

March 23, 2021

C-4

HONORABLE MAYOR AND CITY COUNCIL
City of Long Beach
California

RECOMMENDATION:

Receive and file the attached report, "Elevation Changes in the City of Long Beach, November 2019 through October 2020." (Citywide)

DISCUSSION

The City of Long Beach (City), through its Energy Resources Department (ER), supervises oil production and subsidence control operations in the Wilmington Oil Field. ER conducts ground elevation surveys every six months to monitor ground elevation changes in the oil fields and adjacent city areas. This report focuses on ground elevation changes that have occurred from November 2019 through October 2020. The ER survey includes the following areas: Civic Center, Central City, Alamitos Bay, Naples, Harbor District, and the offshore area encompassing the existing four oil islands.

The results of the last two six-month surveys indicate that ground elevations were stable in the Civic Center, Central City, Naples, and Alamitos Bay. During the first half of the year, the offshore Islands Grissom and Freeman were stable. The elevations of Islands White and Chaffee declined by 0.06 foot (0.7 inch) during the period. The ground elevation decrease was within normal limits for field operations. Water injection and fluid production requirements were adjusted, and the ground elevation loss did not continue in the second half of the year. In the Harbor District, the western portion was stable during the twelve-month period while much of the central portion rose in ground elevation. Ground elevations on Piers B, C, D, E, S, and T increased by as much as 0.11 foot (1.3 inches). The increase is on the high end of normal limits, but still considered minor and will be closely monitored. Changes to waterflood requirements will minimize future ground elevation gains.

The ER survey uses a series of benchmarks to determine ground elevation changes. Studies by the Department's engineers and geologists show the benchmarks may rise and fall in such a manner as to make a survey either optimistic (slightly up in ground elevation) or pessimistic (slightly down in ground elevation). These changes in ground elevations may be associated with tidal cycles, drought, temperature changes, deep earth tectonic changes, dewatering activities, and/or re-pressuring operations in the oil field. Ground elevations over the active Wilmington Oil Field can be expected to fluctuate under changing waterflood conditions.

This matter was reviewed by Deputy City Attorney Richard F. Anthony on February 17, 2021 and by Revenue Management Officer Geraldine Alejo on February 26, 2021.

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TIMING CONSIDERATIONS

City Council action on this matter is not time critical.

FISCAL IMPACT

This recommendation has no staffing impact beyond the normal budgeted scope of duties and is consistent with existing City Council priorities. There is no fiscal or local job impact associated with this recommendation.

SUGGESTED ACTION:

Approve recommendation.

Respectfully submitted,



ROBERT M. DOWELL
DIRECTOR OF ENERGY RESOURCES

ATTACHMENT: ELEVATION CHANGE REPORT

APPROVED:



THOMAS B. MODICA
CITY MANAGER

**ELEVATION CHANGES
IN THE
CITY OF LONG BEACH**

NOVEMBER 2019 THROUGH OCTOBER 2020

PREPARED

FOR

LONG BEACH CITY COUNCIL

BY THE

ENERGY RESOURCES DEPARTMENT

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ELEVATION SURVEY ANALYSIS

The City of Long Beach semi-annual elevation surveys of the Civic Center, Central City, Harbor District, Alamitos Bay, Naples, and offshore drilling islands were conducted during May 2020 and November 2020. Changes in elevation that have occurred since the last three surveys, November 2019, May 2020 and November 2020, are discussed in this report. The results in this report reflect elevation changes both within and beyond the scope of oil field operations. Some changes are due to natural geologic factors.

Elevation Change – November 2019 through April 2020

(Figure 1)

Elevations throughout the Alamitos Bay, Naples, Central City, Civic Center were stable during the six-month period. The offshore islands Grissom and Freeman were also stable during the period. The elevations of Islands White and Chaffee declined by 0.06 foot (0.7 inch) during the period. The elevation decrease was within normal limits for field operations. Water injection and fluid production requirements were adjusted, and the elevation loss did not continue in the second half of the year.

The Piers in the Harbor District were stable during the period, except for a portion of Piers D and T. Piers D and T adjacent to the Back Channel experienced an elevation increase of up to 0.07 foot (0.8 inch). The elevation increase is considered minor at this time. Adjustments to field operation activities were made to mitigate further changes.

Elevations in the City of Long Beach to the north of the boundaries of the Wilmington Oil Field indicate the region was slightly up during the six-month period.

Elevation Change – May 2020 through October 2020

(Figure 2)

Elevations throughout the Alamitos Bay, Naples, Central City, Civic Center and the offshore islands remained stable during the six-month period. A small area near the Recreation Park district lost up to 0.06 foot (0.7 inch) of elevation during the period. The area of elevation loss is within the Long Beach Oil Field but is not related to oil field activities. The elevation change is possibly due to normal motion of the active Newport-Inglewood Fault in the area. The loss of elevation is not expected to continue.

