CITY OF LONG BEACH
Gas & Oil
DEPARTMENT

C-17

ROBERT DOWELL
DIRECTOR

2400 EAST SPRING STREET · LONG BEACH, CA 90806
(562) 570-2000 · www.lbgo.org

February 20, 2018

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 2016 through October 2017." (Citywide)

DISCUSSION

The City of Long Beach, through the Long Beach Gas and Oil Department (LBGO), supervises oil production and subsidence control operations in the Wilmington Oil Field. LBGO 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 2016 through October 2017. The LBGO 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 last two six-month surveys indicate that elevations were stable in the Civic Center, Central City, Alamitos Bay, and the offshore area. During the second half of the year, the Naples area experienced an elevation loss of up to 0.06 foot (0.7 inch). The area is outside oilfield boundaries and the decline is not oilfield related. The Harbor District was stable for the year, except for the central harbor area. Piers B, C, D, S, and T experienced an elevation increase of up to 0.11 foot (1.3 inches) during the year. The increase may have been due to increased water injection in the area. Cessation of dewatering activities associated with construction of the new Gerald Desmond Bridge and a wetter-than-normal rain season may have also impacted elevations locally. Waterflood requirements will be reviewed and adjusted as necessary to ensure there is no over-pressurization in the oil producing zones.

The LBGO 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 January 23, 2018 and by Revenue Management Officer Geraldine Alejo on January 24, 2018.

TIMING CONSIDERATIONS

City Council action on this matter is not time critical.

FISCAL IMPACT

There is no fiscal or local job impact associated with this recommendation.

SUGGESTED ACTION:

Approve recommendation.

Respectfully submitted,

ROBERT DOWELL
DIRECTOR OF LONG BEACH GAS AND OIL

Attachment

APPROVED:

PATRICK H. WEST
CITY MANAGER

ELEVATION CHANGES
IN THE
CITY OF LONG BEACH

NOVEMBER 2016 THROUGH OCTOBER 2017

PREPARED

FOR

LONG BEACH CITY COUNCIL

BY THE

**LONG BEACH GAS AND OIL
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 2017 and November 2017. Changes in elevation that have occurred since the last three surveys, November 2017, May 2017 and November 2016, 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 2016 through April 2017 (Figure 1)

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

The Piers in the Harbor District were also stable during the period, except for a small portion of Pier T. Pier T experienced an elevation increase of up to 0.06 foot (0.7 inch). The elevation increase was within normal limits.

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 2017 through October 2017 (Figure 2)

Elevations throughout the Alamitos Bay, Central City, Civic Center and the offshore islands remained stable during the six-month period. The Naples area experienced a minor elevation decline of up to 0.06 foot (0.7 inch). The area of elevation decline is outside the oilfield boundaries and is not oilfield related.

In the Harbor District, pier A, E, F, G, H and J were stable. Portions of Piers B, C, D, S and T experienced an elevation increase of up to 0.94 foot (1.1 inches). The increase is on the high end of normal limits, but still considered minor and will be closely monitored.

To the extent that over-pressurization may have occurred in the oil producing zones, waterflood operations will be reviewed and adjustments will be made as necessary to minimize future elevation gains.

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

Elevation Change – November 2016 through October 2017 **(Figure 3)**

Elevations in the Alamitos Bay, Naples, Civic Center, Central City and the offshore drilling islands were stable during the twelve-month period.

While much of the Harbor area was stable during the twelve month period the central area consisting of Piers B, C, D, S and T experienced a net elevation increase of up to 0.11 foot (1.3 inches) that was observed in the second half of the year. Other than oilfield operations, factors that may have contributed to the rise include an unseasonably wet winter and the cessation of near-surface dewatering activities related to construction of the new Gerald Desmond bridge. The increase is still considered minor, and adjustments to waterflood requirements will be made as necessary to ensure there is no over-pressurization in the oil producing zones. The elevation increase is not expected to continue.

