Appendix B-2

Tier II Alternatives Analysis-Potential Research Variables for Study

Potential Revegetation Test Variable	Test Variable Type (technical or CDOT process)	Description	Expected or Observed Result	Remarks	Scoring Average (5 best-1 worst)
REVEGETATION PROCESS					
Certification or prequalification of CDOT Revegetation Contractors	Process	Create a prequalification or certification process for Revegetation Contractors. Try to filter out companies that cannot perform proper revegetation.	Increased success by experienced companies with proper revegetation equipment.	Qualified contractors would increase positive results and would create a sense of accountability to CDOT.	5.0
Inspection of Material Application	Process	Ensures the proper application and rate of amendment, seed, mulch etc.	Increased effectiveness of existing specifications	This is needed to make sure existing specifications are being enforced.	5.0
Additional training of CDOT staff or using an outside source for inspection	Process	Provide additional training to inspectors or project engineers on what they are looking for in proper revegetation.	If more people are properly inspecting the equipment, materials and methodology used on CDOT projects there would be in an increase in revegetation success.	Existing manuals could be utilized for training	5.0
Full Time Reclamation Specialist inspector during revegetation installation	Process	Assign a qualified representative to the project area during revegetation; provide direction to Contractor; daily oversight	Better revegetation results and less Contractor short cutting	Already done by CDOT but not sure if in specifications. How do we determine qualified individual? Should have education in plant and soil science.	5.0
Seed Mix Design	Process	Make sure the seed mix is properly designed with proper species and balance. Use approximately 60 seeds per square foot (drill rate) as a general reference.	Increased success by targeting species that will thrive in post construction site conditions. Designing to achieve the proper seeds per square foot will eliminate die off from overcrowded seedlings.	A few recent CDOT mixes were evaluated and found to have very heavy seed mix rates some with rates as high as 600 seeds per square foot.	5.0
Contract mechanisms to ensure proper revegetation installation and compliance to revegetation plan	Process	Develop Contractor language to force revegetation accountability and responsibility	Develop contract language that specifies Contractor expectation and measures of success		4.7
On-Call Revegetation Maintenance Contractors	Process	Have prequalified and contracted revegetation contractors hired to be on call for touch up seeding and reveg maintenance items.	Take some pressure off of CDOT's maintenance crews and have qualified firms evaluating and maintaining challenging sites.		4.7
Correct equipment for job	Process	Spec equipment: Drill seeders, crimpers, deep rippers, cultivation, etc.	Increase efficiency of contractors and ensure that proper equipment is being used	Could eliminate low cost providers. Will eliminate low end contractors	4.7
Develop a revegetation plan	Process	Revegetation objectives, description and map of each revegetation unit, desired outcomes, noxious weed management, laws and regulations, project background, analysis and limiting factors, mitigation measures, strategy methodology, key contracts and responsibilities, budget, schedule, monitoring approach, corrective actions based upon monitoring. Region specific plans developed for reference.	A management tool for the Project Manager as well as DOT landscape/environmental representatives; identifies expected outcomes and responsibilities at a minimum. Regional plans could be more cost effective solution than site-specific plans	Andy Stecklein and Jennifer Gorek CDOT both mentioned a region specific reclamation plan.	4.7