In the Harbor District, all piers were stable during the six-month period, except for Piers C, D and S. The elevation of a small portion of Piers C, D and S adjacent to the Inner Harbor Turning Basin increased by up to 0.07 foot (0.8 inch). The elevation increase was within normal limits for the area. Oil field operations are being monitored to determine the cause of the increase and make necessary operation adjustments.

Elevations in the City of Long Beach beyond the boundaries of the Wilmington Oil Field indicate the region continued to move slightly down during the six-month period.

Elevation Change – November 2019 through October 2020

(Figure 3)

Elevations in the Alamitos Bay, Naples, Civic Center, and Central City were stable during the twelve-month period. Elevations on Oil Islands White, Chaffee and the adjacent shoreline declined up to 0.05 foot (0.6 inch) during the twelve-month period. The decrease is considered minor and within normal limits. Adjustments were made to waterflood and fluid production requirements that mitigated further elevation change in the second half of the year.

In the Harbor District the western portion was stable during the twelve-month period while much of the central portion rose in elevation. Elevations on Piers B, C, D, E, S and T increased by as much as 0.11 foot (1.3 inches).

The increase is on the high end of normal limits, but still considered minor and will be closely monitored. Changes to waterflood requirements will minimize future elevation gains.

Use of Global Positioning System (GPS)

This report is based solely upon computer processed data utilizing the Long Beach Deformation Network (LBDN). The LBDN consists of thirteen permanent, reference GPS base stations, communication equipment, computer server, monitoring software and five mobile GPS receivers. The Long Beach Energy Resources and contractor surveyors use the mobile GPS receivers linked to the reference base stations to measure approximately 240 City and Harbor bench marks.

APPENDIX

Brief History of Long Beach Subsidence

Long Beach and the general vicinity have a history of regional subsidence (losses of elevation) since 1929. Elevation changes were minor, amounting to an average of about -0.036 foot (-0.43 inch) per year until about 1939. Geologic movement such as the Long Beach Earthquake of March 1933 altered this average rate at times. Contributing causes of the subsidence were groundwater withdrawal from aquifers in the Long Beach area, regional basin sediment compaction, and tectonic effects of local faulting.

Development of the Wilmington Oil Field began in 1936. Oil operations accelerated subsidence and within twenty years created a 29-foot deep subsidence bowl centered in the Wilmington-Long Beach Harbor area near Bench Mark 8772, at the Edison power plant. Development of the Ranger Zone west of Pine Avenue and its extension seaward in 1947 started the first definitive subsidence in the Central Business District that could be attributed to oil production.

Repressuring operations began in the 1950s. By 1965, subsidence stopped throughout the Long Beach portion of the Wilmington Oil Field. Several bench marks recovered over

one foot in elevation, due to waterflood repressuring. As an example, from 1960 to 1970, Bench Mark 1735, near the corner of Ocean Boulevard and Magnolia Avenue, recovered approximately one foot of elevation. The recovery of bench mark elevations is known as rebound.

The Alamitos Bay and Naples area had losses in elevation prior to development of the adjacent oil operations. These original small losses were most likely due to the regional effects of basin sediment compaction and tectonic movements along the Newport-Inglewood Fault Zone. Later, the coastal strip from the Civic Center eastward to the Alamitos Bay Peninsula lost elevation due to oil and gas production from the West Wilmington Oil Field and possibly the adjacent oil fields. The coastal strip rebounded slightly due to water injection from the offshore Oil Islands that began in 1965.

Survey Accuracy

The May 2002 Elevation Leveling Campaign marked the conversion from spirit, first and second order rod leveling, to GPS surveying of bench mark elevations.

Through statistical analysis of satellite, base station, and mobile instrument geometries, a coincident spirit leveling and GPS bench mark elevation survey, City surveyors estimate the relative accuracy of GPS elevations to be 0.025 foot (0.30 inch). Areas are considered to be stable where elevation change is less than 0.050 foot (0.60 inch) over a six-month survey period.

Studies by the City's subsidence control engineers, geologists, and consultants show that the bench marks may, at times, rise and fall somewhat concurrently city-wide in such a manner as to make an entire survey either optimistic or pessimistic. These elevation changes are random and can be due to a variety of factors. Repressuring operations and the resulting rebound can mask the rise or fall pattern. Surface elevations in a rebounded area can be expected to fluctuate under changing water flood conditions. Because of these fluctuations, conclusions based upon short-term survey data should be viewed with caution. Short-term survey data are useful for possible early detection and confirmation of subsidence trends or relative elevation changes, but should not be accepted without

consideration of the above factors. Annual survey data tend to average these fluctuations and depict a more dependable picture of the relative movements of bench marks.

