Oracle Spatial Summit

2015

Innovative Approaches to Modeling GPS/GNSS Construction Data with Oracle Spatial and Graph

Tracy McLane, Bechtel GIS Manager

Oracle BIWA with Oracle Spatial Summit 2015

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Speaker Bio

- ***Tracy McLane*** *is currently the* ***GIS Manager*** *for the Bechtel Infrastructure Global Business Unit (GBU), where she also serves as the* ***GIS Technical Discipline Lead*** *for the company. She is responsible for the development of the* ***GIS Technical Center of Excellence for Bechtel*** *and has implemented an Enterprise GIS database and centralized GIS Knowledge Bank for the Bechtel GIS user community. Tracy was named as one of ten* ***Bechtel Distinguished Scientists in the Bechtel Distinguished Engineers and Scientists (BDES)*** *program in 2012, and currently serves as the* ***Vice Chairman*** *on the* ***Oracle Spatial Special Interest Group (SIG) Board of Directors*** *in the Independent Oracle Users Group (IOUG).*
- *Ms. McLane has worked in the GIS industry for more than 20 years, and has provided GIS support for each of Bechtel's Global Business Units (GBUs) during her 16+ years with the company. Ms. McLane's previous GIS experience includes work at the Tennessee Valley Authority and the U. S. Department of Energy Bechtel Savannah River Site before taking her current position with Bechtel in March of 2007.*
- *Ms. McLane holds a Masters of Science degree in Geography from the University of Tennessee in Knoxville, Tennessee and a Bachelor of Arts degree in International Business from Eckerd College in Saint Petersburg, Florida.*

Bechtel
Bechtel Corporate Enterprise GIS (BecGIS)

OVERVIEW

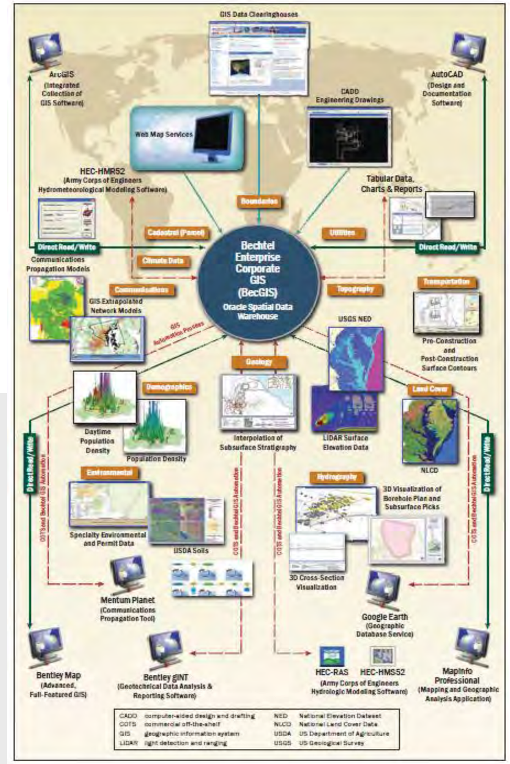
- Company: Bechtel
  - – Top U.S. construction contractor by *Engineering News-Record (ENR)* for 15 straight years
  - – Bechtel has worked on more than 25,000 projects in 160 countries on all seven continents.
  - – Bechtel has some 40 offices and 53,000 employees in nearly 40 countries.
  - – Signature Projects: Hoover Dam, English Channel Tunnel, Hong Kong International Airport, Ivanpah Solar Energy Site
- System: BecGIS
  - Internal users for multiple Global Business Units (GBUs)
  - Development and Production Environments
  - GIS Architecture on Bechtel Network

CHALLENGES / OPPORTUNITIES

- GIS Data Configuration Management Processes
- Spatial Data Content Sharing and the User Experience
- Scalable, Multi-Tiered Data Security
- Integration of Disparate Data
- Effective Spatial Data Process Workflows
- Data Integrity and Documentation of Accuracies

SOLUTIONS

- Oracle Database 10g Enterprise Edition (migrating to 12c)
  - Spatial Option with GeoRaster, Network Data Model
  - Partitioning
- Oracle PL/SQL



RESULTS

- Consolidation of field data collection and other spatial data in a centralized repository
- More effective Big Data handling and processing
- Improved data accuracies and field verification, making basis for construction activities more reliable

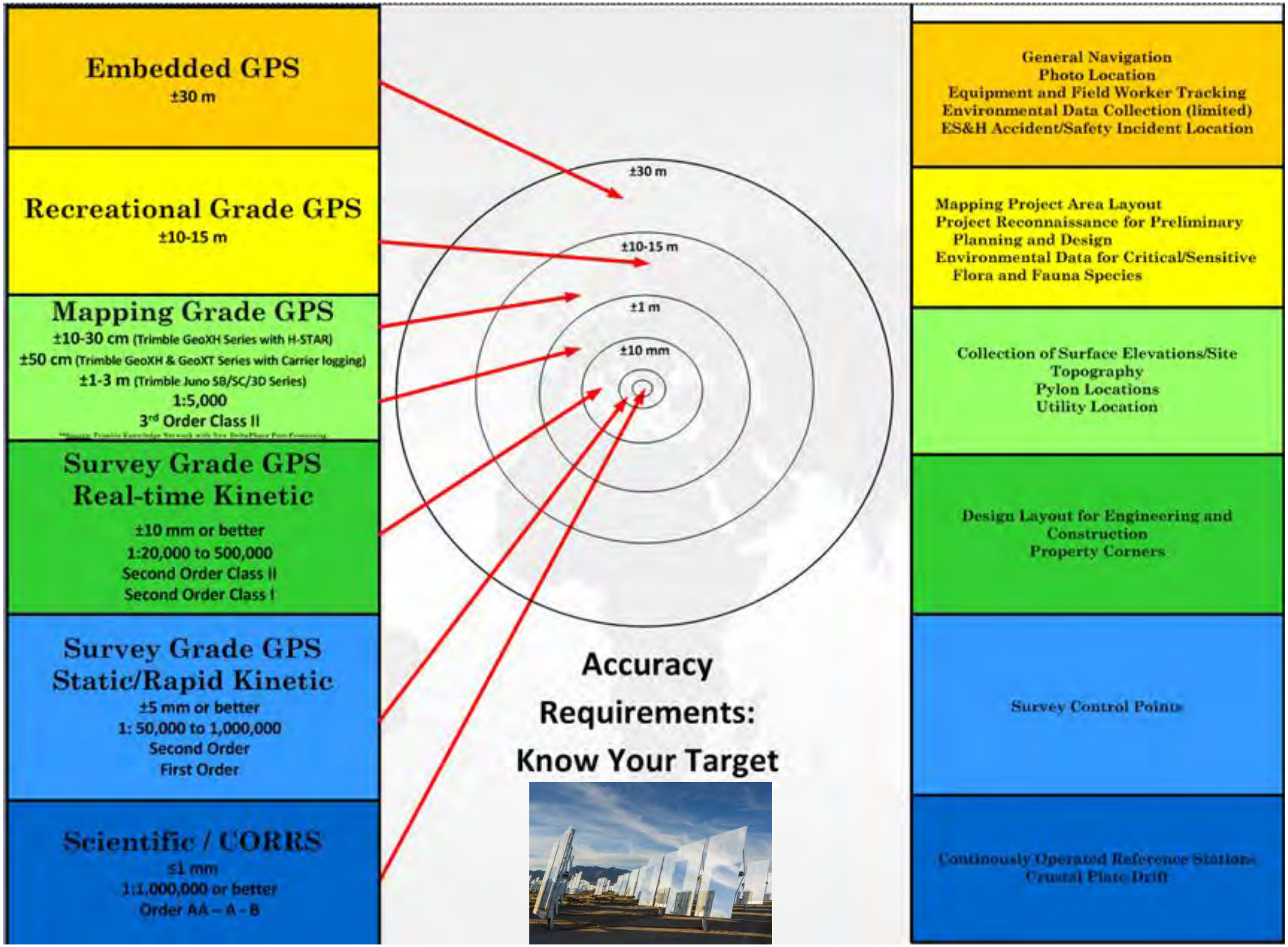
Objectives

To show how innovative approaches to Oracle Spatial and Graph database design and spatial analysis, in conjunction with GPS/GNSS mapping and survey data, can improve data processing efficiencies, streamline process workflows and document data quality parameters for engineering design and construction, using the examples below:

- Big Data Analysis
  - Analysis of GPS/GNSS Geomagnetic Effects and Data Collection Parameters
- Oracle Spatial Survey Geometry Creation
  - 3-Dimensional Geometry Creation from Feature-coded Survey Data
  - 3-Dimensional Surface Modeling from Construction Survey Data
- “Select Distinct” Spatial Analysis for 3D Subsurface Point Data
- Oracle Spatial Database Design for GPS/GNSS Construction Spatial Quantities and Quality Reporting Tool (SQ2RT)


Big Data –
Analysis of GPS/GNSS Geomagnetic
Effects and Data Collection Parameters

