Appendix E

Excerpted from EOEA Build-Out Methodology Specifications

Initial Map & Source Materials
A variety of source materials and information needs to be collected from the town – this may involve several visits and some personal interaction with town staff. The contractor needs to collect at a minimum the following documents:

- Current town zoning by-law
- Any additional land use controls relating to subdivisions, flood zones, parking etc.
- Current zoning map or maps
- Board of health regulations
- Conservation by-laws such as local wetlands or riverfront protection

In order to map subdivisions and/or to update the land use mapping, which will be critical inputs to the process, the contractor should look at the history of subdivision filings since the date of MacConnell land use mapping. If there are a sufficient number of non-ANR subdivisions to warrant, a separate subdivision layer should be created. Essential attribute information to be collected and assigned to the subdivision polygons includes subdivision-id, name, date, number of lots, number of houses built to date and total acreage. Ideally this information would come in soft-copy form and could be linked to the subdivision mapping. Additionally the contractor should obtain any available map showing the new subdivisions at a scale suitable for transfer to a town-wide map.

If the town has a digital basemap and has compiled its assessor's parcel maps in digital form, those files may provide useful ancillary information and should be collected, along with the assessor's database.

After obtaining and reviewing all the above documents, if locus maps/site plans for recent subdivisions are not available, the contractor should seek the assistance of a local official such as the town planner or engineer in compiling their boundaries on a large-format map of the community. Town base maps may have severe limitations in terms of geographic registration and accuracy, so it would be recommended to use a map of known accuracy (such as a USGS topo or ortho image base map) for this purpose.

Deliverable: If EOEA is providing additional production support or review, then copies of the materials collected should be forwarded to EOEA at this point.

Critical GIS Data Inputs
For every town, the contractor shall determine the status/availability of the following input layers:

- Zoning and overlays (some towns available from MassGIS)
- Update of MacConnell land use
- Open space (available from MassGIS)
- Recent subdivisions (source data described above)

The first three and possibly the fourth as described above will constitute the minimum GIS data inputs for the buildout. Even if the zoning, land use updates or recent subdivisions exist in

digital form, **the contractor will need to review these data layers and possibly reformat them or update them** as part of this project. (See "Local Review"). If not currently available, they will need to be digitized from scratch using the source materials described above and the available GIS data such as the orthophotos. Careful attention to coincident features in the creation of these new layers will save much grief during subsequent overlay procedures. For instance, the MHD roads layer should be the standard road centerline and the MassGIS boundary coverage should be the standard for town boundaries.

What follows is detail on each of these layers.

Zoning

The contractor will develop or update zoning (ZONE) and zoning overlays (OVER) from the most current town zoning map or maps, digitized with reference to the most current town zoning by-law and registered to the town boundary layer from MassGIS. The polygon attribute table of these GIS layers must conform to the MassGIS/RPA standard for attributes as implemented in the MassGIS library which is attached to this contract. Zoning overlays should be digitized only if they will have a real impact on development – in many cases they impose minor restrictions which won't affect the basic buildout analysis.

Subdivisions

If needed, the contractor will develop a GIS layer representing subdivisions (SUBD) filed and approved since the date of the last MacConnell land use photo-interpretation. This layer will have attributes as follows:

NAME 40 40 C
SUB_I 8 8 C subdivision id from local listing
SUB_CODE 4 4 I field for optional use in processing
DATE_APPR 8 8 I date approved
DATE_DIG 8 8 I date digitized
NO_UNITS 4 4 I total number units approved
UNITS_BLT 4 4 I number units built to date
TOT_ACRES 4 8 F 2 total area of approved sudivision

Land Use

The contractor will provide a new GIS layer (NEWLU) to complement the subdivision layer which shows all other new development not shown in that layer. This will be developed from visual interpretation of the most recent orthophoto if available. **For the land use update, only one attribute field will be required,** defined as

TYPE 3 3 C land use type

The codes for this new land use will be as follows:

- R new residential development
- C/I new industrial/commercial development

Note that this layer will be used as an update of the MacConnell land use, but is being kept separate since the methodology of its creation and attribution are so different.

