

# Interim (Adaptive) Wet Weather Management Plan



Prepared for  
The  
General Services Department  
City of Chico Parks and Open Space Division



Prepared by  
Chico Environmental  
Science and Planning

December, 2009

## **1.0 Background**

Bidwell Park contains over 50 miles of trails for recreation including hiking, running, horse back riding, and mountain biking. The creation and maintenance of a sustainable trail system provides quality recreational opportunities and access to Bidwell Park's points of interest without diminishing the natural resources. Due to the nature of the soils in the park, and year-round heavy traffic from multiple uses, a plan is needed to mitigate damage to the trails which has led to compaction of soils and degradation of habitat.

When wet, trails with natural tread surfaces are often subject to severe damage from trail users such as equestrians and mountain bikers. Horses and mountain bikes leave depressions and ruts in and around the trails, and compact soils leading to pools or channelization of runoff. Many trails in the park have been widened beyond what is necessary, and eroded down to bedrock, which has reduced vegetation coverage.

The purpose of this plan is to outline opening and closure policies for all Upper Park Trails and the Highway 32 Disc Golf Courses within Bidwell Park, in order to protect against resource degradation. The Plan is meant to accompany the Bidwell Park Master Management Plan and the Bidwell Park Trails Manual as an adaptive tool to manage wet weather use of Bidwell Park.

## **2.0 Environmental Setting**

Bidwell Park is characterized by steep slopes and thin soils of the low foothill canyon between the North and South Rim ridges. Slopes on the ridges vary between 3-15%, with steeper slopes in the canyon between 30-50%. Thicknesses and types of soils vary greatly depending on the landform or slope, but generally have a depth to bedrock of only 2-20 inches. Elevations in the park range from 200 – 1600 feet above mean sea level.

The climate in and around Bidwell Park is typical of a Mediterranean climate, characterized by hot, dry summers, and wet rainy winters. Trails within the park meander through sensitive areas of annual grassland, Oak woodland and riparian vegetation. Bidwell Park is home to several endangered species and their critical habitat.

## **3.0 Adaptive Closure Policy**

To make the closure policy objective and transparent to the public, the trails will normally be closed based on publicly available data. Emergency or special circumstances/events may warrant closure at the discretion of the parks' staff. The closure policy should be applied no

more than once per day, and should occur before 11 am. Trails will be closed when estimated precipitation reaches threshold values. One estimate will be used for the Middle Park/Horseshoe Lake Trailhead area and for the Hwy 32 Disc Golf Trailhead area.

### 3.1 Upper Park Trails and Hwy 32 Disc Golf Courses

As the trails in Upper Bidwell Park are generally accessed via the Horseshoe Lake area, estimated precipitation in the Horseshoe Lake area will provide an effective tool in determining when to close trails due to wet conditions. The same precipitation estimate will be used to close the Disc Golf Courses at the Hwy 32 site. It must be understood that field conditions on portions of individual trails, and courses may be very different from conditions near Horseshoe Lake. In addition, as a resource protection policy, trail conditions and disc golf use which includes trail and off-trail use need to be considered in making opening and closing decisions.

Web accessible precipitation data is available on the California Data Exchange Center web site ([cdec.water.ca.gov](http://cdec.water.ca.gov)). The nearest gauge to the Horseshoe Lake area is the Chico (CHI) gauge placed at the USDA Experimental Forest approximately 4.1 miles due south of the lake. Precipitation is not expected to vary greatly over this short distance thus the CHI gauge serves to estimate the precipitation near Horseshoe Lake as well. When greater than **.25inches** of precipitation are recorded in a 24-hour period on the CHI gauge or if any footprint within the trail tread is evident trails in Upper Park should be closed. **Appendix A** lays out the Standard Operating Procedure for accessing and calculating 24-hour data from the CHI (Chico) Gauge. {**Appendix A-1** outlines a SOP for estimating precipitation at the Highway 32 Disc Golf Course. This value should be calculated and recorded, but not used at this time.}

**Time to complete Task:** 10 minutes

**Note:** The absolute values presented herein (bold) should be re-assessed *several times* during the 2009-2010 winter season to calibrate field conditions with desired policy. A Monitoring and Reporting Program (MRP) is included as **Appendix B** which details methods for evaluating the effectiveness of the Wet Weather Policy.