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 LBGO Oil Operations 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 8 to 10 millimeters (0.025 foot or 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

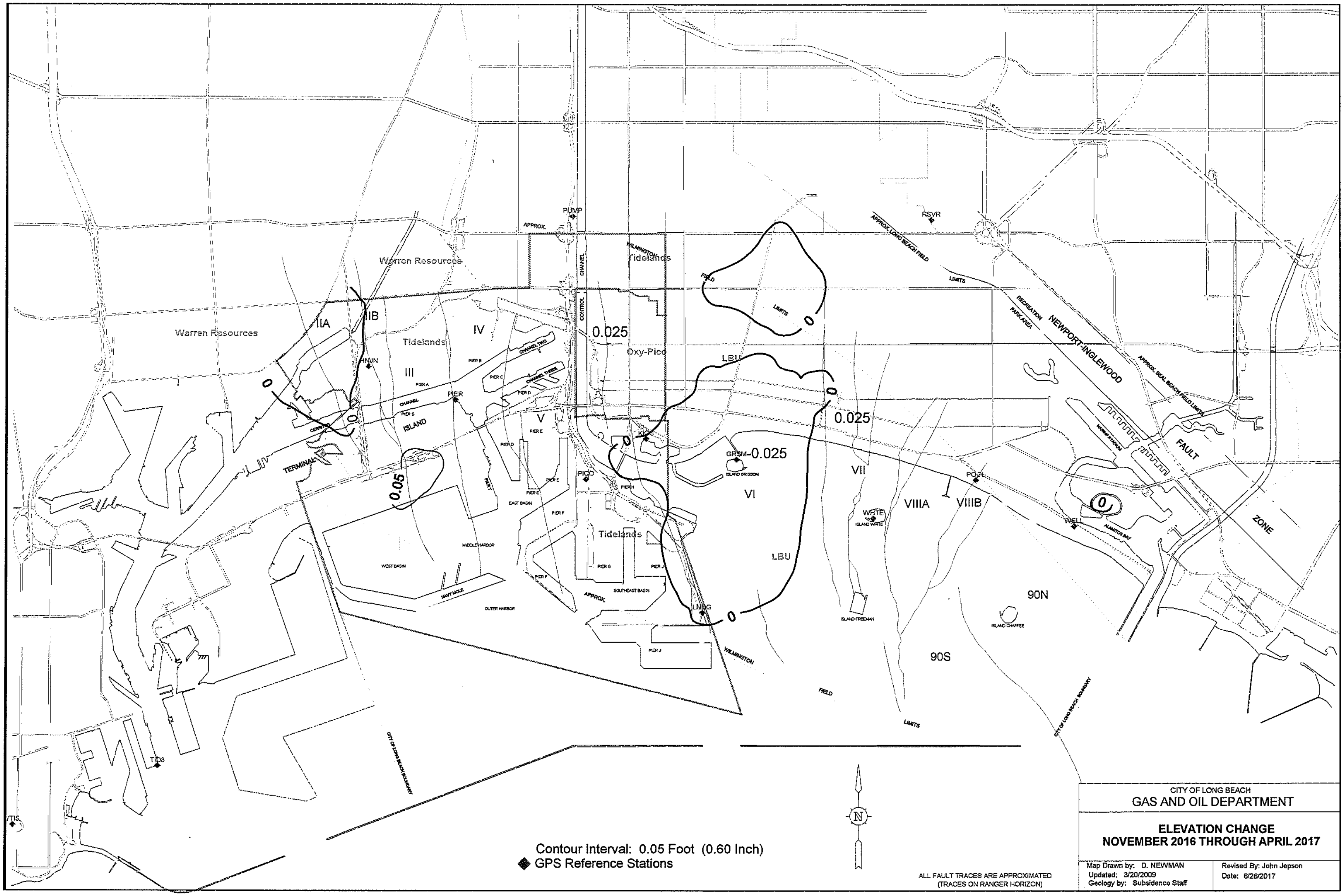
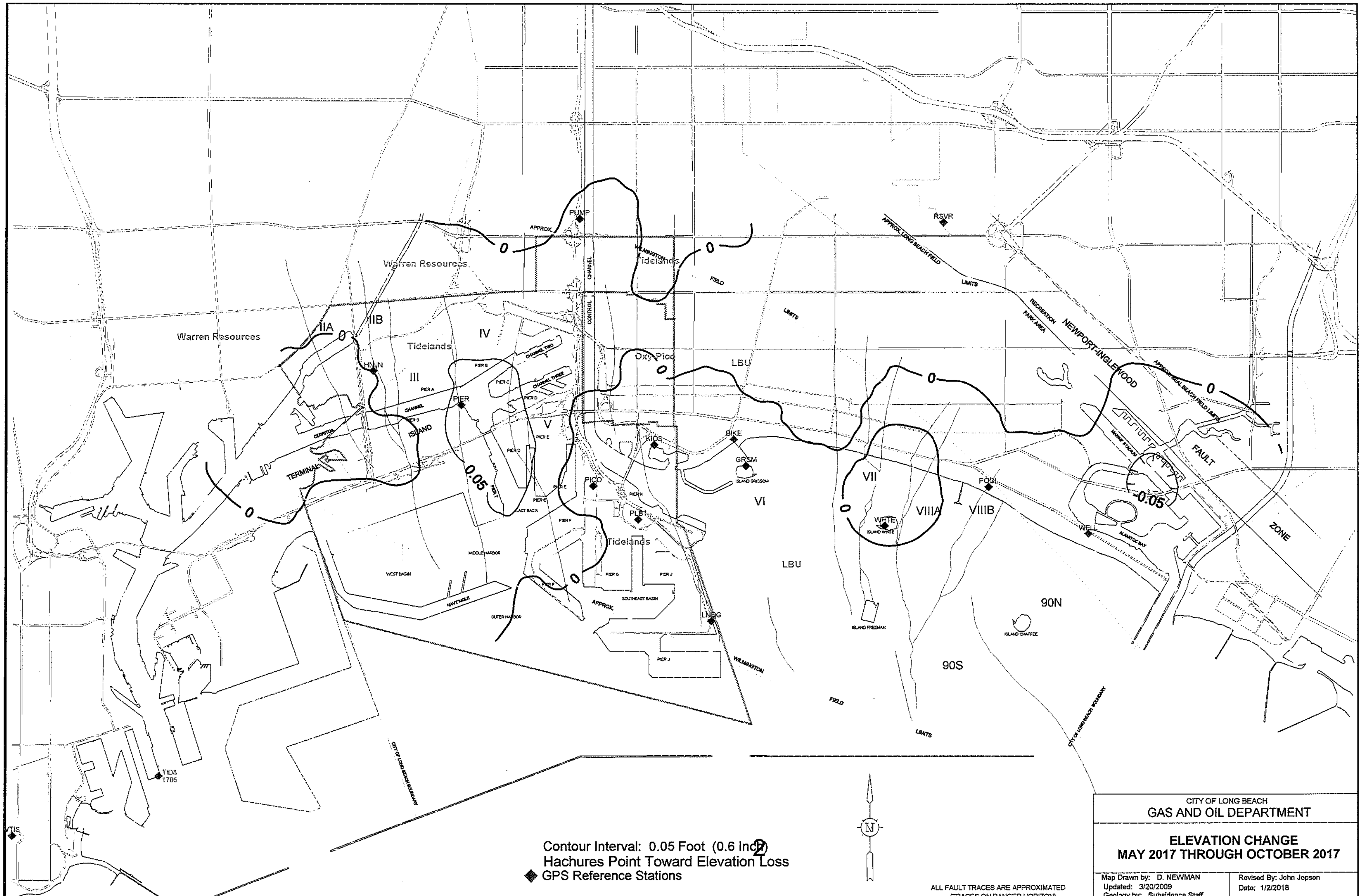
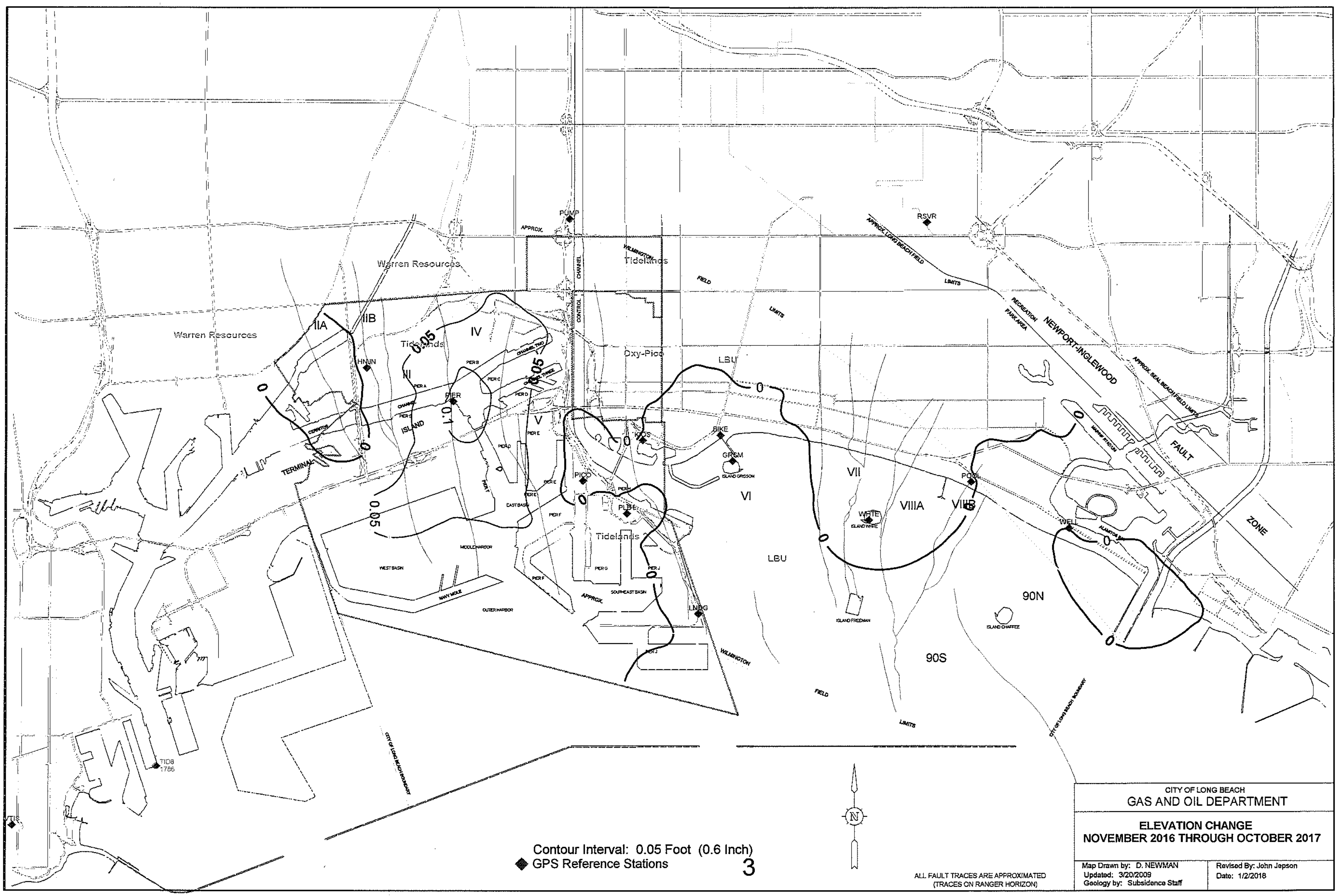

