Section 4

Improving Water Quality

Photo Credit: Kendall Guidroz

Section 4. Improving Water Quality

The success of solutions recommended by this WPP will be due in large part to how well they are scaled and targeted to address the pollutant sources identified in Section 3. The Partnership conducted a water quality modeling effort[41] to determine the amount of improvement needed for *E. coli*. The purpose of this effort was to establish how much *E. coli* needed to be reduced to meet the SWQS. **Load duration curves** (LDCs) were used in combination with water quality data to determine these results. Based on these analyses, assessments of land cover and pollution sources, and the locations of points at which future compliance would be measured, different attainment areas were identified within the total watershed. Unique improvement goals were generated specific to the magnitude and composition of pollutant sources estimated for each attainment area.

Load Duration Curves for *E. coli*

Pollutants can enter the water body from discrete sources or from nonpoint sources in different flow conditions. The amount of water flowing through a water body can affect concentrations of pollutants. LDCs use observed water quality data (see Section 3) to indicate the difference between observed levels of pollutants in a waterway, and the levels at which the applicable water quality standards would be met. The difference then becomes the basis for improvement goals.

The LDC approach uses flow data from a stream gauge or other source to create a flow duration curve. These curves indicate what percentage of days the flow of water meets certain flow levels (*e.g.*, a certain waterway may meet its base flow 100% of the time, but its highest peak flows only 5% of the time). Based on the numeric criteria for a water quality standard, a maximum allowable load of pollutant is calculated for all flow conditions. Lastly, monitoring data for the pollutant are multiplied by flows to produce a load duration curve, which shows how the actual load of a pollutant in the water changes in different flow situations (an example LDC is shown in **Figure 32**). More importantly, the curve indicates under what flow conditions, and by how much, the observed pollutant levels exceed the allowable load. Areas in which the load duration curve line exceeds the maximum allowable load curve line indicate that the standard is not being met in those flow conditions. If the areas of exceedance are primarily in high flow conditions, it is likely that nonpoint sources are most prominent. If areas of exceedance are instead primarily in the low flow conditions, point sources are more likely suspects. In situations where there is a mix of flow conditions related to exceedances, or in which contaminants exceed the

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[41] For greater detail on the modeling for *E. coli* discussed in this section, please refer to the Bacteria Modeling Report on the project website at:
https://eastforkpartnership.weebly.com/uploads/1/3/0/7/130710643/30143_4.3_bacteria_modeling_report_final.pdf

allowable limit in all conditions, a mix of point and nonpoint sources is likely. The amount in which the observed loads exceed the allowable loads is the basis for developing improvement goals.

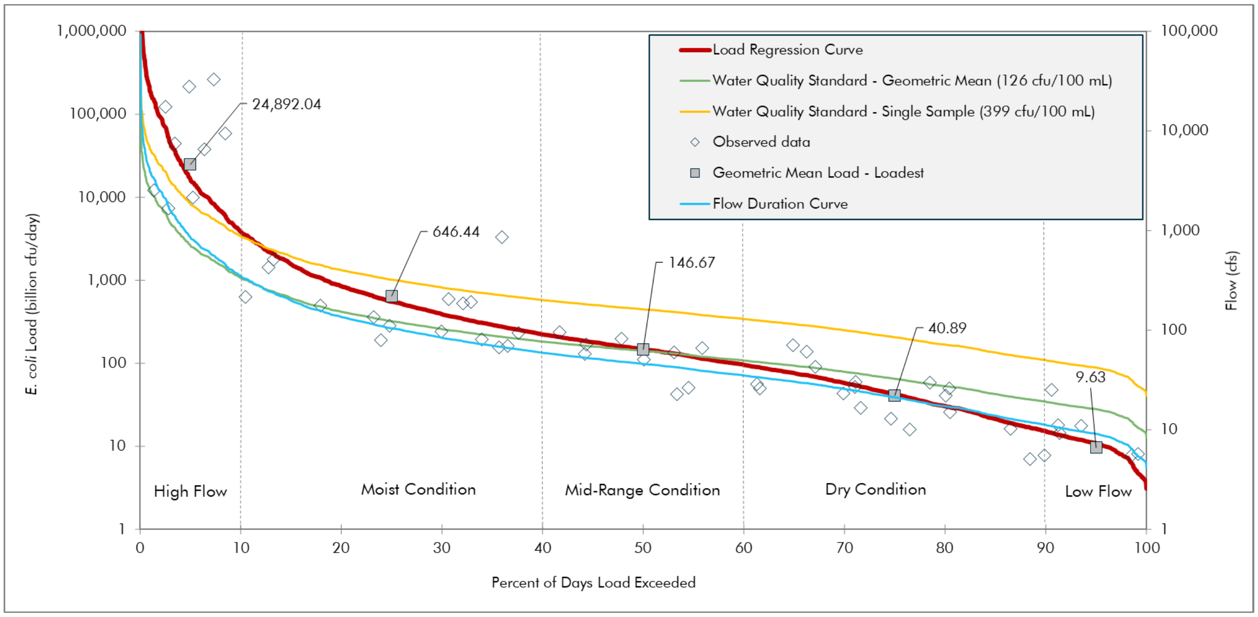

Figure 32. Example of a load duration curve for *E. coli*

Data Development

Project staff developed LDCs for *E. coli* at several monitoring stations throughout the East Fork San Jacinto River watershed. The purpose of the LDCs was to identify which flow conditions demonstrated exceedances, and to generate goals for *E. coli* reduction.

