JEWEL LAKE FECAL COLIFORM ASSESSMENT

Final Report

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1. Overview

This final report is being prepared under Grant Number ACWA 09-17, Jewel Lake Fecal Coliform Assessment. The grant agreement is between the Alaska Department of Environmental Conservation (ADEC) Division of Water (grantor), and the Anchorage Waterways Council (AWC)(grantee).

Jewel Lake is located in the Municipality of Anchorage (MOA), the urban center of the Anchorage Bowl in southcentral Alaska. The state of Alaska included this lake as a Category 4a waters (impaired with a completed Total Maximum Daily Load (TMDL)) in the 2004 Integrated Water Quality Monitoring and Assessment Report (ADEC, 2006a). The TMDL established in 1997 stated that the primary source of fecal coliform in Jewel Lake was runoff from a public beach on the northeast side of the lake where Canadian geese congregate in June and July.

Applicable water quality standards for fecal coliform in Jewel Lake include criterion for the protection of designated uses for water supply, water recreation, and growth and propagation of fish, shellfish, other aquatic life, and wildlife. The TMDL was developed for the most stringent of these—the fecal coliform criteria for drinking, culinary, and food processing water supply and states that in a 30-day period, the geometric mean may not exceed 20 FC/100 ml, and not more than 10% of the samples may exceed 40 FC/100 ml. (18 AAC 70.020(b)(2)(A)(i)) (ADEC, 2006b).

The ADEC initiated this project to collect updated data on Jewel Lake, to determine the current water quality status, and to reassess the Category 4a status of this waterbody.

2. Location and Physical Description of Study Sites

2.1 Geography

Jewel Lake is located in the Anchorage Bowl, in the Municipality of Anchorage (MOA), the urban center of southcentral Alaska (Figure 1). Jewel Lake is in the Campbell Creek watershed, and lies to the northwest of Campbell Lake and to the south of Sand and Sundi Lakes (Figure2). Information on the size, depth and elevation are shown in Table 1. Jewel Lake Park borders the northeast corner of the lake and is a popular recreation spot with picnic tables, restrooms, a playground and several ball fields; the lake itself is one of the most popular lakes for summer swimming in Anchorage. A parking area is located at the southern end of the lake and provides access for fishing. Jewel Lake has been stocked since 1996 with Arctic Char, Rainbow Trout, and Chinook Salmon by the Alaska Department of Fish and Game (ADFG, 2008).

Table 1. Physical characteristics of Jewel Lake (ADFG, 2008)

Surface Acres	26.2 Acres
Volume	170.2 Acre Ft.
Elevation	100 Feet
Mean Depth	6.5 Feet
Maximum Depth	15 Feet
Shoreline Length	0.9 Miles

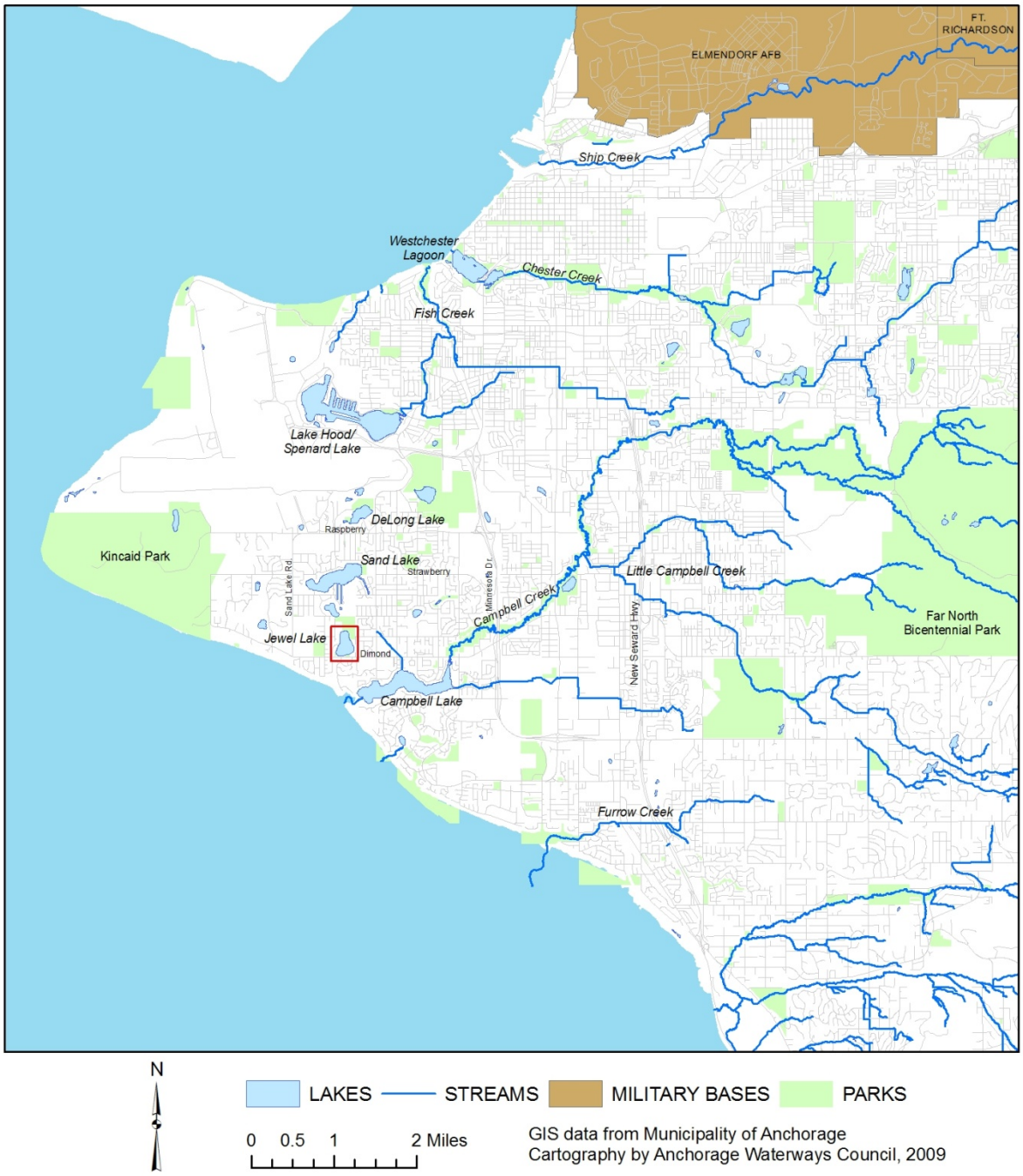

Figure 1. Map of the Anchorage bowl and the location of Jewel Lake.

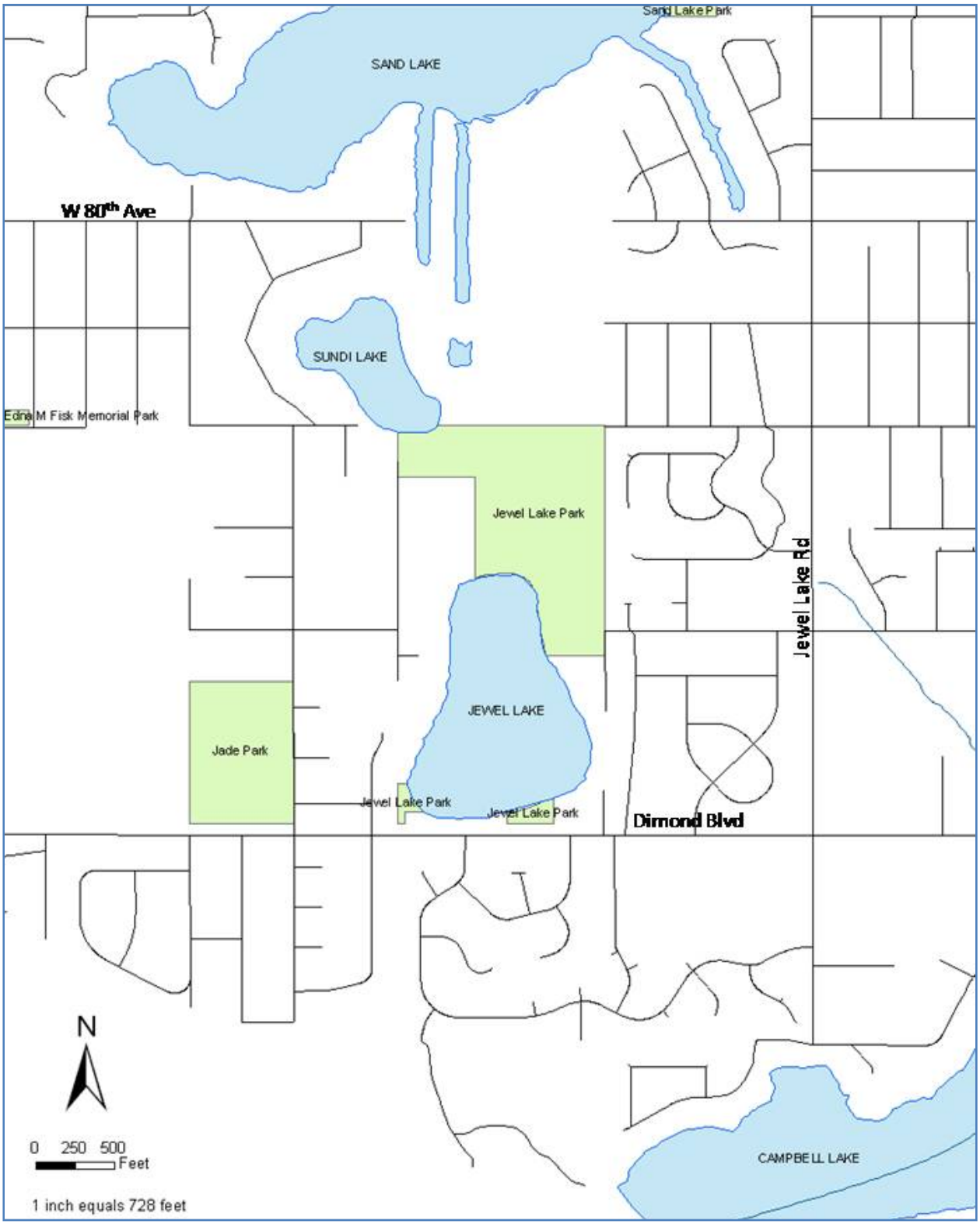

Figure 2. The study site Jewel Lake, Anchorage, AK and immediate surroundings.

2.2 Land Use

The dominant land use in the Jewel Lake area is residential and park land.

2.3 Climate

Anchorage is located in a transitional climate zone in Alaska, between maritime and continental zones. The climate is warmer and wetter than the continental, interior climate zone and cooler and drier than the maritime, coastal climate zone (Dilley and Dilley, 2000). Transitional zone temperatures normally range from 0°F–65°F (WWRC, 2002). Temperatures are moderated by the surrounding mountain ranges and Cook Inlet. In Anchorage, the average high temperature is 42.9°F and the average low is 28.9°F based on data from Ted Stevens International Airport from April 1952-December 2000; monthly averages are provided in Figure 3.

The Chugach Mountains serve as a barrier for the warm, moist air from the Gulf of Alaska and the result is often precipitation. Average annual precipitation (rain and snowmelt) is less than 20 inches (Dilley and Dilley, 2000). Average annual snowfall ranges from approximately 70 inches on the west side of Anchorage and 90 inches on the east side; total snow increases as elevation increases in the Chugach Mountains (AWSO, 1997). Average monthly snowfall data from Anchorage's official measuring station at Ted Stevens International Airport are shown below (Figure 4).

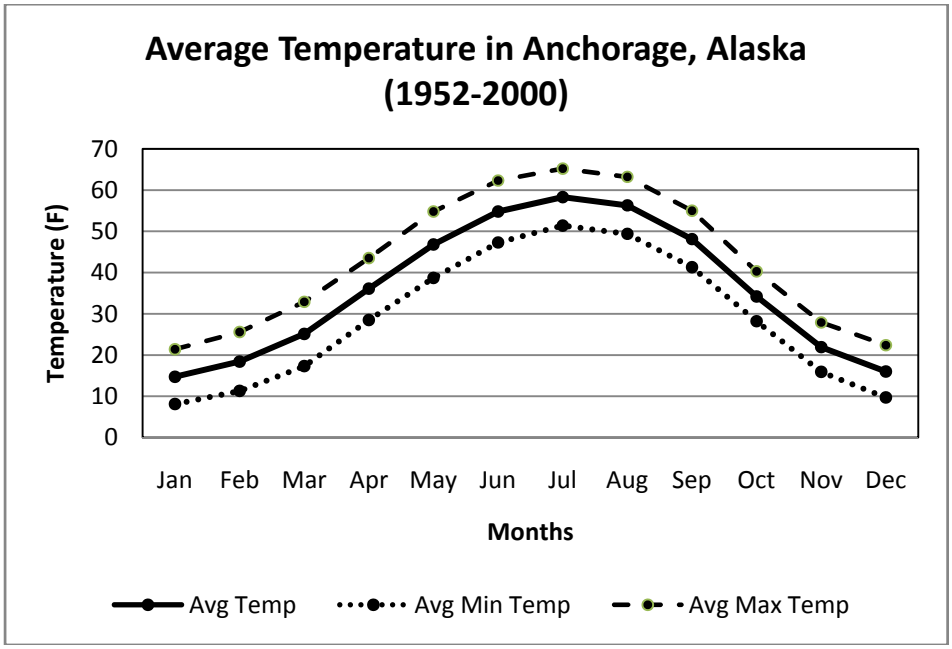

Figure 3. Average temperature in Anchorage, Alaska by month, based on climate data collected at Ted Stevens International Airport from 1952-2000.

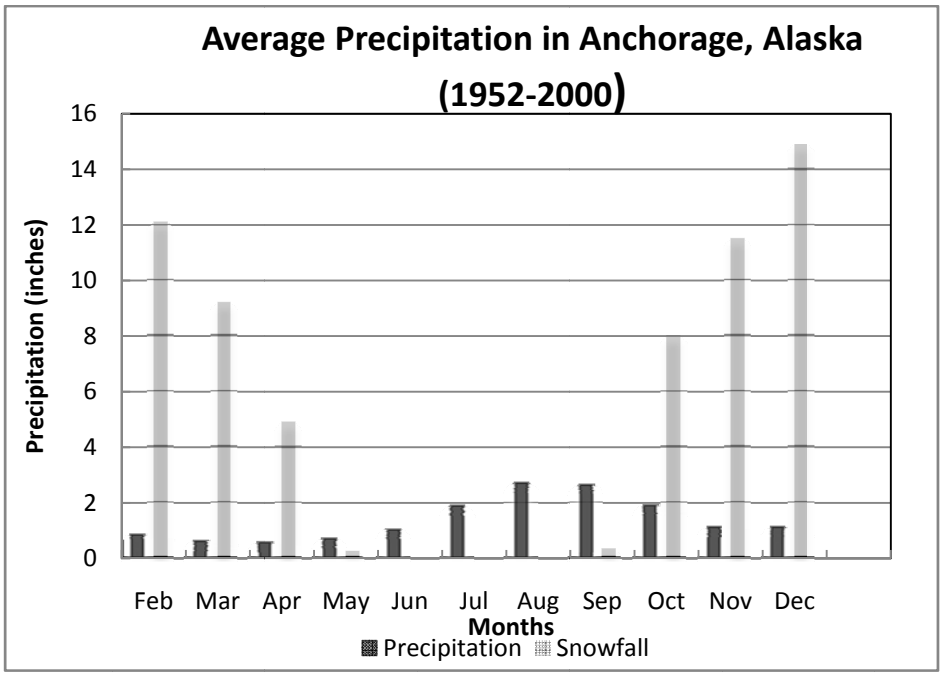

Figure 4. Average precipitation and snowfall in Anchorage, Alaska by month, based on climate data collected at Ted Stevens International Airport from 1952-2000.

3. Summary of Pre-existing Water Quality Status

Title 18, Chapter 70 of the Alaska Administrative Code (ACC) establishes water quality standards for the State of Alaska. The ACC also includes designated "uses" that are to be protected and the water quality criteria necessary to ensure protection of those uses. The following uses have been designated and apply to Little Rabbit Creek and Little Survival Creek: 1) water supply, 2) water recreation, and 3) growth and propagation of fish, shellfish, and other aquatic life.

Past data indicate that Jewel Lake did not meet the applicable water quality standards for fecal coliform during the summer months.

3.1 Non-attainment of Fecal Coliform Bacteria Standard

In 1996 the State of Alaska included Jewel Lake in the EPA's Section 303(d) impaired waters list for non-attainment of the fecal coliform Bacteria standard (ADEC, 2006a). A Total Maximum Daily Load (TMDL) for fecal coliform was developed and approved by the EPA in 1997, attributing summer spikes in fecal coliform exceedances to the presence and usage of the lake are by Canadian geese (EPA, 1997). Jewel Lake was removed from the Section 303(d) list after the TMDL's were developed and is currently listed as a Category 4a waters in Alaska's 2006 Integrated Water Quality Monitoring and Assessment Report, for non-attainment of the fecal coliform Bacteria standard due to urban runoff (ADEC, 2006a). Class 4a waters are designated as impaired, but not needing a TMDL because one has already been completed. The Alaska Water Quality Standards for fecal coliform are presented in Table 2.

3.1.1 Non-point Sources

During TMDL development, both non-point source and point source fecal coliform pollution was considered. The primary non-point source of fecal coliform was determined to be runoff from the Jewel

Table 2. Alaska water quality standards for fecal coliform bacteria (Source: ADEC, 2006b).