Elevation Change Map Construction

(Figures 1, 2 and 3)

All data are presented as contour lines showing the average change in surface elevation during a particular time period. For example, any point along a line reading 0.05 foot (0.60 inch) on an Elevation Change Map gained an elevation of one-twentieth of a foot or six-tenth of an inch during that period. The small hachures along contour lines point towards a loss in elevation.

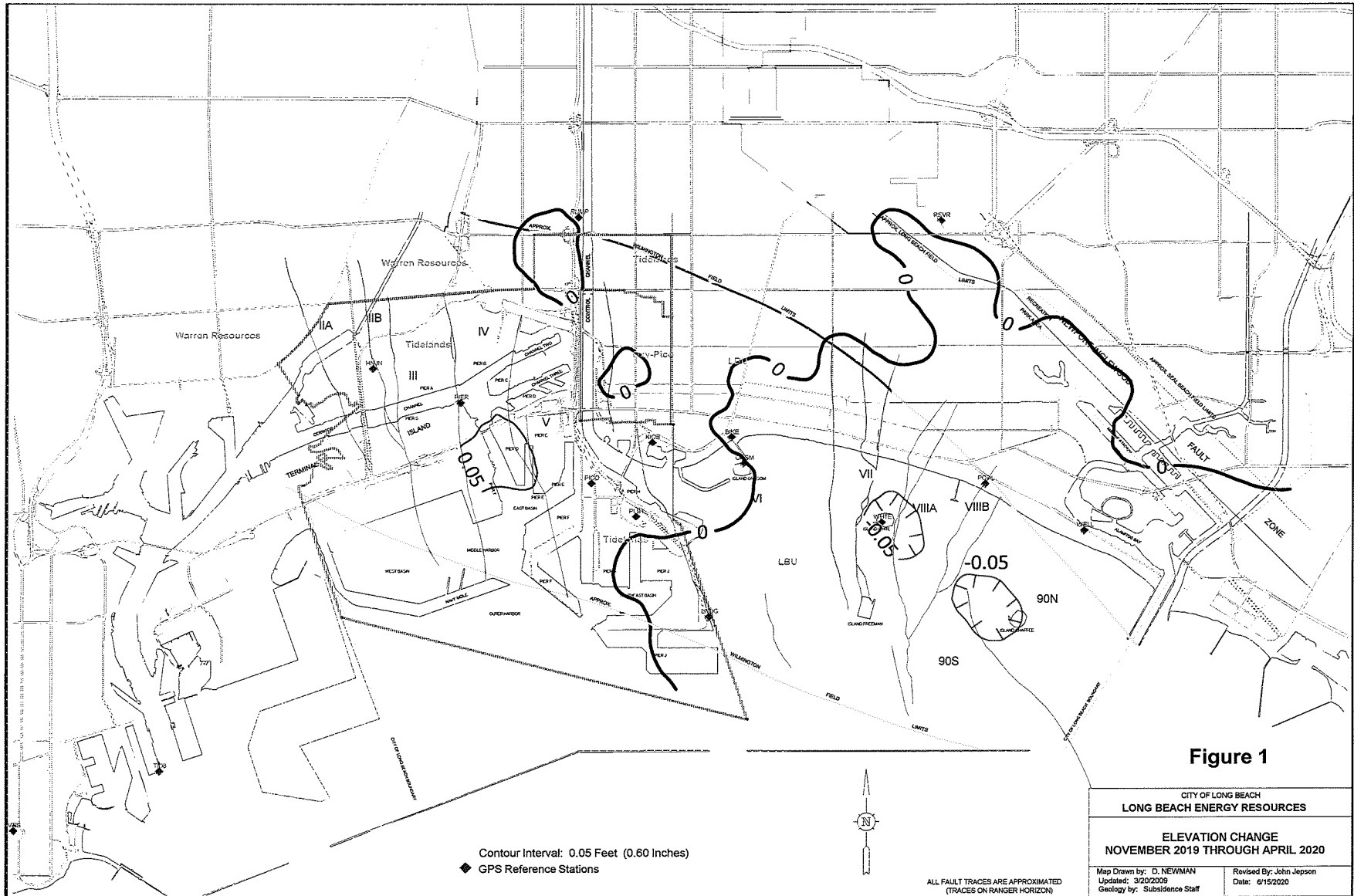


Figure 1

CITY OF LONG BEACH	
LONG BEACH ENERGY RESOURCES	
ELEVATION CHANGE	
NOVEMBER 2019 THROUGH APRIL 2020	
Map Drawn by: D. NEWMAN	Revised By: John Jepson
Updated: 3/20/2020	Date: 6/15/2020
Geology by: Subsidence Staff	

