Floodplain Evaluation
Jordan River Sports Complex

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Prepared for: Jeff Niermeyer, Director of Public Utilities

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Subject: Great Salt Lake and Jordan River Influences on the Proposed Jordan River Sports Complex Site

Introduction

The Director of the Salt Lake City Department of Public Utilities (SLCPU) asked for a detailed study into the influences that the varying lake elevations may have on the proposed Sports Complex site. Information was obtained from the United States Geological Society (USGS) and reviewed in relationship to elevation fluctuations over time. At the same time, the GIS Manager of SLCPU, Nick Kryger, obtained aerial photographs of the proposed site to provide a review of the visual relationship of the proposed Sports Complex site with the elevations of the Great Salt Lake between 1983 and 1990. The influences from the Jordan River and other local drainage upon the proposed Sports Complex were also reviewed.

The following is a discussion of the process and findings of that study and how it affects the proposed Sports Complex. The discussion relies heavily upon the chart "Fluctuation in Water Surface Elevation, Great Salt Lake, 1847 to 2009," included with this report.

Datum

There has been some confusion in the past discussions about the elevations. It is important to understand that there are two datums that have been used. The official datum that the USGS uses is NGVD29 to measure the lake elevation. The other datum, NAVD88, is the datum that the City uses for topography and is also the datum that FEMA uses in Salt Lake County for floodzones with a known water surface elevation. The difference between the two datums, as converted at the Saltair Boat Harbor gage station is 3.24-feet. For clarity, the discussion below will have added 3.24-feet conversion to the lake elevation data (which is given in NGVD29), so that the entire discussion is consistently made in NAVD88.

History of Flooding – Great Salt Lake

There have been two measured instances where the Great Salt Lake climbed above 4213.0 (NAVD88). The first happened from July 1868 through November 1877, with the peak reaching 4214.84 in June 1872 and again in July 1873. Fortunately, the high water during that time impacted few people. The other peak happened in May 1985 through August 1987. The peak elevation of 4214.84 was reached on June 1986 and again in April 1987. In both situations, the elevation dipped below 4213.0 for a small portion of time. From the start of the rise of the first flood to the start of the rise of the second flood, based upon when 4213.0 was reached, is about 118-years. There were 107.5-years of time between the two events where the surface stayed below 4213.0. A chart showing the history of the lake elevation can be found in Appendix A.

Sports Complex Site

This section discusses issues that relate directly to the proposed Sports Complex, located at approximately 1900 North and Redwood Road, in Salt Lake City. To provide a clear discussion, all elevations discussed in this section will be provided in the NAVD88 datum. Elevations of the lake have had their USGS elevations added to the 3.24-foot conversion amount to give the elevations of the lake in the current city datum.

Influence from the Great Salt Lake

Nick Kryger, the GIS Manager at SLCPU was able to obtain aerial photographs of the proposed Sports Complex for various years and then using the data obtained from the USGS, determine how the elevation of the lake corresponds to flooding within the proposed Sports Complex project boundary. The following table represents the months of the photographs obtained and the monthly mean lake elevations, provided in NAVD88, for those months.

Month	Elevation (ft, NAVD88)
April 1983	4205.34[1]
June 1984	4212.04
April 1985	4212.74
March 1986	4213.09
March 1987	4214.59
March 1988	4212.34
April 1989	4209.34
April 1990	4207.13

Table 1: Elevations and annual aerial photographs at Sports Complex

The city has had detailed topography of taken through the Light Detection And Ranging (LiDAR) method which is accurate to 0.05 meters (2.3 inches). Reviewing the LiDAR topography of the city shows the elevation of the proposed Sports Complex to be at an average elevation between 4213 and 4214-feet. The elevation of the Great Salt Lake has only been above 4213-feet during two periods of recorded history: from July 1868 to November 1877; and again in March 1986 until August 1987. During the earlier period, the elevation of the lake dipped below 4213.0 several times, one period of note takes place between 1874 and 1876. In the latter period the lake elevation also briefly hit 4213.0 for a few weeks before the seasonal drop in May 1985. Information shows that the lake was below 4213.0 for 107.5-years between the two time periods. In 167-years of data, the elevation of the lake has only been over 4211.0 twice, during the two same general time periods. In only 30-years of the 167-years of data (18%) has the lake been above the elevation of 4208-feet.

Given the elevation data discussed above, aerial photographs were obtained and reviewed for each year during the 1980s. From March 1986 until August 1987, it appears that the same time the lake elevation

[1] Gage data is not available from October 1982 through September 1983 due to flooding damage to the USGS gage. This elevation is an interpolation of the values, assuming a constant increase over the time the gage wasn't available.

was above 4213.0, the area of the Sports Complex also exhibited signs of ponding or high groundwater. The moisture first appears in the low-lying area of the site and by 1987 most of the site is inundated and the banks of the City Drain appear to be under water. Further, the rapid decrease in lake elevation in 1988 and 1989 appears to correlate to the ponding elevations at the Sports Complex where the water, which can be seen in 1987, quickly dissipates, returning the site to dry ground.