Site Selection

Site selection for LDCs was based on support for a mix of considerations, including known water quality conditions[42], the need for long-term assessment of progress toward the water quality standard, projected needs for BMP siting decisions, and stakeholder input.

- *Known Water Quality Conditions* — Based on a review of historical ambient water quality trends, wastewater treatment facility discharge monitoring reports, and sanitary sewer overflow information, water quality in the project watershed indicated that conditions in the assessed tributaries and main channel both had a degree of variability and potential for continued exceedance. A single station would not be representative of the variability of conditions based on the water

[42] For more information, see the Water Quality Data Analysis Summary Report on the project website at: https://eastforkpartnership.weebly.com/uploads/1/3/0/7/130710643/30143_3.2_acquired_data_analysis_report_final.pdf

quality review. Therefore, several LDC locations were chosen to represent varying conditions along the waterway. One station on each AU with an impairment or concern was selected to assess water quality throughout the watershed. This design allows for a greater degree of scrutiny of geographic variability of loads in the watershed, and an ability to target reductions more precisely. Evaluating several areas independently ensures area-specific problems would not be lost when diluted by a larger waterway, and that end results reflect variability of conditions throughout the waterway.

- *Long Term Assessment Considerations* — To ensure sufficient periods of record and continued data availability, LDC locations were drawn from existing CRP monitoring stations that have been monitored for at least 10 years and are planned to provide ongoing data. Availability of corresponding long-term streamflow data from USGS gage sites was also considered for site selection. Data from CRP stations and associated USGS gages (**Table 26**, **Figure 33**) selected for LDC analysis include:
  - **East Fork San Jacinto River (Lower)** – This area is represented by Station 11235 (East Fork San Jacinto River at FM 1485) and stream flow was assessed from USGS gage 08070200.
  - **East Fork San Jacinto River (Middle)** – This area is represented by at Station 11238 (East Fork San Jacinto River at SH 105) and USGS gage 08070000 was used to measure flow.
  - **East Fork San Jacinto River (Upper)** – This area is represented by Station 17431 (East Fork San Jacinto River at SH 150). This station is not represented by a USGS gage, but because it occurs on the same water body as a gaged station (11238), stream flow was estimated by applying a drainage area ratio. To do this, the drainage area of 11238 was compared to that of 17431 to determine a ratio to use as a multiplier for daily mean stream gage measurements taken at 11238. The resulting values were used as daily flow values for 17431.
  - **Winters Bayou Creek** – Ambient data for this area are represented by Station 21417 (Winters Bayou at Tony Tap Road near Cleveland) Station 21417 occurs after the confluence with Nebletts Creek but before the confluence with the East Fork San Jacinto River. This station is not represented by a USGS gage. Because 21417 occurs on a separate water body from the nearest USGS gaged station (11238), a linear regression method was applied. Instantaneous flows measured during quarterly sampling events at 21417 were compared to daily mean flow measured at 11238 to develop a linear regression equation. This equation was applied to daily mean flows from 11238 to estimate daily flows at 21417.

  - **Boswell Creek** – Ambient data were collected from Station 21934 (Boswell Creek at Four Notch Road). As with Station 17431 in SW3, stream flow data were assessed by applying a drainage area ratio to the regression values from 21417. The drainage area ratio was used in this case as opposed to the regression method due to the limited record of instantaneous flow data available at this station.
- *BMP Siting Requirements* — As discussed previously, LDCs were chosen in part to reflect geographic variability. A greater number of LDC locations is beneficial to compare with modeling results to scale and site solutions (*i.e.*, solution requirements can be refined to the subwatershed level based on the specific reduction needs of the LDC assessment area in which the subwatershed falls).
- *Stakeholder Input* — Project staff built the aforementioned considerations into a set of LDC locations, which were reviewed with stakeholders in the preliminary meetings of the East Fork San Jacinto River Watershed Partnership.