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Project contains enough funding to stabilize soils and provide sustainable revegetation	Process	Ensures revegetation and water quality is being protected for several years after construction	Project manager and/or maintenance representatives need to know the real cost of revegetation to protect water quality and regulatory compliance	The only costs mentioned are Basis of Payments to Contractor and in 104.02 the Engineer can re-assess cost or time required.	4.7
Split Reveg Contract separate from general	Process	Temporary seeding through general on larger projects and final seeding completed by qualified revegetation contractor.	Qualified contractors performing revegetation work. Later permanent seeding.	It allows time for soil sampling of replaced soil but it also delays permanent seeding. General contractor to perform temp seeding.	4.3
Get Revegetation Contractor involved early on in the process.	Process	Get the Revegetation Contractor involved during pre-construction and lean on their knowledge of the area for value engineering or input to increase success.	Increased ownership in the project and an opportunity to increase success of the project.	More ownership to the project and allows the inspectors and engineers to set the stage for process and expectations.	4.3
Early revegetation planning	Process	Early in the construction process and revegetation is not a afterthought	Revegetation is planned for well in advance		4.3
Communication and cooperation among reclamation scientist with design engineers	Process	Reclamation Scientists and environmental representatives talk about revegetation with design engineers early in the process	Better planning and organization with will result in improved revegetation	(6) CDOT landscape Arch. and (1) Engineer involved in Project Review	4.3
Reclamation planning at the front end of projects	Process	Use qualified reclamation scientists to evaluate the sites soils and vegetation prior to construction to establish a reclamation plan	Site specific reclamation plans will increase reveg success and in some cases save money on costly operations that are not needed (i.e.. compost)	This could be an outside resource or an internal process for CDOT.	4.3
Timing of Seeding	Process	Make sure proper seeding windows are being utilized.	Increased coverage due to taking advantage of natural precipitation	Easy way to increase revegetation success	4.0
Imprint seeding	Process	Modify seeding approach to increase soil moisture content	Increased seedling establishment	Shown success in the Red desert of Wyoming	4.0
Identify clear objectives with benchmarks	process	Ensure there are objectives with performance metrics to manage revegetation	Ability to measure success or provide adaptive management for corrective actions	214.04 (a): Contractor, Eng., and CDOT Landscape Arch. conduct plant inspection. Also mention of replacing dead plants.	4.0
Companion Crop seeding	Process	Determine if companion crops help or hinder seed establishment	Reduce expensive straw mulch and erosion	Research is mixed	4.0
Compaction Relief	Process	How to measure compaction in the field? Standard pentrometers are dependent on sampling techniques	Increased reclamation success and decreased erosion	Pretty well documented	3.7
Reclamation Scientists and landscape contractor discuss revegetation approaches and commitment during Pre-Construction Meeting	Process	Reclamation scientists and environmental representatives talk about revegetation with construction project managers and engineers early in the construction process	Better planning, organization and cooperation from Contractor; ensures commitment	214.03: Planting done in accordance with good horticulture (agricultural) practices	3.7
Equipment Calibration Inspection	Process	Ensures the proper application of amendment, seed, mulch etc.	Increased effectiveness of existing specifications	This is needed to make sure existing specifications will be effective. This goes for any future specs as well.	3.3

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Consistent monitoring and maintenance	Process	Ensure revegetation approach provided by the Contractor and their subs meet the revegetation objectives; make corrective actions as necessary	Helps ensure Contractor accountability for the contact duration; allow for corrective actions if revegetation is having problems and water quality issue are a potential	Only mentions distance of plants and shrubs from pavement, nothing on how vegetation assists erosion control or specific plans to maximize planting arrangement.	3.3
Soils training	Process	Train inspectors on what to look for in proper topsoil identification and handling	Increase in suitable topsoil and decrease in amendment usage.	Results from KDOTs project have not been observed yet because the program is still in its first year.	3.0
Records of jobs	Process	Inspectors and maintenance crews inspecting and cataloging a project. GIS can map and create logs of reveg diaries.	Increased knowledge per region and a powerful database on information.	This could be more powerful than test studies over time.	2.5
Seed harvesting by botanist for native planting	Process	Collect native seed from local reference area	Collect native plant seed for improved revegetation	May be labor intensive and expensive; local group support may be advisable	2.0
Consistent landscaping over political boundaries	Process	Provide a consistent revegetation approach that will be ecologically sound and promote soil stability	Reach agreement on the revegetation approach among political stakeholders for one consistent revegetation approach		1.7
TECHNICAL					
Inventory project site for native plants, shrubs and trees for replanting	Technical	Identify plant native species specific to project area. Use inventory to establish seed mixes.	Identify native, local plants that fit the region ecology and stabilize soils	Has shown success in Oil and Gas operations	5.0
Obtain initial site/soil conditions	Technical	Evaluate soil types, chemistry, existing vegetation, solar exposure, slope, precipitation, and other limiting factors (deicing)	Provides more data to select the correct native seed species along with necessary soil augmentation elements		5.0
Salvage topsoil	Technical	Salvage topsoil prior to construction	Provides native soils from project area	Topsoil salvage has shown to increase reclamation results in the mining industry and is a BMP for most industries. Topsoil is a BMP and likely does not need further testing.	5.0
Soil Testing and Analysis	Technical	Test soils for reclamation potential	Increased reclamation success on problematic soils	Done in agriculture all the time. Can not fix the problem if we do not understand the	5.0
Site specific amendment rates	Technical	Base reclamation plan on site specific conditions	Improved conditions for reclamation		5.0
Application of Amendments	Technical	If amendments are being applied make sure they are being applied in the most effective manner (topical or incorporated)	Increased effectiveness of costly amendments.	Take advantage of amendments that are currently being used.	4.7
Organic fertilizers	Technical	Are organic fertilizers working and at what rates are they effective? Are they all created equal?	There is a cost benefit to using amendments in some situations if applied properly.	This would be a great test plot at a BMP or maintenance facility.	4.7
Species selection in seed mix	Material	Make sure plant species are site specific to increase likelihood of success.	Develop a methodology for observing and selecting proper seed mixes.	Easy way to increase revegetation success	4.3

