APPENDIX D

ALTERNATIVES

To:	Doug Murphy	*cc:*
From:	Thomas Dumm / George Rest	
Re:	Water Supply Alternatives Evaluation	
Date:	February 13, 2011	

A detailed step-by-step process was utilized for screening and evaluating the water supply alternatives in the Duck River Agency's Comprehensive Regional Water Supply Plan. The process included evaluations of the alternatives based on their unique characteristics as well as head-to-head comparisons with other alternatives. Key aspects of the alternatives were grouped using seven criteria.

A list of 40 potential water supply alternatives (see attached partial list of alternatives obtained from Duck River DEIS, 2000) was reduced to 26 unique alternatives that were evaluated in the Comprehensive Regional Water Supply Plan:

- Alt. #1 - Water Efficiency Measures
- Alt. #2 - Increase Normandy Reservoir Release to Meet Columbia Constraint Without Raising Dam or Pool Levels
- Alt. #3 - Regional Drought Management Plan
- Alt. #4 - Optimize Releases from Normandy Reservoir
- Alt. #5 - Raise Normandy Reservoir Winter/Spring Pool Level Without Raising Dam
- Alt. #6 - Modify Normandy Flood Rule Curve (Early Refill)
- Alt. #7 - Reduce Irrigation Withdrawals
- Alt. #8 - Modify River Constraints to Preserve Storage in Normandy Reservoir
- Alt. #9 - Raise Normandy Dam
- Alt. #10 - Improve DRUC Intake
- Alt. #11 - Construct Second DRUC Intake
- Alt. #12 - Construct Fountain Creek Reservoir and Pipe Raw Water to Columbia WTP
- Alt. #13 - Construct Fountain Creek Reservoir with Downstream Release
- Alt. #14 - Upgrade Existing Columbia City Dam to Allow Releases
- Alt. #15 - Monsanto Lake (Existing Offstream Storage Reservoir)
- Alt. #16 - Utilize Quarries
- Alt. #17 - Construct Pipeline from Tennessee River to Columbia WTP
- Alt. #18 - Construct Pipeline from Tims Ford Reservoir
- Alt. #19 - Convey Arnold Cooling Water to Normandy Reservoir
- Alt. #20 - Purchase Water from Nearby Systems
- Alt. #21 - Utilize Groundwater Sources
- Alt. #22 - Pump Treated Wastewater from Columbia WWTP to Below Columbia Dam
- Alt. #23 - Construct New Intake for Maury County at River Mile 163
- Alt. #24 - Construct Water Intake near Williamsport and Pump Back to Columbia WTP
- Alt. #25 - Construct New Intake for Maury County at River Mile 108 and Pump Back to Columbia Dam Pool
- Alt. #26 - Construct Infrastructure to Return Treated Wastewater from Tullahoma WWTP to Normandy Reservoir

A matrix was developed which described each alternative and documented key aspects of each alternative related to seven criteria:

- Reliable capacity - Reliable quantity of raw water to meet projected demands through the planning period. This criterion addressed interruptibility of sources of supply.

- Raw water quality - Raw water quality that meets existing water quality requirements, and can readily achieve future anticipated regulations. This criterion also addressed water quality preferences such as superior raw water quality, and finished water taste.
- Cost - The present worth cost for proposed raw and finished water improvements, including capital, operating and maintenance costs. This cost could include allowance for wholesale water purchases.
- Implementability – Addressed the relative ease of implementing the proposed improvements in time to meet projected demands. This criterion considered the potential that regulatory permitting, public acceptance, property acquisition, or constructability issues could delay implementation.
- Flexibility – Addressed the ability to phase implementation and spread the cost over time, while still meeting projected demands.
- Environmental benefits - This criterion included environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.
- Recreation - This criterion included recreational benefits, either reservoir or riverine, (e.g., boating, fishing, canoeing, sightseeing) and related economic benefit of the recreational features (e.g., tourism/eco tourism, enhanced property values).

Using the seven criteria, the 26 alternatives were screened down to the recommended structural and non-structural alternatives over the course of several work sessions with stakeholders based on a step-by-step process that provided ample opportunities for stakeholder input and collaboration. A matrix was developed which included key findings for each of the alternatives for the seven criteria (see attached "Draft Summary of Water Supply Alternatives"). The screening process used to develop the package of recommended alternatives was based on narrowing down the alternatives as quickly as possible using the seven criteria and the following rationale:

- 26 Alternatives
  - Baseline. The baseline alternatives optimize use of existing water supply sources and these actions are expected by EPA Region 4 as part of the water supply planning process. The baseline alternatives include the following:
    - Alt. #1 - Water Efficiency Measures
    - Alt. #3 - Regional Drought Management Plan
    - Alt. #4 - Optimize Releases from Normandy Reservoir

- 23 Alternatives Remaining (No cost estimates at this stage)
  - Fatally Flawed. Four alternatives were eliminated because the alternatives provided no added reliable capacity and were therefore considered fatally flawed:
    - Alt. #7 - Reduce Irrigation Withdrawals
    - Alt. #14 - Upgrade Existing Columbia City Dam to Allow Releases
    - Alt. #21 - Utilize Groundwater Sources
    - Alt. #23 - Construct New Intake for Maury County at River Mile 163

- 19 Alternatives Remaining (No cost estimates at this stage)
  - DRUC Intake Combined with other Alternatives. Two alternatives were considered to be an element of Alt. #2 because the need to improve the DRUC intake would be necessary only if reservoir levels were dropped lower than the 2007 drought levels (i.e., 850 ft).
    - Alt. #10 - Improve DRUC Intake

- Alt. #11 - Construct Second DRUC Intake

- 17 Alternatives Remaining (Project costs developed for each alternative which included capital costs plus allowances)
  - Flood Rule Curve Combined with other Alternatives. Alt. #6 which addressed modifying the flood rule curve for Normandy Reservoir (early refill) was combined with Alt. #5 (Raise Normandy Reservoir Winter/Spring Pool Level Without Raising Dam) and will be reviewed as part of the Alt. #3 (Regional Drought Management Plan).