Open Space

The **MassGIS open space data need to be reviewed and updated as part of this project**. New data on permanently protected open space must be provided as an edited version of the MassGIS data, using the coding conventions and other guidance contained in the document "Guidance Notes" distributed to open space mapping volunteers. Permanently protected open space is land which is either held in fee ownership by a government agency or a private non-profit organization for the purpose of conservation or water supply protection or land with deeded limitations on development e.g. conservation restriction, APR or other permanent legal interest. **For the purposes of this contract, all the attribute fields relating to site name, ownership or other legal interest, primary purpose and level of protection are critical and must be collected.** If a Municipal Open Space plans is available, this may help focus the Open Space layer update.

Additional GIS Data Inputs
For every town, the following data layers will be provided by MassGIS as part of the regular data distribution of a Data Viewer CD for that town. This will include the assignment of an ArcView 3.1 license to facilitate the use of Mr. SID imagery.

- Black and white ortho
- 1:25k USGS topo imagery
- MacConnell land use
- Q3 floodplains data (100 year floodplain only)
- Classified slopes (based on USGS 25k DEM)
- Areas of critical environmental concern
- Locations of public water supply wells and wellhead protection zones
- MHD Roads
- USGS/MassGIS hydrography including wetlands polygons
- Rivers Protection Act buffers
- MHD Mass transit
- USGS transmission lines

The MacConnell land use will be part of the analysis and needs to be reclassified to show residential, commercial/industrial and undeveloped land. How some classes are treated may be a matter for judgement and later review; MAPC, for example, has found that gravel pits, presumably classified as industrial/commercial developed, might need to be reclassified to allow for future development.

Also note that many of the above data layers may not represent constraints, but should be available for display and query in interaction with the town.

The contractor will determine in consultation with MassGIS and any other sources the availability/status of the following standardized data layers which might contribute significantly to the analysis:

- NRCS soils
- National Wetlands Inventory
- DEP/WCP 1:5k wetlands

Note that the NRCS mapping of soils, or any derivative of that mapping, needs to be used with great caution, since soil suitability tables may greatly overstate the limitations on development imposed by poorly-drained soils or high water table, alternative technologies may be used, etc.

The DEP Wetlands Conservancy Program mapping is the most detailed, and should be used if available, with the NWI data being next most desirable and the 25k USGS hydrography as the default choice. The NWI should be coded to allow for display of the five wetlands systems with an item SYSTEM, 1, 1, C whose domain is "P","L","R","E","M".

Finally, after analysis of the town zoning by-law and the other source documents collected above, the contractor will determine if any other legal, physical or environmental factors will so significantly influence or constrain future development in the town that no reasonable buildout analysis can be done without considering them. These might include:

- particular ownership of parcels of land
- "grandfathering" of certain large parcels
    - water and sewer infrastructure
    - buffers to any of the data layers mentioned above
    - miscellaneous factors such as transmission lines

The miscellaneous layer should be standardized with the name MISC and fields as follows:
COMMENT 40 40 C
MISC_CODE 4 4 I

As digital GIS layers, these factors may be included as absolute or partial constraints as described below under "GIS Methodology". They may also simply represent information that needs to be considered visually when estimating the potential for buildout. Every such GIS layer must be documented fully with descriptive text and data dictionary. However, within the time constraints of this project, it is unlikely that there will be sufficient time to complete the development of much additional data.

Local Review
At this stage, the contractor should produce one or more overview maps of the town with various data layers plotted out for local review. It is critical that the appropriate town officials review the various GIS layers developed or updated for this project. If at all possible, the contractor should review the mapping of environmental or legal constraints with the following municipal staff:

- community planner, if there is one, or the zoning enforcement officer,
- a member of the conservation commission or its staff,
- the town engineer or assessor
- the public health officer.

Time constraints may not permit the contractor to meet with all of these, in which case the contractor's reasonable judgement about which data layers are most in need of review should determine the level of effort. All suggested changes should be incorporated into the datasets above.

**** Deliverable: As soon as all GIS inputs have been created or updated and reviewed, they must be delivered to EOEA along with appropriate, brief documentation describing each**

one and whether or not it represents an absolute or partial constraint (see "GIS methodology") .

