

Section 1 700/800 MHz Trunked Radio & Communications System Coverage Performance

1.1 Overview of Required Coverage

Reliable two-way radio coverage is the foundation of any Public Safety and Local Government radio communications system. The City of Houston has outgrown its current Police, Fire / EMS, and Public Works & Engineering radio systems and is in the process of replacing these systems. The new radio system developed through this project will represent a new start, a new system, and a new era in wireless communications for the City of Houston.

The purpose of this section in the RFP is to clearly articulate the City's preliminary radio coverage requirements for the new system so that proposers can develop their system offerings with a clear understanding of the City's expectations and requirements. There are many aspects of radio coverage performance that will be addressed in this Section of the RFP so that proposers can have relevant, factual information upon which to develop their system designs. It is important to note that the information that follows is preliminary and is subject to change prior to release of the finalized system RFP. The City will not be responsible for any costs involved in the vendors' proposal development.

The enclosed information is being released early, prior to the release of the full system RFP in an effort to provide qualified responders preliminary information so that they can begin the process of developing their system strategies. Hopefully, this early information will help reduce the time needed for the preparation of system proposals after the final RFP document is released by the City.

Some of the topics contained in this early release include:

- A description of the City's required coverage areas
- The type of coverage required i.e. mobile, portable on street, portable in light structures, portable in medium / heavy structures, and coverage in special areas such as the City's downtown tunnel system and selected buildings
- Use of portable radios (head level / belt level, speaker mics, radio carrying devices such as swivel attachments for belt use)
- Delivered audio quality performance (TIA / TSB-88 DAQ – voice sound quality required for the system)
- Coverage reliability throughout the defined coverage areas
- A brief overview of coverage acceptance testing requirements that will be used to verify coverage performance once the system has been constructed

Each of these issues is addressed in detail in the following pages of this Section.

The City of Houston understands that one of the more challenging aspects of system development involves site selection and the number of sites needed for use in developing a system configuration. Any new system implemented by the City must comply with FCC regulatory requirements, including spectral efficiency. It is important that the system proposed for this project be capable of meeting radio coverage and spectral efficiency requirements without having to add a significant number of additional repeater sites after the initial purchase.

To assist vendors in system development, several helpful pieces of information will be included in this Section of the RFP.

This information includes the following:

- A listing of existing City radio tower locations
- A listing of City water towers
- A listing of City properties that may potentially support the development of new additional tower sites needed to meet coverage requirements
- A detailed listing of required buildings in which coverage is mandatory including a supplemental map of the Houston area with the buildings plotted on the map.
- A map of the Downtown underground tunnel system which must be covered

1.1.1 Coverage Definition

Coverage is defined as the ability to successfully complete inbound (field to dispatch) outbound, (dispatch to field), and radio to radio voice communications in a repeat mode via the system infrastructure throughout the designated areas, standing still, and while in motion, with at least the minimum required level of audio quality (per TIA / TSB-88B or latest approved version DAQ) and with at least the specified level of propagation reliability stated in this Section. This level of performance is required for analog (if proposed), digital, and digitally encrypted modes of operation.

Audio Quality

For informational purposes, proposers will be required to submit with their proposals their recorded samples of analog and digital voice messages for the following DAQ levels:

- ◆ DAQ 2.0
- ◆ DAQ 3.0
- ◆ DAQ 3.4
- ◆ DAQ 4.0
- ◆ DAQ 5.0

Audio samples may be submitted in the .WAV file format on CD-R media and will be reviewed by the City's evaluation team. For reference, the DAQ definitions, as defined in Bulletin TSB-88 are listed below:

Table 1 – Delivered Audio Quality Scale Definitions

Delivered Audio Quality	Subjective Performance Description
DAQ 5.0	Speech easily understood.
DAQ 4.5	Speech easily understood. Infrequent Noise/Distortion.
DAQ 4.0	Speech easily understood. Occasional Noise/Distortion.
DAQ 3.4	Speech understandable with repetition only rarely required. Some Noise/Distortion.
DAQ 3.0	Speech understandable with slight effort. Occasional repetition required due to Noise/Distortion.
DAQ 2.0	Understandable with considerable effort. Frequent repetition due to Noise/Distortion.
DAQ 1.0	Unusable, speech present but unreadable.

Coverage Reliability

All references to coverage reliability in this document refer to area reliability. For example, the phrase "95% coverage" indicates that 95% of the bounded areas described shall exhibit the specified coverage resulting in a DAQ 3.4 at least 95% of the time. It will not be acceptable to provide a design where two or more adjacent failed grids exist, that is, failed points shall not be unique to any one vicinity, while still meeting the overall coverage reliability goals.

1.1.2 Mobile Radio Coverage

Mobile radio coverage will likely be limited by the Region 51 700 MHz plan guidelines which are undergoing finalization at this time. Mobile coverage performance will be expected to exceed and extend beyond the range of portable radios. Additional information regarding mobile coverage will be provided in the final system RFP.

The Houston Police Department currently utilizes low silhouette "blade type" radio antennas mounted on the trunk lid of its police vehicles. HPD wants to continue this practice; therefore the antennas for the HPD units shall be of this type.

Portable Radio Coverage On-Street

Portable radio coverage on-street shall be provided with the portable radio and antenna worn on the waist (3' AGL) throughout the designated areas in Figure 1 that follows. For day-to-day operation, some user agencies may use speaker/microphones with antennas, however for system design, radio coverage prediction, proposal development and system acceptance testing, speaker/microphones with antennas on the mic shall not be used. The radio will be positioned at belt level with the antenna.

Unusually large portable radio antennas may present operational problems for some user personnel. Proposers must clearly identify the specific antenna proposed for this project and must provide sample radios with the proposed antenna at their oral presentation after submission of a system proposal. Other portable radio antennas that are not proposed shall not be shown at the oral presentations.

