

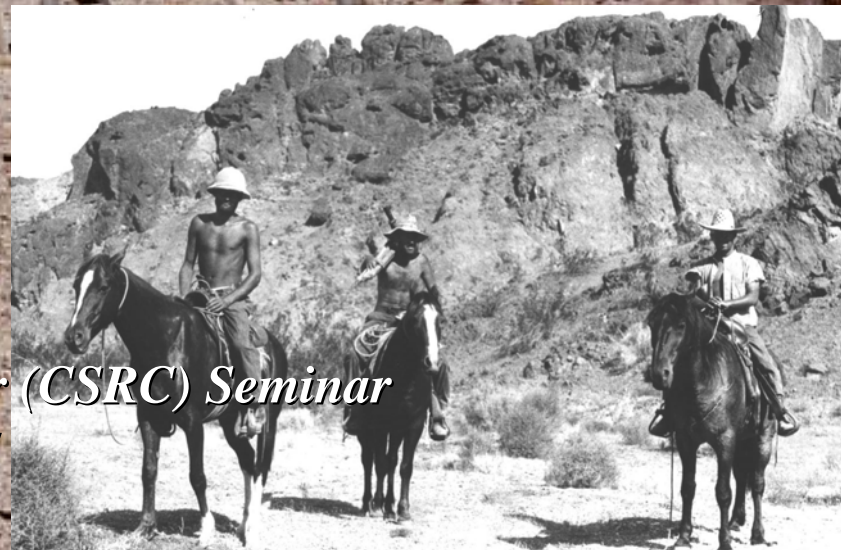
MWD Real Time Network Utilizing Continuous GPS (CGPS) stations



*"GNPS"
CGPS at MWD
Genewash Reservoir*



*California Spatial Reference Center (CSRC) Seminar
February 4, 2005*



Who is the Metropolitan Water District of Southern California?

- Provide approximately 60% of the drinking water used by 17 million people in Southern California
- Water supplies come from the Colorado River via a 242 mile aqueduct that carries 1.3 million acre-feet annually
 - includes 5 pump plants, 92 mi. of tunnel, 144 underground siphons, 1617 ft. of total lift
- 775 miles of pipeline for water distribution spread over 6 counties, 5200 sq.mi. and 240 cities
- 10 reservoirs
 - from 212 ac-ft to 800,000 ac-ft capacity
- 5 filtration plants each encompassing:
 - an average of 8 settling and mixing basins
 - 1 or 2 finished water reservoirs
- 15 hydroelectric plants

Overview of MWD RTN

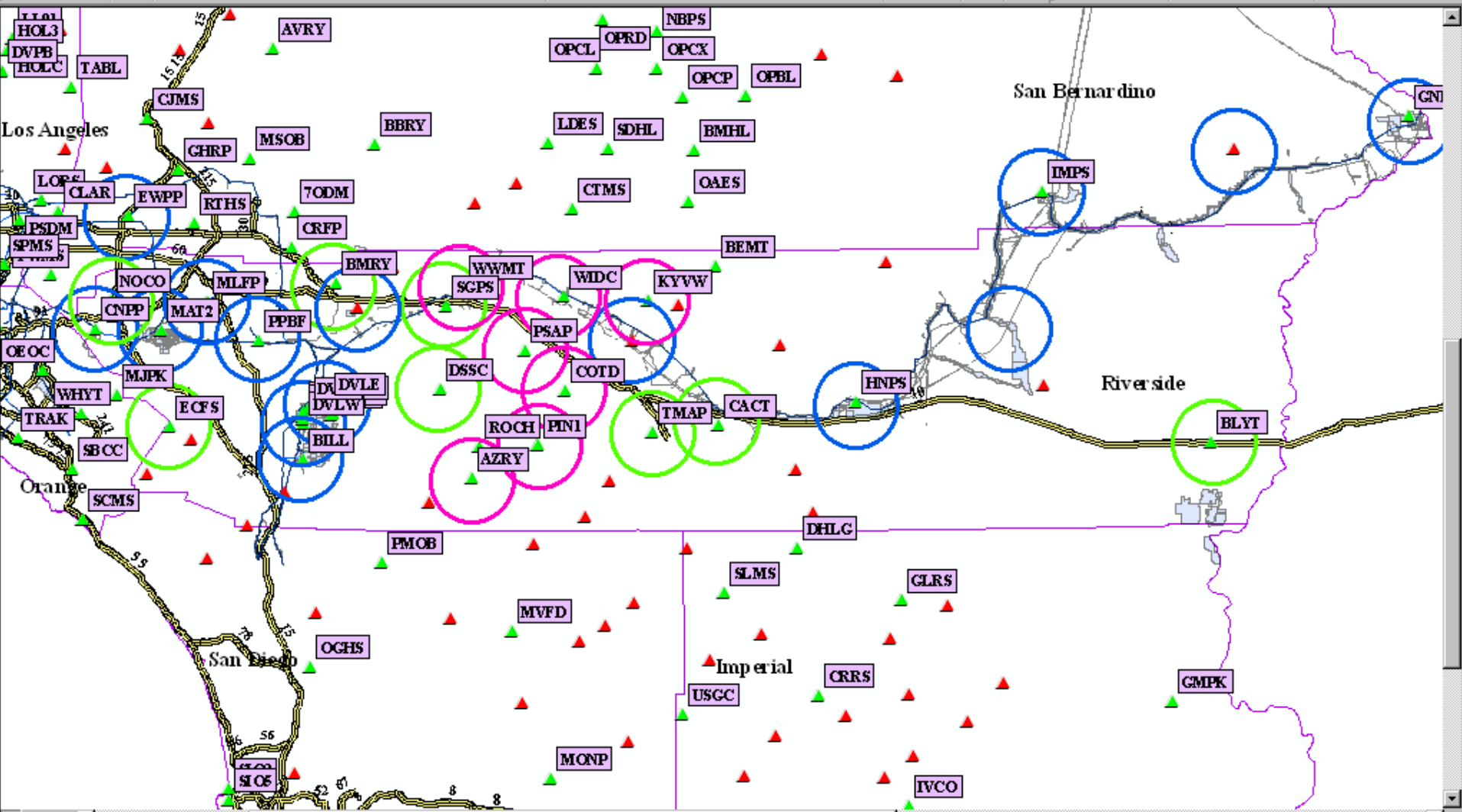
- 17 CGPS sites on MWD property in RVCo (4 PBO)
- Will include data collection of 18 additional CGPS sites in RVCo
- Data collection over MWD Communications backbone – 5 main locations
- MWD server to transmit data to MWD crews only
- Data transmission to SOPAC/CSRC for archiving and further transmission if needed
- Data transmission to Orange Co. for temporary serving of data to public (until RVCo is ready)