Water Use	Fecal Coliform Bacteria Standard
(A) Water Supply (i) drinking, culinary and food processing	In a 30-day period, the geometric mean may not exceed 20 FC/100 ml, and not more than 10% of the samples may exceed 40 FC/100ml. For groundwater, the FC concentration must be less than 1 FC/100 ml, using the fecal coliform Membrane Filter Technique, or less 3 FC/100 ml, using the fecal coliform most probable number (MPN) technique.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	The geometric mean of samples taken in a 30-day period may not exceed 200 FC/100ml, and not more than 10% of the samples may exceed 400 FC/ml. For products not normally cooked and for dairy sanitation of unpasteurized products, the criteria for drinking water supply, (1)(A)(i), apply.
(A) Water Supply (iii) aquaculture	For products normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 200 FC/100ml, and not more than 10% of the samples may exceed 400 FC/100ml. For products not normally cooked, the criteria for drinking water supply (1)(A)(i), apply.
(A) Water Supply (iv) industrial	Where worker contact is present, the geometric mean of samples taken in a 30-day period may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml.
(B) Water Recreation (i) contact recreation	In a 30-day period, the geometric mean of samples many not exceed 100 FC/100 ml, and not more than one sample, or more than 10% of the samples if there are more than 10 samples, may exceed 200 FC/100 ml.
(B) Water Recreation (ii) secondary recreation	In a 30-day period, the geometric mean of samples may not exceed 200 FC/100 ml, and not more than 10% of the total samples may exceed 400 FC/100ml.
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	Not applicable.

Lake Park and beach area. Large numbers of waterfowl (i.e., geese) have been observed in the area in the summer months of June and July.

Additionally, several residences on the western side of the lake were not connected to the city sewer system and the septic tanks were considered as a potential non-point source. However, after an assessment of the location and slope of the septic tanks relative to the lake, combined with the fact that fecal coliform counts in the lake were not as high as those typically associated with failing septic systems, the EPA determined the 3 homes were not a source of fecal coliform (EPA, 1997).

Runoff from other residential areas around the lake were also initially considered as potential non-point sources of fecal coliform due to runoff from cat, dog, moose and other wildlife excrement . If runoff were a significant source of fecal coliform to the lake, counts would peak around the time of spring break up, April and May. Although no data was available for April, data collected in May suggested that levels were well below the fecal coliform water supply standard (EPA, 1997). Therefore, runoff from residential property was not considered a significant source of fecal coliform for the lake.

However, migratory geese arrive in Anchorage in late May/early June and goslings hatch in June and July. During July the geese molt and brood and remain in their immediate area until August. This is the

time of year geese are observed on lawns and near the public swimming beach on the northeastern portion of the lake. Waterfowl counts and fecal coliform data collected from 1993-1997 indicate that fecal coliform counts are highest in July which is also when the greatest number of geese are observed on the lake (EPA, 1997). Geese near Jewel Lake congregate in the grassy area of the park and near the gravel/swimming beach, while few geese have been observed on residential lots bordering the lake (EPA, 1997). It is probable that runoff after rain events transports fecal matter into the lake from the park area. In addition, geese directly defecate into the lake.

3.1.2 Point Sources

A storm water outfall that drains runoff from a section of Dimond Boulevard into the south portion of Jewel Lake was considered a potential point source for fecal coliform during TMDL development (EPA, 1997). However, no data was available from the storm drain discharge. Instead, a site visit and assessment was made by EPA and ADEC staff. It was determined that the storm drain discharge was unlikely to contain significant levels of fecal coliform because only a short section of the paved road was being drained by the outfall in question. Additionally, the storm drain only discharges to the lake periodically.

4. Sampling Methods

The purpose of the work described in the remainder of this report was to monitor fecal coliform levels along with concurrent turbidity and secchi depth measurements and reassess the non-attainment status of Jewel Lake with respect to the fecal coliform standards, identify possible sources, and determine temporal and spatial fluctuations.

4.1 Sample Collection

Fecal coliform bacteria samples, turbidity measurements, and secchi depth were collected once a week from nine randomly selected locations in Jewel Lake. The lake was generally ice free from May through early October in any given year. A duplicate sample was collected for fecal coliform analysis each week.

All samples were collected in accordance with AWC's ADEC approved Quality Assurance Project Plan. At each site, water samples for fecal coliform were collected first, followed by turbidity measurements and then secchi depth. This order was selected to prevent contamination by collecting the bacteria sample first. Turbidity was measured before secchi depth because lowering the secchi disk to the bottom stirred up sediment and could have artificially increased the turbidity readings.

A 100 ml water sample for fecal coliform analysis was collected at each site using the sterile sample bottles provided by SGS Environmental Services, Inc. Water samples were collected where water is > 2 ft deep to avoid sampling in the "swash zone" (the area of low wave/nearshore water) (Nevers and Whitman, 2001). When the sample site was located by GPS, the sample container was carefully opened with effort made not to touch the interior of the container. The container was then swept down through the water in a U-shaped motion to elbow depth and then turned upright to fill. The container was then be immediately closed and placed in a cooler on ice. After completion of sampling for the day, samples were delivered to SGS and analyzed for fecal coliform under Standard Method 9222D. The 6 hour hold time was observed.

Turbidity samples were collected in the instrument container designed for the LaMotte Model 2020e Portable Turbidity Meter . The hand-held dip sampling procedure for non-isokinetic sampling of surface waters method described in the USGS National Field Manual for the Collection of Water-Quality Data (USGS, 2006) was used.

A 20 cm secchi disk with 20 meters of calibrated line was used, in addition to turbidity measurements, to assess water clarity in Jewel Lake. The secchi disk was lowered into the water, on the shaded side of the boat, at each sample site. The depth at which the disk is no longer visible was recorded. The secchi disk was pulled up and the depth at which the disk becomes visible again was recorded. The two depths were then averaged. To maintain consistency in reading the secchi disk, every effort was made to have the same staff member determine secchi depth for all samples.

Additionally, field notes were recorded about weather, presence of wildlife, and human and pet activities on the sample date. All data was recorded in a bound field notebook and turned into ADEC at the project's completion.

4.2 Sampling Locations

Nine samples and 1 duplicate sample were collected, one day per week. Weekly samples were collected between July 16 - October 15, 2008 and again May 15 - June 29, 2009 for a combined total of 22 weeks and 220 samples. Sample days were varied throughout the week, although sample collection times were in the morning and early afternoon to ensure samples are delivered to the lab and processed within business hours. Sample sites were randomly selected using ArcGIS and supplemental ArcGIS tools created by Hawthorn Beyer (www.spatialecology.com/htools/). The supplemental ArcGIS tools are detailed on the Geographic Information Network of Alaska (http://gina.uas.alaska.edu/). Sample sites that were less than 2 ft deep could not be effectively sampled without disturbing the bottom sediment. In the absence of bathymetric data for the lake at the 2 ft depth, if a randomly selected site was too shallow, it was skipped and the next randomly selected site was sampled. To avoid points on the shore, a buffer of 20 feet was established around the inside perimeter of the lake. In selecting the random points, a list of 250 points, with a minimum distance of 50 feet between points, was generated on July 7, 2008. Points were generated so they did not fall within the 20 ft shoreline buffer. 250 points were generated to provide back-up points should the any of the 230 sample locations be in water that is too shallow to sample (<2 ft) or otherwise inaccessible. The coordinates for each sample points can be found in the Microsoft Excel database that was turned into ADEC at the project's completion. The map below shows the overall distribution of the 250 points.

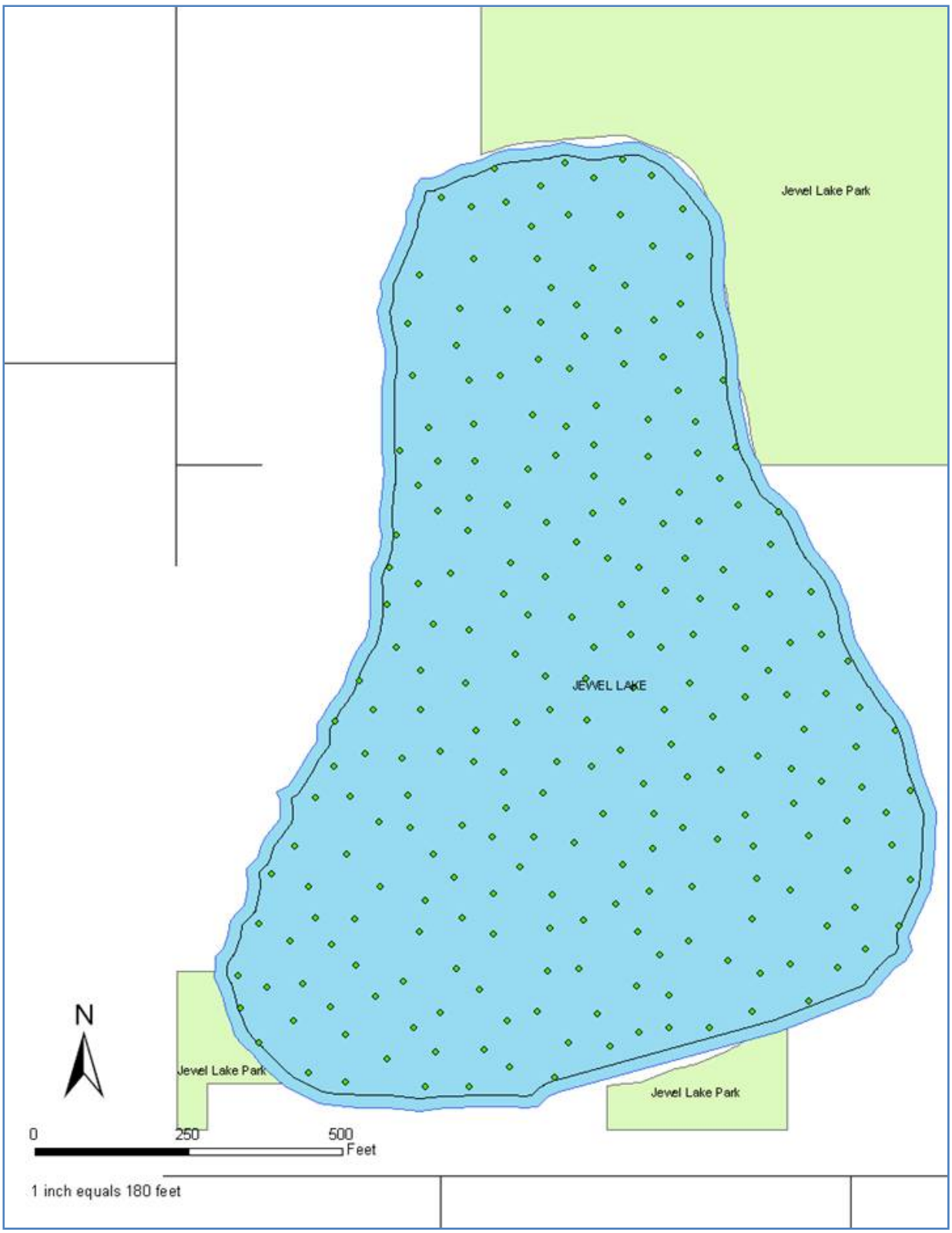

Figure 5. Distribution of 250 randomly generated sample points within Jewel Lake with the 20 foot shoreline buffer shown.

5. Jewel Lake Data Analysis

5.1 Descriptive Statistics

5.1.1 Turbidity

Turbidity in Jewel Lake during the sampling period ranged from 0.00- 3.16 Nephelometric Turbidity Units (NTU's), with a median of 0.29 and an average of 0.49 NTU's. Turbidity was highest in May 2009 (average=1.09 NTU; maximum=3.16 NTU) and was lowest in October 2008 (average=0.18 NTU; maximum=0.40 NTU (Figure 6). Monthly descriptive statistics are included for turbidity in Jewel Lake in Table 3.

Turbidity for the entire period of record is shown spatially in Figure 7. The highest values (i.e., red dots) occurred in the southern portion of the lake. Depths are also greater in the southern portion of the lake. Monthly turbidity values were also mapped in Figures 8-13.

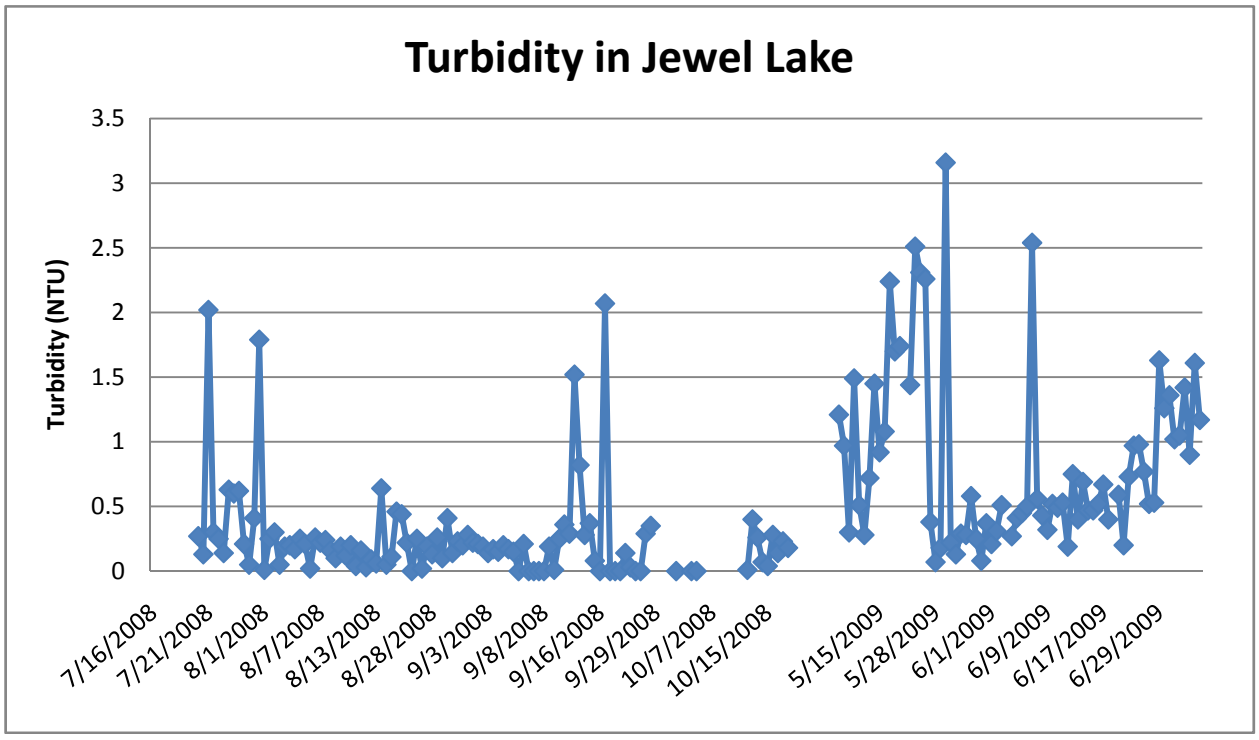

Figure 6. Timeseries of turbidity in Jewel Lake during the study period.

Table 3. Summary of Jewel Lake turbidity data by month.

Month	No. of sampling events	No. of sites	Turbidity (NTU)			
			Min	Median	Mean	Max
July 2008	2	9	0.13	0.30	0.55	2.02
August 2008	5	45	0.00	0.19	0.22	1.79
September 2008	5	39	0.00	0.15	0.23	2.07
October 2008	2	9	0.01	0.18	0.18	0.40
May 2009	3	26	0.07	0.95	1.09	3.16
June 2009	5	43	0.08	0.52	0.70	2.54

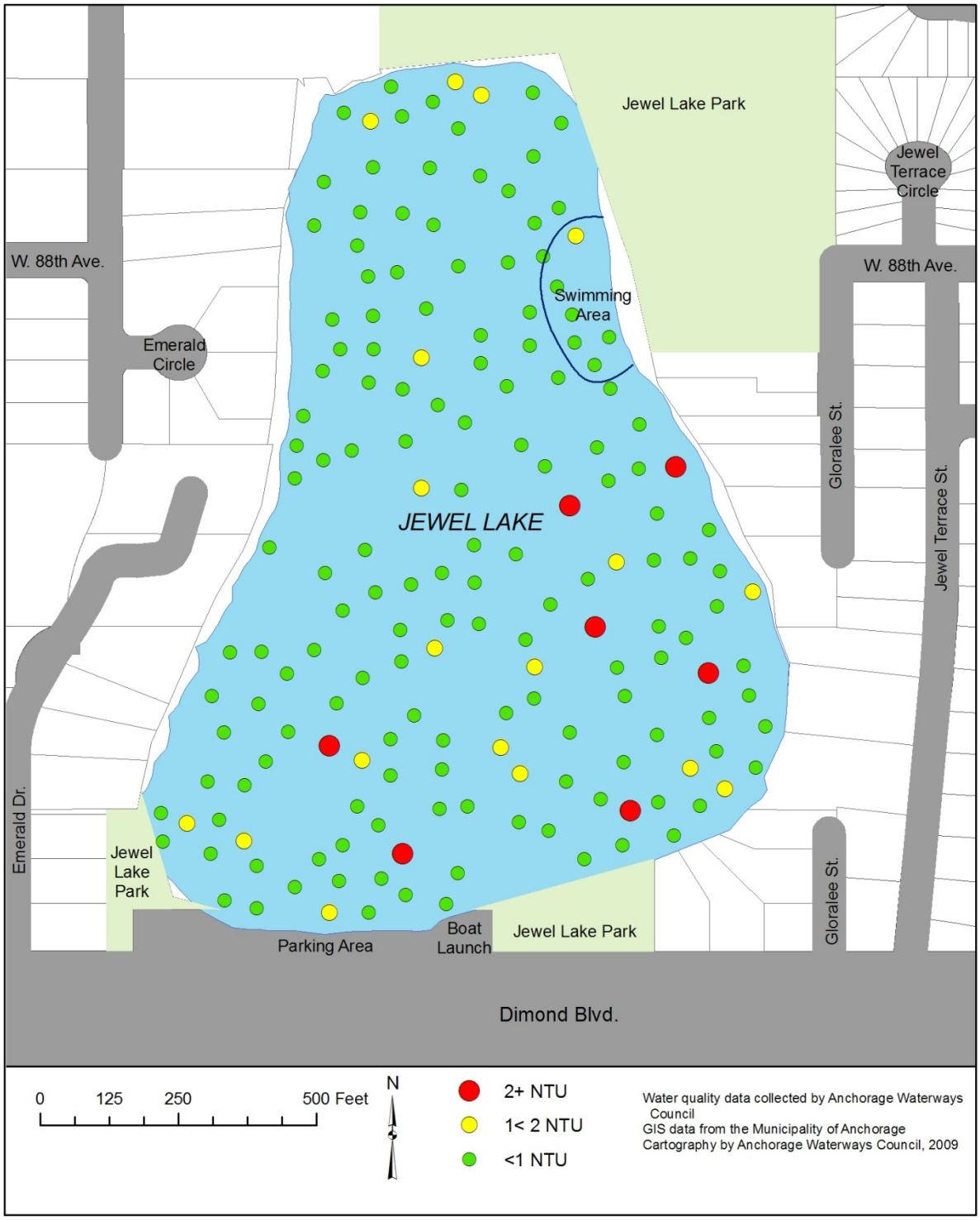

Figure 7. All turbidity data collected in Jewel Lake for the period of record (July 2008-June 2009).