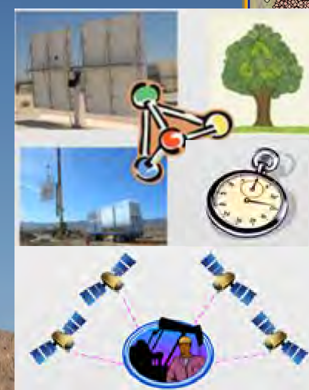
GPS/GNSS Accuracies by Device Classification

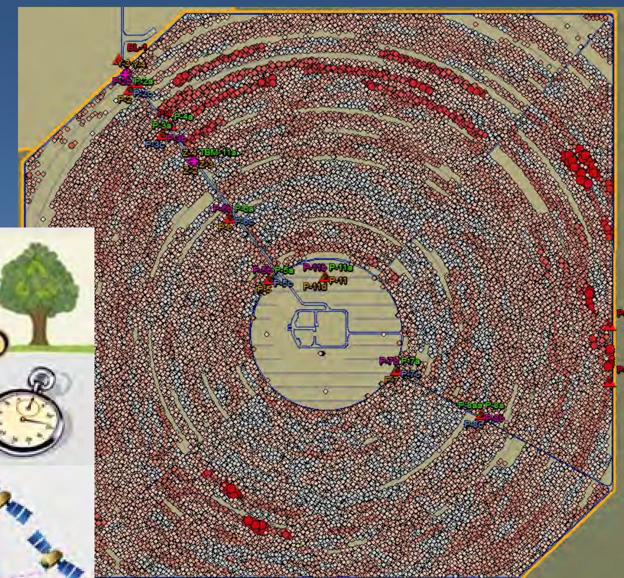


Source: Tracy McLane, Robert Voss, Wayne Bergstrom, David Campos, Walter Cudmore, Khaled Eloseily, Brandon Graham, James Henson. "GPS-GNSS Standards for Positioning Requirements and Verification: A Case Study for Renewable Energy Infrastructure" Final Report: Bechtel Technical Grant Program. December, 2012.

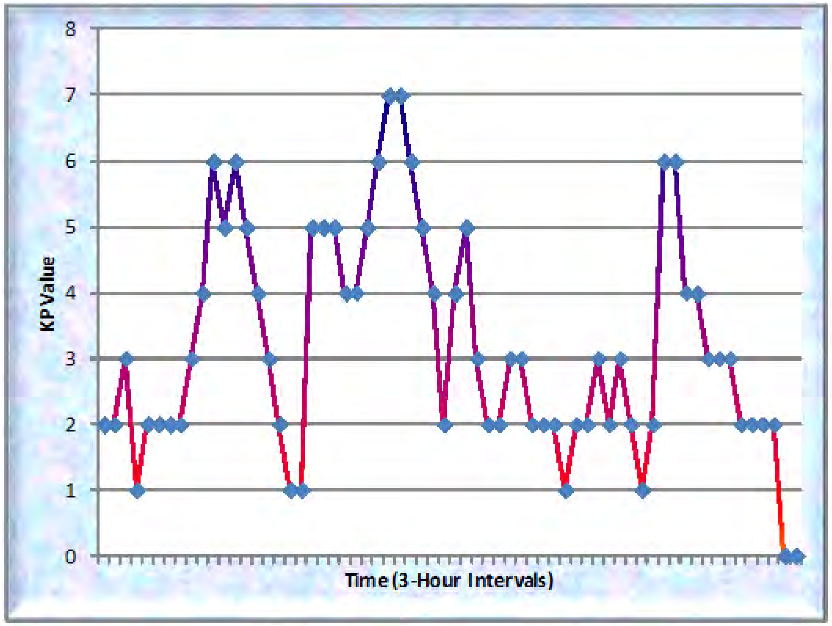
Factors that Affect GPS/GNSS Accuracy

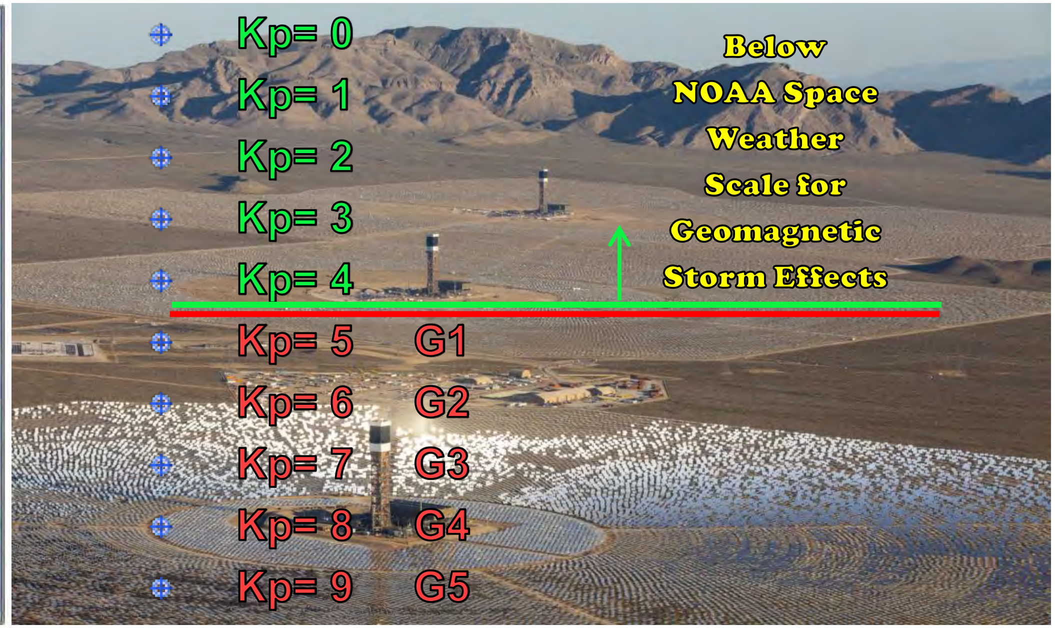
- Multipath Interferences
- Number of Available Satellites
- Satellite Positioning
- Duration of Observation
- Space Weather





Space Weather Indicator: KP Index





KP_INDEX	OBS_MONTH	OBS_DAY	OBS_YEAR	OBS_DATE	OBS_STIME	OBS_ETIME	OBS_DESC	SOURCE_FILE	FROM_HOUR	TO_HOUR	TO_HOUR2	TO_HOUR3	FROM_TIME	TO_TIME
0.1	08	19	2011	20110819	12:00:00 AM	3:00:00 AM	Period 1	20110820_kp.gif	00	03	01	02	20110819000000	20110819030000
2	08	22	2011	20110822	12:00:00 AM	3:00:00 AM	Period 1	20110823_kp.gif	00	03	01	02	20110822000000	20110822030000
3	08	23	2011	20110823	12:00:00 AM	3:00:00 AM	Period 1	20110823_kp.gif	00	03	01	02	20110823000000	20110823030000
2	08	25	2011	20110825	12:00:00 AM	3:00:00 AM	Period 1	20110826_kp.gif	00	03	01	02	20110825000000	20110825030000
1	08	26	2011	20110826	12:00:00 AM	3:00:00 AM	Period 1	20110826_kp.gif	00	03	01	02	20110826000000	20110826030000
0.1	08	31	2011	20110831	12:00:00 AM	3:00:00 AM	Period 1	20110901_kp.gif	00	03	01	02	20110831000000	20110831030000
0.1	09	2	2011	20110902	12:00:00 AM	3:00:00 AM	Period 1	20110904_kp.gif	00	03	01	02	20110902000000	20110902030000
2	09	4	2011	20110904	12:00:00 AM	3:00:00 AM	Period 1	20110904_kp.gif	00	03	01	02	20110904000000	20110904030000
2	09	5	2011	20110905	12:00:00 AM	3:00:00 AM	Period 1	20110907_kp.gif	00	03	01	02	20110905000000	20110905030000
3	09	11	2011	20110911	12:00:00 AM	3:00:00 AM	Period 1	20110913_kp.gif	00	03	01	02	20110911000000	20110911030000
4	09	12	2011	20110912	12:00:00 AM	3:00:00 AM	Period 1	20110913_kp.gif	00	03	01	02	20110912000000	20110912030000
4	09	13	2011	20110913	12:00:00 AM	3:00:00 AM	Period 1	20110913_kp.gif	00	03	01	02	20110913000000	20110913030000
0.1	09	17	2011	20110917	12:00:00 AM	3:00:00 AM	Period 1	20110919_kp.gif	00	03	01	02	20110917000000	20110917030000
1	09	20	2011	20110920	12:00:00 AM	3:00:00 AM	Period 1	20110922_kp.gif	00	03	01	02	20110920000000	20110920030000
0.1	09	24	2011	20110924	12:00:00 AM	3:00:00 AM	Period 1	20110925_kp.gif	00	03	01	02	20110924000000	20110924030000
1	09	25	2011	20110925	12:00:00 AM	3:00:00 AM	Period 1	20110925_kp.gif	00	03	01	02	20110925000000	20110925030000