Table 26. LDC site information

LDC Site	CRP Station	USGS Gage	Assessed Area	Number of *E. coli* Samples
East Fork San Jacinto River at FM 1485	11235	08070200	Subwatershed 1	59
East Fork San Jacinto River at SH 105	11238	08070000	Subwatershed 2	58
East Fork San Jacinto River at SH 150	17431	No Gage	Subwatershed 3	33
Winters Bayou at Tony Tap Road near Cleveland	21417	No Gage	Subwatershed 4	31
Boswell Creek at Four Notch Road	21934	No Gage	Subwatershed 5	17

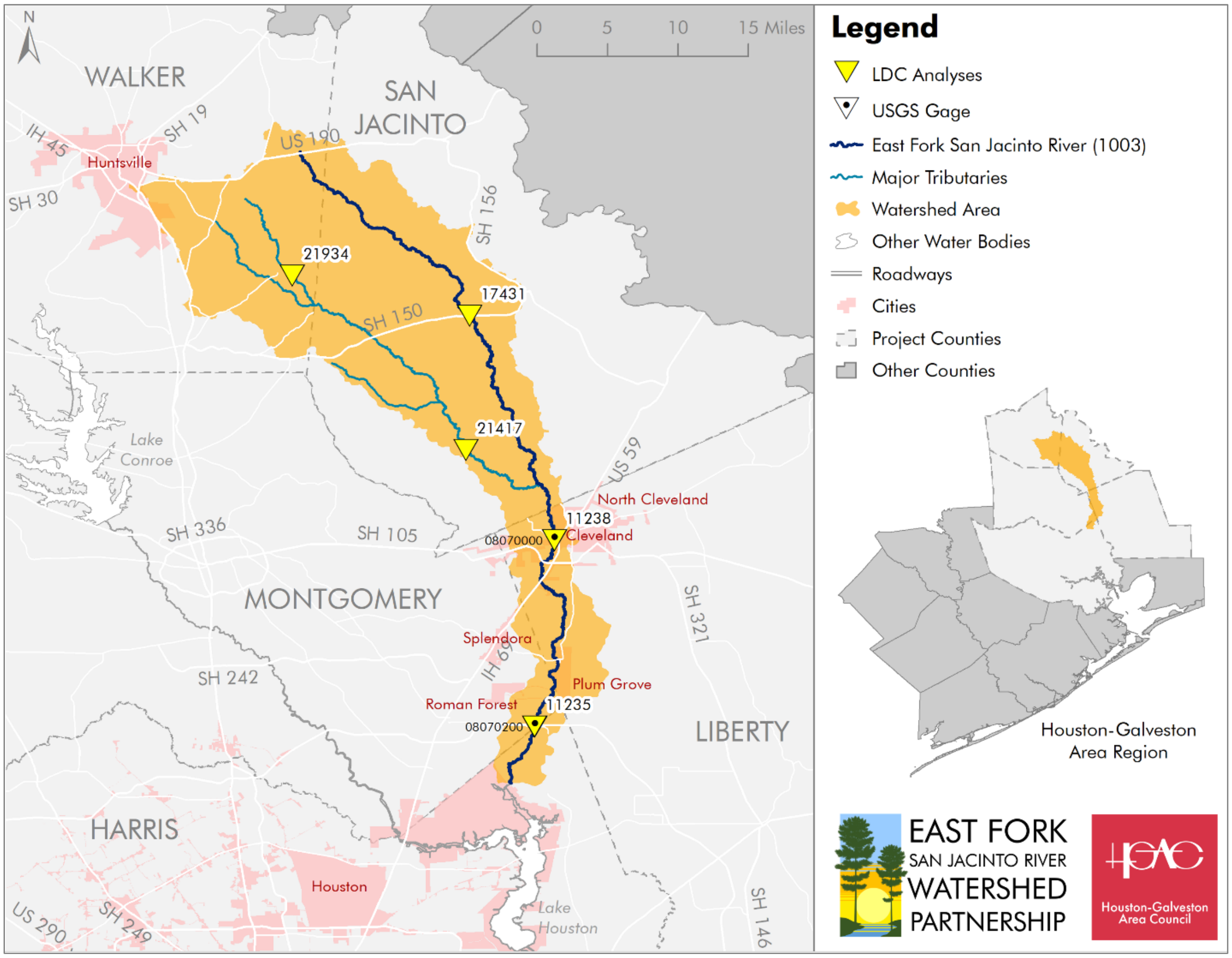

Figure 33. LDC sites

Quality Assurance

Quality-assured ambient water quality results from CRP monitoring were available for all six stations. All stations on the East Fork of the San Jacinto River have at least 10 years of data available and range from 33 to 59 samples for *E. coli* (**Table 26**). Regular sampling on the tributaries to the East Fork of the San Jacinto River, Winters Bayou and Boswell Creek, have begun in more recent years, therefore, the dataset is more limited. However, an analysis of these waterbodies will provide a more complete understanding of bacteria loading throughout the watershed. For *E. coli*, both single sample and geomean values were evaluated against their respective criteria, but only geomean values were used in the process of assessing reductions for this modeling effort.

In addition to ambient water quality data, streamflow data is also required (with continuous flow data being preferable) to produce LDCs. Two of the East Fork San Jacinto River watershed LDC sites (11235 and 11238) have corresponding USGS gages. For Stations 17431, the drainage area of gaged Station 11238 was compared to that of 17431 to determine a ratio to use as a multiplier for daily mean stream gage measurements taken at 11238. This process has been used in previous watershed-based plans and meets the quality objectives of the project. Similarly, no USGS gage data is available for Station 21417 on Winters Bayou. Because 21417 occurs on a separate water body from the nearest USGS gaged station (11238), a linear regression method was applied. Instantaneous flows measured during quarterly sampling events at 21417 were compared to daily mean flow measured at 11238 to develop a linear regression equation. Lastly, estimations for stream flow data at Station 21934 on Boswell Creek were assessed by applying a drainage area ratio to the regression values from 21417. The drainage area ratio was used in this case as opposed to the regression method due to the limited record of instantaneous flow data available at this station. These processes were reviewed internally and with project stakeholders and found to be sufficient for the quality objectives of the project.