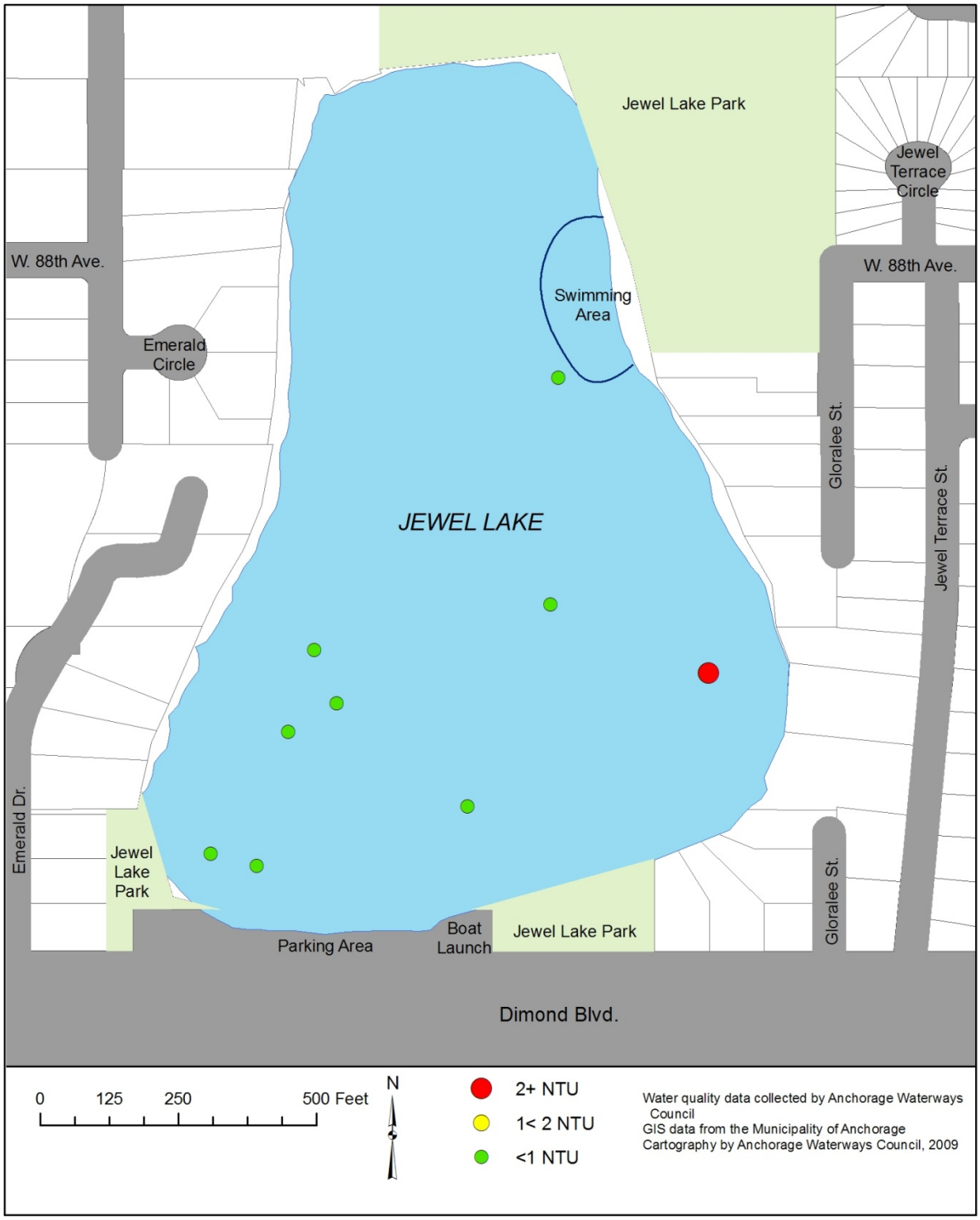

Figure 8. Turbidity data collected in July 2008 in Jewel Lake.

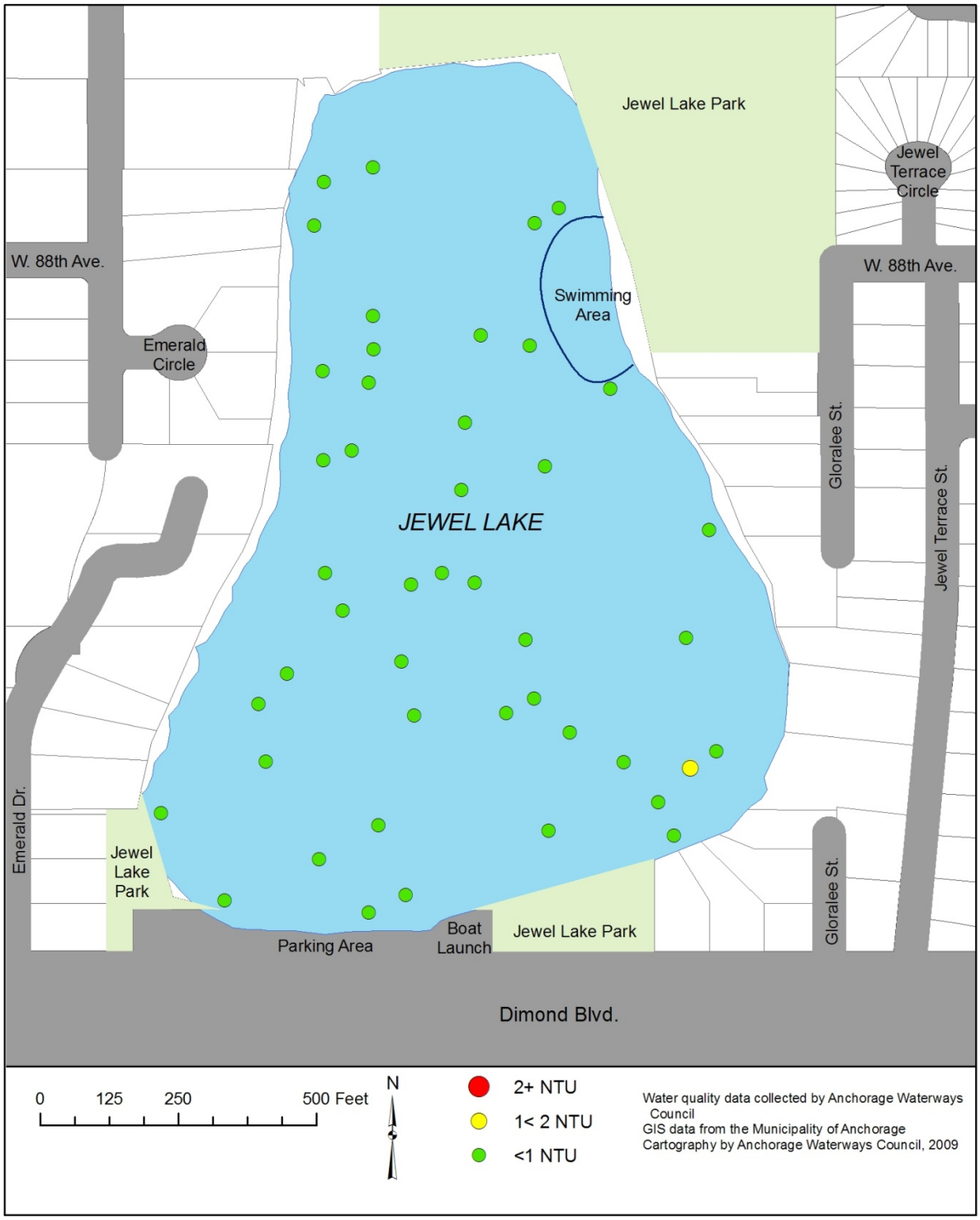

Figure 9. Turbidity data collected in August 2008 in Jewel Lake.

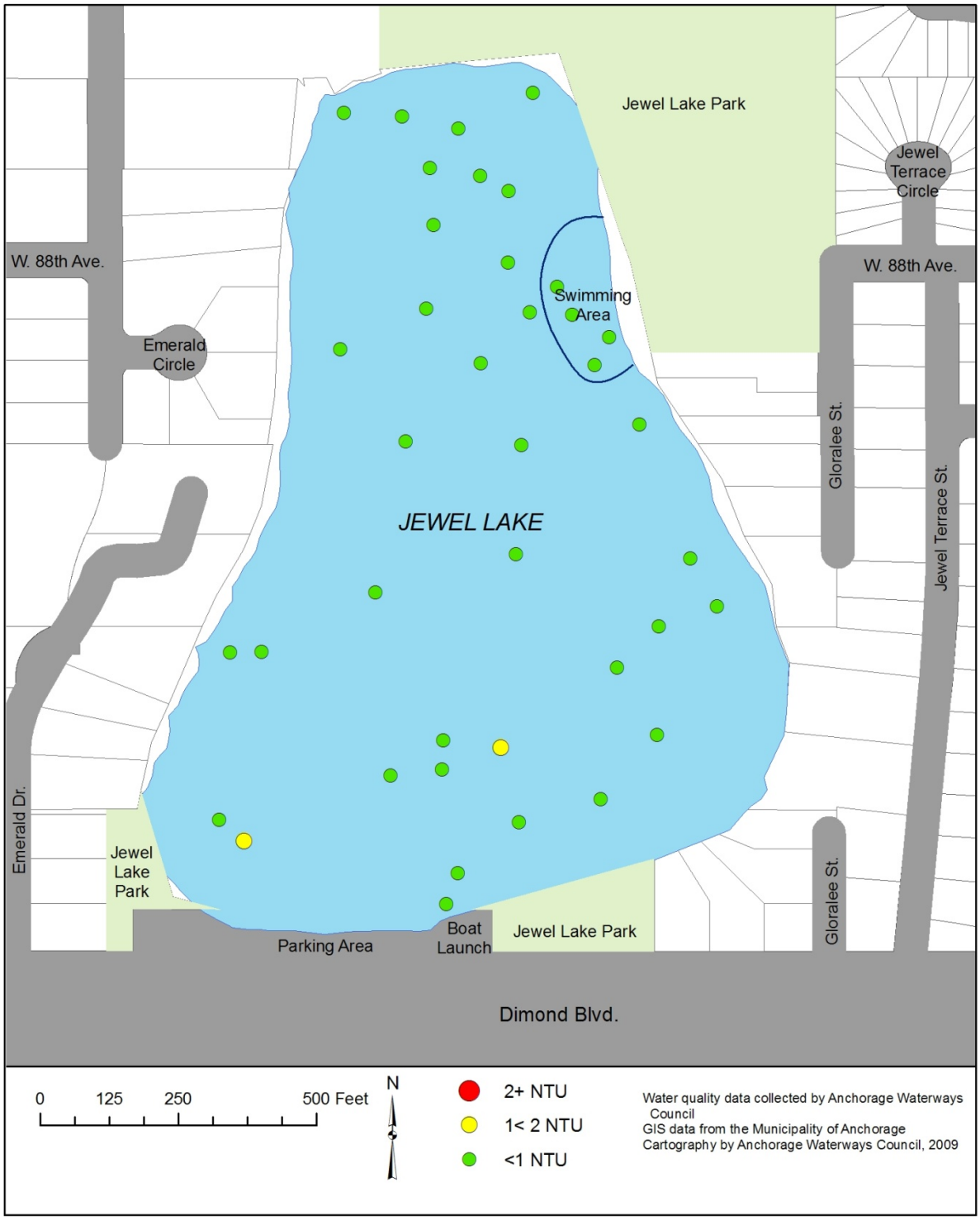

Figure 10. Turbidity data collected in September 2008 in Jewel Lake.

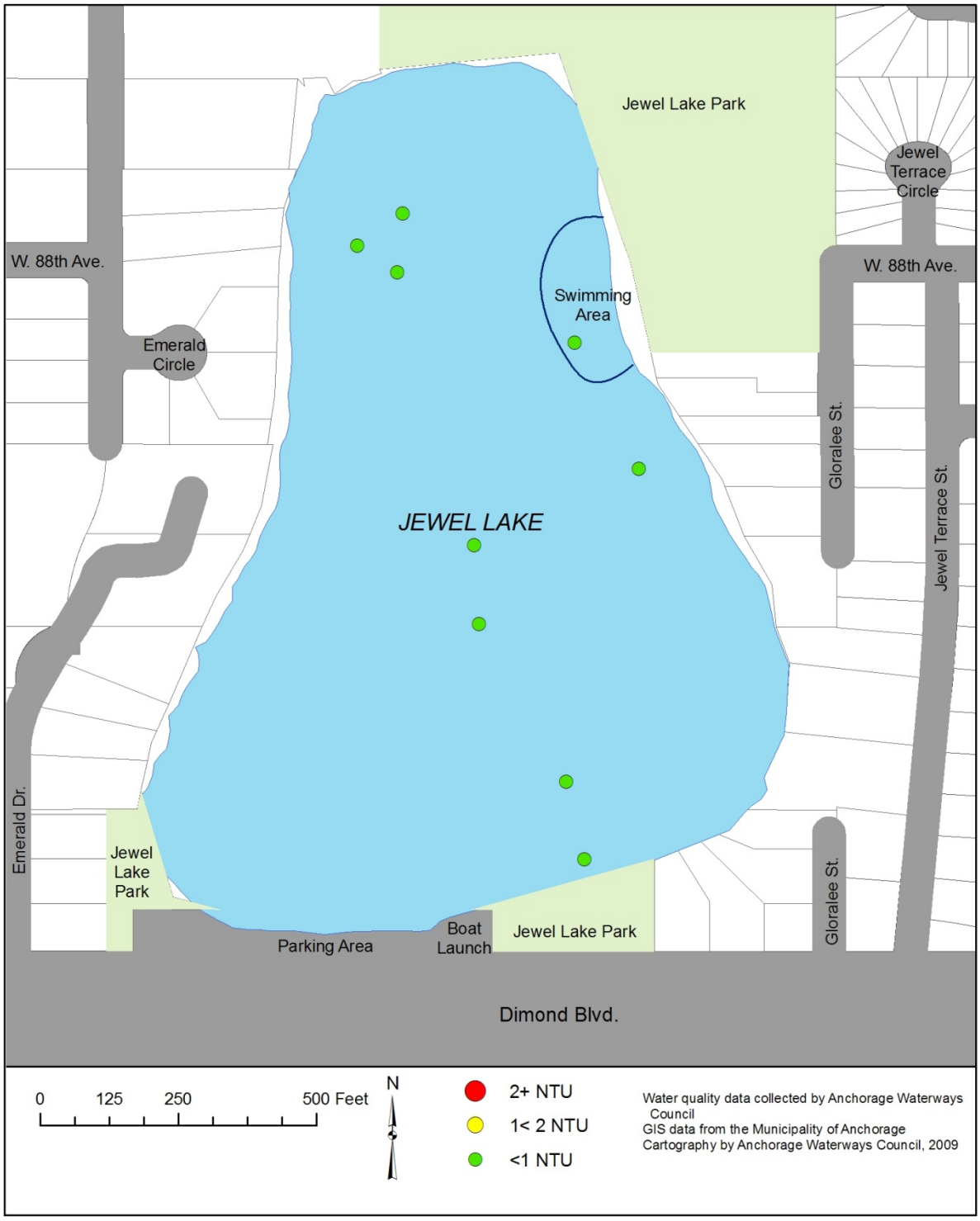

Figure 11. Turbidity data collected in October 2008 in Jewel Lake.