  - Highly Unlikely due to Difficult Permitting. Several alternatives were considered highly unlikely primarily due to potential difficulty in permitting:
    - Alt. #12 - Construct Fountain Creek Reservoir and Pipe Raw Water to Columbia WTP (i.e., major issues include water quality and quantity, aquatic ecology, endangered and threatened species and their critical habitats, wetlands, archeological and historic resources)
    - Alt. #13 - Construct Fountain Creek Reservoir with Downstream Release (i.e., major issues include water quality and quantity, aquatic ecology, endangered and threatened species and their critical habitats, wetlands, archeological and historic resources)
    - Alt. #18 - Construct Pipeline from Tims Ford Reservoir (i.e., interbasin transfers and potential impact on environmental flows in the Elk River downstream of Tims Ford Reservoir)
    - Alt. #22 - Pump Treated Wastewater from Columbia WWTP to Below Columbia Dam (i.e., potential transfer of species during pumping from downstream location to upstream location, change in permit conditions and flows for WWTP)
    - Alt. #26 - Construct Infrastructure to Return Treated Wastewater from Tullahoma WWTP to Normandy Reservoir (i.e., significant reduction or elimination of flow in existing stream if Tullahoma WWTP flow is diverted to Normandy Reservoir during dry weather conditions)

  - Highly Unlikely due to Potential High Cost. Alt. #17 requires construction of 60-miles of 42-inch diameter transmission main to the Tennessee River and the cost is roughly 5 to 10 times the cost of other structural measures under consideration. Alt. #20 involves purchasing water from a neighboring utility which would likely have a high cost due to the need for a large transmission and reservation of treatment and transmission capacity in facilities owned by the neighboring utility.

  - Highly Unlikely due to Better Configuration. Alt. #25 involves constructing an intake near Williamsport and pumping water to the existing Columbia Dam pool. It was concluded that Alt. #24 which is similar and pumps water directly to the Columbia WTP was a better solution because it avoids the potential transfer of species from the downstream location.

- 8 Alternatives Remaining (see attached "Draft Summary of Water Supply Alternatives – Compatibility Matrix")
  - Backup Alternatives
    - Alternative #2 (Increase Normandy Reservoir Release to Meet Columbia Constraint Without Raising Dam or Pool Levels) provides no "new" water and requires TVA to

change its current policies by establishing a new targeted release for Columbia which is 116 river miles downstream (roughly 80 hours of travel time). Accurately meeting the target flow at the Shelbyville constraint which is 27 river miles downstream of the dam (roughly 18 hours of travel time) is difficult and moving the target an additional 98 river miles downstream would require that TVA release greater quantities of "excess" water from Normandy Reservoir to compensate for uncertainties in the reduction in flow between Shelbyville and Columbia.

- Alternative #8 (Modify River Constraints to Preserve Storage in Normandy Reservoir) was considered as a backup because the State and Federal agencies responsible for establishing the river constraints have made no indication that the river flow constraints could be modified.
- Alternative #16 (Utilize Quarries) involves storing water in quarries for use during drought events and is considered a backup because of the relatively small size of the inactive quarries along the Duck River.
- Alternative #19 (Convey Arnold Cooling Water to Normandy Reservoir) is considered a backup because of the potential lack of control associated with obtaining water from the AFB during drought conditions.

- 4 Alternatives Remaining
  - Normandy Reservoir alternatives
    - Alt. #5 - Raise Normandy Reservoir Winter/Spring Pool Level Without Raising Dam
    - Alt. #9 - Raise Normandy Dam

    Compared to the Backup and Highly Unlikely alternatives presented above, the Normandy Reservoir alternatives (Alt. #5 and Alt. #9) exhibit the following benefits:

    - Water supply – enhances reliable yield for water supply
    - In-lake recreation – higher pool level for longer use during drought
    - Instream flow – longer duration of releases from Normandy Reservoir to Duck River during drought periods
    - Flooding – reduction in flood risk to communities/properties downstream of Normandy Reservoir due to increased flood storage
    - Shoreline – reduces exposed shoreline and erosion
    - Environmental – avoids impacts to upstream wetlands and streams

    The following presents a comparison of Alt. #5 and Alt. #9:

    - Alternative #5 includes the purchase of flood-prone property along the Duck River between Normandy Reservoir and Shelbyville in order to offset the loss of flood storage volume associated with raising the Normandy Reservoir Winter/Spring pool level without raising the dam (i.e., maintaining current flood storage volumes). Because of the reduction in flood storage in Normandy Reservoir, the frequency and extent of flooding downstream of the dam would increase. Prior to increasing the Winter/Spring pool level in Normandy Reservoir and increasing the water supply reliability for the region, the DRA would need to purchase or acquire flood easements for the downstream flood-prone properties which is very ill-defined and would likely require decades to study, meet with stakeholders, negotiate agreements on properties, etc. A cost of $10 million has been

estimated for this alternative although the true cost would not be known until the agreements with individual property owners are finalized.

- Alternative #9 reduces the risk of downstream flooding by raising Normandy Dam to maintain the volume of flood storage under the Winter/Spring seasons and increasing flood storage under the Summer/Fall seasons (i.e., Summer/Fall pool level maintained at current level of 875 ft). The project cost for raising Normandy Reservoir is estimated to be between $15M and $30M depending on the need to relocate roadways, bridges and campgrounds.

For the Normandy Reservoir alternatives (Alt. #5 and Alt. #9), the cost for operation and maintenance of Normandy Reservoir would be borne by TVA and would be essentially the same for both alternatives. Consequently, the capital costs for both alternatives can be directly compared. At this time, it appears that the capital costs for Alt. #5 and Alt. #9 may be roughly the same. It is not clear what portion of the capital cost for purchasing property or acquiring flood easements under Alt. #5 would be the financial responsibility of DRA. It is possible that partnerships with The Nature Conservancy and other organizations may assist with defraying the cost borne by DRA. Similarly with Alt. #9, it is not clear whether the roadways, bridges and campgrounds need to be relocated and whether TVA would be willing to partner with DRA on the cost for raising Normandy Dam. The answers to these questions are being further investigated and have the potential to significantly reduce the project costs borne by DRA making Alt. #5 and Alt. #9 even more attractive from a financial standpoint compared to the backup and highly unlikely alternatives screened out in previous steps outlined above. In addition, Alt. #9 is preferred when compared to Alt. #5 because the capital costs could be similar and Alt. #9 allows DRA to more effectively govern the schedule for implementation and provides additional flood protection for downstream communities.

- Maury County alternatives
  - Alt. #15 - Monsanto Lake (Existing Offstream Storage Reservoir)
  - Alt. #24 - Construct Water Intake near Williamsport and Pump Back to Columbia WTP

Compared to the Backup and Highly Unlikely alternatives presented above, the Williamsport alternatives (Alt. #15 and Alt. #24) exhibit the following benefits:

- Water supply reliability – highly reliable source of supply (not limited by instream flow)
- River constraint – increases instream flow at Columbia gage to assure minimum 100 cfs for all uses.
- Columbia intake – existing intake could be used as backup, eliminating routine withdrawals from Columbia pool.
- Spring Hill intake – existing Spring Hill intake could be used as backup which may improve flow in critical segment of river during drought conditions.
- Regional water system – potential to develop as a regional finished water system for Maury County.