Load Duration Curve Implementation

Both the requisite flow and constituent sample data was sufficient to develop LDCs for all locations and will likely continue to support future revisions and the adaptive management process of evaluating WPP success. Results of the LDC analyses were reviewed internally and with project stakeholders. No issues with the data development and implementation were identified based on quality assurance review and feedback. Full profiles for each LDC site are included in the Bacteria Modeling Report[43].

Load Duration Curve Analysis Summary

Results of LDC analyses for East Fork San Jacinto River have been reviewed internally and subjected to stakeholder analysis. H-GAC staff discussed these results with stakeholders at partnership meetings and in more focused, one-on-one conversations. Stakeholder support and positive feedback support confidence in the estimated levels of fecal bacteria loadings and reduction targets for the East Fork San Jacinto River watershed.

LDC analyses of fecal bacteria loads at all sites throughout the watershed indicated a need for considerable reductions in high flow and moist conditions (**Table 27**). Reduction needs at lower levels of flow varied among sites. Sites on the East Fork of the San Jacinto River (11235, 11238, and 17431) require reductions for a wider range of flow levels (high flows through mid-range conditions and occasionally dry conditions) compared to those in the

[43] For more information, please refer to the Bacteria Modeling Report on the project website at: https://eastforkpartnership.weebly.com/uploads/1/3/0/7/130710643/30143_4.3_bacteria_modeling_report_final.pdf

watershed areas of the tributaries (21417 and 21934; reductions only required in high flow and moist conditions). Low flow conditions are within range of the standard at all sites.

Table 27. Summary of LDC results

LDC Location	Area Represented	Findings
Lower East Fork San Jacinto River (11235)	Segment 1003; Subwatershed 1	The results of LDC analyses for Station 11235 indicate a need for moderate reductions in fecal bacteria loading at high flow, moist, mid-range, and dry conditions. *E. coli* geomean loads expressed in billion colony forming units per day (cfu/day) were higher at higher levels of flow and implicate nonpoint sources as the greater pressure in this subwatershed area.
Middle East Fork San Jacinto River (11238)	Segment 1003; Subwatershed 2	The results of LDC analyses for Station 11238 indicate that fecal bacteria require reduction in high flows, moist, and mid-range conditions. Comparative to Station 11235, reduction levels at Station 11238 were comparable in high flow and moist conditions. *E. coli* geomean loads at mid-range were lower than at 11235 and were within state standard range in both dry and low flow conditions.
Upper East Fork San Jacinto River (17431)	Segment 1003; Subwatershed 3	The results of LDC analyses for Station 17431 are more in line with the analysis conducted on 11235 in that reductions in fecal bacteria are recommended for all flow conditions excluding low flow.
Winters Bayou (21417)	Segment 1003A; Subwatershed 4	The results of LDC analyses for Station 21714 differ from those observed in the East Fork of the San Jacinto River in that *E. coli* reductions are only required in high flow and moist conditions. This indicates that nonpoint sources of fecal bacteria loading are of greater concern at this site.
Boswell Creek (21934)	Segment 1003C; Subwatershed 5	The results of LDC analyses for Station 21934 more closely resembled those of Station 21417 with exceedances of the *E. coli* water quality standard observed only in periods of high flow and in moist conditions.

Improvement Goals for *E. coli*

The LDCs provided the basis for setting improvement goals for *E. coli* in the form of percentage reductions of instream loading.

Attainment Areas

In developing improvement goals, the Partnership considered whether a single, watershed-wide goal for *E. coli* was appropriate. Based on the varied character of the watershed, and to provide for better monitoring of project progress, the Partnership elected to set separate goals for distinct areas in the watershed.

In both LDC and SELECT model results, different fecal bacteria source pressures are indicated in different areas of the watershed. To streamline the process of determining load reduction targets while recognizing different loading pressures affecting different areas of the watershed, project staff recommend using attainment areas as the base level target areas for determining fecal bacteria reductions. Attainment areas are groupings of similar geographical areas such as subwatersheds which share similar characteristics including land cover or pollutant loading pressures. The East Fork San Jacinto subwatersheds were grouped into three attainment areas (**Figure 34**). The respective stream segments and watershed areas for station 21417 and 21934, along with those of Nebletts Creek, were grouped together into an attainment area because of the similarities in model results and land cover and to differentiate the tributary portion of the watershed from the subwatersheds representing the East Fork of the San Jacinto River. The "East Fork San Jacinto River Tributaries" attainment area will be represented by Station 21417 due to its location (furthest downstream) and data record. The Lower East Fork San Jacinto River subwatershed is unique due to the large percentage of developed land cover in this area. This subwatershed will comprise a separate attainment area represented by data from Station 11235. The remaining subwatersheds (Middle and Upper East Fork San Jacinto River) will be grouped into a final attainment area due to similarities in LDC model results and land cover. The representative station for this "Upper East Fork San Jacinto River" attainment area will be Station 11238. The monitoring stations and their associated LDCs and improvement goals for these three areas will be the primary focus of measuring water quality achievements under the WPP.