Source: *http:www.swpc.noaa.gov/info/Kindex.html*

Space Weather Parameters

Observation Time Conversions

Local Date and Time Stamp:	November 2012 8:15 AM PST
UTC Date and Time Stamp:	November 11, 2012 1:15 AM UTC
Concatenated Time Stamp:	YYYY + MM + DD + HH + MM + SS
	2012 + 11 + 11 + 07 + 01 + 15
Identifier for DOP Parameters:	2012 + 11 + 11 + 07 + 01 + 00*
Identifier for KP Indices:	2012 + 11 + 11 + 07 + 00 + 00**

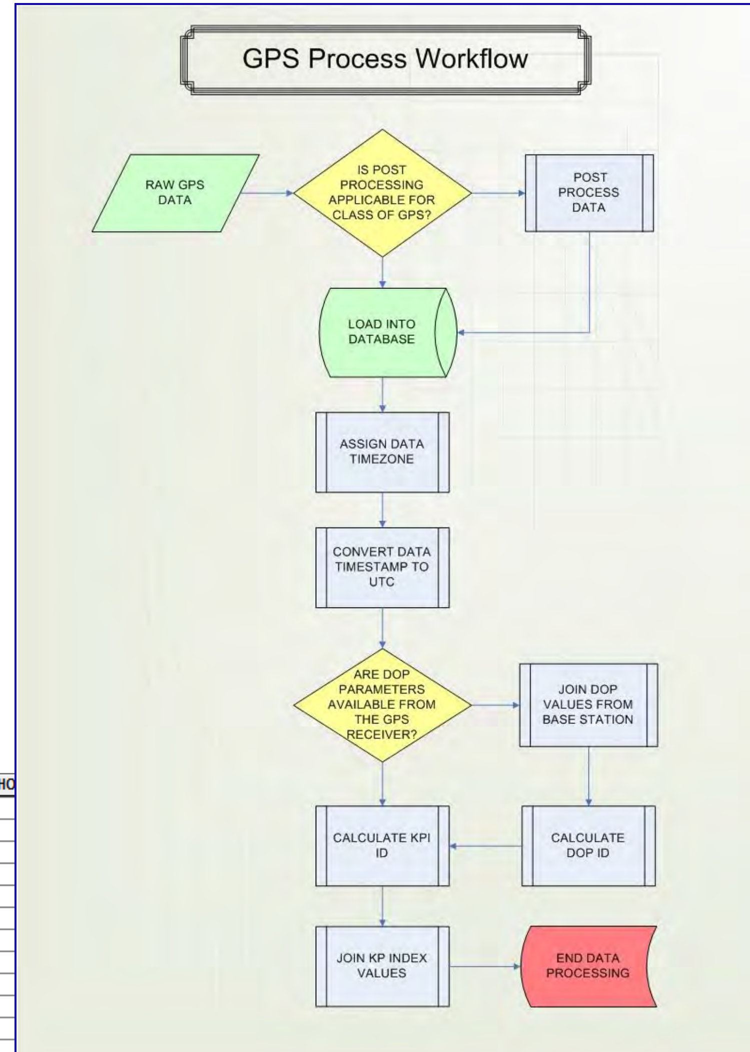
Dilution of Precision Parameters

COLUMN_NAME	COLUMN_TYPE	DESCRIPTION
DOP_DATE	Date/Time	The date of the DOP reading, in Coordinate Universal Time (UTC)
DOP_TIME **	Date/Time	The timestamp of the DOP reading, in Coordinate Universal Time (UTC)
GDOP	Double	The geometric dilution of precision
TDOP	Double	The time dilution of precision
PDOP	Double	The positional dilution of precision
HDOP	Double	The horizontal dilution of precision
VDOP	Double	The vertical dilution of precision
GPS	Long Integer	The number of GPS satellites visible to the point of observation
GLN	Long Integer	The number of GLONASS satellites visible to the point of observation
GAL	Long Integer	The number of GALILEO satellites visible to the point of observation
COM	Long Integer	The number of COMPASS satellites visible to the point of observation
TOTAL	Long Integer	The total number of satellites visible to the point of observation
FILE_NAME	Text	The file from which the DOP reading originated

KP Index Parameter

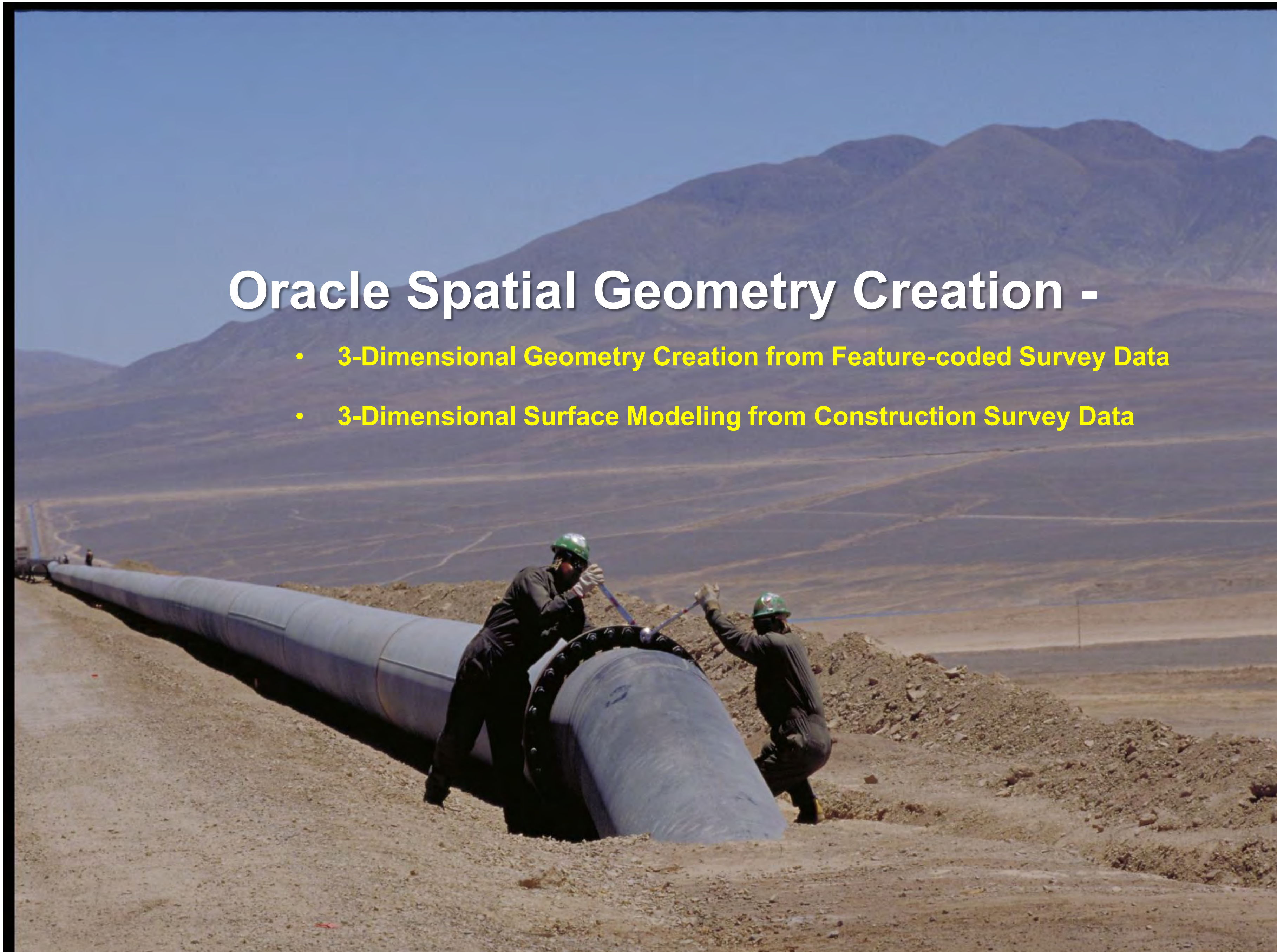
COLUMN_NAME	COLUMN_TYPE	DESCRIPTION
KPI_INDEX	Double	The planetary Kp value as collected on a three-hour interval basis.
OBS_DATE	Date/Time	The date/timestamp of the space weather KPI data
OBS_STIME	Date/Time	The starting time of the three-hour interval for the KPI observation
OBS_ETIME	Date/Time	The ending time of the three-hour interval for the KPI observation
OBS_DESC	Text(20)	The period of the day of the observation ("Period 1" for first three-hour interval, etc.)
SOURCE_FILE	Text(60)	The source .GIF image of the KPI value chart from which the data was extracted.
OBS_YEAR	Text (4)	The year of the KPI reading, in YYYY format.
OBS_MONTH	Text (2)	The month of the KPI reading, in MM format.
OBS_DAY	Text (2)	The day of the KPI reading, in DD format.
OBS_HOURS	Text (2)	The hour of the KPI reading, in HH format.
OBS_MIN	Text (2)	The minute of the KPI reading, in MM format.
OBS_SEC	Text (2)	The year of the KPI reading, in SS format.
FROM_HOUR	Text (2)	The two-digit hour of the start of the observation three-hour interval.
TO_HOUR	Text (2)	The two-digit hour of the end of the observation three-hour interval.
TO_HOUR2	Text (2)	The two-digit hour of the start+1 of the observation three-hour interval.
TO_HOUR3	Text (2)	The two-digit hour of the start+2 of the observation three-hour interval.
FROM_TIME	Text (16)	The concatenated "from" timestamp of the KPI reading, in YYYYMMDDHHMMSS format.
TO_TIME	Text (16)	The concatenated "to" timestamp of the KPI reading, in YYYYMMDDHHMMSS format.
TO_TIME2	Text (16)	The concatenated "to" timestamp of the KPI reading, in YYYYMMDDHHMMSS format.
TO_TIME3	Text (16)	The concatenated "to" timestamp of the KPI reading, in YYYYMMDDHHMMSS format.