Some vendors state that their portable radio carrying devices impact coverage performance. To eliminate ambiguity in this area, the City is requiring that the system design be based on a "belt clip" carrying device. If the carrying devices for your portable radio (leather case with swivel attachment, etc.) have an impact on coverage performance, such impact shall be clearly described in the section of your proposal that includes your proposed coverage maps. It is important that the system design be based on real-world operational characteristics and a "worst case" carrying device which will be defined as the belt clip device.

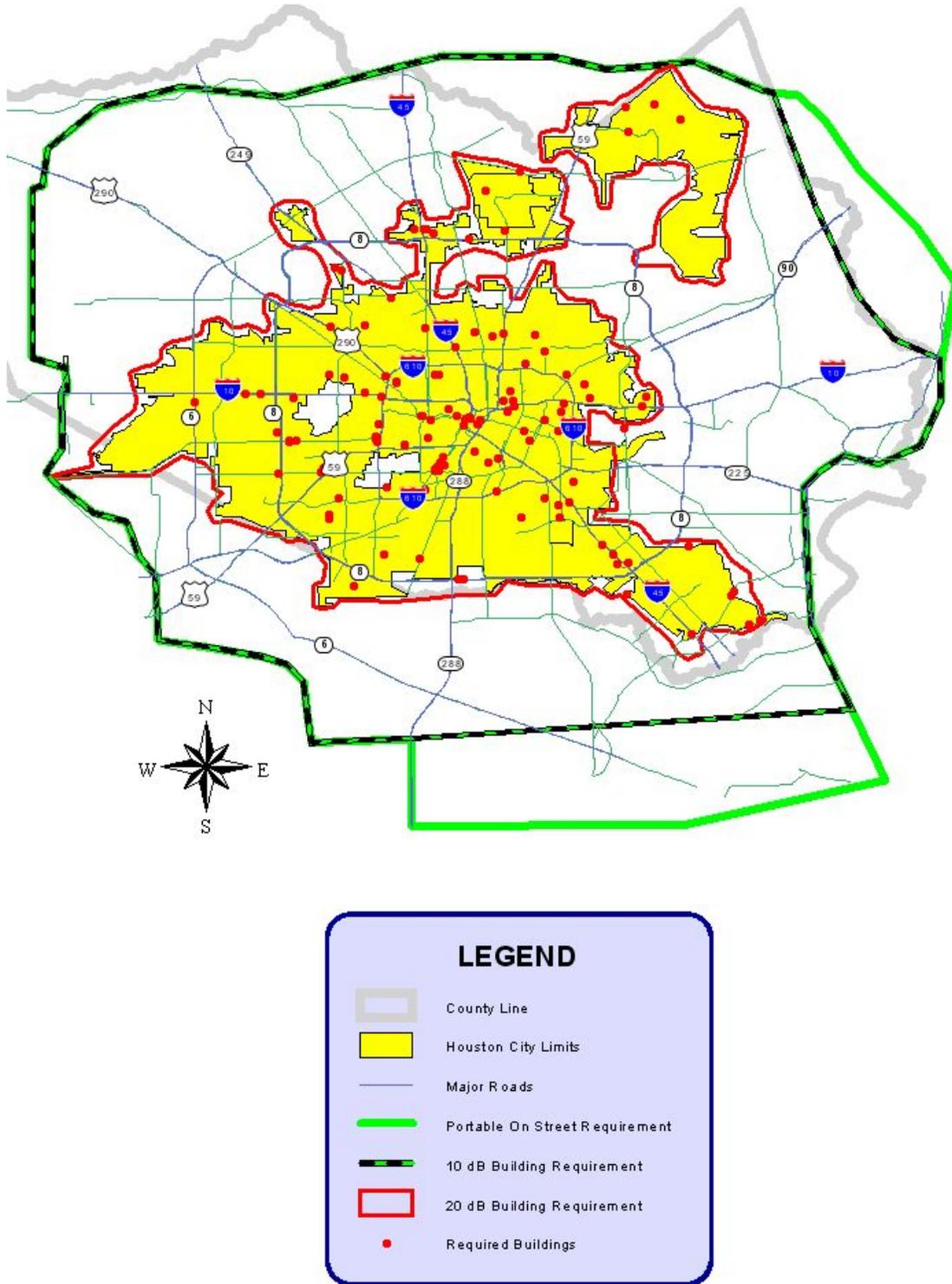


Figure 1 – Required Coverage Areas for Portable Radios (Excludes 30 dB)

In-Building Coverage – 10 dB Structures (Typically residential structures)

Coverage is required for portable radios worn on the belt within residential or other structures, defined as buildings with 10 dB or less penetration loss, within the area depicted in Figure No. 1 on the previous page.

In-Building Coverage – 20 dB Structures (Typically medium to heavy structures)

A system infrastructure baseline of 20 dB in-building coverage is required for portable radios worn on the belt while operating within structures having up to 20 dB of penetration loss within the areas depicted in Figure No. 1 on the previous page.

Downtown Area In-Building Coverage – 30 dB Structures (Typically heavy structures)

A system infrastructure baseline of 30 dB in-building coverage is required for portable radios worn on the belt while operating within the bounded downtown area depicted in Figure No. 2 that follows. Heavier coverage is required in this area due to the type and nature of structures in the downtown area.

Downtown Tunnel System

Portable radio coverage is required throughout the tunnel system and in the accompanying underground business locations that are directly attached to or at the intersections of tunnels.