E. coli Source Load Reduction Goals

With the establishment of the three primary attainment areas, the Partnership developed specific *E. coli* reduction targets for current and target year (2040) conditions. The first step was to identify a single improvement goal based on the LDCs for each attainment area.

The design for generating single target reductions for each attainment area[44] was based on a compromise between the worst-case scenario (*i.e.*, equating the reduction need to the **highest** possible reduction need in any flow category) and the least conservative approach (*i.e.*, equating the reduction to the **average** reduction needed based on all flow conditions). H-GAC proposed, and the stakeholders affirmed, a moderate approach in which reduction targets would be established based on a weighted average of the flow conditions in which reductions were needed, for each attainment area.

[44] As opposed to the modeled reduction values for each flow category.

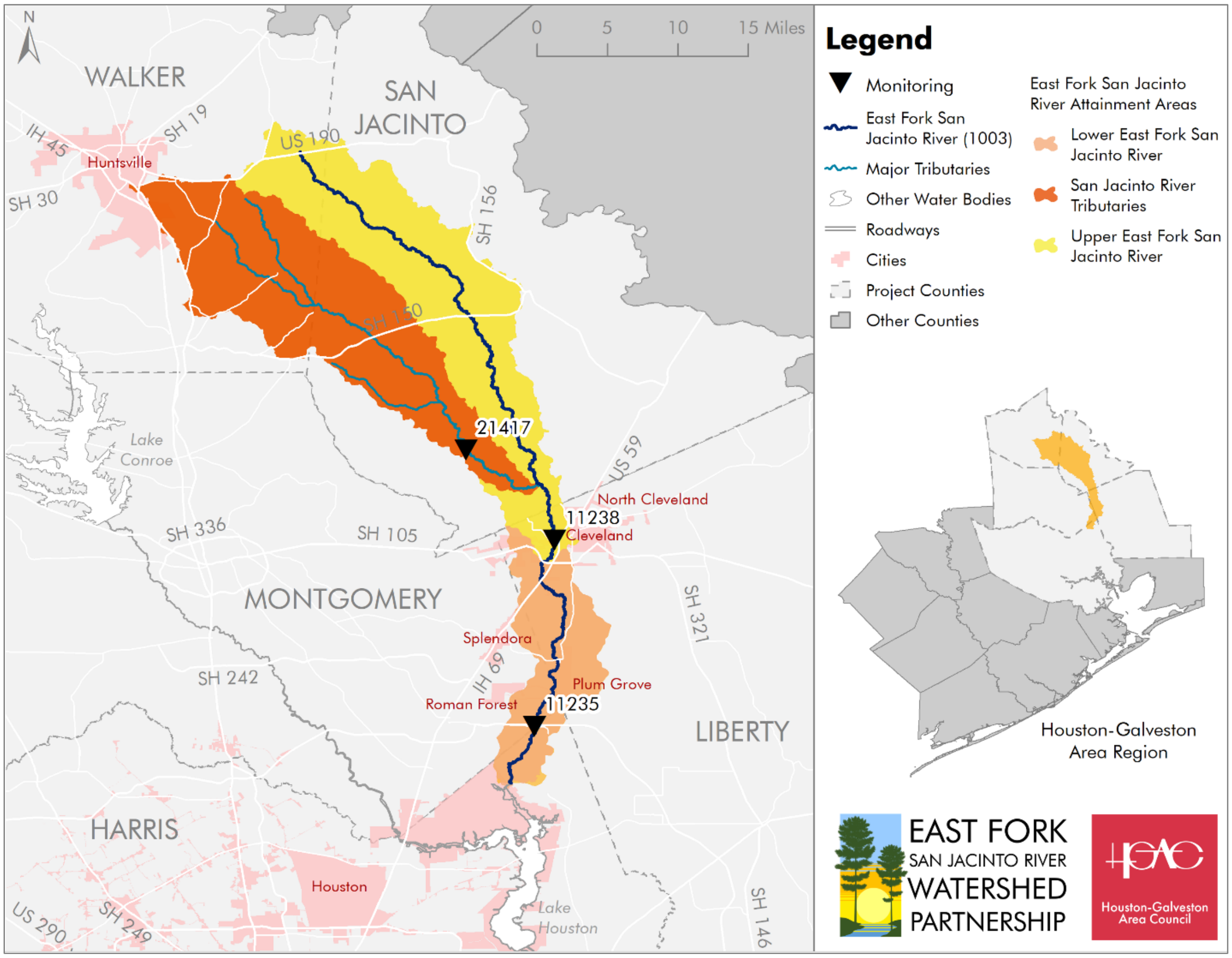

Figure 34. East Fork San Jacinto River watershed attainment areas

The equation below demonstrates the calculation used to determine this average, where *W* represents the weighting factor (percent of flows) at high flow (*h*), moist (*m*), mid-range (*mr*), dry (*d*), and low flow (*l*) conditions, and *R* represents the reduction value required at each rate of flow.