GIS Methodology
Given the datasets described above, the basic approach can be summarized in the following series of steps. Sample code, training and support will be provided to contractors as part of the project.

1. The assumption is that development will occur on land that is not now developed, so the analysis begins by creating a GIS layer of all developed land by combining areas identified in the mapping of subdivisions and the update of land-use with areas extracted from the MacConnell land use mapping. The use of the MacConnell information should be documented – the developed categories would include spectator and water-based recreation (8,9), residential (10,11,12,13), commercial (15), industrial (16), transportation (18), waste disposal (19), and water (20). Mining (5) is debatable but is probably not an absolute constraint. The assumption that "developed" land cannot be further developed may be questionable; if specific land-use categories or areas that are already developed can be identified where infill or densification should be considered then those areas should be left out of the developed layer and used instead as partial constraints. (See discussion below under step 7.)

2. Subtract all developed land-use from zoning to produce a GIS layer of undeveloped land with attributes of zoning disrict code.

3. Subtract all permanently protected open space from GIS layer of undeveloped land to produce unprotected, undeveloped land . As described above, permanently protected open space is land which is held in fee ownership by a government agency or a private non-profit organization for the purpose of conservation or water supply protection or which has deeded restrictions on development,

4. If relevant, combine all wetlands information into one data layer.

5. Decide what data layers represent **absolute constraints** on development for **both residential and commercial/industrial zoning**. This analysis must reflect the way in which the zoning by-law treats resource areas such as wetlands and floodplains. For example, if wetland areas can be included in gross building lot area minimums, then wetlands are not an absolute constraint on development. Only areas which can neither be built on nor contribute to how much building is allowable should be mapped as absolute constraints.

6. Subtract the no-build layers from the unprotected, undeveloped land to produce a GIS layer of all unprotected, undeveloped land which could potentially be developed or contribute to development.

7. Decide what data layers represent **partial constraints** on development and need to be included in the analysis. For example, large areas to be subdivided within a given soil type may typically allow only 30% of the gross area to be developed due to poor drainage. Wetlands or floodplains may be partial constraints as discussed above. Zoning overlays for water supply protection are another example of a partial constraint that should be mapped if they restrict the density or type of development in a given area. The next step is to overlay the GIS mapping of potentially developable land with all areas representing partial constraints on development to produce a GIS layer of potentially developable land which includes the attributes of zoning district and all the attributes of the partial constraints on development.

8. Three types of summary table may be produced from the polygon attribute table for potentially developable land from step 7. One table gives, for each zoning district classification, the total area within the town for each combination of constraints present within that zoning district. Thus, if floodplains are mapped as a partial constraint, the town might have 2000 hectares of R1 district without any constraint, and an additional 100 hectares of land in the R1 district that are in the 100 year floodplain. This table can be the basis of the analysis of a generalized analysis that provides a rough estimate of buildout potential. If all constraints are treated as absolute constraints, then there is simply one record for each zoning category giving the total potentially developable area within that district.

Optionally, a second, more detailed analysis will require summarizing by individual zoning polygon – this would be appropriate where the distribution of partial constraints is very irregular and certain polygons end up with little or no allowable building because of an atypical concentration of constraints. In this case, the zoning polygon –id should be referenced to a map with those –ids printed for the individual zoning polygons. Finally, if parcel mapping is available, the analysis can be done to summarize for each parcel (or each parcel above a certain minimum) the characteristics of that parcel.

** **Deliverable: As soon as the overlay analysis has been completed and a summary table generated, all intermediate GIS layers and the final summary table should be sent to EOEA.**

Analysis and Implications
At whatever level of detail is chosen, the summary table should be moved to a spreadsheet package to complete the analysis. For each zoning category, or for each zoning polygon or parcel if more detailed analysis is undertaken, the contractor must estimate either the number of residential units or total square footage of industrial/commercial building floor area that can be developed. These results should be stored in the last two columns of the spreadsheet. Additional columns may be used to enter in coefficients for estimating net buildable area or the net floor area ratio for commercial/industrial square footage. For example, calculation of residential buildout will need to subtract a percentage of land area from what is available for building lots in order to account for roads, irregular lots, etc. Calculation of commercial/industrial buildout will need to consider floor area ratio, parking requirements, percentage lot cover, height restrictions, and Board of Health regulations.