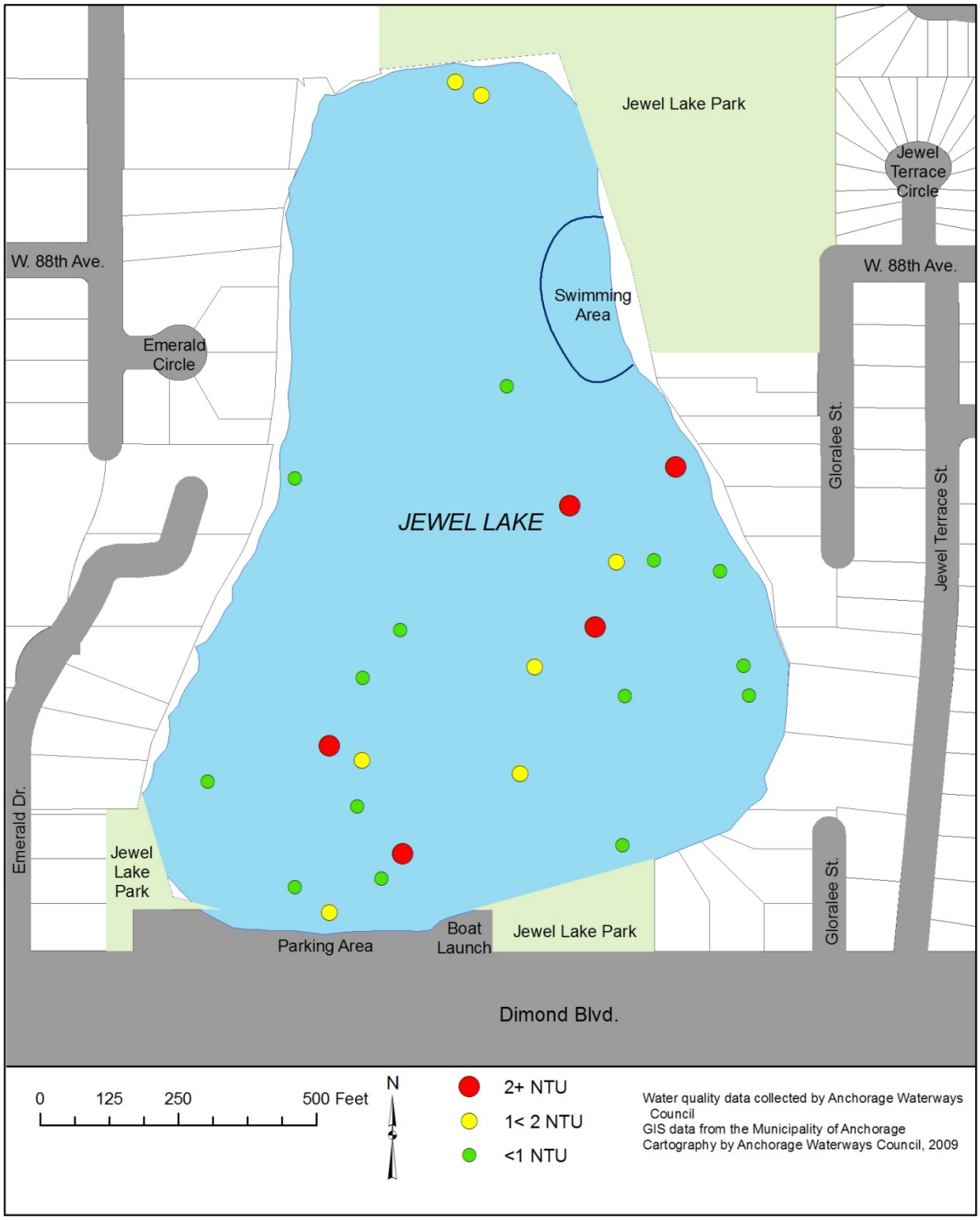

Figure 12. Turbidity data collected in May 2009 in Jewel Lake.

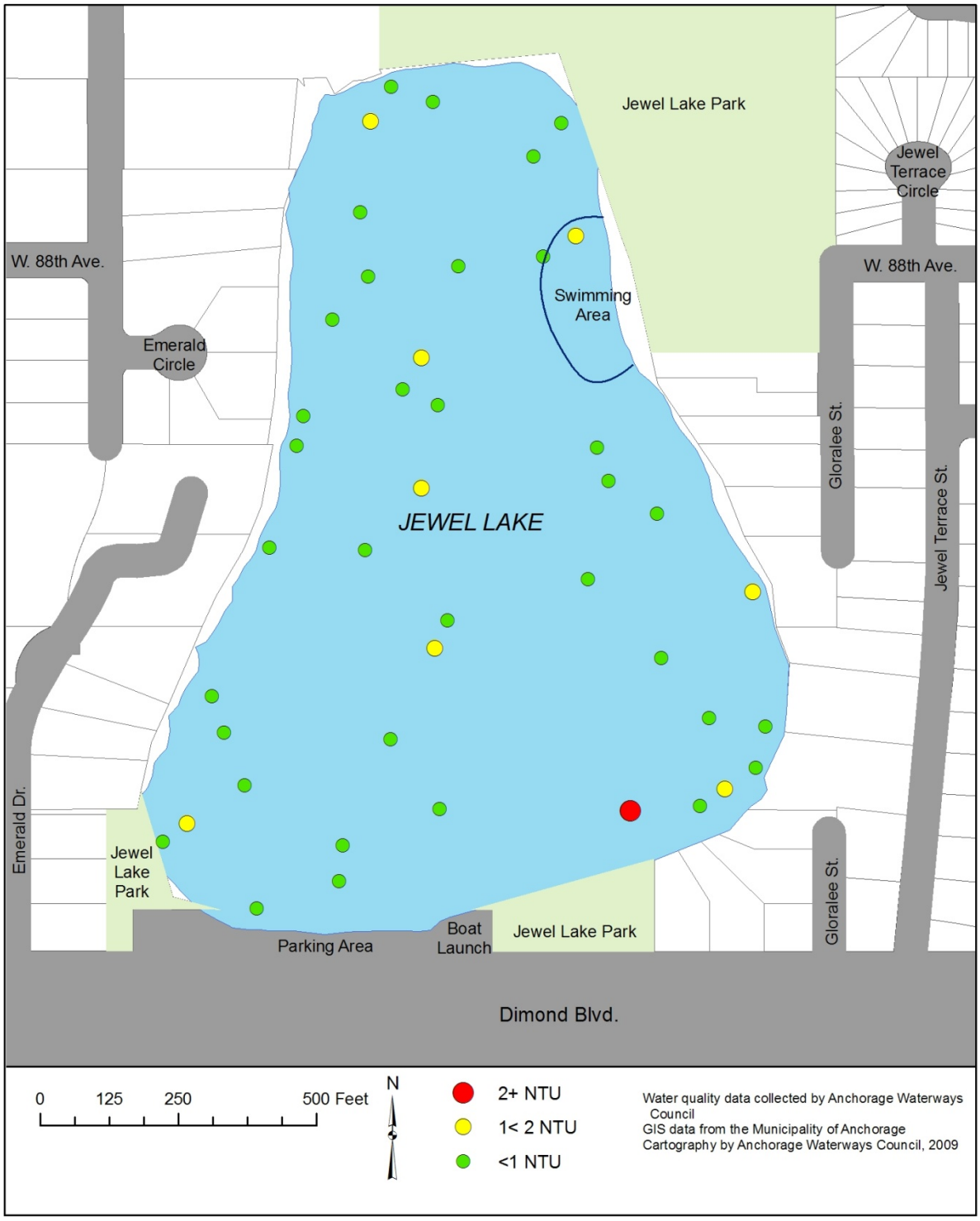

Figure 13. Turbidity data collected in June 2009 in Jewel Lake.

5.1.2 Secchi Disk Depth

Secchi depth in Jewel Lake for the sampling period ranged from 0.5-5.0 meters (m), with a median of 2.5 and a mean of 2.5 m. Secchi depth (i.e., water quality) was highest in September 2008 and lowest in May and June 2009. The low range values are also an indication of the overall shallow depths found in Jewel Lake. Monthly descriptive statistics of secchi depth are included for Jewel Lake in Table 4.

Secchi depth results for the entire period of record are shown spatially in Figure 14. The greatest depths (i.e., black dots) generally occurred in the southern portion of the lake. While secchi depth is a measure of water clarity, it is also a function of depth, as lake depths are greater in the southern portion of the lake. In the northern, shallower portion of the lake, the secchi disk would commonly be visible at the bottom of the lake. Monthly secchi depth results were also mapped in Figures 15-21.

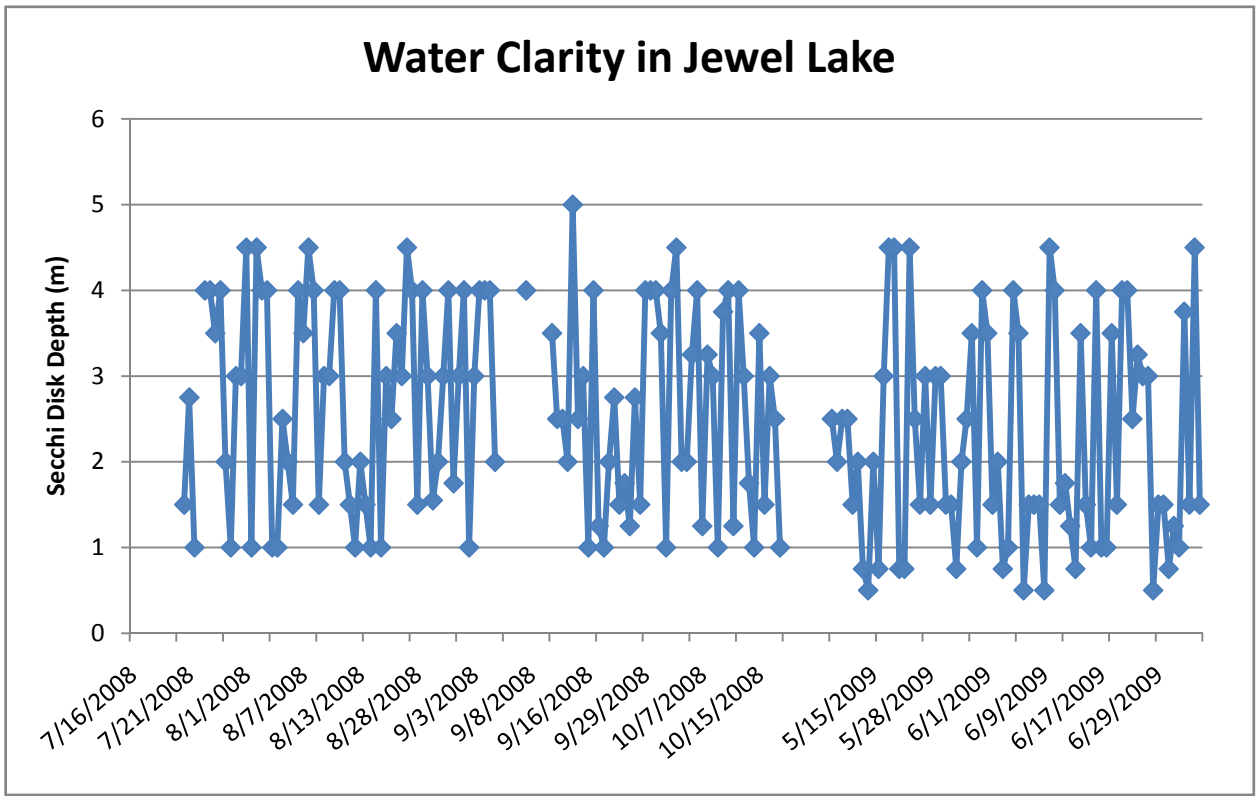

Figure 14. Water clarity (secchi depth) in Jewel Lake during the study period.

Table 4. Summary of Jewel Lake secchi depth, by month.

Month	No. of sampling events	No. of samples	Secchi Depth (m)			
			Min	Median	Mean	Max
July 2008	2	7	1.0	3.5	3.0	4.0
August 2008	5	45	1.0	3.0	2.7	4.5
September 2008	5	36	1.0	2.8	2.8	5.0
October 2008	2	18	1.0	3.0	2.56	4.0
May 2009	3	27	0.5	2.0	2.14	4.5
June 2009	5	45	0.5	1.50	2.2	4.5

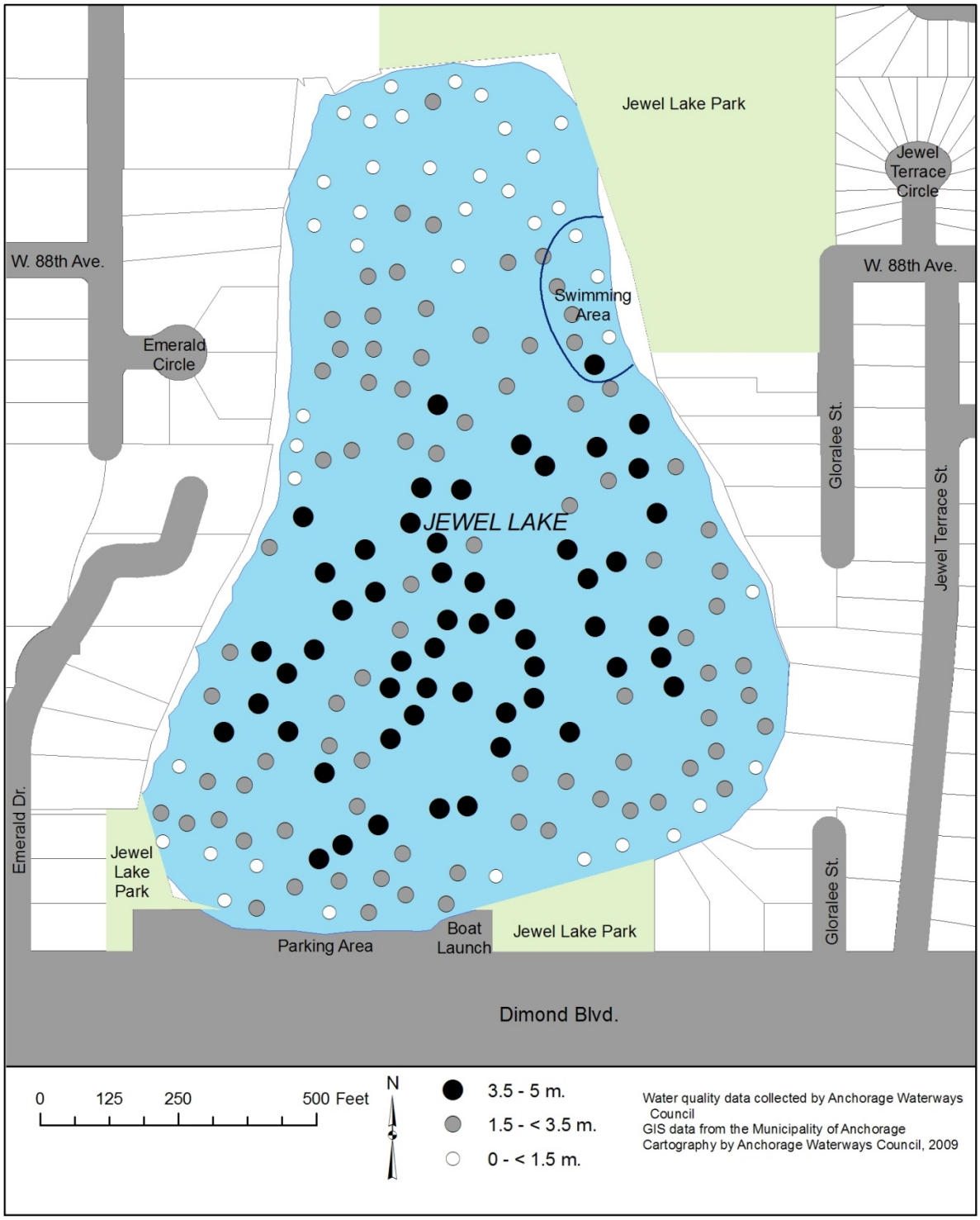

Figure 15. All secchi depth data collected in Jewel Lake for the period of record (July 2008-June 2009).

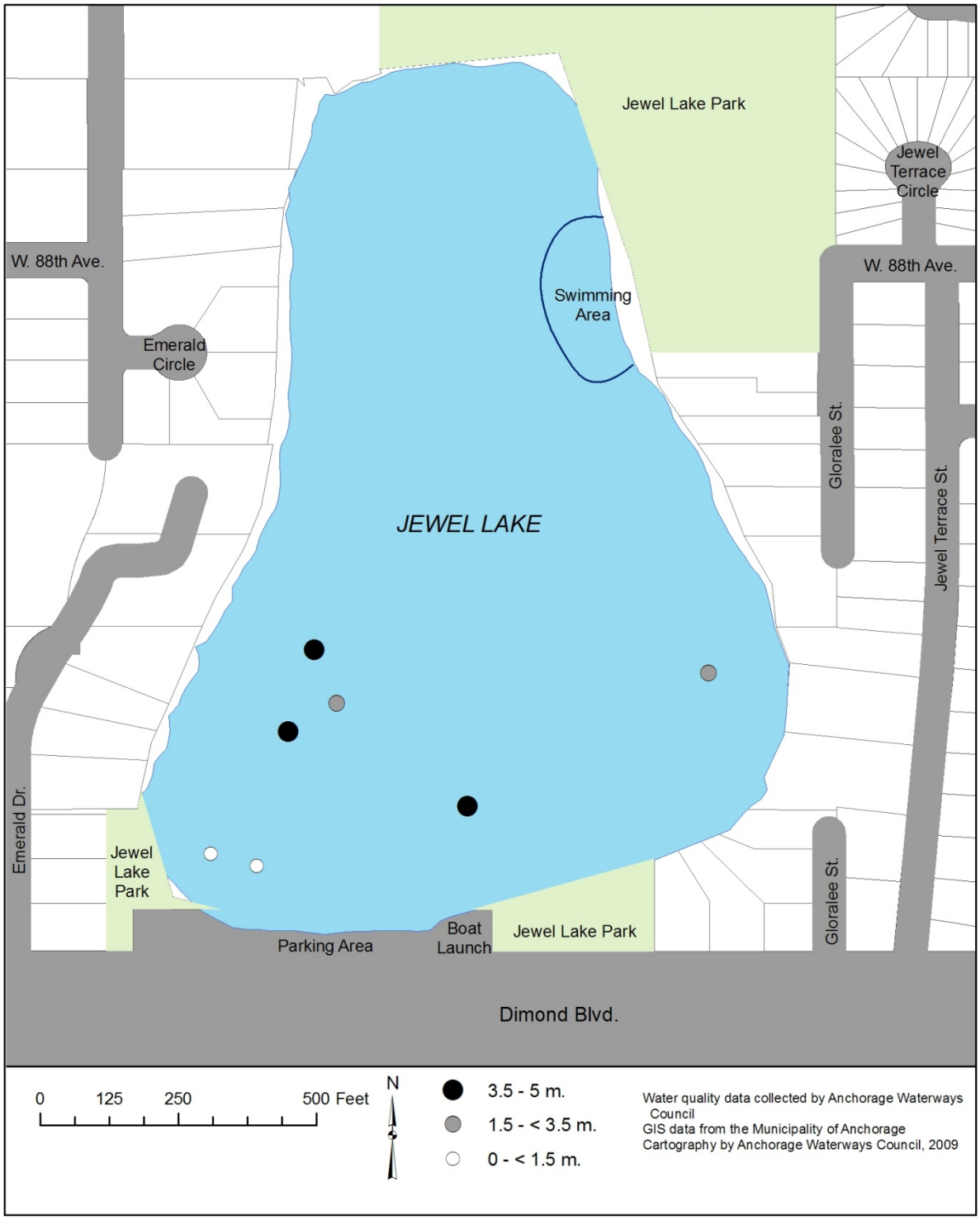

Figure 16. Secchi depth data collected in July 2008 in Jewel Lake.