$$\text{Weighted Average Reduction} = \frac{WHRH+WMRM+WMRRMR+WDRD+WLRL}{WH+WM+WMR+WD+WL}$$

For example, 11235 is the farthest downstream station in the attainment area of the lower East Fork San Jacinto River and was used to represent the area as shown in **Table 28**. At the high flow category which represents the top 10% of flows, an *E. coli* reduction of 83% is recommended. *E. coli* observed in the next 30% of flows (moist conditions) require a reduction of 56% and *E. coli* observed in the following 20% of flows (mid-range conditions) require a 31% reduction. Finally, *E. coli* observed in dry conditions comprising the following 30% of flows only require a 1% reduction. Low flow conditions are not factored into this calculation as no reductions were indicated by the LDC model. The calculation for the weighted average reduction for Station 11314 is shown below:

$$\text{Weighted Average Reduction} = \frac{(10\times 83)+(30\times 56)+(20\times 31)+(30\times 1)}{10+30+20+30}$$

$$\text{Weighted Average Reduction} = \frac{830+1,680+620+30}{90}$$

$$\text{Weighted Average Reduction} = \frac{3,160}{90} = 35.1$$

This calculation was also used to determine the weighted average fecal bacteria reduction needed at Station 11238 which was selected as the best representative station in the upper East Fork San Jacinto attainment area, and Station 21417 which represents the attainment area for the tributaries of the East Fork San Jacinto River. Only weighting factors and reduction targets from high, moist, and mid-range flows were considered for Station 11238 as no reductions were indicated by the LDC model at dry and low flow conditions. For the same reason, only high and moist conditions were used in the weighted average reduction target calculation for station 21417. The resulting value is shown in **Table 28**.

Table 28. *E. coli* load reduction goals by percentage of load

Attainment Area	LDC Station	Subwatersheds	Weighted Average *E. coli* Reduction Target
Lower East Fork San Jacinto River	11235	1	35%
Upper East Fork San Jacinto River	11238	2 and 3	38%
East Fork San Jacinto River Tributaries	21417	4, 5, and 6	36%

Model Linkage

SELECT was used to generate potential source loads and characterize the source profile. The percent reduction improvement goals developed under the LDCs were applied directly to the source loads to generate the source load reduction targets. This process was developed with H-GAC and TCEQ project staff and reviewed and accepted by the stakeholders. No granular fate and transport modeling was completed for this project. Instead, the linkage relies on the assumption of a linear relationship between source loads and instream conditions. The percent reduction from the LDCs, rather than an absolute number of *E. coli* to reduce, is used for the linkage.

With the model linkage established, calculating *E. coli* reduction targets required that the stakeholders consider two other primary questions: 1) what milestone year would reduction targets be based on; and 2) how would source load reductions be spread out among the fecal waste sources?

Milestone Year

WPPs typically are written to be executed over a 5 to 15-year period. The existing projections developed during the SELECT analyses allowed the stakeholders to target any of the five-year milestone dates between 2022 and 2050. However, the further out the projections went, the greater the uncertainty. In deciding on a target milestone year, the stakeholders balanced the need to set near term, achievable goals within a period of relative certainty, and the need to account for the amount of future growth projected for the watershed. A 5-year plan would not adequately address the appreciable increase in loads through 2050, whereas a more long-term plan would have to rely on less certain predictions[45]. The Partnership and project staff agreed to target the year 2040, allowing a long-term focus to account for watershed change, while focusing on meaningful interim action. For a WPP approved in 2024, this would represent a 16-year plan life.

Allocating Reductions

The mix of sources present in the watershed, and the shift of relative contribution through 2050, posed a challenge for allocating how reduction targets would be met. Stakeholders considered several options, including: 1) targeting all sources proportional to their contribution (*e.g.*, if in 2040, source X made up 30% of the total load, then 30% of the reduction value would be met by addressing that source.); 2) allocating reduction subjectively based on potential solutions; and 3) allocating reduction based on current relative contribution (rather than 2040). Project staff proposed the first option as an initial guide for the calculation of reduction targets, with the understanding that the WPP would stress opportunistic implementation in addition to adaptive management strategies that will be most feasible in the short term. The proportional allocation was modeled for the whole watershed, subwatersheds, and attainment area groupings, with the proposed allocations to focus on the attainment areas. Stakeholders affirmed the proposal.

Based on these decisions, project staff generated reduction targets for each attainment area, subwatershed, and source. Overall reduction targets for each of the attainment areas and the linkage of the reduction target percentages to the source loadings were used to generate the target source load reductions for estimations as of the year 2022, and for the 2040 milestone year (**Table 29**). The load reductions needed by source for each of the two attainment areas, were also determined for conditions in 2040 (**Table 30**; **Table 31**;**Table 32**).