Residential

The broad-brush estimate of the future number of house-lots within each zoning district can be calculated by:

Total potentially buildable acreage within zoning district
- 10 to 30% of total potentially buildable acreage (for roads and lot size variation)

= Total net area for building lots

The total net area for building lots divided by the area required for each lot will yield the potential additional number of lots for each zoning district. The proposed methodology will provide a broad estimate of the potential total buildout for residential lots in the municipality. The following is a list of limitations that are inherent in this methodology:

1) Because the MacConnell Land Use data do not show single houses on large lots (e.g. farms) as being in the category of developed land, there will be a slightly upward bias in the estimates of future number of houses. For example, a development model of an 80-acre estate into 65 building sites would not take into account the existing house on the estate, and would therefore overestimate the total number of new houses by one. (The "developed land" category includes commercial, industrial, residential, and urban lands. The lands available for development therefore include farms, forests etc.).

2) However, a bias in the opposite direction may also occur because the MacConnell mapping may not show all of the small developable lots within the municipality core as being available for future development (i.e. these lots have already been placed in the developed lands category).

3) Depending on how wetlands are treated as partial constraints, this methodology may also underestimate the effect of wetland regulations, as the scale of the maps may not allow for all wetlands to be shown. Although most towns allow at least some wetlands to be included in the lot area required for zoning, typically only the large wetlands show on the buildout constraints map. These are the wetlands that are likely to be predominantly "excess acreage" as part of houselots. The assumption is that smaller wetlands that do not show on the Buildout Constraints Map are the ones which will be incorporated into future houselots.

4) The analysis does not include any potential residential units in the business, commercial or industrial zones. These areas are instead analyzed for the potential for commercial or industrial development.

5) An assumption of this study is that the municipality will have 10% of its housing stock qualified as "affordable", and the community will therefore not be subject to proposals for higher density "Chapter 40B" developments.

6) The estimate of households can be viewed as conservative, since it does not include the potential for conversion of existing single family houses to two-family units (where allowed), and also does not account for variances or special permits that would increase the total number of units of housing or the amount of commercial or industrial space.

To calculate the residential buildout, the simplest approach is to calculate a multiplier for each zoning district that relates the raw land acreage to the potential number of houselots that could be established from that raw acreage. For example, in a community with requirements for 50-foot-wide road right-of-way for new subdivision roads, in a 1-acre zoning district which has a minimum frontage requirement of 200 feet (Note: use lot width, if that is greater than the frontage requirement), then the calculation is:
Area required for roadway = percent of land used for roads in subdivision plus lot requirement

For example:
25 (1/2 of right-of-way) x 200 (lot width required) = 5,000
43,560 (zoning lot requirement) + 5,000 (10.3%) = 48,560

However, when the most recent 10 years of subdivisions are compared for lot yield from gross acreage, it becomes obvious that the average subdivision within a particular zoning district does not meet the theoretical maximum number of lots that could be generated from the raw land that was the basis of the subdivision. This is the result of wetlands, steep slopes poor soils (on the areas served by septic systems) and odd lot configurations that will not allow a developer to maximize the number of lots. These additional constraints can be modeled using the GIS as

described above. In areas where the subdivisions were on sewer and where wetlands and steep slopes do not appear to be a constraint, an additional 10% may have to be removed from the raw land acreage to account for the odd lot configuration. This would mean that in the above case, a total of 20.3% of the raw land would need to be removed from the buildout calculations.

The calculations for lot yield from a raw land acreage of 531,432 square foot area (12.2 acres) would therefore be as follows:
531,432 (raw land square feet) x .797 (100% - 20.3%) /
43,560 (acreage per lot required by zoning)

= 9.7 or 9 lots
Note that for smaller lot zoning districts, the roadway takes up a larger percentage of the gross lot acreage. For example, in a 15,000 square foot zoning district with a 125 foot frontage requirement in the same community as the example above (i.e., with the same 50' wide road right-of-way requirement), then the calculations would be as follows:

25 (1/2 right-of-way) x 125 (lot width required) = 3,125 (or 17.2%)
3,125 + 15,000 = 18,125

When an additional 10% is added (to account for odd lot sizes and shapes), a total of 27.2% should be removed from the gross land acreage as part of the buildout calculation.