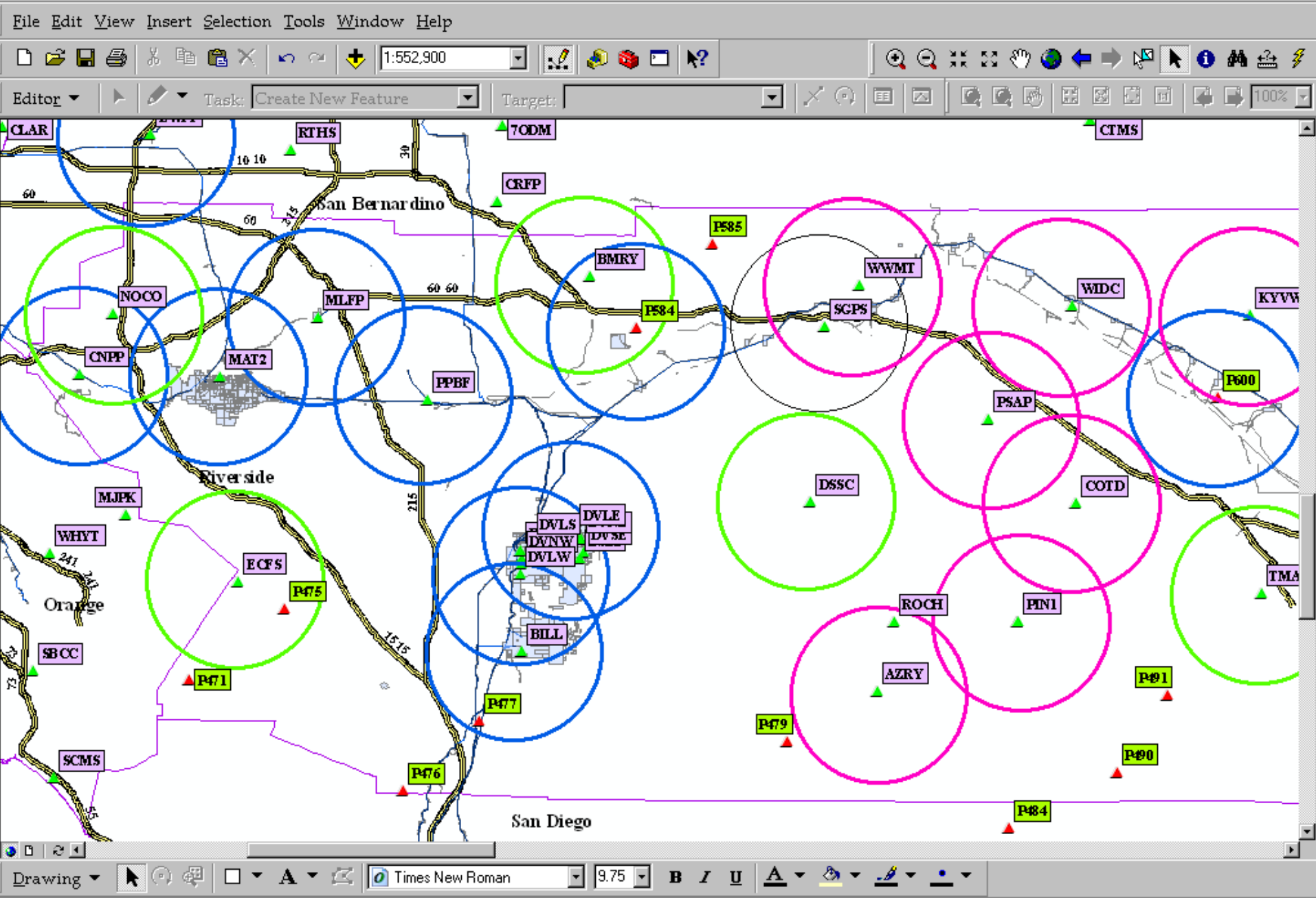
Planned Installation Schedule

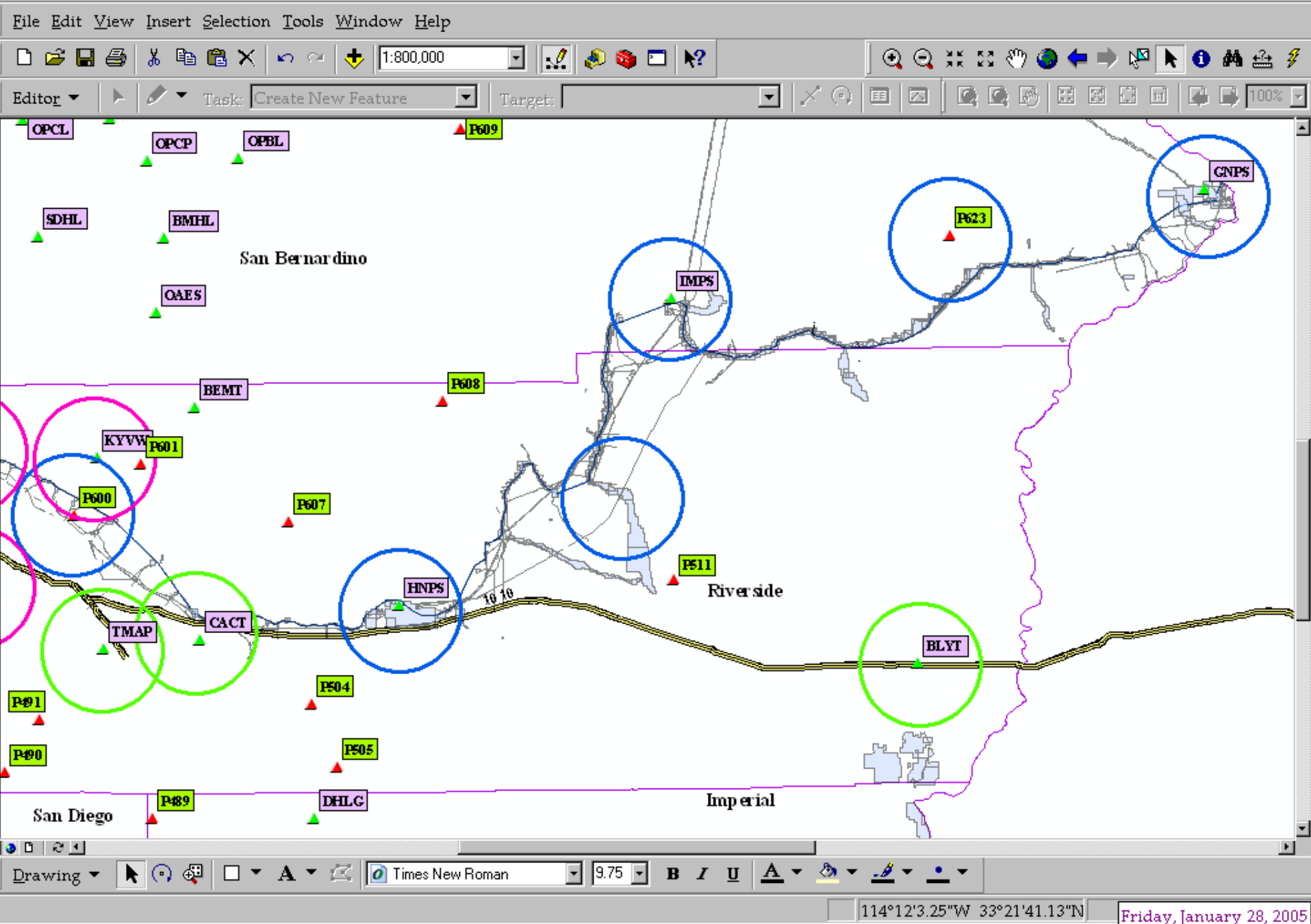
- First equipment arrived last week
- Installation of upgrades to communications backbone to begin this month
- Installation of first CGPS site upgrade by end of month
- MWD server is currently being set up
- Data transmission to begin as sites upgraded
- As soon as data flows into MWD server it will be available at Orange Co. and CSRC
- Complete initial installation by May 2005 (?)

Current Status of MWD RTN









Riverside County RTN

MWD Users



Wireless Internet



MWD



Internet

SOPAC



Internet

Orange Co.