The following presents a comparison of Alt. #15 and Alt. #24:

- Alternative #15 includes development of offstream storage by purchasing Pond 15 which is located between Columbia and Williamsport, repairing the dam and spillway, and filling Pond 15 with water. Compared to the new intake on the Duck River near Williamsport (Alt. #24), Pond #15 (Alt. #15) was considered to be less reliable because it

has a limited volume of storage for use during a prolonged drought. The estimated project cost for Pond #15 was $48M.

- Alternative #24 is more reliable in prolonged droughts, involves straight-forward permitting, and the project cost is estimated to be $38M which is $10M less expensive than Alt. #15.

For the Maury County alternatives, the energy costs associated with operating the raw water intake, pumping station and pipeline from an intake on the Duck River near Williamsport or from an intake in Pond 15 is essentially the same. As proposed in the Comprehensive Regional Water Supply Plan, raw water would originate from nearly the same elevation (i.e., Duck River) and would ultimately be pumped to the same location (i.e., Columbia's WTP). The cost for maintaining the dam and reservoir at Pond 15 would be an additional cost borne by DRA and not associated with Alt. #24. Consequently, Alt. #24 is recommended when compared with Alt. #15 because of its higher level of reliability and its lower project cost and a lower operation and maintenance cost.

At this time, it appears that the capital costs and the operation and maintenance costs for Alt. #24 are less than Alt. #15. It is not clear what portion of the capital cost for the intake, pumping station, regional treatment plant, and pipeline under Alt. #24 would be the financial responsibility of DRA. It is possible that the water utilities in Maury County may elect to invest in some portion of these new regional facilities in lieu of expanding existing facilities or constructing new facilities. The answers to these questions are being further investigated and have the potential to significantly reduce the project costs borne by DRA making Alt. #24 even more attractive from a financial standpoint compared to the backup and highly unlikely alternatives screened out in previous steps outlined above.

In summary, the findings for each of the alternatives are as follows:

- **Alt. #1: Water Efficiency Measures – Baseline (Recommended)**
- Alt. #2: Increase Normandy Reservoir Release to Meet Columbia Constraint Without Raising Dam or Pool Levels – Backup (does not provide "new" water)
- **Alt. #3: Regional Drought Management Plan – Baseline (Recommended)**
- **Alt. #4: Optimize Releases from Normandy Reservoir – Baseline (Recommended)**
- Alt. #5: Raise Normandy Reservoir Winter/Spring Pool Level Without Raising Dam – Cornerstone (difficult to obtain property or acquire easements in timely manner and may be similar in cost to Alt. #9)
- Alt. #6: Modify Normandy Flood Rule Curve (Early Refill) – Combined with Alt. #5
- Alt. #7: Reduce Irrigation Withdrawals – Fatally Flawed (no added reliable capacity)
- Alt. #8: Modify River Constraints to Preserve Storage in Normandy Reservoir – Backup (no indication that agencies will change river flow constraints)
- **Alt. #9: Raise Normandy Dam – Cornerstone (Recommended)**
- Alt. #10: Improve DRUC Intake - Combined with Alt. #2
- Alt. #11: Construct Second DRUC Intake – Combined with Alt. #2
- Alt. #12: Construct Fountain Creek Reservoir and Pipe Raw Water to Columbia WTP – Highly

Unlikely (permitting obstacles)

- Alt. #13: Construct Fountain Creek Reservoir with Downstream Release – Highly Unlikely (permitting obstacles)
- Alt. #14: Upgrade Existing Columbia City Dam to Allow Releases – Fatally Flawed (no added reliable capacity)
- Alt. #15: Monsanto Lake (Existing Offstream Storage Reservoir) – Cornerstone (less reliable and less expensive compared to Alt. #24)
- Alt. #16: Utilize Quarries – Backup (relatively small storage volume)
- Alt. #17: Construct Pipeline from Tennessee River to Columbia WTP – Highly Unlikely (high cost and energy requirements associated with long pipeline)
- Alt. #18: Construct Pipeline from Tims Ford Reservoir – Highly Unlikely (complex permitting and significant opposition)
- Alt. #19: Convey Arnold Cooling Water to Normandy Reservoir – Backup (potential lack of control makes this poor fit for cornerstone)
- Alt. #20: Purchase Water from Nearby Systems – Highly Unlikely (potential high cost due to infrequent use and lack of control)
- Alt. #21: Utilize Groundwater Sources – Fatally Flawed (no added reliable capacity)
- Alt. #22: Pump Treated Wastewater from Columbia WWTP to Below Columbia Dam – Highly Unlikely (potential permitting obstacles due to relocation of Columbia WWTP discharge upstream)
- Alt. #23: Construct New Intake for Maury County at River Mile 163 – Fatally Flawed (no added reliable capacity)
- **Alt. #24: Construct Water Intake near Williamsport and Pump Back to Columbia WTP – Cornerstone (Recommended)**
- Alt. #25: Construct New Intake for Maury County at River Mile 108 and Pump Back to Columbia Dam Pool – Highly Unlikely (Alt. #24 is similar and is a better option)
- Alt. #26: Construct Infrastructure to Return Treated Wastewater from Tullahoma WWTP to Normandy Reservoir – Highly Unlikely (difficult permitting)

Using the evaluation criteria and working closely with stakeholders, the Strategic Planning Team identified and recommended implementation of the following non-structural and structural measures:

- Alt #1 - Develop a regional drought management plan.
- Alt. #3 - Implement a water use efficiency program.
- Alt. #4 - Optimize releases from Normandy Reservoir to preserve storage in the reservoir for when it is most needed.
- Alt. #9 - Raise Normandy Dam without raising the Summer/Fall pool. This approach increases water storage for use during droughts and enhances flood protection while minimizing environmental impacts.
- Alt. #24 - Relocate Columbia's water withdrawal to a new intake approximately 25 miles downstream where there is adequate flow during droughts to satisfy projected needs.