Several exhibits were produced using the aerial images, the city's LiDAR topography and historic lake elevations. These exhibits are located in Appendix A. Using the information in Table 1, the mean monthly lake elevations for each particular month and year were taken and a blue overlay was placed on the image for areas lower than the lake elevation during that particular month.

From this review it would appear that the elevation of the Great Salt Lake provides a direct correlation to the potential flooding at the proposed Sports Complex. As the elevation of the lake rises above 4213.0, ground water appears and begins to inundate the project site and as the elevation of the lake drops the project site also dries.

It should be understood that in 1987, in response to high lake levels, the state authorized $60 million for the West Desert Pumping Project, which is designed to control the levels of the Great Salt Lake by pumping water into the West Desert. Without the pumps, the lake would naturally flow into the west desert at 4220. With the pumps, this area can be used for storage and evaporation as early as the lake reaches 4210-feet in elevation. This effectively increases the surface area of the lake to aid in the evaporation while helping to control rising water surface elevations. The pumps remain in storage, ready to use again, should they need to be used in the future to help protect from loss due to rising lake elevations. [2]

Influence from the Jordan River

As discussed previously, precipitation in 1982, 1983 & 1984 resulted in the rise of the lake from 4201.64-feet in December 1981 to 4212.24-feet in July 1984. This equates to 10.6-feet of rise in 31-months. During a portion of that period, from September 1982 until June 1983, the lake rose 5.1-feet for the largest recorded seasonal rise. The only other time in recorded history that a similar rise occurred was from December 1906 to July 1907 where lake elevation rose 3.4-feet in seven months. With this dramatic change in water surface elevation, the USGS measured the flow originating from the three rivers that feed into the Great Salt Lake: the Bear River, the Jordan River, and the Weber River. According to USGS river data and the Water Supply Paper 2332, the following data is obtained about the rivers that feed into the Great Salt Lake:

[2] http://www.water.utah.gov/construction/gsl/index.htm

Flow Rate (cfs)	Approximate[3] Percent of Total Flow into Lake	River	Date of Peak Flow	Percent of flow above average
9770	48.0%	Bear River	June 4, 1983	70%
3350	16.4%	Jordan River	June 12, 1983	260%
7250	35.6%	Weber River	June 2, 1983	60%
20370		Total Combined		

Table 2: Distribution of flow entering the Great Salt Lake during 1983

The Water Supply Paper 2332 doesn't mention which gage(s) the above flow rates are taken from. Researching various flow gages along the Jordan River provides the following insight:

Peak Flow Rate (cfs)	Location	Date of Measured Flow	USGS River Gage#
3140	Surplus Canal at 2100 South	June 12, 1983	10170500
210	Jordan River at 1700 South	June 12, 1983	10171000
863	Jordan River at 500 North	June 1, 1983	10172550

Table 3: Distribution of flows in Jordan River during June 1983

It would appear that the runoff identified in WSP-2332 is the combined flow from the Surplus Canal and the Jordan River, as measured at about 2100 South. It should be understood that many other drainage channels empty into the Jordan River below the 1700 South Bridge. It can be seen from the river gage located at 500 North that additional flow is found in the river below the 1700 South gage. It is unclear if measurements taken on the Bear and Weber Rivers also follow similar approximations.

River data illustrates that during historical time when unprecedented flow raised the lake elevation more than 10-feet that the peak flow in the river at 500 North never exceeded 863-cfs[4]. As a matter of perspective, the FEMA Flood Insurance Study defines the 1.0 percent annual chance flood event in the Jordan River to be 1790-cfs at 500 North, or 2.1 times the actual observed peak flow. This information leads to the conclusion that the actual flow in the river is much less than the estimated flow and that during a period of intense flooding and rapid lake rise that the Jordan River was safely contained within the banks of the river.

On June 1, 1984 the flow from the Surplus Canal and the Jordan River, both measured at about 2100 South, reached combined 4286-cfs. This is 936-cfs more than the peak in 1983; however, more water was passed down the Surplus Canal, resulting in only 707-cfs measured flow at 500 North. When referring to the Lower Jordan River (the river from the diversion structure at 2100 South, northward to the lake) the worst event on record was seen on June 1, 1983.

[3] These percentages would be approximate, as well as the total combined flow between the three sources, since the peak flow rates happened on different days. The point is to emphasize how little the Jordan River contributes to the overall inflow to the Great Salt Lake.