Commercial / Industrial

The analysis is based upon a combination of the Floor Area Ratio (FAR) and percent lot coverage and height limitations in the local zoning code taking account of impacts of the local parking, open space, and Board of Health requirements on this FAR. This establishes an "effective FAR" that takes all of the various regulations into account. Analysis will be made for the various potential uses within each zoning district. In order to not overestimate the potential square footage, these figures should be based upon a realistic mix of alternative allowable land uses within each district (i.e., upon existing patterns and trends).

The buildout analysis for the business, commercial and industrial districts within a community results in a total additional square footage of commercial or industrial space that could reasonably be built under the regulations within a community. This analysis is based upon the Floor Area Ratio, percent lot coverage, height limitations, parking regulations, open space requirements, and (on rare occasions) the board of health regulations. Note that in some communities, these various regulations may have different limitations within an aquifer protection district. Also note that the definitions may vary from town to town; for instance one town may allow gross square footage of floor space and gross lot area to be used in calculating floor area ratio, while another town may base this calculation on net rentable square footage (no stairways or storage areas included) and dry upland lot area (no floodplain or wetlands). The regulations and the definitions must both be examined.

Because commercial and industrial facilities tend to be very large, and in most cases appear to have sufficient existing road frontage (or could have such frontage by lot consolidation), one would not include road area as a reduction factor for calculations of commercial and industrial future potential development. Areas determined to be "developed" by the MacConnell data generally are left in that category. However, areas on commercial or industrial lands that are used only for junkyards or extensive outdoor storage are not deemed to be developed, and are generally added back into the calculations. Gravel pits within the commercial and industrial

zones may also be added back in, on the assumption that they will be built upon at the end of the mining cycle. Areas in narrow strips between developments shown on the MacConnell datalayers are generally removed as non-developable buffer strips (they are likely to be greenbelt buffers required as part of the adjacent developed areas).

Floor Area Ratios:

- Some communities have Floor Area Ratio (FAR) regulations. This is generally a ratio of the gross floor area of the structure (i.e., total of all floors) to the total area of the lot (although, as noted above, it is important to check the definitions in the zoning bylaws for occasional critical differences).

Percent Lot Coverage

- For communities without FAR, most have percent lot coverage and height limits. Percent lot coverage is generally the ratio of land area covered by buildings to the total land area of the lot (although it is again critical to read definitions regarding the rare exceptions).

Height Limits

- In conjunction with the percent lot coverage, the height limits can give an approximate maximum of a floor area ratio in a community without an FAR regulation. However, this must be further tempered by a realistic evaluation of the actual number of stories that would be built for a particular use (e.g. warehouses are generally 1 story), as well as other restrictions (e.g., parking requirements).

Parking Regulations:

- The zoning bylaws of a community generally list the minimum required number of parking spaces for a particular land use, although, once again, there are exceptions (e.g., a community that lists maximum spaces, with requirements for participation in transit programs to address any excess demand). For the purposes of buildout analyses, parking is frequently the most limiting factor. This is because although the FAR or a combination of the Height Limit and Percent Lot Coverage may allow for a relatively high amount of floor area, the physical limits of the lot may significantly reduce the amount of floor space by limiting the amount of parking that may be associated with any building on the lot. This is particularly true if there is a significant amount of wetlands on the property, or if there is a requirement for a large percentage of the property to be in green vegetated open space as part of any development. Unless there is very strong evidence to the contrary, it should be assumed that there will be no structured parking associated with the future development. Structured parking is very expensive, and will be used with only the highest value land uses. If structured parking is assumed, then parking is not likely to be a limiting factor on the square footage of future development. Parking lot design requirements vary from town to town. Area required for parking lots consist of stall space, aisle space, planting strips, and unusable space at corners and other buffer areas. For purposes of consistency across a large number of communities, it would appear appropriate to use a standard value of 420 square feet of parking lot per required parking space.