Suggested ways of meeting the anticipated need for additional water supply in the Maury / southern Williamson County Water Service Area (Duck River DEIS, 2000)

Suggestions within the Maury / southern Williamson County Water Service Area

- Finish Columbia Dam
- Build Fountain Creek Reservoir (at elev. 630)
- Build some other full-pool reservoir in the area
- Build a run-of-the-creek reservoir on Fountain Creek (elev. 600)
- Increase capacity of the pool upstream from the existing Columbia City dam
- Construct a water intake at River Mile 163 to supply the Maury County and southern Williamson County water systems
- Construct a water intake at River Mile 108 to help supply this service area
- Ground water – intercept 5 to 10 cfs loss along Duck River
- Improve the river habitat downstream from River Mile 133 and request a waiver from the State for that reach during droughts (down to 80 cfs)
- Discharge the Columbia wastewater closer to the water intake
- Pump water downstream for the sewage outfall to the Columbia City damn pool
- Recycle wastewater
- Go to a closed-loop system at Columbia

Suggestion within the Duck River Watershed

- Higher discharge from Normandy Reservoir
- Re-evaluate Normandy curve guide
- Raise Normandy pool elevation
- Build off-stream storage to harvest flood water (active or passive filling)
- Raise and repair Lillard Mill dam to augment its use as a source
- Relocate the Lewisburg wastewater outfall to the Duck River
- Drill wells in the watershed
- Reduce irrigation withdrawals and develop a plan to compensate farmers
- Require industrial water conservation
- Require return of all withdrawals from the Duck River
- Impose mandatory reductions during droughts
- Water conservation through pricing and other measures; withdrawal charges
- Water rates – Jack price up past 7000 gpd use; index to rainfall records
- Promote better cooperation between water systems (consolidations?)
- Water allocation formula – consensus approach
- Manage future growth; recognize water limits
- Restrict future growth
- Educate the public about the integrated nature of water use
- Establish an (annual) intensive water use / availability assessment program

Suggestions Involving a Wider Area

- Pipe water in from some other source (inter-basin transfer)
- Pipeline between Tims Ford and Normandy Reservoirs
- Discharge Arnold Engineering cooling water into Duck
- Buy water from nearby systems
- Search for nearby groundwater sources

Draft Summary of Water Supply Alternatives Matrix ("Required Alternatives" shaded in green, "Baseline Alternatives" shaded in yellow, "Fatally Flawed Alternatives" shaded in purple) – Workshop No. 4

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
1	Water Efficiency Measures **(BASELINE)**	Better management of water including water conservation, public outreach, system optimization, water reuse, etc. Full cost pricing of water including setting rates to reflect the full cost of service to help utilities capture the actual cost of operating water systems, raise revenues and help conserve water. Efficient water use including reducing leaks, metering, building retrofits, water sensing fixtures, irrigation systems, rainwater harvesting, etc. Watershed approaches including source water protection, return water to river, etc.	- Satisfies a portion of 32 mgd river deficit in 2060. - In aggregate, Water Efficiency Measures likely reduce water demands by 5% to 10% of total unrestricted demand. - Continued reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- No change.	$??	- Public acceptance could delay implementation of certain water efficiency measures. - Minimal permitting, property acquisition or constructability issues. - Voluntary participation required by customers for certain water efficiency measures.	- Alternative can be implemented in multiple phases.	- Water Efficiency Measures can reduce water supply withdrawals and thereby provide environmental benefits.	- No recreational benefits or impacts.
2	Increase Normandy Reservoir Release to Meet Columbia Constraint Without Raising Dam or Pool Levels and Improve DRUC Intake **(UNDETERMINED)**	Modify Normandy Reservoir release protocol to increase releases during low flow conditions (i.e., drought events) to meet the 64 mgd (100 cfs) constraint at the Columbia gage. This alternative does not include raising the Normandy Dam height or pool levels. Improvement to the existing DRUC intake are proposed to allow access to water below the current low water level threshold (approximately 840 ft) in the event that the water levels in Normandy Reservoir drop below the future levels predicted for 2007 drought conditions (roughly 851 ft).	- Satisfies entire river deficit of 32 mgd in 2060. - Compared to 2010 conditions, release from Normandy Reservoir to meet Columbia constraint in 2060 results in approximately 3 ft lower water levels in Normandy Reservoir under conditions of 2007 drought and 2060 water demands. Three feet is considered to be the minimum reduction or best case condition under ideal modeling and river conditions. - Continued reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- No change.	$4 million (project cost)	- EA or EIS involving detailed environmental studies of flow alteration will be required. Likely would require ESA Section 7 consultation with USF&WS. - Intake modifications would require TVA 26a permit and NEPA compliance, Corps Section 404/Section 10 permit NWP or IP, and TDEC Section 401 Certification.	- Alternative can be implemented in multiple phases.	- Need to identify if increased release has significant impact/ environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- Lower water levels in Normandy Reservoir as a result of satisfying constraint at Columbia (maximum of 3 ft additional drawdown during critical drought and 2060 demands is best case condition based on ideal modeling and river conditions) could further impact recreation during drought.
3	Regional Drought Management Plan **(BASELINE)**	Develop drought management plan that reflects both human and environmental uses of flow. Drought Plan will identify triggers or actions to be taken during drought conditions based on numerous factors which could include time of year, reservoir water levels, groundwater conditions,	- Drought management planning could involve demand management during droughts that could extend the supply availability. Could also involve reduced releases during initial stages of	- No change.	$??	- EA or EIS involving detailed environmental studies of flow alteration will be required. Likely would require ESA Section 7 consultation with USF&WS. - Requires participation	- Alternative can be implemented in multiple phases.	- Need to identify if increased release and modified operating protocol has significant impact/	- Benefits or impacts to recreation associated with changes in reservoir operation are uncertain.