Warren Resources
Warren Resources
Tidelands
Tidelands
Tidelands
Oxy-Pico
IIA
IIB
III
IV
V
VI
VII
VIIIA
VIIIB
90N
90S
LBU
LBU
0.025
0.025
-0.025
0.05
0
NEWPORT-INGLEWOOD
FAULT
ZONE
WILMINGTON
FIELD
LIMITS
CONTROL
CHANNEL
TERMINAL
ISLAND
PUMP
RSVR
HNIN
PIER
KIOG
GRSM
PICO
WHTE
POCL
LNBG
TIDS
CITY OF LONG BEACH
GAS AND OIL DEPARTMENT
ELEVATION CHANGE
NOVEMBER 2016 THROUGH APRIL 2017
Map Drawn by: D. NEWMAN
Updated: 3/20/2009
Geology by: Subsidence Staff
Revised By: John Jepson
Date: 6/26/2017
Contour Interval: 0.05 Foot (0.60 Inch)
GPS Reference Stations
ALL FAULT TRACES ARE APPROXIMATED
(TRACES ON RANGER HORIZON)

Figure 2



PUMP
APPROX.
WILMINGTON
Tidelands
FIELD
LIMITS
RSVR
APPROX. LONG BEACH FIELD
RECREATION PARK AREA
NEWPORT-INGLEWOOD
FAULT
ZONE
Warren Resources
Warren Resources
IIA
IIB
Tidelands
III
IV
V
VI
VII
VIIIA
VIIIB
90N
90S
LBU
LBU
Oxy Pico
HNJN
PIER
KIOS
BIKE
GRSM
PICO
PLBI
POOL
WRTE
WELL
LNGG
TID8
1786
VTIS
TERMINAL
ISLAND
CHANNEL
CONTROL
0
0.05
-0.05
WEST BASIN
MIDDLE HARBOR
NAVY MOLE
OUTER HARBOR
SOUTHEAST BASIN
ISLAND FREEMAN
ISLAND CHAFFEE
ISLAND WHITE
ISLAND GRISSOM
CITY OF LONG BEACH BOUNDARY
Contour Interval: 0.05 Foot (0.6 Inc2)
Hachures Point Toward Elevation Loss
GPS Reference Stations
N
ALL FAULT TRACES ARE APPROXIMATED
(TRACES ON RANGER HORIZON)
CITY OF LONG BEACH
GAS AND OIL DEPARTMENT
ELEVATION CHANGE
MAY 2017 THROUGH OCTOBER 2017
Map Drawn by: D. NEWMAN
Updated: 3/20/2009
Geology by: Subsidence Staff
Revised By: John Jepson
Date: 1/2/2018

Figure 3



Warren Resources
Warren Resources
Tidelands
Tidelands
Tidelands
Oxy-Pico
LBU
LBU
IIA
IIB
III
IV
V
VI
VII
VIIIA
VIIIB
90N
90S
NEWPORT-INGLEWOOD
FAULT
ZONE
PUMP
RSVR
HNUN
PIER
PICO
PLBE
KIDS
BIKE
GRSM
POOL
WHTE
WELL
LNDG
TID8
1786
CITY OF LONG BEACH
GAS AND OIL DEPARTMENT
ELEVATION CHANGE
NOVEMBER 2016 THROUGH OCTOBER 2017
Contour Interval: 0.05 Foot (0.6 Inch)
GPS Reference Stations
ALL FAULT TRACES ARE APPROXIMATED
(TRACES ON RANGER HORIZON)
Map Drawn by: D. NEWMAN
Updated: 3/20/2009
Geology by: Subsidence Staff
Revised By: John Jepson
Date: 1/2/2018