CITY OF
LONG BEACH

Long Beach Energy Resources
2400 East Spring Street, Long Beach, CA 90806
(562) 570-2000

C-4

March 17, 2020

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 2018 through October 2019." (Citywide)

DISCUSSION

The City of Long Beach, through the Energy Resources Department (ER), supervises oil production and subsidence control operations in the Wilmington Oil Field. ER conducts elevation surveys every six months to monitor elevation changes in the oil fields and adjacent city areas. This report focuses on elevation changes that have occurred from November 2018 through October 2019. The ER survey includes the following areas: Civic Center, Central City, Alamitos Bay, Naples, Harbor District, and the offshore area encompassing the four oil islands.

The results of the last two six-month surveys indicate that elevations were stable in the Civic Center, Central City, Naples, and Alamitos Bay. During the first half of the year, the offshore islands were stable except for Island Freeman. The elevation of Island Freeman declined by 0.06 foot (0.7 inch). The elevation decrease is within normal limits and did not continue in the second half of the year. Water Injection and fluid production were closely monitored for significant changes.

During the first half of the year, the Harbor District was stable, except for a small portion of Piers D, E, F and a portion of Piers A and S. The ends of Piers D, E and F experienced an elevation increase of up to 0.07 foot (0.8 inch). The increase may have been due to ongoing construction in the Middle Harbor area. The elevation of the western portion of Piers A and S also increased up to 0.07 foot (0.8 inch). The increase was within normal limits and did not appear to have resulted from any change in the oil operations. The Harbor District was stable during the second half of the year.

The ER survey uses a series of benchmarks to determine 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 elevation) or pessimistic (slightly down in elevation). These changes in 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. Surface elevations over the active Wilmington Oil Field can be expected to fluctuate under changing water flood conditions.

This matter was reviewed by Deputy City Attorney Richard F. Anthony on February 11, 2020, and by Revenue Management Officer Geraldine Alejo on February 26, 2020.

TIMING CONSIDERATIONS

City Council action on this matter is not time critical.

FISCAL IMPACT

This recommendation has no staffing impact beyond the 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
ACTING CITY MANAGER

ELEVATION CHANGES
IN THE
CITY OF LONG BEACH

NOVEMBER 2018 THROUGH OCTOBER 2019

PREPARED

FOR

LONG BEACH CITY COUNCIL

BY THE

ENERGY RESOURCES DEPARTMENT

CONTENTS

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 2019 and November 2019. Changes in elevation that have occurred since the last three surveys, November 2018, May 2019 and November 2019, 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 2018 through April 2019 (Figure 1)

Elevations throughout the Alamitos Bay, Naples, Central City, Civic Center were stable during the six-month period. The offshore islands were stable during the period, except for Island Freeman. The elevation of Island Freeman declined by 0.06 foot (0.7 inch) during the period. The elevation decrease was within normal limits. Water injection and fluid production requirements were closely monitored for significant changes.

The Piers in the Harbor District were stable during the period, with the exception of a portion of Piers D, E, F and a portion of Piers A and S. The ends of Piers D, E and F experienced an elevation increase of up to 0.07 foot (0.8 inch). The increase may have been due to ongoing construction in the Middle Harbor area. The rise did not continue in the second half of the year. A western portion of Piers A and S also increased up to 0.07 foot (0.8 inch). The increase was within normal limits and did not continue in the second half of the year.

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 2019 through October 2019 **(Figure 2)**

Elevations throughout the Alamitos Bay, Naples, Central City, Civic Center and the offshore islands remained stable during the six-month period.

In the Harbor District, all piers were stable during the six-month period.

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

Elevation Change – November 2018 through October 2019 **(Figure 3)**

Elevations in the Alamitos Bay, Naples, Civic Center, Central City were stable during the twelve-month period. Elevations on Oil Islands Chaffee and Freeman declined up to 0.09 foot (1.1 inches) during the twelve-month period. The decrease is considered minor, and adjustments to waterflood and fluid production requirements will be made to mitigate further changes. The elevation decrease is not expected to continue.

The Harbor District was stable during the period, with the exception of a portion of Piers D and T. An elevation increase of up to 0.07 foot (0.8 inches) was observed on a small portion of Piers D and T. The increase was considered minor and occurred during the first half of the year.