[4] This discussion relates to mean daily flow rates in the Jordan River. Instantaneous peaks were not reviewed and may result in higher numbers.

Aerial photographs taken on April 15, 1983 and June 14, 1984 show the land at the proposed Sports Complex not being impacted from the Jordan River. These two photographs represent times of the greatest impact the Jordan River has had upon the Sports Complex site. The photos show the entire river is being contained within its banks.

Influence from other sources

Review of LiDAR topography of the Sports Complex area shows a graded embankment at about 1900 North that serves to provide an access road between the Jordan River and the City Drain (located immediately east of I-215, near the proposed Sports Complex). This graded embankment was present before the floods of 1983 and 1984. There is also a residential subdivision that was constructed south of the proposed Sports Complex around the year 2000. This residential subdivision has directed their drainage back to a detention pond located at 1850 West 1700 North before draining to the west across I-215. There does not appear to be any boundary located north of the Sports Complex and the land drains to the north along natural drainage paths. Between the raised access road, the banks of the Jordan River, and the banks of the City Drain, it appears that the proposed Sports Complex, though located in a local depression, does not suffer from local flooding from offsite flow entering the project area.

Summary

Over the past 167-years, the elevation of the Great Salt Lake has been closely watched and measured, with the quality of measurements increasing as technology becomes available. Through close monitoring programs, in times when corrections are warranted, the USGS has provided applicable adjustments in ensure accurate records.

With regards to the proposed Sports Complex, it would appear that neither the Jordan River nor local drainage contributes to any significant flooding of the site. Evidence suggests that the elevation of the lake has a direct relationship on the flooding at the proposed site.

To have the elevation of the lake rising above the elevation of the proposed sport complex site is a rare event having occurred only twice in a 167-year history of records. Since the last high water event, mitigation measures with the West Desert Pumping project have been implemented to control the Great Salt Lake elevation and help keep it below the historic high water elevation.

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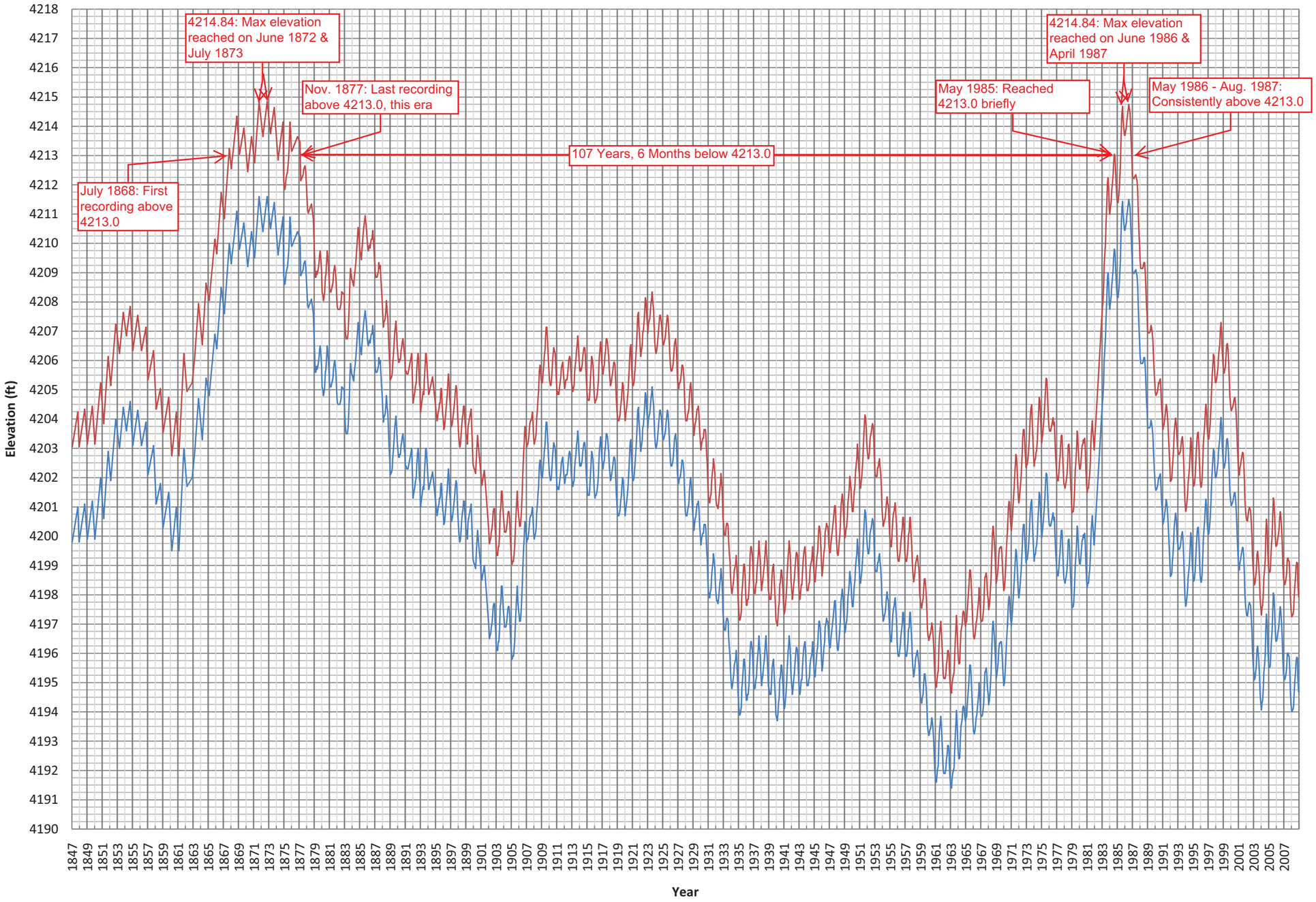
Salt Lake City Department of Public Utilities