Joining and Filtering of Space Weather Parameters



KP_INDEX	OBS_MONTH	OBS_DAY	OBS_YEAR	OBS_DATE	OBS_STIME	OBS_ETIME	OBS_DESC	SOURCE_FILE	FROM_HOUR	TO_HO				
0.1	08	19	2011	20110819	12:00:00 AM	3:00:00 AM	Period 1	20110820_kp.gif	00	03				
2	08	22	2011	20110822	12:00:00 AM	3:00:00 AM	Period 1	20110823_kp.gif	00	03				
3	08	23	2011	20110823	12:00:00 AM	3:00:00 AM	Period 1	20110823_kp.gif	00	03				
2	08	25	2011	20110825	12:00:00 AM	3:00:00 AM	Period 1	20110826_kp.gif	00	03				
1	08	26	2011	20110826	12:00:00 AM	3:00:00 AM	Period 1	20110826_kp.gif	00	03				
0.1	08	31	2011	20110831	12:00:00 AM	3:00:00 AM	Period 1	20110901_kp.gif	00	03				
0.1	09	2	2011	20110902	12:00:00 AM	3:00:00 AM	Period 1	20110904_kp.gif	00	03				
2	09	4	2011	20110904	12:00:00 AM	3:00:00 AM	Period 1	20110904_kp.gif	00	03				
2	09	5	2011	20110905	12:00:00 AM	3:00:00 AM	Period 1	20110907_kp.gif	00	03				
3	09	11	2011	20110911	12:00:00 AM	3:00:00 AM	Period 1	20110913_kp.gif	00	03				
4	09	12	2011	20110912	12:00:00 AM	3:00:00 AM	Period 1	20110913_kp.gif	00	03				
4	09	13	2011	20110913	12:00:00 AM	3:00:00 AM	Period 1	20110913_kp.gif	00	03				
0.1	09	17	2011	20110917	12:00:00 AM	3:00:00 AM	Period 1	20110919_kp.gif	00	03	01	02	20110917000000	20110917030000
1	09	20	2011	20110920	12:00:00 AM	3:00:00 AM	Period 1	20110922_kp.gif	00	03	01	02	20110920000000	20110920030000
0.1	09	24	2011	20110924	12:00:00 AM	3:00:00 AM	Period 1	20110925_kp.gif	00	03	01	02	20110924000000	20110924030000
1	09	25	2011	20110925	12:00:00 AM	3:00:00 AM	Period 1	20110925_kp.gif	00	03	01	02	20110925000000	20110925030000

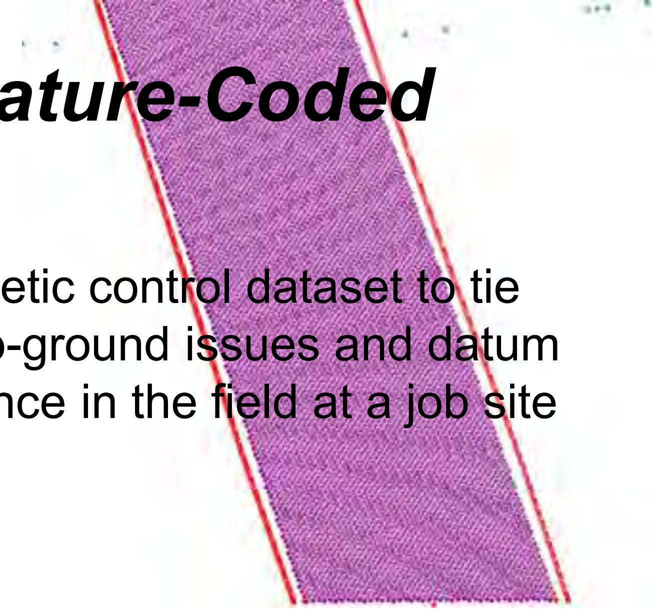
Source: Tracy McLane, Robert Voss, Wayne Bergstrom, David Campos, Walter Cudmore, Khaled Eloseily, Brandon Graham, James Henson. "GPS-GNSS Standards for Positioning Requirements and Verification: A Case Study for Renewable Energy Infrastructure" Final Report: Bechtel Technical Grant Program. December, 2012.



Oracle Spatial Geometry Creation -

- 3-Dimensional Geometry Creation from Feature-coded Survey Data
- 3-Dimensional Surface Modeling from Construction Survey Data

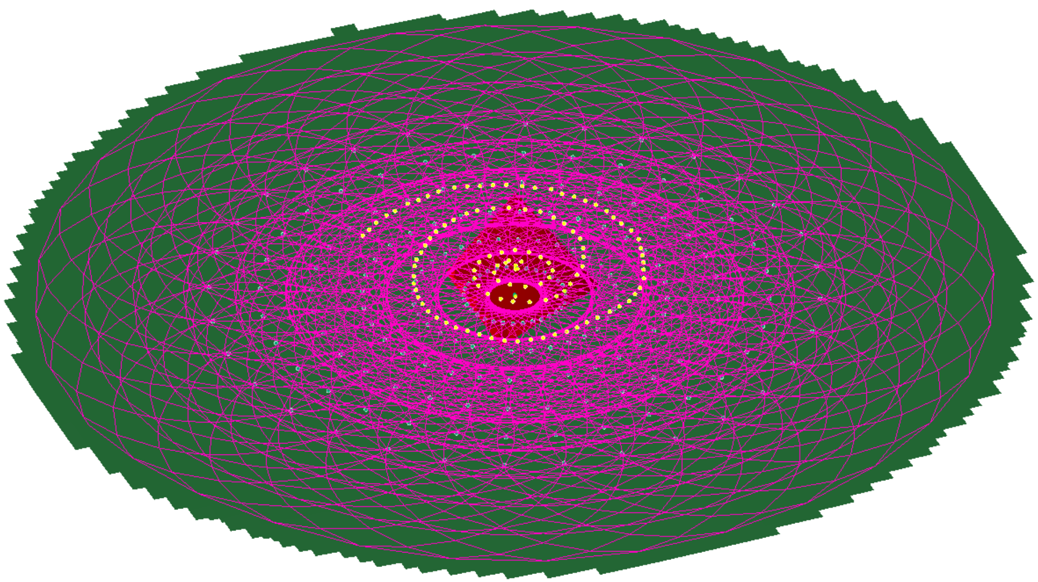
Geometry Creation from Feature-Coded Survey Data



For construction environments, development of a geodetic control dataset to tie down design features is essential for minimizing grid-to-ground issues and datum referencing issues that construction personnel experience in the field at a job site

The example below creates a single 3-dimensional survey point feature from feature-coded survey point data, which can be run in batch using PL/SQL:

```
INSERT INTO SPOT_ELEVATION_POINT
(OBJECTID, DATALINK,SPT_ELE_ID,
META_ID,MEDIA_ID,SPOT_TYP_D,
ELEVATION,ELEV_U_D,FEAT_DESC,
FILE_NAME,USER_FLAG,FEAT_NAME,
FEAT_CODE,SHAPE)
VALUES
(11771,'2000','11771',
'ESCD-LF-000020-2014',
'CJB 210601','ELEVATION',2613.972,'M',
'Bechtel Survey Location-INFOGRAFIA
INTERFERENCIAS SECTOR TORRE 511
EB4-1,
EB4-2','004 23-06-14, T LEV EB4-1, EB4-2
TORRE 511 DC.xlsx','1','PUNTOS DE
RELLENO',
'200',SDO_GEOMETRY
(3001,32719, SDO_POINT_TYPE
(475524.598,7322276.875,2613.972),null,null));
```