Wireless Internet

Science Users



MWD Data Hub

ESRW	WWMT
DVNW*	WIDC
DVSW*	KYVW
DVLW	PSAP
DVLS*	COTD
DVLE	PIN1/PIN2*
DVNE*	AZRY
DVSE*	CACT
ESE2	TMAP
MLFP	BMRY
MAT2	ECFS
HNPS	DSSC
IMPS	BLYT
GNPS	NOCO
EWPP	SPMS
PPBF	TWMS
BILL	PSAP
CNPP	
PPCK	
PCOX	
PTIN	

*Internal

Serial to IP converter



MWD Backbone



MWD/DVL (9)
(monitoring network)

ESRW
DVNW
DVSW
DVLW
DVLS
DVLE
DVNE
DVSE
ESE2

MWD/RTN (12)

MLFP*
MAT2*
HNPS*
IMPS*
GNPS*
EWPP*
PPBF*
BILL*
CNPP*
PPCK (PBO)
PCOX (PBO)
PTIN (PBO)

*In the upgrade queue

SCIGN (18)

WWMT*	BLYT*
WIDC	NOCO*
KYVW	SPMS*
PSAP	TWMS*
COTD	PSAP*
PIN1/PIN2	DSSC*
AZRY	
CACT*	
TMAP*	
BMRY*	
ECFS*	

Programs to run network:

RTD = network solution

CLP = handles incoming raw data

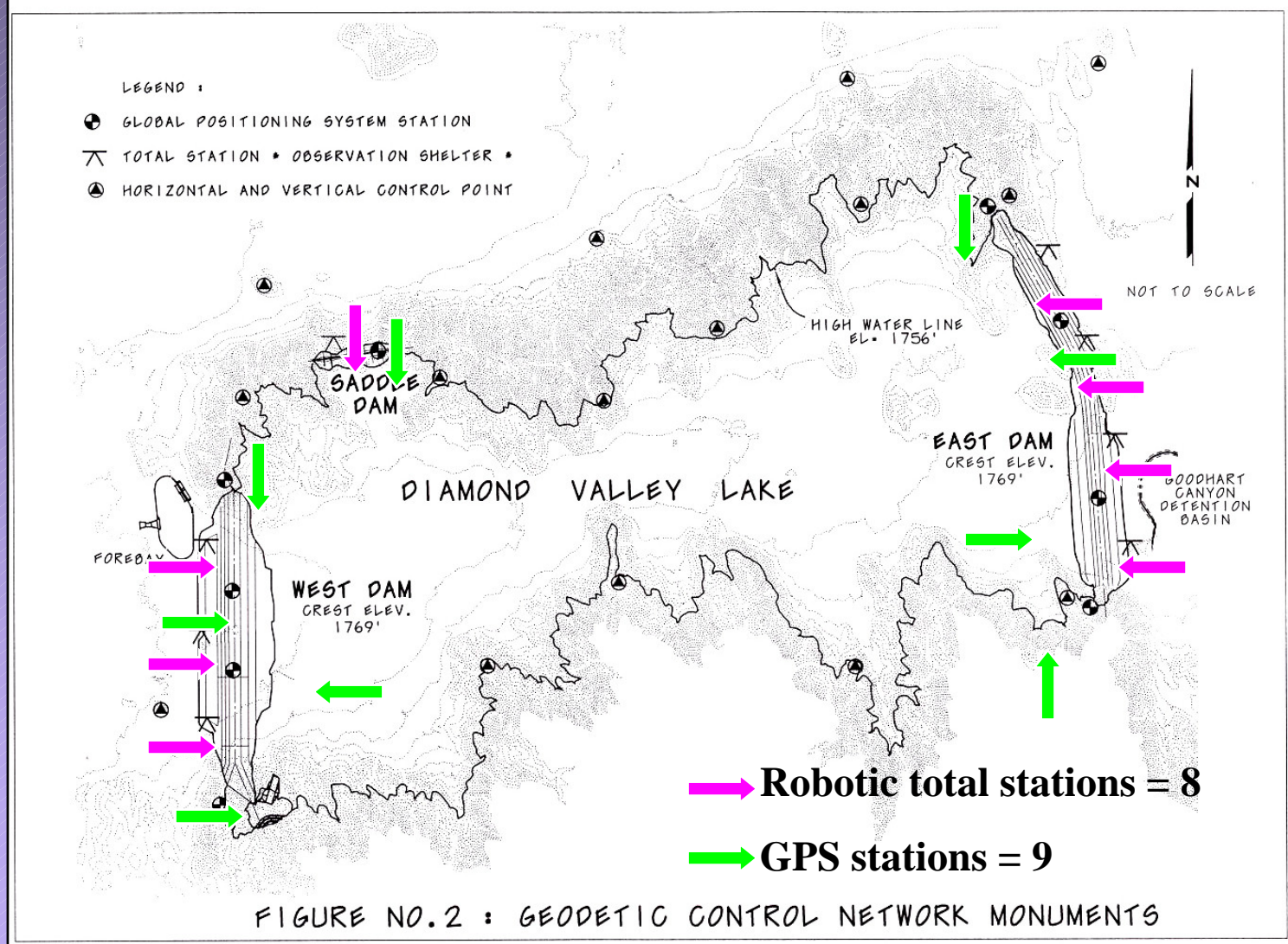
The Metropolitan Water District (MWD)

February 2

General Users



DVL Geodetic Monitoring Array



ESE2 – New Base at South Abutment of East Dam (replaced ESRE)



DVSE “Rover” Station on South End of East Dam Crest



Real-Time GPS with RTS Verification



DVSE – Real Time GPS Equipment Box



Radial Gate Building with Relay Antennas





Start

Ge...

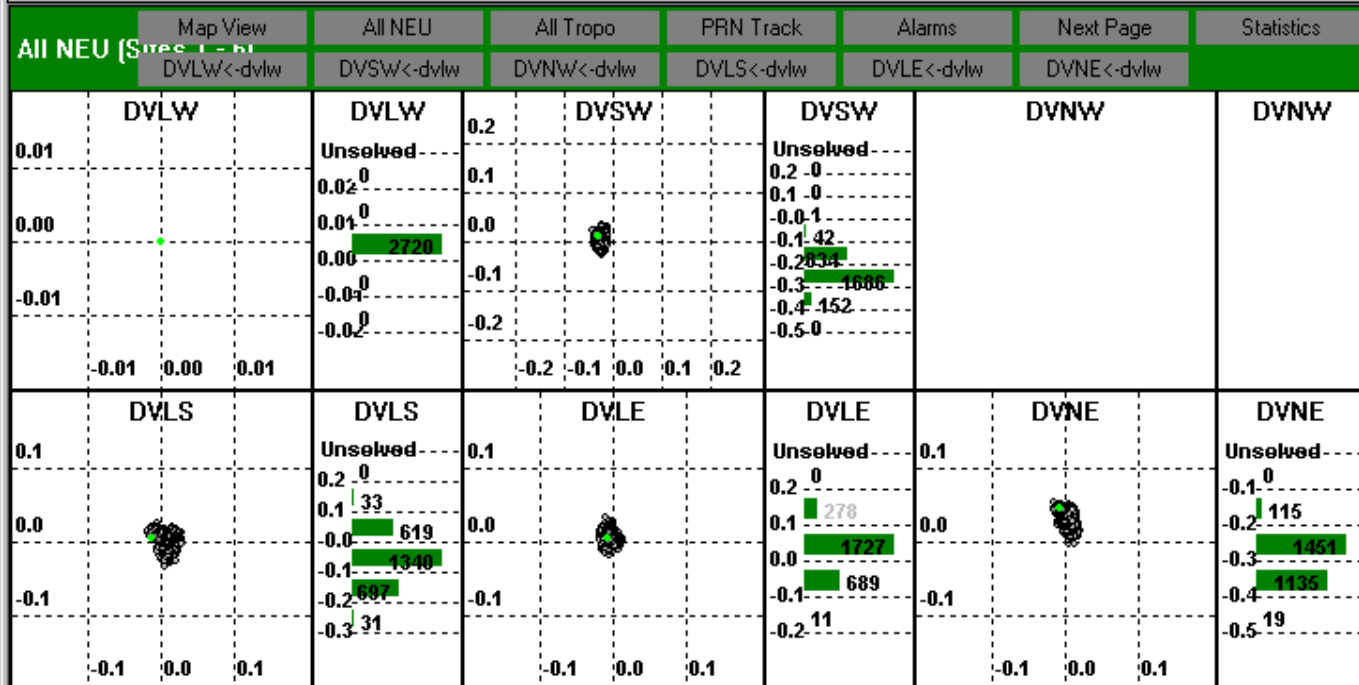
dv...

dvl.rtd - Geodetics RTD

File View Network Tools Help

☐ View Outliers ☒ Interlock Scaling ☐ Alarm Lines ☒ Map Data ☐ Velocity

Code	Name	Type	Status	RX Type	Comm Type	Prior X	Prior Y	Prior Z
DVLW	West Dam Reference	M	2/3 21:45:19	Leica CRS1000	TCP/IP	-2418456.5801	-4732710.0903	+3515198.8
DVSW	West Dam South		2/3 21:45:19	Leica CRS1000	TCP/IP	-2418049.2645	-4732195.4743	+3516131.2
DVNW	West Dam North			Leica CRS1000	TCP/IP	-2417900.8495	-4731891.8196	+3516638.8
DVLS	Saddle Dam		2/3 21:45:19	Leica CRS1000	TCP/IP	-2416372.8350	-4731446.8510	+3518275.1
DVLE	East Dam Reference		2/3 21:45:19	Leica CRS1000	TCP/IP	-2411745.1529	-4733176.9752	+3519160.4
DVNE	East Dam North		2/3 21:45:19	Leica CRS1000	TCP/IP	-2411356.8145	-4733839.4590	+3518496.8
DVSE	East Dam South		2/3 21:45:19	Leica CRS1000	TCP/IP	-2411438.1550	-4734677.5630	+3517321.4



