur at the site or within the offsite areas downslope of Broderson as a result of he effluent disposal. There is essentially no change in the potential for liquefaction or sesmic settlement to occur within the soils encountered as a result of the effluent disposal system and estimated mounding at Broderson."

Section 6.3.2 of Geotechnical Report:
"..... The effluent disposal sites are generally underlain by relatively dense dune sand and Paso Robles Formation that extend below the groundwater table, and are not considered susceptible to liquefaction".

Code Based Design Criteria
Section 4.1.2 of Addendum:
"Structures should be designed to resist the lateral forces generated by earthquake shaking in accordance with the building code and local design practice. This section presents seismic design parameters for use with the 2010 California Building Code (CBC). The site coordinate and USGS interactive web page "Seismic Design Values for Buildings" (USGS 2008) was used to obtain seismic design criteria. Based on these criteria, the seismic data for use with code-based designs are provided:

California Building Code	Seismic Parameter	Values for Site Class D	Value for Site Class F (liquefaction)
Site Coordinates	Latifude, degrees	35.3127	35.3127
	Longitude, degrees	-120.8383	-120.8383
Section 1613.5.1 Figure 1613.5	Ss, Seismic Factor, Site Class B at 0.2 sec	1.472	1.472
	S_1, Seismic Factor, Site Class B at 1 sec	0.555	0.555
	Site Class	S_D, Stiff Soil*	S_F, Liquefiable**
Section 1613.5.3 Table 1613.5.3(1)	Fa, Site Coefficent for Site Class	1.0	0.9
Section 1613.5.3 Table 1613.5.3(2)	Fv, Site Coefficient for Site Class	1.5	2.4
Section 1614A	S_{MS}, Stie Specific Response Parameter for Site Class at 1 sec	1.472	1.325
	S_{M1}, Site Specific Response Parameter for Site Class at 1 se.	0.833	1.333
	S_{DS} = 2/3 S_{MS}	0.981	0.883
	S_{D1} = 2/3 S_{M1}	0.555	0.889

* Assumes site mitigation performed to address liquefaction.
**Assume no site mitigation is performed to address liquefaction and is equivalent Site Class E

Based on potential liquefaction hazards, lower portions of the collection system area and some pump station locations are classified as Site Class F per the building code. The values and subsequent response spectra were estimated for a Site Class E, "S_E", soft soil site, based on the estimated residual shear strength of potentially liquefiable soils. Other areas of the site, and prior to there being liquefaction, are classified as Site

Class D, "S_D". The design for pump stations should consider the higher of either the Site Class F or Site Class D values presented in the table above for design and the structural period being considered."

Pipe Zone Material
Section 4.2.3 of Addendum:
"Pipe zone material placed above the bedding to at least 12 inches above the top of the pipe should be compacted to at least 90 percent relative compaction prior to placing trench backfill. Compaction within the pipe zone should be performed such that the pipe is fully supported, and such that excessive deformation or damage to the pipe does not occur. Material should be hand shoveled and sliced below the haunches of the pipe during placement to provide support for the pipe and assist with compaction."

Trench Backfill
Section 4.2.4 of Addendum:
"Trench backfill is material placed above the pipe zone material and below the ground surface, finished grade, or pavement structural section. Trench backfill should consist of excavated on-site soil that conforms to the suggested material specifications of this report, or imported material that is fee of organics, debris and other deleterious materials. Trench backfill should be compacted to at least 90 percent relative compaction, except in roadway areas where trench backfill placed within 3 feet of finished grade of the pavement surface should be compacted to at least 95 percent relative compaction."

Backfill and Compaction
Section 4.2.5 of Addendum:
"Fill placement and grading operations should be performed according to the grading recommendations of this report. We recommend that fill materials be compacted to at least 90 percent relative compaction, as determined by the latest approved edition of ASTM D1557 unless a higher degree of compaction is otherwise recommended. We recommend the following minimum relative compaction be provided for the locations indicated:"

Location	Min. Relative Compaction
General	90% U.O.N.
Pipe Zone and Bedding	90% U.O.N.
Trench backfill in non-pavement areas or placed greater than 3 feet below finished grade in pavement areas	90% U.O.N.
Trench backfill placed within 3 feet of finished grade in pavement areas	95%
Aggregate Base or Subbase	95%
Asphalt Concrete	95%
Building Areas	95%

U.O.N. = Unless otherwise noted

Condition Satisfied–Collection System

Jason H. Giffen
Director, SLO County Planning

2-7-2012
Date

Condition Satisfied–Treatment Facility

Jason H. Giffen
Director, SLO County Planning

2-7-2012
Date