Appendix A: Charts and Figures

Fluctuation in Water Surface Elevation, Great Salt Lake, 1847 to 2009



Note:
- Elevations in annotations are provided in NAVD88 datum to be consistent with modern survey standards.
- USGS has always provided lake elevations in NGVD29 datum.
- Datum difference of 3.24-ft as computed at Boat Harbor Gage.
- Prior to 1880, Lake elevations were measured about twice a year. Elevations have been measured consistently since Oct. 1902.
- Elevations from Traditional Data as computed by G.K. Gilbert and E.C. LaRue.

Water Surace Elevation (NGVD29, ft)

Water Surface Elevation (NAVD88, ft)

1847-1875 Traditional Data
1875-1877 Black Rock Gage
1877-1879 Farmington Gage
1879-1881 Lakeshore Gage
1881-1901 Garfield Gage
1902-1903 Midlake Gage
1903-1938 Saltair Gage
1938-present Boat Harbor Gage

Legend

0

Elevation 4207.19 High 1990

Image April 1st 1990

Value

High :255

Low :0

Soccer Field Area 1990

N

W E

S

0 250 500

Feet

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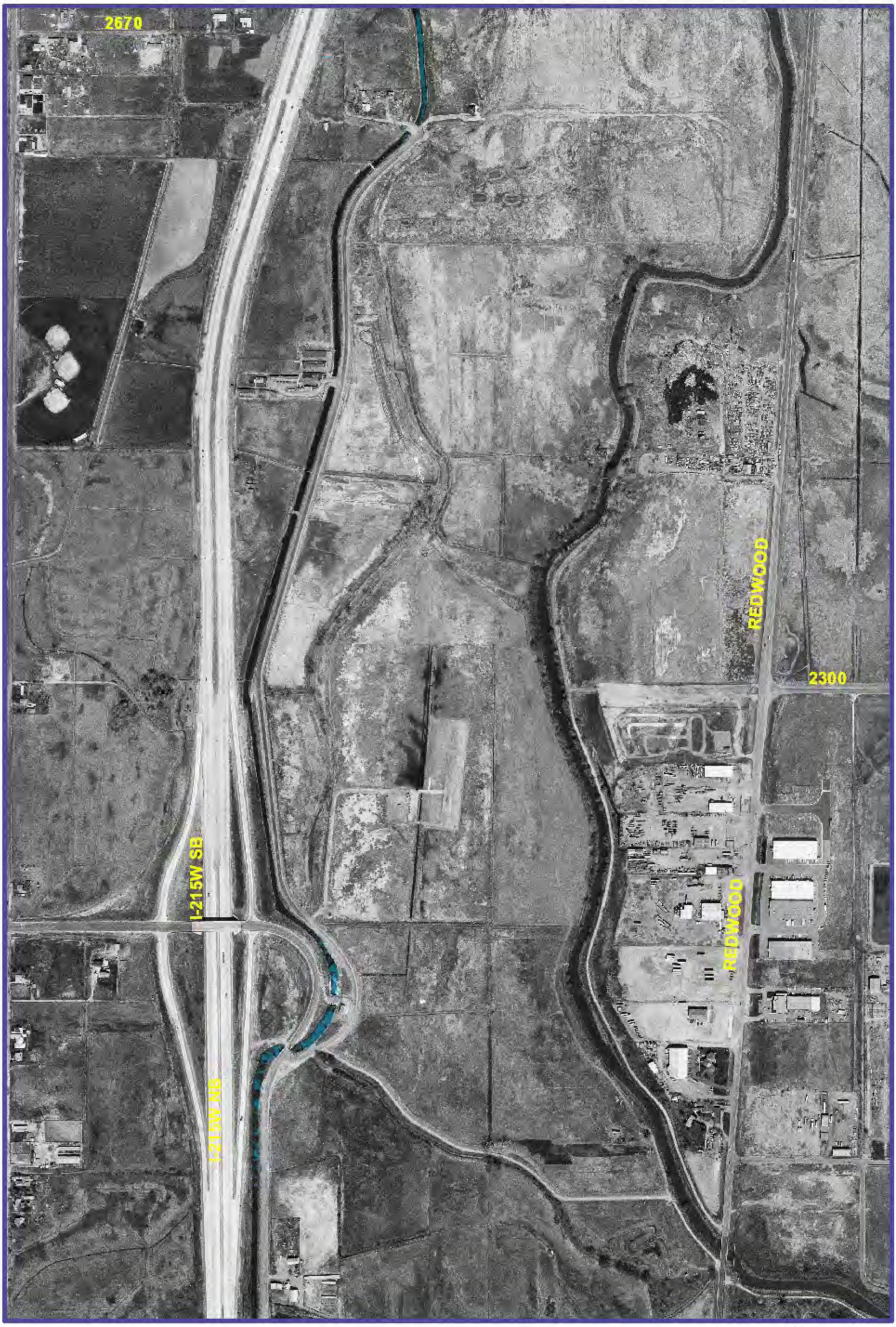
Salt Lake City Public Utilities