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[45] This should not be taken to indicate a failure of the modeling methodology, but a reflection of the potential for unaccountable change the further out a model is used to predict conditions.

Table 29. 2022 and 2040 source load reduction targets

Attainment Area	Sub-watersheds	Weighted Average *E. coli* Reduction Target	2022 Total Source Load in Billion cfu/day[46]	2022 Source Load Reduction Target in Billion cfu/day	Incremental Load, 2022 to 2040 in Billion cfu/day[47]	2040 Total Source Load Reduction Target in Billion cfu/day[48]
Lower East Fork San Jacinto River	1	35%	7,821.74	2,737.61	7,737.36	10,474.97
Upper East Fork San Jacinto River	2 and 3	38%	15,293.54	5,811.55	1,029.77	6,841.31
East Fork San Jacinto River Tributaries	4, 5, and 6	36%	18,206.81	6,554.45	2,774.56	9,329.01

[46] Current source load is generated by summing the source loads for the subwatersheds within the attainment area.
[47] The incremental load represents the difference between the 2040 load and the 2022 load. See the next footnote for explanation of its use in generating 2040 source reduction load target.
[48] The 2040 reduction target is generated by through the equation $C_r+(F_l-C_l)$; where C_r= current source reduction load, F_l = future total source load, and C_l = current total source load. In essence, the incremental load generated between 2022 and 2040 is added to whatever existing reduction load exists in 2022. This approach is used because LDCs cannot estimate future reduction percentages, and because it is assumed the waterway will not have additional assimilative capacity in 2040.

Table 30. Load reduction targets by source, Lower East Fork San Jacinto River attainment area, 2040

Source	% Total Load, 2040	Proportion of 2040 Load Reduction Target in Billion cfu/day
OSSFs	11.92%	1,291.63
WWTFs	0.02%	2.31
Dogs	48.39%	5,243.44
Cattle	21.03%	2,279.05
Horses	0.13%	13.89
Sheep and Goats	1.97%	213.47
Deer	0.25%	27.71
Other Sources	6.30%	682.36
Feral Hogs	9.99%	1,082.4
Total	**100.00%**	**10,836.26**

Table 31. Load reduction targets by source, Upper East Fork San Jacinto River attainment area, 2040

Source	% Total Load, 2040	Proportion of 2040 Load Reduction Target in Billion cfu/day
OSSFs	1.00%	150.36
WWTFs	0.01%	0.77
Dogs	4.59%	695.4
Cattle	61.26%	9,275.56
Horses	0.19%	29.31
Sheep and Goats	5.74%	868.82
Deer	0.47%	71.31
Other Sources	9.28%	1,404.89
Feral Hogs	17.46%	2,644.01
Total	**100.00%**	**15,140.43**

Table 32. Load reduction targets by source, East Fork San Jacinto River Tributaries attainment area, 2040

Source	% Total Load, 2040	Proportion of 2040 Load Reduction Target in Billion cfu/day
OSSFs	0.34%	79.32
WWTFs	0.00%	0.45
Dogs	1.19%	287.24
Cattle	70.78%	17,024.05
Horses	0.13%	30.47
Sheep and Goats	6.63%	1,594.59
Deer	0.32%	77.59
Other Sources	8.50%	2,044.54
Feral Hogs	12.11%	2,912.42
Total	**100.00%**	**24,050.67**

Representative Units and Scaling Implementation

To determine what the source load reduction targets meant in terms of the scaling of solutions, representative units were used. Representative units simplify the conceptualization of load reduction targets by converting load values in cfu/day to practical units. The total number of units that would need to be addressed in each attainment area in 2040 was calculated by dividing the target load reductions by the per-unit *E. coli* load of each source (*e.g.*, one representative unit for pet waste is equal to the daily *E. coli* load produced by one dog) (**Table 33**). The per-unit *E. coli* loads from each source are largely adapted from Teague et al., 2009[49] with the exception of cattle which were revised to reflect more recent estimations (See Section 3). All units are rounded up to the nearest whole unit. In SELECT analyses using the buffer approach, the instream load contributed by each source varies by proximity to the waterway. However, when calculating representative units, no spatial distinction was made. This conservative method of converting target load reductions to representative units could over-represent reductions to be made in areas outside the buffer.

Table 33. Representative units to address by 2040, Lower East Fork San Jacinto River attainment area

Source	Representative Unit	Representative Unit Daily Load (billion cfu/day)	Units to Address by 2040
OSSFs	1 failing OSSF	3.71	348
WWTFs	1 million gallons of effluent	4.77	NA[50] (0)
Dogs	(waste of) 1 dog	2.50	2,388[51] (2,097)
Cattle	(waste of) 1 cow	11.00	207
Horses	(waste of) 1 horse	0.21	NA (66)
Sheep & Goats	(waste of) 1 sheep or goat	9.00	24
Deer	(waste of) 1 deer	0.18	NA (158)
Feral Hogs	(waste of) 1 feral hog	4.45	243

[49] See: https://ssl.tamu.edu/media/11291/select-aarin.pdf

[50] WWTF, horse, and deer units to address are shown as NA as the Partnership elected to over-convert reductions in other sources given the negligible impact of WWTF and horse waste on instream loading, and a lack of viable reduction solutions for deer waste. The numbers in parentheses represent the number of units that would have needed to be reduced if the Partnership had not chosen this course.