For Help, press F1

Processing 2005/02/03 21:45:00

2005/02/03 21:45:00

- 9000 2 clients
144.166.59.21
132.239.152.72
- 9001 2 clients
144.166.59.21
132.239.152.72
- 9002 1 clients
132.239.152.72
- 9003 2 clients
144.166.59.21
132.239.152.72
- 9004 2 clients
144.166.59.21
132.239.152.72
- 9005 2 clients
144.166.59.21
132.239.152.72
- 9006 2 clients
144.166.59.21
132.239.152.72
- 9008 1 clients
132.239.152.72

HTTP Port: 80

Go

Start

Inbox - Microsoft O...

d:\Documents and ...

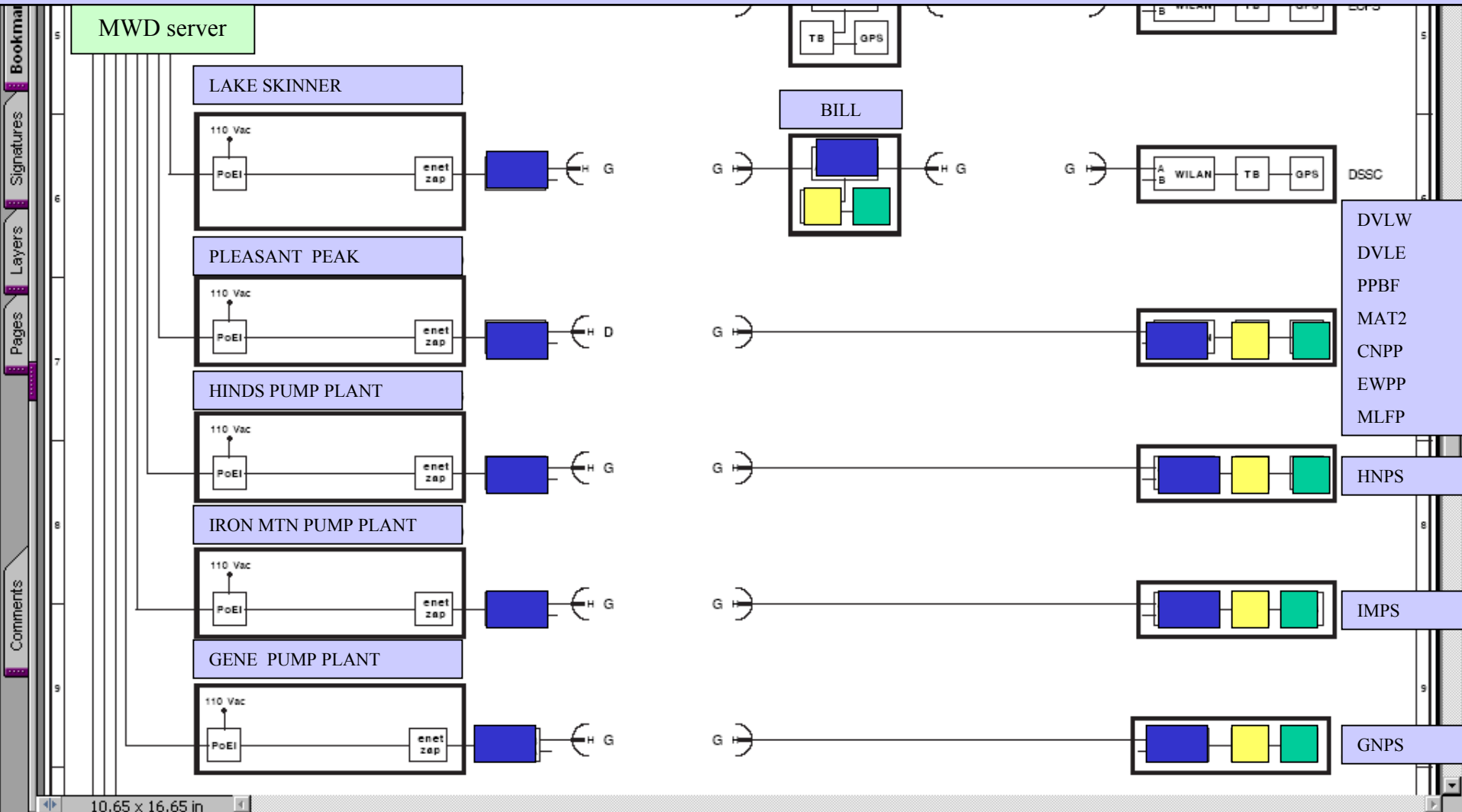
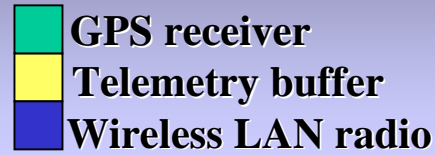
mwdtrn.ppt

GPS CORs - pcAn...

GPS_CORs - pcAnywhere

1:45 PM

Schematic of Network Connections



CGPS Upgrade Equipment

- Each site upgrade includes:
- Ethernet 2.4GHz WiLAN (wireless LAN) radio
- SIO telemetry buffer and cable
- Appropriate antenna (usually 24 dBi semi-parabolic grid antenna)
- WiLAN radio cable
- Miscellaneous parts (pipe clamps, etc.)