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Elevation 4209.34 High 1989

Image April 6th 1989

Value

High : 255

Low : 0

Soccer Field Area 1989

N

W E

S

0 250 500

Feet

Printing Date: 2/8/2010
File: Jordanriver_Soccerarea_1989_11x17.mxd
Salt Lake City Public Utilities

Legend

0

Elevation 4212.34 High 1988

Image March 16th 1988

Value

High : 255

Low : 0

Soccer Field Area 1988

N

W E

S

0 250 500

Feet

Printing Date: 2/8/2010
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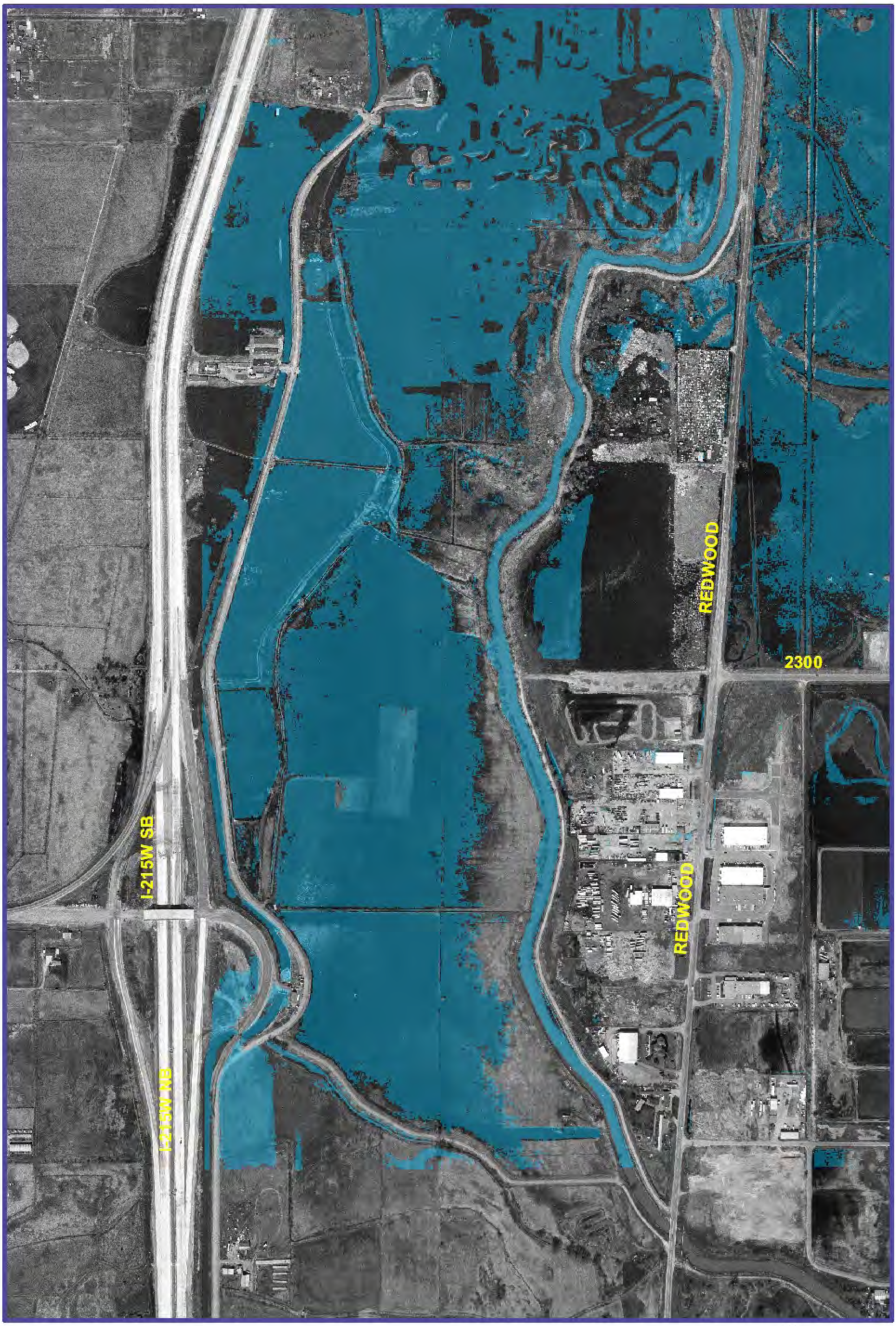