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
		downstream flow conditions, etc. Consequently, the Drought Management Plan would consist of a package of alternatives and would define the timing and trigger for enacting elements of alternatives such as water use restrictions, reductions in releases from Normandy Reservoir, etc.	droughts for use at latter stages of drought. Amount of impact to be determined in proposed Drought Management Plan. - Continued reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.			and actions from State agencies.		environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	
4	Optimize Releases from Normandy Reservoir **(BASELINE)**	Install stream gages and modify dam controls as needed to allow releases from Normandy Reservoir to more closely match flow requirements at Shelbyville. Alternative preserves storage at initial stages of drought and allows for releases in latter stages when lower flow conditions occur.	- Projected deficits used in this study were computed assuming optimization of releases from Normandy Reservoir. - Continued reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- No change.	$??	- No change in operating rules.	- Alternative can be implemented in multiple phases.	- Need to identify if reduced release during initial stages of drought has significant impact/ environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- Preserves pool storage for recreation in Normandy Reservoir due to ability to match required release.
5	Raise Normandy Reservoir Winter/Spring Pool Level without Raising Dam **(UNDETERMINED)**	Raise Normandy Reservoir Winter/Spring pool level from 864 ft to 869 ft to preserve water storage from Winter/Spring pool for human and environmental needs during drier Summer/Fall months. This alternative would need to be combined with a modified release from Normandy Reservoir to satisfy the projected deficit of the downstream users. Cost includes an allowance for acquisition of 2000 acres of flood prone land downstream of Normandy Reservoir (delineation of flood prone areas is needed).	- Satisfies entire river deficit of 32 mgd in 2060. - Increases water supply storage by approximately 5 BG, exceeding the 2-3 BG of storage needed at Normandy Reservoir to meet the 1.4 BG constraint at Columbia in 2060. Reduces flood storage volume by roughly 5 BG. - Continued reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- No change.	$15 million (project cost) Cost includes an allowance for acquisition of 2000 acres of flood prone area downstream of Normandy Reservoir that may be required.	- EA or EIS involving detailed environmental studies of flow alteration will be required. Likely would require ESA Section 7 consultation with USF&WS. - May require land acquisition in flood prone areas downstream of dam.	- Alternative can be implemented in multiple phases.	- Potential negative impacts on stream due to higher frequency of flooding.	- Preserves pool storage and extends recreation in Normandy Reservoir during drought due to higher water levels.
6	Modify Normandy Reservoir Flood Rule Curve **(COMBINED WITH ALT. 5)**	Initiate refill of Normandy Reservoir earlier in the Spring (say February 1st instead of March 1st) in order to capture high Spring flows and refill prior to dry weather conditions which begin in June. This alternative would need to be combined with a modified release from Normandy Reservoir to	- No added reliable capacity. - Increases storage for water supply by capturing high spring flood flows. Risk associated with potential for no storm event in Normandy	- No change.	Not applicable.	- EA or EIS involving detailed environmental studies of flow alteration will be required. May require ESA Section 7 consultation with USF&WS. - May require land	- Alternative can be implemented in multiple phases.	- Downstream restrictions could be an issue but this alternative is better for reservoir biota. Objective is to	- Preserves pool storage and extends recreation in Normandy Reservoir during drought due

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
		satisfy a portion of the projected deficit of the downstream users. This alternative could be combined with other alternatives involving modification of the operating rule curve at Normandy Reservoir.	Reservoir drainage area between February 1st and March 1st. - Reduces volume of flood storage between February 1st and March 1st. - Continued reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.			acquisition in flood prone areas downstream of dam.		fill it and maintain a steady pool level in the reservoir for spawning.	to higher water levels.
7	Reduce Irrigation Withdrawals **(FATAL FLAW)**	Reduce irrigation withdrawals and develop a plan to compensate farmers or provide water storage for use during drought conditions.	- No added reliable capacity. - Withdrawals could be significant for short term (i.e., a few days) but cannot be defined because irrigation withdrawals are not restricted and effectiveness of incentives will have to be based on voluntary participation.	- No change.	Not applicable	- Delays in implementation possible due to need for voluntary participation. - Requires legislative action.	- Alternative can be implemented in multiple phases.	- Not applicable.	- No recreational benefits or impacts.
8	Modify River Constraints to Preserve Storage in Normandy Reservoir **(UNDETERMINED)**	Modify flow constraints at Columbia by changing instantaneous requirement of 100 cfs to weekly average (or similar) or by reducing 100 cfs instantaneous flow requirement.	- Potential to satisfy entire river deficit of 32 mgd in 2060. - Reduced releases during droughts which preserves storage for use at latter stages of drought. - Continued reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- Raw water quality could improve if wastewater discharge treated to a higher level.	$2 million (project cost)	- EA or EIS involving detailed environmental studies of flow alteration will be required. May require ESA Section 7 consultation with USF&WS.	- Alternative can be implemented in multiple phases.	- Environmental benefits associated with improvements in level of wastewater treatment.	- Preserves pool storage and extends recreation in Normandy Reservoir during drought due to higher water levels.
9	Raise Normandy Dam (Increase Winter/Spring Pool and Retain Summer/Fall Pool Level) **(REQUIRED)**	Increase the height of Normandy Dam and Winter/Spring pool level by 5 ft (i.e., increase flood pool from 880 ft to 885 ft, retain Summer/Fall pool at 875 ft, and increase Winter/Spring pool from 864 ft to 869 ft). Increase releases from Normandy Reservoir to meet needs at Shelbyville and Columbia.	- Satisfies entire river deficit of 32 mgd in 2060. - Increases storage by approximately 5.5 BG. - No impact on flood storage volume. - Continued reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- No change.	$15 million to $30 million (project cost) Range of cost depends on need to raise roads and bridges, etc.	- EA or EIS involving detailed environmental studies of flow alteration will be required. May require ESA Section 7 consultation with USF&WS. - Inundated streams and wetlands would require TDEC ARAP and Antidegradation analysis. - Short Springs (State Designated Natural	- No flexibility to phase implementation for construction, but could phase increases in pool level.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- Potential impacts to campgrounds and boat ramps would be minimized by retaining Summer/Fall Pool level. - Upgrades to existing 30-year old campground

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
						Area) major issue. - Loss of shoreline vegetation. - If action requires placement of dredged or fill material, Corps Section 404 permit required. Must be shown to be LEDPA pursuant to 404(b)(1).			facilities, beaches and boat ramps.
12	Construct Fountain Creek Reservoir and Pipe Raw Water to Columbia WTP **(REQUIRED)**	Construct a dam on Fountain Creek 0.2 miles upstream of confluence with Duck River at River Mile 146. At this location, the watershed drainage area for Fountain Creek Reservoir is 102 square miles. The inundated area of the reservoir under normal pool level is approximately 2,200 acres. Alternative includes construction of 32 mgd reservoir intake and pumping station, a 42-inch pipeline to a treatment plant (5 miles) and a continuous downstream release of 5 cfs.	- <u>Satisfies entire river deficit of 32 mgd in 2060.</u> - 48 mgd yield based on 2000 PEIS. - Potential for significant water loss from reservoir due to karst geology. - Direct ownership maximizes control of supply. - Direct connection between reservoir and Columbia WTP assures delivery of required supply (eliminates potential for loss of raw water or other needs in Duck River between Normandy Reservoir and Columbia). - Reduces reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- Shallow reservoir with long residence time yields high potential for nutrient enrichment, low dissolved oxygen, and water quality issues based on 2000 PEIS. - Construct a multi-port intake to obtain highest quality water. - Fountain Creek watershed contains high levels of nutrients. - Potential to discharge high temperature and low DO water to free flowing segment of Duck River. - Two 303(d) listed streams drain to Fountain Creek. Stream listing due to municipal/industrial landfills (Cedar Ridge Landfill and other landfill are regulated by solid waste). - Basin management plan may be required to minimize watershed impacts on reservoir water quality.	$70 million (project cost)	- EIS involving detailed environmental studies will be required and ability to obtain necessary permits is uncertain. - 2000 PEIS identified potential impacts on species diversity, wetlands, and T&E species habitat. - Potential substantial loss of forested wetlands (225 acres). - Inundation of Fountain Creek will alter ecology of the impounded tributary. - Need field determination of wetland impacts and development of a mitigation plan. - Need to establish release downstream of dam. - Rare, threatened, or endangered species may exist in Fountain Creek. - Corps Section 404 IP required. Must be found to be LEDPA pursuant to 404(b)(1). - TDEC Section 401 certification.	- No flexibility to phase implementation.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- Inundation of Fountain Creek results in loss of riverine environment on Fountain Creek and land on Game Reserve. - Potential for fishing and other recreational opportunities associated with Fountain Creek Reservoir.
13	Construct Reservoir on Fountain Creek with Downstream	Construct dam on Fountain Creek just upstream of confluence with Duck River at River Mile 146. Alternative includes construction of	- <u>Satisfies entire river deficit of 32 mgd in 2060.</u> - 48 mgd yield based on 2000 PEIS.	- Shallow reservoir with long residence time yields high potential for nutrient	$43 million (project cost)	- TVA lead agency EIS involving detailed environmental studies will be required and	- No flexibility to phase implementation.	- No apparent environmental benefits associated with	- Inundation of Fountain Creek results in loss of