  The "Effective Floor Area Ratio" used in the buildout analysis calculations should be based on whichever of the various regulations is the most limiting. This will avoid over-estimating

the potential square footage of space that may be constructed within a particular zoning district.

Examples:

1) A district which allows a mix of retail and office space, where the number of spaces required is 5 per 1000 square feet of floor area for both uses. Assume that the regulations specify a height limit of 25 feet (or two stories) and a percent lot coverage of 25%. Based on the percent lot coverage and the height limit, one could expect an FAR of .50 in the absence of any other constraints. The following illustrates that parking is a limiting factor:

Total square footage of floor space /
(Lot square footage occupied by structure) + (# parking spaces x 420) =

Effective FAR
2000 (assuming offices over one story retail, or 2-story offices) /
1000 + (10 x 420) =
.38 Effective FAR
If these were the only two uses allowed in this particular zoning district, and the assumption was made that there would be offices over all of the one-story retail, then the above calculation would also be the Effective FAR for the district.

2) A District which allows for a mix of offices, warehousing and manufacturing, with a 35 foot (or three story) height limit and a 40% lot coverage. Parking regulations vary for the three uses, being 5 per 1000 square feet for offices, 4 for manufacturing, and 2 for warehouses.

For Offices, assume 3 story to maximize the total square footage on the smallest land area:

3000 (1000 on each floor) /
1000 + (15 x 420) =

.41 Effective FAR
For Warehousing, assume 1 story because that is the current construction practice for these types of facilities:

1000 / 1000 + (2 x 420) = .54 Effective FAR

Note, however, that the 40% lot coverage bylaw is more restrictive than the figures calculated from analysis of the parking. Therefore, parking is not limiting, and the Effective FAR for Warehousing is .40 based on the lot coverage bylaw.

For Manufacturing Facilities, also assume one story construction, as that is the current industry standard:

1000 / 1000 + (4 x 420) = .37 Effective FAR

Note that in this case, the Effective FAR based on the parking analysis is more restrictive than the lot coverage bylaw, and so the .37 figure would be used.

To calculate the Overall Effective FAR for the above District, the relative amounts of future growth expected in each category would need to be determined in conjunction with the Town Planner. This is an important phase of the analysis, because an assumption of 100% warehouse space will yield a much higher result than an assumption of 100% manufacturing or a mixed use assumption. If one assumes a future mixed use of 1/3 of each of the above land uses in the District, then the Effective Floor Area Ratio for the District is calculated to be.39 FAR

Similar calculations would have to done to account for required green space or other amenities.

If it is not possible to obtain local input in projecting the mix of uses, the pattern of existing uses may also be used as an estimate for the mix of future allowable uses. For example, if the land use within an existing commercial district is 30% warehouse, then this figure could be used as the estimate for the future proportion of warehouse development in that district.

Total number of additional houses can be multiplied by the appropriate local multiplier (based on existing demographic data) to yield information regarding projected total additional students for the schools or projected total additional population. Additional calculations regarding water supply or sewer demands of the future population can also be made. These are based upon appropriate multipliers for these demands measured on a per future household basis, or in the case of commercial and industrial uses, on a per 1000 square feet of floor area basis.

Final Review and Comment

The contractor should assure that all town officials who contributed information and any others who might be able to provide useful comments have an opportunity to comment before the presentation of the analysis. This would include as many as possible of those mentioned above:

- community planner, if there is one
- zoning enforcement officer
- a member of the conservation commission or its staff
- town engineer or assessor
- public health officer
- at least one member of the board of selectmen or town council
- town manager if there is one
- plus any other elected or appointed official whose support and involvement would be critical to the success of the project.

GIS Products and Presentation

Just as the data products developed in this project must be standardized**,** the intent is for the processing, mapping and presentation of the results to be consistent for all towns. This means that the same code will be used to prepare the areal summaries for all towns, and the same Arcview project will be used as the basis for interaction with the data and display of the results. Legend files for the core data sets will be standardized. Map products will be generated from the same Arcview project which will contain template layouts for a series of maps illustrating the analysis.