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Elevation 4214.74 High 1987

Image March 30th 1987

Value

High :255

Low :0

Soccer Field Area 1987

N

W E

S

0 250 500

Feet

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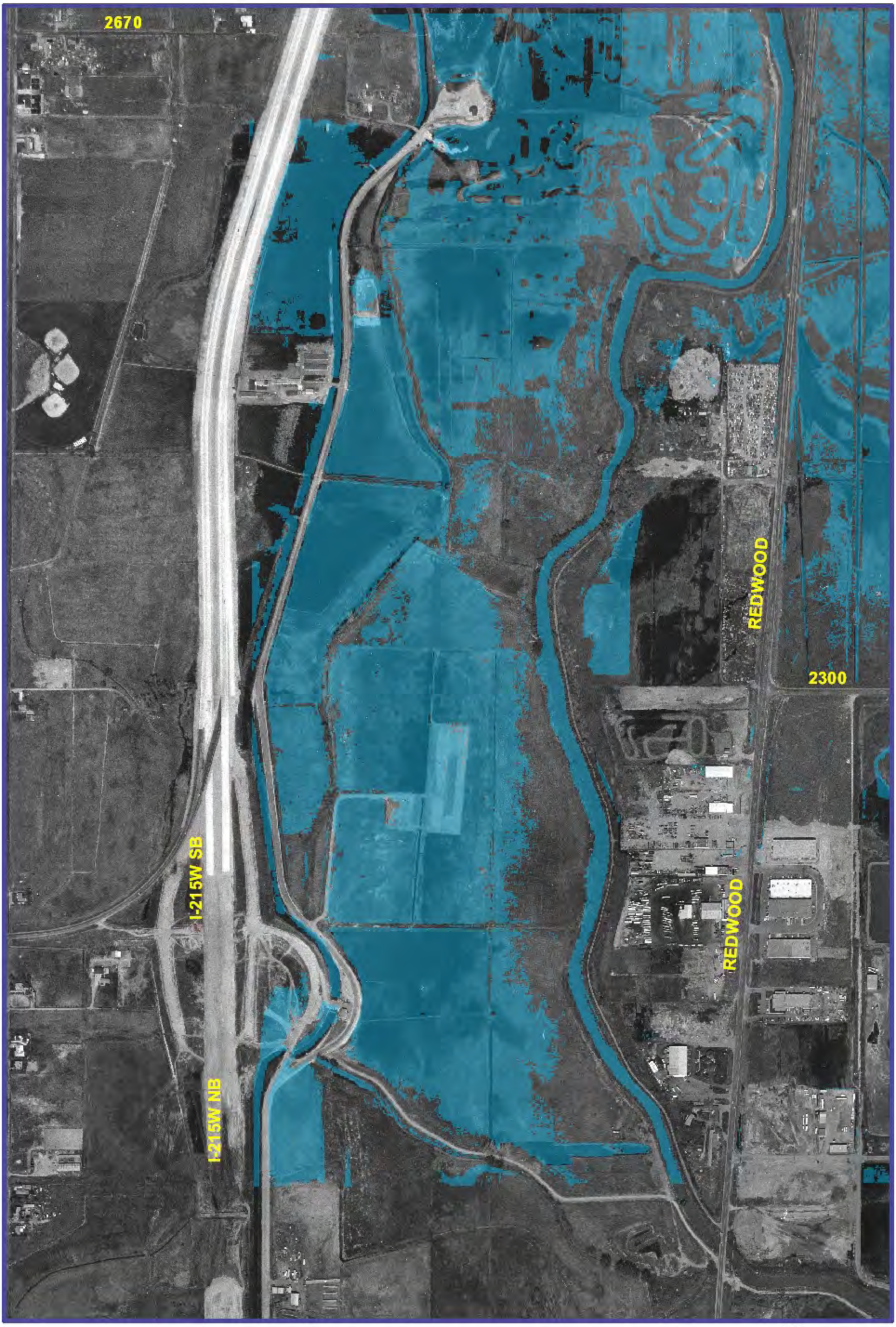