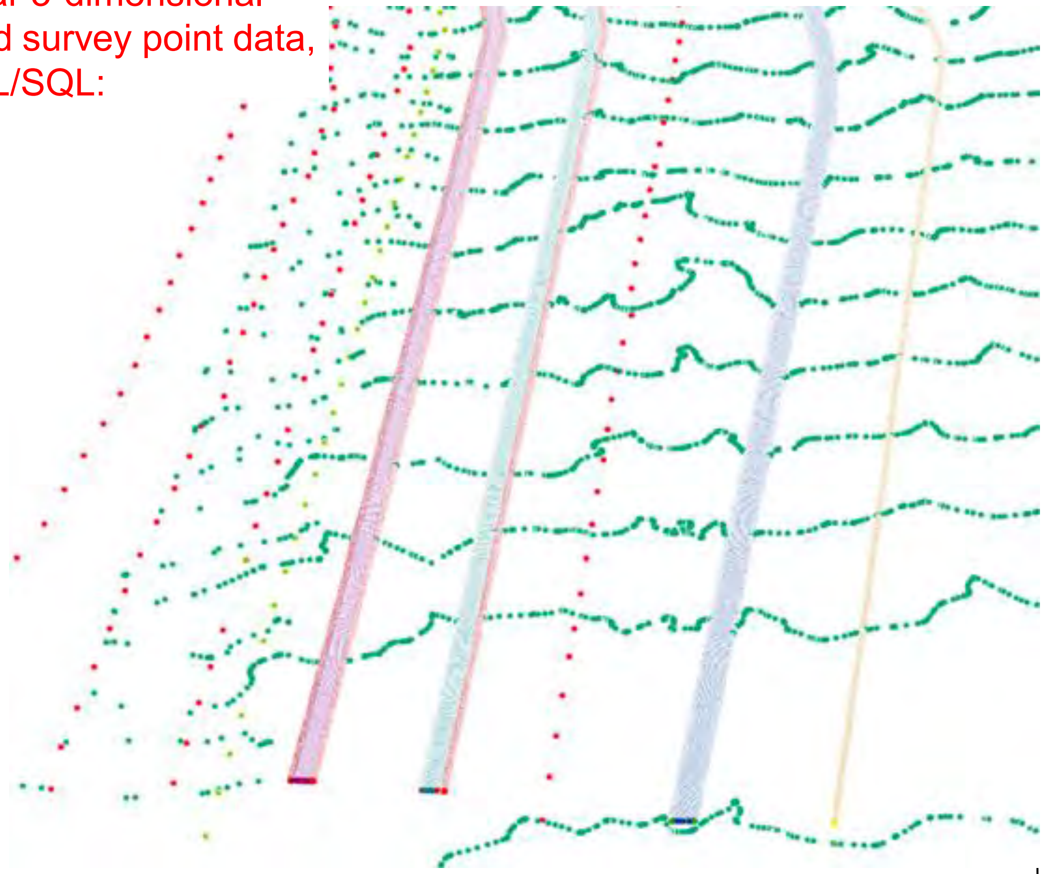


Modeling Geometries from Survey Data

Due to cost and schedule limitations for field collection, it is often beneficial to use field data to model other more detailed geometry features using a sample of field survey point data and the Oracle Spatial SDO_GEOMETRY function

The example below creates a linear 3-dimensional pipeline feature from feature-coded survey point data, which can be run in batch using PL/SQL:

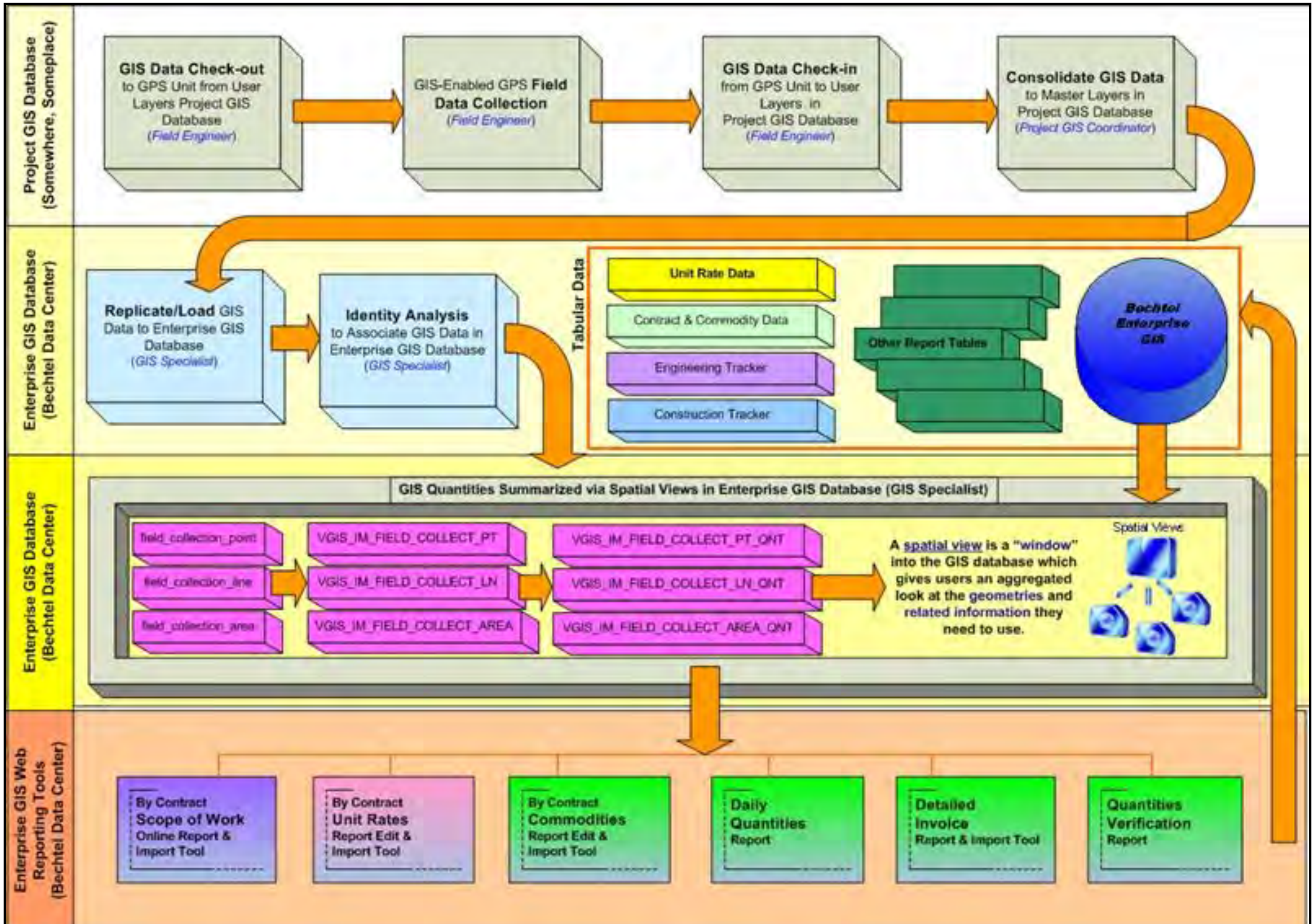
```
INSERT INTO PIPELINE_LINE
(OBJECTID,FEAT_NAME,
FEAT_CODE,SHAPE)
VALUES
(2,'Bechtel Survey Location’,'906',
SDO_GEOMETRY(3002, 32719, null,
SDO_ELEM_INFO_ARRAY(1,2,1),
SDO_ORDINATE_ARRAY (
452962.39,7334378.237,1516.462,
452989.24,7334357.069,1517.341,
453015.778,7334336.737,1517.861,
453042.731,7334315.67,1518.677,
453070.143,7334294.362,1519.574,
453096.341,7334273.967,1520.216,
453122.154,7334254.268,1520.905,
453147.967,7334234.478,1521.392,
453174.639,7334214.097,1521.569,
453201.704,7334192.756,1522.8,
453228.9,7334172.249,1523.623,
453255.021,7334151.973,1524.126)));
```



Oracle Spatial Database Design -

Construction Spatial Quantities and Quality Reporting Tool (SQ2RT)

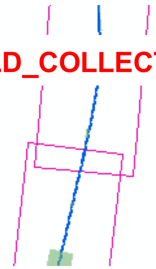
GPS/GNSS Field Data Collection Process Diagram

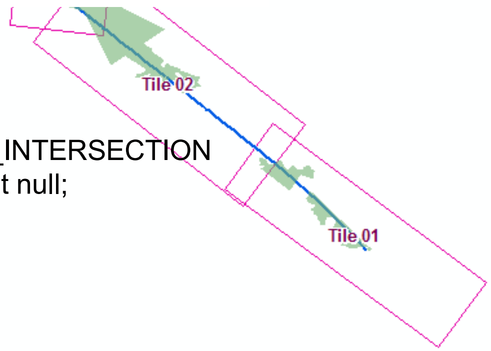


Source: *Tracy McLane, Yongmin Yan and Kevin Saso*. "Database Driven and Web Based Field Work and Quality Control System for Construction: *Spatial Quantities & Quality Reporting Tool (SQ2RT)* " Final Report: Bechtel Technical Grant Program. December, 2014.