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 Public Works Bureau of Engineering 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-feet 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

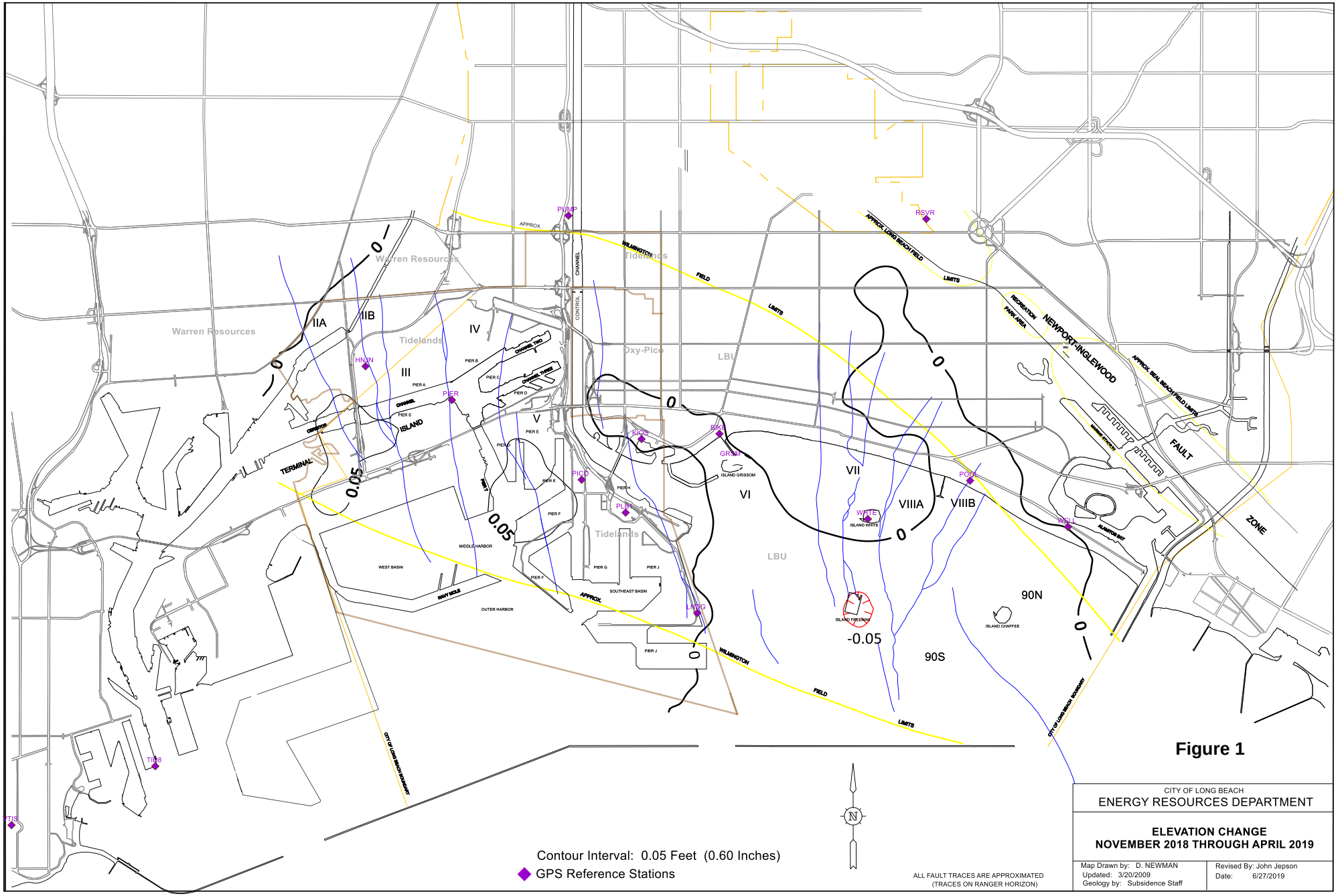
The May 2002 Elevation Leveling Campaign marked the conversion from spirit, first and second order rod leveling, to GPS surveying of bench mark elevations.

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.