### 4.0 Adaptive Opening Policy

While the procedures for estimating precipitation listed above are helpful in determining when the Upper Park Trails and Disc Golf Courses should be closed due to wet conditions, they are not as useful in determining when the trails and course are dry enough for use. Unfortunately there are no automated, web- accessible soil moisture meters in the vicinity of Bidwell

Park. Deployment of automated sensors (or a full weather station) and connection to a telemetry network could be a useful tool for managing wet weather use of the park in the future. The Upper Park Trails and Disc Golf Trailhead should be assessed no more than once per day, prior to 11 am with the results recorded on the Opening Policy Form provided in **Appendix C**.

#### **4.1 Middle Park (Upper Park Trails):**

From the Horseshoe Lake Trailhead, a park employee should walk along the Middle Trail and observe the impact of their footprints, then cross (down a connector trail) to Lower Trail and return to the parking lot (The route is shown in **Appendix D**). At the same time, the employee should take and record 10 soil moisture measurements (at points shown in **Appendix D-1**) using a Soil Moisture Meter ([www.benmeadows.com](http://www.benmeadows.com) SKU 9JB-221166 \$78.60). The moisture meter probe should be inserted 1" into the ground. If any footprints within the trail tread are visible, the trails should remain closed. If three or more soil moisture readings are **8 units or greater**, then the trails should remain closed. If no foot steps within the trail tread are visible, and **eight or more** soil moisture readings are less than **8units**, the trails are likely suitable for non-pedestrian use. As soon as one of the threshold values is reached or exceeded, the observer may terminate the observation and make a determination without completing the observation.

**Time to complete Task:** 5- 30 minutes (600 meter walk)

#### **4.2 Hwy 32 Disc Golf Course and Trailhead:**

From the "long course" kiosk, a park employee should walk north towards the Tee area for Hole 1, proceed east down Hole 1 past the pin towards the "short course" staying on existing pathways and observe the impact of their footprints. The employee should then proceed south across the short course passing holes 9, 7, 8, 2 and 1 (in that order) to the entrance of the short course. **Appendix E** shows a map of the recommended walking path for this area. The employee should measure and record soil moisture in five locations on the long course, and five locations on the short course (using the same Soil Moisture Meter as mentioned above- **Appendix E-1** shows the locations of measurement points.). If any footprints within the trail tread are visible, the courses and trailhead should remain closed. If three or more soil moisture readings are **8 units or greater**, the courses and trailhead should remain closed. If no footsteps within the trail tread are visible and **eight or more** soil moisture readings are less than **8units**, the courses and trailhead are likely suitable for non-pedestrian use. As soon as one of the threshold values is reached or exceeded, the observer may



terminate the observation and make a determination without completing the observation.

**Time to complete Task:** 5- 25 minutes (800 meter walk)

**Note:** The absolute values presented herein (bold) should be re-assessed *several times* during the 2009-2010 winter season to calibrate field conditions with desired policy. A Monitoring and Reporting Program (MRP) is included as **Appendix B** which details methods for evaluating the effectiveness of the Wet Weather Policy.

### 5.0 Additional Rain Gauges

An additional method for evaluating the accuracy of the precipitation estimates would be to install simple rain gauges in the Horseshoe Lake and Hwy 32 Disc Golf areas. By measuring actual precipitation at the sites, the *in situ* measurement could be compared with the online gauge reading to determine if the web based estimate is accurate. A basic gauge such as the "Tru-Check® Rain Gauge" (<http://www.benmeadows.com> SKU 9JB-110800 \$9.60) could be placed at the Horseshoe Lake kiosk (shown in Photo 10 of Appendix D-1) and at the Hwy 32 Disc Golf Course Kiosk. These locations would make it easy to check and empty the gauges during normal wet weather observations.

Ultimately it is recommended that long term monitoring include more sophisticated rain gauges such as a Tipping Bucket Rain Gauge (<http://www.benmeadows.com> \$762) or buried soil moisture meters. The most effective method for assessing wet weather use is soil moisture and not precipitation (many factors affect soil moisture other than precipitation). These meters could be incorporated into a system that transmits the data to a web accessible location (telemetry) for which several options are available but at a cost of several thousand dollars.