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
	Release **(UNDETERMINED)**	32 mgd reservoir intake and a continuous downstream release of 5 cfs. Storage in Fountain Creek Reservoir is released downstream to the existing Columbia Pool for withdrawal at the existing Columbia intake.	- Potential for significant water loss from reservoir due to karst geology. - Direct ownership maximizes control of supply. - Release proximate to Columbia Dam Pool enhances reliability of delivery of required supply (eliminates potential for loss of raw water or other needs in Duck River between Normandy Reservoir and Columbia). - Reduces reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	enrichment, low dissolved oxygen, and water quality issues based on 2000 PEIS. - Construct a multi-port intake to obtain highest quality water. - Fountain Creek watershed contains high levels of nutrients. - Potential to discharge high temperature and low DO water to free flowing segment of Duck River. - Two 303(d) listed streams drain to Fountain Creek. Stream listing due to municipal/industrial landfills (Cedar Ridge Landfill and other landfill are regulated by solid waste). - Basin management plan may be required to minimize watershed impacts on reservoir water quality.		ability to obtain necessary permits is uncertain. - 2000 PEIS identified potential impacts on species diversity, wetlands, and T&E species habitat. - Potential substantial loss of forested wetlands (225 acres) - Inundation of Fountain Creek will alter ecology of the impounded tributary. - Need field determination of wetland impacts and development of a mitigation plan. - Need to establish release downstream of dam. - Rare, threatened, or endangered species may exist in Fountain Creek. - Corps Section 404 IP required. Must be found to be LEDPA pursuant to 404(b)(1). - TDEC Section 401 certification.		hydrologic regime, physical habitat, water quality and biota.	riverine environment on Fountain Creek and land on Game Reserve. - Potential for fishing and other recreational opportunities associated with Fountain Creek Reservoir.
14	Upgrade Existing Columbia City Dam to Allow Releases **(FATAL FLAW)**	Install valves or gates in the existing Columbia Dam to allow intermittent releases downstream of the dam to temporarily maintain flow constraint at Columbia with refill of the Columbia Reservoir occurring from releases from Normandy Reservoir, releases from quarry storage, or from the Duck River watershed.	- No added reliable capacity.	- Potential impact due to release of sediments downstream of the dam. - Requires review of data on sediment accumulation behind dam and the need for dredging.	Not applicable	- EIS involving detailed environmental studies of flow alteration will be required and ability to obtain necessary permits is uncertain.	- No flexibility to phase implementation.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.
15	Monsanto Lake (Existing Offstream Storage Reservoir) **(UNDETERMINED)**	Purchase Monsanto Lake which is a 5 BG offstream storage reservoir along Duck River approximately 8 miles northwest of Columbia. Utilize existing Columbia intake, upgrade existing Columbia pumping station, and construct 42-inch pipeline (10 miles) from reservoir to Columbia	- 5 BG of new storage delivered directly to Columbia satisfies minimum 1.4 BG river deficit at Columbia in 2060. - Direct ownership maximizes control of	- Construct a multi-port intake in the reservoir to obtain highest quality water.	$45 million (project cost) Cost includes an allowance of $7 million for potential improvement	- Pipeline crossing of jurisdictional waters subject to Section 404, TDEC 401 certification, and TVA 26a review.	- Alternative can be implemented in multiple phases.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water	- Potential for fishing and other recreational opportunities associated with offstream

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
		WTP to convey water from reservoir to WTP and to refill reservoir from the Duck River.	supply. - Direct connection between reservoir and Columbia WTP assures delivery of required supply (eliminates potential for loss of raw water or other needs in Duck River between Normandy Reservoir and Columbia). - Reduces reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.		s to dam and spillway that may be required.			quality and biota.	storage reservoir.
16	Utilize Quarries **(UNDETERMINED)**	Utilize storage in existing inactive Hardison Mills Quarry (300 MG) to supply flow to Duck River during low flow conditions. Construct 5 mgd intake and pumping station on the Duck River, 16-inch pipeline from Duck River to quarry (1300 ft), and 5 mgd intake and pumping station at quarry. Use quarry water storage to augment flows in the Duck River during low flow conditions to meet Columbia constraint and refill quarry by "skimming" water from the Duck River during high flow conditions.	- Existing Hardison Mills Quarry is located along the Duck River upstream of Columbia and satisfies 0.3 BG of roughly 2 BG river deficit at Columbia in 2060. - Reduces reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- Need to construct multi-port intake or floating intake to allow withdrawal of appropriate temperature water from storage.	$4 million (project cost)	- Would have to demonstrate that quarry water was not connected to Duck River baseflow (groundwater). - Intake and pumping station on Duck River would require Section 10 /Section 404 permit – Section 404(b)(1) compliance. TDEC 401 certification and Antidegradation review. TVA 26a permit required.	- No flexibility to phase implementation. Numerous quarries along the Duck River that could be added in the future as they become inactive.	- Utilizing quarries protects quarry site from illicit dumping or other uses that could impact water quality.	- No recreational benefits or impacts.
17	Construct Pipeline from Tennessee River to Columbia WTP **(REQUIRED)**	Construct 32 mgd intake and pumping station and 42-inch pipeline from Tennessee River near I-40 crossing to Columbia WTP (60 miles). Additional piping could be constructed in the future to extend supply to other utilities.	- Satisfies entire river deficit of 32 mgd in 2060. - Drought proof and highly reliable. - Potential for future increases in supply. - Reduces reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- No change.	$165 million (project cost)	- Pipeline crossing of jurisdictional waters subject to Section 404, TDEC 401 certification, and TVA 26a review. Intake and pumping station on Tennessee River would require Section 10/Section 404 permit – Section 404(b)(1) compliance. TDEC 401 certification and Antidegradation review. TVA 26a permit required. - Potential to artificially extend range of exotic species or increase the likelihood that exotic species could invade these watersheds.	- Could be constructed in stages starting in Columbia and working toward the Tennessee River.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.
18	Construct Pipeline from Tims Ford Reservoir	Construct 10 mgd intake and pumping station at Tims Ford and 24-inch pipeline from Tims Ford	- Satisfies entire river deficit of 32 mgd in 2060. - Drought proof and highly	- Need to construct multi-port intake to allow withdrawal of	$25 million (project cost)	- Pipeline crossing of jurisdictional waters subject to Section 404,	- No flexibility to phase implementation.	- No apparent environmental benefits	- No recreational benefits or