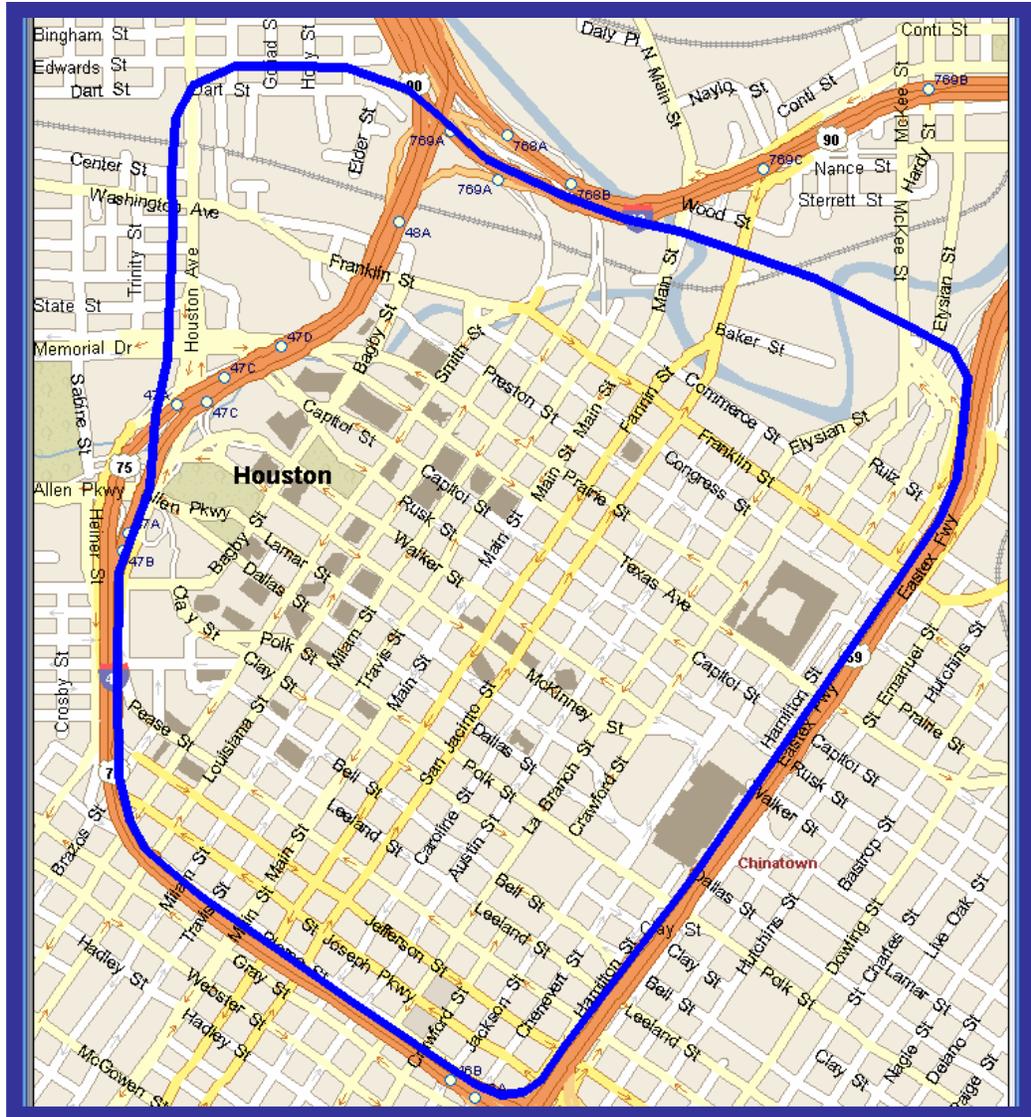


Figure 2 – Bounded area for 30 dB In-Building Coverage

Specific Buildings in which In-Building Coverage is Required

In-building portable radio coverage is required within the facilities listed below. This list may be amended as part of RFP finalization. As part of proposal development, proposers are expected to evaluate each facility to determine its associated building loss. Proposals shall include the listing of facilities that follows with a statement indicating whether each facility is covered, partially covered, or not covered at the proposed system cost. If the response is partially covered, a detailed description of expected coverage limitations must be provided on a case by case basis as well as a percentage of the facility that is expected to be covered.

Figure 1 provides a high level view of the locations of required buildings. A set of ESRI ArcView .shp files is available on CD from City Purchasing to facilitate a more in-depth review of required coverage areas and buildings.