[51] Dog waste unit numbers are increased to cover WWTF, horse, deer, and other sources reduction loads in both the Lower East Fork San Jacinto River attainment area per stakeholder preference. Because there is no representative unit for other sources, that reduction value is not shown. Equivalent reduction values for dogs are added to the total representative units. The number in parentheses represents the number of dogs required to be addressed if WWTF, horse, deer, and other sources loads were not converted into equivalent values.

Table 34. Representative units to address by 2040, Upper East Fork San Jacinto River attainment area

Source	Representative Unit	Representative Unit Daily Load (billion cfu/day)	Units to Address by 2040
OSSFs	1 failing OSSF	3.71	41
WWTFs	1 million gallons of effluent	4.77	NA[52] (0)
Dogs	(waste of) 1 dog	2.50	278
Cattle	(waste of) 1 cow	11.00	843
Horses	(waste of) 1 horse	0.21	NA (140)
Sheep & Goats	(waste of) 1 sheep or goat	9.00	97
Deer	(waste of) 1 deer	0.18	NA (407)
Feral Hogs	(waste of) 1 feral hog	4.45	933[53](594)

Table 35. Representative units to address by 2040, East Fork San Jacinto River Tributaries attainment area

Source	Representative Unit	Representative Unit Daily Load (billion cfu/day)	Units to Address by 2040
OSSFs	1 failing OSSF	3.71	21
WWTFs	1 million gallons of effluent	4.77	NA[54] (0)
Dogs	(waste of) 1 dog	2.50	115
Cattle	(waste of) 1 cow	11.00	1,548
Horses	(waste of) 1 horse	0.21	NA (145)
Sheep & Goats	(waste of) 1 sheep or goat	9.00	177
Deer	(waste of) 1 deer	0.18	NA (443)
Feral Hogs	(waste of) 1 feral hog	4.45	1,138[55](654)

Because the other sources as a category do not have a representative unit, they are not included in this table. Reduction targets for WWTFs, horses, deer, and other sources were converted into equivalent dog waste in the Lower East Fork San Jacinto River attainment area and feral hog waste in the Upper East Fork San Jacinto River and East Fork San Jacinto River Tributaries attainment areas to account for negligible instream loads expected from WWTFs and horse waste in addition to stakeholder preference in not selecting specific

[52] See Footnote 50.
[53] Dog waste unit numbers are increased to cover WWTF, horse, deer, and safety margin reduction loads in both the headwaters and downstream attainment areas per stakeholder preference. Because there is no representative unit for the safety margin, that reduction value is not shown. Equivalent reduction values for dogs in the headwaters and downstream are added to the total representative units. The number in parentheses represents the number of dogs required to be addressed if WWTF, horse, deer, and Safety Margin loads were not converted into equivalent values.
[54] See Footnote 50.
[55] See Footnote 53.

solutions to target deer and wildlife. While WWTFs and horses are not estimated to contribute significantly to bacteria loading in the East Fork San Jacinto River watershed, they will still be considered a focus of implementation, education and outreach, and continued monitoring.

The solutions for livestock are based on the implementation of TSSWCB Water Quality Management Plans (WQMPs) and similar conservation plans through USDA Natural Resources Conservation Service (NRCS). Section 5 provides details on these solutions. To translate the number of livestock units to address into number of plans, project staff worked with TSSWCB and the local Soil and Water Conservation Districts (SWCDs) in this and previous projects to develop an assumed average number of livestock units (50) to be served by each plan. The number of plans is then derived by dividing the number of livestock units by the average units per plan and rounding up to the nearest whole representative plan (**Table 36**). The actual load reduction value for each plan will differ depending on the mix of livestock involved (given their different representative unit loading values).

Table 36. Agricultural plans needed to address livestock loads by 2040

Attainment Area	Total Livestock Units to Address	Total Plans
Lower East Fork San Jacinto River	231	5
Upper East Fork San Jacinto River	940	19
East Fork San Jacinto River Tributaries	1,725	34

Source Load Reduction Summary

Forecasted increases in *E. coli* loads highlight the need for intervention through the WPP and other means. Current water quality issues will be compounded by future loads, leading to degrading water quality through the planning period absent any effort to the contrary.

Uncertainty is present throughout the assumptions and methodologies of this modeling approach, as noted throughout this document. Project staff used the best available data and stakeholder feedback to minimize uncertainty wherever possible, but the results should be taken in the context of their use in characterizing fecal waste pollution on a broad scale, and for scaling and siting BMPs. For these purposes, the level of uncertainty and precision of the results was deemed to be acceptable by the stakeholders. Further refinement of results may be needed in the future in light of changing conditions.