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
	(REQUIRED)	Reservoir to DRUC WTP or intake (16 miles). This alternative would need to be combined with a modified release from Normandy Reservoir to satisfy the projected deficit of the downstream users.	reliable. - Potential for future increases in supply. - Provides emergency backup source of supply for DRUC customers if Normandy Reservoir water is unavailable. - Supplying 2-3 BG of storage to Normandy Reservoir during critical drought in 2060 from Tims Ford Reservoir would result in a drop in water level in Tims Ford Reservoir of approximately 12-16 inches.	appropriate temperature and quality of water from Tims Ford.		TDEC 401 certification, and TVA 26a review. Intake and pumping station on Tims Ford would require Section 10/Section 404 permit – Section 404(b)(1) compliance. TDEC 401 certification and Antidegradation review. TVA 26a permit required. - Need to address interbasin transfer concerns. - Potential to artificially extend range of exotic species or increase the likelihood that exotic species could invade these watersheds.		associated with hydrologic regime, physical habitat, water quality and biota.	impacts likely due to maximum water level drop of 8 inches during critical drought.
19	Convey Arnold Cooling Water to Normandy Reservoir (UNDETERMINED)	Construct a 24-inch pipeline (7 miles) to convey cooling water from the cooling lake at Arnold AFB to a pipeline which discharges directly to Normandy Reservoir. Cooling lake obtains water pumped from Woods Reservoir (approximately 25 BG total storage) which was constructed exclusively for water supply (1 mgd) and cooling water for Arnold AFB and its operation is controlled by Arnold AFB. Water from the Woods Reservoir system is treated and supplied to the AFB for drinking and other potable water needs.	- Adequate storage in Woods Reservoir to satisfy 2-3 BG of storage needed at Normandy Reservoir to meet 1.4 BG deficit at Columbia in 2060. - Arnold AFB would need to identify any restrictions on use to assess reliability.	- Need to define source and location of water contamination.	$8 million (project cost)	- Pipeline crossing of jurisdictional waters subject to Section 404, TDEC 401 certification, and TVA 26a review. - TVA NEPA compliance required, EA/EIS, TDEC ARAP, and Antidegradation review.	- No flexibility to phase implementation.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.
20	Purchase Water from Nearby Systems (UNDETERMINED)	Construct 42-inch finished water pipeline from Nashville to Columbia (50 miles).	- No added reliable capacity. - Serious concerns regarding access to reliable capacity. - Requires an interbasin transfer.	- No change.	$??	- Pipeline crossing of jurisdictional waters subject to Section 404, TDEC 401 certification, and TVA 26a review. - Requires TDEC interbasin transfer permit.	- No flexibility to phase implementation.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.
21	Utilize Groundwater Sources (FATAL FLAW)	Construct new groundwater wells or access underground flow for the Duck River between Shelbyville and Columbia.	- No added reliable capacity. - Serious concerns regarding access to reliable groundwater sources.	- No change.	Not applicable	- EIS involving detailed environmental studies of flow alteration will be required and ability to obtain necessary permits is uncertain.	- Alternative can be implemented in multiple phases.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
22	Pump Treated Wastewater from Columbia WWTP to Columbia Dam **(UNDETERMINED)**	Construct a 20 mgd pumping station at the Columbia WWTP and a 36-inch pipeline (5 miles) to return treated wastewater from the Columbia WWTP to a location just downstream of the existing Columbia Dam. Pumping flow back to the location downstream of the Columbia Dam would only be required under this alternative during low flow conditions in the Duck River.	- Satisfies 20 mgd of 32 mgd river deficit in 2060. - Drought proof and highly reliable. - Capacity increases over time. - Reduces reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- Must meet TDEC water quality requirements for discharge. - Higher levels of treatment may be needed to avoid impacts on raw water quality immediately downstream of dam where threatened and endangered species exist.	$14 million (project cost) Potential costs which might be required for a higher level of wastewater treatment not included.	- Pipeline crossing of jurisdictional waters subject to Section 404, TDEC 401 certification, and TVA 26a review. - TDEC may not permit or may require a higher level of treatment of wastewater. - Potential impact to threatened and endangered mussels immediately downstream of existing Columbia Dam.	- High level of flexibility in that capacity can be increased over time.	- Potential environmental benefit if higher level of treatment is provided for Columbia WWTP discharge to meet assimilative capacity requirements just downstream of Columbia Dam.	- No recreational benefits or impacts.
23	Construct Water Intake for Maury County at River Mile 163 **(FATAL FLAW)**	Construct a 32 mgd water intake on Duck River at River Mile 163 and a 42-inch pipeline (24 miles) for Maury and South Williamson Counties (Columbia gage is at River Mile 132 which is roughly 30 river miles downstream).	- No added reliable capacity.	- No change.	Not applicable	- TDEC permit needed for water supply withdrawal but ability to obtain necessary permits is likely.	- No flexibility to phase implementation.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.
24	Construct Water Intake near Williamsport and Pump Back to Columbia WTP **(REQUIRED)**	Construct a 32 mgd water intake and pumping station on Duck River in vicinity of River Mile 108 near Williamsport and a 42-inch pipeline (17 miles) to convey water to the Columbia water treatment plant.	- Satisfies entire river deficit of 32 mgd in 2060. - Drought proof and highly reliable. - Minor reduction in downstream flows due to consumptive uses in the Maury and South Williamson County water systems. - Reduces reliance on Normandy Reservoir (208 sq mi drainage area) as sole source of water during severe droughts to satisfy many needs.	- No change.	$56 million (project cost)	- Pipeline crossing of jurisdictional waters subject to Section 404, TDEC 401 certification, and TVA 26a review. - Lower downstream flows not likely to cause adverse impacts on aquatic life.	- No flexibility to phase implementation but alternative could ultimately be a component of the Tennessee River pipeline alternative.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.
25	Construct Water Intake near Williamsport and Pump Back to Columbia Dam Pool **(UNDETERMINED)**	Construct a 32 mgd water intake and pumping station on Duck River in vicinity of River Mile 108 near Williamsport and a 42-inch pipeline (17 miles) to convey water to the pool behind the existing Columbia Dam.	- Satisfies entire river deficit of 32 mgd in 2060. - Drought proof and highly reliable. - Minor reduction in downstream flows due to consumptive uses in the Maury and South Williamson County water systems. - Reduces reliance on Normandy Reservoir (208 sq mi drainage	- No change.	$56 million (project cost)	- Pipeline crossing of jurisdictional waters subject to Section 404, TDEC 401 certification, and TVA 26a review. - Lower downstream flows not likely to cause adverse impacts on aquatic life.	- No flexibility to phase implementation but alternative could ultimately be a component of the Tennessee River pipeline alternative.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.