Spatial Views for Assigning Field Collection Features to a Geographic Index Tile

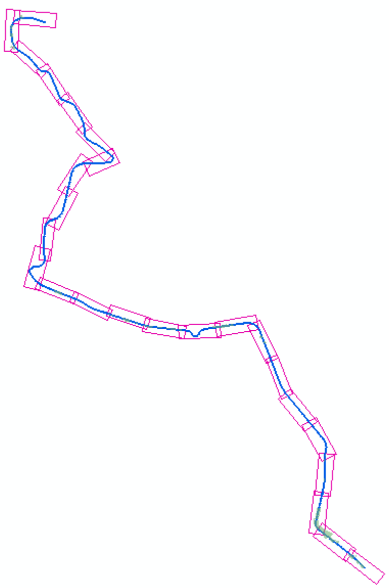
```
CREATE OR REPLACE VIEW VGIS_AN_FIELD_COLLECT_PT_GEO1
AS SELECT
input.OBJECTID OBJECTID,
input.FEAT_NAME FEAT_NAME,
input.FEAT_DESC FEAT_DESC,
target.GEOG1_INDEX TILE_CODE,
target.FEAT_NAME TILE_NAME,
SDO_GEOM.SDO_CENTROID(input.shape,0.001).SDO_POINT.X COORD_X,
SDO_GEOM.SDO_CENTROID(input.shape,0.001).SDO_POINT.Y COORD_Y,
SDO_GEOM.SDO_INTERSECTION(input.shape, target.shape, 0.005) SHAPE
FROM
SCPX.VGIS_IM_FIELD_COLLECT_PT input,
VGIS_GD_MAP_INDEX_AREA_GEO1 target
WHERE
SDO_GEOM.SDO_AREA(SDO_GEOM.SDO_INTERSECTION
(input.shape, target.shape, 0.005),0.005) is not null;
```





OBJECTID	FEAT_CODE	FEAT_NAME	AREA_SIZE
15	T0706.02	Tile 12	5127.63760607543
23	T0705.02	Tile 12	1201.97883095714
16	T0707.01	Tile 12	556.813630520656
23	T0705.02	Tile 13	240.590763783457
27	T0700.01	Tile 13	305.495664076814
28	T0706.01	Tile 13	320.02258130363
28	T0706.01	Tile 14	95.1956443908474

This SQL example creates an Oracle Spatial view using SDO_INTERSECTION to assign field geometry features to a geographic index. When combined with other geographic indices, these attributes can be joined back to the spatial features and commodity information in a spatial view and be used as “GROUP BY” columns for summarizing quantity statistics:

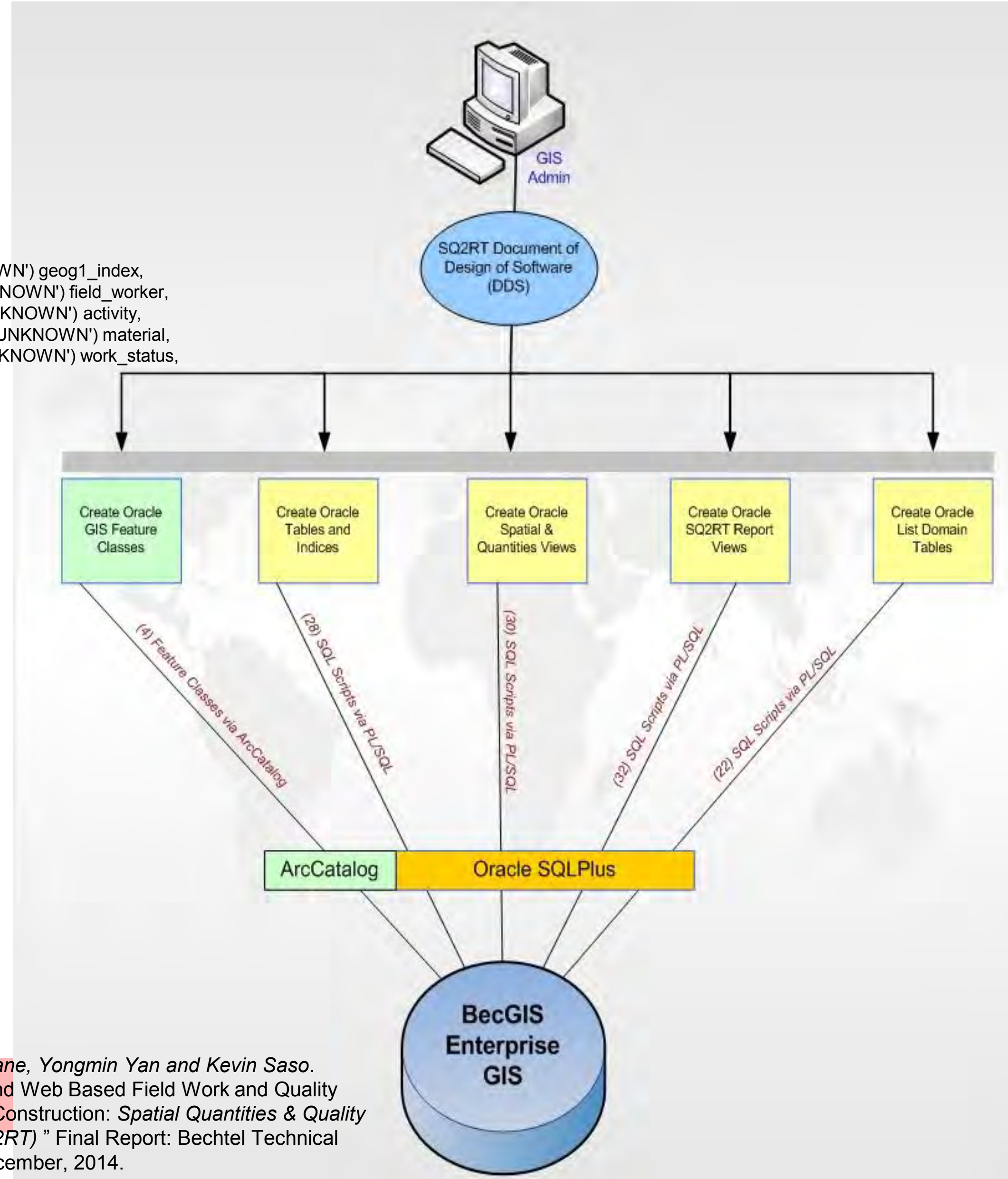


META_ID	MAP_TILE	GEOG1_INDE	GEOG2_IND	GEOG3_INDEX	GEOG4_INDEX	SCOPE_ID	FEAT_CODE	FEAT_DESC
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.212	11.212	Clear and Grub - Lightly Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.214	11.214	Clear and Grub - Heavily Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.214	11.214	Clear and Grub - Heavily Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.213	11.213	Clear and Grub - Medium Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.213	11.213	Clear and Grub - Medium Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.213	11.213	Clear and Grub - Medium Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.214	11.214	Clear and Grub - Heavily Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.213	11.213	Clear and Grub - Medium Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.214	11.214	Clear and Grub - Heavily Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.214	11.214	Clear and Grub - Heavily Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.212	11.212	Clear and Grub - Lightly Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.214	11.214	Clear and Grub - Heavily Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.212	11.212	Clear and Grub - Lightly Wooded
SCPX-IM-000001-2014	000004_GEO2	Southern	Spread 4	Map Sheet 07	Operating Area 08	000004.11.212	11.212	Clear and Grub - Lightly Wooded

Creation of Oracle Spatial Database Design for Field Data Collection Quantities

The example below creates an Oracle Spatial view of 3-dimensional field collection points with decoded domain assignments and other field attribution:

```
CREATE OR REPLACE VIEW vgis_im_field_collect_pt AS SELECT
field_collection_point.objectid objectid,
field_collection_point.g_point_id feature_id,
field_collection_point.meta_id meta_id,
DECODE (field_collection_point.geo1_d, d_geo1.domainvalu, d_geo1.domaindesc, 'UNKNOWN') geog1_index,
DECODE (field_collection_point.fld_wkr_d, d_fldwkr.domainvalu, d_fldwkr.domaindesc, 'UNKNOWN') field_worker,
DECODE (field_collection_point.actv_typ_d, d_actgen.domainvalu,d_actgen.domaindesc,'UNKNOWN') activity,
DECODE (field_collection_point.material_d, d_genmat.domainvalu, d_genmat.domaindesc, 'UNKNOWN') material,
DECODE (field_collection_point.wrk_stat_d, d_wrkstt.domainvalu, d_wrkstt.domaindesc, 'UNKNOWN') work_status,
SUBSTR (field_collection_point.geo2_d,1,6)||'.'||field_collection_point.feat_code scope_id,
field_collection_point.feat_code feat_code,
field_collection_point.feat_name feat_name,
field_collection_point.feat_desc feat_desc,
field_collection_point.feat_num feat_num,
field_collection_point.field_time field_time,
field_collection_point.photo_link photo_link,
field_collection_point.remarks field_notes,
SDO_GEOM.SDO_CENTROID(shape,0.001).SDO_POINT.X coord_x,
SDO_GEOM.SDO_CENTROID(shape,0.001).SDO_POINT.Y coord_y,
SDO_GEOM.SDO_CENTROID(shape,0.001).SDO_POINT.Z coord_z,
field_collection_point.date_last date_updated,
field_collection_point.horz_dat_d horiz_datum,
field_collection_point.horz_u_d horiz_units,
field_collection_point.vert_dat_d vertical_datum,
field_collection_point.vert_u_d vertical_units,
field_collection_point.projectn_d projection_type,
field_collection_point.projectn_n projection_name,
field_collection_point.sec_clas_d security_level,
field_collection_point.source_d source,
field_collection_point.file_name file_name,
field_collection_point.file_ver file_ver,
field_collection_point.file_rev file_rev,
field_collection_point.narrative narrative,
field_collection_point.shape shape,
field_collection_point.se_anno_cad_data se_anno_cad_data
FROM
field_collection_point,d_fldwkr, d_actgen, d_genmat, d_wrkstt, d_geo1
WHERE
field_collection_point.meta_id = 'SCPX-IM-000003-2014' AND
field_collection_point.user_flag = '1' AND
field_collection_point.geo1_d = d_geo1.domainvalu(+) AND
field_collection_point.fld_wkr_d = d_fldwkr.domainvalu(+) AND
field_collection_point.actv_typ_d = d_actgen.domainvalu(+) AND
field_collection_point.material_d = d_genmat.domainvalu(+) AND
field_collection_point.wrk_stat_d = d_wrkstt.domainvalu(+) ;
```