Rover Equipment

- Each rover setup will be running the network version of RTD
- Allows for solution of an adjusted position based on two CGPS in the network available at your site – not a radial solution
- Better accuracy, less possibility for error
- Currently testing program on a PDA device
- PDA not great for field use – not rugged enough, but less expensive for testing

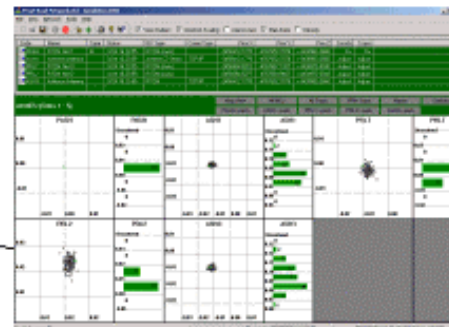
RTD-Rover



- **PIN Positioning: Precise Instantaneous Network Positioning**
- **Instantaneous Multiply-Determined Solutions**
- **Employs Geodetics Epoch-by-Epoch™ Technology**
- **Utilizes any reference geodetic receiver (does not require RTK software).**
- **Can utilize L1 only geodetic receivers on short baselines (< 5km).**
- **Works on laptops, tablet PC's and PDA's.**

RTD Total Solution

Platform Independent
Reference Network



II-GPS
Precise
Instantaneous
GPS

Internet

Compatible with
existing Rovers



Bluetooth

Sprint, Verizon or Cingular
Wireless Data



Bluetooth



Compatible with various
Data Loggers

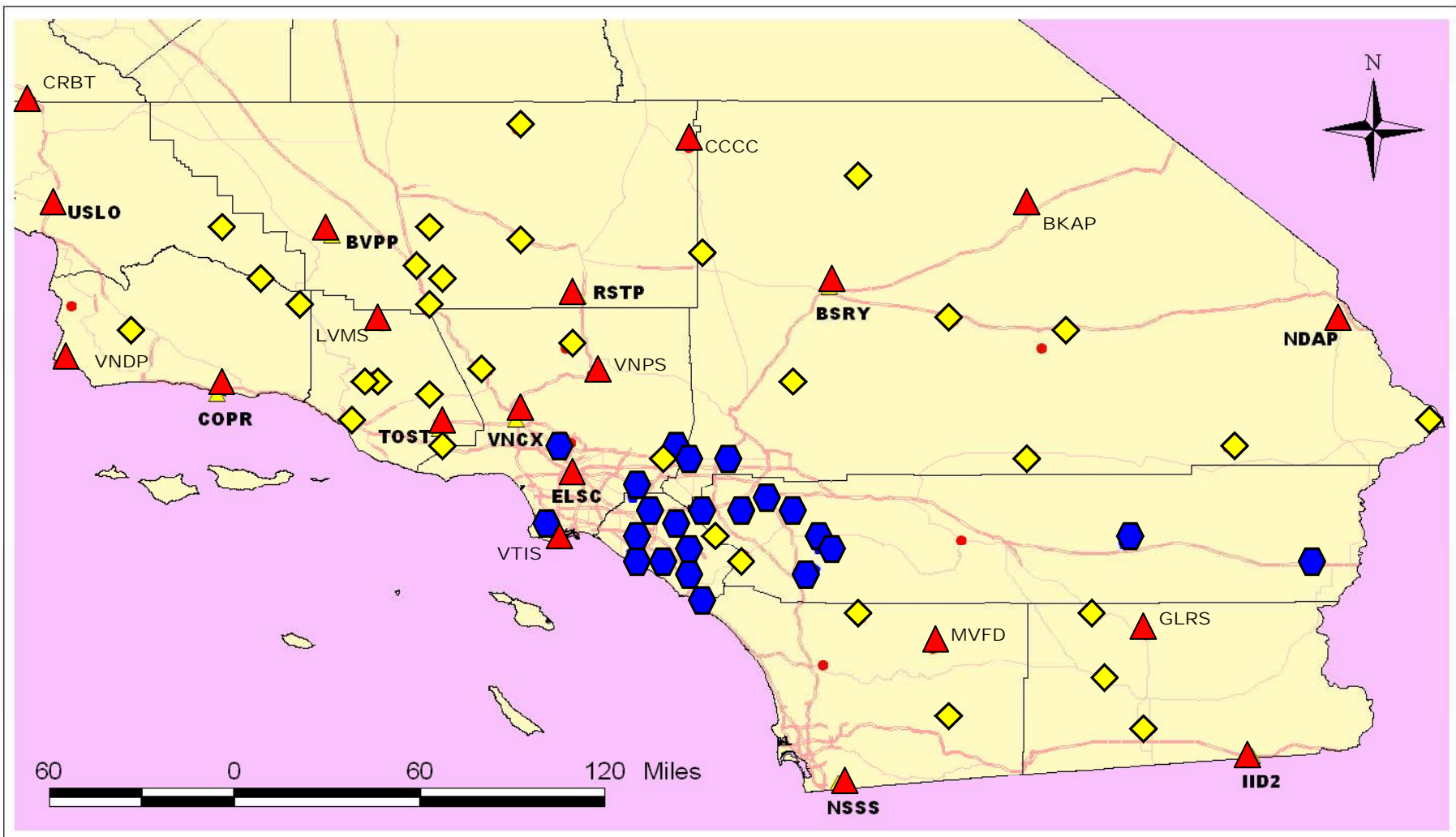
PIN Positioning
Precise Instantaneous Network Positioning

Cost Summary for Network

- 5 backbone sites - \approx \$2000 per location
- 11 initial CGPS sites - \approx \$5000 per site
- MWD will provide the labor
- MWD already owned the RTD software to run the server, just purchased latest upgrade
- Rover costs – rugged field device - \approx \$2500 + software cost

Benefits for MWD

- Labor cost savings
 - ↳ one person crews
 - ↳ shorter field set up time
 - ↳ useable at most of our facilities
 - ↳ will save us money on outside contracts
- Emergency response
 - ↳ Available 24/7
 - ↳ Allows for instant response
- Coverage
 - ↳ Covers most of our aqueduct and desert facilities
 - ↳ Covers most of our service area in conjunction with OCRTN, LARTN and SDRTN