Ref. #	Address	Building Name	Occupancy	Hazard Type
1	13430 NORTHWEST FWY	The Granite Tower	High Rise Office	Life/Fire/EMS
2	6001 ANTOINE DR 12221 N HOUSTON	Akzo Nobel International Paint	Industrial	Fire/HM
3	ROSSLYN RD	Vetco Gray Inc	Industrial	Fire/HM
4	8615 GOLDEN SPIKE LN	In Line Plastic Co	Industrial	Fire/HM
5	7225 FM 1960	Willow Brook Mall	Retail Shopping	Life/Fire/EMS
6	8850 LONG POINT RD	Spring Branch Medical Center	Hospital	Life/Fire/EMS
7	1615 HILLEND AHL	Sam Houston Gardens	Elderly Care	Life/Fire/EMS
8	777 N POST OAK RD	The Forum	High Rise Elderly	Life/Fire/EMS
9	921 GESSNER DR	Memorial City Hospital	Hospital	Life/Fire/EMS
10	7810 KATY FWY	IKEA Houston	Warehouse Store	Life/Fire/EMS
11	5300 MEMORIAL DR	The Shanks Law Firm	High Rise Office	Life/Fire/EMS
12	5400 MEMORIAL DR	Memorial Towers	High Rise Residence	Life/Fire/EMS
13	6900 OVERMEYER DR	Goodman Manufacturing	Warehouse	Fire/HM
14	6867 WYNNWOOD LN	Morrison Plumbing Supply	Warehouse	Fire/HM
15	4400 W 18TH ST	HISD Headquarters	Office	Life/Fire/EMS
16	3000 WASHINGTON AVE	Sunbeam Bakery	Large Bakery Plant	Fire/HM
17	1500 ALLEN PKWY	Federal Reserve Building The Center Mental Health Complex	Govt Office	Life/Fire/EMS/Terror
18	810 MARSTON ST		Hospital	Life/Fire/EMS
19	6100 MAIN	Rice University Complex Admiral Linen and Uniform Service	University	Life/Fire/EMS
20	2030 KIPLING ST		Industrial	Fire/HM
21	501 CRAWFORD ST	Minute Maid Park	Stadium	Life/Fire/EMS/Terror
22	1510 POLK	Toyota Center	Stadium	Life/Fire/EMS/Terror
23	1600 LAMAR 1001 AVENIDA DE LAS AMERICAS	Hilton Americas	High Rise Hotel	Life/Fire/EMS/Terror
24		George R. Brown	Convention Center	Life/Fire/EMS/Terror
25	600 TRAVIS	Chase Tower	High Rise Office	Life/Fire/EMS
26	1000 LOUISIANA ST	Wells Fargo Plaza	High Rise Office	Life/Fire/EMS
27	1111 BAGBY ST	Texaco Heritage Plaza	High Rise Office	Life/Fire/EMS
28	1600 SMITH	Continental Building	High Rise Office	Life/Fire/EMS
29	611 WALKER	611 Walker Annex	COH High Rise Office	Life/Fire/EMS
30	333 CLAY	Three Allen Center	High Rise Office	Life/Fire/EMS
31	1919 SMITH	Mickey Leeland Fed. Bldg.	Federal Office	Life/Fire/EMS/Terror
32	400 NORTHLINE MALL	Northline Mall	Shopping Center	Life/Fire/EMS
33	5850 N SHEPHERD DR	Montalbano Lumber	Lumber Yard	Fire/HM
34	330 W 19TH ST	Houston Heights Tower	High Rise Elderly	Life/Fire/EMS
35	1635 N LOOP W	Memorial Herman NW Hospital	Hospital	Life/Fire/EMS
36	1950 HEIGHTS BLVD	Heights House	High Rise Elderly	Life/Fire/EMS
37	4514 LYONS	Barbara Jordan Health Center	Health Facility	Life/Fire/EMS
38	4100 CLINTON DR	KBR / Halliburton Engineering	Industrial	Life Hazard
39	1701 BRINGHURST ST	E.O. Smith Elementary School	School	Life/Fire/EMS
40	4801 PROVIDENCE	Wheatley High School	School	Life/Fire/EMS
41	4202 LIBERTY RD	Dogan Elementary School	School	Life/Fire/EMS
42	9111 EASTEX FWY	Harris County Annex # 60	High Rise	Life/Fire/EMS
43	8826 HARRELL	Leo Daniels Towers	High Rise Elderly	Life/Fire/EMS
44	5656 KELLEY	LBJ Hospital	Hospital	Life/Fire/EMS

45	9400 IRVINGTON BLVD	Sam Houston High School	School	Life/Fire/EMS
46	9000 HOMESTEAD RD	Fm Tidwell N. on Homestead to City Limits	Open Area	
47	7201 KIRKPATRICK BLVD	Rail Yard at Kirkpatrick and Ley Rd	Industrial	Fire/HM
48	520 MERCURY	Furr High School	School	Life/Fire/EMS
49	3100 FEDERAL RD	Washburn Tunnel	Transportation	Life/Fire/EMS
50	816 CIMARRON	Cimarron Elementary School	School	Life/Fire/EMS
51	13111 EAST FWY	East Houston Medical Center	Hospital	Life/Fire/EMS
52	10044 WALLISVILLE RD	Oates Elementary School	School	Life/Fire/EMS
53	8800 CITY PARK LOOP	Michelin North America	Storage	Fire/HM
54	2300 FEDERAL RD	East Water Purification Plant	Plant	Life/Fire/EMS/Terror
55	775 GELLHORN	Anheuser Busch	Industrial	Fire/HM
56	1431 PLEASANTVILLE	Pleasantville Elementary School	School	Life/Fire/EMS
57	2800 N TERMINAL RD	Bush Intercontinental Airport IAH	Airport	Life/Fire/EMS/Terror
58	208 GREENS RD	Greenspoint Mall	Retail Shopping	Life/Fire/EMS
59	15747 JOHN F KENNEDY BLVD	Double Tree Hotel	High Rise Hotel	Life/Fire/EMS
60	12450 GREENSPOINT DR	Six Greenspoint Plaza	High Rise Office	Life/Fire/EMS
61	16825 NORTHCHASE DR	Two Greenspoint Plaza	High Rise Office	Life/Fire/EMS
62	1212 N SAM HOUSTON PKWY E	North East Purification Plant	Plant	Life/Fire/EMS/Terror
63	515 W GREENS RD	One Commerce Green	High Rise Office	Life/Fire/EMS
64	4015 WOODLAND HILLS DR	Kingwood Park High School	School	Life/Fire/EMS
65	22999 N US 59	Kingwood Hospital	Hospital	Life/Fire/EMS
66	2701 KINGWOOD DR	Kingwood High School	School	Life/Fire/EMS
67	4104 APPALACHIAN TRL	Hidden Hollow Elementary	School	Life/Fire/EMS
68	2910 HIGH VALLEY DR	Riverwood Middle School	School	Life/Fire/EMS
69	4503 BEECHNUT ST	Beechnut Police Station	Police Station	Life/Fire/EMS
70	8299 KIRBY DR	Reliant Stadium	Stadium	Life/Fire/EMS/Terror
71	6410 FANNIN	Herman Hospital Complex	Hospital	Life/Fire/EMS
72	6431 FANNIN	UT Medical School	Hospital / School	Life/Fire/EMS
73	1502 BEN TAUB LOOP	Ben Taub Hospital	Hospital	Life/Fire/EMS
74	1709 DRYDEN RD	Medical Towers	Hospital	Life/Fire/EMS
75	1 BAYLOR PLAZA	Baylor College of Medicine	School / Office	Life/Fire/EMS
76	1100 HOLCOMBE BLVD	M.D. Anderson Cancer Center	Hospital	Life/Fire/EMS
77	6540 BELLOWS LN	Favrot Tower	High Rise Dorm	Life/Fire/EMS
78	6565 FANNIN	Methodist Hospital Complex	Hospital	Life/Fire/EMS
79	1101 BATES AVE	St. Lukes Heart Institute/TCH	Hospital	Life/Fire/EMS
80	10 GREENWAY PLAZA DR	Lakewood Church	Public Assembly	Life/Fire/EMS/Terror
81	24 GREENWAY PLAZA DR	24 Greenway Plaza	High Rise Office	Life/Fire/EMS
82	4200 PORTSMOUTH	Twelve Oaks Hospital	Hospital	Life/Fire/EMS
83	1200 POST OAK BLVD	1200 Post Oak Bldg.	High Rise Residence	Life/Fire/EMS
84	2800 POST OAK BLVD	Williams Tower	High Rise Office	Life/Fire/EMS
85	2929 POST OAK BLVD	The Hampton House	High Rise Elderly	Life/Fire/EMS
86	5011 WESTHEIMER RD	The Westin Oaks Hotel	High Rise Hotel	Life/Fire/EMS
87	5060 WEST ALABAMA ST	The Westin Galleria Hotel	High Rise Hotel	Life/Fire/EMS
88	5015 WESTHEIMER RD	The Galleria	Retail Shopping	Life/Fire/EMS
89	2700 POST OAK BLVD	2700 Post Oak Building	High Rise Office	Life/Fire/EMS
90	6200 N BRAESWOOD BLVD	Seven Acres Retirement Home	Elderly Care	Life/Fire/EMS
91	10909 FONDREN RD	Goldberg Towers	High Rise Elderly	Life/Fire/EMS/Terror
92	11168 FONDREN RD	Fondren Police Station	Police Station	Life/Fire/EMS