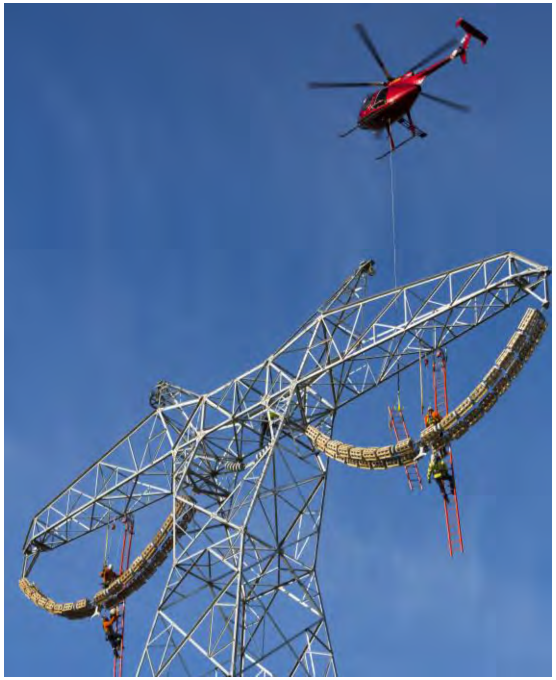


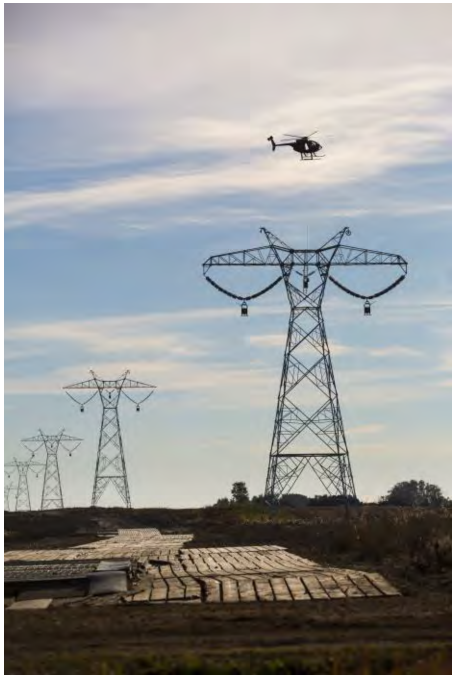
Source: *Tracy McLane, Yongmin Yan and Kevin Saso*. "Database Driven and Web Based Field Work and Quality Control System for Construction: *Spatial Quantities & Quality Reporting Tool (SQ2RT)* " Final Report: Bechtel Technical Grant Program. December, 2014.

Field Quantity Summaries with Spatial Views

The example below creates an Oracle Spatial view that tabulates the quantities metrics and summarizes them by field collection commodity and geographic indices:

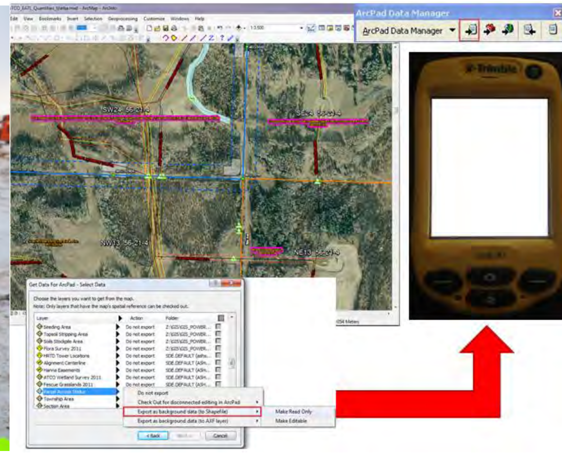
```
CREATE OR REPLACE VIEW vtbl_im_field_collect_pt_qnt
AS SELECT DISTINCT
vgis_im_field_collect_pt.project_id project_id,
vgis_im_field_collect_pt.meta_id meta_id,
vgis_im_field_collect_pt.map_tile map_tile,
vgis_im_field_collect_pt.geog1_index geog1_index,
vgis_im_field_collect_pt.scope_id scope_id,
vgis_im_field_collect_pt.feat_code feat_code,
vgis_im_field_collect_pt.feat_name feat_name,
vgis_im_field_collect_pt.feat_desc feat_desc,
vgis_im_field_collect_pt.activity activity,
vgis_im_field_collect_pt.material material,
SUM(vgis_im_field_collect_pt.feat_num) feat_num,
COUNT(vgis_im_field_collect_pt.feat_code) total
FROM
vgis_im_field_collect_pt
GROUP BY
vgis_im_field_collect_pt.project_id,
vgis_im_field_collect_pt.meta_id,
vgis_im_field_collect_pt.map_tile,
vgis_im_field_collect_pt.geog1_index,
vgis_im_field_collect_pt.geog2_index,
vgis_im_field_collect_pt.geog3_index,
vgis_im_field_collect_pt.geog4_index,
vgis_im_field_collect_pt.geog5_index,
vgis_im_field_collect_pt.scope_id,
vgis_im_field_collect_pt.feat_code,
vgis_im_field_collect_pt.feat_name,
vgis_im_field_collect_pt.feat_desc,
vgis_im_field_collect_pt.activity,
vgis_im_field_collect_pt.material;
```





ITEM_NAME	ACTION_TYP	GEO1_D	TOT_PRI	UNIT_PRI	QUANT_VAL	QUANT_U_D
Top Soil Stripping (8" Depth)	SITE WORK	NORTH	1144500	2.1	545000	SM
Top Soil Stripping (6" Depth)	SITE WORK	CENTRAL	988085	1.84	545000	SM
Fence Line - 3-Barb Wire	SITE WORK	NORTH	422000	211000	40	LM
Fence Line - 3-Barb Wire	SITE WORK	CENTRAL	422000	211000	40	LM
Fence Line – 3-Barb Wire	SITE WORK	SOUTH	422000	211000	40	LM
Fence Line - 4-Barb Wire	SITE WORK	NORTH	422000	211000	40	LM
Fence Line - 4-Barb Wire	SITE WORK	CENTRAL	422000	211000	40	HRS
Fence Line - 4-Barb Wire	SITE WORK	SOUTH	422000	211000	40	HRS
Land Clearing Area – Vegetation	SITE WORK	SOUTH	379200	3792	100	SITE
Traffic Sign – Stop Sign	SITE WORK	SOUTH	375000	1500	250	DAYS
Land Clearing Area - Shrub and Brush	SITE WORK	SOUTH	363860.9	1.5	252576	SM
Land Clearing Area - Vegetation	SITE WORK	NORTH	242751	0.5	485502	SM
Gate Location - 4-Barb Wire	SITE WORK	SOUTH	236260	236.26	40	KU Off ROW
Land Clearing Area - Timber	SITE WORK	SOUTH	232403.4	0.45	538969	SM
Land Clearing Area – Timber	SITE WORK	NORTH	220677.3	5.45	511775	SM
Foundation Excavation Area - Backfill	SITE WORK	NORTH	174115.1	9.38	19075	CM
Foundation Excavation Area - Backfill	SITE WORK	SOUTH	158545.6	8.54	19375	CM
Land Clearing Area - Shrub and Brush	SITE WORK	NORTH	158374.3	1.13	146915	SM
Land Clearing Area - Timber	SITE WORK	CENTRAL	147886	0.65	227520	SM
Foundation Excavation Area - Backfill	SITE WORK	CENTRAL	99300	6	16560	CM
Land Clearing Area - Shrub and Brush	SITE WORK	CENTRAL	72787.55	0.55	132341	SM
Land Clearing Area - Vegetation	SITE WORK	CENTRAL	69678	0.09	790000	SM
Top Soil Stripping (6" Depth)	SITE WORK	SOUTH	50000	10	5000	EA

Spatial Field Collection Quantities Web Reporting



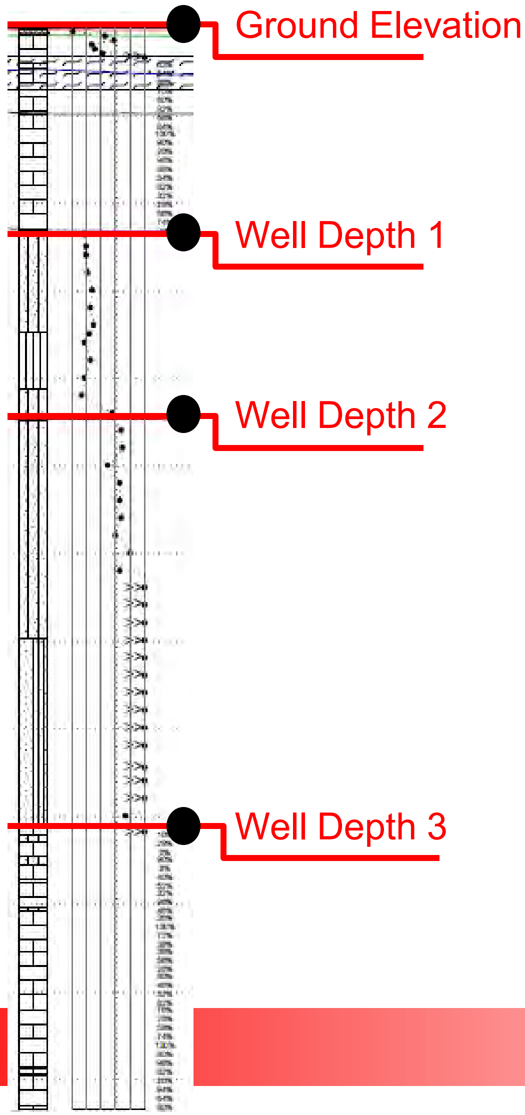
Cover Sheet \ Work Order \ T&M - Daily Report | Unprotect sheet | Browse... | Import Report | Initiate Report

Work order read from saved report. Work order created from BecGIS.