Contour Interval: 0.05 Feet (0.60 Inches)

GPS Reference Stations

ALL FAULT TRACES ARE APPROXIMATED
(TRACES ON RANGER HORIZON)

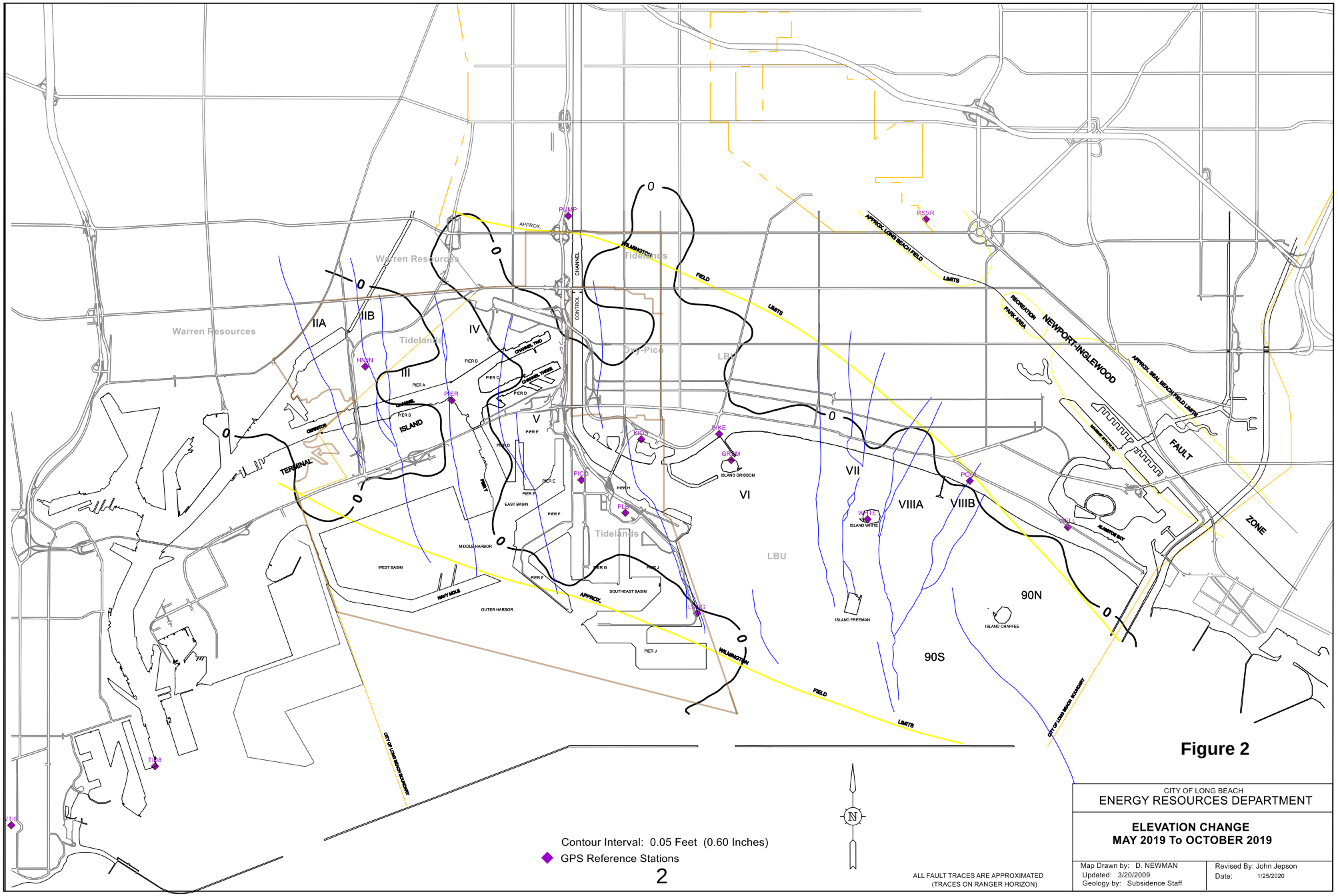
Figure 1

CITY OF LONG BEACH
ENERGY RESOURCES DEPARTMENT

ELEVATION CHANGE
NOVEMBER 2018 THROUGH APRIL 2019

Map Drawn by: D. NEWMAN
Updated: 3/20/2009
Geology by: Subsidence Staff

Revised By: John Jepson
Date: 6/27/2019



Contour Interval: 0.05 Feet (0.60 Inches)

GPS Reference Stations

2

ALL FAULT TRACES ARE APPROXIMATED
(TRACES ON RANGER HORIZON)