93	7737 SOUTHWEST FWY	Southwest Memorial Hospital	Hospital	Life/Fire/EMS
94	7225 BELLERIVE DR	Bellierieve Apartments	High Rise Elderly	Life/Fire/EMS
95	7575 BELLAIRE BLVD	Conquistador	High Rise Elderly	Life/Fire/EMS
96	9301 SOUTHWEST FWY	Memorial Herman Prof. Bldg.	Hospital	Life/Fire/EMS
97	7400 CLAREWOOD DR	Clarewood House	High Rise Elderly	Life/Fire/EMS
98	7500 BELLAIRE BLVD	Sharpstown Mall	Retail Shopping	Life/Fire/EMS
99	738 S SH 6	Memorial 6 Bldg. 11111 Katy Freeway High Rise	High Rise Office	Life/Fire/EMS
100	11111 KATY FWY	Office	High Rise Office	Life/Fire/EMS
101	11757 KATY FWY	Kirkwood Atrium Office Park	High Rise Office	Life/Fire/EMS
102	14703 PARK ROW	Holiday Inn Houston I-10 West	High Rise Hotel	Life/Fire/EMS
103	16225 PARK TEN PL	Park Ten	Office / Industrial	Fire/HM
104	2101 CITYWEST BLVD	BMC Software Bldg.	High Rise Office	Life/Fire/EMS
105	2900 BRIARPARK DR	Marriott Westchase	High Rise Hotel	Life/Fire/EMS
106	10200 BELLAIRE BLVD	Halliburton Complex	Office / Industrial	Life/Fire/EMS/Terror
107	9801 WESTHEIMER RD	Westchase Bank	High Rise Office	Life/Fire/EMS
108	9999 WESTHEIMER RD	Westchase Hilton	High Rise Hotel	Life/Fire/EMS
109	235 N GREENWOOD ST	Sara-Lee Food Service	Industrial	Fire/HM
110	6745 HARRISBURG BLVD	AT&T Terminal Switching Station	Industrial	Fire/HM
111	7299 CLINTON DR	Port Terminal Railroad Assoc.	Industrial	Fire/HM
112	111 E LOOP N	Port of Houston Office Bldg.	Office	Life/Fire/EMS
113	1717 TURNING BASIN	Port Way Plaza	Office	Life/Fire/EMS
114	7810 BELLFORT ST	Shopping Center	Retail Shopping	Life/Fire/EMS
115	7990 BELLFORT ST	Apartment Complex	Residential	Life/Fire/EMS
116	8600 PARK PLACE BLVD	Goodyear Chemical Plant	Industrial	Fire/HM
117	8200 BROADWAY ST	Center America Capital Partners		
118	8900 BROADWAY ST	Hobby Airport (HOU)	Airport	Life/Fire/EMS/Terror
119	8300 MYKAWA	S.E. Police & Jail Building	Police Station	Life/Fire/EMS
120	6000 TELEPHONE	Houston Housing Authority	High Rise Elderly	Life/Fire/EMS
121	4800 CALHOUN RD	U of H Moody Towers	High Rise Residence	Life/Fire/EMS
122	4800 CALHOUN RD	U of H M.D. Anderson Library	University	Life/Fire/EMS
123	4600 CULLEN BLVD	U of H Science and Research	University	Life/Fire/EMS
124	6720 BERTNER AVE	St. Lukes Hospital	Hospital	Life/Fire/EMS
125	1200 MOURSUND	Baylor College of Medicine	Hospital	Life/Fire/EMS
126	3100 CLEBURNE ST	Texas Southern University	University	Life/Fire/EMS
127	2901 S SAM HOUSTON PKWY E	Wayne's Landscape Supply	Industrial	Life/Fire/EMS
128	3250 S SAM HOUSTON PKWY E	Industrial Polymers Inc.	Industrial	Life/Fire/EMS
129	6400 MARTIN LUTHER KING BLVD	Welch & Sackett Properties	Office	Life/Fire/EMS
130	11800 ASTORIA BLVD	Memorial Herman Southeast	Hospital	Life/Fire/EMS
131	12301 KURLAND DR	Centerpoint Energy Houston	Office	Life/Fire/EMS
132	12200 GULF FWY	Macy's Dept. Store	Retail Shopping	Life/Fire/EMS
133	9598 ROWLETT	Walmart Dept. Store	Retail Shopping	Life/Fire/EMS
134	11101 FUQUA ST	Sam's Club Retail Outlet	Retail Shopping	Life/Fire/EMS
135	2101 NASA PKWY	NASA Bldg. 17	Industrial	Life/Fire/EMS/Terror
136	16600 SPACE CENTER BLVD	NASA Bldg. 338	Industrial	Life/Fire/EMS/Terror
137	18000 SPACE CENTER BLVD	NASA Bldg. 207D	Industrial	Life/Fire/EMS/Terror
138	3000 NASA PKWY	NASA Bldg. 232	Industrial	Life/Fire/EMS/Terror
139	500 BAYBROOK MALL	Baybrook Mall	Retail Shopping	Life/Fire/EMS
140	3400 BAY AREA BLVD	U of H Clear Lake Campus	University	Life/Fire/EMS