A CONTRACT FOR NAVD88 LEVELING TO
CONTINUOUS OPERATING REFERENCE
STATIONS (CORS) FOR THE CALIFORNIA
SPATIAL REFERENCE CENTER (CSRC)



NAVD88 Elevations/Levels per this contract

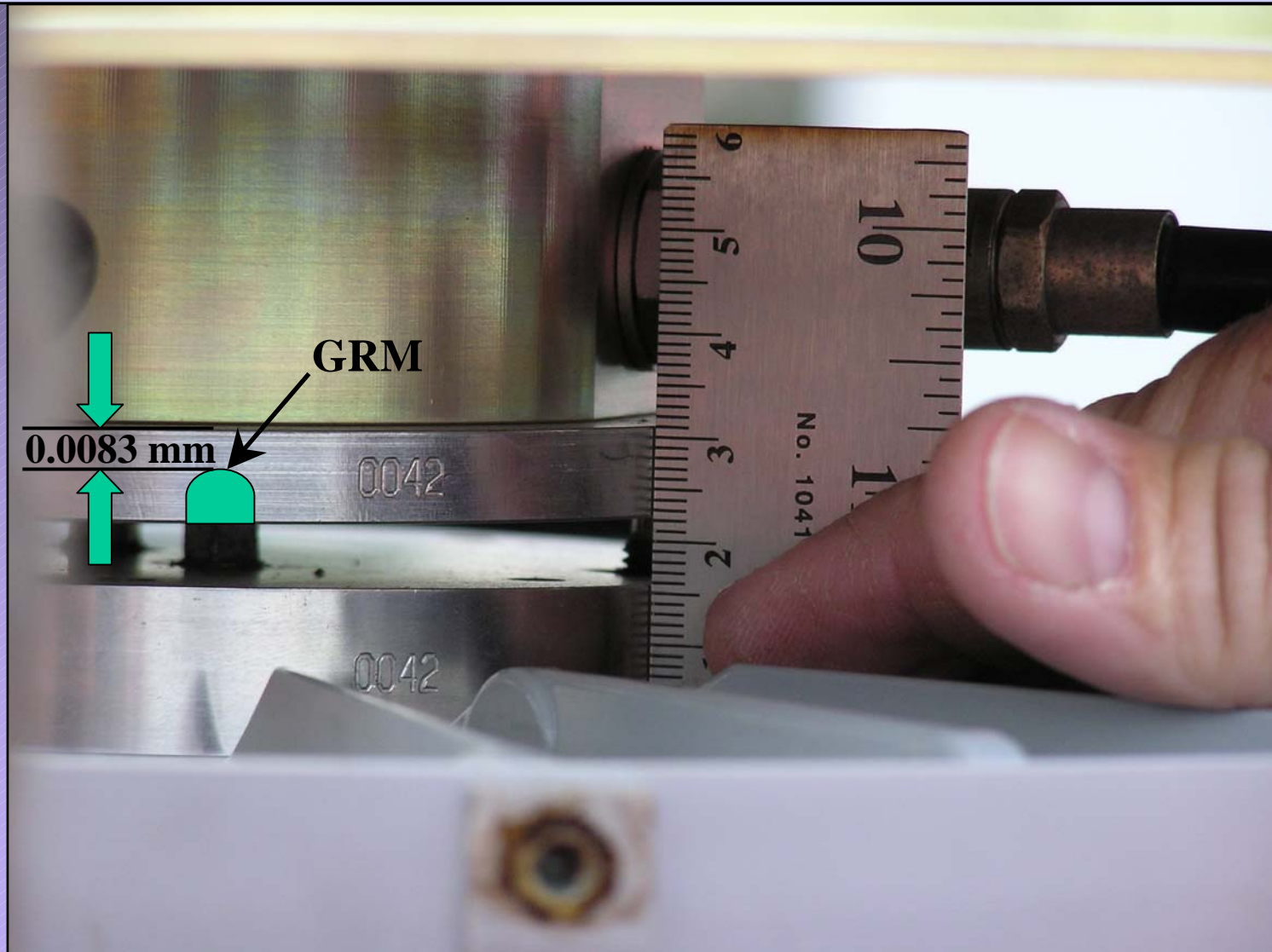


Possible alternative sites



NAVD88 Elevations completed

Measurement from Base of Adaptor to Top of Adaptor



Continuous GPS Stations Differential NAVD88 Elevations

Name	Latitude 2004.0 Epoch (dated 5/11/04)	Longitude 2004.0 Epoch (dated 5/11/04)	Ellipsoid Height (mtrs) 2004.0 Epoch (dated 5/11/04)	Elev at Tripod Reference (ARD) (mtrs)	Elev at Geodetic Reference Mark (GRM) (mtrs)	Measured Geoid Height (mtrs) (Ellp - GRM)	Elev at Bottom of Antenna (BPA) (mtrs)	Location
Imperial County								
GLRS	N33°16'29.310656"	W115°31'16.889146"	-47.8527	-14.126	-13.994	-33.859	-13.986	Galeano Reservoir
IID2	N32°42'22.194230"	W115°01'54.443621"	10.6342	45.046	45.163	-34.529	45.171	Imperial Irrigation District, Drop 2
Los Angeles County								
BRAN*	N34°11'05.603210"	W118°16'37.327305"	246.9662	N/A	280.947	-33.981	281.192	Brand Canyon Debris Basin
CLAR*	N34°06'35.724734"	W117°42'31.662715"	374.3598	N/A	407.532	-33.172	407.669	Claremont Botanical Field Station
ELSC	N34°01'47.024009"	W118°12'30.304073"	61.9194	97.043	97.149	-35.230	97.157	East LA Science Center
GVR5*	N34°02'50.791517"	W118°06'46.364221"	155.2510	189.977	190.103	-34.852	190.111	Garvey Reservoir
LORS	N34°07'59.960429"	W117°45'14.599157"	449.6302	482.589	482.713	-33.083	482.721	Live Oak Reservoir
PVRS	N33°46'25.888518"	W118°19'14.064208"	60.5608	96.282	96.432	-35.871	96.440	Palos Verdes Reservoir
TORP	N33°47'52.055815"	W118°19'50.119017"	-4.4869	31.431	31.431	-35.918	31.519	Torrance Airport
VNCS	N34°17'35.477643"	W118°29'04.289955"	329.2993	363.386	363.504	-34.205	363.512	Van Norman Complex; near I-5 and 405
VNPS	N34°30'05.315115"	W118°07'16.116225"	962.6139	994.306	994.431	-31.817	994.439	Vincent Pump Station
VTIS	N33°42'45.486066"	W118°17'37.709223"	60.2270	95.835	96.091	-35.864	96.099	Marine Exchange
Orange County								
BLSA	N33°47'58.338894"	W118°01'43.183357"	-22.3982		13.159	-35.557	13.167	Bolsa Chica Channel
CCCS	N33°51'45.856637"	W117°51'53.740001"	32.5699	67.323	67.452	-34.882	67.460	Carbon Creek Control Structure
FVPK	N33°39'44.359569"	W117°56'08.517720"	-10.7996		24.481	-35.281	24.489	Fountain Valley Park
OEOC	N33°45'57.072264"	W117°44'38.833764"	359.3655		393.606	-34.240	393.614	Orange Emergency Operations Center
SACY*	N33°44'35.665458"	W117°53'44.026736"	-10.4945		24.635	-35.130	24.643	Santa Ana City Yard
SBCC	N33°33'10.782771"	W117°39'41.296978"	89.4343		123.764	-34.330	123.772	Saddleback Community College
SCMS	N33°26'38.886661"	W117°38'04.375004"	24.0247		58.722	-34.697	58.730	San Clemente Middle School
SNHS	N33°55'38.396595"	W117°55'43.006271"	67.1611	101.956	102.075	-34.914	102.083	Sonora High School
TRAK*	N33°37'04.549285"	W117°48'12.312669"	116.2897		150.970	-34.680	151.507	Bommer Canyon, Orange Co.
WHYT	N33°40'28.148953"	W117°38'36.393484"	266.1658		300.047	-33.881	300.055	Whiting Park