Legend

0

Elevation 4214.63 High 1986

Image March 31 1986
Value
High :255
Low :0

Soccer Field Area 1986

N
W E
S

0 250 500
Feet

Printing Date: 2/8/2010
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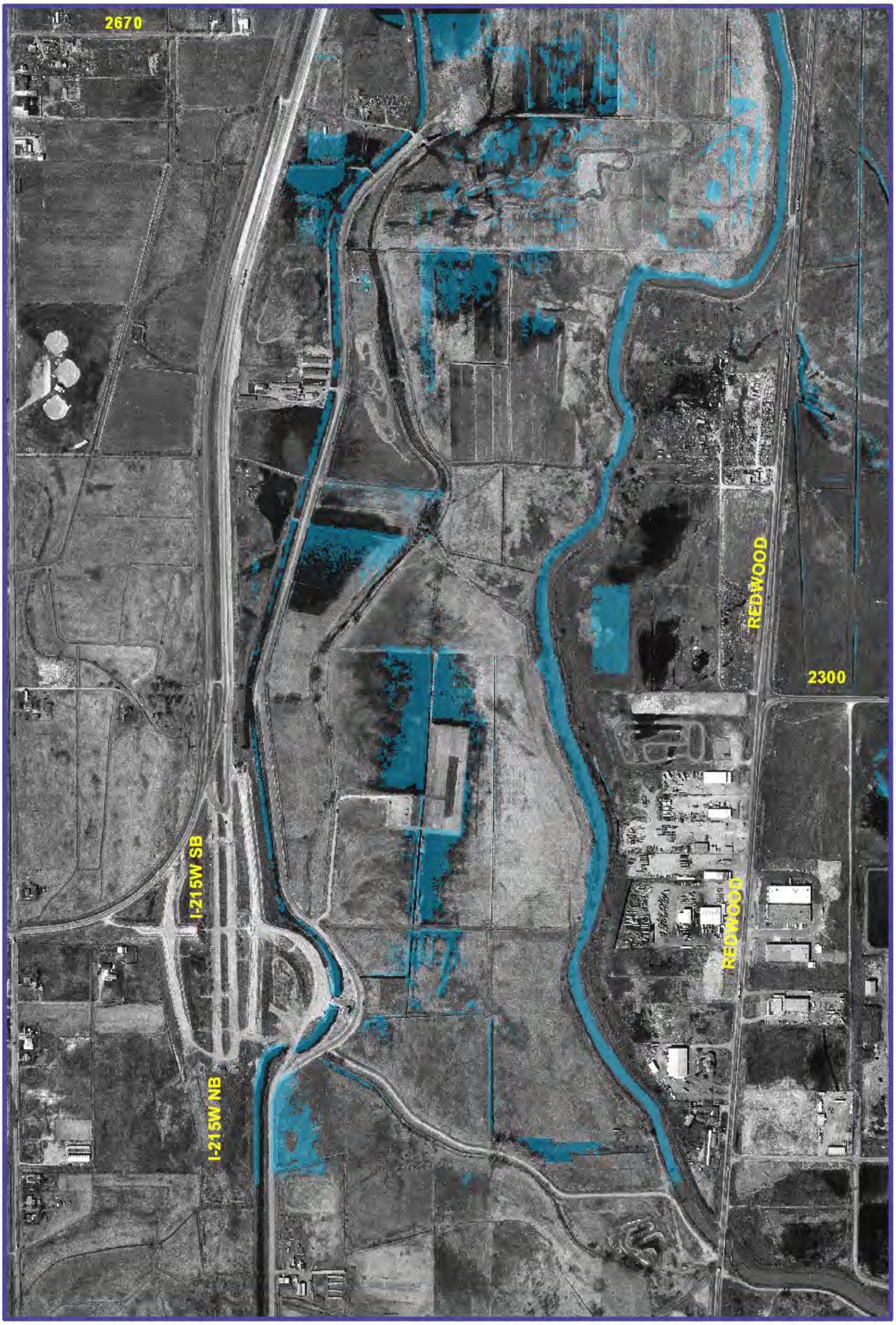
Salt Lake City Public Utilities