### 6.0 Conclusion

These policies work best for well-spaced storm events which allow time for soil to dry out in between. Parks staff should monitor the National Weather Service (NWS) website ([nws.noaa.gov](http://nws.noaa.gov)) for Chico to determine when rain is predicted. During periods of alternating weather conditions, the NWS prediction can be used to eliminate the need to field check the sites for opening. When enough precipitation is recorded to close the trails, it is highly likely that the ground would not have sufficient time to dry by the next day. Upper Park Trails and Disc Golf Courses should not be reopened if there is a high (70% or higher) possibility of precipitation on that day, and thus there would be no reason to field check the sites. Following any rain

event that resulted in trails being closed (DB 1/4/10), trails should remain closed for at least one day after the event (without field observations).

## **References**

<http://www.ayso26.org/parainpolicy.html>

Bidwell Park Master Management Plan

Bidwell Park Trails Manual 2006 (revised)

[www.cdec.water.ca.gov](http://www.cdec.water.ca.gov)

[www.nws.noaa.gov](http://www.nws.noaa.gov)

**Appendix A**  
SOP for Horseshoe Lake Precipitation Estimation

**Standard Operating Procedure  
for  
Estimating Precipitation in Middle Park/ Horseshoe Lake Trailhead Area**

1. Navigate to [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=CHI](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CHI) (or go to <http://cdec.water.ca.gov/> and search for the station “CHI”)
2. The 9th sensor from the top of the page is described as “**PRECIPITATION, ACCUMULATED**, inches ([hourly](#))([RAIN](#))SATELLITE”- click on the ([hourly](#)) icon.
3. Record the latest value (reported in inches) in the first column “Rain- inches” and note the time of that reading.
4. Click on the “earlier” icon and locate the entry 24- hours prior to the value from **Step 3**.
5. Subtract the earlier value from the later value to obtain the depth of precipitation (in inches) for the previous 24-hour period. This value will serve as a best estimate for the amount of precipitation in the Middle Park/ Horseshoe Lake Trailhead area.

**Note:** The CHI (Chico) station is located approximately 4.1 miles due south of Horseshoe Lake. This station represents the closest publicly accessible precipitation gauge to Middle Park/ Horseshoe Lake Trailhead.

Chico- [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=CHI](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CHI)

<b>Station ID</b> CHI	<b>Elevation</b> 230' ft
<b>River Basin</b> BUTTE CR	<b>County</b> BUTTE
<b>Hydrologic Area</b> SACRAMENTO RIVER	<b>Nearby City</b> DURHAM
<b>Latitude</b> 39.7120°N	<b>Longitude</b> 121.7830°W
<b>Operator</b> CA Dept of Forestry	<b>Data Collection</b> SATELLITE



## **Appendix A-1**

### **SOP for Hwy 32 Disc Golf area Precipitation Estimation**

**Standard Operating Procedure  
for  
Estimating Precipitation at the Hwy 32 Disc Golf Trailhead**

1. Navigate to [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=CHI](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CHI) (or go to <http://cdec.water.ca.gov/> and search for the station “CHI”)
2. The 9th sensor from the top of the page is described as “**PRECIPITATION, ACCUMULATED**, inches ([hourly](#))([RAIN](#))SATELLITE”- click on the ([hourly](#)) icon.
3. Record the latest value (reported in inches) in the first column “Rain- inches” and note the time of that reading.
4. Click on the “earlier” icon and locate the entry 24- hours prior to the value from **Step 3**.
5. Subtract the earlier value from the later value to obtain the depth of precipitation (in inches) for the previous 24-hour period. Record this value.
6. Repeat Steps 1-5 for the “CST” (Cohasset) gauge.
7. Repeat Steps 1-5 for the “PDE” (Paradise) gauge using the sensor “**PRECIPITATION, TIPPING BUCKET**, inches ([hourly](#))([RAINTIP](#))SATELLITE”.

Direct links are as follows (and should be bookmarked for easy reference):

Chico- [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=CHI](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CHI)

Cohasset- [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=CST](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CST)

Paradise- [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=PDE](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=PDE)

8. Once 24-hour values are gathered for each of the three sensors, enter them into the formula:

$$[(CST + PDE)/2] *.70] + [CHI*.30] = \text{Estimated Precipitation in inches}$$

This value will serve as a best estimate for the amount of precipitation at the Highway 32 Disc Golf Trailhead. The formula uses a weighted average of the three gauges based on elevation, location, topography and typical storm track.