141	18300 ST JOHN DR 3100 GENOA RED BLUFF	St. John's Hospital Southeast Water Purification	Hospital Plant	Life/Fire/EMS Life/Fire/EMS/Terror
142	RD	Plant	Plant	Life/Fire/EMS/Terror
143	2929 BAY AREA BLVD	Clear Lake High School	School	Life/Fire/EMS
144	13131 ALMEDA RD	Allpoly National Container	Industrial	Life/Fire/EMS
145	14000 STANCLIFF ST	Dowling Middle School	School	Life/Fire/EMS
146	16111 CHIMNEY ROCK RD	Station 80	Fire Station	Life/Fire/EMS
147	9455 W MONTGOMERY RD	North Police Substation	Police Station	Life/Fire/EMS

The listing of buildings is substantial. The City prefers that in-building coverage be provided directly by the radio infrastructure. The City also recognizes that even with a baseline system providing 20 dB of in-building coverage, (30 dB in the downtown area) there will still be some buildings within the City that have much greater penetration loss. Additional measures may be required to facilitate coverage in those facilities.

To extend coverage beyond the 20 and 30 dB levels, the City will consider secondary methods of providing heavier coverage within such structures. Such methods might include:

- Increasing the baseline coverage of the infrastructure in a particular area of the City to support higher levels of building penetration as was done in the immediate downtown area.
- Installation of multi-band channelized bi-directional amplifier systems in selected buildings where building access is permitted. Costs for such solutions shall be provided on a case by case basis so that the City can utilize available funding in a manner that best meets the City's needs.
- Installation of a fiber optic based in-building RF distribution system
- Utilization of vehicular repeater systems or other similar systems to extend tactical on-scene radio coverage into heavy structures

Hi-rise buildings present significant communication problems for the Police and Fire Departments when working events inside such facilities, particularly when trying to communicate between the lower floors and upper floors of the facility. It is the intent of the City to resolve such problems to the extent feasible as part of this project.

Downtown Underground Tunnel System

The City of Houston downtown tunnel system consists of a number of underground walkways that allow people to travel throughout many parts of the downtown area under the streets and from building to building. The system consists of the following tunnels:

- Main Tunnel Loop (One Shell Plaza)
- S. Louisiana Tunnel
- W. Dallas Tunnel
- W. Walker Tunnel
- N. Louisiana Tunnel
- N. Travis Tunnel

- E. McKinney Tunnel
- Harris County Tunnel

All of the tunnels are interconnected with the exception of the Harris County Tunnel.

The 6-mile network of tunnels connects most major buildings. Originally designed for individual businesses, the tunnels were extended bit by bit to connect over 82 buildings. Now more than 100 shops, restaurants, cafes and galleries have been built into the tunnel system. The tunnels themselves are generally narrow (10-15 ft) walkways, as seen in Figure 3, that open into larger areas where shops and restaurants or food courts are located (Figure 4).



Figure 3: Typical Downtown Tunnel Walkway



Figure 4: Tunnel Shop/Restaurant Area

1.2 Listing of City Owned Radio Facilities

The following table provides a listing of City radio resources that will likely be available for use in development of the new radio system infrastructure. Additional new sites will likely be required. A separate listing of City properties that may potentially be used for site development has been provided in Section 1.3 that follows.