No.	Raw Water Source (Workshop #3 Status)	Description	Evaluation Criteria						
			Reliable Capacity	Raw Water Quality	Cost (Order of Magnitude Concept Level Estimates)	Implementability	Flexibility	Environmental Benefits	Recreation
			area) as sole source of water during severe droughts to satisfy many needs.						
26	Construct Infrastructure to Return Treated Wastewater from Tullahoma WWTP to Normandy Reservoir **(UNDETERMINED)**	Construct 10 mgd pumping station and 24-inch pipeline (9 miles) to return treated wastewater from Tullahoma WWTP to Normandy Reservoir. This alternative would need to be combined with a modified release from Normandy Reservoir to satisfy the projected deficit of the downstream users.	- Return flow satisfies roughly 1.5 BG of the 2-3 BG of storage needed at Normandy Reservoir to meet 1.4 BG deficit at Columbia in 2060. - Reliable 2 mgd in 2010 increasing over time to 3 mgd in 2060 as Tullahoma wastewater flow increases (assumes 70% return flow). - Slight reduction in the level of reliance on Normandy Reservoir.	- Must meet TDEC water quality requirements for discharge, but current level of treatment is apparently adequate.	$16 million (project cost) Cost includes an allowance of $4 million for higher level of wastewater treatment that may be required.	- Need to conduct studies and obtain permit for a new NPDES permit for wastewater discharge into Normandy Reservoir. - Pipeline crossing of jurisdictional waters subject to Section 404, TDEC 401 certification, and TVA 26a review.	- Flexible to accommodate increases in flow over time. - Could extend piping to Tims Ford Reservoir in future to convey flow to Normandy Reservoir.	- No apparent environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.	- No recreational benefits or impacts.

Draft Summary of Water Supply Alternatives – Compatibility Matrix

Alt. No.	Description	Highly Unlikely	Backup	Cornerstone	Alt. 5/6 Raise Normandy Reservoir Winter/Spring Pool Level without Raising Dam/Flood Rule Curve Modifications	Alt. 9 Raise Normandy Dam (Increase Winter/Spring Pool and Retain Summer/Fall Pool Level)	Alt. 15 Monsanto Lake (Existing Offstream Storage Reservoir)	Alt. 24 Construct Water Intake near Williamsport and Pump Back to Columbia WTP
2	Increase Normandy Reservoir Release to Meet Columbia Constraint Without Raising Dam or Pool Levels and Improve DRUC Intake	12	15 ✔	2	Interim Note 1	Interim Note 7	Interim Note 10	Interim Note 10
5/6	Raise Normandy Reservoir Winter/Spring Pool Level without Raising Dam/Flood Rule Curve Modifications	0	3	26 ✔	Cornerstone Note 2	Interim Note 8	Long-term Note 4	Long-term Note 4
8	Modify River Constraints to Preserve Storage in Normandy Reservoir	9	12 ✔	8	Interim Note 1	Interim Note 9	Interim Note 10	Interim Note 10
9	Raise Normandy Dam (Increase Winter/Spring Pool and Retain Summer/Fall Pool Level)	3	7	18 ✔	Incompatible Note 3	Cornerstone Note 2	Long-term Note 4	Long-term Note 4
15	Monsanto Lake (Existing Offstream Storage Reservoir)	6	6	16 ✔	Long-term Note 4	Long-term Note 4	Cornerstone Note 2	Incompatible Note 12
16	Utilize Quarries	7	18 ✔	3	Backup Note 5	Backup Note 5	Backup Note 5	Backup Note 5
19	Convey Arnold Cooling Water to Normandy Reservoir	15	13 ✔	1	Incompatible Note 6	Incompatible Note 6	Backup Note 11	Backup Note 11
24	Construct Water Intake near Williamsport and Pump Back to Columbia WTP	8	10	11 ✔	Long-term Note 4	Long-term Note 4	Incompatible Note 12	Cornerstone Note 2

Notes:

1. Alt. 2 and Alt. 8 are not compatible backups for Alt. 5/6 because raising Normandy Reservoir pool level under Alt. 5/6 adds storage which is considered an enhancement of Alts. 2 or 8. Alt. 2 or Alt. 8 could allow deferral of capital expenses for Alt. 5/6.
2. Satisfies entire deficit and is receiving further consideration as a key element of the 50-year water supply plan.
3. Approval to raise Normandy Reservoir pool level under Alt. 5/6 eliminates need to raise dam under Alt. 9.
4. Additional cornerstone could be added to meet needs beyond the 50-year planning period.
5. Alt. 16 provides relatively small part of deficit (20% or less) and needs to be combined with cornerstone.
6. Raising Normandy Reservoir pool level under Alt. 5/6 or Alt. 9 facilitates refill of reservoir in late Spring/early Summer so additional water from Alt. 19 (Arnold AFB) would be likely be spilled and therefore would provide minimal benefits.
7. Could secure approval to implement Alt. 2 more quickly than approval and construction of Alt. 9. Alt. 2 could also allow deferral of capital expenses for Alt. 9.
8. Could provide for partial raising of pool (say 1-2 ft) under Alt. 5/6 and deferral of dam raising under Alt. 9 until additional storage is needed.
9. Could secure approval to implement Alt. 8 more quickly than approval and construction of Alt. 9. Alt. 8 could also allow deferral of capital expenses for Alt. 9.
10. Alt. 2 or Alt. 8 could allow deferral of capital expenses for Alt. 15 or Alt. 24.
11. Concerns over long-term control (federally-owned) and water quality cause Alt. 19 to be viewed as backup only.
12. Duplication of benefits from cornerstone. Alts. 15 and 24 both provide all of the required water to Columbia WTP.