Chico- [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=CHI](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CHI)

<b>Station ID</b> CHI	<b>Elevation</b> 230' ft
<b>River Basin</b> BUTTE CR	<b>County</b> BUTTE
<b>Hydrologic Area</b> SACRAMENTO RIVER	<b>Nearby City</b> DURHAM
<b>Latitude</b> 39.7120°N	<b>Longitude</b> 121.7830°W
<b>Operator</b> CA Dept of Forestry	<b>Data Collection</b> SATELLITE

Cohasset- [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=CST](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CST)

<b>Station ID</b> CST	<b>Elevation</b> 1600' ft
<b>River Basin</b> SACRAMENTO R	<b>County</b> BUTTE
<b>Hydrologic Area</b> SACRAMENTO RIVER	<b>Nearby City</b> CHICO
<b>Latitude</b> 39.8753°N	<b>Longitude</b> 121.7706°W
<b>Operator</b> CA Dept of Forestry	<b>Data Collection</b> SATELLITE

Paradise- [http://cdec.water.ca.gov/cgi-progs/staMeta?station\\_id=PDE](http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=PDE)

<b>Station ID</b> PDE	<b>Elevation</b> 1750' ft
<b>River Basin</b> FEATHER R	<b>County</b> BUTTE
<b>Hydrologic Area</b> SACRAMENTO RIVER	<b>Nearby City</b> PARADISE
<b>Latitude</b> 39.7536°N	<b>Longitude</b> 121.6247°W
<b>Operator</b> CA Dept of Water Resources	<b>Data Collection</b> SATELLITE

**Appendix B**  
Monitoring and Reporting Program

# **Monitoring and Reporting Program For the Interim (Adaptive) Wet Weather Management Plan**

To assess the effectiveness of the Wet Weather Management Plan, monthly inspections of the Upper Park Trails and the Hwy 32 Disc Golf Courses shall occur during the 2009-2010 Winter season (October 2009- April 2010). A report shall be generated within one week of the end of month and shall be submitted to the City of Chico, General Services Department- Parks and Open Space Division. Based on the findings of the reports, the Wet Weather Management Plan may be adapted as necessary to prevent unnecessary environmental damage to Bidwell Park from improper use of the park. The report will include a summary of the previous month data and inspection reports described below.

To expedite inspections of the Disc Golf Course and Trails, three sites shall be chosen and closely monitored which represent conditions on trails, and three sites shall be chosen and monitored which represent conditions on the Disc Golf courses (see Figure 1). Monitoring locations should be chosen to represent one degraded/eroding site, one unimpacted site, and one typical site representing overall conditions.

The monthly report shall include the following:

1. Table with daily data for entire month: date, precipitation at CHI gauge, precipitation estimate for Hwy 32 site (SOP below), trail status, Disc Golf Course status (open or closed), footstep impact, soil moisture readings from "Observation for Opening" events, and observed rainfall totals from "Observation for Opening" events. A sample chart is provided below.

Inspection reports (sample provided):

2. Reference photographs of each site (from same vantage point for comparison)
3. Written evaluation of site and changes since last observation- (vegetation status, presence or absence of topsoil, increase in number or character of exposed rocks, standing water, widening of paths or trails, etc.)
4. Evidence of improper use (i.e. deep bicycle tire tracks, deep horse footprints, deep human foot prints, short cut trails, etc.)
5. Documentation of significant issues and recommendations for Plan changes, or site specific remediation.

[illegible]



## Site Inspection Field Sheet (sample- no format specified)

Site: *Disc Golf Hole 2*

Latitude: 39.779370° Longitude: -121.734224°

Date 9-23-09 Inspector J. Lane

Site evaluation (vegetation status, presence or absence of topsoil, increase in number or character of exposed rocks, standing water, widening of paths or trails, etc.):

*Vegetation is dry and has been trampled in some areas. Top soil has been eroded from lower portion of original tee area and in path towards target, more rocks visible than last inspection. Trail is .5 feet wider than last inspection. See reference points 2 and 3.*

Evidence of Improper Use (deep bicycle tire tracks, deep horse footprints, deep human foot prints, short cut trails, etc.):

*Bike tire marks in bare dirt area. Appear to be skids during dry weather.*

Significant Issues:

*Tee area is unprotected from erosion as is trail(s) to target 2.*

Recommendations:

*Move tee to flat upper area. Seed and cover bare dirt in original tee area.*



Reference point 1: Looking West from Tee 2.



Reference point 2: Looking North from below Tee 2.



Reference point 3: Previous bench location at Tee 2.



Photo 4: Path is eroding. More exposed rocks and less soil.



Photo 5: Additional erosion and mtn bike tracks.



Photo 6: Deep rut with horse prints.