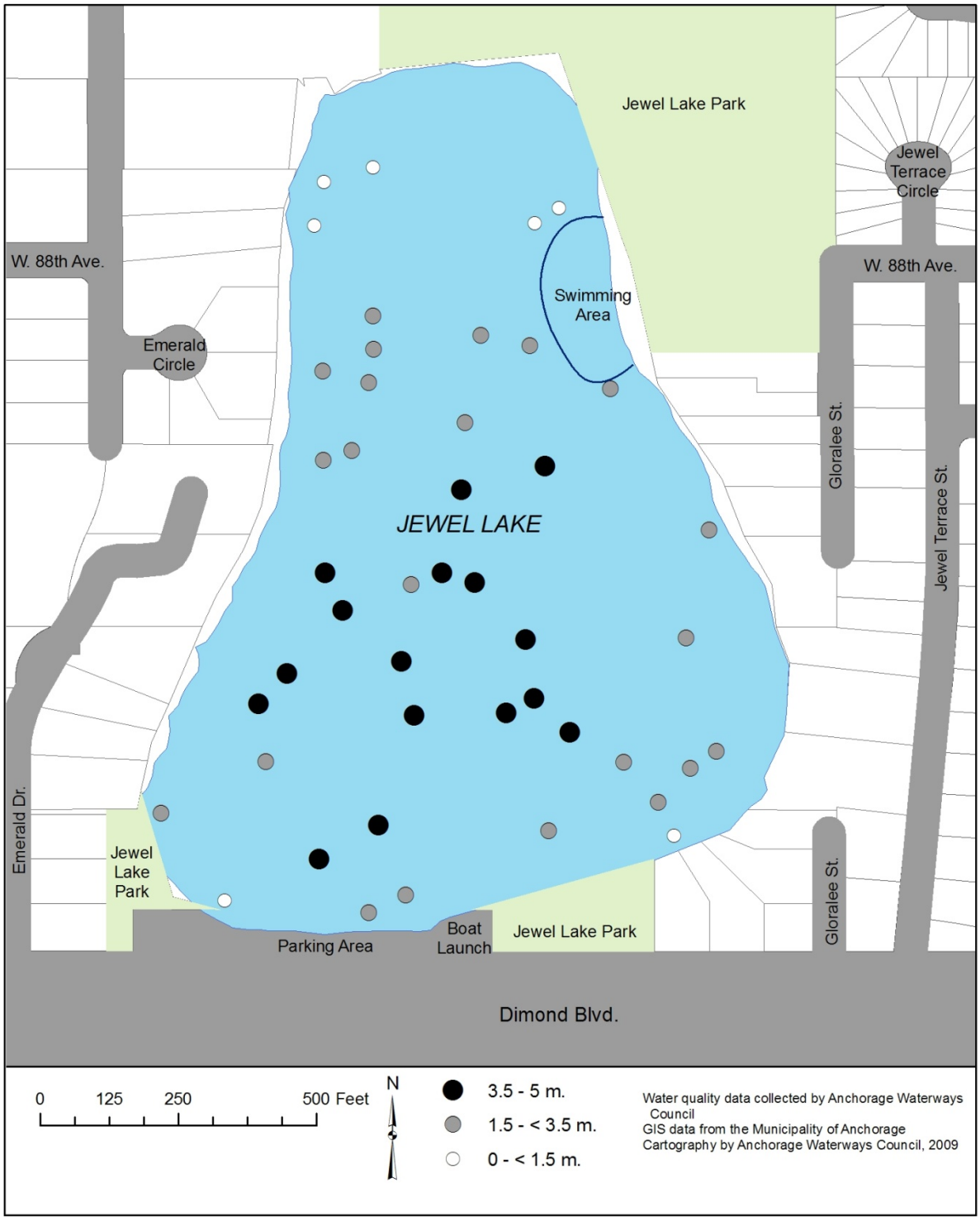

Figure 17. Secchi depth data collected in August 2008 in Jewel Lake.

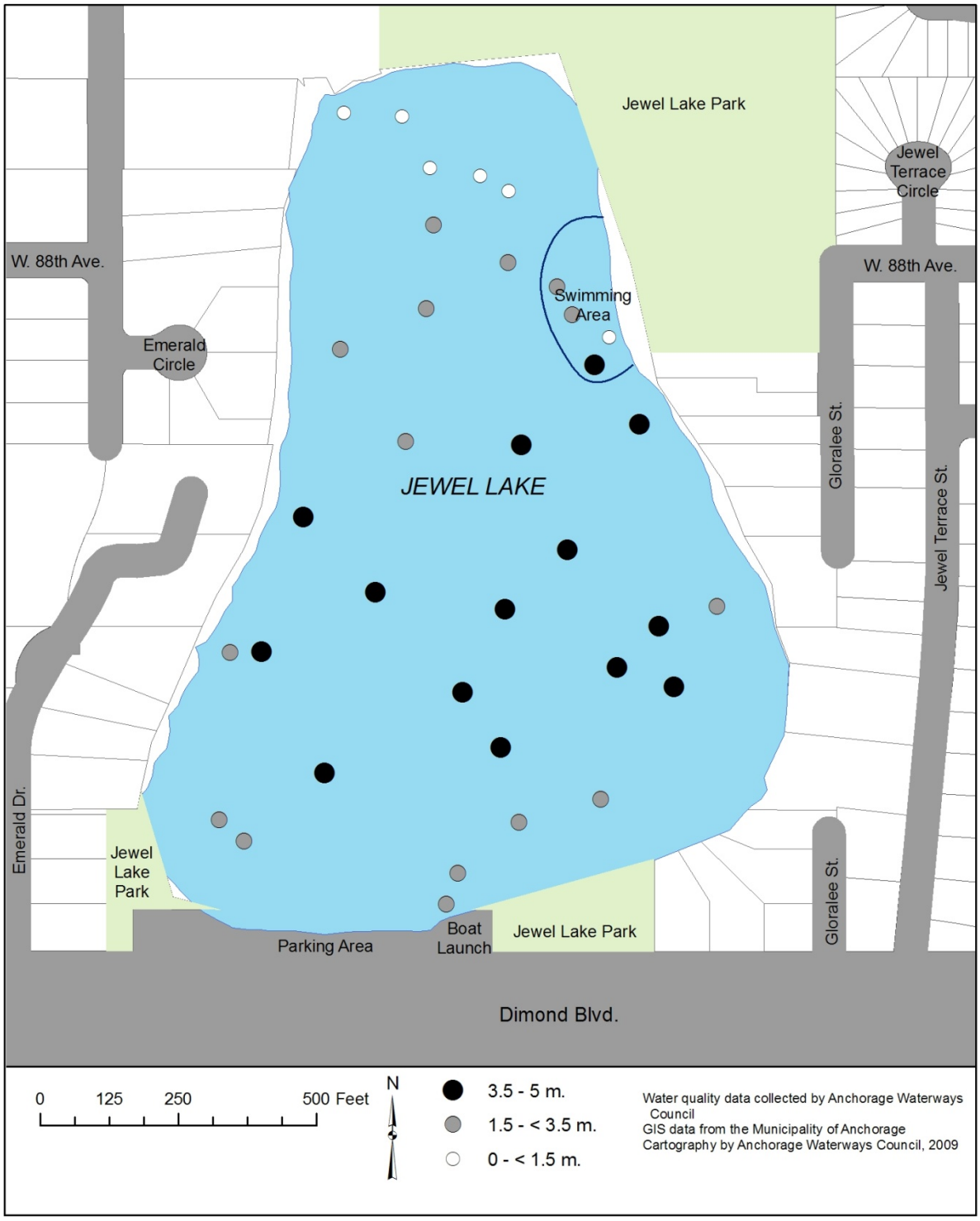

Figure 18. Secchi depth data collected in September 2008 in Jewel Lake.

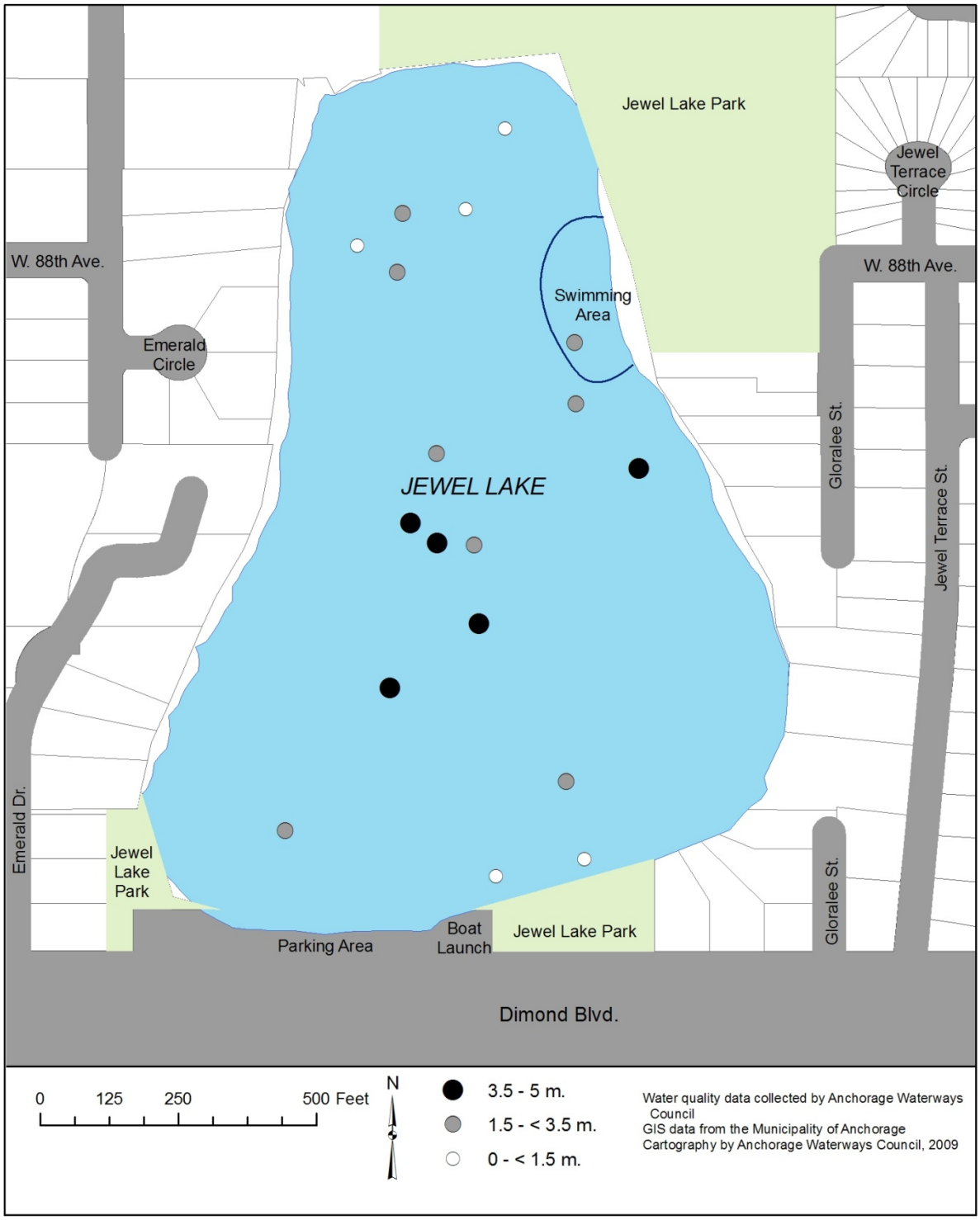

Figure 19. Secchi depth data collected in October 2008 in Jewel Lake.

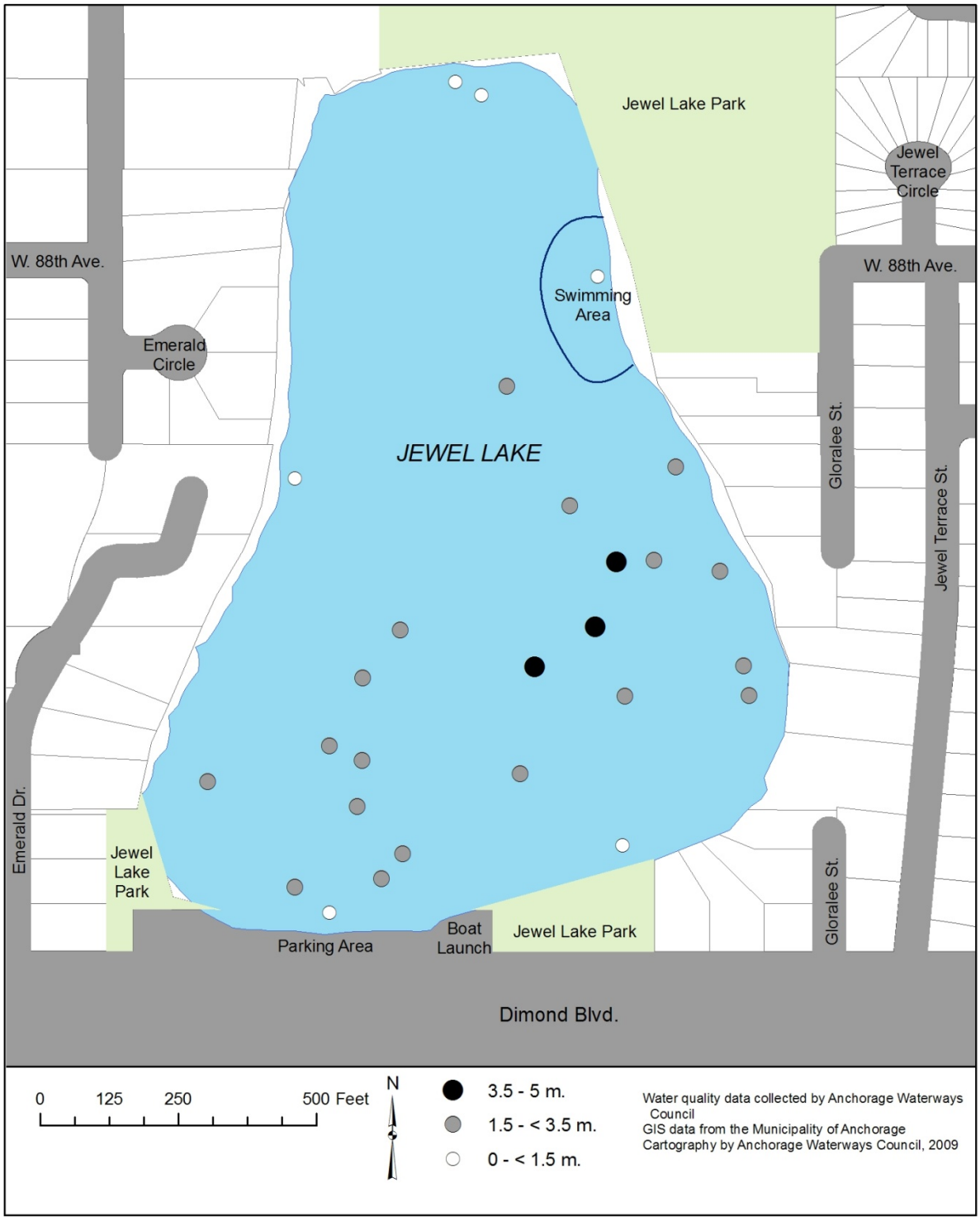

Figure 20. Secchi depth data collected in May 2009 in Jewel Lake.