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Proper number of seeds per square feet	Material	Make sure the proper number of seeds are being added per square foot in order to increase success	Increases chances of seedling survival and needed coverage	Easy way to increase revegetation success	4.3
Use stockpiled soils	Technical	Mostly flat areas; stockpiled top soil to depth of 6 inches and tacked with heavy equipment; native seed mix from local reference site	Use stockpiled soils with organic matter to promote revegetation; reduce import costs and noxious weed introduction	HOWEVER, no mention of OM in section 207 and Native Seeding only in non-irrigated areas in section 212.06	4.3
Use of cover crops in off season seeding	Technical	Utilize cover crops to stabilize site and then interseed into stubble in following years	Annual covers will stabilize site and then provide mulch cover for establishing natives.		4.3
Fertilization	Technical	Fertilizer rate studies	Increased weed competition, increased stand establishment, Weed management	Research is mixed	4.3
Topographical planting along roadway	Technical	Change seed mix based on distance from road and soil moisture regime	Improve reclamation success due to better plant selection	Likely not feasible due to increase cost and time. May speed reclamation and save money if done properly.	4.0
Chemical Soil Amendments	Technical	Addition of soil amendments to alter soil chemistry	Increased reclamation success on degraded soil chemistry sites	Research shows improved reclamation results	4.0
Organic Amendment applications (Compost and BioChar)	Technical	Add organic material to reestablish soil characteristics, microbial activity, soil moisture characteristics and aggregate stability.	Increased seedling establishment	Up and coming research has a sustainability aspect	3.3
Soil Pitting/Micro Pocketing on Steep Slopes	Technical	Creating micro environments to hold water and shade seedlings to increase revegetation success.	Increased success in some challenging sites.		3.0
Supplemental Watering	Process	Addition of watering in contracts to help establish cover quickly. Utilize temp irrigation to increase reveg. Success and decrease amount of time needed for 70% establishment	Increased up front cost with quicker permit release. Would need to look at ROI. This could be practical on some sites and impractical on others.	This would be an effective but expensive way to quickly establish cover. Temp irrigation can range between $.06 a sf to $.30 a sf based on location.	3.0
Use salt tolerant native species	Technical	Identify salt tolerant native species that fit the eco-region	Improved chances for revegetation in saline soils	Table in 212.02 states max EC for mulch. Only mention of salts. Need to understand salts used for deicing	3.0
Mycorrhizae Inoculation	Technical	Inoculate soil with mycorrhizae	Increased reclamation success for plants that are susceptible to mycorrhizae invasion	Has shown good results in many studies	3.0
Compost Tea	Technical	Effluent from fermented compost	Increase reclamation success	Unknown	3.0
Weed Free Straw Specifications	Technical	Ensure all weed free straw meets minimum requirements for use. Wheat straw with sufficient length to crimp is becoming difficult to find due to the advent and use of rotary combines. Need to make sure all straw length is a minimum of 6 inches	Increase reclamation success and stabilization	It is known that straw less than 6 inches in length can be difficult to adequately crimp.	2.3

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Compost berm to replace silt fencing onto rocky soils	Technical	Import in compost dirt material and stabilize to replace silt fencing	Prevent soil erosion and transport using a LID approach; difficult or impossible to trench in silt fencing in some areas		1.7
Blown in place compost over rip-rap	Technical	Used for steep slopes; compost can be made up of recycled organics containing beneficial bacterial and mycorrihizal fungi, and binding agent; mixed with native seed, tackifier use	Promote short and long term stabilization especially on steep slopes	Use of compost was 5X more expensive than traditional hydro seeding ($0.15/sf versus $0.03/sf); may be cost effective on steep slopes within sensitive environments like river systems	1.7
Rock mulch	Technical	On steep slopes, 4-6 inch diameter rocks spread over the entire slope; depth of rock was 12 inches; hydro seed mixture of woody shrubs; 30#/acre; annual grasses at 8#/acre; bonded fiber matrix sprayed t secure seeds. Perennial grasses suggested. Flush slope with water to fill voids with applied dirt/compost	Promote short and long term stabilization especially on steep slopes	May have initial aesthetic concerns	1.7
PAM	Technical	Add PAM to other soil amendments to increase site stabilization	Help aggregate soil and stabilize site until vegetation can be established	Could be inexpensive soil stabilization technique	1.7

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