**Appendix C**  
Opening Policy Form

**Bidwell Park Wet Weather Trails/ Disc Golf Opening Policy Form**

Name of Observer \_\_\_\_\_ Date \_\_\_\_\_

Time of Observation \_\_\_\_\_

Location (Circle One):      Hwy32 Site              Horseshoe Lake Site

Soil Moisture readings:

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_ 5. \_\_\_\_\_  
6. \_\_\_\_\_ 7. \_\_\_\_\_ 8. \_\_\_\_\_ 9. \_\_\_\_\_ 10. \_\_\_\_\_

Units \_\_\_\_\_ Meter Type \_\_\_\_\_

Footstep Observations (Circle One):    >0.5"              <0.5"

Rain Gauge Reading \_\_\_\_\_ units \_\_\_\_\_ (then empty gauge)

Predicted weather from (National Weather Service) \_\_\_\_\_

Determination (Circle One):    Open              Remain Closed

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Time of Observation \_\_\_\_\_

Location (Circle One):      Hwy32 Site              Horseshoe Lake Site

Soil Moisture readings:

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_ 5. \_\_\_\_\_  
6. \_\_\_\_\_ 7. \_\_\_\_\_ 8. \_\_\_\_\_ 9. \_\_\_\_\_ 10. \_\_\_\_\_

Units \_\_\_\_\_ Meter Type \_\_\_\_\_

Footstep Observations (Circle One):    >0.5"              <0.5"

Rain Gauge Reading \_\_\_\_\_ units \_\_\_\_\_ (then empty gauge)

Predicted weather from (National Weather Service) \_\_\_\_\_

Determination (Circle One):    Open              Remain Closed

**Appendix D**  
Recommended Observation Path in Middle Park





Horseshoe Lake

Rod and Gun Club

Parking Area

Middle Trail

Lower Trail

Upper Park Rd

Wildwood Ave

Image © 2009 DigitalGlobe  
© 2009 Tele Atlas

Google

677 ft

Imagery Date: Aug 10, 2006

lat 39.772609° lon -121.777985°

Eye alt 2341 ft



**Appendix D-1**  
Locations of Soil Moisture Measurements- Middle Park



#1: 39.773646, -121.778018- Triangle where path from parking lot meets Middle Trail.



#2: 39.773824, -121.777590- just east of first creek crossing, middle trail is shown on right.



#3: 39.772960, -121.776182- Fork of middle trail and other trail, in triangle between trails.



#4: 39.773250, -121.775237- Between Middle Trail and connector to Lower Trail.



#5: 39.772519, -121.775946- Switchback on connector trail from Middle to Lower Trail.



#6: 39.772478, -121.775260- Up hill from connector trail and Lower Trail fork.



#7. 39.772061, -121.776800- Lower Trail turns north, point is in triangle with other paths.



#8. 39.772687, -121.776967- Lower Trail where path intersects from east.



#9. 39.772980, -121.777619- Lower Trail where path shortcuts to parking lot.



#10. 39.772951, -121.778285- Just behind trails sign and pet waste bag station.

**Appendix E**  
Recommended Observation Path at Hwy 32 Disc Golf Site





Short Course Kiosk

Highway 32

Long Course Kiosk

Parking Area Entrance

Image © 2009 DigitalGlobe  
© 2009 Tele Atlas

©2009 Google

686 ft

Imagery Date: Aug 10, 2006

lat 39.778534° lon -121.733272°

Eye alt 2374 ft



## **Appendix E-1**

Locations of Soil Moisture Measurements- Hwy 32 Disc Golf Site





#1: 39.777470, -121.732691- Near Ponderosa Pine between Kiosk and Target 18.



#2. 39.778006, -121.733857- Just west of Tee 1 area.



#3. 39.778364, -121.733898- Center of Fairway 1, adjacent to largest rock in fairway.



#4. 39.778731, -121.733888- Near Target 1, between 3 trees and Target area.



#5. 39.779274, -121.734067- Between Target 1 and Tee 2, where trail forks and leads to short course.



#6. 39.779617, -121.733428- Near large rock, visible from where trail emerges onto short course.



#7. 39.780015, -121.732975- Between tree and large rock, between holes near cliff.



#8. 39.780032, -121.732337- Near Ponderosa Pine, central portion of short course.



#9. 39.779747, -121.732112- Near lone damaged oak, west of Tee 2 area.



#10. 39.779753, -121.731461- Just east of Tee 1 area.