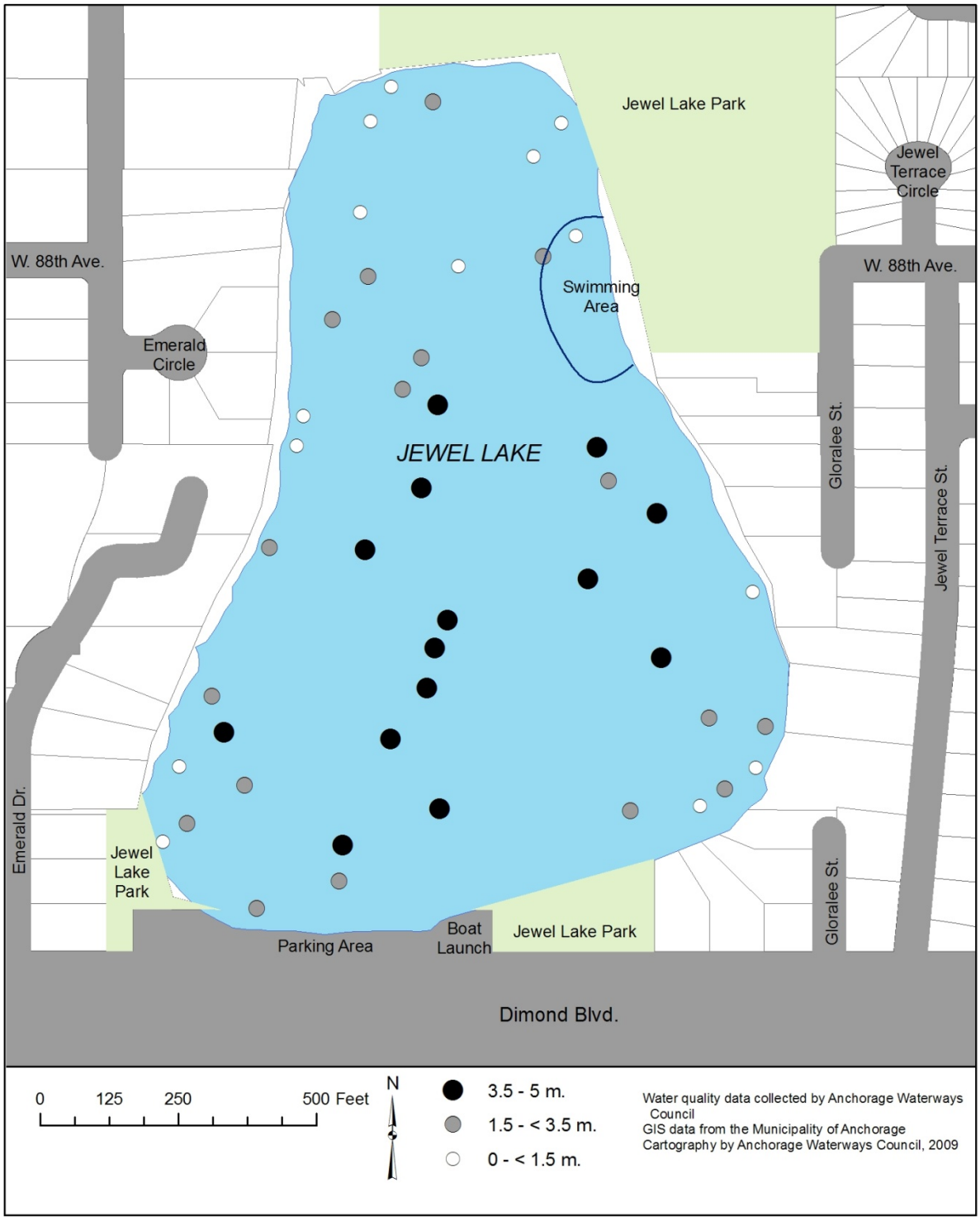

Figure 21. Secchi depth data collected in June 2009 in Jewel Lake.

5.1.3 Fecal Coliform Bacteria

Fecal coliform concentrations in Jewel Lake for the sampling period ranged from 0-27 Fecal Colonies/100ml, with a median concentration of 0 and a mean of 1.44/100ml. Fecal coliform concentrations were highest in September 2008, and lowest in July 2008 (Figure 22). Monthly descriptive statistics are included for Jewel Lake in Table 5.

Fecal coliform concentrations showed a relatively homogenous spatial pattern throughout the lake, with the highest value of 27 Fecal Colonies/100ml occurring one time in the southeast corner (Figure 23). The data is also mapped by month in Figures 24-29.

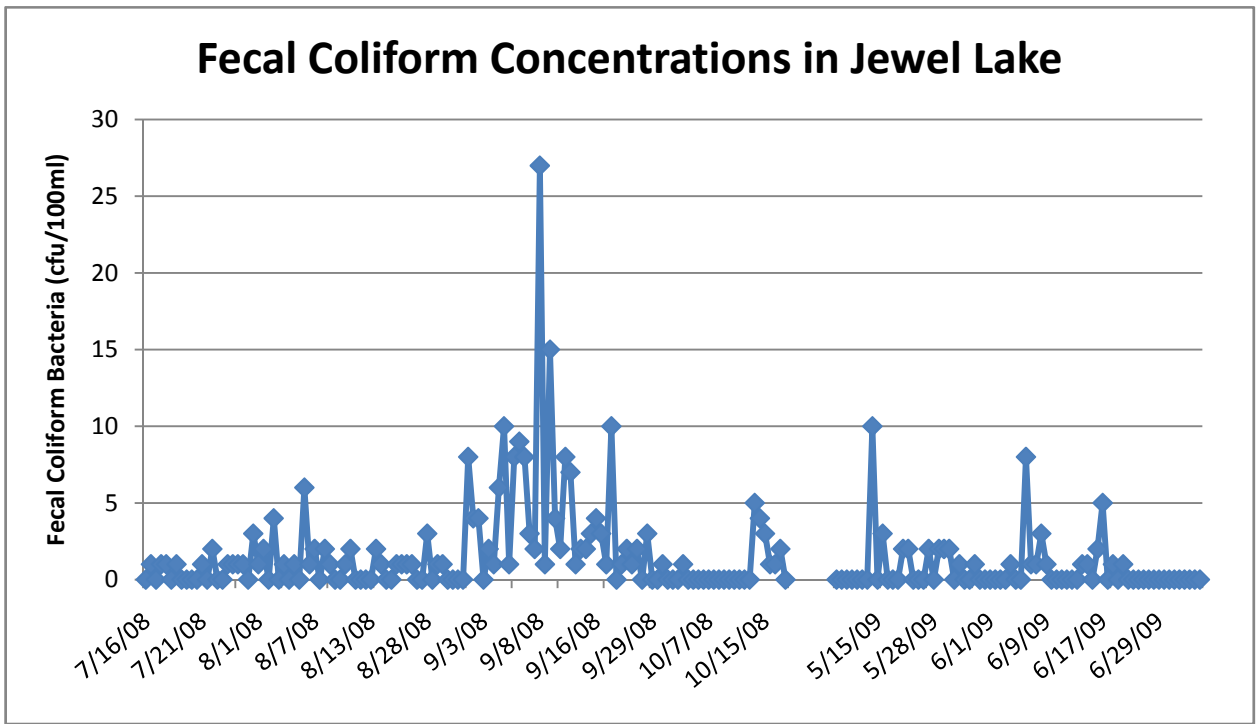

Figure 22. Fecal coliform concentrations in Jewel Lake during the study period.

Table 5. Summary of Jewel Lake fecal coliform data by month.

Month	No. of samples	Fecal Coliform (FC/100ml)			
		Min	Median	Mean	Max
July 2008	18	0	0	0.5	2
August 2008	45	0	1	0.91	6
September 2008	45	0	2	3.71	27
October 2008	18	0	0	0.89	5
May 2009	27	0	0	0.96	10
June 2009	45	0	0	0.6	8

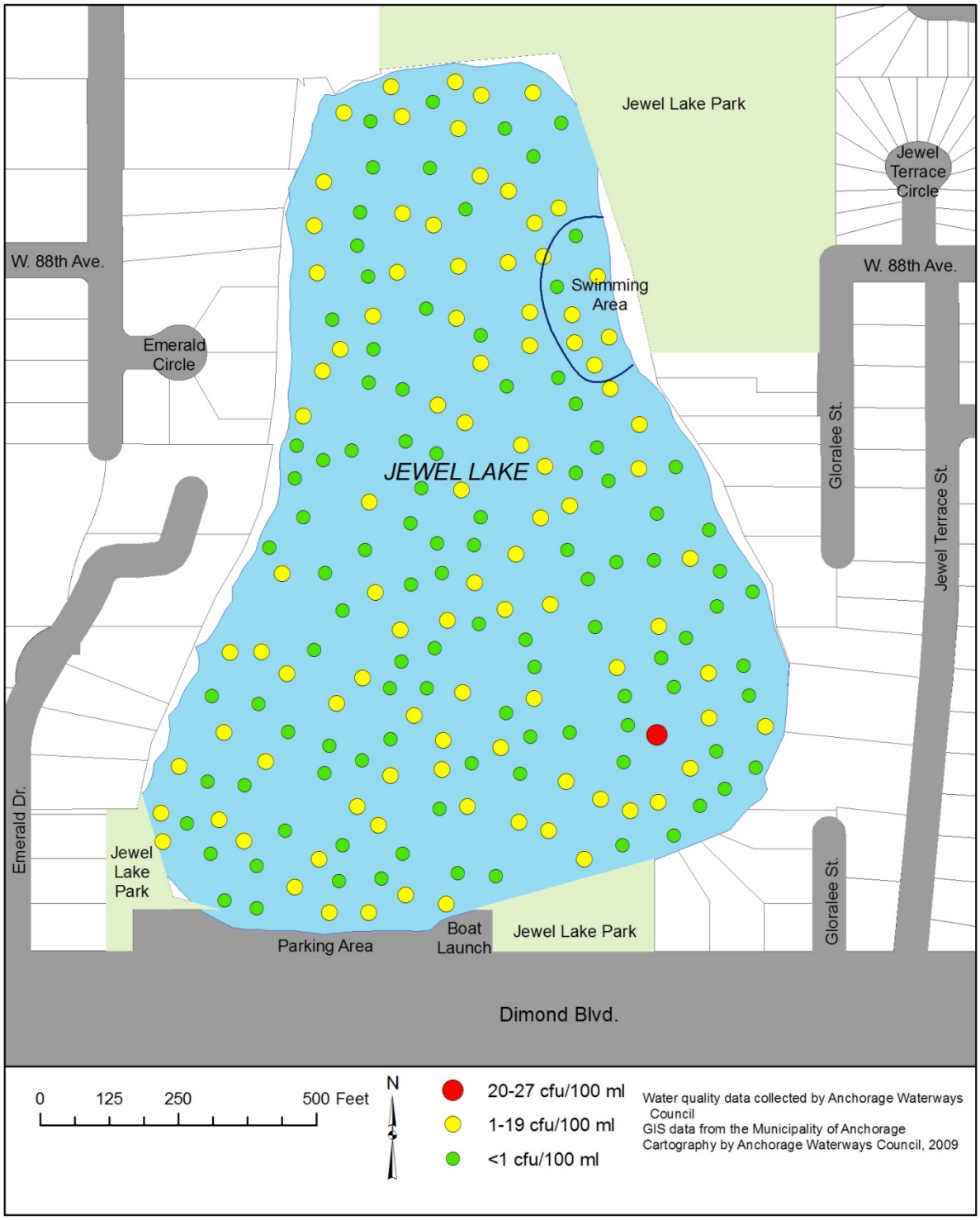

Figure 23. All fecal coliform bacteria data collected in Jewel Lake for the period of record (July 2008-June 2009).

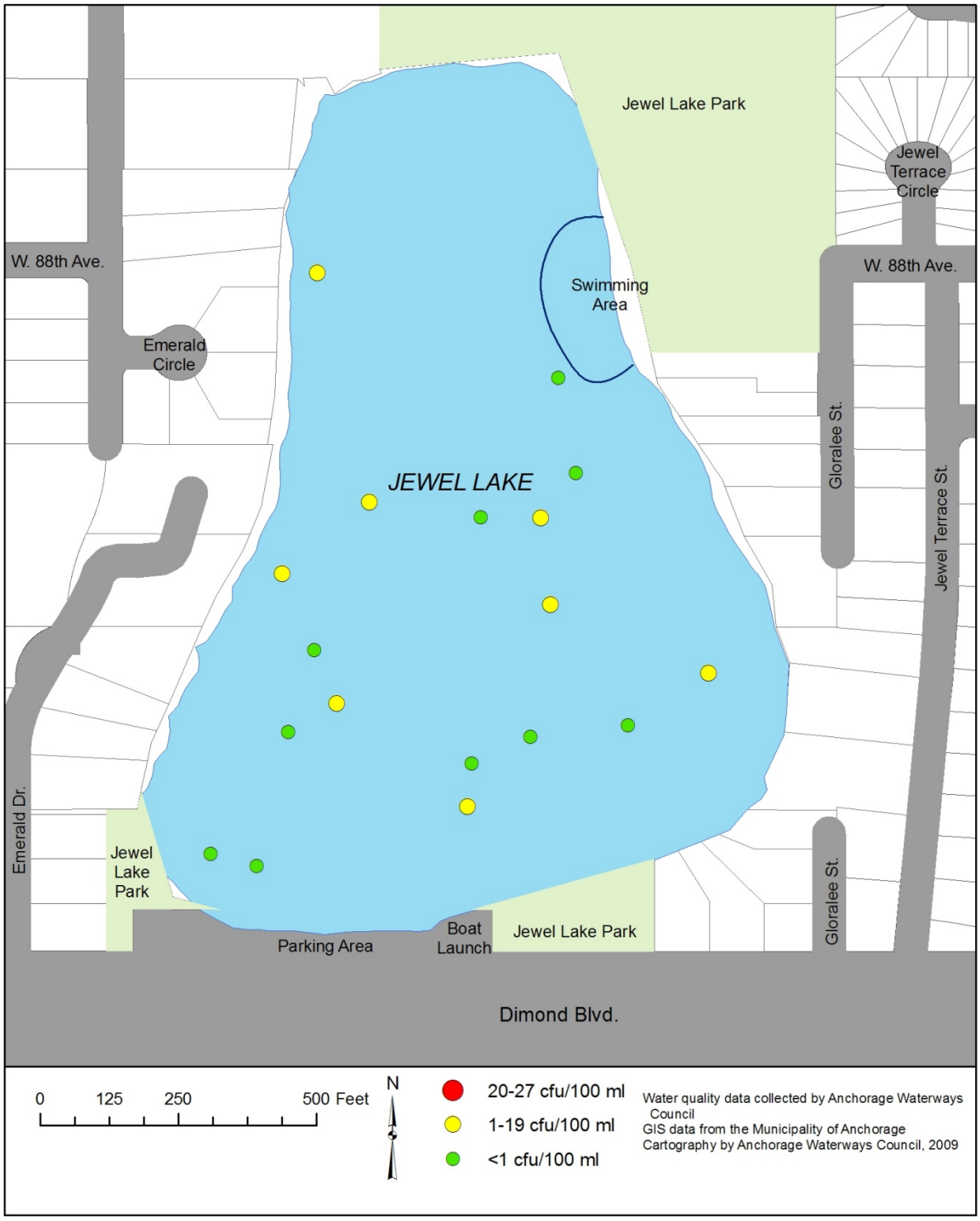

Figure 24. Fecal coliform bacteria data collected in July 2008 in Jewel Lake.

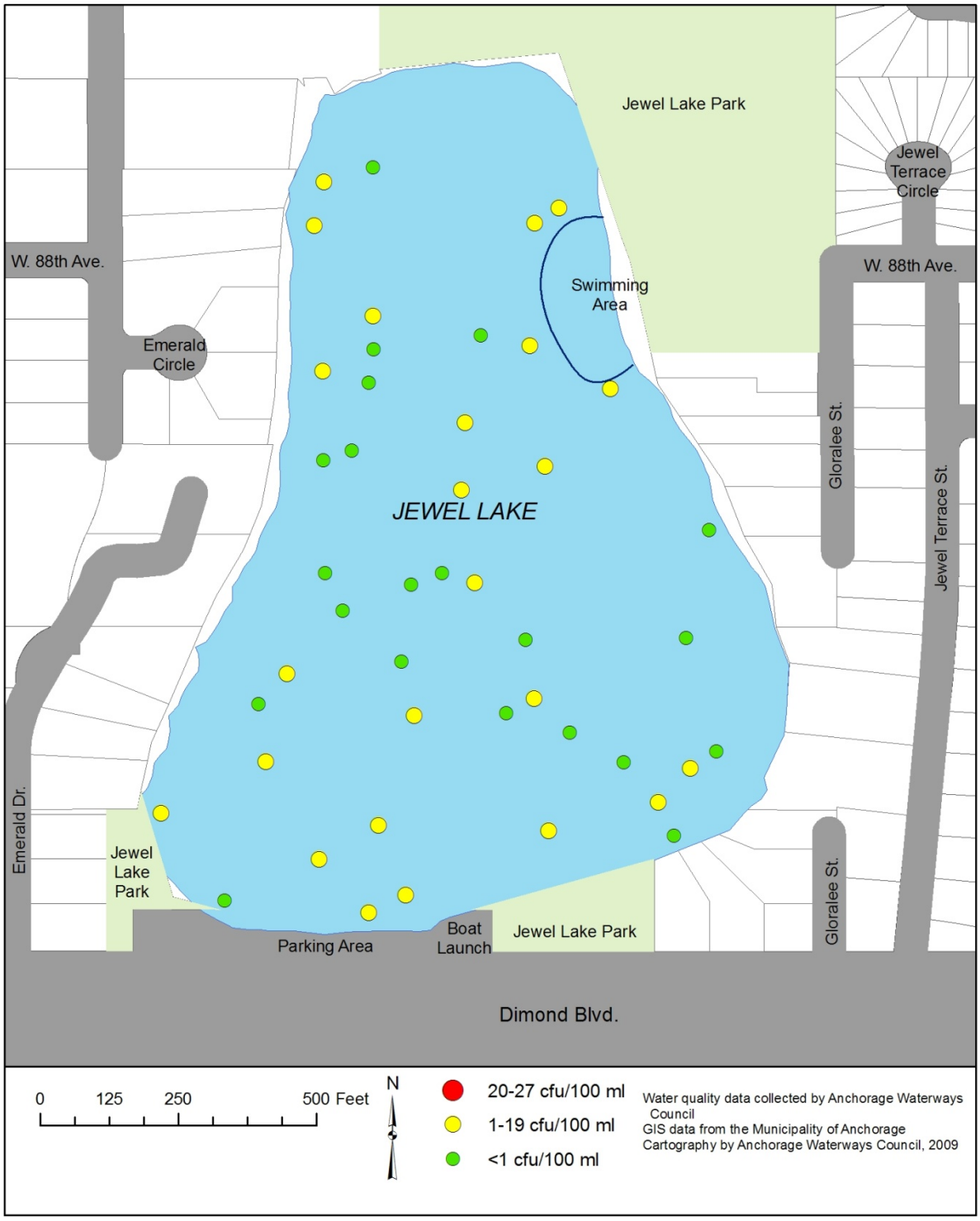

Figure 25. Fecal coliform bacteria data collected in August 2008 in Jewel Lake.