Riverside County								
BILL	N33°34'41.658499"	W117°03'52.508466"	470.8182	503.052	503.155	-32.337	503.163	Lake Skinner
BLYT	N33°36'37.478992"	W114°42'53.416744"	86.7397					Blythe
BMRY	N33°57'45.641554"	W116°59'04.876869"	788.0164	819.732	819.888	-31.871	819.896	Beaumont Road Yard
CNPP	N33°51'27.458759"	W117°36'32.057520"	301.0511	334.700	334.819	-33.768	334.827	Corona Power Plant
COTD	N33°43'56.936206"	W116°23'12.750433"	28.5302	61.066	61.178	-32.648	61.186	College of the Desert, Rancho Mirage
DVLE*	N33°42'02.088417"	W117°00'02.415097"	533.2638		565.538	-32.274	565.676	Diamond Valley Lake - NE base
DVLS*	N33°41'28.071340"	W117°03'12.994288"	509.3675		541.737	-32.370	541.957	Diamond Valley Lake - Saddle Dam
DVLW*	N33°39'27.683254"	W117°04'02.716741"	528.8167		561.207	-32.390	561.357	Diamond Valley Lake - SW base
DVNE*	N33°41'36.711132"	W116°59'37.303309"	509.1962		541.461	-32.265	541.824	Diamond Valley Lake - N half EDam
DVNW*	N33°40'24.233778"	W117°03'57.962357"	509.8896		542.319	-32.429	542.553	Diamond Valley Lake - N half WDam
DVSE*	N33°40'50.866526"	W116°59'25.349771"	509.4540		541.707	-32.253	542.066	Diamond Valley Lake - S half EDam
DVSW*	N33°40'04.448589"	W117°03'57.728821"	509.8606		542.278	-32.417	542.508	Diamond Valley Lake - S half WDam
ESE2	N33°40'29.240560"	W116°59'37.833980"	513.5740		545.786	-32.212	545.792	Diamond Valley Lake - SE base; reset
ESRW*	N33°40'54.390575"	W117°04'00.973066"	549.3129		581.764	-32.451	581.748	Diamond Valley Lake - NW base
HNPS	N33°42'18.007120"	W115°38'07.159016"	394.7350	427.009	427.135	-32.400	427.143	Hinds Pumping Station
MAT2	N33°51'24.320695"	W117°26'12.062677"	399.0603	432.061	432.213	-33.152	432.221	Lake Mathews
MLFP	N33°55'06.235826"	W117°19'04.597068"	473.7220	506.428	506.554	-32.824	506.554	Mills Filtration Plant
NOCO	N33°55'10.933872"	W117°34'10.438300"	187.5522	221.107	221.240	-33.688	221.248	Norco Community College
PPBF	N33°50'08.598754"	W117°10'55.467415"	428.8531	461.291	461.418	-32.565	461.426	Perris Pumpback Facility
SGPS	N33°54'45.112957"	W116°41'44.418183"	477.4875					San Geronio Pass
WIDC	N33°56'05.111522"	W116°23'30.365023"	445.8042	477.538	477.846	-32.042	477.854	Wide Canyon
San Bernardino County								
BKAP	N35°17'13.356349"	W116°04'49.479702"	252.7822	283.295	283.418	-30.636	283.426	Baker Airport
BSRY	N34°55'06.988126"	W117°00'43.125384"	614.2315	645.510	645.634	-31.403	645.643	Barstow Road Yard
EWPP	N34°06'15.096620"	W117°31'32.053784"	331.2176	363.986	364.123	-32.905	364.131	Etiwanda Power Plant
NDAP	N34°46'03.661109"	W114°37'07.018387"	242.1751	272.580	272.706	-30.531	272.714	Needles Airport
San Diego County								
MVFD	N33°12'39.124884"	W116°31'31.076280"	1190.8764	1222.512	1222.649	-31.773	1222.657	Montezuma Valley Fire Department
NSSS	N32°34'45.516854"	W116°58'21.602584"	124.3905	158.697	158.848	-34.458	158.857	Naval Space Surveillance Station

ary 2005

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Phone: 909-392-2591

*The California Spatial Reference
Center*

CSRC website: <http://csrc.ucsd.edu>