Houston Site List

Site Name	Address	Latitude	Longitude	Site Height
Teague Tower Site	5850 Teague Road	29:51:19 N	95:32:21 W	500 ft.
Lake Houston Tower Site	13501 Aqueduct Road	29:54:47 N	95:08:47 W	500 ft.
Clodine Tower Site	21002 FM 1093	29:42:17 N	95:44:54 W	500 ft.
Beechnut Tower Site	4503 Beechnut	29:41:15 N	95:27:05 W	300 ft.
Police Communication Center (PCC)	61 Riesner	29:45:12 N	95:22:12 W	470 ft.
Police Academy Site	17000 Aldine Westfield	29:57:57 N	95:21:47 W	140 ft.
Reed Road Tower Site	4000 Reed Road	29:39:27 N	95:22:08 W	300 ft.
COMFAC Tower Site	5711 Neches	29:48:43 N	95:20:15 W	250 ft.
Westside Command Center Site	3203 Dairy Ashford	29:43:43.6 N	95:36:19.8 W	75 ft.
DPS Tower Site	10110 Northwest Freeway	29:48:28 N	95:27:17 W	300 ft.
Coletto Tower Site	8201 Dalton	29:42:07 N	95:16:25 W	300 ft.
Houston Fire Department				
HFD Logistics-	1205 Dart St.,	29:46:10.4 N	95:22:09 W	50 ft.
HFD Station 5	2020 Hollister Road	29:48:36 N	95:30:21 W	60 ft.
HFD Station 10	6600 Corporate Drive	29:42:23 N	95:33:06 W	100 ft.
Station 56	5820 Little York Road	29:52:11N	95:18:20 W	120 ft.
Station 44	675 Maxey Road	29:46:40 N	95:13:04 W	75 ft.
Station 70	11410 Beamer Road	29:36:06 N	95:13:45 W	110 ft.
Station 72	17401 Saturn Lane	29:33:29 N	95:26:28 W	90 ft.
Station 102	4102 W. Lake Houston	30:03:56 N	95:11:16 W	100 ft.
Station 96-	7409 Willow Chase	29:58:09 N	95:32:26 W	100 ft.
Station 64	3000 Greens Road	29:57:02 N	95:20:30 W	80 ft.
Station 82	11250 Braesridge Drive	29:39:26 N	95:30:40 W	140 ft.
Station 4	6530 West Little York	29:51:58 N	95:29:21 W	150 ft.

1.3 Listing of City Owned Properties for Potential Site Development

Where a physical address is not available (undeveloped land) an HCAD account number is given as reference.

1. Fire Station #36, 7720 Airport Blvd., 77061; Lat:29:39:28, Long: 95:16:47
2. 0 Cullen, HCAD account # 0410070120006
3. 10150 Old Katy Rd, 77043; HCAD #0583030000023
4. 0 Lumpkin Rd, 77043, HCAD # 0401590000182
5. 0 E. Little York Rd, 77093; HCAD # 0420540000261
6. 10677 Homestead Rd, 77016, HCAD # 0420540000196
7. 0 Seneca Rd., 77016; HCAD #1173580010003
8. 0 Homestead Rd., 77016; HCAD #1173580010002
9. 2855 Bay Area Blvd, Houston, TX 77062; HCAD # 1170200010004
10. Fire Station # 73, 9640 Wilcrest Dr., 77099 – Lat: 29:40:22, Long: 95:34:14
11. Fire Station #90, 16525 Park Row, 77084 – Lat: 29:47:20, Long: 95:40:14

1.4 Listing of City Owned Water Towers

The following table provides a listing of City water towers that may potentially support a repeater site. Yellow shading denotes sites that may already have a Utility microwave system on the tower, which will likely not be available for radio system use.

Structure No.	Address	Key Map	Coordinates		TCL Elev. (ft)
			Latitude	Longitude	
	10711 Silkwood	530W	29°39'49"N	95°32'12"W	
030ET1	8619 Bellaire Blvd.	530E	29°42'16"N	95°32'14"W	228.1
042ET1	3835 W.Orem	572J	29°37'39.73619"N	95°26'05.77349"W	201.8
071 ET1	11900 Plaza Verde	372U	29°56'10.73600"N	95°25'02.73695"W	218.4
087ET1	7501 Langley	415W	29°52'01.44886"N	95°17'32.99521"W	202.1
090ET1	16335 Hillcroft	610D	29°35'22.65783"N	95°30'28.23193"W	221.4
099ET1	306 Bluetail	338L	30° 1'37"N	95°6'56"W	207.4
102ET1	11330 West Hardy	373T	29°56'1 2.58942"N	95°22'55.52109"W	229.3
102ET2	15960 West Hardy	373P	29°56'55.13132"N	95°23'05.35264"W	226.7
103ET2	10602 1\2 Braewick	530Z	29°39'57.42350"N	95°29'50.13774"W	210.7
106ET1	12705 Brantrock	528D	29°42'54.27006"N	95°36'25.44232"W	227.8
107ET1	1642 W.Greens Blvd.	372Q	29°57'05.89614"N	95°25'27.42938"W	253.7
108ET1	12844 Westheimer	488U	29°44'14.62702"N	95°36'40.99465"W	216.1
124ET1	1455 Baybrook	617Z	29°32'38.37995"N	95°09'04.70807"W	170.0
125ET1	3710 Eldridge	528B	29°43'04.36208"N	95°37'27.17080"W	218.4
127ET1	10903 Ella Blvd.	372T	29°56'20.28117"N	95°26'02.12405"W	244.7
128ET1	14315 Park Row	448W	29°47'1 9.61476"N	95°38'25.04557"W	245.9
128ET2	18324 Addicks Levee	447W	29°47'34.28839"N	95°41'41.20967"W	250.9
132ET1	7203 W.Greens Blvd.	370K	29°57'17.68704"N	95°32'05.69588"W	266.0
140ET1	900 Tristar	617B	29°35'20.37912"N	95°10'46.90802"W	172.4
154ET1	1110 Mustang Tr.	336F	30°02'24.87369"N	95°14'20.58260"W	235.3
156ET1	2802 Kingwood Dr.	336C	30°03'10.36984"N	95°13'35.77858"W	228.6
156ET4	1500 Woodland Hills	336G	30°02'00.65963"N	95°13'01.87136"W	227.9
157ET2	3211 Appalachian Tr.	297N	30°04'42.23962"N	95°11'28.48732"W	227.6
158ET3	2903 High Valley	297Z	30°03'33.41091"N	95°09'22.79341"W	227.5

1.5 Radio Coverage Prediction

For the purposes of your proposal, radio system coverage shall be predicted through the use of a radio wave propagation model which has been developed on the basis of theoretical and empirical data, and which will take into account channel bandwidth, modulation schemes, delivered audio quality, coverage reliability, terrain irregularity, foliage, land use / land cover, building penetration losses, noise, and long- and short-term signal variations. The model used for the purposes of the coverage prediction process shall be identified in your proposal, and the rationale for system gains and losses used must be provided in your proposal. A table of system coverage parameters such as gains and losses utilized in each propagation analysis must be provided. A terrain database with a minimum of 3 arc-seconds of resolution is required. You must identify the terrain data model used in your coverage predictions. Your propagation analysis system must utilize both vertical and horizontal antenna patterns.