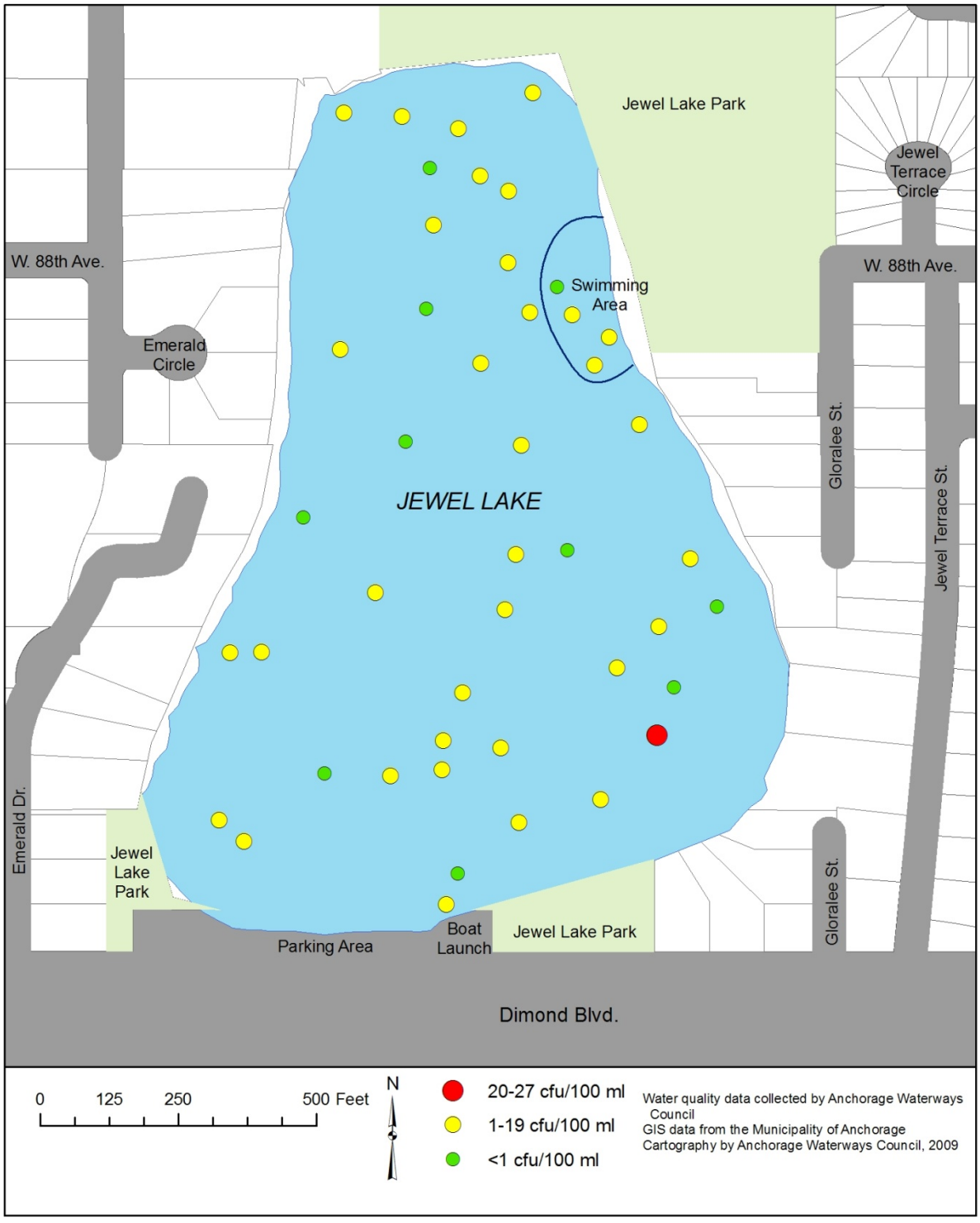

Figure 26. Fecal coliform bacteria data collected in September 2008 in Jewel Lake.

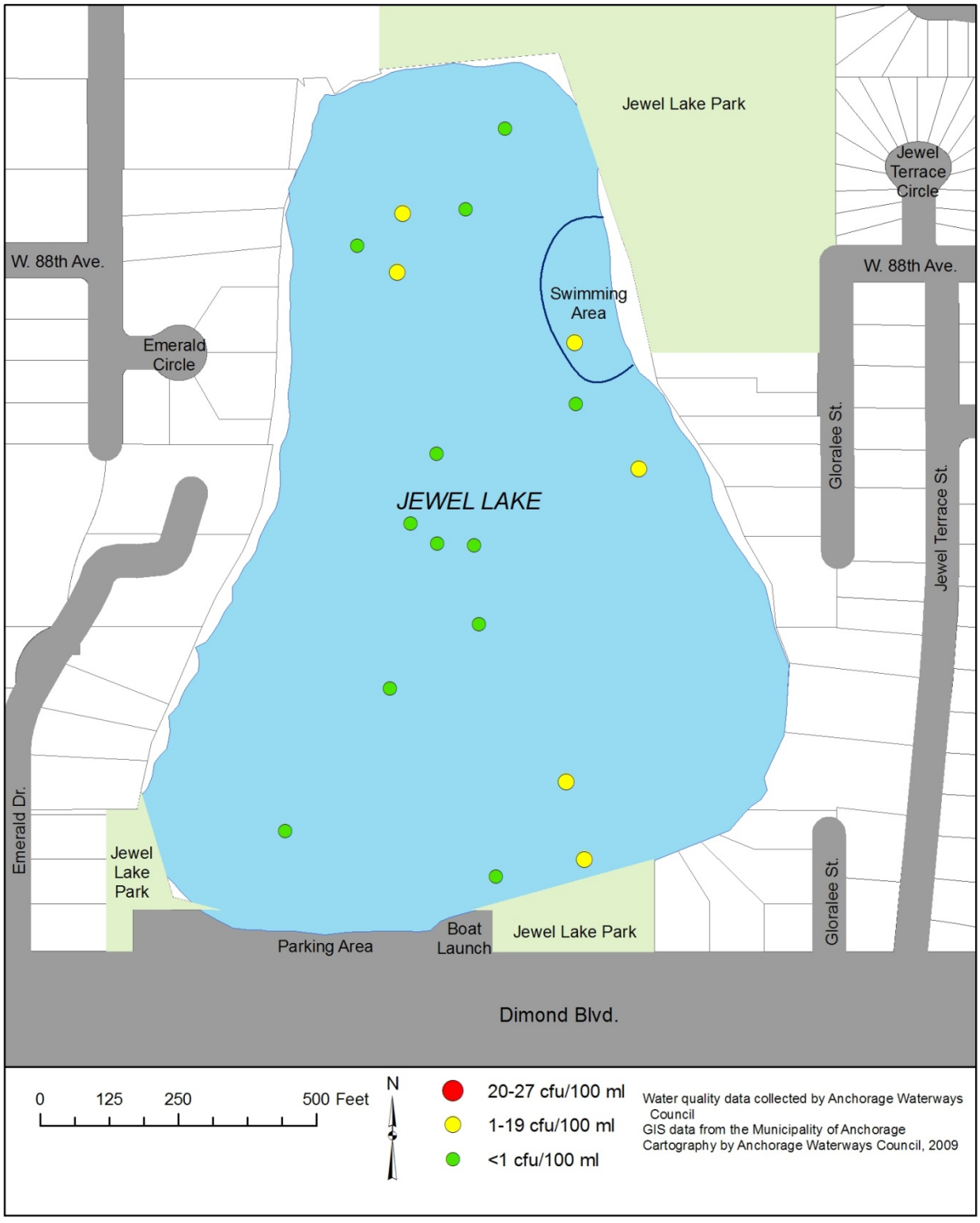

Figure 27. Fecal coliform bacteria data collected in October 2008 in Jewel Lake.

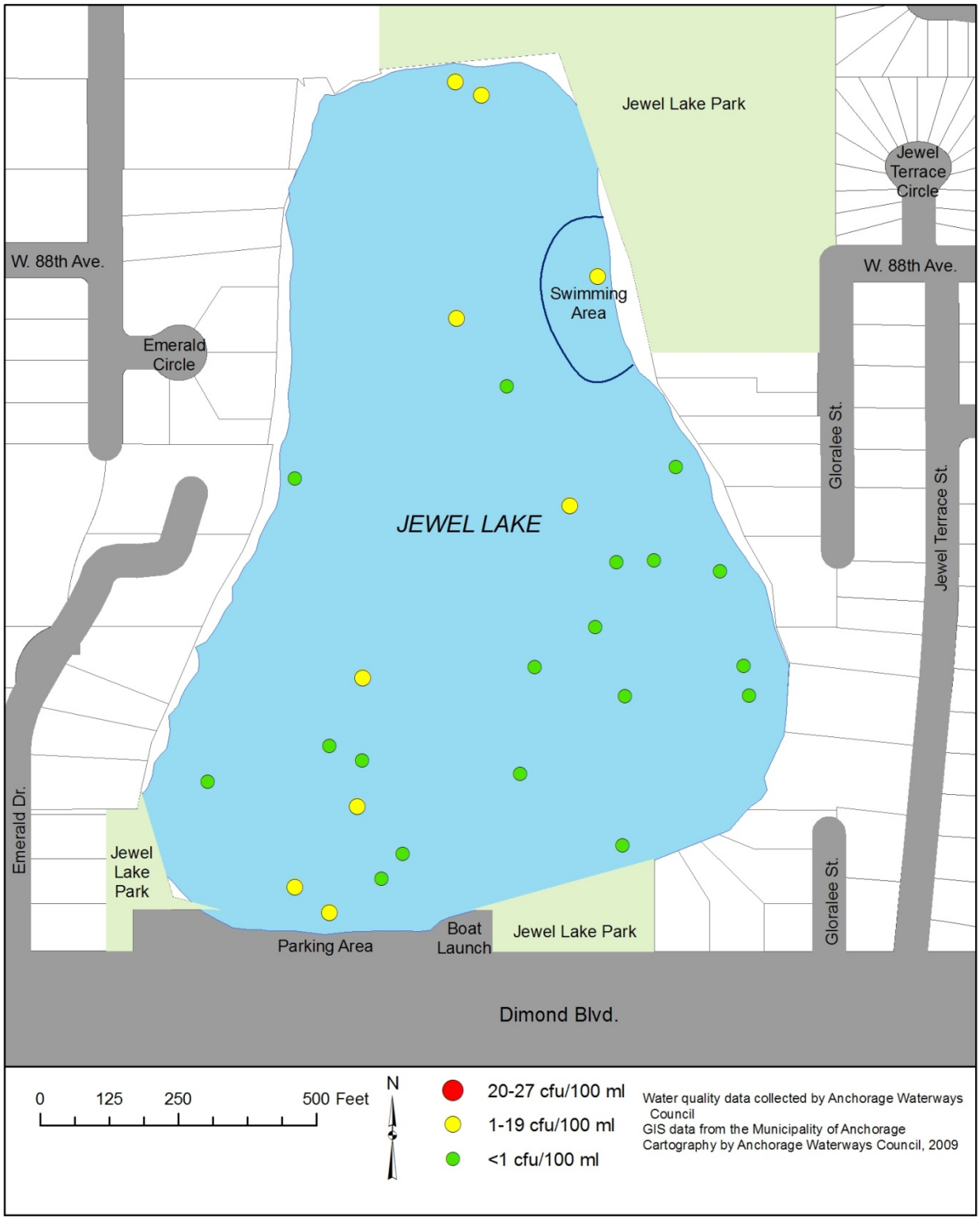

Figure 28. Fecal coliform bacteria data collected in May 2009 in Jewel Lake.

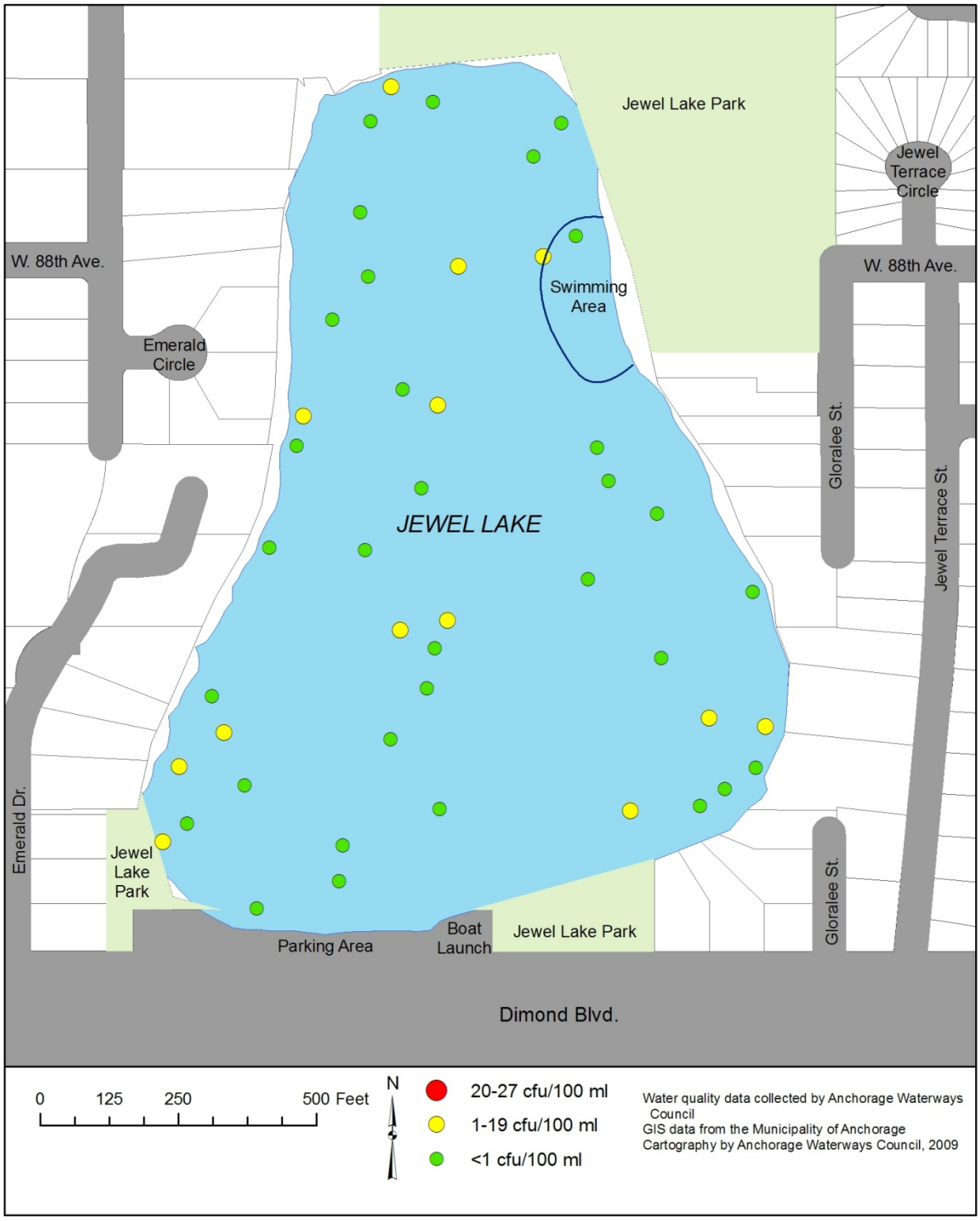

Figure 29. Fecal coliform bacteria data collected in June 2009 in Jewel Lake.

5.2 Correlations

Although correlations do not establish causality among variables, they can help identify potential relationships. It has been suggested that fecal coliform has an affinity for sediment particles, suggesting that fecal coliform concentrations may also increase with increases in turbidity. Secchi depth is a measurement of water clarity and it follows that fecal coliform concentrations could potentially be higher when secchi depth is lower. However, secchi depth results are influenced by the overall depth of the lake at the sample spot. To assess how accurate secchi depth is in assessing water clarity, turbidity data will be correlated with secchi depth.

5.2.1 Secchi Depth and Turbidity

Data from Jewel Lake does not show a relationship between secchi depth and turbidity. This is likely due to the fact that the secchi results are not corrected for lake depth and therefore do not provide an accurate measure of water clarity in Jewel Lake (Figure 30).

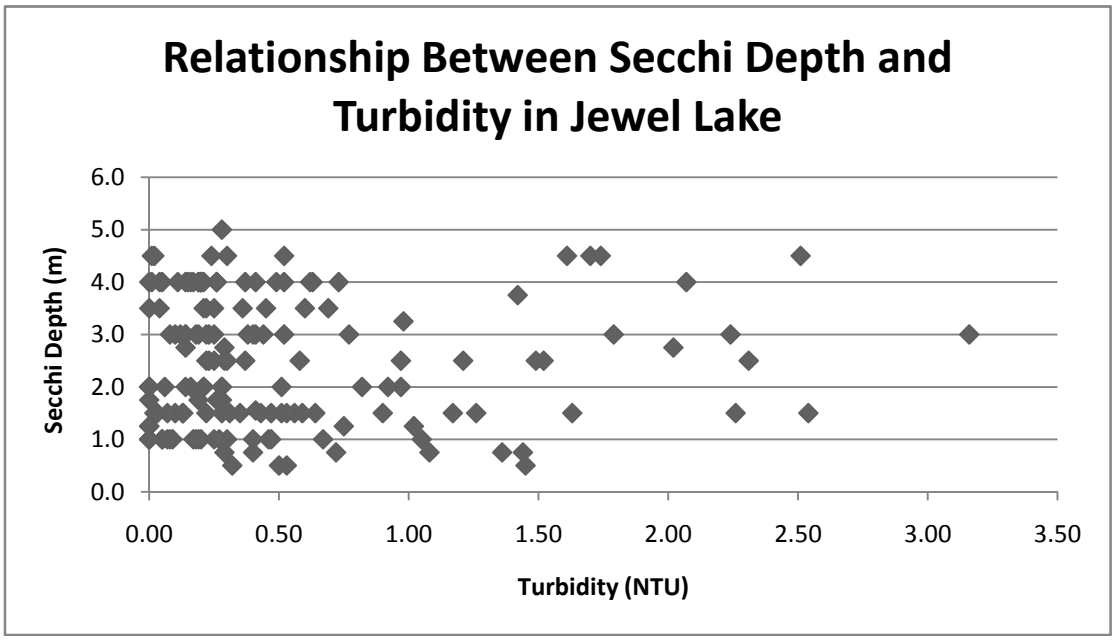

Figure 30. Relationship between secchi disk depth and turbidity in Jewel Lake during the study period.