Tower Number:		Segment		Region:	
Work Order No.		Contact		Date	
Contract #:		ERP #		FC Name:	
Work Pay Item	Multiple				

	Scope # Tower.Scope.#.Rev	WP Rev Release	Description	Unit	Quantity	Unit Price	Hourly Rate	TOTAL
X	1057.1810.1.1	1	General Maintainance - Snow Removal - -	T&M				
X	1057.00010.11.1.1	2	Mat Area - INSTALL	Per Mat	24			0
X	1057.00010.13.1.1	2	Mat Area - RENTAL	Monthly per Mat	24			0
X	1057.00041.TM.1.1	2	Aboriginal Site T-Post	TM	4			0
X	1057.00042.TM.1.1	2	Construction Area Wooden Stake	TM	26			0
X	1057.00049.TM.1.1	2	Sign T-Post - Stay on Travel Lane	TM	6			0
X	1057.00052.TM.1.1	2	Travel Lane T-Post	TM	3			0
X	1057.00053.TM.1.1	2	Wetland/Fescue/Mat T-Post	TM	19			0
X	1057.00004.TM.1.1	3	T-Post	TM	32			0
X	1057.00010.11.2.1	3	Mat Area - INSTALL	Per Mat	24	6.25		150
X	1057.00010.13.2.1	3	Mat Area - RENTAL	Monthly per Mat	24	3.75		90
X	1057.00042.TM.2.1	3	Wood Stake - Construction Area	TM	26	0		0

Subsurface Investigation As-Built Survey Data – Dynamic Spatial Locations from Potentiometric Pick Data



1) CREATE OR REPLACE VIEW
VGIS_HY_WELL_PT_FILTER
SELECT
WELL_ID,
SDO_GEOM.SDO_CENTROID(shape,0.001).SDO_POINT.X,
SDO_GEOM.SDO_CENTROID(shape,0.001).SDO_POINT.Y,
shape, se_anno_cad_data, AQUIFER_SAMPLE_POINT.OBJECTID
FROM
AQUIFER_SAMPLE_POINT;

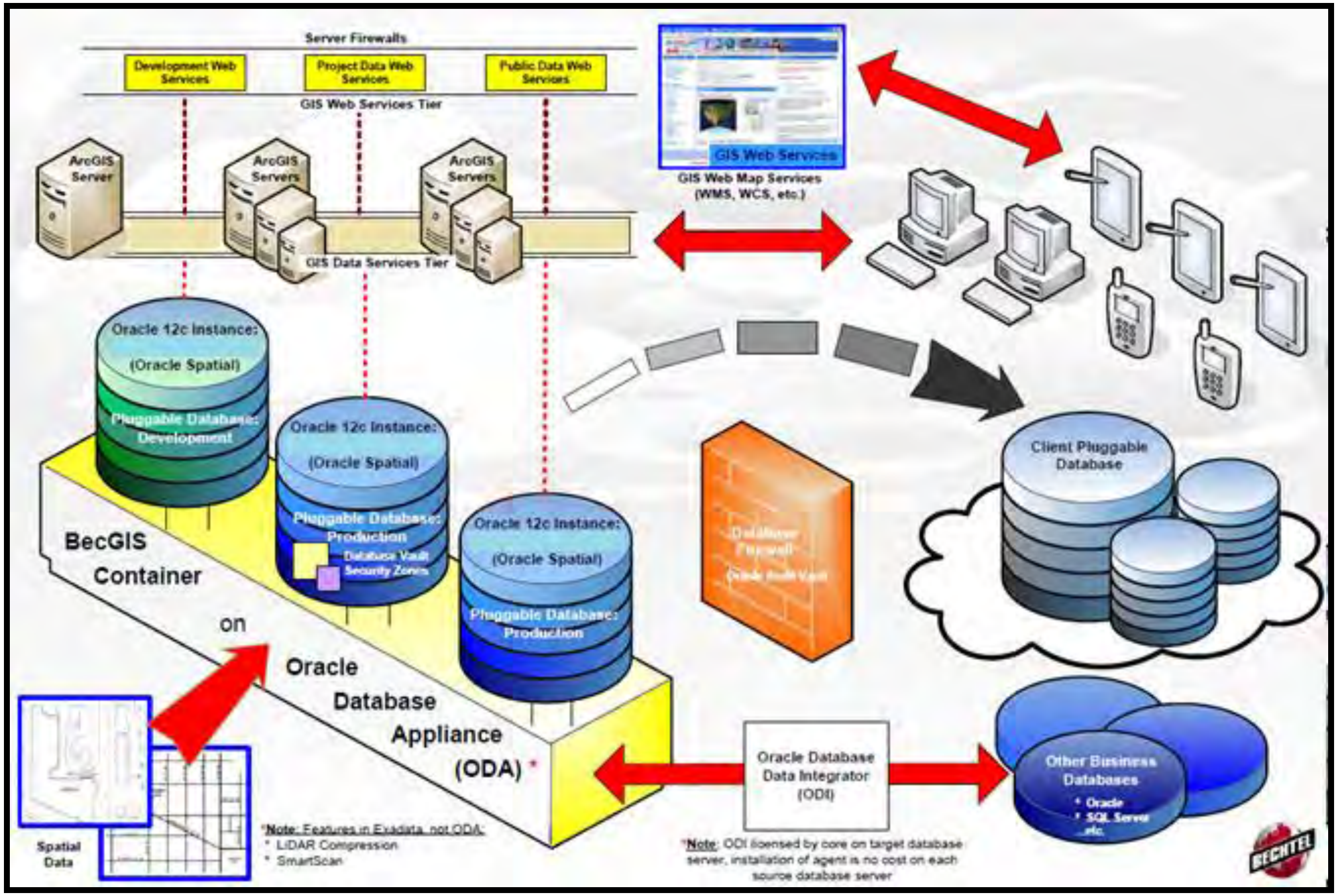
WELL_NAME	COORD_X	COORD_Y	SE_SDO_ROWID
OW-202L	2448065.05913365	570934.718099043	82

2) CREATE OR REPLACE VIEW
VTBL_HY_WELL_LUT
SELECT
WELL_ID WELL_NAME,
MAX(SE_SDO_ROWID) SE_SDO_ROWID
FROM
VGIS_HY_AQUIF_PT_FILTER
GROUP BY
WELL_ID;

3) CREATE OR REPLACE VIEW
VTBL_HY_AQUIF_PT_UNIQUE
SELECT vtbl_hy_well_lut.well_name,
vgis_hy_aquif_pt_filter.shape,
VGIS_HY_AQUIF_PT_FILTER.SE_SDO_ROWID,
VGIS_HY_AQUIF_PT_FILTER.SE_ANNO_CAD_DATA
FROM
VGIS_HY_AQUIF_PT_FILTER,
VTBL_HY_WELL_LUT
WHERE
vtbl_hy_well_lut.se_sdo_rowid=
vgis_hy_aquif_pt_filter.se_sdo_rowid(+);

Equivalent of a Spatial "*Select Distinct*" using both spatial and basic Oracle functions

Future Conceptual Model of Bechtel Enterprise GIS Data Center Architecture



Source: Concept integrated from the Bechtel GIS Design Guide on Spatial Data Management and information on emerging technologies at the Oracle Openworld 2014 Conference (T. McLane)

Key Takeaways

- Effective Enterprise Database Design should include the Use of Oracle Spatial Functions and Spatial Views to:
  - Improve the Ability to Work with Big Data
  - Ensure Data Integrity with Quality Parameter Integration
  - Summarize and Report Field Construction Quantity Metrics
  - Streamline Data Processing Workflows

- Oracle Spatial Geometry Creation from Field Survey Data can:
  - Improve the Accuracies of Construction GIS Features
  - Minimize Grid-to-Ground Issues in Engineering Drawings and BIM Models

Questions?

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