Figure 2

CITY OF LONG BEACH
ENERGY RESOURCES DEPARTMENT

ELEVATION CHANGE
MAY 2019 To OCTOBER 2019

Map Drawn by: D. NEWMAN
Updated: 3/20/2009
Geology by: Subsidence Staff

Revised By: John Jepson
Date: 1/25/2020

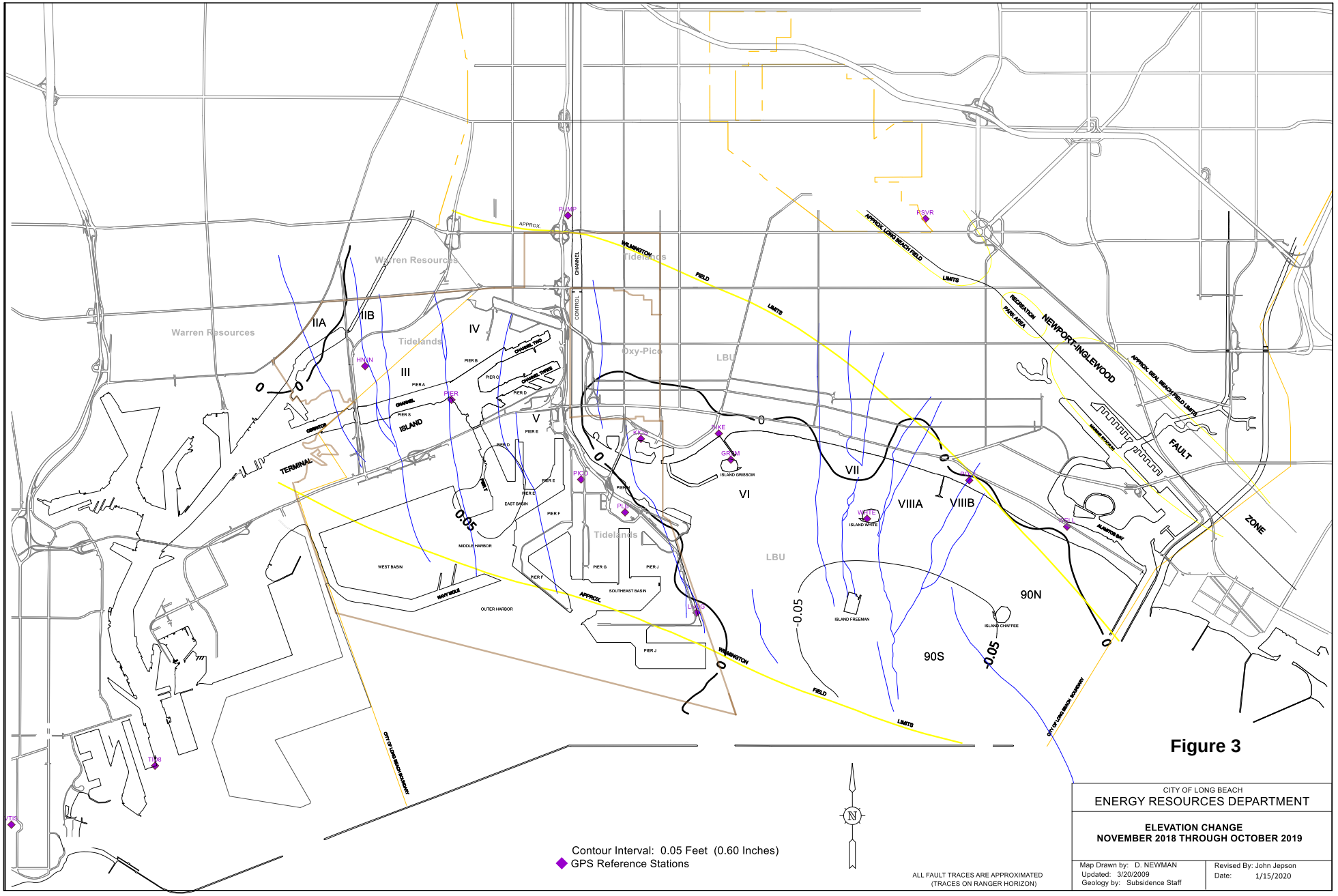


Figure 3

CITY OF LONG BEACH
ENERGY RESOURCES DEPARTMENT

ELEVATION CHANGE
NOVEMBER 2018 THROUGH OCTOBER 2019

Map Drawn by: D. NEWMAN
Updated: 3/20/2009
Geology by: Subsidence Staff

Revised By: John Jepson
Date: 1/15/2020