5.2.2 Fecal Coliform Concentration and Turbidity

In Jewel Lake, fecal coliform concentrations appear to exhibit a slight inverse relationship, with the highest fecal coliform concentration (27 FC/100 ml) occurring when turbidity was 0 NTU and the highest turbidity observed (3.25 NTU) when fecal coliform concentrations were low (Figure 31).

5.2.3 Fecal Coliform Concentration and Secchi Depth

Fecal coliform concentrations were not correlated with secchi depth in Jewel Lake (Figure 32).

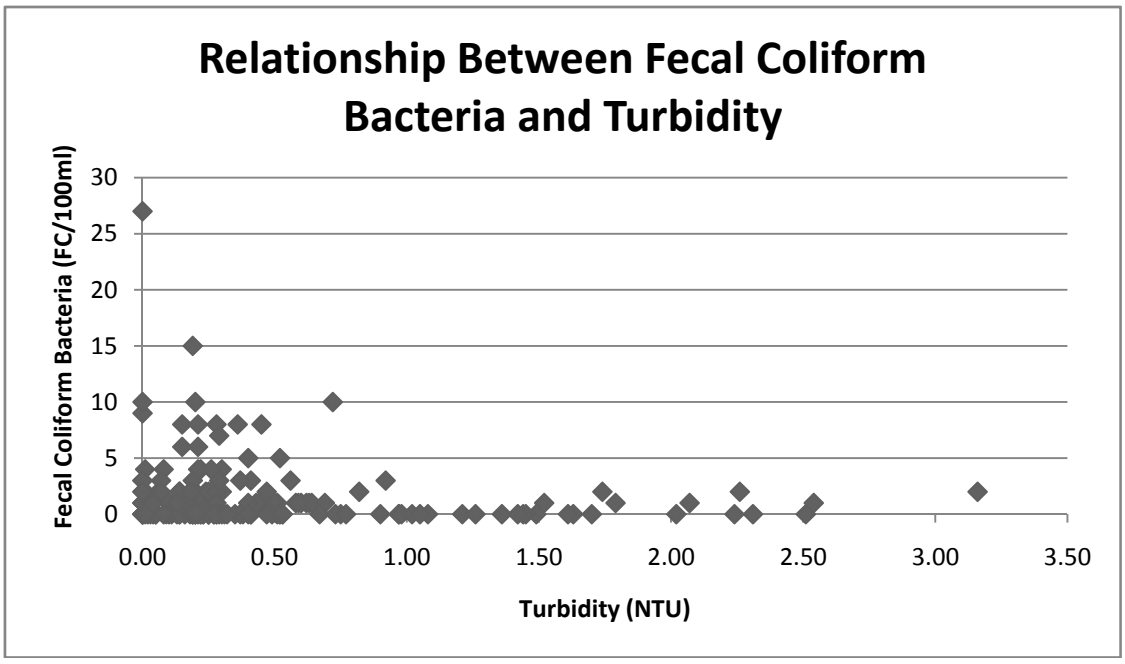

Figure 31. Relationshipbetween fecal coliform and turbidity in Jewel Lake during the study period.

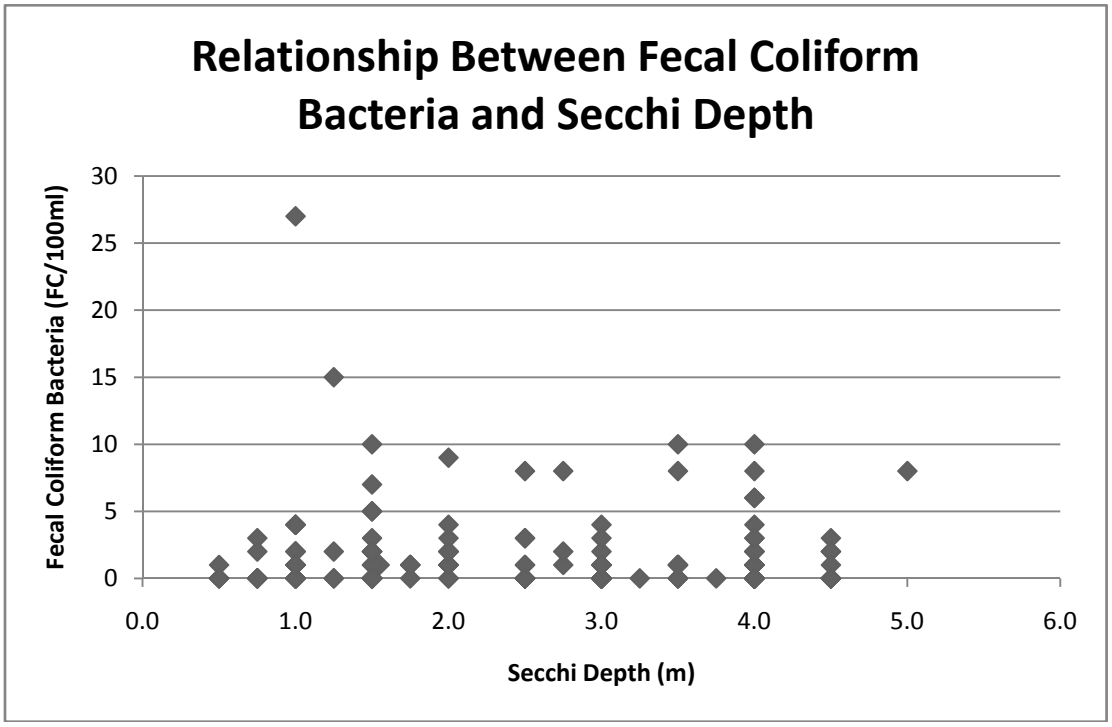

Figure 32. Relationship between fecal coliform and secchi depth in Jewel Lake during the study period.

5.3 Lake-wide Fecal Coliform Exceedances

5.3.1 Geometric Mean

The Alaska State Water Quality Standards require the use of a geometric mean to determine exceedances. The geometric mean is calculated for a 30-day period and requires a minimum of five samples within the 30-days (Tim Stevens, ADEC, pers. comm., March 6, 2008). To calculate the geometric mean, ADEC requested that the calendar month be used as the 30-day period (Tim Stevens, ADEC, pers. comm.)The monthly 30-day periods and the number of sampling events within each period are shown in Table 6.

Table 6. Details of geometric mean calculations of fecal coliform exceedances in Jewel Lake. Each monthly 30-day period contains a variable number of sampling events, but each sampling event consisted of 9 fecal coliform samples.

Year	Month	30-day period	1st and Last Sample Dates	No. of Sampling Events	No. of Bacteria Samples
2008	July	1st	7/16/2008-7/21/2008	2	18
	August	2nd	8/1/2008-8/28/2008	5	45
	September	3rd	9/3/2008-9/29/2008	5	45
	October	4th	10/7/2008-10/15/2008	2	18
2009	May	5th	5/15/2009-5/28/2009	3	27
	June	6th	6/1/2009-6/29/2009	5	45

The geometric mean was calculated in Microsoft Excel, using the GEOMEAN formula. Because the formula does not permit zero values, also zeros (non-detects) were replaced with 1's (Tim Stevens, ADEC, pers.com, July 2007).

Table 7 shows the geometric mean results for Jewel Lake. The Alaska State Water Quality Standard for fecal coliform was described in detail in Section 3. The relevant criteria for Jewel Lake are the water supply standard for drinking, culinary and food processing. This stipulates that the geometric mean may not exceed 20 FC/100ml in a 30-day period. The second part of the standard, related to percent of samples is described in the next section (Section 5.3.2). Additionally, the less stringent water recreation standard for contact recreation may also be examined in the event that Jewel Lake is considered for a less stringent, and possibly more relevant, water use. The contact recreation standard states that the geometric mean may not exceed 100FC/100ml in a 30-day period.

Jewel Lake did not exceed the water quality standard of 20 FC/100ml in any month during the period of record (Table 7).

Table 7. Geometric mean of fecal coliform for Jewel Lake. There were no exceedances based on the Alaska State Water Quality Standards for water supply and water recreation, which defines an exceedance of the water supply standard as a geometric mean of 20 FC/100ml or greater and the water recreation standard as a geometric mean of 100 FC/100ml or greater).

Year	Month	30-day Window	Geometric Mean
2008	July	1st	1.04
	August	2nd	1.22
	September	3rd	2.41
	October	4th	1.30
2009	May	5th	1.32
	June	6th	1.13

6. Assessment of Best Management Practices (BMP's)

A visual assessment of lake shore properties was conducted to see if property owners are implementing best management practices to prevent polluted runoff from entering the lake and provide quality riparian lake shore habitat. The assessment was conducted on 2 separate dates, June 17, 2009 and June 25, 2009. Photos of each property were taken and are included in electronic Appendix A that accompanies this report. However, representative photos of good (Figure 33, 34), fair (Figure 35, 36) and poor (Figure 37, 38) quality shoreline habitat are provided. Additionally, a map showing areas with good, fair and poor quality shoreline habitat is shown in Figure 39. Properties were evaluated and ranked based on the checklist shown below.

Checklist for BMP Assessment for Jewel Lake:

1. Limit turf/landscaped areas to 25 ft from shoreline; plant a shoreline buffer of native shrubs/plants;
2. Ensure that all pollutants like gas, paint, fertilizer, etc. are stored properly in containers and at least 50 feet from water's edge;
3. Preserve natural structure at shoreline; allow emergent vegetation to colonize some portion of waterfront area;
4. Limit impervious surfaces (walkways, etc.) on sloping property;
5. Limit exposed soil, poorly established vegetation;
6. No visible pet waste left in yard (i.e., scoop the poop);
7. No evidence of discarded lawn clippings/yard waste being dumped in lake.

To create a useful measure, a scale of 100 was used to assess each property. Each item on the BMP checklist was worth 14.29 points. A property could receive half points for each measure if it was partially, but not completely, met. The point value was translated to a color coded grading scale in Figure 36 for easy interpretation.

The following scoring system was used:

- A/Good =91-100 points (green dot)
- B/Fair=85-90 points (yellow dot)
- C/Poor=71-84 points (red dot)

Figure 33. Area of park land (adjacent to boat launch) bordering Jewel Lake that received a Good (A) habitat quality rating based on the BMP Assessment.

Figure 34. Example of lakeshore residential property on Jewel Lake that received a Good (A) habitat quality rating based on the BMP Assessment.

Figure 35. Residential property on northwest portion of lake that received a Fair (B) habitat quality rating based on the BMP Assessment.

Figure 36. Another residential property on the west side of Jewel Lake that received a Fair (B) habitat quality rating.

Figure 37. Residential property on the southeastern side of Jewel Lake that received a Poor (C) habitat quality rating, due mainly to the lack of buffer present and mowing the lawn too close to the edge of the lake.

Figure 38. City park property, bordering Jewel Lake, which serves as a parking lot with limited vegetation on the dirt slope. This area received a Poor (C) habitat quality rating.

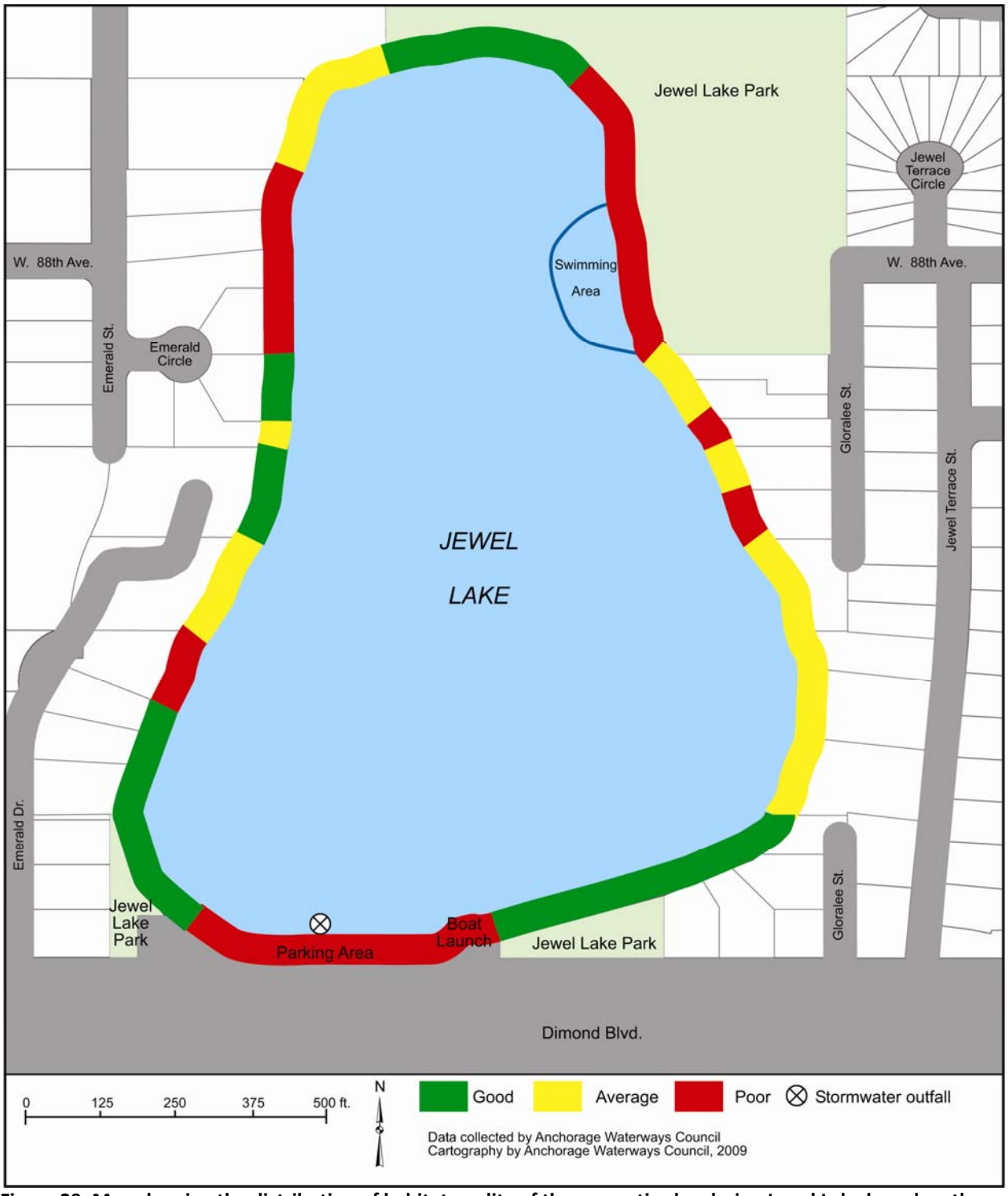

Figure 39. Map showing the distribution of habitat quality of the properties bordering Jewel Lake based on the Best Management Practices Assessment.

7. Summary of Current Water Quality Status and Recommendations

7.1 Water Quality and State Standards

Jewel Lake met the state water quality standard for fecal coliform during the duration of this study. Fecal coliform bacteria concentrations in Jewel Lake were very low compared with past data that exceeded the state water quality standards. The highest fecal coliform concentration recorded was a one-time value of 27 FC/100ml. However the state standard is based on a geometric mean of 20 FC/100 ml, not a singularly occurring value.

Turbidity data in Jewel Lake was not positively correlated with fecal coliform concentrations as anticipated. Because fecal coliform bacteria have been described as having an affinity to sediment particles, it was expected that the highest bacteria concentrations would be observed during periods of high turbidity. However, a slight inverse relationship was found between bacteria concentrations and turbidity. No relationship was observed between fecal coliform concentrations and secchi disk depth.

Fecal coliform concentrations were mapped to allow analysis by location in an effort to isolate potential sources and hot spots of fecal coliform loading in Jewel Lake. However, the range of values were rather homogenously distributed throughout the lake and the highest value of 27 FC/100ml was not found near the swimming beach, where geese, children and dogs congregate, nor directly in front of the discharge outfall from Dimond Blvd.

7.2. Potential Sources of Fecal Coliform

The identification of sources of fecal coliform pollution is an important step in improving water quality conditions in waterbodies that are not meeting state water quality standards. The Alaska 303d list identifies urban runoff and land development as the source of fecal coliform pollution in Jewel Lake (ADEC, 2006a). Bacteria is deposited by domestic animals (e.g., cats and dogs), and wildlife (e.g., moose, bear, etc.) and accumulates on the land surface or is directly deposited in the streams. Rainfall and snowmelt transport bacteria deposited on land into the creeks. Estimating the amount of fecal coliform and locations where it is deposited is typically difficult, due to the mobility and large range of animals throughout the MOA. However, the Canadian geese inhabit Jewel Lake for a specific amount of time and loadings calculations were done in the Jewel Lake TMDL report in 1997 (EPA, 1997).

7.3 Recommendations for Future Efforts

Based on the data and results obtained during this study, several recommendations can be made for future sampling in Jewel Lake.

1) Continuity in Available Data: Because the ADEC grant period begins on July 1st of a given year, and ends June 30th, data for a continuous summer-fall period has not been collected. An additional year of data collection is recommended.
2) Consideration of the Designated Water Use : Currently, Jewel Lake is required to meet the Alaska State Water Quality Standards for the most stringent standard which is for water supply-drinking, culinary and food processing. Consideration could be given as to whether, based on actual use of these waterbodies, the water recreation standard for contact recreation would be a more appropriate standard based on the use of these waterbodies.

8. References

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