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Elevation 4213.04 High 1985

Image April 5th 1985

Value

High :255

Low :0

Soccer Field Area 1985

N

W E

S

0 250 500

Feet

Printing Date: 2/8/2010
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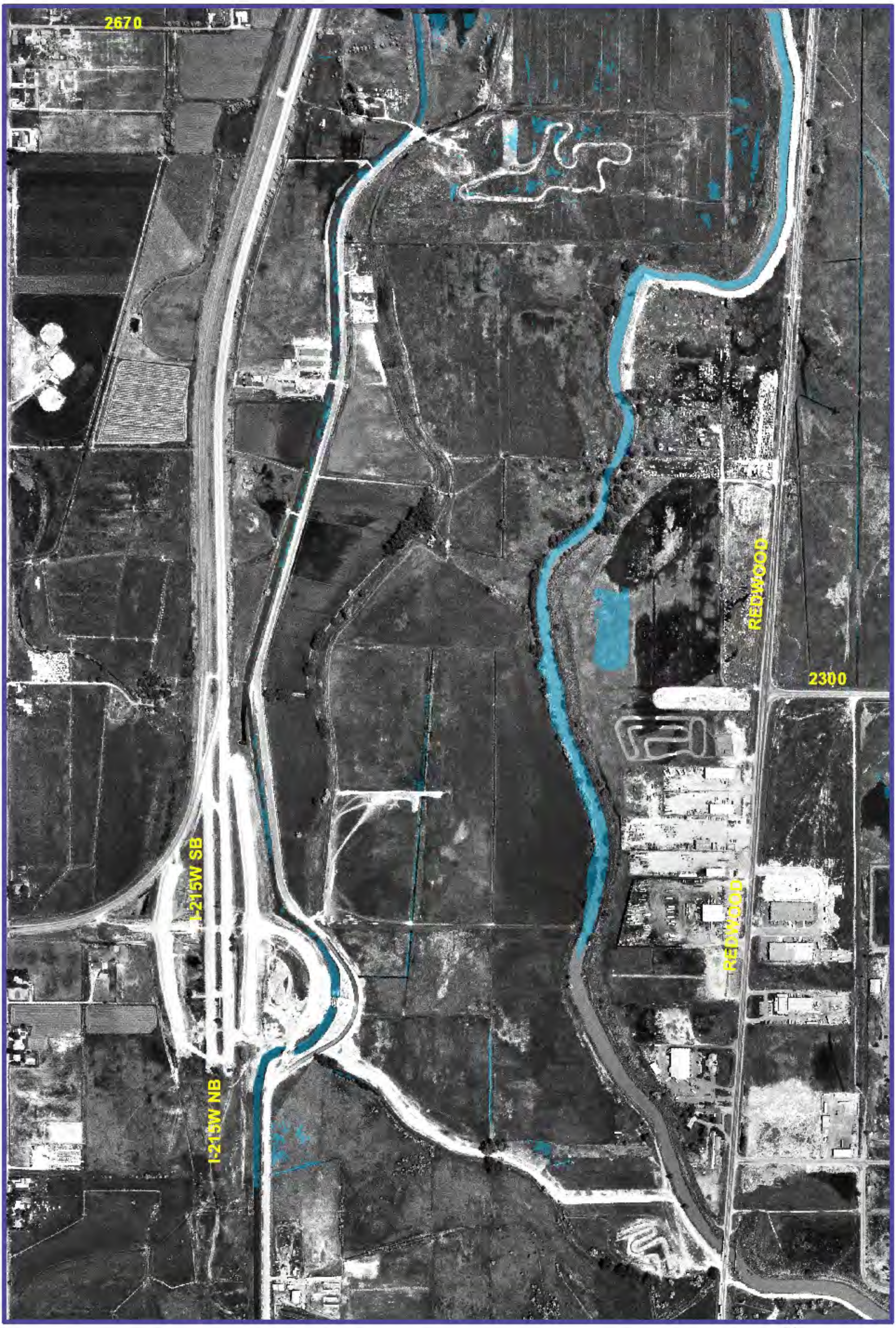
Salt Lake City Public Utilities



Legend

0

Elevation 4212.04 High 1984

Image June 14th 1984

Value

High :250

Low :5

Soccer Field Area 1984

N

W E

S

0 250 500

Feet

Printing Date: 2/8/2010
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Salt Lake City Public Utilities

Legend

0

Elevation 4208.49 High 1983

Image April 15th 1983

Value

High :255

Low :0

Soccer Field Area 1983

N

W E

S

0 250 500

Feet

Printing Date: 2/8/2010
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Salt Lake City Public Utilities

Soccer Field Area 2009

N
W E
S

0 250 500
Feet

Legend

Printing Date: 2/10/2010
File: Jordanriver_Soccerarea_2009_11x17.mxd
Salt Lake City Public Utilities