Coverage maps for individual site analyses shall be presented on 11" x 17" media using a USGS 1:250,000 scale topographical maps. The scale on the finished map shall be 1" = 4 miles. Each coverage analysis shall include a legend with the following information:

- Type of coverage displayed on the map, mobile, portable on-street, portable in 10 dB buildings, portable in 20 dB buildings, portable in 30 dB buildings.
- Location of portable radio (radio and antenna at belt level – 3ft. AGL)
- Delivered Audio Quality (DAQ)
- Analog (if proposed), digital clear mode, digital encrypted mode.
- Radio coverage reliability shown, percent reliability and type of reliability (area vs. contour)
- Type of carrying device used with portable radio (belt clip)
- RF signal levels in dBm corresponding to the coverage colors displayed on the map
- Simulcast capture ratio in dB and targeted propagation delay in microseconds for simulcast sites
- Square mileage of each type of proposed coverage shown on the coverage analysis or on an accompanying parameter sheet

To streamline the evaluation process, the City is requiring that all vendors use the same map format as shown below:

- On-Street portable coverage with portable radio worn at hip level (3' AGL) using a speaker microphone without antenna (coverage shown in green)
- In-building portable coverage, radio worn at belt level (3' AGL):
 - ◆ Inside standard structures, up to 10 dB penetration loss (*blue*)
 - ◆ Inside heavy structures, up to 20 dB penetration loss (*red*)

- ◆ Inside downtown area structures, up to 30 dB penetration loss (yellow)
- ◆ Mobile coverage, trunk mounted blade type antenna, centerline at 4' above ground (purple)

Portable coverage maps shall be prepared for the limiting case (talkout vs. talkback). A mobile talkout coverage map shall also be provided along with the bit error threshold for DAQ performance. All RF coverage maps shall be provided to the City in both printed and electronic formats. The electronic versions shall be provided in a common GIS format for further coverage analysis by the City. The following map file formats are acceptable.

- ESRI shape files
- ESRI export files
- Mapinfo Mif or Mid

Land Use / Land Cover Data

A separate map exhibit must be provided showing your land use / land cover data used for this project. The source and publication date of your Land use / land cover database must be provided. The latest available data is preferred along with a color land use map showing where each use category was used. A table that describes each use category and lists the loss value associated with it shall accompany this map.

Simulcast Time Delay Interference

In the event that your proposed system configuration utilizes simulcast technology, your proposed coverage maps must account for (display) any harmful time delay interference (TDI) that may occur in your proposed system configuration. This means that forecasted areas of TDI must be clearly shown on your coverage maps or be shown as "non-covered" areas.

If you are proposing a simulcast configuration, you must identify the delay threshold in microseconds and capture ratio in dB on which the City's system design is based.

1.6 Brief Overview of Radio Coverage Testing

Coverage testing shall be conducted as part of the System Acceptance Testing process to verify that the appropriate levels of coverage performance have been provided. The following provides a brief preliminary listing of tests that shall be performed to verify coverage performance. The final system RFP will include more complete detail regarding coverage testing.

The City of Houston will supervise the entire coverage testing process. For test purposes, with the exception of the downtown area, the City shall be divided into uniform square grids of approximately 1/2 mile by 1/2 mile in area. For better testing resolution downtown, the downtown area as shown in Figure 2 will be divided into 1/10 mile by 1/10 mile grids.

The City and vendor will test coverage in all accessible grids. Grids that are not accessible by the test teams shall not be counted in the reliability calculation. The City may elect to pass certain grids if it is obvious that they are adequately covered.

The portable radio voice testing shall be performed using random sentences read from daily, periodicals. Both analog (if proposed) and digital (clear and encrypted) voice modes will be tested. Extrapolation of results from tests in one direction to reach conclusions about the other direction will not be acceptable. This is a two-way radio system. A failure in the inbound, outbound, or radio to radio mode, either moving or stationary at a test location, will constitute a failed test location, which will be subject to a test retry.

Test Retry

In the event that the first test call (inbound, outbound or radio to radio) is unsuccessful, the field team will be allowed to move up to 5' and a retry will be permitted. If the second attempt to communicate fails (no access or audio quality below DAQ 3.4), that test location will be deemed a failure.

All retries will be counted. No more than 5% of the retries will be allowed to pass this portion of the coverage testing process.

Roaming Software

If your proposed system utilizes roaming software in the user radios to change sites as the user radio moves throughout the City's service area, that software must be properly installed, calibrated, and optimized prior to radio coverage testing. If proposed by the vendor, site roaming will be an important part of day to day operation and will be factored into the coverage testing process. This means that if a radio fails to affiliate with the proper repeater site and the test calls are unsuccessful as a result, the test call fails.

Portable Radio Coverage

Portable radio coverage will be thoroughly tested. The following tests are currently planned:

- On-Street Voice Quality Tests throughout the specified area
- In-Building Voice Quality Tests
 - ◆ Random buildings with up to 10 dB of penetration loss
 - ◆ Random buildings with up to 20 dB of penetration loss
 - ◆ Downtown buildings with up to 30 dB of penetration loss
 - ◆ Downtown underground tunnel system
 - ◆ All required buildings

Mobile Radio Coverage

- Outbound Signal Strength Measurement and Bit Error Rate test throughout the required areas
- Voice Quality Tests (stationary, and vehicle moving up to 80 MPH)